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PRINCIPLES OF ECOLOGY

Earth is the only planet in the solar system that supports life. This is because of the balance between the three physical systems on it, that is, soil, water and air. Each one of these provide material essential for life. All the living beings differ from each other but they are all interdependent and interact with each other directly or indirectly as well as with their environment. Considering the significance of life on earth and to sustain it we should understand the earth's life support system and help to maintain a balance between the living things and their nonliving environment. In this lesson we will study the relationships between the organizations and their environment, the different level of organization, the characteristics of ecosystems and the major biomes.



OBJECTIVE

After completing this lesson, you will be able to:

- *define environment, ecology and biosphere;*
- *list the various components of the environment;*
- *name the biotic and abiotic components of the environment;*
- *discuss inter-relationship between plants and animals in an ecosystem;*
- *describe the food chain and food web;*
- *trace the path of energy flow through the food chain;*
- *differentiate between food chain and food web;*
- *pinpoint the position of human beings in food chain;*
- *define biome;*
- *list the various biomes and their characteristics (flora and fauna);*
- *describe the biogeochemical cycles such as carbon and water cycles.*



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24.1 ENVIRONMENT ECOLOGY AND BIOSPHERE

24.1.1 Environment

The term environment denotes all the physical, chemical and biotic conditions surrounding and influencing a living organism. Favourable environmental conditions are required to sustain life on earth.

The environment can be divided into two main components

1. **Abiotic** : All the physical (climatic), edaphic (nature of soil) and chemical factors. They are also called nonliving factors. The important abiotic factors are temperature, light, pressure, humidity, precipitation, wind, mineral elements of soil and composition of air. Some of these environmental factors serve as **resources** (air, soil and water) while others act as **regulatory factors** (light, temperature and pressure etc).
2. **Biotic** : All living organisms found in the environment and that includes plants, animals and microorganisms.

24.1.2 Ecology

Ecology is the scientific study of the relationship between organisms and their environment. The term ecology is derived from a Greek word *Oecologie* where “*oikos*” meaning “household” and “*logos*” meaning “the study of”. Literally ecology is the study of organisms at home. This term was introduced for the first time by a German Biologist Earnst Haeckel in 1869. Charles Elton a modern Ecologist defined Ecology as the study of animals and plants in relation to their habit and habitat. Thus ***Ecology deals with various forms of interactions between the organisms and their environment.***

These *interactions* can be studied at the various levels of organizations in the living systems starting from the molecules such as DNA (genes) to a biological community and the whole **biosphere**. Each step of independent interaction is called a **level of organization**. These are as follows :

Genes → Cell → organ → organism → Population → Community

At each level of organization there is a direct interaction of the physical system that is matter and energy.

The study of ecology has presently contributed a lot to the socio-economic and political issues of the world as it plays an important role in agriculture, fishery biology pest control, conservation of soil, forests and water resources. All the international issues of environment such as pollution and resource management need a sound knowledge of ecology.

Levels of biotic organizations showing a direct impact of the environment

- An organism is a self reproducing system capable of growing and maintaining itself and is directly influenced by the surrounding environment.
- A population is an assemblage of similar organisms belonging to the same species, living together at one place at a given time. A population always has a specific place of its living which is known as its *habitat*. The habitat of sunfish

is pond and lion is a forest. The group of lions living in one forest or the group of sunfish living in one pond belong to one population.

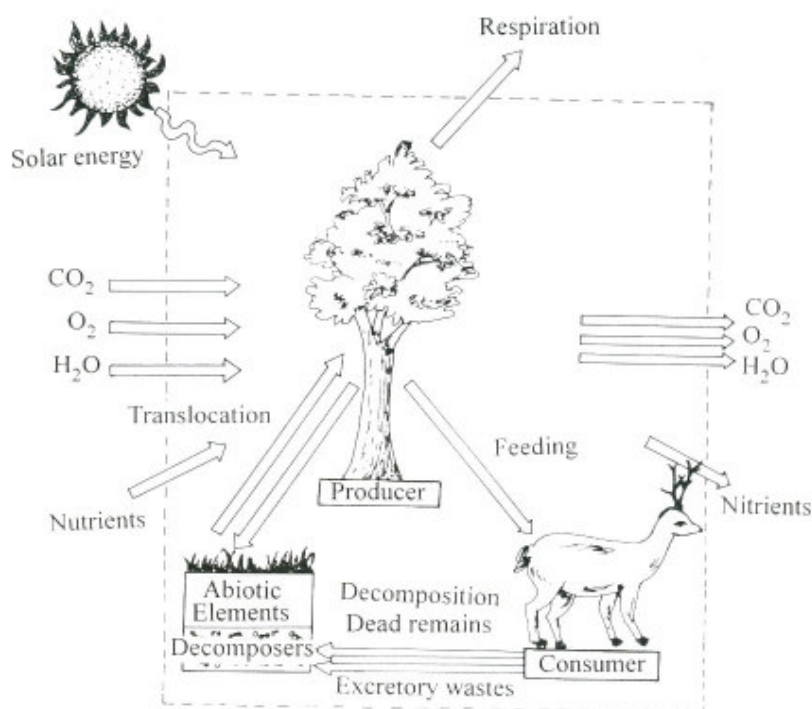


Fig. 24.1 Components of an ecosystem.

Species : If you bring the sunfish from two different ponds and put them together in one pond, they can interbreed. So both the populations of sunfish belong to one species. A *species* is defined as a group of organisms which can interbreed and produce a successful offspring. These organisms may be separated in space and time into smaller groups called *populations*.

- **Biological community** refers to the populations of different species occupying a common place of living. For example all the living organisms in a pond belong to one community. A biological community along with its nonliving environment of energy and matter makes an **ecosystem** (as shown in the figure). Ecosystem can range in size from a puddle of water to a stream or a patch of wood to entire forest or desert.

*The study of groups of organisms in relation to their environment is called **synecology**.*

24.1.3 Biosphere

A thin layer on and around the earth which sustains life is called **biosphere**. Life exists in the diverse forms of living organisms. All these living organisms of the biosphere are directly or indirectly dependent on one another as well as on the physical components of the earth. The three physical components of the earth are **atmosphere**, **lithosphere** and **hydrosphere** (air, land and water).

The **atmosphere** is a gaseous envelope surrounding the earth's surface, It is made up of nitrogen, oxygen, carbon dioxide and many other gases in very small amounts.



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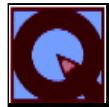
Hydrosphere is all the water supply to the earth which exists as liquid, vapour or frozen form of fresh and salt water.

Lithosphere comprises the soil and rock of the earth’s crust.

Recently the term **ecosphere** is being used more commonly. It is used to denote biosphere (living components) along with its three abiotic components –atmosphere, hydrosphere and lithosphere of the earth as one entity (unit).

Ecosphere = Biosphere + Lithosphere + Hydrosphere + Atmosphere

*In fact **ecosphere** is the largest worldwide ecosystem. Ecosphere is very huge and can not be studied as a single entity. It is divided into many distinct functional units called ecosystem.*



INTEXT QUESTIONS 24.1

1. Who coined the term ecology?
.....
2. Name the various levels of organizations.
.....
3. Define the term ecology.
.....
4. What the three physical systems that support life on earth?
.....

