

Lecture 38:

Ecosystem (Part-I)

Introduction: So far we have discussed about many topic related to the evolution, physiology, molecular cell biology and structure-function of selected macromolecules. In the current lecture, we will discuss the local habitat, and relationship between different organisms. Now the question is, **What is mean by Ecosystem?** An animal can not live in isolation and interact with biota and abiotic factors, these relationship constitute the ecological system or ecosystem. In other words, ecosystem is defined as structural and functional unit of the biosphere, comprising living and non-living factors and their interaction.

DIFFERENT TYPES OF ECOSYSTEM: Ecosystem is an open system and material can exchange from one ecosystem to another ecosystem. For ex. Frog move from the pond to the land and vice-versa. The ecosystem can be classified based on size, nature and duration;

(1) Nature : On the basis of nature, it can be natural or artificial.

Natural Ecosystem: This ecosystem forms naturally without interference of human. Example include are pond, river, forest, village, hill etc.

Artificial Ecosystem: This ecosystem is developed and mainted by human. Example include are flowerbed, backyard, aquarium etc.

(2) Duration: On the basis of duration, ecosystem can be classified as temporary or permanent.

Temporary ecosystem: it is short lived and man made or natural. Example include rain fed pond.

Permanent ecosystem: it is long lived and self supported natural ecosystem for very long period. Example includes forest, river etc.

(3) Size: Ecosystem is classified as small or large ecosystem.

Small: it is small and also known as microecosystem. It can be temporary or permanent. For ex. Pond, flowerpot etc

Large: it is large in size and also known as macroecosystem. It is always permanent and mostly natural. For ex. Ocean, river, forest and desert.

STRUCTURE OF ECOSYSTEM: Each and every ecosystem has several components to sustain it for long duration. It needs matter (water, oxygen, mineral, carbon dioxide), different types of organisms and continuous recycling of energy (Figure 38.1). These requirements are met by two important components present in ecosystem; biotic components and abiotic components.

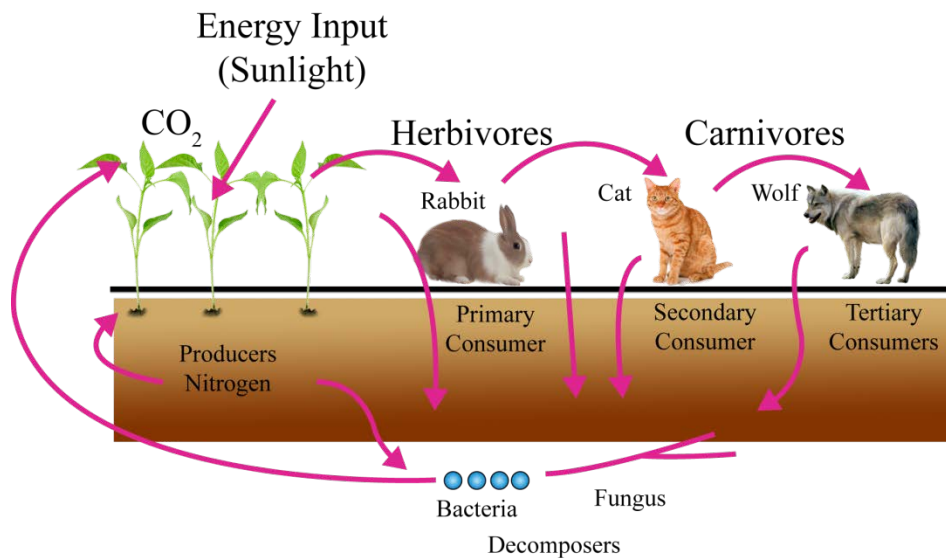


Figure 38.1: Structure of the Ecosystem.

Biotic Components: The living organisms present in an ecosystem form the biotic component. They are connected through food. In this series, few organisms are producing food whereas others are consuming the food.

(i) **Producers:** The role of producers is to prepare food to provide nutrition to the other organisms present in the ecosystem. There are two types of producers; photoautotrophs and chemotrophs.

Photoautotrophs: These are green plants which can trap sun light to form carbohydrate, simple sugar from carbon di-oxide and water. This process is known as photosynthesis and these organisms are called as photoautotrophs.

