# Unit 1 Environmental Science and Ecosystem

## Environment and its components

**Environment**- is derived from the french word *Environner* which means to encircle or surround. Environment means our surroundings. All the biological and non-biological things which surround an organism are included in environment.

According to Environment (Protection) Act 1986, environment is sum total of water, air and land, inter-relationship among themselves and also with the human beings, other living organism and property.

## Types of Environment

It is of two types

1. **Natural Environment**- The natural environmental system operates through self regulating mechanism, called homeostatic environment mechanism, i.e. any change in natural ecosystem brought about by natural process is counter balanced by changes in other component of the environment.

2. **Anthropogenic** or **Man-made Environment**- man is the most powerful environmental agent, spearheaded by modern technologies capable of modifying the environment according to his needs to a great extent. Man made environment includes: technology, transportation, industrial revolution, dam- building.

## Components of Environment

There are two components of environment

- **Biotic component**
- **Abiotic component**

1. Biotic component (living component)- the biotic component of environment consists of flora and fauna, including human being as the important factor. The biotic environment includes the living components of the biosphere. For an organism, the biotic factors constitute all the other organisms with which it comes into regular contact.
   If the relationship exists between organisms of the same species it is known as intraspecific relationship or intraspecific association, while if it takes place between organisms of different species, it is called interespecific relationship or interspecific association.

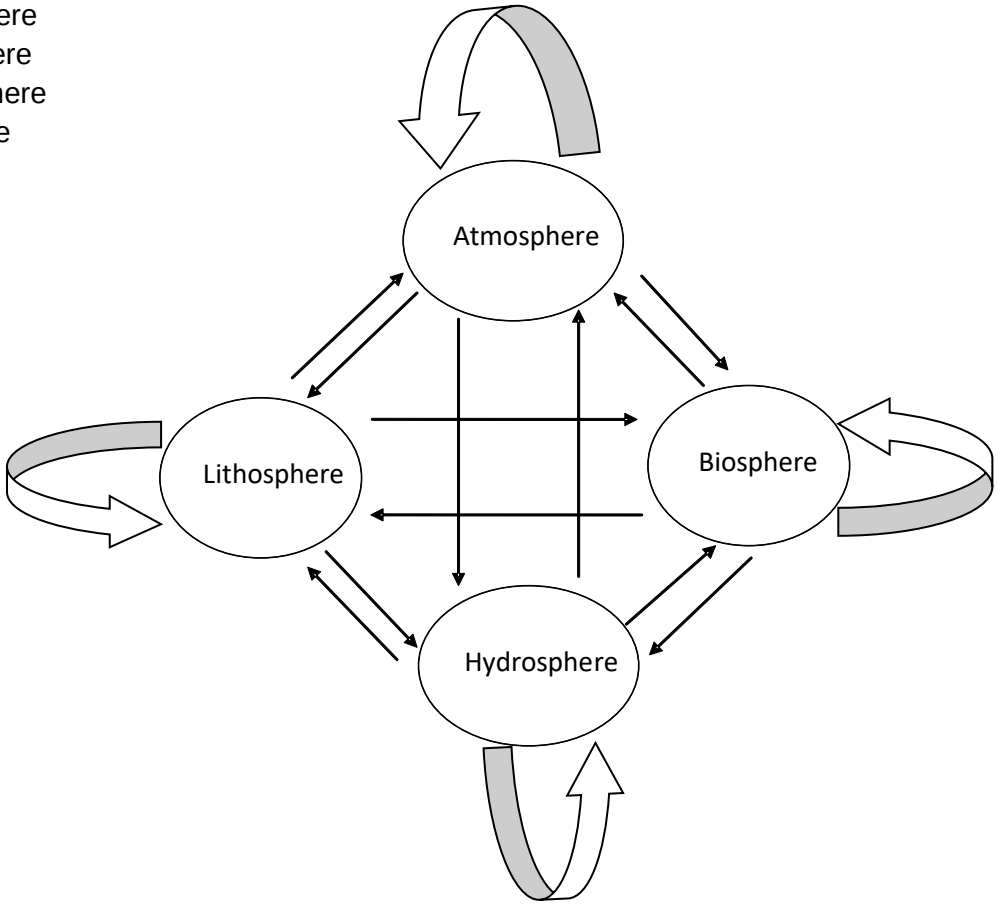
2. Abiotic component (non-living component)- includes all non-living factors. This includes water, air (atmosphere, altitude, pressure, wind, air currents and humidity), soil, temperature, light, topography etc. Lithosphere, hydrosphere and atmosphere come under abiotic component.
   Climatic factors- which includes atmosphere, light, temperature, humidity etc.
   Edaphic factors- which comprises lithosphere or soil.

Topographic factors- which consist of altitude, direction of mountain chains, plains, lakes, rivers, sea level and valleys etc.

**Segments of Environment**

There are four segments of atmosphere

1. Atmosphere
2. Lithosphere
3. Hydrosphere
4. Biosphere




All four segments are interconnected to each other. Above schematic shows the interrelationship between all the four segments of environment. The circle represents the sphere and arrows the flow pathways of matter. Matter may flow from one segment to another in both directions, the matter may also flow within a given compartment from physical location to another without leaving the sphere.

1. **Atmosphere-** the blanket of air that surrounds earth is known as the atmosphere.

Or

The cover of air that envelops the earth is known as the atmosphere.

Atmosphere consists of many gases. The composition of earth's atmosphere is shown in following table

| S. No. | Gas | Relative percentage |
|---|---|---|
| 1 | Nitrogen | 78.08 |
| 2 | Oxygen | 20.95 |
| 3 | Argon | 0.93 |
| 4 | Carbon Dioxide | 0.03 |
| 5 | Neon | 0.0018 |
| 6 | Helium | 0.00052 |
| 7 | Methane | 0.00015 |
| 8 | Krypton | 0.0001 |
| 9 | Hydrogen | 0.00005 |
| 10 | Nitrous oxide | 0.00005 |
| 11 | Xenon | 0.000009 |
| 12 | Ozone | 0.000007 |

Atmosphere also serves many functions. For example,
It absorbs most of the sun's harmful radiations and protects living things from their harmful effects.
Several cycles are also present in the atmosphere that relate to the movement of matter between an organism and its environment. These cycles of matter include the water cycle, the carbon cycle, the nitrogen cycle, the phosphorus cycle and others.

There is no boundary between the atmosphere and the void of outer space. However, 75 percent of the earth's atmosphere lies within 10 miles of the atmosphere and 99 percent lies below an altitude of 30 kms.

In the atmosphere, there are concentric layers of air and each layer has a different density. These layers can be differentiated on the basis of temperature and each layer has its own characteristics. The various layers of atmosphere are troposphere, stratosphere, mesosphere, thermosphere and exosphere.

1. **Troposphere**-

- This atmospheric layer lies closest to the earth's surface and it is the lowest layer of atmosphere in which humans alongwith other organisms live.
- The depth of this layer varies from 8 to 16 kilometers. Greatest depth occur at the trophics where warm temperatures cause expansion of the lower atmosphere. From the tropics to the Earth's polar regions the troposphere becomes gradually thinner. Average depth of the troposphere is approximately 11 kilometers.
- About 80% of the atmosphere's total mass is contained within troposphere, which is characterised by a steady decrease in temperature.
- It is a turbulent, dusty zone, containing much water vapour and clouds and thus the region of strong air movements and cloud formation. Weather occurs in the Earth's troposphere.
- Maximum air temperature also occurs near the earth's surface.
- With increasing height, air temperature drops uniformly with altitude at a rate of approximately 6.5$^{o}$C per kilometre. This phenomenon is commonly called the **Environmental Lapse Rate**.
- Towards the upper levels of troposphere, the temperature decreases upto -56.5 $^{o}$C.

- At the upper edge of the troposphere is a narrow transition zone known as **Tropopause**.

**2. Stratosphere-** above the troposphere is the stratosphere.

- This layer extends from an average altitude of 11 to 50 kilometres above the earth's surface.
- This stratosphere contains about 19.9% of the total mass found in the atmosphere.
- In the first 9 kilometers of the stratosphere, temperature remains constant with height. A zone with constant temperature in the atmosphere is called an **isothermal layer**.
- From an altitude of 20 to 50 kms, temperature increases with an increase in altitude. The higher temperature is found in this region because of a localized concentration of ozone gas molecules. These molecules absorb ultraviolet radiations creating heat energy that warms the stratosphere. This layer of ozone is called **ozone layer**.
- Ozone is formed from oxygen by a photochemical reaction in which energy from the sun decomposes the oxygen molecule into reactive atomic oxygen.
- This ozone layer protects organisms at the earth's atmosphere from ultraviolet radiation. Without the ozone layer life could not exist on the earth's surface.

Above the stratosphere is a narrow transition zone called stratopause.

