ECOSYSTEM

- **Ecosystem** is a self-regulatory and self-sustaining structural and functional unit of landscape (biosphere) consisting of community of living beings and the physical environment, both interacting and exchanging materials between them.
- **A.G. Tansley** (1935) coined the term ecosystem.
- Ecosystems are divisible into two categories, **terrestrial** or **land ecosystem** (*e.g.,* forests, grasslands, desert, garden) and **aquatic** or **water ecosystem** (*e.g.,* ponds, lakes, streams, estuaries, sea).

COMPONENTS OF ECOSYSTEM

- Every ecosystem has both structure and function. The **structural component** includes all the living organisms and their inter-relationships. The **functional components** include exchange of materials, energy flow, nutrient cycling, etc.
- Ecosystem has two major components namely, **abiotic** (non-living) components and **biotic** (living) components.

Abiotic components

- Abiotic components of an ecosystem consist of non-living substances and factors. The important ones include **temperature, wind, light, water, soil, minerals,** etc. (*Discussed in detail in previous chapter Organisms and Population*).

Biotic components

- All the living organisms in an ecosystem constitute the biotic component. This biotic component is further classified as follows depending on their nutritional (trophic) relationships.

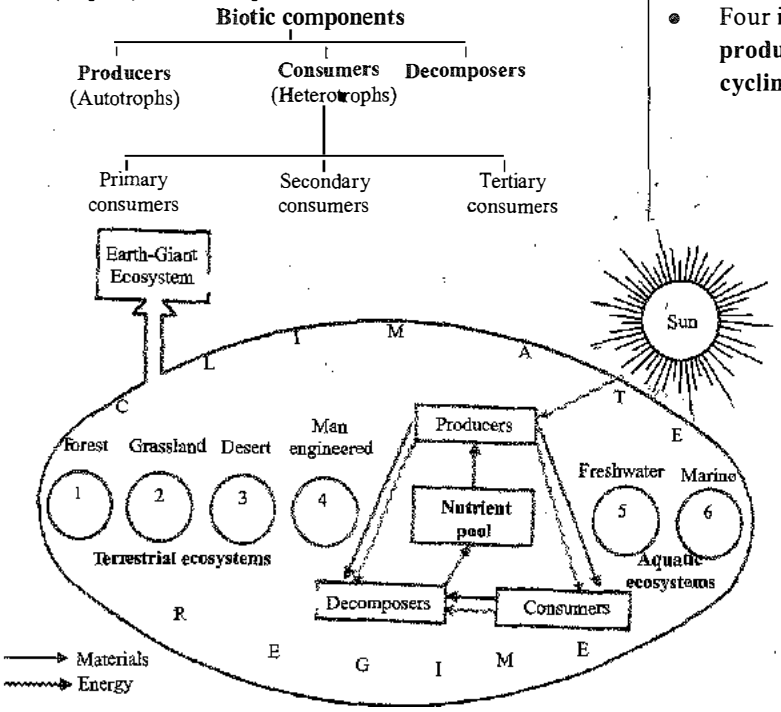


Fig.: Diagrammatic representation of the basic types of ecosystems, all of which together constitute the giant ecosystem - the biosphere. Note, in the centre, the generalised scheme of the structure and function of any unit ecosystem of the biosphere

STRUCTURE OF ECOSYSTEM

- Interaction of biotic and abiotic components results in a physical structure that is characteristic for each type of ecosystem.
- **Species composition :** Identification and enumeration of plant and animal species of an ecosystem gives its species composition.
- **Stratification :** It is formation of vertical layers where vegetation is dense, *e.g.,* 5 - 7 strata in tropical rain forests. Stratification is absent or rare in deserts.
- **Trophic structure :** Trophic structure of ecosystem is a type of **producer - consumer arrangement**, in which each **food level** is called trophic level. The producers occupy the first trophic level, herbivores the second, and the carnivores constitute the third trophic level. Each ecosystem has specific food chains and food webs, *e.g.,* grazing food chain in grassland.
- **Standing crop :** It is the amount of living biomass present in an ecosystem. It indicates the productivity and luxuriance of growth. Dry weight is preferred over fresh weight because the latter is liable to be influenced by seasonal moist differences.
- **Standing state :** It is the amount of inorganic nutrients present any time in the soil/water of ecosystem. It tends to vary from season to season and ecosystem to ecosystem.

FUNCTIONS OF ECOSYSTEM

- Four important functional aspects of the ecosystem are **productivity, decomposition, energy flow** and **nutrient cycling.**

Productivity

- **Productivity** refers to the rate of biomass production *i.e.,* the rate at which sunlight is captured by producers for the synthesis of energy rich organic compounds.
- It is of following types :
  - **Primary productivity**
  - **Secondary productivity**
  - **Net productivity.**
- Energy accumulated by plants (producers) in an ecosystem is called primary production. **Primary productivity is the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.**

  It can be divided into **gross primary productivity** and **net primary productivity.**
- The rate of energy production by green plants using organic matter during photosynthesis is the **gross primary productivity (GPP).**

- A considerable amount of GPP is utilised by plants in respiration. The energy left after respiration and stored as organic matter in the producers is called **net primary productivity (NPP)**.

$$NPP = GPP - R$$

- **Secondary productivity** refers to the rate of assimilation of the food energy at the level of consumers; it is the amount of energy available at the consumer level for transfer to the next trophic level.
- **Net productivity** refers to the rate of storage of organic matter not used by the heterotrophs (consumers) *i.e.* equivalent to net primary production minus consumption by the heterotrophs during the unit period, as a season or year etc.

