CHAPTER

16

Man and His Environment

Animation 16: Ecology- Man and his environment
Source & Credit: Wikispaces

Every organism has its specific surrounding or environment with which it continuously interacts and remains fully adapted. An organism's environment is the sum of physical (abiotic) and biological (biotic) conditions which influence that organism. The study of the interrelationship between organisms and their environment is called **ecology.**

16.1 Levels Of Biological Selection

In ecology, the levels of organization range from organism to biosphere. An organism may be unicellular or multicellular. A group of the organisms of the same species inhabiting a specific geographical area (habitat) at a particular time is called a **population**. All the populations that live in a habitat and interact in various ways with one another are collectively called a **community.**

Recalling
A species is a group of organisms which can interbreed freely in nature, to produce fertile offspring.

Living organisms cannot live isolated from the non-living part of their environment. The biotic and abiotic components of environment interact with each other to form a system. The self-sufficient unit of an environment that is formed as a result of interactions between its biotic community and the abiotic components is known as an **ecosystem**. A pond, a lake and a forest are examples of natural ecosystems. Ecosystems may also be artificial for example an aquarium.

All **ecosystems** of the world together form the biosphere. It includes all the ecosystems of the planet Earth. In other words, the biosphere consists of all organisms present on the Earth and all regions of the Earth where they live. **Biosphere** ranges from the floor of oceans to the tops of the highest mountains. It is about 20 kilometres thick.

The biosphere makes a thin layer surrounding the planet Earth. If you consider the Earth as of the size of an apple, then the biosphere will be as thick as the apple's skin.

16.1.1 Components of Ecosystem

We have studied in lower classes about the basic components of an ecosystem. We know that an ecosystem comprises of two basic parts i.e. **abiotic components** and **biotic components.** The abiotic components include the non-living factors present in ecosystem. The important non-living factors are light, air, water, soil and the basic elements and compounds. The biotic components comprise the living part (organisms) of the ecosystem. Biotic components are further classified as producers, consumers and decomposers.

Recalling
Omnivores are the consumers that eat animal flesh as well as plants and plant products. Find examples of omnivores.

The **producers** are the autotrophs present in an ecosystem. Producers include plants, algae and photosynthetic bacteria. These organisms are able to synthesize complex organic compounds (food) from inorganic raw materials. Producers form the basis of any ecosystem. In terrestrial ecosystems, plants are the main producers. In aquatic ecosystems, the main producers are the floating photosynthetic organisms (mainly algae) called phytoplankton and shallow water rooted plants.

The **consumers** are heterotrophs. They cannot synthesize their food and so depend upon producers for food. Consumers include all animals, fungi, protozoans and many of the bacteria. The animals are the major consumers of ecosystems. They are further classified as herbivores and carnivores. Herbivores e.g. cattle, deer, rabbit, grasshopper etc. feed on plants.

They are the **primary consumers**. They feed directly on plants or products of plants. Carnivores feed on other animals. Primary carnivores **(secondary consumers)** feed on herbivores. Fox, frog, predatory birds, many fishes and snakes etc. are primary carnivores. Secondary carnivores **(tertiary consumers)** feed on primary carnivores. Wolf and owl etc. are secondary carnivores. Tertiary carnivores e.g. lion, tiger etc. feed on secondary carnivores

Tertiary carnivores are not eaten by any other animals. They are also called top carnivores.

Decomposers or reducers break down the complex organic compounds of dead matter (of plants and animals) into simple compounds. They secrete digestive enzymes into dead and decaying plant and animal remains to digest the organic material. After digestion, decomposers absorb the products for their own use. The remaining substances are added to environment. Many types of bacteria and fungi are the principal decomposers of biosphere.

The minerals, which are released by decomposers, are used as nutrients by the producers.

Analyzing and Interpreting:

- Identify the producers and consumers in a pond ecosystem and describe the interactions among the biotic and abiotic factors involved here.

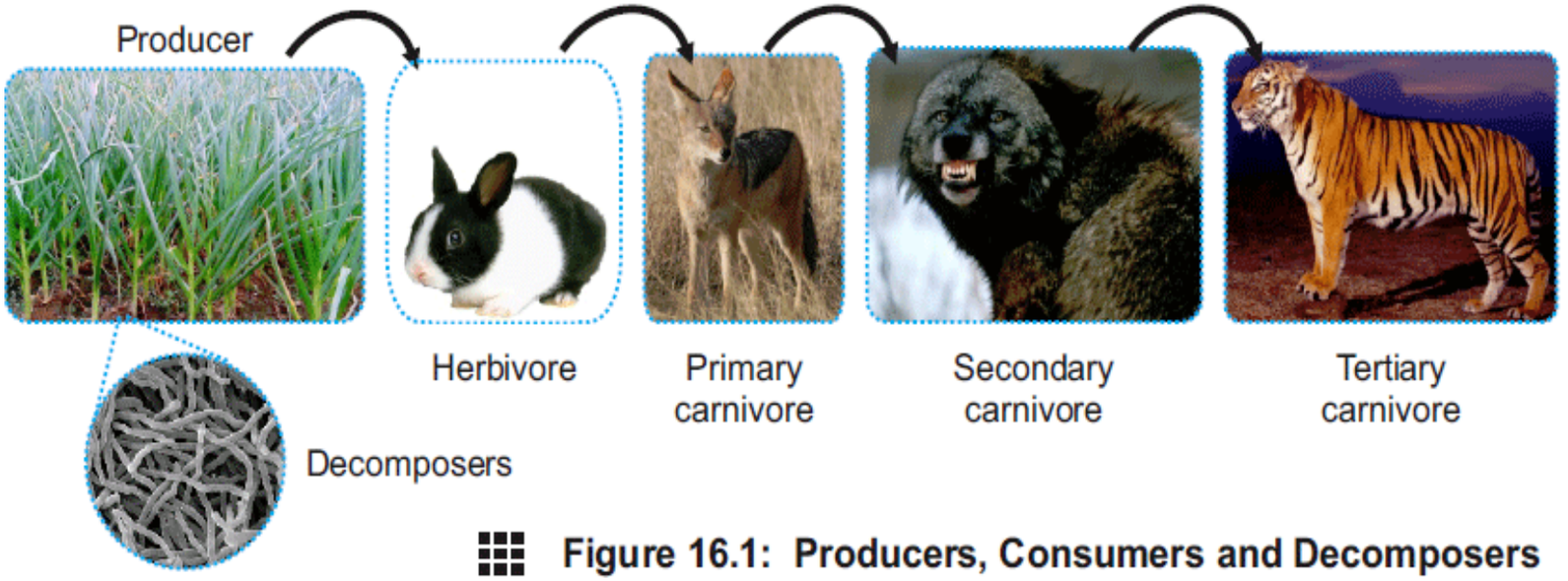


Figure 16.1: Producers, Consumers and Decomposers

16.2 Flow Of Materials And Energy In Ecosystem

In an ecosystem, energy as well as materials travel from one trophic level to the next. Trophic (food) level is the level at which an organism feeds in food chain. The first trophic level is made of producers; the second of primary consumers and so on.

16.2.1 Flow of Energy

The flow of energy in different trophic levels of ecosystem is unidirectional. The following is an overview of the flow of energy in an ecosystem (Fig. 16.2).

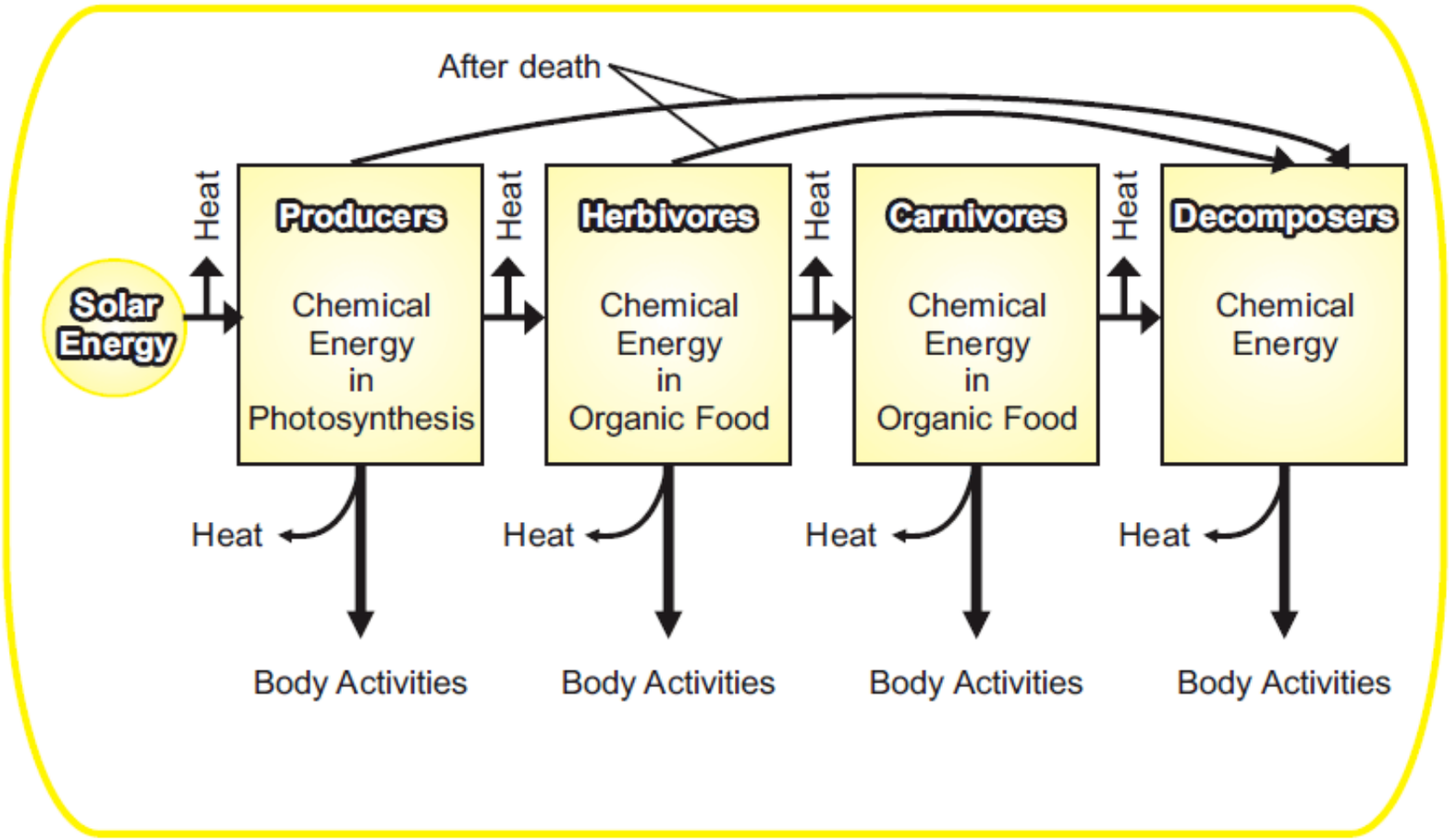


Figure 16.2: Energy flow in an ecosystem

The Sun is the primary source of energy for all ecosystems. Producers get solar energy and transform it into chemical energy by the process of photosynthesis. They store this energy in their tissues and also transform it into mechanical and heat energy during their metabolic activities.

