ORGANISM AND ITS ENVIRONMENT

- The entirety of living and non-living elements, substances, and circumstances that encircle and potentially affect organisms without integrating into them.
- The orbit of our planet around the Sun and the tilt of its axis bring about yearly changes in the strength and length of temperature, leading to different seasons. These changes, along with yearly fluctuations in rainfall (remember, rainfall includes both rain and snow), contribute to the creation of significant biomes like deserts, rainforests, and tundra.

Terrestrial Biomes

1. Tundra
2. Taiga (coniferous forest)
3. Temperate forest
4. Grasslands
   (i) Temperate grassland
   (ii) Tropical savanna grassland (grass cover with scattered trees)
5. Desert
6. Tropical rain forest.

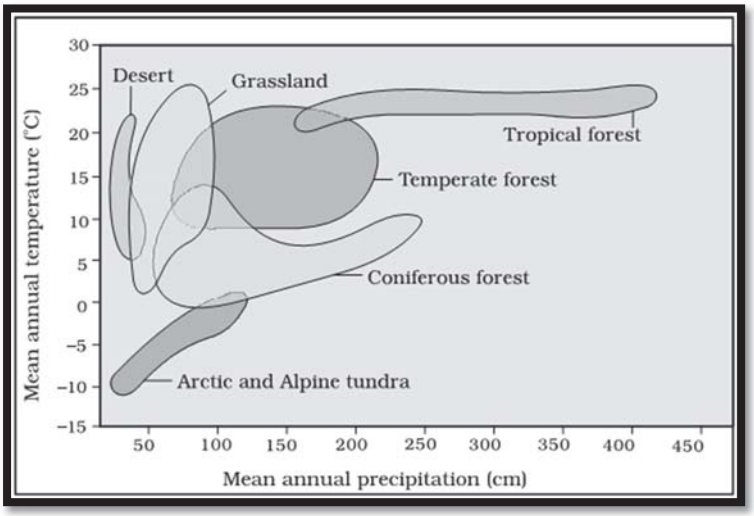


Figure - Biome distribution with respect to annual temperature and precipitation

Major biomes of India: 1. Tropical rain forest 2. Deciduous forest 3. Desert 4. Sea cost

- We believe that over time, the organism has developed adaptations through natural selection to improve its chances of surviving and reproducing in its environment.
- Each organism has a specific range of conditions it can endure, uses diverse resources, and plays a unique role in the ecological system. Altogether, these factors make up its niche.

Environmental Factors:

- They directly or indirectly affect the form and functioning of organisms in any specific way.
- They are two types.

1. **Abiotic Factors**
2. **Biotic Factors**

Major Abiotic Factors

1. **Abiotic Factors:** They are of four types.
   - **(1) Climatic**
   - **(2) Edaphic**
   - **(3) Topographic**
   - **(4) Fire**

(1) Climatic Factors:

- Light, temperature, humidity, air, precipitation, involve in this category.

Light:

- Sunlight is the main natural source of light. About 1% of light coming from the sun is utilized by plants.
- The visible range of electromagnetic spectrum is about 390 nm to 760nm. Out of them wavelength of photo synthetically active radiation (PAR) is 400–700 nm that is effective in photosynthesis in plants.

  Solar constant: Just before entering the mesosphere, the energy content of solar radiations is 2 Cal/ cm^2 /min.
- Sunlight involves ultraviolet rays, light spectrum and infrared rays.
- Ultraviolet rays are of three types

S.No.	Type of UV rays	Wavelength of UV rays
1	UV-C	100 - 280 nm
2	UV-B	280 - 320 nm
3	UV-A	320 - 400 nm

- UV-C rays are deadly, and UV-B rays are quite harmful. The ozone layer absorbs UV-C and half of UV-B radiation.
- Light affects many activities such as photosynthesis, growth, coloration, movements, daily rhythms in animals, and response to day length.
- Plants rely on sunlight for photosynthesis, which produces food using sunlight as energy. This highlights the importance of light for living organisms, especially autotrophs. Some small plants in forests have adapted to low-light conditions because they are shaded by tall trees. Many plants also need sunlight to trigger flowering. Animals use light cues for timing activities like feeding, breeding, and migration. Light availability on land is closely linked to temperature since the sun provides both. However, deep in the ocean (>500m), it is dark, and marine organisms don't have access to sunlight. Their source of energy is different. The type of sunlight, including UV radiation, affects life in the ocean. UV rays can harm many organisms, and not all colors of visible light are available at different depths. Among red, green, and brown algae in the ocean, which is likely to be found deepest? And why?

