GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

ENVIRONMENT DEFINITION: It is defined as the sum total of water, air, and the inter-relationship that exists among them and with the human beings, other living organisms and materials.

SCOPE: As a subject it has a wide scope. It encompasses a large number of areas and aspects, which may be summarized as follows

1. Natural resources
2. Ecology and biodiversity
3. Environmental pollution and control
4. Social issues in relation to development and environment
5. Human population and environment

Career Options:

1. Research and development in environment
2. Green Advocacy
3. Green marketing
4. Green Media
5. Environmental Consultancy

Importance:

Whatever be the occupation or age of a person, he will be affected by environment and also he will affect the environment by his deeds. To mark some important aspect or issue of environment we internationally observe international calendar

1. World wetland day Feb 2
2. World forest day March 21
3. Earth day April 22
4. Ozone week Sept 16-23
5. Anti-tobacco day May 31

Global vs local Nature of Environment.

Issues like global warming, Depletion of ozone layer, dwindling forests and energy resources, loss of global biodiversity etc. which are going to affect the mankind as a whole are global in nature and for that we have to think and plan globally.

Some issues have localized importance. E.g. impact of mining or hydro-electric project in an area, problems of disposal, management of solid wastes and river or lake pollution.

Individualistic Nature of Environment:

Environmental Studies is very important since it deals with the most mundane problems of life where each individual matters, like dealing with safe and clean drinking water, hygienic living conditions, Clean

and fresh air, fertile land, healthy food and sustainable development.

IMPORTANCE OF RISK AND HAZARDS: **(Chemical, Physical & Biological Hazards.)**

Risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss.

For example: The risk of developing cancer from smoking cigarettes could be expressed as "cigarette smokers are 12 times (for example) more likely to die of lung cancer than non-smokers". Another way of reporting risk is "a certain number, "Y", of smokers per 100,000 smokers will likely develop lung cancer" (depending on their age and how many years they have been smoking). These risks are expressed as a probability or likelihood of developing a disease or getting injured, whereas hazards refer to the possible consequences (e.g., lung cancer, emphysema and heart disease from cigarette smoking).

Factors that influence the degree of risk include:

1. how much a person is exposed to a hazardous thing or condition,
2. how the person is exposed (e.g., breathing in a vapour, skin contact), and
3. how severe are the effects under the conditions of exposure.

An **environmental hazard** is any condition, process or state adversely affecting the environment. Environmental hazard manifest as physical or chemical pollution in air, water and soils. Environmental hazard can cause wide spread harm to humans and the physical environment.

Three specific examples are:

1. lead, an element historically used in many products causing neurological problems
2. PCBs, or polychlorinated biphenyls, a group of nearly indestructible molecules with cancer-causing properties
3. Asbestos, a widely used flame retardant which leads to cancers with long latency periods.

TYPES OF HAZARDS:

Chemical hazard: depends on physical, chemical and toxic property of the chemicals.

Biological Hazard: bacteria, Virus, insects, plants, birds and animals

Physical hazard: Radiation, Magnetic field, pressure extreme (vacuum), noise.

CONCEPT OF AN ECOSYSTEM:

ECOSYSTEM:

An ecosystem is a natural unit consisting of all plants, animals and micro organisms in an area functioning together with all the non living physical factors of the environment. The term ecosystem has emanated from a Greek word meaning study of home.

Definition: A group of organisms interacting among them and with the environment is known as an ecosystem. Thus, an ecosystem is a community of different species interacting with one another and with

their non-living environment exchanging energy and matter.

Ecology is the study of interactions among organisms or group of organisms with their environment. The environment consists of both biotic components (living organisms) and abiotic components (non-living organisms). Or Ecology is the study of ecosystem. Ecosystem is the basic functional unit of ecology. A group of organisms interacting among themselves and with environment is known as ecosystem. Thus an ecosystem is a community of different species interacting with one another and with their non-living environment exchanging energy and matter.

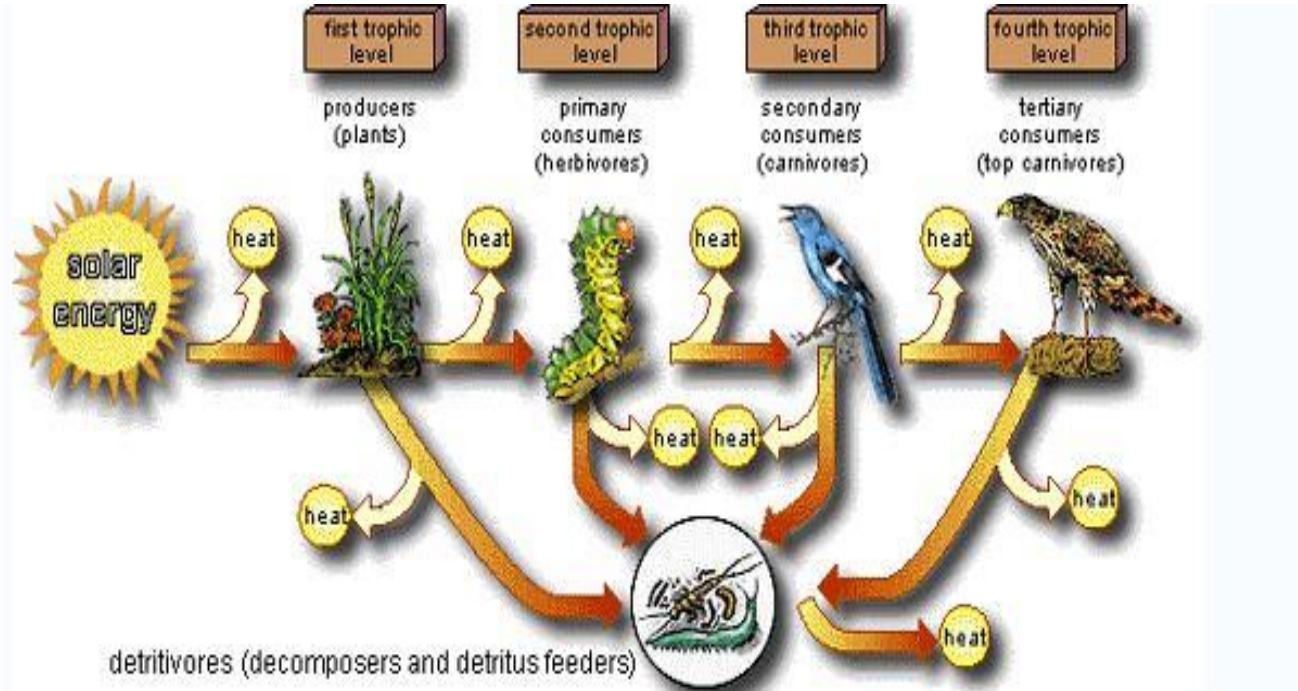
All living organisms, whether, plant or animal or human being is surrounded by the environment, from which it derives its needs for its survival. Each living component interacts with non-living components for their basic requirements from different eco systems.

STRUCTURE AND FUNCTION OF AN ECOSYSTEM:

STRUCTURAL FEATURES OF THE ENVIRONMENT:
There are three major and important components comprising the environment.

