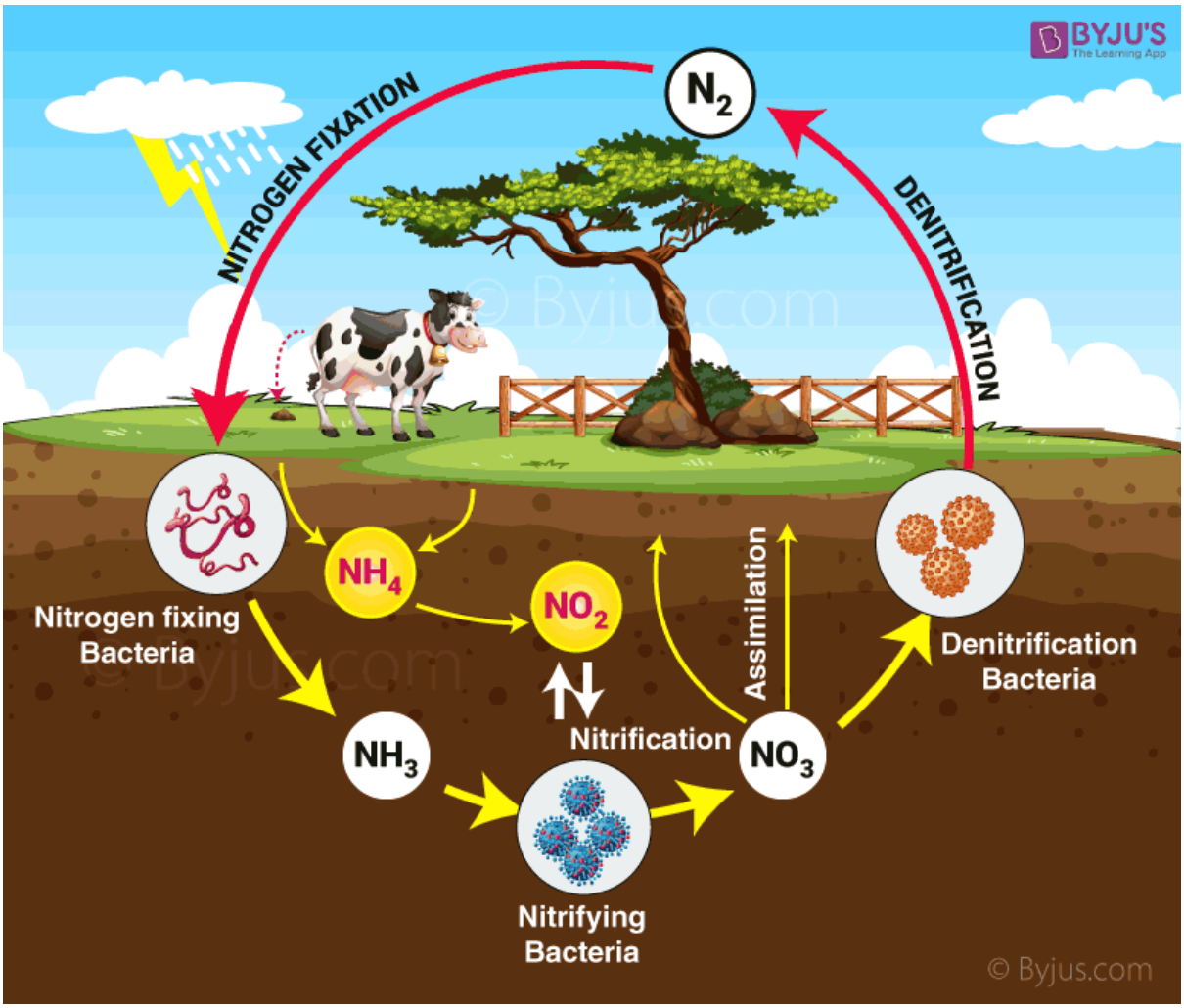
Nitrogen Cycle



Nitrogen Cycle Definition

"Nitrogen Cycle is a biogeochemical process which transforms the inert nitrogen present in the atmosphere to a more usable form for living organisms."

Furthermore, nitrogen is a key nutrient element for plants. However, the abundant nitrogen in the atmosphere cannot be used directly by plants or animals. Read on to explore how the Nitrogen cycle makes usable nitrogen available to plants and other living organisms.

What is Nitrogen Cycle?

Nitrogen Cycle is a biogeochemical process through which nitrogen is converted into many forms, consecutively passing from the atmosphere to the soil to organism and back into the atmosphere.

It involves several processes such as nitrogen fixation, nitrification, denitrification, decay and putrefaction.

The nitrogen gas exists in both organic and inorganic forms. Organic nitrogen exists in living organisms, and they get passed through the food chain by the consumption of other living organisms.

Inorganic forms of nitrogen are found in abundance in the atmosphere. This nitrogen is made available to plants by symbiotic bacteria which can convert the inert nitrogen into a usable form – such as nitrites and nitrates.

Nitrogen undergoes various types of transformation to maintain a balance in the ecosystem. Furthermore, this process extends to various biomes, with the marine nitrogen cycle being one of the most complicated biogeochemical cycles.

Stages of Nitrogen Cycle

Process of Nitrogen Cycle consists of the following steps – Nitrogen fixation, Nitrification, Assimilation, Ammonification, and Denitrification. These processes take place in several stages and are explained below:

Nitrogen fixation

It is the initial step of the nitrogen cycle. Here, Atmospheric nitrogen (N2)which is primarily available in an inert form, is converted into the usable form -ammonia (NH3).

