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OUR ENVIRONMENT

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BIOLOGY CBSE

OUR ENVIRONMENT

- **Our Environment**
  - **Ecosystem** Interacting organism of an area + non living constituents
    - **Types**
      - Natural ecosystem
        - Terrestrial Eg. forest, grasslands, Aquatic E.g. Pond, Lakes, Oceans
      - Artificial Ecosystem Eg. Crop field, Garden, Aquarium
    - **Components**
      - Biotic: Living components Eg. Plants, Animals, and Microbes
      - Abiotic: Non-living components physical factors like temperature, rainfall, wind, soil etc.
    - **Representation of relation between different biotic components**
      - Foods Chain: A series of organisms feeding on one another taking part at various levels
      - Food Web: A network of interconnected food chains

Trophic Levels

It is each step or level of the food chain.

I. **Trophic Level:** Producers Eg. green plants, Blue green algae (cyanobactria), phytoplankton's (microscopic free floating aquatic plant)

II. **Trophic Level:** Primary consumers or herbivores.

III. **Trophic Level:** Secondary consumers or small carnivore.

IV. **Trophic Level:** Tertiary consumers or large carnivore.

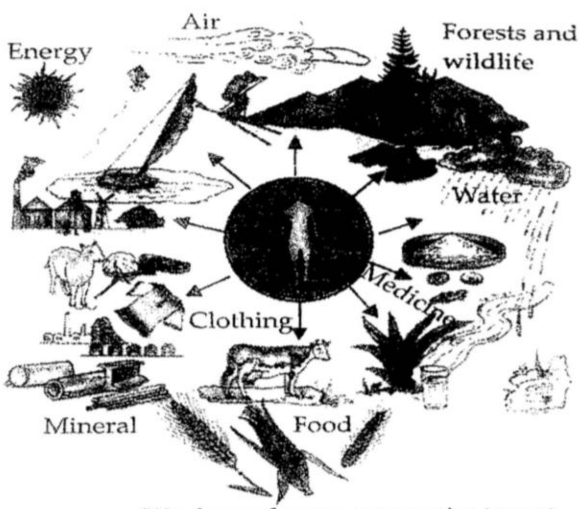
Flow of Energy

- 1% energy available from the sum of the terrestrial plants is converted into food.
- 10% energy in food is transferred to next level of consumer, 90% is lost.
- No. of steps of food chain is only 3 or 4 as very little energy is available to higher levels.
- No. of organisms decrease as we move up in a food chain.
- Flow of energy in a food chain is unidirectional.
- Bio magnification of pollutants: Progressive accumulation of harmful substances like pesticides takes plane.

- **Waste**
  - **Type of Waste**
    - Biodegradable waste can be broken down by the enzymes of bacteria or fungi Eg. Plant & animal waste, paper, wood
    - Non-Biodegradable waste can't be broken down by the enzymes of bacteria or fungi (Decomposers) Eg. plastics.
  - **Effect of Waste**
    - **Ozone depletion:** CFC damage ozone layer. Progressive accumulation of harmful substances like pesticides takes place in a food chain.
  - **Waste Management**
    - Land fills; Recycling sewage treatment incineration use of disposable paper cups

In our solar system, life exists only on earth, as various physical conditions required to sustain life occur only on earth. These physical conditions include proper temperature, air, water and soil etc. Due to these favourable factors, different types of plants and animals flourish on earth. Continuity of life on earth is the result of interactions of these physical factors with the living world. Every living organism is affected by its surroundings. Living beings (plants and animals) and physical factors (wind, rainfall etc.) together constitute our surroundings or environment.

Environment (derived from the word' *environ'* meaning **'to encircle' or 'surround') can be defined** as the physical **and** biological world where we live. Literally speaking, organism's immediate surroundings constitute its environment which includes everything around the organism, *i.e.,* both non-living (abiotic) and living (biotic) components. Environment affects organisms without becoming an integral part of them. We depend upon our environment for all our needs.



We depend upon our environment for our needs

Environment has two major components: abiotic and biotic. In the environment, living organisms, whether plants or animals, influence each other. In addition, both abiotic and biotic components interact with each other. This interdependent interaction among organisms as well as with the abiotic components maintains a balance in nature.

ECOSYSTEM

An ecosystem may be defined as a structural and functional unit of the biosphere comprising living organisms and their non-living environment which interact by means of food chains and biogeochemical cycles resulting in energy-flow, biotic diversity and material cycling to form a stable, self-supporting system.

There are two basic processes involved in. an ecosystem:

(i) Cycling of material: It is a cycle of exchange of materials between living beings and the environment, to maintain continuous supply of these materials to living beings for stability of life on earth. These cycles are termed as 'biogeochemical cycles'.

(ii) Flow of energy: The energy trapped by green plants from sun is passed on to the other organisms of the food chain.

The term ecosystem' was first proposed by British ecologist A.G. Tansley in 1935. However, the idea of an ecosystem was given previously by a German, Karl Mobiuu (1877) arid S.A, Forbes (1687) but they used the terms. Biocoenosis and microcosm, respectively in place of ecosystem.

Types of ecosystem

In the biosphere, ecosystems may be classified on the basis of their nature, duration and size:

On the basis of nature

On the basis of nature, ecosystems are classified into two types:

(i) Natural ecosystems: These ecosystems operate in the nature by themselves without any human interference. Common examples of natural ecosystems are: pond ecosystem, Lake Ecosystem, desert ecosystem, grassland ecosystem, forest ecosystem, oceanic ecosystem etc.

(ii) Artificial ecosystems: These are maintained by man and hence are also termed man-made or man-engineered ecosystems. In these ecosystems, man maintains, disturbs the natural balance by the addition of energy and planned manipulations. Common examples of artificial ecosystems are croplands, orchards, gardens, aquarium etc.

On the basis of duration

On the basis of duration, ecosystems are classified into:

(i) Temporary ecosystems: These are short-lived ecosystems which may be natural or man- made. Common examples include rainfed pond and laboratory culture of protozoans.

(ii) Permanent ecosystems: These are self-supporting natural ecosystems that maintain themselves for relatively long duration, *e.g., a* lake, a forest, a desert etc.

On the basis of size

On the basis of size, ecosystems are classified into:

(i) Small ecosystems: Small-sized ecosystems are also termed **micro ecosystems,** *e.g., a* flowerpot, a site under a stone etc.

(ii) Large ecosystems: Very large-sized ecosystems are also termed **macro ecosystems,** *e.g.,* an ocean, a forest, a desert etc.

Components of ecosystem

The various components of any ecosystem may be grouped into two main types:

(i) Abiotic (non-living) components

(ii) Biotic (living) components.

Abiotic (non-living) components

These include the non-living physico-chemical factors of the environment. These components not only affect the distribution and structure of organisms but also their behaviour and interrelationships.

Abiotic factors include inorganic substances, organic compounds and climatic factors.

(i) Inorganic substances: Inorganic substances, *e.g.,* carbon, nitrogen, oxygen, calcium, phosphorus etc. and their compounds (water, carbon dioxide, etc.) constitute the main abiotic components.

These occur either in the form of compounds dissolved in water in the soil or in Free State in the air.

(ii) Organic compounds: These include carbohydrates, proteins, lipids, nucleic acids etc. These are present in living organisms and dead remains of -them. The dead organic matter is broken down by the action of decomposers *(e.g.,* bacteria and fungi) into inorganic substances for their recycling.

(iii) Climatic factors: These include light, temperature, humidity, wind, rainfall, water and edaphic factors *(e.g.,* soil and substrate, topography, minerals, pH) etc.

Biotic (living) components

The living organisms present in an ecosystem form the biotic component. Regarding the mode of obtaining food, the organisms occurring in an ecosystem are classified into three main categories which are:

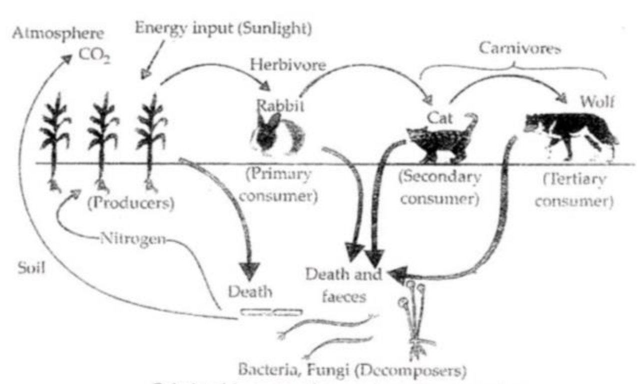
(i) Producers: Producers are organisms that can produce their food using simple inorganic compounds. These include all green plants, blue green algae (cyanobacteria), some bacteria and free-floating autotrophic microorganisms called phytoplanktons. Green plants possess photosynthetic pigments. They can utilize solar energy with the help of photosynthetic pigments *(e.g.,* chlorophyll) to form glucose (simple carbohydrate) from simple inorganic substances, namely, carbon dioxide and water. This process is called **photosynthesis.** It may be briefly represented by the following equation:

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6\ O_2}$$

Oxygen is released in this process. From the basic organic glucose, plants then form complex organic compounds such as starch, protein and lipid. As green plants, blue green algae etc. prepare their organic food themselves with the help of sunlight. Thus, both of them (plants and blue green algae) are known as photoautotrophs (*photos*-light, *auto*-self, *trophos*-nutrition) or simply autotrophs. The organic compounds produced by autotrophs, constitute food not only for the autotrophs but also for the heterotrophs. Producers in an ecosystem are mainly green plants. As producers utilize solar energy and convert it into chemical energy of organic compounds, they are also termed as transducers.

