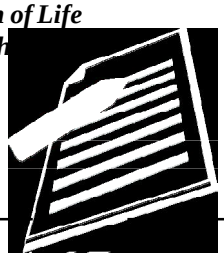


14

BIOSPHERE

We know that our earth is the only planet where life is found. That is why this planet is also known as living planet or 'sphare' of 'life'. This sphere contains those qualities atmosphere, lithosphere and hydrosphere. They all enable the life to exist on this planet. But do you know this is a very small portion of the earth where life exists. Beyond this narrow space of the earth, there is no life forms found. What is so special about this narrow zone of the earth which made life possible? It is because of right mixture of many things – energy, some living beings and some non-living things and their interaction. For millions of years, nature has provided some checks and balances which sustain these life forms without any problems. But today the situation has changed. Now this living planet is in danger. This is mainly due to unsustainable human intervention. Our Father of Nation, Mahatma Gandhi has rightly said "Earth has everything to meet human needs but not its greed." It we want to save this unique living planet, then we have to control our greed and change our life style and behaviour pattern. In this lesson we will discuss about some of these issues related to biosphere.

OBJECTIVES

After studying this lesson you will be able to:

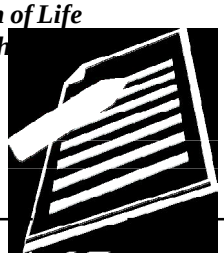
- state the elements of biosphere and its inter-relationship with lithosphere, atmosphere and hydrosphere;
- infer the limits of biosphere;
- give reasons for the unique nature of biosphere;
- define the key concepts like ecology, eco-system, global warming, ozone layer depletion, acid rain and sustainable development;
- state the ecological processes in the eco-system;
- understand the interactions of the biosphere with different types of environments;

- appreciate the importance of balance, inter-dependance and energy flow in different ecosystems;
- identify the causes of climatic changes as global warming, ozone layer depletion, acid rain and also those caused by human activities;
- highlight the efforts made for coping with the elements of climatic change at global and local level;
- explain the need and importance of sustainable development.

14.1 BIOSPHERE AND ITS LIMIT

In simpler terms, biosphere refers to the narrow zone of the earth in which all life forms exist. Do you know why life becomes possible in this zone? It is because this is the zone in which all the three essentials things which are required for susteinance of life are found in a right mixture. They are land (lithosphere), air (atmosphere) and water (hydrosphere). In other words, this narrow zone is a place where lithosphere, atmosphere and hydrosphere meet (see fig. 14.1). We must appreciate that how narrow this zone is? It extends vertically into the atmosphere to about 10km, downward into the ocean to depths of about 10.4 km and into about 27,000 ft of the earth's surface where maximum living organism have been found. There are some life forms which are found in extreme conditions. Two examples of this type are algae and thermophillic. Algae which is supposed to be one of the earliest forms of life can exist even in the most hostile environment such as frozen Antarctica. On the other extreme side, thermophillic (heat loving) bacteria usually inhabit deep sea volcanic vents having a temperature of more than 300^0C. In fact, these bacteria can not survive in a temperature below boiling point.

The situation was not like this when the life form began. About 700 million years ago, it is believed to have been only a narrow discontinuous land encompassing only shallow parts of the oceans. As per the trend of expansion of area in terms of the availability of life form, it can be predicated that may be after a few million years, the expanse of the biosphere gets extended beyond the upper troposphere. This shows that biosphere has been evolving over the time. Till now we have discussed about the vertical expansion, but horizontally the biosphere covers the entire globe, though the life may not be possible in some of the hottest and the coldest parts. However, most living things are confined to a narrow band which permits the capture of solar energy through the process of photosynthesis, which is essential for any organic life. This narrow region extends from about 180-200 feet below sea level to the highest value of snowline in Tropical and sub-tropical mountain ranges (say 6,550M above sea levels). When it extends beyond this line, life forms become very limited.



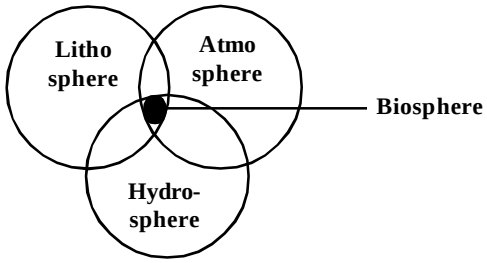


Fig. 14.1 Biosphere

14.2 COMPONENTS OF BIOSPHERE

Biosphere has three basic components. These are (A) abiotic (physical and inorganic) components; (B) biotic (organic) components and (C) energy components. Let us discuss about these three components in detail.

(A) Abiotic Components: These components broadly consist of all non-living elements which are essential for the survival of all living organisms. These are (i) lithosphere (solid part of the earth crust), (ii) atmosphere and (iii) hydrosphere. Mineral nutrients, certain gases and water are the three basic requirements of organic life. Soils and sediments constitute the chief reservoir of mineral nutrients. Atmosphere constitutes the chief reservoir of gases essential for organic life. Ocean consitutes the chief reservoir of liquid water. where all these three reservoirs intermingle and that area becomes the most fertile area for organic life. The upper layer of the soil and shallow parts of the ocean constitute the most important areas, box sustaining organic life. The upper layer of soil, permits easy penetration of gases and percolation of moisture, while shallow parts of oceans, allow penetration of sunlight, intermingling of dissolved gases and nutrients from land surface and ocean bottoms.

(B) Biotic Components: Plants, animals and human beings including micro-organisms constitute the three biotic components of environment. In a way these can be called as the three sub-systems.

(i) Plants: Plants are most important among biotic components. They are the only primary producers as they produce their own food through the process of photo synthesis and hence are called autotrophs. Not only plants alone produce all kinds of organic matter but also help in cycling and recycling of organic matters and nutrients. Thus, plants are the major source of food as well as energy for all organisms.

(ii) Animals: While plants are the primary producers, the animals are the main consumers. Therefore, animals are heterotrophs. There are three main functions of animals: (i) to use organic matter made available by plants as food. (ii) to transform the food into energy and (iii) to utilise the energy for growth and development.

