- Environment means surrounding

Working environment, operating environment, computer environment….

- Environment *(Definition)*

"A holistic view of the world as its functions at any point of time, with a multitude of spatial, elemental and socio-economic systems, distinguished by quality and attributes of space, and mode of behaviour of abiotic (physical/ non-living) and biotic (living) forms.

Abiotic: temperature, light, atmospheric gases, mountain, land, water, ocean

Biotic: all surrounding living species

Types of Environment

Physical	Biological	Cultural
Lithosphere	Flora	Social
Hydrosphere	Fauna	Political
Atmosphere	Microbe	Economical

Aspects of man (biotic environment)

- **Physical man**
  - Component of organismic population; requires basic elements of physical environment
- **Social man**
  - Establishes social institution, forms rules, policies to safeguard his existence, interest, social welfare
- **Economic man**
  - Derives and utilises resources from biotic and abiotic environment with skills and technologies

The field of Environmental Science consists of the following subjects

- Sociology, Economics, Physics, Chemistry, Law Engineering Agriculture Biology Politics Philosophy Computer Earth Science

Nature and Scope

- Environmental Science
  - Theoretical Aspects
    - Identification of environmental problems

      How emission of green house gas affect climate, agricultural yield etc.

      How discharge of wastewater affects aquatic ecosystems etc.
  - Applied Aspects
    - Developing solutions to the identified environmental problems

Need for Environmental studies (Environmental protection starts by creating awareness)

1. It is very important for every person for self-fulfilment and social development.
2. It helps to understand different food chains and ecological balance in nature.
3. It helps to understand and appreciate how the environment is used for making a living and for promoting a material culture.

4. It helps in appreciating and enjoying nature and society.
5. It generates concern for the changing environment in a systematic manner for the future as well as immediate welfare of mankind.
6. It directs attention towards population explosion, exhaustion of natural resources and pollution of environment and throws light on solutions.

Goals of Environmental education

"*To develop a world population that is aware of and concerned about environment as a whole and the problems associated with it, and committed to work individually as well as collectively towards solutions of current problems and prevention of future problems*"

Primary objectives: (**SPEAK Awareness**)

1. **S**kill: Acquire skills for identifying and solving environmental problems.
2. **P**articipation: To provide an opportunity to be actively involved at all levels in working towards the solution of environmental problems.
3. **E**valuation ability: Develop the ability to evaluate environmental measures and education programmes in terms of ecological, economic, social and aesthetic factors.
4. **A**ttitude: Acquire a set of values and feelings of concern; motivation for active participation to improve and protect environment.
5. **K**nowledge: Gain a variety of experiences and acquire a basic understanding of the environment and its associated problems.
6. Awareness: Acquire an awareness of the environment as a whole and its allied problems and sensitivity.

Guiding principles:

1. To consider the environment in its totality (natural, artificial, moral, cultural etc.)
2. To consider a continuous life process (pre-school to degree, formal, non-formal)
3. To be inter-disciplinary in approach
4. To emphasise active participation in the prevention and control of environmental problems
5. To examine the major environmental issues from local, national and global point of view
6. To focus on current potential environmental situations
7. To consider environmental aspects in plans for growth and development
8. To emphasise the complexity of environmental problems and the need to develop critical thinking and problem solving skills
9. To promote the value and necessity of local national and global cooperation in the prevention and control of environmental problems
10. To utilise diverse approaches for teaching and learning about environment
11. To help learners discover the symptoms of real causes of environmental problems
12. To relate environmental sensitivity, knowledge, problem solving and value clarification at every level

13. To enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences

Environmental education programmes

1. Environmental Studies

This is concerned with the environmental disturbances and the minimisation of their impacts through changes in the society (social sciences)

2. Environmental Science

It deals with the study of the processes in water, air, soil and organisms which lead to pollution or environmental damage and to know a scientific basis for establishing a standard which can be considered acceptably clean, safe and healthy for human beings and the natural ecosystems (physical and natural sciences)

3. Environmental Engineering

This is the study of the technical processes which are used to minimise the pollution and assess their impact on the environment (engineering sciences)

Man-Environment relationships

1. Period of hunting and food gathering
2. Period of animal domestication and pastoralism
3. Period of plant domestication and agriculture
4. Period of Science, technology and industrialisation

1. Period of hunting and food gathering

- Related to primitive man
  - Man was part of natural environment
  - He was concerned with food (fruits) and shelter (caves, on trees)
  - He had a friendly relationship with environment
- Started hunting animal for food
  - First exploitation of natural resources
  - Had very less impact on environment (low population, disorganised society)
- Discovery of fire, invention of tools
  - Continued exploitation of natural resources
  - Careless mistakes led to forest fires, destruction of forests

Fire was the first major ecological tool used by human beings to change the environment for their own Benefit

2. Period of animal domestication and pastoralism

- Started domesticating animal for meat and milk
  - Created habitat for these animals
  - This led to destruction of forest
  - This also led to the first community life among people
  - Domesticated animal population increased

Pastoralism is the branch of agriculture concerned with the raising of domesticated animals.