(ii) Consumers: These are mainly the animals. They are unable to synthesize their food. Therefore, they utilize materials and energy stored by the producers or eat other organisms. They are known as the heterotrophs. The consumers are of following types:

(a) Primary or first-order consumers: These include the animals which eat plants or plant products. They are called herbivores or primary (first orders-consumers. As the herbivores feed on plants/ plant products and convert them into animal matter, they are often called key industry animals. Cattle, deer, goat, rabbit, hare, rats, mice, grasshoppers are the common herbivores in terrestrial ecosystems, and snails, mosquito larvae, tadpoles, tortoises etc. are the common herbivores in aquatic ecosystems.



Relationship among the members of an ecosystem.

(b) Secondary or second order consumers: These include the animals which feed on the flesh of herbivores. They are called **primary carnivores** or **secondary** (second **order) consumers.**

Cats, dogs, foxes etc. are secondary consumers in terrestrial ecosystems, and water bugs, water beetles, frogs, small fish etc. are secondary consumers in aquatic ecosystems.

(c) Tertiary or third order consumers: These are larger carnivores which feed on primary carnivores (secondary consumers). These are termed as **secondary carnivores** or **tertiary (third order) consumers.** Common examples include large fish and water birds in aquatic Ecosystems, and wolves, snakes etc. in terrestrial ecosystems.

(d) Quaternary or fourth order consumers: These are even larger carnivores which feed on secondary carnivores (tertiary consumers). Tigers, lions and eagles/hawks are examples in land ecosystems and sharks, crocodiles are examples in aquatic ecosystems.

In any food chain, the consumer present at the end of the chain is called top carnivore. It is the largest carnivore of the food chain and is itself not eaten by other animals *e.g.,* tigers, lions etc. in terrestrial ecosystem.

(iii) Decomposers (Reducers): These include bacteria and fungi. They obtain food from the organic materials of dead producers *(e.g.,* plants) and consumers *(e.g.,* animals) and their waste products. The decomposers-degrade dead remains of plants and animals and waste organic matter into (i) simple small organic molecules which they utilize themselves, and (ii) inorganic substances that are released into the environment for reuse as raw materials by the producers. In this *way* decomposers help in recycling of nutrients in biosphere and form nutrient cycles or biogeochemical cycles. The fertility of soil is maintained by these cycles. Decomposers provide space for new life in the biosphere and so are the essential components of ecosystem. Without them, all life will ultimately cease to exist as dead remains and waste organic matter will pile up. The decomposers are also called **saprotrophs.**

Omnivores: Many animals *(e.g., crow, bear, dog,* cat etc.) and human beings eat both plant and animal matter. They are termed **omnivores** or **double consumers.** As they can eat upon more than one trophic levels, (producers or consumers) thus, they are the only organisms which can exist at more than one trophic levels in a food chain.

Parasites; These are also a category of consumers. These live on or inside the body of other organisms to obtain their *food, e.g., Escheriehia cali* (bacterium), *Entamoeba histolytica* (protozoan), liver fluke, tape worm (flat worms) etc.

Detritivores: These are the organisms which feed on detritus (dead remains of plants and animals) and breakdown it into smaller fragments (examples—earthworm, termites, vultures). Detritivores are also called **scavengers.** Note that detritnwes break detritus into smaller fragments but do not cause release of inorganic compounds. Smaller fragments of detritus left by detridvores are worked upon by decomposers. Decomposers completely breakdown me detritus into free inorganic material.

Table: Differences between autotrophs and heterotrophs.

	Autotrophs	Heterotrophs
1.	They are producer organisms.	They are consumer organisms,
2.	They prepare their organic nutrients themselves.	They do not prepare their organic nutrients themselves.
3.	They get only inorganic materials from outside, using which they synthesize organic materials inside their body.	They get both organic and inorganic materials from outside.
4.	These obtain energy from sunlight or inorganic chemical reactions.	These obtain energy from organic nutrients
5.	These usually add O_2 to the environment.	These add CO_2 to the environment.
6.	These include plants and blue green algae.	These include animals, many protest, bacteria and fungi.
7.	These possess photosynthetic pigments *(e.g.,* chlorophyll).	Photosynthetic pigments are lacking in them.
8.	They constitute the first trophic level.	They belong to second and. higher trophic levels.

Garden ecosystem

It is an artificial, terrestrial ecosystem. It comprises of following components:

Abiotic components: They include soil, its chemical (pH, nutrient concentration etc.) and physical (soil texture, soil water, aeration, porosity etc.) characters, sunlight, air etc.

Biotic components include:

(i) Producers: Grasses, flower bearing plants *(e.g.,* rose, jasmine etc.) and trees are producers.

(ii) Consumers: Animals such as frogs, insects and birds are consumers. All three types of consumers *i.e.,* primary *(e.g.,* insects), secondary *(e.g.,* frogs) and tertiary *(e.g.,* kites) are present in a garden ecosystem. All these living organisms interact with each other and their growth, reproduction and other activities are influenced by the abiotic components of ecosystem.

(iii) Decomposers: Decomposers are microorganisms present in the soil. These cannot be seen with naked eye. These provide raw materials back to the environment, by decomposition of dead, decaying matter, for their reuse by the producers. They maintain fertility of the garden soil.

Pond Ecosystem

A pond is a classical example of an aquatic ecosystem. The pond ecosystem comprises the following four components:

Abiotic components: These include water and the physical and chemical environment of water.

Physical environment comprises of temperature, light intensity, pH, of water etc. while the chemical environment constitutes the basic elements, minerals, and dissolved gases, organic and inorganic compounds.

Biotic components include:

(i) Producers (autotrophs): These include rooted and floating plants as well as phytoplankton's.

(ii) Consumers: These include the heterotrophs-mainly animals that feed upon other organisms.

The primary consumers (C_1) are minute floating fauna (zooplanktons), water fleas and larvae of insects. Consumers of the second order (C_2) are crustaceans, rotifers, small fish and frogs. The tertiary consumers (C_3) are large fish and water birds.

(iii) Decomposers: These include aquatic bacteria and fungi. Although they are distributed throughout the pond, they are abundantly present in the mud at the bottom of the pond. Producers (plants) receive solar energy to form organic materials through photosynthesis.

ACTIVITY CORNER

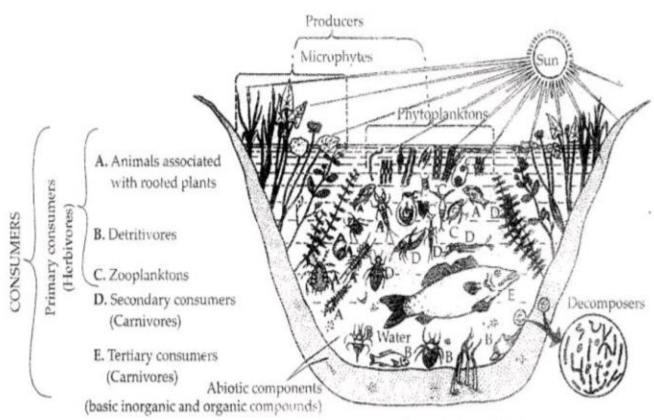
To make artificial or man-made ecosystem-aquarium.

Requirements: A large rectangular glass jar with lid, oxygen pump (aerator), few aquatic plants and animals, fish-food etc.

Observation: In the aquarium, aerator (oxygen pump) supplies oxygen in dissolved form (DO) for the living organisms to survive in it. Aquatic plants act as producers. They capture sunlight to synthesize organic food. Small microorganisms present in water and small fishes feed on plant matter. These act as herbivores. Small fishes also feed on supplement food we add in the aquarium. In this way, transfer of energy occurs from producers to herbivores.

Conclusion: Of these three groups of organisms, aquatic plants are of primary importance because these convert solar energy into chemical energy of organic compounds by the process of photosynthesis. All animals are directly or indirectly dependent on plants for food (energy).

Producers are eaten by primary consumers (insect larva, rotifers, molluscs) which in turn are eaten by secondary consumers (insects, fish, frogs). The secondary consumers become the prey of tertiary consumers (large fish, snakes, water birds). At some stage or the other producers and different grades of consumers die. Their dead bodies are acted upon by decomposers who are responsible for breaking the complex organic substances into simple substances to be utilized again by producers. In this way, pond is an ideal example of an ecosystem.



A pond ecosystem with its biotic and abiotic components

ILLUSTRATION

1. Why life exists only on earth?

Ans. Life exists only on earth because the various, physical conditions required to sustain life occur only on earth. These physical conditions include proper temperature, air, water and soil etc.

2. How many components are in environment? Name them.

Ans. Environment has two major components:
(i) Abiotic component (ii) Biotic component.

3. What do you mean By artificial ecosystems?

Ans. Ecosystems in which natural balance are maintained or disturbed by man by addition of energy and planned manipulations are called artificial ecosystems. Common example of artificial; ecosystems are crop lands, orchards, gardens, aquarium etc.

4. **What are omnivores?**

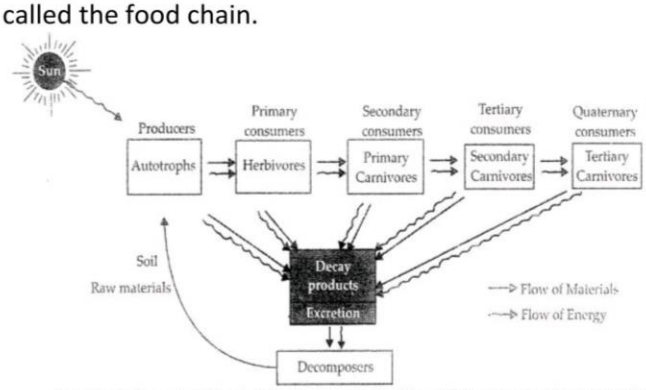
Ans. Many animals, *e.g.,* crow, bear, dog, cat, etc. and human beings eat both plant and animal matter. They are termed as omnivores or double consumers.

