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Prelims

Jammu and Kashmir Public Service Commission

GS Paper 1 || Volume - 5

Environment and Ecology

SIERRA INNOVATIONS

INDEX

1 CHAPTER

Basics of Environment and Ecosystem

- The study of environment and ecosystems provides vital insights into how living beings coexist with their surroundings.
- It explores the dynamic interactions between organisms and the abiotic world, highlighting essential processes like adaptation, energy flow, and nutrient cycling.
- Grasping these basics is key to understanding and conserving Earth's natural systems.

Basic Definitions

1. Environment

- All physical, chemical, and biological factors surrounding an organism, at a given point in time and space, and all the related behaviour are termed as environment.

- **Physical Components**: Water (hydrosphere), air (atmosphere), soil, sunlight, temperature.
- **Chemical Components**: Biogeochemical cycles (carbon, nitrogen, phosphorus, sulfur, etc.); pH, dissolved gases, nutrients.
- **Biological Components**: Plants, animals, microorganisms, biomolecules, food webs, symbiotic associations.

2. Habitat

- Habitat is the physical environment in which an organism lives (address of an organism). Many habitats together make up the environment.
- A single habitat may be common for multiple organisms that have similar requirements.

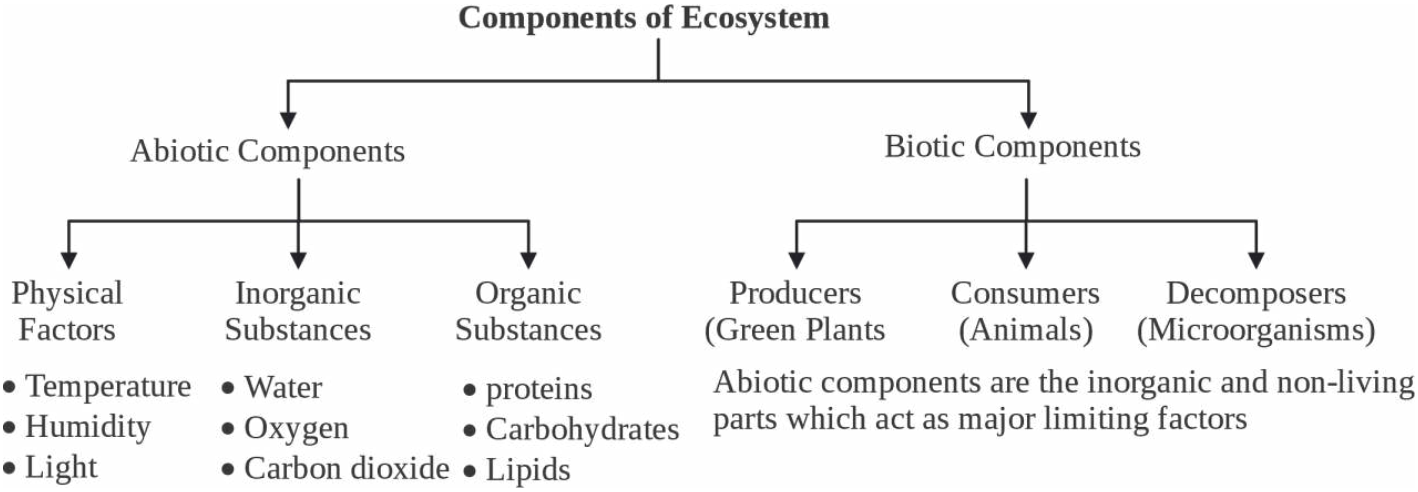
DID YOU KNOW?

A habitat always has life in it, whereas the environment does not necessarily have life in it.Habitat conditions vary with latitude and altitude due to differences in environmental factors, and organisms have different physiological requirements. All habitats are environments, but all environments are not habitats.

3. Ecosystem

- Ecosystem is a structural and functional unit of nature where living organisms (biotic) interact with each other and with their physical environment (abiotic) to exchange energy and cycle materials.
- The components of ecology are majorly divided into biotic (living) and abiotic (non-living).
- The biotic and abiotic components are linked together through nutrient cycles and energy flows.

- **Characteristics of Ecosystem**: All ecosystems are environments, but not all environments form self-contained ecosystems.



- **Biotic Components:** refer to the living organisms in an ecosystem that interact with each other and their environment. These include producers, consumers, and decomposers, playing distinct roles in maintaining ecological balance.
  - ✓ **Autotrophs (Producers)**: Use sunlight/inorganic chemicals to synthesize organic matter.
  - ✓ **Examples:** Green plants, cyanobacteria, diatoms, microscopic algae
  - ✓ **Heterotrophs (Consumers)**: Depend on others for energy. They include:
  - ✓ **Macro-consumers**:
    - Herbivores (sheep, rabbits)
    - Secondary Consumers (wolves, dogs)
    - Tertiary Consumers (lions)
    - Omnivores (humans, bears)
  - ✓ **Micro-consumers**:
    - Phagotrophs (protozoa ingest particles)
    - Osmotrophs (fungi absorb dissolved nutrients)
    - Saprotrophs/Decomposers (bacteria, fungi)
    - Detritivores (earthworms)
- **Abiotic Components:** are the non-living physical and chemical elements in an ecosystem that influence living organisms. They form the foundation for the functioning of ecosystems by providing essential resources and conditions for life.
  - ✓ **Light**:
    - High intensity → robust root growth, thicker leaves.
    - Spectral quality (red, blue, UV) influences morphology.
  - ✓ **Temperature**:
    - Extremes damage proteins, cause desiccation, frost damage.

- ✓ **Water**: Essential for all physiological reactions; influences distribution.
- ✓ **Soil & Minerals**: Anchor plants; supply nutrients (Nitrogen, Phosphate, potassium, micronutrients).
- ✓ **pH**: Affects nutrient availability and microbial activity.
- ✓ **Wind**: Seed dispersal, transpiration, pollination.
- ✓ **Precipitation**: Quantity/timing critical for plant growth; drives productivity.
- ✓ **Dieback**: Adaptive shedding of shoots under drought; roots survive (e.g., Sal, Red Sanders).

➢ **Role of components**:

- ✓ Provides resources: food, water, energy, oxygen, shelter.
- ✓ Shapes habitats and niche availability.
- ✓ Mediates ecological processes: photosynthesis, respiration, decomposition, nutrient cycling, pollination, seed dispersal.

DID YOU KNOW?

Payment for Ecosystem Services (PES) is a concept that aims to provide financial incentives to individuals or communities for the preservation, restoration, or enhancement of ecosystems and the services they provide.

4. Ecology

➢ It is the scientific study of the interactions between living organisms and their environment, including both the biotic (living) and abiotic (non-living) components.

➢ It was coined by Ernst Haeckel in 1866 ("oekologie" = study of household or environment).

➢ Its scope includes:

- ✓ Relations among organisms (energy flow, mineral cycling).
- ✓ Relations between organisms and their physical surroundings.

Principles of Ecology

1. Adaptation

➢ It is the appearance/behaviour/structure/mode of life of an organism that allows it to survive in a particular environment. The different types are:

- ✓ **Morphological:** when trees grew higher, the giraffe's neck got longer.
- ✓ **Physiological:** Venom production in snakes for prey capture and defense.
- ✓ **Behavioral:** Hibernation in bears, bats, ground squirrels to survive cold and food scarcity.

2. Variation

➢ It means changes in genetic makeup due to the addition or deletion of specific genes. Eg: difference in the colour of skin, and type of hair among different ethnic groups.

- The major causes are:
  - ✓ **Mutations**: Errors in DNA replication introduce new genes.
  - ✓ **Gene flow**: Movement of genes between populations.
  - ✓ **Genetic drift**: Random changes in allele frequencies.
  - ✓ Climatic changes, geographical barriers over time.

3. Speciation

- It is defined as the process of formation of new species.
- It has the following mechanisms:
  - ✓ **Allopatric (Geographic) Speciation**: Physical isolation (mountains, rivers) leading to divergent evolution due to which new species form.
  - ✓ **Sympatric Speciation:** In this population in the same area diverge without physical barriers. Disruptive selection drives subgroups to exploit different niches, food sources or mating preferences, eventually causing reproductive isolation.
  - ✓ **Hybridization:** it occurs when two different species mate and produce hybrid offspring.

4. Mutation

- Mutation is defined as the changes in genetic material that result from an error in DNA replication, causing the rise of new genes.
- As a result, members of the same species show 'variation' and are not identical.

5. Theory of Natural Selection

- The **theory of natural selection** is a fundamental concept in evolutionary biology, first proposed by **Charles Darwin** in 1859.
- It explains how species evolve over time through the differential survival and reproduction of organisms that are better adapted to their environment.