Chemoautotrophs: Few bacteria such as sulfur bacteria, nitrifying bacteria, can be able to utilize free energy released from the chemical reactions to prepare organic food with it. They are called chemoautotrophs and the process is known as chemosynthesis.

(ii) consumers: These are mainly the animals. They are unable synthesize their own food and depends on producers. They utilizes the oxygen being released from the producers as well. Several consumers doesn't get the food from the producers but they are depended on consumers it self. As a result, consumers are related to each other through multiple food chains. There are many types of consumers and we will discuss in details about these consumer in the subsequent lecture. The consumers are known as heterotrophs.

(iii) decomposers: These are mainly bacteria and fungi. Their primary purpose in the ecosystem is to decompose the complex organic material into the simple inorganic material so that it can be use for producers to prepare food.

ABIOTIC COMPONENTS: These factors include the non-living physiochemical factors of the environment. Abiotic factors are as follows:

(i) Inorganic substances: Inorganic substances like carbon, nitrogen, oxygen, water, carbon di-oxide, calcium, phosphorus and their inorganic compounds. These are available as free form or dissolved in water and may be adsorbed on the soil particles.

(ii) Organic compounds: These are carbohydrates, proteins, lipids, nuceltic acids etc. This material is present in dead organic matter. These are broken into the simple compounds by decomposers in ecosystem for recycling of matter.

(iii) Climatic factors: These are factors present in the environment such as temperature, humidity, light, wind, rainfall an atomospheric gaseous etc.

Study of specific Ecosystem: Lets take a example of fresh water pond to understand the function of individual components.

1. Abiotic Components: Non-living part of the pond includes: (1) water with dissolved gases, mineral and suspended organic matter. (2) air, CO₂ and O₂ on the water surface (3) sunlight.

2. Biotic Components: The biotic constituents include the plants, animals and microorganisms. They play different role in ecosystem.

Producers: Green plants act as producers.. As discussed previously, they utilized the sun light, CO₂ and water to prepare the food for other organisms.

Consumers: These includes crustaceans, worms, insect larvae and fishes.

Decomposers: Dead plants and animals form the organic debris in the pond. The decomposer such as bacteria and fungi decay dead body into the simple organic and inorganic substances.

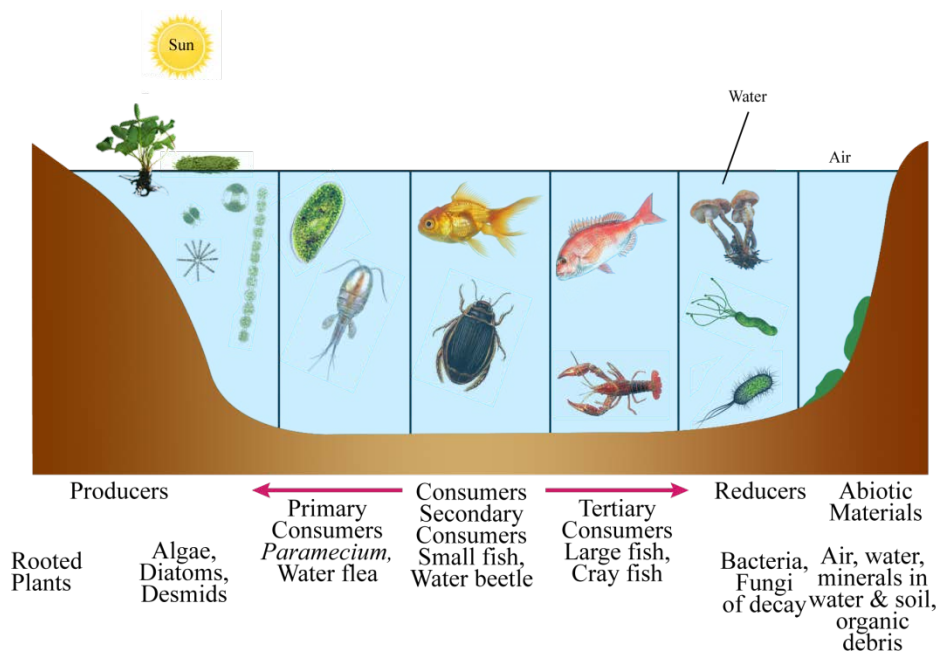


Figure 38.2: Fresh Pond ecosystem.

