

Soil Pollution

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What Is Soil?

- Biologically active, complex mixture of:
 - ❖ Mineral matter : sand, silt and clay
 - ❖ Organic materials: appreciable quantities of nitrogen, phosphorus and sulfur
 - ❖ Air and water : occupy the pore spaces in soils

Important Gases in Soil

Oxygen

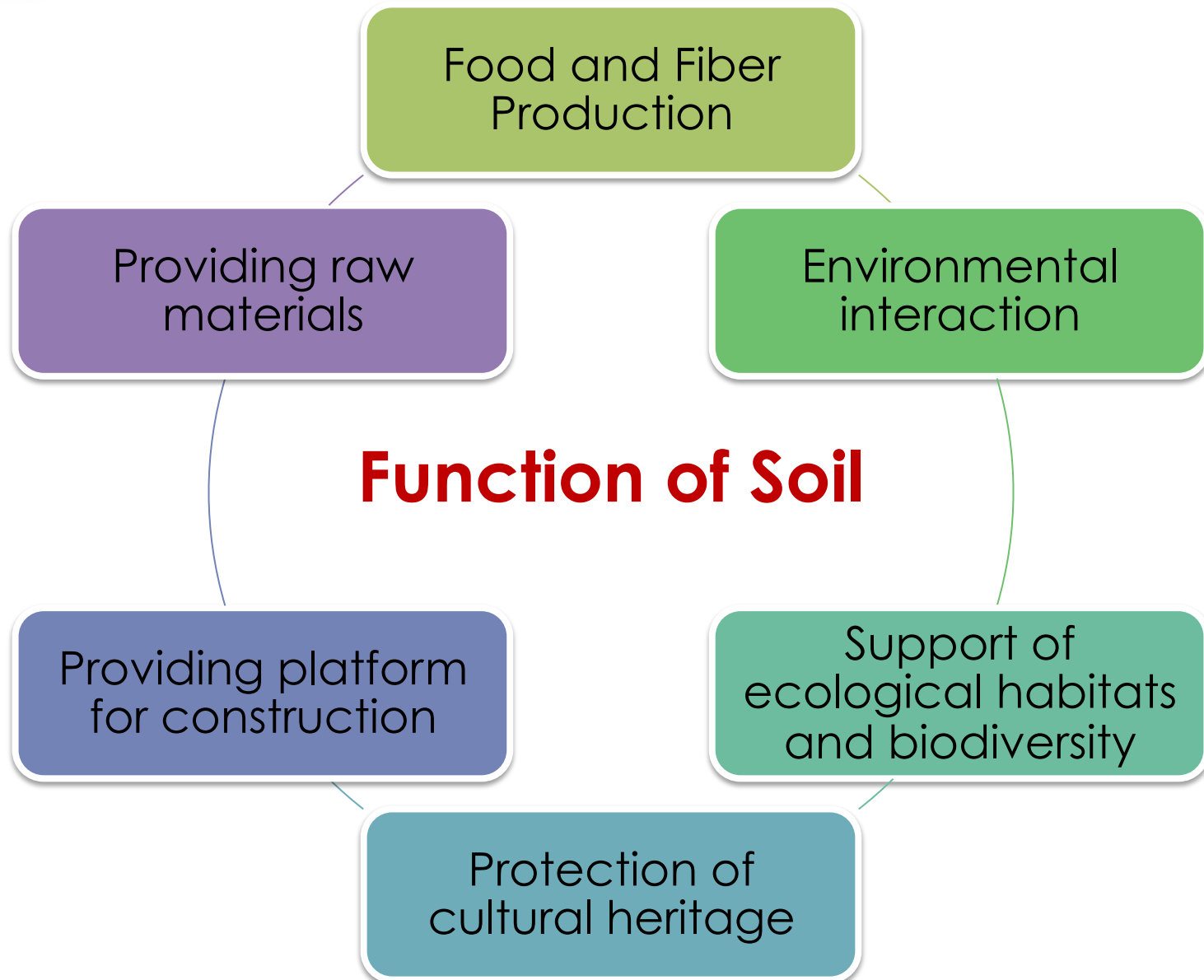
- Required by soil organism for respiration

Nitrogen

- Required by nitrogen fixing bacteria

Carbon Dioxide

- Involved in weathering
- $\text{CO}_2 + \text{H}_2\text{O} = \text{H}_2\text{CO}_3$ (weak carbonic acid)



Soil Contamination

Soil contamination can be caused by either liquid or solid **hazardous substances**. Usually, contaminants in the soil are physically or chemically **attached** to soil particles, or, if they are not attached, are **trapped** in the small spaces between soil particles.

