# Pollution and Enviormental Protection BOT 346

# A brief introduction to the course

- Environment
- The concept of the ecosystem
- The atmosphere and its components
- The concept of pollution
- The effect of pollution on the ecosystem
- The sources and nature of pollutants
- (Air, Water, Soi)
- Noise pollution
- Radioactive pollution
- Pesticide pollution
- Biological means of controlling pollution
- Deterioration of vegetation and soil and means of protection

| | |
|---|---|
| Course Objetives: | Providing the student with basic concepts about environmental pollution, the factors affecting different environments, and the results of those effects. |
| Teaching Strategies: | • Lectures, laboratories, work modules<br>• Library and internet search<br>• Scientific reports based on web search |
| Assesment methods | • Midterm exams (02)<br>• Student reports and essays<br>• Practical exam<br>• Final exam |
| Proportion of Assessment | • Semester 60 • Final 40 |

# Assessment methods

| | |
|---|---|
| • Attendance & effectiveness | 5 |
| • Research Task | 5 |
| • Midterm Exam | 10x2 |
| • Practical | 30 |
| • Final Exam | 40 |

# Course contents

## Introduction

- Environment
- The ecosystem and its components
- Biosphere
- Life cycle and environmental balance
- Pollution and its types
- Movement of energy in the ecosystem, food chains and webs
- Environmental pyramids
- Natural cycles of environmental elements
- Development and environment
- Factors contributing to environmental pollution

What is the environment and what are its components?

What is an ecosystem and what are its components?

What is pollution and what are its sources?

# What is the environment and what are its components?

An environment is everything that is around us, which includes both living and nonliving things such as soil, water, animals and plants, which adapt themselves to their surroundings. It is nature's gift that helps in nourishing life on earth.

Summation of all biotic ( living) and abiotic (non-living) components that surround or potentially influence the organisms and their habitats

Components of Environment


Food chain



Ecology

Ecosystem

The environment plays an important role in the existence of life on the planet earth. The word Environment is derived from the French word **“Environ”** which means **“surrounding.”**

It is a complex of factors acting, reacting and interacting with the organism complex, i e organisms and their environment are wedded together in state of constant flux.

- **Macro environment** (prevailing regional climate)
- **Micro environment** (close to an organism to be influenced by it)

# Micro-environment vs. Macro-environment

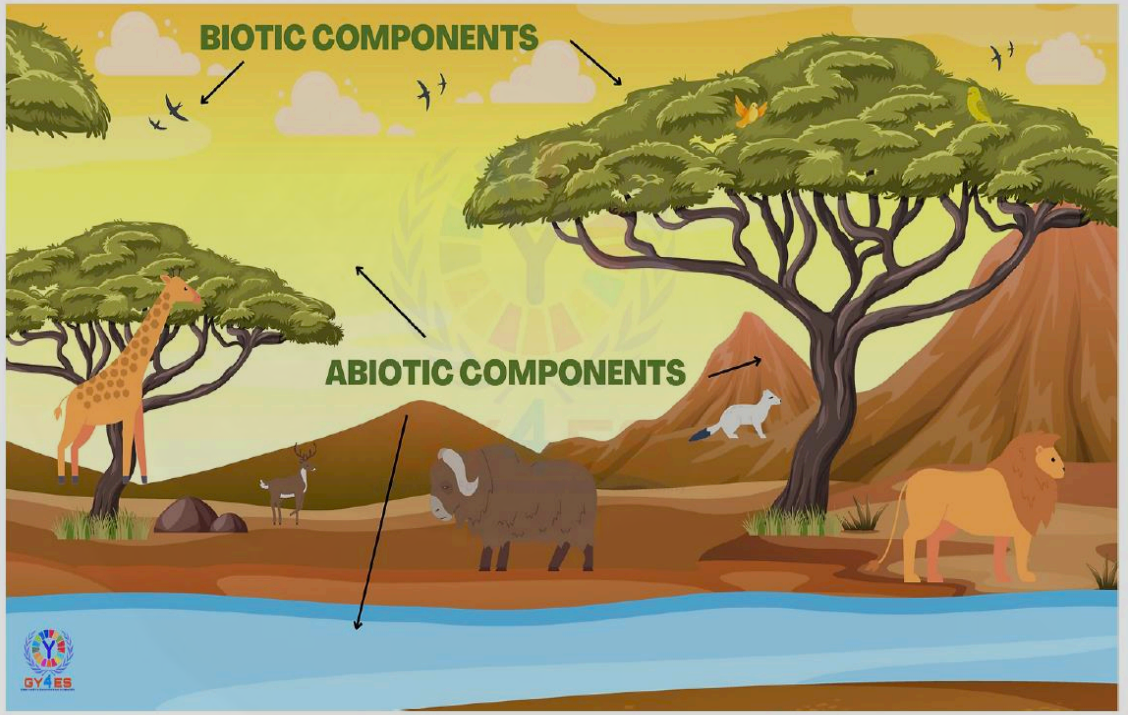
We can frequently differentiate the macro-**environment** from the micro-environment. Macro-environmental factors are those that are common to a given location at a given time. Examples are the amount of rainfall and average temperature during a season.

Micro-environmental factors are those that are unique to a single plant or to a small group of plants. An important example of a micro-environmental factor is plant-to-plant spacing in a row. In **Figure**, the plants in the two rows have different micro-environments resulting from different plant spacings, and this difference will affect numerous phenotypes later in development.  For example, the plants with greater spacing likely will produce larger leaves and better growth than those with less spacing because of reduced competition for light, water, and nutrients.

The environment is a complex and dynamic system composed of diverse elements that interact and influence one another. The components of environment is comprises of two major factors, which are Abiotic and Biotic Factors

1. **Abiotic Factors:** Abiotic factors refer to the non-living components of the environment that influence the survival, distribution, and behaviour of organisms. These factors include various physical and chemical elements that interact to create diverse habitats and ecosystems.

2. **Biotic Factors:** Biotic factors encompass all living organisms within an ecosystem.

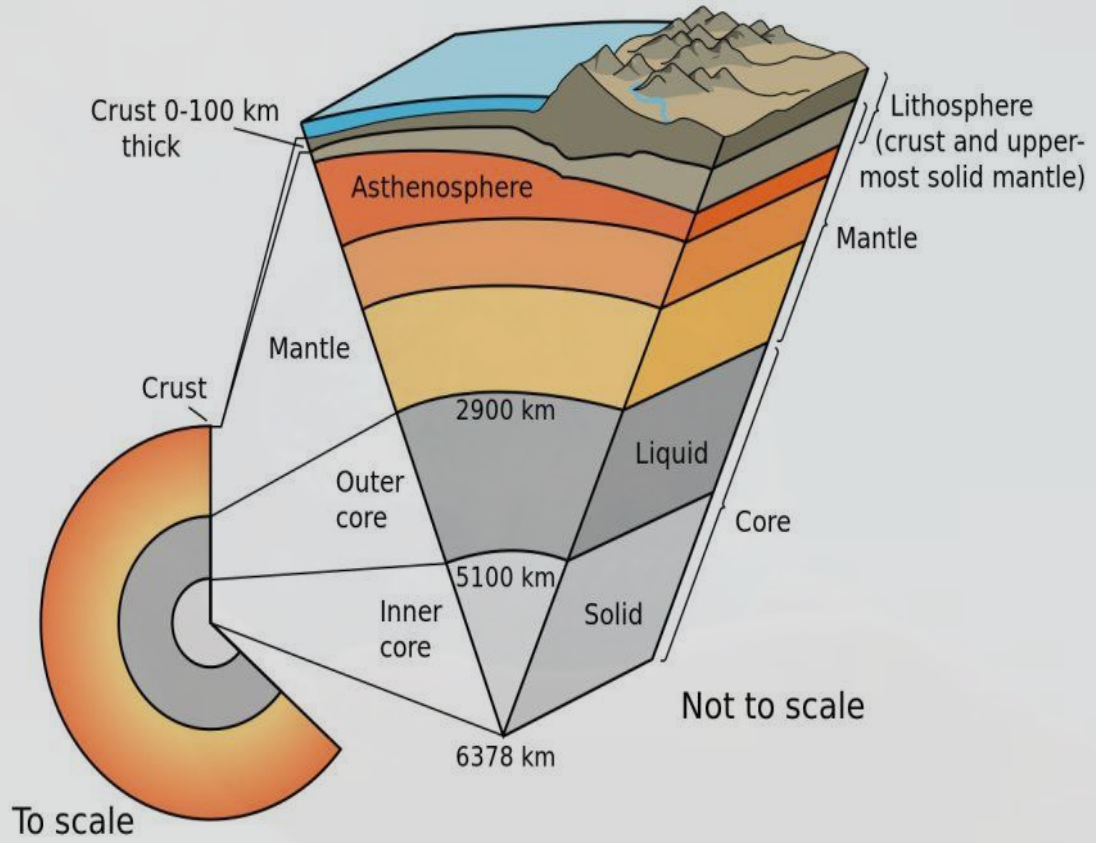


# Components of Environment

- Lithosphere or the rocks
- Hydropshere or the water
- Atmoshphere or the air
- Biosphere

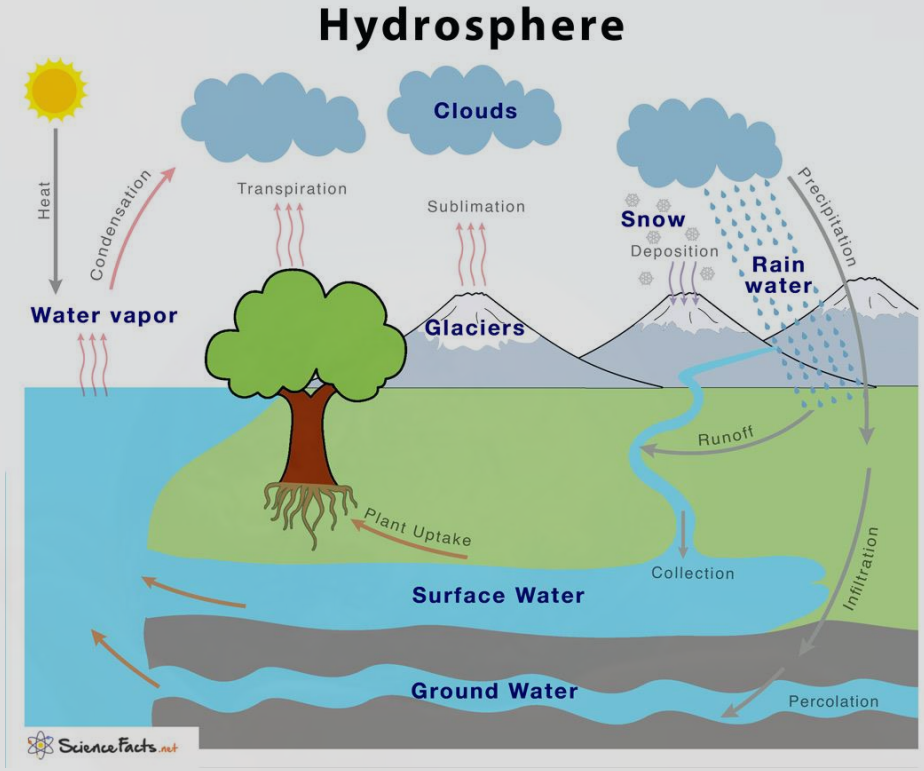
# Lithosphere

- Greek word: *Lithos* menaning rock
- Earth structure can be stratified into outer crust, middle mantle and inner core regions.
- Lithosperhe is the outermost layer of the crust which repsrsent the land mass of the planet.

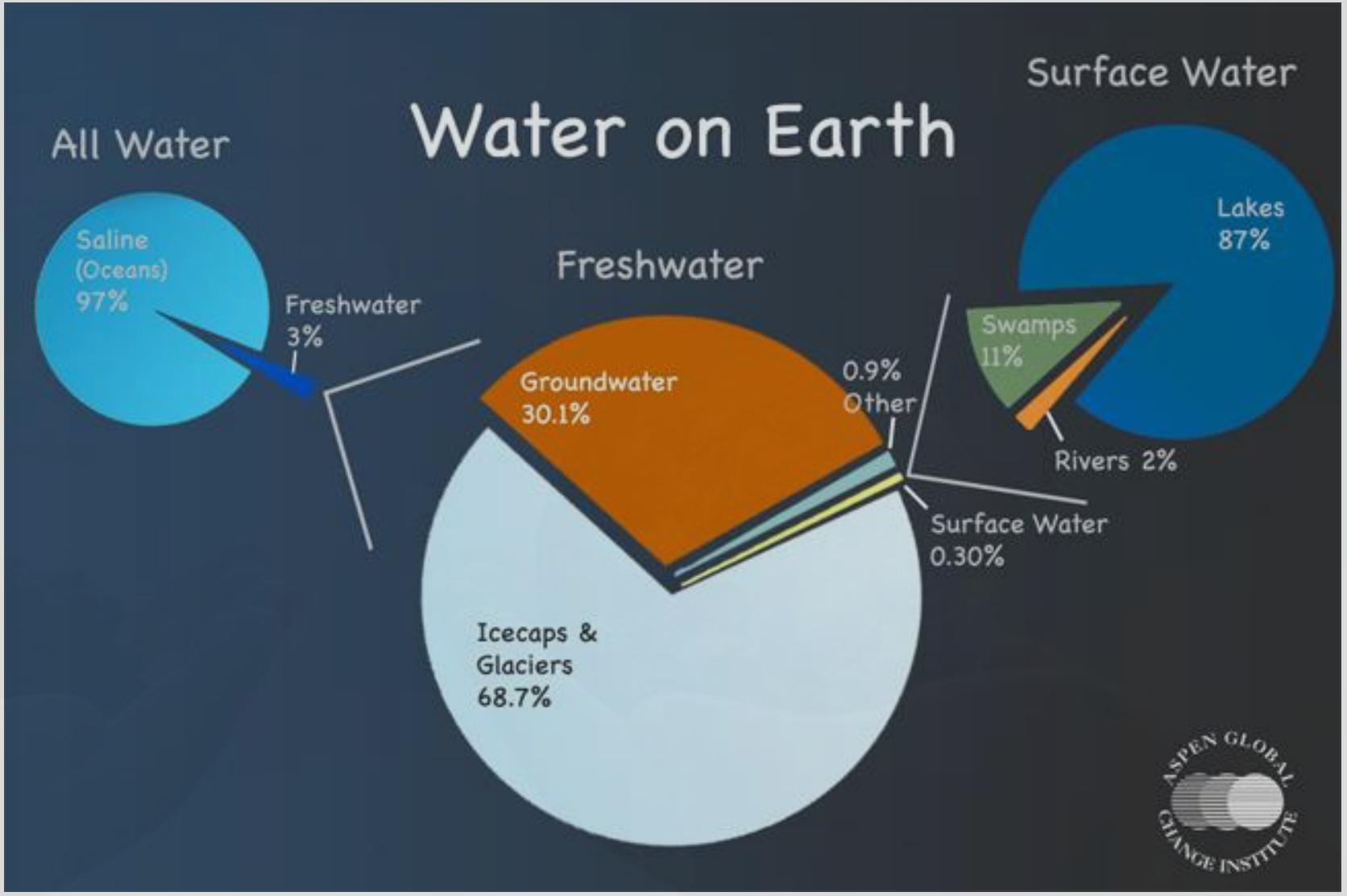


# Hydrosphere

- Greek word: *Hydor* menaning water
- Hyrosphere respent th water masses on the planet present in solid (ise cover, galciers etc.) liquid (water bodies) and gaseuous (water vapours) phase.
- Hydrosphere covers alomost three-fourth of the total surface area of the earth.



# Hydrosphere



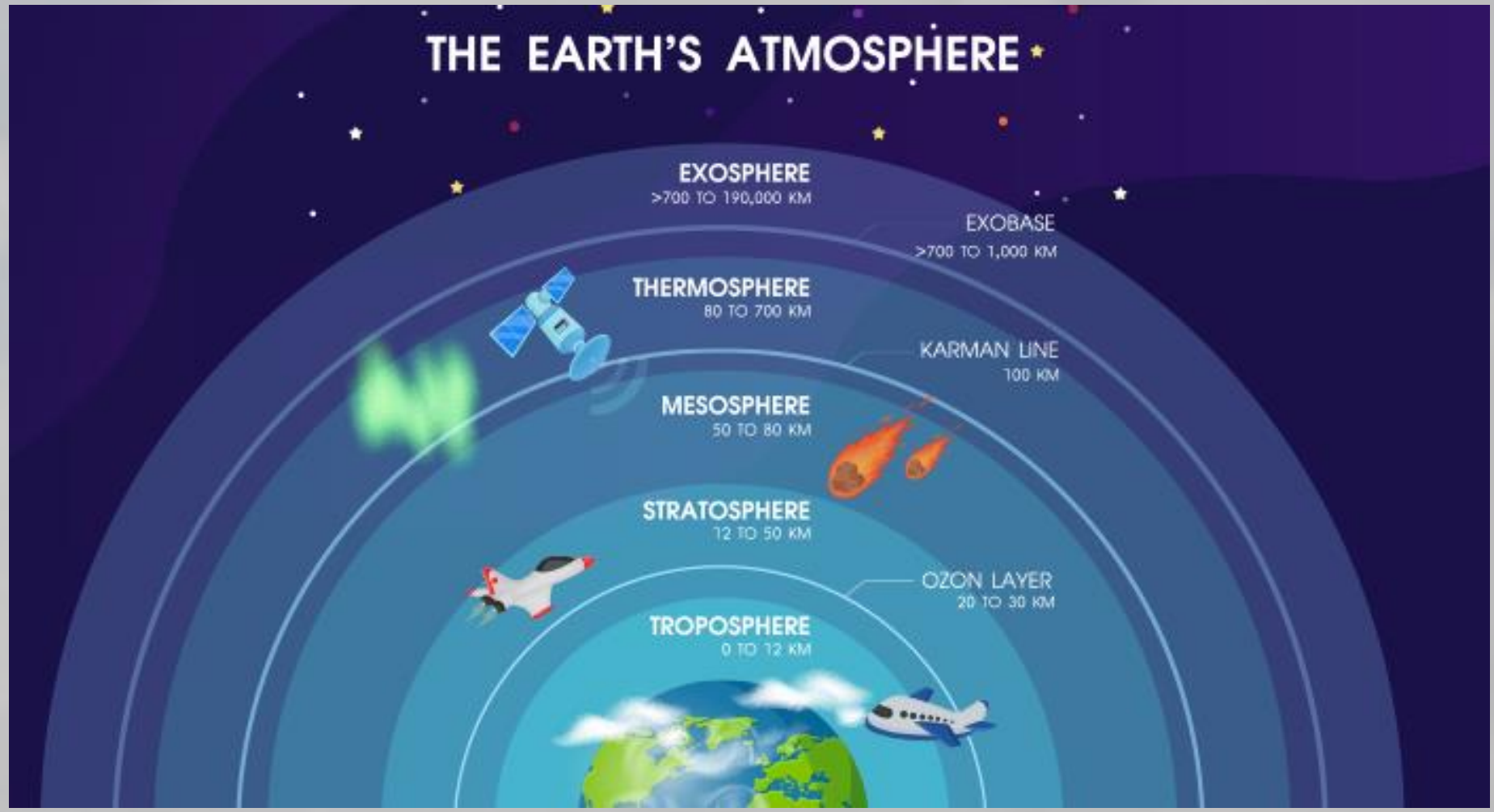
# Atmosphere

One of the main components of Earth's interdependent physical systems is the atmosphere. An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases.

The atmosphere has five distinct layers that are determined by the changes in temperature that happen with increasing altitude.

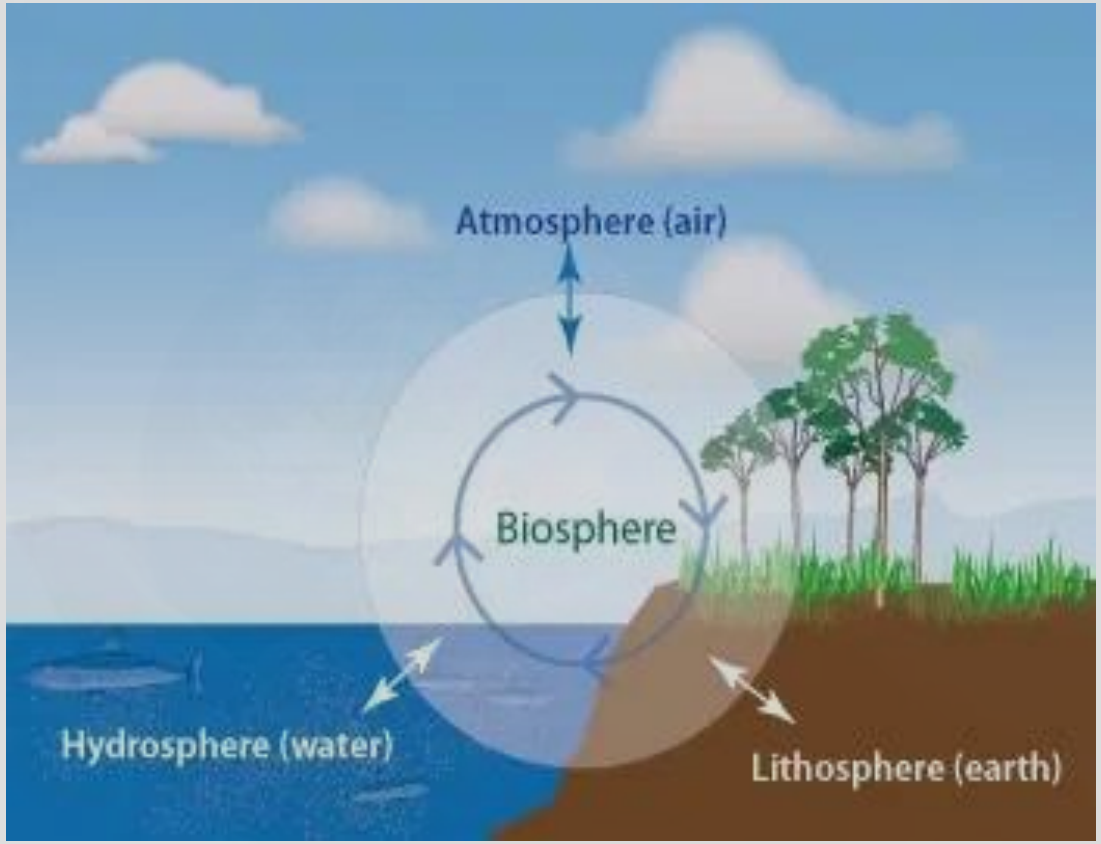
- Exosphere
- Thermosphere
- Mesosphere
- Stratosphere
- Troposphere

# Atmosphere


THE EARTH'S ATMOSPHERE
EXOSPHERE
>700 TO 190,000 KM
EXOBASE
>700 TO 1,000 KM
THERMOSPHERE
80 TO 700 KM
KARMAN LINE
100 KM
MESOSPHERE
50 TO 80 KM
STRATOSPHERE
12 TO 50 KM
OZON LAYER
20 TO 30 KM
TROPOSPHERE
0 TO 12 KM

# Biosphere
# (Sphere of Life)

- Greek word: *Bios* menaning life
- Bioshpere is the self-regulating overlapping region of atmosphere, lithosphere and hydrosphere in the environment where life exist, nourshided and flurished by the healthy interaction between biotic and abiotic components of nature
- Total portion of lithosphere , hydrosphere and atmosphere that supports the life of organisms.



**Ecology:** is the science that deals with the relationship of living things to one another and their environment, or the study of such relationships.

- Groups of interacting populations at a particular location comprise what is known as a community . Examples: consider the plant community of a tropical rainforest, the fish community of a freshwater lake, or the bird community of a saltwater marsh.

- One of the most important of these is the number of species present in a community or the species diversity of the community.

**Diversity** can be defined as the number of different items and their relative frequencies.

**Biodiversity**: Refers to the variety and variability among living organisms and the ecological complexes in which they occur.

For **biological diversity**, these items are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity .

Thus, the term encompasses different ecosystems, species, and genes.

- **What is an ecosystem and what are its components?**

- An **Ecosystem** is a community of living organisms, referred to as biotic components, interacting with their non-living surroundings, known as abiotic components. These interactions create a delicate balance where energy, nutrients, and materials flow through various pathways, supporting the functioning and survival of the ecosystem as a whole.

- All organisms and their physical environment in a single location.

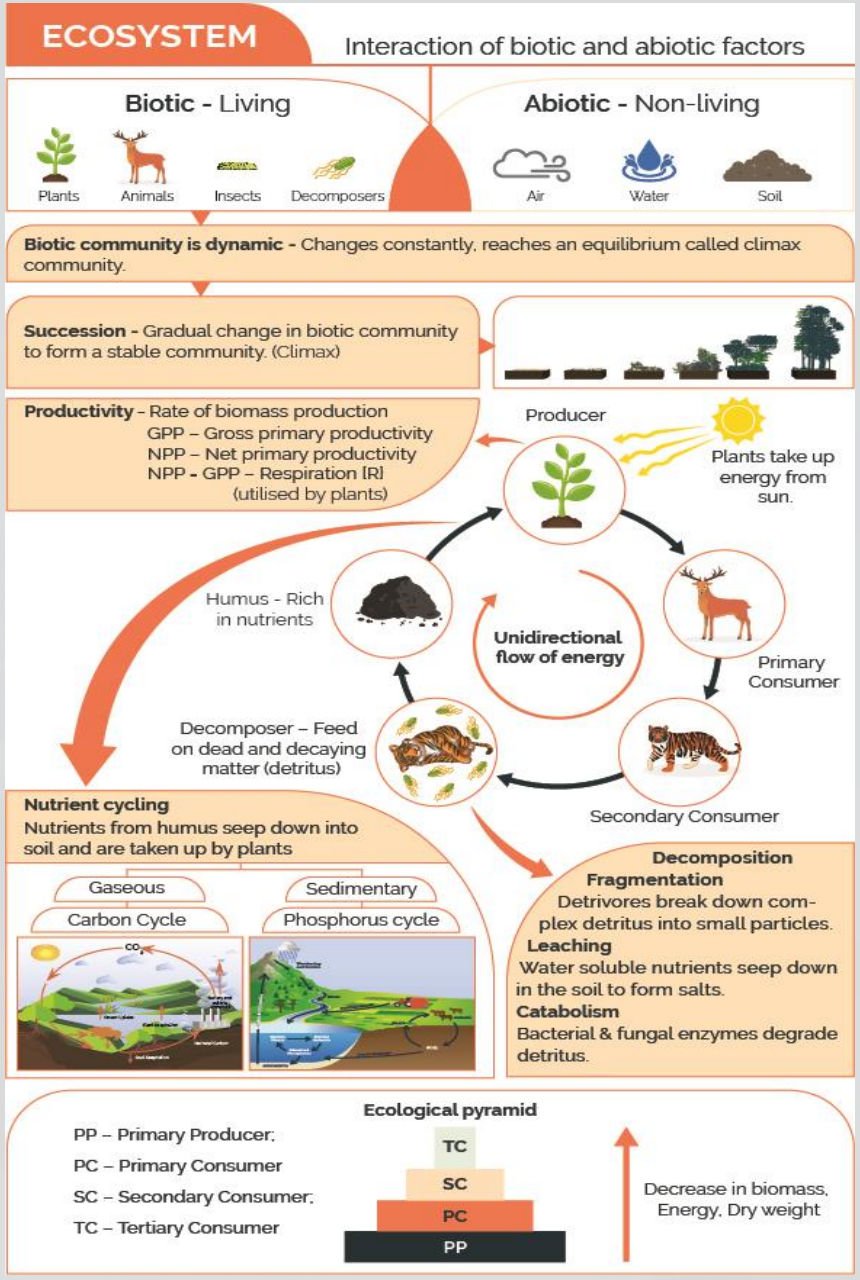
- Self sustaining and self-regulating communities of organisms interacting with one another and with their environment

# Types of Ecosystem

There are two main types of ecosystems;

**1. Natural ecosystem** – It is a naturally produced biological environment found in nature. It includes deserts, forests, grasslands, lakes, mountains, ponds, rivers, oceans, etc.

**2. Artificial ecosystem** – It is an artificial environment which is created and maintained by man. It includes an aquarium, crop fields, gardens, parks, zoo, etc.