Temperature:

- Temperature is a crucial environmental factor that influences where many plants and animals live and affects their bodily functions like enzyme activity.
- You know that land temperatures change with the seasons, decrease as you move from the equator to the poles, and from lowlands to high mountains. Temperatures vary widely, from freezing in Polar Regions and high altitudes to over 50°C in tropical deserts during summer. However, there are exceptional places like hot springs and deep-sea vents where temperatures surpass 100°C. It's common knowledge that mango trees can't grow in places like Canada and Germany, snow leopards aren't found in Kerala forests, and tuna fish are rarely found beyond the tropical regions of the ocean.

Temperature gradient over earth's surface is called lapse rate that is 6.4 – 6.5ºC per 1000m altitude.

- On the basis of occurrence in different climatic zones, the plants are classified into four groups, according to their surrounding temperature.

(i) **Megatherms:** In this zone, plants grow in high temperature throughout the year. E.g. Tropical rain forest
(ii) **Mesotherms:** Growth of plants takes place in alternate high and low temperature e.g. Tropical deciduous forest.
(iii) **Microtherms:** Plants grow in low temperature e.g. temperate needle forest.
(iv) **Hekistotherms:** Plants grow in very low temperature e.g. alpine vegetation.

On the basis of ability of organisms to tolerate variations in surrounding temperature, organisms are of two types.

(i) **Stenothermal**
They live within narrow range of temperature throughout the year. E.g. Polar Bear, lizards, amphibians, plants like Picea, Abies, and coconut.

(ii) **Eurythermal**
These organisms can tolerate a wide range of temperature variations, e.g. most mammals & birds.

Effect of Temperature on animals:

(i) **Allen's Rule:** Extremities like tail, ears, feet of animals of colder areas are shorter then Animals of warmer areas.
(ii) **Bergaman's Rule:** Birds and mammals of colder areas are larger in size as compared to their equivalents in warmer areas.
(iii) **Gloger rule:** Homeothermal animals of tropical region or hot and humid area are darker in colour than cold area.

Thermoperiodicity :

- Regular change in temperature at specific intervals of time is called thermoperiodicity it involves two types

(a) **Diurnal Thermoperiodicity:**Temperature is higher during the day and cooler during night. The response of organisms to change of temperature is called diurnal thermoperiodicity.
(b) **Seasonal Periodicity :** Organisms show different responses in different seasons of the year.That is called seasonal periodicity that favour different aspects of plants and animal life or phenology.

Thermal stratification in lakes :

Usually three zones are found in water body.

(i) **Epilimnion :** It is upper zone of water body it is warmer in summer and colder in winter.
(ii) **Metalimnion :** It is found between epilimnion and hypolimnion as transitional zone. It shows maximum temperature fluctuations its middle part is called thermocline.
(iii) **Hypolimnion:** In the lower depths of a body of water, temperatures typically change less. In temperate lakes, oxygen and nutrients circulate twice a year, in spring and autumn, creating conditions for abundant phytoplankton growth. These lakes are known as dimictic. Phytoplankton thrive when surface waters warm in spring and cool in autumn. Conversely, there's minimal phytoplankton growth during summer and winter.

Many freshwater animals cannot live for long in sea water and vice versa because of the osmotic problems, they would face.

(C) Water

Water is one of the most crucial factors affecting organisms' lives. Life originated in water and cannot exist without it. In deserts, water is scarce, and only specialized adaptations allow organisms to survive there. Plant productivity and distribution heavily rely on water availability. While you might assume that organisms in oceans, lakes, and rivers don't face water-related issues, that's not the case. For aquatic organisms, water quality, including chemical composition and pH, is vital. The salt concentration, known as salinity, varies: it's less than 5 in freshwater, around 30-35 in seawater, and over 100 in some hypersaline lagoons. Some organisms can tolerate a wide range of salinities (euryhaline), while others can only survive in a narrow range (stenohaline). Many freshwater animals can't survive in seawater for long, and vice versa, due to osmotic challenges they'd encounter.