Soil contamination (soil pollution) is caused by the presence of **human-made** (xenobiotic) chemicals or other **alteration** in the natural soil environment

Sources of Soil Contamination

Rupture of
underground
storage tank

Application of
pesticides

Percolation of
contaminated
surface water to
surface strata

Oil and fuel
dumping

Leaching of
waste from
landfills

Direct discharge
of industrial
waste to the soil

Major Categories of Soil Contamination

Lead

- Source: Sewage sludge, industrial waste and leaded petrol fumes
- Effect: Toxic to humans → absorbed into the bloodstream

Cadmium

- Source: Used in paints (often present as a contaminant in zinc or may be present in sewage sludge).
- Effects: Toxic to humans

Major Categories of Soil Contamination (Cont')

Mercury

- Source: Used in some pesticides, present in sewage sludge and some industrial waste
- Effects: Toxic to humans

Zinc

- Source: Normally present in soil in small amounts. Higher levels may occur in some industrial waste.
- Effects: Although zinc is essential to both plants and animals, high levels can be toxic. It can interfere with photosynthesis in plants.

Major Categories of Soil Contamination (Cont')

Acidity

- Source: Some soils are naturally acidic. Others are altered by acid rain and other forms of pollution.
- Effects: Some plants and soil organisms are killed by acidic conditions

Methane

- Source: Landfill, waste disposal sites
- Effects: Methane gas can restrict plant growth