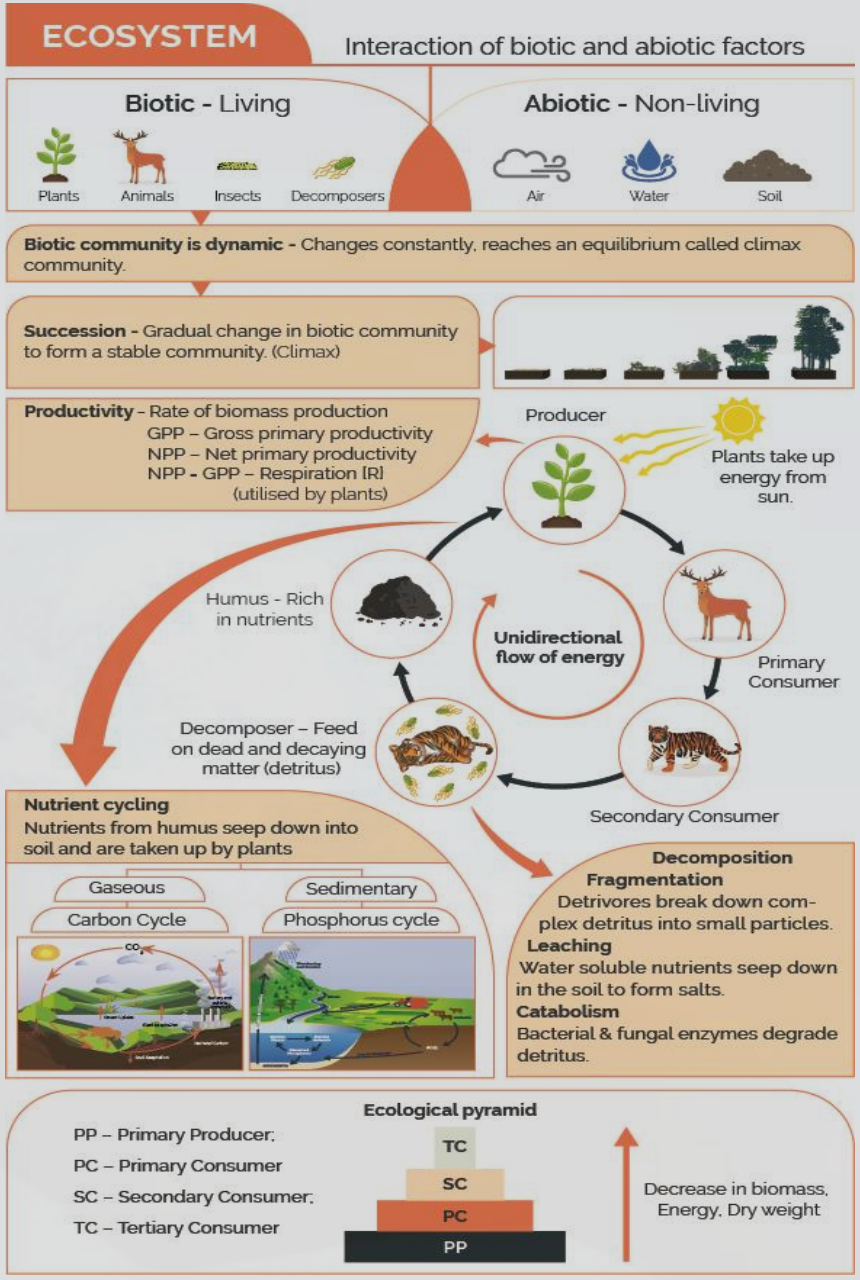
# Ecosystem Structure

## 1. Abiotic components:

- Energy solar energy
- Physical factors: Temperature, light, wind, etc.
- Chemicals factors:
  - Inorganic: substances (oxygen, carbon, etc.)
  - Organic substances (carbohydrates, proteins, etc.)

## 2. Biotic components:

- Producers: green plants (autotrophs)
- Consumers: animals (heterotrophs)
- Herbivores: (primary consumer)
- Carnivores (primary, secondary, tertiary, etc.)
- Omnivores ( can feed on both plants and animals.
- Scavengers (top utilize the dead remains of animals
- Decomposers (saprotrophs) bacteria and fungi



**Various ecosystems make up the largest life unit called BIOSPHERE**

The interactions between ecosystem components involve two general processes

1. Energy flow
2. Nutrient cycling

## Frequently Asked Questions

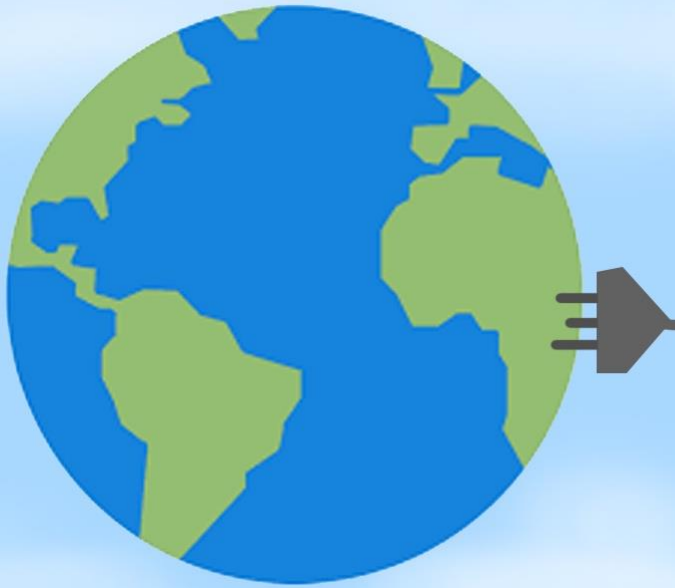
- What is the Environment?
- What are different components of the Environment?
- What is an Ecosystem?
- What factors influence the ecosystem?
- Difference Between Environment and Ecosystem.
- What are the types of ecosystems?

# Multiple Choice Questions (MCQs)

1. **The word "Environment" is derived from which language?**
   a) Greek
   b) French
   c) Latin
   d) Spanish

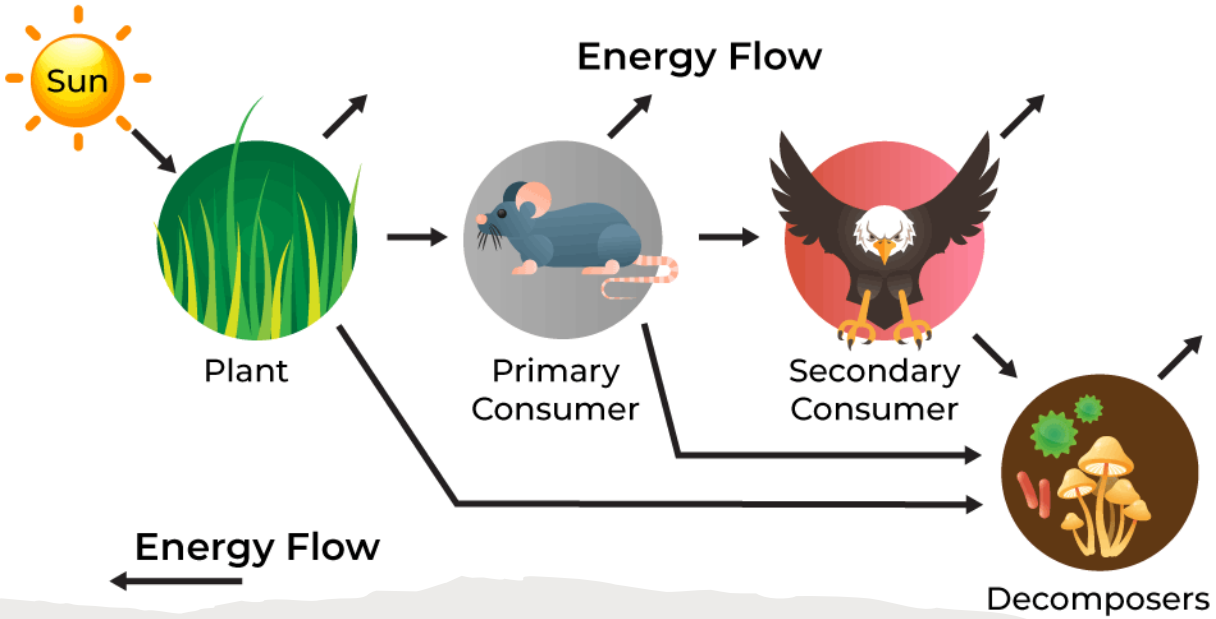
2. **Which of the following are components of the environment?**
   a) Abiotic and Biotic factors
   b) Lithosphere and Biosphere
   c) Hydrosphere and Atmosphere
   d) All of the above

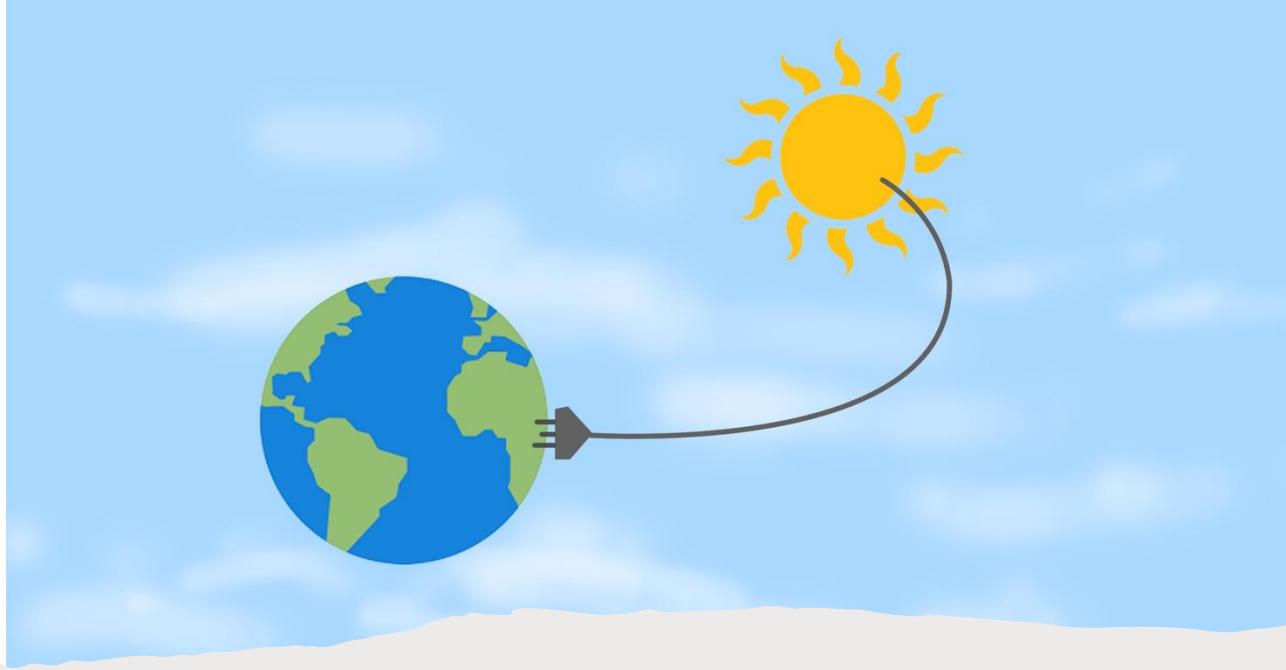
3. **What is the composition of nitrogen in Earth's atmosphere?**
   a) 21%
   b) 78%
   c) 1%
   d) 0.03%



# Energy Flow in Ecosystem

The energy flow in the ecosystem is one of the major factors that support the survival of such a great number of organisms. For almost all organisms on earth, the primary source of energy is **SOLAR ENERGY**. It is amusing to find that we receive less than 50 per cent of the sun's effective radiation on earth. **When we say effective radiation, we mean the radiation, which can be used by plants to carry out photosynthesis.**



# What is Energy Flow of Ecosystem?

***Energy flow in an ecosystem is defined as the movement or transfer of energy from one trophic level to another in an ecosystem. The energy that is passed is in the form of chemical energy.***

# What is Energy Flow of Ecosystem?

Energy flow in ecosystem refers to the movement of energy through a series of organisms, starting from primary producers to various levels of consumers.

All the components of an ecosystem constantly interact with each other, which leads to the growth and regeneration of its plants and animal species.

- For this interaction to operate and continue, energy is required.

The Sun is the ultimate source of energy for all the ecosystems in the world, except for the deep sea hydrothermal ecosystems.

Energy from the sunlight is captured by primary producers and converted into chemical energy.

This energy then moves from one organism to another as they consume one another, forming the basis of energy flow in ecosystem.

Energy flow is unidirectional and governed by the laws of thermodynamics.

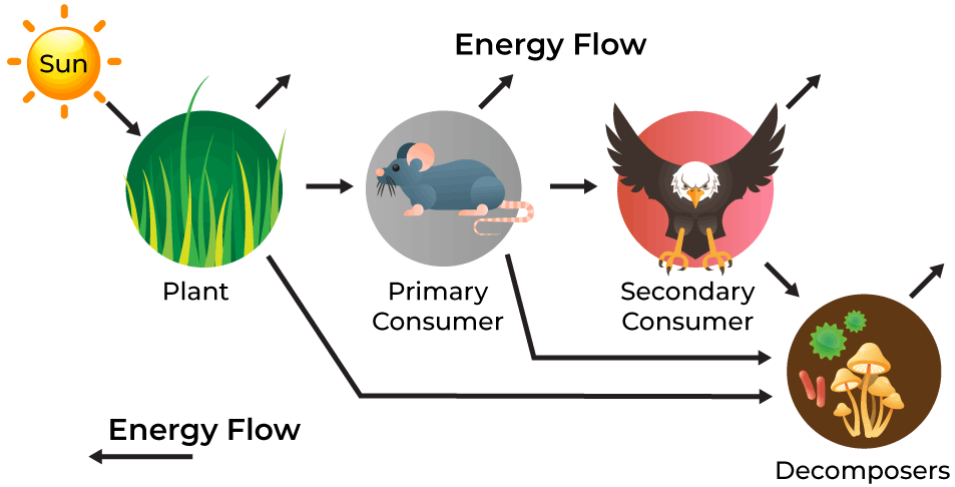
# Laws of Thermodynamics in Ecosystem

The energy flow in an ecosystem is governed by the first two laws of thermodynamics.

- **First Law of thermodynamics:** It states that energy can neither be created nor destroyed, but it keeps changing from one form to the other. Similarly in an ecosystem, the main source of energy is the sun, and this energy from the sun is transferred from one level to the other.

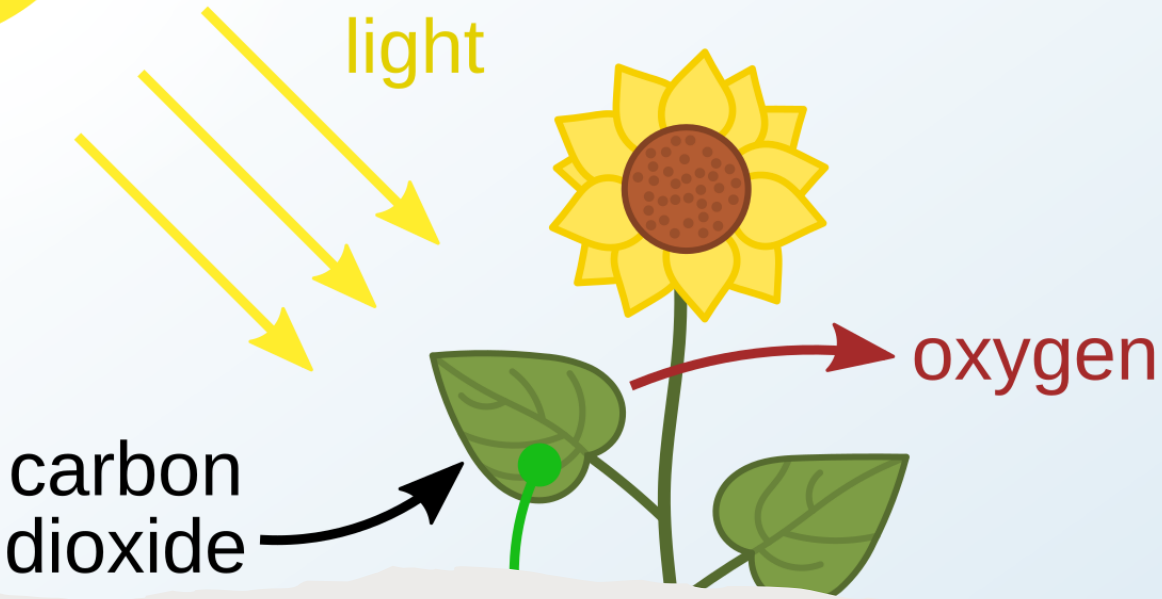
- **Second Law of thermodynamics:** It states that when energy transforms from one form to another, some part of it is lost as heat to the surroundings. **Thus, the energy at one level is never completely transferred to the other.**

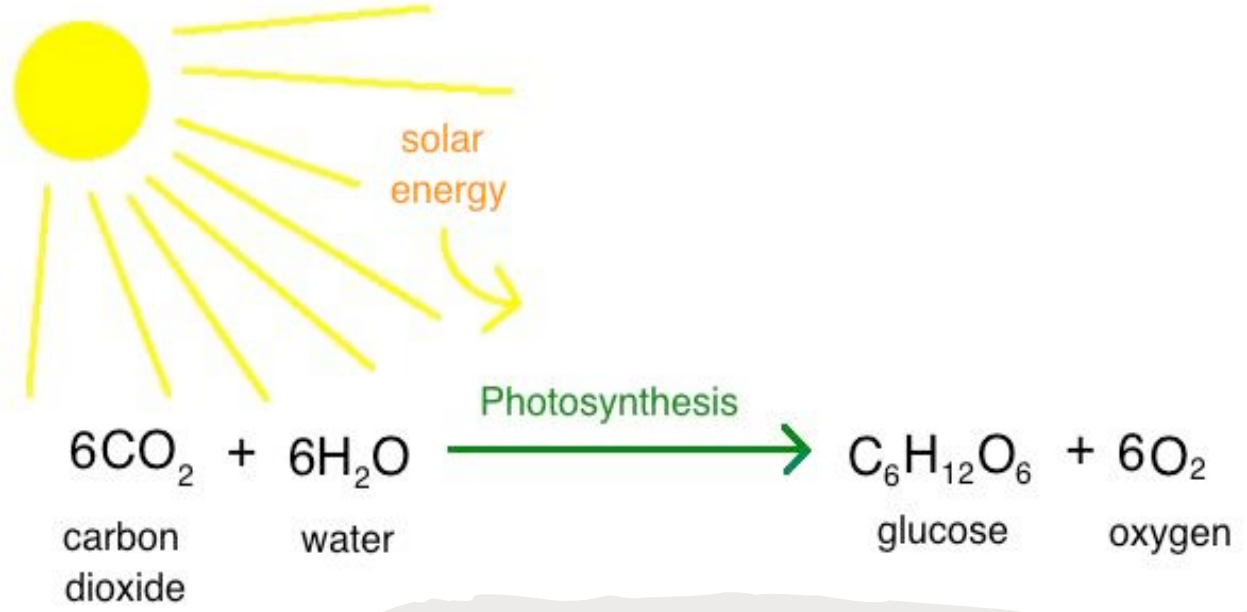
# Mechanism of Energy Flow in Ecosystem




Animals get energy in two forms: radiant energy and fixed energy. Radiant energy comes from electromagnetic waves, like light. Fixed energy is stored in objects and substances as chemical energy.

Organisms that convert radiant energy to fixed energy are called **autotrophs.** Heterotrophs get their energy from autotrophs. The sun is the main source of energy in our ecosystem. But less than half of the sun's energy is used by plants for photosynthesis i.e. 50% of this energy is **photosynthetically active radiation (PAR)**.



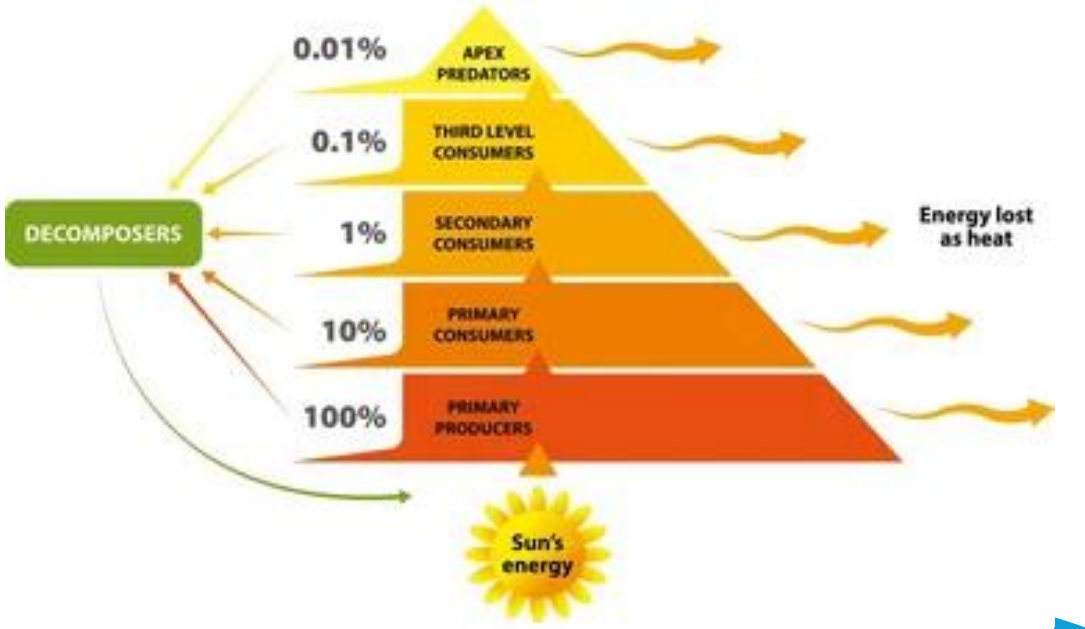




# Mechanism of Energy Flow in Ecosystem

Plants convert radiant energy to fixed energy and pass it on to other organisms. When the sun shines on plants, they use it along with carbon dioxide and water to make glucose and oxygen. The oxygen goes into the atmosphere and the glucose stays in the plant. **When herbivores eat plants, they get energy from the plant. Some of this energy is lost as heat.**

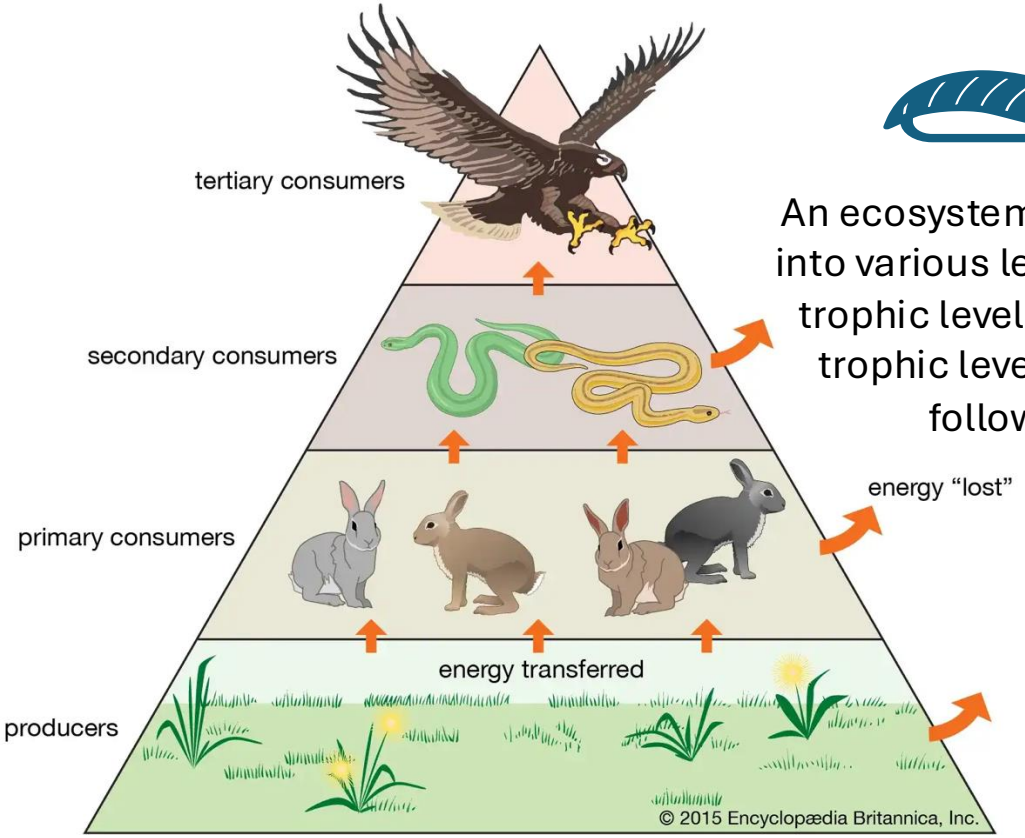
# Mechanism of Energy Flow in Ecosystem

When carnivores eat herbivores, there is again a loss of some energy. We call this the 10% law because only 10% of the energy available at one level is transferred to the next level. The flow of energy in an ecosystem is unidirectional, meaning it only goes in one direction. We can't transfer energy to a previous level. To understand this, we need to learn about trophic levels and the food chain.



# Trophic Levels

**A trophic level is a position in a food chain or a food web or an ecological pyramid that is occupied by a group of organism having a similar feeding mode**




An ecosystem is divided into various levels called trophic levels. Various trophic levels are as follows:

**First trophic level:** This level is occupied by the **producers** which include the plants.

**Second trophic level:** It is occupied by the primary consumers that consume plants. For example, herbivores such as cows, goats, etc.

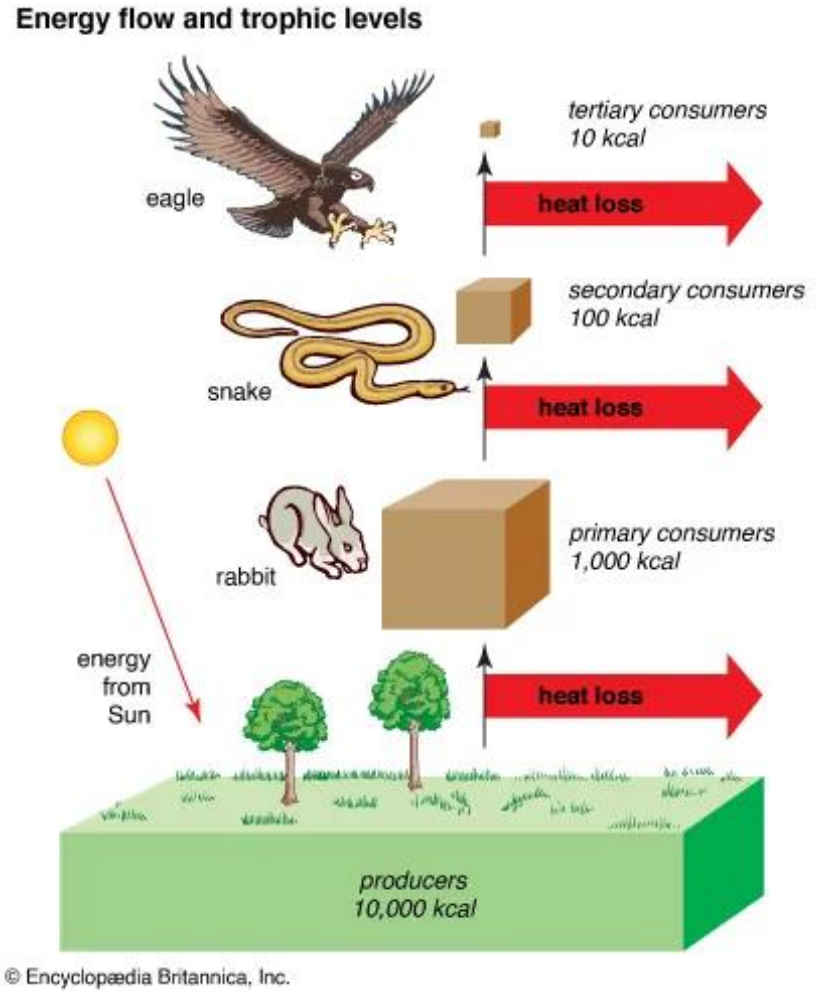
**Third Trophic Level:** This level is occupied by the primary carnivores or secondary consumers such as snakes, frogs, birds, etc.

**Fourth trophic level:** Large carnivores that are also called tertiary consumers make up this level. Example: Lion, Tiger, Cheetah, etc.

