Chapter 13

Organisms and Populations

Ecology: Organisms & their Environment

Ecology

The study of interaction or inter-relationship of organisms with their environment is called ecology. Organisms and environment are always interdependent, inter related or mutually reactive.

- The term ecology was coined and described by **E Haeckel.**
- The term ecology was first authentically used by **Reiter.**
- Father of ecology: **Reiter**
- The term Ethology for ecology was used by: **Geoffroy Hilaire.**
- The term Hexicology for ecology was used by: **G. H. Mivart.**
- The study of ecology was initiated in India by: **W. Dudgeon.**
- Father of Indian Ecology: **Prof. Ram Deo Misra.**
- First of all term ecology was employed for the study of the plant by: **Warming.**

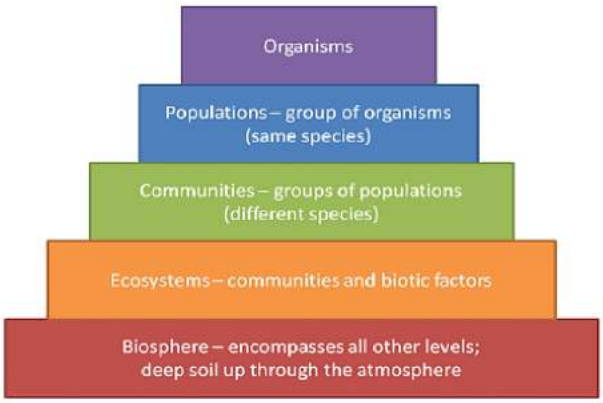
Branches of Ecology

It is based on the organism level.

1. **Autecology:** Study of the relation of a species with its environment is known as autecology.

2. **Synecology–** Study of the relation of the group of different species with their environment.

Ecological Hierarchy



Organism

In biology, an organism is an individual entity that embodies the properties of life. It is a synonym for "life form".

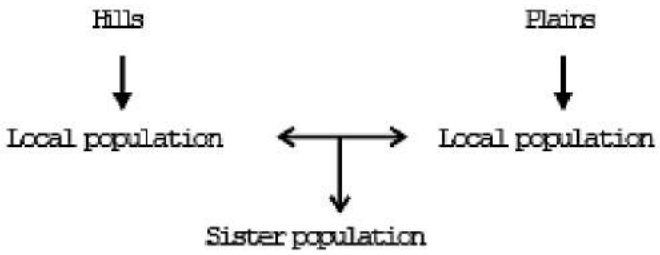
- It may be small, large, unicellular or multicellular.
- Fixed life span and organized life cycle (birth to death).

Fig: Organism

Population:

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

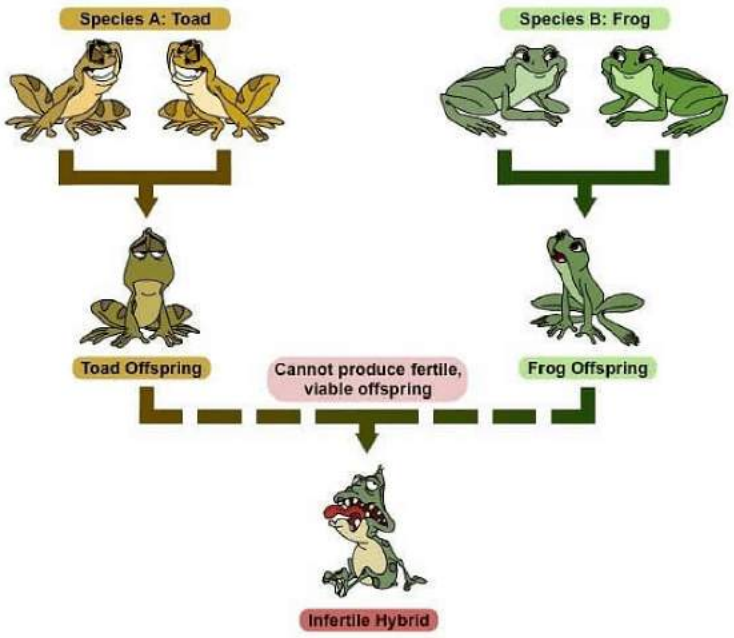
- **Local Population or demes (Subgroups of the population)–** Population of organism inhabiting a particular area. **eg.** Homosapiens inhabiting hills, plains.
- **Sister population–** Different population of same kind of organisms which are found in different places are known as sister population.



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

Species

A 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 interbreed under natural conditions and be reproductively isolated from another group of organisms.



Species

Terms Related to Species:

- **Endemic Species or Endemism:** A species that is found only in a particular area is known as endemic species.
  e.g. Metasequoia is found only in the valley of China, Kangaroo in Australia.
- **Key-stone Species:** The species which have a great influence on the community's characteristics relative to their low abundance or biomass are called keystone species. The activities of keystone species determine the structure of the community.
  e.g. Lion in the forest, Kangaroo rat in the desert.
- **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 works as pollinators of flowers.

Intraspecific Interaction

It is of two types:

1. Cooperative interactions
2. Competitive interactions

Cooperative Interactions (+ve)

1. Group formation for breeding: They are of two types-
Monogamous: In this interaction, one male and one female come together and form a breeding group. They live together whole life.

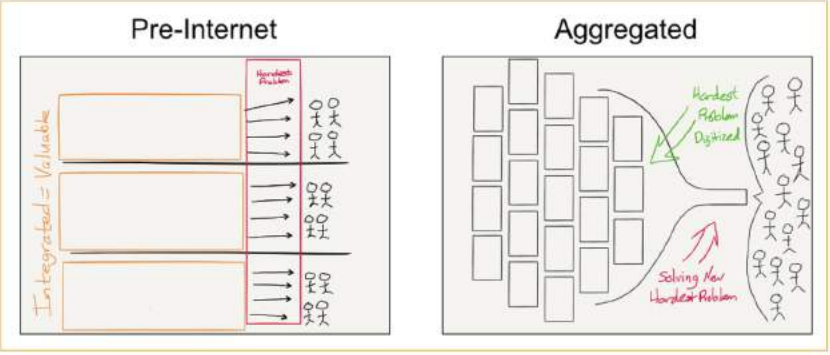
Fig: Monogamous

- **Example:** Wolf, Fox, Swan Sparrow, predaceous insects, spiders, owls, tigers are solitary animals. Their partnership breaks down at the end of a breeding season. Adult male and female come together only for a short duration for mating purpose.
- **Polygamous:** It is an example of group formation.
  Example: Seal, walrus and Deer.

2. Mating behaviour: It is the precopulatory sexual behaviour of two sexes of the same species towards each other during copulation.
Example: Dancing behaviour in peacock, Whistling by the cicada, Nest building by male stickle beck to attract the female
3. Parental care:

- Care of eggs
- Nest building
- **Carrying eggs or person Advantage:** Protection, chances of survival of young ones, transfer of knowledge to young ones.

4. Aggregation: When a number of solitary animals aggregate for some particular activity it is called aggregations.



Advantages: Protection, facility in sexual reproduction, transfer of knowledge.
There are two types of aggregation:

- Temporary Aggregations
  Example: During migration in birds, Snakes aggregate temporarily during hibernation.
- Permanent Aggregation

5. Altruism: It is the behaviour of an individual to increase the chances of survival of other individuals of the same species i.e. sacrificial behaviour. **e.g.** Altruism is observed in spotted deer, wild turkey, workers of the honey bee, termites etc.

Fig: Altruism

Note: Lemmings are important example. When their number exceeds food supply, there is large scale exodus to commit mass suicide so that workable relationship or balance is re-established between food resources and population size.
6. Dominance: Subordinate behaviour or hierarchial social order in a flock or herd, where the ranking of individuals is present for eg. female subordinate to males, young to adult.
7. Communication: Transmission or exchange of information among the members of the same species.

Communication

Modes of communication:

(i) Chemical signals: Some organisms release pheromones. Pheromones act as sex attraction alarms, signals, path indicator, territory markers etc.

- Ants release chemicals containing pheromones, which help other members of the colony to find their path to the colony or to the source of food.
- In several animals sex pheromones are secreted by females during the breeding season, this indicates their receptivity to attract the male. A dog can smell a bitch from almost one kilometre.

(ii) Tactile Signals:

- By physical contact during courtship and mating
- Mutual preening in birds, grooming in mammals.

(iii) Visual communication:

- Workers honey bee informs about the direction and distance of food-source by its dancing movements.
- Round dance– when the food source is less than 75 meters.
- Tail wagging dance– when the food source is at long distance.

(iv) Auditory communication: By producing some specific sound.

- Male frog →croaks
- Song of birds →for sex, location, mating call, alarm

Fig: Auditory Communication

Competitive Interactions

It is the competitive relationship between two organisms of the same species for getting the same resources (food, habitat, light, moisture).

Note: Intraspecific struggle is the strongest and most severe type of interaction because members of same species have same requirement such as food, shelter and same structural, functional and behavioural adaptation.

Example: Sparrows fight for a particular shelter, wall lizards fight to catch insects.
Plants also compete for space, water, light and minerals.

Advantage: It helps in maintaining the ecological balance.

Home Range and Territory

Home Range:

Several members of a species may cover a definite area for searching for food, mates and shelter, this is called home range.

1. The home range of different groups can overlap.
2. The home range is larger in size and natural and has many breeding groups.
3. It is usually not defended.

4. Its size may be few meters (Ants) or many km.(African hunting dog)

Territory:

In-home range particular geographic space/area marked by an individual or a group of breeding individuals (breeding pairs) for breeding is known as a territory. It is an area that is a family habitat.

