XII
14

ECOSYSTEM

SYLLABUS

Patterns, components; productivity and decomposition; Energy flow; Pyramids of number, biomass, energy; Nutrient cycling (carbon and phosphorous); Ecological succession; Ecological Services-Carbon fixation, pollination, oxygen release.

KEY CONCEPTS

ECOSYSTEM

* Total living factor (biotic) and total non living factor (abiotic) of the environment present in a particular area is called ecosystem.
* The term "ecosystem" first of all coined by **A.G. Tansley.**
* According to Tansley : Ecosystem is symbol of structure and function of nature.
* Father of ecosystem ecology : **E.P. Odum.**
* The boundaries of ecosystem are indistinct and have a overlapping character over each other.
* Ecosystem is the smallest structural and functional unit of nature or environment. It is a self regulatory and self sustaining unit.
* Ecosystem may be large or small. Single drop of water may be an ecosystem.
* Ecosystem may be temporary or permanent.

Types of Ecosystems:

(A) Based on nature :

(i) Natural : Terrestrial : Forests, Grasslands, Deserts etc.
Aquatic: Marine: Seas, Oceans, Estuaries etc.,
Freshwater: Ponds, Lakes, Rivers, Streams etc.

(ii) Manmade/Artificial : Aquariums, Crop fields, Flowerbeds, etc.

(B) Based on duration :

(i) Temporary : Rain-fed Ponds, Laboratory culture of microbes etc.

(ii) Permanent : Forests, lakes etc.

(C) Based on size :

(i) Small/ Micro ecosystems : Flowerpots, logs, bushes

(ii) Large/ Macro ecosystems : Oceans, Deserts etc.

ECOSYSTEM - STUCTURE AND FUNCTION

* Identification and description of plant and animal species of an ecosystem gives its species composition.
* Vertical distribution of different species occupying different levels is called **stratification**. The levels are called **strata.**
* For example, trees occupy top vertical strata or layer of a forest, shrubs the second and herbs and grasses occupy the bottom layers.
* The components of the ecosystem are seen to function as a unit:
  - Productivity.
  - Decomposition.
  - Energy flow and
  - Nutrient cycle.

Description of pond as an ecosystem:

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

Basic events (in terms of function) in an ecosystem:

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

PRODUCTIVITY

* **Primary production :** The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (g^{-2}) or energy (kcal m^{-2})
* **Primary productivity :** The rate of biomass production is called productivity. It is expressed in terms of g^{-2} yr^{-1} or (Kcal m^{-2}) yr^{-1} to compare the productivity of different ecosystem. It can be divided into GPP and NPP.

(a) **Gross primary productivity (G.P.P.) :** It is the total amount of energy fixed (organic food) in an ecosystem (in producers) in unit time including the organic matter used up in respiration during the measurement period. It is also known as total (Gross) photosynthesis.

(b) **Net primary productivity (N.P.P.) :** It is the amount of stored organic matter in plant tissues after respiratory utilisation.

NPP = GPP – R

(R = Respiration + Metabolic activities)

or GPP = NPP + R

* NPP is the available biomass for the consumption to heterotrophs.
* The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of the organic matter productivity of the ocean are only 55 billion tons.
* **Table : Net Primary Productivities (NPP) for selected ecosystems**

Ecosystem	Average NPP (g dry matter/m^2/year)
Algal beds and reefs	2500
Tropical rain forest	2200
Swamp and marsh	2000
Estuaries	1500
Temperate evergreen forest	1300
Temperate deciduous forest	1200
Savanna	900
Boreal (northern) forest	800
Woodland and shrubland	700
Agricultural land	650
Temperate grassland	600
Upwelling zones in ocean	500
Lake and stream	250
Arctic and alpine tundra	140
Open ocean	125
Desert and semidesert scrub	90
Extreme desert (rock, sand, ice)	3

Factors affecting Primary Productivity

* Plant species inhabiting a particular area.
* Environmental factors
* Availability of nutrients
* Photosynthetic capacity of plants.

Secondary productivity :

* It is the rate of formation of new organic matter by consumers.

Net community productivity or Net productivity :

* The rate of storage of organic matter not used by the heterotrophs NCP = N.P.P. – HR, where (HR = Energy used by Heterotrophs or consumers)

Some informations related to productivity :

1. Primary productivity depends on the plant species inhabiting a particular area. It also depends on a variety of environmental factors availability of nutrients and photosynthetic capacity of plants. Therefore it varies in different type of ecosystem. The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of the organic matter productivity of the ocean are only 55 billion tons.

2. In perunit area maximum productivity is found in tropical rain forest.

3. In water, least productive ecosystem is very deep lakes and highly productive ecosystem is coral reef.

4. Nitrogen is the limiting factor in ocean and phosphorus is the limiting factor in lake productivity.

In land - Tropical rain forest i.e. 5 kg/m^2/year.

- Lowest productivity is of Deserts tundra.

5. Most productive Agro-ecosystem is Sugar cane and rice ecosystem - 3-4 kg/m^2/year.

Some information:

(i) Ecological efficiency : The percentage of energy transferred from one trophic level to the next is called ecological efficiency or food chain efficiency.

$$E.E. = \frac{\text{Energy in biomass production at a trophic level}}{\text{Energy in biomass production at previous trophic level}} \times 100$$

(ii) Assimilation efficiency : It is the proportion of consumed energy that is assimilated.

$$A.E. = \frac{\text{Food energy assimilated}}{\text{Food energy ingested}} \times 100$$

(iii) Net production efficiency :

$$N.P.E. = \frac{\text{Net pri productivity}}{\text{G.P.P.}} \times 100$$

(iv) Photosynthetic efficiency :

$$P.E. = \frac{\text{G.P.P.}}{\text{Incident total solar radiation}} \times 100$$

DECOMPOSITION

* The decomposers break down complex organic matter into inorganic substances like carbon dioxide, water and nutrients. This process is called decomposition.
* **Detritus:** Dead remains of plants and animals is called detritus.
* **Detritivores:** Animals that feed on decaying organic matter. Eg: earthworms, termites, snails etc.
* **Steps of decomposition are :**

(i) Fragmentation : Break down of detritus into smaller particles by detritivores (earthworm).

(ii) Leaching : Water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

(iii) Catabolism : Bacterial and fungal enzymes degrade detritus into simple inorganic substances.

(iv) Humification : Accumulation of a dark coloured amorphous substances called humus.

Importance of humus:

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

(v) Mineralisation : The humus is further degraded by some microbes and release of inorganic nutrients occur.

Factor affects rate of decomposition:

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

ENERGY FLOW IN ECOSYSTEM

* SUN- Main Source of energy
* 50% of incident light is **photosynthetically active radiation (PAR).**
* 2-10 % of PAR is captured by plants.
* Only a small fraction of this (stored as organic compounds) is transferred to consumers; the rest is used up in respiration and other life-supporting activities of the plants.
* As energy is transferred as food, most part is lost as heat at each stage.
* Only about 10% of the biomass is transferred from one trophic level to the next one is a food chain. And only about 10% chemical energy is retained at each trophic level. This is called 10% law of Lindeman (1942).
* **Unidirectional flow of Energy:**
  Sun → Producers → Consumers
* **Interdependence** of different organisms on each other for food forms the basis of food chains.

Food chain:

* Food chains represent energy flow through ecosystems.
* Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their trophic level.
* Producers belong to the first trophic level, herbivores (primary consumer) to the second and carnivores (secondary consumer) to the third.

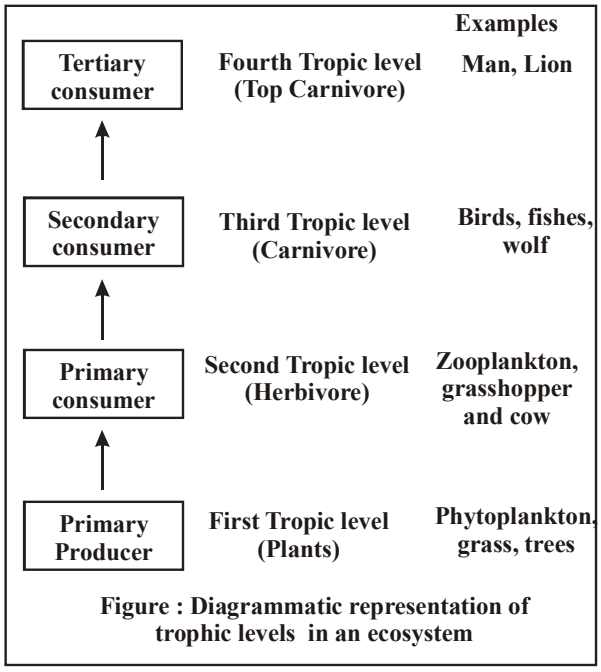


Figure : Diagrammatic representation of trophic levels in an ecosystem

Grazing food chain:

* It extends from producers through herbivore to carnivore.
* Primary source of energy : Solar radiations.
* First trophic level includes - All Producers.
* Grass (Producer) ⟶ deer (Primary Consumer) ⟶ Lion (Secondary Consumer)
* In aquatic ecosystem GFC is the major conduit for energy flow.
* GFCs are Long-sized chains

Detritus food chain:

* Begins with dead organic matter (detritus) and pass through detritus feeding organism in soil to organisms feeding on detritus-feeders.
* Primary source of energy is Detritus.
* First trophic level includes Detritivores
* In terrestrial ecosystems a much larger fraction of energy flows through the detritus food chain than through GFC.
* DFCs are small-sized chains
* Dead leaves ⟶ Woodlouse ⟶ Blackbird

Food web :

* The Natural Interconnection of Several Food Chains form a Food web.
* Provides alternate pathways for food availability.
* Unlike food chains, food webs are never straight.
* Help in ecosystem development an stability.
* **Standing crop:** each trophic level has a certain mass of living material at a particular time called as the standing crop. It is measured as the mass of living organisms (biomass) or the number in a unit area.
* **Ten Percent Law :** (By Lindemann in 1942) States that : during transfer of energy from one trophic level to another, only about 10% is stored at higher levels; remaining 90% is lost in respiration (heat).

ECOLOGICAL PYRAMID

* Graphical representation of ecological parameters at different trophic level in ecosystem is called pyramids. These parameters are Number, Biomass and Energy. First of all, pyramid was formed by Charls Elton; So we called it Eltonian pyramids.

* In pyramids basal, mid and top tiers show the parameter values for producer, herbivores and carnivores in the ecosystem.

Types of pyramids :

(i) Pyramids of number : In this type of pyramid the number of individual organism in various trophic level is shown.

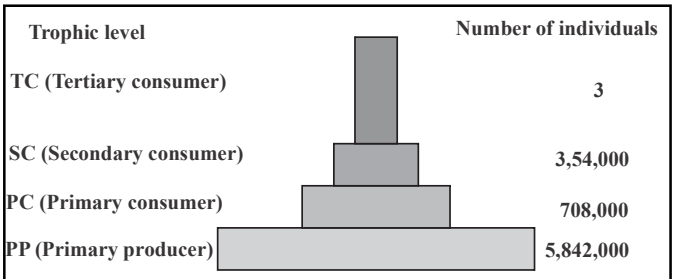


Figure : Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants

(ii) Pyramid of Biomass : Pyramid of biomass represent the total amount of biomass of each trophic level of ecosystem, mostly these pyrmaids are also upright (erect) e.g. (tree ecosystem), forest ecosystem.

Pyramids of biomass in aquatic ecosystem is inverted because in it producers are micro-organism and their biomass is very less.

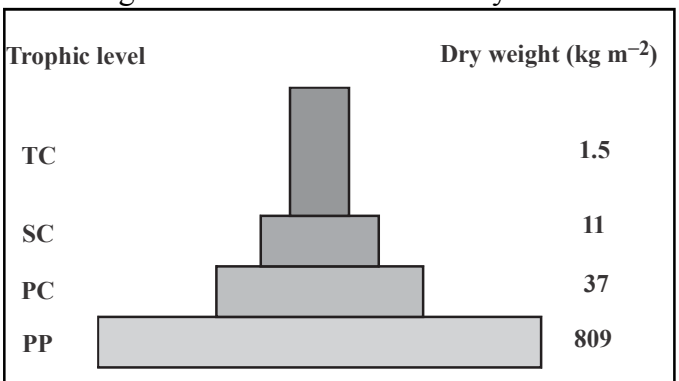


Figure (a) : Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels.

Figure (b) : Inverted pyramid of biomass-small standing crop of phytoplankton supports large standing crop of zooplankton

(iii) Pyramids of energy :

* It represents amount of energy at different trophic levels, energy pyramids are always upright or erect because there is a gradual decrease in energy at successive trophic levels.
* Pyramids of energy represent the productivity of ecosystem as well as transfer of production in ecosystem.

