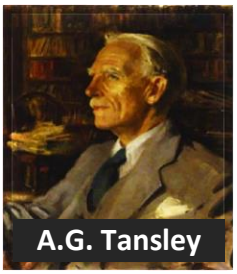
02 Ecosystem

01. INTRODUCTION

- **Definition –** Total living factor (biotic) and total non-living factor (abiotic) of the environment present in a particular area is called ecosystem.

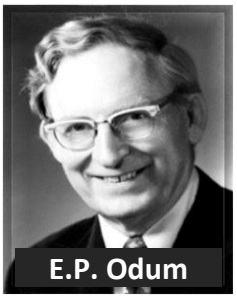

A.G. Tansley

A.G.Tansley – The term "ecosystem" first of all coined by **A.G. Tansley**.

According to Tansley – Ecosystem is symbol of structure and function of nature.

E.P. Odum – Father of ecosystem ecology.

According to E.P. Odum – Ecosystem is the smallest structural and functional unit of nature or environment.


E.P. Odum

- The boundaries of ecosystem are indistinct and have a overlapping character over each other.
- Ecosystem is the smallest structural and functional unit of nature or environment. It is a self regulatory and self sustaining unit.
- Ecosystem may be large or small. Single drop of water may be an ecosystem.
- Ecosystem may be temporary or permanent.
- Ecosystems are of two type - Natural or Artificial.

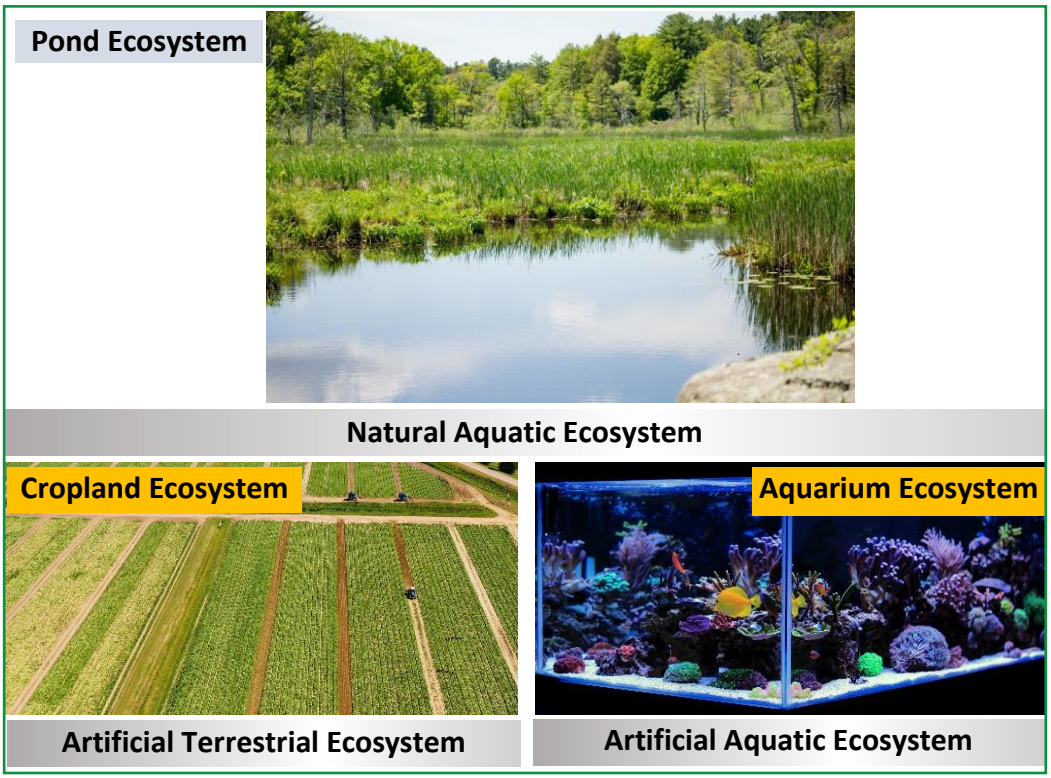
Natural Terrestrial Ecosystem – *e.g.* forest, grassland, tree, desert ecosystem

Natural Aquatic ecosystem – Aquatic ecosystem is again of two type:

- Lentic ecosystem → Stagnant water ***e.g.*** lake, pond, swamp.
- Lotic – Running fresh water ecosystem ***e.g.*** river

Artificial Ecosystem / Man made ecosystem

e.g. cropland, gardens, an aquarium etc.

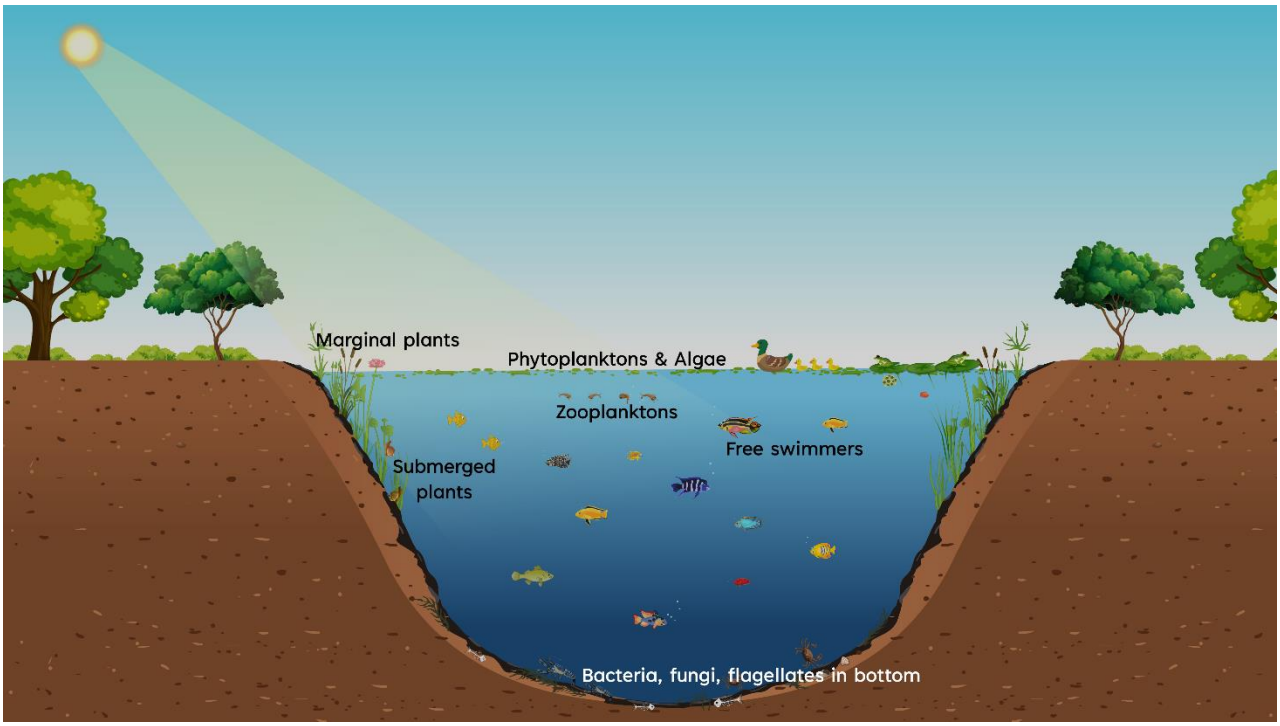


- Every ecosystem is composed of two components – Biotic component & Abiotic component.
- Biotic component involve all livings (plant, animal and microbes) of ecosystem. Biotic component are mainly of two types - producer and consumer.
- Major abiotic components of ecosystems that lead to so much variation in the physical and chemical conditions of different habitats of ecosystems are temperature, water, light and soil.
- Major functional aspects of ecosystems are energy flow, nutrient cycle, decomposition and productivity.

POND : AN AQUATIC ECOSYSTEM

To understand the ethos of an aquatic ecosystem let us take a small pond as an example. This is fairly a self-sustainable unit and rather simple example that explain even the complex interactions that exist in an aquatic ecosystem. A pond is a shallow water body in which all the above mentioned four basic components of an ecosystem are well exhibited. The abiotic

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



NCERT Question :

Fill in the blanks.

(a) Plants are called as _____ because they fix carbon dioxide.

NCERT Question :

Describe the components of an ecosystem.

02. BIOTIC COMPONENTS

(A) PRODUCERS :

All the autotrophs of ecosystem are called producers. They prepare their own food. The green plants are the main producers. In the process of photosynthesis, producers absorb solar energy and convert it into chemical energy so producers are also called **transducers** or **converters.** Energy enters into the ecosystem through the producers. The **solar energy** is the only ultimate source of energy in ecosystem. This energy is available for the remaining living organisms.

In aquatic ecosystem : Floating plants called **phytoplankton** are the major autotrophs.

