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 imporattn components present in ecosystem; biotic components and abiotic components.

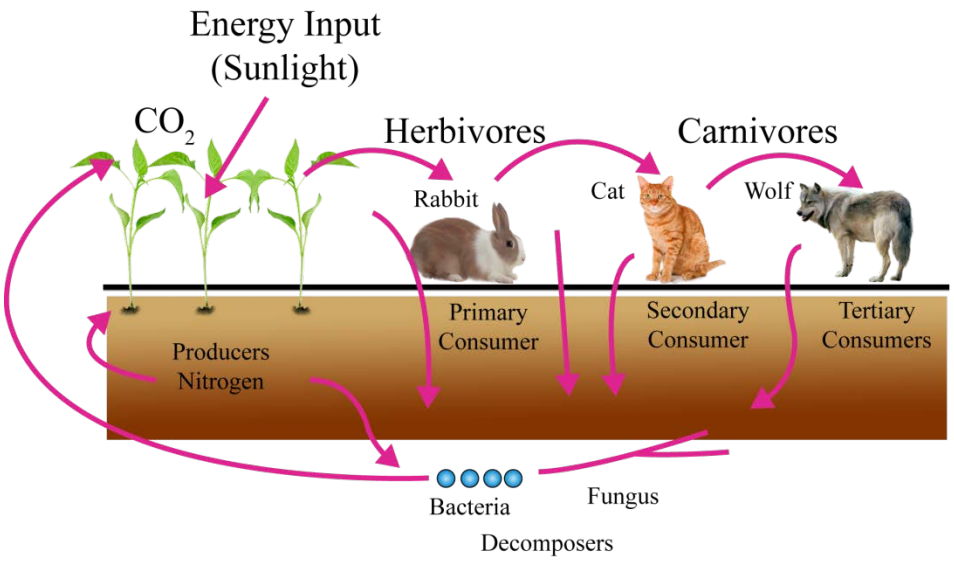

Figure 38.1: Struture of the Ecosystem.

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 consuling 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 comsumers 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.

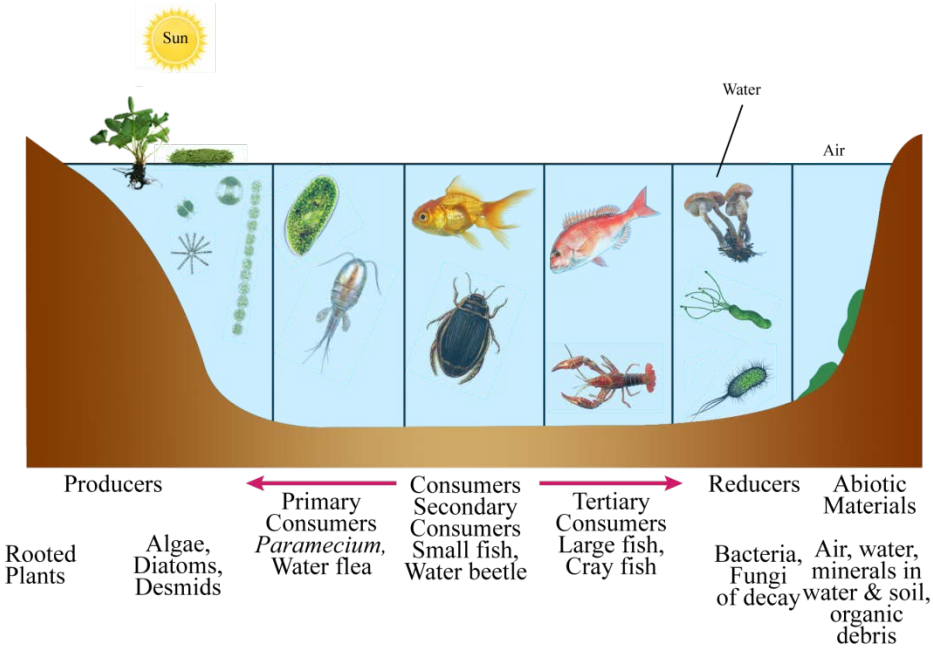

Figure 38.2: Fresh Pond ecosystem.

