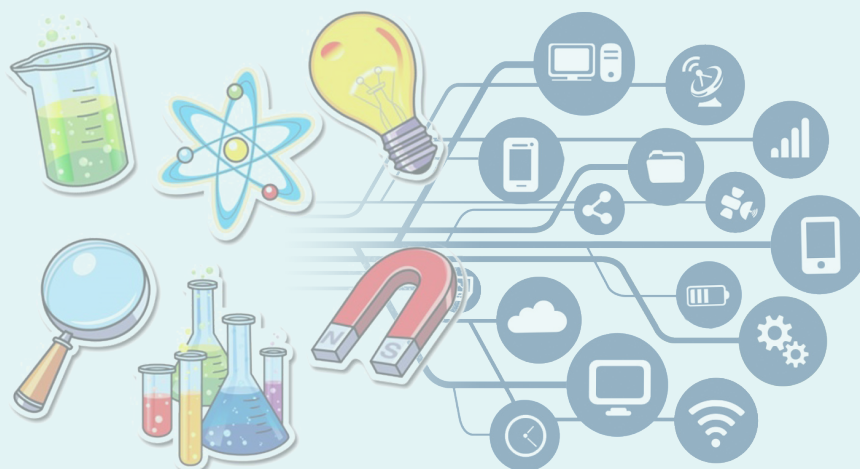




Environment & General Knowledge

FIRST STEP

NCERT Based Course for CSE
after Class 12





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PART I

Environment



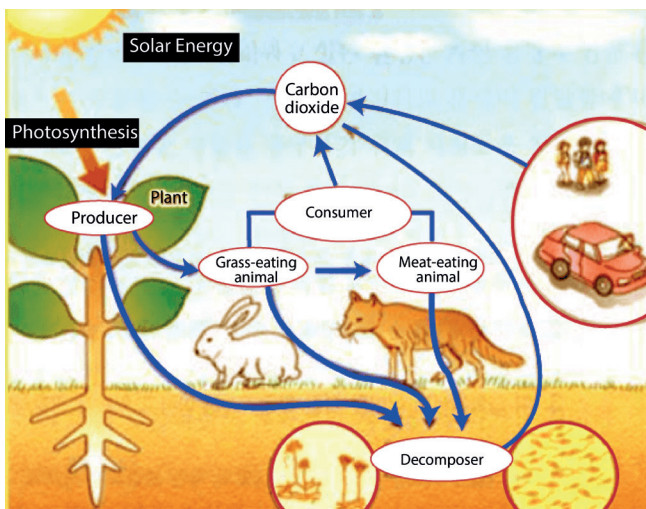
2.1 Ecosystem

An ecosystem is a structural and functional unit of ecology in which various living organisms interact with one another and their non-living surroundings. Ecosystems are always evolving. This is due to the fact that many human acts have a direct or indirect impact on the environment and ecology.

Deforestation, pollution, disease transmission across natural boundaries, the transfer of non-native species and the degradation of natural habitat due to overgrowth are examples of such human acts. Natural disasters, on the other hand, are equally to blame for ecosystem alterations.

2.2 Structure of the Ecosystem

The structure of an ecosystem primarily refers to the description of both biotic and abiotic components in their surroundings. It concerns the distribution of energy in the environment in particular.

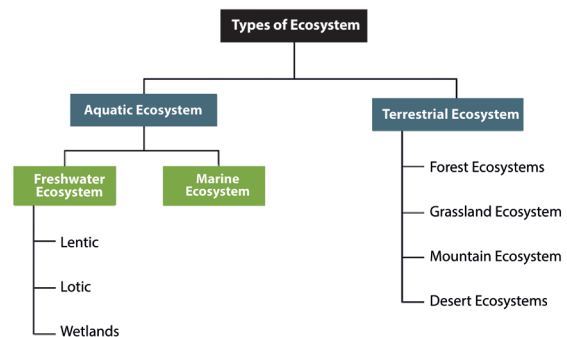


It also incorporates the numerous climatic conditions that exist in that particular environment. Both biotic and abiotic components are interconnected and form an open system in which energy is transferred from one particular component to another.

2.3 Types of Ecosystem

There are different types of ecosystems based on different climates, habitats, and life forms. This means that ecosystems can typically be divided into hundreds and thousands of smaller systems. However, all such types generally fall into one of the following two categories:

- Aquatic Ecosystem
- Terrestrial Ecosystem



Aquatic Ecosystem

Aquatic ecosystems refer to all such ecosystems that are primarily located on or inside water bodies. The nature and characteristics of all living and non-living organisms in the aquatic system are determined based on the environment surrounding their ecosystem. Organisms in these ecosystems interact with other organisms in aquatic and terrestrial ecosystems.

All ecosystems that are largely found on or inside water bodies are referred to be aquatic ecosystems. The environment around their ecosystem determines the nature and characteristics of all living and non-living organisms in the aquatic system. These ecosystems' creatures interact with those in aquatic and terrestrial habitats.

The aquatic ecosystem is mainly sub-divided into the following types:

Freshwater Ecosystem

One of the most important habitats for humans and other land-based species is the freshwater ecosystem. This is due to the fact that this environment provides drinking water. It also aids in the provision of energy and water for transportation, recreation, and other purposes.

Lentic, lotic, and wetlands are the most common freshwater ecosystems.

- **Lentic:** Water bodies that are moving slowly or are still in some places come under lentic. For example, ponds, lakes, pools, etc. Lakes are known as large water bodies and are surrounded by land.
- **Lotic:** Water bodies that are moving at a fast pace fall under a lotic. For example, streams and rivers.
- **Wetlands:** Environments characterized by soils saturated with water for a long time fall under wetlands.

The freshwater ecosystem is the smallest type of ecosystem among the major types of ecosystems. There is usually no salt content in the freshwater ecosystem. Besides, it consists of many insects, small fish, amphibians, and various plant species. Plants help provide oxygen through photosynthesis and also provide food for the organisms living in this ecosystem.

Marine Ecosystem

Marine ecosystems are usually characterized by the presence of salt content. These ecosystems have a higher salt content than the freshwater

ecosystem. Moreover, they are known as the largest type of ecosystem on Earth. It usually includes all the oceans and their parts. Besides, marine ecosystems have a distinctive flora and fauna, which support greater biodiversity than freshwater ecosystems. This type of ecosystem is essential for both marine and terrestrial environments.

In particular, this ecosystem includes salt marshes, lagoons, coral reefs, estuaries, intertidal zones, mangroves, seafloor, and deep seas. Salt marshes, mangrove forests, and sea-grass meadows are said to be among the most productive ecosystems. Coral reefs are known to provide adequate quantities of food and shelter to most marine inhabitants worldwide.

Terrestrial Ecosystem

Terrestrial ecosystem refers to all such ecosystems which are mainly located on land. Although the presence of water in these ecosystems is measured, they are entirely land-based and exist on land. More specifically, a low and sufficiently needed amount of water is there in terrestrial ecosystems. The low amount of water separates these ecosystems from aquatic ecosystems.

Besides, terrestrial ecosystems typically have temperature fluctuations in both seasonal and diurnal climates. It is also a specific factor that makes these ecosystems different from aquatic ecosystems in similar environments.

Furthermore, the availability of light is somewhat higher in terrestrial ecosystems than in aquatic ecosystems. The reason for this is that the climate in the land is relatively more transparent than water. Due to entirely different light availability and temperature in terrestrial ecosystems, they have diverse flora and fauna.

Terrestrial ecosystems are mainly classified into the following types:

Forest Ecosystems

A forest ecosystem is one in which many organisms coexist with abiotic elements of the

environment. This ecosystem contains a diverse range of flora and fauna. This usually indicates a dense population of living organisms coexisting with non-living abiotic elements in the forest ecosystem. Plants, microorganisms, animals, and other species commonly make up the forest ecosystem.