24.2 COMPONENTS OF THE ENVIRONMENT

The environment has two basic components

- (A) Abiotic (B) Biotic

(A) Abiotic Components (Nonliving) : They can be classified into following two categories

1. Physical components : They are the various climatic characteristics such as light, temperature, humidity precipitation, pressure and soil profile. These factors sustain and control the growth of organisms in an ecosystem. Deficiency or excess of any one of these is harmful for their growth.

2. Chemical components

- (a) **Inorganic components** : Substances such as carbon, carbon dioxide, nitrogen, oxygen, phosphorus sulphur, zinc, water and many other minerals are the inorganic nutrients required by all living beings. They may be classified into the micronutrients and macronutrients.. The essential inorganic elements such as carbon, hydrogen, nitrogen, phosphorus, calcium, potassium which are required in large quantities are called macronutrients. The essential elements required in small amounts are the micronutrients e.g. zinc, boron and magnesium. Sources of all nutrients for plants are air, water and soil. All these nutrients are converted into the living biomass by the plants.

- (b) **Organic components** : The complex molecules such as carbohydrates, proteins and lipids are the organic substances in an ecosystem. These substances when out side the organism make the abiotic component but in the living organism they make an important component of the biomass. They make a link between the biotic and abiotic components.



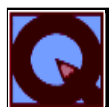
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(B) Biotic Components (living)

The living organisms form the biotic component of the environment. All the living things require energy for their life processes and material for formation and maintenance of their body structure. Food meets both these requirements.

The biotic components can be classified as producers, consumers and decomposers.

1. **Producers** : Only plants are capable of capturing solar energy and transforming it into food energy for all the other living organisms. Therefore, they are called as producers. These plants are also named as autotrophs since they make their own food.
2. **Consumers** : Animals depend upon the plants directly or indirectly for their food and are called consumers. Their mode of nutrition is called heterotrophic. Consumers can be herbivores, carnivorous, omnivorous, parasitic or scavengers as described later in this lesson.
3. **Decomposers** : They feed on dead and decaying animals and plants. They are small microscopic organisms and help in recycling of nutrients in the environment.



INTEXT QUESTIONS 24.2

1. Name the major components of the environment.
.....
2. Enumerate the various physical factors of the environment
.....
3. What is the role of decomposer in nature?
.....
4. Why are plants called autotroph and animals called heterotrophs?
.....

24.3 ECOSYSTEM

Ecosystem is a self sustaining unit of nature. It is defined as a functionally independent unit (of nature) where living organisms interact among themselves as well as with their physical environment. In nature two major categories of ecosystem exist : **terrestrial** and **aquatic**.

Forests, deserts and grasslands are examples of terrestrial ecosystem.



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Ponds, lakes, wet lands and salt water are some example of aquatic ecosystem. Crop lands and aquarium are the example of man made ecosystems.

The interaction between the living organisms and their environment can be studied in a puddle of water or a hole in a tree, which are very small ecosystems or in large ecosystems such a forest, river or ocean. Irrespective of their sizes all ecosystems share many common characteristics. Let us study moderate sized pond ecosystem to understand its structural and functional components.

In the Fig. 24.2 (pond ecosystem), you can see that it is a shallow body of water. Sun's light can penetrate into it. It has sediment as a substrate at the bottom that is a source of nutrition for living organisms. The living organisms in it are small floating plants, submerged vegetation and rooted plants. There are animals of various sizes ranging from microscopic to large fishes. All these components of the pond ecosystem can be arranged to give it a definite structure.

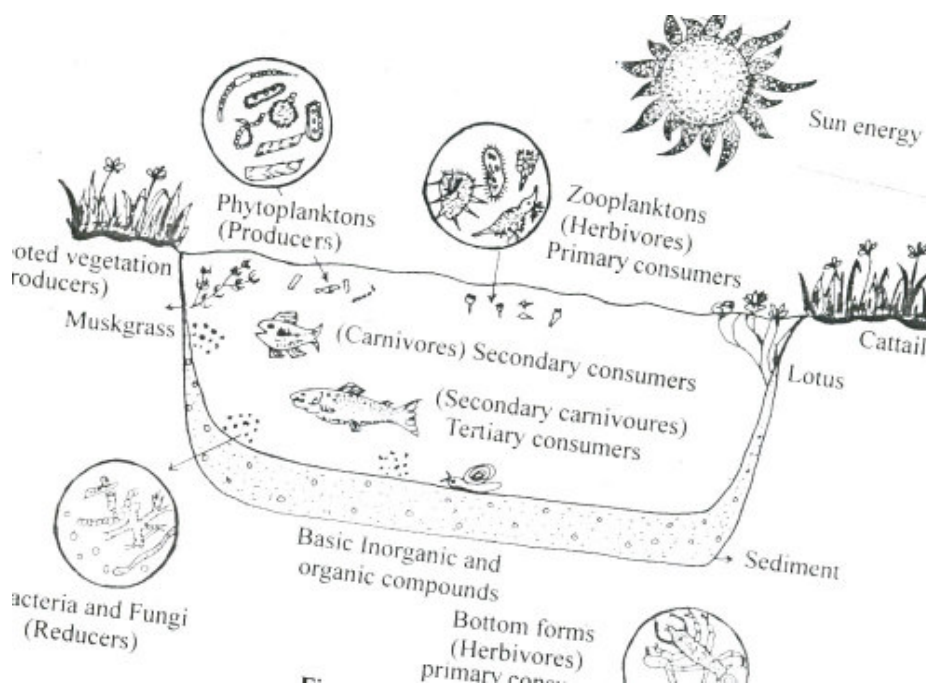


Fig. 24.2 Pond ecosystem

24.3.1 Structure of Pond Ecosystem

Abiotic Components

1. **Physical or climatic regime** : Pond receives solar radiation, which provides it heat and light energy to sustain life.

- (a) **Light** : In case of shallow ponds with clear water sun light can penetrate up to the bottom . In deep ponds penetration of light depends on the transparency of water The amount of dissolved/suspended particles, nutrients and number of animals and plants determine the transparency of water and control the penetration of light in it.

- (b) **Temperature** : Heating effect of solar radiation leads to diurnal (day and night) or seasonal temperature cycles. In the tropical regions there are not much temperature variations. At higher latitudes there are remarkable seasonal temperature variations.
- Inorganic substances** : These are water, carbon, nitrogen, phosphorus, calcium and a few other elements like sulphur or phosphorus depending on the location of the pond. O_2 and CO_2 are in the dissolved state in water. All animals and plants depend on water for their food and exchange of gases.
 - Organic compounds** : The commonly found organic matter in the pond is amino acids and humic acids and the breakdown products of dead animal and plant tissues. They are partly dissolved in water and the remaining are accumulated in sediment.