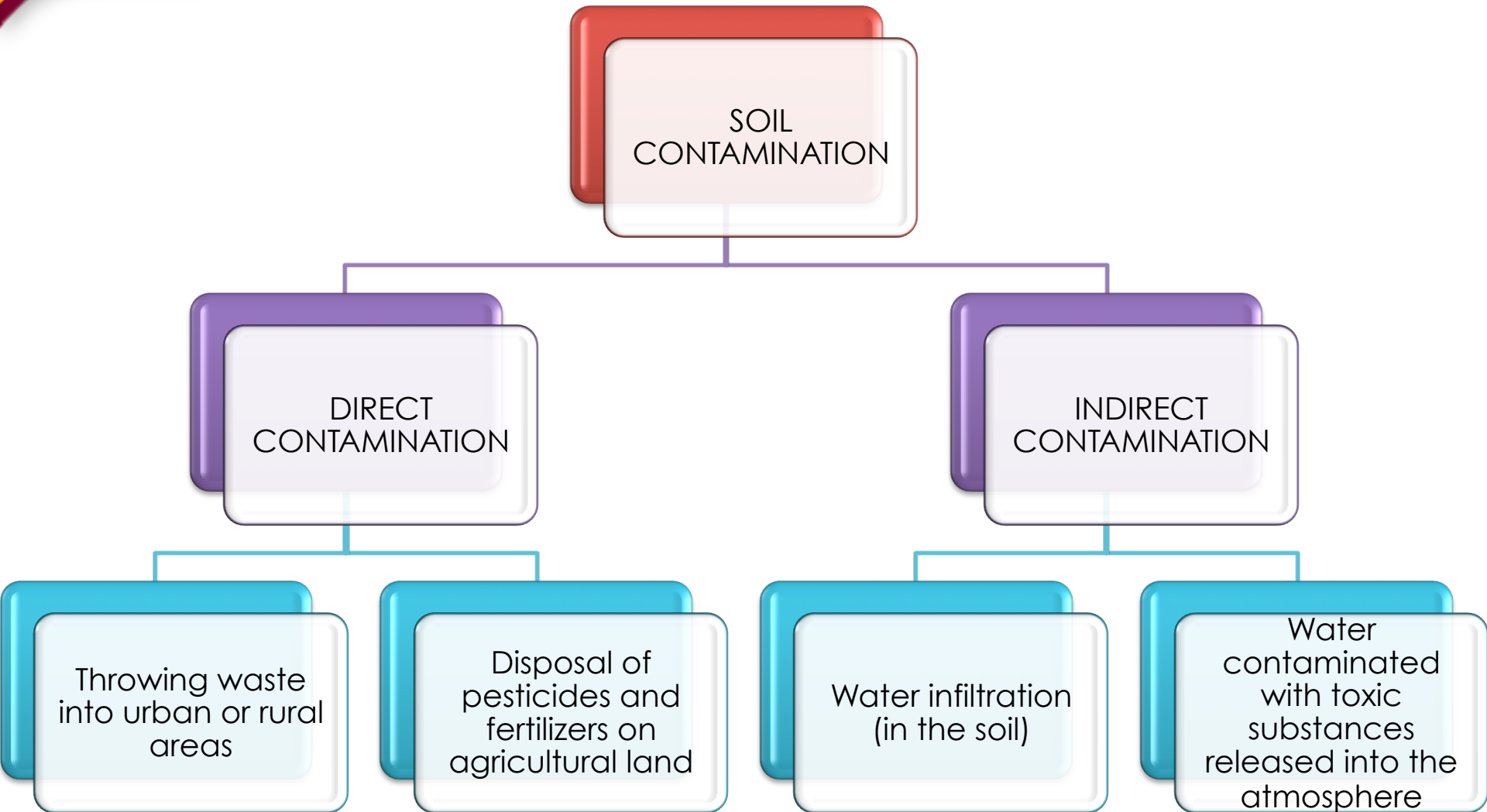
Oil

- Source: Spillage
- Effects: Toxic to human, animals and plants

Soil contamination can occur when:

hazardous substances are either spilled or buried directly in the soil or migrate to the soil from a spill that has occurred elsewhere.

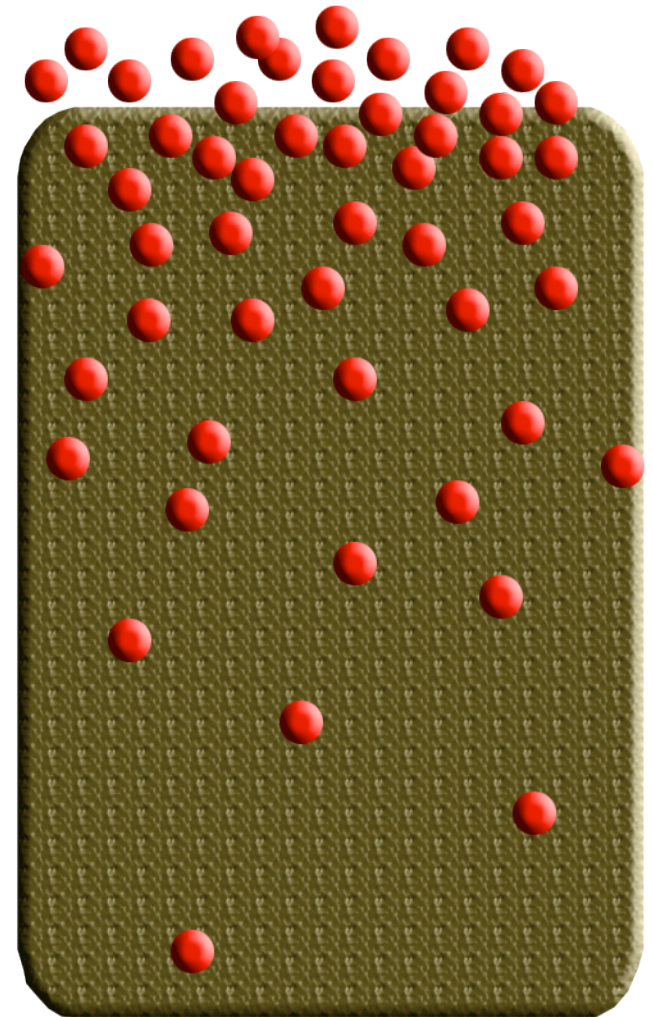
dust fallout or hazardous airborne particles



Process of Contamination

DIFFUSION

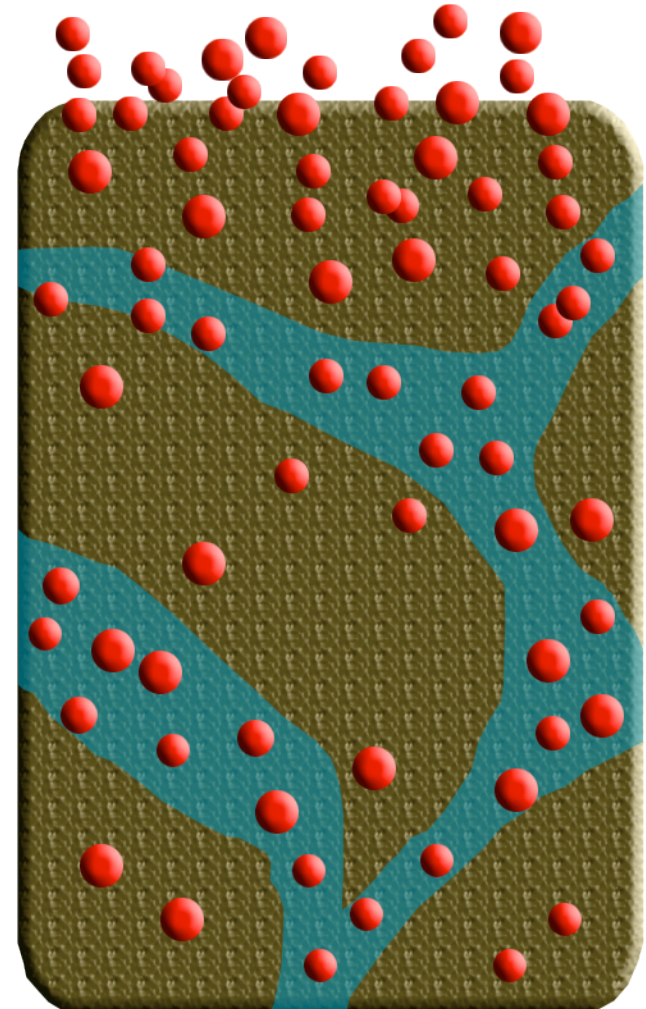
- Contaminants move from areas of high concentration on the surface to areas of low concentration in the soil



