

Environmental Science

Unit –I Environment and Ecosystem

Part-I Environment

(Segments of Environment: Atmosphere, hydrosphere, Lithosphere, biosphere. Cycles in Ecosystem – Water, Carbon, Nitrogen.)

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Environmental Science

- **Environmental science** is the study of:
 - How the Nature works
 - How the environment affects the humans and vice versa

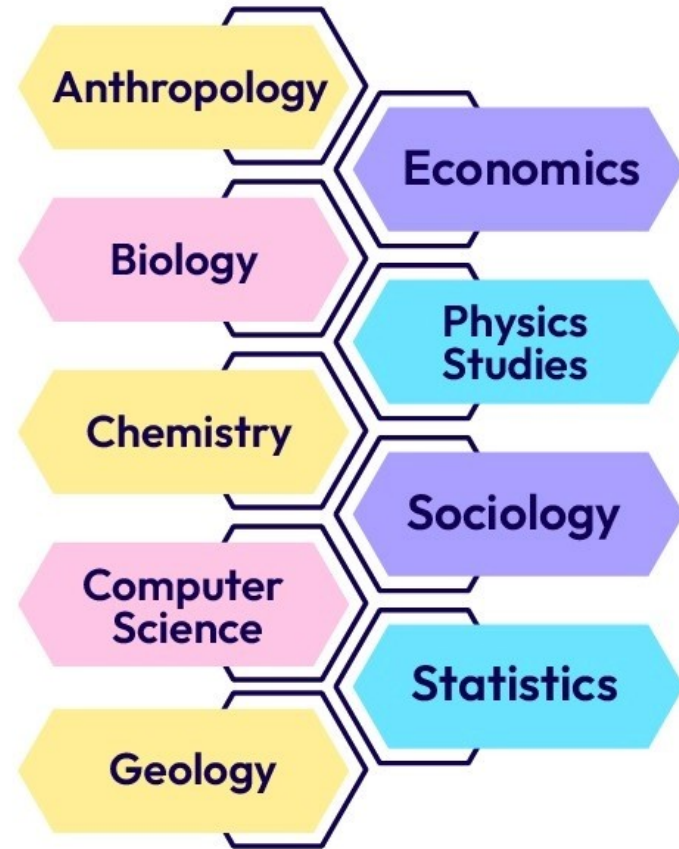
"(Environmental science is) an interdisciplinary field that integrates areas of life, physical and earth science to study and address problems facing the environment and to implement science-based solutions."



Environmental Science :

The science of Environment studies is multi-disciplinary.

It comprises various branches of studies like chemistry, physics, medical science, life science, agriculture, public health, sanitary engineering and many more



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Definitions of Environment Science

- The word 'Environment' is derived from the French word 'Environner' which means to encircle, around or surround.
- The biologist Jacob Van Uerkal (1864-1944) introduced the term 'environment' in Ecology.
- Ecology is the study of the interactions between an organism of some kind and its environment.
- Environmental Science is the interdisciplinary field and requires the study of the interactions among the physical, chemical and biological components of the Environment with a focus on environmental pollution and degradation.





Definitions of Environment Science

- The science of Environment studies comprises various branches of studies like chemistry, physics, life science, medical science, agriculture, public health, sanitary engineering, geography, geology, atmospheric science, etc.
- It is the science of physical phenomena in the environment. It studies the sources, reactions, transport, effect and fate of a biological species in the air, water and soil and the effect of and from human activity upon these.
- Environmental Science deals with the study of processes in soil, water, air and organisms which lead to pollution or environmental damages and the scientific basis for the establishment of a standard which can be considered acceptably clean, safe and healthy for human beings and natural ecosystems.





What is Environment?

- The Environment is about the surrounding external conditions influencing development or growth of people, animal or plants; living or working conditions etc.
- This involves three questions i.e.,
 - ✓ what is surrounded?
 - ✓ by what surrounded? and
 - ✓ where surrounded?
- The answer to the first is living objects in general and man in particular.
- The answer to the question what surrounded is that human life is concerned to be the main in the study of environment, however it cannot exist or be understood in isolation from the other forms of life like animal life and from plant life.





What is Environment?

1. Environment belongs to all living beings and is thus important for all.
2. Hence, environment refers to the sum total of conditions surround in space and time.
3. In the primitive age, the environment consisted of only physical aspects of the planet earth ie., land, water and air as biological communities. As of now, it includes social, economic and political conditions also.
4. The answer for the question where surrounded is in nature that physical component of the planet earth, viz land, air, water etc., support and affect life in the biosphere..



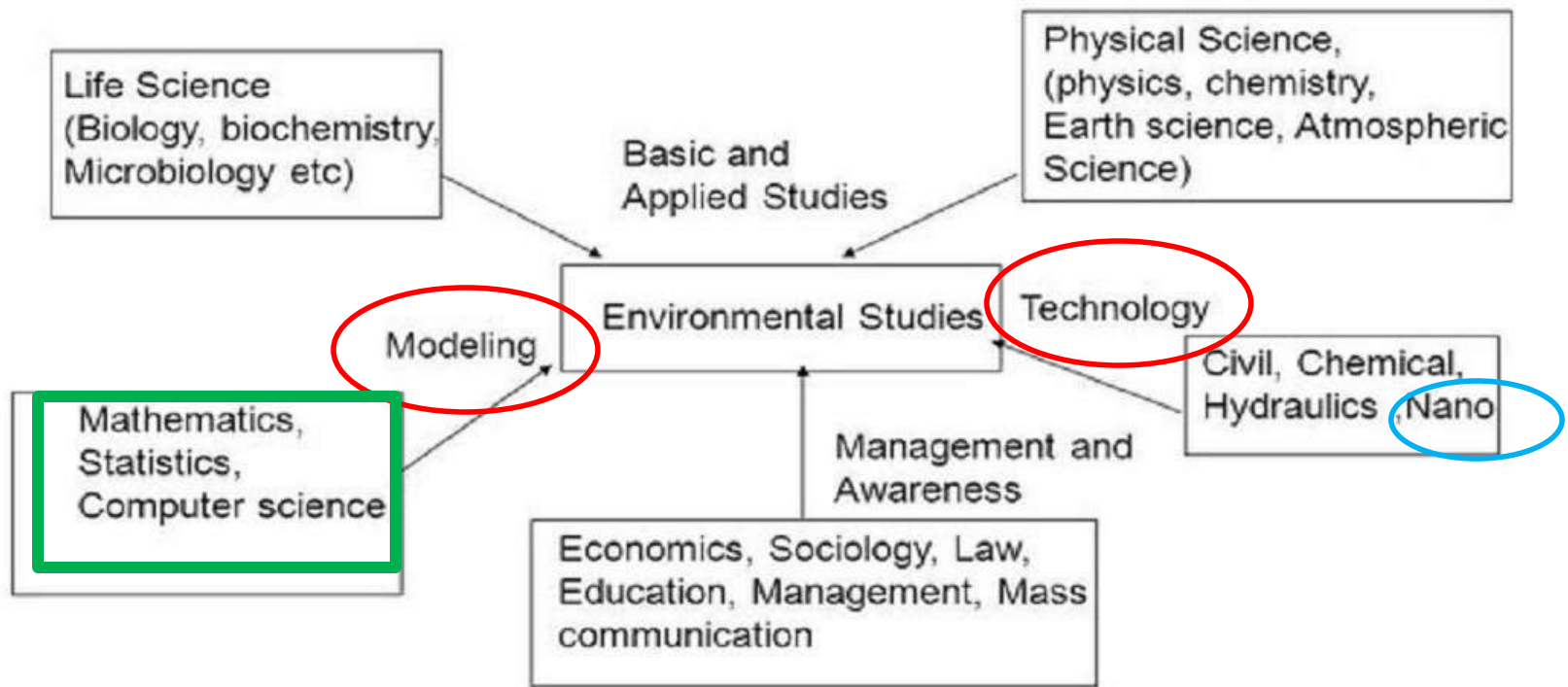
Environment is the sum total of land, water, air, interrelationships among themselves and also with the human beings and other living organisms.