5. What is the role of decomposers in the ecosystem?

Ans. Decomposers are microbes (bacteria and fungi), which act on the dead bodies of producers and consumers to break the complex organic substances into simpler ones. They absorb some of the substances and release others into the environment to be recycled and to be used in future by the producers,
In this way, decomposers have a very important role in cycling the materials in the biosphere and maintaining the food chain by providing raw materials for producers. They also make the soil fertile and have become the integral part of ecosystem.

FOOD CHAIN

Food acts as a fuel to provide energy to do work. It is true for all living organisms. In any given ecosystem, all living organisms are linked in a systematic chain with respect to their mode of manufacturing food, feeding habits. The interactions among various components of the environment involves flow of energy from one component of the ecosystem to other. For instance, in a grassland ecosystem, all green plants (herbs, shrubs and trees) are producers. These autotrophs manufacture their food by utilizing the radiant energy of the sun by the process of photosynthesis. During photosynthesis, producers capture solar energy and convert it into chemical energy. These autotrophs (producers) are eaten up by plant eaters, *i.e.,* herbivores (primary consumers). The herbivores are subsequently eaten up by flesh eating animals, *i.e.,* carnivores (secondary consumers). The carnivores maybe eaten up by larger carnivores (tertiary consumers). Thus, beginning with the producers, onward to herbivores, carnivores and next level carnivores, all organisms are inter- linked in a definite sequence and involve transfer of energy from producers onward to the last link in the chain. The sequential interlinking of organisms involving transfer of food energy from the producers, through a series of organisms with repeated eating and being eaten is called the food chain.



Generalized scheme of nutritional relationships amongst the different biotic components of an ecosystem.

Trophic Levels

The various steps, representing organisms in a food chain, at which the transfer of food and **energy takes place** are called trophic levels. The various trophic levels are given below:

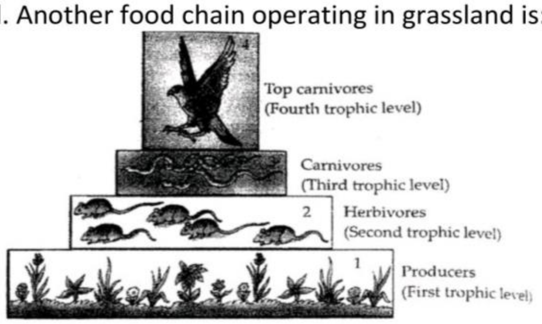
- The **plants** or the **producers** which fix the solar energy and provide it for consumers constitute **the first trophic level,** *e.g.,* green plants.
- The **herbivores or the primary** consumers form the second trophic level, *e.g., rats,* rabbit, deer, goat, etc.
- **Carnivores** or the **secondary consumers** which feed on herbivores make up the third **trophic level,** *e.g.,* snakes, wall lizard, frog, small birds, small fish, etc.
- Large carnivores or **top carnivores,** which feed upon the small carnivores constitute the last **trophic level.** Thus, in a food chain, consisting of four trophic levels, tertiary consumers are top

carnivores (fourth trophic level) but in a food chain with five trophic levels, quaternary consumers are top carnivores (fifth trophic level). Some examples of top carnivores are eagle, tiger, lion, etc. These organisms are not preyed upon; instead they die of old age, disease or injury.

Examples of trophic level

One of the simplest food chains is:

Grass (Producer) → *Deer* (Herbivore) → *Lion* (Carnivore) In the above food chain, grass (producer) represents the first trophic level. Deer (herbivore) represents the second trophic level and lion (carnivore) represents the third trophic level. Another food chain operating in grassland is:

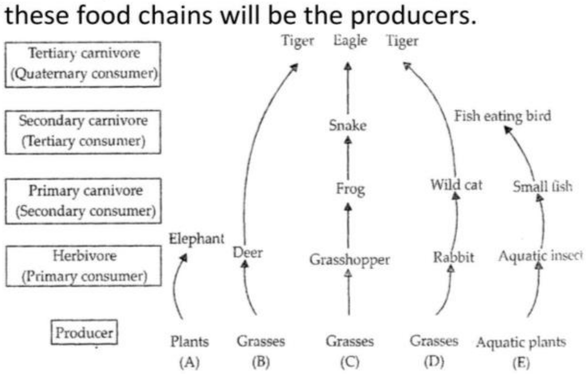


Various trophic levels in a food chain.

Grass (Producer) First trophic level → Insect (Herbivore) Second trophic level → Frog (Carnivore) Third trophic level → Snake (Bigger carnivore) Fourth trophic level → *Eagle* (Top carnivore) Fifth trophic level

Length of food chains

In ecosystems, different food chains may have two, three, four or maximum five trophic levels. Accordingly, a food chain may end at the (i) herbivore (primary consumer) level, (ii) primary carnivore (secondary consumer) level, (iii) secondary carnivore (tertiary consumer) level or (iv) tertiary carnivore (quaternary consumer) level. First trophic level in all of these food chains will be the producers.



Characteristics of food chain

(i) A food chain involves a nutritive interaction between the living organisms (biotic components) of an ecosystem. In a food chain, there occurs repeated eating, *i.e.,* each group eats the other group and subsequently is eaten by some other group of organisms.

(ii) A food chain is **always straight** and proceeds in a progressive straight line.

(iii) In a food chain, there is unidirectional flow of energy from sun to producers and subsequently to series of different types of consumers.

(iv) Usually, there are 3 or 4 trophic levels in the food chain. In few chains, there may be a maximum of 5 trophic levels.

(v) Some organisms are omnivores. These occupy different trophic positions in different food chains.

(vi) At each transfer, generally 80-90% of energy is lost as heat in accordance with second law of thermodynamics.

(vii) An interesting feature of food chain is that some harmful no biodegradable chemicals (pesticides, *e.g.,* D.D.T. and heavy metals such as mercury, arsenic, cadmium etc.) enter the bodies of organisms through the food chains and go on concentrating at each trophic level.

This phenomenon is called **bio magnifications or biological magnification.** For example, in a food chain operating in a pond, river or lake, the water contains a small amount — 0.02 ppm (parts per million) of harmful chemicals. When this water is consumed by phytoplanktons and zooplanktons, the concentration of these chemicals increases to 5 ppm. Fishes feeding on these accumulate 240 ppm. Birds feeding on these fishes were found to contain 1600 ppm of these chemicals. Thus, there is an increase in the concentration of the chemicals at each trophic level.

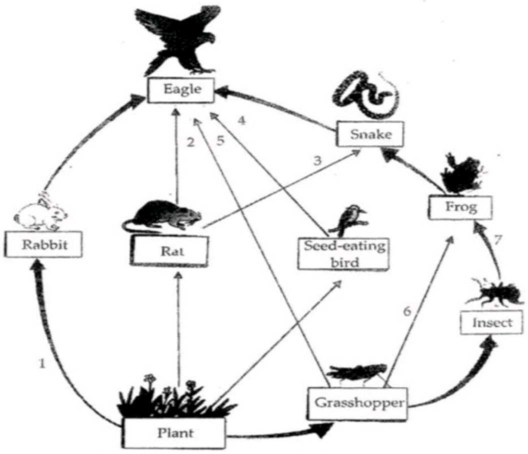
Water (0.02 ppm water) → Zooplanktons (5 ppm) → Large fishes, Small fishes (240 ppm) → Fish eating bird (1600 ppm)

Bio magnifications

As human beings usually occupy the highest trophic level in food chain, they get maximum quantity of harmful chemicals.

FOOD WEB

The various food chains, operating within an ecosystem or the biosphere cannot function in isolation. Many of these food chains are interconnected by organisms which are a part of more than one food chain. Thus, various food chains form a network with interconnections and linkages called food web. More precisely, **food** web is a **network** of **food chains which become inter- connected at various trophic** levels so as **to form a number of feeding** connections amongst different **organisms of a biotic community.**



Several interconnected food chains: a food web.

In a food web, one organism may occupy more than one position. An organism can obtain its food from different sources and in turn may be eaten up by different types of organisms. For example, as shown in figure, a rat may be consumed by a snake or an eagle. Similarly, a grasshopper may be consumed by a frog, an eagle or a bigger insect. This food web has seven interconnected food chains.

These are:

Plant → Rabbit → Eagle

Plant → Rat → Eagle

Plant → Rat → Snake → Eagle

Plant → Seed-eating bird → Eagle

Plant → Grasshopper → Eagle

Plant → Grasshopper → Frong → Snake → Eagle

Plant → Grasshopper → Bigger Insect → Frog → Snake → Eagle

Characteristics of food web

(i) Unlike food chains, food webs are **never straight.** Instead, each food web is formed by interlinking of food chains.

(ii) A food web provides alternative pathways of food availability. For example, if a particular species of producer is destroyed by a disease in the ecosystem, the herbivores of that are can feed on other species of producers. Similarly, secondary consumers *(e.g.,* predator birds) may feed on rats or mice in the event of decrease in population of rabbits in that are on which they commonly feed.

(iii) Greater alternatives available in a food web make the ecosystem more stable.

(iv) Food webs also help in checking the overpopulations of highly reproductive species o plants and animals.

