

CHAPTER 14**ECOSYSTEM****Topics Discussed**

INTRODUCTION

TYPES OF ECOSYSTEM

ECOSYSTEM- COMPONENTS, STRUCTURE AND
FUNCTION

ECOLOGICAL PYRAMIDS

ECOLOGICAL SUCCESSION

NUTRIENT CYCLE

ECOSYSTEM SERVICES

1. Introduction

On earth surface wide range of living organisms are present. Maintaining a balance in nature, all living organisms such as plants, animals and microorganisms interact among themselves and also with the surrounding physical environment. A self-sustaining or functional unit of the living world called as ecosystem. Interaction of biotic component comprising living organisms and abiotic components comprising physical factors like temperature, rainfall, wind, soil and minerals is an ecosystem. The term Ecosystem was coined by Arthur G Tansley (1935). Other terms used for ecosystem are Biocoenosis (by C. Mobius), Microcosm (by Forbes), Giobiocoenosis (by Sukhachev). This chapter gives overview of different types of ecosystem, structural as well as functional aspects related to productivity, energy flow, decomposition, ecological efficiencies and nutrient cycling.

Objectives

At the end of this chapter, you will be able to:

- Learn about types of ecosystem.
- Establish components, structure and function of a typical ecosystem.
- Define the composition of ecological pyramids.
- Learn about ecological succession.
- Learn about nutrient cycle.
- Study the ecosystem services.

2. Types of Ecosystem

From a small pond to a large forest or a sea, ecosystem varies greatly in size. The entire biosphere is considered by many ecologists as a global ecosystem as a composite of all local ecosystem on earth. This system is too complex and big to be studied at one time, so to make the study easier, it is broadly divided into two basic categories

- a. **Terrestrial Ecosystem:** consists of land. **E.g., Forest, grassland, desert.**
- b. **Aquatic Ecosystem:** consists of water bodies. **E.g., Ponds, lakes, fresh water rivers, wet lands, sea, salt water estuaries.**

Ecosystem which develops with or without human interference are of two types

- a. **Natural ecosystem:** Ecosystem which develops in nature without human support or interference. **E.g., Forests, marine ecosystem.**
- b. **Anthropogenic ecosystem or man-made ecosystem:** Ecosystem which is created and maintained by human beings.

E.g., Crop fields, garden, aquarium. Agro ecosystem or agriculture is the largest man-made ecosystem.

2.1 Components/Constituents of Ecosystem

An ecosystem consists of two components namely abiotic and biotic components.

- **Abiotic Components**

The physical environmental factors or the non-living factors in an ecosystem are the abiotic components. Three types of abiotic components i.e., climatic, edaphic, topographic are mentioned below.

- **Climatic factors** include **temperature, water, light, wind, humidity, air currents.**
- **Edaphic factors** include factors related to the **structure** and **composition** of **soil**, including its **physical** and **chemical** properties.
- **Topographic factors** include factors related to **physical features** of **earth** like **slope, valley, mountain** and **plains** etc.

- **Biotic Components**

The biotic components of the ecosystem are living organisms i.e., plants, animals and microorganisms that are present in environment. These are classified into three main groups on the basis of their role in the ecosystem:

- **Producers: Green photosynthetic** plants entrap solar energy through chlorophyll to synthesize organic food from inorganic raw materials and are called autotrophs (self-nourishing).
Major **producers in terrestrial ecosystem** are **herbaceous** and **woody plants**.
Major **producers in aquatic ecosystem** are **phytoplanktons, algae** and the **floating, submerged** and **margin plants** found at the edges.
Producers convert solar energy into chemical energy stored in the bonds of sugars, hence are also known as “**converters**” or “**transducers**”.
- **Consumers: Animals** that are **not capable** of **synthesizing** their own **food** materials. Dependent on producers directly or indirectly for their survival. Hence are also termed as **heterotrophs**. Consumers are of following types
 - (a) **Primary Consumers (PC)/First Order Consumers:** These are **organisms/animals** directly feeding on **producers** for their main source of nutrients/food consumptions. They are also called as **herbivores**.
Terrestrial ecosystem: Common herbivores are **grasshopper, cow** and **deer**.
Aquatic ecosystem: Common herbivores are **mollusks, tadpole** and **mosquito larvae**.
 - (b) **Secondary Consumers (SC)/Second Order consumers/Primary Carnivores: Organisms/animals** feeding on **PC/herbivores** are **Secondary Consumers**.
Terrestrial ecosystem: Common SCs include **toad, spiders, lizards, centipedes** and **insectivorous birds**.
Aquatic ecosystem: Common SCs include **Hydra, frog** and **some fishes**.
 - (c) **Tertiary Consumers (TC)/Third Order Consumers/Secondary Carnivores: Carnivores** which feed upon **secondary consumers**. **E.g., Large fishes (aquatic ecosystem), snake (terrestrial ecosystem)**. There may be **quaternary** or **fourth order consumers** which **prey upon secondary carnivores**.
 - (d) **Top Carnivores:** These are carnivores which are not eaten or attacked by other organisms are called as **top carnivores**. They may belong to the category of **primary, secondary, tertiary carnivores**. **E.g. Man, tiger, lion, panthers** and **falcon/peacock**.
- **Decomposers/Osmotrophs: Saprophytic microorganisms** deriving their **food** material from **organic matter** present in **dead remains** of **plants** and **animals** are decomposers. **Digestive enzymes** secreted by them converts **complex** organic substances into **simpler** molecules. The microorganisms assimilate a part of the digested **organic** matter and the rest is broken down into simpler inorganic compounds for recycling. **Cyclic exchange** of materials between biotic community and the environment are brought about by decomposers. They are very essential components of an

ecosystem. Capable of degrading the dead organisms they are also called as **reducers**. These are the **fungi, bacteria** and **flagellates** especially abundant in the bottom of the pond.

Complex organic substances → Simple organic substances → Inorganic compounds

Functions of decomposers in ecosystem:

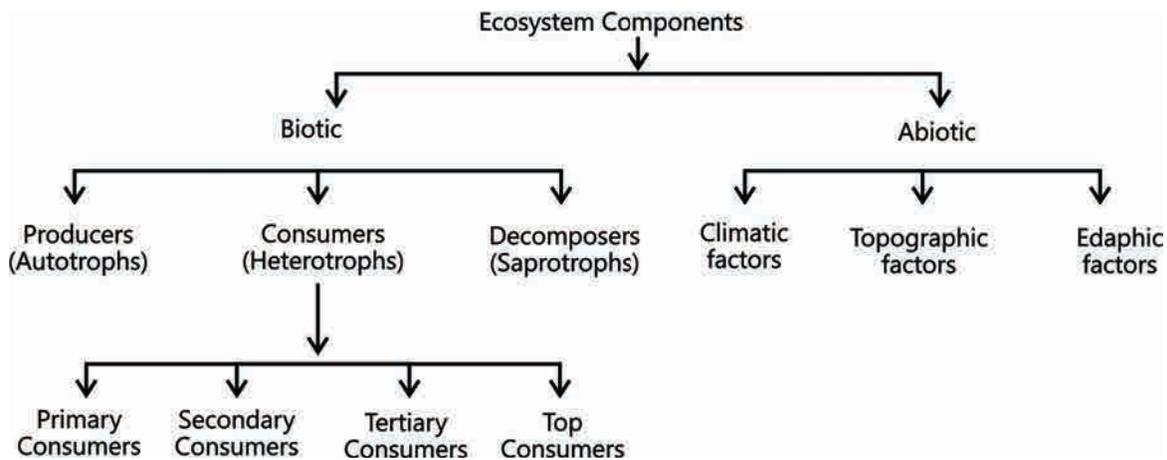
- They **reduce** the **organic** remains of earth and behave as **natural scavengers**.
- **Replenish** the **soil** naturally with **minerals** that are essential for growth of **plants** and hence, maintenance of ecosystem.

Other categories namely **scavengers, detritivores** and **parasites** are included as living beings amongst the **biotic** component of an ecosystem.

Parasites belong to **diverse** groups such as **bacteria, fungi, protozoans, worms etc.**

Detritivores are animals which feed on detritus such as **termites, earthworm** etc. which are helpful in quick disposal of the dead bodies.

Organisms/animals that feed on **dead** or injured animals and they clean the earth of organic garbage are **scavengers**. **E.g., Carrion beetles, marabou storks, crow, hyenas** and **vultures** which act as **full-time scavengers** by surviving on scraps of dead flesh.



Flowchart 14.1: Flowchart displaying arrangement of different components of ecosystem

KNOWLEDGE BUILDER**Table 14.1:** Components of a typical ecosystem with examples


Biotic			Abiotic		
Producers (Autotrophs)	Consumers (Heterotrophs)	Decomposers (Saprotrophs)	Climatic factors	Topographic factors	Edaphic factors
Herbaceous and woody plants, phytoplanktons, algae and the floating, submerged and marginal plants found at the edges	Primary Secondary Tertiary Top	Scavengers (carrion beetles, marabou storks, crow and vultures), detrivores (termites, earthworm) and parasites (bacteria, fungi, protozoans, worms)	Temperature, water, light, wind, humidity, air currents	Physical features of earth like slope, valley, mountain and plain etc.	Structure and composition of soil, including its physical and chemical properties

TRY IT YOURSELF

- 
1. Ecosystem: Forest, grassland, Estuaries, Pond, Lake, Wetland.
 - a. From the above given options, how many can be categorized into terrestrial and aquatic ecosystem respectively?
 - b. Amongst these which is smallest ecosystem?
 2. In terrestrial ecosystem what are major producers?
 3. Chief producer in aquatic ecosystem is _____.
 4. Which biotic component is involved in maintaining soil fertility?
 5. Choose odd one out w.r.t. consumers: Insects, chemosynthetic bacteria, Tadpole.

Did You Know

- **Global** ecosystem is biosphere and the two categories are **terrestrial** and **aquatic**.
- **Three** categories can be distinguished under **biotic** component of ecosystem i.e., **producers consumers, decomposers**.
- **Whale**, which is a mammal is considered as a secondary consumer in the aquatic system since its major diet consists of aquatic **plankton**.
- **Parasites** surviving on **plant** are known as **primary consumers** since they directly feed on the nutrients prepared by **producers/autotrophs**. On the other hand, **parasites** thriving on/within **animals** such as bacteria *E. coli*, *Entamoeba histolitica*, **liver fluke, tapeworm etc.**, are known as **secondary consumers** since they consume nutrients from the heterotrophs/carnivores who themselves derive food from other sources including autotrophs.
- All the **insectivorous** plants have **double role** as **producers** as well as **secondary consumers** because they are capable of synthesizing their own food through photosynthesis while also **trapping insects simultaneously** for nutrient/energy needs.
- **Man** and **peacock** are labeled as **omnivores** since they feed on both **autotrophic plants** as well as other **heterotrophic organisms**.
- **Organisms/microbes** which feed on milk or curd are known as **secondary consumers**.



2.2 Structure of Ecosystem

Physical structure that is characteristic for each type of ecosystem is due to interaction of biotic and abiotic components. Important structural features include

- **Species Composition:** Each ecosystem is an active and dynamic interaction between the different species that it supports and nourishes. These components varies from one ecosystem to another.
- **Identification** and enumeration of plant and animal species of an ecosystem is Species Composition. E.g., Tropical rain forest is dense with amazing number of biological species. On the other hand, vegetation is sparse in the desert ecosystem.
- **Stratification:** Vertical distribution of different species occupying different levels in an ecosystem is Stratification. It is the structure recognizable pattern in spatial arrangement of the members of the communities such as layering of the vegetation in a community (**stratum – layer**).

E.g., In a typical forest the generally observed vertical subdivisions are **top layer** occupied by **trees**; the following **second layer** is abundant in **shrubs** and **short bushes** while the **last bottom layer** near the **base** or **ground** is where grasses and herbs flourish.

2.3 Function of Ecosystem

Eco system have a natural tendency to **persist**. This is made possible by a variety of functions (activities undertaken to ensure persistence) performed by the structural components. The components of the ecosystem are seen to function as a unit to ensure its persistence. The key functional aspects of the ecosystem are

2.3.1 Productivity

It is the rate of biomass production. Productivity in ecosystem is of two types – Primary and Secondary productivity.

- **Primary Productivity:** Rate at which biomass or organic matter which is produced by plants or producers during photosynthesis per unit area over a time period.

Primary Productivity can also be defined as the rate at which sunlight is captured by producers for the synthesis of energy-rich organic compounds through photosynthesis.

It is expressed in terms of **weight** as $\text{gm m}^{-2} \text{yr}^{-1}$ or **energy** as $\text{Kcal m}^{-2} \text{yr}^{-1}$. To compare the productivity of different ecosystems it can be further divided into two categories:

- **Gross Primary Productivity (GPP):** Rate of production or synthesis of organic matter by producers during photosynthesis per unit time and area. The **energy capture process** occurs in the **green, photosynthetic tissues**; these as well as other plant tissues consume the food material or **photosynthate** during respiration. Hence, **considerable amount** of **GPP** is utilized by plants in respiration.
- **Net Primary Productivity (NPP):** **Gross primary productivity minus respiration losses (R)**. It is the rate of organic matter build up or stored by producers in excess of respiratory utilization per unit time and area.

$$\text{NPP} = \text{GPP} - \text{R}$$

Net primary productivity is the available biomass for the consumption to heterotrophs i.e. both herbivores and decomposers.

Factors affecting primary productivity: Primary productivity is affected by several biotic and abiotic factors such as:

- The ability to utilize incident solar radiation to raise gross primary productivity i.e. photosynthetic capacity of producers.
- Available solar radiations at a given point of time.
- Temperature.
- Soil moisture.
- Availability of Nutrients.

Productivity of biosphere: The annual NPP of calculated for the whole biosphere is approximately 170 billion tons (dry weight) of organic matter. The productivity of oceans accounts for about 55 billion tons and while for terrestrial system it is relatively higher at 115 billion tons. This despite water bodies occupying nearly 70% of the earth's surface.

In deep marine habitats, **two** main limiting factors are the reasons for the low productivity of oceans:

- **Light** – Intensity decreases/reduces with depth.
 - **Nutrients** – Nitrogen is the most limiting nutrient of marine ecosystem as compared to terrestrial ecosystems where it is easily fixed.
- Secondary productivity: It is the rate of formation of new organic matter by consumers.



Did You Know

- Composition of species and stratification are the two important structural features of ecosystem.
- There are four functional aspects of ecosystem namely productivity, decomposition, energy flow and nutrient cycling.



Try It Yourself

1. State True or False

- a Vertical stratification is more diverse in grassland than desert ecosystem.
- b Maximum species diversity is associated with tropical rain forest.
- c The magnitude of primary productivity is affected by only biotic factors.
- d Value of Net primary productivity is considerably higher than Gross primary productivity.
- e Rate at which sunlight is captured by autotrophs represents _____.
- f Global area occupied by oceans is _____ but productivity contribution is _____.