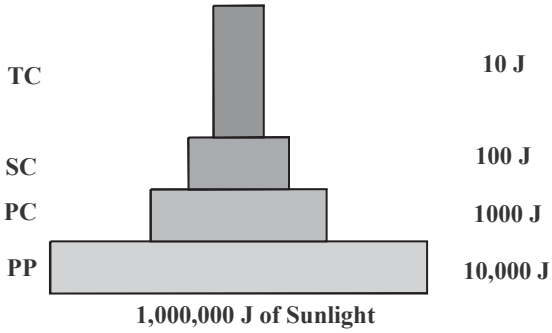


Figure : An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

Limitations of ecological pyramids:

* It does not take into account the same species belonging to two or more trophic levels.
* It assumes a simple food chain, it never exits in nature. It dose not accommodate food web.
* Saprophytes are not given place in ecological pyramids.

ECOLOGICAL SUCCESSION

* The gradual and fairly predictable change in the species composition of a given area is called **ecological succession.**
* Composition and structure of the community constantly change in response to changing environmental condition.
* This change is orderly and sequential, parallel with the changes in the physical environment.
* All the changes lead finally to a community that is in near equilibrium with the environment and that is called **climax community.**
* During succession some species colonise an area and whereas populations of other species decline and even disappear.

* The entire sequences of communities that successively change in a given area are called **sere**.
* The individual transitional communities are termed as **seral stages.**

Ecological succession shows certain characteristics

(i) Gradual replacement from short lived to long lived plant.
(ii) Continuous change in communities towards a state of stability or climax.
(iii) Increase species diversity, biomass, niche specialization, humus content.
(iv) Decrease - net community productivity or annual yield.
(v) Future seral communities can be predicted as it is a directional process.

Types of Ecological succession:

* **Primary succession:** succession that starts in an area where no living organisms are there- these could be areas where no living organism ever existed may be a bare rock or new water body. Primary succession occurs in:-newly cooled lava, bare rock, Newly created pond or reservoir.

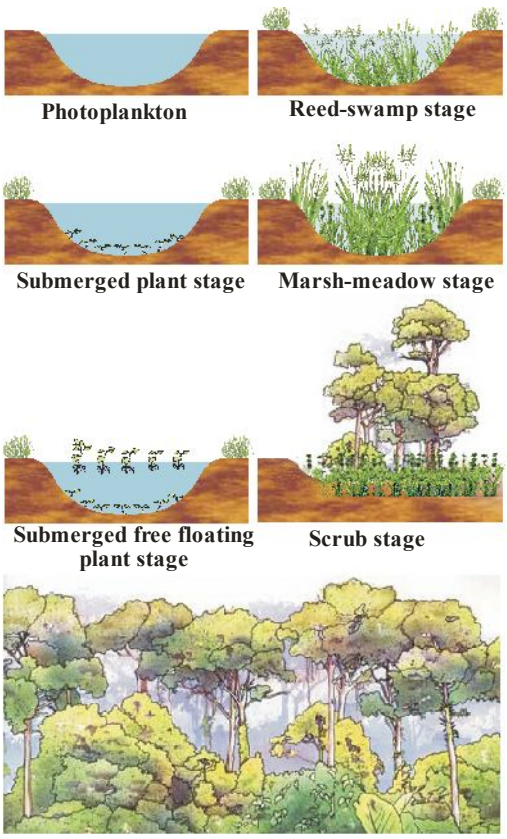


Figure : Diagrammatic representation of primary succession

* **Secondary succession:** succession that starts in areas that somehow, lost all the living organisms that existed there. Secondary succession begins in areas where natural biotic communities have been destroyed such as
  - In abandoned farm lands.
  - Burned or cut forest,
  - land that have been flooded
* Since some soil or sediment is present, secondary succession is faster than primary succession.

Succession in plants:

* **Based on the nature of habitat** - whether it is water or it is on very dry areas- succession of plants is called hydrarch or xerarch.
* **Hydrarch succession** takes place in water areas and the successional series progress from hydric to mesic condition.
* **Xerarch succession** takes place in dry areas and the series progress from **xeric** to **mesic** conditions.
* Both hydrarch and xerarch successions lead to medium water conditions (mesic) - neither too dry (xeric) nor too wet (hydric)

Xerarch succession: Succession in bare rock:

* The species that invades bare area are called pioneer species.
* In primary succession on bare rock the pioneer species is the lichen.
* Lichen secretes acid to dissolve rock, helping in weathering and soil formation.
* The little soil, leads to growth of bryophytes (mosses).
* The mosses speed up the process of soil accumulation by trapping wind-blown particles.
* Lichen moss carpet provides suitable substratum for the germination of seeds of herbaceous plants.
* Gradually more soil is accumulated and herbaceous species make way for the invasion of shrubs followed by trees.
* At last, a stable climax forest is formed.
* The xerophytic habitat gets converted into a mesophytic one.
* Bare rock → Lichen moss stage (Pioneer species) → Annual herb stage → Perennial herb stage → Shrub stage → Forest (Climax community).

Hydrarch (succession in aquatic environment)

* In primary succession in water, the pioneer species are phytoplankton.
* The phytoplanktons are replaced by free-floating angiosperms.
* Rooted angiosperms invade sedges, grasses and finally the trees.
* At last, a stable climax forest is formed.
* All the succession whether taking place in water or on land, proceeds to a similar climax community - the mesic.
* Phytoplankton stage (Pioneer species) → Submerged plant stage → Submerged free floating plant stage → Reed swamp stage → Marsh-Meadow stage → Scrub stage → Forest (Climax community)

NUTRIENT CYCLING

* Organism needs constant supply of nutrients to grow, reproduce, and regulate various body functions.
* **Standing state:** the amount of nutrients such as carbon, nitrogen, phosphorus, calcium etc. present in soil at any given time.
* **Nutrient cycling:** The movement of nutrient elements through the various component of an ecosystem is called nutrient cycling.
* Another name of nutrient cycling is **biogeochemical cycle.**
* Nutrient cycles are of two types:

(a) Gaseous cycle (b) Sedimentary cycle.

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

CARBON CYCLE

* Carbon constitutes **49 percent** of dry weight of organism.
* Out of total global carbon:
  - 71 percent carbon found dissolved in ocean.
  - About 1 percent in the atmosphere.
* 4×10^{13} kg of carbon is fixed in the biosphere by photosynthesis, annually.
* Large amount of carbon returned to the atmosphere as CO_2 through respiration of producers and consumers.
* Decomposers also return CO_2 to reservoir during decomposition process.

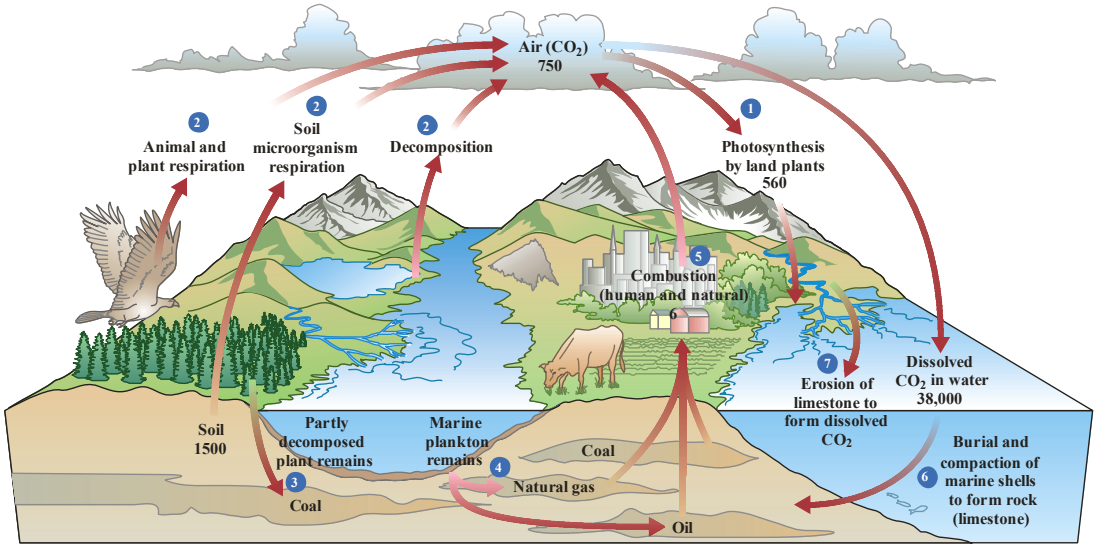


Figure : A simplified diagram of the carbon cycle.
All but a tiny fraction of Earth's estimated 10^{23} g of carbon is buried in sedimentary rocks and fossil fuel deposits. The values shown for some of the active pools in the global carbon budget are expressed as 10^{15} g of carbon.
For example, the soil contains an estimated 1500×10^{15} g of carbon.

* Some amount of Carbon is lost to sediments and removed from circulation.

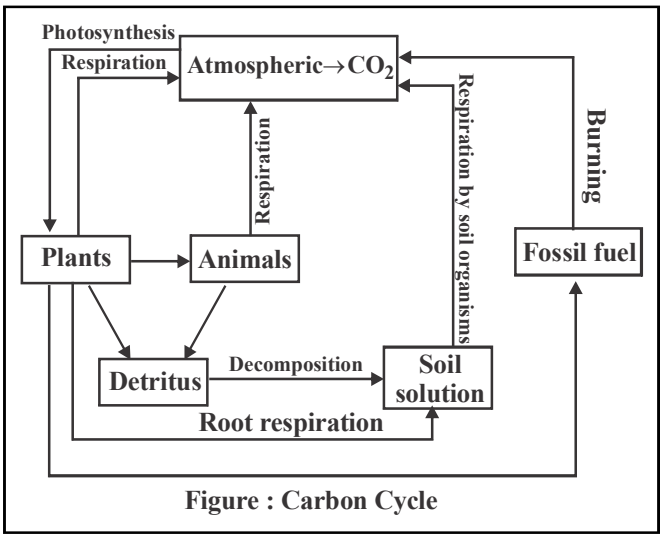


Figure : Carbon Cycle

* Burning wood, forest fire, combustion of organic matter, fossil fuel, volcanic activities are additional sources for releasing CO_2 to atmosphere.

* **Influence of human activity on Carbon cycling.**
  - Rapid deforestation.
  - Massive burning of fossil fuel for energy and transport
  - Increased the rate of release of CO_2 into the atmosphere.

NITROGEN CYCLE

* Atomsphere is the only source of nitrogen 78% nitrogen is present in atmospheric air. Plants absorb nitrogen the form of nitrate ions.

* Nitrogen cycle is completed in following steps :

1. **Nitrogen fixation :** In this process first of all some bacteria and blue green algae converts atmospheric nitrogen into nitrogenous compouds viz. ammonia, amino acid or nitrate salts.
Eg : Bacteria : Rhizobium, Aerorhizobium, Azospirillum, Frankia, Clostridium, Azotobacter : In several tropoical glasses
Blue green algae : Anabeaena, Alosira, Nostoc : In flooded rice field in tropic.

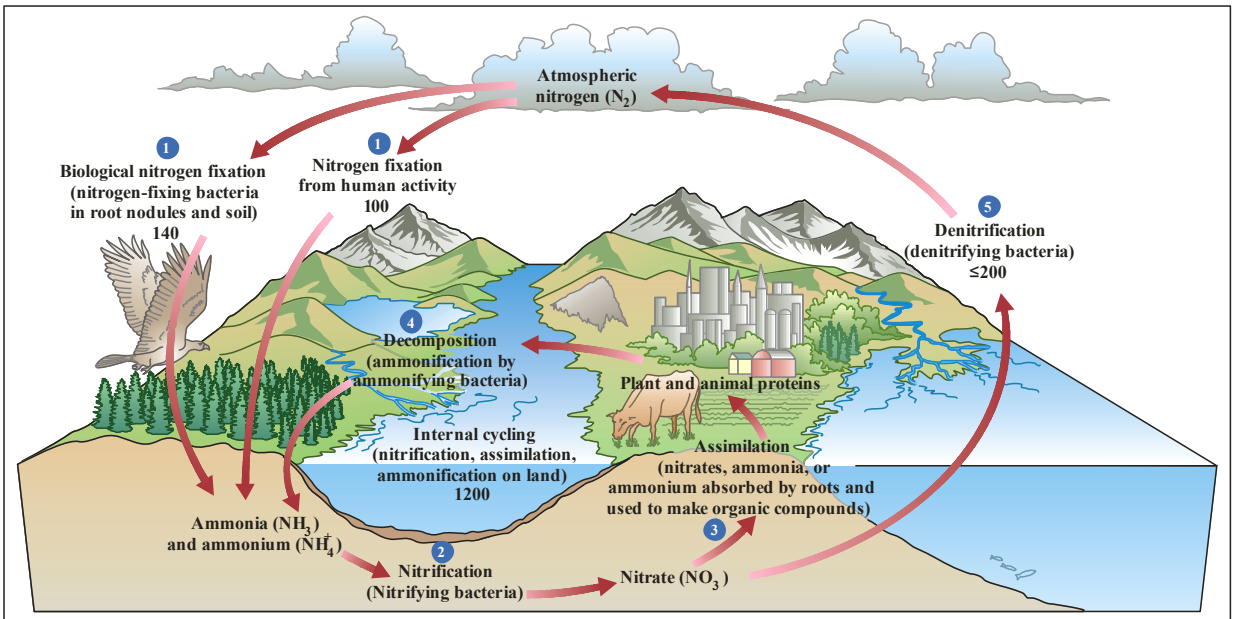


Figure : A simplified diagram of the nitrogen cycle
The largest pool of nitrogen, estimated at 3.9×10^{21} g, is in the atmosphere. The values shown for selected nitrogen fluxes in the global nitrogen budget are expressed as 10^{12} g of nitrogen per year and represent terrestrial values.
For example, each year humans fix an estimated 100×10^{12} g of nitrogen.