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 utilizying 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.

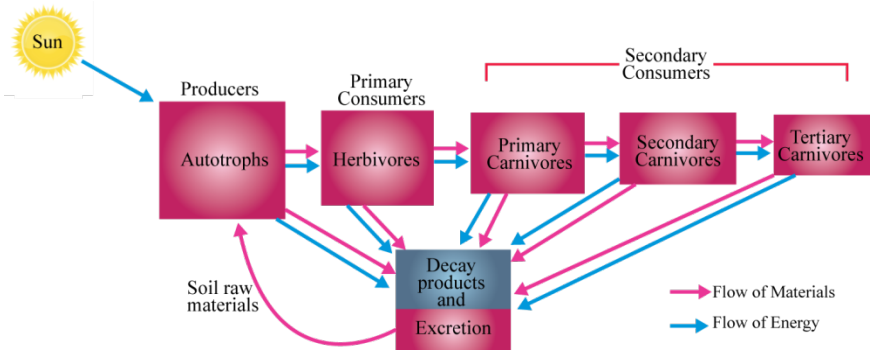

Figure 39.1: An Over-view of relationship between different organism in ecosystem.

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.

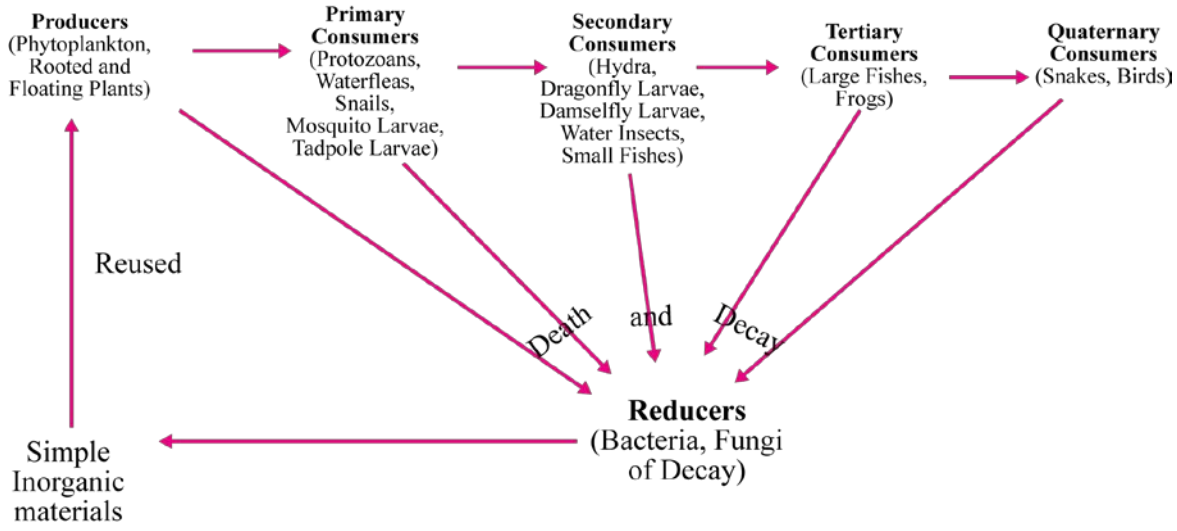

Figure 39.2: Food Chain in Pond.

(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 represents 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 organism become the food for bacteria and fungus to produce simple inorganic materials for reuse by the producers.