2.3.2 Decomposition

Synthesis and building processes are involved in productivity, decomposition is equally important. Decomposition is breakdown of complex organic matter to inorganic raw materials like CO_2 , H_2O , and various nutrients by decomposers. The upper layer of soil in terrestrial habitats and bottom of water bodies is the major site of decomposition. Raw material for decomposition constitute detritus which are dead remains such as leaves, bark, flowers and dead remains of animals including faecal matter.

- **Decomposition Processes:** Fragmentation, leaching and catabolism are the three important steps in the process of decomposition. These processes occur simultaneously.

- **Fragmentation of Detritus:** Detrivores are small invertebrate animals such as earthworms, termites that feed on detritus. They bring about its fragmentation. A part of detritus eaten by detrivores comes out in highly pulverized state in their faeces. Detritus is changed into fine particles due to fragmentation during eating and pulverization in digestive tracts having a large surface area.
- **Leaching:** In the fragmented and decomposing detritus (e.g. sugars, inorganic nutrients), part of water-soluble substances present go down into the soil horizon by percolating water and get precipitated as unavailable salts and is known as Leaching.
- **Catabolism:** Saprotrophic bacteria and fungi secrete digestive enzymes over the fragmented detritus. These enzymes change complex organic compounds into simple compound and inorganic substances are released in this process.

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

- **Humification:** Decomposition of detritus to form humus is termed as **humification**. A dark-colored, amorphous, more or less decomposed organic matter rich in cellulose, lignin, tannins, resin, etc. and is highly resistant against microbial action is Humus. At an extremely slow rate it undergoes decomposition. Humus is slightly acidic, colloidal and functions as reservoir of nutrients.
- **Mineralization:** The release of inorganic substances such as CO_2 , H_2O , minerals from organic matter or humus during the process of decomposition is termed as **mineralization**. When digestive enzymes are poured over organic matter by saprotrophic microbes they are formed along with simple and soluble organic substances.
- **Factors affecting decomposition:** Chemical nature of detritus and a number of climatic factors control the rate of decomposition of detritus.
 - **Chemical nature of detritus:** If it contains lignin chitin, tannins (phenolic) and cellulose, decomposition of detritus is slow. If detritus possesses more of nitrogenous compounds (like proteins, nucleic acids) and water-soluble reserve carbohydrates or sugars it is rapid.
 - **Temperature:** Decomposers are very active in soils having good moisture, aeration and at a temperature of more than 25 °C. It takes less than 3-4 months for complete decomposition of detritus in humid tropical regions. The rate of decomposition is very slow even if moisture and aeration are optimum under low temperature conditions (<10 °C) of soils.
 - **Moisture:** Detritus is quickly decomposed in optimum moisture. The rate of decomposition is reduced by reduction in moisture as in areas of prolonged dryness like tropical deserts where otherwise, the temperature is quite high. Excessive moisture also delays decomposition. The most important climatic factors i.e. temperature and soil moisture regulate the decomposition through their effects on the activities of soil microbes.
 - **Aeration:** Required for activity of decomposers and detrivores. The process of decomposition will slow down as aeration is reduced.

Warm and moist environment favor decomposition whereas low temperature and anaerobiosis inhibit decomposition resulting in buildup of organic materials.

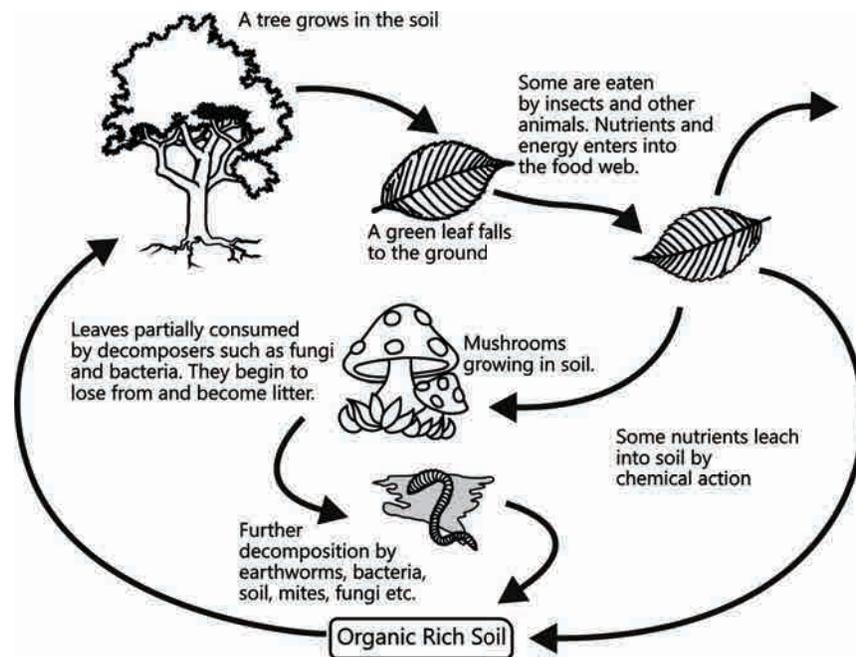


Figure 14.1: Diagrammatic representation of the decomposition cycle in a typical terrestrial ecosystem

Did You Know

Biosphere: Composed of all the biotic (living) as well as abiotic (non living) thing factors/ components of the earth/biome combined together, constituting a big ecosystem. The other terms for **Biosphere** is **Ecosphere** and was coined by Cole (1958).

Earth is also termed as **biome/Biosphere**

The Earth/biome is divided into the following spheres

- **Lithosphere**—The biotic as well as abiotic components located on the earth surface constitutes the lithosphere.
- **Hydrosphere**—The biotic as well as abiotic components located in the water constitutes the hydrosphere
- **Atmosphere**—The biotic as well as abiotic components located in air constitutes the atmosphere.

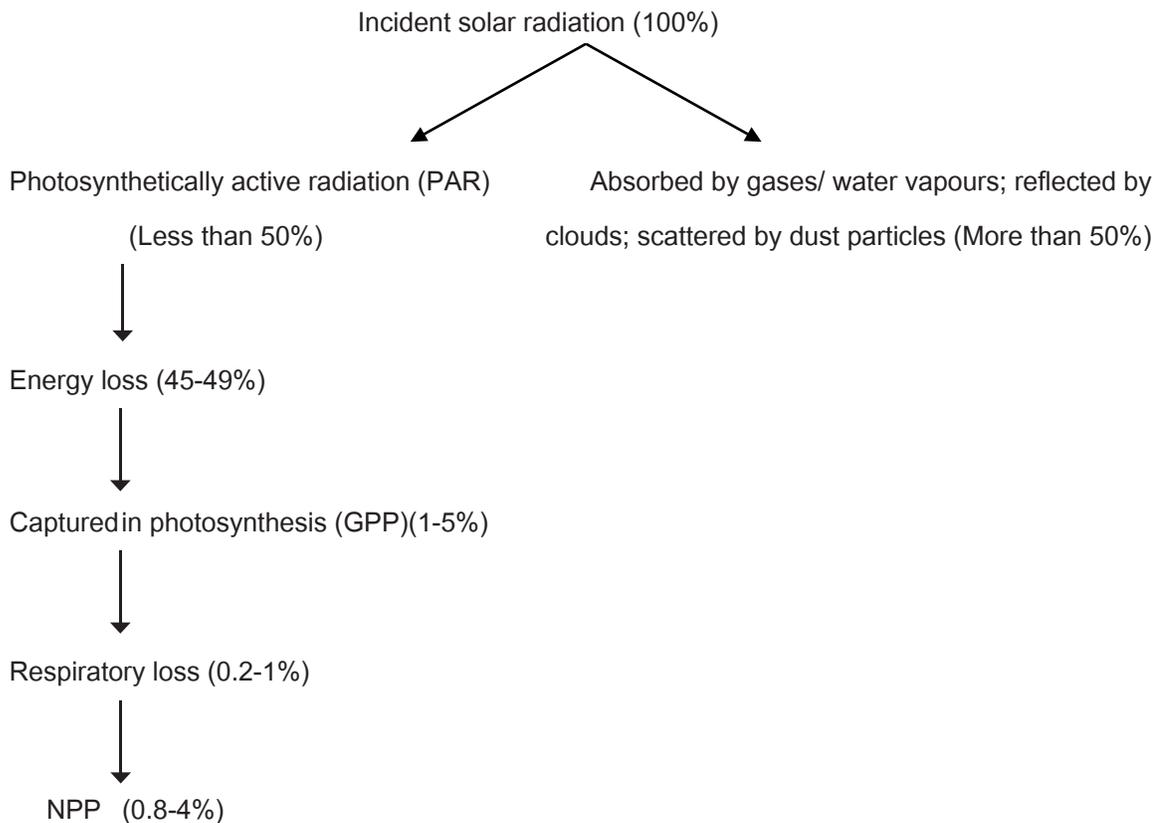
Earth as a biosphere is a closed system of minerals but is considered as an open system w.r.t energy.

TRY IT YOURSELF

1. Which of the following terms are not associated with humus?
Amorphous, Light colored, Acidic, Colloidal, Labile, and Reservoir of nutrients.
2. Two major decomposers include _____ and _____.
3. What results in the piling up of organic matter amongst the factors given below?
Warm environment, Anaerobic condition, Low moisture, < 10°C temperature
4. State True or False
 - a. Rate of decomposition is controlled by climatic factors only.
 - b. Fragmentation is performed by detritivores resulting in breakage of large size organic matter into smaller one which increases surface area for action of microbes.

2.3.3 Energy Flow

Sequential process of the movement of energy in an ecosystem through a series of organisms is energy flow. For all ecosystems on earth (except for deep sea hydrothermal ecosystem), sun is the only source of energy. Flow of incident energy is shown below:



Flowchart 14.2: Sequential flow of incident solar energy

Source of Energy: From the incident solar radiation which is assumed to be 100%, less than 50% of it is **photosynthetically active radiation (PAR)**. Only 2-10 % of PAR and 1-5% of incident solar radiation are captured by **plants** for the synthesis of organic matter. Around 20% of the captured solar radiation is consumed in **respiration** so the net primary productivity is 0.8-4% of incident radiation or 1.6-8% of PAR.

In any organisms energy does not remain trapped permanently and indefinitely. It is either passed on to the higher trophic level or becomes available to detritivores or decomposers after the organism dies. Herbivores feed on producers. Some of the energy is used in digestion and assimilation. Some of the assimilated food is broken down to release energy for performing body activities. A very small proportion becomes part of the body of herbivore. Herbivores are eaten by primary carnivores, latter by secondary carnivores and so on. So, energy flow in an ecosystem is always unidirectional and moves in one way from **Solar radiation** -> **Producers** -> **Herbivores** -> **Carnivores**-> **Decomposers**

The energy which passes from autotrophic plants to the herbivores does not pass back to the plants.

Energy flow follows laws of thermodynamics: This large expenditure of energy in the ecosystem is based on **two** basic laws of thermodynamics. In accordance with the **first law of thermodynamics**, which proposes that energy is neither created nor destroyed, but can be transformed from one state to another, **solar** energy from sunlight can be **transformed** into **storage** energy of food and **heat** energy. The **second** law of **thermodynamics** proposes that no transfer of energy occurs unless and until it is accompanied by degradation or dissipation of energy from **concentrated** to **dispersed** form i.e. **entropy** or **disorderliness** of the system **increases**. The transfer of energy from one organism to another is accompanied by degradation and loss of major part of food energy as heat energy. Energy of food is stored in concentrated form while its highly dispersed/released form is **heat**.

TRY IT YOURSELF

State True or False :

1. Energy transfer is cyclic.
2. Value of PAR is >50% of solar radiation.
3. Exception to source of energy is hydrothermal ecosystem.
4. Give a scheme or flow chart representing flow of energy in an ecosystem.
5. Energy of sunlight is fixed by green plants and trapped in C-C bond of sugars through process of photosynthesis is explained by _____ law of thermodynamics.

2.3.4 Food Chain

Journey/transfer of food **energy** from **producers**, through a series of organisms with repeated events of eating and being eaten is termed as **food chain**. Each level or step in a food chain where transfer of energy takes place is called as **trophic level**.

Types of Food Chain:

- **Grazing Food Chain (GFC)/Predator food chain:** Consists of **producers, consumers** and **decomposers**. **Sun** serves as the main source of energy for such food chain.
 - **Primary Producers (PP): Autotrophic** organisms which fix up the **solar** energy and synthesize their **own** organic **food** from organic **raw** material are termed as **Primary Producers**. They form base of food chain constituting **first trophic level (T_1)**.
 - **Primary Consumers (PC)/Primary Carnivores:** Animals which feed on green plants or plant products are termed as **Primary Consumers**. They constitute the **second trophic level (T_2)**.
 - **Secondary Consumers (SC)/Primary Carnivores:** Animals which feed on herbivores are termed as **Secondary Consumers** and form the **third trophic level (T_3)**.
 - **Tertiary Consumers (TC)/Secondary Carnivores:** Animals which feed on secondary consumers constitute **Tertiary Consumers** and are on the **fourth trophic level (T_4)** and so on.

Levels	PP	PC	SC	TC	Top consumer
Trophic levels	T_1	T_2	T_3	T_4	T_5

Terrestrial food chain: Grass → Grasshopper → Frog → Snake → Eagle

Aquatic food chain: Phytoplankton → Zooplankton → Small Fish → Large Fish

The major reservoir of energy flow in aquatic ecosystem is defined by GFC. It is commonly observed that at higher trophic levels, **size** of the organisms progressively **increases**.

- **Detritus Food Chain (DFC)/Saprophytic food chain:** Detritus or dead organic matter initiates with Detritus Food Chain. **DFC** consists of decomposers which are **heterotrophic** organisms mainly **fungi** and **bacteria**. **Detrivores** act over the **dead**, decaying **matter** present in the **detritus** and hence the **food energy** present in the detritus is passed into them. Consumption of **detrivores** and **decomposers** by **smaller carnivores** which in turn are eaten by **larger carnivores** and so on.

A common detritus food chain with **earthworm** serving as detrivore is given below.

Detritus → Earthworm → Sparrow → Falcon.

Relatively **higher fraction** of **energy** flows through DFC as compared to GFC in terrestrial ecosystems.

