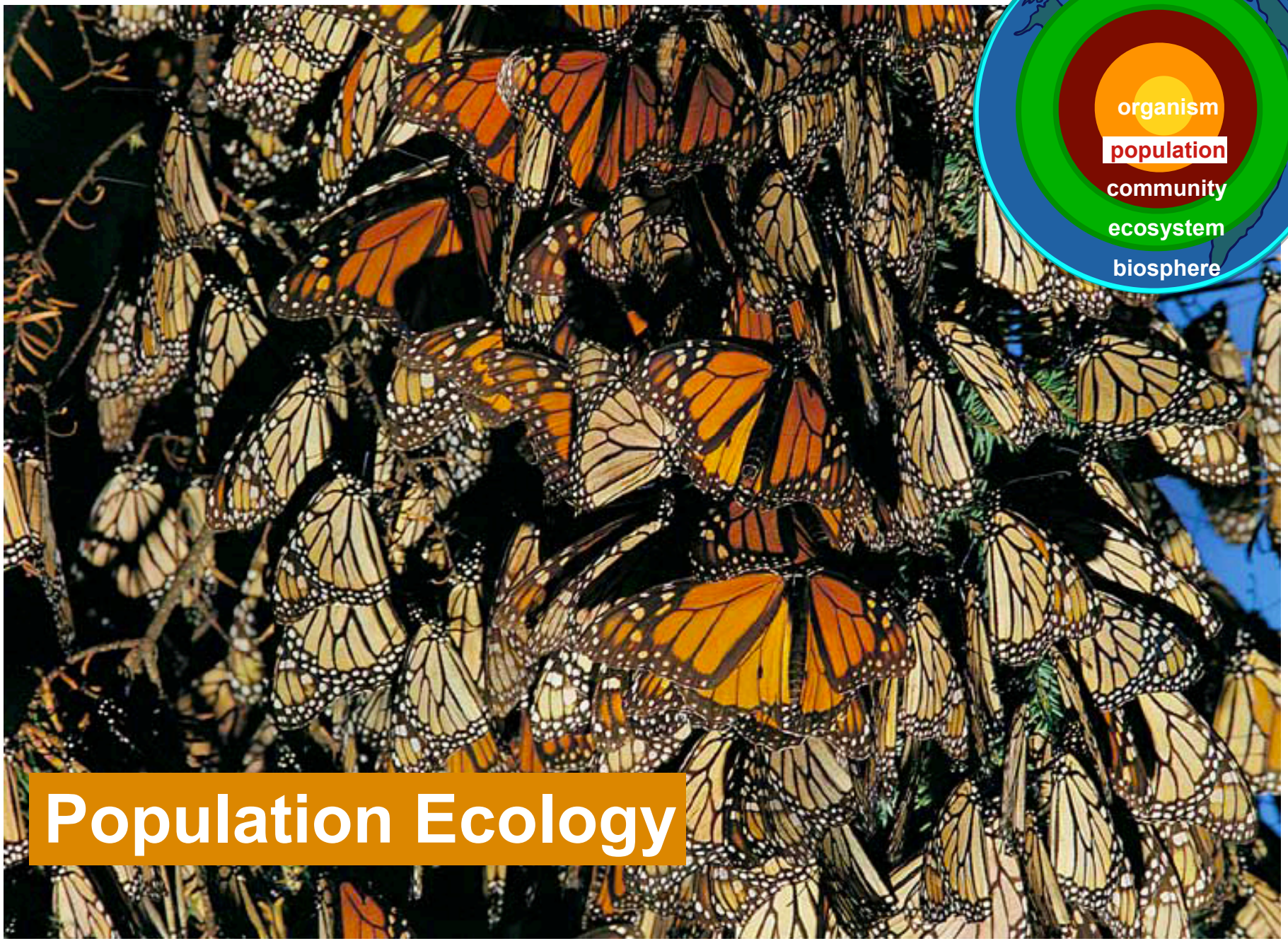
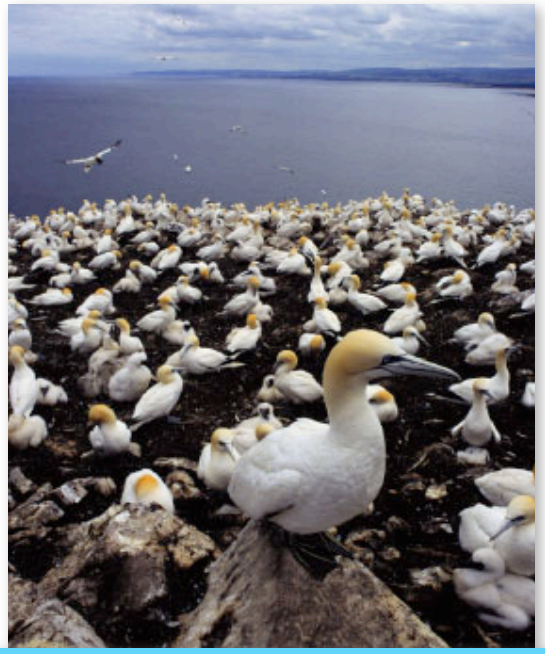



# Population Ecology

# Life takes place in populations

- **Population**
  - group of individuals of same species in same area at same time

- rely on same resources
- interact
- interbreed



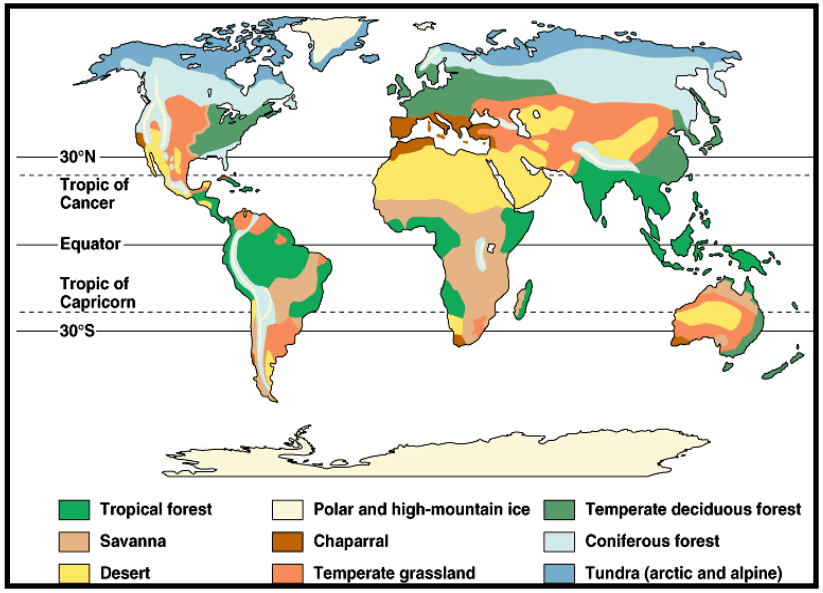
**Population Ecology: What factors affect a population?**

# Why Population Ecology?

- Scientific goal
  - understanding the factors that influence the size of populations
    - general principles
    - specific cases
- Practical goal
  - management of populations
    - increase population size
      - endangered species
    - decrease population size
      - pests
    - maintain population size
      - fisheries management
        - maintain & maximize sustained yield

# Factors that affect Population Size

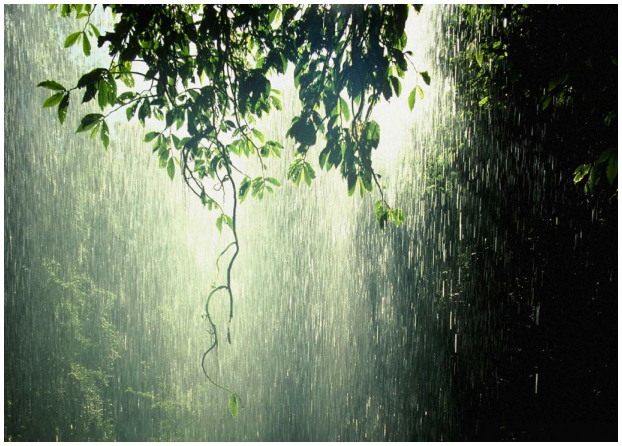
- **Distribution and abundance of organisms are affected by**
  1. **Abiotic factors: nonliving factors**
  2. **Biotic Factors: Living factors**
  3. **Intrinsic Factors: Factors that have to do with the animal's phenotype itself**




- **Abiotic Factors**
  - **temperature**
    - Cells may rupture when water freezes
    - Proteins denature above 45 C
  - **precipitation / water**
    - Terrestrial organisms are always threatened by desiccation
    - need to obtain and conserve water

# Factors that affect Population Size

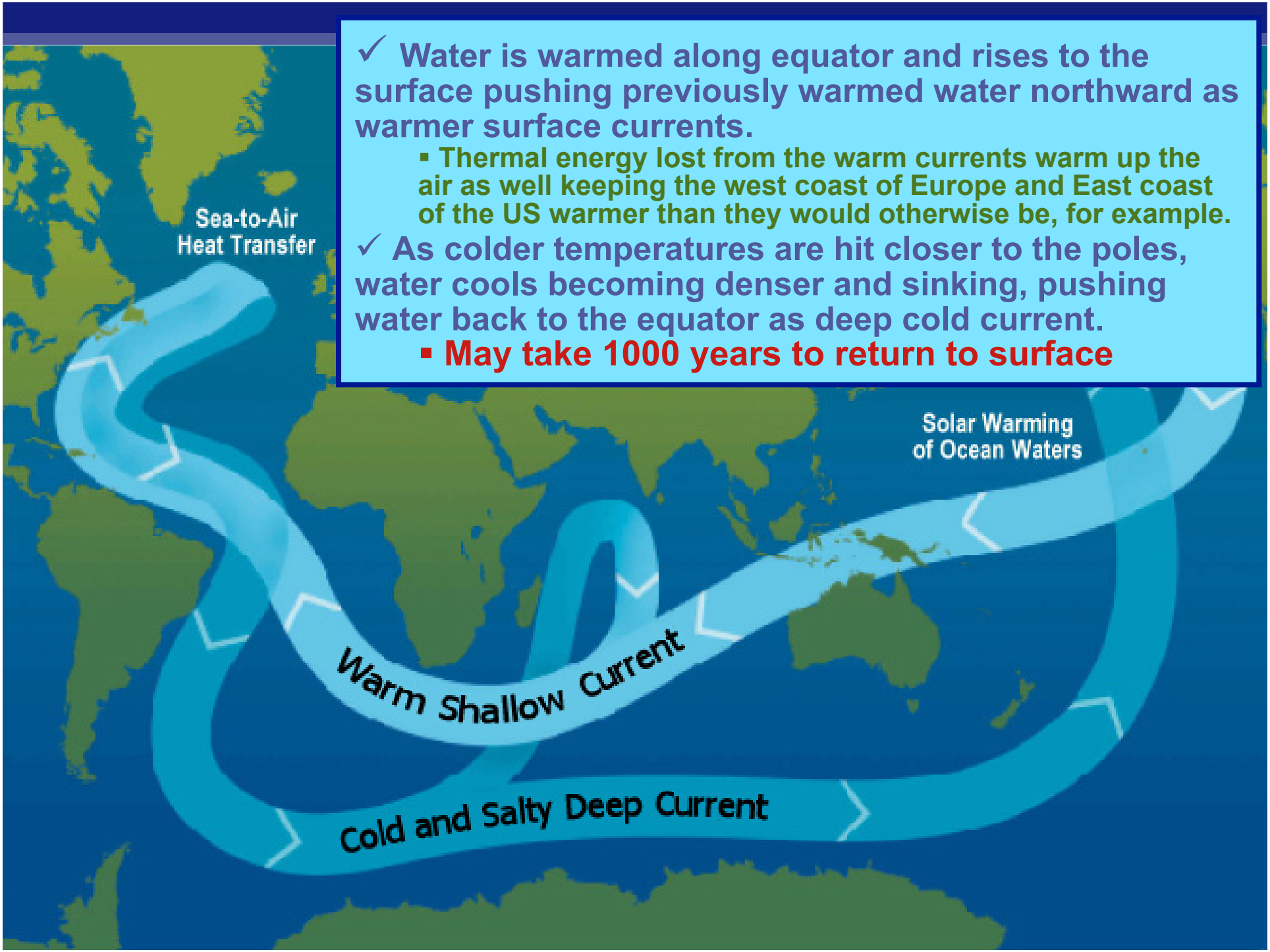
- **Abiotic Factors**
  - **Sunlight**
    - Without light no photosynthesis can occur
      - Every meter of water absorbs 45% of red light and 2% of blue light
      - Photosynthesis usually occurs near the surface
    - Too much light is damaging as well
      - Atmosphere is thinner at higher elevations, absorbs less UV
      - In alpine environments the sun's energy can do easier damage to DNA and proteins
        - Protection is needed and abilities to cool off