Note:

(i) Azotobacter is acerobic bacteria.

(ii) Clostridium is anaerobic bacteria.

(iii) Symbiotic relationship where the nitrogen fixing bacteria does not penetrate deep into host tissue, is known as associative symbiosis.

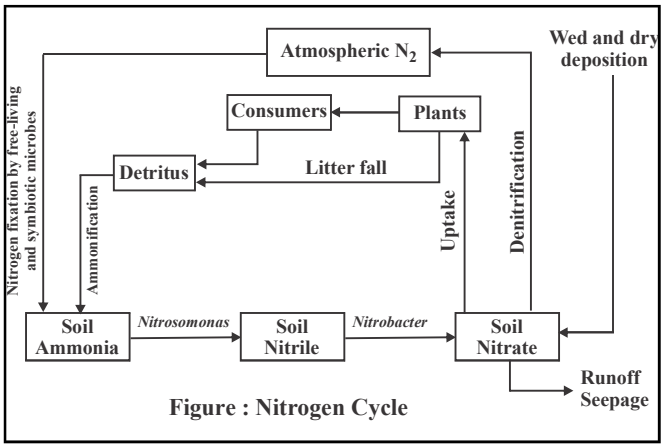


Figure : Nitrogen Cycle

2. Nitrification :

Conversion of ammonia into nitrate is called nitrification.

Nitrificaton process complete in two steps.

$$NH_3 \xrightarrow{\text{Nitrosomonas}} NO_2^- \xrightarrow{\text{Nitrobacter}} NO_3^-$$

Note:

(a) Few quantity of nitrate comes in soil by electrochemical or photochemical process.

(b) Now few quantity of this nitrate absorb by plants.

3. Nitrogen assimilation : Plants absorb nitrate from the soil and form protein. When consumers eat these plants, these plant proteins is transferred into consumer. After the death of plants and consumers litter is formed in which protein is present.

4. Ammonification : Protein present in litter, is converted into ammonia by some ammonifying bacteria. e.g. Bacillus vulgaris, Bacillus mycoides, Bacillus ramosus.

5. Denitrification : Some quantity of nitrate which is not used by plants is converted into nitrogen bv denitrifying bacteria.e.g. Thiobacillus denitrificans, Pseudomonas denitrificans.

Note : Some nitrate washed out from the ecosystem through seepage.

PHOSPHORUS CYCLE

* Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer system (ATP).

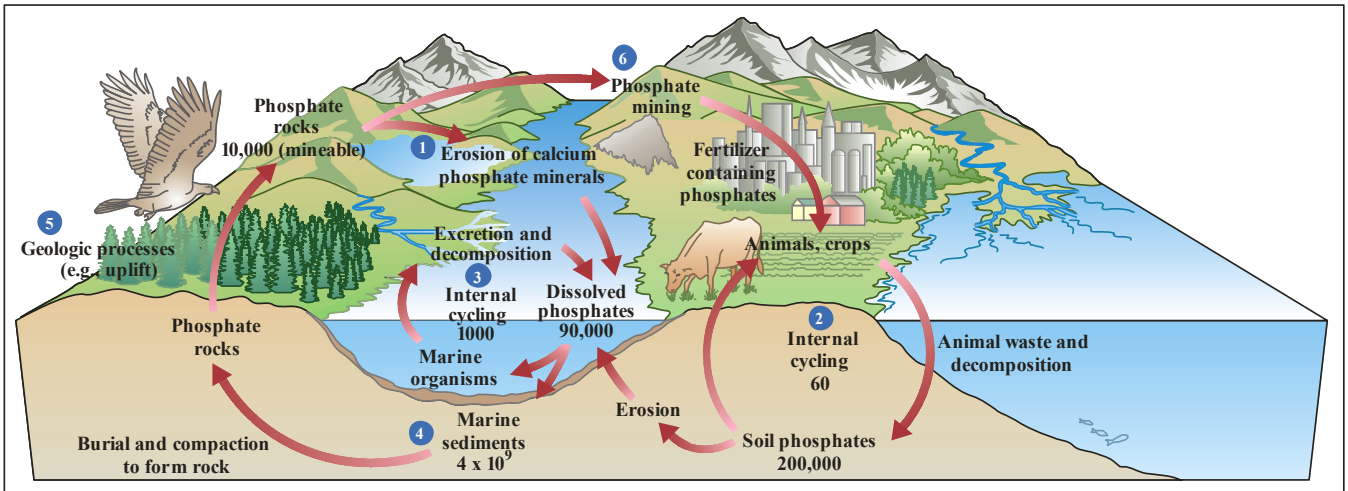


Figure : A simplified diagram of the phosphorus cycle
Some values of the global phosphorus budget are given, in units of 10^{12} g phosphorus per year. For example, each year an estimated 60×10^{12} g of phosphorus cycles from the soil to terrestrial organisms and back to the soil.

* Animals need phosphorus to make shell, bones and teeth.
* Reservoir pool of phosphorus is the rock, which contain phosphorus in the form of phosphates.

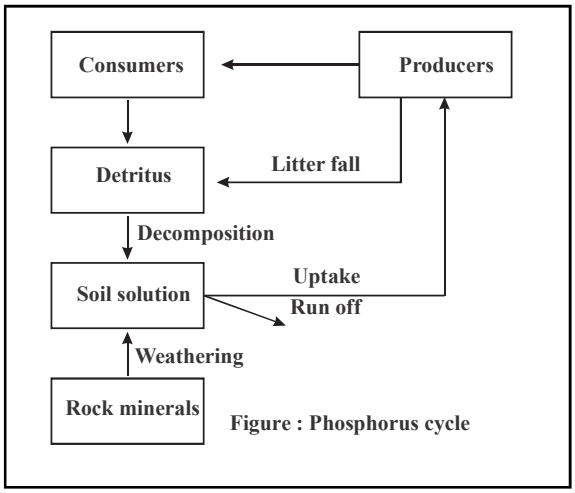


Figure : Phosphorus cycle

* During weathering of rock small amount of phosphates dissolved in soil solution and are absorbed by the roots of the plants.
* Herbivore and other animals obtain organic form of phosphorus from plants.
* The waste product and dead organisms are decomposed by phosphate-solubilising bacteria releasing phosphorus.

How phosphorus cycle differs from carbon cycle?

* There is no respiratory release of phosphorus into atmosphere.
* Atmospheric inputs of phosphorus through rainfall are much smaller.
* Gaseous exchange of phosphorus between organism and environment are negligible.

CONCEPT REVIEW

* **Energy flow** through an ecosystem is linear, from the sun to producer to consumer to decomposer. Much of this energy is converted to heat as it moves from one organism to another, so organisms occupying the next **trophic level** cannot use it.

First trophic level $[T_1]$ = Producers
Second trophic level $[T_2]$ = Primary consumers
Third trophic Level $[T_3]$ = Secondary consumers
Fourth trophic level $[T_4]$ = Top consumers

* Trophic relationships may be expressed as **food chains** or, more realistically, as **food webs**, which show the many alternative pathways that energy may take among the producers, consumers, and decomposers of an ecosystem.
* **Ecological pyramids** typically express the progressive reduction in numbers of organisms, biomass, and energy found in successive trophic levels.
* A **pyramid of numbers** shows the number of organisms at each trophic level in a given ecosystem. A pyramid of biomass shows the total biomass at each successive trophic level. A pyramid of energy indicates the energy content of the biomass of each trophic level.
* **Gross primary productivity (GPP)** of an ecosystem is the rate at which photosynthesis captures energy. **Net primary productivity (NPP)** is the energy that remains (as biomass) after plants and other producers carry out cellular respiration.
* Carbon dioxide is the important gas of the **carbon cycle**. Carbon enters plants, algae, and cyanobacteria as CO_2, which photosynthesis incorporates into organic molecules. Cellular respiration, combustion, and erosion of limestone return CO_2 to the water and atmosphere, making it available to producers again.
* The **nitrogen cycle** has five steps. **Nitrogen fixation** is the conversion of nitrogen gas to ammonia. **Nitrification** is the conversion of ammonia or ammonium to nitrate. **Assimilation** is the conversion of nitrates, ammonia, or ammonium to proteins, chlorophyll, and other nitrogen-containing compounds by plants; the conversion of plant proteins into animal proteins is also assimilation. **Ammonification** is the conversion of organic nitrogen to ammonia and ammonium ions. **Denitrification** is the conversion of nitrate to nitrogen gas.

* The **phosphorus cycle** has no biologically important gaseous compounds. Phosphorus erodes from rock as inorganic phosphate, which the roots of plants absorb from the soil. Animals obtain the phosphorus they need from their diets. Decomposers release inorganic phosphate into the environment. When phosphorus washes into the ocean and is subsequently deposited in sea beds, it is lost from biological cycles for millions of years.
* The **hydrologic cycle**, which continually renews the supply of water essential to life, involves an exchange of water between the land, ocean, atmosphere, and organisms. Water enters the atmosphere by evaporation and **transpiration** and leaves the atmosphere as precipitation. On land, water filters through the ground or runs off to lakes, rivers, and the ocean. Aquifers are underground caverns and porous layers of rock in which groundwater is stored. Runoff is the movement of surface water from land to ocean.
* If **bottom-up processes** dominate an ecosystem, the availability of resources such as nutrient minerals controls the number of producers (that is, the lowest trophic level), which in turn controls the number of herbivores, which in turn controls the number of carnivores.
* **Top-down processes** regulate ecosystems from the highest trophic level-by consumers eating producers. If top-down processes dominate an ecosystem, an increase in the number of top predators cascades down the food web through the herbivores and producers.
* **Primary succession** occurs in an area that has not previously been inhabited (such as bare rock). **Secondary succession** begins in an area where there was a pre-existing community and well formed soil (such as abandoned farmland).
* Aquatic life is ecologically divided into **plankton** (free-floating organisms), **nekton** (strongly swimming organisms), and **benthos** (bottom-dwelling organisms).
* **Phytoplankton** are photosynthetic algae and cyanobacteria that form the base of the food web in most aquatic communities.
* **Zooplankton** are nonphotosynthetic organisms that include protozoa, tiny crustaceans, and the larval stages of many animals.
* Freshwater ecosystems include flowing-water ecosystems (streams and rivers), standing water ecosystems (ponds and lakes), and freshwater wetlands. In **flowing-water ecosystems** the water flows in a current. Flowing-water ecosystems have few phytoplankton and depend on detritus from the land for much of their energy.
* Large **standing-water ecosystems** (freshwater lakes) are divided into zones on the basis of water depth. The marginal **littoral zone** contains emergent vegetation and algae and is very productive. The **limnetic zone** is open water away from the shore that extends as far down as sunlight penetrates. Organisms in the limnetic zone include phytoplankton, zooplankton, and larger fishes. The deep, dark **profundal zone** holds little life other than bacterial decomposers.
* **Freshwater wetlands**, lands that are transitional between freshwater and terrestrial ecosystems, are usually covered at least part of the year by shallow water and have characteristic soils and vegetation. Freshwater wetlands perform many valuable **ecosystem services.**
* An **estuary** is a coastal body of water, partly surrounded by land, with access to both the ocean and a large supply of fresh water from rivers. Water levels rise and fall with the tides, and salinity fluctuates with tidal cycles, the time of year, and precipitation. Temperate estuaries usually contain **salt marshes**, whereas **mangrove** forests dominate tropical coastlines.

* Grazing food chain and detritus food chain

S.No.	Grazing food chain	Detritus food chain
1.	In this food chain, energy is derived from the Sun.	In this food chain, energy comes from organic matter (or detritus) generated in trophic levels of the grazing food chain.
2.	It begins with producers, present at the first trophic level.	It begins with detritus such as dead bodies of animals or fallen leaves.
3.	This food chain is usually large.	It is usually smaller as compared to the grazing food chain.

