Unit–9

MAN AND HIS ENVIRONMENT

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Introduction

Environment and environmental problems such as pollution, rapidly depleting natural resources, climatic changes and many other problems related to the environment are topics of hot debate in today's society. Everybody seems to be seriously concerned about environmental problems. Life of man and all other living beings is said to be at stake due to environmental deterioration. It is interesting to note that we, human beings are said to be the culprits causing all these problems.

Have you ever seriously considered what is environment? What is pollution and what are its causes? Why are natural resources diminishing? How are these problems related to environment? What is meant by sustainability of environment? What is the role of man in creating these problems? What type of human activities are the cause of environmental change and deterioration? And most importantly why the survival of man and other living beings on this planet is at stake?

In this unit, we have tried to answer these and many other questions related to environment; environmental problems, effect of environmental problems on human life in particular and life in general and role of man in deterioration of his environment.
We hope that you will find this unit, interesting and informative.

Objectives

After studying this unit, you will be able to:

- explain what is environment and what are its components.
- define ecosystem and enumerate its component.
- explain energy flow in ecosystem.
- explain the types of ecosystems.
- describe the cycles in ecosystem.
- define pollution and describe its various forms.
- explain the concept of conservation of environment.

9.1 Environment & its Components

It is said that earth is the only known planet which sustains life. So any discussion of human environment is related to earth. Life exists everywhere on this earth; it is present in water, in soil and even in the air. It is therefore important that prior to any discussion on human environment we learn about earth and its system.

Scientists have classified the different areas of earth into four inter-connected "geo-spheres:" (geo means earth and sphere means space, field or area). These four spheres include:

- Atmosphere
- Hydrosphere
- Lithosphere
- Biosphere

The terms used for these spheres have been derived from the Greek words. Litho means stone, “atmo” means air while hydro is for water and as you may know ‘bio” means life. Life can exist in any of these four spheres. All these spheres are interconnected and make earth’s system. A system has different components or parts which are interconnected and work together in the form of a complex.

The major areas of earth include: Atmosphere, Hydrosphere, Lithosphere and Biosphere. These are connected and work together as a system.

In any system the parts are so closely interconnected that any change or disturbance in one part affects the working of the other parts. Like any other system these four components of the earth's system are also interlinked in such a manner that a change in one sphere often affect other spheres. Consider for example, hydrosphere, it contains living organisms. Any change in hydrosphere will affect the biosphere. Similarly any change in atmosphere or air surrounding the earth will affect the hydrosphere.

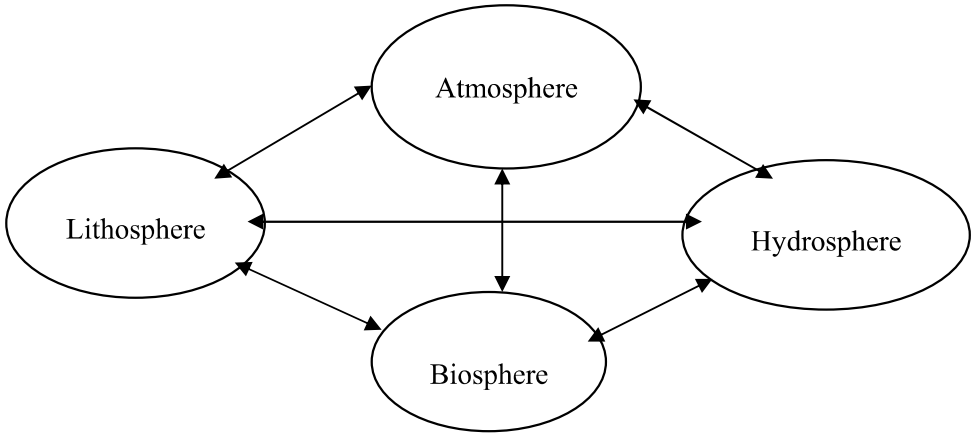


Figure 1: Earth’s spheres are interconnected in the form of a system

1. Atmosphere

The atmosphere is actually a layer of air which surrounds the whole earth. Most of the earth's atmosphere is near its surface; hence it is most dense near the earth's surface. It consists of many gases like oxygen, carbon dioxide and nitrogen. Seventy nine percent of atmosphere is Nitrogen, and about 21 percent is oxygen, the rest of it is composed of carbon dioxide and other gases. You must remember that this is natural undisturbed composition of earth's atmosphere and any disturbance in it will affect the other spheres particularly biosphere.

2. Hydrosphere

Hydrosphere includes all the water mass on or near the earth. This includes oceans, rivers, streams, lakes, ponds, moisture in the air, ground water (water in soil and beneath the earth surface) glaciers, and the snow cover ice caps on the mountains. Hydrosphere is about seventy percent (70 %) of the earth's surface. Oceans make ninety-seven percent of the earth's water the remaining three percent is fresh water.

3. Lithosphere

Is the solid, rocky cover or crust of the earth and the whole earth is covered by it. It is composed of minerals. In lithosphere weathering of rocks produces soil and minerals for plants. Soil contains decayed organic material (Humus) which is a source of nutrients for plants. Humans are found from the decay of dead plants and animals.

The lithosphere is the solid, rocky crust covering entire planet. This crust is inorganic and is composed of. It covers the entire surface of the earth from the top of Mount Everest to the bottom of the Mariana Trench.

It is the dark or black carbon containing residue in the soil resulting from the decomposition of vegetative tissues of plants originally growing in soil.

4. Biosphere

Biosphere is that part of the lithosphere, hydrosphere and atmosphere in which life can exist. It means that wherever there will be life there will be air, water and hard part of the earth that is lithosphere. Living things or biosphere interacts with the components of the other three spheres: Lithosphere, hydrosphere, and atmosphere. As a result of interaction between living beings and other components of biosphere changes may occur in the earth's system. Human interventions in the environment have changed and are continuously changing the natural earth system.

Biosphere is capable of sustaining and supporting life. Life on this earth exists from three meters below the earth's surface to thirty meters above it and also in the upper 200 meters of the oceans and seas. Biosphere of the earth evolved about three billion years ago.

9.1.1 Ecosystem and Its Components

The word environment has been derived from the French word "environ" meaning "encircle" so with reference to life on this planet, all the things encircling human beings and other living

things are called environment. Since biosphere is part of lithosphere and atmosphere, therefore everything in earth's spheres which surround living beings makes environment. These include physical, chemical and biological factors. To describe it in more inclusive terms, "environment is the sum of all elements, factors and conditions which may have an impact on the development or survival of living and non living things or organism".

All the needs of and requirements of every living organism are met/fulfilled from their environment. Therefore the knowledge of environment is important for the existence and survival of every living organism.

Environment means everything which exists around us and which can influence us in any way. It includes components of lithosphere, hydrosphere and biosphere.

If you look around, you will realize that there are factors and elements in the environment which are naturally present For example, forests, rivers, oceans soil, air, sun and its energy, wildlife, weather and man himself. There are also a number of things which man has added in the environment for his comfort For example, buildings, gardens, factories, industries, alternate energy resources such as electric light, machines, cultivated crops and new varieties of plants etc.

We can say that environment may be natural or artificial. When we refer to the environmental problems we mean natural environment. Unfortunately, improper and unwise interventions in the natural environment have caused its deterioration and disturbance in the earth's systems.

As we know human being are the most important and the most intelligent creatures that almighty Allah has created. Over the past two centuries there has been an unprecedented growth and development in science and technology. Man has not only extended his reach to the vastness of the universe to the depths of the oceans but has also molded and modified natural environment to best suit his needs and requirements. Industrialization and development of new communication technologies have brought a revolution in life style. Unfortunately all this development of human societies has caused more harm than benefit to the natural environment. Besides human activities, exponential increase in human population is also one of the major causes of environmental deterioration. Overpopulation causes deterioration of the natural environment in a number of ways. As the human population increases in size waste products accumulate and natural system of disposal of waste is disturbed.

There is a complex relationship between population size and environmental change. Increasing population affects environment in a number of ways. Population is continuously increasing however there is no increase in the available land nor is there any increase in the natural resources such as land, drinking water, and forests. Decrease in the land available for farming affect the food production. Similarly, population growth increases the demand for drinking water. It has been estimated that between 1900 and

1995 water consumption has increased six fold which is more than double the rate of population growth.

Developments in technology have affected the energy use which has serious consequences for the quality of environment. With the technological development the consumption of energy resources such as oil, natural gas, and coal has increased. Due to industrialization the use of natural energy resources has increased along with parallel increase in addition of harmful gases and other industrial wastes in the environment. Addition of harmful gases in the environment is adversely affecting the atmosphere of the earth. You might have read or heard about global warming. The term "global warming" refers to the observed and projected increases in the average temperature of Earth's atmosphere and oceans. According to scientists, during the 20th century, the Earth's average temperature has increased by about 0.6° Celsius (1.1° Fahrenheit).

Consumption of natural resources also plays an important role in straining the environment. Due to overpopulation and unwise use and waste of natural resources, for example, waters and energy, our present human race and our future generation is running short of natural resources which are crucial for survival of life on this earth. As you may have concluded from this discussion, the quality of environment has badly deteriorated over the past century. "Environmental quality is a set of properties and characteristics of the environment, either generalized or local, as they impinge on human beings and other organisms. It is a measure of the condition of an environment relative to the requirements of one or more species and or to any human need or purpose".

Environmental quality means the set of natural environmental conditions without interference of human activities.

Thus the environmental quality has been degraded by the following main factors.

- Rapid increase in human population
- Industrialization and advancement in technology
- Increase in waste products

If the aforementioned factors were not controlled, the living organism like plants, animals etc. would be unable to adapt to polluted environment therefore, it is the need of the hour to give proper consideration and keep care of environmental resources which cannot be reproduced or regenerated easily if once utilized. The supply of non-renewable resources is running short for example, fossil fuels which include coal petroleum, natural gas etc. Various minerals and metals are also included in non-renewable resources. Modern man is using these resources very rapidly and these resources may be depleted very soon. Now it is a dire need of the have to take practical steps to save our natural resources. We should realize the future time when all of its natural resources will be utilized and the survival of this human population will be endangered.

From the previous section you have learned that Earth's environment is composed of two major types of factors or elements: living factors i.e. animals and plants and non-living factors which include air, water, soil, energy etc. These are called biotic and a -biotic factors respectively. You also know that living things draw all their basic needs from the environment. A-biotic factors such as air, water, soil all play a very important role in sustaining life. Living and non-living factors of the environment constantly interact with each other forming a complex system which is termed as ecosystem. The term ecosystem was first introduced by Roy Clapham in 1930 and according to him "the sum total of physical and biological components of an environment makes the ecosystem".

"A unit area in which living and non living organisms interacts and influence upon each other is called an Ecosystem".

This unit area could be a pond, a stream, or a forest. It means that on this Earth a number of ecosystems exist. Combination of many ecosystems on earth forms the global ecosystem which is called "Ecosphere". A particular ecosystem of a region is also called as biome. Before studying about the ecosystem in detail, we should study some basic concepts regarding ecosystems.

1. Population

You are familiar with the term "population. Generally we use the term to mean a group of people living in an area, For example, population of Pakistan. When used with reference to ecosystem it means group of organisms of same kind which live in a specific place and reproduce their own kind. A group of organisms of same kind which can interbreed and reproduce fertile offspring is called a "species "So we can define population as:

A population is a group of individuals of the same species living together in a specific set of environment.

A population comprises all the individuals of a given species in a specific area or region at a certain time.

2. Community

The term community is used in more than one meaning. When used in sociological terms with reference to human beings, it means "group of interacting people, living in the same space and time. However, in biological terms, a community means a group of interacting living organisms sharing a populated environment. It means that unlike population a community includes individuals of different species living in a common place.

3. Biosphere

In the previous section you have read about the biosphere that it is the space on earth occupied by living organisms. It could be a part of lithosphere, atmosphere and hydrosphere.

Thus biosphere includes all form of life on the earth e.g. plants, animals and micro organisms etc. Biosphere is supported by nonliving environment. Every organism within

the biosphere affects the life of other organism directly or indirectly, e.g. man cannot continue to live without the green plants which are a source of food and other basic needs of man. The green plants also depend on bacteria which convert dead bodies of plants and animals into inorganic form so that plants can absorb them and manufacture their food. Biosphere is a system comprising of many interacting components. This interaction is in the form of exchange of materials between living and non living components of the environment. The materials added to the environment are again used by the living things. Waste materials excreted by the living organisms e.g. carbon dioxide, urea etc. and dead organisms become a part of the non-living environment. There is a constant exchange of materials between living and nonliving environment. This exchange of materials between biotic and abiotic factors creates a balance in the natural environment. The harmful materials do not exceed a certain level and there is also a constant supply of materials needed by the living organisms due to natural systems of recycling of materials in the environment. Thus biosphere is a system of natural checks and balances.

Unfortunately man through his activities is destroying the natural balance of the environment. So there is a dire need to develop some strategies to save the quality of environment in biosphere.

4. Habitat

Different types of animals and plants occupy particular spaces in the environment. For example, termites live in soil or wood, similarly fish lives in water. There are different kinds of fish some live in sea, others are found in fresh water while there are some which are found in rivers. So we can say that organisms live in particular places with particular set of environmental conditions, these places are termed as “habitat”. Like many scientific terms, “habitat” is a Latin word meaning "it inhabits”. It means:

“An environmental area that is inhabited by a particular species of animal, plant or other type or organism” or it is the natural environment in which an organism lives, or the physical environment that surrounds (influences and is utilized by) a species population.