Forests are significant carbon sinks that help to regulate and balance the Earth's overall temperature. Forest ecosystem changes have an impact on the entire ecological balance, and severe changes or destruction of forests can kill the entire ecosystem. Forests are generally classified into tropical deciduous forests, tropical evergreen forests, temperate deciduous forests, temperate forests, and Taiga.

Grassland Ecosystems

Grassland ecosystems are defined as those with a low number of trees. Grass, shrubs, and herbs make up the majority of these ecosystems. This means grasses, along with legumes from the composite family, are the primary vegetation in these ecosystems.

Grassland ecosystems can be found in both tropical and temperate climates around the world, but they have distinct differences. Savanna grasslands and temperate grasslands are examples of these ecosystems. The Grazing animals, insectivores, and herbivores all live there.

Mountain Ecosystems

The mountain ecosystem, as its name implies, is characterized by mountainous regions with cold climates and low rainfall. These ecosystems now have a diverse range of habitats where various animal and plant species can be found as a result of climate change. The climate in mountainous areas at high altitudes is cold and harsh. This explains why these ecosystems only have treeless alpine vegetation. Thick fur coats are commonly found on animals in these ecosystems to protect them from the cold.

Furthermore, the lower slopes of the mountains are mostly covered in coniferous trees. Mountain tops in Arctic regions are examples of mountain ecosystems. Also, for the majority of the year, they are covered in snow.

Desert Ecosystems

Desert ecosystems are found all over the world, accounting for about 17% of desert land.

These are areas where annual rainfall is typically less than 25 millimeters. Due to fewer trees and land of sand, sunlight intensifies in these ecosystems. This is why these ecosystems have extremely high temperatures and limited water supply.

The nights, on the other hand, are bitterly cold. The flora and fauna of the desert ecosystem are unique. Plants grow with little water and conserve as much as they can in their leaves and stems. The spiny-leaved cactus, for example, is a desert plant that has the ability to store water in its stem. Animals, too, have adapted to the harsh conditions of desert ecosystems. Some common animals are camels, reptiles, a diverse range of insects and birds.

2.4 Functions of Ecosystem

The ecosystem has some functional properties which keep all the components interlinked and running together. The components of the ecosystem are seen to function as a unit when the below-mentioned aspects are considered:

- Productivity
- Decomposition
- Energy Flow
- Nutrient Cycling

Productivity

Solar Energy is necessary for any ecosystem to function. Primary production is defined as the amount of biomass or organic matter produced per unit area over a time-period by plants during photosynthesis. The rate of biomass production is called productivity.

Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.

Net primary productivity = Gross primary productivity - Respiration.

Net primary productivity is the available biomass for the consumption to heterotrophs (herbivores and decomposers). Consumers define secondary productivity as the rate of formation of new organic matter.

Primary productivity depends on the plant species inhabiting a particular area. It also depends on a variety of environmental factors including 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.

Decomposition

Decomposers break down complex organic matter into inorganic substances like carbon dioxide, water and nutrients. The entire process carried out by the decomposers is called decomposition. It is largely an oxygen-requiring process. e.g. Dead organisms are the raw material for decomposition.

Humification and Mineralisation:

It occurs during decomposition in the soil. It leads to accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature, it serves as a reservoir of nutrients. Some microbes further degrade the humus and release of inorganic nutrients occur by the process known as mineralisation.

Energy Flow

All the components of an ecosystem are constantly interacting with each other. These interactions lead to the growth and regeneration of its plants and animal species for which energy is required. Sun is the ultimate source of energy for all the ecosystems in the world, except for the deep sea hydrothermal ecosystems.

Only 50 percent of the solar radiation is Photosynthetically Active Radiation (PAR). The producers capture only 2-10 percent of this PAR and this small amount of energy sustains the entire living world. This energy goes through different organisms occupying trophic levels in an ecosystem.

PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR)

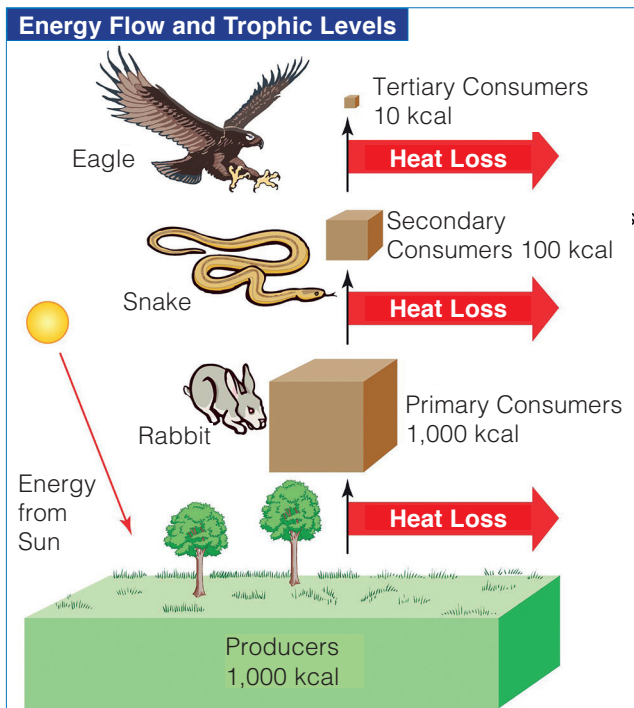
- It is the amount of light available for photosynthesis, which is light in the 400 to 700 nanometer wavelength range. PAR changes seasonally and varies depending on the latitude and time of day.
- It is needed for photosynthesis and plant growth. Higher PAR promotes plant growth. Monitoring PAR is important to ensure plants are receiving adequate amount of light for this process.

Trophic Levels

Trophic Level is defined as the position of an organism in the food chain and ranges from a value of 1 for primary producers to 5 for marine mammals and humans. The method to determine the trophic level of a consumer is to add one level to the mean trophic level of its prey.

At the first trophic level, primary producers like green plants, algae, and some bacteria use solar energy to produce organic plant material

through photosynthesis. The second trophic level is occupied by Herbivores, animals that feed solely on plants.. Similarly, the third trophic level is occupied by Predators who eat herbivores.



NOTE

As there is high energy loss at subsequent trophic levels, most terrestrial ecosystems have no more than five trophic levels and marine ecosystems generally have no more than seven. This difference between terrestrial and marine ecosystems is likely due to differences in the fundamental characteristics of land and marine primary organisms. In marine ecosystems, microscopic phytoplankton carries out most of the photosynthesis that occurs, while plants do most of this work on land.

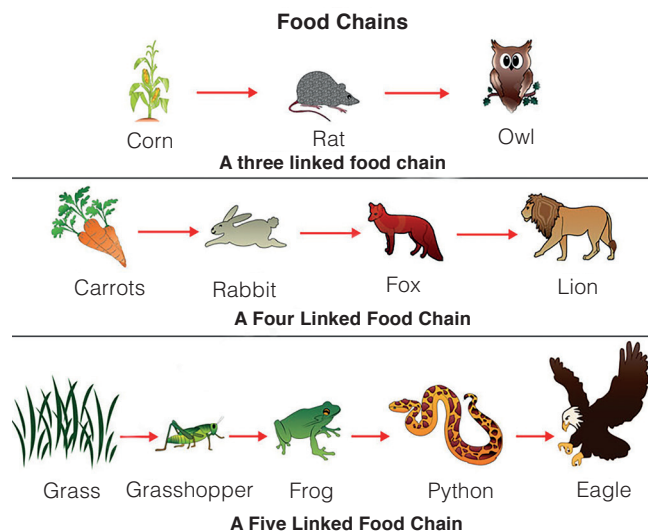
Phytoplankton are small organisms with extremely simple structures, so most of their primary production is consumed and used for energy by grazing organisms that feed on them. In contrast, a large fraction of the the land plants produce, such as roots, trunks, and branches, cannot be used by herbivores for food, so proportionately less of the energy fixed through primary production travels up the food chain.

The highest amount of energy is concentrated in the first trophic level, subsequently dispersing into organisms of different trophic levels. The amount of energy decreases as one moves higher up in the trophic level in an ecosystem.

