Key Takeaways

1. **Types of ecosystem**
   - Based on location
   - Based on human interference
2. **Ecosystem components**
   - Abiotic
   - Biotic
3. **Ecosystem structure**

Ecosystem functions 4

- Productivity
- Decomposition
- Nutrient cycling
- Energy flow

5 **Food chain**

- Grazing food chain
- Detritus food chain

Food Web 6

7 **10% law**

- **Ecological pyramids** — 8
  - Pyramid of numbers
  - Pyramid of biomass
  - Pyramid of energy
- **Nutrient cycle** — 10
  - Carbon cycle
  - Phosphorus cycle
- 9 — **Ecological successions**
  - Primary succession
  - Secondary succession
- 11 — **Ecosystem services**

Summary

Ecosystem

- **Ecosystem is the functional unit** of nature.
- The term was coined by **A.G. Tansley**.
- It is self-sustainable.
- Organisms **interact** and use **available resources**, such as food, space, light, heat, water, air and shelter to survive.
- Each population of organisms and the individuals within it **interact in limited specific ways wherein they can derive benefit from other organisms.**
- Interactions between different organisms are numerous and are described according to their **positive (beneficial), negative or neutral effect on each other.**
- The interactions between **living things and their non-living counterparts in the environment** make up a total ecosystem.
- Entire biosphere (global ecosystem) = sum of all local ecosystems.

Types of Ecosystem

- There are 2 types of ecosystem based on location:

Types of Ecosystem

Natural ecosystem

Develops in nature without human interference

Terrestrial

Forest

Desert

Grassland

Aquatic

Pond

Ocean

Man-made/Anthropogenic ecosystem

Created and maintained by human beings

Aquarium

Crop fields

Garden

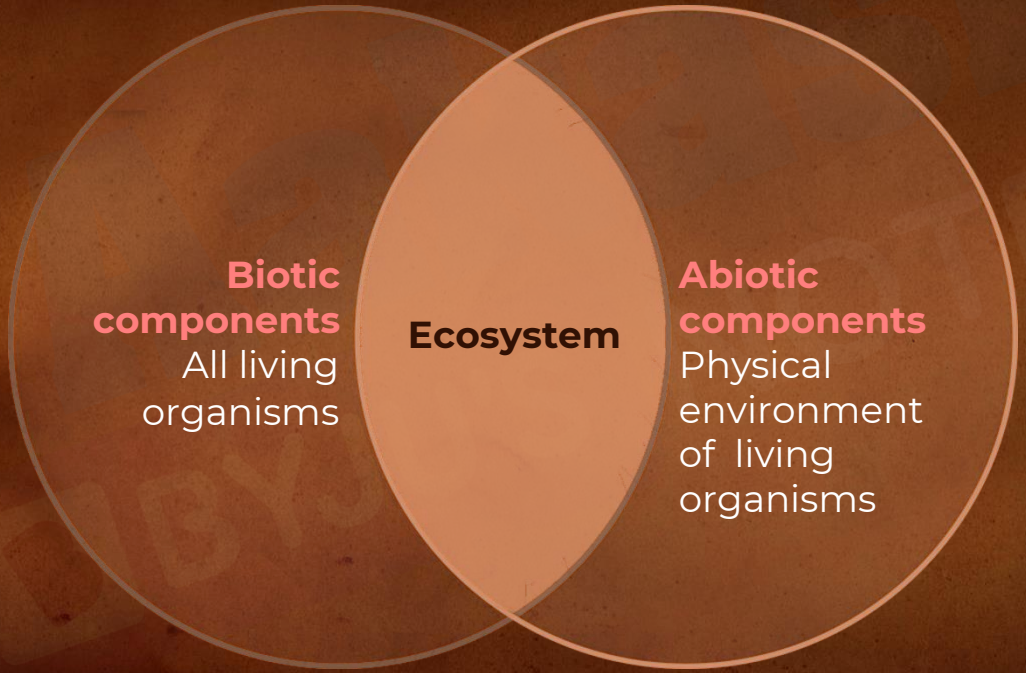
Did You Know!

- **Agriculture** or **agroecosystem** is the **first** and **largest man-made ecosystem.**
- It was formed for **fulfilling** the **needs** of the **increasing** human **population.**

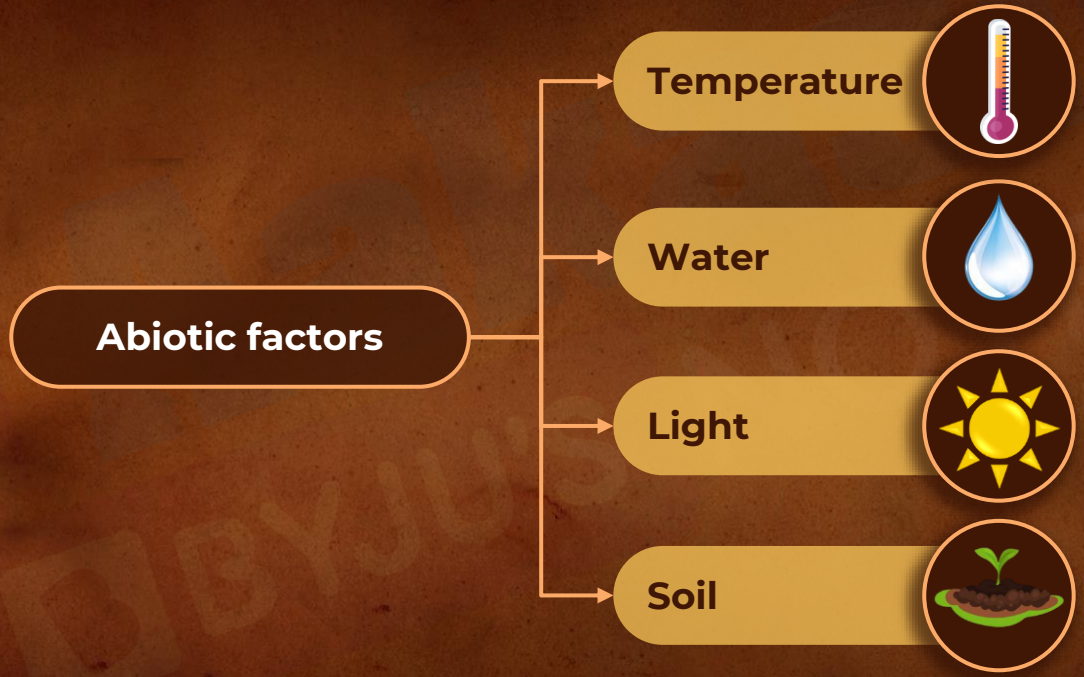
Agricultural crop fields

Components of Ecosystem

- Ecosystem is made up of **biotic** and **abiotic** components.



Components of Ecosystem



Components of Ecosystem

Biotic factors

- **Producers**
- **Consumers**
  - Primary consumer/ First order consumer
    - Feeds directly on producers
    - Also called **herbivores**
    - Ex - grasshopper, cow, tadpoles, molluscs
  - Secondary consumer/ Second order consumer
    - Feed on herbivores
    - Also called **primary carnivores**
    - Ex - spiders, lizards, hydra, frog
  - Tertiary consumer/ Third order consumer
    - Feed on secondary consumers
    - Also called **secondary carnivores**
    - Ex - snake, large fishes
- **Decomposers**

Note:

Top carnivore

- **Not eaten** by any other organism
- Can exist at any level
- E.g. - tiger, lion, panthers, peacock

Components of Ecosystem

Producers

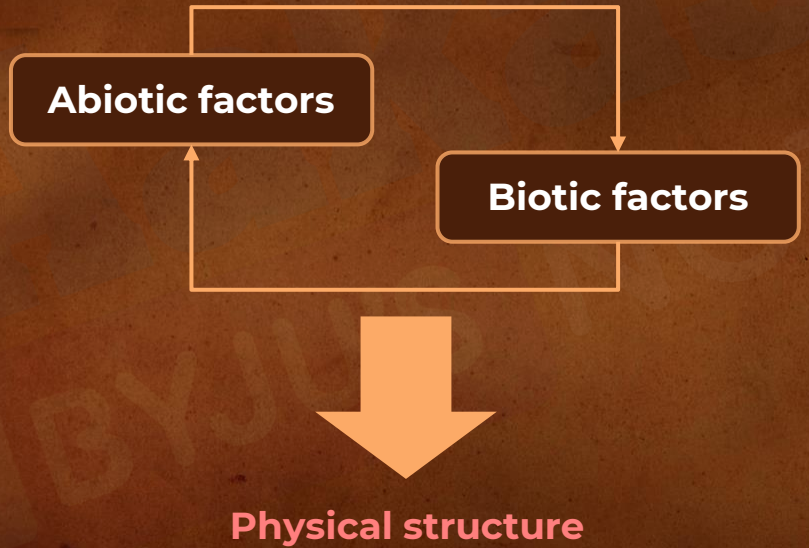
- **Green photosynthetic plants**
- Also called **autotrophs/transducers/converters**
- Producers in **terrestrial ecosystem -** herbaceous, woody plants
- Producers in **aquatic ecosystem -** phytoplankton, algae, submerged plants

Decomposers

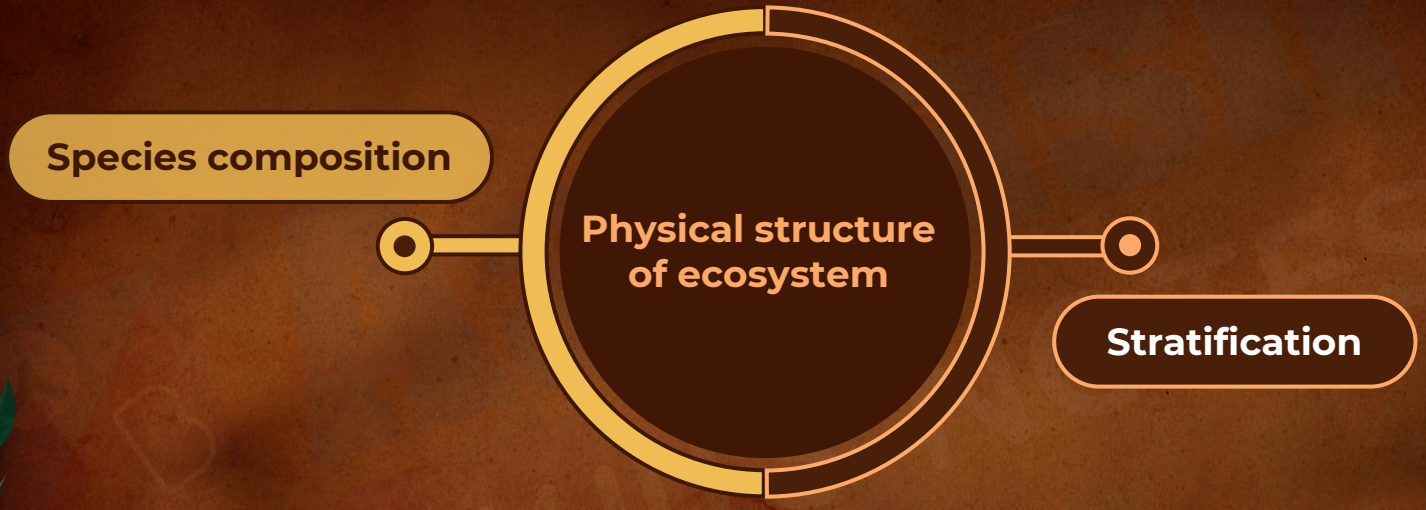
- **Saprophytic microorganisms**
- Also called **reducers** as they are capable of decomposing dead organisms
- Functions -
  - Brings about cyclic exchange of minerals between biotic and abiotic elements
  - Naturally replenishes soil with minerals

Components of Ecosystem

The interaction of **biotic** and **abiotic** components results in **physical structure** that is **characteristic** for each type of **ecosystem.**



Structure of Ecosystem



- Physical structure of ecosystem includes **species composition** and **stratification.**

Structure of Ecosystem

Species composition

- **Identification** and **listing** of plants and animals in an ecosystem.
- Based on **geography** and **climate** – it differs from one ecosystem to another.

Coral reef

Grassland

Stratification

- **Vertical distribution** of species at **different levels**
- E.g. - Following subdivision are present in a forest
  - Top layer - Trees
  - Second layer - Shrubs
  - Bottom layer - Grasses and herbs

Function of Ecosystem Components

- **Productivity** - Synthesis of organic matter by producers
- **Decomposition** - Degradation of dead organic matter
- **Nutrient cycling** - Cycling minerals and nutrients
- **Energy flow –** Sequential process of movement of energy through the ecosystem

Function of Ecosystem Components

Productivity
(Rate of biomass production)

Primary productivity

- Rate at which biomass is produced by producers during photosynthesis per unit area over a time period
- Expressed in terms of weight as $(gm/m^2)/yr$
- Expressed in terms of energy as $(kcal/m^2)/yr$

Secondary productivity

- Rate of formation of new organic matter by consumers

Productivity

Primary productivity is divided into:

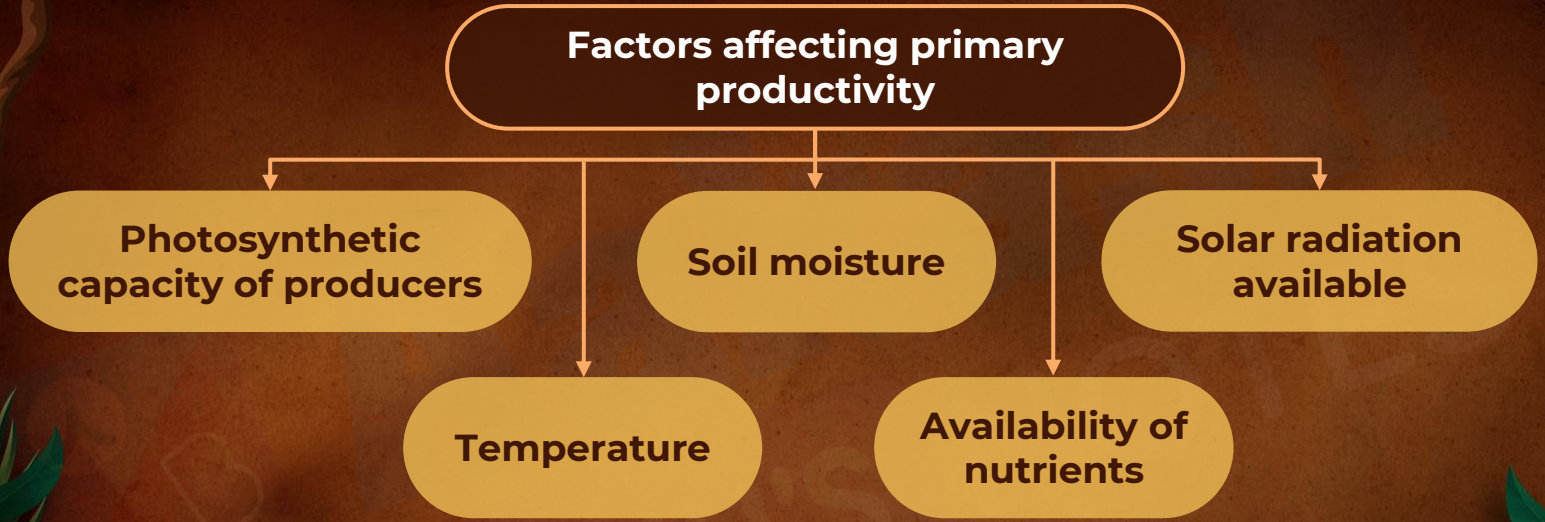
Gross primary productivity (GPP)

- It is rate of production of organic matter **during photosynthesis.**
- Plants use some of the GPP in respiration **(R).**

Net primary productivity (NPP)

- It is the **organic matter available** for consumption by the **heterotrophs.**
- **GPP – R = NPP**
  - **R = Respiratory loss**

Productivity



Reasons for low primary productivity of deep marine habitats

- **Low light** which decreases further with depth
- **Limited nutrients** - Most limiting nutrient of the marine ecosystem is nitrogen

Productivity

Some important terms

- **Community productivity =** It is the rate of net synthesis and build up of organic matter by a community per unit time and area
- **Ecological efficiency =** $\frac{\text{Energy converted into biomass at trophic level}}{\text{Energy present in biomass at lower trophic level}} \times 100$
- **Photosynthetic efficiency =** $\frac{\text{Gross primary productivity}}{\text{Incident total solar radiation}} \times 100$
- **Net production efficiency =** $\frac{\text{Net primary productivity}}{\text{Gross primary productivity}} \times 100$

Did You Know?