(iii) **Micro-organisms:** These consist of a variety of micro-bacteria, fungi etc. Their numbers are unlimited and are popularly known as decomposers. As the name suggest, these organisms decompose the dead plants and animals and other organic matters. It is through this process they obtain their food. Through this process of decomposition, they differentiate and separate the complex organic matter, so that the same could be put to re-use by the primary producers i.e., the plants.

(C) **Energy:** This is the third and vital component of the biosphere without which life could not have been possible on this planet. It is essential for generation and reproduction of all biological life on this planet. All organisms in the biosphere are like machines which use energy to work and also to convert one form of energy into another. But do you know the source of such energy required for the functioning of the biosphere? Sun is the major source of energy without which we can not think about the existence of the biosphere.

INTEXT QUESTION 14.1

1. Give one word for each of the following
   (a) The narrow zone in which life exists. _____
   (b) The non-living components of the biosphere. _____
   (c) The living component of the biosphere. _____
   (d) The organisms which decompose, plant, animal, and organic matters. _____
2. Fill in the blanks:
   (a) _____ is the primary source of energy for the biosphere.
   (b) _____ are those who take their food through their mouth.
   (c) The biotic component of the biosphere mainly consists _____, _____ and _____.
   (d) Biosphere is a narrow zone where _____, _____ and _____ meet which made life possible.

14.3 ECOLOGY AND ECO SYSTEM

Ecology is the study of interactions between the organisms and their environment. Now, the ecologists feel that the two components of nature–organisms and environment, are not only related but both these components function in an orderly manner as a definite system. Infact, the two components, organisms and environment are not distinct. For a particular organisms, other organisms can constitute a part of its environments. Similarly, environment can also be modified and influenced by organisms, thus, organisms and environment are interacting parts of a system.

Therefore, the term ecosystem is now used to describe such a system. The word eco-system is a short form of ecological system. The term was first used by A.G. Tansley in 1935. An ecosystem can be defined as a system of regularly interacting and interdependent components forming a unified whole. In otherwords, any segment of the landscape that includes biotic and abiotic components is known as ecosystem, if all it's components are integrated with each other. For example, a lake or pond is an eco-system when it is considered in its totality and not just a water body. In that sense, pond is a representative of small ecosystem and biosphere is considered as the largest ecosystem. Basically, the concept revolves around two aspects.

(i) First, it studies inter-action among the various components and sub-components and

(ii) Second, flow of energy among various components of eco-system which is the essential determinants of how a biological community functions.

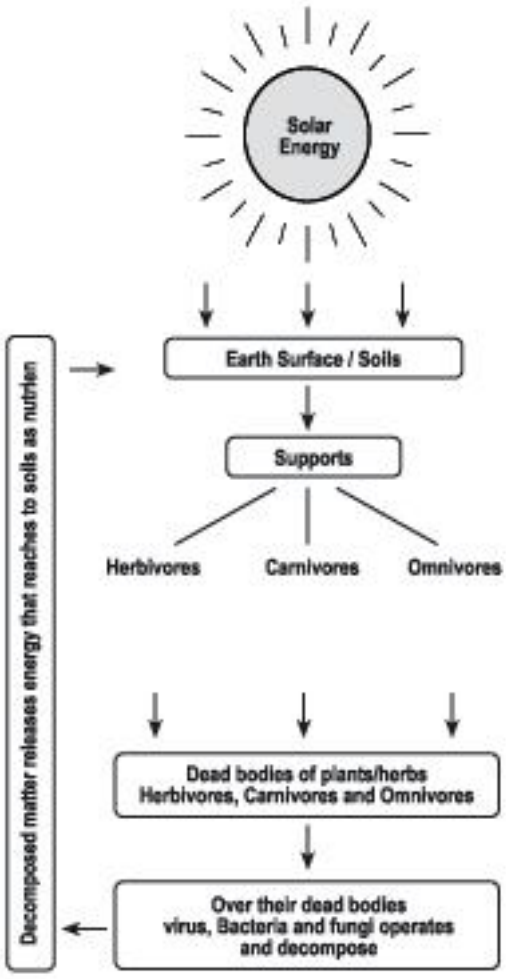


Fig. 14.2 : Flow of Energy in an Ecosystem

Therefore, if we study functional aspects of an ecosystem, then, we may study it in terms of the following:

- Energy flow
- Food Chain
- Nutrient or bio-geochemical cycles.
- Development and evolution.
- Control mechanisms or cybernetics.
- Diversity pattern in time and space
- Let us study each components briefly.

(a) Flow of Energy in the Ecosystem

As discussed earlier that continuous interaction goes on within an eco-system. This interaction between components and sub-components involves the flow of energy and cycling of mineral nutrients. A generalized diagrammatic representation of energy and mineral movements are given above (See figure No). In this process transfer of energy takes place from one level to another. This is known as trophic level. Therefore, trophic level is the level or the stage at which food energy passes from one group to another. To understand it in a better manner we have to discuss about food chain and it's associated activities. In the biosphere, there are broadly two groups of living organisms. Autotrophs and heterotrophs. On the basis of food habits, these heterotrophs are further sub-divided into three categories. They are herbivores, carnivores and omnivores. Herbivores are plant eating animals, carnivores are flesh eating animals and omnivores are both plant and animal eaters organisms.

(b) Food chain/cycle

Let us now understand what is a food chain? Food chain can be defined as a sequence of transfer of energy from organisms in one trophic level to those in another trophic level. Sun is the major source of energy. It helps in the growth of plants on the soil and water bodies. Plants form the basis of food for large number of herbivores. These herbivores are used as food substances for carnivores. Besides, there are omnivores who feed on plants as well as animal flesh. The solar energy absorbed by the soil is reflected in the form of plants and animals. These organism have a limited cycle and die after some time. Once these organisms die, another group of organism start their functioning as they feed on dead material. They help in decomposing the dead bodies of plants and animals on releasing the energy which is again absorbed by the soil to enrich its production of plants. Thus cycle completes.

