4. How is artificial selection used for the improvement of crops?
5. Differentiate between different types of dominant relations.
6. Write down the phenotypes of the individuals in the following table.

Genotype	Phenotype
I^AI^A or	
I^BI^B	
I^Bi	
I^Ai	
ii	
I^AI^B	

C. Write detailed answers to the following questions:

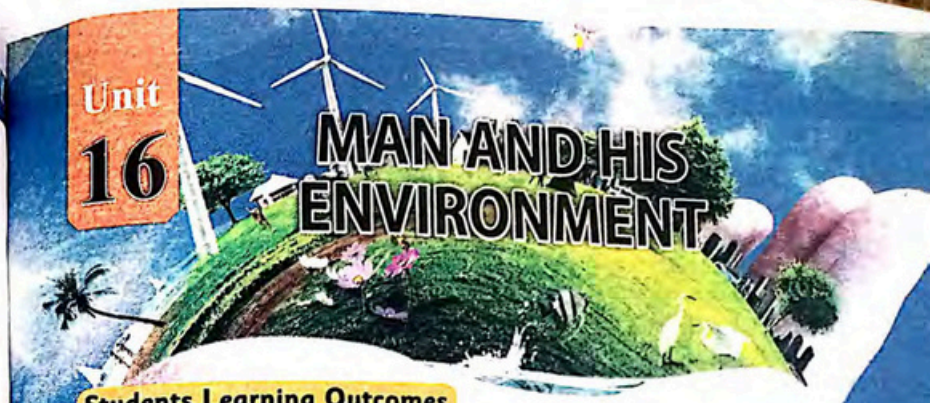
1. Relate the structure of chromosome with DNA and gene. Draw a concept chart to explain your answer.
2. Explain with the help of a diagram the relationship amongst DNA, RNA and proteins.
3. Explain why Mendel selected peas as a subject for studying genetics?
4. Explain the law of independent assortment with the help of an example and chart.
5. Describe the sources of variations. Explain the importance of variations in organisms.
6. Draw a cross between two pea plants. One of them has round green seeds (RRyy) while the other has wrinkled yellow seeds (rrYY).

Activity

1. Draw the chromosomes of a plant cell after observing it in a prepared slides / unlabelled charts.

Science, Technology and Society

1. Describe various possibilities if humans could control the functioning of genes.
2. Prepare a report using newspaper clippings on the recent advances and future possibilities in genetics.
3. Rationalise life as a product of the diversity brought about by chromosomes, genes and DNA.
4. Outline the scientific findings and some of the technological advances that led to the modern concept of gene.
5. Analyse the concept of the gene to produce various proteins of the body.
6. Describe the importance of scientific investigation and mathematical knowledge in genetics.
7. Explain how genetics can predict the progeny of two individuals which are crossed.
8. Describe the effects of the environment that lead to the selection of a variant which is more adapted to it.



Unit 16 MAN AND HIS ENVIRONMENT

Students Learning Outcomes

The students will be able to:

- Describe levels of ecological organisation.
- Define ecosystem.
- Describe components of the ecosystem.
- Describe the interrelationships between different components of the ecosystem.
- Explain that the sun is the principal source of energy for all biological systems.
- Compare and contrast the flow of materials (cyclic) and the flow of energy (non-cyclic) in the ecosystem.
- Describe food chains and food webs.
- Describe and compare energy relations between different trophic levels.
- Interpret pyramids of numbers and biomass.
- Describe carbon and nitrogen cycles.
- Relate biogeochemical cycles with flow of energy and ecological balance.
- Explain competition, predation and symbiosis (parasitism, mutualism, commensalisms).
- Relate competition, predation, and parasitism with population growth.
- Describe the importance of balance in nature.
- Explain the human impact on the environment.
- Explain some global and regional environmental problems (population growth, urbanisation, global warming, deforestation, acid rain).
- Explain causes of air, water, and land pollution.
- Describe effects of pollution on plants, animals and human beings.
- Describe possible actions to control pollution.
- Explain conservation of nature.
- Explain different strategies for conservation of nature (reduced resource use, reuse and recycling of materials etc.).

Introduction

Recall from earlier grades that the environment is defined as the surroundings in which and organism lives. You also know that the environment has two components i.e. biotic and abiotic. The abiotic component includes the air (atmosphere), water (hydrosphere) and land (lithosphere). The biotic component includes plants, animals and the microbes. Organisms are dependent on the environment to fullfil their needs. A healthy environment is an absolute necessity for the wellbeing of all organisms, including that of human beings. In this chapter you will study different aspects of the environment and how it is being damaged. You will also learn why we need to conserve our precious resources, which by no means are unlimited.

16.1 Levels of Ecological Organisation

Environments exhibit different levels of organisation. Each level in this organisation represents its own characteristic nature and function. The various levels of ecological organisation are as under:

1. Species

A species is a group of similar organisms that can breed with one another naturally to produce fertile offsprings. Members of the same species have the same needs (food, living place etc.) and, therefore, compete with one another for their needs.

2. Population

In ecology, population is defined as a group of individuals, belonging to the same species, living in the same place at the same time and sharing the same resources e.g population of students in a school, population of frogs in a pond, population of pine trees in the forest etc.

Do You Remeber?

A specific locality, with a particular set of environmental conditions where an organism lives is called habitat. Freshwater streams and rivers are the habitats of fish, a tree is a habitat of large varieties of birds and a rotten log is a habitat of insects, fungi and microorganisms. In a particular habitat, each organism has a specific role to play. This ecological role that a species plays in a habitat is called niche.

3. Community

A community consists of all the interacting organisms of different populations living in an area. For example, all the fish, turtles, plants, algae, and bacteria in the pond make up a community.

4. Ecosystem

Ecosystem is the basic structural and functional unit of ecology. Ecosystem can be defined as a natural area where the living organisms (plants and animals) and their environment interact and exchange materials between them. This interaction as a result leads to functional stability of an ecosystem.

Do You Remeber?

The regional ecosystems classified according to the predominant vegetation are called biomes. The major biomes of the world are tundra, forest, grassland, desert etc.

5. Biosphere

The parts of the earth where life exists is called the biosphere. It is the broadest level of ecological organisation. The biosphere is about 20 km thick and extends into the atmosphere (air), lithosphere (earth) and hydrosphere (water).

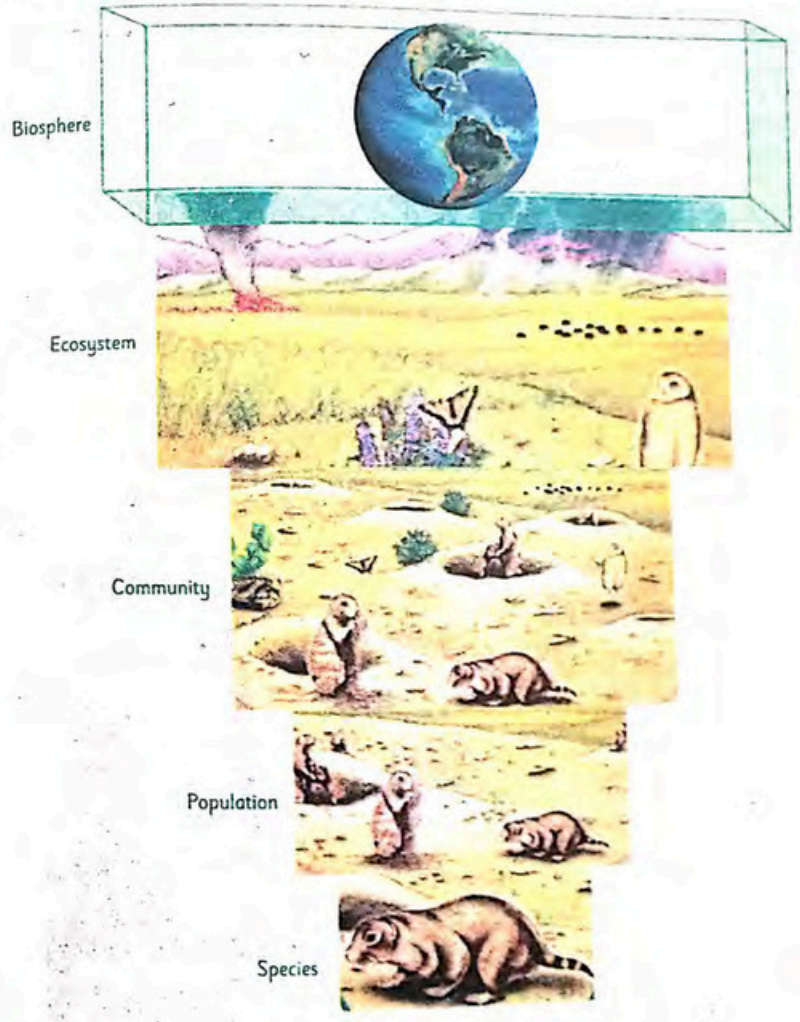


Fig.16.1 Levels of ecological organisation

16.1.1 Components of an Ecosystem

An ecosystem consists of two major components namely, abiotic components and biotic components. Both these components are equally important for the proper functioning of the ecosystem.

a. Abiotic Components of an Ecosystem

These are the physical and chemical characteristics of the environment. Abiotic components of the environment include sunlight, water, temperature, soil, air, humidity, pH, salinity, availability of nitrogen, precipitation etc. The following are the major abiotic components of an ecosystem.