Decomposition

- It is physical and chemical breakdown of complex organic remains with the help of organisms called decomposers. Organic remains (dead plant parts, animal remains and excretions) are also called **detritus**.
- The processes involved in decomposition are
  - **Fragmentation of detritus :** Detritivores (*e.g.*, termites, carrion beetles, earthworms) feed on larger pieces and smaller fragments are left.
  - **Catabolism :** The decomposers (*e.g.*, bacteria, fungi) excrete digestive enzymes over the detritus. It changes insoluble complex organic substances into simple and soluble organic compounds and inorganic substances.
  - **Leaching :** Soluble substances formed during decomposition are subjected to leaching or passage to deeper layers of soil/ground water by percolating water.
- Decomposition process gives rise to humus and **inorganic nutrients by humification** and **mineralisation** respectively.
- Humification is the process of formation of humus from detritus or organic remains. Humus is dark coloured, amorphous and organic matter **rich in lignin** and **cellulose.** It is highly **resistant to microbial action** and undergoes decomposition at an extremely slow rate. It is colloidal in nature, a reservoir of nutrients and helpful in maintenance of soil moisture as well as aeration. Nutrients are released slowly as the humus is slowly decomposed.
- Mineralisation is the release of inorganic substances, both non-mineral (*e.g.*, CO_2, H_2O) and minerals (*e.g.*, Ca^{2+}, Mg^{2+}, K^+, NH_4^+) from organic matter.
- Decomposition is dependent on **oxygen availability.** It also depends on the **chemical composition** of detritus and **climatic conditions.** Decomposition is **faster** when detritus is rich in nitrogen and sugars than when detritus is rich in lignin and chitin. **Warm** and **moist environment** favours decomposition.

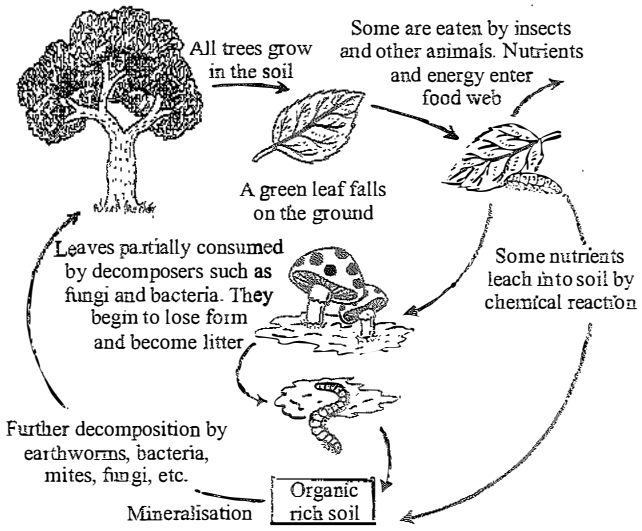


Fig.: Schematic representation of decomposition cycle in a terrestrial ecosystem

Energy flow

- **Sun** is the ultimate source of energy in all ecosystems. Of the sun's energy which reaches the Earth, about 40% is reflected immediately from the clouds, dust in the atmosphere and the Earth's surface without having any heating effect. A further 15% is absorbed and converted to heat energy in the atmosphere.
- The remaining 35% of incoming energy penetrates to the Earth's surface. Just under half the radiation striking the Earth's surface is in the photosynthetically active range (PAR), the visible wavelengths. However, even under optimum conditions only a very small proportion, about **5% of incoming radiation (10% PAR) is converted in photosynthesis into gross primary productivity** (GPP).
- Roughly 20% of it is consumed in respiration so that net capture of energy (net primary productivity) is 0.8 – 4% of incident radiation or 1.6 – 8% of PAR. **Flow of energy in an ecosystem is unidirectional.**

Trophic levels

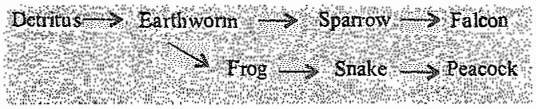
- Trophic level is a step or division of food chain which is characterised by the method of obtaining its food. The number of trophic levels is equal to the number of steps in the food chain. The two fundamental trophic levels are **producers** and **consumers.**
- **Producers** belong to **first trophic level or T_1**. They are **autotrophic** or photosynthetic organisms found in an ecosystem which synthesize organic nutrients from inorganic raw materials with the help of solar radiations not only for themselves but also for heterotrophic organisms or consumers.
- **Consumers** are heterotrophic organisms which cannot manufacture their own food. They obtain ready-made organic food from outside sources. Depending upon the mode of obtaining nourishment, heterotrophic organisms are of three main types - herbivores, carnivores and

decomposers.

