Ecosystem

- Ecosystem is the interaction of living things among themselves and with their surrounding environment.
- There are two basic ecosystems – terrestrial and aquatic.

Structure of Ecosystem

- The interactions between the various biotic and abiotic factors of an ecosystem lead to the maintenance of the ecosystem.
- Stratification is the vertical distribution of the different species occupying the different levels. For example, trees occur at a higher level then shrubs.
- The various aspects taken into consideration to study the functioning of ecosystem are:
    - Productivity
    - Decomposition
    - Energy flow
    - Nutrient cycling

Productivity

- A constant supply of sunlight is required for the proper functioning of any ecosystem.
- The amount of biomass produced per unit area over a time period by plants during photosynthesis is defined as the **primary productivity**.
- It is expressed as weight (g^{-2}) or energy (Kcal m^{-2}).
- Productivity can be mainly divided into gross primary productivity (GPP) and net primary productivity (NPP). GPP is the rate of production of organic matter during photosynthesis.

  NPP = GPP − Respiratory losses (R)
- **Secondary productivity** is defined as the rate of formation of new organic matter by consumers.
- Primary productivity depends upon
    - type of plant species inhabiting a particular area

    - photosynthetic capacity of plants
    - nutrient availability
- Annual net productivity for whole biosphere is about 170 b tons of organic matter.

Decomposition

- It is the process of breakdown of complex organic matter into inorganic substances such as carbon dioxide, water, nutrients, etc.
- **Fragmentation** – Breaking down of detritus (dead plant and animal remains, faecal matter) into smaller particles by detritivores (decomposers)
- **Leaching** - Process by which these inorganic matters enter the soil
- **Catabolism** – Process by which detritus is degraded into simpler inorganic substances by bacterial and fungal enzymes
- **Humification** – Accumulation of humus in the soil.
  Humus is resistant to microbial action and decomposes at an extremely slow rate. It acts as a reservoir of nutrients.
- **Mineralization** – Process by which humus further degrades to release minerals into the soil
- It is an oxygen consuming process and is controlled by the chemical composition of detritus and climatic conditions.

Energy Flow

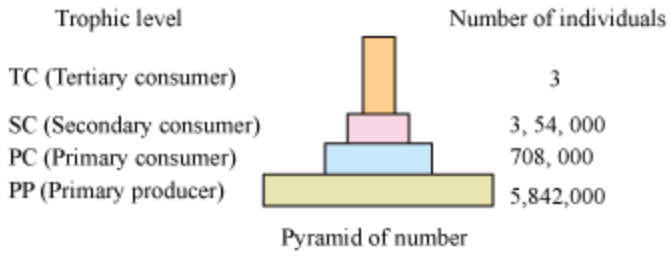
- Sun is the sole source of energy for all ecosystems on the earth.
- Plants and other photosynthetic organisms utilize less than 50% of the solar radiation known as the **photosynthetically active radiation (PAR)**.
- In an ecosystem, plants are called **producers** and all animals depend upon the plants directly or indirectly for their food. Hence, they are known as consumers or heterotrophs.
- The consumers can be further divided into primary consumers (herbivores), secondary consumers (primary carnivores), and tertiary consumers (secondary carnivores).
- **Food chain** – The energy flow among the various constituent animals

is known as the food chain.

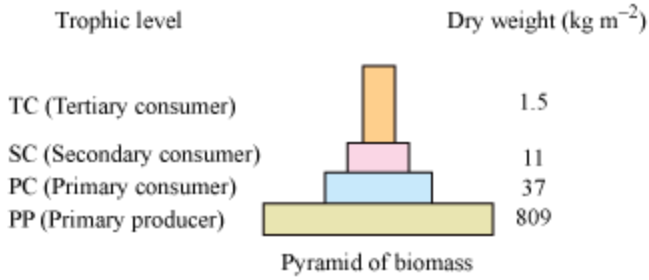
- **Food web** – The interconnection of the various food chains is called the food web.
- **Trophic level** – Every organism occupies a specific level in their food chain known as the trophic level.
- **Standing crop** – Each trophic level contains a certain amount of living material at a certain time known as the standing crop.
- The number of trophic levels in a food chain is restricted since the energy transfer follows the 10 percent law i.e., only 10% of the energy is transferred from a lower trophic level to a higher one.