# Factors that affect Population Size

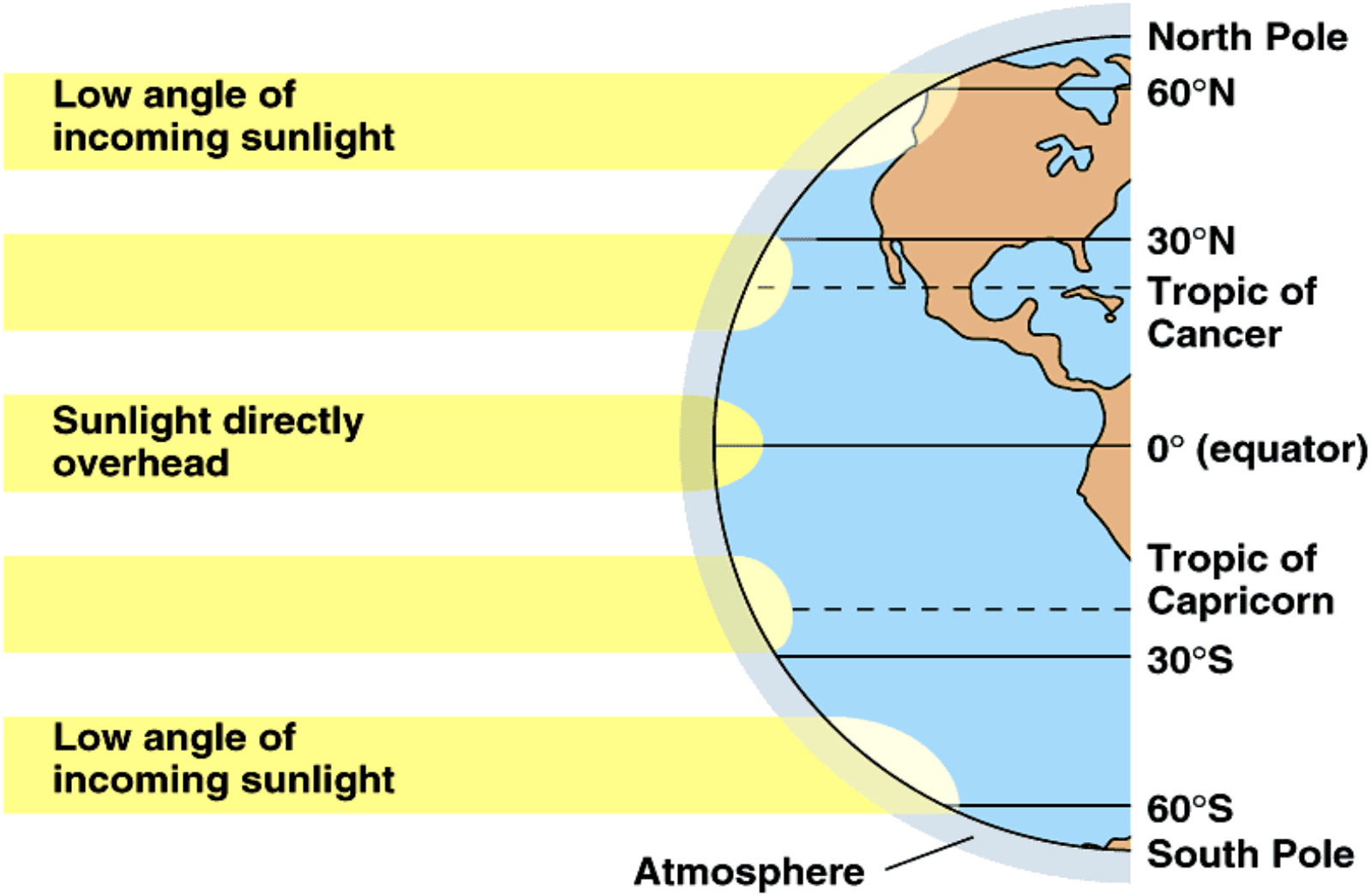
- **Abiotic Factors**
  - soil / inorganic nutrients
    - Ph
    - Mineral composition
    - Physical structure of rocks and soils
    - Solubility of nutrients and toxins


- Temperature, precipitation, sunlight, and wind: make up **CLIMATE**
  - The long-term prevailing weather conditions in a particular area
    - Determined largely by amount of solar energy and planet's movement in space


✓ Water is warmed along equator and rises to the surface pushing previously warmed water northward as warmer surface currents.
▪ Thermal energy lost from the warm currents warm up the air as well keeping the west coast of Europe and East coast of the US warmer than they would otherwise be, for example.
✓ As colder temperatures are hit closer to the poles, water cools becoming denser and sinking, pushing water back to the equator as deep cold current.
▪ May take 1000 years to return to surface
Sea-to-Air Heat Transfer
Solar Warming of Ocean Waters
Warm Shallow Current
Cold and Salty Deep Current

# Sunlight intensity is highest near or at the equator

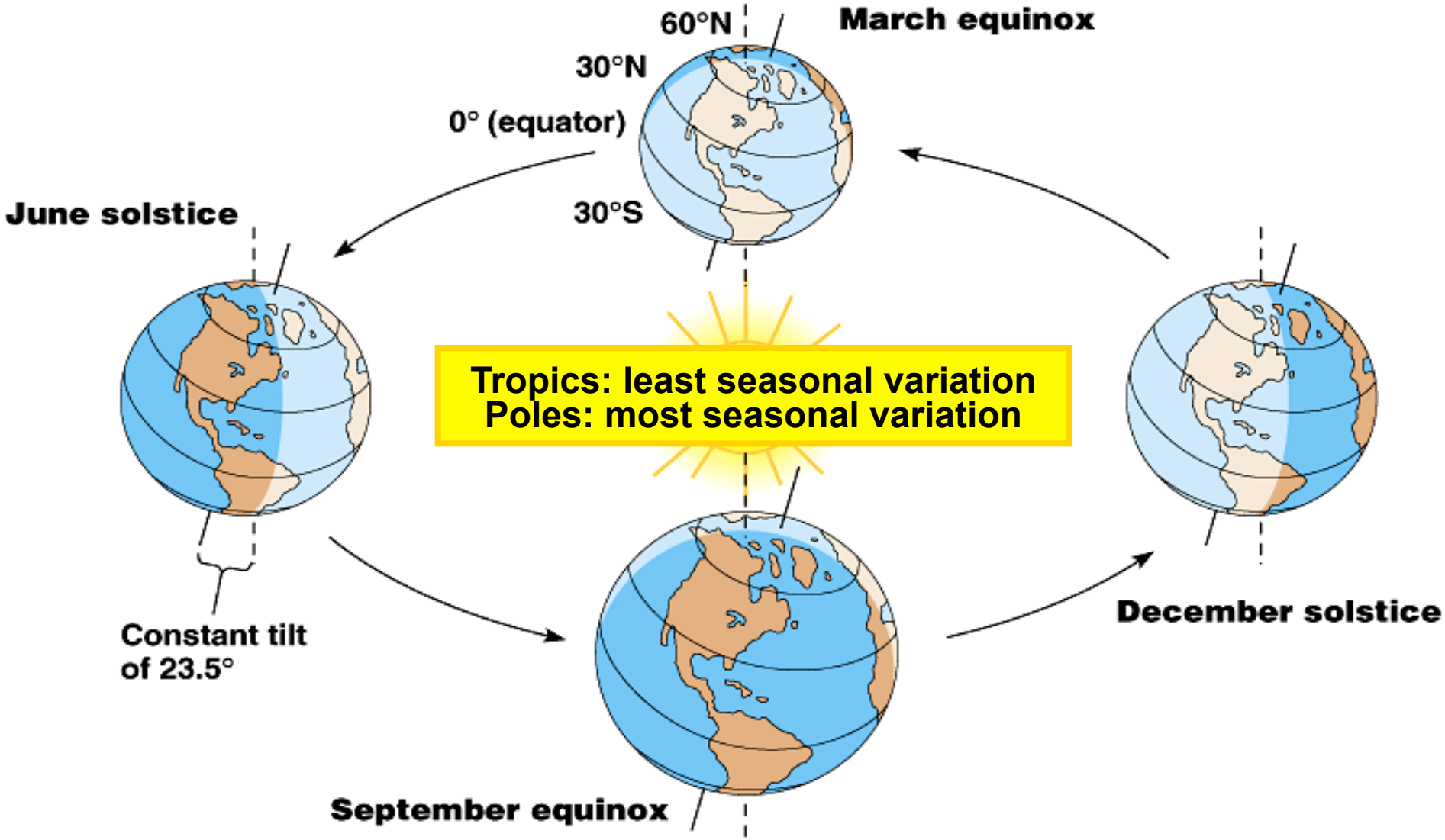
**Here the solar energy is not spread out over as large a surface area since the photons of energy hit earth at a near 90 degree angle vs. the poles where the sun's energy hits earth at a much larger angle, the energy spreading out over a larger surface area of land.**




AP B

# Earth's tilt (23.5 degrees) causes seasonal variation in intensity of solar radiation

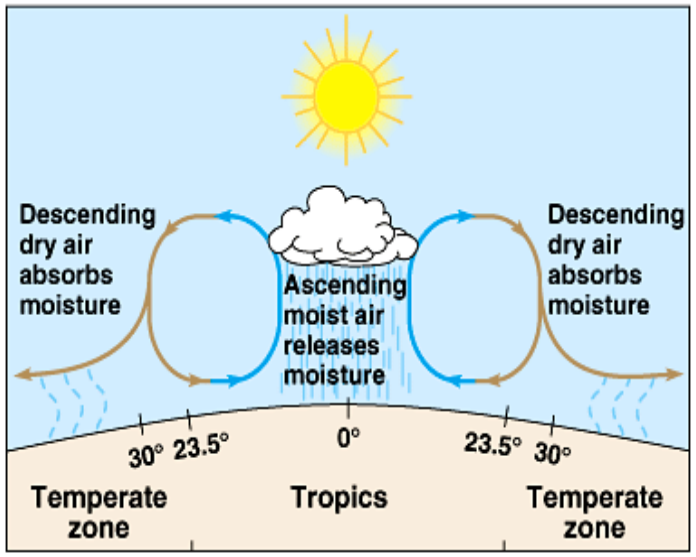
(the amount of energy hitting Earth per unit of surface area varies, being highest between latitudes 23.5 N & S, decreasing as you move to the poles due to the spherical shape of Earth, which parts of the Earth get hit with the most solar energy and sunlight depending also on the time of the year, sun exposure changing as Earth orbits around the sun).