NCERT Question :

Secondary producers are :-

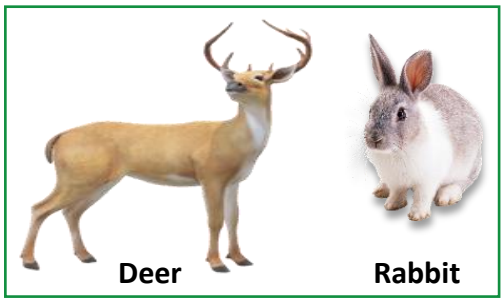
(a) Herbivores (b) Producers (c) Carnivores (d) None of the above

(B) CONSUMER :

All the heterotrophs of the ecosystem are known as consumers. They directly (herbivores) or indirectly (Carnivores) depend on the producers for food.

Types of consumer – Macroconsumers & Microconsumers

(i) Macro consumers (Phagotrophs or holozoic) – They digest their food inside the body i.e. first ingestion then digestion.



Macro consumers are of following type

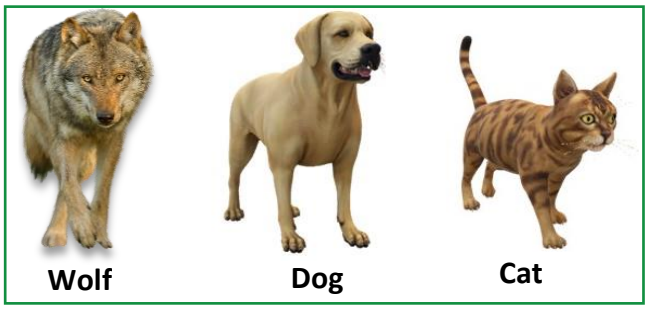
(a) Primary consumer – Such living organisms which obtain food directly from producers or plants are known as primary consumers.

e.g. Herbivores of ecosystem, cow, grazing cattle, Rabbit etc.

These are also known as **secondary producers** .

(b) Secondary consumers or primary carnivores – Animals which feed upon primary consumers and obtain food. Those carnivores which kill and eat the herbivores.

e.g. Dog, cat, snake etc.



(c) Top Consumers – Those animals which kill other animals and eat them, but they are not killed & eaten by other animal in the nature.

e.g. Lion, man, hawk, peacock etc.

(ii) Micro Consumers/Decomposers or Saprotrophs/osmotrophs –

Those living organisms which decompose the dead body of producers and consumers are known as decomposers or reducers or transformers or osmotrophs.

Note – The main decomposers in ecosystem are bacteria and fungi.

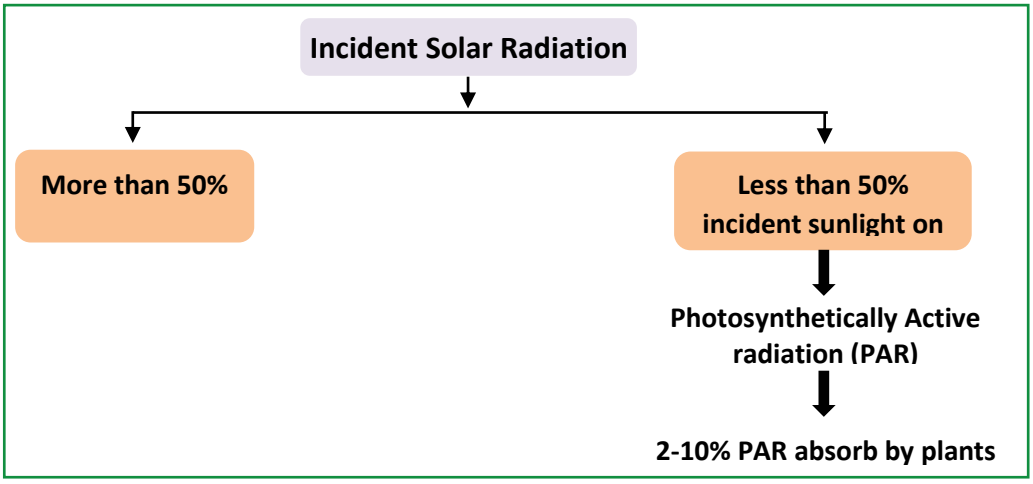
Decomposers play a significant role in mineral cycle. Decomposers are responsible for converting complex organic material of dead animals or plants into simpler organic matter through the process of decomposition and release mineral substances into the soil where these are reused by the producers, so that soil is considered as the best resource of minerals.

In bacteria and fungi, process of decomposition completely takes place outside the body. They release enzymes from their body on dead remains and decompose it into simpler organic substances and then absorb it so these are also called as **osmotrophs.**

		Examples
Tertiary Consumer	Fourth trophic level (Top Carnivore)	Man, lion
Secondary Consumer	Third trophic level (Carnivore)	Birds, fishes, wolf
Primary Consumer	Second trophic level (Herbivore)	Zooplankton, grasshopper and cow
Producer	Firth trophic level (Plants)	Phytoplankton, grass, trees

Fig. 12.2 : Diagrammatic representation of trophic levels in an ecosystem

(C) ENERGY FLOW :



The storage, expenditure, transformation of energy is based on two basic law of thermo-dynamics.

First Law Of Thermodynamics (FLOT) : Energy is neither created nor destroyed but only transformed from one state to another state.

Second Law Of Thermodynamics (SLOT - the law of entropy) : The transfer of food energy from one to another organism leads to loss of energy as heat due to metabolic activity. **Further, ecosystems are not exempt from the Second Law of thermodynamics. They need a constant supply of energy to synthesise the molecules they require, to counteract the universal tendency toward increasing disorderliness.**

NCERT Question :
Distinguish between :
(i) Grazing food chain and detritus food chain
(ii) Food chain and Food web

(D) FOOD CHAIN :

- In ecosystem every organism depends on other organism for food material and all organism are (Plants, herbivores, carnivores) arranged in a series in which food energy is transferred through repeated eating and being eaten. It is called food chain. In food chain, energy flow is in the form of food.
- In a food chain, food material or food energy transfer is from one trophic level to next trophic level.
- **Four trophic levels are present in the ecosystem, because level of energy decreases during the flow of energy from one trophic to the another trophic level.**

First trophic level	$[T_1]$	=	Producers
Second trophic level	$[T_2]$	=	Primary consumers
Third trophic Level	$[T_3]$	=	Secondary consumers
Fourth trophic level	$[T_4]$	=	Top consumers

Note :

- There are **five trophic levels** found in highly complex ecosystem in which tertiary consumer is present in between the secondary consumers and top consumer. Then the fifth trophic level (T_5) is formed by the top consumer.
- In food chain energy flow is **unidirectional** (producers to top consumers)
- Shorter food chains will provide greater energy.
- Generally the decomposers (Bacteria and Fungi) are not included in the food chain.

Type of food chains :- In nature three types of food chains are present

(i) Grazing food chains or Predatory food chain – Most of food chain in nature are of this type. This food chain begins with **producers** (plants) and in successive order it goes from **small organism to big organism**.

Terrestrial Ecosystem :-

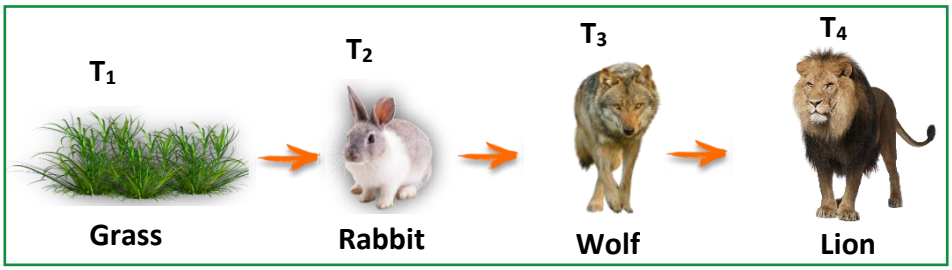


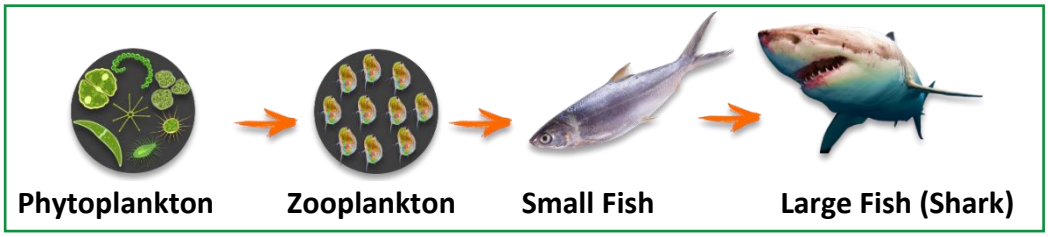
Fig. 12.3

NCERT Question :

The second trophic level in a lake is

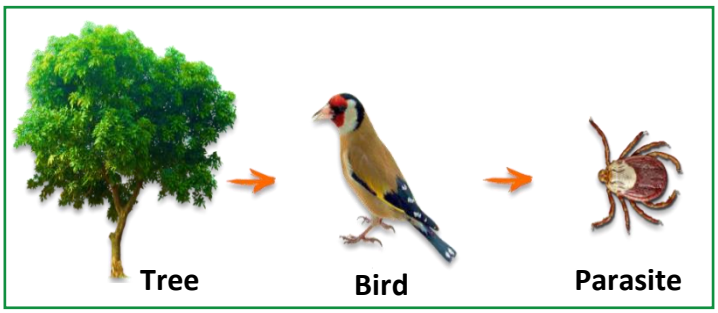
(a) Phytoplankton (b) Zooplankton (c) Benthos (d) Fishes

Aquatic Ecosystem



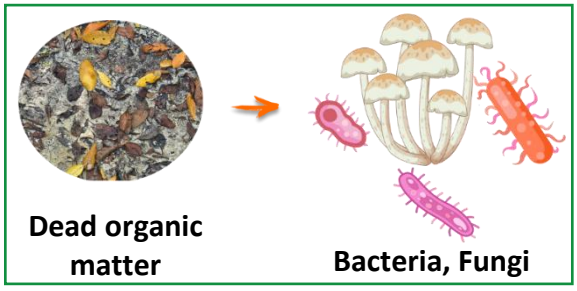
(ii) Parasitic food chain – This food chain also starts from **producers** but in successive order it goes from **big organism to the smaller organism**.

e.g. **Tree ecosystem –**



Note : Both above food chains are directly dependent on **solar radiation** (as a primary source of energy) and have **rapid energy flow**.