Ecological Pyramids

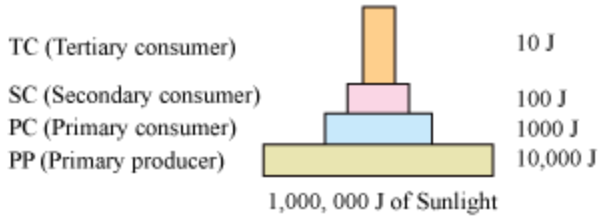
- The energy relationship between the different trophic levels is represented by the ecological pyramids.
- Their base represents the producers or the first trophic level while the apex represents the tertiary or top level consumer.
- Ecological pyramids are of 3 types:
    - Pyramid of number
    - Pyramid of biomass
    - Pyramid of energy



Pyramid of number



Pyramid of biomass



Pyramid of energy

- In most ecosystems, the three pyramids are upright except in some cases:
    - The pyramid of biomass is inverted in an ocean ecosystem since a small standing crop of phytoplankton supports a large number of zooplankton.
    - The pyramid of number can be inverted when, say, a large tree is eaten by small insects.
    - However, the pyramid of energy is always upright.
- A trophic level represents a functional level and not a single species as such. Also, a single species may become a part of more than one trophic level in the same ecosystem at the same time depending upon the role it plays in the ecosystem.
- Limitations of ecological pyramids:
    - The ecological pyramids do not take into account the same species belonging to more than one trophic level.

    - It assumes a simple food chain that almost never exists in nature. It does not explain food webs.
    - Saprophytes are not given a place in ecological pyramids even though they play a vital role in ecosystem.

Ecological Succession

- The composition of all ecosystems keeps on changing with change in their environment. These changes finally lead to the climax community.
- **Climax community** – It is the community which is in equilibrium with its environment. Gradual and fairly predictable change in the species' composition of a given area is called ecological succession.
- **Sere(s)** – It is the sequence of communities that successively change in a given environment. The transitional communities are called seral stages or seral communities.
- Succession happens in areas where no life forms ever existed as in bare rocks, cool lava, etc. (**primary succession**), or in areas which have lost all life forms due to destructions and floods (**secondary succession**).
- Primary succession takes hundreds to thousands of years as developing soil on bare rocks is a slow process. Secondary succession is faster than primary succession since the nature does not have to start from scratch.
- During succession, any disturbances (natural/man-made) can convert a particular seral stage to an earlier one.
- **Hydrarch succession** – It takes place in wet areas and converts hydric conditions to mesic.
- **Xerarch succession** – It takes place in dry areas and converts xeric conditions to mesic.
- **Pioneer species** – These are the species that first invade a bare area. On land, these could be lichens that secrete enzymes to dissolve the rock surfaces for soil formation while in water, pioneer species could be phytoplanktons.

- The ultimate result of all successions is a climax community, a mesic.

Nutrient Cycling

- The amount of nutrients present in the soil at a given time is known as the standing state.
- Nutrients are never lost from the ecosystem. They are only recycled from one state to another.
- The movement of nutrients through the various components of the ecosystem is called nutrient cycling or biogeochemical cycles. They are of two types:
    - **Gaseous** – Reservoir for these types of cycles exist in the atmosphere.
    - **Sedimentary** – Reservoir for these types of cycles exist in the earth's crust.

Carbon Cycle

- About 49% of the dry weight of living organisms is made up of carbon.
- The ocean reserves and fossil fuels regulate the amount of CO_2 in the atmosphere.
- Plants absorb CO_2 from the atmosphere for photosynthesis, of which a certain amount is released back through respiratory activities.
- A major amount of CO_2 is contributed by the decomposers who contribute to the CO_2 pool by processing dead and decaying matter.
- The amount of CO_2 in the atmosphere has been increased considerably by human activities such as burning of fossil fuels, deforestation.

Phosphorus Cycle

- Phosphorus is an important constituent of cell membranes, nucleic acids, and cellular energy transfer systems.
- Rocks contain phosphorus in the form of phosphate.
- When rocks are weathered, some of the phosphate gets dissolved in the soil solution and is absorbed by plants.
- The consumers get their phosphorus from the plants.
- Phosphorus returns back to the soil by the action of

phosphate-solubilising bacteria on dead organisms.