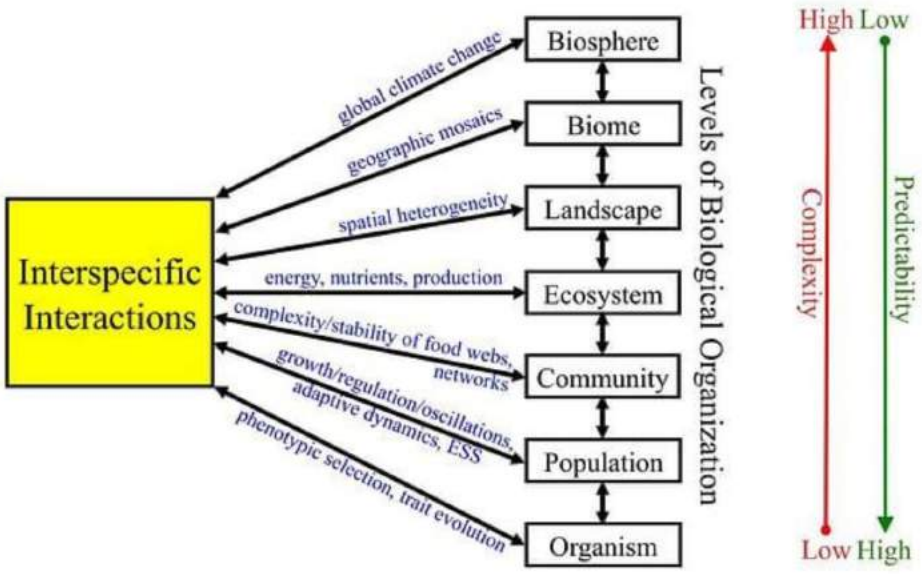
1. A home range is formed by many territories, territory is defended against a member of the same species except the mating partners.
2. Boundaries of territory are marked by urine eg. Dogs, Tiger. Secretion like pheromones– e.g. Rabbit.
3. The territory of different groups cannot overlap.

Note: Territory reduces the competition for basic needs (shelter, food).

Population Interactions

INTER SPECIFIC INTERACTIONS

Due to increase in different species in community, interaction (for food, habitat) also starts between them.



Interspecific Interactions

(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 Symbiosis: (co-evolution) Positive inter specific interaction in which members of two different species completely depend on each other for growth and survival, physical contact is present in between both the interacting species. 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 plant and bacteria – e.g. legume plant and Rhizobium.
- Mutualism between algae and higher plant e.g. Nostoc, Anabaena and Anthoceros plant.
- Mutualism between algae and fungi– e.g. Lichens.
- Mutualism between fungi and higher plants– e.g. Mycorrhizal association.

Note : Extra eg.

- **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 larval. 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 pollinator 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 beans resemble to the female of the bee in size, colour and markings. The male bee is attracted 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 (ANTAGONISM)/DETRIMENTAL

Two types of negative interaction:

(1) Exploitation
(2) Amensalism

(1) Exploitation – One species harms the other by making its direct or indirect use of 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 does **not kill** the host.

Type of Parasites:

(i) **Ectoparasite** → lives on the body of host.
- **Ectozooparasite –** Leech on cattle, ticks on dogs, copepods on marine fish and lice, mosquitoes, sandfly live on man
- **Ectophytoparasite –** Amphids, Lac insects, Red cotton bug.

(ii) **Endoparasites** → lives in the body of host.
- Tapeworm, Taenia, Ascaris, Entamoeba → live in intestine of man.
- Plasmodium → live in R.B.C. of human.

- **Hyper parasitism** → A parasite living on another parasite. **e.g.** plasmodium on female anopheles mosquito, 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** → Parasites 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.
Santalum – partial root parasite

Note : Arceuthobium is the smallest parasite.

(b) Predation (+/–):–A free living organisms which catches and **kills** another species for food.
Insectivores fungi – Dactylella, Dactylaria, Arthrobotrys.
Carnivores animals – Lion, snake.
Insectivores plants – Drosera, Utricularia, Nepenthes.
(2) Amensalism (– / 0) – amensal = (–) inhibitor = (0)
In this interaction one species is inhibited by toxic secretion of another species. Inhibitor species is neither benefitted nor harmed.
Type of Amensalism
(i) Allelopathy (ii) Antibiosis
(i) Antibiosis – Secretion of antibiotics –
- Penicillium fungi secretes penicillin which inhibits growth of Staphylococcus bacteria.
- Chlorella algae secretes bacteriocytes which not only kills but also inhibits growth of the bacteria.
- Microcystis (BGA) secretes hydroxyl amine, this causes the death of fishes.

(ii) Allelopathy – Secretion of toxic chemical –
- **Parthenium –** Trans Cinnamic acid is secreted by Parthenium which inhibits the growth of some plants like Cassia tora and Vincaregia. This phenomenon is known as allelopathy.

- Sunflower, Barley, Sorghum, Occimum also show allelopathy.

• **Silver oak shows autopathy** – It destroys own seed.
Allochemics – Chemicals secreted by a species are known as allochemics. **Types of allochemics** • **Allamon –** Chemicals which repel other enemies is called allamon. **e.g.** Cuttle fish (Sepia) • **Depressants –** Chemicals which kill or inhibit the growth of other organism **e.g.** Parthenium • **Kairmons** – The chemicals secreted by one organism which benefits the another organism **e.g.** Nematodes in soil → stimulate growth of fungi.
• **Cannabalism** → organisms eaten by own species **e.g.** cockroach, termites • **Competition (–, –):** Process in which the fitness of one species is significantly lower in the presence of another species.

RAUNKIAER'S LIFE FORMS

On the basis of position and the degree of protection to perennating organs (bud) during adverse season, Raunkiaer divided the plant in to five life forms (growth process)

1. Phanerophytes – The buds are located much above the surface of the earth. Such type of plants are found more in tropics, epiphytes are included in phanerophytes.

2. Chamaeophytes – The buds are situated very close/near to the ground surface. Such types of plants are found in cold places or high altitudes.

3. Hemicryptophytes – The buds present just below or just above the surface of ground. Such plants are found in temperate climate.
4. Cryptophytes – The buds lie very deep in the ground.
5. Therophytes – Those plants which are passing the unfavourable climate through their seeds.

SOME TERMINOLOGY RELATED TO COMMUNITY

(1) Formation → A well developed plant community in any climate is called formation.
Eg.→ Tropical forest.

(2) Association → A sub-unit of formation. A smaller community of plant formation with its two or more dominant species is known as association. A formation has many association

(3) Consociation → Sub unit of association, means a community with a single dominant species.

METHODS OF STUDY OF PLANT COMMUNITIES

1. Direct Method – This method is used to find out the species and members present in a community and study about them. This method can be used only for small community.

2. Sampling method – In this method we study the community in the form of sample. This method is also useful for large community. Samples are taken in the form of quadrats. The quadrats are formed with the help of rope to know the size of a quadrat, sequentially increase the size of quadrats according to increase in number of species, when the no. of the species becomes constant then estimate the number of plants present in the same size of quadrats. Then after that table work is done.

(i) Frequency → No. of (Percentage) of samples on sampling unit in which species is present. It indicates species dispersal.

$$\text{Frequency} = \frac{\text{No. of samples in which specific species present}}{\text{No. of total samples}} \times 100$$

e.g.The plants of prosopis species were present in 90 samples out of 100 sample,

$$\text{than the frequency of prosopis} = \frac{90}{100} \times 100 = 90\%$$

(ii) Density – The number of individuals per unit area, it indicates abundance of a species.

$$\text{Density} = \frac{\text{Total no. of individuals of the species in all samples}}{\text{Total no. of sample taken}}$$

e.g. 10,000 prosopis were present in 100 sample

$$\text{then the density of prosopis} = \frac{10000}{100} = 100$$

ANALYSIS OF PLANT COMMUNITIES:

Analysis of community characters is generally done for :

- Recording variations within and between communities.
- Naming and classifying communities.

Community analysis involves measurements of various characters in sample plots or quadrats located with in the community.

Frequency – Based on percentage of plots or quadrat in which a species (which is being studied) is present.
Diversity (Density) – Number of individuals per unit area.
Cover – Percentage land area occupied by a species-cover is expressed by basal cover (basal cover area occupied by stem bases) or crown cover (crown cover-area covered by canopy).
Biomass – Quantity of living materials per unit area.

Various community characters can be categorised as:

(i) Analytic characters – Characters which are directly observed or measured in sample plots or quadrats.

(ii) Synthetic characters – Which are derived from the measurements of analytic chracters.

Analytic characters Synthetic characters

- **Frequency** → Dispersion of species

  Note: Frequency is an analytic character which show or indicate dispersion of species which is a synthetic character.
- **Diversity** → Relative abundance
- **Biomass** → Growth of plant
- **Cover** → Influence zone of species

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 modified 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.
Biological (phyto-climatic) spectrum – The ratio or percentage distribution of different life forms in any plant community is called biological spectrum.

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.
Gause's competitive exclusion principle – This principle state that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior are will be eliminated eventually. This may be true if resources are limiting but not otherwise.
Ecological Equivalents– Organism that occupy the same or similar ecological niche in different geographical regions are known as Ecological equivalents. e.g. Arctic fox and African Jackal, both are scavengers Grazers of North America and Kangaroo's of Australia
Habitat – Physical area covered by any organism
Micro climate and Micro habitat – Subdivision of habitat is called micro habitat. 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
Competitive release –A species whose distribution is restricted to a small geographical area because of the presence of a comparatively superior species. If one of the superior competitor is removed then range of the distribution of inferior species get increased.
Resource partitioning – If two species compete for the same resource, they could avoid competition by choosing, for instance different time for feeding or different foraging patterns.