3. **Mesosphere**-

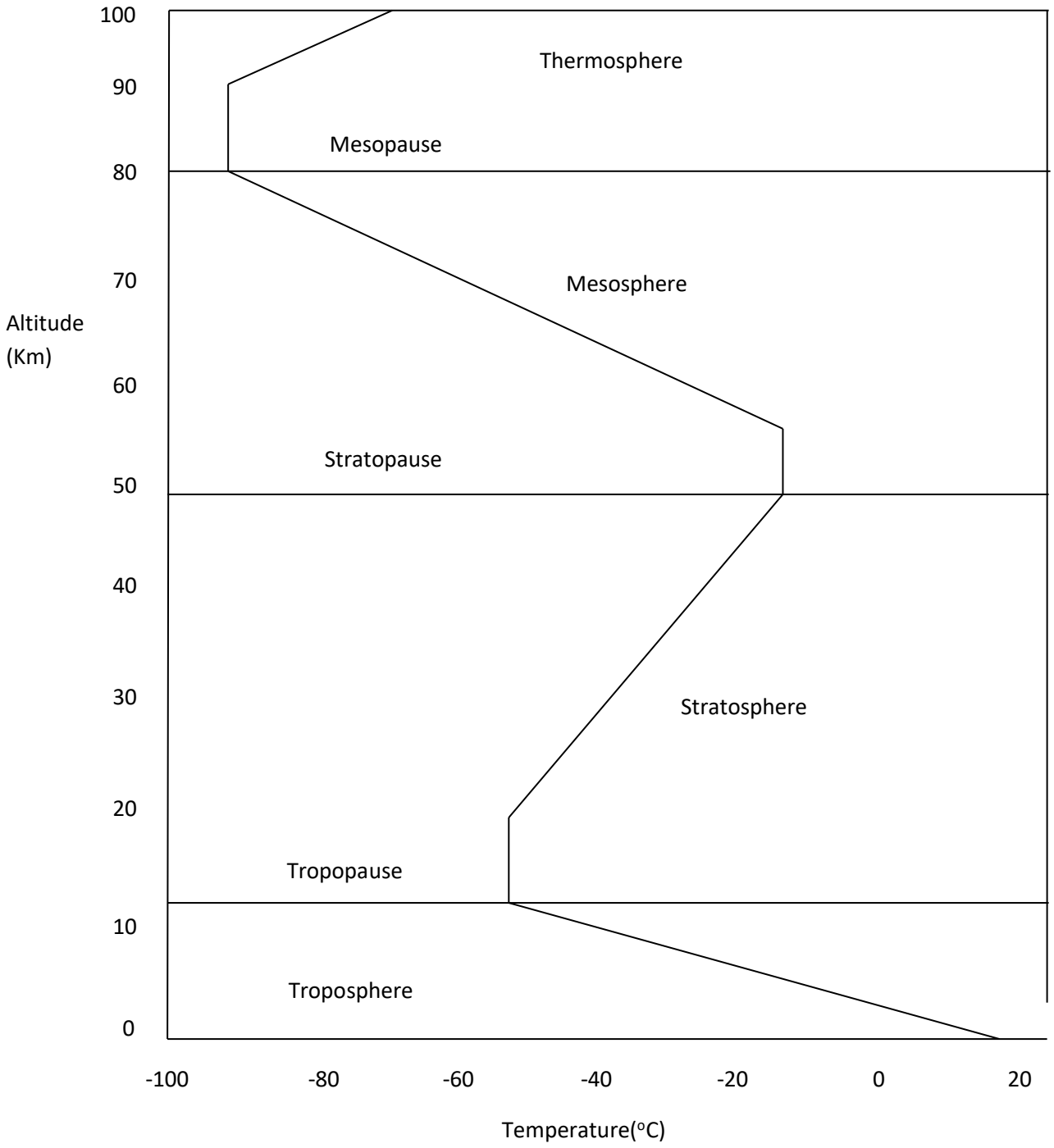
- This layer ranges between an altitude of 50 to 80 kilometers.
- Atmosphere reaches its coldest temperature (-90$^{o}$C) at a height of approximately 80 kms from earth surface.
- It is the layer where most of the meteors burn up.
- At the top of mesosphere is another transition zone called Mesopause.

**4. Thermosphere or Ionosphere**

- This layer of atmosphere ranges from 80 kms to 500 kms above the earth surface.
- Temperature increases with height in thermosphere and reaches upto 1200 $^{o}$C.
- Ionosphere contains electrically charged particles called ions. It consists of ionized gaseous components such as $O_2^+$,$O^+$, $NO^+$.
- These particles reflect radio waves back to the earth surface thus enables us to have wireless communication.

**5. Exosphere**

- This is the uppermost layer. This region is also called the outer space.
- This layer is extended to an altitude of 1600 kms.
- It contains $H^+$ and $He^{++}$ and has very high temperatures due to solar radiations.

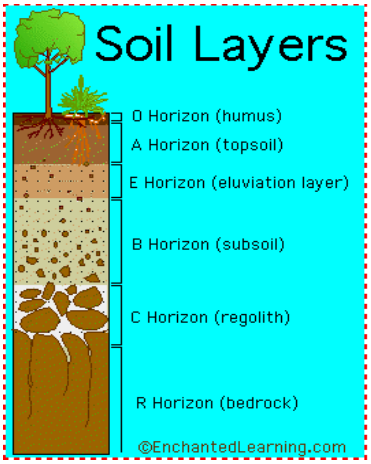


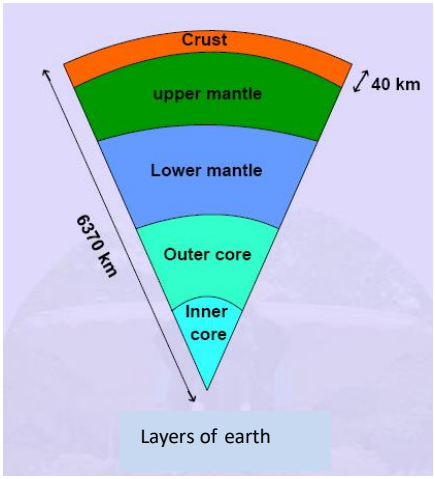

**2. Lithosphere**-

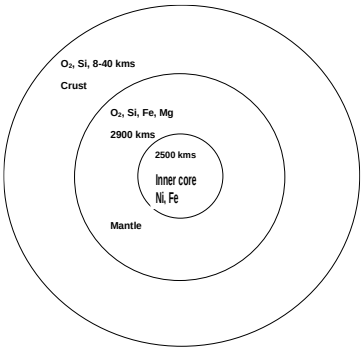
Lithosphere is composed of soil particles, and underlying rocks down to depth of 50 kms. The soil layer is also termed as pedosphere.

Lithosphere contains cold hard solid land of earth's crust(surface), the semisolid land underneath the crust, and liquid land near the centre of the earth.

Pedosphere contains mixture of inorganic and organic solid matter, air, water and microorganisms.
Outermost layer of lithosphere consists of loose soil rich in nutrients, oxygen and silicon.
Beneath this layer lies a very thin solid crust of oxygen and silicon.
Next is a thick, semisolid mantle consists of oxygen, silicon, iron and magnesium.
Below this layer is a liquid outer core of nickel and iron.
At the centre of earth is a solid inner core of nickel and iron.




Layers of soil

O Horizon - The top, organic layer of soil, made up mostly of leaf litter and humus (decomposed organic matter).

A Horizon - The layer called topsoil; it is found below the O horizon and above the E horizon. Seeds germinate and plant roots grow in this dark-colored layer. It is made up of humus (decomposed organic matter) mixed with mineral particles.

E Horizon - This eluviation (leaching) layer is light in color; this layer is beneath the A Horizon and above the B Horizon. It is made up mostly of sand and silt, having lost most of its minerals and clay as water drips through the soil (in the process of eluviation).

B Horizon - Also called the subsoil - this layer is beneath the E Horizon and above the C Horizon. It contains clay and mineral deposits (like iron, aluminum oxides, and calcium carbonate) that it receives from layers above it when mineralized water drips from the soil above.

C Horizon - Also called regolith: the layer beneath the B Horizon and above the R Horizon. It consists of slightly broken-up bedrock. Plant roots do not penetrate into this layer; very little organic material is found in this layer.

R Horizon - The unweathered rock (bedrock) layer that is beneath all the other layers.

**3. Hydosphere**-

Hydrosphere is composed of all the water on or near the earth. It includes, oceans, lakes, rivers, and moisture in air. It ranges from 10-20 km in thickness.

Hydrosphere extends from earth's surface downward several kilometers into lithosphere and upward around 12 kms into the atmosphere.

The hydrosphere can be divided into 2 compartments. First A conveyer, a river which collects the substance within the watershed and delivers them to second hydrologic compartment, Oceans.

Hydrosphere covers approx. 71% area of earth. 97.5% of earth water is salty and is placed Oceans.

