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Ecosystem

Terrestrial and the aquatic.

- Forest, grassland and desert are some examples of terrestrial ecosystems; pond, lake, wetland, river and estuary are some examples of aquatic ecosystems.
- Crop fields and an aquarium may also be considered as man-made ecosystems.
- Vertical distribution of different species occupying different levels is called stratification. For example, trees occupy top vertical strata or layer of a forest, shrubs the second and herbs and grasses occupy the bottom layers.

The components of the ecosystem are seen to function as a unit when you consider the following aspects:

(i) Productivity;

(ii) Decomposition;

(iii) Energy flow; and

(iv) Nutrient cycling.

- The abiotic component is the water with all the dissolved inorganic and organic substances and the rich soil deposit at the bottom of the pond.
- The solar input, the cycle of temperature, day-length and other climatic conditions regulate the rate of function of the entire pond.
- The autotrophic components include the phytoplankton, some algae and the floating, submerged and marginal plants found at the edges.
- The consumers are represented by the zooplankton, the free swimming and bottom dwelling forms.
- The decomposers are the fungi, bacteria and flagellates especially abundant in the bottom of the pond.
- This system performs all the functions of any ecosystem and of the biosphere as a whole, i.e., conversion of inorganic into organic material with the help of the radiant energy of the sun by the autotrophs; consumption of the autotrophs by heterotrophs; decomposition and mineralisation of the dead matter to release them back for reuse by the autotrophs, these event are repeated over and over again.
- There is unidirectional movement of energy towards the higher trophic levels and its dissipation and loss as heat to the environment.
- Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.
- The rate of biomass production is called productivity.

- It can be divided into gross primary productivity (GPP) and net primary productivity (NPP).
- Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.
- A considerable amount of GPP is utilised by plants in respiration.
- Gross primary productivity minus respiration losses (R), is the net primary productivity (NPP).
- Net primary productivity is the available biomass for the consumption to heterotrophs (herbivores and decomposers).
- Secondary productivity is defined as the rate of formation of new organic matter by consumers.
- Primary productivity depends on the plant species inhabiting a particular area.
- It also depends on a variety of environmental factors, availability of nutrients and photosynthetic capacity of plants.
- The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of organic matter.
- Of this, despite occupying about 70 per cent of the surface, the productivity of the oceans are only 55 billion tons.
- Rest of course, is on land. decomposers break down complex organic matter into inorganic substances like carbon dioxide, water and nutrients and the process is called decomposition.
- Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter, constitute detritus, which is the raw material for decomposition.
- The important steps in the process of decomposition are fragmentation, leaching, catabolism, humification and mineralisation.
- Detritivores (e.g., earthworm) break down detritus into smaller particles. This process is called fragmentation.
- By the process of leaching, water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
- Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called as catabolism.
- Humification and mineralisation occur during decomposition in the soil.
- Humification leads to accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate.
- Being colloidal in nature it serves as a reservoir of nutrients.
- The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as mineralisation.
- Decomposition is largely an oxygen-requiring process.
- The rate of decomposition is controlled by chemical composition of detritus and climatic factors.

- In a particular climatic condition, decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.
- Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes.
- Warm and moist environment favour decomposition whereas low temperature and anaerobiosis inhibit decomposition resulting in build up of organic materials.
- The detritus food chain (DFC) begins with dead organic matter.
- It is made up of decomposers which are heterotrophic organisms, mainly fungi and bacteria.
- They meet their energy and nutrient requirements by degrading dead organic matter or detritus.
- These are also known as Saprotrophs (sapro:to decompose).
- Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them. In an aquatic ecosystem, GFC is the major conduit for energy flow.
- As against this, in a terrestrial ecosystem, a much larger fraction of energy flows through the detritus food chain than through the GRAZING FOOD CHAIN.
- Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores.
- These natural interconnection of food chains make it a food web.
- The consumers that feed on these herbivores are carnivores, or more correctly primary carnivores (though secondary consumers).
- Those animals that depend on the primary carnivores for food are labeled secondary carnivores.
- Organisms occupy a place in the natural surroundings or in a community according to their feeding relationship with other organisms.
- Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their trophic level.
- Producers belong to the first trophic level, herbivores (primary consumer) to the second and carnivores (secondary consumer) to the third the amount of energy decreases at successive trophic levels.
- When any organism dies it is converted to detritus or dead biomass that serves as an energy source for decomposers.
- Organisms at each trophic level depend on those at the lower trophic level for their energy demands.
- Each trophic level has a certain mass of living material at a particular time called as the standing crop.
- The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area.
- The biomass of a species is expressed in terms of fresh or dry weight.