(iii) Detritus food chain or Saprophytic food chain – This food chain begins with decomposition of dead organic matter by **decomposers** so it is also known as saprophytic food chain. In this food chain primary consumers are bacteria and fungi.



Note :

- In detritus food chain **energy flow** is rather very slow yet **magnitude** of energy is great.
- In mangrove vegetation this food chain goes up to big organism.
  Dead mangroves leaves → Bacteria & fungi → Aphids, molluscs, crabs, nematodes → Small fishes → Tiger.
- In an aquatic ecosystem, **GFC (Grazing Food Chain)** is the major conduit (source) of energy flow. As against this, in a terrestrial ecosystem, a much larger energy flow through the **(DFC) Detritus food chain** than through the grazing food chain.

Special point of Biotic Factor :

- In Sundarbans, Tigers feed on the fishes and crab in the absence of their natural prey.
- **Nutrient Immobilisation -** In the process of decomposition, some nutrients get tied up with the biomass of microbes and become temporarily unavailable to other organisms. Such incorporation of nutrient in living microbes (bacteria & fungi) is called **nutrient immobilisation.**
- In aquatic system **whale** is secondary consumer. It is an example of **filter feeder** because it feeds on plankton.
- **Plant parasites** are known as primary consumers while **animals parasites** (*E.coli* bacteria, *Entamoeba histolytica*, liver fluke, tapeworm) are known as secondary consumers.

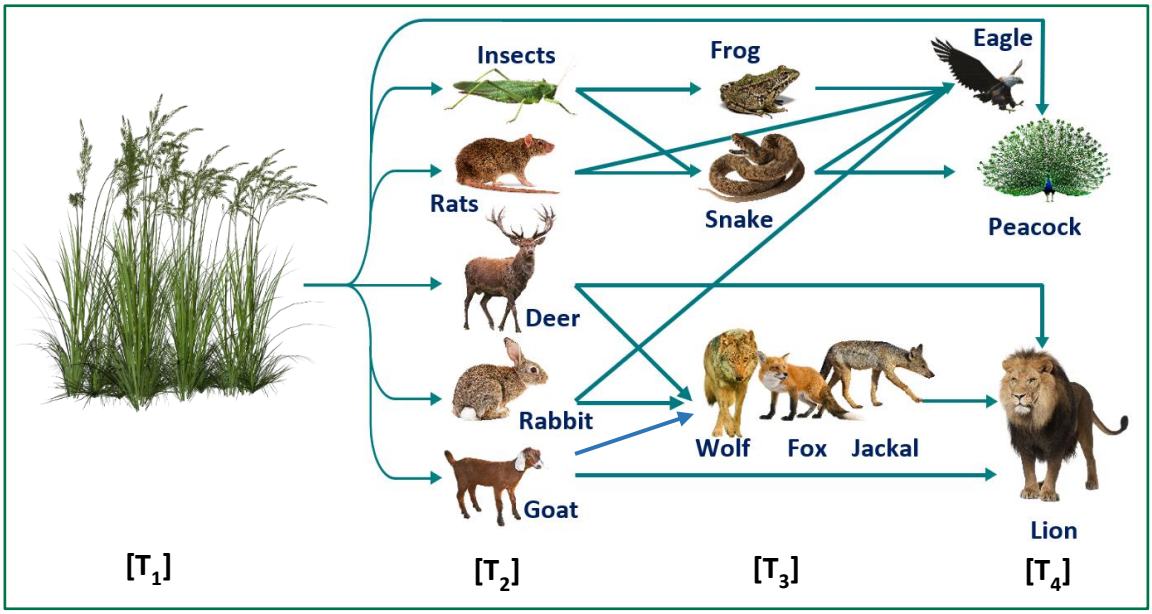
- **All the insectivorous** plants play the double role i.e. producer as well as secondary consumer because they synthesise their own food through photosynthesis and they eat insects simultaneously.
- **Man, peacock, cockroach, crow, sparrow & Fish** are omnivores.
- Organisms which use **milk** or curd as food, are known as secondary consumer.

Note : **Inorganic materials** (CO_2 ,H_2O, Light), autotrophs (**Producers**) and **decomposers** are essential in ecosystem but, **macro consumers** are non-essential.

- Guild $\rightarrow$ Members of same trophic level.

(E) FOOD WEB :

- In big ecosystem many food chains are interlinked together on different trophic levels to form food web. In food web transfer of food energy is unidirectional but from many different alternative pathways.
- In food web members of a particular trophic level obtain their food according to their choice and taste but that type of facility is not present in food chain. It means they have more than one option or alternative for getting food.



As much as food web is complex that ecosystem is more permanent or stable, such type of ecosystem is not destroyed naturally and continues for long time. This ecosystem is not affected by loss of any organism of any particular trophic level. **Those ecosystems which have simple food web are not very stable** it means that they can be finished at any time, if there is a change in any particular trophic level.

(F) HOMEOSTASIS :

- Ecosystem is a dynamic (functional) system because continuous interaction is going on in between biotic or abiotic components so ecosystem is present in an equilibrium position. Ecosystem is also self-maintainable and self-regulatory system, it means an ecosystem maintains a balance in between different trophic levels. Each trophic level controls the other trophic level in an ecosystem. If any change take place in any trophic level of ecosystem, the other trophic levels of this ecosystem may react according to it. So ecosystem always remain in equilibrium. This feature of system is known as **homeostasis.**

NCERT Question :
Distinguish between Upright and inverted pyramid.

NCERT Question :
Define ecological pyramids and describe with examples, pyramids of number and biomass.

(G) ECOLOGICAL PYRAMIDS :

- Graphical representation of ecological parameters at different trophic level in ecosystem is called pyramids. These parameters are Number, Biomass and Energy. First of all, pyramid was formed by **Charls Elton**; so we called it Eltonian pyramids.
- In pyramids basal, mid and top tiers show the parameter values for producer, herbivores and carnivores in the ecosystem.

These pyramid are of three types -

(i) Pyramids of number **(ii) Pyramids of biomass** **(ii) Pyramids of energy**

NCERT Question :
In an ecosystem dominated by trees, the pyramid (of numbers) is _____ type.

(i) Pyramids of number –

In this type of pyramid the number of individual organisms in various trophic level is shown. These pyramids are mostly upright, because number of producers [T_1] is maximum and No. of herbivores and carnivores decrease towards apex or at successive trophic levels, such as Grassland ecosystem and aquatic ecosystem.

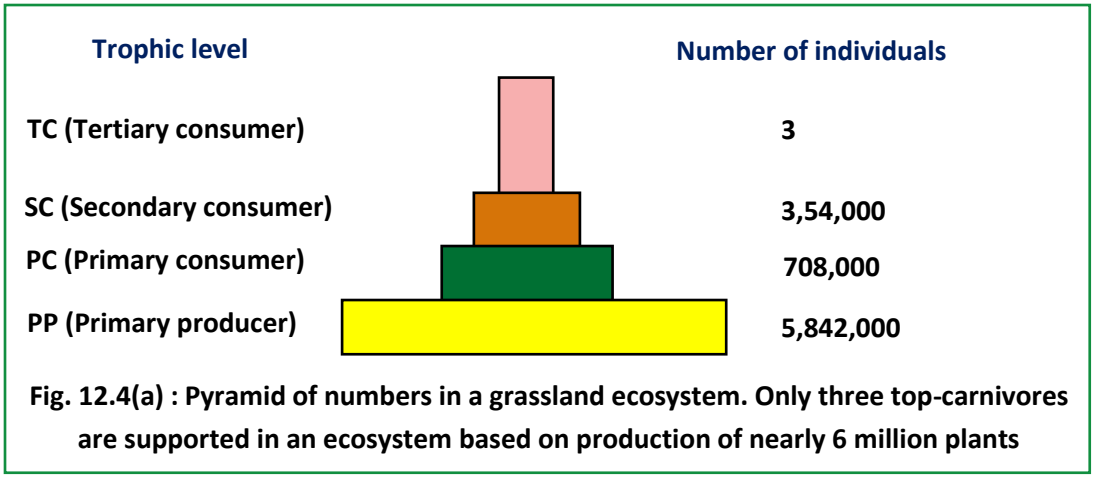
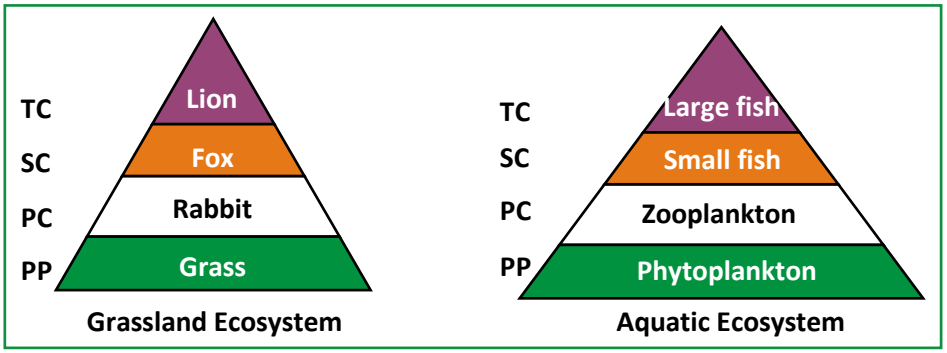
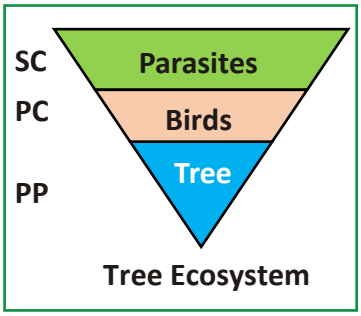


