Bio-geological cycles

- Nutrients are recycled in the ecosystem
- About 40 elements are essential for living organisms
- Nutrients are in limited quantity in earth system; nature has evolved unique method(Linkages between organisms) for materials recycling continuously

nutrients

- Macro nutrients: C,H,O,N,P,K, ETC.,
- MICRONUTRIENTS: Cu,Fe,Zn,S, etc.,

Bio-geological cycles

Sedimentary cycles	Gaseous cycles
Main reservoir: SOIL	ATMOSPHERE
BOTTH CYCLES:	
1. INVOLVES BIOTIC & ABOITIC COMPONENTS	2. ARE DRIVEEN BY THE FLOW OF ENERGY
3. ARE TIED UP WITH WATER/HYDROLOGICAL CYCLE	

CARBON CYCLE

- Is the most essential ingredient:
  - From the point of energy flow
  - Material synthesis: carbohydrates, glucose, proteins, fats etc.,
  - For STRUCTURE(BODDY BONES,SKULL)
  - For FUNCTION (Producer uses CO2 for photo synthesis)

- Living organisms obtains energy by Oxidation & releases CO_2
- GLUCOSE is the starting point for the Synthesis of other organic compounds(amino acids, Nucleotides, fats, DNA,RNA, enzymes)
- Since CO_2 is the stating point for Photosynthesis; its continuous regeneration is essential for Living systems.
- This feat is accomplished by CARBON CYCLE

Carbon Cycle:

- The carbon, found in organic compounds, is included in both the abiotic and biotic parts of the ecosystem.
- Carbon is a building block of both plant and animal tissues.
- In the atmosphere, carbon occurs as carbon dioxide (CO_2).
- In the presence of sunlight, plants take up carbon dioxide from the atmosphere through their leaves.
- The plants combine carbon dioxide with water, which is absorbed by their roots from the soil.
- In the presence of sunlight they are able to form carbohydrates that contain carbon.

- In this process, plants release oxygen into the atmosphere on which animals depend for their respiration.
- Plants therefore help in regulating and monitoring the percentage of Oxygen and Carbon dioxide in the earth's atmosphere.
- Herbivorous animals feed on plant material, which is used by them for energy and for their growth.
- Both plants and animals release carbon dioxide during respiration.
- They also return fixed carbon to the soil in the waste they excrete.
- When plants and animals die they return their carbon to the soil.
- These processes complete the carbon cycle.

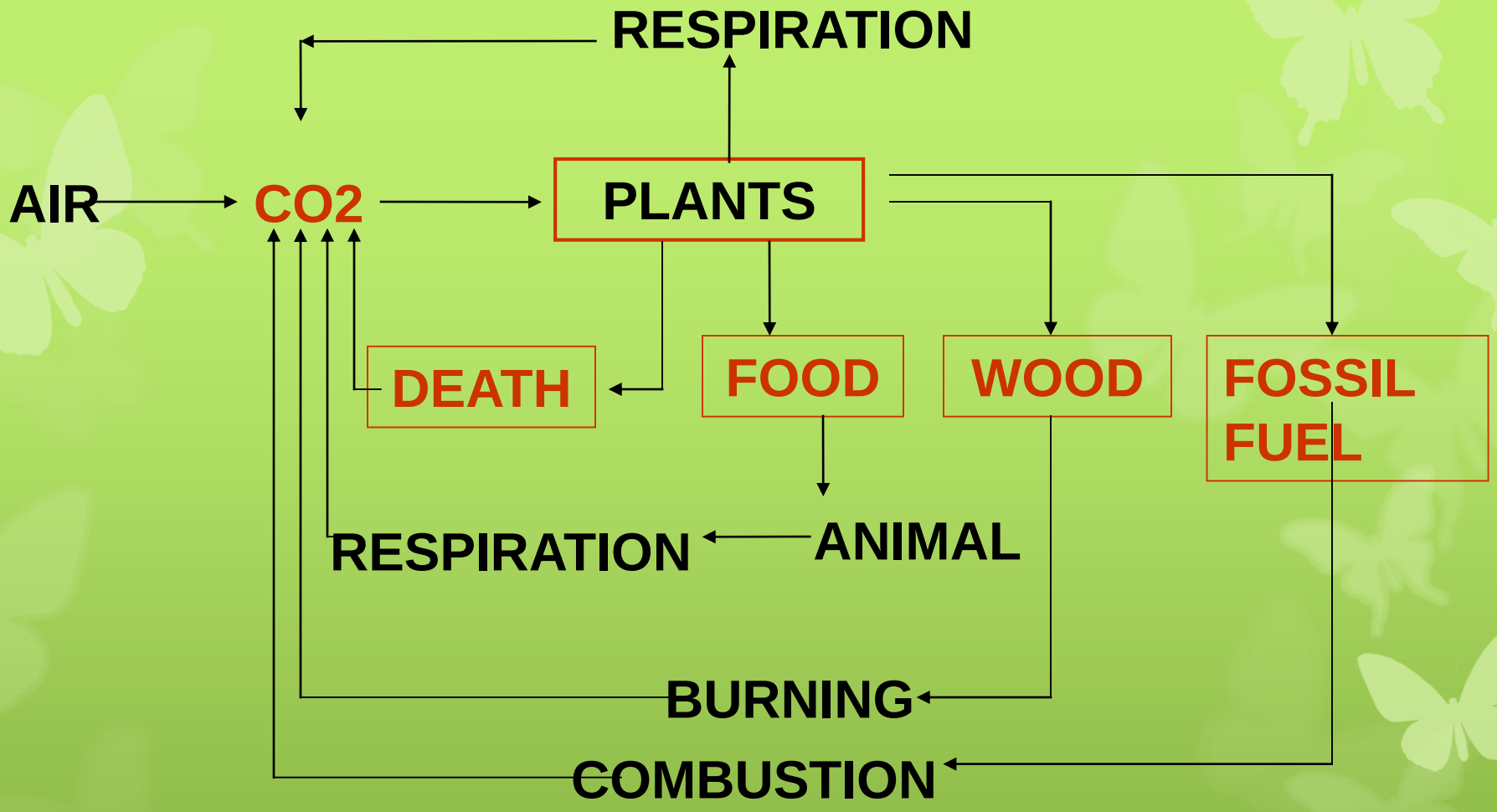


Fig: Carbon Cycle

The source of atmospheric CO_2 are variable but only plants can utilize atmospheric carbon directly.

