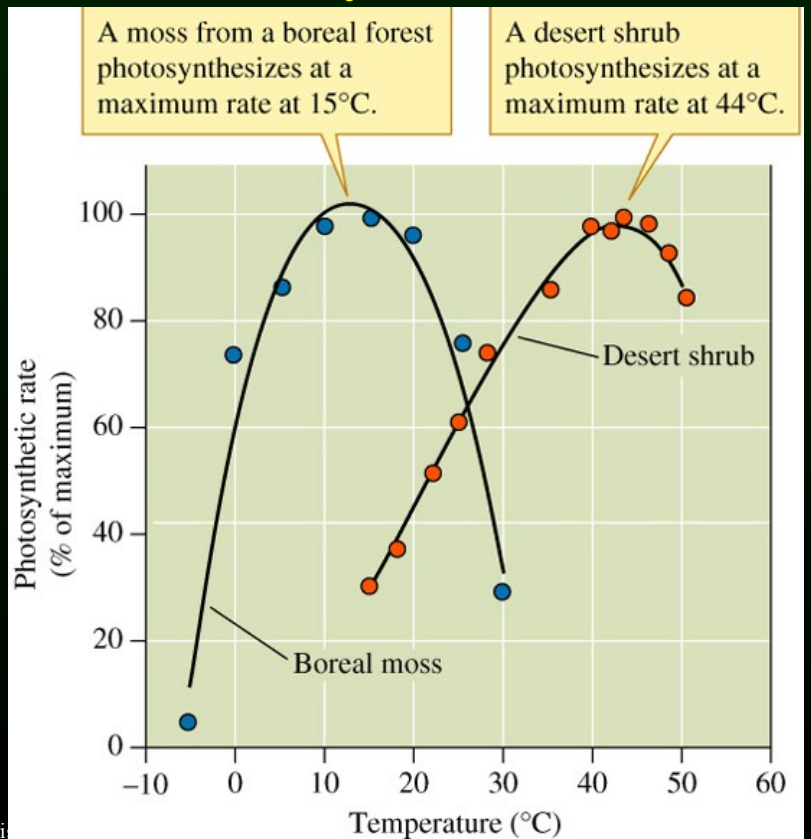
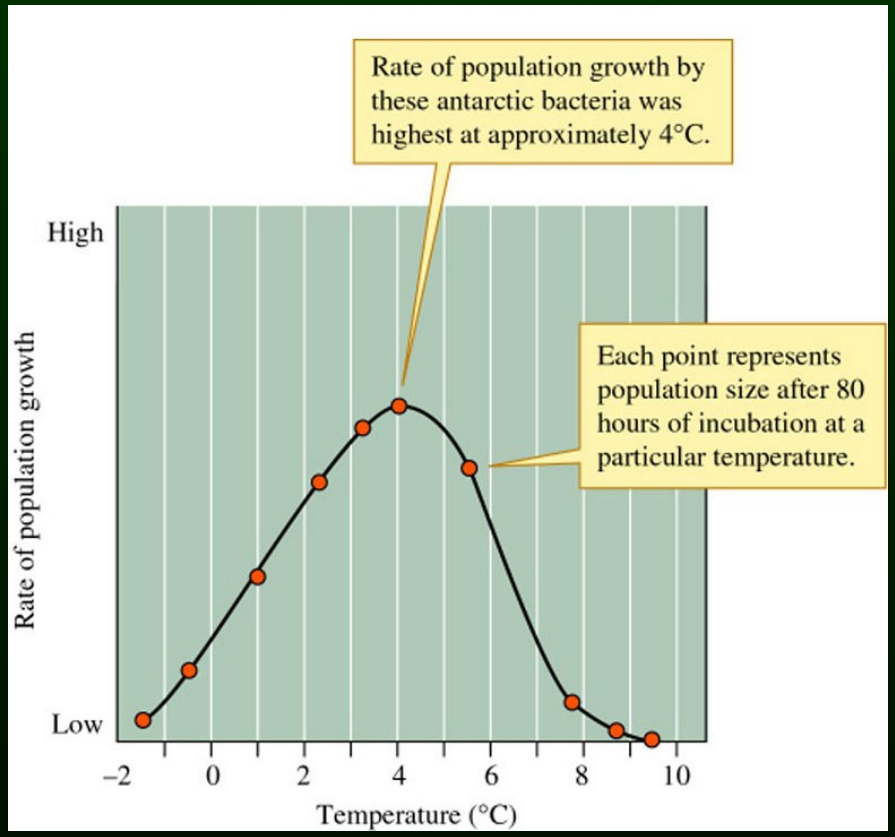
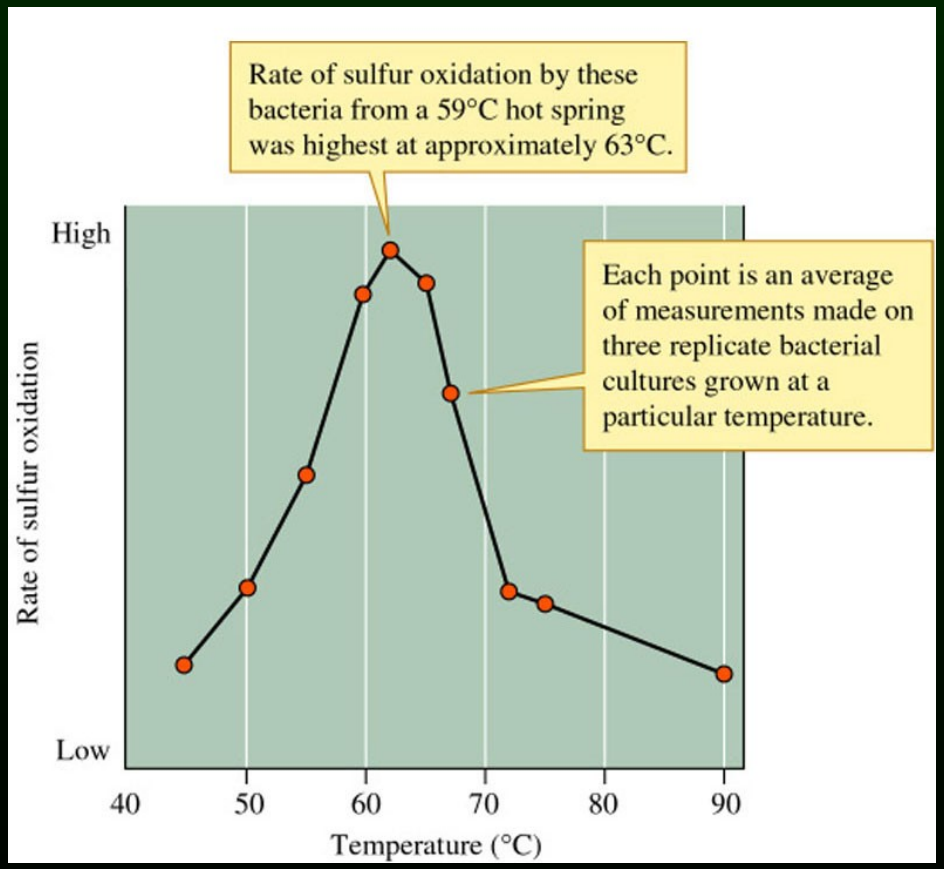
Organisms Interacting with their Environment
Temperature & Water Relations
Chapters 5 & 6

