36. Ecosystem : Structure and Function

1. Introduction

Ecosystem (By Tansley) : Biocenosis (Mobius) or microcosm (Forbes) or geobiocoenosis (Sukachev) or holon (Koestler).
It is a segment of nature/biosphere consisting of a community of living being and the abiotic/physical environment both interacting and exchanging materials between them.
The energy that flows through ecosystems is obtained primarily from the sun. It generally enters the system through photosynthesis, a process that also captures carbon dioxide from the atmosphere. By feeding on plants and on one another, animals play an important role in the movement of matter and energy through the system. They also influence the quantity of plant and microbial biomass present. By breaking down dead organic matter, decomposers release carbon back to the atmosphere and facilitate nutrient cycling by converting nutrients stored in dead biomass back to a form that can be readily used by plants and other microbes.
Natural if developed under natural conditions (e.g., forest, sea), artificial or man-made, e.g., Garden, Piggery, Poultry, Apiary, agriculture or agro-ecosystem.
Depending upon size, ecosystem is very large or mega-ecosystem (Sea), large or mesoecosystem (deciduous tropical forest, coniferous forest), small sized microecosystem (pond, lake, crop land) and very small sized nanoecosystem (aquarium, garden, log of wood).

2. Ecosystem and Its Classification

Ecosystem has two components: (a) Biotic / Standing crop/ biomass (b) Abiotic or Standing state.

2.1. Biotic Component

Include all living beings present in an ecosystem – producers, consumers and decomposers.
Biomass: Living matter present in individual/ population/community/trophic level/ ecosystem. Biomass is measured on both fresh and dry weight basis (better).

(1) **Producers :** They are autotrophs, synthesizing complex organic substances from simple inorganic substances like CO_2 and H_2O during photosynthesis.
Producers are also called transducers as they convert solar radiations into chemical energy.
Sunlight provides the energy for the process, solar energy is converted into chemical energy and is stored in different complex organic substances like carbohydrates, proteins, lipids, etc

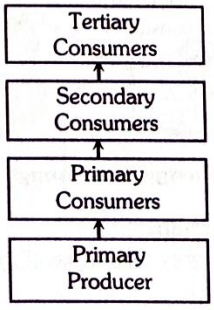
(2) **Consumers:** They are heterotrophic organisms incapable of synthesizing their own food. They depend upon plants (producers) for their food requirement directly or indirectly.
Broad category of 'Predators also include parasites and pathogens.
Predators are Live-feeders' as they feed directly on other living organisms in order to survive.
The consumers are different types:

- **Primary consumers :** They are herbivores which feed upon plants or plant products, e.g., rabbit deer, field mouse, cow, elephant, small fish, tadpoles, several insects, zooplanktons like Paramecium, Daphnia, etc. These are called Key industry animals as they convert plant matter into animal matter.
- **Secondary consumers :** They do not feed upon plants directly; instead feed upon herbivores, so are primary carnivores e.g., fox, jackal, frog, fish, several birds, etc.
- **Tertiary consumers:** They are larger carnivores which feed upon smaller carnivores e.g., wolf feeding upon fox, snake feeding on frog. These carnivores may also become prey to still larger carnivores. The latter are termed top carnivores e.g., tiger, lion, shark, crocodile, eagle, etc.

(3) **Decomposers/Reducer:** Decompose organic matter into inorganic minerals.
They are also known as mineralisers as they change organic remains into inorganic minerals.
A food chain may vary in length but usually consists of 4 or 5 steps or trophic levels. A few common food chains are given below:

3. Trophic Levels

- They are steps of divisions of food chain characterized by specific method of obtaining food.
- Producers belong to T_1 or first trophic level, herbivores/primary consumers T_2, primary carnivores/secondary consumers T_3, secondary carnivores/ tertiary consumers T_4, tertiary carnivores/quaternary consumers T_5, Decomposers atlast T_6 or detritus trophic level.
- An organism may occupy more than one trophic level simultaneously. One must remember that the trophic level represents a functional level, not a species as such.
- A given species may occupy more than one trophic level in the same ecosystem at the same timer; for example, a sparrow is a primary consumer when it eats seeds, fruits, peas, and a secondary consumer when it eats insects and worms.
- Parasites and omnivores (human, ant, and crow) do not have any fixed trophic level.



	Examples
Fourth trophic level (Top carnivores)	Man, lion
Third trophic level (Carnivores)	Birds, fishes Wolf
Second trophic level (Herbivores)	Zooplanktons, grasshopper and cow
First trophic level	Phytoplanktons, grasses, trees (Plants)

- **Guild** is group of species belonging to same trophic level and consuming same resource.
- Decomposers are not included in food chain as they operate at all trophic levels.

4. Food Chain

Sequence of living organisms due to interdependence in which one organism consumes another.
The ultimate source of energy used by all living organisms is the sunlight which is entrapped by green plants, and utilized for thesynthesis of complex organic substances (carbohydrates) during photosynthesis.
The energy trapped in organic substances by autotrophs is passed on to different living organisms through food. Exchange of both energy and materials thus occurs through food. The sequence of populations or organisms or trophic levels in an ecosystem through which food and its contained energy flows constitutes a food chain.
The number of trophic levels in a food chain is equal to the number of steps involving the transfer of food from one organism to the other.

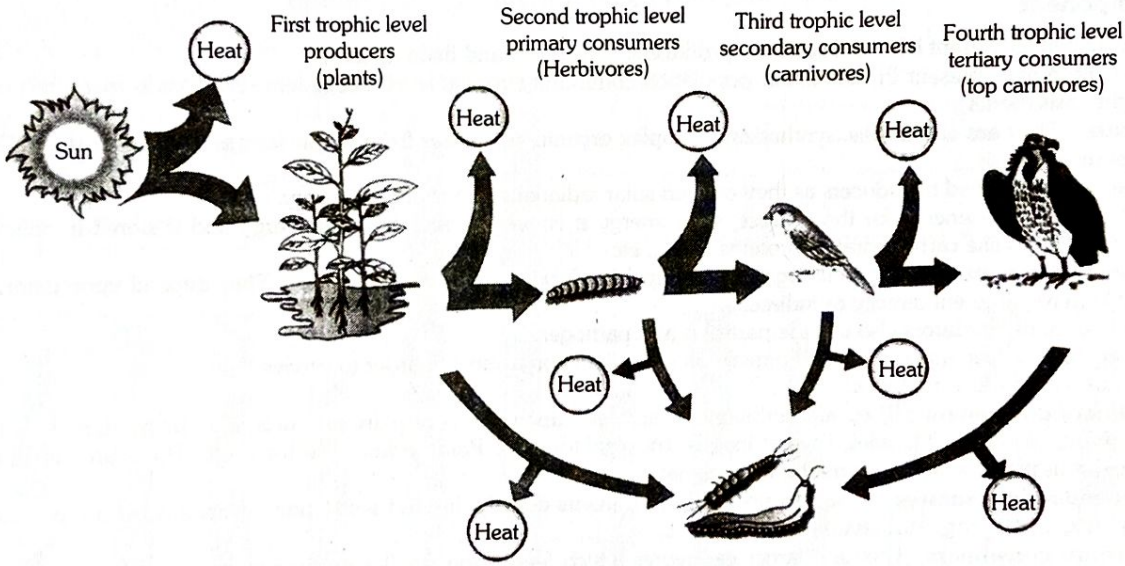
4.1. Types of Food Chain

(1) Grazing food Chain (GFC)/predator food Chain

- Major conduit for energy flow in aquatic ecosystems.
- Always begins with producers
- Sun is the only source of energy
- Size of organisms commonly increase at higher trophic levels

(2) Detritus Food Chain (DFC) Death of an organism is the beginning of DFC.

- In terrestrial ecosystems, a much larger function of energy flows through the DFC than through the GFC.
- Source of energy is detritus not sun.



- Composed of a long chain of detritus eating organisms (detritivores)
- In some ecosystems (Tropical rain forest) more energy flows in this chain than GFC.
- DFC may be connected with the GFC at some levels, as some of the organisms of DFC are prey to certain GFC animals and in a natural ecosystem, some organisms like cockroaches, crows etc. are omnivores

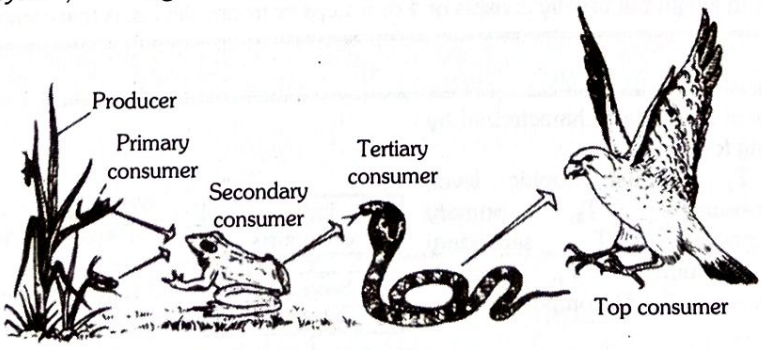


Fig. : Energy flow through different trophic levels

(3) Parasitic food chain/Auxillary food chain

Size of the organisms finally reduces at higher trophic level (parasite). e.g., Tree → herbivore birds → lices and bugs.

- **Terrestrial food chains**
  (1) Grass → Rabbit → Cat → Wolf → Tiger
  (2) Grass → Grasshopper → Frog → Snake → Peacock → Falcon.
  (3) Vegetation → Insect → Predator bird → Hawk.

- **Aquatic food chains**
  (1) Phytoplanktons → Zooplanktons → Crustaceans → Predator insects → Small fish → Large fish.
  (2) Phytoplanktons → Zooplanktons → Crustaceans → Predator insects → Kingfisher → Stork.

5. Food web

In ecosystem, linear food chains as shown above seldom exist, because every organism has alternate source of food. An animal may have preference for a particular prey, but if the latter has a small population, it may feed upon some other prey.

- Single 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.
- It is a network of food chains, which are interconnected at different trophic levels.
- It increases the food quantity and quality at each trophic level.
- The network of interconnected food chains at different trophic levels in a biotic community is termed food web. Occurrence of food webs provides stability to ecosystem. Food webs operate because of taste preference for particular food and unavailability of food. One animal may feed upon organism of even different trophic level like – Snakes may feed upon mice (herbivore) and frogs (carnivore), jackals are both carnivores and scavengers.

5.1. Function

Food webs distinguish levels of producers and consumers by identifying and defining the importance of animal relationships and food sources, beginning with primary producers such as plants, insects and herbivores.

5.2. Significance

Food webs are important tools in understanding that plants are the foundation of all ecosystems and food chains, sustaining life by providing nourishment and oxygen needed for survival and reproduction.

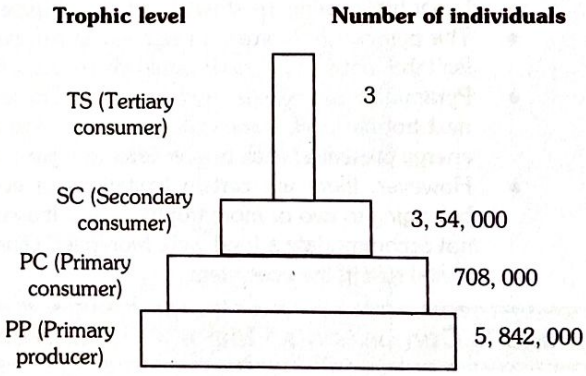
5.3. Ecological Pyramids/Eltonian Pyramids (1927)

Graphic representation of an ecological parameter (number, biomass, energy) sequence-wise in trophic levels of a food chain. Quantity at each trophic level is indicated by length of bar in the graph so also called bar diagrams.

It can be upright (gradual decreasement of parameter), inverted (gradual increasement of parameter) or spindle-shaped (first increasement then decreasement of parameter).

The base each pyramid represents the producers or the first trophic level while the apex represents tertiary or top level consumer.

The three ecological pyramids that are usually studied are (a) pyramid of number; (b) pyramid of biomass and (c) pyramid of energy.



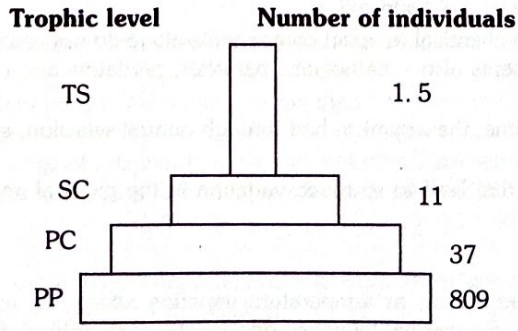
(1) Pyramid of Numbers :

It represents number of individuals per unit area at various trophic levels sequence-wise (producers at base and various consumers at successively higher levelsIt is generally **upright** as maximum individuals occur at producer level, followed by smaller number of herbivores, fewer primary carnivores and still fewer higher levels of carnivores.

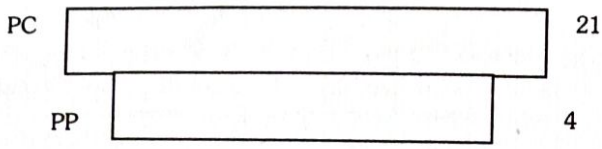
Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants

(2) Pyramid of Biomass :

It represents the biomass in various trophic levels. It is more real than the numbers at various trophic levels. Pyramid of biomass is **upright,** except in aquatic food chain involving short lived plankton.



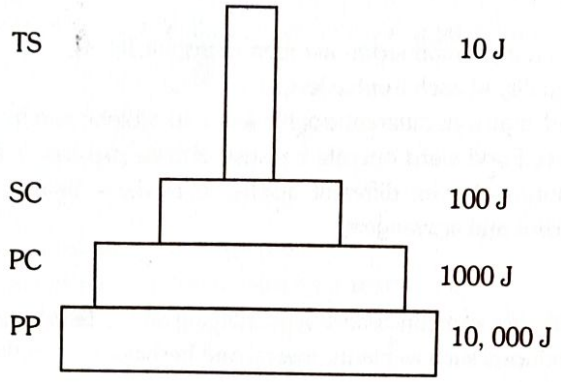
Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels



Inverted pyramid of biomass-small standing crop of phytoplanktion supports large standing crop of zooplanktion

(3) Pyramid of Energy:

Represents amount of energy trapped by different trophic levels per unit area. It is more accurate than other type of pyramid. Always upright because during transfer of energy from one trophic level to next, a lot of wastage occurs respiration



An ideal pyramid of energy

Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP.

- **Note :** Any calculations of energy content, biomass, or numbers has to include all organisms at that trophic level. No generalizations we make will be true if we take only a few individuals at any trophic level into account.
- In most ecosystems, all the pyramids, of number, of energy and biomass are upright, i.e., producers are more in number and biomass than the herbivores, and hervivores are more in number and biomass than carnivers. Also energy at a lower trophic level is always more than at a higher level.
- There are exceptions to this generalization: If you were to count the number of insects feeding on a big tree what kind of pyramid would you get? Now add an estimate of the number of small birds depending on the insects, as also the number of larger birds eating the smaller. Draw the shape you would get.
- The pyramid of biomass in sea is also generally inverted because the biomass of fishes far exceeds that of phytoplankton. Isn't that a paradox? How would you explain this?
- Pyramid of energy is always upright, 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. Each bar in the energy pyramid indicates the amount of energy present at each trophic level in a given time of annually per unit area.
- However, there are certain limitations of ecological pyramids such as it does not take into account the same species belonging to two or more trophic levels. It assumes a simple food chain, something that almost never exists in nature; it does not accommodate a food web. Moreover, saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

6. Abiotic Components / Major Abiotic Factors

Ecology at the organismic level is essentially physiological ecology which tries to understand how different organisms are adapted to their environments in terms of not only survival but also reproduction.

