ECOLOGY

- The term ecology was coined and described by - **E. Haeckel**
- Father of ecology - **Reiter**
- Father of Indian Ecology - **Prof. Ram Deo Misra**
- First of all term ecology was employed for study of plant by - **Warming**

The study on interaction or inter-relationship of organisms with their environment is called ecology.

Organism ‡ ˆ† Environment

Organism and environment are organization always interdependent, inter related or mutually reactive.

Branches of Ecology - It is based on organization level

1. **Autecology –** Study of the relation of a single species with its environment is known as autecology
2. **Synecology –** Study of the relation of the group of different species with their environment is known as synecology.

ECOLOGICAL HIERARCHY

Organism → Population (species) → Community → Ecosystem → Biome → Biosphere

Size → Increase

Complexity → Increase

ORGANISM

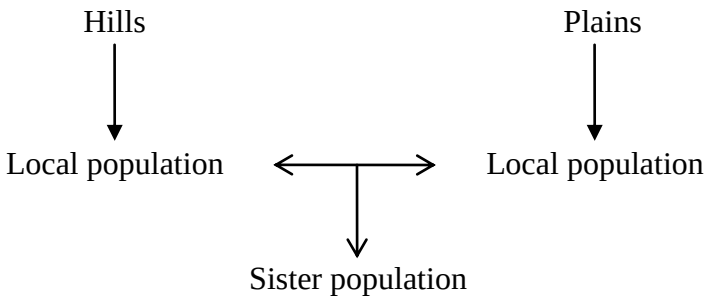
An organism is the smallest unit of ecological hierarchy and basic if ecological study.

- ♦ It may be small/large, unicellular/multicellular.
- ♦ Fixed life span and organized life cycle (birth to death)
- ♦ Ecology at the organismic level is essentially physiological ecology.

POPULATION

A group of Individuals (members) of same species living at one place (specific geographical area) constitute a population.

- ♦ **Local Population or demes (Sub groups of population) –** Population of organism inhabiting a particular area.
  e.g. Homosapiens inhabiting hills, plains
- ♦ **Sister population –** Different population of same species if organisms which are found in different places are known as sister population.



- **Meta population –** A set of local population which are interconnected by dispersing individuals.

SPECIES

Definition – Species is a basic unit of classification, defined as the group of living organisms similar in structure, function and behaviour and produced by similar parents, have common gene pool, can inter breed under natural conditions and reproductively isolated from other group of organism.

SOME TERMS RELATED TO SPECIES

- **Endemic Species or Endemism :**
  A species which is found only in a particular area is known as endemic species.
  e.g. Meta sequoia is found only in valley of China, Kangaroo in Australia
- **Key-stone Specie:**
  The species which have great influence on the community's characteristics relative to their low abundance or biomass are called key-stone species. The activities of key-stone species determine the structure of the community.
  e.g. Lion in forest, kangaroo rat in desert, fig tree in tropical forest.
- **Critical link Species :**
  The species which establishes an essential link with other species to help the latter in some vital activity is called link species.
  e.g. Mycorrhizal fungi, many insect species which work as pollinators of flowers.

COMMUNITY

Groups of organisms of different species that live in common area, which are interrelated and interdependent. It is a natural aggregation of plants and animals in the same environment.

Biotic Community = Animal community + Plant community + Microbial community

Characteristics of a community –

1. **Species Diversity -**
   There are different types of population (species) found in community, this is called species diversity. It depends on size of the area, type of area, type of soil, altitude, climate.
2. **Dominance –**
   The highest number of organism of a species present in community, is called as the dominant species. Whole community is known by the name of that particular dominant species.

e.g. Prosopis in Aravali hills, Pinus in Himalaya

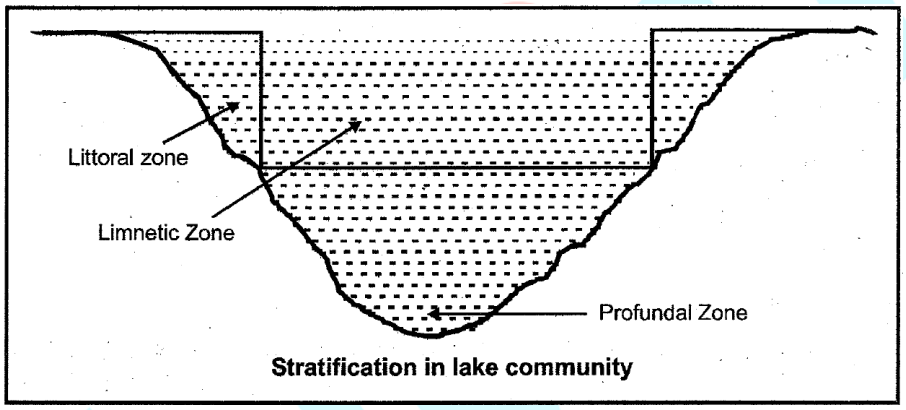
3. Stratification –

The different growth form (trees, shrubs, under shrubs, herbs) determines the structure of a plant community. Stratification is based on mode of arrangement of various growth forms.

(i) Stratification in lake

In deep lake, zonation or stratification may be according to the need of light. There are three types of zones differentiated in a deep lake.

- **Littoral Zone -** This zone is found at bank of lake where very shallow water or marshy land is present. Rooted vegetation is found is this zone.
- **Limnetic zone -** This is the zone of lake water, where light reaches in sufficient amount to entire surface area. It means this is not too deep. In this region different types of floating plants (phytoplanktons), suspended and submerged plants are present.
- **Profundal zone –** It is very deep area of the lake where light does not reach up to the bottom. Only heterotrophs are present in this zone.



Stratification in lake community

(ii) Stratification in forest -

The clear stratification (vertical arrangement) in various growth forms of plants according to the need of light in any dense forest.

Surface dewellers → Herbs → Under shrubs → Shrubs → Trees

Note :

- The **clear stratification** is found in tropical rain forest. So it is known as **multistoried forest.**

SUCCESSION

Development of plant community on barren area is called ecological succession or Biotic succession. The replacement of existing community by new ones, in an orderly sequence in barren area with time due to change in environmental conditions. **Biotic communities are never stable**. They are changing more or less over period and space, due to presence of different types of climatic & environmental conditions. So a continuous interaction is going on between the community and environment till state of stability.

Term for community in succession:-

- **Pioneer community -** The first community to inhabit an area is called Pioneer community.
- **Climax community -** The last and stable community in an area is called climax community. This is more stable. Usually **mesophytes** are present in climax community.
  An important characteristic of all communities is that composition and structure constantly change in response to the changing environmental conditions. This change is orderly and sequential parallel with the changes in the physical environment. These changes lead finally to a community that is in near equilibrium with the environment and that is called a **climax community.**
- **Seral communities or seral stage -** In succession, communities or stages which comes in between pioneer community and climax community is called transitional or seral communities.
- **Sere -** The entire sequence of communities that successively change in a given area is called sere.
  The name of sere depends on where the succession occurs or takes place.

- Succession in water → **Hydrosere / Hydrarch**
- Succession in -salty water → **Halosere**
- Succession in acidic water → **Oxalasere**
- Succession at dry Region → **Xerosere I Xerarch**
- Succession on rocks → **Lithosere**
- Succession on sand → **Psammosere**

Ecological succession shows certain characteristics :-

(1) Gradual replacement → from short lived to long lived plant.
(2) Continuous change occur in communities towards a state of stability or climax.
(3) Increases species-diversity, biomass, niche specialization, humus content.
(4) Decrease in net community productivity or annual yield.
(5) Future seral communities can be predicted as it is a directional process.
(6) Succession and evolution would-have been parallel process.
(7) Description of ecological succession usually focuses on changes in vegetation: However, these vegetational changes in turn affect food and shelter for various types of animals. Thus as succession proceeds, the numbers and types of animals and decomposers also change.

CAUSES OF SUCCESSION-

1. Biotic factors -The action of each seral community with it's environment makes the area less favourable for itself and more favourable for next seral community in the succession.

2. **Physiographic factors -** These include climatic and other physical factors like soil erosion, soil deposition, landslide, volcanic lava. These all factors like soil erosion, soil deposition, landside, volcanic lava. These all factors makes an area barren.

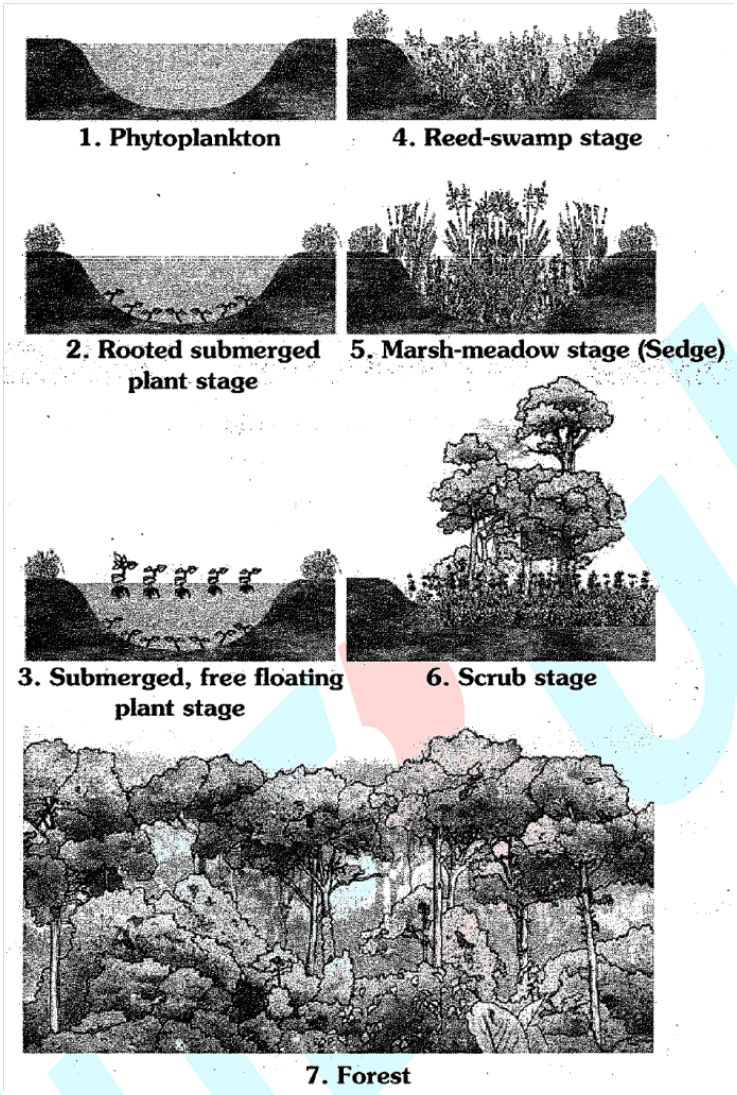
TYPES OF SUCCESSION-

1. **Primary succession -** Occurs in the barren area where there was no previously any type of living matter. e.g. volcanic lava, igneous rock, sand dunes, land slide, coral reefs.
   Note : It requires 1000(s) of years.
2. **Secondary succession -** This type of succession occur where. vegetation was. present previously but vegetation was destroyed due to natural or artificial causes i.e. fire, flood, sudden changes in climate.
   Note : This succession is comparatively more rapid, requires 50-100 years for grass land and 100-200 years for forest

HYDROSERE:

Stages of hydrosere or hydrarch succession in the newly formed pond or lake.

1. **Phytoplankton stage-** It is pioneer community, first coming minute autotrophic organism. These produce organic-matter
   e. g. Soft mud diatoms, Cyanobacteria
2. **Rooted submerged stages-** eg. Vallisneria
3. **Floating stages -** eg. Nymphaea, Nelumbium
4. **Reed swamp Stage (amphibious stage) -** Most part of these rooted plants remain exposed to air eg. Typha, Azolla
5. **Sedge** (Meadow stage or marsh meadow stage) - Muddy plants
6. **Scrub stage-** woody shrubs, tolerates water logging
7. **Forest stage -**
   e.g. Tree (Oak, Salix)



LITHOSERE:

Stages of Lithosere (Succession on rocks)

1. **Crustose lichens stage-** It is pioneer community, tolerates desiccation, produces organic acid which causes weathering of rocks. so first minerals are released for own use.
2. **Foliose lichens stage -** large lichens with leafy thalli
3. **Moss stage**
4. **Herb stage -** Annual hardy grasses
5. **Shrub stage**
6. **Forest stage**

GOLDEN KEY POINTS

1. Ecology at the organismic level also known as Physiological ecology.
2. The activities of key-stone species determine the structure of the community.
3. Stratification of lake and forest found according to the need of light.
4. The clear stratification is found in tropical rain forest.

5. In succession, climax community is always mesophytes.
6. Primary succession is slow while secondary succession is fast process.

BEGINNER'S BOX-1

1. Two populations which are interconnected by dispersing individual known as
(1) Local population (2) Metapopulation (3) Sister population (4) None

2. Kangaroo rat in desert is an example of :
(1) Keystone species (2) Critical link species
(3) Endemic species (4) Dominant species

3. Pinus community at Himalayas is an example of :
(1) Endemic species (2) Rare species (3) Dominant species (4) Keystone species

4. Which of the following zone of lake stratification also known as ecotone area ?
(1) Littoral zone (2) Limnetic zone (3) Profundal zone (4) Benthic zone

5. In which of the zone of lake stratification only heterotrophs are present ?
(1) Limnetic zone (2) Littoral zone (3) Profundal zone (4) Ecotone zone

6. Succession on sand known as :
(1) Halosere (2) Hydrosere (3) Lithosere (4) Psammosere

7. Which of the following is a pioneer community in Lithosere ?
(1) Phytoplankton (2) Foliose lichen (3) Crustose lichen (4) Moss

INTER SPECIFIC INTER ACTIONS

Due to increase in different species in community, interaction for food, habitat and light etc. also starts between them.

(a) **Positive or beneficial interaction-** Member of one or both the interacting species are benefitted but neither is harmed.

(b) **Negative interaction** - One or both interacting species is harmed.

POSITIVE OR BENEFICIAL INTERACTIONS

It is a wide spread phenomenon, it includes → mutualism, commensalism, protocooperation.

1. **Mutualism (+, +) or Obligate mutualism (co-evolution, co-existence and co-extinction)**
Positive inter specific interation in which members of two different species completely depend on each other for growth and survival. **It is obligatory relationship.**

- **Mutualism between animal and animal -**
  e.g. Termites and Flagellates (Trichonympha)
- **Mutualism between plant & animals -**
  e.g. Yucca plant flowers and Pronuba insects – Pollination of yucca plant by pronuba (Female yucca moth)
- **Mutualism between algae and fungi -**
  e.g. Lichens

- **Fig tree and wasp species -** In many species of fig trees, there is a tight one to one relationship with the pollinator species of wasp, It means that a given fig species can be pollinated only by its partner wasp species and no other species. The female wasp uses the fruit not only as an oviposition (egg-laying) site but uses the developing seeds with in the fruit for nourishing its larvae. The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. In return for the favour of pollination the fig offers the wasp some of its developing seeds, as food for the developing wasp larvae.
- **Bees and orchid flower -**
  Orchids show diversity of floral patterns, which have evolved to attract the right pollnator insect (bees and bumblebees) and ensure guaranteed pollination by it.
  The mediterranean orchid **Ophrys** employs "sexual deceit" to get pollination done by a species of bee. One petal of its flower bears resemblance to the female of the bee in size, colour and markings. The male bee is attaracted to what it perceives as a female, **pseudocopulates** with the flower and during that process is dusted with pollen from the flower, it transfers pollen to it and thus, pollinates the flower.

2. Commensalism (+, 0) -
Association between members of two species in which one is benefitted while other is almost unaffected.

- **Lianas -** are woody plants. Their roots are present in soil but their stem use other plant or object for support to get better light. They are found in dense forest. No nutritional relationship. Lianas are the speciality of tropical rain forest.
  e.g. Bauhinia, Tinospora
- **Epiphytes -** Small plants grow on other plants in tropical rain forest. They utilise only the space of host plant for light & humidity
  e.g. Orchids, Hanging mosses
- **Epizones -** Those animals which depends on plants or other animals.

Sucker fish (Echeneis)	-	Shark
Pilot fish	-	Shark
E. coli bacteria	-	Intestine of man
Clown fish	-	Sea anemone
Barnacles	-	Whale
Cattle egret birds	-	Cattle

3. Proto-cooperation (+/+) - Association in which both organisms are benefited but can live separately, it is a facultative or optional or occasional association also called as **non-obligatory** relationship.

e.g.

• Hermit crab	-	Sea anemone
• Tick bird (Red-billed or yellow billed)	-	Rhinoceros
• Crocodile	-	Bird

Scavenging - Association in which one partner called scavenger or saprobiont, eats the dead bodies of other animals, which have died naturally or killed by another animal

e.g. Jackal, Vulture, Ant, Crow

Helotism - Association in between two organisms, when one behaves as a master and another as slave.

e.g. Lichen

NEGATIVE INTERACTION (ANTAGONICSM) DETERIMENTAL

Three type of negative interaction

(1) Exploitation (2) Amensalism (3) Competition

(1) Exploitation - One species harms the other by making its direct or indirect use for support, shelter or food.

It is of two types

(a) Parasitism

(b) Predation

(a) Parasitism (+ / –) → This association involves individuals of two species of different size in which smaller (Parasite) is benefitted and larger (host) is harmed. The parasite gets nourishment and shelter from host but **do not kill** the host.

Majority of the parasites harm the host: they may reduce the survival, growth and reproduction of the host and reduce its population density. They might render the host more vulnerable to predation by making it physically weak.

Many parasites have evolved to be host-specific (they can parasitise only a single species of host) in such a way that both host and the parasite tend to co-evolve; that is, if the host evolves special mechanisms for rejecting or resisting the parasite, the parasite has to evolve mechanisms to counteract and neutralise them, in order to be successful with the same host species. In accordance with their life styles, parasites evolved special adaptations such as the loss of unnecessary sense organs, presence of adhesive organs or suckers to cling on to the host, loss of digestive system and high reproductive capacity.

Type of Parasite :

(i) Ectoparasite → lives on the body of host

- **Ectozooparasite -** Leech on cattle, ticks on dogs, copepods on marine fish and lice on human.
- **Ectophytoparasite -** Aphids, Lac insects, Red cotton bug live on plants.

(ii) Endoparasites → live in the body of host

- Tapeworm, Taenia, Ascaris, Entamoeba → live in intestine of man
- Plasmodium → live in R.B.C. of human.

Note :

The life cycle of parasite are often complex, involving one or two intermediate host or vectors to complete their life cycle.

For example : The human liver fluke (a trematode) depends on two intermediate host (snail and fish) to complete its life cycle.

- **Hyper parasitism** → A parasite living on another parasite
  e.g. Bacteriophages on bacteria.
- **Brood parasitism** → Parasitism in which the parasitic bird (cuckoo) lays its eggs in the nest of its host (crow) and lets the host incubate them, this relation is known as brood parasitism .
- **Holo parasite** → Parasite which are totally dependent upon the host for their requirement ·
  e.g. Rafflesia, (Total root parasite)

Cuscuta (Total stem parasite)

- **Hemiparasite** → Parasite which partially depend on the host

e.g. Viscum – on oak; Loranthus – on mango } both are partial stem parasite.

Note:

(1) Arceuthobium is the smallest parasitic angiosperm.

(2) Female Anopheles mosquito is not considered as parasite.

(b) **Predation (+/–)** :- A free living organisms which catches and **kills** another species for food.

1. When we think of predator and prey, most probably it is the tiger and the deer that readily come to our mind, but a sparrow eating any seed is no less a predator.