96.5% as salty water

2.5% as fresh water

0.93% as saline ground water

0.07% as saline lakes.

Out of this 2.5% fresh water:

68.6% exists as snow in glaciers and ice caps.

30.1% as ground water. (0.75% of total earth water)

1.3% exists as surface water and other fresh water.

Now this 1.3% surface water can further be categorized as:

73.1% as ice and snow

20.1% as Lakes.

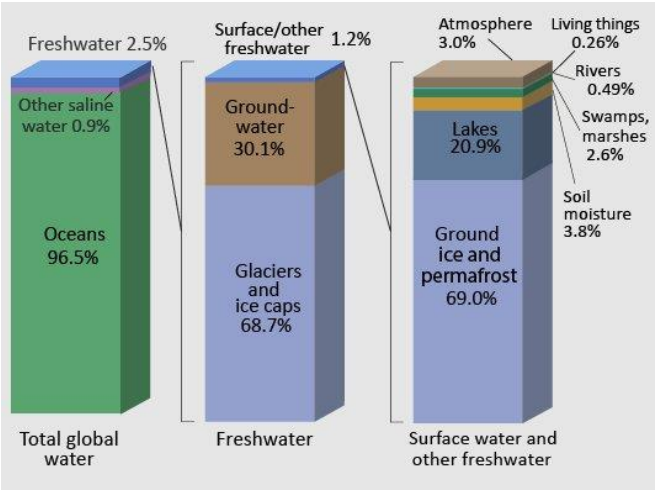
3.52 % as soil moisture.

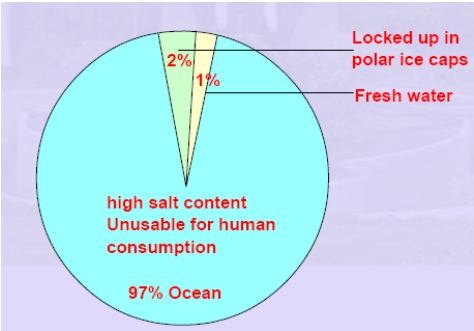
2.53% as Swamp and marshes.

0.46% as Rivers

0.22% Biological water

0.22% as atmospheric water.





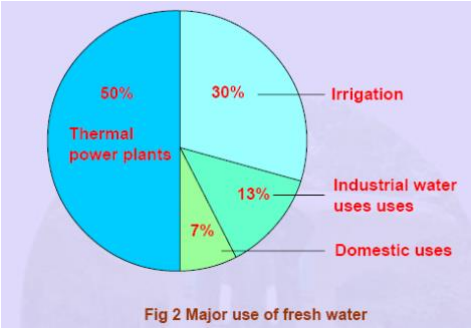




Fig 2 Major use of fresh water

**4. Biosphere-**

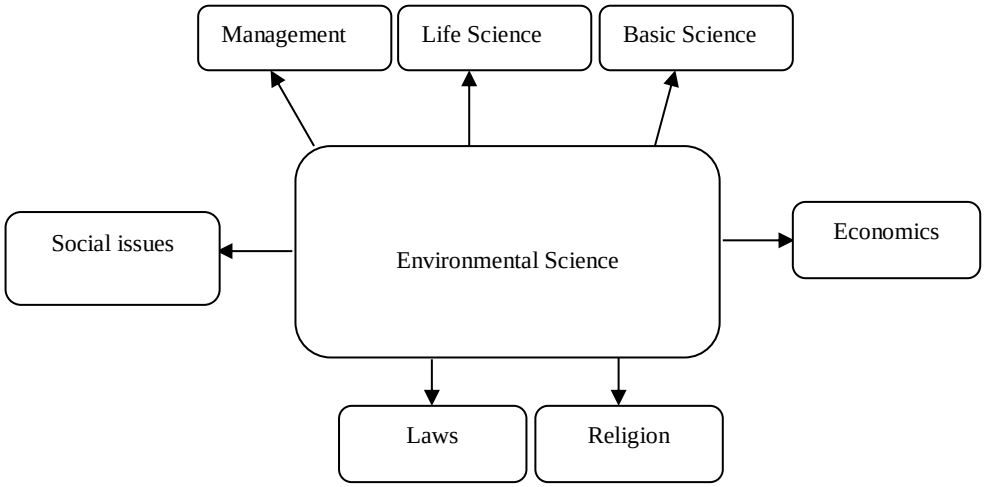
- This term was first used by Eduard Suess.
- It is composed of all living organisms. Plants, animals and one celled organisms are all part of the biosphere.
- The life is found from three meters below the ground to thirty meters above it and in the top 200 meters of the oceans and seas.
- Living things form ecological communities based on the physical surroundings of an area. These communities are referred to as biomes. Examples of biomes are deserts, grasslands etc.
- It occupies the least volume of all the spheres but maximum flow of matter takes place in this segment.
- The biosphere is responsible for the grand scale recycling of energy and matter on earth.
- Ecosystems operate in this part of the earth.

**Environmental Science**

The systematic study of environment and our interaction with it is known as **environmental science**.

**Environmental science** is multidisciplinary in nature. It deals with all aspects of life that is related to us in any way. It is not a single subject but it has the characteristics of various disciplines of life science (botany, zoology, biochemistry, microbiology, biotechnology and genetics). It also interacts with basic science (physics, chemistry, mathematics) and some aspects of life such as economics, management, religion, laws and social issues.

Environmental science incorporates information and ideas from multiple disciplines. By combining aspects of the natural sciences, social sciences, and the humanities, the field of environmental science can cover more concepts and also examine problems and topics from many different points of view.



**Environmental education** is the education through environment, about the environment and for the environment. Environmental education has long been defined to include three critical components: awareness, leading to understanding, which in turn creates the potential and capacity for appropriate actions. Environmental education includes:

- Developing personal awareness of the environment and one's connections to it.
- Developing an understanding of environmental concepts and knowledge of ecological, scientific, social, political, and economic systems.
- The capacity to act responsibly upon what a person feels and knows, in order to implement the best solutions to environmental problems.

**Objectives of Environmental Education**

The world's first Inter-governmental Conference on Environmental Education organised by UNESCO was held in Tbilisi, Georgia (USSR) in 1977. Most environmental educators have since universally adopted these objectives.

- Awareness and sensitivity about the environment and environmental challenges.
- Knowledge and understanding about the environment and environmental challenges.
- Attitude concern for the environment and help to maintain environmental quality.
- Skills to mitigate the environmental problems.
- Participation for exercising existing knowledge and environmental related programs.

**Importance of Environmental Education**

- Environmental education helps in economy and welfare of human society.
- It helps us in solving different issues like pollution measures, over exploitation of natural resources, food problems and sustainable development.
- Environmental education helps us in finding ways to maintain ecological balance.
- As industrialization is increasing and new technologies are growing , to conserve and protect the environment we need ecofriendly products and methods, it can be achieved only through proper knowledge of environment.
- Environmental education trains us to conserve our fast depleting natural resources.
- It helps to understand different food chains and the ecological balance in nature.
- It helps in encouraging environmental protection, inculcating attitude and values and understanding of inter-dependence of nature and man.

**Scope of Environmental Education**

- Natural Resources- their conservation and management
- Ecology
- Biodiversity and its conservation
- Environmental pollution and control
- Natural disasters
- Social issues in relation to development and environment
- Human population and environment

**Ecology and Ecosystem**

**Ecology**- deals with the study of relationship between organisms and between the organism and the environment is known as ecology.

**Ecosystem**- The term ecosystem was proposed by A.G. Tansley in 1935.

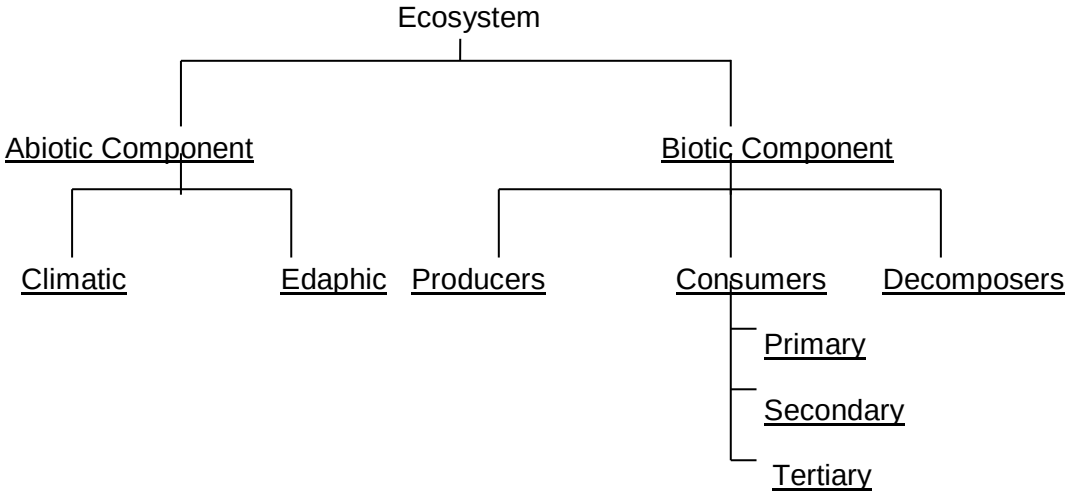
It includes a group of biotic communities of species interacting with one another in an area and their surroundings, in which they interact with each other and exchange energy and matter.

or

Ecosystem is a dynamic entity composed of a biological community and its associated abiotic environment.