Biotic Components

- Producers or Autotrophs** : They synthesize food for all the heterotrophs of the pond. They are of the following two types.
 - Floating plants
 - Rooted plants
 - Floating plants** : They are called **phytoplankton** (“phyto”- plants, “plankton” - floating.) for example, *Spirogyra*, *Ulothrix*, diatoms and *Volvox*.
 - Rooted plants** : These plants occur in concentric layers from periphery to the deeper zones. Some examples of rooted plants are *Typha bulrushes*, *Sagittaria*, *Hydrilla*, *Rupia*, *Chara*.
- Consumers or Heterotrophs** : Animals, which feed directly on autotrophs (e.g. insect larvae, tadpole, snails) or on other animals (sunfish and bass)
- Decomposers** : They are distributed in the whole pond but are most abundant at the bottom of the pond in the sediment e.g. bacteria and many different types of microbes.



INTEXT QUESTIONS 24.3

- Define an ecosystem.
.....
- What are the main components of an ecosystem?
.....
- Give reason, why are decomposers necessary in an ecosystem?
.....

24.4 ECOSYSTEM : STRUCTURE AND FUNCTION

You have already learnt that ecosystem are capable of persisting as independent units of nature. In the following part of the lesson you will learn about the structure



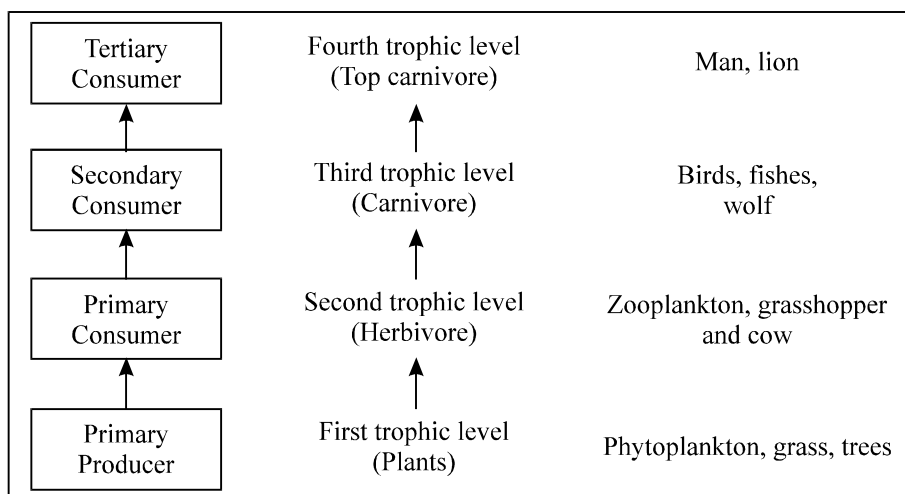
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and functions of ecosystem. Interaction biotic and abiotic components result in a physical structure characteristic of each type of ecosystem. The important structural features are **species composition** (types of plants and animals) and **stratification** (vertical and horizontal distribution of various species occupying different levels). Another way of looking at the structural components is through food relationships of producers and consumers. Several **trophic levels** exist in the ecosystem. These feeding relationships can be studied as food chain, food web and standing crops. These structural components function as a unit and produce certain functional aspects of ecosystem. Some these aspects are :

- Productivity, energy flow, nutrient cycle



Diagrammatic representation of trophic levels in an ecosystem

24.1.1 Species Composition

A community is an assemblage of many populations that are living together at the same place and time. For example a tropical forest community consists of trees, vines, herbs and shrubs along with large number of different species of animals. This is known as species composition of tropical forest ecosystem. Each ecosystem has its own species composition depending upon the suitability of its habitat and climate. If you compare animal and plant populations of a forest they are entirely different from that of a grass land. Not only the types of species are different in these two ecosystems even their total number and biomass varies. A forest ecosystem supports much larger number of species of plants and animals than a grassland. The total number and types of species in a community determine its stability and **ecosystem balance** (ecosystem equilibrium).

24.5.4 Stratification

The vertical and horizontal distribution of plants in the ecosystem is called **ecosystem stratification**. You would have observed that the plants are of different heights in forests. Tallest trees make the top canopy. This is followed by short trees and shrubs and then the forest floor is covered with herbs and grasses. Some burrowing animals live underground in their tunnels or on the roots of the plants.

Each layer from the tree top to the forest floor has its characteristic fauna and flora. This is termed as vertical stratification of forest ecosystem. On the other hand desert ecosystem shows low discontinuous layers of scant vegetation and animals with some bare patches of soil showing a type of horizontal stratification.

24.4.3 Food Chain

Transfer of food from the plants (producers) through a series of organisms with repeated eating and being eaten is called a food chain e.g.

Grasses → Grasshopper → Frogs → Snakes → Hawk/Eagle
 1 2 3 4 5

1. Each step in the food chain is called trophic level. In the above example grasses are first and eagle represents the fifth trophic level.
2. Some more examples of food chain are given in Fig. 24.3.

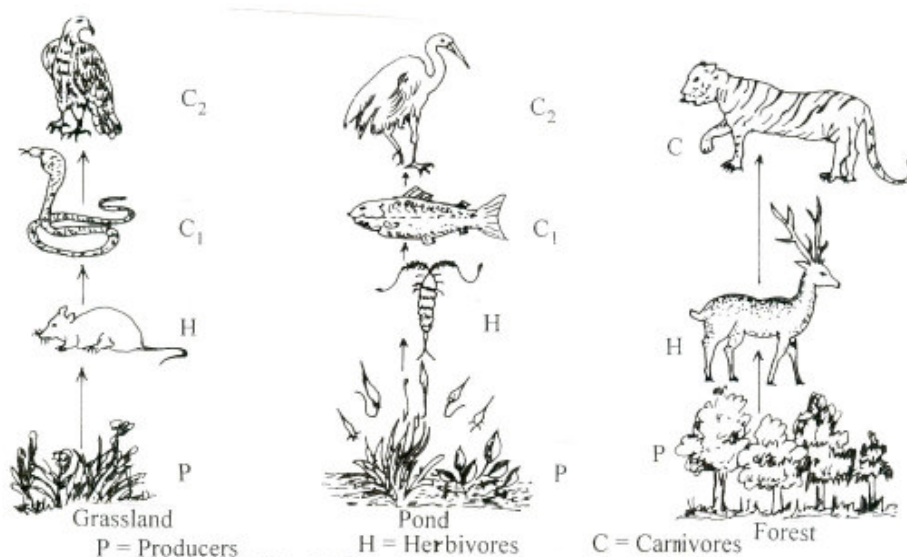


Fig. 24.3 Some examples of food chain.

Three important features that you can note in these chains are :

- Weaker organisms are attacked by the stronger organisms
- Number of organisms is reduced at each higher level but the size of organisms is increases.
- The number of steps in a food chain is limited to 4-5.

A. A food chain consists of the following trophic levels :

- (i) **(Producers) Autotrophs :** They produce food for all other organisms of the ecosystem. Autotrophs represent the first trophic level. They are largely green plants they convert inorganic substances by the process of photosynthesis into food (organic molecules) in the presence of sun light. The total rate at which the radiant energy is stored by the process of photosynthesis in the green plants is called Gross Primary Productivity (GPP). This is also known as total photosynthesis. A part of the gross primary productivity is utilized by the



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plants for their own metabolism, maintenance and reproduction. Energy required for all these functions is produced by the process of respiration. The remaining is stored by them as Net Primary Productivity (NPP) and is available to the heterotrophs or consumers, (The next trophic level)

$$GPP = NPP + R \quad \text{or} \quad GPP - R = NPP$$

Productivity in the biological system is a continuous process but it is different in different ecosystems.