The energy in producers' tissues flows to herbivores when producers are eaten. Herbivores transform it into mechanical and heat energy during their metabolic activities and store the rest in their tissues. Carnivores eat herbivores and get energy. They also use it for their body activities and store the rest in their tissues. After the death of producers and consumers, the energy stored in their tissues is used by decomposers.

The storage and expenditure of energy in an ecosystem is in accordance with the basic law of thermodynamics i.e. 'energy can neither be created nor destroyed but can be transformed from one form into another'.

In an ecosystem there is,

- Constant flow or transfer of energy from the Sun through producers to consumers and decomposers.
- A significant decrease in useful energy during transfer of energy at each trophic level.

16.2.2 Flow of Materials

The materials flow from one trophic level to the next by means of food chains and food webs. A food chain is a series of organisms within an ecosystem, in which each organism feeds on the one before it and is fed by the one after it. For example, following is a food chain in an ecosystem:

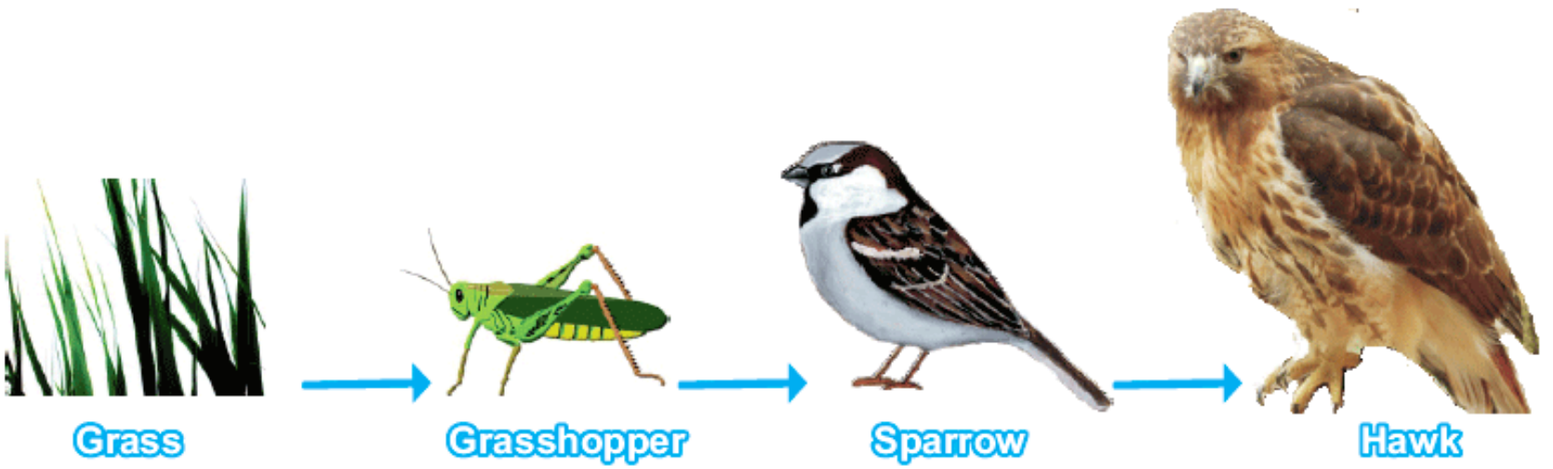


Figure 16.3: A simple food chain

The base of food chain is always formed by a plant (producer). It is eaten by a primary consumer, which is preyed upon by a secondary consumer. The secondary consumer may be eaten by a tertiary consumer. A food chain, can therefore, be represented as,

Producer →Primary Consumer → Secondary Consumer → Tertiary Consumer

A food chain involves a nutritive interaction among the biotic components of an ecosystem. Usually there are 4 or 5 trophic levels. Shorter food provide greater available energy and vice - versa.

Analyzing and Interpreting:

- Construct food chains and food webs through observation of a local pond or grassland ecosystem

In nature, food chains are very complex, as one organism may be the food source of many other organisms. Thus, instead of a simple linear food chain, there is a web-like structure formed by these interlinked food chains. Such interconnected food chains collectively make **'food web'.** Food web can be defined as, "a network of food chains which are interconnected at various trophic levels.

16.2.3 Ecological Pyramids

In 1927, Charles Elton (an English ecologist) developed the concept of ecological pyramids.

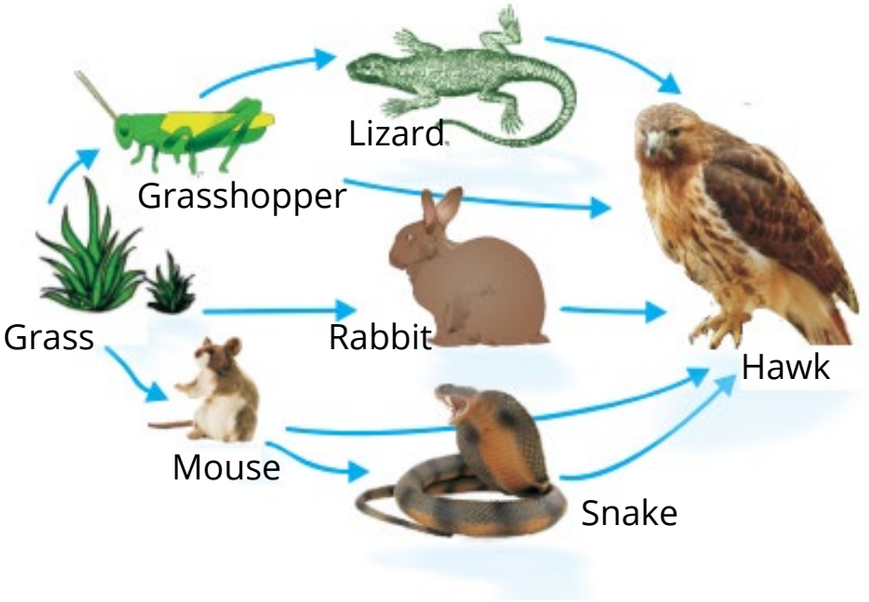


Figure 16.4: A food web in grassland ecosystem

He noted that the animals present at the beginning of food chain are abundant in number while the animals present at the end of food chain are fewer in number. Ecological pyramid can be defined as, "A representation of the number of individuals or amount of biomass or energy present in various trophic levels of a food chain". Ecological pyramids are of three types. Here, we will study two of them.

1. Pyramid of Numbers

It is the graphic representation of the number of individuals per unit area at various trophic levels. Usually, producers are present in large number, primary consumers are in lesser number, secondary consumers are fewer, and so on. So, the producers are of smallest size but maximum in number, while the tertiary consumers are larger in size but lesser in number (Fig. 16.5).

The total amount of living or organic matter in an ecosystem at any time is called "biomass".