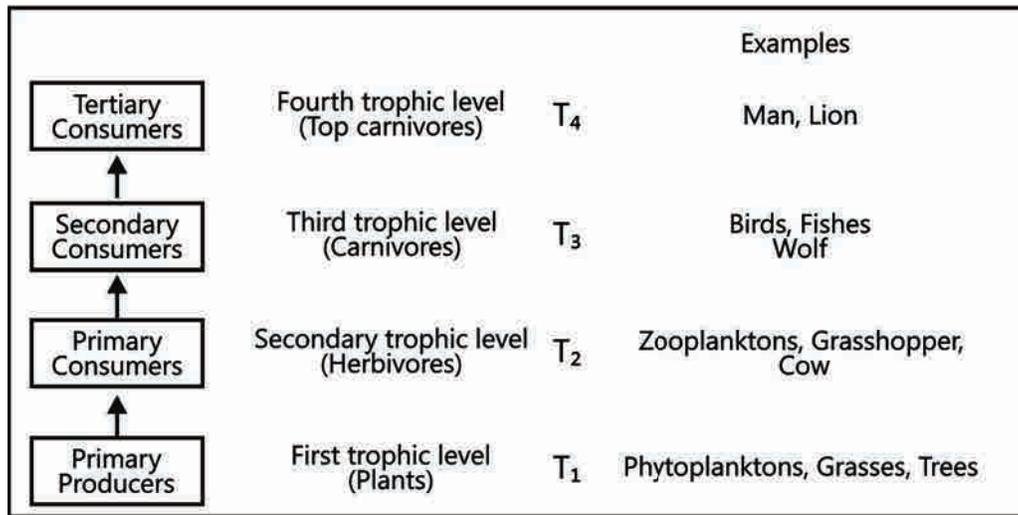


Figure 14.2: Schematic representation of the various trophic levels in a typical ecosystem

TRY IT YOURSELF

1. Mention the trophic level for the following organisms
 - i. Fruit eating birds Zooplanktons
 - ii. Grasses Chemosynthetic bacteria

2. For the below food chain answer the following questions

Grass → Rabbit → Wolf

- i. Type of food chain _____.
- ii. Trophic level of grass is _____ and rabbit is _____.
- iii. Wolf belongs to _____.

2.4 Food Web

At certain specific levels **DFC** may be **connected** with **GFC** chains. The GFC animals prey on some of the organisms of DFC. In ecosystems, linear food chains as described above rarely exist, since every organism at each trophic level has multiple sources of food. An animal may have preference for a particular prey, but if the prey is present in small numbers, the particular animal may feed upon some other prey. Also the primary carnivore animals may be eaten by different secondary carnivore animals and thus different food chains get **interconnected** and one animal may serve as a **link** in more than one type of food chain. **Food web** is the **network of inter connected food chains at different trophic levels** in a **biotic community**. Occurrence of food webs provides **stability** to **ecosystem**. Organisms of one particular trophic level may feed on organisms of different trophic levels and not just of the consecutive trophic level.

E.g. Snakes feeds upon both mice (herbivores) and frogs (carnivores). Jackals/foxes are both carnivores and scavengers. Sparrow is a primary consumer when it eats seeds, fruits etc. and a secondary consumer when it eats insects and worms.

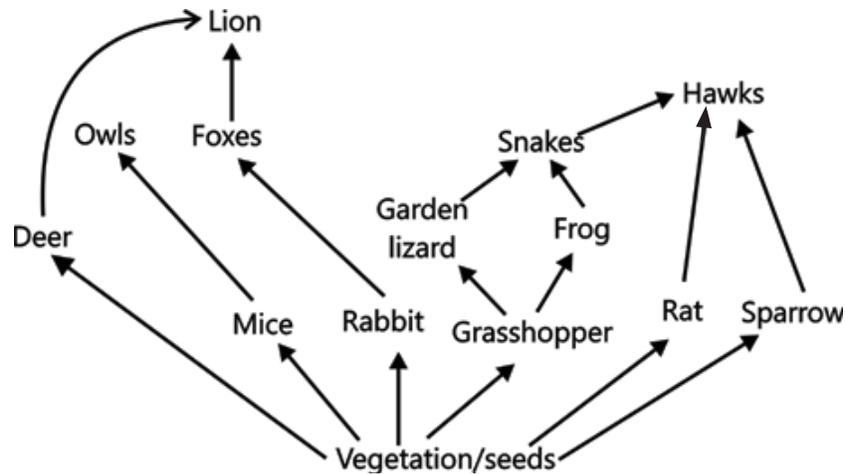


Figure 14.3: Schematic representation of a typical terrestrial food web

Ten Percent Law of Energy Transfer: In 1942, Lindeman proposed the **Law of Energy Transfer**. The transfer of energy from one trophic level to another trophic level is accompanied by loss of energy at each level or step. About 10% of energy in the food is fixed into animal flesh while 90% is consumed in ingestion, respiration, maintenance of body heat and other activities/processes when the plants are eaten by herbivore. Again about 10% of energy is fixed when a carnivore consumes that herbivore. Therefore, at each transfer only 10% of the total energy is actually available to the next trophic level. It is termed as 10% (ten percent) law.

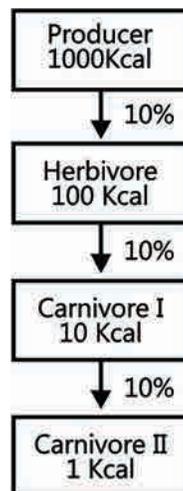


Figure 14.4: Schematic representation of ten percent law of energy transfer

Residual energy reduced drastically within **two-three trophic levels**. An ecosystem can hence support only a limited number of trophic levels sometimes between 3-5.

Standing state/quality: The **amount** of all the inorganic substances present within in a particular ecosystem per unit area at a given time is called as **standing state or quality**.

Standing crop: Amount of living material present in different trophic levels at a given time. It is expressed as the numbers or biomass of organisms per unit area. The biomass of a species is expressed in terms of either fresh or dry weight. Measurement of biomass in terms of dry weight is more preferred to avoid variations in weight due to seasonal moisture differences in biomass.

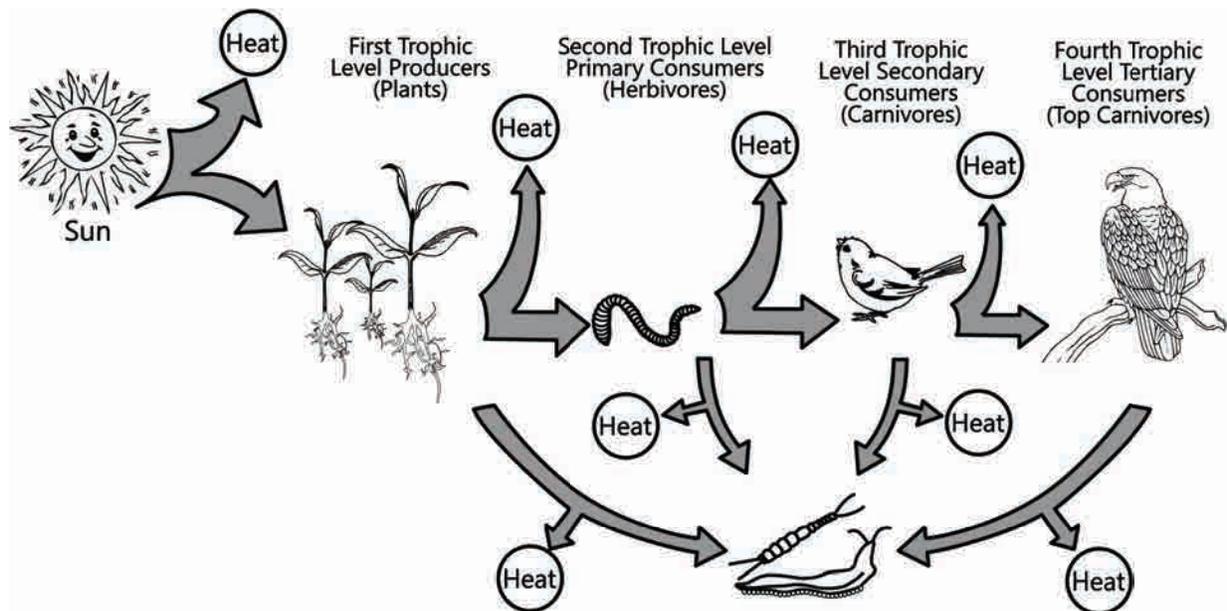


Figure 14.5: Diagrammatic representation of energy flow through the different trophic levels

TRY IT YOURSELF

1. Mention the names of two omnivores.
2. At each trophic level the energy transferred is around 50%. (True/False)

3. Ecological Pyramids

Graphical representations of various ecological parameters at the **successive trophic levels of food chains** with **producers** at the **base**, **top** carnivores located at the **apex** and **intermediate levels** in **between** being occupied by other heterotrophic consumers is known as **ecological pyramid**. **Ecological pyramid** were developed by **Charles Elton** in 1927 and hence are also called as **Eltonian pyramid**. **Length of bar** in the graphical diagram represents **quantity** at each **trophic level**. Number of individuals, biomass and energy at different trophic levels are the common parameters used in preparing ecological pyramids. The three ecological pyramids studied are:

3.1 Pyramid of Numbers

- Upright:** The number of **producers** is **maximum** in **most ecosystems**. During transfer of food at any trophic level, only **10%** of the **food** becomes part of the next trophic level while **90%** of the **food** is either **wasted (loss)** or **broken down** during cellular respiration for providing energy for supporting various life activities. Producers can thus support fewer herbivores and herbivores can support even fewer carnivores and so on. Thus the **amount of top carnivores** is **too small** to **support** any other **trophic level** and do **not** act as **prey** to any other **organisms**.

E.g. Only **top three** carnivores are supported in an ecosystem based on production of nearly **6 million plants**.

Thus, with **each successive trophic level**, the **number/amount of individuals** begin to **reduce**. Hence, the **pyramid of number** is **upright**. **E.g. Grassland ecosystem** and **Pond ecosystem**.

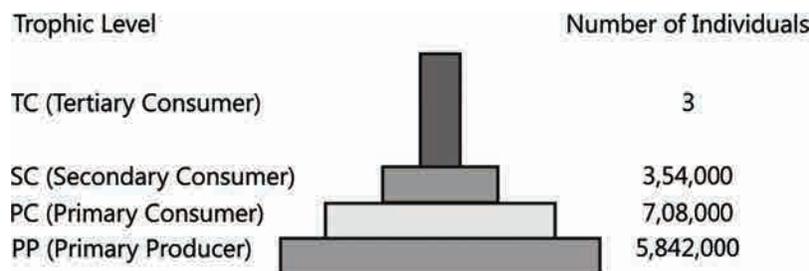


Figure 14.6: Diagrammatic representation of upright pyramid of number in a typical grassland ecosystem

- Inverted:** The **number** of the **organisms** at a particular trophic is **higher** than in the preceding one and the **size reduces** gradually at each **successive level**. Shape of pyramid may be **inverted**.

E.g., A **large-sized tree (producers)** may support and provide **nourishment** to **several birds**. The number of **ectoparasites** like **mites, ticks, lice, bugs** etc. dependent upon the number of birds for nourishment therefore exist in **much higher number** than the **birds**. The number thus increases at **each trophic level**.

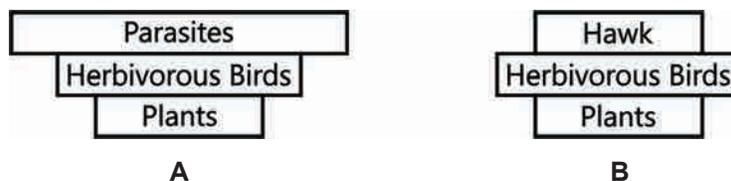


Figure 14.7: Diagrammatic representation of **A. Inverted** and **B. Spindle** pyramid of number in a typical grassland ecosystem

- Spindle:** A **tree** supports a number of smaller, **herbivores** birds. The smaller birds are eaten by **one** or **two** larger hawks of the area. Hence, the number of smaller herbivorous birds is the largest while the other trophic levels of trees and hawks have relatively smaller numbers.

3.2 Pyramid of Biomass

- **Upright:** The amount of living matter expressed as weight at any particular trophic level at a given time is termed as biomass. In terrestrial ecosystems, pyramid of biomass is usually upright. Total biomass of plants which serve as producers in a specific area is higher than that of herbivores which serve as primary consumers and it gradually decreases at each successive trophic level for upright pyramid. It is least in the level consisting of top carnivores. E.g., Tree and grassland ecosystems.

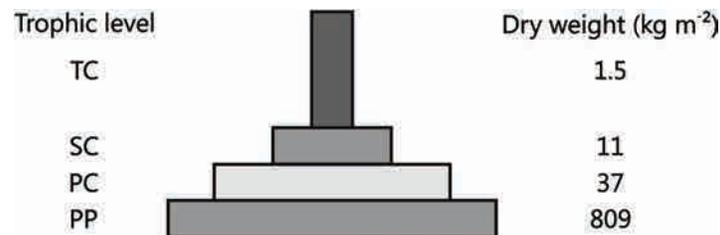


Figure 14.8: Diagrammatic representation of upright pyramid of biomass showing a reduction in biomass at higher trophic levels

- **Inverted:** In aquatic ecosystem, the pyramid of biomass may be inverted. E.g. Biomass of zooplanktons is higher than that of phytoplanktons as life span of former is longer while the latter multiplies relatively quickly though despite having shorter life span. A number of generations of phytoplanktons may be consumed by a single generation of zooplanktons. Biomass of fish may still be larger as fishes are much larger in size with longer life spans and a number of generations of zooplanktons can be consumed by a single generation of fishes. However during transfer, only 10% of the biomass of one generation is passed on to next trophic level.



Figure 14.9: Diagrammatic representation of inverted pyramid of biomass showing a higher biomass at higher trophic levels of zooplanktons below which is the lower biomass of phytoplanktons

3.3 Pyramid of Energy

The flow of energy is unidirectional from producer to consumer level, hence the pyramid of energy is always upright. Producers have the maximum energy content. Since a part of the energy is lost as heat and major part of energy is liberated during respiration for use in various activities, the energy decreases at each trophic level of food chain. As proposed by 10 percent law of Lindeman only 10% of the energy of previous trophic level is received by the next trophic level.

E.g. Of the 10,000,000 J of incident solar energy, around 10,000 J of energy is stored in a plant assuming plants trap 1% solar energy. Herbivores which feed upon plants, will retain 1,000 J of the available stored energy and carnivores feeding upon them will gain only 100 J of the usable energy giving below pyramid shape.

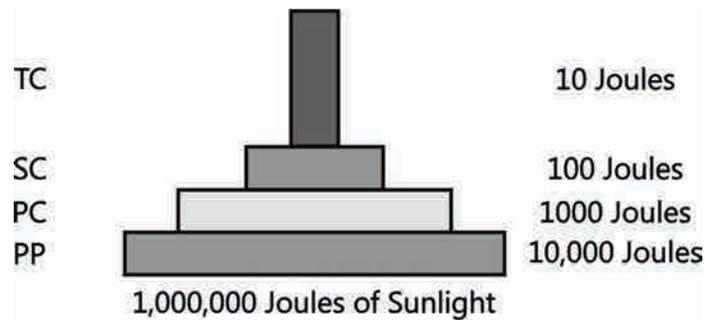
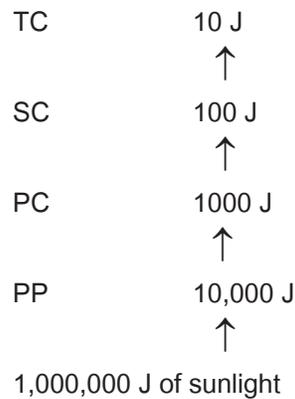


Figure 14.10: Diagrammatic representation of an ideal upright pyramid of energy showing the reduced energy transfer at higher trophic levels



Flowchart 14.3: Display of ten percent law of Lindeman

All the pyramids of **numbers**, **energy** and **biomass** are **upright** in most ecosystems. Producers are **higher** in **number** and **biomass** than the **carnivores**. Also, energy at a **lower** trophic level is always **higher** than at a **higher** level.