On an average, about 10 percent 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, defecation, and non-predatory death (organisms that die but are not eaten by consumers).

Food Chains

All the organisms need energy to grow, move and reproduce. For this purpose, smaller insects eat plants, bigger animals eat smaller insects and so on. This feeding relationship forms a food chain in an ecosystem. Thus, food chain is a linear sequence of organisms through which transfer of energy and nutrients takes place. The energy and nutrients flow in the form of food from organism to organism by eating and being eaten.



Each link in the food chain is known as Trophic level.

The particular organism need not occupy a unique trophic level in a food chain. Many Omnivores can be at the second trophic level surviving directly by eating the plants or higher up the order, eating other animals. Example: Man.

Also, in an ecosystem, there may be more than one food chain

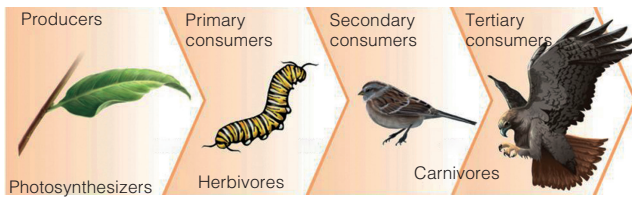
Grass → Rabbit → Fox-Wolf → Tiger

Grass → Grasshopper → Frog → Snake → Hawk

There are two types of food chains:

Grazing Food Chains

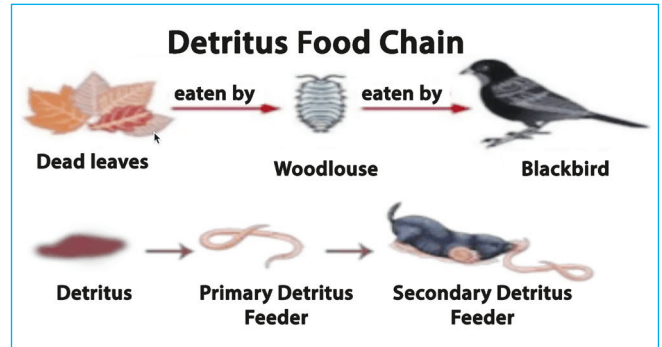
This type of food chain is more prevalent in those ecosystems where a substantial part of the net primary production is grazed on by herbivores. Thus, there is enough energy to support the higher trophic level and in turn a food chain. It starts from a green plant base, goes to grazing herbivores and on to carnivores.



Detritus Food Chains

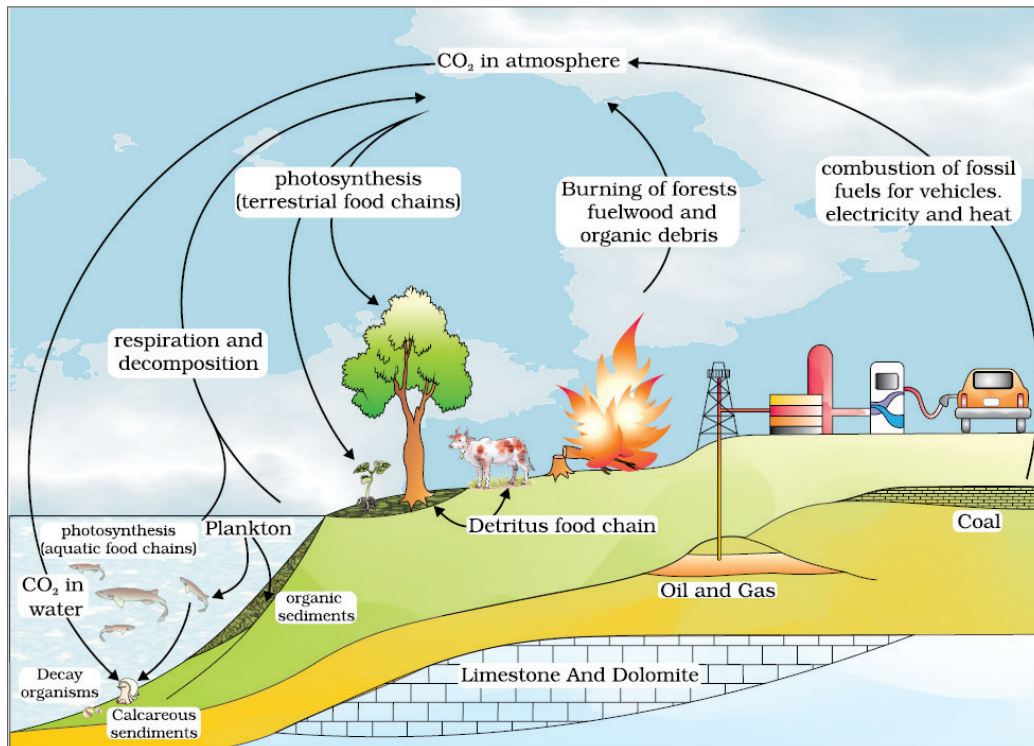
This type of food chain starts with a dead organic matter which is decomposed by microorganisms, which in turn are eaten by other organisms. Clearly,

it is less dependent on direct solar energy and more on the supply of organic matter produced by another ecosystem.



Food Web

Food chain follows a single path as animals eat each other. In natural environment or an ecosystem, the relationships between the food chains are interconnected. These relationships are very complex, as one organism may be a part of multiple food chains. Hence, a web like structure is formed in place of a linear food chain. The web like structure if formed with the interlinked food chain and such matrix that is interconnected is known as a food web.



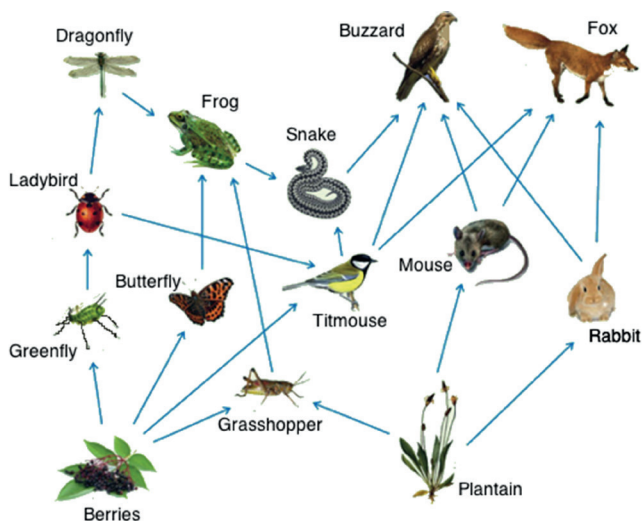
Carbon Cycles

Food Web as Interconnected Food Chains

Although it looks complex, it is just several food chains joined together. Here are some of the food chains in this food web:

- Berries → Butterfly → Frog → Snake
- Berries → Greenfly → Ladybird → Dragonfly → Frog → Snake → Buzzard
- Plantain → Rabbit → Fox
- Plantain → Mouse → Buzzard

FOOD CHAIN	SIMILARITY	FOOD WEB
Single linear pathway	Represents who-eats-who	Made of several interconnecting pathways
Isolated food chains decrease stability of the ecological community	10% of energy passes from one trophic level to another	More complex food webs increase the stability of ecological community
One individual occupies one trophic level only		One individual occupies many trophic level
Less adaptive		More adaptive



Ecological Pyramids

Ecological Pyramid is the graphical representation of the relationship between the producer and different levels of consumers in terms of a number of species, biomass or energy accumulated.