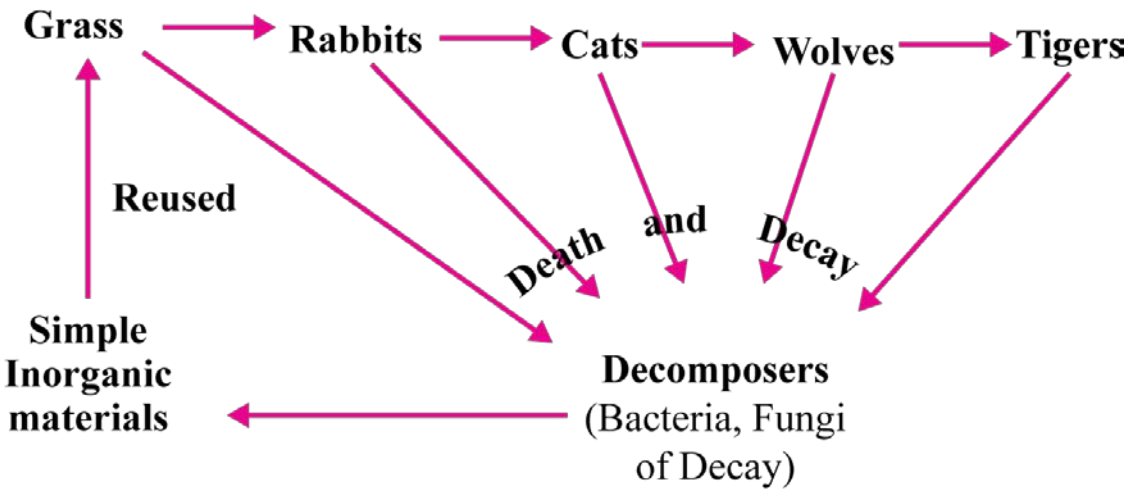

Figure 39.3: Food Chain on land.

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 doen't depends 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 covert 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 decresing 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.

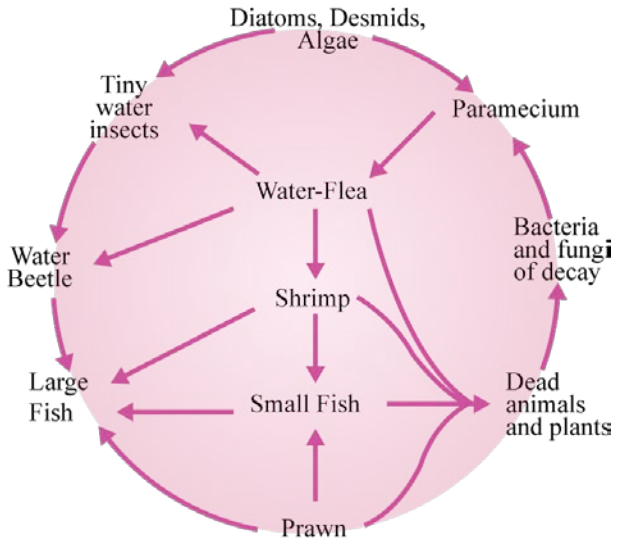

Figure 39.5: Food web in a pond.

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.

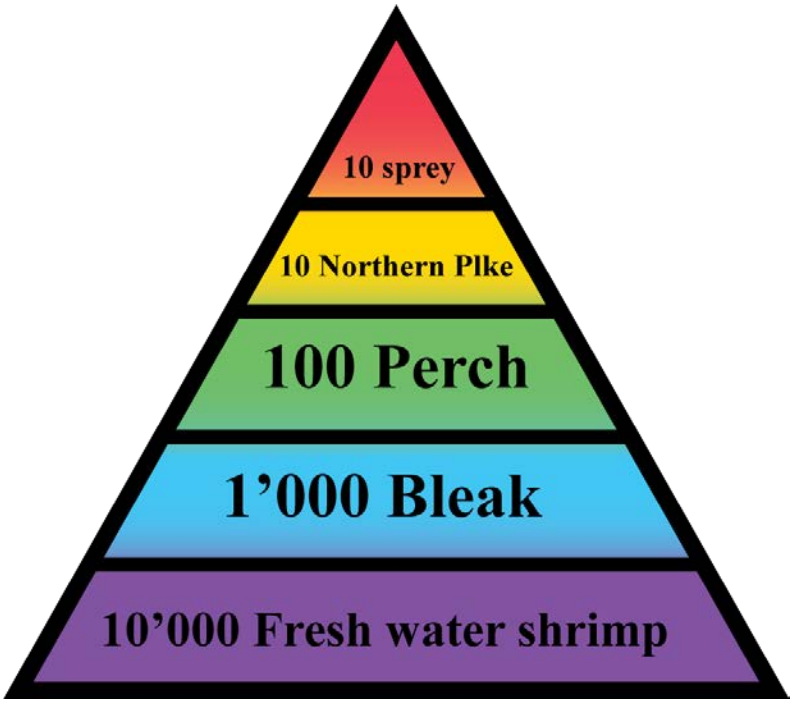

Figure 39.6: Ecological Pyramid in a pond.

