

ECOSYSTEM

The interaction between the living organism and the non-living environment is called **ecosystem**.

ECOSYSTEM – STRUCTURE AND FUNCTION

- Interaction of biotic and abiotic components results in a physical structure that is characteristic of each type of ecosystem.
- Identification and description of plant and animal species of an ecosystem gives its **species composition**.
- Vertical distribution of different species occupying different levels is called **stratification**.

Components of the ecosystem

- Productivity**
- Decomposition**
- Energy flow**
- Nutrient cycle**

Description of pond as an ecosystem

- The abiotic components include all dissolved inorganic and organic substances and the rich soil deposit at the bottom of the pond.
- The solar input, cycle of temperature, day length, regulates the rate of function of the entire pond.
- The **producer** (autotrophic) includes phytoplankton, some algae and the floating, submerged and marginal plants found in edge of pond.
- The **consumers** are represented by zooplankton, free swimming and bottom dwelling animals.
- The **decomposers** are the fungi, bacteria especially abundant at the bottom of the pond.

Basic events (in terms of function) in an ecosystem

- Conversion of inorganic into organic material (photosynthesis) by producers.
- Consumption of the autotrophs by heterotrophs.
- Decomposition and mineralization of the dead organic matter to release them back for reuse by the autotrophs
- There is unidirectional flow of energy towards the higher trophic levels and its dissipation and loss as heat to the environment.

Primary productivity

- The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.
- It is expressed in terms of weight (g m^{-2}) or energy (kcal m^{-2})
- The rate of biomass production is called **productivity**.

Gross primary productivity

- GPP is the rate of production of organic matter during photosynthesis.

Net primary productivity

- Net primary productivity is the available biomass for the consumption to heterotrophs (herbivore and decomposers).
- A considerable amount of energy is utilized by plants in respiration.
- Gross primary productivity minus respiration losses (R) is the net primary productivity.
- $GPP - R = NPP$.

Secondary productivity

- It is defined as the rate of formation of new organic matter by the consumer

Earthworm is said to be **'friends'** of farmer

1. Breakdown the complex organic matter.
2. Loosening of the soil helps in aeration and entry of root

DECOMPOSITION

- Break down of complex organic matter into inorganic substances like carbon dioxide, water and nutrients

Detritus

- Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter constitute detritus.

Process of decomposition

- **Fragmentation** : Break down of detritus into smaller particles by detritivore (earthworm).
- **Leaching**: Water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
- **Catabolism** : Bacterial and fungal enzymes degrade detritus into simple inorganic substances.
- **Humification**: Accumulation of dark coloured amorphous substances called humus.
- **Mineralization**:
The humus is further degraded by some microbes and release of inorganic nutrients occur.

Importance of humus

- Highly resistance to microbial action.
- Undergo decomposition at an extremely slow rate.
- Being colloidal in nature, it serves as reservoir for nutrients.

Factors affecting rate of decomposition

- Decomposition is largely an oxygen-requiring process.
- Detritus rich in chitin and lignin has slow rate of decomposition.
- Detritus rich in nitrogen and water-soluble substance like sugar has faster decomposition.
- **Temperature** and **soil moisture** are most important climatic factor that regulate decomposition
- **Warm** and **moist** environment favor decomposition.
- **Low temperature**, **dryness** and **anerobiosis** inhibit decomposition.

ENERGY FLOW IN ECOSYSTEM

- Energy flow in the ecosystem is **unidirectional**
- Only 10% of energy transferred from one trophic level to other.

Grazing food chain

- Extends from producers through herbivore to carnivore
- In aquatic ecosystem **GFC** is the major conduit for energy flow

Detritus food chain

- Begins with dead organic matter (detritus) and pass through detritus feeding organism in soil to organisms feeding on detritus-feeders
- In terrestrial ecosystems a much larger fraction of energy flows through the **detritus food chain** than through GFC

Food web

- Different food chains are naturally interconnected e.g. a specific herbivore of one food chain may serve as food of carnivores of other food chains

Trophic level

- A group of organism irrespective of their size having same source of energy or similar food habit constitute a **trophic level**

Standing crop

- Mass of living material at a particular time at a trophic level
- The standing crop is measured as the mass of living organisms (**biomass**) or the **number** in a unit area.

