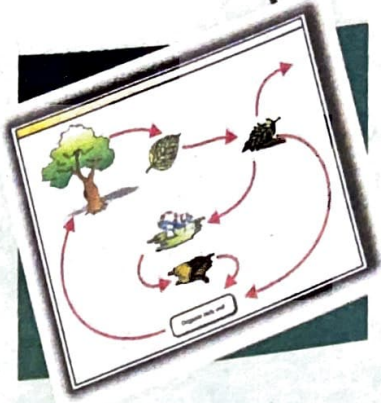


CHAPTER 14

ECOSYSTEM



• Tansley coined the term ecosystem and defined it as sum of total all interaction b/w living and non-living component having ind. existence.

- 14.1 Ecosystem-Structure and Function
- 14.2 Productivity
- 14.3 Decomposition
- 14.4 Energy Flow
- 14.5 Ecological Pyramids
- 14.6 Ecological Succession
- 14.7 Nutrient Cycling
- 14.8 Ecosystem Services

An ecosystem can be visualised as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment. Ecosystem varies greatly in size from a small pond to a large forest or a sea. Many ecologists regard the entire biosphere as a global ecosystem, as a composite of all local ecosystems on Earth. Since this system is too much big and complex to be studied at one time, it is convenient to divide it into two basic categories, namely the 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. * mca

or anthropogenic

We will first look at the structure of the ecosystem, in order to appreciate the input (productivity), transfer of energy (food chain/web, nutrient cycling) and the output (degradation and energy loss). We will also look at the relationships - cycles, chains, webs - that are created as a result of these energy flows within the system and their inter-relationship.

- * characteristic of anthropogenic
- no self regulatory mech.
- simple food chain
- little diversity
- little nutrient cycling
- high productivity

Terrestrial ecosystem:

Major producers are herbaceous and woody plants.

Aquatic ecosystem: Chief producer are phytoplankton, algae, floating, submerged and marginal plants, found at edges.

Producers are autotrophic consumers or standards.

Consumers: Directly feed on herbivores (key individuals) herbivores - grasshopper goats and deer.

Aquatic - herbivores like zebrafish (top) and mosquito (gravid).

Secondary - herbivores by 2° consumers: weaverbirds: toad, lizards, heron etc.

Aquatic: heron etc. terrestrial: snake, fox etc.

terrestrial: large fish aquatic: snake.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

terrestrial: snake, fox etc.

Species comp. 2 main feature of ecosystem.

Structure and function.

ecosystem - structure and function.

er 13. you have looked at the various components of the biotic-abiotic and biotic. You studied how the individual biotic factors affected each other and their surrounding. Let us look at these components in a more integrated manner and see how the flow of energy takes place within these components of the ecosystem.

Interaction of biotic and abiotic components result in a physical structure that is characteristic for each type of ecosystem. Identification and enumeration of plant and animal species of an ecosystem gives its species composition. 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:

Productivity

Decomposition

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Energy flow and Nutrient cycling

Primary productivity

Factors affecting productivity: Net primary productivity is the available biomass for the consumption of 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. Therefore, it varies in different types of ecosystems. 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. Discuss the main reason for the low productivity of ocean with your teacher.

14.3 Decomposition: You may have heard of the earthworm being referred to as the 'farmer's friend'. This is so because they help in the breakdown of complex organic matter as well as in loosening of the soil. Similarly, decomposers breakdown 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.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus (Figure 14.1). Humification and mineralisation occur during decomposition in the soil. Humification leads to the formation of humus, a dark brown substance that is rich in nutrients and is difficult to decompose further. It is a stable form of detritus that is available to plants as nutrients.

Factors of dependence of primary productivity: Net primary productivity is the available biomass for the consumption of 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. Therefore, it varies in different types of ecosystems. 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. Discuss the main reason for the low productivity of ocean with your teacher.

14.3 Decomposition: You may have heard of the earthworm being referred to as the 'farmer's friend'. This is so because they help in the breakdown of complex organic matter as well as in loosening of the soil. Similarly, decomposers breakdown 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.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus (Figure 14.1). Humification and mineralisation occur during decomposition in the soil. Humification leads to the formation of humus, a dark brown substance that is rich in nutrients and is difficult to decompose further. It is a stable form of detritus that is available to plants as nutrients.

