# Government of Tamilnadu

## Department of Employment and Training

Course : TNPSC Group I Mains Material

Subject : Environment, Biodiversity and Disaster Management

Topic : Ecology: Structure and function of Ecosystem



**Commissioner,**

**Department of Employment and Training.**

# ECOLOGY – STRUCTURE & FUNCTION OF ECOSYSTEM

## ECOLOGY:

Scientific study of the reciprocal relationship between organisms includes Microbes, Plants, Animals, Man with their environment.

## STRUCTURE OF ECOSYSTEM

### Level of Organization in ecology

Ecology encompasses the study of individual organisms (species), population, community, ecosystem, biome and biosphere which form the various levels of ecological organization.

### 1.Individual

Organism is an individual living being that has the ability to act or function independently. Species are a group of living organisms consisting of similar individuals capable of exchanging genes or of interbreeding. They are considered as the basic unit of taxonomy and are denoted by a Latin binomial, e.g. Homo sapiens.

### 2.Population

Population is a community of interbreeding organisms (same species), occupying a defined area during a specific time. Population growth rate can be positive due to birth and/or immigration or negative due to death and/or emigration.

### 3.Community

Communities in most instances are named after the dominant plant form. A Community is not fixed or rigid; community may be large or small. For example, a grassland community is dominated by grasses, though it may contain herbs, trees, etc.

### Types of community

On the basis of size and degree of relative independence communities divided in two types:

**Major Communities**

These are large sized, well organized and relatively independent. They depend only on the sun's energy from outside. E.g**. Tropical evergreen forests.**

**Minor Communities**

These are dependent on neighboring communities and are often called **societies**. They are secondary aggregations within a major community. E.g. A mat of lichen on a cow dung pad.

**4.Ecosystem:**

An ecosystem is a structural and functional unit of biosphere consisting of community of living beings and the physical environment, both interacting and exchanging materials between them.

**Major components of an ecosystem**

The ecosystem is made up of two main components: A. Abiotic Component and B. Biotic Component

**A. Abiotic Component:** This component of the ecosystem includes the non-living substance of the environment. Example; light, air, soil, water, climate, minerals, etc. Sun is the main source of energy for the earth.

**B. Biotic Component:** This includes a variety of living organisms such as microorganisms, plants and animals. The biotic component of an ecosystem can be further divided into producers, consumers and decomposers based on their capacity to sustain themselves

**a. Producers:** Organisms that can produce or manufacture their own food are known as producers. They do not need to eat other organisms to do this. Producers are also called autotrophs**.** Plants that have green pigments or chlorophyll, produce their own food in the presence of $CO_2$ in the atmosphere, water from the soil and sunlight through a process called 'photosynthesis'. These green plants are called as 'autotrophs' (auto – self; trophs – nourishing) as they manufacture their own food.

**b. Consumers**: Consumers are organisms that cannot manufacture their own food and get their food and nutrients from producers directly or from other organisms. All animals are consumers as they cannot produce their own food. They are called as 'heterotrophs' (hetero – others; Trophs – nourishing). Consumers can be divided into primary, secondary and tertiary consumers.

**1. Primary Consumers** Organisms that feed on producers (green plants) are called primary consumers. They are also called as 'herbivores' or plant eating organisms. Examples of terrestrial herbivore are grasshopper, sheep, goats, cow, rabbit, deer, elephant etc. Examples of aquatic herbivores are zoo plankton, krill, squid, small fish, sea urchin, etc.

**2. Secondary Consumers** Animals that kill and eat the herbivores or plant eating animals are called secondary consumers. They are also called as 'carnivores', Example; lion, tiger, foxes, frogs, snakes, spider, crocodiles, etc.

**3. Tertiary Consumers** They are top predators in a food chain. They are carnivores at the topmost level in a food chain that feed on other carnivores or secondary consumers. Example: an owl eats a snake but an owl is eaten by a hawk, therefore a hawk is a tertiary consumer. Tertiary consumers that occupy the top trophic level, and are not predated by any other animals are called 'apex predators'.

However, when they die their bodies will be consumed by scavengers besides the decomposers Example: alligator and hawk. Some organisms eat both plants and animals. These animals are called as omnivores. Example: cockroach, foxes, seagull and human.

Some omnivores are 'scavengers', which eat food that other animals have left behind Example: hyena and vultures. Plants and animals that live on or inside other plants or animals are called as Parasites. Example: mistletoe lives on other plants. Other examples are tapeworms, round worms, lice, ticks, flea etc.

'Detritivores' are consumers that feed on detritus. Detritus includes fallen leaves, parts of dead trees and faecal wastes of animals. Ants, termites, earthworms, millipedes, dung beetle, fiddler crabs and sea cucumbers are detritivores.

**4. Decomposers:** Decomposers are organisms that help decompose dead or decaying organisms. Decomposers are also heterotrophs. Decomposers are nature's built-in recycling system. By breaking down materials – decomposers return nutrients to the soil. They, in turn, create another food source for producers within the ecosystem. Mushrooms, yeast, mould, fungi and bacteria are common decomposers.