Process of Contamination (Cont')

ADVECTION

- Chemicals are picked up in the groundwater and transported to the site they could not reach by diffusion alone



Cleaning Approach

soil can be **excavated** from the ground and be either treated or disposed

soil can be left in the ground and **treated in place** using water, chemical solvents, and microbiological treatment.

soil can be **left** in the ground and **contained** to prevent the contamination from becoming more widespread and reaching plants, animals, or humans

Cleaning Approach (Cont')

- Containment of soil in place is usually done by placing a large plastic cover over the contaminated soil to prevent direct contact and keep rain water from seeping into the soil and spreading the contamination.
 - Containment using plastic liners
 - Containment using geomembrane
 - Containment using reinforced polyethylene

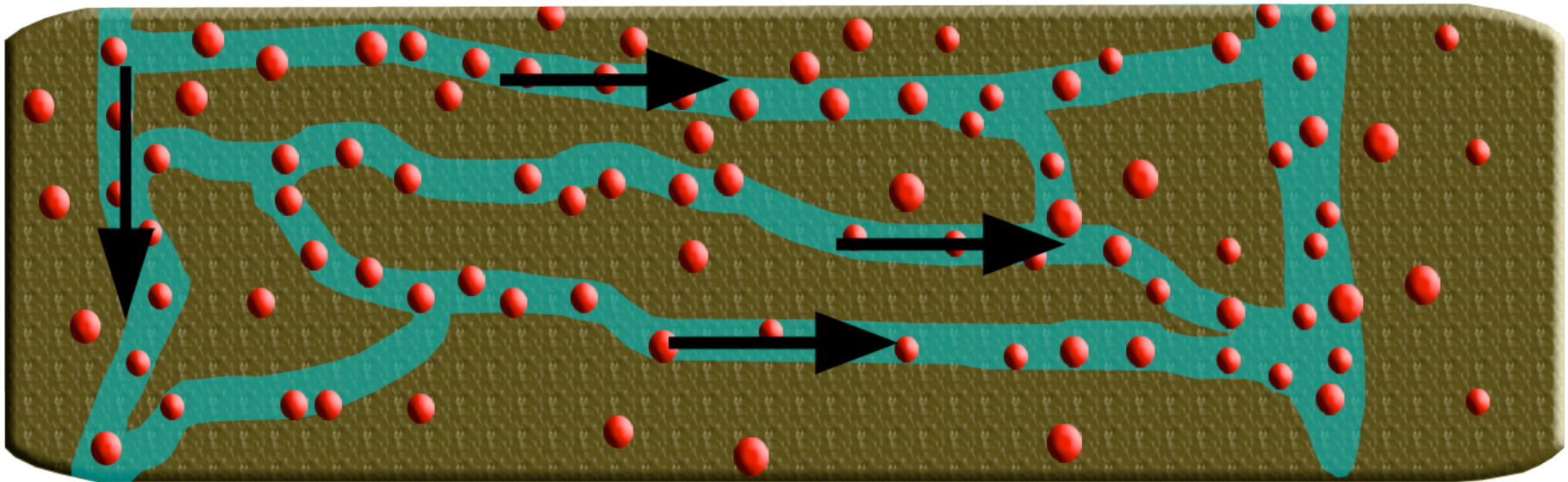
Cleaning Approach (Cont')

flushing
contaminants
out of the soil
using water,
chemical
solvents, or air

destroying the
contaminants
by incineration;
encouraging
natural
organisms in the
soil to break
them down

adding material
to the soil to
encapsulate the
contaminants
and prevent
them from
spreading

Cleaning Approach by Soil Washing



In “washing”, a liquid that can dissolve the contaminant is pumped through the soil and used to carry the contaminants until they can be removed by pumping.