Most species perform best in a fairly narrow range of temperatures



Optimal Growth Temperatures





Some bacteria are psychrophilic, some are thermophilic

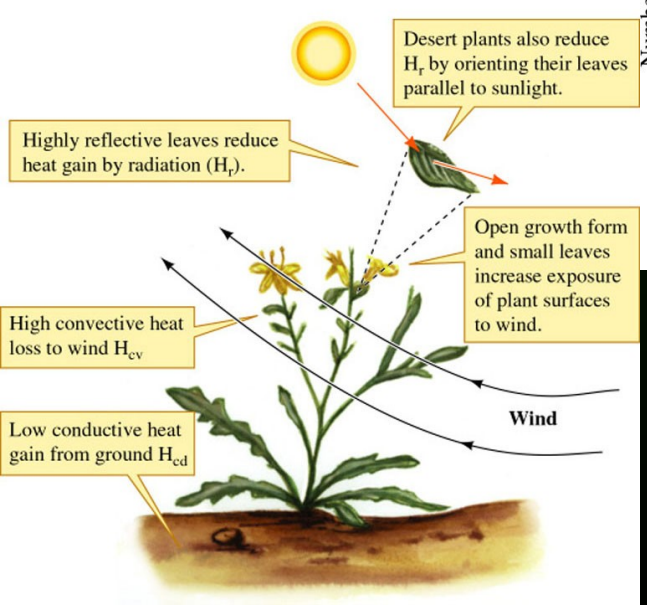
Body Temperature Regulation

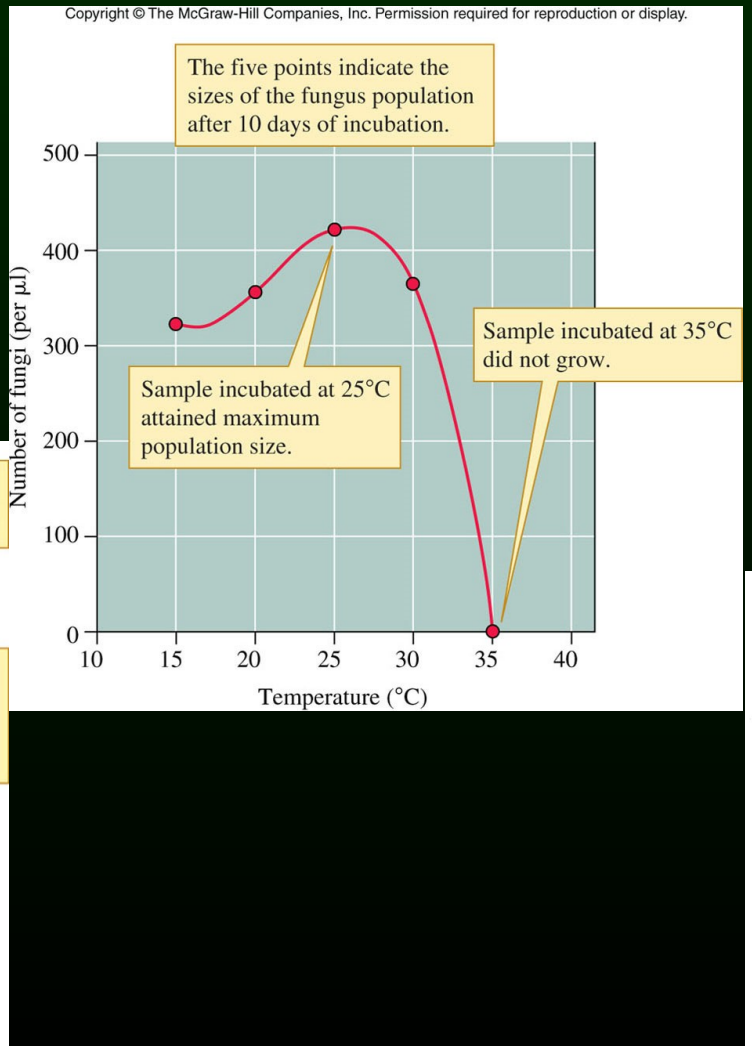
- Poikilotherms
  - Body temperature varies directly with environmental temperature.
- Ectotherms
  - Rely mainly on external energy sources.
- Endotherms
  - Rely heavily on metabolic energy.
    - Homeotherms maintain a relatively constant internal environment.

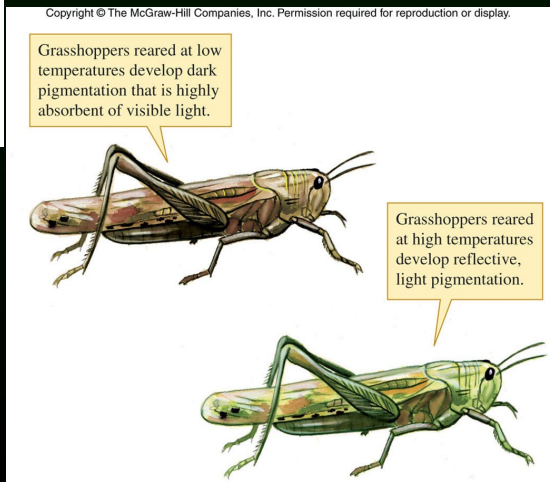
Temperature Regulation by Plants & Ectothermic Animals

Morphology and Behavior play a large role!