Abiotic Factors & Responses to Abiotic Factors

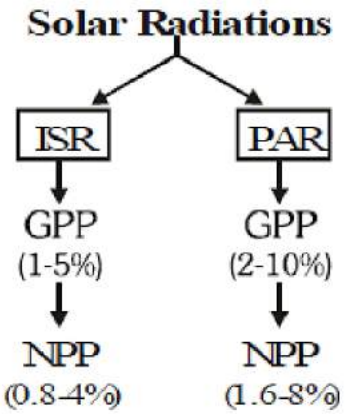
ABIOTIC ENVIRONMENTAL FACTORS OF ECOSYSTEM
(A) Light
(B) Temperature
(C) Soil
(D) Other

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 (l) of light or visible spectrum is 0.4 to 0.7 mm (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 μm)
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.



Effect of light –

Photokinesis – Regulation of speed of locomotion due to light is called **photokinesis** e.g. larvae of mussel crab move faster if light intensity increases.

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

Effect of Temperature on plants –
Temperature causes dessication (injury due to dehydration), chilling injury (injury of plant due to cold climate) and freezing injury (injury to plant cell due to ice crystal formation in the intercellular spaces)

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. Allens rule –
The tail, ears, limbs, eyes, snout and hair of mammals are smaller in colder region and larger in warm region.

3. Jorden's rule –
Fishes in cold water possess more vertebrae than those living in warm water.

4. Gloger rule –
Warm blooded animals in hot and humid area (tropical region) are moredarker in colour (heavily pigmented) than cold area.

5. Renschs rule –
Birds in cold region have narrow wings and in warm region have broader wings.

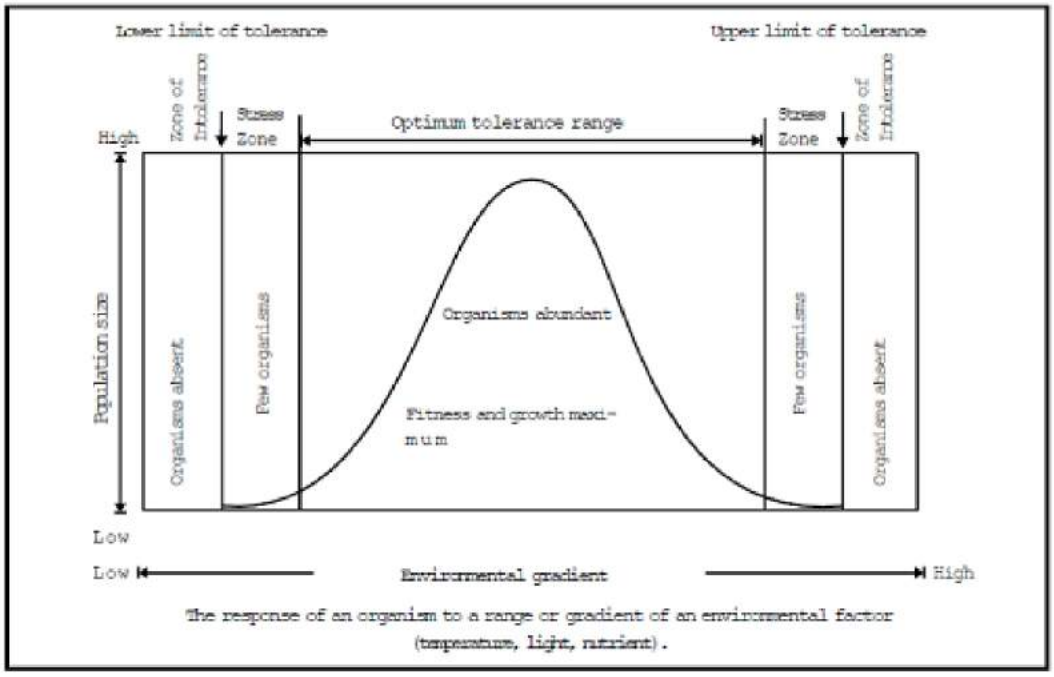
SOME EXAMPLES OF MIGRATION

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.

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.

Shelford law of tolerance –
Every organism has minimum and maximum limit of tolerance (ecological amplitude) with respect to environmental factors like temperature, sunlight or nutrient concentration in between those limits the central optimum range are found in which organisms are abundant this is known as **optimum zone of tolerance**.

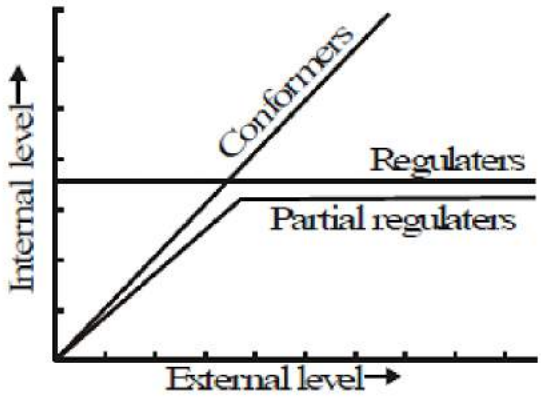


The response of an organism to a range or gradient of an environmental factor (temperature, light, nutrient).

On the basis of temperature vegetation is divided into four groups
Megatherms – The plants growing in high temperature throughout the year
e.g. Tropicalrainforest
Mesotherms – The plants growing in alternate high and low temperature
e.g. Deciduous tropical forest
Microtherms – Plants growing in low temperature
e.g. Coniferous forest
Hekistotherms – Plant growing in very low temperature
e.g. alpine vegetation
On the basis of temperature animals divided into two groups
(1) Eurythermous or Homeo thermal/endo thermal/warm blooded – Animals which are able to tolerate wide variation of temperature
e.g. birds, man, etc.
(2) Stenothermous or Poikilothermal/ecto thermal/cold blooded – Animals which are unable to tolerate wide variation in temperature
e.g. Arctic fishes Reptiles, Amphibians

Regulaters:

Organisms who are able to maintain homeostasis by physiological (some time behavioural also) means which ensures constant body temperature, (thermoregulation) constant osmotic concentration (osmoregulation) eg. all birds and mammals.

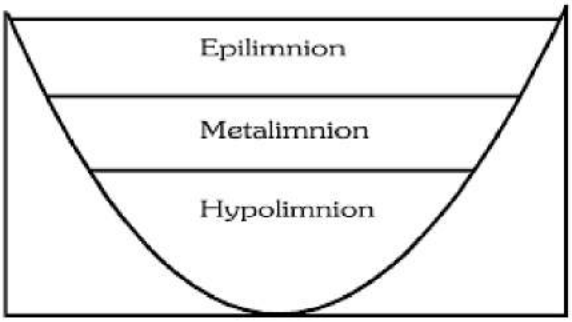


Conformers:

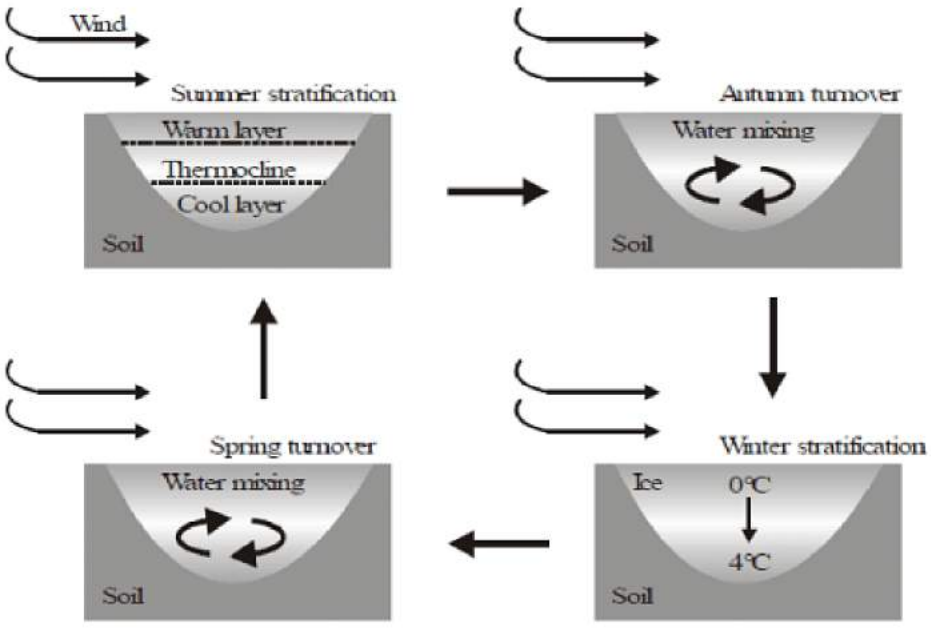
Organism who cannot maintain a constant internal environment means their body temperature or osmotic concentration change with external environment.
The response of an organism to a range or gradient of an environmental factor (temperature, light, nutrient).
Note: If the stressful external condition are localised or remain only for a short duration the organism has two
alternatives, tosurvive.
(i) Migration
(ii) Suspension

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 water below
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.



Difference in temperature of water at different depths results in thermal stratification in deep water bodies. During summer, temperature is higher on the surface water, whereas in lower layer temperature is low.
During winter in a temperature lake, water is at freezing temperature on the surface, whereas in the lower layer temperature is about 4°C. The surface water is cooled during autumn, and warmed in spring. This results in a free mixing of water in the whole water body, also known as autumn and spring turnover.
During spring and autumn due to turnover of water oxygen and nutrients are redistributed, resulting in a bloom of phytoplankton growth while during winter and summer, growth of phytoplankton is low due to low nutrients and oxygen availability.



STUDY OF OCEAN ENVIRONMENT

All the ocean basins are roughly of the shape of a wash basin or an inverted hat.
Type I – On the basis of structure:

From the coast line a gradually sloping region extends for about 160 km into the sea. This zone is called continental shelf and has a depth of 8-200 meters. The angle of the slopes then abruptly steepens to form the continental slope. The continental slope levels off into a more or less horizontal ocean floor. The depth of the ocean floor is in the range of several thousand meters.

