14. ECOSYSTEM

1. PRODUCTIVITY

- **Solar energy** is the basic requirement for an ecosystem to function and sustain.
- Amount of biomass (organic matter) produced per unit area over a time period by plants during photosynthesis is called **primary production.** It is expressed in weight (g^{-2}) or energy (kcal m^{-2}).
- The rate of biomass production is called **productivity**. It is expressed in $g^{-2}\ yr^{-1}$ or (kcal m^{-2}) yr^{-1}.
- It is divided into gross primary productivity (GPP) and net primary productivity (NPP).
- **Gross primary productivity (GPP):** It is the rate of production of organic matter during photosynthesis. A considerable amount of GPP is used by plants in respiration.
- **Net primary productivity (NPP):** It is the available biomass for the consumption to heterotrophs (herbivores & decomposers). i.e., NPP is the Gross primary productivity minus respiration losses (R).

$$NPP = GPP - R$$

- **Secondary productivity:** It is the rate of formation of new organic matter by consumers.
- Primary productivity varies in different ecosystems because it depends on
  - The plant species inhabiting an area.
  - Environmental factors.
  - Availability of nutrients.
  - Photosynthetic capacity of plants.
- **Annual net primary productivity** of whole biosphere is about **170 billion tons** (dry weight) of organic matter. Of this, despite occupying about 70 % of the surface, the productivity of the oceans is only 55 billion tons.

2. DECOMPOSITION

- It is the breakdown of complex organic matter by decomposers into inorganic substances like CO_2, water and nutrients. It is largely an oxygen-requiring process.
- Raw material for decomposition is called **Detritus.** E.g. dead plant remains (leaves, bark, flowers etc.), dead remains of animals, fecal matter etc.

Steps of decomposition

a. Fragmentation: It is the breakdown of detritus into smaller particles by **detritivores** (e.g. earthworm).

b. Leaching: Water soluble inorganic nutrients go down into soil horizon and precipitate as unavailable salts.

c. Catabolism: Degradation of detritus into simpler inorganic substances by bacterial and fungal enzymes.

The above three processes occur simultaneously.

d. Humification: Accumulation of **humus** (dark amorphous substance) in soil. Humus is resistant to microbial action and so decomposes very slowly. Being colloidal, it serves as a reservoir of nutrients.

e. Mineralization: It is the release of inorganic nutrients due to the degradation of humus by some microbes.

Factors influencing decomposition

- **Chemical composition of detritus:**
  - Decomposition is slow in detritus rich in lignin & chitin.
  - It is quicker in detritus rich in nitrogen and water-soluble substances like sugars.
- **Climatic factors (temperature & soil moisture):**
  - Warm and moist environment favour decomposition.
  - Low temperature & anaerobiosis inhibit decomposition resulting in buildup of organic materials.

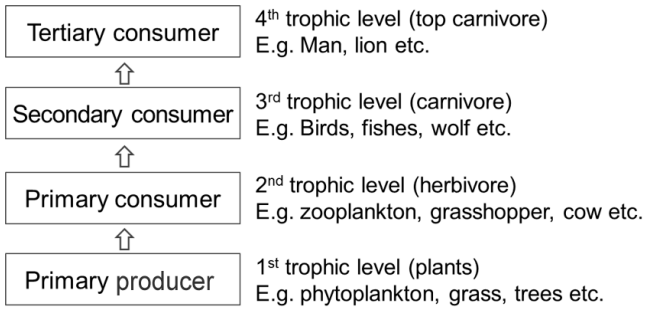
3. ENERGY FLOW

- The chain of feeding relationship between different organisms is called a **food chain.** It is 2 types:
  - **Grazing Food Chain (GFC):** Here, primary consumer feeds on living plants (producer). E.g.

Grass ⟶ Goat ⟶ Man
(Producer) (Primary Consumer) (Secondary consumer)

  - **Detritus Food Chain (DFC):** Here, primary consumer feeds on dead organic matter (detritus). Death of organism is the beginning of the DFC.
- Detritus is made up of **decomposers (saprotrophs**) such as fungi & bacteria. They secrete digestive enzymes that breakdown detritus into simple, inorganic materials, which are absorbed by them. Thus, they get energy & nutrients.
- In an aquatic ecosystem, GFC is the major conduit for energy flow.
- In a terrestrial ecosystem, a much amount of energy flows through the DFC than through the GFC.

- DFC may be connected with GFC at some levels. Some organisms of DFC are prey to the GFC animals. Some animals (cockroaches, crows, human etc.) are omnivores. Such interconnections of food chains are called **food web**.
- A specific place of organisms in the food chain is known as their **trophic level**.



- The amount of energy decreases at successive trophic levels. When an organism dies it becomes **dead biomass (detritus).** It is an energy source for decomposers.

