

TEMPERATURE

Dr. S. ACHIRAMAN

Assistant Professor

Chemical Ecology Research Lab

Department of Environmental Biotechnology

Bharathidasan University

Tiruchirappalli – 620 024

Tamilnadu, India

Email: **achiramans@gmail.com**

Temperature as an abiotic ecological factor

- ✓ The Measure of the intensity of heat is called **Temperature**
- ✓ The units of temperature commonly expressed in Degrees of **Fahrenheit scale** or on **Celsius scale**
- ✓ The Main source of **heat energy** is the **Sun**

Ranges of temperature

- Extreme variations in temperature
 - ✓ Diurnal variation - day to night
 - ✓ Seasonal variation - season to season are found in Inland area
 - ✓ Altitude
 - ✓ Equator/Poles
 - ✓ Aquatic thermal variation
 - ✓ Terrestrial thermal variation

NASA - What's the Difference Between Weather and Climate?

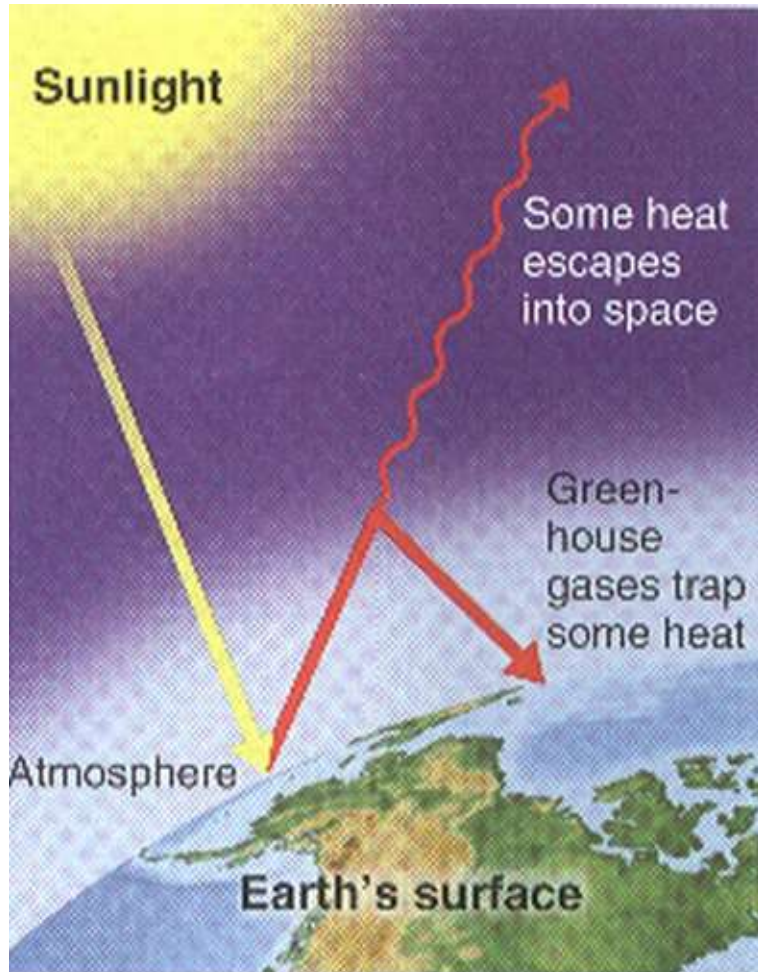
The difference between weather and climate is a measure of time.

- ✓ Weather is what conditions of the atmosphere are over a short period of time, and
- ✓ Climate is how the atmosphere "behaves" over relatively long periods of time.
- ✓ **Weather** is the state of the atmosphere, describing for example the degree to which it is hot or cold, wet or dry, calm or stormy, clear or cloudy. ...
- ✓ **Weather** refers to day-to-day **temperature** and precipitation activity, whereas ,
- ✓ Climate is the term for the averaging of atmospheric conditions over longer periods of time.