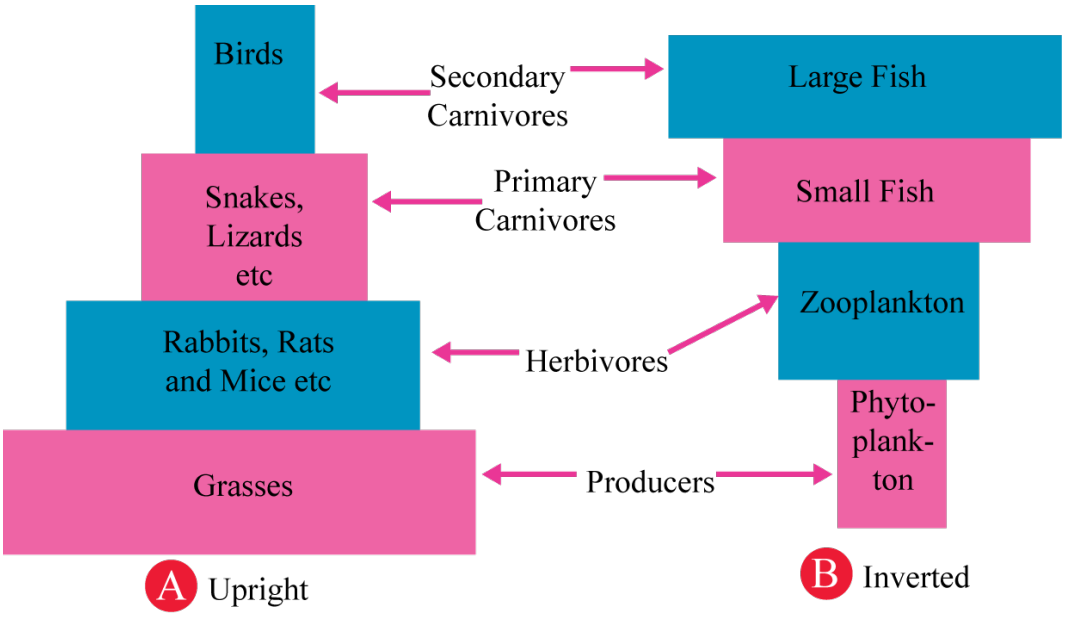

Figure 39.7: Inverted Ecological Pyramid Food web in a grass land.

Flow of energy in food chain: Sun is the ultimate source of energy on earth and plants utilizes it to produce food for rest of the member of the ecosystem. Only the 1% of the total energy fall on 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, lindermann proposed the law of ten per cent law. This law proposed that during transfer of food energy from one trophic level to the other, only 10% is stored at higher trophic and the rest 90% is lost in respiration, decomposition and waste in the form of heat (Figure 39.8). For example, 5000 jules fall on leaves, it will convert only 50 jules into the chemical form (food). It will be eaten by rabbit, he will get only 5 jules (10% of 50 jules) on next trophic level. Rabbit will be consumed by carnivorous and they can be able store only 0.5 jules (10% of 5 jules).