The part of the earth where these ecosystems operate is called the **Biosphere**.

**Structure of an ecosystem**



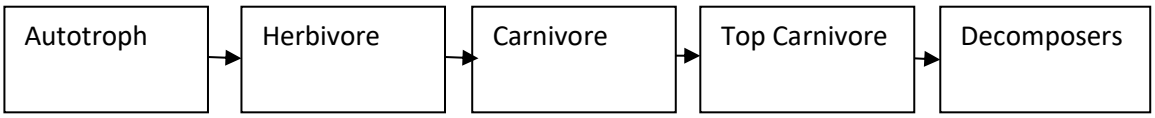

The functional unit of the ecosystem consists of two distinct structural components or factors namely biotic and abiotic components.

Abiotic components or non-living environmental factors are

**Climatic factors**- it is the weather characteristic of a given place which depends on various factors like temperature, light, humidity, wind, velocity and atmospheric gases etc.
**Edaphic factors**- it includes chemical and physical characteristics of the soil.

The **biotic component** of an ecosystem consists of all living components of the environment such as plants, animals, human beings and microbes. All living organisms of our environment can be further categorized depending on their self- food producing capability.

They can be categorized as autotrophic component or producers and heterotrophic component or consumers.




Producer Primary consumer Secondary consumer Tertiary consumer

Autotrophic component or Producer- includes all those organisms like green plants, bacteria and algae which contain chlorophyll and are capable of converting solar energy into chemical energy and storing foodstuff in the presence of $CO_2$ and $H_2O$.
$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

Heterotrophic component or consumer- organisms which cannot convert solar energy into food and depend on autotrophs to obtain their energy for survival, are called consumers or heterotrophs. Heterotrophs utilize, rearrange and decompose the complex material produced by autotrophs. Depending upon their feeding habits, the heterotrophs are classified as follows:

Primary consumers- organisms or animals, which feed on green plants to obtain energy for survival are called primary consumers or herbivores. Example cows, goat.

Secondary consumers- animals which feed on herbivores are known as secondary consumers. Example frog, lizards.

Tertiary consumers- are those that eat the flesh of secondary consumers. Example tiger, lion, vultures. Since they are not killed and eaten by other animals they are known as top carnivores.

Decomposers or saprophytes- Plants and animals supply organic matter to the soil system though shed tissues and death. Consumer organisms that feed on this organic matter are known as decomposers. Decomposers play the vital role of releasing essential materials from the dead organic matter or the plant, therby maintaining a continuous cycle of materials.

**Food chain** –is the sequence of who eats whom in a biological community to obtain nutrients and energy. or

The sequence of feeding relationships in an ecosystem is called food chain.

or

The sequential inter-linking of organisms involving the transfer of food energy from the producers through a series of organisms with repeated eating and being eaten is referred to as the food chain.

A food chain is always straight and proceeds in a progressive straight line. Each organism in an ecosystem is assigned a feed level or trophic level.

**Types of food chain**

1. **Grazing food chain-** it starts from green plants and goes from herbivores to carnivores and so on. Example

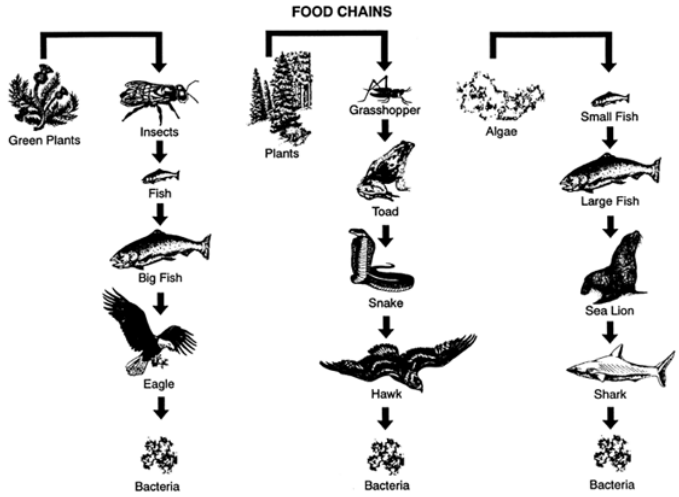
Grass ⟶ Insects ⟶ Frog ⟶ Snake ⟶ Eagle

2. **Detritus food chain-** the dead organic matter of plant and animal is called detritus. Many animals such as protozoas, nematodes, insects etc., eat detritus hence they are called deterivores. The chain proceeds to Detritus, Deterivores, Carnivores and Top Carnivores.

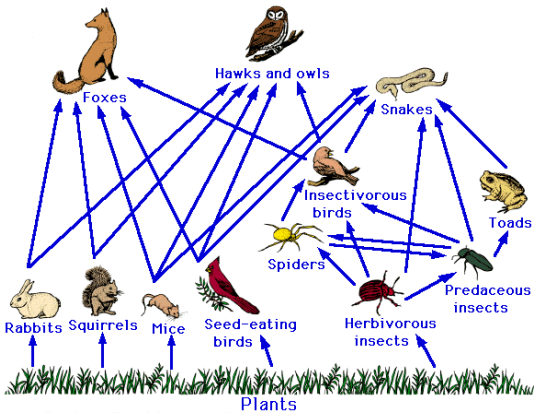
Detritus ⟶ Deterivores ⟶ Carnivores ⟶ Top Carnivores

3. **Parasitic food chain-** they also start from green plants and then herbivores then proceeds to parasites and finally hyperparasites. They process from larger to smaller organisms.

Green Plants ⟶ Herbivores ⟶ Parasites ⟶ Hyperparasites



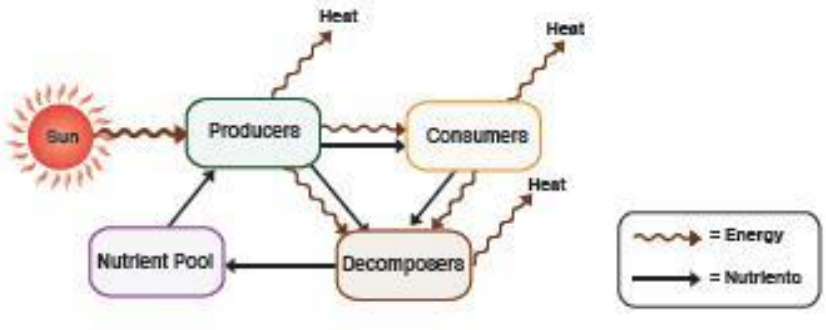

**Food Web-** is a network of food chains which become interconnected at various trophic levels so as to form a number of feeding connections amongst different organisms of a biotic community. These are never straight.



**Significance of food chain:**

1. Food chain maintain energy flow and nutrient cycling.
2. Food chain maintains ecological balance by regulating population size
3. Food chain biologically magnify toxicity of harmful chemicals.

**Energy and nutrient flow in an ecosystem**



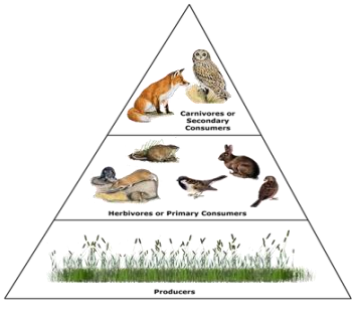

Both energy and nutrients are passed along a food chain. While energy is eventually lost to heat, nutrients are constantly being recycled. Energy flow is unidirectional whereas nutrient flow is cyclic.

Sunlight is converted into energy as glucose by a process called photosynthesis and stored in plants. As first level consumers eat plants this stored energy is transferred through carbon-carbon bonds which release energy when they are broken. During respiration the bonds are broken and carbon combines with oxygen to form carbon dioxide. The energy that is released is used by the organism or is lost as heat. Ultimately all energy in a food chain returns to the system as heat. On an average about 10% of net energy production at one trophic level is passed on to the next level. Processes that reduce the energy transferred between trophic levels include respiration, growth, and reproduction, defection and non-predatory death.

plant --> eaten by animal --> carbohydrates digested into glucose --> respiration --> energy for cell processes

Some of the carbohydrates digested into glucose will be converted into other substances, such as fats.