Factors of dependence of primary productivity: Net primary productivity is the available biomass for the consumption of 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. Therefore, it varies in different types of ecosystems. 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. Discuss the main reason for the low productivity of ocean with your teacher.

14.3 Decomposition: You may have heard of the earthworm being referred to as the 'farmer's friend'. This is so because they help in the breakdown of complex organic matter as well as in loosening of the soil. Similarly, decomposers breakdown 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.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus (Figure 14.1). Humification and mineralisation occur during decomposition in the soil. Humification leads to the formation of humus, a dark brown substance that is rich in nutrients and is difficult to decompose further. It is a stable form of detritus that is available to plants as nutrients.

Factors of dependence of primary productivity: Net primary productivity is the available biomass for the consumption of 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. Therefore, it varies in different types of ecosystems. 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. Discuss the main reason for the low productivity of ocean with your teacher.

14.3 Decomposition: You may have heard of the earthworm being referred to as the 'farmer's friend'. This is so because they help in the breakdown of complex organic matter as well as in loosening of the soil. Similarly, decomposers breakdown 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.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus (Figure 14.1). Humification and mineralisation occur during decomposition in the soil. Humification leads to the formation of humus, a dark brown substance that is rich in nutrients and is difficult to decompose further. It is a stable form of detritus that is available to plants as nutrients.

Factors of dependence of primary productivity: Net primary productivity is the available biomass for the consumption of 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. Therefore, it varies in different types of ecosystems. 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. Discuss the main reason for the low productivity of ocean with your teacher.

14.3 Decomposition: You may have heard of the earthworm being referred to as the 'farmer's friend'. This is so because they help in the breakdown of complex organic matter as well as in loosening of the soil. Similarly, decomposers breakdown 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.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus (Figure 14.1). Humification and mineralisation occur during decomposition in the soil. Humification leads to the formation of humus, a dark brown substance that is rich in nutrients and is difficult to decompose further. It is a stable form of detritus that is available to plants as nutrients.