Any calculation of energy content, biomass or numbers has to include all organisms at that trophic level.

Limitations of Ecological Pyramid:

- **Same** species belonging to **two** or **more** trophic levels. **E.g., insectivorous plants** is not taken into account.
- Does **not accommodate** a food web as it **assumes** a **simple** food chain.
- In ecological pyramids, **saprophytes**, **decomposers**, **microbes** and **detrivores** are not given any place.

KNOWLEDGE BUILDER

Table 14.2: Types of Biome, their location and vegetation with examples

Biome	Location	Vegetation
Tundra region/Arctic desert/Alpine tundra Fragile biome	Mountain tops such as peaks of Himalaya, Andes mountain etc.	Lichen, Moss, Grass. This biome is without trees. a. Timber line – Line beyond which trees are not found. b. Perma frost – In this region soil is covered by snow or ice.
Northern coniferous/ Needle leaf/Temperate forest	Lower regions of the mountainous and hilly terrain.	Pine (<i>Pinus</i>), Deodar (<i>Cedrus</i>), Cypress (<i>Cupressus torulosa</i>), Spruce (<i>Picea smithiana</i>), Silver Fir (<i>Abies pindrow</i>). a. Coniferous forest have characteristic needle like leaves b. This forest is also known as taiga.
Temperate deciduous/ Broad leaf forest	Base of the mountainous and hilly terrain.	Oak (<i>Quercus</i>). a. Trees shed their leaves in autumn season which flourish again in spring season.
Tropical deciduous forest	Located in abundance in the northern and southern part of the country in plain and low hilly areas.	Sal (<i>Shorea robusta</i>), Teak (<i>Tectona grandis</i>), Tendu, Chiraungi, Khair. Leaves of most of the tree fall before summer season.
Tropical rain forest	Tropical rain forest are found close to the equatorial region around the Earth. In India tropical rain forest are distributed mainly along western Ghats and Eastern Himalayan regions.	<i>Dipterocarpus</i> and <i>Hopea</i> are most common tree species in India. Lianas are also found.
Chaparral (Mediterranean) scrub forest	These forest are found along the pacific coast of North America and the South Australian coast	Draught resistant and fire resistant plant species are found. E.g. Small tree, shrub (sage).



KNOWLEDGE BUILDER

Tropical savanna biome (Thorn forest)/ Tropical grassland	Tropical savanna biome are found in South America and Australia.	Coarse grass – <i>Dichanthium</i>, <i>Sechima</i>, <i>Phragmites</i>. Trees – <i>Acacia</i>, <i>Eucalyptus</i>, <i>Zizyphus</i>, <i>Capparis</i> In this biome grass and scattered tree are located in the same soil.
Grass land biome	Prairies – North America Pampas – South America Tussocks – New Zealand Steppes – Europe and Asia Veldts - Africa	
Desert Biome	Hot Sahara desert – North Africa Hot Thar desert – Asia Cold Gobi desert – Tibet, Asia	

TRY IT YOURSELF

State True or False

1. Pyramid of biomass is always upright.
2. Upright pyramid can be seen for all the ecological parameters in grassland ecosystem.
3. 10% law of Lindeman justify upright shape of pyramid of energy.
4. Base of ecological pyramid represents producers.

4. Ecological Succession

Biotic community is always **dynamic**. Interactions between biotic and abiotic components changes its composition with time. This **change** is **orderly** and **sequential**, **parallel** with the **changes** in the **physical** environment. These changes lead finally to a community that is in near equilibrium with the environment and is called as **climax community**. **Ecological succession** is defined as the **gradual** and **fairly predictable** changes observed in the **species composition** of a given **area**. During succession, some species **colonize** an area and their **populations** become more **numerous**, where as **populations** of other **species decline** and even **disappear**.

4.1 Types of Successional Communities

- **Pioneer community:** Pioneer community is the **first biotic community** that develops in a bare **area**. E.g., **Lichens on rock, phytoplanktons and zooplanktons in pond**.
- **Transitional or serial community:** The pioneer community is **followed** by a **specific orderly sequence** of series of plant communities known as **serial communities**. E.g., **Bryophytes, herbs, shrubs in xerosphere; submerged, floating etc. in pond**.
- **Climax community:** Climax community is the **last community** in **biotic succession** which is **relatively stable** and exists in **near equilibrium** with the **environment** of that **area**. E.g., **Forests**.

The **entire series** of **communities** occurring in **biotic succession** is called as **sere**. The **individual transitional communities** are termed as **seral stages** or **seral communities**.

4.2 Types of Succession

- 1. Based upon **nature** of **habitat** it **initiates**, succession is of two types
 - **Xerosere/Xerarch succession** – Occurs in **dry areas like rock (lithosere), sand (psammosere) and saline conditions (halosere)**.
 - **Hydrosere/Hydrarch succession** – Occurs in **aquatic habitat**.
- 2. Based upon the **type** of **nudity** of the area, succession is classified into the two types
 - **Primary succession:** It initiates at **barren area** with **no** signs of **vegetation** or **living organism** of any type ever **existing**. The areas where primary succession starts are **cooled volcanic lava, sand dunes, igneous rocks, newly exposed sea or newly submerged terrestrial habitats in water**, etc. This succession takes a very long time since it is very difficult for the pioneer community to get established in these areas.

Before a **biotic** community of **diverse** organisms can become **established**, there must be **soil**. Depending mostly on the climate, it takes natural processes several hundred to several thousand years to produce fertile soil on bare rock.

- **Secondary succession:** **Areas** that somehow **lost** all the **living organisms** that existed on it leads to **secondary succession**. **Secondary succession** is found in natural **biotic communities** that have been destroyed such as in **abandoned farmlands, burned or cut forestlands** that have been **flooded**.

This **secondary succession** is **quicker** since some soil or sediment is **present**. Climax is also reached more **rapidly**. The species that invade in this succession depend on the **condition** of the **soil, availability of water, seeds** or other present factors.

Ecosystem characteristics that change during succession:

- Some **species colonize** an area and their populations become more **numerous**, whereas populations of other species **decline** and even **disappears** i.e. **change in diversity of species**.

- ii. **Little to high degree** of species diversity i.e., **increase** in the **total** number of **species** of the **ecosystem**.
- iii. **Increase** in the **total biomass**.
- iv. **Elevated humus content** of the **soil**.
- v. **Aquatic** or **dry** conditions to **mesic** conditions i.e., both **Hydrarch** and **Xerarch** succession leads to **medium water** conditions which is termed as **mesic**, **neither too dry** which is termed as **xeric** nor **too wet** which is termed as hydric.
- vi. **Changes/variations** in **vegetation** in turn affects the **food** and **shelter** for various types of **animals**. Thus, as **succession proceeds**, the **number** and **types** of animals and **decomposers** also **changes**.

TRY IT YOURSELF

1. Climax community exhibits high species diversity. True/False.
2. Succession and evolution had occurred simultaneously. True/False.
3. Choose the correct match

(i) Primary succession	(a) Fast
(ii) Secondary succession	(b) Cooled volcanic lava
	(c) Slow
	(d) Abandoned farm land

The present day communities in the world have been formed because of the succession that has occurred over millions of years since life began on planet earth. Actually succession and evolution would have been parallel processes occurring at the same time.

DID YOU KNOW

Retrogressive Succession: At any given time during the phase of occurrence of primary or secondary succession, natural or human-induced disturbance such as fire, deforestation can convert a particular seral stage of succession to an earlier stage.

4.2.1 Succession of Plants

- **Xerarch Succession:** Primary succession on rocks is termed as **xerarch succession**. The xeric conditions ultimately leads to **mesic conditions**.

- **Pioneer Community:** Lichens are usually considered under pioneer community as they are able to secrete **acids** to **dissolve rock** which helps in **weathering** and **soil formation**. This makes the habitat more suitable for the **next seral** stage which is composed of **bryophytes**.
- **Transitional Communities: Mosses/Bryophytes** are able to **hold** in the small amount of **soil** generated by lichens. Bryophytes show **gregarious** habit, their **rhizoids** can **penetrate deeper** within the soil **enhancing weathering** or **soil formation**. During **rainy** season, the compact **mat** formed by **mosses** on **weathered rock** retains sufficient moisture and the habitat thus become suitable for **germination** of **seeds** of larger plants. **Larger plants** such as annual grass replaced by **perennial** which is further replaced by **shrubs stage**.
- **Climax community:** The **shrubs** are very **quickly** replaced by **hardy trees** forming the **stable climax** forest community. The **climate** of that area is responsible for the **nature** of the climax **forest**.

Sequence of various stages in a sere can be represented as

Lichens → Bryophytes → Herbs Shrubs → Forest

- **Hydrarch Succession:** The **succession** occurring in an **aquatic** habitat like **freshly** formed **pond** is termed as **hydrosere**. The successional series progress from **hydrarch** to **mesic** conditions as well.
 - **Pioneer Community:** It is formed by the **minute microscopic autotrophic organisms** like **diatoms**, **unicellular**, **colonial** or **filamentous green algae** and **blue-green algae (cyanobacteria)** called as the **phytoplanktons**. **Winds** or **animals** serve as the **carrier** which transports the **spores** of these organisms to the **newly formed pond**. High multiplying rates of such organisms make a suitable **habitat** for **zooplanktons** which feed upon them. The organic matter formed by **death** and **decay** of **planktons**, mixes with the **clay** and **silt** at the bottom of pond which results in the formation of **soft mud**. The habitat thus becomes suitable for the **growth** of **next stage**.
 - **Transitional Communities:**
 - (a) **Submerged plant stage:** These plants are anchored in the mud at the bottom of water body with their roots. **E.g., Myriophyllum, Hydrilla, Vallisneria, Potamogeton etc.**
 - (b) **Submerged free-floating plant stage:** Due to the **accumulation** of **dead** and **decaying remains** the **submerged plant bottom level** is **raised**. The ponds also become **rich** in **minerals (nutrients)** which become **suitable** for **free-floating plants**. **E.g., Azolla, Wolffia, Pistia etc.**
 - (c) **Reed – swamp stage:** More shallowing of plants takes place due to the continued siltation process which paves the way for the growth of rooted emergent plants such as reeds which are amphibious plants. **E.g., Typha, Sagittaria, Phragmites etc.**
 - (d) **Marsh-meadow stage:** Marshy plants **invade** the Reed- swamp stage. With **increased settling** of **silt** and **deposition** of the **dead organic matter** derived from the **floating** and **rooted** species, the **pond** becomes **shallower** until it gets **transformed** into **terrestrial habitat**. **E.g., Carex, Juncas, Cyperus.**
 - (e) **Scrub stage:** The **Marsh- meadow stage** is **replaced** by **shrubs**. **E.g., Salix, Populus, Alnus.**
 - **Climax community:** The **shrub stage** is **replaced** by **trees** which **grows** to **greater heights**. The nature of the climax community is highly influenced by the climatic conditions of that area. **E.g., Forest.**

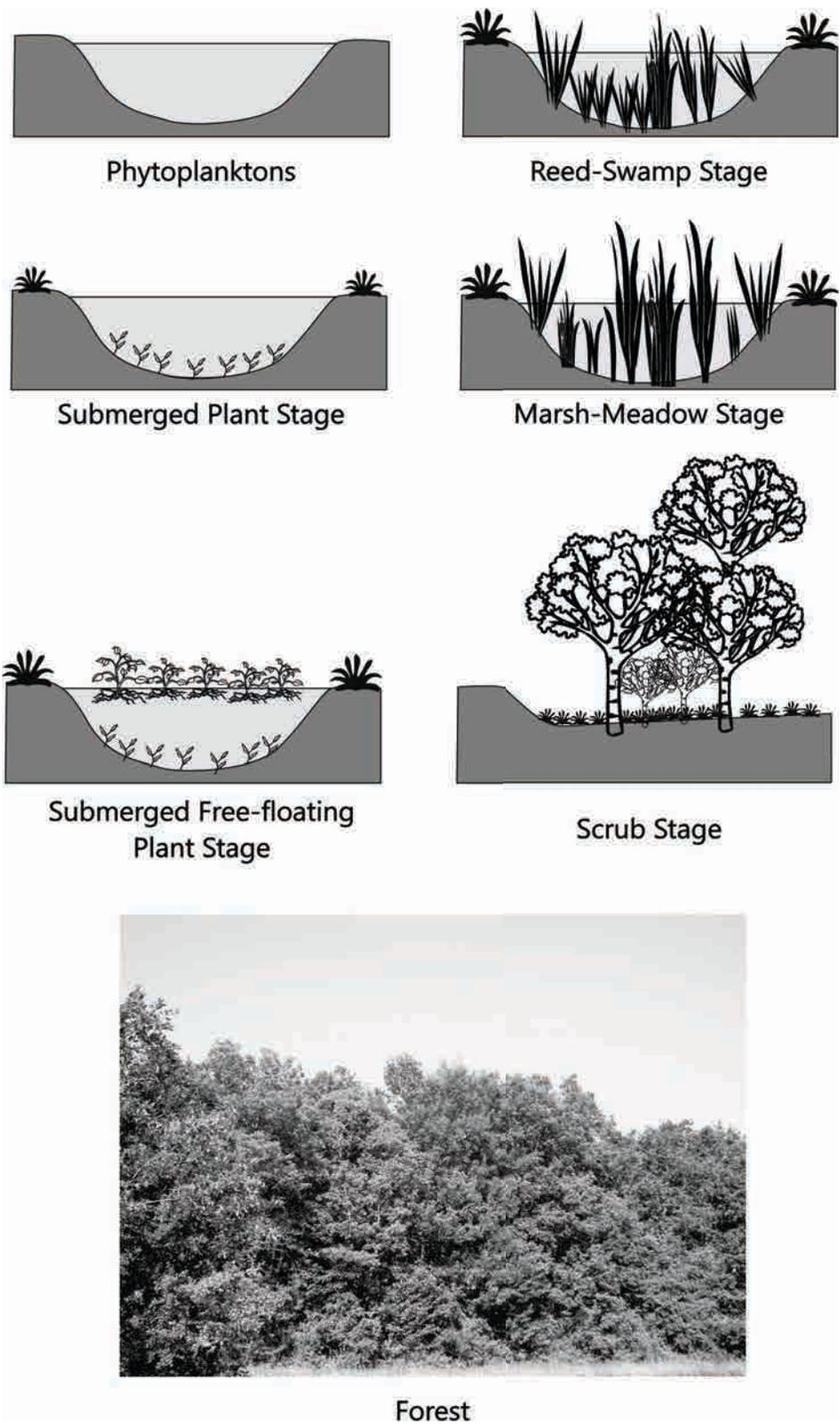


Figure 14.11: Diagrammatic representation of the primary hydrarch succession in pond



TRY IT YOURSELF

- 1 State True or False
 - a Lichen secretes weak acids.
 - b Pioneer community in newly formed pond in plankton stage.
 - c In hydrarch succession scrub stage is preceded by forest community.
 - d Climatic factors govern or decide type of community in secondary succession.
2. Answer appropriately as per the sere given below:

Lichens → ? → Herbs → Shrubs → Forest

 - a Mention the name of missing seral stage
 - b What type of environmental conditions occurs in climax community?