SOURCE: http://en.wikipedia.org/wiki/Habitat

Several populations may share a habitat. For example,, in a small pond several aquatic populations may live in the same water at the same time. An aquarium is a good example of a shared habitat. Habitat is named after a specific characteristic of habitat or any other particular character. Examples of habitats include stream habitat, fresh water habitat, and marine habitat. In the above mentioned examples stream, fresh water ponds and marine water are prominent features that is why habitats have been named after them. The size of the habitat depends on the kind of organism livings there, e.g. the habitat of a frog may be a shady place near the bank of a pond. Likewise the habitat of pine trees may be pine forests spread on a vast area.

5. Biomes

Biomes are defined as "the world's major communities, classified according to the predominant vegetation and characterized by adaptations of organisms to that particular environment" (Campbell).

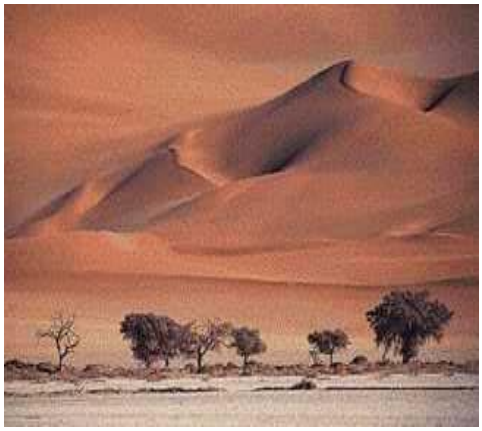
A biome is a large geographical area of distinctive plant and animal groups, which are adapted to that particular environment. The climate and geography of a region determines what type of biome can exist in that region. Major biomes include deserts, forests, grasslands, tundra, and several types of aquatic environments. Each biome consists of many ecosystems whose communities have adapted to the small differences in climate and the environment inside the biome.

6. Ecosystem

Living organism depends on each other and also influences living as well as non living components of the environment within a specific habitat. For example, green plants manufacture food by the process of photosynthesis which animals cannot do. So the animals depend on green plants for their food. Likewise plants depend on soil for the absorption of minerals. Moreover green plants obtain gases from the atmosphere through stomata. Living organisms also interact with their physical environment for example, light, temperature and water. This interaction of organism with their environment is called as ecological system or ecosystem.

A natural unit area, in which living and non living organisms interact and influence each other, is called on ecosystem.

Ecosystems can be as small as a puddle or as large as the Earth itself.



Desert is a large ecosystem

Lotus lake in Islamabad is a small ecosystem

Fig.1 Two different ecosystems

Ecosystem has the following properties and characteristics:
Ecosystems always maintain a balance. Whenever there is any change, ecosystems have the ability to adjust themselves in new ecological conditions to some extent.

Different types of cycles operate in ecosystem such as carbon-Hydrogen-Oxygen cycle, phosphorous and Nitrogen cycle etc.

There is an energy flow in ecosystems whose source is sun. Solar energy maintains life in ecosystems. Ecosystems are self running systems.

Factors of Ecosystem

Like other systems, ecosystem is also composed of interconnected factors. Functions of various factors of ecosystem are dependent on each other and influence each other. Basically ecosystems are composed of two kinds of components (i) Abiotic component and (ii) Biotic component.

Abiotic (A means = none and biotic means living) All the non-living factors that directly or indirectly influence the existence of living organisms in an ecosystem are the abiotic factors. Abiotic components include factors such as light, temperature, water, atmosphere, soil, topography and inorganic nutrients. These abiotic factors are very important for sustaining and maintaining life on this planet.

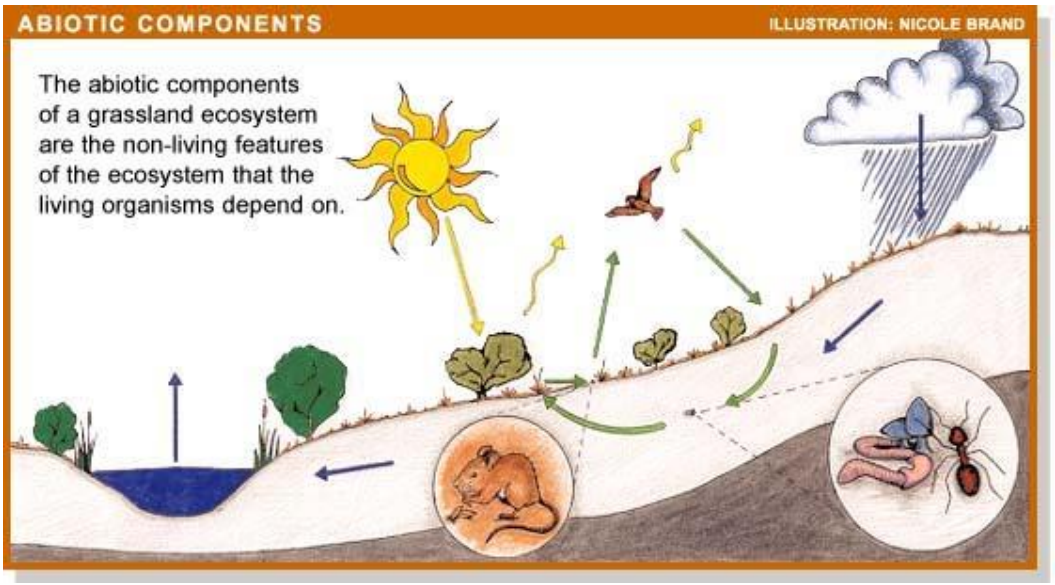


Fig. 2 Abiotic Factors

Biotic or biological components of ecosystem consist of all living part of ecosystem like plants, animals and decomposers. The examples of natural ecosystem are ponds, lakes, oceans, and forests etc. there may be artificial ecosystems e.g. cities, towns etc.

Abiotic	Biotic
Light, Temperature, Water, Atmosphere and wind, Fire, Soil, Gravity, Topography, Inorganic nutrients	Producers (Green Plants, Consumers(Animals & non-green plants, decomposers (Bacteria and Fungi)

Table 9.1 Factors of ecosystem

9.1.2 Abiotic (physical) Components of Ecosystem

Abiotic components of ecosystem play vital roles in the establishment of an ecosystem. A brief description of these abiotic components is as follow:

1. Light

The visible part of solar radiation is called light. Light is very important for existence of life in biosphere. It is the primary source of energy for all kinds of ecosystems on earth. We can safely say that "No life without light". Plants use light to convert Co_2 and H_2O into glucose. So the light energy is converted into green plants food. The rest of the living organisms in the biosphere directly or indirectly consume green plants as food for energy.

To understand why sun's light energy is essential to sustain ecosystems, carefully study the figure and try to follow the flow of energy in the ecosystem. From the sun, energy is captured by plants to prepare their food. Animals eat green plants. These animals are in turn are food for meat eaters or carnivores. When plants and animals die, organisms like crows, vulture, beetles, and microorganisms like bacteria, consume the dead bodies.

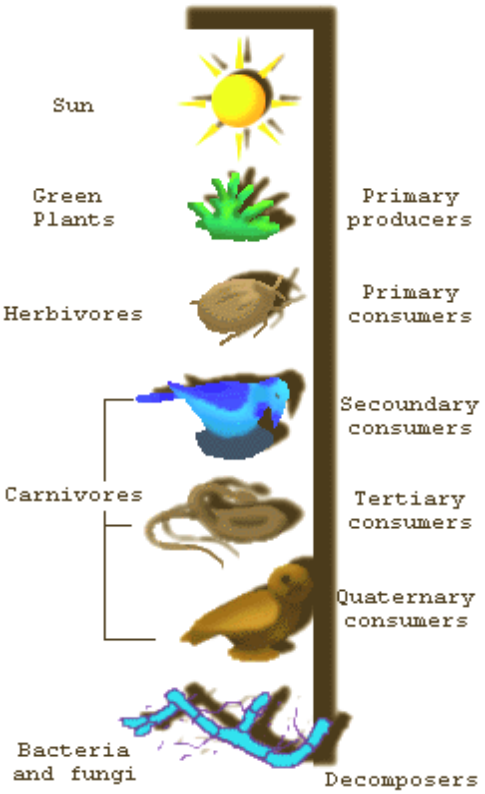


Fig.3 Flow of energy in ecosystem

This is how energy transfers from its primary source that is sun to all life in the ecosystem.

Three characteristics of light affect the ecosystem: i) quality of light, ii) intensity of light, and duration of light.

i. Quality of Light

Light comes from sun to earth in the form of rays. The visible light has seven colors, whose wavelength ranges from 390 nm to 760 nm. Blue and red light is important for plants to perform photosynthesis.

Activity 1

Take a prism. Place a white paper in front of prism place, the prism parallel to the sunrays, so that light may pass through it. Observe different colours of light formed on white paper. Enlist your observations in a notebook and share discuss with your tutor.

ii. Intensity of Light

Second is the "intensity of light", which directly affect the living organism. For example, chlorophyll does not develop fully in plants growing in shady places. That is why leaves become pale in absence of light.

Intensity of light that is how strong the light is affects the living organisms, particularly the plants which use light energy to manufacture their food. You may have noticed that when the leaves of the plants are placed under shade for a long period their leaves turn pale or yellow. The green substance or chlorophyll, present in the green parts of the plant, needs sunlight to develop. When there is less light it does not develop fully therefore the leaves turn yellow. As you may know in shady places light intensity is less than in the open areas.

iii. Duration of light

The duration for which plants and animals are exposed to sunlight also affects plants as well as many animals. You are aware that in summer, days are longer hence sunlight is available for longer period than in the winters. The production of flowers, fruits new leaves and growth all are dependent on relative day lengths, likewise hibernation or winter sleep in cold blooded animals (e.g. snakes), migration of birds from one place to the other and reproduction etc. all depend on duration for which sunlight is available which in turn is dependent upon relative day lengths.

If you are interested in birds you might have heard or noticed that many new birds start arriving in Pakistan in October and November and stay with us till March when the weather is mild. These are migratory birds which migrate to Pakistan to escape harsh cold in Russia and China. Sometimes they travel more than 4,500 kilometers from their original habitat. Cranes, ducks-mallards, common pochards, common teal, northern pintail, northern shoveler, cormorant, snipes, stints, plovers, gulls and score of other birds fly to Pakistan every winter. Bears go to sleep during winters

Fig. 4Effect of duration of light on different animals

Activity 2

Observe the birds in your area during winter and summer and make notes of the types of birds you see during different seasons. Find out if there are some birds which visit your area only during a particular season. You can also ask the farmers and gardeners of your area about their observations in this regard.

2. Temperature

The measurement of intensity of heat is called temperature. Different scales are used for the measurement of temperature. Celsius or centigrade and Fahrenheit scales are the most commonly used scales. Temperature affects the growth and distribution of organisms in ecosystems. Most of the living organisms in the biosphere carry out their physiological activities within a temperature range of $0C^{o}$ to $50C^{o}$. The optimum temperature range for life is $15C^{o}$-$35C^{o}$. Organism have various adaptations to overcome extremes of temperature. For example,, the deserts plants have very long roots that reach deep into the ground for underground supplies of water. Most other plants have evolved large root systems that lie close to the ground surface. Roots are then close to the water when it rains and can absorb the moisture in the soil surface before it evaporates under the desert sun. Their leaves have small area to reduce evaporation of water i.e. transpiration. Most plants stop growing at temperature below $6C^{o}$. Similarly rate of metabolism in animals decreases at low temperature and animals become lazy and slow.

3. Water

Water is essential for life in any ecosystem. Life is impossible without water. It is found in abundance in aquatic ecosystem while very little water is present in deserts and on mountain tops. Water is also present in the atmosphere in a very limited amount. Water circulates in the biosphere by three processes i.e. rainfall, evaporation and transpiration. Water possesses some very unique properties due to which it is one of the most important life - supporting bio-molecule. First of all it is best solvent; it provides a fluid material for various reactions to occur.

4. Atmosphere and Wind

Atmosphere or air is a gaseous envelope surrounding our earth. Air or atmosphere in motion is called wind. Atmosphere and wind are very important in maintaining life in the

ecosystems. The important gases in the atmosphere are nitrogen, oxygen, carbon dioxide and water vapors. The relative concentrations of these gases have been given in table 9.2.

Gases	Percentage in atmosphere
Nitrogen	78-79%
Oxygen	21%
Argon	0.934%
Carbon Dioxide	0.03-0.04%
Other gases	0.003%

Table 9.2: The concentrations of various gases in the atmosphere.

Another important constituent of atmosphere is water vapors. Water vapors are released into atmosphere by transpiration in plants and evaporation. The amount of water vapors in the atmosphere determines the amount of rainfall in different ecosystems.

5. Fire

We often hear about the fire outbreaks in natural forests. Forest fire is regarded as a natural ecological factor of the environment. Fire affects include physical, chemical, and biological impacts on ecosystem resources and the environment. The effects of fire on abiotic factors include changes in air and water quality, soil properties etc. It also effect biotic factors i.e. plants and animals. It can alter vegetation which in turn will affect wildlife. The particular effect of fire on any one of these components (e.g., the fire severity) is not fixed, but will vary according to site characteristics and fire behaviour. For example, the effects of a fire burning under the same conditions may be very different on soils of different textures. Likewise, the effects of fires burning under different fuel and weather conditions can be very different on similar soils.

