



Ecosystem- Concept, Types & Functions

पारिस्थितिकी तंत्र
प्रकार और कार्य

Ecology, Ecosystem and Environment

- Ecosystem is a unit which has living and non-living components and their interactions while being dependent on one another.
- Ecology is the study of ecosystems. It studies the organisms and their relations with each other and the environment.
- Environment usually refers to the physical surroundings in which an organism lives. An ecosystem functions with the environment to make a big unit.

Ecosystem

- The term 'ecosystem' was coined by A.G. Tansley in 1935.
- An ecosystem is the structural and functional unit of biosphere.

एक पारिस्थितिकी तंत्र जैवमंडल की संरचनात्मक और कार्यात्मक इकाई है

- An ecosystem consists of a community of living beings and their physical environment, which interact and exchange materials between them. (Open System)

समुदायों की जीवों की रचना कार्य व उनके वातावरण के पारस्परिक संबंध को पारिस्थितिकी तंत्र कहते हैं

It has many interconnected habitats.

Components of an ecosystem पारिस्थितिकी तंत्र के घटक

- The components of an ecosystem are broadly classified into
 - Biotic or living components
जैविक या जीवित घटक
 - Abiotic or non-living components
अजैविक

Components of Ecosystem

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graph TD; A[Components of Ecosystem] --> B[Abiotic Components]; A --> C[Biotic Components]; B --> D[Physical factors]; B --> E[Inorganic substances]; B --> F[Organic substances]; C --> G[Producers]; C --> H[Consumers]; C --> I[Decomposers];
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Abiotic Components

Physical factors

Inorganic substances

Organic substances

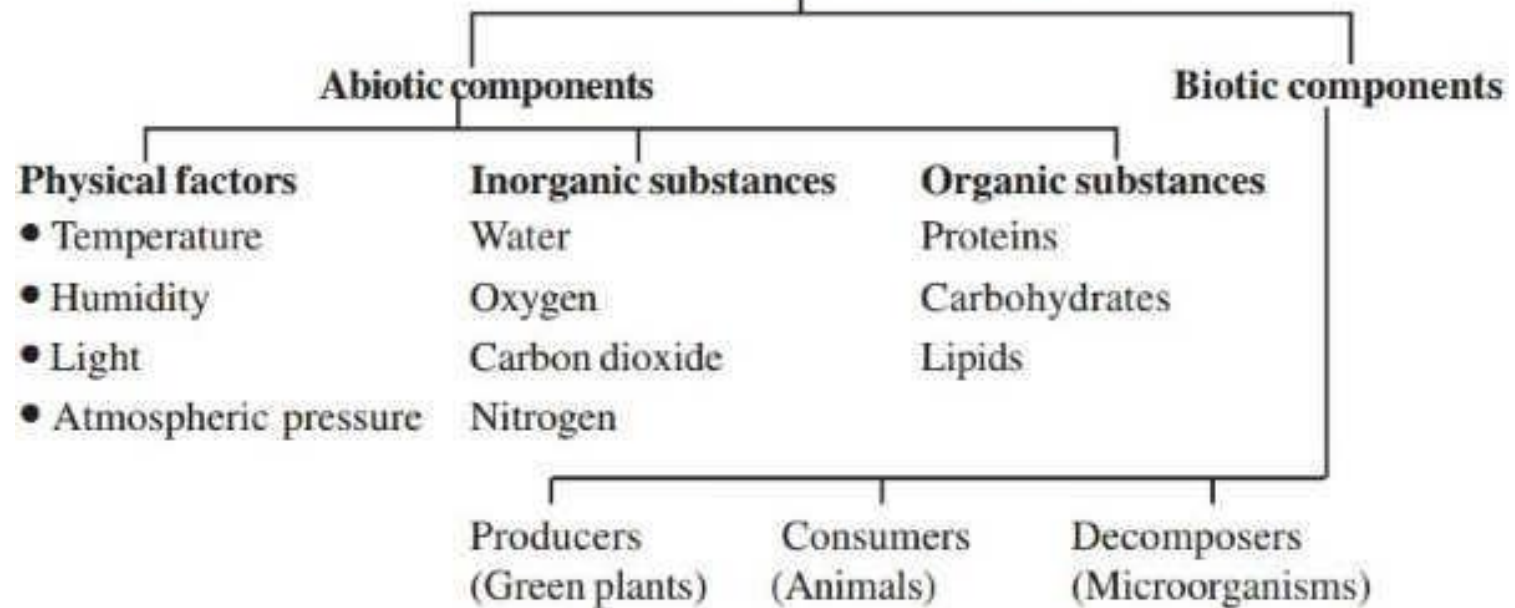
Biotic Components

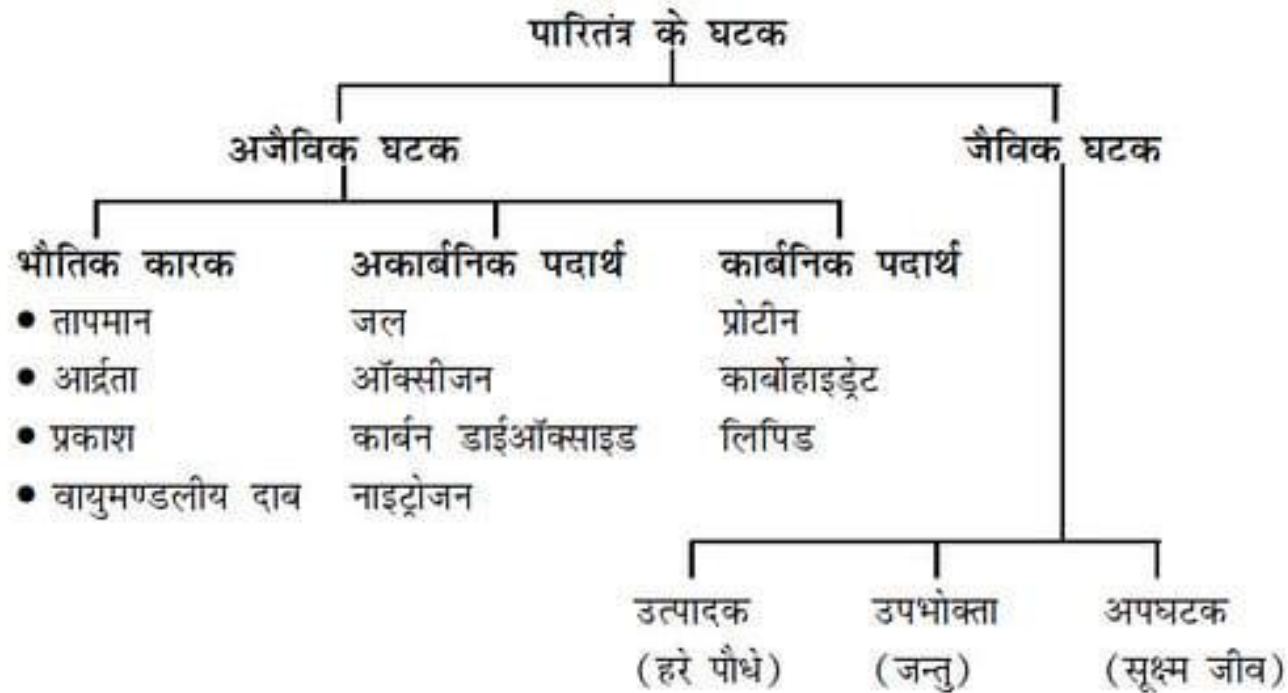
Producers

Consumers

Decomposers

Components of Ecosystem





Abiotic components (Nonliving)

Physical factors	Sunlight, temperature, rainfall, humidity and pressure	They sustain and limit the growth of organisms in an ecosystem.
Inorganic substances	Carbon dioxide, oxygen, nitrogen, phosphorus, sulphur, water, rock, soil and other minerals	They play an important role in the growth of living organisms.
Organic compounds	Carbohydrates, proteins, lipids and humic substances	They form the building blocks of living organisms. Therefore, they interlink the biotic and abiotic components.

Sunlight

- Plants use solar energy directly for photosynthesis and food production.
- Animals cannot use solar energy directly. Therefore, they obtain it indirectly by eating plants or animals or both.
- Sunlight determines the temperature of all places which in turn decides the flora and fauna of a region
- Energy also determines the distribution of organisms in the environment

Temperature

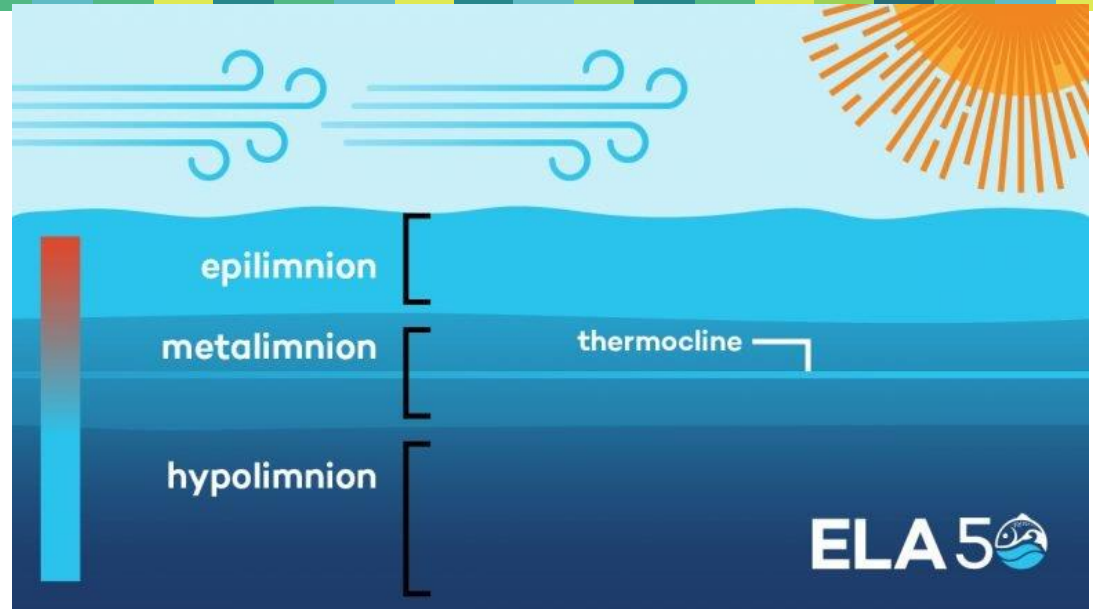
Organisms can tolerate only some ranges of temperature and humidity

- The levels of thermal tolerance of different species determine to a large extent their geographical distribution.
- Eurythermal organisms - organisms which can tolerate and thrive in a wide range of temperatures. Plants- Roses, daisies, some vegetables and fruits etc. Animals- Cat, **tiger**, dog etc
- Stenothermal organisms - organisms which are restricted to a narrow range of temperatures. polar bear, frog, lizards, coconut,

Homeothermic animals are warm-blooded and maintain a constant body temperature -
example **birds** and **mammals**. गर्म रक्त वाले जीव समतापी

Heterothermy a physiological term for **animals** that vary between self-regulating their body temperature, and allowing the surrounding environment to affect it

Cold Blooded animal शीत रक्त वाले जीव गर्म रक्त वाले जीव
विषमतापी



Thermal stratification is the phenomenon in which lakes develop two discrete layers of water of different temperatures: warm on top (*epilimnion*) and cold below (*hypolimnion*).

These layers are each relatively uniform in temperature but are separated by a region of rapid temperature change (the *metalimnion* or *thermocline*).

Water

- Water is essential for all living beings.
 - It not only facilitates and provides a medium for majority of biochemical reactions but also regulates the body temperature of most of the living organisms.
 - Also, water bodies are the habitat for many aquatic plants and animals.
- Euryhaline - organisms that tolerate a wide range of salinities. green crab
 - Stenohaline - organisms restricted to a narrow range of salinities. plants and **animals** most often found in the brackish waters of estuaries

Soil

- Soil provides water and nutrients in the form of organic and inorganic substances which are tapped by the roots of plants which grow through the soil.
- The soil of a place is dependent on the climate, the weathering process, whether soil is transported or sedimentary and how soil developed.

Atmosphere

- All gases essential for living organisms are present in the atmosphere.
- Plants use carbon dioxide for photosynthesis, oxygen for respiration and nitrogen for nutrition.
- Human beings and animals use oxygen for respiration.
- The amount of gases present in the atmosphere are regulated through biogeochemical cycles

Biotic components

Producers (autotrophs): उत्पादक

- Producers are mainly the green plants and some bacteria and algae.
- They are also known as autotrophs/ self-nourishing organisms.
- The food for the entire ecosystem are provided by plants through the process of photosynthesis.
- Plants utilise sunlight, water, CO_2 and nutrients for photosynthesis.

इसके अंतर्गत वे सभी हरे पौधे आते हैं जो प्रकाश संश्लेषण की क्रिया द्वारा CO_2 एवं जल की उपस्थिति में सूर्य के प्रकाश द्वारा लुकुस में परिवर्तित करते हैं
संश्लेषण की क्रिया में CO_2 का अपचयन रिडक्शन तथा जल का उपचयन ऑक्सीडेशन होता है

Consumers (Heterotrophs/ phagotrophs): macroconsumers उपभोक्ता

- They are called heterotrophs as they are incapable of producing their own food. They consume food synthesized by the autotrophs.
- They can be grouped into three broad categories based on food preferences:
 - **Herbivores** - feed directly on plants, e.g. cow, deer and rabbit etc.
शाकाहारी
 - **Carnivores** - animals which eat other animals, eg. lion, cat, dog etc.
मांसाहारी
 - **Omnivores** - organisms which feed on both plants and animals, e.g. human, pigs and sparrow, etc. सर्वाहारी

इसके अंतर्गत जीवधारी

आते हैं जो अपना भोजन प्राथमिक उत्पादकों अथवा अन्य जीव धारियों को खाकर प्राप्त करते हैं

Consumers can also be classified as:

1. **Primary consumers:** herbivores which feed mainly on plants e.g. cow, rabbit, deer, etc.
2. **Secondary consumers:** organisms who feed on primary consumers e.g. wolves, tigers, etc.
3. **Tertiary consumers:** organisms which feed on secondary consumers e.g. lions eating wolves, humans, etc.

