

**2.1 ECOLOGY :**

The term ecology is composed of two Greek words 'Oikos' means house or place of living and 'logos' means to study.

**Ecology** is the science which deals with the study of relationship of living organisms with each other and with their non-living environment.

Ecology can be defined in a number of ways as described below :

1. The scientific study of the interactions of the organisms with their physical environment and with each other is called ecology. - Helena Crutis
2. Ecology is defined as 'the science of the environment'. - Karl Frienderichs
3. Ecology is defined as the study of structure and function of nature. - E. P. Odum
4. The study of animals and plants in their relation to each other and to their environment. - S. C. Kendeigh

**2.2 ECOSYSTEM :**

Living organisms (biotic components) interact with their physical environment (abiotic components) like air, water, soil, temperature, etc. and produce a stable self sustained system, which is called the **ecosystem**.

Living organisms always require their physical environment like air, water, soil, temperature, humidity, etc. to get material and energy flow for their survival. Thus interaction between living organisms and nonliving environment take place.

Thus, the structural and functional unit of ecology is known as the ecosystem.

Ecosystem is a community of interdependent organisms together with the environment. There is a continuous production and exchange of materials between the living and nonliving components of the ecosystem.

● **Characteristics of ecosystem :**

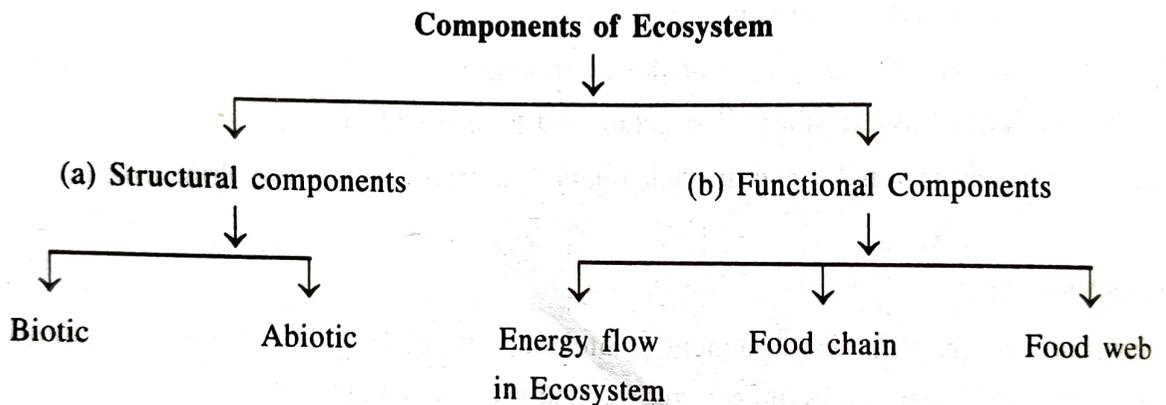
1. Ecosystem has no particular size.  
It can be as large as a desert or a lake or as small as a tree or puddle (small pool of water).
2. The ecosystem may be natural or man-made (artificial).  
Natural ecosystems - Forest, lake, desert, grassland, pond, etc.  
Man-made ecosystems - aquarium, crop field, etc.
3. Ecosystem can change with time.  
e.g. fresh water lake can become eutrophic (nutrient), both supporting different type of life.

4. In the ecosystem there is always a flow of matter and energy in and out, i.e. all ecosystems are open systems.
5. In the ecosystem, different organisms interact with each other and every organism (species) has a role to play.
6. It is a system where biotic and abiotic components work together, i.e. water, plants, animals, microorganisms, air, temperature, light, soil, etc. all work together. If there is no light or water or the soil does not have the right nutrients, the plants will die.
7. The foundation on which ecosystem rests is the production of organic matter by photosynthesis.

● **COMPONENTS OF ECOSYSTEM :**

An ecosystem comprises of two basic components :

- (a) Structural components
- (b) Functional components



(a) **Structural Components of ecosystem :**

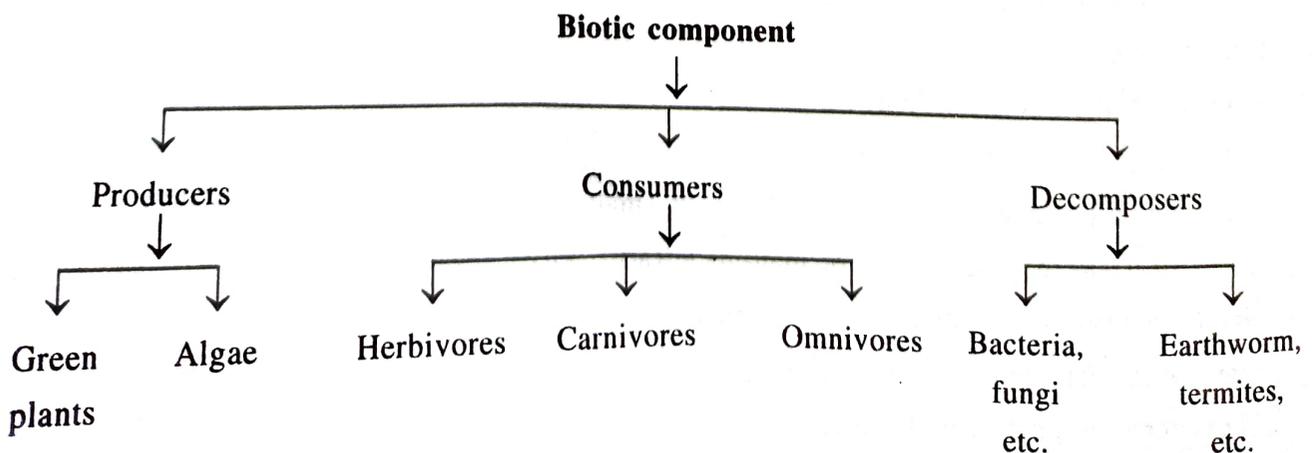
There are two basic structural components of ecosystem :

1. Biotic components (living)
2. Abiotic components (non-living)

1. **Biotic components :**

The living organisms including plants, animals and micro-organisms (bacteria and fungi) that are present in an ecosystem form the biotic component of the ecosystem.

On the basis of their role in the ecosystem the biotic components are further classified into :



**(i) Producers (Autotrophs) :**

The set of living organisms which are capable of producing the food on their own are known as **producers** or **autotrophs**.

e.g. green plants, algae.

Green plants and algae, directly utilize the sunlight energy to convert  $\text{CO}_2$  and water to simplest carbohydrates called glucose and release oxygen as a by-product. This process is called **photosynthesis**.

Some bacteria are able to use the energy in some inorganic chemicals to form organic matter from  $\text{CO}_2$  and water. This process is called **chemosynthesis**. Such organisms are also called producers.