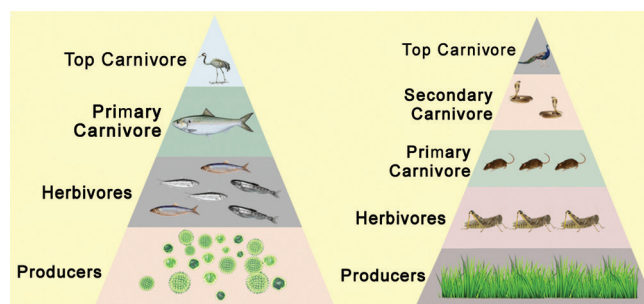
They are the graphical representations of trophic levels in an ecosystem. There are three types of ecological pyramids:

- Pyramid of Numbers
- Pyramid of Biomass
- Pyramids of Energy

Pyramid of Numbers

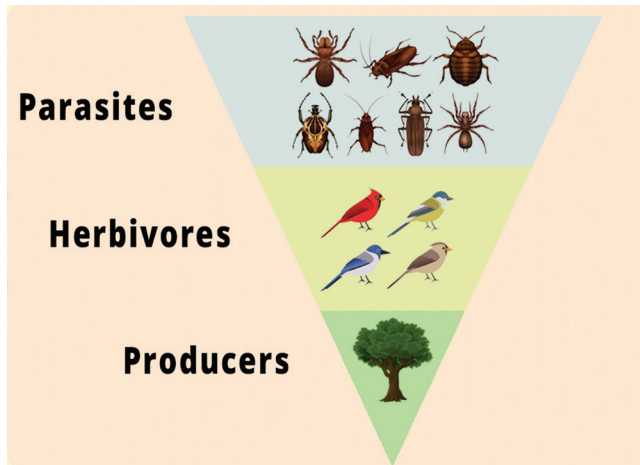
It is the relationship between the producers and various consumers as shown in terms of the population at each trophic levels. Pyramid of numbers is advantageous over other types of pyramids because it is a simple method and one only needs to count the number of organisms, also it is good for comparing changes to the ecosystem at different times of years. However, it has limitations as number of species may be too high to measure accurately. It also includes all the organisms ignoring their sizes which lead to inverted pyramids.

- **Erect Pyramid of Numbers:** This type of pyramid is found in the *aquatic and grassland ecosystem*. In these ecosystems, there are numerous small autotrophs which support lesser herbivores which in turn support smaller number of carnivores and hence this pyramid is upright. For Example: In grassland ecosystem, numbers of grasses are much more than the number of herbivores and, in turn, the number of herbivores is more than the number of carnivores.



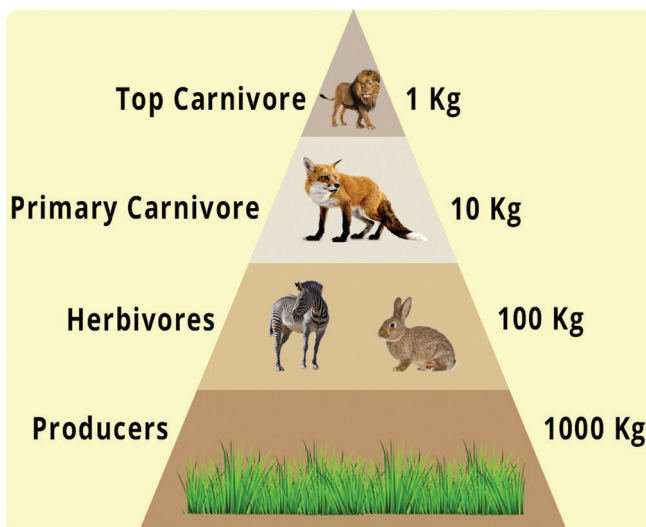
- **Inverted Pyramid of Numbers:** This type of ecological pyramid is seen in parasitic food chain where one primary producer supports numerous parasites which support more hyperparasites. For example: In the Tree

ecosystem, there are many herbivores feeding on a single tree. In turn, numbers of parasites feeding on a single herbivore are many.



Pyramid of Biomass

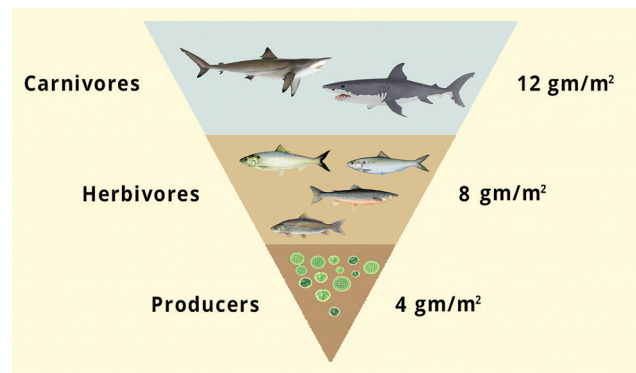
It is the graphical representation of the producers and various levels of consumers in terms of their biomass. *Pyramid of biomass can be erect as well as inverted.*



A pyramid of biomass is a more accurate indication of how much energy is passed on at each trophic level.

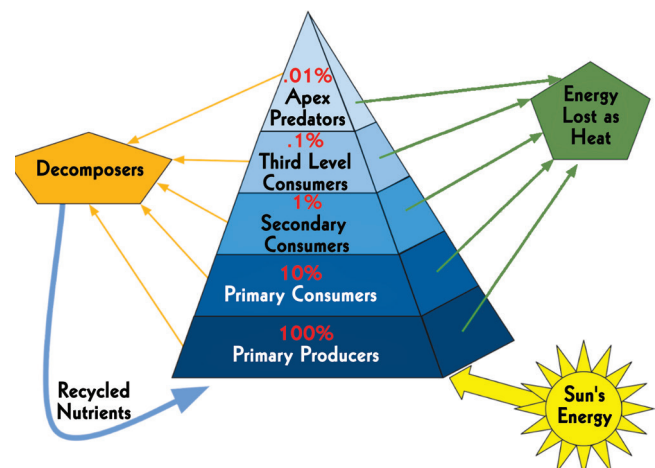
- **Erect Pyramid of Biomass:** This occurs when the larger net biomass of producers support a smaller weight of consumers in most of the terrestrial ecosystem, it is erect.

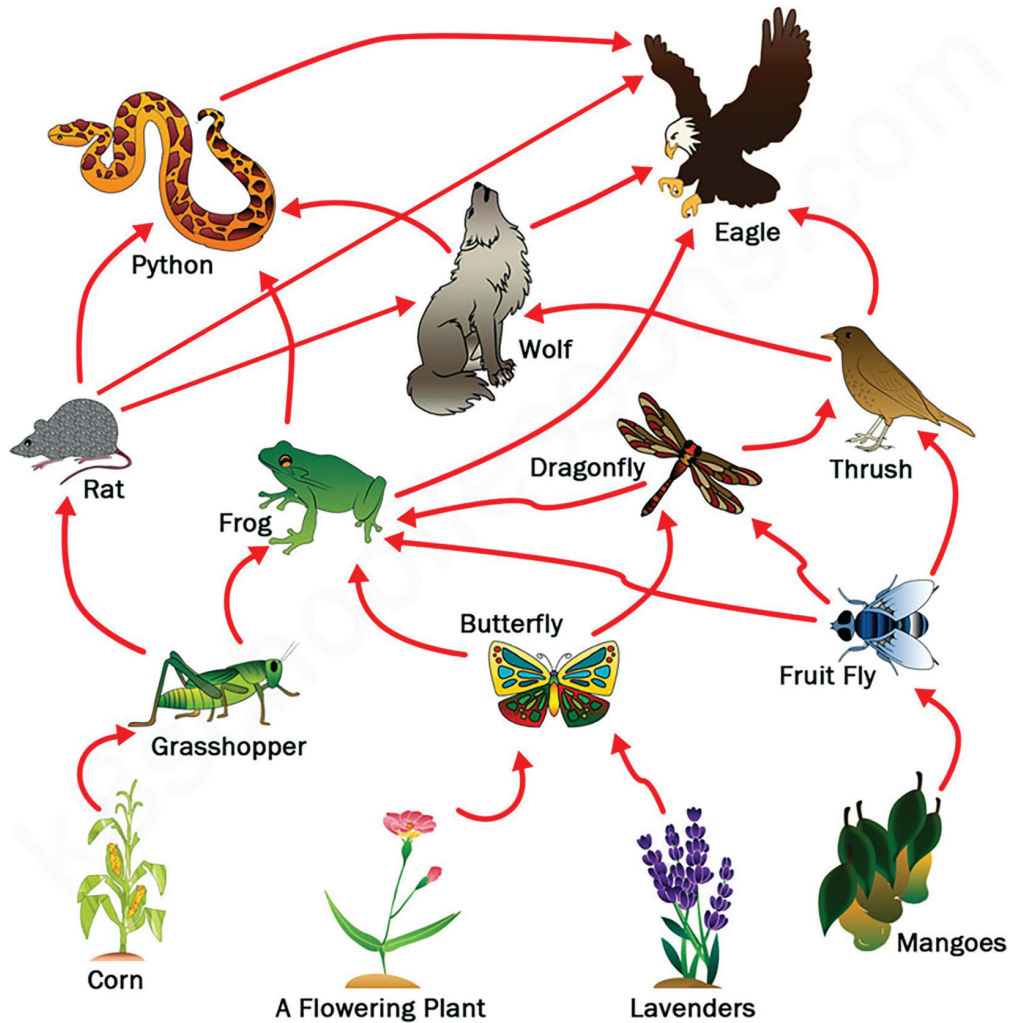
- **Inverted Pyramid of Biomass:** This happens when the smaller weight of producers support consumers of larger weight. It is especially found in case of *aquatic ecosystems*. For example, in a pond ecosystem, the phytoplankton (the producers) has a very short span of life and a rapid turnover rate (i.e. they are rapidly replaced by new plants). Thus, at any given time, their total biomass is less than the biomass of the herbivores supported by them.