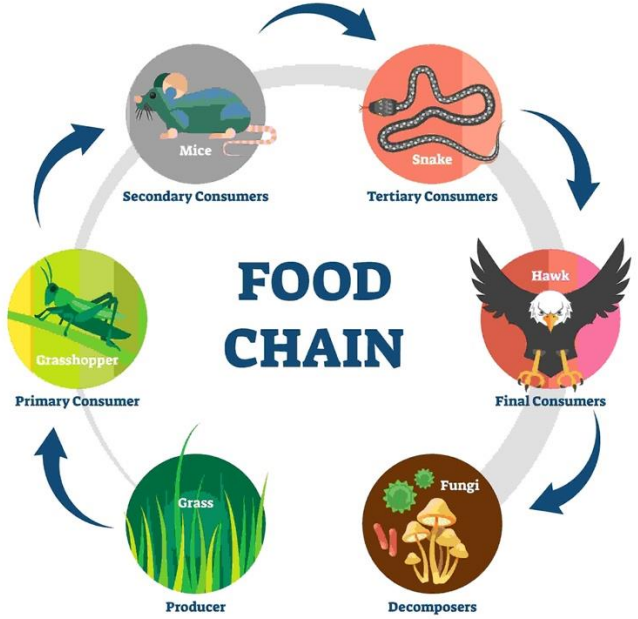
# 10% Rule in Energy Transfer

Ten percent law of energy transfer in food chains was given by **Reymond Lindeman**. **It is also called as Lindeman's trophic efficiency rule.** According to this rule, the 10% of transfer of energy is transferred from one trophic level to the next successive trophic level. The rest is lost largely through metabolic processes as heat. **The first trophic level has the maximum energy.**

If a grassland ecosystem has 10,000 kilocalories (kcal) of energy concentrated in vegetation, only about 1,000 kcal will be transferred to primary consumers, and very little (only 10 kcal) will make it to the tertiary level. Energy pyramids such as this help to explain the trophic structure of an ecosystem: the number of consumer trophic levels that can be supported is dependent on the size and energy richness of the producer level.



# Food Chain




A food chain represents the flow of energy and nutrients among different organisms in an ecosystem. It tells us how energy and nutrients are transferred from one trophic level to another and how the organisms interact in an ecosystem. In a food chain, each organism represents a particular trophic level according to its food behavior.

- **Producers** are living organisms that produce their own food by utilizing solar energy through the photosynthesis process. For example, plants, green growth, etc.
- **Consumers** are living organisms that cannot produce their own food and obtain energy by consuming other organisms. For example, lions, tigers, wolves, foxes, etc.
- **Decomposers** are the organisms that breaks down dead organic matter and recycles nutrients back into the ecosystem. They are present at the last stage of the food chain, that breaks down waste and remains from all other trophic levels. For example, bacteria and fungi.

# Food Chain

***A food chain is a linear sequence of organisms where each organism serves as a source of food for the organism at the next trophic level, demonstrating the transfer of energy and nutrient in an ecosystem.***

In the first stage, plants are eaten by herbivores such as grasshoppers.

Then herbivores such as deer are consumed by carnivores such as lions, tigers, etc.

On the death of carnivores, they are consumed by scavengers such as eagles and vultures.

When vultures die, their bodies are broken down by bacteria and fungi to nutrients.

These nutrients are again used by the plants for their growth.

# Types of Food Chain

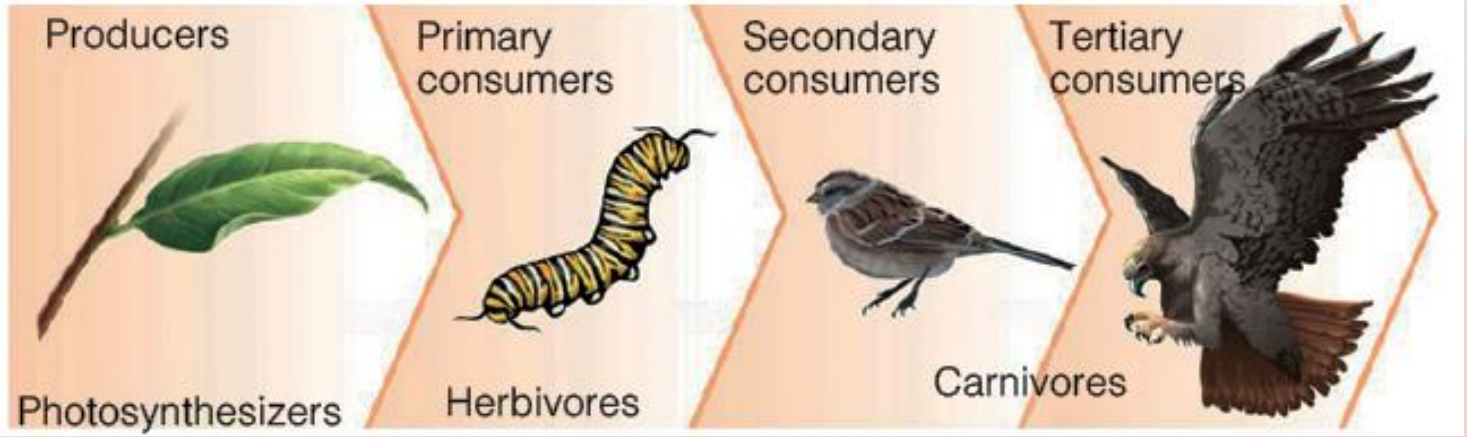
Broadly, there are **two types of food chains in any ecosystem – Grazing Food Chains and Detritus Food Chains**.

**Grazing Food Chains**

This type of food chain is more prevalent in those ecosystems where a substantial part of the net primary production is grazed on by herbivores.

Thus, there is enough energy to support the higher trophic level and in turn a food chain

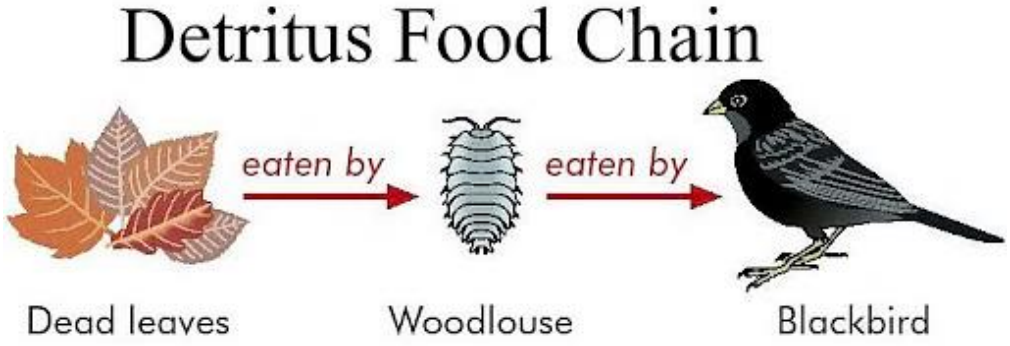
- It starts from a green plant base, goes to grazing herbivores and on to carnivores.



# Types of Food Chain

**Detritus Food Chains**

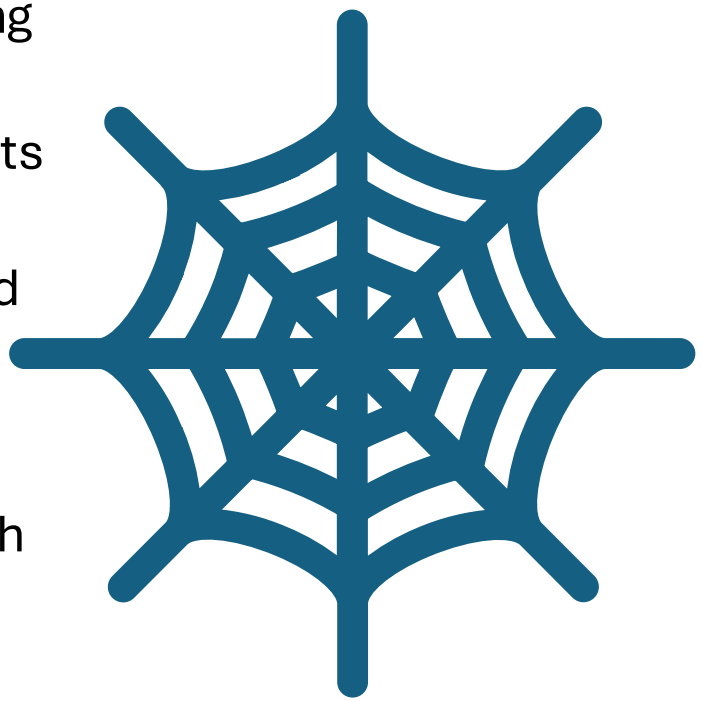
- This type of food chain starts with dead organic matter which is decomposed by microorganisms, which, in turn, are eaten by other organisms.
- Thus, it is less dependent on direct solar energy and more on the supply of organic matter produced by another ecosystem.
- The organisms that feed on dead organic matter or detritus, are known as detritivores or decomposers.




**In general, the food chain exists only in small ecosystems, and this is replaced by a food web in complex ecosystems.**

# Food Feb

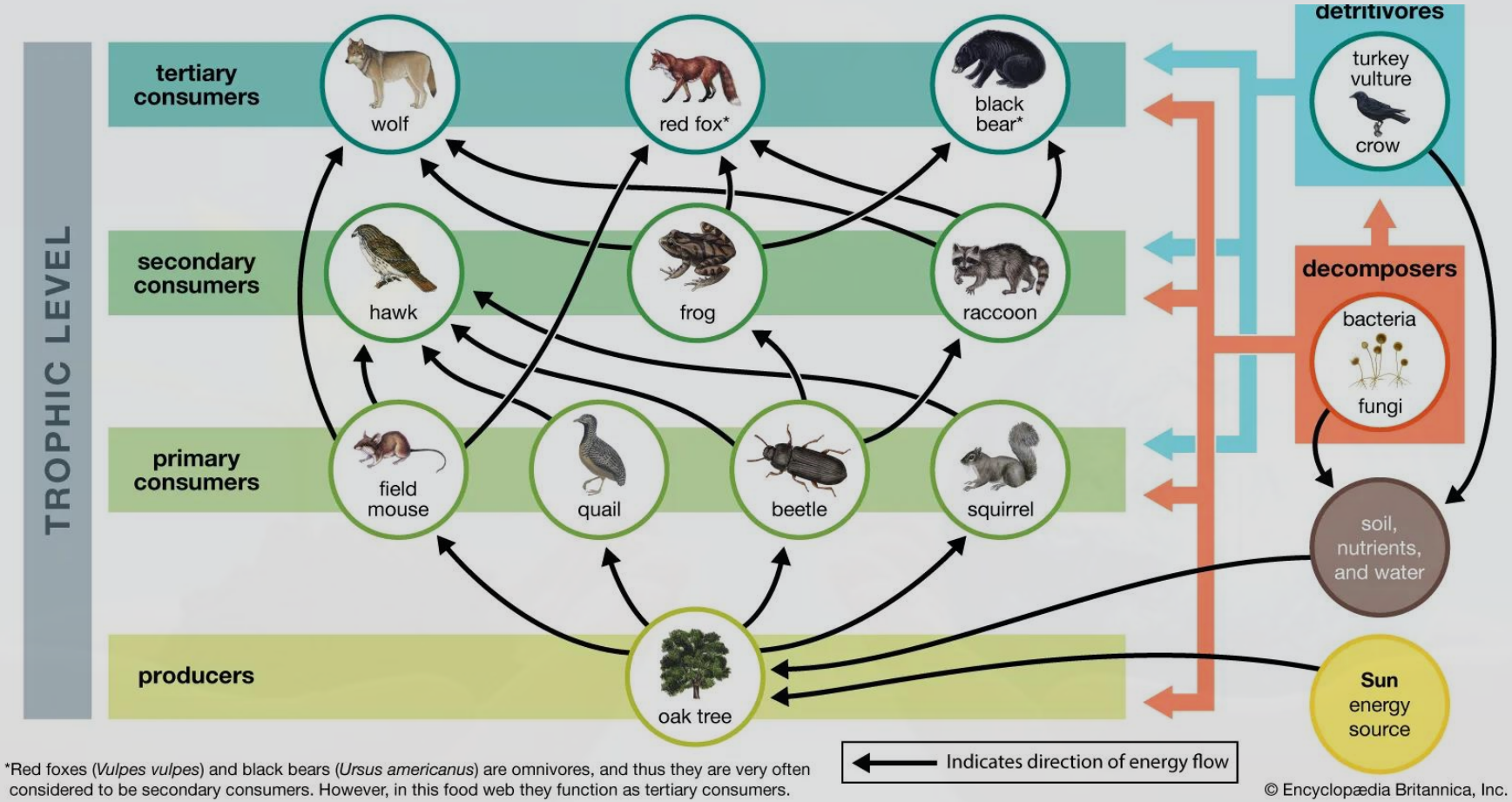
- Food web is an important ecological concept, represents feeding relationships within a community.
- It also implies the transfer of food energy from its source in plants through herbivores to carnivores.
- Normally, food webs consist of a number of food chains meshed together.



A food web is a complex, interconnected network of multiple food chains within an ecosystem, representing the various paths through which energy and nutrients flow as organisms interact with one another.

A food web is a complex network of feeding relationships that connects all the organisms in an ecosystem.

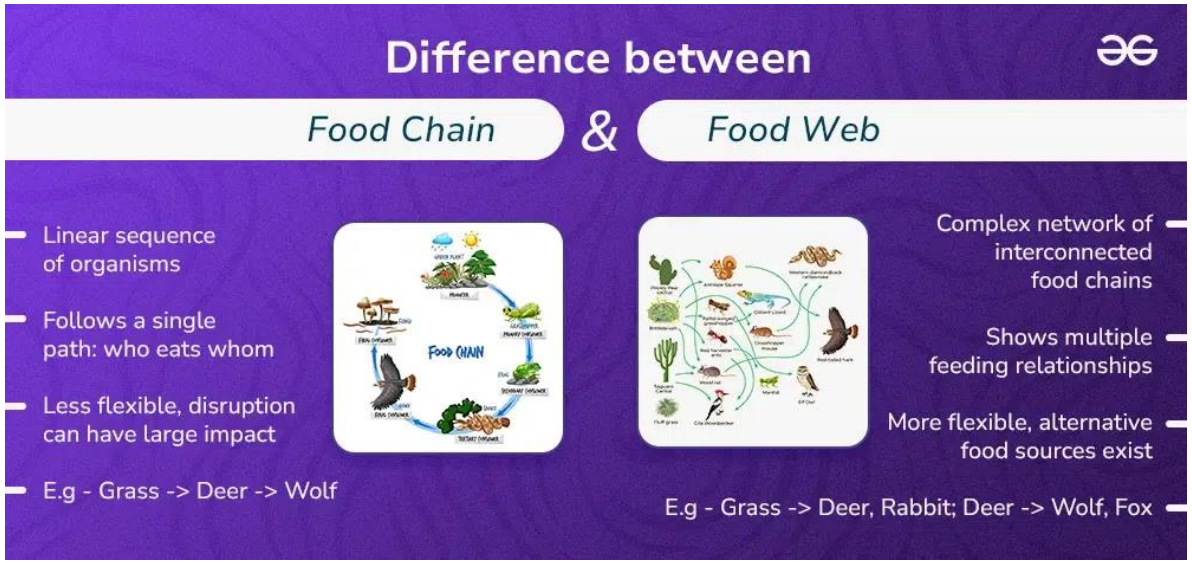
# Food Feb




**An example diagram of a food web including decomposers, producers, consumers, primary, secondary consumers, and tertiary consumers!**

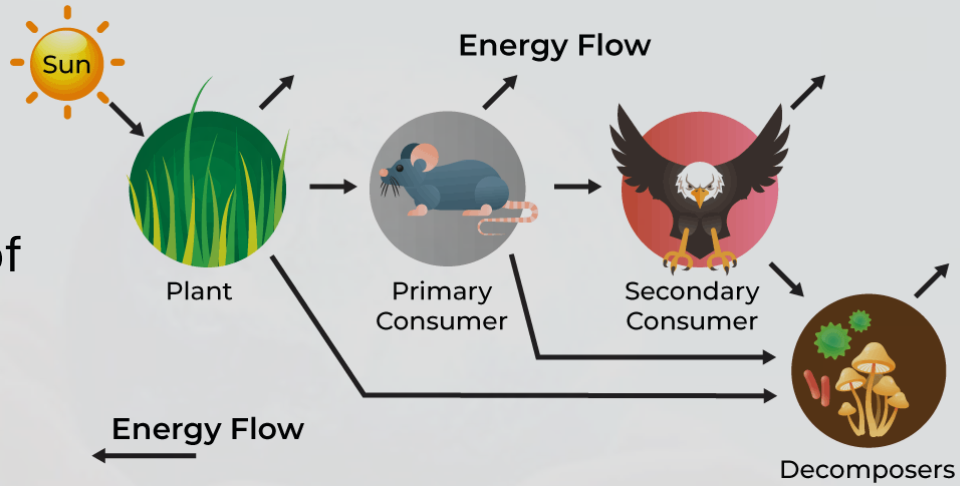
# The Difference Between Food Chain and Food Web?

The **difference between a food chain and a food web** lies in their complexity and structure. The Food chain and food web both represent the flow of energy and nutrients through ecosystems. A food chain represents a linear sequence of organisms where each is eaten by the next, while a food web depicts multiple interconnected food chains.



# What is the Direction of Energy Flow of Energy in an Ecosystem?

The direction of the energy flow in an ecosystem is **unidirectional**. It flows from the primary source of energy **i.e. the sun's light energy to producers or autotrophs which then transferred to the consumers**. The producer uses the solar energy to produce organic food which flows through a series of **trophic levels**. Each trophic level captures a portion of this energy for its metabolic needs, while the rest is passed to the next level.



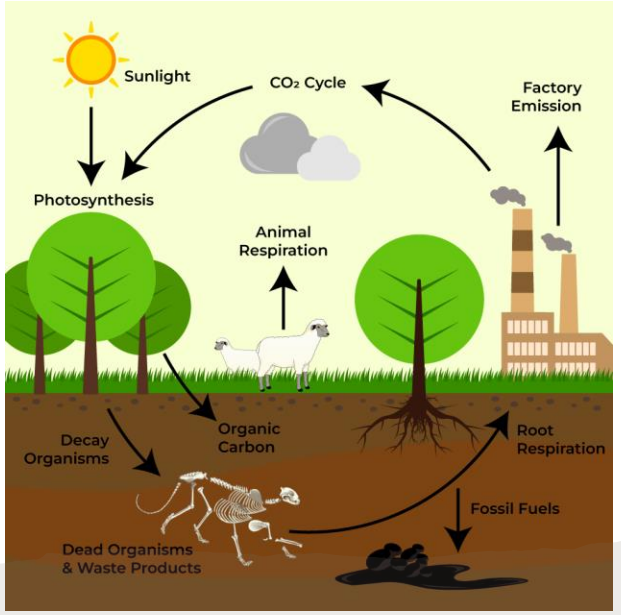

The flow of energy follows the following pathway;

**Solar Energy –> Producer (autotrophs) –> Consumer (herbivores) –> Consumer (carnivores) –> Consumer (higher levels of carnivores) –> Decomposer**

# Nutrient Cycle

The term **“nutrient cycle”** or **“biogeochemical cycle”** refers to the movement or exchange of nutrients among the living and nonliving constituents of an **ecosystem**. The phrase **“biogeochemical cycles”** refers to the interactions between organic and inorganic elements and focuses on the chemistry and motion of chemical elements and molecules. Nutrient cycling is the process through which components change into different forms and then return to their original state.

- The standing state of soil is the amount of nutrients (like carbon, nitrogen, phosphorus, and calcium) in it at a specific time.
- Plants, also called producers, absorb these nutrients from the soil.
- Plants convert the nutrients into organic matter.
- Organic matter helps transfer nutrients to other living things in the food chain.
- Nutrient cycling in the soil is influenced by:
  - Living organisms (biotic factors)
  - Non-living elements (abiotic factors)
  - Chemical processes
  - Physical conditions



# Energy Flow and Nutrient Cycle

**Energy flow**, which refers to both the food chain and the food web, can be described as the movement of energy from one trophic level to another. It is well recognized that the energy flow in an ecosystem is unidirectional, with heat being transferred from one trophic level to another. Here, sunlight is regarded as the best possible source of energy.

The transport of nutrients from the physical environment to living organisms and back to the environment is known as "**nutrient cycling**," and it is a cyclical process. Where nutrients are recycled further converted into various forms and then used again on Earth.

# Types of Nutrient Cycle

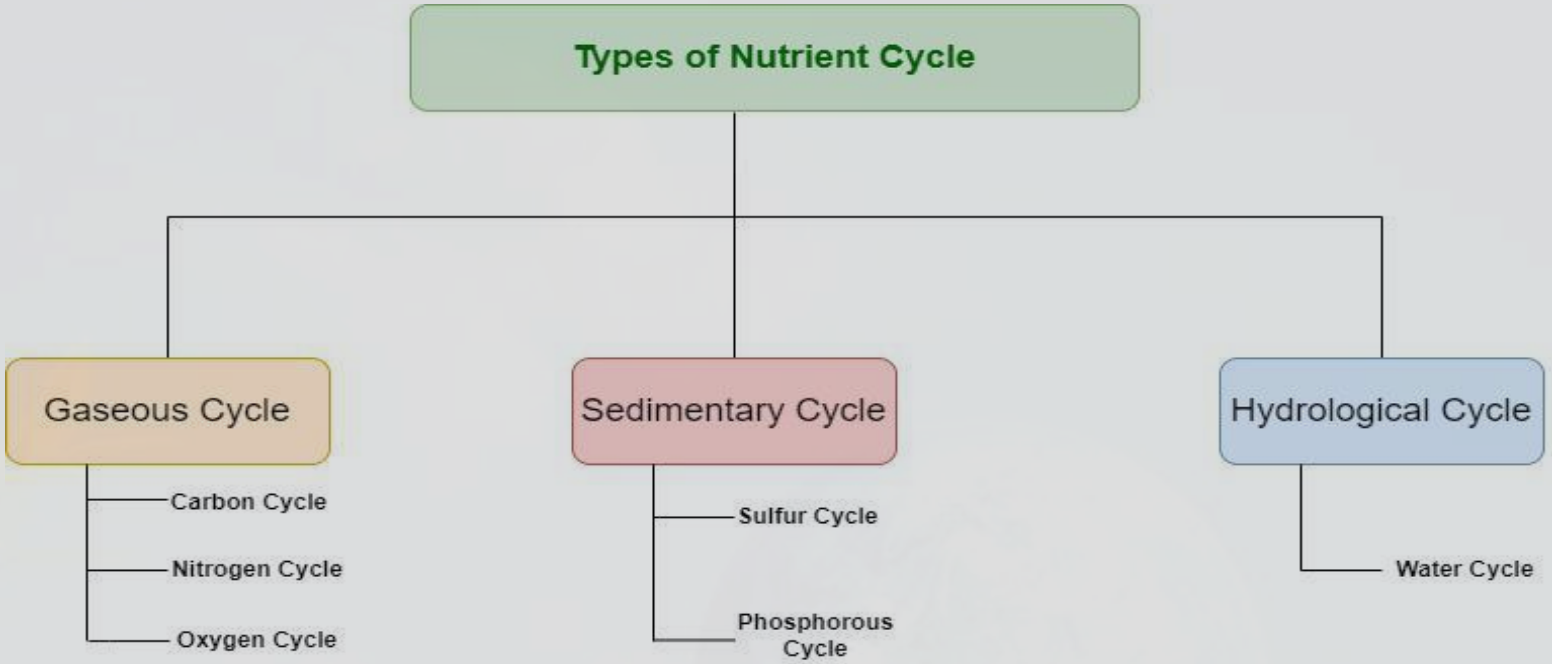
Depending on their reservoirs, an ecosystem exhibits one of three different nutrient cycles.

1. **Gaseous Cycles:** The atmosphere and ocean serve as the primary chemical storage spaces in these cycles. These non-mineral compounds are used in this kind of cycle. Examples of this type of nutrient cycle include the Nitrogen, Carbon, Hydrogen, and Oxygen cycles.

2. **Sedimentary Cycles:** Soil and rocks serve as the primary chemical storage spaces in these cycles. Mineral compounds are part of these cycles. Sedimentary cycles include the cycles of phosphorus and sulfur.

3. **Hydrological Cycle**: The reservoir in this cycle could be in the soil or the atmosphere. One illustration of this kind is the water cycle.

# Energy Flow and Nutrient Cycle

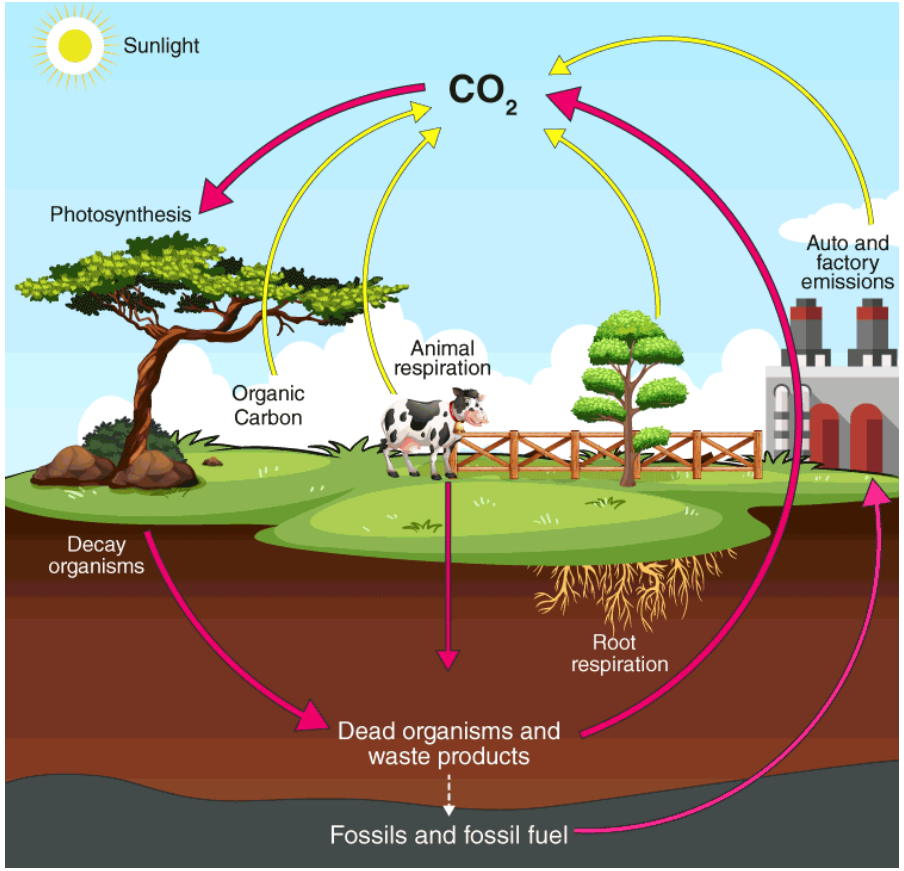



The main important nutrient cycles of an ecosystem are:

- Carbon cycle
- Nitrogen Cycle
- Oxygen Cycle
- Water Cycle

# Carbon Cycle

- Carbon is one of the essential parts of living organisms as it constitutes 49 percent of dry weight of the organisms.
- As for sources of Carbon, 71 per cent of carbon is dissolved in oceans.
- It is also present in the earth's crust as a fossil fuel.
- Carbon is present in the atmosphere in mainly two forms, Carbon dioxide and methane.
- Thus, the cycle involves all the components, including the atmosphere, oceans, living organisms and dead matter of an ecosystem.



# Impact of Human Activities on Carbon Cycle

The natural balance of the cycle of carbon has been distorted by the human activities, especially since the industrialization.

Destruction of forests combined with the release of carbon dioxide from industries and power plants have led to increasing Carbon dioxide emissions, which is causing global warming.

**Why is energy flow in an ecosystem called calorific?**

Energy flow in an ecosystem is called calorific because energy in an ecosystem is measured in terms of calories, which represent the amount of energy available and transferred between organisms.

**How many types of energy flow in ecosystem are there?**

There are two types of energy flow in an ecosystem i.e. the **radiant energy** of **sun or solar energy**, and the **fixed energy**.