* Production and decomposition

S.No.	Production	Decomposition
1.	It is the rate of producing organic matter (food) by producers.	It is the process of breaking down of complex organic matter or biomass.
2.	It depends on the photosynthetic capacity of the producers.	It occurs with the help of decomposers.
3.	Sunlight is required by plants for primary production.	Sunlight is not required for decomposition by decomposers

* Upright and inverted pyramid

S.No.	Upright pyramid	Inverted pyramid
1.	The pyramid of energy is always upright.	The pyramid of biomass and the pyramid of numbers can be inverted.
2.	The number and biomass decreases at each trophic level in a food chain.	The number and biomass of increases at each tropic level.

* Food chain and Food web

S.No.	Food chain	Food web
1.	It is a single linear sequence of organisms.	It contains a number of inter-connected food chains.
2.	Members present at higher trophic levels feed on single types of organisms.	One organism has alternate food sources.

* Litter and detritus

S.No.	Litter	Detritus
1.	Litter contains all kinds of wastes generated above the ground.	Detritus is composed of the remains of dead plants and animals.
2.	Litter contains both biodegradable and non-biodegradable matter.	Detritus contains only biodegradable matter.

* Primary and secondary productivity

S.No.	Primary productivity	Secondary productivity
1.	It is defined as the amount of organic matter produced by producers per unit area over a period of time.	It is defined as the rate of production of organic matter by consumers over a period of time.

IMPORTANT POINTS

* Phosphorus cycle is sedimentary cycle.
* Tropical rain forests are found in Andamans.
* *Nepenthes* belongs to the category of both producer and secondary consumer.
* Pyramid of numbers in a pond ecosystem is irregular.
* Pyramid of numbers in a forest ecosystem is upright.
* Second most important trophic level in a lake is zooplankton.
* Tropical dry deciduous forests occur in India in Madhya Pradesh.
* Sal forest (*Shorea robusta*) is a deciduous forest.
* The world has high density of organisms in tropical rain forests.
* In an ecosystem, trophic level of man is omnivore.
* Grass = Producer
  Grasshopper = Primary consumer.
  Frog = Primary carnivores.
  Hawk = Secondary carnivores.
* Pyramid of numbers in grass ecosystem is upright.
* Maximum absorption of rainfall water occurs in tropical evergreen forest.
* *Salvadora* = Desert
  Cenchrus = Savanna
  Abies = Coniferous forest
  Quercus = Broad leaf forest.
* Loss of energy from one trophic level to next higher trophic level is 90%.
* In grazing food chain, carnivores are secondary consumers.
* The pyramid of biomass in sea is inverted.
* The amount of solar radiation reaching the surface of the earth is 2 cals/sq.cm/min. It is more or less constant and is called solar constant or solar flux. About 95 to 99% of the energy is lost by reflection. Plants utilize only 0.02% of the energy reaching earth.
* Only about 10 to 20% of the primary production is converted into secondary production. The remaining 80 to 90% is lost by the consumers in the form of faeces.
* Nitrificaton process complete in two steps.

$$NH_3 \xrightarrow{\text{Nitrosomonas}} NO_2^- \xrightarrow{\text{Nitrobacter}} NO_3^-$$

* Plants absorbs pohsphate from the soil in the form of orthophosphate (PO_4^{3-}).
* **Seral communities or seral stage :**
  In succession, communities or stages which comes in between pioneer community and climax community is called transitional or seral communities.
  Sere : The entire series of communities is called sere.
  The name of sere depends on where the succession occurs or takes place.
  The name of sere depends on where the succession occurs or takes place.
  Succession in fresh water → Hydrosere
  Succession in salty water → Halosere
  Succession in acidic water → Oxalosere
  Succession at dry Region → Xerosere
  Succession on rocks → Lithosere
  Succession on sand → Psamosere
  Succession at moistened region → Mesosere
  Succession of microbes on → Serula

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.4

Match the column I with column II.

Q.1

	Column I	Column II
a.	Scavengers	i. Autotrophs
b.	Parasites	ii. Heterotrophs
c.	Producers	iii. Consumers that feed on a small part of a living being
d.	Phagotrophs	iv. Consumers of dead bodies

(A) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)
(B) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)
(C) (a) – (i), (b) – (ii), (c) – (iv), (d) – (iii)
(D) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

Q.2

	Column I
a.	Primary succession
b.	Secondary succession
c.	Hydrarch succession
d.	Xerarch succession

	Column II
i.	The plant succession which takes place in wet area
ii.	The plant succession which takes place in dry area.
iii	Buried or cut forest
iv.	Newly cooled lava

(A) (a) – (ii), (b) – (iv), (c) – (iii), (d) – (i)
(B) (a) – (i), (b) – (ii), (c) – (iv), (d) – (iii)
(C) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)
(D) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

Q.3

	Column I	Column II
a.	Primary succession	i. Ecosystem development
b.	Climax community	ii. Crustose lichens
c.	Pioneer community on lithosphere	iii. Community that has completed succession
d.	Ecological succession	iv. Colonisation of a new environment

(A) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)
(B) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)
(C) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(D) (a) – (iv), (b) – (iii), (c) – (i), (d) – (ii)

Q.4

	Column I	Column II
a.	Population	i. Parts of the earth consisting of all the ecosystems of the world
b.	Community	ii. Assemblage of all the individuals belonging to different species occurring in an area.
c.	Ecosystem	iii. Group of similar individuals belonging to the same species found in an area
d.	Ecosphere	iv. Interaction between the living organisms and their physical environmenl components.
		v. Classification of organisms based on the type of environment

(A) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)
(B) (a) – (v), (b) – (ii), (c) – (iii), (d) – (iv)
(C) (a) – (ii), (b) – (iii), (c) – (v), (d) – (i)
(D) (a) – (iii), (b) – (ii), (c) – (iv), (d) – (i)

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.5 to Q.24 :

Choose one word for the given statement from the list.

Gross production, Stratification, Primary productivity, Carbon cycle, Secondary productivity, Phosphorus, Hydrologic cycle, Seral communities, Nitrogen cycle, Detritus food chain, Phosphorus cycle, Abiotic, Biotic, 49%, Mineralisation, Pyramid of numbers, Produces, Inverted, Light, Earthworm, ants and mites, Ocean.

Q.5 Vertical distribution of different species occupying different levels in an ecosystem is called ____.

Q.6 The food chain which begin with dead organic matter is called ____.

Q.7 Energy storage at the consumer level is called ____.

Q.8 The process by which humus is degraded by some microbes to release inorganic nutrients is known as ____.

Q.9 An individual transitional communities in ecological succession are termed as ____.

Q.10 To show how many organisms are present at each level of a food chain, ecologists use a model called ____.

Q.11 Total energy fixed by an ecosystem is called ____.

Q.12 Plants are called as_____ because they fix carbon dioxide.

Q.13 In an ecosystem dominated by trees, the pyramid (of numbers) is _____ type.

Q.14 In aquatic ecosystems, the limiting factor for the productivity is _____.

Q.15 Common detritivores in our ecosystem are __.

Q.16 The major reservoir of carbon on earth is ___.

Q.17 Carbon constitutes __ of dry weight of organisms.

Q.18 Atmospheric inputs of _____ through rainfall are much smaller than carbon inputs and gaseous exchange of _____ between organism and environment are negligible.

Q.19 Inorganic nutrients, air, water and soil are ____ components while producers, consumers and decomposers are ____ components.

Q.20 ____ is the rate at which radiant energy is stored by producers.

Q.21 Name the biogeochemical cycle associated with each item

(i) ammonification
(ii) fixation into organic form mainly by photosynthesis.
(iii) fixation into organic form mainly by prokaryotes
(iv) largest available reservoir is bicarbonate ions in the oceans.
(v) largest available reservoir is the atmosphere
(vi) largest available reservoir is the earth's crust
(vii) largest available reservoir is the earth's oceans.

Q.22 Percentage of energy converted into biomass by a lower trophic level over the energy of food resources available at the higher trophic level is called trophic level efficiency. **[True / False]**

Q.23 Source of energy is sun in detritus food chain. **[True / False]**

Q.24 Ecological pyramid does not accommodate a food web. **[True / False]**

For Q.25-Q.27

If the statement is false, make it correct by changing the underlined word(s) and writing the correct word(s).

Q.25 A pyramid of biomass is sometimes inverted because it sometimes <u>over estimates</u> the importance of large organisms.

Q.26 A pyramid of energy can never be inverted because the <u>transfer of energy from one trophic level to the next is never 100% efficient.</u>

Q.27 A pyramid of numbers is sometimes inverted because it under estimates the importance of <u>small</u> organisms.

SECTION - 3 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : ECOSYSTEM - STRUCTURE AND FUNCTION

Q.28 In an aquatic ecosystem, the trophic level equivalent to cows in grasslands is
(A) phytoplanktons (B) zooplanktons
(C) nektons (D) benthos

Q.29 Who proposed the term 'ecosystem'?
(A) Odum (B) Gardner
(C) Warming (D) Tansley

Q.30 Abiotic components refers to
(A) non-living physico-chemical factors
(B) living physico-chemical factors
(C) gases produced by industries
(D) living organisms

Q.31 The primary consumers in a pond ecosystem are
(A) phytoplankton (B) zooplankton
(C) fishes (D) bacteria

Q.32 Biotic components refer to –
(A) gases produced by industries
(B) nutrient-deficient soil
(C) living organisms
(D) fossil fuels

Q.33 In a comparative study of grassland ecosystem and pond ecosystem, it may be observed that
(A) the biotic components are almost similar
(B) the abiotic components are almost similar
(C) primary and secondary consumers are similar
(D) both biotic and abiotic components are different.

Q.34 Ecosystem is
(A) always open.
(B) always closed.
(C) both open and closed depending upon community.
(D) both open and closed depending upon biomass.

PART - 2 : PRODUCTIVITY

Q.35 Which ecosystem has the highest gross primary productivity?
(A) Rainforests (B) Coral reefs
(C) Mangroves (D) Grass lands

Q.36 Highest value in $g/m^2/yr$ of a grassland ecosystem would be
(A) gross primary productivity
(B) net primary productivity
(C) secondary productivity
(D) tertiary productivity

Q.37 Which of the following ecosystems is most productive in terms of net primary production?
(A) Deserts (B) Tropical rain forests
(C) Oceans (D) Estuaries

Q.38 Secondary productivity is
(A) the rate of formation of new organic matter by consumers.
(B) greater than primary productivity
(C) 5% less than primary productivity
(D) equal to the gross primary productivity

Q.39 Productivity is the rate of production of biomass expressed in terms of:
i. ..... $^{-3})$ yr^{-1} ii. g^{-2} yr^{-1}
iii. g^{-1} yr^{-1} iv. (kcal m^{-2}) yr^{-1}
(A) ii (B) iv
(C) ii and iv (D) i and iii

Q.40 Rate of conversion of light energy into chemical energy of organic molecules in an ecosystem is
(A) gross primary productivity
(B) net primary productivity
(C) net secondary productivity
(D) gross secondary productivity

Q.41 Ecosystem having the highest primary productivity is
(A) pond (B) ocean
(C) desert (D) forest

PART - 3 : DECOMPOSITION

Q.42 The enzymatic process by which degraded detritus is converted into simpler inorganic substances is called
(A) catabolism (B) leaching
(C) mineralisation (D) fragmentation

Q.43 The process of breaking down complex organic matter into inorganic substances like CO_2, water and nutrient is called
(A) humification (B) mineralisation
(C) decomposition (D) leaching

Q.44 Decomposers like fungi and bacteria are
I. autotrophs II. heterotrophs
III. saprotrophs IV. chemoautotrophs
Choose the correct option.
(A) I and II (B) I and IV
(C) II and III (D) I and III

Q.45 The process of mineralisation by micro organisms 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 & formation of humus.

Q.46 The products of decomposition process are
(A) humus (B) inorganic nutrients
(C) organic nutrients (D) Both (A) and (B)

Q.47 Among the following, where do you think the process of decomposition would be the fastest?
(A) Tropical rain forest (B) Antarctic
(C) Dry arid region (D) Alpine region

Q.48 Microbes that breakdown the complex organic matter into simple substances like carbon, nitrogen, water, etc., are
(A) producers (B) decomposers
(C) consumers (D) symbionts

Q.49 The decomposition rate is higher when detritus is rich in
(A) nitrogen and sugar
(B) phosphorus and sugar
(C) calcium and sugar
(D) Both (B) and (C)

Q.50 What will happen if all the bacteria and fungi are destroyed?
(A) There will be no disease and death
(B) No antibiotics would become available
(C) Dead bodies and excretions will pile up
(D) Soil will become rich of all nutrients

PART - 4 : ENERGY FLOW

Q.51 Identify the food chain.
Dead animal → Blow fly maggots → Common frog → Snake
(A) grazing food chain
(B) detritus food chain
(C) decomposer food chain
(D) predator food chain

Q.52 What is the percentage of Photosynthetically Active Radiation (PAR), if incident solar radiation is considered 100%?
(A) 100% (B) 1-6%
(C) 2-20% (D) 50%

Q.53 Which of the following statements regarding food chain is false?
(A) In an aquatic ecosystem, grazing food chain is the major conduit for energy flow.
(B) In terrestrial ecosystems, a large fraction of energy flows through detritus food chain
(C) The detritus food chain begins with dead organic matter.
(D) Primary consumers belong to th first trophic level.