Pyramids of Energy

It is the graphical representation of the producers and various levels of consumers in terms of their total energy accumulated by them. As the energy flow decreases while moving higher up in the trophic level, *the pyramid of energy is always erect*, both in aquatic and terrestrial ecosystems. This method overcomes the issue with above methods as it shows the actual energy transferred but it is very difficult to collect the energy data of a trophic level.





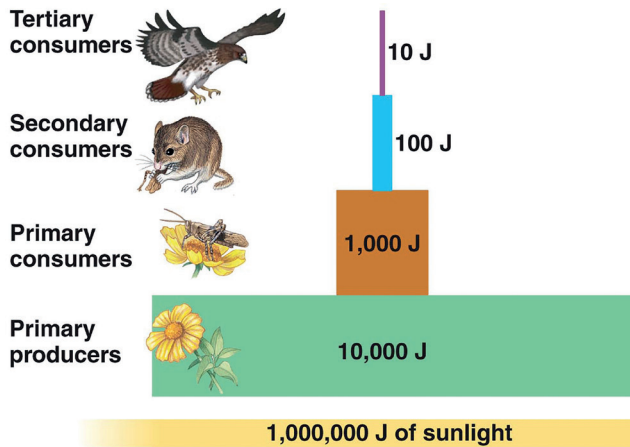
Food Web

Lindeman's Law (10% Law)

- According to Raymond Lindeman, in an ecosystem when energy is transferred from one trophic level to another, then 90% energy is used in maintenance of metabolic processes and only 10% energy is transferred from one trophic level to another.
- A metabolic process means the energy used in digestion respiration and locomotion etc.

Ecological Efficiency

Ecological Efficiency is defined as the ratio between the amount of energy acquired from the lower trophic level and the amount of energy transferred to the higher trophic level. Thus, it describes the efficiency with which energy is transferred from one trophic level to the next.



We know that the amount of energy transferred from one trophic level to the next decreases because some portion of energy is lost in respiration or in metabolism and some portion is lost as heat. Lindman proposed the 10 percent rule in 1942 for the ecological efficiency i.e. only 10 percent energy is transferred from one trophic level to the next. However, the efficiency may vary between 5-35 percent depending on different ecosystems. For example, Silver Spring ecosystem in Florida has an ecological efficiency of 16%.

Pollutants and Trophic Levels

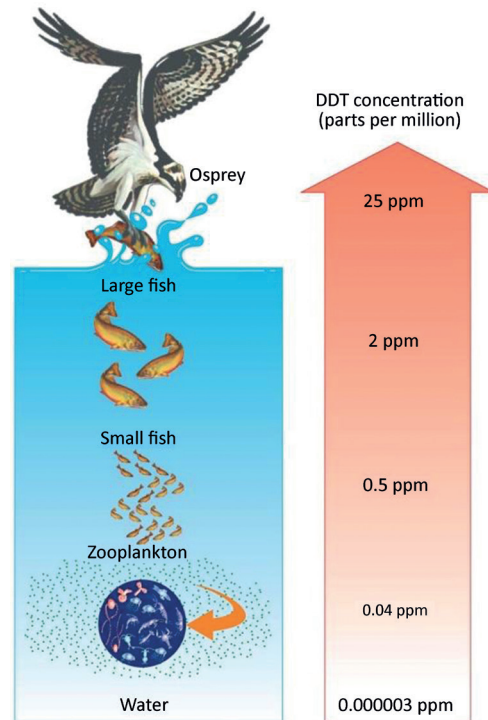
A pollutant is any substance which, upon introduction to an ecosystem, affects it adversely by reducing its productivity, stability, usefulness and reduces the growth rate of species or interferes with food chains.

Bioaccumulation

It is the process through which a substance or pollutant accumulates in living organisms and it happens over a period of time. One of the functions of the body is to remove the unwanted and toxic substance. Bioaccumulation starts when the rate of accumulation of the pollutant becomes greater than the rate of removal.

Biomagnification

It refers to the tendency of pollutants to concentrate as they move from one trophic level to the next. Thus, in biomagnification there is an increase in concentration of a pollutant from one link in a food chain to another. In order for biomagnification to occur, the pollutant must be: long-lived. Example: Mercury, Cadmium in shellfish.

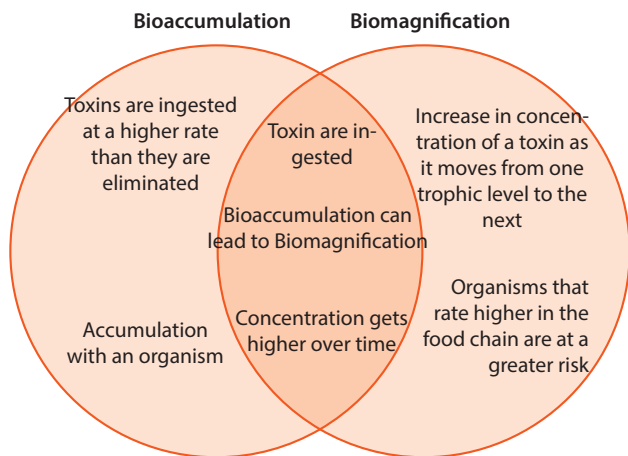


Conditions for Bioaccumulation

- The pollutant should be highly mobile.
- It should be soluble in fat.
- It should have longer life time.
- It should be biologically active.

Bioaccumulation and Biomagnification: A Comparison

Bioaccumulation is when the concentration of pollutant increases inside an organism whereas biomagnification is the comparative increase in the concentration of the pollutant in the organism of higher trophic level as compared to the concentration present in the organism of lower trophic level. Clearly, bioaccumulation takes place within a given trophic level but we talk about biomagnification as we move higher in the trophic level.



Nutrient Cycling

Some of the important nutrients are Carbon, Nitrogen, Water, Phosphorous and Sulphur.

Based on the reservoir in which the nutrient cycling is taking place, there are two types of nutrients cycles:

- **Gaseous Nutrient Cycle:** For this cycle, the reservoir is the atmosphere. Important gaseous cycles include Carbon, Nitrogen and Water.
- **Sedimentary Nutrient Cycle:** For this cycle, the reservoir is the Earth's crust. Important Sedimentary cycles include Phosphorous and Sulphur.

