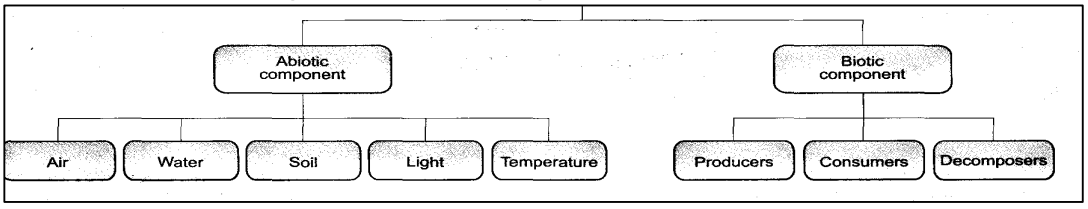
The environment of an organism means the physical and biological conditions in which it lives. The physical conditions include soil, light, temperature, etc. And the biological conditions include the other plants, animals and microorganisms around it. A change in any of these conditions can affect the organism. To understand how, we need to look at the different ways in which an organism interacts with others and with its surroundings. In this chapter we will look at the interactions between the organisms of an ecosystem.

Ecosystem: An organism cannot live in isolation. It needs other organisms, nutrients from its environment, and so on, to survive. So, nature has provided functional units in which different organisms of a given area can live and interact among themselves and with their surroundings.

An ecosystem is a functional unit consisting of all the living beings of an area and the nonliving components of their environment, interacting to form a stable system. They can be natural ecosystems such as deserts, grasslands, forests and lakes, or man-made ecosystems such as gardens, aquariums and crop fields. An ecosystem may be as small as an aquarium or as big as an ocean. A pond is an example of an aquatic ecosystem. All the 1lgae, plants, insects, microorganisms and fish in the pond, and the water and soil of the pond are part of this ecosystem. The organisms of the pond get everything they need from the pond itself. And they help to keep its water and soil in good condition, replenishing the nutrients they take from them. This makes the ecosystem self-sustaining.

In a garden you will find different plants and animals such as bees, butterflies, earthworms, frogs and birds. They depend on each other and on the nonliving things like the soil, air and water. For example, the earthworms gets nutrition from the soil. In turn, they keep the soil fertile. So do certain kinds of bacteria living in the soil. Birds, bees and butterflies get food from the plants in the garden. They help to keep the ecosystem working by helping in the pollination of the plants.

Stability in Ecosystems: All ecosystems are stable systems. This means that they maintain a natural balance. An ecosystem involves the flows of nutrients and energy (in the form of food). However, a balance is maintained between the availability and use of nutrients by recycling them through natural processes. A balance is also required to provide different amounts of energy (from food) needed by different organisms. For example, in a forest ecosystem, the numbers of the prey (like rabbits) are always more than the numbers of the predator (like foxes), to ensure adequate food for the predator.



Structure of an Ecosystem: An ecosystem consists of two components—the abiotic component (nonliving component) and the biotic component (living component).

Abiotic component: The abiotic, or nonliving, component consists of the physical environment, nutrients and climatic factors. The physical environment consists of soil, water and air. Inorganic substances such as carbon dioxide, oxygen, nitrogen,

water, phosphorus, sulphur, sodium, potassium and calcium constitute nutrients. Things like sunlight, rainfall, temperature, humidity and atmospheric pressure constitute the climatic factors.

Biotic component: The biotic, or living, component of an ecosystem can be classified on the basis of how the organisms get their food, i.e., whether they are producers, consumers or decomposers.

Producers: Organisms which make their own food are called producers. They are also called autotrophs. All green plants and certain blue-green algae act as food producers in ecosystems.

Consumers: Organisms that depend on other organisms for food are called consumers or heterotrophs. All animals which eat plants or other animals are consumers. Bacteria and fungi that depend on dead plants and animals for food are also in a way consumers. Consumers can be classified as herbivores, carnivores and omnivores. Herbivores eat only plants and plant products. Cows, deer and rabbits are herbivores. Carnivores eat only the flesh of other animals. Tigers, snakes and hawks are carnivores. Omnivores eat plants as well as the flesh of other animals. Man and crow are examples of omnivores.