**Types of Ecosystem:**

Ecosystems can be either natural or artificial.

**Natural ecosystem**

Ecosystem originated without human intervention is called a natural ecosystem. This can be an aquatic ecosystem or a terrestrial ecosystem. The ecosystem in water is called aquatic ecosystem. Sea, river, lake, pond and puddle are some examples of natural aquatic ecosystem. Ecosystems outside the water body and on land are called terrestrial ecosystems. Forests, Mountain regions, Deserts etc., are examples of natural terrestrial ecosystems.

**Artificial ecosystem**

Artificial ecosystems are created and maintained by human. They have some of the characteristics of natural ecosystems. They are much simpler than the natural ecosystems. These can be the terrestrial ecosystems such as paddy fields, gardens etc. or the aquatic ecosystem such as fish tank.

**Ecotone:**

The zone of junction between two or more diverse ecosystems called ecotone.

Characteristics of ecotone:

1. It may be very narrow or quite wide.
2. It has the conditions intermediate to the adjacent ecosystems. Hence it is a zone of tension.
3. It is a linear as it shows progressive increase in species composition one in coming community and simultaneous decrease in species of the other outgoing adjoining community.

**4.Edge Effect:**

The number of species and the population density of some the species is much greater in this zone than either community.

**Niche:**

A niche is the unique functional role or place of a species in an ecosystem. The physical, chemical and biological factors that a species needs to survive, stay healthy, and reproduce. A niche is unique for a species, which means no two species have exact identical niches. Niche plays important role conservation of organism.

**Types of Niche:**

1. Habitat niche-Where it lives
2. Food niche-what it eats or decomposes and what species it competes with.
3. Reproductive niche-how and when it reproduces
4. Physical and chemical niche-temperature, land, shape, land slope, humidity and other equipment.

**Biomes:**

A biome is a geographically extensive ecosystem where all flora and fauna are found collectively. It is the total assemblage of plant and animal life interacting within the biosphere. Biomes are defined by abiotic factors like, relief, climate, soils and vegetation. They are classified into two broad categories, terrestrial biomes and aquatic biomes.

**Types of Biomes**

World Biomes are mega ecosystems existing and operating over large areas. These divisions are based on climate pattern, soil types, and the animals and plants that inhabit an area. Basically, biomes are classified into two major groups such as Aquatic biomes and Terrestrial biomes. Wetlands are transition zones between aquatic and terrestrial biomes

To understand the earth biomes, it is necessary to understand the following:

1. The characteristics of regional climates.
2. Aspects of the physical environment.
3. The type of soil and the processes contributing to soil development.
4. The distribution of flora in the area.
5. The distribution of fauna in the area and their adaptation to the environment.

## A. Aquatic Biomes

The aquatic biomes are the most important of all the biomes as, the water forms the vital resource and is essential for any life form. Since many types of species live in the water, it is one of the most important natural resources that need to be protected.

**Aquatic Biome is further divided into:**

a. Fresh Water Biome
b. Marine Biome
c. Corals
d. Wetlands
e. Estuaries.
f. Mangroves

### a. Fresh Water Biome:

These biomes are spread over all parts of the earth and have different set of species depending on their location and climate. Fresh water Ecosystem are classified as lotic (moving water) includes streams, springs, rivulets, creeks, brooks, and rivers., and lentic (stagnant water) includes ponds, pools, ponds, some swamps. Lakes and ponds are stagnant water bodies and are smaller in their area. The diversity of life forms in river changes with increasing water volume. For example, Dolphins are found in the river Ganges, Brahmaputra and the Indus which carry huge volumes of water.

### b. Marine Biome

The Marine biome is an aquatic biome which is salt water biome occupying seas and oceans of the world. Nearly three quarter of earth's surface is covered by ocean with an average depth of 3750 m and with salinity 35ppt, about 90 percent of which is sodium chloride. Marine biome plants have various roles, plants such as sea grasses and macro algae give shelter and nutrient for many animals.

### c. Corals

Marine plants are sources of nutrients for the corals and help corals to build up reefs. The reefs are kept intact by plants like coralline algae. Corals are marine invertebrates which live in compact colonies. They inhabit tropical oceans and seas.

Corals cannot survive in waters below 20°C but grow optimally in temperatures between 23°–29° Celsius. Coral reefs are marine ecosystems which are held together by structures made of calcium carbonate secreted by the corals. Coral reefs are mainly classified into three types – Fringing reef, Barrier reef and Atoll.

**Fringing reefs** grow seaward from the shore along the coast forming a fringe. They are the common type of reefs.

**Barrier reefs** also border the shoreline but are separated from the coast by an expanse of water or lagoon.

**Atolls** are coral reefs that are circular in shape enclosing a lagoon with absence of an island in the center. Marine biome includes fishes, whales, crustaceans, molluscs, sea anemones, fungi and bacteria. Marine species are continuously impacted by change in climatic condition and the oceans are frequently disturbed by ocean waves and currents.