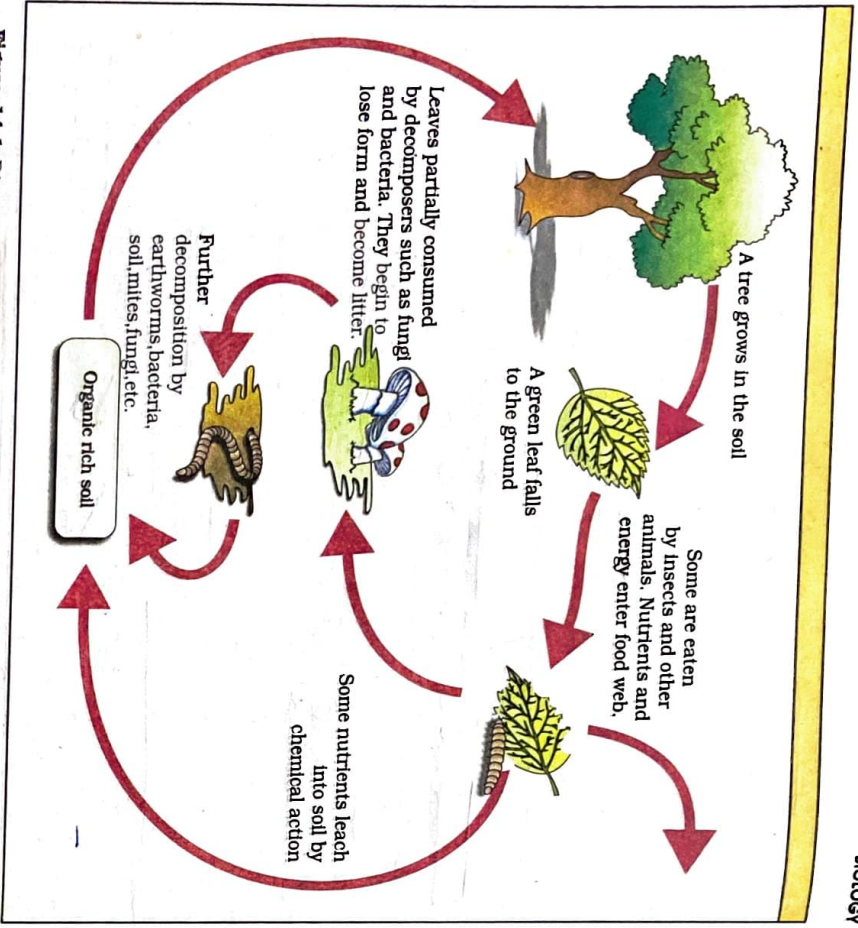


Figure 14.1 Diagrammatic representation of decomposition cycle in a terrestrial ecosystem

- Factors Affecting Decomposition :-

- Chemical nature of detritus.
- Temp. (Not Opt.)
- Moisture (Not Opt.)
- Aerobion

HUMUS - Humus obt. from detritus by decomposers.

Rich in cellulose + lignin.

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.

14.4 ENERGY FLOW

Except for the deep sea hydro-thermal ecosystem, sun is the only source of energy for all ecosystems on Earth. Of the incident solar radiation less than 50 per cent of it is photosynthetically active radiation (PAR). We know that plants and photosynthetic bacteria (autotrophs), fix Sun's radiant energy to make food from simple inorganic materials. Plants capture only 2-10 per cent of the PAR and this small amount of energy sustains the entire living world. So, it is very important to know how the solar energy captured by plants flows through different organisms of the ecosystem. All organisms are dependent for their food on producers, either directly or indirectly. So you find unidirectional flow of energy from the sun to producers and then to consumers. Is this in keeping with the first law of thermodynamics? → energy not created but transferred.

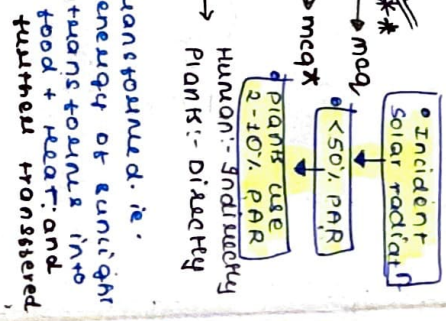
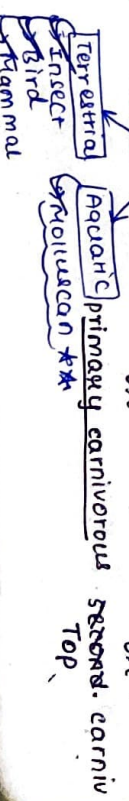
Further, ecosystems are not exempt from the Second Law of thermodynamics. They need a constant supply of energy to synthesise the molecules they require, to counteract the universal tendency toward increasing disorderliness → About entropy

The green plant in the ecosystem are called **producers**. In a terrestrial ecosystem, major producers are herbaceous and woody plants. Likewise, producers in an aquatic ecosystem are various species like phytoplankton, algae and higher plants.

You have read about the food chains and webs that exist in nature. Starting from the plants (or producers) food chains or rather webs are formed such that an animal feeds on a plant or on another animal and in turn is food for another. The chain or web is formed because of this interdependency. No energy that is trapped into an organism remains in it for ever. The energy trapped by the producer, hence, is either passed on to a consumer or the organism dies. Death of organism is the beginning of the detritus food chain/web.

All animals depend on plants (directly or indirectly) for their food needs. They are hence called **consumers** and also heterotrophs. If they feed on the producers, the plants, they are called primary consumers, and if the animals eat other animals which in turn eat the plants (or their produce) they are called secondary consumers. Likewise, you could have tertiary consumers too. Obviously the primary consumers will be herbivores. Some common herbivores are insects, birds and mammals in terrestrial ecosystem and molluscs in aquatic ecosystem.