Type II – On the basis of availability of light:
The vertical zones of the ocean are determined by the availability of light or penetration of light for photosynthesis that is

- **Photic or Euphotic zone –** It is upper lighted zone up to a depth of about 200 meters.
- **Aphotic zone –** Middle region where diffused light penetrate which is insufficient for photosynthesis, it extends up to the depth of 200-2000 meters.
- **Abyssal zone –** It is deeper part where light do not reach below 2000 meter, is the area of perpetual darkenss.

Type III – On the basis of environment:
Three major environmentl may be recognised in the ocean basin.

- **The Littoral zone –** Comprising the edge of the continental shelf.
- **The benthonic zone –** Formed of sea floor along with the continental slope and the aphotic and abyssal zone.
- **The pelagic zone –** Constituting the water of the ocean basin.

Note

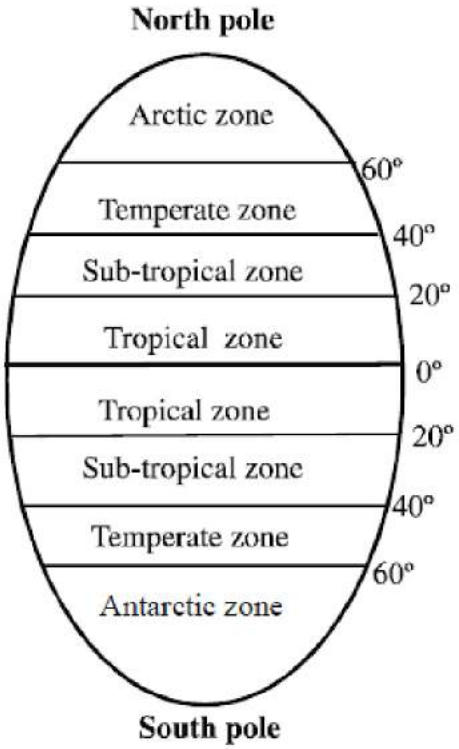
- The shallow shore region of a marine area is called neritic zone.
- The part have been cut off from river is called ox-bow-lake
- Estuaries - The region where, river enter the ocean are known as estuaries.

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 = 00 – 200 latitude
(2) Subtropical = 200 – 400 latitude

(3) Temperate = 400 – 600 latitude
(4) Arctic and antarctic = 600 – 800 latitude



here 0° showing equator

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)

SOIL OR EDAPHIC FACTOR

On the basis of the soil condition there are seven ecological group of plant

- Halophytes – Plants grow in saline soils
- Psamophytes – Plants grow in sand
- Lithophytes – Plants grow on rock surface
- Chasmophytes – Plants grow in rock crevices
- Chersophytes – Plant grow in waste land
- Eremophytes – Plant grow in dry area
- Cryophytes or Psychrophytes – Plant grow in low temperature or cold soil

Soil – Soil is the uppermost layer of earths crust formed by weathering of rocks. It is the mixture of living or non living materials.
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 five types on 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 or Grit	2mm – 5mm
Coarse Gravel	Above 5.00

Sandy Soil = 85% sand + 15% clay or silt or both
Loamy Soil = 70% sand + 30% clay or silt or both
Silt Soil = 90% silt + 10% sand
Note: Loam Soil is the best soil for growing of crops, it has 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 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 semple 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 in 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 detritusis rich in lignin and chitin, and quicker, if detritusis 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.

Two types of Humus –

(i) Mor (Coarse terxtured humus) – It is raw humus and is formed in acidic soil (PH - 3.8 – 4.0) in which decomposition of litter is slow because it has less number of decomposer organism.
(ii) Mull – This is completely decomposed litter i.e. humus because rate of decomposition is fast due to high PH of soil.

SOIL WATER

It is of three types
Holard – The total amount of water present in the land is called holard.

Hygroscopic water – A thin layer of water attached tightly to soil particles due to forces of cohesion or adhesion. This is non available to plant.

Gravitational water – The water that moves downwards due to gravity, it is non available to plant.

Capillary water – Inter particle spaces or porous spaces act as minute capillaries and some amount of water is present in these capillaries due to surface tension This is capillary water. Itis theonly formof soil water which is available to plant.

Combined water – The water which is present as hydroxides of iron, aluminium silicon, etc. is called
combined water.

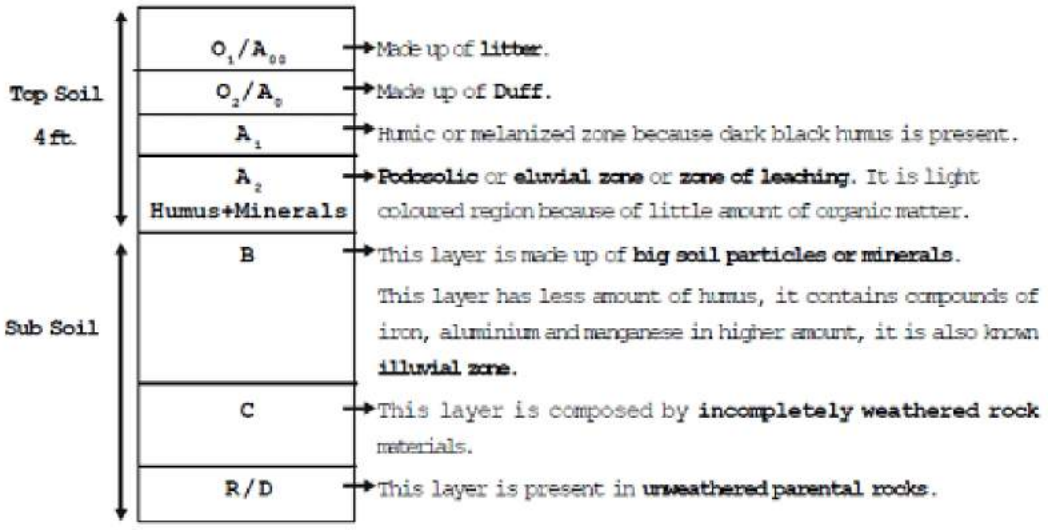
Some Terminology:

1. Field capacity – When soil holds all the water except gravitational water, it is known as field capacity. It is upper limit of water availability.
Field capacity = Holard – Gravitational water,
or
Field capacity = Capillary water + Hygroscopic water + Combined water

2. Water holding capacity (Storage capacity) –
W.H.C. = Holard – (Hygroscopic water + Combined water + Gravitational water)

3. Wilting point: The lower limit of water availability of a soil is called wilting point.
Note:
1. The water potential of soil at field capacity is (–0.01 Mpa) **[Mpa = Mega pascal]**
2. The water potential of soil at wilting point is (–1.5 Mpa)
3. Amount of water in soil measured by tensiometer.

SOIL PROFILE



Note: A Horizon + B Horizon = Solum

Type of soil on the basis of the mode of their formation –

(1) Residual soil – The soil in which soil formation i.e., weathering and pedogenesis, occurs at same place.
(2) Transported soil – Soil in which weathering process occurs at one place and pedogenesis occurs at another place.
(a) Colluvial soil → Itisbroughtbygravity.
(b) Alluvial soil → It is brought throughwater, it is highly fertilesoil.
(c) Glacial soil → Soil isbrought by ice.
(d) Eolian soil → This soil is brought through wind.

SOME TERMINOLOGY RELATED TO SOIL

LATERIZATION:

In the tropical area due to high temperature, high rainfall, litter is decomposed very rapidly in A layer. Due to mineralization of litter Al and Fe are liberated in the upper layer (A - layer) of soil, colour of this soil becomes redish-brown, this process is known as laterization.

PODSOLIZATION:

In temperate area temperature is low and high humidity occurs. Humus and minerals contents dissolve and percolate with water and are leached from A layer to B layer. Due to loss of chemicals the colour of soil of A layer (horizon) turns to light ash colour. This process is known as podsolization and soil is known as podosols.

GLEIZATION:

In tundra region due to low temperature and humid condition humus is formed in less quantity and moves slowly in B layer. So colour of B layer becomes blue – grey due to deposition of Fe salt. This process is known as gleization and soil is known as gleys.

Note:

- Best pH of the soil for cultivation of plant is 5.5 – 6.5
- Excess water produces salinity problem in soil.
- **Calcifuge plants →** Those plants which can grow in little amount of calcium in soil
  (pH – 3.8 to 4.0) e.g. Rhododendron, Rumax etc.
- **Calcarious soil →** Soil having excess of calcium carbonate.

- Alkaline soil can be corrected by adding gypsum ($CaSO_4$) and heavy irrigation whereas acidic soil can be corrected by adding lime $Ca(OH)_2$
- Availability of nutrients from the soil is related with pH of soil.

Note:

- **Black cotton –** Soil of Maharashtra are commonly known as regur soil
- **Sierozen –** Light coloured soil of arid region
- **Bog soil –** Soil of marshes and swamps
- **Solnetz/Solansltz –** Black alkaline soil
- **Peat soil –** In which 90% humus in present.
- **Solonchak –** White alkaline & Saline soil

OTHER ABIOTIC COMPONENT

1. Precipitation – It is a source of soil water. The hydrological cycle is the movement of water between earth, air and atmosphere.

Forms of precipitation –

(i) Drizzle – Minute drops of water floating in air
(ii) Rain – Large drops of water
(iii) Snow – Water in solid form
(iv) Sleet – Ice in minute granular from
(v) Hails – Large balls of ice

2. Humidity –
Atmospheric moisture in the form of invisible vapour is known as humidity. It is expressed in terms of relative humidity.

Relative humidity –
The amount of moisture in air as percentage of the amount which the air can hold at saturation at the existing temperature. If temperature ↑ RH ↓
Note:
R.H. is measured by Psychrometer.
Wind speed is measured with the help of anemometer.