DID YOU KNOW?

Acclimatisation is the process by which an individual organism makes small, short-term physiological adjustments to cope with minor changes in its environment.

6. Evolution

- The process by which living organisms change over time through changes in the genome.
- May give rise to new species and make the organism better suitable for the present environment through natural selection, variation etc.

7. Extinction

- The complete disappearance of a species from Earth primarily due to environmental changes, biological competition or inability to evolve fast enough to cope with the changing environment.

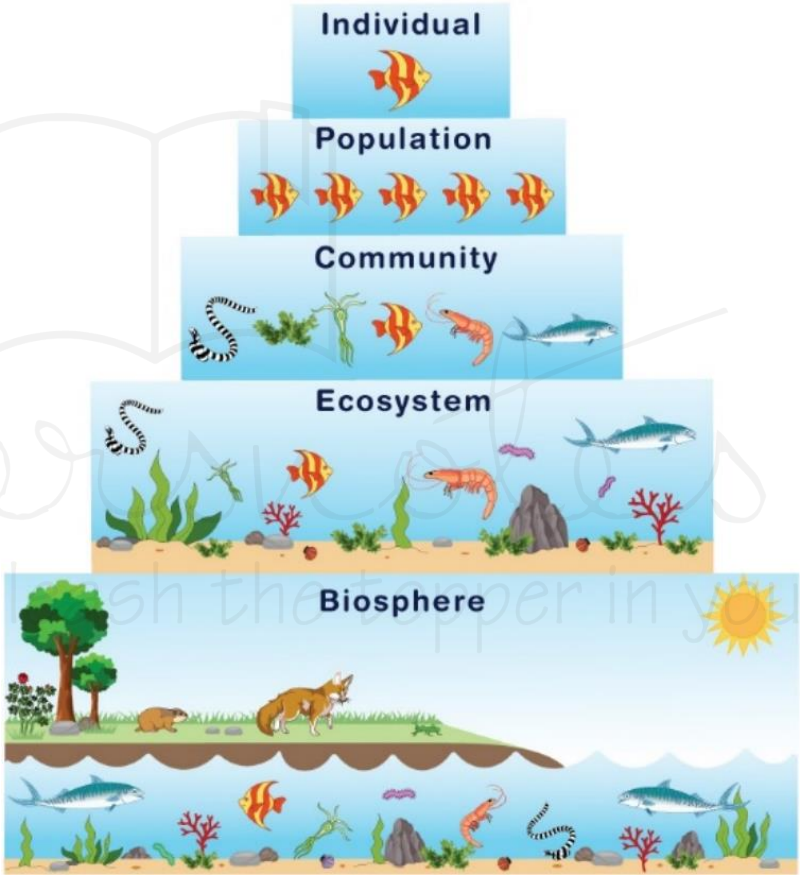
- Currently, the 6th Mass Extinction (***Anthropogenic Extinction – human-induced***) is in progress, exacerbated by mankind's over-exploitation/misuse of natural resources, fragmentation/loss of natural habitats, destruction of ecosystems, pollution, and global climate change.

8. Hibernation

- It is an extended dormancy with reduced metabolism to survive adverse conditions.
- **Examples**:
  - ✓ **Mammals**: Bears (decreases metabolic rate in winters), Ground Squirrels (body temp nearly equals freezing).
  - ✓ **Reptiles**: Painted Turtle (underwater anaerobic), Green Iguana (burrow).

Ecological Hierarchy

Levels of Ecological Organisation



1. **Individual**: Single organism capable of independent life functions.
2. **Species**: Group of similar individuals able to interbreed (e.g., Homo sapiens).
3. **Population**: All individuals of one species in a defined area at a given time.
4. **Community**: Assemblage of populations of different species interacting in a location.
   - ✓ **Major Community**: Largely self-sustaining (e.g., tropical evergreen forest).
   - ✓ **Minor Community (Society)**: Dependent on adjacent communities (e.g., lichen on a cow-dung pad).
   - ✓ **Stable Community**: Low year-to-year productivity variation; resilient to disturbance.
5. **Ecosystem**: Community + abiotic environment interacting as a functional system.
6. **Biome**:

   The Large geographic areas sharing climate and dominant vegetation (forest, grassland, desert, tundra, aquatic).

7. **Biosphere**:
   The portion of Earth where life exists—includes lithosphere, hydrosphere, atmosphere; absent only in extreme polar, high-altitude, deep-ocean zones.

Ecological Niche, Ecotone & Edge

1. Ecological Niche

- Ecological niche refers to a specific area, role, or position within a larger system or environment that a person, organism, or object occupies.
- No two species in a habitat can have the same niche because of competition with one another until one is displaced.
- **Components of a Niche**
  - ✓ **Habitat:**: Physical Space occupied by an organism.
  - ✓ **Resources:**The food, water, nutrients and other materials a species consumes or requires to survive.
  - ✓ **Interactions:** Relationships with other organisms:
    - **Competition** for shared resources
    - **Predation** or herbivory
    - **Mutualism**, commensalism or parasitism
  - ✓ **Role in Ecosystem**
  - ✓ The ecological functions a species performs, such as:
    - **Pollination** (e.g., bees)
    - **Seed dispersal**
    - **Soil stabilization** (e.g., mangrove roots preventing erosion)

Niche Overlap

- Niche overlap describes the situation in which co-occurring species share parts of their niche space with each other.
- Overlapping niches may lead to competitive exclusion (two species competing for the same resource cannot coexist) or resource partitioning (species dividing resources among them).

2. Ecotone & Ecocline

- **Ecotone**: is a transition zone between adjacent ecosystems, exhibits species from both plus unique edge species;
  - ✓ Examples: Mangrove forest (marine–terrestrial), grassland–forest boundary.

The appearance of diverse ecological characteristics, a high number of species and population density in the ecotone compared to either community is termed the **edge effect.**

- **Ecocline**: It is a zone of gradual but continuous change from one ecosystem to another.
  - ✓ No sharp boundary between the two in terms of species composition.
  - ✓ It occurs across the environmental gradient (gradual change in abiotic factors such as altitude, temperature, salinity , depth, etc.)

Ecosystem Functions

The key functions can be explored under three broad aspects:

1. Ecological Succession
2. Energy Flow
3. Biogeochemical Cycles (Nutrient Cycling)

1. Ecological Succession

- Ecological succession is the directional, sequential change in species composition and ecosystem structure over time, following the creation of new substrate or disturbance of an existing community.
- Succession increases habitat complexity, productivity and nutrient availability until a stable climax community is established.

1.1 Stages of Succession

i. Pioneer Community

- First colonizers of a barren or disturbed site (e.g., lichens, mosses on bare rock).
- Modify substrate (soil formation, moisture retention).

ii. Serial (Transitional) Communities

- Series of intermediate communities (series) each replacing the previous as conditions change.
- Characterized by increasing species diversity, biomass, productivity and food-web complexity.

iii. Climax Community

- Final, stable stage in which species composition remains relatively constant until the next disturbance.
- Self-perpetuating and in equilibrium with local climatic and soil conditions.

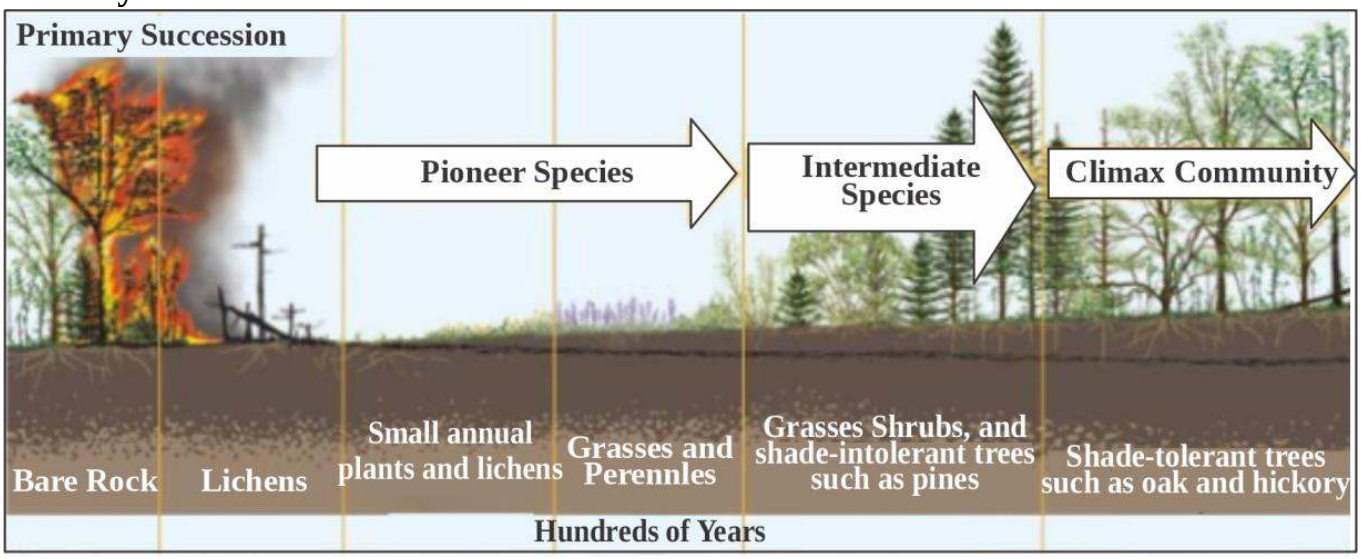
The correct sequence of ecological (biotic) succession is:

1. **Migration** – Arrival of propagules (seeds, spores, etc.) from nearby areas into a barren or new habitat.
2. **Ecesis** – Successful establishment of these species (germination, growth, and reproduction in the new habitat).
3. **Reaction** – Modifications of the environment by the established organisms (like changes in soil, moisture, shade).
4. **Stabilisation (Climax)** – Final stable community that is in equilibrium with the environment.

1.2 Types of Succession

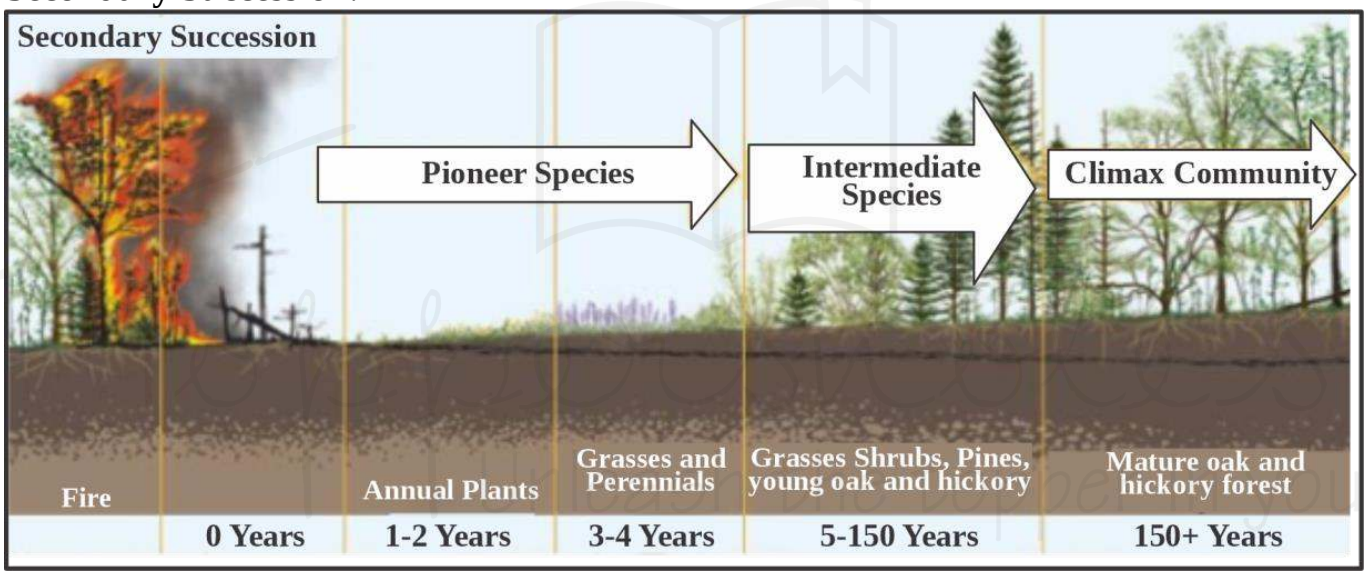
i. By Origin

- **Primary Succession**:



  - ✓ Occurs on newly formed substrates with no pre-existing soil or biota (e.g., lava flows, sand dunes). Slow, beginning with microbial, lichen and moss pioneers.

- **Secondary Succession**:



  - ✓ It is the sequential development of biotic communities after the partial or complete destruction of an existing community (e.g., after fire, flood or human clearing). Soil persists, so succession proceeds more rapidly through herbaceous to woody stages.

ii. By Driver

- **Autogenic Succession**: Driven by biological activities of resident organisms (e.g., soil enrichment by nitrogen-fixers).
- **Allogenic Succession**: Driven by abiotic forces (fire, floods, wind-blown sediments).

iii. By Habitat

- **Xerarch**: Occurs on land with low moisture content e.g., bare rock. (bare rock → lichen → grass → shrub → forest).
- **Hydrarch**: Takes place in water bodies like ponds, lakes(open water → phytoplankton → floating plants → rooted hydrophytes → emergent reeds → swamp forest).

- **Lithosere (Rock-Based Succession)**: A type of primary succession starting on bare rocks.
  - ✓ Stages: Lichens and mosses break down rock to form soil. Followed by grasses, shrubs, and trees.
  - ✓ **Psammosere**- Succession occurring on sand dunes. Pioneer plants like marram grass stabilize the sand. Gradual development of shrubs and woodland. Halosere (Saltwater-Based Succession)
  - ✓ **Halosere**- Succession in saline environments like salt marshes or mangroves. Begins with salt-tolerant plants (halophytes). Progresses to less salt-tolerant species as soil salinity decreases.

2. Energy Flow

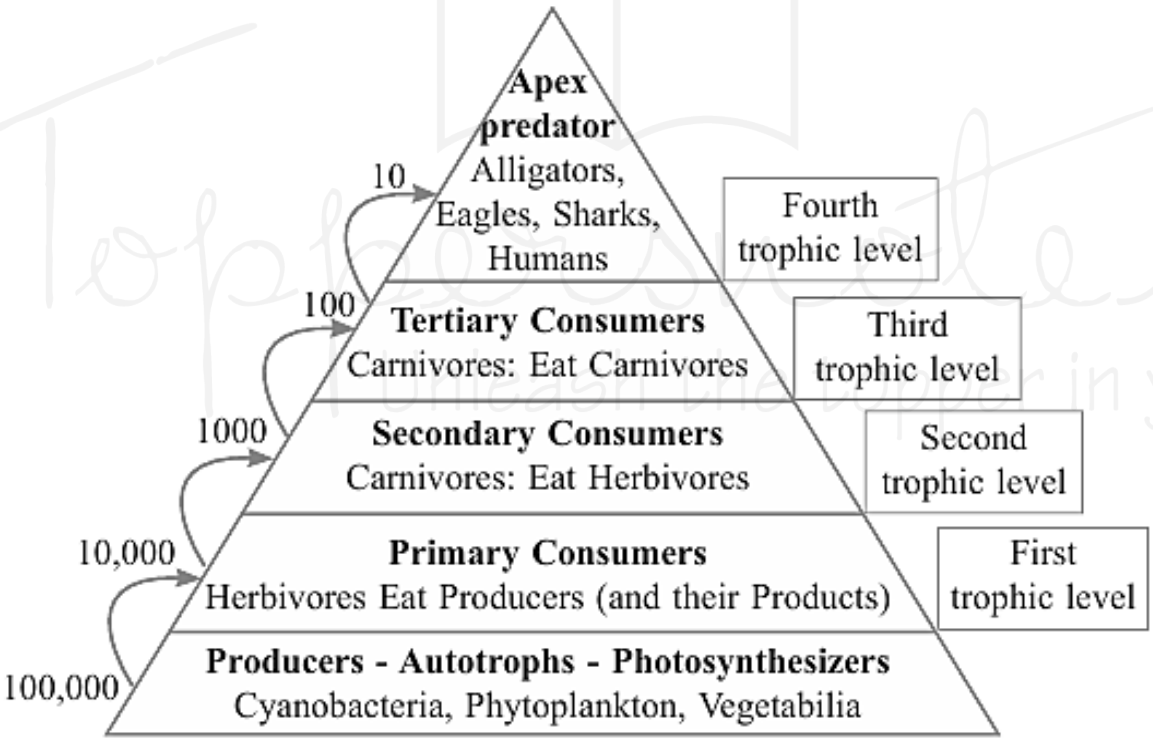
- It refers to the unidirectional transfer of energy from one organism to another.
- It's a fundamental process that sustains life by moving energy from the sun to producers (like plants) and then through various levels of consumers.