### d. Wetlands

A wetland is an area of land which is permanently or periodically saturated with water and exists as a distinct ecosystem. Wetlands play many roles in the environment, such as water purification, flood control, carbon sink and shoreline stability. Wetlands are home to a wide range of aquatic plants and animal life. Wetlands can be freshwater, brackish, or saltwater. Examples of aquatic vegetation that thrive in wetlands are milkweed, bald cypress trees, mangroves and cattails.

### e. Estuaries

Coastal bays, river mouths, and tidal marshes form the estuaries. In estuaries fresh water from rivers meet ocean water and the two are mixed by action of tides. Estuaries are highly productive as compared to the adjacent river or sea.

## B. Terrestrial Biome

Terrestrial biomes are a group of living organisms that live and interact with one another on land. They are mainly determined by temperature and rainfall. Terrestrial biomes are very large ecosystems over land and they vary according to latitude and climate. They can be divided into numerous sub-types. In this lesson they are broadly divided into eight types.

### i. Tropical Evergreen Rain Forest Biome

Tropical Evergreen Rain Forest Biome extends between 10° North and South of the equator.

**Regions:**

This biome is seen in the Amazon Basin of South America, Congo Basin of Africa and the Indo Malaysian Region of Southeast Asia (Java, Sumatra, Borneo, Malaysia and Guinea)

**Characteristics:**

This biome receives direct sunlight throughout the year and so temperatures are high year-round. The average annual temperature is 20°C to 30°C. The average annual rainfall of the tropical evergreen rain forest is 200 cm. The Tropical Evergreen Rain Forest Biome has the largest number of plant and animal species. Broad leaved, tall evergreen hard wood trees are found in this biome. Trees grow up to 20 to 35 meters high. The forest is characterized by thick undergrowth and creepers.

The main trees in this biome are mahogany, rose wood, ebony, cinchona, rubber, coconut palm, cane, bamboo etc. This forest biome has innumerable insects, birds, reptiles and furless animals. At the edge of the forest animals like gorilla, and monkey are found.

**Tribes:**

Important tribes inhabit this biome, for example the Pygmies in the jungles of Africa and the Yanomani and Tikuna tribes of the Amazon region. Traditionally they live by hunting and gathering food. In the recent years in South East Asia, the tropical evergreen rainforest has been slowly replaced by rubber and sugarcane plantations. The human settlements in this biome are small and scattered.

### ii. Tropical deciduous Forest/Monsoon Forest Tropical Monsoon forest

Tropical deciduous forest is found in the regions experiencing monsoon climate. This biome is also called as the dry forest or monsoon forest biome.

**Regions:**

This is found in South and South East Asia in parts of India, Myanmar, Vietnam, Thailand, Cambodia and southern coastal China. It is also found in eastern Brazil and in

smaller areas in South and Central America, the West Indies, southeastern Africa, and northern Australia.

**Characteristics:**

In this biome, the temperature varies from one season to another season. In summer the maximum temperature ranges from 38°C to 48°C. Summer season is warm and humid. In the dry winter season temperature ranges between 10°C to 27°C. The total amount of precipitation is 75 to 150 cm/year and this affects the natural vegetation of the tropical deciduous forest biome. The plants shed their leaves during the dry season. Trees here have huge trunks with thick rough barks.

The plants grow at three different levels. The common trees are teak, sal, sandalwood, mahua (illupai), Mango, Wattle, Bamboo, semal (Illavamaram), sheesham (Karuvellamaram) and banyan. The animals of this biome are elephant, lion, tiger, leopards, bison, tapier, hippopotamus, wild boar, flying squirrel along with a wide variety of bird species. This biome faces rapid rate of deforestation and is, therefore, one of the most disturbed ecosystems in the world. Large tracts of forests have been destroyed for agriculture and urban development. Several species of precious animals have now become endangered Example: lions, tigers, leopards, etc.

**iii. Temperate Deciduous Forest Biome**

The temperate deciduous forest is a biome that is always changing. This biome lies in the mid- latitude areas of the earth, between the tropics and Arctic Circle i.e., between 30° and 50° north and south of the equator.

**Regions:**

The temperate deciduous forest biome can be seen in the eastern United States, most parts of Europe, China, Japan, North and South Korea. The average annual temperature is 10°C.

**Characteristics:**

These biomes have four seasons such as winter, spring, summer and fall. Winters are cold and summers are warm. As winter approaches, the duration of day light decreases. In this biome, deciduous trees shed their leaves in the fall. The production of chlorophyll in the leaves slows and eventually stops revealing leaves having bright red,

yellow and orange colors. These forests are also known as broad leaved forest, because the trees have wide flat leaves.

Some important trees found here are oak, maple, beech, hickory, cedar and chestnut. On the forest floors that receive very little sunlight are found mosses, azaleas and mountain laurels. Inhabiting the temperate deciduous forest are ants, insects, flies, bees, wasps, cicadas, walking sticks, moths, butterfly, dragon flies, mosquitoes and praying mantises. Frogs, toads, snakes and salamanders are some of the reptiles in this biome.