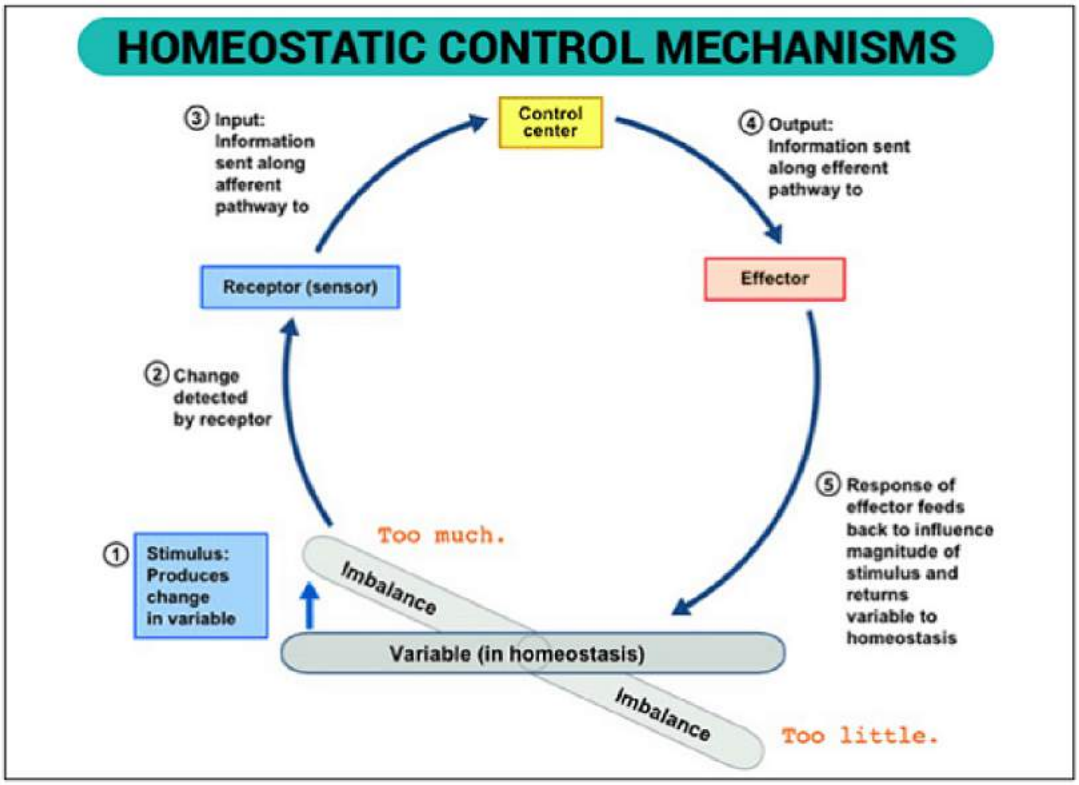
3. Topography –

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.

Homeostasis

Homeostasis:

A human being is shaped by millions of cells that are working together for the maintenance of all organs in a human body. All cells require quite the similar metabolism but they perform different functions. For the well-being for the entire human organism, every individual cell needs to maintain the internal environment like glucose, oxygen, mineral ions and waste removal.
The process that a body maintains internally is collectively called as homeostasis. The concept of homeostasis was first described in 1865 by a French Physiologist named Claude Bernard, but the word was first used in 1926 by Walter Bradford Cannon.



What is Homeostasis?

Homeostasis is a property of a human biological system where the self-regulating process tends to maintain the balance for the survival. The regulation takes place in a defined internal environment. For example, the regulation of body temperature, glucose in blood plasma, extracellular fluids of an animal changes despite what the

animal has eaten or what it is doing. Every variable is controlled by homeostasis together to maintain life.
In simple terms, it could be referred as a balance in a system to maintain a stable internal environment for the survival of the animal. If the homeostasis regulates successfully, life continues or if unsuccessful, death or disaster occurs.
The regulation by homeostasis consist of three mechanisms:

1. Receptor
2. Control Center
3. Effector

Receptor: The receptor acts as a receiver. It receives the changes in the environment.
Control Center: The Control Center is also known as integration center. It receives all the information that the receptor has collected from the changes in the environment.
Effector: As the name suggests, it responds to the commands of the control center. It could either oppose or change the stimulus.
The entire process continuously works to maintain the homeostasis regulation. For instance, the regulation of body temperature, there are receptors in the skin, that communicates information to the brain, which acts as the control center and the blood vessels (effector) and sweat glands in our skin maintain the temperature.

Examples of physiological homeostasis:

1. Arterial blood pressure homeostat.
2. Blood glucose homeostat.
3. Blood oxygen content homeostat.
4. Blood partial pressure of oxygen and carbon dioxide homeostasis
5. Core body temperature homeostat.
6. Extracellular fluid pH homeostat.
7. Extracellular potassium concentration homeostat.
8. Extracellular sodium concentration homeostat.
9. Plasma ionized calcium homeostat.
10. Volume of body water homeostat.

Homeostasis Breakdown:

The failure of homeostasis function in an internal environment will result in many diseases. A functional component of homeostasis can malfunction due to an inherited defect or by affected disease. Few homeostasis has the capability of inbuilt redundancy, ensuring safer life even if a homeostasis component malfunctions.

However, in other cases, a malfunction in any component of homeostasis leads to severe disease or death.

Body Systems and Homeostasis:

The body system participates in maintaining homeostasis regulations. The function of body system describes various regulatory mechanisms where every system is contributed to homeostasis. Here are few tables that describe the function of every organs homeostasis.

Formed Elements	
Name	**Function**
Platelets	It assist blood clotting
Red blood cells	Helps to transport hydrogen and oxygen ions
White blood cells	It fights against infection

Plasma	
Component	**Function**
Nutrients	Required for cellular metabolism
Proteins	Create osmotic pressure, aid clotting, and help buffer blood
Hormones	Known as chemical messengers
Water	Provides fluid environment
Salts	Aid metabolic activity and help buffer blood
Wastes	Produced by cellular metabolism

Nervous System
Central Nervous System

Cerebrum	Consciousness, creativity, thought, morals, memory
Lower portions	Reception of sensory data, coordination of muscular activity, homeostasis
Spinal cord	Automatic reflex actions
Peripheral Nervous System	
Autonomic system	Those cranial and spinal motor nerves that control internal organs
Cranial nerves, spinal nerves	Carry sensory information to motor impulses from the CNS

Major Endocrine Glands and Their Major Hormones		
Name	**Hormone**	**Function**
Adrenal cortex	Glucocorticoids (e.g., cortisol)	Promotes gluconeogenesis
	Mineralocorticoids (e.g., aldosterone)	Promotes sodium reabsorption by kidneys
Adrenal medulla	Epinephrine and norepinephrine	Stimulates fight or flight reaction
Anterior pituitary	Thyroid-stimulating	Stimulates thyroid
	Adrenocorticotropic	Stimulates adrenal cortex
	Gonadotropic	Stimulates gonads
Gonads	Androgens (male) Estrogens and progesterone (female)	Promotes secondary sex characteristics
Hypothalamus	Hypothalamic-releasing and release-inhibiting hormones	Regulate anterior pituitary hormones
Posterior pituitary	Antidiuretic	Promotes water reabsorption by kidney
Parathyroid	Parathyroid	Maintains blood calcium and phosphorus levels
Thyroid	Thyroxin	Increases metabolic rate

Pancreas	Insulin	Lowers blood sugar level
	Glucagon	Raises blood sugar level

Ecology: Community & Biome

COMMUNITY

Groups of organisms of different species that live in common area, which are interrelated and interdependent form a community.
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 community at Aravali hills, Pinus community at Himalaya

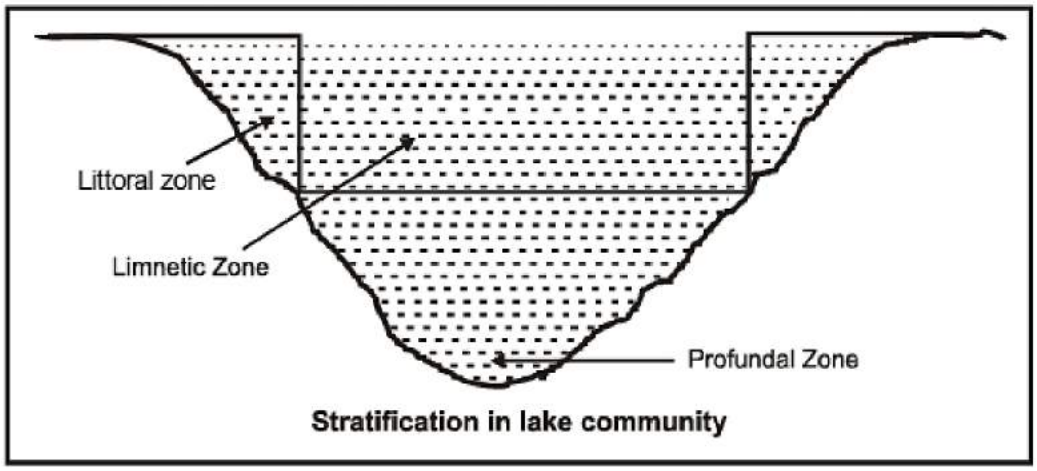
3. Stratification – The different growth form (trees, shrubs, under shrubs, herbs) determines the structure of a plant community.
Stratification is based on mode of arrangement of various growth forms.

- 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.

A. Littoral Zone – This zone is found at bank of lake where very shallow water or marshy land is present. Rooted vegetation is found in this zone.

B. Limnetic zone – This is the zone of lake water, where light reaches in sufficient amount to the 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.

C. 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

- **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 dwellers → Herbs → Under shrubs → Shrubs →Trees.