1. Biotic or living component &
    a) Producers
    b) Consumers
        I. Herbivores (Plant eaters) / Primary Conumers
        II. Carnivores (Meat Eaters) / Secondary Consumers
        III. Omnivores / tertiary consumers
        IV. Detritivores (Detritus Feeders or Saprotrophs)
    c) Decomposers

2. Abiotic or non-living component;
    a. Physical factors
    b. Chemical factors



Biotic Component

1. Producers: Organisms, such as plants, that produce their own food are called autotrophs. The autotrophs convert inorganic compounds into organic compounds. They are called producers because all species of the ecosystem depend on them.

2. Consumers: All the organisms that cannot make their own food (and need producers) are called heterotrophs. In an ecosystem heterotrophs are called consumers because they depend on others. They obtain food by eating other organisms. There are different levels of consumers as Primary, Secondary and Tertiary Consumer.

Those that feed directly from producers, i.e. organisms that eat plant or plant products are called *primary consumers*. In the figure above the grasshopper is a primary consumer.

Organisms that feed on primary consumers are called *secondary consumers*. Those who feed on secondary consumers are tertiary consumers. In the figure above the snake acts as a secondary consumer and the hawk as a tertiary consumer. Some organisms, like the squirrel are at different levels. When the squirrel eats acorns or fruits (which are plant product), it is a primary consumer; however, when it eats insects or nestling birds, is it is a *tertiary consumer*.

Depending on what they eat they are classified as Herbivores, Carnivores and Omnivores and detritivores.

a. Herbivores are those that eat only plants or plant products. Examples are grasshoppers, mice, rabbits, deer, beavers, moose, cows, sheep, goats and groundhogs.

b. Carnivores, on the other hand, are those that eat only other animals. Examples of carnivores are foxes, frogs, snakes, hawks, and spiders.

c. Omnivores are the last type and eat both plants (acting a primary consumers) and meat (acting as secondary or tertiary consumers). Examples of omnivores are:

- Bears --They eat insects, fish, moose, elk, deer, sheep as well as honey, grass, and sedges.
- Turtles -- They eat snails, crayfish, crickets, earthworms, but also lettuce, small plants, and algae.
- Monkeys -- They eat frogs and lizards as well as fruits, flowers, and leaves.
- Squirrels -- They eat insects, moths, bird eggs and nestling birds and also seeds, fruits, acorns, and nuts.

d. Detritivores (Detritus feeders or saprotrophs): They feed on the parts of dead organisms, wastes of living organism, their cast-offs and partially decomposed matter. E.g beetles, termites ants crabs, eartworms etc

3. Decomposers (various bacteria and fungi): They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and ultimately into organic compounds and ultimately into inorganic nutrients.

Abiotic Component:

The physical and chemical components of an ecosystem constitute its abiotic structure. It includes climatic factors, edaphic (soil) factors, energy, nutrients, and toxic substances.

A. Physical Factors

The sunlight and shade, intensity of solar flux, duration of sun hours, average temperature, maximum-minimum temperature, annual rainfall, wind, latitude, Altitude, Soil type, Water availability, Water currents etc. are some of the important physical features which have strong influence on the ecosystem.

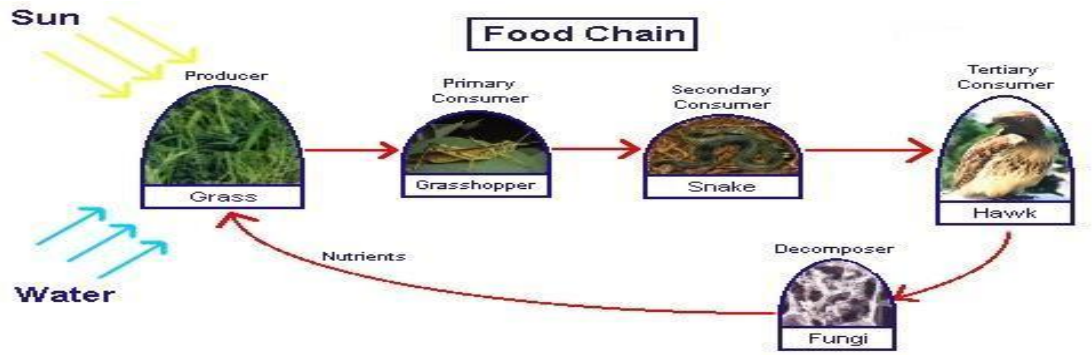
B. Chemical factors
Availability of major essential nutrients like carbon, nitrogen, phosphorus, potassium, hydrogen, oxygen and sulphur, level of toxic substances, salinity and various organic components present in the soil or water largely influence the functioning of the ecosystem.

FUNCTIONAL ATTRIBUTES.

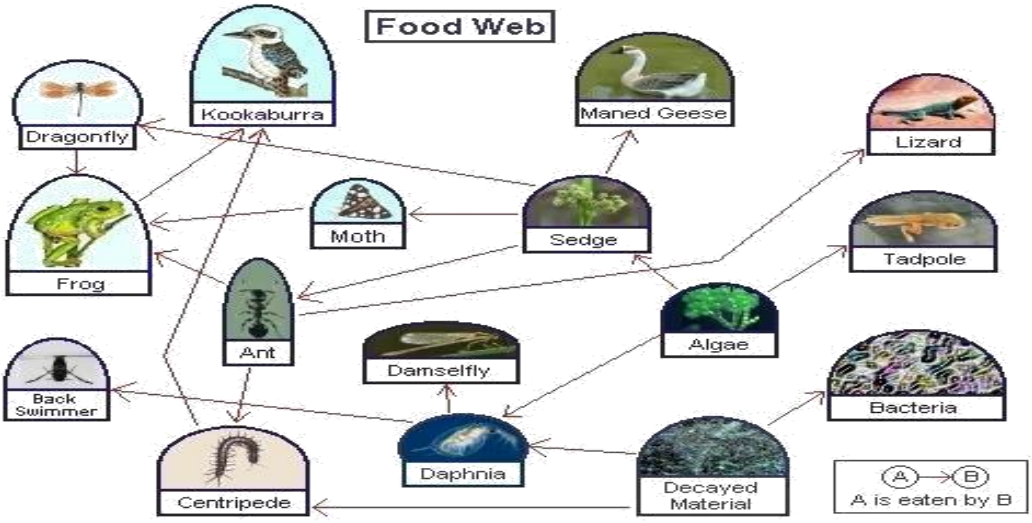
- Food chain, Food web and trophic structure
- Energy Flow
- Cycling Of Nutrients
- Primary and secondary production
- Ecosystem development and regulation

Food chain: The sequence of eating and being eaten in an echo system is known as food chain. 'Transfer of food energy from the plants through a series of organisms is referred to as food chain' is another definition. These food chains are present in a grass land, in a pond, in a forest ecosystem etc.

Here is a figure showing one such food and energy chain in Grassland ecosystem:



Food Webs: In looking at the previous picture, the concept of food chain looks very simple, but in reality it is more complex. Think about it. How many different animals eat grass? And from the Facts about Red-tailed Hawks page, how many different foods does the hawk eat? One doesn't find simple independent food chains in an ecosystem, but many interdependent and complex food chains that look more like a web and are therefore called food webs. A food web that shows the energy transformations in an ecosystem looks like this:



SIGNIFICANCE OF FOOD CHAINS AND FOOD WEB:

a) Energy flow and nutrient cycling take place through them
b) Maintains the ecological balance
c) It has the unique property of Biological Magnification.