Like basking!
Like pigmentation!



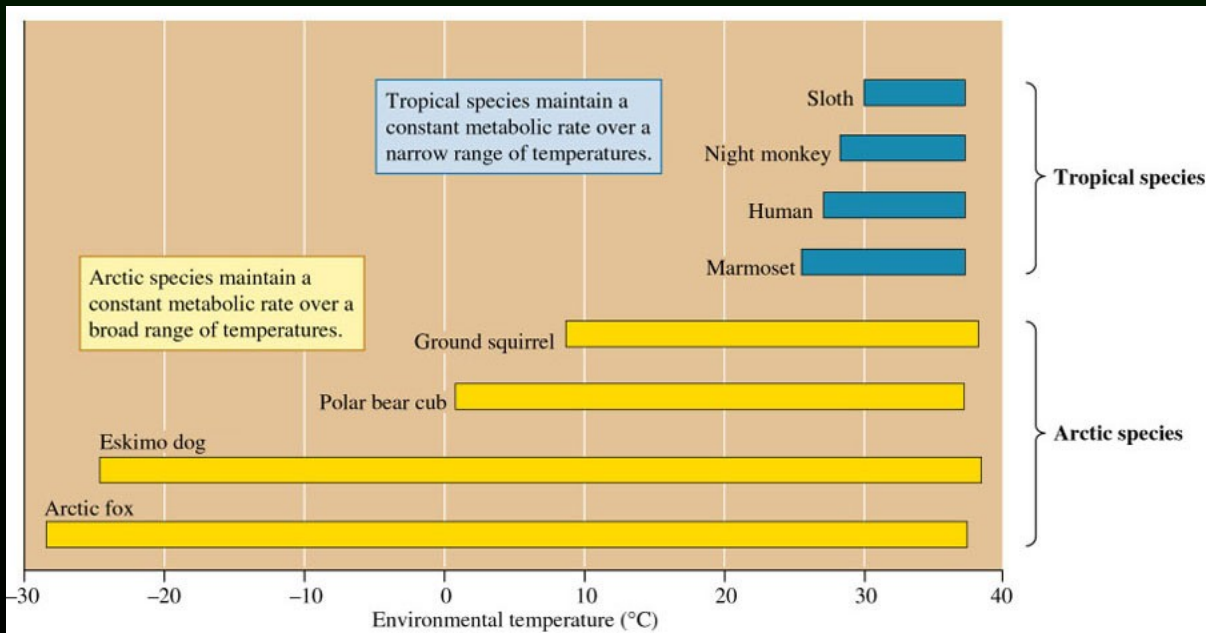




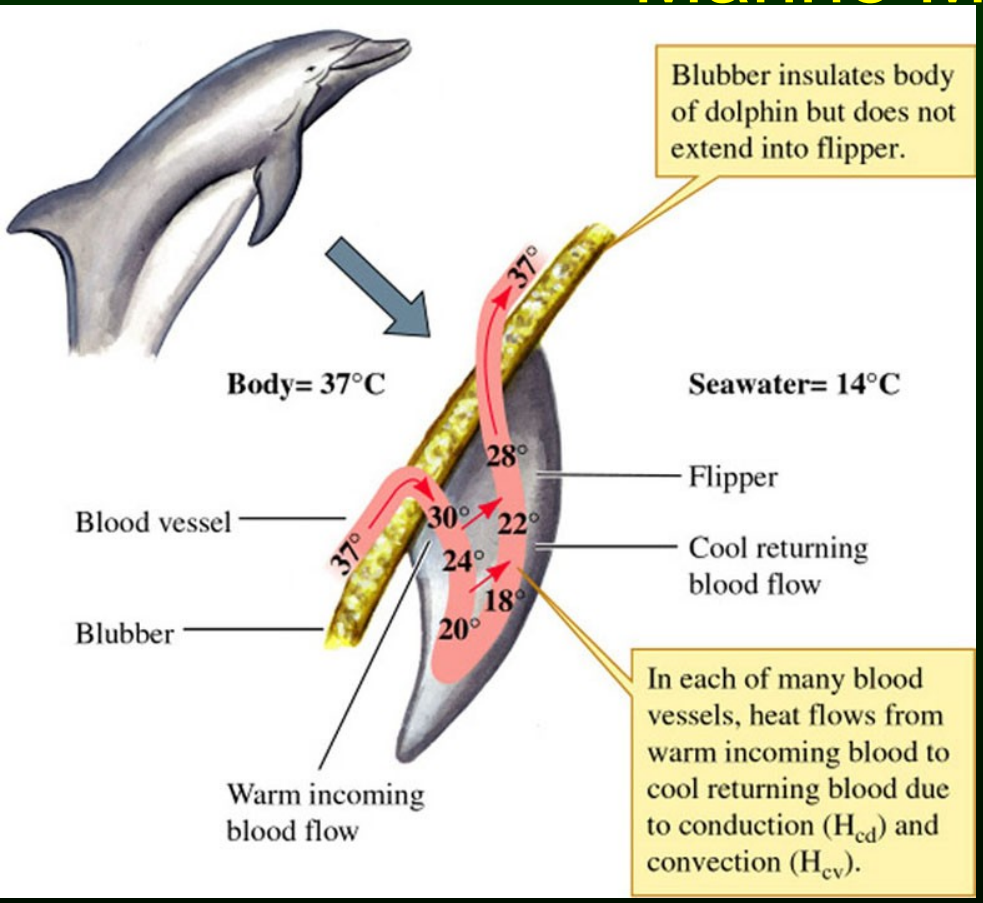
Temperature Regulation by Endothermic Animals