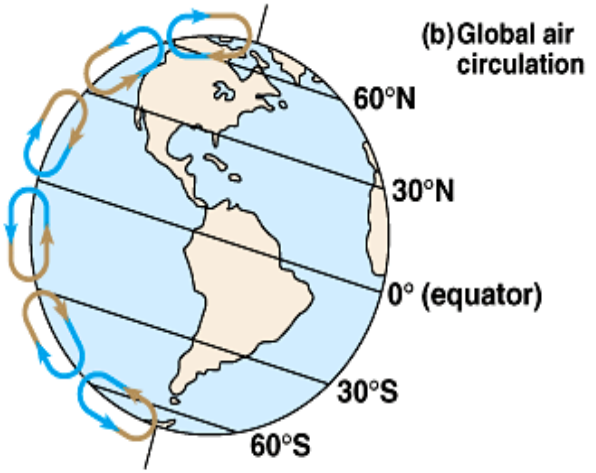
# Intense sun near equator initiates a global pattern of air circulation and, therefore, precipitation.

**Warmed up** air is less dense + rises into atmosphere carrying with it water evaporated from Earth's surface.

- As air rises it cool - water vapor condenses into liquid rain creating moist conditions on land below.



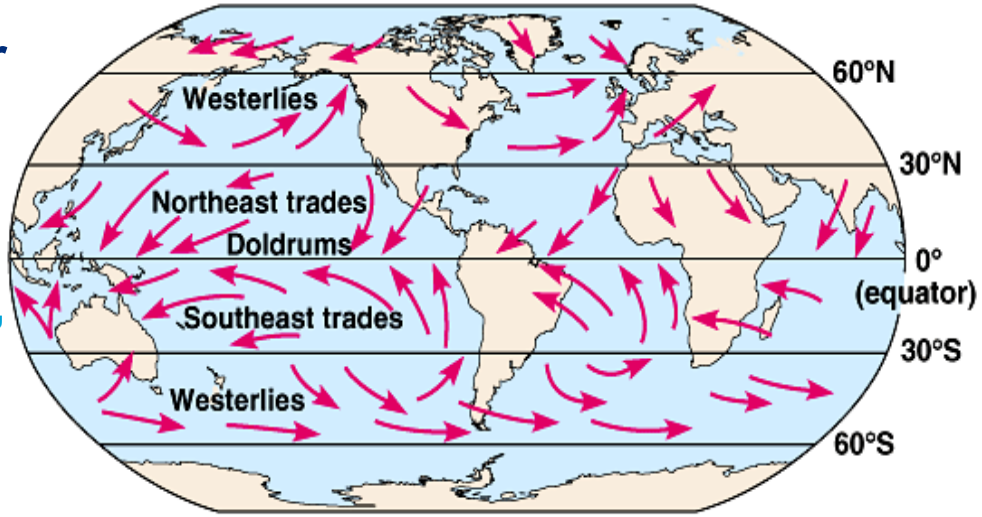

(a) Air circulation and precipitation near the equator



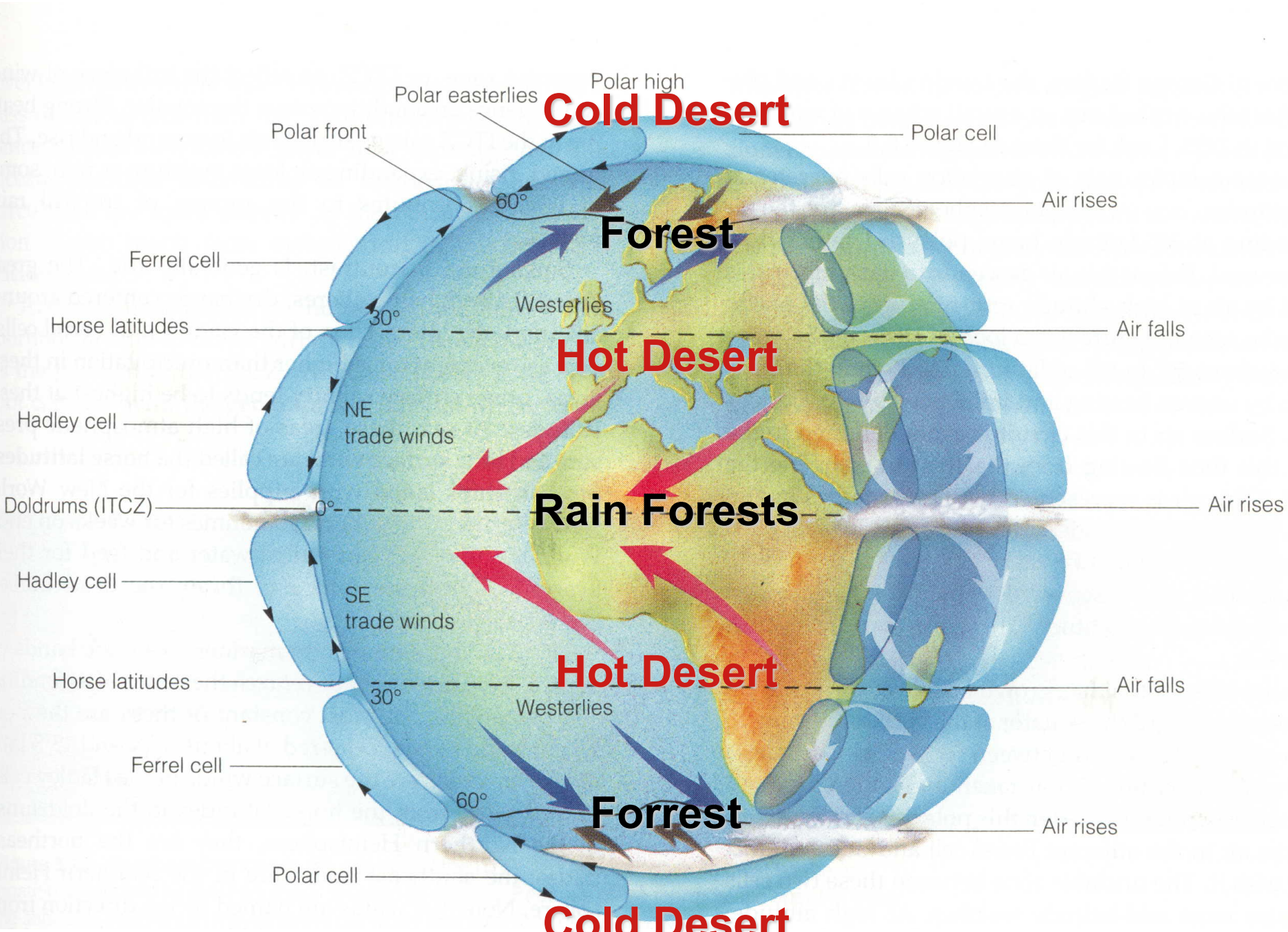

(b) Global air circulation

**Cooled down**, now dry air is more dense and sinks back down to Earth

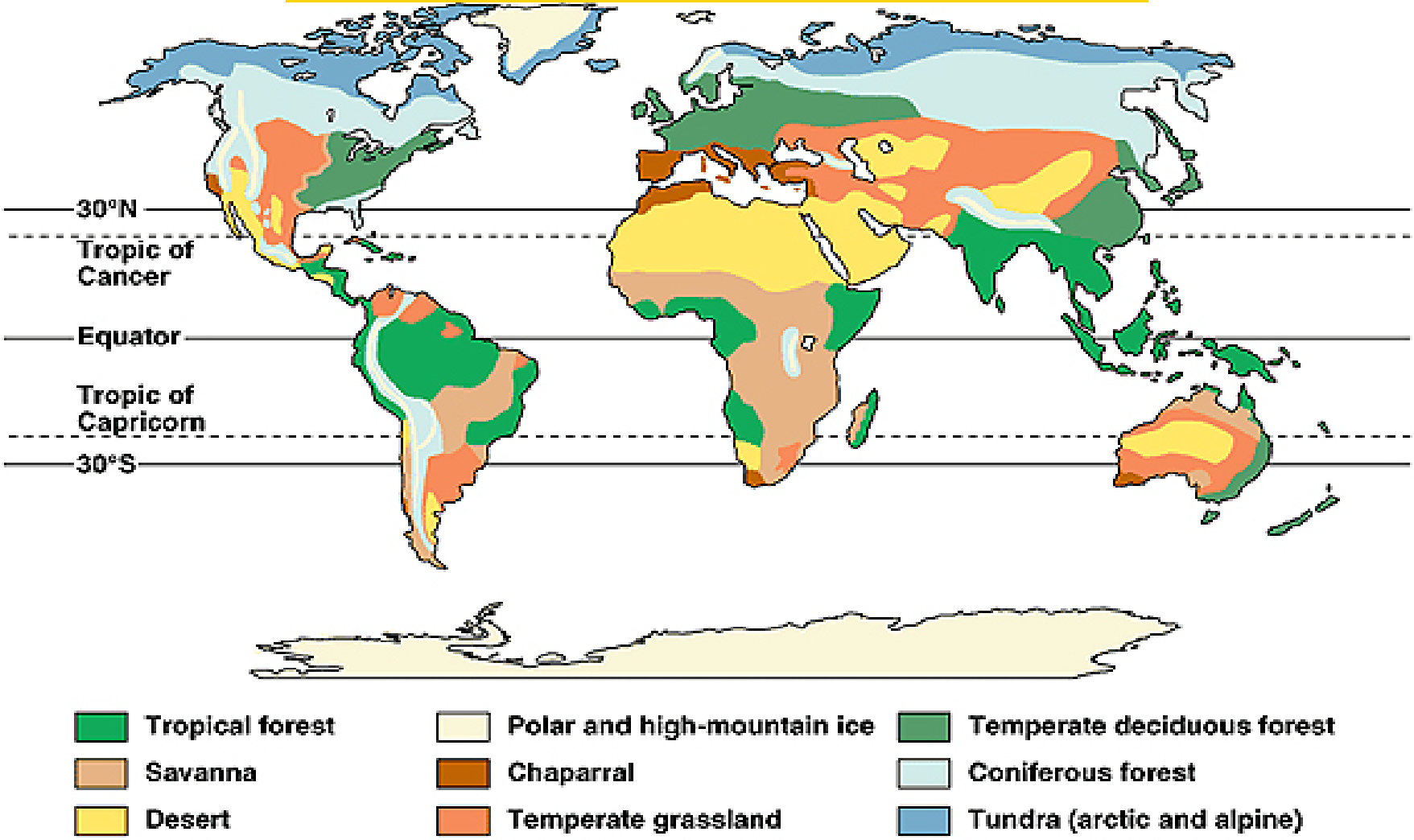
- Dry air hitting Earth's surface starts to warm again and change density, absorbing water from Earth's surface as it passes, creating very dry conditions on land.