Soil or Edaphic Factor

Soil

The top layer of the Earth's crust is formed by the weathering of rocks, consisting of a mixture of living and non-living materials.

- The nature and properties of soil vary depending on factors such as climate, weathering processes, transportation or sedimentation, and soil development. Characteristics like soil composition, grain size, and aggregation affect how water moves through the soil and its ability to retain water. These features, along with factors like pH, mineral composition, and terrain, largely determine the vegetation in an area, which in turn influences the types of animals that can live there. Similarly, in aquatic environments, sediment characteristics often determine the types of benthic animals that can thrive.
- Soil consists of minerals (45%), water (25%), air (25%), and organic matter (5%).
- Soil formation is a slow process, with just one inch of soil forming over 500-1000 years.

Pedogenesis – development of soil or soil formation
Pedology (Edaphology) – study of soil

Soil mineral matter -

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

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

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

Note

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

Soil Organic Matter

- The deceased organic material found in soil is termed humus, resulting from the breakdown of plant and animal remnants. Recently fallen plant and animal material are referred to as detritus or litter, while partially decomposed litter is known as duff. When litter is fully decomposed, it transforms into humus.
- Litter → Duff → Humus

Decomposition (Formation of Humas) :

- Decomposers transform complex organic matter into simpler organic matter (humus) and inorganic substances like carbon dioxide, water, and nutrients through a process known as decomposition. Detritus, which includes dead plant parts like leaves, bark, and flowers, as well as animal remains and waste, serves as the initial material for decomposition. The key stages in decomposition are fragmentation, leaching, catabolism, humification, and mineralization.
- Detritivores, such as earthworms, break down detritus into smaller particles in a process called fragmentation. Leaching involves water-soluble nutrients moving down into the soil and becoming unavailable salts. Bacterial and fungal enzymes degrade detritus into simpler organic and inorganic substances, known as catabolism.
- It's important to note that all these steps occur simultaneously during decomposition. Humification results in the accumulation of dark-colored, amorphous humus, which is resistant to microbial action and decomposes very slowly. Humus, being colloidal in nature, acts as a nutrient reservoir. Some microbes further degrade humus, releasing inorganic nutrients in a process called mineralization.
- Decomposition primarily relies on oxygen, and its rate depends on the chemical composition of detritus and climatic conditions. In specific climates, decomposition is slower if detritus contains more lignin and chitin, but faster if it's rich in nitrogen and water-soluble substances like sugars. Temperature and soil moisture are crucial climatic factors regulating decomposition by influencing soil microbe activity. Warmer and moister environments promote decomposition, while low temperatures and anaerobic conditions inhibit it, leading to the accumulation of organic materials.

Soil Profile

Top soil 4 ft.	O_1 / A_{00}	Made up of litter.
	O_2 / A_0	Made up of Duff.
	A_1 Humus>Minerals	Humic or melanized zone because dark black humus is presnt.
	A_2 Humus<Minerals	Zone of leaching. It is light coloured region because of little amount of organic matter.
Sub soil	B Minerals	This layer is made up of smell soil particles or minerals. This layer less amount of humus, it contains compounds of iron, aluminum and manganese in higher amount.
	C	This layer is composed by incompeletely weathered rock materials.
	R/D	This layer is present in unweathered parental rocks.

Note :

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

Topography

The layout of land, known as topography, which includes its physical features such as hills, plains, or slopes, affects where living things are found. For instance:

(i) The middle and outskirts of a pond or stream
(ii) The visible and hidden parts of a rock
(iii) The northern and southern sides of a ridge or mountain typically have different types of living organisms.

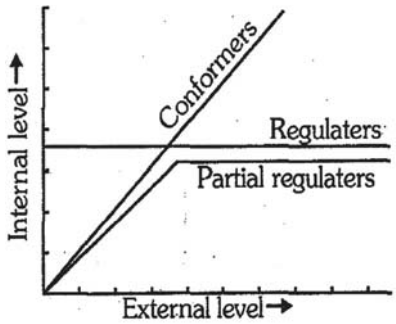
Responses to Abiotic Factors:

Response to abiotic factors –

- Various environmental conditions exist at different times, and all factors are interconnected.
- Homeostasis refers to an organism's ability to maintain a stable internal environment despite significant changes in external conditions. This stability allows biochemical reactions and physiological functions to operate at their best, enhancing the overall fitness of the species.
- Living organisms employ certain strategies to endure stressful conditions.