Biological magnification: Several pesticides and heavy metals are non bio-degradable and are not decomposed by micro organism and they move from one trophic level to another. At each level they keep increasing in concentration known as biomagnifications or biological magnification

CHARACTERISTICS OF FOOD CHAINS AND FOOD WEBS:

- Ecosystem is the major ecological unit.
- It contains both biotic and abiotic components.
- Through the biotic and abiotic components nutrient cycle and energy flow occur.
- The boundary of the ecosystem is not rigidly defined and it is flexible.
- The function of ecosystem is related to the cycling of materials and flow of energy.

NUTRIENT CYCLING:

Nutrients like carbon, nitrogen, sulphur, oxygen, hydrogen, phosphorus etc. move in circular path through biotic and abiotic components and are therefore known as **biogeochemical cycle.**

1. Oxygen Cycle
2. Nitrgen Cycle

1. Oxygen Cycle:

- Exchange of O_2 between the lithosphere and atmosphere and hydrosphere is known as the

oxygen cycle.

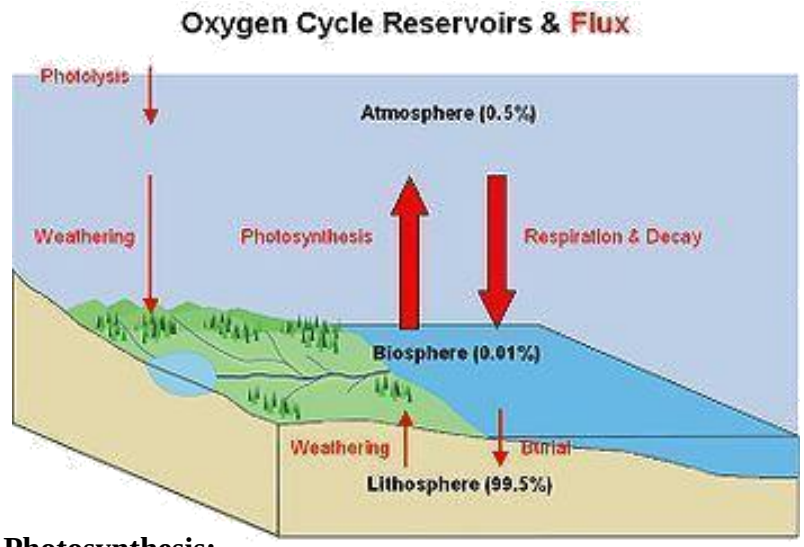
- *Transpiration* is the process by which plants take CO_2 and give out oxygen. This oxygen is released to the atmosphere. The atmosphere contains 21% of Oxygen. Man then takes in O_2 from the environment by respiration
- Water is made up of O_2 and Hydrogen. Rain is precipitated from clouds.

The oxygen cycle is the biogeochemical cycle that describes the movement of oxygen within its three main reservoirs: the atmosphere (air), the total content of biological matter within the biosphere (the global sum of all ecosystems), and the lithosphere (Earth's crust). Failures in the oxygen cycle within the hydrosphere (the combined mass of water found on, under, and over the surface of planet Earth) can result in the development of hypoxic zones.

The main driving factor of the oxygen cycle is ***photosynthesis*** and sometimes through ***Photolysis*** atmospheric oxygen is created when sun reacts with the watervapour.

Almost all living things need oxygen. They use this oxygen during the process of creating energy in living cells.
Oxygen is used for the decomposition of dead animals.
The process of rusting, also called oxidation, occurs when oxygen combines with metal.

Fire is a chemical reaction that involves Oxygen.



a.Photosynthesis:

Plants mark the beginning of the oxygen cycle. Plants are able to use the energy of sunlight to convert carbon dioxide and water into carbohydrates and oxygen in a process called photosynthesis.

$$O_2 + \text{carbohydrates} \rightarrow CO_2 + H_2O + \text{energy}$$

This means that plants "breathe" in carbon dioxide and "breathe" out oxygen. So oxygen is created in plants and used up by animals, as is shown in the picture above. But the oxygen cycle is not actually quite that simple. Plants must break carbohydrates down into energy just as animals do. During the day, plants hold onto a bit of the oxygen which they produced in photosynthesis and use that oxygen to break down carbohydrates. But in order to maintain their metabolism and continue respiration at night, the plants must absorb oxygen from the air and give off carbon dioxide just as animals do. Even though plants produce approximately ten times as much oxygen during the day as they consume at night, the night-time consumption of oxygen by plants can create low oxygen conditions in some water habitats.

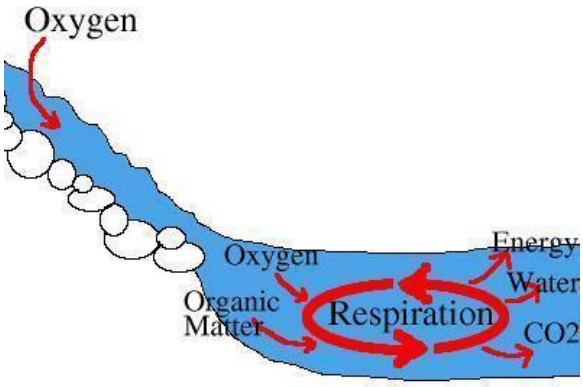
b.**Animals** form the other half of the oxygen cycle. We breathe in oxygen which we use to break carbohydrates down into energy in a process called respiration.

O_2 + carbohydrates → CO_2 + H_2O + energy

Carbon dioxide produced during respiration is breathed out by animals into the air.

c.Oxygen in Water:

Oxygen in water is known as dissolved oxygen or DO. In nature, oxygen enters ater when water runs over rocks and creates tremendous amounts of surface area. The high surface area allows oxygen to transfer from the air into the water
very quickly.



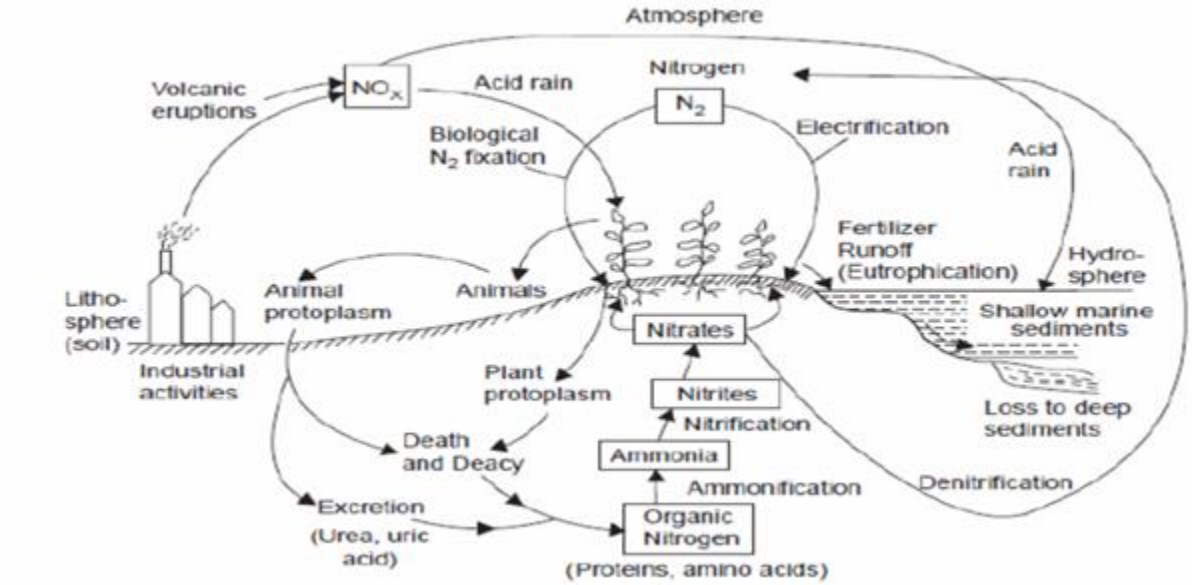
When the water in a stream enters a pond, microorganisms in the pond begin to metabolize (break down) organic matter, consuming oxygen in the process. This is another form of oxygen cycle - oxygen enters water in rapids and leaves water in pools.