There are three requirements for fire.

i. Presence of dry organic matter.
ii. Dry environmental condition and
iii. Source of fire

Source may be natural lightning or man- made fires are also frequent, especially in grasslands fires are made to eliminate dry organic matter. Fire in an ecosystem has unpredictable results. However it is not always fatal. It is an important regulatory and decomposing agent. Fire eliminates certain unwanted species of plants and favoring survival of others. Following are the role of fire in an ecosystem:

In dry and hot regions the dead parts of the plants are too dry for decomposers to act on them. If these plants catch fire the nutrients are released and become part of the soil. The gases which result from burning are added to air thus it increases productivity by increasing fertility of the soil.

Fire promotes life cycle of many plants. For example, the seeds of some species of pine are only released out of their cones by fires. In this way it is the fire which starts their life cycle.

Some time fire results in selective destruction, destroying some species while leaving the others. If the fire destroys unwanted weeds and leave the beneficial then it helps in natural management of the forest.

Periodic and controlled fire has good effects on animals and plants. It plays a significant role in shaping the distribution and composition of much of plants and animals. Many species develop specific mechanisms to survive periodic fire; some even depend on it for critical life stages. It also causes migration of some animals.

6. Gravity

Gravity is an ecological factor which remains unchanged throughout the biosphere. Gravity can be defined as under:

Gravity is a force with which earth attracts different objects towards its centre.

We often think that gravity is the force with which earth attracts everything towards its center but, actually it is the force of attraction which exists between any two bodies. It is proportional to their masses. We are all familiar that gravitation is the agent that gives weight to objects with mass and causes them to fall to the ground when dropped. It is due to this force of attraction that dispersed matter fuses, and fused matter stays fused. The existence of the Earth, the Sun, and most of the macroscopic objects in the universe is due to the force of gravity. Hence you can imagine that it is a very important abiotic factor of the ecosystem.

Both animals and plants are affected by gravity and respond to this force in different ways. Response of plants to gravity is termed as geotropism. For example, the gravity affects the growth of roots and shoots. Roots grow towards gravity, so are said to be positively geotropic. The shoots grow away from gravity hence are negatively geotropic. The force of gravity pulls everything to overcome this pull or force objects need energy. Plants and animals have developed certain adaptations for gravity. In plants shoots grow upward i.e. away from the gravity. In order to supply water to its upright branches and stem plants have to transport water against the gravity. To solve this problem a special system of vessels have evolved in plants to conduct water and minerals from soil to arial parts of plants, it is called xylem tissue. Roots are positively geotropic and shoots are negatively geotropic.

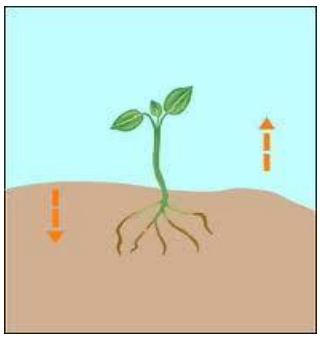


Fig.5: Geotropism in plants

Birds have forelimbs modified into wings to fly against gravity while vertebrates have vertebral column as an adaptation. It helps them to rise above the ground which is a movement against the gravity.

7. Topography

Topography is the study of surface, shape and features of the Earth and other observable heavenly objects including planets, moons, and asteroids. It is also the description of such surface shapes and features (especially their depiction in maps). The surface of the earth is not uniform at all places. In certain parts mountains are present, while there are low level sites in some other parts. Topography i.e. the features of earth surface, has indirect influence on the organisms. It affects the other abiotic factors such as climate, temperature etc. which in turn affect biotic components of the ecosystem. For example, with the increase in altitude the temperature decreases, wind velocity and intensity of sun rays increase at high altitude. These conditions enhance the atmospheric moisture and result in increased amount of rain fall. Steepness of slopes affects drainage and stability of soil. Soil is instable on steeper slopes, so stable plants communities do not develop. It means the erosion is greater on steeper slopes. Less steep slopes support more communities of organisms.

8. Soil

Soil is the uppermost layer of earth's crust. Factors such as water, ice, snow; wind and gravity break and disintegrate the rocks into soil.

Weathering is a set of physical, chemical and biological processes that change the physical and chemical state of rocks and soil at or near the earth's surface. Rock and soil is altered physically by disintegrating and chemically by decomposing.

The importance of soil in the ecosystem can be judged by the fact that all terrestrial plants and animals live on soil. All plants which have economic value grow on soil. Soil particles consist of sand, silt and clay. Loam is regarded as the best soil for plant growth. Loam is soil which has equal amounts of humus and soil particles.

Soil is formed through disintegrated of rocks. Soil is formed when factors such as water, chemicals, cold, and heat act on rocks over a long period of time and disintegrate them into soil. However this process is very slow and takes a very long time. There are two types of layers of the soil:

i. Top soil and ii. Subsoil.

i. Top Soil

Top soil is the surface soil which contains humus. Humus is organic matter formed from decay of dead plants and animal. It contains nutrients which are required for the plant growth.

ii. Sub Soil

It is located below the top soil. It is much thicker as compared to the top soil. It plays the following roles in maintaining life on biosphere; all plants whether trees, shrubs or herbs are rooted in the soil.

Soil provides water and mineral to plants. It provides oxygen to roots of plants and other animals living in the soil. Soil supports the life of a number of soil organisms like bacteria, fungi, algae, lichens, and a number of animals.

You can imagine how any deterioration in the quality of soil will affect the organisms, including man, for which soil is a habitat and a source of food.

9. Inorganic Nutrients

These includes various mineral nutrients like Calcium, Magnesium, Phosphorous, potassium, sulfur, and molecules like water, carbon dioxide etc. Usually these are present in solutions form in aquatic ecosystems. But in terrestrial ecosystem they are found stored in rocks. From rocks they are released slowly by weathering of rocks. Their presence or absence affects the efficiency of ecosystem greatly.

9.1.3 Biotic (Biological) Components of Ecosystem

Biotic components i.e. living organisms have different roles in the ecosystem and on the basis of their roles they have been classified into three groups:

1. Producers
2. Consumers
3. Decomposers

The detail of each classified group is as follows:

1. Producers

In any ecosystem sun is the main source of energy. Green plants use this energy to prepare their food thus convert the sun's energy into food energy. The green plants prepare food by CO_2 and water in the presence of sunlight this process is called photosynthesis. Green plants perform the function of production of food which is used by all other living organisms directly or indirectly. Therefore, green plants are called producers. Another term used for green plants is "autotrophs", (auto=self, troph=food) i.e. organisms which prepare their own food.

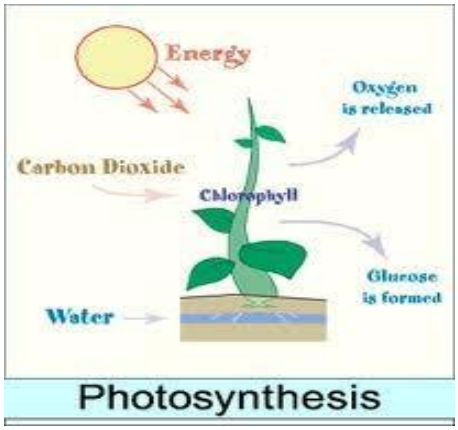


Fig. 6: Photosynthesis

Aquatic plants usually float on the surface of water or are present submerged in water. But terrestrial plants are usually rooted in the soil. Aquatic unicellular plants which float on the surface of water are called as phytoplankton (phyto= plant, plankton= swimming). The carbohydrates which are prepared by green plants are mostly used in their growth and respiration. The leftover food is used by other living organisms.

2. Consumers

The term consumers mean all those non green plants and animals which obtain food from green plants i.e. they only consume food they do not make it. Animals, fungi and some parasitic plants are consumers which lack chlorophyll in their cells and hence cannot prepare their food by photosynthesis. All the consumers are heterotrophy. (Hetero= other, troph= food) i.e. they obtain their food from others). There are various kinds of consumers depending upon the method of getting food.

i. Primary Consumers

They are also called as herbivores, because they utilize the plant parts directly e.g. cattle, rabbits etc. major consumers in terrestrial habitat are insects, rodents, (rats, squirrels). Cattle (goat, sheep, cow, buffalo), while in the aquatic habitat these are small crustaceans (a type of arthropods) mollusks and some fishes.

ii. Secondary Consumers

They are also known as carnivores. The secondary consumers use the flesh of herbivores as their food. Examples are dog, lion, tiger etc.

iii. Omnivores

Some animals use both plants and animals as their food. These are called as omnivores. For example, human beings, crow etc.

iv. Parasites

The organisms which derive their food from other living plants and animals are called parasites. Likewise scavengers which feed on dead animals are also regarded as consumers e.g. vultures, mushrooms etc. are few examples.

3. Decomposers

Decompose to breakdown complex compounds into simple substances. The Organism which break down or decompose the complex organic compounds of dead plants and animals into simple substances are called decomposers. The decomposers derive energy from the process of breakdown of complex organic compounds.

The inorganic substances produced by decomposition are again utilized by green plants during photosynthesis and other biochemical process. Thus the cycling of materials continues in the ecosystems chief decomposers in the ecosystem are bacteria and fungi. The action of decomposers is vital because if it did not occur, all the nutrients would remain blocked in dead bodies and no life would be produced. Temperature has marked influence on the rate of decomposition. In colder climate the rate is slower while in hot climate the rate is very rapid.

Key Points

1. Environment means everything which exists around us and which can influence us in any way. It includes components of lithosphere, hydrosphere and biosphere.
2. Environmental quality means the set of natural environmental conditions without interference of human activities.
3. A unit area in which living and non living organisms interacts and influence upon each other is called an Ecosystem.
4. A population is a group of individuals of the same species living together in a specific set of environment.
5. Scientists have classified the different areas of earth into four inter-connected geo-spheres: Atmosphere, lithosphere, Hydrosphere and Biosphere.
6. The atmosphere is a layer of air which surrounds the whole earth.
7. Hydrosphere includes all the water mass on or near the earth.
8. Lithosphere is the solid, rocky cover or crust of the earth.
9. Biosphere is that part of the lithosphere, hydrosphere and atmosphere in which life can exist.
10. "Habitat" is a Latin word meaning it inhabits.
11. A community means a group of interacting living organisms sharing a populated environment.
12. Ecosystems are composed of two kinds of components (i) Abiotic component and (ii) Biotic component.
13. All the non-living factors that directly or indirectly influence the existence of living organisms in an ecosystem are the aboitic factors.
14. Biotic or biological components of ecosystem consist of all living part of ecosystem like plants, animals and decomposers.
15. Abiotic factors include, air, water, soil, fire, light, gravity, and topography.
16. Biotic factors include all living organisms.
17. Quality, intensity, and duration of light affect both plant and animal life.
18. Forest fire is a natural ecological factor of the environment. It affects all other factors of ecosystem i.e. physical, chemical, and biological factors as well as resources and the environment in general.
19. Temperature affects the growth and distribution of organisms in ecosystems. Most of the living organisms in the biosphere carry out their physiological activities within a temperature range of $0C^{o}$ to $50C^{o}$. The optimum temperature range for life is $15C^{o}$-$35C^{o}$.

Self Assessment Exercise 9.1

1. Define Environment.
2. What is meant by environmental quality?
3. Do you know what factor has caused degradation of environmental quality?
4. What is the difference between renewable and non-renewable environmental resources?
5. Enlist some of the important renewable environmental resources.
6. Enlist the major components of earth's system.
7. Describe biosphere.
8. Define habitat.
9. What is the criterion of naming a habitat?
10. Which factor or factors determine the size of habitat?
11. Define ecosystem.
12. What are the major basic components of ecosystem?
13. What is the range of wavelength of visible light?
14. What is the range of temperature for organism in which they can service?
15. Which factor produces sudden change in ecosystem?
16. What is the importance of soil in terrestrial ecosystem?
17. Which soil is the best for plant growth?
18. Give examples of the following:
    a. Herbivores b. Decomposers c. Omnivores
19. What is the effect of temperature on decomposition?
20. Define phytoplankton.
21. What is the importance of decomposition in ecosystem?
22. Define autotrophs and heterotrophs.

9.2 Energy Flow in Ecosystem

For the biosphere sun is the ultimate source of energy for all type of reactions taking place in the ecosystem. Animals in any ecosystem cannot utilize solar energy as green plant does. The reason for this fact is that the green plant possesses necessary apparatus chloroplast for the capture of light in the form of Glucose. The chlorophyll and related pigments are responsible for entrapping light energy by which green plants manufacture their food. Thus light energy is converted into chemical energy.

Then this chemical energy of food is transferred from plant to animals. Because this transfer of energy follows a straight path i.e. from green plants to animal and finally to decomposers which derive some chemical energy by decomposing dead organic matter of plants and animals. So this flow of energy is strictly unidirectional. Up to 2% of total solar radiation is absorbed by green plants and is converted into chemical energy of food. Some part of this food is utilized by green plants themselves in their respiration. During respiration energy is released which is mostly stored in the cells in the form of ATP while some part of this energy is lost as heat.

When this food is transferred to animals it is again degraded in the cells during respiration. In this process energy is also released but overall amount of energy available to animals is less as compared to plants. The reason for this is that most part of the energy is lost during transfer from plants to animals. The flow of energy can be explained on this basis of two laws of thermo dynamics. According to first law of conservation of energy, energy can neither be created nor destroyed but it can be converted from one form to the other. As already discussed light energy is captured by green plants and converted into food energy through photosynthesis. Most of the solar energy i.e. 98% is not used by green plants and thus goes waste, only 25% of absorbed solar energy is used in photosynthesis. The food synthesized by green plants during photosynthesis is called as gross production. Some part of the gross production is used in respiration to get energy. Food energy stored in green plants after utilization in respiration is called as net production. Net production comprises 40% of the total gross production. Thus gross production can be presented as flows.