Note:

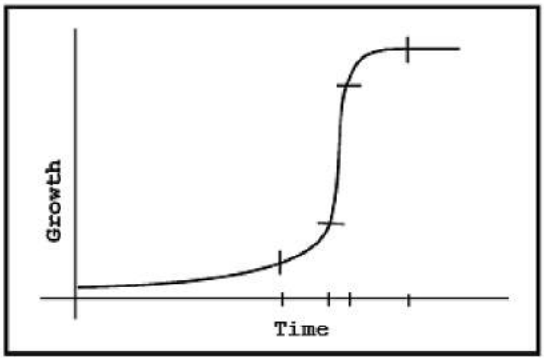
- The clear stratification is found in tropical rain forest. So it is known as multi-storied forest.
- Another example of stratification is mountain.

Population Growth

Population

Population Growth Curve:

For human population, growth curve is **S - shaped/sigmoid** shaped in which **5 stages** are present.



1. Lag Phase: In the earlier stages of growth curve a species (Human population & Macro Organism) comes into the new environment so due to the **lack of resources** and **lack of adaptations** minimum (negligible) growth occurs in this phase.

2. Log Phase:
3 Sub Stages –
(i) Positive Acceleration phase: In this stage, growth rate increases with the **development of resources** and **adaptation**. In this stage, birth rate increases and death rate is negligible.

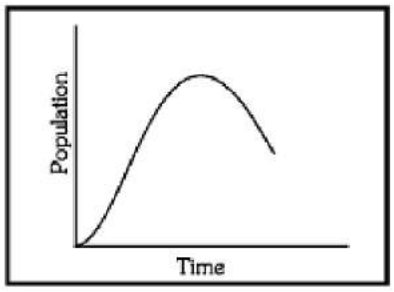
(ii) Exponential Phase: In this middle stage of log phase, species completely become adapted to their new environment due to presence of **sufficient resources, rapid growth** occurs in this phase.
Birth rate – Very high
Death rate – Low
This phase for human population begin in 1750 A.D.. Now the population is running in this phase.

(iii) Negative acceleration phase: In this stage of log stage growth rate decrease because resources start **become limited** in this stage.
Growth rate **decrease** in this phase so this is called negative acceleration phase.

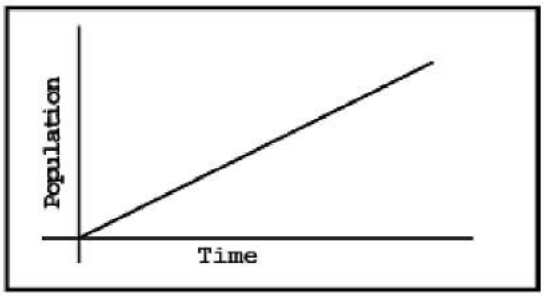
3. Stationary phase/plateau phase/equilibrium/zero phase/constant phase.
In this last stage of growth curve, resources become limited so zero growth occurs in this phase.
In this stage **birth rate is equal to death rate** so the growth rate is zero.
This stage for human population will occur when population reaches carrying capacity. (8-10 Billion).

- In the growth curve of **bacteria** after stationary phase with the end of resources, growth rate also decreases. so there are 4 stages in the growth curve of bacteria.

I – Lag Phase
II – Log Phase
III – Stationary Phase
IV – Decline phase



- If semi log curve plotted for per minute growing bacteria (b/w – time & growth) curve is **ascending straight line**.



(1) **Lag Phase:** In this stage a new species comes into the **new environment** so minimum growth occurs in this phase.

(2) **Exponential Phase:** Due to presence of sufficient resources these organisms show **rapid growth**.

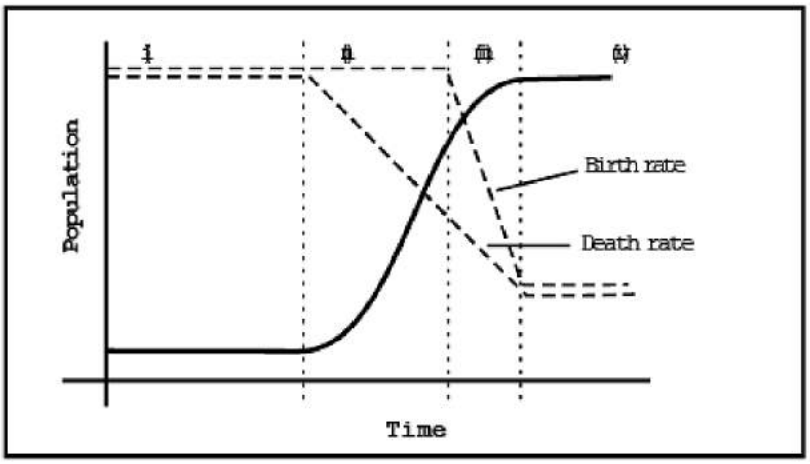
(3) **Crash Phase:** With end of resources species escape from this environment in any other new environment in which resources are sufficient in amount or this leads to **mass starvation** and **Mortality**.

Demographic Transition in Demographic Cycle: When Birth and death rates were equal, a zero population growth rate would result which is called **demographic transition.** Demographic transition might occur in all countries as they become developed. But it may take many decades.

Demographic cycle: mainly 4 steps occur –

(i) First Stage (High Stationary) :

$$B_{high} - D_{high} = 0$$



This stage is characterised by high birth and high death rate which cancel each other and the population remain stationary.
***Ex.*:** India was in this stage till 1920.

(ii) Second stage (Early expanding): $B_{high} - D_{low} = G \uparrow\uparrow$ The death rate begins to decline while the birth rate remains unchanged.

Ex.*:* Many countries of South Asia and Africa, Bangladesh, Kenya.

(iii) Third stage (late expanding) :
$B_{low} - D_{low} = G$
The death rate declines still further and the birth rate tend to fall, the population continues to grow because birth exceed death.
***Ex.*:** India, China, Singapore.
(iv) Fourth Stage (Low stationary):
$B_{low} - D_{low} = O$
Low birth rate and low death rate with the result the population become stationary.
Ex. – Austria, U.K., Denmark, Sweden.

Definitions:

1. Exponential Growth and Human population explosion.

In 1700 A.D. human population was around 0.6 billion. At the beginning of the twentieth century, it increased to 1.6 billion, and by the end of the century, the human population stood at 6.1 billion. **This dramatic increase in population size over a relatively short period is called population explosion.** In the 150 years from 1700 A.D. human population doubled from 0.6 billion to 1.2 billion. In contrast, it increased five times during the next 150 years.
Reason of population Explosion:

(1) Decline in death rate - In India the death rate per 1000 was 44.4 in 1901 & 12.5 in 1981 and 9.8 in 1991. It is due to better medical care.
(2) Longer life span - Life expectancy has increased in most countries, 75 – 80 years in advanced countries & 56 – 60 years in developing countries.
(3) Increased food output.
(4) Better storage & transport facility.
(5) Illiteracy.
(6) Early marriage.
(7) Traditional religious beliefs.
(8) Desire of male child.
(9) Lack of entertainment facility.

2. Maximum Carrying Capacity: Maximum population size that can be supported by the environment is called the maximum carrying capacity (8 – 10 Billion). There is a limit of maximum population size (number of individuals) that can be supported with a given space and resource base. The maximum population size that can be supported by the environment is called the maximum carrying capacity. For this purpose it is useful to consider environment as having the following three major components :
(i) The first component consists of **productive systems**, such as croplands, orchards, etc. and provides food and fibre;
(ii) The second component comprises **protective systems**, such as climax forests, oceans, etc. It buffers air and water cycles, moderates extremes in temperature, etc.;
(iii) The final component has **waste assimilative systems**, such as water ways, wetlands, etc. that assimilate the wastes produced by human activities.

3. Sustainable development: Development that meets the needs of present without compromising the needs of future generations.

4. Vital Index: It is percentage ratio of natality and mortality in a population.

$$\text{V.I.} = \frac{\text{Natality}}{\text{Mortality}} \times 100$$

$> 100 = (+)$ ve growth (Population is increasing)
$100 = 0$ growth
$< 100 = (-)$ve growth (Population is decreasing)

5. Generation time or population doubling time: Time between birth of individual and birth of their off spring, or in bacteria time between two divisions in E.coli - 20 min., Tuberculosis - 20 hour, Lepra bacilli - 20 days.

6. Replacement Level (R.L.): Number of children a couple must produce to replace themselves. The actual R.L. is always slightly high than 2.0 since some children will

die before reaching reproductive age.
In developed countries = 2.1 Developing Countries = 2.7 Due to higher death rate at the immature stage and shorter life expectancy)

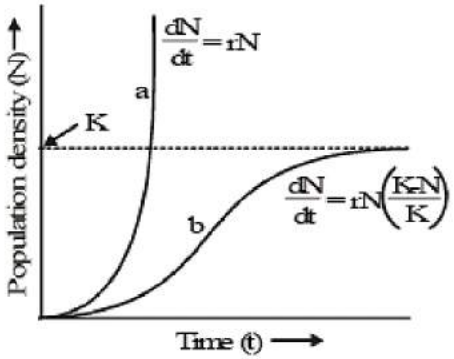
Malthus theory of Human Population growth: In 1778, T.R. Malthus a British economist, put forward a theory of human population growth in his 'Essay on Population'.
(1) He stated that population grows geometrically when unchecked but food supply grows only arithmetically.
(2) Naturally after some time an imbalance would occur in the population and the environment.
(3) When the imbalance reaches a certain value, some factors like hunger, epidemics, floods, earth quakes, war, etc. will bring the population to a desired level. Such factors are called "Positive checks by Malthus"(Catastrophic factor of population).