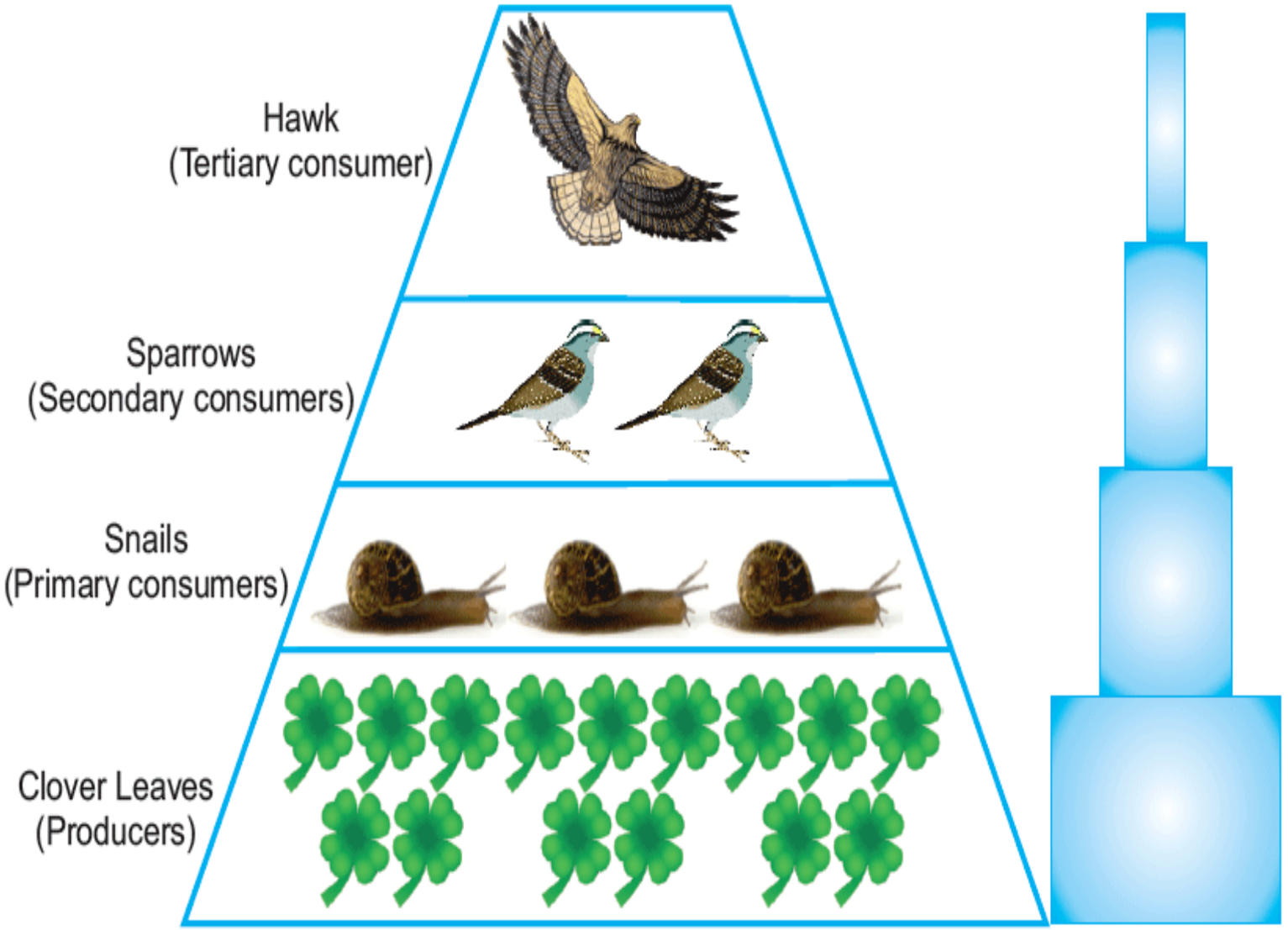


Figure 16.5: Pyramid of numbers in an ecosystem

2. Pyramid of Biomass

It is the graphic representation of biomass present per unit area at different trophic levels. In a terrestrial ecosystem, the maximum biomass occurs in producers, and there is progressive decrease in biomass from lower to higher trophic levels.

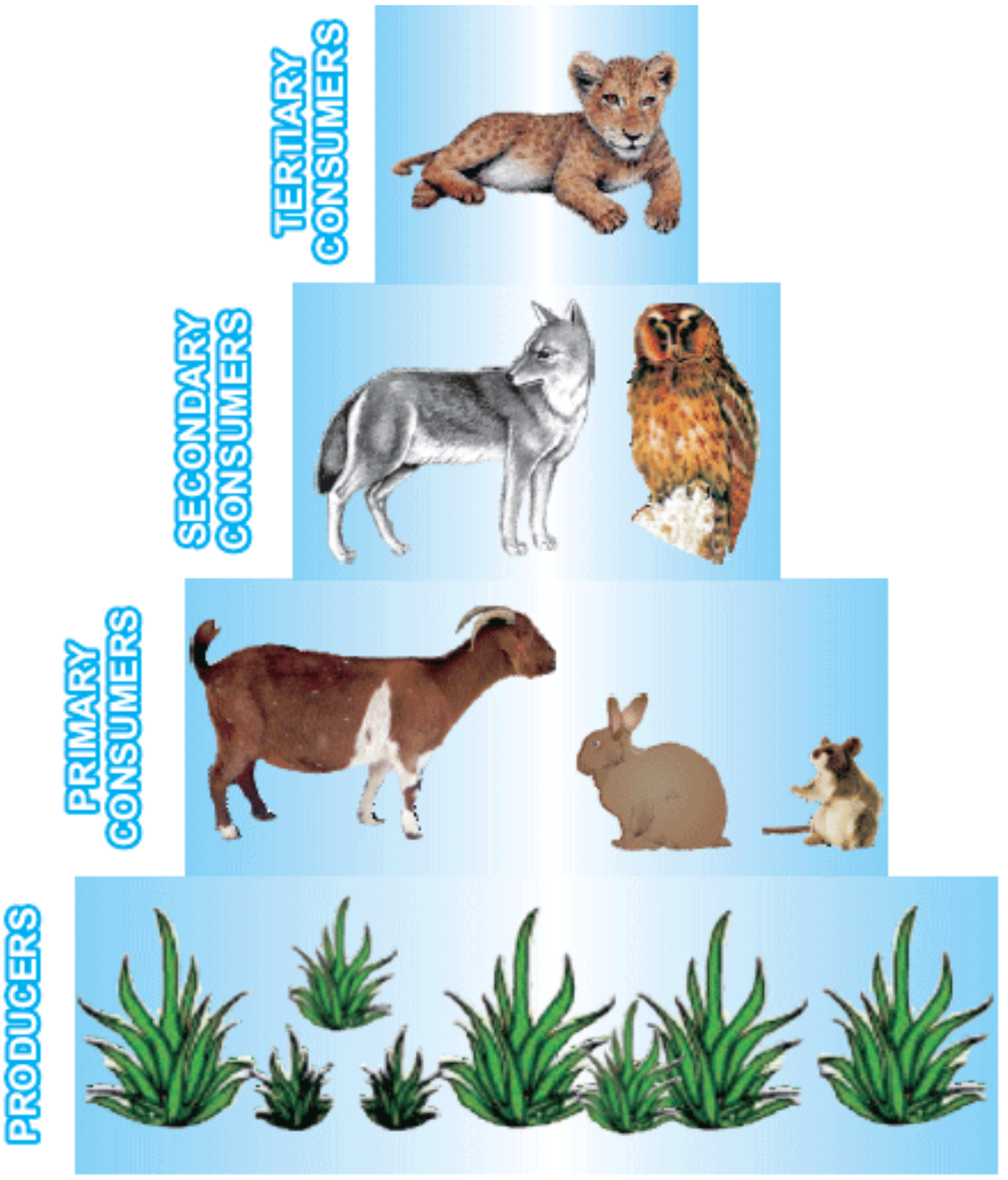


Figure 16.6: Pyramid of biomass in an ecosystem

16.2.4 Biogeochemical Cycles

We know that environment is the source of materials for all living organisms. Environment provides bioelements which are used by organisms for their bodies and metabolism. The materials are continuously recycled between organisms and environment. Biogeochemical cycles are the cyclic pathways through which materials move from environment to organisms and back to environment.

Since such movement of elements and inorganic compounds is essential for maintenance of life, they are also called “nutrient cycles”.

1. Carbon Cycle

Carbon atom is the principal building block of many kinds of biomolecules. Carbon is found as graphite and diamond in nature. It also occurs as carbon dioxide in atmosphere.

Major source of carbon for the living world is carbon dioxide present in atmosphere and water. Fossil fuels like peat, coal, natural gas and petroleum also contain carbon. Carbonates of Earth’s crust also give rise to carbon dioxide.

Carbon cycle is a perfect cycle in the sense that carbon is returned to atmosphere as soon as it is removed.

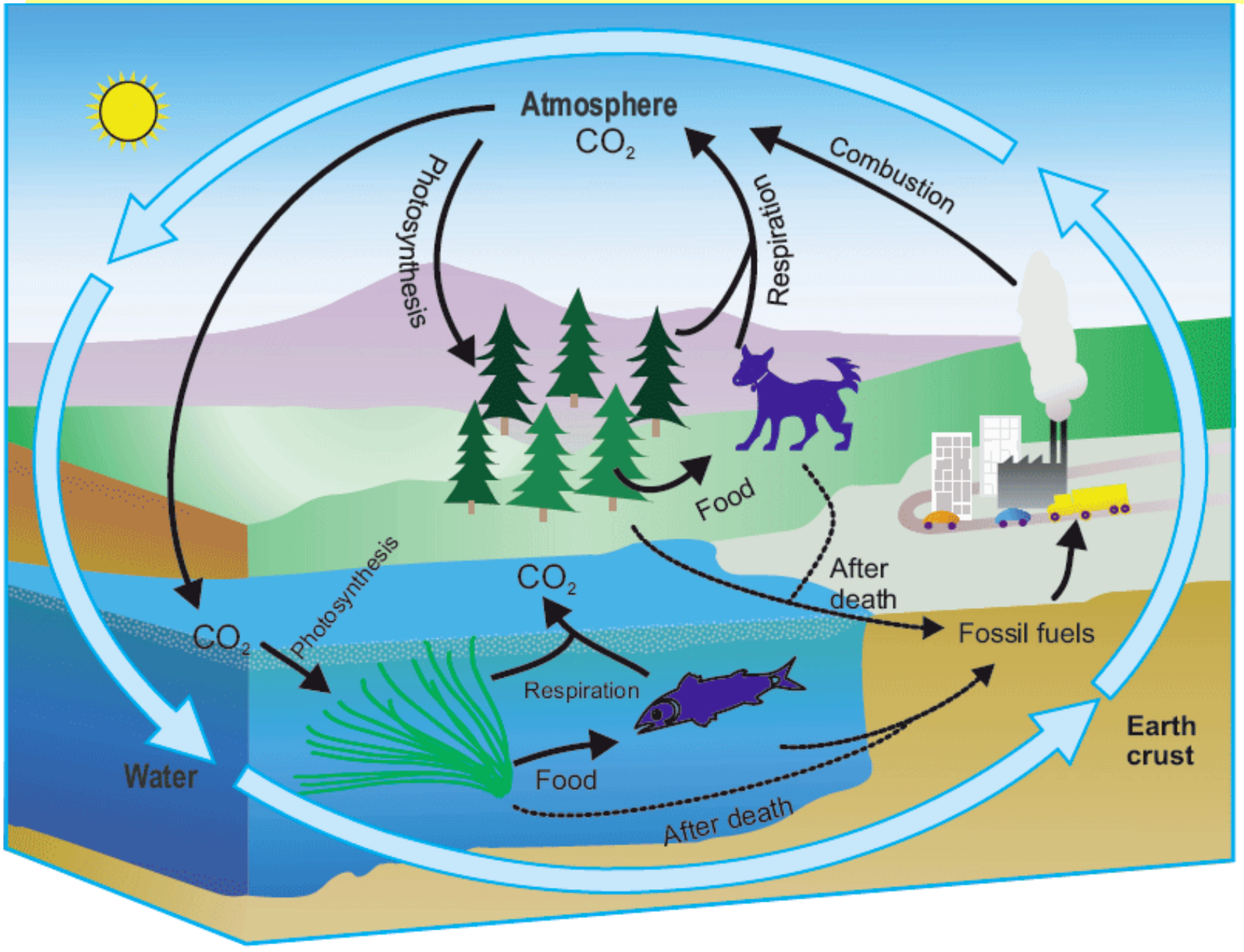


Figure 16.7: Carbon cycle

The major process that brings carbon from atmosphere or water into living world is photosynthesis. Producers take in carbon dioxide from atmosphere and convert it into organic compounds. In this way, carbon becomes a part of the body of producers. This carbon enters food chains and is passed to herbivores, carnivores and decomposers.