Gross Production	=	Net production	+	Respiration
Net production	=	Gross production	–	Respiration

When herbivores eat green plants food energy saved in the form of net production is transferred to herbivores then it is transferred to carnivores and so on.

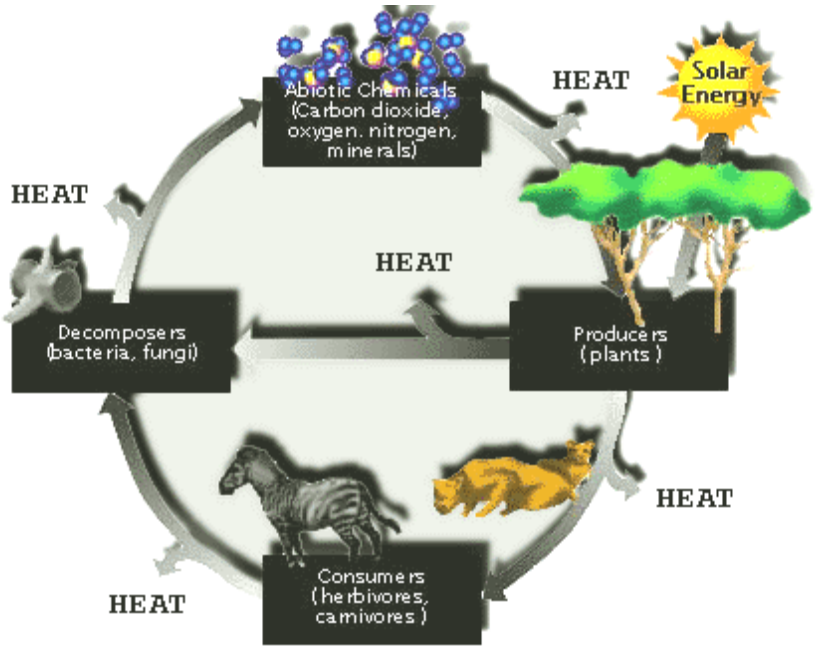


Fig.7: Energy Flow in Ecosystem

http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/ecosystem/ecosystem.html

There is a gradual decrease of energy at every transfer from one organism to the other because at each stage organism will use some of the food for growth, movement, and reproduction. It means that amount of available energy decreases at every energy transfer. Thus net production is the form of energy available to all heterotrophic plants and animals, by which they prepare biomass of their bodies.

Biomass' is the amount of living or organic matter present in an organism. In an ecosystem biomass refers to the total amount of living matter present in the organisms at each trophic level. All the living matter present in living plant and animals is known biomass.

The energy loss at each transfer from one organism to the other is according to second law of thermodynamics which states that "there can be no transformation of energy unless there is some loss of energy in the form of heat energy".

The total food energy obtained by herbivores will be gross production at herbivores' level. Some part of this food energy is used by herbivores in their respiration to perform life activities. Food energy stored in herbivores other than used in respiration is called as net production at herbivore level. Only about 10 percent of net plant production

comprises the net herbivore production. When energy transferred to carnivores there is further decrease in available energy.

9.2.1 Food Chains and Food Webs

As you know from previous sections, biotic components of the ecosystem include: producers, consumers and decomposers. Producers capture sun's energy and make their food, consumers use green plants and other organisms as their food, decomposers live on dead bodies of plants and animals. In this way a chain of energy flow is established. It is called food chain. Food chain can be defined as.

The series of organisms through which food energy moves with repeated stage of eating and being eaten is called as food chain.

The food chain is the route through which energy in the form of food is transferred from producers to herbivores, then to carnivores and finally to decomposers. The pattern of energy flow can be outline as flows:

Producers ⟹ Herbivores ⟹ Carnivores ⟹ Decomposers

Food chains may be of following types:

1. **Parasitic Food Chain**
   In this food chain energy flows from hosts to parasites many types of bacteria, fungi, protozoan, nematodes and some flowering plants are parasites.

2. **Saprophytic Food Chain**
   Saprophytes are the organisms that feed on dead organic matter. For example, mushrooms. In this type of food chain energy flows from dead organic matter to decomposers, like bacteria and fungi.

3. **Grazing Food Chain**
   This type of food chain is found in land conditions and food energy is transferred from green plants to large animals, including man in aquatic environment it may consist of algae ⟶ water fleas ⟶ small fishes ⟶ large fishes ⟶ man in grassland. This food chain may be as follows:

In the above mentioned examples arrows indicate the direction of flow of food energy.

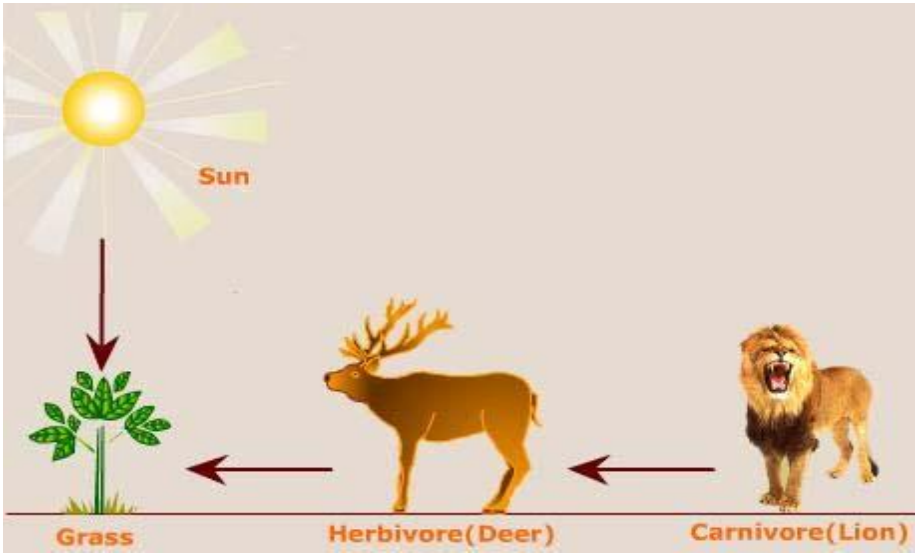


Fig. 8: Grazing Food chain

A simple food chain. Arrows indicate flow of energy from sun to green plants, to herbivore and then to carnivores.

Trophic Levels in a Food Chain

In the above description of food chains you may have noticed that in each food chain there are a number of levels of energy transfer. For example, the first level is of green plants which capture the sun's energy, then second level is of organisms which eat green plants i.e. herbivores, at the third level are meat eaters or carnivores i.e. the organisms which derive their energy from herbivores.

In a natural community each level in the food chain is called as trophic level

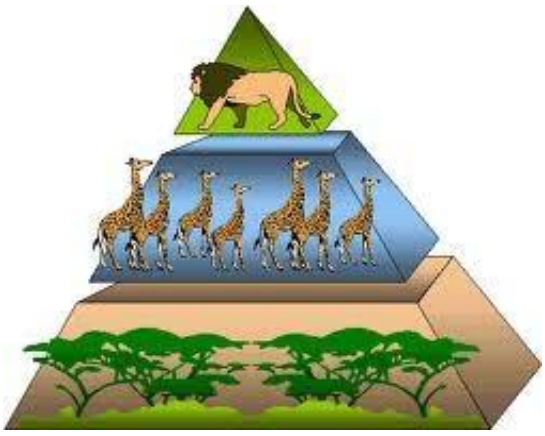


Fig. 9: Trophic levels in a food chain

The green plants constitute the first trophic level called as producer level. Herbivores are second trophic level or primary consumer level. Carnivores that eat herbivores are at the third trophic level or secondary consumer level. Thus there may be more than one trophic level in a food chain.

Look at the above diagram of the trophic levels. Green plant is at the first trophic level their number is very large as compared to the organisms at the upper levels hence the trophic levels are presented in the form of a pyramid. A trophic pyramid or energy pyramid is a graphical representation designed to show the biomass or biomass productivity at each trophic level in a given ecosystem. Another type of ecological pyramid is used to refer to show the production of biomass at different trophic levels it is called productivity pyramid.

Food web

As you may have realized food chain represent a single path of energy transfer. The communities in n ecological system are self sustaining systems in which the energy flows through a number of interconnected food chains thus form a complex or network of energy flow. This complex or network is called food web. The food web is defined as.

A complex relationship formed by interconnecting and overlapping food chains in an ecosystem is called food web.

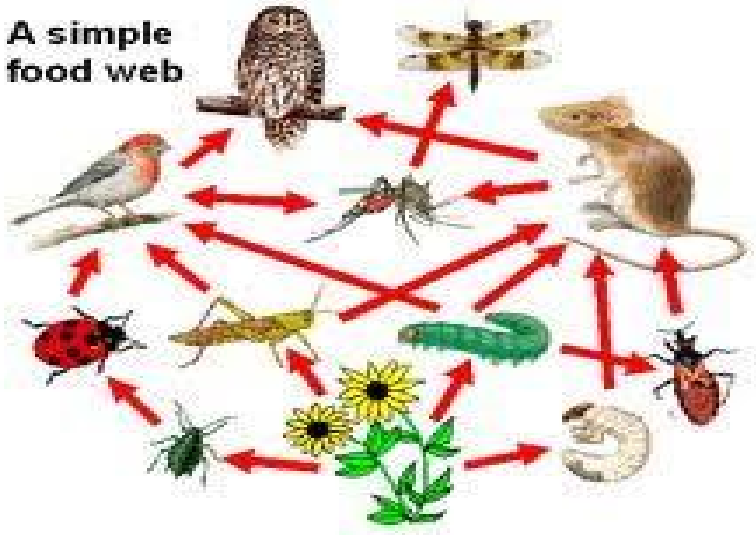


Fig.10: A simple Food Web

In complex communities there may be many alternate sources of food for herbivores and carnivores. The alternate sources of food in any ecosystem represent stability of an ecosystem. If there are more alternative food sources, the ecosystem will be more stable.

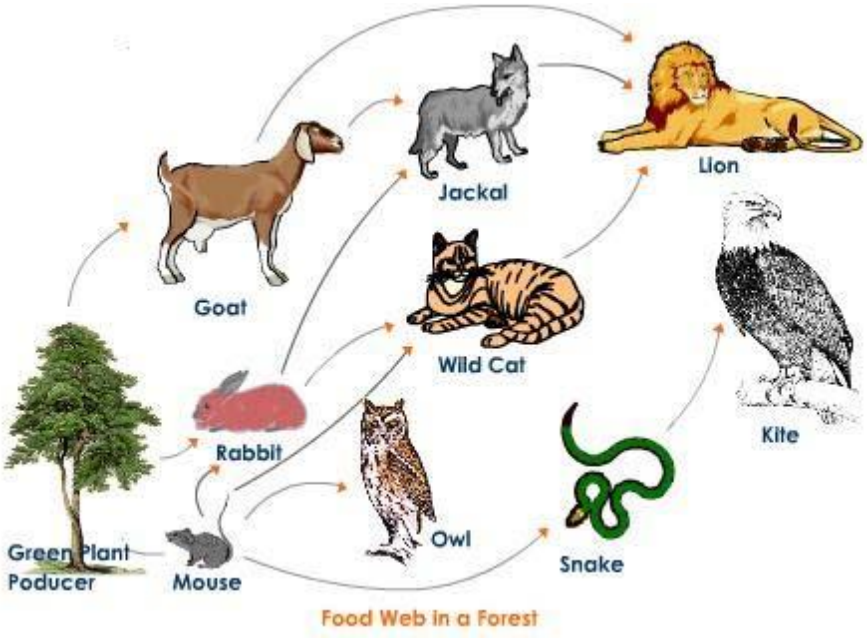


Fig. 11: Food web in forest

Key points

1. For all type of reactions taking place in the ecosystem, sun is the ultimate source of energy.
2. Food energy stored in green plants after utilization in respiration is called as net production.
3. The series of organisms through which food energy moves with repeated stage of eating and being eaten is called as food chain.
4. In a natural community each level in the food chain is called as trophic level.
5. A complex relationship formed by interconnecting and overlapping food chains in an ecosystem is called food web.
6. Biomass' is the amount of living or organic matter present in an organism. In an ecosystem biomass refers to the total amount of living matter present in the organisms at each trophic level. All the living matter present in living plant and animals is known biomass.
7. In a natural community each level in the food chain is called as trophic level.
8. A complex relationship formed by interconnecting and overlapping food chains in an ecosystem is called food web.

Self Assessment Exercise 9.2

Q.1 Answer the following questions:

i. What is meant by a food chain?

ii. How much solar radiation is absorbed by green plants?

iii. What is a food web?

Q.2 Complete the sentences with appropriate word or words.

a. A level of energy transfer in an ecosystem is called_____.

b. The organisms which consume dead organisms to obtain energy are called_____.

c. The role of bacteria in the food chain is to_____.

d. When many food chains are interconnected they form a _____.

e. If we consider the pyramid of trophic levels the green plants are at the____ of the pyramid.

f. Biomass is the _____ in an ecosystem.