5. Nutrient Cycle

Biogenetic Nutrients: They are essential elements provided by Earth required by organisms for their survival, building and maintenance of the physical body and several metabolic processes. The **standing state** is the **amount** of **nutrients** present in the **soil** at any **given time**. It varies in different **kinds** of **ecosystems** and also based on **seasonal variations**.

Circulation or **exchange** of **biogenetic** nutrients between the **biotic** and **abiotic components** is as the **nutrient cycle** or **biogeochemical cycle** when at global scale.

Whole living matter is composed of **nutrients**, either as **structural** components or **biochemical** as **enzymes**. An ecosystem has a **limited supply** of **biogenetic nutrients** in its **abiotic environment**. A major part of the organic matter is synthesized by the **producers**. From producers the nutrients in the form of **organic matter** is transferred to the **higher trophic** levels. Decomposers release them back to **abiotic environment** acting on the organic wastes and **dead bodies** of **organisms**. In this way the **same** nutrients repeatedly move through **living** and **non-living components** i.e. **biotic** and **abiotic components** of the **ecosystem**.

Bulk of **nutrients** are stored in the **abiotic reservoirs** relatively in **in active state** with only a **smaller active fraction**, often existing in **ionic form** and involved in **cyclling**.

Types of Biogeochemical Cycles

- **Gaseous cycle**
 - Exchange of nutrients occurs in gaseous or vapour form
 - Biogeochemical is non-mineral
 - Atmosphere or hydrosphere is the reservoir pool.

E.g., Nitrogen, Carbon, Oxygen, Hydrogen cycle.

- **Sedimentary cycle**
 - Biogeochemical component is **mineral**.
 - Earth's crust or lithosphere is reservoir pool.

E.g., Sulphur, Phosphorous cycle.

The deficit which occurs due to **imbalance** in the **rate** of **influx** and **efflux** is the **function** of **reservoir**.

5.1 Carbon Cycle

Importance of carbon: **Carbon** is one of the most **abundant element** on **earth**. All **organic** components of **protoplasm** like **carbohydrates, lipids, proteins, nucleic acids, enzymes, hormones etc.** have **carbon** as their **chief component**. It constitutes **49%** of **dry weight** of **biotic organisms**.

Source of carbon:

- **71% carbon** of the total quantity of global carbon is **dissolved** in **oceans**.
- **CO₂** in the **atmosphere** is regulated by the **carbon** reservoirs found in the oceans.
- **Carbonates** and **graphites** in **rocks**.
- **Fossil fuels** and **gases**

Circulation: Carbon cycling occurs through the atmosphere, hydrosphere namely rivers, sea and oceans as well as through living and dead organisms.

Utilization: It is estimated that 4×10^{13} kg of carbon is fixed annually in the biosphere through the photosynthesis process.

Some amount of the fixed carbon is lost to **sediments, shells, skeletons**, and removed from **circulation**.

Addition:

- Through the respiratory activities of the **producers** and **consumers** a considerable amount of **carbon returns** to the **atmosphere** as **CO₂**.
- **Decomposers** also contribute substantially to the **CO₂ pool** by processing of the waste materials and the **dead organic** matter of **land** or **oceans**.
- Additional sources for releasing **CO₂** in the atmosphere are **burning** of **wood, forest fire** and **combustion** of **organic matter, fossil fuels**, and **volcanic activities**.
- **Human activities** like **rapid deforestation, transportation, massive burning** of **fossil fuels** have significantly **influenced** the **carbon cycle** by elevating the **carbon dioxide** level of the **atmosphere**.

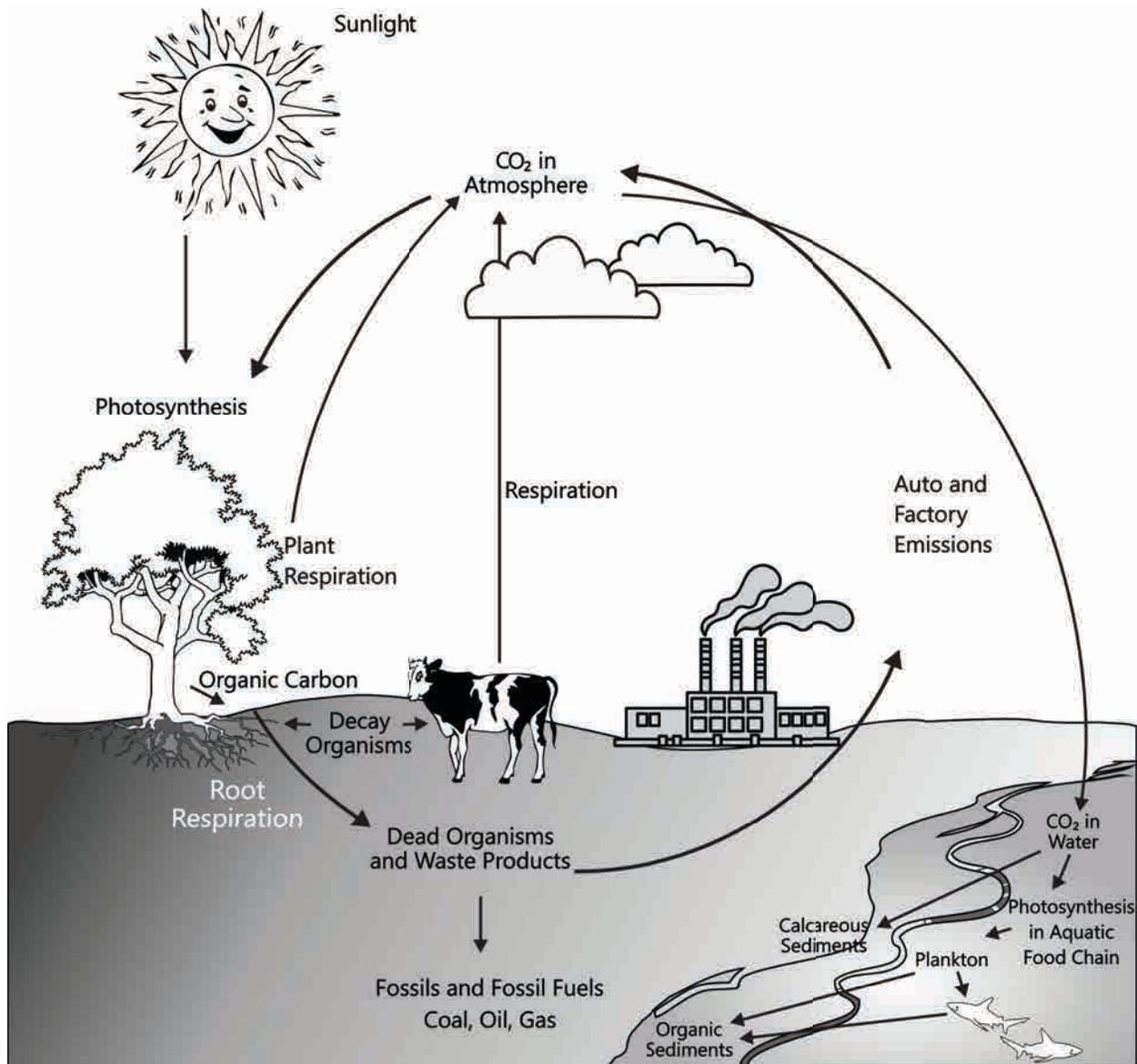


Figure 14.12: Diagrammatic representation of simplified carbon cycle occurring in the biosphere

5.2 Phosphorous Cycle

Importance of Phosphorous: Phosphorous is a major component of **biological membranes**, **nucleic acids** and **cellular energy (ATP) transfer system**. It is also required by animals to synthesize **shells**, **bones** and **teeth**. Phosphorous is the second most **critical element**, after nitrogen.

Main Sources: The natural reservoir of phosphorous is **rock** which is abundant in **phosphates**.

Utilization and Addition: Small amount of phosphate is always added to soil through **weathering of rocks**.

- o **Roots** of the plants **absorb** it from the soil.

- **Herbivores** and other **animals** obtain this **element** from **plants**.
- **Excretion** of animals and **dead** bodies of organisms are acted upon by **decomposers** which is added back into the **soil**.
- Phosphorous released in the process becomes available for reutilization of plants.

Difference from carbon cycle:

- No respiratory release of phosphorous into the atmosphere as it exists as solid not gas.
- Inputs of phosphorous through rainfall are much smaller.

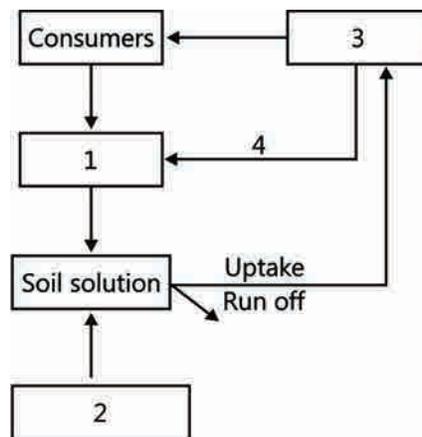


Figure 14.13: Schematic representation of simplified carbon cycle in the biosphere

6. Ecosystem Services

The **products** of ecosystem have **environmental**, **aesthetic** and **indirect economic value** are named as **ecosystem services**. For best services the ecosystems must be healthy. Following are ecosystem services:

- Purification of air and water by the healthy forest ecosystem.
- Mitigate droughts and floods.
- Nutrient cycles.
- Generation of fertile soils.
- Providing wild life habitat.
- Maintaining biodiversity.
- Pollination of crops.
- Providing storage site for carbon.
- Providing aesthetic, cultural and spiritual values.

Robert Constanza and his colleagues have put an average price tags of US \$33 trillion a years on these fundamental services i.e. nearly twice the value of a global GNP-US \$ 18 trillion. The cost is distributed as such:

- Soil formation – 50%

- o Recreation < 10%
- o Nutrient cycling - <10%
- o Climate regulation – 6%
- o Habitat for wildlife – 6%

KNOWLEDGE BUILDER

- **Stratification** is the structural **component** of ecosystem. It represents the **vertical zonation** in the **community**.
- The **sum total** biomass of **benthic animals** and **brown algae** exceeds that of the other **producers** and **consumers** in an **aquatic ecosystem**.
- A **tree** ecosystem terminating in the parasitic food chain shows **inverted pyramid** of **number**.
- **Secondary succession** never initiates on a **bare** area.
- **Nutrients** incorporated in microbes become resistant to **leaching** or **washing** out and called as **nutrient immobilization**.
- The study of **lake** is called as **Limnology**.
- **Succession** on **sand** is called **Psammosere**.
- Photosynthetic carbon fixed annually in biosphere is estimated to be 4×10^{13} kg.
- Large **biotic** communities of the world which is **distinct** in its **climatic conditions** and has its **specific** type of **plant** and **animal** life is known as **biomes**.
- Major **ecosystems (biomes)** include **terrestrial** and **aquatic** ecosystem.
- **Terrestrial** biomes are of two types: **Latitudinal** and **Altitudinal** biomes.
- **Latitudinal** biomes include **Tundra, Taiga, Temperate deciduous forests, Tropical rain forests, Mediterranean scrub forest, Tropical savannah, grasslands** and **deserts**.
- **Altitudinal biomes** include **alpine tundra** and **terai**.
- **Organisms** which can shift between **autotrophy** and **heterotrophy** are known as **auxotrophs**.
- **Autotrophic metabolism** occurs in the **upper green belt**, whereas **maximum heterotrophic metabolism** occurs in the **lower brown belt** in **aquatic ecosystem**.
- **Energy** content per **unit** weight of **biomass** is known as **caloric value**.
- **Photosynthetic active radiation (PAR)** are **visible light** which carries **less** than **50%** of the energy of total **incident solar radiation** and is available to **producers** for **absorption**.





TRY IT YOURSELF

1. Mention name of two elements, where reservoir pool is lithosphere.
2. Major reservoir of carbon is _____
3. Maximum price tag is for which ecosystem service?
4. Mention name of ecosystem service which is involved in sexual reproduction of plants.
5. ____ percentage of the total cost of ecosystem service is devoted to soil formation. (40/50)



DID YOU KNOW

- **Ecosystem:** Sum total of interactions between living and non-living components which is capable of independent existence.
- **Stratification:** Vertical distribution of different species occupying different levels in an ecosystem.
- **Productivity:** The rate of biomass production.
- **Primary productivity:** Rate of biomass production per unit area over a time period by plants during photosynthesis.
- **Gross primary productivity:** Rate of organic matter synthesized by producers per unit area per unit time.
- **Net primary productivity:** Rate of organic matter built up or stored by producers in their bodies per unit time and area in excess of respiratory utilization.
- **Secondary productivity:** Rate of increase in energy containing organic matter or biomass by heterotrophs or consumers per unit time and area.
- **Community productivity:** Rate of net synthesis or built up of organic matter by a community per unit time and area.
- **Ecological efficiency:** Percentage of energy converted into biomass by a higher trophic level over the energy of food resources available at the lower trophic level.
- **Decomposition:** Breakdown of complex organic matter into inorganic substances with the help of decomposers.
- **Detritus:** Dead plant remains such as leaves, bark, and flower and dead remain of animals, including fecal matter.
- **Fragmentation:** Breakdown of detritus into smaller particles by detritivores.
- **Leaching:** Process of loss of water – soluble inorganic nutrients from top layer and deposition into the lower soil horizon.



KNOWLEDGE BUILDER

- A **pond** has **two zones**: **production** or **euphotic zone** which is the **upper photosynthetic** part and **decomposition** or **regeneration zone** which is the **lower** part where **decomposition** occurs.
- **Deep sea** is an **incomplete system** as the **producers** are **absent** due to **total darkness** in the **aphotic zone** of **ocean**.
- **Koala bears** are **monophagous** and **die** if **eucalyptus leaves** are not available.
- **Living organisms** of **specific area** are **collectively** known as **biota**.
- **Primary succession** occurs in **biological sterile** area, while **secondary succession** occurs in **biologically fertile** area.