Total biosphere productivity is approximately **170 tons**

Terrestrial

Productivity is **115 billion tons**

Aquatic

Productivity is **55 billion tons**

Decomposition

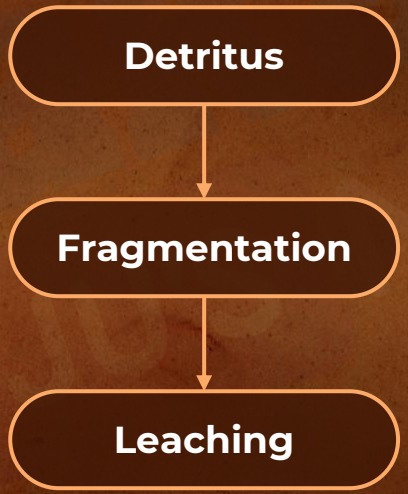
- The process of breaking down **complex organic matter** into **simpler compounds** like nutrients, minerals, carbon dioxide and water is known as **decomposition**.
- The **complex materials** are the **dead plant remains** such as leaves, bark, flowers and dead remains of animals, including faecal matter.
- The complex materials constitute **detritus**, which is the raw material for decomposition.

Decomposition - Fragmentation

- Decomposition occurs in a stepwise manner starting from fragmentation.
- The **detritivores** like earthworms, small insects etc., **feed** on the detritus (dry leaves) and **break them** down into **smaller particles.** This process is known as **fragmentation.**

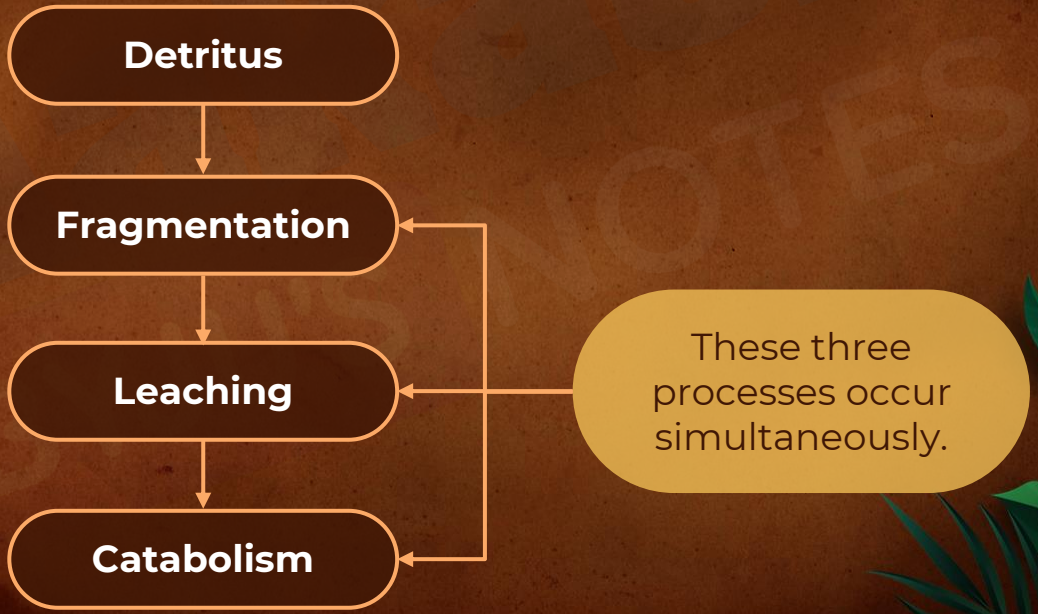
Decomposition - Leaching

- Water soluble inorganic nutrients **go down** into the soil horizon and get precipitated as unavailable salts. This process is called **leaching.**



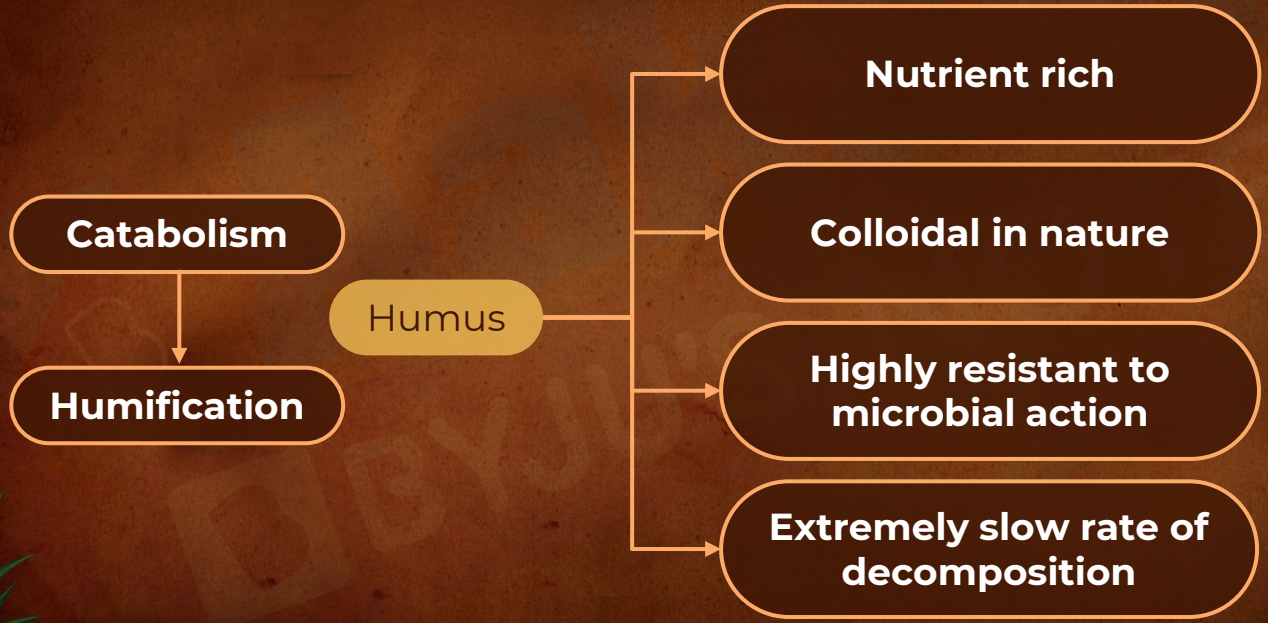
Decomposition - Catabolism

Fungal, bacterial enzymes act on the detritus to **degrade** it into simple **inorganic substances**. This is **catabolism.**



Decomposition - Humification

- During decomposition, **accumulation** of **dark amorphous substance** (as a thin layer) is called **humification**. The dark substance formed is called **humus**.



Decomposition - Mineralisation

- Humus is further **degraded** by action of **microbes.**
- It releases inorganic substances from humus. Hence, this process is known as **mineralisation.**

Catabolism

↓

Humification

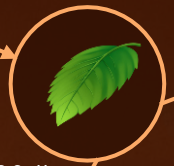
↓

Mineralisation

Decomposition

A tree grows in the soil

A green leaf falls to the ground



Some are eaten by insects and other animals. Nutrients and energy enter food web.

Some nutrients leach into soil by chemical action

Leaves partially consumed by decomposers such as fungi and bacteria. They begin to lose form and become litter

Further, decomposition by earthworms, bacteria, soil, mites, fungi, etc.

Organic rich soil

- **Detritus**
- **Fragmentation**
- **Leaching**
- **Catabolism**
- **Humification**
- **Mineralisation**

Decomposition

Nutrient immobilisation

- Phenomenon in which inorganic nutrients in the soil are taken up by microbes in soil and converted into organic form by **incorporation of nutrients** in **living microbes**
- Immobilised nutrients become available again for solubilisation after the death of microorganisms
- Immobilisation **protects nutrients from being washed out** and lost from ecosystem

What Affects Decomposition?

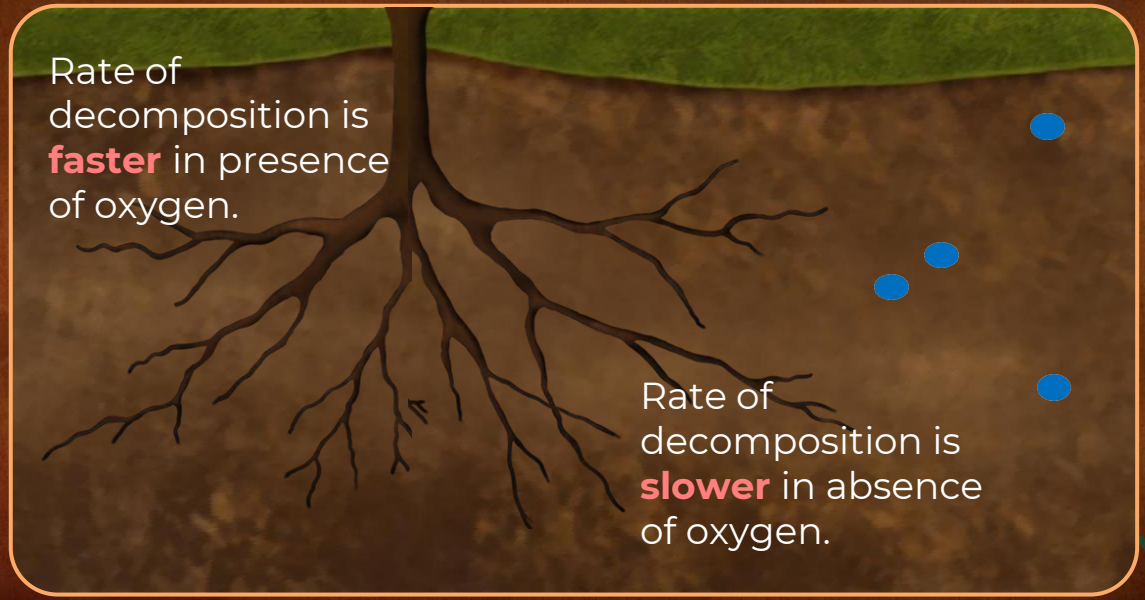
1. Climatic condition: Temperature, moisture

Rate of decomposition is **slower** in cold and dry conditions.

Rate of decomposition is **faster** in warm and moist conditions.

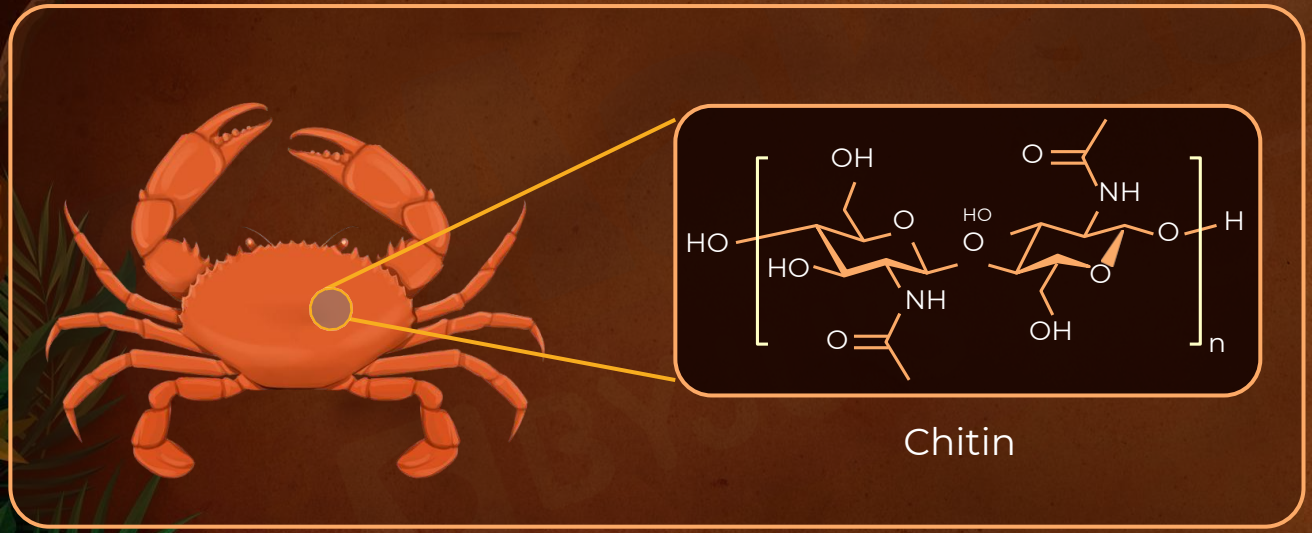
What Affects Decomposition?

2. Aerobic and anaerobic conditions



What Affects Decomposition?

3. Chemical composition of detritus



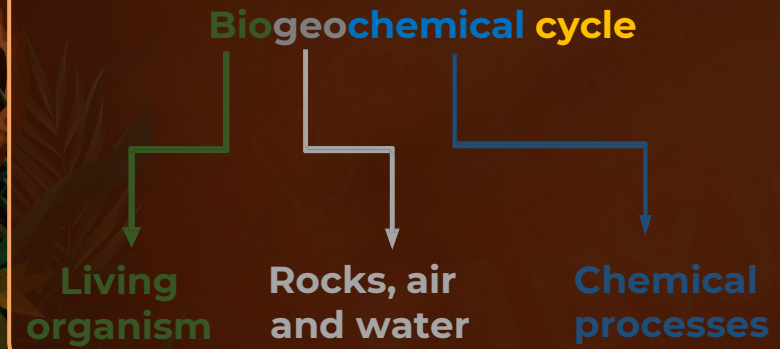
Chitin

If **chitin, lignin, tannins and cellulose** are present in the detritus, the rate of decomposition is **slow.**

If **water-soluble substances like sugars, nitrogenous compounds** etc., are present in the detritus, the rate of decomposition is **quicker.**

Nutrient Cycling

Movement of nutrient elements through various components of an ecosystem is also known as nutrient/ **biogeochemical cycle**.



Nutrient cycles are of two types

Gaseous cycle

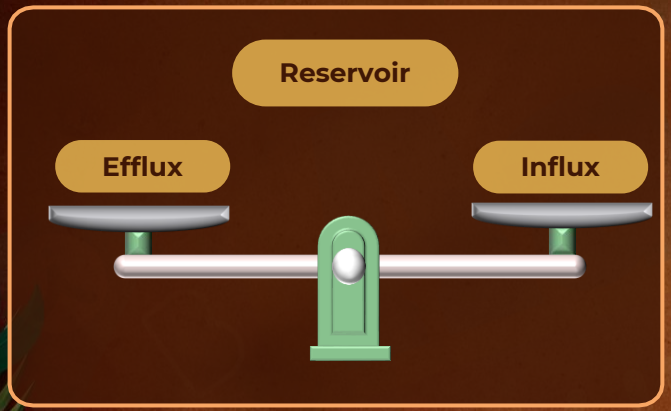
Have **reservoir in the atmosphere**
E.g.- Carbon, oxygen and nitrogen cycles

Sedimentary cycle

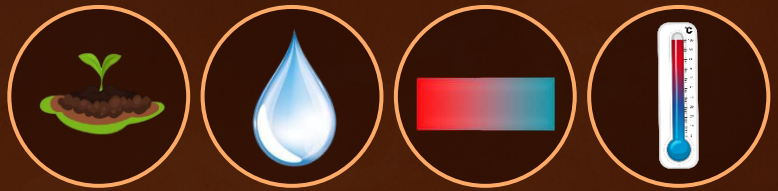
Have **reservoir in the earth's crust**
E.g.- Phosphorous and sulphur cycles

Nutrient Cycling

The function of the reservoir is to meet the deficit which occurs due to **imbalance in the rate of influx and efflux of nutrients**.