- The rotation of our planet around the sun and the tile of its axis cause annual variations in the intensity and duration of temperature, resulting in distinct seasons.
- These variations together with annual variation in precipitation (remember precipitation includes both rain and snow account for the formation of major biomes such as desert, rain forest and tundra.
- Regional and local variations within each biome lead to the formation of a wide variety of habitats.
- There are few key elements that lead to so much variation in the physical and chemical conditions of different habitats. The most important ones are temperature, water, light and soil.
- We must remember that the physic-chemical (abiotic) components alone do not characterize the habitat of an organism completely; the habitat includes biotic components also – pathogens, parasites, predators and competitors – of the organism with which they interact constantly.
- We assume that over a period of time, the organism had through natural selection, evolved adaptations to optimize its survival and reproduction in its habitat.
- The most important key elements that lead to so much variation in the physical and chemical conditions of different habitats are temperature, light, water and soil.

6.1. Temperature

Ecologically it is the **most relevant** factor, as temperature variation affects the enzyme kinetics, basal metabolic activities and physiological functions of organisms. So thermal tolerance decides the geographical distribution of different species to a large extent as for

Mango trees do not and cannot grow in temperate countries like Canada and Germany, snow leopards are not found in Kerala forests and tuna fish are rarely caught beyond tropical latitudes in the ocean.

Based upon thermal tolerance, organisms are of two types :

Stenothermal : Such organisms live in areas where the temperature is uniform throughout the year. The organisms cannot tolerate large temperature variation.

Eurythermal: Such organisms can tolerate large changes in temperature.

The organisms are classified into four temperature groups on the basis of their occurrence in different climatic zones:

(i) **Megatherms:** Organisms are adapted to high temp. throughout year as found in tropical zone.

(ii) **Mesotherms :** They are adapted to mild winters and high summer temperature. The organisms live in subtropical zone.

(iii) **Microtherms :** They live in temperate areas where the winter temperature is low but the summer temperature is moderate.

(iv) **Hekistotherms :** The organisms are adapted long snowy winter period. This condition occurs in arctic tundra or alpine tundra.

Some Rules Based Upon Effects of Temperature:

(i) **Bergman's Rule :** Warm blooded animals (birds and mammals) have larger body size in cold climate than in hotter areas.

(ii) **Allen's Rule :** Extremities (legs, ears, tail and mouth) of warm blooded animals become smaller in colder areas as compared to animals of warmer areas.

(iii) **Jordan's Rule :** As the temperature is lowered, some fishes possess larger size with larger number of vertebrae.

Thermal Stratification in Lakes

The occurrence of temperature variations in different horizontal layers as in a deep water body is called thermal stratification.

A deep water body has three temperature strata – epilimnion, metalimnion and hypolimnion.

(a) **Epilimnion :** Upper stratum, with highest dissolved oxygen concentration. This area is warmer during summers.

(b) **Hypolimnion :** Lower stratum of water characterized by a temperature gradient of less than 1°C per meter. It contains denser, cooler and relatively quite water.

(c) **Metalimnion :** It is transitional stratum of marked thermal fluctuations between hypolimnion and epilimnion. Its middle layer is characterized by temperature gradient of more than 1°C per meter of depth called as thermocline.

Tropical lakes show mixing (turnover) or water one (monomictic) while temperate lakes show, the mixing twice a year (dimictic), on the other hand the hypersaline lakes show incomplete (half) mixing (meromictic).

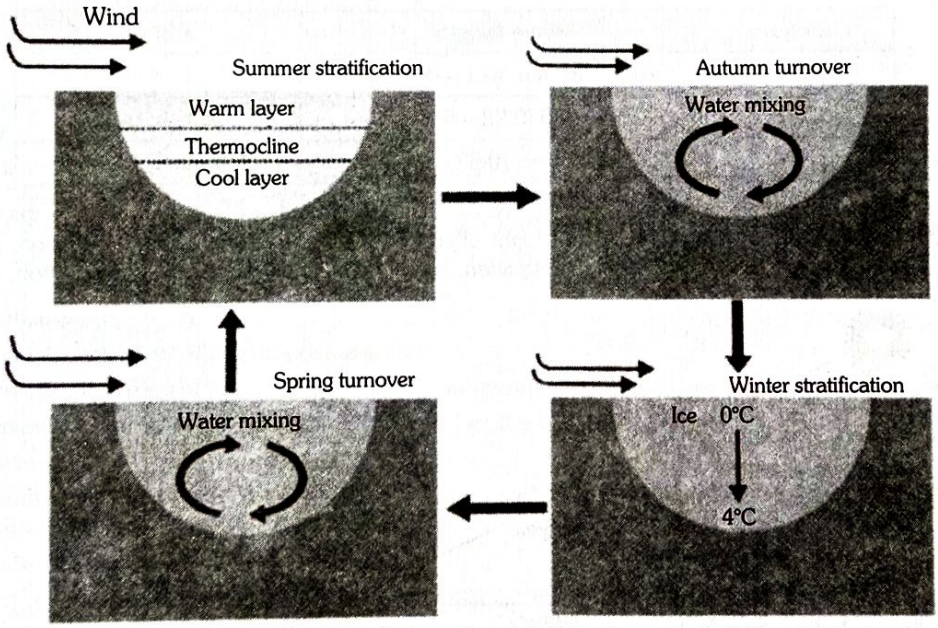


Fig. : Thermal stratification in a temperate lake

6.2. Water

Next to temperature, water is another important factor influencing the life of organisms. Water is present over 71% surface of earth as oceans, lakes, rivers, ice caps and glaciers.

Sea water has high percentage of salt content (3.5%). Water present on land is called fresh water. Its salt content is low i.e., less than 0.5%.

Salt concentration (measured as salinity in parts per thousand) is less than 5 percent in inland water, 30–35 percent for sea and more than 100 percent in hypersaline lagoons.

Some organisms are tolerant to a wide range of salinities (euryhaline), but others are restricted to a narrow range (stenohaline).

On the basis of dependence of plants on water, Warming recognized three kinds of plant communities : (1) Hydrophytes, (2) Mesophytes and (3) Xerophytes

(1) Hydrophytes

Plants growing in water or in water saturated soil are called hydrophytes. These are of basic three types :

(A) **Submerged :** Submerged plants are those in which are leaves are entirely beneath the water e.g., Hydrilla, Vallisneria, Potamogeton and Ceratopyllum

(B) **Floating :** In floating plants leaves float on the water surface, but roots and stem may remain in water, or float on water like the leaves. These are classified into two groups.

(i) **Free floating :** They change their position due to water current, because their roots are not embedded in soil e.g., Wolffia, Lemna, Eichhornia, Pistia.

(ii) **Rooted floating :** In these plants leaves float but the roots adhere to bottom soil particles e.g., Nelumbium speciosum, Nymphaea stellata, Jussiaea, Trapa etc.

(C) **Amphibious plants :** The basal part of the body (roots and lower portion of stem) is embedded in water saturated soil e.g., Typha, Ranunculus.

(2) Mesophytes

Plants growing in places of moderate water supply. e.g., garden plants and corps.

(3) Xerophytes

Plants growing in places of deficient water supply. These plants grow in deserts or on rocks, e.g., Opuntia, Aloe, Agave, Casuarina, Calotropis, Muehlenbeckia, etc.

Types of Xerophytes :

On the basis of life cycle and water storage:

(a) **Ephemerals :** Short living, brief life span (6-8 weeks), escape dry season by disappearing leaving their seeds; so are called **drought evaders/drought escapers** e.g. Cassia, Tribulus.

(b) **Succulents (fleshy xerophytes) :** Water is stored it in different body parts; suffer only externally; hence drought **avoiding** or **drought resistant** xerophytes.

(i) **Stem Succulents (chylocauly) :** e.g., Opuntia, Euphorbia E. tirucalli, Cereus.

(ii) **Leaf Succulents (chylophyllous) :** e.g., Aloe, Agave, Bryophyllum.

(iii) **Root Succulents : e.g. Cieba**

(c) **Non-Succulents : Drought endures,** true xerophytes: can tolerate long drought periods by anti transpiring structures (permnnial non succulents) e.g., Casuarina, Zizyphus, Nerium, Acacia, Capparis.

6.3. Light

At 83 km above Earth's surface, solar radiation carries energy equivalent to 2 cal/cm^2/min. This value is called as solar constant.

Category	Wave length	Effect
UV–C	100 – 280 nm (0.1 – 0.28 μm)	Lethal
UV-B	280 – 320 (0.28 – 0.32 μm)	Quite harmful
UV-A	320 – 400 nm (0.32 – 0.4 μm)	Moderately harmful

UV-C and about half of UV-B radiations are absorbed by ozone layer of stratosphere. A large amount of the rest is dissipated by particles of troposphere, only a small amount reaches on Earth. Light affects photosynthesis, growth, reproduction, movements stratification, photoperiodism and phenology in plants, It affects migration, reproduction, development, pigmentation, locomotion and periodic activity in animals.

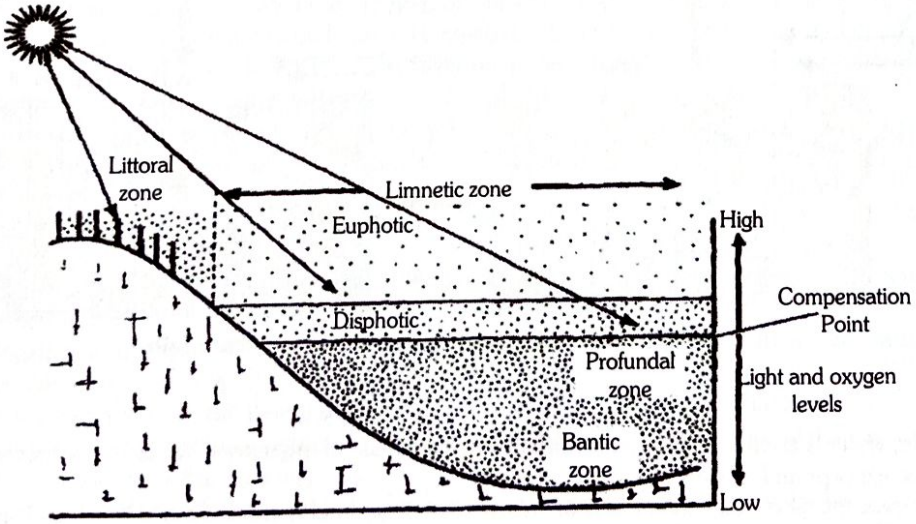


Fig. : Zonation in deep lake showing gradient of light and oxygen

Knowledge Plus:

(1) Ecological Equivalents: They are organisms occupying the same type of niches but in different habitats. e.g. Owl and cat feeding upon mice and shrew.

(2) Ecological Amplitude : It refers to the range of tolerance for all the factors influencing a species. Higher the amplitude, wide will be the distribution range.

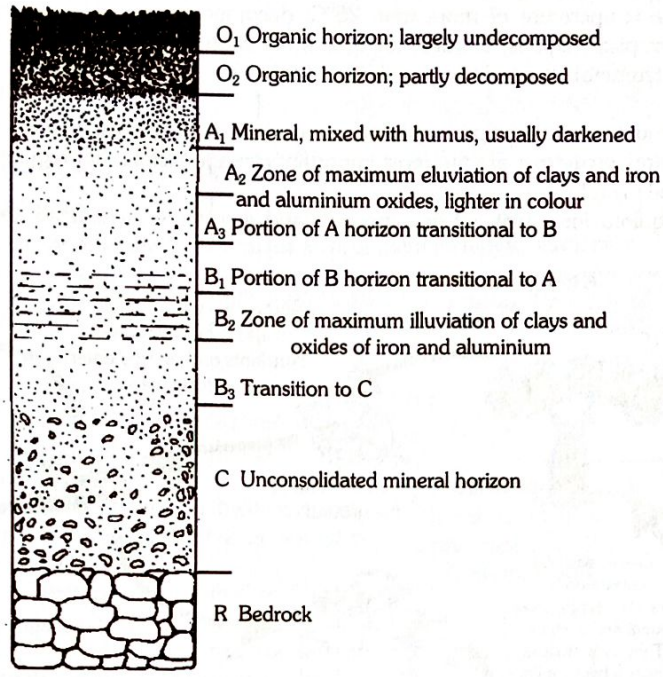
6.4. Soil

Earth's uppermost crust, upto which roots gets penetrated. Study of soil is called Pedology.

(1) Soil Composition

Soil consists of four components, two solid and tow non-solid. The solid components are mineral particles and organic matter. The two non-solid components are air and water. A fifth component of variable nature is soil organisms. The proportion of different components is

Mineral Particles	40%
Organic Matter	10%
Air	25%
Water	25%



Soil profile

Chief characteristics of the soil are studied with the help of soil profile. Type of soil profile depends upon climate and vegetation of the area. The smallest three dimensional volume of soil required to study its profile is called pedon. Most soils possess 3 – 4 horizons and a number of sub horizons. A soil horizon is a horizontal layer approximately parallel to soil surface that possesses distinctive properties which are unlike the ones present in adjoining regions. In general, a profile consists of O, A, B, C & R horizons.

(2) Soil Formation :

Soil formation includes weathering and pedogenesis.

(1) **Weathering :** Breaking of rocks into fine particles as present on soil. It occurs due to following methods :

(2) **Pedogenesis :** Formation of soil from dead organic matter by decomposition.

(3) Decomposition

It is the process of physical and chemical breakdown of complex organic remains by organisms called decomposers, so as to produce inorganic raw materials (CO_2, H_2O, minerals, etc.) for recycling.

(4) Decomposition Processes

There types of processes occur simultaneously during decomposition of detritus, viz. fragmentation, leaching and catabolism.

(1) **Fragmentation of Detritus:** Small invertebrate animals called detrivores feed on detritus, e.g., Earthworms, termites. They bring about its fragmentation.

(2) **Leaching :** Part of soluble substances present in the fragmented and decomposing detritus (e.g., sugars, inorganic nutrients) get leached to upper layers of soil by percolating water.

(3) **Catabolism :** It is carried out by saprotrophic bacteria and fungi. They secrete digestive enzymes over the fragmented detritus. The enzymes change complex organic compounds into simple compounds. Inorganic substances are also released in the process.

The rate of catabolic action or breakdown of different complex substances is different. This differential decomposition produces two substances, humus and inorganic nutrients in processes respectively called humification and mineralization, which occurs in soil.

(i) **Humification :** It is the process of partial decomposition of detritus to form humus. Humus is a dark coloured, amorphous, partially decomposed organic matter rich in cellulose, lignin, tannins, resin, etc. and is highly resistant against microbial action. It undergoes decomposition at an extremely slow rate. Humus is slightly acidic, colloidal and functions as reservoir or nutrients.

(ii) **Mineralization :** It is the release of inorganic substances (e.g., CO_2, H_2O, minerals) from organic matter during the process of decomposition.

(5) Factors Affecting Decomposition

The rate of decomposition of detritus is controlled by a number of factors.

(i) **Chemical Nature of Detritus :** Decomposition of detritus is slow if it contains lignin, chitin, tannins (phenolics) and cellulose. It is rapid if detritus possesses more of nitrogenous compounds (like proteins, nucleic acids) and water soluble reserve carbohydrates.

