



Lec. 6

Medical microbiology

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Nutrient Cycles and Regulation

1. Nitrogen Cycle

What is the 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.
- 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.

Why is nitrogen important for life?

- Nitrogen constitutes many cellular components and is essential in many biological processes. For instance, the amino acids contain nitrogen and form building blocks that make up various components of the human body such as hair, tissues and muscles.

Why do plants need nitrogen?

- Plants need nitrogen as this element is an important component of chlorophyll. Consequently, chlorophyll is vital for the process of photosynthesis, so lack of nitrogen can cause deficiency disorders, stunted growth and other abnormalities.

List the different steps that explain the Nitrogen Cycle process.

- Ammonification
- Nitrification
- Denitrification
- Nitrogen Fixation

What is Ammonification?

Ammonification occurs during the decomposition of organic matter, where ammonifying bacteria convert organic nitrogen into inorganic components like ammonia or ammonium ions.

What is Nitrification?

Nitrification is a process that converts ammonia into nitrate by bacteria. Initially, the ammonia is converted to nitrite (NO_2^-) by the bacteria *Nitrosomonas*, or *Nitrococcus*, etc. and then to nitrate (NO_3^-) by Nitro Bacterium.

What is Denitrification?

Denitrification is the process of converting the nitrate back into molecular nitrogen by bacteria such as *Pseudomonas*, *Thiobacillus*, *Bacillus subtilis* etc.

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 by 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

Which part of the plant is involved in nitrogen fixation?

The process of nitrogen fixation is carried out naturally in the soil within nodules in the plant's root systems.

Importance of Nitrogen Cycle

The 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 the necessary nutrients required for cultivation.
5. Nitrogen is an integral component of the cell and it forms many crucial compounds and important biomolecules.

2. Phosphorus Cycle

- Phosphorus is an essential nutrient for living organisms. It's a key part of nucleic acids, like DNA and of the phospholipids that form our cell membranes. As calcium phosphate, it also makes up the supportive components of our bones.
- The phosphorus cycle is slow compared to other biogeochemical cycles such as the water, carbon, and nitrogen cycles.
- In nature, phosphorus is found mostly in the form of phosphate ions³. Phosphate compounds are found in sedimentary rocks,
- Phosphate compounds in the soil can be taken up by plants and, from there, transferred to animals that eat the plants.
- When plants and animals excrete wastes or die, phosphates may be taken up by detritivores or returned to the soil. Phosphorus-containing compounds may also be carried in surface runoff to rivers, lakes, and oceans, where they are taken up by aquatic organisms.