The above said food chains are very simple food chain But food chains are not always so simple and isolated sequences. Several inter-connected and overlapping food chains present a complicated patterns. Such patterns are called food web.

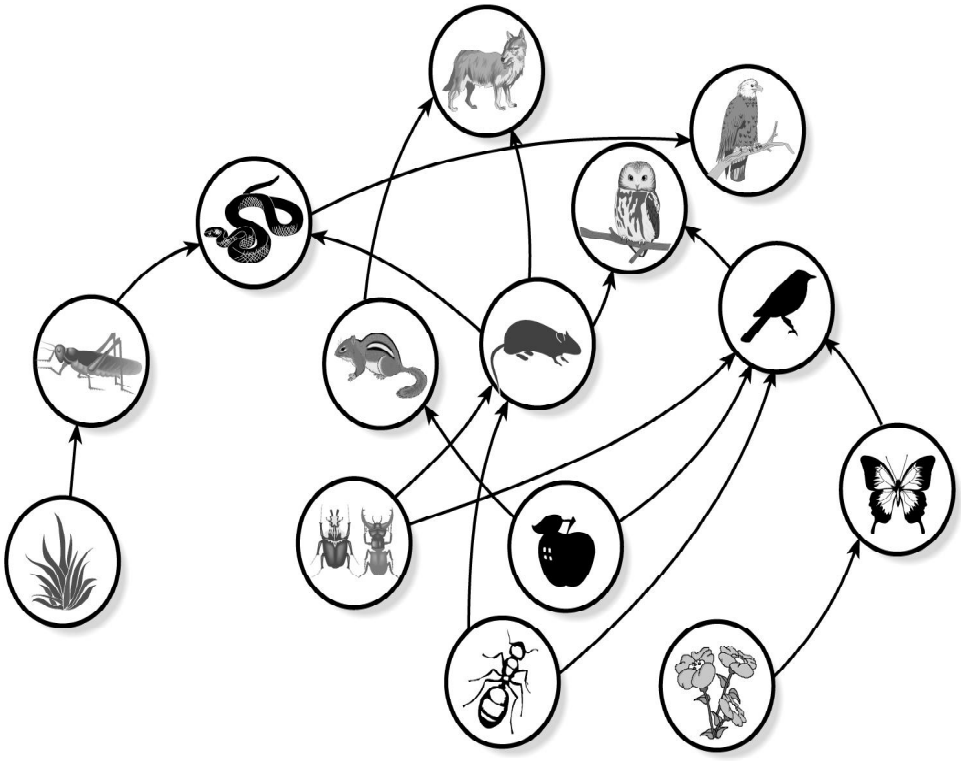


Fig. 14.3: Food Web

Now let us see what are the various trophic levels? As we have discussed earlier sun or solar energy is the source for all the plants for preparation of their food. The energy which is stored by the plants is known as trophic level I. It becomes the source of energy for the herbivores. Therefore, transfer of energy from trophic level I to trophic level II takes place when the plant eating animals consume these plants. Again this chemical energy (through foods) consumed by herbivores gets stored at trophic level II and becomes source of energy for the carnivores at trophic level III. Carnivores are flesh eating animals and depend upon other animals for food. These animals require a lot of energy for building their tissues. They receive their energy from trophic level II through food consumption. A part of the chemical energy from this level III of the food chain is transferred to omnivores at trophic level IV. Therefore, omnivores are at the top level of the food chain which receives their energy from all the three levels. So, in a food chain the members at the successive higher levels becomes smaller in number. When the numbers at successive levels are plotted, they assume the shape of a pyramid, hence it is called food pyramid or pyramid of numbers. (see figure)

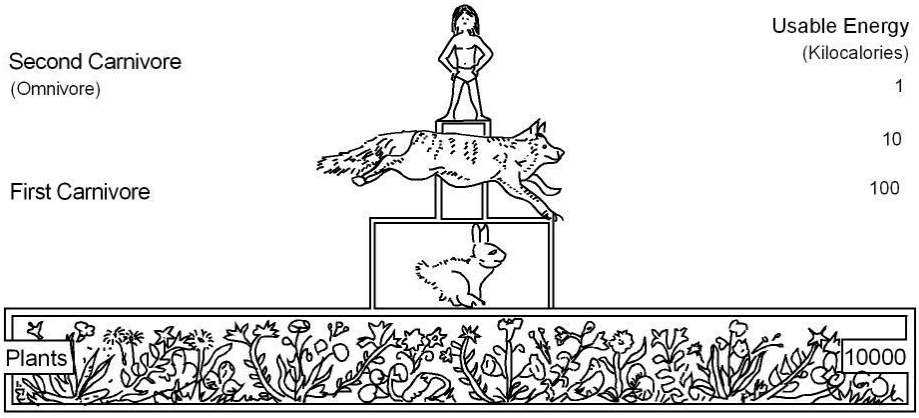
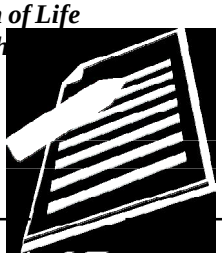


Fig. 14.4: Food Pyramid

The number of organisms at any trophic level depends upon the availability of food at its lower level. With an increase in availability of food at the lower level, there is a consequent increase in the number and variety of organisms at its higher trophic level. Thus, availability of food is the main factor which maintains the grand balance of nature. This balance is dynamic and fluctuates within certain limits. So, every ecosystem has its own system of mechanism to control the balance. This happens because in an eco-system there are certain inherent processes in which nutrients or materials are transferred. Some times in a single direction and some times in cycles. Let us discuss some of these cycles.