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 labelled **secondary carnivores**. A simple grazing food chain (GFCC) is depicted below:





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 **GFC**. **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**, **pic**, are omnivores. These natural interconnection of food chains make it a **food web**. How these natural interconnection of food chains make it a **food web**? How **interconnecting** would you classify human beings?

Sorakohell
 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 (Figure 14.2).

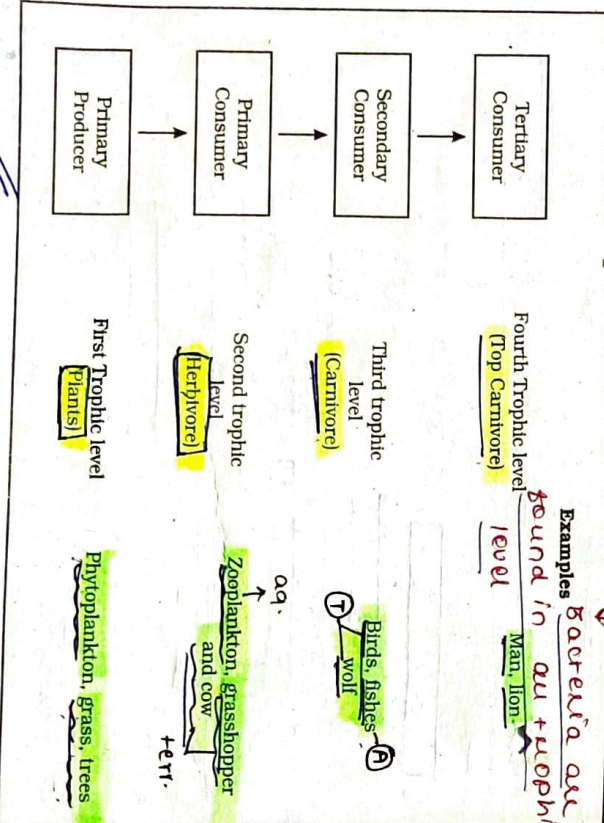


Figure 14.2 Diagrammatic representation of trophic levels in an ecosystem

The important point to note is that 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. Why? The number of trophic levels in the grazing food chain is restricted as the transfer of energy follows **10 per cent law** - only 10 per cent of the energy is transferred to each trophic level from the lower trophic level. In nature, it is possible to have so many levels - producer, herbivore, primary carnivore, secondary carnivore in the grazing food chain (Figure 14.3). Do you think there is any such limitation in a detritus food chain?

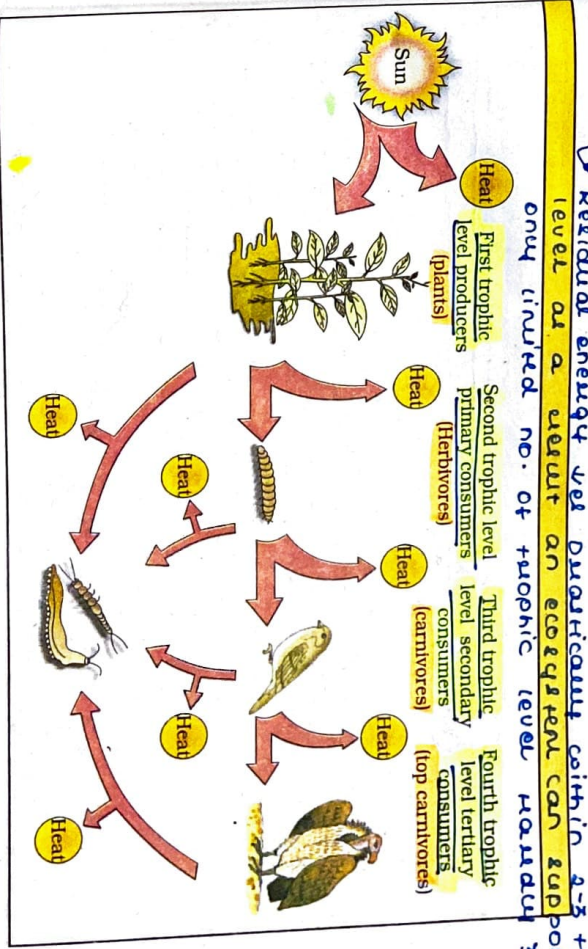


Figure 14.3 Energy flow through different trophic levels

14.5 ECOLOGICAL PYRAMIDS

You must be familiar with the shape of a pyramid. The base of a pyramid is broad and it narrows towards the apex. One gets a similar shape, whether you express the food or energy relationship between organisms