Lecture 39:

Ecosystem (Part-II)

Summary of Previous Lecture: In the previous lecture, we have discussed several aspects of ecosystem, various components of ecosystem and their relevance in maintaining ecology. Now in the current lecture, we will discuss, the relationship between different organisms and their role in the ecosystem.

CHARACTERISTICS OF FOOD CHAIN: The sequential inter-linking of organisms involving transfer of food energy from the producers, through a series of organisms with repeated eating and being eaten is referred as **“food chain”**. The biotic components of the ecosystem are linked to each other through food chain. In a typical food chain, producers are at the bottom and their role is to provide food for rest of the community utilizing solar energy (Figure 39.1). Other organisms belongs to the consumers and finally decomper are present at the bottom to recycle the organic content. In this manner, a nutritive interaction relationship exist between the living organisms of an ecosystem. It is always straight and always follow progressive straight line. The flow of energy is also unidirectional, from sun to producer and then different series of consumers. In a typical food chain, there are always 4 or 5 trophic level in the food chain. The distinct sequential steps in the straight food chains are referred as different trophic levels. For ex. Green plants stand at the first trophic level; the herbivorous are the second trophic level; and flesh eaters represent the third trophic levels. The position of plant is at the bottom but the position of other organism varies to different trophic level in different food chains. The typical representative food chains are given in the Table 39.1.

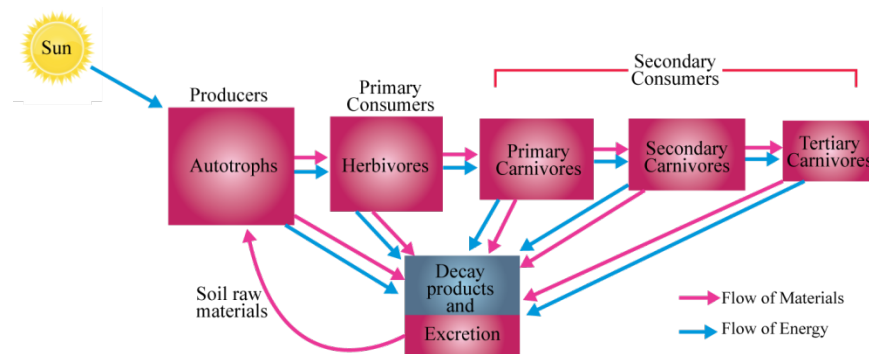


Figure 39.1: An Over-view of relationship between different organism in ecosystem.

Table 39.1 : Typical examples of food chains in different ecosystem.

Type of Ecosystem	Producers	Herbivores	Primary Carnivores	Secondary Carnivores	Tertiary Carnivores
Grassland Ecosystem	Grasses	Insects Rat and mice Grazing Cattle	Frogs Snakes Carnivore mammals	Snakes Predatory birds	Predatory birds
Aquatic Ecosystem	Phytoplanktons	Zooplanktons	Small fishes	Large fishes	
Forest Ecosystem	Trees	Phytophagous insects Herbivora mammals	Lizards, birds Foxes	Predatory birds Wolves	Lions, Tiger
Dessert Ecosystem	Shrubs, bushes Grasses and some tree	Rats and mice	Snakes	Predatory birds	

TYPES OF FOOD CHAIN: There are two different types of food chains; grazing food chain and detritus food chain.

Grazing food chain: In the grazing food chain, solar energy is entrapped by the plants and then biomass, in tuen eaten by the herbivorous, and these are subsequently been consumed by a variety of carnivorous. These are longer food and these food chains end at the decomposer level. Here are two typical example of this type of food chain to understand this type of food chain.

(1) Food chain in a pond: In a pond, floated or rooted plants and algae are responsible for performing photosynthesis to prepare food for other member of ecosystem. They represent producers in the food chain (Figure 39.2). Unicellular algae are consumed by protozoan, water flies, snail, mosquito larvae and tadpoles. These small organisms represent primary consumers. These organisms are eaten by hydra, dragonfly larvae, giant insects and small fishes. These are secondary consumers. Large fishes and frog fed on these organism and represent tertiary consumers. Frog and fishes are eaten by snakes, birds and these are quaternary consumers. Death of all these organism become the food for bacteria and fungus to produce simple inorganic materials for reuse by the producers.