Decomposers (saprotrophs):

- Decomposers are bacteria and fungi which obtain energy and nutrients by decomposing dead organic substances (detritus) of plants and animals.
- The products in the decomposition process are reused and recycled by the producers.
- Earthworm, nematodes, and arthropods etc. are also known as detritus feeders.
- They help in the decomposition of organic matter and are called detritivores

अपघटनकरता घटक है वह वह जो प्रायः उत्पादक तथा उपभोक्ताओं की मृत्यु के पश्चात उनके शरीर अपघटन करते हैं तथा इनसे निर्मित साधारण पदार्थों द्वारा अपना भोजन एवं ऊर्जा प्राप्त करते हैं

STEPS IN DECOMPOSITION

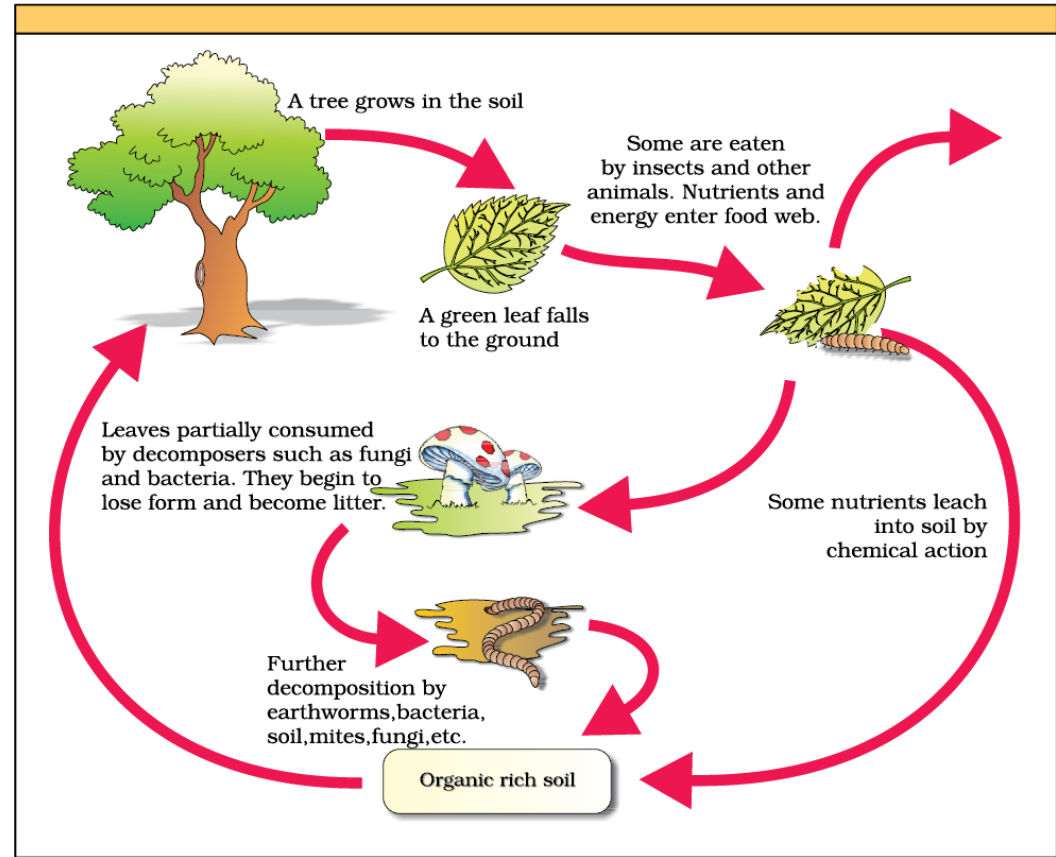
FRAGMENTATION

LEACHING

CATABOLISM

HUMIFICATION

MINERALIZATION



Ecotone

- Ecotone = transition zone of two or more diverse ecosystems.
- For e.g. the mangrove forests is a transition zone between marine and terrestrial ecosystem
- Ecotone is referred as the zone of tension- because it inherits the conditions intermediate to the adjacent ecosystems, and therefore has more competition among species for available resources.
- Example- Wetlands.

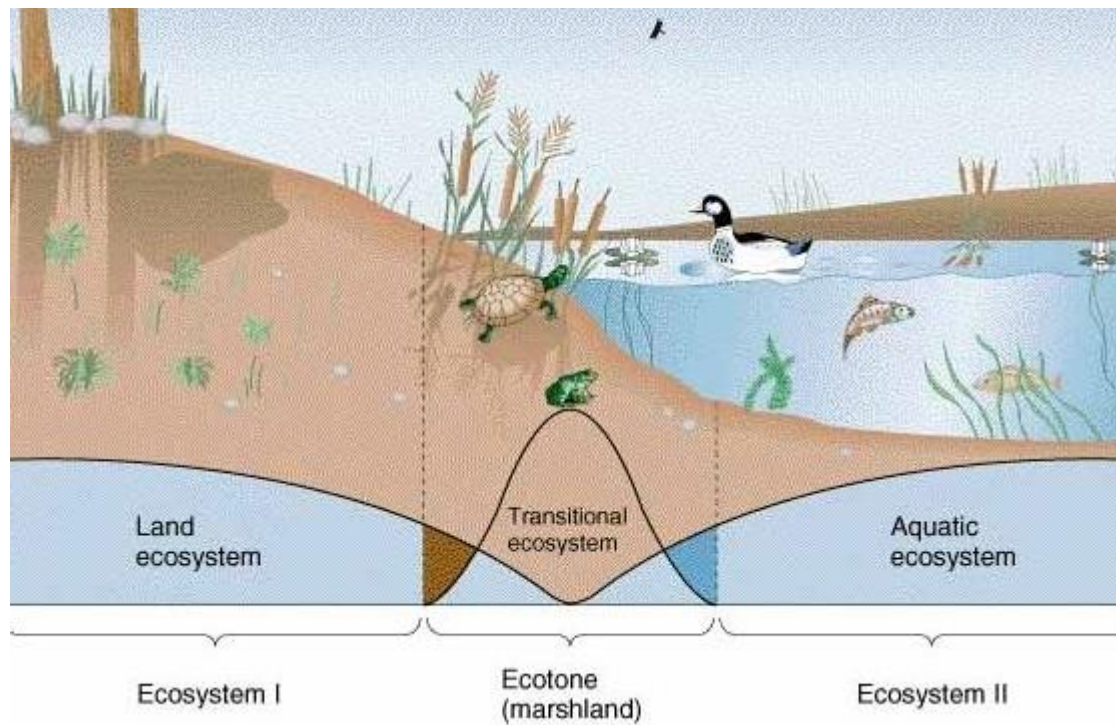
संक्रमिका: दो या उससे अधिक विविध समुदायों के मध्य संक्रमण क्षेत्र को संक्रमिका (Ecotone) कहते हैं, जैसे-घास स्थल तथा वन क्षेत्र। इकोटोन क्षेत्र में दोनों क्षेत्रों की विशेषताएँ पाई जाती हैं।

•यह दो या अधिक पारिस्थितिकी तंत्र का संक्रमण क्षेत्र होता है। इसीलिये यह तनाव का क्षेत्र होता है।

•एक पूर्ण विकसित इकोटोन में कुछ ऐसे जीव पाए जाते हैं जो आसन्न समुदायों से पूरी तरह अलग होते हैं।

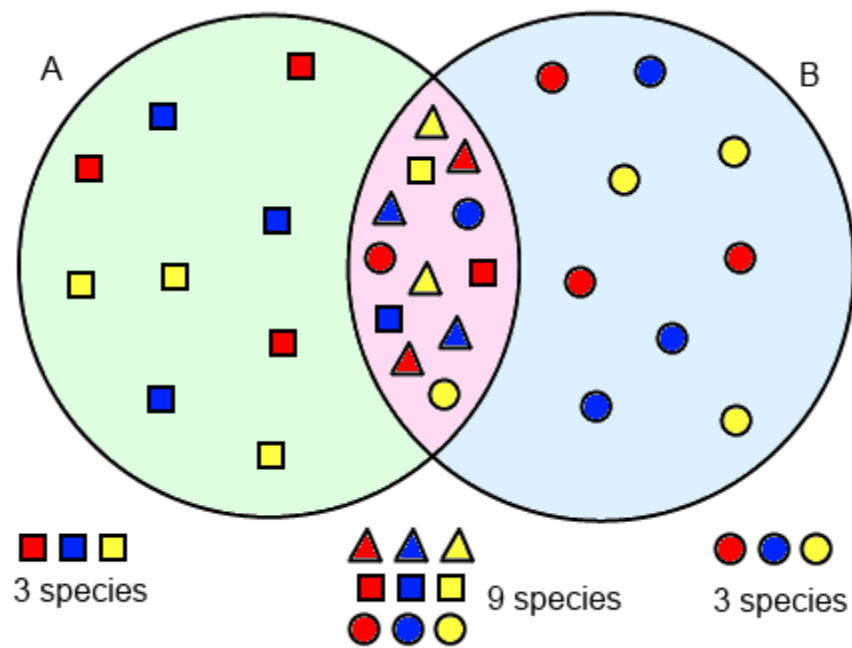
•संक्रमिका बहुत छोटे क्षेत्र (चारागाह और जंगल के बीच) से लेकर बहुत विशाल क्षेत्र (जंगल और रेगिस्तान के बीच) तक फैला हो सकता है

- An ecotone can have a sharp vegetation transition, with a distinct line between two communities.
- For example, a change in colors of grasses or plant life can indicate an ecotone.
- Also, a change in physiognomy (physical appearance of a plant species) can be a key indicator.



Edge effect

- Sometimes in an ecotone, the number and population density of some of the species is much greater than either communities. This is called edge effect.
- The organisms which occur primarily or most abundantly in this zone are known as edge species.
- In the terrestrial ecosystems, edge effect is especially applicable to birds.
- For example, the density of birds is greater in the mixed habitat of the ecotone between a forest and a desert.
- Areas with small habitat fragments exhibit pronounced edge effects.
- As the edge effects increase, the ecotone allows for greater biodiversity



- **कोर प्रभाव (Edge Effect)** - कोर प्रभाव एक पारिस्थितिकीय अवधारणा है जहाँ दो पारितंत्र आपस में मिलते हैं वहाँ विशाल विविधता पाई जाती है। इस कोर प्रभाव में जहाँ दो क्षेत्र परस्पर व्याप्त (ओवरलैप) होते हैं वहाँ दोनों क्षेत्रों को प्रजातियाँ पाई जाती हैं। कोर प्रभाव के कुछ उदाहरण हैं -
 - नदी तट के किनारे घास का मैदान।
 - जहाँ पर्वत व घाटी मिलती है।
 - जंगलों के अंतिम बिन्दु।
 - जहाँ एश्वुअरी समुद्र से मिलती है।

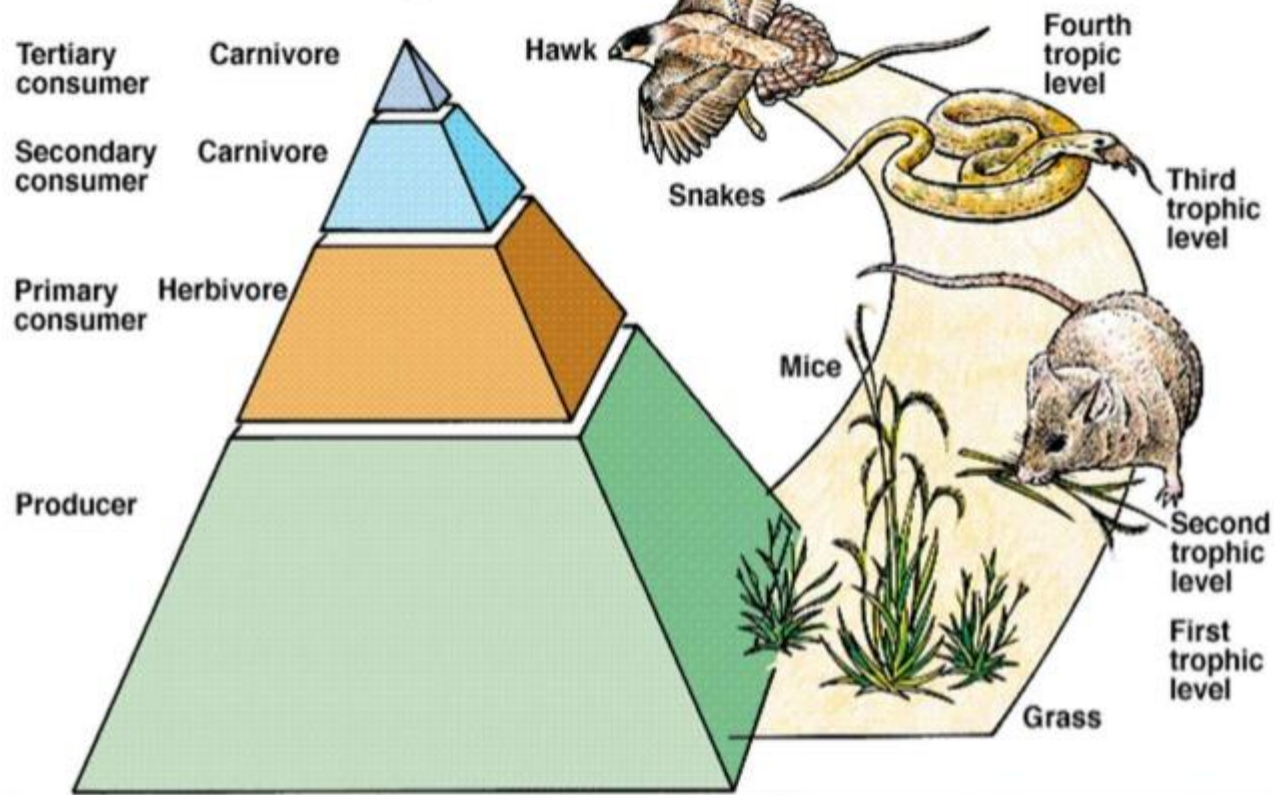
Functions of an Ecosystem

- Ecosystems are complex dynamic system. They perform certain functions. These are:-
 - (i) Energy flow through food chain
 - (ii) Nutrient cycling (biogeochemical cycles)
 - (iii) Ecological succession or ecosystem development

Energy flow

- Energy helps organisms in their functioning and metabolic activities.
- Energy flows from the producers to the consumers in a unidirectional way.
- Food chains and food webs show the energy flow in an ecosystem.
- The biotic and abiotic components of an ecosystem are linked through them

Energy Flow Through an Ecosystem





Quaternary
consumers

Carnivore



Tertiary
consumers

Carnivore



Secondary
consumers

Carnivore



Primary
consumers

Herbivore



Primary
producers

Plant

A terrestrial food chain



Carnivore



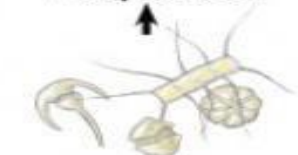
Carnivore



Carnivore



Zooplankton



Phytoplankton

A marine food chain

Food chain

- A chain of interdependence of plants and animals for food is called a food chain.
- A food chain also shows the transfer of energy from plants to other organisms. Energy transfer is always unidirectional.
- Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their trophic level.
- The energy transferred decreases through each successive trophic level.

Types of food chains

There are two types of food chains in nature:

1. **Grazing food chain:**

- It starts from the green plants at the base of the food chain.
- Herbivores are at the next trophic level and then carnivores and so on.
- A grazing food chain (GFC) has

Grass (Producer) ---> Goat (Primary consumer) ---> Man (Secondary consumer)

Food Chains



Corn



Rat



Owl

A three linked food chain



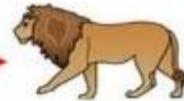
Carrots



Rabbit



Fox



Lion

A four linked food chain



Grass



Grasshopper



Frog



Python



Eagle

A five linked food chain

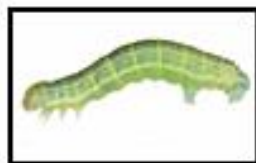
2. Detritus food chain:

- It starts from dead organic matter of plants and animals.
- Microorganisms, detritus feeders, carnivores form the next trophic levels.
- Detritus food chain derives its initial energy from the waste materials and dead organic matter from the grazing food chain.