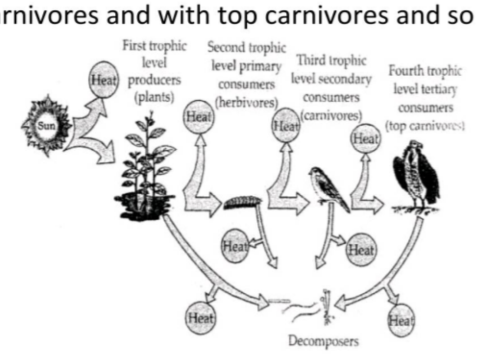
(v) Food webs also help in ecosystem development.

FLOW OF ENERGY IN AN ECOSYSTEM

Green plants capture about 1% of the solar energy incident on the earth through the process of photosynthesis. A part of this trapped energy is used by plants in performing their metabolic activities and some energy is released as heat into the atmosphere. The remaining energy is chemical energy stored in the plants as photosynthetic products.

When plants are eaten up by herbivores, the chemical energy stored in the plants is transferred to these animals. These animals (herbivores) utilize some of this energy for metabolic activities, some energy is released as heat and the remaining energy is stored in their body.

The process of energy transfer is similarly repeated with carnivores and with top carnivores and so on.



Energy flow through different trophic levels

Characteristics of energy transfer

The following are the characteristics of energy transfer in the biosphere:

- Energy is supplied by the sun and it is not created in the biosphere. Energy is only converted from one form to another in the biosphere.
- There is a continuous transfer of energy from one trophic level to the next in a food chain.
  This flow of energy is **unidirectional.**
- At each trophic level, there is some loss of energy, which goes into the environment and remains unutilized.
- At each trophic level, some of the energy is utilized by the organisms for their growth, reproduction and development.

- At each trophic level some amount of energy is lost due to respiration and other metabolic activities.
- At each trophic level, rest of the energy is stored in organism's body. This stored energy is transferred to next trophic level through food chain.

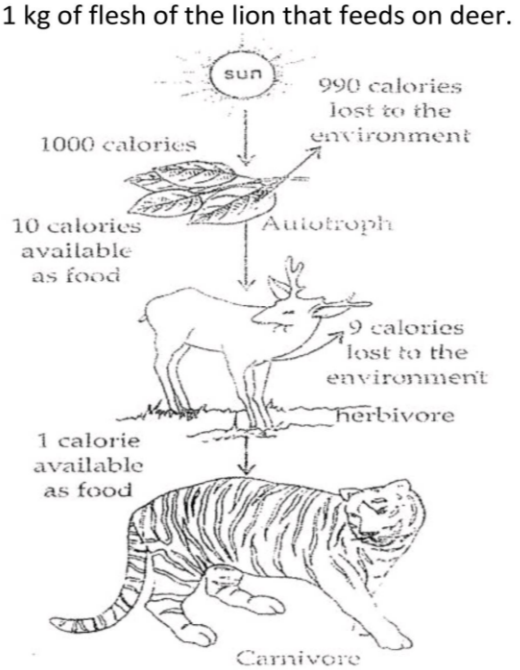
  Thus, at each trophic level, the amount of energy available is less than that available at the previous level. Since, amount of available energy goes on decreasing at each trophic level, food chains usually consist of only 3 or 4 steps and rarely maximum of 5 steps.

10 percent Law

In an ecosystem, transfer of energy follows 10 per cent law *i.e.,* only 10 per cent of the energy is transferred to each trophic level from the lower trophic level.

Lindeman propounded 10 percent law in 1942. This law states that in nature some fraction of energy entering any population is available for transfer to the next population that feed upon the former. In any food chain about 10 percent of the energy in eaten food is turned into biomass of the eater.

For example, 100 kg of organic matter in grass will turn into , 10 kg of flesh of the deer, which in turn will form 1 kg of flesh of the lion that feeds on deer.



10 percent law of energy flow-shown through a simple food chain

ILLUSTRATION

6. What are trophic levels? Give an example of a food chain and state the different trophic levels in it.

Ans. Every step of the food chain where transfer of energy occurs is called a trophic level. The common example of food chain in a terrestrial ecosystem is: Plants → Deer → Tiger Plants belong to the first trophic level of the food chain. They are the producers. Deer being a herbivorous animal, feeds upon plants arid constitutes the second trophic level; in the Tow chain As the primary consumer arid tiger is the secondary consumer occupying the third trophic level as it feeds; upon deer.

7. What is the source of energy in an ecosystem?

Ans. Sun is the ultimate source of energy in any ecosystem.

8. How much incident energy is captured by green plants?

Ans. Green plants capture about 1% of the solar energy incident on the earth through the process of photosynthesis.

9. How much energy is passed to the next higher trophic level?

Ans. Only 10% of the total energy is passed to the next higher, trophic level.

EFFECTS OF HUMANS ON THE ECOSYSTEM

Human beings are the only organisms who try to change the environment to fulfill their needs (food, shelter, clothing's, transport, industry etc.). Increase in human population and great advancement in technology in the recent past have damaged the balanced and healthy environment. This environmental imbalance, created by uncontrolled human activities, has given rise to various environmental problems.

We are an integral part of the ecosystem. Changes in the environment affect us and our activities change the environment around us. Exploitation of nature by us has turned uncontrollable. We use to eradicate an entire forest for our needs. Due to such human activities the food chain gets disturbed. This leads to imbalance in the functioning of ecosystem. For example, due to extensive hunting of lions in Rajasthan, the food chain got disturbed leading to increase in the population of herbivores. These herbivores feed on grass and due to overgrazing most part of Rajasthan was converted into deserts.

The effects due to disturbance in food chain can be understood by taking an example of following food chain:

Grass → Deer → Lion

Situation I

Suppose we kill all the lions, then the population of deer will increase as there will be no lion? (Predators) to feed on them.

The increase in deer population may lead to a high consumption of grass (producers).

Thus, the producers may be completely eliminated.

Situation II

Suppose we remove all deer population from the food chain. This will decrease the lion population as no food (prey) is available to lion. Lion may then resort to killing and feeding on other prey such as domestic animals or even human beings.

If lion or deer are operating in a food web, then removal of either of them would disturb the ecosystem.

ENVIRONMENTAL PROBLEMS

Various components of ecosystems maintain a balance in nature. Disturbances in any component of the environ merit cause an imbalance. Human activities such as industrial revolution, urbanization, increasing population and rapid change in the modern technology are largely responsible for accelerating the pace of the imbalance in nature. The irresponsible use of technology and contamination of air, water and land have led to environmental problems like global warming, greenhouse effect, ozone depletion, acid rain, etc.

Ozone layer depletion

One of the adverse effects of human activities on environment is thinning of ozone layer. The thinning of ozone layer is commonly called **ozone depletion.** Ozone is being depleted by air pollutants like aerosols, methane etc.

Ozone layer

A condensed layer of ozone gas is present around earth in atmosphere. It is termed as ozone **layer.** The sun emits radiations of different wavelengths. Of these, radiations important to our planet are visible rays, infrared rays (heat waves) and ultraviolet radiations. Visible rays and infrared rays carry little energy which does not harm living beings. The energy content of ultraviolet radiation however, is beyond the limits of tolerance of a living cell and may cause harm or-even become lethal to a living system. Thus, protection from UV-radiation of sun is necessary for survival and sustenance of living beings and the ecosystem. Ozone layer is a protective shield around earth which absorbs most of the UV-radiation of the sun protecting the living beines of the earth from health hazards. Ozone layer is largely found in the stratosphere between 20 to 26 km above sea level. Stratosphere extends from 12 km to 50 km above sea level.

Ozone formation

Molecular oxygen present in the stratosphere absorbs short wavelength of ultraviolet radiation in the range of 1800Å to 2200 2200Å. This causes splitting of molecular oxygen into its constituent atoms. The constituent atoms combine with molecular oxygen to produce ozone.

$$O_2 \rightarrow O + O$$

$$O_2 + O \rightarrow O_3 \text{ (ozone)}$$

In this way, ozone is a result of photochemical reactions in which starting molecule is oxygen.

In stratosphere along with the above reaction another photochemical reaction also occurs.

Ozone absorbs UV-radiation in the range of $2000 - 2900\text{Å}$, which causes breakdown of ozone molecules.

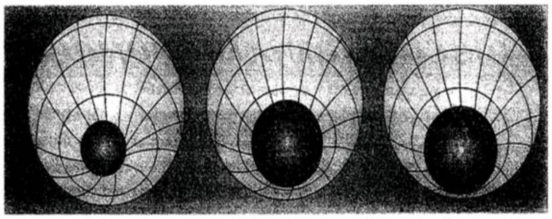
$$O_3 \rightarrow O_2 + O$$

$$O_3 + O \rightarrow 2O_2$$

The two photochemical reactions, i.e., formation and destruction of ozone molecules-in normal circumstances balance each other. It results in the effective absorption of short wavelength of ultraviolet radiation in the stratosphere and resist them to reach the earth.

Ozone Hole

Declined thickness of ozone layer over a restricted area is called ozone hole. Ozone hole was first discovered over Antarctica in 1985. Later on, ozone hole was also noticed over Arctic in 1990, and this phenomenon is known as ozone layer depletion.



Satellite picture showing the hole in the ozone layer over Antarctica.

Distribution of ozone layer

Ninety per cent of the ozone is concentrated at an altitude of about 15-40 km above sea level. However, it is not uniformly distributed in the whole stratosphere. Equator receives maximum amount of ultraviolet radiation. Hence, maximum production of ozone occurs over equator. However, its concentration is the lowest at equator and highest on latitude of about *70°* north and south. This is because bulk of ozone produced over equator is displaced and driven towards poles by the movement of atmospheric air. Secondly, the concentration of O_3 in the stratosphere changes with season. The concentration of ozone remains the highest during the period of February to April (spring season) arid the lowest during July to October (fall season).