2.1 Trophic Levels & Unidirectional Energy Flow

i. Trophic Levels:

- ✓ A trophic level is the position an organism occupies in a food chain (e.g., producers at level I, herbivores at level II, carnivores at levels III–V)
- ✓ Energy enters at the first trophic level (autotrophs) and passes up sequentially.

ii. Unidirectional Flow & Energy Loss:



Lindeman's Law of ten percent (10%)
The Efficiency of Energy Transfer from one Trophic level to the next is about 10%

- Energy flows only from lower to higher trophic levels; it cannot cycle back.
- At each transfer, ~90% of energy is lost as heat through metabolism and respiration, leaving only ~10% for the next level (Lindeman's "10 Percent Law").

2.2 Food Chains

- A food chain is a linear sequence showing "who eats whom" and how energy and nutrients pass from one organism to another.

i. Types of Food Chains:

- ✓ **Grazing Food Chain:** Starts with living producers (plants or phytoplankton) consumed by herbivores, then by carnivores.
  - Example: Grass → Grasshopper → Frog → Snake → Hawk.
  - Marine Example: Diatoms → Krill/Crustaceans → Small Fish (herrings) → Larger Fish.
- ✓ **Detritus Food Chain:** Begins with dead organic matter (detritus) broken down by decomposers(fungi & bacteria) and detritivores(Earthwarm, Millipedes & woodlice).

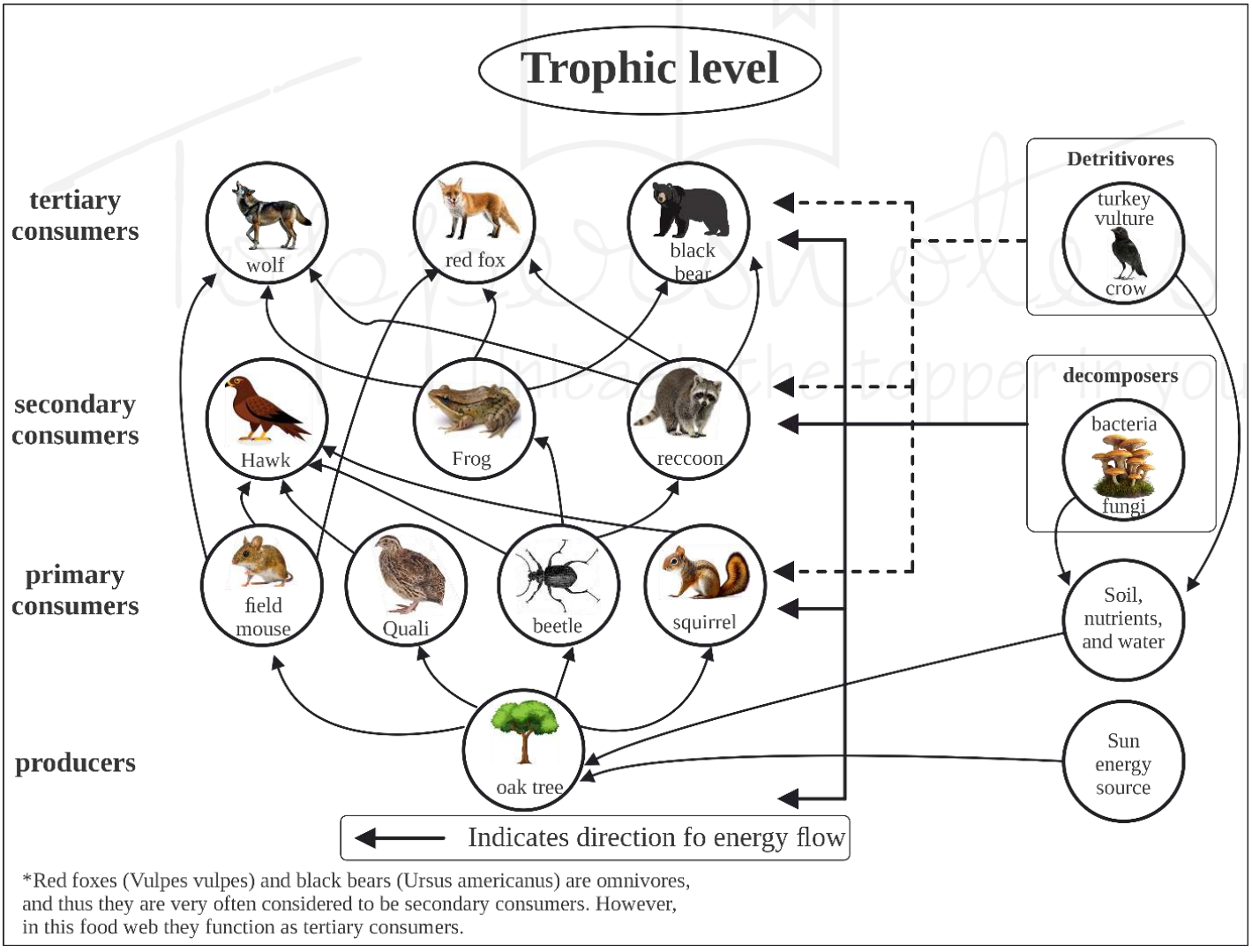
  Dead leaves $\xrightarrow{\text{eaten by}}$ Woodlouse $\xrightarrow{\text{eaten by}}$ Blackbird

ii. Ecosystem Dominance:

- ✓ **Marine:** Grazing chains dominate, because phytoplankton directly support zooplankton and fish.
- ✓ **Terrestrial:** Detritus chains dominate, as most plant biomass enters the soil food web.

2.3 Food Webs & Biotic Interactions

i. Food Web:



*Red foxes (Vulpes vulpes) and black bears (Ursus americanus) are omnivores, and thus they are very often considered to be secondary consumers. However, in this food web they function as tertiary consumers.

ii. A complex network of interconnected food chains illustrating multiple feeding links among organisms,a food web provides most organisms in an ecosystem with more than one alternative for food and, therefore, increases their chance of survival.

iii. Key Biotic Interactions:

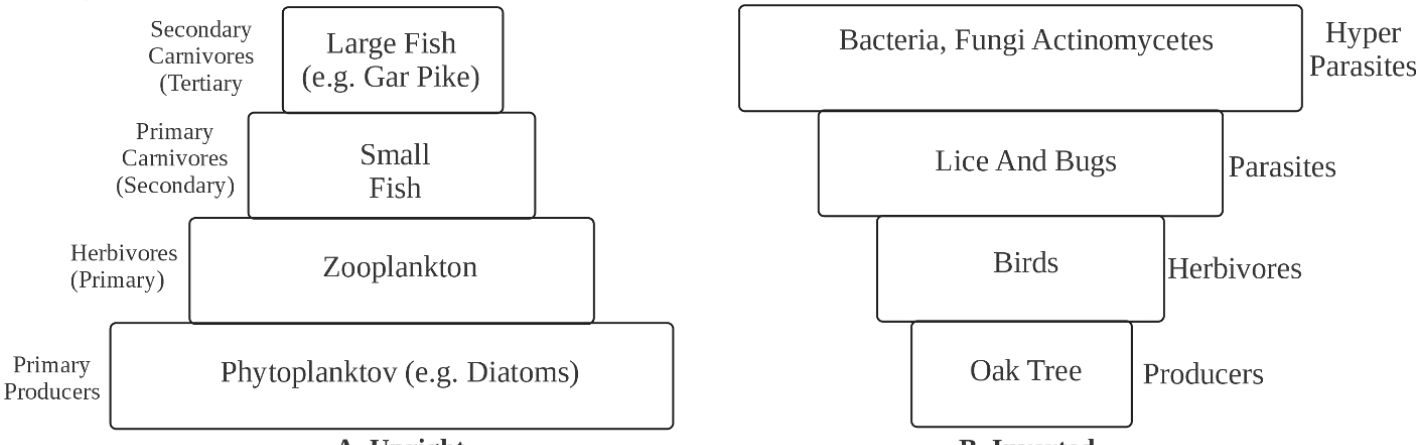
Interaction	Definition	Example
Mutualism	Both species benefit	Bee pollinating a flower, Lichen **(fungus + alga)**
Commensalism	One benefits, other is unaffected	Remoras hitching a ride on sharks
Parasitism	One benefits at the expense of the other	Tapeworm in an animal's gut
Predation	One kills and consumes the other	Lion eating a zebra
Competition	Both are harmed by sharing limited resources	Lions and hyenas competing for prey
Amensalism	One is harmed, other is unaffected	Black walnut inhibiting nearby plants
Facilitation	One indirectly benefits another	Nurse plants shading seedlings

- **Symbiosis-** It is a type of biotic interaction in which two or more different species live in close association with each other.
  - ✓ Example - Lichen are plant-like organisms that consist of a symbiotic association of algae and fungi. Fungi provide shelter, water and minerals to the algae and, in return, the alga provides food.
  - ✓ Some symbiotic relationships are parasitic, in which one species benefits at the expense of the other, while others are commensal, in which one species benefits without affecting the other.