Pyramid of Number:

Upright: -
 Eq: grassland and pond
 inverted: -
 Eq: in tree ecosystem
 A large size tree may support and provide nourishment to several frugivorous birds a no. of herbivorous birds
 Herbivorous birds are eaten by one or two hawks of area.

at trophic level. This relationship is expressed in terms of number, energy or biomass. The base of each pyramid represents the producers and the apex represents tertiary or top level. The three ecological pyramids that are usually studied are pyramid of number, pyramid of biomass and pyramid of energy. (See Figure 14.4 a, b, c and d).

BIOLOGY



Figure 14.4 (a) Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants

In an inverted food chain, size of org. finally reduced at higher T.L.

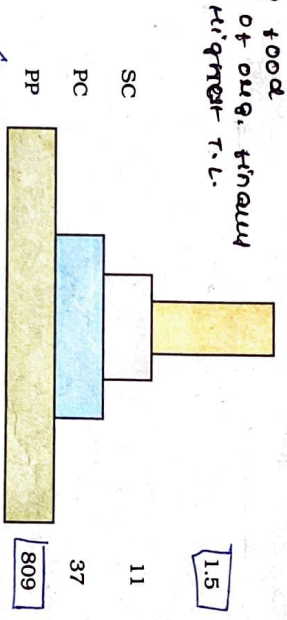


Figure 14.4 (b) Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels



Figure 14.4 (c) Inverted pyramid of biomass - small standing crop of phytoplankton supports large standing crop of zooplankton

ECOSYSTEM

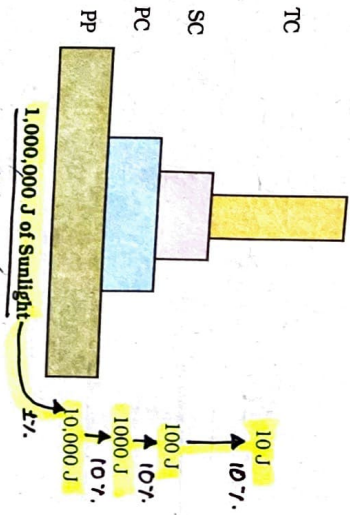


Figure 14.4 (d) An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

Any calculations of energy content, biomass or numbers, has to include all organisms at that trophic level. No generalisations we make will be true if we take only a few individuals at any trophic level into account. Also a given organism may occupy more than one trophic level simultaneously. One must remember that the trophic level represents a functional level, not a species as such. A given species may occupy more than one trophic level in the same ecosystem at the same time; for example, a sparrow is a primary consumer when it eats seeds, fruits, peas, and a secondary consumer when it eats insects and worms. Can you work out how many trophic levels human beings function at in a food chain?

In most ecosystems, all the pyramids, of number, of energy and biomass are upright, i.e., producers are more in number and biomass than the herbivores, and herbivores are more in number and biomass than the carnivores. Also energy at a lower trophic level is always more than at a higher level.

There are exceptions to this generalisation. If you were to count the number of insects feeding on a big tree what kind of pyramid would you get? Now add an estimate of the number of small birds depending on the insects, as also the number of larger birds eating the smaller. Draw the shape you would get.

The pyramid of biomass in sea is generally inverted because the biomass of fishes far exceeds that of phytoplankton. Isn't that a paradox? How would you explain this?

Pyramid of energy is always upright, can never be inverted because some 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.

Eq. of one animal and 2 trophic level

In most ecosystems, energy and biomass are more at lower trophic level than at higher level.