Ozone Depleting Substances (ODS)

These are the substances which react with the ozone layer in the stratosphere and destroy it. The main ODS are chlorofluorocarbons, halons, methane, nitrous oxide, carbon tetrachloride and chlorine. Of these, chlorofluorocarbons are the principal ODS. Jets and rockets release some ODS in the stratosphere while others slowly enter from the troposphere into the stratosphere.

Chlorofluorocarbons (CFCs) are synthetic, harmful chemicals which are widely used in refrigerators and air conditioners as coolants; in fire extinguishers, in aerosol sprayers and as propellants. Once released in the air, these harmful chemicals produce 'active chlorine' (Cl and C10 radicals) in the presence of UV radiations. These radicals, through chain reactions, then destroy the ozone by converting it into oxygen. Due to this, the ozone layer in the upper atmosphere (i.e., stratosphere) becomes thinner.

Effects of ozone depletion

The thinning of ozone layer allows more UV radiations to pass through it which then strike the earth. These cause following harmful effects on man, animals and plants:

(i) Cancers: UV radiations increase incidences of skin cancer.

(ii) **Eye sight:** UV radiations cause damage to eyes resulting in dimming of eye sight, photo burning as well as increased incidences of cataract in eyes.

(iii) Immune system: UV radiations cause damage to immune system and hence reduce the body's resistance to diseases.

(iv) Increased embryonic mortality: Harmful UV radiations would increase mortality of developing embryos in the mother's uterus.

(v) Photosynthesis: UV radiations would result in 10-25% decline of photosynthesis in plants.

(vi) Global warming: Decreased photosynthesis would result in increase in the concentration of CO_2. This will result in global warming.

International efforts to check ozone depletion

The thinning of ozone layer was noticed in 1980s. A spring time ozone hole was discovered over Antarctica in 1985 by **Farman and coworkers.** The hole continued increasing in diameter over the years. A small ozone hole has also been discovered over North Pole. These findings forced the environmentalists to develop effective strategy to check the thinning of ozone layer, such as:

(i) Montreal protocol: In 1987, the United Nations Environment Programme (UNEP) succeeded in forging an agreement between nations to limit CFCs production of half the level of 1986. It was also decided that all the signing nations would take necessary steps to decrease the use of all ODS, particularly chlorofluorocarbons (CFCs). It was also recommended that alternate technology will be developed to replace the use of CFCs. This agreement is called Montreal **Protocol.** To-date, more than 175 countries, including India, have signed this protocol. This protocol was signed on September 16, 1987 so September 16 is celebrated by international community as "International Day for the Preservation of Ozone layer."

(ii) Helsinki Declaration: In 1989, majority of the nations pledged to phase out chlorofluorocarbons by the year 2000. Production of CFCs have been stopped since then and CFCs have been replaced with hydro fluorocarbon (HFC) and hydrochlorofluoro carbons (HCFC).

- The thickness of ozonosphere averages 300 DU or ~ 0.30 cm above, the equator but may exceed

400. DU or 0.40 cm, above the poles, during the winter months. Here DU is Dobson's **Unit,** a unit of .measurement, of atmospheric ozone.

- Ozone layer absorbs high energy ultra violet radiation of UV-C (100-280 nm), partly UV- B (280-329 nm). It however, allows low energy UV-A radiations (320-390 Am).
- During the early part of the second half of 20th century, scientists noticed depletion of ozone layer at places. The problem of ozone depletion was first aroused by HaroidrJohnson a U.S. chemist, in 1971. He cautioned that nitric oxide produced by supersonic aircrafts shall catalytically attack ozone molecules to covert them info O_2 thus, resulting in the depletion of ozone layer. Farman and his co-workers in 1985 recorded a net reduction of about 40 per cent in ozone content over Antarctica in a duration from 1979 to 1985.
- **A single chlorine atom** can destroy 1 lakh **(1,00,000) ozone molecules.**

ACTIVITY CORNER

To find out the chemicals responsible for the depletion of the ozone layer and find out if the regulation put in place to control the emission of these chemicals have succeeded in reducing the damage to the ozone layer. Has the size of the hole in the ozone layer changed in recent years?

Resources required: Library, Internet.

Discussion: Chlorofluorocarbons (CFGs), methane (CH_4) and oxides of nitrogen (NO_x) are responsible for the depletion of ozone layer and are together called ozone depleting substances (ODS). Of these, chlorofluorocarbons are the most harmful chemicals.

In 1987, United Nations Environment Programme (UNEF) succeeded in forging an agreement between nations to freeze CFCs production at half of the 1986 levels. Continuous less use of ozone depleting substances has shown positive results and, therefore, the size of the ozone hole has decreased in recent years.

Environmental Pollution

Environmental pollution is defined as an undesirable change in the physical, chemical or biological characteristics of air, water and soil which cause harm to living organisms. The environmental pollution is caused due to addition of a number of wastes. Some of these polluting wastes are listed below:

Table: Various sources of wastes.

Sources of wastes	Types of wastes
1. Industrial wastes	• CO, CO_2, SO_2, H_2S and hydrocarbons (air released from automobiles also). • Many organic compounds like phenol, naphtha, aromatic compounds, etc.
2. Domestic wastes	• Sewage of sanitary facilities of residential, commercial, institutional and other public places. • Sewage with many types of pathogenic organisms like bacteria, encysted protozoans, viruses, eggs of helminthes, etc.
3. Agricultural wastes	• CO_2, Methane (from paddy fields), organ pesticides and chlorinated hydrocarbons, etc. • Traces of fertilizers with nitrates, phosphates and sulphates of potassium.
4. Commercial wastes	• Building wastes, printing press wastes, biomedical wastes of medical institutions and hospitals, etc.

Biodegradable and no biodegradable wastes

The environmental pollutants are divided into two categories:

(i) Biodegradable wastes: These wastes can be degraded by biological or microbial actions. These include domestic sewage, livestock wastes, municipal wastes, etc. These cause pollution only when they are added in larger amounts than their rate of degradation.

(ii) No biodegradable wastes: These wastes are not acted upon by the microbes or acted upon very slowly so that they cannot be degraded. These wastes undergo biological magnification in the food chain. These include glass and plastic wastes, aluminium cans, radioactive substances, synthetic polymers, heavy metals, pesticides (e.g., DDT, BHC, etc.), polyethylene bags, etc.

ACTIVITY CORNER

Requirements: *To find out the biodegradable and no biodegradable*

Procedure: Collect waste material from your homes. This could include all the waste generated during a day, like kitchen waste (spoilt food, vegetable peels, used tea leaves, milk packets and empty cartons), waste paper, empty medicine bottles, strips, bubble packs, old and torn clothes and broken footwear,

Bury this material in a pit in the school garden or if there is no space available, you can collect the material in an. old bucket/flower pot and cover with at least 15 cm of soil.

Keep this material moist and observe at 15 day intervals.

Observation: (i) Polythene milk packets, plastic medicine bottles are the materials which re-main main unchanged over long periods of time. These materials are known as no biodegradable, materials.

(ii) Vegetable peels, used tea leaves, spoilt food are the materials that change very fast. While old and torn clothes, broken footwear, waste paper, empty cartons are the materials which change their form and structure over time. All these materials are known as biodegradable materials.

Conclusion: We should reduce the use of no biodegradable materials as these are not easily broken down into its constituents. These materials are inert and persist in the environment for a long time and may harm the various members of the ecosystem.

Biodegradable plastics

Our whole world seems to be wrapped in plastic. Almost every product we buy, most of the food we eat, and many of the liquids we drink, come encased in plastic. The environmental impact of persistent plastic wastes is evoking more global concern as alternating disposal methods are limited. Incineration (burning) may generate toxic air pollution and satisfactory landfill sites are limited.

The continuously growing concern has stimulated research interest in biodegradable polymers as alternative to conventional non-biodegradable polymers of petrochemical products such as polyethylene and polystyrene etc.

The plastics that will decompose in natural environment by microorganisms are known as **biodegradable plastic.**

Biodegradable plastics are made from sustainable materials such as corn, hemp and chicken feathers etc. Most of the biodegradable plastics are made from corn. It has been manufactured since 1989. The basic ingredient of corn based plastics is **resin polyactide or** PLA extracted from corn. Corn based plastics are biodegradable however they can only biodegrade quickly in controlled, composting facilities. Composting plants allow compost to reach 140°F for ten days to incite the biodegradation process.

The conventional plastic made from petroleum products never biodegrade.

ILLUSTRATION

10. Why are some substances biodegradable and some non-biodegradable?

Ans. Some substances can be easily degraded and broken down into simpler substances by the action of enzymes secreted by microorganisms called decomposers. So, such substances are biodegradable. On the other hand, some substances, mainly the man-made, substances, cannot be degraded or broken d own into simpler substance's through the enzymes secreted by the decomposing microbes. Hence, these are nonbiodeeradabie substances.

11. Give any two ways m which biodegradable substances would affect the environment.

Ans. (i) During the decomposition of biodegradable substances, tout smell and some harmful gases are produced which spread in the environment and make life difficult for the people living in nearby areas.

(ii) The decomposing material provides an ideal medium for the reproduction and growth of flies, insects and microbes, which in turn act as vectors for several diseases like cholera, typhoid, diarrhoea, etc.

12. Give any two ways in which aonbiodegradable substances would affect die- environment.

Ans. (i) Pesticides and allied chemicals are no biodegradable substances. They enter the living body from the environment through water and food and cause several harmful effects. They also get magnified biologically through the food chain.

(ii) During the process of recycling of no biodegradable substances like plastic and.

Polythene, carcinogenic toxins like dioxins and furans are released into the environment which reach the body of humans and other animals through different sources and cause health problems.