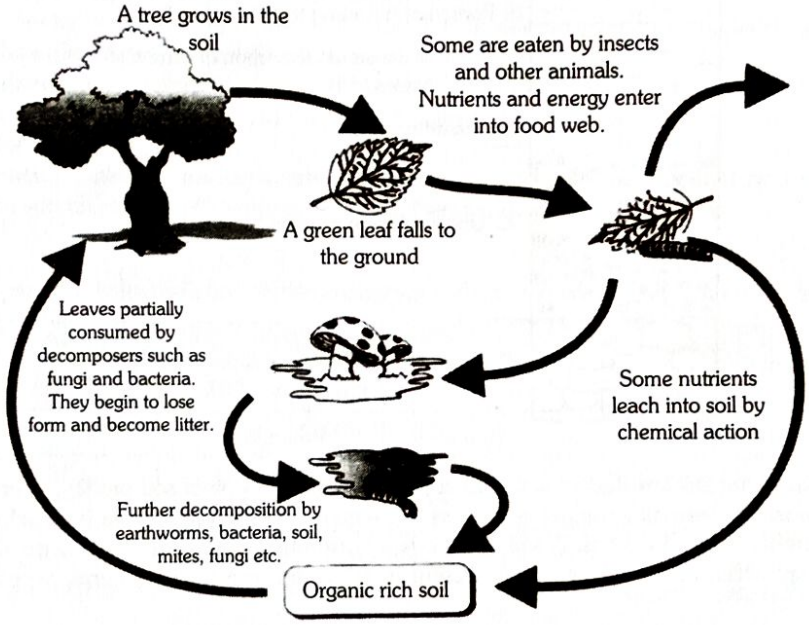
(ii) **Soil pH :** Detrivores are fewer in acidic soils. Microbial activity is also low in such soils. Therefore, rate of decomposition of organic matter is slow in acidic soils. Detrivores are abundant in neutral and slightly alkaline soils, while decomposer microbes are rich in neutral and slightly acidic soils.

(iii) **Temperature :** At a temperature of more than 25°C, decomposers are very active in soils having good moisture and aeration. In humid tropical regions, it does not take more than 3 – 4 months for complete decomposition of detritus. However under low temperature conditions (> 10°C) of soils, rate of decomposition is very slow even if moisture and aeration are optimum.

(iv) **Moisture :** An optimum moisture helps in quicker decomposition of detritus.

Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes.

(v) **Aeration :** It is required for activity of decomposers and detrivores. A reduced aeration will slow down the process of decomposition.



Diagrammatic representation of decomposition cycle in a terrestrial ecosystem

(6) Eluviation and Illuviation

They two processes bring about transport and deposition of materials in the soil. Eluviation is washing down of materials from upper strata. Eluviation helps in enriching different layers of soil with minerals. Illuviation is deposition of washed down minerals in lower strata.

Mineral Matter : It consists of inorganic substances present as particles of different sizes and composition.

(i) **Gravel :** It is made of fine particles with a size of 2 – 10 mm.

(ii) **Sand :** It has grains of quartz or silicon dioxide (SiO_2). Size varies from 0.02–2.0 mm. It is chemically inert. It allows quick percolation of rain or irrigation water. Aeration is good.

(iii) **Silt :** It is formed of fine grains of quartz. The size is 0.002 – 0.02 mm. it is chemically inert.

(iv) **Clay :** Made of Al, Fe and Si. The size is below 0.002 mm. Clay particles are chemically active and have fine interspaces that can hold abundant water but aeration is poor.

Soil Porosity : It is percentage of interspaces present per unit weight of soil. Soil porosity is 30% in sandy soils, 45% in loam soil and 50% in clay soil. There are two types of soil pores, micropores and macropores. Micropores are small sized interspaces having a diameter of 20 μm.

Soil Air

It is air present in macropores with a size between 20-50 μm. A good soil should have 25% air by volume. Soil air is required for respiration of roots. Soil air is richer in CO_2 and poor in O_2.

Residual soils develop in situ. Transported soils are brought from other places through gravity (colluvial), running water(deposited at flood plains and called alluvial). Wind (eolian = aeolian) and glacier (glacial soil).

Soil pH

It determines the type of soil microorganism, solubility of different minerals and type of plans which can grow. In alkaline soils (pH above 7), there is reduced availability of Zn, Mn, Cu and Fe. In acidic soils there is abundance of iron, Mn and Al, but deficiency of Ca, Mg and K. Some soils possess excess of salts especially those of Na and Mg. They are called Saline soils. Salinity increases with excessive irrigation.

(E) Topography

Surface configuration of an area (physical features like hills, plains or slopes) also influences the distribution of organisms.

(F) Rainfall: Measured by rain gauge. Vegetation of a place is primarily determined by rainfall.

(1) Rainfall through year ----- Tropical rain forest,

(2) Rainfall only in summer----- Grassland,

(3) Rainfall only in summer----- Sclerophyllous vegitation.

Vegetation and Annual Rainfall

(i) Evergreen Tropical Forest : 250 – 400 cm.

(ii) Tropical Deciduous Forest : 100 – 200 cm.

(iii) Taiga : 100 – 250 cm.

(iv) Temperate deciduous Forest : 75-150 cm.

(v) Chapparal : 50-75 cm (in winter).

(vi) Grassland and Savannah : 25-75 cm.

(vii) Desert : Less than 25 cm.

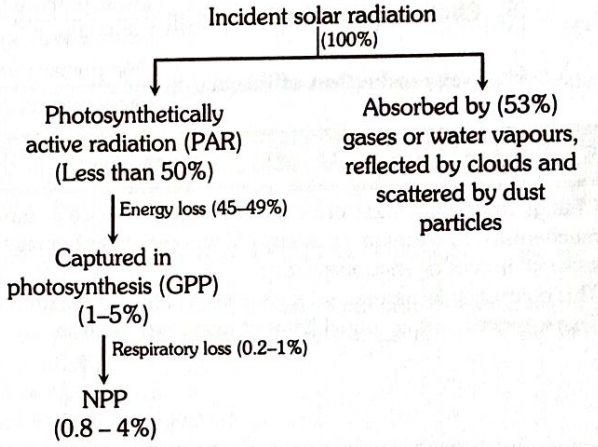
(vii) Topography : Surface behaviour of earth determines environment including wind, rainfall, light and temperature.

7. Energy Flow

Ultimate source of energy in ecosystem is sun.

Flow of incident energy is shown below :

- It means plant capture only 2-10% of the PAR and this small amount of energy sustains the entire living world. All organisms depend upon plants (directly or indirectly) for energy.
- There is a unidirectional or one way flow of energy in the ecosystems. Source of all energy is solar energy. 50% of incident solar energy is photosynthetically active radiation (PAR).
- Storage & expenditure of energy in ecosystems is governed by first two laws of thermodynamics.
- Transfer to energy from one trophic level to another occurs by second law of thermodynamics Transfer to food energy from one trophic level to another is accompanied by loss of major part of food energy (roughly 90%) as heat. Only 10% or less is stored as biomass (Lindeman Law).
- Under favourable condition, 1-5% of incident solar radiation of 2-10% of incident PAR (photosynthetically active radiation) is captured by producers in their photosynthesis as gross primary productivity (G.P.P.).



- 20% of trapped energy in G.P.P. is utilized by producers in their own respiration. So, net primary productivity (NPP = G.P.P. minus respiratory loss) is 0.8-4.0% of total incident solar radiation of 1.6 – 8.0% of PAR.
- NPP is available to herbivores. Herbivory removes only a part of NPP. Remaining unutilized NPP is ultimately changed into detritus. It is energy source of decomposers.
- It is estimated that biomass energy available at herbivore level forms only 10% or less biomass energy at primary carnivore level. There is a similar reduction in energy at successive higher carnivore level.
- Energy availability decreases at higher trophic level, so ecosystem has only 3-5 trophic levels.

7.1. Productivity of Ecosystem

The rate of biomass production is called productivity. It is expressed in terms of $(gm^{-2})\ yr^{-1}$ or $(k\ cal\ m^{-2})\ yr^{-1}$ to compare the productivity of different ecosystems.

(i) Coral reefs, tropical rain forests, sugarcane fields are most productive.

(ii) Deserts and deep sea ecosystems are least productive.

Ecosystem productivity is maintained by flow of energy derived from the sun. Energy trapped by plants varies from ecosystem. Table below shows **energy absorption** at different levels:

1.	Aquatic ecosystem	0.2%
2.	Terrestrial ecosystem	1%
3.	Grassland	1.15%
4.	Mixed forest	0.81%
5.	Modern crops	5%
6.	Sugarcane field	10-12% (Most efficient)

7.2. Types of productivity

(1) **Primary Productivity** : The rate at which radiant energy is stored by photoautotrophs and chemoautotrophs.

- **Gross Primary Productivity (GPP) :** It is the rate of organic matter synthesized by producers per unit area per unit time.
- **Net Primary Productivity :** It is the rate of organic matter built to or stored by producers in their bodies per unit time and area. Net productivity is equal to gross primary productivity minus loss due to respiration and other reasons. NPP is the available biomass for the consumption to heterotrophs i.e. herbivores and decomposers.
  Net primary productivity = Gross primary productivity – Respiratory loss.
  Primary productivity depends on the plant species inhabiting a particular area, availability of nutrients and photosynthetic capacity of plants. This is available to herbivore level.
  The annual NPP of whole biosphere is approximately 170 billion tons (dry wt.) of organic matter, despite occupying about 70% of the surface, the productivity of the oceans is only 55 billion tons. In deep marine habitats, both light and nutrients become limiting. The most limiting nutrient of marine ecosystem is nitrogen.

(2) **Secondary productivity :** Rate of increase in energy containing organic matter or biomass by heterotrophs or consumers per unit time and area is known as secondary productivity. It is available to carnivore level.

(3) **Community productivity :** It is the rate of net synthesis of built up of organic matter by a community per unit time and area.

(4) **Ecological efficiency/Trophic level efficiency :** The percentage of energy converted into biomass by a higher trophic level over the energy of food resources available at the lower trophic level is called ecological efficiency. No organism is 100% efficient.

$$\text{Ecological efficiency} = \frac{\text{Energy converted inb biomass at a trophic level}}{\text{Energy present in biomass at lower trop hic level}} \times 100$$

(5) **Photosynthetic efficiency** $= \frac{\text{Gross primary productivity}}{\text{Incident total solar radiation}} \times 100$

(6) **Net production efficiency** $= \frac{\text{Net primary productivity}}{\text{Gross primary productivity}} \times 100$

8. Response to Abiotic Factors

Change in one environmental factor leads to change in others also i.e., all factors are integrated. An organism would have evolved various mechanisms to maintain its internal Environment at homeostasis to perform its physiology and biochemical functions in response to changing external factors of environment.
This constancy in necessary for its overall fitness or maximum performance. This may be maintained naturally or artificially.
There appear various possibilities of responses, such as:

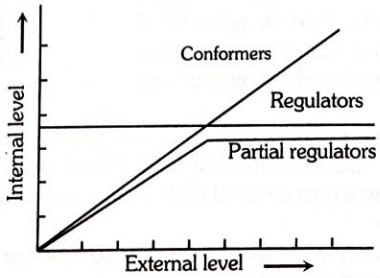


Fig. : Diagrammatic Representation of Organismic Response

8.1. Regulate

It is maintenance of homeostasis by physiological or behavioural means like thermoregulation and osmoregulation. e.g., all birds and Mammals, a few lower vertebrate and invertebrates; but plants do not have such mechanisms.
Evolutionary success of mammals is believed largely due to their regulation ability.

8.2. Conform

These organisms cannot maintain thermal and osmotic balance with environment. e.g., approximately 99% of animals and nearly all plants. Thermoregulation is energetically especially for small animals having large surface area relative to their volume, due to this, very small animals are rare in polar regions.
Some species have ability have ability to regulate upto a limited range, beyond which they simply conform (partial regulators).
For localized or short outburst of stressful conditions the organisms have two alternatives, like migration of suspended growth.

8.3. Migrate

Temporary movement of organisms from stressful area to more favourable area in terms of food, shelter, spawning of climate. e.g., Siberian crane migration from Siberia to Keoladeo National Park (Bharatpur, Rajasthan).
Locust migrates for food and Salmon fish migrates for egg spawning. Ungulate migration of Africa is for food.

8.4. Suspend

It is the stage in life cycle where an organism changes its development, physiological, structural, biochemical behaviour to pass through unfavourable conditions. e.g., Thick walled spores in bacteria, fungi and lower plants.

8.5. Dormancy

in seeds and other vegetative parts in higher plants.

8.6. Hibernation

(winter sleep) is shown by organisms which are unable to migrate, like Bears.

8.7. Aestivation

summer sleep) is shown by e.g., snails and fishes.

8.8. Diapause

State of temporary suspension of development under unfavourable conditions. e.g., Zooplanktons in lakes and ponds.

8.9. Adaptation

Changes occurs to survive in an environment is called adaptation. It may be morphological, physiological, behavioral. They can be genetic or non genetic.

8.10. Some adaptations are given below

(1) Seals have a thick layer of fat (blubber) below the skin to reduce loss of body heat.
(2) Altitude sickness can be expressed at high altitude where body does not get enough oxygen due to low atmospheric pressure and causes nausea, fatigue and heat palpitations. Under these conditions, body increases RBC production, decreases binding capacity to Hb and increases breathing rate. These physiological adaptations allow organisms to respond quickly to stressful conditions.
(3) Archaebacteria can flourish at temperature exceeding 100°C while humans can perform the metabolism in a narrow range (37°C).
(4) Antarctic fishes can survive below 0°C and a variety of invertebrates and fishes are adapted biochemically to survive great depths with crushing pressure. In Antarctic fishes, body fluid contains antifreeze solutes.
(5) Desert lizards lack the physiological ability to cope with extreme temperature but manage the body temperature by behavioural means.
(6) Kangaroo rat of North American desert fulfils water demands by internal oxidation of fats and it also has the ability to concentrate its urine.

9. Niche/Ecological Niche (Grinnel, 1971)

It is specific part of habitat occupied by individuals of a species, which is circumscribed by its range of tolerance, range of movement, microclimate, type of food and its availability, shelter, type of predator, and timing of activity.
Tadpole and adult frog occupy different niches as former is herbivorous while latter is carnivorous.
Both Owl and Cat of different habitat feed on Mice so occupy same niche, so called ecological equivalents.

10. Ecosystem- Structure and Function

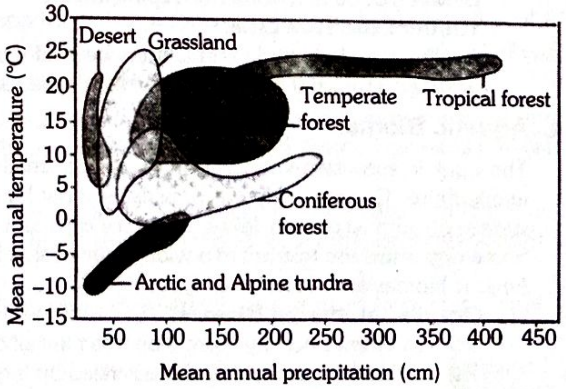
10.1. Biome (Major Ecosystems)

Large natural ecosystem which is distinct in its climatic conditions and has its specific group of climax plants and associated animals forms a biome. Regional and local variations within each biome lead to the formation of a wide variety of habitats. Rainfall, temperature range,nature of soil, barriers, latitude and altitude determine the nature and extent of biomes

(a) **Terrestrial:** On land, e.g. tundra, taiga, deciduous forest, tropical forest, chapparal.
(b) **Aquatic:** Aquatic biomes include ocean, lake, pond, marsh and stream.