Common birds found in this biome are woodpecker, robin, jays, cardinals, owls, turkeys, hawks and eagles. Small mammals like rabbits, otters, monkeys, beavers, squirrels and porcupine are also seen in this biome along with bears, grey fox, wolves, white tailed deer and moose. Animals that live in this biome adapt to the changing seasons. Some animals migrate or hibernate in winter. Most of these forests on the earth are cleared for agriculture. The soil here is very fertile. This is one of the most important agricultural regions of the world.

**Grasslands**

Grasslands are found bordering the deserts and make up for one fourth of the natural vegetation of the earth. Those that lie in the low latitudes are called tropical grasslands and the ones which lie in the mid latitudes are called temperate grasslands.

**iv Tropical Grassland Biome or Savanna Biome**

The tropical grass land biome is generally referred to as the Savanna biome. A savanna is a rolling topography that features vast open grasslands scattered with small shrubs and isolated trees.

**Region:**

It is found between the tropical rainforest and desert biome. Tropical grassland biomes are mainly found in Africa, South America and Australia. Tropical grasslands in Africa is known as the savannas. Tropical grasslands are called as llanos in Columbia and Venezuela and as Campos in Brazil of South America.

**Characteristics:**

Savanna biomes experience warm temperature year around. It has very long and dry winter season and a very wet summer season. The grass here is very tall often one or two metres tall scattered with small shrubs and isolated umbrella shaped trees like the acacia and the baobab trees which store water in their trunks.

Most of the animals in the savanna have long legs, like the giraffe and kangaroo. The carnivorous animals like lions, leopards, cheetahs, jackal and hyenas live in this biome. Zebras and elephants are also found in this biome. In many parts of the savannas of Africa people have started using the grassland for grazing their cattle and goats. Due to overgrazing in this region most of the tropical grasslands here are lost to the Sahara Desert year after year.

**v. Temperate Grassland Biome or Steppe**

**Region**

The temperate grassland biomes are generally found in the interior of the continents in the mid latitudes.

**Characteristics:**

These grassland biomes are found in the transitional zone between the humid coastal areas and the mid latitude deserts. The temperate grasslands are known as Steppes in Europe and Asia, Prairies in North America (Canada and USA), Pampas in South America, Veldts in South Africa, Downs in Australia and Puszta in Hungary. The annual range of temperature is quite large with summer temperature reaching as high as 38°C and winter temperatures falling down to -40° C. The rainfall is moderate from 25 cm to 50 cm. Grasses form a major part of the vegetation in the temperate grasslands. The height of the grasses depends upon the amount and distribution of rainfall.

The animals in this area include the bison, wolves of the Prairies of North America. The other animals and birds are coyotes, prairie dog, foxes, mice, rabbits, badgers, rattle snakes, pocket gophers, weasel, grasshoppers, quails and hawks.

### vi. Tropical Desert Biome

A tropical desert is the hottest and driest place on earth where rainfall is very scanty and irregular.

**Regions:**

This biome is typically found in the western parts of the continents within the tropics. In the northern hemisphere, the Afro – Asian deserts form the longest belt which includes the Sahara Desert, Arabian desert and the Thar deserts. In North America the tropical deserts cover, California, Arizona and New Mexico states of USA and it further extends to Mexico. The deserts in the southern hemisphere are, the Atacama Desert west of Andes mountains in South America, the Namibian and the Kalahari deserts in southern Africa and the Great Australian desert in the central and southern parts of Australia.

**Characteristics:**

The tropical deserts are not conducive for the growth of vegetation due to shortage of water. The plants found here are the xerophytes which have their own moisture conserving methods such as long roots, thick barks, waxy leaves, thorns and small leaves so as to avoid evaporation-transpiration. The main trees and bushes found in this region are acacia, cacti, date palm, kikar, babul etc. The animals in this biome are limited in number. They are able to bear the drought and the heat of the desert. Animals like the camel, antelopes, fox, spotted hyena, fallow deer, cape hare, hedgehog etc., live in the desert. The tropical desert biomes are agriculturally unproductive except in and near the oasis. In the oasis, cultivation is carried through irrigation either from streams or from underground sources. Date palms are widely grown here. The people in the deserts are generally nomads living in tents and moving from place to place. They are the Berbers of North Africa, the Bedouins of the Arabian deserts, the Damara in Namibia, the Bushman of the Kalahari Desert and the Aborigines of Australia. They practice food gathering and hunting while some herd cattle, goats and camel and some of them practice very simple subsistence farming.

### vii. Taiga or Boreal Forest Biome

The taiga biome is the largest terrestrial biome and extends across Europe, North America and Asia. The taiga biome is also known as coniferous forest or boreal forest biome.

**Regions:**

It extends from about 50° to 55° North to 65 ° to 70° North latitudes. This region lies between the temperate grassland in the south and the polar tundra in the north. The taiga region is absent in the southern hemisphere mainly because of the narrowing of continents towards the South Pole.

