PUC 1st Year Semester – II

Unit VI: Ecology and Environment

Module No: 34: Bio geochemical cycles: (Nitrogen, Carbon & Phosphoruscycles)

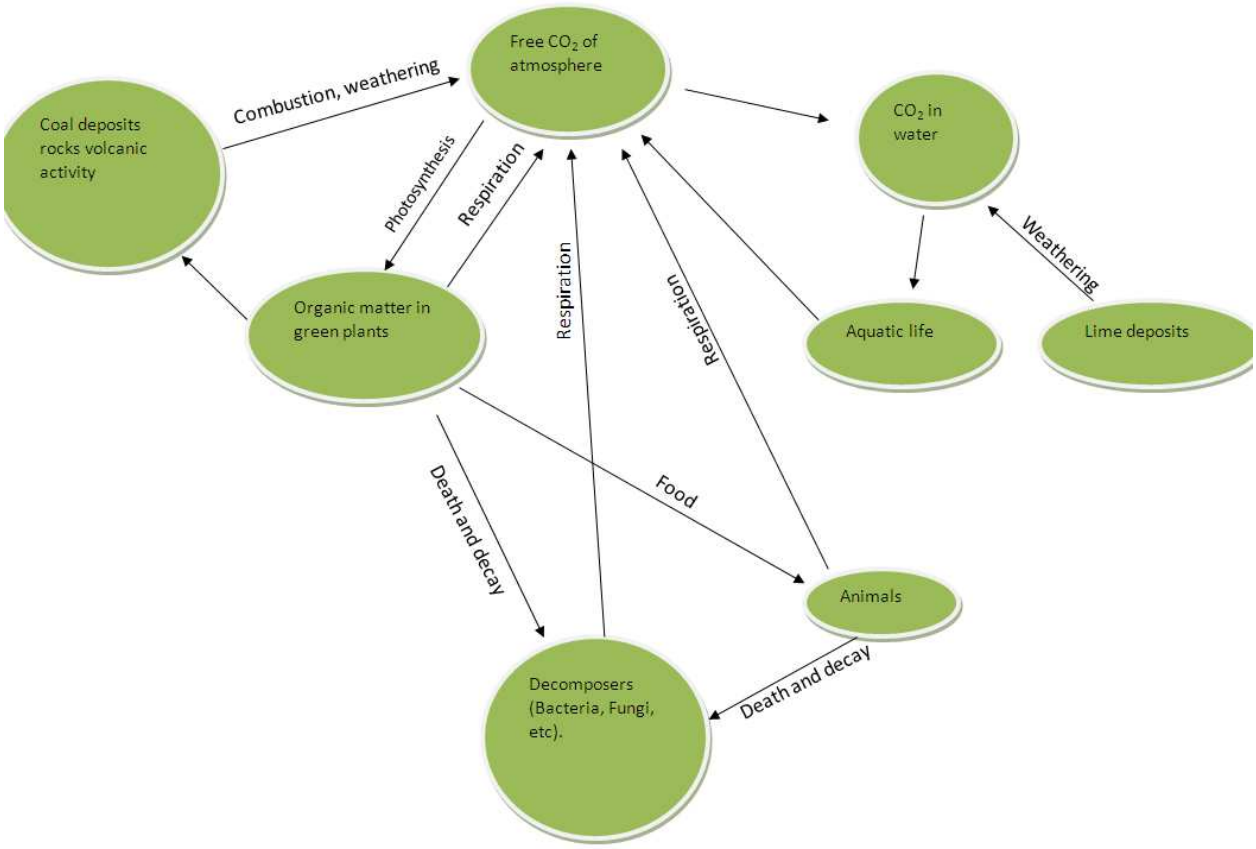
Animals and plants require about 33 to 44 elements for their normal growth and maintenance of life. These elements are known as nutrients. These are of two types - Macro nutrients and micro nutrients. The macronutrients are the elements and their compounds are required in comparatively larger quantity. Important macronutrients are carbon, hydrogen, oxygen, nitrogen phosphorous, calcium, potassium, magnesium, sulphur etc, The mineral elements needed by living organisms in a very small quantity are called micronutrients. The important micronutrients are iron, copper, zinc, sodium, manganese, boron, molybdenum, chlorine, cobalt etc, These nutrients flow from the non-living environment to the living component, and then back to non-living form in a more or less circular path. Cycling of materials between the living and non-living world is called nutrient cycling or Biogeochemical cycle.