Grazing food chain



Living oak leaf



Moth caterpillar



Insectivorous bird



Hawk

Detritus food chain



Dead oak leaf



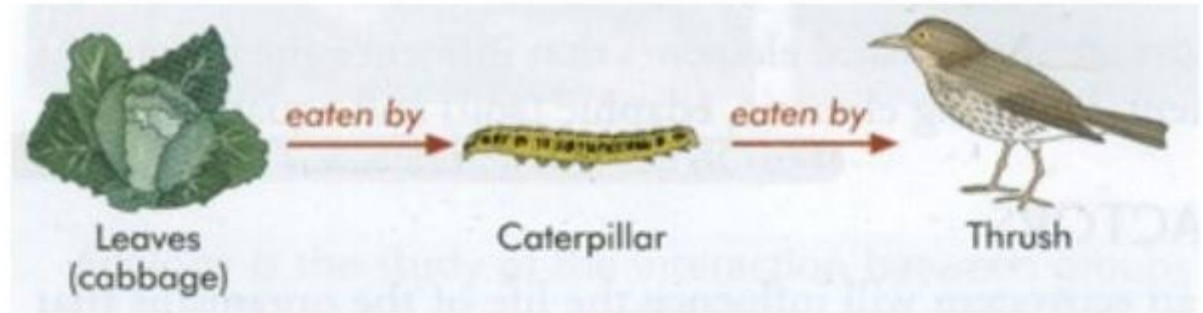
Earthworm



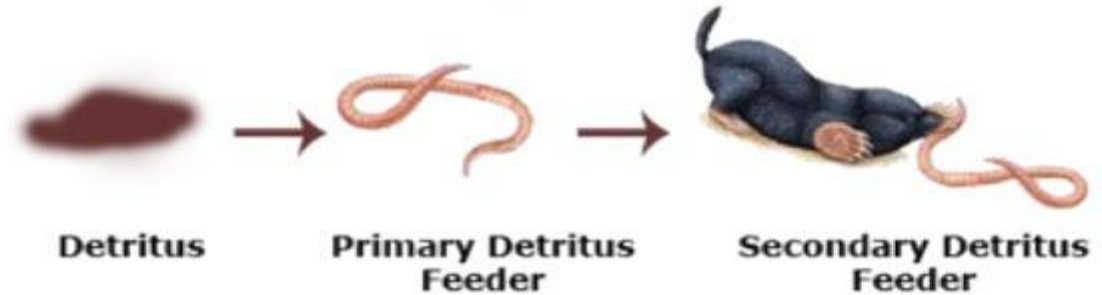
Shrew



Grazing and Detritus Food Chain



Grazing Food Chain



Detritus (**Dead organic matter**) Food Chain



Diatoms

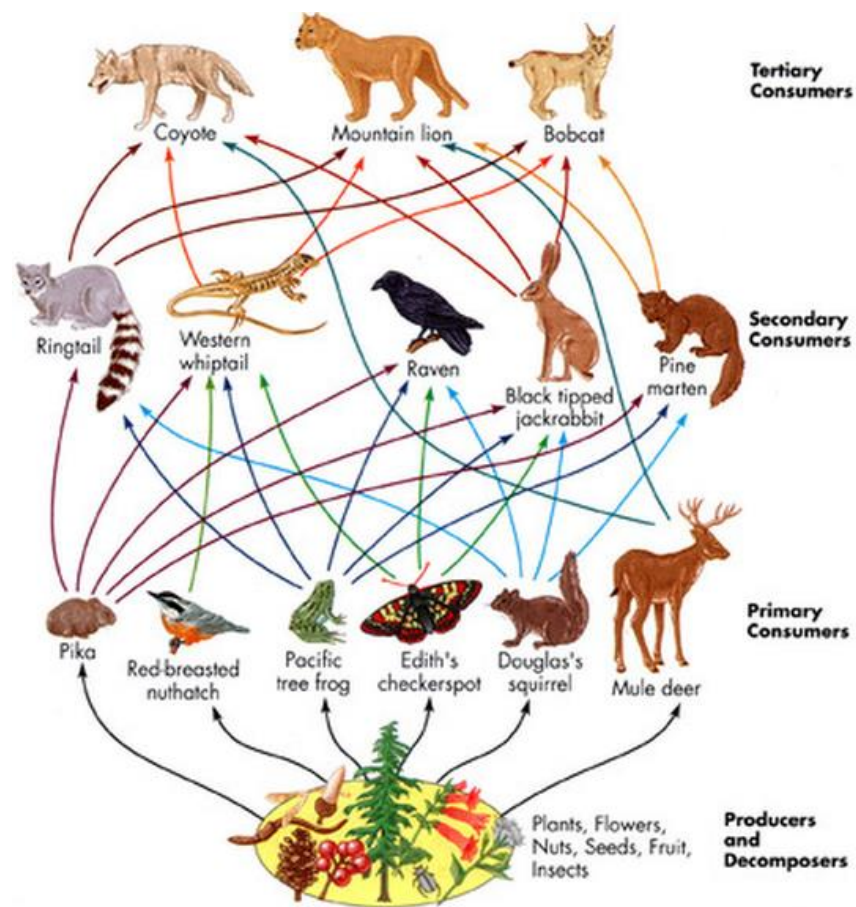


Herrings

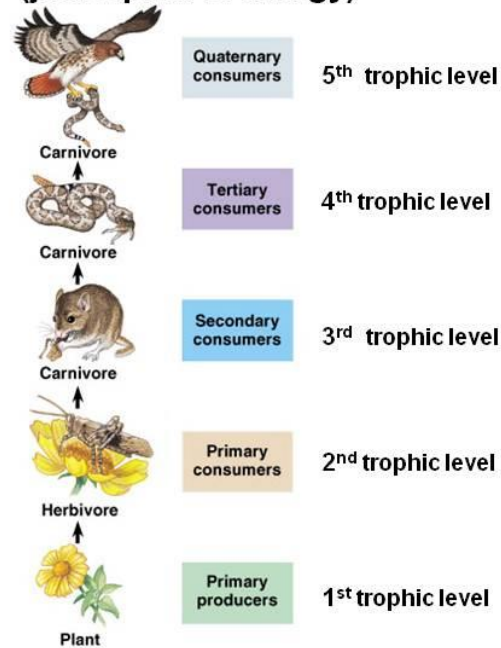


Food web

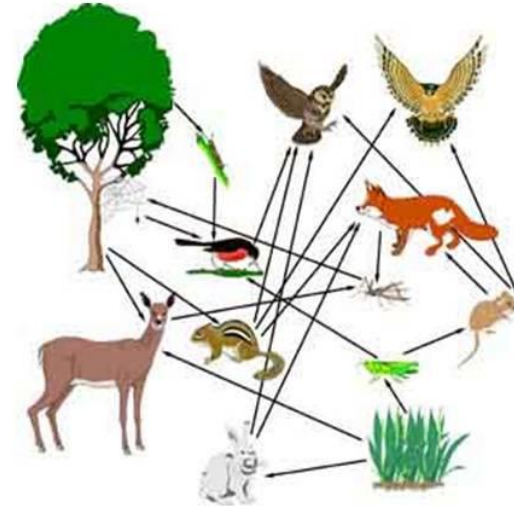
- It is a network of interconnected food chains in an ecosystem.
- This interconnection of food chains happens when one of the consumers is a member of many food chains at a time.
- Food webs provide more realistic models of energy flow through an ecosystem.
- A food web has all possible transfers of energy and nutrients among the organisms in an ecosystem, whereas a food chain traces only one pathway of the food.
- More complex the web, more stable is the ecosystem



Food Chain (just 1 path of energy)



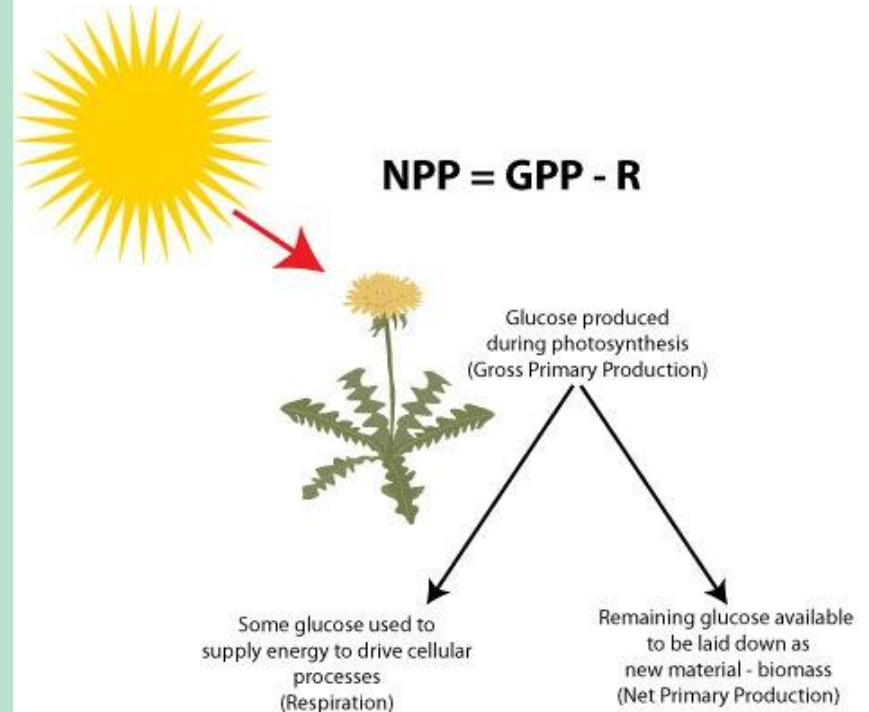
Food Web (all possible energy paths)



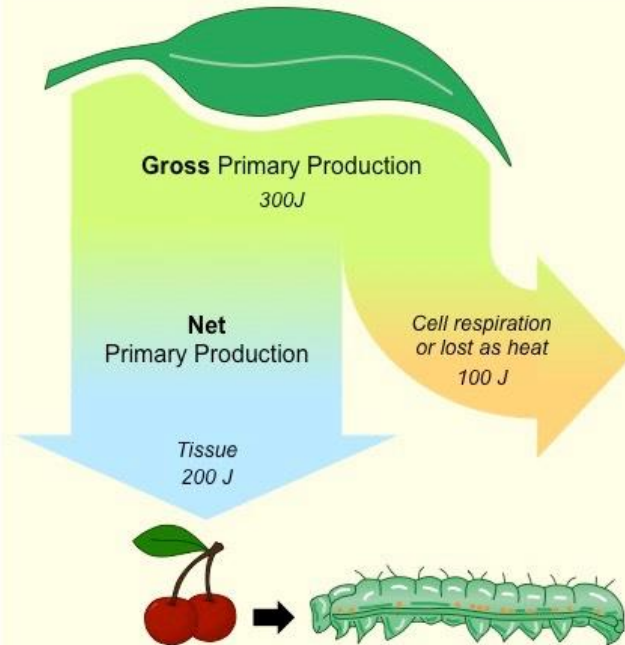
The *arrow* points to the eater and shows the transfer of energy.

GPP vs NPP Gross Primary Production Net Primary Production

- The total rate at which the solar energy is stored by the process of photosynthesis in the green plants is called Gross Primary Production (GPP).
- GPP is also known as total photosynthesis.
- A part of the gross primary productivity is utilized by plants for its own metabolism.
- The remaining amount is called Net Primary Production (NPP). It is stored by the plant and is made available to the consumers.

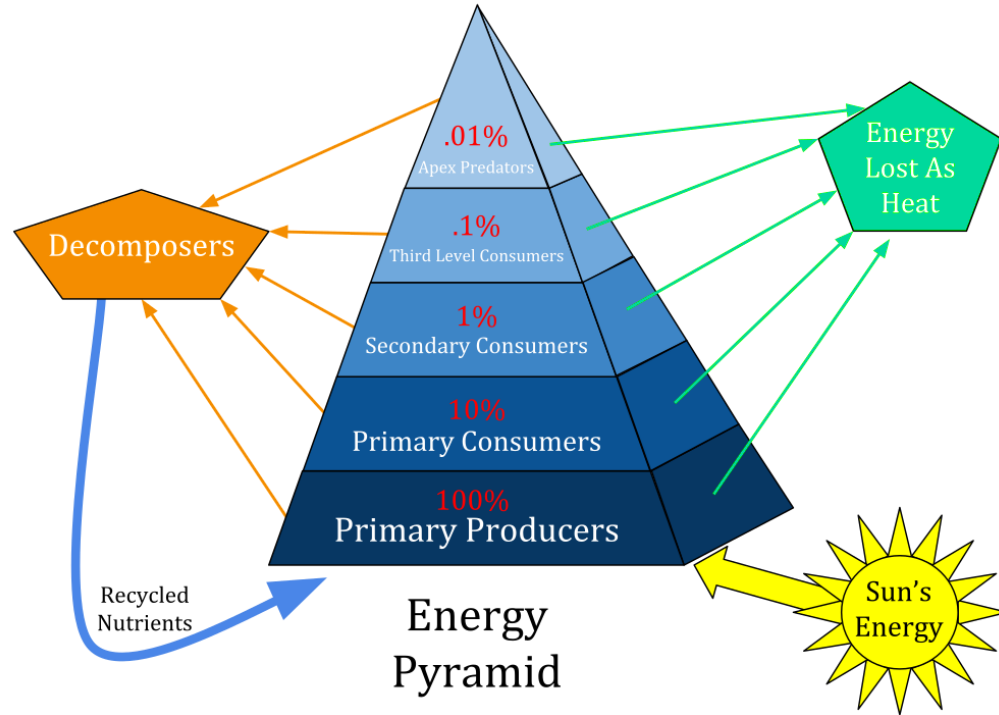


PRIMARY PRODUCTIVITY



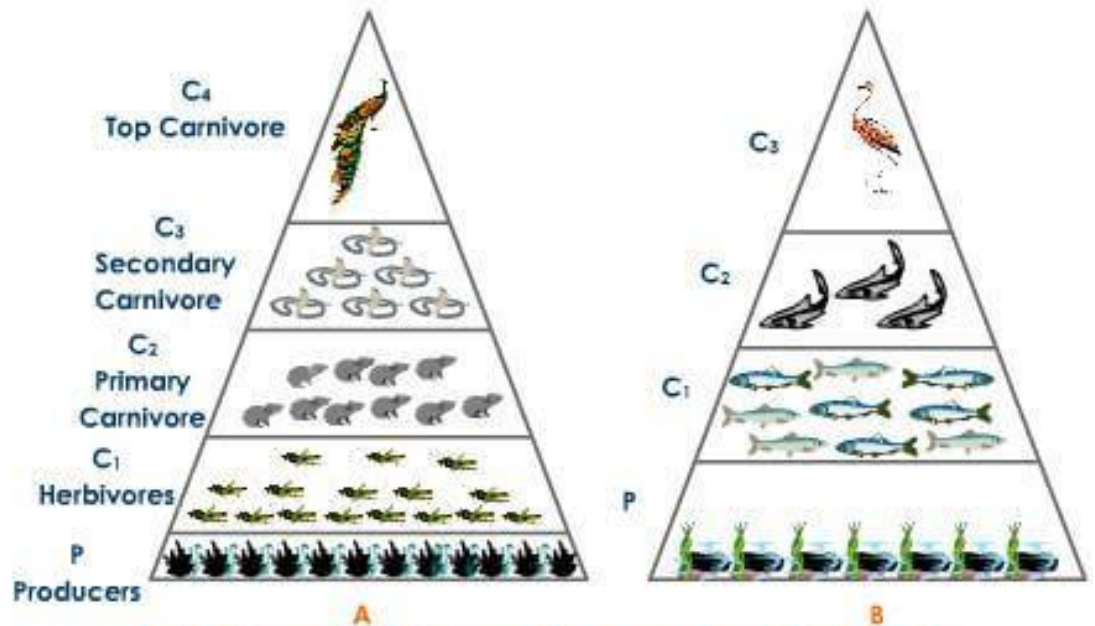
Ecological pyramids

- Ecological pyramids are the diagrammatic representation of trophic levels in an ecosystem.
- Producer forms the base whereas top carnivore forms the tip of the pyramid.
- There are three types of ecological pyramids:
 1. Pyramid of numbers
 2. Pyramid of biomass
 3. Pyramid of energy or productivity

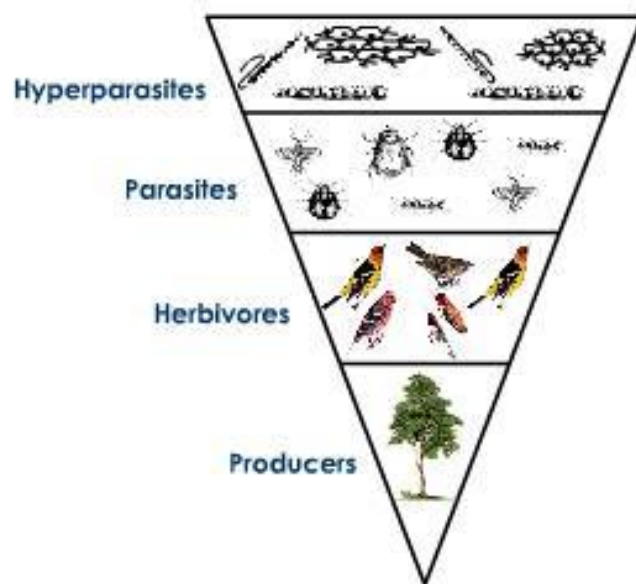


Pyramid of numbers

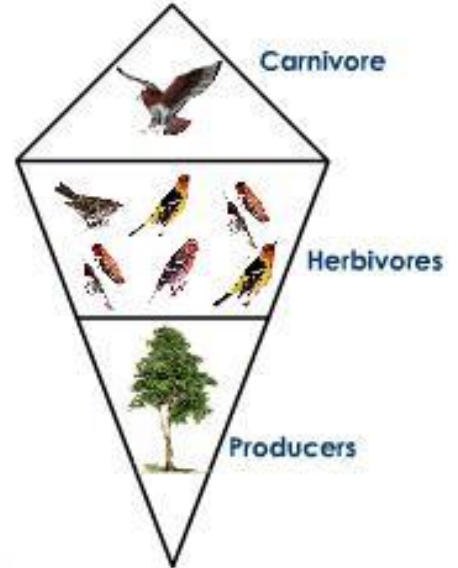
- This pyramid represents the total number of individuals at each trophic level in an ecosystem.
- Depending upon the size and biomass, the pyramid of numbers can be either upright or inverted.
- Upright pyramids are generally seen in a grassland ecosystem where grasses are in abundance and top carnivore are the least in numbers.
- Inverted pyramid: In a forest, trees (producers) form the base and provide food to herbivore birds. Parasites and hyperparasites form the wider tip of pyramid.