**Characteristics:**

This biome has short wet summer and long cold winters. The taiga region has low mean annual precipitation ranging between 35 cm and 60 cm and the rainfall occurs mostly in summer. It receives plenty of snow during winter. The taiga or boreal forest biome consists mainly of evergreen coniferous forests. The important coniferous trees in this biome are pines, spruces, firs, maples and cedars. During the short summer season snow melts and this helps lichens, mosses and short grasses to grow and cover the ground. These are called meadows. Taiga is the home of some larger animals like moose, deer, and bears, while smaller animals like bobcats, squirrels, chipmunks, ermine, and moles are also found. Animals of the taiga have specialised adaptation including lot of thick fur or feathers and the ability to change colours during different seasons example ermine.

Lumbering is the main occupation of the people in areas which are easily accessible. The softwood from the coniferous forests is widely used in the manufacture of wood pulp and paper, newsprint, matches, furniture and building materials. The hunting of fur bearing animals like musk rats, ermine, and silver fox are important economic activities. The taiga forest is endangered due to logging and mining by humans. When trees are cut down in the taiga it takes a very long time to restore itself because of the very short growing season.

**viii. Tundra Biome**

Tundra is a Finnish word which means barren land.

**Region:**

The tundra region is a vast bowl lying beyond the Arctic Circle (66.5° North latitude) in the northern hemisphere along the shores of the Arctic Ocean. The Arctic tundra extends southwards from North Pole to the Taiga forest. Tundra is also found in the high altitudes especially in the Alpine region.

**Characteristics:**

Due to long and severe cold winters, this region is treeless and has very little vegetation. The growing season for plants is very short. Natural vegetation mainly consists of shrubs, sedges, grasses, mosses and lichens. The main features of this climate in the tundra region are the general absence of insolation and presence of very low temperature throughout the year. The average annual temperature is about -12°C. The ground surface is covered with snow for at least 8 to 9 months in a year.

In this biome, the sub soil remains permanently frozen and is known as permafrost. Permafrost tundra covers vast barren areas of northern Russia and Canada. Algae and fungi are found on the rocky cliffs and rosette plants grow in rock and gravel beds. Spongy turf and lichen develop in the drier inland tundra. Animals common to Arctic tundra are the polar bear, arctic wolf, arctic fox, arctic hare and arctic weasel.

Large herbivores such as musk oxen, caribou and reindeer are found. Lemmings are also found in this Biome. Insects like moths, butterflies, beetles, mosquitoes and black flies are common in the Arctic tundra. Migratory birds include tundra swans, harlequin ducks, sand pipers, plovers, geese and gulls. The Antarctic region is covered with ice sheets. It is too cold and dry to support vegetation. However, some portions of the continent have areas of rocky soil that support plant life. Vegetation comprises of mosses, lichens and liverworts. This area is referred to as Antarctic tundra. Seals and Penguins inhabit the shore areas of Antarctica.

**Biosphere:**

The word Biosphere originates from the Greek words bios = life and sphaira = sphere. Earth is the only planet in the solar system that supports life. There are many reasons that contribute to this and the most important being the earth's distance from the sun, the presence of oxygen in the atmosphere and the presence of water. The above factors, along with the existence and interaction of the three spheres of the earth (the lithosphere, hydrosphere and atmosphere) gives rise to the fourth sphere which is the life sphere or biosphere. The term Biosphere was coined by Eduard Suess in 1875. Later contributions to the study of biosphere were from, Charles Darwin and many other scientists. Thus, in the biosphere, life exists on land, water and air and life forms range from microorganisms

to plants, animals, birds, amphibians, reptiles and mammals including human beings. The biosphere is formed of biotic components. It consists of organisms, population, community and ecosystem.

**Organism** – includes animals, plants and microorganisms.

**Population** – is a group of similar plants or animals living in an area.

**Community** – refers to all the plants and animals living in an area.

**Ecosystem** – all living and non living things and their interaction within an area.

## FUNCTION OF ECOSYSTEM

The function of ecosystem is a broad, vast and complete dynamic system.

The functions are:

1. Energy flow
2. Pollutants and trophic level
3. Food chain
4. Food web
5. Energy pyramids
6. Nutrient cycling
7. Ecological succession

### 1.Energy Flow:

Energy is a path way along which the energy flows through the organisms from producers to top carnivores called energy flow which is Unidirectional. Energy is basic force responsibilities for all metabolic activities. The available energy in a food chain decreases with each step or trophic levels up in the food chain. As such, there is less energy available to support organisms at the top of the food chain. That is why the tertiary and quaternary consumers are far less in number in an ecosystem than organisms at lower trophic levels.

The food chain begins with the energy given by the Sun. Sunlight triggers photosynthesis in plants. The energy from the Sun is stored in the plant parts. When the grasshopper eats the grass, the energy flows from grass to grasshopper. Frog gets energy by eating grasshopper. This energy is transferred to a crow, when the frog is eaten by a

crow. Thus, we conclude the primary energy production in the world of living things is made by plants; that is by photosynthesis.

