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**PRELIMS HARVEST™**



**ENVIRONMENT**

# **OFFICERS IAS ACADEMY**



# **ENVIRONMENT**

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## **OFFICERS IAS ACADEMY**

(IAS Academy by IAS Officers)

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## MESSAGE FROM THE DIRECTOR

### Dear Aspirant,

This book is dedicated to YOU, the untiring civil service aspirant who has the drive and commitment to persevere towards clearing this exam which is considered as one of the toughest exams in the world.

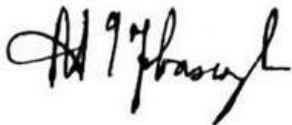
We congratulate you on choosing this book for “**Environment**”. Our attempt here is to simplify important concepts without losing the key points. Hence, we hope you will find this book useful in your civil services journey.

### About this book

This book is a distillation of the expertise of the faculty at Officers IAS academy, explained in simple and easy to understand language. What you get to study in this book has been painstakingly collated by our faculty through their years of teaching and mentoring thousands of aspirants.

A strong zeal from you to clear this exam combined with our coaching and textbook will, I am sure help you scale great heights.

I wish you the very best in the most important endeavour of your life.



R. A. Israel Jebasingh

(IAS, 2004 Batch All India Rank 59)

Director of Officers IAS Academy

## HOW TO USE THIS BOOK?

### **Hello Aspirant!**

There is a subtle difference between putting in effort and putting in the right & focussed effort. That difference could mean whether you get into the civil services or not!

Aspirants know that the first step to become a Civil Servant is to crack the Preliminary Exam (Prelims) conducted by the UPSC. At first glance, any UPSC Prelims question paper might give the impression that many of the questions asked were 'random', 'remote', 'unexpected', 'out of syllabus', 'from obscure areas' etc.,

But, upon careful consideration one can see that there are some hidden patterns present in the way how some of them were framed. We in the R&D of Officers IAS Academy, understand this.

Our R&D team consists of about 25 members, all of whom have appeared in multiple UPSC Mains & Interviews. This team of veterans spent a year, meticulously combing through the question papers of the past 26 years of UPSC preliminary exams to identify patterns, repetitions & outliers.

The team carefully isolated all such patterns, high-value topics from every subject and has prepared a 'hitlist'. Based on these insights we have prepared books, which we rightfully call as 'Prelims Harvest' books.

Please note: We do not advocate the use of these books as 'Standard' sources. However, instead of reading endless number of books for the UPSC preparation, aspirants can focus on the standard books (NCERTs, etc.,) for the foundational knowledge and then devote the rest of their time in studying the Officers IAS Academy's Prelims Harvest books.

So, please use the Prelims Harvest Books in conjunction with the primary sources (NCERTs, etc.,) and get the best value for your time invested in your UPSC preparation.

Thank you!

**R&D Team,**

Officers IAS Academy, Chennai.

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## **ORGANISMS & POPULATION**

### **Environment**

- The **environment** is the external conditions, resources, stimuli, etc., with which an organism interacts.
- It may also refer to the external surroundings including all of the biotic and abiotic factors that surround and affect the survival and development of an organism or population

### **Habitat**

- Habitat is the physical environment in which an organism lives (address of an organism).
- A single habitat may be common for more than one organism which have similar requirements.
- For example, a single aquatic habitat may support a fish, frog, crab, phytoplankton and many others.

### **Biosphere**

- The biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere, and atmosphere.
- It can also be termed the zone of life on Earth.
- Biosphere is absent at extremes of the North and South poles, the highest mountains and the deepest oceans, since existing hostile conditions there do not support life.

### **Population Growth**

- The size of a population for any species is not a static parameter. It keeps changing with time, depending on various factors including food availability, predation pressure and adverse weather

### **Factors Affecting Population Growth**

1. **Natality** refers to the number of births during a given period in the population that are added to the initial density.

2. **Mortality** is the number of deaths in the population during a given period.
3. **Immigration** is the number of individuals of the same species that have come into the habitat from elsewhere during the time period under consideration.
4. **Emigration** is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.

### **Biotic Interactions**

- In ecology, a biological interaction is the effect that a pair of organisms living together in a community have on each other.
- They can be either of the same species (intraspecific interactions), or of different species (interspecific interactions).
- They could be beneficial, detrimental or neutral (neither harm nor benefit) to one of the species or both.
- Assigning a '+' sign for beneficial interaction, '-' sign for detrimental and 0 for neutral interaction, let us look at all the possible outcomes of interspecific interaction from the table given below.

**Table 11.1 : Population Interactions**

<b>Species A</b>	<b>Species B</b>	<b>Name of Interaction</b>
+	+	<i>Mutualism</i>
-	-	<i>Competition</i>
+	-	<i>Predation</i>
+	-	<i>Parasitism</i>
+	0	<i>Commensalism</i>
-	0	<i>Amensalism</i>

- 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).

- The interaction where one species is benefitted and the other is neither benefitted or harmed is called **commensalism**.
- In **amensalism** on the other hand one species is harmed whereas the other is unaffected.
- **Predation, parasitism** and **commensalism** share a common characteristic—the interacting species live closely together.

<b>Biotic Interaction</b>	<b>Examples</b>
<b>Mutualism</b>	Pollination
<b>Commensalism</b>	Cow dung provides food and shelter to dung beetles.
<b>Amensalism</b>	A large tree shades a small plant, retarding the growth
<b>Predation</b>	Lion feeding on deer
<b>Parasitism</b>	Flea on dogs
<b>Competition</b>	Lions and tigers feeding on the same prey

### Lichens

- It is a **symbiotic association** of **algae** and **fungi**
- It occurs as crusty patches or bushy growths on trees, rocks and bare ground.
- Lichens are widely used as environmental indicators or bio-indicators.
- If air is very badly polluted with Sulphur Dioxide there may be no lichens present, just green algae may be found. If the air is clean, shrubby, hairy and leafy lichens become abundant.
- A few lichen species can tolerate quite high levels of pollution and are commonly found on pavements, walls and tree bark in urban areas.
- In the primary succession of any terrestrial site, often lichens, mosses and microbes are the pioneer species.

# ECOSYSTEM

## Ecosystem

- An ecosystem can be visualised as a **functional unit** of **nature**, where living organisms interact among themselves and also with the surrounding physical environment.
- Ecosystems are of two types- **terrestrial** and **aquatic**.
- Forest, grassland and desert are some examples of terrestrial ecosystems; pond, lake, wetland, river and estuary are some examples of aquatic ecosystems.
- Crop fields and an aquarium may also be considered as man-made ecosystems.