## What is 10% Rule?

*As per the 10% rule the flow of energy from one trophic level to another will only be 10% of the total energy as the rest 90% energy will be used for metabolism and loss in the form of heat.*

## What is the Direction of Flow of Energy in an Ecosystem?

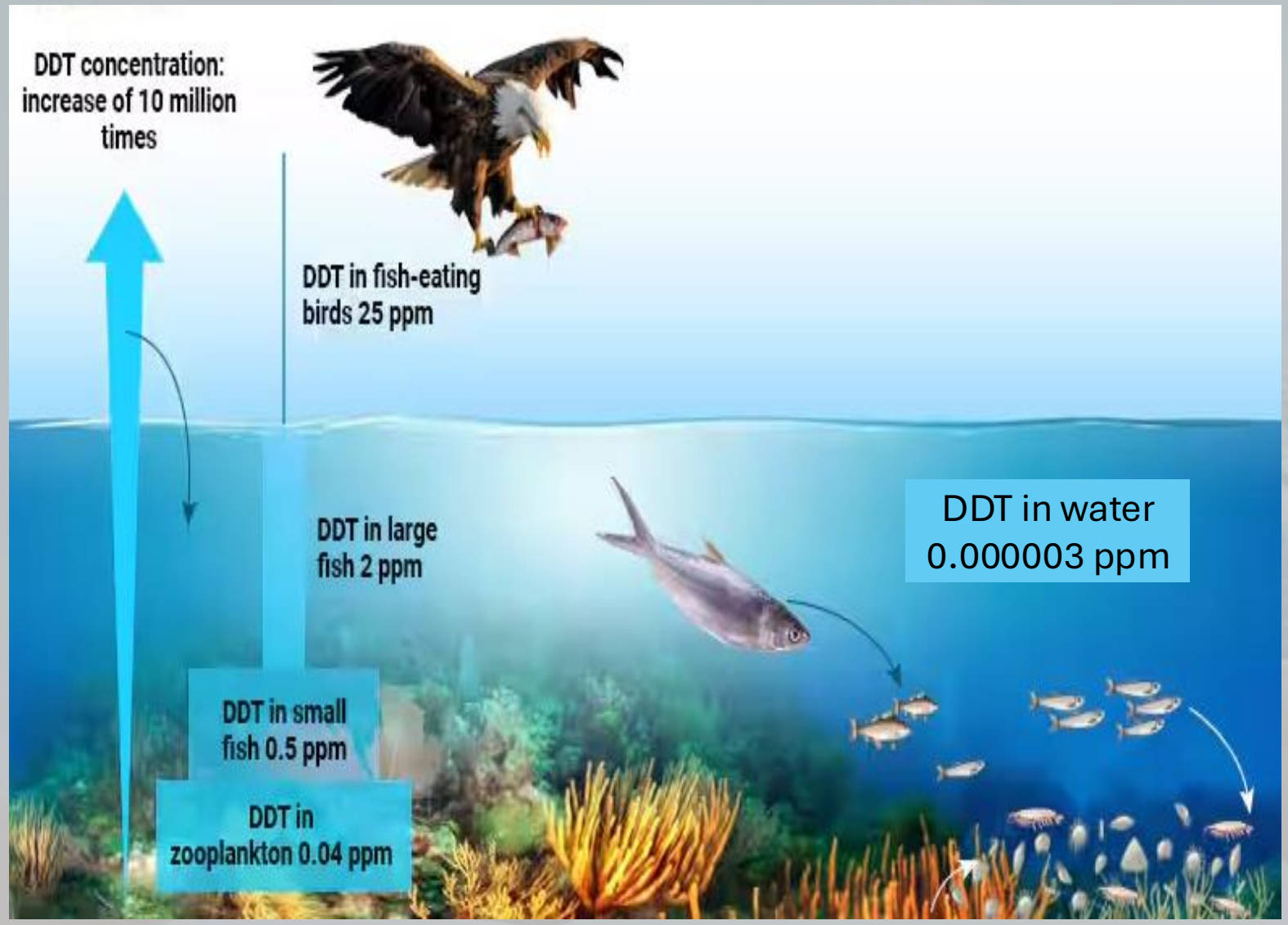
*The direction of energy flow in an ecosystem is unidirectional i.e moving from the primary source, usually sunlight, to producers, then to consumers and decomposers.*

What is the environment and what are its components?

What is an ecosystem and what are its components?

What is pollution and what are its sources?

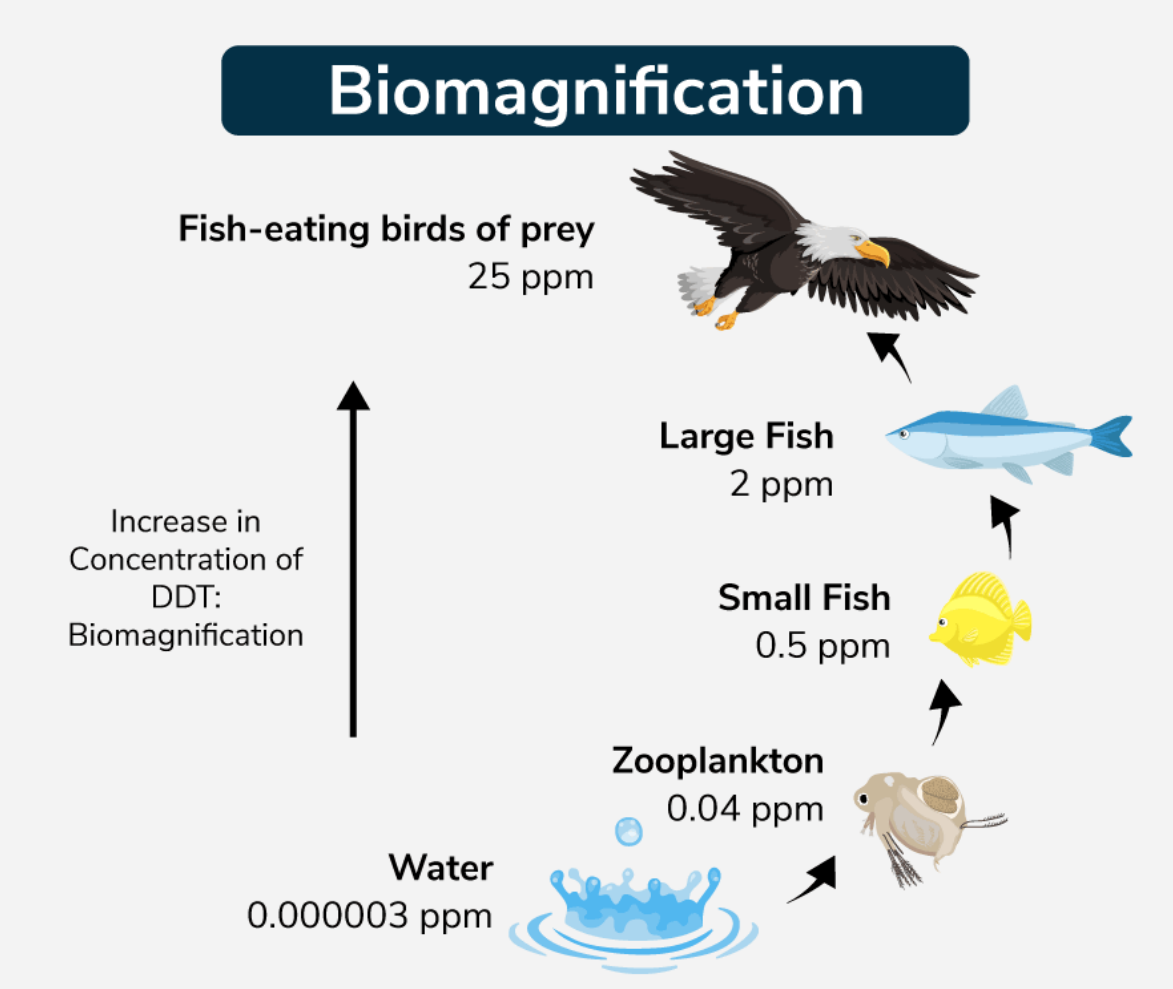
# What is pollution and what are its sources?




When the environment is polluted with chemical pollutants, we find that these pollutants enter food chains.

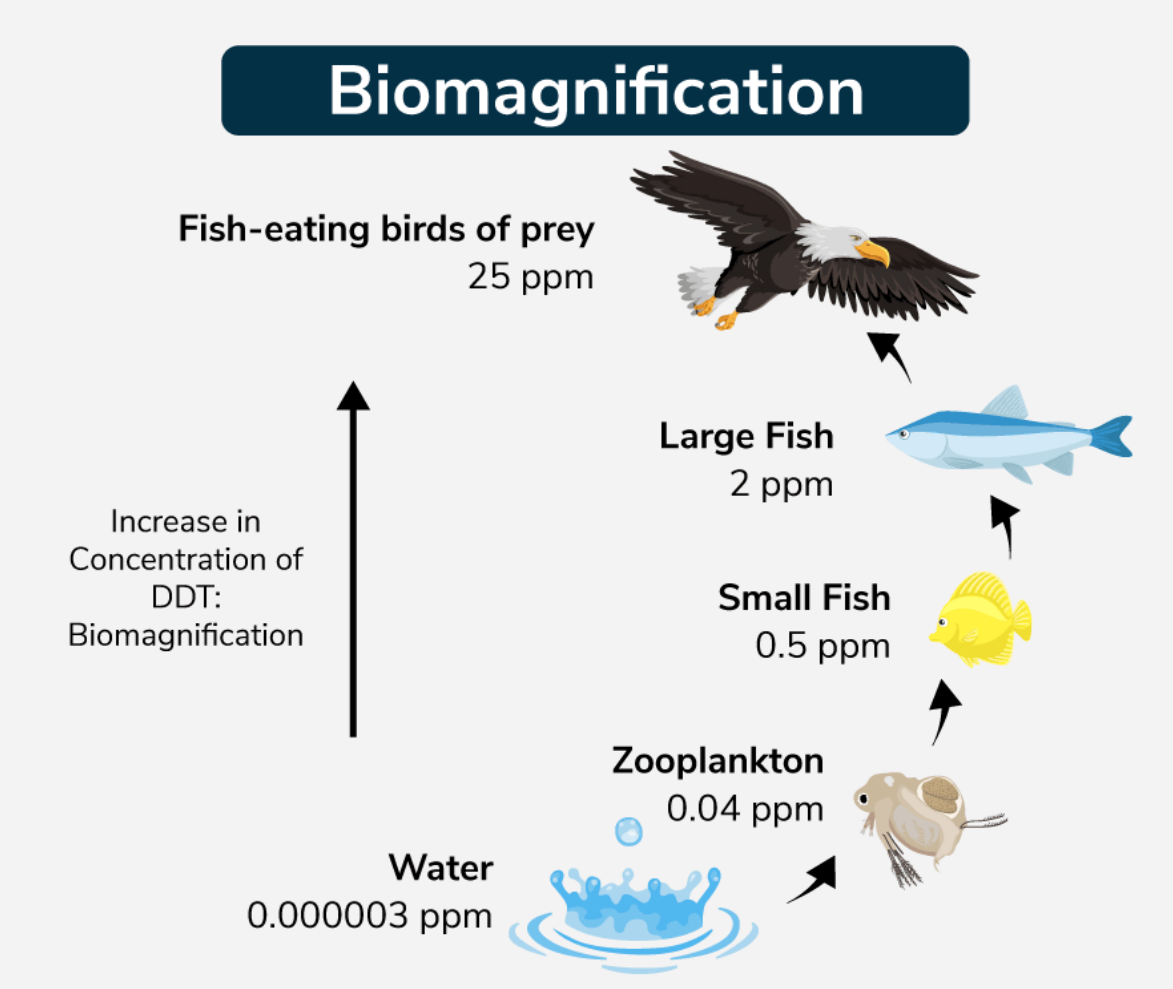
Concentrations may be low in the environment, but these concentrations accumulate within the bodies of living organisms, and the concentration of these substances increases with progress in food chains.

# Biomagnification




**Biomagnification** is the accumulation of harmful substances, pesticides, and heavy metals at every step in the food chain. Such pollutants cannot be decomposed and therefore accumulate within an organism's tissues. The toxins are accumulated by small organisms, and then through a food chain if a larger animal feeds on them, their concentration will increase the toxin levels within the top top predators. This results in serious health and environmental problems.

# Biomagnification




## Steps of Biomagnification

- Various sources link pollutants entering the ecosystem through water, soil, and air.
- These are then absorbed by organisms at the lower trophic levels, for example, plankton and small fish.
- Since these organisms are consumed, it progresses to increasing the concentration of pollutants as they go up the food chain.
- The top predators have the highest concentrations and, therefore, suffer the most devastating effects of biomagnification.

# Pollution

The efficiency of the ecosystem is greatly reduced or completely paralyzed when there is a change in the harmonic movement between the various elements.

Quantitative or qualitative change that occurs in the composition of the components of the ecosystem - leads to an imbalance in this system.

Environmental pollution adds an element that is not already present in the ecosystem, or it increases or decreases the presence of one of its components in a way that causes a disruption in the ecosystem in a specific area.

# Pollution

Environmental Pollution has emerged as one of the most pressing challenges of the 21st century. The issue has led to threats to human health, ecosystems, and the overall well-being of our planet.

Pollution, also called environmental pollution, the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

A very bad condition of environment in terms of quality and quantity is called as **POLLUTION.**

The influence of any substances causing nuisance, harmful effects, and uneasiness to the organism is called as **POLLUTION.**

**Contamination of natural environment that will be harmful to ecosystem is called as POLLUTION**

# Pollution

**Environmental contamination** significantly contributes to non-infectious diseases like cancer and respiratory illnesses, causing approximately **nine million deaths** annually. Air pollution alone is responsible for nearly seven million deaths.

Pollution, through **air**, **freshwater** and **ocean** contamination, accumulates **toxic chemicals** in the food chain, harming humans and animals. Biological and chemical pollutants also increase antimicrobial resistance.

# Pollution

- Any harmful material that, by getting introduced into the environment, causes environmental pollution is called a **Pollutant**.
- In other words, a **pollutant** is any substance that contaminates air, water, soil, etc., and damages their quality.
- **Pollutants** can be natural, such as volcanic ash, or created by human activity, such as trash or factory runoff.

# Pollution

Sources of environmental pollution:

1. Natural pollution (natural pollutants)

Pollutants that are not cause human intervention.

(e.g. forest fires, dust storms, pollen etc. Volcanic eruption, desert dust, sea spray, meteorites, decay of radon, and fires)

2. Pollution caused by human activity

- Industrial pollutants

(e.g. transportation - Factory - human livelihood)

- Chemical pollutants

(e.g. pesticides, industrial detergents, petroleum industries, textile industries, iron and steel, fertilizers, and others.)

- Physical pollutants

(noise, atomic radiation, and thermal pollution)

# Causes of Pollution

## ➢ Rapid Industrialization

- The concentration of industries in urban areas releases pollutants into the air, water, and soil, causing environmental pollution.
- The rapid pace of urbanization also increases waste generation and resource consumption, exacerbating pollution and causing severe environmental pollution.
- Industries also generate hazardous wastes in many forms, including liquids, solids, gases, and sludge.

## ➢ Rapid Urbanization

- The increased pace of urbanization in recent times has led to worsening environmental pollution.
- It creates issues such as deforestation and habitat loss, increased emissions and waste generation, etc.

# Causes of Pollution

## ➢ Forest Fires

- The frequency of forest fires or wildfires has increased because of human actions, such as land clearing, encroachment, etc.
- These wildfires are a huge source of environmental pollution, adding large amounts of gaseous and other pollutants to the environment.

## ➢ Improper Agricultural Practices

- According to the IPCC report, the agriculture sector produces at least 23 % of global **greenhouse gas emissions** (second only to the energy sector).
- Using chemical fertilizers, pesticides, and herbicides in agriculture contributes to soil and water pollution and environmental pollution.
- Intensive farming practices also lead to deforestation, soil erosion, habitat destruction and environmental pollution.

# Causes of Pollution

## ➢ Deforestation

- Deforestation refers to the decrease in forest areas worldwide that are lost for other uses, such as agricultural croplands, urbanization, or mining activities.
- This causes an imbalance in the local ecology and reduces nature's capability to absorb pollutants, leading to environmental pollution.

## ➢ Other Causes

- Other prominent causes of environmental pollution include continued reliance on fossil fuels, vehicular emissions, and improper waste management.

# Types of Pollution

Environmental pollution can be categorized into several types based on the nature of the pollutants and the media they affect.

Some of the major types of environmental pollution are described below.

| Air Pollution | Water Pollution | Soil Pollution | Noise Pollution | Thermal Pollution | Nuclear Pollution or Radiation Pollution | Marine Pollution | Plastic Pollution |
|---|---|---|---|---|---|---|---|

# Life Cycle and Environmental Balance

Environmental balance is a system of maintenance and sustainability. This power is strongly influenced by the magnitude of human activities that damage the order of an ecosystem.

Inorganic compounds (carbon dioxide, phosphorus, nitrogen, mineral salts, and water) are converted by autotrophs (green plants) into organic substances (sugars, for example).

These sugars are used as an energy source to produce various types of chemical compounds (proteins, fats, vitamins, etc.).
Through food, these substances are transferred to the primary consumers (plant-eaters), followed by consumers at the second level (carnivores), then the third, etc.

Decomposer organisms break down the waste and remains of previous organisms and transform them into simple inorganic materials that plants exploit again to recycle these compounds.

# Environmental Imbalance

If there is a defect or deficiency in the components of the environment due to an external influence, such as air, water, or soil pollution, or the extinction of some types of plants or animals for example, this affects the nature of the relationships and interactions between them, and the system begins to become imbalanced and disturbed, loses its balance, and what is called environmental imbalance occurs, and the appearance that accompanies it multiple environmental problems.

**Ecological imbalance** is the disruption of the natural balance of an ecosystem as a result of natural or human-caused disturbances.

**Disturbance** is any change that causes an imbalance in the ecosystem.

# Environmental Imbalance

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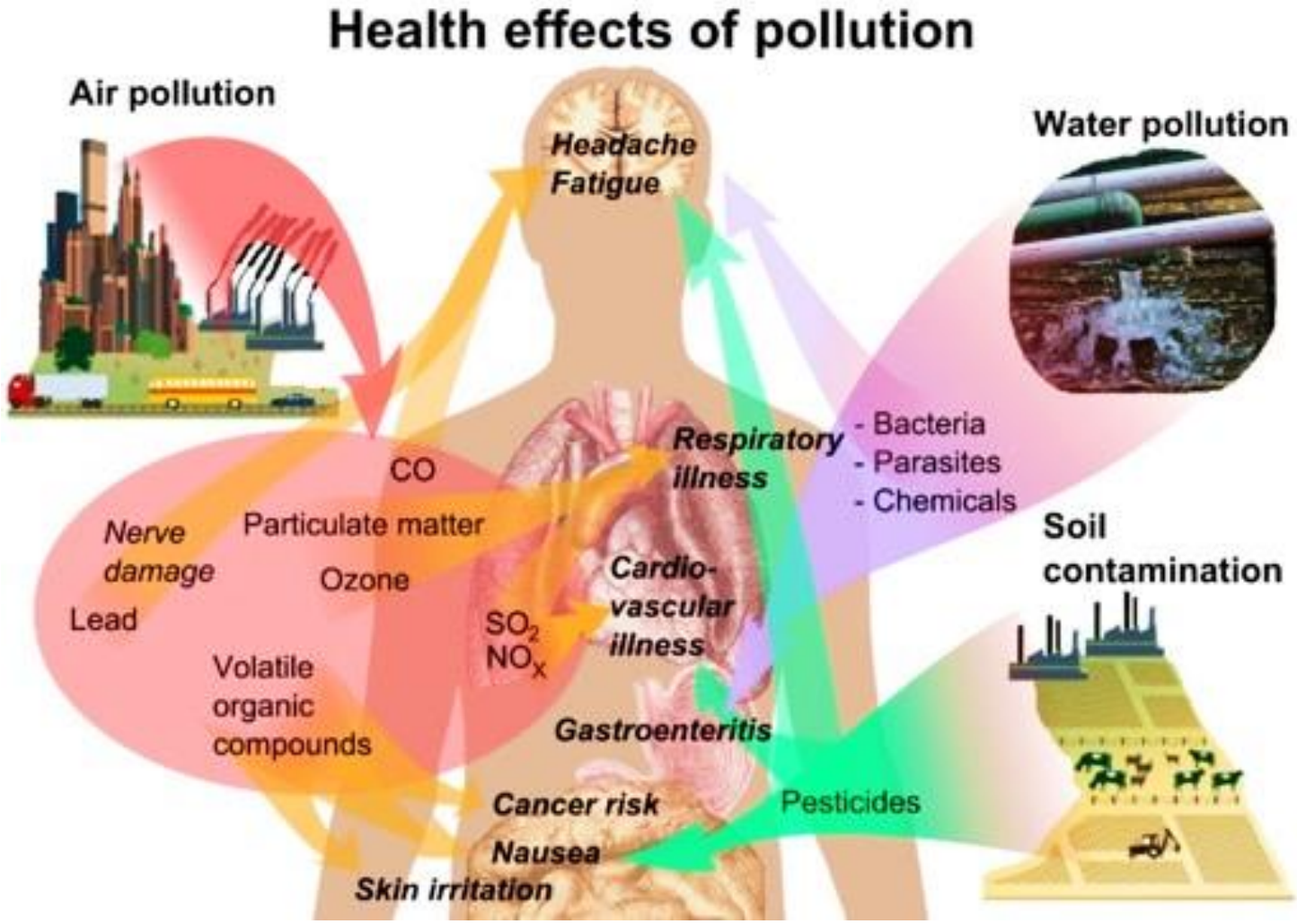
# Environmental Imbalance

Through food chains, webs, and energy transfer, we can understand how pollutants are transferred to the human body and how they accumulate.

Many chemical pollutants build up in fat and break down very slowly. Because of this, they stay in the body for a long time and keep accumulating. Over time, this can lead to long-term poisoning, but people don't notice it until the chemicals reach a dangerous level. At that point, they start interfering with how cells work and disrupt the vital processes of cells which can lead to various diseases.



According to World Health Organization (WHO) estimates, air pollution is responsible for **7 million premature deaths a year** due to respiratory, cardiovascular, and immune system ailments. The damage caused by polluted indoor air must also be taken into consideration.

Water pollution is so widespread that nearly two billion people, or a quarter of the world's population, drink **contaminated water** **on a** daily basis.

Furthermore, pollutants such as waste from the pharmaceutical and cosmetics industries, when dispersed into the environment, cause an increase in **bacterial resistance to antibiotics.**

Climate change also means an increase in extreme events such as **cyclones, floods** and **drought**.

# Air Pollution

# Atmosphere?

One of the main components of Earth's interdependent physical systems is the atmosphere.

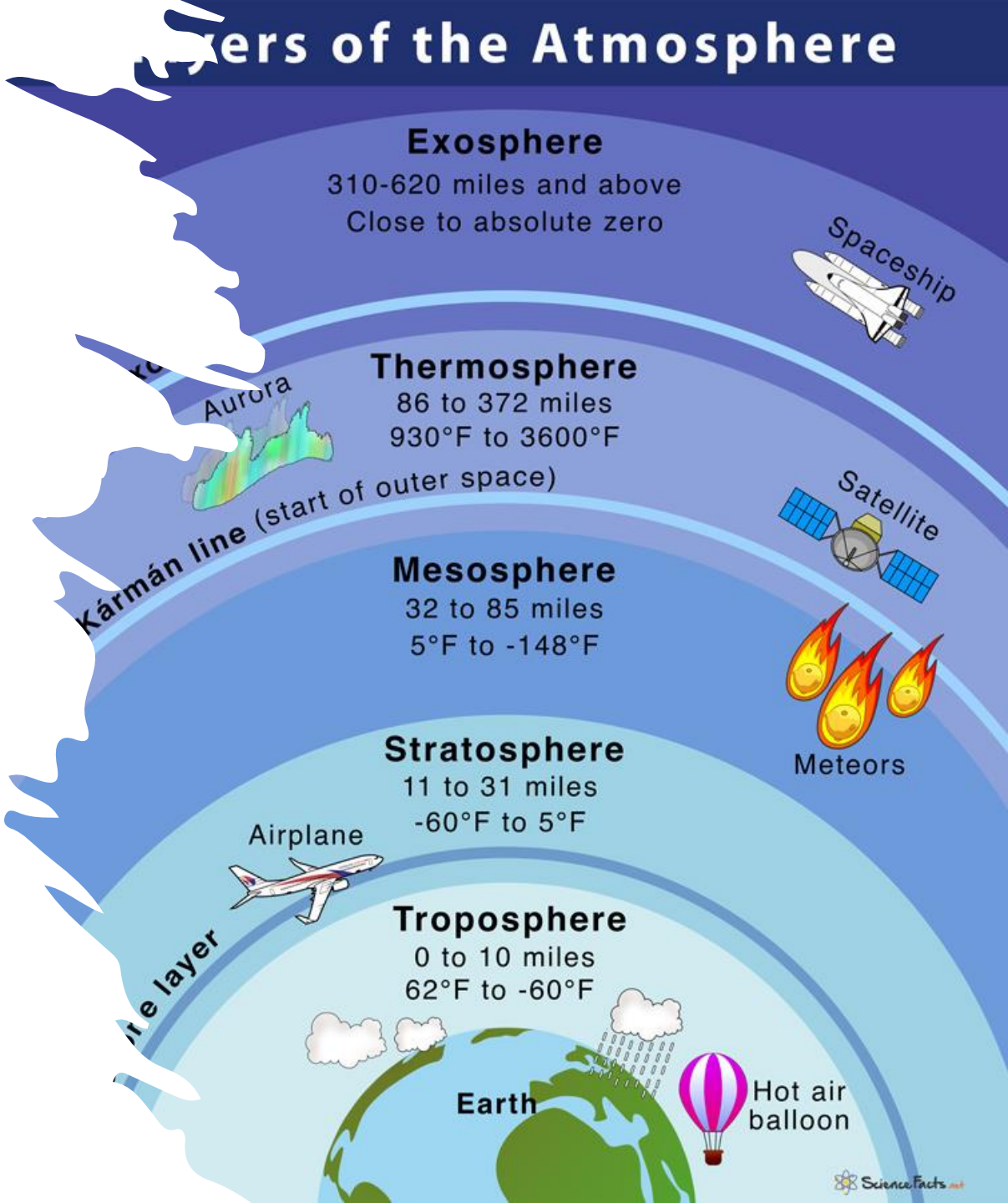
An atmosphere is made of the layers of gases surrounding a planet or other celestial body.

---

Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases.

These gases are found in atmospheric layers (troposphere, stratosphere, mesosphere, thermosphere, and exosphere) defined by unique features such as temperature and pressure.

These layers protects us from direct radiation of Sun (UV rays) and other harmful cancer-causing radiations.



# Whats is air pollution?

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere.

It is the contamination of air by harmful gases, dust and smoke which affects plants, animals and humans drastically.

WHO data show that almost all of the global population (99%) breathe air that exceeds WHO guideline limits and contains high levels of pollutants, with low- and middle-income countries suffering from the highest exposures.

**Air pollution** can occur naturally or be caused by human activities.

**Air pollution** can cause diseases, allergies, and even death; it can also cause harm to animals and crops and damage the natural environment (for example, climate change, ozone depletion or habitat degradation) or built environment (for example, acid rain).

Air pollution causes around 7 or 8 million deaths each year. It is a significant risk factor for a number of pollution-related diseases, including heart disease, stroke, chronic obstructive pulmonary disease (COPD), asthma and lung cancer.

It is the fourth-largest risk factor overall for human health as 99% of people are exposed to harmful levels of air pollution.

Outdoor particulate pollution (PM2.5) is the largest cause of death (4.7 million), followed by indoor air pollution (3.1 million) and ozone (0.5 million)

# What are Air Pollutants?

**Pollutants** are the substances which cause pollution. Air pollutants, consisting of particles and gases, are emissions that contaminate the atmosphere, exerting negative effects on human health and on the environment. There are two types of air pollutant;

1. **Primary Pollutants:** Primary pollutants are produced directly by a source and remain in the same chemical form after they have been emitted into the atmosphere. Examples include ash from a volcanic eruption, carbon monoxide gas from motor vehicle exhausts, and sulfur dioxide released from factories.

2. **Secondary Pollutants:** Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. Ground-level ozone is a prominent example of a secondary pollutant.