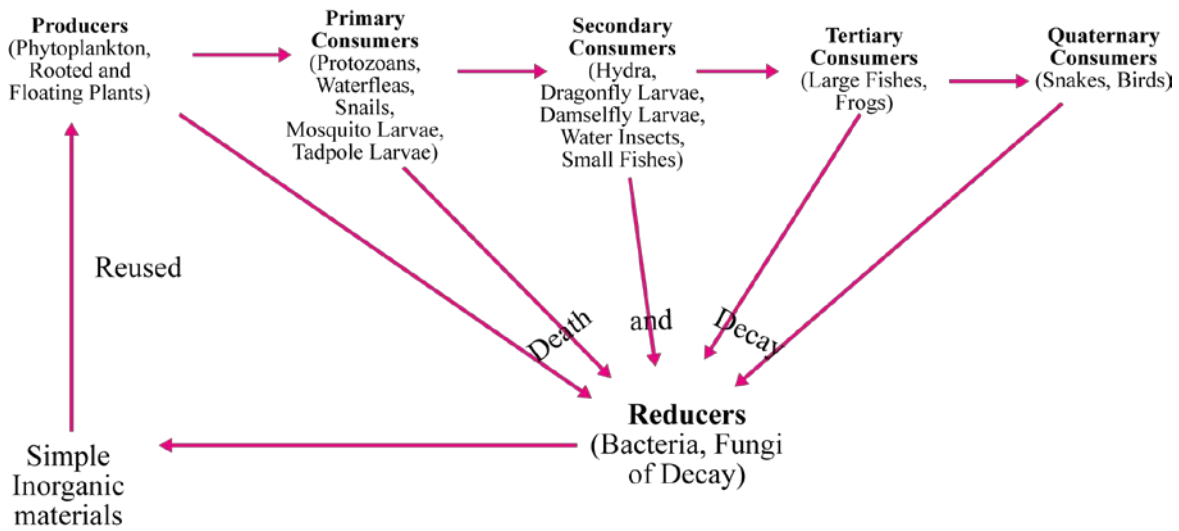


Figure 39.2: Food Chain in Pond.

(2) Food chain on land: A typical land food chain is given in Figure 39.3. In land food chain, grass and tree are the producers. Grass is eaten by rabbit and other herbivorous. They represent the primary consumers. Rabbit is eaten by cats (secondary consumers), which in-turn eaten by wolves (tertiary consumers). Both cat and wolves will be consumed by tigers and other big carnivorous (quaternary consumers). Death of all these organisms become the food for bacteria and fungus to produce simple inorganic materials for reuse by the producers.

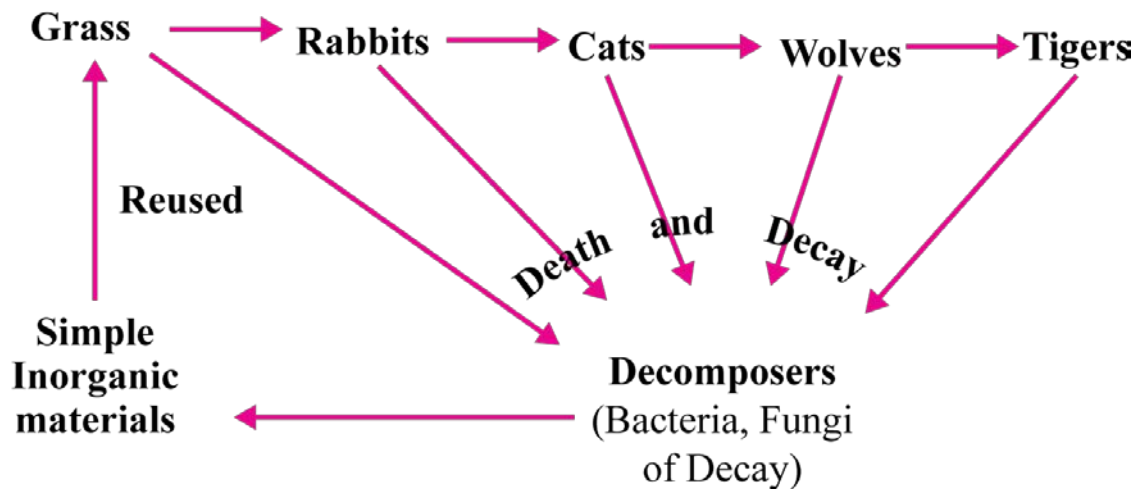


Figure 39.3: Food Chain on land.