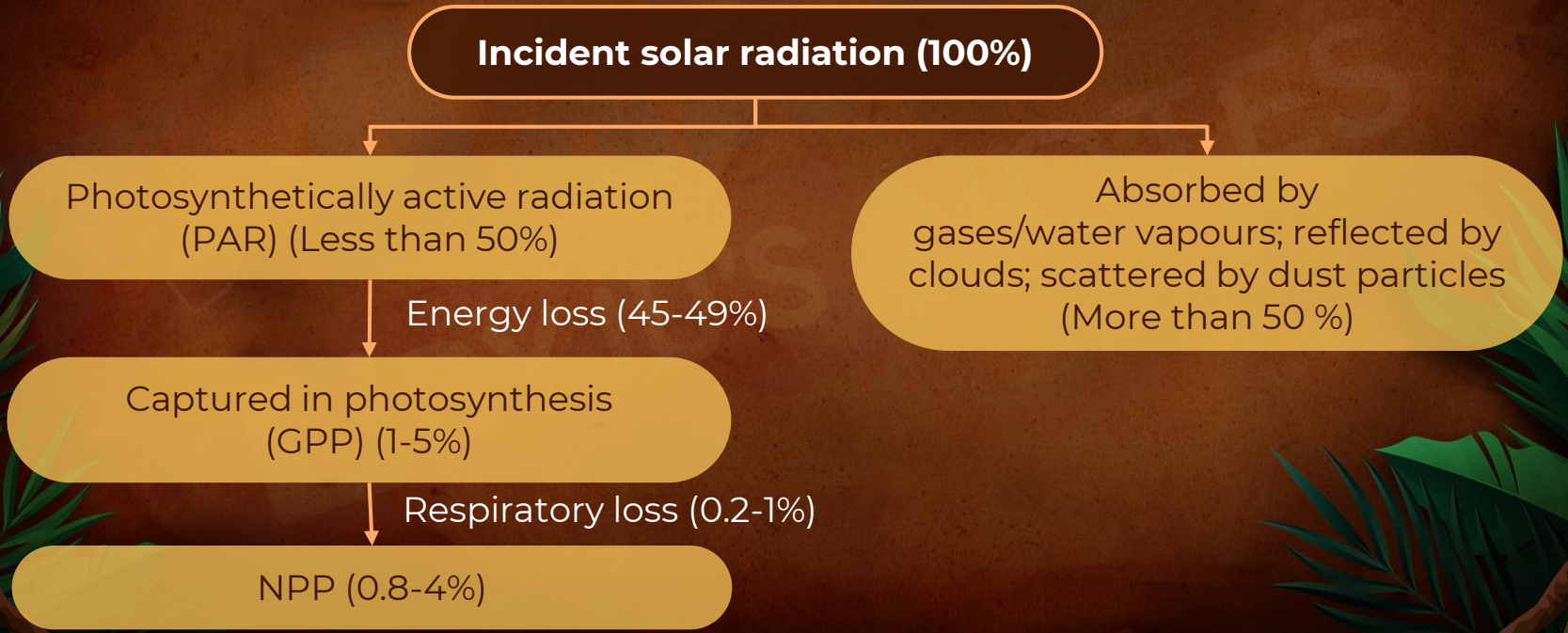


Factors affecting nutrient release



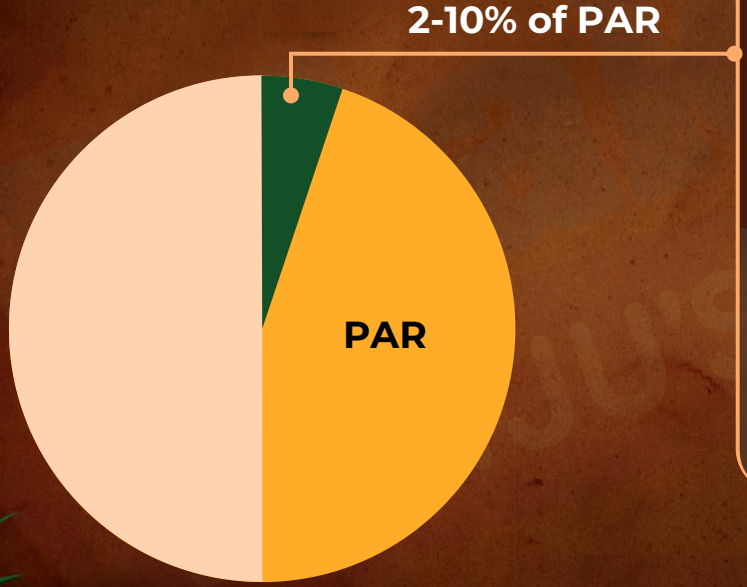
Energy Flow

- It is a sequential process of the movement of energy through a series of organisms in an ecosystem.
- **Sun** is the **only source** of **energy** common to all ecosystems on Earth, except for deep sea hydrothermal vents.



Sun-Source of Energy

- 50 per cent of all the sun's radiation is **Photosynthetically Active Radiation (PAR)**



Only 2-10% of PAR is captured by plants and photosynthetic bacteria

Energy Flow

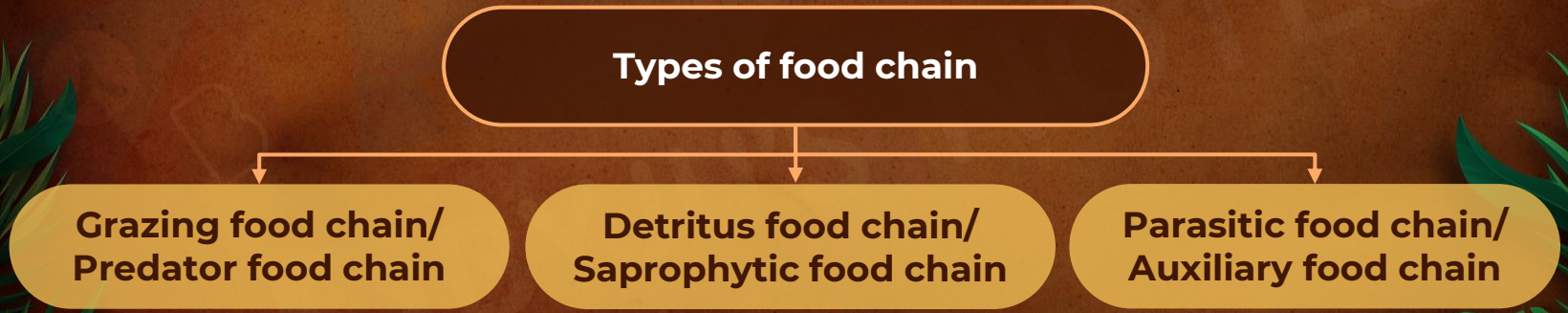
- Energy from **plants** is transferred **to other organisms.**
- Energy flow in an ecosystem is always **unidirectional.**
- Herbs, shrubs and woody plants act as **producers.**
  - **Green plants** of the ecosystem are **producers.**
  - Examples:
    - Forest ecosystem: **Trees**
    - Aquatic Ecosystem: **Phytoplanktons**

Energy Flow

- All other organisms depend on plants (directly or indirectly) for their food needs.
- Hence, they are called **consumers and heterotrophs.**
  - Herbivores are **primary consumers.**
    - Animals that feed on producers
    - Example:
      Terrestrial system: Insects, birds, deer etc.
      Aquatic system: molluscs, clams etc.
  - Primary carnivores are **secondary consumers.**
    - Animals that feed on herbivores (indirectly feed on plants).
    - Example: Fox feeding on deer.
  - Secondary carnivores are **tertiary consumers.**
    - Animals that feed on primary carnivores (indirectly depend on plants).
    - Example: Tiger feeding on fox.

Food Chain

- Chronological (organisms arranged order) **series of organisms** each **depending** on other **for food.**
- Each **level** in a food chain where **transfer of energy** takes place is called **trophic level.**
- Organisms of a trophic level depend on the organisms at the **lower trophic level** for their **energy demands.**



Food Chain – Trophic levels

4th trophic level		**Top carnivores** (Tertiary consumers)
3rd trophic level		**Carnivores** (Secondary consumers)
2nd trophic level		**Herbivores** (Primary consumers)
1st trophic level		**Producers**

Food Chain – Trophic levels

1st trophic level

Total biomass (mass of organic matter) of producers in a unit area = standing crop of producers

Fresh weight

Dry weight

- Biomass expressed in **fresh or dry weight**
  - Fresh weight is **weight** recorded **immediately after the organism dies** or part of an organism is harvested.
  - Dry weight is the **weight** of the organism or part of the organism **after it has been dried.**

Food Chain – Trophic levels

Standing crop of 4th trophic level

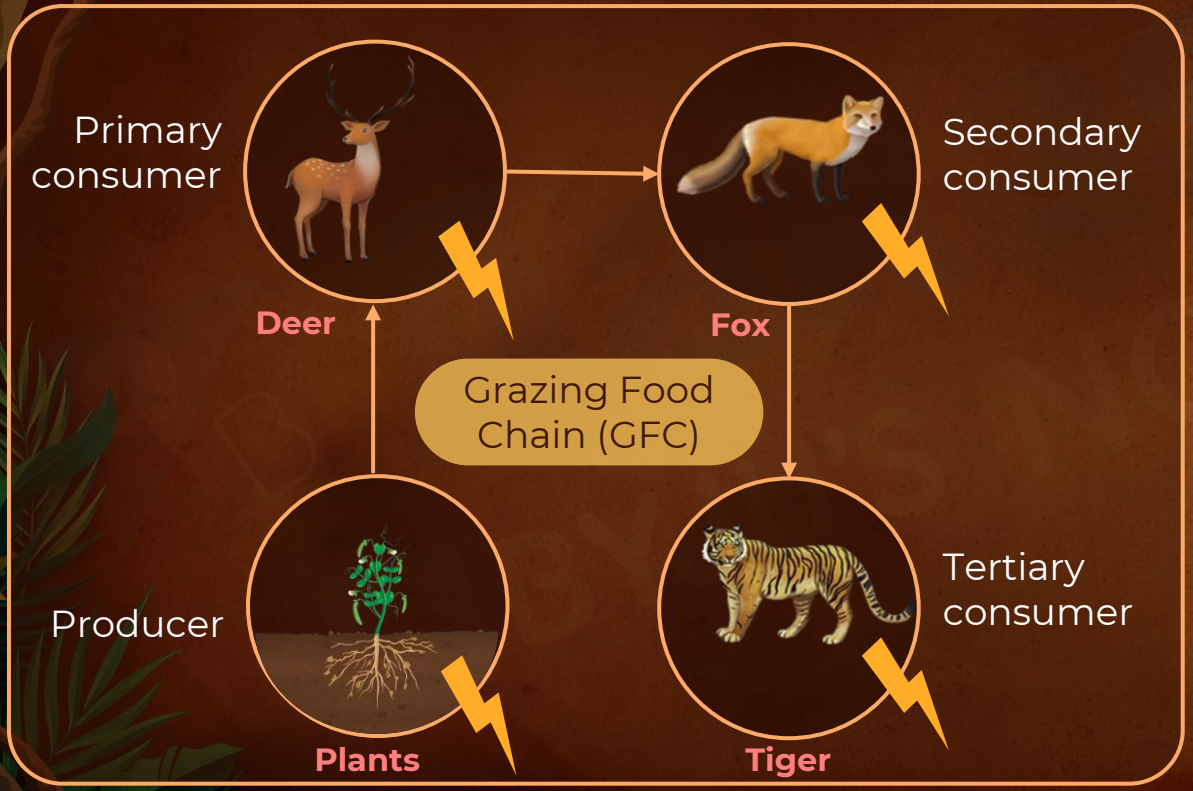
Standing crop of 3rd trophic level

Standing crop of 2nd trophic level

Standing crop of 1st trophic level

- **Standing crop** refers to amount of **living matter** present in **different trophic levels** at a given time
- Expressed in numbers or biomass of organisms per unit area

Grazing Food Chain

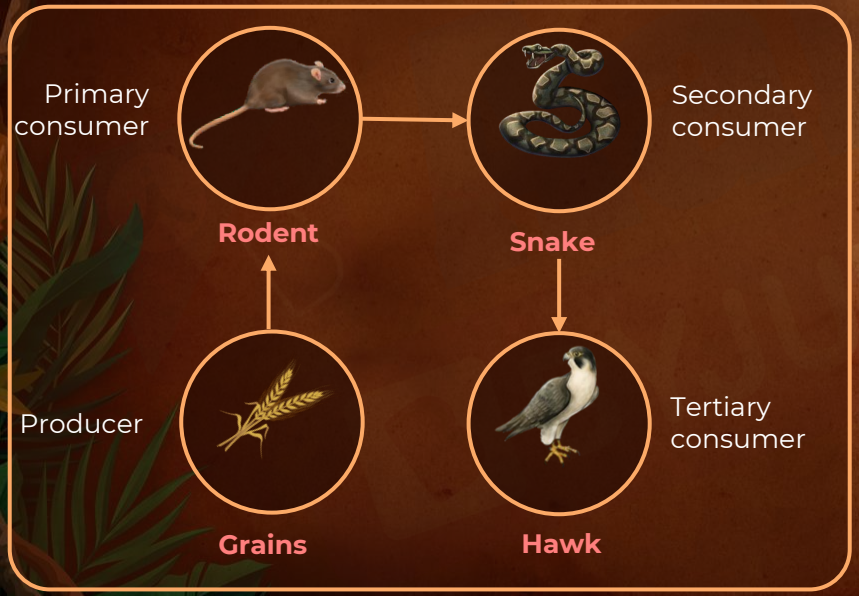


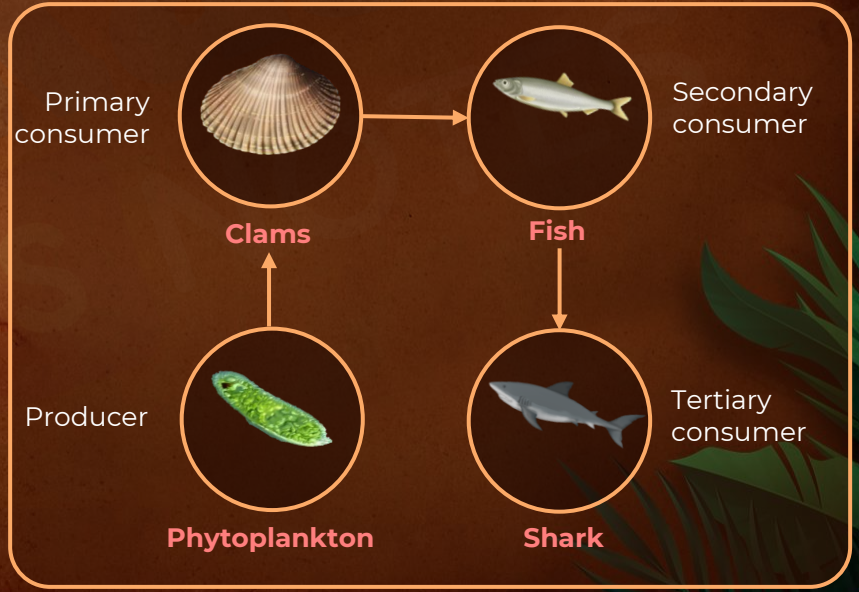
- As an organism consumes another organism, **the energy produced by producers is passed on to next organism**.
- Energy is gained from photosynthesis.
- Such a food chain is known as **grazing food chain.**

Grazing Food Chain

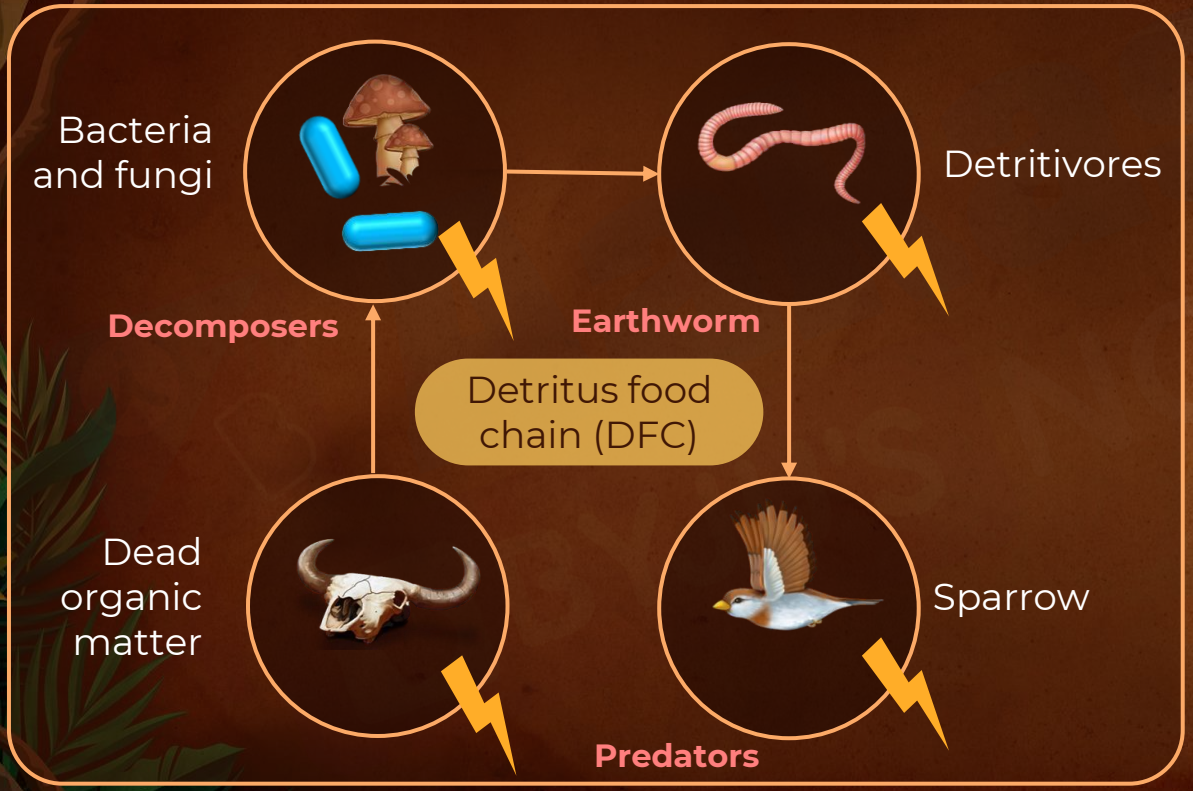
Grazing food chain (GFC) examples:

- In aquatic ecosystem, GFC is major conduit of energy flow.



