

## Environment Class 04

27th February, 2024 at 1:00 PM

### NITROGEN CYCLE (01:06 PM)

- Nitrogen is a vital component of amino acids, proteins, and nucleic acids in living organisms.
- Majority of nitrogen on earth is in form of atmospheric nitrogen ( $N_2$ ) which is present in the atmosphere, and most organisms cannot use it directly.
- The nitrogen cycle involves several steps that transform nitrogen into various forms.
- **The major stages are:**
- **1. Nitrogen Fixation**
- It includes the conversion of atmospheric nitrogen into ammonium.
- There are three ways fixation can occur:
- **a. Atmospheric Fixation:** Lightning, Combustion, Volcanic Activity
- **b. Bacterial Fixation:**
- This includes:
- i. This includes **symbiotic bacteria**: Rhizobium in the root nodules of certain plants can fix nitrogen. clover, tamarind, lentils, soyabean, peanuts
- These plants are called **leguminous plants**. Examples: Beans, Chickpeas, Alfalfa, etc.
- Free living bacteria:
- ii. These bacteria do not directly depend upon other living organisms.
- E.g. Azotobacter, cyanobacteria (blue-green algae), Nostoc, etc.
- **c. Industrial Fixation** Anabaena
- **2. Nitrification:**
- Conversion of Ammonia to **Nitrite** and then to **Nitrate**.
- This also occurs because microorganisms from Ammonia to Nitrite **bacteria** such as **Nitrosomonas**, and **nitrosococcus** are involved and from nitrite to nitrate through **nitrobacter** is involved.
- **3. Assimilation**
- Plants absorb nitrate and ammonium from the soil and use them to create **amino acids, proteins, and nucleic acids**.
- This involves plants directly. From plants, these nitrogen-based organic molecules are passed on to other trophic levels.
- **4. Ammonification:**
- Decomposition of Organic nitrogen from dead organisms and waste products in ammonia and uric acids.
- This is because of decomposers such as bacteria and fungi
- **5. Denitrification:**
- Conversion of nitrate and nitrite into **gaseous nitrogen** or **nitrous oxide** which is released into the atmosphere.
- Anaerobic bacteria such as **pseudomonas and bacillus**.

↓  
This includes

Phosphorus is a crucial component of

Phosphorous is also essential for teeth and bone formation.

## PHOSPHORUS CYCLE (01:41 PM)

- It is found in ATP, DNA-RNA, and **phospholipids** that form all cellular membranes.
- It is often the **limiting nutrient**, particularly in aquatic ecosystems because of phosphorus scarcity and primary productivity in deep water bodies. *is less.*
- **This cycle** does not include significant **atmospheric components**, given that **phosphorous and phosphorous-based molecules are usually solids** at typical room temperature and pressure.

The major stages are :

- **The weathering Process** causes rocks to release **phosphate ions** and other minerals. *Weathering:*
- Plants **convert inorganic phosphate into organic molecules** and it is passed on to higher trophic levels. *Assimilation:*
- **Decomposition:** When plants and animals *die* bacteria and fungi break *them down* releasing phosphorous back into the soil.
- **Sedimentation:** some of the phosphorus-based compounds can accumulate in water and settle and get deposited as sediment at the bottom.
- Some of the phosphorus in water can settle and can lead to forming new phosphate rocks.
- **Geological uplift:** Earth's geological forces can uplift the rocks from *the ocean floor to* the land. *100k*
- *However,* This process is slow and the average phosphate ion can remain in the ocean for **20k-30k years**.

## EUTROPHICATION

- It is the process whereby water bodies such as lakes, rivers, and coastal oceans, receive excess nutrients.
- **Primarily nitrogen and phosphorous** leading to excessive algal growth.
- This begins when an external source introduces **excess nutrients**.
- Main sources include **agricultural runoff and wastewater discharge**. *and decomposers such as*
- After rapid growth and bloom the algae eventually ~~died and sank~~ to the bottom *die and sink* decomposing as bacteria and fungi started to break this organic matter.
- This process consumes dissolved oxygen in the water, reduction in dissolved oxygen can cause the death of other aquatic organisms.
- Such regions are called **dead zones**.

-> because of this foul smell can occur, other toxins will develop and tourism will get destroyed.

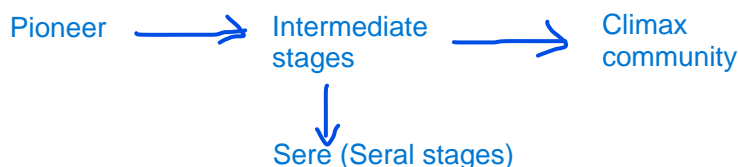
-> Eutrophication happens through human activities like excessive use of fertilizers is known as cultural eutrophication.