ECOLOGICAL PYRAMID

- The base of the pyramid is broad and it narrows down at the apex when food or energy relationship between organisms at different trophic level is shown.
- The base of the pyramid represented by producer and apex is the top consumer; other trophic levels are in between.
- The pyramid of **number** in a tree ecosystem is **inverted**.
- The pyramid of **biomass** in sea also **inverted** because the biomass of fishes is far exceeds that of phytoplankton.
- Pyramid of **energy** is **always upright**.

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, it never exists in nature.
- It does not accommodate food web.
- Saprophytes are not given place in ecological pyramids.

ECOLOGICAL SUCCESSION

- The gradual and fairly predictable change in the species composition of a given area is called **ecological succession**.

climax community

- A community that is in near equilibrium with the environment

Sere

- The entire sequences of communities that successively change in a given area are called **sere**.

Seral stages

- The individual transitional communities are termed as **seral stages**.

Primary succession

- Starts where no living organisms are there.
- These could be areas where no living organism ever existed may be a bare rock or new water body.
- Primary succession occurs in newly cooled lava, bare rock, newly created pond or reservoir.

Secondary succession

- Succession that starts in areas that somehow, lost all the living organisms that existed there.
- Secondary succession occurs in abandoned farm lands and burned or cut forest, lands that have been flooded
- Since some soil or sediment is present, **secondary succession is faster than primary succession.**

Hydrarch succession

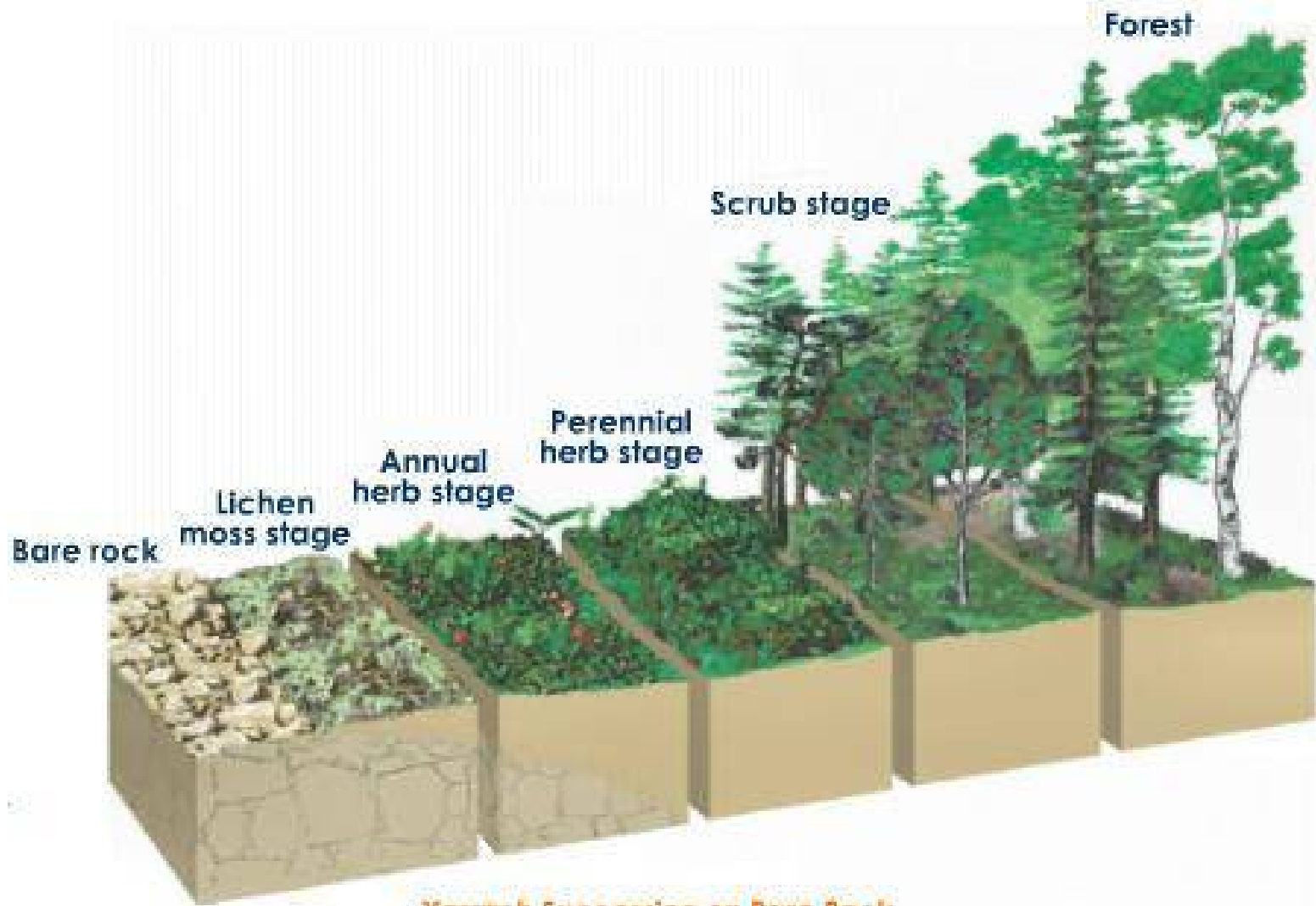
- Takes place in water areas and the successional series progress from hydric to mesic condition.