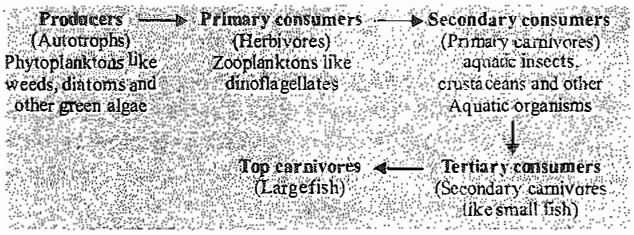
- **Herbivores** or consumers of first order constitute the **second trophic level or T_2.** Consumers of the second order or primary carnivores form **third trophic level or T_3.** There may be 2 - 3 levels of carnivores. The ultimate or **top carnivores** belong to T_4 or T_5 trophic level.
- **Decomposers** form the last or detritus trophic level (*e.g.*, T_6). Parasites do not have any fixed trophic level since they feed on producers, herbivores as well as carnivores of various levels, *e.g.*, aphids, ticks, mites, leeches, mosquitoes.

Food chain

- A **food chain** is defined as a sequence of organisms in which there is transfer of food energy through a series of repeated process of eating and being eaten. A food chain is always **straight** and proceeds in a progressive **straight** line. Usually there are 4 or 5 trophic levels in the food chain.
- Food chains are of three type– **parasitic, detritus** and **grazing.**
- **Parasitic food chain,** also called **auxilliary food chain** begins with host and usually ends in parasites.
- **Detritus food chain (DFC)** begins with detritus or dead organic matter. Detritivores and decomposers feed over it. Therefore, food energy present in detritus passes into them. Detritivores and decomposers are consumed by smaller carnivores which in tum become food for larger carnivores and so on. A common detritus food chain with earthworm as detritivore is



- **Grazing food chain (GFC)** is the most common food chain. It is also called **predator food chain** as predation occurs at every step. This food chain consists of producers, consumers and decomposers.
- The sequence of food chain in an **aquatic ecosystem** is as follows :



Food web

- Food web is a network of food chains which become interconnected at various trophic levels so as to form a number of feeding connections amongst different organisms of abiotic community.
- The energy stored by plants is passed through the community of an ecosystem in a series of steps of eating and being eaten. There is transfer of 10% of energy from one trophic level to another. This is also called **10% law** which was formulated by **Raymond Lindemann** (1942).

ECOLOGICAL PYRAMIDS

- An ecological pyramid is a **graphic representation** of relationship between the individuals present in various trophic levels of a food chain with producers forming the base and top carnivores the tip. The relationship may be in terms of **number, biomass** and **energy content** of producers and consumers. Ecological pyramids were developed by **Charles Elton** (1927) and are, therefore, also known as **Eltonian pyramids.**
- In a pyramid, the various steps of a food chain are represented sequence-wise with producers at the base, herbivores above them, followed by primary carnivores and then top carnivores constituting the top of the pyramid.
- Ecological pyramids are of three general types :
  - **Pyramid of number :** showing the number of individual organisms at each level.
  - **Pyramid of biomass :** showing the total dry weight and other suitable measures of total amount of the living matter.
  - **Pyramid of energy :** showing the rate of energy flow and/or productivity at successive trophic levels. The **pyramid of number** and **biomass** may be **upright** or **inverted** depending upon the nature of food chain in the particular ecosystem, **whereas pyramids of energy is always upright.**
- In a **parasitic food chain,** the pyramid of number is **always inverted.** This is due to the fact that a single plant may support the growth of many herbivores and each herbivore in tum may provide nutrition to several parasites, which support many **hyperparasites.** Thus, from the producer towards consumers, there is a reverse position, *i.e.*, the number of organisms gradually shows an increase, making the pyramid **inverted in shape.**
- However, in **pond ecosystem,** the producers are small organisms, their biomass is the least, and this value gradually shows an increase towards the apex of the pyramid, thus making the **pyramid of biomass inverted** in shape.

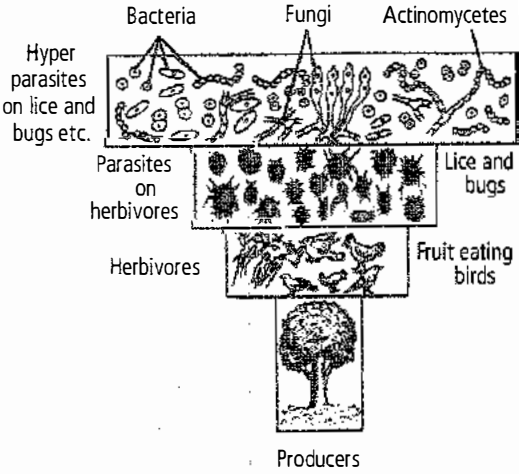


Fig.: Pyramid of number in parasitic food-chain

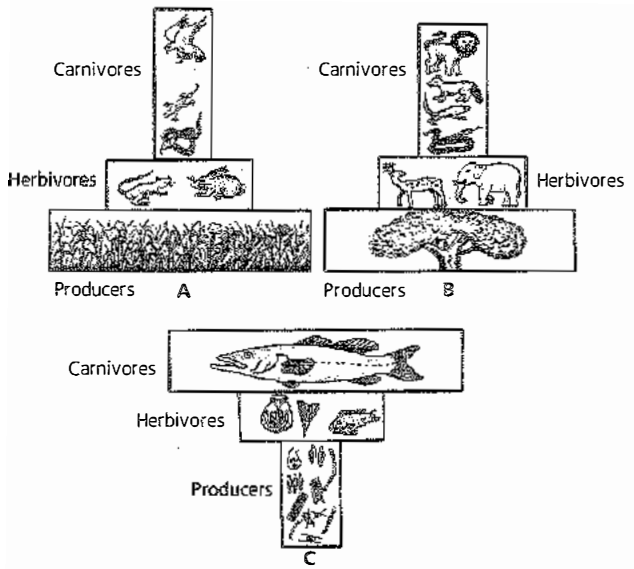


Fig.: Pyramids of biomass in different ecosystems
A. Grassland ecosystem B. Forest ecosystem C. Pond ecosystem

- Pyramid of energy is **always upright**, as in most of the cases there is always a gradual decrease in the energy content at successive trophic levels from the producers to various consumers.