## SULFUR CYCLE (02:06 PM)

- It is essential in the synthesis of some amino acids and vitamins.
- The sulfur cycle has **lithospheric and atmospheric phases**.
- **The major stages are:**
- Release from sediments that are buried deep in the earth.
- This release can occur due to geological uplift or volcanic eruption.
- **H<sub>2</sub>S (Hydrogen sulfide) and SO<sub>2</sub> (Atmospheric components)**
- H<sub>2</sub>S can be released because of volcanoes and **geothermal activities**.
- **H<sub>2</sub>S quickly oxidizes** into the atmosphere to form sulfur dioxide which can further oxidize to form sulphate. → SO<sub>4</sub><sup>2-</sup>
- This can combine with **water vapor** and form sulphuric acid which gets deposited on the surface with rainfall.
- Lands take up sulfate from the soil or water and make organic molecules.
- Decomposition of organic matter by bacteria and fungi.
- This can release H<sub>2</sub>S.
- Return to sediments
- **Acid rain:**
- Oxides of **nitrogen** and sulfur can contribute to acid rains which adversely affect plants, aquatic organisms, and heritage structures.
- The biggest anthropogenic source for these oxides is the burning of fossil fuels coal petroleum, and natural gas.

## 4. ECOLOGICAL SUCCESSION (02:27 PM)

- It is the process by which the **composition and structure of communities** constantly change in response to changing environmental conditions.
- Initially, **pioneer species** colonize an area even when there is **no soil like lichens and mosses**.
- These species break down rocks creating the first bit of soil, and small plants can grow now.
- These small plants are succeeded by bigger plants and after several more stages, a stable **climax Forest community** or grassland community is formed.
- The individual transitional communities are called **seral communities**
- **Primary succession**
- It begins in an area with no life where there is no soil, newly formed volcanic islands, areas exposed by retreating glaciers.
- **Secondary succession** occurs in an area that **lost all living organisms** that existed there burnt forest, flooded lands.
- The **climax community** may be similar in both primary and secondary succession.
- However, **secondary succession is much faster** because some soil is already present.



## **AUTOGENIC AND ALLOGENIC SUCCESSION (03:04 PM)**

- changes in the community structure brought about by the **biological activities of species themselves** is called autogenic succession.
- This can include altering the pH value of soil, organic matter in the soil, and water-holding capacity among others.
- changes driven by **abiotic environmental factors** is called allogenic succession
- for example: river sediment deposition
- **Hydrarch and Xerarch succession**
- Hydrarch succession begins in **water-locked areas**.
- The initial stages might involve species like phytoplanktons but in the final stage climax community may be a forest.
- Xerarch succession starts in **dry areas** and eventually can lead to a climax community of forest or grassland.
- **Intermediate disturbance hypothesis**
- This hypothesis predicts that the greatest diversity occurs at a **moderate level of disturbance**.
- High levels of disturbance will wipe out most of the species. Very low levels of disturbance will lead to superior competitors driving other species to extinction.

## **5. HOMEOSTASIS (03:23 PM)**

- Ecosystems are capable of maintaining their state of equilibrium.
- They can regulate their species' structure and functional processes
- This capacity of **self-regulation** is called homeostasis. of an Ecosystem.
- In a homeostatic system, a **negative feedback mechanism** is responsible for maintaining stability
- However, the homeostatic capacity of the ecosystem is not unlimited and not everything is always well-regulated.

## **6. ECOSYSTEM SERVICES (03:39 PM)**

- these are the benefits that people obtain from ecosystems
- These benefits are grouped into four categories
- **Provisioning services:** products obtained from ecosystem food, freshwater, timber, medicinal resources etc.
- **Regulating services:** Benefits obtained from the regulation of ecosystem processes
- Temp regulation water regulation water purification, carbon sequestration, pollination.
- **Supporting services** necessary for the production of all others from the ecosystem. **Ex:**
- Nutrient cycling, **Soil formation, primary production.**
- Primary production
- **Cultural services**
- Non-material benefits from the ecosystem such as eco-tourism, spiritual and religious values cultural heritage among others.

## **Topic for the Next Class: Environment and Ecology (Continued)**

**Q: What do you understand by Carrying Capacity of an ecosystem? How the concept of Carrying Capacity help us in sustainable development of a region?**