(1) Latitude :
(i) Equator : 0°.
(ii) Tropic of Cancer : 23.5°N
(iii) Tropic of Capricorn : 23.5°S of equator.
(iv) Arctic Circle: 66.72°N.
(v) Antarctic Circle : 66.72°S

(2) Biotic Zones :
(i) Tropical : Between 23°N and 23°S)
(ii) Subtropical : Between 23° to 40°.
(iii) Temperate : Between 40° to 60°.
(iv) Arctic : Between 60° to 70° N.



10.2. Major Biomes of India

(1) **Tropical Rain forests :** In India, tropical rain forests are found mainly along western ghats and in North – Eastern Himalayas. These possess highest standing crop among all biomes. Buttress and leaf drip tip are common. Woody climbers and epiphytes grow profusely in these forests.

(2) **Tropical Deciduous Forests :** They occur in northern and southern parts of India in plains and low hilly areas. Sal, teak, tendu, khair and chiraunji are common trees of these forests.

(3) **Desert :** In these biomes the vegetation is very sparse due to extremes of temperature and very little rainfall (below 10 cm). It occupies 1/5 of land. It lacks rain (less than 10 cm) due to

(a) **Rain Shadow :** Area beyond high mountains which cut off clouds (e.g. Tibet).

(b) **Lack of cloud Intercepting Mountains :** (e.g., Thar).

(c) **Lying Away from Cloud Seeding Regions :** e.g. Death Valley (Great Western Desert) of U.S.A. Sahara (Africa), Gobbi, Arabian and Thar of Asia (Rajasthan).

Hot deserts are characterized by high rate of evapotranspiration and albedo.

(4) **Coastal Biome :** Coastal areas are zones of transition between oceanic and terrestrial habitats, so are very sensitive. These are detritus based biomes, where plants have to adapt for salinity and water logged conditions.

Mangrooves are the major types alongwith salt marshes or swamps. Mangrooves are characterized by presence of pneumatophores and viviparous seed germination.

(5) **Temperature Broad Leaf Forests :**

(i) Between 1500 m – 2400 m altitude in western Himalayas predominated by oaks. e.g., Quercus floribunda(ii) Show peak leaf fall during summer but never become leafless.

(6) **Temperate Needle Leaf of Coniferous Forest :**

(i) Between 1700–3000 m altitude.

(ii) Predominated by economically valuable gymnospermous, like – Pine (Pinus wallichiana), Deodar (Cedrus deodara), Silver fur (Abies), Spruce (Picea) and Cypress (Cupressus).

10.3. Some Important Biomes of the World – A Brief Account

(1) Tundra : It is located in the north of timber line or 60° N latitude below the polar ice. It is absent in southern hemisphere. It extends across North America. Europe and Asia. Also called as arctic tundra. Subsoil remains frozen except upper few inches in the summers. The condition is called permafrost.

Vegetation is scanty, low growing and devoid of trees and thus, the region is termed arctic desert.

(2) **Taiga (North coniferous/temperate needle leaf forest):** It occurs in North America, Europe and Asia. It is also found in southern hemisphere.

(3) **Chapparal (Mediterranean scrub forest):** The biome extends along the Mediterranean, Pacific coast of North America, Chile, South Africa and South Australia. Natural fires are characteristic of this biome. Rainfall is very limited, occurs only in winter. The climate remains dry in the rest of the year.

(4) **Grasslands :** (a)**Savanna : Tropical grassland** with well developed grass cover interspersed with scattered shrubs and small trees.

(a) Distributed in warmer parts of India, Africa and Australia.

(b) **Temperate Grasslands :** The temperate grasslands are present in North America (Canada and U.S.A.), South America, Eastern Europe, Central Asia, South Africa and Australia. These are of different types depending upon the constituent flora in different countries, such as Prairies (Canada and the USA), Pampas (South America), Steppes (Europe and Asia), Veldts (South Africa), Tussocks (New Zealand) and Dawns (Australia).

(5) **Alpine/Alpine Tundra**

It is tree-less area on high mountains (above 3500 m), which has snow for long months.

It is well drained and slopy. Plants include lichens, mosses, grasses, small shrubs (e.g., Artemesia, Primula) and dwarf trees (e.g., Rhododendron, Juniperus). Long tree are absent.

In eastern Himalayas (i) Up to 1600 m elevation – Subtropical vegetation (ii) Between 1600 and 3600 m – Temperature (iii) Between 3600 and 4600 m – Alpine tundra.

Timber Line/Tree Line:

It is the zone in latitude and altitude beyond which trees cannot grow. Only shrubs and herbs (alpine/arctic meadow) occur. It is between 3100-3600 m in western Himalayas.

10.4. Aquatic Biomes

The aquatic ecosystems range from ocean to small ponds or lakes showing wide range of variations regarding salinity, depth and temperature. Consequently the organisms show lot of diversity in their adaptations to the surroundings Water is present over 71% surface of earth as oceans, lakes, rivers, ice caps and glaciers.

Some organisms are tolerant to a wide range of salinities (euryhaline), but others are restricted to a narrow range (stenohaline).

Aquatic biomes are of four main types.

(1) **Oceanic or Marine Biomes:**

Oceanic biomes occupy more than two third of the earth's surface.

The marine environment is characterized by high concentration of salts (about 3.5% in open sea) and mineral ions (mostly Na^+ and Cl^- ions followed by sulphur, magnesium and (calcium).

The productivity of oceanic biome is less than that of most the terrestrial biomes.

The ocean basin is always like a wash basin or inverted hat.

- **Open Sea :** It includes the area of sea beyond continental shelf and is divided into 3 zones – euphotic, disphotic and abyssal zone depending upon the degree of light penetration. On the basis of environment, it has two parts-pelagic (open water zone) and benthic (bottom zone).

  The open sea/pelagic part is differentiated into euphotic zone (upto 200m depth, sufficient light penetrates the zone), disphotic /aphotic zone (200-2000 m depth, little light) and abyssal zone (dark zone).

Both producers and consumers occur in photic zone in abundance, whereas only few producers alongwith consumers occur in disphotic zone. The abyssal zone is characterized by the presence of consumers, scavengers and decomposers, while producers are absent.

- **Coastal Region :** It is the area of continental shelf and is usually divided into 3 zones: intertidal, littoral and neritic zones.
- **Estuary:** Ecotone areas where river mouth meets the oceanic water. This area shows wide fluctuations in salinity due to mixing of fresh and sea-water. Estuary constitutes one of the most productive ecosystems. It includes both fresh water and marine organisms. Highly productive due to turbulence (measured by Secchi disc).

Euryhaline : Organisms which can tolerate wide fluctuations in salt concentration.

Stenohaline : Organisms cannot toerate fluctuations is salt concentrations.

Catadermous (migrating to marine water) and Anadermous (migrating to fresh water) organisms are found.

(2) **Ponds and lakes :** These are stationary fresh water bodies (Lentic ecosystems) on land occur in almost all biomes.

Ponds vary in size and may be natural or man-made depressions which get filled with rain or run off water. These may be seasonal or permanent.

Depending upon the Productivity, Lakes are of Three Types:

(i) **Eutrophic Lakes** have rich flora and fauna. These lakes are shallow with quick circulation of nutrients e.g., Dal Lake of Kashmir.

(ii) **Oilgotrophic Lakes** have lesser flora and fauna with low circulation of nutrients, particularly phosphates, is poor. e.g., Sambar Lake of Rajasthan.

(iii) **Dystrophic Lakes :** Rich in humic acid, low productivity, like bog, peat filled lake.

(3) **Streams and Rivers :**

These are fresh water bodies (Lotic ecosystems) which differ in physical and chemical conditions, oxygen content, temperature, speed and volume of water.

(4) **Marshes :**

These are temporarily produced low lying areas, few *cms* in depth, containing turbid water.

Man-Made/Artifical Ecosystems

They include aquaria, dams, parks, gardens, orchards, human settlements and agriculture.

These have little accumulation of biomass and unstable due to little diversity, little recycling of nutrients and no self regulatory mechanisms.

11. Biotic/Ecological Succession

Successive development of communities at same site till development of climax community. Stability, diversity, niche specialization, biomass increases from pioneer to stable community. Concept of succession was given by Warming & Clements. Term was given by Hult.

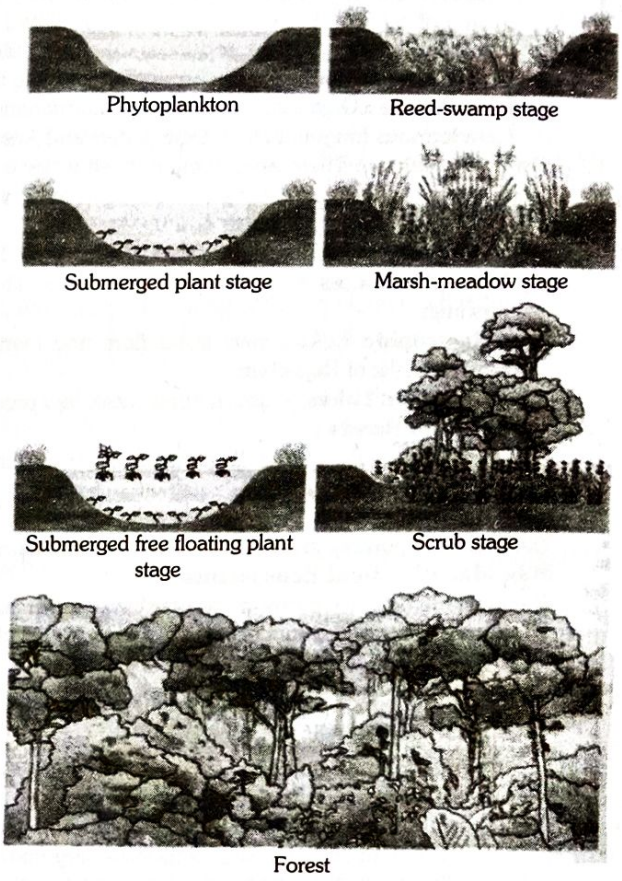
Succession is universal and unidirectional in vegetation during ecological time. The characteristics of population and community and also their response to environment and how such responses vary from an individual response.

- An important characteristic of all communities is that their composition and structure constantly change in response to the changing environmental conditions.
- This change is orderly and sequential, parallel with the changes in the physical environment. These changes lead finally to a community that is in near equilibrium with the environment and that is called a climax community.
- The gradual and fairly predictable change in the species composition of a given area is called ecological succession. During succession some species colonise an area and their populations become more numerous, whereas populations of other species decline and even disappear.
- The entire sequence of communities that successively change in a given area are called sere(s).
- The individual transitional communities are termed seral stages or seral communities. In the successive seral stages there is a change in the diversity of species of organisms, increase in the number of species and organisms as well as an increase in the total biomass.
- The present day communities in the world have come to be because of succession that has occurred over millions of years since life started on earth. Actually succession and evolution would have been parallel processes at that time.
- Succession is hence a process that starts where no living organisms are there-these could be areas where no living organisms ever existed, say bare rock; or in areas that somehow, lost all the living organisms that existed there. The former is called primary succession, while the latter is termed secondary succession.
- Example of areas where primary succession occurs are newly cooled lava, bara rock, newly created pond or reservoir. The establishment of a new biotic community is generally slow. Before a biotic community of diverse organisms can become established, there must be soil.
- Depending mostly on the climate, it take natural processes several hundred to several thousand years to produce fertile soil on bare rock.
- Secondary succession begins in areas where natural biotic communities have been destroyed such as in abandoned farm lands, burned or cut forests, lands that have been flooded. Since some soil or sediment is present, succession is faster that primary succession.
- Description of ecological succession usually focuses on changes in vegetation. However, these vegetational changes in turn affect food and shelter for various types of animals. Thus, as succession proceeds, the numbers and types of animals and decomposers also change.

- At any time during primary or secondary succession, natural or human induced disturbances (fire, deforestation, etc.), can convert a particular seral stage of succession to an earlier stage. Also such disturbances creates new conditions that encourage some species and discourage or eliminate other species.

11.1. Succession of Plants

- Based on the nature of the habitat-whether it is water (or very wet areas or it is on very dry areas – succession of plants is called hydrarch or xerarch, respectively. Hydrarch succession takes place in wetter areas and the successional series progress from hydirc to the mesic conditions. As against this, xerarch succession takes place in dry areas and the series progress from xeric to mesic conditions. Hence, both hydrarch and xerarch successions lead to medium water conditions (mesic) – neither too dry (xeric) nor too wet (hydric).
- The species that invade a bare area are called pioneer species. In primary succession on rocks these are usually lichens which are able to secrete acids to dissolve rock, helping in weathering and soil formation. These later pave way to some very small plants like bryophytes, which are able to take hold in the small amount of soil. They are, with time, succeeded by bigger plants, and after several more stages, ultimately a stable climax forest community is formed. The climax community remains stable as long as the environment remains unchanged. With time the xerophytic habitat gets converted into a mesophytic one.
- In primary succession in water, the pioneers are the small phytoplanktons, they are replaced with time by free-floating angiosperms, then by rooted bydrophytes, sedges, grasses and finally the trees. The climax again would be a forest. With time the water body is converted into land.
- In secondary succession the species that invade depend on the condition of the soil, availability of water, the environment as also the seeds or other propagules present. Since soil is already there, the rate of succession is much faster and hence, climax is also reached more quickly.



- What is important to understand is that succession, particularly primary succession, is a very slow process, taking maybe thousands of years for the climax to be reached. Another importantfact is to under stand that all succession whether taking place in water or on land, proceeds to a similar climax community – the mesic.

Sere: Sequence of development stages from pioneer to climax communities, e.g., lithosere/xerosere (on rock), psammosere (on sand), hydrosere (in water).

11.2. Causes of Succession

(i) Bareness of an area.
(ii) Changes caused by pioneer and seral communities not favourable to them but favourable to next

11.3. Steps of Succession

(i) Baring of an area or nudation.
(ii) Migration of pioneers into bared area.
(iii) Their establishment or ecesis.
(iv) Aggregation/Group formation.
(v) Competition.
(vi) Coaction amongst organisms.

They ultimately lead to stabilization or development of climatic climax community.

11.4. Lithosere-Xerosere (Succession on Bare Rock)

(i) **Lichen Stage:** Bare rock is invaded first by crustose lichens (e.g., Gaphis, Rhizocarpon). Then by foliose lichens (e.g., Parmelia, Dermatocarpon).

In tropics, blue-green algae are pioneers instead of lichens

(ii) **Moss Stage:** Mosses capable of tolerating drought invade the humus created by foliose lichens, e.g., Tortula, Polytrichum. They create more humus and shade to eliminate lichens.
(iii) **Annual Grass Stage:** Annual grasses and herbs invade the humus rich moss dominated rock surface, e.g., Aristida, Poa.
(iv) **Perennial Grass Stage:** Herbs are replaced by perennial grasses, e.g. Heteropogon, Cymbopogon.
(v) **Shrub Stage:** Shrubs increase humus and moisture, e.g., Rubus, Rhus, Capparis, Zizyphus.
(vi) **Climax Community:** Ultimately, trees, shrubs and herbs representing climax community.