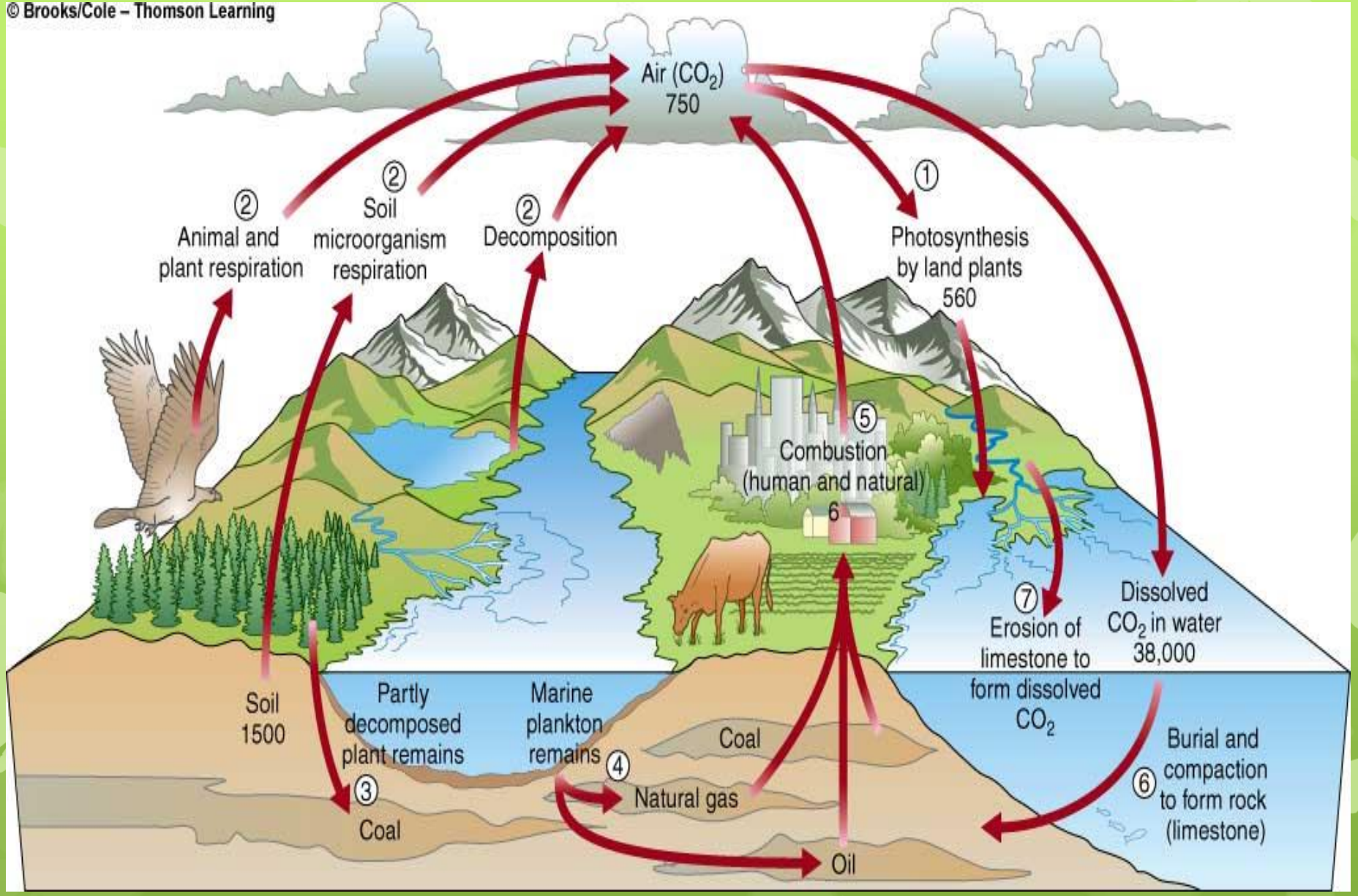


Fig: Carbon Cycle

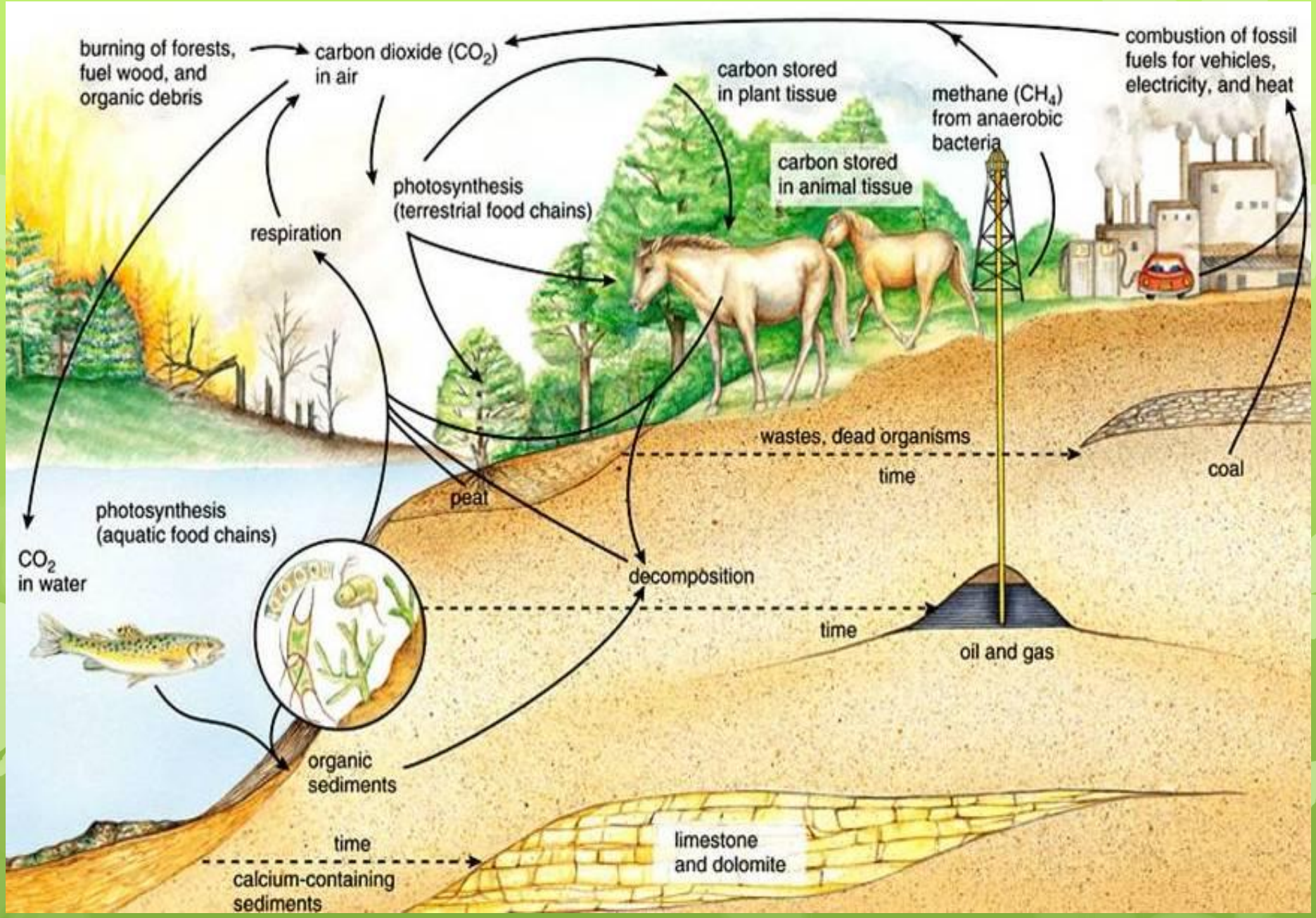