Upright Pyramids of Numbers. (A) In a Grass Land (B) In a Pond



Inverted



Spindle-shaped

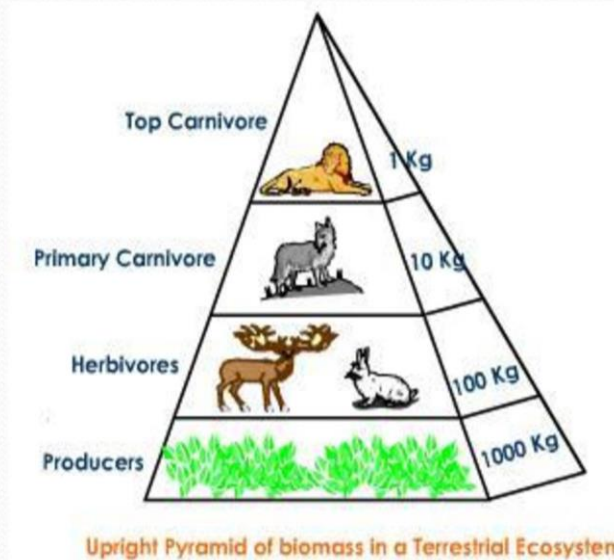
Pyramid of Numbers

- Pyramid of numbers is not a good representation of trophic structure of an ecosystem as counting the numbers of organisms in each level is a difficult task.

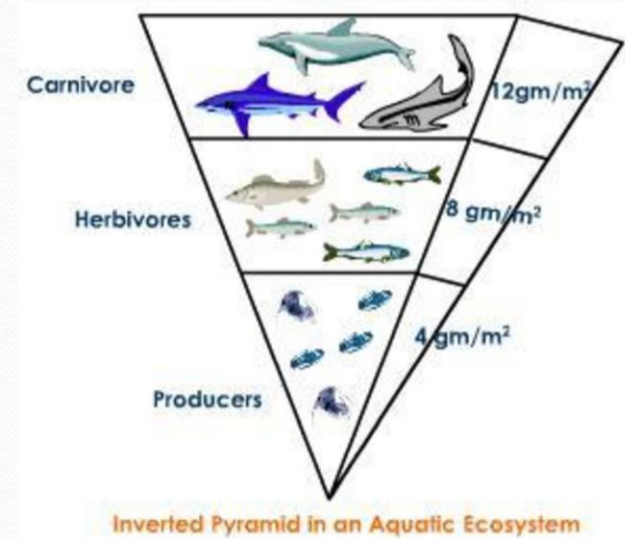
Pyramid of biomass

- In pyramid of biomass, individuals in each trophic level are weighed (total dry weight) instead of being counted.
- It represents the total standing crop biomass at each trophic level.
- Standing crop biomass is the amount of the living matter at any given time. It is expressed as gm/unit area or kilo cal/unit area.

- Upward pyramid of biomass is mostly found in terrestrial ecosystems where the biomass of producers (autotrophs) is maximum and therefore they have a wide base.
- Inverted pyramid is generally found in aquatic ecosystems where producers are small phytoplanktons who grow rapidly but have the least biomass therefore small base.



Upright

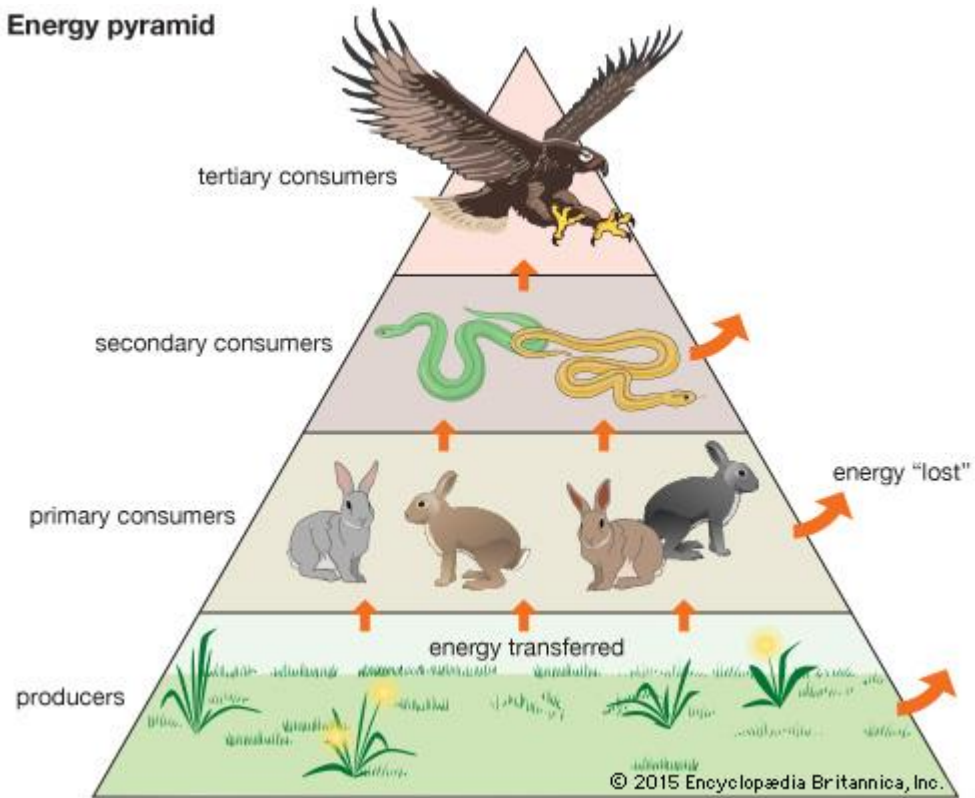


Inverted

Pyramid of energy

- Energy pyramid is the most common parameter to compare the functional roles of the trophic levels in an ecosystem.
- An energy pyramid reflects the conversion of solar energy to chemical energy and heat energy at each trophic level.
- As there is loss of energy at each trophic level, the pyramid is always upward, with a large energy base at the bottom.
- Energy pyramid concept helps in explaining the phenomenon of biological magnification, the tendency for toxic substances to increase in concentration progressively at higher levels of the food chain.

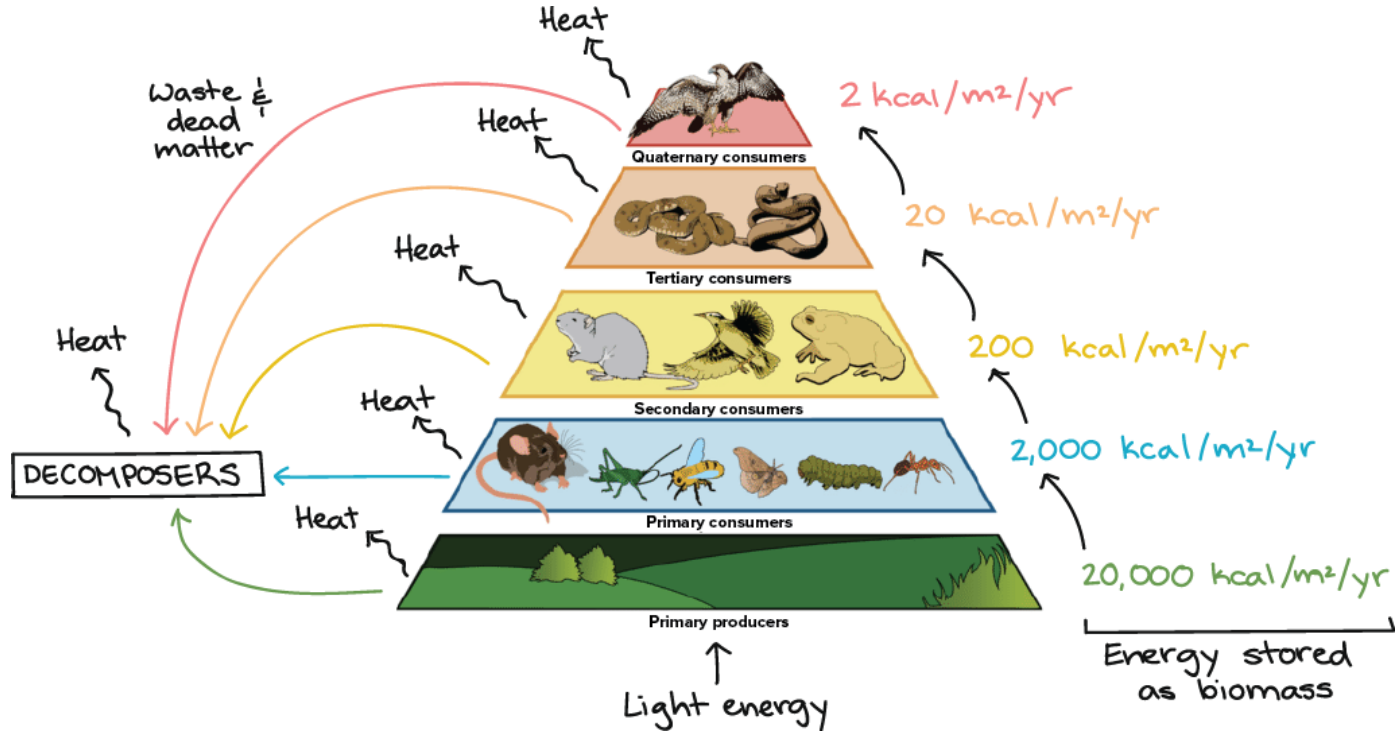
Energy pyramid

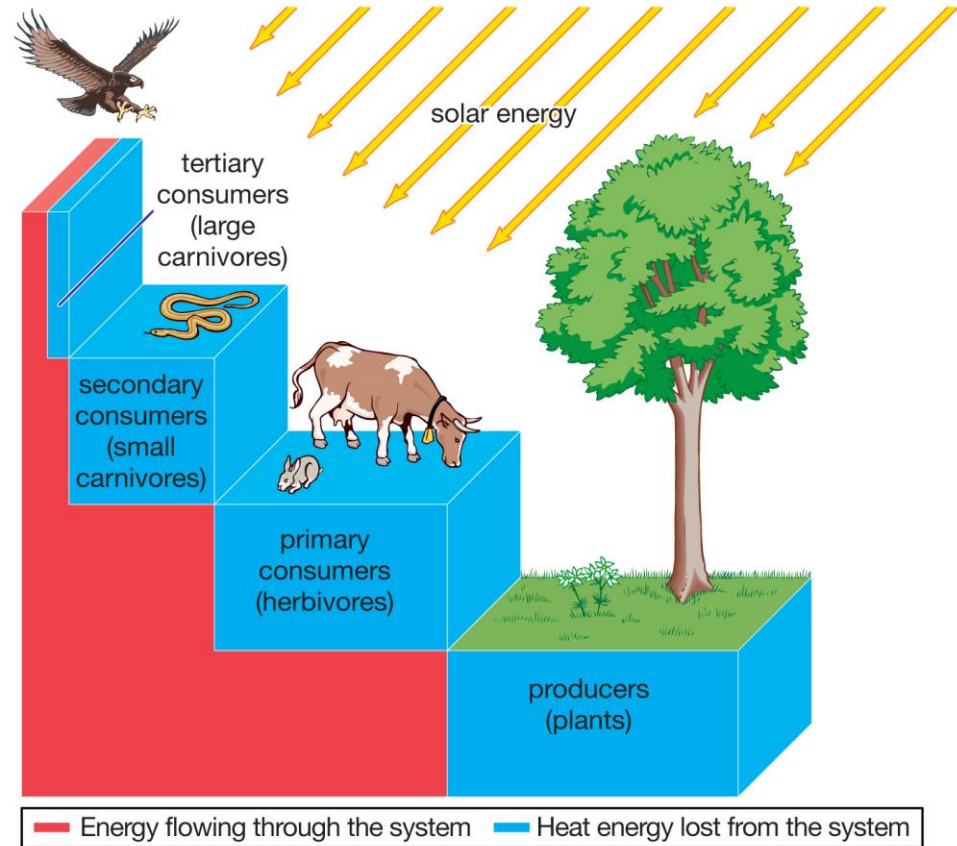


- The amount of energy decreases at each subsequent trophic level due to two reasons:
 1. At each trophic a part of the available energy is lost in respiration or used up in metabolism.
 2. A part of energy is lost at each transformation, i.e. when it moves from lower to higher trophic level as heat.

Ecological efficiency

- It is defined as efficiency of transfer of energy from one trophic level to the next trophic level.
- Lindman in 1942 defined these ecological efficiencies for the 1st time and proposed 10% rule.
- E.g. if autotrophs produce 100 cal, herbivores will be able to store 10 cal. and carnivores 1 cal.





Limitations of pyramids

- It does not take into account the same species belonging to two or more trophic levels.
- It assumes a simple food chain, which never exists in nature.
- It does not accommodate a food web.
- Moreover, saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

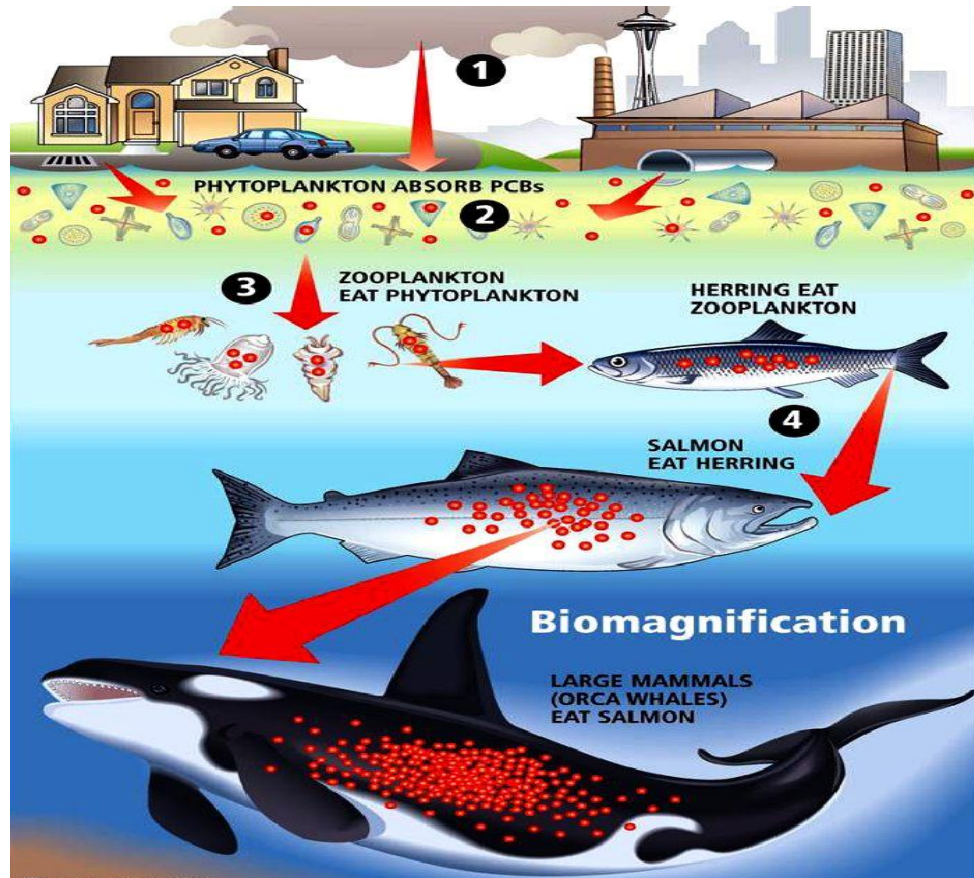
- Bioaccumulation is the gradual accumulation of pollutants, chemicals (chronic poisoning) or other substances in an organism.
- Bioaccumulation occurs when the rate of loss of the substance from the body of the organism through catabolism (breakdown of complex molecules in living organisms), or excretion is lower than the rate of accumulation of the substance.