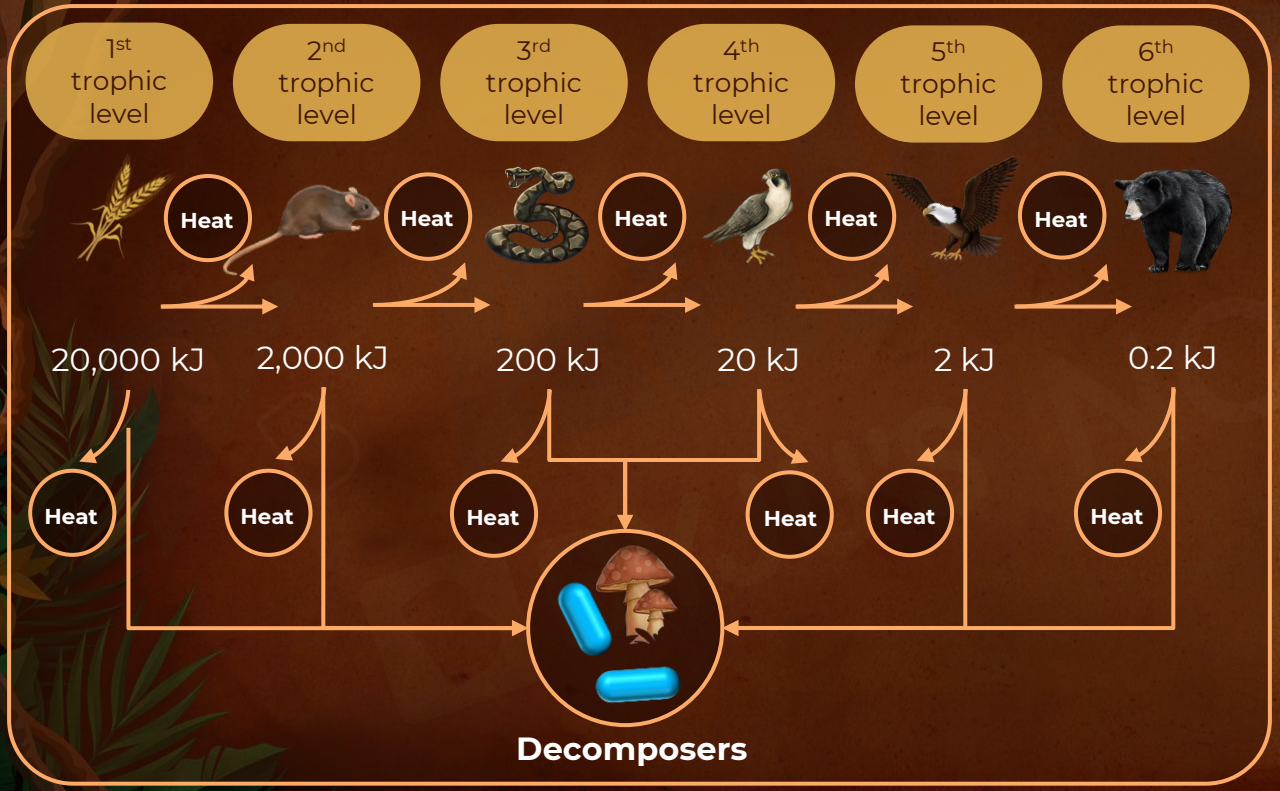


Detritus Food Chain



- Food chain where energy is obtained from **dead organic matter**
- **Begins** with **dead organic matter**, followed by **decomposers, detritivores** and then their predators
- In terrestrial ecosystems, a much larger fraction of energy flows through DFC than through GFC.

Detritus Food Chain

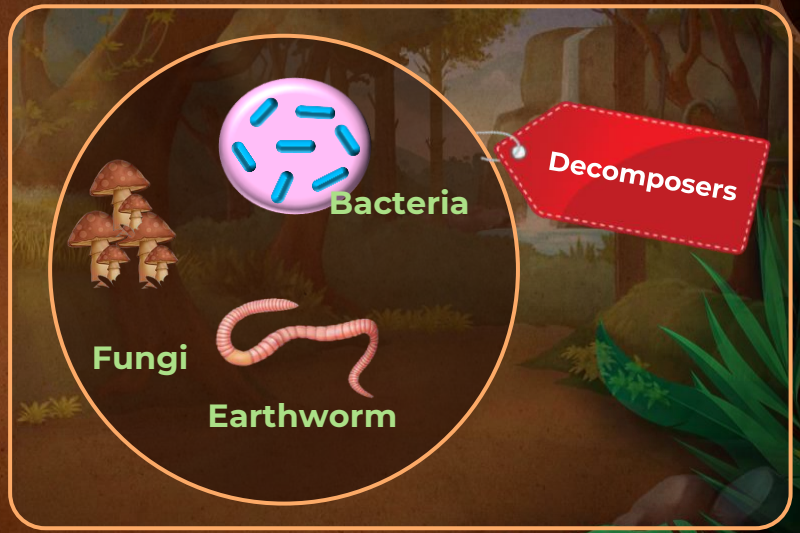


- Energy is lost in DFC as well.
- Example:
  - **Plants die without being consumed** by animals.
  - Their biomass is not passed onto next consumer.
  - Decomposition of waste/dead matter leads to **loss of energy in the form of heat.**

Detritus Food Chain

Decomposers

- Decomposers are heterotrophic.
- They are also known as **saprotrophs (sapro = to decompose).**
- They meet their energy and nutrient requirements by degrading dead organic matter.
- When an organism dies, **decomposers secrete digestive enzymes that breakdown dead** and waste materials into simple, inorganic materials.
- They are **subsequently absorbed by the decomposers.**



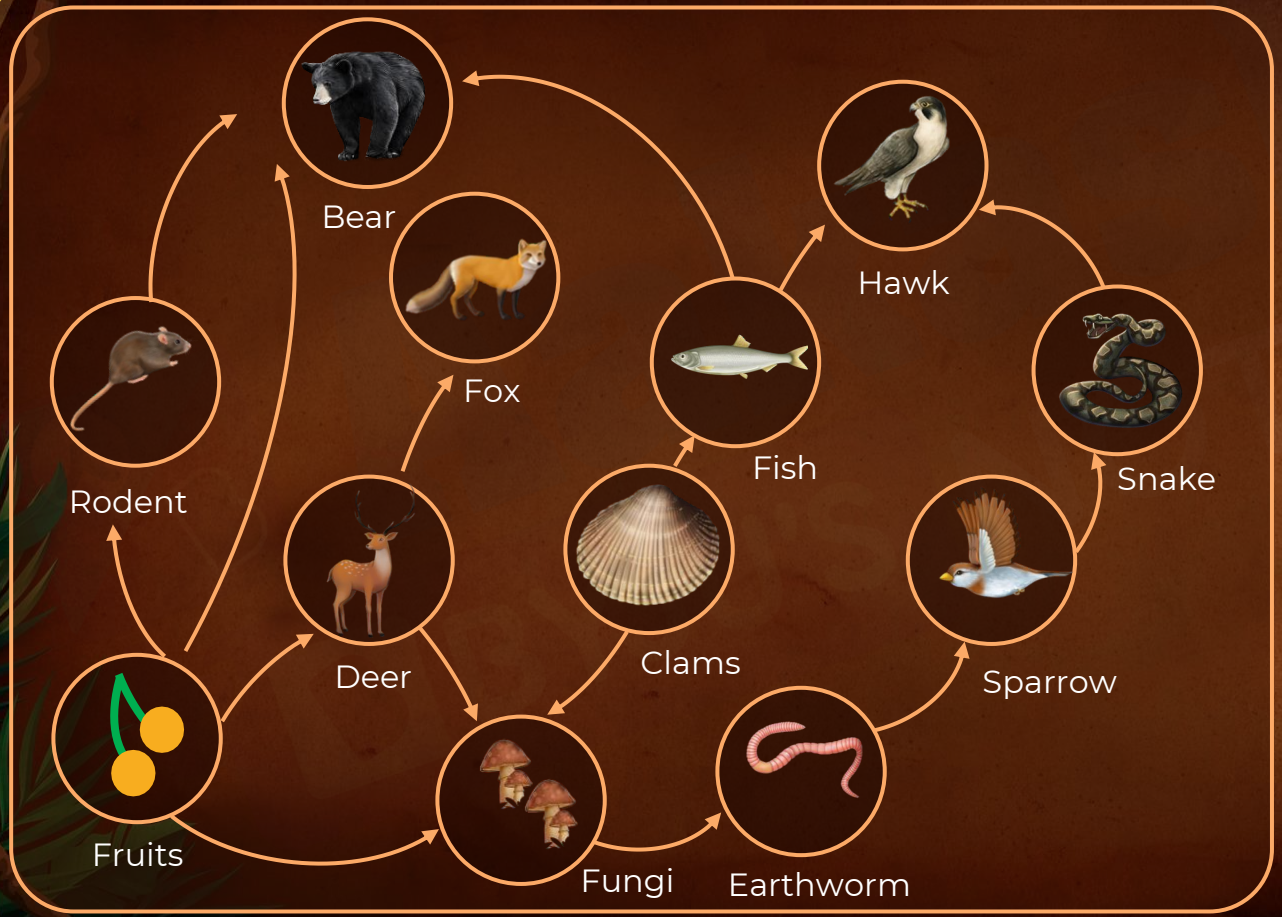
Detritus Food Chain

Decomposers

The **earthworm,** which is a **detritivore, feeds on such bacteria, fungi** and further decomposes detritus.

Earthworms are eaten by small birds such as sparrows.

Food Web



- An animal may be eaten by different animals and thus, **different food chains get interconnected,** and one animal may be a link in more than one food chain.
- Bear, fish, deer, fungi etc., are such organisms that lead to interconnection of food chains.

Food Web

Food web is a network of food chain interconnected to each other.

- Food web is **more real** than food chain.
    - E.g. - **Jackals are** both **carnivores** and **scavengers**
    - E.g. - Sparrow is a **primary consumer** when it eats **seeds** but **secondary consumers** when it eats **insects** and **worms**
- Food Web is essential for the **stability of an ecosystem.**
- Provides opportunity for the **endangered prey to recover its number.**

10% Law

- At every stage of organism's lifecycle, energy is lost to environment.
- Example:
  - Excretion
  - Respiration

Energy flow in ecosystem follows
1st law of thermodynamics

It states that energy can neither be created nor destroyed, only altered in form.

Energy is always conserved.

10% Law

- Energy flow in the ecosystem follows the **2nd law of thermodynamics.**
  - It states that whenever energy is converted from one form to another, there is a tendency toward disorder (entropy) in the system or some of the energy is lost to environment.
- **Thus, energy is lost** to environment when it moves from one trophic level to other.

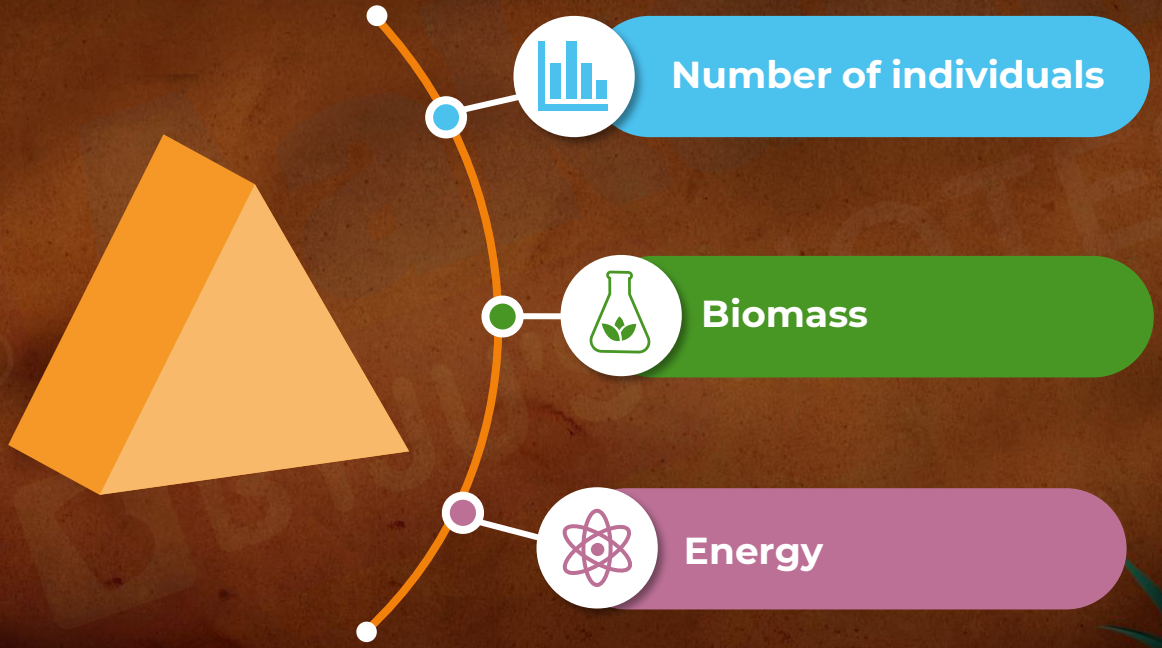
10% Law

10% Law

- **10 percent of the energy is transferred to each trophic level** from the lower trophic level
- Proposed by **Lindeman** in 1942
- Consequently, an ecosystem can support only a limited number of trophic level (3-5)

Ecological Pyramids

- It is the **graphical representation** of ecological parameters at the successive trophic levels of a food chain.

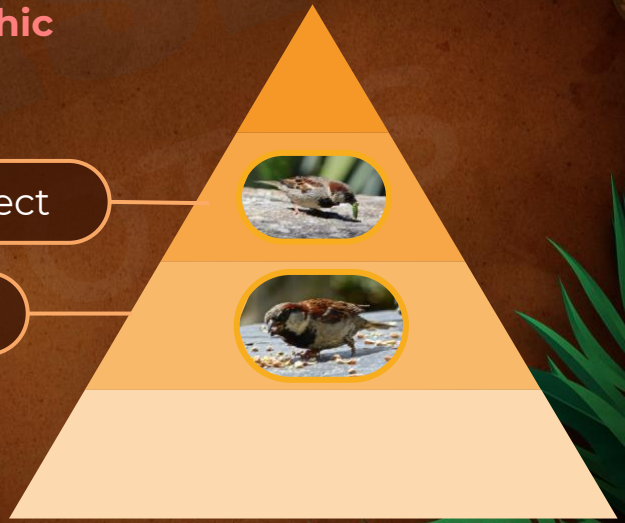


Ecological Pyramids

- To constructs the ecological pyramids, **all organisms at that trophic level** should be included.
- Trophic level represent **functional levels.**
- One organism can occupy **more than one trophic level** simultaneously.