Detritus food chain: Unlike grazing food chain, detritus food chain starts with the dead organic matter either from fallen leaves or dead animal bodies. This food chain doesn't depend on solar energy. Common example of detritus food chain is marsh land where mangrove leaves fall into the warm, shallow water (Figure 39.4). The detritus-eating animals ex. Bacteria, fungi and protozoan act upon the dead matter of dead leaves to convert them into simple inorganic substances. The detritivorous are subsequently eaten by insect larvae, grass shrimp, copepods, crabs, nematodes, bivalve mollusks, amphipods, mysids etc. In the last step, the detritus consumers are finally eaten by fishes.

Figure 39.4: Detritus food chain on marsh land.

Mangroove Fallen Leaves	Bacteria, Fungi and Protozoa	Insect Larvae, Certain crustaceans, mollusks	Minnows, small game fishes	Large fishes, fish eating birds
------------------------------------	---	---	---	--

Food Web: The different food chains are inter connected at various trophic level to develop a food web (Figure 39.5). For example, in grassland ecosystem, grass is consumed by the rabbit but in their absence, it may be eaten by the grazing cattle. Similarly, rat or mouse is eaten by snake but snake can be eaten by predatory birds. In contrast to food chain, food web has several distinct characteristic. (1) Food web are never straight. (2) Food web is formed due to interlinking of food chains. (3) A food web in the ecosystem brings alternate source of food. The complex food web gives better stability to the ecosystem. Most of the animals are polyphagous and they feed on more than one kind of organism. If the availability of one particular animal is decreasing in the ecosystem, they start eating alternate animal. As a result, it gives chance to other animal to reproduce and grow in number and in addition, it gives chance to predator to survive.

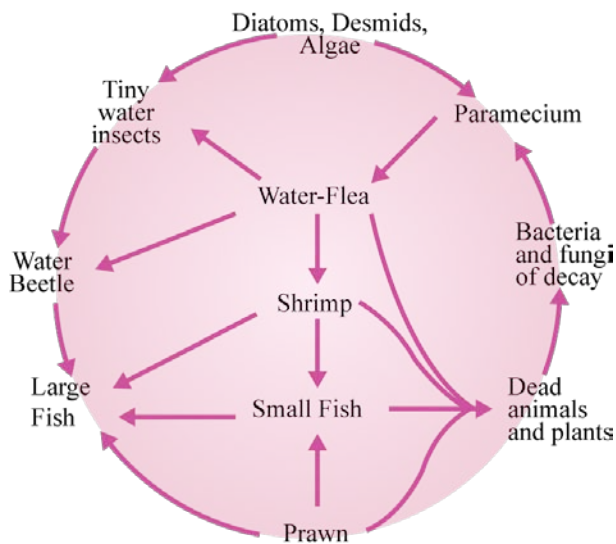


Figure 39.5: Food web in a pond.

Ecological Pyramids: In a food chain, producers and consumers at different trophic level are connected in terms of number, biomass and energy. These properties reduces from producers to consumers and representing these parameters for food chain gives a pyramid with a broad base and a tapering apex (Figure 39.6). Ecological pyramids can be of three types:

- (a) Pyramid of Numbers
- (b) pyramid of biomass
- (c) pyramid of energy

Example of inverted ecological pyramid is provided by parasitic food chains (Figure 39.7). A single mango tree supports large number of birds, which in turn supports a large number of parasites like lice and bugs. Hyperparasites, such as bacteria and fungus are the greatest in the number and occupy the top of the invertes pyramids.