- This led to meaningful exploitation of environment resources.
- Still not much damage is done on the environment

3. Period of plant domestication and agriculture

- Started domesticating plant for food
  - Nomad life style changed to settled life style
  - Started cultivating crops
  - This led to the earliest river valley civilisation
  - This changed the friendly and cordial relationship
  - Gradual increase of human population
  - More forest were cleared for agricultural land
  - Man developed cultural environment, Built house, school, temple, road etc.
  - This continued until Industrial revolution

4. Period of Science, technology and industrialisation

- Industrial revolution started around 1860
  - Emergence of science, development of efficient technology
  - Initiated hostile relationship with environment
  - Birth of technological man
  - Indiscriminate exploitation of natural resources led to present ecological problems

Famous inventors of 18th - 19th Century

Person	**Invention**	**Date**
James Watt	First reliable Steam Engine	1775
Eli Whitney	Cotton Gin, Interchangeable parts for muskets	1793, 1798
Robert Fulton	Regular Steamboat service on the Hudson River	1807
Samuel F. B. Morse	Telegraph	1836
Elias Howe	Sewing Machine	1844
Isaac Singer	Improves and markets Howe's Sewing Machine	1851
Alexander Graham Bell	Telephone	1876
Thomas Edison	Phonograph, Incandescent Light Bulb	1877, 1879
Nikola Tesla	Induction Electric Motor	1888
Rudolf Diesel	Diesel Engine	1892
Orville and Wilbur Wright	First Airplane	1903
Henry Ford	Model T Ford, Assembly Line	1908, 1913

Impact of Man on Environment

Direct or intentional impact (preplanned , man is aware of consequences)

1. Land use changes
   - Clearing of forests, burning of land, felling of trees, changes in cropping pattern

2. Construction and excavation
    - Construction of dams, diversion of rivers, construction of roads, bridges, urbanisation
3. Agricultural practices
    - Mechanisation of agriculture, use of chemical fertiliser, pesticide etc.
4. Weather modification programme
    - Cloud seeding to induce precipitation, dispersal and clearing of clouds, fogs
5. Nuclear programme
    - Use of nuclear energy for constructive and destructive purposes

Example of Construction of dams, diversion of rivers

Three Gorges Dam was built on Yellow river, China. The Chinese government regards the project as a historic engineering, social and economic success

Direct or intentional impact (preplanned , man is aware of consequences)

Human impact on the environment is also called as **anthropogenic** impact on the environment includes impacts on biophysical environments, biodiversity and other resources. Many are noticeable quickly but have impact over longer period of time.

We can reverse the impact by taking appropriate actions

Afforestation

Change of form farming practices

Indirect or unintentional impact (industrial development for economic growth)

Many are not noticeable quickly but have impact over longer period of time.

These are non-reversible.

Affect the natural system in a detrimental way.

Examples include pollution and environmental degradation

Biogeochemical cycles

What is biogeochemical cycle?

It is the movement of nutrient elements like C, N, H, O, P, and S through the Earth's atmosphere, ocean and sediments.

Newey defined biogeochemical cycle as *large scale cycles, involving inorganic substances which pass through a biotic phase and then return to an inorganic state.*

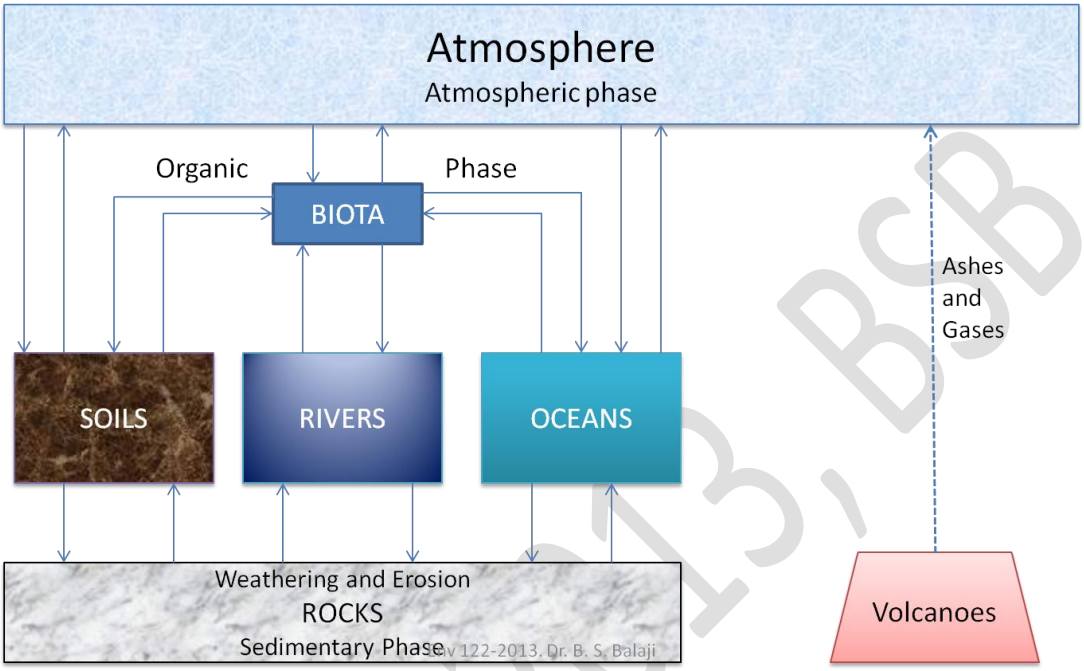
- The uptake of nutrients (inorganic elements) by plants through their roots in solution form from the soils
- During sedimentation these inorganic elements deposited on soils
- Some nutrients leached from soil to ocean through river