1. Sunlight

Sunlight influences the growth and distribution of living organisms. Plants utilise sunlight during photosynthesis and prepare food. Light intensity, light quality and light duration affect lives of animals and plants in one way or the other. For example, the plants growing under insufficient light do not develop chlorophyll and a very high intensity of light destroys chlorophyll.

2. Water

Water is a vital component of life. Water covers more than 70% of the surface of the Earth and acts as a universal solvent. It dissolves minerals in the soil, which are then taken by plants. Water is one of the raw materials of photosynthesis. In a deserts environment, water is scarce and therefore there are few species, while rainforests have plenty of rainfall throughout the year, so it has numerous species and are full of life.

Fig.16.2 Rainforests are home to rich biodiversity

3. Temperature

Temperature plays an important role in the distribution of plants and animals. Temperature has great effects on the growth, function and distribution of organisms. The range of temperature for the activity of life lies between 10°C to 45°C. Cells may rupture if water in them freezes at the temperature below 0°C. Enzymes and proteins may denature at temperatures above 45 °C.

Tidbit

At optimum temperature, the activities of organisms are at the maximum. Certain animals migrate to places of optimum temperature. Such movements are called thermal migration.

4. Atmosphere and Wind

Atmosphere is the gaseous reservoir, which surrounds the Earth. It contains nitrogen (78%), oxygen (21%) and carbon dioxide (0.04%).

Nitrogen forms a significant part of proteins, chlorophyll, nucleic acids and vitamins in living things. Some bacteria and algae present in the soil fix nitrogen from the atmosphere and convert it into compounds of nitrogen. Plants utilise these for the synthesis of proteins and other compounds. Animals feeding on plants get these proteins and other nitrogenous compounds. When plants and animals die, bacteria and fungi present in the soil converts the nitrogenous wastes into nitrogenous compounds, which are in turn used by plants again. Certain other bacteria convert some parts of them to nitrogen gas, which goes back into the atmosphere. Therefore, green plants fix nitrogen in the atmosphere and its level remains constant.

Fig.16.3 Flag form trees result from unidirectional movement of wind

Oxygen is required for respiration of organisms. Carbon dioxide is essential for photosynthesis. Humidity is also an important factor in controlling the rate of evaporation and transpiration. It also affects the behaviours of animals e.g. desert animals come out of their hideouts only at the time when moisture in the air at is maximum.

The atmosphere in motion is called wind which is an important abiotic factor. Strong wind can damage buds on the windward side and produce flag form trees. Strong winds cause soil erosion, uproot trees and breaks branches. Wind is also responsible for pollination and dispersal of seeds and fruits.

5. Soil

Soil is the upper layer of the Earth's crust. Plants are anchored in the soil and it is a source of water and nutrients for them. The structure and chemical makeup of soil in an area affect the types of plants that grow there. For example: little grasses often dominate areas with dry soil. These grasses have extensive roots that obtain scarce moisture in the soil. In aquatic environments, the characteristics of the underlying sand affect the types of plants and algae that can grow. This in turn influences the other organisms found there.

For Your Information

Fire is an important abiotic factor. Human and lightning are the causes of fire. Fires can destroy an ecosystem by destroying producers and by driving out consumers from the ecosystem. It also adversely affects the fertility of soil by destroying organic matter in the soil. Fire also release many important nutrients for recycling which help in new growth of plants. Fire improves the growth of grasses.

6. Gravity

Gravity is a constant abiotic factor, which acts as an external stimulus on the growth of the roots of plants. As a result of gravity roots grow downwards into the soil and can access nutrients. Conversely some organisms have adapted to deal with gravity. For instance, birds overcome the problem of the gravitational pull due to wings and light bones.

b. Biotic Components of Ecosystem

These are the living components of an ecosystem. They are of three types, namely producers, consumers and decomposers.

1. Producers

Autotrophs are able to produce food by utilising energy and inorganic nutrients. They are called producers. The producers themselves utilise a part of this food while consumers and decomposers utilise the remaining food. Green plants and algae are the major producers. They carry out photosynthesis in which they use sunlight for the preparation of food. Some types of bacteria are also producers. These bacteria carry out chemosynthesis, in which they use energy stored in inorganic molecules to produce food.

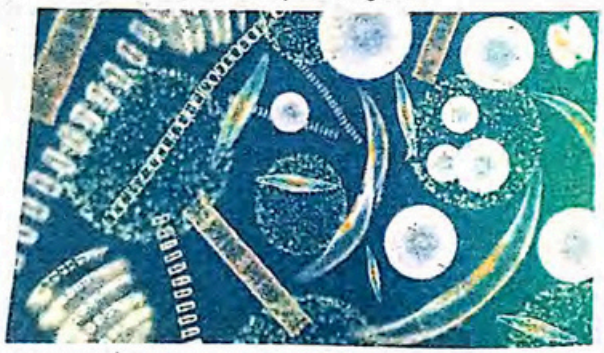


Fig. 16.4 The Algae – major producers in aquatic ecosystems

2. Consumer

Consumers cannot prepare food and depend upon the other organisms for their food. All animals, most protists, all fungi, and many bacteria are included in this group. The consumers are also called heterotrophs. The consumers are of three types, namely primary, secondary and tertiary consumers.

For Your Information

Consumers may also be classified according to what they eat. A consumer that eats only producers is a herbivore (e.g. horse). A consumer that eats only other consumers is a carnivore (e.g. lion). A consumer that eats both producers and consumers is an omnivore (e.g. humans and bear).

(i) Primary consumers: Also called herbivores, primary consumers feed directly on producers. Primary consumers in the terrestrial habitat are insects, rabbits, goats, sheep, cows etc. In an aquatic habitat the primary consumers are crustaceans (arthropods), molluscs and some fishes.

(ii) Secondary consumers: The secondary consumers feed on primary consumers (herbivores) or producers. Those, which feed on herbivores, are called carnivores like lizards, frogs etc.

(iii) Tertiary consumers: They are the top consumers and get their food from primary consumers and secondary consumers e. g. lion, tiger, hawk etc.

3. Decomposers

Decomposers are also called saprophytes. They get their energy by decomposing the remains of dead animals and plants. Many bacteria and fungi are included in this group. The decomposers are also called cleaners of the ecosystem. They help to run various biogeochemical cycles like the nitrogen cycle, carbon cycle etc. In this way valuable nutrients are recycled for reuse.

Observing, Analysing and Interpreting

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

16.1.2 Interrelationships between Different Components of Ecosystem

Biotic and abiotic components depend on one another. Plants take nutrients from the soil and carbon dioxide from the atmosphere. Then with the help of sunlight they prepare food for themselves and consumers. When the producers and consumers die they are converted into simpler substances like carbon dioxide, nitrogen, water etc. by the action of decomposers. These substances mix with the soil or are released into the air after which they are used again by plants, and the whole cycle is repeated again and again. So, for smooth running of an ecosystem all biotic components interact with each other as well as with the non-living world.

16.2 Flow of Material and Energy in the Ecosystem

The existence of the living world depends upon the flow of energy and circulation of materials through the ecosystem.

16.2.1 Comparison between Flow of Materials and Energy

The sun is the ultimate source of energy in all ecosystems. It provides energy in the form of sunlight. A tiny fraction of sunlight reaches the Earth. The producers can use a small part of this sunlight. They transform sunlight into chemical energy (food) through photosynthesis. The chemical energy "flows" through the ecosystem in the form of food.

Fig.16.5 Flow of energy in an ecosystem

When respiration occurs, energy is released. The organism uses a portion of this energy for its metabolism and other activities, while the rest of it is lost in the surroundings as heat. The arrows in Figure 16.5 represent the movement of this energy. All energy comes from the Sun, and the ultimate fate of all energy in ecosystems is to be lost as heat. It means that energy does not recycle in the ecosystem.

The other components shown in the diagram are the materials. The producers obtain the inorganic materials (carbon dioxide, water etc.) from the environment and use them to prepare organic material (food). The materials are passed from organism to organism, as one organism is consumed by another. Ultimately, all organisms die and become detritus. Decomposers feed on detritus and break the organic materials into inorganic. The inorganic materials are returned to the environment to be taken up again. In this way, the materials are recycled in the ecosystem.