During the process of Nitrogen fixation, the inert form of nitrogen gas is deposited into soils from the atmosphere and surface waters, mainly through precipitation. Later, the nitrogen undergoes a set of changes, in which two nitrogen atoms get separated and combines with hydrogen to form ammonia (NH4+).

The entire process of Nitrogen fixation is completed by symbiotic bacteria which are known as Diazotrophs. Azotobacter and Rhizobium also have a major role in this process. These bacteria consist of a nitrogenase enzyme which has the capability to combine gaseous nitrogen with hydrogen to form ammonia.

Nitrogen fixation can occur either by the atmospheric fixation- which involves lightening or industrial fixation by manufacturing ammonia under high temperature and pressure condition. This can also be fixed through man-made processes, primarily industrial processes that create ammonia and nitrogen-rich fertilisers.

Types of Nitrogen Fixation

1. **Atmospheric fixation:** A natural phenomenon where the energy of lightning breaks the nitrogen into nitrogen oxides and is then used plants.
2. **Industrial nitrogen fixation:** Is a man-made alternative that aids in nitrogen fixation by the use of ammonia. Ammonia is produced by the direct combination of nitrogen and hydrogen, and later, it is converted into various fertilisers such as urea.
3. **Biological nitrogen fixation:** We already know that nitrogen is not usable directly from the air for plants and animals. Bacteria like Rhizobium and blue-green algae transform the unusable form of nitrogen into other compounds that are more readily usable. These nitrogen compounds get fixed in the soil by these microbes.

Nitrification

In this process, the ammonia is converted into nitrate by the presence of bacteria in the soil. Nitrites are formed by the oxidation of Ammonia with the help of Nitrosomonas bacterium species. Later, the produced nitrites are converted into nitrates by Nitrobacter. This conversion is very important as ammonia gas is toxic for plants.

The reaction involved in the process of Nitrification is as follows:

$$2NH_4^+ + 3O_2 \rightarrow 2NO_2^- + 4H^+ + 2H_2O$$

$$2NO_2^- + O_2 \rightarrow 2NO_3^-$$

Assimilation

Primary producers – plants take in the nitrogen compounds from the soil with the help of their roots, which are available in the form of ammonia, nitrite ions, nitrate ions or ammonium ions and are used in the formation of the plant and animal proteins. This way, it enters the food web when the primary consumers eat the plants.

Ammonification

When plants or animal die, the nitrogen present in the organic matter is released back into the soil. The decomposers, namely bacteria or fungi present in the soil, convert the organic matter back into ammonium. This process of decomposition produces ammonia which is further used for other biological processes.

Denitrification

Denitrification is the process in which the nitrogen compounds makes its way back into the atmosphere by converting nitrate (NO_3-) into gaseous nitrogen (N). This process of the nitrogen cycle is the final stage and occurs in the absence of oxygen. Denitrification is carried out by the denitrifying bacterial species- Clostridium and Pseudomonas, which will process nitrate to gain oxygen and gives out free nitrogen gas as a byproduct.

Nitrogen Cycle in Marine Ecosystem

The process of the nitrogen cycle occurs in the same manner in the marine ecosystem as in the terrestrial ecosystem. The only difference is that it is carried out by marine bacteria.

The nitrogen-containing compounds that fall into the ocean as sediments get compressed over long periods and form sedimentary rock. Due to the geological uplift, these sedimentary rocks move to land. Initially, it was not known that these nitrogen-containing sedimentary rocks are an essential source of nitrogen. But, recent researches have proved that the nitrogen from these rocks is released into the plants due to the weathering of rocks.

Importance of Nitrogen Cycle

Importance of the nitrogen cycle are as follows:

1. Helps plants to synthesise chlorophyll from the nitrogen compounds.
2. Helps in converting inert nitrogen gas into a usable form for the plants through the biochemical process.

3. In the process of ammonification, the bacteria help in decomposing the animal and plant matter, which indirectly helps to clean up the environment.
4. Nitrates and nitrites are released into the soil, which helps in enriching the soil with necessary nutrients required for cultivation.
5. Nitrogen is an integral component of the cell, and it forms many crucial compounds and important biomolecules.

Nitrogen is also cycled by human activities such as combustion of fuels and the use of nitrogen fertilisers. These processes increase the levels of nitrogen-containing compounds in the atmosphere. The fertilisers containing nitrogen are washed away in lakes and rivers and results in eutrophication.

Conclusion

- Nitrogen is abundant in the atmosphere, but it is unusable to plants or animals unless it is converted into nitrogen compounds.
- Nitrogen-fixing bacteria play a crucial role in fixing the atmospheric nitrogen into nitrogen compounds that can be used by the plants.
- The plants absorb the usable nitrogen compounds from the soil through their roots. Then, these nitrogen compounds are used for the production of proteins and other compounds in the cell.
- Animals assimilate nitrogen by consuming these plants or other animals that contain nitrogen. Humans consume proteins from these plants and animals, and then, the nitrogen assimilates into our system.
- During the final stages of the nitrogen cycle, bacteria and fungi help decompose organic matter, where the nitrogenous compounds get dissolved into the soil which is again used by the plants.
- Some bacteria then convert these nitrogenous compounds in the soil and turn it into nitrogen gas. Eventually, it goes back to the atmosphere.
- These set of processes repeat continuously and thus maintain the percentage of nitrogen in the atmosphere.