Carbon Cycle

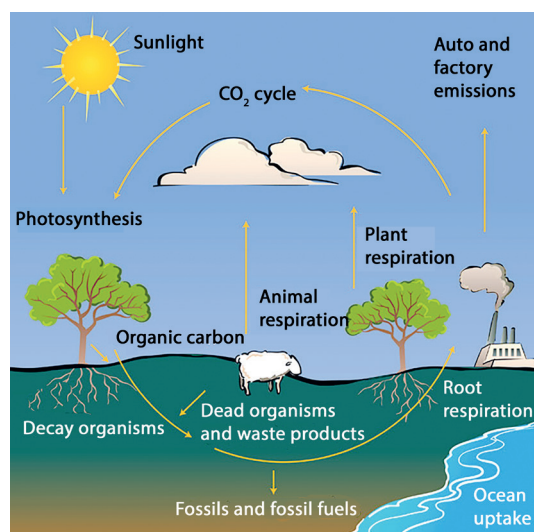
Carbon is one of the essential parts of living organisms as it constitutes 49 percent of dry weight of the organisms. As for sources of Carbon, 71 percent of carbon is dissolved in oceans. It is also present in the earth's crust as the fossil fuels. Carbon is present in the atmosphere in mainly two forms, Carbon dioxide, and methane. Thus, the cycle involves all the components including atmosphere, oceans, living organisms and dead matter.

The cycle is completed in following steps:

- **Photosynthesis:** It is the process in which green plant, in the presence of sunlight, converts atmospheric inorganic carbon (carbon dioxide) into organic matter (food) and release oxygen.

This food is utilized by the plants for their own functions and also passed on to the organisms of higher trophic levels.

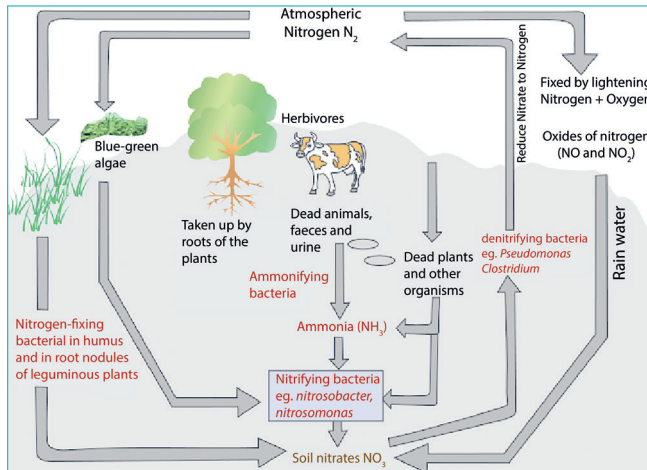
- **Respiration:** The food needs to be converted into energy. Respiration is the process in which this food is oxidized and converted to energy, releasing carbon dioxide and water. This carbon dioxide is released into the atmosphere.
- **Decomposition:** Only a part of the photosynthesized food is oxidized to produce energy. Remaining part gets stored as biomass of an organism which is acted upon by the detritus on the death of the organism, releasing the carbon dioxide in the atmosphere again.
- **Combustion:** Other than decomposition, the burning of biomass directly releases the carbon dioxide in the atmosphere.
- **Impact of Human Activities:** The natural balance of carbon cycle has been distorted by the human activities, especially since the industrialization. Destruction of forests combined with release of carbon dioxide from industries and power plants have led to increasing carbon dioxide emission which is causing the global warming.



Nitrogen Cycle

Nitrogen cycle is the biogeochemical cycle that describes the transformation of nitrogen and nitrogen-containing compounds in nature. Atmospheric nitrogen is the biggest source of

nitrogen. Green plants absorb nitrogen in the form of nitrates and nitrites from the soil and water. Animals get nitrogen when they feed upon plants. Nitrogen is an essential component of proteins and nucleic acids in living organisms.



The nitrogen cycle can be studied in five steps:

- Nitrogen fixation:** The nitrogen can be fixed in two ways:
 - Lightening during cloud formation: Nitrogen and oxygen combine with each other to form oxides of nitrogen in the atmosphere by lightening. These nitrogen oxides then dissolve in rainwater and on reaching the earth's surface becomes a part of the soil and water.
 - Free living micro-organisms present in the soil and by the symbiotic bacteria in the root nodules of certain leguminous plants: Microbes like the blue green algae and bacteria fix the atmospheric nitrogen into nitrites and nitrates. These nitrogenous compounds are then released into the soil.
- Nitrogen assimilation:** Plants absorb nitrogen in the form of nitrates to prepare amino acids. This nitrogen is then taken up by the animals in the form of proteins through the food chain.
- Ammonification:** The proteins in the body of the animals are broken down into simpler form like urea and ammonia. These are then removed from the body along with urine and excreta. Dead plants and animals also return nitrogen

to the soil as ammonium compounds. These ammonium compounds are then converted to ammonia by ammonifying bacteria.

- Nitrification:** Conversion of ammonia into nitrates is called nitrification. Nitrifying bacteria like Nitrosobacter and Nitrosomonas found in the soil convert ammonia into nitrate. Some other bacteria present in the soil convert ammonia into nitrites. Some of this nitrates and nitrites are again taken up by the plants for their nutrition.

Nitrifying bacteria (Nitrosobacter, Nitrosomonas) → Convert ammonia to nitrate

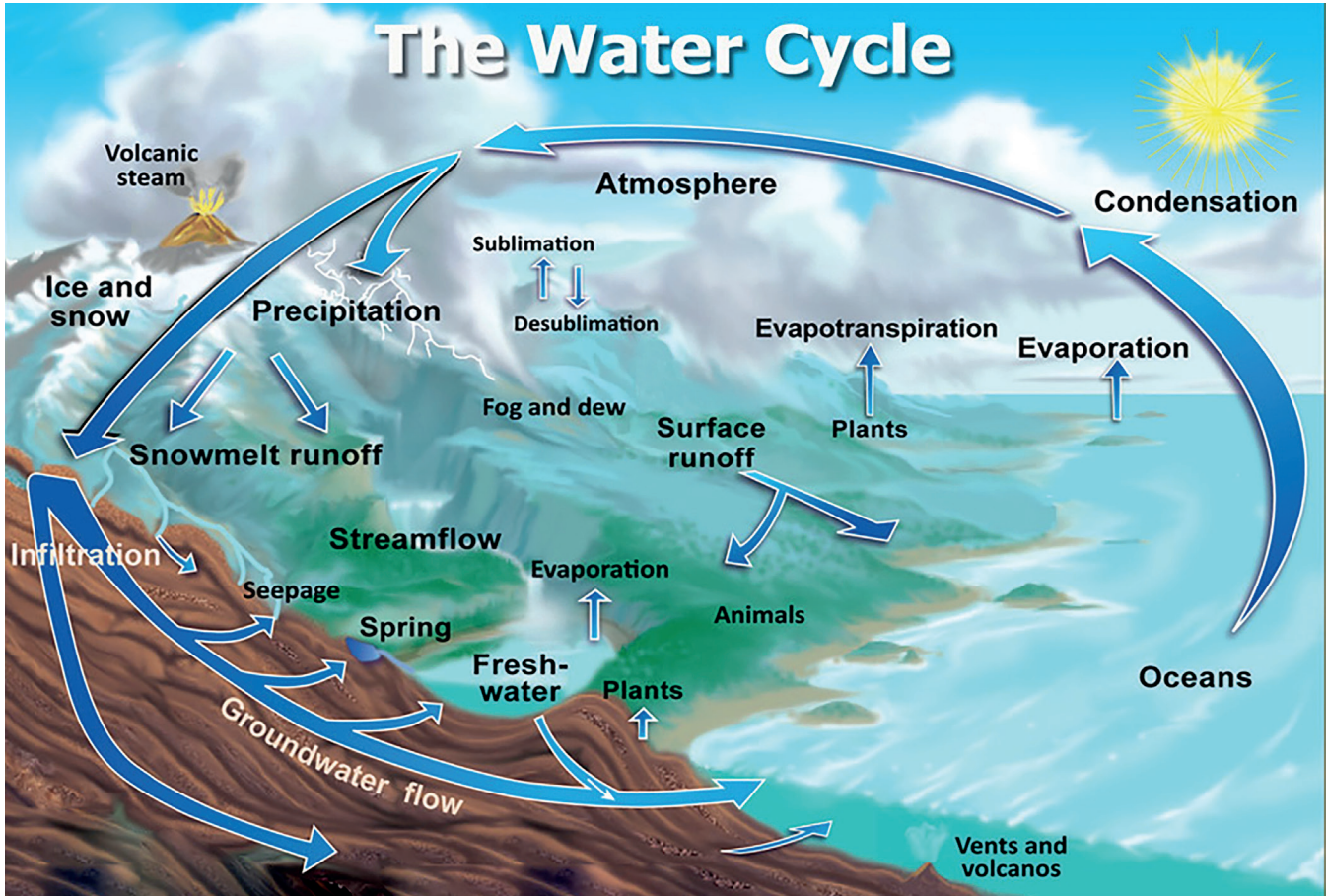
- Denitrification:** Denitrifying bacteria like Pseudomonas and Clostridium living in the soil reduce the soil nitrites and nitrates into nitrogen which is returned back into the atmosphere.