- Measurement of biomass in terms of dry weight is more accurate.
- Pyramid of energy is always upright, can never be inverted, because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step.
- Each bar in the energy pyramid indicates the amount of energy present at each trophic level in a given time or annually per unit area.
- An important characteristic of all communities is that composition and structure constantly change in response to the changing environmental conditions.
- This change is orderly and sequential, parallel with the changes in the physical environment.
- These changes lead finally to a community that is in near equilibrium with the environment and that is called a climax community.
- The gradual and fairly predictable change in the species composition of a given area is called ecological succession.
- During succession some species colonise an area and their populations become more numerous, whereas populations of other species decline and even disappear.
- The entire sequence of communities that successively change in a given area are called sere(s).
- The individual transitional communities are termed seral stages or seral communities.
- In the successive seral stages there is a change in the diversity of species of organisms, increase in the number of species and organisms as well as an increase in the total biomass.
- Succession is hence a process that starts where no living organisms are there – these could be areas where no living organisms ever existed, say bare rock; or in areas that somehow, lost all the living organisms that existed there.
- The former is called primary succession, while the latter is termed secondary succession.
- Examples of areas where primary succession occurs are newly cooled lava, bare rock, newly created pond or reservoir.
- The establishment of a new biotic community is generally slow.
- Before a biotic community of diverse organisms can become established, there must be soil.
- Depending mostly on the climate, it takes natural processes several hundred to several thousand years to produce fertile soil on bare rock.
- Secondary succession begins in areas where natural biotic communities have been destroyed such as in abandoned farm lands, burned or cut forests, lands that have been flooded.
- Since some soil or sediment is present, succession is faster than primary succession.
- Based on the nature of the habitat – whether it is water (or very wet areas) or it is on very dry areas – succession of plants is called hydrach or xerarch, respectively.

- Hydrarch succession takes place in wetter areas and the successional series progress from hydric to the mesic conditions.
- As against this, xerarch succession takes place in dry areas and the series progress from xeric to mesic conditions. Hence, both hydrarch and xerarch successions lead to medium water conditions (mesic) – neither too dry (xeric) nor too wet (hydric).
- The species that invade a bare area are called pioneer species.
- In primary succession on rocks these are usually lichens which are able to secrete acids to dissolve rock, helping in weathering and soil formation.
- These later pave way to some very small plants like bryophytes, which are able to take hold in the small amount of soil.
- They are, with time, succeeded by bigger plants, and after several more stages, ultimately a stable climax forest community is formed.
- The climax community remains stable as long as the environment remains unchanged.
- With time the xerophytic habitat gets converted into a mesophytic one. succession, particularly primary succession, is a very slow process, taking maybe thousands of years for the climax to be reached.
- Another important fact is to understand that all succession whether taking place in water or on land, proceeds to a similar climax community – the mesic.
- The movement of nutrient elements through the various components of an ecosystem is called nutrient cycling.
- Another name of nutrient cycling is biogeochemical cycles (bio: living organism, geo: rocks, air, water).
- Nutrient cycles are of two types: (a) gaseous and (b) sedimentary.

Phosphorus Cycle

- Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems.
- Many animals also need large quantities of this element to make shells, bones and teeth.
- The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates.
- When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants.
- Herbivores and other animals obtain this element from plants.
- The waste products and the dead organisms are decomposed by phosphate-solubilizing bacteria releasing phosphorus.
- Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.
- The other two major and important differences between carbon and phosphorus cycle are firstly, atmospheric inputs of phosphorus through rainfall are much

smaller than carbon inputs, and, secondly, gaseous exchanges of phosphorus between organism and environment are negligible.

- Healthy ecosystems are the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as ecosystem services, for example, healthy forest ecosystems purify air and water, mitigate droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values.

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