11.5. Hydrosphere

(i) **Plankton Stage:** Phytoplanktons (diatoms, flagellates, BGA and green algae) are pioneers. Plankton produces organic matter, which mixed with bottom soil for growth of next stage.
(ii) **Submerged Stage:** Hydrilla, Potamogeton grow at bottom and made it organic matter rich.
(iii) **Floating Stage:** In shallower regions floating plants. e.g., Nymphaea, Nelumbo, Azolla.
(iv) **Reed Swamp Stage :** In shallower water, amphibian plants begin to grow e.g., Sagittaria, Typha, phragmites). They add more silt and humus at the bottom so that shores built up.
(v) **Sedge/Marsh Meadwo Stage:** On newly built up shores, Carex (Sedge), Juncus, Cyperus and herbs (Themeda, Caltha, Polygonum) grow rapidly and lower the water table.
(vi) **Woodland Stage:** Shrubs, small trees appear on edges of marsh meadow, e.g., Populus, Alnus.
(vii) **Climax Stage:** Trees, shrubs and herbs appear in perfect harmony with climate of area.

11.6. Succession on Sand Dunes (Psammosere)

It is also a type of xerosere, which occurs on bare sand dunes under xeric environment. Trend of seral communities in psammosere is similar to lithosere. Difference lies in pioneers. Pioneer community is BGA, which grow over sand dunes and add humus to make it fertile.

11.7. Climax Community

Most stable, self perpetuating and last community of succession. Clements proposed monoclimax theory to explain importance of climate in attainment of climax. He suggested climatic factors are importance and responsible for climax stage. However, other ecologists believe that climax is attained by interaction of several factors like edaphic factors, biotic factors and climatic factors – a polyclimax theory (Tansley).

12. Biosphere

Biosphere (Suess, 22.5 *km*) or ecosphere is the living mantle or biologically inhabited part of earth (soil, water and air from depth of oceans to tops of mountains) alongwith its abiotic/physicochemical components.

12.1. Sub-divisions of Biosphere

Biosphere consists three interacting subdivisions: Atmosphere, Lithosphere and Hydrosphere

(1) **Atmosphere:** It is transparent gaseous mantle surrounding earth which extends to several *kilometers* and is differentiated into troposphere (10-18 *km*), stratosphere (10-50 *km*), mesosphere (50-100 *km*), thermosphere (100-500 *km*) & exosphere (500 - 1600 *km*).
Troposphere shows lowering of temperature with height (15°C to 55°C), cloud formation. Dust particles are restricted to its lower part. Supersonic jets fly in the stratosphere. Their exhausts deplete the ozone layer.
Stratosphere contains an ozonosphere or ozone layer (for filtering ultraviolet rays) at a height of about 25km.
O_3 is produced by action of UV on oxygen, $(3O_2 \rightarrow 2O_3)$.
Ionosphere is a region of thermosphere, which is protective and radioreflective.
(2) **Lithosphere :** It is outer solid crust of earth. The exposed part or soil supports terrestrial life.
Lithosphere part of biosphere is, therefore, actually paedosphere (Odum).
(3) **Hydrosphere :** Hydrosphere is liquid mantel of earth.
Foundation/maintenance of life is based on (i) Flow of energy (ii) Circulation of nutrients or biogeochemical cycles. Earth is an **open system** for energy. It is continuously receiving solar energy. A fraction of it is trapped by autotrophs. Earth is closed **system** for materials, neither receiving nor giving out any. There is recycling of materials/matter between biotic and abiotic components of biosphere.

13. Cycles of Matter/Biogeochemical Cycles/Recycling of Materials

They are exchanges/circulation of biogenetic nutrients between living and nonliving components of biosphere.
Organisms need a constant supply of nutrients to grow, reproduce and regulate various body functions.
Amount of nutrients, such as carbon, nitrogen, phosphorus, calcium, etc., present in soil at any given time, is referred to as standing state. It varies in different kinds of ecosystems and also on a seasonal basis.
What is important is to appreciate that nutrients which are never lost from the ecosystems, are recycled time and again indefinitely.

13.1. Biogenetic Nutrients/Biogeochemicals :

Essential elements required by organisms are provided by earth and return to earth after their death and decay.

13.2. Reservoir Pool :

It is the reservoir of biogenetic nutrients from which the latter are slowly transferred to cycling pool, e.g., Atmosphere, Lithosphere, hydrosphere.

13.3. Cycling Pool:

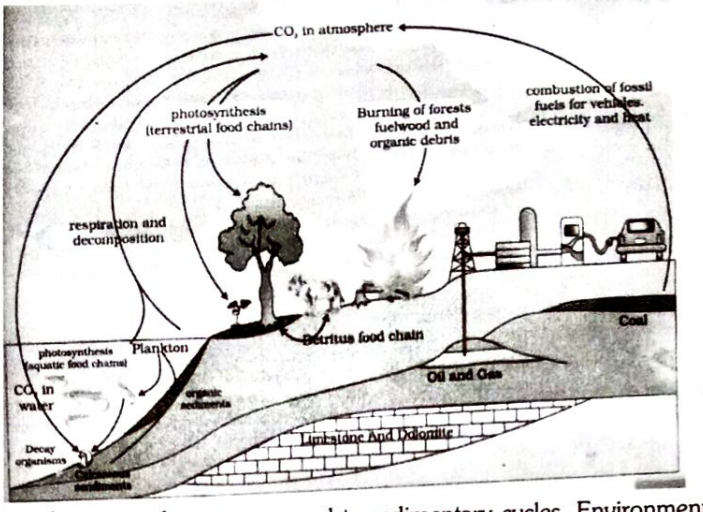
Pool, which is being emptied and filled repeatedly by exchange between biotic and abiotic components of biosphere.

13.4. There are three types of nutrient cycle:

(1) **Gaseous Cycles of Matter:** When the reservoir pool is atmosphere or hydrosphere, e.g., Carbon, Hydrogen, Oxygen, Nitrogen, Water.

(2) **Sedimentary Cycles of Matter :** When the reservoir pool is lithosphere, e.g., Phosphorus, Calcium, Magnesium.

(3) **Mixed Cycle :** Sulphur has both sedimentary and gaseous phases.



Gaseous cycles are rapid and more perfect as compared to sedimentary cycles. Environmental factors. e.g., soil, moisture, *pH*, temperature, etc., regulate the rate of release of nutrients into the atmosphere. The function of the reservoir is to meet with the deficit which occurs due to imbalance in the rate of influx and efflux.

14. Carbon Cycle

- The composition of living organisms, carbon constitutes 49 per cent of dry weight of organisms and is next only to water. If we look at the total quantity of global carbon, we find that 71 percent carbon is found dissolved in oceans. This oceanic reservoir regulates the amount of carbon dioxide in the atmosphere.
- Fossil fuel also represent a reservoir of carbon. Carbon cycling occurs through atmosphere, ocean and through living and dead organisms. According to one estimate *kg* of carbon is fixed in the biosphere through photosynthesis annually.
- A considerable amount of carbon returns to the atmosphere as through respiratory activities of the produces and consumers.
- Decomposers also contribute substantially to pool by their processing of waste materials and dead organic matter of land or oceans.
- Some amount of the fixed carbon is lost to sediments and removed from circulation. Burning of wood, forest fire and combustion of organic matter, fossil fuel, volcanic activity are additional sources for releasing in the atmosphere.
- Human activities have significantly influenced the carbon cycle Rapid deforestation and massive burning of fossil fuel for energy and transport have significantly increased the rate of release of carbon dioxide into the atmosphere.
- Carbon occurs as carbon dioxide in atmosphere (6×10^{14} kg), bicarbonate, carbonic acid in hydrosphere ($1.3 - 5.0 \times 10^{15}$ kg) and in lithosphere (2.8×10^{21} kg) as carbonate and fossil fuels (coal, petroleum and natural gas).

Carbon dioxide is being added to the atmosphere through two types of processes :

14.1. Biological

Respiration and decomposition release carbon dioxide. CH_4 is also produced by rice fields, marshes and by ruminants.

14.2. Nonbiological

Burning of biomass and fossil fuel release a lot of carbon dioxide. Burning of fossil fuels adds $6 \times 10^{12} kg$ of carbon (as carbon dioxide) into atmosphere.

Photosynthesis fixes some $7 \times 10^{13} kg$ of carbon. It releases oxygen (about $9 \times 10^{13} kg$). One hectare of good forest picks up 30,000 kg of CO_2/8000 kg of carbon and releases 10,000 kg of O_2 annually.

14.3. Green House Effect

Arrhenius coined the term green house effect. The effect was discovered by Fourier (1827). Warming effect due to green house gases, which allows solar radiations to pass in but preventing long wave heat radiations to pass out. Humid/cloudy nights are warmer due to it. Two most important green house gases are carbon dioxide (57%) and methane (12%). Others are chlorofluorocarbons/ halons (15%), nitrogen oxides (6%), water vapours (5%) and ozone. CFCs are 1500 times more active in warming than CO_2 while CH_4 has 25 times more heat trapping potential than CO_2. Methane is being added to atmosphere by paddy fields/marshes/cows. Stratosphere, mesosphere and thermosphere are showing corresponding signs of cooling. Cooling in the stratosphere is more harmful as it will create bigger ozone hole not only over Antarctica but also over Arctic region. Cooling in thermosphere would disrupt radio communications and further warm the lower atmosphere. The latter will cause melting of polar snow and glaciers to produce floods, raising of sea level and inundation of coastal areas. Greenland ice has melted between 20-100 cm during 1993-1998 (NASA). In Kyotoconference of 1997, rich nations have agreed to limit the emission of green-house gases.

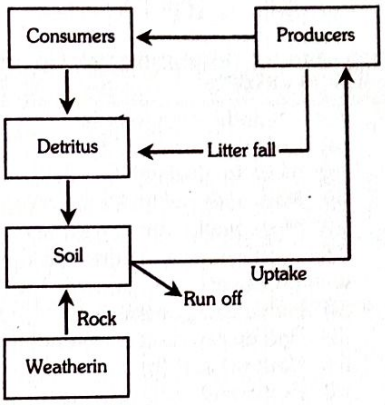
15. Phosphorus Cycle

Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems. Many animals also need large quantities of this element to make shells, bones and teeth, the natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates.

When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants. The waste products and the dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus. Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere. Can you differentiate between the carbon and the phosphorus cycle?

The other two major and important differences between carbon and phosphorus cycle are firstly, atmospheric inputs of phosphorus through rainfall are much smaller than carbon imputes, and secondly, gaseous exchanges of phosphorus between organism and environment are negligible.

A simplified model of phosphorus cycling in a terrestrial ecosystem



16. Oxygen cycle

O_2 occurs as free gas (20.99%) in atmosphere, dissolved in water, as component of other chemicals in lithosphere.

(i) **Consumption of Oxygen :** Oxygen is consumed in respiration, combustion.

(ii) **Liberation of Oxygen :** Major source of oxygen liberation is photosynthesis.

17. Hydrologic/Water Cycle

- Of total hydrosphere 97% occurs in oceans. Only 3% is fresh water. 70% of fresh water is found as snow, 22.4% as ground water and rest in lakes, rivers. Water vapours condense and form clouds, which precipitate to produce rain and snow.
- 90% of ocean evaporation returns to it as rain, while 10% falls on land.
- Rivers are pouring water into oceans. Ground water is pumped and withdrawn by plants.
- At any time atmosphere has 0.13×10^{20} G ($1G = 10^{20}$ g) water vapours. Annual precipitation is around 4.46×10^{20} G.
- Hydrologic cycle has two components, global and local.
- Local component is also short cycle. It involves evaporation of water from an area, its condensation high up in the atmosphere and precipitation over the same area. Local rain also occurs is some forests.
- Global component is long cycle that involves circulation of water vapours in the atmosphere, movement of clouds, precipitation, movement of water from one area to another. Hydrological or water cycle is energized by solar energy

36. Ecosystem : Structure and Function – Multiple Choice Questions

1. Ecosystem

1. A man-made ecosystem is
(a) Less in diversity
(b) More in diversity
(c) Man does not make the ecosystem
(d) More stable than a natural ecosystem

2. The food chain is a series of the population which starts with producers. It is concerned with
(a) Biotic components only
(b) Energy flow and transfer of nutrients
(c) Both (a) and (b)
(d) Biotic and decomposers

3. The maximum biomass of living diatoms is to be found in
(a) Marine pelagic habitats (b) Moist soil and swamps
(c) Deep coastlines (d) Salt lakes

4. In a food web, each successive trophic level has
(a) Increased total energy
(b) Less total energy content
(c) More total energy content
(d) Non estimated energy content

5. When peacock eats snakes which eat insects thriving on green plants, the peacock is
(a) A primary consumer
(b) A primary decomposer
(c) Final decomposer
(d) The apex of food pyramid

6. Which are the biotic components of the forest ecosystem
(a) Producers (b) Decomposers
(c) Consumers (d) All of the above

7. In a food chain, the total amount of living material is depicted by
(a) Pyramid of biomass (b) Pyramid of energy
(c) Pyramid of number (d) Trophic levels

8. Which one of the following components of ecosystem comes from outside
(a) Oxygen (b) Temperature
(c) Insects (d) Energy

9. *Nepenthes* is a
(a) Primary producer
(b) Consumer
(c) Primary producer and consumer
(d) None of the above

10. Generally, the food chain has how many trophic levels
(a) One (b) Two
(c) Three or Four (d) Three

11. In an ecosystem decomposer include
(a) Bacteria and fungi
(b) Only microscopic organisms
(c) Above two
(d) Above two plus macro-organisms

12. The pyramid that cannot be inverted in a stable ecosystem, is pyramid of
(a) Number (b) Energy
(c) Biomass (d) All the above

13. Snake generally belongs to
(a) Saprophytes (b) Primary consumer
(c) Second trophic level (d) None of these

14. Trophic levels are formed by
(a) Organisms linked in the food chain
(b) Only plants
(c) Only animals
(d) Only carnivores

15. Which must be preserved in an ecosystem, if the system is to be maintained
(a) Producers and carnivores
(b) Producers and decomposers
(c) Carnivores and decomposers
(d) Herbivores and carnivores

16. In a forest ecosystem, the pyramid of number is
(a) Upright (b) Inverted
(c) Any of the two (d) None of the above

17. The ecosystem has two components
(a) Plants and animals (b) Weeds and trees
(c) Biotic and abiotic (d) Frog and men

18. In a pond ecosystem, benthos means
(a) Primary consumers in the depth of a pond
(b) Zooplankton on the water surface
(c) Periphyton
(d) Epineuston

19. In a food chain, the lion is an
(a) Secondary consumer (b) Primary consumer
(c) Tertiary consumer (d) Secondary producer

20. Ecological pyramids are of
(a) Two types (b) Three types
(c) Four types (d) Five types

21. Decomposers are
(a) Autotrophs (b) Heterotrophs
(c) Autoheterotrophs (d) Organotrophs

22. The dominant second trophic level, in a lake ecosystem, is
(a) Benthos (b) Plankton
(c) Zooplankton (d) Phytoplankton

23. Transition zone between two ecosystems or vegetational regions is termed

Or

Overlapping region between two ecosystems
(a) Ecocline (b) Ecotone
(c) Ecad (d) Barrier

24. Pneumatophores plants are found
(a) In desert (b) Near river banks
(c) In grasslands (d) On mountains

25. Plants growing in acidic soils are known as
(a) Psammophytes (b) Oxylophytes
(c) Lithophytes (d) Halophytes

26. Which is not true of hydrophytes
(a) The poorly developed root system
(b) Thin membranous leaves
(c) Poorly developed large air spaces
(d) Poorly developed vascular bundles

27. The waxy surface of the floating leaves of the hydrophytes prevents
(a) Respiration (b) Photosynthesis
(c) Transpiration (d) Clogging of stomata