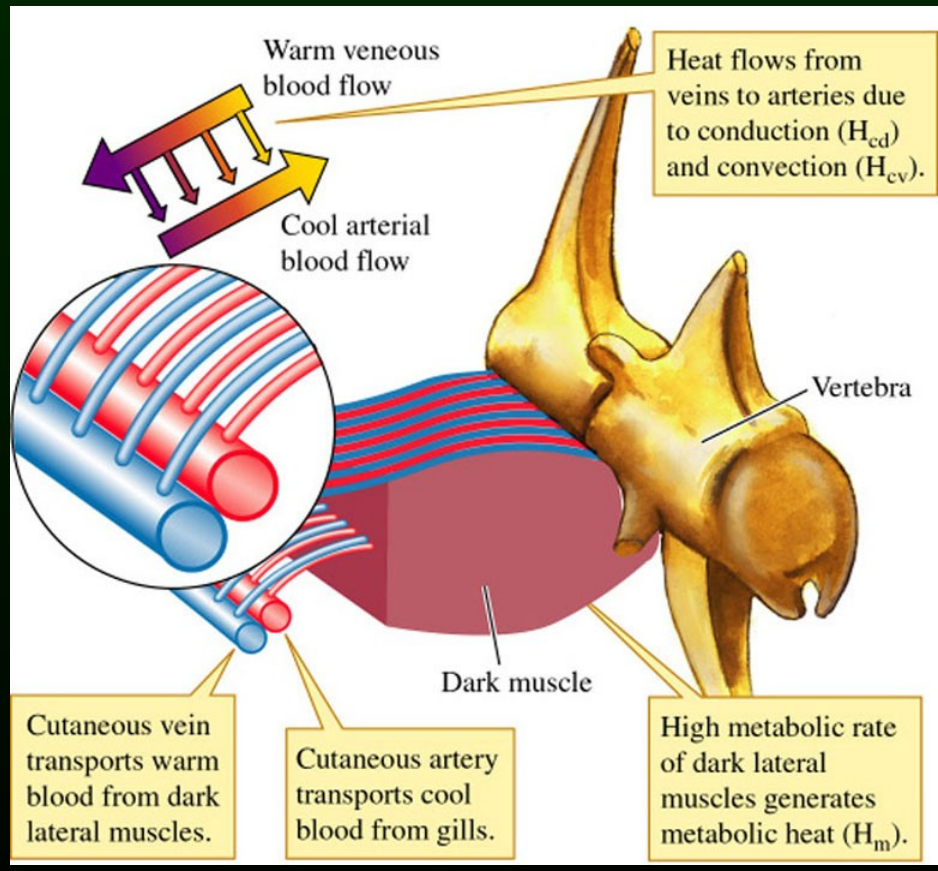
- Thermal neutral zone is the range of environmental temperatures over which the metabolic rate of a homeothermic animal does not change.
  - What happens to you when you go to different temperatures???
  - Breadth varies among endothermic species.

