NUTRIENT CYCLING / BIOGEOCHEMICAL CYCLE:

Bio	–	Living organism
Geo	–	Rock, Soil, Water
Chemcial	–	Material or Nutrients

- In the natural world, various materials essential for ecosystems, apart from energy, are consistently accessible thanks to recycling. This ongoing process involves a steady interchange of materials between living organisms and their non-living surroundings, known as the biogeochemical cycle.
- Mineral elements absorbed by green plants, acting as producers, from the soil and air, are eventually released back into the environment through the activities of consumers and decomposers.

The following types of cycles are found in an ecosystem

- In the gaseous cycle, which involves carbon, hydrogen, nitrogen, and oxygen, the primary storage is in the atmosphere or the water bodies of the hydrosphere.
- The sedimentary cycle, encompassing phosphorus, sulfur, and calcium, stores its elements primarily in the Earth's crust, known as the lithosphere.
- During these cycles, most of the materials stay stored in inactive reserves on the Earth's crust, such as sediment at the bottom of seas or other water bodies.

Types of Biogeochemical Cycles

(a) Input of nutrients:

Ecosystem receives input of nutrients from external sources.

It is of four types:

(1) Wet deposition by rain fall. **(2) Dry deposition by dust fall.**

(3) Biological N_2 fixation. **(4) Weathering of rocks.**

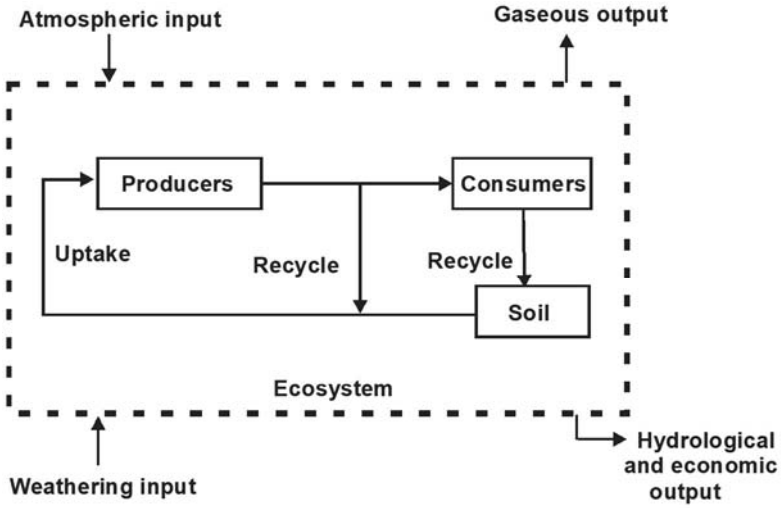


Fig: Nutrient cycling – A generalised model

(b) Output of nutrients

Nutrient output occurs through various processes such as runoff water, soil erosion, grazing by cattle, denitrification, tree falls, and deforestation, as well as during crop harvesting.

(c) Internal nutrient cycling

Internal nutrient cycling involves the absorption of nutrients from the soil by plants, known as uptake. These nutrients circulate through different levels of consumers via plants, and upon the death of these organisms, the nutrients return to the soil in a process known as recycling.

- In a mature ecosystem, the rate of nutrient uptake matches the rate of recycling.
- However, in a young ecosystem, the rate of uptake exceeds the rate of recycling.
  Thus Retention = Uptake – recycling.
- According to Odum, (1963) three types of cycles are operating in an ecosystem. These are

(i) Hydrological cycle i.e water cycle

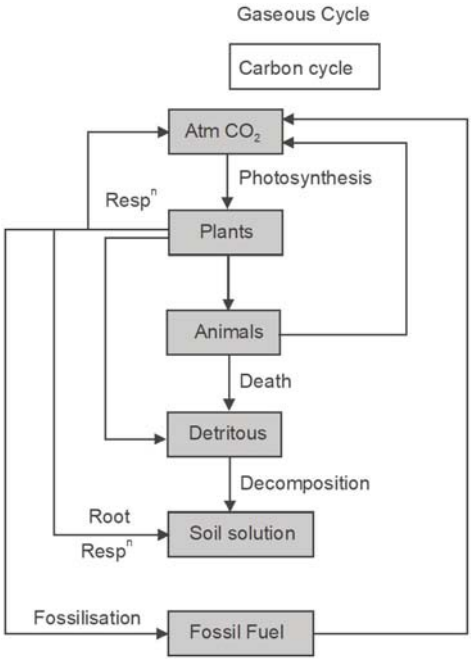
(ii) Biogeochemical cycles e.g. carbon & nitrogen cycles.

