ENVIRONMENTAL STUDIES

UNIT –II

ECOSYSTEM & BIO-DIVERSITY

BASIC TERMS & DEFINITIONS:

Ecology	The study of ecosystems
Ecosystems	A group of organisms interacting with one another and with surroundings
Autotrophs	They prepare their own food materials
Heterotrophs	They cannot prepare their own food they depend on autotrophs
Food chain	The sequence of eating and being eaten in an ecosystem
Foodweb	The interlocking of many foodchains
Trophic level	The sequence through which food passes in an ecosystem
Climax community	The stable community in an ecosystem
Biodiversity	Variety of life exhibited by living organisms
Biogeographical area	A region with characteristic climatic,biological and land resources
Biosphere	Zone of earth where life is found.
Hotspot	Area which exhibits high species richness
Extinct species	A species is said to be extinct when it is no longer found in the world
Endemism	A species which are restricted only to a particular area
Endangered	A species going to extinct
Poaching	Killing of animals
Vertebrates	Animals with backbone

Introduction of Ecology:

The term "Ecology" was derived from Greek words viz., **Oikes** means house or place and **logs** means a discussion or study. So, ecology is the **scientific study of the distribution** and the **interactions** between organisms and their natural environment. The environment (surroundings) consists of: **living organisms (** biotic **)** and **non-living things (** abiotic **)** such as physical components of wind, temperature, rainfall, water, humidity , light, soil etc and chemical components of C,H,N,K,P,S etc..(in-organic components) and carbohydrates, proteins (organic components). Hence, Ecology involves studying the ecosystems. According to **George Jackson,** an Ecosystem is a natural unit consisting of all plants, animals and micro-organisms in an area functioning together with all of the non-living things. An ecosystem is the smallest unit of biosphere that has all the characteristics to support life. Pond ecosystem, forest ecosystem, desert ecosystem, marine ecosystem, urban ecosystem are some of the examples for ecosystems. An ecosystem varies in sizes from a few square kms to hundreds of square kms. Similarly an ecosystem may be temporary like a fresh pool / agriculture field or permanent like a forest / ocean.

Scope of ecosystem:

Ecology plays an important role in agriculture crop rotation, weed control (unwanted land); management of grasslands, forestry etc., biological surveys, fishery surveys, conservation of soil, wild life, surveys of water bodies like rivers, lakes; ponds etc...

Concept of ecosystem:

In an ecosystem, the interaction of life with its environment takes place at many levels. A single bacteria in the soil interacts with water, air around it within a small space while a fish in a river interacts with water and other animals, rivals in a large space. Considering the operational point of view; the biotic and biotic components of an ecosystem are so interlinked such that their separation from each other is practically difficult. So, in an ecosystem both organisms (biotic communities) and a biotic environment (rainfall, temperature, humidity) each influence the properties with other for maintenance of life.

Kinds of Ecosystems: Ecosystem may be natural or artificial.

Artificial Ecosystem: These are maintained or created artificially by man. The man tries to control biotic community as well as physico chemical environment.

Eg: Artificial pond, urban area development.

Natural Ecosystem: It consists of Terrestrial and Aquatic Ecosystems which are maintained naturally.

Terrestrial Ecosystem:

This ecosystem relates to biotic components living on the land. Vegetation dominates the community and the types of vegetation affect the climate, soil structure & a rapid exchange of O_2, water & CO_2

Aquatic Ecosystem:

This ecosystem relates to biotic community living in water. The types of water (fresh water, saline water, polluted water) dominate and affect the pH of water, depth of water, temperature of water etc. Aquatic ecosystem has been sub-divided into **fresh water** and **saline water** based on the quality of water.

Sturcture & Function of Ecosystem

The two major aspects of an ecosystem are: (1) Structure and (2) Function together they illustrate the organization of an ecosystem.

The Structure of an ecosystem consists of:

Abiotic structure includes the non-living things of the ecosystem such as physical factors (soil, temperature, light & water) and chemical factors consisting the inorganic compounds (N, C, H, K, P,S) & organic compounds (carbohydrates, proteins).

Biotic structure includes plants, animals & microorganisms present in an ecosystem form the biotic component. These organisms have different nutritional behavior and status in the ecosystem and are known as Autotrophs Producers), Heterotrophy (Consumers) & Micro-consumers (Decomposers) based on how they get their food. Hence, the structure of an ecosystem comprises

- **a.** The composition of biological community species (plants, animals, microorganisms), their population, life cycles, distribution in space etc
- **b.** The quantity and distribution of non-living things such as soil; water etc.
- **c.** The range or intensity of conditions like temperature, light, rainfall, humidity, wind & topography plays a major role in the structure of ecosystem.

Function of ecosystem means how an ecosystem works/ operates under natural conditions. The rate of biological energy flow ; the rate of nutrient cycles ie Bio- Geo-Chemical cycles and Ecological regulation (means regulation of organisms by Environment and regulation of Environment by organisms) plays a major role in the function of an ecosystem

1. Autotrophic components (Producers):

Autotrophic means self nourishing. Since these organisms are self nourishing, they are also called producers.

Eg: Algae, Green plants, Bacteria of photo synthetic. Green plants prepare their food themselves by making use of CO_2 present in the air & water in the presence of sunlight through the process of photosynthesis.

$$CO_2 + 2H_2O \rightarrow CH_2O + O_2 + H_2O$$

(Carbon dioxide) (Water)(Carbohydrates) (Oxygen) (Water)

A few micro-organisms which can produce organic matter (nutrients) to some extent through oxidation of certain chemicals in the absence of sunlight known as chemo autotrophs.

Eg: In the Ocean depths, where there is no sunlight, chemo-autotrophic bacteria make use of the heat generated by the decay of radioactive elements for preparation of their food.

2. Hetero-trophic components (Consumers):

Hetero-trophic means dependent on others for nourishment directly or indirectly upon the utotrophs (producers) for their food. These are of the following types:

a. Herbivores (Primary consumers): These animals feed directly on living plants or remains of plants. Eg: Rabbits, Deer's, Insects.

b. Carnivores (secondary consumers): These carnivores (flesh eating) feed on the herbivores. Eg: Snakes, birds, Lizards, fox.

c. Tertiary consumers (or) Tertiary carnivores: These feed on the primary & secondary consumers. Eg: Lions, Tigers.

d. Omnivores: These consumers feed on both plants & animals. Eg Human beings, Birds (hawk)

3. Decomposers or Micro consumers: They feed on organic compounds of dead or living plants and animals for their food and energy. They absorb some of the products from decomposed material and release organic compounds (nutrients) making them available to producers.

Eg: Bacteria, Fungi, and Flagellates. The decomposers are also called as "Saprotrophs".

Food Chain:

The transfer of food energy from the producers (plants) through a series of organisms (Herbivores, Carnivores) successively with the repeated activities of eating and being eaten is known as food chain. In an ecosystem(s), one organism is eaten by the second who in turn is eaten by the third and so on... This kind of feeding relationship is called food chain.

Examples of food chain:

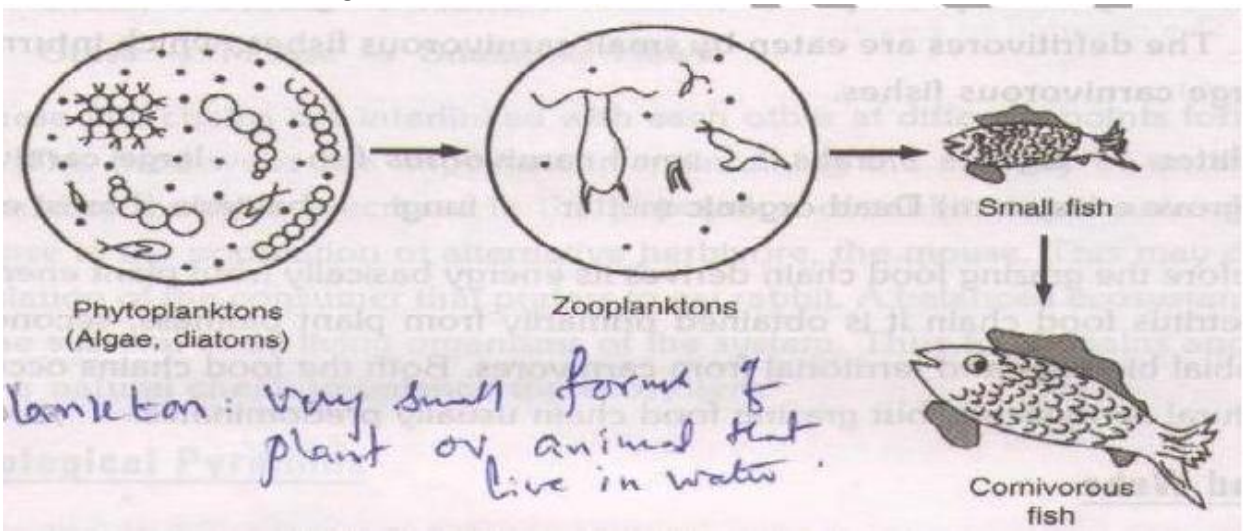
1. Grass→ Grasshopper→ Frog→ Snake→ Hawk.
2. Grass→ Mouse→ Snake →Hawk
3. Grass→ Rabbit→ Man.
4. Grass→ Mouse→ Hawk.
5. Plant leaf →Caterpillar →Sparrow →Hawk.

Explanation: A caterpillar eats a plant leaf, a sparrow eats the caterpillar, and a hawk eats the sparrow. When they all die, they are all consumed by micro organisms like bacteria (or) fungi which break down the organic matter and convert it into simple inorganic substances that can again be used by the plants.

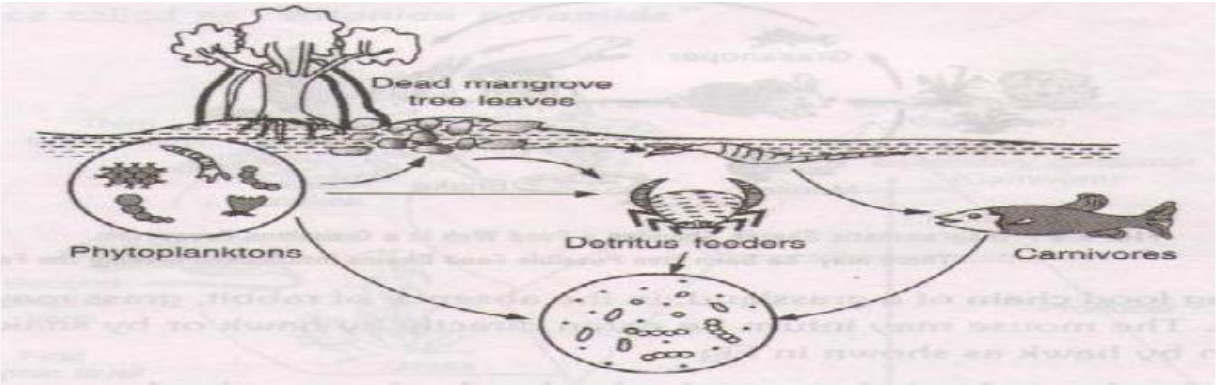
In nature, there are two basic types of food chains viz: 1.
Grazing food chain and (2) Detritus food chain

Grazing food chain: This food chain starts with green plants (primary producers) and goes to herbivores and on to carnivores.