Sometimes it is useful to classify the consumers in an ecosystem on the basis of **'who eats whom'**. Primary consumers are those who feed directly on the producers (plants). Carnivores who feed on plant-eating animals (herbivores) are secondary consumers. For example, a grasshopper that feeds on plants is a primary consumer, and the frog that eats the grasshopper is a secondary consumer. The frog could be eaten by a larger carnivore like a snake. A carnivore that feeds on smaller carnivores is called a tertiary consumer. This consumer may be eaten by the largest carnivore, or the top carnivore, of the ecosystem. The top carnivore is not killed and eaten by other animals of the ecosystem. The top carnivore belongs to a higher order of consumers.

Decomposers: Organisms which feed on dead plants and animals are called decomposers. Decomposers are also called saprotrophs or saprophytes. They include bacteria, fungi and worms. Decomposers break down (decompose) the compounds present in dead plants and animals into simpler substances and obtain nutrition from them. The substances formed in decomposition are released into the soil and the atmosphere. Thus, decomposers play an important role in the recycling of materials, replenishment of the soil's nutrients, etc. They also clean up our surroundings by decomposing dead organisms and wastes from animals and plants.

Food Chain: For an ecosystem to work there has to be a flow of energy within it. The organisms of the ecosystem need energy in the form of food. The ultimate source of this energy is the sun. A series of organisms through which food energy flows in an ecosystem is called a food chain. It may also be defined as follows. **A food chain in an ecosystem is a series of organisms in which each organism feeds on the one below it in the series.** In a forest ecosystem, grass is eaten by a deer, which in turn is eaten by a tiger. The grass, deer and tiger form a food chain. In this food chain, energy flows from the grass (producer) to the deer (primary consumer) to the tiger (secondary consumer). In a freshwater aquatic ecosystem like a pond, the organisms in the food chain include algae, small animals, insects and their larvae, small fish, big fish and a fish-eating bird or

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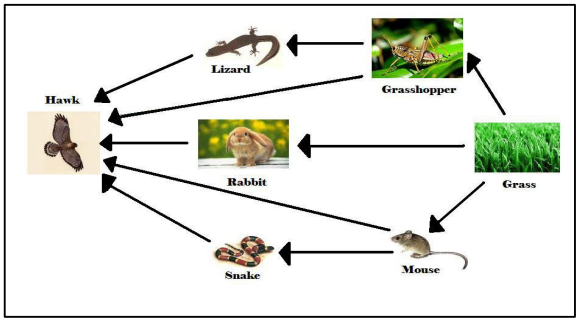
animal. A food chain always begins with producers. Herbivores (plant-eaters) come next in the chain. They are consumed by carnivores (flesh-eaters). A few food chains can be long and may extend to the fourth, fifth or even sixth order of consumers. Some common food chains are mentioned below.

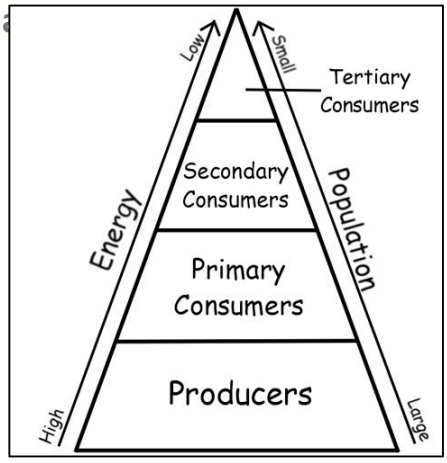
Plants → Deer → Lion
Plants → Worm → Bird → Cat
Plants → Grasshopper → Frog → Snake → Hawk
Algae → Small animal → Small fish → Big fish → Bird

Food Web: A food chain is a linear arrangement of animals. It does not give a complete picture of the feeding relationships among the different organisms of an ecosystem because many of them eat more than one kind of food. For example, a snake does not eat only mice. It may eat insects, frogs, small birds, etc. Snakes, in turn may be eaten by hawks, eagles, peacocks, owls, etc. Thus, an organism can be a part of many food chains. **A food web is a series of interconnected food chains representing the feeding relationships of the organisms within an ecosystem.** Unlike a food chain, a food web has several alternative pathways for the flow of energy. In the food web of a grassland ecosystem shown in Figure, there are five food chains.