The other component that travels through a food chain is inorganic nutrients, which do not contain carbon-carbon bonding. These include phosphorous, cellular membranes, nitrogen and iron. The movement of these substances comes from an inorganic nutrient pool, usually the soil or water surrounding plants or algae. They are absorbed by the plants and passed from organism to organism as they are consumed. When the organism dies the nutrients are recycled as they are decomposed and become available for plants as the cycle continues.

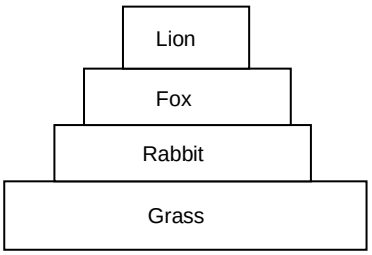


**Ecological Pyramid-** Charles Elton in 1927 gave the idea of ecological pyramids. An ecological pyramid may be defined as graphical representation of trophic structure and function of an ecosystem i.e. these are the graphical representation of the numbers or biomass or status of accumulated energy at different trophic levels in a food chain in an ecosystem. Ecological pyramids begin with producers at the bottom (such as plants) and proceed through the various trophic levels (such as herbivores, carnivores then next level carnivores and so on). They can be upright or inverted.

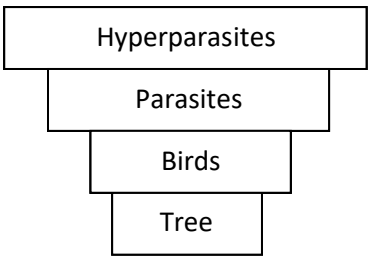
These are of three types-

1. Pyramid of number- is a graphical representation showing the arrangement of number of individuals per unit area at different trophic level of a food chain in an ecosystem. It can be upright or inverted. An aquatic ecosystem is an example of upright pyramid where the number of organisms becomes fewer and fewer higher up in the pyramid. An inverted pyramid of numbers is one where the number of organisms depending on the lower levels grows closer toward the apex. A parasitic food chain is an example.

   *Upright pyramid of number*
   *Example- grassland ecosystem*

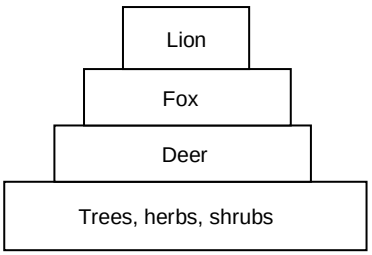



   Inverted pyramid of number
   Example- Tree ecosystem

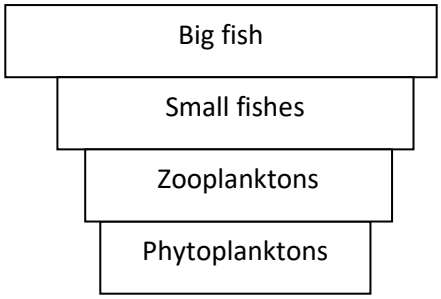



2. Pyramid of biomass- is a graphical representation of biomass (total amount of living or organic matter in an ecosystem at any time) present per unit area in different trophic levels. It can be upright or inverted. An upright pyramid is one where the combined weight of producers is larger than the combined weight of consumers. An example is a forest ecosystem. An inverted pyramid is one where the combined weight of producers is smaller than the combined weight of consumers. An example is an aquatic ecosystem.

   Upright pyramid of biomass
   Example- Forest ecosystem

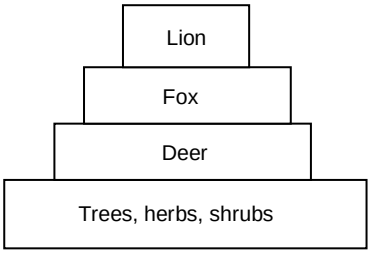


Inverted pyramid of biomass
Example- Pond ecosystem




3. Pyramid of energy- is a graphical representation of amount of energy per unit area at different trophic levels of a food chain. This pyramid is always upright as there is gradual decrease in energy at successive trophic levels.

Pyramid of energy
Example- Forest ecosystem




**Biogeochemical cycle**- the circulation of chemical nutrients like carbon, oxygen, nitrogen, phosphorus, calcium, and water etc. through the biological and physical world are known as biogeochemical cycles. In effect, the element is recycled, although in some cycles there may be places (called *reservoirs*) where the element is accumulated or held for a long period of time.

Or

It is a pathway by which a chemical element or molecule moves through both biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) compartments of earth. A cycle is a series of change which comes back to the starting point and which can be repeated.

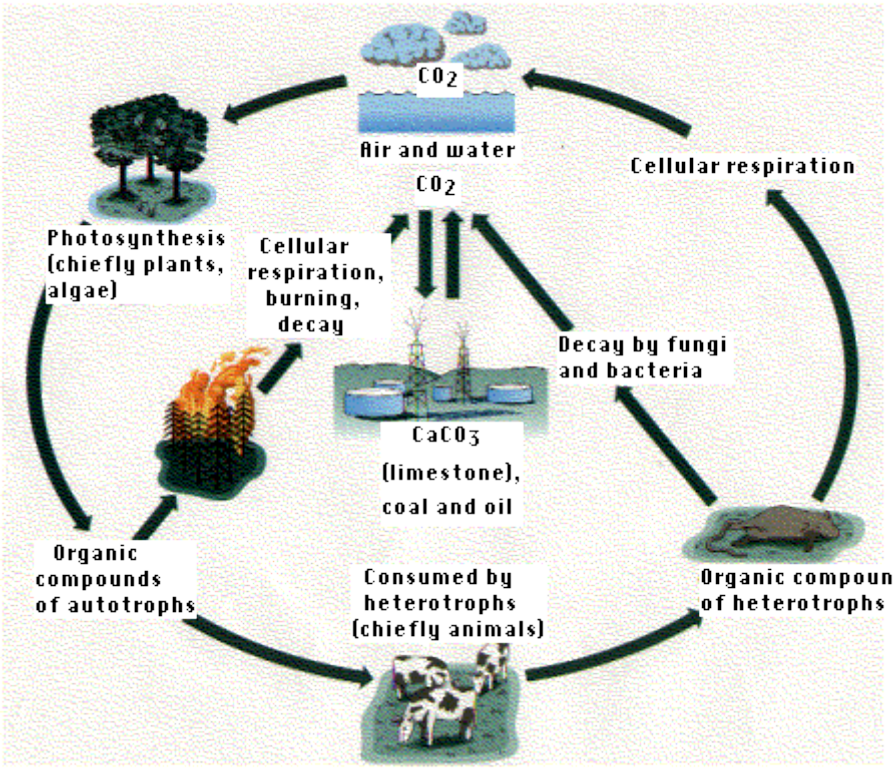
The term “biogeochemical” tells us that biological, geological and chemical factors are all involved.

1. **Carbon Cycle**

Carbon is an element. It is part of oceans,air, rocks, soil and all living things. Carbon doesn’t stay in one place.

- **Carbon moves from the atmosphere to plants**.
  In the atmosphere, carbon is attached to oxygen in a gas called carbon dioxide ($CO_2$). With the help of the Sun, through the process of photosynthesis, carbon dioxide is pulled from the air to make plant food from carbon.
- **Carbon moves from plants to animals**.
  Through food chains, the carbon that is in plants moves to the animals that eat them. Animals that eat other animals get the carbon from their food too.

- **Carbon moves from plants and animals to the ground**.
  When plants and animals die, their bodies, wood and leaves decay bringing the carbon into the ground. Some become buried miles underground and will become fossil fuels in millions and millions of years.



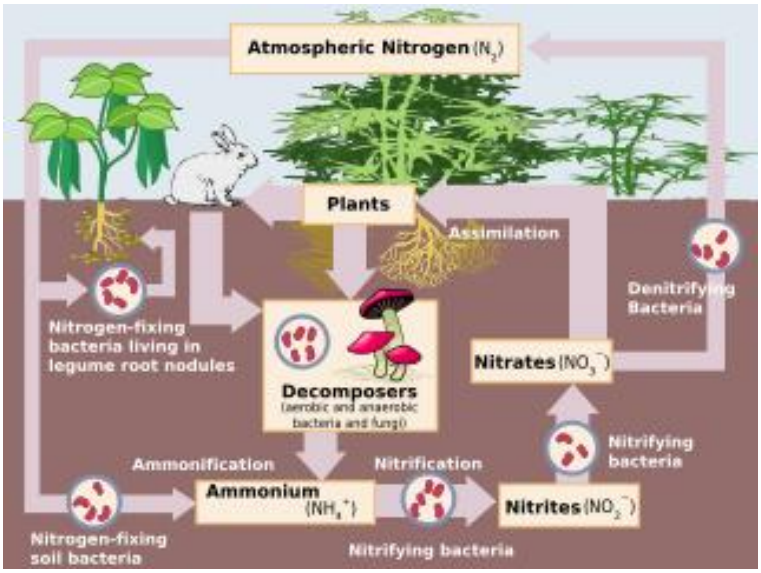

2. **Nitrogen cycle**

The nitrogen cycle is the process by which nitrogen is converted between its various chemical forms. This transformation can be carried out through both biological and physical processes.