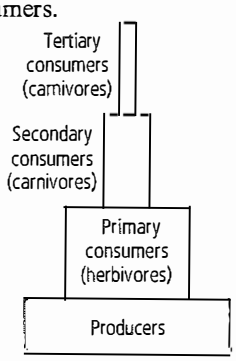


Fig.: Pyramid of energy in any ecosystem

ECOLOGICAL SUCCESSION

- Biotic or ecological succession is the natural development of a series of biotic communities at the same site, one after the another till a **climax community** develops which does not evolve further because it is in perfect harmony with environment of the area.
- A biotic community is influenced by **biotic factors, physico-chemical factors** and **geographical factors**.
- During succession some species colonise an area and their populations become more numerous, whereas populations of other species decline and even disappear.
- The present day communities in the world have came into existence because of the succession that has occurred over the millions of years since life had started on earth. Actually succession and evolution would have been parallel processes at that time.
- Ecological succession is of two types: **primary** and **secondary succession.**
- Primary succession is a biotic succession which occurs on a previously bare or unoccupied area, *e.g.,* new exposed rock area, sand dunes, igneous rocks, deltas, newly created pond or reservoir.
- The **first** biotic community which develops in a bare area is called **pioneer community. Climax community** is the stable, self-perpetuating and **final** biotic community that develops at the end of biotic succession and is in perfect harmony with the physical environment. Climax community is also termed as **climatic climax community.** Climax community has maximum diversity and niche specialization.
- The various biotic communities that develop during biotic succession or the intermediate communities between the pioneer and climax communities are termed as **seral stages** or **transitional communities.**
- Another general type of succession is **secondary succession** which starts from previously built up substrata with already existing living matter. The action of any external force, such as, a sudden change in climatic factors, biotic intervention, fire, etc., causes the existing community to disappear.

Some examples of primary succession

Hydrosere

- **Hydrosere** is an **ecological succession** in the **newly formed pond or lake.** It starts with the colonization of some phytoplanktons which form the pioneer plant community, and finally terminates into a forest, which is the climax community.

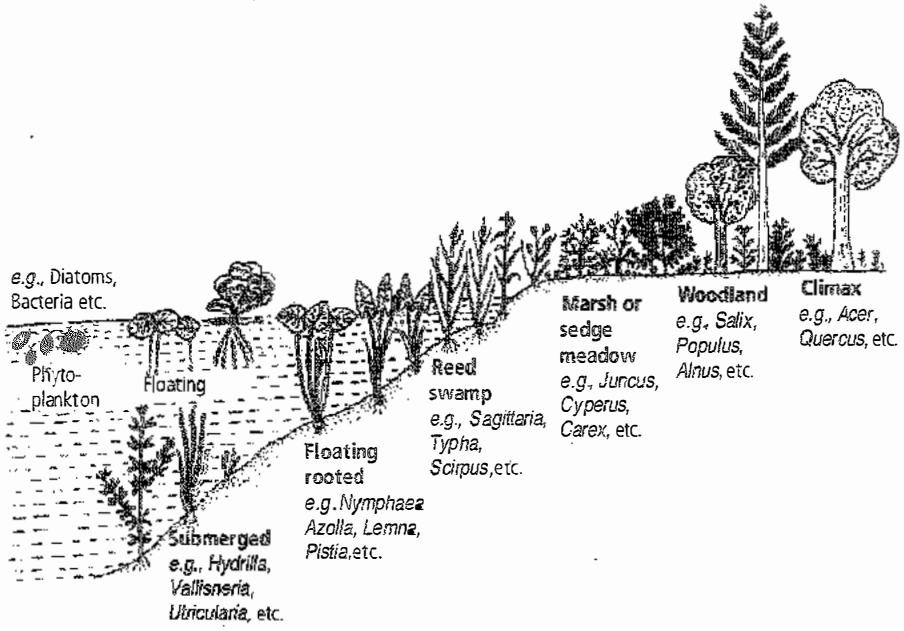


Fig.: Different stages of hydrosere.