(iii) Sedimentary cycles such as those of Sulphur, Phosphorus etc.

- Biogenetic elements, including both macro and micro nutrients, move cyclically between the environment and plants. This exchange of nutrients between the non-living and living parts of the ecosystem forms the biogeochemical cycles.

Carbon Cycle:

- It A certain percentage of carbon is dissolved in the ocean, and this reservoir in the ocean helps control the amount of CO^2 in the atmosphere.



- The main sources of carbon are the atmosphere and rocks containing carbonates in the hydrosphere. In the lithosphere, carbon exists in the form of coal and petroleum. When these materials release carbon, it becomes carbon dioxide in the atmosphere. Green plants use carbon dioxide from the air to make food, which is then consumed by other organisms. Carnivores get their food from herbivores. When these organic materials break down through oxidation or respiration, they release carbon dioxide, which is absorbed by plants again.
- Each year, about 4×10^{13} kilograms of carbon are taken in by the biosphere through photosynthesis.

Phosphorus Cycle

- Phosphorus is a vital component of cell membranes, DNA, RNA, and energy transfer systems within cells.
- Many animals require phosphorus to build shells, bones, and teeth. The main source of phosphorus is rocks, which contain it in the form of phosphates. When rocks break down due to weathering, tiny amounts of phosphates dissolve in the soil and are taken up by plant roots. Herbivores and other animals get phosphorus from plants. Phosphate-solubilizing bacteria break down waste and dead organisms, releasing phosphorus.
- Unlike the carbon cycle, phosphorus isn't released into the atmosphere through respiration.
- Two significant differences between the carbon and phosphorus cycles are that phosphorus inputs from rainfall are much smaller than carbon inputs, and there is very little exchange of phosphorus gas between organisms and their environment.

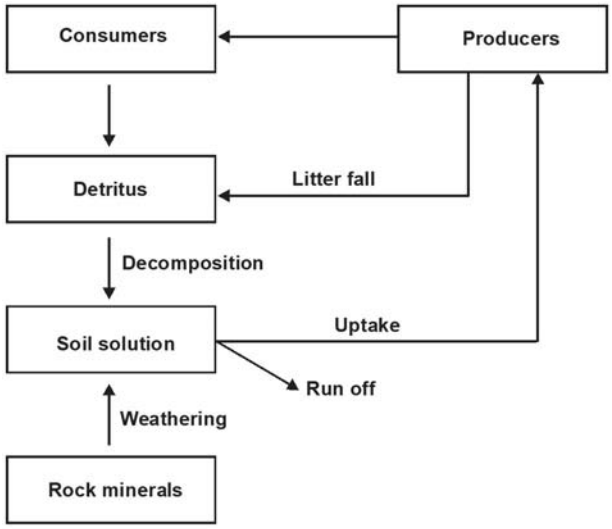


Fig: Phosphorus cycle–A simplified model

Nitrogen Cycle

The atmosphere is the primary source of nitrogen, with about 78% of it found in the air. Plants primarily absorb nitrogen in the form of nitrate ions.

Nitrogen cycle is completed in following steps:

1. **Nitrogen fixation -**

In this process, certain bacteria and blue-green algae first convert atmospheric nitrogen into nitrogen compounds such as ammonia, amino acids, or nitrate salts.

e.g.