2.4 Ecological Pyramids

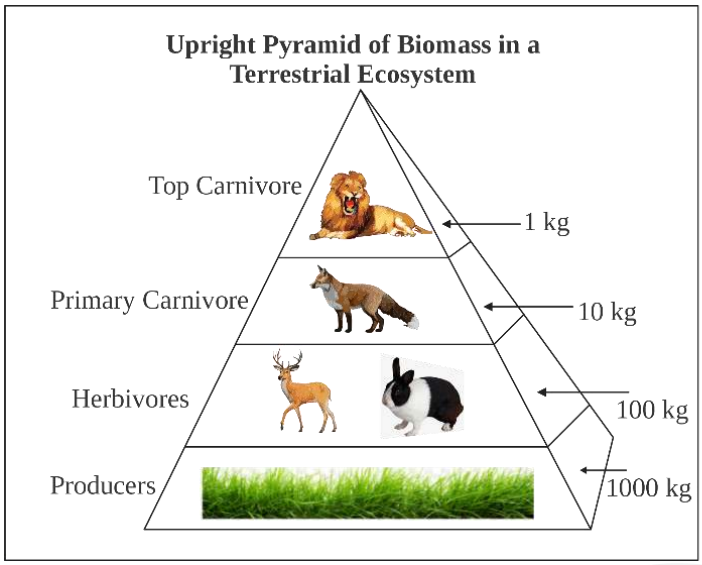
- The pyramidal representation of trophic levels of different organisms based on their ecological position (producer to final consumer) is called an ecological pyramid.
- The ecological pyramids are of three categories:
  (1) Pyramid of numbers (2) Pyramid of biomass, and
  (3) Pyramid of energy or productivity.

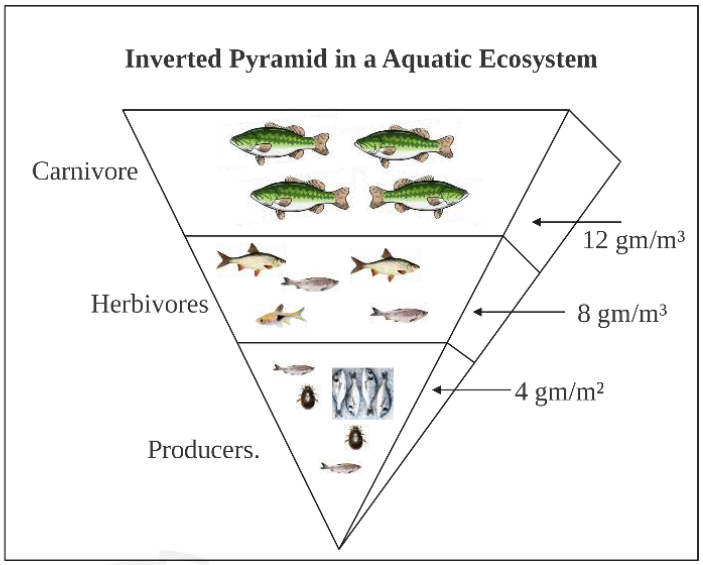
i. Pyramid of Numbers:



- Illustrates the number of individuals at each trophic level, usually decreasing upward.
- **Exception:** A single tree (producer) may support many insects (primary consumers), inverting the pyramid locally.

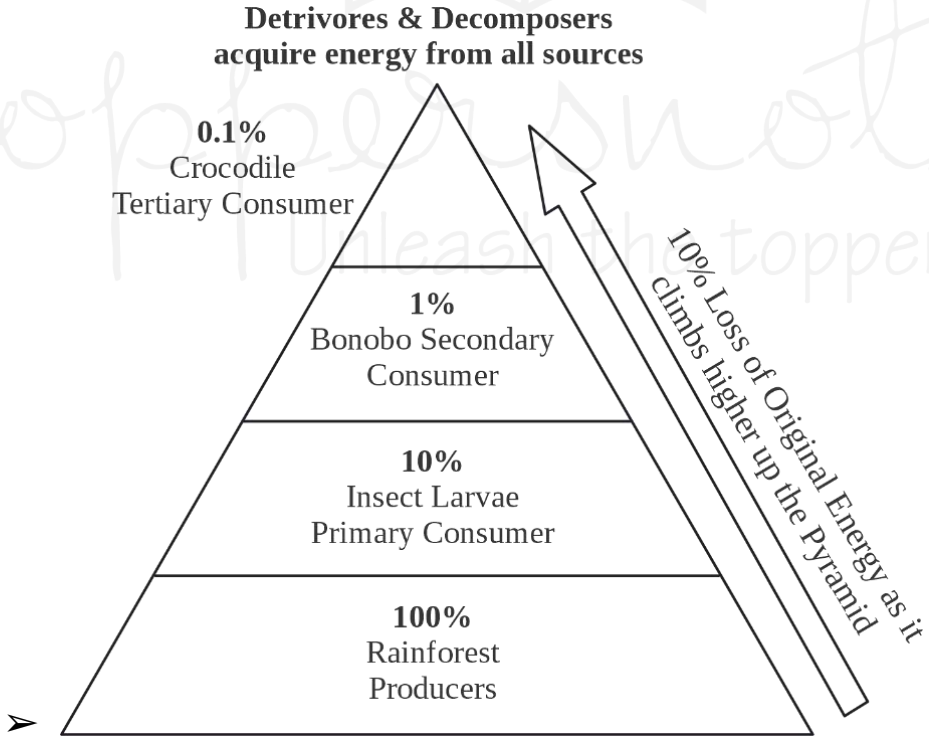
ii. Pyramid of Biomass:





- Depicts total dry mass at each level, generally tapering upward.
- Aquatic Exception: Phytoplankton biomass is low but turns over rapidly, supporting large zooplankton and fish biomass—resulting in an inverted pyramid.

iii. Pyramid of Energy (Productivity):



- Always upright, showing the flow of energy per unit area per time .
- Demonstrates the ~90% energy loss at each transfer, with only ~10% available to the next level.

Bioaccumulation vs Biomagnification

- **Bioaccumulation**: Gradual buildup of pollutants in an organism over time.Pollutants accumulate when the rate of intake exceeds the rate of excretion or breakdown.Persistent, long-lasting pollutants with low degradation (e.g., DDT).
- **Biomagnification**: Progressive increase in pollutant concentration across trophic levels in a food chain.Higher trophic levels consume organisms with accumulated pollutants, leading to magnified levels.Long biological half-life, fat-soluble, and insoluble in water (e.g., DDT).

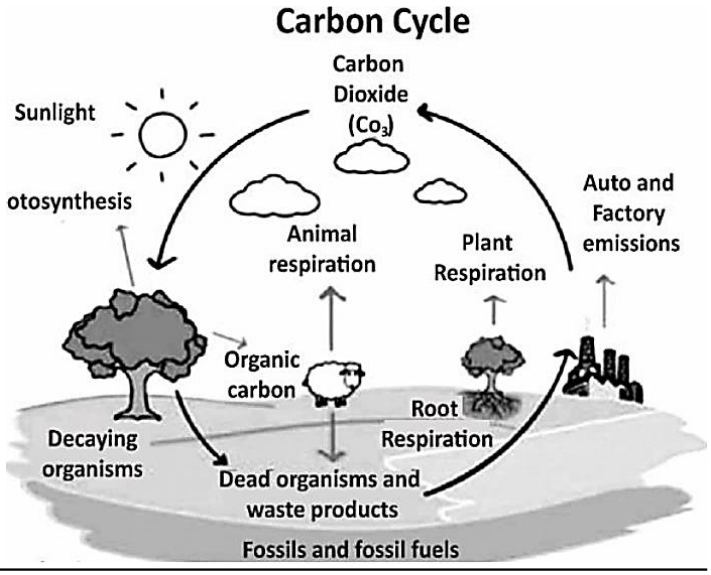
Ecosystem Productivity: is defined as the biomass generation or stored energy in an ecosystem per unit area per unit time. It is divided into two types:

- Gross Primary Productivity: is the rate of production of organic matter during photosynthesis.
- Net Primary Productivity: is the Gross Primary Productivity minus respiration losses (R). [NPP = GPP - R]

Producer	**Biomass productivity ($gC/m^2/yr$)**
Swamps and Marshes	2,500
Tropical rainforests	2,000
Coral reefs	2,000
Algal beds	2,000
River estuaries	1,800
Temperate forests	1,250
Cultivated lands	650
Tundras	140
Open ocean	125
Deserts	3

Biogeochemical / Nutrient Cycles

- A biochemical cycle is the natural pathway through which essential elements and compounds circulate in ecosystems, involving both living organisms (biotic) and non-living components (abiotic).
- These cycles are crucial for recycling nutrients necessary for life.