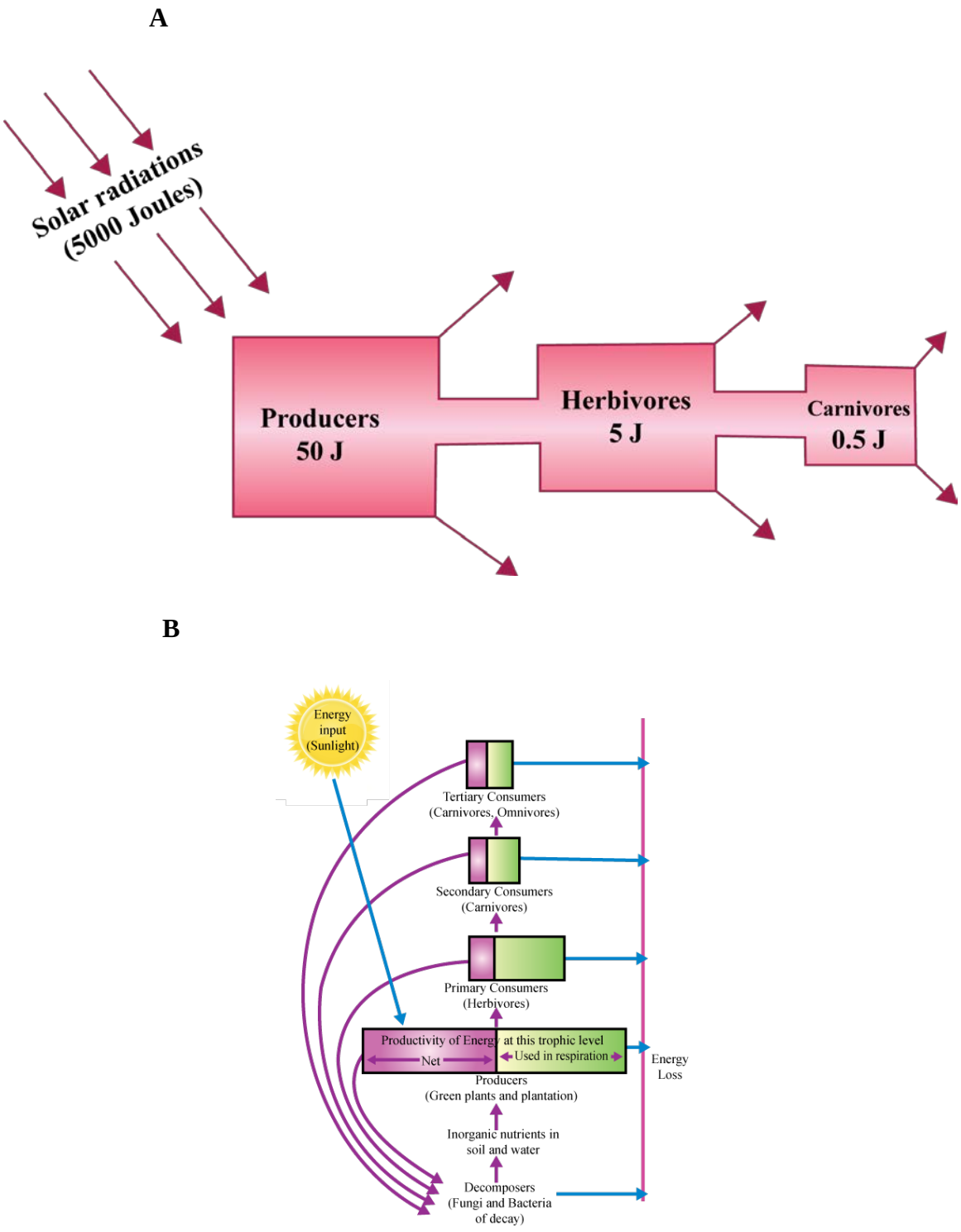

Figure 39.8: Flow of Energy and Ten per cent law in food chain.

Lecture 40: Ecosystem (Part-III)

Summary of Previous Lecture: In the previous lectures, we have discussed several aspects of ecosystem, interaction between different biotic components and their relevance in maintaining ecosystem. Now in the current lecture, we will discuss, different abiotic components, regulation of these factors and their role in the ecosystem.