Q.54 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

Q.55 Which of the following two organisms producers?
(A) Plants and phytoplanktons
(B) Plants and consumers
(C) Zooplanktons and phytoplanktons
(D) Phytoplanktons and chlorophyll

Q.56 Energy enters in any ecosystem through –
(A) herbivores (B) carnivores
(C) Trophic level (D) decomposers

Q.57 A much small fraction of energy flows in a terrestrial ecosystem through
(A) grazing food chain
(B) detritus food chain
(C) complex food chain
(D) food web aquatic ecosystem

Q.58 In terrestrial ecosystem such as forest, maximum energy is found in which trophic level?
(A) T_1 (B) T_2
(C) T_3 (D) T_4

Q.59 The 10% law is related to
(A) Mendelian genetics
(B) non-Mendelian genetics
(C) energy transfer from lower trophic level to higher trophic level
(D) energy consumption during photosynthesis in C_4-plants

Q.60 In what order do a hawk, grass and rabbit form a food chain in a meadow?
(A) Hawk → grass → rabbit
(B) Grass → hawk → rabbit
(C) Rabbit → grass → hawk
(D) Grass → rabbit → hawk

Q.61 Each tropical level has a certain mass of living material at a particular time called
(A) standing crop
(B) biomass
(C) branching lines
(D) progressive straight line

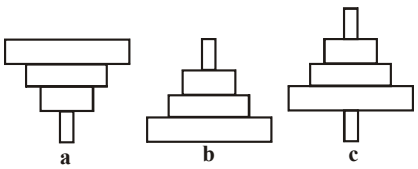
PART - 5 : ECOLOGICAL PYRAMIDS

Q.62 Which is an example of true pyramid in an ecosystem?
(A) Pyramid of biomass (B) Pyramid of number
(C) Pyramid of energy (D) None of these

Q.63 An inverted pyramid of biomass can be found in which ecosystem?
(A) Forest (B) Marine
(C) Grass land (D) Tundra

Q.64 The ecological pyramid that is always upright
(A) pyramid of energy (B) pyramid of biomass
(C) pyramid of number (D) None of these

Q.65 Which of the following representations show the pyramid of numbers in a grassland ecosystem?



(A) a (B) b
(C) c (D) None of these

Q.66 Pyramid of numbers is:
(A) Always upright
(B) Always inverted
(C) Ether upright or inverted
(D) Neither upright nor inverted.

Q.67 Peacock eats a snake and snake eats frog and frog eats insects, while insects eat green plants. The position of peacock is
(A) primary producer
(B) secondary producer
(C) decomposer
(D) at the apex of food ecological pyramid

Q.68 The pyramid of biomass will be inverted in the ecosystem of
(A) forests (B) ponds
(C) grasslands (D) drylands

PART - 6 : ECOLOGICAL SUCCESSION

Q.69 The sequential, gradual and predictable changes in the species composition in an area are called
(A) seral community (B) climax community
(C) ecological succession (D) pioneer species

Q.70 The final stable community in an ecological succession is –
(A) pioneers (B) sere
(C) climax (D) carnivore

Q.71 Primary succession on rocks starts with
(A) lichen (B) grass
(C) mosses (D) ferns

Q.72 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.

Q.73 Ecological succession is a
(A) long term process (B) very fast process
(C) short term process (D) migration

Q.74 Series of changes in structure and composition of communities on previously barren area is
(A) sere (B) climax community
(C)primary succession (D) secondary succession

Q.75 Climax community is in a state of:
(A) non-equilibrium (B) equilibrium
(C) disorder (D) constant change

Q.76 Primary succession is the development of communities on –
(A) cleared forest area
(B) previously unoccupied sites
(C) fresh harvested crop field
(D) pond filled after a day season

PART - 7 : NUTRIENT CYCLING

Q.77 Which of the following is known as the sedimentary cycle because its reservoir is a sedimentary rock?
(A) Carbon cycle (B) Hydrologic cycle
(C) Nitrogen cycle (D) Phosphorus cycle

Q.78 Among the following bio-geo-chemical cycles which one does not have losses due to respiration?
(A) Phosphorus (B) Nitrogen
(C) Sulphur (D) All of the above

Q.79 In an ecosystem, the cycling of nutrient is known as
(A) geological cycle (B) chemical cycle
(C) geochemical cycle (D) biogeochemical cycle

Q.80 Which is involved in sedimentary cycle?
(A) Carbon (B) Nitrogen
(C) Hydrogen (D) Phosphorus

Q.81 The exchange pool in the carbon cycle is
(A) fossil fuels (B) sedimentary rock
(C) water (D) atmosphere

Q.82 The reservoir for the gaseous type of bio-geo chemical cycle exists in
(A) stratosphere (B) atmosphere
(C) ionosphere (D) lithosphere

Q.83 Which of the following is a sedimentary cycle?
(A) Sulphur cycle (B) Nitrogen cycle
(C) Carbon cycle (D) Oxygen cycle

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 When a big fish eats a small fish which eats water fleas supported by phytoplankton, water fleas are
(A) producers
(B) primary consumers
(C) secondary consumers
(D) top consumers.

Q.2 The available biomass for consumption to heterotrophs is
(A) net primary productivity.
(B) gross primary productivity.
(C) secondary productivity
(D) standing state.

Q.3 Which of the following would NOT cause levels of atmospheric carbon dioxide to rise?
(A) burning fossil fuels
(B) destruction of terrestrial forests
(C) increased rates of organismal respiration
(D) increased rates of photosynthesis

Q.4 In an aquatic ecosystem which type of food chain is major conduit for energy flow
(A) GFC (B) Parasitic food chain
(C) DFC (D) Both (A) and (C)

Q.5 Which of the following processes returns N_2 to the atmosphere?
(A) ammonification (B) denitrification
(C) nitrification (D) nitrogen fixation

Q.6 Energy stored by consumers as it is transferred to them from producers is –
(A) gross primary productivity
(B) net primary productivity
(C) respiration
(D) secondary productivity

Q.7 Which of the following is an abiotic component of the ecosystem?
(A) Bacteria (B) Plants
(C) Humus (D) Both (A) and (C)

Q.8 Energy in ecosystems usually flow through which two types of food webs?
(A) detrital and decomposer food webs.
(B) grazing and detrital food webs.
(C) predator and prey food webs.
(D) producer and consumer food webs.

Q.9 The rate of conversion of solar energy into chemical energy by autotrophs is called –
(A) gross primary productivity.
(B) net primary productivity.
(C) respiration.
(D) standing crop biomass.

Q.10 Among the following, you think the process of decomposition would be the fastest?
(A) Tropical rain forest (B) Antarctic region
(C) Dry arid region (D) Alpine region

Q.11 The two types of nutrient cycles are –
(A) atmospheric and sedimentary
(B) biotic and abiotic
(C) organic and inorganic
(D) terrestrial and aquatic

Q.12 Carbon enters the biotic (living) component of the ecosystem via –
(A) ammonification (B) photosynthesis
(C) precipitation (D) respiration

Q.13 Which is incorrect regarding phosphorus cycle?
(A) Adding NPK fertilizers to soil will interfere with phosphorus cycle.
(B) Soils and rocks are major reservoir of phosphorus.
(C) Atmospheric input of phosphorus through rainfall is equivalent to that of carbon.
(D) There is no respiratory release of phosphorus into atmosphere.

Q.14 In net primary productivity of whole biosphere what is the contribution of oceans
(A) 50% (B) 70%
(C) 42% (D) 55%

Q.15 Which of the following is used to estimate the amount of energy being processed each trophic level in a food web?
(A) biomass at each trophic level.
(B) number of individual organisms at each trophic level.
(C) total solar input
(D) Both (A) and (B)

Q.16 In a particular food chain, energy at producer level is 33 kJ. What will be the amount of energy present at the level of tertiary consumer?
(A) 33 kJ (B) 330 J
(C) 33 J (D) 3.3 J

Q.17 Decomposition is one of the important functional aspect of ecosystem. About which statement is not correct
(A) Warm and moist environment favours decomposition.
(B) Nitrogen and sugar component favours decomposition.
(C) Low temperature & anaerobiosis favours decomposition.
(D) Decomposition is largely an oxygen requiring process.

Q.18 Which of the following is the logical sequence of primary succession in rocks?
(A) Small bryophytes → Lichen → Herb → Shrubs → Trees → Forest
(B) Lichen → Small bryophytes → Herbs → Shrubs → Trees → Forest
(C) Lichen → Herbs → Shrubs → small bryophytes → Trees → Forest
(D) Herb → Shrubs → Lichen → Small bryophytes → Trees → Forest

Q.19 Which of the following is NOT true of ecosystem modeling?
(A) It attempts to identify the most important factors that are involved in ecosystem function.
(B) It describes ecosystem processes but has no predictive value.
(C) It simplifies events that occur in nature.
(D) It uses mathematical equations to define relationships between populations and the environment.

Q.20 The components of ecosystem are seen to function as an unit when we consider which of the following aspect
(A) Productivity and decomposition.
(B) Decomposition and energy flow.
(C) Productivity and energy flow.
(D) Productivity, decomposition, energy flow and nutrient cycling.

Q.21 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

Q.22 The annual net primary productivity of the whole biosphere is approximately
(A) 170 billion tons (B) 50 billion tons
(C) 55 billion tons (D) 710 billion tons

Q.23 Which type of pyramid shows best efficiency of ecosystem-
(A) Number (B) Biomass
(C) Volume (D) Energy

Q.24 By digestion and pulverisation detritus get fragmented. This fragmentation step of decomposition helps in
(A) Increasing porocity of detritus.
(B) Increasing surface area of detritus.
(C) Increasing rate of sedimentation.
(D) All the above

Q.25 Which among the following factors are most important climatic factors that regulate decomposition through their effects on the activities of soil microbes
(A) Temperature & soil moisture
(B) Temperature and pH of soil
(C) Temperature and oxygen
(D) pH of soil and oxygen.

Q.26 About flow of food energy by the process of eating and being eaten, which of the following is incorrect.
(A) In an aquatic ecosystem GFC is major conduit for energy flow.
(B) In terrestrial ecosystem detritus food chain is main.
(C) In predator food chain there is increase in size of organism with trophic level.
(D) DFC can never be connected with GFC.

Q.27 Mass of the living material at a particular time caued as the standing crop. Biomass of a species is expressed in terms of ____ is more accurate.
(A) Fresh weight (B) Dry weight
(C) Both (A) and (B) (D) Kcal m^{-2}/yr^{-1}

Q.28 Which of the following is true regarding the phosphorus cycle?
(A) Excess phosphorus from fertilizers is a pollutant of lakes and ponds.
(B) Phosphorus cycles slowly through terrestrial ecosystems.
(C) Phosphorus is made available to plants through fixation by prokaryotes.
(D) The atmosphere is the largest reservoir of phosphorus.

Q.29 The gradual and fairly predictable changes in the species composition of a given area is called
(A) Bioprospecting
(B) Biofortiftcation
(C) Ecological succession
(D) Ecological assessment

Q.30 The gradual and fairy predictable changes in the species composition of a given area is not characterised by –
(A) Increase in number of species.
(B) Increase in number of individuals (organisms)
(C) Increase in biomass.
(D) Decrease in niche specialisation.

Q.31 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

Q.32 Which of the following regulate the rate of release of nutrients into atmosphere
(A) Soil (B) Moisture
(C) pH and Temperature (D) All the above

Q.33 The rate of biomass production is called productivity. It may be primary or secondary productivity. Primary productivity does not depends on –
(A) Plants species inhabitating a particular area.
(B) Predation.
(C) Environmental factors.
(D) Photosynthetic capacity

Q.34 Leaching is one of the important step of Decomposition. During leaching which of the following nutrient godown into the soil horizon
(A) Water soluble inorganic substance
(B) Water insoluble inorganic substances
(C) Water soluble organic substances
(D) Water insoluble organic substances

Q.35 How much amount of carbon is fixed in biosphere through photosynthesis annually
(A) 2×10^{13} kg (B) 4×10^{13} kg
(C) 5×10^{13} kg (D) 6×10^{13} kg

Q.36 Which among the following is not considered as an ecological service
(A) Generation of fertile soil
(B) Wild life habitat formation
(C) Products of antibiotics
(D) Crop pollination

Q.37 During decomposition humification leads to accumulation of a dark coloured amorphous substance called humus. About Humus which of the following is correct
(A) Susceptible to microbial action.
(B) Undergoes decomposition at an extremely high rate.
(C) Being colloidal in nature.
(D) It promote compaction of soil.