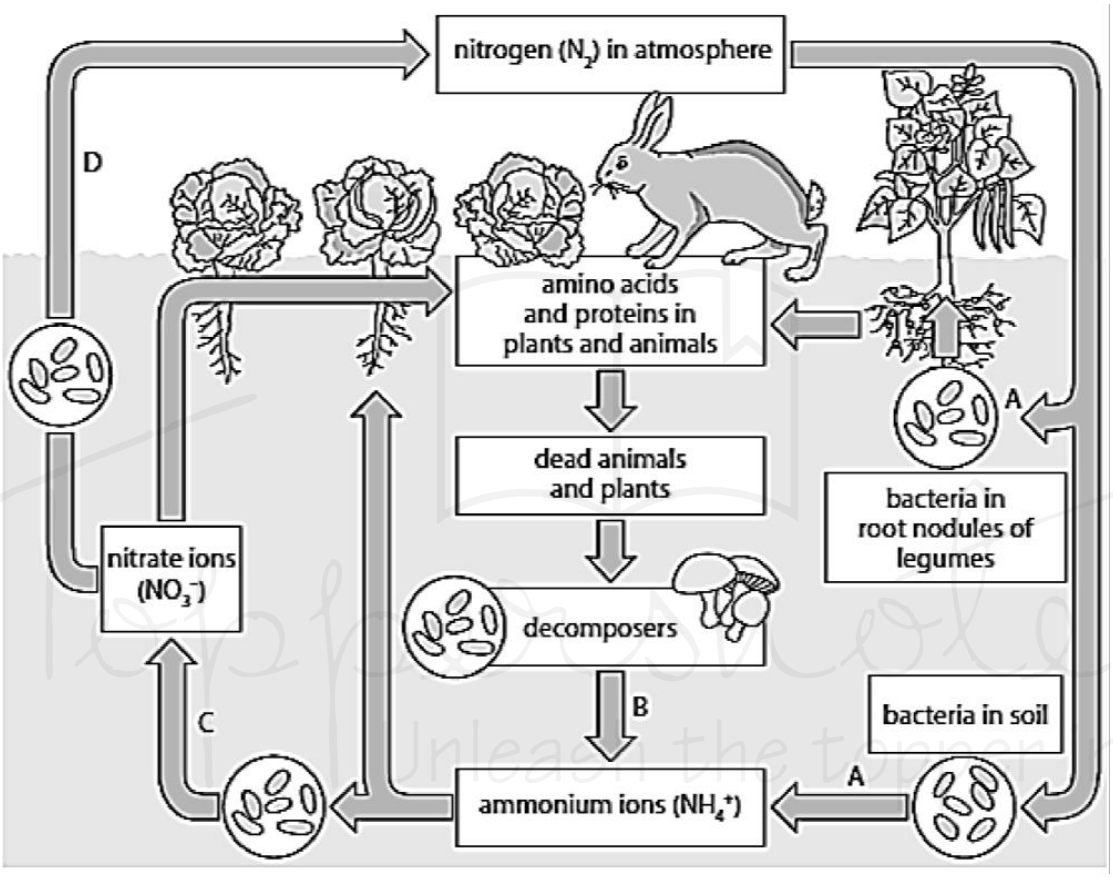
1. Gaseous Cycles

i. Carbo0n Cycle

- The carbon cycle refers to the movement of carbon between living organisms like plants, animals, and microbes, as well as the earth's minerals and the atmosphere.

- As the fourth most abundant element in the universe, carbon plays a critical role in forming complex molecules like DNA and proteins, making life on Earth possible.
  - ✓ **Short-term exchange**: Atmospheric CO_2 is absorbed by plants and phytoplankton via photosynthesis, then returned by respiration and decomposition.
  - ✓ **Long-term storage**: Some carbon is buried in marshy soils, aquatic sediments, or deep ocean for years to millions of years until geological processes expose it.
  - ✓ **Fossil fuels**: Organic matter transformed under heat and pressure into coal, oil, and gas; burning these releases stored carbon as CO_2.
  - ✓ **Peatlands**: Congo Basin peat holds ~3 years of global fossil-fuel CO_2 emissions. Its loss would have major climate impacts.

ii. Nitrogen Cycle

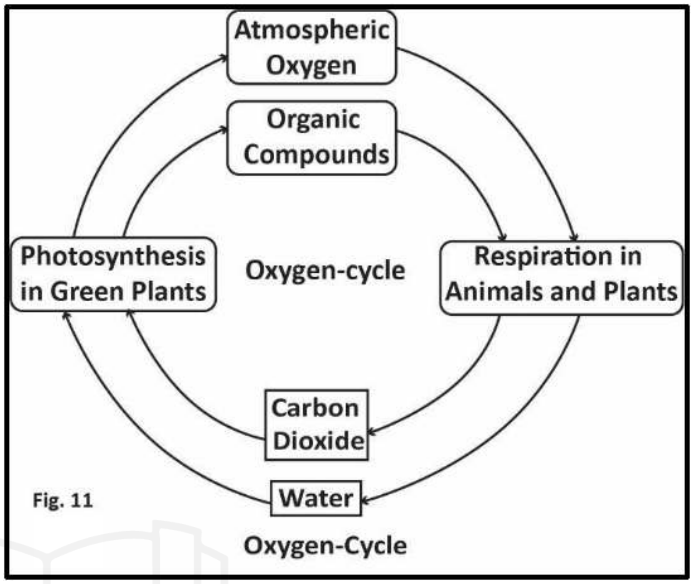


- The nitrogen cycle refers to the movement of nitrogen through both land and water ecosystems, with human activities, like the use of synthetic fertilizers, affecting the process.
- This cycle is essential for plant growth and plays a key role in food production within the ecosystem.
  - ✓ **Fixation & Inputs**: Atmospheric N_2 (Nitrogen) is converted to NH_3/NH_4^+ (Ammonia) by biological (Azotobacter, Rhizobium, cyanobacteria), abiotic (lightning, Haber–Bosch), and combustion-derived NO_x (from vehicles, power plants) which deposit as nitrates.
  - ✓ **Nitrification**: Process by which ammonia can be directly used by plants as a source of nitrogen (NH_4^+ is oxidized first to NO_2^- by Nitrosomonas/Nitrococcus, then to NO_3^- by Nitrobacter); plants absorb NO_3^- and assimilate it into amino acids.

- ✓ **Ammonification**: Decomposition of dead organisms and animal waste (urea, uric acid) by microbes releases NH_3/NH_4^+ back into the soil.
- ✓ **Denitrification**: Denitrifying bacteria (Pseudomonas, Thiobacillus) reduce NO_3^- to N_2/N_2O, returning nitrogen to the atmosphere.
- ✓ **Biotic/Abiotic Inputs**: Animal wastes, industrial NO_x, forest fires.

iii. Oxygen Cycle

- ➢ The oxygen cycle describes how oxygen moves between the atmosphere, biosphere, and lithosphere.
- ➢ It's a complex cycle driven by photosynthesis, respiration, and other processes that maintain oxygen levels in the atmosphere.
  - ✓ **Reservoirs**: Atmosphere (~21% O_2), biosphere (living tissues), hydrosphere (dissolved), lithosphere (minerals/rocks).
  - ✓ **Processes**: Photosynthesis produces O_2; respiration, decomposition & combustion consume O_2 and release CO_2.



  - ✓ **Exchanges**: Atmosphere ,Biosphere via gas exchange; Hydrosphere–Lithosphere via dissolution and weathering.
  - ✓ **Human Impact**: Deforestation and fossil-fuel burning deplete O_2 and elevate CO_2 levels.