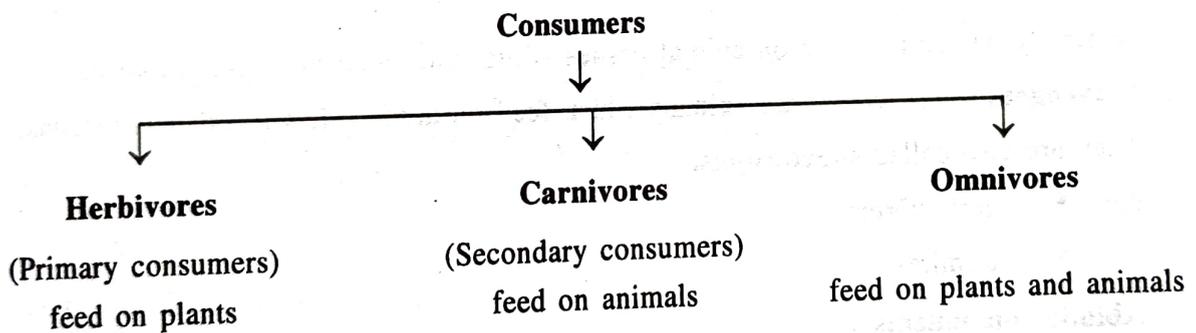
All other organisms in an ecosystem get the energy and nutrients they need by feeding on producers. Thus, producers are the building blocks of every ecosystem.

**(ii) Consumers :**

The set of living organisms feeding on producers are consumers.

They are also called **heterotrophs**. i.e. nourish on others.

The subgroups of consumers are :

**• Herbivores :**

Herbivores are animals and other organisms that feed directly on plants.

- e.g.
- cow
  - deer
  - goat
  - grasshopper, etc.

They are also called **Primary consumers** or **first order consumers**.

**• Carnivores :**

The animals which feed on the herbivores are called **carnivores**.

Birds that feed on insects are carnivores.

Hawks that feed on birds are also carnivores.

Other examples are fox, snakes.

Carnivores are also called **secondary consumers** or **second order consumers**.

•• **Tertiary consumers :**

They are basically large carnivores because they feed on secondary consumers.

They are third order consumers.

e.g. lion, tiger, etc.

•• **Omnivores :**

The animals that feed both on plants and animals are called **omnivores**.

e.g. man, frog

Omnivores are also called **opportunistic feeders** (survive by eating what is available).

They are the top level carnivores.

(iii) **Decomposers (Reducers) :**

Decomposers are microorganisms which breakdown dead organic material of producers and consumers to simple organic substances and by-products to get their food.

Decomposers convert complex organic matter into simpler one with reduction in volume of material, so they are also called reducers.

e.g. • bacteria

• fungi

Generally bacteria attacks on animal tissues while fungi attacks on plant tissues.

**Scavengers** (detritivores) are animals which feed on dead bodies of other organisms.

They are also called **saprotrophs**.

e.g. • earthworms

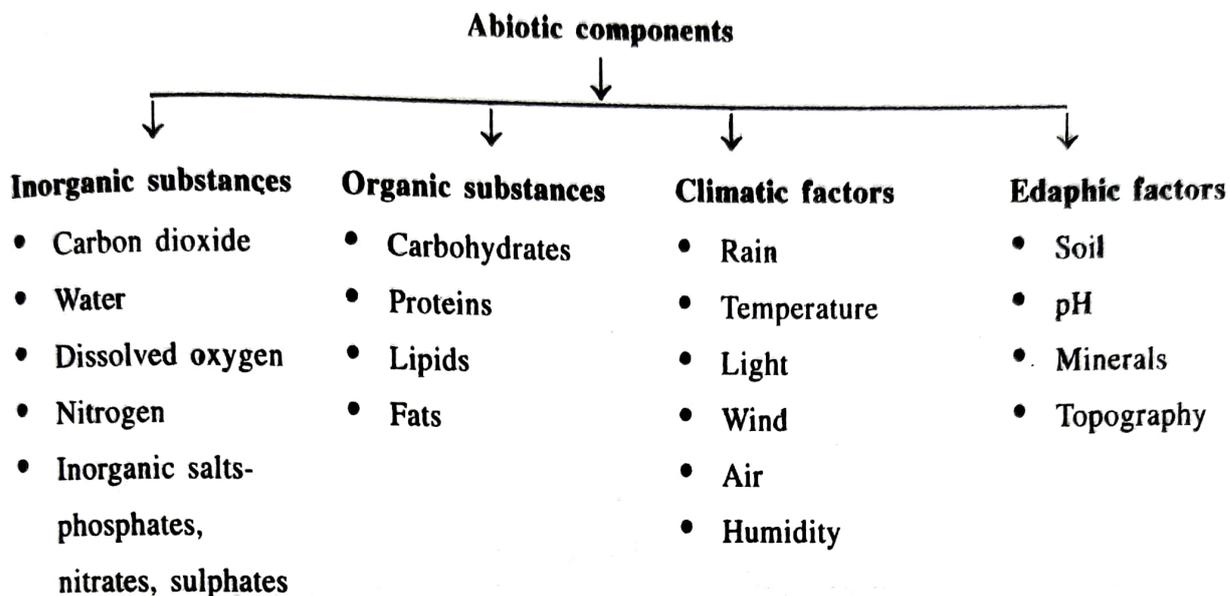
• termites

**2. Abiotic components :**

All the non-living components of ecosystem are called abiotic components. They play an important role in maintaining the balance in the ecosystem.

Abiotic components are the physical and/or the chemical factors that act on the living organisms at any part of their life. These are also called as the ecological factors. The physical and chemical factors are characteristic of the environment. Light, air, soil, and nutrients, etc. form the abiotic components. The abiotic factors vary from ecosystem to ecosystem. In an aquatic ecosystem, the abiotic factors may include water pH, sunlight, turbidity, water depth, salinity, available nutrients and dissolved oxygen. Similarly, abiotic factors in terrestrial ecosystems can include soil, soil types, temperature, rain, altitude, wind, nutrients, sunlight etc.

They are classified as under :



● **Importance of abiotic components :**

(i) **Atmosphere :**

- (a) Atmosphere provides  $\text{CO}_2$  for photosynthesis and Oxygen for Respiration.
- (b) The process of Evaporation, Transpiration and Precipitation cycle occurs between atmosphere and earth's surface.

(ii) **Solar Radiation :**

- (a) Solar radiation is used in Ecosystems to heat the atmosphere and to evaporate and transpire water into the atmosphere.
- (b) Sunlight is necessary for photosynthesis.

(iii) **Soil :**

- (a) Soil provide nutrients, water, home and structural growing medium for organisms.
- (b) It provides minerals required by organisms.

(iv) **Water :**

Most living tissues are composed of a very high percentage of water. The source of water is precipitation from the atmosphere.