(OR)

The sum total of all surroundings of a living organism, including natural forces and other living things, which provide conditions for development and growth as well as of danger and damage.



Concept of Environment: air, water, land, living organisms and materials surrounding us and their interactions together constitute environment.





- Life sciences including botany, zoology, microbiology, genetics, biochemistry, biotechnology help in understanding the biotic components and their interactions.
- The physical and chemical structure of the biotic components and energy transfer and flow are understood with the help of basic concept of physics, chemistry, atmospheric science and oceanography.
- Mathematics, statistics and computer science serve as effective tools in environmental modelling and management.





- Economics, sociology and mass communication provides the input for dealing with socio economic aspects associated with various developmental activities.
- A synthesis with environmental engineering, civil engineering and chemical engineering form the basis for various technologies dealing with the control of environmental pollution, waste treatment and development of cleaner technologies that are important for protection of environment.
- Environmental laws provide the tools for effective management and protection of the environment.





Segments of Environment

- The environment consists of four segments :
 1. Atmosphere (**Air**)
 2. Hydrosphere (**Water**)
 3. Lithosphere (**Land**)
 4. Biosphere (**Living organism**)





Planet Earth

- **Geosphere (Lithosphere):**

Crust: < 1% (Thin)

Everest: 8.85 km

Mantle, Cores

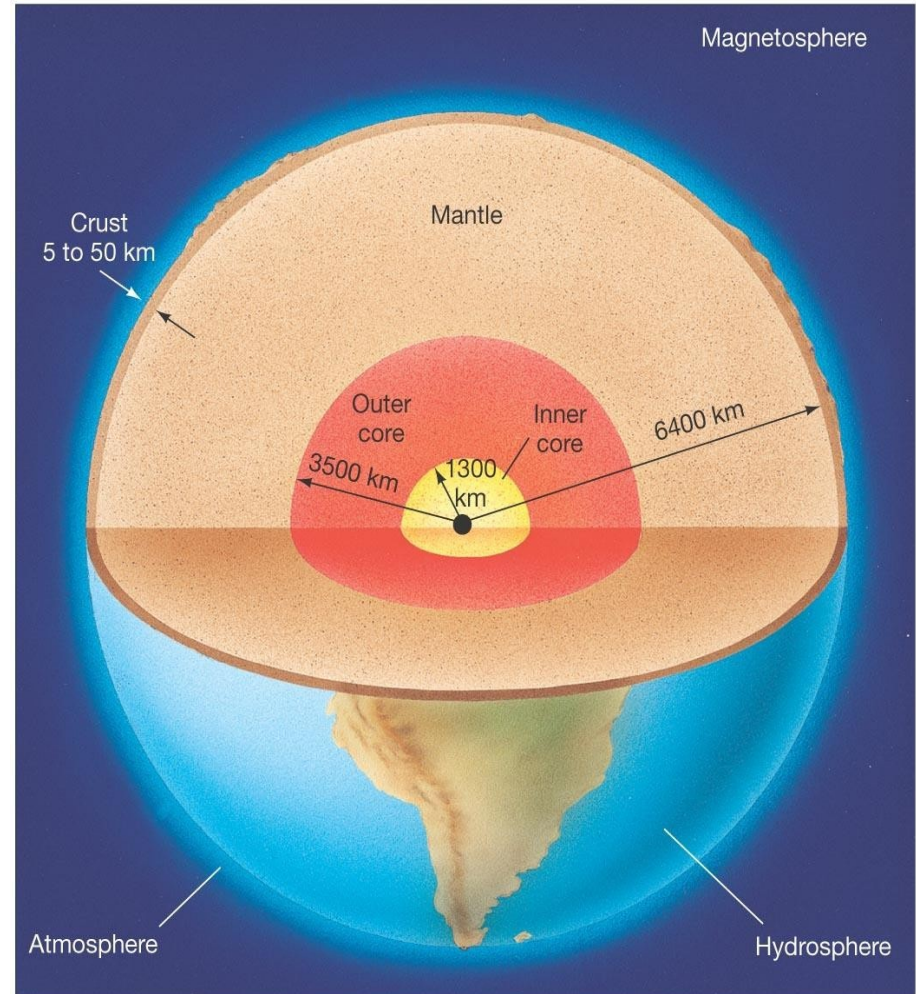
- **Hydrosphere: (oceans)**

Mariana Trench ~ 0.2 %

The Mariana Trench is an oceanic trench located in the western Pacific Ocean, about 200 kilometres east of the Mariana Islands; it is the deepest oceanic trench on Earth.

- **Atmosphere: 30 km (99% of air) extends to 120 km**

- **Biosphere:**



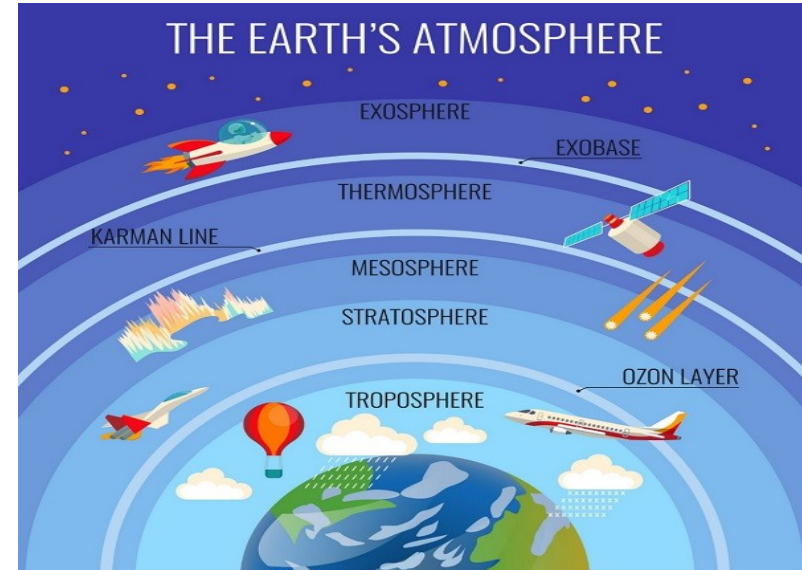
The magnetosphere shields our home planet from harmful solar and cosmic particle radiation, but it can change shape in response to incoming space weather from the Sun.