Carbon dioxide is released back to environment by respiration of producers and consumers. It is also released by the decomposition of organic wastes and dead bodies by decomposers. Burning of wood and fossil fuels also adds large amount of carbon dioxide into atmosphere.

The balance of carbon cycle has been upset by human activities such as deforestation and excessive burning of fossil fuels. As a result, the amount of carbon dioxide in atmosphere is increasing, causing the green house effect and global warming.

2. Nitrogen Cycle

Nitrogen is an important component of many biomolecules, like proteins and nucleicacids (DNA and RNA). Atmosphere is the reservoir of free gaseous nitrogen. Living organisms cannot pickup this gaseous nitrogen directly from atmosphere (except for nitrogen fixing bacteria). It has to be converted into nitrates to be utilised by plants. Nitrogen cycling involves several stages:

a- Formation of Nitrates

It is done by the following ways:

i. Nitrogen Fixation

Conversion of nitrogen gas into nitrates is called nitrogen fixation. It occurs in the following ways.

- Thunderstorms and lightning convert atmospheric gaseous nitrogen to oxides of nitrogen. These oxides dissolve in water and form nitrous acid and nitric acid. The acids in turn combine with other salts to produce 'nitrates'. It is called as **atmospheric nitrogen fixation.**
- Some bacteria also have the ability to transform gaseous nitrogen into nitrates. It is called **biological nitrogen fixation.** Some of these nitrogen fixing bacteria live as symbionts and many are free-living.

Nitrogen fixation is also done in industries. In **industrial nitrogen fixation,** hydrogen is combined with atmospheric nitrogen under high pressure and temperature. It produces ammonia which is further converted into ammonium nitrate.

ii. Ammonification and Nitrification

Ammonification is the breakdown of the proteins of dead organisms and nitrogenous wastes (urea, uric acid etc.) to ammonia. It is done by ammonifying bacteria. After the formation of ammonia, it is converted into nitrites and nitrates. It is called nitrification and is done by nitrifying bacteria. First, ammonia is converted into nitrites by bacteria (e.g. Nitrosomonas). The nitrites are then converted into nitrates by other bacteria (e.g. Nitrobacter).

b- Assimilation

The nitrates formed by the above processes, are absorbed by plants and are utilized for making proteins etc. Animals take nitrogenous compounds from plants. The utilization of nitrates by organisms is called assimilation.

c- Denitrification

It is a biological process in which nitrates and nitrites are reduced to nitrogen gas by denitrifying bacteria. By this process, nitrogen is returned to atmosphere

Excessive denitrification reduces soil fertility and is stimulated by water logging, lack of aeration and accumulation of organic matter in the soil.

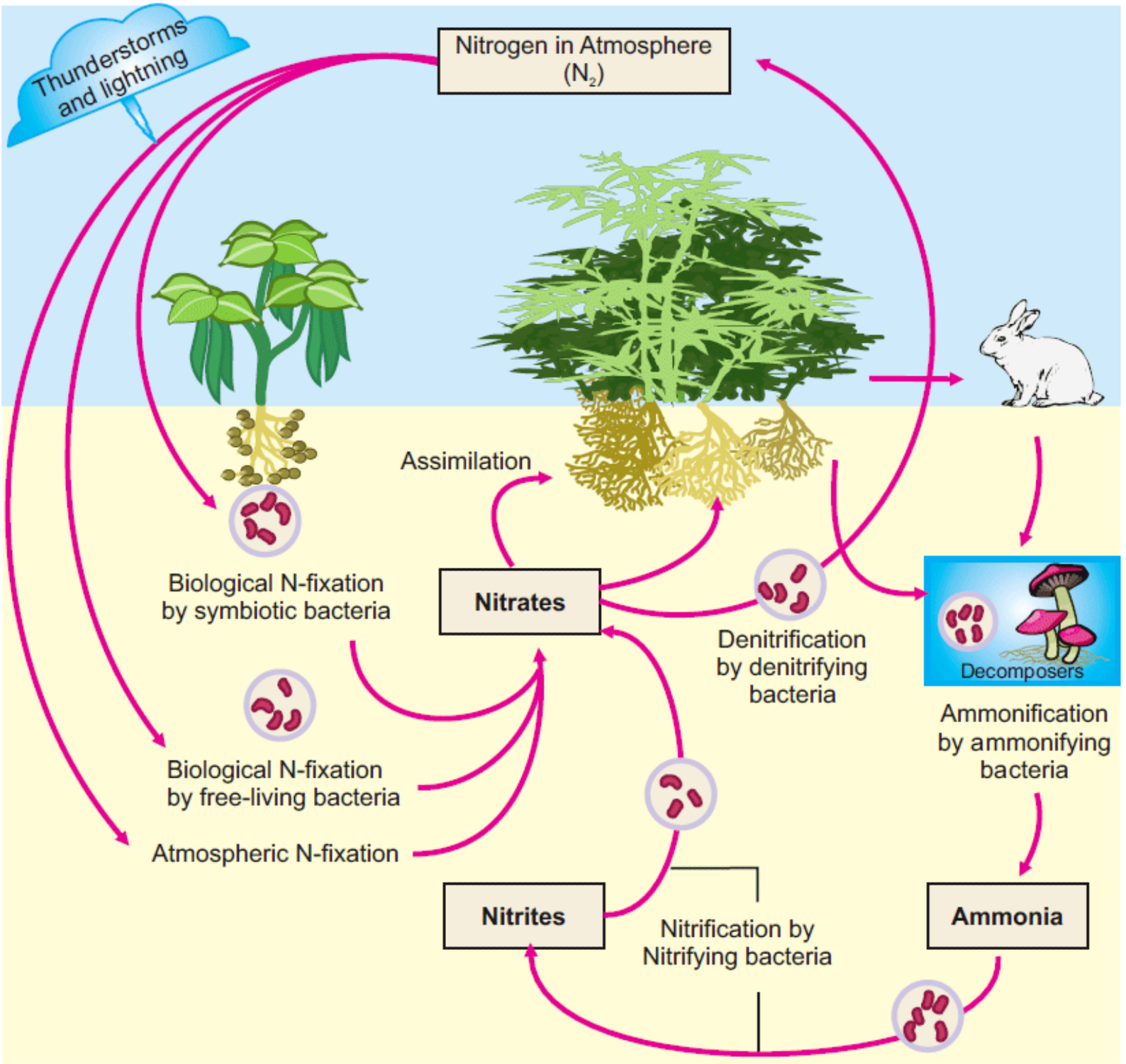


Figure 16.8: Nitrogen cycle

16.3 Interactions In Ecosystems

In all ecosystems, there are many kinds of interactions among living organisms. The **interactions** between the members of the same species are called **intraspecific interactions** while the interactions between the members of different species are called **interspecific interactions**. Some important interactions among living organisms in ecosystems are given below.

16.3.1 Competition

In ecosystems, the natural resources e.g. nutrients, space etc. are usually in short supply. So there is a competition among the organisms of ecosystem for the utilization of resources. The competition may be intraspecific or interspecific.
Intraspecific competition is always stronger and more severe than the interspecific competition. Competition helps in maintaining a balance between the available resources and the number of individuals of a species.

16.3.2 Predation

It is an interaction between two animals of different species or between a plant and an animal. In predation, one organism (the predator) attacks, kills and feeds on other organism (the prey). Some examples of predation are given below.
All carnivore animals are predators (Fig. 16.9). For example, frog preys upon mosquito and fox preys upon rabbit. There are some examples where a predator is preyed upon by a second predator and then the second one is preyed upon by a third predator. For example, frog (predator 1) is preyed upon by a snake (predator 2) and the snake is preyed upon by an eagle (predator 3).

Plants also show competition for space, light, water and minerals.