9.3 Types of Ecosystem

Ecosystem can be divided into two types:
1. Aquatic Ecosystem and
2. Terrestrial or Land Ecosystem

Here is the detail of each ecosystem:

1. Aquatic Ecosystem

Aquatic or water based ecosystem can further be classified into two categories:
i. Fresh water ecosystem
ii. Marine ecosystem

i. Freshwater Ecosystem

Freshwater ecosystem can further be divided into:
a. Standing water ecosystem
b. Running water ecosystem

The detail of fresh water categories is as follows:

a. Standing Water Ecosystem

Ecosystems of standing water include ponds and lakes. On the basis of depth of various parts of the lake or pond it is divided into three parts or zone: i) Littoral Zone, ii) Limnotic Zone, and iii) Profundal Zone
Different types of plants and animals are found in each type of the zone.

b. Running Water Ecosystem

Running water ecosystem is of two types:
- Fast or rapid flowing water
- Slow flowing water or pool

The bottom of running water is very important in determining the kind of organisms present there. There are some difference between the standing and running water bodies which are as follow.

- The water currents vary greatly in their velocity in various parts of some stream at different times. Standing water bodies have very few water currents.
- The stream is more closely associated with the surrounding land because in case of streams land water junction is larger than that of standing waters.
- Water in stream is usually shallow and has large exposed surface and is in constant motion as compared to ponds.

These three factors result in uniform distribution and abundant supply of oxygen. The stream or a canal makes a good example of rapids. The number and kinds of plants and animals in a stream, depends on the rapidity of waves in streams because organisms have to adjust themselves in rapidly flowing water. They have few adaptations in their bodies to remain at fixed positioning streams for examples plants are usually rooted in soil of bank while their

stems are present in water. Few examples of plants are members of green algae like cladophora, diatoms, etc, stream animals are mostly present at the bottom. The producers and consumers of streams are very specific and support very few consumer communities. Due to shallowness the temperature of water stream shows wider fluctuations as compared to ponds. Moreover there is high oxygen concentration in streams that is why stream animals have a very narrow range of oxygen tolerance. Stream communities are also sensitive to water pollution. The examples of animals in streams are sponges, arthropods, mollusks. In pools or slow running water, various plants and animal are adapted to fix their positions due to running water Nekton and Burrowing animals are good examples of pool animals.

Activity 3

Visit to a bank of a pond or stream observe various types of plants and animals found there record your observations regarding their place and types in your note book and discuss with your tutor.

ii. Marine Ecosystem

An ocean serves as a very vast reservoir of life. Like ponds or lakes oceans have been divided into various zones depending upon availability of light, amount of nutrients, oxygen, temperature and depth. Each zone has its characteristic plants and animals.

Some animals are exclusively found in the sea for example, an interesting animal called chaetognath is found only in the sea. It has a very transparent body; these are commonly called sea worms. Echindermata is also a phylum of sea animals. Its name has been derived from a Greek word. “Echino” which means spiny and “derm” mean skin. Most but not all, of these animals have spiny skins. Animals such as star fish, sea star, and sea Urchins are some of the animals found in the sea. They have no left or right and like a cake cut into equal sized pieces, their body has many identical pieces which are joined, see the diagram of star fish. Usually echinoderms have five arms or rays, but there are some exceptions. Over 6,000 species of echinoderms have been found in the sea.

Marine animals belong to all phyla except amphibians, centipedes, millipedes and onchophora while ctenohora, chaetognaths, and brachiopods are exclusively found in oceans. The number of these animals is greater near water surface and their number decreases with increasing depth.

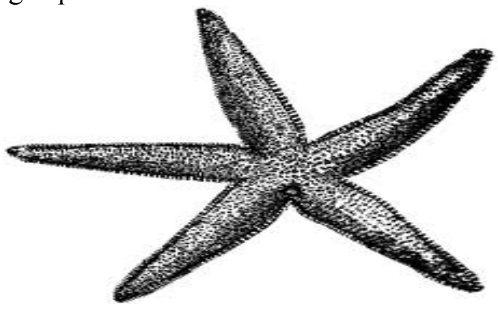


Fig.12: Star Fish: a type of echinoderm
Source: Starfish clip art, http://www.clker.com/clipart-13906.html

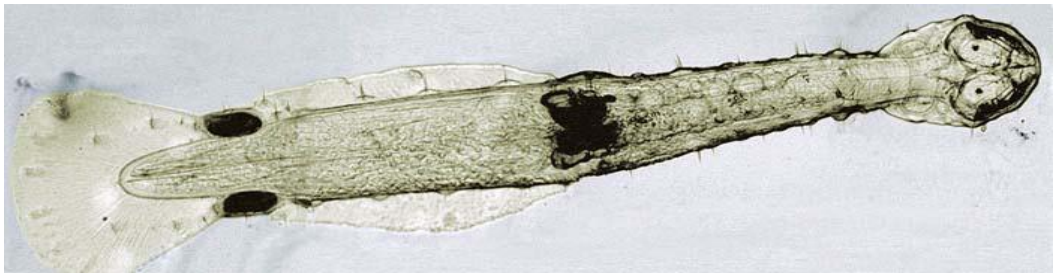


Fig. 13: The chaetognath

Source: Cavanihac,Jean-Marie. (1999). The chaetognath, a strange creature. France

http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artjan00/chaet.html

2. Terrestrial or Land Ecosystem

The following are some of the major types of land ecosystem. These are also called as "Biomes" because these are affected by the local climate.

i. Forest Ecosystem
ii. Grassland Ecosystem
iii. Savanna Ecosystem
iv. Desert Ecosystem
v. Tundra Ecosystem

The detail of each terrestrial or land ecosystem.

i. Forest Ecosystem

The forest ecosystem can further be divided into following categories.

a. Tropical rain forest
b. Temperate deciduous forest
c. Coniferous forest

Here is the detail of each forest:

a. Tropical Rain Forest

The regions of the Earth surrounding the Equator are called tropics. The Equator is an imaginary line on the Earth's surface which divides the Earth into the Northern Hemisphere and Southern Hemisphere. It is at equal distance from the North Pole and South Pole. The tropical areas receive abundant rainfall therefore the forests are very thick and dense and are called tropical rain forests. Tropical rain forests have following features or characteristics.

- **Climate**
  These forests receive abundant rainfall, all the year round. The average annual rainfall exceeds 2000 mm. Temperature in general remains high which remains up to 40^0C during day time. Forests are very dense due to abundant water supply.

- **Location**
  On the world map these forests are spread between the tropics of cancer (it is the part on the globe which lies towards north above the equator) and tropic of Capricorn (it is the part on the globe which lies towards south below the equator). These forests are present in the countries like Indonesia, Malaysia, and Africa (around river Congo). In South America, tropical rain forests are present in basin of River Amazon (Brazil). The richness of vegetation can be estimated from the fact that in some parts of Brazilian rain forest, there are as many as 300 species of plants in 2sq-km area.

At many places forests are so thick that no one can enter. Light cannot reach the forest floor hence the plants even during the summer time so plants grow taller and taller to get light.

Activity 4

Get a globe and locate equator, tropics of cancer and Capricorn on it. Then note down what countries are located in these areas.

- **Producers and Consumers**

The plants of top storey or canopy are extremely dense. The canopy is the portion of a plant community or crop which is above the ground formed by plant crowns.

With reference to forests, the term canopy also refers to the upper layer or habitat zone, formed by mature tree crowns and including other biological organisms.
Due to very little light reaching the forest floor shade loving plants i.e. the plants which grow well under shade are in abundance in these forests. These plants are called sciophytes. Moreover there are many epiphytes in these forests. Epiphytes are the plants which grow on the surface of other plants.

The examples of epiphytes are some ferns, Lichens, certain mosses and orchids. There are many types of animals too e.g. tree frogs, pheasant, monkey, lemurs snakes, birds insects, rodents, deers and peccaries etc. Mostly animals live on trees and thus are called as arboreal animals.

Nutrient cycling is very rapid in these forests, because bacteria and fungi decompose the organic matter very rapidly. The productivity of the tropical forests is very high.

Productivity is the amount of carbohydrates prepared by green plants through the process of photosynthesis.

b. Temperate Deciduous Forests

The features of temperate deciduous forests are as follows:

- **Climate**

  Temperate deciduous forests are found in areas with abundant evenly distributed rainfall and moderate temperature. The average rain fall is about 750 to 1500mm. There is a distinct difference between summers and winters. Most areas of this forest have been affected by the activities of human beings.

- **Location**

  These forests are located in eastern North America, Europe, parts of Japan, China, Australia and Southern parts of South America.

- **Producers and Consumers**

  The number and quality of vegetation in temperate deciduous forest depends upon amount of rainfall which is variable in different parts of the world. Temperate conditions prevail in Shogran and Neelam Valley of Azad Kashmir in Pakistan. Common plants are pines and sanober.

c. Coniferous Forest

The prominent feature of these forests is the presence of plants belonging to gymnosperm group "conifers" (name given due to presence of cones as reproductive structures). There are two types of these forests.

i. Coniferous alpine forest
ii. Coniferous boreal forest

- **Location**

  These forests are found in North America and Eurasia just south of the tundra.

- **Climate**

  Temperature in these forests remains low throughout the year. The temperature may be as low as 10^0C. The winter is long and severe with a constant cover of snow. The growing season is very brief as compared to temperate deciduous forest and lasts for 3-4 months

In Pakistan these forest are present in northern mountainous regions like upper reaches of Kaghan, Jaba valley in Swat, Dir and Chilas. As mentioned earlier there are two types of coniferous forest i.e. coniferous boreal forests and coniferous alpine forests.

Coniferous forest found at high altitudes (high mountains) are called coniferous alpine forest and those found at high latitudes are called as coniferous boreal forest.

- **Producers and Consumers**
  Major producers of this forest include deodar, cheer etc. Animals include snow leopards, black bears, Morcopolo sheep, and flying squirrels etc.

ii. Grassland Ecosystem

Grasslands are found at those places in the world where average annual rainfall is in the range of 250-270mm. Such amount of rainfall is insufficient for plant growth. More often there is severe drought in grasslands.

- **Location**
  Grasslands are found in temperate climates in the interiors of continents. Grasslands have been variously named in different regions of the world for example, prairies in North America, Pampas in Argentina, steppes in Russia, and veld in South Africa True grasslands do not have any kind of tree in them. However tropical grasslands have some patches of trees and are known as savanna. In Pakistan, grasslands are found in the northern mountain range such as lower chitral, part of Gilgit and Kashmir, Waziristan and north Kallat. Here rains are heavier than normal grasslands.

- **Climate**
  Grasslands occur in areas of scanty rainfall usually 250-270mm on the average annually such amount of rainfall cannot support the growth of trees. Often there are severe droughts. Grasslands are the areas of stress because there is no shade and protection for the animals from sun and winds. In the absence of shade grasslands are subjected to greater variations of temperature, moisture, winds, intensity of sunlight etc.

- **Producers and Consumers**
  Mainly various species of grasses are present in typical grassland. Tall grasses may range 5 - 8 feet in height but depending upon the amount of rainfall smaller species do not exceed more than 6 inches in height.

Grassland support communities of herbivores only. Large mammals like bison, antelope, Zebras, wild horses are common. Small burrowing birds like prairie chickens, meadow larks and some reptiles are also found. The burrows act as refuges during periods of intense heat and from attacks of predators. Predators of grassland include foxes, badgers and rodent eating hawks. Tigers and lions are found in grasslands of S. Africa. The soil of grassland is very rich in humus because of the rapid growth of grasses and decay of plants. In grasslands wheat and maize crops can be gown well.

iii. Savanna Ecosystem

Thus savannas are formed as a result of climatic conditions, but a few are formed by the destruction of tropical rain forests especially in African countries.

In savanna ecosystem there is a great variety of trees. Acacias are the most common plants of savanna ecosystems. Most common animals are large grazing mammals like zebras and large carnivores as lion and tigers.

Productivity of savanna ecosystem is less than tropical rain forests. Water is a limiting factor especially in the production of savanna ecosystem. Man has greatly affected savanna through fire, hunting and agricultural activities.

iv. Desert Ecosystem

Desserts are those areas where average annual rainfall is less than 250 mm. The other characteristic features of desert ecosystem are as follows:

- **Climate**

  The amount of rainfall in deserts is very little (less than 250 mm) which is not even distributed throughout the year. There may be frequent rains during one particular year but then many years may go completely dry. The plants in deserts are widely spaced due to insufficient water.

  The desert plants are very small in number. Atmospheric humidity is also low. Due to hot and dry winds, the variation between day and night temperatures may be as great as 50^0 C. In the absence of any barriers the strong winds cause damage to plants.

  Extreme shortage of water has made plant and animal to develop special adaptations to conserve water in their bodies.

- **Location**

  Sahara desert in Africa is the largest desert in the world. Other deserts are found in Australia, North America, Gobi desert in Mangolia, Chilli etc. In Pakistan the deserts are found mainly in the parts of Balochistan and Sindh i.e. Thar, and Cholistan.

- **Producers**

  Deserts plants are of two types;

  a. Surface Feeders
  b. Deep feeders

a. Surface Feeders

The plants in this category have shallow roots that spread just below the surface soil they absorb water very quickly before it is evaporated after rain. These plants have ability to complete their life cycle very rapidly in few days.

b. Deep Feeders

Most of the desert plants are deep feeders. They have deep roots and absorb water from deeper layers of the soil. The deep feeders live for many years as compared to surface feeders. Following are the major adaptations of desert plants to conserve water.