2. Predators acting as **'conduits'** for energy transfer across trophic levels, also play other important roles. They keep prey populations under control. In the absence of predators, prey species could achieve very high population densities and cause ecosystem instability. When certain exotic species are introduced into a geographical area, they become invasive and start spreading fast because the invaded land -does not have its natural predators.

The **prickly pear cactus** introduced into Australia in the· early 1920's caused havoc by spreading rapidly into millions of hectares of rangeland (grassland). Finally, the invasive cactus was brought under control only after a cactus-feeding predator (a moth) from its natural habitat was introduced into the country.

3. Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.

In the rocky intertidal communities of the American Pacific Coast the starfish **Pisaster** is an important predator. In a field experiment, when all the starfish were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year, because of **interspecific competition**.

4. If a predator is too efficient and **overexploits** its prey, then the prey might become extinct and following it, the predator will also become extinct due to lack of food. This is the reason why predators in nature are **'prudent'** (clever).

5. Prey species have evolved various defenses to lessen the impact of predation. Some species of insects and frogs are cryptically-coloured (camouflaged) to avoid being detected easily by the predator. Some are poisonous and therefore avoided by the predators. **The Monarch butterfly** is highly distasteful to its predator (bird) because of a special chemical present in its body. This butterfly acquires this chemical during its caterpillar stage by feeding on a poisonous weed.

6. For plants, **herbivores are the predators**. Nearly 25 per cent of all insects are known to be phytophagous (feeding on plant sap and other parts of plants). The problem is particularly severe for plants because, unlike animals. they cannot run away from their predators. Plants therefore have evolved an astonishing variety of morphological and chemical defences against herbivores. **Thorns (Acacia. Cactus)** are the most common morphological means of defence.

Many plants **produce and store chemicals** that make the herbivore sick when they are eaten. inhibit feeding or digestion. disrupt its reproduction or even kill it. The weed **Calotropis** produces highly poisonous **cardiac glycosides** and that is why you never see any cattle or goats browsing on this plant.

(2) **Amensalism (– / 0) -**

In this interaction one species is inhibited by toxic secretion of other species.
e.g. Parthenium

(3) Competition (–, –) :

Process in which the fitness of one species is significantly lower in the presence of another species.

1. It is generally believed that competition occurs when closely related species compete for the same resources that are limiting, but this is not entirely true. Firstly, totally unrelated species could also compete for the same resource. For e.g. in some shallow South American lakes, visiting **flamingoes** and **resident fishes** compete for their common food, the zooplankton in the lake.

Secondly, resources need not be limiting for competition to occur: in interference competition (indirect competition), the feeding efficiency of one species might be reduced due to the interfering and inhibitory presence of the other species, even if resources (food and space) are abundant.

2. Therefore, competition is best defined as a process in which the fitness of one species (measured in terms of its 'r' the intrinsic rate of increase) is significantly lower in the presence of another species. It is relatively easy to demonstrate in laboratory experiments, as **Gause and other** experimental ecologists did, when resources are limited the competitively superior species will eventually eliminate the other species. The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats.

3. **Connell's elegant field experiments** showed that on the rocky sea coasts of Scotland, the larger and competitively **superior barnacle Balanus** dominates the intertidal area, and excludes the **smaller barnacle Chathamalus** from that zone.

4. **Gause's 'Competitive Exclusion Principle'** states that two closely related species competing for the same resources cannot co-exist long period and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting, but not otherwise.

More recent studies do not support such gross generalisations about competition. While they do not rule out the occurrence of interspecific competition in nature; they point out that species facing competition might evolve mechanisms that promote co-existence rather than exclusion. One such mechanism is **'resource partitioning'**. If two species compete for the same resource, they could avoid competition by choosing, different times for feeding or different foraging patterns. **MacArthur showed** that five closely related species of **warblers** living on the same tree were able to avoid competition and co-exist due to behavioural differences in their foraging activities.

5. Another evidence for the occurrence of competition in nature comes from what is called 'competitive release'. A species whose distribution is restricted to a small geographical area because of the presence of a competitively superior species, is found to expand its distributional range when the competing species (Superior species) is experimentally removed.

Note : Interspecific competition is a potent force in organic evolution.

SOME TERMINOLOGY

Ecotone - The transition zone in between two communities is called ecotone or tension zone. It has greater number of species & density or it is a transition zone between two communities

where one type of community is modifying into another type of community is known as ecotone.

Edge effect - Species which occur most abundantly and spend their time in ecotone are called edge species. The tendency to increase variety and density of some organism at the community border is known as edge effect.

Biotic potential (Reproductive potential or potential ability) → The term biotic potential was first used by **Chapmann**.

Under most favourable environmental conditions the maximum reproductive capacity of an species is known as biotic potential.

Vitality- Capacity of normal growth and reproduction for survival of a species. It depends upon weight of plant, stem height, root length, leaf number etc.

Ecological Niche - Word is given by **Grinnel**. It is the **functional role** of any species in a ecosystem or community. In other words it is a occupational address or profession of a species it means it is a functional position or status in an ecosystem.

Habitat - Physical area covered by any organism

Micro climate and Micro habitat - Subdivision of habitat is called microhabitat it is an immediate climate (real climate) of an organism which is different from the average climate of region.

e.g. Forest floor, Burrow and surface of desert.

GOLDEN KEY POINTS

1. Mutualism is obligatory relationship, in which related species show co-evolution, co-extinction and co-existence.

2. In parasitism both host and parasite tend to co-evolve. If the host evolves special mechanism for rejecting or resisting the parasite, the parasite has to evolve, mechanism to counteract and neutralise them.

3. Predators help in maintaining species diversity in a community.

4. In competition fitness of one species is significantly lower in the presence of another species.

5. **Gause's competitive exclusion principle** states that two closely related species competing for the same resources cannot co-exist long period and the competitively inferior one will be eliminated, but this may be true- if resources are limiting, but not otherwise.

6. **Predation parasitism and commensalism -share a common characteristic -** the interacting species live closely together.

7. Herbivores and plants appear to be more adversely affected by competition than carnivores.

BEGINNER'S BOX-2

1. Relation between fig tree and wasp species :
(1) commensalism (2) Mutualism (3) Parasitism (4) Amensalism

2. Predators help in :
(1) Maintaining species diversity (2) Reduce the competition between prey species
(3) Maintaining ecological balance (4) All

3. Which one is example of holoparasite ?
(1) Cuscuta (2) Viscum (3) Loranthus (4) Sea anemone

4. Which one is example of ectoparasite :
(1) Ticks (2) Plasmodium (3) Ascaris (4) Taenia

5. Relation between clown fish and sea anemone :

(1) Mutualism (2) Commensalism (3) Parasitism (4) Sea anemone

ECOSYSTEM

- **A.G. Tansley -** The term "ecosystem" first of all coined by A.G. Tansley.
  According to Tansley - Ecosystem is symbol of structure and function of nature.
- **E.P. Odum -** Father of ecosystem ecology.
  According to E.P. Odum - Ecosystem is the smallest structural and functional unit of nature or environment.

Definition - Total living factor (biotic) and total non living factor (abiotic) of the environment present in a particular area is called ecosystem.

Note:

- The boundaries of ecosystem a.re indistinct .and have a overlapping character over each other.
- Ecosystem is the smallest structural and functional unit of nature or environment. It is a self regulatory and self sustaining unit.
- Ecosystem may be large or small. Single drop of water may be an ecosystem.
- Ecosystem may be temporary or permanent.

TYPE OF ECOSYSTEM

(1) Natural Ecosystem (2) Artificial Ecosystem

(1) Natural Ecosystem-

(a) Terrestrial Ecosystem-
e.g. forest, grassland, tree, desert ecosystem

(b) Aquatic ecosystem - Aquatic ecosystem is again of two type :
(i) Lentic ecosystem → Stagnant water e.g. lake, pond, swamp.
(ii) Lotic - Running fresh water ecosystem e.g.- river.

(2) Artificial Ecosystem - Man made e.g. cropland, Gardens etc.

On the basis of size, types of ecosystem

(i) Mega ecosystem - Ocean/Sea
(ii) Macroecosystem - Forest
(iii) Microecosystem - Pond
(iv) Nanoecosystem - Drop of water

COMPOMEMTS OF ECOSYSTEM

Every ecosystem is composed of two components ..:

(A) Biotic component (B) Abiotic component

It involve all living (plant, animal and microbes) of ecosystem. Biotic component are mainly of two type.

1. Producers-

All the autotrophs of ecosystem are called producers. They prepare their own food. The green plants are the main producers. In the process of photosynthesis, producers absorb solar energy and convert it into chemical energy so producers are also called **transducers** or **converters.** Energy enters into the ecosystem through the producers. The **solar energy** is the only ultimate source of energy in ecosystem. This energy is available for the remaining living organisms.

- **In aquatic ecosystem :** Floating plants called **phytoplankton** are the major autotrophs.

2. Consumer-

All the heterotrophs of the ecosystem are known as consumers. They directly (herbivores) or indirectly (Carnivores) depend on the producers for food.

Types of consumer

(i) Macroconsumers (ii) Microconsumers

(i) Macro consumers (Phagotrophs or holozoic) -

They digest their food inside the body i.e. first ingestion then digestion.

Macro consumers are of following type

(a) Primary consumer - Such living organisms which obtain food directly from producers or plants are known as primary consumers.

e.g. herbivores of ecosystem, cow, grazing cattle, Rabbit etc .

- These are also known as secondary producers.

(b) Secondary consumers or primary cornivores - Animals which feed upon primary consumers and obtain food. Those carnivores which kill and eat the herbivores.

e.g. Dog, cat, snake etc.

(c) Top Consumers- Those animals which kill other animals and eat them, but they are not killed & eaten by other animal in the nature.

e.g. Lion, man, hawk, peacock etc.

(ii) Micro Consumers/Decomposers or Saprotrophs/osmotrophs-

Those living organisms which decompose the dead body of producers and consumers are known as decomposers or reducers or transformers or osmotrophs.

Note-

- The main decomposers in ecosystem are bacteria and fungi.
- **Decomposers play a significant role in mineral cycle.** Decomposers are responsible for converting complex organic material of dead animals or plants into simpler organic matter through the process of decomposition and release mineral substances into the soil where these are reused by the producers, So that soil is considered as the best resource of minerals.
- In Bacteria and fungi, process of decomposition completely takes place outside the body. They release enzymes from their body on dead remains and decompose it into simpler organic substances and then absorb it so these are called as **osmotrophs (absorptive).**

Functional aspects of ecosystem :-

(i) Energy flow
(ii) Nutrient cycling
(iii) Productivity
(iv) Decomposition

Energy flow - The storage, expenditure, transformation of energy is based on two basic law of thermodynamics :-

- **First law of thermodynamics -** Energy is neither created nor destroyed but only transformed from one state to another state.
- **Second law of thermodynamics (the law of entropy) -**The transfer of food energy from one to another organism leads to loss of energy as heat due to metabolic activity. Further, ecosystems are not exempt from the Second Law of thermodynamics. They need a constant supply of energy to synthesise the molecules they require; to counteract the universal tendency toward increasing disorderliness.

FOOD CHAIN

In ecosystem every organism depends on other organism for food material and all organism are (Plants, herbivores, carnivores) arranged in a series in which food energy is transferred through repeated eating and being eaten. It is called food chain. In food chain, energy flow is in the form of food.

In a food chain, food material or food energy transfer is from one trophic level to next trophic level.

Four trophic levels are present in the ecosystem, because level of energy decreases during the flow of energy from one trophic to the another trophic level.

First trophic level	$[T_1]$	=	Producers
Second trophic level	$[T_2]$	=	Primary consumers
Third trophic Level	$[T_3]$	=	Secondary consumers
Fourth trophic level	$[T_4]$	=	Top consumers

Note-

1. There are **five trophic levels** found in highly complex ecosystem in which tertiary consumer is present in between the secondary consumers and top consumer. Then the fifth trophic level(T_5) is formed by the top consumer.

2. In food chain energy flow is **unidirectional** (producers to top consumers)

3. Shorter food chains will provide greater energy.

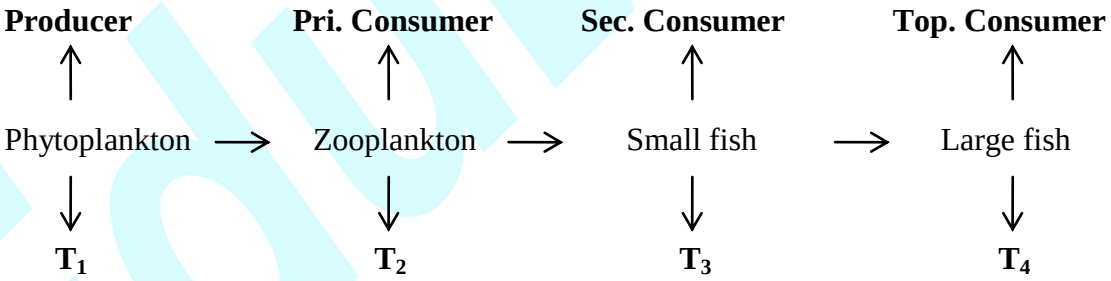
4. Generally the decomposers (Bacteria and Fungi) are not included in the food chain.

TYPE OF FOOD CHAINS

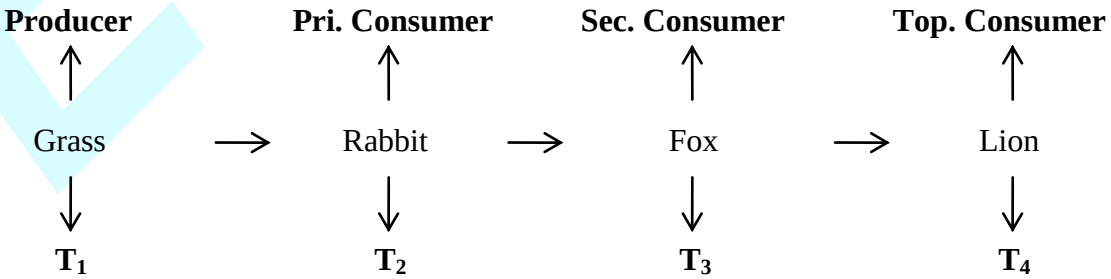
In nature three types of food chains are present

1. **Grazing food chains or Predatory food chain -** Most of food chain in nature are of this type. This food chain begin? with **producers** (plants) and in successive order it goes from **small organism to big organism.**

Aquatic ecosystem :

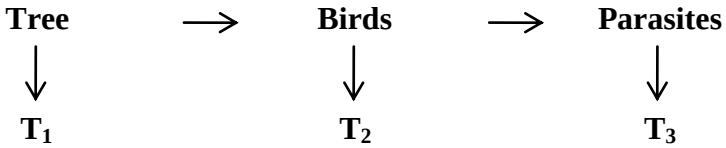


Grass land ecosystem :



2. **Parasitic food chain** – This food chain also starts from **producers** but in successive order it goes from **big organism to the smaller organism.**

Tree ecosystem -



Note : Both above food chains are directly dependent on **solar radiation** (as a primary source of energy) and have **rapid energy flow.**

3. **Detritus food chain or Saprophytic food chain –** This food chain begins with decomposition of dead organic matter by **decomposers** so it is also known as saprophytic food chain. In this food chain primary consumers are bacteria and fungi.

Dead organic matter → bacteria, fungi

Note :

- In detritus food chain **energy flow** is rather very slow yet **magnitude** of energy is great.
- In mangrove vegetation this food chain goes up to big organism.

  Dead mangroves leaves → Bacteria & fungi → Amphipds, molluscs, crabs, nematodes → small fishes → Tiger.
  - In an aquatic ecosystem, **GFC (Grazing Food Chain)** is the major conduit (source) of energy flow. As against this, in a terrestrial ecosystem, a much larger energy flow through the **(DFC) Detritus food cahin** than through the grazing food chain.
  - In Sunderbans, Tigers feed on the fishes and crab in the absence of their natural prey.

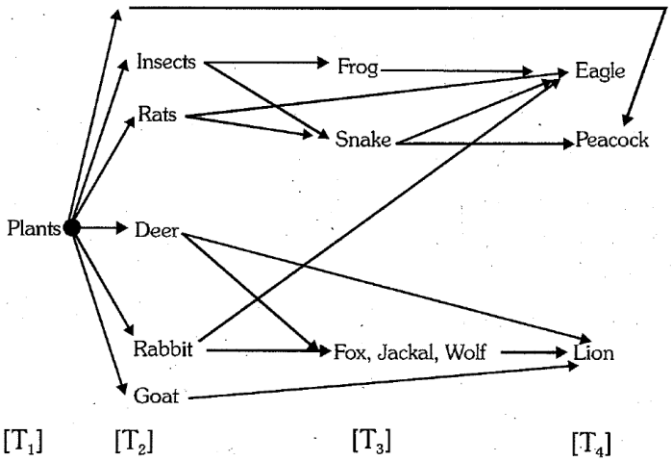
SPECIAL POINT OF BIOTIC FACTOR

- **Nutrient Immobilisation -** In the process of decomposition, some nutrients get tied up with the biomass of microbes and become temporarily unavailable to other organisms. Such incorporation of nutrient in living microbes (bacteria & fungi) is called nutrient immobilisation.
- In aquatic system **whale** is secondary consumer. It is an example of **filter feeder** because it feeds on plankton.
- **Plant parasites** are known as primary consumers while animals parasites (E. coli bacteria, Entamoeba histolitica, liver fluke, tapeworm) are known as secondary consumers.
- **All the insectivorous** plants play the double role i.e. producer as well as secondary consumer because they synthesise their own food through photosynthesis and they eat insects simultaneously.
- Man, peacock, cockroach and crow are omnivores.
- Organisms which use milk or curd as food, are known as secondary consumer.

  Note : Inorganic materials autotrophs (**Producers**) and **decomposers** are essential in ecosystem but, **macro consumers** are non essential.

FOOD WEB

In big ecosystem many food chains are interlinked together on different trophic levels to form food web. In food web transfer of food energy is unidirectional but from many different alternative path way. In food web members of a particular trophic level obtain their food according to their choice and taste but that type of facility is not present in food chain. It means they have more than one option or alternative for getting food.



As much as food web is complex that ecosystem is more permanent or stable, such type of ecosystem is not destroyed naturally and continues for long time. This ecosystem is not affected by loss of any organism of any particular trophic level. Those ecosystems which have simple food web are not very stable it means that they can be finished at any time, if there is a change in any particular trophic level.

Homeostasis -

Ecosystem is a dynamic (functional) system because continuous interaction is going on in between biotic or abiotic components so ecosystem is present in an equilibrium position. Ecosystem is also self maintainable and selfregulatory system, it means an ecosystem maintains a balance in between different trophic levels. Each trophic level controls the other trophic level in an ecosystem. If any change take place in any trophic level of ecosystem, the other trophic levels of this ecosystem may react according to it. So ecosystem always remain in equilibrium. This feature of system is known as homeostasis.

PYRAMIDS OF ECOSYSTEM

Graphical representation of ecological parameters at different trophic level in ecosystem is called pyramids. These parameters are Number, Biomass and Energy. First of all, pyramid was formed by Charls Elton ; So we called it Eltonian pyramids.

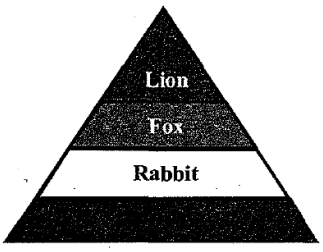
In pyramids basal, mid and top tiers show the parameter values for producer, herbivores and carnivores in the ecosystem.