Biomass pyramid

Energy pyramid



Limitations of Ecological Pyramids

① However, there are certain limitations of ecological pyramids such as it does not take into account the same species belonging to two or more trophic levels. It assumes a simple food chain, something that almost never exists in nature. It does not accommodate a food web. Moreover, saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

14.6 Ecological Succession → BY KULT.

You have learnt in Chapter 13, the characteristics of population and community and also their response to environment and how such responses vary from an individual response. Let us examine another aspect of community response to environment over time.

An important characteristic of all communities is that their 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 whereas populations of other species decline and even disappear.

The entire sequence of communities that successively change in a given area are called **series** (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. The present day communities in the world have come to be because of ecological succession that has occurred over millions of years since life started on earth. Actually **succession** and **evolution** would have been parallel processes at that time.

Succession is hence a process that starts in an area 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.

Abdoul
Pricinary &
Secondary.

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.

Description of ecological succession usually focuses on changes in vegetation. However, these vegetational changes in turn affect food and shelter for various types of animals. Thus, as succession proceeds, the numbers and types of animals and decomposers also change.

At any time during primary or secondary succession (natural or human induced disturbances (fire, deforestation, etc.), can convert a particular seral stage of succession to an earlier stage. Also such disturbances create new conditions that encourage some species and discourage or eliminate other species. → fire etc

14.6.1 Succession of Plants

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 **hydrarch** or **xerarch**, respectively. **Hydrarch succession** takes place in wet 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 higher 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.

In primary succession in water, the pioneers are the small phytoplanktons which are replaced with time by rooted, submerged plants, rooted-floating angiosperms followed by free-floating plants, then reed-swamp, marsh-meadow, scrub and finally the trees. The climax again would be a forest. With time the water body is converted into land (Figure 14.5).

In secondary succession the species that invade depend on the condition of the soil, availability of water, the environment as also the seeds or other propagules present. Since soil is already there, the rate of succession is much faster and hence, climax is also reached more quickly.

What is important to understand is that succession, particularly primary succession, is a very slow process, taking maybe thousands of

Actual word
for
succession

Xerarch succession
Pioneer community
lichens.

Successional stages:
Annual grasses
Perennial grasses
Shrub stage
Mosses
Mosses
Mosses
Mosses