As persistent organic pollutants like DDT are long-lasting, the risk of bioaccumulation is high even if the environmental levels of the pollutant are not high

- **Biomagnification** refers to **progressive bioaccumulation (increase in concentration) at each trophic level with the passage of time.**
- In order for biomagnification to occur, the pollutant must have a long biological half-life (long-lived), must not be soluble in water but must be soluble in fats. E.g. DDT.
- If the pollutant is soluble in water, it will be excreted by the organism.

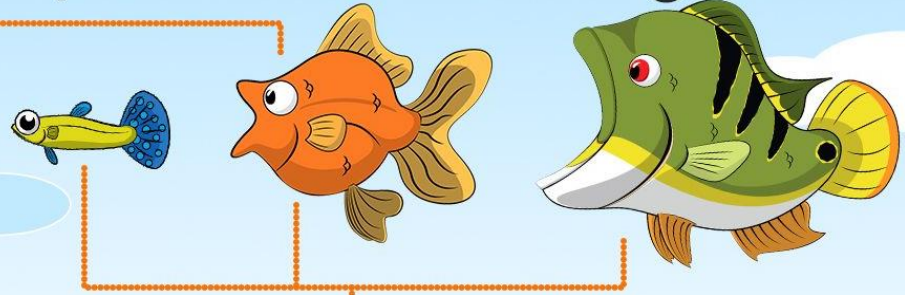
Pollutants that dissolve in fats are retained for a long time.

Polychlorinated biphenyl



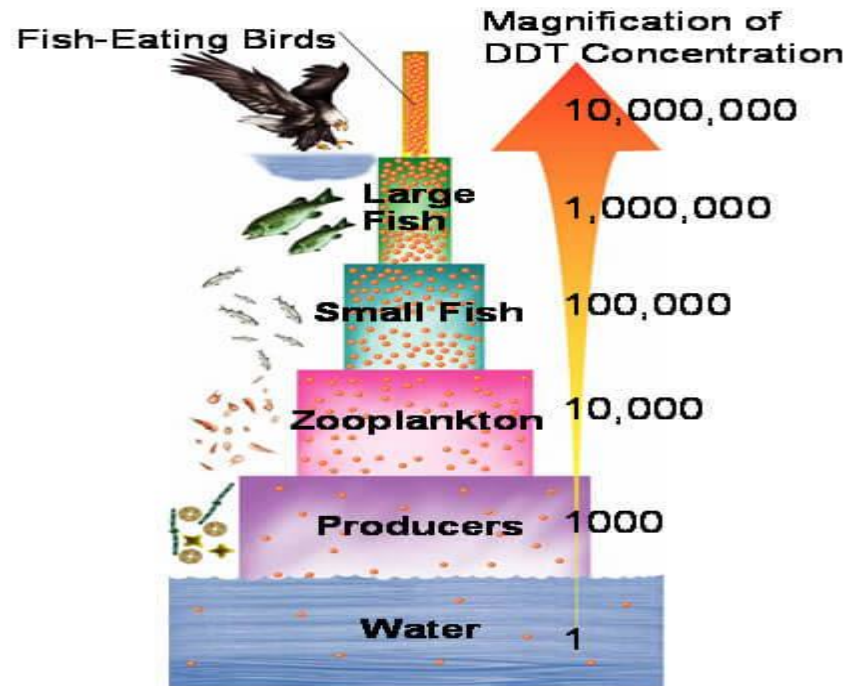
Bioaccumulation

Increase in concentration of a pollutant in an organism.



Biomagnification

Increase in concentration of a pollutant in a food chain.





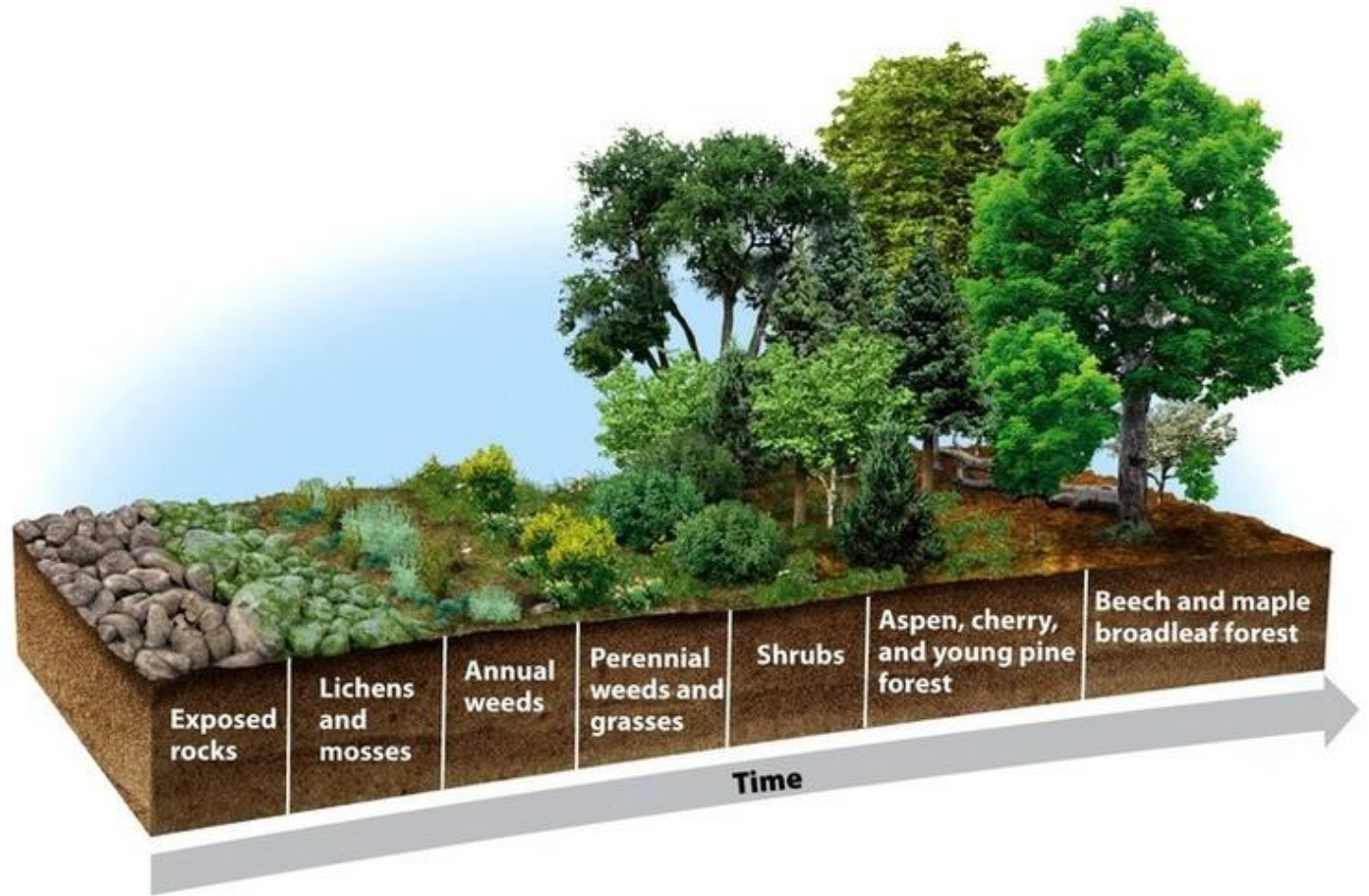
Ecological succession

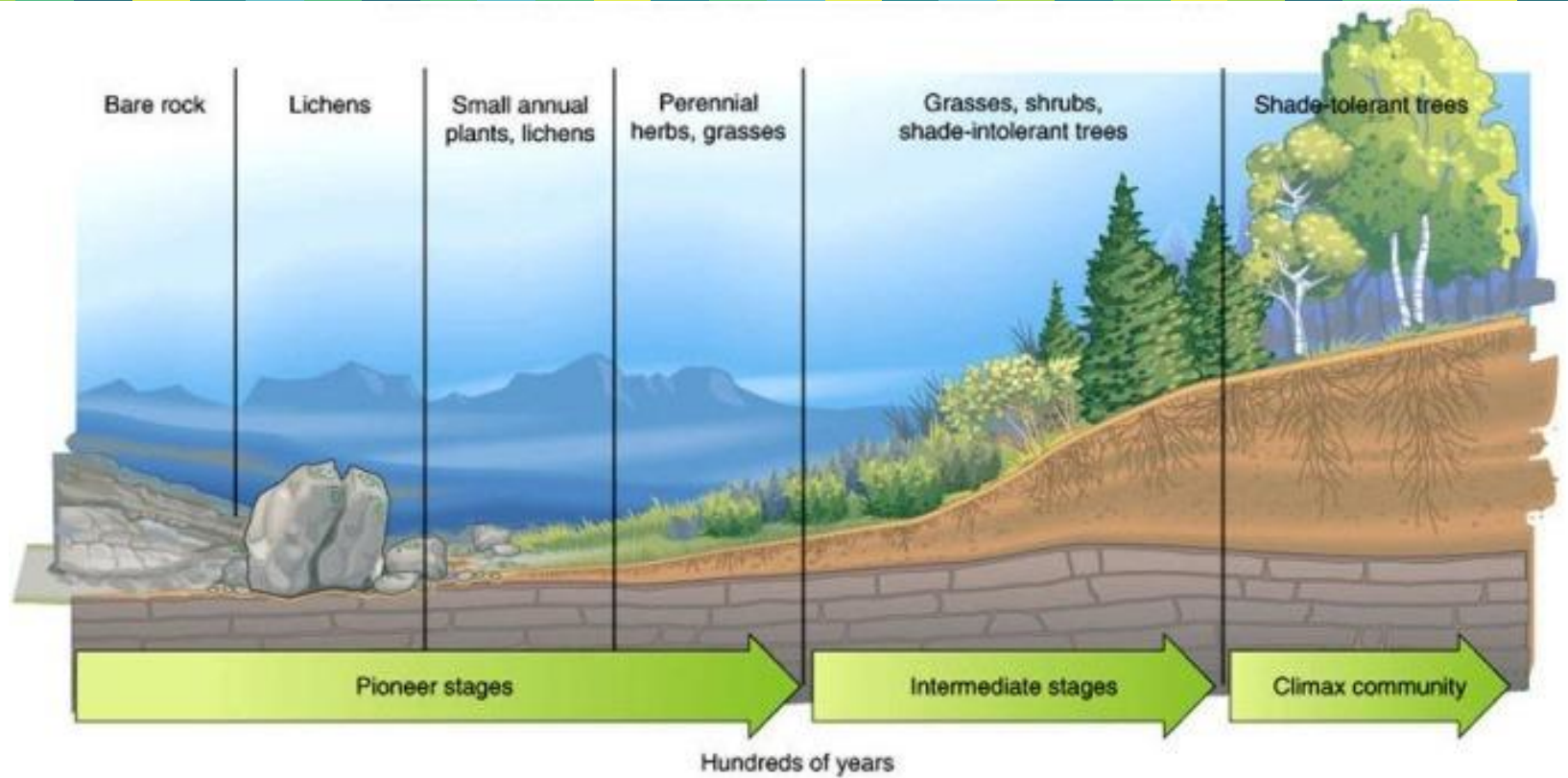
- It is the **process by which one community is replaced by another community over a period of time.**
- The changes are **brought about by both the biotic and abiotic components** in the community.
- The extent of change is influenced by the **physical environment.**

अनुक्रमण: समुदाय में परिवर्तन

इस क्रिया में समुदाय और पर्यावरण में पारस्परिक क्रिया से जो परिवर्तन उत्पन्न होते हैं उसके फल स्वरूप क्रमशः है एक समुदाय दूसरे के द्वारा प्रतिस्थापित होते हैं यह एक कल पथ गामी पारिस्थितिक समय में होने वाला वानस्पतिक परिवर्तन है

- The first plant to colonize an area is called the **pioneer community**. नवीन समुदाय
- The final stage of succession is called the **climax community**. चरम समुदाय
- **A climax community is stable, mature, more complex and long-lasting.**
- The stage leading to the climax community is called **successional stages or seres**.
- Each transitional community that is formed and replaced during succession is called a **stage in succession or a seral community**. क्रम की समुदाय





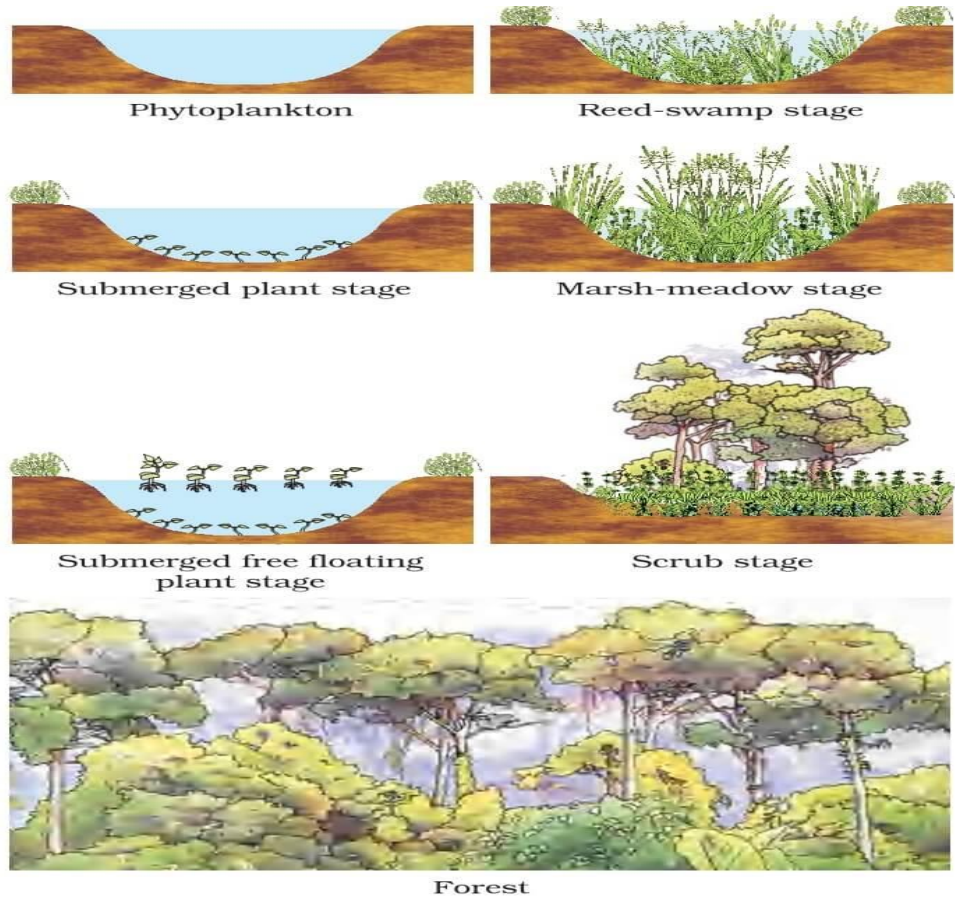


Figure 14.5 Diagrammatic representation of primary succession

Types of Seres	Explanation
Hydrosere	Succession in aquatic habitat.
Xerosere	Succession in dry habitat.
Lithosere	Succession on a bare rock surface.
Psammosere	Succession initiating on sandy areas.
Halosere	Succession starting in saline soil or water.
Senile	Succession of microorganism on dead matter.
Eosere	Development of vegetation in an era.

