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.
- It 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.
- These plants are called leguminous plants. Examples: Beans, Chickpeas, Alfalfa, etc.
- ii. These bacteria do not directly depend upon other living organisms.
- E.g. Azotobacter, cyanobacteria (blue-green algae), Nostoc, etc.
- **c. Industrial Fixation**
- **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 bacterias such as pseudomonas and bacillus.

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.
- 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.
- Plants convert inorganic phosphate into organic molecules and it is passed on to higher trophic levels.
- **Decomposition:** When plants and animals bacteria and fungi break 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 land.
- 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.**
- After rapid growth and bloom the algae eventually died and sank to the bottom 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.**

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_2S (Hydrogen sulfide) and SO_2**
- H_2S can be released because of volcanoes and geothermal activities.
- H_2S quickly oxidizes into the atmosphere to form sulfur dioxide which can further oxidize to form sulphate.
- 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_2S.
- 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.

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 plans 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 serial 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.

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.
- 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.

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
- **Regulating services:** Benefits obtained from the regulation of ecosystem processes
- Temp regulation water regulation water purification, carbon sequestration
- **Supporting services** necessary for the production of all others from the ecosystem.
- Nutrient cycling
- 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)