
ORGANISMS AND
POPULATIONS

Ecology is the study of interactions among organisms and between the organism & its physical (abiotic) environment.

Ecology is concerned with 4 levels of biological organization

Organisms	Populations	Communities	Biomes

ORGANISMS AND ITS ENVIRONMENT

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- **Physiological ecology** (Ecology at organismic level) is the study of adaptation of an organism to environments in terms of survival and reproduction.





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- The rotation of earth and the tilt of its axis cause annual variations in temperature & seasons. Major biomes (desert, rain forest, tundra etc.) are formed due to these variations & precipitation (rain & snow).
- Regional and local variations within a biome lead to the formation of different habitats.

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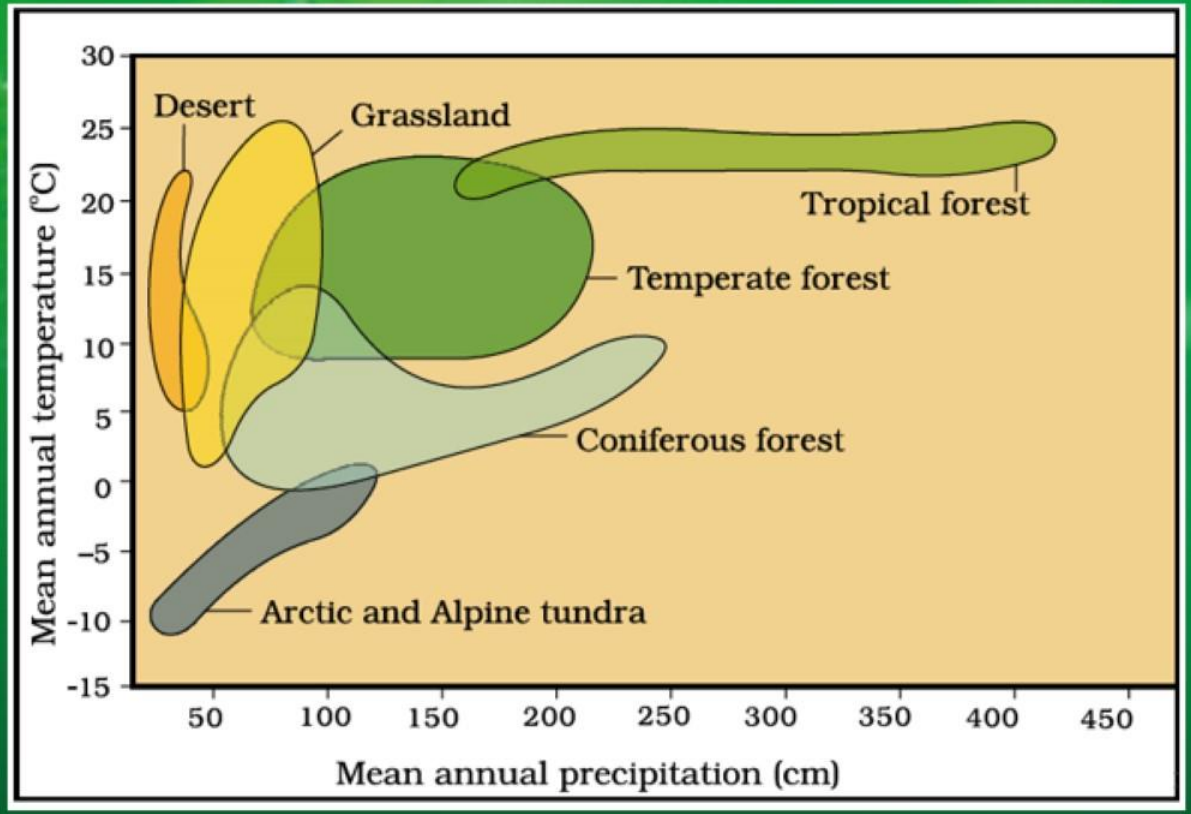
Biome distribution with respect to annual temperature and precipitation



ORGANISMS AND ITS ENVIRONMENT

Life exists even in extreme & harsh habitats. E.g.