A bio-geochemical cycle may be defined as "the more or less circular path which brings about the circulation of mineral elements including all essential elements of protoplasm, from environment to organisms and back to the environment".

Nutrient cycling is of two types – the gaseous and the sedementary cycles. In the gaseous cycle, the reservoir is the atmosphere. Carbon and nitrogen cycles are the examples of gaseous cycles. The reservoir for sedimentary cycle is the Earth's crust. Sulphur cycle and phosphorus cycle are the examples of sedimentary cycles.

I.Carbon cycle :

This is a gaseous cycle, Carbon is the basic building element of all the living organisms. The cycling of carbon between biotic and abiotic systems is called carbon cycle. The main source of all carbon found in the living organisms is free atmospheric CO_2 and dissolved CO_2 in water. In atmosphere 0.032% Co_2 is present, Carbon moves from the atmospheric pool to green plants (producers), then to animals (consumers) and finally from these both to bacteria, fungi and other micro organisms (decomposers) then return it to the atmosphere , through decomposition of dead organic matter. In water CO_2 also reaches from lime deposits. Green plants mainly through photosynthesis fix the CO_2 to form complex organic food. Plants are eaten by animals. Some proportion of organic matter of green plants contributes to the formation of coal deposits, rocks etc, which as a result of weathering and combustion return the CO_2 to atmosphere. The respiratory activity of producers and consumers accounts for return of considerable amount of the biologically fixed carbon as gaseous CO_2 to the atmosphere. There is considerable interplay between atmospheric and aquatic CO_2. The inter change between the two phases occur through diffusion. The direction of diffusion is dependent on relative concentrations in the two environments. Thus we find the carbon cycle is relatively a complicated one. Actually there are a number of inlets and outlets by which carbon can enter or leave the cycle. However, human beings may upset the system by excessive use of fossil fuels and other activities like deforestation, massive burning of fossil fuels etc.,



II. Nitrogen cycle:

This is a gaseous cycle. There is 79% nitrogen in atmosphere. But this cannot be taken in by the organisms. It needs to be fixed as nitrates and then utilized and fixation requires an input of energy. This fixation comes about in two ways. One is by high energy fixation such as cosmic radiation, meteorite trails and lightning that provide the high energy needed to combine nitrogen with oxygen and hydrogen of water. The resulting ammonia and nitrates are carried to the earth in rain water.