Desert plants have thick, fleshy stems and leaves to store water. This water is used in dries water. Many desert plants have very reduced leaves to check the loss of water during transpiration. Desert plants have thick cuticle, spines these features check the loss of water during transpiration. Even many desert plants close their stomata during day and open them in night.

- **Consumers**

  Very few animals live in deserts. Those living there have certain adaptations to conserve water in their bodies like plants Adaptations are as follows.

  Many animals live in burrows where humidity is higher and temperature is less than that of outside the burrow. They are nocturnal i.e. only come out of their burrows during night.

  Many desert animals drink either little water or do not drink and rely on the water present in their succulent food like cactus plants. The fat in the body of camel is converted to water to meet the water demands of the body. Camel can live for seven days without drinking water.

  Some desert animals like reptiles and insects excrete nitrogenous wastes in the form of uric acid which doesn't need water for removal out of the body.

  A few species of mammals have become secondarily adapted to desert by excreting concentrated urine.

  Absence of sweat glands, possession of salt secreting glands and large ears to radiate heat are the other adaptations to check loss of water from body, and keeping it cool.

v. Tundra Ecosystem

Tundra is a derivative of a Russian word meaning large treeless area. Tundra is referred to describe all types of vegetation in treeless high latitudes between taiga and polar ice caps.

- **Location**

  Tundra is found at very high altitudes across the mountains above the timberline. Timberline is an area where no tree can grow due to severe cold. In Pakistan tundra is present on Karakoram and Hindukush mountains. Tundra is also present near Polar Regions. There are two types of tundra depending upon their location:

  i. Arctic Tundra ii. Alpine Tundra

  i. Arctic Tundra

  Tundra of high latitudes is called arctic tundra. It is found in North America, Northern Europe and Siberia in Russia.

ii. Alpine Tundra

Tundra found on high altitudes of mountains is called alpine tundra. In alpine tundra the ultraviolet rays are very intense. Alpine tundra is found in mountains worldwide. The flora of the alpine tundra is characterized by dwarf shrubs close to the ground. The cold climate of the alpine tundra is caused by the low air pressure, and is similar to polar climate. There are strange sweeping winds. Water is available only for a short growing season. The most important feature is the permafrost.

Permafrost is a subsoil layer which remains permanently frozen due to very low temperature.

In permafrost trees or plants roots cannot penetrate. During summer upper, 10-20 cm. thick layer of soil thaws and allows some herbaceous plants to grow in it. But it freezes during the winter again.

- **Producers and Consumers**

As it has been mentioned earlier, there are no trees in tundra ecosystem. The producers of tundra are dominated by herbaceous plants such as grasses, sedges rushes and heaths, mosses, lichens and small flowering plants. The number of producers in tundra is small because of severs winters and permafrost.

Plants and animals have developed many adaptations to combat severe climatic conditions. For example rosette shape of the plants is an adaptation to protect delicate buds. A rosette is a concentric ring of leaves around a central bud. This shape of the plant serves to protect the fragile growth bud from cold winds. It may also serve to trap insulating snow in winter and dew during the dry growing season.

Animals are also limited in number. Due to extreme cold conditions and low productivity very little amount of food supply is available to animals tundra animals include caribou, Reindeer, Musk etc. They have large feet which act as snow shoes. Large animals like caribou, musk ox, and reindeer are migratory because there is not enough vegetation in one local area to support them. Predators of tundra include foxes, wolves and polar bears. The number of animals varies greatly. Due to unstable conditions during summer many birds like geese, migrate to plains areas to complete their reproductive cycle.

Key Points

1. There are two types of ecosystems, aquatic ecosystem and terrestrial or land ecosystem.
2. Aquatic or water based ecosystem can further be classified into two categories:
   i. Fresh water ecosystem
   ii. Marine ecosystem
3. Running water ecosystem is of two types:
   Fast or rapid flowing water
   Slow flowing water or pool
4. Aquatic or water based ecosystem can be classified into two categories, fresh water ecosystem, and marine ecosystem.
5. Ecosystems of standing water include ponds and lakes.
6. On the basis of depth of various parts of the lake or pond standing water ecosystems is divided into three parts or zone: i) Littoral Zone, ii) Limnotic Zone, and iii) Profundal Zone
7. There are many types of land of terrestrial ecosystems. Some of the major types of land ecosystem are forest ecosystem, grassland ecosystem, savanna ecosystem, desert ecosystem and tundra ecosystem.
8. The forest ecosystem can further be divided in three categories including tropical rain forest, temperate deciduous forest and coniferous forest.
9. Permafrost is a subsoil layer which remains permanently frozen due to very low temperature.
10. In the desert ecosystem, there are two types of plants; surface feeders and deep feeders.
11. Tundra is a derivative of a Russian word meaning large treeless area.

Self Assessment Exercise 9.3

Q.1 Select the correct answer:

a. What are arboreal animals? Animals which …
   i) dig burrows
   ii) have a body armor
   iii) live on trees
   iv) fly in the air

b. What is the amount of rainfall in tropical rain forests?
   i) 500mm
   ii) 1000 mm
   iii) 1500 mm
   iv) 2000 mm

c. Why plants in tropical rain forest compete for light? Because ……
   i) in tropical areas days are very short and nights are long
   ii) forest is too thick to allow light to reach the ground
   iii) all plants are of the same type and need same amount of light
   iv) none of the above

d. Which of the following plants are epiphytes?
   i) Coniferous trees
   ii) Pine trees
   iii) Lichens
   iv) Cheer

e. Grasslands are found in the areas which have average annual rainfall…
   i) 250 – 270 mm
   ii) 300 – 350 mm
   iii) 400 – 450
   iv) 500 – 550 mm

f. What is the characteristic feature of nocturnal animals?
   i) They live in tunnels
   ii) They have long hard claws.
   iii) They pray and feed at night.
   iv) They live in northern hemisphere

g. How camels can live for seven days without drinking water?
   i) They store water in their stomach
   ii) They eat little so that they do not need water
   iii) The fat stored in their hump is converted in to water
   iv) The excretion of water from their body is minimum

Q.2 Answer the following questions:

i. What is a biome?
ii. Define productivity? In which ecosystem productivity is greater?
iii. Differentiate between coniferous alpine and boreal forests.
iv. Explain the term savanna.
v. Why grass lands are the areas of stress for animals?
vi. For which crops grass lands are suitable?
vii. What is the meaning of the term tundra?
viii. What is timberline or tree line?
ix. Why plant roots cannot penetrate permafrost?
x. Why plants are rosette like in tundra?

9.4 Cycles in Ecosystem

As you may know living things obtain all the materials required for their survival from the environment. For example plants obtain minerals and water from the soil, oxygen and carbon dioxide from the air. Earth's biosphere contains a fixed amount of water, carbon, nitrogen, oxygen, and other materials that cycle through the environment and is reused by different organisms.

There are two main types of cycles in the ecosystem: gaseous and sedimentary. In a gaseous cycle, the element is mainly stored in the earth's atmosphere where it exists as a gas. Sedimentary cycles have the earth's crust as the main storage area for their elements.

Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorous and sulfur etc. circulate between living organisms and their non living environment. The circulation of these materials between living and non-living environment is called as "biogeochemical cycling". The term "bio" means life, "geo" refers to rocks, soils, water and air, and "chemical" refers to the changes that occur as the elements go through these cycles. The biogeochemical cycles are important for normal functioning of ecosystems. In any ecosystem green plants capture solar energy and convert it into chemical energy of food. From green plants food energy flows to animals this flow of food energy from green plants to animals is called food chain.

By definition, we can interpret biogeochemical cycles as follows.

Green plants take up mineral substance from their environment and convert them into various biochemical compounds. By means of food these chemicals flow from plants to animals.

When the living organisms die their bodies are decomposed. As a result of decomposition complex compounds are broken down into simpler compounds or elements which become part of the soil and plants use them for their needs. In this way the materials are used and reused and biogeochemical cycles continue.

To explain how these cycles function in an ecosystem and how any disturbance in these cycles can affect the system examples of three major cycles have been cited below and on the following pages.

1. The Carbon Cycle

Carbon is an important element of all living and non living things. All living things are made of carbon. Carbon is also a part of the ocean, air, and even rocks.

In the atmosphere, carbon exists in the form of a gas called carbon dioxide. Plants use carbon dioxide and sunlight to make their own food and grow. In this way the carbon becomes part of the plant. Plants that die and are buried over millions of years may turn into fuels made of carbon like coal and oil. This is called fossil fuel.

The term fossil has been derived from Latin word “fossus”, which means “having been dug up. The term is used for the preserved remains or traces of animals, plants, and other organisms from the remote past. When humans burn fossil fuels, most of the carbon quickly enters the atmosphere as carbon dioxide. Carbon dioxide is referred to as greenhouse gas since it traps heat in the atmosphere.

Without it and other similar gases which trap heat, Earth would be a frozen world.

However, if the level of carbon dioxide in the atmosphere is too high that is also dangerous for life. Humans have burned so much fuel that there is about 30% more carbon dioxide in the air today than there was about 150 years ago. Higher than required level of carbon dioxide in the atmosphere is affecting the life on the planet.

There are gases in the atmosphere that absorb and emit radiation within the thermal infrared range. The primary greenhouse gases in the Earth's atmosphere are:

- water vapor (H_2O)
- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- ozone (O_3)

These gases greatly affect the temperature of the Earth; without them, Earth's surface would be colder than at present; the temperatures on average will be about 33 °C (59 °F).

Keeping in view the importance of carbon as a part of living and non living things and as a factor in maintaining atmospheric temperature it is essential that its amount should be maintained at an optimum level in the atmosphere. The natural cycle of rotation of carbon atoms from living to non living things in a cyclic manner maintains its levels in the ecosystem.

Let's study carbon cycle and explore how carbon atoms move through our natural world. Plants, animals, and soil interact to make up the basic cycles of nature. In the carbon cycle, plants absorb carbon dioxide from the atmosphere and use it to manufacture their food through a process called photosynthesis.

The process of photosynthesis incorporates the carbon atoms from carbon dioxide into sugars. Herbivorous (plant eating animals) animals, such as the cows, goats and rabbits eat the plants and use the carbon to build their own tissues. Meat eating i.e. carnivorous animals such as the lions, cats and fox, eat herbivorous animals. In this way carbon atoms are transferred from the atmosphere to plants and to animals and again to the soil.

These animals return carbon dioxide into the air when they breathe, and into the soil when they die, and are decomposed. The carbon atoms in soil may then be used in a new

plant or small microorganisms. Ultimately, the same carbon atom can move through many organisms and even end in the same place where it began. In this way the same atoms are recycled for millennia.

The carbon cycle is an important gaseous cycle. Most of the carbon in our world is stored as carbon dioxide, in either the atmosphere or dissolved in the ocean. Plants need carbon dioxide to carry on photosynthesis, a process where the carbon atoms become part of molecules of simple carbohydrates (sugars) and may later be changed to fats, proteins or complex carbohydrates. The carbon becomes part of the energy system for ecosystems, since fats and carbohydrates are forms of stored energy. The carbon atoms travel through food chains, with decomposers at any step of the way. To fuel their bodies living things take in oxygen from their environment and use it to oxidize carbohydrates to release energy, the reverse process of photosynthesis. The process in which this energy is made available for growth and other activities is called respiration, and produces carbon dioxide which must be excreted from the body, usually through lungs, gills or leaves.

The process of respiration makes carbon dioxide available for photosynthesis. In animals Carbon is present in the bones. When the bones decay after the animal's death, it becomes part of the soil and the plants use them.

Cycle is started by photosynthesis in which all the terrestrial and aquatic green plants utilize CO_2 and water to synthesize carbohydrates. Carbohydrates are utilized by all living organisms both plants and animals, in their respiration. Photosynthesis is also a source of releasing oxygen into atmosphere; process can be presented by following equation.

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

(Carbon dioxide + water $\xrightarrow[\text{Chlorophyll}]{\text{Sunlight}}$ Glucose Oxygen)

Some part of the glucose synthesized during photosynthesis is used in their own growth and metabolism. When herbivore animals eat green plants Carbon, Hydrogen and Oxygen come in the bodies of animals. There are two methods by which these elements can return back to environment.

i. Respiration
ii. Decomposition

In both cases energy is released. During respiration animals utilize glucose and convert it to carbon dioxide and water along with energy production. This energy is used for growth and metabolism of animals while CO_2 and water are returned to atmosphere. The process of respiration can be represented as follow.

$C_6H_{12}+60_2$ + Enzymes ⟶ $6Co_2+6H_2O$+ Energy

Glucose + oxygen+ Enzymes ⟶ Carbon dioxide + water.

After the death of the living organisms organic compound present in their bodies are decomposed by decomposers like bacteria and fungi. After decomposition organic compounds are converted into inorganic nutrients.

Combustion is another process in which fossil fuels or dry plant materials are burnt with the help of oxygen and carbon dioxide and water vapors are released into atmosphere, along with energy (heat).

Thus photosynthesis, respiration and decomposition are the main processes responsible for operating the carbon-hydrogen and oxygen cycle in nature.

Thus photosynthesis, respiration and decomposition are the main processes responsible for operating the carbon cycle in nature.