Six Factors that Affect Climate

- Heat trapping of the atmosphere (Greenhouse effect)
- Latitude
- Transport of heat by winds, ocean currents
- Amount of Precipitation from the wind, etc.
- Shape/Elevation of Land
- Energy of incoming sunlight

a. **Greenhouse Effect**- atmospheric gases (CO_2 , CH_4 , H_2O), etc.) trap heat like a blanket and maintain Earth's temperature range



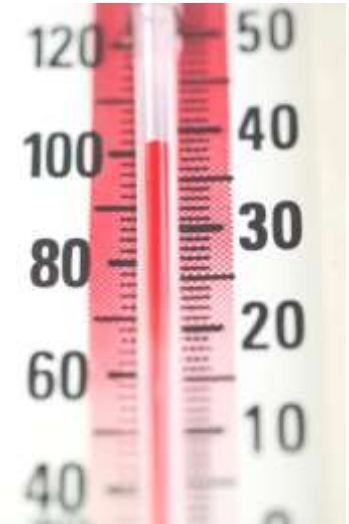
1). Solar energy can penetrate atmosphere

2). Sunlight hits surface of Earth and turned into heat energy

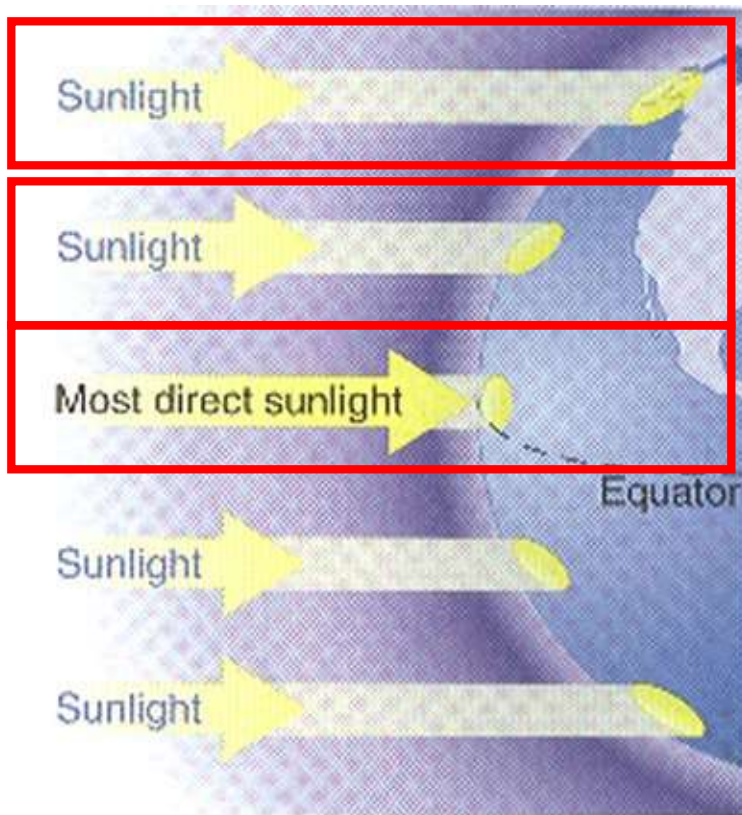
3). Gasses trap heat energy

WHAT IF NO “GREENHOUSE EFFECT”?

- The Earth would be 30 **Celsius** Degrees colder!!!
- That is equal to 86 Degrees Farenheit colder!!



b. **Effect of Latitude**- The earth is tilted on its axis so the surface of the Earth receives varying amounts of solar radiation because of different angles of sunlight. Three main climate zones