Two approaches are used to study

Cycling of all elements together E.g. Water cycle

Cycling of individual elements E. g. carbon cycle, nitrogen cycle

Biogeochemical cycles



Carbon cycle (phases of storage and movement in biosphere)

1. **Gaseous phase**: carbon is present as **CO_2** in the atmosphere
2. **Liquid phase**: carbon is present as **dissolved CO_2** in water
3. **Solid phase**: carbon is stored in **sediments**, **fossil fuels** and **organic matter**

Carbon cycle (circulation of carbon within biosphere)

1. **Gaseous cycle**: carbon is present as **CO_2** in the atmosphere and **dissolved CO_2** in water (river and ocean)
2. **Non- gaseous cycle**: solid phase of carbon e.g. carbohydrates (**organic matter)**, hydrocarbon (**fossil fuels)**, mineral carbonates

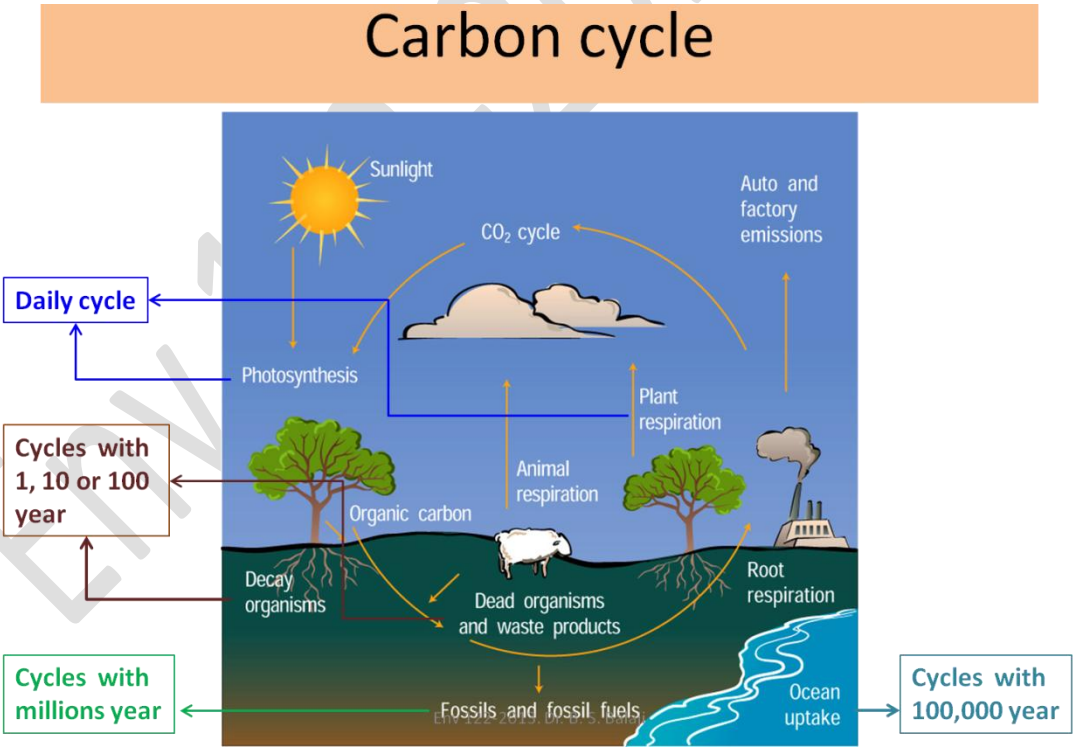
Portions of Earth	Carbon content (%)
Atmosphere	1
Living organisms on land	1.5
Dead organic matter	5.5
Fossil fuel	21
Dissolved in ocean	71