Sweating, shivering, panting, licking



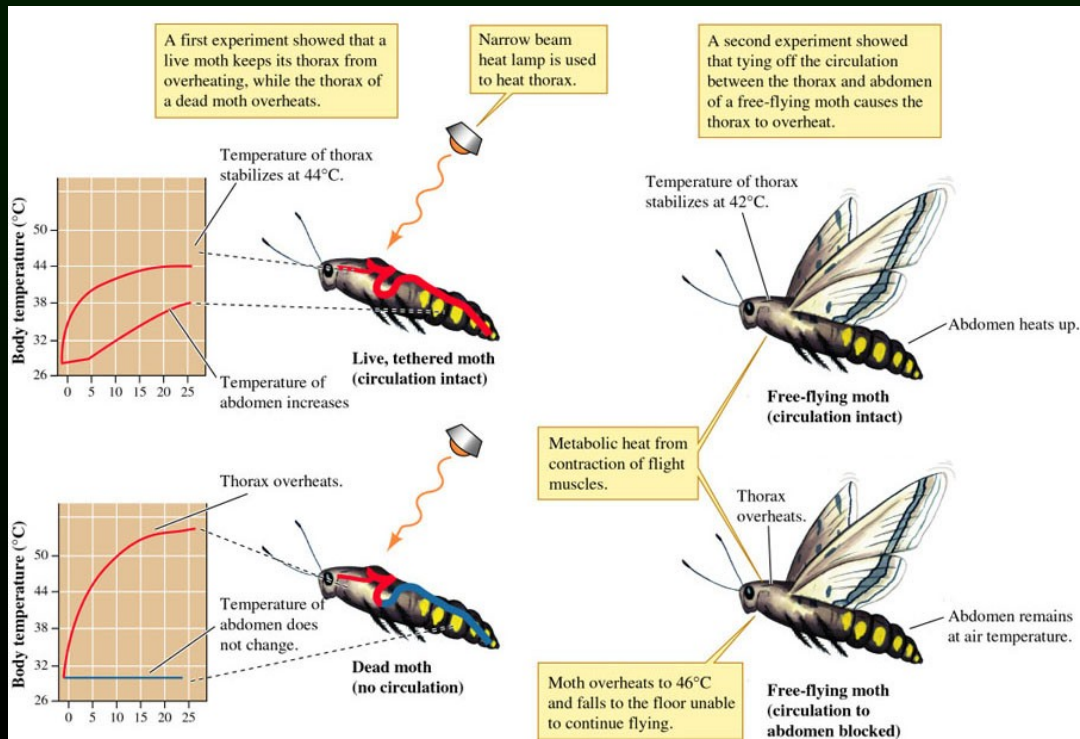
Countercurrent Heat Exchange in Fish & Marine Mammals





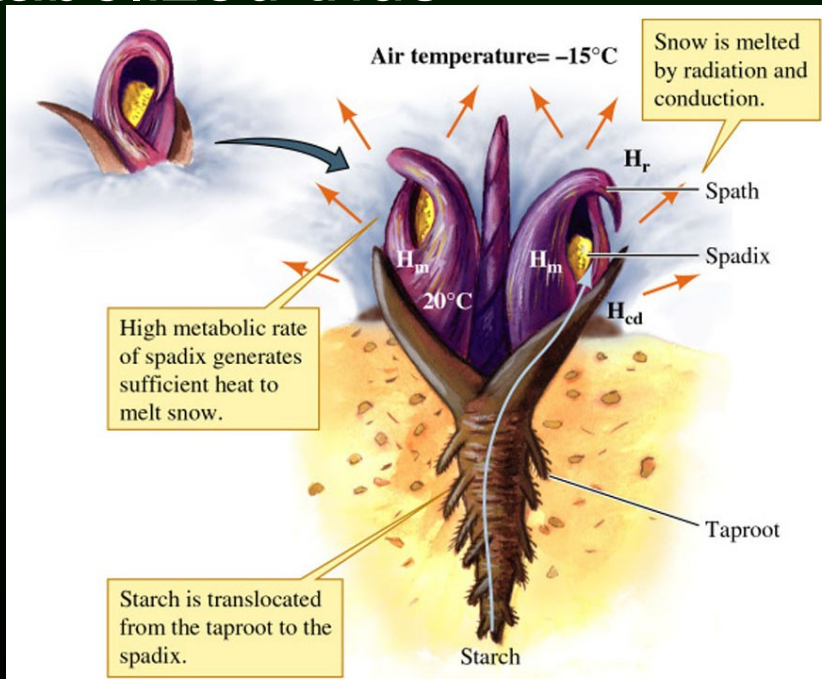
Temperature Regulation by Endothermic Animals