Atmosphere

- The **Atmosphere** forms a distinctive protective layer about 100 km thick around the earth.
- A blanket of gases called the atmosphere surrounds the earth and protects the surface of earth from the Sun's harmful, ultraviolet rays.
- It also regulates temperature, preventing the earth from becoming too hot or too cold.
- It saves it from the hostile environment of outer space.
- The atmosphere is composed of nitrogen and oxygen besides, argon, carbon dioxide and trace gases (**water vapor, carbon dioxide, ozone, methane, various oxides of nitrogen, neon, and helium**).
- It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.





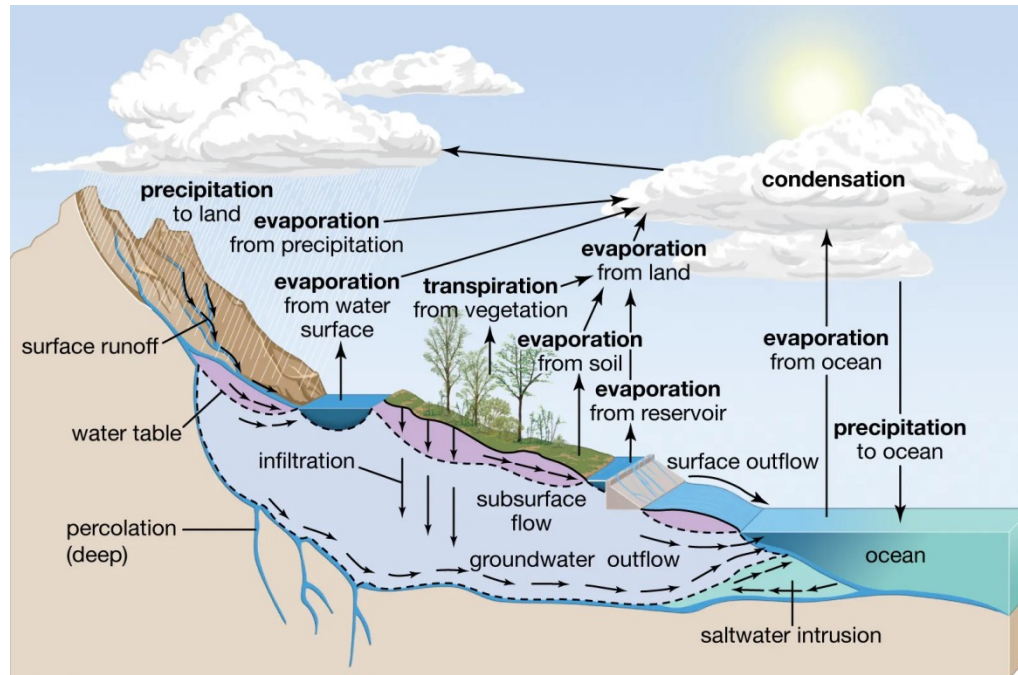
Issues need to be addressed in Atmosphere

- Pollution, acid rain, and holes in the ozone disrupt how the atmosphere normally functions. 1. Air in the atmosphere is made up of several gases. It is 78% nitrogen (N) and 21% oxygen (O₂).
- [Aerosols](#) |
- [Air Quality](#) |
- [Atmospheric Chemistry](#) |
- [Atmospheric Pressure](#) |
- [Atmospheric Radiation](#) |
- [Atmospheric Temperature](#) |
- [Atmospheric Water Vapor](#) |
- [Atmospheric Winds](#) |
- [Clouds](#) |
- [Precipitation](#) |
- [Weather Events](#)



Hydrosphere:

1. The **Hydrosphere** comprises of all types of water resources oceans, seas, lakes, rivers, streams, reservoirs, polar icecaps, glaciers, and ground water.
2. Oceans represent 97% of the earth's water and about 2% of the water resources is locked in the polar icecaps and glaciers.
3. Only about 1% is available as fresh water as surface water in rivers, lakes, streams, and as ground water for human use.



soil moisture
 groundwater
 ocean covers 71 percent of Earth's surface
196,950,000 sq mi (510,000,000 sq km)

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Issues need to be addressed in Hydrosphere

- Inadvertent and deliberate discharge of petroleum, improper sewage disposal, and thermal pollution also are seriously affecting the quality of the hydrosphere. The present discussion focuses on three major problems—
- eutrophication (the gradual increase in the concentration of phosphorus, nitrogen, and other plant nutrients in an aging aquatic ecosystem such as a lake),
- acid rain, and the buildup of the so-called greenhouse gases.

- Every year in the oceans there is discharge of 30 million tons of oil, of which 10.5 million tons - from maritime accidents, with coastal cities
- Leakage from the soil and rivers is made about 62 million tons of nitrogen and phosphorus
- Only in the North Sea annually dumped more than 60,000 tons of various chemical contaminants, including 8 tons of mercury
- 31,800 tons of chlorides, sulfates 14,000 tons, 9,700 tons of calcium, magnesium 3443 tons, 2000 tons of nitrate

- 25% of the world's population has a risk to become sick as result of low quality of water
- approximately every 10th resident of the planet becomes sick
- nearly 4 million children and 18 million adults die
- It is admitted that 100 cases of cancer of 20 to 35 years old (especially colon and bladder) are due to consumption of chlorinated drinking water





Lithosphere & Biosphere

Lithosphere: It means the mantle of rocks constituting the earth's crust. The solid component of the earth is called Lithosphere, which includes soil, earth, rocks and mountains etc. The lithosphere mainly contains three layers

- (a) Inner and Outer Core: Central fluid or vaporised sphere of diameter of about 2500km from the centre.
- (b) Mantle: It is about 2900-3000 km above the core in molten state.
- (c) Crust: Outermost solid zone about 8-40 km above mantle.

Biosphere: This segment of environment consists of atmosphere (air- O_2 , N_2 , CO_2). Lithosphere (land- minerals, salts, food, nutrients) and hydrosphere (water- dissolved oxygen, Salts) which influences and support the entire biotic and abiotic life systems.