Oxygen uptake rate (O.U.R.) is the rate at which oxygen is consumed by living organisms in the water. Since organisms are constantly using up oxygen in the water and oxygen is constantly reentering the water from the air, the amount of oxygen in water remains relatively constant. In a healthy ecosystem, the rates of oxygen transfer (being used up) and oxygen uptake are balanced in the water.

2.Nitrogen cycle:

- The exchange of nitrogen between the lithosphere and atmosphere is nitrogen cycle.
- Free nitrogen from atmosphere is taken up by plants as nitrates
- These nitrates are denitrified to ammonia by anaerobic bacteria – *denitrification*
- Nitrosomonas converts ammonia to nitrites.
- Nitrobacter converts nitrites to nitrates. This processes is called nitrification
- Rhizobium is the N_2 fixing bacteria present in the roots.

Nitrogen is present in the atmosphere as N_2 in large amount (78%) and it is fixed either by the physical process of lightening or biologically but some bacteria and/or cyanobacteria (blue green algae). The nitrogen is taken by the plants and used in metabolism for biosynthesis of amino acids, proteins, vitamins etc. and passes through the food chain. After death of the plants and animals, the organic nitrogen in dead tissues is decomposed by several groups of ammonifying and nitrifying bacteria which convert them into ammonia, nitrites and nitrates, which are again used by plants. Some bacteria convert nitrates, into molecular nitrogen or N_2 which is released back into the atmosphere and cycle goes on.



ENERGY FLOW IN THE ECOSYSTEM:

Ist law of thermodynamics states that energy can neither be created nor be destroyed but it can be transformed from one form to another.

IInd law of thermodynamics states that energy dissipates as it is used or in other words, it gets converted from a more concentrated to dispersed form.

In an ecosystem, plants capture the sun's energy and use it to convert inorganic compounds into energy-rich organic compounds [1]. This process of using the sun's energy to convert minerals (such as magnesium or nitrogen) in the soil into green leaves, or carrots, or strawberries, is called photosynthesis.

Photosynthesis is only the beginning of a chain of energy conversions. There are many types of animals that will eat the products of the photosynthesis process. Examples are deer eating shrub leaves, rabbits eating carrots, or worms eating grass. When these animals eat these plant products, food energy and organic compounds are transferred from the plants to the animals. These animals are in turn eaten by other animals, again transferring energy and organic compounds from one animal to another. Examples would be lions eating deer, foxes eating rabbits, or birds eating worms.

This chain of energy transferring from one species to another can continue several more times, but it eventually ends. It ends with the dead animals that are broken down and used as food or nutrition by bacteria and fungi. As these organisms, referred to as **decomposers**, feed from the dead animals, they break down the complex organic compounds into simple nutrients. Decomposers play a very important role in this world because they take care of breaking down (cleaning) many dead material. There are more than 100,000 different types of decomposer organisms! These simpler nutrients are returned to the soil and can be used again by the plants. The energy transformation chain starts all over again.

ECOLGICAL SUCCESSION PROCESSES:

Ecological succession: In an area one community may be replaced by another community or by a series of communities. Thus the progressive replacement of one community by another community till the development of stable community in a particular area is called ecological succession.

The first group of organism, which establishes their community in the area is called 'Pioneer' community. The various developmental stages of a community is called 'seres'. The group of plants or animals living in an area is called a community.

There are two types of ecological succession recognized by ecologists, based on the conditions present at the beginning of the process. Primary succession: It involves the gradual establishment of biotic communities on a lifeless ground. [Hydrarch or Hydrosere: Establishment starts in a watery area like pond and lake; Xerarch or Xerosere: Establishment starts in a dry area like, desert and rock.] Secondary succession: It involves the establishment of biotic communities in an area, where some type of biotic community is already present.

The different steps in the process of ecological succession are:

1. Nudation – Development of bare area without any life form. The bare area may be caused due to landslides, volcanic eruption, etc(topographic factor) or due to drought glaciers(climatic factor) or due to over grazing, disease outbreak(Biotic factors).

2. Invasion – establishment of one or more species on a bare area through migration (migration of seeds is brought about by wind, water or birds) followed by establishment (Seeds after migration germinate and grow on the land and establishes their pioneer communities).

3. Competition and coaction– as the number of individual species grows, there is a competition with the same species and between different species for space, water and nutrients,

4. Reaction – Living organisms take water, nutrients and grow and modify the environment and it is known as reaction. Reaction may not suit the existing species but may favour new species which replace the existing species leading to seral communities,

5. Stabilizations – it leads to stable community, which is in equilibrium with the environment.

Biodiversity is the richness & varied species of different organisms contained in a particular ecosystem – Indian biodiversity is highly diverse and rich such that there are various hot spots. However there are numerous threats to our Biodiversity.

INTRODUCTION, TYPES, CHARACTERISTIC FEATURE AND FUNCTION OF THE

1. FOREST ECOSYSTEM
2. GRASSLAND ECOSYSTEM
3. DESERT ECOSYSTEM
4. AQUATIC ECOSYSTEM **(ponds, streams, lakes, rivers, oceans, estuaries)**

1. FOREST ECOSYSTEM

A forest ecosystem is the one in which tall and dense trees grow to support many animals and birds. The forests are found in undisturbed areas receiving moderate to high rainfall. The forest occupies nearly 40% of the world's land area. In India it occupies only 19% of its total land area. Forests are habitats in which the trees are the dominant form of vegetation. They occur in many regions and climates around the globe—the tropical rainforests of the Amazon basin, the temperate forests of eastern North America, and the boreal forests of northern Europe are just a few examples.

The different types of forest eco system are:

1] **Tropical rain forests:** These are found near the equator and are characterized by high temperature. They have broad leafed trees like teak and sandal and the animals like lion, tiger and monkey.

Forest Structure: The species composition of a forest is often unique to that forest, with some forests consisting of many hundreds of species of trees while others consist of just a handful of species. Forests are constantly changing and progress through a series of succession stages during which species composition changes within the forest.

Mature forests often have several distinct vertical layers. These include:

- Forest floor
- Herb layer
- Shrub layer
- Understory
- Canopy
- Emergent

The **forest floor** is often blanketed with decaying leaves, twigs, fallen trees, animal scat, moss, and other detritus. The forest floor is where recycling occurs, fungi, insects, bacteria, and earthworms are among the many organisms that break down waste materials and ready them for reuse and recycling throughout the forest system.