28. Decomposers like fungi and bacteria are
(i) Autotrophs (ii) Heterotrophs
(iii) Saprotrophs (iv) Chemoautotrophs
Choose the correct answer
(a) (i) and (ii) (b) (i) and (iv)
(c) (ii) and (iii) (d) (i) and (ii)

29. Productivity is the rate of production of biomass expressed in term of
(i) $(kcalm^{-3})yr^{-1}$ (ii) $(g^{-2}\,yr^{-1})$
(iii) $(g^{-1}\,yr^{-1})$ (iv) $(kcalm^{-2})yr^{-1}$
Choose the correct answer
(a) (ii) (b) (iii)
(c) (ii) and (iv) (d) (i) and (iii)

30. An inverted pyramid of biomass can be found in which ecosystem
(a) Forest (b) Marine
(c) Grassland (d) Tundra

31. Pyramid of numbers is
(a) Always upright
(b) Always inverted
(c) Either upright or inverted
(d) Neither upright or inverted

32. Approximately how much of the solar energy that falls on the leaves of plants is converted to chemical energy by photosynthesis
(a) Less than 1% (b) 2-10%
(c) 30% (d) 50%

33. Which of the following type of ecosystem is expected in an area where evaporation exceeds precipitation and mean annual rainfall is below 100mm
(a) Grassland (b) Shrubby forest
(c) Desert (d) Mangrove

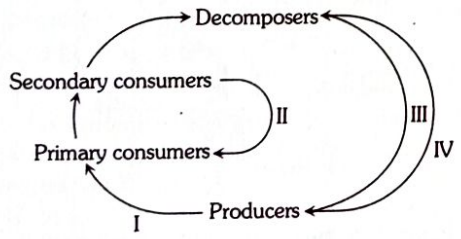
34. The zone at the edge of a lake or ocean which is alternatively exposed to air and immersed in water is called
(a) Pelagic zone (b) Benthic zone
(c) Lentic zone (d) Littoral zone

35. Which of the following is an ecosystem service provided by a natural ecosystem
(a) Cycling of nutrients
(b) Prevention of soil erosion
(c) Pollutant absorption and reduction of the threat of global warming
(d) All of the above

36. Abyssal zone of oceans is characterized by
(a) Presence of sunlight and producers
(b) The absence of sunlight and all living organisms
(c) The absence of sunlight but the presence of producers
(d) The absence of sunlight and the presence of consumers and decomposers

37. Among the plants listed, point out one that does not fit into an ecological group represented by other plants
(a) *Acacia* (b) *Rhizophora/Vallisneria*
(c) *Euphorbia* (d) *Aloe*

38. The figure given below represents the flow of materials between trophic levels. Which arrow is not correct



(a) IV (b) III
(c) II (d) I

39. Phytoplanktons are
(a) Heterotrophs (b) Autotrophs
(c) Saprotrophs (d) All of these

40. A progressive series of changes in plant and animal life of an area from initial colonization is known as
(a) Evolution (b) Succession
(c) Specialisation (d) Selection

41. Which of the following is an example of the man-made ecosystem
(a) Herbarium (b) Aquarium
(c) Tissue culture (d) Forest

42. Which of the following supports a dense population of plankton and littoral vegetation
(a) Oligotrophic (b) Eutrophic
(c) Lithotrophic (d) Agro Ecotrophic

43. In a pyramid of biomass, if the total dry weight (kg/m^2) of primary producers is about 809 it will decrease at the tertiary consumer level upto
(a) $37 kg/m^2$ (b) $11 kg/m^2$
(c) $5 kg/m^2$ (d) $1.5 kg/m^2$

44. The loss of energy as one proceeds from one trophic level to the next higher level is approximately
(a) 30% (b) 40%
(c) 60% (d) 90%

45. The number of individuals at the trophic level decreases from the producer level to the consumer level in
(a) The pyramid of numbers (b) The pyramid of biomass
(c) The pyramid of energy (d) None of these

46. Which of the following is false
(a) The quantity of biomass in a trophic level at a particular period is called as standing crop
(b) The energy content in a trophic level is determined by considering a few individuals of a species in that trophic level
(c) The succession that occurs in newly cooled lava is called primary succession
(d) The rate of succession is faster in secondary succession
(e) Phytoplanktons are the pioneers in the aquatic ecosystem

47. Which is the correct sequence in the food chain in a grassland
(a) Grass → wolf → deer → Buffalo
(b) Bacteria → grass → rabbit → wolf
(c) Grass → insect → birds → snakes
(d) Grass → snake → insect → deer

48. Which of the following relations is correct regarding GPP and NPP of an ecosystem
(a) NPP=GPP – Animal consumption
(b) NPP=GPP + Plant respiration
(c) NPP=GPP – Plant respiration
(d) NPP=GPP + Animal consumption

49. Which of the following does not affect the forest ecosystem
(a) Deforestation (b) Soil erosion
(c) Climatic variation (d) None of these

50. The first link in any food chain is always a green plant because
(a) They are widely distributed
(b) They are firmly fixed to the soil
(c) They alone have a capacity to fix atmospheric CO_2 in the presence of sunlight
(d) All of the above

51. Which one of the following is a correct food chain
(a) Grasshopper → Grass → Snake → Frog → Eagle
(b) Grass → Grasshopper → Frog → Snake → Eagle
(c) Eagle → Snake → Grasshopper → Grass → Frog
(d) Frog → Snake → Eagle → Grasshopper → Grass

52. Which of the following habitats is most unsuitable for primary productivity
(a) Meadow (b) Forested river bank
(c) Cave (d) Pond

53. Ecosystem may be defined as

(a) Group of plants which act as the energy suppliers

(b) Group of organisms which form population

(c) Functional unit for ecological studies

(d) None of these

54. Which one of the following regarding ecological pyramid is not correct

(a) In most ecosystems, the pyramid of numbers and biomass are upright

(b) In a tree-dominated ecosystem, the pyramid of numbers is inverted

(c) The pyramid of energy expresses mainly the rate of food production

(d) In deep water ecosystem, the pyramid of biomass is upright

(e) The total energy flow at a successive trophic level always decreases

55. Which of the following is a source of energy to an ecosystem

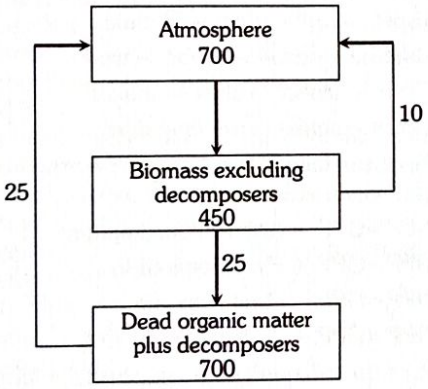
(a) Solar energy

(b) Sugar stored

(c) The heat liberated during respiration

(d) ATP

56. The figure given below shows estimated values for carbon fixation in a terrestrial ecosystem. Diagram refer to tones × 10^9, fixed or available for fixation



Which result can be drawn from the figure

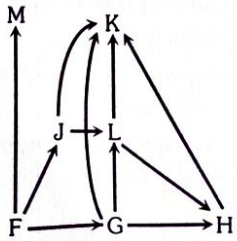
(a) There is a net loss to the decomposers

(b) There is a net loss to the atmosphere

(c) The system is in balance

(d) There is a net gain to the producers

57. The figure given below shows a particular food web. Each alphabet represents a different species. Arrows indicate the flow of energy and materials. Which of the following would probably have the greatest total biomass



(a) K+M (b) K

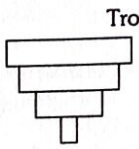
(c) J+ G (d) F

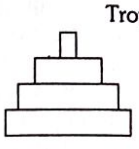
58. Two food chains are given below

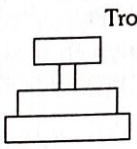
Tree → aphid → insectivorous bird → bird of prey.

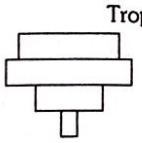
Phytoplankton → zooplankton → plankton-feeding fish → carnivorous fish.

Which diagram is a pyramid of energy representing both food chains

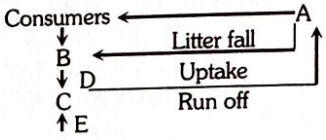
(a)


(b)


(c)


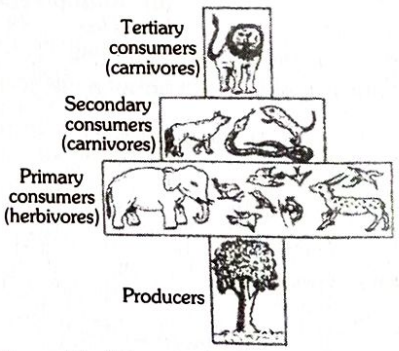
(d)


59. In the following simplified model of a nutrient cycle, identify A, B, C, D and E



	A	B	C	D	E
(a)	Producers	Soil solution	Detritus	Weathering	Decomposition
(b)	Producers	Soil solution	Detritus	Decomposition	Weathering
(c)	Producers	Detritus	Soil solution	Weathering	Decomposition
(d)	Producers	Detritus	Soil solution	Decomposition	Weathering

60. The following figure is the best example of



(a) Pyramid of the number in forest ecosystem

(b) Pyramid of the number in a grassland ecosystem

(c) Pyramid of biomass in forest ecosystem

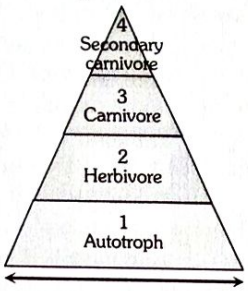
(d) Pyramid of the number in the parasitic food chain

61. Using the figure, determine which animals would be found in the same trophic level

A. Trophic level

Trophic level	Feeding strategy	Grazing food chain	Decomposer food chain
4	Secondary carnivore	Cooper's hawk	Owl
3	Carnivore	Robin	Shrew
2	Herbivore	Cricket	Earthworm
1	Autotroph	Maple tree leaves	Dead maple leaves

B. Pyramid of productivity



(a) Humans and horses
(b) Eagles and blue jays
(c) Pine trees and garden snakes
(d) Crickets and cows

62. Plants growing in saline soil/high concentration of salts are
(a) Xerophytes (b) Halophytes
(c) Heliophytes (d) Hydrophytes

63. The process of mineralization by microorganisms helps in the release of
(a) Inorganic nutrients from humus
(b) Both organic and inorganic nutrients from detritus
(c) Organic nutrients from humus
(d) Inorganic nutrients from detritus and formation of humus

64. Which of the following is not a producer
(a) Spirogyra (b) Agaricus
(c) Volvox (d) Nostoc

65. Which of the following ecosystems is most productive in terms of net primary production
(a) Deserts (b) Tropical rainforests
(c) Oceans (d) Estuaries

66. Among the following, where do you think the process of decomposition would be the fastest
(a) Tropical rainforest (b) The Antarctic
(c) Dry and region (d) Alpine region

67. How much of the net primary productivity of a terrestrial ecosystem is eaten and digested by herbivores
(a) 1% (b) 10%
(c) 40% (d) 90%

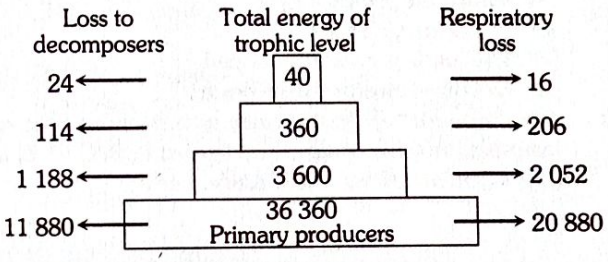
68. If the carbon atoms fixed by producers already have passed through three species, the trophic level of the last species would be
(a) Scavenger (b) Tertiary producer
(c) Tertiary consumer (d) Secondary consumer

69. Edaphic factor refers to
(a) Water (b) Soil
(c) Relative humidity (d) Altitude

70. The important steps in the process of decomposition are
(a) Fragmentation and mineralization
(b) Leaching and catabolism
(c) Humification and mineralization
(d) All of these

71. Microscopic aquatic organisms lacking the locomotory ability and drifting with the water currents are
(a) Plankton (b) Nekton
(c) Pleuston (d) Seston

72. The figure shows a pyramid of energy which represents energy loss from a food chain to decomposers, upward transfer of energy to the next trophic level and energy loss through respiration. All diagram are in $km^{-2}\ Y^{-1}$



What is illustrated in this figure
(a) The energy of the final trophic level is not used
(b) Food chain efficiency is about 10%
(c) Energy loss to decomposers is higher than the respiratory loss
(d) A pyramid of energy shows the nutrient transfer less clearly than a pyramid of numbers

73. The flow of energy among various trophic levels of an ecosystem is
(a) Unidirectional (b) Bidirectional
(c) Multidirectional (d) Circular

2. Ecological Succession

1. A community which starts succession in a habitat is
(a) Pioneer community (b) Serial community
(c) Biotic community (d) Ecosphere

2. A climax community is in a state of
(a) Non-equilibrium (b) Equilibrium
(c) Disorder (d) Constant change

3. During the process of ecological succession, the changes that take place in communities are
(a) Orderly and sequential
(b) Random
(c) Very quick
(d) Not influenced by the physical environment

4. Aquatic photo diffraction is
(a) Euphotic, disphotic and aphotic
(b) Aphotic, euphotic and disphotic
(c) Euphotic, aphotic and disphotic
(d) Euphotic, disphotic and euphotic

5. In ecological succession from pioneer to climax community, the biomass shall
(a) Decrease
(b) Increase and then decrease
(c) No relation
(d) Increase continuously

6. Lichen is the pioneer vegetation on which succession
(a) Hydrosere (b) Lithosere
(c) Psammosere (d) Xerosere

7. Mangrove vegetation is found in
(a) Dehradun valley (b) Kullu valley
(c) Western Ghats (d) Sunderbans

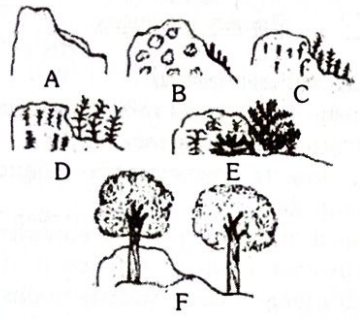
8. *Casuarina equisetifolia* is a
(a) Mesophyte (b) Xerophyte
(c) Halophyte (d) Forest epiphyte

9. In ecological succession, the climax community is best recognized by the following state
(a) P=R (b) P>R
(c) P<R (d) P≠R

10. In succession complexities in the structure are
(a) Drastically increasing (b) Slowly increasing
(c) Not increasing (d) Constant

11. One of the following is not true for hydrophytes
(a) Vessels are usually absent
(b) Tracheids are absent
(c) The cuticle is poorly developed
(d) Air chambers are well developed

12. The diagram refers to the biotic succession on bare rock (lithosere). At which stage (s) (as labeled A, B, C, D, E, and F) will you find plants like Solidago, Festuca



(a) Stage E (b) Stage D and E
(c) Stage D (d) Stage C

13. The sequence of communities of primary succession in water is
(a) Phytoplankton, sedges, free-floating hydrophytes, rooted hydrophytes, grasses, and trees
(b) Phytoplankton, free-floating hydrophytes, rooted hydrophytes, sedges, grasses, and trees
(c) Free-floating hydrophytes, sedges, phytoplankton, rooted hydrophytes, grasses and trees
(d) Phytoplankton rooted submerged hydrophytes, floating hydrophytes, reed swamp, sedges, meadow, and trees

14. Biotic succession is caused by
(a) Competition amongst species
(b) Occurrence of diseases
(c) Changes are grazing habits
(d) Adaptive ability to environmental changes