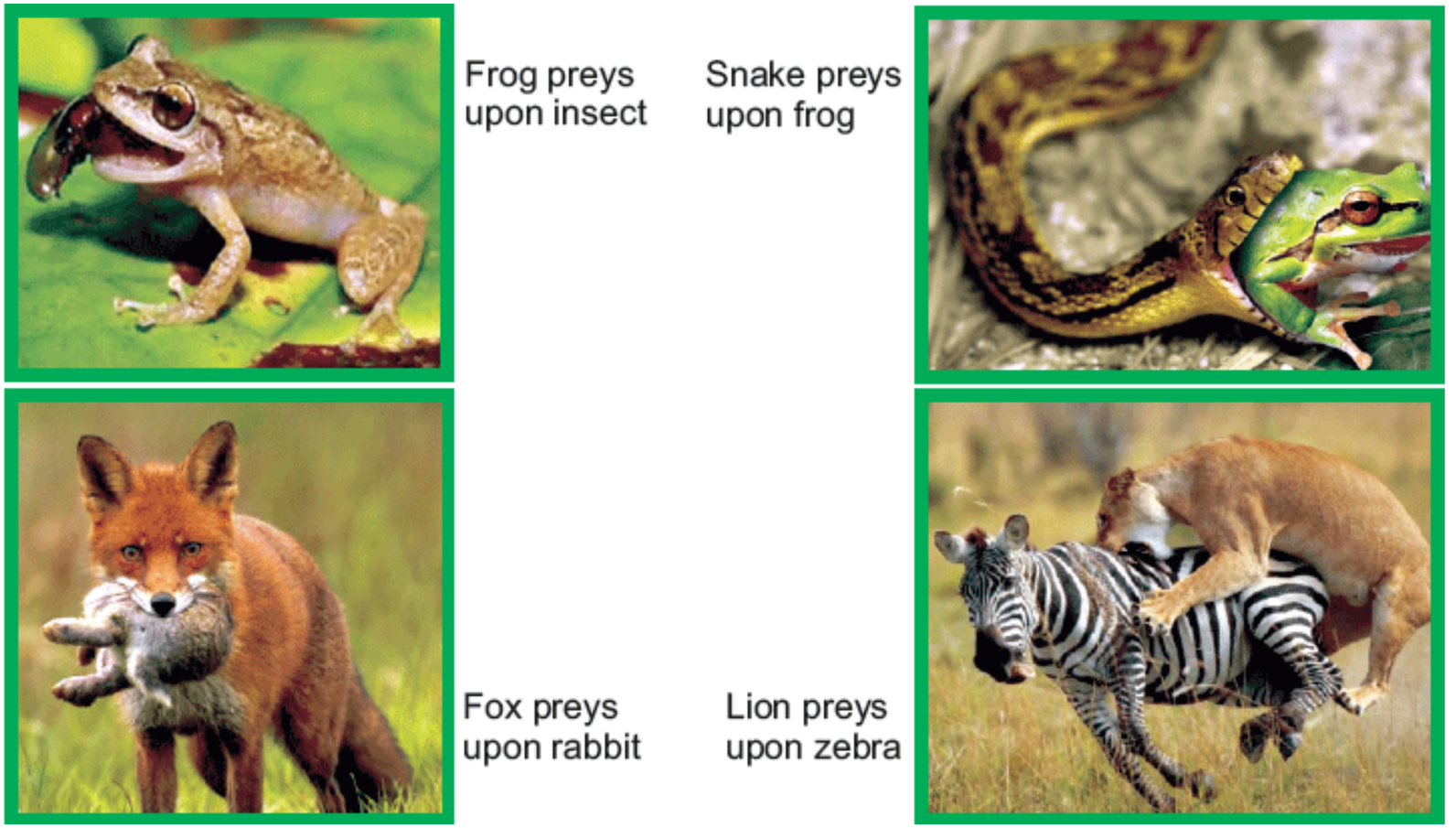


Figure 16.9: Examples of predators and their preys

- Certain plants (Pitcher plant, sundew, Venus fly trap etc.) are carnivorous and live as predators (Fig. 16.10). Such plants live in the areas where minerals and other nutrients are lacking. They feed on insects to fulfill their nitrogen requirements. These plants have mechanism to attract insects. For example, they secrete sweet nectar that attracts the insects searching for food. Their leaves are also modified to capture the prey.

Host can survive without parasite, but parasite cannot survive without host.

Figure 16.10: Predator Plants

Predation keeps the prey population under check, so as to maintain an ecological balance. Humans benefit from this interaction in the biological control of weeds and pests. In order to control pests in an area, their predators are released there.

16.3.3 Symbiosis

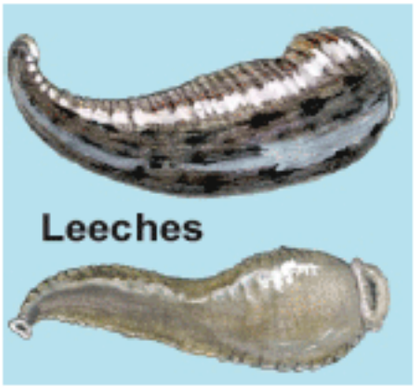
It is a relationship between members of different species, in which they live together for longer or shorter periods of time. Symbiosis is of three types.

a. Parasitism

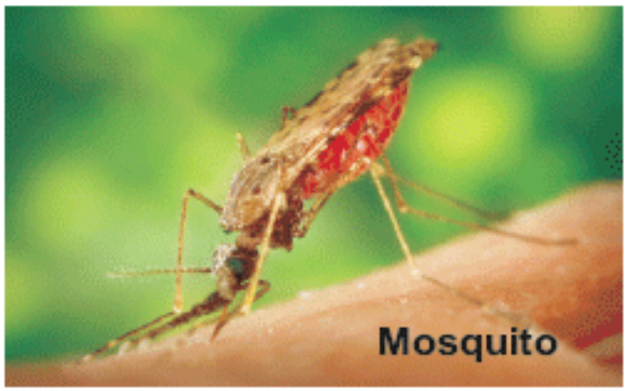
It is a type of symbiosis (between members of different species), in which smaller partner (parasite) derives food and shelter from the body of larger partner (host) and, in turn, harms it.

In temporary parasitism, the parasite spends most of its life cycle as independent free-living organisms. Only a part of its life cycle is spent as a parasite.

Leech, bed bug, mosquito are common temporary parasites of humans. In permanent parasitism, the parasites spend their whole life cycle as parasites. Many disease causing bacteria and all viruses are permanent parasites. Parasites may also be classified as ectoparasites and endoparasites. Ectoparasites live outside i.e. on the surface of host's body and get food from there. Mosquitoes, leeches, lice etc. are the examples of ectoparasites.



Leeches



Mosquito

Endoparasites live inside the body of host and get food and shelter. Bacteria, viruses, tapeworm, Ascaris, Entamoeba, Plasmodium etc. are the examples of endoparasites.

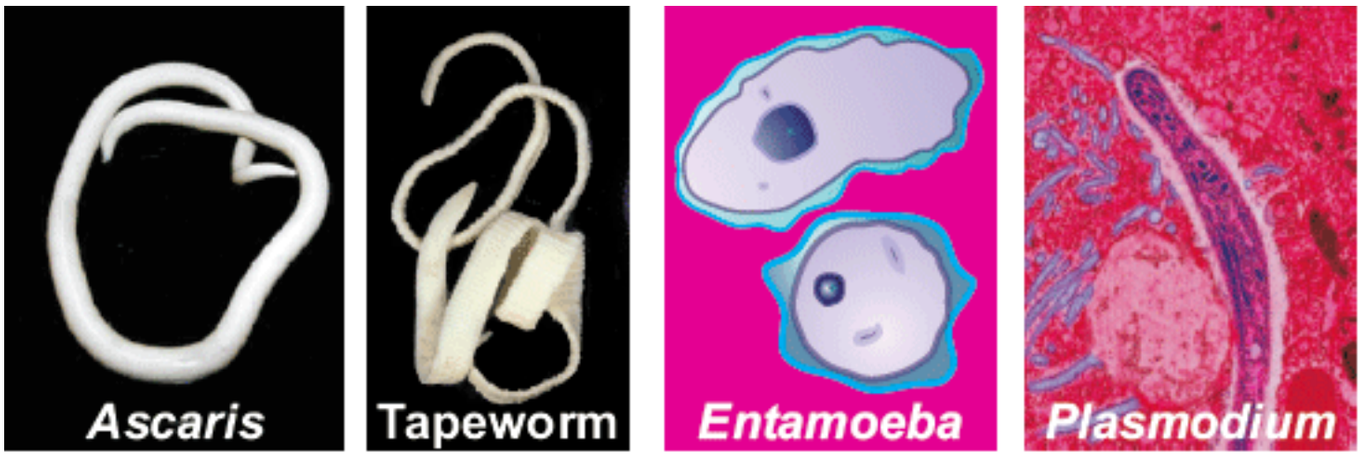


Figure 16.12: Some endoparasites

Some plants (e.g. Cuscuta, also called dodder) are parasites on other plants.
Parasitic plants grow special types of roots (haustoria) into host body and suck the required nutrients from the vascular tissues of host.

b. Mutualism

In this type of symbiotic interaction, both partners (of different species) get benefit and neither is harmed. For example, Termites eat wood but are not able to digest it. A protozoan lives in its intestine. It secretes 'cellulase' enzyme to digest the cellulose of wood. In return, the termite provides food and shelter to the protozoan (Fig. 16.14). The nitrogen fixer bacteria Rhizobium live in the root nodules of leguminous plants like pea, gram etc. The bacteria obtain food and shelter from plants while in return they fix gaseous nitrogen into nitrates for the plant which is required for their growth.

Figure 16.13: A parasitic plant and its host tree trunk

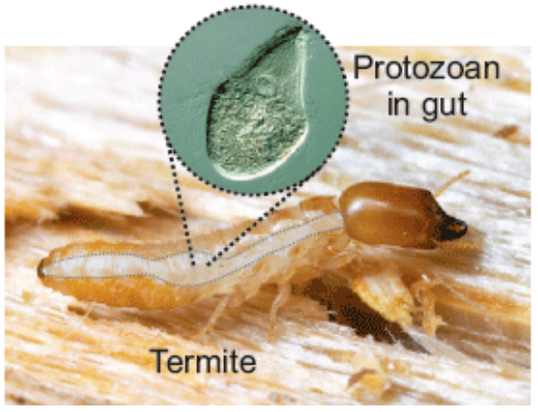


Figure 16.14: Termite, with a protozoan in its gut

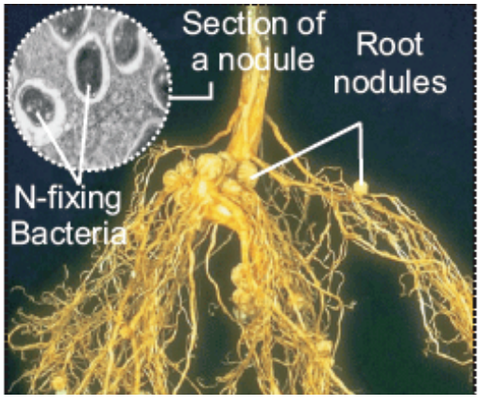


Figure 16.15: Bacteria in root nodules

c. Commensalism

It is a type of symbiosis in which one partner is benefited while the other is neither benefited nor harmed. For example:

- Epiphytes are small plants found growing on other larger plants for space only (Fig. 16.16-a). They absorb water and minerals from atmosphere and prepare their own food. The larger plants are neither benefited nor harmed in any way.
- Sucker fish attaches to the surface of sharks by its sucker (Fig. 16.6-b). In this way, the shark provides easy transport to the sucker fish to new feeding grounds.