Q.38 Which of the following chemical will not reduce the rate of decomposition of detritus
(A) Lignin (B) Chitin
(C) Cutin (D) Sugars

Q.39 Phosphorus usually becomes a limiting factor at certain times of the year in which ecosystem –
(A) Aquatic ecosystem
(B) Grassland ecosystem
(C) Forest ecosystem
(D) All the above

Q.40 How much amount of incident solar radiation and PAR is capture as GPP
(A) 1-5% and 2-10%
(B) 2-10% and 1-5%
(C) 1-4% and 2-8%
(D) 0.4-4% and 0.8-8%

Q.41 Which type of pyramid shows standing crop ecosystem –
(A) Pyramid of energy (B) Pyramid of number
(C) Pyramid of biomass (D) None of above

Q.42 Succession in saline soil is –
(A) Mesosere (B) Lethasere
(C) Psammosere (D) Halosere

Q.43 If a predator overexploits its prey in a ecosystem then what might be consequences of this?
(A) Prey might be extinct
(B) Predator might be extinct
(C) Both (A) and (B)
(D) No affect on prey and predator

Q.44 Edaphic factor refers to:
(A) Water (B) Soil
(C) Relative humidity (D) Altitude

Q.45 Choose the correct statements for phosphorus cycle.
I. Rocks are the natural reservoirs of phosphorus.
II. Weathering of sedimentary rocks makes phosphate available to the soil.
III. Herbivores and carnivores obtain phosphorus from plant directly or indirectly.
(A) I and II (B) I and III
(C) II and III (D) I, II and III

Q.46 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 one (D) Littoral zone

Q.47 In autogenic succession –
(A) early and continued dominance of autotrophic organisms takes place
(B) replacement of existing communities caused largely by any other external condition
(C) early dominance of heterotrophs takes place such as bacteria, fungi and other animals
(D) community itself modifies its own environment thus causing its own replacement by new communities

Q.48 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%

Q.49 Choose the correct statements.
I. Productivity is expressed in g_{-2} yr^{-1} or (kcal m^{-2}) yr^{-1}.
II. The amount of biomass or organic matter produced per unit area over a time period in plants during photosynthesis is called primary production.
III. Primary production is expressed in term of weight (g^{-2}) or energy (kcal m^{-2}).
IV. Sugarcane have more efficiency to trap sunlight, so they accumulate more primary productivity.
(A) I and II (B) I and IV
(C) I, II, III and IV (D) None of these

Q.50 Which of the following is not a producer?
(A) *Spirogyra* (B) *Agaricus*
(C) *Volvox* (D) *Nostoc*

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

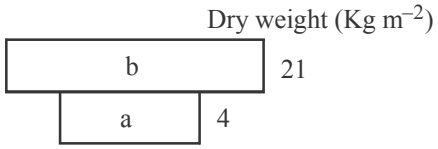
Q.1 Match Column-I with Column - II

	Column-I		Column-II
a.	Standing state	(i)	Fast and maintain nutrient circulation
b.	Gaseous cycles	(ii)	Amount of nutrients present in soil at any given time
c.	Standing crop	(iii)	Slow; nutrients may get out of circulation
d.	Sedimentary cycles	(iv)	Amount of living matter present in an ecosystem

(A) a - (ii), b - (i), c - (iv), d - (iii)
(B) a - (iii), b - (i), c - (iv), d - (ii)
(C) a - (i), b - (iii), c - (ii), d - (iv)
(D) a - (ii), b - (iii), c - (iv), d - (i)

Q.2 About succession which of the following statement is correct –
(A) In xerosere, xeric conditions progress to hydric conditions.
(B) In hydrosere, mesic environment progress to hydric conditions.
(C) In hydrosere hydric environment progress to mesic conditions.
(D) Abandoned farm lands show primary succession.

Q.3 Given figure represents a pyramid of biomass in an aquatic ecosystem.



Identify a and b and select the correct answer.
(i) a is the species which supports and b is the species which is supported.
(ii) a is the species which is supported and b is the species which supports.
(iii) a is phytoplanktons and b is zooplanktons.
(iv) a is zooplanktons and b is phytoplanktons.
(A) (i) and (iv) (B) (ii) and (iii)
(C) (i) and (iii) (D) (ii) and (iv)

Q.4 Ecological pyramids show diagramatic representation of ecological parameters like number, biomass and energy. Which is / are limitation of ecological pyramids
(A) It does not take into account the same species belonging to two or more trophic levels.
(B) It does not accomadate a food web.
(C) Saprophytes are not given any place in pyramids.
(D) All the above

Q.5 Read the following statements and select the correct ones.
(i) Secondary succession is faster than primary succession.
(ii) Lichens are usually pioneer species on bare rocks.
(iii) Pyramid of energy can be inverted if you take sunlight into consideration
(iv) Number of trophic levels in grazing food chain are restricted by the transfer of energy.
(A) (i) and (ii) (B) (i), (ii) and (iii)
(C) (iii) and (iv) (D) (i), (ii) and (iv)

Note (Q.6-Q.11) :
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1.
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement- 2 is False.
(D) Statement-1 is False, Statement-2 is False.

Q.6 **Statement 1 :** Food web consists of several food chains.
Statement 2: Food web decreases the stability of an ecosystem.

Q.7 **Statement 1 :** The conversion of productivity at next trophic level is 10%.
Statement 2 : Energy is lost in the respiration process.

Q.8 **Statement 1 :** Net primary productivity is gross primary productivity minus respiration and other processes.
Statement 2 : Secondary productivity is produced by heterotrophs.

Q.9 **Statement 1 :** Ecological pyramids are also called Eltonian pyramids.
Statement 2 : An ecological pyramid is always upright.

Q.10 **Statement 1 :** Biomes are the major ecosystem of the world.
Statement 2 : Tundra is an example of biome.

Q.11 **Statement 1 :** A network of food chains existing together in an ecosystem is known as a food web.
Statement 2 : An animal like kite can not be a part of a food web.

Q.12 Consider the following statements.
I. The pyramid of biomass is inverted in a pond ecosystem.
II. Pyramid of energy is never inverted.
III. Pyramid of number is inverted in a tree ecosystem.
IV. Pyramid of biomass in forest ecosystem is upright.
Which of the statements given above are correct?
(A) I, II and III (B) I, III and IV
(C) II, III and IV (D) I, II, III and IV

Q.13 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) Shrub stage → forest → annual herb stage → perennial herb stage → lichen → moss stage
(D) Forest → shrub stage → annual herb stage → perennial herb stage → lichen → moss stage

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

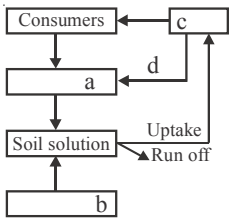
Q.1 Natural reservoir of phosphorus is **[NEET 2013]**
(A) Fossils (B) Sea water
(C) Animal bones (D) Rock

Q.2 Secondary productivity is rate of formation of new organic matter by : **[NEET 2013]**
(A) Decomposer (B) Producer
(C) Parasite (D) Consumer

Q.3 Which one of the following processes during decomposition is correctly described ? **[NEET 2013]**
(A) Leaching – Water soluble inorganic nutrients rise to the top layers of soil.
(B) Fragmentation – Carried out by organisms such as earthworm.
(C) Humification – Leads to the accumulation of a dark coloured substance humus which undergoes microbial action at a very fast rate.
(D) Catabolism– Last step in the decomposition under fully anaerobic condition.

Q.4 Match the following and select the correct option
(a) Earthworm (i) Pioneer species
(b) Succession (ii) Detritivore
(c) Ecosystem service (iii) Natality
(d) Population growth (iv) Pollination
(A) a-(i), b-(ii), c-(iii), d-(iv) **[AIPMT 2014]**
(B) a-(iv), b-(i), c-(iii), d-(ii)
(C) a-(iii), b-(ii), c-(iv), d-(i)
(D) a-(ii), b-(i), c-(iv), d-(iii)

Q.5 Identify the blanks (a-d) for phosphorus cycle.



Options : **[AIPMT 2014]**
(A) a-Rock minerals, b-Detritus, c-Litter fall, d-Producers
(B) a-Litter fall, b-Producers, c-Rock minerals, d-Detritus

(C) a-Detritus, b-Rock minerals, c-Producers, d-Litter fall
(D) a-Producers, b-Litter fall, c-Rock minerals, d-Detritus

Q.6 If 20 J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following chain? **[AIPMT 2014]**

Plant → Mice → Snake → Peacock

(A) 0.02 J (B) 0.002 J
(C) 0.2 J (D) 0.0002 J

Q.7 The mass of living material at a trophic level at a particular time is called: **[AIPMT 2015]**

(A) Standing state
(B) Net primary productivity
(C) Standing crop
(D) Gross primary productivity

Q.8 Vertical distribution of different species occupying different levels in a biotic community is known as : **[AIPMT 2015]**

(A) Stratification (B) Zonation
(C) Pyramid (D) Divergence

Q.9 Secondary Succession takes place on/in : **[AIPMT 2015]**

(A) Degraded forest (B) Newly created pond
(C) Newly cooled lava (D) Bare rock

Q.10 Most animals are tree dwellers in a : **[AIPMT 2015]**

(A) thorn wood land
(B) temperate deciduous forest
(C) tropical rain forest
(D) coniferous forest

Q.11 In an ecosystem the rate of production of organic matter during photosynthesis is termed as : **[AIPMT 2015]**

(A) Gross primary productivity.
(B) Secondary productivity.
(C) Net productivity.
(D) Net primary productivity.

Q.12 In which of the following both pairs have correct combination ? **[RE-AIPMT 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

Q.13 During ecological succession: **[RE-AIPMT 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 equilbrium with the environment and is called pioneer community.
(D) the gradual and predictable change in species composition occurs in a given area.

Q.14 Which one of the following is a characteristic feature of cropland ecosystem?

(A) Absence of soil organisms
(B) Least genetic diversity
(C) Absence of weeds **[NEET 2016 PHASE 1]**
(D) Ecological succession

Q.15 The term ecosystem was coined by **[NEET 2016 PHASE 1]**

(A) E.P. Odum (B) A.G. Tansley
(C) E. Haeckel (D) E. Warming

Q.16 The primary producers of the deep-sea hydrothermal vent ecosystem are

(A) Green algae **[NEET 2016 PHASE 2]**
(B) Chemosynthetic bacteria
(C) Blue-green algae
(D) Coral reefs

Q.17 Which ecosystem has the maximum biomass? **[NEET 2017]**

(A) Forest ecosystem (B) Grassland ecosystem
(C) Pond ecosystem (D) Lake ecosystem

Q.18 What type of ecological pyramid would be obtained with the following data? **[NEET 2018]**
Secondary consumer : 120 g
Primary consumer : 60 g
Primary producer : 10 g
(A) Upright pyramid of numbers
(B) Pyramid of energy
(C) Inverted pyramid of biomass
(D) Upright pyramid of biomass

Q.19 Which of the following ecological pyramids is generally inverted? **[NEET 2019]**
(A) Pyramid of numbers in grassland
(B) Pyramid of energy
(C) Pyramid of biomass in a forest
(D) Pyramid of biomass in a sea

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (A) **(2)** (C) **(3)** (A) **(4)** (D)
(5) **Stratification**
(6) **Detritus food chain**
(7) **Secondary productivity**
(8) **Mineralisation**
(9) **Seral communities**
(10) **Pyramid of numbers**
(11) **Gross production**
(12) Produces **(13)** Inverted **(14)** Light
(15) Earthworm, ants and mites **(16)** Ocean
(17) 49% **(18)** Phosphorus, phosphorus
(19) abiotic, biotic **(20)** Primary productivity
(21) (i) nitrogen cycle (ii) carbon cycle (iii) nitrogen cycle ; (iv) carbon cycle ; (v) nitrogen cycle; (vi) phosphorus cycle; (vii) hydrologic cycle
(22) False **(23)** False **(24)** True
(25) True **(26)** True **(27)** False

EXERCISE - 1 [SECTION-3]

Q	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
A	B	D	A	B	C	B	A	B	A	B	A	B	A	B	A	C	C	A	D	A
Q	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
A	B	A	C	B	D	D	C	A	C	A	A	C	D	A	C	B	A	B	C	D
Q	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83				
A	B	C	C	A	A	A	C	B	B	D	D	D	D	D	B	A				

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	B	A	D	A	B	D	C	B	A	A	A	B	A	D	D	C	C	B	B	D
Q	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
A	C	A	B	B	A	D	B	A	C	D	D	D	B	A	B	C	C	D	A	A
Q	41	42	43	44	45	46	47	48	49	50										
A	C	D	C	B	D	D	D	B	C	B										

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13
A	A	C	C	D	D	C	A	B	C	B	C	D	A

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	D	D	B	D	C	A	C	A	A	C	A	D	D	B	B	B	A	C	D

SOLUTIONS

EXERCISE-1

(1) (A) **(2)** (C) **(3)** (A)

(4) **(D).** Population consists of organisms of same species. Community have organisms of different species and ecosystem include biotic and abiotic components. Ecosphere is part of the earth consisting of all the ecosystems of the world.