Carbon cycle (based on rate of transfer)

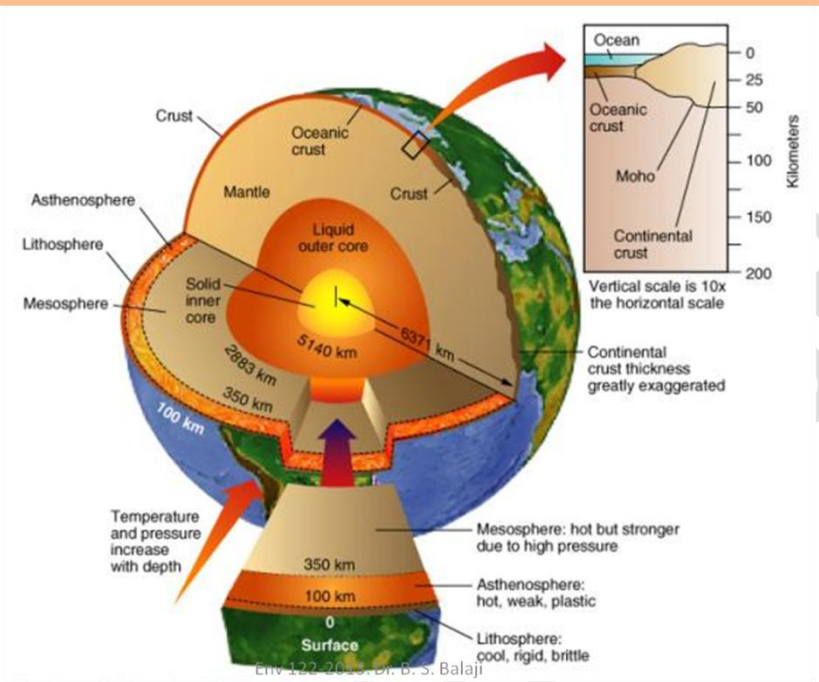
1. **Daily cycle**: For photosynthesis plant use lot of CO_2 during day, during night respiration predominates. So the CO_2 concentration in the atmosphere changes.
2. **Cycles requiring years, decades or centuries**: Large quantity of carbon is converted in to plant tissue, leaves, branches, wood. When the plant or tree die these decompose and broken down to CO_2 and water.
3. **Cycles of 1,00,000 years or more**: The largest amount of carbon (71 %), dissolved in ocean exchanges slowly with atmosphere.
4. **Cycles involving millions years**:
    a) **Organic matter**: Due to incomplete decay organic matter accumulates. This occurs in the peaty layers of bogs and marshes, or on the ocean floor. E.g. coal, oil and natural gas.
    b) **Inorganic matter**: Carbonate rocks such as limestone are formed when dissolved CO_2 reacts with certain minerals (Ca, Mg etc.).

Quantity of carbon is measured in gigatonnes per year. One Gigatonne (Gt) = One Petagram (Pg) = 10^{15} grams = 1 cubic kilometer of water.

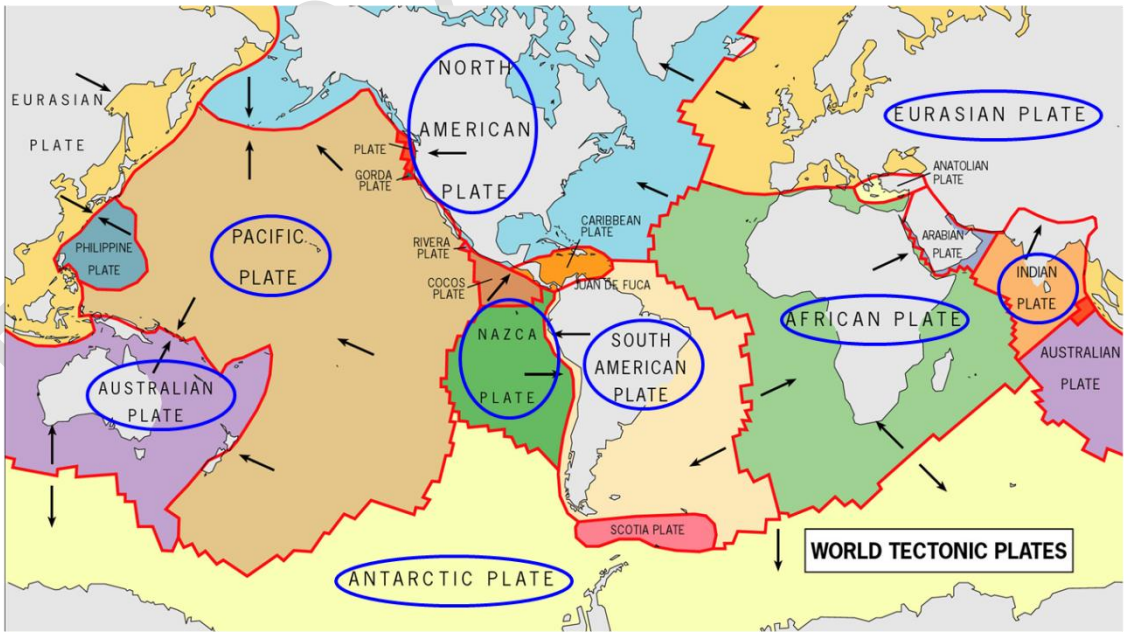
Carbon dioxide levels in the atmosphere are often measured in parts per million (ppm). One ppm of CO_2 in the air is equivalent to 2.12 Gt of carbon.