1. Phytoplankton's→ Zooplanktons →Small fish→ Tuna.
2. Phytoplankton's→ Zooplanktons→ Fish→ Man.
3. Grass→ Rabbit→ Fox→ Tiger.



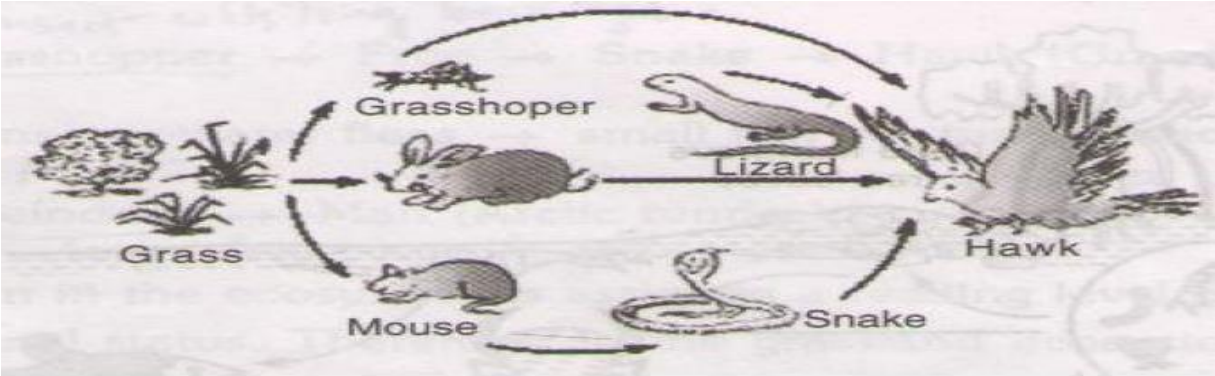
Detritus food chain: This food chain starts from dead organic matter (dead leaves/ plants / animals) and goes to Herbivores and on to Carnivores and so on…..
Leaves or dead plants→ Soil mites→ Insects→ Birds.
Dead organic matter→ Bacteria → Insects.
Dead leaves → Algae→ Fish→ Man.



FOOD WEB:

Food web is a net work of food chains where different types of organisms are connected at different trophic levels so that there are a number of options of eating and being eaten at each trophic level. (A trophic level refers to an organism's position in the food chain).

1. Grass→ Grasshopper→ Hawk
2. Grass→ Grasshopper→ Lizard→ Hawk
3. Grass→ Rabbit→ Hawk
4. Grass→ Mouse→ Hawk
5. Grass→ Mouse→ Snake→ Hawk

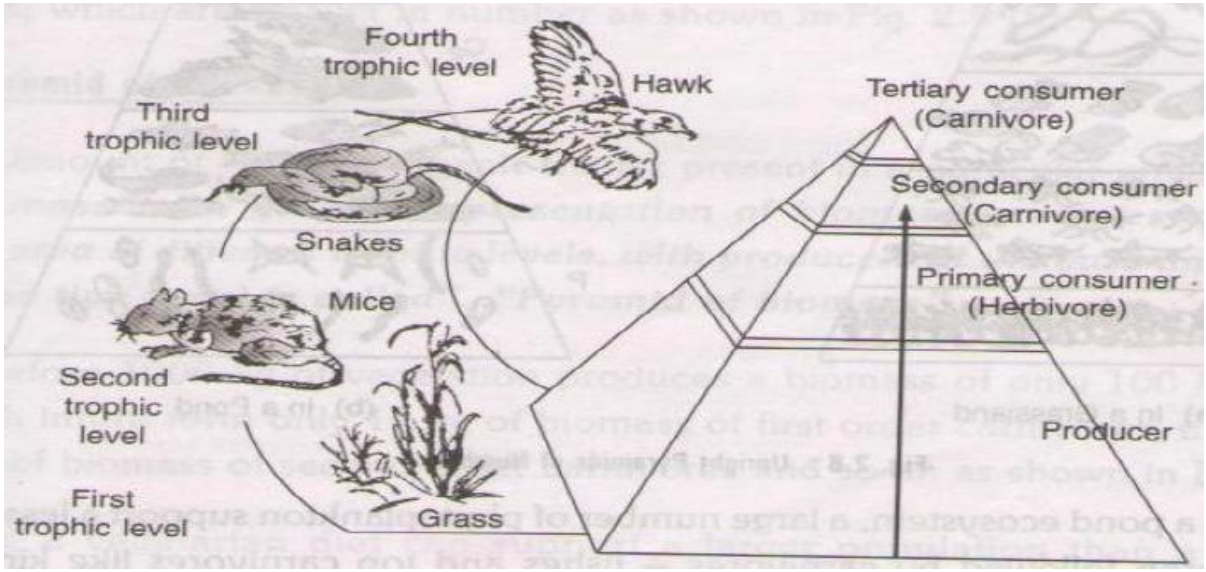


ECOLOGICAL PYRAMID:

Ecological pyramids were first studied by a British ecologist Charles Eltan (1927). An Ecological Pyramid is a graphical representation consisting varioustrophic levels with producers forming the base and top occupy the carnivores. In an ecological pyramid the huge number of tiny individuals form at the base and a few large individuals occupy the top / apex . This formation is known as ecological pyramid. Hence, all producers (micro & macro plants) belong to the *I trophic level*; all primary consumers belong to *II trophic level* and organisms feeding on these consumers belong to the *III trophic level* and so on.

The ecological pyramids are of three types. They are:

1. The pyramid of Numbers (showing population).
2. The pyramid of Biomass (showing total mass of organisms).
3. The pyramid of energy (showing energy flow).



1. The pyramid of Number:

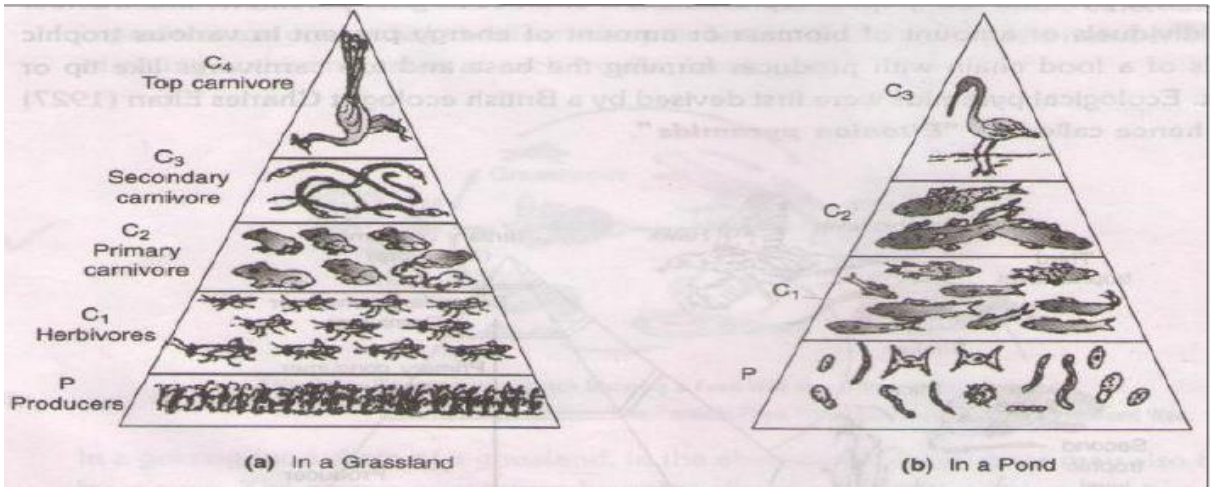
It shows the relationships among the producers, herbivores and carnivores at successive trophic levels in terms of their number. Mostly the pyramid of number is straight (or) upright with number of individuals in successive higher trophic levels goes on decreasing from base to apex.

The maximum number of individuals occurs at the producers' level. They support a small number of herbivores. The herbivores, in turn, support a fewer number of primary carnivores and so on….. Top carnivores are very few in number.

For Example:

(1) In a grass land ecosystem: Grass→ Grasshoppers→ Frogs→ Snakes→ Peacock / Hawk.

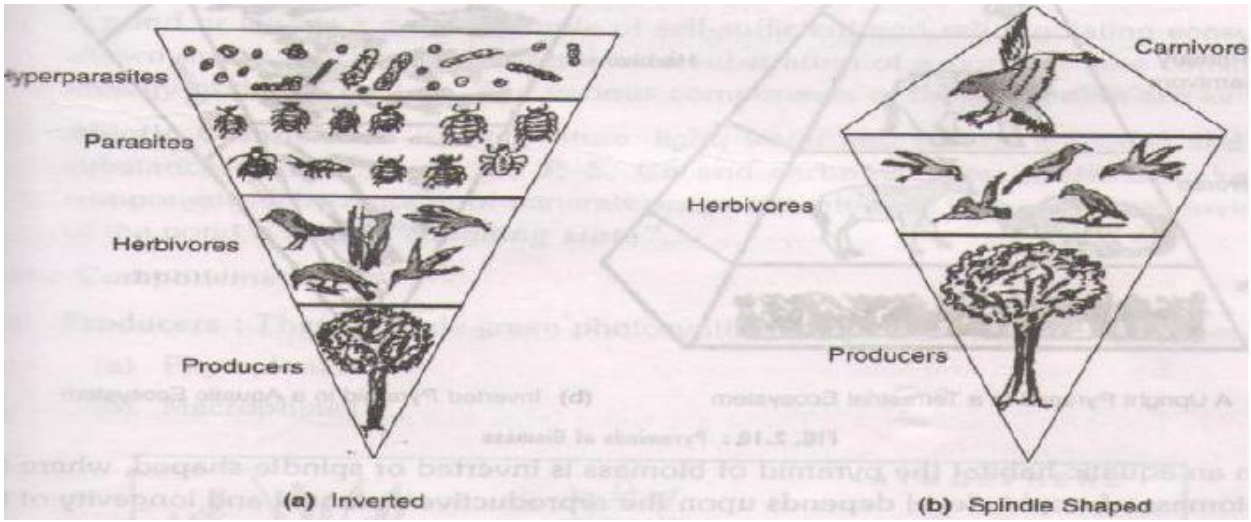
(2) In a pond ecosystem: Phytoplankton→ Zooplankton→ Fish→ Crane



The pyramids may be **inverted** in a few cases:

A single plant may support the growth of many herbivores and each herbivore in turn provides nutrition to several parasites which support many hyper-parasites. Thus, from the producer towards consumers, there is a reverse position i.e., the number of organisms gradually shows an increase making the pyramid inverted in shape.