Fig. 12.4(a) : Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 million plants

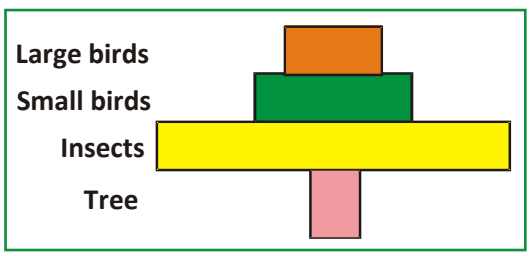


But in a tree ecosystem the pyramid of numbers is inverted. This is called parasitic ecosystem because birds (herbivores) depend on the tree (producer) and parasites (consumer) depend on birds, therefore with increase in the no. of trophic levels, the number of the organisms increases sequentially.



Note: Pyramid of number shows **biotic potential** of an ecosystem.

- Maximum number of producers are present in aquatic ecosystem. **The number of organisms at any trophic level depends upon the availability of organism which are used as food** on lower level so availability of food is main factor.
- If on a big tree, large number of insects feed followed by a number of small birds depending on the insects and large birds eating smaller birds. Shape of pyramid of number – spindle shape



(ii) Pyramid of Biomass –

Pyramids of biomass represent the total amount of biomass of each trophic level of ecosystem, mostly these pyramids are also upright (erect) ***e.g.*** (tree ecosystem), forest ecosystem.

Note : The pyramids of biomass show the **standing crop** of ecosystem.

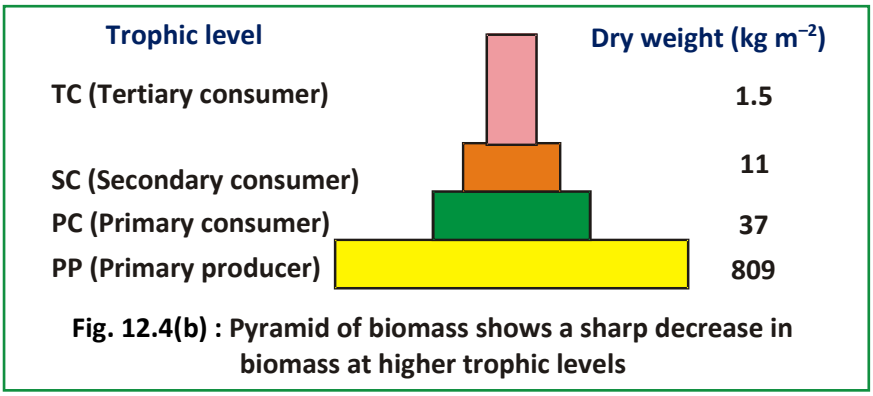
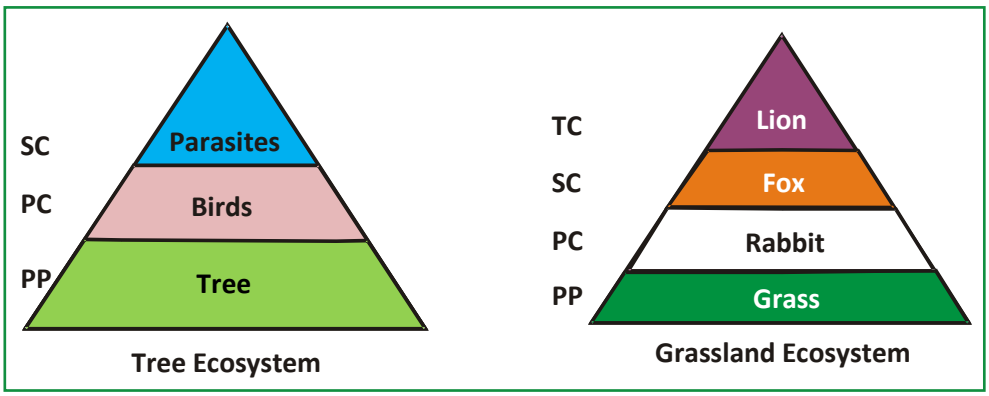


Fig. 12.4(b) : Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels

Fig. 12.4(c) : Inverted pyramid of biomass-small standing crop of phytoplankton supports large standing crop of zooplankton



Pyramids of biomass in **aquatic ecosystem** is inverted because in it producers are micro-organism and their biomass is very less.

NCERT Question :
Give an account of energy flow in an ecosystem.

(iii) Pyramids of energy –

It represents amount of energy at different trophic levels, energy pyramids are always upright or erect because there is a gradual decrease in energy at successive trophic levels.

According to the **10% law of Lindeman**, the 90% part of obtained energy of each organism

is utilized in their various metabolic activities and heat and only 10% energy is transferred to the next trophic level. So 90% energy is lost at each trophic level, therefore **top consumers like lion etc. are ecologically weakest** but physically they are strong.

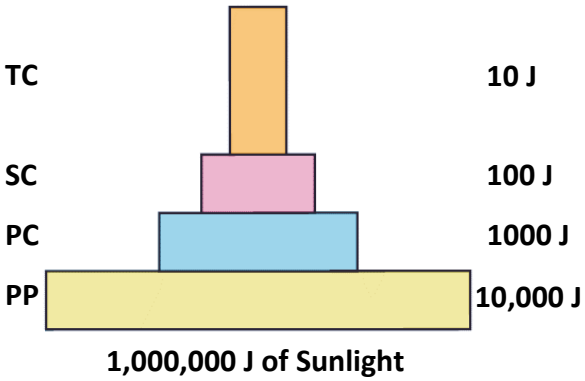


Fig. 12.4(d) : An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

Note : Pyramids of energy represent the productivity of ecosystem as well as transfer of production in ecosystem.

Limitations of Ecological Pyramids :

- It does not take into account (consider) the same species belonging to two or more trophic levels.
- It assumes a simple food chain, something that almost never exists in nature. It does not accommodate a food web.
- Saprophytes are not given any place.

Some Special point :

- **Standing crop –** Total amount of **living organic matter** present in particular area in particular time in an ecosystem is known as standing crop. It may be expressed in terms of weight per unit area.
- Biomass is the standing crop expressed in terms of weight (i.e. organism mass).
- **Standing quality or Standing state** – Total amount of **inorganic substances** such as P, S, N, H present in particular area at a particular time in an ecosystem is known as standing state.

NCERT Question :
Distinguish between Primary and secondary productivity.

NCERT Question :
What is primary productivity? Give brief description of factors that affect primary productivity.

(H) PRODUCTIVITY :

There are two type of productivity present

(i) Primary productivity :

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 (g/m^2) or energy (Kcal m^{-2}). The rate of biomass production is called productivity. It is expressed in terms of g m^{-2} yr^{-1} or (Kcal m^{-2}) yr^{-1} to compare the productivity of different ecosystem.

It is of two types :

(a) Gross primary productivity (G.P.P.) : It is the total amount of energy fixed (organic food) in an ecosystem (in producers) in unit time is called G.P.P. including the organic matter used up in respiration during the measurement period. It is also known as total (Gross) photosynthesis. A considerable amount of GPP is utilised by plants in respiration.

(b) Net primary productivity (N.P.P.): It is the amount of stored organic matter in plant tissues after respiratory utilisation

NPP = GPP – R (R = Respiration / Metabolic activities)

or

GPP = NPP + R

NPP is the available biomass for the consumption to heterotrophs.

(ii) Secondary productivity – Sec. productivity is the rate of formation of new organic matter by consumers.

Note: Net community productivity or Net productivity:

The rate of storage of organic matter not used by the heterotrophs

NCP = N.P.P. – HR (HR = Energy used by Heterotrophs)

During Succession net community productivity or annual yield decreases.

Some information's related to productivity:

- 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 type of ecosystem. The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of the organic matter, productivity of the ocean are only 55 billion tons.