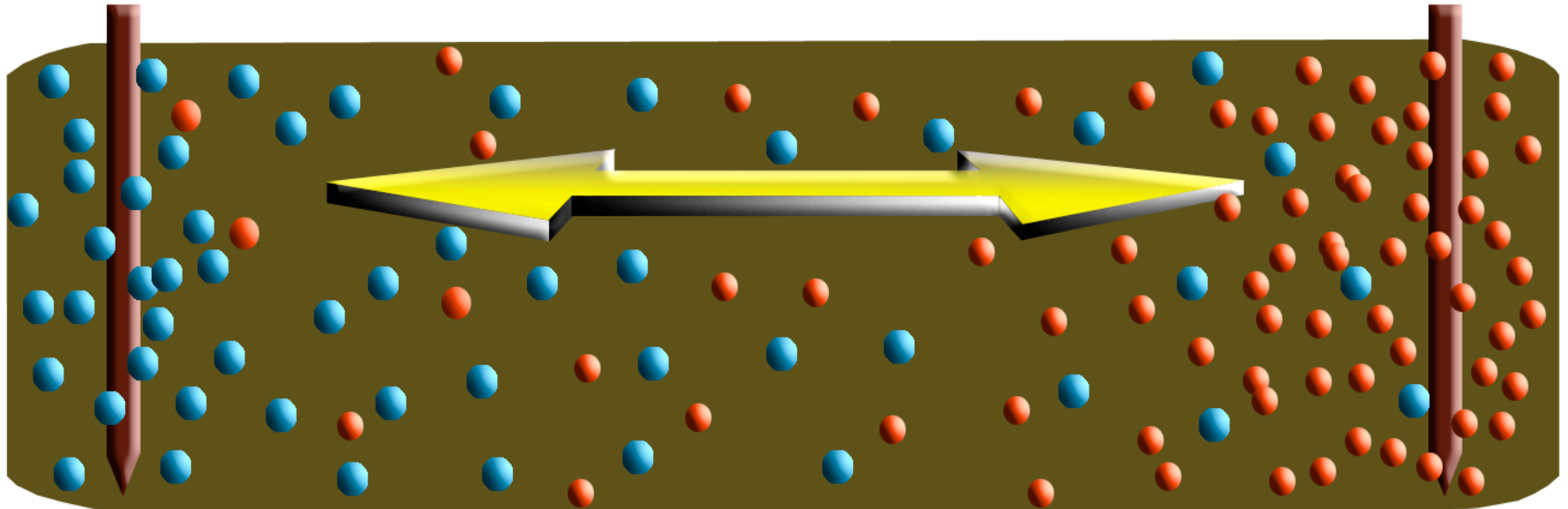
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Cleaning Approach by Electric Field

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+ (attracts ●)



Electric Fields can also be used to decontaminate soil:
 Charged and polar molecules are attracted to the electrode of the opposite charge. The soil around the electrodes, which contains a high concentration of the contaminant, is then removed.

Cleaning Approach by Bioremediation

- Involves inciting the growth of naturally occurring waste-eating microorganisms to help remove soil contaminants (most environmentally sound).
- The use of microorganisms to degrade organic contaminants in the soil can happen either **after excavation** or **at the site**.
- The microorganisms break down contaminants by using them as a food source during the aerobic processes, which requires oxygen.

Cleaning Approach by Bioremediation (Cont')

- If this method being used after removing the soil, a slurry bioremediation method can be applied.
- **SLURRY BIOREMEDIATION** = mix the soil in water to keep the soil suspended and the microbes in contact with the contaminants.
- **SOLID-PHASE BIOREMEDIATION** = places the excavated soil in an isolated site where it's tilled with water and nutrients to spark the growth of the microorganisms.

Effects of Soil Contamination

Health

- Many of the pesticide and herbicide formulations are carcinogenic to all populations
- Lead is especially hazardous to young children, in which there is a high risk of developmental damage to the brain and nervous system

Ecosystem

- There are radical soil chemistry changes which can arise from the presence of many hazardous chemicals even at low concentration.
- These changes can manifest in the alteration of metabolism of microorganisms.

Reducing Soil Contamination

- Reduce use of herbicides and pesticides
 - Encourage organic farming
 - Dispose waste properly
 - Recycle
 - Avoid over packaged items
- Utilize natural resources efficiently and reduce wastage

THE END