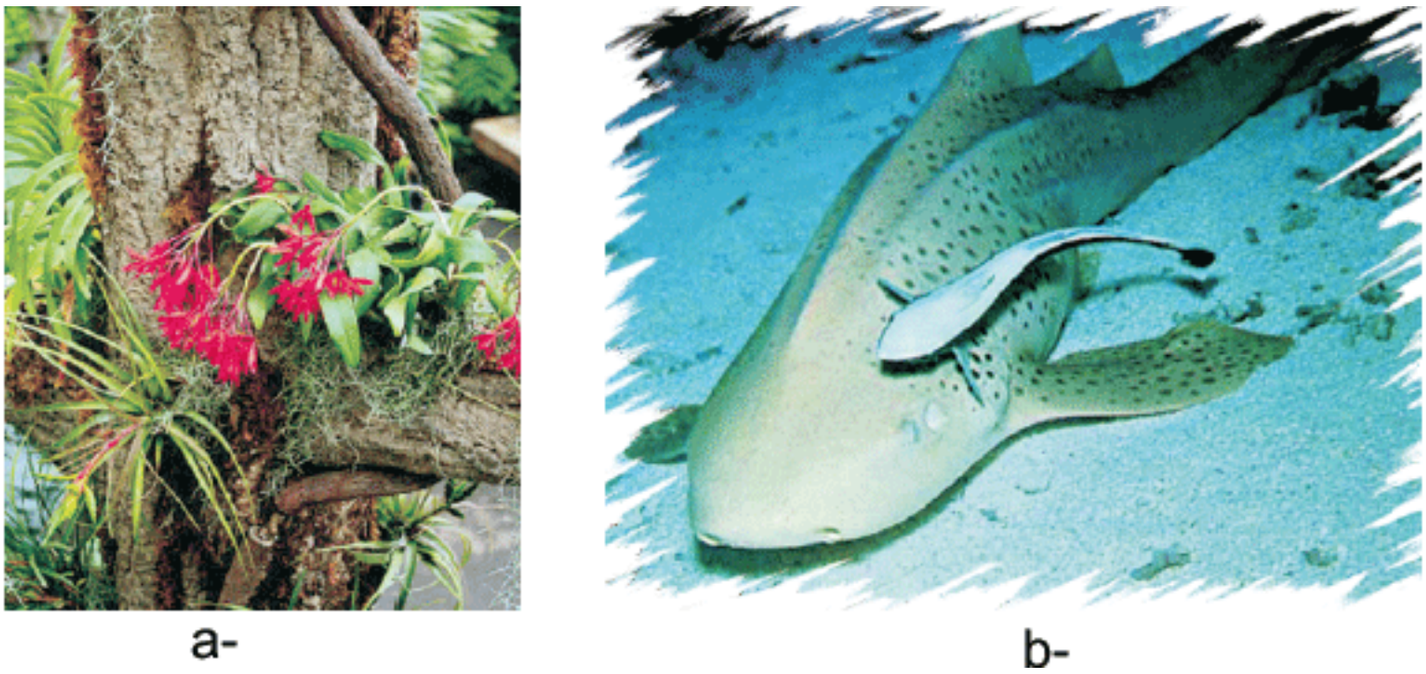


Figure 16.16: a- An epiphyte orchid plant growing on a tree trunk; b- A sucker fish attached with shark

What type of symbiosis is it?

The honeyguide bird feeds on wax and the larvae present in honeycombs. It flies around looking for honeycombs, but it is not strong enough to open the comb. Badgers are large mammals that feed on honey. When a honeyguide bird goes to find honeycombs, the badger follows it. When the bird finds a honeycomb, it calls the badger. Sometimes the bird has to stop and wait for the slow-moving badger. After reaching there, the badger opens the honeycomb and both of them eat their foods together. Traditionally, humans have also used these birds to find honeybee colonies.

16.4 Ecosystem Balance And Human Impact

The interactions among organisms and between organisms and the abiotic components of their environment produce steady and balanced ecosystems. Biogeochemical cycles also maintain the balance in ecosystems by recycling natural resources, so that they do not deplete.

Humans try to modify environment (e.g. cutting of trees) to fulfill their needs. This has upset the delicate balance in ecosystems and nature as well. Some of the human impacts on the balance of ecosystems and nature are described next.

1. Global Warming

The addition of greenhouse gases (e.g. carbon dioxide, methane, ozone) in atmosphere increases the temperature of the Earth. These gases remain in the lowest part of Earth's atmosphere and do not allow solar radiations to reflect back into space. As a result, heat remains within the Earth's atmosphere and increases its temperature. This is called global warming.

Due to global warming, polar ice-caps and glaciers are melting faster than the time taken for new ice layers to form. Sea water is also expanding causing sea levels to rise. Due to melting glaciers, rivers overflow and cause floods.

The Maldives' Survival

Scientists fear that the sea level is rising up to 0.9cm a year. Rise in sea level has worst effects on coastal countries. Most of the islands of the Maldives are less than 1 metre above sea level. It is estimated that within 100 years, the Maldives might become uninhabitable and the citizens would be forced to evacuate.

In 1990, the United Nations established Intergovernmental Panel on Climate Change (IPCC). It provides scientific advice to the world leaders on issues like the build-up of greenhouse gases and its prevention. According to IPCC, Earth's surface temperature has increased ≈0.2°C per decade in the past 30 years.

Greenhouse Effect

The term 'Greenhouse Effect' refers to the phenomenon in which certain gases (called greenhouse gases) trap heat in the atmosphere. These gases act like the glass in a greenhouse, which does not allow the inner heat to escape. When sunlight reaches the surface of the Earth, much of its energy is transformed into heat energy. The Earth surface reflects this heat energy towards space as infrared

radiation. The greenhouse gases trap infrared radiation and send it back to Earth. Carbon dioxide, methane and nitrous oxide are important greenhouse gases. Since 1800, the amount of Carbon dioxide in atmosphere has increased 30 %. The amount of methane has more than doubled and the amount of nitrous oxide has increased about 8%.

2. Acid Rain

When rain falls through polluted air, it comes across chemicals such as oxides of sulphur and nitrogen. These chemicals interact with water vapours in the presence of sunlight to form sulphuric acid and nitric acid. These acids remain as vapour at high temperatures.

As temperature falls, the acids begin to condense into liquid form and mix with rain or snow, on the way down to the Earth. This makes rain acidic with pH range of 3 to 6. Some of the significant ill effects of acid rain are:

- Acid rain destroys the necessary nutrients present in the waters of rivers and lakes etc. Its also lowers the pH of water. Most of the aquatic animals cannot survive at this pH.
- Acid rain washes nutrients out of soil, damages the bark and leaves of trees and harms root hairs. Leaf pigments (chlorophyll) are also destroyed.
- Metallic surfaces exposed to acid rain are easily corroded. Fabrics, paper and leather products lose their material strength or disintegrate easily.
- Building materials such as limestone, marble, dolomite, mortar and slate are weakened with acid rains because of the formation of soluble compounds. Thus, acid rain is dangerous for historical monuments. The building of famous Taj Mahal has been corroded at many places, due to acid rains (Fig. 16.17).