(c) Global wind patterns


Polar high
Polar easterlies
Cold Desert
Polar front
Polar cell
60°
Air rises
Forest
Ferrel cell
Westerlies
30°
Horse latitudes
Air falls
Hot Desert
Hadley cell
NE
trade winds
Doldrums (ITCZ)
0°
Rain Forests
Air rises
Hadley cell
SE
trade winds
Hot Desert
Horse latitudes
30°
Air falls
Westerlies
Ferrel cell
60°
Forrest
Air rises
Polar cell
Cold Desert

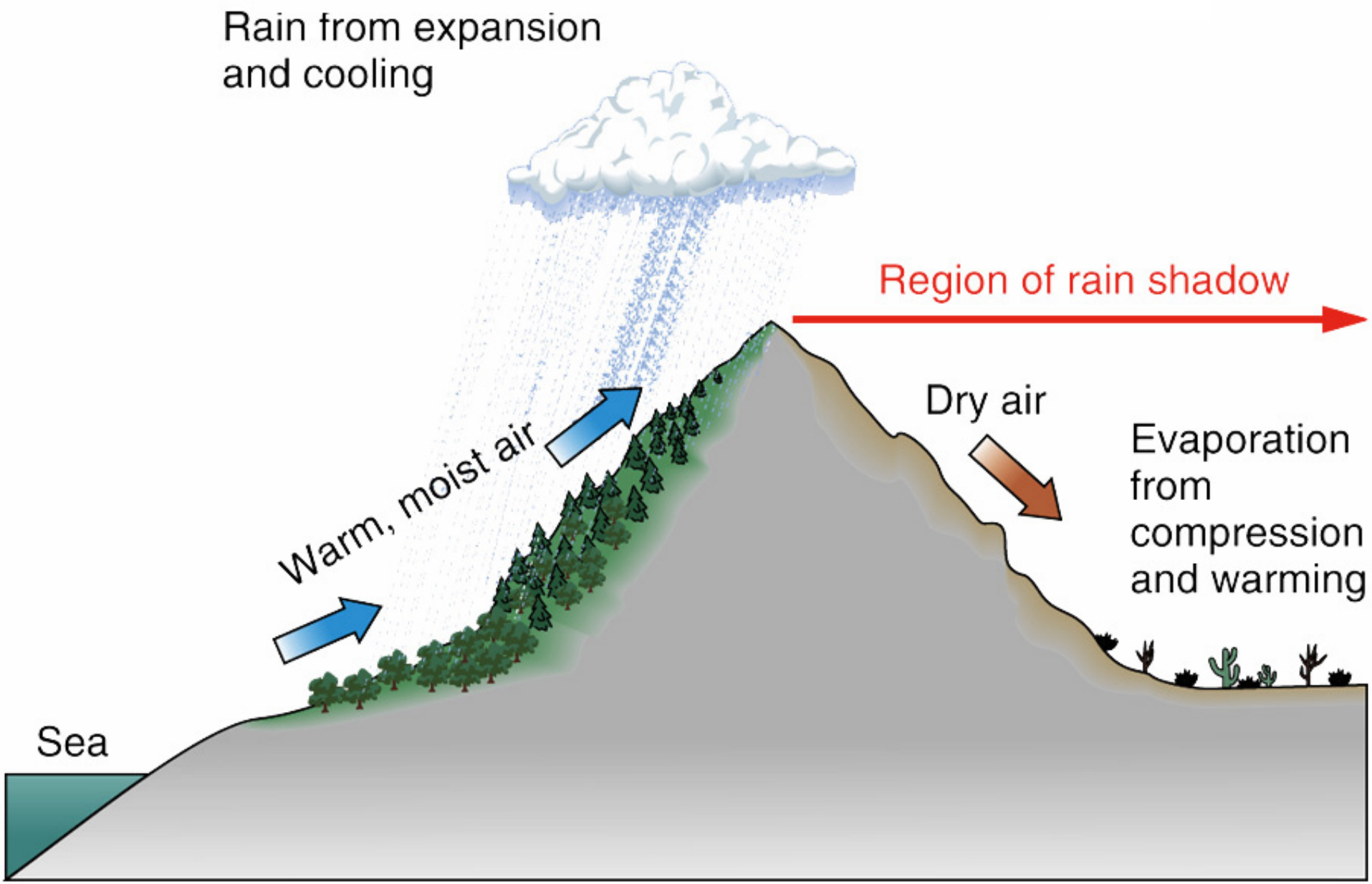
# Earth's Terrestrial Biomes Results



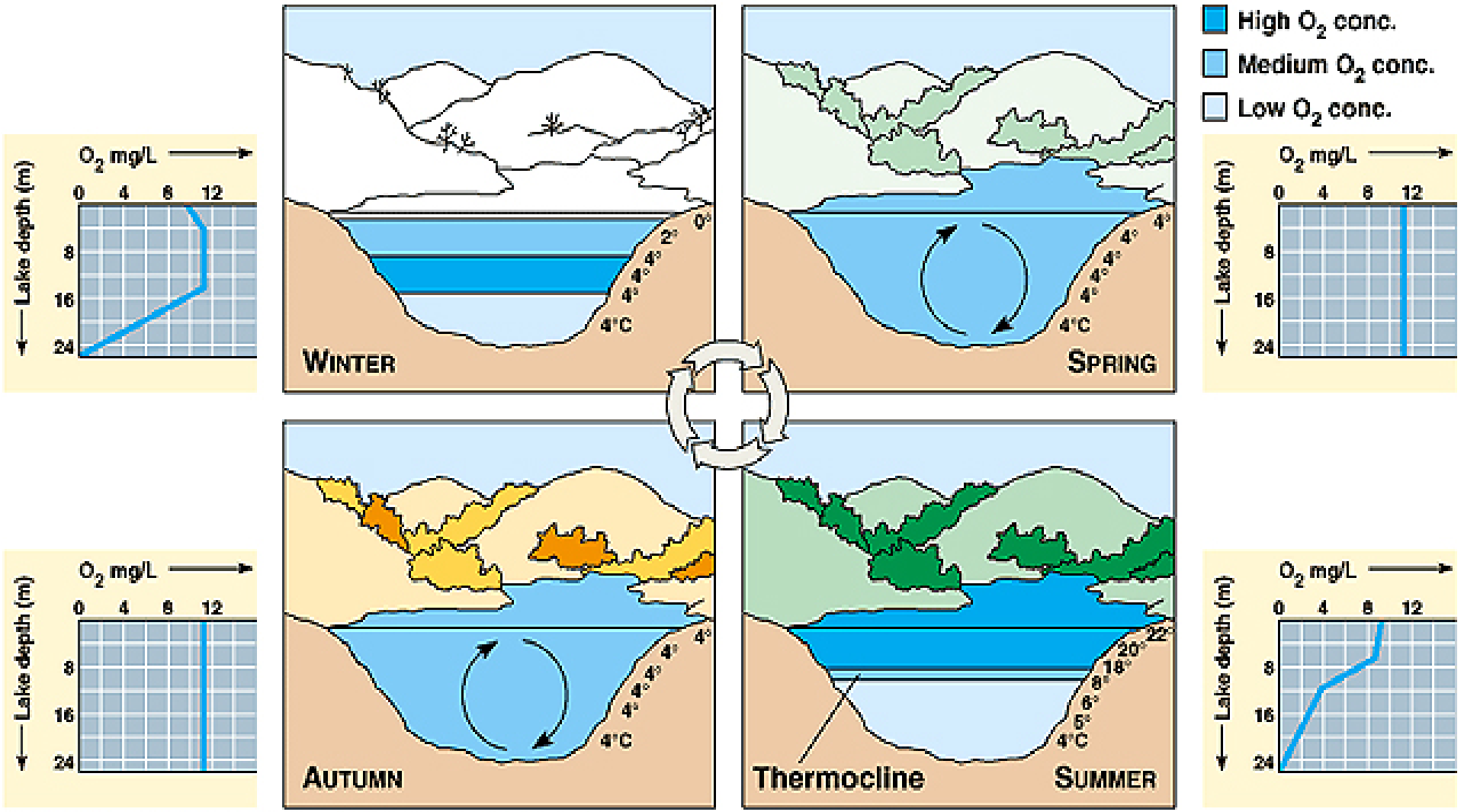

**Know the key features of each biome - see textbook & biome packets!**

***Understand biomes in terms of the amount of precipitation, examples of animal & plant life, timing of dry vs. wet seasons, seasonal temperature patterns, & any unique biotic & abiotic conditions organisms face.***

**Rain Shadow:** **Rainfall and humid conditions dominate on the seaside of the mountain chain, while dry conditions dominate the continental side.**



# Seasonal Turnover in winter ice covered lakes

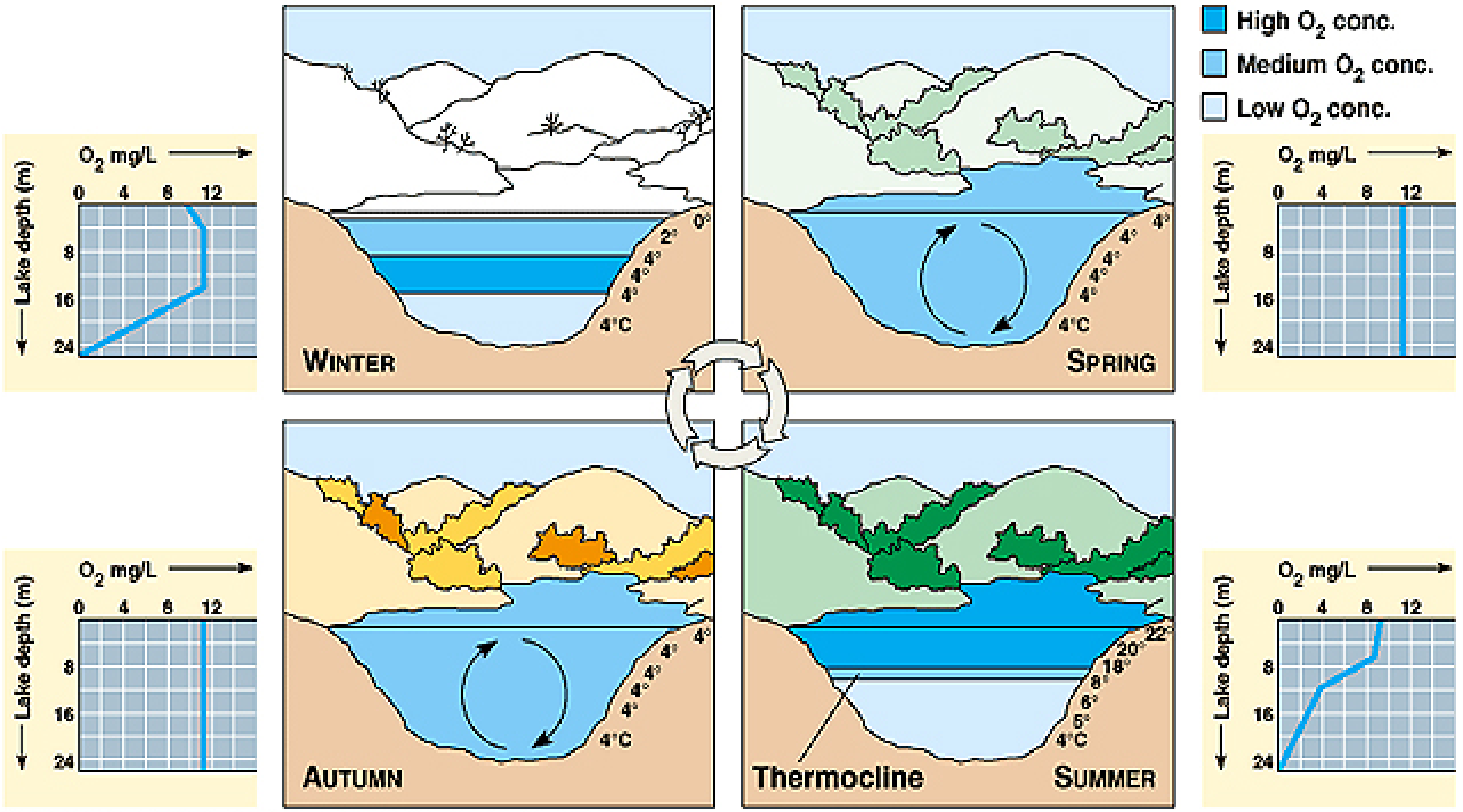



**Winter:** Coldest water right below frozen floating surface as thermal energy lost to colder ice and ice looses thermal energy to colder surface air, but since it is under 4C it is less dense and closer to forming ice. Deepest water dense & close to 4C

**Spring:** Surface warms as heat is gained from warming air and radiant energy from sun to 4C, becomes dense, and sinks, eliminating stratification. Turnover takes place:

Oxygenated water taken down, nutrient rich water brought up.