## Ecosystem – Structure and Function

- Interaction of biotic and abiotic components result in a physical structure that is characteristic for each type of ecosystem
- Vertical distribution of different species occupying different levels is called stratification.
- The components of the ecosystem are seen to function as a unit when you consider the following aspects: **(i) Productivity; (ii) Decomposition; (iii) Energy flow; and (iv) Nutrient cycling**

### i) 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 (**gm<sup>-2</sup>**) or energy (**kcal m<sup>-2</sup>**).
- The rate of biomass production is called **productivity**. It is expressed in terms of **gm<sup>-2</sup> yr<sup>-1</sup>** or **(kcal m<sup>-2</sup>) yr<sup>-1</sup>**.
- **Gross primary productivity** of an ecosystem is the rate of production of organic matter during photosynthesis.
- A considerable amount of GPP is utilised by plants in respiration.
- **Gross primary productivity** minus **respiration losses (R)**, is the **net primary productivity (NPP)**
- **Secondary productivity** is defined as the rate of formation of new organic matter by consumers.



**ii) Decomposition**

- **Decomposers** break down complex organic matter into 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**, watersoluble **inorganic nutrients** go down into the soil horizon and get precipitated as unavailable salts.
- Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called 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 occurs 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 through their effects on the activities of soil microbes.



- Warm and moist environments favour decomposition whereas low temperature and anaerobiosis inhibit decomposition resulting in build up of organic materials.

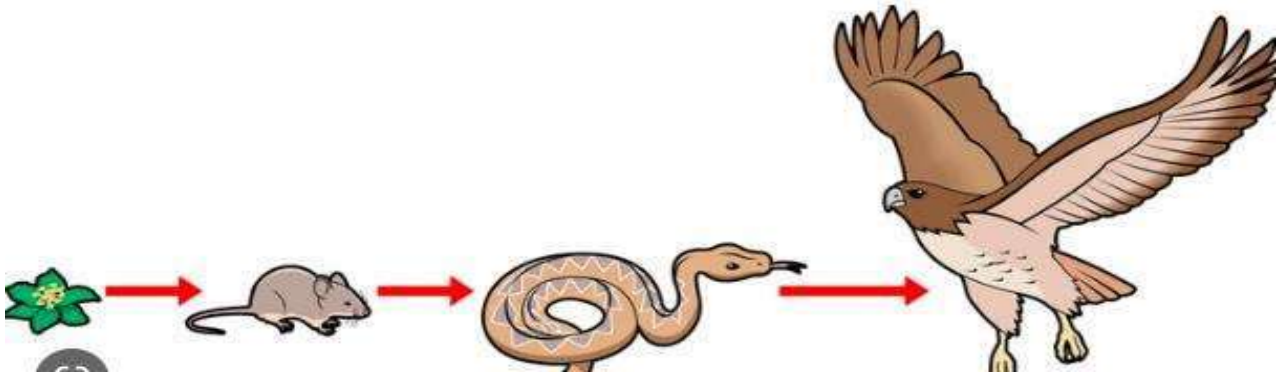
### **iii) Energy Flow**

- Except for the deep sea hydro-thermal ecosystem, the sun is the only source of energy for all ecosystems on Earth.
- Of the incident solar radiation less than 50 per cent of it is photosynthetically active radiation (PAR).
- Plants capture only 2-10 percent of the PAR and this small amount of energy sustains the entire living world
- The green plants in the ecosystem are called producers. In a terrestrial ecosystem, major producers are herbaceous and woody plants. Likewise, producers in an aquatic ecosystem are various species like phytoplankton, algae and higher plants.
- All animals depend on plants (directly or indirectly) for their food needs. They are hence called consumers and also heterotrophs.
- If they feed on the producers, the plants, they are called primary consumers, and if the animals eat other animals which in turn eat the plants (or their produce) they are called secondary consumers. Likewise, there are tertiary consumers too.
- The primary consumers will be herbivores. Some common herbivores are insects, birds and mammals in terrestrial ecosystem and molluscs in aquatic ecosystem.

### **Food Chain**

- Energy is the basic force responsible for all metabolic activities. The flow of energy from producer to top consumers is called energy flow which is unidirectional.
- Transfer of food energy from green plants (producers) through a series of organisms with repeated eating and being eaten is called a food chain
- Each step in the food chain is called trophic level. In the above example grasses are 1st, and eagle represents the 4th trophic level.

- During this process, some energy is lost into the system as heat energy and is not available to the next trophic level. Therefore, the number of steps is limited in a chain to 4 or 5.



- **Food chain in an aquatic ecosystem: diatoms-crustaceans- herrings**
- The food chain starts with a producer and ends with a top consumer.
- **Phytoplanktons** are the primary producers in the oceans. They include:
  - **Diatoms (unicellular algae),**
  - **Coccolithophores (unicellular, eukaryotic protist),**
  - **Cyanobacteria (Blue Green algae)-  
Synechococcus, Prochlorococcus, Nostoc, spirogyra.**
  - **Dinoflagellates (flagellated protists).**
- Crustaceans form a very large group of arthropods which includes crabs, lobsters, crayfish, shrimp, krill and barnacles
- Herrings are a fish, and they eat crustaceans.