- Rajasthan desert
- Rain-soaked Meghalaya forests

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- High mountain tops

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- Rajasthan desert
- Rain-soaked Meghalaya forests
- Deep ocean trenches
- Torrential streams
- Permafrost (snow laden) polar regions
- High mountain tops
- Thermal springs
- Compost pits

Our intestine is a habitat for many microbes.

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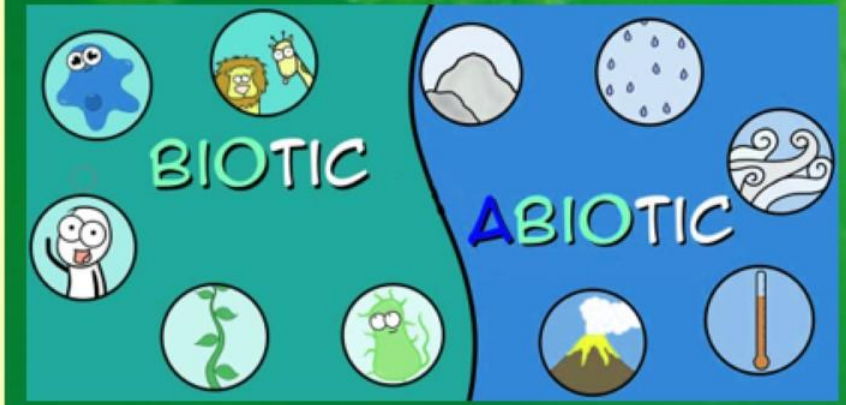

- The **physico-chemical (abiotic) components** (water, light, temperature, soil etc.) & **biotic components** (pathogens, parasites, predators, competitors etc.) lead to variation of different habitats.
- The distinct role and position of an organism in its environment is called its **niche.** By this, each organism tolerates various conditions, utilises various resources etc.

ORGANISMS AND ITS ENVIRONMENT

Abiotic factors

a. Temperature
b. Water
c. Light
d. Soil

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Abiotic factors

a. Temperature

- Most ecologically relevant environmental factor.
- Temperature on land varies seasonally. It gradually decreases from equator to the poles and from plains to mountain tops. It ranges from subzero levels (in polar areas & high altitudes) to >50^{0}C (in tropical deserts).
- Average temperature in thermal springs & deep-sea hydrothermal vents exceed 100^0 C.

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Abiotic factors

a. Temperature

- Mango trees cannot grow in temperate countries (Canada, Germany etc.).
- There is no Snow leopard in Kerala forests.
- Tuna fishes are rare beyond tropical latitudes in the ocean.

Temperature affects kinetics of enzymes, basal metabolism and other physiological functions of the organism.

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Abiotic factors

a. Temperature

Based on range of thermal tolerance, organisms are 2 types:

- **Eurythermal:** They can tolerate a wide range of temperatures.
- **Stenothermal:** They can tolerate only a narrow range of temperatures.

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Abiotic factors

b. Water

- Second most important factor.
- Desert organisms have special adaptations to limited water.
- Productivity & distribution of plants is dependent on water.

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Abiotic factors — b. Water

- For aquatic organisms, water quality (chemical composition, pH) is important.
- The salt concentration (salinity in parts per thousand) is
  - < 5 in inland waters
  - 30-35 in the sea
  - > 100 in some hypersaline lagoons