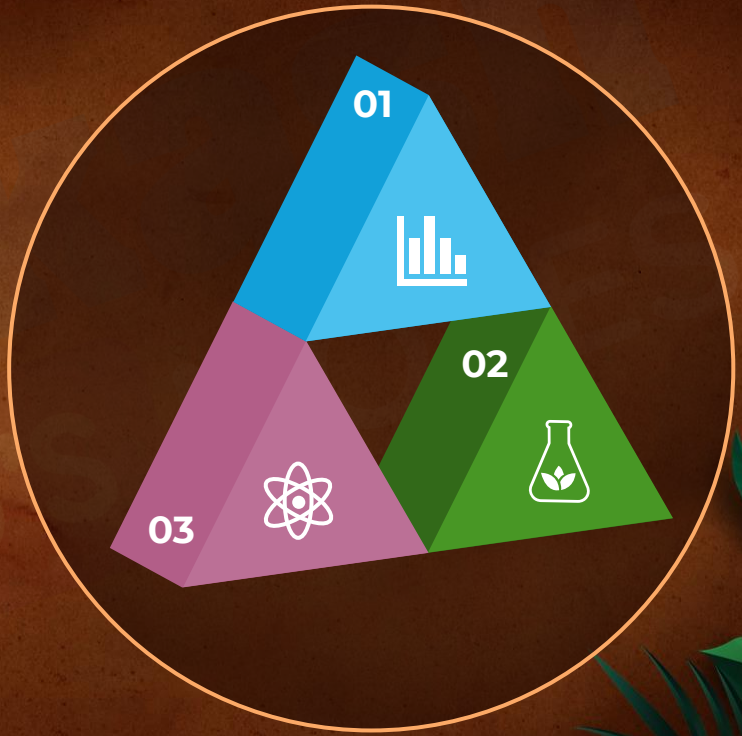
Sparrow as secondary consumer when it eats insect

Sparrow as primary consumer when it eats seed, fruit, etc



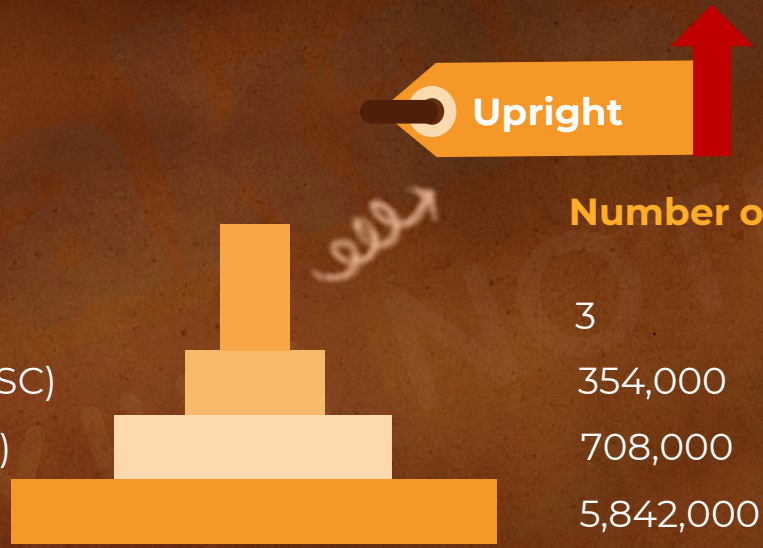
Ecological Pyramids

- Pyramid of numbers
- Pyramid of biomass
- Pyramid of energy



Ecological Pyramids

Pyramid of numbers



Pyramid of number in grassland ecosystem

- The number of **top carnivores** is too small to support any other trophic level and they **do not act as prey** for any other organism.

Ecological Pyramids

Pyramid of numbers

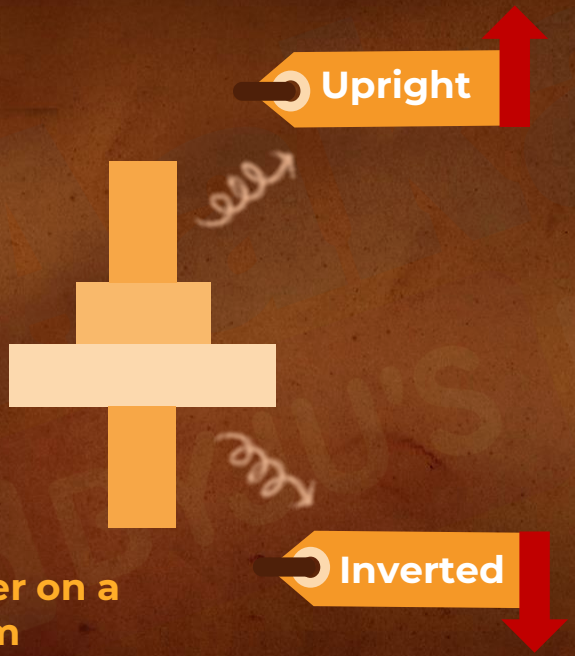
Trophic levels

Large birds (TC)

Small birds (SC)

Insects (PC)

One big tree (P)



Pyramid of number on a big tree ecosystem

- There are exceptions to this generalization:
  - If the number of insects feeding on a big tree are counted, then **inverted** pyramid is obtained.
  - The number of small birds depending on the insects are less and the number of larger birds eating the smaller birds are few, then **upright** pyramid is obtained.

Ecological Pyramids

Pyramid of biomass

Upright

Trophic levels	Dry weight (Kg m-2)
Tertiary consumers (TC)	1.5
Secondary consumers (SC)	11
Primary consumers (PC)	37
Producers (P)	809

Pyramid of biomass in forest ecosystem

- Pyramid of biomass in terrestrial ecosystems is usually **upright.**

Ecological Pyramids

Pyramid of biomass

Trophic levels

Large fishes (TC)

Small fishes (SC)

Zooplankton (PC)

Phytoplankton (P)

Pyramid of biomass in aquatic ecosystem

- However, a different shape of the pyramid of biomass can be seen in aquatic habitats
  - The pyramid of biomass in sea is generally **inverted** because the biomass of fishes far exceeds that of phytoplankton.
  - The producers are **very small** and have limited biomass, they also reproduce and die quickly.
  - So, there is **less biomass of producers** at any given time compared to consumers.

Ecological Pyramids

Pyramid of energy

- Pyramid of energy is **always upright**, **it 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.
- Primary producers convert **only 1%** of the energy in the sunlight available to them into NPP.
- 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.

Ecological Pyramids

Pyramid of energy

Always Upright

Trophic levels	Energy (J)
Tertiary consumers (TC)	10
Secondary consumers (SC)	100
Primary consumers (PC)	1000
Producers (P)	10,000

Pyramid of energy in any ecosystem

Limitations of Ecological Pyramids

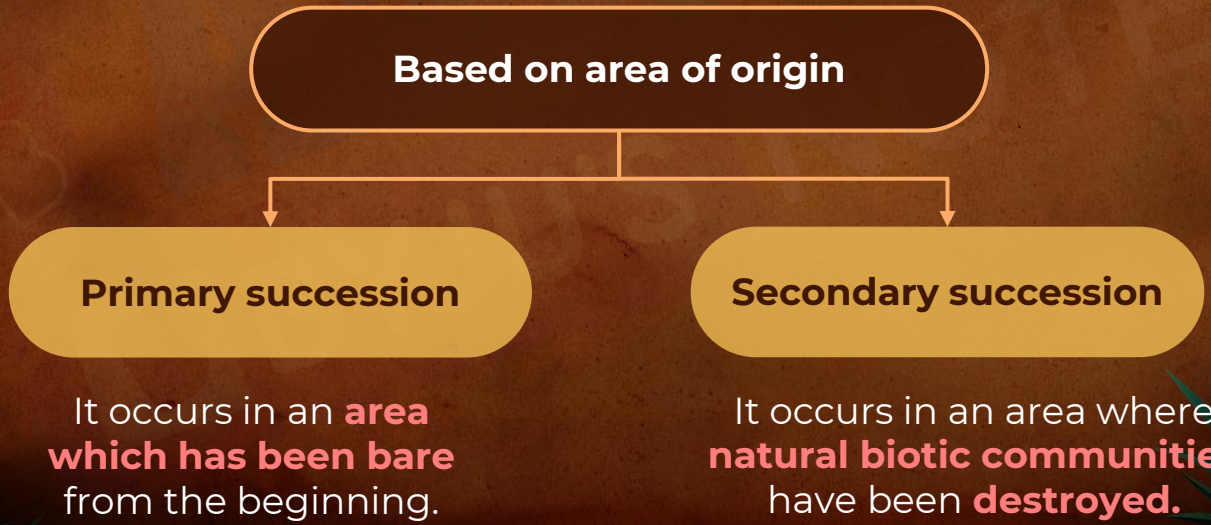
1. Does not account for same species belonging to **more than one** trophic level

2. Does not accommodate **food web**; assumes simple food chain

3. No place in ecological pyramids for **saprophytes**

Ecological Succession

- It is the **gradual and fairly predictable changes** in the species composition of a given area.
- This change is **orderly** and **sequential.**
- Succession and evolution are ideally parallel processes.



Primary Succession

Succession starts in an area where there are **few or no living organisms (barren area).**

- Newly exposed **sea floor**
- Newly cooled **lava sediments**
- Newly created **pond or reservoir**
- **Bare rock**

Pioneer species is the **first biotic community** which develops in a bare area.
E.g. - Lichens on rocks, phytoplankton and zooplanktons in a new pond.

Bare area with only rocks

Grasses and small plants begin to appear

Bigger plants begin to appear

Primary Succession

Sere

- It is the **entire sequence of communities** that successively change in an area. E.g. bryophytes, herbs, shrubs, on a bare rock.

Seral stage/Community

- They are the individual transitional communities.
- Following things occur during different seral stages:
  - Diversification of species
  - Increase in number of species
  - Increase in total biomass

Bigger plants begin to appear

Trees begin to appear

Climax Community

It is the last community that forms as a **result of ecological succession** which is relatively stable and is in near equilibrium with the environment.
E.g. : Forests

Secondary Succession

Secondary succession is **recolonization of habitats** (of plants and animals) after major disturbances like:

Abandoned farmland

Flooded land

Deforested land

Forest fire

Secondary Succession

- After **disturbances**, all the vegetation is lost, **only soil** is left.
- **Small plants** like grasses slowly start growing here.
- Later, **bigger plants** like shrubs appear.
- With time, **trees appear** to reach the **climax community.**
  - Example : Forest

Grasses and small plants begin to appear

Bigger plants begin to appear

Climax community

Ecosystem characteristics that Change During Succession

- **Change in diversity of species** - Some species colonise an area and their populations become more numerous, whereas populations of other species decline and even disappear
- **Little diversity to high degree of diversity** - Increase in the number of species
- **Total biomass increases**
- **Increase in humus content of soil**
- **Aquatic or dry conditions to mesic conditions -** Both hydrarch and xerarch successions lead to medium water conditions (mesic), neither too dry (xeric) nor too wet (hydric)
- **Vegetational changes -** This in turn affect food and shelter for various types of animals.
- Thus, as succession proceeds, the number and types of animals and decomposers also change

Xerarch Succession

Stage I - Lichen stage

- Lichen are symbiotic association of (algae) **photobionts** and **mycobionts** (fungi).
- They are **pioneer species.**
- They can tolerate desiccation, excessive heat and cold temperatures.
- They secrete acids to dissolve rock to form soil. This process is called **weathering.**

Bare rocks without water

Stage II - Moss stage

- Mosses help in **further weathering as their rhizoids can penetrate deeper.**
- This leads to accumulation of **more soil and organic matter** which can **retain more moisture**.

Growth of **moss** on rocks

Xerarch Succession

Stage III - Grass stage

- The **roots of grasses** penetrate the rocks and contribute to **weathering.**
- They provide **shade to small animals.**
- Accumulates soil and moisture helps in germination of seeds of annual grasses and herbs

Growth of grass and shrubs

Stage IV - Shrub stage

- The **roots of shrubs penetrate the rocks** and contribute to weathering.
- They provide **shade for larger animals.**

Stage V – Forest/Climax stage

- **Trees** begin to grow.
- The land can turn into coniferous, deciduous or temperate **forest.**

Forest

Hydrarch Succession

Stage I - Plankton stage

- **Phytoplanktons** and zooplanktons are the pioneer species.
- The death of these organisms provide **organic matter.**

Growth of phytoplanktons

Stage II - Submerged plant stage

- **Submerged plants** are rooted in the **bottom mud layer.**
- The death of these organisms provide organic matter.
- Water becomes **shallower.**

Submerged plants

Hydrarch Succession

Stage III - Submerged free-floating plant stage

- **Free floating plants** provide **minerals and organic matter.**
- The water becomes shallower on the **periphery.**

Submerged free-floating plants

Stage IV – Reed-swamp stage

- **Amphibious plants** start to grow.
- They **transpire** large amounts of water.
- They produce organic matter.
- Their tangled roots **accumulate silt.**

Amphibious plants

Hydrarch Succession

Stage V – Marsh-meadow stage

- Reed-swamp stage is invaded by **marshy plants**.
- **Pond becomes shallower** due to deposition until it gets transformed into terrestrial habitat.

Stage VI - Scrub stage

- **Shrubs** can tolerate **sunlight and water-logged conditions.**
- They **transpire** large amounts of water.
- They add **organic matters to bottom layer.**

Stage VI - Forest stage

- This is the **climax stage.**
- Trees begin to grow.
- The **land can turn** into coniferous, deciduous or temperate **forest.**

Shrubs

Forest

Nutrients

- Organisms need a **constant supply of nutrients** to grow, reproduce and regulate various body functions.
- Numerous **different nutrients are needed to sustain life.**
- However, the most essential ones are carbon, hydrogen, oxygen, phosphorus and sulphur- in short also known as "**CHNOPS**".
- Along with them there are other nutrients needed like calcium, potassium, sodium, etc.

Standing State

The amount of nutrients such as carbon, nitrogen, phosphorous, calcium, etc., **present in the soil at any given time,** is referred to as **standing state.**

- The amount of nutrients vary in different kinds of ecosystem.
- The amount of nutrients vary on a seasonal basis.

Pond

Grassland

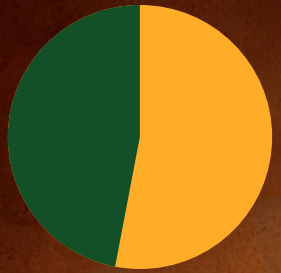
Desert

Ocean

Forest

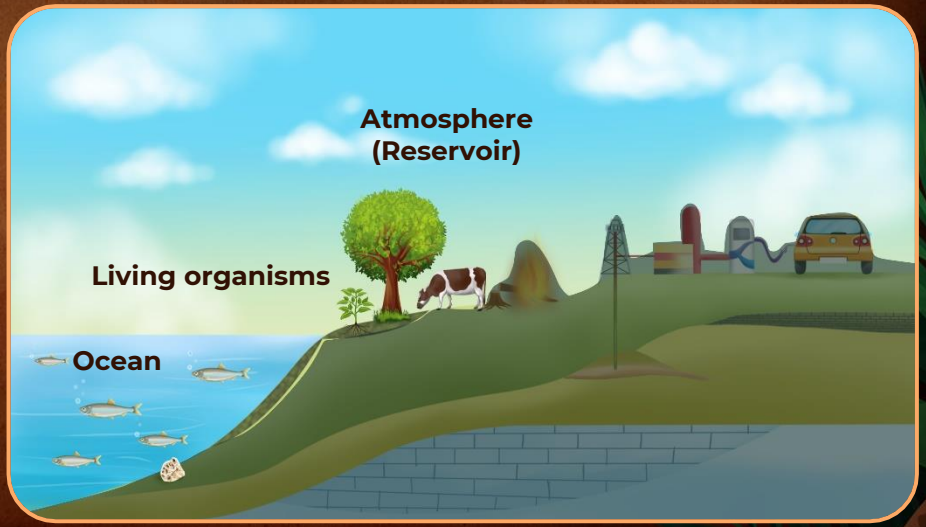
Gaseous Cycles

Carbon cycle



- Carbon is important element found in all the living beings.
- Carbon constitutes **49% dry weight** of organisms.

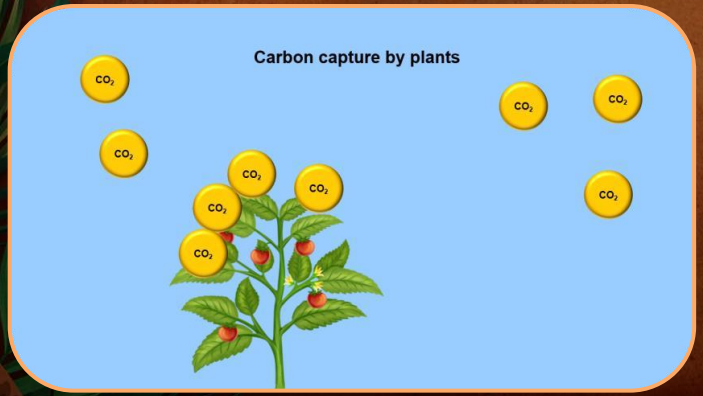
- **Carbon cycle** occurs through atmosphere, ocean and through living and dead organisms.
- Atmosphere is the reservoir for gaseous nutrient cycle.