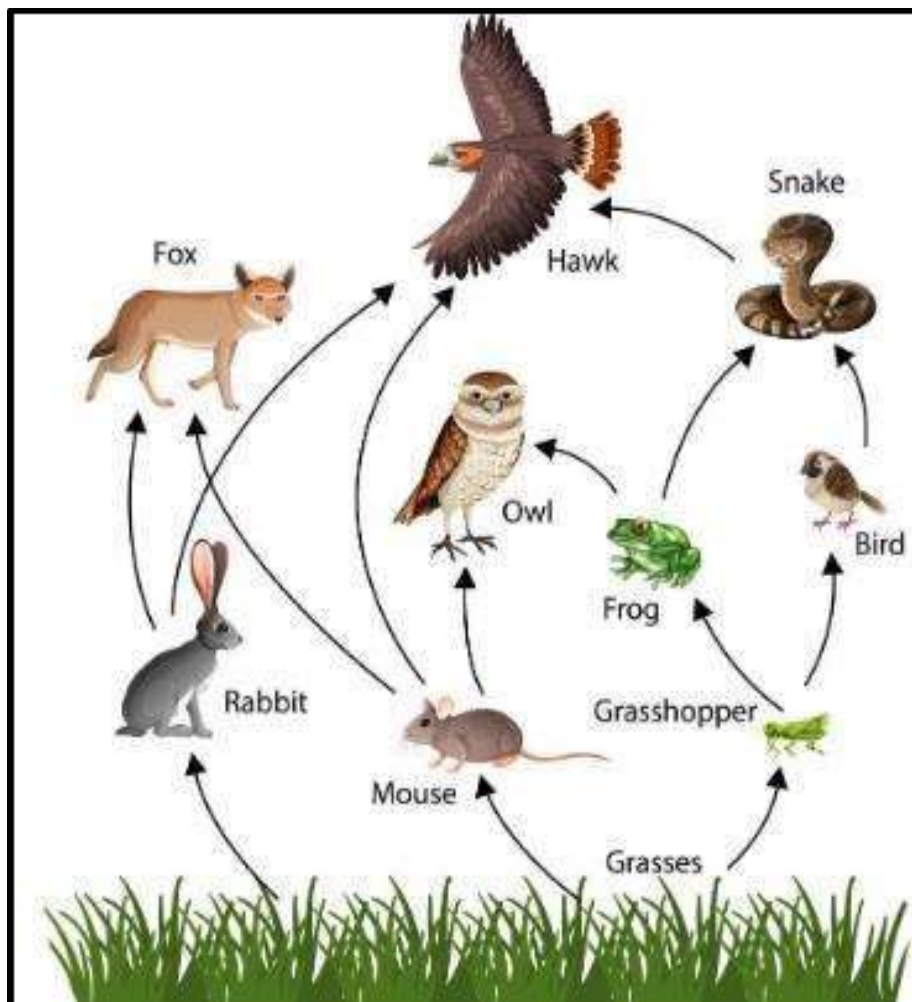
### **Types of Food Chain**

- **Grazing food chains** start from the green plants that make food for herbivores and herbivores in turn for the carnivores.
- **Detritus food chains** start from the dead organic matter to the detritivorous organisms which in turn make food for protozoan to carnivores etc.
- The detritus food chain (**DFC**) begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms, mainly fungi and bacteria.
- They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as **saprotrophs** (sapro: to decompose).

- Decomposers secrete digestive enzymes that break down dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.
- In an aquatic ecosystem, GFC is the major conduit for energy flow. As against this, in a terrestrial ecosystem, a much larger fraction of energy flows through the detritus food chain than through the GFC.
- Detritus food chain may be connected with the grazing food chain at some levels: some the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores.
- Each trophic level has a certain mass of living material at a particular time called the **standing crop**. The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area.

### **Food Web**

- A food web is the natural interconnection of food chains and a graphical representation of what-eats-what in an ecological community.
- Each living thing in an ecosystem is part of multiple food chains.
- Each food chain is one possible path that energy and nutrients may take as they move through the ecosystem.



### **Ecological Pyramids**

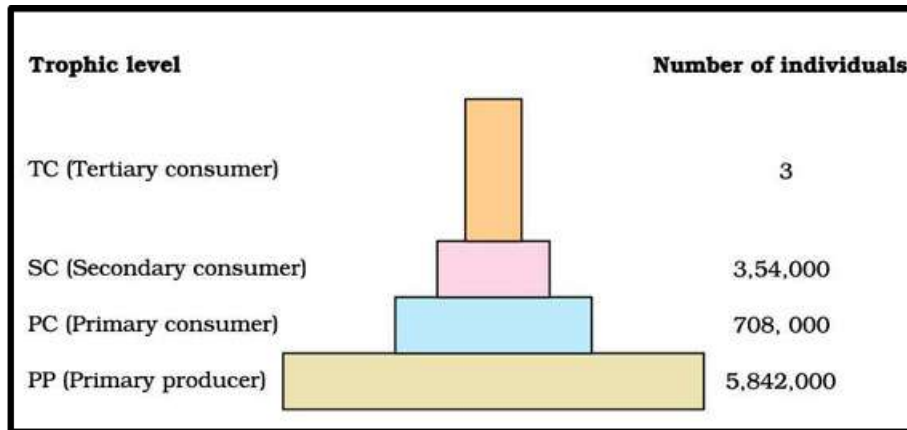
- The base of a pyramid is broad and it narrows towards the apex.
- This relationship is expressed in terms of number, biomass or energy.
- The base of each pyramid represents the producers or the first trophic level while the apex represents tertiary or top level consumer.
- The three types of ecological pyramids that are usually studied are
  - (i) pyramid of number;
  - (ii) pyramid of biomass and
  - (iii) pyramid of energy
- In most ecosystems, all the pyramids, of number, of energy and biomass are upright, i.e., producers are more in number and biomass than the herbivores, and herbivores are more in number and biomass than the carnivores.
- Also energy at a lower trophic level is always more than at a higher level.

- Pyramid of energy is always upright, can never be inverted, because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step.
- Each bar in the energy pyramid indicates the amount of energy present at each trophic level in a given time or annually per unit area.

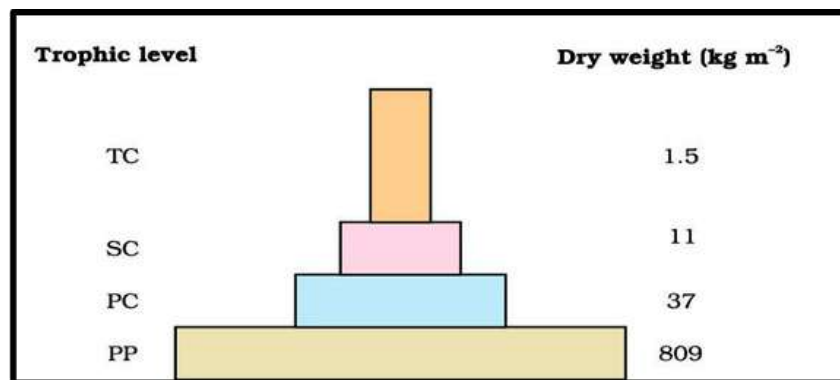
### **Limitations of Ecological Pyramids**

- It does not take into account 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.
- Moreover, saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

**i) Pyramid of Number - Terrestrial Ecosystem**

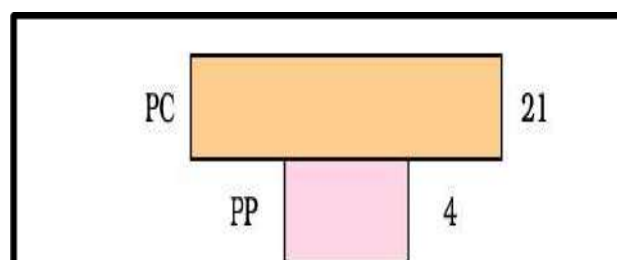


**ii) Pyramid of Biomass- Terrestrial Ecosystem**



**Inverted Pyramid of Biomass- Aquatic Ecosystem**

- Small standing crop of phytoplankton supports a large standing crop of zooplankton.