(c) Natural / Bio-geochemical Cycles

Biogeochemical cycles (biological, geological and chemical interactions) are nothing but the movement and circulation of soluble inorganic substances (nutrients) derived from soil and atmospheric phases of inorganic substances through organic phase of various biotic components. Simillarly, a retun circulation and movement of organic substances takes place in favour of inorganic objects such as soil and atmosphere. Thus these two systems are supplementary to each other and complete the cycle. The study of biogeochemical cycles can be approached on two scales e.g., (i) cycling of all elements together or (ii) cycling of individual elements e.g., hydrological cycle, carbon cycle, nitrogen cycle, phosphorous cycle, oxygen cycle, sulphur cycle etc. Besides these cycles, sediment cycles and mineral cycles are also included in the broader biogeochemical cycles. These natural or biogeochemical cycles functions in a balanced manner which stabilizes biosphere and sustains the life processes on the earth. If we disturb them, it will lead to various negative



consequences which ultimately affects the biosphere. Let us discuss some of these cycles in brief. (These cycles are already discussed in lesson nine of this book, but here our discussion is related to biosphere or environment. You can refer these cycles which are given in detail under lesson – 9)

1. The Hydrological Cycle

This cycle helps in exchange of water between air, land, sea, living plants and animals. Solar energy is used to drive the hydrological cycle. Massive evaporation of water from the oceans, cloud formation and rainfall gives us our supply and reserves of fresh water.

At sub-zero temperature, rainwater freezes into snow and in presence of strong wind forms hail. Water as rain, snow and hail is precipitated on land and water surfaces. On land surface water seeps into the soil and is stored as ground water. The natural water level or water table exists below the ground. The water table is supported by the underlying clay and rock strata. Ground water does not remain static but moves in various directions. It moves up through capillary action and reaches soil surfaces where it is drawn by plant roots.

2. The Nitrogen Cycle

Nitrogen and its compounds are essential for life processes in the biosphere. There is continuous exchange of nitrogen within the ecosystem operating the nitrogen cycle. Proteins produced by plants and animals in their metabolic processes are organic compounds of nitrogen. The major load of nitrogenous organic residue in soil originates from death and decay of plants and excreta of animals. These organic residues in soil are taken up by various soil micro-organisms who break down soil nitrate into nitrogen by denitrification process while others transform nitrogen into soluble nitrogen compounds.

3. The Carbon Cycle

The carbon cycle is a very important chemical cycle. The atmosphere is the minor reservoir of carbon. Hydrosphere is the major reservoir which contains approximately 50 times more as that of atmosphere. It is stored as bicarbonate mineral deposit on the ocean floor. The later regulates the carbon dioxide level in the atmosphere. The cycle operates in the form of carbon dioxide exchanging among the atmosphere, biosphere and the oceans.

Notes

14.4 TYPES OF ECO-SYSTEMS

Ecosystem can be classified into various types on various basis. The most widely used and simple classification is on the basis of habitats. The idea behind this classification is that each habitat exhibits a particular physical environmental condition. These conditions determine the nature and characteristics of biotic communities and therefore there are spatial variations in the biotic communities. On this basis the eco-system can broadly be divided as (i) terrestrial ecosystems and (ii) aquatic ecosystems. These ecosystems are further sub-divided in to various sub-types. We will discuss briefly about these two eco-systems and their sub-types.

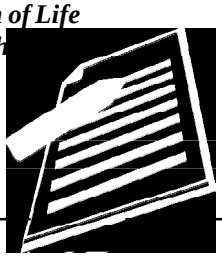
(i) Terrestrial Ecosystems

As the name suggests it covers the entire 29% of the land area found on the earth surface. The terrestrial ecosystems are the major source of food and raw material for human beings. Here, the plant and animal communities are more diversified than aquatic eco-systems. Land organisms have a greater range of tolerance than the aquatic ecosystem. But, in some cases, water is a limiting factor for terrestrial ecosystems. As far as productivity is concerned, terrestrial ecosystems are more productive than aquatic ecosystem.

The above said discussion is a comparison between terrestrial and aquatic ecosystem in general. But there are further variations in the terrestrial ecosystems in terms of physical conditions and their response to biotic communities. Therefore, the terrestrial eco-systems are further sub-divided into various sub-types. Major sub-types are (i) upland or mountain eco-system (ii) low land eco-system (iii) desert eco-system etc. These sub-systems, may be further sub-divided depending on specific purpose and objectives. Maximum life forms are found in low lands and they keep on decreasing with the increase in height as the level of oxygen and atmospheric pressure decreases.

(ii) Aquatic Eco-system

This ecosystem refers to the 71% of the water present on the earth surface in various forms. Like terrestrial eco-system, aquatic ecosystem can be further divided into various sub-types. But the major sub-divisions of this ecosystem may be fresh water, estuarine and marine. Again these ecosystems can be further subdivided into smaller ones. If we see interms of extent or what we call in geography in terms of scale, it ranges from open sea to small pond. The variations within the various types of aquatic ecosystem are mainly related to abiotic factors. But, there are also variations in terms of biotic communities that are living within these ecosystems. Why are these variations?



As discussed earlier, the limiting factors in aquatic eco-systems are the depth upto which sunlight can penetrate, the availability of nutrients and the concentration of dissolved oxygen. If we keep all these factors into consideration, it is found that estuarine ecosystems are the most productive of aquatic eco-systems. In marine ecosystems, shallow continental shelves are more productive than open oceans. Though open oceans are most extensive in areas, they are the least productive of all ecosystems like the deserts in terrestrial ecosystem.

Another aspects which is the determinants of diversity of life in acquatic ecosystem is the adaptability of organisms. Some of the organisms exclusively live in water namely fishes whereas some of the organisms are amphibious in nature. Some of the important amphibians are frogs, crocodiles, hippopotamus and variety of aquatic birds. Again within water, some organisms live only in either fresh water or saline water and some organisms live in both fresh water and saline water. Hilsa fish is an example of the later type. Echinoderms and Coelenterates live only in saline water and there are various types of fishes like Rohu, Catla etc found only in fresh water.

INTEXT QUESTION 14.2

1. Fill in the blanks with appropriate words.

   (a) _____ are those which manufacture their own foods.

   (b) Plant eating animals are known as _____.

   (c) On the basis of food habits human being belongs to which category _____.

   (d) Several inter-connected and overlapping food chains present a complicated pattern which is known as _____.

   (e) _____ is considered as the largest ecosystem.

2. Answer the following questions very briefly

   (a) Define ecology.

   _____

   (b) What is a food chain?

   _____

   (c) What is a food pyramid?