The Earth crust



Tectonic plates



Total 15 tectonic plates. 9 are major and 6 are minor

Oxygen cycle

Oxygen is essential for all living organism.

Various forms of oxygen in biosphere are molecular oxygen, water, carbon-di-oxide, inorganic oxides, carbonates etc.

Source of oxygen include photosynthesis, reduction of various mineral oxides, volcanic Eruption.

Oxygen is used in

respiration of organisms

mineral oxidation

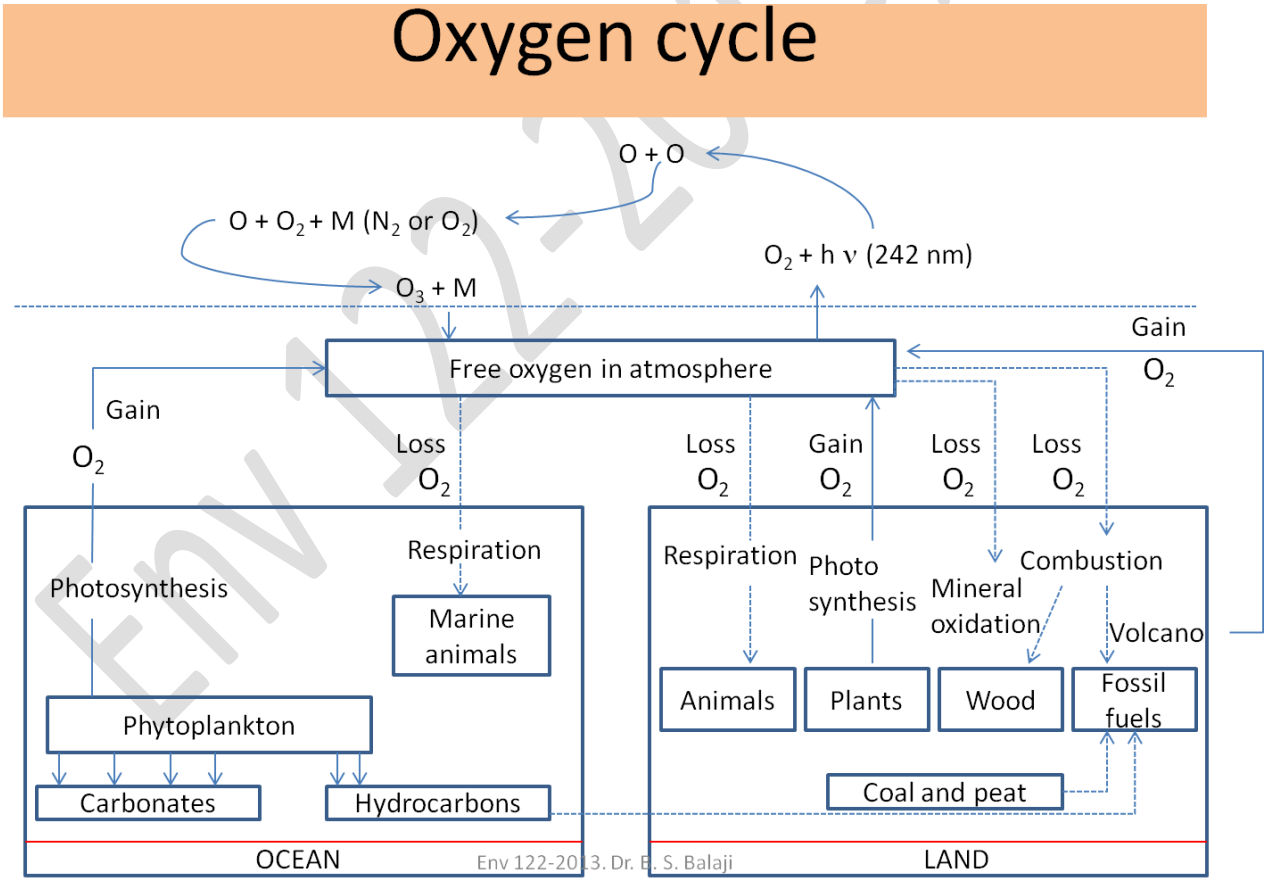
burning of fuels

Ozone (O_3)

Formed by photochemical and three body reaction

$$O_2 + h\nu\ (242\ nm) \longrightarrow O + O$$

$$O + O_2 + M\ (N_2 \text{ or } O_2) \qquad O_3 + M$$



Ozone (O_3)

Formed by photochemical and three body reaction

O_3 strongly absorbs UV rays and protects us from the harmful UV rays of Sun.