Special Point:

1. Anthropology – Scientific study of man (origin, development of physical, culture, religious and social attributes).
2. Species occuring in different geographical areas are called allopatric.
3. Set of conditions and resources used by population is called "Niche of population".
4. World population consumes 107 tons of food per year.
5. First 'National population policy' is framed in April 1976. It called for an increase in legal minimum age of marriage from 15 to 18 for females and 18 to 21 for males.
6. Total fertility rate (TFR)- is the average number of children that would be born to a women during her life time.
7. Net reproduction rate- is defined as number of daughter a new born girl will bear during her life time.
8. Reduction in birth rate rather than death rate is the only solution to control the world population problem.
9. In tissue culture, cells always show exponential growth.
10. The S-shape sigmoid growth form is represented by the following equation

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right) = rN\left(1-\frac{N}{K}\right)$$

= Environmental resistance



Population growth curve:
a = when responses are not limiting the growth, plot is exponential
b = when responses are limiting the growth, plot is logistic,
K is carrying capacity

Population Attributes

Introduction

It is known to all of us that life of organisms could not exist on earth without interactions. Ecology is the study of the communication of organisms between an area within their environment. This type of communication establishes an overall adjustment of the organisms to their environment which also includes the continuity of species.
There is not a single habitat, which is solely occupied by a single species. Within an ecosystem, organisms live in a group, and they share or compete for resources. They grow as a population.

Organisms and Population

A population could be defined as the set of all organisms of the same species existing in a geographical area which is capable of interbreeding. Both sexual and asexual reproductions contribute to the population. Rats in an abandoned dwelling, teak wood trees in a forest tract, bacteria in a culture plate, are all examples of a population.
The environmental conditions are variable and populations of a particular region learn to adapt to its environmental conditions. Evolution through natural selection also had a role in shaping the populations.

Population Attributes

There is a line of difference between being a part of a population and an organism.

Populations have some features that, as an organism, a species lacks. Following are the different attributes of a population.

- Birth and Death Rates
- Sex Ratio
- Age Distribution
- Population Density

1. **Birth and Death Rates:** These attributes could be statistically measured for a population, but not for an organism. This is because an organism has birth and death, but not birth rate and death rate.
   Birth and death rates are the per capita births and deaths in a population respectively. In other words, the birth rate is calculated by dividing the total number of births by the total population in a given period of time. These rates vary as per the number of members in a population.
2. **Sex Ratio:** The sex ratio calculates the ratio of male to female individuals of a population.
3. **Age Distribution:** Next population attribute is age distribution. A population comprises different age groups such as pre-reproductive, reproductive and post-reproductive age groups. This age distribution is graphically represented by an age pyramid. The age pyramid indicates whether a population is growing, stable or declining.
4. **Population Density:** The population density tells the size of a population. This attribute is the reflection of the condition of a habitat. More density indicates that the habitat provides more favourable living conditions.

Hence, we can summarise that the population attributes provide a lot of information about an ecosystem and thus help in **population ecology**.

Population Interactions

Population Interaction

"Population interaction is the interaction between different populations. It refers to the effects that the organisms in a community have on one another."

Population Interaction

When a certain group of species lives in a certain ecosystem, they have effects on one another. This phenomenon affecting nearby living and non-living beings are called Population Interaction.
Ecology is a vast arena in Biology, which is a study of organisms, their distribution and interaction with each other and the environment. To study the relationship between prey, predators, other interactions and phenomenon like competition, camouflage, mimicry etc., it is mandatory to study the theory of population interaction.

Population Interaction in the Ecosystem

The environment consists of both abiotic (physical) and biotic (biological) factors. Nutrients in the soil, carbon dioxide, water, temperature, atmospheric pressure, wind and osmotic balances are some of the physical aspects required for a living being.
Along with these abiotic factors of the ecosystem, the population can be very much affected by their interactions.
Following are the main modes of interaction between populations:

- **Competition:** As the name suggests, it is a relationship when two or more species compete for the same limited resources at the same time, which may be food, water, light, or any prey. All these things are crucial for any organism's growth and survival.
- **Predation:** This is a relationship where one species depends entirely on the other for its food and survival. The species which feeds on other species is called predator whereas the one that is fed upon is called the prey. This entire relationship is called Predation.
  Predator is usually stronger than the prey, and hence it consumes preys

during its entire life cycle. In some food chains and food webs, a predator can also fall prey as all living organisms develop a kind of defense mechanisms after a certain period of time.
The words 'predator' and 'prey' are not always limited to animals. They are implied on the relationship between animals and plants as well. For example – rabbit feeding on carrot, bear eating berry and grasshopper and leaf.

- **Camouflage:** Camouflage literally means 'to disguise'. It is the phenomena where an organism or a species develops structural adaptation that helps them to blend with their surroundings is known as camouflage. This helps them avoid getting detected by predators.

Types of Population Interaction

In nature, all organisms and their populations interact with one another to some degree or the other. That is how an ecosystem works perfectly! This population interaction is generally between two different species populations. These interactions can be beneficial or neutral or detrimental. Accordingly, there are six types of population interaction.
The different ways populations of two different species interact with each other can be summarized under the following headings.

- **Mutualism:** When the two different population species interact in such a manner that it is beneficial to each other, then this form of interaction is called mutualism. Lichens are a classic example of mutualism in between **fungi** and **algae**. Even plants and animals show good mutualism.
  Plants need some agents for pollination and seed dispersal. And these agents are the animals. Animals, in turn, are rewarded with the nectar or the **fruits** of the plants. But, even in mutualism, there are some cheater species, which may not reward the other species. This leads to co-evolution of the species.
- **Competition:** When the closely related species fight for limited resources, there is a competition between the species. These types of interactions are called competition. This fight for resources can occur between diverse groups of the population also.
  Competition can occur even when there is an unlimited supply of resources. Here, it depends on the superiority of one species over the other. In the presence of one population species, the other population species may not use the resources effectively. But if the dominant species is removed, then the other species will use the resources to their full capacity.

- **Predation:** This interaction is a very important one as it ensures that there is stability in the ecosystem. The two main populations interacting in predation are the predators and the prey.
  Without the predators, the prey population will go out of control. The species diversity in a community is also maintained by the predators. They reduce the intensity of the competition between prey species. The prey species have also evolved several mechanisms to lessen the impact of predation.

- **Parasitism:** This is an interaction of populations where a parasitic mode of nutrition is clearly seen, with one species being completely dependent on the other host species for all its meals/ nutrient requirements. Parasitism is clearly seen in many taxonomic groups, right from plants to higher vertebrates.

- **Commensalism:** In this kind of integration, one species population benefits from the other species population. But the other species population does not benefit nor is it harmed in any way. If you have been to rural areas, you have seen many birds perching on cattle. This is a good example of commensalism.
  Here the cattle do not benefit anything nor cause any harm. But as the

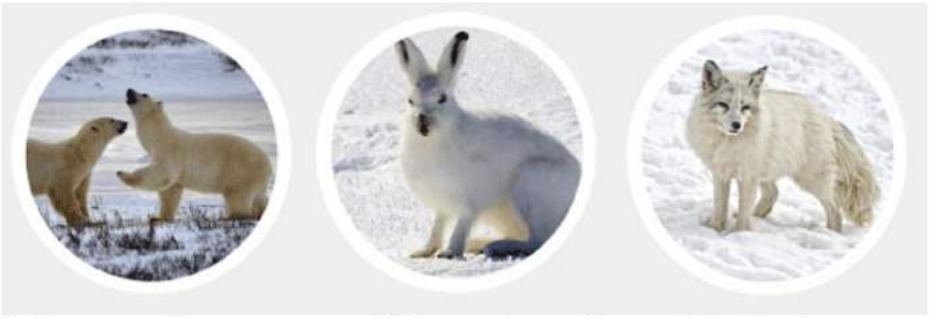
cattle moves, they stir up the small insects hiding in the grass. It is these insects that the birds feed on, thereby benefiting to large extent.

- **Amensalism:** In this kind of interaction between populations, one population finds itself in harm while the other is unaffected. A good example for amensalism could be a condition where the wider and taller plants inhibit the growth of the nearby smaller plants. A few plants secrete some substances which inhibit the growth of the plants growing nearby. They may also kill them out rightly to remove the competition.

Adaptation & Habitats

Introduction

"Adaptation is defined as the process where a species or an organism gradually becomes better acclimated to its environment."



Animals living in the extreme cold have dense fur and fat for heat insulation

Adaptation Meaning

The meaning of adaptation implies how a species changes its body and behaviour to better suit its natural environment. There are an estimated 8.7 million species

currently living on earth. They are found across a wide and diverse natural environment, ranging from frozen and desolate Arctics to the sweltering sands of the Sahara.
The natural environment is an ever-changing feature of planet earth. The process of adaptation ensures that the species which adapts the most, survive.

Examples of Adaptation

- **In Humans:** Long hours of exposure to the sun results in a tan. As the exposure to heat and UV rays increases, the melanocytes present in the skin ramp up the production of melanin.
  This pigment helps to absorb the heat and protects the nucleus, thus protecting the DNA from mutation due to UV radiation. Hence, the process of tanning represents how our body adapts to the heat and UV radiation from the sun.
  Example 2: In high-altitude environments, the human body signals an increase in the production of red blood cells. This is done to compensate for the relatively low-oxygen content in the air.
  But this is not an instantaneous process, hence, people who are not acclimatized to the highaltitude environment might feel a shortness of breath.
- **In Animals:** Animals living in extremely cold environments have thick fur and fat around their body to provide insulation. Pregnant polar bears bulk up on fat before the winter. This is an adaptation that helps them survive the harsh winter where food is very scarce.

Sometimes, adaption is often mistaken for evolution, though both are very different processes. Evolution brings about drastic changes that occur in the genetic level, whereas adaptation is a short-term process where the changes that occur are usually reversible.
But adaptation does lead to evolution. Following is an example illustrating how evolution is different from adaptation.

Example of Evolution

- **Giraffe:** Giraffes are the tallest land mammals today, but they weren't so tall a few million years ago. During the Miocene Epoch, nearly 25 million years ago, the earliest giraffe ancestor was the size of a modern red deer. It did not have a long neck, nor long legs like its modern-day relatives.
  However, the competition for food with other herbivores was rather stiff. However, the leaves in the taller shrubs and trees was an untapped

niche. But only the animals with longer necks were able to graze on the foliage higher up in the trees.
So, traits that contained the genes for longer necks were passed down over many generations. Eventually, this adaptation led to the gradual evolution of animals with longer necks. 25 million years later, we have the tallest land animal on earth today – the giraffes.