# Seasonal Turnover in winter ice covered lakes

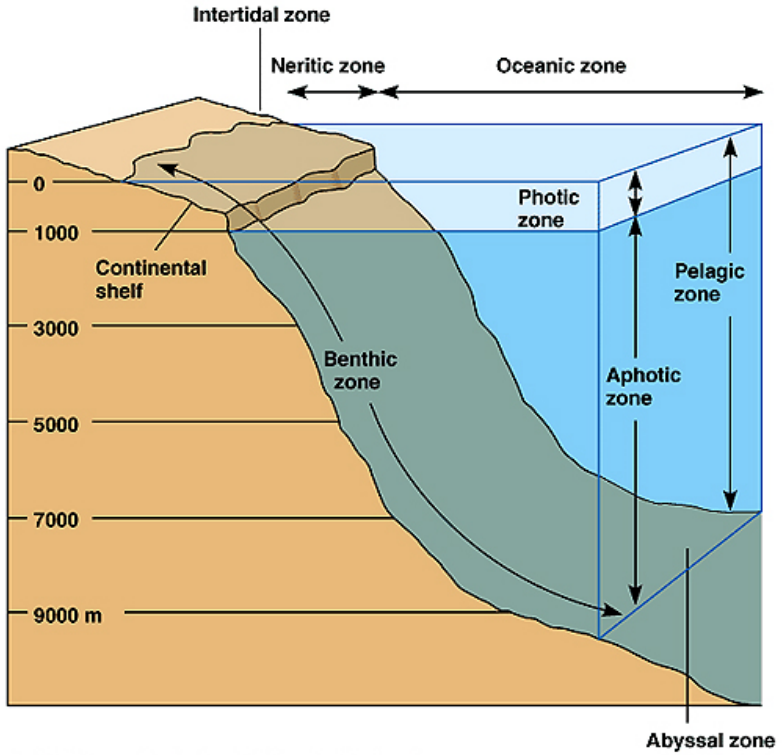



**Summer:** Thermocline (narrow layer of abrupt temperature change) exists. Warm water on top, warmed by radiant energy from the sun and thermal energy air transferring into water. Densest and coldest water on bottom.

**Autumn:** Surface cools (as thermal energy lost to colder air above) and water sinks, mixing water again. Turnover takes place.

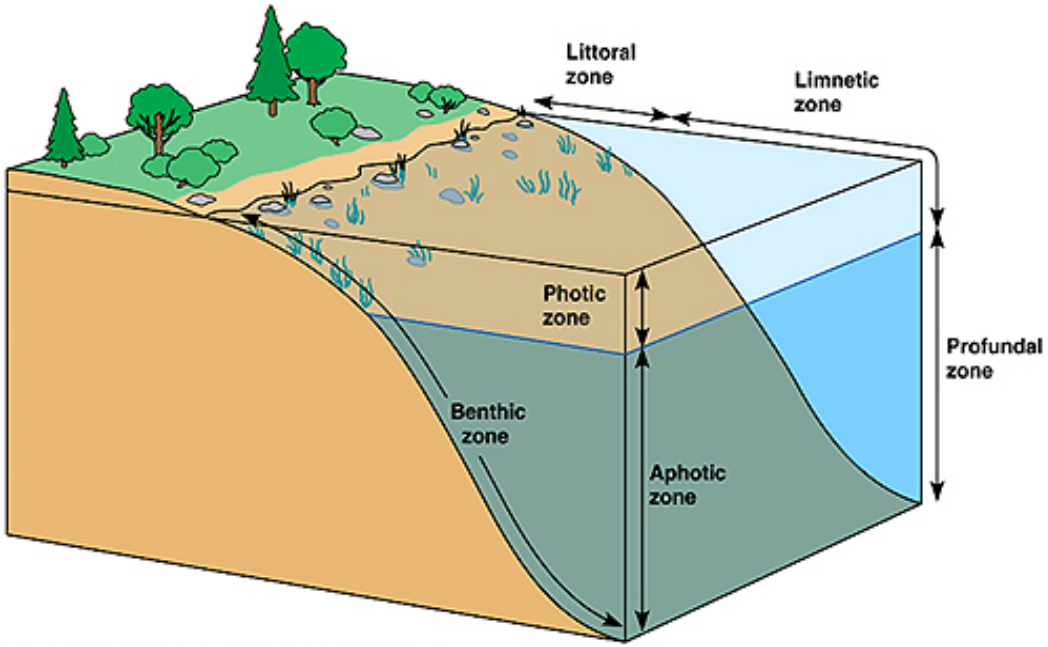
# Names of Regions within Marine & Lake Environments