Ozone layer hole is caused by chlorofluoro carbons (coolants used in refrigerator)

$$O_3 + O \longrightarrow O_2 + O_2$$

$$O_3 + HO^{\cdot} \longrightarrow O_2 + HOO^{\cdot}$$

$$O + HOO^{\cdot} \longrightarrow O_2 + HO^{\cdot}$$

$$O_3 + NO \longrightarrow NO_2 + O_2$$

$$NO_2 + O \longrightarrow NO + O_2$$

Do you know DU?

Amount of ozone in atmosphere is measured in terms of **dobson unit (DU)**. **1 DU = 0.01 mm** thick ozone layer would be formed if ozone is compressed in to one layer at 0 °C and 1 atm pressure. General ozone layer thickness is 300 DU. When it falls below 200 DU it is called ozone-hole.

Do you know (SPICED)

Ozone layer depletion leads to Skin problems, Phytoplankton death, Immune system suppression, Cancer, Eye defects, Damage to plants.

Nitrogen cycle

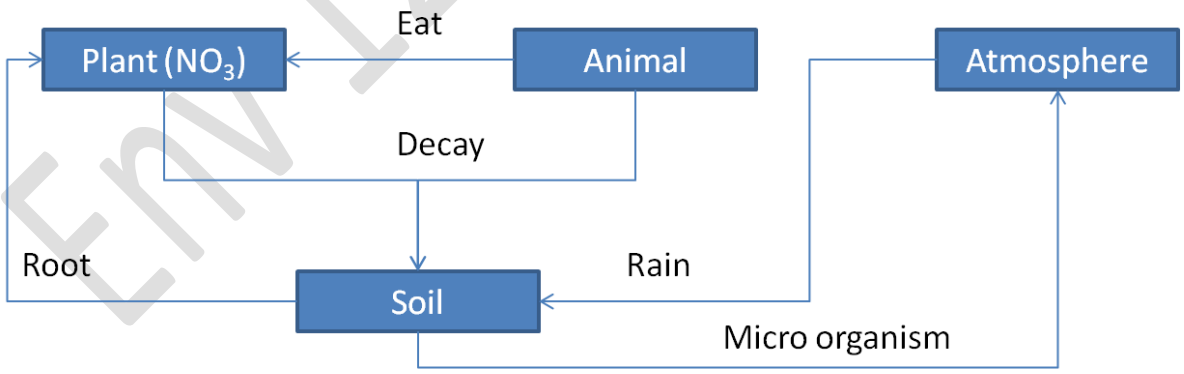
- Nitrogen is essential for all life forms.
- It is an essential part of amino acids (proteins).
- Various forms of nitrogen in biosphere are molecular nitrogen, oxides of nitrogen (N_2O, NO_2, NO), nitrogen-hydrogen compounds (NH_3, NH, HNO_2)