Gaseous Cycles

Carbon cycle

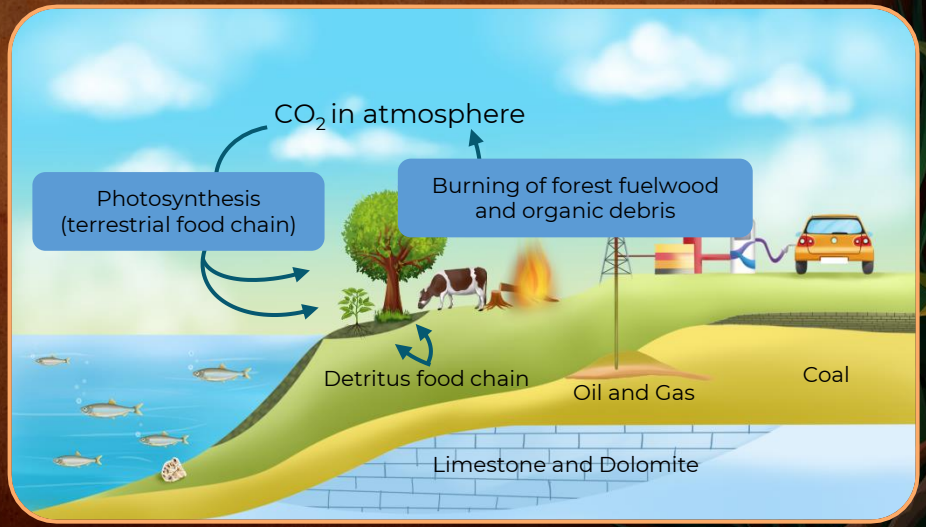
- Carbon is present in atmosphere in the form of carbon dioxide.
- Only **1%** of the **global carbon** is found in the **atmosphere.**
- **71%** of carbon is present in **dissolved form in the ocean.**
- Some of the remaining carbon dioxide is captured by plants.



Gaseous Cycles

Carbon cycle

- Carbon from atmosphere reaches plants in the form of carbon dioxide which is converted to **glucose** by photosynthesis.
- Animals get the required **carbon through plants.**
  - Primary consumers like deer feed on plants to get the carbon.
  - Carnivores like tiger feed on deer.
- When these animals and plants die, **decomposers release carbon.**
- Decomposers act on decomposing and decaying matter, further contributing to the **release of carbon dioxide.**
- Carbon is released back as Carbon dioxide majorly through **respiratory activities of producers and consumers.**



Gaseous Cycles

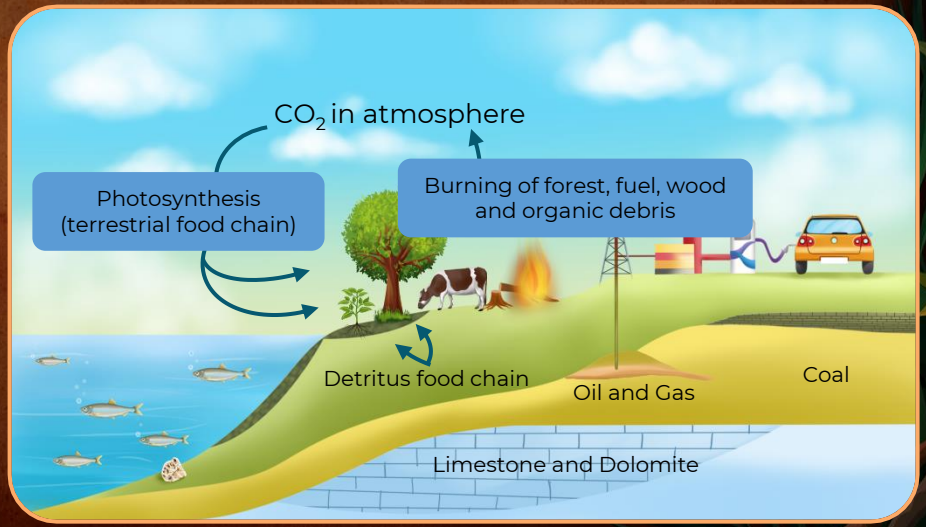
Carbon cycle

- In addition to the above, **burning of wood, forest fire and combustion of organic matter, fossil fuels, volcanic activity** are other sources which release **carbon dioxide** into the atmosphere.
- Carbon cycle's part on land ends here. Carbon cycle occurs through oceans as well.

Burning wood and fossil fuels

Volcanic activity

Forest fires

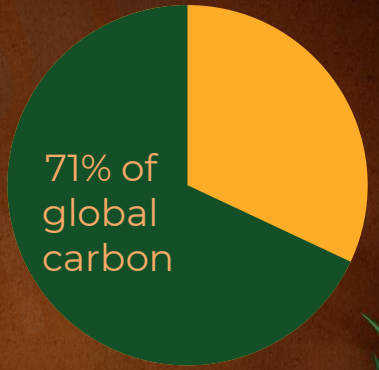


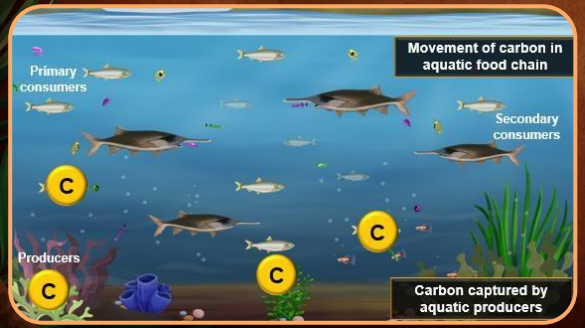
Gaseous Cycles

Carbon cycle

- In oceans, **carbon dioxide** is captured by underwater **plants, seaweeds and phytoplankton.**
- These **producers are eaten by smaller fishes**, which in turn are eaten by **larger fishes.**
- Carbon **is transferred from one organism to another** when one feeds on the other.
- Some of the carbon dioxide is **released back into the atmosphere** when these organisms respire.

71% of global carbon is found dissolved in oceans





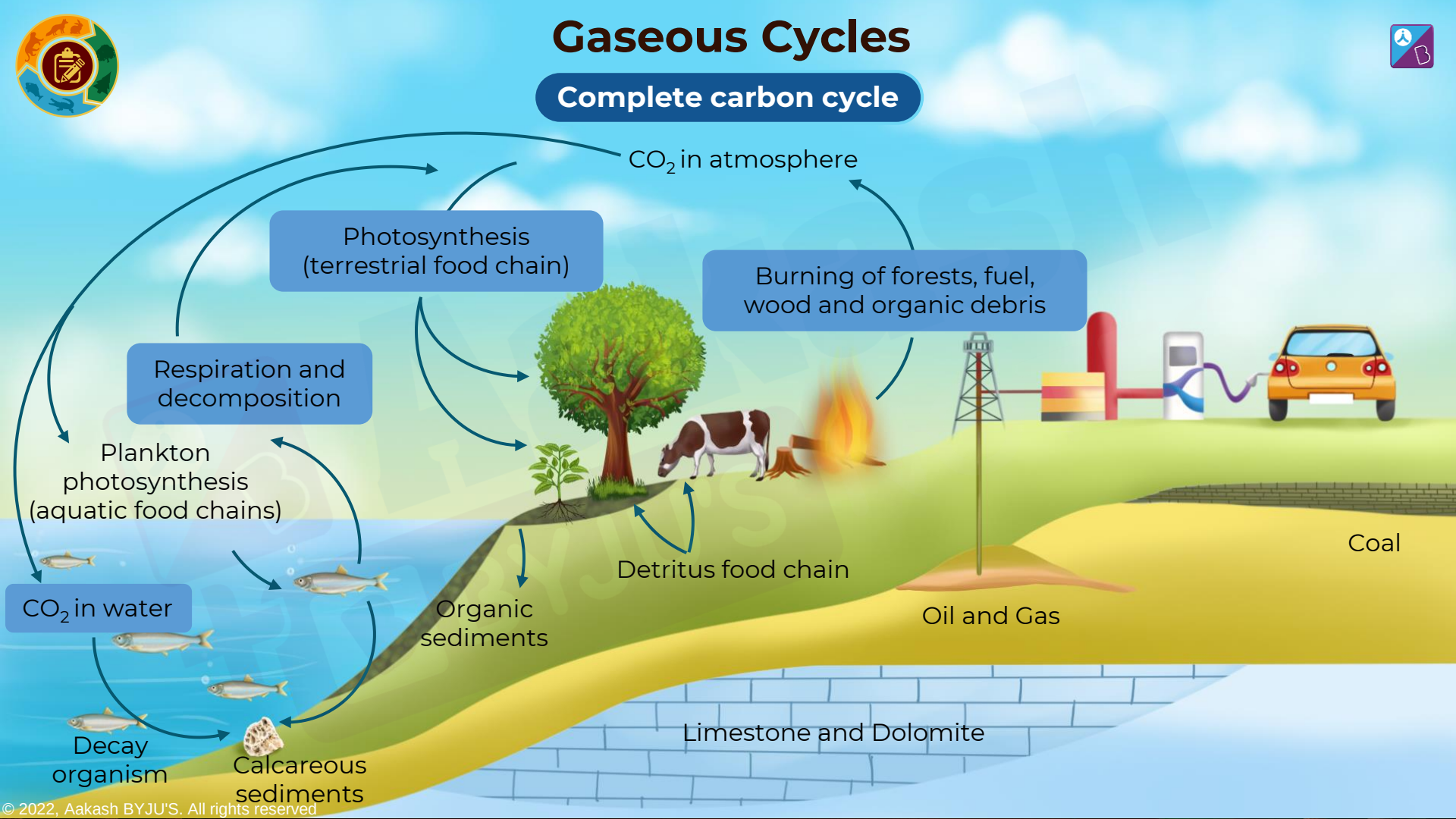
Gaseous Cycles

Carbon cycle

- Further, when these organisms die, **decomposers present in the ocean decompose them.**
- Some of the carbon is released as carbon dioxide
- **Shells and skeleton** of these organisms get **deposited in the deep ocean** to form **calcareous sediments.**
- Thus, some amount of the **fixed carbon is lost to sediments** and removed from circulation.

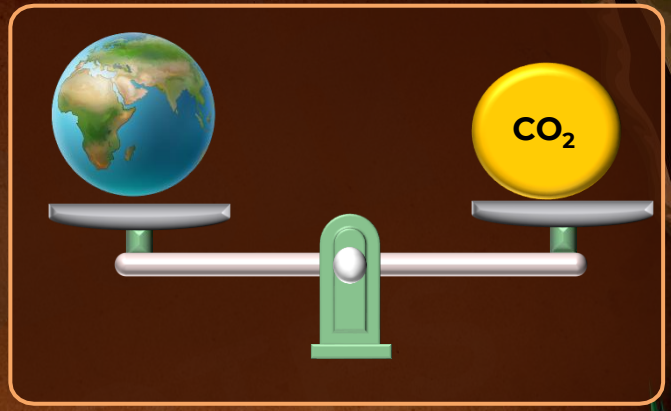
Gaseous Cycles

Complete carbon cycle

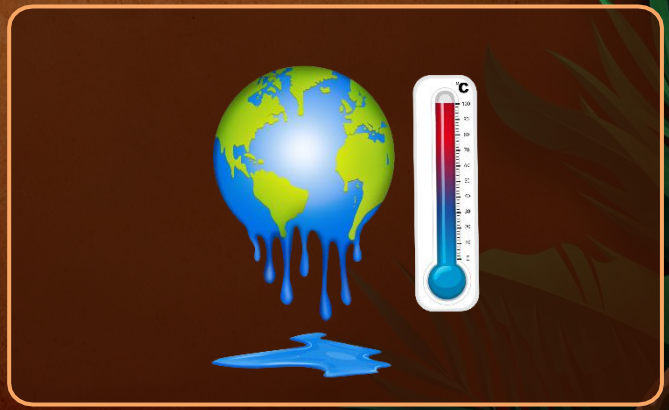


Carbon Cycle

- Carbon cycle **maintains and balances total amount of global carbon.**
- However, human activities have significantly affected the carbon cycle.
- Human activities have **increased the rate of release of CO_2, thereby causing increase in the global temperature.**
- For example:
  - **Rapid deforestation**
  - Massive burning of **fossil fuels** for energy and transport.

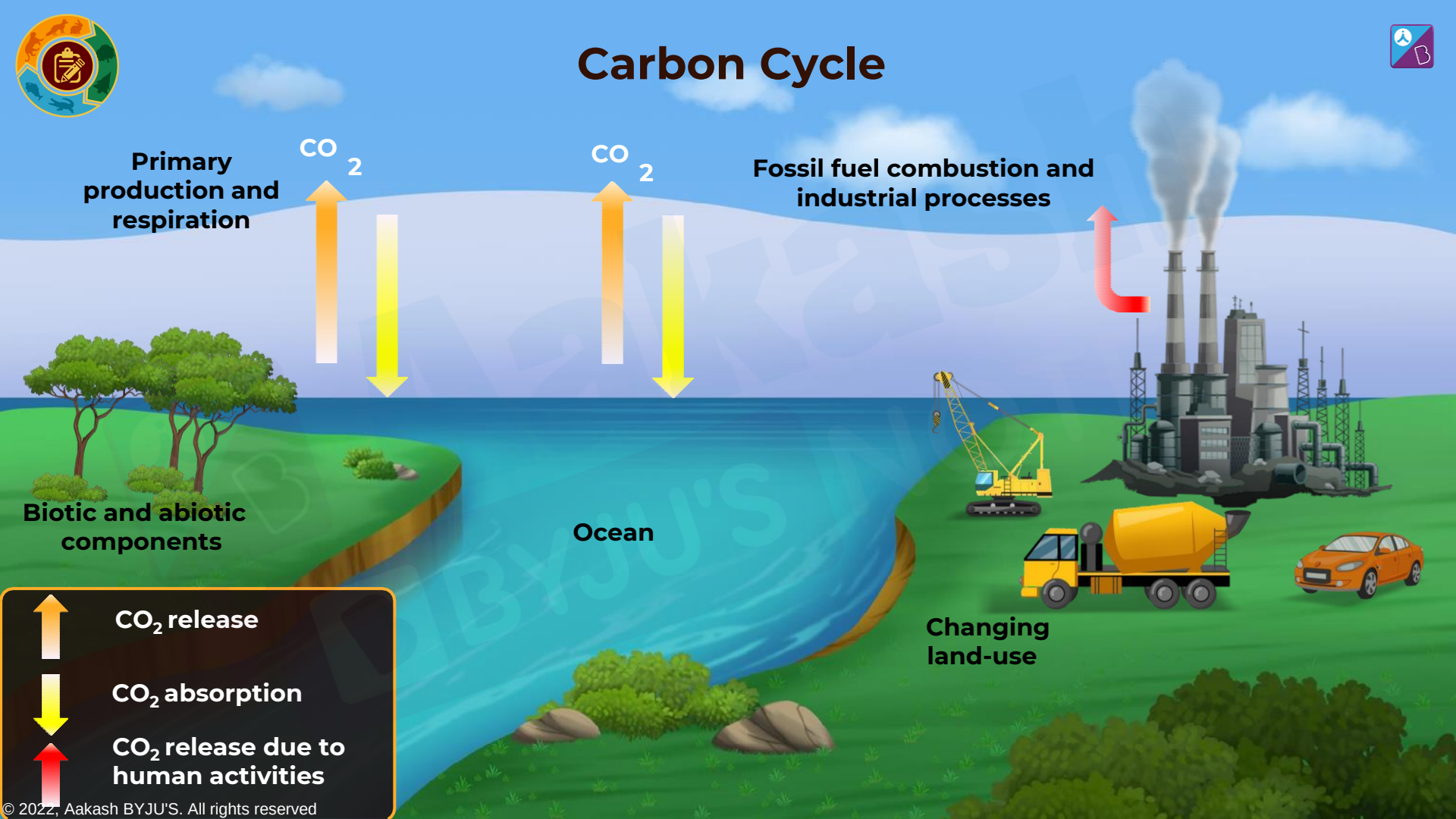


Total amount of global carbon



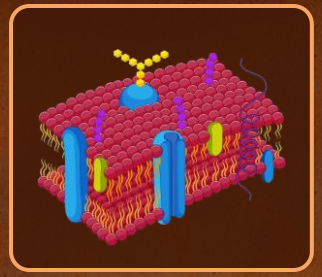
Increase in global temperature

Carbon Cycle

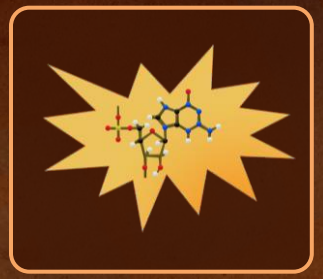


Phosphorus Cycle

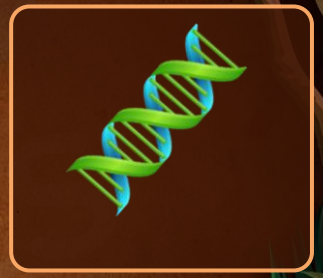
- Phosphorus is another **biologically important** element.
- It is a major **constituent of different biological membranes, ATP molecules, nucleic acids.**
- They are also required in large quantities to make **bones and teeth**, as well as **shells** in certain animals.