2. Nitrogen Cycle

Nitrogen is essential for all living organisms to prepare proteins and nucleic acids (DNA and RNA) moreover nitrogen is present in vitamins, chlorophyll, fats and many hormones, antibodies etc. Its importance for living organisms should never be overlooked. The earth atmosphere contains about 78-79% nitrogen gas. But green plants cannot absorb and utilize atmospheric nitrogen directly. Green plants absorb Nitrogen in the form of No_3 (nitrate ions) mostly other plants can also absorb nitrogen in the form of ammonium compounds. It is therefore essential that atmospheric nitrogen is converted into nitrate ions or some other form in which green plants can absorb it. The conversion of nitrogen into nitrate occurs by following methods:

i. Decomposition of nitrogenous compounds
ii. Nitrogen fixation
iii. Thunder storms

The detail of each is as follows:

i. Decomposition of Nitrogenous Compounds

Decomposition means break down of organic matter into inorganic form. Decomposition of nitrogenous compounds like proteins, DNA, RNA, vitamins, chlorophyll etc. is the chief source of soil nitrates it occurs in two steps:

a. Ammonification
b. Nitrification

The description of each step is as follows:

a. Ammonification

In this process the nitrogenous compounds present in the dead bodies of plants and animals are acted upon by certain bacteria and fungi which affect the breakdown of these compounds. After decomposition water, carbon dioxide and amino acids are released. Energy is also produced during this breakdown which is used by bacteria and fungi for their own metabolism. Amino acids are then converted into ammonia or ammonium ions therefore this process is termed as ammonification.

b. Nitrification

In this process ammonia or ammonium compounds are converted into nitrates. Bacteria control the reaction. It occurs in soils which has abundant air spaces in it because bacteria require oxygen for their respiration. There are two kinds of bacteria involved in nitrification and thus they are called nitrifying bacteria.

ii. Nitrogen Fixation

Nitrogen Fixation means the process of conversion of free atmospheric nitrogen into nitrates by bacteria and certain members of blue green algae. Bacteria which convert nitrogen to nitrates are of two types. First type includes those forms which live in the roots of higher plants symbiotically (symbiosis is a term used to describe a mutually beneficial relationship between two different types of organisms. Second type of bacteria lives freely in the soil and fixes nitrogen. On the basic of bacteria involved there are two types of nitrogen fixation.

a. Symbiotic N- fixation

This type of nitrogen fixation is carried out by bacteria living symbiotically in the roots of higher plants. Mostly these bacteria are present in the roots of plants in the family leguminosae. Plants such as moongphali, imli, shesham, kikar, siris or sirin, belong to this family of plants.

Of these plants there are certain swellings or knot like structures called nodules. Rhizobium is a kind of bacteria which is present in root nodules of these plants. Rhizobium absorbs nitrogen from pores or spaces in the soil where plants are growing and convert it into nitrates (NO_3) thus the nitrogen requirements of the leguminous plants are fulfilled. In return the plants provide bacteria with energy for their life activities.

> The term “Symbiosis” has been derived from a Greek word meaning “living together”. In ecology, it is used to describe close and often long-term interaction between different biological species in which either one benefits from the other or both get benefit from each other.

b. Non Symbiotic Nitrogen Fixation

This type of Nitrogen fixation is carried out by bacteria and blue green algae. In this case the bacteria are not living on the plant but live freely in the soil. The

examples of free living bacteria carrying out nitrogen fixation in soil are Azatobacter, and clostridium. There are many species of blue green algae which also fix atmospheric nitrogen. When the organisms which have nitrogenous compounds in their bodies die the nitrogenous compounds are decomposed and are converted into soil nitrates. The soil nitrates are used by new green plants in this way nitrogen atoms are transferred from atmosphere to soil to plants and other organisms and back to the soil in a cyclic manner.

c. Fixation by Thunderstorm

Thunderstorm is also a source of nitrogen fixation. During lightning and thunderstorm free nitrogen of air is converted into various oxides of nitrogen with the help of oxygen. Along with rain water these are brought into soil which is finally converted in nitrate. Soil nitrates from all sources are absorbed by green plants and synthesized into proteins and other nitrogenous compounds. When plants are consumed by herbivores the nitrogenous compounds are transferred in to animals. There are two sources by which nitrogen is returned to nonliving compounds like urea, uric acid and ammonia are returned to environment.

When plants and animals die the decomposers cause decomposition of their bodies releasing nitrates again in the soil thus cycle can be started by green plants again.

3. The Water Cycle

Water covers approximately 75% of the Earth's surface, in both liquid and frozen forms. For the past 3.8 billion years large amounts of water have flowed on Earth. According to scientists, water initially appeared on the surface of the earth through the volcanic eruptions. In our solar system earth is the only planet which has water. Water is a necessary substance for the development and nourishment of life. Without water life would not be possible on the earth.

Water is the only known substance that can naturally exist in all three forms of the matter that is liquid, solid and gas form. The amount of water content on the planet earth is about 1.39 billion cubic kilometers (331 million cubic miles). About 96.5%, of the earth's water is in the oceans. Approximately 1.7% is stored the polar icecaps as ice, or in the glaciers, and permanent snow form. Only 1.7% of the water is present in groundwater, lakes, rivers, streams, and soil. Only a very small amount (thousandth of 1% of the water on Earth) exists in the atmosphere as water vapors.

The apparently negligible amount of water vapors in the atmosphere has a huge influence on the weather and climate of the planet. Water vapor travels around the globe transporting latent heat with it. As the water changes from liquid to solid or vapor form water molecules obtain heat which is called Latent heat. When the water changes from vapors to liquid or solid form this heat is released. Water vapors in the atmosphere act as a powerful greenhouse gas, and it is a major factor which determines the Earth's weather and climate as it travels around the globe.

You may think that the earth has infinite amount of water. That water keeps going around and around and around and around and (well, you get the idea) in what we call the "Water Cycle".

This cycle consists of the following main stages:

i. Evaporation (and transpiration)
ii. Condensation
iii. Precipitation
iv. Collection

The discussion of each stage is as follows:

i. Evaporation

You are aware that when water is heated it changes from liquid form to vapor or stream form this process is called evaporation. The sun energy heats the water in the river, lake or ocean and changes it into vapors. The vapor or steam leaves the surface of water and become a part of the air.

ii. Condensation

You have also observed that when the water vapor gets cold it changes back into liquid. This process is called condensation. The water vapor in the air when gets cold it changes to water and we see it as clouds.

You often observe this happening in your daily life. When you pour cold water in a glass of on a hot day water drops appear on the outside of the glass. That water does not somehow leak through the glass! Actually, when water vapor in the warm air touches the cold surface of the glass it turns back into liquid.

iii. Precipitation

Precipitation occurs when so much water has condensed that the air becomes saturated with water vapor and cannot hold it anymore. The clouds get heavy and water falls back to the earth in the form of rain, hail, sleet or snow.

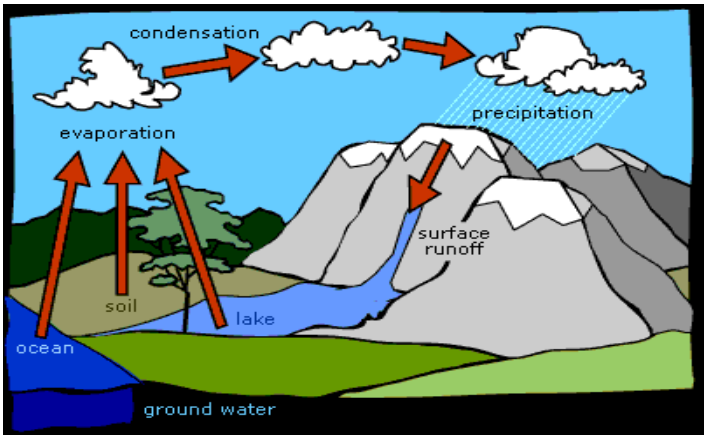


Fig. 14: Water Cycle

iv. Collection

When water falls back to earth as precipitation, it may fall into the oceans, lakes or rivers or it may fall on land and either is absorbed into the earth or become part of the "ground water" that plants and animals use to drink or it may run over the soil and become a part of the oceans, lakes or rivers where the cycle starts.

Here you may have noticed that moves in the form of cycle from earth to atmosphere. It is the same water which is used again and again.

4. The Oxygen Cycle

Just as carbon, water and nitrogen moves from earth to atmosphere and back to earth, oxygen is also cycled through the environment. Oxygen cycle depends on mainly two major life processes of animals and plants; photosynthesis and respiration.

You know that plants use the energy of sunlight to convert carbon dioxide and water into carbohydrates in this process oxygen is released which enters the atmosphere. This process is called photosynthesis.

$$- 6CO_2 + 6\ H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

Animals breathe in oxygen released by the plants to use it to break carbohydrates down into energy. This process is called respiration. In this process carbon dioxide is released

Carbon dioxide produced during respiration is breathed out by animals into the air and is used by the plants in photosynthesis.

So plants release oxygen and animals use it for respiration. But plants also need oxygen to break carbohydrates down into energy just as animals do. During the day, plants use the oxygen which they produce in photosynthesis and use that oxygen to break down carbohydrates. At night, the plants absorb oxygen from the air and excrete carbon dioxide just as animals do.

From the previous sections you may have gathered that there is an inherent equilibrium in the ecosystems. Plants and animals interact so as to produce a stable, continuing system of life on Earth. For example, waste products produced by one species are used by another, and resources used by some are replenished by the others; the oxygen needed by animals is produced by plants while the waste product of animal respiration, carbon dioxide, is used by plants as a raw material in photosynthesis. The nitrogen cycle, the water cycle, and the control of animal populations by natural predators are other examples. However, the activities of human beings can, and frequently do, disrupt the balance of nature. Man's desire to make his life more comfortable and to modify the environment to the best of his interests has some very serious effects on the ecosystem which have put the whole life at stake. In the next section you will read about it in detail.

Key Points

1. Earth's biosphere contains a fixed amount of materials that cycle through the environment and in this way they are used again and again by different organisms.
2. Cycles of materials in the ecosystem are termed as "biogeochemical" cycles.
3. Many materials cycle through the environment, e.g. water, oxygen, nitrogen, carbon.
4. Carbon is a very important element. It is an important constituent of structure of all living organisms. It is also present in the atmosphere as carbon dioxide gas.
5. Carbon is one the important green house gases.
6. The term green house gas is used for the gases which trap heat
7. Carbon is a very important element. It is an important constituent of structure of all living organisms. It is also present in the atmosphere as carbon dioxide gas.
8. The term green house gas is used for the gases which have the ability to absorb and hold heat in the atmosphere, a phenomenon known as the "greenhouse effect."
9. Nitrogen is essential for all living organisms to prepare proteins
10. There are two methods by which carbon and other elements can return back to environment: respiration and decomposition.
11. Nitrogen is essential for all living organisms to prepare proteins which are an important part of structure of living organisms.
12. The earth atmosphere contains about 78-79% nitrogen gas.
13. Nitrogen is added back in the environment in three main ways: decomposition of nitrogenous compounds, nitrogen fixation, and thunder storms.
14. Decomposition of nitrogenous compounds is the chief source of soil nitrates it occurs in two steps: ammonification and nitrification.
15. Water is the most important compound to sustain life on planet.
16. Water cycles through environment in three forms: vapors, liquid and ice/snow.
17. Like other substances oxygen is also cycled through the environment. Oxygen cycle depends on mainly two major life processes of animals and plants; photosynthesis and respiration.

Self Assessment Exercises 9.4

Q.1 Answer the following questions:

i. Define biogeochemical cycles.
ii. Explain the importance of biogeochemical cycles in the ecosystems.
iii. Read the description of biogeochemical cycles and explain as to why it is said that we use the same water and other materials again and again?
iv. What is the contribution of human beings in adding to the amount of carbon dioxide in the environment?
v. How do plants help in maintaining the levels of oxygen in the ecosystem?

Q.2 Identify the correct and incorrect statements and also correct the incorrect statements.

a. The natural resources are infinite.
b. Water cycle consists of three stages.
c. Condensation means change of water from vapor to liquid form.
d. Collection is a stage in water cycle when the water collects in the form of clouds.
e. The amount of water vapors in the atmosphere plays a key role in determining the climate of an area.
f. Plants do not use oxygen during day time.
g. Carbon dioxide, vapors and some other gases are called green house gases because these are produced in green houses.
h. Ammonification is a process in which ammonium compounds are converted into nitrates.
i. Thunderstorm converts ammonia into nitrates.
j. Urea is a major source of adding ammonia back into the environment.

9.5 Pollution & Conservation of Environments

You hear a lot about environmental pollution and how dangerous it is for life in general and for human life in particular. But, have you ever thought what pollution is? What are its causes? And how or why it has put life in danger? Pollution is an undesirable change which alters physical, chemical and biological properties of atmosphere, water and soil. In other words it disrupts the balance in ecosystems.

Environmental pollution can be defined as:

Presence of matter (gas, liquid, solid) or energy (heat, noise, radiation) whose nature, location, or quantity directly or indirectly alters characteristics or processes of any part of the environment, and causes (or has the potential to cause) damage to the condition, health, safety, or welfare of animals, humans, plants, or property.

Man himself is the major culprit in causing pollution. Human activities which have caused imbalance and pollution in the ecosystem mainly include:

- Building industries for various human needs - directly and indirectly
- Use of transport for mobility of human beings
- Cutting forests to make the land available for various purposes and to use wood.
- Need for energy for various direct human needs and industrial needs.

Industrial revolution has, apparently, improved the quality of life. However it has caused serious damage to the ecosystem. Industrial wastes for example smoke chemicals etc.; have increased the amount of various substances to harmful levels, in the air, water and soil and in the atmosphere in general.