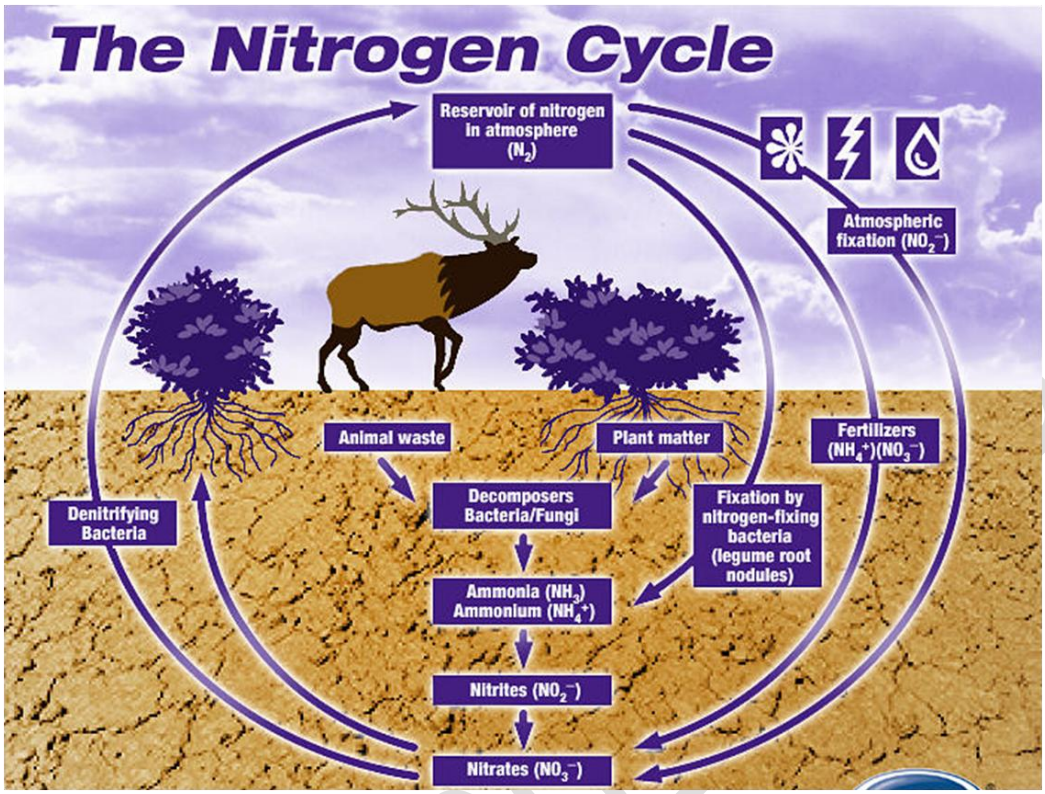
$$N_2 + O_2 \longrightarrow 2\ NO$$

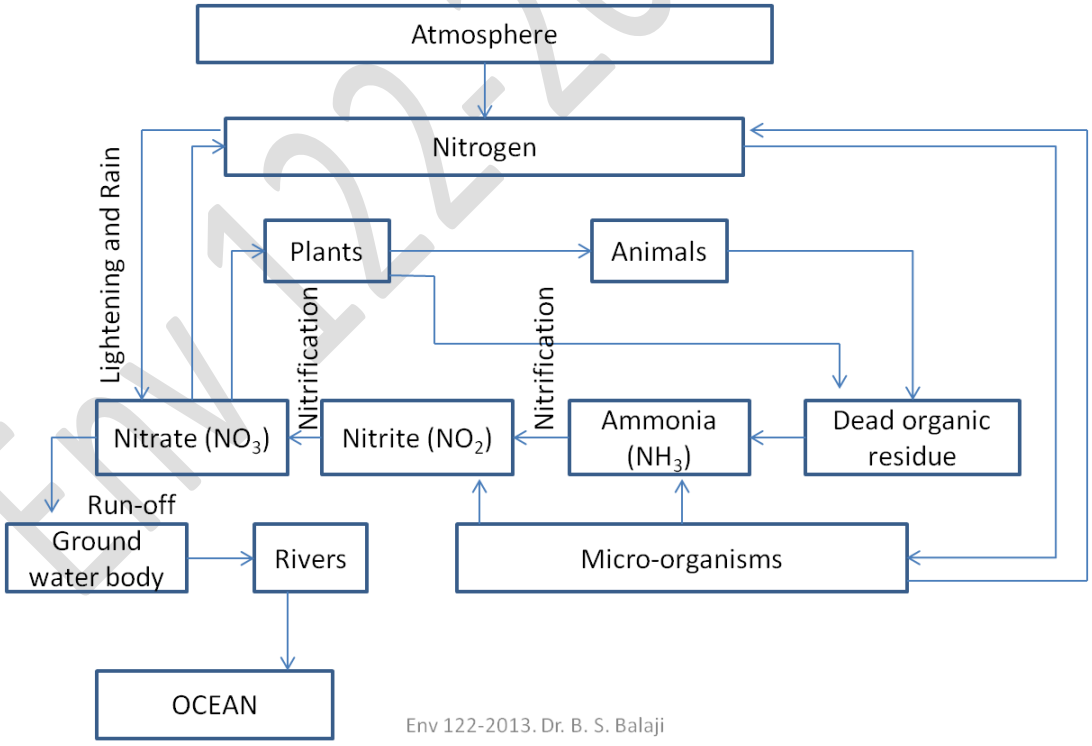
$$2\ NO + O_2 \longrightarrow 2\ NO_2$$

$$4\ NO_2 + 2\ H_2O + O_2 \longrightarrow 4\ HNO_3$$

$$2\ HNO_3 + CaCO_3 \longrightarrow Ca(NO_3)_2 + CO_2$$




The Nitrogen Cycle
Reservoir of nitrogen in atmosphere (N_2)
Atmospheric fixation (NO_2^-)
Animal waste
Plant matter
Fertilizers (NH_4^+)(NO_3^-)
Denitrifying Bacteria
Decomposers Bacteria/Fungi
Fixation by nitrogen-fixing bacteria (legume root nodules)
Ammonia (NH_3) Ammonium (NH_4^+)
Nitrites (NO_2^-)
Nitrates (NO_3^-)


Atmosphere
Nitrogen
Lightening and Rain
Plants
Animals
Nitrification
Nitrification
Nitrate (NO_3)
Nitrite (NO_2)
Ammonia (NH_3)
Dead organic residue
Run-off
Ground water body
Rivers
Micro-organisms
OCEAN

Phosphorus cycle

Second most important substance after water.