13. What is ozone and how does it affect any ecosystem?

Ans. Ozone is present in the stratosphere of the earth's atmosphere in the form of a protective shield. It contains three oxygen atoms (O_3) which are formed as a consequence of photochemical reaction in the environment. Ozone absorb harmful ultraviolet radiations of the sun. In this Way, it protect protects all living beings on the earth. When the ozone layer gets depleted, the UV-radiations reach the earth and plants are the worst sufferers. Being producers lying at the base of the trophic level, destruction of plants can upset the whole ecosystem. The planktons present on water surface may die on exposure to UV- radiation. This will affect the aquatic ecosystem.

UV-radiation caused severe effect on microbes, which are important decomposers in our ecosystem.

Enhanced UV radiations would affect humans and other animals by causing:

– Skin cancer

– Blindness and increased chances of cataract in eyes.

– Malfunctioning of immune system.

14. Why ozone hole forms over Antarctica?

Ans. Chlorofluorocarbons are released into the atmosphere and the winds move them towards the poles. Environmental conditions prevailing in Antarctica and extremely low temperature (-85°C) facilitates the formation of wind (polar vortex) completely isolates Antarctic air from the rest of the world. The ice clouds provide the catalytic surface for the reaction of chlorine atoms and then ozone. This results in the thinning of ozone layer every year over most of the Antarctica. This hole disappears in summer due to warming up of air and the mixing up of Antarctic air with that of the rest of the world.

SOLID WASTE MANAGEMENT

In our daily life, we generate a lot of materials and throw them away. The useless left over or discarded materials are termed as wastes. The waste materials can be gaseous (*e.g.,* automobile exhausts, smoke from chimneys of industries and houses), liquid (*e.g.,* effluents from industries, sewage water) or solid (*e.g.,* food waste, cow dung and human excreta, trash and rubbish, farm waste, industrial and chemical wastes). Solid wastes are the main sources of soil pollution.

Solid Wastes

Solid wastes generally come from households, vegetable and fruit markets, cattle sheds, industries, agricultural fields, and many other places. These can be conveniently categorized into following categories:

(i) Food waste: It includes waste of vegetable and fruit markets and kitchens (*e.g.,* rotten, left over vegetables and fruits and their peels), waste of slaughter houses and food canning industries.

(ii) Cow dung, human excreta and farm waste.

(iii) Trash and rubbish: It includes dirt, ash, sand and bricks, polythene bags and plastic waste;

Broken, useless boards, card boards, waste paper, waste rubber, and leather articles; waste, broken glass articles; worn out clothes and metal articles etc.

(iv) Solid waste from chemical and other **industries.**

(v) Hospital waste: It includes used cotton, bandages, used/broken syringes and needles, used plastic or glass bottles etc.

When accumulated, these heaps of solid wastes make the surroundings dirty and pollute the soil. When the human population was low and technology was in its infancy, the solid wastes, generated due to human activities, were easily degraded by decomposers present in nature and these did not create any significant harmful effect on the environment. In the recent times, however, human population has increased tremendously and the technology has become greatly advanced. These two factors have contributed significantly in the deterioration of our environment.

Advancement in the technology has resulted in improvements in our life styles and also has changed our attitudes. As a result, we have started using more and more of disposable articles thereby generating huge amounts of waste material.

Few examples are cited below:

- **Use of disposable plastic, paper cups in trains:** Millions of disposable cups are used and thrown away on daily basis into the environment. Initially, the use of disposable plastic cups in trains was hailed as a step forward for reasons of hygiene, as none at that time, had thought about the impact of this step on the environment. Now, disposable biodegradable paper cups are being used in trains in place of disposable non-biodegradable plastic cups.

- **Use of disposable materials in marriage and other parties:** This is another example where we use and throw away huge quantity of disposable materials such as plastic, paper cups, plates, spoons etc. (biodegradable and non-biodegradable) in the environment without realizing their impact on the environment.
- Some time back, **kulhads (disposable cups made of clay)** were suggested as an alternative of disposable plastic cups for use in trains. However, a little thought discouraged this suggestion as making these kulhads on a large scale would have resulted in the **loss of the fertile top soil.**

Methods of solid waste disposal

Landfilling

In this, solid wastes are dumped into low lying areas. The refuge is dumped in layers of about 1.5 metre and each layer is covered by soil of about 20 cm thickness. Such landfills can be used for developing parks or other recreational sites. So **dumping is simple and economical** method to manage the urban solid wastes and **reclaim the** Sow-lying areas for better use.

Composting

In this, organic matter of solid wastes is digested anaerobicaily or aerobically by microbial action and converted into humus and *stable* mineral compounds. Although aerobic composting is more attractive, it has a drawback that most of the com posting plants have unacceptable odour. However, it is of great use, if its products are used as manure in soil. The crop yield is improved and there is less need of fertilizers and pesticides. Anaerobic composting is more advantageous due to:

– No need of aeration.

– Produces biogas (55% methane and 45% CO_2) which can be used for heating or generation of electric power.

Incineration

It involves the aerobic burning of the combustible constituents of solid wastes like garbage, **rubbish and dead animals** in **the properly-constructed** hearth **of** furnaces at high temperature (>670°C). It can also be used to generate steam power (when burnt at about 1000°C temperature).

This is also the ideal method for medical waste management as it eliminates the infectious organisms.

ACTIVITY CORNER

To find out how the local body (panchayat, Municipal Corporation, resident welfare association) deals with the waste. Are these mechanisms in place to treat the biodegradable and non-biodegradable waste separately?

Observations and Conclusion: The waste that is generated at home is collected in dustbins daily in each home. The municipal corporation of town/city has set up a system to remove such garbage on daily basis. Large collection containers are set up at specific sites to collect the household waste. People, living in localities, put their household waste regularly in these collection containers.

Municipal trawlers then collect these wastes and dump them at a specific vacant site on the extreme edge of the town. Here, non-biodegradable waste is separated. The biodegradable waste is -then burnt arid the ash left is put in ditches by land fill technique. In some towns, bulk of biodegradable waste is burnt at very high temperature (process called **incineration)** and the left over ash is removed by landfills.

Non-biodegradable wastes such as plastics, glass objects, metals etc. are sent to respective recycling units, where these are remolded and again put to use.

In some villages/towns community biogas plants have been established to use biodegradable waste to generate biogas and manure.

Pyrolysis

It involves **anaerobic destructive distillation of the combustible constituents of the solid wastes at high temperature** (650°C to 1000°C), so as to recover the chemical constituents and chemical energy of organic wastes.

Table: Differences between incineration and pyrolysis:

Characters	Incineration	Pyrolysis
1. Definition	**Aerobic burning** of combustible	**Anaerobic burning** of combustible components of

	components of solid wastes at high temperatures.	solid wastes at high temperature.
2. Final products	Ashes and clinkers.	Chemical energy and chemical constituents.

ACTIVITY CORNER

(i) *Find out how plastics are recycled.*

(ii) *Search the internet or library to find out what hazardous materials have to be dealt with while disposing of f electronic items. How would these materials affect the environment?*

Observations and Conclusion:

Many types of plastics can be remolded easily. Such plastic items are isolated from garbage and sent to specific industries where these are melted and then remoulded to form various plastic items for reuse. In this way, recycling process reduces certain wastes from the environment.

Recently, biodegradable plastic materials are being used to avoid their long term accumulation in the environment.

When we dispose of electronic items, the hazardous materials include non-biodegradable plastics and electronic chips made of silicon. Both these materials cannot be degraded by microorganisms present in the environment and, therefore, these remain as such for a long time.

ILLUSTRATION

15. How can you help in reducing the problem of waste disposal? Give any two methods.

Ans. Disposal of waste materials is a global problem of high magnitude. This problem can be reduced through:

(i) Sorting out biodegradable and non-biodegradable wastes and then dumping the biodegradable waste into preplanned site to be converted into manure or for land filling.

(ii) Non-biodegradable materials may be converted into ash through incineration by controlled burning. Ashes obtained by incineration constitute about 10% of the total mass of the waste material.

16. What are the different methods of solid waste disposal?

Ans. Different methods of solid waste disposal are:

(i) Land filling (ii) Composting

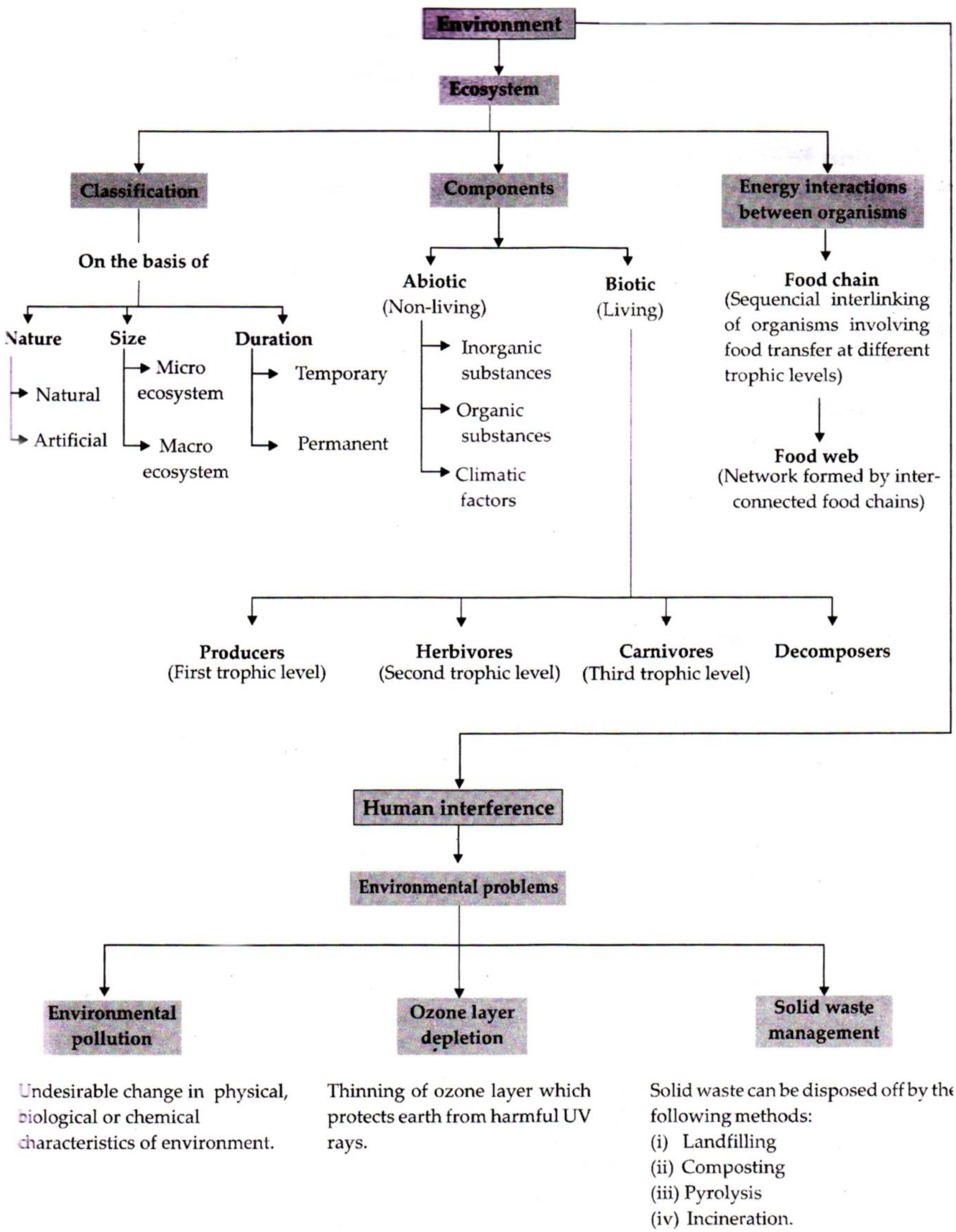
(iii) Pyrolysis (iv) Incineration.

What are the drawbacks of composting?

Ans. (i) Unacceptable odour from composting plant.

(ii) Pathogenic microbes can spread diseases in nearby areas.

CONCEPT MAP


Environment
Ecosystem
Classification
Components
Energy interactions between organisms
On the basis of
Nature
Natural
Artificial
Size
Micro ecosystem
Macro ecosystem
Duration
Temporary
Permanent
Abiotic (Non-living)
Inorganic substances
Organic substances
Climatic factors
Biotic (Living)
Food chain (Sequencial interlinking of organisms involving food transfer at different trophic levels)
Food web (Network formed by inter-connected food chains)
Producers (First trophic level)
Herbivores (Second trophic level)
Carnivores (Third trophic level)
Decomposers
Human interference
Environmental problems
Environmental pollution
Ozone layer depletion
Solid waste management
Undesirable change in physical, biological or chemical characteristics of environment.
Thinning of ozone layer which protects earth from harmful UV rays.
Solid waste can be disposed off by the following methods:
(i) Landfilling
(ii) Composting
(iii) Pyrolysis
(iv) Incineration.

ESSENTIAL POINTS For COMPETITIVE EXAMS

TYPES OF FOOD CHAINS

- Two types of food chains are found depending upon the first trophic level, (i) Grazing food chains and (ii) Detritus food chains.

Grazing food chains

- These are directly dependent upon solar radiations as the primary source of energy.
- Green plants (or producers) form the first trophic level of the food chain. They synthesize their food by the process of photosynthesis.
- Herbivores or primary consumers eat upon the producers and form the second trophic level.
- Herbivores are eaten by carnivores of different categories.
- These are longer food chains.
- They always end at decomposer level.

Detritus food chains

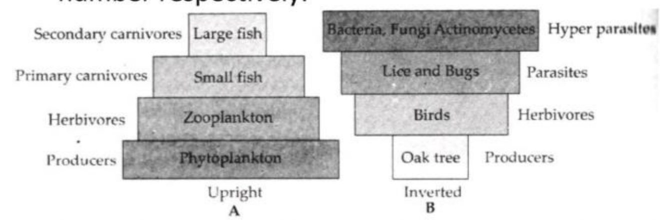
- Primary energy source of detritus food chains is dead organic matter called detritus.
- Main sources of dead organic matter are fallen leaves or dead animal bodies.
- Primary consumers are detritivores (detritus eating). These include protozoans, bacteria, fungi etc.
- The detritivores are eaten by secondary consumers which include insect larvae, etc.
- They are shorter than grazing food chains.

ECOLOGICAL PYRAMIDS

- Idea of ecological pyramids was developed by **Charles Eiton** (1927). Thus ecological pyramids are often called as **Estonian pyramids.**
- An **ecological pyramid may be defined** as **a graphic representation of an ecological** parameter (numbers or biomass or amount of accumulated energy) at different trophic levels in a food chain in an ecosystem.
- On the basis of ecological parameters, ecological pyramids are of three types.

Pyramid of numbers

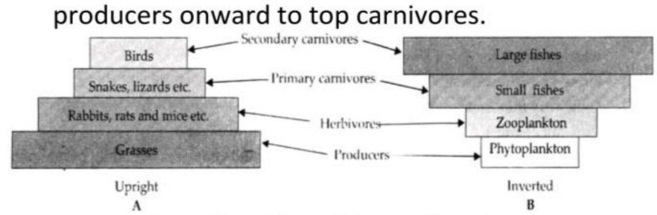
- A pyramid of numbers is the graphic representation depicting the arrangement of number of individuals of different trophic levels in a food chain in an ecosystem.
- The shape of pyramids of numbers may be **upright** *(e.g.,* in pond ecosystem and in grassland ecosystem) or **inverted** *(e.g.,* in parasitic food chain) depending upon whether Producer individuals are greater in number or lesser in number respectively.



- In upright pyramid of numbers, the number of organisms decrease from producer level to top carnivore level. On the contrary, in inverted pyramid of numbers, single oak tree (producer) supports a large number of herbivorous birds which, in turn, support a still larger number of parasites like lice and bugs Hyperparasites *(e.g.,* bacteria, fungi) are the greatest in number in this inverted pyramid of numbers.

Pyramid of biomass

- A pyramid of biomass is the graphic representation of biomass (total amount of living or organic matter in an. ecosystem at any time) per unit area in different trophic levels.
- Pyramid of biomass may also be upright *(e.g.,* in a grassland ecosystem) or **inverted** *(e.g.,* in a pond ecosystem) depending upon whether the biomass of organisms gradually decreases or gradually increases at successive trophic levels from producers onward to top carnivores.

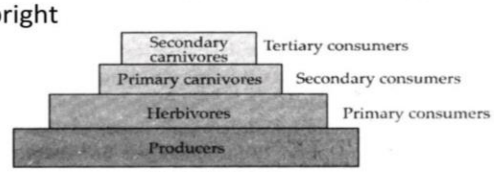


Pyramids of biomass (A) in a grassland ecosystem (B) in a pond ecosystem.

Pyramid of Energy

- A pyramid of energy is a graphic representation of amount of energy per unit area at different trophic levels of a food chain in an ecosystem.
- The available energy is the highest at producer level. According to second law of thermodynamics, there is gradual decrease in available energy at successive trophic levels,

Therefore, the pyramid of energy is always upright



Pyramid of energy.

Bio magnifications of Toxins

- **Bio magnifications,** also **called** biological concentration or biological amplification, is **characterized** by the increase in amount of nonbiodegradabie substances in. successive trophic levels **of** a food chain.

- **Pesticides** are the chemicals used to kill the plant and animal pests. These include bactericides, fungicides, nematicides, insecticides, rodenticides and herbicides (or weedicides). These are collectively called biocides. Most biocides are non-biodegradable and toxicants. These biocides show bio magnification. Some of the most toxic biocides are: DDT (Dichloro diphenyl trichloroethane), **BHC** (Benzene hexachloride), **chlordane,** heptachlor, methoxychlor, aldrin, **endrin** and **PCBs** (Polychlorinated biphenyls). Indiscriminate use of biocides could result in bio magnification.

Harmful effects of bio magnification

- **DDT** interferes with the egg-shell formation in many birds. The shells remain thin and break by bird's weight during incubation. **Dieldrin** is about 5 times more toxic than DDT when ingested and 40 times more poisonous when absorbed.

- The chlorinated hydrocarbons are known to affect CNS (central nervous system), cause softening of brain, cerebral haemorrhage, cirrhosis of liver, hypertension, cancer, malformation of sex hormones, etc.
- Bio magnification of mercury into fish through the food chain was responsible for large number of deaths due to **Minamata disease** in Japan.

- **Selenium** accumulates in the plants growing on selenium-rich soils. Through food chain, such plants cause stunted growth, loss of appetite, gastro-intestinal disorders, etc. in the animals grazing on such plants.

CLIMATE CHANGE

- Climate refers to the physical environmental factors of an area. These physical factors include duration and quantity of light, temperature, humidity, wind, gases, water, etc. Such conditions which average for about 30 years is called **climate.** While daily conditions of these factors are termed weather. Usually climatic conditions of a particular region are characteristic of, it and show very minor variations. But due to drastic effects of human activities, gradually, climate is showing changes e.g., increase in average temperature of earth.
- **These changes in the physical environmental factors of an area over long period of time** are **collectively called climatic change** which may adversely affect the agriculture, migration of animals, hydrological cycle, thermal gradient between the poles and equator, wind pattern, distribution of rainfall, etc.