(3) In a Forest ecosystem: Tree→ Birds / deer →Parasites→ hyper parasites
Tree→ Birds→ eagle



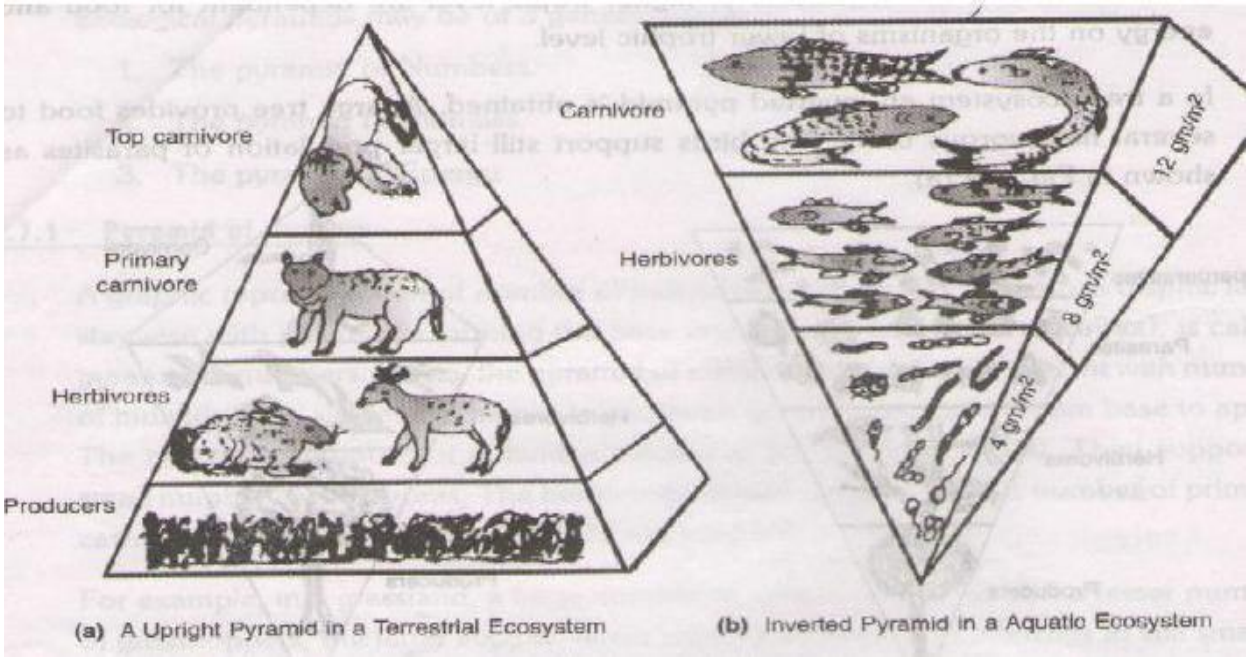
(a) Inverted (b) Spindle Shaped

2. The Pyramid of Biomass: The amount of organic matter present in environment is called biomass. In pyramids of biomass, the relationship between different trophic levels is mentioned in terms of weight of organisms**.** The pyramid may be upright for grassland ecosystem and inverted for pond ecosystem.

Example: Vegetation produces a biomass of 1000 kg. Out of this 100 kgs of biomass for herbivores, which in turn only 10 kg of biomass for primary carnivores that gives rise 1 kg of biomass for second order carnivores and so on…

1000 kgs	100 kgs	10 kgs	1 kg
Vegetation	Herbivores	primary carnivores	Secondary carnivores

Hence, a vegetarian diet can support a larger population than a Non – vegetation diet.

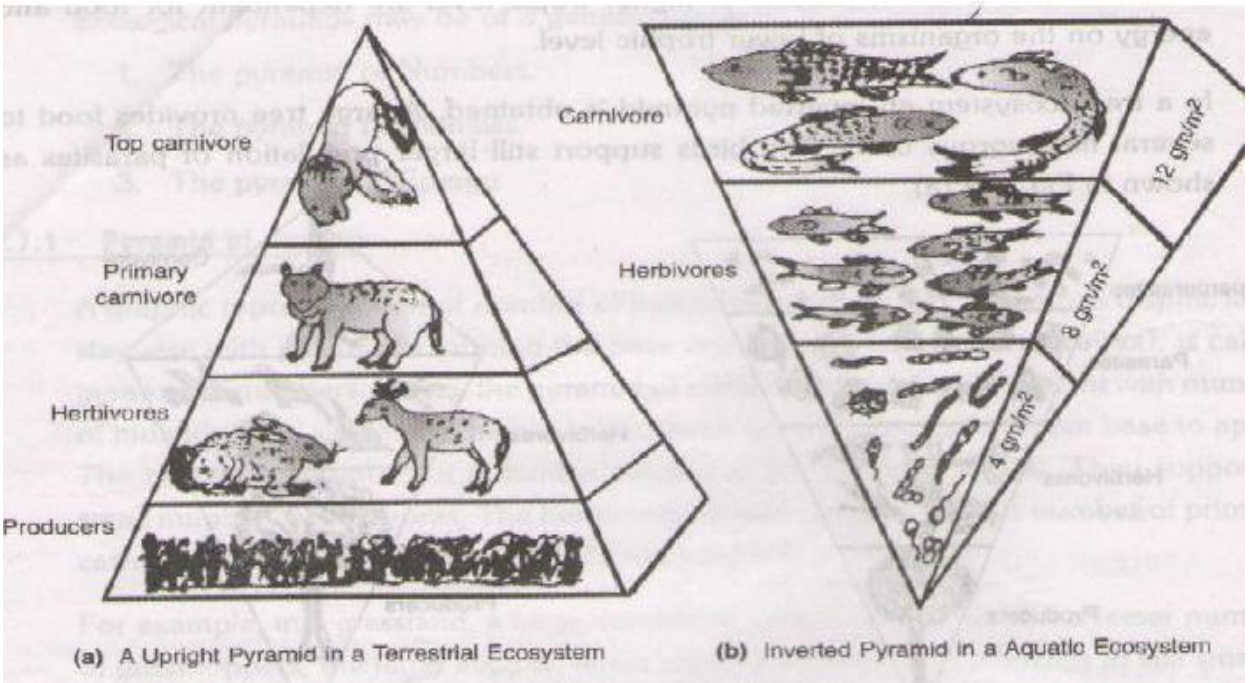


(a) A Upright Pyramid in a Terrestrial Ecosystem (b) Inverted Pyramid in a Aquatic Ecosystem

3. The pyramid of energy: The amount of energy trapped per unit time and area at different trophic levels of a food chain with producers forming the base and the top carnivores at the apex is called pyramid of energy. The energy content is generally expressed as K cal /m^2 / year or KJ / m^2 / year.
Large Fish ---126 KJ / m^2 / year
Small Fish ----840 – 126 KJ / m^2 / year Zooplankton ----
7980 KJ / m^2 / year Phytoplankton (producers) ---
31080 KJ / m^2 / year

Energy flow /Transformation of energy in Ecosystem

The movement of energy (or) transfer of energy through a series of organisms in an ecosystem from the external environment and back to the external environment again is known as energy flow.In the



(a) A Upright Pyramid in a Terrestrial Ecosystem (b) Inverted Pyramid in a Aquatic Ecosystem

universe, the main source of energy is SUN that produces energy in the form of light or solar radiation. Different ecosystems in the world receive variable quantities of solar energy depending upon their location on the globe. The other chief factors that control the amount of solar energy received by an ecosystem are Latitude and Longitude ; Slope; Cloud formation; Pollutants in the atmosphere The transformation of energy in an ecosystem begin first with the input of energy from the sun by the process of photosynthesis. Carbon dioxide is combined with Hydrogen (derived from the splitting of water molecules) to produce carbohydrates (CH_2O) and the energy is stored in the high energy bonds of Adenosine Tri Phosphate (ATP).

Herbivores obtain their energy by consuming plants or plant products,

Carnivores eat herbivores and **micro-organisms** consume the droppings and carcasses (dead bodies). In an ecosystem, the utility of energy is taken place in the following manner:

The sun provides heat to maintain the required temperature in which proper Physical and chemical processes can take place. Certain bacteria obtain useful energy by oxidation of a few elements such as sulphur and iron.

Bio – Geo-Chemical Cycles: In every ecosystem sunlight or solar radiant energy is accepted by producers (green plants) and the energy doesn't recycle through an ecosystem. But nutrients like Carbon; Nitrogen; Oxygen, Hydrogen; Water, Sulphur, Phosphorous etc move in circular paths through biotic and abiotic components and they are known as Bio-geochemical cycles.