Phosphorus is essential for growth and maintenance of bones, teeth, organo-phosphates are essential for cell division.

Due to poor water solubility only 10 % of phosphorus is involved in phosphorus cycle. The rest 90 % remains in the soil.

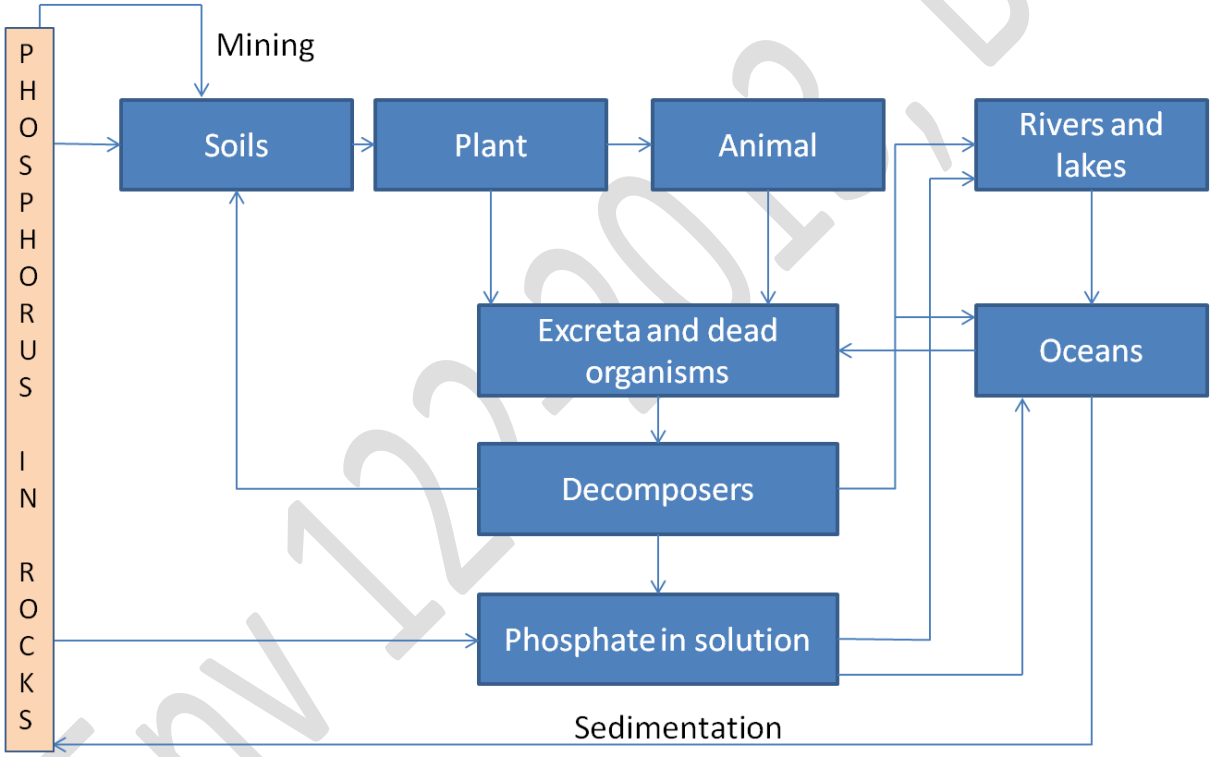
Phosphorus cycle

Affected by mining.

Agricultural run-off containing phosphate fertilisers.

Domestic sewage from excreta and detergents.

Phosphate pollution leads to algal bloom (Eutrophication). This reduces dissolved oxygen and disrupts natural food chain.



Sulphur cycle

- Required for amino acid (Cysteine and methionine), protein synthesis.
- Soil is the reserve pool for sulphur.
- Burning of fossil fuel releases SOx gases.
- SO_2 and H_2S return to land during acid rain.
- Sulphur Bacteria converts soils sulphur to be used by plants.
- In polluted water (anaerobic) H_2S is produced-----→ FeS.
- In clear water (aerobic) sulphides are converted to sulphates.

Do you know?

Ecosystems in the deep sea, where no sunlight can penetrate use sulfur for energy. Hydrogen Sulphide near Hydrothermal vents can be utilized by organisms. Here Sulphur cycle runs on oxidation- reduction and in this cycle sulfur can be forever recycled as a source of energy.

Sulphur cycle