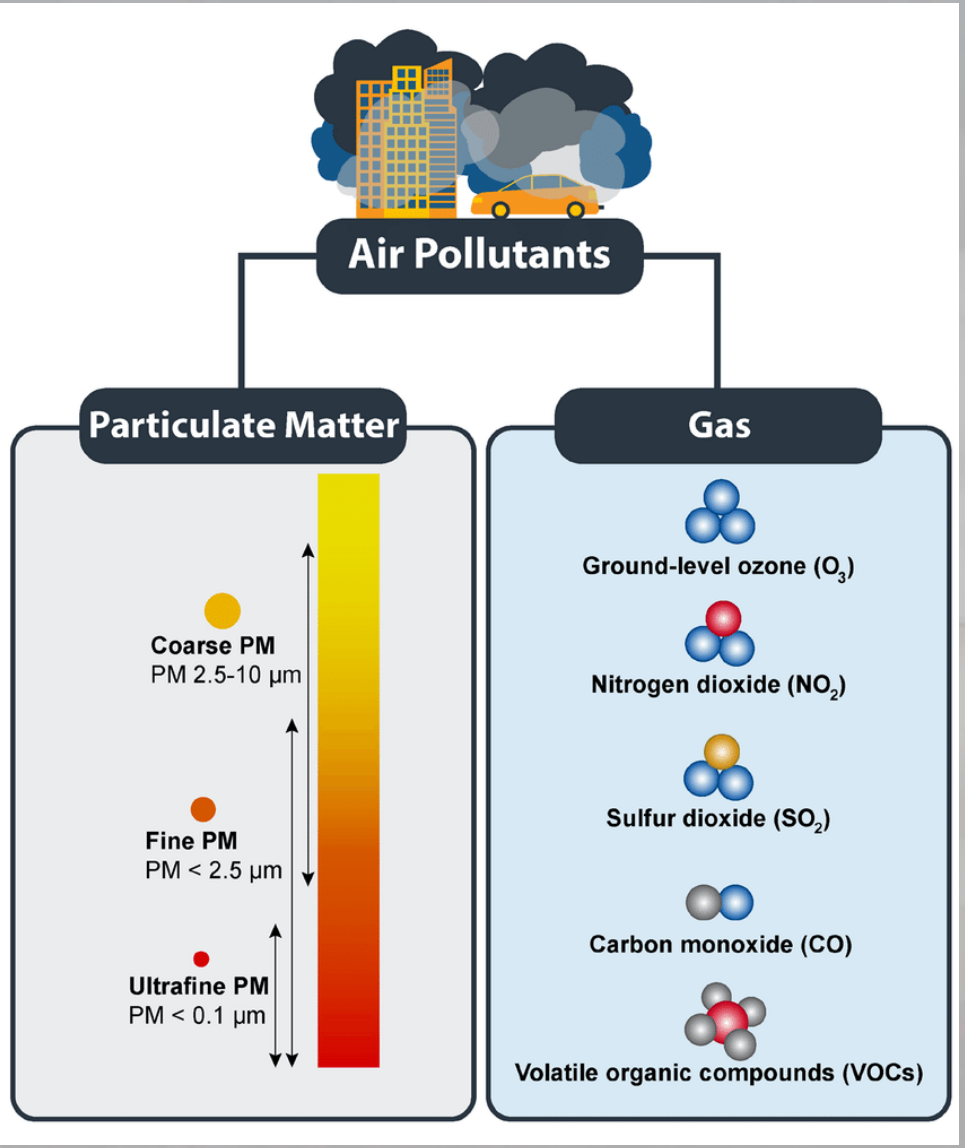
# Major Air Pollutants

**Table 20.1 Major Air Pollutants**

| Pollutant | Composition | Primary or Secondary | Characteristics |
|---|---|---|---|
| ***Particulate matter*** | | | |
| Dust | Variable | Primary | Solid particles |
| Lead | Pb | Primary | Solid particles |
| Sulfuric acid | $H_2SO_4$ | Secondary | Liquid droplets |
| ***Nitrogen oxides*** | | | |
| Nitrogen dioxide | $NO_2$ | Primary | Reddish-brown gas |
| ***Sulfur oxides*** | | | |
| Sulfur dioxide | $SO_2$ | Primary | Colorless gas with strong odor |
| ***Carbon oxides*** | | | |
| Carbon monoxide | CO | Primary | Colorless, odorless gas |
| Carbon dioxide* | $CO_2$ | Primary | Colorless, odorless gas |
| ***Hydrocarbons*** | | | |
| Methane | $CH_4$ | Primary | Colorless, odorless gas |
| Benzene | $C_6H_6$ | Primary | Liquid with sweet smell |
| ***Ozone*** | $O_3$ | Secondary | Pale blue gas with acrid odor |
| ***Air toxics*** | | | |
| Chlorine | $Cl_2$ | Primary | Yellow-green gas |

# Classification of Pollutants

In terms of environmental chemistry, these pollutants are broadly divided into two categories – Gaseous Pollutants and Particulate pollutants (Particulate matters-PM).



# Classification of Pollutants

| Particulate Pollutants | Gaseous Pollutants | |
|---|---|---|
| 1. Lead<br>2. Fly Ash<br>3. Metallic Oxides<br>4. Nanoparticles | 1. Carbon monoxide (CO)<br>2. Carbon dioxide (CO2)<br>3. Chlorofluorocarbons (CFCs)<br>4. Ozone (O3)<br>5. Nitrogen oxide (NOx)<br>6. Sulphur dioxide (SO2) | • Volatile organic compounds (VOCs)<br>• Benzene<br>• Ethylene<br>• Biological pollutants<br>• Asbestos<br>• Radon |

The most common air pollutants are typically classified into six main categories, known as criteria pollutants.

- Ozone ($O_3$)
- Particulate matter
- CO
- $SO_2$
- $NO_2$
- Pb

## The Six Criteria Pollutants

| | |
|---|---|
| **OZONE** | • Made up of three oxygen atoms<br>• Occurs in Earth's upper atmosphere (good) and at ground-level (bad)<br>• Ground-level ozone is a harmful air pollutant and the main ingredient in smog |
| **PARTICULATE MATTER** | • Mixture of solid particles and liquid droplets found in the air<br>• Can be harmful due to the small size of the solids or droplets<br>• Droplets can be inhaled which may cause serious health problems |
| **CARBON MONOXIDE** | • Colorless, odorless gas that can be harmful when inhaled in large quantities<br>• Released when something is burned<br>• Cars, trucks and other vehicles, or machinery that burn fossil fuels are the main sources of outdoor CO pollution |
| **SULFUR DIOXIDE** | • Emitted to the air from the burning of fossil fuels by power plants and other industrial facilities<br>• Can be harmful to the human respiratory system and make it difficult to breathe<br>• Reacts with nitrogen dioxides, water, and other chemicals to create acid rain |
| **NITROGEN DIOXIDES** | • Part of a group of highly reactive gases known as nitrogen oxides (NOx)<br>• Primarily emitted from the burning of fuel and forms from emissions from cars, trucks, buses, off-road equipment, and power plants<br>• Reacts with other chemicals in the air forming particulate matter, ozone, and acid rain |
| **LEAD** | • Emitted into the air from ore and metals processing and piston-engine aircraft operating on leaded aviation fuel; highest concentrations found near lead smelters<br>• Can negatively affect the nervous system, kidney function, immune system, reproductive and development systems, and the cardiovascular system |

## Sources of Air Pollution

There are many different sources of air pollution. Some air pollutants (such as nitrogen oxides) originate mainly from human activities, while some (notably dust and gases) come mostly from natural sources. However, many air pollutants (including dust and sulfur dioxide) come from a mixture of natural and human sources. he primary sources of air pollution include:

- **Burning of Fossil Fuels:** The combustion of fossil fuels emits a large amount of Sulphur dioxide. Carbon monoxide released by incomplete combustion of fossil fuels also results in air pollution.
- **Automobiles:** The gases emitted from vehicles such as jeeps, trucks, cars, buses, etc. pollute the environment. These are the major sources of greenhouse gases and also result in diseases among individuals.

- **Agricultural Activities:** Ammonia is one of the most hazardous gases emitted during agricultural activities. The insecticides, pesticides and fertilizers emit harmful chemicals in the atmosphere and contaminate it.
- **Factories and Industries:** Factories and industries are the main source of carbon monoxide, organic compounds, hydrocarbons and chemicals. These are released into the air, degrading its quality.
- **Mining Activities:** In the mining process, the minerals below the earth are extracted using large pieces of equipment. The dust and chemicals released during the process not only pollute the air, but also deteriorate the health of the workers and people living in the nearby areas.
- **Domestic Sources:** The household cleaning products and paints contain toxic chemicals that are released in the air. The smell from the newly painted walls is the smell of the chemicals present in the paints. It not only pollutes the air but also affects breathing.

# Air pollution concerns geographers at three levels;

- Global
- Regional
- Local

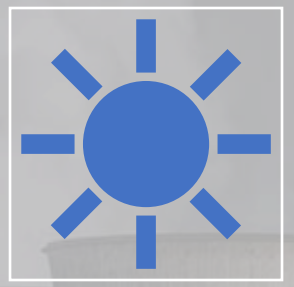
- Global
  - Global warming
    - Pollution may be causing Earth's temperature to rise
  - Greenhouse effect
    - Anticipated temp increase on Earth caused by carbon dioxide trapping some of the radiation emitted by the surface
    - Can have devastating consequences, even if only a few degrees
  - Global-scale ozone damage
    - Stratosphere contains ozone gases
      - Absorbs dangerous UV rays
    - Threatened by pollutants called chlorofluorocarbons (CFCs)

- Regional
  - At regional scale, air pollution may damage vegetation and water supply through acid deposition
    - Definition: tiny droplets of sulfuric acid and nitric acid form and return to Earth's surface
    - Leads to acid precipitation

- Local
  - Urban air pollution
    - Carbon monoxide
    - Hydrocarbons
    - particulates

# Global Effect of Air Pollution

Climate Change/Global warming



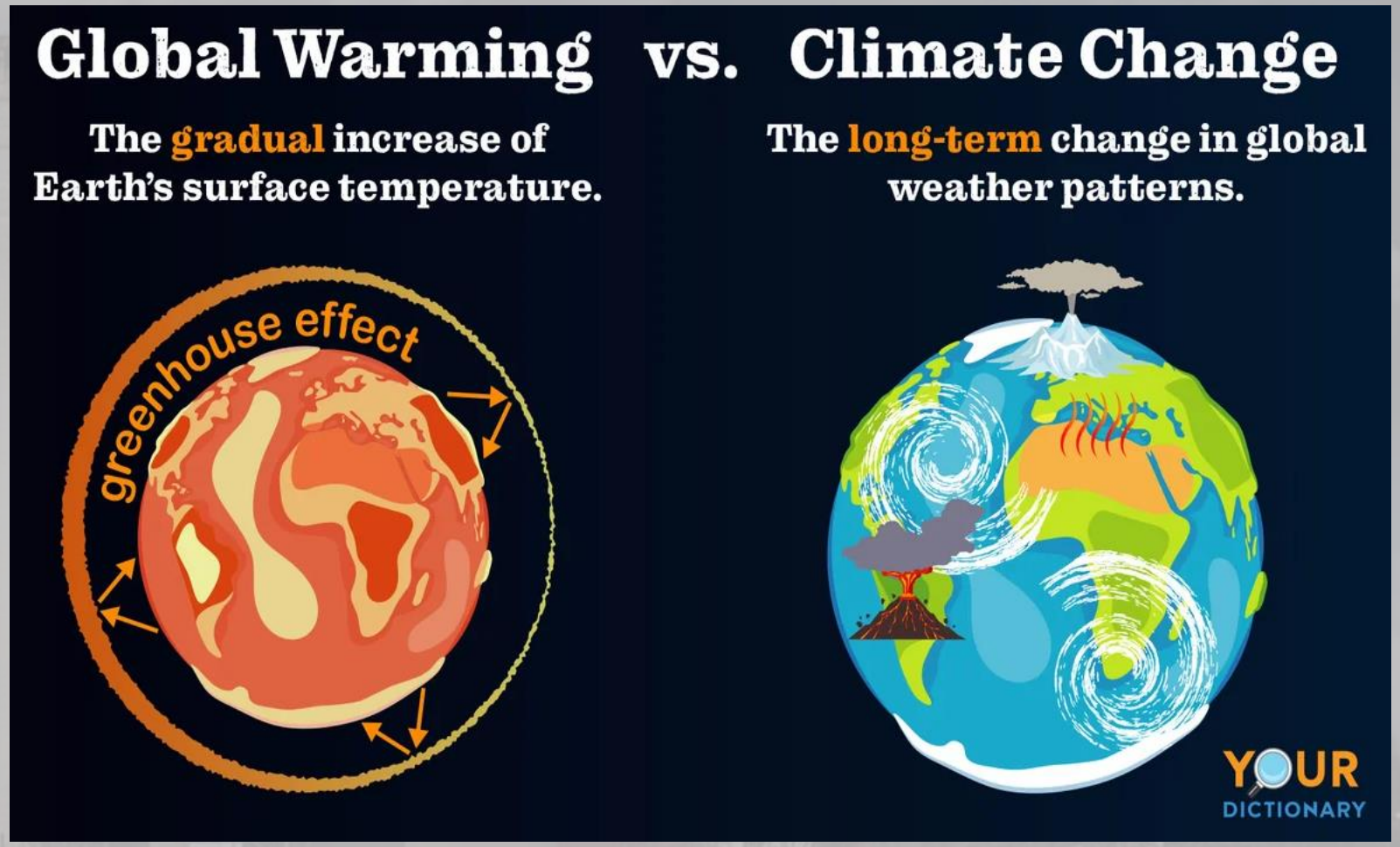
Ozone depletion

Acid Rain

# Global Warming vs Climate Change

Do you know the difference between **global warming** and ?

While **climate change** these two words are similar, they have distinct definitions.



# Global Warming vs Climate Change

| | Global Warming | Climate Change |
|---|---|---|
| **What Is It?** | Gradual increase of the surface temperature of Earth | Long-term change of the local, regional and global weather patterns around the world including global warming and its side effects |
| **What Causes It?** | $CO_2$ and other greenhouse gases | Human factors or natural changes of Earth |
| **Example** | Rising of the global sea temperature of 1.5 degrees Fahrenheit since 1901 | Changes in plants' blooming times |

# Ozone Layer & Depletion in Stratosphere

**Ozone ($O_3$), or trioxygen,** is mainly found in two layers of our atmosphere:

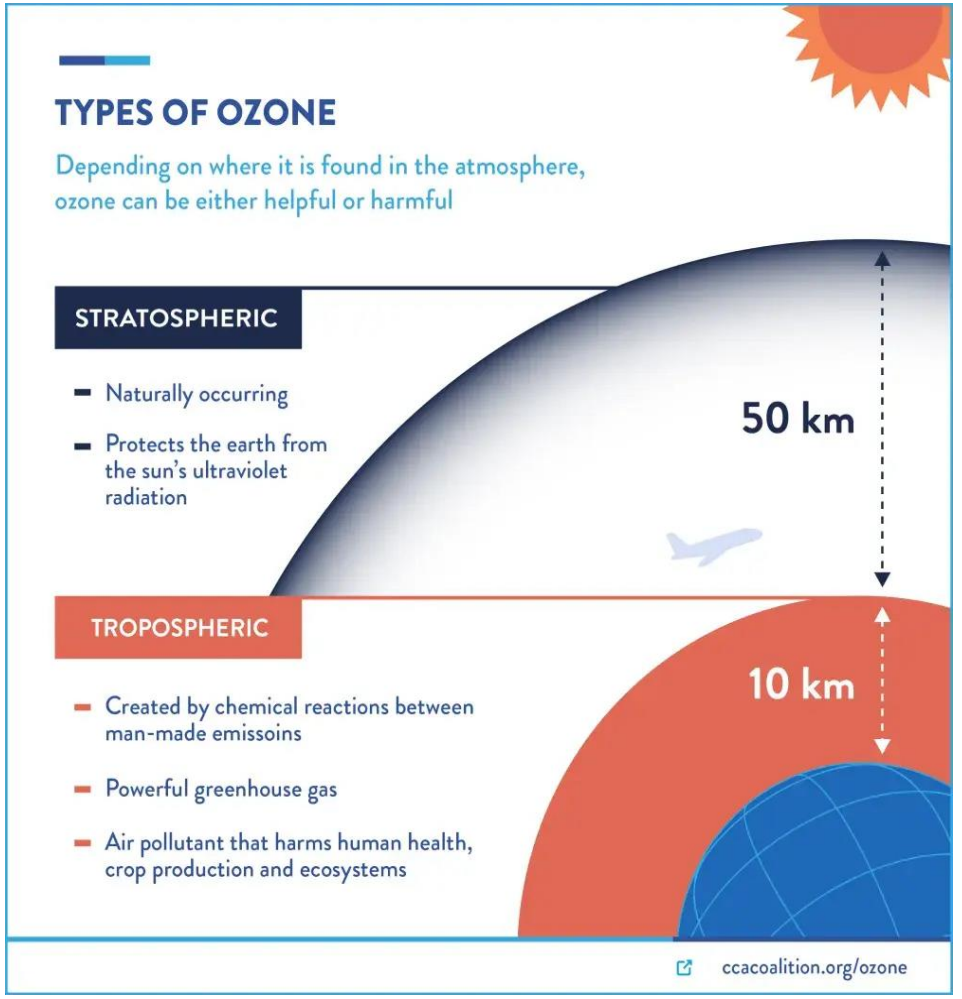

The stratosphere, a layer in the atmosphere between approximately 10 and 50 kilometers above the Earth's surface, contains around **90%** of the total atmospheric ozone amount. This stratospheric ozone is generally known as the "**Ozone layer**".

The ozone in the troposphere, the lowest layer in the atmosphere that reaches from the Earth's surface to an altitude between 8 to 15 kilometers, accounts for the remaining **10%** of ozone.

# Ozone Layer & Depletion in Stratosphere

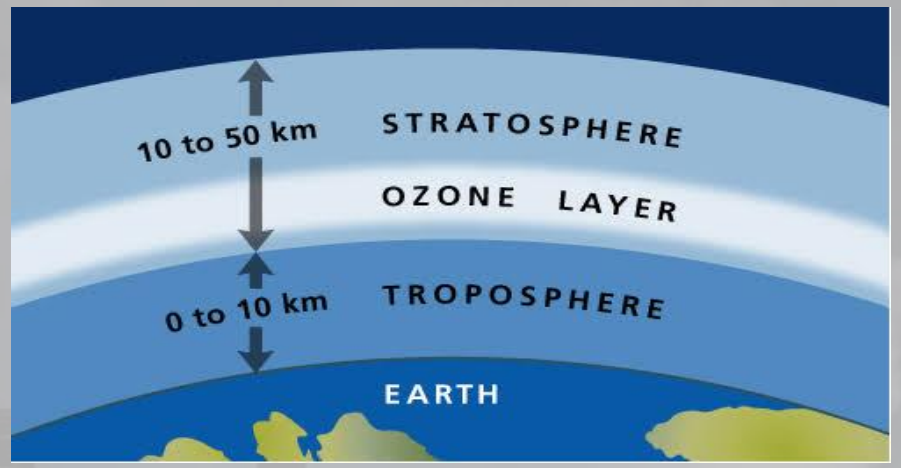
**Stratospheric ozone** is formed naturally through the interaction of UV radiation with oxygen ($O_2$), reduces the amount of harmful UV radiation reaching the Earth's surface. Affected by the man-made pollutants like CFC.

**Tropospheric or ground-level ozone** – what we breathe – is formed primarily from photochemical reactions between two major classes of air pollutants, volatile organic compounds (VOC) and nitrogen oxides (NOx). Ozone in this layer contributes to what we typically experience as "**smog**" or "**haze**".



# Ozone Layer & Depletion in Stratosphere

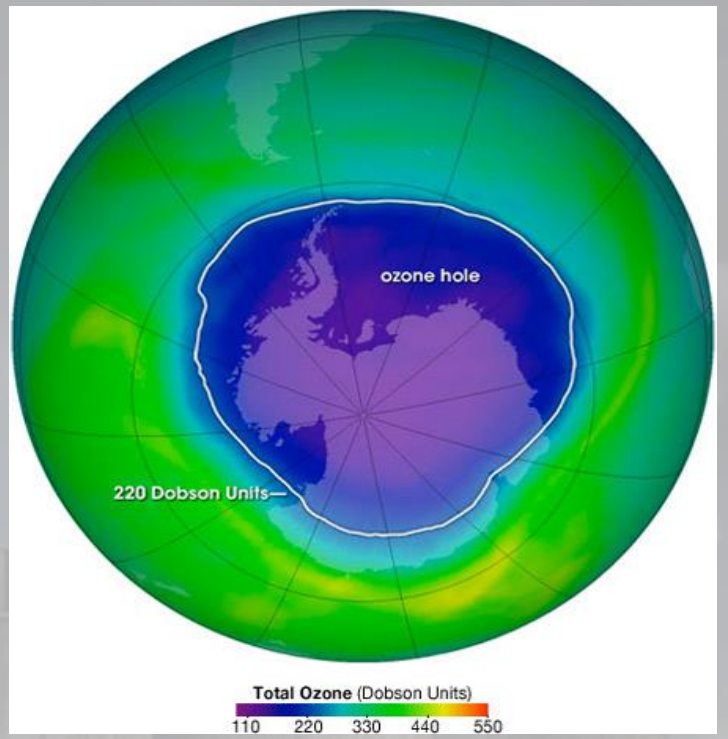
***"The ozone layer is a region in the earth's stratosphere that contains high concentrations of ozone and protects the earth from the harmful ultraviolet radiations of the sun."***




When chlorine and bromine atoms come into contact with ozone in the stratosphere, they destroy ozone molecules. One chlorine atom can destroy over 100,000 ozone molecules before it is removed from the stratosphere. Ozone can be destroyed more quickly than it is naturally created. **This imbalance leads to a thinning of the ozone layer, a process known as "Ozone depletion".**

# Ozone Layer & Depletion in Stratosphere

Some compounds release chlorine and bromine on exposure to high ultraviolet light, which then contributes to ozone layer depletion. Such compounds are known as **Ozone Depleting Substances (ODS).**




It was first discovered in 1985 over **Antarctica**

**ODS** that release chlorine include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), carbon tetrachloride, and methyl chloroform. ODS that release bromine include halons and methyl bromide.

**Chlorofluorocarbons are the most abundant ozone-depleting substance. It is only when the chlorine atom reacts with some other molecule, it does not react with ozone.**

# Acid Rain/Acid Deposition

## What is Acid Rain?

Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.

## What Causes Acid Rain

Acid rain results when sulfur dioxide ($SO_2$) and nitrogen oxides ($NO_X$) are emitted into the atmosphere and transported by wind and air currents. The $SO_2$ and $NO_X$ react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.

# Acid Rain/Acid Deposition

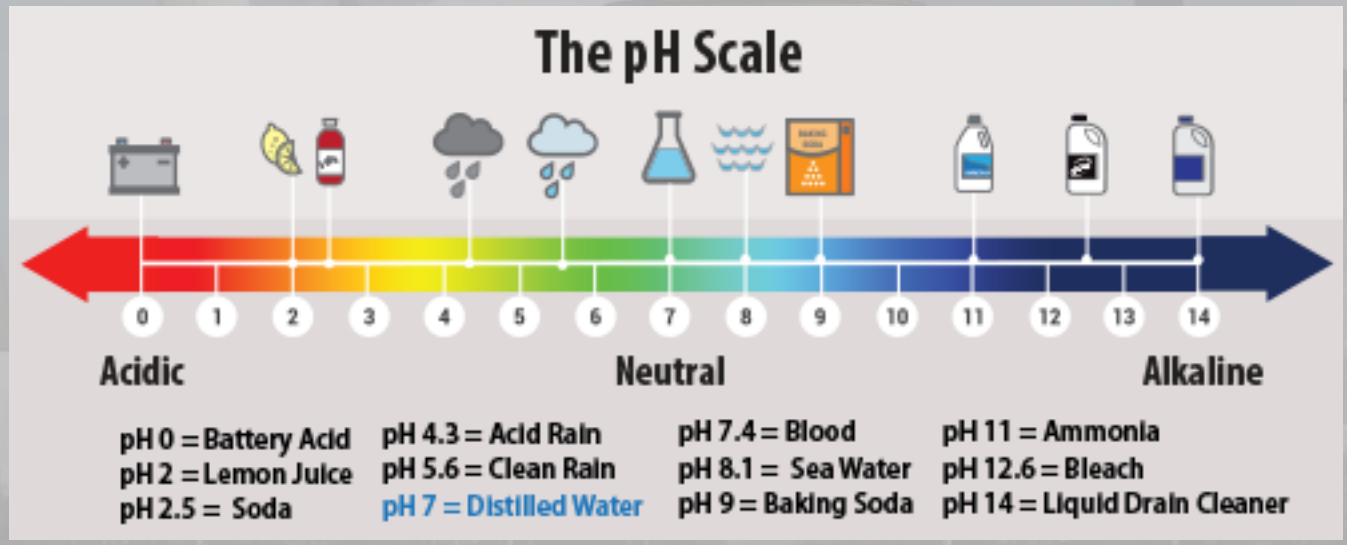
While a small portion of the $SO_2$ and $NO_X$ that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels. The major sources of $SO_2$ and $NO_X$ in the atmosphere are:

- Burning of fossil fuels to generate electricity. Two thirds of $SO_2$ and one fourth of $NO_X$ in the atmosphere come from electric power generators.
- Vehicles and heavy equipment.
- Manufacturing, oil refineries and other industries.

Winds can blow $SO_2$ and $NO_X$ over long distances and across borders making acid rain a problem for everyone and not just those who live close to these sources.

# Measuring Acid Rain

Acidity and alkalinity are measured using a pH scale for which 7.0 is neutral. The lower a substance's pH (less than 7), the more acidic it is; the higher a substance's pH (greater than 7), the more alkaline it is. Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide ($CO_2$) dissolves into it forming weak carbonic acid. Acid rain usually has a pH between 4.2 and 4.4