About forty chemical elements are considered to be essential for living organisms. They are macronutrients of C, H, O, P, K, I, N, S , Mg, Ca etc.. and micro nutrients of Cu, Fe, Co……While all inorganic nutrients have cycles, we focus on the following:

WATER CYCLE

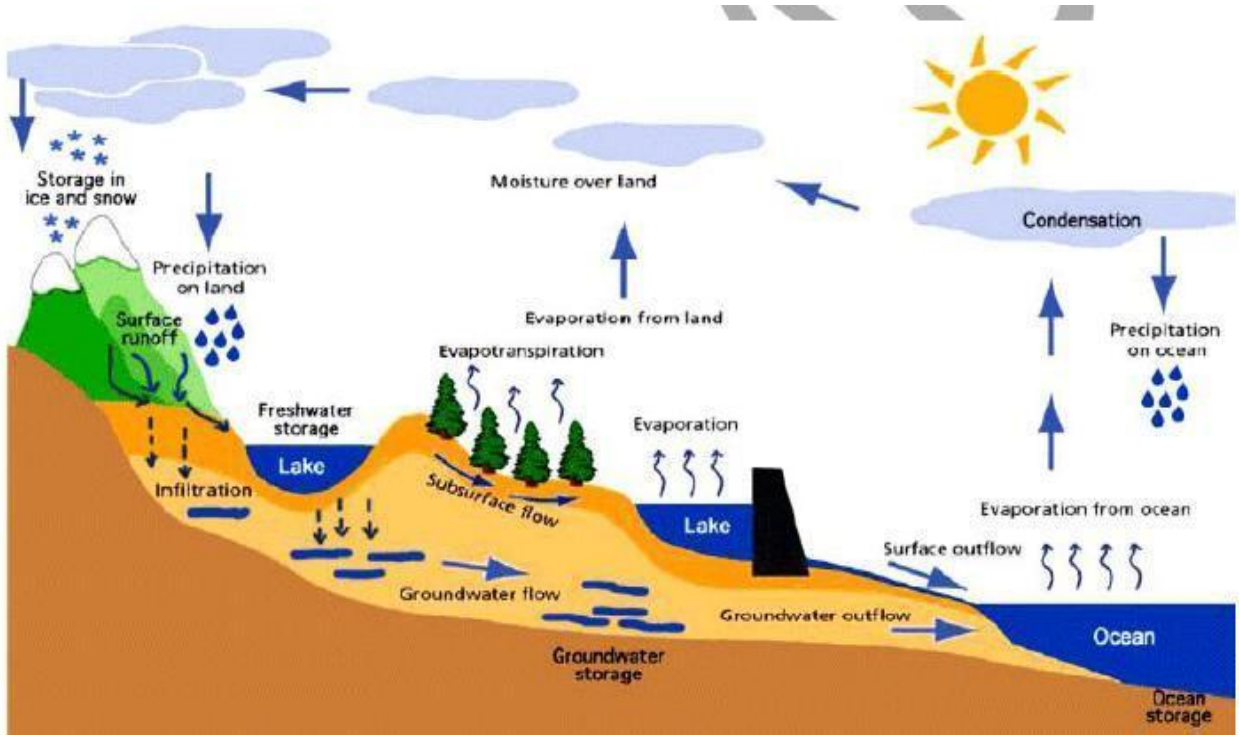
CARBON CYCLE

OXYGEN CYCLE NITROGEN

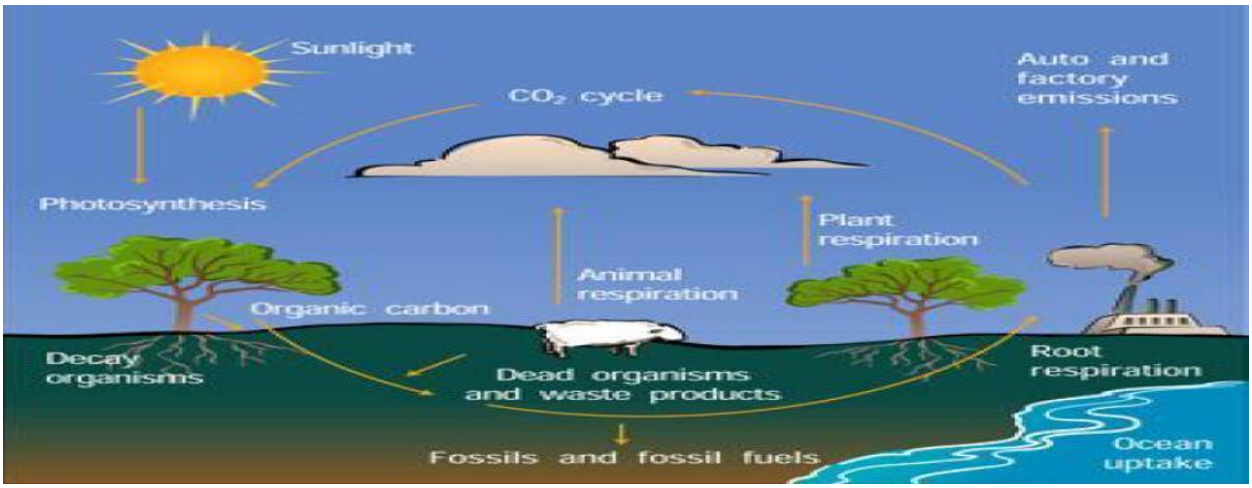
CYCLE POTASSIUM CYCLE

PHOSPHOROUS CYCLE

The Water Cycle Or Hydrologic Cycle: Due to the solar heat, water evaporates or water is lost to the atmosphere as vapour from the seas / oceans which is then precipitated back in the form of rain, snow, frost etc.. The evaporation and precipitation continues for ever, and thereby a balance is maintained between the two. This process is known as Hydrologic cycle.



Carbon Cycle: All life is based on the element carbon and hence carbon is the main constituent of living organisms.. Carbon may be present in most organic matter from fossil fuels to the complex molecules (DNA & RNA). In fact, the lithosphere is only 0.032% carbon by weight. In comparison, oxygen and silicon make up 45.2% and 29.4% respectively of the earth's surface rocks. Plants absorb CO_2 during photosynthesis whereas animals emit CO_2 during respiration. Animals obtain all their carbon through their food and thus, all carbon in biological systems ultimately comes from plants (autotrophs). The dead bodies of plants and animals as well as the body wastes are decomposed by micro-organisms which release carbon in the form of CO_2. Even plant debris if buried a longer time cause for the formation of coal, oil, natural gas and these releases carbon when they burned. Otherwise, the carbon in limestone or other sediments released to the atmosphere when they are subducted (using forces) or undergo chemical reactions. The weathering of rocks also contribute CO_2 into the environment.



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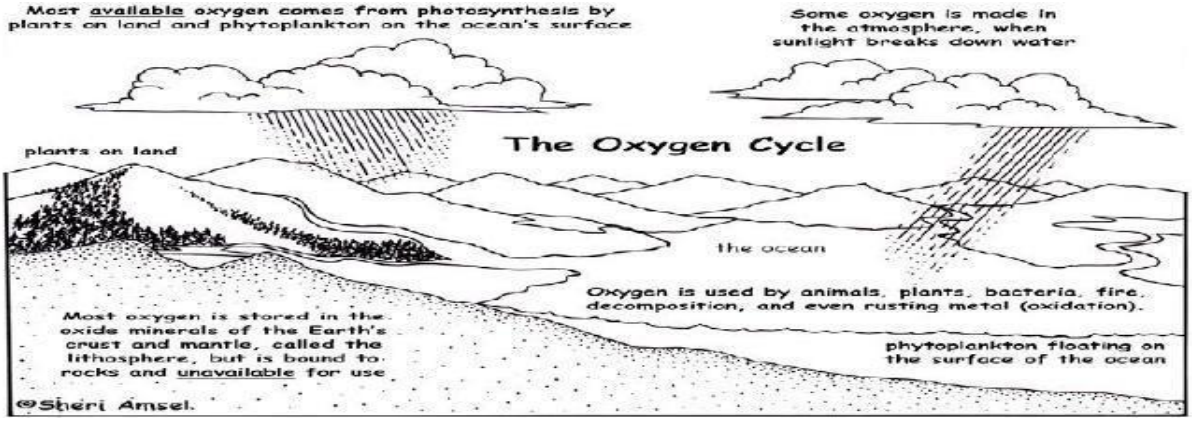
OXYGEN CYCLE: Oxygen is present in CO_2, CH_2O (carbohydrates) and H_2O. Oxygen is released into the atmosphere by plants during photosynthesis and taken up both autotrophs and Heterotrophs during respiration. All the oxygen in the atmosphere is biogenic ie., it was released from water through the process of photosynthesis. Because of the vast amounts of oxygen in the atmosphere, even if all photosynthesis cease it would take 5000 million years to strip out more or less all oxygen.



NITROGEN CYCLE: Nitrogen is used by living organisms to produce a number of complex organic molecules like Amino acids; Proteins ; Nucleic acids ; Enzymes; Chlorophyll etc.. The largest reservoir of nitrogen is the atmosphere where it exists as a gas mainly N_2. But atmospheric nitrogen is not utilized directly. However, nitrogen gas undergoes many changes in the nitrogen cycle like: Nitrogen Fixation, Ammonification, Nitrification.

Nitrogen fixation or conversion of free nitrogen into biologically acceptable form is referred to as Nitrogen Fixation.

$N_2 + 2(O)$ −electric discharge → 2 NO

Nitrogen gas oxygen radical nitrogen oxide In physico chemical process; nitrogen combines with oxygen during lightning or electrical discharges in the clouds and produces different nitrogen oxides (N_2O_5).

These nitrogen oxides get dissolved in rain water and react with mineral compounds to form Nitrates and Nitrogenous compounds on the earth.

$N_2O_5 + H_2O \rightarrow 2HNO_3$

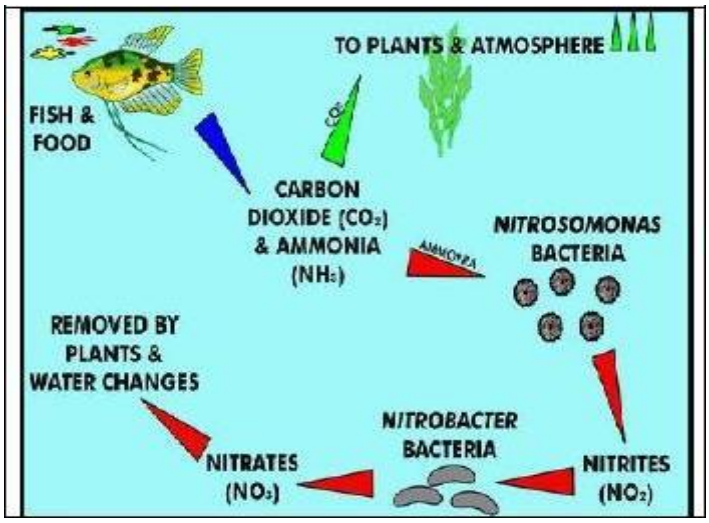
$2HNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$

Nitrogen fixation is also carried out by biological process by means of blue – green algae in the oceans.

Examples: Rhizobium bacteria fix nitrogen in the roots of Leguminous plants Blue – green algae (Nostoc, Anabena) fix Nitrogen.

Ammonification: when plants or animals die or release waste, the nitrogen is returned to the soil as ammonia. The bacteria (nitrite bacteria) in the soil and in the water which take up ammonia and convert it to Nitrite (NO_2). Another bacteria (Nitrate bacteria) take nitrite and convert it to Nitrate (NO3) which can be taken up by plants to continue the cycle.

Nitrification means conversion of ammonia into nitrite by some of the bacteri as such as Nitrosmonas, Nitrococcus in oceans and soils.