Ecological Equilibrium: Ecosystem always remain in the state of equilibrium. The equilibrium is dynamic is nature and biotic components appear and disappear time to time due to their death or predator. In addition, decomposer convert the complex organic matter of dead plant and animals into the simple inorganic substances. These simple inorganic substance pass through the soil, plants and animals in a cyclic manner, and this keeps the life going on in an ecosystem. Thus, both biotic and abiotic components are in a dynamic state.

Pollution: The disturbance of dynamic equilibrium due to excessive introduction of containment leads to the development of pollution. It may effect the environment in different forms such as noise, heat, light or chemical substances. The major forms of pollution are as follows:

Air Pollution: The release of chemicals and particulate matter into the environment to disturb air quality. The major pollutant belongs to carbon monoxide, sulfur dioxide, chlorofluorocarbons and nitrogen oxides. The major source of these gaseous are motor vehicles and industrial waste (Figure 40.1). In addition, reaction of hydrocarbon with sunlight to generate photochemical ozone and smog. Particulate matter or fine dust present in air contributes into the air pollution.

Soil Pollution: The flow of chemicals from contaminated water reservoir such as river or lake, as well as from rain water leads to the spreading of chemicals on the soil. It leads to the contamination of soil with hydrocarbons, heavy metals, pesticides, herbicides and chlorinated hydrocarbons.

Radioactive Pollution: With the evident advancement in the atomic physics, nuclear power plants are estabilished to produce energy and electricity. These activities generates large quantity of radioactive waste in the environment and contaminate air, water and soil.

Thermal Pollution: The release of energy from nuclear power plant into the natural water bodies leads to the change in temperature of water. In addition, accumulation of green house gases into the environment causes trapping of solar energy into the atmosphere and ultimate raise in temperature of earth.

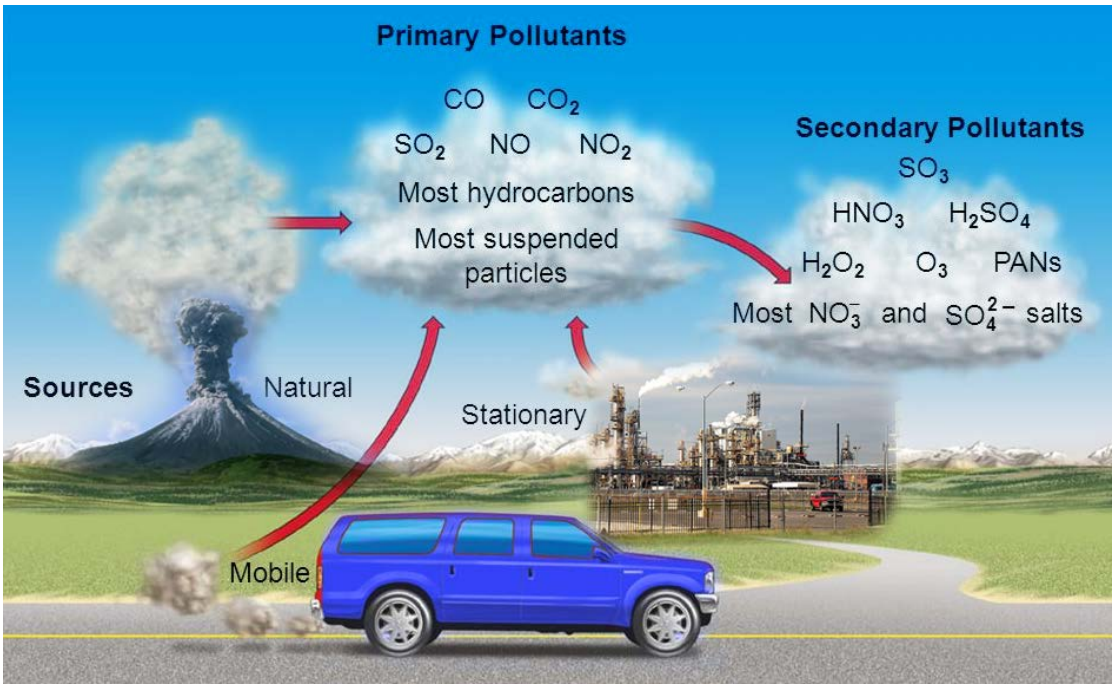

Figure 40.1: An Over-view of Air Pollution.