Important processes in the nitrogen cycle include fixation, ammonification, nitrification, and denitrification.

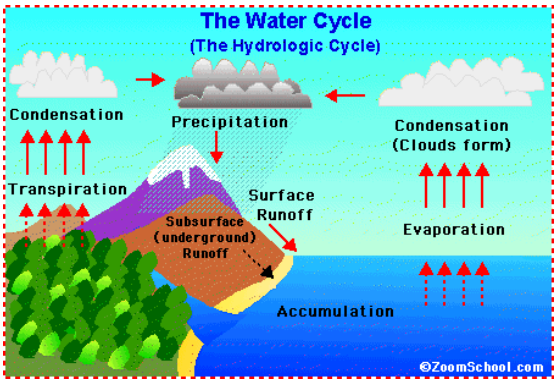
- Nitrogen is inert and cannot be directly utilized by most of the living organisms. The conversion of nitrogen ($N_2$) from the atmosphere into a form readily available to plants and hence to animals is an important step in the nitrogen cycle, which distributes the supply of this essential nutrient.
- The elemental nitrogen is converted into usable forms by the process of nitrogen fixation and added to the soil.
- Nitrogen fixation is possible by the activity of lightening and nitrogen fixing bacteria.
- Plants obtain their nitrogen supply from the soil and convert them into essential biomolecules. Animals obtain their nitrogen requirements from plants.
- After the death of plants and animals nitrogen compounds again reach to the soil.

- The nitrogenous organic compounds in the soil undergo microbial decomposition by the process of ammonification and nitrification.
- The compounds are again absorbed by the plant root or get converted into free nitrogen through denitrification process.
- The conversion of ammonia to nitrites is performed by nitrosomonas bacteria. While other bacterial species, such as nitrobacter are responsible for the oxidation of nitrites into nitrates.
- Nitrates are reduced back to nitrogen gas by the process of denitrification. This process is performed by bacterial species such as pseudomonas.



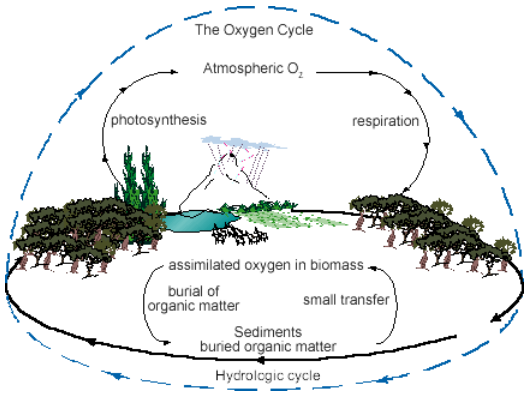

**Water cycle**

- Water from the transpiring plants, oceans, rivers and lakes evaporates into the atmosphere.
- These water vapours cool and condense to form clouds and water.
- Water precipitates back as rain and snow to the earth.




**Oxygen cycle**

- The oxygen cycle is the cycle that helps move oxygen through the three main regions of the Earth, the Atmosphere, the Biosphere, and the Lithosphere.
- The Atmosphere is the region of gases that lies above the Earth's surface and it is one of the largest reservoirs of free oxygen on earth.
- The Biosphere is the sum of all the Earth's ecosystems. This also has some free oxygen produced from photosynthesis and other life processes.
- In the biosphere the main cycles are respiration and photosynthesis. Respiration is when animals and humans breathe consuming oxygen to be used in metabolic process and exhaling carbon dioxide. Photosynthesis is the reverse of this process and is mainly done by plants and plankton.
- Photolysis takes place in atmosphere through which oxygen is formed in the atmosphere.
- The largest reservoir of oxygen is the lithosphere. Most of this oxygen is not on its own or free moving but part of chemical compounds such as silicates and oxides. Most of the time the process is automatic all it takes is a pure form of an element coming in contact with oxygen such as what happens when iron rusts. A portion of oxygen is freed by chemical weathering. When a oxygen bearing mineral is exposed to the elements a chemical reaction occurs that wears it down and in the process produces free oxygen.




## Ecological Succession

The systematic and orderly development of series of biotic communities one after the other in the same area till permanent and most stable community, the climax community can be obtained.

The first community to invade any area is called as **pioneer** community which show very little diversity. As the number of organisms grows they use water and nutrients from the substratum, have a strong influence on the environment and in turn are modified by the environment. Such modifications make the existing community unable to adopt in changed conditions and are replaced by several transition communities called as **seral** communities. These seral communities ultimately reaches to most stable community called as **climax** which shows diversity and persists till other natural calamity occurs.

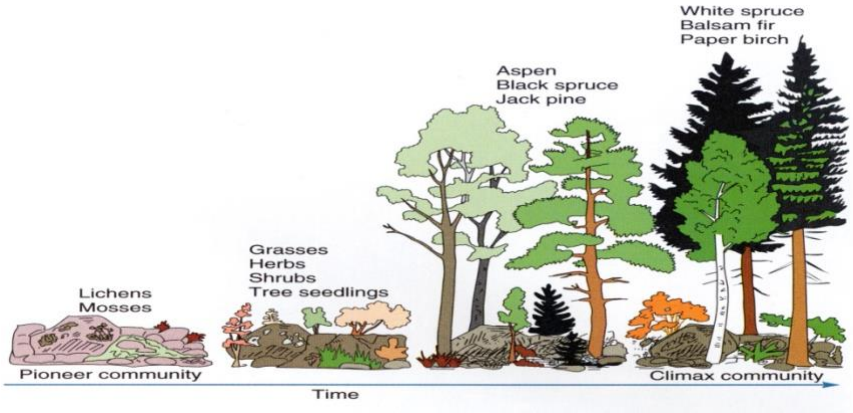
### Causes of Ecological Succession

1. **Biotic factor-** overgrazing of animals, humans destroying natural resources
2. **Climatic factor-** wind, snowfall, hail, drought, flood

3. **Physiographic factor-** erosion in hills, filling up of lakes or streams with silt, forest fires, landslide etc

### Types of Ecological succession

**Primary succession** – takes place in barren unhabitat area which has not been occupied by any earlier living community. For example area exposed by retreating glacier, lava deposit, newly formed pond, flood plains. Its development takes a very long time.

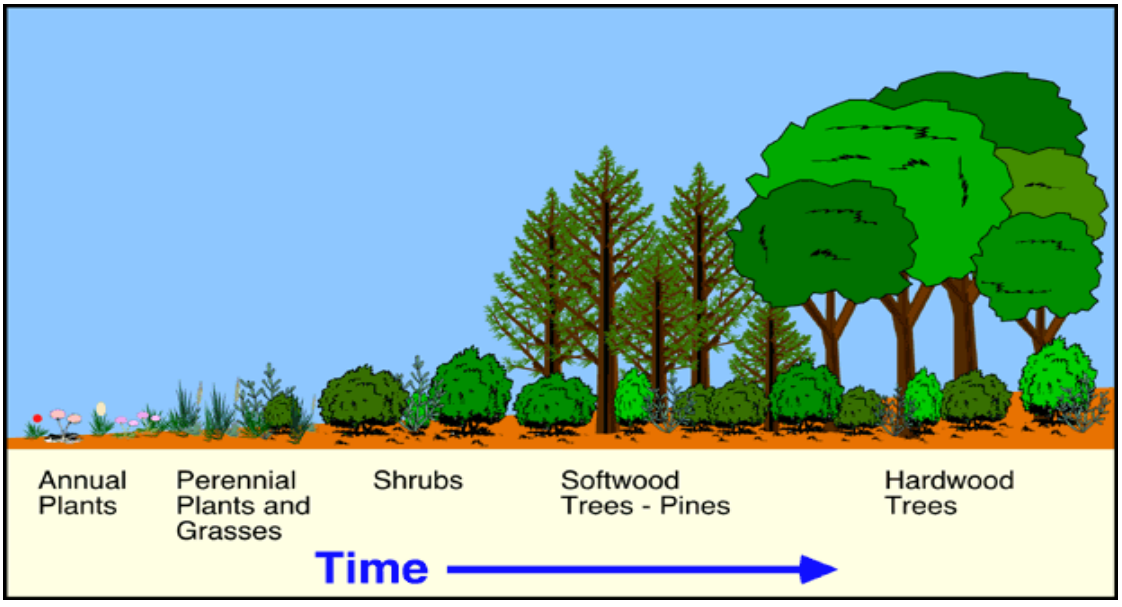



**Primary Succession**

**Secondary succession**- takes place in the previously occupied area but somehow this area got disturbed. For example forest fire, deforestation, overgrazing. This process of succession is comparatively easier as some form of life may exist which makes the process of succession comparatively smooth.

or

It occurs when an area that has previously had an ecological community is so disturbed or changed that the original community was destroyed, and a new community moves in. This is more common than primary succession and is often the result of natural disasters such as fires, floods, and winds, as well as human interference.