Hydrarch succession
Pioneer community
Algae
Algae
Algae
Algae

Secondary succession
Pioneer community
Mosses
Mosses
Mosses
Mosses



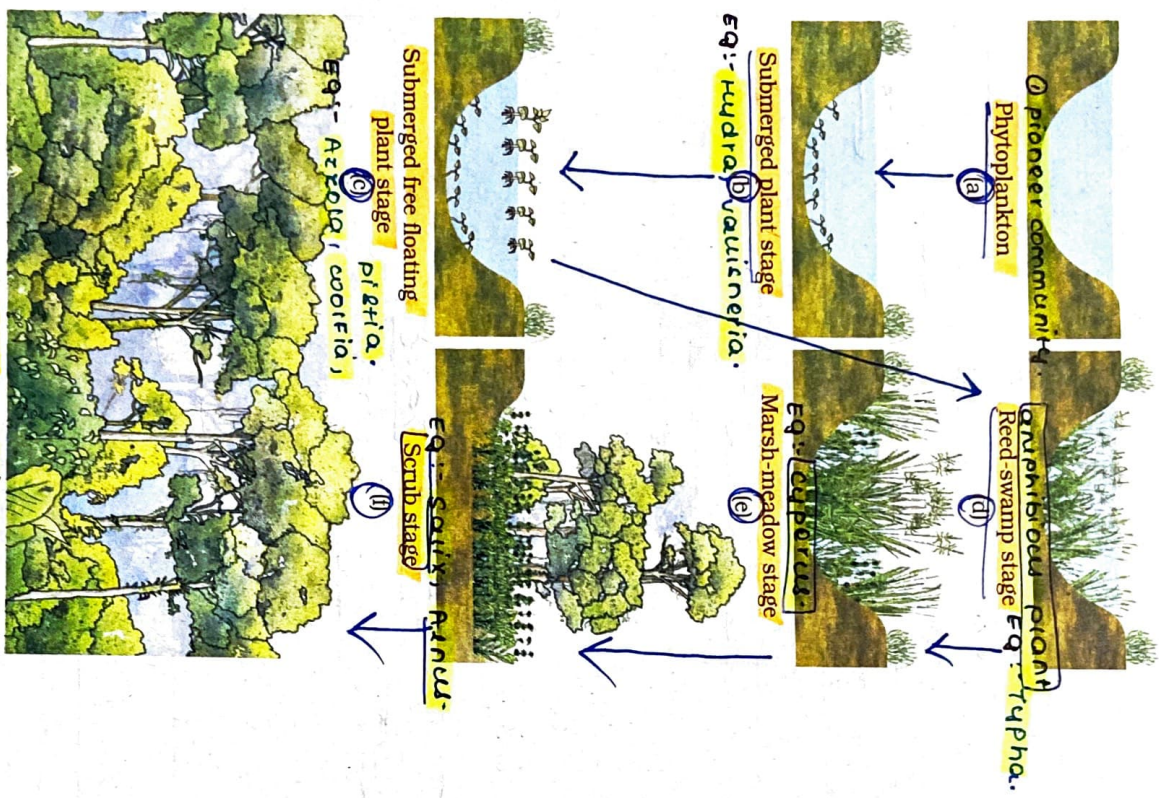


Figure 14.5 Diagrammatic representation of primary succession

14.7 NUTRIENT CYCLING

You have studied in Class XI that organisms need a constant supply of nutrients to grow, reproduce and regulate various body functions. The amount of nutrients, such as carbon, nitrogen, phosphorus, calcium, etc., present in the soil at any given time, is referred to as the **standing state**. It varies in different kinds of ecosystems and also on a seasonal basis. What is important is to appreciate that nutrients which are never lost from the ecosystems, rather they are recycled time and again indefinitely. 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**. The

→ Denitrification
→ Standing crop
(living material at particular time).

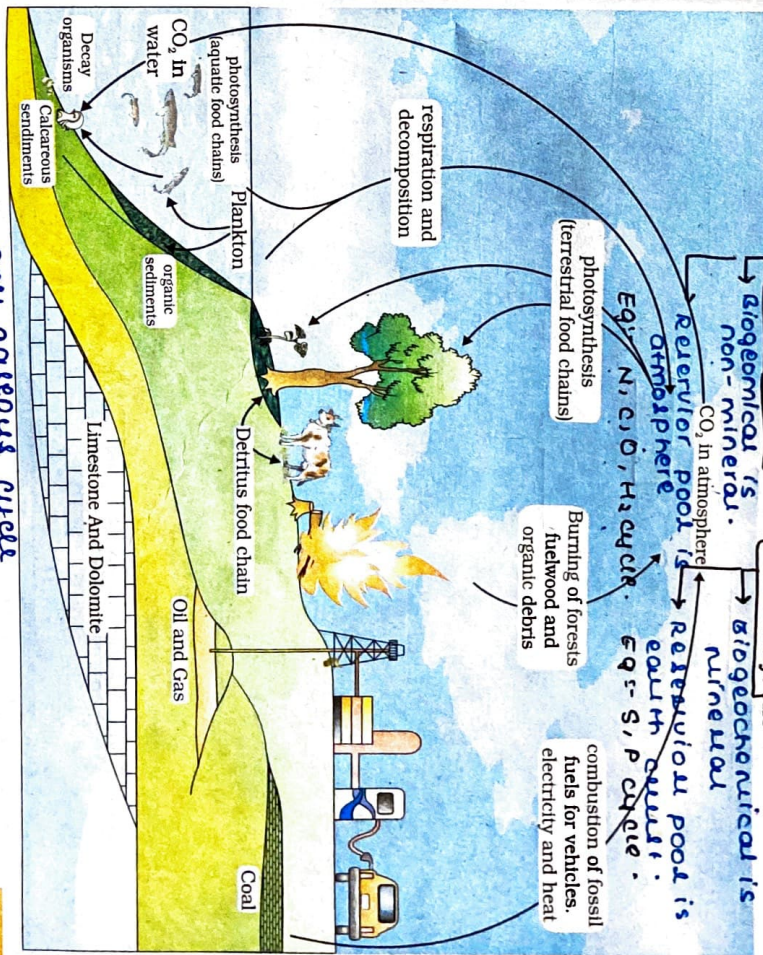


Figure 14.6 Simplified model of carbon cycle in the biosphere

reservoir for gaseous type of nutrient cycle (e.g., nitrogen, carbon cycle) exists in the atmosphere and for the sedimentary cycle (e.g., sulphur and phosphorus cycle), the reservoir is located in Earth's crust. Environmental factors e.g. soil moisture, pH, temperature etc., regulate the rate of