15. Find out the correct order of succession levels in Xerarch
(a) Lichen, moss stage, Annual herb stage, Perennial herb stage, Shrub stage, Forest
(b) Annual herb stage, Perennial herb stage, Lichen moss stage, Shrub stage, Forest
(c) Perennial herb stage, Annual herb stage, Perennial Shrub Stage, Lichen moss stage
(d) Shrub stage, Forest, Annual herb stage, Lichen moss stage, shrub stage, forest
(e) Forest, Shrub stage, Annual herb stage, Perennial herb stage, Lichen moss stage

3. Biomes

1. Estuaries are considered as nutrient trap due to the mixing of
(a) River and sea water (b) Pond and lake
(c) Lake and river (d) Ocean and pond

2. What is the main cause for the extinction of some species in tropical forest
(a) Deforestation (b) Afforestation
(c) Pollution (d) Soil erosion

3. Savannah's are
(a) Tropical rain forest
(b) Desert
(c) Grassland with scattered trees
(d) Dense forest with close canopy

4. Succulent xerophytes are likely to be found in
(a) Tropical rain forest (b) Deciduous forest
(c) Desert (d) Tundra

5. Tropical rain forests are found in
(a) Andamans (b) Bihar
(c) Himachal Pradesh (d) Jammu and Kashmir

6. Maximum productivity is found in
(a) Grass land (b) Tropical rain forest
(c) Ocean (d) None of these

7. They are dominant plants of the cold desert
(a) Shrub and small trees
(b) Low stature shrub and perennial grass
(c) Tall trees and herbaceous plants
(d) Low stature shrub and herbaceous plants

8. Treeless biome of cold climates is
(a) Savannah biome (b) Chaparral biome
(c) Temperate biome (d) Tundra biome

9. The organisms dwelling at the bottom of a lake are called
(a) Phytoplankton's (b) Zooplanktons
(c) Nektons (d) Benthos

10. Alpine forests occur at altitude
(a) 3900–6000 *m* (b) 1900–3000 *m*
(c) 1000–1500 *m* (d) 500–1000 *m*

11. Annual rainfall in the area of a tropical deciduous forest is
(a) Over 300 *cm* (b) 200-250 *cm*
(c) 100-150 *cm* (d) 50-75 *cm*

12. Match Column I (Indian forest types) with Column II (dominant tree genera) and choose the correct option

	Column I		Column II
A.	Tropical rain forest	1.	Hopea
B.	Tropical deciduous forest	2.	Shorea
C.	Temperate broad leaf forest	3.	Quercus
D.	Temperate coniferous forest	4.	Picea

(a) A – 1, B – 2, C – 3, D – 4
(b) A – 2, B – 1, C – 4, D – 3
(c) A – 3, B – 2, C – 1, D – 4
(d) A – 1, B – 2, C – 4, D – 3
(e) A – 4, B – 3, C – 2, D – 1

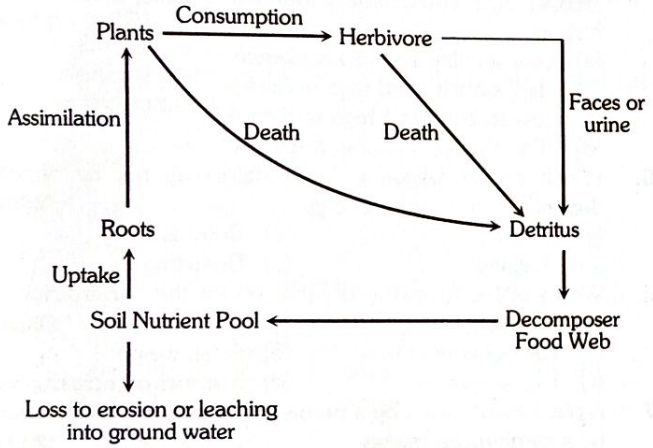
13. Rhododendron is the characteristic vegetation of
(a) Tropical zone (b) Alpine zone
(c) Gangetic plains (d) Mangrove belt

14. Grasslands of Asia are
(a) Savannah (b) Pampas
(c) Steppes (d) Veldt
(e) Prairies

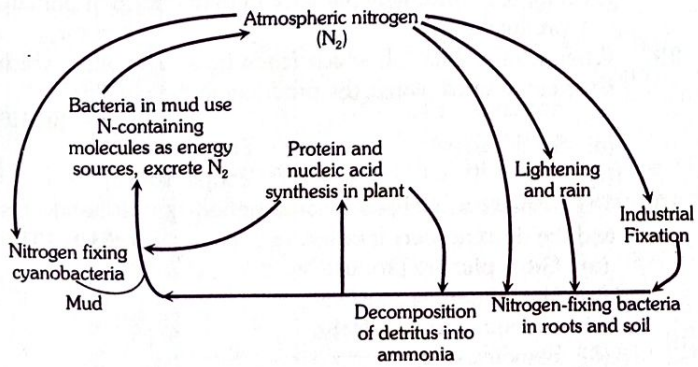
15. Alpine forests of Himalayas have
(a) Tall evergreen coniferous trees
(b) Tall broad-leaved evergreen trees
(c) Tall broad-leaved deciduous trees
(d) Dwarf shrubby plants

4. Bio-Geochemical cycle

1. In the phosphorus cycle, phosphate becomes available by weathering of rocks first to
   (a) Consumers (b) Producers
   (c) Decomposers (d) None of these
2. Which of the following cycle would be affected if decomposers of an ecosystem vanish
   (a) Producer's cycle (b) Consumer's cycle
   (c) Decomposer's cycle (d) Biogeochemical cycle
3. Degradation of proteins play a part in
   (a) Calvin cycle (b) Water cycle
   (c) Sulphur cycle (d) Nitrogen cycle
4. Amount of nitrogen fixed electrochemically and photo chemically is
   (a) 140 $mg/m^2/yr$ (b) 78 $mg/m^2/yr$
   (c) 35 $mg/m^2/yr$ (d) 15 $mg/m^2/yr$
   (e) 350 $mg/m^2/yr$
5. Nitrogen is a critical element of the ecosystem because it is
   (a) Essential element (b) Abundant in atmosphere
   (c) Labile (d) Fixed by microbes
6. In water receiving regions, what does forest regulate
   (a) Hydrological cycle (b) Carbon cycle
   (c) Nitrogen cycle (d) Calcium cycle
7. which of the following is NOT true for the biogeochemical cycle according to the following cycle



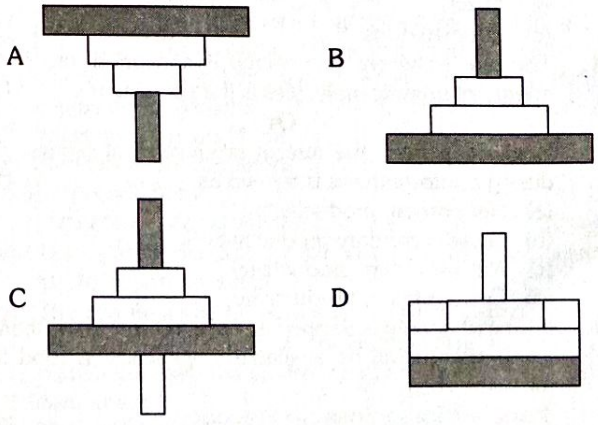
   (a) Nutrients remain in an animal until the animal's death
   (b) If the plant dies the nutrients and the plant biomass become litter
   (c) Nutrients pass to animal members of the ecosystem once plants are eaten
   (d) Nutrients are taken up from the soil by plants and incorporated into plant tissue
8. Figure given below refers to the nitrogen cycle



   Which of the following is NOT part of the natural nitrogen cycle
   (a) Fossil fuels (b) Biological fixation
   (c) Lightening (d) Decomposition
9. Among the following bio-geochemical cycles which one does not have losses due to respiration
   (a) Phosphorus (b) Nitrogen
   (c) Sulphur (d) All of the above
10. The reservoir for the gaseous type of bio-geo chemical cycle exists in
    (a) Stratosphere (b) Atmosphere
    (c) Ionosphere (d) Lithosphere
11. Concentration of nitrogen remains constant by
    (a) Nitrogen cycle (b) Thundering and light
    (c) Enzymes (d) Both (a) and (b)

5. NEET

1. Benthic organism are affected most by **[2013]**
   (a) Light reaching the forest floor
   (b) The surface turbulence of water
   (c) Sediment characteristics of aquatic ecosystems
   (d) Water-holding capacity of the soil
2. If the bamboo plant is growing in a far forest then what will be its trophic level **[2002]**
   (a) First (b) Second
   (c) Third (d) Fourth
3. 10% law of flow of energy in the ecosystem was proposed by **[1996]**
   (a) Lindeman (b) Carl Mobius
   (c) Tansley (d) Darwin
4. Energy enters into the ecosystem through **[1998, 2003; 2001]**
   (a) Herbivores (b) Carnivores
   (c) Producers (d) Decomposers
5. Which one of the following is a primary consumer in maize field ecosystem **[2013]**
   (a) Grasshopper (b) Wolf
   (c) Phytoplankton (d) Lion
6. Which of the following acts as " nature's scavengers" **[1997]**
   (a) Man (b) Animals
   (c) Insects (d) Micro-organisms
7. Which of the following is a correct sequence in the food chain **[1991]**
   (a) Fallen leaves →bacteria →insect larvae →birds
   (b) Phytoplankton →zooplankton →fish
   (c) Grasses →fox →rabbit
   (d) Grasses →chameleon →insects →birds
8. Which of the following representations shows the pyramid of numbers in a forest ecosystem **[2010]**



   (a) D (b) A
   (c) B (d) C

9. Which one of the following statement for the pyramid of energy is incorrect, whereas the remaining three are correct [2011]
(a) It is upright in shape
(b) Its base is broad
(c) It shows the energy content of different trophic level organisms
(d) It is inverted in shape

10. What energy percentage can be captured by the organisms of next trophic level [1999]

Or

Transfer of energy from one trophic level to other trophic level is according to the second law of thermodynamics. The efficiency of energy transfer from herbivores to carnivores is [1996; 2004]
(a) 20% (b) 30%
(c) 90% (d) 10%

11. In a biotic community, primary consumers are [1995]
(a) Omnivores (b) Carnivores
(c) Detritivores (d) Herbivores

12. Which of the following is the most stable and largest ecosystem in the world [1995; 2000]
(a) Mountain (b) Desert
(c) Forest (d) Ocean

13. The rate of formation of the new organic matter by a rabbit in a grassland is called [2001; 2012; 2013]
(a) Net productivity
(b) Secondary productivity
(c) Net primary productivity
(d) Gross primary productivity

14. Of the total incident solar radiation, the proportion of PAR is [2011]
(a) More than 80% (b) About 70%
(c) About 60% (d) Less than 50%

15. If the forest area is reduced to half, which one of the following will be a long-term effect [1996]
(a) The natives (tribes) of that area will die on account of hunger
(b) Cattles of that area will die due to the scarcity of fodder
(c) The diversity in germplasm will affect the crop breeding
(d) It will be converted into a large desert

16. Which of the following ecosystem has the highest gross primary productivity [1997, 2004]
(a) Grassland (b) Coral reef
(c) Mangroves (d) Rainforest

17. The maximum biomagnification would be in which of the following in case of aquatic ecosystem [1999]
(a) Fishes (b) Birds
(c) Zooplanktons (d) Phytoplanktons

18. The rate at which light energy is converted into chemical energy of organic molecules is the ecosystem's [1998]

Or

In an ecosystem, the rate of production of organic matter during photosynthesis is termed as [2015]
(a) Net primary productivity
(b) Gross secondary productivity
(c) Net secondary productivity
(d) Gross primary productivity

19. If 20 J of energy is trapped at the producer level, then how much energy will be available to peacock as food in the following chain
Plant → Mice → Snake → Peacock [2014]
(a) 0.2 J (b) 0.0002 J
(c) 0.02 J (d) 0.002 J

20. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time [2011]
(a) Goat (b) Frog
(c) Sparrow (d) Lion

21. Food chains are met with only in the [1999; 2001]
(a) Sea (b) Cities
(c) Forests (d) In all the places

22. Which one of the following types of organisms occupy more than one trophic level in a pond ecosystem [2009]
(a) Phytoplankton (b) Fish
(c) Zooplankton (d) Frog

23. Consider the following statements concerning food chains
A. Removal of 80% tigers from an area resulted in the greatly increased growth of vegetation
B. Removal of most of the carnivores resulted in an increased population of deers
C. The length of food chains is generally limited to 3-4 trophic levels due to energy loss
D. The length of food chains may vary from 2 to 8 trophic levels
Which two of the above statements are correct [2008]
(a) A, D (b) A, B
(c) B, C (d) C, B

24. An ecosystem which can be easily damaged but can recover after some time if damaging effect stops will be having [2004]
(a) Low stability and low resilience
(b) High stability and high resilience
(c) Low stability and high resilience
(d) High stability and low resilience

25. Which of the following food chain may not be directly dependent upon solar energy [2002]
(a) Grazing (b) Detritus
(c) Soaking (d) Depleting

26. Which of the following is not used for the construction of ecological pyramids [2006]
(a) Rate of energy flow (b) Fresh weight
(c) Dry weight (d) Number of individuals

27. A plant being eaten by a herbivorous which in turn is eaten by a carnivorous makes [2002]
(a) Food chain (b) Food web
(c) Omnivorous (d) Interdependent

28. In an ecosystem, the population of [1988]
(a) Primary producers are more than that of primary consumers
(b) Secondary consumers are largest because they are powerful
(c) Primary consumers outnumber primary producers
(d) Primary consumers are least dependent upon primary producers

29. When a man eats fish which feeds on zooplankton which have eaten small plants, the producer in the chain is [2013]
(a) Small plants (b) Fish
(c) Man (d) Zooplankton

30. The biomass available for consumption by the herbivores and the decomposers is called [2010; 2012]
(a) Gross primary productivity
(b) Net primary productivity
(c) Secondary productivity
(d) Standing crop

31. The word "ecosystem" was first coined by [1989, 95, 2002; 1997, 2001; 2005; 2016]
(a) Weaver and Clements (b) A.G. Tansley
(c) E.P. Odum (d) By all the above

32. Study the four statements (*A* – *D*) given below and select the two correct ones out of them

(A) A lion eating a deer and a sparrow feeding on grain are ecologically similar in being consumers

(B) Predator starfish *Pisaster* helps in maintaining species diversity of some invertebrates

(C) Predators ultimately lead to the extinction of prey species

(D) Production of chemicals such as nicotine, strychnine by the plants are metabolic disorders

The two correct statements are **[2010]**

(a) (A) and (B) (b) (B) and (C)

(c) (C) and (D) (d) (A) and (D)

33. The character of an ecosystem is determined by the environmental factor which is the shortest supply. This is the **[1994]**

(a) Law of minimum

(b) Law of diminishing returns

(c) Law of limiting factors

(d) Law of supply and demand

34. Tip of the ecological pyramid is occupied by **[1999; 2001]**

(a) Herbivores (b) Carnivores

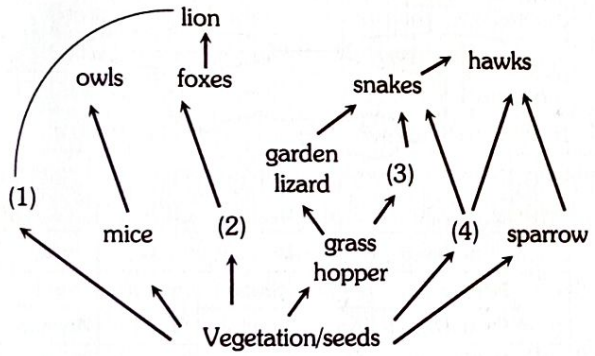
(c) Producers (d) Decomposers

35. Identify the possible link "A" in the following food chain: Plant → insect – frog → "A" → Eagle **[2012]**

(a) Rabbit (b) Wolf

(c) Cobra (d) Parrot

36. Identify the likely organisms (1), (2), (3) and (4) in the food web shown below **[2012]**



Options :