(5) **Stratification.** Vertical distribution of different species occupying different levels is called stratification, e.g., in a forest ecosystem, trees occupy top vertical strata or layer, shrubs the second and herbs and grasses occupy the bottom layers.

(6) **Detritus food chain.** Detritus Food Chain (DFC) begins with detritus or dead organic matter. Detrivores and decomposers feed over it.

Detritus → Earthworm → Sparrow → Falcon
↳ Frog → Snake → Peacock

(7) **Secondary productivity.**
Secondary productivity is the rate of energy storage at consumer's level, i.e., herbivores, carnivores and decomposer.

(8) **Mineralisation.** The process by which humus is further degraded by some microbes to release inorganic nutrients is called mineralisation.

(9) **Seral communities.** The various biotic communities that develop during biotic succession are termed as seral or transitional communities.

(10) **Pyramid of numbers.** Pyramid of number is used to know how many organisms are present at each level of a food chain.

(11) **Gross production.** Total energy fixed by an ecosystem is called gross production.

(12) Produces **(13)** Inverted **(14)** Light

(15) Earthworm, ants and mites **(16)** Ocean

(17) 49% **(18)** Phosphorus, phosphorus

(19) abiotic, biotic **(20)** Primary productivity

(21) (i) nitrogen cycle (ii) carbon cycle (iii) nitrogen cycle ; (iv) carbon cycle ; (v) nitrogen cycle; (vi) phosphorus cycle; (vii) hydrologic cycle

(22) False **(23)** False **(24)** True

(25) True **(26)** True **(27)** False. Large

(28) **(B).** In an aquatic ecosystem, the trophic level equivalent to cows in grasslands is zooplankton.

(29) **(D).** The term 'ecosystem' was introduced by Tansley in 1935 to describe the whole complex of living organisms, living together as sociological units in their habitats.

(30) **(A).** A biotic components includes the non-living physico-chemical factors of the environment. These components not only affect the distribution and structure of organisms but also their behaviour and inter-relationships. Abiotic factors include inorganic substances, organic compounds, climatic factors and edaphic factors.

(31) **(B).** The small crustaceans (water fleas, Cyclops) are herbivores as they feed upon phytoplanktons. They are free-floating animals and form the zooplankton. The primary consumers in pond ecosystem are zooplanktons and other primary consumers are mosquito larvae, tadpoles, snails and tortoises.

(32) **(C).**

(33) **(B).** According to Odum (1983), ecosystem has six components, in which abiotic components are almost similar in every ecosystem.

(i) Abiotic components

(a) Inorganic substances C, N, S, K, CO_2, H_2O, temperature, humidity, soil, light, pressure, etc.

(b) Organic substances
Proteins, carbohydrates, lipids, etc.

(ii) Biotic components
Producers, macroconsumers, microconsumers.

(34) **(A).** Ecosystem is an open system. It receives input in the form of solar energy and matter. It results in productivity or synthesis of organic food. Food with its contained energy passes through various components of ecosystem.

(35) **(B).** Productivity is maximum in the coral reefs because they grow in areas having good light and abundant nutrients.

(36) **(A).** The rate of total capture of energy or the rate of total production of organic material is gross primary productivity, while the. balance or biomass remaining after meeting the cost of respiration of producers is net primary productivity. Hence, the Gross Primary Productivity (GPP) has highest value in grassland ecosystem.

(37) **(B).** Tropical rain forests have an average net primary productivity (NPP) of 1,500 $g/m^2/yr$. Open oceans and deserts have average NPPof 125 and 90 $g/m^2/yr$ respectively. Algal beds and reefs ecosystem have average NPP of 2,500 $g/m^2/yr$.

(38) **(A).** The rate of formation of new organic matter by consumers is called secondary productivity.

(39) **(B).** The rate of synthesis of energy containing organic matter or biomass by any trophic level per unit area in unit time is described as its productivity. It is measured as weight (e.g., $g/m^2/yr$) or energy (e.g., $Kcal/m^2/yr$). Hence, only unit (iv) is correct.

(40) **(A).** Gross primary productivity is the rate of production of organic matter during photosynthesis in an ecosystem.

(41) **(B).** **Ocean :** The highest primary productivity in terms of per unit area is of estuaries > Swamps and marshes > Tropical rain forest > Temperate forest while in terms of average net primary production is ocean > Tropical rainforest > Temperate rainforest > Savannah > Northern coniferous forest.

(42) **(A).** Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called catabolism.

(43) **(C).** Decomposition is the process of breaking down a substance into its constituent parts. Decomposition of dead organic matter (plants, animals and waste products of animals) occurs in nature and it is also called decay or putrification. In a terrestrial ecosystem, the upper layer of soil is the main site of decomposition.

(44) **(C).** Decomposers are heterotrophs and saprotrophs, which feeds on dead bodies of organisms and organic wastes of living organisms. These are mainly bacteria and fungi.

(45) **(A).** Mineralisation is the release of inorganic substances, both non-mineral (e.g., CO_2, H_2O) and mineral (e.g., Ca^{2+}, Mg^{2+}, K^+, NH_4^+) from organic matter. The process is slow because of trapping of these nutrients in humus and their immobilisation in decomposers/detrivores. It prevents their washing out or leaching. Nutrients immobilised in decomposer microbes and detrivores are again exposed to humification and mineralisation after the death of these organisms.

(46) **(D).** The end result of decomposition is the production of dark brown, smelling, humus rich organic matter and inorganic substance like carbon dioxide, water and nutrients.

(47) **(A).** Tropical rain forests are the richest and most productive ecosystem in the world. Consequently, the rate of decomposition is also high, as the conditions of moisture and temperature are optimum.

(48) **(B).** Decomposers or the microconsumers (bacteria and fungi) are also called as saprobes or saprophytes. They breakdown the complex organic substances of dead plants and animals to release most of inorganic substances back into the environment for their reuse by the producers.

(49) **(A).** The decomposition rate is higher when detritus is rich in nitrogen and water-soluble substances like sugars.

(50) **(C).** As decomposers are the primary weapons to decompose the dead organic matter so, the extinction of the decomposers will severely destroy the nature as the dead remains in the nature will accumulate and they will not get decomposed. The dead matter will not get decomposed and as a result the soil will not get the nutrients by the decomposition of dead matter and hence the soil will become infertile.

(51) **(B).** Detritus food chain begins from dead organic matter.

(52) **(D).** Out of the total incident solar radiation, only 50% of it is Photosynthetically Active Radiation (PAR). Plants capture only 2-10% of the PAR and this small amount of energy sustains the entire living world.

(53) **(D).** All animals depend on plants directly or indirectly for their food needs. They are hence, called consumers and also heterotophs. If they feed on the producers, the plants (belonging to the first trophic level), they are called primary consumers. Obviously the primary consumers will be herbivores. Primary consumers belong to th second trophic level.

(54) **(C).** Length of a food chain i.e. number of trophic levels is limited by the efficiency of energy transfer i.e. 10% law.
Producers → 1° consumers
→ 2°consumers → 3° consumers
If the carbon atoms fixed by producer already have passed through three species then the trophic level of the last species (i.e. third species) would be tertiary consumer. Scavengers (e.g. vultures) can be tertiary consumers, but they can be at other trophic levels too.

(55) **(A).** In a terrestrial ecosystem, plant grows by manufacturing food from carbon dioxide of air and water and minerals of soil with the help of chlorophyll and sunlight. Plants, thus acts as the producer on land.
In a pond, phytoplankton (rooted and floating plants) synthesise food materials from dissolved nutrients by photosynthesis. They, thus act as the producers.
Consumers are not producers. They eat (consume) producers.

(56) **(C).** The ultimate source of energy for biosphere is solar energy, which is captured by producers through photosynthesis and stored in organic compounds. The stored energy in the form of food is transferred from producers to herbivores & then carnivores.

(57) **(A).** A much less fraction of energy flows through grazing food chain in ecosystem terrestial. Energy for the food chain comes from the sun. Food chain adds energy into the ecosystem.

(58) **(A).** Maximum energy is found in first trophic level (T_1) i.e., producers.

(59) **(C).** The number of trophic levels in the food chain is restricted as the transfer of energy follows 10% law. This law states that only 10% of the energy is transferred to next trophic level from the lower trophic level.

(60) **(D).** Producers → Herbivores → Carnivores
(Grass) (Rabbit) (Hawk)

(61) **(A).** Each trophic level has a certain mass of living material at a particular time called the standing crop. The standing crop is measured as the biomass of living organisms (biomass), as the number in a unit area.

(62) **(C).**

(63) **(B).** In an aquatic ecosystem, producers have least biomass and this value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted in shape. Biomass basically depends upon reproductive potential and age of individuals.

(64) **(A).** The pyramid of energy is always upright because energy is always lost as heat at each step. It represents the total amount of energy utilised by different trophic level organisms in unit area over a period of time.

(65) **(B).** In a grassland ecosystem, a larger number of grass plants or herbs support a fewer number of grasshoppers that support a still smaller number of frogs, the support still a smaller number of snakes and the snakes very few peacocks or falcons.

(66) **(C).** Ecological pyramids are pictorial representation of relationship between organisms at different trophic levels, regarding energy, biomass or number. Pyramid of numbers can be either upright or inverted. For example in a grassland ecosystem, number of primary consumers are less than primary producers and that of secondary consumers are less than primary consumers and so on. On the other hand, if a single big tree ecosystem is taken into

consideration, pyramid of number will be inverted.

(67) **(D).** Green plants → Insects → Frog → Snakes → Peacock
From the above food chain, it is clear that the peacock stands at the top.

(68) **(B).** The amount of living matter present in an ecosystem is known as biomass. It is upright in case of a tree, which supports a large number of birds and inverted in a pond where a large fish feeds upon a large number of phytoplanktons.

(69) **(C).** Ecological succession is a sequence of series from baren land to the climax. In ecological terms, the developmental stages of a community are known as seral stages and the final stage as the climax community. The change is orderly and sequential. It is a long term process.

(70) **(C).**

(71) **(A).** Primary succession on rock starts with lichen species *Rhizocarpon* like *Rinodina* and *Lecanora*. They produce some acid, which bring about weathering of rocks. That result into soil formation.

(72) **(A).** Biotic or ecological succession is the natural development of a series of biotic communities at the same site, one after the other till a climax community develops which does not change further because it is in perfect harmony with the environment of the area. The change is orderly and sequential. The first biotic community which develops in a bare area is called pioneer community. It has very little diversity. Climax community is a stable, self perpetuating and final biotic community that develops at the end of biotic succession.

(73) **(A).** Ecological succession is directional because succession proced in a direction and is a long term process.

(74) **(C).**

(75) **(B).** The process of sequential establishment of various plant communities in any habitat is called plant succession. Finally that community is established which is in complete equilibrium with the prevailing environment. This stage is called climax stage and its establishment is called stabilization.

(76) **(B).** The primary succession occurs in the barren, soilless, uninhabited regions such as igneous rock emerged from the sea, lava deposit, sand dune, newly created pond or reservoir.

(77) **(D).** In the sedimentary cycle, the reservoir for the nutrient elements is in the sediments of the earth. Elements, such as phosphorus, sulphur, potassium and calcium have sedimentary cycle.

(78) **(D).** Phosphorus, nitrogen and sulphur do not have losses due to respiration because they are not particularly involved in gaseous exchange.

(79) **(D).**

(80) **(D).**

(81) **(D).** The exchange pool in the carbon cycle is the atmosphere. In the gaseous cycle (carbon cycle) the reservoir is the atmosphere.

(82) **(B).** Biogeochemical cycles can be grouped into 3 types:

(i) Gaseouscycle (material involved in circulation are gases or vapours and the reservoir pool is the atmosphere or hydrosphere) e.g., Nitrogen cycle.

(ii) Sedimentary cycle (Materials involved in circulation are non-gaseous and the reservoir pool is lithosphere) e.g. phosphorus, calcium and magnesium cycles.

(iii) Mixed cycle (materials involved in circulation has both gaseous and non-gaseous state). e.g., Sulphur cycle.

(83) **(A).**

EXERCISE-2

(1) (B) **(2)** (A)

(3) **(D).** Photosynthesis is the only one the four choices that removes carbon from the atmosphere.