- (ii) **Primary consumers Herbivores** : These are animals which feed directly on the plants. They are first level consumers and therefore they are also known as primary consumers and make the second trophic level in the food chain e.g. grasshopper in the above example. Other examples are insects, birds, rodents and ruminants. Herbivores are capable of converting energy stored in the plant tissue into animal tissue and therefore they are also known as key industry. They can digest high cellulose diet.
- (iii) **Secondary consumer Carnivores** : Carnivores are the animals that feed on other animals or its tissues. Therefore they are secondary, tertiary or quaternary level consumers. Frog is secondary level consumers as it feeds on herbivorous grasshopper. Snake is tertiary level consumer since it consumes other carnivore that is frog. Frog, snake, dog, cat and tiger are all carnivores. Generally the size of the carnivore/ increases at each trophic level.
- (iv) **Decomposers** : They make up the final trophic level in a food chain. Decomposers are the organisms that feed on dead organic matter called detritus of all the trophic levels and help in recycling the nutrients. They can be grouped into two classes: microdecomposers and macrodecomposers. Microdecomposers are very small microscopic organisms like bacteria, fungi, and protozoans. Macrodecomposers are large but less in number. They are visible to the naked eye e.g. springtails, mites, millipedes, earthworms, nematodes, slugs, crabs and molluscs.

Special feeding groups (Consumers)

- (i) **Scavengers** : These are the animals that feed on the dead plants and animals. e.g. termites and beetles feed on the decaying wood, and many marine invertebrates. Vultures, gulls and hyena are other examples of scavengers.
- (ii) **Omnivores** : Omnivores consume both plants and animals as source of their food e.g. human beings. Some of the omnivores like the red fox feeds on berries small rodents as well as on dead animals. Thus it is a herbivore, carnivore and also a scavenger.
- (iii) **Parasites** : They live and feed on/in other living organisms called *host*. Parasites not only feed on their host but they also cause lethal or nonlethal disease in it.

B. Position of human beings in the food chain ; Human beings are consumers and may occupy

Primary, secondary or tertiary levels. Vegetarian people are 'primary consumers; when they consume small fish chicken or goat meat they are 'secondary'



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consumers and when they consume big fishes they are ‘tertiary’ consumers. Can you explain why big fishes feed upon small fishes and other smaller aquatic animals?

24.4.4 Food Web

In nature the food chains are not isolated sequences but they are interconnected with one another. A net work of food chains which are interconnected at various trophic levels of the food chain to form a number of feeding connections is called a food web. In a food web one trophic level may be connected to more than one food chain. A snake can feed on frog or rat or any other small rodent. In the figure given below sunfish consumes zooplanktons as well as bloodworms.

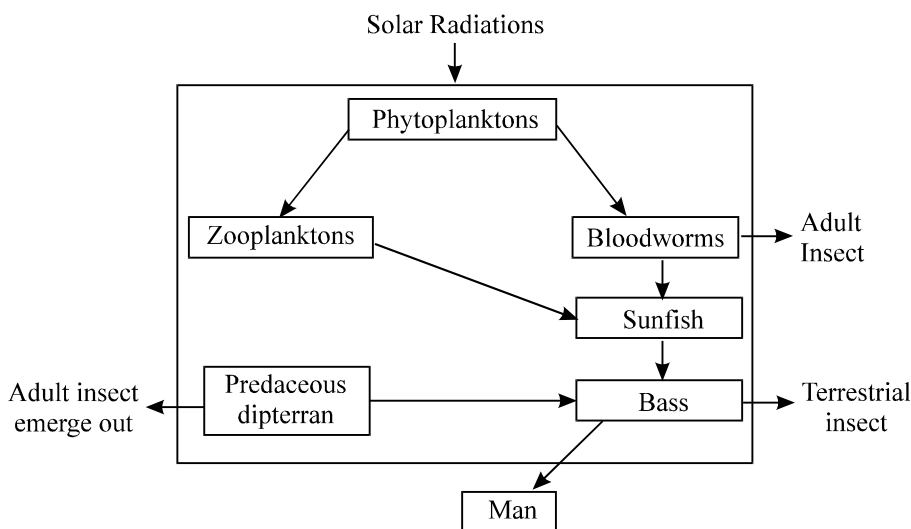
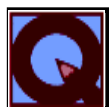


Fig 24.4 Simple food web in a pond ecosystem.(modified from Odum)



INTEXT QUESTIONS 24.4

1. Give one example of food chain.
.....
2. Name the trophic level frog belongs to.
.....
3. Snake can be both a secondary as well are tertiary consumer justify.
.....

24.4.5 Energy flow through an ecosystem

The energy enters into the ecosystem in the form of solar radiation and is converted into food (plant biomass) by the producers. Food stored by the plants and their biomass (matter) is the chemical form of energy. From the producers this chemical form of energy passes through various trophic levels in the food chain. This process of transfer of energy through various trophic levels of the food chain is known as flow of energy.



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All the functions of ecosystem depends on the flow of energy through it. In figure 24.5, boxes represent the trophic level and the pipes depict the energy flow in and out of each trophic level. The quantity of energy flowing through the successive trophic levels decreases as indicated by the reduced size of the boxes and thickness of pipes in the figure. This is because all the energy entering at each trophic level is not used for production of biomass due to the following two reasons.

- Firstly a part of the energy is lost (not utilized).
- Secondly a part of it is used up by the organisms for their own metabolism through the process of respiration.

If herbivores consumes 1000 kcal. of plant energy in the form of food, only 100 kcal. is converted into herbivore tissues, and 10 kcal. into first level carnivore and only 1 kcal into second level carnivore. This is known as 10% law (or ecological rule of thumb) where by only 10% of the energy is transferred to the next higher trophic level.

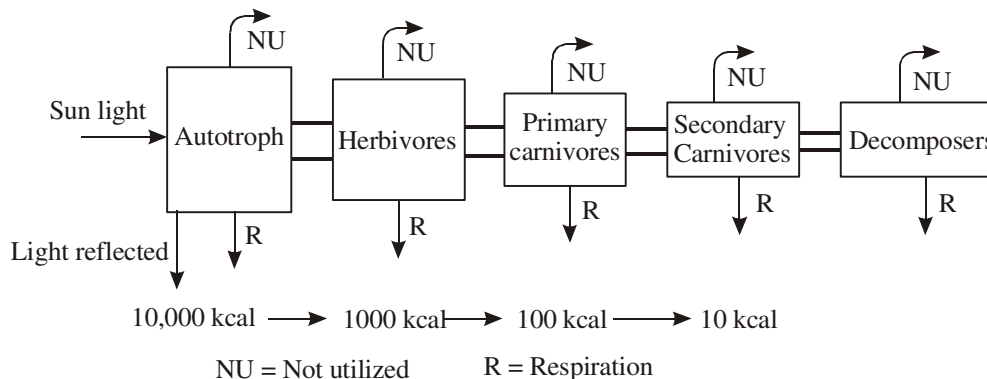


Fig. 24.5 Energy flow in a ecosystem. Boxes indicate the standing crop biomass and pipes indicate the energy flowing

The entire process of energy flow can be summarized in the following four steps:

- The flow of energy in an ecosystem is always linear or one-way.
- At every step in a food chain the energy received by the organism is also used for its own metabolism and maintenance. The left over is passed to next higher trophic level. Thus energy flow decreases with successive trophic levels.
- It follows the ecological thumb rule of 10%.
- The number of steps is limited to four or five in a food chain for the transfer of energy.