Xerarch succession

- Takes place in dry areas and the series progress from **xeric** to **mesic** conditions.

Xerarch succession: Succession in bare rock

- **Pioneer species i.e. lichen.**
- **Bryophytes (mosses).**
- The mosses speed up the process of soil accumulation by trapping wind-blown particles.
- Lichen moss carpet provides suitable substratum for the germination of seeds of **herbaceous plants.**
- Gradually more soil is accumulated and herbaceous species make way for the invasion of **shrubs** followed by **trees.**
- The **climax community** is generally dominated by **trees.**



Xerarch Succession on Bare Rock

Hydrarch (succession in aquatic environment)

- In primary succession in water, the **pioneer species are phytoplankton.**
- Zooplanktons.
- Sub merged plant stage. (rooted hydrophytes)
- Sub merged and free-floating plant stage.
- Reed-swamp stage.
- Marsh-meadow stage.
- Shrub stage
- Trees
- The climax again would be the forest
- All the succession whether taking place in water or on land, proceeds to a similar climax community – the mesic.

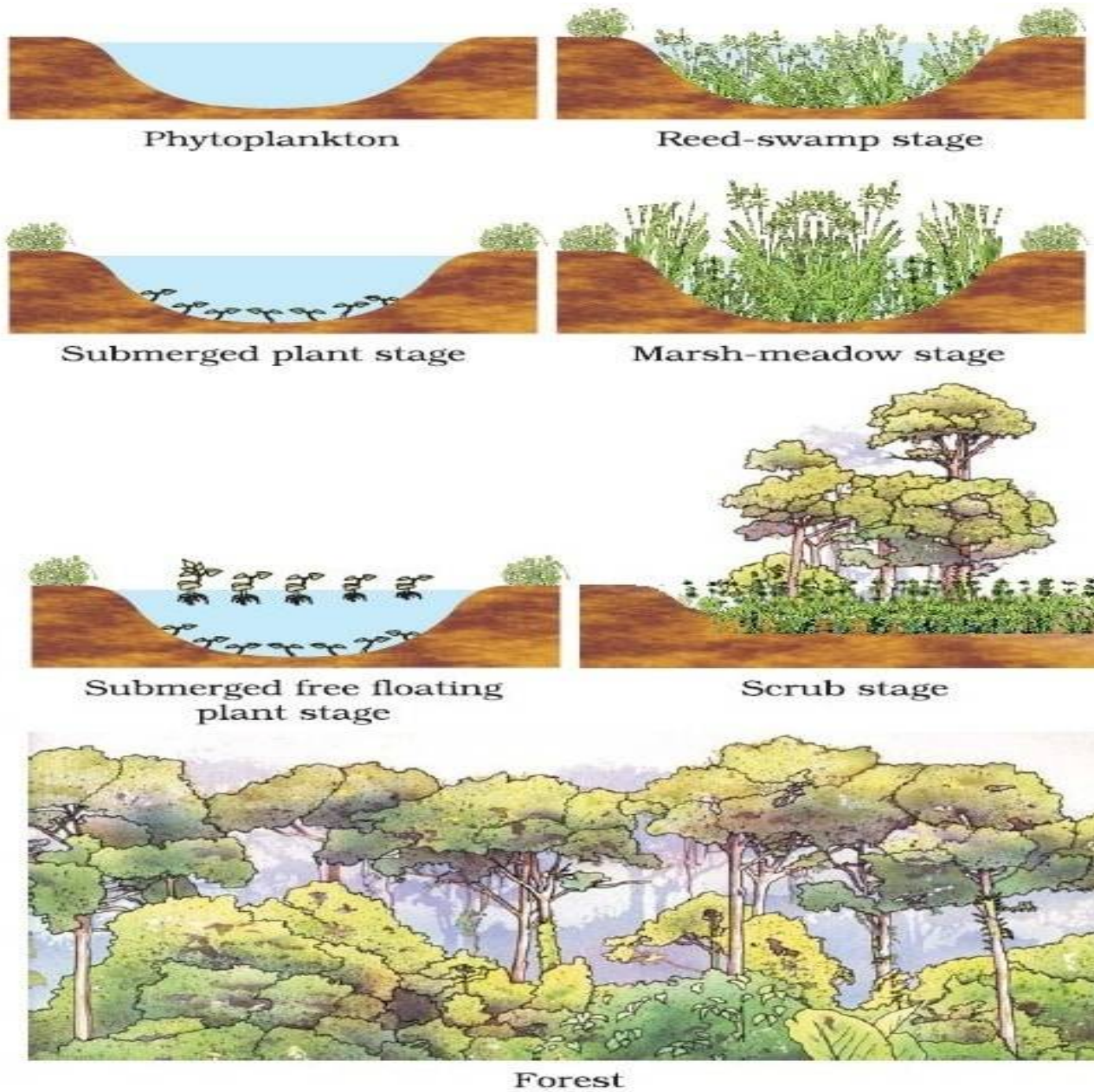


Figure 5. Diagrammatic representation of primary succession

Standing state

- The amount of nutrients such as carbon, nitrogen, phosphorus, calcium etc. present in soil at any given time.

NUTRIENT CYCLING

- The movement of nutrient elements through the various component of an ecosystem is called nutrient cycling.