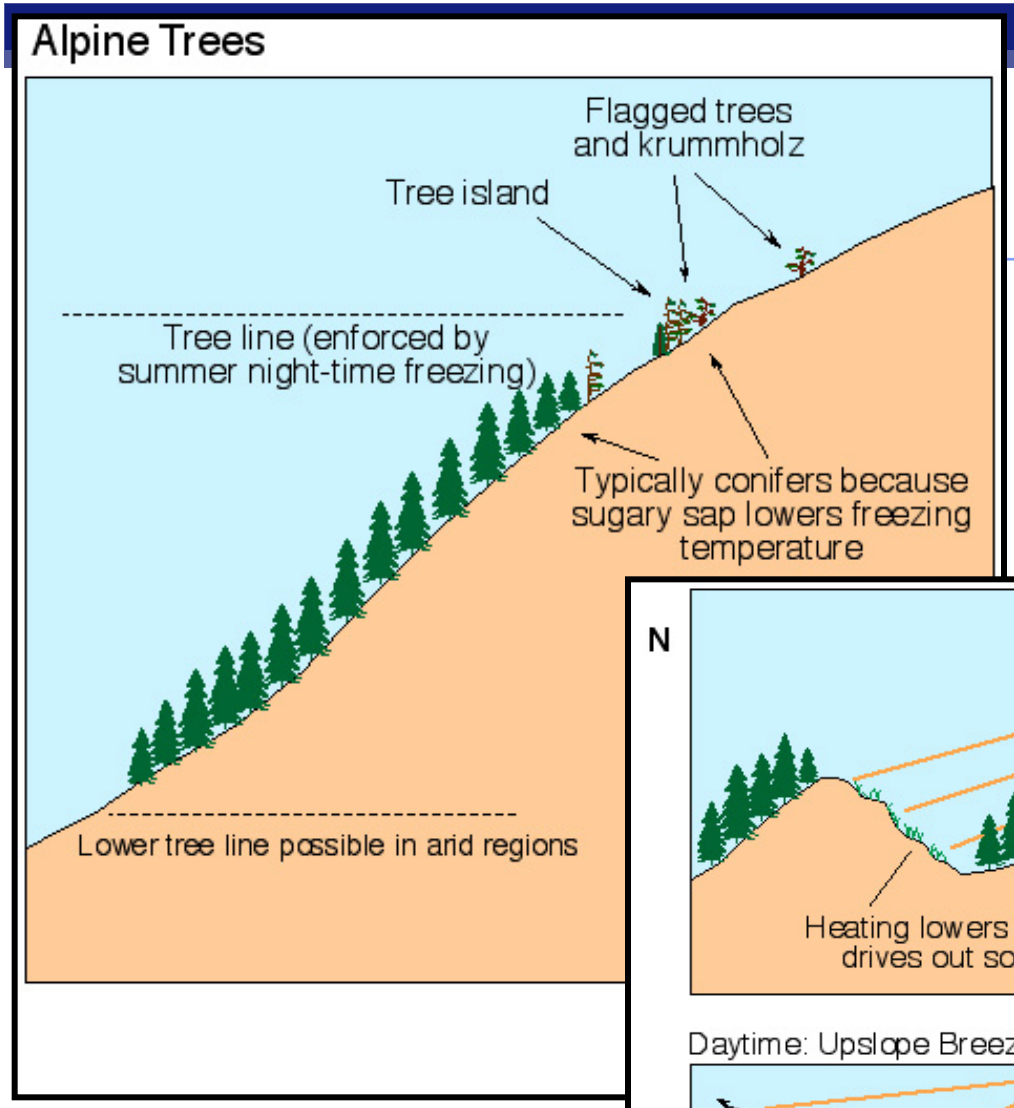
## Marine Zonation





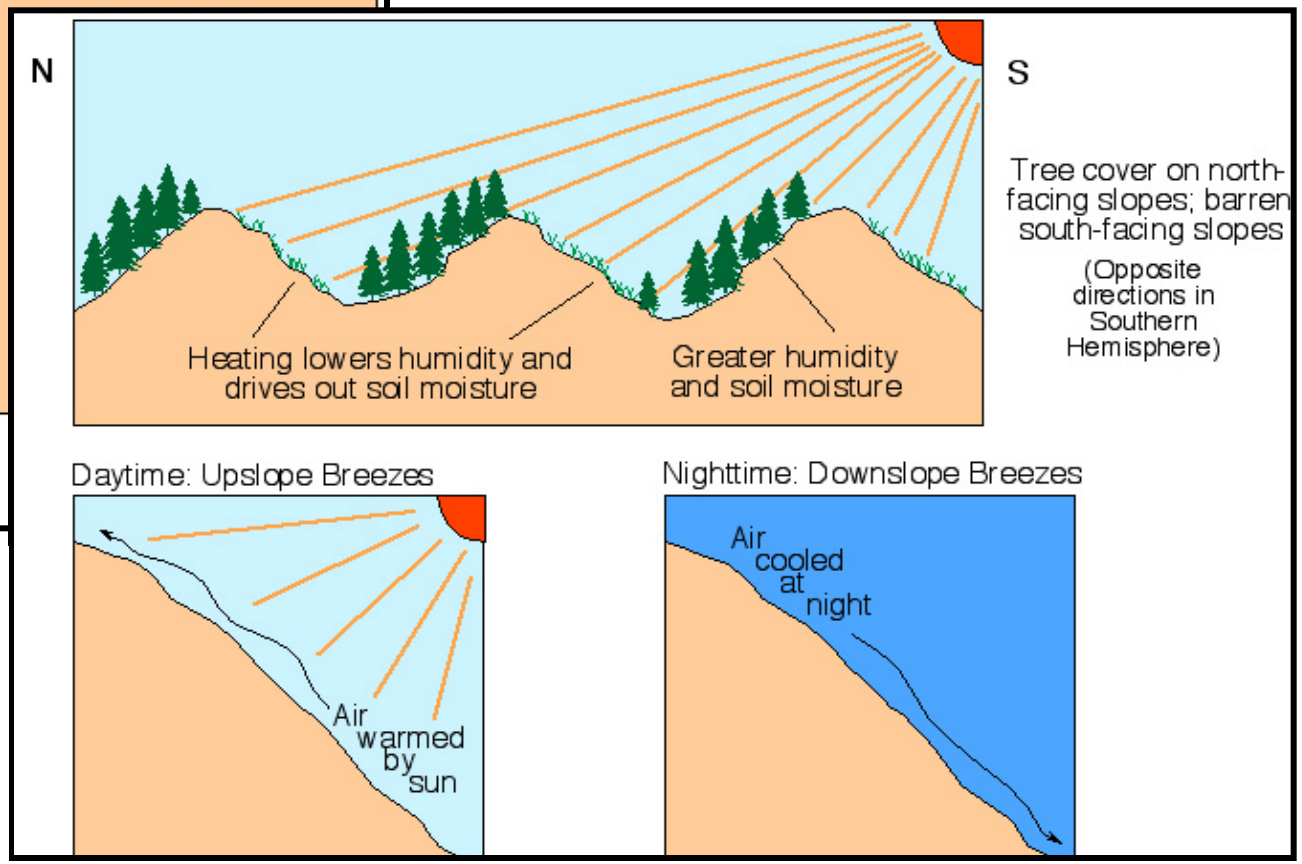

## Lake Zonation





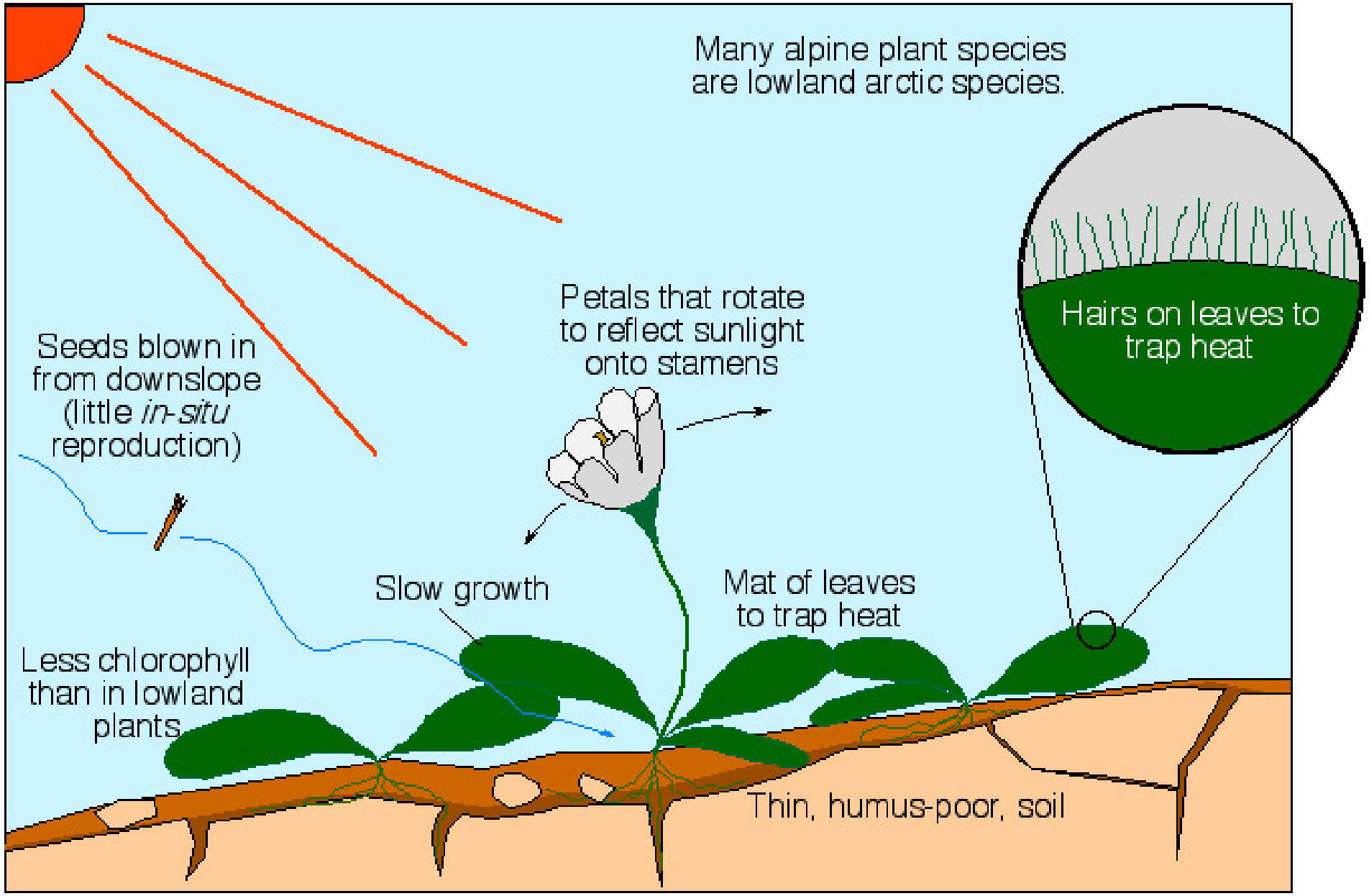

**Alpine regions share similarities with latitudes closer to the poles:**

* **Not a lot of liquid water available** ***(water frozen at certain times)***
* **Cold air temperatures**




**Alpine organisms also are exposed to more <u>DNA-Damaging UV radiation</u>** ***(less atmosphere filtering electromagnetic radiation from above)***

# Common Features of Alpine Plants and Soils

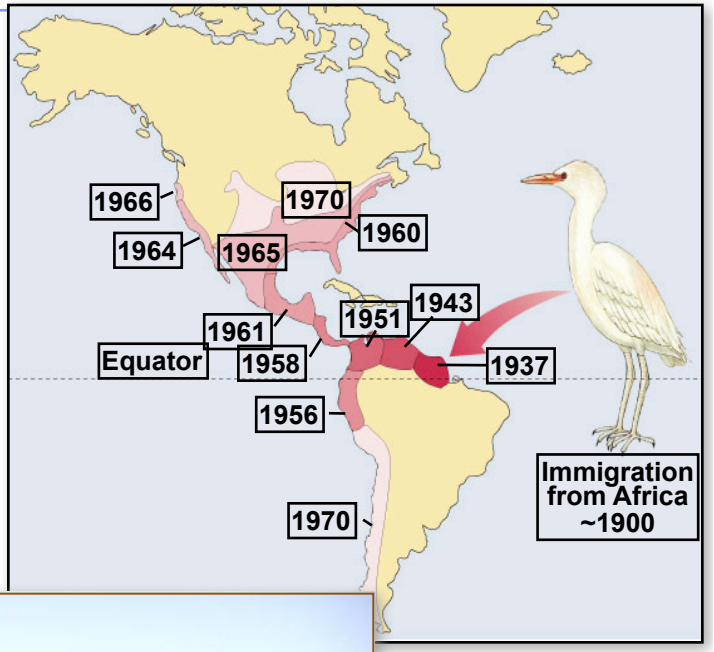


# Factors that affect Population Size

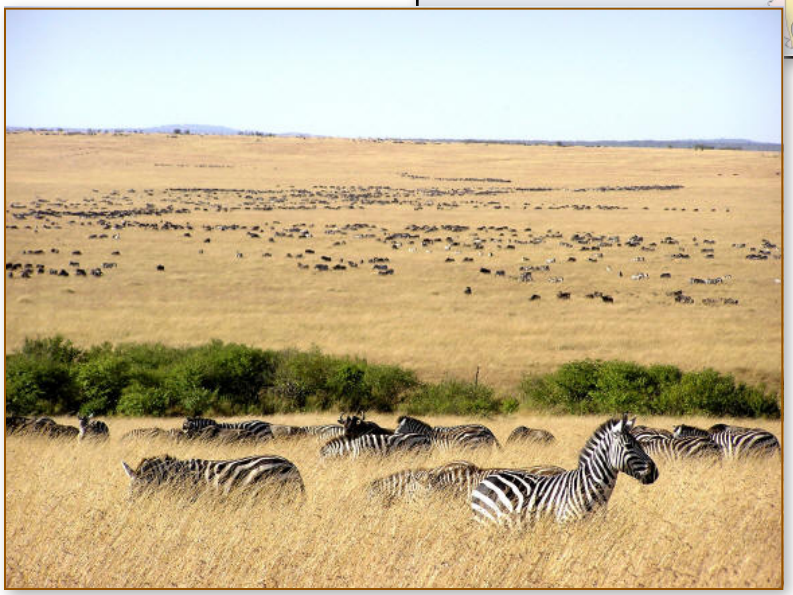
- **Biotic factors**
  - involves other living organisms (from same or other species)
    - prey (food)
    - competitors
    - Predators & Herbivores
      - Organisms that can eat limit the distribution of organisms that get eaten
    - Pollinators
    - Parasites & pathogens
- **Intrinsic factors**
  - Organisms may or may not have adaptations that benefit him in surviving and reproducing

# Characterizing a Population

- **Describing a population**
  1. population **range** (area occupied)
  2. pattern of **spacing**
     - *i.e. population density*
  3. **size** of population (#'s)
  4. **age distribution**




range

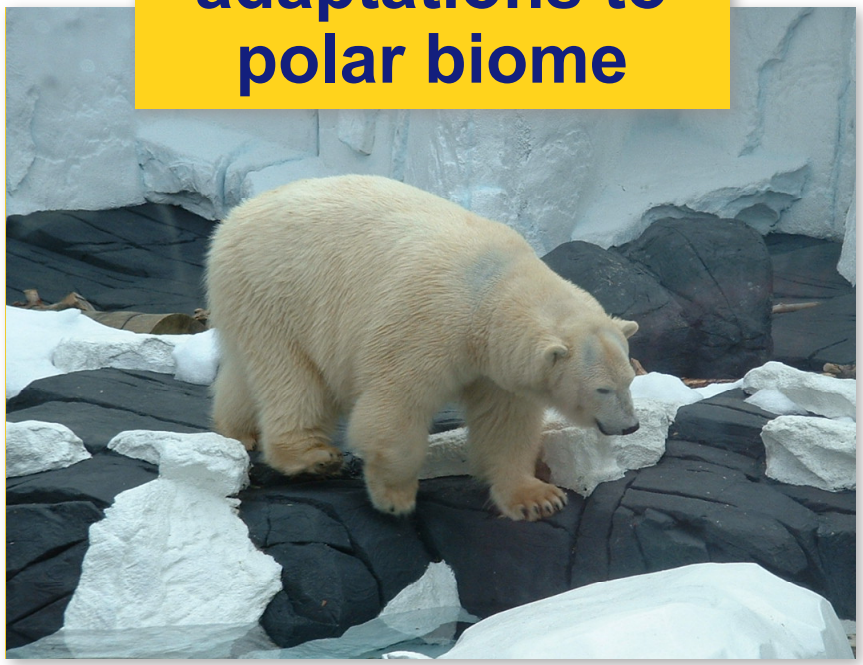


density

# Population Range

- Populations have geographic limitations
  - Determined by abiotic & biotic factors
    - Ex: temperature ranges, rainfall amounts, availability of nutrients (“food”)and other resources and, presence of predators, etc.
      - The location in which an organism lives can alsobe referred to as its habitat

adaptations to polar biome

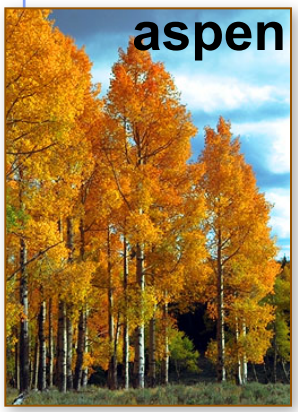


adaptations to rainforest biome

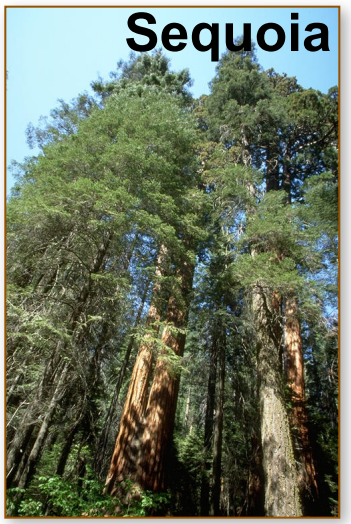
AP

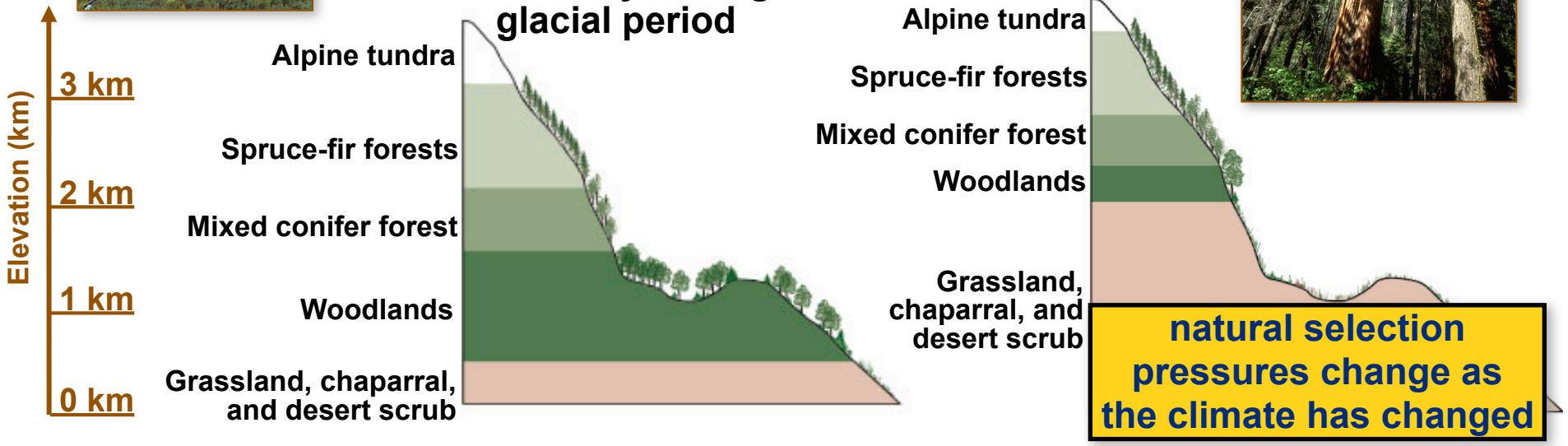
# Changes in range

- **Range expansions & contractions can occur**
  - **As the biotic and abiotic environmental variables change over time**