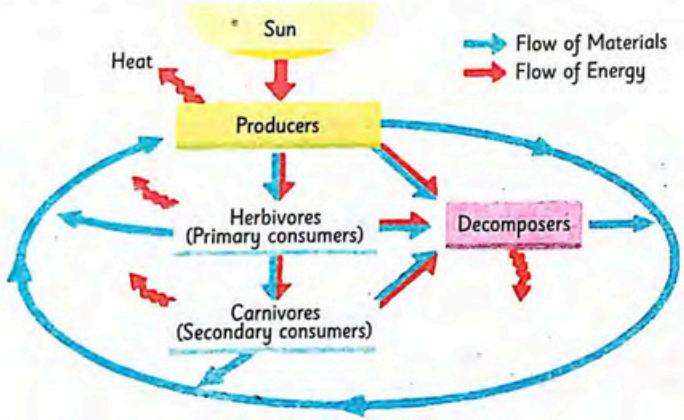


Fig.16.6 Flow of materials and energy in ecosystem

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16.2.2 Food Chain

A food chain comprises of a sequence of consumptions through which energy and nutrients are taken in and used up. Simply, a food chain is defined as a process of eating and being eaten.

An example of a simple food chain in a terrestrial ecosystem could be

Grass → Grasshopper → Rat → Snake → Eagle

Similarly, the following is an example of food chain in a marine ecosystem.

Algae → Zooplanktons → Small fish → Large fish → Whales

All food chains begin from producers to consumers. The major feeding levels are called **trophic Level.** Producers belong to the **first trophic level.** Primary consumers form the **second trophic level.** Organisms that feed on other consumers belong to the **third tropic level.**

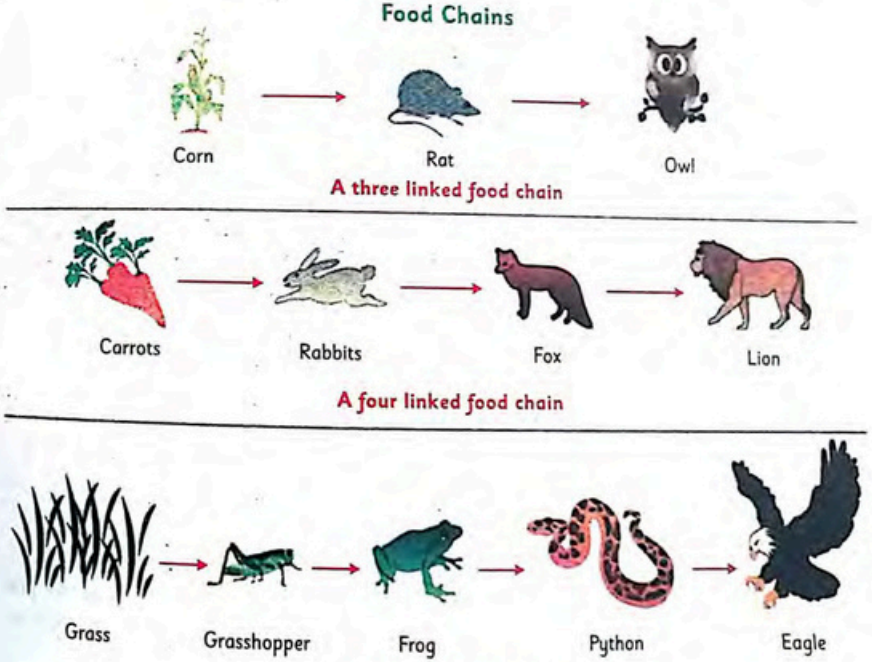

Fig.16.7 Simple food chains

16.2.3 Food Web

The feeding relationships in a community cannot be represented by simple food chains, because a single consumer eats more than one producer and is eaten by more than one consumer. Thus, many simple food chains are linked together and make a food web. A food web is a graphical description of feeding relationships among the organisms in an ecological community.

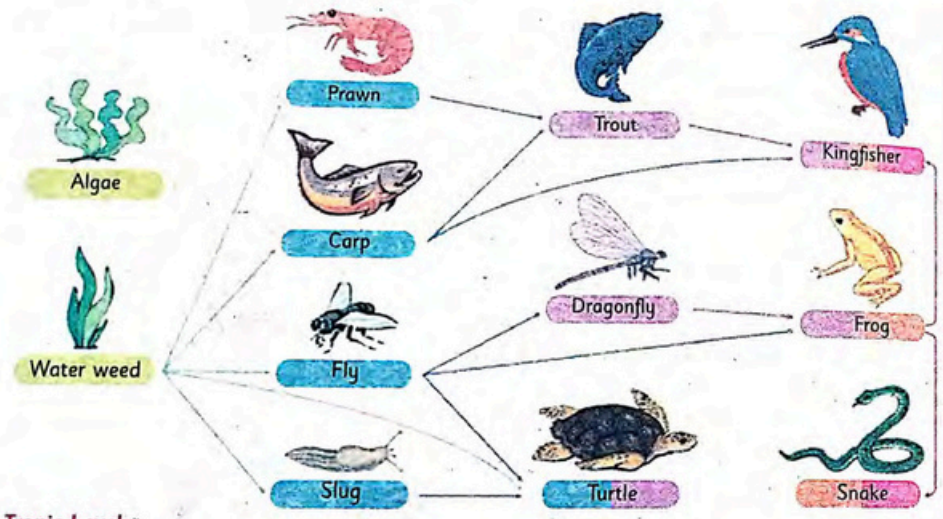

Fig.16.8 Food web in an ecosystem

Observing, Analysing and Interpreting

- Construct food chains, food webs through observation of the local pond or grassland ecosystem.

16.2.4 Energy Relations between different Trophic Levels

The trophic levels in ecosystems can be represented by numbers. Producers are at the first trophic level. The next trophic levels are made of herbivores (primary consumers), carnivores (secondary consumers) and so on.

When producers capture energy (sunlight), they convert a small percentage of it into their biomass while the rest is used in metabolic processes and is also lost. Therefore, at each level the amount of energy reduces during the transfer to the next level. In general only 10% of the

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energy consumed by one level is available to the next. For example if rabbits consume 1000 K Cal of plant energy, they might only be able to form 100 K Cal of new rabbit tissues. So the foxes consume about 10 K Cal of rabbit biomass, and convert perhaps 10 K Cal into new fox biomass.

16.2.5 Pyramid of Biomass

The pyramid of biomass represents the amount of biomass (total amount of living or organic matter of all organisms) in each trophic level in an ecosystem. Because biomass is lost in the transfer from one level to the next, there is successively less total biomass as you move up trophic levels. In general, we would expect that higher trophic levels would have less total biomass than those below.

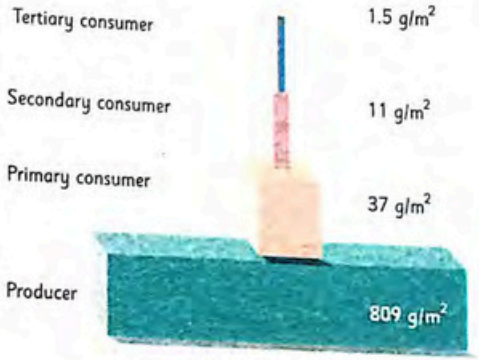

Fig.16.9 Pyramid of biomass

16.2.6 Pyramid of Numbers

It represents the number of organisms at each trophic level in an ecosystem. In pyramids of numbers, each successive trophic level has fewer organisms. The number of producers is largest in an ecosystem. At the next trophic level of primary consumers or herbivores, the number of organisms is less than the previous level. At the third trophic level of secondary consumers or carnivores, there are lesser number of organisms than primary consumers. Similarly, in all successive trophic levels, the numbers of organisms go on decreasing.

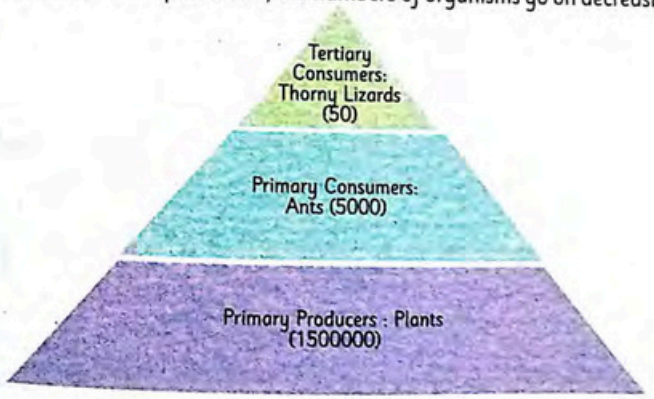

Fig.16.10 Pyramid of numbers

16.3 Biogeochemical Cycles

Dead bodies of living organisms are decomposed by microorganisms which result in the release of nutrients in the environment. These nutrients are used by plants in their growth, which in turn form food for the heterotrophic organisms. These movements of chemical elements between organisms and environment along circular paths are known as biogeochemical cycles. In following section you will study some of the major biogeochemical cycles operating in nature.