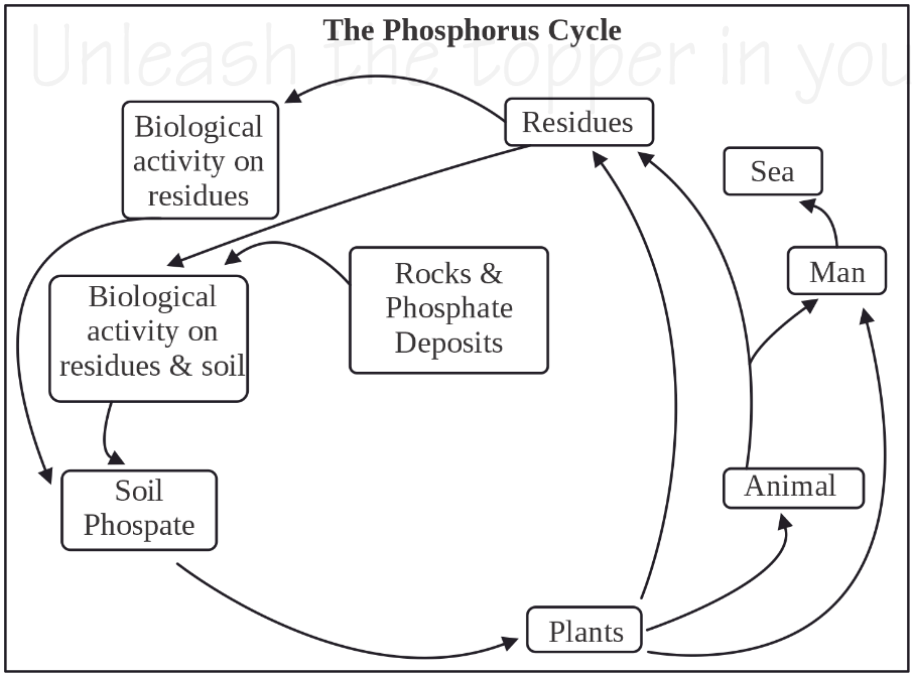
Methane Cycle

- ➢ The methane cycle describes the continuous movement of methane (CH4) through the Earth's atmosphere, soil, and various natural and human-influenced processes.
- ➢ It involves both the production and destruction of methane.

2. Sedimentary Cycle

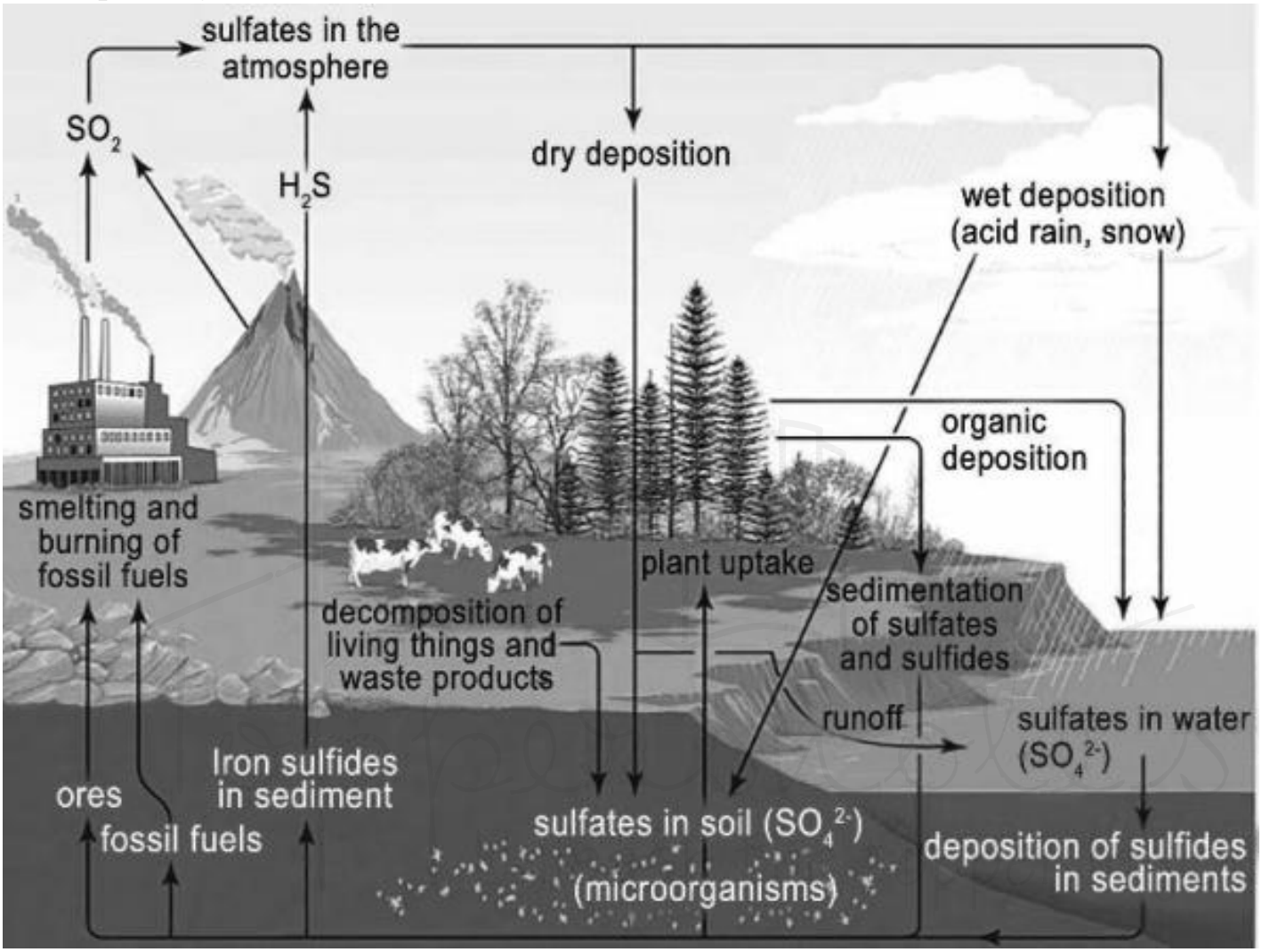
i. Phosphorus Cycle

- ➢ The phosphorus cycle is the sedimentary biogeochemical cycle that describes the movement of phosphorus through the lithosphere, hydrosphere, and biosphere.
  - ✓ **Rock Weathering & Runoff**: Wind, rain, erosion, mining, and agricultural runoff release phosphates from rocks into soils, rivers, and oceans.



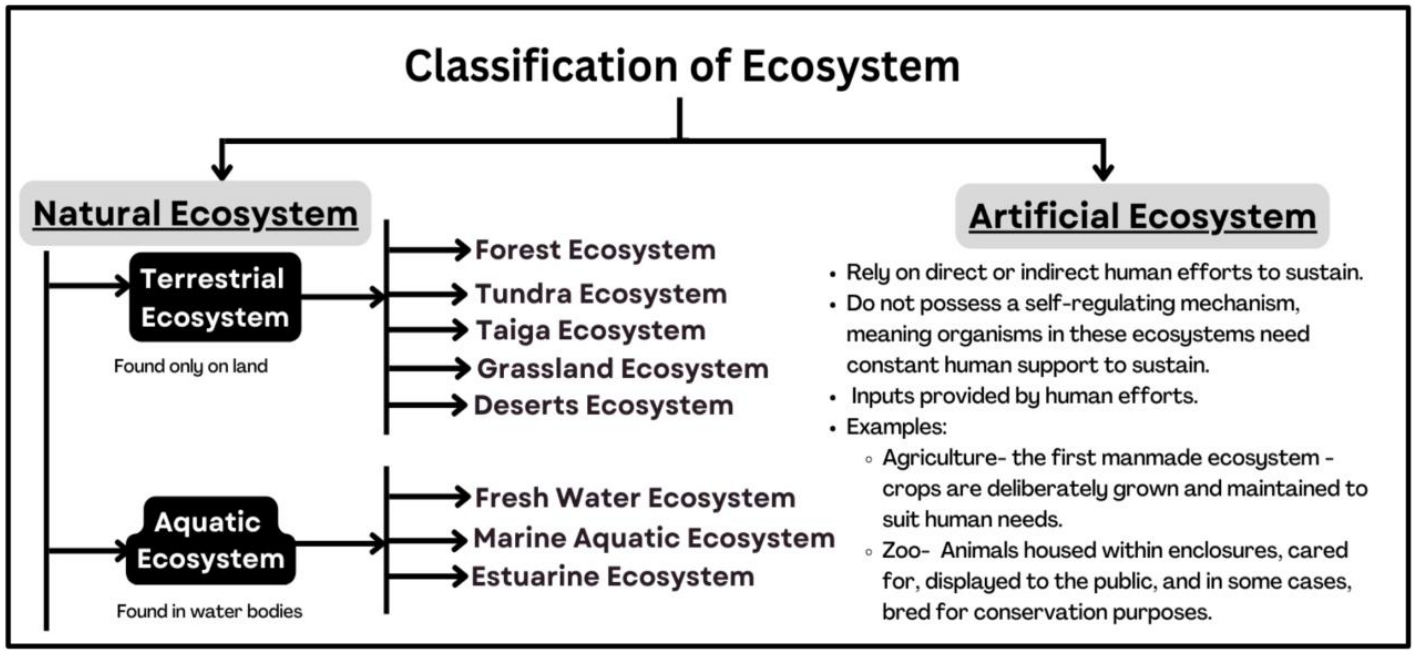
- ✓ **Biological Uptake & Recycling**: Plants absorb soil phosphates; animals eat plants; decomposers return phosphates to the soil.
- ✓ **Sedimentation**: In aquatic systems, phosphates settle as insoluble deposits on continental shelves.
- ✓ **Geological Uplift**: Over millions of years, tectonic uplift raises seabed sediments into new rock, making phosphates available again.