THESE PYRAMID ARE OF THREE TYPES

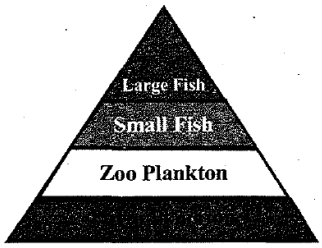
(1) Pyramids of number (2) Pyramids of biomass (3) Pyramids of energy

(1) Pyramids of number-

In this type of pyramid the number of individual organism in various trophic level is shown. These pyramids are mostly upright, because number of producers [T_1] is maximum and No. of herbivores and carnivores decrease towards apex or at successive trophic levels, such as Grassland ecosystem and aquatic ecosystem.

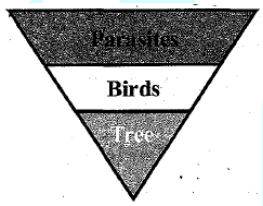


Grass land Ecosystem



Aquatic Ecosystem

But in a tree ecosystem the pyramid of numbers is inverted. This is called parasitic ecosystem because birds (herbivores) depend on the tree (producer) and parasites (consumer) depend on birds, therefore with increase in the no. of trophic levels, the number of the organisms increases sequentially.



Tree Ecosystem

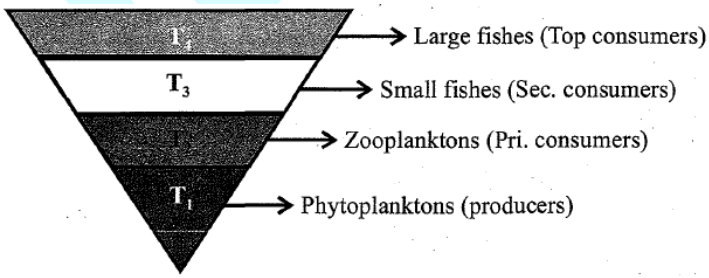
Note: **(1)** Pyramid of number shows **biotic potential** of a ecosystem.
(2) Maximum number of producers are present in aquatic ecosystem. **The number of organism at any trophic level depends upon the availability of organism which are used as food** on lower level so availability of food is main factor.

(2) Pyramid of Biomass -

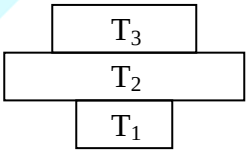
Pyramids of biomass represent the total amount of biomass of each trophic level of ecosystem, mostly these pyramids are also upright (erect) e.g. (tree ecosystem}, forest ecosystem.

Tree ecosystem Grass land ecosystem

Pyramids of biomass in **aquatic ecosystem** is inverted because in it producers are micro-organism and their biomass is veryless.

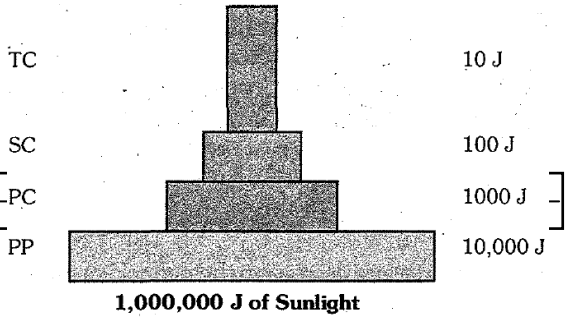


Note : Pyramid of lake on the basis of biomass –



(3) Pyramids of energy -

It represents amount of energy at different trophic levels, energy pyramids are always upright or



erect because there is a gradual decrease in energy at successive trophic levels. According to the 10% law of Lindeman, the 90% part of obtained energy of each organism is utilized in their various metabolic activities and heat and only 10% energy is transferred to the next trophic level. So 90% energy is lost at each trophic level, therefore top consumers like lion etc. are ecologically weakest but physically they are strong.

Note : Pyramids of energy represent the productivity of ecosystem as well as transfer of production in ecosystem.

Limitations of Ecological Pyramids -

(i) It does not take into account the same species belonging to two or more trophic lavels.
(ii) It does not accommodate a food web.
(iii) Saprophytes are not given any place.

Some Special point related to biomass :

(i) **Standing crop -** Total amount of **living organic matter** present in particular area in particular time in an ecosystem is known as standing crop. It may be expre5sed in terms of weight per unit area. Biomass is the standing crop expressed in terms of weight (i.e. organism mass). Biomass is measured by **bombcalorimeter**.

(ii) **Standing quality or Standing state-** Total amount of **inorganic substances** such as P, S, N, H present in particular area at a particular time in an ecosystem is known as standing state.

Note : The pyramids of biomass show the standing crop of ecosystem.

PRODUCTIVITY

There are two type of productivity present

(i) **Primary productivity -**

Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (g/m^2) or energy (Kcal m^{-2}). The rate of biomass production is called productivity. It is expressed in terms of g m^{-2} yr^{-1} or (Kcal m^{-2}) yr^{-1} to compare the productivity of different ecosystem.

It is of two types :

(a) **Gross primary productivity (G.P.P.) -** It is the total amount of energy fixed (organic food) in an ecosystem (in producers) in unit time is called G.P.P. including the organic matter used up in respiration, during the measurement period. It is also known as total (Gross) photosynthesis. A considerable arnount of GPP is utilised by plants in respiration.

(b) **Net primary productivity (N.P.P.) -** It is the amount of stored organic matter in plant tissues after respiratory utilization

NPP = GPP – R (R = Respiration I Metabolic activities)

or

GPP = NPP + R

- NPP is the available biomass for the consumption to heterotrophs.

(ii) **Secondary productivity -** Sec. productivity is the rate of formation of new organic matter by consumers.

Note : Net community productivity or Net productivity -

The rate of storage of organic matter not used by the heterotrophs

NCP = N.P.P. – HR (HR = Energy used by Heterotrophs)

Some informations related to productivity -

(1) Primary productivitydepends on the plant species inhabiting a particular area. It also depends on a variety of environmental factors availability of nutrients and photosynthetic capacity of plants. Therefore it varies in different type of ecosystem. The annual net primary productivity of the whole biosphere is approximately **170 billion tons** (dry weight) of the organic matter. Productivity of the ocean are only **55 billion tons.**

(2) In perunit area maximum productivity found in tropical rain forest.

(3) In water, least productive ecosystem is very deep lakes and highly productive ecosystem is coral reef.

(4) Nitrogen is the limiting factor in ocean and phosphorus is the limiting factor in lake productivity.

GOLDEN KEY POINTS

1. The boundaries of ecosystem are indistinct and have a overlapping character over each other.
2. Natural ecosystem show high stability as compare to artificial ecosystem due to high species diversity.
3. During photosynthesis primary producers absorb solar energy and convert it into chemical energy so producers are also called **transducer** or **converters**.
4. Decomposers play a significant role in mineral cycle so that presence of decomposers is essential for stability or existence of ecosystem.
5. There are two basic function of ecosystem (i) Energy flow (ii) Nutrient cycling
6. Ecosystem are not exempt from the second law of thermodynamics.
7. Tertiary consumer is present in between the secondary consumer and top consumer.
8. Generally the decomposers (Bacteria/Fungi) are not included in the food chain but when included then included as the last trophic level.
9. Pyramid of number shows biotic potential of a ecosystem. Pyramid of biomass show the standing crop of ecosystem. Pyramid of energy represent the productivity of ecosystem.
10. **Net primary productivity (NPP)** is the available biomass for the consumption to heterotrophs.

BEGINNER'S BOX - 3

1. Grass $\rightarrow$ Deer $\rightarrow$ Tiger
In this food chain, the biomass of grass is 1 tonne. The tiger biomass will be :
(1) 100 kg (2) 10 kg (3) 1 kg (4) 1000 kg

2. An ecosystem is a complete interaction of :
(1) Individual (2) Population
(3) Community and their soil condition (4) Community and their physical environment

3. What is correct for transducers :
(a) They converts solar energy into chemical energy
(b) They have first trophic level
(c) They are osmotrophs
(d) Those are show nutrient immobilization
(1) b, c (2) a, b (3) c, d (4) a, d

4. Ecosystem resists change because its stage is :
(1) Imbalance (2) Homeostasis
(3) Deficient component (4) Affected by light

5. On Earth in per unit area maximum productivity occur in :
(1) Tropical rain forest (2) Ocean
(3) Temperate deciduous forest (4) Marsh

6. In which of the following ecosystem pyramids are always upright ?
(1) Tree ecosystem (2) Lake ecosystem
(3) Grass land ecosystem (4) All of above

7. On the basis of ecology which is not essential for self sustaining ecosystem :
(1) Producer (2) Macro-consumers (3) Micro-consumers (4) All of above

8. Which of the following is not recycled in an ecosystem :
(1) Water (2) Carbon (3) Energy (4) Nitrogen

ABIOTIC ENVIROMENTAL FACTORS OF ECOSYSTEM

Key elements that lead to so much variation in the physical and chemical conditions of different habitats?
The most important ones are temperature, water, light and soil.
(A) Light **(B) Temperature** **(C) Soil** **(D) Other**

LIGHT

It is a complex physical environmental factor. Light is measured by **luxmeter or photometer**. It is a electromagnetic spectrum.
Solar Constant- Solar radiation before entering the atmosphere carries energy at a constant rate i.e., 2 cal cm^{-2} min^{-1} known as the solar constant.

In solar radiation wavelength (λ) of light or visible spectrum is 0.4 to 0. 7 μm (400-700 nm) it is also called **photosynthetically active radiation (PAR).**

The U. V. radiation distinguished in
u. v. - c → (0.100 to 0.280 μml
U. V. - B → (0.280 to 0.320 μm)
U. V. -A → (0.320 to 0.400 μm)

Albido value-
The ability of a surface to reflect the incoming radiation is called albido value (AV) it is 80% for fresh snow, **20-30%** for sand, **5-10%** for the forest.

Except for the deep sea hydro-thermal ecosystem. sun is the only source of energy for all ecosystems on Earth. Of the incident solar radiation (SRl) less than **50 per cent** of it is photosynthetically active radiation **(PAR).** Plants capture only **2-10 per cent** of the PAR and this small amount of energy sustains the entire living world.

Many species of small plants (herbs and shrubs) growing in forests are adapted to photosynthesise optimally under very low light conditions because they are constantly overshadowed by tall, canopied trees. Many plants are also dependent on sunlight to meet their photoperiodic requirement for flowering. For many animals too, light is important in that they use the diurnal and seasonal variations in light intensity and duration (photoperiod) as cues for timing their foraging, reproductive and migratory activities. The availability of light on land is closely linked with that of temperature since the sun is the source for both, But, deep

(500m) in the oceans, the environment is perpetually dark and its inhabitants are not aware of the existence of a celestial source of energy called Sun. What, then is their source of energy?).

TEMPERATURE

Temperature is measured by the thermometer and under water by thermistor.

Effect of Temperature on animal -

Temperature affect the absolute size of an animal and its body parts.

1. **Bergman rule -**
   Birds and mammals attain greater body size in cold region and lesser in warm region.
2. **Aliens rule -**
   Mammals from colder climates generally have shorter ears and limbs to minimise heat loss. (This is called the **Allen's Rule.**)

Heat loss or heat gain is a function of surface area. Since small animals have a larger surface area relative to their volume, they tend to lose body heat very fast when it is cold outside; then they have to expend much energy to generate body heat through metabolism. This is the main reason why very small animals are rarely found in polar regions.

Temperature is the most ecologically relevant environmental factor. You are aware that the average temperature on land varies seasonally, decreases progressively from the equator towards the poles and from plains to 'the mountain tops. It ranges from subzero levels in polar areas and high ·altitudes to in tropical deserts in summer. There are, however, unique habitats such as thermal springs and deep-sea hydrothermal vents where average temperatures exceed 100°C. It is general knowledge that mango trees do not and cannot grow in temperate countries like Canada and Germany, snow leopards are not found in Kerala forests and tuna fish are rarely caught beyond tropical latitudes in the ocean. You can readily appreciate the significance of temperature to living organisms when you realise that it affects the kinetics of enzymes and through it the basal metabolism, activity and other physiological functions of the organism.

A few organisms can tolerate and thrive in a wide range of temperatures (they are called eurythermal), but, a vast majority of them are restricted to a narrow range of temperatures (such organisms are called stenothermal). The levels of thermal tolerance of different species determine to a large extent their geographical distribution. Can you think of a few eurythermal and stenothermal animals and plants?

Adaptations –

- In the polar seas aquatic mammals like seals have a thick layer of fat (blubber) below their skin that acts as an insulator and reduces loss of body heat (Physiological adaptation)
- Many desert plants have a thick cuticle on their leaf surfaces and have their stomata arranged in deep pits to minimise water loss through transpiration. They also have a special photosynthetic pathway (CAM) that enables their stomata to remain closed during day time **(Physiological adaptation).** Some desert plants like **Opuntia** have no leaves. Leaves modified into spines to reduce transpiration the photosynthetic function is taken over by the flattened stems **(Morphological adaptation).**

Suspension -

- **Hibernation -** Winter sleep or period of dormancy
  - ♦ Cold blooded animals
    e.g. Amphibians, reptiles
  - ♦ Hot blooded animals
    e.g. Polar bear, North ground squirrels

- Aestivation (Summer sleep) -' Escape from heat of sun
  e.g. Lung fishes, Snails, Ground squirrels in south-west desert
- Diapause - Under unfavourable conditions many zooplankton species in lakes and ponds are known to enter diapause, a stage of suspended development

Acclimatisation -

Acclimatisation is a gradual physiological adjustment of the organism to the slowly changing new environmental condition. If there is a shift in some environmental factor beyond the tolerance range of an organism the latter can come to the resting stage or migrate.

1. **Anti freezeing protein** compounds allow the fishes in Antarctica region to remain active in sea water **(Physiological adaptation)**.
2. Many xerophytes may accumulate **proline** (an amirio acid) in their cells to maintain osmotic and water potential in their leaves **(Physiological adaptation).**
   The heat shock protein **(chaperonins)** provide physiological adaptations to plants to high temperature. This protein help other protein to maintain their structure and avoid denaturation at high temperature (Physiological adaptation).
3. In the absence of an external source of water. the kangaroo rat in north American deserts is capable of meeting all its water requirements through its internal fat oxidation (in which water is a by product). It also has the ability to concentrate its urine so that minimal volume of water is used to remove excretory products **(Physiological adaptation)**.
4. Some organisms posses adaptations that are physiological which allow them to respond quickly to a stressful situation. If we go high altitude place we experienced what is called altitude sickness. Its symptoms include nausea fatigue and heart palpitations. This is because in the low atomospheric pressure of high altitudes the body does not get enough oxygen. (Our body solve this problem- The body compensates low oxygen availability by increasing red blood cell production. decreasing the binding capacity of haemoglobin and by increasing breathing rate.) Many tribes live in the high altitude of Himalyas have a higher red blood cell than people living in the plains {Physiological adaptation).

Type of migration	Examples	Activities
Long-distance	Arctic tern	Nests close to north pole in summer. Flies from North (Arctic) to Antarctica in autumn and returns to North pole again each spring.
Short-distance	Caribou, Elk and whale	Migrates in search of food each winter to warmer place.
Periodic	Locust (Tiddi)	Large population migrate in search of feeding grounds.

Note : Thermal Migration - Thermal migration has been seen in birds (siberian cranes, arctic tern), mammals (Bison, caribou), fishes (salmon) etc.

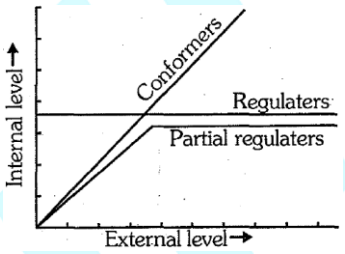
Some organisms show behavioural responses to cope with variations in their environment. Mammals have to deal with the high temperatures of their habitat. but manage to keep their body temperature fairly constant by behavioural means. **Desert lizards** lack the physiological ability. They bask in the sun and absorb heat when their body temperature drops below the comfort zone. but move into shade, when the ambient temperature starts increasing. Some species are capable of burrowing into the soil to hide and escape from the above-ground heat **(Behavioural adaptation)**.

Response to abiotic factors -

A few organisms can tolerate and thrive in a wide range of temperatures (they are called **eurythermal**), but, a vast majority of them are restricted -to a narrow range of temperatures (such organisms are called stenothermal). The levels of thermal tolerance of different species determine to a large extent their geographical distribution.

Regulaters :

Some organisms are able to maintain homeostasis by physiological (sometimes behavioural also) means which ensures constant body temperature, constant osmotic concentration, etc. All birds and mammals, and a very few lower vertebrate and invertebrate species are indeed capable of such regulation (thermoregulation and osmoregulation). Evolutionary biologists believe that the 'success' of mammals is largely due to their ability to maintain a constant body temperature and thrive whether they live in Antarctica or in the Sahara desert.



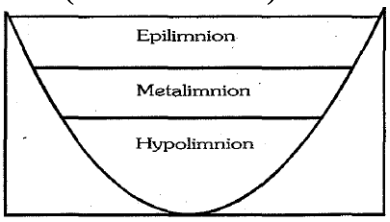
Conformers :

Organism who cannot maintain a constant internal environment means their body temperature or osmotic concentration change with external environment. An overwhelming **majority (99 per cent) of animals** and nearly all plants cannot maintain a constant internal environment. Their body temperature changes with the ambient (atmospheric) temperature. In aquatic animals, the osmotic concentration of the body fluids change with that of the ambient (surrounding) water osmotic concentration. These animals and plants are simply conformers.

THERMAL STRATIFICATION IN LAKES

Thermal stratification occurs in deep water body because of difference in temperature of water at different depth. Mainly three layer or zone occurs in lake below (like in summer)

1. **Epilimnion** - The top layer gains warmth.
2. **Metalimnion/thermocline -** Middle region steady decline in temperature or a gradual change in temperature.
3. **Hypolimnion** - Bottom which is not affected by temperature.



SOIL OR EDAPHIC FACTOR

Soil: The uppermost layer of earths crust formed by weathering of rocks. It is the mixture of living or non living materials.

The nature and properties of soil in different places vary; it is dependent on the climate, the weathering process, whether soil is transported or sedimentary and how soil development occurred. Various characteristics of the soil such as soil composition, grain size and aggregation determine the percolation and water holding capacity of the soils. These characteristics along With parameters such as pH, mineral composition and topography determine to a large extent the vegetation in any area. This in turn dictates the type of animals that can be supported. Similarly, in the aquatic environment the sed1ment characteristics often determine the type of benthic animals that can thrive there.

Minerals 45% + Water 25% + Air 25% + Organic matter (living + non living) 5%

Soil formation is slow process 1 inch soil is formed in 500–1000 years

Pedogenesis – development of soil or soil formation

Pedology (Edaphology) – study of soil

Soil mineral matter -

As a result of weathering the mineral particles of different size are formed. The soil is divided into types in the basis of **size of soil particles.**

Soil Type	Size of particles
Clay	less than 0.002 mm
Silt	0.002 – 0.02 mm
Fine sand	0.02 – 0.20
Coarse sand	0.20 – 2.0
Gravel of Grit	2mm – 5mm
Coarse Gravel	Above 5.00

Sandy Soil = 85% sand + 15% clay or silt or both
Loamy Soil = 50% sand + 50% clay or silt or both
Silt Soil = 90% silt + 10% sand

Note: Loam Soil is the best soil for growing of crops due to high water holding capacity, high aeration and high root penetration.