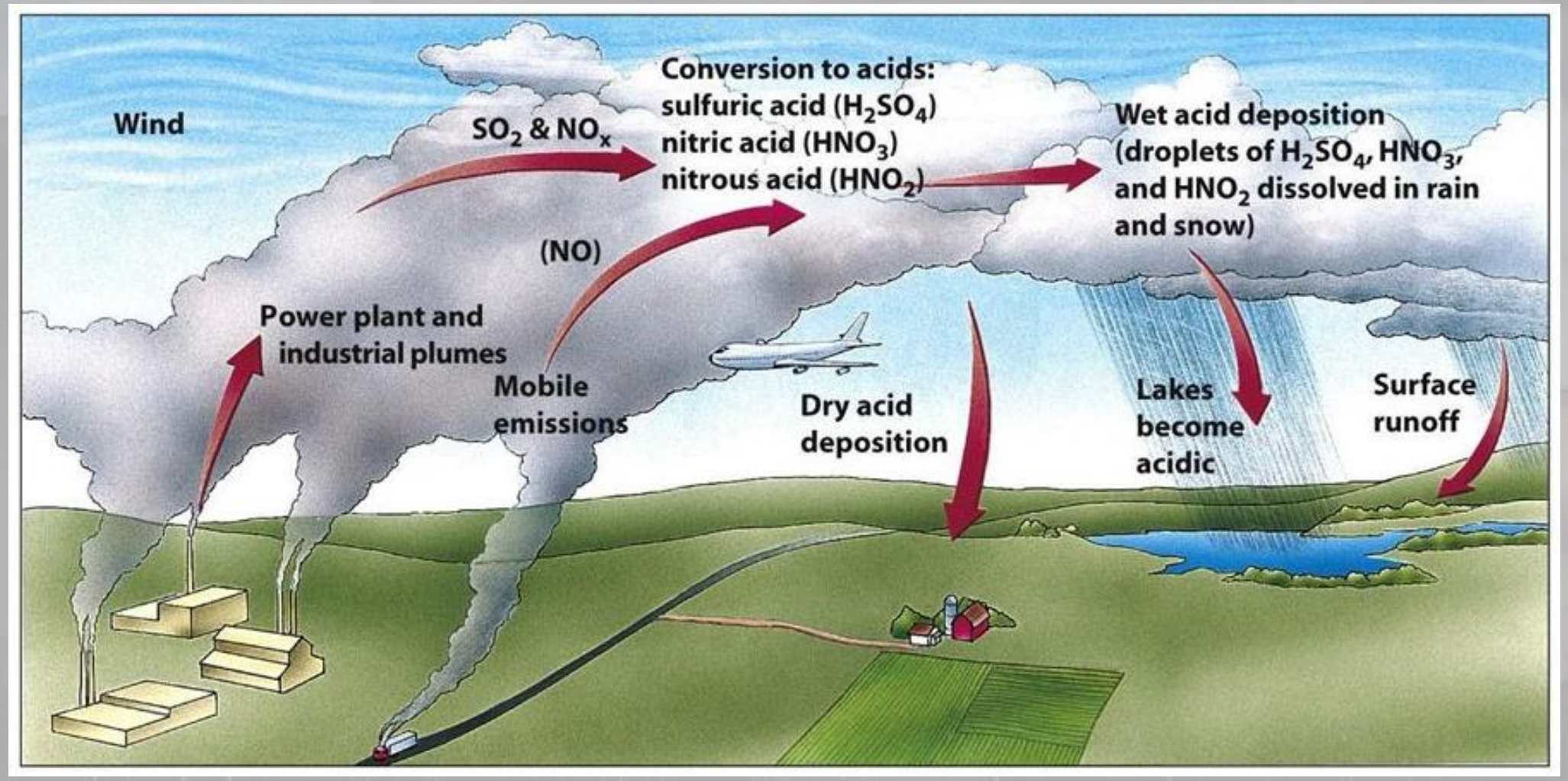


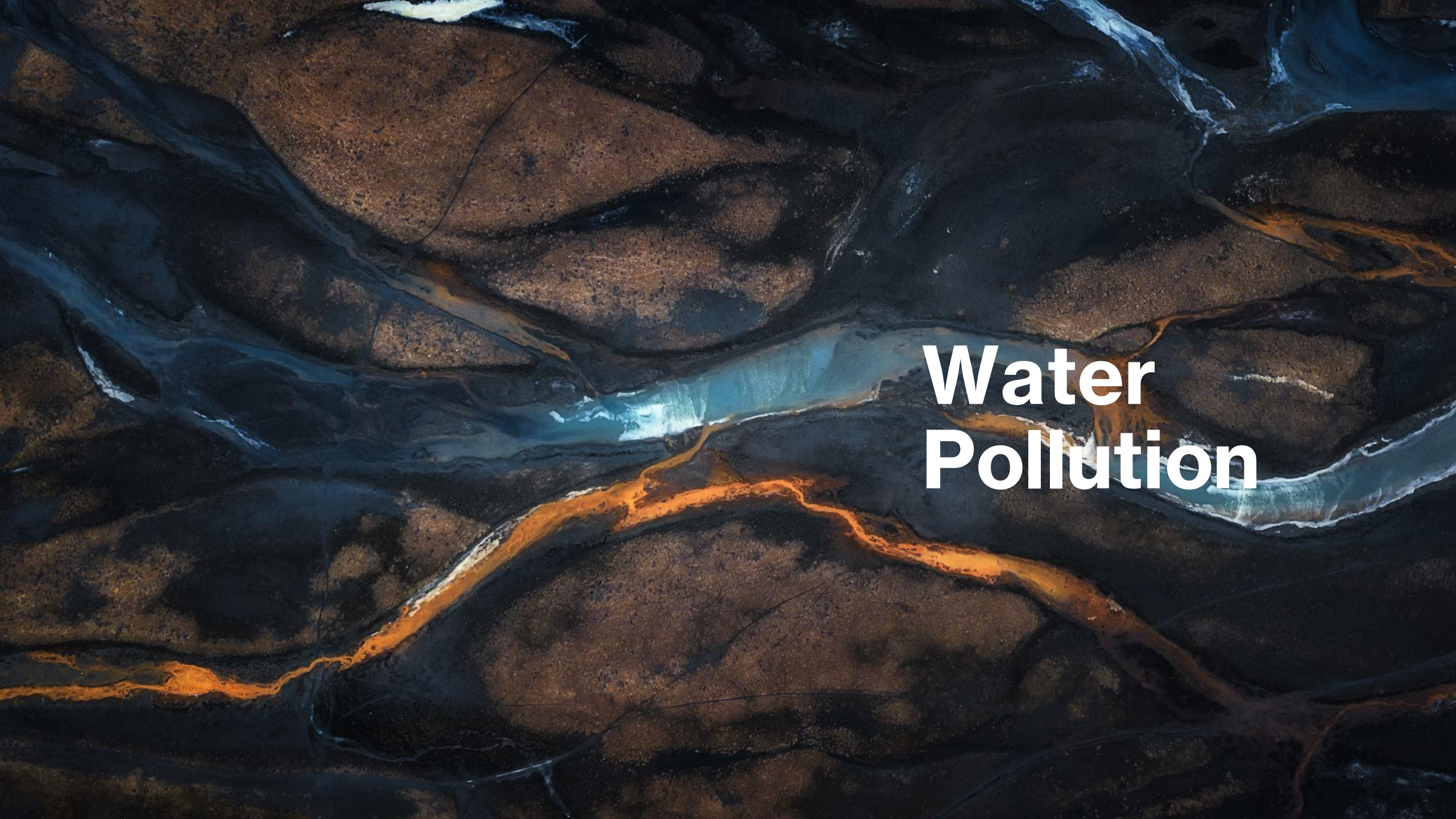
# Forms of Acid Deposition

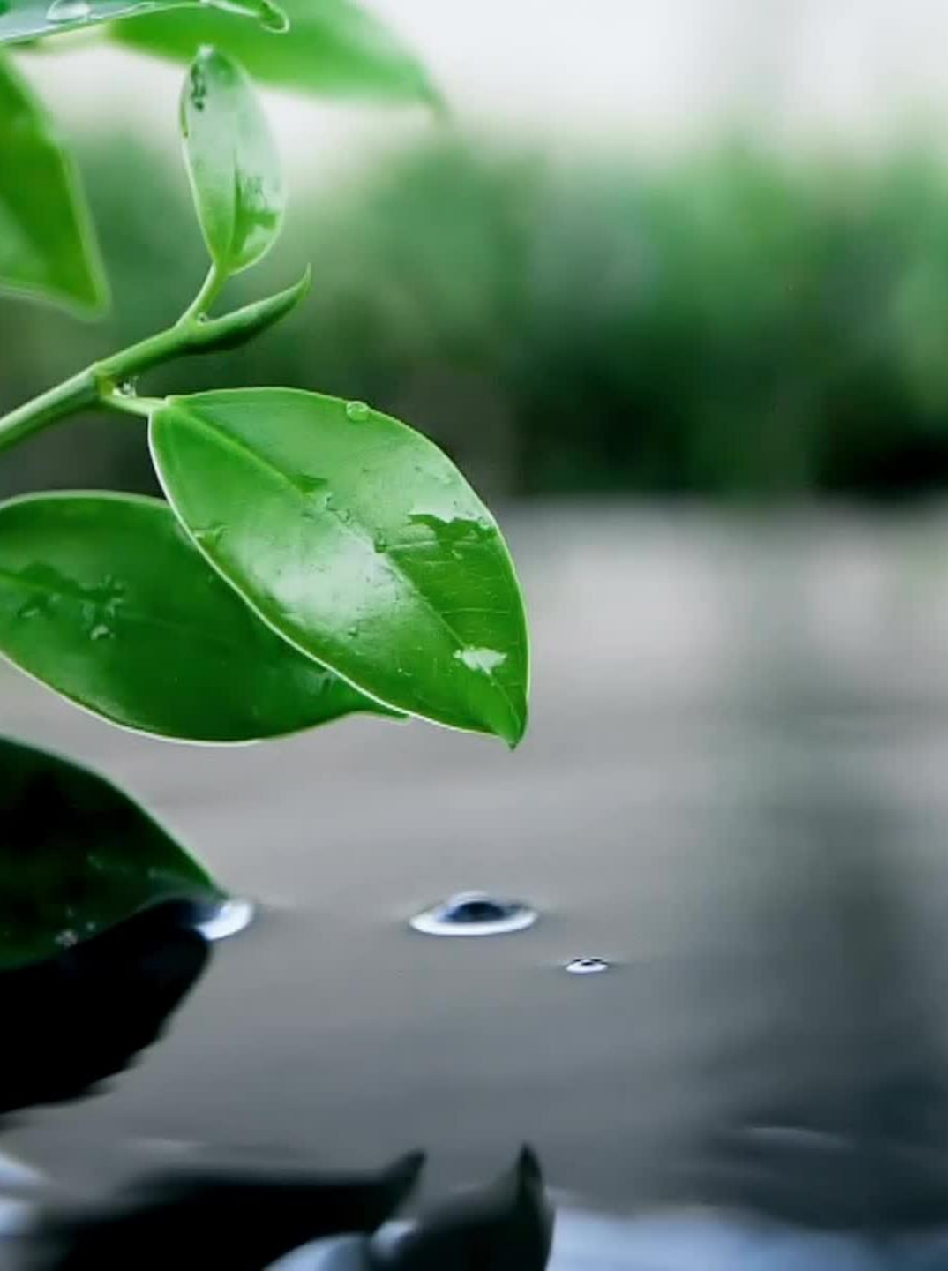
**Wet Deposition:** Wet deposition is what we most commonly think of as ***acid rain***. The sulfuric and nitric acids formed in the atmosphere fall to the ground mixed with rain, snow, fog, or hail.

**Dry Deposition:** Dry deposition occurs when acidic particles and gases settle from the air without moisture. They can land on water, plants, and buildings or form larger harmful particles. When rain washes them off, the acidic water can damage plants, insects, and fish.

# How Acid Deposition Develops




Water
Pollution



Comprising over 70% of the earth's surface, water is undoubtedly the most precious natural resources that exists on our planet.

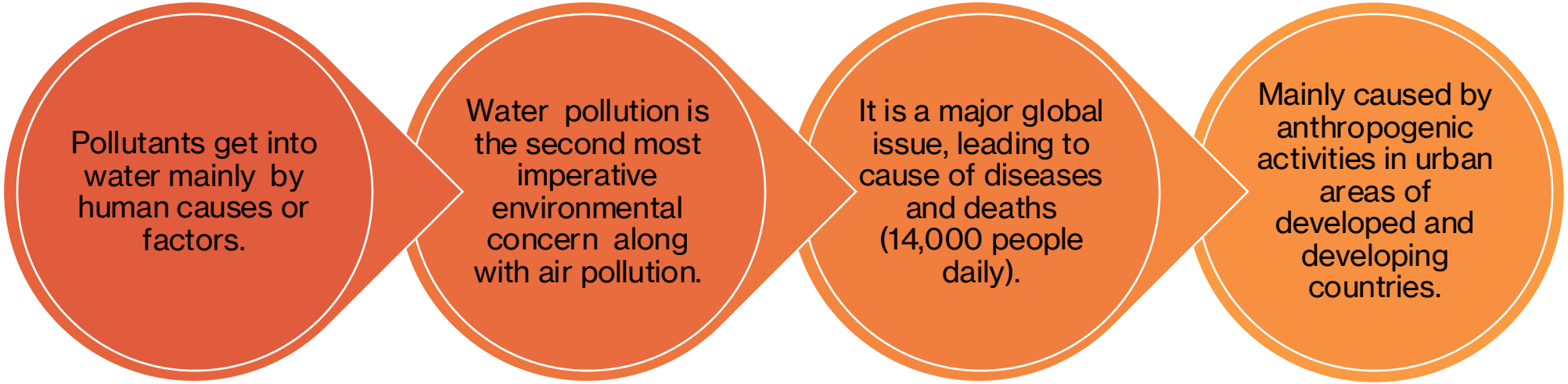
Clean water is essential for sustaining life, as it is necessary for drinking sanitation, and agriculture, ensuring human health and food production. It also supports biodiversity and ecosystem health, contributing to a balanced and thriving environment.

Although we as a humans recognize this facts, we disregard it by polluting our rivers, lakes and oceans. Subsequently we are slowly but surely harming our planet.

**Water pollution** is the contamination of water bodies (e.g. lakes, rivers, oceans and groundwater), very often by human activities.

Any change or modification in the physical, chemical and biological properties of water that will have a detrimental consequence on living things is water pollution.

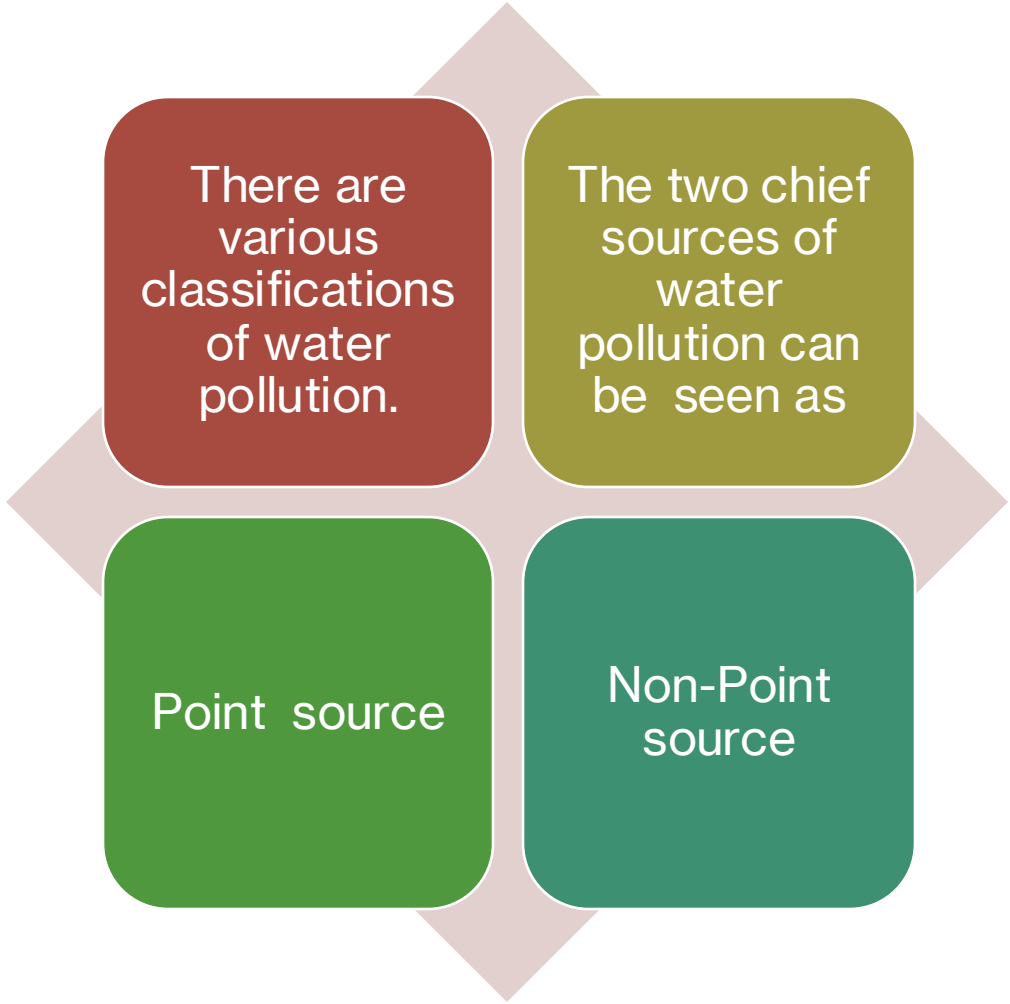
It occurs when pollutants are discharged directly or indirectly into water bodies without enough treatment to get rid of harmful compounds.


Pollutants get into water mainly by human causes or factors.
Water pollution is the second most imperative environmental concern along with air pollution.
It is a major global issue, leading to cause of diseases and deaths (14,000 people daily).
Mainly caused by anthropogenic activities in urban areas of developed and developing countries.

# Pollutants

- It is a substance which when introduced into environment causes undesirable effects or spoils resources.
- Pollutants may harm you permanently or temporarily.
- Pollutants may be of different types and having different properties:
- **Biodegradable** - Pollutants only have a temporary negative impact. Some pollutants, such as DDT, degrade to produce new pollutants like DDD and DDE.
- **Non-biodegradable** - Plastics, synthetic chemical and heavy metals have no or very little absorptive capacity. These pollutants accumulate in environment with the passage of time. Their damage increases as their quantity increases.

# Sources of Water Pollution



## Point source

Those sources which discharge water pollutants directly into the water are known as point sources of water pollution.

When source of water pollution is known or pollutants that are entering into water are from identifiable source like ditch, industry pipes, storm drain and sewage treatment plants etc. pollution is known as point source pollution. It can be distinguished from other pollution sources.

## Non-Point source

Those sources which do not have any specific location for discharging pollutants, in the water body are known as non-point sources of water pollution.

When source of water pollution is not known or pollution does not come from single discrete source pollution is known as non-point source pollution. It is very difficult to control and may come from different sources like pesticides, fertilizers industrial wastes etc.

# Non-Point source

Non-point source pollution is the main and leading cause of water pollution in USA. The list of contaminants included in the EPA definition is both diverse and disturbing:

- Fertilizers, herbicides, and insecticides
- Oil, grease, and toxic chemicals
- Sediment from construction sites, crop and forest lands, and eroding streambanks
- Salt from irrigation
- Acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems
- Atmospheric deposition and modifying waterways

# What are the types of water pollution

- Nutrients Pollution
- Surface water pollution
- Ground water pollution
- Oxygen Depleting
- Suspended Matter
- Chemical Water Pollution
- Thermal Pollution
- Oil Spillage

# Nutrients Pollution

Some wastewater, fertilizers and sewage contain high levels of nutrients.

If they end up in water bodies, they encourage algae and weed growth in the water.

This will make the water undrinkable, and even clog filters.

Too much algae will also use up all the oxygen in the water, and other water organisms in the water will die out of oxygen starvation.

Nutrient pollution is the process where too many nutrients, mainly nitrogen (N) and phosphorus (P), added to bodies of water and can act like fertilizer, causing excessive growth of algae.

The enrichment of water with nutrients such as nitrates and phosphates that triggers the growth of green algae is called **EUTROPHICATION.**

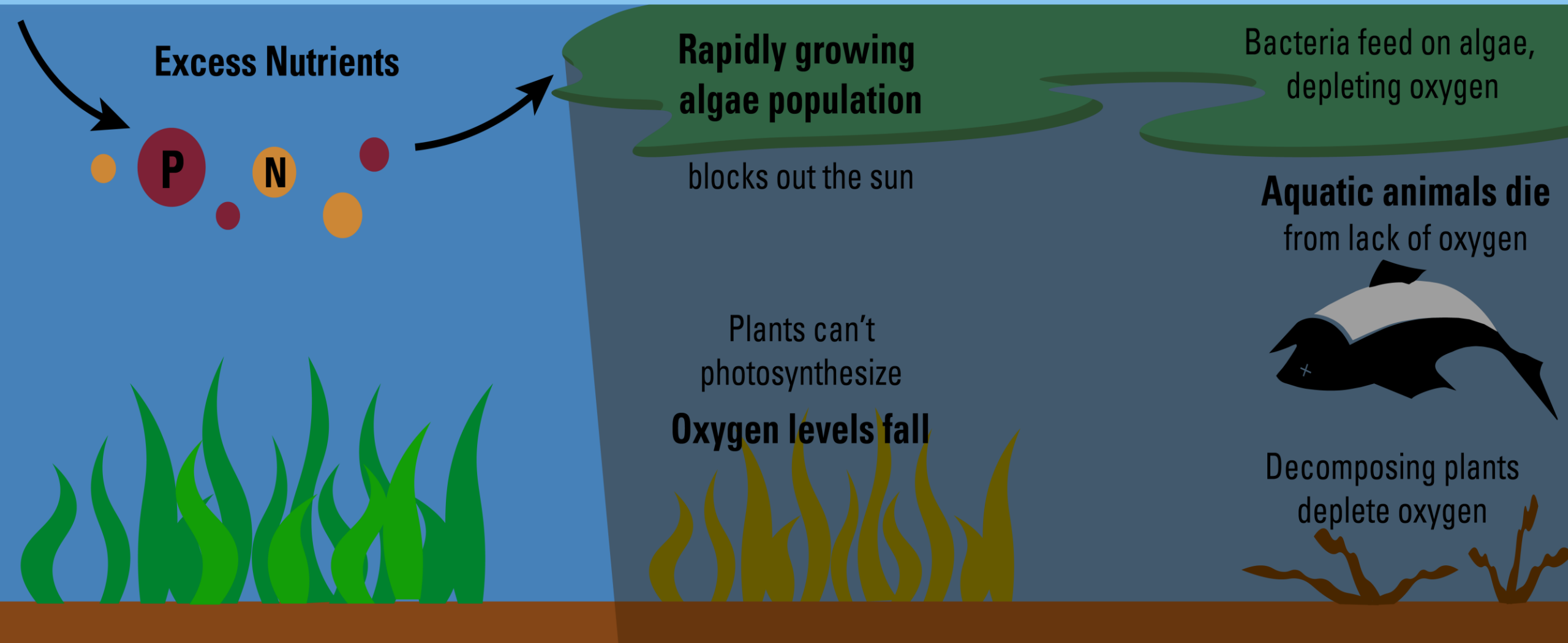
This fast growth of algae followed by decomposition depletes the water body of its dissolved oxygen.

As a result, aquatic animals die of oxygen shortage.

What is Eutrophication?

https://youtu.be/6LAT1gLMPu4?si=EKjLdsCwaYTVmhS5

# Nutrient Pollution



# Surface Water Pollution

Surface water includes natural water found on the earth's surface, like rivers, lakes, lagoons and oceans.

Hazardous substances coming into contact with this surface water, dissolving or mixing physically with the water can be called surface water pollution.

Generally caused by pathogens, nutrients, plastics, chemicals such as heavy metals, pesticides, antibiotics, industrial waste discharges, and individuals dumping into waterways.

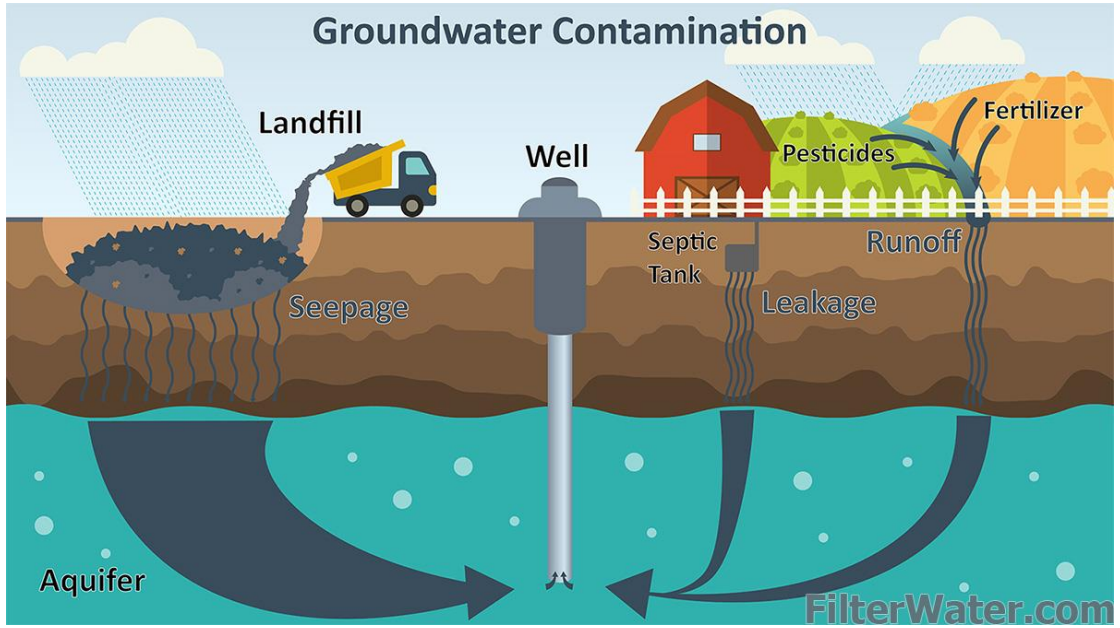
# Ground Water Pollution

When pollutants which are present on ground enter the water bodies under earth they cause ground water pollution.

When humans apply pesticides and chemicals to soils, they are washed deep into the ground by rainwater.

This gets to underground water, causing pollution  underground.

This means when we dig wells and  bore holes to get water from underground, it needs to be checked for water pollution.



# Oxygen Depleting

Water bodies have micro-organisms including aerobic and anaerobic organisms.

When  to much biodegradable matter end up in water, it encourages more microorganism growth, and they use up more  oxygen in the water.

If oxygen is depleted,  aerobic organisms die, and anaerobic organism  grow more to produce harmful toxins such as  ammonia and sulfides.

# Oxygen Depleting

Hundreds of dead fish pile up in the channel south of the Lake Bella spillway on Sunday, Sept. 1, 2024, after low-oxygen levels in the water led to the fish suffocating. Source: Tim Middagh / The Globe

# Suspended Matter

Some pollutants (substances, particles and chemicals) do not easily dissolve in water.

This kind of material is called particulate matter.

Some suspended pollutants later settle under the water body.

This can harm and even kill aquatic life that live at the floor of water bodies.

# Chemical Water Pollution

Many industries and farmers work with chemicals that end up in water.

These include chemicals that are used to control weeds, insects and pests.

Metals and solvents from industries can pollute water bodies.

These are poisonous to many forms of aquatic life and may slow their development, make them infertile and kill them.

Chemical pollutants include heavy metals such as mercury, lead, cadmium, etc., solvents from industries, pesticide run-offs, oil spills from ships, etc.

They are poisonous to aquatic life forms and cause infertility and death. The metal wastes are dangerous to humans as well when they get absorbed in our body.

# Thermal pollution

Thermal pollution, sometimes called "thermal enrichment", is the **degradation of water quality by any process that changes ambient water temperature**.

Heat is considered to be a water pollutant because it decreases the capacity of water to hold dissolved oxygen in solution, and it increases the rate of metabolism of fish. Valuable species of game fish (e.g., trout) cannot survive in water with very low levels of dissolved oxygen.

A major source of heat is the practice of discharging cooling water from power plants into rivers; the discharged water may be as much as 15 °C (27 °F) warmer than the naturally occurring water.

The rise in water temperatures because of global warming can also be considered a form of thermal pollution.

# Oil Spillage

An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially the marine ecosystem, due to human activity, and is a form of pollution.

Oil spills usually have only a localized effect on wildlife but can spread for miles.

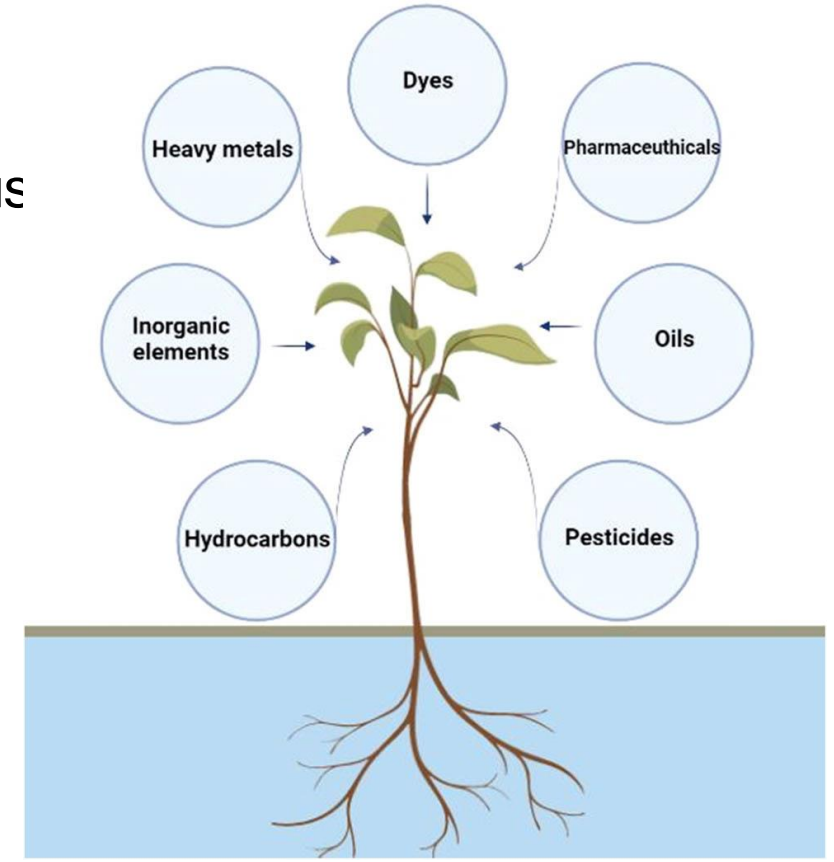
The oil can cause the death to many fish and get stuck to the feathers of seabirds causing them to lose their ability to fly.

**THE SCENE OF THE OIL SPILL IN THE WATERS AROUND MAURITIUS AFTER JAPANESE BULK CARRIER, MV WAKASHIO, RAN AGROUND ON 25 JULY 2020. GREENPEACE**

# Effective water pollution solutions: Phytoremediation technology

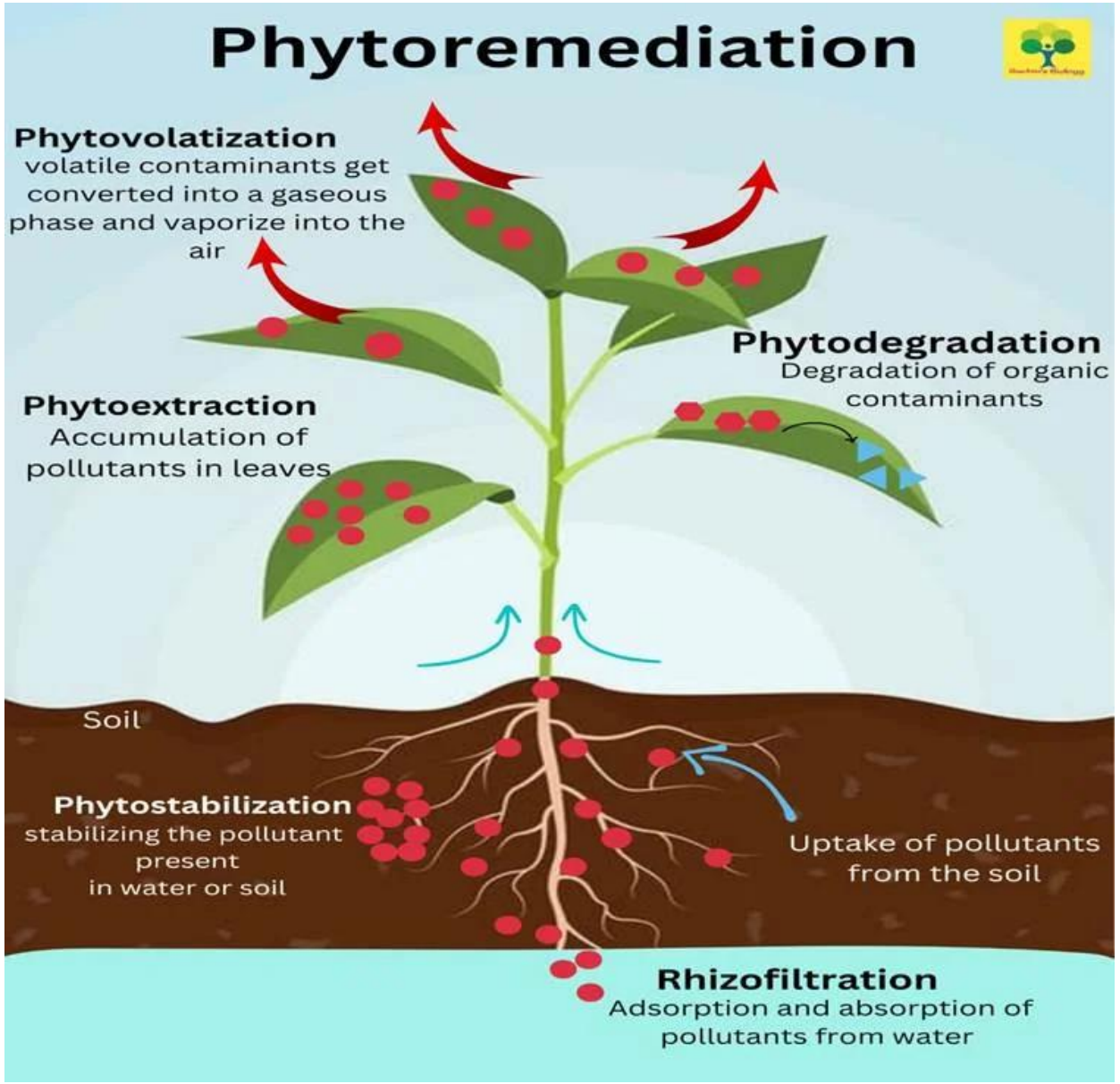
Phytoremediation technology is an emerging green approach used to detect, degrade, and remove various types of pollutants from the environment.