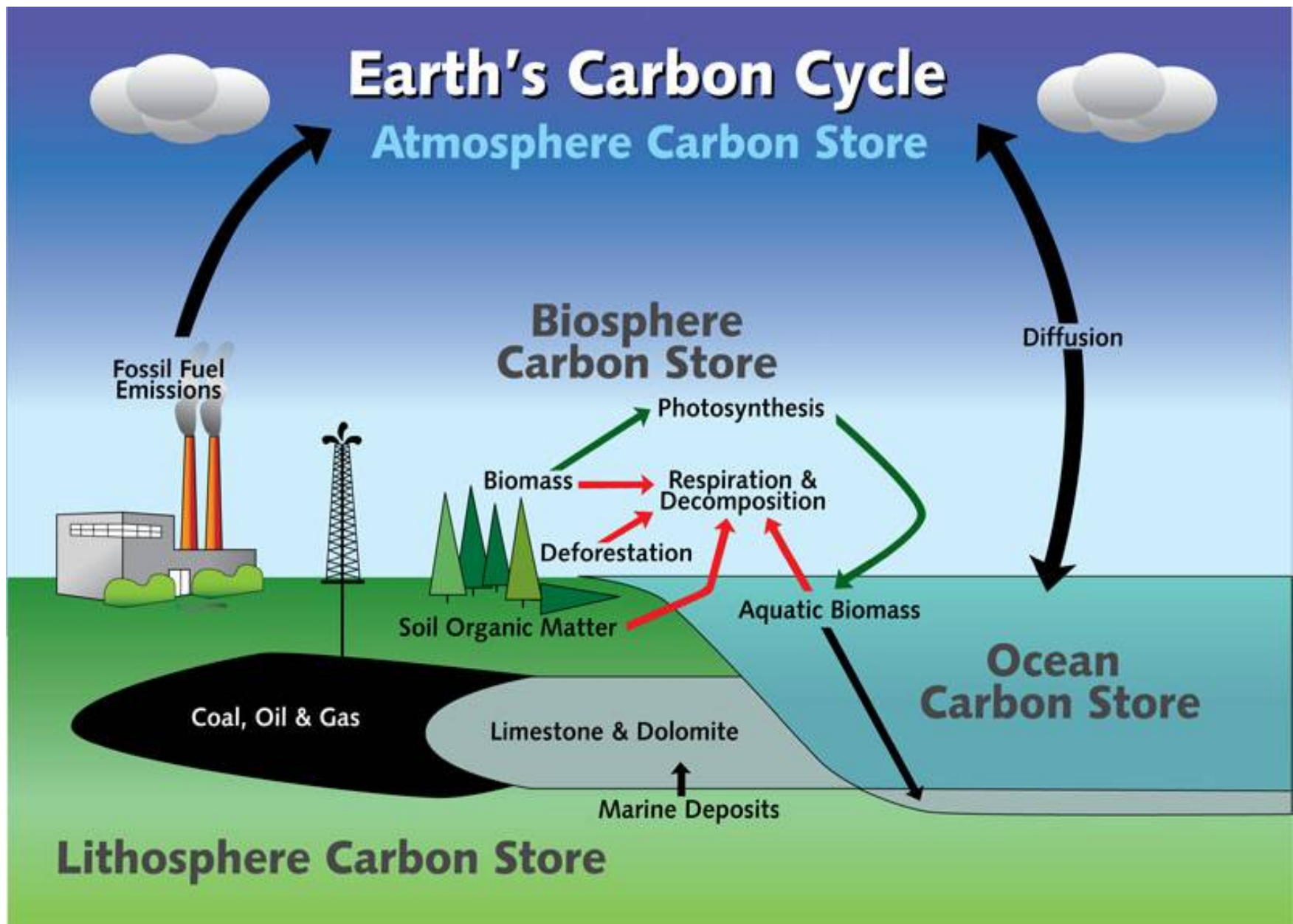
Nutrient cycles are of two types

- 1. Gaseous cycle**
- 2. Sedimentary cycle**

- The reservoir for gaseous type of nutrient cycle (nitrogen, carbon) exists in the atmosphere.
- The reservoir for sedimentary cycle (sulphur, phosphorus) is Earth's crust.
- Environmental factors like soil, moisture, pH temperature regulate the **rate of release of nutrient into the atmosphere.**
- The function of the reservoir is to meet the deficit which occurs due to imbalance in the rate of influx and efflux.

Carbon cycle

- Carbon constitutes 49 percent of dry weight of organism.
- Out of total global carbon:
 - 71 percent carbon is found dissolved in ocean.
 - About 1 percent in the atmosphere.
- Carbon is fixed in the biosphere by photosynthesis.
- Large amount of carbon is returned to the atmosphere as CO_2 through respiration of producers and consumers.
- Decomposers also return CO_2 to reservoir during decomposition process.
- Some amount of Carbon is lost to sediments and removed from circulation.
- Burning wood, forest fire, combustion of organic matter, fossil fuel, volcanic activities are additional sources for releasing CO_2 to atmosphere.