SOIL ORGANIC MATTER

The dead organic matter present in soil is called humus; which is formed by decomposition of plant and animal remains. Freshly fallen plant and animal material called detritus or litter, partially decomposed litter is called duff. Fully decomposed litter is called humus.

Litter → Duff → Humus

Decomposition (Formation of Humas) :

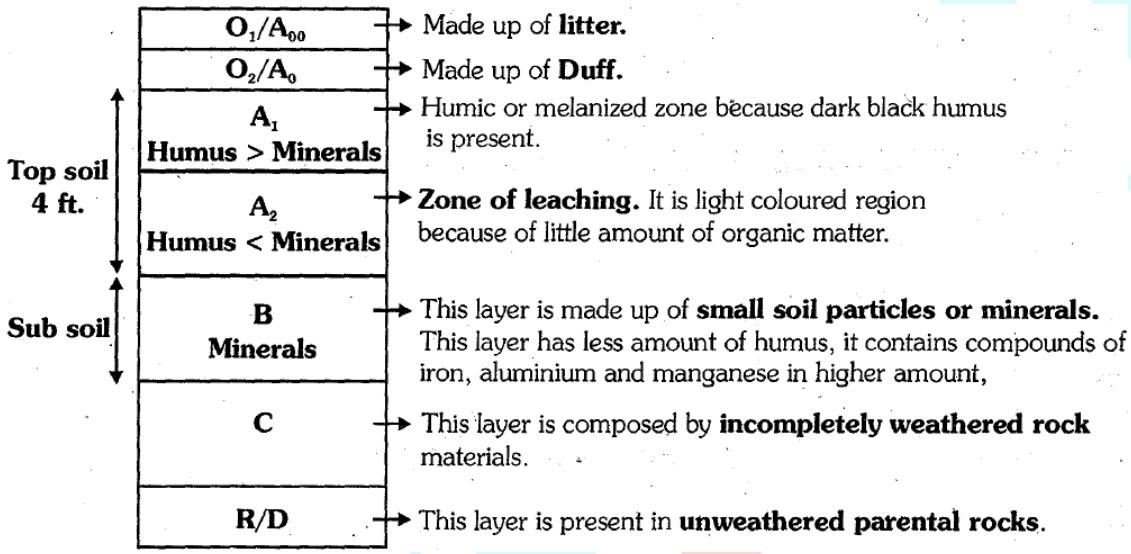
Decomposers break down complex organic matter into simple organic matter (humus) and inorganic substances like carbon dioxide, water and nutrients and the process is called decomposition. Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter, constitute detritus, which is the raw material for decomposition. The important steps in the process of decomposition are **fragmentation, leaching, catabolism, humification and mineralisation.**

Detritivores (e.g. earthworm) break down detritus into smaller particles. This process is called fragmentation. By the process of leaching, water soluble inorganic nutrients go down into the soil horizon and get precipitated, as unavailable salts. Bacterial and fungal enzymes degrade detritus into simple organic and inorganic substances. This process is called as catabolism.

It is important to note that all the above steps in decomposition operate simultaneously on the detritus. **Humification and mineralisation** occur during decomposition in the soil. Humification leads to accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal iri nature it serves as a reservoir of nutrients. The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as **mineralisation.**

Decomposition is largely an oxygen-requiring process. The rate of decomposition is controlled by chemical composition of detritus and climatic factors. In a particular climatic condition, decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars. **Temperature** and **soil moisture** are the most important climatic factors that regulate decomposition though their effects on the activities of soil microbes. Warm and moist enviroment favour decomposition wheres low temperature and an anaerobiosis inhibit decompositon resulting in build up of organic materials.

SOIL PROFILE



Note :

- Best pH of the soil for cultivation of plant is 5.5 – 6.5
- Excess irrigation produce water logging and salinity in soil

OTHER ABIOTIC COMPONENT

1. **Water** - Next to temperature, water is the most important factor influencing the life of organisms. You might think that organisms living in oceans, lakes and rivers should not face any water-related problems, but it is not true. For aquatic organisms the quality (chemical composition, pH) of water becomes important. The salt concentration (measured as salinity in parts per thousand), is less than **5 PPT** in inland waters, **30 - 35 PPT** the sea and more then **100 PPT** in some hypersaline lagoons. Some organisms are tolerant of a wide range of salinities (euryhaline) but others are restricted to a narrow range (stenohaline). Many freshwater animals cannot live for long in sea water and vice versa because of the osmotic problems, they would face.
2. **Topography-** It includes the physical features of the earth like altitude, slope, exposure, mountain chains valleys plants. It affects distribution of organism by influencing the climatic factor like light, wind, rainfall etc.

GOLDEN KEY POINTS

1. Geographical distribution of different species is determined by the level of thermal tolerance.

2. The availability of light on land is closely linked with temperature since the sun is the source of for both.

3. In aquatic environment, the sediment characteristics often determine the type of benthic animals that can thrive there.

4. Under unfavourable conditions many zooplankton species in lakes and pond are known to enter diapause, a stage of suspended development.

BEGINNER'S BOX - 4

1. A majority of organisms which are restricted to a narrow range of temperature are called as :
(1) Stenothermal (2) Endothermal (3) Homeothermal (4) Eurythermal

2. Percolation and water hodling capacity of soil is dependent upon :
(1) Soil composition (2) Grain size (3) Aggregation (4) All of these

3. Which of the following is not the stage of suspension ?
(1) Migration (2) Hibernation (3) Aestivation (4) Diapause

4. Seals have a thick layer of fat (blubber) below their skin that act as an :
(1) Thermostat (2) Capacitor (3) Resistor (4) Insulator

5. The salinity in sea water in parts per thousand (ppt) ranges between :
(1) 5-15 (2) 30-35 (3) 50 - 75 (4) More than 100

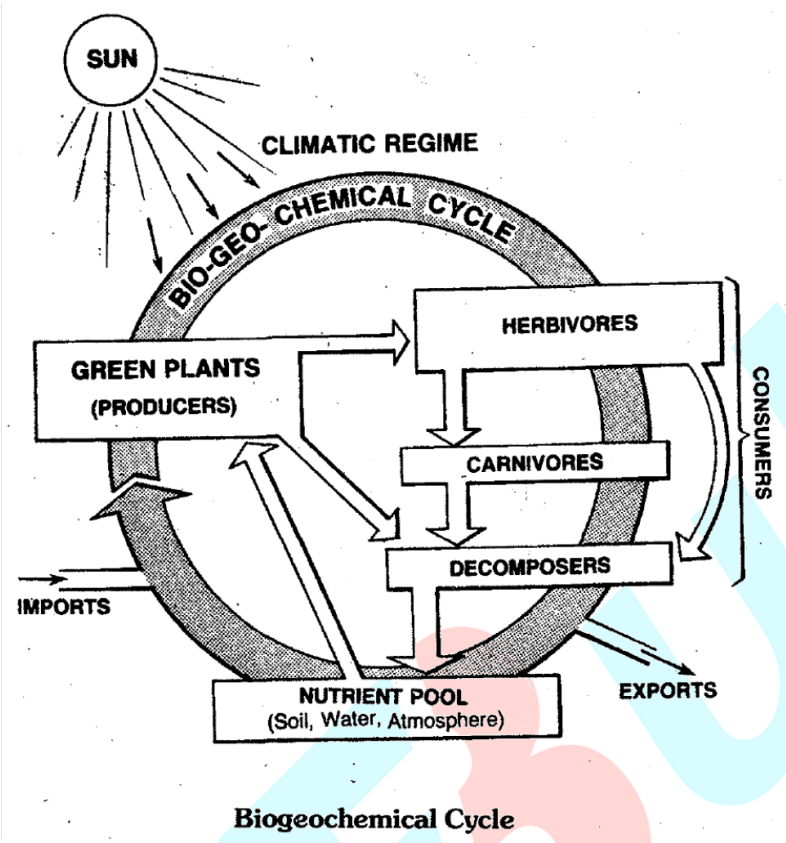
6. To avoid summer related problems such as heat and dessication fish undergoes:
(1) Hibernation (2) Diapause (3) Aestivation (4) Dormancy

BIO-GEO CHEMICAL CYCLE OR NUTRIENT CYCLE

Bio - Living organism
Geo - Rock, Soil, Air, Water
Chemical - Material or Nutrients
Cycle - Path

All the types of material required by ecosystem in addition of energy, are available continuously to system through recycling. Thus there is a constant exchange of materials between the living organism and their abiotic environment through the recyling of materials. This is called Bio-geo chemical cycle.

Note : Environmental factors, e. g., soil, moisture, 'pH, temperature etc., regulate the rate of release of nutrients into the atmosphere.



Biogeochemical Cycle

The following types of cycle are found in an ecosystem :

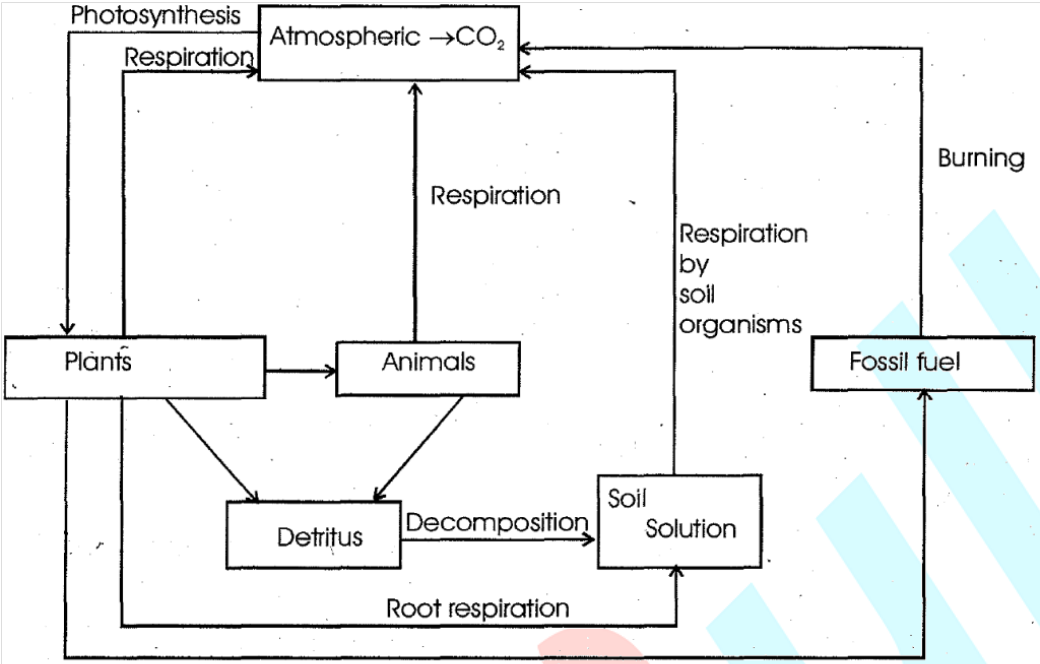
(i) **Gaseous Cycle-** C, H, N, 0 cycles. Reservoir is in the atmosphere (air) or in Hydrosphere(water).

(ii) **Sedimentary cycle -** P, S, Ca cycles reservoirs are in earth's crust (lithosphere)

Note : In these cycles, the bulk material remains in the inactive reservoir on earth crust like sediment of sea, or water bodies.

CARBON CYCLE

Main reservoir of carbon are **atmosphere, Ocean, Carbonate, Rocks, Coal** and **Petrolium**. The carbon released from them is present in the atmosphere in the form of carbondioxide. Carbon is present in every organic component of organism. The green autotrophs utilize CO_2 from the air to synthesize food materials which is obtained by other organisms as food. Carnivores obtain their carbonic food from the herbivores. These carbonic matter produce CO_2 through the oxidation or respiration which dissolve in air or water and again utilized by the plants.

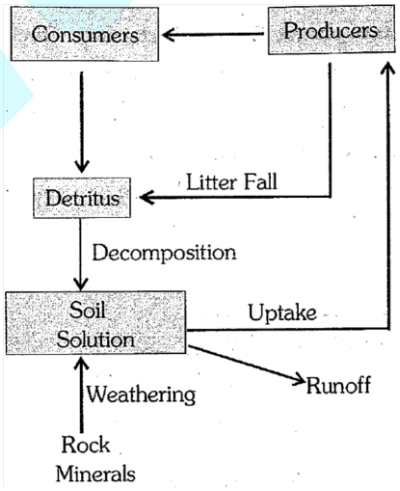


Carbon Cycle

- If we look at the total quantity of global carbon, we find that 71 per cent carbon is found dissolved in oceans. This oceanic reservoir regulates the amount of carbon dioxide in the atmosphere.
- Carbon cycling occurs through atmosphere, ocean and through living and dead organisms.
- According to one estimate 4×10^{13} kg of carbon is fixed in the biosphere through photosynthesis annually.

PHOSPHORUS CYCLE

Main source of phosphorus is **rocks**. It comes from the weathering of phosphorus containing rock in the soil. Plants absorb this phosphrous from the soil and transfer this phosphate to animals and after the death of animals it is released again into the lithosphere by the action of decomposers. Phosphorus is the main constituent of protoplasm, plasma membrane, bones and teeth.



Phosphorus cycle

Sometimes some of the elements like phosphorus and calcium reach into the sea through water, from where they transform into rocks. They separate from the cycle for a long time so it is also known as **sedimentary cycle**.

But when these rocks break after sometime then this phosphorus is again made available to the sea plant or sea weeds, which pass into fish and sea birds. The excretory materials of birds on the rocks of sea shore is called **Guano** and it is a source of phosphorus.

Note :- Plants absorb phosphate from the soil in the form of orthophosphate (Po_4^{3-})

Difference between Carbon and Phosporus cycle

1. Atmospheric inputs of phosphorus through rainfall are much smaller than carbon.

2. Gaseous exchanges of phosphorus between organism and environment are negligible.

ECOSYSTEM SERVICES

Healthy ecosystems are the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as **Ecosystem services**, for example, healthy forest ecosystems purify air and water, mitigate (minimise) droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values. Though value of such services of biodiversity is difficult to determine, it seems reasonable to think that biodiversity should carry a hefty (bulk) price tag.

Robert Constanza and his colleagues have very recently tried to put price tags on nature's life-support services. Reserchers have put an average price tag of **US $ 33 trillion** a year on these fundamental ecosystems services, which are largely taken for granted because they are free. This is nearly twice the value of the global gross national product GNP which is **(US $ 18 trillion)**

Out of the total cost of various ecosystem services, the soil formation accounts for about 50 percent, and contributions of other services like recreation and nutrient cycling, are less than 10 percent each. The cost of climate regulation and habitat for wildlife are about 6 percent each.

TERRESTRIAL BIOMES

ALTITUDE AND LATITUDE

Altitude : Height above the sea surface of any place.

Latitude : The distance of any place from the equator

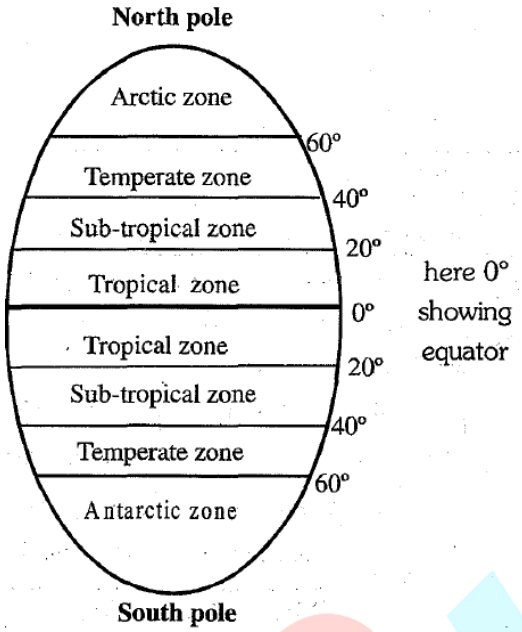
On the basis of variation in mean temperature along latitude the main climatic regions are

(1) **Tropical** = 0° - 20° latitude

(2) **Subtropical** = 20° - 40° latitude

(3) **Temperate** = 40°- 60° latitude

(4) **Arctic and antarctic** = 60° - 80° latitude



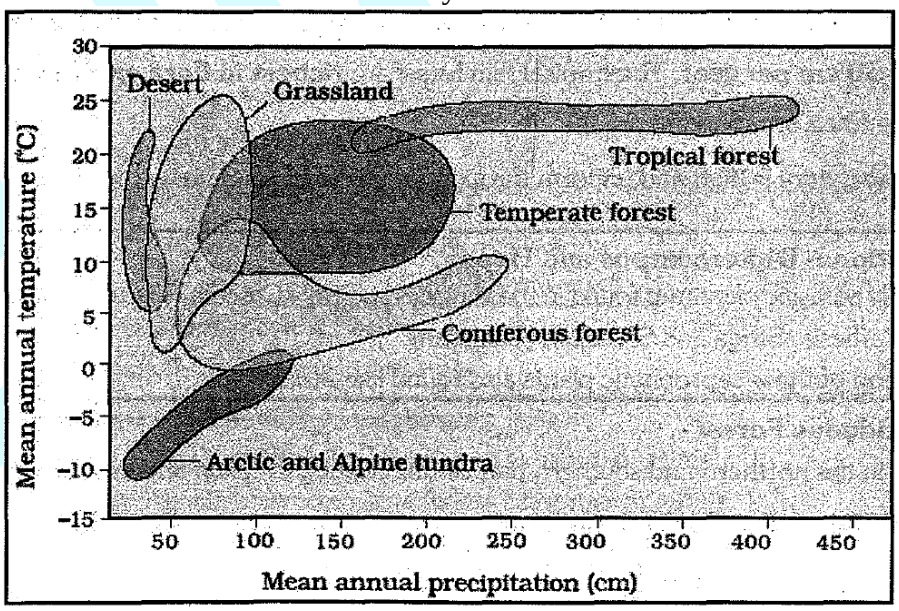
Note:

- The temperature and light values are maximum at the equator, decreases gradually towards the pole . Effect of altitude and latitude are almost same on temperature.
- The types of vegetation from sea level to measuring altitudes are similar to increasing latitude (distance from equator)

BIOME

Large ecosystem is called biome. Mainly large aquatic and terrestrial ecosystem are called biomes.

- In each biome climax community is uniform and each biome is identified by its climax community .
- Altitude and latitude determine the boundary of biome.



1. Tundra Biome :

This region lies above 60° North latitude (or North of timber line or tree line) is known as Tundra. (Timber line - Line beyond which trees are not found). In this region soil is covered by snow and ice (perma frost) almost whole of the year:

- At 3600 m height of Himalayas called Alpine tundra.
- The annual rain fall is low and generally below 25 cm/year.

This biome is without trees so it is called tree less biome. The trees and shrubs are absent in this biome so it is also known as Arctic desert. It is most delicate and fragile biome

Vegetation :- Lichens, Mosses, Grasses etc.

2. The northern coniferous or Needle-leaf forest -

The northern or temperate coniferous forest is also known as Taiga or North wood. It is situated immediately south of the Tundra.

- Distributed over 1700 to 3000 m altitude in himalaya.
- Annual rain fall is **50-170 cm/year.**
- The average winter temperature is 6°C and 20°C in summer.
- The evergreen temperate forests are found on Himalaya.

Vegetation – Pines, Silver fir, Maple, Hemolock, Spruce, Deodar, Cypress

3. The Temperate Deciduous Forest :-

- The deciduous forest lies in temperate zone about 40°-60° N latitude and 1500 - 2400 m altitude central location.
- The annual rainfall about **100-250 c.m.**

Vegetation :- Broad leaved forest which includes oak (Quercus), Birch, Maple, Hickory Beech etc.

Note :- The trees shed their leaves in autumn and bear again in spring.