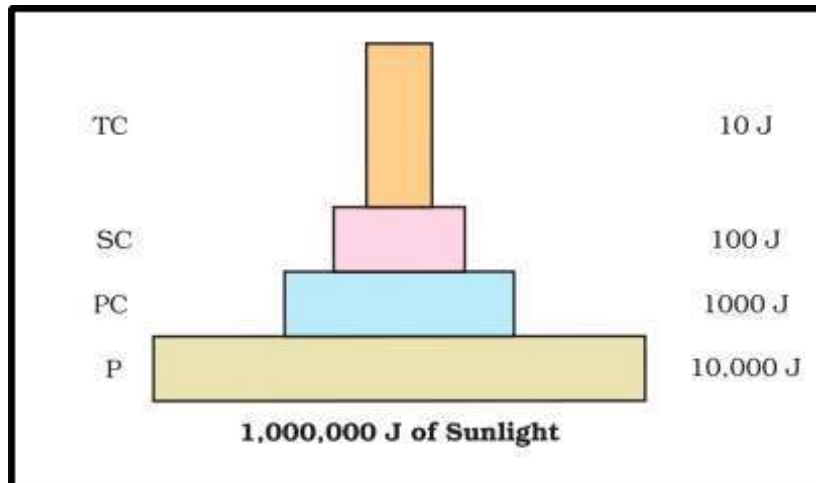




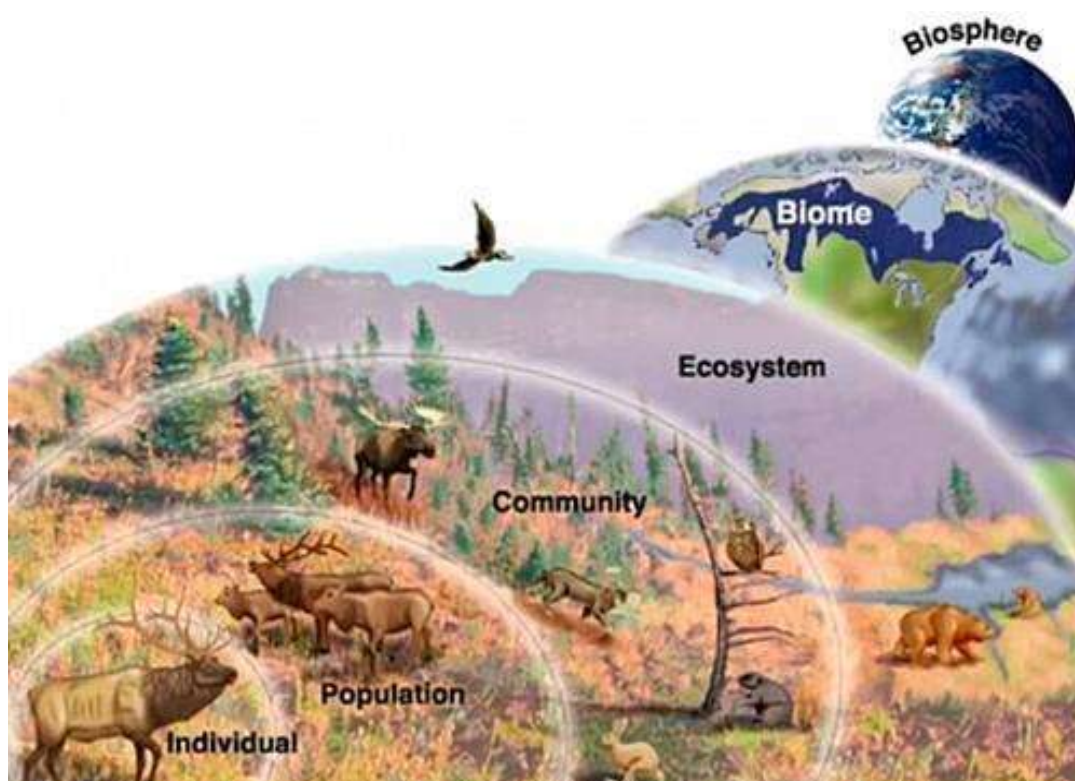
### iii) Pyramid of Energy

- **Lendman's Rule,**

- During the transfer of organic matter/energy from one trophic level to the next, only about 10% of the energy is transferred.
- The remaining is lost during transfer or broken down in respiration.