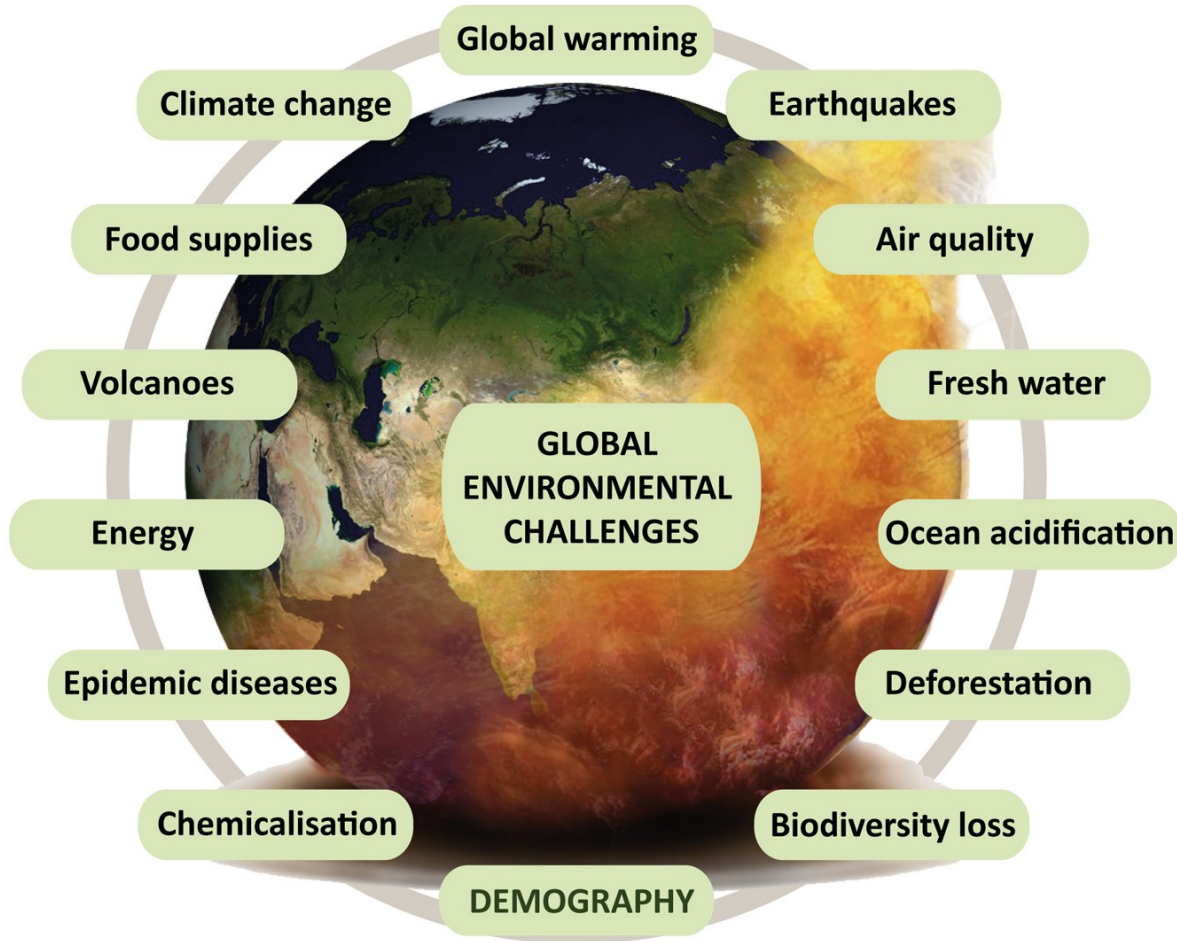


Biosphere

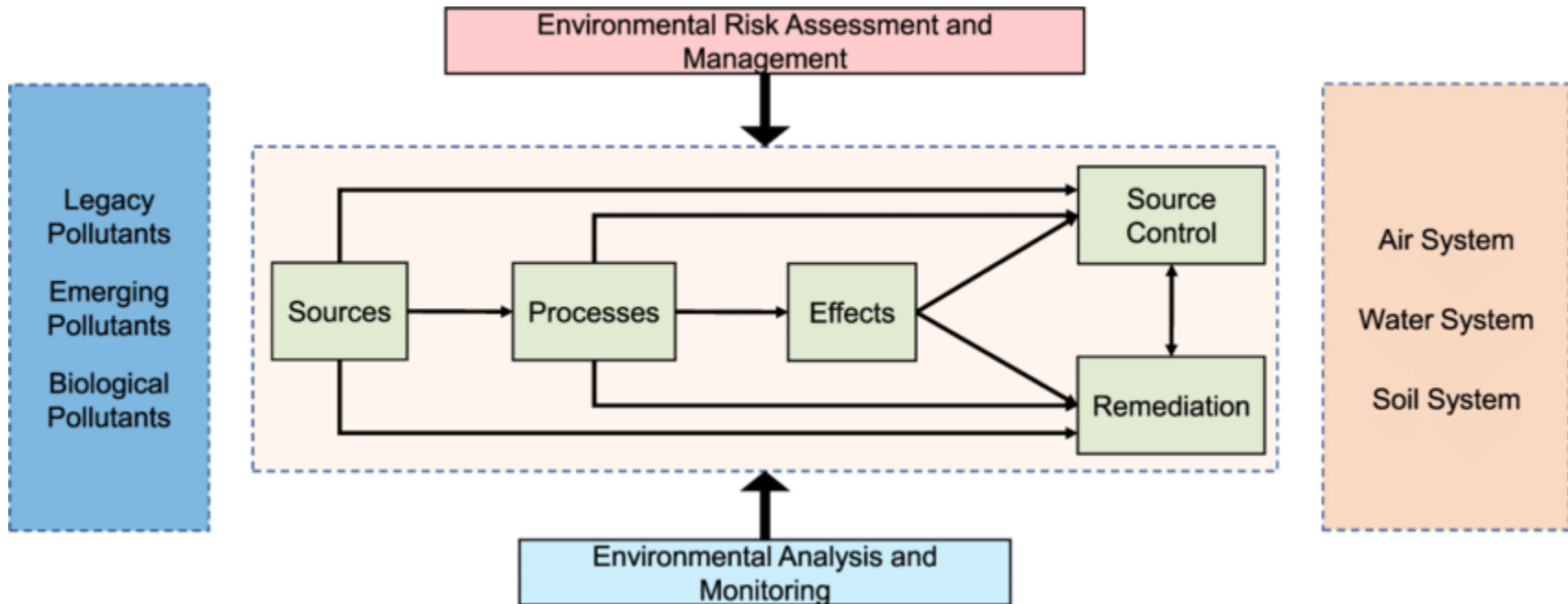
- Biosphere indicates the realm of living organisms and their interactions with environment, viz atmosphere, hydrosphere and lithosphere.