AQUATIC ECOSYSTEM:

Eco system that exists in water is known as aquatic ecosystem. Water is the primary requirement for life in biological community. The aquatic ecosystems range from a small pond to a large ocean. Varying quantities of nutrients are carried from terristrial (land) ecosystem by the movement of water and deposited in aquatic ecosystems. The life in aquatic communities is influenced mostly by physical factors like**:**

Water depth
Amount of light
Temperature
Salinity of water
Amount of oxygen and Carbondioxide.

Aquatic ecosystems are broadly classified into ***fresh water*** and ***marine water*** ecosystems. In some regions, the marine and fresh water environments overlaps creating "***Estuaries***".

Fresh Water: Eg: lakes, ponds streams, rivers water
Marine: Eg: salt lakes, seas, oceans
Estuaries: Eg: water bodies mix of fresh & sea

I. Ponds & Lake Ecosystems*:* A pond is a small area of still water, especially is artificial whereas a lake is a large area of water body and the water is natural. The life span of ponds range from a few weeks or months and whereas the life span for lakes depend upon their location, size and depth. Depending upon temperature, the upper part of the lake becomes warm and is called ***eplimnion*** and the lower part of the lake becomes cold which is called as ***hypolimnion.*** These two zones are separated by **thermocline zone** which acts as a barrier to exchange of material / nutrients within the pond. During rainy season, entire water body gets same temperature due to mixing of water while in non-rainy season very small amount of mixing occurs by surface waves due to wind blow.

The ***non-living (abiotic) components*** of a pond include Heat; light, pH value of water; organic compounds (water, CO_2, O_2, Ca, N, P) and ***living (biotic) component***s of Autotrophs or producers (green plants, bacteria, rooted plants of Trapa, Typha, Sagi Haria), Consumers (Herbivores, insects and large fish) and micro cosumers (bacteria, fungi).

2. Stream & River Ecosystems*:* Rivers and streams are flowing fresh water bodies. Out of all natural ecosystems, rivers are the most intensively used ecosystems by man. The organization of river and stream ecosystem include:

Abiotic Components: include volume of water, speed of water flow, dissolved oxygen content, temperature etc. The energy flow usually the organic matter which is being imported from adjacent terrestrial ecosystems.

Biotic Components: include Producers (algae, grass, amphibians); consumers (leaches, water insects, snails, fishes, crocodiles, reptiles) and Decomposers (bacteria, fungi, protozoa).

3. **Ocean or Marine Ecosystems:** The marine environment is characterized by its high concentration of salts and minerals. The major oceans of the world are Atlantic; Pacific; Indian, Arctic and Antarctic. These are deep and life extends to all its depths. The sea water contains salt content in the form of NaCl and rest are Mg, Ca, K . Temperature ranges from 0° to 30° C and pressure of 1 ATM at surface and 1000 ATM at bottom of oceans. The ocean ecosystem consists of the following;

Biotic components of Producers (phytoplanktons, marine plants, Ruppia, Zostera, Halophile are true marine angiospers), Consumers of Molluscas, fishes and Decomposers of bacteria and Fungi.

Abiotic components include Na, Cl, Mg, Ca, Sulphur, Dissolved oxygen content, light, temperature, pressure variations etc.

4. Estuarine Ecosystem: Estuary is the area at the mouth of the river joins the sea and continents. It has a free connection with the open sea and is thus strongly affected by tidal action. Estuaries are mixed with fresh water from land drainages. River mouth, coastal bay etc are the examples for estuarine ecosystem. Estuaries are one among the naturally fertile in the world. The components of estuarine ecosystem are given below:

Abiotic components: Estuaries have their own ecological characteristics. Physical factors such as salinity, temperature, tidal activity etc are variable in estuaries when compared to the sea or ocean.

Biotic components include Producers, consumers and Decomposers. Producers: Three major life forms of Autotrophs play a significant role in grass production. They are

(a) macrophytes (sea weeds, sea grass, spartina,Thalassia, marsh grass, nagrove trees)
(b) Phytoplankton and
(c) Benthic flora (algae).

Consumers include a number of zooplankton, oysters, crabs and some species of fishes capable of surviving in estuarine conditions form primary, secondary, tertiary consumers of the estuarine ecosystem. Decomposers include bacteria and fungi which actively take part in the breaking down the complex and dead organic matter (Fungi of actinomycites).

FOREST ECOSYSTEM

Introduction: Forest is a type of terrestrial (land) ecosystem. It consists of trees, shrubs or woody vegetation occupying an extensive area of land. Forests are important renewable resources. A different types of forests are seen on this earth. The type of forest depend upon its geographical location and environment factors (Temperature and moisture) that influence the kind of vegetation that occur in an area.

Types of forests:

1. Savannas: These forests develop where a seasonal rainfall occurs. The grass lands of North Africa are known as savannas.
Eg: North Africa, America, Burma & India.

2. Tropical forests: These exits in areas of good rainfall (>200cm per year) with uniform warm temperature. The Soils found in there forests are old, acidic in nature & poor in nutrients.
Eg: Amazon rain forest (South America, India).

3. Deciduous forests (or) Temperate forests: Deciduous forests consists of broad leaved trees & occur where rainfall is plenty (750 - 1000 cms per year).
Eg: Europe & North-East America.

4. Coniferous forest: These occur in areas with long winters with heavy snowfall. In other words, where moisture is limited & rainfall is low. Herbivores (animals eating plants) & insects exist in these forests.
Eg: Moscow.

(5) Tundras: These are the large flat Arctic regions of Northern Europe, Asia and North America where no trees grow and where the soil below the surface of the ground is always frozen. The growing season is short and plants grow very slowly.

Following are the types of forests present in India:

1. Tropical, forests present in Western Ghats of Maharashtra, Karnataka, Kerala.
2. Deciduous forests present at Dehradun, Eastern Ghats of Andhra Pradesh, Tamil Nadu, M.P.
3. Littoral and swamp forests present at Sunderbans in West Bengal and Andaman islands.
4. Tropical Thorn forests present in New Delhi, Punjab and Gujarat.
5. Mountain wet temperature forests present at Nilgiri and Palani hills.
6. Alpine scrub forests present at Ladakh and Sikkim.

The characteristic features of a forest ecosystem are as follows:

Abiotic components include inorganic and organic compounds and dead organic debris. Further, the natural light conditions are different in forests due to complex stratification in the vegetation. Biotic components include Producers, consumers and Decomposers. Producers: These are plants and trees and produce the food through photosynthesis. The dominant species of trees are Quercus, Acer, Betula, Thuja, Picea, Abies, Pinus, Cedrus etc.

Consumers: The primary consumers are Ants, beetles, leaf hoppers, bugs, spiders, deers, squirrels etc. The secondary consumers are Snakes, birds, lizards, foxes etc are the examples. The tertiary consumers are lion, tiger, hawk etc.

Decomposers include micro organisms like bacteria, fungi etc. Consume the dead or decayed bodies.

Tropical rain forests are found in the hot and humid regions near the equator: These regions have abundant rainfall (2000 – 4500 mm per year) that occurs almost daily. These forests are found in South and Central America, Western and Central Africa , SE Asia and some islands of the Indian & Pacific Oceans. These rain forests are marked by a variety of tall trees and a dense canopy. The soils are thin and acidic with poor nutrients. A team of Brazilian scientists conducted a research and found that a forest could return as much as 75% of the moisture it received back into atmosphere. Hence, more trees are meant for more rain.

Temperate forests are very cold in winter and warm or humid in summer. These forests grow where the annual rainfall is about 750 – 2000 mm per year and are found in Western and Central Europe, Eastern Asia, Eastern America. Soil is rich in temperate forest areas. oaks, maples, beech, pine trees, ferns, lichens, mosses etc are found in these forests. Temperate forests contain abundant micro – organisms and mammals (squirrels, porcupines, chipmunks, raccoons, hares, deer, foxes, coyotes, bears. Birds like warblers, wood peckers, owls, hawks are seen. Snakes, frogs are also common these forests.

Coniferous forests derive the name from the abundance of coniferous trees like spruce, fir, pine, hemlock etc. Coniferous tree produces dry fruits called cones. In coniferous forests, winters are usually long and cold. The soil in these forests is acidic and humus rich. The main animals found in these forests are deer, moose, elk, caribon, mice, hares, squirrels, foxes, bears and birds.

Status of Forests in India:

Forest Survey of India (FSI) , Dehradun estimated, the country's forest cover as 6,76,000 sq km Of this 6,76,000 sq km; 259000 sq km is open forest, 417000 sq km is covered by dense forest and mangroves occupied 4490 sq kms. Madhya Pradesh accounts for the largest forest cover of the country with 77265 sq km followed by Arunachal Pradesh 68045 sq km and Chhattisgarh with 56448 sq km.

DESERT ECOSYSTEM:

Deserts occur in regions when the annual rainfall is in the range of 250 to 500 mm and **evaporation rate is high.** Deserts occupy about 30% of land area on the globe. Deserts are found 30 above north and below south of the equator. Deserts are characterized by extremely hot days and cold nights. The largest deserts are found in the interiors of continents where moisture bearing winds do not reach. The desert soils has very little organic matter but rich in minerals. The desert plants have adapted to the dry conditions and conserve water by having few or no leaves.

Examples:

(1) A plant namely Saguaro cactus has a stem that can expand to store water
(2) Many desert plants have thorns or toxins to protect themselves from being grazed by animals.
(3) Some desert plants have wax – coated leaves that minimize the loss of moisture.
(4) Some desert plants have deep roots that reach the ground water.

(5) A few desert plants have shallow roots that collect water after any rain and store it in spongy tissues. Desert ecosystem is characterized by scanty flora and fauna. The organisms which with stand the extreme temperatures can survive here. Desert animals are usually small in size and come out during the nights for food.

Human impact on deserts:

Slow rate of growth of vegetation if topsoil is eroded due to heavy vehicle transportation across the desert. Desert cities, depletion of ground water, land disturbance, pollution from mining, storage of toxic wastes are some of the
human activities that cause damage.

Abiotic components include temperature, rainfall, soil, water etc plays a major role to control the desert ecosystem. Biotic components include **producers** (shrubs, bushes, grasses, a few trees and plants namely Cacti, Acacias, Euphorbias).

Consumers of insects, reptiles, rodents of rats & rabbits; birds, camels which are capable of living under desert conditions.

Decomposers include Bacteria, Fungi due to poor vegetation and the less quantity of dead organic matter.