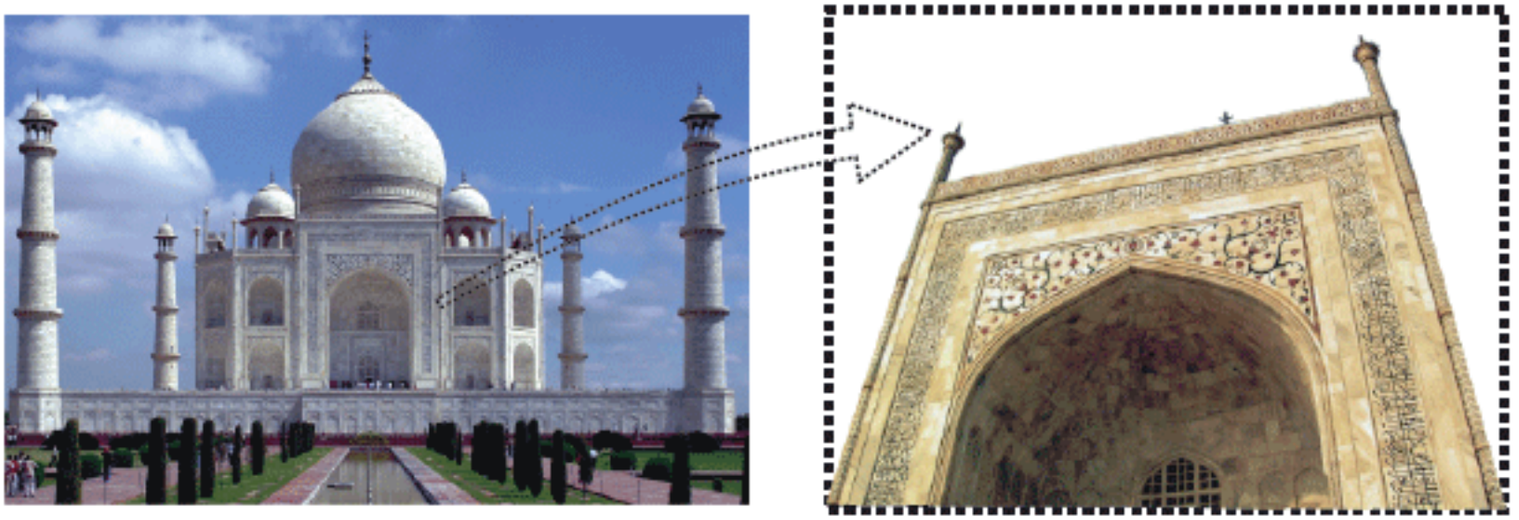


Figure 16.17: Taj Mahal and its corroded door

3. Deforestation

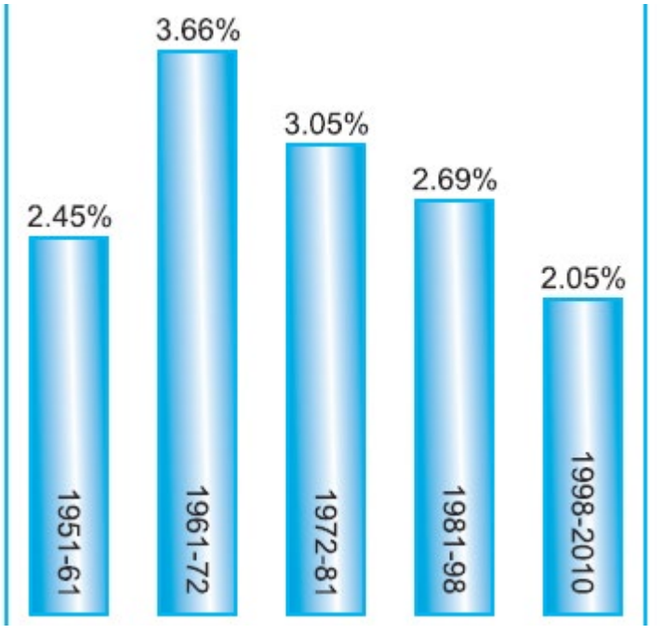
Deforestation means clearing of forests by natural causes or humans. Large areas of forests have been cleaned for agriculture, factories, roads, rail tracks and mining. Humans cut trees for getting wood (lumber), which is then used for making structures and for heat production. Human preys upon forest animals, which are the predators of many insect pests. In this way,
insect pests destroy forests by eating the shoots and spreading diseases. The effects of deforestation include floods, droughts, landslides and soil erosions, global warming and loss of habitat of many species.

Figure 16.18: Forests are cut for making roads

4. Overpopulation

When the industrial revolution started some 250 years ago, the world population was at 600 million - that seems like a lot of people but now the world population is almost ten times at 6 billion and will grow to 8 billion by 2025. Better health facilities and lowered mortality rates have contributed in population growth.

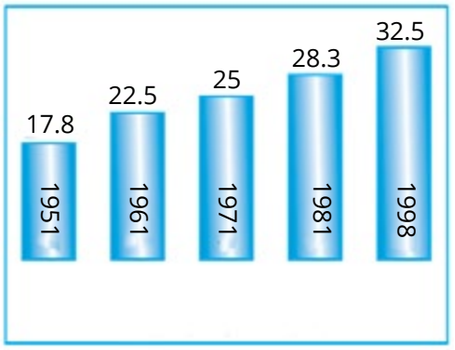
Year	Population
1981	85,096,000
1984	92,284,301
1987	99,953,232
1990	107,975,060
1993	116,444,165
1996	125,409,851
1999	134,790,000
2002	144,902,409
2005	155,772,000
2008	166,111,487
2009	169,708,303
2010	173,510,000



Pakistan Population Growth Rates
Source: Pakistan Economy survey
Ministry of Population Welfare
Government of Pakistan

5. Urbanization

Urbanization means growing of cities. People move from rural areas to cities in search of better jobs, education opportunities and higher standards of living. If there is rapid urban growth, the governments find it difficult to provide even the basic facilities like health, education, shelter, water, electricity etc. Most of the migrants in cities do not find good jobs and become the part of urban poor. There is overcrowding in schools, hospitals etc. The slum areas increase in number and people living there are at greater risk of diseases.



Pakistan Urban population in %age
Source: The world Bank

Urbanization is a global problem and cannot be stopped but it can be managed. The current level of urbanization in Pakistan is about 32% which is not high by global standards. A planned urbanization can solve many problems. The cities should have thick green belts in their surroundings to control pollution. The open spaces in cities should be reserved through zoning and land plans. The urban spread-out should also be controlled. Utilization of public transport instead of individual transports also proves effective way to manage urbanization.

16.5 Pollution; Consequenses And Control

For better life, human society is becoming more and more dependent on technology and industries. Technology and industry are making life easier and convenient for humans but are also contributing towards the pollution of
environment. Pollution is defined as any undesirable change in the physical, chemical or biological characteristics of air, water and land that may harmfully affect living organisms and natural resources.

1. Air Pollution

Air pollution is one of the major environmental issues of today. It is defined as the change of composition of air by the addition of harmful substances (e.g. industrial and automobile gases and particulate matter). All sources of air pollution are related to human activities. Burning of coal produces a lot of smoke and dust whereas burning of petroleum produces sulphur dioxide. In addition to these, air pollutants include carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons, particulate matter and traces of metals. Different industries produce air pollution in the following way.

The substances that actually cause pollution are called the pollutants. They may be the industrial effluents, domestic wastes, medical wastes etc. Pollutants are of two types i.e. biodegradable and non-biodegradable.

Fertilizer industries release oxides of sulphur and nitrogen, hydrocarbons, particulate matter and fluorine. Thermal industries are coal based and their pollutants are fly ash, soot and sulphur dioxide. Textile industries release cotton dust, nitrogen oxides, chlorine, smoke and sulphur dioxide. Steel industries release carbon monoxide, carbon dioxide, sulphur dioxide, phenol, fluorine, cyanide, particulate matter etc.

Effects of Air Pollution

We have studied that global warming is one of the consequences of air pollution. Other effects of air pollution are as follows.

Smog formation:

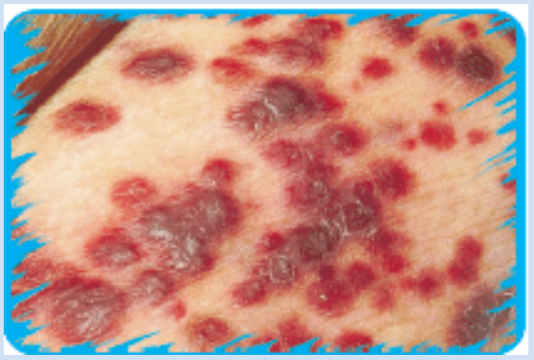
When pollutants like hydrocarbons and nitrogen oxides combine in the presence of sunlight, smog is formed. This is a mixture of gases. It forms a yellowish brown haze especially during winter and hampers visibility. It also causes many respiratory disorders and allergies as it contains polluting gases.

Acid rains:

The air pollutants like sulphur dioxide and nitrogen oxides react with water in the atmosphere producing acid rains.

According to estimates, at the current rate of increase, the average global temperature will go up by 3^{o}C to 8^{o}C in the next 100 years.

Ozone depletion: The upper layer (stratosphere) of the atmosphere has ozone (O_3) which absorbs ultraviolet (UV) rays present in the sun's radiation. However, the air pollutants like chlorofluorocarbons (CFCs) destroy the ozone molecules and so break the ozone layer. Ozone holes are created which permit UV rays to reach the Earth's surface. The UV rays increase the temperature and also cause skin cancers.



The harmful effects of the UV rays are visible in the countries such as Australia and New Zealand where the rate of skin cancer is higher than the other regions of the world.

Control of Air Pollution

For effective control of air pollution, it is important to create public awareness about the ill-effects of air pollution. Air pollution can be controlled by the following ways:

Afforestation: It means the establishment of new forests by planting on non-forest areas. Forests are effective means to control air pollution because plants can filter and absorb air pollutants

Modification of industrial effluents: The air pollutants coming from industries should be passed through filters and other devices, so that the particulate matter is removed before the waste gases are released out. The smoke producing units should have long chimneys to take the polluting gases far above and then disperse over a larger area. Industries should also invest for solar cookers or for producing bio gas.

Environment friendly fuels: Lead-free fuels should be used in automobiles. Similarly, sulphur-free fuel should be used in coal-based industry to reduce pollution by sulphur dioxide.

2. Water Pollution

It is the change in the composition of water by the addition of harmful substances. Water pollution severely affects the health of people. Sewage is one of the major pollutants of water. It contains organic matter and the excreta of human and other animals. Organic matter encourages the growth of microorganisms which spread diseases. The wastes of industries (acids, alkalis, dyes and other chemicals) are disposed in nearby water bodies. These wastes change the pH of water and are harmful or even fatal to aquatic organisms. Certain industries release a lot of hot water from their cooling plants. It results in heating up of water bodies and kills aquatic life. Fertilizers and pesticides enter into water bodies with the rain water flow and the ground water by seepage. These chemicals remain in water for a long time and can enter food chains. They cause a number of diseases in animals. Oil tankers and offshore petroleum refineries cause oil leakage into water.

Oil floats on the water surface and prevents atmospheric oxygen from mixing in water. So, aquatic animals begin to die due to oxygen shortage.
Some heavy metals e.g. lead, mercury, arsenic and cadmium also make the water polluted. Such metals can be present in the water, released from industrial and urban areas.

If water with such heavy metals is given to plants, the metals enter the vegetables that grow on these plants. Such contaminated vegetables are harmful for human health. Heavy metals reduce growth and development, and cause cancer and nervous system damage. Mercury and lead can cause joint diseases such as rheumatoid arthritis, and diseases of kidneys, circulatory system and nervous system.

There are more than 200 tanneries (industry where raw skin is treated to make leather) operating in Kasur city. The industry discharges 9000 cubic metres of waste water daily into the nearby water bodies. This water contains heavy metals and becomes a part of the underground water. In 2003, a survey showed that two-thirds of residents and 72 percent of tannery workers suffered cancer, infections of the kidney, or loss of eyesight. Tests showed that the drinking water was contaminated with lead, mercury and chromium. The Pakistan government and the United Nations Development Programme (UNDP) launched the Kasur Tannery Pollution Control Project. The project has established an effluent treatment plant, chromium plant and a solid waste disposal site.

Effects of Water Pollution

The following are major effects of water pollution.

Eutrophication: Enrichment of water with inorganic nutrients (nitrates and phosphates) is called **eutrophication.** The sewage and fertilizers contain large amount of inorganic material (nutrients). When sewage and fertilizers reach water bodies, the nutrients present in them promote algal blooms (excessive growth) there (Fig. 16.19). Rich algal growth leads to increase in the number of the decomposers. Decomposers use the oxygen present in water and it results in the depletion of oxygen. Algal bloom also reduces the light reaching the lower layers in water.