Environmental Challenges



Areas of Research in Environmental Science





Different types of cycles

- A natural process in which elements are continuously cycled in various forms between different compartments of the environment (e.g., air, water, soil, organisms). Examples include the carbon, nitrogen and phosphorus cycles (nutrient cycles) and the water cycle..
 - Water Cycle
 - Carbon Cycle
 - Nitrogen Cycle
 - Oxygen Cycle
 - Phosphorus Cycle
 - Sulphur Cycle

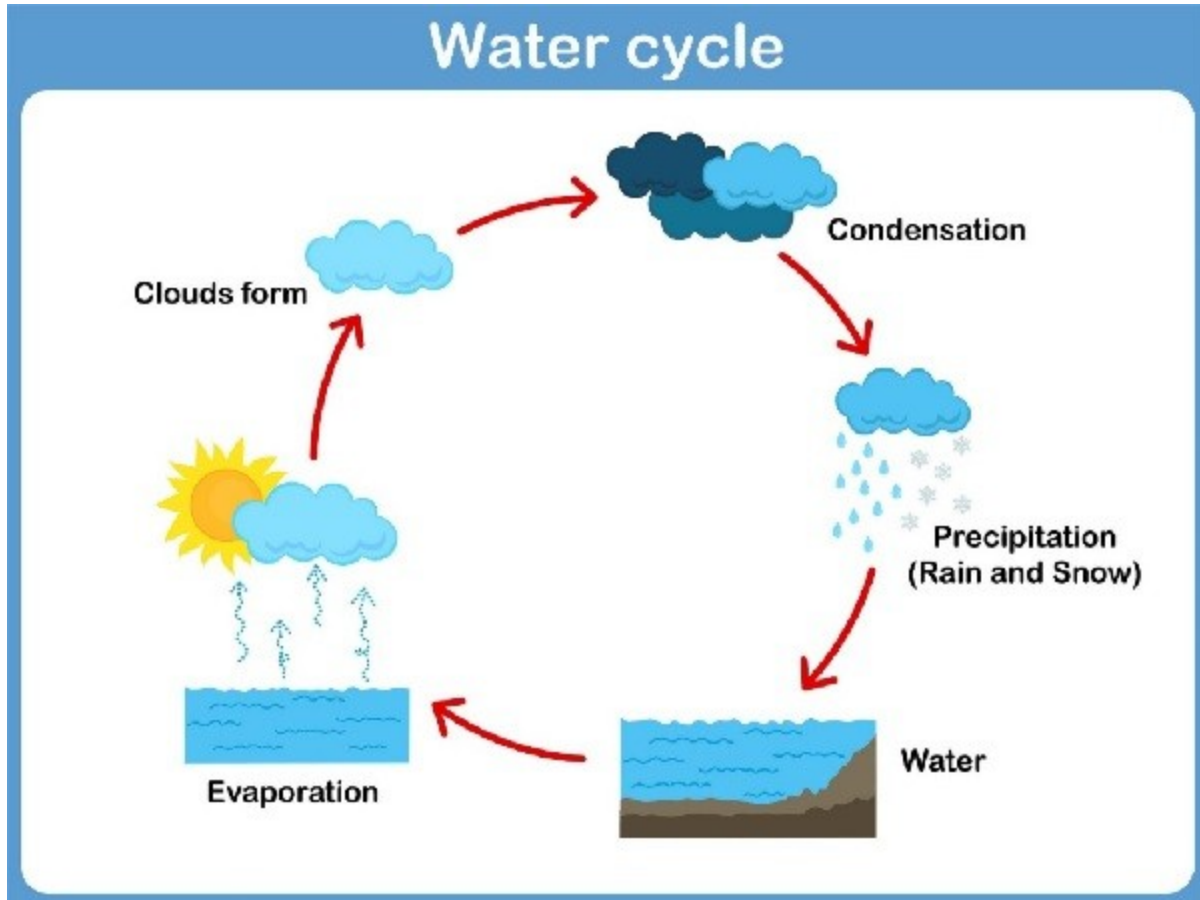




The Water Cycle

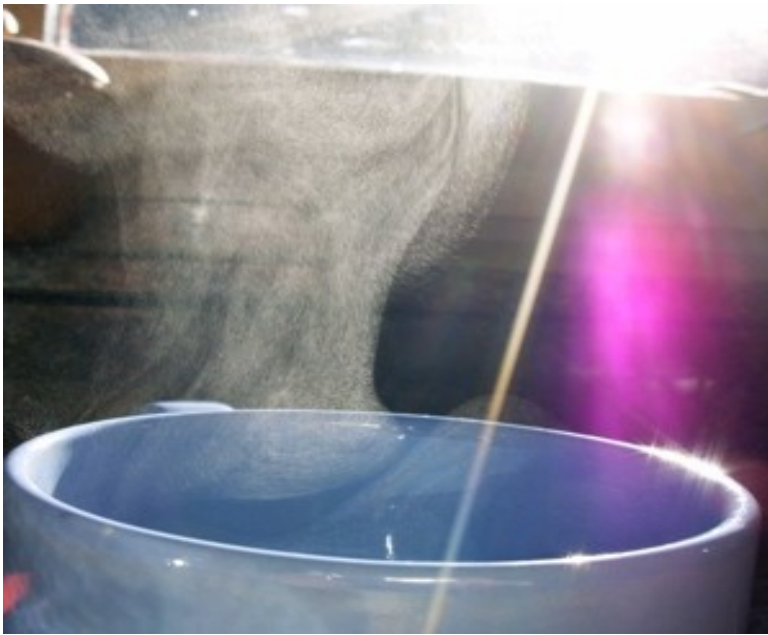
- Life on Earth depends on water.
- Even before there was life on earth, water cycled through stages.
- Plants use water to produce food through the process of photosynthesis.
- Heterotrophs use water in almost every life process throughout their entire life.





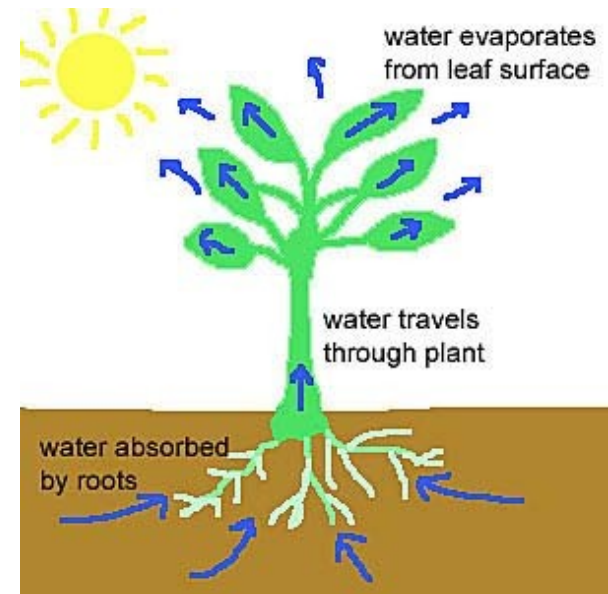
Steps of the Water Cycle

- **Evaporation** is the change of a liquid to water vapor (gas).
- **Condensation** is the change of water vapor (gas) to a liquid.