DID YOU KNOW

- **Catabolism**: Process of degradation of detritus into simpler inorganic substances by activity of bacterial and fungal enzymes.
- **Humus**: Dark colored amorphous substance that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate to release nutrients.
- **Humification**: Process of formation of humus from detritus.
- **Mineralization**: Release of inorganic substance from organic matter during the process of decomposition.
- **Food chain**: Sequence of living organisms due to interdependence in which one organism consumes another.
- **Food web**: It is interconnection of food chains.
- **Standing state**: amount of all the inorganic substance present in an ecosystem per unit area at a given time.
- **Standing crop**: Amount of living material present in different trophic levels at a given time.
- **Ecological pyramid**: Graphic representation of trophic levels of a food chain w.r.t. number of individuals, biomass and energy.
- **Nutrient cycling**: Movement of nutrient elements through the various components of an ecosystem.
- **Ecological succession**: Gradual and fairly predictable changes in the species composition of a given area.
- **Litter (Above Ground detritus)**: All dead, fresh organic matter fallen recently to the ground.
- **Duff**: Partially decomposed litter.

Summary

- A functional unit of nature, where living organisms interact among themselves and with the surrounding physical environment is an ecosystem.
- Abiotic components are inorganic nutrients, air, water and soil while biotic components are producers, consumers and decomposers.
- Species composition and stratification are main structural features of an ecosystem.
- The functional components of ecosystem are studied with aspects like productivity, decomposition, energy flow and nutrient cycling.
- The rate at which radiant energy is stored by producers is primary productivity. It is divided into two types; gross primary productivity (GPP) and net primary productivity (NPP).
- The rate of formation of new organic matter by consumers is secondary productivity.
- Complex organic matter is converted into inorganic substances by the decomposers and is called decomposition. Important steps of decomposition are fragmentation, leaching and catabolism.
- In an aquatic ecosystem, GFC is the major conduit for energy flow while in a terrestrial ecosystem, a much larger fraction of energy flows through the DFC than through the GFC.
- The pyramids, of number, of energy, and biomass are upright in most ecosystem.
- Saprophytes are not given any place in ecological pyramids.
- Atmosphere or hydrosphere is the reservoir for the gaseous type of cycle, whereas Earth's crust is the reservoir for sedimentary type
- Succession begins with invasion of a bare lifeless area by pioneers which later pave way for successors and ultimately a stable climax community is formed.

EXERCISE**Objective Questions**

Q.1 Which of the following represents largest man made ecosystem?

- (A) Zoo (B) Garden (C) Aquarium (D) Agroecosystem

Q.2 Natural scavengers are:

- (A) Phytoplanktons, Zooplanktons (B) Insects, Birds
(C) Bacteria, Fungi (D) Lion, Tiger

Q.3 Vertical distribution of different species occupying different levels represents:

- (A) Standing state (B) Stratification
(C) Standing crop (D) Standing quality

Q.4 Rate of production of organic matter by producers per unit time and area is:

- (A) GPP (B) NPP
(C) NPP-R (D) More than one option is correct

Q.5 Magnitude of primary productivity is affected by:

- (A) Temperature, Availability of nutrients.
(B) Solar radiations available, Availability of nutrients
(C) Photosynthetic capacity of producers
(D) All of these

Q.6 Buildup of organic material in soil is under which of the following conditions?

- (A) $<10^{\circ}\text{C}$ temperature, Absence of oxygen
(B) Warm temperature, Humid environment
(C) Aerobic conditions, $> 25^{\circ}\text{C}$ temperature
(D) Nitrogen rich detritus, Reduce moisture

Q.7 Humification results in the formation of _____ substance

- (A) Colloidal, basic (B) Acidic, Dark coloured
(C) Amorphous, Light coloured (D) Light coloured, Colloidal

Q.18 In hydrarch succession, reed swamp stage is preceded by:

- (A) Forest community (B) Scrub stage
(C) Sedge meadow stage (D) Floating stage

Q.19 Ecological succession is _____ and _____ change in species composition

- (A) Orderly and sequential (B) Unpredictable and orderly
(C) Gradual and nonsequential (D) Sequential and disorderly

Q.20 Pioneer community established on a bare rock is:

- (A) Mosses (B) Lichens
(C) Phytoplanktons (D) Higher plants

Q.21 Succession proceeds from:

- (A) Xeric - Mesic conditions (B) Hydric - Mesic conditions
(C) Mesic - Xeric conditions (D) More than one option is correct

Q.22 In gaseous cycle:

- (A) Nutrient is mineral (B) Reservoir is lithosphere
(C) Rate of influx and efflux is fast (D) Withdrawal from reservoir pool is large.

Q.23 Carbon constitutes _____ of dry weight of organism and _____ percentage is present in oceans out of total global carbon

- (A) 49%, 71% (B) 71%, 49% (C) 49%, 49% (D) 71%, 71%

Q.24 Which of the following element is second most critical element after nitrogen?

- (A) Phosphorus (B) Potassium (C) Sulphur (D) Oxygen

Q.25 Choose incorrect option for the cost distribution of ecosystem services:

- (A) Soil formation – 50% (B) Nutrient cycling >10%
(C) Climate regulation – 6% (D) Habitat for wildlife – 6%

Q.26 Choose the correct change during ecological succession:

- (A) Total biomass decreases (B) Decomposers also change
(C) Low degree of diversity (D) Humus content decreases

Q.27 The most common shape of pyramid of number is:

- (A) Inverted (B) Upright
(C) Spindle (D) None of the above

Q.28 Insectivorous plants can occupy more than one trophic levels, i.e.

- (A) T_1, T_4 (B) T_2, T_1 (C) T_3, T_1 (D) T_1, T_5

Q.29 Which of the following organisms convert plant matter into animal matter?

- (A) Earthworm (B) Tadpole (C) Termites (D) Frog

Q.30 Energy flow is _____ and nutrients shows _____

- (A) Bidirectional, cycling (B) Unidirectional, non-cyclic
(C) Unidirectional, cycling (D) Bidirectional, non-cyclic

Q.31 Productivity contributed by oceans is _____ but area covered is comparatively _____

- (A) High, less (B) Low, more (C) 10%, 71% (D) 50%, 71%

Q.32 Mineralization is performed by:

- (A) Small carnivores (B) Detrivores
(C) Saprophytic bacteria and fungi (D) Earthworm, termites

Q.33 Which terrestrial ecosystem has maximum productivity?

- (A) Coral reefs (B) Tropical rain forest
(C) Grassland (D) Temperate forest

Q.34 Converters and reducers respectively are:

- (A) Transducers and decomposers (B) Autotrophs and saprotrophs
(C) Consumers and decomposers (D) More than one option is correct

Q.35 To make the study of global ecosystem easier, it is broadly divided into how many basic categories?

- (A) Three (B) Two (C) Four (D) Five

Q.36 Major site of decomposition in the soil and water bodies respectively is:

- (A) Bottom and upper layer (B) Upper and bottom layer
(C) Upper and top layer (D) Bottom and top layer

Q.37 Raw material for decomposition represented by dried freshly fallen leaves is:

- (A) Detritus (B) Litter (C) Duff (D) Humus

Q.38 Which of the following trophic levels are occupied by sparrow?

- (A) Primary consumer, primary producer (B) Secondary consumer, top carnivore
(C) Primary producer, secondary producer (D) Primary consumer, secondary consumer

Q.39 Amount of inorganic substances present in an ecosystem is _____ which is a _____ feature of ecosystem

- (A) Standing crop, structural (B) Standing state, functional
(C) Standing crop, functional (D) Standing state, structural

Q.40 Seral stages in succession:

- (A) Possess low diversity
(B) Have higher biomass
(C) More numerous in secondary succession
(D) Show maximum niche specialization

Q.41 Choose odd one out w.r.t. gaseous cycle.

- (A) Carbon (B) Hydrogen (C) Nitrogen (D) Phosphorus

Q.42 Area where succession can take several thousand years to reach climax community is:

- (A) Burnt and cut forest (B) Sand dunes
(C) Flooded land (D) Abandoned farm lands

Q.43 Succession on bare rocks is called:

- (A) Psammasere (B) Hydrosere (C) Lithosere (D) Halosere

Q.44 Major utilization of carbon from atmosphere is through:

- (A) Decomposition (B) Photosynthesis (C) Respiration (D) Human activities

Q.45 According to Robert Constanza average price tag for ecosystem services is:

- (A) US \$ 18 trillion (B) US \$ 33 trillion
(C) US \$ 180 trillion (D) US \$ 13 trillion

Q.46 Which of the following organisms were not given any place in ecological pyramids?

- (A) Working at several trophic levels (B) Decomposers
(C) Parasites (D) More than one option is correct

Q.47 Rate of formation of new organic matter at higher trophic levels is:

- (A) Primary productivity (B) NPP
(C) GPP (D) Secondary productivity

Q.58 Ecosystem may be defined as -

- (A) A localized association of several plants and animals
- (B) Different communities of plants, animals and microbes together with their Physico-chemical environment.
- (C) Different communities of plants microbes plus their Physico-chemical Environment
- (D) None of the above

Q.59 The importance of ecosystem lies in:

- (A) Flow of energy
- (B) Cycling of materials
- (C) Both the above
- (D) None of the above

Q.60 Ecosystem is -

- (A) Any functional unit that includes the whole community in a given area interacting with the abiotic factors
- (B) A group of green plants
- (C) A group of animals interacting with environment
- (D) Man and pets living together

Q.61 Who proposed that ecosystem is symbol of structure and function of nature?

- (A) Gardner
- (B) Odum
- (C) Tansley
- (D) Reiter

Q.62 Largest ecosystem of the world are:

- (A) Forests
- (B) grass lands
- (C) Great
- (D) Oceans

Q.63 Which of the following is a man made artificial ecosystem?

- (A) Grassland ecosystem
- (B) Forest ecosystem
- (C) Ecosystem of artificial lakes and dams
- (D) None of these

Q.64 A pond is a:-

- (A) Biome
- (B) Natural ecosystem
- (C) Artificial ecosystem
- (D) Community of plants and animals

Q.65 Nepenthes (Insectivorous pitcher plants) is -

- (A) Producer
- (B) Consumer
- (C) Both (A) and (B)
- (D) None of these

Q.66 Which one is omnivorous?

- (A) Frog
- (B) Lion
- (C) Deer
- (D) Man

Q.76 Path of energy flow in an ecosystem is:

- (A) Herbivorous → producer → carnivorous → decomposer
- (B) Herbivorous → carnivorous → producer → decomposer
- (C) Producer → carnivorous → herbivorous → decomposer
- (D) Producer → herbivorous → carnivorous → decomposer

Q.77 Pyramid of energy are -

- (A) Always upright
- (B) Always Inverted
- (C) Mostly upright
- (D) Mostly inverted

Q.78 The ecological pyramid of numbers in pond ecosystem is -

- (A) Upright
- (B) Inverted
- (C) May be upright or inverted
- (D) First upright or inverted

Q.79 An ecosystem resists change because it is in a state of -

- (A) Homeostasis
- (B) Regular illumination
- (C) Static imbalance
- (D) Food accumulation

Q.80 What is true about an ecosystem -

- (A) It is self regulatory
- (B) It is self sustained
- (C) Top carnivores have climax trophic level position
- (D) All

Q.81 The pyramid of numbers in grassland ecosystem will be

- (A) Upright
- (B) Inverted
- (C) Irregular
- (D) Linear

Q.82 Which ecosystem has maximum number of producers in a unit area -

- (A) Pond
- (B) Grassland
- (C) Forest
- (D) Tundra

Q.83 The storage of energy at consumer level is known as -

- (A) Gross primary production
- (B) Secondary productivity
- (C) Net primary productivity
- (D) Net productivity

Q.84 Gross primary productivity is-

- (A) Rate at which organic molecules are formed in an autotroph
- (B) Rate at which organic molecules are used up by an autotroph
- (C) Storage of organic molecules in the body of an autotroph
- (D) Rate at which organic molecules are transferred to next higher trophic level

Q.85 Carbon cycle includes (the following is a logical sequence) -

- (A) Producer - consumer - decomposer
- (B) Decomposer - consumer - producer
- (C) Producer - decomposer - consumer
- (D) Consumer - producer - decomposer

Q.86 The bulk of nitrogen in nature is fixed by -

- (A) Lightning
- (B) Chemical industries
- (C) Denitrifying bacteria
- (D) Symbiotic bacteria

Q.87 The flow of materials from non living components to living components and back to the non living components in a more or less cyclic manner is called a-

- (A) Gaseous cycle
- (B) Sedimentary cycle
- (C) Biogeochemical cycle
- (D) Hydrologic cycle

Q.88 Which is best for plant growth?

- (A) Loamy soil
- (B) Silt
- (C) Sandy soil
- (D) Clay soil

Q.89 The least porous soil among the following -

- (A) Loamy soil
- (B) Clay soil
- (C) Sandy soil
- (D) Peaty soil

Q.90 The science dealing with soil is called:

- (A) Pedology
- (B) Acarology
- (C) Geology
- (D) Peaty soil

Q.91 A good soil is that which:

- (A) holds whole of the water entering into it
- (B) Allows limited amount of water into it
- (C) Allows the water to percolate slowly into it
- (D) Allows the water to pass very quickly from it

Q.92 The soil near the surface is usually darker than the soil about one meter down. This is because the top soil is:

- (A) Young and wet
- (B) Richer in organic matter
- (C) Richer in Ca and Mg
- (D) Dry

Q.93 A soil is said to be fertile when

- (A) It is rich in organic matter
- (B) It has capacity to hold water
- (C) It has a capacity to hold nutrients
- (D) It holds water and all essential nutrients in a definite proportion

Q.94 What is the best pH of the soil for cultivation of plants?

- (A) 3.4 - 5.4
- (B) 6.5 - 7.5
- (C) 4.5 - 8.5
- (D) 5.5 - 6.5

Q.95 Forest near equator region are called -

- (A) Deciduous
- (B) Tropical rain forests
- (C) Coniferous forests
- (D) Temperate forests

Q.96 Grass lands with scattered tree are called -

- (A) Pampas
- (B) Steppes
- (C) Prairies
- (D) Savanna

Q.97 Temperate evergreen forests in India found in -

- (A) Himalaya
- (B) West Bengal
- (C) Andaman
- (D) Rajasthan

Q.98 Which biome refers to arctic desert -

- (A) Tundra
- (B) Taiga
- (C) Savannah
- (D) Thar desert

Q.99 Which biome refers to arctic desert -

- (A) Deciduous forests
- (B) Chaparral
- (C) Tropical rain forests
- (D) Taiga

Q.100 Autumn colouration of leaves appear only in -

- (A) Tropical regions
- (B) Evergreen plants
- (C) Temperate deciduous plants
- (D) Deserts

Q.101 Veldts of Africa and Pampas of South America are

- (A) Rain forest biomes
- (B) Chaparral biomes
- (C) Temperate biomes
- (D) Grassland biomes

Q.102 Savannahs are

- (A) Tropical rain forest
- (B) Desert
- (C) Grassland with scattered trees
- (D) Dense forest with close canopy

Q.103 All the living organisms and non-living factors of the earth constitute -

- (A) Biosphere (B) Community
(C) Biome (D) Association

Q.104 The term biosphere is used for the zone of the earth where life exists

- (A) On the lithosphere
(B) In the hydrosphere
(C) In the lithosphere and hydrosphere
(D) In the lithosphere, hydrosphere and atmosphere

Q.105 A biosphere is composed of

- (A) Living organisms
(B) Living organisms + lithosphere
(C) Living organisms + lithosphere + atmosphere
(D) Living organisms + lithosphere + atmosphere + hydrosphere

Previous Years' Questions

Q.1 Pond is an example of _____ ecosystem.