16.3.1 Carbon Cycle

Carbon is the main component of organic compounds present in living things. Earth's atmosphere contains almost 0.04% carbon dioxide. By the process of photosynthesis, producers use sunlight to take carbon from environment and make it a part of glucose.

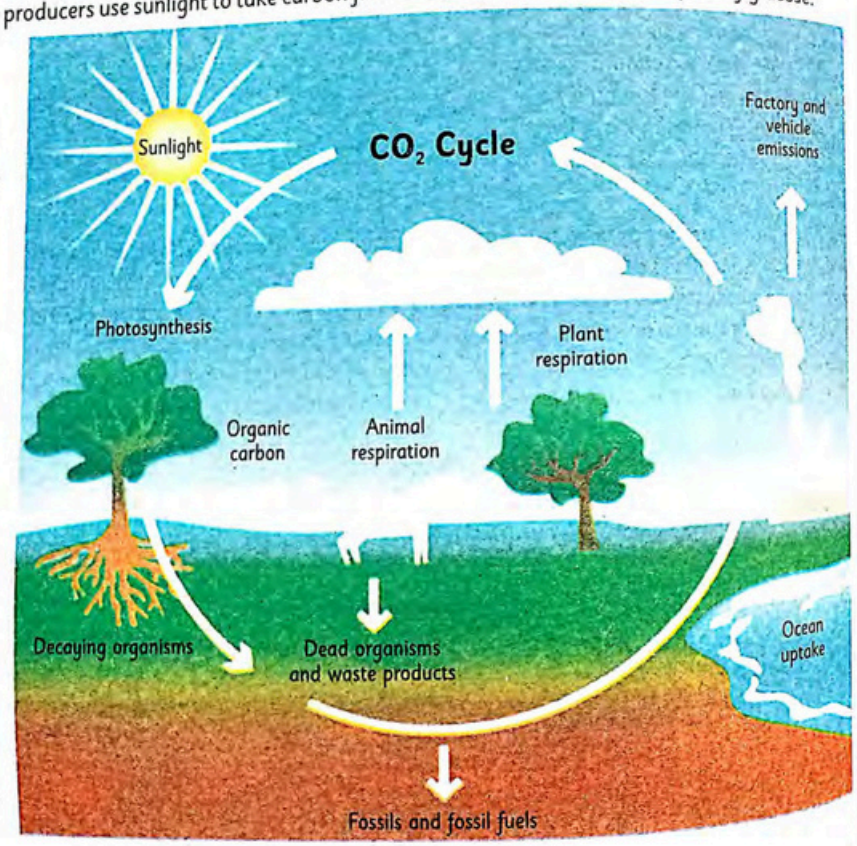

Fig.16.11 Carbon Cycle

Through other metabolic processes, producers convert glucose to other carbohydrates and proteins, or fats. Consumers (animals) obtain their carbon by eating and digesting plants. So carbon moves through the biotic environment through the trophic system. Herbivores eat plants, but are themselves eaten by carnivores.

Carbon returns to the physical environment in a number of ways. Both plants and animals respire, so they release CO_2 during respiration. Another route of CO_2 back to the physical environment occurs through the death of plants and animals. When organisms die, decomposers consume their bodies. CO_2 is released into the atmosphere through the process of decomposition. Some of the carbon returns to the physical environment by way of fossilization. The burning of fossil fuel produces CO_2, which returns to atmosphere.

16.3.2 Nitrogen Cycle

Nitrogen (N) is an essential component of DNA, RNA, and proteins, the building blocks of life. All organisms require nitrogen to live and grow. The nitrogen cycle consists of four main stages, nitrogen fixation, nitrogen uptake, nitrification and denitrification.

1. Nitrogen fixation

Nitrogen fixation is the process where N_2 is converted to ammonium with the help of certain bacteria, for example genus *Rhizobium*. Nitrogen fixing bacteria often form symbiotic relationships with legume (e.g. beans, peas). In addition to nitrogen fixing bacteria, high-energy natural events such as lightning, forest fires, and even hot lava flows can cause the fixation of smaller amounts of nitrogen.

2. Nitrogen uptake and decay

The ammonia produced by nitrogen fixing bacteria is incorporated into proteins and other organic compounds by bacteria themselves, or by another soil organism. When these organisms die, decomposers consume the organic matter. During this process, the organic compounds are broken and nitrogen is converted to ammonium. This ammonium is available for use by plants or for further transformation into a nitrate ion (NO_3^-) through a process called nitrification.

For Your Information

Although the majority of the air we breathe is N_2, most of the nitrogen in the atmosphere is unavailable for use by organisms. This is because the strong triple bond between the N atoms in N_2 molecules makes it relatively inert. In fact, in order for plants and animals to be able to use nitrogen, N_2 gas must first be converted to such forms as ammonium (NH_4^+), nitrate (NO_3^-), or organic nitrogen (e. g. urea – $(NH_2)_2CO$).

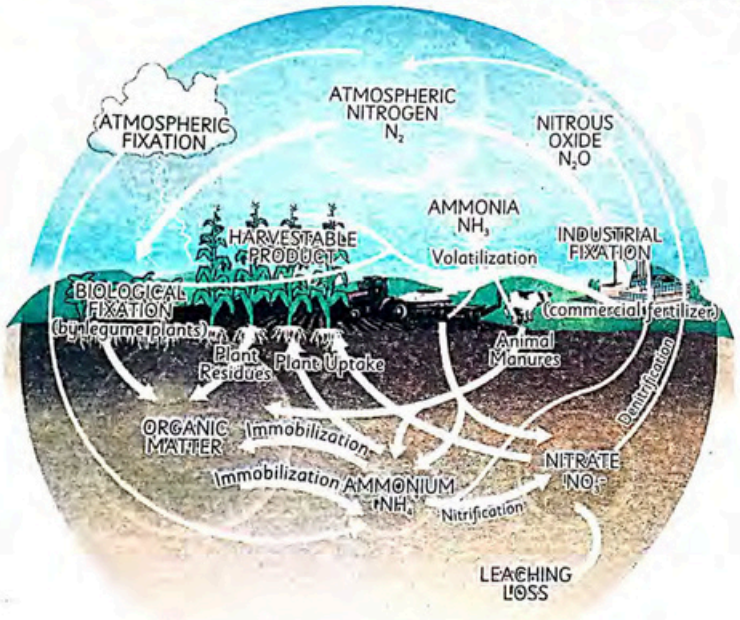

Fig.16.12 Nitrogen Cycle

3. Nitrification

Some of the ammonium produced by decomposition is converted to nitrate via a process called nitrification. Nitrification is accomplished by two groups of bacteria. One group of bacteria *(Nitrosomonas)* converts ammonia into nitrites and a second group of bacteria *(Nitrobacter)* converts nitrites into nitrates.

4. Denitrification

Through denitrification, oxidized forms of nitrogen such as nitrate and nitrite (NO_2) are converted to molecular nitrogen (N_2) and, to a lesser extent, nitrous oxide gas. Denitrification is carried out by bacteria *(Pseudomonas)*, which converts nitrates to molecular nitrogen. Molecular nitrogen is rapidly lost to the atmosphere. Denitrification is the only nitrogen transformation that removes nitrogen from ecosystems, and it roughly balances the amount of nitrogen fixed by the nitrogen fixers described above.

16.4.3 Biogeochemical Cycles and Flow of Energy and Ecological Balance

Through biogeochemical cycles, the chemical elements or molecules cycle through biotic and abiotic components of the environment. These cycles also move energy at different trophic levels.

All the essential nutrients like carbon, nitrogen, oxygen, phosphorus, and sulphur are recycled instead of being lost and replenished constantly. In this way, these cycles help in maintaining the ecological balance in nature.

16.4 Interactions in the Ecosystem

The existence of the living world depends on the flow of energy and circulation of materials through the ecosystem. In all ecosystems, the organisms living in the same area interact with each other. These interactions may be intraspecific i.e. between the organisms of the same species or inter-specific i.e. between the organisms of different species. The following are some of the important interactions among organisms

a. Competition

Competition is an interaction between organisms for limited supply of at least one resource (such as food, water and space). Competition is an important factor that affects the community structure. Competition may be intraspecific (among members of the same species) or inter-specific (among individuals of different species). For example, lions and leopards compete with each other for prey (e.g. zebras). Similarly, many plant species compete for soil or sunlight.