Noise Pollution: The main source of noise pollution is the contribution of sound from vehicles, aircraft noise, loud speaker, industrial machines and other source of sound (Figure 40.2). High noise can cause the development of cardiovascular effects such as rise in blood pressure, stress and vasoconstriction, and other coronary complications.

Figure 40.2: An over-view of Noise Pollution.

Water Pollution: The contamination of water from commercial and industrial waste causes water pollution(Figure 40.3). In addition, discharge of untreated domestic waste, sewag and chemical contaminants such as chlorine. The run away of chemicals from agricultural lands contains chemical fertilizers and pesticides into the river, lake also causes water pollution.

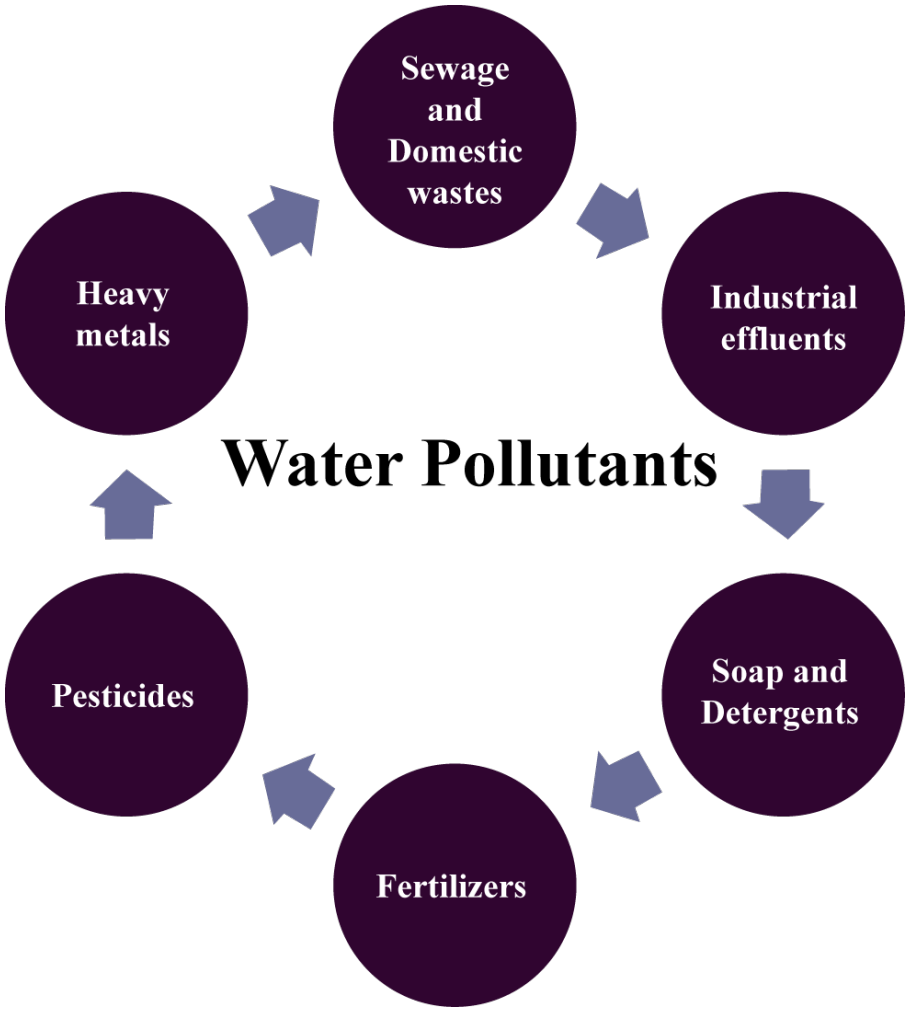

Figure 40.3: An Over-view of Water Pollution.