The **herb layer** of the forest is dominated by herbaceous (or soft-stemmed) plants such as grasses, ferns, wildflowers, and other ground cover. Vegetation in the herb layer often gets little light and in forests with thick canopies, shade tolerant species are predominant in the herb layer.

The **shrub layer** is characterized by woody vegetation that grows relatively close to the ground. Bushes and brambles grown where enough light passes through the canopy to support shrub growth.

The **understory** of a forest consists of immature trees and small trees that are shorter than the main canopy level of the tree. Understory trees provide shelter for a wide range of animals. When gaps form in the canopy, often times understory trees take advantage of the opening and grow to fill in the canopy.

The **canopy** is the layer where the crowns of most of the forest's trees meet and form a thick layer. **Emergents** are trees whose crowns emerge above the rest of the canopy.

2] **Tropical deciduous forests**: These are found a little away from the equator and are characterized by a warm climate with rain only during monsoon. They have different types of deciduous trees like maple, oak and hickory and animals like deer, fox, rabbit and rat.

3] **Tropical scrub forests:** These are characterized by a dry climate for longer time. They have small deciduous trees and shrubs and animals like deer, fox etc.

4] **Temperate rain forests:** They are found in temperate areas with adequate rainfall. They are characterized by coniferous tees like pines, firs, red wood etc., and animals like squirrels, fox, cats, bear.

5] **Temperate deciduous forests:** These are found in areas with moderate temperatures. They have major trees including broad leaf deciduous trees like oak, hickory and animals like deer, fox, bear etc.

6] **Coniferous or Boreal Forest:**

Characteristics of Forest ecosystems:

1. Forests are characterized by warm temperature and adequate rainfall, which make thegeneration of number of ponds, lakes etc.

2. Forests maintain climate and rain fall,

3. Forests support many wild animals and protect biodiversity,

4. The forest soil is rich in organic matter and nutrients which support the growth of trees.

Since the penetration of light is so poor, the conversion of organic matter into nutrients is very fast

2. GRASSLAND ECOSYSTEM:

Grass land occupies about 20% of earth' surface. In addition to grass species which dominates Grass land ecosystem, some shrubs and trees are also present in grasslands. Limited grazing helps to improve the net primary production of the grasslands. Overgrazing leads to their degradation.

Types of Grassland ecosystems: (i) Tropical grasslands, (ii) Temperate grasslands & (iii) Polar grasslands

Tropical grass lands: Found near the borders of tropical rain forests are characterized by high temperature and moderate rainfall. (also known as Savanna type). They have tall grasses with scattered shrubs and shunted trees and animals like zebras, giraffes, antelopes etc.

During dry season, fires are quite common. It has zebras, giraffes, gazelle, antelopes,etc. The termites gather the detritus containing cellulose and build up a mound.

It has an efficient system of photosynthesis and carbon is assimilated by them in the form of carbohydratesin the rhizomes. Carbon dioxide which is responsible for global warming is released in huhe manner during grassland fire.

Temperate grass lands: Usually found in the centres of continents, on flat, sloped hills characterized by very cold winters and hot summers. Intense grazing and summer fires do not allow growth of shrubs and trees.

The soil is very fertile and so cleared vastly for agriculture. They are known by different names Priaries(US), pampas(south america), Velds(Africa), and steppes(Asia).

Polar grasslands: Found in arctic polar regions are characterized by severe cold and strong winds with ice and snow. In summer several small annual plants grow and inhabited by animals like arctic wolf, weasel, arctic fox etc.

A thick layer of ice remains frozen under the soil surface called as Permafrost. In summer shallow lakes appear where mosquitoes, insects and migratory birds live

Characteristics of grassland ecosystem: plain land occupied by grasses; Soil very rich in nutrients and organic matter; tall grass facilitates grazing of animals and low or uneven rain fall are encountered.

Structure and function of the grassland ecosystem:

I. Abiotic components: Nutrients, C. H, O, N, P, S etc. These abiotic components are supplied by CO_2, H_2O, nitrates, phosphates and sulphates.

II. Biotic components:

(1) Producers: Grasses, forbs and shrubs. (They produce food)

(2) Consumers (a) Primary consumers (herbivores): Cows, buffaloes, deer, sheep etc. They depend on grasses for food. (b) Secondary consumers (Carnivores) Snakes, lizards, birds, Jackals, fox etc. They feed on herbivores.(c) Tertiary consumers: Hawks, eagles, etc. The feed on secondary consumers.
(3) Decomposers: Fungi and bacteria. They decompose the dead organic matter.

3. DESERT ECOSYSTEM:

In this region evaporation exceeds precipitation. $1/3^{rd}$ of our worlds land is covered by deserts. The atmosphere is very dry and called as poor insulator. It has little species and drought resistant plants. Desert animals like reptiles and insects with thick outer covering live inside burrows where humidity is better.

a) Tropical deserts
b) Temperate deserts
c) Cold deserts

Tropical deserts (Sahara, Nambia, Thar desert) are driest of all and have few species. Wind blow and sand dunes are common.
Temperate deserts (Mojave in california) are very hot in summer and cool in winter.
Cold desert (Gobi desert in china) has cold winters and warm summers.

Desert Plants:

- It has scaly and succulent leaves to reduce water loss (transpiration) and to store water.
- Flat stems develop chlorophyll to increase photosynthesis.
- Leaves have waxy cuticle to prevent water loss from transpiration.

4. AQUATIC ECOSYSTEM

Aquatic Ecosystem: The aquatic ecosystem deals with water bodies. The major types of organisms found in aquatic environments are determined by the water salinity.Aquatic ecosystems are those ecosystems exist in the medium of water. Some of the aquatic ecosystems are : pond, lake, stream, river, wet land, estuary, sea and ocean ecosystems.

The characteristic features of aquatic ecosystems are as follows :

i) They may be lentic (ie, standing or non-flowing) or lotic (i.e flowing) systems.
ii) Aquatic food chains are inter linked with terrestrial food – chains.
iii) The medium contains moderate to less nutrients.
iv) Much of the solar energy is fixed in ecosystems, and
They are the reservoirs or exchange pools for hydrological cycle.

Lakes are large natural shallow water bodies and are used for various purposes. Lakes are supplied with water from rainfall, melting snow and streams.

A. POND ECOSYSTEM: A pond is a fresh water aquatic ecosystem, where is water is stagnant. It receives water during rainy season. It contains contains several types of algae, aquatic plants, insects, fishes and birds. Pond is temporary- only seasonal- stagnat fresh water body-gets polluted easily due to limited amount of water. Abiotic components: Temperature, light, water, inorganic and organic compounds. Biotic components: Green photosynthetic organisms – a) Phytoplanton-microscopic aquatic plants which float freely on water surface – algae, small floating plants likevolvox, pandorina, anabaena, cosmarium b) Mycrophytes- Large floating plants explain Consumers, and decomposers of pond eco system

B. LAKE ECOSYSTEM: Different types of Lakes are: Oligotrophic lake- having low nutrient concentrations, Eutrophic Lakes- over nourished by nutrients Nitrogen and Phosphorous, Dystrophic lakes- have low pH, high Humic acid content and brown waters, Volcanic lakes-receive water from magma afer volcanic eruptions, meromictic lakes- rich in salts, artificial lake4s – created due to dam constructions.