Regulaters

Some living things can keep their internal conditions steady using bodily processes, sometimes with the help of behaviors. This helps them maintain a constant body temperature, consistent levels of substances like salt, and so on. Birds and mammals, along with a few other animals, are examples of creatures capable of this kind of regulation, which includes controlling body temperature (thermoregulation) and managing salt levels (osmoregulation). Evolutionary scientists think that mammals' ability to keep a steady body temperature has played a big role in their success, allowing them to survive and thrive in diverse environments, from Antarctica to the Sahara Desert.



Partial regulators

Some organisms have the ability to regulate body functions to a limited extent beyond which they become conform. These organisms are called partial regulators. e.g. Cray fishes.

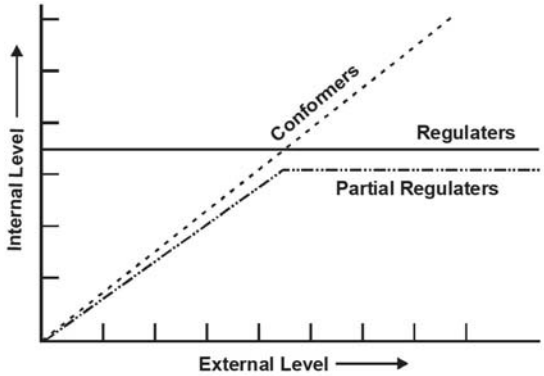


Fig:- Diagrammatic representation of ways or organismic response.

Conformers:

An organism that can't keep its internal conditions steady, like its body temperature or salt levels, will experience changes matching the external environment. The vast majority (99 percent) of animals and almost all plants fall into this category. Their body temperature fluctuates with the surrounding air temperature, while aquatic animals' salt levels adjust to match the water around them. These organisms simply adapt to their surroundings rather than regulating their internal environment.

Migrate:

- Temporary movement of organisms from the unfavourable habitat to more favourable area for obtaining
- Food, climate, shelter, breeding and comeback during favourable conditions. For e.g. Migration of siberian
- crans from siberia to the keoladeo Ghana national park Bharatpur (Raj.) in winter.

Suspend

Unfavourable conditions of environment are passed by organisms through the changes in their behaviour. e.g. (1) polar bears undergo hibernation during winter to escape extreme cold.

Diapause:

- A stage of suspended development under unfavourable conditions e.g. Many Zooplanktons

Adaptations

Ecological Adaptations:

- Adaptation is any quality of the organism that enables the organisms to survive and reproduce in it habitat.

Plant Adaptations :

- The ecological factors affect the vegetation of particular area. Plants develops various types of adaptation to protect itself from these factors.

Plant Adaptations to Light Regime – Sun and Shade plants :

Differences between Heliophytes & Sciophytes		
S.No	**Heliophytes (Sun plants)**	**Sciophytes (Shade plants)**
1.	They grow in bright light	They grow in low intensity of light
2.	Stems bear shorter and thicker internodes	stems bear large internodes
3.	Leaves are smaller, thicker & pale green in colour	Leaves are larger, thinner & bright green in colour
4.	Palisade tissue is more developed & spongy parenchyma is weakly developed	Palisade tissue is less developed & spongy parenchyma is well developed
5.	Mechanical tissues are well developed	they are moderately developed
6.	There is abundant flowering and fruiting	Vegetative growth is more while flowering and fruiting are less.
7.	Stomata are generally sunken and found on lower surface.	Stomata are present in level with surface and found on both the surfaces.

Warming & schimper classified plants into following groups on the basis of availability of water.

(1) **Hydrophyte**
(2) **Xerophyte**
(3) **Halophyte**
(4) **Mesophyte**

(1) Hydrophyte :

They are of following types

(i) **Submerged hydrophytes :** They are of two types.
  (a) **Submerged suspended hydrophytes:** They fully live inside the water. e.g. Najas, Ceratophyllum, Utricularia.
  (b) **Submerged rooted hydrophytes :** They are fixed in the bottom of water bodies e.g. Hydrilla, Vallisnaria, Potamogeton.