Steps of the Water Cycle

- **Precipitation** is any atmospheric water vapor that falls to the Earth.
 - Rain
 - Freezing rain
 - Snow
 - Sleet
 - Hail
- **Transpiration** is the evaporation of water from parts of plants, especially leaves but also stems, flowers and roots.





Carbon Cycle

- Carbon enters into the living world in the form of carbon dioxide through the process of photosynthesis as carbohydrates. These organic compounds (food) are then passed from the producers to the consumers (herbivores & carnivores). This carbon is finally returned to the surrounding medium by the process of respiration or decomposition of plants and animals by the decomposers. Carbon is also recycled during the burning of fossil fuels.
- The **atmosphere**; carbon dioxide gas is one form of carbon in the air.
- **Photosynthesis**- Autotrophs use carbon dioxide in photosynthesis. In photosynthesis, the sun's energy is used to make high-energy carbon molecules.
- **Wastes**- Autotrophs and heterotrophs break down the high-energy carbon molecules for energy. Carbon dioxide is released as a waste.
- **Organisms**- use high-energy carbon molecules for growth. A large amount of the world's carbon is contained in living things.

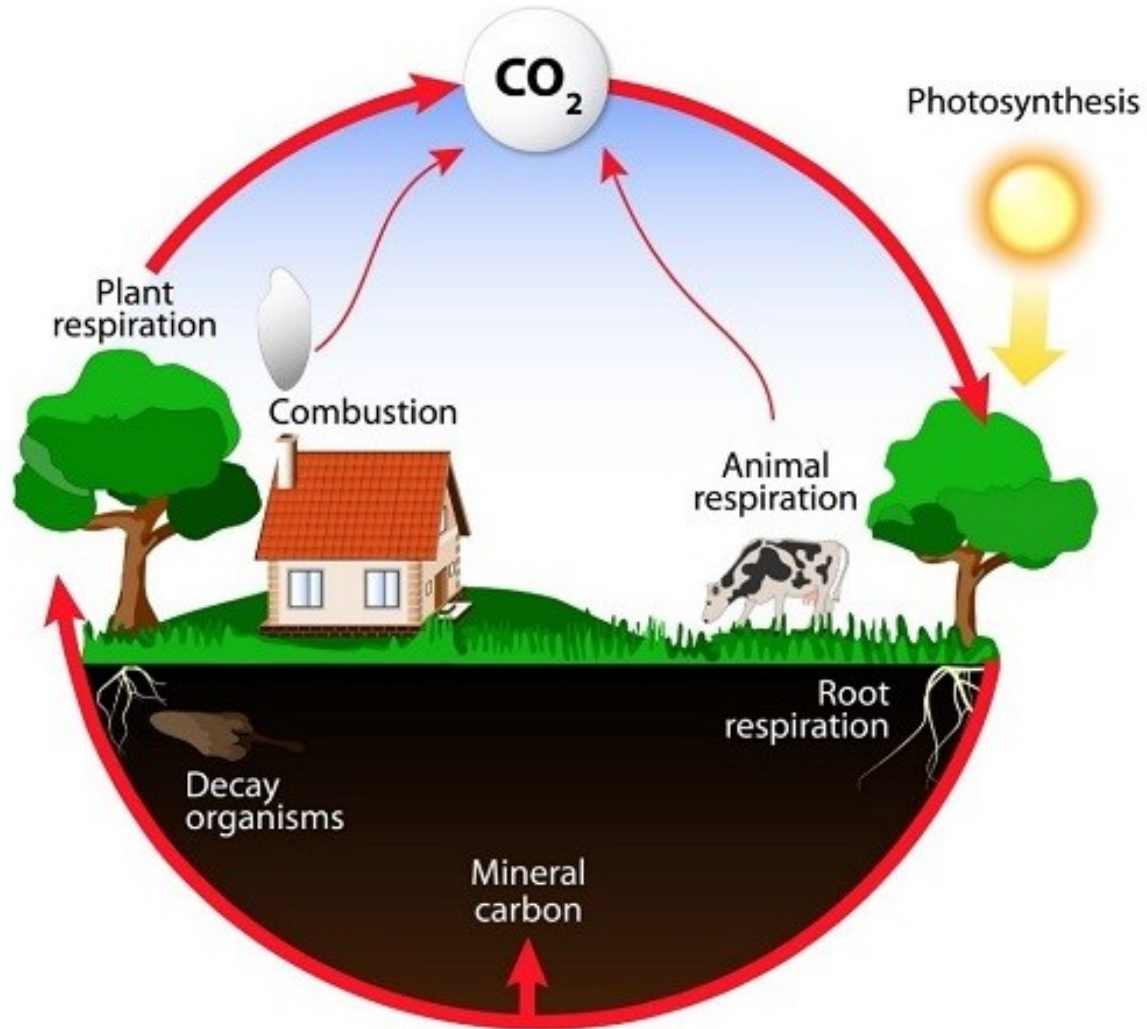




Carbon Cycle

- **Soil**- When organisms die and decay, the carbon molecules in them enter the soil. Microorganisms break down the molecules, releasing carbon dioxide.
- **Fuel**- Over millions of years, the remains of dead organisms are converted into fossil fuels, such as coal, gas, and oil. These fuels contain carbon molecules.





Carbon Cycle

- Pollution- combustion of fossil fuels and wood releases carbon dioxide.





Nitrogen Cycle

- Nitrogen (N_2) makes up about 78% of our atmosphere. It is not usable to humans and animals in this form however, it takes lightning and certain bacteria to convert nitrogen into a usable form.
- Plants use the nitrogen to make important molecules such as proteins. (fertilizers)
- Herbivores eat plants and convert nitrogen-containing plant proteins into nitrogen-containing animal proteins.
- Decomposers break down urine, an animal waste which contains excess nitrogen.
- When an animal urinates, nitrogen returns to the water or soil.
- When organisms die. Their nitrogen molecules return to the soil. Plants reuse these nitrogen molecules.
- Nitrogen “Fixing” Bacteria also act on these molecules and put nitrogen back into the air.