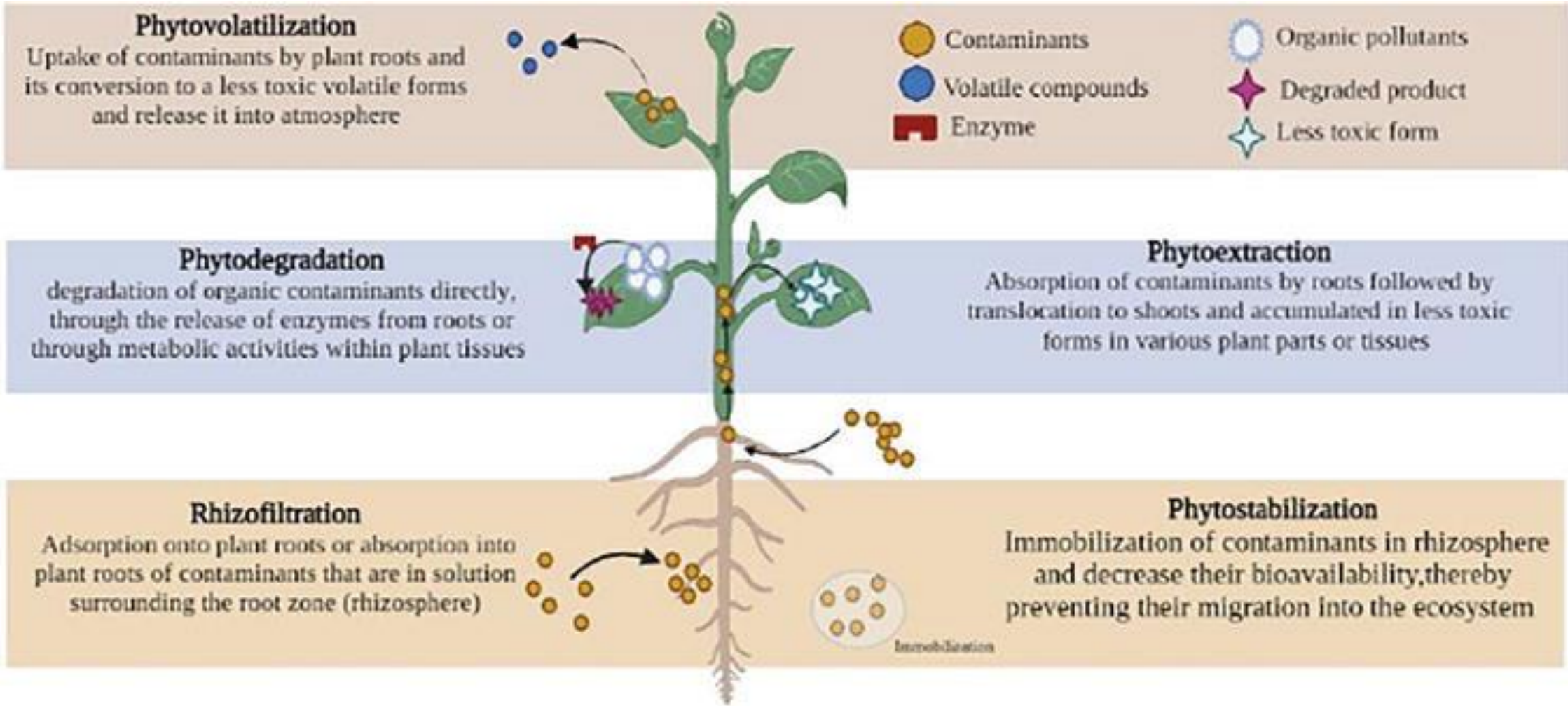
Different types of contaminants that cause harmful effects on human health and other biological systems are removed using plant species. These plant species uptake these pollutants from the environment and detoxify their toxic effect.



## Effective water pollution solutions: Phytoremediation technology

Several mechanisms are involved in the remediation of pollutants from water, especially metal contaminants, to convert these into nontoxic compounds, leading to the removal of waste from water.




Phytovolatilization
Uptake of contaminants by plant roots and its conversion to a less toxic volatile forms and release it into atmosphere
Contaminants
Volatile compounds
Enzyme
Organic pollutants
Degraded product
Less toxic form
Phytodegradation
degradation of organic contaminants directly, through the release of enzymes from roots or through metabolic activities within plant tissues
Phytoextraction
Absorption of contaminants by roots followed by translocation to shoots and accumulated in less toxic forms in various plant parts or tissues
Rhizofiltration
Adsorption onto plant roots or absorption into plant roots of contaminants that are in solution surrounding the root zone (rhizosphere)
Phytostabilization
Immobilization of contaminants in rhizosphere and decrease their bioavailability,thereby preventing their migration into the ecosystem


Soil Pollution

# Soil Pollution

Soil pollution is one of the significant concerns worldwide. **World Soil Day** on **5 December** is meant to raise awareness about the growing challenges in soil management and soil biodiversity loss.

**Soil pollution** refers to the contamination or degradation of soil quality due to the presence of harmful substances or pollutants, which can have adverse effects on soil health, ecosystems, human health, and agricultural productivity.

It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste.

# Soil Pollutants

The most common soil pollutants are

- Plastics
- Agro-chemicals
- Fertilizers
- Heavy metals

# Plastics

- Major part of global domestic and industrial waste
- Not easily biodegraded
- Waste plastic accumulates much thus adds to severe pollution problem
- Takes several years to disintegrate – 400 years to degrade mineral water bottles
- In USA, plastics are 7% in weight and 30% of the volume
- Use of biodegradable plastic solves the problem of pollution

# Agrochemical pollution

- Include pesticides, herbicides, fungicides
- Pesticides applied reach the soil ultimately
- Accumulation of pesticide residues in biosphere creates ecological stress causing soil, water and food contamination
- Persisting chemicals are hazardous to human health
- Total remediation is impossible
- Reduction of residue levels through redeeming technology (desirable)

# Fertilizer pollution

- Continuous application – Deterioration in soil properties, cultivated soils lose their characteristics
- Application of Amm. sulphate, Amm. chloride & Urea reduce soil pH
- Crops – potato, grapes, citrus, beans – sensitive to chloride toxicity
- Application of organic manures and biofertilizers reduce the soil from pollution

# Heavy metal pollution


**Heavy metal** is a broad term that describes a group of naturally occurring metallic elements of high molecular weight and density compared to water.

Metals with atomic number greater than 23 or more than 5 gm per ml (eg. Hg – 70 gm $ml^{-1}$)

They are hazardous, not acceptable to biological system

Toxic to man & other life forms

Most are slow poison, accumulate in the body and cause serious disorders

Common toxic metals- Hg, Pb, As, Cr, Cd

# Source of Soil Pollution

- **Industrial Activities:** Industrial processes can release various pollutants into the soil, including heavy metals, organic chemicals, solvents, petroleum hydrocarbons, and toxic substances from manufacturing and mining.
- **Agricultural Practices:** Agricultural activities can contribute to soil pollution through the use of fertilizers, pesticides, herbicides, and other agrochemicals, as well as the application of animal manure and sewage sludge.
- **Waste Disposal:** Improper disposal of solid waste, hazardous waste, and industrial waste can lead to soil pollution through leaching, runoff, and the release of pollutants.

# Source of Soil Pollution

- **Mining and Resource Extraction:** Mining operations can release pollutants into the soil through the extraction, processing, and disposal of minerals, ores, and waste materials.
- **Urbanization and Land Development:** Urbanization and land development can result in soil pollution through the construction of roads, buildings, and infrastructure, which can disrupt soil structure, compaction, and drainage, as well as introduce pollutants from construction materials, vehicle emissions, and urban runoff.

# Types of Soil Pollution

- **Chemical Pollution:** Chemical pollutants in soil can include heavy metals (e.g., lead, mercury, cadmium), organic chemicals (e.g., pesticides, herbicides, industrial chemicals), petroleum hydrocarbons (e.g., oil spills, fuel leaks), and other toxic substances from various sources.
- **Nutrient Pollution:** Nutrient pollution in soil can result from the excessive application of fertilizers, manure, and sewage sludge, leading to soil enrichment with nutrients such as nitrogen, phosphorus, and potassium, which can cause eutrophication, soil acidification, and nutrient imbalances.

# Types of Soil Pollution

- **Microbial Pollution:** Microbial pollutants in soil can include bacteria, viruses, fungi, and parasites from human and animal waste, sewage, and contaminated runoff, which can pose risks to human health through the transmission of waterborne and soilborne diseases.
- **Radioactive Pollution:** Radioactive pollutants in soil can result from natural sources (e.g., radon gas, uranium deposits) or human activities (e.g., nuclear testing, nuclear accidents, radioactive waste disposal), which can lead to soil contamination with radioactive isotopes, such as uranium, radium, and cesium.

# Effects of Soil Pollution

- **Impacts on Soil Health:** Soil pollution can degrade soil quality, fertility, structure, and biodiversity, leading to soil erosion, compaction, salinization, acidification, and loss of beneficial soil organisms, such as earthworms, bacteria, and fungi.
- **Ecological Impacts:** Soil pollution can harm terrestrial ecosystems, including plants, animals, and microorganisms, through direct toxicity, bioaccumulation, biomagnification, and disruptions to food webs, nutrient cycling, and ecosystem processes.

# Effects of Soil Pollution

- **Human Health Risks:** Soil pollution can pose risks to human health through exposure to contaminated soil, dust, air, water, and food, leading to ingestion, inhalation, or dermal contact with hazardous substances, which can cause acute and chronic health effects, including cancer, respiratory problems, neurological disorders, and reproductive problems.
- **Agricultural Impacts:** Soil pollution can affect agricultural productivity and food safety by contaminating crops, livestock, and groundwater with pesticides, heavy metals, pathogens, and other pollutants, leading to reduced yields, crop failures, and foodborne illnesses.
- **Economic Costs:** Soil pollution can impose significant economic costs through impacts on agriculture, land use, property values, environmental cleanup, public health expenditures, and loss of ecosystem services, such as water purification, carbon sequestration, and biodiversity conservation.

# Mitigation measure

- **Pollution Prevention:** Pollution prevention strategies, such as source reduction, waste minimization, pollution control technologies, and best management practices, aim to reduce the release of pollutants into the soil from industrial, agricultural, and urban sources.
- **Remediation and Cleanup:** Remediation technologies, such as soil washing, bioremediation, phytoremediation, and soil vapor extraction, can be used to treat contaminated soil and restore soil quality, fertility, and functionality.

# Mitigation measure

- **Regulatory Frameworks:** Governments establish laws, regulations, and standards to control and reduce soil pollution, including soil quality criteria, land use planning, waste management regulations, and enforcement mechanisms to protect soil resources.
- **Soil Conservation:** Soil conservation practices, such as erosion control, soil stabilization, crop rotation, cover cropping, agroforestry, and organic farming, aim to protect and restore soil health, fertility, and resilience to pollution and degradation.
- **Monitoring and Assessment:** Monitoring programs assess soil quality, contamination levels, and ecological health indicators to identify polluted sites, prioritize cleanup efforts, and track trends in soil pollution over time.

# Bioremediation

The use of naturally occurring microorganisms such as bacteria, fungi & plants to break down or degrade toxic chemical compounds that have accumulated in the environment

Bioremediation is the process of using biological microorganisms to breakdown hazardous materials and substances into less toxic or nontoxic products.

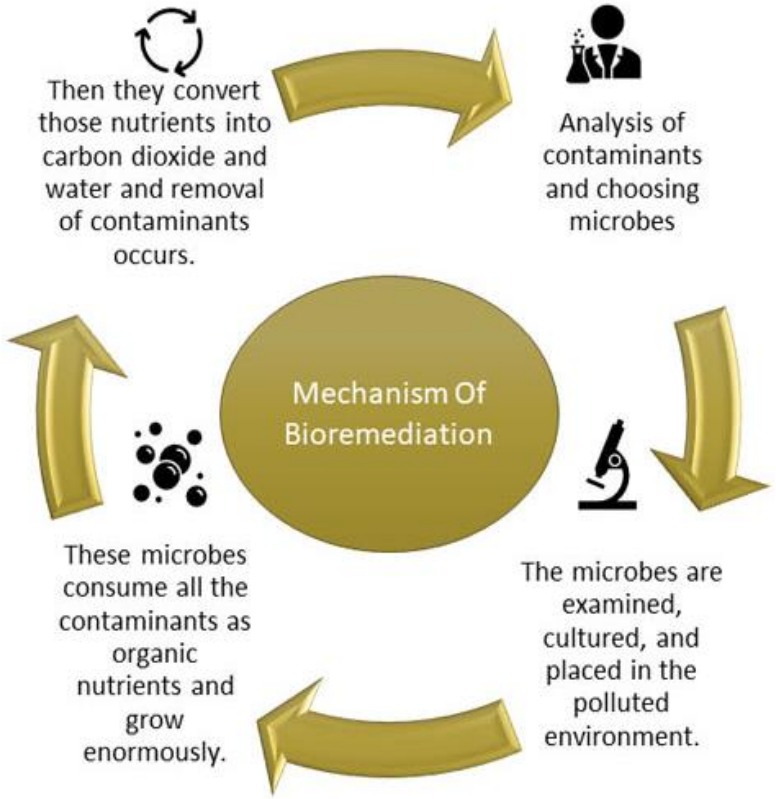
It is a method that treats the soils and renders them non-hazardous, thus eliminating any future liability that may result from landfill problems or violations.

# Bioremediation

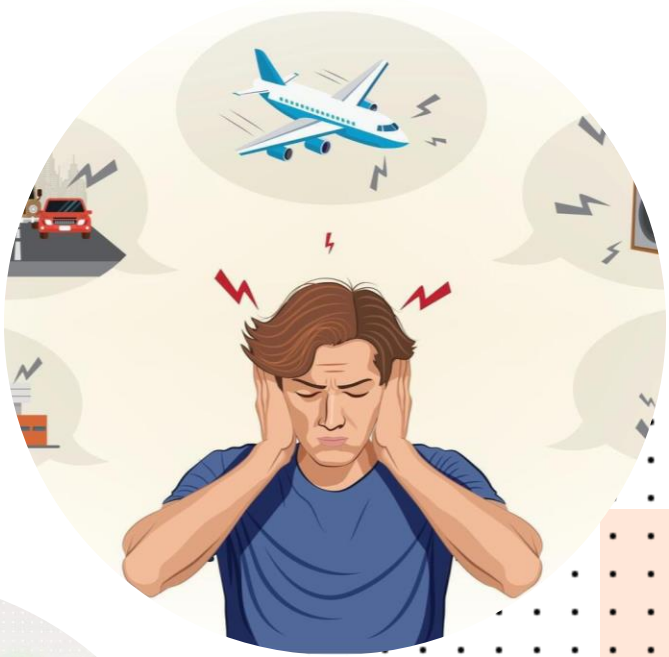
This process involves the addition of oxygen, nutrients, or microbes into contaminated soil to remove toxic pollutants.

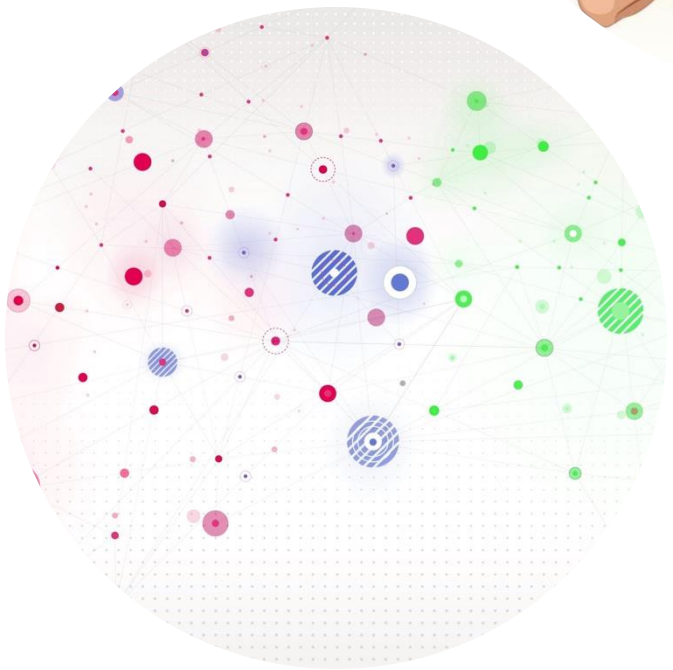
Contamination includes buried waste and underground pipe leakage that infiltrate ground water systems.

The addition of oxygen removes the pollutants by producing carbon dioxide and water.



# NOISE POLLUTION





# WHAT IS NOISE POLLUTION?

"The word noise comes from the Latin word noxia or nausea meaning "injury" or "hurt" "

Noise is an unwanted, unpleasant and annoying sound caused by vibration of the matter. Vibrations impinge on the ear drum of a human or animal and setup a nervous disturbance, which we call sound. When the effects of sound are undesirable that it may be termed as **"Noise"**.

# WHAT IS NOISE POLLUTION?

Physically there is no distinction between sound and noise. Sound is a sensory perception, and the complex pattern of sound waves is labeled as noise, music, speech etc. **Noise** has become a very important "stress factor" in the environment of man.

# WHAT IS NOISE POLLUTION?


- Sound that is unwanted or disrupts one's quality of life is called as noise. When there is lot of noise in the environment, it is termed as **noise pollution**.
- Sound becomes undesirable when it disturbs the normal activities such as working, sleeping, and during conversations.
- It is an underrated environmental problem because of the fact that we can't see, smell, or taste it.
- World Health Organization stated that "Noise must be recognized as a major threat to human well-being.

**The sound is measured in decibels (dB)**, which determines the intensity of a sound wave, and it is used to determine sounds that the human ear can hear. Generally, the range of human hearing spans 0 decibels (dB) to 120-130 dB. Above 130 dB ear pain may be caused indicating the threshold of pain.

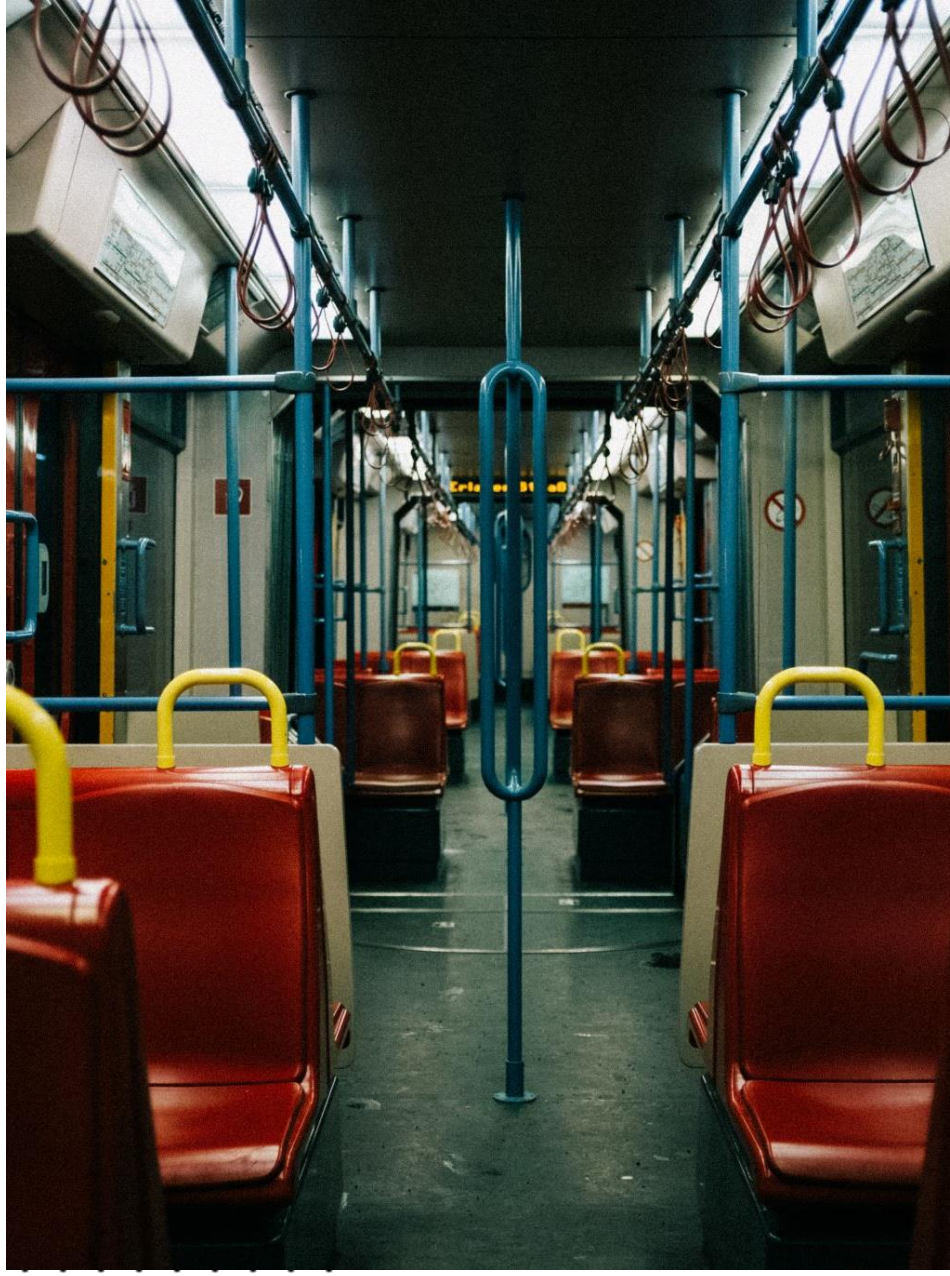
## What is a safe SPL level?

You can listen to sounds at 70 dBA or lower for as long as you want. Sounds at 85 dBA can lead to hearing loss if you listen to them for more than 8 hours at a time.

The ambient SPL in a library is about 35 dB, while that inside a moving bus or subway train is roughly 85 dB; building construction activities can generate SPLs as high as 105 dB at the source.

SPL is a ratio of sound pressure and reference sound pressure, expressed in decibels (dB).

SPLs decrease with distance from the source.



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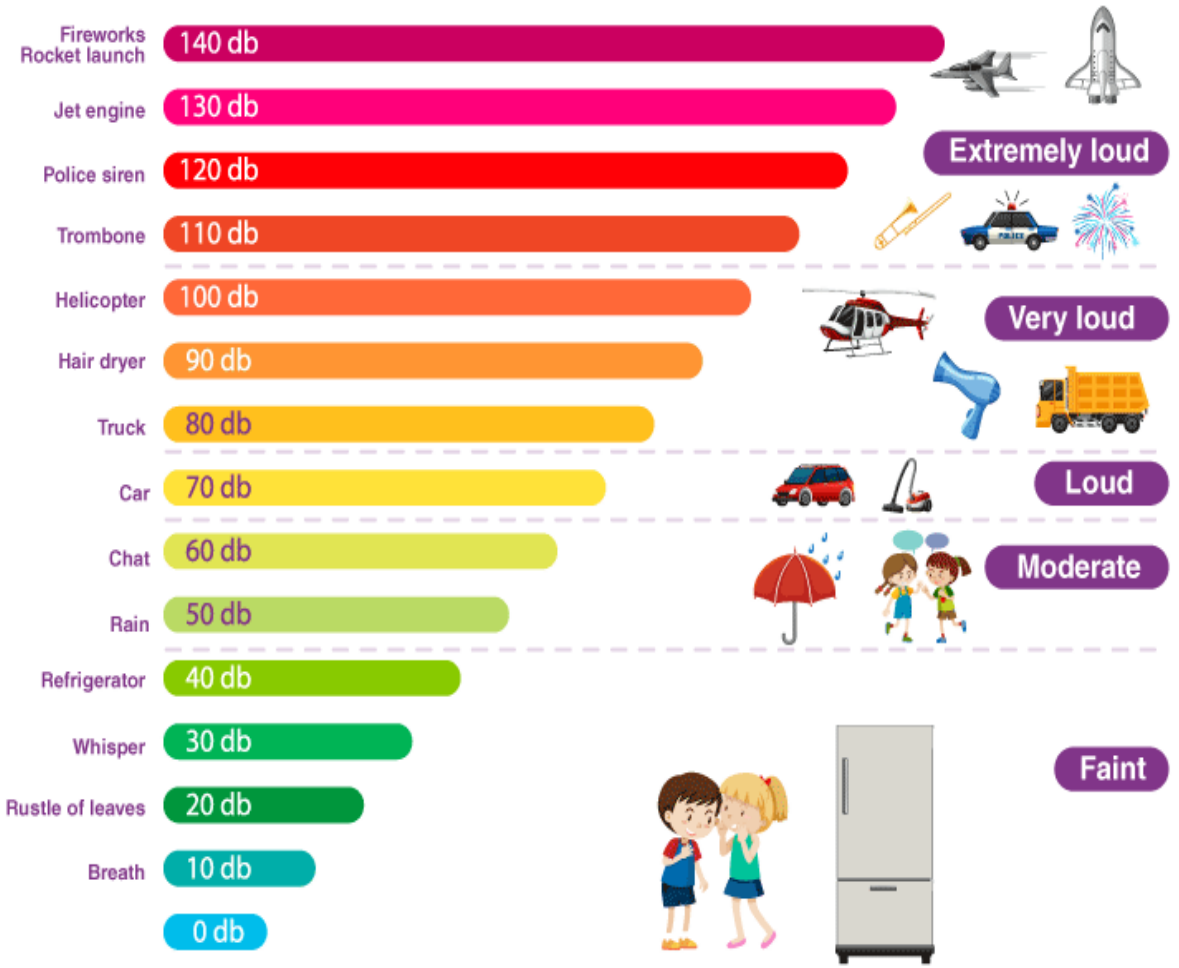


Types of Noise Pollution

Following are the three types of pollution:

- Transport Noise
- Neighborhood Noise
- Industrial Noise

**Transport Noise:** It mainly consists of traffic noise which has increased in recent years with the increase in the number of vehicles. The increase in noise pollution leads to deafening of older people, headache, hypertension, etc.

**Neighborhood Noise:** The noise from gadgets, household utensils etc. Some of the main sources are musical instruments, transistors, loudspeakers, etc.

**Industrial Noise:** It is the high-intensity sound which is caused by heavy industrial machines. According to many researches, industrial noise pollution damages the hearing ability to around 20%.

# Causes and Sources of Noise Pollution:

Following are the causes and sources of noise pollution:

**Industrialization:** Industrialization has led to an increase in noise pollution as the use of heavy machinery such as generators, mills, huge exhaust fans are used, resulting in the production of unwanted noise.

**Vehicles:** Increased number of vehicles on the roads are the second reason for noise pollution.

**Events:** Weddings, public gatherings involve loudspeakers to play music resulting in the production of unwanted noise in the neighborhood.

**Construction sites:** Mining, construction of buildings, etc. add to the noise pollution.

**Effects of Noise Pollution on Human Health:** Noise pollution adversely affects the lives of millions of people. Studies have shown that there are direct links between noise and health.

**Hypertension:** It is a direct result of noise pollution which is caused due to elevated blood levels for a longer duration.

**Hearing loss:** Constant exposure of human ears to loud noise that are beyond the range of sound that human ears can withstand damages the eardrums, resulting in loss of hearing.

# Effects of Noise Pollution on Human Health

**Sleeping disorders:** Lack of sleep might result in fatigue and low energy level throughout the day affecting everyday activities. Noise pollution hampers the sleep cycles leading to irritation and an uncomfortable state of mind.