The microorganism reduces the excreta and the dead bodies of animals into primary simple components and puts them back into soil. It is this material that help the plants to grow. Thus, we can see that there is a cycle of materials from primary producers to highest level predators, then back to soil.

**2.Pollutants and Trophic level**

Pollutants especially non degradable ones move through the various trophic levels in ecosystem. non degradable pollutants mean materials which cannot be metabolized by the living organism.

Movement of pollutants involves two main processes

**1.Bio Accumulation:** It refers to how pollutants enter a food chain, there is increase in concentration of a pollutants from the environment to the first organism in a food chain.

**2.Biomagnification:** It refers to the tendency of pollutants to concentrate as they move from one trophic level to another trophic level. It increases the concentration of a pollutant from one link in a food chain to another.

**Trophic level:** The study of trophic level interaction in an ecosystem gives an idea about energy flow through the ecosystems also deals with how the members of an ecosystem are connected based on nutritional needs.

Trophic levels:

1. Autotrophs-green plants(producers)
2. Heterotrophs
    a. Herbivore (primary consumers)
    b. Carnivore (secondary consumers)
    c. Carnivores (tertiary consumers)
    d. Top carnivores (quaternary consumers)

Energy flow through the trophic levels from producers to subsequent trophic levels. The energy always flows from lower to higher trophic level.

## 3.Food chain:

A food chain describes the flow of food in an ecosystem. This flow or feeding structure in an ecosystem is called 'trophic structure'. Each level in this structure is called a trophic level. In any ecosystem there is a chain like relationship between the organisms that live there. This sequence of who eats whom in an ecosystem is called as food chain. It describes how organisms get energy and nutrients by eating other organisms. A food chain shows the relationship between producers (e.g. grass) and consumers (e.g. deer, goats, cows and tiger).

### Types of food chain:

### Grazing food chain:

Consumer which start the food chain, utilizing the green plant or plant part as their food constitute the grazing food chain. Example: Plant (primary producer) is eaten by a rabbit (herbivores, primary consumer), rabbit is eaten by a snake (carnivores, consumer or primary carnivore) and the snake is eaten by a hawk (tertiary consumer).

### Aquatic food chain:

In aquatic ecosystem phyto-planktons is eaten by zoo planktons which is eaten by fishes and fishes are eaten by pelicans. Eg - phytoplankton zooplankton fish pelican

### Detritus food chain:

It starts from dead organic matter of decaying animals and plant bodies consumed by the microorganisms and then to detritus feeding organism called detrivores or decomposer.

Litter →earthworms → chicken→ hawk

### Importance of food chain

1. Learning food chain help us to understand the feeding relationship and interaction between organisms in any ecosystem.
2. Understanding the food chain also helps us to appreciate the energy flow and nutrient circulation in an ecosystem. This is important because pollution impacts the ecosystem.
3. The food chain can be used to understand the movement of toxic substances and their impacts.

## 4.Food web

A Food Web is a complex network of interconnected food chains. Food chains show a direct transfer of energy between organisms.In a food web, the mouse might eat seeds, but it also might eat some grains, or maybe even some grass. The mouse might be eaten by a snake, or the eagle, or even a fox. The snake could be eaten by the eagle, but also might be eaten by a fox in the forest. Since each organism can eat multiple organisms and be eaten by multiple organisms, a food web is a much more realistic scheme of the transfer of energy within an ecosystem.

Food chains and food webs are found in both terrestrial and aquatic ecosystems. Organisms in a food chain or food web are linked and dependent on one another for survival. If organisms in one trophic level become threatened, it impacts the organisms in other trophic levels. Primary consumers get less food due to loss or destruction of habitat. This in turn means less primary consumers for secondary and tertiary consumers to feed.

The plant and animal species in such an environment could become endangered or even extinct. For this reason, it is vital that an ecosystem remains balanced containing an appropriate proportion of producers and consumers. Consumers have different sources of food in an ecosystem and do not rely on only one species for their food. If we put all the food chains within an ecosystem together, then we end up with many interconnected food chains. This is called a food web.

A food web is very useful to show the many different feeding relationships between different species within an ecosystem.

## 5.Ecological pyramids:

The steps of trophic levels expressed in a diagrammatic way referred as ecological pyramid. The pyramid consists of a number of horizontal bars depicting specific trophic levels which are arranged sequentially from primary producer level, through herbivore, carnivore onwards. The length of each bar represents the total number of individuals at each trophic level in an ecosystem.

**The ecological pyramids are three categories:**

1. **Pyramid of numbers**

**Pyramids of numbers upright:**

The number of individuals decreased from lower level to higher level. This type of pyramid can be seen in grassland ecosystem.

The number of individuals is increased from lower level to higher trophic level. This type of pyramid can be seen in parasites.

**2. Pyramid of biomass**

To overcome the shortcomings of pyramid of numbers, the pyramid of biomass is used in this method each trophic level weighed instead of being counted. pyramid of bio mass means the total dry weight of all organism at each trophic level at particular time. Biomass is measured in g/m2. The upward biomass is in terrestrial ecosystem, the inverted pyramid is in aquatic ecosystems.