24.4.6 Ecological Pyramids Standing Crop

Standing crop is the amount of biomass or energy present in different trophic levels at any given time. This is another important characteristic of an ecosystem. It can be expressed in terms of

- biomass,
- number or
- total energy fixed at each step at each trophic level.



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These three parameters give a definite trophic structure to the ecosystem. It is represented with the producers at the base and the subsequent trophic levels as the tiers. This gives a gradually sloping pyramidal shape.

This graphical representation of the standing crop expressed as number, biomass or energy is called pyramid of number, pyramid of biomass and pyramid of energy respectively. Collectively they are known as ecological pyramids. Some examples of pyramids are given below :

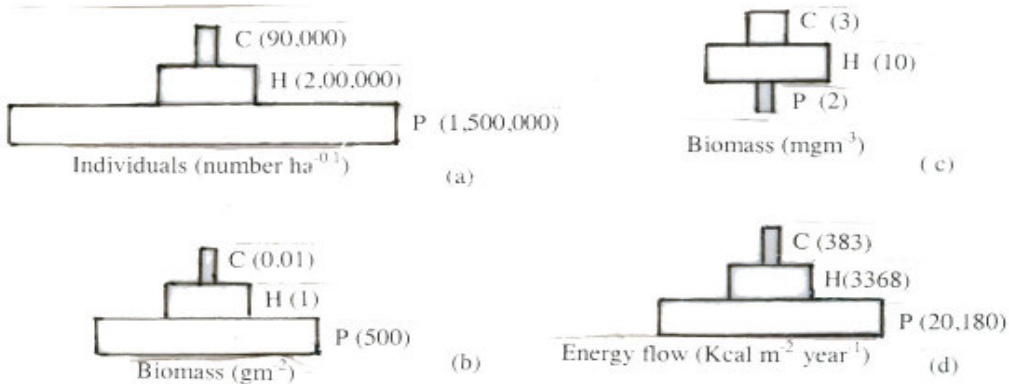


Fig. 24.6 Ecological Pyramids (P = producer; C1 Herbivores; C2 Primary carnivores; C3 secondary carnivores)



INTEXT QUESTIONS 24.5

1. What can be the maximum number of steps in a food chain?
.....
2. Why is energy flow linear in ecosystem?
.....
3. Define : (a) biomass (b) pyramid of number.
.....
4. What is meant by community stratification?
.....

24.5 TYPES OF ECOSYSTEMS – NATURAL AND HUMAN MODIFIED

You have already learnt about the components, structure and functions of an ecosystem. Now you can easily identify and study a few ecosystems around you. Ecosystems are classified as natural and human modified depending upon whether they are fully dependent on the solar radiation and other natural sources of energy or on fertilizers and fossil fuels. Natural ecosystems are such as ponds, lakes, meadows, marshlands, grasslands, desert and forests. They are our natural resources and provide us food, fuel, fodder and medicines. Human modified ecosystem are made and managed by human beings for their better living. Urban ecosystem, rural



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ecosystem, agro-ecosystems, aquaculture and spaceship are some examples of the human modified ecosystems.

24.6 BIOMES

When you travel long distances in a train from one part of the country to the other you enjoy watching outside. Your train passes through the thick forests, grasslands deserts, croplands and some times mountains. If you look at the earth from a distance it shows beautiful kaleidoscopic patterns. All these patterns are because of the different types of plants that grow in these regions. The plant growth is determined by physical, edaphic and geographical characteristics of a place. These are the natural broad biotic zones of the biosphere called, **Biomes**. Each biome is characterized by uniform life form of vegetation such as grass, desert plants, deciduous trees or coniferous trees. A Biome is a large ecosystem which is embracing the large land scape, characterised by specific flora and fauna. Biomes can be classified as :

- A. Terrestrial :** These are the biomes found on land e.g., Tundra, forest, deserts, grasslands
- B. Aquatic.** These are the biomes found in water. These can be :
- (i) Fresh waters, such as pond, lake and river
 - (ii) Marine as oceans, shallow sea

24.6.1 Terrestrial Biomes

A. Forests : Forests are one of the largest plant formations, densely packed with tall and big trees. Forests are of many different types, depending on the climatic regime in which they are found. Three main forest types are:

1. Tropical rain forests
2. Temperate deciduous forests
3. Boreal or north coniferous forests

1. Tropical Rain (Ever green) Forest : These are in the tropical region showing very high rain fall. These forests occur between tropics of cancer and capricorn. Such forests are well developed over the western coast of India and North eastern Himalayas and scattered in south east Asia, west Africa and north cost of South America.

Main characteristics

- Temperature and light intensity are very high
- Rain fall is greater than 200 cm. per year.
- Soil of these regions is rich in humus,
- The rate of **turn over** of the nutrients is very high leading to high productivity and have highest standing crop and biomass.

- The vegetation includes broad evergreen trees of about 200 feet like bamboos, ferns, shrub etc. Epiphytes and woody vines (liannas) are also abundant. Many tree species show buttresses (swollen stem bases) and leaves with drip tips.

These forests have rich invertebrate and vertebrate fauna. Snails, centipedes, millipedes and many insect species are common near the forest floor. *Rhacophorus* (lying frog), aquatic reptiles, *Chameleon* and many birds are common in these forests. Mammals of these forests are sloths, monkeys, ant eaters, leopards, jungle cats and giant flying squirrels.

- 2. Temperate Deciduous Forests :** Trees of deciduous forests shed their leaves in autumn and a new foliage grows in spring. They occur mostly in northwest, central and eastern Europe, eastern north America, north China, Korea, Japan, far eastern Russia and Australia.

Climate : These forests occur in the areas of moderate climatic conditions such as

- Annual rainfall is 75 to 150 cm
- Winter lasts for four to six months.
- Temperature ranges between 10 to 20°C.
- Soil is brown and rich in nutrients.

Flora and fauna : Commonly found trees in this ecosystem are oak, birch, heath, hickory, bass wood, chest nuts, pitch pine, cypress. Invertebrate fauna comprises green oak moth, bark beetle, green flies, aphids, sapflies, moths and butterflies. Prominent grazers are grass eating rodents, deer and bison. Rodents play a very important role in these forests. They feed on the seeds, fruits and leaves of the trees and consume much more food than the large sized grazers. Common carnivores in temperate forests are wild cat, wolves, foxes, tawny owl and sparrow hawk. Black bear, raccoons and skunks are the omnivorous animals of these forests.

- 3. Coniferous forests :** Coniferous forests are also known as **Taiga** or **Boreal** forests. They extend as a continuous belt across north America and north Eurasia below the arctic tundra. In the Himalayas, these are distributed above 1700 to 3000 metre altitude. They also occur at high altitude below the alpine tundra and tree line.

Climate : Climate is cold.