4. The Tropical Rain forest-

The tropical rain forest biome lies on the **equatorial region** around the earth In India tropical rain forest is found in Eastern Himalaya and Western Ghats. Tropical rain forest are present in Assam, W. Bengal, Kerela and Andman in India. The main feature of this biome is the large amount of annual rainfall which is more than at least 200-450 cm per year. The tropical rain forest are richest in flora and fauna. The highest species of plants and animals are found here.

- The temperature is high and uniform throughout the year. Climate warm and humid.

Vegetation :- Dipterocarpus and Hopea.

Generally parasitic plants are found in these places such as - Cuscuta, Viscum, Loranthus, Orobanche, Rafflesia, Striga and Santalum (Chandan).

In addition of these saprophytic plants also found like Monotrapa.

5. Tropical Deciduous Forest-

Occurs widely in the northern and southern part of our country in plain and low hilly area.

- Annual Rain fall :- 90-160 cm/year
- Leaves of most of the trees fall before the summer.

Vegetation:- Sal (Shorea robusta), Teak (Tectona grandis), Tendu, Chiraungi, Khair.

6. The Chaparral (Mediterranean Scrub forest) Biome -

The mediterranean forests occur along the pacific coast of **South America and South coast of Australia.**

- There is limited rain during the winter and remaining time it is dry.
- The drought resistant species of plants are found in this biome.

Vegetation - Fire resistant evergreen plants, small trees and shrub like sage etc.

7. The Tropical Savanna Biome -

The Tropical Savanna biome is located in South America and Australia.

- It is also called tropical grassland.
- The rain fall is seasonal and very high.
- In this biome gr-ass are found with few **scattered** tree.

Vegetation -

- Coarse grass - Dichanthium, Sechima, Phragmites
- Trees - Acacia, Zizyphus, Prosopis

8. The Grass land Biome -

- Annual rainfall between 25-75 cm
- Winter and summer have longer duration and the **maximum rain fall is in summer**.

Name of Grass lands	Place
Prairies	North America
Pampas	South America
Steppes	Europe and Asia (Russia)
Tussocks	Newzealand
Veldts	Africa

9. The Desert Biome -

The desert biome stretches in the dry region of the world where there is very little rainfall.

- The deserts are located around the tropic of cancer and tropic of capricorn, between latitude 15° to 35° north and south.
- The annual rainfall is very less (less than 25 cm).
- Flora and fauna are found very less.

The main deserts sare the Sahara desert of North Africa, the Thar, Gobi and Tibet desert of Asia.

Sahara – North Africa
Tibet, Gobi, Thar -Asia

Note: (1) Gobi desert is cold desert.
(2) Sahara and Thar are hot desert.

Reasons behind higher biodiversity in Tropics :

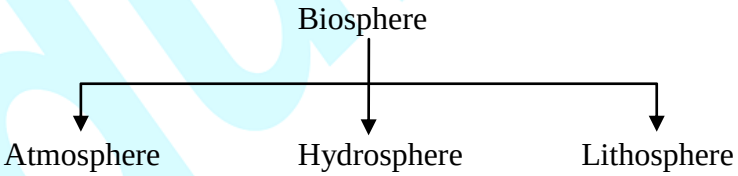
1. Due to undisturbed environment they have long evolutionary time.
2. Constant and predictable environment with less seasonal variations.
3. More solar availability and more rain fall.

Note : In temperate deciduos forest soils, the top horizon of soil is a rich mixuture of humus (nutrient) and inorganic components but top soil of tropical rain forest is nutrient poor and shallow due to heavy rainfall.

Biome	Latitude	Altitude	Vegetation
1. Tundra (fragile-biome)	Above 60° North	3600 meter height of Himalaya	**Lichen, Moss, Grass** **Note :** • This biome is tree less and also known as arctic desert or alpine tundra • Timber line – Line beyond which trees are not found. • Perma frost – In this region soil is covered by snow or ice.
2. Northern coniferous or Needle leaf or temperate forest	40° – 60°	1700 to 3000 meter	**Pine (Pinus), Deodar (Cedrus), Cypress (Cupressus torulosa), Spruce (Picea smithiana), Silverfir (Abies pindrow)** **Note :** • Coniferous forest posses needle like leaves • This forest also known as Taiga
3. Temperate decidous or broad leaf forest	40° – 60°	1500 to 2400 meter	**Oak (Quercus)** **Note :** • Trees shed their leaves in autumn and bear again in spring
4. Tropical deciduous forest	Occurs widely in the Northern and Southern part of our country in in plain and low hilly area.		**Sal (Shorea robusta), Teak (Tectona grandis), Tendu, Chiraungi, Khair** **Note :** • Leaves of most of the tree fall before summer.
5. Tropical rain forest	Tropical rain forest are found at equatorial region around the earth. In India tropical rain forest are distributed mainly along western Ghats and Eastern Himalya (Assam, W. Bengal, Andman, Manipur)		**Dipterocarpus and Hopea are most common tree species in India. Lianas are also found.**
6. Chaparral (Mediterranean) scrub forest	These forest are **found pacific coast of North America and South coast of Australia**		Draught resistant and fire resistant plant species are found eg. Small tree, Shrub (sage)
7. Tropical Savanna biome (Thorn forest)	Tropical Savanna biome are found in South America and Australia.		**Coarse grass – Dichanthium, Sechima, Phragmites** **Trees – Acacia, Eucalyptus, Zizyphus, Capparis** **Note :** • In this biome grass are found with scattered tree. • This biome also known as tropical grass land
8. Grass land biome			**Name of Grass lands → Place** Prairies → North America Pampas → South America Steppes → Europe and Asia (Russia) Tussocks → Newzealand Veldts → Africa
9. Desert Biome			**Name of desert – Place/Area** Sahara – North Africa Tibbet, Gobi, Thar – Asia **Note :** • Gobi desert is cold desert • Sahara and Thar are hot desert

BIOSPHERE

All the living and non living thing (Biotic + Abiotic) of the earth (biomes) combine together to constitute a big ecosystem called Biosphere. Biosphere is also called Ecosphere. The term ecosphere for biosphere was used by Cok.



1. **Lithosphere -**
   The living components and non living components present on the earth surface consititutes the litho sphere.
2. **Hydrosphere-**
   All living components and non living components present in water constitutes the hydrosphere.
3. **Atmosphere -**
   All living components and non living components of air consitutes the atmosphere:
   Note : Biosphere (space ship or earth) is a closed system for minerals and biosphere is an open system in regards with the energy.

GOLDEN KEY POINTS

1. The reservoir function is to fulfill the deficit in biogeochemical cycle created by imbalance between Influx and Efflux.

2. The formation of biome is mainly decided by two abiotic factor temperature and precipitation.
3. Upper soil of temperate deciduous forest is more fertile than tropical rain forest.

BEGINNER'S BOX-5

1. Which is known as flora and fauna rich biome ?
   (1) Temperate deciduous (2) Tropical rain forest
   (3) Desert (4) Alpine

2. Which biome is specialised by thick covering of snow year to year ?
   (1) Tropical rain forest (2) Tundra biome
   (3) Taiga biome (4) Grassland

3. Savana biome is characterised by :
   (1) Only grasses (2) Grasses with scattered trees
   (3) Broad leaf trees (4) All of the above

4. Which is not a reservoir for phosphorous in phosphorous cycle ?
   (1) Atmosphere (2) Lithosphere (3) Hydrosphere (4) All of the above

ENVIRONMENTAL ISSUES (POLLUTION)

"Any undesirable change in physical, chemical or biological characteristic of air, water and land which is harmful to the man directly or indirectly through his animals, plants, industrial units or raw materials is called pollution".

Pollutants :- "Any material or act on the part of man, or nature which leads to pollution is called pollutants."

USUALLY POLLUTANTS ARE DIVIDED INTO FOLLOWING CATEGORIES

1. **Nonbiodegradable pollutants :-** Many of such pollutants are usually not degraded or degraded partially in environment. Such as aluminium packs, Mercury compounds, Iron, Compounds of phenols, Glass, D.D.T. benzene, BHC pesticides, etc.

   They are collected in the environment and cause pollution. These pollutants are harmful even in low concentration and harm increases with their increasing concentration. No treatment is found in the nature for their recycling. There are two methods by which we can stop the pollution caused by pollutants
   (i) Such type of substances should be banned by law,
   (ii) Use their alternative substances.

2. **Biodegradable pollutants-** If much of domestic sewage papers, woods, garbage, live stock wastes, etc. are easily degraded completely by microorganisms, it becomes useful. But if these materials enter the environment in such large quantities, that they can not be degraded completely then addition of these materials causes pollution in environment.

……

1. **Primary pollutants -** These persist in the form in which they are added to the environment e.g. DDT, CO etc.
2. **Secondary pollutants -**These are formed by chemical reaction among primary pollutants e.g. Photochemical smog, London smog, PAN, O_3 etc.

   Synergism - Formation of secondary pollutants is known as synergism. secondary pollutants are more toxic than primary pollutants.

……

1. **Quantitative pollutants :-** These are the substances which occur in nature but become pollutant when their 'concentration reaches beyond a threshold value in the environment
   e.g. CO_2, Nitrogen Oxide etc.

2. **Qualitative pollutants -** These are the substances which do not occur in the environment but are passed in through human activity
   e.g. fungicides, herbicides, D.D.T., etc.

Other type of pollution :

1. **Natural pollution -** Caused by natural sources like, CH_4 from paddy fields and cattle, marsh, forest fire.
2. **Anthropogenic pollution -** Caused by human activities.

……

1. **Negative pollution -** Loss of soil productivity.
   e.g., Overgrazing, Soil erosion.
   Removal or absence of desirable substances at right place which results in loss of soil productivity.

2. **Positive pollution -** Presence or addition of undesirable substances at wrong place which results in reduction of soil fertility e.g. more use of fertilizer, Land filling by wastes.

DIFFERENT KINDS OF POLLUTION

AIR POLLUTION

The air pollution is caused due to addition of unwanted substances or gases. The atmospheric pollution is mainly caused by the activities of man and concentrated to the inhabited and the industrial complexes in cities.

There are two main categories of air pollutants

(i) Gases (ii) Particulates

Gases:

The gaseous materials include various gases and vapours of volatile substances or the compound with a boiling point below 200°C.

MAJOR AIR POLLUTANTS AND THEIR EFFECTS

1. **Carbon monoxide (CO)-**
   Source - It is the main air pollutant released from smoke of automobile and burning of fossil fuels (Petrol, diesel, coal)
   Effect- Carbon monoxide is highly toxic gas, it combines with haemoglobin of the blood and blocks the transportation of oxygen. Thus, it impairs respiration and it cuases death due to asphyxiation when inhaled in large amount.

2. **Unburnt Hydrocarbons - (3,4 Benzopyrine, Benzene)**
   Source- These are mainly released from automobiles and burning of fossil fuel (petrol, diesel, coal). Methane (CH_4) is the most abundant hydrocarbon in atmosphere and its main source is marshy area and paddy field.
   Effect - Hydrocarbons causes lung cancer.

3. **Ethylene-**
   Source - Ethylene released in air during fruits ripening.
   Effect- Falling of leaves without particular reason, falling of flowering bud before time.

4. **Nitrogen oxide- (NO, NO_2)**
   Source - Burning (combustion) of fossil fuel in automobiles.
   Effect - These nitrogen oxide form photochemical smog in atmosphere and release ozone. Nitrogen oxide also responsible for acid rain. Entry of these nitrogen oxide causes respiratory trouble such as emphysema, bronchitis, swelling of lungs and lung cancer etc.

5. Sulphur oxide- (SO_2, SO_3)

Source - Main source of sulphur oxides are coal burning, smelters, oil refineries.

Effect - Lichen and mosses do not grow in SO_2 polluted areas. Lichen and mosses are indicator of SO_2 pollution. Sulphur oxides causes chlorophyll destruction. Taj Mahal also get affected.

6. Smoke – (SO_2, SO_3, NO_2, NO, Co, CO_2)

SECONDARY POLLUTANTS

A. Smog (Smoke + Fog) -

This word was given by Desvoeux. Smog/Smoke is measured by **Ringlmann method.**

Smog is two types

(a) Los Angeles Smog or Photo Chemical smog -

It was first observed in Los Angeles. In this process smoke; fog, nitrogenoxide, hydrocarbons, oxygen, UV light and high temperature are essential. These components react with each other and form reddish brown smog (PAN + O_3 + Nitrogen oxides) or brown haze/brown air. Los angles smog is light induced smog.

Effect-

- Photochemical smog causes -irritation in eyes and harms the lungs. Due to smog elastic substances (rubber/tyers) also affected.
- Ozone causes harm to mucous membrane.
- During smog peroxyacetyl nitrate (PAN) is formed. PAN stops or inhibits the photolysis of water in hill reaction of photosynthesis and affect or inhibit the photosystem - II. PAN also inhibit the chlorophyll formation in plants.

(b) London smog or sulphur smog –

It was first observed in London. In this process coal, smoke, fog, sulphur oxide and low temperature are essential. These components react with each other and form vapour (fog) of H_2SO_4 which is known as London smog.

Effect-

- Due to inhalation of H_2SO_4 vapour with fog 4000 people died in London in 1952.

B. Acid rain -

This word was given by Robert August. NO_2 and SO_2 released from different sources in form of smoke and dissolved in atmospheric water vapour to form acid (H_2SO_4 + HNO_3). These acids come down on earth with rain water this is called acid rain.

(a) Wet deposition :- If acid comes down on earth with rain, fog and smog; it is known as wet deposition.

(b) Dry depositon :- If acid settled on earth surface through solid dust particles with nitrate or sulphate, this is called· dry deposition.

Note:

- The pH of acid rain is lesser than < 5.6
- In acid rain the ratio of H_2SO_4 and HNO_3 is 7: 3 (70% H_2SO_4 + 30% HNO_3)

Effects-

(1) Due to acid rain acidity of soil and water increases ..

(2) Acid rain also causes damages historical monuments. e.g. Taj Mahal, Red Fort.

CONTROL OF AIR POLLITION

(1) Control of particulate matter - Two devices are use to remove particulate air pollutants

(a) Arresters (b) Scrubbers

(a) ARRESTERS

These are used to separate particulate matters from contaminated air.

Arresters are of different types :

(i) Cyclonic separators and Trajectory separators :- These are commonly used to separate out particulate matters from industrial emissions with minimum moisture content. These separators work on the principle of dust separation by centrifugal force.

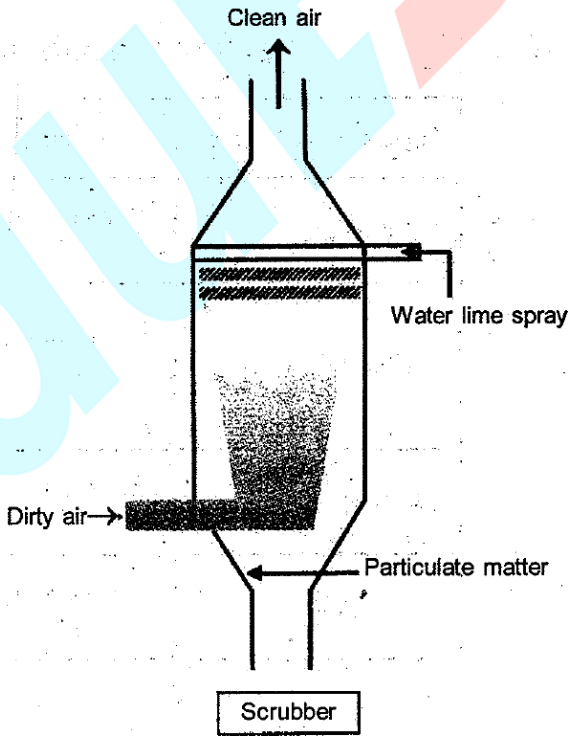
(ii) Electrostatic precipitator :- It is the most efficient device to remove fine particulate pollutants. Electrostatic precipitation device work on the principle of electrical charging of the dust particles and collecting it on a differently charged platform.

- There are several ways of removing **particulate** matter; the most widely used of which is the electrostatic precipitator, which can remove over 99 per cent particulate matter present in the exhaust from a thermal power plant.

- It has electrode wires that are maintained at several thousand volts, which produce a corona that releases electrons. These electrons attach to dust particles giving them a net negative charge. The collecting plates attract the charged dust particles. The velocity of air between the plates must be low enough to allow the dust to fall.

(b) SCRUBBERS :

A scruber can remove gases like sulphurdioxide. In a scrubber, the exhaust is passed through a spray of water or lime.



(2) Control of Gaseous pollutants- Combustion, absorption and adsorption technique are used to control gaseous pollutants.

(a) **Combustion -** In combustion process, oxidisable gaseous pollutants are completely burnt at a high temperature. Petrochemical, fertilizer, paints and varnish industries used combustion control of gaseous pollutants.

(b) **Absorption :-** In this· technique, gaseous pollutants are absorbed in suitable (liquid) absorbent materials.

(c) **Adsorption :-** T.b.is technique is applied to control toxic gases, vapours and inflammable compounds that could not be efficiently removed or transferred by a fore said technique. Such air pollutants are adsorbed on large solid surface.

A CASE STUDY OF DELHI

1. The government of India through a new auto fuel policy has laid out a roadmap to cut down vehicular pollution in Indian cities. More stringent norms for fuels means steadily reducing the sulphur and aromatics content in petrol and diesel fuels.

For example **Euro Ill norms,** stipulates that sulphur be controlled at **350 parts-per-million** (ppm) in diesel and 150 ppm in petrol. Aromatic hydrocarbons are to be contained at **42 percent** of the concerned fuel. The goal, according to the roadmap, is to reduce **sulphur to 50 ppm** in petrol and diesel and bring down the level to **35 percent.** Corresponding to the fuel, vehicle engines will also need to be upgraded.

Thirteen most polluted cities of India - Delhi and NCR, Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra, Sholapur, Lucknow

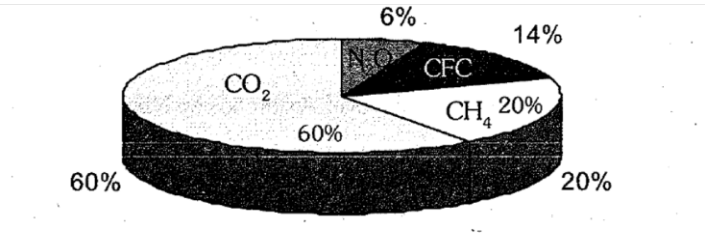
According to an estimate, a substantial fall in CO_2 and SO_2 level has been found in Delhi between 1997 and 2005.

Table showing the mass emission standards in India

Types of vehicles	Norms	Cities of implementation
4 Wheelers	Bharat stage III	Through out the country since October 2010
4 Wheelers	Bharat stage IV	13 mega cities (Delhi and NCR, Mumbai, Kolkata, Chennai, Bangalore, Surat, Kanpur, Agra, Lucknow and Sholapur) Since April 2010.
3 Wheelers	Bharat stage III	Through out the country since October 210
2 Wheelers	Bharat stage III	Through out the country since October 2010

GREEN HOUSE EFFECT

Usually carbon dioxide is not considered as pollutant, but its higher concentration forms a thick layer above the earth's surface, checks the radiation of the heat from the earth surface. Because of this, temperature of the earth's surface increases, this is called "green-house effect" or global warming.



The relative contribution of different green house gases

Main green house gases are CO_2, CH_4, CFC, N_2O, excluding this SO_2, O_3, water Vapour are also released from industries and NO_2 released from agriculture which are responsible to increase the green house effect.