Causes of Climate Change

- Main culprit of such climatic change is man himself. **Anthropogenic (man-made) activities** are mainly responsible for upsetting the delicate balance between the various components of the environment.
- These climate affecting activities of man include: population explosion, rapid industrialization, ubranization, unjudicious use of fossil fuels, deforestation, biomass burning, increased use of automobiles, jet-aeroplanes, etc.
- These activities release greenhouse gases like CO_2, methane, N_2O and chlorofluorocarbons (CFCs), etc. in the atmosphere and cause increase in the average global temperature. It is estimated that earth's temperature is increasing at the rate of 0.5 to 1°C for every 100-200 years.

GLOBAL WARMING

- The average global temperature is 15°C which is maintained due to presence of certain gases like CO_2 methane, water vapour, nitrous oxide and chlorofluorocarbons present in the troposphere (lowermost zone of atmosphere). These gases are collectively called heat-trapping or **greenhouse** gases **(GHGs).**
- Earth's temperature is maintained by absorption of **reradiated infra-red (heat) radiations from the earth surface by these GHGs which prevent the heat from escaping to outer space,** so GHGs are

functionally comparable to glass panels of a greenhouse which keep CO_2 concentration higher and so higher temperature inside the greenhouse. So this effect is called **greenhouse effect.** These GHGs contribute to the average global temperature of 15°C as in their absence, average global temperature would have been as low as -18°C.

- But due to human activities, the levels of GHGs increase which in turn increases the earth's temperature. This temperature increase results in **global warming.**

Relative contribution of different GHGs to global warming

(i) Carbon dioxide: Main sources of CO_2 are combustion of fossil fuels like coal, oil, etc. (about 67%) in the homes and factories; process of respiration, volcanic activities; deforestation; etc. It is estimated that more than 18 billion tonnes of CO_2 is produced annually from the fossil fuels It contributes about 60% of global warming. It has increased from 280 ppm (in 1750 A.D.) to 368 ppm level in 2000 A.D. and if this trend continues, it may increase to a level between 540 and 970 ppm by the end of 21st century.

(ii) Chlorofluorocarbons (CFCs): Main sources of CFCs are refrigerators and air conditioners, plastic foams, aerosols (chemicals present in air as fine liquid droplets) emitted in jet emission, etc. These are responsible **for** 14% of **global** warming. CFCs are mainly responsible for ozone depletion.

(iii) Methane: About 40% of methane is produced from swamps, wetlands, paddy fields, guts of lives tocks like sheep, buffaloes, etc. and burning of biomass, during production and use of petroleum oil. It is responsible for about 20% of global warming.

(iv) Nitrous oxide (N_2O): Its main sources are nylon products, burning of coal, breakdown of nitrogen fertilizers in soil, etc. It is responsible for about 6% of global warming.

Harmful effects of global warming

(i) Rise in sea level: Global warming will melt the polar ice caps. It is estimated that if all the ice on the earth melts, about 200 feet of water would be added to the surface of all oceans. Satellite pictures have shown that the polar ice has been shrinking by 10 per cent per decade since 1980.

Due to global warming, **India-Khumbu glacier of** Mt. Everest has retreated by 5 km since 1953 while sea ice cover of Arctic ocean has declined by 6% from 1978 to 1995. It is estimated that an increase of only 3°C atmospheric temperature may rise sea level by 0.2 - 1.5 meters over the next 50 -100 years. This **may inundate** low **lying coastal cities** like Shanghai, Bangkok, Dhaka, Venice, San Francisco, Cairo, Sydney, etc. In India, this effect may also threaten the inundation of Lakshadweep islands, Mumbai and deltas of Ganges (West Bengal), Kaveri (Tamil Nadu), Godavari (Andhra Pradesh) and Mahanadi (Orissa).

(ii) Increase in global temperature: It is estimated that if the present input trend of GHGs continued, then earth's mean global temperature will rise.

A report has predicted that global warming would be faster during the 21st century and average global temperature would be 5.5°C higher by 2100 A.D.

(iii) Ecological disturbance: Due to global warming:

(a) North America will be warmer and drier while North Africa, India, W. Australia and Mexico will be warmer and wetter. Worst drought of 2001 in Kenya which affected about 4 million people was due to global warming.

(b) Deserts are likely to crease.

(c) Chances of hurricanes, cyclones and floods will be more which will damage the lagoons, estuaries and coral reefs.

These ecological disturbances due to global warming may cause extinction of more than one million species of animals and plants by 2050 A.D.

(iv) Effect on agriculture: The response of plants to elevated concentrations of CO_2 is called Carbon **dioxide fertilization effect.** It is estimated that with increase in C_2O, concentration, some plants will show increased photosynthesis, reduced transpiration, more water-use efficiency, greater root production, increased nitrogen-fixation in the root nodules, etc. which may increase the growth of plants by about 30 per cent. But all these beneficial effects will be negated by the ill effects on most of plants by: increased evaporation, decreased soil moisture, increased pest growth, etc. which may adversely affect the wheat and maize production.

(v) **Effect on human health:** Increased temperature and humidity caused by global warming will increase the chances of spread of vectors of a number of human diseases like malaria, filariasis schistosomiasis etc. These climatic changes will also increase the incidence of respiratory and skin diseases in human beings.

- Keeping in view these ill-effects of global warming, UNEP (United Nations Environmental Programme) chose the following slogan in 1989.

Global warming: Global warning

- Since 1989, **"5th June"** is celebrated as **"World Environment Day".**

Measures to check global warming

(i) **Control of population growth** by decreasing the birth rate.
(ii) **A forestation** (planting more trees on new areas).
(iii) Deforestation reversal by reforestation.
(vi) **Reduction** in the use of **chlorofluorocarbons.**
(v) To trap and use **methane as a fuel.**
(vii) Shift from **coal to natural gas** or electricity as energy source.
(vii) More use of **non-conventional sources of energy** like nuclear energy, wind power and solar energy.
(viii) Automobiles should be made more fuel efficient and less taxing on the environment.
(ix) Reduction in atmospheric carbon dioxide concentration with the help of algal growth.
(x) Some international initiatives for mitigating global climate change have been taken, such as:
– **Montreal Protocol:** In 1987, 27 industrialized countries signed this protocol to stabilize the atmospheric concentrations of GHGs. In this landmark international agreement, these countries agreed to limit the production and use of ozone depleting substances, phasing out of ozone depleting substances and helping the developing countries to implement use of alternatives of CFCs.
– **First Earth Summit:** The United Nations Conference on Environment and Development (UNCED) held its first Earth Summit at Rio de Janeiro, Brazil in **1992.** This summit established the principles for reducing greenhouse gas emission.
– **Conference of Parties (COP)** are being organized.
COP-I was held at **Berlin** (Germany).
COP-II was held at **Geneva** (Switzerland) in July 1996.
COP-III was held at **Kyoto** (one of Japan's least polluted cities) in December, 1997. The Kyoto protocol requires that the European nations will reduce their **greenhouse emission** by 8 per **cent** below the 1990 level, the **United States** by 7 **per cent and Japan by 6 per cent** by the commitment period **2008 and 2012.**
COP-IV to be held at Hague in November 2000 was suspended and was later held at Bonn (Germany) in July 2001.

ACID RAIN

When the rain water contains large quantities of acids like nitric acid and sulphuric acid formed by dissolution of oxides of nitrogen and sulphur in water it is called as acid rain.

Two forms of acid deposition

(i) Wet deposition: It is formed of acidic water received on soil through rain, fog and snow

(ii) Dry deposition: It is formed of wind-blown acidic gases and particles in the atmosphere which fall on ground with rain water.
About half of acidity in the atmosphere comes to earth through dry deposition. On moist surface of soil, these gases dissolve in water and form acids as in the acid rain.

Composition of acid rain

- Acid rain consists 60-70% of oxides of sulphur *(e.g.,* SO_2 and SO_3) and 30-40% of oxides of nitrogen *(e.g.,* NO_2, and NO_3). Oxides of nitrogen are produced due to combustion process of fossil fuels at high temperatures in industries, automobiles, nitrogen fertilizer plants; while oxides of sulphur are mainly produced due to burning of coal, ore-smelters and oil refineries.
- A study has shown that main sources of oxides of sulphur are volcanoes (67%), industries (22%), vehicles and forest fires. Presence of acids in the rain water lowers its pH value. Rainfall pH value has been estimated to be in between 5.6 to 6.5 in Bangalore, Delhi, Nagpur and Pune. Average pH in rainfall over eastern United States during 1979-1980 was less than 5.0.

Harmful effects of acid rain

- Acid rain damages a number of heritage monuments like **Statue of Liberty** of New York and **Taj** Mahal of Agra. Due to acid rain, marble of Taj is changing to magnesium sulphate.
- Acid rain below 5 pH causes **death of planktons, molluscs** and **fish** in the aquatic systems so disturbs the food chains. It also causes reproductive failure in the fish.
- Acid rain also **kills the useful soil microbial community** so disturbing the terrestrial ecosystems.
- Acid rain also **damages the foliage** so decreasing the growth and yield of the plants.
- Trees become **more susceptible** to diseases, low temperature, drought, pathogens, etc.

Control of acid rain

- **Cleaning systems** can be fitted into the industrial chimneys to remove harmful gases.
- Use of **sulphur-free** or low sulphur petroleum in the automobiles.

Polymer coating of the pipes supplying the drinking water.