ECOSYSTEM

1. Ecosystem

It is a functional unit of nature, where living organisms interact among themselves and also with their surrounding physical environment. The concept of ecological system was put forward by Karl Mobius (1877). The term ecosystem was coined by A G Tansley (1935).

According to him, the ecosystem is a system which is exhibited by the inter-relationships between abiotic and biotic components of its environment. It is considered as an interactive system, which can be either natural or artificial.

(i) **Natural Ecosystems**These are capable of maintaining and operating themselves, without the interference of man. They are further classified into terrestrial and aquatic types.

(ii) **Artificial Ecosystems** These are maintained and manipulated by man for different purposes, e.g. cropland, aquarium, etc.

2. Components of an Ecosystem

The ecosystem consists of the following components

(i) Biotic Components These are composed of animals, plants and microorganisms and have the following main parts

● Producers The green plants which make their own food by photosynthesis are called producers, e.g. all green plants and green algae.

● Consumers All heterotrophic animals obtain their food from green plants directly or indirectly. These are divided into two categories, i.e. herbivores and carnivores. Rabbit, rat, squirrel, goat, cattle, etc., are examples of herbivores and birds, hawk, snake, fox, etc., are examples of carnivore animals. Consumers are of three types–primary, secondary and tertiary.

Omnivores These eat both producers and consumers, e.g. pig, bear, etc.

Detritivores These depend on dead and decaying organic matter for obtaining their food, e.g. vultures, earthworm.

- Decomposers These obtain their food by decaying dead organic matter, e.g. bacteria and fungi. These are also called saprobes or mineralisers.

(ii) Abiotic Components These include temperature, water, light and soil.

3.Structure and Functions of Ecosystem

Two important structural features of an ecosystem are

(i) **Species composition** is calculated by the characteristic identification and enumeration of plants and animals of an ecosystem.

(ii) **Stratification** is the vertical distribution of different species occupying different levels in an ecosystem, e.g. trees occupy top vertical strata or layer of a forest, shrubs at the second and herbs and grasses occupy the bottom (third) layer.

The important functional aspects of an ecosystem are productivity, decomposition, energy flow and nutrient cycling.

4. Productivity of an Ecosystem

The rate of synthesis of biomass by any trophic level per unit area in unit time is called its productivity. It is expressed in terms of $g^{-2}yr^{-1}$ or (kcal m^{-2}) yr^{-1}. Productivity of an ecosystem can be categorised as **primary** and **secondary** productivity.

(i) **Primary Productivity**It is the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (g^{-2}) or energy (kcal m^{-2}).

The total sum of organic matter synthesised by primary producers via photosynthesis is called **gross primary productivity**.

The organic matter/energy stored by the primary producers after utilisation of some energy for respiration is called net primary productivity. It is a part of gross primary productivity. Net primary productivity = Gross primary productivity − Respiratory loss by plants.

(ii) **Secondary Productivity**It is the rate of new organic matter synthesised by the consumers. It is less than primary productivity and tends to decrease with an increase in trophic level.

Ecological efficiency is the amount of energy received by one trophic level from the other in an ecosystem.

5. Decomposition

It is the process of breaking down of complex organic matter into inorganic substances like water, carbon dioxide and nutrients by decomposers. Detritus is the raw material needed for the decomposition. It involves following steps

(i) **Fragmentation**It is a process of breakdown of detritus into small particles by detritivores, e.g. earthworm.

(ii) **Leaching**It is the process by which water soluble inorganic nutrients reach into soil horizon and get precipitated as unavailable salts.

(iii) **Catabolism**It is the process of degradation of detritus into simple organic material by the action of bacterial and fungal enzymes and then their further conversion into simpler inorganic compounds.

(iv) **Humification**It is a process that leads to accumulation of a dark coloured amorphous and colloidal substance called **humus**, which is highly resistant to microbial action and undergoes decomposition at a very slow rate.

(v) **Mineralisation**It is the process of degradation of humus by microbial action and releases of inorganic nutrients. Factors affecting decomposition are as follows

(a) Chemical Decomposition of Detritus Decomposition will slow, if detritus is rich in lignin and chitin, but it will quicker if detritus is composed of nitrogen and sugar.

(b) Climatic Factors Warm and moist environment favour decomposition, while low temperature and anaerobic conditions inhibit it.

6. Energy Flow

The Sun is the only source of energy in all ecosystems on the Earth, except for deep hydrothermal vents. Out of the incident solar radiation, less than 50% of it is Photosynthetically Active Radiation (PAR). Plants and photosynthetic bacteria (autotrophs) use only 2% of the Sun’s radiant energy to produce food from simple inorganic materials.