Different zones of lake: Depending upon their depth and distance from the shore lakes consist of four distinct zones. Littoral Zones – top layer of a lake having shallow water; Limnetic Zone-next to the littoral – effective penetration of solar light takes place; Profundal zone –The deep open water, where it is too dark and /benthic zone-found at lake bottom.

Characteristic features of lake ecosystem: It is a shallow fresh water body; a permanent water body with large water resources helping in irrigation and drinking

Structure and function of Lake Ecosystem:

I. Abiotic components: Temperature, light, proteins and lipids, turbidity, O_2 and CO_2.
II. Biotic components:
1. Producres: They are green plants, may be submerged, free floating and amphibious plants.
2. Consumers:(a) Primary consumers (Zooplanktons): Cilictes, protozoans etc. They feed on

phytoplankton

(b) Secondary consumers (carnivores): Insects and small fishes. They feed on Zooplankton.

(c) Large fishes like game fish. They feed on smaller fish

3. Decomposers: Bacteria, fungi and actinomycetes. They decompose dead plants and animals.

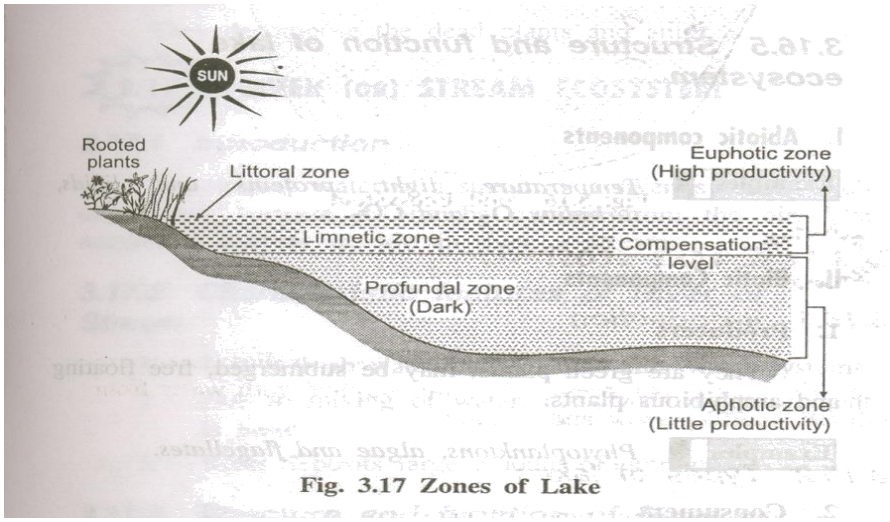


Fig. 3.17 Zones of Lake

C.STREAMS:

These are fresh water aquatic ecosystem where water current is a major controlling factor, oxygen and nutrient in the water is more uniform amd land water exchange is more expensive. Although stream organisms have to face more extremes of temperature and action of currents as compared to pond or lake organisms, but they do not have to face oxygen deficiency under natural conditions. This is because the streams are shallow, have a large surface exposed to air and constant motion which churns the water and provides abundant oxygen. Their dissolved oxygen level is higher than that of ponds even though the green plants are much less in number. The stream animals usually have a narrow range of tolerance to oxygen. Streams are worst victims of industrial Waste.

D.RIVER ECOSYSTEM:

Rivers are large streams that flow downward from mountain highlands and flowing through the plains fall into the sea. So the river ecosystems show a series of different conditions.

The Mountain Highland part has cold, clear waters rushing down as waterfalls with large amounts of dissolved oxygen. The plants are attached to rocks and fishes are cold water, high oxygen requiring fish like trouts.

In the second phase on the gentle slopes, the waters are warmer and support a luxuriant growth of plants and less oxygen requiring fishes.

In the third phase, the river waters are very rich in biotic diversity. Moving down the hills, rivers shape the land. They bring with them lots of silt rich in nutrients which are deposited in the plains and in the delta before reaching the ocean.

E.OCEAN ECOSYSTEM:

These are gigantic reservoirs of water covering more than 70% of our earth's surface and has 2, 50,000 marine species. Oceans provide us iron, magnesium, oil, Natural gas, sand and gravel. They are major sinks of carbon dioxide and play an important role in regulating biogeochemical cycles and hydrological cycle. The ocean has two major life zones,

1. Coastal Zone: It is relatively warm, nutrient rich shallow water. Due to high nutrients and sunlight , it is the zone of high primary producticvity.
2. Open Sea:it is the deeper part of the ocean, away from the continental shelf.It is vertically divided into 3 regions.
    I. Euphotic Zone-Abuntant sunlight and high photosysnthesis activity.
    II. Bathyal Zone- Dimlight and usually geologically active.
    III. Abyssal Zone – dark zone 2000 to 5000 meters deep. Has no primary source of energy(no sunlight). It is the world's largest ecological unit but it is an incomplete ecosystem.

F.ESTUARY ECOSYSTEM

An estuary is a partially enclosed coastal area at the mouth of a river where fresh water and salty seawater meet.these are transition zones which are strongly affected by tides. There are wide variations in the strean flow and tidal currents at any given location diurnally, monthly and seasonally. Therefore, the organisms present in estuaries show a wide range of tolerance to temperature and salinity. Such organisms are known as **eurythermal** and **euryhaline**. Coastal bays and tidal marshes are examples of estuaries. There are many migratory species of fishes like eels and salmons in which half of the life is spent in fresh water and half in salty water. Estuaries are highly productive ecosystems. They have rich biodiversity and many of the species are endemic.

INTRODUCTION TO BIODIVERSITY DEFINITION: GENETIC, SPECIES AND ECOSYSTEM DIVERSITY:

BIODIVERSITY DEFINITION: Bio means 'life' and diversity means 'variety', hence Biodiversity refers to variety of life on the earth. Planet earth (biosphere) contains more than 20 million species of organisms. They differ widely from one another. Diversification in the species is influenced by various physical and climatic factors, resulting in the production of new sub-species. Biodiversity is defined as, "the variety and variability among all groups of living organisms and the ecosystem in which they occur".

LEVELS OF BIODIVERSITY:

A. GENETIC BIODIVERSITY

The genes found in organisms can form enormous number of combinations each of which gives rise to some variability. When the genes within the same species show different versions due to new combinations, it is called genetic variability. For example rice belongs to the species oryza sativa which has many varieties that differ in size, shape, aroma etc.

B. SPECIES BIODIVERSITY

This is the variability found within the population of a species or between different species of a community. It broadly represents the species richness and their abundance in a community. Shannon Wiener index and Simpson index are two popular indices of measuring species diversity.

C. ECOSYSTEM BIODIVERSITY

This is the diversity of ecological complexity showing variations in ecological niches, trophic structure, food webs, nutrient cycling etc. The ecosystem also shows variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc.