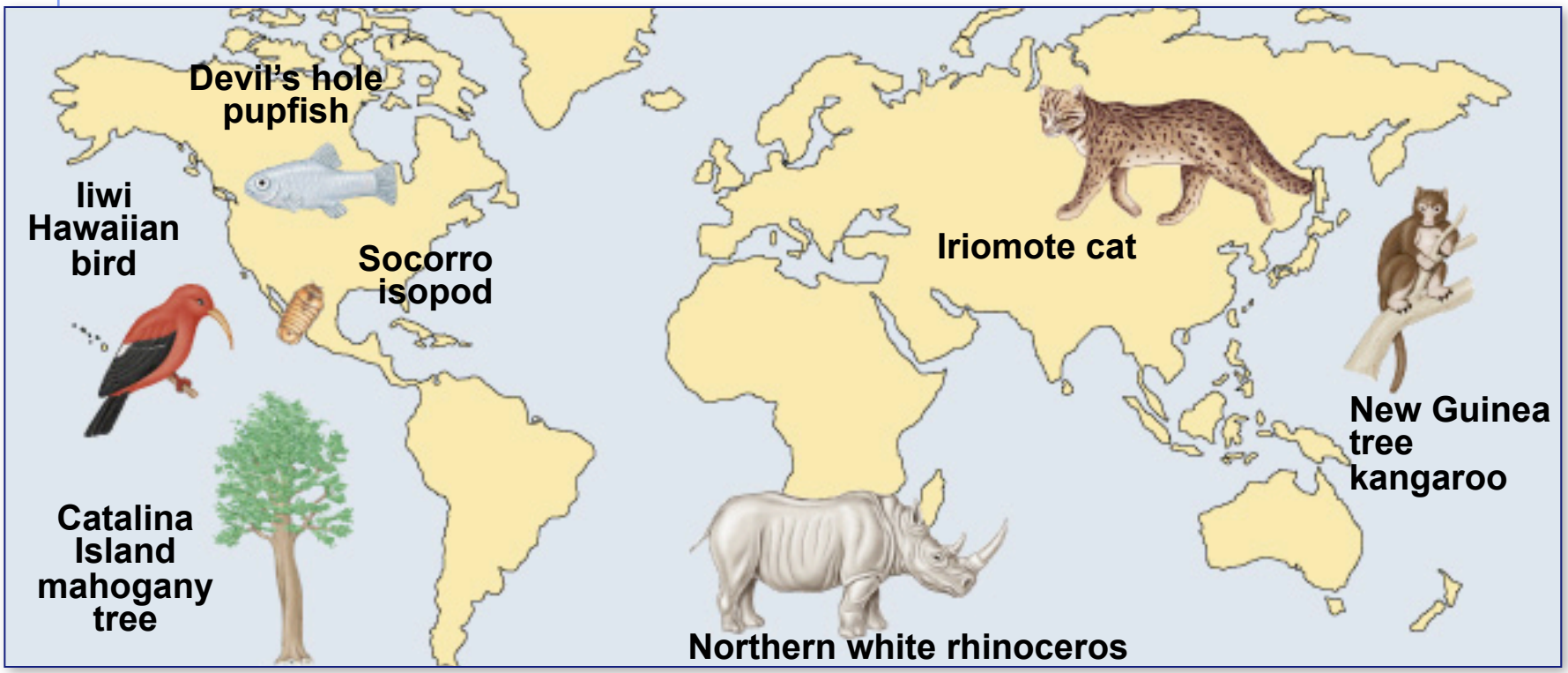


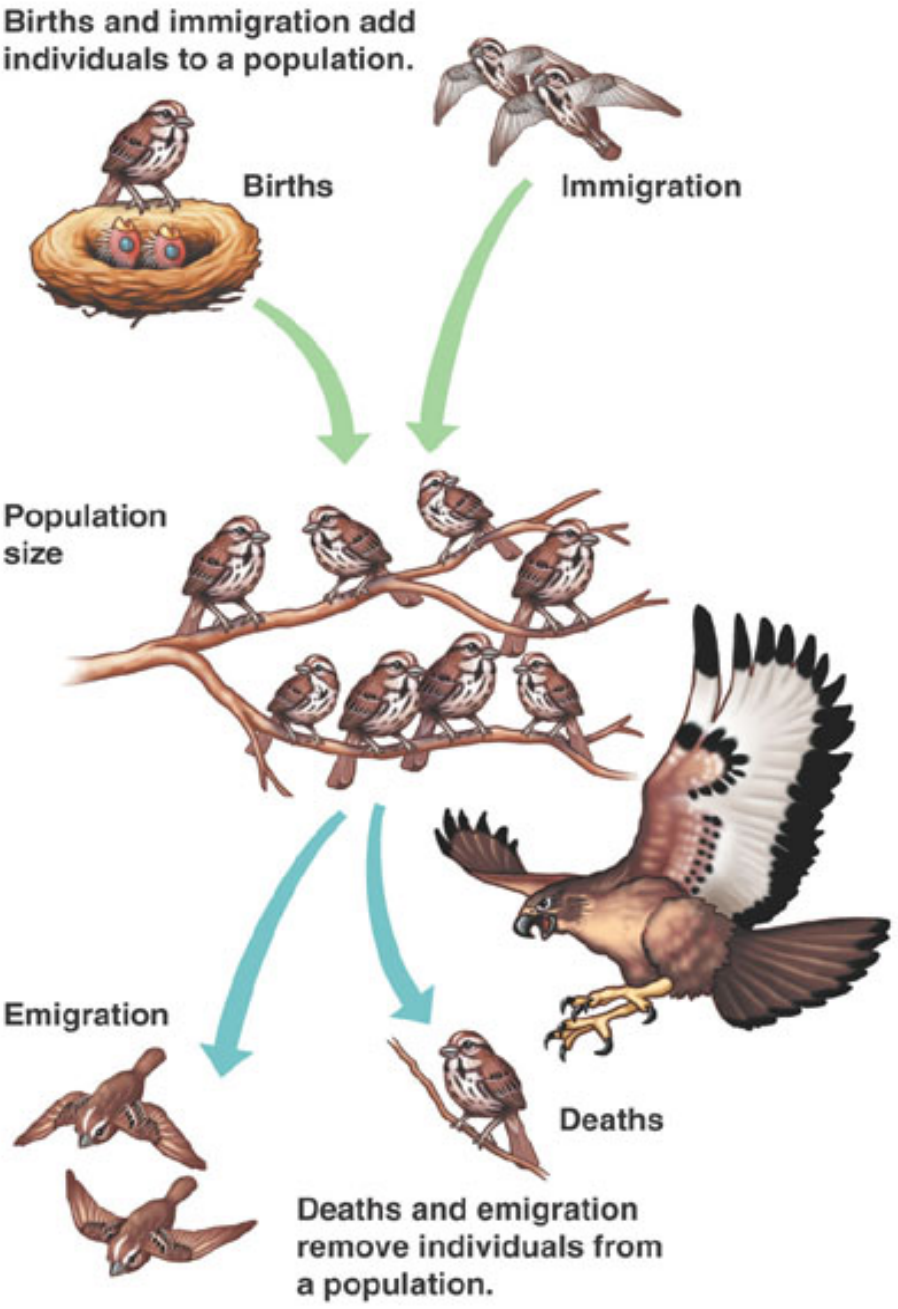
# At risk populations

- **Endangered species**
  - There are limitations to the habitat an organism can occupy
    - Places species at risk of extinction when they can no longer survive and reproduce
      - It isn't impossible for them to always move into new areas or change the biotic &abiotic factors they rely on for survival



# Population Size

- Changes to population size
  - adding & removing individuals from a population
    - birth & immigration
    - death & emigration



# Population growth rates

- **Factors affecting population growth rate**
  - **sex ratio**
    - how many females vs. males?
  - **generation time**
    - at what age do females reproduce?
  - **age structure**
    - how many females at reproductive age in cohort?

**Why do teenage boys pay high car insurance rates?**

# Demography

- **Demography involves studying vital statistics that affect population growth and decline, and how they change over time**
  - **Life tables = age-specific summaries of the survival pattern of a population - Follow the fate of a cohort, a group of individuals of the same age from birth to death**
    - **The data includes determining the # of individuals that die in each age group and proportion surviving from one age to next**

**Life table**

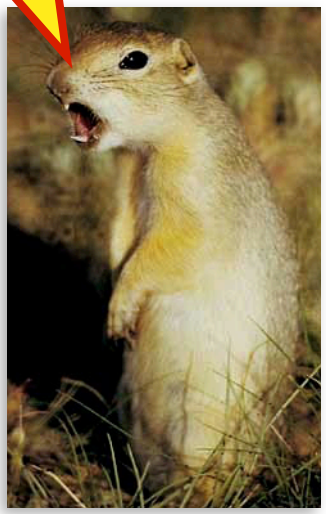
**Table 52.1 Life Table for Belding Ground Squirrels (*Spermophilus beldingi*) at Tioga Pass, in the Sierra Nevada Mountains of California***

| Age (years) | females: Number Alive at Start of Year | females: Proportion Alive at Start of Year | females: Number of Deaths During Year | females: Death Rate† | females: Average Life Expectancy (years) | males: Number Alive at Start of Year | males: Proportion Alive at Start of Year | males: Number of Deaths During Year | males: Death Rate† | males: Life Expectancy (years) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–1 | 337 | 1.000 | 207 | 0.61 | 1.33 | 349 | 1.000 | 227 | 0.65 | 1.07 |
| 1–2 | 252†† | 0.386 | 125 | 0.50 | 1.56 | 248†† | 0.350 | 140 | 0.56 | 1.12 |
| 2–3 | 127 | 0.197 | 60 | 0.47 | 1.60 | 108 | 0.152 | 74 | 0.69 | 0.93 |
| 3–4 | 67 | 0.106 | 32 | 0.48 | 1.59 | 34 | 0.048 | 23 | 0.68 | 0.89 |
| 4–5 | 35 | 0.054 | 16 | 0.46 | 1.59 | 11 | 0.015 | 9 | 0.82 | 0.68 |
| 5–6 | 19 | 0.029 | 10 | 0.53 | 1.50 | 2 | 0.003 | 0 | 1.00 | 0.50 |
| 6–7 | 9 | 0.014 | 4 | 0.44 | 1.61 | 0 | | | | |
| 7–8 | 5 | 0.008 | 1 | 0.20 | 1.50 | | | | | |
| 8–9 | 4 | 0.006 | 3 | 0.75 | 0.75 | | | | | |
| 9–10 | 1 | 0.002 | 1 | 1.00 | 0.50 | | | | | |

*Males and females have different mortality schedules, and they are tabulated separately.
†The death rate is the proportion of individuals dying in a specific time interval.
††Includes 122 females and 126 males first captured as one-year-olds and therefore not included in the count of squirrels age 0–1.