Competition maintains a balance between the resources and the size of populations. In competition, one species is able to use a resource more efficiently than the other. As a result, less of the resource is available to the weaker species. It results in a reduction in the size of the weaker population or its complete elimination.

b. Predation

Predation is an inter-specific interaction i.e. between members of two different species. In predation the predator captures, readily kills and feeds on an individual of another species, called the prey.

Predation has important effects on the distribution and abundance of organisms. A prey in an area without its natural predator becomes a menace for example the introduction of rabbits in Australia where without its predator, they multiplied enormously and became a menace for the local farmers.

Fig.16.13 An example of a predator and its prey

Predator Plants

Some plants e.g. the pitcher plant; sundew, Venus flytrap etc. live as predators. They capture and eat insects. They attract insects by their colours or nectars. These plants capture their prey with the help of their modified leaves. After capturing it, they secrete enzymes on insects and absorb the digested food. Such plants usually grow in areas where there is deficiency of nitrogen in the soil. They get nitrogen containing compounds e.g. proteins from the prey insects.

Fig.16.14 Leaf modifications in different predator plants

c. Symbiosis

Symbiosis literally means, "living together". It is defined as a close interaction between organisms of different species for an extended time. Although one species always benefits in a symbiotic relationship, the second species may be harmed, not affected or benefited. There are three types of symbiosis.

(i). Parasitism

In parasitism, an organism called a parasite lives on or in the body of a larger living organism called the host. The parasite gets its nourishment from its host's tissues and causes harm to it. Parasites always get benefit from the host. The diseases in host organisms caused by parasites, are called infestations. Parasites such as aphids, lice, leeches, fleas, ticks, and mosquitoes remain on the outside of their hosts' bodies. They are called **ectoparasites**. Many parasites live inside the host's body and are called **endoparasites** e.g. plasmodium, tapeworm, polio virus etc.

Figure 16.15: Female **Anopheles** sucking blood from its victim (Human Being).

Some plants (e.g. cuscuta) also live as parasites. The cuscuta plant does not have green leaves. It cannot manufacture food. It grows on the surface of big plants (hosts). Here, it obtains food and causes harm to the host plant. The cuscuta plant attaches itself to a plant

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and wraps itself around it. After which it produces 'haustoria' (root) through which it inserts itself into the host. Subsequently, the original root of the cuscuta in the soil dies. The cuscuta can grow and attach itself to multiple plants. This is how the cuscuta plant draws nourishment from its host and weakens it.

Parasites have a strong negative effect on the growth of the host's population. The epidemics of parasitic diseases can even cause the extinction of the host population.

(ii). Mutualism

In this type of relationship, both the partners are mutually benefited and none of them is harmed. For example, the roots of the leguminous plants (pea, bean etc.) have small nodules, which contain Nitrogen fixing bacteria. These bacteria get food from these plants. In return, bacteria convert the atmospheric nitrogen into nitrates and pass them on to the host plant.

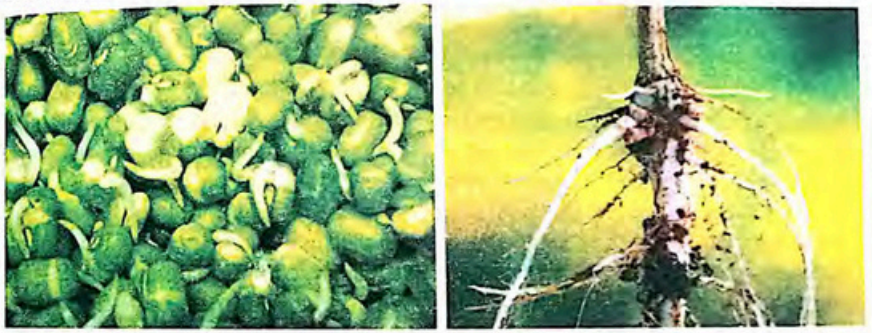

Fig.16.16 Mutualism in beans

Another example of mutualism can be observed between termites and the protists living in their gut. Termites eat wood and the protists help them to digest the cellulose of wood. In return, the termite provides food and shelter to protists. Similarly many bacteria live in our intestine. Our body gives them food and a proper environment to live in. In turn, these bacteria produce vitamin K, which is essential for blood clotting.

Recalling

Do protists have a relationship with some other organism? Find out.

(iii). Commensalism

In commensalism only one partner is benefited and the other is neither benefited nor harmed. For example many epiphytes, such as orchids are found growing on the branches of other trees. These epiphytes use the tree only for the attachment. They prepare their own food by photosynthesis. Here the orchids are benefited but the tree is neither benefited nor harmed. Similarly barnacles attach with the body of marine animals including whales. Barnacles get a ride to better places but the large animals are not affected.

Fig.16.17 Commensalism: Epiphytic fern growing on a tree (left); Barnacles on the body of whale (right)

Observing, Analysing and Interpreting

• Prepare a list showing predators and their preys, and parasites and their hosts. Elaborate at least one example from your immediate environment.

16.5 Balance in the Ecosystem and Human Impact

All the organisms living on Earth are dependent on the environment for their needs. The environment provides all the resources, which are necessary for the survival of organisms. The species living in an ecosystem get the resources through interactions with the environment and among themselves. Biogeochemical cycles also play an important role in the availability of natural resources to the species. In a balanced ecosystem, the interactions and biogeochemical cycles run smoothly and all the species get natural resources. A balanced ecosystem is important not only for a single species but also for the whole biodiversity of the ecosystem.

However, human beings try to modify their environment to meet their needs. This has disturbed the delicate balance in the environment. For example, until the beginning of the 19th century, the size of the human population was small in relation to environmental resources. So there was no immediate shortage of environmental resources. However, with the increase in population at an unexpected rate, humans are using environmental resources at an increasing rate. This has not only created degradation and depletion of resources but it has also produced some local effects, like pollution, deforestation etc.

Fig.16.18 Human intervention in the environment has mostly resulted in the degradation and depletion of natural resources

Due to the tremendous increase in population, urbanisation and industrialisation more sewerage enters the rivers and more gases are released into the atmosphere. Thus the environmental conditions become gradually worse. The local problems of environmental pollution have now become global ones. New industrial products, toxic chemicals and solid wastes have made the land, air and water polluted. Thus the degradation and depletion of resources and the modification of the environment are the direct results of human intervention.

16.5.1 Global and Regional Environmental Problems

1. Over Population

Overpopulation is arguably the most critical threat to the environment. Population control is an urgent issue because of the following reasons:

- To reduce burden and stabilise our resources.
- To reduce the incidence of famine.
- To reduce threats to the already stressed ecosystem.
- To give our current and future generations better education.
- To provide chances for employment and better survival.

The ever-increasing human population growth requires an effective method for production of more food, which has resulted in extensive agriculture. Some of the bad effects of extensive agriculture are given below:

a) More land being brought under cultivation results in the destruction of habitats
b) Extensive agriculture requires supply of water and development of canals, which in turn causes waterlogging and salinity.
c) Overuse of fertilizers has polluted the soil and water.
d) Over-use of pesticides and herbicides can make water toxic, which can affect aquatic life.
e) Forests are destroyed to bring land under cultivation
f) Clearing of land for agriculture, results in soil erosion.
g) Excessive irrigation can cause loss of top fertile soil.
h) Soil erosion results in silting, which decrease, the life span of dams.

2. Urbanisation

Urban growth, also known as urbanisation, accelerated dramatically with the advent of industrialisation some 200 years ago. At that time, large numbers of people moved to cities in search of jobs, mostly in factories. While less than one-third of the world's population lived in cities in 1950, about two thirds of humanity is expected to live in urban areas by 2030. Most of that urbanisation is taking place in Asia, Africa, and Latin America.

In cities, people are concentrated in a small space rather than being spread out over a large territory. This allows the government and others to provide more services such as, water, electricity, and transportation to a larger number of people. Schools and shops are more easily accessible than in rural areas.

The current level of urbanisation in Pakistan is about 37%, which has increased uniformly

over the decades. The urban population in Khyber Pakhtunkhwa is about 18.6% of the total 30.5 million of its population. In newly merged districts of FATA regions of KP, only 2.8% of the population lives in urban areas.

Fig.16.19 Slums along side multi-storied skyscrapers as seen in Sao Paulo, Brazil are common sights in megacities of the world

Cities have always been at the centre of economic growth and technological advances. The promise of jobs and prosperity pulls people to cities. However, their rapid growth has also brought many negative effects with it e.g. violence, poverty, overcrowding, health problems, and pollution.