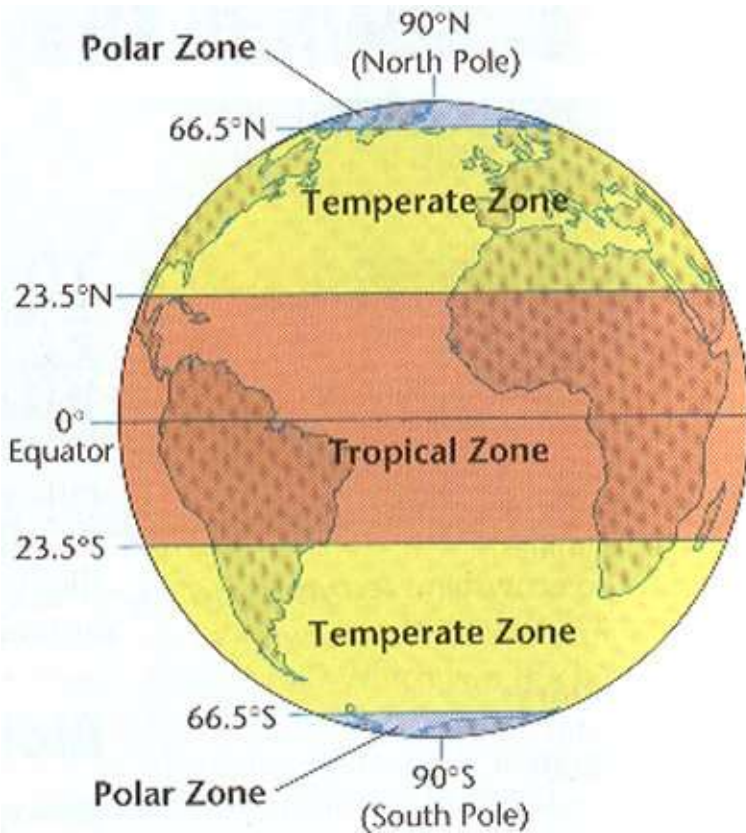


1). **Polar Zone**- sun strikes at low angle

2). **Temperate Zone**- zone affected more by changing angle of sun- climate changes hot to cold

3). **Tropical Zone**- direct sun all year. Always warm

c. **Heat transport in Biosphere**- unequal heating of Earth's surface drives winds and ocean currents



1). Warm air at equator rises and cool air at poles sinks – creates winds, which alter expected climate of latitude

2). Cold water at poles sinks and rises in warmer regions (**upwelling**)- creates currents.

3). Landmasses affect winds and ocean currents (physically interfere with circulation).

4). Winds, currents, landmasses influence temperature and precipitation which in turn create Earth's climate

Thermal stratification

Thermal stratification in lakes in the temperate regions with marked variations of temperature occurs with the change of Seasons

Thermal stratification occurs only in - Temperate lakes

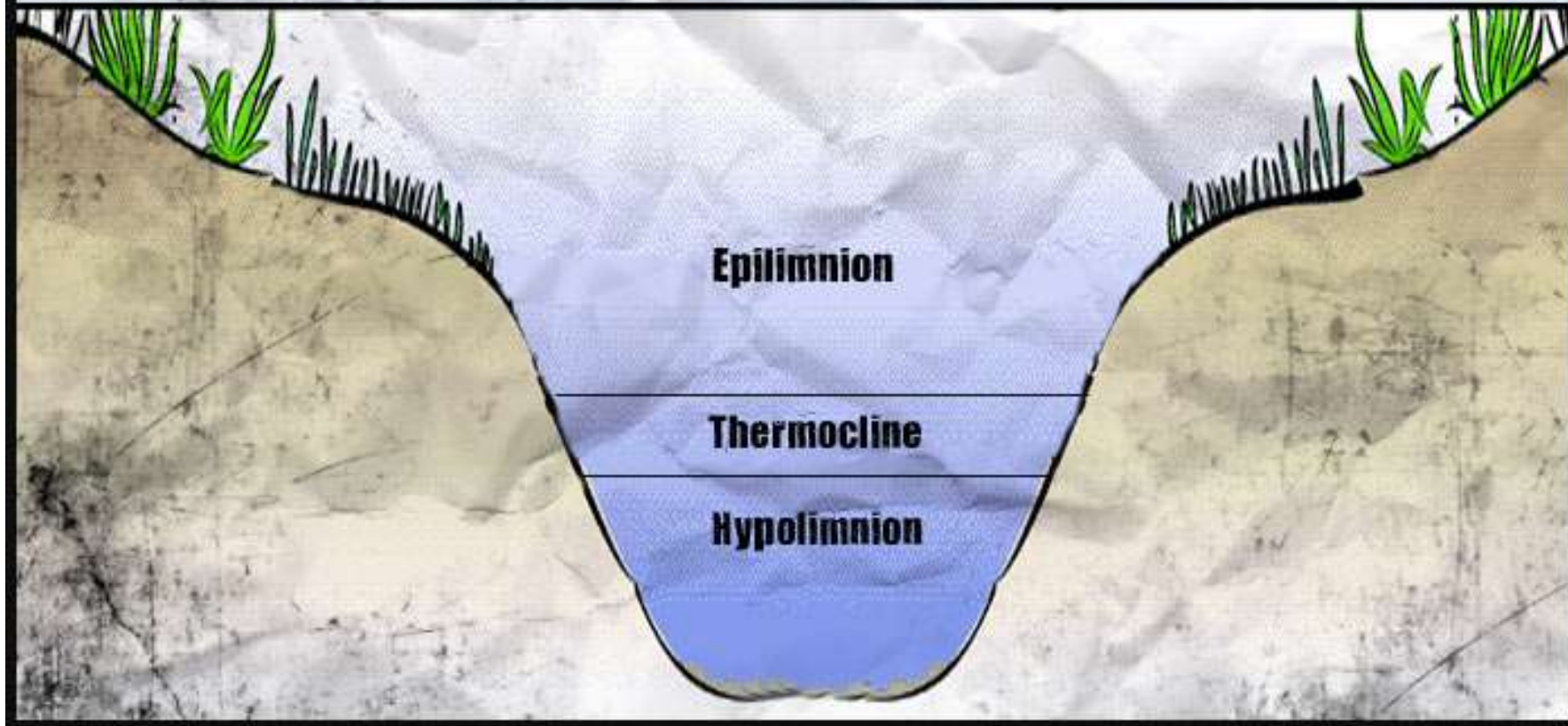
Formation of different layers of water in freshwater lakes due to temperature variations is called Thermal stratification