1. Plants → Grasshopper → Hawk
2. Plants → Grasshopper → Lizard → Hawk
3. Plants → Rabbit → Hawk
4. Plants → Mouse → Snake → Hawk
5. Plants → Mouse → Hawk

Trophic Levels: Sometimes it is useful to study an ecosystem by grouping its organisms by their positions or levels in food chains. A level position in a food chain is called a **trophic level**. Energy and materials are transferred from one trophic level to another. The producers in a food chain are at the first trophic level. The herbivores, which feed upon plants, are at the second trophic level. The carnivores, which feed upon herbivores, are at the third trophic level, and so on. So, each trophic level supports the one above it in terms of food. In a simple food chain of a grassland ecosystem, there are three trophic levels. Grass (producer) is at the first trophic level. Deer (herbivore) is at the second trophic level and lion (carnivore) is at the third trophic level.



What would happen if all the organisms of a trophic level are removed? The natural balance would be disturbed and the results would be disastrous. For example, in a grassland ecosystem, if all the carnivores (like lions) at the third trophic level are removed, the numbers of herbivores (like deer) in the trophic level below would go on increasing. Their numbers would soon be more than that can be supported

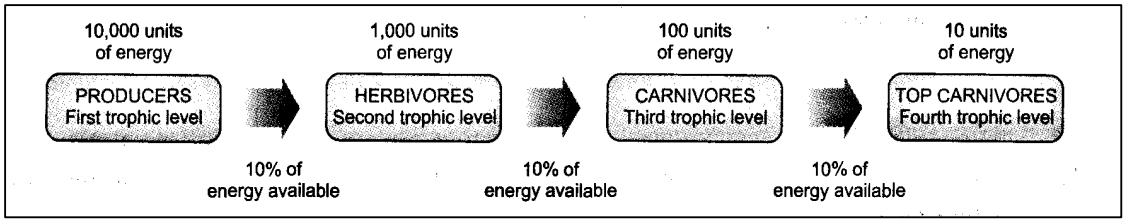
by the plants of the region. They would eat up all the plants and turn the area into a desert.

Flow of Energy: The flow of energy is unidirectional, i.e., it flows in one direction—from the producers to the consumers at successively higher trophic levels. This energy cannot flow back because a higher-level consumer such as a snake cannot be food for a lower-level consumer such as a rabbit. Let us now look at the flow of energy a bit more closely.

Green plants absorb a very small fraction (about 1%) of the solar energy reaching the outer part of the atmosphere. Through photosynthesis they convert this energy into chemical energy, which is stored as food (carbohydrates). A part of the trapped energy is used by plants in metabolic activities like the growth of new tissues, and a part of it is lost into the surroundings as heat. The remaining energy is available as food to primary consumers. Thus we see that only a fraction of the energy absorbed by plants is finally available to the next trophic level.

When primary consumers like deer eat plants, they get the available energy in plants. Some of this energy is used for activities like moving, digesting, etc., and some of it is lost as heat. Only about 10% of the available energy in the food gets transformed into new tissues (flesh) of the deer. This is available to the carnivores (secondary consumers) at the next trophic level. At this level too, the usage, loss and storage of energy follow the same pattern. And this continues at every trophic level. Apart from this, energy from dead plants and animals is transferred to the decomposers.

We find that when energy flows from the producers to the consumers at different levels, there is a loss of energy at each trophic level. It has been found that about 10% of the energy available to a trophic level is transferred to the next higher level. This is called the ten percent law. Let us look at an example. If 10,000 kilocalories of energy are available to grass (producers), 1,000 kilocalories of energy would be available to grasshoppers (primary consumers), 100 kilocalories would be available to frogs (secondary consumers) and only 10 kilocalories would be available to snakes (consumers of the third order). After this, very little energy would be left for the next level. So, food chains generally have up to three or four trophic levels.



Now, the organisms at a trophic level are food for the organisms at the next higher trophic level. But there is a loss of energy as one goes from a lower to a higher trophic level. Therefore, the organisms at the higher level need to eat a large amount of food to fulfil their requirement of energy. So, the number of organisms at a lower trophic level is usually more than that at the next higher trophic level. If the numbers of organisms at different trophic levels are represented graphically, a pyramid is formed, which is called the pyramid of numbers.