- The various stages together with their chief components of plant species during primary succession in water are:
- **Phytoplankton stage/Pioneer stage :** Constitutes the pioneer community. Some blue-green algae, green algae, diatoms and bacteria etc. were the first organisms to colonize the primitive medium of the pond.
- **Rooted submerged stage :** A new habitat suitable for the growth of rooted submerged hydrophytes like *Elodea, Utricularia, Potamogeton, Hydrilla* etc.
- **Rooted floating stage :** These plants colonize the habitat with their **rhizomes.** They all are rooted floating hydrophytes which include *Nelumbo, Limnanthemum, Trapa, Nymphaea* etc. Some free floating plants as *Azolla, Lemna, Wolffia, Pistia, Salvinia* etc. also become associated with the rooted plants, due to availability of salts and other minerals in abundance.
- **Reed swamp stage :** The plants of this community are rooted but most parts of their shoots (assimilatory organs) remain exposed to air Species of *Sagittaria, Phragmites, Typha* etc. are the chief plants of this stage.
- **Marsh or Sedge meadow stage :** Because of the successive decrease in water level and further changes in the substratum, species of *Carex, Juncus, Cyperus, Eleocharis,* etc. colonize this area.
- **Woodland stage :** Due to disappearance of marshy sedge-meadow stage, soil becomes drier for most time of the year This area is now invaded by terrestrial plants, which are some shrubs (*Salix* and *Cornus*) and trees (*Alnus* and *Populus*).
- **Climax forest stage :** Forest stage is the climax community The woodland community is gradually invaded by several trees *e.g., Acer, Quercus.*

Lithosere (A xerosere on rock)

- The sequence of successional stages that occur on bare rocks is called **lithosere.** The first inhabitants or pioneers of such a habitat are usually **lichens** in the temperate regions.
- **Crustose lichen stage :** The lichens of this stage are represented by the species of *Rinodina, Lecanora, Rhizocarpon* etc. They produce some acids which cause weathering of rocks. The dead organic matter of lichens becomes mixed with small (weathered) particles of rocks. As a result, these lichens are replaced by **foliose type of lichens.**
- **Foliose lichen stage :** They can absorb and retain more water and are able to accumulate dust particles which build up the suitable substratum for the moss stage.
- **Moss stage :** A thin soil layer develops on rock surfaces, especially in crevices, and favours the growth of such xerophytic mosses as species of *Tortula, Grimmia* and *Polytrichum.*
- **Herbs stage :** This stage is constituted by shallow rooted grasses as *Festuca, Solidago, Aristida,* etc.
- **Shrub stage :** Due to much accumulation of soil, the habitat becomes suitable for shrub vegetation which starts migrating in the area. This habitat includes the species of *Phytocarpus, Rhus* etc.
- **Forest stage :** From shrub stage, there develops finally a forest community.

Importance of biotic succession

- It tells us how a biotic seral stage like grasses and herbs of a pasture can be maintained by not allowing the biotic succession to proceed further through interference like grazing and fire.
- Information gained through biotic succession is used in having controlled growth of one or more species by preventing their superiors to invade the area, *e.g.,* maintenance of teak forest.
- Dams are protected by preventing siltation and biotic succession to occur.
- It gives information about the techniques to be used during reforestation and afforestation.

Points to be noted

- **Autogenic succession :** When the succession has begun, the vegetation itself is responsible for replacing itself by changing existing environmental conditions.
- **Allogenic succession :** When in succession other conditions (not vegetation itself) are responsible for replacing communities, then it is called allogenic succession.
- **Autotrophic succession** is characterised by early and continued dominance of autotrophic organisms like green plants. It starts in a predominantly inorganic environment and the energy flow is maintained indefinitely.
- **Heterotrophic succession** is characterised by early dominance of heterotrophs such as bacteria, fungi and actinomycetes. It begins in a predominantly organic environment and there is a progressive decline in the energy content.
- **Induced succession** occurs due to extensive external interference. Here the initial community has high productivity which gradually decreases. Agriculture can be deemed as an example of induced succession. Here a steady stage is maintained for an ultimate good harvest.
- Due to environmental thrust and human interference the climax vegetation may retrograde into shrub land or savannah. This is referred to as **retrogressive succession.**
- When the succession doesn't proceed through its normal course and side tracks, the advancement line is called **deflated succession.**

NUTRIENT CYCLING

- Nutrient cycles involve storage and transfer of nutrients through various components (living and non-living) of the ecosystem so that the nutrients are repeatedly used.
- **Biogenetic nutrients/biogeochemicals** are essential elements required by organisms for their body building and metabolism which are provided by earth and return to earth after their death and decay. The amount of nutrients varies in different kinds of ecosystems and also on a seasonal basis.
- There are **two** types of nutrient cycles – **gaseous** and **sedimentary**. The **gaseous type** of nutrient cycle is

generally located in the atmosphere or the hydrosphere, *e.g.*, **carbon, oxygen, water, nitrogen, hydrogen**. In the **sedimentary type**, the reservoir exists in the earth's crust, *e.g.*, **phosphorus, calcium, magnesium.**

Carbon cycle

- Carbon is the main component of all the organic compounds of protoplasm like carbohydrates, lipids, nucleic acids, enzymes, hormones. The biospheric carbon cycle is primarily concerned with the atmospheric CO_2 gas, its incorporation into organic matter by photosynthesis and its subsequent release by the respiration by all biota. Carbon also occurs in the earth's rock predominantly as calcium and magnesium carbonates. **The reservoir pool is lithosphere.** The carbon fixed by producers enters the food chain and is hence passed to herbivores, carnivores and decomposers. During photosynthesis the carbon component of the atmosphere and hydrosphere decreases. It can be replenished by various methods like :
  - Respiration
  - Decomposition of organic wastes
  - Burning of wood and fossil fuel
  - Weathering of carbonate containing rocks
  - Volcanic eruptions and hot springs.
- Some carbon is being removed from circulation and added to lithosphere by hard carbonaceous shells, animal skeletons, fossilization, seepage of carbon rich water into interior earth and caving in of forests during earthquakes. Major exchange in carbon cycle is between organisms and the atmosphere or hydrosphere.