(v) **Organic and Inorganic substances :**

All organic and inorganic substances are very essential for survival of living organisms. They provide source of nutrient.

(vi) **Temperature :**

Living organisms can withstand a narrow range of temperature change. Extreme temperature may alter their physiological and behavioural changes.

**(vii) Humidity :**

It is the amount of water vapour present. It should be in a reasonable range for survival of living organisms.

**(b) Functional components of Ecosystem :**

The functional components of ecosystem comprises of :

1. Energy flow in ecosystem.
2. Food chain
3. Food web

**1. Energy Flow in Ecosystem :**

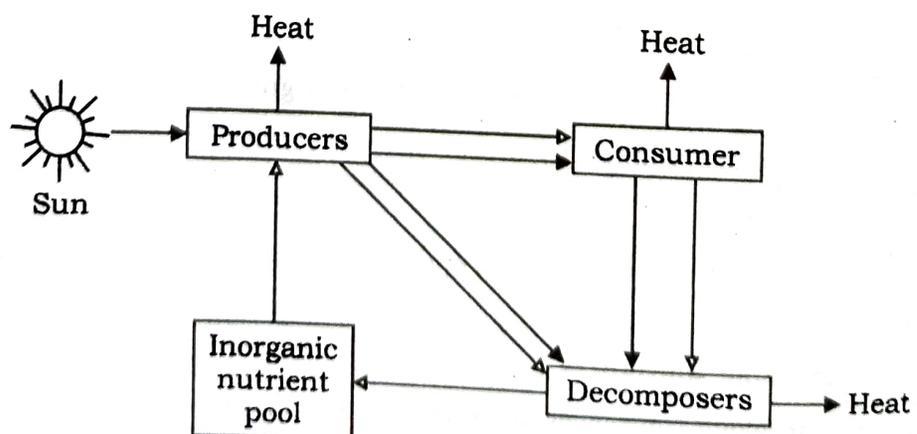
Sun is the primary source of energy for every ecosystem. In the process of photosynthesis green plants take energy from sunlight to convert carbon dioxide into glucose to get energy. The energy transfers from one trophic level to another, i.e. from producers to top carnivores.

Flow of energy in ecosystem is governed by two basic laws of thermodynamics :

- Energy can neither be created nor destroyed but can be transferred from one state to another.
- Each transfer of energy causes loss of energy within the ecosystem from one level to another.

Energy flows through the ecosystem in the form of carbon – carbon bonds. When respiration occurs, the carbon-carbon bonds are broken and the carbon is combined with oxygen to form carbon dioxide. This process releases energy, which is either used by the organism (to move its muscles, digest food, excrete wastes, etc.) or the energy may be lost as heat.

The dark arrows represent the flow of energy. Note that all energy comes from the sun will be converted to heat, which is lost to space. Only 10% of energy available in food is incorporated into biomass, the remaining 90% is lost. *Energy does not recycle.*



[FIG. 2.1 ENERGY AND NUTRIENT FLOW IN ECOSYSTEM]

The other components shown in the diagram are the inorganic nutrients flow. They do not contain carbon-carbon bonds as they are inorganic. These inorganic nutrients include the phosphorus

in your teeth, bones and cellular membranes, the nitrogen in your amino acids (building blocks of proteins) and the iron in your blood. The movement of the inorganic nutrients is represented by open arrows. Producers (autotrophs) obtain these inorganic nutrients from the inorganic nutrient pool (soil or water surrounding the plants or algae). These inorganic nutrients are passed from organism to organism, as one organism is consumed by another. Ultimately, all organisms die and become detritus, food for the decomposers. At this stage the last of the energy is extracted (and lost as heat) and the organic nutrients are returned to the soil or water to be taken up again. The organic nutrients are recycled, the energy is not.

• Salient features of energy flow in ecosystem :

1. The sun is the ultimate source of energy.
2. Fate of energy is to be lost as heat lastly.
3. Energy and nutrients are passed from organism to organism through the food chain as one organism eats another.
4. Decomposers remove the lost energy from the remains of organisms.
5. Inorganic nutrients are cycled, but energy is not.

## 2. Food chain :

There are three types of organisms in a food chain: producers, consumers and decomposers.

**1. Producers :** These organisms absorb the sun's energy and convert the energy into food for themselves, allowing them to grow larger, make flowers and fruit, etc. An example of a producer is a plant, such as the flower in the picture.

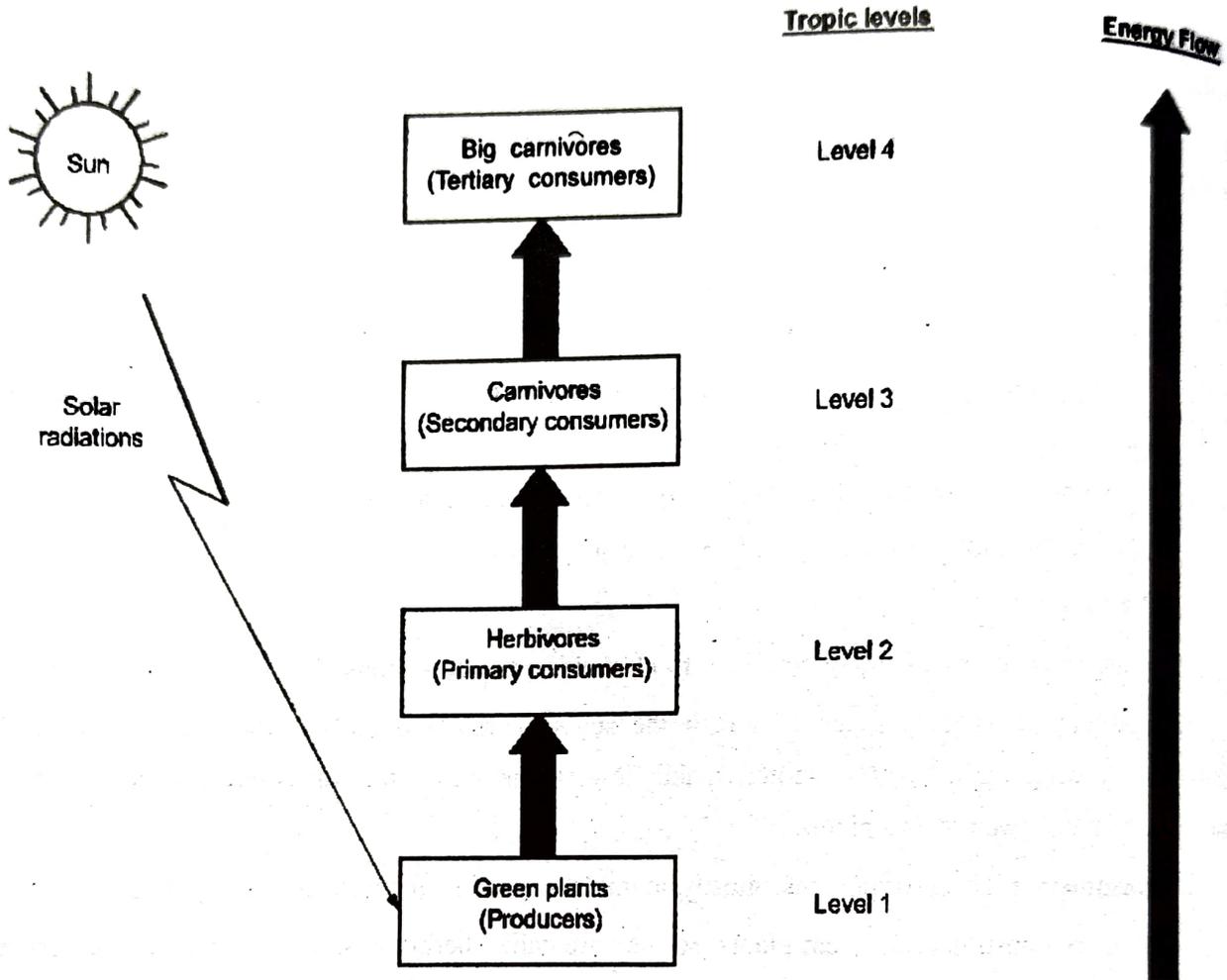
**2. Consumers :** These organisms, mostly animals, can be split into a few categories:

- Primary consumers only eat plants, so they are called herbivores. The primary consumers in the picture are the bee and grasshopper.
- Secondary consumers eat primary consumers. Many secondary consumers also eat plants, which makes them omnivores (meat and plant eaters). The secondary consumers in the picture are the wasp and beetle.
- Tertiary consumers eat the secondary consumers and are usually carnivores (meat eaters). The tertiary consumers in the picture are the frog and snake.
- Quaternary consumers eat the tertiary consumers and are carnivores. The quaternary consumer in the picture is the hawk. In this picture, the food chain ends with the hawk, which claims the title as the top carnivore.

**3. Decomposers :** These organisms turn dead material (such as a fallen tree, or a dead hawk) into soil and recycle nutrients so they can be re-used by producers to create food. Decomposers are not shown in this picture, but they live underground where the flower's roots are. Decomposers include earthworms, small soil beetles, fungi, and bacteria.

**Trophic Levels :**

In a food chain, food energy passes from one group of organisms to other groups of organisms at different levels. These feeding levels of organisms are called **trophic levels**.



[FIG. 2.2 TROPHIC LEVELS]

The food chain consists of four trophic levels.

**Trophic level-1 :**

The green plants are producers and form trophic level-1.

**Trophic level-2 :**

Herbivores are primary consumers and form trophic level-2.

e.g. cow, goat, deer, rabbit, etc.

**Trophic level-3 :**

Small carnivores are secondary consumers and form trophic level-3.

e.g. foxes, snakes, etc.

**Trophic level-4 :**

Big carnivores are tertiary consumers and form trophic level-4.

e.g. wolves, hawks, tiger, lion etc.

**Types of food-chain :**

A food chain shows a single, connected path of energy flow through an ecosystem. Some animals only eat plants while some animals eat other animals. A food chain shows the different levels of eating within an ecosystem. The arrows show the flow of energy from one organism to the next. Most food chains begin with the sun as a start. Ultimately a food chain always begins with the producers. The various components of the food chain can be defined as a group of organisms in which there is transfer of food energy.

All ecosystems possess two types of food chains :

(i) Grazing food chain

(ii) Detritus food chain

**(i) Grazing food chain :**

In a grazing food chain there are basically four trophic levels – Auto trophic, primary consumers, secondary consumers and tertiary consumers. Thus the nutrition produced by plants utilizing energy of solar radiation are used in the following three ways –

(i) Used for respiratory activity of the plant

(ii) Get decayed

(iii) May be consumed by herbivores

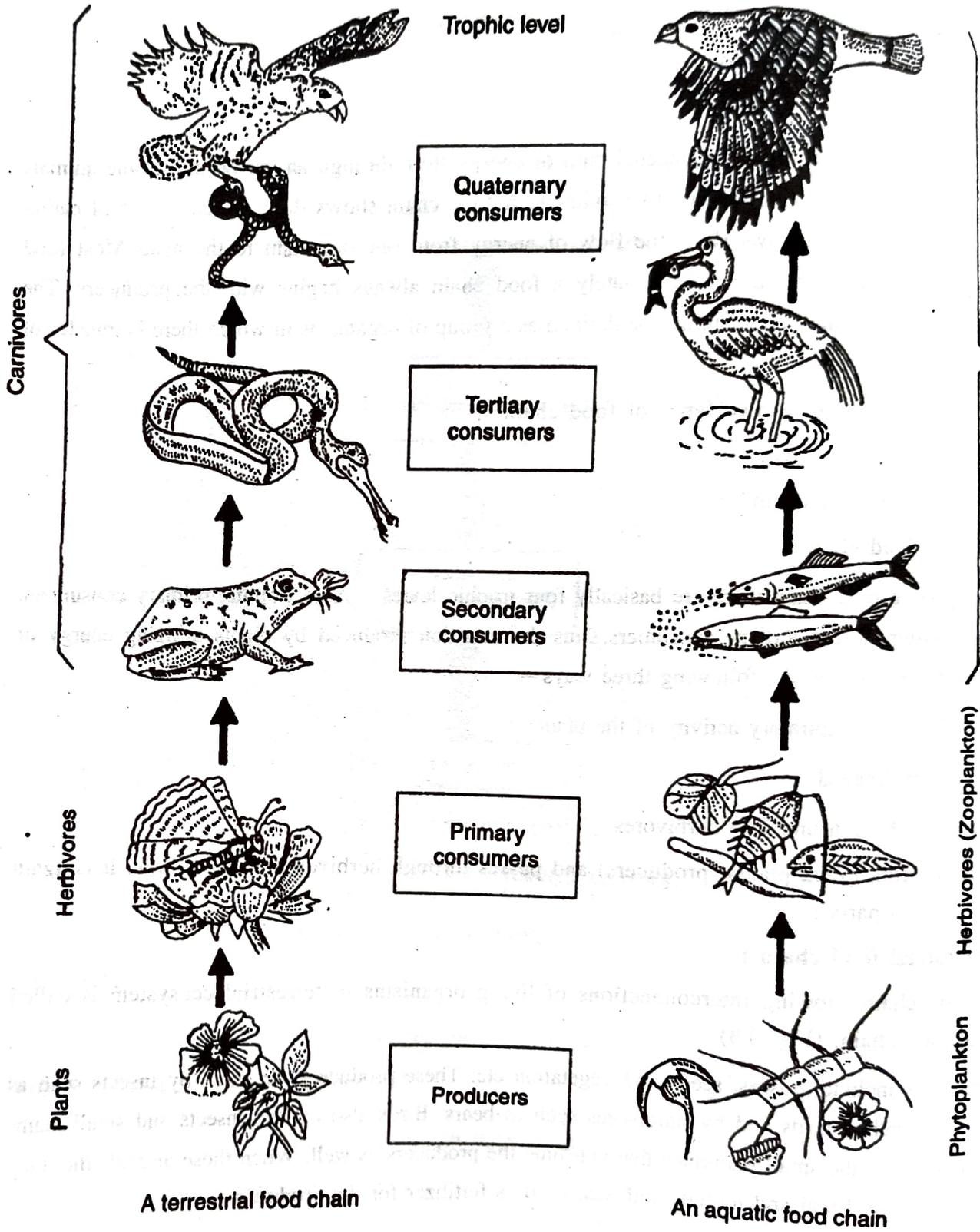
It starts from green plants (producers) and passes through herbivores to carnivores. It is again divided into two parts :