Fig: Carbon Cycle

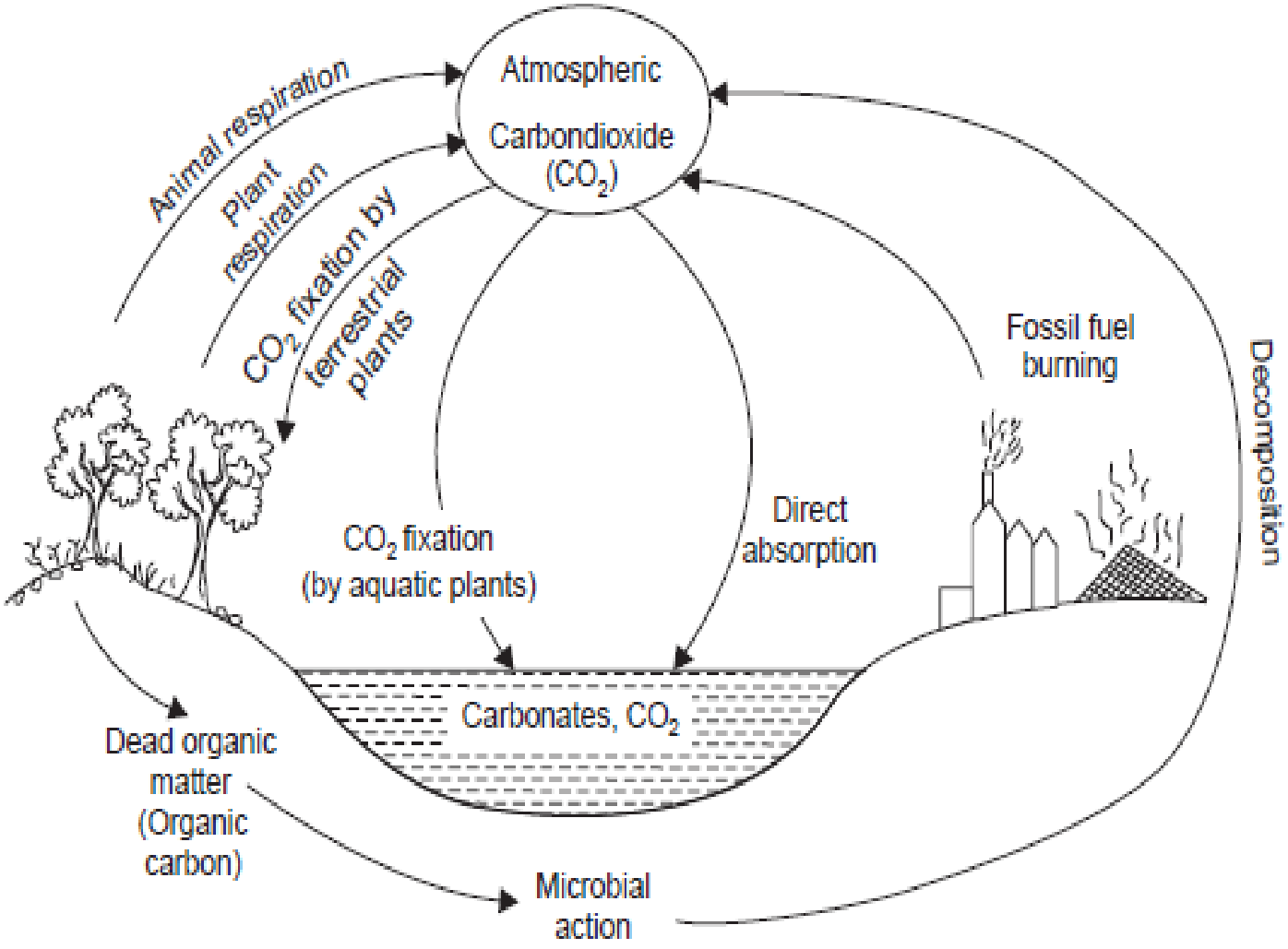


Fig. 3.12. Carbon cycle.