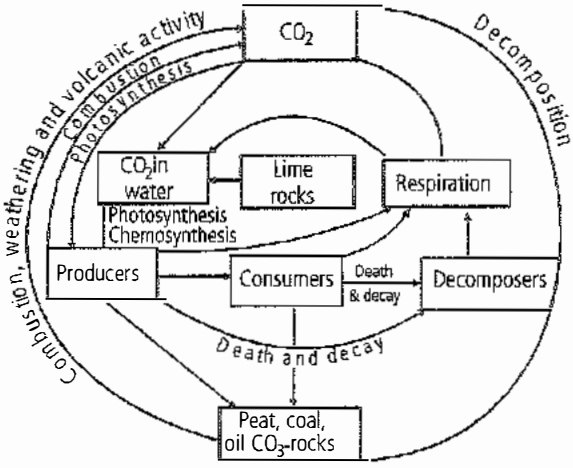


Fig.:Carbon cycle

Phosphorus cycle

- Phosphorus is an inorganic component of nucleic acids, phospholipids, ATP, bones and teeth. It takes part in metabolic reactions involved in release of energy from food and utilization of this energy in various functions of the body. It is found in nature, in soil, as rock phosphate, in combination with calcium, iron and aluminium etc. Phosphate circulates in the abiotic environment in lithosphere as well as in hydrosphere. Phosphate present in the soil may occur in insoluble form. It is dissolved by chemicals secreted by micro-organisms and plant roots. The dissolved phosphate is absorbed by the plants and changed to organic form. Phosphate fertilizers are added to the soil to increase its availability.
- From plants, phosphorus travels to animals alongwith the food chain. Animal excretions and dead bodies of organisms are acted upon by decomposers. Phosphorus is released in the process. The same becomes available for re-utilization by plants.
- Inside the soil, some phosphorus is lost through **leaching.** Similarly, a sufficient amount of phosphorus combines with calcium, iron or aluminium and becomes insoluble. It settles down at the bottom of lake or ocean as sediment.
- Bone and teeth may also remain undegraded. Such phosphorus becomes part of lithosphere. It is released after a very long interval when these rocks containing them are exposed to weathering agencies or are mined.

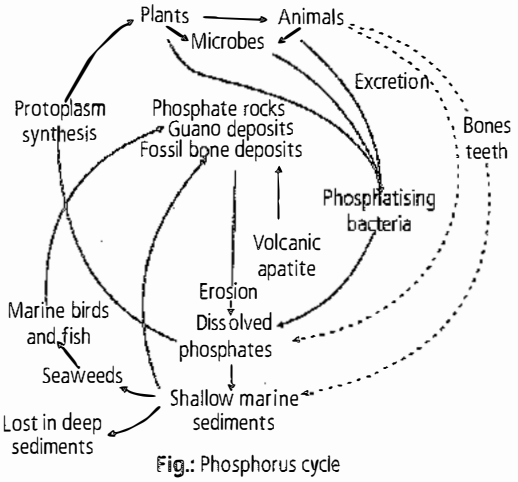


Fig.: Phosphorus cycle

Nitrogen cycle

- N_2 gas of atmosphere is converted into nitrates and nitrites by the process of nitrogen-fixation.

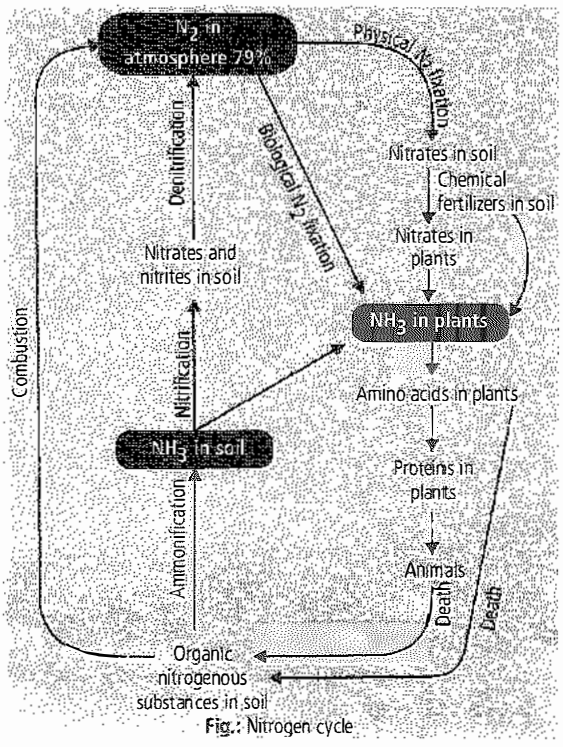


Fig.: Nitrogen cycle

- The conversion of organic nitrogenous substances in soil into NH_3 (ammonia) is called **ammonification,** which is due to ammonifying bacteria, *e.g., Bacillus mycoides, B. vulgaris* and *B. ramosus*, etc.
- The conversion of NH_3 in soil into nitrates and nitrites is called **nitrification,** which is done by nitrifying bacteria, *e.g., Nitrosomonas, Nitrosococcus* (convert NH_3 into nitrites) and *Nitrobacter* (convert nitrites into nitrates).
- The conversion of nitrates and nitrites in soil into atmospheric N_2 is called **denitrification,** which is done by denitrifying bacteria, *e.g., Micrococcus denitrificans* and *Bacillus denitrificans.*