- Even some insects do it!!!
  - Sphinx moths (*Manduca sexta*) increase thoracic temperature due to flight activity.
    - Thermoregulates by transferring heat from the thorax to the abdomen



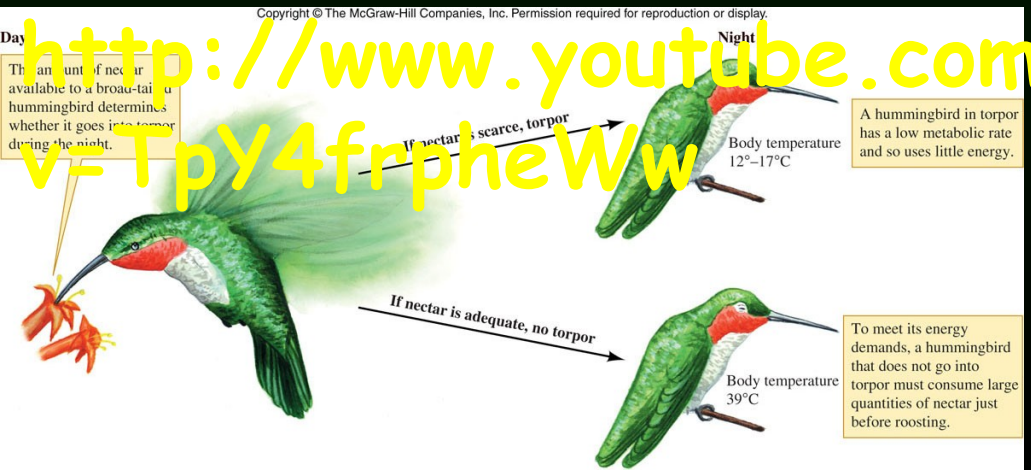
Temperature Regulation by Thermogenic Plants – plants can do it too, but it's rare!!!

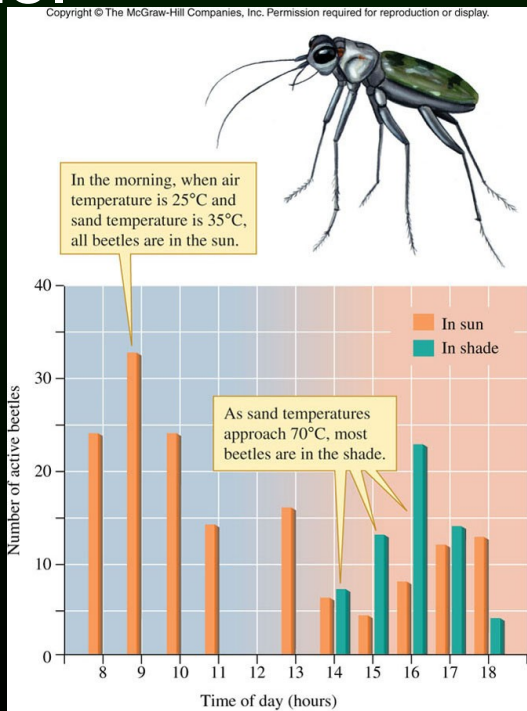
- Almost all plants are poikilothermic ectotherms.
  - Plants in family Araceae use metabolic energy to heat flowers.
  - Skunk Cabbage stores large quantities of starch in large root, and then translocate it to the inflorescence where it is metabolized thus generating heat.