**(a) Terrestrial food chain :**

A food chain showing interconnections of living organisms in terrestrial ecosystem is called terrestrial food chain, (Fig. 2.3)

Producers include grasses, seeds and vegetation etc. These producers are eaten by insects such as butterflies, as well as birds and by omnivores such as bears. Birds also eat the insects and small mammals, and bears eat the small mammals that consume the producers as well. When these animals die, they are decomposed by fungi and insects, and then used as fertilizer for the producers.

**Example-1 :**

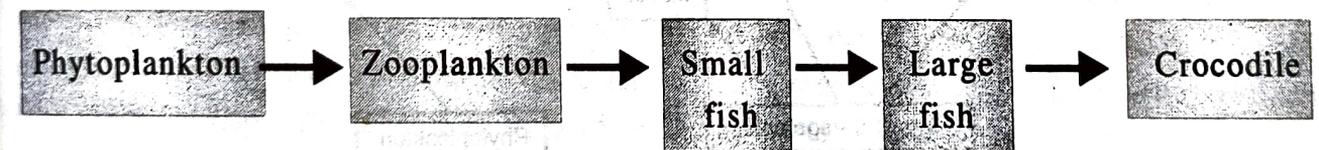


[FIG. 2.3 FOOD CHAIN AND TROPHIC LEVELS IN TERRESTRIAL AND AQUATIC ECOSYSTEM]

**Example-2 :****(b) Aquatic food chain :**

A food chain showing interconnections of living organisms in aquatic ecosystem is called aquatic food chain.

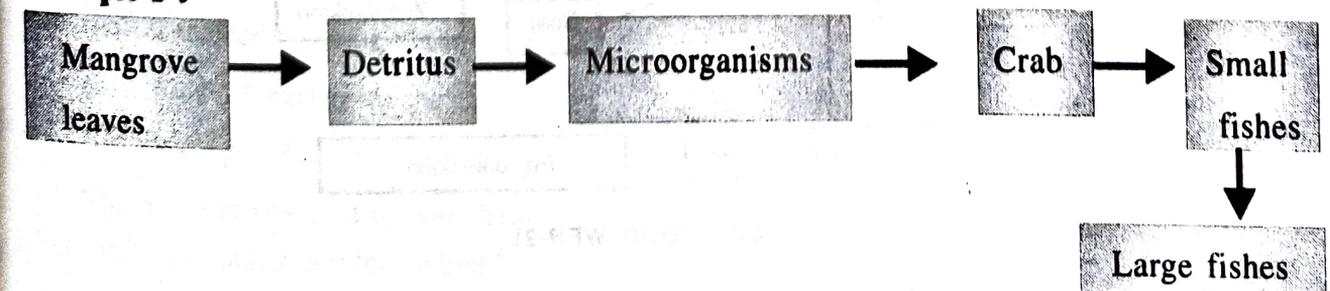
Food chains in aquatic ecosystems are made up in both freshwater and saltwater. In freshwater there are shredders like the stonefly, who feed on organic matter. Phytoplankton are a main producer in the aquatic food chain. Some phytoplankton and terrestrial organic matter fall to the bottom of an aquatic ecosystem where they are eaten by bottom grazers. Other phytoplankton is eaten by zooplankton. The primary consumers of zooplankton are small fish and whales. Secondary consumers are larger fish who eat the smaller fish, which can then also be eaten by larger fish or tertiary consumers.

**Example-1 :****Example-2 :****(ii) Detritus food chain :**

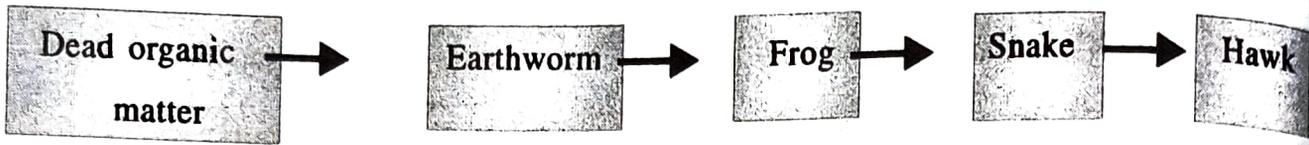
The food chain in which microorganisms such as fungi and bacteria break down and metabolize dead organic matter and act as producer is known as detritus food chain.

Detritus means dead organic matter. The detritus food chain starts from dead organic matter which is eaten by microorganisms (detritivores) which are then eaten by other organisms. In fact, such food chains are less dependent upon the direct solar energy and mainly depend on the supply of organic matter.

The example of detritus food chain is seen in mangrove ecosystem. The leaves of mangrove trees fall into the warm shallow waters. The fallen leaf fragments are eaten by detritivores like crabs. The detritivores are eaten by small fishes, which in turn, eaten by large fishes.