Orderly Sequence of Primary Succession

Pioneers Stages

Pioneer Species/Community

High growth rate but short life span
Bare Rocks, Lichens

Intermediate Stages

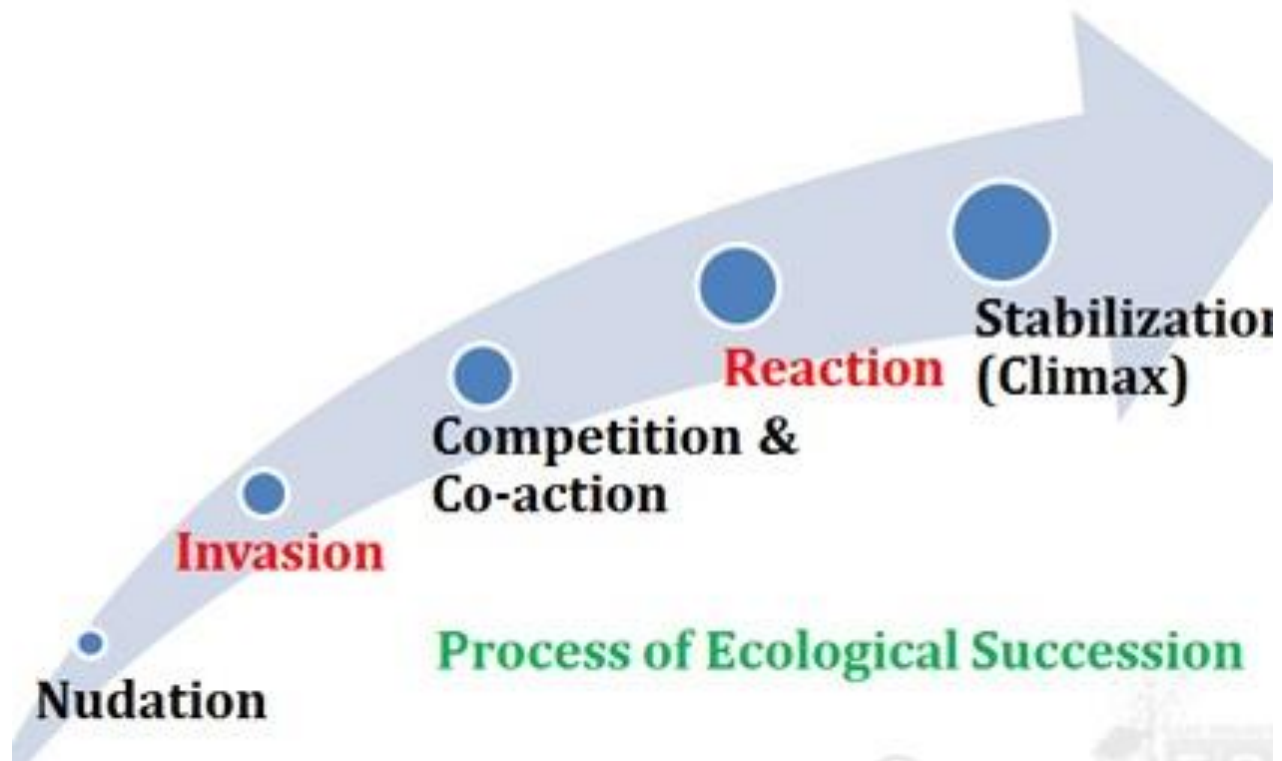
Seral Community: Temporary Community

Grasses, Shrubs

Climax Community

Terminal/Final Community

Stable, mature, more complex and long lasting. Shade tolerant trees



Nudation:

The development of bare area is the initial prerequisite. The cause of nudation may be topographic (soil erosion, landslide, volcanic activity, etc), climatic and biotic (human beings and pathogens).

न्यूडेशन

Invasion: आक्रमण

This is the successful establishment of a species in a bare area. The species actually reaches this new site from any other area..

Competition and coactions: स्पर्धा

After aggregation of a large number of individuals of the species at the limited place, there develops competition mainly for space and nutrition. Individuals of a species affect each other's life in various ways and this is called coactions. The species, if unable to compete with other species, if present, would be discarded.

Reaction: प्रतिक्रिया

This is the most important stage in succession. The mechanism of the modification of the environment through the influence of living organisms on it, is known as reaction. As a result of reaction, changes takes place in soil, water, light conditions, temperature etc. of the environment. Due to all these the environment is modified, becoming unsuitable for the existing community which sooner or later is replaced by another community (seral community). The whole sequence of communities that replaces one another in the given area is called a sere, and various communities constituting the sere as seral communities.

Stabilization (climax): चरम अवस्था

This is the final stage of development. Climax community is nearly stable and will not change so long as the climate and physiographic remain the same. However, the environment as well as the community are in a dynamic state.

Some ecologists (Gleason, 1929) have talked of retrogressive succession in which continuous biotic influences have some degenerating influence on the process. Due to destructive effects on organisms, sometimes the development of disturbed communities does not occur and the process of succession instead of progressive becomes retrogressive. As for example, forest may change to shrubby or grassland community. This is called retrogressive succession.

- Ecological succession is characterised by the following:
 - **increased productivity,**
 - **the shift of nutrients** from the reservoirs,
 - **increased diversity of organisms** with increased development of niche, and
 - a consequent increase in the **complexity of food webs.**
- Succession occurs **faster in areas existing in the middle part of a large continent.**
- This is because, here all communities and seeds of plants belonging to the different seres would reach much faster, establish, and ultimately result in the climax community.

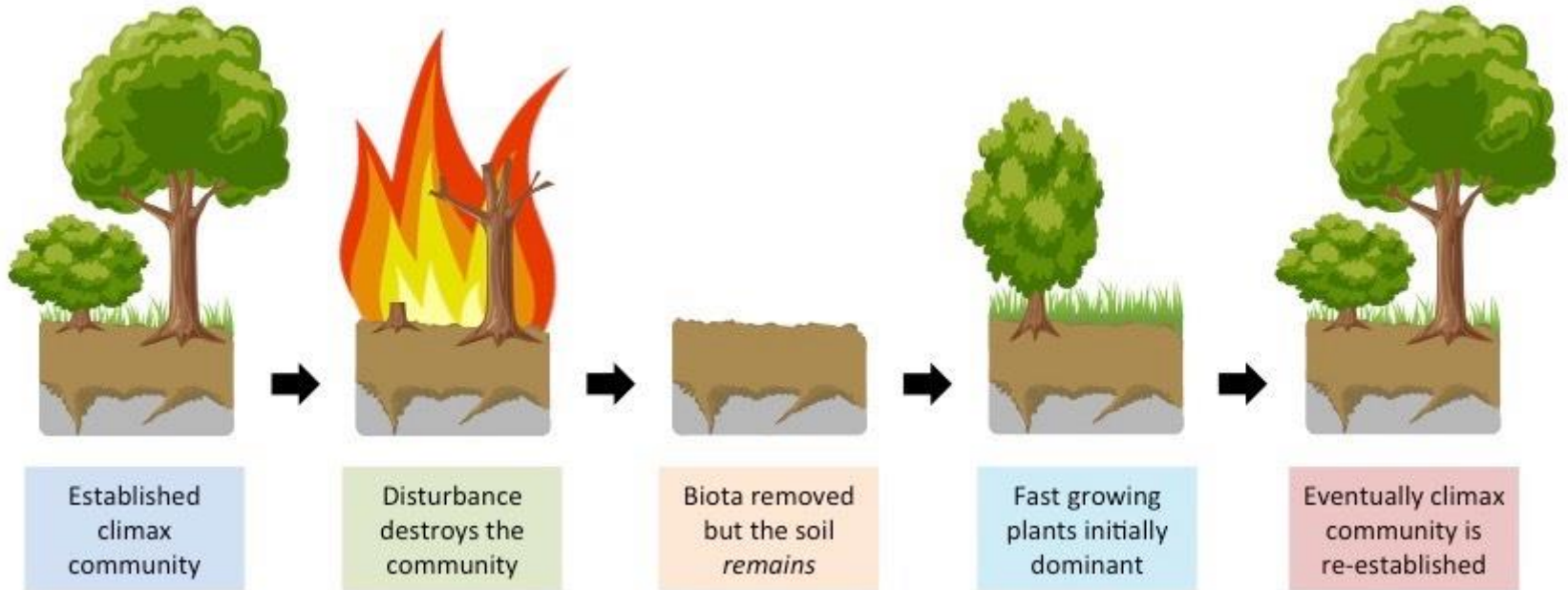
- During succession, **some species colonise an area and their populations become more numerous**, whereas populations of **other species decline and even disappear**.
- There are **two types** of successions such as
 1. **Primary** succession and
 2. **Secondary** succession

Primary Succession

- It takes place in a region **where a community never existed previously.**
- Such regions include **emerging islands, newly formed deltas, newly created pond, reservoir, etc.**
- The species that invade a bare area are called **pioneer species.**
- A pioneer species have **a short lifespan though it may have a high growth rate.**
- The collection of pioneer species that form in a bare region is called the **pioneer community.**

Secondary Succession

- When an existing community is destroyed, another community forms at the same place. Such a **process through which a community develops after the destruction of an existing community** is called secondary succession.
- The removal or destruction of the existing community **takes place due to natural disasters** like forest fires, volcanoes, etc or **due to human activities** like tilling or harvesting.
- In secondary succession, the species that invade **depend on the condition of the soil, availability of water, the environment as also the seeds or other propagules present.**



Primary vs Secondary Succession

- It is **difficult to observe primary succession**, unlike secondary succession.
This is because there are **relatively very few places on earth** that do not already have communities of organisms.
- **Primary succession is very slow** as compared to secondary succession.
This is because **soil formation takes a long time in primary succession** while secondary succession starts on soil that is nutritious.

Seral Community

- In the succession process, **the pioneer community** after some time gets **replaced by another community with different species combinations.**
- This **second community** gets replaced by a **third community** and so on.
- This **process continues sequentially in which a community replaced previously by another community.**
- Each **transitional (temporary) community** that is formed and replaced during succession is called **a stage in succession** or **a seral community.**
- The **entire sequence of communities** that successively change in a given area is called **sere(s).**

Climax Community

- The **final community** which is established by ecological succession and is **in near equilibrium** with the environment is the climax community.
- The climax community that is established is **stable, mature, more complex, and long-lasting**.
- As long as it is undisturbed, a **climax community remains relatively stable in dynamic equilibrium** with the prevailing climate and habitat factors.

Different Types of Succession

Autogenic and Allogenic

When succession is **caused by living inhabitants** of that community itself, the process is called autogenic succession, while change brought about **by external forces** is known as allogenic succession. An allogenic succession can be brought about in a number of ways which can include:

- Volcanic eruptions
- Meteor or comet strike
- Flooding
- Drought

Xerarch and Hydrarch

- Succession that **occurs on land where moisture content is low** for e.g. on bare rock is known as Xerarch.
- Succession that **takes place in a water body**, like ponds or lakes is called Hydrarch.

Autotrophic and Heterotrophic

- Succession in which, the **green plants (initially) are much greater in quantity** is known as autotrophic succession and the ones in which the **heterotrophs are greater in quantity** are known as **heterotrophic succession**.

Biotic Interactions

सामुदायिक अंतः क्रियाएं

- The individuals in a biological community of an area or ecosystem **interact with one another in a number of ways.**
- The interactions that **occur among different individuals of the same species** are termed as **Intraspecific interaction.**
- The interactions **among individuals of different species** in a community are called **Interspecific interaction.**

'0' is no effect; '-' is detrimental; '+' is beneficial.

Types of Interaction		Result	
		Species 1	Species 2
Negative (at least one of the species is harmed)	Amensalism	-	0
	Predation	+	-
	Parasitism	+	-
	Competition	-	-
Positive (both species are benefited)	Commensalism	+	0
	Mutualism	+	+

1. Amensalism असहबोजी

- It is a type of **negative association**.
- In amensalism, **one species is harmed by the other species which remains unaffected by the presence of the other species**.
- For example, the **bread mould fungi Penicillium** produces penicillin an antibiotic substance that **inhibits the growth of a variety of bacteria**.
- **Penicillium** benefits apparently by having greater availability of **food** when the competition because of the bacteria is removed.

Amensalism (0/-)

- Ex: Black Walnut Trees produce chemicals which prevent other trees from growing near them



2. Predation पशुपक्षी

- Predators act as **conduits for transferring energy from one trophic level to another**. They keep **prey populations under control**.
- **The introduction of an exotic species into an area may become invasive** if there are no natural predators.
- Predators also help in **maintaining species diversity in a community**, by **reducing the intensity of competition** among competing for prey species.
- Prey species (plants and animals) are **adapted in various ways to prevent being captured by the predator**.



3. Parasitism परजीविता

- One species is harmed and the other benefits.
- The parasite lives in/on another living species called the host from which the parasite gets its nourishment and often shelter.
- The parasite is benefited and the host is harmed.
- Parasites have special adaptations to counteract and neutralise the mechanisms of the host species. Eg. Cuscuta plant has no leaves.
- Tapeworm, roundworm, malarial parasite, many bacteria, fungi, and viruses are common parasites of humans.



PARASITISM

- Example: Fleas and mosquitoes feed on blood from other organisms.
 - In this type of parasitic relationship, the host needs to stay alive and it is not damaged greatly



- **Ectoparasites-**

Parasites that **feed on the external surface of the host organism** are called ectoparasites. Eg. - lice on humans and ticks on dogs.

- **Endoparasites-**

Endoparasites are those that **live inside the host body at different sites** such as a tapeworm, that lives inside its host.

Brood Parasitism-

Brood parasitism in birds is **a fascinating example of parasitism** in which the parasitic bird lays its eggs in the nest of its host and lets the host incubate them. Eg. cuckoo and crows.

4. Competition प्रतिस्पर्धा

- This is an interaction between two populations in which **both species are harmed to some extent.**
- Competition occurs when two populations or species, **both need a vital resource that is in short supply.**
- The vital resource could be **food, water, shelter, nesting site, mates or space.**
- For instance, in some shallow South American lakes **visiting flamingoes and resident fishes compete** for their common food, the zooplankton in the lake.