Nitrogen Cycle:

- Carnivorous animals feed on herbivorous animals that live on plants.
- When animals defecate, this waste material is broken down by worms and insects mostly beetles and ants.
- These small soil animals break the waste material into smaller bits on which microscopic bacteria and fungi can act.
- This material is thus broken down further into nutrients that plants can absorb and use for their growth.
- Thus nutrients are recycled back from animals to plants. Similarly the bodies of dead animals are also broken down into nutrients that are used by the plants for their growth.
- Thus the nitrogen cycle on which life is dependent is completed.
- Nitrogen fixing bacteria and fungi in soil gives this important element to plants, which absorb it as nitrates.
- The nitrates are a part of the plant's metabolism, which help in forming new plant proteins.
- This is used by animals that feed on the plants.

Nitrogen Cycle:

- Nitrogen is crucial for all organisms
  - Nucleic acids
  - Proteins
  - Chlorophyll
- Nitrogen- 78% in Atmosphere
- N_2 is very stable and must be broken apart by organisms, combined with other atoms into a usable form.
- Nitogen cycle completes in 5 steps:

1) Nitrogen Fixation:

Conversion of $N_2 \rightarrow NH_3$:

- Combustion, volcanic action, Industrial processes (making fertilizer). Bacteria (Azotobactor, Clostridium, Nostoc etc.)

2) Nitrification: $NH_3 \rightarrow NO_3$

Soil bacteria convert in a two step process.

3) Assimilation:

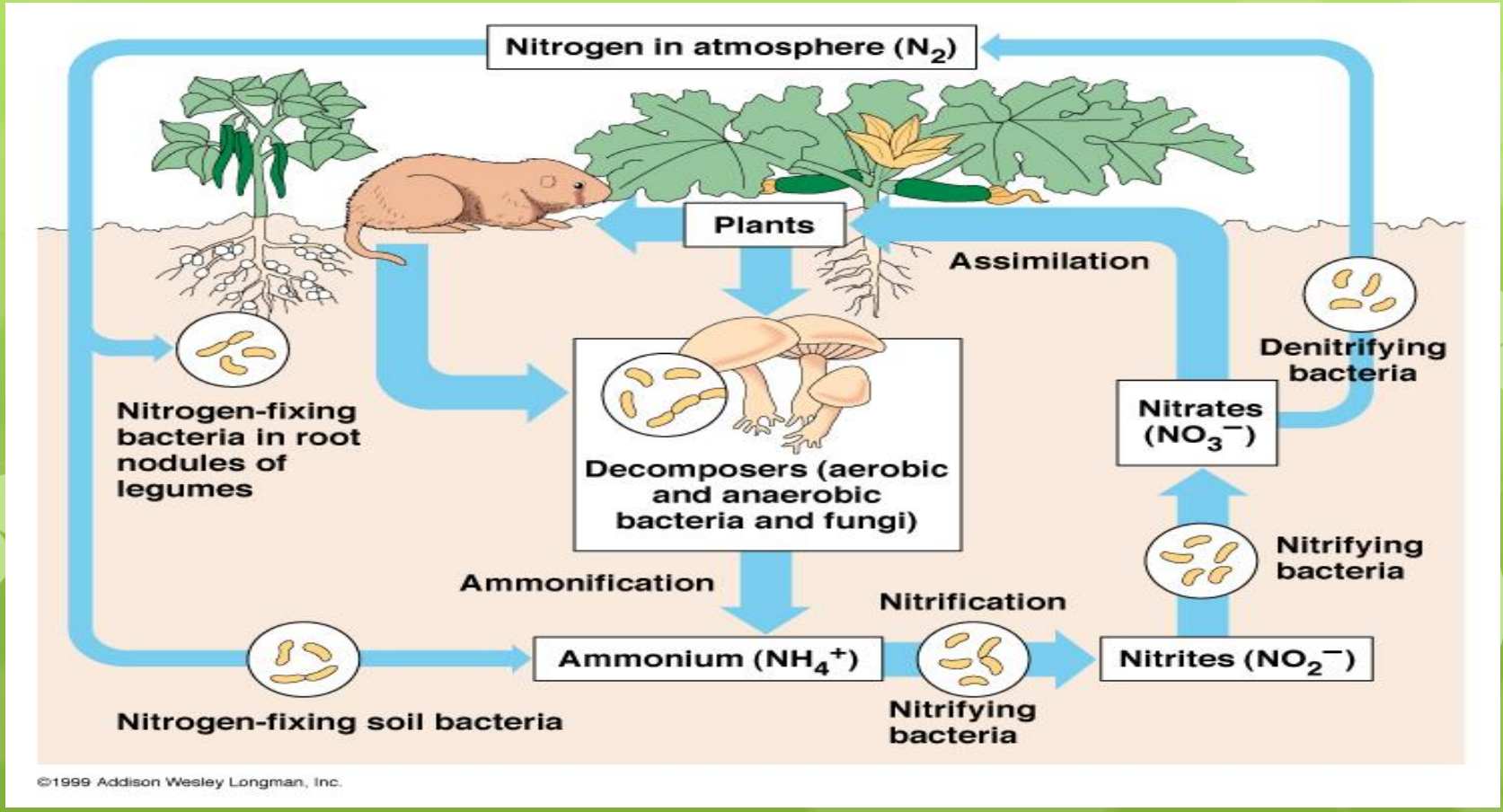
Roots absorb NH_3, NH_4, or NO_3 and incorporate them into nucleic acids and protein.