Denitrifying bacteria (Pseudomonas, Clostridium) → Reduce nitrates and nitrites to nitrogen

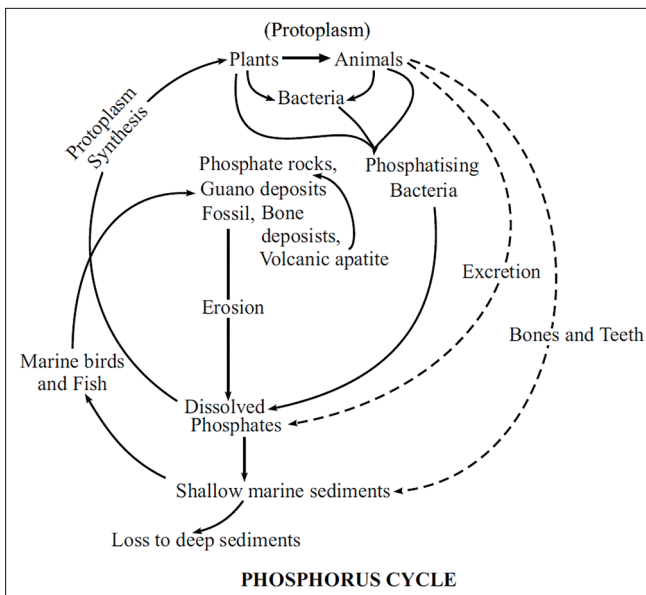
Hydrological Cycle

The water cycle is mainly driven by two forces: Solar radiation and Gravity. The cycle involves following processes:

- Evapotranspiration:** Due to solar radiation, water from oceans, rivers, lakes, ponds etc evaporates into the atmosphere. Water is evaporated from the plants leaves also in the process of transpiration. This water remains in the atmosphere in vapor state and forms cloud which can be carried to faraway places with winds.
- Condensation:** As the water vapor is much lighter than the surrounding air, it rises up and form clouds. These clouds again rise upwards which involves the release of heat of condensation, warming the cloud more and thus making it lighter. After rising to great heights, these clouds start to condense and changes into tiny water droplets.
- Precipitation:** These tiny droplets further combine to form big water droplets which fall on the surface of earth in the form of rain, snow, hail and sleet under the force of gravity.



Phosphorous Cycle



Phosphorus is very important for all living organisms as it is a major part of biological membranes, nucleic acids and cellular energy transfer systems. It is also needed to make shells, bones and teeth

among many animals. Phosphorus is a limiting factor in the soil for plant growth as it is available in a limited amount. To overcome this, farmers apply phosphorus-rich fertilizers to the soil.

Phosphorus Cycle involves following processes:

- **Weathering:** Phosphorus is mainly found in rocks in the form of Phosphates. This is released from the rocks by weathering, especially during the rainy season. Due to this, the inorganic Phosphate ions are distributed through soil and water.
- **Through Different Trophic Levels:** Plants absorb these inorganic phosphate ions through their roots from water and soil. Animals at higher trophic level, receives the phosphorus by eating the plants or the plant-eating animals. In plants and animals, this phosphorus is incorporated into organic molecules including DNA etc.
- **Decomposition:** finally the phosphate-solubilizing bacteria liberates the phosphorus into the soil by decomposing the dead organisms and other waste products.

Sulphur Cycle

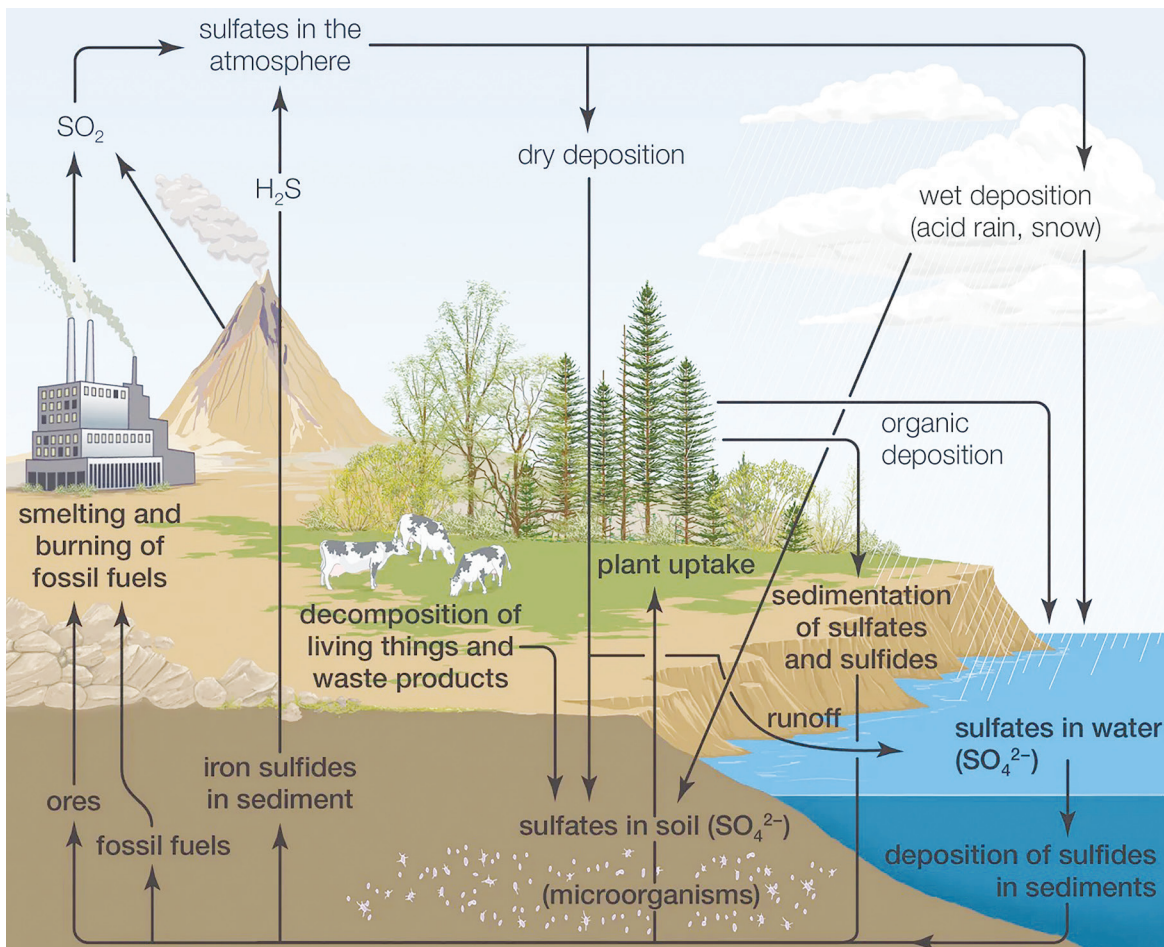
Sulphur is found mainly in the earth's crust as sulfate salts in rocks and minerals. It is found in the gaseous form also in the form of Hydrogen sulfide and Sulphur dioxide but their lifetime in atmosphere is very small. Sulphur is one of the important components of proteins, amino acids, enzymes and vitamins. Thus it is essential for both plants and animals. The cycle involves following steps:

- **Weathering:** Weathering of sulphur containing rocks releases the sulphur into the soil which gets converted into sulfate when it comes into contact with air.
- **Precipitation:** Hydrogen sulfide and Sulphur dioxide are released into the atmosphere through volcanic eruption and burning of fossil fuels. The gases react with tiny water droplets in the atmosphere, forming sulphuric acid which falls to the earth in the form of precipitation. Thus mixing with the soil.