[Uttaranchal 2005]

- (A) Artificial (B) Natural (C) Forest (D) Grassland

Q.2 Which of the following is the most productive ecosystem?

[West Bengal JEE 2007]

- (A) Estuary (B) Open sea (C) Desert (D) Mountain

Q.3 The pyramid of energy in a forest ecosystem is

[CG PMT 2004]

- (A) Always upright (B) Always inverted
(C) Both upright and inverted (D) None of the above

Q.4 The importance of ecosystem is

[CG PMT 2004]

- (A) Flow of energy (B) Cycling of materials
(C) Both (A) and (B) (D) None of the above

- Q.5** Which is the correct path of energy flow in an ecosystem? **[CG PMT 2004]**
- (A) Producers → Carnivores → Herbivores → Decomposers
(B) Producers → Herbivores → Carnivores → Decomposers
(C) Herbivores → Carnivores → Producers → Decomposers
(D) Herbivores → Producers → Carnivores → Decomposers
- Q.6** The number of primary producers within a specified area would be maximum in **[CG PMT 2004]**
- (A) Grassland ecosystem (B) Forest ecosystem
(C) Pond ecosystem (D) Deserts
- Q.7** A food chain starts with **[CG PMT 2004]**
- (A) Nitrogen fixation organisms (B) Photosynthesizing organisms
(C) Respiration (D) Decomposers
- Q.8** *Nepenthes* is a **[CG PMT 2004]**
- (A) Primary producer (B) Consumer
(C) Both primary producer and consumer (D) None of the above
- Q.9** Biological equilibrium is found among **[CG PMT 2005]**
- (A) Producers and consumers (B) Producers and decomposers
(C) Producers, consumers and decomposers (D) Producers and light
- Q.10** The number of individuals of a species in a particular ecosystem at a given time remains constant due to **[CG PMT 2005]**
- (A) Man (B) Parasites (C) Predators (D) Available food
- Q.11** The two components of an ecosystem are **[CG PMT 2005]**
- (A) Biotic and abiotic (B) Plants and animals
(C) Weeds and microorganisms (D) Plants and light
- Q.12** The pyramid of number in a grassland ecosystem is **[CG PMT 2005]**
- (A) Linear (B) Upright (C) Irregular (D) Inverted

- Q.13** The cycling of elements in an ecosystem is called **[CG PMT 2006]**
(A) Chemical cycle (B) Biogeochemical cycle
(C) Geological cycle (D) Geochemical cycle
- Q.14** Which of the following bacteria has potential for nitrogen fixation? **[CG PMT 2006]**
(A) *Nitrosomonas* (B) *Nitrobacter* (C) *Nitrosococcus* (D) *Rhizobium*
- Q.15** Ecosystem has **[Jharkhand 2006]**
(A) Plant and animal (B) Air and H₂O
(C) Soil and light (D) Biotic and abiotic components
- Q.16** Sal and teak are found in **[Jharkhand 2006]**
(A) Tropical rain forest (B) Tropical deciduous forest
(C) Temperature board leaf forest (D) Temperature needle leaf forest
- Q.17** Decomposers are **[Jharkhand 2005]**
(A) Autotrophs (B) Heterotrophs (C) Organotrophs (D) Autoheterotrophs
- Q.18** During food chain, the maximum energy is stored in **[Jharkhand 2005]**
(A) Producers (B) Decomposers (C) Herbivores (D) Carnivores
- Q.19** In the phosphorus cycle, weathering makes phosphate available first to **[Jharkhand 2005]**
(A) Decomposers (B) Consumers (C) Producers (D) All of the above
- Q.20** In a food chain, the total amount of living material is depicted by **[Jharkhand 2005]**
(A) Pyramid of biomass (B) Pyramid of energy
(C) Pyramid of number (D) Trophic levels
- Q.21** Nitrates are converted to nitrogen **[Jharkhand 2005]**
(A) Nitrogen fixing bacteria (B) Ammonification bacteria
(C) Denitrifying bacteria (D) Nitrifying bacteria
- Q.22** In pond ecosystem, diatoms represent **[Jharkhand 2004]**
(A) Producers (B) Primary consumers
(C) Secondary consumers (D) Tertiary consumers

- Q.33** In an ecosystem **[RPMT 2000]**
- (A) Primary producers are more than primary consumers
(B) Primary consumers are larger than primary producers
(C) Secondary consumers are larger than primary producers
(D) Primary consumers least depend on primary producers
- Q.34** In which types of forest is humus formed by dry and dead leaves? **[RPMT 2011]**
- (A) Coniferous forest (B) Deciduous forest
(C) Tundra forest (D) Alpine
- Q.35** A pond is a **[RPMT 2002]**
- (A) Biome (B) Natural ecosystem
(C) Artificial ecosystem (D) Community of plants and animals
- Q.36** The importance of ecosystem lies in **[RPMT 2003]**
- (A) Energy flow (B) Cycling of materials
(C) Both (A) and (B) (D) None of these
- Q.37** The concept of ecological pyramid was given by **[RPMT 2004]**
- (A) Odum (B) Elton (C) Darwin (D) Reiter
- Q.38** Stratification is found in **[RPMT 2004]**
- (A) Tundra (B) Tropical forest (C) Deciduous forest (D) Desert
- Q.39** The driving force of ecosystem is **[RPMT 2004]**
- (A) Producers (B) Plants with carbohydrates
(C) Biomass (D) Solar energy
- Q.40** Ecosystem creates **[RPMT 2005]**
- (A) Food chain (B) Food web (C) Any of the two (D) None of these
- Q.41** The term ecosystem was coined by **[RPMT 2005]**
- (A) P. Maheshwari (B) Tansley (C) R. Mishra (D) P. Odum

Q.42 The importance of ecosystem lies in **[CPMT 1980]**

- (A) Flow of energy
(B) Cycling of materials
(C) Both (A) and (B)
(D) None of the above

Q.43 A pond is a **[CPMT 1980]**

- (A) Biome
(B) Natural ecosystem
(C) Artificial ecosystem
(D) Community of plants and animals

Q.44 Which biotic components mainly help in the recycling of materials? **[CPMT 1980]**

- (A) Producers
(B) Consumers
(C) Decomposers
(D) All the above

Q.45 Path of energy flow in an ecosystem is **[MP PMT 2002]**

- (A) Herbivorous → Producer → Carnivorous → Decomposer
(B) Herbivorous → Carnivorous → Producer → Decomposer
(C) Producer → Carnivorous → Herbivorous → Decomposer
(D) Producer → Herbivorous → Carnivorous → Decomposer

Q.46 The number of primary producers in a specified area would be the maximum in

[RPMT 1985, CPMT 86, MP PMT 85, 95]

- (A) Pond ecosystem
(B) Grassland ecosystem
(C) Forest ecosystem
(D) Desert ecosystem

Q.47 Carbon cycle includes (the following is a logical sequence) **[CPMT 1979]**

- (A) Producer → Consumer → Decomposer
(B) Decomposer → Consumer → Producer
(C) Producer → Decomposer → Consumer
(D) Consumer → Producer → Decomposer

Q.48 The bulk of nitrogen in nature is fixed by **[CPMT 1982]**

- (A) Lightening
(B) Chemical industries
(C) Denitrifying bacteria
(D) Symbiotic bacteria

Q.49 Hydrological cycle is controlled by **[RPMT 1985]**

- (A) Grasslands
(B) Forests
(C) Planktons
(D) Epiphytes

Q.50 In India, the temperate, evergreen type of vegetation is found mostly in **[CPMT 1976]**

- (A) Western Himalayas above 3500 m
- (B) Eastern and western Himalayas less than 3500 m
- (C) Rajasthan and South Punjab
- (D) Western Ghats and Assam

Q.51 If 20J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following chain?

Plant → Mice → Snake → Peacock **[AIPMT 2014]**

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

Q.52 Biosphere refers to **[MP PMT 1980]**

- (A) Plants of the world
- (B) Special plants
- (C) Area occupied by living beings
- (D) Plants of a particular area

Q.53 *Acacia*, *Prosopis*, and *Caparis* belong to **[AIPMT 1998]**

- (A) Deciduous forest
- (B) Tropical forest
- (C) Thorn forest
- (D) Evergreen forest

Q.54 The total amount of energy trapped by green plants in food is called **[AIPMT 1998]**

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

Q.55 In which biome may a new plant adapt soon? **[AIPMT 1998]**

- (A) Tropical rain forest
- (B) Desert
- (C) Mangrove
- (D) Sea island

Q.56 Percentage energy transferred to higher trophic level in food chain is **[AIPMT 1999]**

- (A) 1%
- (B) 10%
- (C) 90%
- (D) 100%

Q.57 What is the reason for the highest biomass in aquatic ecosystem? **[AIPMT 2000]**

- (A) Nanoplankton, blue green algae, green algae
- (B) Sea grass and slime molds
- (C) Benthonic and brown algae
- (D) Diatoms

Q.58 Which of the following is a correct pair?

[AIPMT 2002]

(A) *Cuscuta* – Parasite

(B) *Dischidia* – Insectivorous

(C) *Opuntia* – Predator

(D) *Capsella* – Hydrophyte

Q.59 Bamboo plant is growing in a tropical rain forest. Then what will be its trophic level?

[AIPMT 2002]

(A) First trophic level (T_1)

(B) Second trophic level (T_2)

(C) Third trophic level (T_3)

(D) Fourth trophic level (T_4)

Q.60 Which of the following is expected to have the highest value ($g/m^2/yr$) in a grassland ecosystem?

[AIPMT 2004]

(A) Tertiary production

(B) Gross production (GP)

(C) Net production (NP)

(D) Secondary production

Q.61 An ecosystem which can be easily be damaged but can recover after some time if the damaging effect stops will have

[AIPMT 2004]

(A) High stability and low resilience

(B) Low stability and low resilience

(C) High stability and high resilience

(D) Low stability and high resilience

Q.62 Which one of the following pairs is mismatched?

[AIPMT 2005]

(A) Savanna – *Acacia* trees

(B) Coniferous forest – Evergreen trees

(C) Tundra – Permafrost

(D) Prairies – Epiphytes

Q.63 Which one of the following is not used for the construction of ecological pyramids?

[AIPMT 2005]

(A) Rate of energy flow

(B) Fresh weight

(C) Dry weight

(D) Number of individuals

Q.64 Which one of the following ecosystem types has the highest annual net primary productivity?

[AIPMT 2007]

(A) Temperature deciduous forest

(B) Tropical rain forest

(C) Tropical deciduous forest

(D) Temperature evergreen forest

Q.65 *Quercus* species is the dominant component in

[AIPMT 2008]

(A) Scrub forests

(B) Tropical rain forests

(C) Temperature deciduous forests

(D) Alpine forests

Q.66 Consider the following statements concerning food chain?

[AIPMT 2008]

- (1) Removal of 80% tigers from an area resulted in greatly increased growth of vegetation.
- (2) Removal of most of the carnivores resulted in an increased population of deers.
- (3) The length of food chains is generally limited to 3 – 4 trophic levels due to energy loss.
- (4) The length of food chains may vary from 2 to 8 trophic levels.

Which of the above two statements are correct?

- (A) (1, 3) (B) (1, 2) (C) (2, 3) (D) (3, 4)

Q.67 The slow rate of decomposition of fallen logs in nature is due to their

[AIPMT 2003]

- (A) Anaerobic environment around them (B) Low cellulose content
(C) Low moisture content (D) Poor nitrogen content

Q.68 Which one of the following types of organisms occupies more than one trophic level in a pond ecosystem?

[AIPMT 2009]

- (A) Frog (B) Phytoplankton (C) Fish (D) Zooplankton

Q.69 Study the four statements, (1) – (4), given and select the two correct ones out of them:

[AIPMT 2009]

- (1) A lion eating a deer and a sparrow feeding on grain are ecologically similar in being consumers.
- (2) Predator starfish helps in maintaining the species diversity of some invertebrates.
- (3) Predators ultimately lead to the extinction of prey species.
- (4) The production of chemicals such as nicotine and strychnine by plants are metabolic disorders.

The two correct statements are

- (A) (1) and (4) (B) (1) and (2) (C) (2) and (3) (D) (3) and (4)

Q.70 The biomass available for consumption by herbivores and decomposers is called [AIPMT Pre 2010]

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

Q.71 Which of the following is one of the characteristics of a biological community?

[AIPMT Pre 2010]

- (A) Stratification (B) Natality (C) Mortality (D) Sex-ratio

Q.72 Which one of the following types of organisms occupy more than one trophic level in a pond ecosystem?

[CBSE Prelims 2009]

- (A) Zooplankton (B) Frog (C) Phytoplankton (D) Fish

Q.73 The correct sequence of plants in a hydrosere is

[CBSE Prelims 2009]

- (A) *Pistia* → *Volvox* → *Scirpus* → *Hydrilla* → *Oak* → *Lantana*
- (B) *Oak* → *Lantana* → *Volvox* → *Hydrilla* → *Pistia* → *Scirpus*
- (C) *Oak* → *Lantana* → *Scirpus* → *Pistia* → *Hydrilla* → *Valvax*
- (D) *Volvox* → *Hydrilla* → *Pistia* → *Scirpus* → *Lantana* → *Oak*

Q.74 The term Homeostasis in an ecosystem refers to

[Chandigarh CET 2009]

- (A) Feed back mechanism
- (B) Self regulatory mechanism
- (C) Influence of production
- (D) State of equilibrium

Q.75 The plants constitute the

[Chandigarh CET 2009]

- (A) First trophic level
- (B) Second trophic level
- (C) Third trophic level
- (D) Fourth trophic level

Q.76 Maximum energy amongst ecosystem is contributed by

[Chandigarh CET 2009]

- (A) Crops
- (B) Forests
- (C) Coral
- (D) Fuel gas

Q.77 The biomass available for consumption by the herbivores and the decomposers is called

[CBSE Prelims 2010]

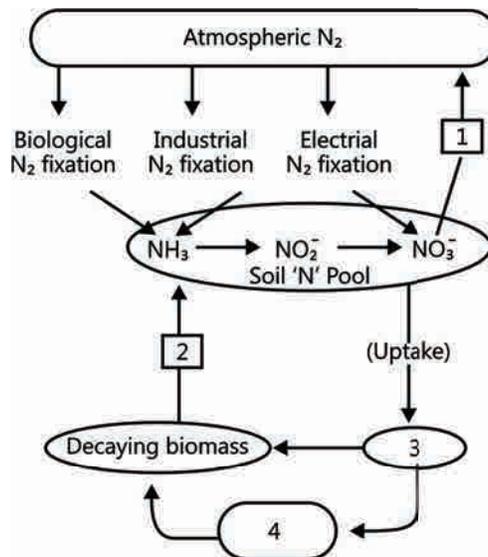
- (A) Gross primary productivity
- (B) Net primary productivity
- (C) Secondary productivity
- (D) Standing crop

Q.78 Which one of the following is one of the characteristics of a biological community?