SOURCE: Data from P. W. Sherman and M. L. Morton, "Demography of Belding's Ground Squirrel," *Ecology* 65(1984): 1617–1628.

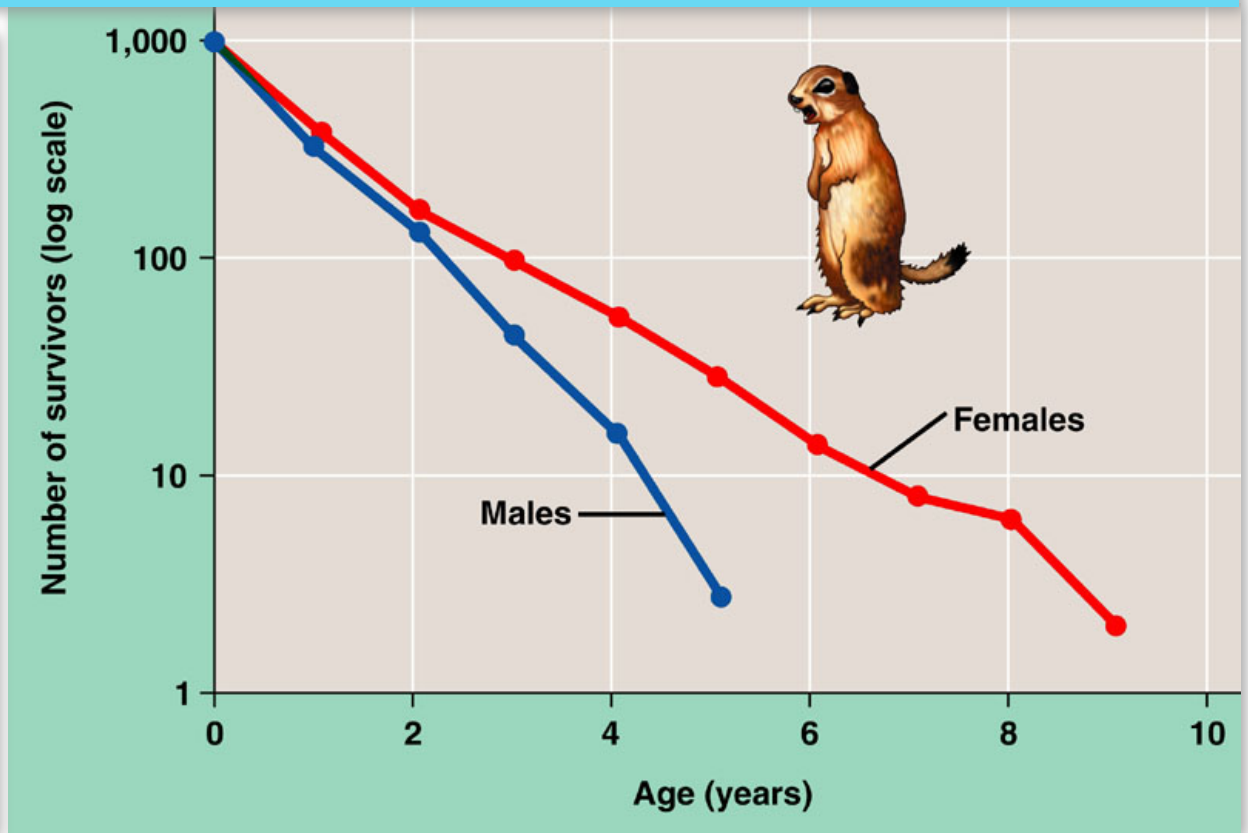
What adaptations have led to this difference in male vs. female mortality?



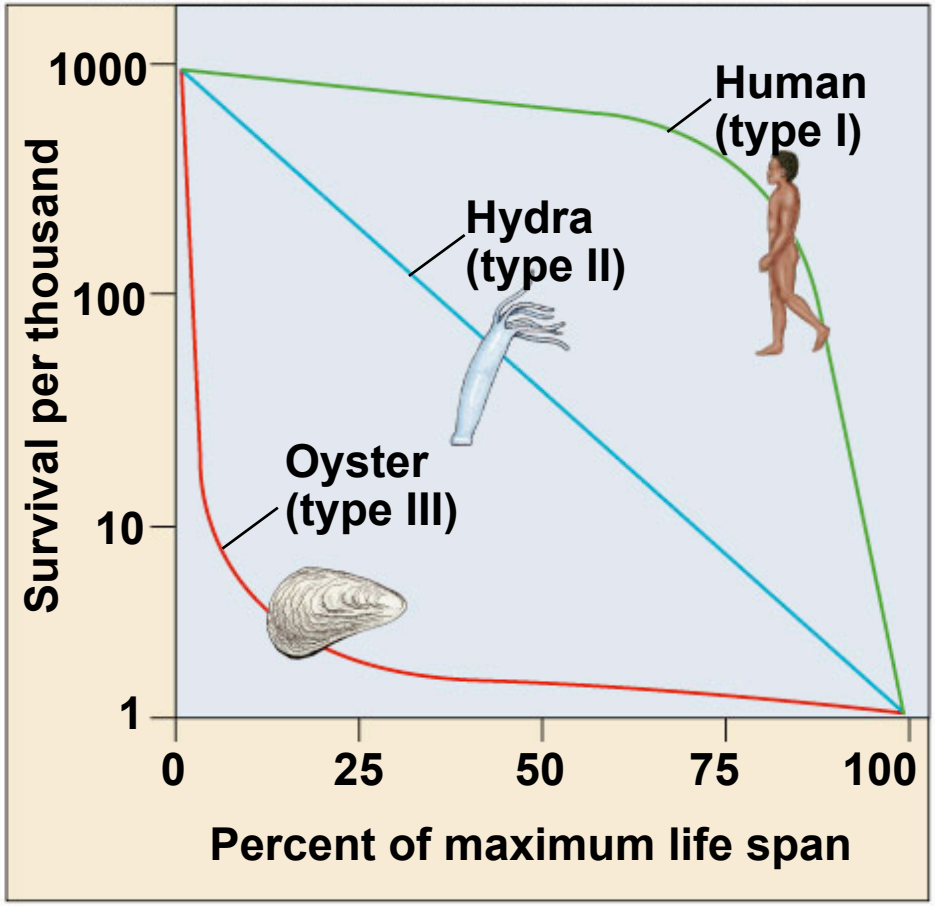
# Survivorship curves

- **Graphic representation of life table**
  - Shows number or proportion of individuals still alive at each age

**The relatively straight lines of the plots indicate relatively constant rates of death throughout a lifetime; however, males have a lower survival rate overall than females Belding ground squirrels have.**

# Survivorship Curves: Type I, II, II




**What do these graphs tell about survival & strategy of a species?**

I. **High death rate in post-reproductive years. Produce few offspring but provide them with good care.**

II. **Constant mortality rate throughout life span. Rodents, various invertebrates, some lizards, and some annual plants.**

III. **Very high early mortality but the few survivors then live long (stay reproductive). Produce very large numbers of offspring but provide little or no care, such as long–lived plants, many fishes, and marine invertebrates.**

**Crabs: May show stair-stepped curve: brief periods of increased mortality during molts and lower mortality with hard exoskeleton**

# Trade-offs: survival vs. reproduction

- **The energy cost of reproduction**
  - **increase reproduction may decrease parental survival so natural selection influences:**
    - **age at first reproduction**
    - **amount of parental care invested per offspring**
    - **number of reproductive cycles per lifetime of parent**
    - **Clutch or litter size per reproductive event, number of seeds produced etc…**

**Natural selection favors a life history that maximizes lifetime reproductive success for that species.**

# Parental survival

## Kestrel Falcons:

### The cost of larger broods to both male & female parents

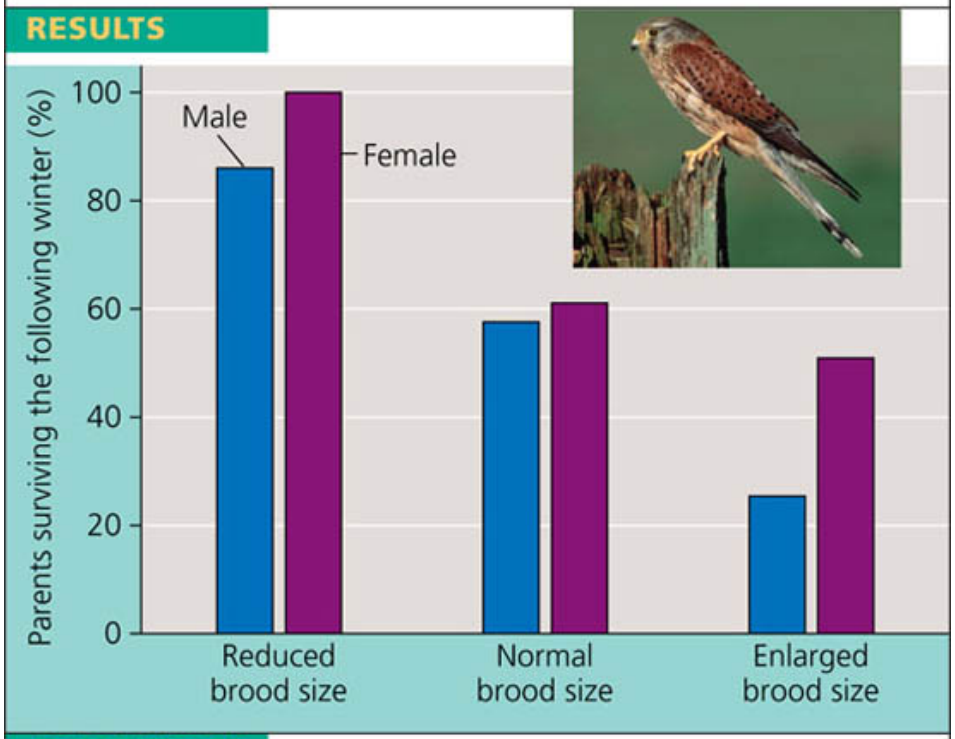
Figure 52.7

**Inquiry** How does caring for offspring affect parental survival in kestrels?

**EXPERIMENT**

Researchers in the Netherlands studied the effects of parental caregiving in European kestrels over 5 years. The researchers transferred chicks among nests to produce reduced broods (three or four chicks), normal broods (five or six), and enlarged broods (seven or eight). They then measured the percentage of male and female parent birds that survived the following winter. (Both males and females provide care for chicks.)

**RESULTS**




**CONCLUSION**

The lower survival rates of kestrels with larger broods indicate that caring for more offspring negatively affects survival of the parents.

# Different life history strategies

- **Where survival rate of offspring is low Big-Bang reproduction (semelparity) is favored**
  - **Natural Selection favors this reproductive strategy of having only one reproductive cycle in a lifetime in variable or unpredictable environments**
    - **Adults are less likely to survive to reproduce another time again so those with highest biological fitness spend a lot of energy producing as many offspring as possible in one reproductive cycle**
    - **Offspring often small and plentiful**
    - **Parents provide little to no parental care (they may not survive long to do so either)**
    - **Most offspring do not survive initially but a few hopefully do**
    - **Resources are plentiful, enough to support many offspring**

# Different life history strategies

- **Where survival rate of offspring is high Repeated Reproduction (iteroparity) is favored**
  - **Natural Selection favors this reproductive strategy of having multiple reproductive cycles in a lifetime in stable environments**
    - **Adults more likely to survive to breed again so they do not have to put all their energy into one reproductive cycle**
    - **Competition for resources are intense so if large numbers of offspring are produced, most would not survive**
    - **Small number of offspring produced per reproductive cycle**
    - **Parent spends energy providing parental care to maximize offspring survival rate**
    - **Fewer, but larger, well-provided for offspring have better chance of surviving until they are capable of reproducing**