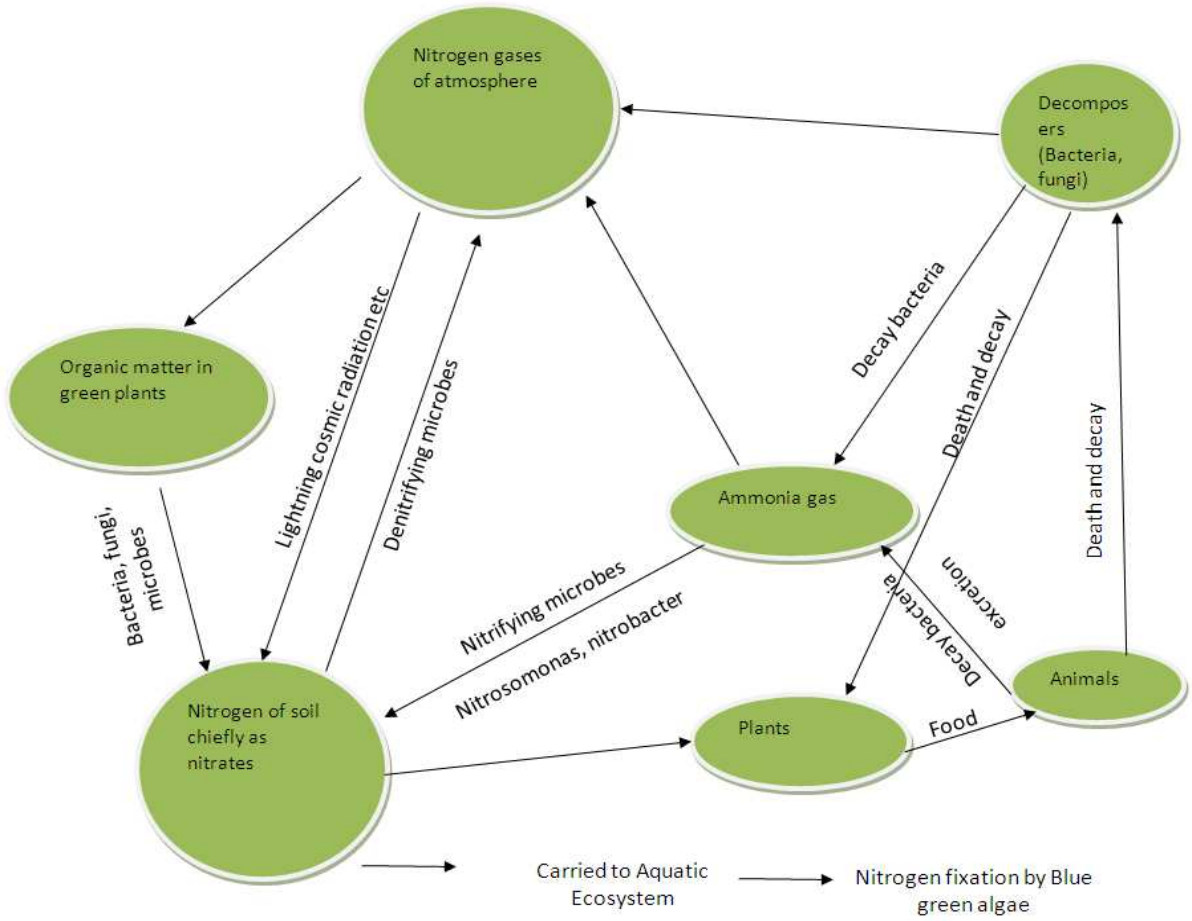
The second method of nitrogen - fixation which contributes about 90% of fixed nitrogen of earth is biological. Some bacteria, (Azobacter, Clostridium etc), fungi, and blue green algae (Nostoc, Calothrix, Anabaena etc) can extract moleculer nitrogen from the atmosphere and combine it with hydrogen to form

ammonia . These nitrogen fixing organisms further convert ammonia into nitrites and nitrates, Biological fixation can also be done by symbiotic bacteria (Rhizobium) in root nodules of legumes.

The nitrogenous wastes and carrion of animals are degraded by the detritus organisms, nitrogen is converted to ammonia. Conversion of ammonia into nitrate is called nitrification. In this process, ammonia is first converted to nitrite by bacteria (Nitrosomonas) and then nitrite is converted to nitrate by bacteria (Nitrobacter). Plants have the capacity to absorb these nitrates from the soil.

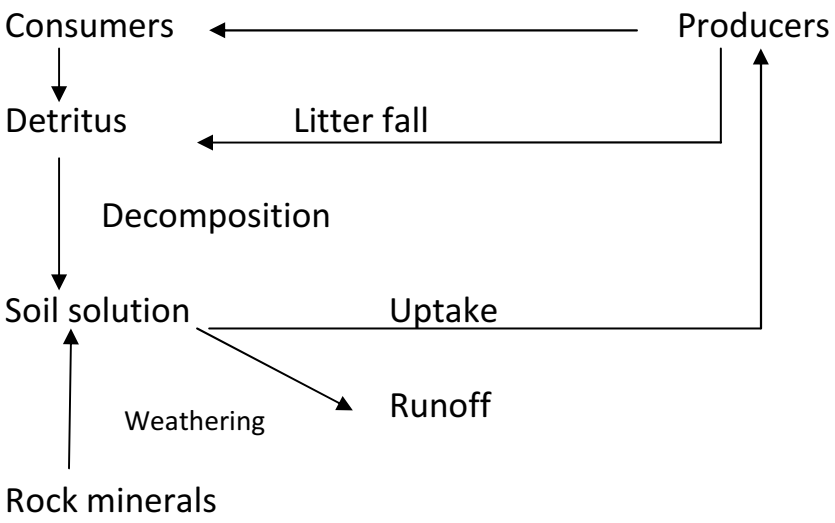
$$2NH_3 + 3O_2 \xrightarrow{\text{Nitrosomonas}} 2NO^-_2 + 2H^+ + 2H_2O$$

$$2NO^-_2 + O_2 \xrightarrow{\text{Nitro bacter}} 2NO^-_3$$



Phorphorus Cycle:

Phosphorus is one of the important and necessary constituents of protoplasm. It is an essential constituent of nucleic acids, phospholipids of protoplasm and cellular energy transfer systems. The great reservoir of phosphorus is not air but the rock deposits of past geological ages are the source for the phosphorus. When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of plants. These phosphates are transferred to consumers and decomposers as organic phosphates. The waste products and the dead organism are decomposed by phosphate- solubilising bacteria releasing phosphorus, which is available for recycling. Most of the phosphates are washed out into the sea.



Check Points

- In a biogeo-chemical cycle, the chemical nutrients or elements flow in a characteristic cyclical paths from abiotic system to the biotic system and back.
- In gaseous cycle the reservoir is the atmosphere. The reservoir for sedmentary cycle is the Earth's crust .

- Carbon cycle is a gaseous cycle.
- The cycling of carbon between biotic and abiotic systems is called carbon cycle.
- The main source of carbon is the CO_2 present in the air and water
- The cycling of nitrogen between abiotic and biotic system is called nitrogen cycle.
- Conversion of atmospheric nitrogen into soluble nitrites and nitrates etc by the activity of certain organisms is called Biological fixation.
- Nitromonas bacteria convert free N_2 into nitrite (NO_2) and Nitrobacter bacteria convert nitrite compound into nitrate compound.
- Reservoir of phosphorus is rock deposits

Object Type Questions:

1. Nitrosomonas converts ammonia into

   A) **Nitrite** B) Nitrate C) Nitrogen D) All

2. Nitrobacter bacteria convert

   A) **Nitrite to nitrate** B) Nitrate to Nitrite

   C)Ammonia to Nitrite D) Ammonia to Nitrate

3. High energy nitrogen fixation takes place by

   A) Cosmic radiation B) Lightning C) Meteorite trails **D) All**

4. Biological nitrogen fixation takes place by

   A) Some bacteria B) Fungi C) Blue green algae **D) All**

5. Conversion of ammonia into nitrate is called

   A) Nitrification B) Nitrogen fixation C) Denitrification D) None

6. The main source of all carbon found in the living organisms

A) Free Co_2 found in the atmosphere

B) Dissolved Co_2 found in the water

C) Coal deposits and rocks

D) A & B

7. Which one of the following is a sedementary cycle

A) Carbon Cycle

B) Nitrogen cycle

C) Oxygen Cycle

D) Phosphorus Cycle

8. An example of free living nitrogen – fixing aerobic bacteria is

A) Clostridium

B) Rhizobium

C) Azobacter

D) Frankia

9. Nitrite is converted to nitrate by

A) Nitrosomonas

B) Nitrobacter

C) Pseudomonas

D) Clostridium

10. Azobacter is the example of

A) Symbiotic nitrogen fixers

B) Non – symbiotic nitrogen fixer

C) Ammonifying bacteria

D) Disease causing bacteria

11. Which of the following is a free living nitrogen – fixing bacteria present in soil

A) Azobacter

B) Nitrosomonas

C) Rhizobium

D) Pseudomonas

12. Co_2 content of atmosphere is about

A) 6.5%

B) 3.334%

C) 0.34%

D) 0.032%

13. Bacterial role in carbon cycle is

A) Chemo synthesis

B) Photosynthesis

C) Decomposition of dead organic matter

D) Assimilation

Short Answer Questions

1. Define Bio geo chemical cycles?
2. Explain Biological Nitrogen fixation?
3. What is nitrification?
4. Describe phosphorus cycle

Long Answer Questions

1. Describe Carbon cycle?
2. Describe Nitrogen cycle?
3. Describe Water cycle?

Glossary

Weathering: -- Effect of the forces of weather on rock surfaces as in forming soil, sand etc.

Combustion: -- The act of process of burning

Or

The process of physico-chemical decomposition of rocks.