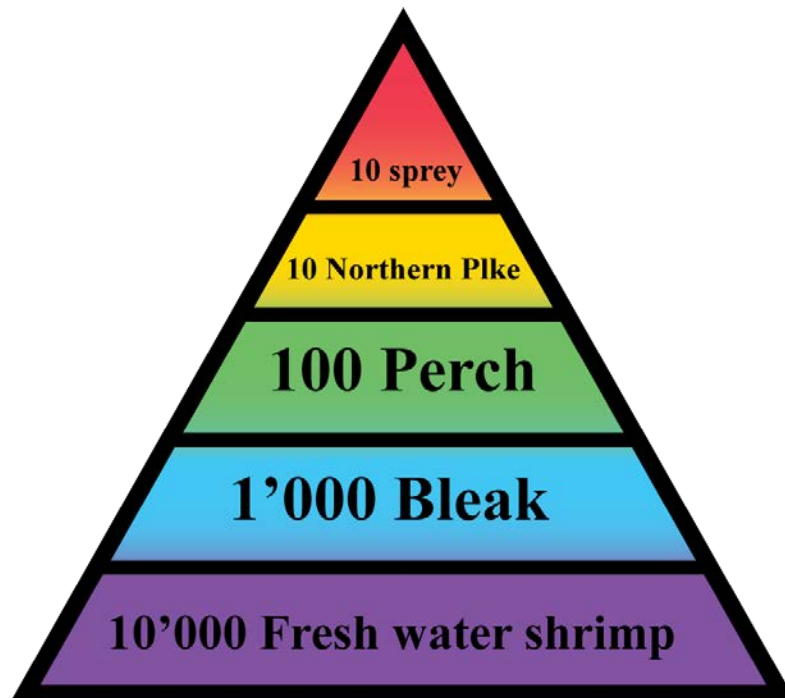


Figure 39.6: Ecological Pyramid in a pond.

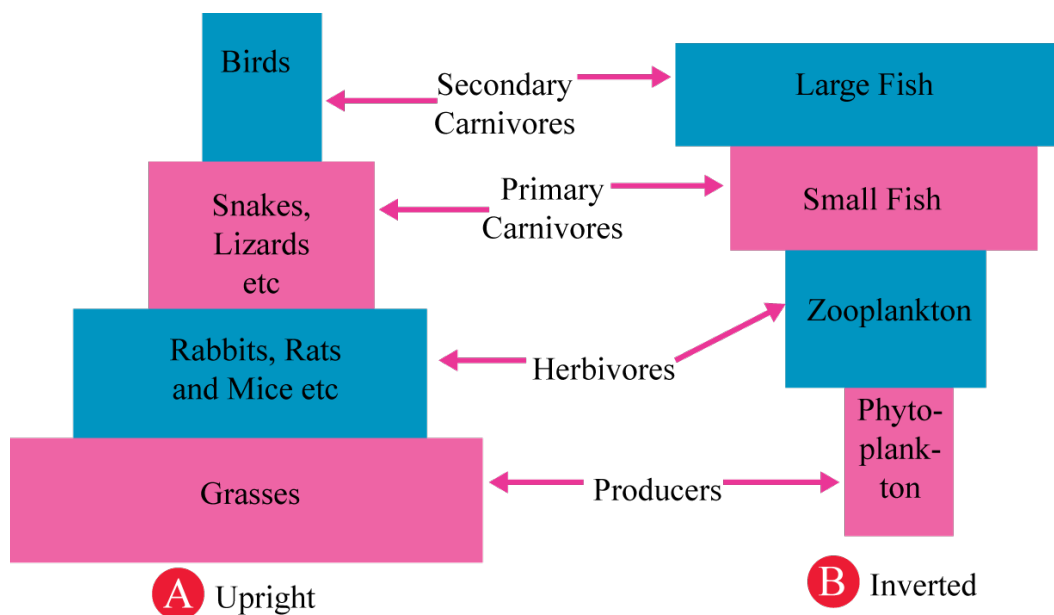
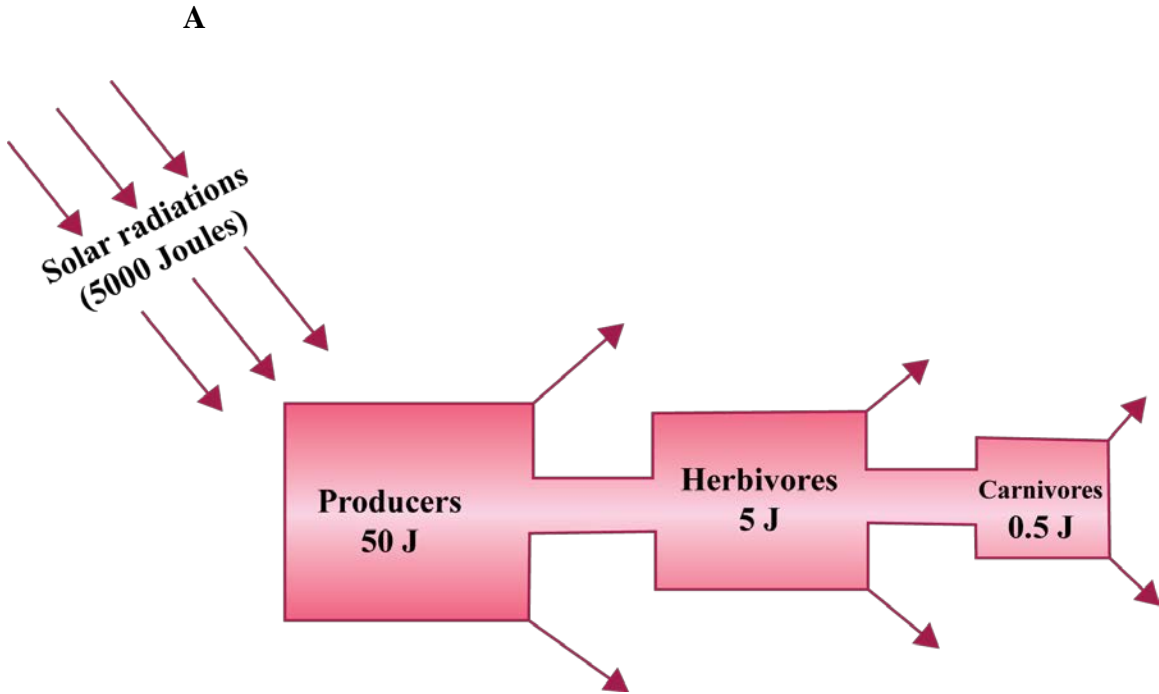