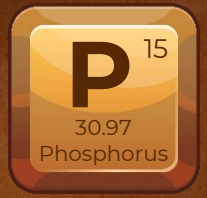
Cell membrane



ATP



Nucleic acids

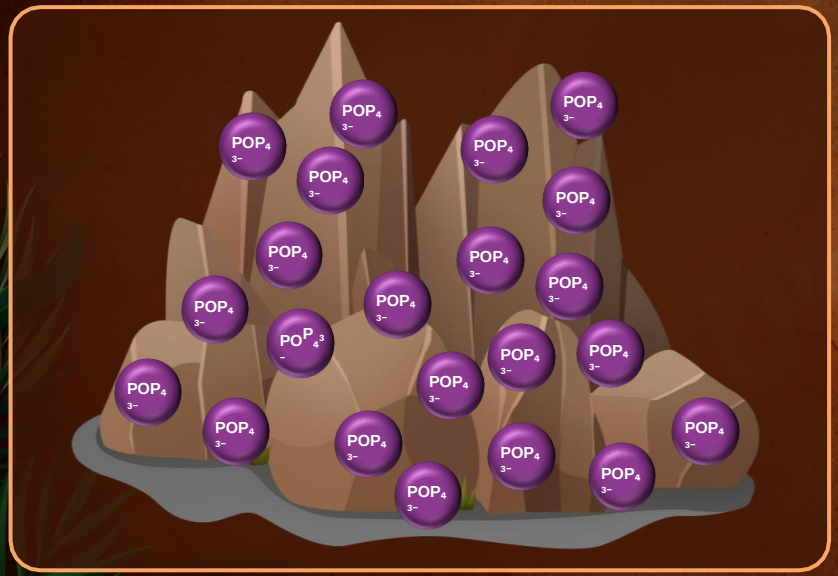


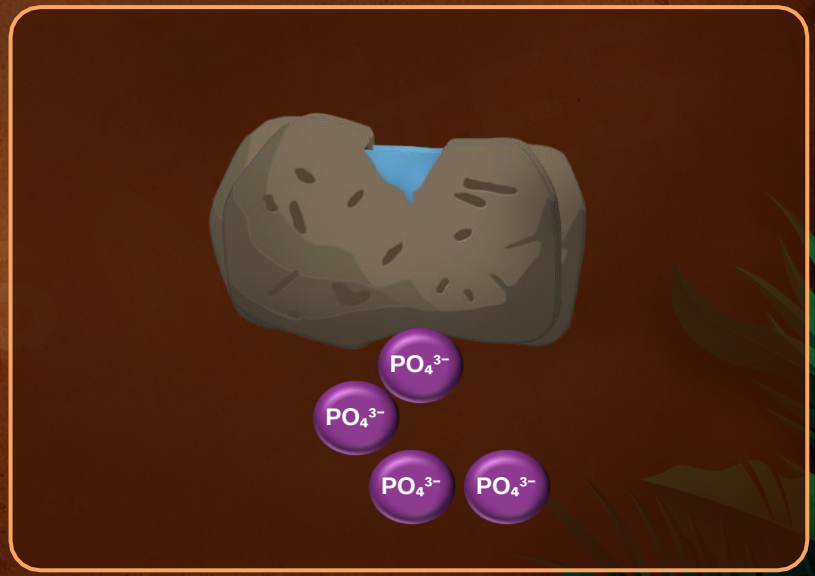
Bones and teeth

Shells of certain animals

Phosphorus Cycle

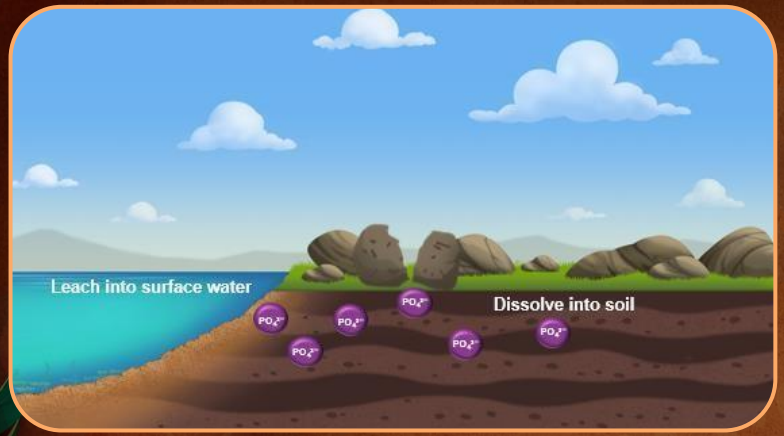
- **Rocks are major natural reservoir** of phosphorus.
- **Minute amounts of phosphate** is released into the soil solution when rocks undergo weathering.





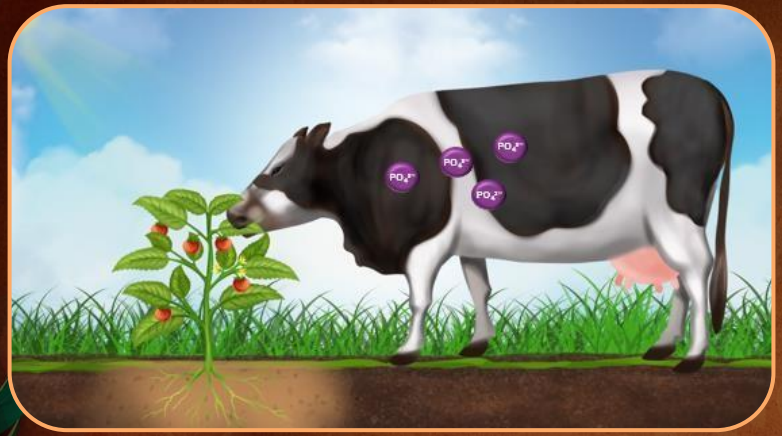
Phosphorus occurs as phosphate in rocks

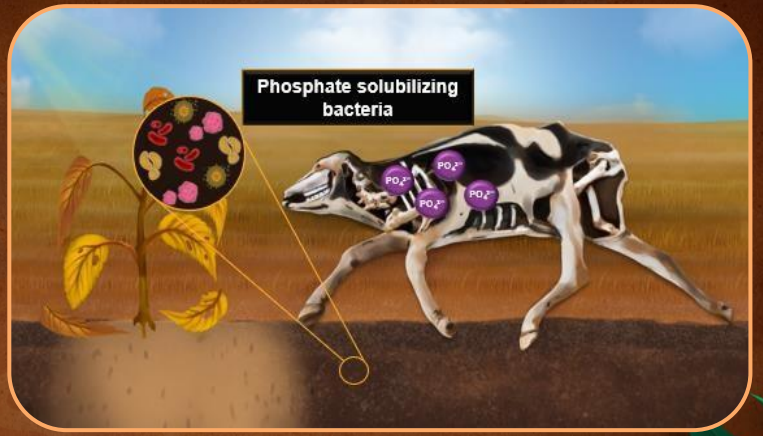
Phosphorus Cycle



- The **released phosphate gets dissolved into the soil** solution and also get leached into surface water.
- The **dissolved phosphate** present in the soil is **absorbed by the plants.**

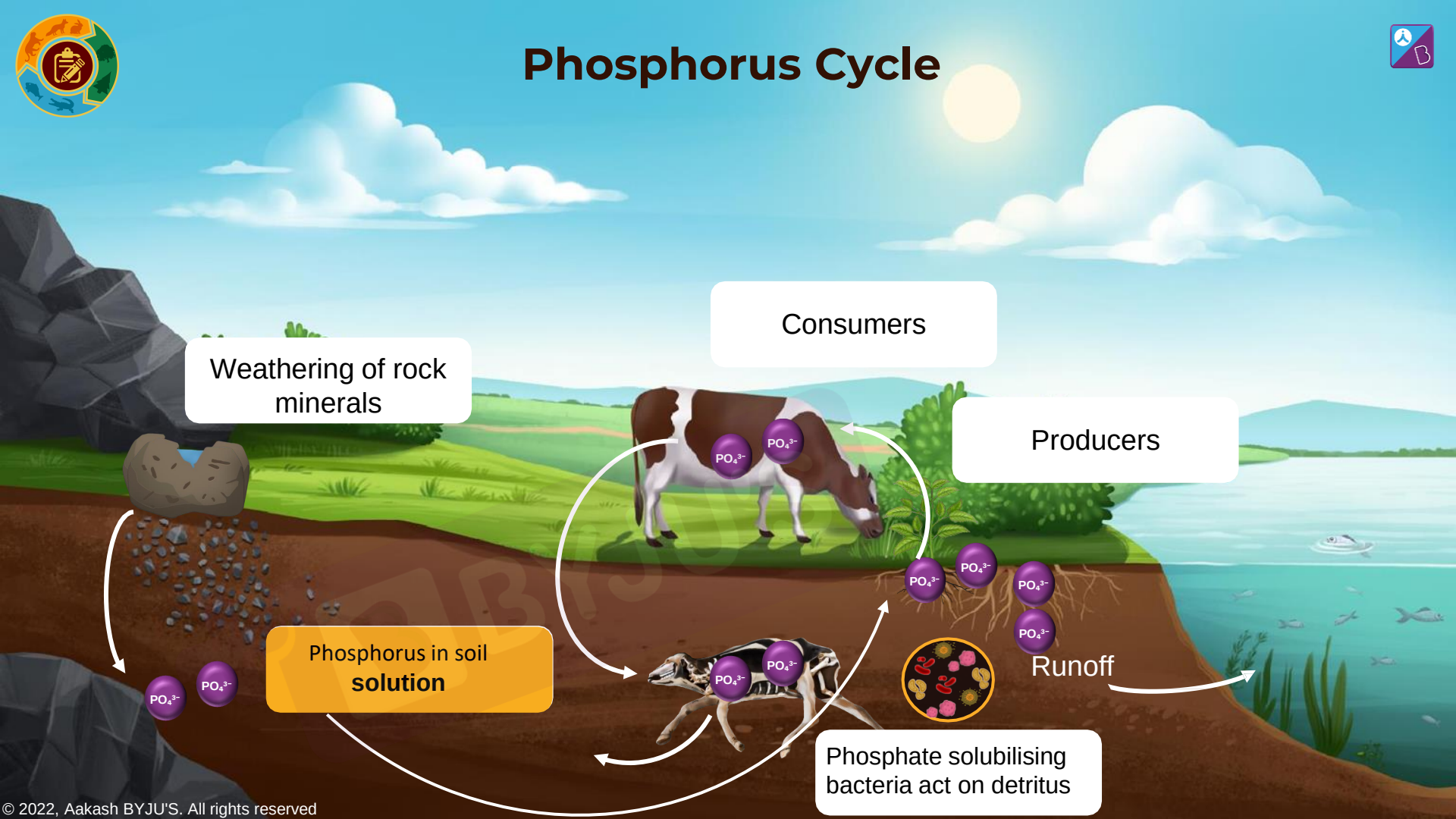
Phosphorus Cycle



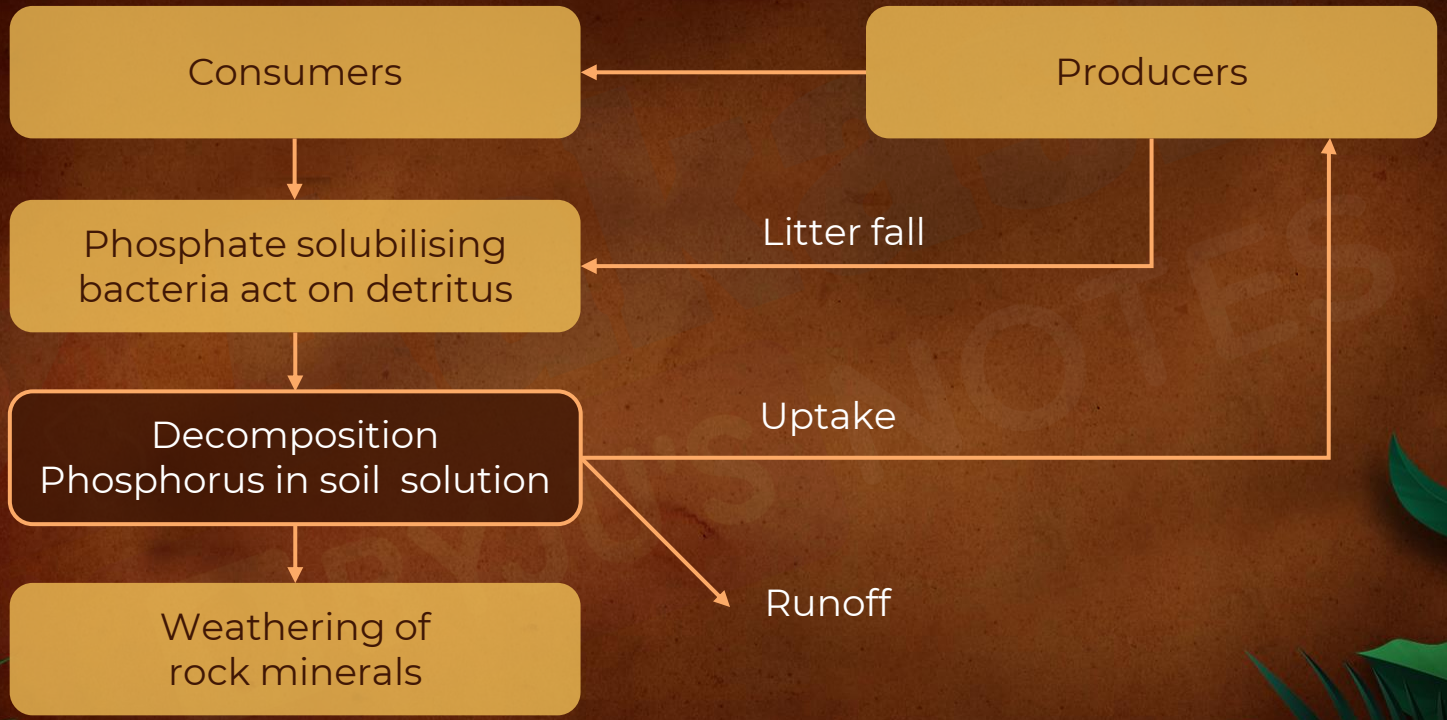


- **Herbivores and other animals obtain phosphorus** by consuming plants.
- After the animals die, they along with other waste products are **decomposed by the phosphate-solubilising bacteria** in the soil.
- Phosphate-solubilising bacteria **release phosphorous** again into the soil.