(4) **(A).** There are three basic types of food chain as discussed

1. **Grazing food chain:** The primary producers are the living green plants which

are grazed on by grazing animals. It is found in aquatic and grassland ecosystem.
E.g. of aquatic ecosystem
Phytoplankton → Zooplankton → Fish → Hawk
E.g. of grassland ecosystem
Grass → Rabbit → Fox → Wolf → Tiger
Grass → Grasshopper → Frog → Snake → Hawk

2. **Detritus food chain:** This type of food chain starts from dead organic matter and so it is less dependent on solar energy. The dead organic matter is broken down into simple nutrients by microorganisms like fungi and bacteria. This type of food chain is found in forest ecosystem.
Dead organic matter → Detritivores → Predators

3. **Parasitic food chain:** In this type of food chain either the producer or the consumer is parasitized and therefore the food passes to the smaller organism. The energy transfer through this kind of food chain is not significant.
Producer → Herbivores → Parasite → Hyperparasites
Trees → Fruit eating birds → Lice and bugs → Bacteria and fungi.

(5) **(B).** Denitrification is an anaerobic process that is carried out by denitrifying bacteria, which convert nitrate to dinitrogen.

(6) (D)

(7) **(C).** Abiotic variables found in terrestrial ecosystems can include things like rain, wind, temperature, altitude, soil, pollution, nutrients, pH, types of soil, and sunlight.

(8) (B)

(9) **(A).** Primary Productivity : It is a term used to describe the rate at which plants and other photosynthetic organisms produce organic compounds in an ecosystem. There are two aspects of primary productivity:
Gross productivity = the entire photosynthetic production of organic compounds in an ecosystem.
Net productivity = the organic materials that remain after photosynthetic organisms in the ecosystem have used some of these compounds for their cellular energy needs (cellular respiration).

(10) **(A).** The tropical rainforest is a biome located across the earth on land on and around the equator. It has the highest biodiversity of all the earth's ecosystems, both in flora and fauna as well as microbes.

(11) (A) **(12)** (B)

(13) (A) **(14)** (D)

(15) **(D).** Biomass and numbers are the basis for two of the three ecological pyramids.

(16) (C) **(17)** (C)

(18) **(B).** Lichen → Small bryophytes → Herbs → Shrubs → Trees → Forest

(19) (B) **(20)** (D)

(21) **(C).** Deserts have been variously classified as true deserts, having less than 120 mm annual rainfall, or extreme deserts showing less that 70 mm yr^{-1} rainfall. In desert biomes, evaporation from soil always exceeds rainfall by 7 to 50 times.

(22) (A) **(23)** (B) **(24)** (B)

(25) (A) **(26)** (D) **(27)** (B)

(28) **(A).** Phosphorous is important for the production of ATP and nucleotides. Inorganic phosphorous is found in the soil or water. Plants and algae assimilate inorganic phosphorus into their cells, and transfer it to other animals that consume them. When organisms die, their phosphorous is released by decomposer bacteria.
Aquatic phosphorous follows a seasonal cycle, inorganic phosphorous peaks in the spring causing rapid algae and plant growth, and then declines. As plants die, it is re-released into the water.
Phosphorous based fertilizers can cause excessive algae growth in aquatic systems, which can have negative impacts on the environment.

(29) **(C).** Ecological succession is the gradual process by which ecosystems change and develop over time. Nothing remains the same and habitats are constantly changing. There are two main types of succession, primary and secondary.

(30) (D)

(31) **(D).** The products of ecosystem processes which have environmental, aesthetic and indirect economic value are named as ecosystem services. Soil formation and soil protection are the major ecosystem services accounting for nearly 50% of their total worth. Plant cover protects the soil from drastic changes in temperature. There is little wind or water erosion as soil particles are not exposed to them. The soil remains spongy and fertile. There are no landslides and no floods. Plant cover of natural ecosystem absorbs polluting gases, causes settling of suspended particulate matter, removes CO_2 and releases O_2, Purified air becomes available. There is no overall depletion of nutrients as the same are repeatedly circulated and recirculated. This keeps the fertility of soil intact.

(32) (D) **(33)** (B) **(34)** (A)

(35) (B) **(36)** (C) **(37)** (C)

(38) (D) **(39)** (A) **(40)** (A)

(41) **(C). Pyramid of biomass :** The pyramid of biomass is more fundamental, they represent the quantitative relationships of the standing crops. In this pyramid there is a gradual decrease in the biomass from the producers to the higher trophic levels. There are two types of pyramid of biomass, they are:

(a) **Upright pyramid of biomass :** This occurs when the larger net biomass of producers support a smaller weight of consumers. Example: Forest ecosystem.

(b) **Inverted pyramid of biomass:** This happens when the smaller weight of producers support consumers of larger weight. Example: Aquatic ecosystem.

(42) **(D).** A halosere is a succession in a saline environment. An example of a halosere is a salt marsh. In a river estuary, large amounts of silt are deposited by the ebbing tides and inflowing rivers.

(43) **(C).** If a predator overexploits its prey then prey might become extinct and following it the predator will also become extinct for lack of food.

(44) **(B).** Edaphic factors are classified under the abiotic factors affecting an ecosystem. Edaphic factors include factors of soil e.g. soil texture, substratum, topography, mineral composition, pH etc. These factors can influence the distribution and interrelationships of organisms, as well as rate of decomposition.

(45) **(D).** The major reservoir for phosphorus is in phosphate rocks and fossil bone deposits laid down in the past geological ages. There is no atmospheric phase in the phosphorus cycle.

Phosphorus becomes available in the soil for plants use by natural erosion of rocks and by human efforts.

Plants takes up phosphorus from the soil. Animals get it from the plants directly or through other smaller animals. Animals excrete phosphorus mainly as phosphates, which the plants can use immediately.

(46) **(D).** Littoral zone is the shallow coastal zone. Light is available upto bottom in this zone. Therefore, producers are found throughout from surface to bottom in this zone. Rooted vegetation occurs along shores. Consumers are also available throughout i.e., from surface to the bottom in this zone.

(47) **(D).** Autogenic succession (auto-self, genic-generate) is the modification and the development of new environment made by the community itself such that the community makes its own replacement by new communities. The changed environment is now favourable for new community.

(48) **(B).** Energy flow in the ecosystem follows the ten percent law (put forth by Lindemann in 1942).

From the level of primary producers onwards, only 10% of energy is stored at the higher trophic level and 90% is lost (as heat or in respiration etc). This energy transfer forms the basis of life.

Producers → Herbivores → Carnivores

20 J 2 J 0.2 J

(49) **(C).** The rate of synthesis of energy containing organic matter by any trophic level per unit area in unit time is described as its productivity. It is measured as weight (e.g. $g^{-2}yr^{-1}$) or energy (e.g., kcal/m^2/yr). The amount of energy accumulation in green plants as biomass or organic matter per unit area over a time period through the process of photosynthesis is known as primary productivity. Primary productivity is expressed in terms of weight (g^{-2}) or energy (Kcal m^{-2}). C_4 plants are more productive than that of C_3 plants. Sugarcane is most productive crop being efficient in trapping light.

(50) **(B).** *Spirogyra* (Green alga), *Volvox* and *Nostoc* (BGA) are chlorophyll containing organisms and thus prepare their own food. *Agaricus* is a fungus (Basidiomycetes), it is achlorophyllus and not a producer. It possesses saprotrophic mode of nutrition.

EXERCISE-3

(1) (A) **(2)** (C) **(3)** (C)
(4) (D) **(5)** (D)

(6) **(C).** Food web is a network of food chains which become interconnected at various trophic levels so as to form a number of feeding connections amongst the different organisms of a biotic community. Food web is meant for increasing the stability of an ecosystem by providing alternate source of food and allowing the endangered population to grow in size.

(7) **(A).** Ten percent law put forth by Lindemann states that while transferring organic food from one trophic level to the next, about ten percent of the organic matter is stored as flesh, the remaining is lost during transfer or broken down in respiration. The net productivity of the next higher trophic level shall be 10% of the first one.

(8) **(B).** Net primary productivity is the rate of organic matter built up 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. Rate of increase in energy containing organic matter or biomass by heterotrophs or consumers per unit time and area is known as secondary productivity.

(9) **(C).** Ecological pyramids were developed by Charles Elton and are, therefore, also called Eltonian pyramids. An ecological pyramid can be upright, inverted or spindle shaped depending upon criteria of formation of pyramid(like energy, biomass or number) and the type of food chain involved parasitic, aquatic or terrestrial.

(10) **(B).** A biome is defined as a large natural ecosystem which is distinct in its climate conditions and has its specific type of plant and animal life. Biomes are two types - terrestrial and aquatic. The major terrestrial biomes are - tundra, taiga, deciduous forest, tropical rain forest, chaparral, tropical savannah, grassland and desert.

(11) **(C).** The series of organisms eating one and being eaten by other is called food chain. A simple food chain consists of producers, herbivores and carnivores. The length of food chain is generally limited to 3-4 trophic levels due-to energy loss. In grazing food chain, the producers, (i.e, plants) are eaten by herbivores (i.e., rabbit, dear, cow, etc) and they are eaten by carnivores.

(12) **(D).** The pyramid of biomass is inverted in a pond ecosystem, where a large fish eats upon a large number of small phytoplanktons.
The pyramid of energy is always upright because the flow energy is unidirectional
Pyramid of number is inverted in a tree ecosystem. In case of a tree, the number of producers is less compared to consumers.
Pyramid of biomass is upright in case of a tree which supports a large number of small birds.

(13) **(A).** Sucession level in xerarch (seroser/lithosere) are
(i) Lichen stage, e.g., crustose lichens followed by foliose lichens.
(ii) Moss stage, e.g., *Tortula, Polytrichum.*

(iii) Annual grass stage, e.g., *Cymbopogon*.
(iv) Perennial herb and shrub stage, e.g., *Rubus, Capparis, Zizyphus*.
(v) Climax community, e.g., forest with herbs shrubs and trees.

EXERCISE-4

(1) **(D).** Phosphorous – Sedimentary cycle
Reservoir – Rocks

(2) **(D).** Secondary productivity is rate of formation of new organic matter by consumers.

(3) **(B).** Fragmentation is one of the steps during decomposition, in which detritus is converted into small fragments.

(4) **(D).** Detrivores, (eg. earthworm) break down detritus into smaller particles.
The species that invade a base area in succession is called pioneer species.

(5) **(C).** a – Detritus ; b – Rock minerals
c – Producer ; d – Litter fall

(6) **(A).** Plant $\rightarrow$ 20 J
Mice $\rightarrow 20 \times 10\% = 2$ J
Snake $\rightarrow 2 \times 10\% = 0.2$ J
Peacock $\rightarrow 0.2 \times 10\% = 0.02$ J

(7) **(C).** The total dried biomass of living organisms present at a trophic level at a particular time is known as standing crop.

(8) **(A).** Stratification is the vertical distribution of different species occupying different levels in a biotic community. Zonation is the horizontal categorisation of biomass into zones based on their distribution or arrangement in habitat as determined by environmental factors, e.g. altitude, latitude, temperature, biotic factors, etc.

(9) **(A).** Secondary succession takes place on degraded forest. It is the process of regrowth of an ecosystem which undergoes a destructive event such as fire, avalanche, agricultural clearing, deforestation or disease.

(10) **(C).** Tropical rain forest biome is in equatorial or sub equatorial regions with abundant rainfall and warmth.
The vegetation is stratified, i.e. each stratum has different fauna contributing to the diversity, because of this most animals in this biome are tree dwellers.

(11) **(A).** The rate of production of organic matter (chemical energy) as biomass that primary producers (via photosynthesis) created in a given duration of time is called Gross Primary Productivity (GPP).
Net primary production is the rate at which all plants (producers) in an ecosystem produce net useful chemical energy. it is equal to difference between the rate at which plants in an ecosystem produce useful chemical energy (GPP) and the rate at which they use some of that energy during respiration.
NPP = GPP-respiration (by plants)
Secondary productivity is the generation of biomass or organic matter by heterotrophic (consumers) in a system.

(12) **(D).** Sulphur and phosphorus are found on earth crust in the form of rocks

(13) **(D).** Ecological succession involves gradual and fairly predictable change in the species composition of a given area.

(14) **(B).** Cropland ecosystem is largest anthropogenic ecosystem characterised by less diversity and high productivity.

(15) **(B).** The term ecosystem was coined by A.G. Tansley.

(16) **(B).** The primary producers of the deep sea hydrothermal vent ecosystem are *Archaebacteria*, they have chemosynthetic mode of nutrition.

(17) **(A).** High productive ecosystem are
* Tropical rain forest * Coral reef
* Estuaries * Sugarcane fields

(18) **(C).** The given data depicts the inverted pyramid of biomass, usually found in aquatic ecosystem.
* Pyramid of energy is always upright
* Upright pyramid of biomass and numbers are not possible, as the data depicts primary producer is less than primary consumer and this is less than secondary consumers.

(19) **(D).** In an aquatic ecosystem, the pyramid of biomass is generally inverted.