- a. Summer stratification and
- b. Winter stratification

Summer stratification

- ✓ The upper layer of water that having a temperature range of 21 to 25 C during summer in temperate lakes is called - **Epilimnion**
 - ✓ The zone of water where there is rapid decrease in temperature at rate of 10 C/meter is called -**Thermocline / Metalimnion**
 - ✓ The cold and oxygen defecient zone of water below the thermocline is called-**Hypolimnion**
-
1. Oxygen levels decrease in hypolimnion if the thermocline is formed - Below the compensation level
 2. Over turn of water occurring in the lake after summer stratification is - Fall overturn
 3. Oxygen rich water from surface reaches

Summer Lake Stratification Zones



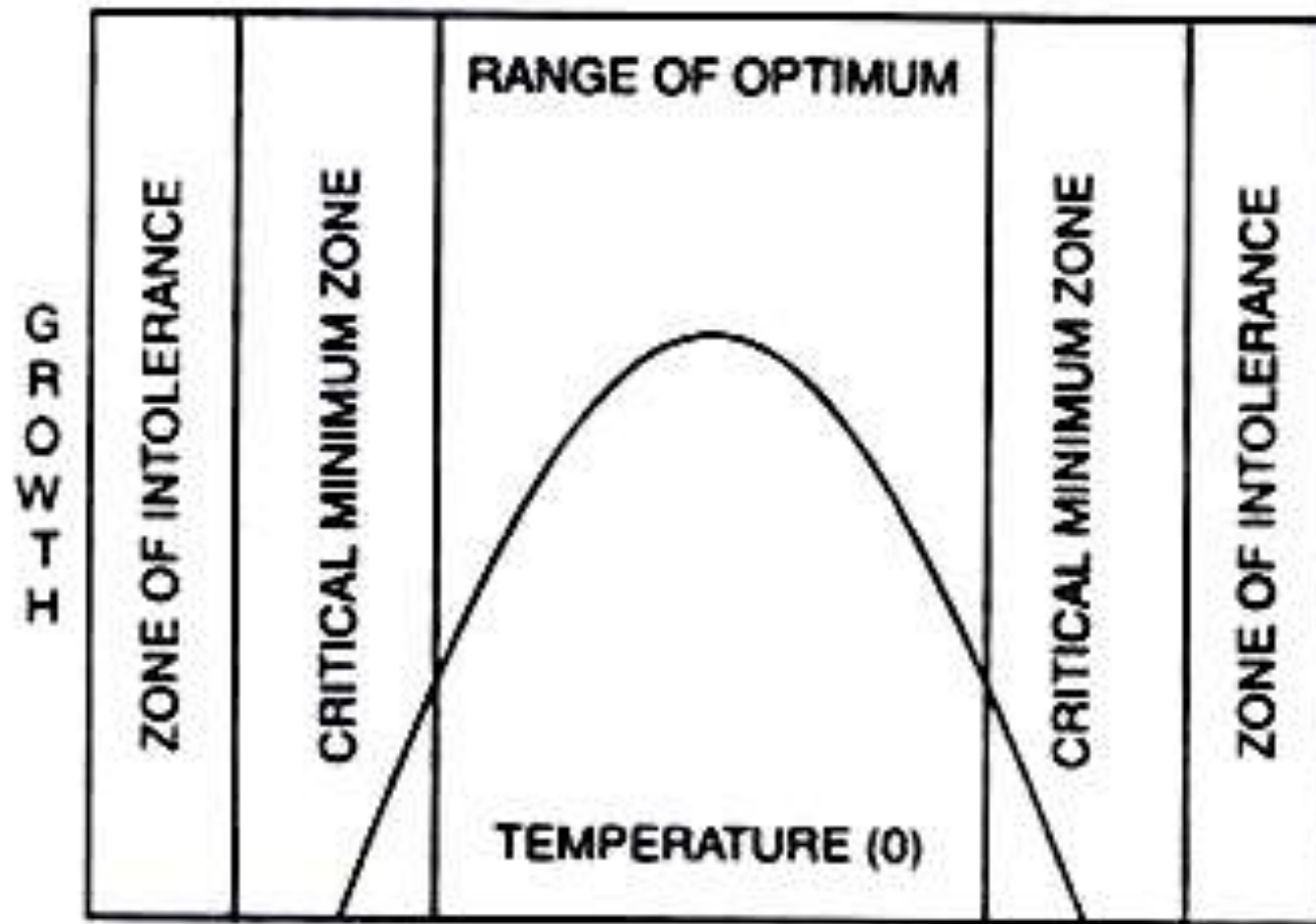
<http://www.untamedscience.com/biology/biomes/lakes-ponds-biome/>