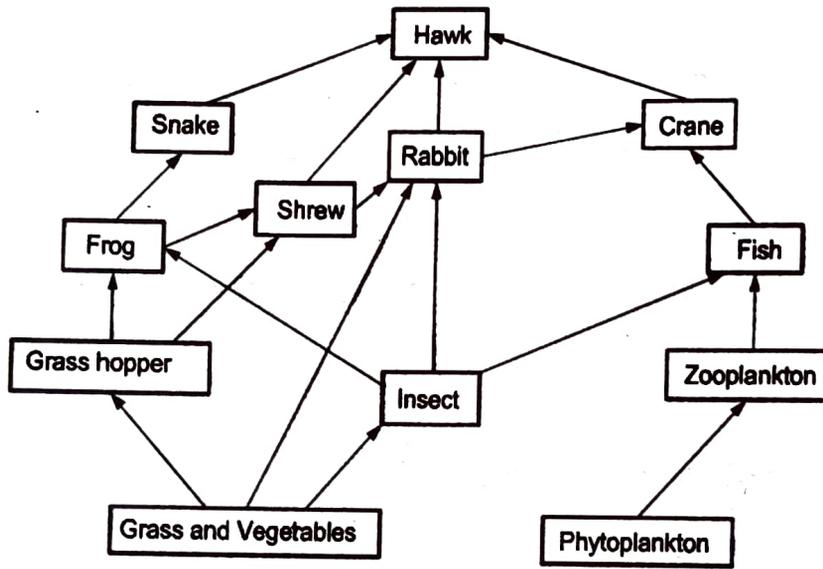
**Example-1 :**

**Example-2 :**

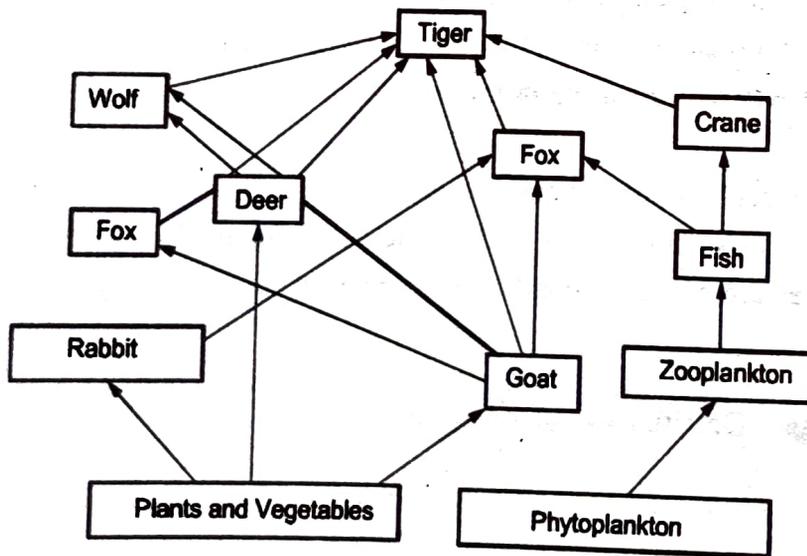


**3. Food web :**

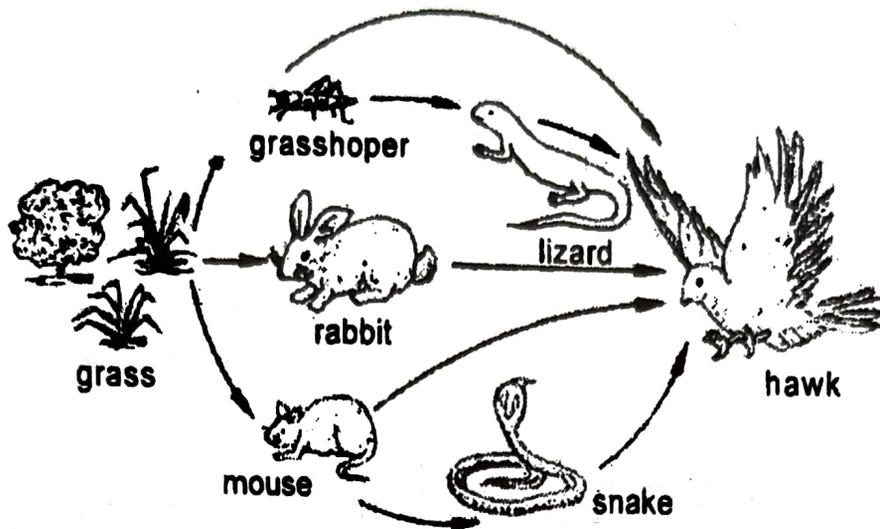
In the ecosystem, a number of food chains operate simultaneously. These food chains are inter-linked with one-another to form a food web. Thus, a food web is a complex network of interconnected food chains, where different types of organisms are interconnected at different trophic levels.



[FIG. 2.4 (a) FOOD WEB-1]



[FIG. 2.4 (b) FOOD WEB-2]



[FIG. 2.5 FOOD WEB IN A GRASS LAND ECOSYSTEM]

It is not the same thing as a food chain, which follows a linear energy path, such as the sun gives energy to the grass, the grass is eaten by a grasshopper, the grasshopper is eaten by a frog, and the frog is eaten by a hawk. A food web, however, acknowledges the complexity of food and energy chains, showing how all members of a food chain are connected by multiple paths. Producers are plants and other organisms that carry out photosynthesis, using the sun as food energy. Consumers include plant-eating herbivores, meat-eating carnivores, and organisms that eat both, called omnivores. Finally there are decomposers, such as bacteria and fungi, which eat non-living organic material. A food web shows how food chains overlap. The same three types of organisms are in food webs: producers, consumers and decomposers.

For, example,

A plant may be food for any herbivore or carnivore such as human beings. A herbivore again becomes food for carnivore or is directly eaten by the top carnivore. For example, a mouse feeding on food grains become food for a snake which is eaten by a hawk. The mouse can be directly eaten by a hawk. In this way, the interrelated complex food chain forms a food web. A food web constitutes a number of alternate paths for energy flow and provides a greater stability to the ecosystem.