Vehicles are a major cause of addition of harmful matters in the air. Smoke, coming out of the vehicles, contains dangerous materials which are harmful for human health.
Man has destroyed forests to use the land for various purposes. Some of the reasons of cutting forests are as follows:

a. Demand of Land for Cultivation

This has been seen all over the world, especially in the countries that have agriculture as the backbone of their economy. Trees have been cut down to obtain land for cultivation of both subsistence and cash crops, both by governments and individuals.

b. Need for Firewood

People, especially those who live in rural areas where electricity and gas are unavailable, resort to use of firewood as a source of heat. Here, wood is cut down and burnt.

c. Need for Land to Build Industries

Industries require a lot of land and while industrialization is important for every country. **d. Need for Land to Build Houses**

With the worldwide increase in population, land to build houses for people to live in is very much required.

e. Need for Wood

For various purposes such as for fuel, for making furniture, to use in buildings wood is required.

The above mentioned activities add harmful materials in air, water and soil. Below and on following pages you shall read about air, water and soil pollution and its causes.

9.5.1 Types of Pollution

Following are some of the major types of pollution.

1. Air Pollution

The presence of unwanted substances in the atmosphere in such a concentration that adversely affect human being in particular and environment in general is called air pollution. Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere. A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutions can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made.

There are two types of air pollutions: primary and secondary pollutions. Usually, primary pollutions are directly emitted from a process, such as carbon monoxide gas emitted from a motor vehicle exhaust or sulfur dioxide released from factories or ash from a volcanic eruption. Secondary pollutions are formed in the air when primary pollutions react or interact. An important example of a secondary pollutant is ground level ozone. Some pollutions may be both primary and secondary: that is, they are both emitted directly and can be formed from other primary pollutions.

Major primary pollutions produced by human activity include:

Sulphur oxides (SO_2) - especially sulfur dioxide, a chemical compound with the formula SO_2. SO_2 is produced by volcanoes and in various industrial processes. Fuels such as coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide. This is one of the reasons for concern over the effect of using these fuels.

Nitrogen oxides (NO) for example nitrogen dioxide (NO_2) are emitted from high temperature combustion, and are also produced naturally during thunderstorms by electrical discharge. Nitrogen dioxide is the chemical compound with the formula NO_2. It

is one of the several nitrogen oxides. This reddish-brown toxic gas has a characteristic sharp, biting odor. NO2 is one of the most prominent air pollutions.

Carbon monoxide (CO) is a product by incomplete combustion of fuel such as natural gas, coal or wood. It is a colorless, odorless, non-irritating but very poisonous gas. A major source of carbon monoxide is vehicular exhaust.

Carbon dioxide (CO_2) is emitted from sources such as combustion, cement production, and respiration. It is also a colorless, odorless, non-toxic greenhouse gas. It naturally exists in the atmosphere and plants use it in photosynthesis. CO2 is a good transmitter of sunlight, but it also partially restricts infrared radiation going back from the earth into space, which produces the so-called greenhouse effect that prevents a drastic cooling of the Earth during the night

Increasing the amount of CO_2 in the atmosphere reinforces this effect and is expected to result in a warming of the Earth's surface.

Tiny particles of solid or liquid suspended in a gas, are referred to as particulate matter (PM) these particles and the gas together are called aerosol. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged over the globe, anthropogenic aerosols—those made by human activities—currently account for about 10 percent of the total amount of aerosols in our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease, lung diseases such as lung cancer.

Gases such as sulfur dioxide are also a cause of air pollution. When sulfur dioxide and nitric oxide are transported long distances by winds, they form secondary pollutions such as nitrogen dioxide, nitric acid vapor, and droplets containing solutions of sulfuric acid, sulfate, and nitrate salts.

These chemicals fall back on the earth's surface in wet form as rain or snow and in dry form as a gases fog, dew, or solid particles. It is known as acid rain. Acid rain can destroy plants and can cause deterioration of soil. In humans it can cause lung and heart diseases.

Pollutions – produced by nuclear explosions, nuclear events, war explosives, and many natural processes can also cause health problems to human and other living things.

2. Water Pollution

Water pollution may be defined as an addition of poisonous matter in ocean or fresh water. It may be possible by three ways.

- Domestic waste
- Industrial waste and
- Agricultural wastes

Domestic waste come from various industrial units like chemical industries, leather industry (tanneries), textile industry, food processing plants, paper mills and detergents. Agricultural wastes include fertilizers, pesticides, and fungicides, Oil refineries and mines also cause some water pollution. While heated water from power plants is also a source of water pollution.

3. Land Pollution

It is a product of solid waste in which residential waste, garbage, agricultural wastes and industrial wastes are included. These waste cause disease in human beings and thus they are very dangerous, sometimes these solid wastes prove fatal. Solid wastes are in the form of heavy metals like mercury, cadmium, beryllium etc. which enter human body through water or food and accumulate in various parts of the body and interfere with normal functions of enzymes. These may cause cancers.

Many chemicals like radioactive substances, sulfur and lead ultimately return to ground from atmosphere through rain and contaminate soil. These chemicals influence both flora and fauna of a particular ecosystem. The number and kinds of certain species are affected. In a forest ecosystem the pollutions affect the soil formation process and reduce the soil fertility. It is very difficult to remove the solid wastes from big lands.

4. Non material pollution

It includes radiation pollution which is a very serious problem at present. Cosmic rays, x-rays, radioactive isotopes, resulting from atomic explosions) are major sources of radiation pollution. These by products from nuclear reactors cause the ionization of biomolecules and result in mutations. Some radio- isotopes email alpha, beta and gamma rays, Alpha and beta rays have low power of penetration while gamma rays have high power of penetration into objects and cause damage to tissues.

5. Noise Pollution

One of the big dangers to human environment is noise pollution. The noise intensity is measured in decibels. According to decibel scale the noise of 80 to 130 decibels is undesirable.

Noise pollution is a common phenomenon of big cities. Height pitch sound is caused by factories vehicles, motor boats, ships, loud speakers, fast music, social gatherings and airplanes etc. Continued high pitched noise can cause deafness, headache, lethargy and irritation.

6. Thermal Pollution

It is a kind of non material pollution which results from industrial work, nuclear reactors and energy running centers which use water as a coolant. This hot water when released into springs and rivers causes increase in the temperatures of water bodies. Due to which aquatic plants and animals may die.

9.5.2 Conservation of Environment and Control of Pollution

The word conservation is derived from two Latin words: “con” meaning together and “servare” meaning to keep or guard. So conservation literally means to keep together any part of our natural environment such as land, water, air, minerals forest, wild life, fish, rangeland and over population; that human can utilize to promote his welfare.

The concept of conservation is the process of allocating natural and manmade resources so as to make optimum use of the environment for satisfying basic human needs at the minimum possible level; and at the same time preventing depletion and degradation of natural resources.

Land as resources should be conserved as man and all land animals directly or indirectly depend on soil for food. Similarly conservation of water implies making the best use of available water resources for human benefits, while not only preventing and controlling its depletion and degradation but also developing it in view of the present and future needs.

Following are some of the important measures/ steps for conservation of water.

- Development of ground, surface water sources and water storage capacity.
- De-salination of sea water and
- Reclamation of sewage and waste water.
- Waste water treatment and recycling of used water.
- Conservation and protection of water from pollution.

Besides protection of nature (environment) from exploitation to prolong its use for present as well as for future generations, agriculture, forestry, wild life, minerals and range land resources need to be conserved.

Other conservation steps include all measures to avoid waste to increase the quantity and quality of production and resources.

Control of Pollution

The pollution is a global phenomenon, it seems almost impossible to eradicate it. However, efforts can be mad to reduce the pollutions and ultimately pollution level. Following are some of the control measures to maintain environmental quality.

- More and more plantation should be maintained so that the level of green house gases may be reduced. The role of plants to maintain environmental quality is clear to everyone. In this respect laws should be developed to stop deforestation in tropical and temperate region of the world.

- The threat of global warming makes it imperative to use a source of energy that does not pollute the atmosphere. Nuclear power and several of renewable sources, such as solar and wind power are the possibilities.

- Adequate sewage treatment and waste disposal are necessary to prevent the pollution of rivers and oceans. New methods are needed to prevent pollution of underground water supplies.

- To reduce the level of green house gases, it is imperative to maintain the automobiles in good condition. Gasoline should be used instead of ordinary petroleum. Gasoline produces smaller quantities of green house gases. Automobiles should be tuned at regular intervals.

- Government should plan media campaign to educate common people regarding pollution.

Key Points

1. Pollution is presence of any form of the matter or energy (heat, noise, radiation) in the environment in such form, quantity or at such location, which directly or indirectly changes the characteristics or processes of any part of the environment, and causes or has the potential to cause, damage to the condition, health, safety, or welfare of animals, humans, plants, or property.

2. Pollutant is a substance which can cause harm to humans and other organisms of the environment

3. Humans have caused imbalance and pollution in the ecosystem mainly through following activities:
   - Building industries
   - Use of transport
   - Cutting forests
   - Unwise use of natural resources for energy.

4. Some of the control measures to control pollution include: More and more plantation, use a source of energy that does not pollute the atmosphere, development of adequate sewage treatment and waste disposal system, use of such materials for fuel which produce smaller quantities of green house gases and creation of awareness and knowledge among public about the dangers of pollution and their role in controlling it.

Self Assessment Exercise 9.5

Q.1 Answer the following:

i. What are the major sources of water pollution?
ii. What diseases are caused by drinking polluted water?
iii. Which frequency of sound is undesirable?
iv. What is the effect of hot waters in fresh water body or ocean?

Answers of Self Assessment Exercises

Self- Assessment Exercise 9.1

1. Surrounding of any organism is called its environment. Or environment means everything which exists around and which can influence us in any way.
2. The environmental conditions without interference of man are said to be environmental quality.
3. Human population growth has caused degradation of environmental quality.
4. The environmental resources which can be regenerated are called renewable resources, while the ones that cannot be regenerated are called non-renewable environmental resources.
5. Air, water, food, soil or land, forests, aquatic organisms and wildlife are some of the important renewable environmental resources.
6. Major components of earth environment are Atmosphere, Hydrosphere, Lithosphere and Biosphere.
7. The part of earth which can maintain life is called biosphere.
8. Place of living of organism is called as habitat.
9. Habitat is named after a prominent feature of habitat.
10. Size of habitat depends on kind of organism living there.
11. A self- sustaining system in a unit area in which both living and non-living environment interact and influence upon each other is called ecosystem.
12. There are two basic components of ecosystem: biotic and abiotic.
13. 390 nm to 760nm.
14. 18. $0\,^{o}C$ to $50\,^{0}C$
15. Fire
16. Soil provides place of living to organisms, moreover plants are rooted in the soil.
17. Loam or loamy soil.
18. (a) cattle (b) bacteria and fungi (c) human, crow
19. High temperature increases decomposition, at low temperature it is slow.
20. Unicellular green plants which swim on water surface are phytoplanktons.
21. This process helps in nutrient cycling.
22. Autotrophs can prepare its food by the process of photosynthesis (green plants), Heterotrophs cannot prepared food, they depend on green plants for food.

Self Assessment Exercise 9.2

Q.1

i. Flow of energy from green plants to animals through repeated stages of eating and being eaten is called food chain.
ii. Only upto two percent (20%) solar radiation is absorbed by green plants.
iii. Complex food chain is called as food web.

Q.2

i. a. Trophic level, b. Saprophyte, c. Decomposers, d. Food Web, e. Base
f. Total mass of organic matter

Self Assessment Exercise 9.3

Q.1

a. iii. live on trees
b. iv. Upto 2000mm annually.
c. ii. The forests are very thick in tropical rain forest, light cannot reach on ground (forest floor) so these plants compete for light.
d. iii. Linchens, Orchids
e. i. 250-270 mm
f. iii. Animals which come out during night are called nocturnal animals.
g. iii. In camel the fat can be converted into water so it may not drink water for seven days.

Q.2

i. Ecosystem of any region can also be called as biome.
ii. The amount of carbohydrates prepared by green plants during photosynthesis per unit time per unit area is called productivity. It is highest in tropical rain forests.
iii. Boreal forests are coniferous forests found at high latitudes which alpine forest are coniferous forests found at high mountains.
iv. Savanna is a grassland with patches of trees.
v. Because there is no protection for animals from weather extremes.
vi. For wheat and maize crops.
vii. Tundra means a treeless land.
viii. On earth's surface a region above which no tree can grow is called timberline or tree line.
ix. Permafrost is a frozen soil that is why roots cannot penetrate in it.
x. Ultra violet rays cause division in meristematic cells so that many branches of same stem are produced and plants assume rosette (shrubby) like.

Self Assessment Exercise 9.4

For questions 1 read the relevant sections of the unit.

Q2. a. Wrong. Natural resources are limited and through a system of cycling same resources are used again and again.
b. Wrong. It consists of four stages.
c. Correct
d. Wrong. It is a stage when it falls back on the earth surface and becomes a part of lakes, rivers, sea and oceans.
e. Correct
f. Wrong. Plants use part of the oxygen they produce during the day for respiration.
g. Wrong. They are called green house gases because they trap the heat and transmit it through the atmosphere.
h. Wrong. It is a process in which compounds breakdown into amino acids which are then converted into ammonia or ammonium ions.
i. Correct
j. Correct

Self Assessment Exercise 9.5

Q.1

i. Domestic waste. Industrial and agricultural waste are the causes of water pollution.
ii. Ulcers, hepatitis, typhoid, gastro- intestinal diseases.
iii. 80-130 decibels
iv. It kills the aquatic animals.

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