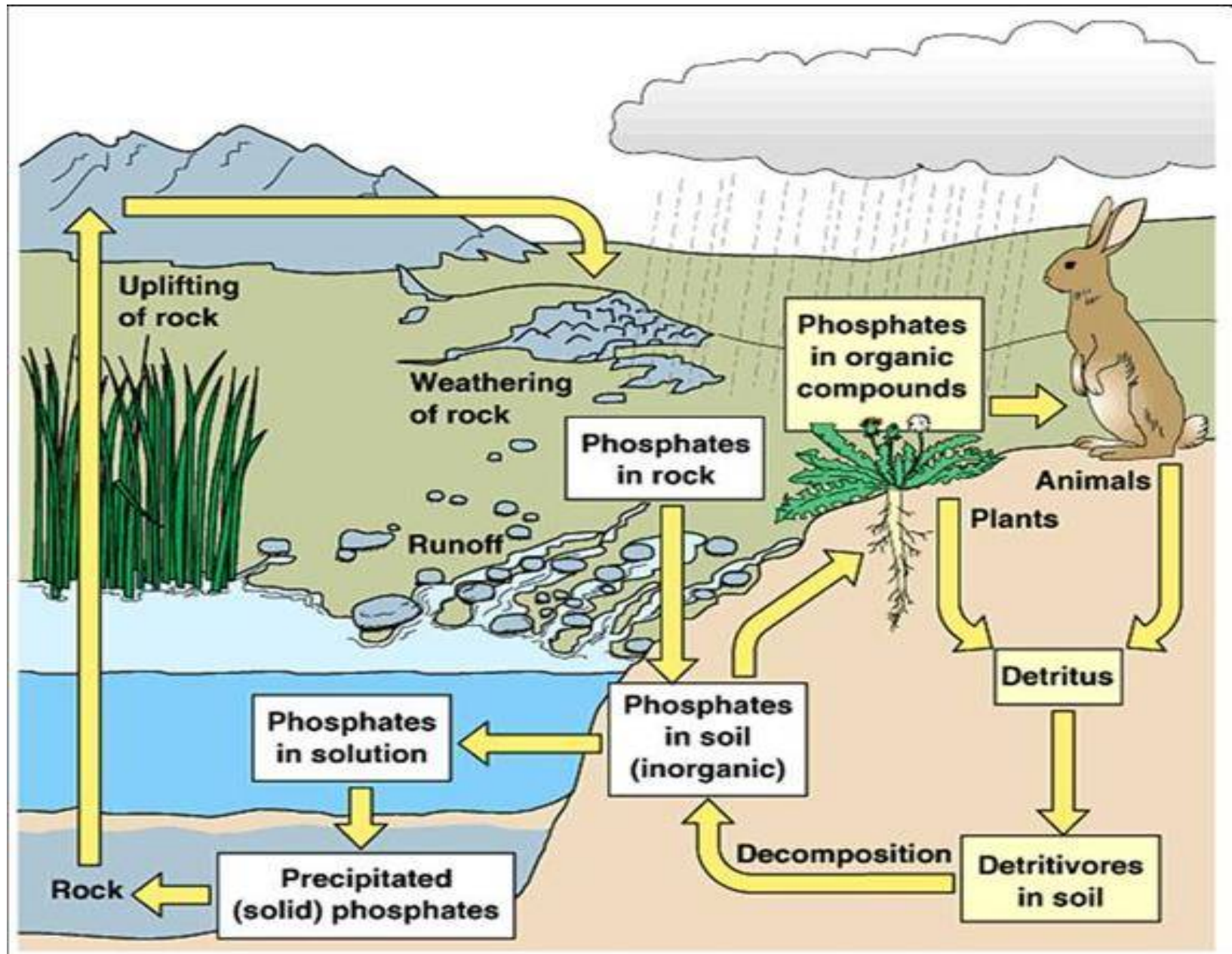


Influence of human activity on Carbon cycling

- Rapid deforestation.
- Massive burning of fossil fuel for energy and transport
- Increased rate of release of CO₂ into the atmosphere

Phosphorus cycle

- Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer system(ATP)
- Animals need phosphorus to make shell, bones and teeth.
- Reservoir pool of phosphorus is the rock, which contain phosphorus in the form of **phosphates**.
- During weathering of rock small amount of phosphates dissolved in soil solution and are absorbed by the roots of the plants.
- Herbivore and other animals obtain organic form of phosphorus from plants.
- The waste product and dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus.



How phosphorus cycle differs from carbon cycle?

- There is no respiratory release of phosphorus into atmosphere.
- Gaseous exchange of phosphorus between organism and environment are negligible.

ECOSYSTEM SERVICES

- The products of ecosystem processes are named as **ecosystem services**.
- Healthy forest ecosystems purify air and water.
- Mitigate droughts and flood.
- Cycle nutrients.
- Generates fertile soil.
- Provide wildlife habitat.
- Maintain biodiversity.
- Pollinate crops.
- Provide storage site for carbon