   _____

   (d) What is a biogechemical cycle?

   _____

14.5 GLOBAL CLIMATIC CHANGE

We have read under bio-geochemical cycle that for the last billion years or so, earth's atmosphere and hydrosphere have been composed of approximately the same balance of chemical components we live with today. The earth has a unique mechanisms for stabilizing and controlling the global climate. These mechanisms are as follows:

(i) The plants and animals balance carbon dioxide level of the atmosphere which in twin acts as global thermostat. It means these elements control the temperature balance within optimum limits.

(ii) The water bodies play important role in regulating global climate.

In recent years, the rapid growth of human population, the rate at which we consume the earth's resources, extravagant life styles etc. lead to substantial increase in the carbon level of atmosphere which has accelerated the process of climatic change.

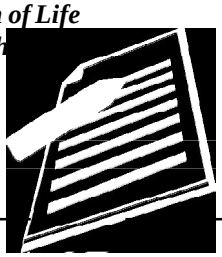
Let us discuss some of these processes affecting the climatic change.

(a) Green House Effects and Global Warming

Global warming refers to a gradual rise of atmospheric temperature and consequent changes in the radiation balance mainly due to human action leading to climatic change at different levels – local, regional and global. As per recent estimates, it has been found that the surface air temperature over the past 100 years has increased by about 0.5^0C to 0.7^0C. Do you know why it is happenning. This is due to green house effect. To have a better understanding about global warming, we should know the functioning of a green house (See Box)

Working of a Green House

In cold countries, a green house is meant for plants, where total heat, especially during winter season, is not sufficient to support plant growth. The transparent walls and roof of the green house are such that these allow the visible sunlight to enter but prevent the longwave radiations to go out. Thus, the sunlight is absorbed by the soil and structure of the green house. It is then re-emitted as heat which can not pass through the glass. The amount of energy in the green house thus increases until its temperature is high enough for the slight leakage of heat through the glass to take away as much energy as gets in as sunlight. Subsequently walls and roof re-emit absorbed radiation into the house. Thus, during the day time, infra-red radiation pass into the green house and warm the atmosphere and the ground on which the green house stands. Coating of glass with a non-heat radiation film transparent to sunlight further maximizes heating effect of the radiation.



Therefore, if our earth has become a green house, then there are certain gases which act like the glass panels of a green house allowing the sun's rays to pass through but preventing the heat from escaping into the outer space and there by warming the atmosphere. This is happening due to deforestation and industrialization. These gases are carbon dioxide (CO_2), methane (CH_4) nitrous oxides (NO_x) and chlorofluorocarbon (CFC) and hence known as green house gases. Out of these four gases, carbon dioxide contributes about 55%, chlorofluorocarbon contributes about 24%, methane (about 15%) and nitrous oxide (about 6%) towards heating of the atmosphere.

Do you know the sources of these gases? Burning of fossil fuels and fire woods, large fleet of automobiles and number of factories emit carbon dioxides. Growing paddies, livestock, waste dumps and coal mining are the major source of methane. The use of aerosols as coolants in refrigerators and air conditioning devices release chlorofluorocarbons into the atmosphere Nitrous oxide is mainly emitted from chemical industries, and due to deforestation and certain agricultural practices.

Construction of green houses in temperate region helps the plant protection and ecological balances whereas concentration of green house gases on the earth's atmosphere upsets the earth's biological system.

Consequences of green house effect

1. It is estimated that if the present rate of increase in CO_2 level continues, it will result in rise of atmospheric temperature by 2^0C to 3^0C by end of 21^{st} century. This will result in receding many glaciers; melting of icecaps in the polar regions and disappearance of deposits of ice on the other parts of world in large scale. According to an estimate, if all the ice on the earth would melt, about 60M of water would be added to surface of all oceans and low lying coastal areas. A rise in sea-level of only 50-100 cm caused by global warming would flood low lying areas of the world such as Bangladesh, West Bengal as well as densely populated coastal cities from Shanghai to San-Fancisco.
2. Because of increased concentration of CO_2 and due to much warmer tropical oceans, there may occur more cyclones and hurricanes. Early snow melt in mountains will cause more floods during monsoon. According to United Nations Environment Programme (UNEP), within about three decades, rising levels of seas will be able to and flood coastal cities like Bombay, Boston, Chittgang and Manila.
3. A slight increase in global temperature can adversely affect the world food

production. Thus the wheat production zones in the northern latitudes will be shifted to north of temperate latitudes.

4. The biological productivity of the ocean would also decrease due to warming of the surface layer, which in turn reduces the transport of nutrients from deeper layers to the surface by vertical circulation.

Control and Remedial Measures of Green House Effect

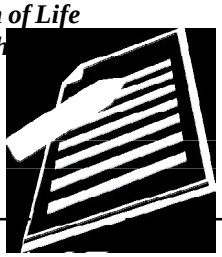
The following measures may be adopted to reduce the ever increasing green house effect.

1. CO_2 concentration can be reduced by drastic cut in the consumption of fossil fuels in the highly developed and industrialized countries like USA and Japan and developing country like China and India.
2. Scientific efforts should be made to develop alternative efficient fuels. Methane may be a substitute of petroleum.

   Development of hydro-electric and thermal power are better alternatives.
3. There should be a restriction on the emission of dangerous CO_2, CFCs, and as NO_2 from the factories and automobiles.
4. Limiting the driving days in megacities can be another option. Cities like singapore and mexico are following the practice.
5. In tropical and sub-tropical countries, the solar energy may be developed as an alternative to the fossil fuels.
6. Biogas plants should be used which is another source of conventional energy for domestic use.
7. Enhancing afforestation will certainly reduce the CO_2 level thereby decreasing the green house effect.