In this phenomenon cover of CO_2 layer around the earth, allow the short wavelength incoming solar radiation to come in but does not allow the long wavelength of out going heat radiation from warm surface of earth and surface keep the earth warm. The consequent increase in the global mean temperature is referred to as global warming.

Note:

1. It has been observed that in the recent past, the level of CO_2 in the atmosphere has increased from **280 ppm to 368 ppm in 1956 to 2002.** If present growth rate is continued then the amount of CO_2 will be doubled upto 2020 century. Even 2-3°C rise in temperature will lead to melting of glaciers and ice caps of polar region and consequently the floods in rivers, rise in sea level and changes in cycle of rain. Islands may be submerged in sea water.

2. **Carbondioxide fertllisation effect-** Due to increased C02 concentration the rate of photosynthesis will increase (up to a few year). The response of the plants to elevated concentration of CO_2 is known as the CO_2 fertilisation effect.

3. The global mean temperature has increased by 0.6°C in 20^{th} century.

4. Sea level has been raised by **1 to 2 mm** per year during 20th century.

5. Without greenhouse effect the a verge temperature at surface of Earth would have been a **chilly –18°C** rather than the present. average of 15 °C.

6. Increase in the level of greenhouse gases has led to considerable heating of Earth leading to global warming. During the past century the temperature of Earth has increased by 0.6°C, most of it during the last three decades.

OZONE DEPLETION

- Ozone is present in less quantity in atmosphere. But at the height of **16 km to 25 km** on earth, concentration of ozone is maximum in stratosphere.
- At normal temperature and pressure thickness of ozone layer is **3 mm.** (But at poles thickness of ozone layer is **4 mm**).
- Ozone hole was first discovered in **1985** over Antarctica by **Nimbus-7** satelite:
- Due to depletion of ozone layer harmful **UV** radiations are penetrating to the earth which causes **skin cancer (Melanoma)** and also acts as strong mutagens. UV radiation of wavelengths shorter than UV-B, are almost completely absorbed by. Earth's atmosphere, given that the ozone layer is intact. But **UV-B** damages **DNA and mutation** may occur. It causes ageing of skin, damage to skin cells and various types of **skin cancers**. In human eye, cornea

absorbs UV-B radiation and high dose of UV-B causes inflammation of cornea, called **snow-blindness, cataract, etc**. Such exposure may permanently damage the cornea. UV radiation causes a disease, **xeroderma pigmentosum**.

The aerosols like C.F.C. (Chloro flouro carbon) release into the atmosphere from the refrigerators air conditioners and jet planes deplete or reduce the ozone layer. This is called ozone depletion and these substances are called O.D.S. (ozone depleting substances). This thin layer ozone is also known as ozone holes.

$$O_3 \xrightarrow[C.F.C]{U.V.} O_2 + O$$

Number of pollutants like **CFCs [14% of total depletion**], Nitrogen oxide [3.5%], CH_4 and halogens (chlorine) cause depletion of ozone layer. Maximum ODP (ozone depleting potential) is of CFCs due to release of chlorine.

Note:

1. In this process of one chlorine atom convert one lakh O_3 molecules into O_2 by photodissociation.

2. The life time of CF_2Cl_2 (CFC-12) is 139 year while that for $CFCI_3$ (**CFC = 11**) is about 77 years.

Chemical process of ozone depletion – chain reaction

$$CF_2Cl_2(g) + hv \longrightarrow \dot{C}l(g) + \dot{C}F_2Cl(g)$$

$$\dot{C}l(g) + O_3(g) \longrightarrow \dot{C}lO(g) + O_2(g)$$

$$\dot{C}lO(g) + O(g) \longrightarrow \dot{C}l(g) + O_2(g)$$

Active chlorine

Some other Informations:

Thickness of ozone layer is measured in **Dobson unit** (l Du = 1 ppb)

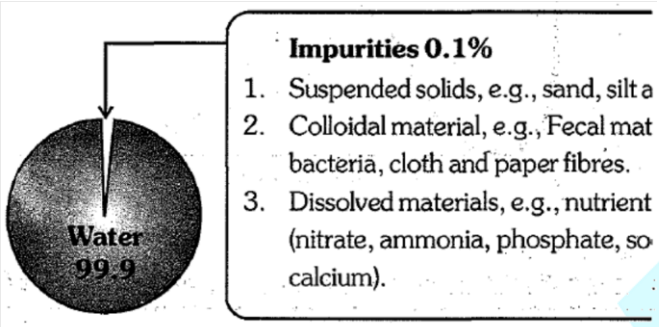
The Ozone hole over Antarctica develops each year between late august and early october.

WATER POLLUTION

The water pollution is caused by the addition of organic and inorganic chemicals as well as the biological materials which change the physical and chemical properties of water. This harmful process is called water pollution.

The water pollution is caused by many sources such as sewage matter, industrial wastage, agricultural wastage, domestic wastage, hot water of thermal plant and nuclear reactors etc.

Note : A mere 0.1 per cent impurities make domestic sewage unfit for human use (Figure).



Composition of waste water

- Domestic sewage primarily contains biodegradable organic matter .
- Water hyacinth (Eichhornia crassipes), the world's most problematic aquatic weed, also called 'Terror of Bengal'.
- Unlike domestic sewage, waste water from industries like petroleum, paper manufacturing, metal extraction and processing, chemical manufacturing, etc., often contain toxic substance,. notably heavy metals (defined as elements woth density > 5 g/cm^3 such as mercury, cadmium, copper, lead, etc.) and a variety of organic compounds.
- ♦ Water having DO content below 8.0 mgL^{-1} may be considered as contaminated and below 4.0 mgL^{-1} heavily polluted.
- ♦ DO is measured by **oximeter**.

1. Biochemical Oxygen Demand (BOD) :

The water pollution by organic wastes is measured in terms of Biochemical oxygen demand. It is the amount of dissolved oxygen **(DO =Dissolved Oxygen)** needed by bacteria in decomposing the organic wastes present in water.

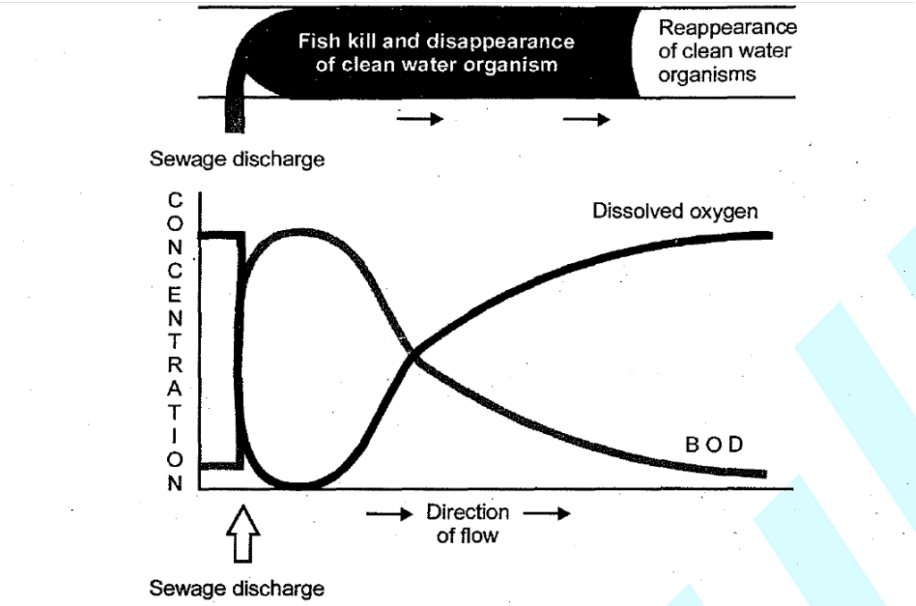
BOD increased= water polluted

BOD $\propto$ input of organic wastes

If B. O. D. is increased dissolved oxygen is decreased in water. Higher amount of organic waste increase the rates of decomposition in water. O_2 is rapidly consumed by microbes, thereby causing drop in DO content in water.

Note:

- ♦ **Daphnia** is the indicator of BOD



Effect of sewage discharge on some important characteristics of a river

2. Chemical Oxygen Demand (COD) :

COD is the oxygen requirement by chemical $K_2Cr_2O_7$ for oxidation of total organic matter (biodegradable + non biodegradable) in water.

Note : COD value is always higher than BOD value.

3. Biological magnification:-

Water ⟶ Phytoplahkton ⟶ ZP ⟶ Small fish ⟶ Large fish ⟶ Fish eating birds

(DDT = 0.003 ppb) (0.003 ppm) (0.04 ppm) (0.5 ppm) (2 ppm) (25 ppm)

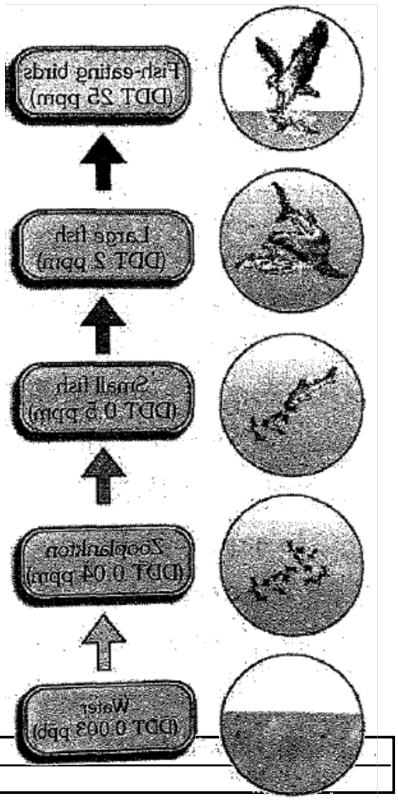
The non biodegradable pollutant like AI, Hg, Fe, DDT, pesticides, phenolic compound ABS (Alkyl benzene sulphonate) are not decomposed by micro-organisms.

They get accumulated in tissue in increasing concentration along the food chain is called biological magnification. **The highest concentration occurs in top consumer.**

Eg.

(i) The concentration of DDT is increased at successive trophic levels; say if it starts at 0.003 ppb (ppb = parts per billion) in water, it can ultimately can reach 25 ppm (ppm = part per million) in fisheating birds, through biomagnification.

Note : High concentration of DDT distrub calcium metabolism in birds. which causes thinning of egg shell and their permature breaking, eventually causing decline in bird populations.



(ii) Minamata disease is cause in humans in Japan by biomagnifications of mercury (Hg)

4. Eutrophication:-

The process of nutrient enrichment of water and consequent loss of species diversity (or death of aquatic animals) is referred to as eutrophication and lake is known as eutrophic lake. In this process presence of nutrients in lake stimulates growth of algae (algal bloom) increase organic loading and bring about reduction in the oxygen content of water causing death of aquatic animals.

Eutrophication can be caused by the following man made source.:-

(i) House hold detergents, (ii) Industrial waste, (iii) Sewage

Sewage:

Sewage contains highest amount of carbonic materials and biological material, as pollutants. These carbonic materials increase the number of decomposers like bacteria and fungus. The acceleration of microbial activity increases BOD of water.

BOD is very less in pure water. The higher BOD is the indication of water pollution and the water of polluted reservoir can not be utilized and very bad smell spreads around the locality. The infections or infectious diseases also takes place.

Note:

- Eutrophication is the natural aging of a lake by biological enrichment of its water. Natural aging of a lake may span thousands of years and lake finally converted into land due to deposition of silt. Pollutants from man's activities like effluents from the industries and homes can radically accelerate the aging process this phenomenon is called **accelerated eutrophication or cultural eutophication.**
- During eutrophication due to organic matter lake become shallow and warmer. Due to warming of lake water, growth of cold water organisms stop and growth of warm water organisms increases.
- B.O.D. of Eutrophic lake is very high .

Types of Lakes -

(i) Eutrophic lake - They are shallow water lakes which contain high amount of organic materials and nutrients. They have little 0 2 because decomposers rapidly use it up. Chironomous larva are commonly present in it.
e.g. Dal lake of Kashmir

(ii) Oligotrophic lakes- These are deep lakes which have **less amount of organic materials and nutrient.**

SEWAGE TREATMENT

Primary treatment : These treatment steps basically involve physical removal of particles-large and small from the sewage through filtration and sedimentation. These are removed in stages; initially, floating debris is removed by sequential filtration. Then the grit (soil and small pebbles) are removed by sedimentation." All solids that settle, form the **primary sludge**, and

the supernatant forms the effluent or primary effluent. The primary effluent from the **primary settling tank** is taken for secondary treatment.

Secondary treatment or biological treatment : The primary effluent is passed into large aeration tanks where it is constantly agitated (mix) mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into **floes** (masses of bacteria associated with fungal filaments to form mesh like structures). While growing, these microbes consume the major part of the organic matter in the primary effluent. This significantly reduces the **BOD** of the effluent. BOD refers to the amount of the oxygen. that would be consumed if all the organic matter in one liter of water were oxidised by bacteria. The sewage water is treated till the BOD is reduced. The BOD test measures the rate of uptake of oxygen by micro-organisms in a sample of water and thus, indirectly, **BOD is a measure of the organic matter present in the water.** The greater the BOD of waste water, more is its polluting potential.

Once the BOD of sewage or waste water is reduced significantly, the effluent or secondary effluent is then passed into a **secondary settling tank** where the bacterial 'floes' are allowed to sediment. This sediment is Galled **activated sludge.** The sludge is pumped into large tanks called **anaerobic sludge digesters**. Here, other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as source of energy as it is inflammable.

The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams. The **Ministry of Environment and Forests** has initiated **Ganga Action Plan** and **Yamuna Action Plan** to save these major rivers of our country from pollution. Under these plans, it is proposed to build a large number of sewage treatment plants so that only treated sewage may be discharged in the rivers.

Daphnia, trout fishes and larva of stone fly are the fresh water indicators and Tubifex (an annelid), chironomous larva, E.coli, Sewage fungus, Sludge worms, blood worms are the indicator of polluted water.

Heated (thermal) wastewaters flowing out of electricity-generating units, e.g., thermal power plants, constitute another important category of pollutants. Thermal wastewater eliminates or reduces the number of organisms sensitive to high temperature, and may enhance the growth of plants and fish, which live in high temperature in cold areas but, only after causing damage to the indigenous flora and fauna.

A CASE STUDY OF INTEGRATED WASTE WATER TREATMENT

- Wastewater including sewage can be treated in an integrated' manner. by utilising a mix of artificial and natural processes. An example of such an initiative is the town of **Arcata**, situated along the northern coast of California. Collaborating with biologists from the **Humboldt State University**, the townspeople created an integrated waste water treatment process within a natural system.

The cleaning occurs in two stages -

(a) The conventional sedimentation, filtering and chlorine treatments are given. After this stage, lots of dangerous pollutants like **dissolved heavy metals** still remain. To combat this, an innovative approach was taken.

(b) Biologists developed a series of **six connected marshes** ver 60 hectares of marshland. Appropriate plants, algae, fungi and bacteria were seeded into this area, which neutralise, absorb and assimilate the pollutants. Hence, as the water flows through the marshes, it gets purified naturally.

- The marshes also constitute a sanctuary, with a high level of biodiversity in the form of fishes, animals and birds that now reside there. A citizens group called Friends of the Arcata Marsh (FOAM) are responsible for the upkeep and safeguarding of this wonderful project.

Ecological sanitation is a sustainable system for handling human excreta. using dry composting toilets. This is a practical, hygienic, efficient and cost-effective solution to human waste disposal. The key point to note here is that with this composting method, human excreta can be recycled into a resource (as natural fertilizer), which reduces the need for chemical fertilisers. There are working **'EcoSan' toilets** in many areas of **Kerala and Sri Lanka.**

SOUND POLLUTION

Increase in the noise in the atmosphere is called noise pollution or sound pollution. Noise is a loud and unwanted or unpleasant sound. The common things which are responsible for noise pollution are - industries and mills, means of transportation, television stereo, loud speaker and jet plant etc.

Intensity :- The intensity of sound is measured in **bel or decibel** [1 bel = 10 decibel]. Normally at 25 decibel, the atmosphere may be peaceful. Above 80 decibel intensity of sound is called noise pollution.

Note : In India, the Air (Prevention and Control of Pollution) Act came into force in **1981**, but was amended in **1987** to include noise as an air pollutant.

A brief exposure to extremely high sound level 150 dB or more generated by take off of a jet plane or rocket may damage ear drums thus permanently impairing hearing ability. Even chronic exposure to a relatively lower noise level of cities may permanently damage hearing abilities of humans. Noise also causes sleeplessness, increased heart beating, altered breathing pattern, thus considerably stressing humans.

Note : Reduction of noise in our industries can be affected by use of sound absorbent material or by muffling noise. Like green muffler.

Green muflur scheme -Tree such as **neem** and **ashoka** absorb sound to a great extent, along road side.

Very Quiet	20 – 30 dB	Sound quiet place is – 20 dB, Motion Picture studio,

		Broadcasting studio
Silence/Quiet	30/35 – 50 dB	Hospitals (30 – 35), School (45 – 50), Libraries (45 – 50), Offices (40 – 50)
Normal voice	55 dB	
Conversational speech	60 dB	
Moderately Loud	70 dB – 90 dB	Average traffic – 70 dB Heavy city traffic – 90 dB
Uncomfortable	Above 100 dB	Air craft (120 dB)
Painful	Above 130 dB	Rocket (180 dB) Jet plane (150 dB)

SOLID WASTES

Solid wastes refer to everything that goes out in trash. Municipal solid wastes are wastes from homes. offices, stores, schools, hospitals, etc., that are collected and disposed by the municipality. The municipal solid wastes generally comprise paper, food wastes, plastics, glass, metals, ruber, leather, textile, etc. Burning reduces the volume of the wastes, although it is generally not burnt to completion and open dumps often serve as the breeding ground for rats and flies. Sanitary landfills were adopted as the substitute for open-burning dumps. In a sanitary landfill, wastes are dumped in a depression or trench after compaction and covered with dirt everyday .

Landfills are also not really much of a solution since the amount of garbage generation specially in the metros has increased so much that these sites are getting filled too. Also there is danger of seepage of chemicals, etc, from these landfills polluting the underground water resources.

CASE STUDY OF REMEDY FOR PLASTIC WASTE

- A plastic sack manufacturer in **Bangalore** has managed to find the ideal solution to the ever-increasing problem of accumulating plastic waste. **Ahmed Khan** aged 57 years old, has been producing plastic sacks for 20 years. About 8 years age, he realised that plastic waste was a real problem. Polyblend, a fine powder of recycled modified plastic, was developed then by his company. This mixture is mixed with the bitumen that is used to lay roads.

- In collaboration with R. V. College of Engineering and the Bangalore City Corporation, Ahmed Khan proved that blends of Polyblend and bitumen, when used to lay roads, enhanced the bitumen's water repellant properties, and helped to increase road life by a factor three. The raw material for creating Polyblend is any plastic film waste. So, against the price of Rs. 0.40 per kg that rag pickers had been getting for plastic waste, Khan now offers Rs.6. Using Khan's technique, by the year 2002, more than 40 kms of road in Bangalore has already been laid. At this rate, Khan will soon be running short of plastic waste in Bangalore to produce Polyblend.

RADIOACTIVE POLLUTION

The various sources of radioactive materials as follows

(1) **Natural sources :-** Cosmic rays, radiation from the earth such as Radium- 224, Uranium 235, Uranium 238, Thorium 232, Radon 222.

(2) **Man made Radiation :-**The radiations are released in the atmosphere during mining and purification of Thorium and Plutonium, and in producing nuclear weapons etc.
Nuclear reactor and nuclear fuel causes pollution by radioactive radiation. The nuclear fuel and coolants are the sources of radioactive radiation. Radioactive waste is also most important radio active pollutants because these wastes are not dumped at particular or right place.