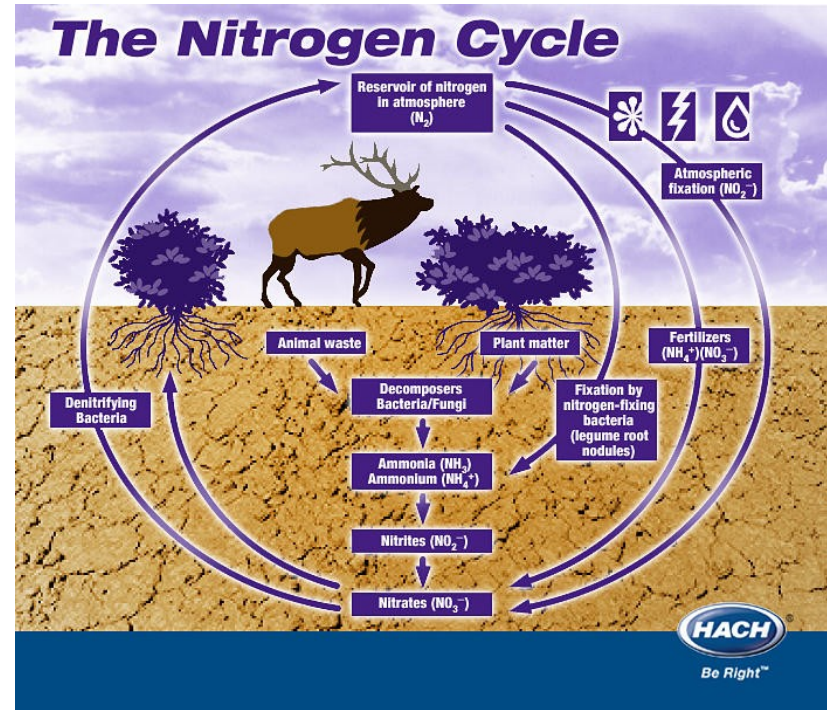
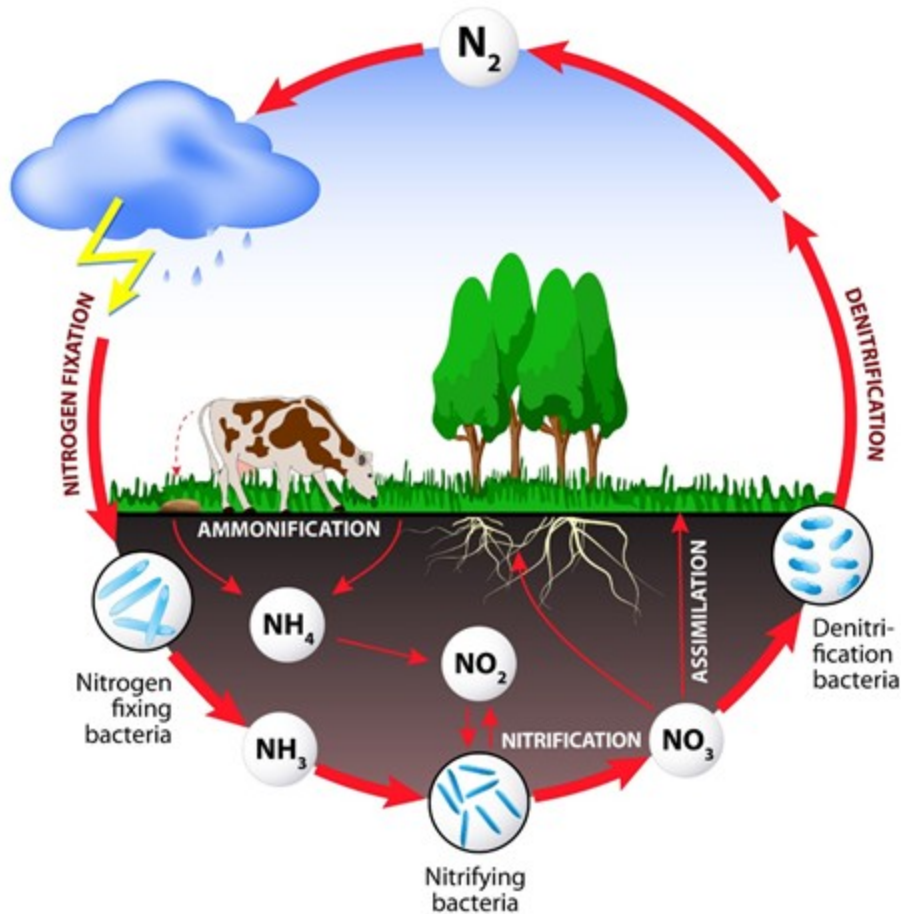




Nitrogen cycle completes in 5 steps:

- **Nitrogen Fixation**
 - Conversion of $N_2 \rightarrow NH_3$
- **Nitrogen Cycle**
 - Combustion, volcanic action, Lightning, Industrial processes (making fertilizer).
 - Bacteria (Azotobactor, Clostridium, Nostoc etc.)
- **2) Nitrification**
 - Conversion of $NH_3 \rightarrow NO_3$
 - Soil bacteria convert in a two step process.
- **3) Assimilation**
 - Roots absorb NH_3 , NH_4 , or NO_3 and incorporate them into nucleic acids and protein.
- **4) Ammonification**
 - Amino acids and nucleotides are broken down into waste products NH_3 or NH_4
- **Denitrification**
 - The reduction of NO_3 to N_2 .Denitrifying bacteria return some of the nitrogen to the atmosphere