(b) Ozone Layer Depletion

Before discussing about the problem of ozone layer depletion, we should know about ozone and the ozone layer. Ozone is a form of oxygen that has three atoms (O_3) rather than the more common two atoms (O_2). It is created in the upper atmosphere by the action of solar radiation on oxygen molecules. As far as its position is concerned, it is found in the form of a thin layer in the stratosphere between 15 to 48 kilometre. About 90% of all atmospheric ozone is found in this layer. Ozne constitutes only less than 0.002 percent of the volume of the atmosphere. However, it's role is very critical as far as lives on the earth is concerned. It strongly absorbs ultraviolet radiation from the sun. Ultraviolet radiation is biologically destructive in many ways. It causes skin cancer and cataracts, suppresses the human immune system, dimimshes the yield of many crops, disrupts the acquatic food chain by killing micro-organisms on the ocean surface and many other negative effects which is still undiscovered.



This is happening due to certain recent human activities which have injected certain chemicals in the stratosphere which consume ozone and reduce its concentration. Depletion is mainly caused by chlorofluorocarbons (CFCs), halons, methyl chloroform and carbon tetrachlorides. These chemical substances are mainly either chlorine or bromine which can reach the stratosphere and catalytically break down ozone into oxygen. CFCs are odourless, non-flamable, non-corosive and nontoxic. For this reason, scientist originally believed CFCs could not possibly have any effect on the environment. That is why it is widely used in refrigeration and air conditioning, in foam and plastic manufacturing and in aerosol sprays.

Not only is the ozone layer thinning, in some places it has temporarily disappeared. A hole in the layer has developed over Antarctic since 1979 and that hole has persisted for a longer and longer time every year. In 1988, an ozone hole was found over the Arctic for the first time and it too has lasted longer and longer each year since then.

Can we prevent this disaster? It needs certain actions both at individual as well as governmental level. Since the last two decades, certain actions have been initiated at global level. Among these Montreal Protocol of 1987 and London Conference of 1992 are important. In both these conferences it was decided that the developed countries would totally ban CFC production by 2000 and the developing countries by 2010AD. Even if it is sincerely followed and strictly implemented by all the 150 countries including India, who are signatory to Montreal Protocol even then the chlorofluorocarbon and chlorine shall continue their influance for another 100 years. Therefore, all over the world research efforts are continuing for development of substitutes of CFC as coolants for refrigerators and air conditioners.

(c) Acid Rain

The term 'acid rain' refers to the deposition of wet or dry acidic materials from the atmosphere on the earth's surface. Although most conspicuously associated with rainfall, the pollutants may fall on the earth's surface either in the form of snow, sleet, hail or fog or in the dry form of gases or particulate matter. Sulphuric acid and nitric acid is considered as the principal agents responsible for acid rain. But the major culprit are human beings. Smokes emitted from the industries is the major source of sulphur dioxide whereas smokes emitted from the motor vehicle is the major source of nitrogen oxide. These emissions mixed with atmospheric moisture form the sulphuric acid and nitric acids which, sooner or later precipitate on earth in various form.

Acidity is measured on a pH scale based on the relative concentration of hydrogen ions. The scale ranges from 0 to 14, where the lower end represents extreme acidity and the upper end extreme alkalinity. (see diagram). As stated earlier acid rain is associated with various forms of precipitation. It we look at rainfall in clean and dust free air, a pH value varies between 5.6 to 6.0, which is slightly acidic in nature. Whenever or wherever the pH value is below 5.6, then the damage becomes noticeable.

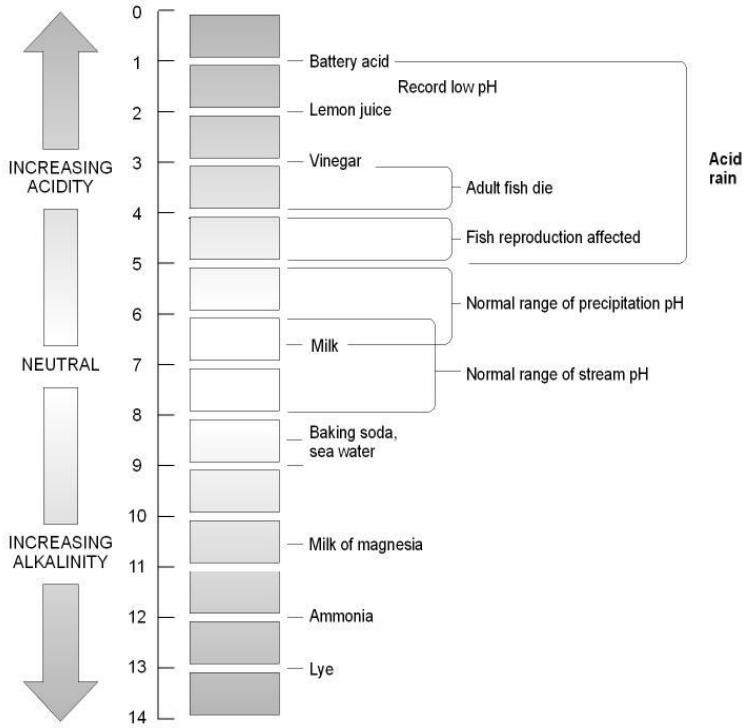


Fig. 14.5 A pH Scale

The long – term effects of acid precipitation on human health and agricultural production have not yet been ascertained precisely. However, the most conspicuous damage is being done to aquatic eco-system. Below given are some of the effects of acid rain. The eco-system of a stream or lake may be severely affected when its pH falls below 5. Total biomass in such systems is reduced from two to ten times because few organisms can tolerate acid. The diversity of species also decreases. The most severe effect of acidification is on fish. Acidic conditions affect the reproductive capabilities of fish, resulting in a slow decline of fish population. This has been documented in various parts of Europe and North America. In Norway, thousands of lakes and streams have largely lost their fish population, over an areas of 33,000 square kilometer. Several lakes in Eastern United States and Canada have become biological deserts during the last quarter century. The precise effects of acid rain on forest are not clearly understood, evidence, however, shows that it is responsible for forests dieback which is occurring in each continent. Forest dieback is a German word which means death or decline of forest. Even buildings and monuments are being destroyed because acid deposition accelerated erosion capacity.

Acid rain is a serious global problem and its impact can spread over long distances from the origin of the pollutant. That is why Scandinavian countries complain about British pollution in Europe whereas Canadians blame United States in North America.