4) Ammonification:

Amino acids and nucleotides are broken down into waste products NH_3 or NH_4

5) Denitrification: The reduction of NO_3 to N_2

Denitrifying bacteria return some of the nitrogen to the atmosphere



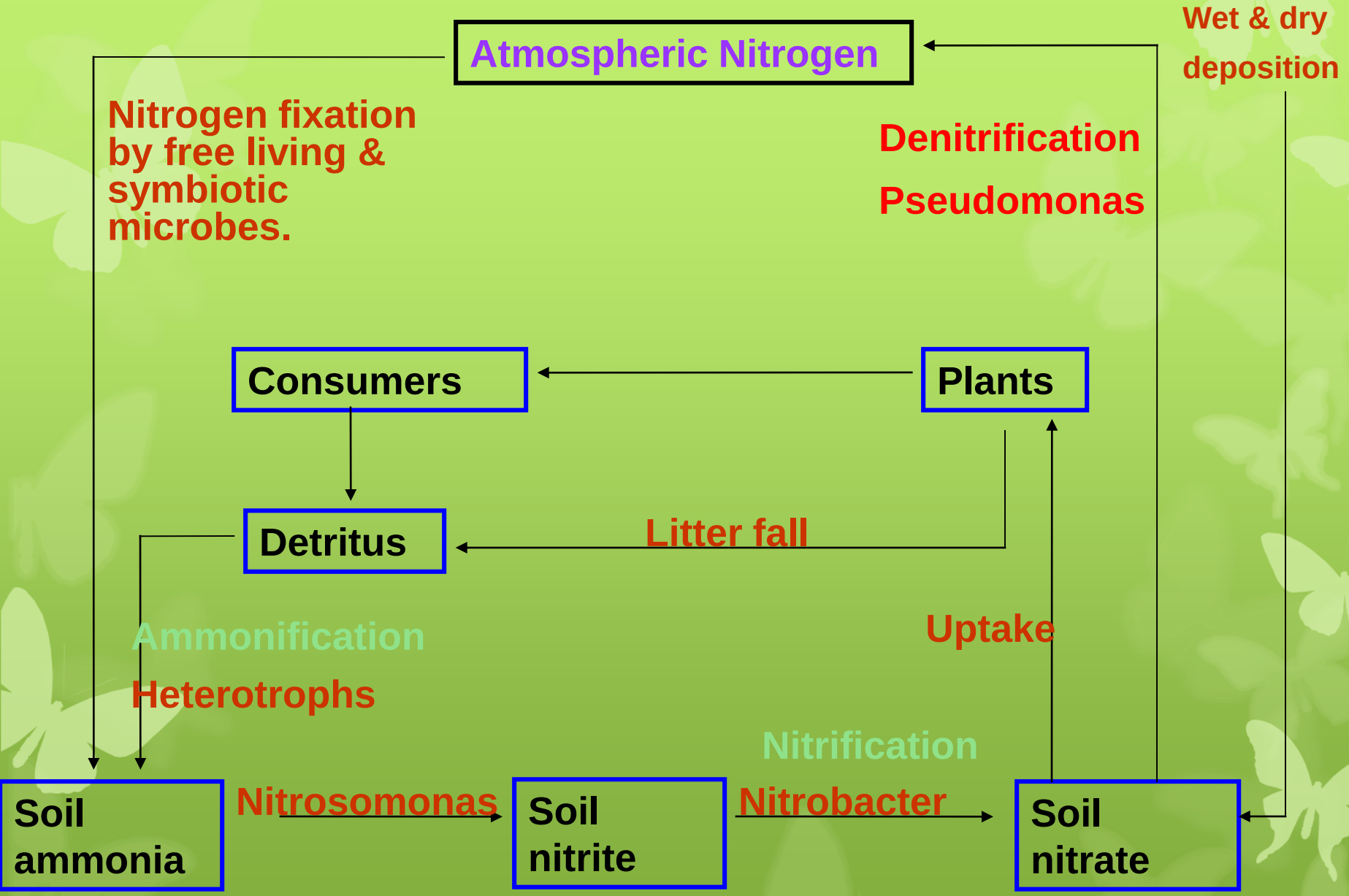


Fig: Nitrogen Cycle

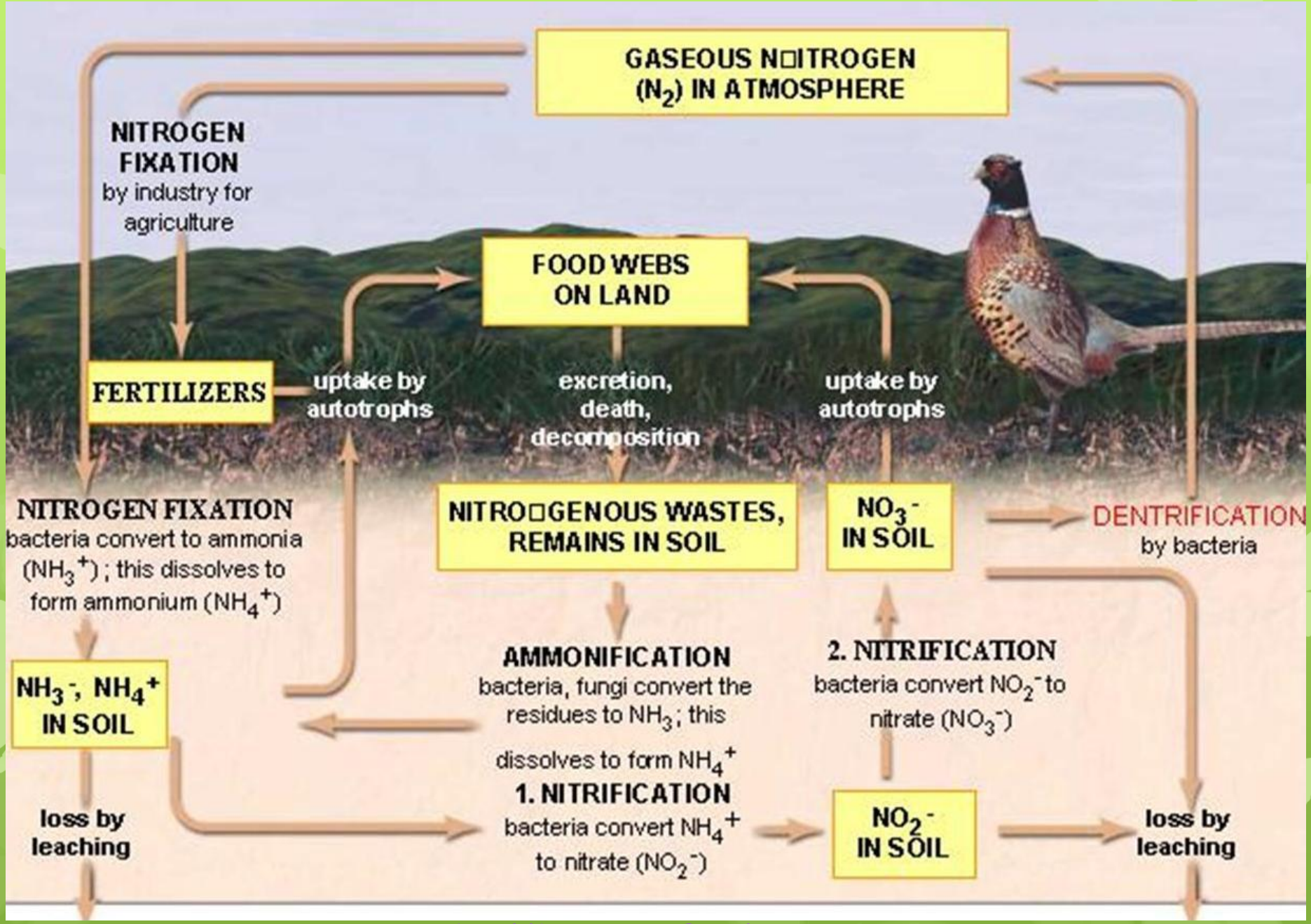


Fig: Nitrogen Cycle

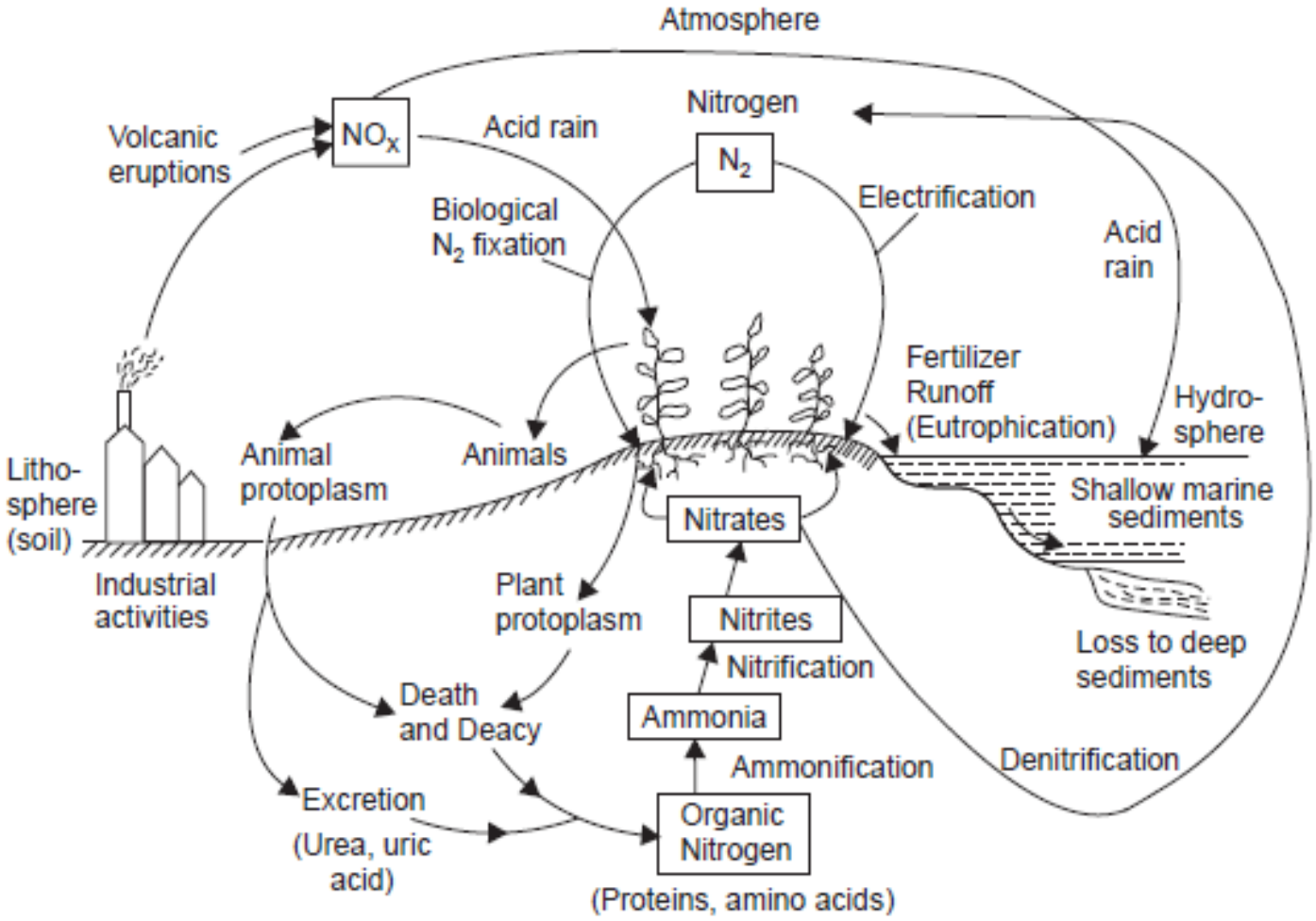
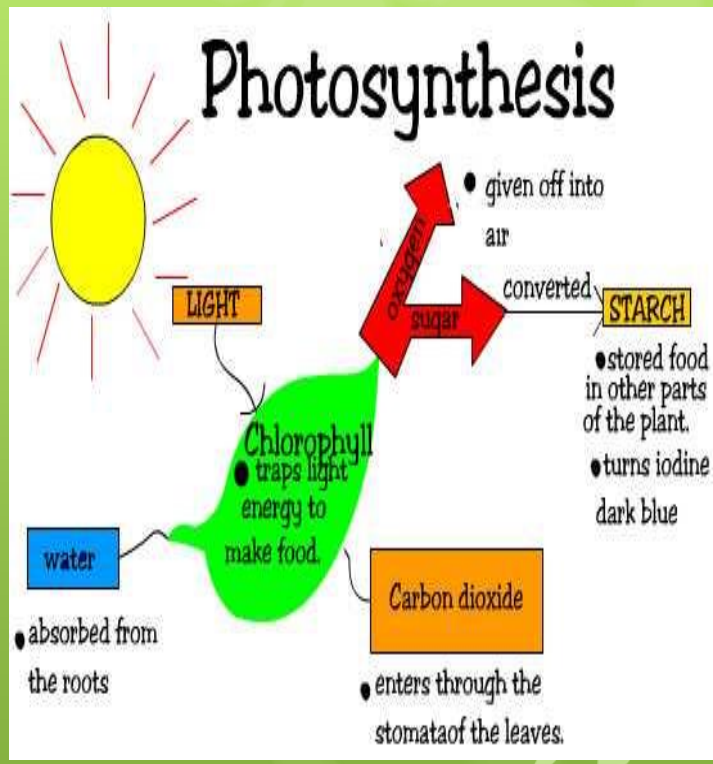