BIOGEOGRAPHICAL CLASSIFICATION OF INDIA:

S. No	Biogeographic zone	Biotic province	Important Flora & Fauna
1	Trans-Himalayan	Upper region	Pine,deodar- Wild sheep,yak,tibetean ass,leopard,wolf
2	Himalayan	Nort west, west,central and East wimalayas	Pine, cork tree, sal,dhaak- Wild bear,sambar,leopard,Sikkim stag, musk deer
3	Desert	Kutch,thar and ladkh	Acacia, zizyphus, khejri, date palm- Camel, bastard, wild ass, desert cat,fox, rat
4	Semi-arid	Central india, Gujarat	Acacia, date palm, peepal - Gir lion, tiger, sariska and Rranthampore tiger
5	Western ghats	Malabar coast Western ghats mountain	Sheeshan, peepal, tuna, bahera- Tortoise, frog, lizards, snakes
6	Deccan peninsula	Deccan plateau	Acacia, palaash,tuna, pine, castor- Sambar, sloth bear, tiger, cheetal, four horned stag, wild elephant, wild buffalo
7	Gangetic plain	Upper and lower gangetic plain	Sal, acacia, jamun, mango, bael- black chinkara, stag, rhinoceros, gazzel, Alligator, turtle
8	North-east india	Brahmaputra valley	Bamboo, sal,jack fruit, tuna, Chestnut cator- Elephnat, Rhinocers, yak, deer, porcupine
9	Islands	Andaman islands, Nicobar islands & Lakshadeep islands	Bahera, Harar, jack fruit,cardamom, coconut, cloves- Dolphin, alligator, Molluscs

10	**coasts**	**West coast** **East coast**	**Coconut, Banana, cashew Nut – Dugong, Dolphin, Turtle, Alligator, Molluscs**

VALUE OF BIODIVERSITY: (consumptive use, productive use, social, ethical, aesthetic and option values)

1. ***CONSUMPTIVE USE VALUE***

- **Food:** A large number of wild plants are consumed by human beings as food. About 80,000 plants are from wild. About 90%of crops are domesticated from tropical forest
- **Drugs and medicine**: About 75% of population depends upon plant or plnt extracts for medicine. Penicillin antibiotic drug is derived from the fungus penicillium.
- **Fuel:** The fossil fuels coal, petroleum and natural gas are products of fossilized biodiversity.

2. ***PRODUCTIVE USE VALUE***

These are the commercially usable values where the product is marketed and sold. It may include lumber or wild gene resources that can be traded for use by scientist for introducing desirable traits in the crops and domesticated animals. It includes animal products like tusk of elephants, musk deer, silk from silk worm, wool from sheep, fur of many animals tc. Many industries like paper and pulp. Silk, textile, ivory works industry depend on them.

3. ***SOCIAL VALUE***

It is associated with social life, customs, religion and psycho-spiritual aspects of the people. Many plants are considered holy and sacred in our country like tulsi, peepal, Mango, Lotus, Bael etc. many animals like cow, snake, peacock, bull, owl etc also have significant place in social importance. The tribal people are very closely linked with the wildlife in the forest.

4. ***ETHICAL VALUE***

It is otherwise called existence value. It involves ethical issues like “al life must be preserved” and “live and let live” concept. For the survival of human race, all biodiversity has to be protected because biodiversity is valuable.

5. ***AESTHETIC VALUE***

People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco –tourism. The willingness to pay concept annually generates 12 billion revenue.

6. ***OPTION VALUE***

It is the value of knowing that there are biological resources existing on the biosphere that may one day prove to be an effective option for something important in the futureit suggests that any species may prove to ba miracle species someday.

7. ***ECOSYSTEM SERVICE VALUE***

It refers to the service provided by ecosystem services like prevention of soil erosion, prevention of floods, maintenance of soil fertility, cycling of nutrients, fixation of nitrogen, cycling of water, their role as carbon sinks, pollutant absorption and reduction of the threat of global warming etc.

BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVEL:

GLOBAL BIODIVERSITY: In 1992 Earth summit took place in Rio de Janeiro. Mapping the biodiversity became an emergency task for conservation plans and practical utilization. **Tropical biodiversity** is reducing half percentage every year. 50 to 80% of global biodiversity lies in rain forest. 1/4 th of worlds prescribed drugs come from tropical forest and 3000 plant species has cancer fighting ability. **Temperate forest** has less biodiversity but has good documentation. It has 1, 70,000 flowering plants, 30,000 vertebrates and about 2, 50,000 other group of species. **Marine diversity** is even much higher than terrestrial biodiversity and ironically, they are still less known and described. Out of 35 existing Phyla of multicellular animals, 34 are marine and 16 of these are exclusively marine

NATIONAL LEVEL - INDIAN BIODIVERSITY:

1. India ranks 10^{th} among the plant rich countries of the world
2. 11^{th} in terms of Endemic species
3. 6^{th} among origin of agricultural crops
4. 1,50,000 species identified
5. It has 2 hot spot regions
6. 12^{th} mega bio diversity countries in the world

REGIONAL OR LOCAL BIODIVERSITY:

1. Point Richness: Refers to number of species at a single point.
2. Alpha Richness: Refers to the number of species found in a small homogeneous area.
3. Beta Richness: Refers to rate of change in species composition across different habitats.
4. Gamma Richness: Refers to the rate of change across large landscape gradients.

INDIA AS A MEGA BIODIVERSITY NATION:

India is one of the 12 mega bio diversity countries in the world. The Ministry of environmental and forests, Government of india (2000) records 47,000 species of plants and 81,000 species of animals which is about 7% and 6.5% respectively of global flora and fauna.

1. Endemism: Species which are restricted to only to a particular area are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic.

2. Centre of origin: A large number of species have known to originate in India. Nearly 5000 flowering species, 166 species of crop plants and 320 species of wild relatives of cultivated crops origin in india.

3. Marine diversity: Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, back waters etc. there exist a rich biodiversity. More than 340 species of corals of the world are found here.

HOTSPOTS OF BIODIVERSITY

A **biodiversity hotspot** is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. To qualify as a biodiversity hotspot on Myers 2000 edition of the hotspot-map, a region must meet two strict criteria:

1. It must contain at least 0.5% or 1,500 species of vascular plants as endemics, and
2. It must have lost at least 70% of its primary vegetation.

Around the world, at least 25 areas qualify under this definition, with nine others possible candidates. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species.

The importance of biodiversity: Biodiversity is often used to draw attention to issues related to the environment. It can be closely related to

- the health of ecosystems.
  For example, the loss of just one species can have different effects ranging from the disappearance of the species to complete collapse of the ecosystem itself. This is due to every species having a certain role within an ecosystem and being interlinked with other species.
- the health of mankind.
  Experiencing nature is of great importance to humans and teaches us different values. It is good to take a walk in the forest, to smell flowers and breath fresh air. More specifically, natural food and medicine can be linked to biodiversity.

Hot spots of Biodiversity in India:

The hot spots of biodiversity are the geographic areas which possess the high endemic species. At the global level these are the areas of high conservation priority, if these species are lost they can never be replaced or regenerated.

Criteria for recognizing Hotspots: The richness of the endemic species is the primary criterion; they should have a significant percentage of specialized species; the site should be under threat and should contain important gene pools of plants of potential use.

Two hot spots of mention in India are 1. Eastern Himalayas (Indo-Burma region) and
2. Western Ghats (Srilanka region).

Eastern Himalayas: comprises of Nepal, Bhutan and neighbouring states of Northern India- 35,000 plant species are found here and 30 % are endemic – also rich in wild plants of economic value eg. Rice, banana,

citrus, ginger, chilli, jute and sugarcane – Taxal yielding plant also sparcely distributed – 63% mammals are from this region- 60% of Indian Birds- huge wealth of fungi, insects, mammals and birds found in this region

Western Ghats: Comprises of parts of Maharashtra, Karnataka, Tamilnadu and Kerala – nearly 1500 endemic, dicotyledones 62% amphibians and 50% lizards are endemic here- Ternstroemia, Japonica, Rhododendron and Hypericum common plants- Blue Bird and Lizard hawk are common animals.