INTEXT QUESTIONS 14.3

1. Answer the following questions briefly

   (a) Name any two factors that are responsible for irrepairable damage to the biosphere

   (i) _____ (ii) _____

   (b) Name any two major green house gases.

   (i) _____ (ii) _____

   (c) Which are the two leading nations in the world that produced carbon dioxide gases.

   (i) _____ (ii) _____

   (d) Where do we generally find ozone layer in the atmosphere

   (i) _____ (ii) _____

   (e) Name any two major chemical substances that are responsible for ozone layer depletion.

   (i) _____ (ii) _____

   (f) What are the two main agents that are responsible for acid rain?

   (i) _____ (ii) _____

   (g) Name any two major effects of acid rain.

   (i) _____ (ii) _____

14.6 SUSTAINABLE DEVELOPMENT

Today, the world has made a lot of progress. Human being with the help of technological advancement and consumption of energy resources have made many inventions and discoveries to make their life more and more comfortable. At present , without technology and mineral and power resources we can not think about the life. It has entered in a large scale in almost every sector, be it agriculture, industry, transport, communication and domestic. Have we ever thought that how it affects the life on earth? Even the situation is such that our ecology is in danger. If we continue in this fashion most of the minerals and power resources will be consumed within next hundred years. Simultaneously, it has affected and endangered four components of ecosphere. These are the climatic system, the hydrological cycle, nutrient cycle and the bio diversity. The situation has worsened to that extent that the resources which are considered renewable become non-renewable. Let us explain this with one example. Take the case of Yamuna water in Delhi. We have polluted the water to such an extent that little aquatic life (mostly fish) is found in this water within Delhi likely. This water can not be consumed despite the treatment.

It has also affected plants and their products. Then the questions arises what is the use of that water which could not be used though it is renewable. Same is the case with air, soil etc. Due to careless and selfish action of the human beings, these natural resources are degraded to such an extent that it becomes non-renewable.

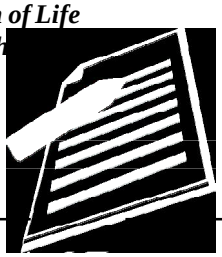
It puts a question mark on the development itself. Does it mean that the world community needs to put a full stop to further development? This is not at all possible. This dilemma bothered entire human kind. A conscious effort was made to address this particular problem. A committee was formed by United Nations under the chairmanship of the then Norway Prime Minister Gro Harlem Brundtland. This Commission was known as United Nations Commission on Environment and Development (UNCED) or popularly Brundtland Commission.

The title of the report prepared by Commission is "Our Common Future." In the beginning, the world was divided into two groups – developed and developing countries and started blaming each other. Developed countries blamed developing countries for the rapid population growth, poverty and primitive technology which leads to pollution. The argument of developing countries was that extravagant life styles of developed countries puts a lot of pressure on existing resources. But after a lot of heated discussions and arguments, it was felt that there should be some common grounds in which all the world should agree to protect it for future. It was felt that there should be balance between ecology, economics and technology. Therefore, Brundtland Commission defined sustainable development as "meeting the needs of the present generation without compromising the ability of future generation to meet their own needs."

Strategies to be adopted for Sustainable Development

Some strategies are given below for achieving sustainable development.

1. **Reviving growth:** Sustainable development must address the issue of poverty. Poverty increases pressure on the environment by following life styles that degrade environment. For example forest cutting for fuel use or expanding deserts by overgrazing activities. At the same time, they are helpless as they do not have alternate sources of livelihood. Majority of people living below poverty line are found in Africa and Asia. Efforts should be made to provide them certain alternatives like skills, training, education, etc. so that they can earn livelihood and come out of poverty. Otherwise, the very purpose of sustainability or sustainable development will be fore feited. Because, as long as poverty will be there, poor people will depend upon nature for their survival.
2. **Ensuring a sustainable level of population:** Today one of the major challenge is to tackle the highest rate of population growth especially in Africa, South Asia and Middle East. Explosion of population has a direct link with quality of life, parameters like access to education, health, housing, safe drinking water, sanitation and means of livelihood. It puts a lot of stress on government to provide additional facilities when population is increasing rapidly.



3. **Meeting essential human needs:** This is a pre-requisite for reviving growth. It is evident that unless the basic needs are satisfied, the individual can not participate in the growth process. Essential human needs include enough food, adequate housing, fresh water supply and health Facilities. More food and quality food should be provided because this is not just to feed people but to attack under nourishment and to develop immune system for preventing diseases.

4. **Changing the quality of growth:** There is a need to change the orientation of growth. When we say growth, we always mean economic growth or materialistic growth, but there is a need for making growth less materialistic, less energy intensive and more equitable. Economic and social development have to be mutually reinforcing. In other words economic development should pay attention towards better social development like education, health, sanitation, etc. Simultaneously social development can boost the economy of the areas, region and country.

5. **Conserving and enhancing the resources base:** There are moral as well as economic arguments for this. The moral argument is that we have to preserve resources for the sustenance of next generation. But simultaneously we have to see economic argument also. The economic argument is that we can not say to the poor people that they must remain in poverty to protect environment. On the otherside, there is a need to challenge the consumerism of the developed countries and through following pro-capitalist economic systems. Somewhere, the process of liberalization, privatization and globalisation must answer the problem of inequality only meeting basic human needs of common people. The challenge in sustainability is that how we conserve resources without geopardising the growth and equal access to resources for livelihood. Simultaneously there is a need to find out alternatives to non-renewable resources, more efficient use of resources, discovery of new resources and discovery of low waste technologies.

6. **Reorienting technology and managing risk:** The implications of above five strategies are for the orientation of technology in two principal ways. First the capacity for innovation needs to be greatly enhanced in developing countries. Second, the effort by developed countries must play a vital role as far as the transfer of technology is concerned. Therefore, all the technological development must pay greater attention to environmental factors. This is closely linked to the issue of risk management wherein environmental impact has to be effectively minimized.

7. **Merging environment and economics in decision making:** Economics and ecology should not be seen in opposition but as interlocking. Sustainable development requires the unification of economics and ecology in international relations.