7. Food Chain

It is a sequence of population of an ecosystem through which the food and its contained energy passes through levels, with each member becoming the food of a later member in the sequence. The food chain present in nature is of two types

(i) Grazing Food Chain (GFC) begins with producers which capture solar energy and pass on energy into food chain through photosynthesis, e.g. Grass → Goat → Man (Producer) (Primary consumer) (Secondary consumer)

(ii) Detritus Food Chain (DFC) begins with dead organic matter and consists of decomposers mainly fungi and bacteria., e.g. Dead leaves → Wood louse → Black bird (Producer) (Primary consumer) (Secondary consumer)

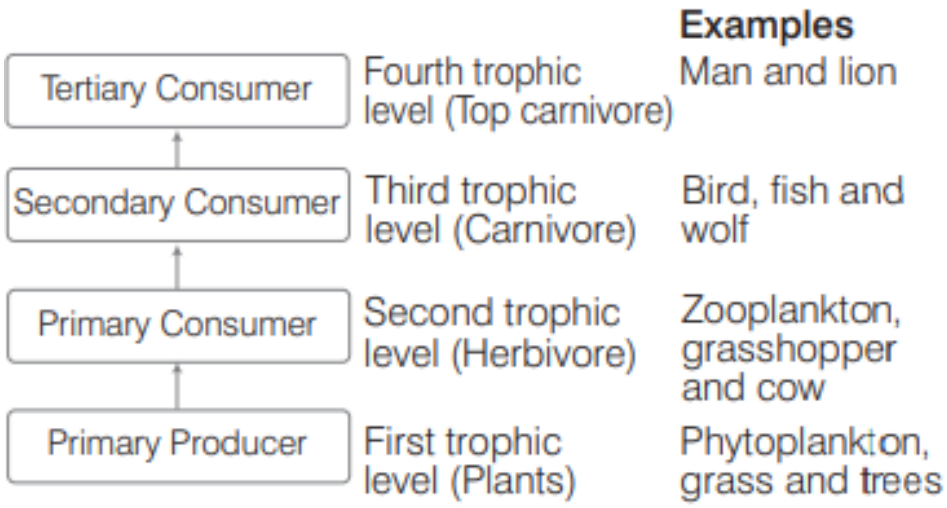
8. Food Web

A network of cross connecting food chains involving producers, consumers and decomposers is termed as a food web. It maintains a kind of homeostasis in an ecosystem to make it stable.

9. Trophic Level

All organisms occupy a particular place in their natural surrounding or in a community according to their feeding relationship among organisms. The particular place of an organism in food chain is called trophic level.

The following diagram shows the various trophic levels in an ecosystem



Note (i) Standing crop is the mass of living material at a particular level at a specific time. It is measured as the mass of living organisms (or biomass) in a unit area.

(ii) Ten per cent law was given by Lindemann in 1942. It states that at each step of food chain, 10% of energy is transferred to next level while remaining is lost as heat.

10. Ecological Pyramids

It is a graphical representation of ecological parameters like biomass, energy or number of individuals present at various trophic levels of food chain. The concept of ecological pyramid was given by Charles Elton (1927). The ecological pyramids are of three types

(i) **Pyramid of number** represents the total number of organisms at each trophic level. It is always upright, but inverted in tree ecosystem.

(ii) **Pyramid of biomass** refers to the total weight of the organisms in each trophic level. It can be upright or inverted.

(iii) **Pyramid of energy** expresses the total energy of the organisms in each trophic level. It is always upright and unidirectional.

11. Ecological Succession

It is a sequential, gradual and predictable change in the species composition of an area over a period of time. The entire sequence of communities change in a given area is/are called **sere** (s). The individual communities are called **seral stages** or **seral communities**.

The changes during ecological succession lead towards equilibrium with the environment which is called as **climax community**.

The species that invade barren area are called **pioneer species**.

Ecological succession is of two types, i.e. primary and secondary succession

(i) **Primary Succession**It occurs on the barren land, newly formed pond or reservoir and newly cooled lava, where no living organisms have existed before.

(ii) **Secondary Succession**It is relatively a faster process as it occurs on the land, where natural biotic communities were present in past but have been destroyed.

Succession of Plants Based on the nature of habitat, it is of two types (i) Hydrarch succession takes place in wetter areas and successional series progress from hydric to mesic conditions.

(ii) **Xerarch succession** takes place in dry areas and series progress from xeric to mesic conditions, e.g. xerarch succession of an ecological community originates in extremely dry conditions such as sand deserts and rock deserts.

12. Nutrient Cycling

Organisms need a constant supply of nutrients for various body functions. The amount of nutrients present in the soil at any given time is called standing state. The movement

of nutrient elements through various components of an ecosystem is called nutrient cycling or biogeochemical cycles. Nutrient cycles are of two types

(i) Gaseous cycle includes nitrogen, carbon, etc.

(ii) Sedimentary cycle includes sulphur, phosphorus, etc.

Carbon Cycling It occurs through atmosphere, ocean and through living and dead organisms. A large amount of carbon returns to the atmosphere as CO_2 through

(i) Respiratory activities of the producers and consumers.

(ii) Breakdown activities of decomposers.

(iii) Forest fire and combustion of organic matter, etc.

Phosphorus Cycle

Phosphorus is a major constituent of biological membranes, nucleic acids, cellular energy transfer systems (ATP) and also of shells, bones and teeth. The natural reservoir of phosphorus is rock which contains phosphorus in the form of phosphates.

The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus in the soil.

13. Ecosystem Services

The products of an ecosystem processes are termed as **ecosystem services**, e.g. pollination of crops, CO_2 fixation, purification of air and water by forests, etc.