Sulphur cycle

- In nature, sulphur mainly occurs in elemental form as metal sulphides and sulphates. SO_2 comes back to earth as H_2SO_4 after getting dissolved in rain water.
- Starting with photosynthesis, plants pick up sulphur in the form of sulphate which is utilized by them in the synthesis of amino acids like **cysteine, cystine** and **methionine.** From plants, it is transferred to the consumers. Excretion and dead bodies of organisms carry it back to the earth. The same is broken by the decomposers to release H_2S under anaerobic conditions; sulphates under aerobic conditions or occasionally as elemental sulphur.

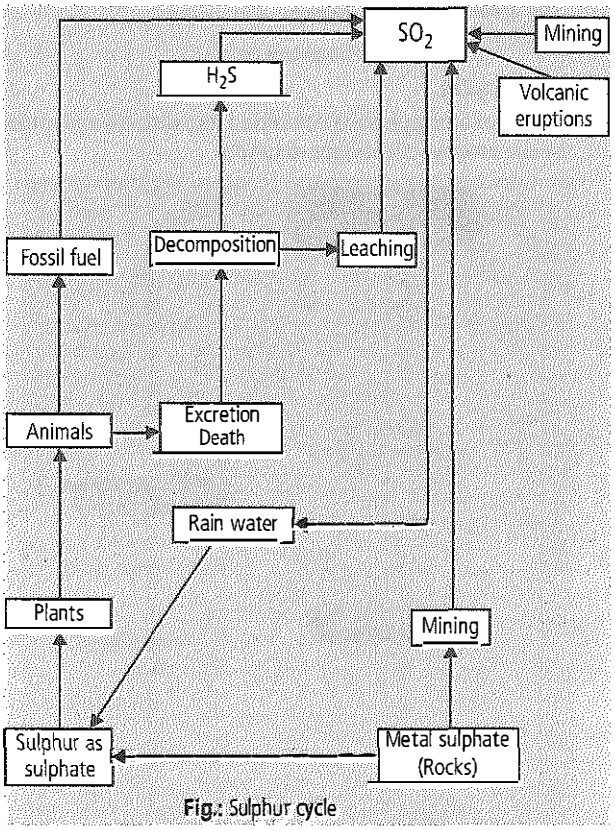
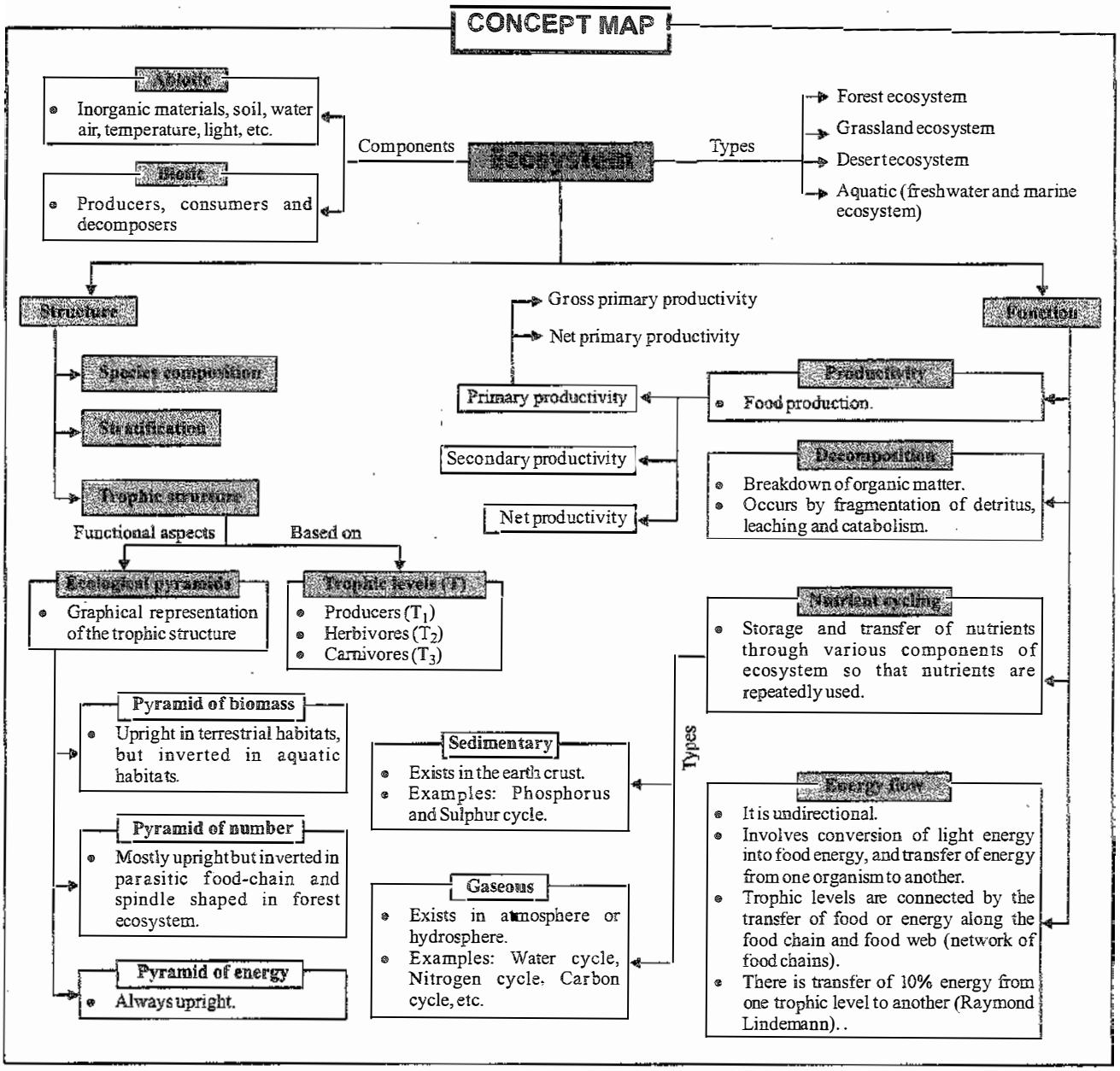