- Long and harsh Winters is for more than six months. Mean annual temperature is below 0°C,
- Soil is poor in nutrients and acidic in nature.

Flora and fauna : Coniferous forests are characterized by conifers (gymnosperms). They are evergreen, drought resistant and woody. In many species the canopy is cone shaped. The common species of trees of these forests are Spruce, fir and pine trees. The productivity is much less than other



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ecosystem. There are very few animals in these forests. The herbivores are red squirrel, deer, goat, mule, moose etc. The carnivores are timber wolves, lynxes, wolverine, weasels mink and bear. Some common birds are cross bill, thrushes, warblers, flycatchers, robin and sparrow.

B. Grasslands

Distribution : Grasslands are dominated by the grasses. They occupy about 20% of the land on earth's surface. They occur in both tropical and temperate regions where environmental conditions are better than that of the desert but rainfall is not enough to support the growth of trees. Grasslands represent an ecotone (a zone in between two ecosystems) and are found between forest on one side and deserts on the other. They are subjected to greater variation of temperature, moisture, wind and light intensity of the sun.. Grasslands are known by various names in different parts of the world. For example they are called prairies, steppes, savannas and pampas.

Tropical grasslands are commonly called Savannas. They occur in eastern Africa South America, Australia and India. Savannas form a complex ecosystem as they contain grasses with groups of trees. Soil of grassland is rich and fertile.

Flora and fauna : Grasses are the dominating plants with scattered drought resistant trees in the tropical grasslands. The height of grasses ranges from 0.2 to 3 meters depending upon the annual rain fall Trees are less than 10 m in height. Animals are very much reduced in grasslands because there is no shelter. The large herbivores of this biome are bison, proghorn (North America) wild horse, ass, saiga (Eurasia) , zebra and antelope (South Africa). Carnivores are quite small in number and size They are coyotes, weasels, badgers foxes and ferrets . Hawks, lark sparrows, warblers, Great Indian Bustard and peafowl are the common birds found in grassland. Grasslands are very rich in reptilian and insect fauna.

C. Deserts

Distribution : Deserts are waterless barren regions of the earth. They occupy about one-seventh of the land on earth's surface. Deserts form an extreme condition in sequence of ecosystems with respect to the climatic condition . They occur in two belts that encircle the northern and southern hemispheres roughly centered over the tropics of Cancer and Capricorn. Sahara deserts of Africa are the largest. Indian Thar deserts are an extensions of Sahara deserts through Arabian and Persian deserts.

Climate:

- Annual rain fall is very little. It may be less than 25 cm per annum. At some places if it is high it is unevenly distributed.
- Temperature may be very high in subtropical deserts and very low in cold deserts e.g. Ladakh.
- Winds have high velocity.

Flora and fauna : Cacti, *Acacia*, *Euphorbia* and prickly pears are some of the common desert plants. Desert animals are insects, reptiles, and burrowing rodents. Desert shrew, fox, kangaroo, wood rat, rabbit, armadillo are common mammals in desert. Camel is known as the ship of the desert as it can travel long distances without drinking water for several days.

D. Tundra

The word tundra means a “barren land” since they are found in those regions of the world where environmental conditions are very severe. There are two types of tundra **arctic** and **alpine**.

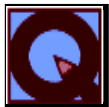
Distribution

- **Arctic tundra** extend as a continuous belt below the polar ice cap and above the tree line on the northern hemisphere. It occupies the northern fringe of Canada Alaska, European Russia, Siberia and island group of arctic ocean.
- **Alpine tundra** occur at high mountain peaks above the tree line. Since mountains are found at all latitudes therefore alpine tundra show day and night temperature variations

Climate

- A permanently frozen subsoil called **permafrost** is found in the arctic and antarctic tundra. The summer temperature may be around 15°C and in winter it may be as low as -57°C in arctic tundra A very low precipitation of less than 400 mm per year
- A short vegetation period of generally less than 50 days between spring and autumn frost
- Productivity is low

Flora and fauna : Typical vegetation of arctic tundra is cotton grass, sedges, dwarf heath, willows birches, and lichens. Animals of tundra are hurepian reindeer, musk ox, arctic hare, caribous, lemmings and squirrel. Their body is covered with fur for insulation, Insects have short life cycles which are completed during favourable period of the year.



INTEXT QUESTIONS 24.6

1. Define alpine tundra ecosystems.
.....
2. Give two examples of plants of tundra.
.....
3. Give two common characteristics of tundra and desert biome.
.....



Notes



Notes

4. Names of three main types of forests.
.....
5. Where are savannas found?
.....
6. What are deciduous trees?
.....

24.6.2 Aquatic Biomes

Aquatic ecosystems are constituted by water bodies . Water covers about one third of the earth’s surface. Origin of life took place in aquatic ecosystem. Therefore, these ecosystems make an important component of our biosphere. Aquatic ecosystems are classified on the basis of salinity into following two types:

1. Freshwater
2. Marine

1. Fresh Water Ecosystem

Water on land which is continuously cycling and has low salt content is known as fresh water. The study of fresh water ecosystem is known as **limnology**. Fresh waters are classified into two types:

- (i) Standing or still water (**Lentic**) e.g. pond, lake, bogs and swamps.
- (ii) Running water (**Lotic**) e.g.. springs, mountain brooks, streams and rivers.

Commonly found flora in ponds and lakes include

- (i) Phytoplankton (freely floating microscopic plants) such as algae, diatoms
- (ii) Floating plant : *Pistia*, water hyacinth, *lemma*, *Azolla*
- (iii) Rooted plant : Hydrilla, vallisnaria, lotus, trapa and water lily.

The common animals in ponds and lakes include

- (i) Zooplankton (freely floating microscopic animals) such a protozoans and crustaceans;
- (ii) Actively swimming fishes, frogs, tortoises.
- (iii) Bottom dwellers like hydra, worms, prawns crabs, snails.
- (iv) Birds such as herons, water fowls and ducks occurs in and around water.

Wetlands are between aquatic and terrestrial ecosystem *They show an edge effect and form a ecotone. Ecotone is a transitional zone between two ecosystems like terrestrial and land.* Examples of wet zone are swamps, marshes and mangroves.

2. Marine Ecosystem

Distribution : Marine ecosystem covers nearly 71 % of the earth’s surface with an average depth of about 4000 m. Fresh water rivers eventually empty into ocean.

Salinity of open sea is 3.6 percent and is quite constant. Sodium and chlorine make up nearly 86 percent of the sea salt and the rest is due to other elements such as sulphur, magnesium, potassium and calcium.

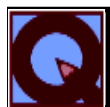
Temperature : The range of temperature variation is much less in sea than on the land although near the surface it is considerable from -2°C in antarctic ocean to 27°C in the warmer waters of pacific ocean. In the deeper layers temperature is constant at about 2°C .

Light : The light reaches up to a certain depth only. Deeper regions are permanently dark.

Pressure : Pressure increases with depth in oceans. It is 1 atmosphere near the surface and 1000 atmospheres at greatest depth.

Tides : The gravitational pulls of the sun and the moon cause tides in oceans. At the time of full moon and new moon tides are high and are called **spring tides**. At quarter moon the tides are exceptionally low and are known as low tide or **neap tides**.