Urban expansion is also encroaching on wildlife habitats everywhere. Increasingly people live and work in close proximity to wild animals whose native habitats have been destroyed. Many animals from mice and cockroaches to pigeons and squirrels have adapted to city life, taking advantage of abundant food and warmer temperatures.

3. Deforestation

The unwise and unplanned destruction or removal of trees is called deforestation. Forests are our most precious wealth. Our life is greatly dependent on forests. They are the natural factories for the production of oxygen. Forests provide green cover to the earth, a living place to wildlife, fuel, timber and recreation to man. They control floods, prevent formation of deserts and keep the air clean. Some of the reasons for deforestation are given below:

a) Urbanisation requires more land, thus forests are cut to build roads and houses etc.
b) More land is required for cultivation.
c) Trees are removed to develop pastures for grazing.
d) Wood is used both as timber or fuel wood.
e) Some plants are collected for their medicinal importance.
f) Some plants are removed to give us fibre.
g) Timber mafia cuts trees for cash.

Fig.16.20 Deforestation in tropical rainforests

Effects on the Environment: Deforestation has many negative effects on the environment. The most dramatic impact is a loss of habitat for millions of species. 70 % of the Earth's land animals and plants live in forests, and many cannot afford deforestation since it results in the destruction of their homes.

Deforestation also results in **climate change.** Forest soils are moist, but without protection from sun-blocking tree cover, they quickly dry out. Trees also help perpetuate the **water cycle** by returning water vapours back into the atmosphere. Without trees to fulfil these roles, many former forest lands can quickly become barren deserts.

Trees also play a critical role in absorbing the greenhouse gases that a responsible for global warming.

4. Acid rain

Acid rain is one of the most dangerous and widespread global environmental problem. Technically, acid rain is the rain that has larger amount of acid in it than normal. The key culprit is smoke and gases emitted by factories and vehicles running on fossil fuels. When these fuels are burnt to produce energy, the sulphur present in the fuel combines with oxygen and becomes sulphur dioxide; some of the Nitrogen in the air becomes nitrogen oxide. These pollutants go into the atmosphere, and become acids.

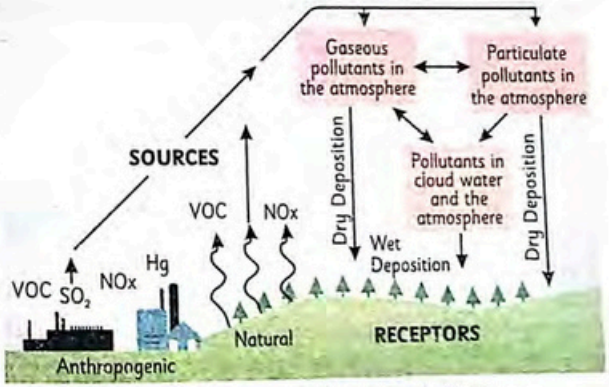

Fig.16.21 Mechanism of formation of acid rain

Sulphur dioxide and Nitrogen oxide are produced especially when coal is burnt for fuel. Automobiles produce Nitrogen oxides (which cause acid rain).

Effects of Acid Rain: Acid rain is extremely destructive and forests, lakes, animals, and plants suffer from it. Acid rain can make trees lose their leaves. Trees can also suffer from stunted growth and have damaged bark. The soil poisons the trees with toxic substances, that have been deposits by the rain.

Lakes are also damaged by acid rain. Fish die, and that removes the main source of food for birds. Acid rain can even kill fish before they are born.

5. Global Warming

The rise in the average temperature of the Earth's atmosphere is called global warming. It is one of the most important environmental issues. There is a direct relationship between average levels of CO_2 in the atmosphere and average global temperatures. Atmospheric CO_2 acts like a glass in a greenhouse, allowing energy in the form of sunlight to enter but absorbing and holding that energy once it has been converted to heat. Several other "greenhouse gases" share this property, including methane, and chlorofluorocarbons (CFCs) as well as water vapours. Fossil-fuel consumption and forest fires are the main causes of carbon dioxide build-up and global warming.

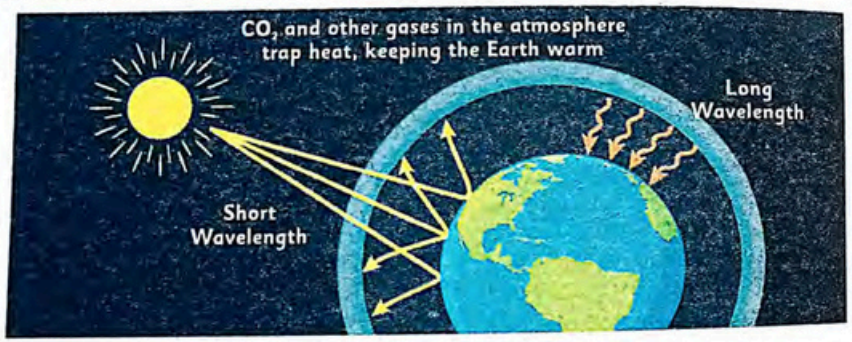

Fig.16.22 Greenhouse Effect

Scientists believe that the greenhouse effect is likely to cause a rise of 1.5°C to 4.5°C in the average global temperature by the end of the century. As the ice caps and glaciers melt in response to this atmospheric warming the sea level will rise, threatening coastal cities and flooding coastal wetlands. Another serious consequence of global warming is a shift in the global distribution of temperature and rainfall.

For Your Information

Some UV rays are helpful in converting cholesterol to vitamin D in our skin. So a reasonable amount of sunlight is good for your body However, prolonged exposure can cause sunburns and increase the risk of skin cancer.

A reason for global warming is also the depletion of the ozone layer. In the stratosphere, there are molecules of ozone (O_3), which form a layer. This layer filters out a lot of the Sun's ultraviolet (UV) rays, which are harmful to life on Earth.

The ozone layer is being depleted by pollutant gases, reaching the stratosphere. It results in more UV rays reaching the Earth's surface. It is increasing the temperature and also causing health problems in human (like skin cancer) and harming plant life.

16.6 Pollution: Consequences and Control

Pollution is defined as "the undesirable change in the physical, chemical or biological characteristics of the air, land or water that may or will harmfully affect human life or life of other species". So any change in the environment, which disturbs life is called pollution and the agent, which causes pollution is called of a pollutant.

16.6.1 Types of Pollution

1. Air Pollution

Air pollution is defined as the presence of any substance in the atmosphere added by the activities of human beings, which can affect the comfort, safety and health of living organisms. Major causes of air pollution are given below:

(a) Oxides of carbon: Combustion of fuel processes produces oxides of carbon like carbon dioxide and carbon monoxides.

(b) Oxides of nitrogen: The sources of oxides of nitrogen are chemical fertilizers, lightning and decay of organic matter.

(c) Oxides of Sulphur: Burning fuels in cars produces sulphur dioxide. It is also emitted from brick kilns and volcanic eruption.

(d) Chlorofluorocarbons: CFCs emissions from refrigerators and air conditioners are major reasons for depletion of the ozone layer.

(e) Lead compounds: Compounds of lead cause air pollution, which can cause damage to the brain.

(f) Particulates: These are the particles suspended in the air like dust particles, ethylene and acetylene.

Fig.16.23 Factories and vehicles are major sources of air pollutants

Effects of Air Pollution

- Reduced lung functioning
- Irritation of eyes, nose, mouth and throat
- Increased respiratory disease such as bronchitis, asthma
- Reduced energy levels
- Headaches and dizziness
- Disruption of endocrine, reproductive and immune systems
- Cardiovascular problems
- Cancer

2. Water Pollution

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans and ground water). Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds. The following are major causes and effects of water pollution:

(a) Incomplete Treatment of Sewage: Domestic sewage water from household is discharged into rivers and lakes. Due to sewage pollution the concentration of ammonia, nitrates and phosphate increases and that of oxygen decreases in water. This results in the death of aquatic life. Sewage serves as food for pathogen. Some waterborne diseases caused as a result include typhoid, amoebiasis, hepatitis, diarrhoea etc.