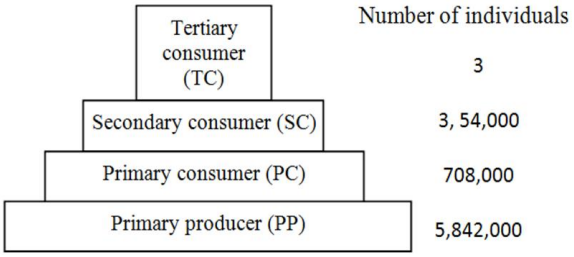
- Organisms at each trophic level depend on those at the lower trophic level for their energy.

- The amount of living material in a trophic level at a given time is called **standing crop**. It is measured as the **biomass** (mass of living organisms) or the **number in a unit area.**

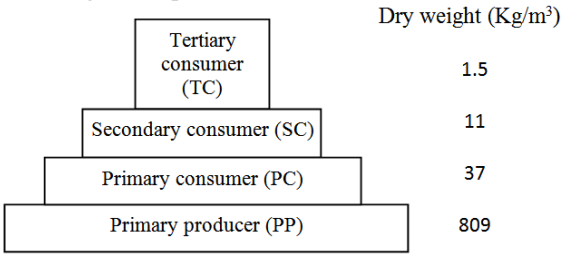
ECOLOGICAL PYRAMIDS

- The representation of a food chain in the form of a pyramid is called **ecological pyramid.**
- The base of a pyramid represents producers (first trophic level). The apex represents tertiary or top-level consumer.
- Ecological pyramids are 3 types: Pyramid of number, Pyramid of biomass and Pyramid of energy.

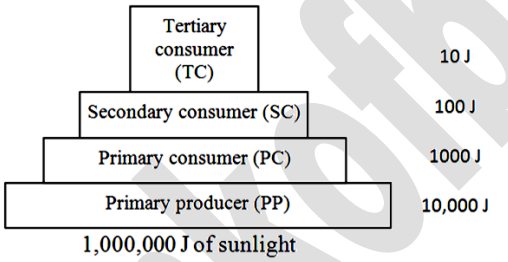
a) Pyramid of number: E.g. grassland ecosystem.



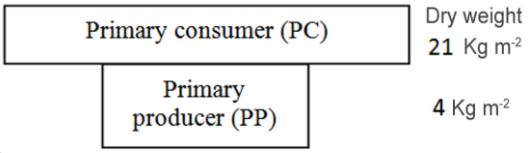
b) Pyramid of biomass: It shows a sharp decrease in biomass at higher trophic levels.



c) Pyramid of energy: Primary producers convert only 1% of the energy in the sunlight available to them into NPP.



- Any calculations of energy content, biomass, or numbers has to include all organisms at that trophic level.
- A trophic level represents a functional level, not a species as such. A species may occupy more than one trophic level in the same ecosystem at the same time. E.g. A sparrow is a primary consumer when it eats seeds, fruits, peas. It is a secondary consumer when it eats insects & worms.
- In most ecosystems, all the pyramids are **upright,** i.e., producers are higher in number, biomass and energy than the herbivores, and herbivores are higher in number, biomass and energy than the carnivores.
- But in some cases, inverted pyramids for number and biomass are present.
- **Inverted pyramid of number:** E.g. Insects feeding on a tree.
- **Inverted pyramid of biomass:** E.g.
  - Small standing crop of phytoplankton supports large standing crop of zooplankton.
  - Pyramid of biomass in sea is inverted because the biomass of fishes far exceeds that of phytoplankton.



- Pyramid of energy is always upright because some energy is always lost as heat at each trophic level. So energy at a lower trophic level is always more than at a higher level.

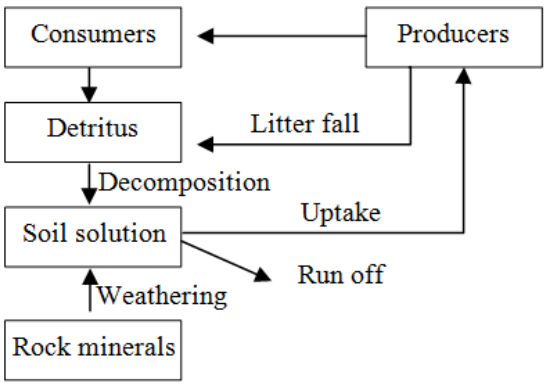
Limitations of ecological pyramids

- It does not consider the **same species** belonging to **two or more trophic levels.**
- It assumes a **simple food chain** that never exists in nature. It does not accommodate a **food web.**
- **Saprophytes** are not included.

4. NUTRIENT CYCLING

Phosphorus Cycle

- Phosphorus is a constituent of biological membranes, nucleic acids & cellular energy transfer systems. Many animals use phosphorus to make shells, bones and teeth.
- The natural reservoir of phosphorus is rock (in the form of phosphates).
- When rocks are weathered, minute amounts of phosphates dissolve in soil solution and are absorbed by the plants. Herbivores and other animals obtain this from plants. The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus.



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