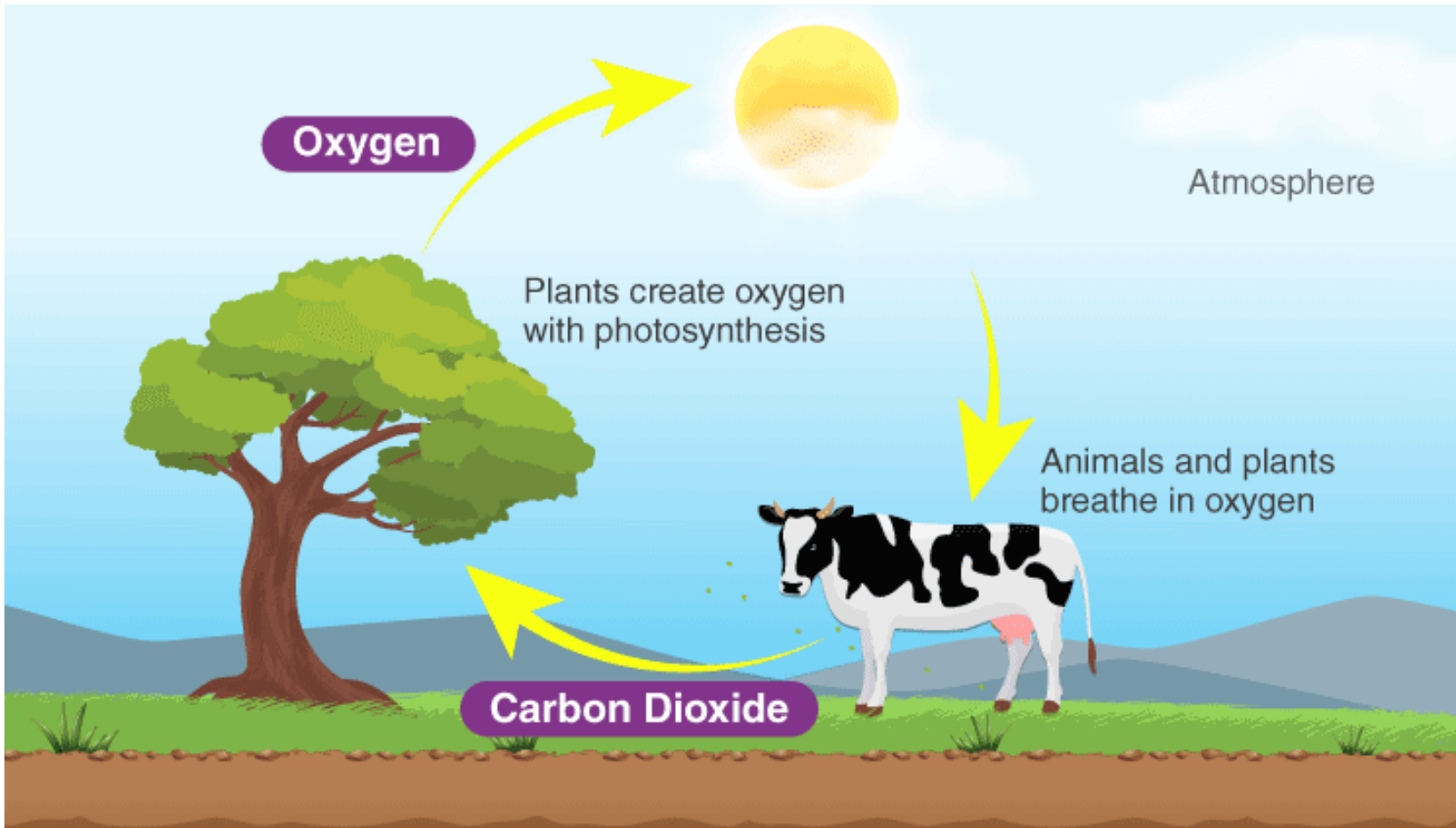




Oxygen Cycle

- This biogeochemical cycle moves through the atmosphere, the lithosphere and the biosphere.
- Oxygen is an abundant element on our Earth. It is found in the elemental form in the atmosphere to the extent of 21%.
- Oxygen is released by the plants during photosynthesis. Humans and other animals inhale the oxygen exhale carbon dioxide which is again taken up by the plants. They utilise this carbon dioxide in photosynthesis to produce oxygen, and the cycle continues.





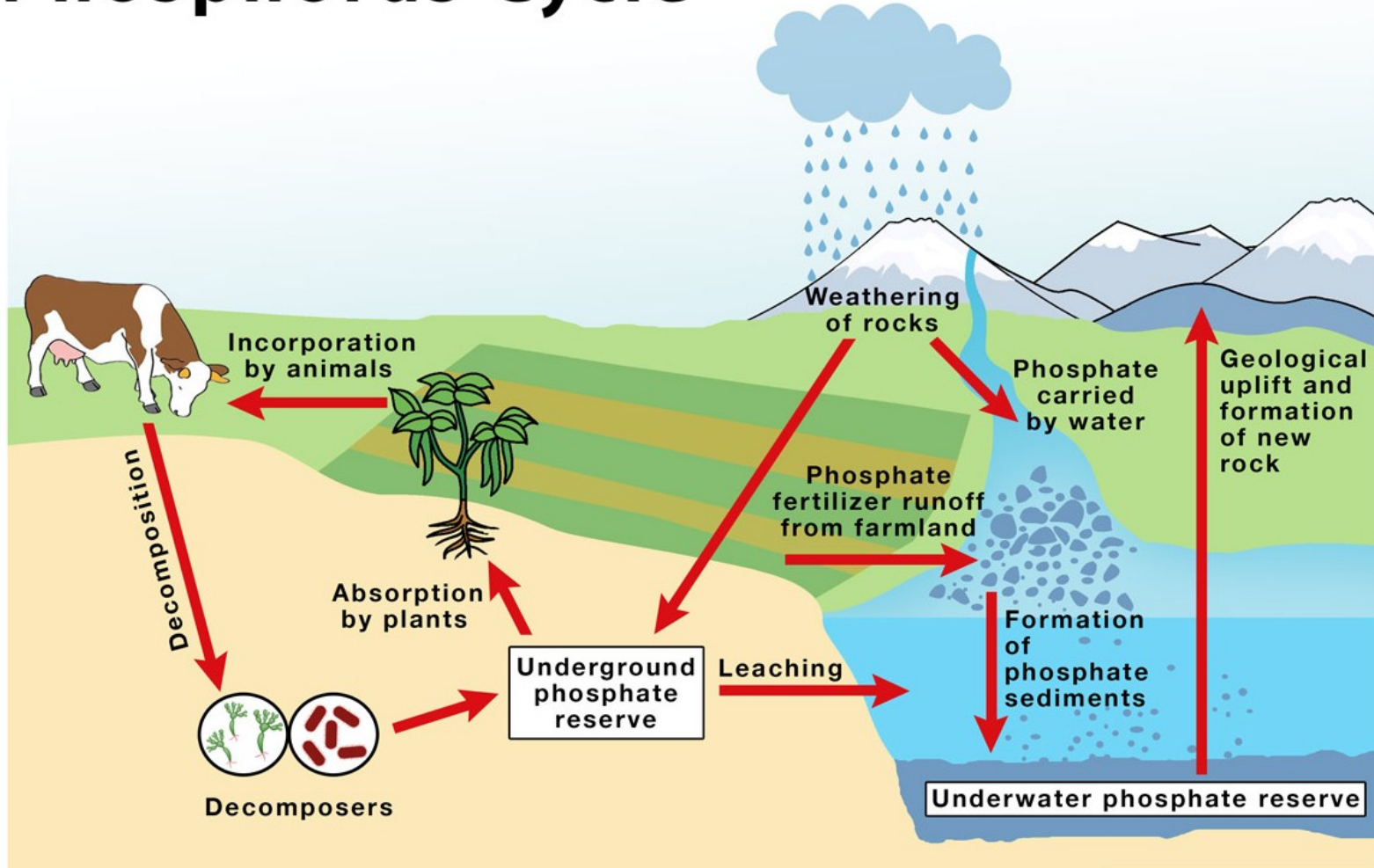


Phosphorous Cycle

- In this biogeochemical cycle, phosphorus moves through the hydrosphere, lithosphere and biosphere.
- Phosphorus is extracted by the weathering of rocks. Due to rains and erosion phosphorus is washed away in the soil and water bodies. Plants and animals obtain this phosphorus through the soil and water and grow.
- Microorganisms also require phosphorus for their growth. When the plants and animals die they decompose, and the stored phosphorus is returned to the soil and water bodies which is again consumed by plants and animals and the cycle continues.



Phosphorus Cycle





Sulphur Cycle

- This biogeochemical cycle moves through the rocks, water bodies and living systems.
- Sulphur is released into the atmosphere by the weathering of rocks and is converted into sulphates. These sulphates are taken up by the microorganisms and plants and converted into organic forms.
- Organic sulphur is consumed by animals through food. When the animals die and decompose, sulphur is returned to the soil, which is again obtained by the plants and microbes, and the cycle continues.



Sulfur Cycle