Succession can be on the basis of moisture content in environment. They can be

1. Hydrosere- succession starts in regions where water is in plenty like pond, lake, streams, swamp.
2. Xerosere- succession starts in a dry area with little moisture. They can be of following type
    a. Lithosere- succession starts on bare rock
    b. Prammosere- succession starts on sand
    c. Halosere- succession starts in saline water or soil

**Process of succession-**
The whole process of primary succession is actually completed through a number of sequential steps, which follow one another. These steps in sequence are as follows

1. **Nudation**- this is the development of a bare area without any form of life. The area may develop because of several causes such as landslide, erosion, deposition etc.

2. **Invasion**- this is the successful establishment of one or more species in a bare area through dispersal or migration followed by species establishment. The species actually reaches this new site from any other area.

3. **Competition and coaction**- after invasion of a large number of individuals of the species at the limited place, there develops competition (inter as well as intraspecific) mainly for space and nutrition. Individuals of a species affect each others life in various ways and this is called coaction. The species unable to compete with other species would be discarded.

4. **Reaction**- The living organisms grow, use water and nutrients from the substratum and in turn they have a strong influence on the environment, which is modified to a large extent. The existing community is replaced by another community. The sequence of communities that replaces one another in the given area is called a sere. The pioneers are likely to have low- nutrient requirements, more dynamic and able to take minerals in comparatively more complex forms.

5. **Stabilization**- After complete or partial disturbance vegetation grows back towards a mature stage “Climax stage” which is in equilibrium with the environment and is not replaced.

**Importance of Succession**

1. It provides information, which helps to have a controlled growth of one or more species in a forest by preventing the invasion of other species in the area.
2. Pastures can be maintained by not allowing biotic succession to proceed through grazing or fire.
3. It also helps in reforestation and forest management programmes.

**Types of ecosystem**
**Natural Ecosystem**

1. **Marine ecosystem-** all the saline water reservoirs on earth such as the seas, oceans, and estuaries with their characteristic biome form the marine ecosystem.
2. **Freshwater ecosystem-** ponds streams, rivers and lakes along with their flora and fauna form the freshwater ecosystem.

3. **Terrestrial ecosystem-** it includes desert ecosystem, grassland ecosystem, tree ecosystem, crop fields, forest ecosystem and so on.

**Man- engineered Ecosystem**-

Agriculture and aquaculture systems are man-engineered ecosystems. These ecosystems have all the essential components such as producers, consumers, decomposers and abiotic materials. This is a monoculture system as a single crop is grown.

Natural ecosystems are polycultural systems and therefore they are more stable compared to man-made ecosystems which are fragile and highly productive and generate lots of pollutants.

## 1. Forest Ecosystem

Forests occupy roughly 40% of the total land. In India about l/10th of the total area is under forests. The different types of forest ecosystems can be broken down into categories based on the types of trees and other flora that grow within them.

1. **Tropical evergreen forest**: Tropical forests that are characterized by high annual rainfall rates and dense vegetation, including tall trees at differing heights for sheltering different types of animals.
2. **Tropical deciduous forest:** Characterized by a broad variety of shrubs, dense bushes, and different types of trees.
3. **Temperate evergreen forest:** Characterized by few trees but many mosses and ferns to make up for the lack of trees.
4. **Temperate deciduous forest:** Located in places with high annual rainfall; trees are characterized by their yearly cycles of leaf-shedding during the winter months.
5. **Taiga:** These forests are situated below the arctic regions and are characterized by the presence of evergreen conifers and are home to migratory birds and insects for half the year.

Forests occupy 31% of the total land. In India about l/10th of the total area is under forests. The chief components of a forest ecosystem are as follows—

**1. Abiotic components:**

In addition to minerals present in the soil, the forest floor is rich in dead and decaying organic matter.

**2. Biotic components:** it consists of

**Primary producers:**

The dominant producers of the forest ecosystem are the higher forms of the plant kingdom, most specifically seed bearing plants. In forest ecosystem, the producers form three major functions. First, they provide the initial source of food. Second, large plant structures provide habitats for other organisms. Third, they are prime agents in soil formation and in modifying the abiotic environment.

The forest ecosystem is directly dependent upon the kinds and number of plants present. The plants are mainly trees, some shrubs and ground vegetation. The evergreen tropical

forests have broad leaved trees with irregular leaf fall. The temperate deciduous forests are dominated by pines with needle-like leaves. At the lower level of such forests are found only shade tolerant plants such as ferns and shrubs. The other forms of tropical evergreen forests are the vines and the epiphytes.

**Primary consumers:**
These are the herbivores that include the foliage arthropods such as ants, flies, beetles, leaf-hoppers, bugs and spiders, etc. and the larger animals grazing on shoots and fruits such as elephants, nilgai, deer, moles, squirrels, shrews, flying foxes, fruit bats and mongooses, etc.
**Secondary consumers:**
These are the carnivores like snakes, birds, lizards and foxes feeding on herbivores. The top carnivores like lion, tiger, etc, prey upon both herbivores and carnivores of the secondary consumer level.
**Decomposers:**
The decomposers of the forest ecosystem, as in other ecosystem, are the bacteria and fungi. These organisms obtain energy to carry on the life functions by breaking down the organic compounds of dead organic matter and organic wastes. In doing so, they prevent the accumulation of organic matter and also release the essential minerals for reuse. Decomposers are mostly found in soil and bacteria are represented by the numerous heterotrophic.

## 2. The Desert Ecosystem:

The deserts occupy about 17% of the land and occur in the regions with an average rainfall of less than 23 cm. Due to extreme of temperature, the species composition of desert ecosystem is less varied and typical. There are two types of deserts: **temperate, or cold**, and **subtropical, or hot**, which gives deserts more than one type of ecosystem. There are similarities as both get less than 10 inches of rain a year, and the air is generally dry in both types of biomes. The lack of water in either type of desert makes them harsh for people or creatures living there.

The differences in the two types of deserts are as numerous as the similarities. The temperate deserts, like Antarctica, are cold. The temperatures in these areas can become cold enough to kill a person. Animals that live in these deserts have physically adapted through the years to be able to survive the cold by having extra layers of fat, or needing less energy and food to survive. The animals that live in the subtropical deserts have the opposite adaptations. Those animals have adapted to handle higher heats and strong sun.

The plants and animals in both deserts have to adapt to survive on less water than those that live in other biomes. Many of the animals that live in the subtropical deserts have also adapted to become nocturnal so that they can avoid the higher heats of the day. This also means that these nocturnal animals have to adapt to the cooler night time temperatures of the desert.

The various components of a desert ecosystem are—

**Producers:**
The shrubs, bushes, grasses and some trees are the main producers in deserts. The shrubs have extensive and much branched root system with the stems and leaves variously modified. Some succulent cacti are also found in deserts. These store water in their stem to be used during the time of water scarcity. Some lower plants such as lichens, xerophytic mosses and blue green algae are also found there.

**Consumers:**
Only a few animals are found in deserts. The most common animals are those reptiles and insects which are able to live under xeric conditions. Mammals are represented by a few species of nocturnal rodents. Some birds are present. The camel, called the ship of desert, feeds on tender shoots of the plants and conserves large quantities of water in its stomach. The larger animals including carnivores are scarce. The desert animals have various morphological and physiological adaptations which enable them to live in such extreme environment.

**Decomposers:**
Due to poor vegetation and less amount of dead organic matter decomposers are few. They are thermophilic fungi and bacteria.

## 3. Grassland Ecosystem

Grasslands (also called Greenswards) are areas where the vegetation is dominated by grasses and other herbaceous (non-woody) plants. Grassland consists of large rolling fields of grasses, flowers and herbs. Grasslands ecosystems emerge due to low levels of sporadic precipitation that is only substantial enough to support smaller plants. Grass survives in these arid conditions because of its deep and highly elaborate root system that enables it to access moisture hidden deep in the soil. There are two main types of grasslands -- tropical and temperate -- with several subcategories within each type. Grasslands occupy about 24% of the earth's surface. They occur in regions too dry for forests and too moist for deserts. The annual rainfall ranges between 25- 75 cm, usually seasonal. The principal grasslands includes Prairies (Canada, USA), Pampas (South America), Steppes (Europe and Asia), and Veldts (Africa).
Grassland biomes are ecosystems in which the predominant vegetation type consists of various grasses rather than trees or large shrubs. Grasslands may be divided into several types, including savannas, temperate grasslands, tallgrass prairies, steppes, alpine tundra and flooded grasslands, among others. The type of grassland that occurs in a particular region is based on the latitude, terrain, local climate, precipitation and wildfire regime. The faunal communities supported by these different types of grasslands vary on the basis of characteristics of the grasslands themselves, as well as by geographic location.
The highest abundance and greatest diversity of large mammals are found in these ecosystems. The dominant animal species include wild horses, asses and antelope of Eurasia, herds of Bison of America; and the antelope and other large herbivores of Africa.