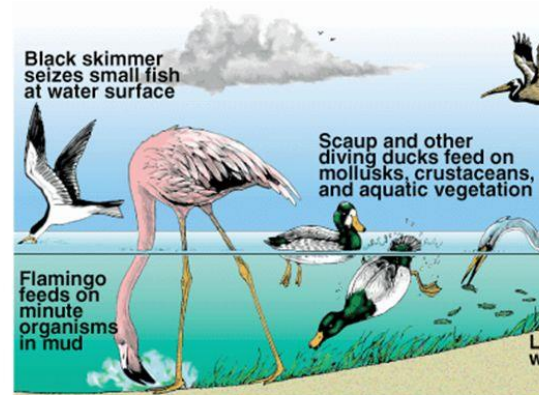


- **Two closely related species competing for the same resources cannot coexist indefinitely** and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting, but not otherwise.
- It can not be ruled out the occurrence of interspecific competition in nature, but **species facing competition might evolve mechanisms that promote coexistence rather than exclusion.**
- Eg. - **resource partitioning.** If two species compete for the same resource, they could avoid competition by choosing, for instance, **different times for feeding or different foraging patterns.**

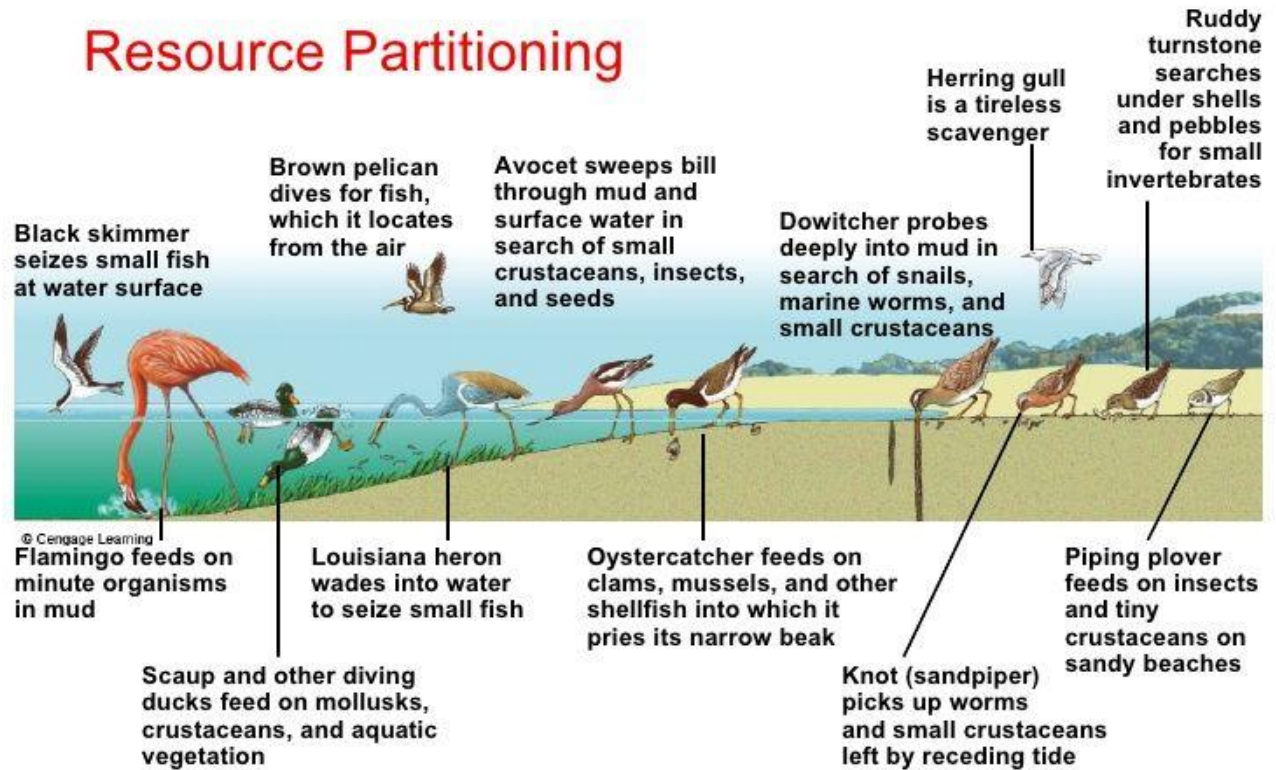
Resource Partitioning

Species with similar resource requirements can coexist because they use limited resources:

- at different times
- in different ways
- in different places



Resource Partitioning



Resource Partitioning

**Blakburnian
Warbler**



**Black-throated
Green Warbler**



**Cape May
Warbler**



**Bay-breasted
Warbler**



**Yellow-rumped
Warbler**



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5. Commensalism સહજીવિતા

- The interaction where **one species is benefitted** and the other is **neither benefitted nor harmed** is called commensalism.
- Some species benefit **by utilising the shelter or transport of another species**.
- For example, **epiphytes live on the surface of other plants** like ferns, mosses, and orchids and use the surface of trees for support and for obtaining sunlight and moisture. The tree does not benefit from this relationship and is not harmed as well.
- Other examples - **barnacles growing on the back of a whale, cattle egret and grazing cattle** in close association, **sea anemone and clownfish**, etc.



6. Mutualism

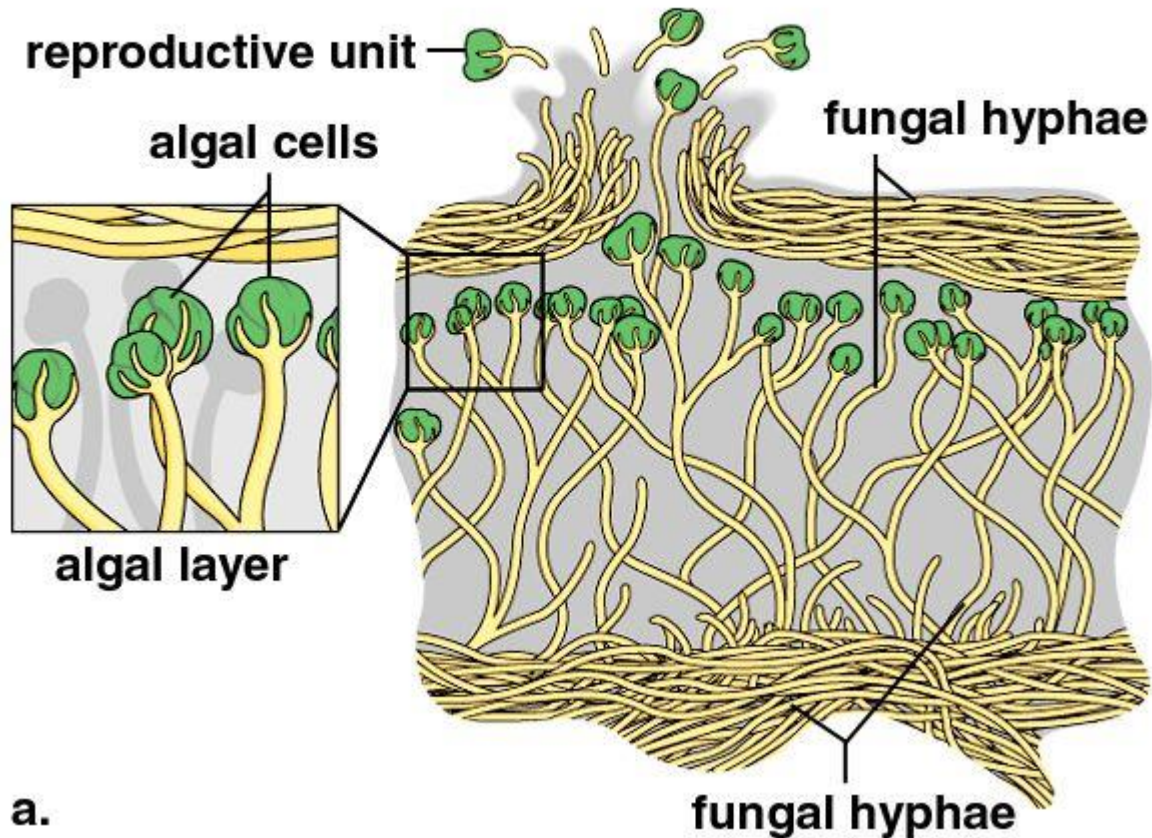
सहोपकारिता

- **Both the species are benefitted** in this interaction.
- In some interactions, mutualism is so strong that the **species involved in the interaction cannot survive without each other.**
- Such an association is called a **symbiotic relationship**. Some examples are such as
 - **Lichens** - algae and fungus
 - **Mycorrhizae** - fungus and roots of higher plants
 - **Plants and animals** - animals help in pollination and plants provide food



The ants obtain food and shelter, and the acacia depends on the ants for protection from browsing animals

Lichen morphology



Some Characteristics of Interactions

- **Both the species benefit in Mutualism and both lose in Competition** in their interactions with each other.
- **In both Parasitism and Predation, only one species benefits** (parasite and predator, respectively) and the interaction is **detrimental to the other species** (host and prey, respectively).
- **Predation, Parasitism, and Commensalisms** share a common characteristic— **the interacting species live closely together.**

Biogeochemical cycles

- The movement of nutrients from the environment into plants and animals and again back to the environment is known as nutrient cycling.
- Nutrients are absorbed from the soil by green plants which are passed onto primary consumers and thereafter to secondary and tertiary consumers.
- When the producers and consumers die, nutrients are released back into the soil by detritivores from the dead remains of organisms.

- Nutrient cycle can be of two types
 - **Gaseous** - atmosphere or the hydrosphere is the main reservoir
 - **Sedimentary** - earth's crust is the main reservoir.

1. Water cycle/hydrological cycle

- Water is essential for life.
- It not only provides transportation for nutrient cycling, but also acts as a solvent medium for the uptake of nutrients by various organisms.
- Precipitation (rain, snow, slush dew etc.) is the only source of water on the earth.
- Water received from the atmosphere on the earth returns back to the atmosphere as water vapour resulting from direct evaporation and through evapotranspiration.

- This continuous movement of water in the biosphere is called water cycle (hydrological cycle).
- The driving forces for water cycle are solar radiation and gravity.
- Evaporation and precipitation are two main processes involved in water cycle. These two processes alternate with each other.
- Water from oceans, lakes, ponds, rivers and streams evaporates by sun's heat energy. Plants also transpire huge amounts of water.
- Water remains in the vapour state in air and forms clouds which drift with wind.
- Clouds meet with the cold air in the mountainous regions above the forests and condense to form rain precipitate which comes down due to gravity.

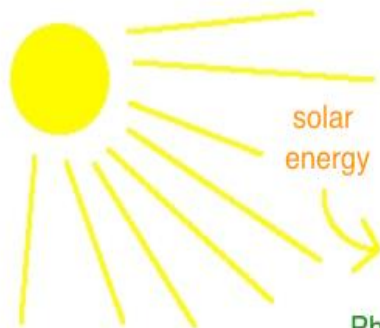
2. Carbon cycle

- Almost all the carbon in nature is derived from carbon dioxide present in the atmosphere.
- It is highly soluble in water. Therefore, oceans also contain large quantities of dissolved carbon dioxide.
- It is vital for the production of carbohydrates through photosynthesis by plants.

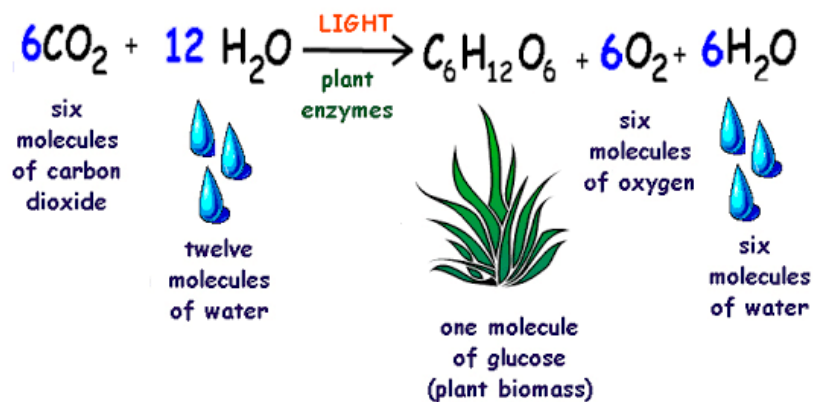
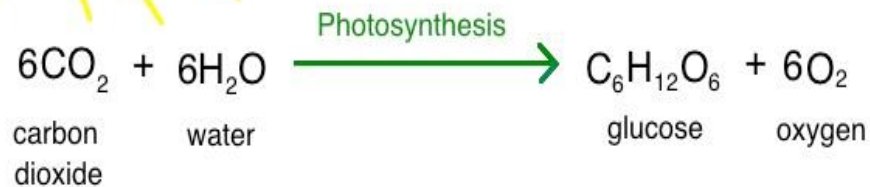
Steps in global Carbon cycle

1. Photosynthesis:

- Green plants in the presence of sunlight utilize CO_2 in the process of photosynthesis.
- A part of the food made is used by plants for their own metabolism.
- Rest of the food is stored as their biomass which is available to various herbivores, heterotrophs, including human beings and microorganisms as food.
- Forests act as reservoirs of CO_2 as carbon fixed by the trees remain stored in them for long due to their long life cycles.



solar
energy



- A very large amount of CO_2 is released through forest fires.

2. Respiration:

- Respiration is a metabolic process where food is oxidized to liberate energy, CO_2 and water.
- The energy released from respiration is used for carrying out life processes by living organisms (plants, animals, decomposers etc.).
- Thus CO_2 is released into the atmosphere through this process.

Adenosine triphosphate (ATP), energy-carrying molecule found in the cells of all living things. **ATP** captures chemical energy obtained from the breakdown of food molecules and releases it to fuel other cellular processes.

Cellular Respiration Equation



- Requirements:

- $\text{C}_6\text{H}_{12}\text{O}_6$ – organic sugar comes from digested foods eaten
- 6O_2 – oxygen comes from air you breathe

- Products:

- 6CO_2 – carbon dioxide is released by breathing out
- $6\text{H}_2\text{O}$ – water is released as a waste in your urine, sweat or breath
- Energy – chemical ATP energy is released

3. Decomposition:

- All the food assimilated by animals or synthesized by plants is not metabolized by them completely.
- A major part is retained by them as their own biomass which becomes available to decomposers on their death.
- The dead organic matter is decomposed by microorganisms and CO_2 is released into the atmosphere by decomposers.

4. Combustion:

Burning of biomass releases carbon dioxide into the atmosphere.

5. Impact of human activities:

Since the industrial era, large scale deforestation and ever growing consumption of fossil fuels by growing numbers of industries, power plants and automobiles are primarily responsible for increasing the emission of carbon dioxide.

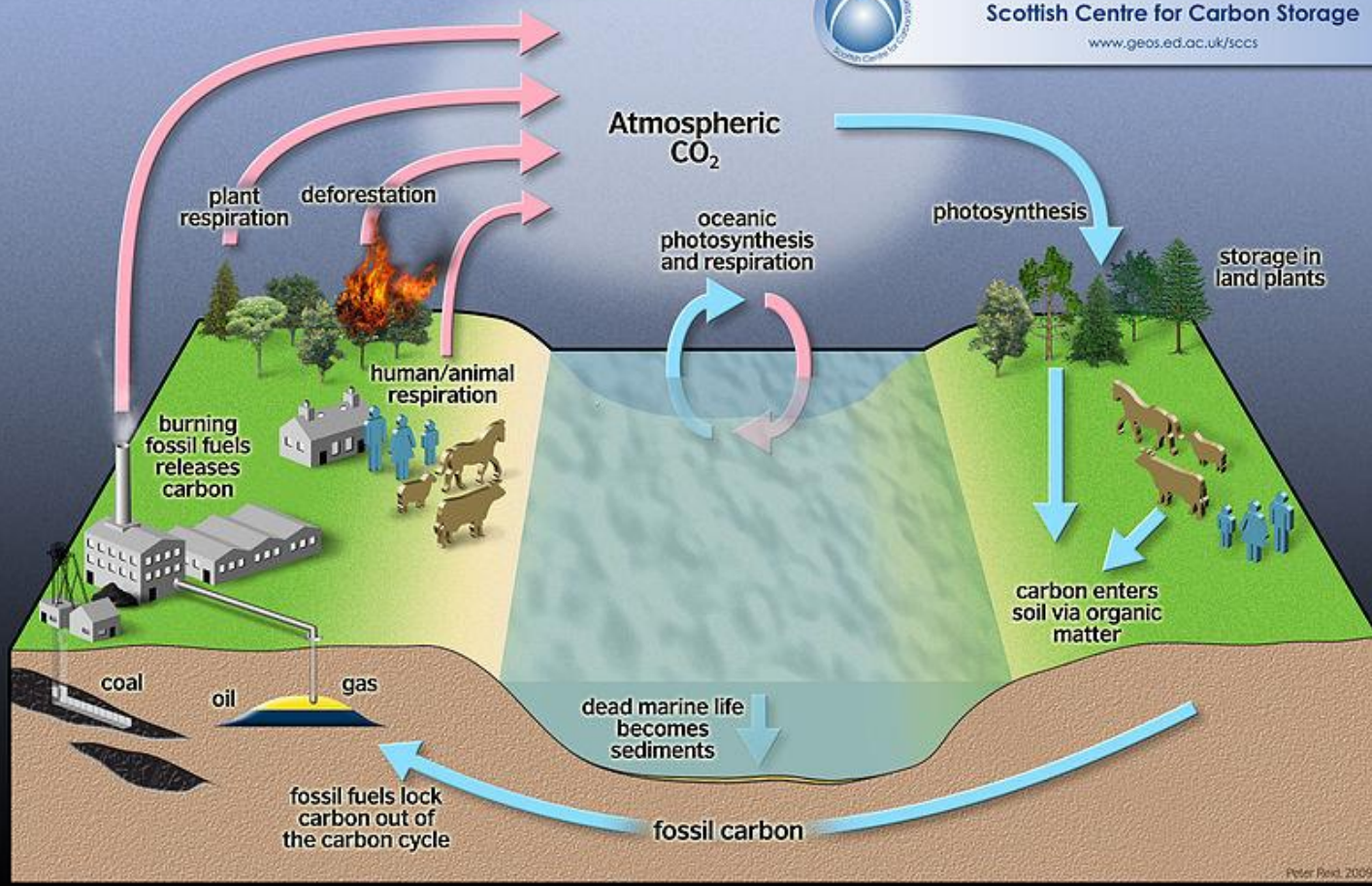
6. Storage in long term cycle:

- Some carbon accumulates as un-decomposed organic matter in marshy soil or as insoluble carbonates in ocean bottom where it remains buried for millions of years.
- The carbonate rocks may be uplifted geologically and exposed to erosion, releasing the carbon compounds into streams and rivers.