Flora and fauna : Life in the oceans is limited but its biodiversity is very high as compared to terrestrial ecosystems. Almost every major group of animals occur somewhere or the other in the sea, except for insects and vascular plants which are completely absent in marine ecosystem.



INTEXT QUESTIONS 24.7

1. What are plankton?
.....
2. Name two phytoplanktons and two bottom dwellers in fresh water ecosystem.
.....
3. What is the maximum pressure in ocean.
.....
4. Give an example of (a) wet land (b) lotic type of ecosystem.
.....

24.7 BIOGEOCHEMICAL CYCLES

You have already learnt that living organisms required several chemical elements for their life processes. They may be used as part of their structural component or as parts of enzymes which influence various life processes unlike energy which flows unidirectionally, nutrients are continuously exchanged between the organisms and their physical environment.

(“Bio” - living, “Geo” - rock, “Chemical” - element). The cycling of the nutrients in the biosphere is called **biogeochemical or nutrient cycle**. It involves movement of nutrient elements through the various components of an ecosystem. There are more than 40 elements required for the various life processes by plants and animals.



Notes



Notes

These elements are continuously cycling in the ecosystem through the biogeochemical cycles and the planet earth has no input of these nutrients. The nutrients (matter) from the dead remains of organisms are recovered and made available to the producers by decomposers. Thus the nutrients are never lost from the ecosystems.

There are two important components of a biogeochemical cycle :

1. **Reservoir pool** : Where atmosphere or rock large stores of nutrient are present e.g. Bulk of nutrients are stored in these abiotic reservoirs.
2. **Cycling pool** : Plants and animals make the cycling pool. They are relatively short-term stores and form only a smaller active fraction of the nutrient in the biosphere. On the basis of the type of reservoir these cycles are classified into two types :
 - (i) **Sedimentary cycles** : In these cycles main reservoir is rock or soil (lithosphere) e.g. Sulphur and phosphorus cycle
 - (ii) **Gaseous cycles** : Atmosphere is the main reservoir in gaseous cycles. Those nutrients that have a prominent gas phase e.g. nitrogen and carbon show this type of cycle. The nutrients are replaced in them as fast as they are utilized. You can understand the events of a biogeochemical cycle from the following two examples

A. Carbon cycle

Atmospheric carbon dioxide is the source of all carbon in both living organisms as well as in the fossils (used as fossil fuel). It is highly soluble in water. Oceans also contain large quantities of dissolved carbon dioxide and bicarbonates.

The carbon cycle comprises the following processes

Photosynthesis

Terrestrial and aquatic plants utilize CO_2 for photosynthesis. Through this process the inorganic form of carbon is converted into organic matter in the presence of sunlight and chlorophyll. The carbon dioxide is thus fixed and assimilated by plants. It is partly used by them for their own life processes and the rest is stored as their biomass which is available to the heterotrophs as food.

Respiration

Respiration is a metabolic process reverse of photosynthesis in which food is oxidized to liberate energy (to perform the various life processes) and carbon dioxide and water. Thus the carbon dioxide of the atmosphere is recovered through this process.

Decomposition

After the death of the organisms the decomposers break down the remaining dead organic matter and release the left over carbon back into the atmosphere.



Notes

Combustion

Fossil fuel such as crude oil, coal, natural gas or heavy oils on burning releases carbon dioxide and carbon monoxide into the atmosphere. Forests make a large amount of fossil fuel. *Fossil fuel is product of complete or partial decomposition of plants and animals as a result of exposure to heat and pressure in the earth's crust over millions of years.*

Forests also act like carbon reservoirs as carbon fixed by them cycles very slowly due to their long life. They release CO₂ by forest fires.

Impact of human activities

Carbon dioxide is continuously increasing in the atmosphere due to human activities such as industrialization, urbanization and increased use of automobiles. This increase in atmospheric CO₂ is bading to green house effect and global warming.

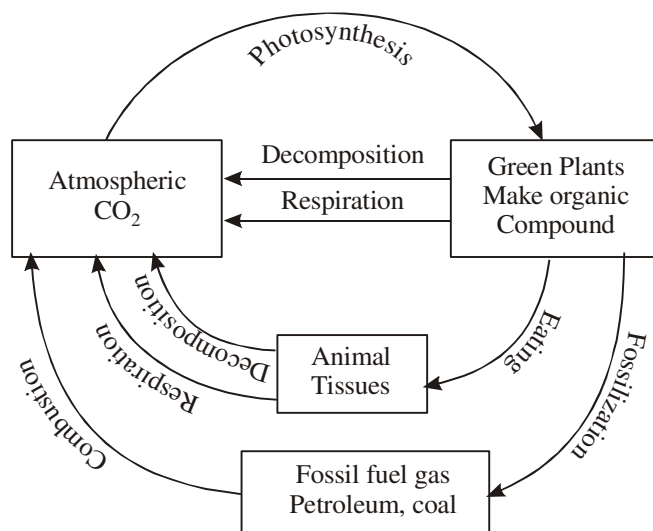


Fig. 24.7 Carbon cycle

(Arrows indicate the processes of the carbon cycle and compartments are the sites of these processes or the store houses of carbon in the reservoir pool and ecosystem)

B. Water cycle

This is also known as hydrologic cycle. You have already studied that earth is a watery planet of the solar system but a very small fraction of this is available to animals and plants. Water is not evenly distributed throughout the surface of the earth. Major % of the total water on the earth is chemically bound to rocks and does not cycle. Out of the remaining, nearly 97.3% is in the oceans and 2.1% exists as polar ice caps. Thus only 0.6% is present as fresh water in, the form of atmospheric water vapors, ground and soil water. The ice caps and the water deep in the oceans form the reservoir.

Solar radiation and earth's gravitational pull are the main driving forces of water cycle.



Notes

Evaporation, condensation and precipitation are the main processes involved in water cycle these processes alternate with each other

Water from oceans, lakes, ponds, rivers, streams and soil surface evaporates by sun's heat energy. Plants also transpire huge amounts of water through their leaves. Water remains in the vapour state in air and forms clouds, which drift with the wind. Clouds meet with the cold air in the mountainous regions above the forests and condense to form rain, which falls due to gravity.

Evaporation from Oceans, Earth and Leaf Surface

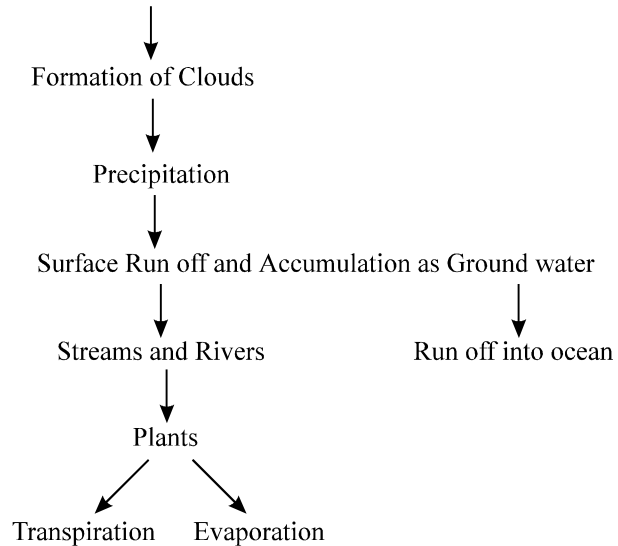
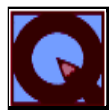


Fig. 24.8 Water cycle

On an average 84% of the water is lost from the surface of the oceans by evaporation. While 77% is gained by it from precipitation. The remaining 7% of the ocean evaporation is balanced by water run off through the rivers from the land. Because on land evaporation is 16% and precipitation is 23%.