- Among terrestrial ecosystems maximum productivity found in tropical rain forest.
- In water, least productive ecosystem is very deep lakes and highly productive ecosystem is coral reef.
- Limiting factor for productivity in ocean is nitrogen and in lake is phosphorus.

(I) DECOMPOSITION :

- Decomposers break down complex organic matter into simple organic matter (humus) and inorganic substances like carbon dioxide, water and nutrients and the process is called decomposition. Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter, constitute detritus, which is the raw material for decomposition. The important steps in the process of decomposition are **fragmentation, leaching, catabolism, humification and mineralisation.**
- **Detritivores** **(*e.g.* earthworm)** break down detritus into smaller particles. This process is called fragmentation. By the process of leaching, water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts. Bacterial and fungal enzymes degrade detritus into simple organic and inorganic substances, this process is called as **catabolism**.
- It is important to note that all the above steps in decomposition operate simultaneously on the detritus. **Humification and mineralisation** occur during decomposition in the soil. Humification leads to accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature it serves as a reservoir of nutrients. The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as **mineralisation**.
- Decomposition is largely an **oxygen-requiring** process. The rate of decomposition is controlled by chemical composition of detritus and climatic factors. In a particular climatic condition, decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars. **Temperature** and **soil moisture** are the most important climatic factors that regulate decomposition though their effects on the activities of soil microbes. Warm and moist environment favour decomposition whereas low temperature and an anaerobiosis inhibit decomposition resulting in build-up of organic materials.

Golden Key Points

- The boundaries of ecosystem are indistinct and have a overlapping character over each other.
- Natural ecosystem show high stability as compare to artificial ecosystem due to high species diversity.
- During photosynthesis primary producers absorb solar energy and convert it into chemical energy so producers are also called transducer or converters.
- Decomposers play a significant role in mineral cycle so that presence of decomposers is essential for stability or existence of ecosystem.
- There are two basic function of ecosystem. (i) Energy flow, (ii) Nutrient cycling
- Ecosystem are not exempt from the second law of thermodynamics.
- Tertiary consumer is present in between the secondary consumer and top consumer.
- Generally, the decomposers (Bacteria/Fungi) are not included in the food chain but when included then included as the last trophic level.
- Pyramid of number shows biotic potential of a ecosystem. Pyramid of biomass show the standing crop of ecosystem. Pyramid of energy represent the productivity of ecosystem.
- Net primary productivity (NPP) is the available biomass for the consumption to heterotrophs.

BEGINNER'S BOX-1

BIOTIC COMMUNITY TO DECOMPOSITION, ECOLOGICAL PYRAMID, PRODUCTIVITY

1. Grass → Deer → Tiger

In this food chain, the biomass of grass is 1 tonne. The tiger biomass will be :

(1) 100 kg (2) 10 kg (3) 1 kg (4) 1000 kg

BES174

2. An ecosystem is a complete interaction of :

(1) Individual

(2) Population

(3) Community and their soil condition

(4) Community and their physical environment

BES175

3. What is correct for transducers :

(a) They converts solar energy into chemical energy

(b) They have first trophic level

(c) They are osmotrophs

(d) Those show nutrient immobilization

(1) b, c (2) a, b (3) c, d (4) a, d

BES176

4. Ecosystem resists change because its stage is :

(1) Imbalance (2) Homeostasis

(3) Deficient component (4) Affected by light

BES177

5. On Earth in per unit area maximum productivity occur in :

(1) Tropical rain forest

(2) Ocean

(3) Temperate deciduous forest

(4) Marsh

BES178

6. In which of the following ecosystem pyramids are always upright ?

(1) Tree ecosystem (2) Lake ecosystem

(3) Grass land ecosystem (4) All of above

BES179

7. On the basis of ecology which is not essential for self-sustaining ecosystem :

(1) Producer (2) Macro-consumers

(3) Micro-consumers (4) All of above

BES180

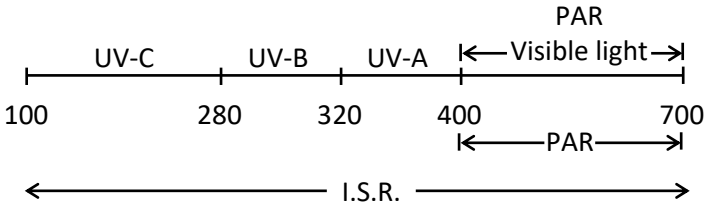
8. Which of the following is not recycled in an ecosystem :

(1) Water (2) Carbon (3) Energy (4) Nitrogen

BES181

(J) Light :

- It is a complex physical environmental factor. Light is measured by luxmeter or photometer. It is a electromagnetic spectrum.
- In solar radiation wavelength (λ) of light or visible spectrum is 0.4 to 0.7 μm (400–700 nm) it is also called photosynthetically active radiation (PAR).



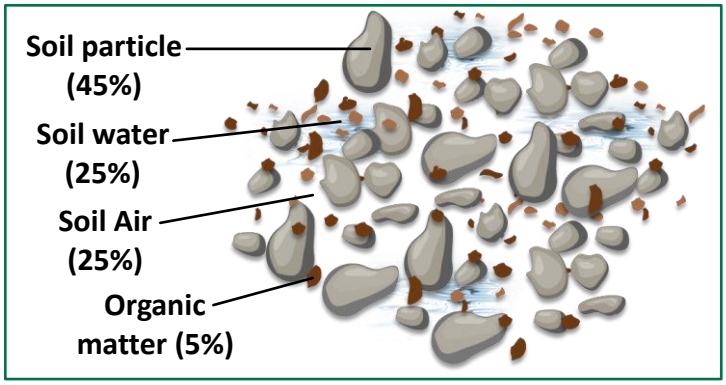
Hydrothermal vents – These are hot water springs in the deep ocean having high concentration of H_2S. Chemosynthetic bacteria oxidizes H_2S producing energy which is used for preparing their own food. Filter-Feeders (clams) eat these bacteria so that this food chain based on chemical energy.

(K) TEMPERATURE :

- Temperature is measured by the thermometer and under water by thermistor.
- Temperature is the most ecologically relevant environmental factor.
- The average temperature on land varies seasonally, decreases progressively from the equator towards the poles and from plains to the mountain tops.
- It ranges from subzero levels in polar areas and high altitudes to >50°C in tropical deserts in summer.
- Temperature affects the kinetics of enzymes and through it the basal metabolism, activity and other physiological functions of the organism.

(L) SOIL :

- Soil is the uppermost layer of earths crust formed by weathering of rocks. It is the mixture of living or non-living materials.



(M) WATER :

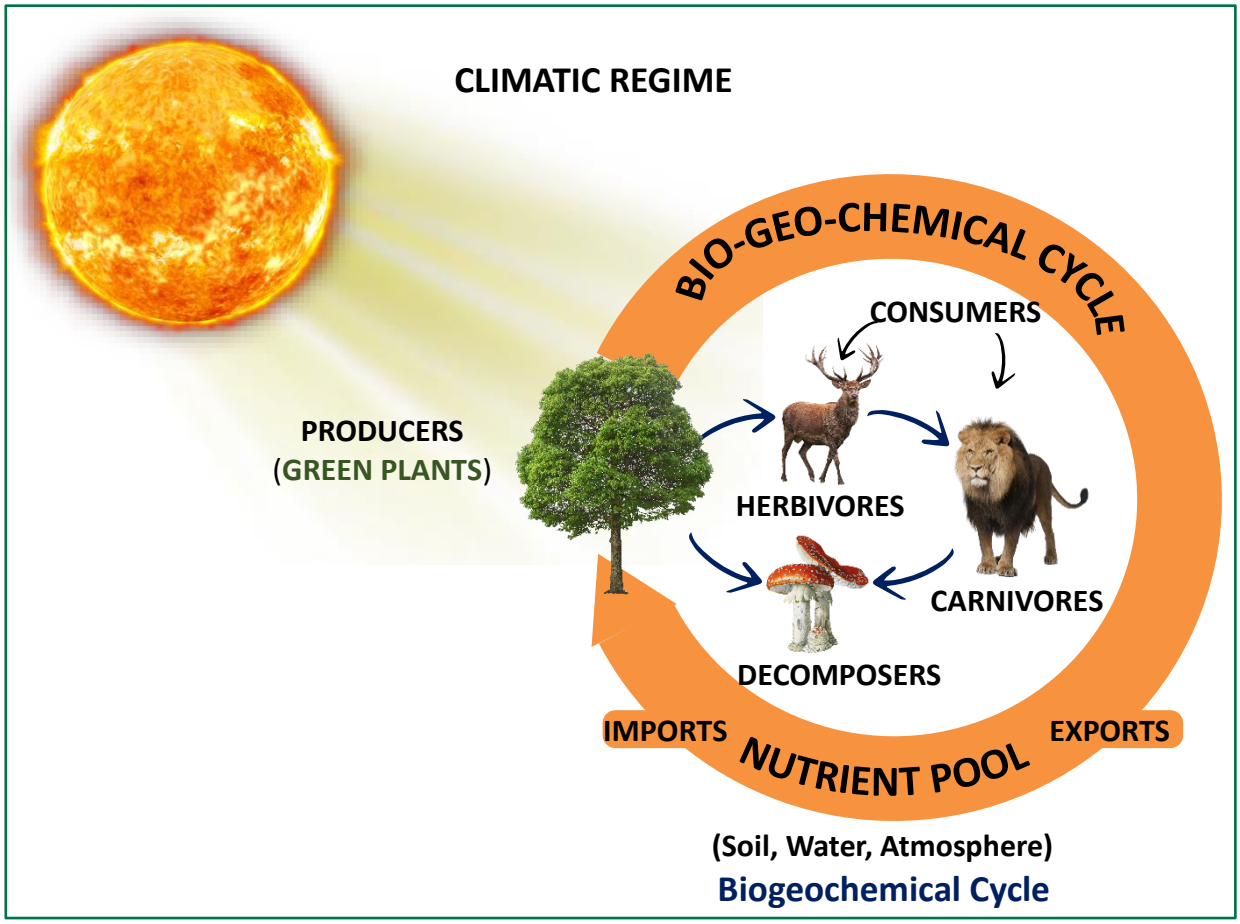
- Next to temperature, water is the most important factor influencing the life of organisms. You might think that organisms living in oceans, lakes and rivers should not face any water-related problems, but it is not true.
- Even life originated in water.