- **Different Trophic Levels:** Plants receive sulphur by absorbing the ions of the sulfate salts from the soil. All the other animals get their requirement of sulphur by eating the plants or the plant-eating animals.
- **Decomposition:** Finally the sulfate salts are released back to the soil by decomposition of the organism after their death which can again be taken up by the plants. Through surface runoff or otherwise, the remaining sulphur settles down in the ocean after combining with iron, forming ferrous sulfide.

2.5 Ecosystem Interactions

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.

Productivity

- Productivity of ecosystem refers to the rate of formation of energy and matters which is stored in different species of different trophic levels.
- A constant input of solar energy is the basic requirement for any ecosystem to function and sustain.

There are two types of productivity:

1. **Primary Productivity:** It refers to the rate at which chemical energy is produced from solar energy. It is measured in dry weight gm calories/unit area/unit time. e.g. for the whole earth, mean net primary productivity is 320 dry gm cal./m²/year.

Primary Productivity for Different Ecosystem	
Ecosystem	Primary Productivity
Desert	Less than 2
Deep oceans	Less than 4
Grasslands	2 – 12
Deep lakes	2 – 12
Continental shelf	2 – 12
Mountain forest	2 – 12
Dry farming	2 – 12
Rainforests	12 – 40
Shallow lakes	12 – 40
Humid grassland	12 – 40
Wet cultivation	12 – 40
Estuaries	40 – 100
Springs	40 – 100
Coral reef	40 – 100

Alluvial plains	40 – 100
Annual crops like sugarcane	40 – 100

Gross Primary Productivity (GPP) is the total amount of organic matter that it produces through photosynthesis.

Net Primary Productivity (NPP) describes the amount of energy that remains available for plant growth after subtracting the fraction that plants use for respiration.

Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (gm⁻²) or energy (kcal m⁻²).

The rate of biomass production is called productivity. It is expressed in terms of gm⁻² yr⁻¹ or (kcal m⁻²) yr⁻¹ to compare the productivity of different ecosystems.

It can be divided into gross primary productivity (GPP) and net primary productivity (NPP).

Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.

A considerable amount of GPP is utilised by plants in respiration.

Gross primary productivity minus respiration losses (R), is the net primary productivity (NPP).

$$GPP - R = NPP$$

Net primary productivity is the available biomass for the consumption to heterotrophs (herbivores and decomposers).

- 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.
2. **Secondary Productivity:** Secondary productivity is the rate of assimilation of food energy by the consumers. In decomposition, complex organic compounds of detritus are converted to carbon dioxide, water and inorganic nutrients by the decomposers. Decomposition involves three processes, namely fragmentation of detritus, leaching and catabolism.

2.6 Keystone and Flag Species

Keystone Species

In any arrangement or community, the “keystone” is considered one of the most vital parts. In a marine ecosystem, or any type of ecosystem, a keystone species is an organism that helps hold the system together. Without its keystone species, ecosystems would look very different. Some ecosystems might not be able to adapt to environmental changes if their keystone species disappeared. That could spell the end of the ecosystem, or it could allow an invasive species to take over and dramatically shift the ecosystem in a new direction.

For example the keystone species are Sea Otters, American Alligator, Bees, Large Mammalian Predators, Sea Stars, Hummingbirds etc.

Flagship Species

A flagship species is one that has been chosen to represent an environmental cause, such as a threatened ecosystem.

These species have been chosen for their vulnerability, attractiveness, or peculiarity in order to get public support and recognition.

For instance, the Indian tiger, African elephant, Chinese giant panda, leatherback sea turtle, and so on.

2.7 Ecotone

Ecotone is a transition area between two biomes (vegetational communities), where two communities meet and integrate. It may be narrow or wide, or may be local zone between field and forest, or regional zone between forest and grassland.

An ecotone may appear on the ground as a gradual blending of two communities across a broad area, or it may manifest itself as a sharp boundary line.

It describes variation in species of flora and fauna.

Ecocline

- Ecocline is a gradation from one ecosystem to another when there is not sharp boundary between the two. It is the joint expression of associated community and complex environmental gradients.
- It refers variation in physio-chemical environment of ecotone i.e. an ecocline indicates thermocline (temperature gradient), chemocline / chemical gradient, halocline (salinity gradient) or pycnocline (variations in density of water).
- It describes variation in forms of species based on genetic differences.
- The term was coined by the English evolutionary biologist Julian Huxley in 1938.

2.8 Edge Effect

The edge effect describes the changes in population or community structure that occur when two ecosystems collide (ecotone). Some species in the ecotone have a substantially higher number of species and population density than those in either community. This is known as the edge effect.

Edge species are organisms that are found predominantly or most abundantly in this zone. The edge effect is particularly relevant to birds in terrestrial habitats. The ecotone between the forest and the desert, for example, has a higher bird density.

Some EDGE species, such as elephants and pandas, are well-known and already receive considerable conservation attention.

2.9 Biological Spectrum

The biological spectrum consists of all living organisms divided into three domains which are co-existing across various levels of biological organization. The three domains are bacteria, archaea and eukaryota, which are further subdivided into kingdoms. All three domains exist on various levels of biological organization, from a cellular level to its biosphere.

2.10 Biome

A biome is very large ecological area on the earth's surface in which flora and fauna adapt themselves in a particular way in the given environment. Biomes is the major subdivision of the biosphere.

It is an assemblage or collection of plants, animals and soil where these biotic and abiotic components have common characteristics. One biome is differentiated from other by its characteristics. Cardinal feature of each biome is that they are recognizable by the characteristic structure of its dominant vegetation.

Biomes pertaining to the land are called Terrestrial Biomes and that related to ocean and water is called Aquatic Biomes.

Biogeographic Regions in India

India has ten biogeographic zones with each zone having different characteristic climate, soil and biodiversity. These are:

- **Trans-Himalayas:** The Trans-Himalayas is an extension to the Tibetan plateau. This region comprises of the high-altitude cold desert in Ladakh (Jammu and Kashmir) and Lahaul-Spiti (Himachal Pradesh).
- **Himalayas:** The Himalayas are the northern boundaries of India. The entire mountain chain is running from Kashmir in the North-west to Assam in the north-east. The Himalayas comprise of a diverse range of biotic provinces and biomes.
- **Western Ghats:** The Western Ghats are a mountain range that runs along the western coast of India. They are a range extending north-south from southern tip of Gujarat in the north to Kanyakumari in the south. This section covers an extremely diverse range of biotic provinces and biomes.
- **Gangetic Plain:** This plain covers the area between the south Himalayas to the Tropic of Cancer. These plains were formed by the Ganges river-system and are relatively homogeneous. Sunderbans forests are located in this region.
- **Desert:** The desert of western Rajasthan, Gujarat and the high-altitude cold desert of Jammu & Kashmir and Himachal Pradesh are the kinds of deserts found in India.
- **Deccan Peninsula:** It is a large triangular plateau south of the Narmada valley. It is the one of largest zones covering the southern and south-central plateau with mostly deciduous trees.
- **Semi-arid:** This zone lies between the desert and the Deccan plateau. It includes the Aravalli hill range.
- **North-east India:** These are non-Himalayan regions of north-eastern India and have a wide variety of vegetation.
- **Coasts:** India has a large coastline distributed both to the east and west with distinct differences between the two.
- **Islands:** The Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep Islands in the Arabian Sea have wide variety of ecosystems.