INTEXT QUESTION 14.4

1. Answer the following question briefly

   (a) Under whose Chairpersonship the United Nation Commission on Environment and Development (UNCED) was formed?

   _____

   (b) What is the title of the report submitted by UNCED?

   _____

   (c) Define sustainable development.

   _____

   (d) Name any three strategies to be adopted for sustainable development.

   (i) _____

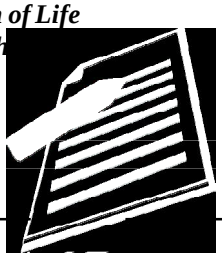
   (ii) _____

   (iii) _____

WHAT YOU HAVE LEARNT

Probably, our earth is the only planet where life is found. Biosphere refers to the narrow part of the earth in which all life form exists. Life is found in this region due to availability of right mixture of land, air and water. There are three major components of biosphere. These are abiotic, biotic and energy component. Examples of abiotic components are soil, air, water etc. whereas plants, animals and micro-organisms are major constituents of biotic component. The third one is energy component for which sun is the major source without which existence of biosphere is not possible.

Ecology is the study of interactions between the organisms and their physical environments on the one hand and among the organisms on the other hand. An eco-system can be defined as a system of regularly interacting and interdependent components forming a unified hole. It we study functional aspects of eco-system then an eco-system can be studied in terms of energy flow, food chain, diversity pattern in terms of time and space, bio-geo-chemical cycle, development and evolution and control mechanisms or cybernetics. In an eco-system, continuous interaction goes on between components and sub-components which involves the flow of energy. Food chain is one such example in which transfer of energy takes place in a sequential manner in one trophic level to those in another trophic level. In a food chain the members at the successive higher levels become smaller in number. When the numbers at successive levels are plotted, they assume the shape



of a pyramid, hence it is called food pyramid. Each ecosystem has certain inbuilt mechanism to maintain balance. Natural/biogeochemical cycle is one way. Biogeochemical cycles are nothing but the movement and circulation of soluble substances derived from sedimentary and atmospheric phases of inorganic substances through organic phase of various biotic components and finally their return to inorganic state. Some of the bio-geochemical cycles include hydrological cycle, carbon cycle, nitrogen cycle and phosphorous cycle.

Ecosystem can be classified into various types. The most widely used and simple classification is on the basis of habitats. On this basis, ecosystem can be divided as terrestrial and aquatic ecosystem. These ecosystems are further subdivided into various subtypes. Biosphere as the largest ecosystem remained undisturbed for billion years. But in recent years due to adverse human actions, lot of damage has been made and some of these are irreversible. Some of these phenomena are global warming, ozone layer depletion, acid rain, sea level changes etc. Today, at the global level, initiatives have been taken to address these problems. One of the significant development was United Nation Commission on Environment and Development. The Commission submitted its report whose title was "Our Common Future". In this report the concept of sustainable development was brought forward. Sustainable development was defined as "meeting the needs of present generation without compromising the ability for future generation to meet their own needs". Some of the strategies for sustainable development include revising growth, meeting essential human needs, ensuring a sustainable level of population, changing the quality of growth, conserving and enhancing the resource base, re-orienting technologies and managing the risks, and merging environment and economics in decision making process.

TERMINAL QUESTIONS

1. What is biosphere? Describe various components of biosphere with suitable examples.
2. Define eco-system. Explain the energy flow in the ecosystem with appropriate diagrams and examples.
3. What are bio-geochemical cycles? Explain hydrological cycles with suitable diagram.
4. Describe various causes and consequences of global warming?
5. Define sustainable development? Suggest measures to be adopted for achieving sustainable development.

ANSWER TO INTEXT QUESTIONS

14.1

1. (a) biosphere (b) biotic (c) biotic (d) decomposer

2. (a) sun (b) biologic (c) plants, animals and micro-organisms (d) lithosphere atmosphere and hydrosphere.

14.2

1. (a) autographs (b) herbivores (c) omnivores (d) food web (e) biosphere

2. (a) Ecology is the study of interactions between the organisms and their interaction

   (b) Food chain can be defined as the sequence of transfer of energy from organisms in one trophic level to those in another trophic level.

   (c) When the numbers at successive levels are plotted they assume the shape of a pyramid, hence it is called food pyramid.

   (d) Bio-geochemical cycles are nothing but the movement and circulation of soluble inorganic substances derived from sedimentary and atmospheric phases of inorganic substances through organic phase of various biotic components and finally their return to inorganic state.

14.3

3. (a) Rapid growth of human population, alarming rate of consumption, extravagant life styles (any two)

   (b) Carbon dioxide, methane, nitrous oxide and chlorofluorocarbon (CFC) (any two)

   (c) United States and Russia

   (d) Stratosphere

   (e) CFCs, halons, methyl chloroform, carbon tetrachloride

   (f) Sulphuric acid and nitric acid

   (g) Effects of acid rain are

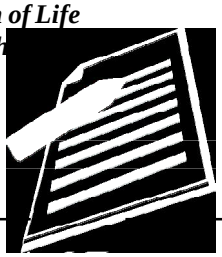
      (i) Severely affects biomass and aquatic life in the lakes and streams

      (ii) Death or decline of forest (iii) destroy building and monuments

14.4

1. (a) Gro-Harlem Brundtlandt

   (b) Our common Future



(c) "Meeting the needs of the present generation without compromising the ability for future generation to meet their own needs"

(d) (i) Reviving growth (ii) Meeting essential human needs (iii) Ensuring a sustainable level of population (iv) changing the quality of growth. (v) conserving and enhancing the resource base (vi) Reorienting technology and managing risk (vii) Merging Government and economics in decision making. (Any three)

HINTS TO TERMINAL QUESTIONS

1. Please see para 14.1 and 14.2
2. Please see 14.3 Ecology and Ecosystem and its part (a) Flow of energy in the Ecosystem.
3. Please see para 14.3 (c) Natural/Bio-geo-chemical cycles
4. Please see para 14.5 (a) Green House Effects and Global warming
5. Please see para 14.6