(N) BIO-GEO CHEMICAL CYCLE OR NUTRIENT CYCLE:

Bio	–	Living organism
Geo	–	Rock, Soil, Air, Water
Chemical	–	Mineral or Nutrients
Cycle	–	Path

- All the types of material required by ecosystem in addition of energy, are available continuously to system through recycling. Thus there is a constant exchange of materials between the living organism and their abiotic environment through the recycling of materials. This is called Bio-geo chemical cycle.

Environmental factors, *e.g.*, soil, moisture, pH, temperature etc., regulate the rate of release of nutrients into the atmosphere.



Biogeochemical Cycle

- The reservoir function is to fulfil the deficit in biogeochemical cycle created by imbalance between Influx and efflux.
- Types of nutrient cycles are found in an ecosystem:

  Gaseous Cycle – C, H, N, O cycles. Reservoir is in the atmosphere (air) or in Hydrosphere (water).

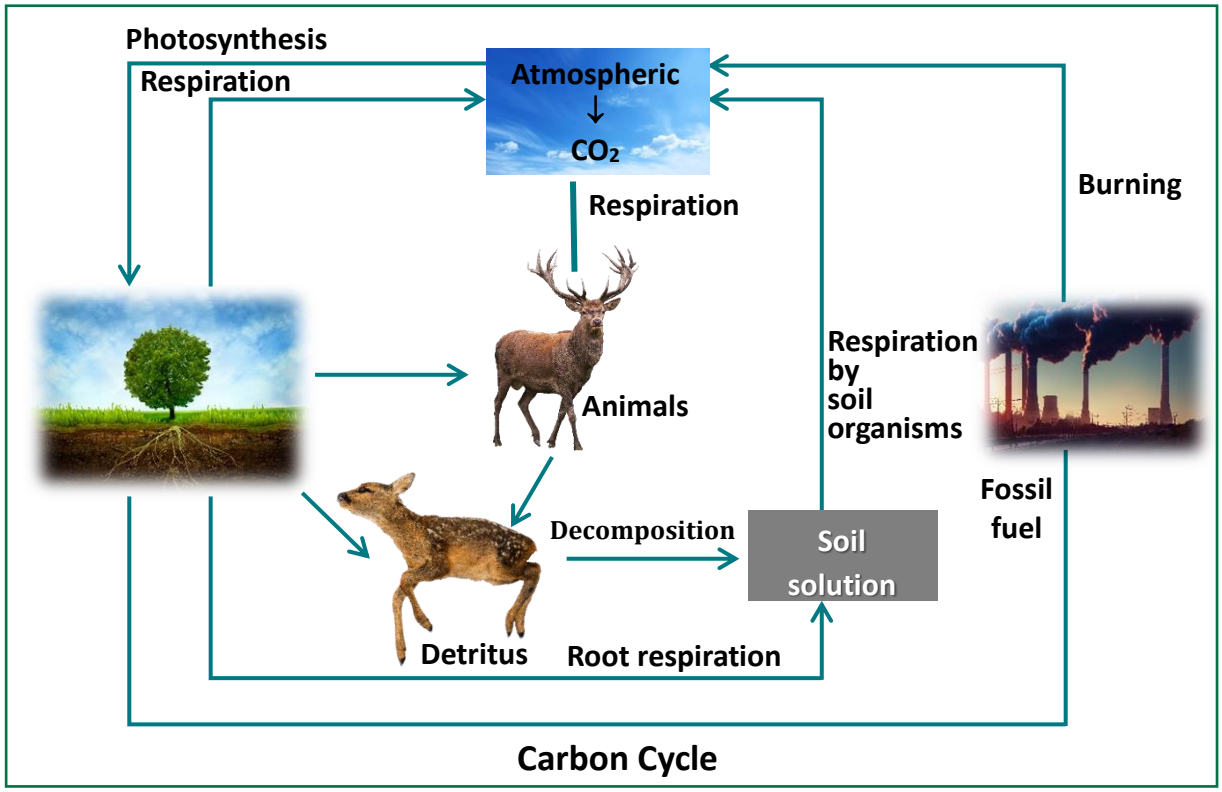
  Sedimentary cycle – P, S, Ca cycles reservoirs are in earth's crust (lithosphere)

Note : In these cycles, the bulk material remains in the inactive reservoir on earth crust like sediment of sea, or water bodies.

(i) Gaseous Cycle :

Carbon Cycle : Main reservoir of carbon are **atmosphere, Ocean, Carbonate, Rocks, Coal** and **Petroleum.** The carbon released from them is present in the atmosphere in the form of carbon dioxide. Carbon is present in every organic component of organism. The green autotrophs utilize CO_2 from the air to synthesize food materials which is obtained by other

organisms as food. Carnivores obtain their carbonic food from the herbivores. These carbonic matter produce CO_2 through the oxidation or respiration which dissolve in air or water and again utilized by the plants.



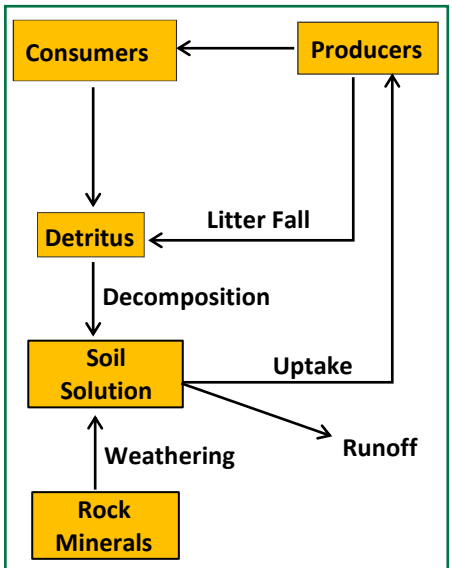
Carbon Cycle

- Carbon constitutes **49%** of **dry weight** of organisms and is next only to water. Atmosphere only contains about **1%** of total global carbon.
- If we look at the total quantity of global carbon, we find that **71 per cent** carbon is found dissolved in oceans. This oceanic reservoir regulates the amount of carbon dioxide in the atmosphere.
- Carbon cycling occurs through atmosphere, ocean and through living and dead organisms.
- According to one estimate **4×10^{13} kg** of carbon is fixed in the biosphere through photosynthesis annually.

(ii) Sedimentary Cycle :

Phosphorus cycle : Main source of phosphorus is **rocks**. It comes from the weathering of phosphorus containing rock in the soil. Plants absorb this phosphorus from the soil and transfer this phosphate to animals and after the death of animals it is released again into the lithosphere by the action of decomposers (Phosphate-solubilising bacteria). Phosphorus is the main constituent of protoplasm, plasma membrane, bones and teeth.

- Sometimes some of the elements like phosphorus and calcium reach into the sea through water, from where they transform into rocks. They separate from the cycle for a long time so it is also known as **sedimentary cycle.**
- But when these rocks break after sometime then this phosphorus is again made available to the sea plant or sea weeds, which pass into fish and sea birds. The excretory materials of birds on the rocks of sea shore is called **Guano** and it is a source of phosphorus.