● **Significance of food chain and food web :**

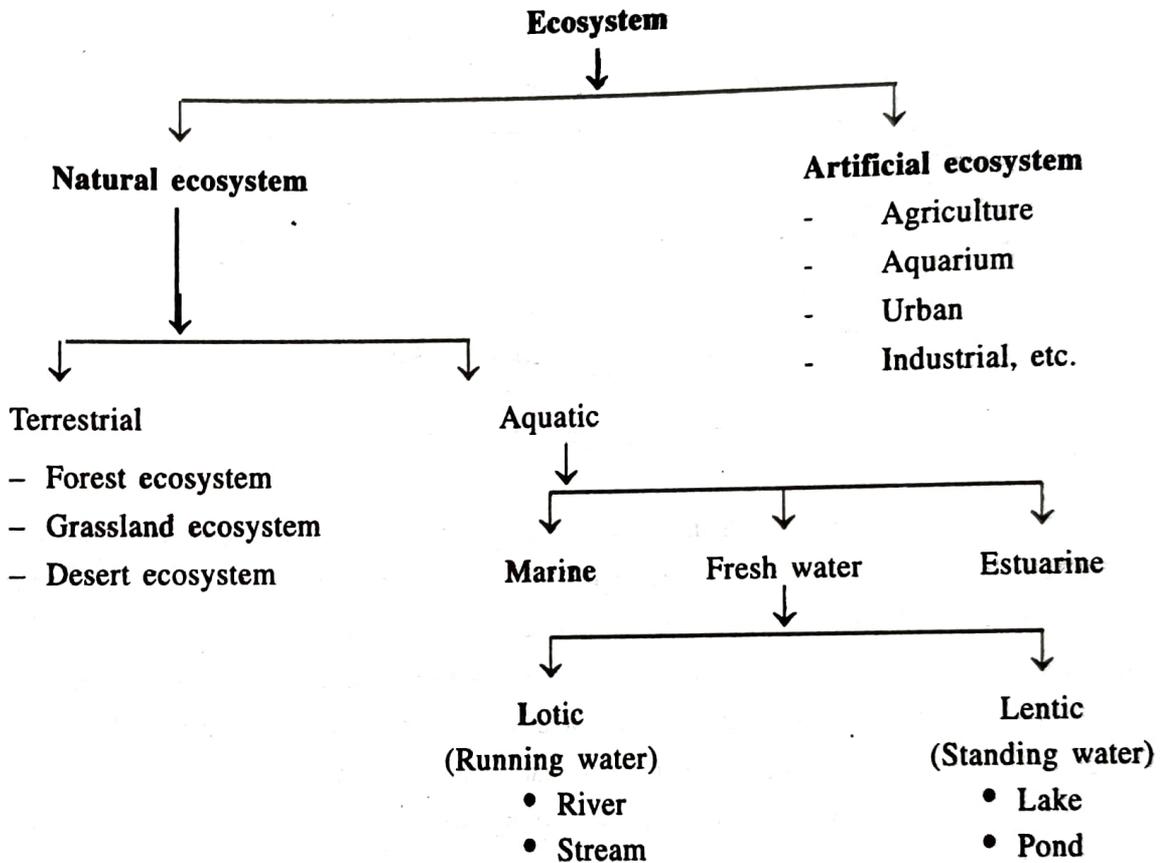
The food chain in the ecosystem helps to maintain :

- (i) The biodiversity of nature.
- (ii) The feeding relationship of nature.
- (iii) Flow of energy of the ecosystem.
- (iv) Passage of nutrients from one organism to another.

The only drawback of a food chain is that along with nutrients it also transports toxic substances from one organism to another which finally results in biomagnification.

## 2.4 MAJOR ECOSYSTEMS :

Earth is the giant ecosystem where biotic and abiotic components are constantly interacting with each other bringing structural and functional changes in it. Due to the vastness, it is classified as under :



### 2.4.1 Forest Ecosystem :

Forests are one of the most important areas on earth. These special ecosystems are homes to thousands of species, animals and plants. It contains interesting biological communities (vegetation) and faunal communities which together interact with the physical environment resulting in an integrated structure. It is always the vegetation which forms the base of the food chain.

According to the forest survey report of 1993, about 19.5% of the total geographical area of India is under forest cover. Depending on factors such as annual rainfall, its distribution, mean monthly temperature, etc. the forests are classified as :

1. Tropical rain forests
2. Tropical deciduous forests
3. Tropical shrub forests
4. Temperate rain forests
5. Temperate deciduous forests
6. Evergreen coniferous forests

### • Functions of Forest Ecosystem :

- To regulate the hydrological cycle.
- To provide shelter and food directly and indirectly to animals and birds.
- To control the atmospheric pollution and give refreshing environment.
- To increase water absorption in soil and increase humidity in air.
- To reduce the abrasion of soil due to floods, storms and heavy winds.

### • Components of forest ecosystem :

#### (a) Biotic components :

It includes producers, consumers and decomposers.

#### 1. Producers :

The vegetation of forest is the producer. The term vegetation includes all types of big trees, medium sized bushes and small herbaceous plants.

Different types of trees are :

- |                  |   |
|------------------|---|
| deciduous trees  | - trees which lose their leaves in winter           |
| evergreen trees  | - trees which keep their leaves throughout the year |
| coniferous trees | - trees which grow in Himalayan region              |
| desert trees     | - trees which have thorns                           |
| Mangrove trees   | - trees in coastal and river delta regions          |

#### 2. Consumers :

##### Primary consumers :

Insects like ants, beetles, flies, spiders, birds, and other herbivores such as deer, squirrels, mongoose, elephants, etc.

##### Secondary consumers :

Carnivores animals like snakes, birds, fox, jackal, etc.

##### Tertiary consumers :

These are top carnivores, such as lions, tigers, hawks, etc. that feed on secondary consumers.

#### 3. Decomposers :

These organisms remain confined to the soil of the forest floor and have the capacity to decompose all dead plants and animals to release nutrients into the soil. These nutrients are again used by the producer.

e.g. fungi, bacteria, protozoa, earthworms, mites, etc.

#### (b) Abiotic components :

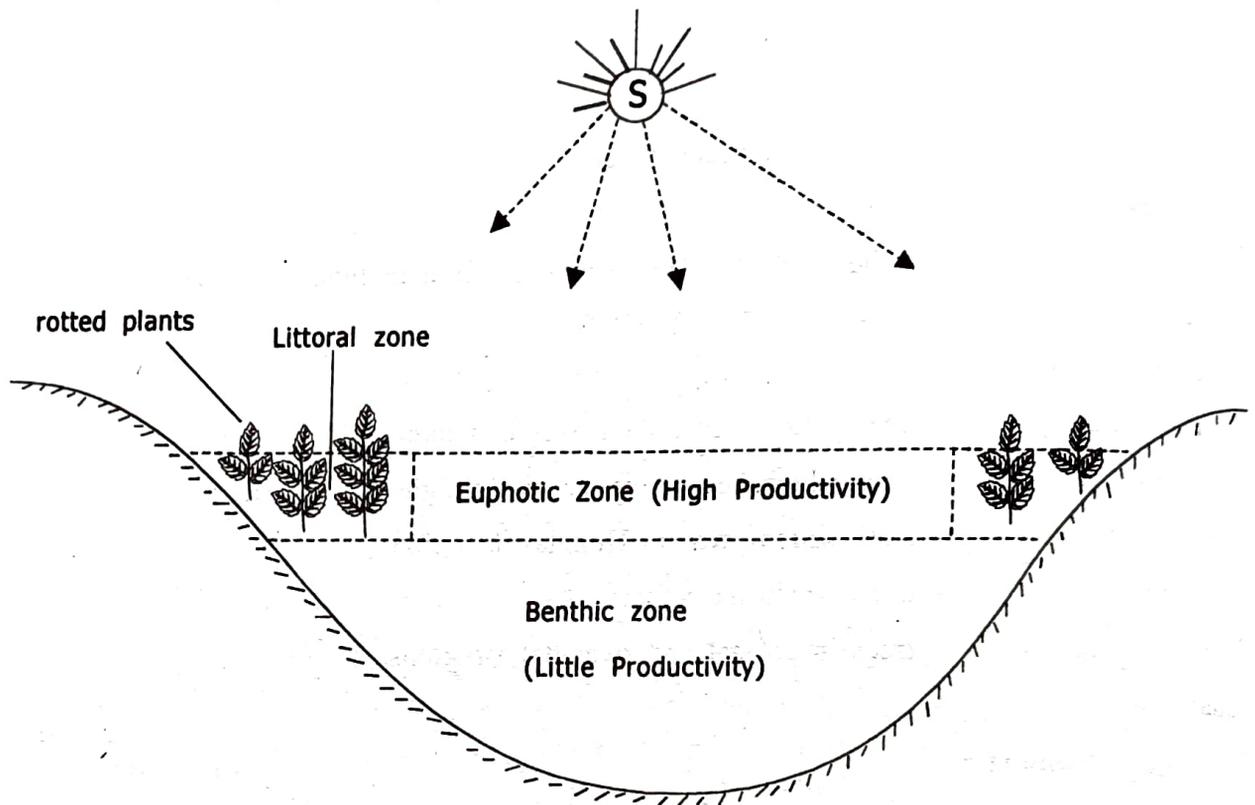
All organic, inorganic and mineral substances present in the environment in the forest constitute the abiotic components.