Winter stratification

- ✓ During winter, surface water freezes to ice whereas water below the surface remains at 4°C and is called Winter stratification
- ✓ The organisms are not subjected to hypoxia during winter stagnation as there is - decrease in bacterial decomposition and respiratory activity of aquatic organisms.
- ✓ Spring overturn occurs in a stratified lake after Winter
- ✓ Periodic replenishment of nutrients and oxygen in stratified lakes takes place by the Overturn in lakes.
- ✓ The phenomenon that upwells the nutrients & increases the productivity is due to - overturns Biological effects of temperature:

Animal Tolerance to temperature

- ✓ Organisms which can tolerate wide fluctuations in temperature are termed - **Eurythermal**. Eg: Lizards, Birds and Mammal
- ✓ Organisms which can tolerate only small variation in temperature are termed-**Stenothermal** organisms Eg: Coral animals, Fishes
- ✓ The temperature at which the organism's life activities are at the maximum level is called **Optimum temperature**



RANGE OF TEMPERATURE TOLERANCE

- ✓ The lowest temperature at which organisms can live indefinitely is called - **Minimum effective temperature.**
- ✓ The highest temperature at which an organism can live indefinitely is called **Maximum effective temperature.**
- ✓ An organisms enters into chill coma if the temperature is - Below minimum effective temperature
- ✓ The lowest temperature at which survival is possible - **Minimum survival temperature**
- ✓ An organism goes into heat coma if the temperature is above maximum effective level

Thermal regulations in animals

- ✓ Animals which can maintain constant body temperature within narrow limits are **Homeotherms** Eg: Birds and Mammals.
- ✓ Animals which are not capable of maintaining constant body temperature are – **poikilotherms** Eg: Fishes, Amphibians, reptiles etc.
- ✓ Internal mechanisms to regulate body temperature are **absent in - Poikilotherms**

Thermal migrations

- ✓ Migration of animals to the places of optimum temperature range to escape extremes of temperature is - **Thermal migration**
- ✓ Desert animals move to shaded places to avoid scorching heat of the sun during – Noon
- ✓ The Organisms which can move between land and water in an attempt to - Minimise the effect of change in temperature on their bodies
- ✓ Thermal migration in desert animals takes place during – Noon
- ✓ The organisms move between land & water to minimise the effect of temperature are - Amphibians, Crocodiles Hippopotamus Metabolism

Temperature and metabolism

- ✓ Effect of temperature on metabolic activities of animals is more significant in Poikilothermic than in Homeothermic animals because Homeotherms maintain constant body temperature.
- ✓ Temperature regulates metabolism because temperature influences the
- Activity of enzymes
- ✓ Effect of temperature is not significant in Homeotherms
- ✓ Doubling of rate of biochemical reactions with ever 10 °C rise in temperature is called - **Van't Hoff; rule.**

Temperature and sex of the animals

- ✓ Increase in the number of male individuals -In Ratflea *xenopsylla cheopis* population than the female individuals is due to increase in temperature.
- ✓ Recent invitro and invivo experiments on turtle embryo have shown bipotential gonads are masculanized in the absence of - Temperature trigger.