Types of Adaptations

Types of adaptations in animals and plants are categorized according to their function and the response observed. **These include:**

- **Structural Adaptations:** These are special attributes that involve some parts of an organism's body, such as skin, colour and shape. These adaptations help the organisms to survive in their natural habitat. Examples include the blubber of a whale, the beak of a woodpecker, baleen of a humpback whale.
- **Physiological Adaptations:** These are mechanisms present in an organism that allow it to perform certain biochemical reactions to survive in its natural habitat. Example: A snake's ability to produce venom, mammal's ability to maintain constant body temperature. Even the ability of our body to produce hydrochloric acid to digest food is considered as a physiological adaptation.
- **Behavioural Adaptations:** These are ways a particular organism behaves to survive in its natural habitat. Migration of animals and birds are considered as a behavioural adaptation. Hibernation and aestivation are also behavioural adaptations.

Animal Adaptations

The most significant animal adaptations entirely depend on the type of habitats they are found in. The earth has several natural environments that are spread across large geographic areas. In the broadest sense, this area, where life exists, is called the biosphere.

1. Animal Adaptations In Deserts

The desert has extreme temperature fluctuations – soaring heat during the day and sub-zero temperatures at night. It also has very limited water bodies and rain is rather scarce. But there are many animals that are well-adapted to life in the desert. Camels, jackrabbits, foxes, snakes, insects are some of the predominant xerocoles or

desert animals. However, these animals in the desert have to face many major challenges, from water conversation to avoiding excess heat.

Various Desert Animal Adaptations:

- **Conservation of water through reduced sweating:** Camels are able to withstand ambient temperatures of 44°C without sweating. Cold-blooded animals entirely lack sweat glands as they rely on the external environment to regulate body temperature.
- **Adaption to nocturnal life:** The average daytime temperatures in the desert often exceed more than 38°C. Nocturnal lifestyle helps to cut down the loss of water, especially in desert biomes. It also enhances osmoregulation. Some animals become active during twilight hours, i.e., during dawn and dusk. Such animals are called crepuscular animals.
- **Specialized Mode of Excretion:** Birds and reptiles in the desert retain water as their metabolic wastes are excreted in the form of an insoluble white compound called uric acid. When compared to mammals, the metabolic wastes are excreted through urea, a considerably more soluble compound.
- **Other Sources of Water:** Natural sources of water, such as lakes and river are almost non-existent or are seasonal. So, animals derive water from desert plants such as cactus. Some insects also tap fluids such as saps and nectars from various parts of the plants.
- **Specialized Appendages:** Animals like the jackrabbit have very large ears that have a network of blood vessels. When these animals rest in the shade, their enormous ears dissipate the excess heat from their bodies.

2. Animal Adaptations In Grassland

Grasslands are areas where the dominant vegetation is grasses. Grasslands are found throughout the world except for Antarctica. The largest grasslands are found in East Africa. One of the characteristic features of grasslands is its wide-open spaces.
This means the average speed of animals is much higher – for predators and prey. Therefore, it is no surprise that two of the fastest land animals in the world are found in grasslands – the cheetah (top speed: 113 km) and the pronghorn antelope (top speed: 98 km)

Few of the Grassland Animals Adaptations:

- **Specialized Digestive systems:** Animals that live in the grasslands like the bison have specialized teeth and digestive systems that help in breaking down the tough grass.
- **Camouflage:** Predators that ambush their prey have skin colours that closely resemble their environment. This enables them to blend in and sneak up to their prey.
- **Feeding Habits:** Grasslands near the equator have relatively high ambient temperatures. Hence, some herbivores such as antelopes graze at night, as this is when the vegetation has the most water content. The same can be said for some nocturnal predators too, as they can prevent unnecessary water loss.

3. Animal Adaptations In Tropical Rainforests

Tropical rainforests are generally hot and humid as it is located near the equator. The average temperature is higher than 15 °C even in the winter and crosses 40 °C in summer. Rainfall is also plenty, with average annual precipitation between 60 inches to 160 inches.
There are also extremes, with some places receiving over 400 inches annually. Tropical rainforests are found in India, Brazil, Central America. The largest tropical rainforests are found in the Amazon River Basin in South America.

Significant Tropical Rainforest Animal Adaptations:

- **Camouflage:** This is an important aspect in almost all biomes, including the animals that live in the tropical rainforests. Primarily, animals need camouflage for either predation or to avoid becoming the prey. The Green-Eyed Tree frog has textured flaps of skin that is designed to resemble the tree barks on which it resides. This adaptation helps the frog to blend in and not become prey.
- **Mimicry:** Sometimes, having a good camouflage is not enough. So, some animals resort to mimicry, where they change their physical appearance to mimic other animals, which are usually poisonous or venomous. This reduces the chances of becoming prey for other predators. The Margin-winged stick insect (Ctenomorpha marginipennis) does mimicry so well that it resembles a piece of twig or a dried-up stalk.

4. Animal Adaptations In Polar Regions

The polar regions represent extreme weather conditions and inhospitable

environments. Polar regions include the north and south poles, countries such as Sweden, Iceland, Norway. These regions are usually covered in snow almost the entire year.
Average winter temperatures reach as low as -37 °C. Furthermore, the sun does not set for over 6 months and for the next 6 months, it does not rise at the poles.

Prominent Polar Region Animal Adaptations:

- **Dense Fur:** This is an important adaptation as it protects the organisms from the extreme cold. Animals such as polar bears have fur even covering the soles of their feet. This prevents them from slipping on the ice. Sometimes, the white colour of the fur helps to camouflage the animal against the background of the snow. This helps in predation or not becoming prey.
- **Blubber:** In some sea mammals such as whales and seals, a thick layer of fat covers the entire body, except for the fins and flippers. This layer provides insulation from the bitter cold and also aids in buoyancy. They can also fall back on this fat as a food resource when there is no food available in the environment or during periods of inactivity (such as hibernation). Moreover, research has found that blubber is much more effective at retaining heat than fur.

Adaptations of Plants

Earth is known to have around 3,00,000 species of plants. Like animals, plant life is also dependent on various fundamental necessities for their survival. Light, water, air, soil, nutrients and suitable climatic conditions are necessary for growth.
But every habitat does not provide the required necessities. Therefore, plants have evolved certain physiological, behavioural and structural modifications to thrive in such environments.

1. Adaptations of Plants In Deserts
Deserts are too dry and hot to imagine life in them. Despite these arid conditions, few plants have adapted to thrive here.

The spines on cacti help prevent excessive loss of water

- Succulents are such plants which can store water in their modified stems and leaves
- The spines on cacti also help prevent excess water loss
- Some plants have long, deep roots which can absorb water from the ground
- Other plants grow short to save energy
- Another form of adaptation is dormancy, few seeds remain dormant until they get the water needed for growth

2. Adaptations of Plants In Tropical Rainforests

Tropical forests are usually packed with big and tall trees. These tall trees often provide stiff competition for small shrubs and herbs. Tall trees block the sunlight from reaching the ground. They are also known to absorb the nutrients from the soil.

Some plants climb the branches of taller trees to get sunlight

- In such conditions, ground level plants start flowering during the spring season. This is because, during autumn, other trees shed their leaves, which means more sunlight reaches the forest floor.
- Other species of ground-level plants are adapted to carry out photosynthesis in low light.

3. Adaptation in Aquatic Plants

Plants which live in water ecosystem like lakes, rivers, ponds, bogs etc. face many problems. The most common are low oxygen content, low light intensity, lack of soil, and nutrients.

Aquatic plants have their roots underwater, but the upper half partially emerges from the water to enable photosynthesis

- Some of these issues are resolved by floating in water streams. Aquatic plants develop in a way such that their roots are in the water, but the upper half partially emerges from the surface of the water for efficient photosynthesis.
- Food, nutrients, and air are absorbed through modified stems and roots.

4. Adaptations of Plants In Polar Regions

Polar regions include one of the coldest regions on earth. And the vegetation found here is quite sparse. Sedges, dwarf shrubs, grasses and certain mosses and lichens are some plant species found in these terrains. The special features of these plants include short stature (not more than 12 inches), hairy parts, darker colour etc.

Only plants with shallow roots grow in the tundra because the deep layers of permanently frozen ice prevent the roots from breaking through the permafrost

Sometimes, trees hold on to dead leaves for insulation. However, larger plants such as trees as uncommon as the roots cannot penetrate deeply because of the permafrost.

5. Adaptations of Plants against Herbivory

Herbivory is the consumption of plant matter by any organism. Since plants are the primary producers in an ecosystem, nearly all consumers depend on them for sustenance. Therefore, to prevent herbivory, plants developed thorns, spines and chemicals.

Plants employ spines, thorns or toxins to deter herbivores

Thorns are the most common form of deterrent. Other plants might use chemicals to leave an unpleasant taste in the mouths of the herbivores. But some of these chemicals are very toxic and might result in the death if consumed.

Habitat

A biome is a place where a plant or animal lives. Biome also is known as a habitat, a part of an ecosystem. The climate, plants, and animals are the identities of a habitat. Habitats are classified into two domains: Terrestrial/ Land habitat and Aquatic/Water habitat.

A habitat is the natural environment of an organism

Land habitat includes forests, grasslands, deserts, coastal and mountain regions. The aquatic ecosystem includes freshwater habitats (lakes, ponds, rivers and streams, wetlands, swamp, etc) and marine habitats (oceans, intertidal zone, reefs, seabed, etc.).
Living organisms sustaining on different habitats depend on that habitat for their food, shelter, reproduction and all other life activities.