PNs cycles do not have any type of respiratory loss.
 It is only in case of C, O cycle.
 You have made a detailed study of nitrogen cycle in class XI. Here we discuss carbon and phosphorus cycles.

14.7.1 Ecosystem - Carbon Cycle

When you study the composition of living organisms, carbon constitutes **49 per cent of dry weight** of organisms and is next only to water. If we look at the total quantity of global carbon, we find that **71 per cent carbon is found dissolved in oceans**. This oceanic reservoir regulates the amount of carbon dioxide in the atmosphere (Figure 14.6). Do you know that the atmosphere only contains about **1 per cent of total global carbon?**

- **Sources for C-cycle**
 - 1) Fossil fuel
 - 2) 4×10^{13} kg through photosynthesis annually
 - 3) Respiration act.
 - 4) Decomposers through CO_2
 - 5) Burning wood
 - 6) Forest fire
 - 7) Combustion
 - 8) Volcanic act.
- **Need of CO_2 rare**
 - 1) Human activities have significantly influenced the carbon cycle. Rapid deforestation and massive burning of fossil fuel for energy and transport have significantly increased the rate of release of carbon dioxide into the atmosphere (see greenhouse effect in Chapter 16).

14.7.2 Ecosystem - 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 (Figure 14.7). Herbivores and other animals obtain this element from plants. The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus. Unlike carbon cycle, there is **no respiratory release of phosphorus into atmosphere**. Can you differentiate between the carbon and the phosphorus cycle?

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

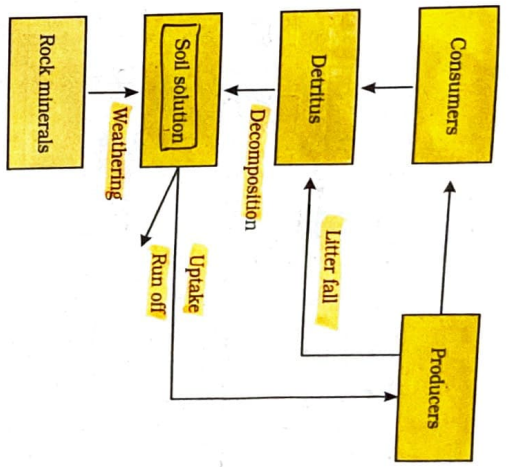


Figure 14.7 A simplified model of phosphorus cycling in a terrestrial ecosystem

exchanges of phosphorus between organism and environment are negligible

14.8 ECOSYSTEM SERVICES

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. Though value of such services of biodiversity is difficult to determine, it seems reasonable to think that biodiversity should carry a hefty price tag. **Robert Constanza and his colleagues** have very recently tried to put price tags on nature's life-support services. Researchers have put an average price tag of **US \$ 33 trillion a year** in these fundamental ecosystem services, which are largely taken for granted because they are free. This is nearly twice the value of the global gross national product GNP which is (US \$ 18 trillion).

Out of the total cost of various ecosystem services, the soil formation accounts for about 50 per cent, and contributions of other services like recreation and nutrient cycling are less than 10 per cent each. The cost of climate regulation and habitat for wildlife are about 6 per cent each.

ECOSYSTEM SERVICES

- Nutrient cycling
- Generate fertile soil
- Provide wildlife habitat.
- Maintain biodiversity
- Pollinating crop
- Provide site of storage of C.

• Soil formation = 50%
 • Recreation < 10%
 • Nutrient cycle < 10%
 • Climate require 6%
 • Habitat for wildlife < 6%
 • Capital for...