Scottish Centre for Carbon Storage

www.geos.ed.ac.uk/sccs

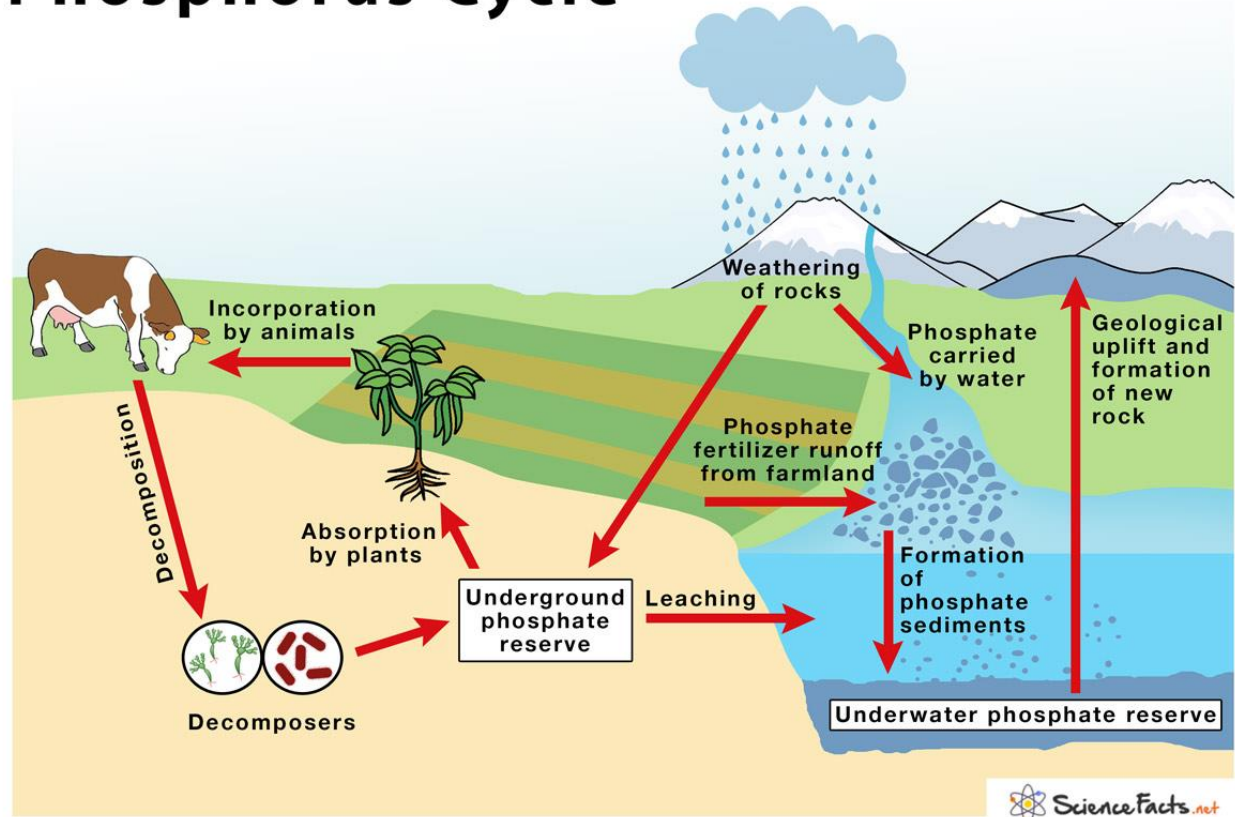


- When fossil fuels such as coals, oil and natural gas etc. are burned, the carbon stored in them is released back into the atmosphere as carbon-dioxide.

C. Phosphorus cycle

- Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems.
- Many animals also need large quantities of this element to make shells, bones and teeth.
- The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates.
- When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants .
- Herbivores and other animals obtain this element from plants.

Phosphorus Cycle



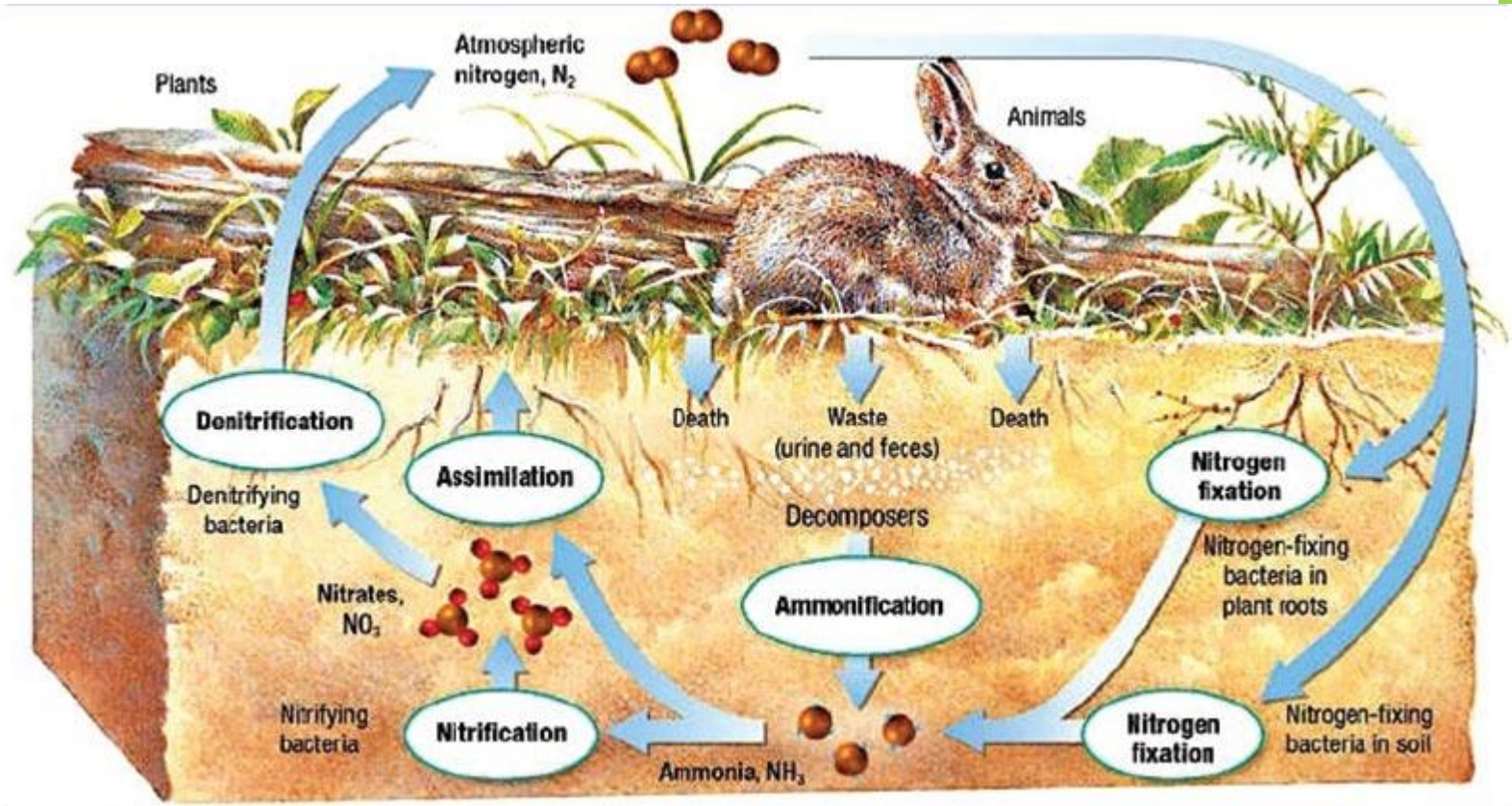
- The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus.

Differences between carbon cycle and phosphorus cycle

- Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.
- Atmospheric inputs of phosphorus through rainfall are much smaller than carbon inputs.
- Gaseous exchanges of phosphorus between organism and environment are negligible.

Nitrogen cycle

- Nitrogen is an essential component of protein required by all living organisms including human beings.
- Our atmosphere contains nearly 78% of nitrogen but it cannot be used directly i.e in its elemental form by the majority of living organisms.
- Therefore, the atmospheric nitrogen needs to be fixed i.e converted to ammonia, nitrites and nitrates so that it is taken by various organisms.
- Like carbon dioxide, nitrogen also cycles from gaseous phase to solid phase then back to gaseous phase through the activity of a wide variety of organisms.



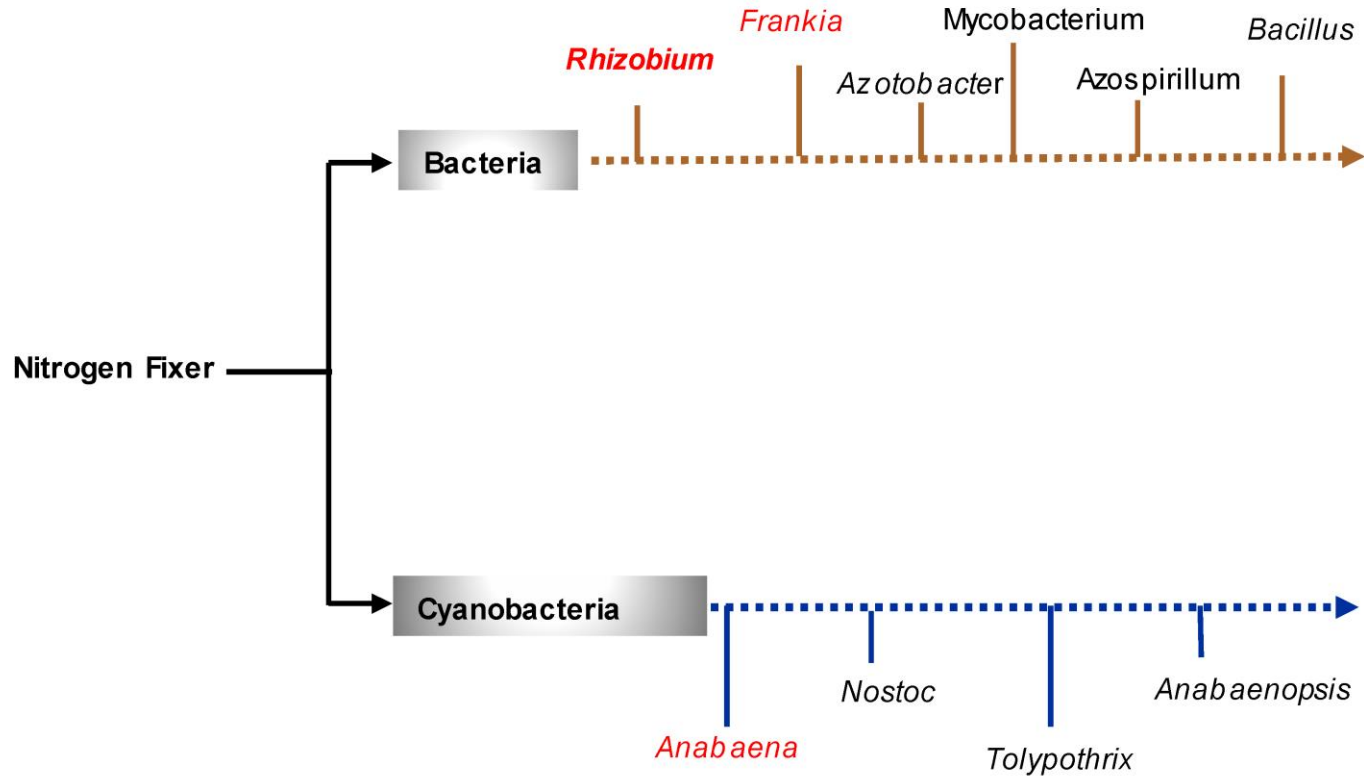
Agents of nitrogen fixation

Atmospheric nitrogen is fixed mainly by three agents:

1. Bacterial fixation: There are two types of bacteria-
 - a. Symbiotic bacteria e.g. Rhizobium in the root nodules of leguminous plants.
 - b. Free Living e.g. 1. Nostoc 2. Azotobacter 3. Cyanobacteria
2. Industrial activities e.g. manufacture of nitrogenous fertilizers
3. Atmospheric phenomena such as thunder and lightning

Processes in nitrogen cycle

- **Nitrogen fixation:** This process involves conversion of gaseous nitrogen into Ammonia, nitrites and nitrates.
- **Nitrification:**
 - It is a process by which ammonia is converted into nitrates or nitrites by Nitrosomonas and Nitrococcus bacteria respectively.
 - Another soil bacteria Nitrobacter can convert nitrite into nitrate



- (a) क्लॉस्ट्रिडियम (Clostridium)—
अवायवीय, मुक्तजीवी व मृदोत्पन्न।
- (b) एजोटोबैक्टर (Azotobacter)—
वायवीय, मुक्तजीवी, मृतोपजीवी व मृदोत्पन्न।
- (c) राइजोबियम (Rhizobium)—
सहजीवी, मृतोपजीवी व मृदोत्पन्न।
- (d) क्लेबसिएला (Klebsiella)—
सहजीवी, मृतोपजीवी व वायोत्पन्न।
- (e) क्लोरोबियम (Chlorobium)—
अवायवीय, आत्मपोषी व मुक्तजीवी।
- (f) रोडोस्पिरिलम (Rhodospirillum)—
अवायवीय, आत्मपोषी व मुक्तजीवी।
- नाइट्रोजन स्थिरीकारक नीले-हरे शैवाल
निम्नलिखित हैं—
- (i) नोस्टॉक (Nostoc), (ii) ऐनाबीना (Anabaena), (iii) ऑलोसिरा (Aulosira), (iv) ग्लीयोट्राइकिया (Gleotrichia), (v) कैलोथ्रिक्स (Calothrix), (vi) रिवुलेरिया (Rivularia)।

Assimilation:

- In this process, nitrogen fixed by plants is converted into organic molecules such as proteins, DNA, RNA etc.
- These molecules make the plant and animal tissue.

Ammonification:

- Living organisms produce nitrogenous waste products such as urea and uric acid.
- These waste products as well as dead remains of organisms are converted back into inorganic ammonia by the bacteria. This process is called ammonification.
- Ammonifying bacteria help in this process.

Examples of ammonifying bacteria contain bacillus, proteus, clostridium,

Denitrification:

- Conversion of nitrates back into gaseous nitrogen is called denitrification.
- Denitrifying bacteria (e.g. pseudomonas) live deep in soil near the water table as they like to live in oxygen free medium.
- Denitrification is reverse of nitrogen fixation.