(ii) **Floating hydrophytes :** They are of two types
  (a) **Free floating hydrophytes :** They swim freely on the surface of water e.g. Wolffia, Lemna, Eicchornia, Pistia, Spirodella.
  (b) **Fixed floating hydrophytes :** They are fixed by roots in the bottom of water body e.g. water chestnut or Trapa, Nymphea, Nelambo nucifera (Lotus)

(iii) **Emergent hydrophytes or Amphibian hydrophytes:** They live in shallow water. They show the heterophylly. Some parts like roots, rhizome are submerged and a part of shoot is aerial e.g. Ranunculus, Limnophylla, Sagittaria. In some hydrophytes entire stem is aerial e.g. scirpus, Typha, Eleochorus.

Adaptations of Hydrophytes:

(a) Morphological adaptations :
(i) Roots are absent in some hydrophytes e.g. Wolffia, Utricularia
(ii) In some hydrophytes roots lack root hairs and root cap e.g. Lemna, pistia.
(iii) In some hydrophytes, roots cap is replaced by root pocket e.g. Pistia, Eicchorinia. It maintains balance of plant in water.
(iv) In some plants roots contain chlorophyll that perform photosynthesis. These are called Assimilatory roots.
(v) Stem is weak, delicate, hollow, green or yellow.
(vi) Leaves are dissected or ribbon shaped e.g. Vallisnaria, In some plants wax deposits on the the upper surface of leaves for protecting the leaves from physical, chemical and biological injury.
(vii) Long & spongy petiole occurs in some plants e.g. Pistia, Eicchornia.

(b) Anatomical Adaptations :

(1) Deficiency of Protective tissues :
(i) Epidermis contains chlorophyll thus it performs photosynthesis along with absorption.
(ii) Thick cuticle is absent on the epidermis.
(iii) Stomata are either absent or nonfunctional.
(iv) Hypodermis is thin or absent.
(v) Root hairs on root and stem hairs on stem are absent.

(2) Abundance of aerenchyma :
- In stem and root cortex, large air spaces are bounded by thin walled parenchymatous cells that are called aerenchyma. The latter provide buoyancy to the plant.

(3) **Deficiency of mechanical tissues :**
- **(i)** Sclerenchyma and collenchyma are absent.
- **(ii)** Secondory growth is absent.
- **(iii)** In leaf mesophyll does not differentiate into palisade tissue and spongy parenchyma.

(4) **Deficiency of vascular tissue :** Xylem and phloem are less develop.

(c) **Physiological adaptations :**
- **(i)** Osmotic pressure is either low or equal to the water of water body.
- **(ii)** Reproduction takes place through vegetative propagation

(2) **Xerophytes :**
- These plants are found in dry habitats. These plants have specific type of adaptation for absorption of higher amount of water and to avoid the loss of water.

On the basis of habitat, xerophytes are of following types.

(a) **Oxylophytes :** That grow in acidic soil.
(b) **Lithophytes :** They grow on rocks.
(c) **Psammophytes :** They grow on sand.
(d) **Cryophytes :** They grow on ice or poles.
(e) **Halophytes :** These plants grow in saline soil.

On the basis of tolerance of dryness, Xerophytes are of following types.

(A) **Ephemeral plants or Drought escaping plants :** They complete their life cycle during rainy season and in the resting time they live as seeds. Ex: Cassia tora, Argemone mexicana, Achyranthus, Indigophora, Tribulus.

(B) **Annuals or Drought Evaders :** The plants live for months evenafter stopase of rains. They have some modification to reduce transpiration. Ex: Echinops echinatus, Solanum surattense.

(C) **Succulents or Drought Resistants :** They bear succulent organs due to storage of water and mucilage. Fleshy stems (chylocauly) Ex: Opuntia, Asparagus, Fleshy roots (chylorhizy) Ex: Asparagus, fleshy leaves Ex: Aloe, Agave.

They bear some adaptations
- **(i)** In opuntia, stems are green and photosynthetic, that are called phylloclades.
- **(ii)** Thick cuticle.
- **(iii)** Sunken Stomata that open during night only.
- **(iv)** They show crassulacean acid metabolism (CAM).

(D) **Non-Succulents or Drought Endurers:** They actually tolerate drought conditions hence they are true xerophytes.