A simplified model of phosphorus cycling in a terrestrial ecosystem

Note : Plants absorb phosphate from the soil in the form of orthophosphate (PO_4^{3-})

Difference between Carbon and Phosphorus cycle

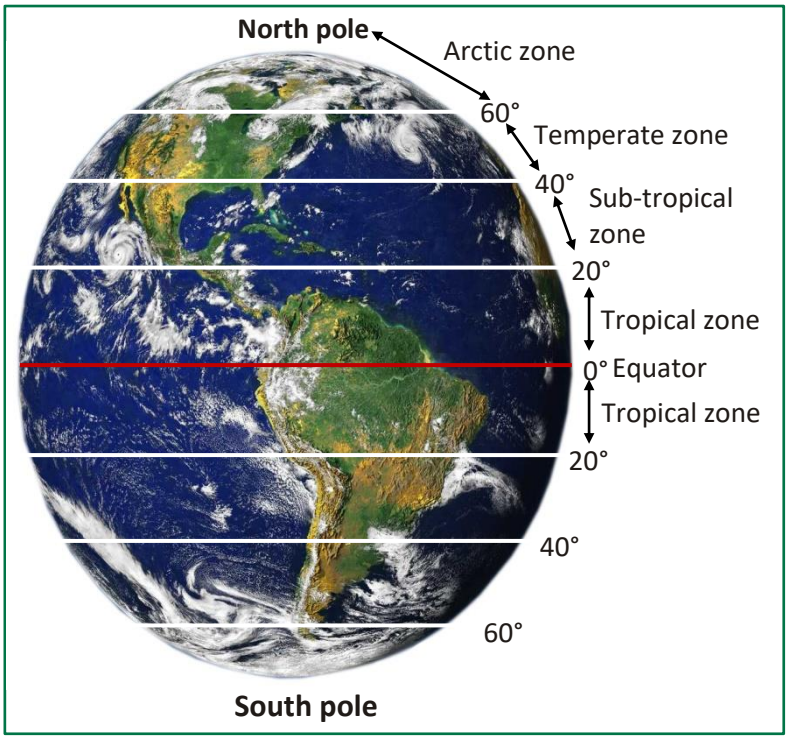
- Atmospheric inputs of phosphorus through rainfall are much smaller than carbon.
- Gaseous exchanges of phosphorus between organism and environment are negligible.

03. ECOSYSTEM SERVICES

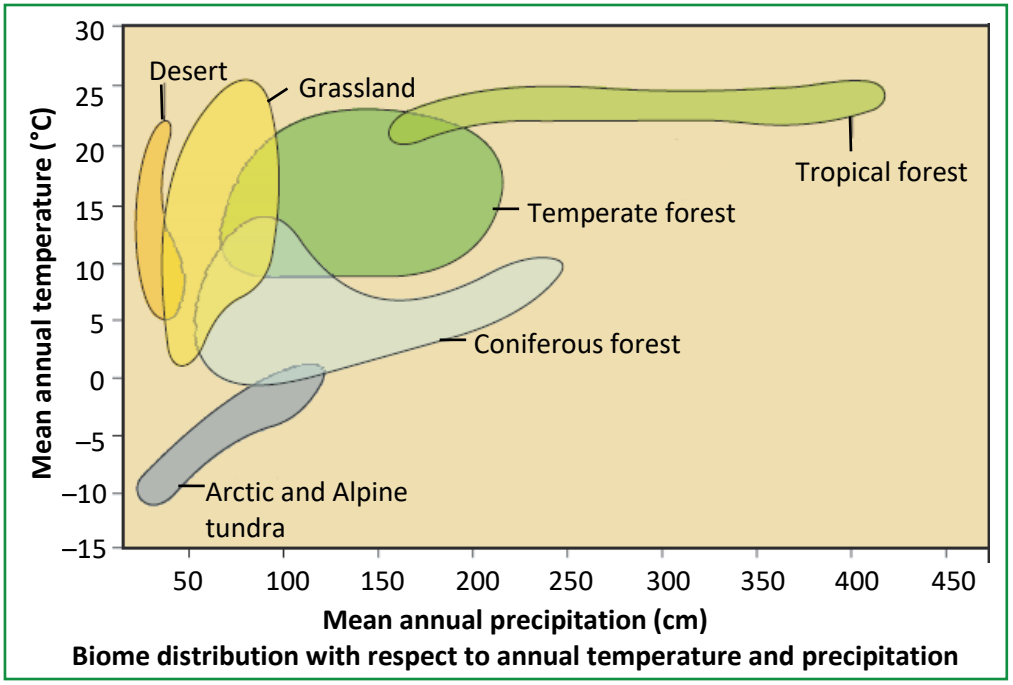
- Healthy ecosystems are the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as **Ecosystem services**, for **example**, healthy forest ecosystems purify air and water, mitigate (minimise) droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values. Though value of such services of biodiversity is difficult to determine, it seems reasonable to think that biodiversity should carry a **hefty (bulk) price tag.**
- **Robert Constanza** and his colleagues have very recently tried to put price tags on nature's life-support services. Researchers have put an average price tag of **US $ 33 trillion** a year on these fundamental ecosystems services, which are largely taken for granted because they are free.

04. BIOMES

- Large ecosystem is called biome. Mainly large aquatic and terrestrial ecosystem are called biomes.
- Altitude and latitude determine the boundary of biome.



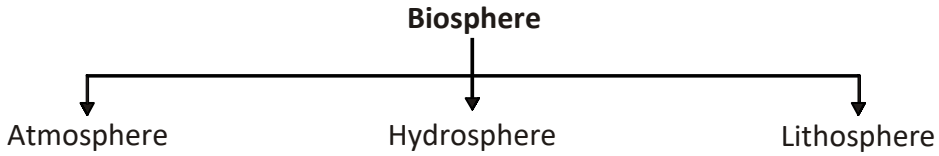
- Regional and local variations within each biome lead to the formation of a wide variety of habitats.



Biome distribution with respect to annual temperature and precipitation

05. BIOSPHERE

- All the living and non-living thing (Biotic + Abiotic) of the earth (biomes) combine together to constitute a big ecosystem called Biosphere. Biosphere is also called Ecosphere.



(A) Lithosphere : The living components and non-living components present on the earth surface constitutes the lithosphere.

(B) Hydrosphere : All living components and non-living components present in water constitutes the hydrosphere.

(C) Atmosphere : All living components and non-living components of air constitutes the atmosphere.

Note : Biosphere (space ship or earth) is a closed system for minerals and biosphere is an open system in regards with the energy.

BEGINNER'S BOX-2 NUTRIENT CYCLE, BIOME AND BIOSPHERE

1. Researchers have put an average price tag of US $ _____.

(1) 33 billion (2) 33 trillion (3) 33 million (4) 32 trillion

BES182

2. Biomes :

(1) Have specific abiotic factors only

(2) Have specific climate and biotic community

(3) are only aquatic

(4) are only terrestrial

BES183

3. Which is not a reservoir for phosphorous in phosphorous cycle?

(1) Atmosphere (2) Lithosphere

(3) Hydrosphere (4) All of the above

BES184

4. Which of the following represents the gaseous type of nutrient cycle :

(1) Nitrogen (2) Carbon

(3) Sulphur (4) Both (1) and (2)

BES185

5. Which of the following characters are changed with altitude and latitude :

(1) Species diversity (2) Vegetation

(3) Temperature (4) All of the above

BES186

BEGINNER'S BOX ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8
	Ans.	2	4	2	2	1	3	2	3

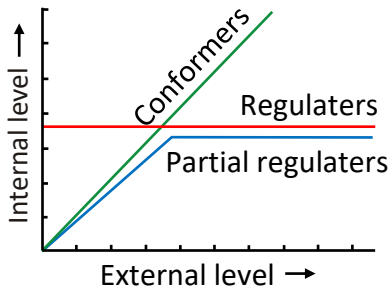
BEGINNER'S BOX-2	Que.	1	2	3	4	5
	Ans.	2	2	1	4	4

Do You Know

Adaptation :

(1) Morphological (2) Physiological (3) Behavioural

- Adaptation is any attribute of the organism (morphological, physiological, behavioural) that enables the organism to survive and reproduce in its habitat.
- **Allen's rule –** Mammals from colder climates generally have shorter ears and limbs to minimise heat loss.
- Some desert plants like Opuntia have no leaves. Leaves modified into spines to reduce transpiration the photosynthetic function is taken over by the flattened stems.
- Many desert plants have a thick cuticle on their leaf surfaces and have their stomata arranged in deep pits to minimise water loss through transpiration. They also have a special photosynthetic pathway (CAM).
- The heat shock protein (chaperonins) provide physiological adaptations to plants to high temperature.
- In the absence of an external source of water, the kangaroo rat in north American deserts is capable of meeting all its water requirements through its internal fat oxidation.
- **Desert lizards** lack the physiological ability. They bask in the sun and absorb heat when their body temperature drops below the comfort zone, but move into shade when the ambient temperature starts increasing (Behaviour Adaptations).
- A few organisms can tolerate and thrive in a wide range of temperatures (they are called **eurythermal**), but, a vast majority of them are restricted to a narrow range of temperatures (such organisms are called **stenothermal**).
- **Regulaters :** Some organisms are able to maintain homeostasis by physiological (sometimes behavioural also) means which ensures constant body temperature, constant osmotic concentration, etc.



- **Conformers :** Organism who cannot maintain a constant internal environment means their body temperature or osmotic concentration change with external environment. An overwhelming majority (99 per cent) of animals and nearly all plants cannot maintain a constant internal environment.