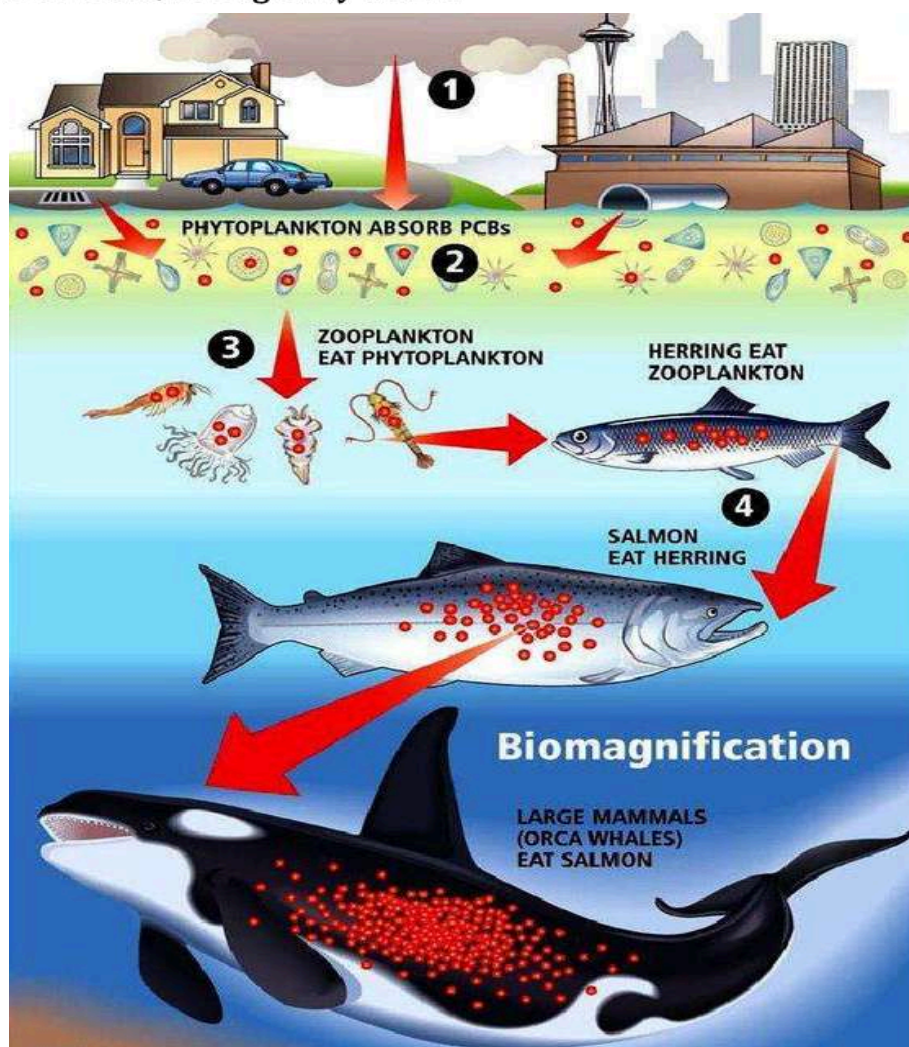
### Levels of Ecological Organisation





## Bioaccumulation and Biomagnification

- Even when pollutants are not dangerous enough to kill animals outright, their presence can have lasting effects on the food web through bioaccumulation and biomagnification.
- **Bio-accumulation** is the process by which toxins enter the food web by building up in individual organisms.
- **Bio-magnification** is the process by which toxins are passed from one trophic level to the next (and thereby increase in concentration) within a food web.
- This phenomenon is well known for mercury and DDT.
- High concentrations of DDT disturb calcium metabolism in birds, which causes thinning of eggshell and their premature breaking, eventually causing decline in bird populations.
- In order for bio-magnification to occur, the pollutant must be **long-lived, soluble in fats, biologically active**.



## **Eutrophication**

- **Eutrophication** is when a body of water becomes overly enriched with minerals and nutrients which induce excessive growth of algae.
- Naturally, the streams draining into the lake introduce nutrients and minerals leading to eutrophication.
- **Causative factors- discharge of surface nutrients, monsoonal run off, upwelling in the seas.**
- However, pollutants from man's activities like effluents from the industries and homes can radically accelerate the aging process. This phenomenon has been called **Cultural or Accelerated Eutrophication**.
- Increase in the **Phosphates** and **Nitrates** concentration increases the process of **eutrophication**. Increase in nutrients such as **nitrogen** and phosphorus can overstimulate the growth of algae leading to **algal bloom**.
- Algal blooms limit the sunlight available to bottom-dwelling organisms and cause wide swings in the amount of dissolved oxygen in the water. When **dissolved oxygen levels decline to hypoxic levels**, fish and other marine animals suffocate. As a result, creatures such as fish, shrimp, and especially immobile bottom dwellers die off. In extreme cases, anaerobic conditions ensure promoting growth of bacteria. Zones where this occurs are known as **dead zones**.
- **Eutrophication sets off a chain reaction in the ecosystem**, starting with an overabundance of algae and plants. The excess algae and plant matter eventually decompose, producing large amounts of carbon dioxide. This lowers the pH of seawater, a process known as **ocean acidification**. Acidification slows the growth of fish and shellfish and can prevent shell formation in bivalve mollusks. This leads to a reduced catch for commercial and recreational fisheries, meaning smaller harvests and more expensive seafood.
- Recent studies have suggested occurrence of **Marine Heat Waves (MHW)**, which are periods of extreme high sea surface temperatures. Marine Heat waves can lead to severe and persistent impacts on marine ecosystems, coral bleaching, changes in phytoplankton blooms, shifts in species composition and **toxic algal blooms**.
- **Since the early 1980s**, the occurrence of harmful algal blooms and pathogenic organisms has increased in coastal areas due to warming, deoxygenation and eutrophication with negative impacts of food provisioning, tourism, economy and human health.

### **Biological Oxygen Demand and Chemical Oxygen Demand**

- **Biochemical oxygen demand (BOD)** is the amount of dissolved oxygen needed (i. e., demanded) by aerobic microorganisms to break down organic material present in a given water sample at certain temperature over a specific time period.
- Higher the BOD, higher is the pollution level in the water. The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die.
- **Chemical oxygen demand (COD)** is a measure of the capacity of water required to consume oxygen during both the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite.

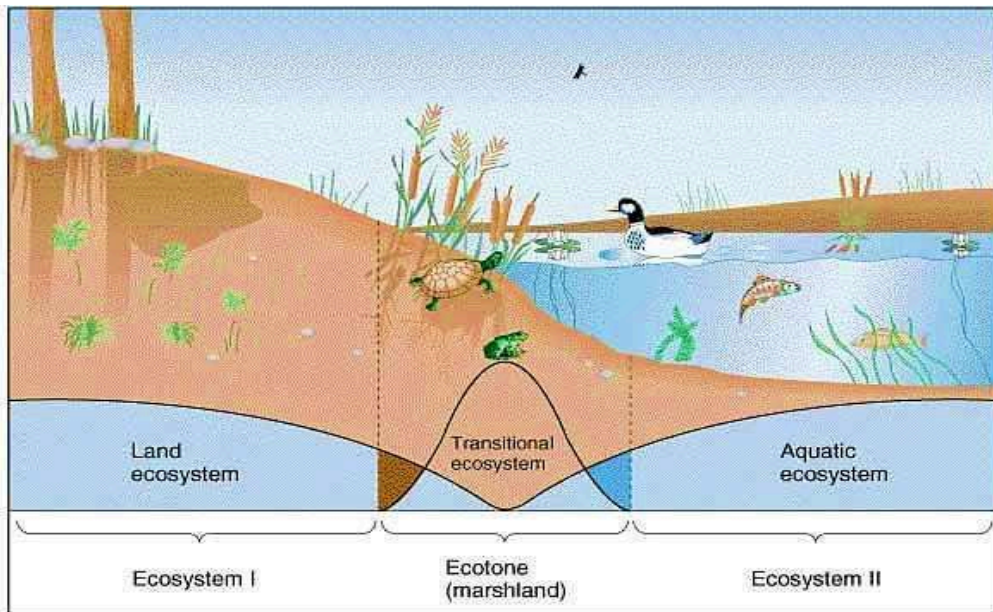
### **Ecological Niche**

- The term **niche** means the sum of all the activities and relationships of a species by which it uses the resources in its habitat for its survival and reproduction.
- If the habitat of a species is like its 'address', niche can be thought of as its 'profession' (i.e. activities and responses specific to the species).
- A niche is unique for a species while many species share the habitat.
- **No two species in a habitat can have the same niche**
- If two species occupy the same niche they will compete with one another until one is displaced.
- The most important resources in the niches of animals are food and shelter while in case of plants, they are sunlight, moisture and nutrients (phosphorous and nitrogen).