(3) **Other sources :-** Some of the radioactive elements (isotops) are used in experimental laboratories for scientific researches which causes radio active pollution. X-rays are also proved to have harmful effects.

- The first is accidental leakage of radiation occurred in the **Three Mile Island** and **Chernobyl**.
- It has been recommended that storage of nuclear waste, after sufficient per-treatment, should be done in suitably shielded containers buried within the rocks, about **500 m deep** below the earth's surface.

SPECIAL POINT

1. **Air pollution :** According to central pollution control board (CPCB), particulate size **2.5 micrometers** or less in diameter are responsible for causing the greatest harm to human health. These fine particulates can be inhaled deep into the lungs and can cause breathing and respiratory problems, irritation, inflammation and damage to the lungs and premature deaths.

2. **Catalytic converters :** Automobiles are a major cause for atmospheric pollution in the metro cities. Proper maintenance of automobiles along with use of lead free petrol or diesel can reduce the pollutants they emit.
Catalytic converters, having expensive metals namely **platinum, palladium** and **rhodium** as the catalysts, are fitted into automobiles for reducing emission of poisonons gases. As the exhaust passes the catalytic converter, unburnt hydrocarbons are converted into C02 and water, and CO and nitric oxide are changed into CO_2 and nitrogen gas respectively. Motor vehicles equipped with catalytic converter should use unleaded petrol because lead in the petrol inactivates the catalyst.

CNG (compressed natural gas) :-

- In the 1990s, Delhi ranked fourth among the 41 most polluted cities of the world.
- All the buses of Delhi were converted to run on CNG by the end of 2002.
- CNG is the better than diesel because CNG burn most efficiently as compared to diesel or petrol in the automobiles and very little of it is left unbrunt. CNG is cheaper than petrol or diesel.

3. **MIC [Methyl Isocyanate]** was released in Bhopal gas tragedy on **3rd December 1984.** Which is used in the production of "Savin" insecticide in Union Carbide factory.
4. Tetraethyl lead and tetramethyl lead are formed by combustion of petroleum. They are known to hamper haemoglobin formation.
   - ♦ The disease produced by use of lead polluted water is called as **Plumbism.**
   - ♦ Lead causes nervousness anaemia in human beings. It also damages kidney.
   - ♦ Lead concentration in blood is considered alarming if it is 10 μg/100 ml.
5. Common dust disease is known as **Pneumoconiosis.**
   - ♦ Disease due to cotton dust in textile workers is **- Lung fibrosis or Byssinosis**
   - ♦ Disease due to coal dust **-Anthracosis**
   - ♦ Disease due to asbestos dust**- Asbestosis**
   - ♦ In stone grinders disease due to sillica dust - **Sillicosis**
   - ♦ In Iron mill disease due to iron dust - **Siderosis**
6. **Stone leprosy** is caused due to acid rain because due to acid rain outer surface of metals, marbles, and stone destroyed.
7. **Blue Baby disease :-** This disease is caused by the high amount of nitrate in water. It is also known as **Methaemoglobinaemia** or **Cyanosis**.
8. **Hypertension and Uremia -** Caused by Copper
9. - ♦ **Arsenic :-** It causes black-foot disease and poisoning in fodder plants which are eaten by live stock and causes their death.
   - ♦ **Cadmium** causes anaemia, hypertension, damage to liver and kidneys. In Japan it caused bone softening or skeleton deformity called **Itai-Itai disease or Ouch-Ouch**
10. **Fluorides:-** The higher concentration of fluorides causes chlorosis or necrosis in tips and margin of leaf (leaf lamina). The compounds of fluorine reach in the animals through the fodder and causes abnormal calcification of teeth, this is called Fluorosis.
    Note : The experts hold that the maximum level of fluoride which the human body can tolerate is 1.5 parts **per million[ppm]**. When ingested in excess over a long period of time causes "Fluorosis".
11. **ELNino effect -** It is the process in which water of Pacific ocean get warm, in this process warm water current flows to equador & peru in between 5 to 8 year at christmas time. **Effect of ELNino is flood, drought** and **monsoon damage in India**. On the other hand when cold water comes in effect in pacific ocean it is called **La-Nina** effect.
12. Major pollutant in Jet plane emission is CFC.

ENVIRONMENT LAW FOR CONTROLUNG POLLUTION

1. **The National Environment (Protection) Act (NEPA) 1986 :-** This act clearly brings the protection of water and soil quality, and the control environmental pollutants.

2. **The insecticide Act, 1968 :-** This act deals with the regulation of import, manufacture, sale, transport; distribution and use of insecticides with a view of preventing risk to human health and other organisms.
3. **The water (Prevention and control of pollution) Act. 1974 :-** This act deals with the preservation of water quality and the control of water pollution with a concern for the detrimental effects of water pollutants on human health.
4. **The air (Prevention and control of Pollution) Act. 1981 :-** This act deals with the preservation of air quality and the control of air pollution with a concern for the detrimental effects of air pollutants on human health and also on the biological world.

Important Informations :

1. Conference on human environment in 1972 held at Stockholm.
2. Recognising the deleterious affects of ozone depletion, an international treaty, known as the **Montreal protocol** was signed in 1987 Montreal (canada) 27 industrialised countries signed the Montreal protocol to protect **stratospheric ozone**. It's effective in 1989. More than 175 countries have signed the montreal protocol.
3. UNCED (United Nations Conference on Environment and Development) Earth Summit held at Rio-deJenerio (Brazil) in 1992 for reducing green house gases & **biodiversity conservation** and make Agenda-
4. Kyoto protocol conference held in **Kyoto** (Japan) for **climate change** (1997). This protocol requires countries to take appropriate measures to reduce their overall green house gas emisson to a level at 5 percent below the 1990 level by the commitment period 2008-2012:
5. World summit on sustainable development (2002) was held in Johannesburg (S. Africa).

IMPORTANT DATES ABOUT ENVIRONMENTAL ISSUES

* COP = Conference of the parties
* UNCED = June 1992 (Adopted)

S. No.	Meeting	Data	Venue
1.	COP-1	March 1995	Berlin, Germany
2.	COP-3	Dec 1997	Kyoto, Japan (Adopted the Kyoto Protocol)
3.	COP-11	Dec 2005	Montreal, Canada (Implemented the Kyoto Protocol)
4.	COP-17	28 Nov-9 Dec-2011	Durbon/South Africa
5.	COP-18	26 Nov-7 Dec-2012	Doha/Qatar
6.	COP-19	22 Nov-2013	Warsaw/Poland
7.	COP-20	12 Dec.-2014	Lima-Peru
8.	COP-21	30 Nov-11 Dec-2015	Paris/France

Marc	9.	COP-22	07 Nov-18 Nov-2016	Marrakesh, Morocco
	10.	COP-23	6 Nov-17 Nov-2017	Bonn, Germany
	11.	COP-24	2 Dec.-14 Dec-2018	Katowice, Poland

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Some Other Informations :-

1. **Third pollution or landscape pollution:-** To make Fertile-land barren by dumping wastes e.g., ash, industrial waste
2. **Incineration -** Solid wastes burning in presence of oxygen. The use of incinerators is crucial to disposal of hospital waste.
3. **Pyrolysis -** Solid wastes burning (combution) in the absence of oxygen.
4. **Flu gas -** Gas which is released from chimnies.
5. **Plume -** Smoke which is released from chimnies.
6. **Hydro thermal vents -** These are hot water springs in the deep ocean having high concentration of H_2S, ocean water oxidizes H_2S producing energy which is used by bacteria, Filter-Feeders (clams) eat the bacteria so that this food chain based on chemical energy. -
7. **Phytotrons -** A such type of house where plants are grown in controlled environment.
8. **Hydrocarbon-** Are also known as volatile organic carbons (VOC).
9. **Electronic wastes** is also called e-wastes.
   - Irreparable computers and other electric goods are known as electronic wastes (e-wastes). E-wastes are buried in landfills or incinerated.
   - Eventually recycling is the only solution for the treatment of e-wastes.
10. Ganga Action plan for controlling pollution in ganga (1985) included city : (i) Kolkata (ii) Kanpur.
11. At 50 ppm, CO converts 7.5% of haemoglobin in to carboxy haemoglobin with in 8 hours.
12. Maximum green house gas released by - **CHINA .**
13. Cotton dust is an important pollutant in Ahmedabad.

EFFECT OF AGRO CHEMICALS AND IMPROPER RESOURCE UTILISATION

In the wake of green revolution use of agro chemicals like inorganic fertilizers and pesticids, weedicids, fungicids etc. has increased manifold for enhancing crop production. It harms the non targeted organisims important component of the soil ecosystem.

- The action of pollutants and improper resource utilization like unrestricted grazing, deforestation and poor irrigation practies increase soil erosion and desertification.
- Irrigation without proper drainage of water leads to water logging which results in increase in soil salinity.

CASE STUDY OF ORGANIC FARMING

Integrated organic farming is a cyclical, **zero-waste procedure**, where waste products from one process are cycled in as nutrients for other processes. This allows the maximum utilisation of resource and increases the efficiency of production. **Ramesh Chandra Dagar**, a farmer in **Sonipat, Haryana,** is doing just this. He includes bee-keeping, dairy management water harvesting, compositing and agriculture in a chain of processes, which support each other and

allow an extremely economical arid sustainable venture. There is no need to use chemical fertilisers for crops, as cattle excreta (dung) are used as manure. Crop waste is used to create compost which can be used as a natural fertiliser or can be used to generate natural gas for satisfying th~ energy needs of the farm. Enthusiastic about spreading information and help on the practice of integrated organic farming. Dagar has created the **Haryana Kisan Walfare Club**, with a current membership of 5000 farmers.

GOLDEN KEY POINTS

1. Automobiles are the major cause of pollution in metro cities.

2. According to **CPCB (Central pollutin control board)** particulate matter of size less than **2.5 micro meter (PM 2.5)** are very harmful for human health.

3. Composition of acid rain- 70% (H2S04) and 30% (HN03) and pH < 5.6

4. Green house effect is a natural phenomenon responsible for heating of atomosphere and earth's surface.

5. Most efficient method for removing particulate matter from exhaust is **Electrostatic precipitator (ESP)**

6. **According to Euro norms-IV Sulphur content should be reduced to 50 ppm in Petrol and Diesel.**

7. Good ozone (responsible UV absorption) is present in stratosphere whereas bad ozone (Pollutant) is present in Troposphere.

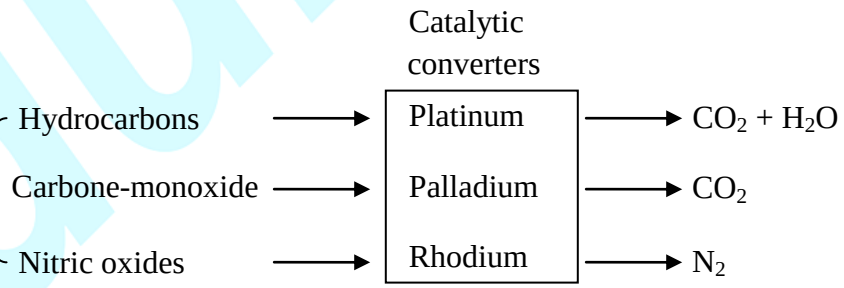
8. Maximum concentration of non-biodegradable pollutants occur in top consumers **(Biological magnification)**

9. Nutrient enrichment leading to **natural ageing** of lake is called **Eutrophication.**

10. Increases pollutants due to human activities can accelerate ageing of lake called accelerated or cultural eutrophication.

11. $\text{BOD} \propto \text{organic matter} \propto \text{pollution} \propto \frac{1}{\text{DO}}$

12.



13. National forest policy **(1988)** in India recommended **33%** of forest cover for plains and 67% of forest cover for hills.

14. Ecological sanitation is sustainable system for handling human excreta by dry composting.

15. Polyblend is a fine powder of recycled modified plastic and raw material for creating it is any plastic film waste.

16. For two wheelers, Bharat stage N is applied all over india since 1st April, 2017.

BEGINNER'S BOX-6

1. Photo-chemical smog is :

(1) $H_2SO_4 + HNO_3$ (2) Vapours of H_2SO_4

(3) $PAN + O_3 + NO_X$ (4) $PAN + H_2SO_4$

2. Due to green house effect, present average temperature of earth is :

(1) – 18°C (2) 15°C (3) 0.6°C (4) 25°C

3. Thickness of ozone layer is measured is :

(1) Deci-bel (2) mg/L (3) PM (4) Dobson unit

4. Which of the following is also called "Terror of Bengal" -

(1) Water hyacinth (2) Water lilly (3) African catfish (4) E.Coli

5. Gas released during Bhopal gas tragedy was :

(1) Ozone (2) Methane

(3) Methyl isocyante (4) Alkyl benzene sulphonate

BIODIVERSITY AND CONSERVATION

Natural Resources

The materials or any component, that can be utilised by man and are necessary for welfare of life, which is available in the natural environment in Atmosphere, Hydrosphere, Lithosphere is called natural resources.

e.g. O_2, Land, Soil, Water, Forest, Animals, Soil, microorganism

Classification of natural resources:

1. **Inexhaustible resources (Non-conventional resources):** Available in unlimited quantities, and the earth quantity may remain unchanged by human impact.
   e.g. Solar Energy, Wind Power, Tidal power, Air, Geothermal Energy
   Note: Its quality can be affected due to continuous increase in human population.
   e.g. Air pollution
2. **Exhaustible resources (Conventional resources) :-**
   These are likely to be finished by human use or unsustainable uses.

It is further divided in two groups

(i) **Renewable resources :** Those which are being continuously consumed by man but renewed continuously by nature, always available if managed in a proper way, otherwise they may even get totally exhausted.
e.g. Biotic resources, forest, grazing animals, Rangeland, wild life, Agriculture crop system and fresh water yield, soil etc.

(ii) **Non renewable resources:** They are not renewable after use and are not replaced by nature, can not be regained.
e.g. Fossil fuel (Coal, Petroleum), Natural Gas, Nuclear energy, Biotic species, Minerals etc.

Note : Nuclear energy is non renewable and unlimited resources.

HYDROSPHERE OR WATER RESOURCES

The total volume of water in the hydrosphere is 1.4 billion cubic kilometers[Km^3], about **97.5%** is the **ocean water**, unsuitable for human use. Only **2.5%** is available as **fresh water**. About **1.97%** is stored in **icecaps** (Polar ice) and glaciers and 0.5% is ground water and soil moisture (0.01 %). The rest [about 0.36 percent] is distributed in lakes swamps, rivers and streams.

Land Resources

At the beginning of 20th century. about **30%** of land in India was covered with forest but the end of the 20th century the forest cover reduced to **19.4%.** Out of **19.4 %,** only **12%** area covered by dense forest.

- Percapita forest area available in India is = **0.06** hec.
- Percapita forest area available in world is = 0.64 hec.

- **National Forest Policy (1988)** of India has recommended **33 per cent** forest cover for the plains and **67 per cent** for the hills.

Shifting Cultivation or Jhum Cultivation :

Slash and burn agriculture, commonly called as **Jhum cultivation** in the north-eastern states of India, has also contributed to deforestation.

It is a major cause of deforestation. Many tribal communities practise slash and burn agriculture in tropical and subtropical regions of Asia, Africa and Oceania. This consists of cutting down trees and setting them or fire and raising crops on the resulting ash called "Jhuming" in north eastern India.

Effect of deforestation - One of the major effects is enhanced carbon dioxide concentration in the atmosphere because trees that could hold a lot of carbon in their biomass are lost with deforestation. Deforestation also causes loss of biodiversity due to habitat destruction, disturbs hydrologic cycle, causes soil erosion, and may lead to desertification in extreme cases.

FOREST CONSERVATION

It is conducted by two methods

1. **Protection or conservation forestry :** By Making national park and Bio-sphere Reserve.
2. **Production or commercial forestry:**

It is of two types

(a) **Social forestry -** To grow the trees and shrubs on unused farmland, road sides, Rail sides, community land etc.

(b) **Agro forestry :** Woody species are grown in combination with herbaceous crops either at the same time or in time sequence.

Taungya system - Growing agricultural crops between rows of planted trees.

CASE STUDY OF PEOPLE'S PARTICIPATION IN CONSERVATION OF FORESTS

- People's participation has a long history in India. In **1731**, the king of **Jodhpur in Rajasthan** asked one of his ministers to arrange wood for constructing a new palace. The minister and workers went to a forest near a village, inhabited by Bishnois, to cut down trees. The Bishnoi community is known for its peaceful co-existence with nature. The effort to cut down trees by the kings was thwarted by the Bishnois. A Bishnoi woman **Amrita Devi** showed exemplary courage by hugging a tree and daring king's men to cut her first before cutting the tree. The tree matiered much more the her than her own life. Sadly, the king's men did not heed to her pleas, and cut down the tree along with Amrita Devi. Her three daughters and hundreds of other Bishnois followed her, and thus lost their lives saving trees.
- The Government of India has recently instituted the **Amrita Devi Bishnoi Wildlife Protection Award** for individuals or communities from rural areas that has shown extraordinary courage and dedication in protecting wildlife .
- You may have heard of the **Chipko Movement** of Garhwal Himalayas. In 197 4, local women showed enormous bravery in protecting trees from the axe of contractors by hugging them.

- **Chipko Movement** was born in March-1974 at Gopeshwar in Chamoli district. The movement had two leaders - Sundarlal Bahuguna of Silyara in Tehri and Chandi Prasad Bhatt of Gopeshwar. It was for plant conservation.
- Realising the significance of participation by local communities, the Government of India 1980s has introduced the concept of Joint Forest Management (JFM) so as to work closely with· the local communities for protecting and managing get benefit of various forest products (e.g., fruits, gum, rubber, medicine etc.) and thus the forest can be conserved in a sustainable manner.

THREATENED SPECIES CONCEPT

In India the **Wildlife (Protection) Act, 1972** provides four schedules categorising the fauna of India based on their conservation status.

The International Union for Conservation of Nature and Natural Resources **(IUCN)**, having its head quarters at **Morgis in Switzerland and maintains a Red Data Book** providing a record of animals and plants which are known to be in danger.

Threatened (T) : The term is used in context with conservation of the species which are in any one of the following category

SOME IMPORTANT EXAMPLES OF THREATENED SPECIES IN INDIA		
Category	**Plants**	**Animals**
(1) Critically endangered	Barberis nilghiriensis	Sus salvanius (Pigmyhog)
(2) Endangered	Bentinckia nicobarica	Ailurus fulgens (Red panda)
(3) Vulnerable	Cupressus cashmeriana	Antelope cervicapra (Black buck)

Note: (1) Rauwolfia serpentiana (medicinal plant) is endangered .
(2) Hornbill and Indian Aconite are also endangered.

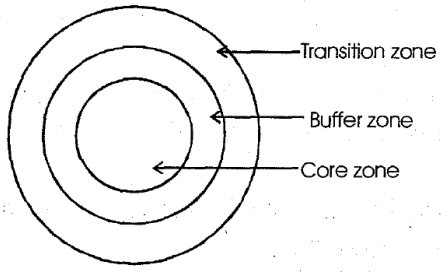
In-Situ conservation - Conservation in natural habitat.

BIOSPHERE RESERVES

It is a specified protected area in which multiple use of the land is permited.

There are 3 zones of Biosphere Reserve.

1. **Core Zone :** It lies at the centre where no human activity is allowed.
2. **The Buffer zone :** Where limited human activity is allowed.
3. **Manipulating zone or Transition zone :** Where a large number of human activites would go on.