Phosphorus Cycle

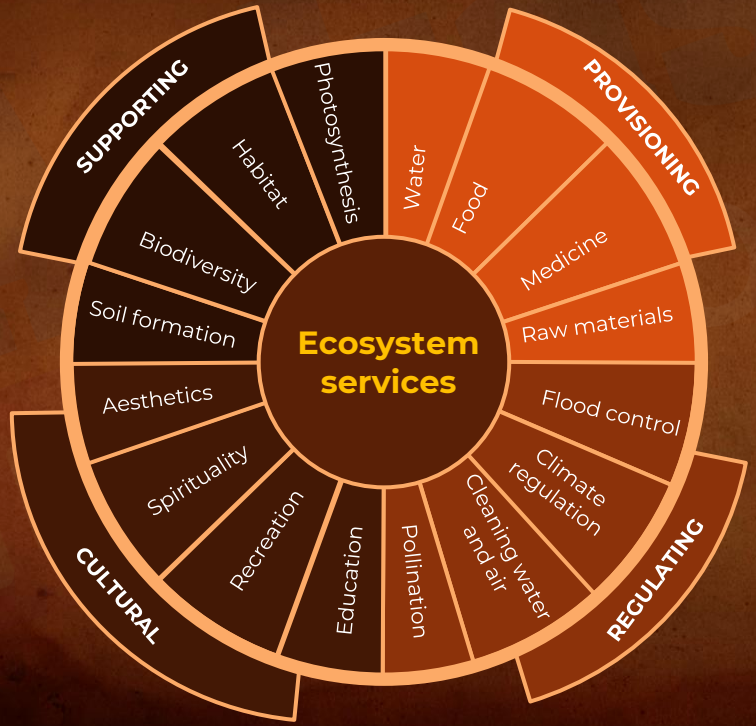


Phosphorus Cycle



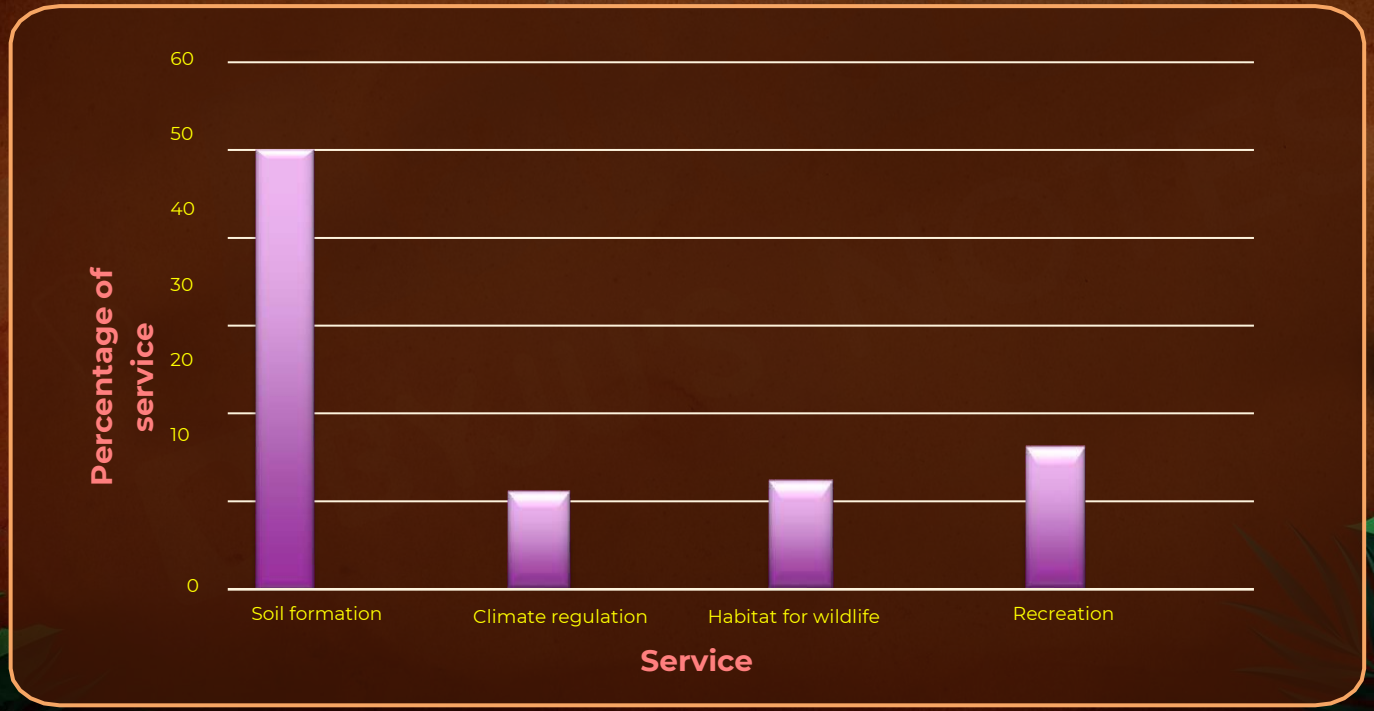
Ecosystem Services

They are the **products of ecosystem** processes which are **beneficial to humans.**



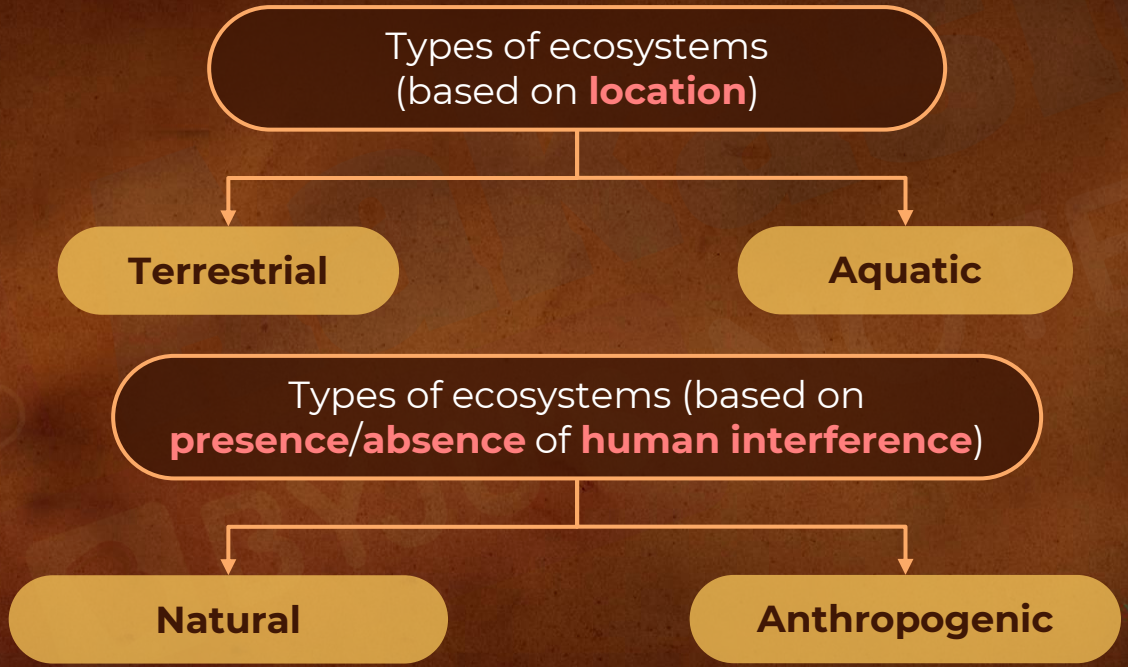
Ecosystem Services

Among the products of **ecosystem processes, soil formation** is the most **beneficial ecosystem service** to humans.



Summary

- **Ecosystem -** It is the **functional unit** of nature which is **self - sustainable.**

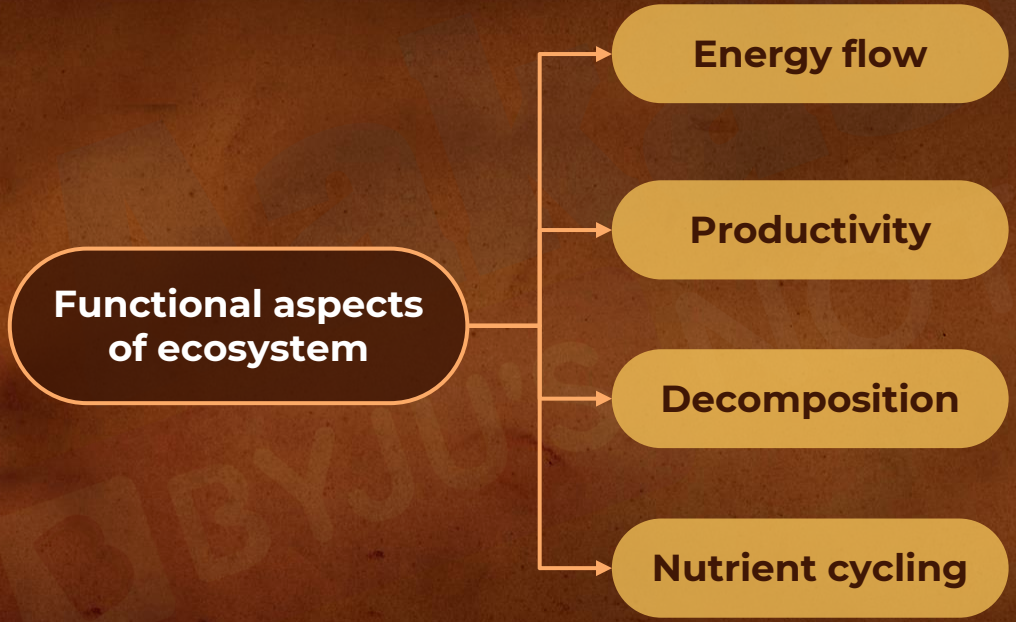


Summary

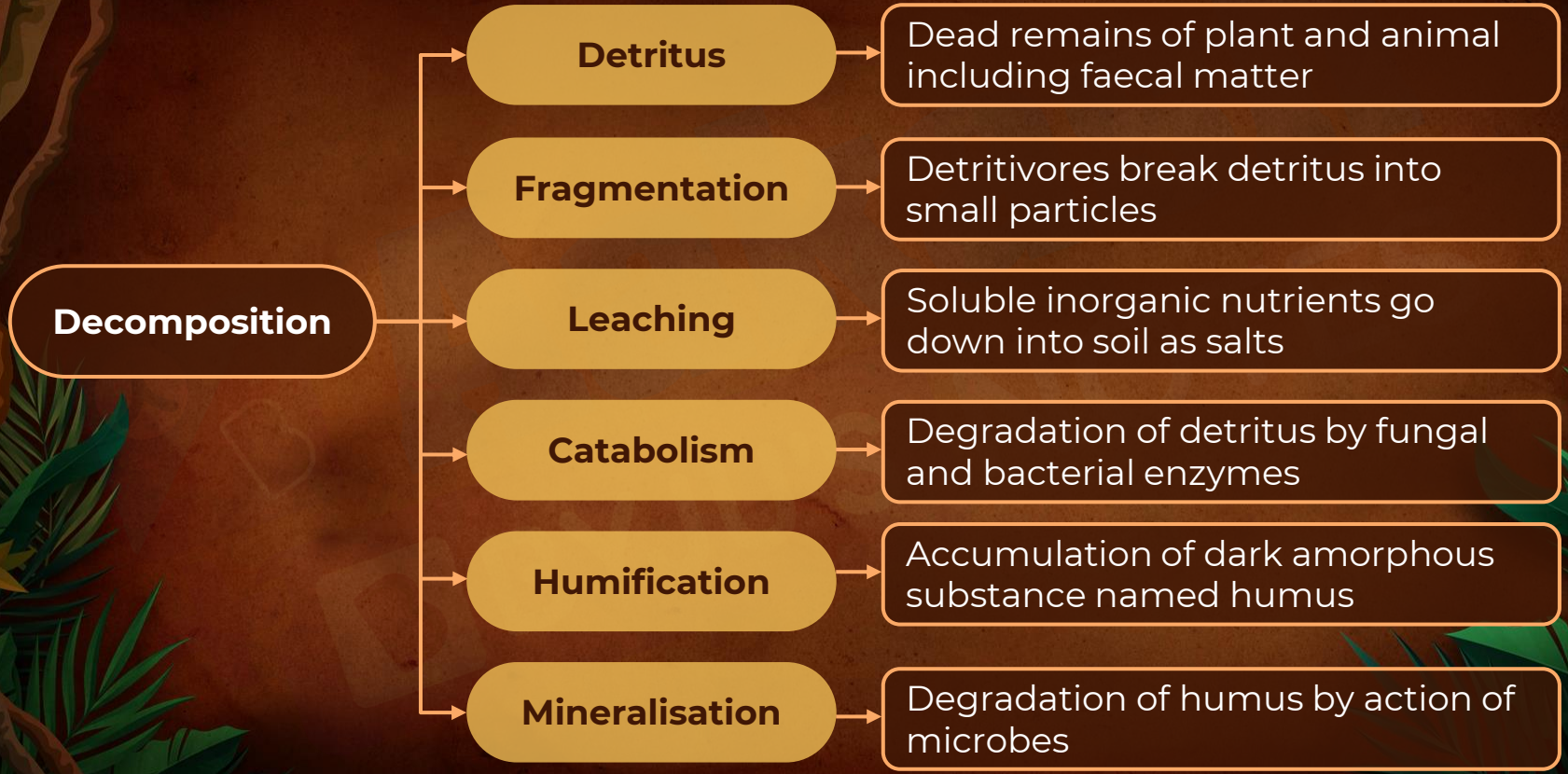
Structure of ecosystem

- **Biotic factors**
  - Producers
  - Consumers
  - Decomposers
- **Abiotic factors**
  - Temperature 
  - Water 
  - Light 
  - Soil 

Summary



Summary



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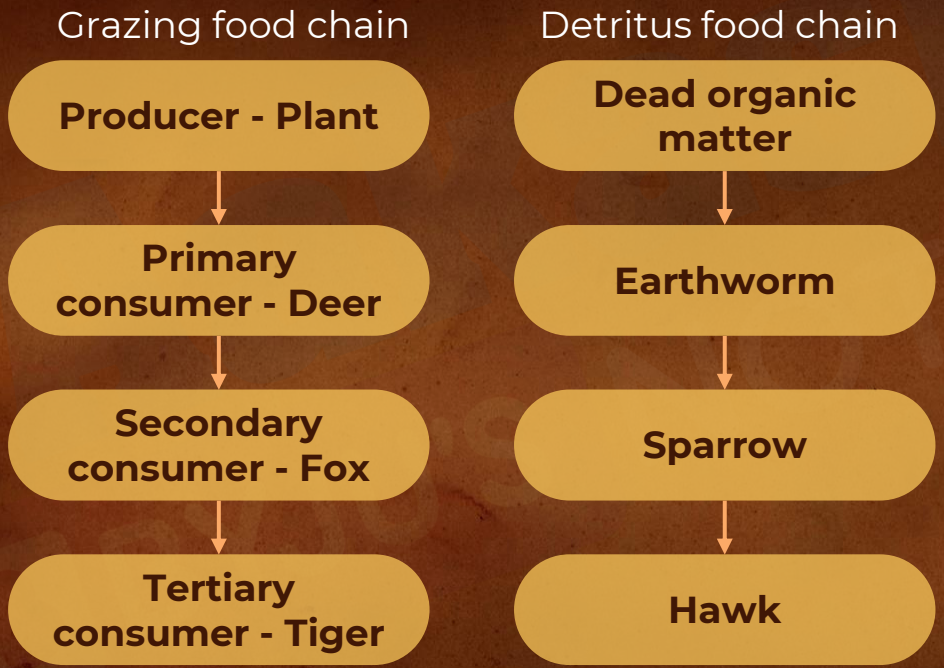

Summary

Ecological pyramid

Pyramid of numbers

- In **grassland ecosystem,** it is **upright.**
- In a **big tree ecosystem,** it is **upright** and **inverted.**

Pyramid of biomass

- In **forest ecosystem,** it is **upright.**
- In **aquatic ecosystem,** it is **inverted.**

Pyramid of energy

- It is **always upright** and **can never be inverted.**

Summary

Ecological succession

It is the gradual and predictable change in the species composition of a given area.

Based on area of origin

Primary succession

It occurs in an area which has been bare from the beginning

Secondary succession

It occurs in an area where natural biotic communities have been destroyed.

Based on plant habitat

Xerarch succession

Ecological succession in dry areas.

- Lichen stage
- Moss stage
- Grass stage
- Scrub stage
- Forest stage

Hydrarch succession

Ecological succession in wet areas.

- Plankton stage
- Submerged plant stage
- Submerged free-floating plant stage
- Reed swamp stage
- Marsh meadow stage
- Scrub stage
- Forest stage

Summary

Primary v/s Secondary succession

Primary succession	Secondary succession
Occurs in barren area	Occurs where natural biotic communities have been destroyed
Soil is absent and is formed during the course of succession	Some soil and microbes are present
Pioneer communities (initial species) are migrants	Pioneer communities (initial species) are already present
Many seral communities are formed	Fewer seral communities are formed
Takes 1000 years or more	Takes 50-200 years or more

Summary

Carbon cycle	Phosphorus cycle
Gaseous type of cycle	Sedimentary type of cycle
Involves respiratory release into the atmosphere	Doesn’t involve respiratory release into the atmosphere
Atmospheric inputs of carbon are higher	Atmospheric inputs of phosphorous are much lower
Involves gaseous exchange between organism and environment	Absorbed by plants from soil through roots and then passed on to consumers