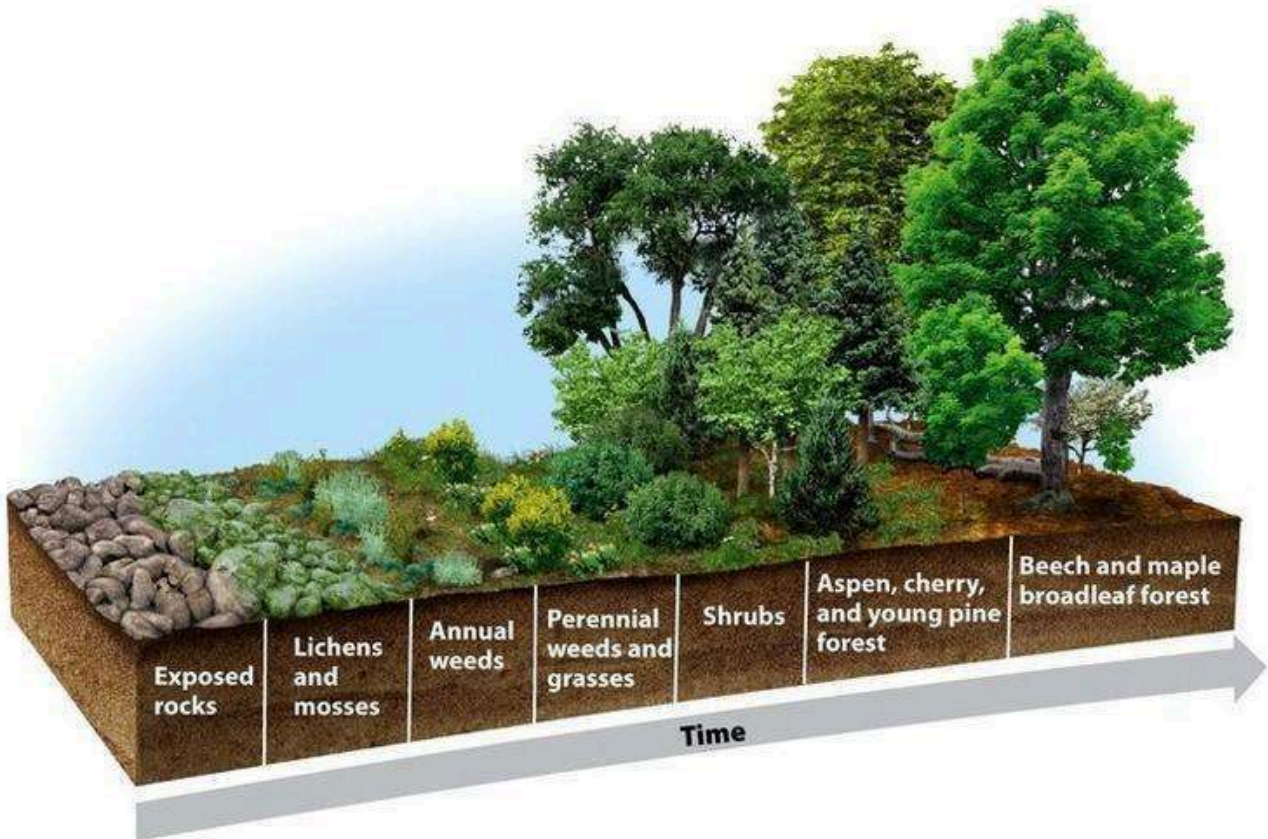
### **Ecotone**

- An **ecotone** is an area that acts as a boundary or a transition between two ecosystems.
  - For Example-Marshland between a river and riverbank, mangroves, estuaries.
- Ecotones are highly influenced by their bordering ecosystems.
- Generally, there is a greater number of species found in these regions (ecotones) and this is called as the **Edge Effect**.
- The species found here are called **edge species**.





## Ecological Succession



- Biotic communities are dynamic in nature and change over a period of time.
- The process by which communities of plant and animal species in an area are replaced or changed into another over a period of time is known as ecological succession.
- This change is brought about both by the activities of the communities as well as by the physical environment in that particular area.
- During succession both the plant and animal communities undergo change.
- There are two types of successions:
  - (i) Primary succession
  - (ii) Secondary succession

### **i) Primary Succession**

- It takes place over bare or unoccupied areas such as rocks outcrop, newly formed deltas and sand dunes, emerging volcano islands and lava flows as well as glacial moraines where no community has existed previously.
- The plants that invade first bare land, where soil is initially absent are called **pioneer species**. The assemblage of such plants is called as the pioneer community.
- The pioneer community after some time gets replaced by another community with different species combination. This second community gets replaced by a third community. This process continues sequence- wise.
- Each **transitional (temporary) community** that is formed and replaced during succession is called a stage in succession or a **seral community**.
- The **terminal (final) stage** of succession forms the community which is called as **climax community**.
- The entire sequence of communities in a given area, succeeding each other, during the course of succession is termed as sere.
- The animals of such a community also exhibit succession which to a great extent is determined by plant succession.
- 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 lake is called **hydrarch**.

### **ii) Secondary Succession**

- Secondary succession is the development of a community which forms after the existing natural vegetation that constitutes a community is removed, disturbed or destroyed by a natural event like hurricane or forest fire or by human related events like tilling or harvesting land.



- A secondary succession is **relatively fast** as, the soil has the necessary nutrients as well as a large pool of seeds and other dormant stages of organisms.
- **Water limits and fire are the main reason why trees do not replace grasses as a part of ecological succession.**

### **Autogenic and Allogenic succession**

- Succession brought about by the living inhabitants of the community is referred to as **autogenic succession** while change brought about by outside forces it is called **allogenic succession**
- **Allogenic succession** is succession driven by the **abiotic components** of an ecosystem. In contrast, **autogenic succession** is driven by the **biotic components** of the ecosystem.