[CBSE Prelims 2010]

- (A) Sex-ratio
- (B) Stratification
- (C) Natality
- (D) Mortality

Q.79 Study the cycle shown below and select the option which gives correct words for all the four blanks A, B, C and D. **[CBSE Main PMT 2010]**

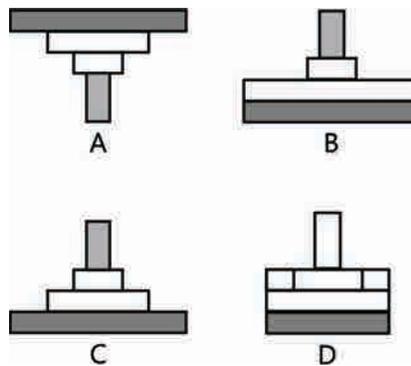


Options:

	1	2	3	4
A	Nitrification	Ammonification	Animal	Plants
B	Denitrification	Ammonification	Plants	Animals
C	Nitrification	Denitrification	Animals	Plants
D	Denitrification	Nitrification	Plants	Animals

Q.80 Which of the following representations shows the pyramid of numbers in a forest ecosystem?

[CBSE Main PMT 2010]



(A) D

(B) A

(C) B

(D) C

Q.81 The plants convert light into chemical energy with a photosynthetic efficiency of
[Chandigarh CET 2010]

- (A) 3-6% (B) 6-20% (C) 20-35% (D) 35-41%

Q.82 Ten percent law of energy transfer at successive levels in food chain was given by
[Chandigarh CET 2010]

- (A) Elton (B) Haeckel (C) Lindman (D) Shimper

Q.83 What is the percentage of photosynthetically active radiation (PAR) in the incident solar radiation?
[HP PMT 2010]

- (A) 100% (B) 50% (C) 1 – 5% (D) 2 – 10%

Q.84 Primary succession is development of communities on
[AMU 2006; HP PMT 2010]

- (A) Cleared forest area (B) Previously unoccupied sites
(C) Freshly harvested crop field (D) Pond filled after a day season

Q.85 Mass of living matter at a trophic level in an area at any time is called
[CBSE Prelims 2011]

- (A) Standing crop (B) Detritus (C) Humus (D) Standing state

Q.86 Of the total incident solar radiation the proportion of PAR is
[CBSE Prelims 2011]

- (A) About 70% (B) About 60% (C) Less than 50% (D) More than 80%

Q.87 Which one of the following statements is correct for secondary succession? **[CBSE Prelims 2011]**

- (A) It begins on a bare rock
(B) It occurs on a deforested site
(C) It follows primary succession
(D) It is similar to primary succession except that it has a relatively fast pace

Q.88 Which one of the following statements for pyramid of energy is incorrect, whereas the remaining three are correct?
[CBSE Prelims 2011]

- (A) Its base is broad
(B) It shows energy content of different trophic level organisms
(C) It is inverted in shape
(D) It is upright in shape

Q.89 Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time? **[CBSE Main PMT 2011]**

- (A) Sparrow (B) Lion (C) Goat (D) Frog

Q.90 Both, hydrarch and xerarch successions lead to **[CBSE Main PMT 2011]**

- (A) Medium water conditions (B) Xeric conditions
(C) Highly dry conditions (D) Excessive wet conditions

Q.91 The breakdown of detritus into smaller particles by earthworm is a process called **[CBSE Main PMT 2011]**

- (A) Humification (B) Fragmentation (C) Mineralisation (D) Catabolism

Q.92 Which Pyramid is always upright and can never be inverted? **[HP PMT 2011; WB JEE 2011]**

- (A) Pyramid of Number (B) Pyramid of Biomass
(C) Pyramid of Energy (D) None of the above

Q.93 Which one of the following is involved in sedimentary cycle? **[HP PMT 2011; 2012]**

- (A) Carbon (B) Nitrogen (C) Hydrogen (D) Phosphorus

Q.94 Identify the possible link "A" in the following food chain

Plant → Insect → Frog → "A" → Eagle

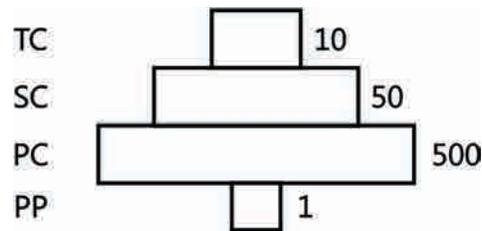
[CBSE Prelims 2012]

- (A) Wolf (B) Cobra (C) Parrot (D) Rabbit

Q.95 The upright pyramid of number is absent in **[CBSE Prelims 2012]**

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

Q.96 Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels? **[CBSE Prelims 2012]**



- (A) Level PP is “phytoplanktons” in sea and “whale” on top level TC
- (B) Level one PP is “pipal trees” and the level SC is “sheep”
- (C) Level PC is “rats” and level SC is “cats”
- (D) Level PC is “insects” and level SC is “small insectivorous birds”

Q.97 Which one of the following is not a functional unit of an ecosystem **[CBSE Prelims 2012]**

- (A) Decomposition
- (B) Productivity
- (C) Stratification
- (D) Energy flow

Q.98 Which one of the following is not a gaseous biogeochemical cycle in ecosystem?

[CBSE Prelims 2012]

- (A) Phosphorus cycle
- (B) Nitrogen cycle
- (C) Carbon cycle
- (D) Sulphur cycle

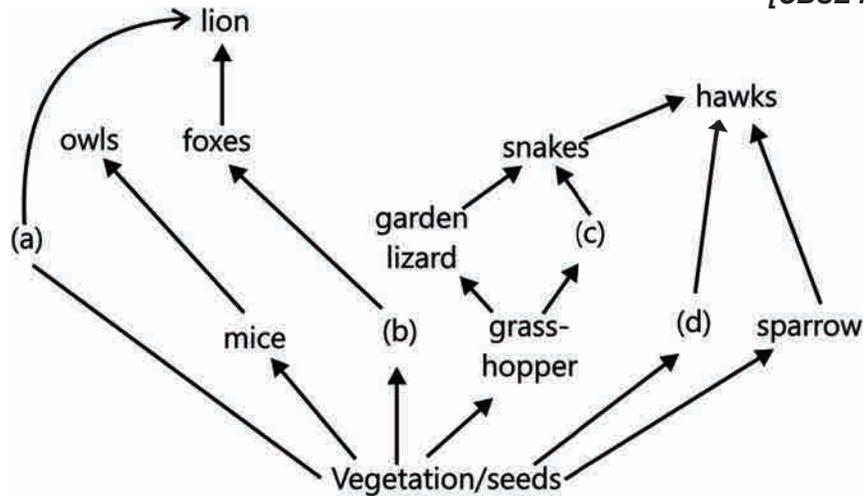
Q.99 The second stage of hydrosere is occupied by plants like

[CBSE Main PMT 2012]

- (A) *Salix*
- (B) *Vallisneria*
- (C) *Azolla*
- (D) *Typha*

Q.100 identify the likely organisms (A), (B), (C) and (D) in the food web shown below

[CBSE Main PMT 2012]



Options:

	a	b	c	d
A	Rat	Dog	Tortoise	Crow
B	Squirrel	Cat	Rat	Pigeon
C	Deer	Rabbit	Frog	Rat
D	Dog	Squirrel	Bat	Deer

Q.101 The rate of formation of new organic matter by rabbit in a grassland is called [CBSE Main 2012]

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

Q.102 'Food web' refers to

[Chandigarh CET 2012]

- (A) Transfer of energy from one trophic level to the next trophic level
(B) Unidirectional energy flow
(C) Capturing solar energy by autotrophs
(D) Connecting feeding pattern in a biotic community

Q.103 The study of interaction between groups of various organisms with their environment is

[Chandigarh CET 2012]

- (A) Ecology (B) Zoogeography (C) Synecology (D) Systems biology

Q.104 The pyramid of biomass in sea is

[HP PMT 2012]

- (A) Upright (B) Slanting (C) Horizontal (D) Inverted

Q.105 Natural reservoir of phosphorus is

[NEET 2013]

- (A) Rock (B) Fossils (C) Sea water (D) Animal bones

Q.106 Which one of the following processes during decomposition is correctly described? **[NEET 2013]**

- (A) Catabolism – Last step in the decomposition under fully anaerobic condition.
(B) Leaching – Water soluble inorganic nutrients rise to the top layers of soil.
(C) Fragmentation – Carried out by organism such as earthworm.
(D) Humification – Leads to the accumulation of a dark coloured substance humus which undergoes microbial action at a very fast rate.

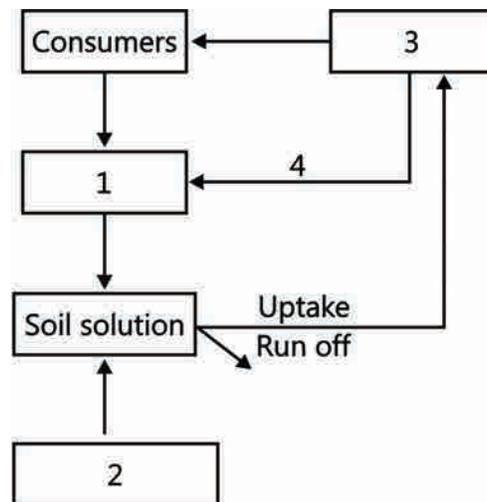
Q.107 Match the following and select the correct option

[AIPMT 2014]

- | | | | |
|-----|-------------------|-------|-----------------|
| (1) | Earthworm | (i) | Pioneer species |
| (2) | Succession | (ii) | Detritivore |
| (3) | Ecosystem service | (iii) | Natality |
| (4) | Population growth | (iv) | Pollination |

- | | | | | |
|-----|-------|------|-------|-------|
| | (1) | (2) | (3) | (4) |
| (A) | (ii) | (i) | (iv) | (iii) |
| (B) | (i) | (ii) | (iii) | (iv) |
| (C) | (iv) | (i) | (iii) | (ii) |
| (D) | (iii) | (ii) | (iv) | (i) |

Q.108 Given below is a simplified model of phosphorus cycling in a terrestrial ecosystem with four blanks (1 - 4). Identify the blanks **[AIPMT 2014]**



- | | 1 | 2 | 3 | 4 |
|-----|---------------|---------------|---------------|-------------|
| (A) | Producers | Litter fall | Rock minerals | Detritus |
| (B) | Rock minerals | Detritus | Litter fall | Producers |
| (C) | Litter fall | Producers | Rock minerals | Detritus |
| (D) | Detritus | Rock minerals | Producers | Litter fall |

ANSWER KEY

Objective Questions

Q.1 D	Q.2 C	Q.3 B	Q.4 A	Q.5 D	Q.6 A
Q.7 B	Q.8 B	Q.9 D	Q.10 C	Q.11 C	Q.12 C
Q.13 B	Q.14 A	Q.15 C	Q.16 C	Q.17 A	Q.18 D
Q.19 A	Q.20 B	Q.21 D	Q.22 C	Q.23 A	Q.24 A
Q.25 B	Q.26 B	Q.27 B	Q.28 C	Q.29 B	Q.30 C
Q.31 B	Q.32 C	Q.33 B	Q.34 D	Q.35 B	Q.36 B
Q.37 B	Q.38 D	Q.39 D	Q.40 A	Q.41 D	Q.42 B
Q.43 C	Q.44 B	Q.45 B	Q.46 D	Q.47 D	Q.48 C
Q.49 C	Q.50 D	Q.51 B	Q.52 D	Q.53 A	Q.54 D
Q.55 B	Q.56 A	Q.57 A	Q.58 B	Q.59 C	Q.60 A
Q.61 C	Q.62 D	Q.63 C	Q.64 B	Q.65 C	Q.66 D
Q.67 C	Q.68 D	Q.69 A	Q.70 B	Q.71 A	Q.72 A
Q.73 D	Q.74 A	Q.75 A	Q.76 D	Q.77 A	Q.78 A
Q.79 A	Q.80 D	Q.81 A	Q.82 A	Q.83 B	Q.84 A
Q.85 A	Q.86 D	Q.87 C	Q.88 A	Q.89 B	Q.90 A
Q.91 C	Q.92 B	Q.93 D	Q.94 D	Q.95 B	Q.96 D
Q.97 A	Q.98 A	Q.99 C	Q.100 C	Q.101 D	Q.102 C
Q.103 A	Q.104 D	Q.105 D			

Previous Years' Questions

Q.1 B	Q.2 A	Q.3 A	Q.4 C	Q.5 B	Q.6 C
Q.7 B	Q.8 C	Q.9 A	Q.10 D	Q.11 A	Q.12 B
Q.13 B	Q.14 D	Q.15 D	Q.16 B	Q.17 B	Q.18 A
Q.19 C	Q.20 A	Q.21 C	Q.22 A	Q.23 A	Q.24 D
Q.25 C	Q.26 B	Q.27 C	Q.28 D	Q.29 A	Q.30 C

Ecosystem

Q.31 D	Q.32 A	Q.33 A	Q.34 B	Q.35 B	Q.36 C
Q.37 B	Q.38 B	Q.39 D	Q.40 C	Q.41 B	Q.42 C
Q.43 B	Q.44 C	Q.45 D	Q.46 A	Q.47 A	Q.48 D
Q.49 B	Q.50 B	Q.51 D	Q.52 C	Q.53 C	Q.54 A
Q.55 A	Q.56 B	Q.57 C	Q.58 A	Q.59 A	Q.60 B
Q.61 D	Q.62 D	Q.63 B	Q.64 B	Q.65 C	Q.67 C
Q.68 C	Q.69 B	Q.70 A	Q.71 A	Q.72 D	Q.73 D
Q.74 D	Q.75 A	Q.76 B	Q.77 D	Q.78 B	Q.79 B
Q.80 C	Q.81 A	Q.82 C	Q.83 B	Q.84 B	Q.85 A
Q.86 B	Q.87 B	Q.88 C	Q.89 A	Q.90 A	Q.91 B
Q.92 C	Q.93 D	Q.94 B	Q.95 A	Q.96 D	Q.97 C
Q.98 A	Q.99 B	Q.100 C	Q.101 D	Q.102 D	Q.103 C
Q.104 D	Q.105 A	Q.106 C	Q.107 A	Q.108 D	