A Case study of Desert ecosystem:

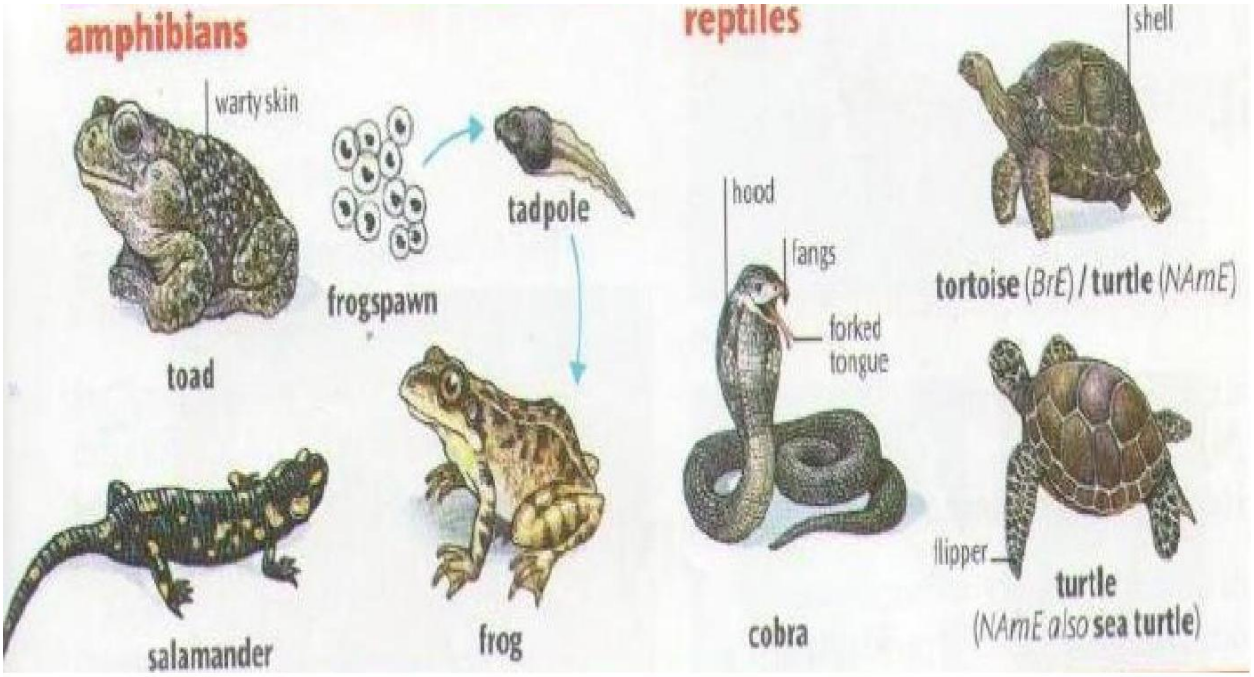
The Thar desert (the Great Indian Desert) is spread over four states in India __ Punjab; Haryana; Rajasthan and Gujarat and two states in Pakistan. Thar desert covers an area of about 4,46,000 sq kms. Though the Thar desert is smaller than the Sahara desert in Africa and the Gobi desert in Russia, the Thar desert is most populated in the world with about 13 million people. The average rainfall is between 100 mm and 500 mm. The only river in the region is the **Ghaggar** which enters Rajasthan from Punjab and dries up in the forest. The Thar desert has no Oasis. Flowering plants like shrubs, grasses, trees (Khejra, Babul, Rohida); fruit trees (Ber; Pilu) are found in Thar desert. Sheep, goats, camels are the common animals found in the Thar desert. In addition, wild ass, black buck deer, hare, red lynx, Jackal, Wild dog etc.. About 23 species of Lizard and 25 species of snakes are found in Thar desert region. part, is gleaning insects. The community provides the habitat—the place where particular plants or animals live. Within the habitat, organisms occupy different niches.

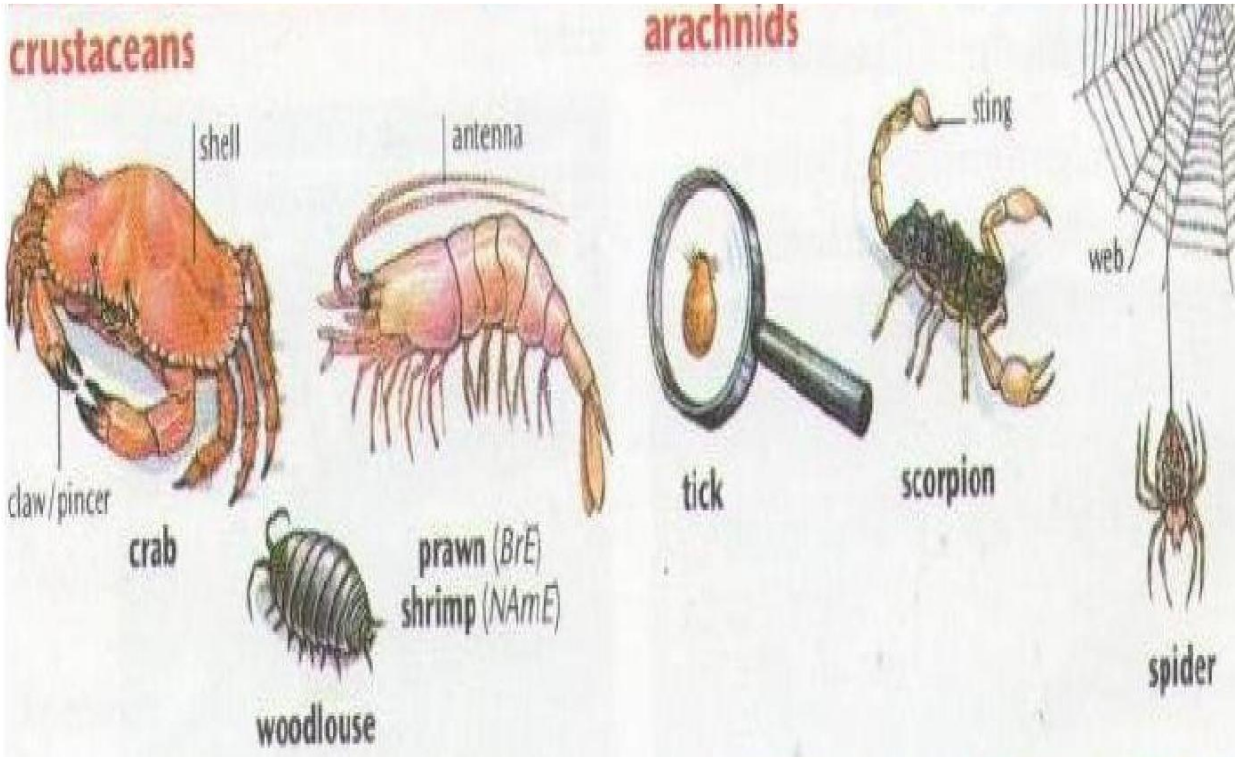
DIFFERENCE BETWEEN HABITAT AND NICHE

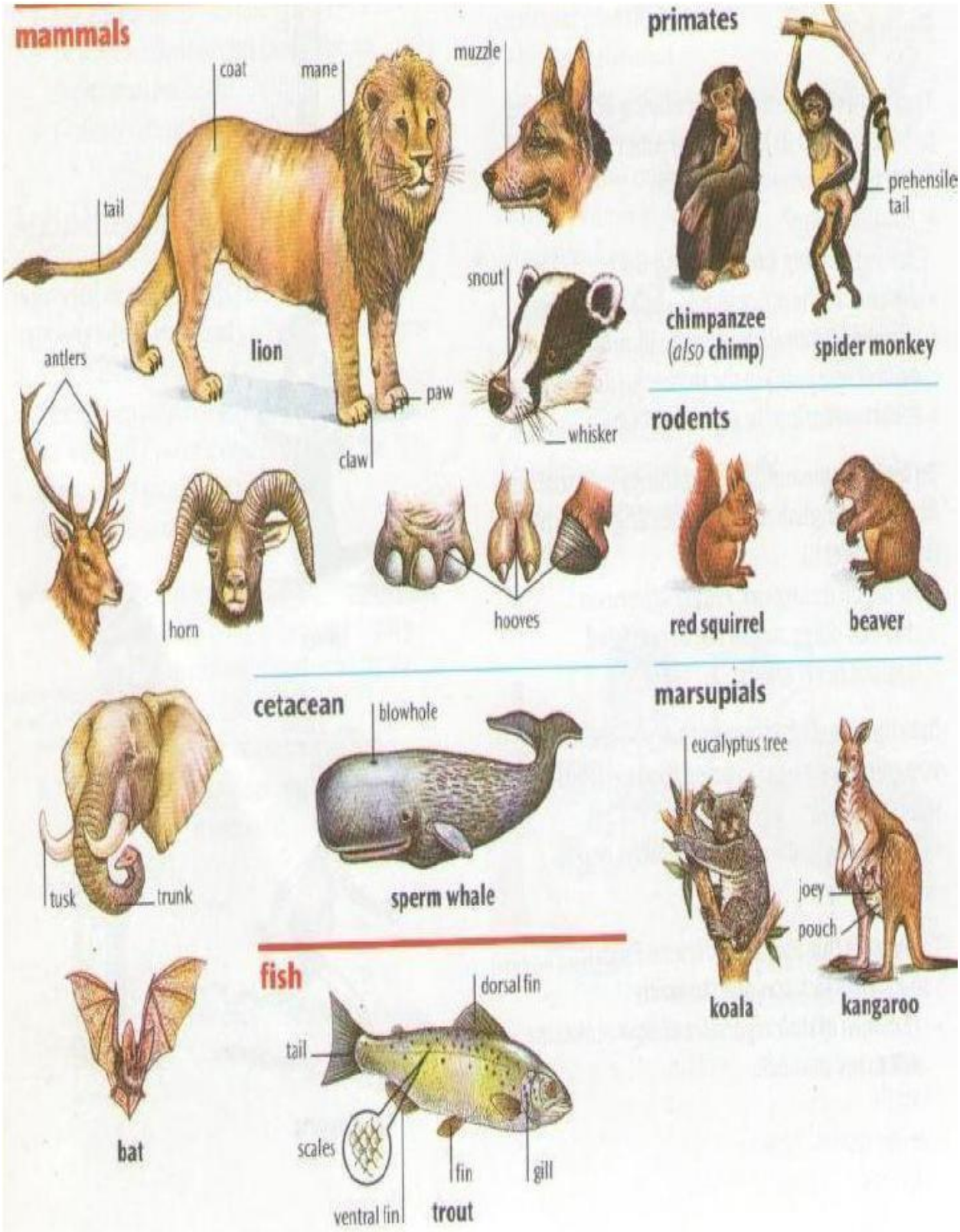
In ecology, a **niche** is a term describing the relational position of a species in its ecosystem to each other. A definition of niche is how an organism makes living. A niche is the totality of all biological and environmental factors that affect a population. It encompasses everything one can think of that allows populations to live, grow, and reproduce. The niche of an animal is all the conditions it can tolerate and

where it lives. There are two types of niches. A broad and narrow niche. An animal that has a broad niche can tolerate more conditions rather than an animal that has a narrow niche. An example of an animal that has a broad niche is an opposum. An example of an animal that has a narrow niche is a panda bear. The ecological niche describes how an organism or population responds to the distribution of resources and competitors. A niche is the functional role of a species in a community—that is, its occupation, or its living. For example, the tanager lives in a deciduous forest habitat. Its niche, its part, is gleaning insects. The community provides the habitat—the place where particular plants or animals live. Within the habitat, organisms occupy different niches.