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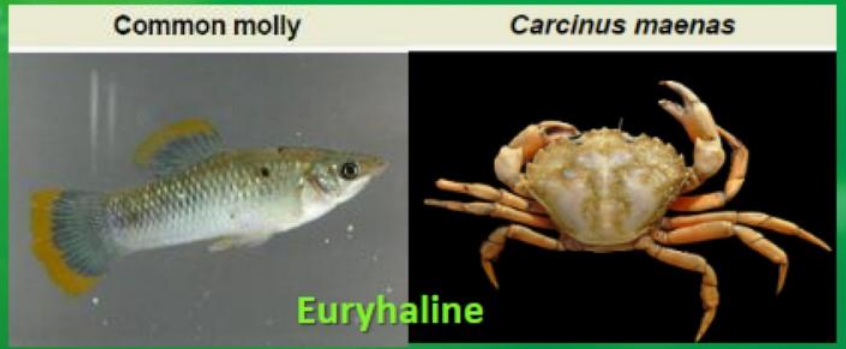
Abiotic factors

b. Water

- Based on the tolerance to salinity, organisms are 2 types:
  - **Euryhaline:** Tolerate a wide range of salinities.
  - **Stenohaline:** Tolerate only a narrow range of salinity.
- Many freshwater animals cannot live for long in sea water and vice versa because of the osmotic problems.



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Abiotic factors

c. Light

- Plants need sunlight for photosynthesis.
- Small forest plants (herbs & shrubs) are adapted to photosynthesize optimally under very low light because they are overshadowed by tall, canopied trees.

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Abiotic factors

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- Many plants depend on sunlight for **photoperiodism** (e.g. flowering).
- Many animals use the diurnal and seasonal variations in **light intensity and photoperiod** for timing their **foraging, reproductive & migratory** activities.

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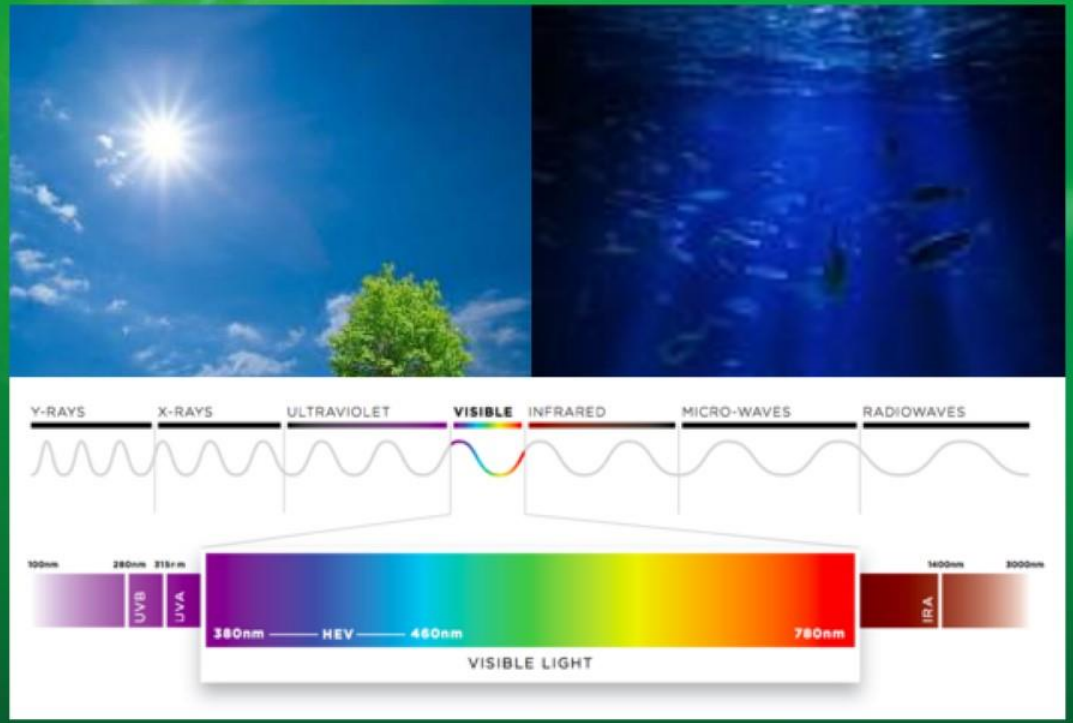
Abiotic factors

c. Light

- Sun is the ultimate source for light & temperature on land.
- Deep (>500m) in the oceans, the environment is dark and there is no energy available from sun.
- The spectral quality of solar radiation is also important for life. The UV spectrum is harmful to many organisms. Not all the colour components of the visible spectrum are available for marine plants.