Biodiversity is the richness & varied species of different organisms contained in a particular ecosystem – Indian biodiversity is highly diverse and rich such that there are various hot spots. However there are numerous threats to our Biodiversity.

THREATS TO BIODIVERSITY :(habitat loss, poaching of wildlife &man-wildlife conflicts)

In 2006 many species were formally classified as rare or endangered or threatened; moreover, scientists have estimated that millions more species are at risk which has not been formally recognized. About 40 percent of the 40,177 species assessed using the IUCN Red List criteria are now listed as threatened with extinction.

LOSS OF HABITAT:

***Habitat destruction*:**

Habitat destruction has played a key role in extinctions, especially related to tropical forest destruction.[125] Factors contributing to habitat loss are: overpopulation, deforestation, pollution (air pollution, water pollution, soil contamination) and global warming or climate change.

Habitat size and numbers of species are systematically related. Physically larger species and those living at lower latitudes or in forests or oceans are more sensitive to reduction in habitat area.

Climate change:

Global warming is also considered to be a major potential threat to global biodiversity in the future. Climate change has seen many claims about potential to affect biodiversity but evidence supporting the statement is tenuous. Increasing atmospheric carbon dioxide certainly affects plant morphology and is acidifying oceans, and temperature affects species ranges, phenology, and weather, but the major impacts that have been predicted are still just *potential* impacts. We have not documented major extinctions yet, even as climate change drastically alters the biology of many species.

POACHING: Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth million of dollars per year continues. The developing nations in Asia, latin America and Africa are the richest source of biodiversity and have enormous wealth in wildlife.

Overexploitation:

Overexploitation occurs when a resource is consumed at an unsustainable rate. This occurs on land in the form of overhunting, excessive logging, poor soil conservation in agriculture and the illegal wildlife trade. Joe Walston, director of the Wildlife Conservation Society's Asian programs, called the latter the "single largest threat" to biodiversity in Asia. The international trade of endangered species is second in size only to drug trafficking

MAN-WILDLIFE CONFLICTS:

CAUSES OF MAN WILDLIFE CONFLICT:

1. Dwindling habitats of elephants, Tigers, rhinos and bears due to forest shrinkage compels them to move outside foraet
2. Usally ill, weak, and injured animals have a tendency to attack the humans.
3. Earlier Forest department used to cultivate paddy, sugarcane within the sanctuaries, due to lack of such practices the animals move out of forest foe food.
4. Villagers put Electric Wiring around their crop field which injures the elephants and turn them violent.
5. Wildlife corridors have been disrupted which makes the animals attack human beings during their migration.

REMEDIAL MEASURES TO CURB THE CONFLICT:

1. Tiger conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc to tactfully deal with any imminent danger.
2. Adequate crop compensation and cattle compensation scheme must be started.
3. Solar powered fencing should be provided to prevent animals from straying into fields.
4. Cropping pattern should be changed near the border.
5. Wildlife corridors should be provided.

Introduced and invasive species:

Barriers such as large rivers, seas, oceans, mountains and deserts encourage diversity by enabling independent evolution on either side of the barrier, via the process of allopatric speciation. The term invasive species is applied to species that breach the natural barriers that would normally keep them constrained. Without barriers, such species occupy new territory, often supplanting native species by occupying their niches, or by using resources that would normally sustain native species.

Genetic pollution:

Endemic species can be threatened with extinction through the process of genetic pollution, i.e. uncontrolled hybridization, introgression and genetic swamping. Genetic pollution leads to homogenization or replacement of local genomes as a result of either a numerical and/or fitness advantage of an introduced species.Hybridization and introgression are side-effects of introduction and invasion.

Hybridization, genetic pollution/erosion and food security

In agriculture and animal husbandry, the Green Revolution popularized the use of conventional hybridization to increase yield. Often hybridized breeds originated in developed countries and were further hybridized with local varieties in the developing world to create high yield strains resistant to local climate and diseases. Local governments and industry have been pushing hybridization. Formerly huge gene pools

of various wild and indigenous breeds have collapsed causing widespread genetic erosion and genetic pollution. This has resulted in loss of genetic diversity and biodiversity as a whole.

ENDANGERED AND ENDEMIC SPECIES OF INDIA:

1. ENDANGERED SPECIES OF INDIA

The international Union for conservation of Nature and Natural Resources (IUCN) publishes the red Data book which includes the list of endangered species of plants and animals.

S.No	Species	Names
1	Reptiles	Gharial, green sea turtle, tortoise,python
2	Birds	Great Indian bustard, Peacock, Pelican, Great Indian hornbill, Siberian White crane
3	Carnivores-Mammals	Indian Wolf, red fox, sloth bear, red panda, tiger, leopard, Stripped Hyena, Indian lion, Golden cat, desert cat, Dugong
4	Primates	Hoolock Gibbon, lion tailed Macaque, Nilgri languor, capped monkey, Golden monkey
5	plants	A large number of species of Orchids, Rhododendrons, Medicinal Plants like Rauvolfia serpentine, the sandal wood tree santalum, Cycas beddonei

2. ENDEMIC SPECIES OF INDIA:

India has two biodiversity hotspots and thus possesses a large number of endemic species. Out of about 47,000 species of plants in our country 7000 species are endemic. Thus, Indian subcontinent has about 62% endemic flora, restricted mainly to Himalayas, Khasi Hills and WesternGhats. Some of the endemic flora includes orchids and species like *Sapria Himalaya*, *Uvaria lurdia*

A large number out of total 81,000 species of animals in our country is endemic. The Western Ghats are particularly rich in amphibians and reptiles. About 62% Amphibians and 50% lizards are endemic to Western Ghats. Different species of Monitor lizards, reticulated python and Indian salamander and viviparous toad are some important endemic species of our country.

CONSERVATION OF BIODIVERSITY (In-situ conservation & Ex-situ conservation)

In-situ and ex-situ conservation along with their merits and limitations:

Conservation of Biodiversity: Biodiversity faces threat of extinction – due human activities – to salvage situation – conservation of biodiversity need of the hour- to preserve biodiversity to prevent their extinction and future flourishing – conservation of Biodiversity required

In-situ conservation: Involves allocating large areas of the land mass for wild life development- such areas can be closed to the public for tourism – wild life can be allowed to flourish in their own environment- promotes genetic diversity- does not stagnate the gene pool

Advantages: cheap and convenient method Species gets adjusted the natural disaters like drought, floods, forest fires.

Limitations: Large surface area of the earth required – shartage of staff and pollution may lead to improper maintenance of the habitat.

Ex-situ conservation: Involves conservation of wild life in zoos, botanical gardens-human supervision- wildlife can grow under controlled conditions - animals would be properly taken care- food, shelter and water- help in the flourishing of endangered species- possible the gene pool could stagnate and result in no genetic diversity taking place.

Advantages: Special care and attention lead to survival of endangered species–In captive breeding, animals are assured food, water, shelter and security - hence longer life span- it is carried out for the endangered species, which donot have any chances of survival in the wild.

Limitations: Expensive method- freedom of wild life is lost – animals cannot survive in such environments