Different species of organisms may appear to have the same habitat but each has a different niche so that they can survive in that habitat. A frog generally tends to have a broad niche. It can live in areas that have little water sources to areas that have a vast region as water sources.






mammals
coat
mane
muzzle
tail
lion
paw
claw
snout
whisker
antlers
horn
hooves
primates
prehensile tail
chimpanzee (also chimp)
spider monkey
rodents
red squirrel
beaver
tusk
trunk
cetacean
blowhole
sperm whale
marsupials
eucalyptus tree
joey
pouch
koala
kangaroo
bat
fish
dorsal fin
tail
scales
fin
gill
ventral fin
trout

BIODIVERSITY

The word biodiversity is a combination of two words: "biological and diversity" and refers to the variety of life on the Earth which includes a large number of living things that exist in a certain area (in the air, on land or in water). The area may be considered as small as heap or as big as whole planet. Hence, Biodiversity means **"the existence of a large number of different kinds of animals and plants which make a balanced environment"** is called as biodiversity. Biodiversity deals with a large variety of flora and fauna on this earth.

Ex: a wide variety of plants and animals are finding in a part of forest. The plant life range from a small herb to a large tree and the animal life vary from a tiny insect to a large mammal in addition to micro-organisms (algae, bacteria and fungi).

Biodiversity is usually considered at three different levels:

1. Genetic diversity means the variation of genes within the species.

Ex: In human species, genetic variation between an Indian and African and genetic variations within a population. (Ex: Within the Indian population) can be seen. In simple terms, genetic matter dictates whether the persons have blue or brown eyes, brown or black hair and tall or short. Genetic diversity can be identified by using a variety of DNA based and other techniques.

One estimate is that there are 1000 crores of different genes distributed across the worlds biota though they do not all make an identical contribution to overall genetic diversity.

2. Species diversity means the richness of species in all ecosystems. It is measured on the basis of number of species in a region. So far 1.75 million species have been described worldwide. Warmer areas tend to support more species than colder ones and wetter areas contain more species than drier ones. Topography and climate of the areas support and control the species of a region.

3. **Ecosystem diversity** means the study of difference between ecosystem types. Ecosystem diversity is difficult to measure since the boundaries of various sub ecosystems are overlap each other. ***Ex:*** for ecosystem diversity is Godavari – Delta ecosystem which consists of grassland ecosystem, river ecosystem, estuarine ecosystem, fresh water aquatic ecosystem, marine water aquatic ecosystem.

Importance of biodiversity: Biodiversity performs a number of ecological series for human kind that have economic and aesthetic values. As an example, the contribution of biodiversity to human health is given below: One out of 125 plant species produce a major drug as per Herb Research Foundation. Of the 118 drugs in the US, 74% are based on plants; 18% on fungi; 05% on bacteria and 03% on vertebrates. 80% of the world population relies on traditional plant medicine.

Value of biodiversity: The value of biodiversity (in terms of its commercial utility, ecological services, social and aesthetic values) is enormous. There are several ways that biodiversity and its various forms are valuable to humans. We get benefits from organisms in an innumerable ways. Sometimes, one realizes the value of the organism only after it is lost from this Earth. Every year numerous species are lost before we have a chance to know anything about them.

The biodiversity value may be classified as follows:

1. Consumptive Value*:* Biodiversity is an essential requirement for the maintenance of global food supply. The main sources of human food include animals, fish and plant produces. A large number of plants are consumed by human beings as food. A few animal species are consumed by people who come from cattle, pigs, sheep, goats, buffaloes, chickens, ducks, geese and turkey species.

Fish: Many fresh water fish can be grown in ponds. Israel and China already get about half of their fish from aqua culture.

Drugs & medicines: About 75% of the world's population depends upon plants or plant extracts for medicines. The drug Penicillin used as an antibiotic is derived from a fungus called Penicillium. Likewise, Tetracycline from bacteria which is used to cure malaria is obtained from the bark of cinchona tree.

Fuel: The fossil fuels like coal, petroleum products and natural gas are the products of biodiversity.

2. **Productive Value:** Some of the organisms are commercially usable where the product is marketed and sold. The animal products like tusks of elephants; musk from deer, silk from silkworm, wool from sheep or goats; fur of many animals etc all of which are traded in the market.

→ **Calabar bean** was tradionally used as a poison in West Africa.

→**Daisy plants** were first used as a lice remedy in the Middle East and this led to the discovery of **Pyrethrum**. Mosquito coils made from Pyrethrum are sold in the market.

→ The bacterium **Bacillus thuringiensis** produces toxic proteins that kill certain insects.

→ The **neem** *tree* has been using in birth control such as parts of neem tree that cause abortion.

3. Social Value: These are the values associated with the social life, religion and spiritual aspects of the people. Many of the plants are considered to be sacred in our country like Tulasi, Mango leaves, Banana leaves. The leaves, fruits, flowers of some of the plants are used in worship. Many animals like cow, snake, bull, peacock also have significant place in spiritual and thus hold special importance. Thus, biodiversity has distinct social value, attached with different societies.

4. Ethical Value: The ethical value means that human beings may or may not use a certain species but knowing the very fact that this species exists in nature gives pleasure.

Ex: a peculiar species of Pigeon, grey / white bird with short legs is no more on this earth. Similarly, Dodo species is also no more. Human beings are not deriving anything direct from Kangaroo, giraffe but strongly feel that these species should exist in nature.

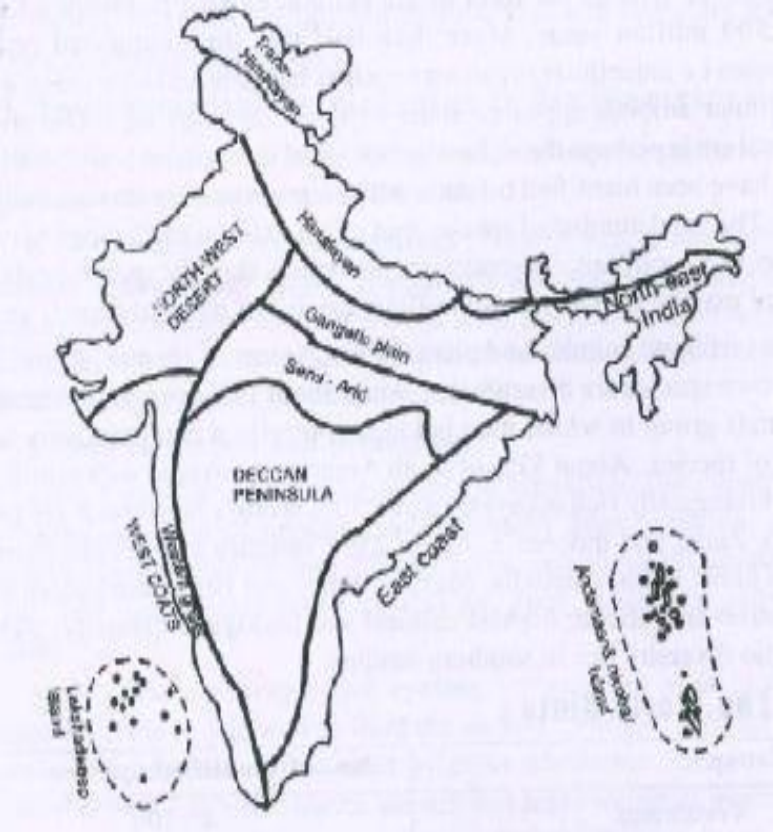
5. Aesthetic Value: Every one of us would like to visit vast stretches of lands to enjoy the visible life. People from farther areas, spend a lot of time and money to visit wild life areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco tourism. Eco-tourism is estimated to generate 12 billion dollars of revenue annually that roughly gives the aesthetic value of biodiversity. A study of the impact of environment on the psyche was undertaken by Kaplan and Kaplan (1989) in whom they found that being near nature relieved working stresses while people who worked in closed environment or human made structures experienced much more job stresses and illnesses.

India as a mega diversity Nation:

India contains a great wealth of biodiversity in the forests, wet lands and marine areas. Hence biodiversity can be observed at all levels ie locally, nationally and globally. India, as a subcontinent representing a major part of South Asia is rich in flora and fauna and hence it is one of the world's "MEGADIVERSITY NATIONS". It is estimated that over 75000 species of animals and over 45000 species of plants are found in India. The identified biodiversity in India and world is:

Group	No of Species in India	No of Species in World
Mammals	350	4629
Birds	1224	9702
Reptiles	408	6550
Amphibians	197	4522
Fishes	2546	21730
Flowering plants	15000	250000

Biogeographic regions of India: According to wild life Institute of India, the country has 10 distinct biogeographic zones or regions. They are:



1. Trans – Himalayan Zone
2. Himalayan Zone
3. Desert Zone
4. Semi – arid Zone
5. Western Ghats
6. Deccan Zone
7. Gangetic plain Zone
8. NE Indian Zone
9. Coastal Zone
10. Islands around the country.