They bear some adaptations.
- **(i)** Roots system is very extensive. In some xerophytes, the roots are very deep and reach the water table. these are called phreatophytes. e.g. Tamarix, prosopis.
- **(ii)** In some plants Lamina fall down in early stage, while petiole enlarges green and perform photosynthesis it is called phyllode e.g. Australian Acacia.
- **(iii)** Chaperonins are heat shock proteins that provide protection to the other proteins from denaturisation at high temperature.
- **(iv)** Osmotic potential and water potential is maintained by proline.

(3) Halophytes

These plants are found in saline habitats like saline soils, mangroves, coastal dunes and tidal marshes. They bear following adaptations.

(i) Osmotic pressure is quite high (40 bars).

(ii) They have succulence in both leaves and stems for the storage of water and mucilage.

(iii) Many halophytes secrete lime or salts by chalk or salt glands e.g. Atriplex.

(iv) Stomata of leaves are scotoactive.

Mangrove plants

These organisms inhabit salty marshlands along seashores and near estuaries. Marshy areas are physiologically dry because of the salt content. They have evolved specific adaptations to thrive in such environments.

(i) **Pneumatophores :** These are negative geotropic roots found in marshy places where oxygen is not available for the respiration of roots. These roots have lenticels for gaseous exchange e.g. Rhizophora, Avicennia, Sonneratia.

(ii) **Vivipary :** Seed germination start while attached to plants. e.g. Rhizophora, Aegiceras, Ceriops, Salicornia, Avicennia, Sonneratia.

Animal adaptations

Animals possess several adaptations.

i. Migration :

Two way movement of animals for food, climate, breeding and other reasons. It involve three types.

(a) Daily: e.g. Sparrow.

(b) Seasonal: e.g. Arctic fern, Golden plover.

(c) Periodic: e.g. locusts.

ii. Camouflage (Cryptic Appearance) :

- It is the ability of animals to blend with the background.
- It allows the animals to remain unnoticed from a distance for protection or aggression. e.g. Praying mantis (Mantis religiosa) , Stick Insect (Carausius marosus) , leaf Insect (Arantia rectifolia).

iii. Mimicry :

- It is resemblance of one species of animals with other species.
- The species that is imitated is called model whereas the animal that imitates is called mimic or mimictic.

  Mimicry is of two types

  (1) Batesian Mimicry

  (2) Mullerian Mimicry

iv. Adaptations to excessive cold (Cold hardening) :

The ability to withstand cold temperatures is achieved by increasing certain substances in body fluids and having specific proteins in the spaces outside cells that help ice formation. Glycerol and antifreeze proteins are examples of substances that prevent freezing by reducing the freezing point of body fluids. For instance, creatures like the Ice Fish or Antarctic Fish can remain active in extremely cold seawater because of this resilience to freezing.

v. Echolocation :

Bats emit high-frequency sounds that bounce off objects and return as echoes, using a principle similar to sonar. These echoes help bats navigate and understand their surroundings, guiding them along their flight path.

vi. Adaptation of water Scarcity:

Animals living in arid or desert regions possess two main types of adaptations:

1. They can endure dry conditions.
2. They minimize water loss.

For instance, the Kangaroo rat, also known as the Desert Rat, rarely drinks water. It obtains 90% of its required water from metabolic processes, while the remaining 10% comes from its food. Similarly, camels exhibit various adaptations to survive in such harsh environments.

vii. Phenotypic adaptations :

In various wild organisms, certain physical adaptations develop to respond to unfavorable conditions. For example, humans often experience altitude sickness at high altitudes (above 3500 meters). Symptoms may include nausea, fatigue, and heart palpitations due to the low atmospheric pressure at high altitudes. To cope with the reduced oxygen availability, the body increases the production of red blood cells, decreases the binding capacity of hemoglobin, and elevates the breathing rate.

viii. Hibernation and Aestivation:

- Ectothermal (cold-blooded) animals like frogs exhibit hibernation (winter sleep) and aestivation (summer sleep) to regulate their body temperature.
- Certain organisms use behavioral responses to adapt to changes in their environment. For instance, desert lizards lack the physiological mechanisms mammals have to cope with high temperatures, but they maintain a relatively constant body temperature through behavior. They sunbathe to absorb heat when they feel too cold, but seek shade when temperatures rise. Some species can burrow into the soil to escape the heat above ground.