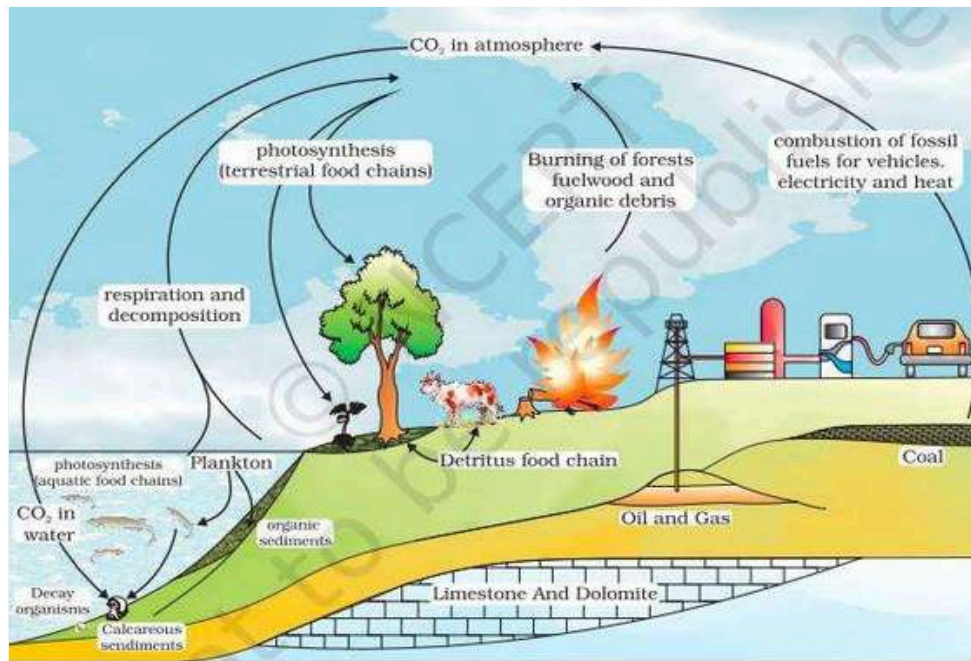
### **Nutrient Cycling**

- The **movement of nutrient elements** through the various components of an ecosystem is called **nutrient cycling**.
- Another name of nutrient cycling is biogeochemical cycles (bio: living organism, geo: rocks, air, and water).
- Nutrient cycles are of two types:
  1. **Gaseous,**
  2. **Sedimentary**
- The **reservoir** for **gaseous type** of nutrient cycle (e.g., nitrogen, carbon cycle) exists in the **atmosphere** and for the **sedimentary cycle** (e.g., sulphur and phosphorus cycle), the reservoir is located in **Earth's crust**.
- Environmental factors, e.g., soil, moisture, pH, temperature, etc., regulate the rate of release of nutrients into the atmosphere.
- The function of the reservoir is to meet with the deficit which occurs due to imbalance in the rate of influx and efflux
- The amount of nutrients, such as carbon, nitrogen, phosphorus, calcium, etc., present in the soil at any given time, is referred to as the **standing state**. It varies in different kinds of ecosystems and also on a seasonal basis.

### **Carbon Cycle**

- **Carbon cycling** occurs through the atmosphere, ocean and through living and dead organisms.

- According to one estimate  $4 \times 10^{13}$  kg of carbon is fixed annually in the biosphere through photosynthesis.
- A considerable amount of carbon returns to the atmosphere as CO<sub>2</sub> through respiratory activities of the producers and consumers.
- Decomposers also contribute substantially to CO<sub>2</sub> pool by their processing of waste materials and dead organic matter of land or oceans.
- Some amount of the fixed carbon is lost to sediments and removed from circulation.
- Burning of wood, forest fire and combustion of organic matter, fossil fuel, volcanic activity are additional sources for releasing CO<sub>2</sub> in the atmosphere.
- Human activities have significantly influenced the carbon cycle.
- Rapid deforestation and massive burning of fossil fuel for energy and transport have significantly increased the rate of release of carbon dioxide into the atmosphere