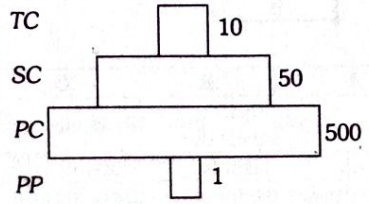
	(1)	(2)	(3)	(4)
(a)	Deer	Rabbit	Frog	Rat
(b)	Dog	Squirrel	Bat	Deer
(c)	Rat	Dog	Tortoise	Crow
(d)	Squirrel	Cat	Rat	Pigeon

37. Which one of the following is not a functional unit of an ecosystem **[2012]**

(a) Energy flow (b) Decomposition

(c) Productivity (d) Stratification

38. Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels **[2012]**



(a) Level *PC* is "insects" and level *SC* is "small insectivorous birds"

(b) Level *PP* is "phytoplankton" in the sea and "Whale" on top-level *TC*

(c) Level one *PP* is "pipal trees" and the level *SC* is "sheep"

(d) Level *PC* is "rats" and level *SC* is "cats"

39. The upright pyramid of number is absent in **[2012]**

(a) Pond (b) Forest

(c) Lake (d) Grassland

40. Most animals that live in deep oceanic waters are **[2015]**

(a) Secondary consumers (b) Tertiary consumers

(c) Detritivores (d) Primary consumers

41. If we completely remove the decomposers from an ecosystem, the ecosystem functioning will be adversely affected because **[1995; 1995]**

(a) Mineral movement will be blocked

(b) Herbivores will not receive solar energy

(c) Energy flow will be blocked

(d) The rate of decomposition of other components will be very high

42. Which of the following organisms are known as chief producers in the oceans **[2018]**

(a) Euglenoids (b) Cyanobacteria

(c) Diatoms (d) Dinoflagellates

43. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other **[2018]**

(a) Viola (b) Banana

(c) Yucca (d) Hydrilla

44. The plants in which vascular tissues are absent and well-developed aerenchyma is present are **[1995; 1999; 2002; 2009, 11]**

(a) Xerophytes (b) Halophytes

(c) Hydrophytes (d) Mesophytes

45. Primary succession is the development of communities on **[1995]**

(a) Newly exposed habitat

(b) Cleared forest area

(c) Freshly harvested crop field

(d) The pond filled after a dry season

46. Which one of the following statements is correct for secondary succession **[2011]**

(a) It is similar to primary succession except that it has a relatively fast pace

(b) It begins on a bare rock

(c) It occurs on a deforested site

(d) It follows a primary succession

47. The correct sequence of plants in a hydrosere is **[2009]**

(a) *Oak – Lantana – Scirpus – Pistia – Hydrilla – Volvox*

(b) *Volvox – Hydrilla – Pistia – Scirpus – Lantana – Oak*

(c) *Pistia – Volvox – Scirpus – Hydrilla – Oak – Lantana*

(d) *Oak – Lantana – Volvox – Hydrilla – Pistia – Scirpus*

48. Both, hydrarch and xerarch succession lead to **[2011]**

(a) Highly dry conditions

(b) Excessive wet conditions

(c) Medium water conditions

(d) Xeric conditions

49. During ecological succession **[2015]**

(a) The establishment of a new biotic community is very fast in its primary phase

(b) The numbers and types of animals remain constant

(c) The changes lead to a community that is in near equilibrium with the environment and is called pioneer community

(d) The gradual and predictable change in species composition occurs in a given area

50. Secondary succession takes place on/in **[2015]**
(a) Degraded forest (b) Newly created pond
(c) Newly cooled lava (d) Bare rock

51. Which of the following would appear as the pioneer organisms on bare rocks **[2016]**
(a) Lichens (b) Liverworts
(c) Mosses (d) Green Algae

52. What type of ecological pyramid would be obtained with the following data
Secondary consumer : 120 *g*
Primary consumer : 60 *g*
Primary producer : 10 *g* **[2018]**
(a) Upright pyramid of biomass
(b) Upright pyramid of numbers
(c) Pyramid of energy
(d) Inverted pyramid of biomass

53. Which one of the following pairs is mismatched **[2005]**
(a) Tundra - permafrost
(b) Savanna - acacia trees
(c) Prairie - epiphytes
(d) Coniferous forest - evergreen trees

54. Large Woody Vines are more commonly found in **[2011]**
(a) Alpine forests (b) Temperate forests
(c) Mangroves (d) Tropical rainforests

55. MAB stands for **[1997]**
(a) Man and biosphere
(b) Man antibiotics and bacteria
(c) Man and biotic community
(d) Mayer, Anderson and Bishby

56. Which part of the world has a high diversity of organisms **[1999]**
(a) Grasslands (b) Savannahs
(c) Deciduous forests (d) Tropical rain forests

57. In desert grasslands, which type of animals are relatively abundant **[1998]**
(a) Diurnal (b) Arboreal
(c) Aquatic (d) Fossorial

58. Plants such as *Prosopis, Acacia and Capparis* represent examples of tropical **[1998]**
(a) Grassland (b) Thorny deserts
(c) Deciduous forests (d) Evergreen forests

59. If there was no CO_2 in the earth's atmosphere, the temperature of earth's surface would be **[1998]**
(a) As such
(b) Less than the present level
(c) Increase from present level
(d) Dependent upon oxygen amount of the environment

60. Quercus species are the dominant component in **[2008]**
(a) Scrub forests
(b) Tropical rain forests
(c) Temperate deciduous forests
(d) Alpine forests

61. Most of the tree dwellers are found in which type of forest **[2009; 2015]**
(a) Deciduous forest (b) Tropical rain forest
(c) Tundra (d) Grassland

62. Which of the following communities is more vulnerable to invasion by outsides animals and plants **[1998]**
(a) Mangroves
(b) Tropical evergreen forests
(c) Temperate forests
(d) Oceanic island communities

63. In which of the following habitats does the diurnal temperature of soil surface vary most **[2004]**
(a) Desert (b) Grassland
(c) Shrub land (d) Forest

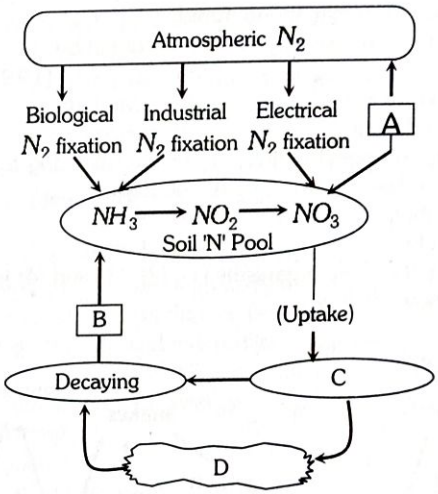
64. The slow rate of decomposition of fallen logs in nature is due to their **[2008]**
(a) Anaerobic environment around them
(b) Low cellulose content
(c) Low moisture content
(d) Poor nitrogen content

65. *Acacia, Euphorbia* and *Cenchrus* grass are characteristics of **[1998]**
(a) Grassland biome (b) Desert biome
(c) Chaparral biome (d) Temperate biome

66. Natural reservoir of phosphorus is **[2013]**
(a) Fossils (b) Sea water
(c) Animal bones (d) Rock

67. Which one of the following is not a gaseous biogeochemical cycle in ecosystem **[2012]**
(a) Sulphur cycle (b) Phosphorus cycle
(c) Nitrogen cycle (d) Carbon cycle

68. Study the cycle shown below and select the option which gives correct words for all the four blanks A, B, C and D.

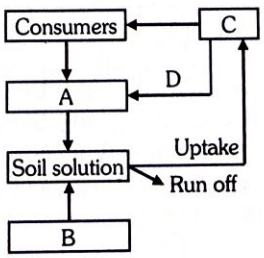


Options: **[2010]**

	A	B	C	D
(a)	Nitrification	Ammonification	Animals	Plants
(b)	Denitrification	Ammonification	Plants	Animals
(c)	Nitrification	Denitrification	Animals	Plants
(d)	Denitrification	Nitrification	Plants	Animals

69. Maximum contribution of O_2 is from **[1989]**
(a) Phytoplankton (b) Grasslands
(c) Herbs and shrubs (d) Dense forest

70. Given below is a simplified model of phosphorus cycling in a terrestrial ecosystem with four blanks (A-D). Identify the blanks



Options: **[2014]**

	A	B	C	D
(a)	Detritus	Rock minerals	Producer	Litter fall
(b)	Producers	Litter fall	Rock minerals	Detritus
(c)	Rock minerals	Detritus	Litter fall	Producers
(d)	Litter fall	Producers	Rock minerals	Detritus

71. Which one of the following pairs is a sedimentary type of biogeochemical cycle **[1995; 2001, 10; 2013]**
(a) Phosphorus and carbon dioxide
(b) Oxygen and nitrogen
(c) Phosphorus and nitrogen
(d) Phosphorus and Sulphur

72. About 70% of total global carbon is found in **[2008]**
(a) Oceans (b) Forests
(c) Grasslands (d) Agro ecosystems

73. Study of Biogeochemical cycles is called Biogeochemistry. Its father is Vernadsky (=Winodgsky). It involves **[1999]**
(a) Cycling of energy (b) Cycling of gases
(c) Cycling of nutrients (d) Cycling of water

74. Cycling of elements in an ecosystem is called **[1987, 99; 1999]**
(a) Chemical cycle (b) Geochemical cycle
(c) Biogeochemical cycle (d) Geological cycle

75. In which of the following both pairs have correct combination **[2015]**

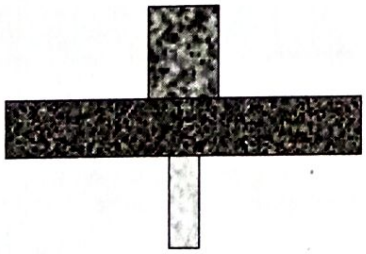
(a)	Gaseous nutrient cycle	Carbon and sulphur
	Sedimentary nutrient cycle	Nitrogen and phosphorus
(b)	Gaseous nutrient cycle	Nitrogen and sulphur
	Sedimentary nutrient cycle	Carbon and phosphorus
(c)	Gaseous nutrient cycle	Sulphur and phosphorus
	Sedimentary nutrient cycle	Carbon and nitrogen
(d)	Gaseous nutrient cycle	Carbon and nitrogen
	Sedimentary nutrient cycle	Sulphur and phosphorus

6. AIIMS

1. Bacteria and fungi in a forest ecosystem are generally **[2010]**
(a) Producers (b) Decomposers
(c) Primary consumers (d) Secondary consumers
(e) Tertiary consumers

2. The food chain in which microbes split energy-rich compounds of the producer community is **[1999]**
(a) Parasitic food chain (b) Detritus food chain
(c) Predators food chain (d) Producer food chain

3. Given below is one of the types of ecological pyramids This type represents **[2005]**



(a) Pyramid of numbers in a grassland
(b) Pyramid of biomass in a fallow land
(c) Pyramid of biomass in a lake
(d) Energy pyramid in a spring

4. The relationship in an ecosystem can be depicted in **[1998]**
(a) Pyramid of energy (b) Pyramid of biomass
(c) Pyramid of numbers (d) All of these

5. The Great Barrier Reef along the east coast of Australia can be categorized as **[2004, 08]**
(a) Population (b) Community
(c) Ecosystem (d) Biome

6. The flora and fauna in lakes or ponds are **[2000]**
(a) Lentic biota (b) Lotic biota
(c) Abiotic biota (d) Field layer

7. In a stable ecosystem, which of the following limits the number of trophic levels **[2010]**
(a) Biomass
(b) The number of nutrients
(c) Availability of nutrients
(d) Presence of contaminants that increase in concentration along the food chain

8. Submerged hydrophytes exchange gases through **[1997]**
(a) Stomata (b) Hydathodes
(c) Lenticels (d) General surface

9. Mr. X is eating curd/ yogurt. For this food intake in a food chain, he should be considered as occupying **[2003]**
(a) First trophic level (b) Second trophic level
(c) Third trophic level (d) Fourth trophic level

10. The sphere of living matter together with water, air and soil on the surface of earth is **[1998]**
(a) Lithosphere (b) Biosphere
(c) Hydrosphere (d) Atmosphere

11. Biome with broad-leaved resinous fire resistant drought enduring plants is **[1997]**
(a) Savannah (b) Steppes
(c) Chaparral (d) Deciduous forest

12. Deciduous forests have **[1996]**
(a) Variety of grasses (b) Broad-leaved trees
(c) Narrow-leaved trees (d) Variety of crocodiles

13. Which of the following rain forest is home to more than 40,000 species of plants, 3,000 of fishes, 1,300 of birds, 427 of mammals, 427 of amphibians, 378 of reptiles and more that 1,25,000 invertebrates **[2009]**
(a) Amazonian (b) Tropical
(c) Arctic tundra (d) Temperate

14. Which one of the following is correct matching of a plant, its habit and the forest type where it normally occurs **[2005]**
(a) *Prosopis*, tree, scrub
(b) *Saccharum*, grass, forest
(c) *Shorea robusta*, herb, tropical rain forest
(d) *Acacia catechu*, tree, coniferous forest

15. Moderate rainfall during summer produces **[1998]**
(a) Desert (b) Grasslands
(c) Scrub forests (d) Deciduous forests

16. In India tropical wet evergreen rain forests are not found in **[1998]**
(a) Tamil Nadu (b) Andaman
(c) West Bengal (d) Madhya Pradesh

17. Dense evergreen vegetation of broad sclerophyllous leaves and shrubs with fire resistant resinous plants is known as **[1997]**

(a) Chaparral vegetation (b) Savannah vegetation
(c) Steppe grassland (d) Tundra vegetation

18. CO_2 content of atmosphere has increased in the last 150 years from **[1997]**

(a) 25 to 35 ppm (b) 270 to 340 ppm
(c) 0.027 to 0.34 ppm (d) 0.2 to 0.3 ppm

19. The limiting factor in nitrification of soil is **[2000]**

(a) *pH* (b) Temperature
(c) Light (d) Air

7. Assertion and Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : A network of food chains existing together in an ecosystem is known as a food web.
   Reason : An animal like kite cannot be a part of a food web.
2. Assertion : In a food chain members of successively higher levels are fewer in number.
   Reason : Number of organisms at any trophic level depends upon the availability of organisms which serve as food at the lower level.
3. Assertion : The rate of decomposition of detritus is reduced in the regions of high altitude.
   Reason : It happens due to the immobilization of nutrients
4. Assertion : Taiga is also called North coniferous forest.
   Reason : The ground flora is absent in Taiga.
5. Assertion : The whole of biogenetic nutrients show circulation.
   Reason : Biogeochemical cycles operate in the biosphere.
6. Assertion : Chaparral is also called "shrub forest".
   Reason : Trees are totally absent in chaparral.
7. Assertion : Tropical rain forests are disappearing fast from developing countries such as India.
   Reason : No value is attached to these forests because these are poor in biodiversity.