INTEXT QUESTIONS 24.8

1. Define nutrient cycle.
.....
2. Where are the bulk of nutrient stored in an ecosystem?
.....
3. Name the nutrient cycle where atmosphere acts as the main reservoir.
.....
4. List any two human activities that have led to increase in atmospheric CO₂.
.....
5. Name the reservoirs for water cycle.
.....



WHAT YOU HAVE LEARNT

- Earth is only planet to support life. Earth provides soil, water and air to support it.
- Environment is defined as the physical, chemical and biotic conditions that surround and influence on living organisms.
- The abiotic components of environment are temperature, light, humidity, precipitation, wind minerals and the composition of air.
- Biotic components include plants, animals and microorganisms.
- Ecology defined as the study of relationship between organism and their environment. Ecology deals with various form of interaction between the organisms and their environment.
- The levels of organisation is the living system starts from genes to community.
- The three physical components of earth are atmosphere, lithosphere and hydrosphere.
- Ecosystem is defined as functionally independent unit of nature where living organisms interact among themselves as well as with their physical environment.
- Terrestrial and aquatic ecosystems are the two categories of natural ecosystems croplands and aquarium are the examples of artificial ecosystem.
- Light temperature, inorganic and organic compounds constitute the abiotic components of ecosystem whereas produces consumers and decomposer are its biotic components.
- These biotic components of ecosystem interact with each other go give a physical character. These represents structural features of an ecosystem to an ecosystem.
- The important structural features of an ecosystem may be represented by its species composition, stratification, food relationship (trophic level, food chain and food web).
- The structural components interact in a unit and produce certain functional aspects of an ecosystem such as productivity, energy flow and nutrient cycle etc.
- Humans occupy both primary and secondary levels of consumers.
- Transfer of food from the plants (producers) through a series of organisms with repeated eating and being eaten is called food chain.
- A network of a connected food chains interrelated form a food web.
- The process of transfer of energy through various trophic levels of the food chain is known as flow of energy.



Notes



Notes

- The quantity of energy flowing through the successive trophic level decreases. This is because a part of the energy is lost and a part of energy used by the organism for its metabolism.
- Only 10% of the energy that enters the trophic level is transferred to the next trophic level. This is known as 10% law. The flow of energy in an ecosystem is always linear.
- The number of trophic level in a food chain is limited in number (4 or 5).
- The graphical representation of standing crop expressed as number biomass or energy is called pyramid of number. Pyramid of biomass and pyramid of energy respectively. These are collectively known as ecological pyramid.
- A biome is a large ecosystem which is embracing the large landscape. Each biome is characterised by a specific flora and fauna.
- The cycling of the nutrients in the biosphere is called biogeochemical or nutrient cycle. Carbon cycle and water cycle are two such examples.
- Photosynthesis, respiration, decomposition and combustion are the important processes in carbon cycle.
- Evaporation, condensation and precipitation are the important processes in water cycle.



TERMINAL QUESTIONS

1. What are the three physical life support systems on the planet earth?
2. Name the various biotic and abiotic components of the environment
3. Give differences between natural and human modified ecosystem
4. Why is the number of trophic levels restricted to four or five in a food chain?
5. Give only two differences between fresh water and marine biome.
6. What will happen if all the floating animals are removed from a lake ecosystem?
7. What are the benefits of natural ecosystems?
8. Give two differences between energy flow and biogeochemical cycle in an ecosystem.



ANSWER TO INTEXT QUESTIONS

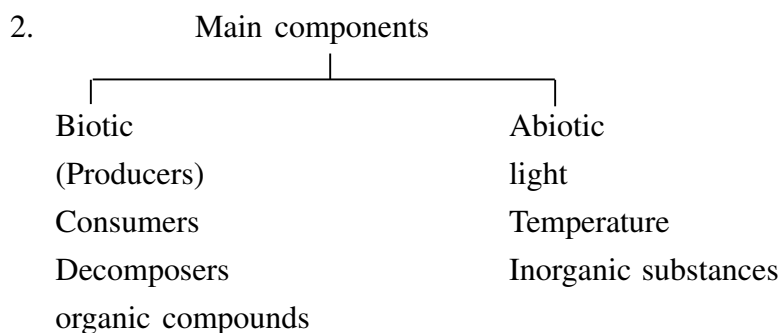
- 24.1**
1. Ernst Haeckel
 2. Genes → Cell → Organ → Organism → Population → Community
 3. Study of animals and plants in relation to their habit and habitat.
 4. Atmosphere, lithosphere and hydrosphere



Notes

- 24.2**
- (i) Abiotic (ii) Biotic
 - light, temperature, humidity, precipitation, pressure and soil profile
 - Helps in recycling of nutrients in the environment.
 - Plants are capable of capturing solar energy and transforming it into food energy. Thus they produce their own food. Animals depend upon plants or other animals for food as they cannot produce their own food.

- 24.3**
- Ecosystem is a unit to study ecology/functionally independent unit to stud. The interrelation between biotic and abiotic components.



- to breakdown products of dead animals and plants tissue.

- 24.4**
- Grass → Grasshopper → Frog → Snake → Hawk/eagle
 - Secondary level consumer
 - Snake can feed on a rat and then it is a secondary consumer. It can also feed on a frog and then it is a tertiary consumer.

- 24.5**
- Upto five (5)
 - Energy from solar radiation is fixed in the form of food by the producer. This energy is passed on to the consumers of different trophic level. At each trophic level energy is used by the member for metabolism and only left over energy is passed on each trophic level (10%).
 - See text
 - Vertical and horizontal distribution of plants in the ecosystem.

- 24.6**
- Its an ecosystem that occurs high mountain peak above the tree line. Environmental conditions are very severe and show day and night temperature variation.
 - Cotton grass, sedges, dwarf leath, willows, birches and lichens (any two).
 - both of them have very harsh climatic conditions.
 - Scarce vegetation.

**Notes**

4. 1. Tropical rain forest temperature.
 2. Deciduous boreal or north.
 3. Coniferous rain forest.
 5. Eastern Africa, South America, Australia and India (any two).
 6. Trees which shed their leaves in autumn and grow new foliage during spring.
- 24.7**
1. Free floating microscopic organisms
 2. diatoms, algae, prawn, crabs, snail (any two)
 3. 1000 atmosphere
 4. (a) swamps, marshes and mangroves (any one)
(b) streams, rivers, springs (any one)
- 24.8**
1. Movement of nutrient elements through the various components of an ecosystem is called nutrient cycle.
 2. In the Reservoirs pool
 3. Gaseous cycle
 4. Industrialization, urbanization, increased used of automobiles (any two)
 5. Polar ice caps and water present deep in the oceans.