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Abiotic factors

d. Soil

- The nature & properties of soils is differed due to the climate, weathering process, sedimentation, method of soil development etc.
- Soil composition, grain size & aggregation determine the percolation and water holding capacity of the soils.
- These characteristics & parameters like pH, mineral composition & topography determine the vegetation and animals in an area.
- In aquatic environment, the sediment-characteristics determine the type of benthic animals.

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Responses to Abiotic factors

- Organisms maintain a constant internal environment *(homeostasis)* despite varying external environmental conditions.
- This is possible by following processes:
  a. Regulate
  b. Conform
  c. Migrate
  d. Suspend

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Responses to Abiotic factors

a. Regulate

- It is the maintenance of homeostasis by physiological & behavioural means.
- It ensures constant body temperature (thermoregulation), constant osmotic concentration (osmoregulation) etc.
- E.g. All birds & mammals, very few lower vertebrates and invertebrates.

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Responses to Abiotic factors — a. Regulate

Thermoregulation in mammals

- The success of mammals is mainly due to their ability to maintain a constant body temperature.
- In **summer**, when outside temperature is more than body temperature (37^{0}C), **sweating** occurs. This results in evaporative cooling and brings down body temperature.
- In **winter**, when the temperature is below 37^{0}C, **shivering** occurs. It produces heat and raises the body temperature.

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Responses to Abiotic factors

a. Regulate

Thermoregulation is energetically expensive especially for small animals (shrews, humming birds etc.). They have a larger surface area relative to their volume. So they lose body heat very fast when it is cold outside. Then they have to expend much energy to generate body heat. Therefore very small animals are rare in Polar Regions.

Humming bird

Shrew

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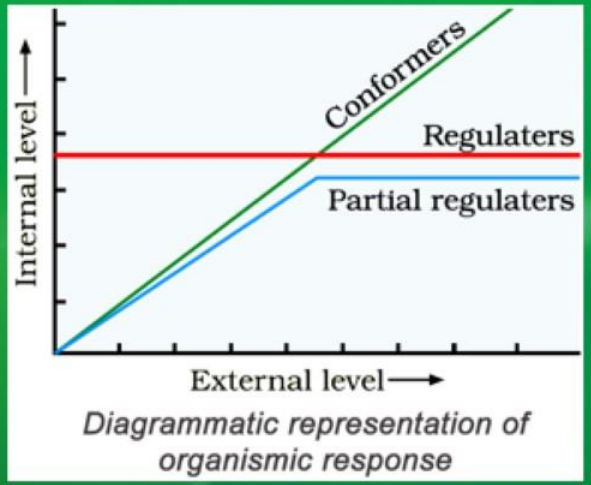
Responses to Abiotic factors

b. Conform

- 99% of animals and nearly all plants cannot maintain a constant internal environment.
- Their body temperature or osmotic concentration change with the surrounding conditions. They are called conformers.
- In aquatic animals, osmotic concentration of body fluids changes with that of the ambient osmotic concentration.



Diagrammatic representation of organismic response





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Responses to Abiotic factors

c. Migrate

- Many animals like birds move away temporarily from stressful habitat to a more hospitable area and return when stressful period is over.
- E.g. During winter, **Keolado National Park (Bhartpur, Rajasthan)** hosts migratory birds coming from Siberia and other extremely cold northern regions.

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Responses to Abiotic factors

d. Suspend

- In bacteria, fungi & lower plants, thick walled spores help to survive unfavourable conditions. Under suitable conditions, they germinate.
- In higher plants, seeds and some vegetative reproductive structures serve to tide over periods of stress by reducing their metabolic activity. They germinate under favourable moisture and temperature.