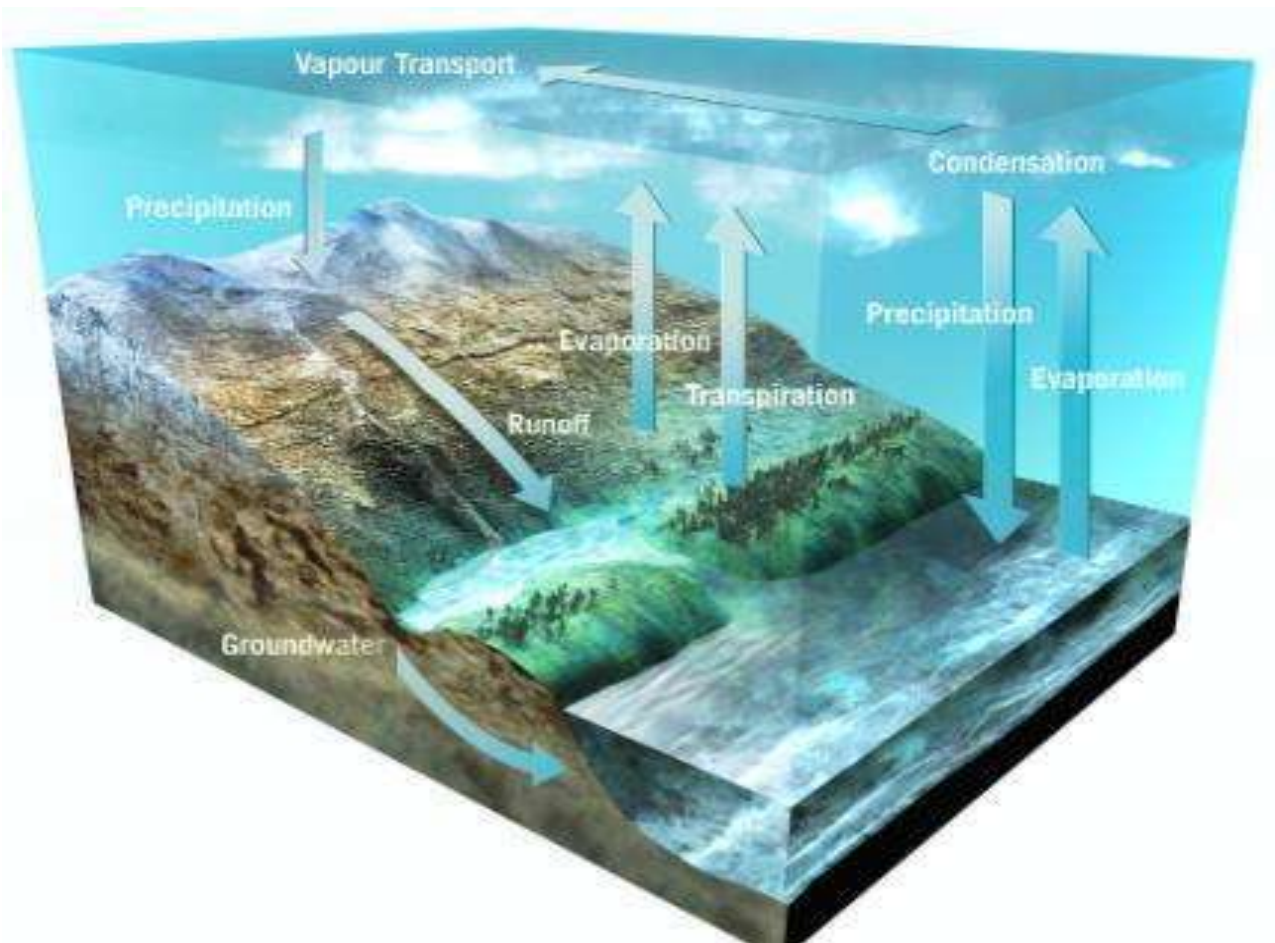


### **Water Cycle**

- The water cycle describes how water evaporates from the surface of the earth, rises into the atmosphere, cools and condenses into rain or snow in clouds, and falls again to the surface as precipitation.



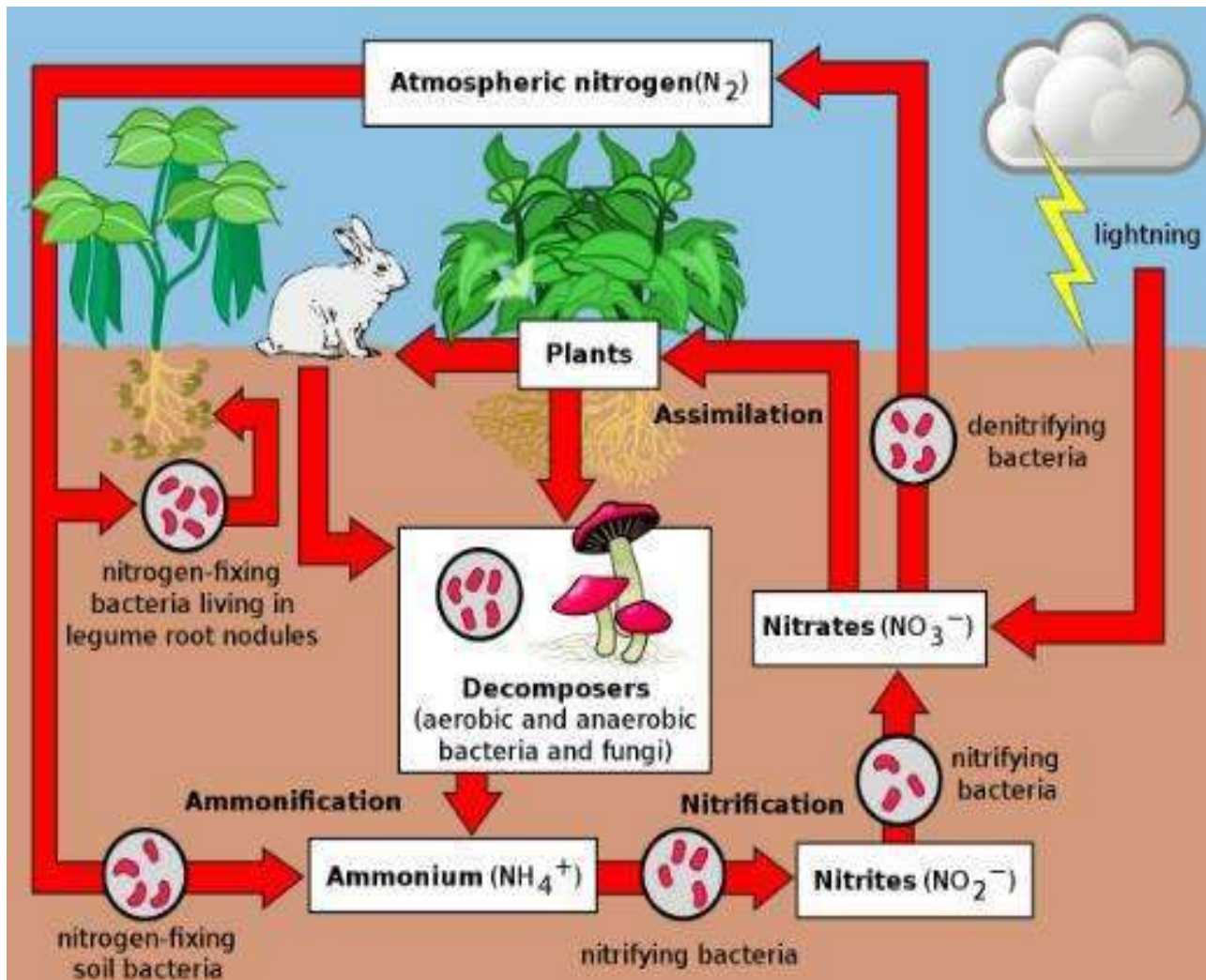
- The water falling on land collects in rivers and lakes, soil, and porous layers of rock, and much of it flows back into the oceans, where it will once more evaporate.
- The cycling of water in and out of the atmosphere is a significant aspect of the weather patterns on Earth.



### **Nitrogen Cycle**

- **Nitrogen** is a constituent of amino acids, proteins, hormones, chlorophylls and many of the vitamins.
- Plants compete with microbes for the limited nitrogen that is available in the soil.
- Thus, nitrogen is a limiting nutrient for both natural and agricultural ecosystems.
- The process of conversion of nitrogen ( $N_2$ ) to ammonia is termed as **nitrogen fixation**.

- In nature, lightning and ultraviolet radiation provide enough energy to convert nitrogen to nitrogen oxides (NO, NO<sub>2</sub>, N<sub>2</sub>O).



- Industrial combustions, forest fires, automobile exhausts and power-generating stations are also sources of atmospheric nitrogen oxides.
- Decomposition of organic nitrogen of dead plants and animals into ammonia is called **ammonification**.
- Some of this ammonia volatilises and re-enters the atmosphere but most of it is converted into nitrate by soil bacteria.
- Ammonia is first oxidised to nitrite by the bacteria *Nitrosomonas* and/or *Nitrococcus*. The nitrite is further oxidised to nitrate with the help of the bacterium *Nitrobacter*. These steps are called **nitrification**.





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