Cyclomorphosis

Female producing temperatures cause the enzyme aromatase to act locally on gonads to produce estrogen and activate the development of Ovaries
Cyclomorphosis

Modifications in the body form in relation to seasonal changes in temperature are **cyclomorphosis**

Cyclomorphosis was observed in Daphnia (by Coker)

- ✓ In winter head of Daphnia is Round
- ✓ The helmet like projection starts on head of Daphnia during Spring season
- ✓ The helmet like projection completely found during Summer
- ✓ The helmet like projection begins to decrease during Autumn
- ✓ The helmet like projection completely disappear & the head becomes round during- winter

During winter Daphnia can float on water due to more density of water.

The hood like structure in Daphnia helps to increasing buoyancy



Bergmann's rule

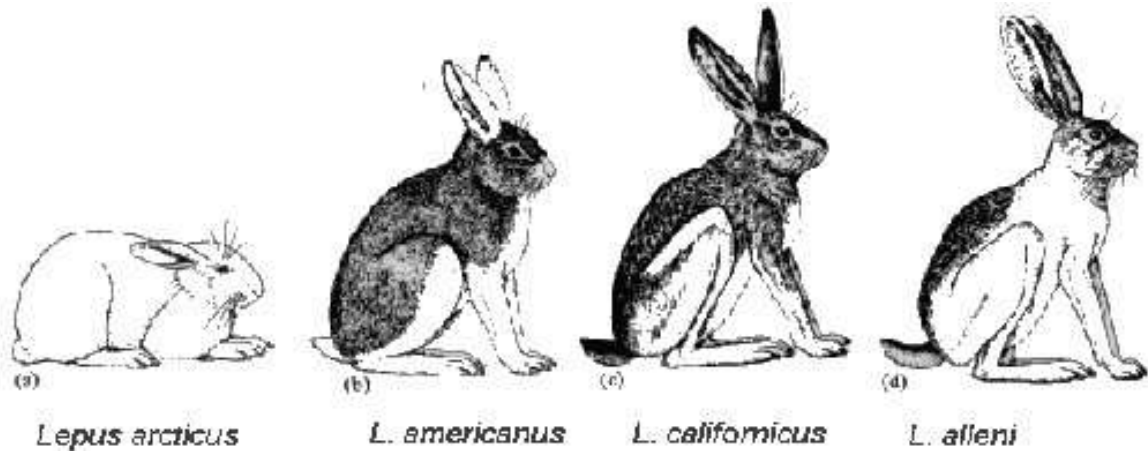
Effect of temperature on the body size of animals is explained by -
Bergmann's rule

Ratio of body surface to the body size of warm blooded animals living
in colder regions is - less than that of their counterparts living in
warmer climates



Allen's rule

- ✓ Effect of temperature on the size of extremities of the body in homeotherms is explained by Allen's rule
- ✓ Examples of Allen's rule - Ear lobes of Fox.
- ✓ According to Allen's rule - large extremities increase the surface area without increasing the volume.



Jordan's rule

- ✓ Effect of temperature on the early segmentation in the development of some fish is explained by Jordan's rule
- ✓ Eg: Number of vertebrae is 56 in - Cod fish hatches in new found land 4°C — 8°C
- ✓ Number of vertebrae is 54 in - Cod fish hatches in new found land 10°C — 11°C

Gloger's rule

- ✓ Effect of temperature on pigmentation of animals is given by Gloger's rule
- ✓ Eg: Pigmentation of skin is more in - Tropical region animals
- ✓ Pigmentation of skin is less in - Temperate region animals

Adaptation: Skin Pigmentation



- Skin color may be adaptive:
- **Gloger's Rule:** Within a species, more pigmented populations live near the Equator (map, upper left)
- Lighter populations live further away from the Equator
- Rationale: melanin serves as protection against ultraviolet rays of sun
- Applies to all mammals and even birds (sparrows, lower left)