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Responses to Abiotic factors

d. Suspend

In animals: Examples are

- ***Hibernation*** of bears during winter.
- ***Aestivation*** of some snails and fishes during summer.
- ***Diapause*** (a stage of suspended development) of many zooplanktons in lakes & ponds.

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Adaptations





- Adaptation is the morphological, physiological & behavioural attribute that enables an organism to survive and reproduce in its habitat.
- Many adaptations have evolved over a long evolutionary time and are genetically fixed.

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Adaptations

Adaptations of Kangaroo Rat

Adaptations of kangaroo rat in North American deserts

- Internal **fat oxidation** gives water as byproduct if there is no external source of water.
- Ability to **concentrate urine** so that minimal volume of water is used to remove excretory products.

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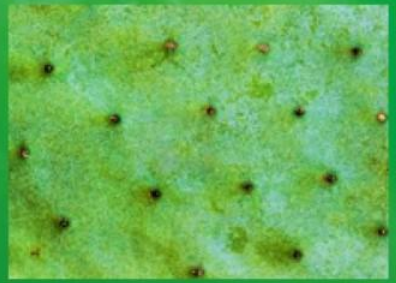
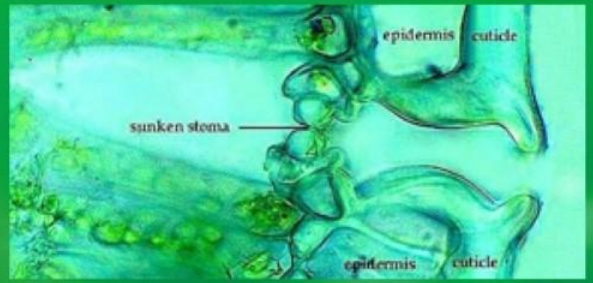
Adaptations

Adaptations of Desert Plants

- Presence of **thick cuticle** on leaf surfaces.
- **Sunken stomata** help to minimise water loss through transpiration.
- **CAM photosynthetic pathway** enables their stomata to remain closed during day time.
- Desert plants like ***Opuntia*** have **no leaves** (they are reduced to spines). Photosynthesis is done by stems.





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Adaptations

Adaptations of Mammals

- Mammals from colder climates have shorter ears and limbs to reduce heat loss. This is called ***Allen's Rule.***
- 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.

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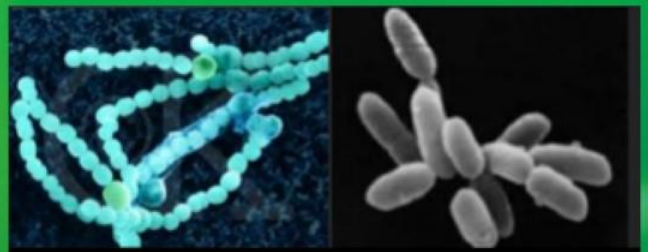
Adaptations > Physiological & Biochemical Adaptations

- *Archaebacteria* are found in hot springs & deep sea hydrothermal vents where temperature is >100^{0}C.
- Many fish thrive in Antarctic waters (temperature is below 0^{0}C).
- Many marine invertebrates & fishes live at great depths in the ocean where the pressure is >100 times the normal atmospheric pressure.



Archaebacteria

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Adaptations > Physiological & Biochemical Adaptations

- At a high altitude place (>3,500 m), we feel *altitude sickness*.
- Its symptoms are nausea, heart palpitations & fatigue. This is due to low atmospheric pressure. So body does not get enough O_2.
- Gradually, we acclimatize the situation and the body compensates low O_2 availability by increasing RBC & breathing rate and decreasing the binding capacity of hemoglobin.

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Adaptations

Behavioural Adaptations

- Desert lizards bask in the sun and absorb heat when their body temperature is low, but move into shade when the ambient temperature starts increasing.
- Some species burrow into the soil to hide and escape from above-ground heat.