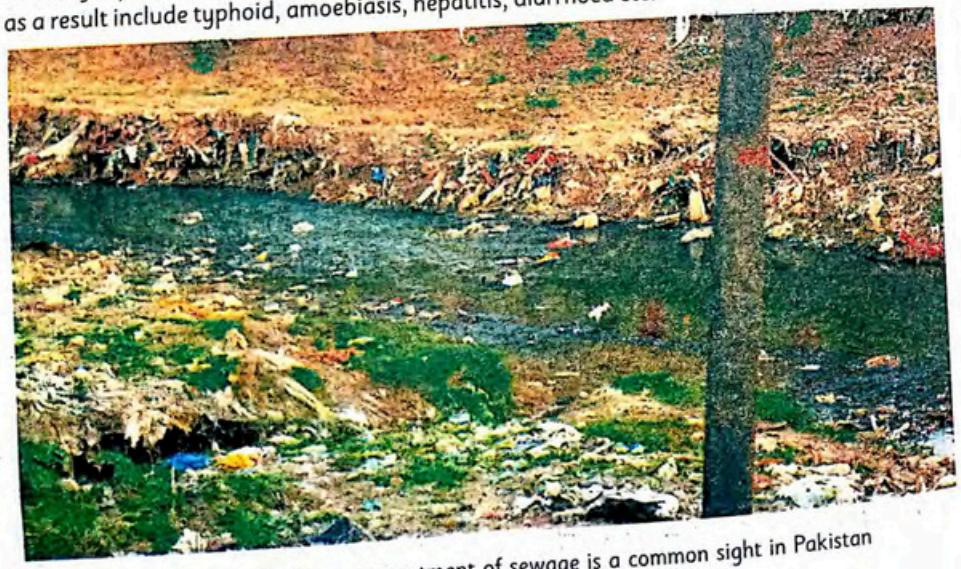

Fig.16.24 Lack of proper treatment of sewage is a common sight in Pakistan

(b) Oil Spills: Water pollution may also be caused due to oil spills during the filling of oil tankers or due to accidents of tankers. Oil discharged into oceans spreads over the water surface preventing the penetration of sunlight and mixing of oxygen with water. As a result of this marine plants and animals die because of suffocation.

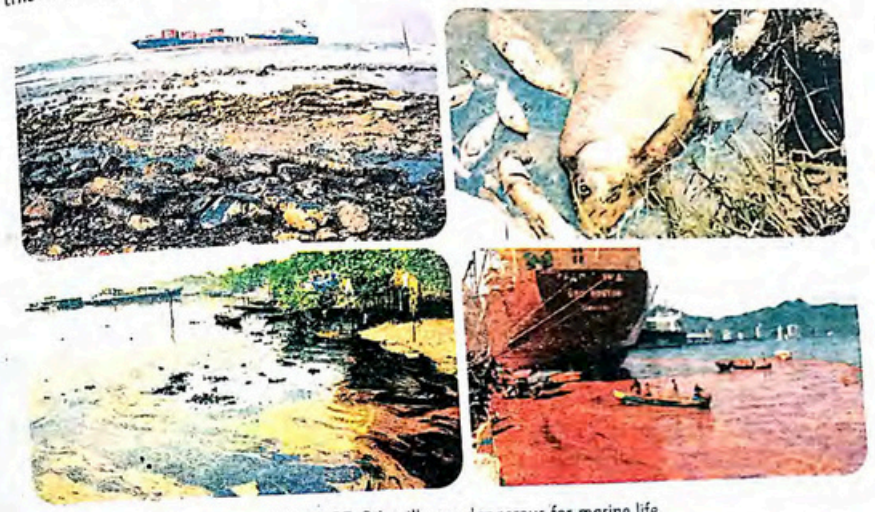

Fig.16.25 Oil spills are dangerous for marine life

(c) Industrial Effluent: Industries generate a lot of waste materials. Some of these wastes contain very toxic compounds of mercury, cadmium, lead, chromium and arsenic.

(d) Insecticides: Decomposers cannot breakdown some insecticides such as DDT. Rainwater may carry such insecticides into streams, river and lakes. The insecticides in water result in the poisoning of fish or other animals drinking such water.

Fig.16.26 Insecticides used in agricultural fields result in polluting water bodies

(e) Herbicides: Herbicides are used to eliminate weeds. Some of the herbicides contain a substance called dioxin, which is harmful. When it is washed by rainwater into streams or rivers, it pollutes that water witch can cause cancer.

(f) Chemical Fertilizers: Most of the fertilizers are not absorbed by the crops and may be washed away by the rainwater into lakes or rivers and thus cause water pollution. Such polluted water adversely affects aquatic life.

(g) Leakage from landfills: Landfills are huge piles of garbage. When it rains, the landfills may leak. The leaking landfills pollute underground water.

(h) Animal wastes: If the waste materials of cattle are not disposed off properly, these are washed away into the rivers when it rains.

(i) Leakage from underground petroleum storage: Petroleum is transported through underground pipes. Accidental leakage from these pipes may cause mixing of petroleum with underground water.

3. Land Pollution

Land pollution is the degradation of the Earth's land surfaces often caused by human activities and misuse of land resources. It occurs when waste is not disposed off properly. The following are the major causes of land pollution.

a. Municipal solid wastes: These are the solid materials added by homes, institutions and industry. Such wastes are of the following types:

- Garbage: moist and decomposable (biodegradable) food wastes;
- Rubbish: dry materials such as paper, glass, textiles, and plastic objects;
- Trash: bulky waste materials (e.g., discarded mattresses, appliances, furniture)
- Medical wastes: surgical gloves, body fluids (e.g. blood), X-ray equipment

Fig.16.27 If solid waste is not properly treated then such sights will keep on increasing in every nook and corner of Pakistan

b. Agricultural activities: Besides domestic waste, pesticides and herbicides used by farmers to increase crop yields also pollute the land when they are washed into the soil.

c. Construction debris: This includes wood and metal objects, concrete rubble, asphalt, and other materials produced when structures are built or demolished.

d. Air and water pollutants: When polluted water enters the soil, it changes the quality of soil and causes land pollution. Similarly, air pollutants can also lead to land pollution. For example, acid rain dissolves away some of the important nutrients present in the soil and changes the composition of the soil.

16.6.2 Control of Pollution

Pollution causes unexpected and sometimes serious and devastating changes in our land, river and sea environments. Pollution can kill animals and plants and it will harm us too. Some of the control measures for pollution are as under.

Tidbit

When you are recharging electronic items (like mobile phones), do not leave them on indefinitely overnight. Recharge them and then unplug them so as not to waste energy.

Control of Air Pollution

Several attempts are being made on personal, industrial and governmental levels to control air pollution and to stop global warming.

1. Treatment of industrial exhausts: Before their release into the atmosphere, the industrial exhausts should be treated to filter dangerous air pollutants from them.

2. Use of public transportation: Governments should encourage people to use public transportation or adopt car-pooling to save energy and money.

3. Use of lead-free and Low sulphur fuels: Lead-free fuels should be used in vehicles. Similarly, coal with low levels of sulphur should be used in industry.

4. Conservation of energy: Large amounts of fossil fuels are burnt to produce electricity. On a personal level saving electricity should be made a habit. For example switching off fans and lights when not in the room. Energy saver lights/LED consume less electricity as compared to traditional bulbs and tube-lights.

5. Use of clean energy resources: Clean energy technologies like solar, wind and geothermal are in high demand these days. These will reduce the amount of electricity being produced through the burning of fossil fuels.

6. Plantation of trees: Trees absorb carbon dioxide from the air, hence causing its reduction in the air. Governments are establishing new forests on clear lands. This process is called **afforestation**.

Control of Water Pollution

1. Waste water treatment: This is the most direct method to control water pollution. It is the removal of impurities from waste water before it reaches water bodies (lakes, rivers, sea).

2. Removal of pollutants from underground water: Water supply agencies should apply techniques, e.g. reverse osmosis and filtration, for the removal of pollutants from water.

3. Reutilisation and recycling of wastes: Various wastes may be recycled to produce benificial products, e.g. urban wastes may be recycled to generate cheaper biogas and electricity.

4. Absorption by plants: Certain plants can absorb pollutants from the water present in soil. They accumulate such pollutants in their bodies without any harm.

Control of Land Pollution

1. Production of less wastes and recycling: People should produce less waste by using and re-using some products like plastic bags, towels etc. The waste materials (plastics, glass, paper etc.) can be recycled to make new objects.

2. Proper disposal of wastes: If wastes is properly disposed off, the chances of reducing land pollution increases significantly. Throwing garbage on the roads and footpaths causes land pollution and huge inconvenience to passers-bys.