**Biotic Components:**
**1. Producer Organisms:**
In grassland, producers are mainly grasses; though, a few herbs and shrubs also contribute to primary production of biomass. Some of the most common species of grasses are: Brachiaria sp., Cynodon sp., Desmodium sp., Digitaria sp.
**2. Consumers:**
**In grassland, consumers are of three main types:**
**(a) Primary Consumers:**
The primary consumers are herbivores feeding directly on grasses. These are grazing animals such as Cows, Buffaloes, Sheep, Goats, Deer, and Rabbits etc. Besides them, numerous species of insects, termites, etc. are also present.
**(b) Secondary Consumers:**
These are carnivores that feed on primary consumers (Herbivores). These include;-Frogs, Snakes, Lizards, Birds, Foxes, Jackals etc.
**(c) Tertiary Consumers:**
These include hawks etc. which feed on secondary consumers.
**3. Decomposers:**

These include wide variety of saprotrophic microorganism like: Bacteria; Fungi; Actinomycetes.

**A-biotic Components:**

These include basic inorganic and organic compounds present in the soil and aerial environment. The essential elements like C, H, N, O, P, S etc. are supplied by water, nitrogen, nitrates, sulphates, phosphates present in soil and atmosphere.

**4. Aquatic Ecosystem**

**a. Pond Ecoystem**

Ponds are small bodies of freshwater with shallow and still water, marsh, and aquatic plants.They can be further divided into four zones: vegetation zone, open water, bottom mud and surface film. The size and depth of ponds often varies greatly with the time of year; many ponds are produced by spring flooding from rivers. Food webs are based both on free-floating algae and upon aquatic plants. There is usually a diverse array of aquatic life, with a few examples including algae, snails, fish, beetles, water bugs, frogs, turtles, otters and muskrats. Top predators may include large fish, herons, or alligators. Since fish are a major predator upon amphibian larvae, ponds that dry up each year, thereby killing resident fish provide important refugia for amphibian breeding. Ponds that dry up completely each year are often known as vernal pools. Some ponds are produced by animal activity, including alligator holes and beaver ponds, and these add important diversity to landscapes.

A pond ecosystem refers to fresh water ecosystem where there are communities of organism dependent on each other with the prevailing water environment for their nutrients and survival. Usually ponds are shallow water bodies with a depth of 12-15 feet in which the sun rays can penetrate to the bottom permitting the growth of plants there.The functional components of a Pond ecosystem are-

**Abiotic Components**

The abiotic substances of Pond ecosystem are formed as a result of the mixture of some organic and inorganic materials.The basic components are water,oxygen,carbon dioxide ,salts of calcium and nitrogen etc**.**Only a small amount of these elements are present in soluble state in pond water,but a large amount is held in reserve solid form in the bottom sediments as well as within the organisms.Various organisms get their nourishment from these abiotic substances.The rate of release of reserve nutrients ,the solar input and the cycle of temperature ,day length and other climatic conditions regulate the function of the Pond ecosystem.

**Biotic Components**

The biotic components of Pond ecosystem consists of –

**Producers:-**The producres are of two types-larger rooted and floating vegetations together termed **macrophytes** and **phytoplanktons-** which are microscopic floating algae.Phytoplanktons are available upto the depth of water where light penetrates. The phytoplanktons are filamentous alga like Ulothrix, Oedogonium, Spirogyra, Anabena,Oscillatoria and minute floating plants like Microcystis, Gloeotrichina volvox etc.The macrophytes include marginal emergent plants like Typha , Acerus, Ipomea ,submerged plants like Hydrilla, Utricularia, Trapa, Nymphrea etc ; surface floating plants like Pistea ,Lemna, Wolffia, Eichhornia, Salvinia etc.

**Consumers:-**Consumers of Pond ecosystem are heterotrophs which depend for their nutrition on other organisms.**Zooplanktons** form primary consumers ,include Brachionus ,Asplanchna ,Lechane **,**(all rotofers) Colops, Dilepteus,Cyclops ,Stenocypris **(**crustacean) ,who feed on phytoplankton.**Nectic animals** like insects,beetles,fishes form secondary

consumers as they feed on zooplanktons.**Benthic animals** like snakes ,big fishes live on nectic animals and are termed tertiary consumers.

**Decomposers:-** Most of the decomposers of Pond ecosystem are saprophytes but some parasites are also found .Bacteria,fungi like Aspergillus Cladosporium Rhizopus,Alternaria,Fusarium,Saprolegnia etc are decomposers.Generally the decomposers either live in the soil layer beneath water or in the mud.They act on dead and decayed organic matter of plants and animals and supply raw materials to the producers.

**Energy Flow in Pond Ecosystem**
Phytoplanktons are the producers of pond ecosystem along with other floating plants.The energy produced by the autotrophs are passed through **"eat and being eaten chain".**In pond the larvae of insects consume autotrophs as food.So according to law of energy flow the larvae assimilate energy from autotrophs .So larvae are primary consumers.These primary consumers are taken as food by prawns ,small carnivorous fishes etc and so they collect energy from larvae.They are ,therefore secondary consumers.Large fishes consume secondary consumers,and are tertiary consumers.

## b. Ocean Ecosystem

Oceans cover approximately 70 per cent of the earth's surface. Major oceans of the world are Atlantic, Pacific, Indian, Arctic and Antarctic.
1. An ocean is a huge pool of salty water that extends over almost an infinite large area.
2. Ecosystem of an ocean is very stable and naturally well balanced.
3. They have high concentration of salts. It is about 3.5 per cent.
4. There is abundance of minerals such Na, CI, Ca, S, Mg etc.
5. Salinity is less near the north & south poles.
6. Salinity is more in deeper regions of the ocean.
7. This type of ecosystem plays an important role in regulating many biogeochemical cycles.
8. Oceans are the major sinks of $C0_2$ and play an important role in biogeochemical cycle.
9. The oceans have two major life zones.

- **Coastal Zone:**

It is relatively warm, nutrient rich shallow water. Due to high nutrients and ample sunlight this is the zone of high primary productivity.

- **Open Sea:**

It is the deeper part of the ocean, away from the continental shelf. It is vertically divided into three regions:
(i) Euphatic Zone, which receives abundant light and shows high photosynthetic activity
(ii) Bathyal zone receives dim light and is usually geologically active.
(iii) Abyssal zone is the dark zone 2000 to 5000 meter deep. It has no sunlight. It is the largest ecological unit but it is an incomplete ecosystem. Various components of the ocean ecosystem are as follows:

**Abiotic Components**
It is more stable in chemical composition due to being saline and moreover other physio-chemical factors such as dissolved oxygen content, light and temperature are also different. Marine water contains NaCl, Ca, Mg and K salts. Water is strongly buffered.

**Biotic Components**

**(i) Producers:**

These are autotrophs. They are mainly phytoplanktons such as diatoms and some microscopic algae, seaweeds etc.

**(ii) Consumers:**
These all are heterotrophic macro-consumers. They depend for their nutrition on the primary producers. These are:

**(a) Primary consumers:**
They are herbivores and feed directly on producers, e.g., molluscs, crustaceans etc.

**(b) Secondary consumers:**
These are carnivorous fishes as Shad, Herring etc.

**(c) Tertiary consumers:**
They feed on other carnivores of the secondary consumers level. These are the top carnivores in the food chain, e.g., Cod, Haddock, and Halibut etc.

**(iii) Decomposers:**
The microbes active in the decay of dead organic matter of producers and Macroconsumers are chiefly bacteria and some fungi.

## 5. The Cropland Ecosystem:

This is manmade ecosystem. Man has been doing his best in modifying the croplands to get maximum benefit out of them. A cropland ecosystem may be illustrated by crops like wheat, maize, rice, sugarcane etc. It has following components.

**Producers:**
A crop along with the weeds growing in the field are the producers of a cropland ecosystem. In the cropland ecosystem of maize, weeds like Cynodon dactylon, Euphorbia hirta, Alysicarpus, Launea nudicairlis are very common.

**Consumers:**
Herbivores are the primary consumers of the cropland ecosystem. These include rats, rabbits, birds, man and insects. The second order and the third order consumers are represented by frogs, snakes, birds such as hawk etc.

**Decomposers and transformers:**
Bacteria and fungi like Bacillus, Aspergillus, Clostridium, Agaricus, Mucor., Aspergillus and Fusarium are common decomposers and transformers of cropland ecosystem of maize.