Fig. 3.11. Nitrogen cycle—a gaseous cycle with major reserve as N_2 (78%) in the atmosphere. Circulation of N- between living components and soil/atmosphere is mediated by a group of micro-organisms which convert one form of N into another.

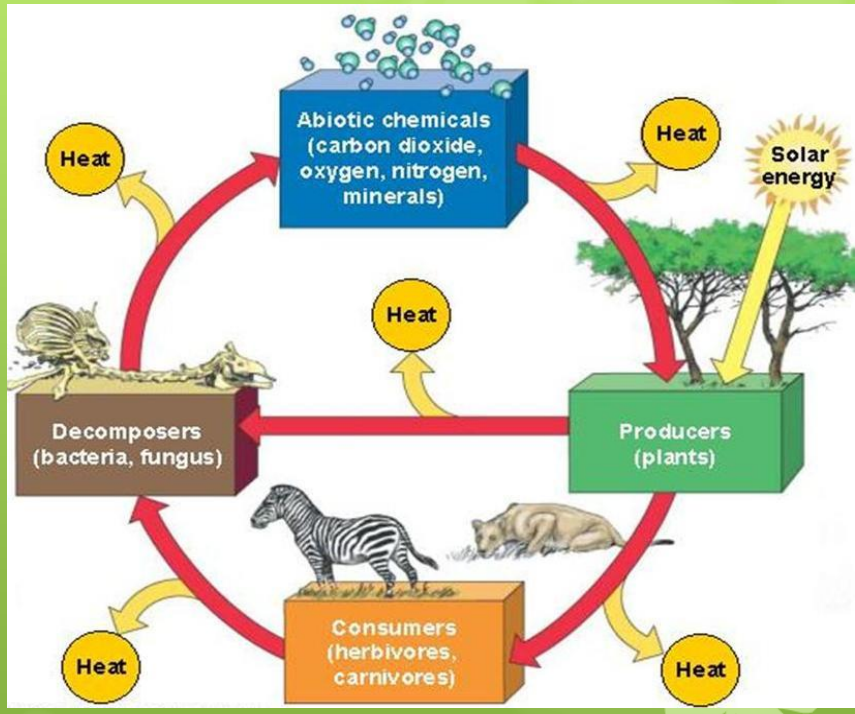
Energy flow in ecosystem:

- All organisms must obtain a supply of energy and nutrients from their environment in order to survive.
- The transformations of energy in an ecosystem begin first with the input of energy from the sun.
- Because, it is the first step in the production of energy for living things, it is called **"Primary production".**
- **Photosynthesis** -- Chemical reaction where green plants use water & carbon dioxide to store the sun's energy in glucose.
- ENERGY is stored in glucose.
- Glucose is stored as starch in plants



Energy flow in ecosystem:

- The majority of autotrophs are photoautotrophs that harness the energy of the sun and pass some of this energy onto consumers through feeding pathways.
- The energy contained within producers and consumers is ultimately passed to the decomposers that are responsible for the constant recycling of nutrients.
- Thus, there is a one-way flow of energy through the biotic community and a cycling of nutrients between the biotic and abiotic components of the ecosystem



Energy flow in ecosystem:

- Energy flow cannot occur in reverse direction.
- Starts from autotrophs (the producer level, i.e., *first trophic level*) to Heterotrophs including plant eaters or Herbivores (*second trophic level*) and so on.
- The amount of energy decreases with successive trophic levels.
- Only About 1% of energy from the sun is used by green plants & rest remains unutilized.
- Similarly, there is loss of energy in each trophic level.