**3. Pyramid of energy**

Energy pyramids are another tool that ecologists use to understand the role of organisms within an ecosystem. An energy pyramid reflects the laws of thermodynamics with conversion of solar energy to chemical energy and heat energy at each trophic level and with loss of energy being depicted at each transfer to another trophic level. Hence the pyramid is always upward, with a large energy base at the bottom.

The most of the energy in an ecosystem is available at the producer level. As you move up on the pyramid, the amount of available energy decreases significantly. It is estimated that only about 10% of the energy available at one trophic level gets transferred to the next level of the energy pyramid. The remaining 90 percent of energy is either utilized by the organisms within that level for respiration and other metabolic activities or lost to the environment as heat. The energy pyramid shows how ecosystems naturally limit the number of each type of organism it can sustain.

**6.Bio Geochemical Cycles:**

Nutrients move through the ecosystem in cycles is called 'biogeochemical cycles'. A biogeochemical cycle is a circuit or pathway by which a chemical element moves through the biotic and the abiotic components of an ecosystem. All life processes are associated with the atmosphere by important cycles such as the Carbon, Oxygen, Nitrogen cycles etc. Through these cycles energy and materials are transferred, stored and released into various ecosystems.

**Types of nutrient cycle:**

Based on the replacement period a nutrient cycle is referred to as perfect or imperfect cycle.

**A perfect nutrient cycle:**

The nutrients are replaced as fast as they are utilized most gaseous cycles are considered as perfect cycles. The gaseous cycles where the reservoir is the atmosphere or the hydrosphere. The gaseous cycles are water, carbon, nitrogen.

**Water Cycle**

Water cycle or hydrological cycle is the continuous movement of water on earth. In this process, water moves from one reservoir to another, from river to ocean or from ocean to the atmosphere by processes such as evaporation, sublimation, transpiration, condensation, precipitation, surface runoff and infiltration, during which water converts itself to various forms like liquid, solid and vapour.

**Evaporation**

Evaporation is a type of vaporization, where liquid is converted to gas before reaching its boiling point. Water evaporates from the surface of the earth and water bodies such as the oceans, seas, lakes, ponds and rivers turn into water vapour.

**Sublimation**

Sublimation is conversion of solid to gas, without passing through the intermediate liquid phase. Ice sheets and ice caps from north and south poles, and icecaps on mountains, get converted into water vapour directly, without converting into liquid.

**Transpiration**

Transpiration is the process by which plants release water vapour to atmosphere through small pores in leaves and stems.

**Condensation**

Condensation is the changing of gas phase into liquid phase and is the reverse of vaporisation. At higher altitudes, the temperature is low. The water vapour present there condenses to form very tiny particles of water droplets. These particles come close together to form clouds and fog.

### Precipitation

Due to change in wind or temperature, clouds combine to make bigger droplets, and pour down as precipitation(rain). Precipitation includes drizzle, rain, snow and hail.

### Run off

As the water pours down, it runs over the surface of earth. Runoff water combines to form channels, rivers, lakes and ends up into seas and oceans.

### Infiltration

Some of the precipitated water moves deep into the soil. Then it moves down and increases the ground water level.

### Percolation

Some of the precipitated water flows through soil and porous or fractured rock. Infiltration and percolation are two related but different processes describing the movement of water through soil.

### Human impacts on water cycle

Major human activities affecting the water cycle on land are urbanization, dumping of plastic waste on land and into water, polluting water bodies and deforestation.

### 1. Nitrogen Cycle

Nitrogen is primary nutrient important for survival of all living organisms. It is an essential component of proteins, DNA and chlorophyll. Atmosphere is a rich source of nitrogen and contains about 78% nitrogen. Plants and animals cannot utilize atmospheric nitrogen. They can use it only if it is in the form of ammonia, amino acids or nitrates. Processes involved in nitrogen cycle are explained below.

### Nitrogen fixation

Nitrogen fixation is the conversion of atmospheric nitrogen, which is in inert form into reactive compounds available to living organisms. This conversion is done by a number of bacteria and blue green algae (Cyanobacteria). Leguminous plants like pea and beans have a symbiotic relationship with nitrogen fixing bacteria Rhizobium. Rhizobia occur in the root nodules of leguminous plants and fixes nitrogenous compounds.

### Nitrogen assimilation

Plants absorb nitrate ions and use them for making organic matter like proteins and nucleic acids. Herbivorous animals convert plant proteins into animal proteins. Carnivorous animals synthesize proteins from their food.

### Ammonification

The process of decomposition of nitrogenous waste by putrefying bacteria and fungi into ammonium compounds is called ammonification. Animal proteins are excreted in the form of urea, uric acid or ammonia. The putrefying bacteria and fungi decompose these animal proteins, dead animals and plants into ammonium compounds.

### Nitrification

The ammonium compounds formed by ammonification process are oxidized to soluble nitrates. This process of nitrate formation is known as nitrification. The bacteria responsible for nitrification are called as nitrifying bacteria.