Fig.: Sulphur cycle

- Colourless sulphur bacteria (*e.g., Beggiatoa*) oxidise H_2S to elemental sulphur and then to sulphuric acid. The photosynthetic green bacteria (*e.g., Chlorobium limicola*) can carry the reduction of H_2S to elemental sulphur. The purple bacteria (*e.g., Thiopedea rosea, Rhodopseudomonas palustris*) oxidise H_2S to sulphates which may be re-circulated and taken up by the producers.

ECOSYSTEM SERVICES

- Healthy ecosystems are the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as **ecosystem services,** for example, healthy forest ecosystems purify air and water, mitigate droughts and floods, cycle nutrients.
- For optimum utility of ecosystems they must be healthy For example:
  - **Soil :** Soil formation and soil protection are the major ecosystem services accounting for nearly 50% of their total worth.
  - Plant cover protects the soil from drastic changes in temperature.
  - **Perennial water :** Plant litter and humus prevent run off water, hold water like sponge and allow percolation of water. A lot of water is held in the soil which slowly passes towards perched water table. It comes out as springs. They are a source of perennial fresh water which is quite pure.
  - **Air :** Plant cover of natural ecosystems absorb polluting gases, cause settling of suspended particulate matter, removes CO_2 and releases O_2.
  - **Wetlands :** Ecosystems protect the land from floods, remove sediments and other pollutants and recharge ground water.
  - **Climate :** Increase in atmospheric humidity and good rainfall have moderate effect on climate.
  - **Biodiversity:** Ecosystem maintains the biodiversity which is of enormous benefits for mankind.
  - **Nutrient cycling :** Due to ecosystem, there is no depletion of nutrients but the same are repeatedly circulated and re-circulated. It keeps the fertility of soil intact.
  - **Wildlife habitat :** Ecosystems are habitat of wildlife.
  - **Pollination :** Bees and other insects of natural ecosystems visit nearby farmlands and pollinate the crop plants.
  - **Tribals :** A large number of tribals live in forests.
  - **Grazing grounds :** Ecosystems are grazing areas for numerous cattle.
  - **Other values :** Natural ecosystems are a source of spiritual, cultural and aesthetic values.


CONCEPT MAP
Abiotic
Inorganic materials, soil, water air, temperature, light, etc.
Biotic
Producers, consumers and decomposers
Components
Ecosystem
Types
Forest ecosystem
Grassland ecosystem
Desert ecosystem
Aquatic (freshwater and marine ecosystem)
Structure
Function
Species composition
Stratification
Trophic structure
Functional aspects
Based on
Ecological pyramids
Graphical representation of the trophic structure
Trophic levels (T)
Producers (T_1)
Herbivores (T_2)
Carnivores (T_3)
Pyramid of biomass
Upright in terrestrial habitats, but inverted in aquatic habitats.
Pyramid of number
Mostly upright but inverted in parasitic food-chain and spindle shaped in forest ecosystem.
Pyramid of energy
Always upright.
Gross primary productivity
Net primary productivity
Primary productivity
Secondary productivity
Net productivity
Productivity
Food production.
Decomposition
Breakdown of organic matter.
Occurs by fragmentation of detritus, leaching and catabolism.
Nutrient cycling
Storage and transfer of nutrients through various components of ecosystem so that nutrients are repeatedly used.
Types
Sedimentary
Exists in the earth crust.
Examples: Phosphorus and Sulphur cycle.
Gaseous
Exists in atmosphere or hydrosphere.
Examples: Water cycle, Nitrogen cycle, Carbon cycle, etc.
Energy flow
It is undirectional.
Involves conversion of light energy into food energy, and transfer of energy from one organism to another.
Trophic levels are connected by the transfer of food or energy along the food chain and food web (network of food chains).
There is transfer of 10% energy from one trophic level to another (Raymond Lindemann)..