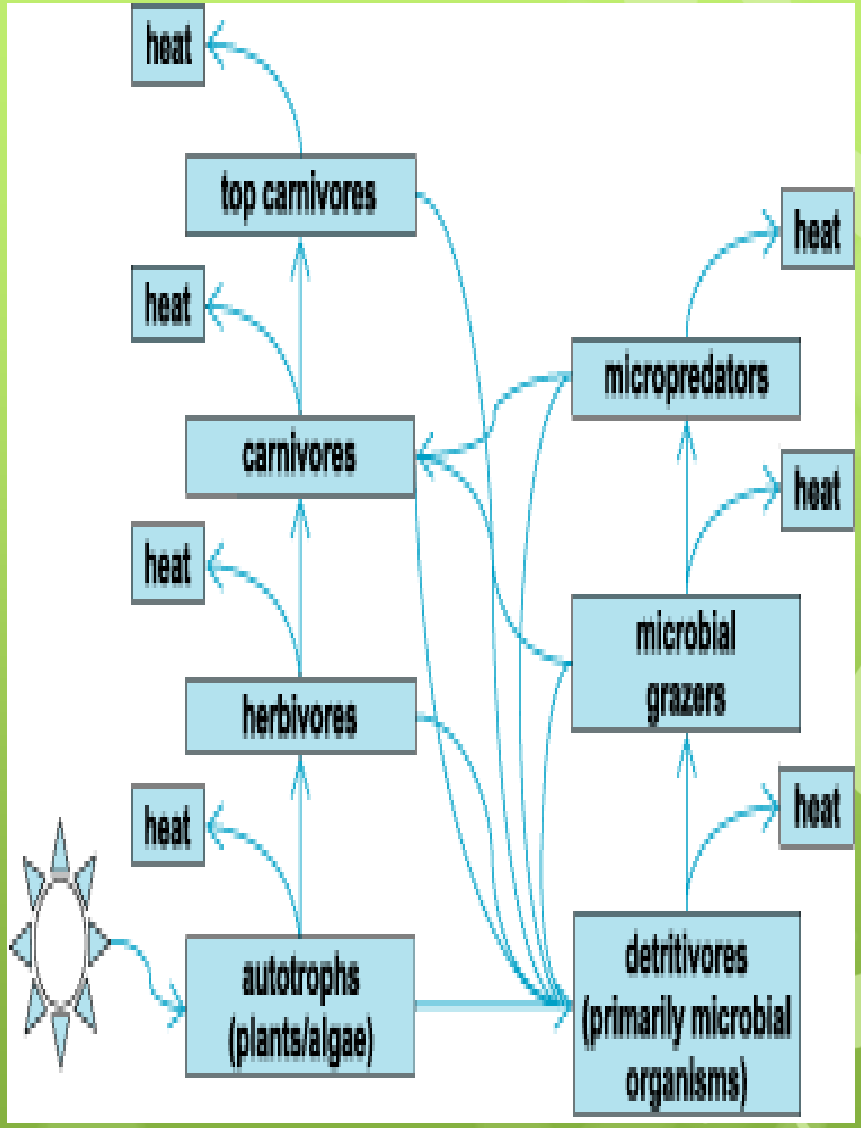
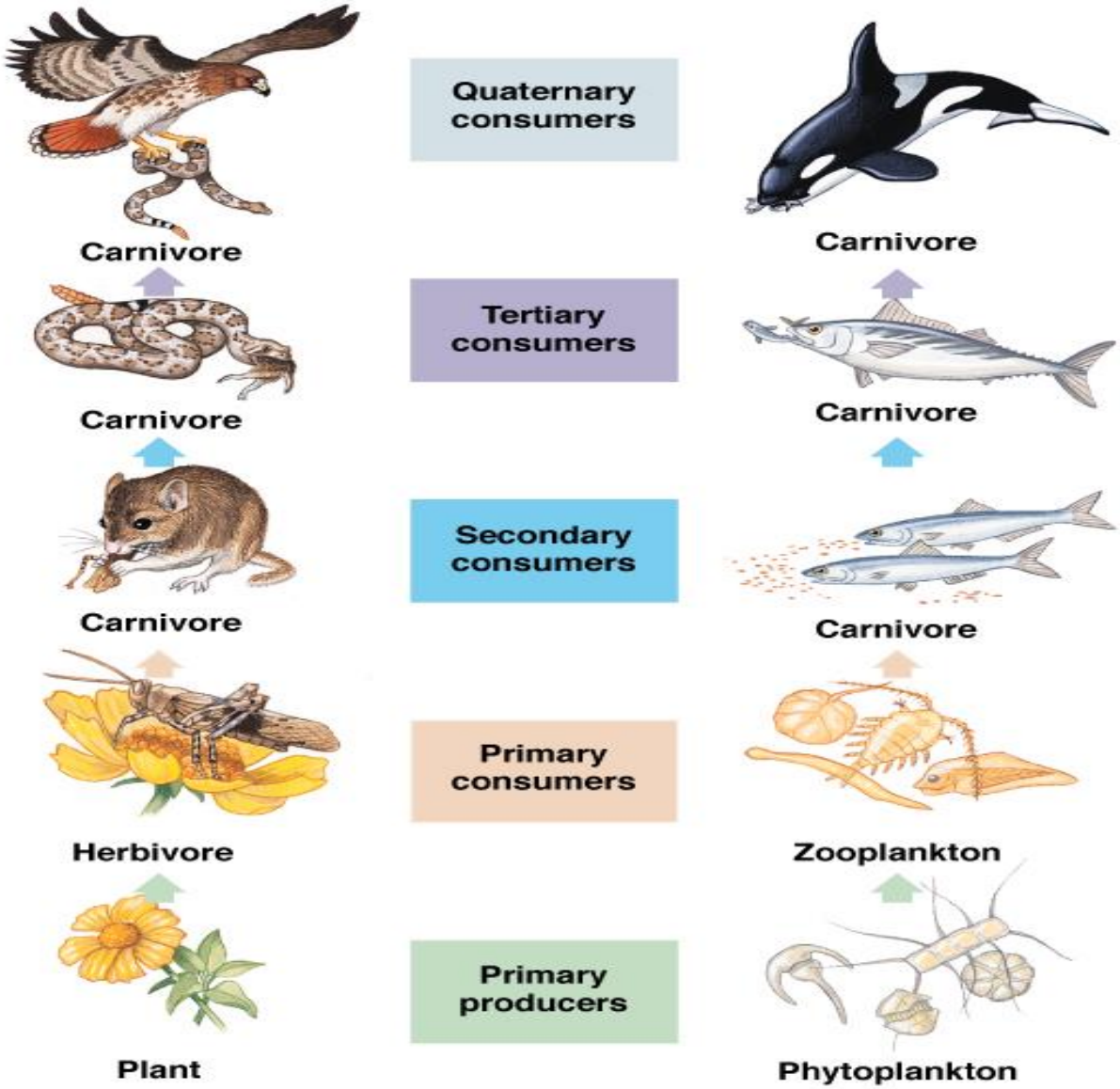


Fig: Energy flow in a system



Energy flow in ecosystem

- Every ecosystem has several interrelated mechanisms that affect human life.
- These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle.
- While every ecosystem is controlled by these cycles, in each ecosystem its abiotic and biotic features are distinct from each other.
- All the functions of the ecosystem are in some way related to the growth and regeneration of its plant and animal species.
- Water cycles depends on rainfall
- Energy cycle recycles nutrients to soil.

Table 3.1. Annual average of gross primary production of some major ecosystems

Ecosystem	Gross Primary Productivity (K Cal/m^2/yr)
Deserts and Tundra	200
Open Oceans	1,000
Grasslands	2,500
Moist Temperate Forests	8,000
Agro-ecosystems	12,000
Wet Tropical Forests	20,000
Estuaries	20,000