### Denitrification

Free living soil bacteria such as Pseudomonas reduce nitrate ions of soil into gaseous nitrogen which enters the atmosphere.

### Human impacts on nitrogen cycle

Burning fossil fuels, application of nitrogen-based fertilizers and other activities can increase the amount of biologically available nitrogen in an ecosystem. Nitrogen applied to agricultural fields enters rivers and marine systems. It alters the biodiversity, changes the food web structure and destroys the general habitat.

### Microorganisms involved in nitrogen cycle

| Role played in nitrogen cycle | Name of the microorganisms |
|---|---|
| Nitrogen fixation | Azotobacter (in soil) |
| | Rhizobium (in root nodules) |
| | Blue green algae- Nostoc |
| Ammonification | Putrefying bacteria |

| | |
|---|---|
| | Fungi |
| | Nitrifying bacteria |
| Nitrification | Nitrosomonas |
| | Nitrobacter |
| Denitrification | Denitrifying bacteria |
| | Pseudomonas |

**2. Carbon cycle:**

Carbon is exchanged, or cycled among all the spheres of the earth. All living organisms are built of carbon compounds. It is the fundamental building block of life and an important component of many chemical processes. Living things need carbon to live, grow and reproduce. Carbon is a finite resource that cycles through the earth in many forms.

Carbon is an essential element in all organic compounds and since there is only a limited amount available it must be recycled continuously. This takes place in the biosphere. Atmospheric carbon is fixed in green plants through photosynthesis. This carbon is passed on to other living organisms through the food chain. The carbon food compound is utilized and later released to the atmosphere through the process of respiration.

By-products of respiration are carbon- dioxide and water which are returned to the air. A carbon cycle is completed by decomposers like bacteria and fungi which break down dead plants and animal tissues there by releasing some carbon to the air, water and soil. All producers and consumers are not decomposed. The organic matter of some of them is preserved in fossil fuels such as coal and petroleum for millions of years.

In a carbon cycle, carbon moves between reservoirs. Carbon reservoirs include the atmosphere, the oceans, vegetation, rocks, and soil. Today, the carbon cycle is changing. Human activities have added more carbon into the atmosphere. More carbon is moving to the atmosphere when fossil fuels, like coal and oil, are burned. More carbon is moving to the atmosphere as humans destroy the forest. This increase in carbon in the atmosphere causes the earth to warm up more than the normal level, leading to climate change and many problems connected with it.

**An imperfect nutrient cycle:**

The cycle also known as sedimentary cycle. Some nutrients are lost from the cycle and get locked into sediments and so became available for immediate cycling. In sedimentary cycle where the reservoir is the earth's crust. The sedimentary cycles are phosphorus and Sulphur cycle.

**1.Phosphorous Cycle:**

Phosphorous plays a central role in aquatic ecosystems and water quality. Unlike carbon and nitrogen, which come primarily from the atmosphere, phosphorous occurs in large amounts as a mineral in phosphate rocks and enters the cycle from erosion and mining activities. This is the nutrient considered to be the main cause of excessive growth of rooted and free-floating microscopic plants (phytoplankton) in lakes (leads to eutrophication). The main storage for phosphorus is in the earth's crust. On land, phosphorus is usually found in the form of phosphates. By the process of weathering and erosion, phosphates enter rivers, streams and finally oceans. In the ocean, phosphorus accumulates on continental shelves in the form of insoluble deposits. After millions of years, the crustal plates rise from the seafloor and expose the phosphates on land. After more time, weathering will release them from rock, and the cycle's geochemical phase begins again.

**2.Sulphur Cycle**

The sulphur reservoir is in the soil and sediments where it is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rock and sulphur rock) in the form of sulphates, sulphides and organic sulphur. It is released by weathering of rocks, erosional runoff and decomposition of organic matter and is carried to terrestrial and aquatic ecosystems in salt solution. The sulphur cycle is mostly sedimentary except two of its compounds, hydrogen sulphide ($H_2S$) and sulphur dioxide ($SO_2$), which add a gaseous component. Sulphur enters the atmosphere from several sources like volcanic eruptions, combustion of fossil fuels (coal, diesel etc.), from the surface of the ocean and gases released by decomposition. Atmospheric hydrogen sulphide also gets oxidized into sulphur dioxide. Atmospheric sulphur dioxide is carried back to the earth after being dissolved in rainwater as weak sulphuric acid (acid rain). Whatever the source, sulphur in

the form of sulphates is taken up by plants and incorporated through a series of metabolic processes into sulphur bearing amino acid which is incorporated in the proteins of autotroph tissues. It then passes through the grazing food chain. Sulphur bound in a living organism is carried back to the soil, to the bottom of ponds and lakes and seas through excretion and decomposition of dead organic material.

**Questions:**

1. What Is Ecology? Explain the Functions of Ecosystem?
2. Explain the Function and Structure of Ecosystem.
3. Give the detailed account of biomes in the ecosystem?
4. What are biogeochemical cycles? Give the account of various biogeochemical cycles present in the ecosystem?