Types of Ecosystems

- **Natural Ecosystem**
  - **Terrestrial Ecosystem**
    - *e.g.* • Forest
      • Grass land
      • Desert
      • Tree
  - **Aquatic Ecosystem**
    - **Lentic ecosystem**
      - *e.g.* • Lake
        • Pond
        • Swamp
    - **Lotic ecosystem**
      - *e.g.* River
- **Artificial Ecosystem**
  - • Man made
    e.g. – Cropland
    – Gardens

Components of Ecosystem

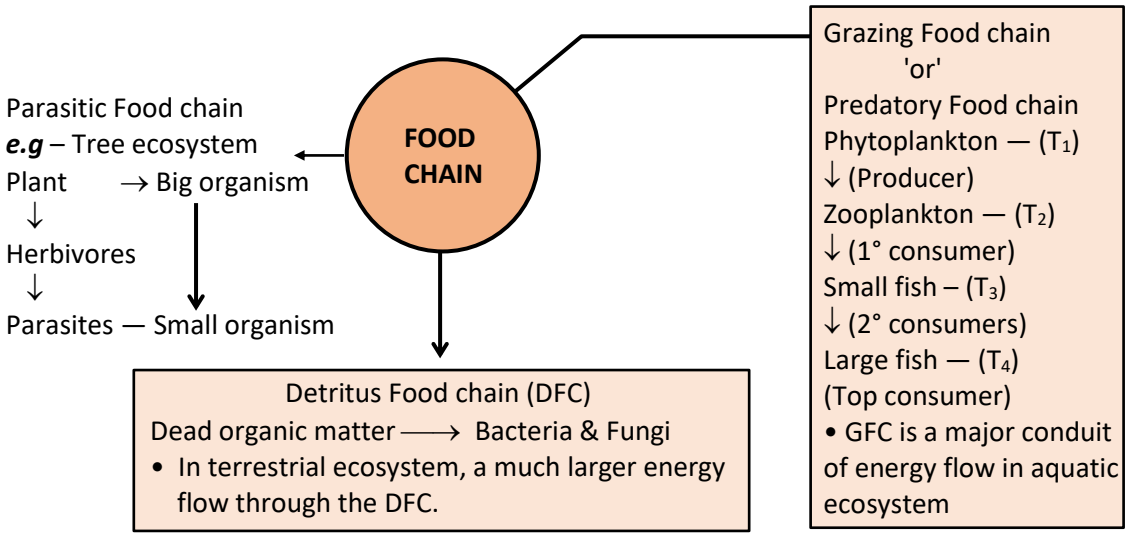
- **Biotic component**
  - Plant → Producer
  - Animal → Macro consumer
  - Microbe → Micro consumer
- **Abiotic component**
  - • Air
  - • Water
  - • Soil
  - • Light
  - • Temperature

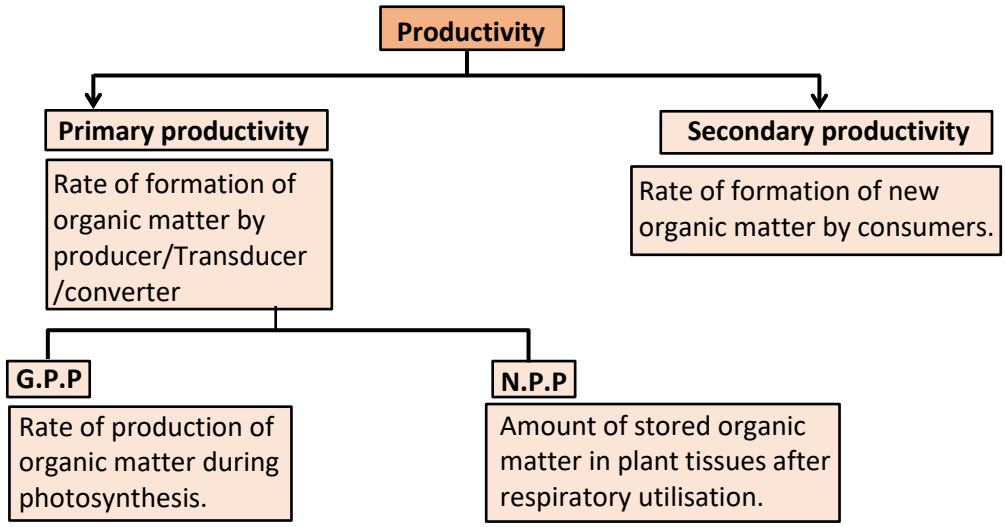
Consumers

- **Macroconsumer**
  - Primary Consumer 'OR' Secondary Producer
    - *e.g.* All herbivores
  - Secondary Consumer 'OR' Primary Carnivores
    - *e.g.* Dog, Cat, Wolf
  - Top Consumer
    - • Kill other animal but not killed and eaten by any other animals in nature.
      e.g. Lion, Man.
- **Microconsumer**
  - *e.g.* • Bacteria
    • Fungi

Functional Aspects of ecosystem.

(i) Energy Flow (ii) Nutrient cycling
(iii) Productivity (iv) Decomposition





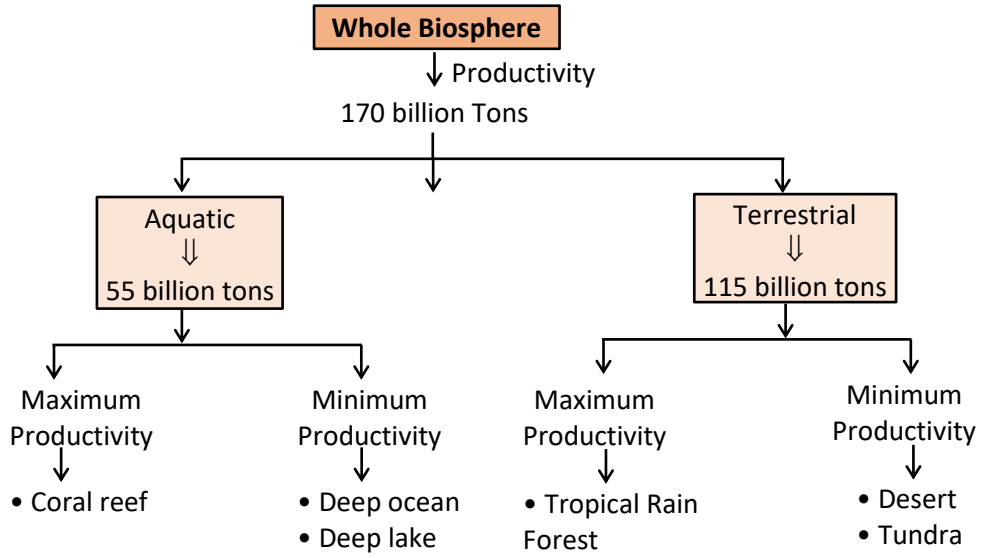
Factors affecting Productivity

(a) Area

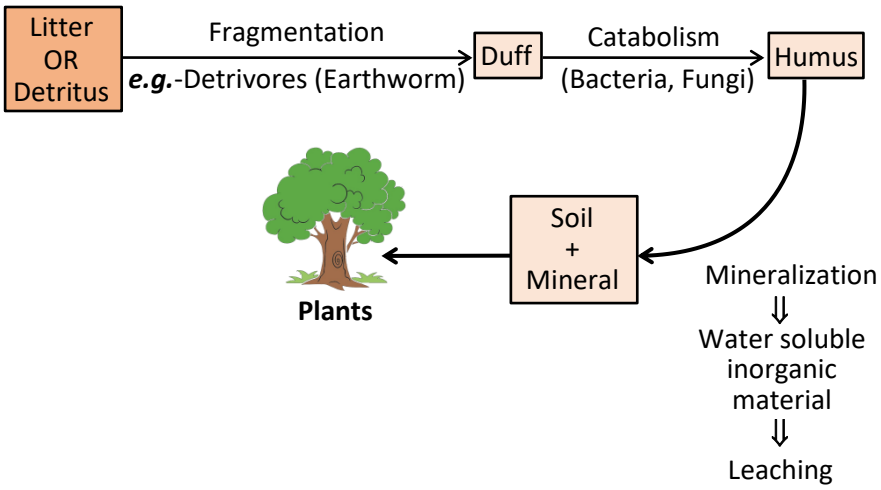
(b) Climate — Light, Temperature, Rainfall

(c) Soil ⟶ Amount of nutrients

(d) Photosynthetic capacity.



Decomposition :



NCERT SUMMARY

An ecosystem is a structural and functional unit of nature and it comprises abiotic and biotic components. Abiotic components are inorganic materials- air, water and soil, whereas biotic components are producers, consumers and decomposers. Each ecosystem has characteristic physical structure resulting from interaction amongst abiotic and biotic components. Species composition and stratification are the two main structural features of an ecosystem. Based on source of nutrition every organism occupies a place in an ecosystem.

Productivity, decomposition, energy flow, and nutrient cycling are the four important components of an ecosystem. Primary productivity is the rate of capture of solar energy or biomass production of the producers. It is divided into two types: gross primary productivity (GPP) and net primary productivity (NPP). Rate of capture of solar energy or total production of organic matter is called as GPP. NPP is the remaining biomass or the energy left after utilisation of producers. 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.

Energy flow is unidirectional. First, plants capture solar energy and then, food is transferred from the producers to decomposers. Organisms of different trophic levels in nature are connected to each other for food or energy relationship forming a food chain. The storage and movement of nutrient elements through the various components of the ecosystem is called nutrient cycling; nutrients are repeatedly used through this process. Nutrient cycling is of two types—gaseous and sedimentary. Atmosphere or hydrosphere is the reservoir for the gaseous type of cycle (carbon), whereas Earth's crust is the reservoir for sedimentary type (phosphorus). Products of ecosystem processes are named as ecosystem services, ***e.g.***, purification of air and water by forests.