e.g. water, air, carbon dioxide, sunlight, rainfall, soil, temperature, pH, etc.

### 2.4.2 Pond / Lake ecosystem :

Pond or lake ecosystem is the area where fresh water almost remains stagnant. It is also called **Lentic ecosystem**.

Pond is defined as any body of water over 1 km<sup>2</sup> area that is inundated wet for more than 3 months.



[FIG. 2.6 ZONATION IN A LAKE OR POND ECOSYSTEM]

Lakes have been found to exhibit distinct zones of biological activities, largely determined by the availability of light and oxygen. The most important biological zones are :

**(i) Littoral zone :**

It is a shallow water zone in which rooted plants exist.

**(ii) Euphotic zone (Limnetic zone) :**

The upper layer of the water through which sunlight can penetrate effectively is called euphotic zone. All plant growth occurs in this zone. In deep water algae grows as the main plant.

**(iii) Aphotic zone or benthic zone :**

It is the deep bottom zone where light penetration is very difficult and practically negligible. It is a zone of little productivity.

- **Components of Lake/Pond Ecosystem :**

- (a) **Biotic components :**

**Producers :**

They are mainly photoplankton, attached algae and other free floating plants like Hydrilla and Hyacinths.

**Consumers :**

Main consumers are zooplankton, insects, crabs, small fishes, crocodiles and many birds.

**Decomposers :**

These are mainly bacteria and fungi.

- (b) **Abiotic components :**

- Inorganic substances like carbon dioxide, water, dissolved oxygen, nitrogen, inorganic salts (Phosphates, nitrates, sulphates)
- Organic substances like carbohydrates, lipids, proteins
- Physical factors like sunlight, rainfall, soil, temperature and pH.

### 2.4.3 Desert Ecosystem :

The regions where evaporation exceeds precipitation are called Desert. The precipitation is usually less than 25 cm per year. About 1/3rd of world is covered by desert. It has little species diversity and consist of drought resistant or drought avoiding plants. The atmosphere is very dry and hence it is a poor insulator, so the soil gets cooled up quickly and making the nights cool. Based on climatic conditions they are divided as follows :

- (1) **Tropical deserts :** Sahara and Namibia in Africa and Thar in Rajasthan are driest tropical deserts.
- (2) **Temperate deserts :** Mojave in Southern California with hot day time temperature and cool in winters is temperate desert.
- (3) **Cold deserts :** Gobi desert in China has cold winters and warm summers. Desert plants and animals are having most adaptations for conservation of water. Many plants show very deep roots to tap the ground water. Many plants have a waxy, thick cuticle over the leaf to reduce loss of water through transpiration. Desert animals like insects and reptiles have thick outer coverings to minimize loss of water. They usually live inside the burrows where humidity is better and heat is less. There are several species of mammals in the desert. Camels can be considered as the mammal and are known as cars of the desert. Desert soil is rich in nutrients but deficient in water (moistake).

● **Components of Desert Ecosystem :**

(1) **Abiotic components :**

It includes the nutrients present in the soil and the aerial environment.

(2) **Biotic components :**

(i) **Producers :** There are shrubs, especially bushes, some grasses and few trees. Sometimes few succulents like cacti are also present. Same lower plants like lichens and mosses may also be present.

(ii) **Consumers :** Reptiles, insects, rodents, birds, mammals and camels.

(iii) **Decomposers :** These are very few, as due to poor vegetation the amount of dead organic matter is less. There are some fungi and bacteria of which most of them are thermophilic.

**: MULTIPLE CHOICE QUESTIONS :**

**Q.1 MCQs**

1. Which one of the following is an autotrophic component  
(a) Algae (b) Virus (c) Lion (d) fungi
2. .... is an autotroph.  
(a) produces (b) consumer (c) Decomposes (d) Non of the above
3. Which one of these is a biotic component ?  
(a) water (b) Soil (c) Air (d) consumer
4. Decomposers are also known as .....  
(a) producers (b) detritivores (c) herbivores (d) carnivores
5. Producers & consumers by respiration return the ..... to atmosphere  
(a) oxygen (b) nitrogen dioxide (c) carbon dioxide (d) carnivores
6. The plants that eat herbivores are also called as .....  
(a) primary consumers (b) Secondary consumers  
(c) tertiary consumers (d) producers
7. Forest is a ..... natural resource  
(a) Biotic (b) abiotic (c) Potential (d) abiotic
8. The shape of energy pyramid is .....  
(a) upright (b) inverted (c) spindle shaped (d) none
9. Thermophilic bacteria are found in .....  
(a) forest ecosystem (b) desert ecosystem  
(c) grass land ecosystem (d) pond ecosystem
10. Energy flow is always .....  
(a) upright (b) inverted (c) Both (d) none

**: SHORT QUESTIONS :****Q. 2 Short questions :**

1. Define Ecosystem ?
2. What is trophic level and which trophic level is occupied by green plants?
3. What is the function of decomposers ?
4. Write the features of pond ecosystem ?
5. What is food chain ?
6. Mention the pyramid of biomass ?
7. Explain about producers of pond ecosystem ?
8. Write about food web ?
9. Mention the characteristics of desert ecosystem ?
10. What are components of ecosystem ?
11. Write short notes on ecosystem and its function.
12. What is a biotic community?

**: LONG QUESTIONS :****Q. 3. Long questions :**

1. Give a detailed account of the desert ecosystem ?
2. Give a detailed account of the pond ecosystem ?
3. Describe how food chain form a food web ?
4. What is pyramid of number ? Explain in detail ?
5. Write a note on biotic component of ecosystem ?
6. Describe the structure of forest ecosystem ?
7. Write about the food chain in ecosystem
8. Write about the pyramid of biomass.
9. Write a note on abiotic component of ecosystem ?
10. Explain pyramid of energy.