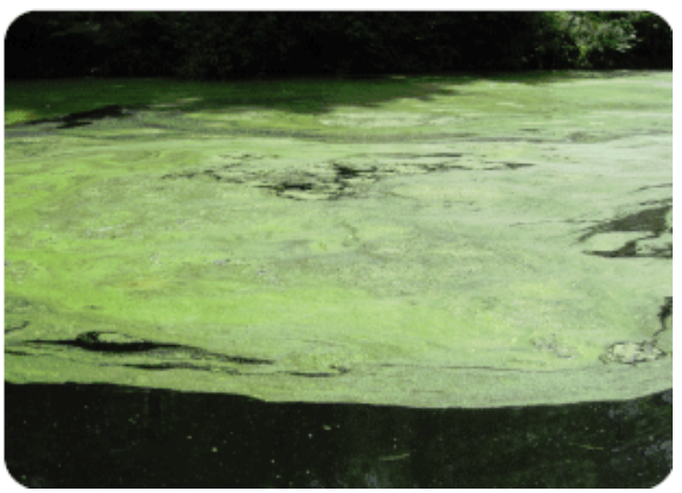


Figure 16.19: Eutrophication in a lake

Food chain contamination: The non-biodegradable water pollutants may stay in water for long times. From water, they enter into small organisms, which are fed upon by fish. The fish in turn are fed upon by land animals including human.

Epidemics: Organic pollutants in water facilitate the growth of germs. Such polluted water causes epidemics like cholera, gastroenteritis etc.

Control of Water Pollution

Public should be made aware of the dangers of water pollution. Before releasing the sewage into water bodies, it must be purified through sewage treatment techniques. Industrial wastes should also be treated before they are released into water bodies.

Analyzing and Interpreting

- Interpret the data about local environmental problems (through survey search).
- Plan and carry out simple investigation to determine the nature and effects of pollutants

3. Land Pollution

Land (soil) is an important resource as it is the basis for the growth of producers. In the recent times, soil has been subjected to pollution.

The pesticides used in agriculture have chemicals that stay in soil for long times. The acid rains change the pH of soil making it unsuitable for cultivation. The household and other city garbage lies scattered in soil in the absence of a proper disposal system. Materials like polythene block the passage of water into soil and so decrease the waterholding capacity of soil.

Many industries produce harmful chemicals which are disposed of without being treated. Improper disposal of nuclear wastes also causes radioactive substances to remain in soil for a long time. Open latrines in villages and some parts of cities are also the source of land pollution.

Control of Land Pollution

There should be suitable and safe disposal of wastes including nuclear wastes. Nonbiodegradable materials like plastic, glass, metals etc. should be recovered and recycled. Inorganic pesticides should be replaced by organic pesticides.

Figure 16.20: Can we control land pollution?

16.6 Conservation Of Nature

Conservation of nature means the conservation of natural resources. Everything that we use or consume e.g. food, petrol etc. is obtained from natural resources. The renewable natural resources e.g. air are reproduced easily but the non-renewable resources (e.g. minerals and fossil fuels) are not replenished once they get depleted. We have to conserve the non-renewable resources because their reserves are limited and humans are heavily dependent on them for daily needs. The renewable resources too have to be judiciously used. To ensure sustainable use of resources in our environment, we should act upon the principle of 'The 3R' i.e. Reduce, Reuse, and Recycle.

The R1: Reduce: We should use the natural resources less and should not waste them. We should use this principle at different places, in our daily lives. We should not waste water, electricity, fuel etc.

We should turn off the tap when not in use. We should bathe with a bucket instead of shower. The lights and fans should be off, when we are not in room. We should take public transport (like buses) or walk short distances instead of using motor fuel. We should not waste food and should give unused food to poor people.

A recycling of one tone paper can save 17 trees

A recycling of one tonne of paper can save 17 trees.

Clean water, air, fuels, agricultural land and forests appeared to be plentiful earlier, but now these are becoming scarce. If we continue depleting them like this, we will be creating untold misery for ourselves and for our future generations.

The R2: Reuse: We should use things again and again. We should not throw away materials such as glass containers, plastic bags, paper, cloth etc. These should be reused at domestic levels rather than being thrown. It also reduces solid waste pollution.

The R3: Recycle: Materials such as paper, plastic, glass etc. can be recycled. This decreases the volume of refuse and helps in the conservation of natural resources.

We can add the R4 i.e. Reforest. Trees should be planted during the rains. Trees make our environment more cool, shady and green.

Plans for the Conservation of Nature

In Grade IX, we have studied the projects and plans of Pakistan for the conservation of wildlife, which is an important natural resource. The following are the projects and plans of our government for the conservation of other resources.

In 1992, Pakistan developed and the National Conservation Strategy. The main objectives of the strategy are conservation of natural resources and improved efficiency in the use of resources. It also covers the policies for promoting efficiency and conservation of energy resources.

The Federal Ministry of Environment has launched the National Drinking Water and Sanitation Policy. It focuses on the provision of clean drinking water to entire population and the conservation of water resources. Water purification plants are being installed all over the country.

In 2006, the UNDP launched the project "Mass Awareness for Water Conservation and Management". The objective of the project was to launch a comprehensive awareness campaign for the conservation and management of water resources in Pakistan.

The organization SCOPE (Society for Conservation and Protection of Environment) works with government for mass awareness and research for the conservation of natural resources in Pakistan.

The WWF (old name is World Wildlife Fund but now it is called World Wide Fund for Nature) is working on many projects related to the conservation of nature. The following are some important programmes of WWF-Pakistan (in collaboration with the government of Pakistan):

- Improving sub-watershed management and environmental awareness around Ayubia National Park
- Plantation of the trees of Jatropha and Mangroves at District Thatta, Sindh
- District-wise forest cover assessment of Pakistan
- Saving Wetlands Sky High Programme (for the conservation and management of high altitude wetlands)
- Indus Basin Water Security Project (to protect the water-flow needed for the maintenance of river ecosystem and for the benefit of nearby areas)
- Regional Climate Risk Reduction in Himalayas

Analyzing and Interpreting

Collect data from internet and state the names of endangered and threatened animals species in Pakistan.

Basic Information about Dengue Fever

Dengue fever is a viral infection transmitted through a mosquito Aedes aegypti. It has become a major health problem in tropical and sub-tropical countries, including Pakistan. There are four types of dengue virus. Recovery from infection by one provides lifelong immunity against that virus but provides no protection against infection by the other three viruses. According to the World Health Organization, there are 50 million dengue infections worldwide every year. Now, there are 2.5 billion people at risk from dengue.

The female Aedes mosquito gets the virus when it bites an infected person. When an infected mosquito bites another person, viruses enter his / her blood and attack white blood cells. Inside WBCs, viruses reproduce and destroy them. In severe cases, the virus affects liver and bone marrow. As a result there is a decrease in the production of blood platelets and patient suffers from bleeding. Other symptoms of dengue include high fever, severe headache, pain behind the eyes, muscle and joint pains and rash.




Adult Aedes ⇨ Eggs of Aedes ⇨ Larva of Aedes ⇨ Pupa of Aedes

Sometimes, dengue fever converts into dengue haemorrhagic fever (DHF) or into dengue shock syndrome (DSS). DHF results in bleeding, low levels of blood platelets and blood plasma leakage. In DSS the blood pressure falls dangerously low. There is no vaccine or treatment for dengue fever. At present, the only method of controlling dengue virus transmission is to check the spread of Aedes mosquitoes. Aedes aegypti breeds primarily in the containers used for water storage, discarded plastic containers, used automobile tyres and other items that collect rainwater. The mosquitoes can be controlled through proper solid waste disposal and improved water storage practices. Small fish and crustaceans have also been used for killing the larvae of the mosquito. Insecticide sprays have not proved efficient in killing the mosquitoes, because spray does not penetrate all habitats of adult mosquitoes.

UNDERSTANDING THE CONCEPT

1. Explain what do you mean by the pyramids of number and biomass.
2. Write a note on Carbon cycle.
3. What are the different stages of Nitrogen cycle?
4. Write notes on competition, predation and symbiosis.
5. Explain how human activities have contributed to the loss of balance in nature.
6. Write note on the causes and effects of the air and water pollutions.

SHORT QUESTIONS

1. What are the different levels of ecological organization?
2. Define ecosystem and its components.
3. How the flow of energy is different from that of materials?
4. Define food chain and food web.
5. What do you mean by the concept of 3Rs with reference to the conservation of natural resources?

THE TERMS TO KNOW

Abiotic
Acid Rain
Ammonification
Atmospheric nitrogen fixation
Biogeochemical Cycle
Biological nitrogen fixation
Biosphere
Biotic
Carbon cycle
Carnivore
Commensalism
Competition
Consumer
Decomposer
Deforestation
Denitrification
Ecological pyramid
Environment
Eutrophication
Food chain
Food web
Global Warming
Interspecific interactions
Intraspecific interactions
Mutualism
Natural resources
Nitrification
Nitrogen cycle
Nitrogen fixation
Non-renewable resources
Overpopulation
Ozone
Parasitism
Phytoplankton
Pollutant
Pollution
Predation
Producer
Pyramid of biomass
Pyramid of numbers
Renewable resources
Symbiosis

ACTIVITIES

1. Make a visit to a pond and compare the abiotic and biotic factors of a pond with that of an aquarium.

SCIENCE, TECHNOLOGY AND SOCIETY

1. State how your city or village is an ecosystem and describe your position and role in that ecosystem.
2. Describe the possible consequences of competition (due to limited resources and overpopulation) in human society.
3. Use data from internet and literature search on Pakistan population growth from 1990 to 2000 and interpret this population growth and the possible consequences on our society.
4. Identify environmental problems in your community. What are the causes and what should be done to solve these problems?
5. Actively participate in the community efforts for the conservation of nature.
6. Organize a poster or picture exhibition at school on some environmental topic.

ON-LINE LEARNING

1. http://www.environment.gov.pk/
2. www.sciencedaily.com/news/earth.../environmental_science/
3. www.globalchange.umich.edu/.../ecosystem/ecosystem.html
4. www.biology.ualberta.ca/facilities/multimedia/.../Ecosystem.swf
5. 3dnature.com/anims.html