**Cardiovascular issues:** Heart-related problems such as blood pressure level, stress and cardiovascular diseases might come up in a normal person and a person suffering from any of these diseases might feel a sudden shoot up in the level.

# Prevention of Noise Pollution

Some noise pollution preventive measures are provided in the points below.

- Honking in public places like teaching institutes, hospitals, etc. should be banned.
- In commercial, hospital, and industrial buildings, adequate soundproof systems should be installed.
- Musical instruments' sound should be controlled to desirable limits.
- Dense tree cover is useful in noise pollution prevention.
- Explosives should not be used in forest, mountainous and mining areas.

## How vegetation helps reduce sound pollution?

Vegetation reduces noise pollution through a phenomenon called sound attenuation, which is the reduction of sound intensity. Normal attenuation of sound occurs as the energy of sound dissipates over long distances until not enough energy is left to vibrate air molecules.

Vegetation reduces noise pollution by absorbing, deflecting, and scattering sound waves.

The effectiveness of trees in noise reduction depends on several factors, including the species, density, and height of the trees, as well as their placement relative to the noise source.

- **Leaves and Branches:** Foliage helps break up and scatter sound waves, reducing their intensity before they reach inhabited areas. Trees with dense canopies and broad leaves are particularly effective at diffusing sound. The rustling of leaves also produces natural white noise, which helps mask unpleasant urban sounds.

- **Tree Trunks and Bark:** The rough surfaces of tree trunks and bark contribute to sound absorption by preventing waves from bouncing off surfaces and amplifying noise. Certain tree species with deeply grooved bark, such as oak and pine, are particularly effective in dispersing sound waves.

- **Soil and Understory Vegetation:** The combination of trees with shrubs, grasses, and other vegetation further enhances noise reduction by absorbing lower-frequency sounds that might otherwise travel unimpeded. The root systems of plants also play a role in stabilizing soil, preventing erosion, and providing additional sound-dampening properties.

# Radioactive Pollution

# What is Radioactive Pollution?

Addition of radition to enviroment by using radioactive elements

- **Radioactive pollution,** like any other kind of pollution, is the release of something unwanted into the environment and, in this case, the unwanted thing is radioactive material.

- **Radioactive pollution** can be defined as the emission of high energy particles or radioactive substance into air, water or land due to human activities in the form of radioactive waste.

- **Radioactive contamination,** also contamination, is the called radiological deposition of, or presence of radioactive substances on surfaces or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable.

- Such contamination presents a hazard because of the radioactive **decay** of the contaminants, which emit harmful ionizing radiation such as **alpha or beta particles, electromagnetic waves such as gamma rays.** The degree of hazard is determined by the concentration of the contaminants, the energy of the radiation being emitted, the type of radiation, and the proximity of the contamination to organs of the body. It is important to be clear that the contamination gives rise to the radiation hazard, and the terms "radiation" and "contamination" are not interchangeable.

- Contamination may affect a person, a place, an animal, or an object such as clothing.

**Radioactive pollution** is defined as a form of physical, nuclear pollution to living organisms and the environment (hydrosphere, lithosphere, and atmosphere) arising from exposure to the release of ionizing radiation from radioactive elements. Such releases occur as a result of radioactive **decay** of radioactive elements during:

- Nuclear explosions and testing
- Disposal of nuclear waste
- Mining radioactive ores
- Accidents at nuclear power plants

- **Radioactive elements:** Radioactive elements are substances characterized by the instability of their atomic nuclei, leading to spontaneous decay and the emission of radiation. The four common radioactive elements are **uranium, radium, polonium,** and **thorium.**
- **Radioactive decay:** Radioactive decay occurs because unstable isotopes tend to transform into a more stable state. Radioactivity is measured in terms of **disintegrations, or decays, per unit time**. Common units of radioactivity are the Bequerel, equal to 1 decay per second, and the Curie, equal to 37 billion decays per second.
- **Radioactive waste:** Radioactive waste is usually the product of a nuclear process such as nuclear fission, which is extensively used in nuclear reactors, nuclear weapons and other nuclear fuel-cycles. Radioactive pollution.

Radioactive waste is spread through the earth's atmosphere is called **"Fallout"**

# Causes

- There are many causes of radioactive pollution. The causes are as you may have guessed, radioactive substances or, mor accurately, radioactive waste but only when improperly dispose of. If radioactive waste is disposed of in the appropriate manner, then it does not contribute towards radioactive pollution. Th causes are as follows:
- Production of nuclear weapons
- Decommissioning of nuclear weapons
- Mining of radioactive ore (uranium, phosphate etc.)
- Coal ash
- Medical waste
- Nuclear power plants

## Production of Nuclear Weapons

Radioactive materials used in this production have high health risks and release a small amount of pollution. Thanks to good current health-standards this release is not significant and is not a danger to us unless an accident occurs.

## Decommissioning of Nuclear Weapons

The decommissioning of nuclear weapons causes slightly more radioactive pollution than in the production, however, the waste (alpha particles) is still of low risk and not dangerous unless ingested

## Mining of radioactive ore

Mining these involves crushing and processing of the radioactive ores and this generates radioactive waste which emits alpha particles. This waste is of low risk unless ingested.

## Coal ash

It may come as a surprise that coal ash can be very dangerous. Some coal contains more radioactive material than usual and is often referred to as **'dirty' coal**; when this is burnt the ash becomes more radioactive as the radioactive particles do not burn well. This level of radioactivity is less than in phosphate rocks, however, due to small amounts being released into the atmosphere and its ability to be inhaled, this ash is significantly more dangerous.


## Medical waste

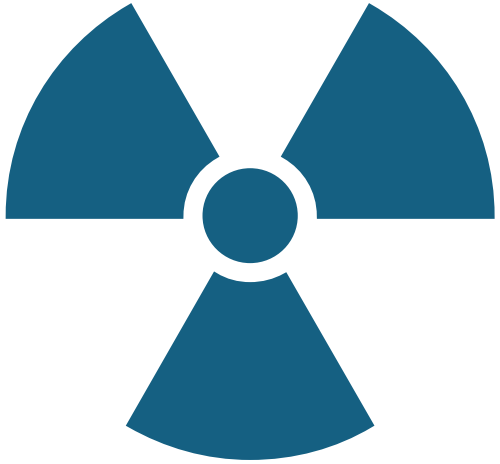
A number of radioactive isotopes are used in medicine, either for treatment or diagnostics. These can be left to decay over a short period after which they are able to be disposed of as normal waste.

## Nuclear power plants

Nuclear power plants under current standards produce little radioactive pollution due to safety precautions that must be adhered to. Accidents at these power plants can cause dangerously high radioactive pollution, such as in the case of **Chernobyl**, the most well-known and worst nuclear disaster in history and the more recent **Fukushima**, after the earthquake and tidal wave in Japan.

## Type of Radioactive Pollution

**Continuous Pollution:** This type of condition exists in uranium mines, nuclear reactors, test labs etc. where the humans are under continuous exposure to radioactive contaminants and protective clothing is required to avoid radiation exposure.



**Accidental Pollution:** This type of condition exists during accidental exposure to radiations by virtue of equipment failure, radiation leak, faulty protective equipment etc.

**Occasional Pollution:** This condition exists during isolated experiment or test of nuclear substance.

# Effect of Radioactive Pollution

Health Effects on Living Organism

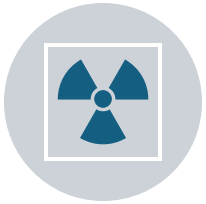
Environmental Impact

Medical and Biological Effect

Social impact

# Health Effects on Living Organism

1



## Acute Radiation Syndrome

**Acute Radiation Syndorme:**
High doses of radiation received over a short period can cause acute radiation syndrome (ARS), which includes symptoms like nausea, vomiting, diarrhea, skin burns, and in severe cases, damage to the bone marrow and vital organs.

2

## Chronic Health Effects

**Contamination of Food Chain:**
Radioactive pollutants can enter the food chain, affecting the quality and safety of food. Plants and animals can absorb these pollutants from contaminated soil or water, and humans may be exposed to them by consuming contaminated food products.

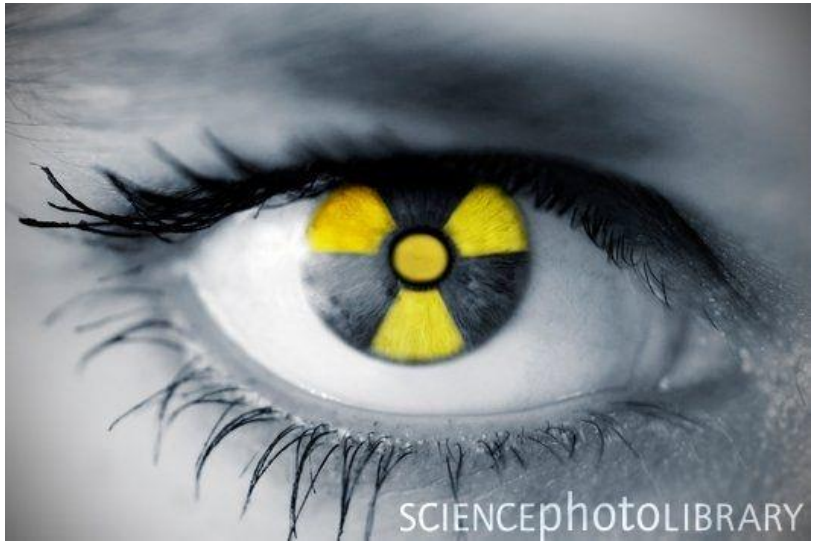
3

## Contamination of Food Chain

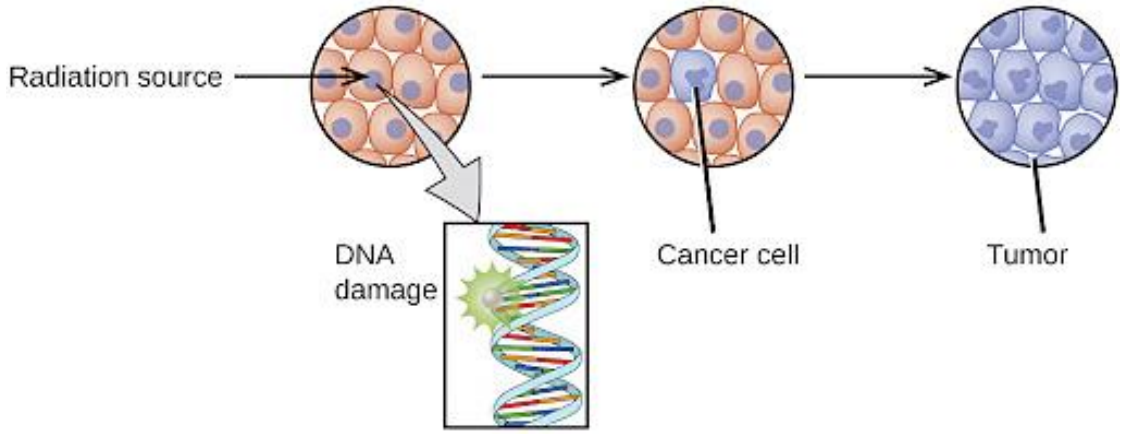
**Chroninc Health Effects:**
Long-term exposure to lower levels of radiation might increase the risk of cancer, especially leukemia, thyroid cancer, and other solid tumors. It can also cause genetic mutations, affecting future generations.

# On Human Beings

- The impact of radioactive pollution on human beings can vary from mild to fatal; the magnitude of the adverse effects largely depends on the level and duration of exposure to radioactivity. Low levels of localized exposure may only have a superficial effect and cause mild skin irritation.
- Long-term exposure or exposure to high amounts of radiation can have far more serious health effects.
  Radioactive rays can cause irreparable damage to DNA molecules and can lead to a life-threatening condition.



- The rapidly growing/dividing cells, like those of the skin, b marrow, are more sensitive towards radioactive emissions.
- On the other hand, cells that do not undergo rapid cell division, such as bone cells and nervous cells, aren't damaged so easily.
- Rays from radioactive element can cause
    - Burns
    - cancers (skin cancer, lung cancer, thyroid cancer )
    - Death
    - hair loss
    - heart failure
    - can damage brain cells



# Radiation exposure

**As fears of a meltdown in Japan rise, so do the fears of radiation exposure. What does radiation do to the human body?**

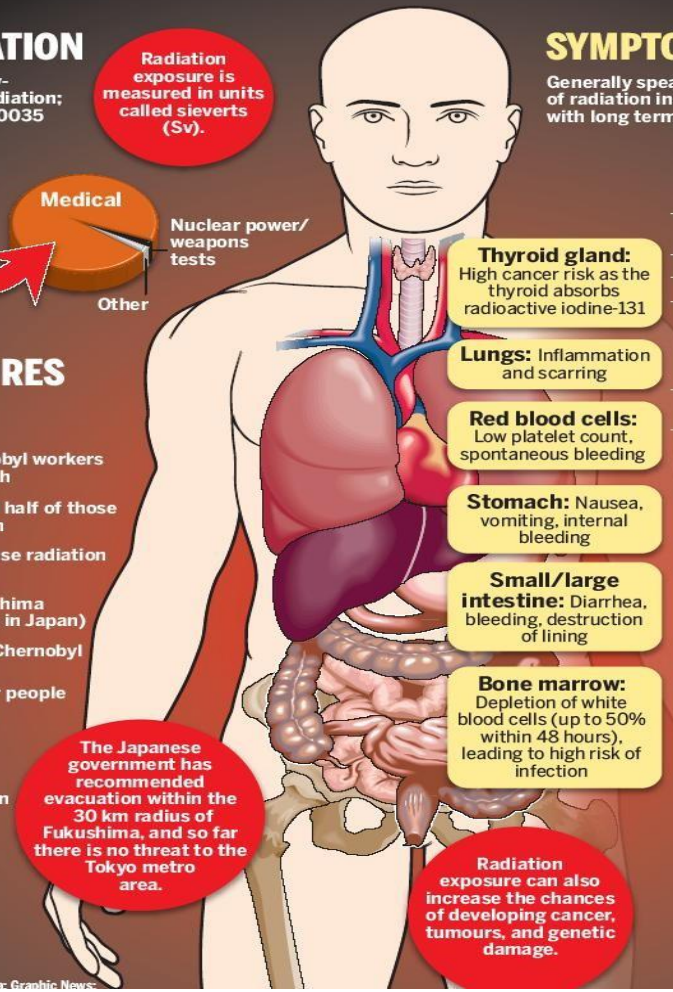
## BACKGROUND RADIATION

Everybody is exposed to both naturally-occurring and artificial background radiation; levels typically range from 0.0015 – 0.0035 Sv/year:

Radiation exposure is measured in units called sieverts (Sv).


## COMPARING EXPOSURES

| | |
|---|---|
| 10 Sv | Fatal within weeks |
| 6 | Typical levels in Chernobyl workers who died within a month |
| 5 | A single dose would kill half of those exposed within a month |
| 1 | A single dose could cause radiation sickness and nausea |
| 0.4 | Detected level at Fukushima (as of Tuesday morning in Japan) |
| 0.35 | Exposure of relocated Chernobyl residents |
| 0.10 | Recommended limit for people working with radiation every 5 years |
| 0.01 | Full-body CT scan |
| 0.002 | Typical natural radiation per year |
| 0.0004 | Mammogram x-ray |
| 0.0001 | Chest x-ray |
| 0.00001 | Dental x-ray |



**Thyroid gland:** High cancer risk as the thyroid absorbs radioactive iodine-131

**Lungs:** Inflammation and scarring

**Red blood cells:** Low platelet count, spontaneous bleeding

**Stomach:** Nausea, vomiting, internal bleeding

**Small/large intestine:** Diarrhea, bleeding, destruction of lining

**Bone marrow:** Depletion of white blood cells (up to 50% within 48 hours), leading to high risk of infection

The Japanese government has recommended evacuation within the 30 km radius of Fukushima, and so far there is no threat to the Tokyo metro area.

Radiation exposure can also increase the chances of developing cancer, tumours, and genetic damage.

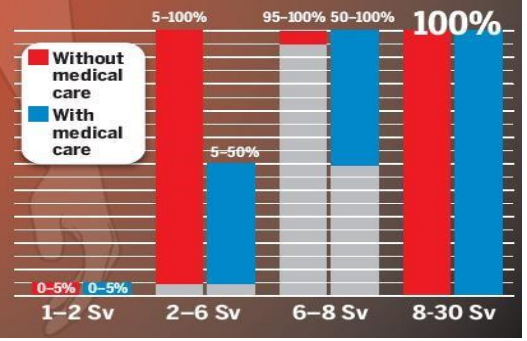
## SYMPTOMS OF RADIATION EXPOSURE

Generally speaking, radiation sickness is brought on by a large dosage of radiation in a short period of time, but it has also occurred with long term exposure.

**Early symptoms, exposure levels and time to symptom onset**

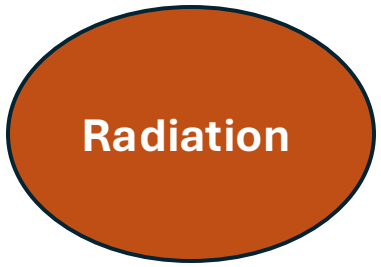
| | 1–2 Sv | 2–6 Sv | 6–8 Sv | 8–10 Sv |
|---|---|---|---|---|
| Nausea, vomiting | 6 hrs. | 2 hrs. | 1 hr. | 10 min. |
| Diarrhea | — | 8 hrs. | 3 hrs. | 1 hr. |
| Headache | — | 24 hrs. | 4 hrs. | 2 hrs. |
| Fever | — | 3 hrs. | 1 hr. | 1 hr. |
| **Later symptoms** | | | | |
| Dizziness, disorientation | — | — | 1 wk. | Immediate |
| Weakness, fatigue | 4 wks. | 1–4 wks. | 1 wk. | Immediate |
| Hair loss, bloody vomit and stools, infections, poor wound healing, low blood pressure | — | 1–4 wks. | 1 wk. | Immediate |

## CHANCES OF DEATH BASED ON EXPOSURE LEVEL




Sources: guardian.co.uk; World Nuclear Association; Wikipedia; Graphic News;

# Environmental Impact

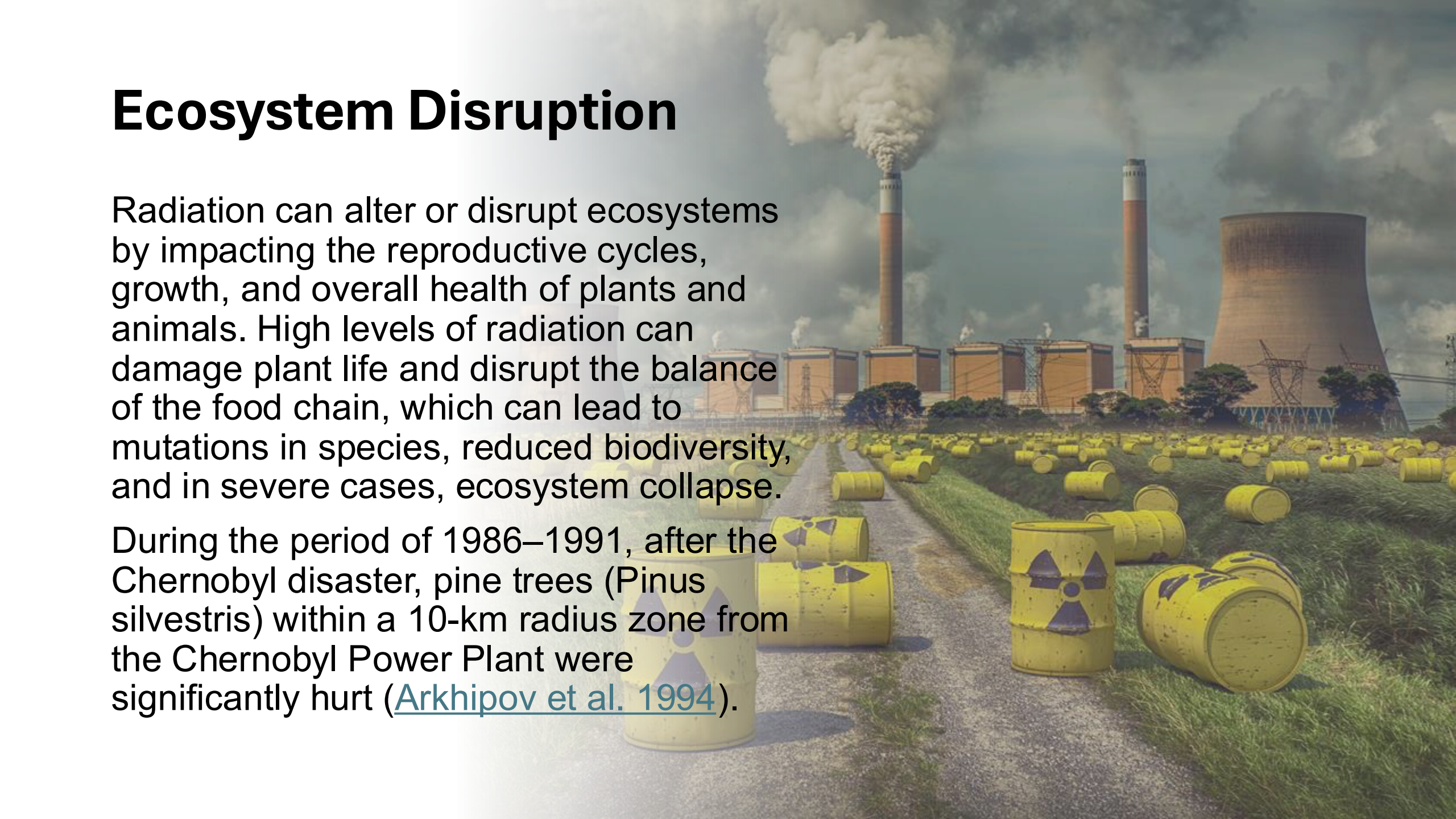



- Ecosystem Disruption
- Water Contamination
- Damage to Agriculture & Livelihoods
- Material Damage

# Ecosystem Disruption

Radiation can alter or disrupt ecosystems by impacting the reproductive cycles, growth, and overall health of plants and animals. High levels of radiation can damage plant life and disrupt the balance of the food chain, which can lead to mutations in species, reduced biodiversity, and in severe cases, ecosystem collapse.

During the period of 1986–1991, after the Chernobyl disaster, pine trees (Pinus silvestris) within a 10-km radius zone from the Chernobyl Power Plant were significantly hurt (Arkhipov et al. 1994).



# Water Contamination

Radioactive pollutants can enter water bodies through various means, contaminating aquatic life and affecting the health of organisms within those ecosystems. It can also impact the drinking water supply for humans and animals. **Uranium, thorium and actinium** are three NORM (Naturally Occurring Radioactive Materials) series that contaminate water resources. A small amount of radiation is found in all types of water, but the extended amount of radiation is harmful to human health.

# Damage to Agriculture & Livelihoods

Radioactive pollution can damage crops, affecting agricultural productivity. It can also harm livestock and decrease the safety of food supplies, impacting the livelihoods of communities dependent on agriculture and farming.

A nuclear war using less than 0.5% of the world's nuclear artilleries, could result in global famine putting up to 2 billion people at risk of experiencing mass starvation — Dr. Ira Helfand, IPPNW Co-President

# Material Damage

Radiation exposure can damage materials such as metals, polymers, and electronics, leading to degradation of structural integrity and performance.

# Social Impact

Radioactive pollution can have significant social effects on individuals, communities, and societies as a whole. Some of these effects include:

- Displacement and Relocation
- Economic Impact
- Social sigma and Discrimination
- Educational and Cultural Disruption
- International Relations

# Social sigma and Discrimination

Incidents involving radioactive pollution, such as nuclear accidents or leaks, can force the evacuation and relocation of communities from affected areas. This displacement can disrupt lives, lead to psychological trauma, and cause social unrest due to the loss of homes, livelihoods, and community ties.

# Economic Impact

Radioactive pollution incidents can have long-term economic consequences. Affected areas might face decreased property values, loss of agricultural productivity due to contaminated soil, and damage to industries reliant on the affected resources, leading to economic instability and job losses.

## Displacement and Relocation

People from areas affected by radioactive pollution might face social stigma and discrimination. This can manifest in various forms, including reluctance from others to interact or trade with individuals from contaminated zones due to fears of radiation exposure.

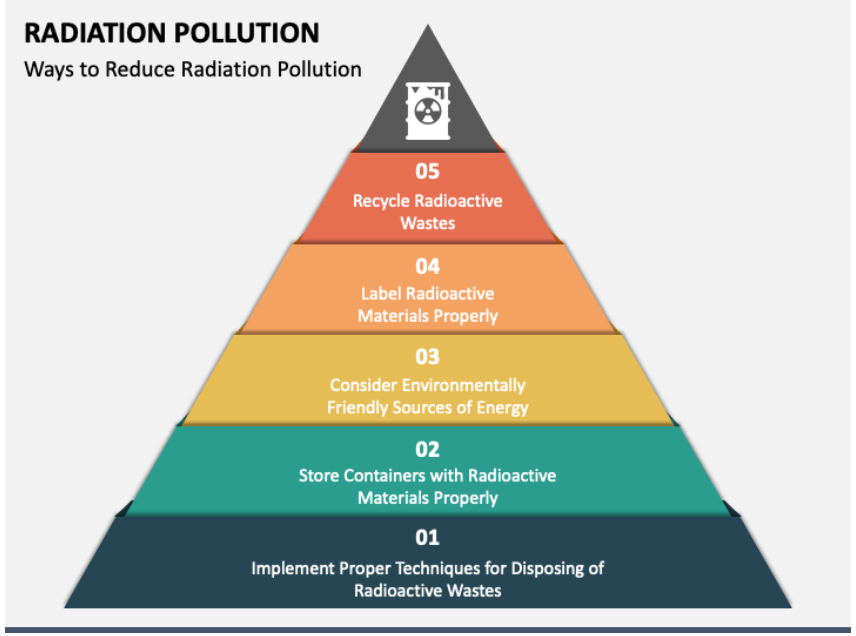
## Educational and Cultural Disruption

Educational institutions, cultural practices, and traditional ways of life in affected areas may be disrupted. Schools might close, cultural practices could be altered, and traditional livelihoods might become unsustainable due to contamination, causing a loss of heritage and social cohesion.

## International Relations

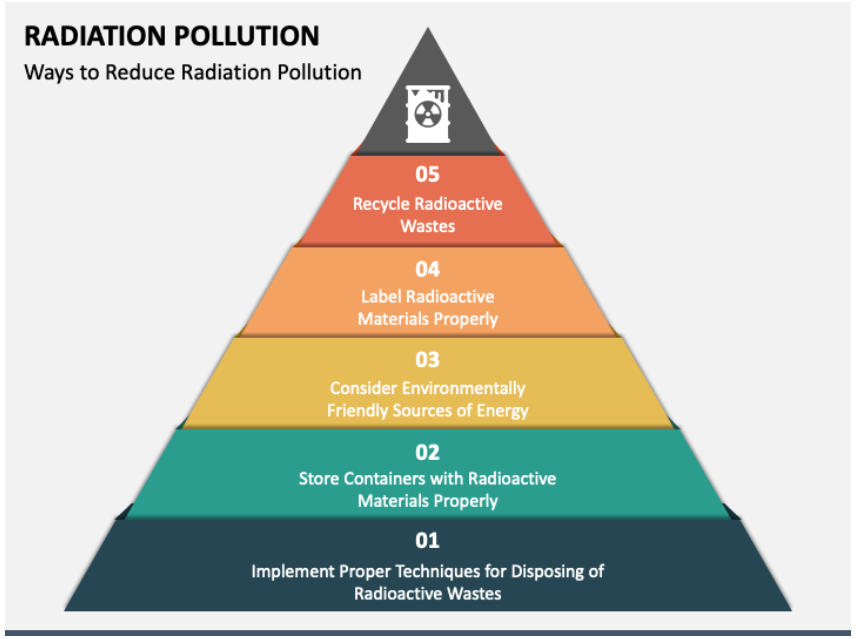
Incidents of radioactive pollution can strain international relations, especially if the contamination spreads across borders. Disputes over responsibility, information sharing, and managing transboundary impacts can lead to tensions between nations.

# Prevention




- Nuclear devices should be exploded under ground.
- Contaminants may be employed to decrease the radioactive emissions.
- Production of radio isotopes should be minimized.
- Extreme care should be exercised in the disposal of industrial wastes contained with radionuclides.
- Use of high chimney and ventilations at the working place where radioactive contamination is high.

# Prevention




- In nuclear reactors, closed cycle coolant system with gaseous coolants of very high purity may be used to prevent extraneous activation products.
- Fission reactions should be minimized.
- In nuclear mines, wet drilling may be employed along with underground drainage.
- Nuclear medicines and radiation therapy should be applied when absolutely necessary and earth minimum doses

# Thanks