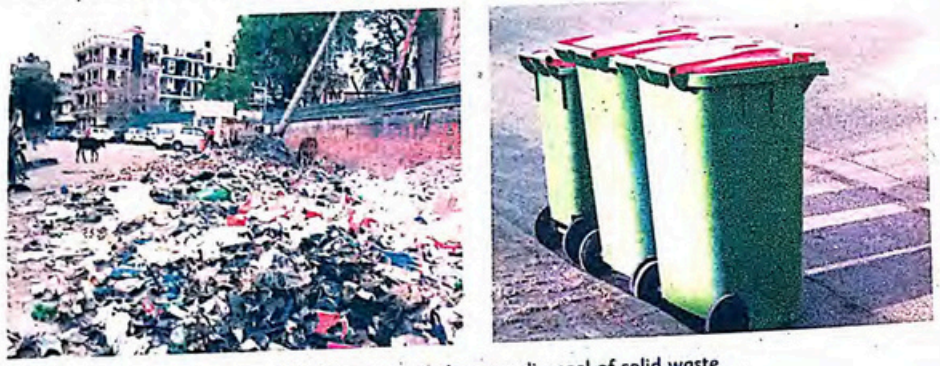

Fig. 16.28 Improper and proper disposal of solid waste

3. Solid waste management: The government should construct standard landfills. Such landfills have an impermeable bottom and do not allow the leakage of pollutants to the underground water. These landfills also do not allow the release of methane gas into the atmosphere. Methane collected in the landfill can be used as biogas.

4. Disposal of dangerous waste: Solid hazardous waste are buried in deep landfills while liquid hazardous wastes are disposed of in deep-wells. The deep landfills have an impermeable bottom and there is 3 metres (10 feet) of soil between the bottom and underlying rock or ground water. Underground deep-wells (into which liquid waste is pumped) are sealed by impermeable layers and are at least 400 metres away from drinking water suppliers.

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Observing, Analysing and Interpreting

- Interpret the data about local environmental problems (data may be collected through surveys or literature review).
- Plan and carry out simple investigations to determine the nature and effects of pollutants.

Pakistan Environmental Protection Agency (Pak-EPA)

Pakistan Environmental Protection Agency was established under the Pakistan Environmental Protection Act, (PEPA) 1997. The basic function of Pak-EPA is to ensure clean environment by;

- Conducting scientific research for the prevention of pollution
- Identifying the needs for various sectors of the environment
- Providing information and guidance to the public on environmental matters
- Specifying safeguards for the prevention of accidents and disasters

Encouraging the formation and working of non-governmental organisations, community organisations, and village organisations to prevent and control pollution and promote sustainable development

16.7 Conservation of Nature

Conservation is the protection and preservation of natural resources. Environmental conservation is the management of the biosphere by humans in a way that it may yield the greatest benefits to the present generation. At the same time maintaining its potential to meet the needs and demands of future generations.

Importance of Conservation

Conservation of natural resources is very essential for ensuring a continuous yield of plants and animals and materials for the fast growing human population. Human activities can upset the balance of nature; therefore conservation of the environment is needed. The following are the main objectives of conservation of nature.

- Ensure the protection of plants and animals species.
- Prevent extinction of plants and animals.
- Maintenance of a stable ecosystem with balanced biochemical cycles.

- Minimise pollution to prevent global warming, greenhouse effect and acid rain.
- Ensure conservation of marine life as it is a major source of food.
- Ensure conservation of forests, which provide fibre, textile, oil, rubber, food, wood, timber, medicine, perfume and furniture.
- Enhance tourism industry.
- Provide employment to people.

Tidbit

Paper is made from wood pulp. So imagine if one ton of waste paper is recycled, it can save approximately 17 trees.

Methods for the conservation of nature

1. Reduce the amount of waste by just curtailing the extra use of resources. Such products should be selected which produce minimum waste e.g. hand-made bags instead of plastic bags. Other examples include use of electronic mail (email) instead of paper, closing water taps when not in use, turning the lights and fans off when not in use, and taking public transport or walking or cycling for short distances.

2. Reuse means utilising the same products again or in another way instead of discarding them. It costs less than purchasing the new product. For example we can reuse plastic bags, aluminium foil, old magazines, newspapers, old clothes, jars, envelopes, and containers. We can also use rechargeable batteries rather than single-use batteries. Use of reusable plates during meals, instead of disposable plates is another method.

3. Recycle products that can be easily recycled. Recycling is the process of taking up of old materials and waste products and using them to make another product. Much of the products used for packaging today like paper, plastic, glass, metal, electronics, aluminium cans are recycled. Recycling is good for the environment. By recycling, resources are saved and less wastes is produced.

Other ways for the conservation of nature

- Plant a tree
- Walk as much as you can
- Ride bikes for short distances
- Use carpooling
- Use less time to take bath
- Use energy-efficient light bulbs
- Use both sides of your paper
- Avoid use of plastic water bottles
- Buy and eat local foods
- Grow your own vegetables
- Go to a car / bike wash rather than washing at home
- Unplug electronics that aren't in use
- Avoid using spray paint

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Key Points

- Population is a group of individuals, belonging to the same species living in the same place, at the same time.
- A group of individual belonging to different populations occupying the same area, living at the same time and sharing the same resources is called community.
- Ecosystem is a natural area where living organisms and the environment interact and exchange material between them so as to achieve functional stability.
- The existence of the living world depends upon the flow of energy and circulation of materials through the ecosystem.
- In mutualism, both the partners are mutually benefited and none of them is harmed.
- In commensalism only one partner is benefited and the other is neither benefited nor harmed.
- The living place of an organism together with its surrounding is called the environment.
- An ecosystem consists of two major components namely, abiotic (non-living) components and biotic (living) components.
- Abiotic components of an ecosystem are light, water, temperature, atmosphere, fire, soil, inorganic nutrients and gravity.
- Biotic components of an ecosystem are of three types, namely producers, consumers and decomposers.
- The Sun is the ultimate source of energy flow in the ecosystem.
- Food chain is defined as a process of eating and being eaten.
- Back and forth movements of chemical elements between organisms and environment along characteristics circular paths are known as biogeochemical cycles.
- Interdependence between organisms may be useful (positive), harmful (negative) for one or both interacting organisms and interdependence may be positive-positive or positive-negative.
- Conservation is the protection and preservation of natural resources.

Exercise

A. Select the correct answer.

1. Energy flow through an ecosystem is always:
   a. Unidirectional b. Cyclic c. Reversible d. Multidirectional
2. The largest reservoir of nitrogen on our planet is:
   a. Ocean b. Atmosphere c. Phage DNA d. Fossil fuels
3. Overgrazing results in:
   a. Soil erosion b. Retention of useful species
   c. Productive soils d. All of the above
4. The three R's responsible for a better environment are:
   a. Reduce, Reuse, Recycle b. Read, Register, Recall
   c. Random, Reduce, Recall d. Reduce, Rebuild, Restrict
5. A food web consists of:
   a. Interlocking food chains b. Producers, consumers and decomposers
   c. A portion of a food chain d. A set of similar consumers
6. Predation helps to maintain balance in:
   a. Community b. Population c. Ecology d. Ecosystem
7. An ecological pyramid refers to the:
   a. Pyramid of energy b. Pyramid of number
   c. Pyramid of biomass d. All of the above
8. When the oxides of nitrogen (NO, NO_2) and sulphur (SO, SO_2, SO_3) interacts with water vapours then the acids produced are:
   a. Acetic and Citric acid b. Sulphuric and Nitric acid
   c. Hydrochloric and Nitric acid d. Sulphuric and Citric acid
9. The process in which nitrates and nitrites are reduced to nitrogen gas by bacteria is:
   a. Assimilation b. Denitrification
   c. Ammonification d. Nitrification
10. The relationship between Rhizobium bacteria and leguminous plants is an example of:
    a. Parasitism b. Mutualism c. Commensalism d. None of these.

B. Write short answers to the following questions.

1. Define the terms: species, biosphere and ecosystem.
2. Differentiate between population and community.
3. Differentiate between food chain and food web.
4. How does deforestation affect the environment?

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5. Distinguish between herbivore, carnivore, and omnivore.
6. Outline the role of bacteria in the nitrogen cycle.
7. How can overpopulation affect the environment?
8. Name any five sources of water pollution.
9. Differentiate between parasitism and mutualism.
10. Define nitrogen fixation and nitrification.

C. Write detailed answers to the following questions:

1. Describe the nitrogen cycle in detail. What would happen if the nitrogen cycle stopped working?
2. Compare the flow of materials and the flow of energy in the ecosystem.
3. Write a note on the energy flow through different components of an ecosystem.
4. What are the different ways through which organisms of the ecosystem interact with each other?
5. Discuss the biotic components of the ecosystem.
6. Write notes on the three types of symbiosis.
7. Enlist the causes of water pollution and also describe how water pollution can be controlled.
8. Write a comprehensive note on land pollution.
9. Explain, by making diagrams, the pyramids of number and biomass.
10. Write a note on the causes and effects of air pollution.

Activities

Visit 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 the Internet and literature on Pakistan's population growth from 1998 to 2017 and interpret this population growth and the possible consequences on our society.
4. Identify the environmental problems in your community. What are the causes and what should be done to solve these problems?
5. How would you design a campaign against pollution in your area? What would the key messages be and what would you prioritise? Give reasons.
6. Organise a poster or picture exhibition at school on some environmental topic.