Effect of pollution on human health: Different forms of pollution effects the human health either directly or indirectly. Few of the selected effects on human health are given in Figure 40.4. These effects are as follows:

1. Depletion of ozone can cause skin cancer due to exposure of harmful ultraviolet radiation.

2. Ozone pollution can cause cardiovascular complications, throat inflammation, chest pain and congestion.

3. Water pollution causes death in developing countries due to consumption of contaminated water. It is the major cause of spreading water born diseases in human society.

4. Oil spilage can cause skin complications and rashes.

5. Noise pollution causes hearing loss, cardiovascular complications and sleep disorders.

6. Air pollution affects the older people due to its effect on lung and heart. Air pollution can cause development of asthama in children and infants. Lead, heavy metals and suspended particles in air cause neurological and developmental complications.

7. Radioactive and chemical pollution causes several types of cancer and birth defects.

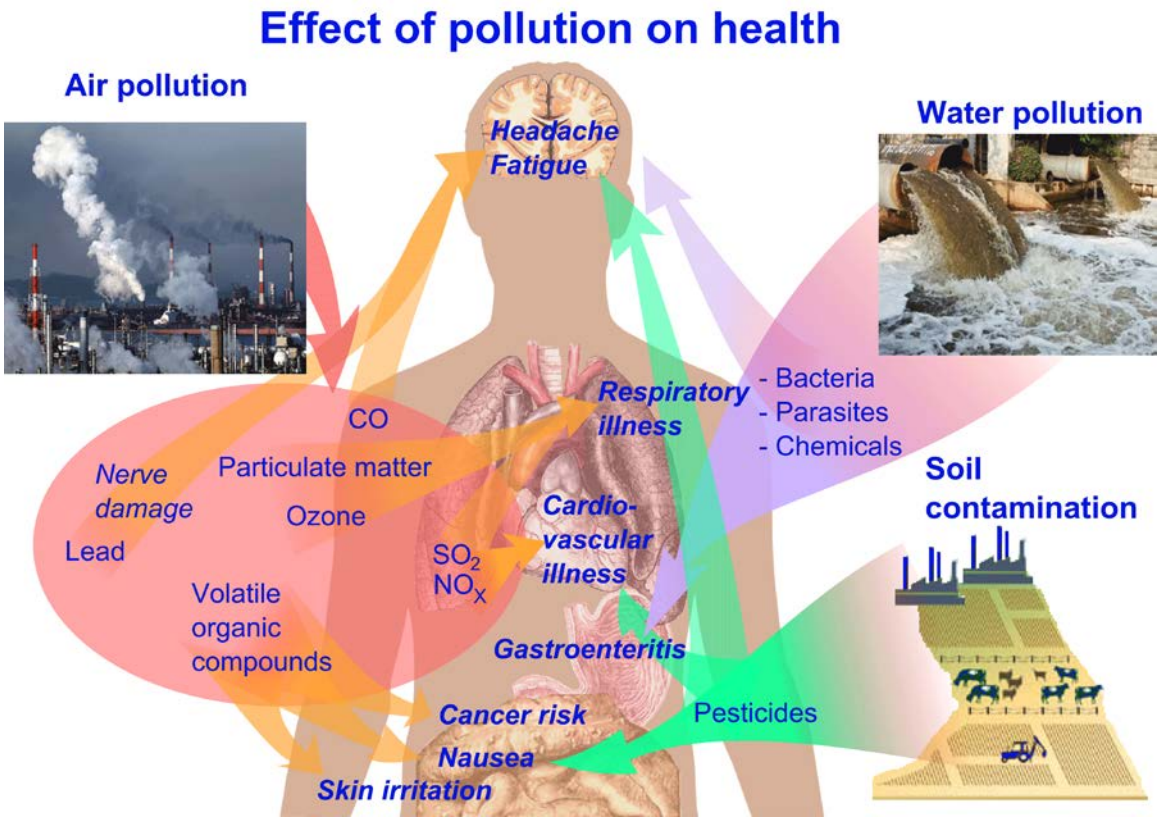

Figure 40.4: Effect of Pollution on human health.