Figure 39.7: Inverted Ecological Pyramid Food web in a grass land.

Flow of energy in food chain: Sun is the ultimate source of energy on earth and plants utilize it to produce food for the rest of the members of the ecosystem. Only the 1% of the total energy that falls on the green part of leaves is changed into the potential energy of the organic substances; the rest of the energy dissipates as heat. To explain the flow of energy, Lindemann proposed the law of ten per cent. This law proposed that during the transfer of food energy from one trophic level to the other, only 10% is stored at the higher trophic level and the rest 90% is lost in respiration, decomposition, and waste in the form of heat (Figure 39.8). For example, 5000 joules fall on leaves; it will convert only 500 joules into the chemical form (food). It will be eaten by a rabbit; he will get only 50 joules (10% of 500 joules) on the next trophic level. The rabbit will be consumed by a carnivore, and they can be able to store only 5 joules (10% of 50 joules).



B

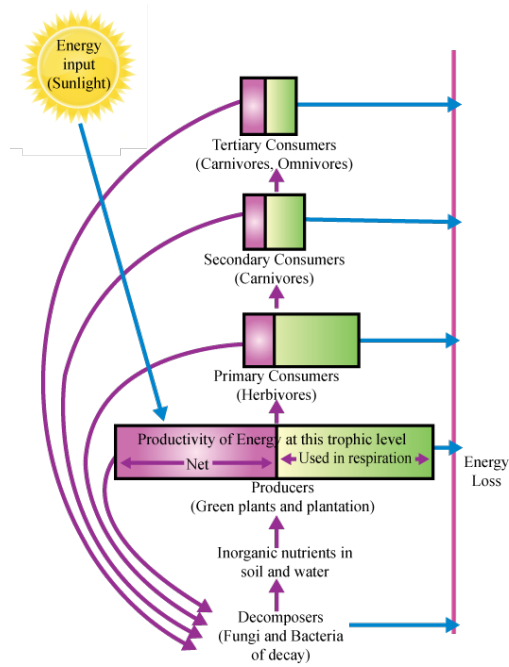


Figure 39.8: Flow of Energy and Ten per cent law in food chain.