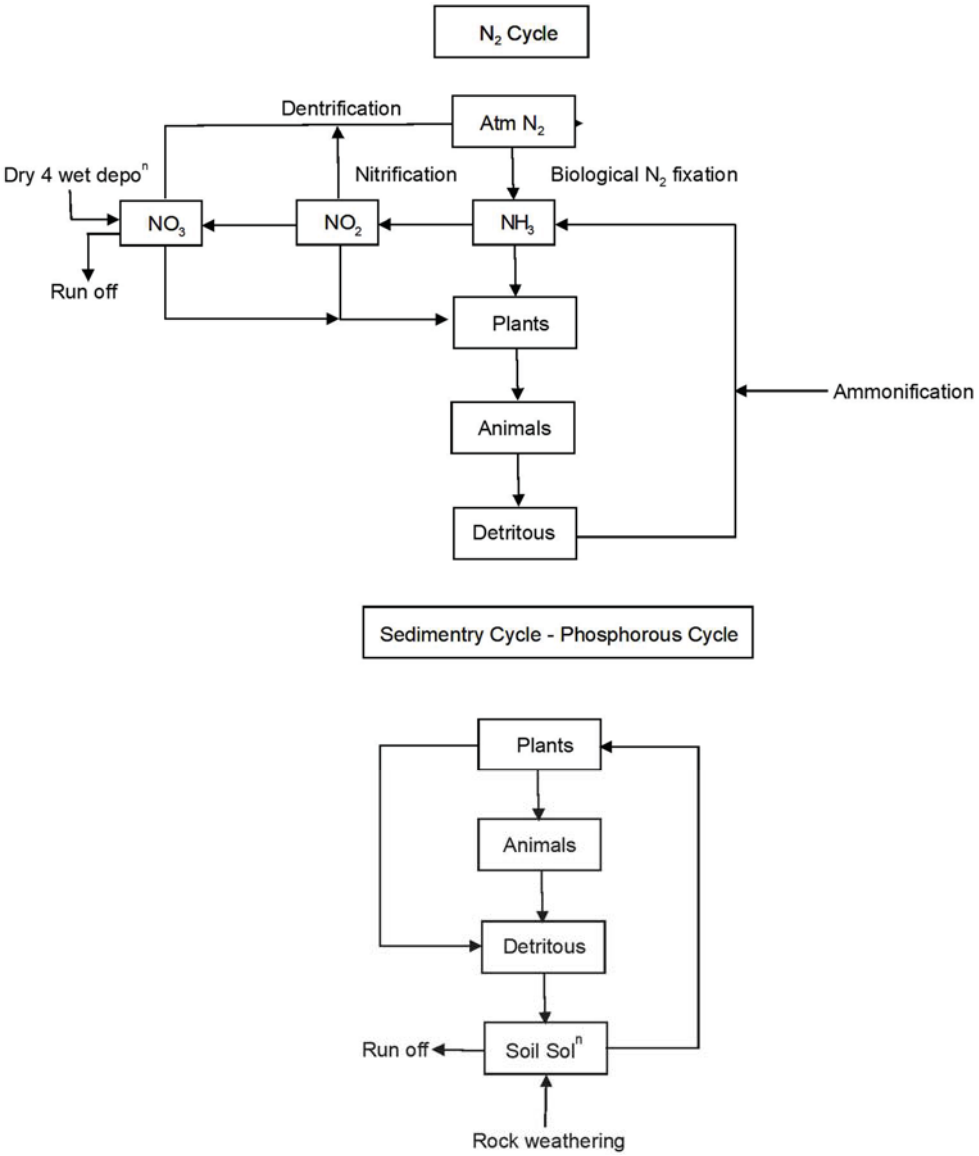
Bacteria	–	Rhizohbium, Aerorhizobium, Azospirillum Frankia, Clostridium, Azotobacter
Blue green algae	–	Oscillatoria, Anabaena, Aulosira, Nostoc → In flooded rice field in tropics

Note

- Azotobacter is aerobic bacteria
- Clostridium is anaerobic bacteria
- Symbiotic relationship where the nitrogen fixing bacteria does not penetrate deep into host tissue, known as associative symbiosis**.** Azospirillum with grass paspalum notatum.

2. **Nitrification –**

The process of turning ammonia into nitrate is called nitrification, which occurs in two steps. A small amount of nitrate enters the soil through electrochemical, photochemical, or physical processes of nitrogen fixation. Plants then absorb some of this nitrate from the soil.



N_2 Cycle

3. **Nitrogen assimilation –**

Plants take in nitrate from the soil and use it to produce proteins. When consumers eat these plant proteins, the nitrogen is transferred into their bodies.

4. **Ammonification –**

Protein present in litter, is converted into ammonia by some ammonifying bacteria.

e.g. Bacillus vulgaris, Bacillus mycoides, Bacillus ramosus

5. **Denitrification –**

σ Some quantity of nitrate which is not used by plants is converted into nitrogen by denitrifying bacteria. e.g. Thiobacillus denitrificans, Pseudomonas denitrificans

Note : some nitrate washed out from the ecosystem through seepage.