Note : 408 Biosphere reserves are located in 94 countries out of which 14 sites are present in India. In India following **14 sites** have been identified as potential biosphere reserves together with their locations:

Biosphere Reserve	State(s)
1. Nanda Devi	Uttranchal
2. Nokrek	Meghalaya
3. Manas	Assam
4. Dibru Saikhowa	Assam
5. Dehang Debang	Arunachal Pradesh
6. Sunderbans	West Bengal
7. Gulf of Mannar	Tamil Nadu
8. Nilgiri	Kerala, Karnataka and Tamil Nadu
9. Great Nicobar	Andaman & Nicobar
10. Simlipal	Orissa
11. Kanchanjunga	Sikkim
12. Pachmarhi	Madhya Pradesh
13. Agasthyamalai	Kerala
14. Achankamar	Madhya pradesh, Chattisgarh

NATIONAL PARK AND SANCTUARIES

In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves. National parks and sanctuaries. India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries. India has also a history of religious and cultural traditions that emphasised protection of nature. In many cultures. tracts of forest were set aside. and all the trees and wildlife within were venerated and given total protection. Such sacred groves are found in Khasi and Jaintia Hills in Meghalaya. Aravalli Hills of Rajasthan. Western Ghat regions of Karnataka and Maharashtra and the Sarguja. Chanda and Bastar areas of Madhya Pradesh. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants.

Some Important National Parks of India

S. No.	Name & Location	IMPORTANT ANIMALS FOUNS
1.	Kaziranga National Park District Sibsagar(Assam)	Rhinoceros
2.	Sundarbans (Tiger Reserve) 24-Pargana(West Bengal)	Tiger
3.	Hazaribagh National Park Hazaribagh Jharkhand	Tiger
4.	Corbett National Park District Nainital (Uttaranchal)	Tiger
5.	Gir National Park District Junagarh (Gujarat)	Asiatic lion
6.	Kanha National Park Mandla and Balaghat (M.P.)	Tiger, panther, chital, chinkara, four horned deer
7.	Tandoba National Park Chandrapur (Maharashtra)	Tiger
8.	Bandipur National Park District Mysore (Karnataka)	Elephant, tiger, leopard
9.	Desert National Park Jaisalmer (Rajasthan)	Great Indian Bustard, Black buck, chinkara.
10.	Nannda Devi- Uttaranchal (Chamoli District)	White Tiger

SOME IMPORTANT SANCUTARIES OF INDIA

S. No.	Name & Location	Important Animals
1.	Keoladeo Ghana Bird Sanctuary Bharatpur (Rajasthan) Famous for birds	**Siberian crane**
2.	Annamalai Sanctuary Coimbatore (Tamil Nadu)	**Tiger, Elephant**
3.	Dachigam Sanctuary Srinagar (Jammu & Kashmir)	**Hangul or Kashmir stag, Musk deer**
4.	Nagarjuna Sagar Sanctuary Guntur Kamool and Nalgonda (Andhra Pradesh)	**Tiger, Panther**
5.	Periyar Sanctuary (Kerala)	**Elephants, Leopard, Hombill**
6.	Chilka Lake Bird Sanctuary Balagaon (Orissa) (Largest brackish water lagoon in Asia) An oasis of bir is like	**Water fowls, Ducks, Cranes**
7.	Manas Wildlife Sanctuary Kamrup (Assam)	**Tiger, Panther**

Some Special Animals -

- **Asiatic wild ass - (Endangered)** - Found in runn of Kutch and Pakistan

- **Red Panda - (Endangered)** - Found in Kanchanjunga (Sikkim)
- **Hangul-Kashmir Stag (Endangered)-** Found in Dachigs;tm (Sri-Nagar - Jammu & Kashmir)
- **Siberian Crane (Critically Endangered)-** Found in Keoladeo (Ghana) National Park Bharatpur (Rajasthan)

The Great Indian Bustard is a huge ground bird with a long neck ·and long bare legs. It is an inhabitant of the semi-arid areas of Rajasthan, Gujarat and Maharashtra.Hunting for its flesh has reduced its population to over 800. It is a Critically endangered bird.

Ex-situ conservation –

- The protection of wild life in zoos and botanical gardens. Other e.g., of Ex-situ conservation are **gene banks, germ plasm bank, seed bank**. In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care. **Zoological parks, botanical gardens** and **wildlife safari parks** serve this purpose. There are many animals that have become extinct in the wild but continue to be maintained in zoological parks.
  In recent years ex situ conservation has advanced beyond keeping threatened species in enclosures. Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques, eggs can be fertilised in vitro, and plants can be propagated using tissue culture methods. Seeds of different genetic strains of commercially important plants can be kept for long periods in seed banks.
- "In situ conservation" is the protection of species (wild life) in their natural habitat or National parks or Biosphere reserve or Sanctuaries or Sacred groves

1. **The world's first National Park (America) -** Yellow stone National Park
2. **India's first National Park -** Jim Corbett National Park- Nainital (Uttaranchal)
3. **Smallest tiger reserve in India -** Ranthambore National Park- Sawaimadhopur (Rajasthan).
4. **Largest Tiger reserve in India -** Nagarjuna Sagar Saisailum Sanctuary- Guntoor- Andhra Pradesh.
5. **Nandan-Kanan zoo (Bhubaneshwar- Orissa) is known for-** White tiger.
   Note: Sunderbans [W.Bengal] is also famous for tigers.

SOME IMPORTANT INFORMATIONS

1. (i) National Forest Policy revised in - 1988.
   (ii) Biodiversity act of India was passed by the Parliament in the year-2002
   (iii) Forest Act-1927.
   (iv) Biosphere Reserve Scheme- 1986

2. **Wild life protection act 1972 (Revised in 1991):**

ABOUT WILDLIFE

- **Red Data Book :-** This book contains a record of **animals & plants** which are known to be in danger. This Book is maintained by the **IUCN** [International Union for Conservation of Natur and Natural Resources].
- **Silent Valley** :- It is tropical evergreen forest in Kerela (Palghat) declared as National Reserve Forest. It is called silent valley because there is no noise in the forest during night, even that of cicadas, as they are not found there. **It is related to conservation of forest.**

BIODIVERSITY AND CONSERVATION

BIODIVERSITY,

Biodiversity is the term popularised by the sociobiologist Edward Wilson to describe the combined diversity at all the levels of biological organisation.

The most important of them are-

(i) **Genetic diversity :** A single species might show high diversity at the genetic level over its distributional range. The genetic variation shown by the medicinal plant Rauwolfia vomitoria growing in different Himalayan ranges might be in terms of the potency and concentration of the active chemical (reserpine) that the plant produces. India has more than 50.000 genetically different strains of rice, and 1.000 varieties of mango.

(ii) **Species diversity:** The diversity at the species level. For example, the Western Ghats have a greater amphibian· species diversity than the Eastern Ghats .

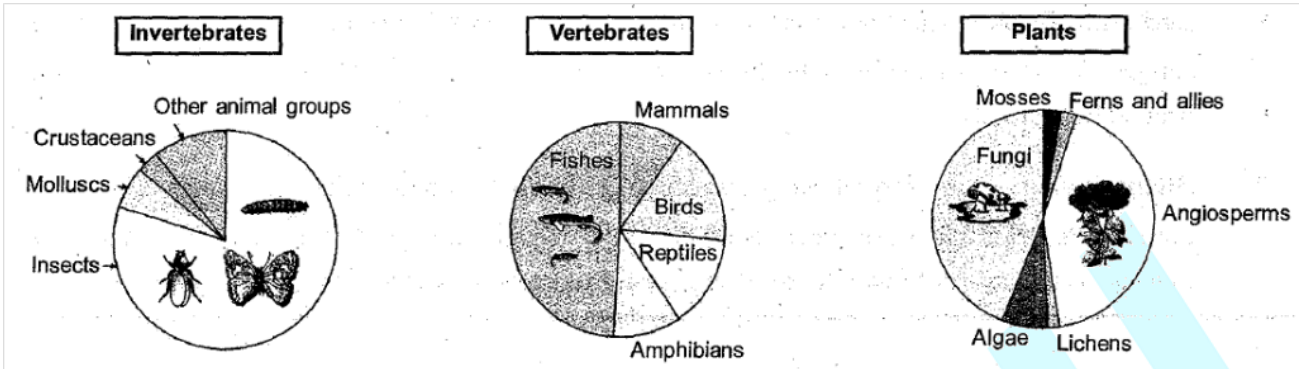
(iii) **Ecological diversity:** At the ecosystem level India, for instance, with its deserts, rain forests, mangroves. coral reefs, wetlands, estuaries, and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.

HOW MANY SPECIES ARE THERE ON EARTH AND HOW MANY IN INDIA

1. According to the IUCN (2004), the total number of plant and animal species described so far is slightly more than **1.5 million**, but a more conservative and scientifically sound estimate made by **Robert May** places the global species diversity at about **7 million**.

2. More than **70 per cent** of all the species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than **22 per cent** of the total. Among animals, insects are the most species-rich taxonomic group, making up more than 70 per cent of the total. That means, out of every 10 animals on this planet 7 are insects. The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.

3. Although India has only **2.4 per cent** of the world's land area, its share of the global species diversity is an 'impressive 8.1 per cent. That is what makes India one of the 12 mega diversity countries of the world. Nearly 45,000 species of plants and twice as many of animals have been recorded from India. How many living species are actually there waiting to be discovered and named? If we accept May's global estimates, only 22 per cent of the total species have been recorded so far.



Representing global biodiversity : Proportionate number of species of major taxa of plants, invertebrates and vertebrates

PATTERNS OF BIODIVERSITY

(i) Latitudinal gradients -

The diversity of plants and animals is not uniform throughout the world but shows a rather unever distribution. In general, species diversity decrease as we move away from the equator towards the poles. The largely tropical Amazonian rain forest in South America has the greatest biodiversity on earth - it is home to more than 40000 species of plants, 3000 of fishes, 1300 of birds, 427 of mammals, 427of amphibians, 378 of reptiles and more than 125000 invertibrates.

(ii) Species-Area relationships -

German naturalist and geographer Alexander von Humboldt observed that within a region species richness increased with increasing explored area, but only up to a limit

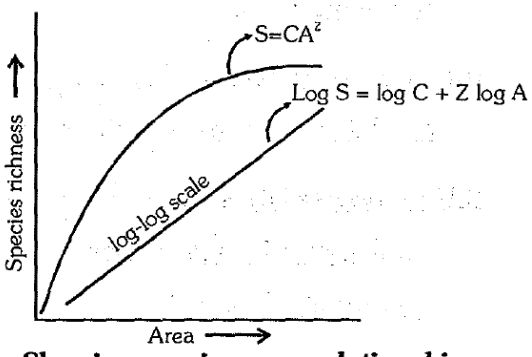
$\log S = \log C + Z \log A$

where

S = Species richness A = Area

Z = slope of the line (regression coefficient)

C = Y-intercept



Showing species area relationship.

Ecologists have discovered for a small region (Britane, California, Newyork) the value of Z lies in the range of **0.1** to **0.2**, regardless of the taxonomic group. For very large areas like the entire continents the value of Z lies in the range of **0.6** to **1.2**. In the tropical forests of different continents for frugivorous (fruit-eating) birds and mammals value of Z found to be 1.15. The steeper slopes in this context means more species richness.

Importance of Species Diversity to the Ecosystem -

Tilman found that plots with more species showed less year-to-year variation in total biomass and showed that increased diversity contributed to higher productivity.

Paul Ehrlich proposed "Rivet popper hypothesis" -

In an air plane (ecosystem) all parts are joined together using thousand of rivets (species). If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct). It may not effect flight safety (proper functioning of the ecosystem) initially, but as more and more rivets are removed the plane become dangerously weak over a period of time. Further more, which rivet is removed may also be crucial.

LOSS OF BIODIVERSITY

1. The biological wealth of our planet has been declining rapidly and the accusing finger is clearly pointing to human activities. The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.

2. The **IUCN Red List (2004)** documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years.

3. Some examples of recent extinctions include the **Dodo (Mauritius), Quagga (Africa), Thylacine (Australia).** Steller's Sea Cow (Russia) and three subspecies (Bali, Javan. Caspian) of tiger.

4. The last twenty years alone have witnessed the disappearance of 27 species. Careful analysis of records shows that extinctions across taxa are not random; some groups like amphibians appear to be more vulnerable to extinction. This is the fact that more than 15,500 species world-wide are facing the threat of extinction.

5. Presently, 12 per cent of all bird species, 23 per cent of all mammal species, 32 per cent of all amphibian species and 31per cent of all gymnosperm species in the world face the threat of extinction.

6. In general, loss of biodiversity in a region may lead to (a) decline in plant production, (b) lowered resistance to environmental perturbations such as drought and (c) increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycles.

CAUSES OF BIODIVERSITY LOSSES

The accelerated rates of species extinctions that the world is facing now are largely due to human activities. There are four major causes ('The Evil Quartet' is the sobriquet used to describe them).

(i) Habitat loss and fragmentation:

This is the most important cause driving animals and plants to extinction. The most dramatic examples of habitat loss come from tropical rain forests. Once covering more than 14 per cent of the earth's land surface, these rain forests now cover no more than 6 per cent. They are being destroyed fast. The Amazon rain forest (it is so huge that it is called the **'lungs of the planet'**) harbouring probably millions of species is being cut and cleared for cultivating soya beans or for conversion to grasslands for raising beef cattle.

Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. When large habitats are broken up into small fragments due to various human

activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

(ii) Over - exploitation :

Humans have always depended on nature for food and shelter, but when 'need' turns to 'greed', it leads to over-exploitation of natural resources. Many species extinctions in the last 500 years (Steller's sea cow passenger pigeon) were due to overexploitation by humans. Presently many marine fish populations around the world are over harvested endangering the continued existence of some commercially important species.

(iii) Alien species invasions :

When alien species are introduced unintentionally or deliberately for whatever purpose some of them turn invasive and cause decline or extinction of indigenous species. The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake.

You must be familiar with the environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia). The recent illegal introduction of the African catfish Clarias gariepinus for aquaculture purposes· is posing a threat to the indigenous catfishes in our rivers.

(iv) Co-extinctions :

When a species becomes extinct the plant and animal species associated with it in an obligatory way also become extinct. When a host fish species becomes extinct, its unique assemblage of parasites also meets the same' fate. Another example is the case of a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

Type of Extinction of species :

(i) Natural extinction : Due to change in environmental condition.

(ii) Mass extinction : Due to catastrophs.

(iii) Anthropogenic extinction : Due to human activities like hunting.

The characteristics of species particularly susceptible to extinction are :-

Large body size, small population size, low reproductive rate, feeding at high trophic levels in the food chain, Fixed migratory routes and habitat and localized and narrow range of distribution.

Why should we conserve Biodiversity

There are many reasons to conserve biodiversity we can group then into three categories.

(1) Narrowly utilitarian :- It is concerned with direct economic benefits from nature food, firewood, fibre, construction material. industrial products and products of medicinal importance. More than 25 percent of the drugs currently sold in the market world wide are derived from plants

(2) Broadly Utilitarian :- It is concentred with indirect benefits from nature, like, photosynthesis, pollination. This argument says that biodiversity plays a major role in many ecosystem services that nature provides Amazon forest is estimated to produce 20% of the total oxygen iri the earth's atmosphere pollination is another Service, ecosystem provide through. insects.

(3) **Ethical** :- It is our moral duty to care for the well being of biodiversity and pass on our biological legacy in good order to future generations:

Note:-

Bioprospecting :- Exploring molecular. genetic and species level diversity for the products of economic importance.

SOME OTHER INFORMATIONS ABOUT BIODIVERSITY

1. **Hot Spot:**

Norman Myers developed the hot spot concept in 1988. This is a mega diversity zone. Where large number of species are found. It is an area of the richest and the most threatened reservoirs of plant and animal life on the earth. Initially 25 biodiversity hot spots were identified in world, now **number of biodiversity hot spot in the world are 34 out of these 3 hotspots are found in India.**

(i) **Western Ghats and Sri Lanka**

(ii) **Indo-Burma**

(iii) **The Himalayas**

Note:

- The key criteria for determining a hot spot are :

1. High level of species richness

2. High degree of endemism (that is, species confined to that region and not found anywhere else)

3. High degree 9f threat which is measured in terms of habitat loss (It means hot spots are regions of accelerated habitat loss) .

- Hot spot covers the 1.4% of the earths land area.
- Although all the biodiversity hotspots put together cover less than 2 percent of the earth's land area, the number of species they collectively harbour is extremely high and strict protection of these. hotspots could reduce the ongoing mass extinctions by almost 30 per cent.

2. Diversity at the level of community - Three types :

(i) **Alpha diversity :** Diversity with in community.

(ii) **Beta diversity :** Diversity between community.

(iii) **Gamma diversity :** Diversity of the habitats over the total landscape or geographical area.

3. **Landscape :** It is a unit of land with a natural boundary having a mosaic of patches. These patches generally represent different ecosystem.

Note : In ecological hierarchy landscape can be present between Ecosystem and Biomes.

4. India is divided into 10 Biogeographical regions.

5. **Wet lands :** Low lying area's covered with shallow water are called wet land's. The wet lands are transitional zones between terrestrial and aquatic area's. **6% 9f the world's** land surface is OCGUPY by wet lands.

- **Marshes :** Wetlands where grass - like plants dominate.
- **Swamps :** Wetlands where trees or shrubs dominate.
- **Reverine forest :** Periodically Flooded forests found in lowland along streams.
- **Mangrove is salty water swamp**

Significance of Wet lands :

(1) Wetland are higly productive, provide food and habitat.
(2) Wetlands helps to control flooding by holding excess water.
(3) Ground water recharging areas.
(4) Help to clean and purify water run-off.
(5) Provides sites for fishing, boating, nature study.

6. Guild- Members of same trophic level.

IMPORTANT DAYS ABOUT ENVIRONMENT

02-Feb	-	World Wetland day
03-Mar	-	World wild life day
22-Mar	-	World water day
22-Apr	-	Earth Day
09-May	-	International migratory Bird Day
22-May	-	International Day for Biological Diversity
05-Jun	-	World Environment Day
08-Jun	-	World ocean Day
11-Jul	-	World population Day
23-28 August	-	World water week
16-Sep	-	World Ozone day
04-0ct	-	World Animal Day
21-Mar	-	World Forest Day
23-Mar	-	World Resources Day
10-Apr	-	World Atmosphere Day
02-08 Oct	-	Wild life Week
14-Dec	-	World Energy Conservation Day
02-Dec	-	National Polutions prevention Day (National Environment Day)
03-Dec	-	Bhopal Tragedy Day

Note : * 2015 Is The International Year of Soil

ANSWER KEY

BEGINNER'S BOX-1

1.	(2)	**2.**	(1)	**3.**	(3)	**4.**	(1)	**5.**	(3)	**6.**	(4)	**7.**	(3)

BEGINNER'S BOX-2

1. (2) **2.** (4) **3.** (1) **4.** (1) **5.** (2)

BEGINNER'S BOX-3

1. (2) **2.** (4) **3.** (2) **4.** (2) **5.** (1) **6.** (3) **7.** (2)
8. (3)

BEGINNER'S BOX-4

1. (1) **2.** (4) **3.** (1) **4.** (4) **5.** (2) **6.** (3)

BEGINNER'S BOX-5

1. (2) **2.** (2) **3.** (2) **4.** (1)

BEGINNER'S BOX-6

1. (3) **2.** (2) **3.** (4) **4.** (1) **5.** (3)