ii. Sulphur Cycle



- ➢ The sulfur cycle describes the movement of sulfur through the atmosphere, soil, and living organisms.
- ➢ It's crucial for various biological and chemical processes, including the formation of proteins, vitamins, and enzymes.
  - ✓ **Atmospheric Input & Deposition:** Volcanoes, fossil-fuel combustion and marine DMS release SO_2/H_2S; these oxidize to sulphuric acid and fall as acid rain.
  - ✓ **Biological Assimilation:** Plants take up SO_4^{2-} to form sulfur-bearing amino acids, which move through the grazing food chain.
  - ✓ **Microbial Transformation:** Lithotrophic and photosynthetic bacteria oxidize reduced sulfur; anaerobic bacteria reduce SO_4^{2-} back to H_2S.
  - ✓ **Return & Recycling:** Decomposers release organic sulfur back into soil and water as SO_4^{2-}, completing the cycle.

Types Of Ecosystems



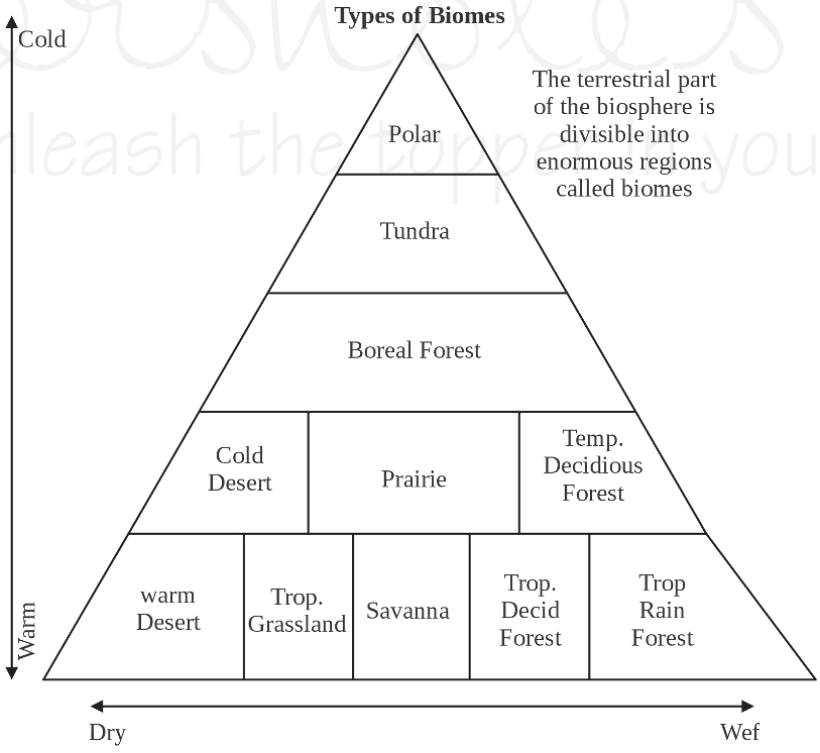
1. **Natural vs Artificial**

- **Natural Ecosystem**: Self-sustaining biotic-abiotic interactions (forests, deserts, grasslands, wetlands, marine).
- **Artificial Ecosystem**: Human-managed, requires continual intervention (croplands, reservoirs, zoos).

2. **Terrestrial Ecosystem or Biomes**

A terrestrial biome is a large geographic area on land characterized by specific climate conditions (temperature and precipitation) and dominant plant life, which in turn influences the types of animal and other life forms that can exist there

- **Tundra**: Permafrost, mosses, lichens; reindeer, arctic fox, polar bear .
- **Forest Biomes**:
  - ✓ Tropical Rainforest: High biodiversity, layered canopy, poor soil, 20% O_2 production, carbon sink
  - ✓ Taiga (Boreal): Conifers; podzolic soils; low productivity.
  - ✓ Temperate Deciduous & Rainforests, Mediterranean (xerophytic), Subtropical.



- **Grasslands**:
  - ✓ Temperate (Steppes), Tropical Savanna—fire-adapted, carbon-neutral burns .
- **Deserts**: Xerophytes, deep roots, water-storage tissues.

3. Aquatic Ecosystems

An aquatic ecosystem is an ecosystem where interactions among the different organisms and their environment take place in water bodies.

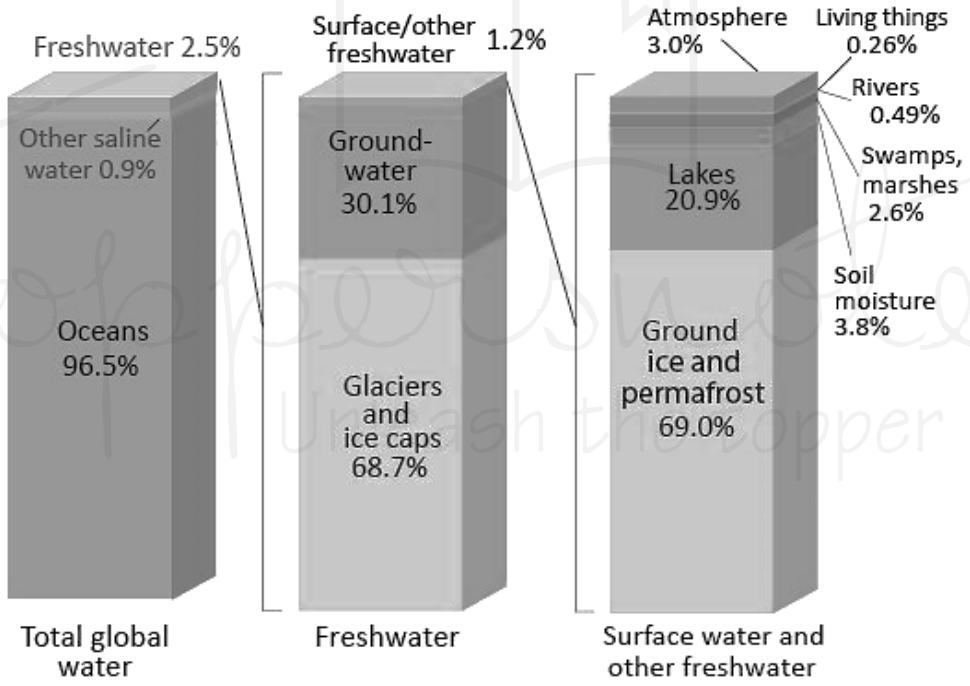
3.1 Types of Aquatic Ecosystems

- **Freshwater Ecosystems** (have <1 % salinity): include **lentic** (standing water) and **lotic** (flowing water) systems.
- **Marine Ecosystems** (have high salinity): cover oceans, stratified into light-based zones (photic, disphotic, aphotic).
- **Brackish Ecosystems**: where fresh and saltwater mix (estuaries, mangroves, coral reefs, seagrasses).

3.2 Freshwater Ecosystems

- **Lentic**: Stagnant or slow-moving waters in closed basins (ponds, lakes); water layers form by temperature (stratification).

Where is Earth's Water?



- **Lotic**: Unidirectional, flowing systems (rivers, streams); transport water and sediments to the sea; support fewer large plants.
- **Key Types**
  - ✓ **Lakes**: Deep, land-locked water bodies fed and drained by rivers (e.g., Loktak, Wular).
  - ✓ **Flood Ponds**: Seasonal pools that dry out; many organisms lie dormant in the dry phase and revive with monsoon.
  - ✓ **Rivers**: Continuous channels carrying surplus rainwater to oceans (e.g., Ganga, Yamuna).