Endangered and Endemic species:

Endangered species A species whose numbers are reduced to the point. That means endangered species are in immediate danger of extinction. The International Union Conservation of Nature (IUCN) classified the species of plants and animals as:

(a) Endangered species
(b) Vulnerable species means depleted species.
(c) Threatened species: Species (including animals, plants, fungi, etc.) which are vulnerable to endangerment in the near future)
(d) Rare species

Among the important endangered animal species, Indian wild ass; the Kashmir stag, the Golden Langur are considered highly endangered. There are also endangered bird species like Siberian crane; the great Indian Bustard; the florican. The IUCN published the data on endangered species of both plants and animals of India. The data symbolizes the working signal for those species which are endangered and if not protected are likely to become extinct in near future. India contains 172 species of animal are considered to be endangered; vulnerable; rare and threatened. These include:

Taxonomic Group	Endangered species	Vulnerable species	Rare species	Threatened species	Un known	Total
MAMMALS (Tiger; Leopard; Indian Lion; Golden cat; Desert cat; Sloth bear; Red fox; Indian wolf; golden monkey; Lion tailed Macaque)	13	20	2	5	13	53
BIRDS (Siberian white crane; Vultures; Great Indian Bustard; peacock; pelican)	6	20	25	13	5	69
REPTILES (Gharial; green sea turtle; star tortoise; python)	6	6	4	5	2	23
AMPHIBIANS	0	0	0	3	0	3
FISHES	0	0	2	0	0	2
INVERTIBRATES (crab; beetle; spider; snail)	1	3	12	2	4	22
	26	49	45	28	24	172

During the recent past, Vultures which were common have suddenly disappeared. Several species of Reptiles (lizard; snakes; star tortoise; crocodiles); ; Amphibians (frog); Invertebrates (crab, beetle; spider; snail) are also threatened due to human anthropogenic activities. India contains some of Asia's rarest animals such as: The Bengal Fox; Asiatic Cheetah; Marbled Cat; Asiatic Lion; Indian Elephant; Asiatic wild Ass; Indian Rhinoceros; Markhor; Gaur; Wild Asiatic Water Buffalo etc…

Description of the Asiatic Lion (Panthera Leo Persica):

The Asiatic Lion is very similar to the African Lion. The lion is yellowish brown in color. The male lion is distinguished by the presence of the **mane**. The lion on an average grow to about 9 feet in length. The young cubs (young lions) are often spotted or striped. Though the Asiatic lions are once widespread throughout SW Asia (Northern Greece to Central India) their numbers declined with the disappearance of grasslands. Today the Asiatic Lion is restricted to GIR National Park, Gujarat, India and the total population of the Asiatic Lion is around 250 only the effort to conserve this species was initiated as long ago as 1910 by the Nawab of Junagadh who banned the hunting of lions within his province. Emperor Ashoka used the Lion as a symbol of Power & Strength.

Endemic Species is a species that confined to a certain region and are restricted to particular areas.

Ex: Penguins usually found on a single ice-land or glaciers. About 33% of the country's flora (plants) are endemic and are concentrated mainly in : NE part of India (Rhinoceros is restricted to Assam but was once found throughout the Gangetic plain) Western Ghats (Lion – tailed macaque & Nilgiri leaf monkey and bull frog; tree frog) NW and Eastern Himalayas (Oak tree; Pine tree; Hangul deer of Kashmir ; snow leopard; jackal; wild dog; Himalayan wolf) Andaman and Nicobar islands and South India (Nilgiri Tahr is found in Nilgiri & Annamalai hills in south India) The Gangetic plains are generally poor in endemics while the Andaman & Nicobar islands are rich.

Hot spots of biodiversity:

Biologically hot spots are areas that are extremely rich in endemic species of both plant and animals. The world is identified with 25 biodiversity hot spots containing 44% of all plant species and 35% of vertebrates & 21% of invertebrates and others of all animal species in land area. The following is the list of identified bio-diversity hot spots of the world:

S.No.	Location	S.No	Location
1	**Tropical Andes** (venezula; Columbia; peru; argentina)	14	Mediterranean Basin (surroundings of Europe, Asia; Africa; Algeria; Libya; Egypt)
2	Meso America (central Mexico)	15	Caucasus
3	Caribbean (West Indies)	16	Sunda land
4	Brazil forest	17	Wallacea
5	Western Ecudor (NW of S.America)	18	Philliphines
6	Brazil's Cerrado	19	Indo-Burma region
7	Central Chile	20	South Central China
8	California Province	21	Western ghats – Sri Lanka
9	Madagascar	22	SW Australia
10	Coastal Forest of Kenya (S Africa)	23	New Caledonia
11	Western African Forests	24	New Zealand
12	Cape Province (S. Africa)	25	Polynesia / Micronesia
13	Karoo (Australia)		

Hot spots in India: Among 25 hot spots of world two found in India extending into neighbouring countries viz., 1) The Western Ghats – Sri Lanka region and 2) The Indo – Burma region covering Eastern Himalayas (The Eastern Himalayas form a distinct region which comprises Nepal, Bhutan ; Sikkim and states of Northern India).

Plants of Endemic Species*:* Of India's 45000 plant species, 1600 endemics are found in a 17000 sq kms in the Western Ghats. In Sikkim, in an area of 7298 sq kms, 4250 plant species are endemic while in Nepal, 500 species are believed to be endemic . Bhutan possesses an estimated species of 750 are considered to be endemic. Eg; oak tree; pine tree etc..

Animals of Endemic Species: Eg: Penguins . Rhinoceros (NE of India); Lion – tailed macaque

& Nilgiri leaf monkey and bull frog; tree frog (Western Ghats) Hangul deer of Kashmir ; snow leopard; jackal; wild dog; Himalayan wolf (NW and Eastern Himalayas); Nilgiri Tahr (Nilgiri
& Annamalai hills in south India).

Major threats to the Biodiversity:

Biodiversity is threatened by anthropogenic activities in many ways (by destruction of forests, over – hunting conversion of wet lands & grass lands into industrialization; mining of minerals / rocks; pollution; constructions of roads; tourism business; exploitation of timber resources etc..) to eliminate millions of species. Habitat loss is the major cause of species extinction. Habitat loss may be qualitative and quantitative losses: Qualitative losses involve a change in the structure, function or composition of the habitat.

Ex: If a paper industry discharging chemicals into a waterway system and polluting / poisoning the water, thus there has been a qualitative loss. Quantitative losses are measured by looking at a previously mapped area and determining how much of the habitat area no longer present is.

Ex: If a wet land is paved over, then there has been a quantitative loss of wet land. Diseases; the spread of non – native species threatens many local species with extinction (Ex: Dodo); climate changes (threatens to force species and ecosystems to migrate towards favorable areas) etc disturb and cause the elimination of species. .

Biogeographical classification of India: India is the 7th largest country in the world and Asia's second largest nation with an area of 32,87,263 sq km. It has a land frontier of 15,200 kms and a coast line of 7516 km. India's northern frontier's are Tibet; China; Nepal and Bhutan. In the

North West, India borders on Pakistan; in the Northeast China and in the East, Burma. The southern peninsula extends into Indian Ocean; Bay of Bengal lying to the Southeast and the Arabian Sea to the Southwest. For administrative purposes India is divided into 28 states and 7 union territories. Physically the country is divided into four relatively well defined regions:

a) Himalayan region
b) The Gangetic river plains or Indo-Gangetic plains.
c) The southern (Deccan) Plateau and
d) The islands of Lakshadweep, Andaman and Nicobar. The Himalayas in the North include the highest peaks in the world.

The highest mountains are:

a) Khanchen Junga (8586 mts) which is located in Sikkim;
b) Pir Panjal (3,600 – 4,600 mts) in Kashmir;
c) Dhaula dhar in Himachal Pradesh and
d) Siwaliks (900 – 1500 mts) in the Indo – Gangetic plains.

The northern plains of India stretch from Assam in the East to the Punjab in the West covering a distance of 2400 kms. Some of the largest rivers in India including the Ganges, Ghaghara, Brahmaputra and Yamuna flows across this region. Thar desert which is located at the western extremity of Indian part of the plains in the states of Rajasthan. Observations show that the biodiversity is far richer in NE Himalayan range compared to Northwest range. The following factors play a major role in the classification of biogeographical / biodiversity:

Climate: The climate of India is dominated by the Asiatic monsoon, mostly by southwest rains between June and October and drier winds from the North between December and February. From March to May the climate is dry and hot. .

Wet Lands: India has a rich variety of wetland habitats. The total area of wetlands excluding rivers in India is 5,82,86,000 hectares . Chilka lake (orissa) and Keoladeo National Park (Bhartpur in Rajasthan) have been designated under the convention of wetlands of International importance. The country's wet lands are generally differentiated by region into 8 categories:

1. The reservoirs of the Deccan Plateau in south
2. the vast saline expanses of Rajasthan and Gujarat
3. Fresh water lakes and reservoirs from Gujarat eastwards.
4. The delta wet lands and lagoons of India's east coast.
5. The fresh water marshes of Gangetic plain
6. The Flood plain of Brahmaputra
7. The marshes and swamps in the hills of NE India and Himalayan foot hills and the lakes and rivers of the mountain region of Kashmir and Ladakh and
8. Wet lands of the island areas of Andaman & Nicobars.

Forests: The panorama of Indian forests ranges from evergreen tropical rain forests in the Andaman and Nicobar Islands; the Western Ghats to alpine forests in the Himalayas to the North. The country has also several types of forests viz.,

a) Semi – ever green rain forests
b) Deciduous forests

c) Thorn forests
d) Pine forests
e) Tropical forests (Andaman & Nicobar Islands; the Western Ghats)
f) Rain forests (Orissa)
g) Western Ghats monsoon forests contain rosewood, Malabar, teak.
h) Tropical evergreen rain forests and tropical monsoon forests (Andaman & Nicobar)

Marine Environment: The coastal waters of India are extremely rich in fishing grounds. In 1981, it was estimated that there were approximately 1,80,000 non – mechanized boats carrying out fishing activities in these waters. At the same time, there were about 20,000 mechanized boats operating mainly out of ports in the states of Maharashtra, Kerala, Gujarat, Tamil Nadu and Karnataka. Indian coral reefs have a wide range of resources which are of commercial value. Exploitation of corals, coral debris is widespread on the Gulf of Mannar and Gulf of Kutch. Ornamental shells and pearls are the important reef industry. Other marine areas are including sea grass and prawns. Five species of marine turtle occur in Indian waters.

1. Green turtle
2. Logger head
3. Olive Ridley
4. Hawksbill
5. Leather back.

Conservation of Biodiversity: In order to maintain and conserve biodiversity, the Ministry of Environment and Forests, Govt of India has already taken several steps to manage wildlife, the objectives of which are:

1. Maintenance of a number of species in protected areas such as National Parks, Sanctuaries.
2. To improve the biosphere reserves
3. Implement strict restrictions of export of rare plants and animals
4. Educate the public on these through the Govt agencies and NGO's. Conservation of biodiversity can be carried out in two ways, as shown:

UNIT –II

1. Explain the structure and function of an ecosystem ?
2. Discuss the models of energy flow in an ecosystem ?
3. Discuss the process of ecological succession ?
4. Describe the silent features of forest ecosystems ?
5. Explain the different values of biodiversity?
6. What are the major threats to biodiversity ?
7. What is In-situ and Ex-situ conservation of biodiversity?
8. Discuss the hotspot of biodiversity?