Surviving Extreme Temperatures

- Many organisms survive by entering a resting stage.
  - Inactivity – seek shelter during extreme periods
  - Reducing Metabolic Rate
  - Hummingbirds enter a state of **torpor** when food is scarce and night temps are extreme.
  - Hibernation - Winter
  - Estivation - Summer





Class discussion questions

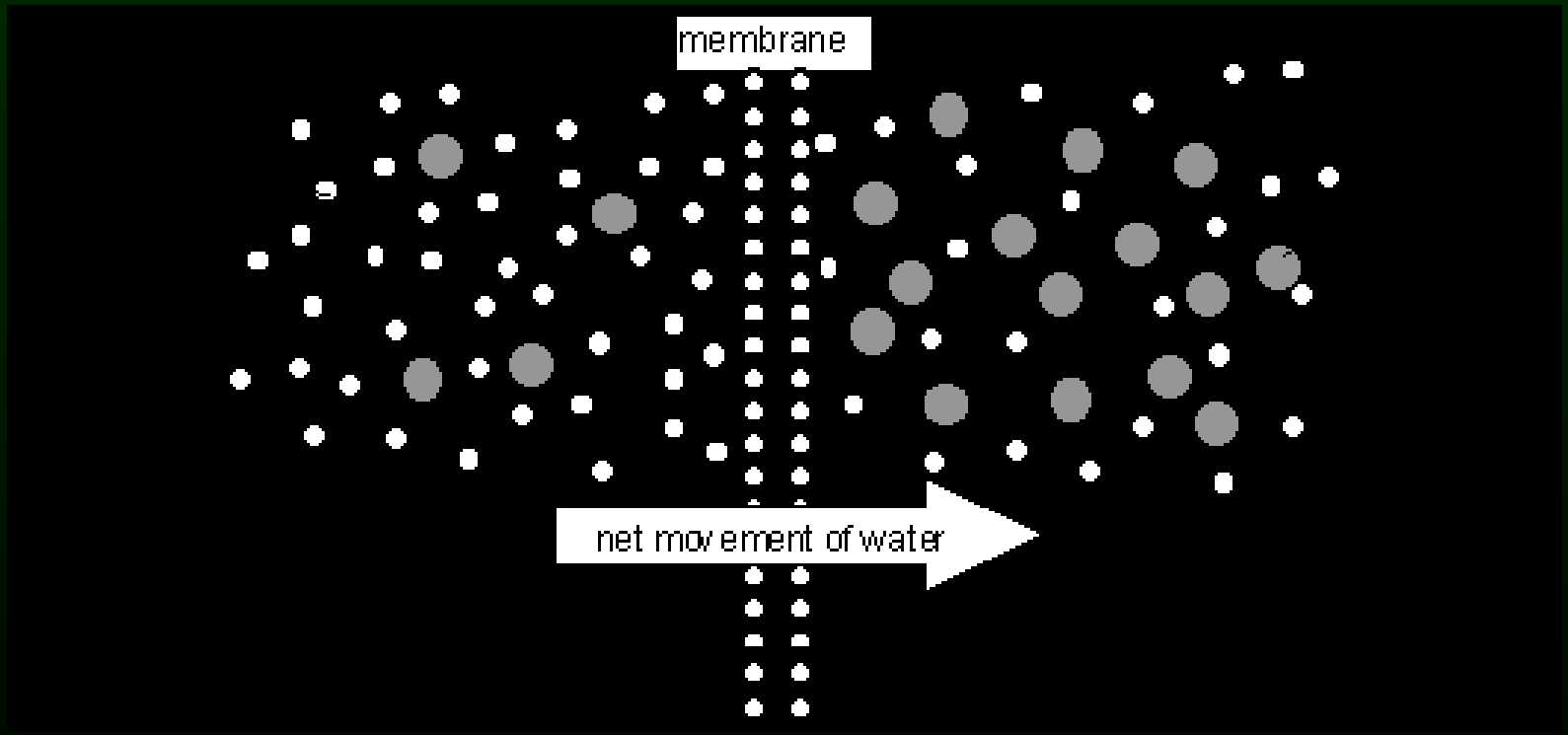
- Why don't organisms hibernate/estivate/go into torpor all the time? They'd save energy that way, right? Why would they not do it?

- Butterflies are ecothermic and are found from the tropics to the Arctic. They can elevate their body temperatures by basking in sunlight. As you go into higher latitudes, how would the basking vs. flying times change? Why?

Water Relations
Chapter 6

Water Availability

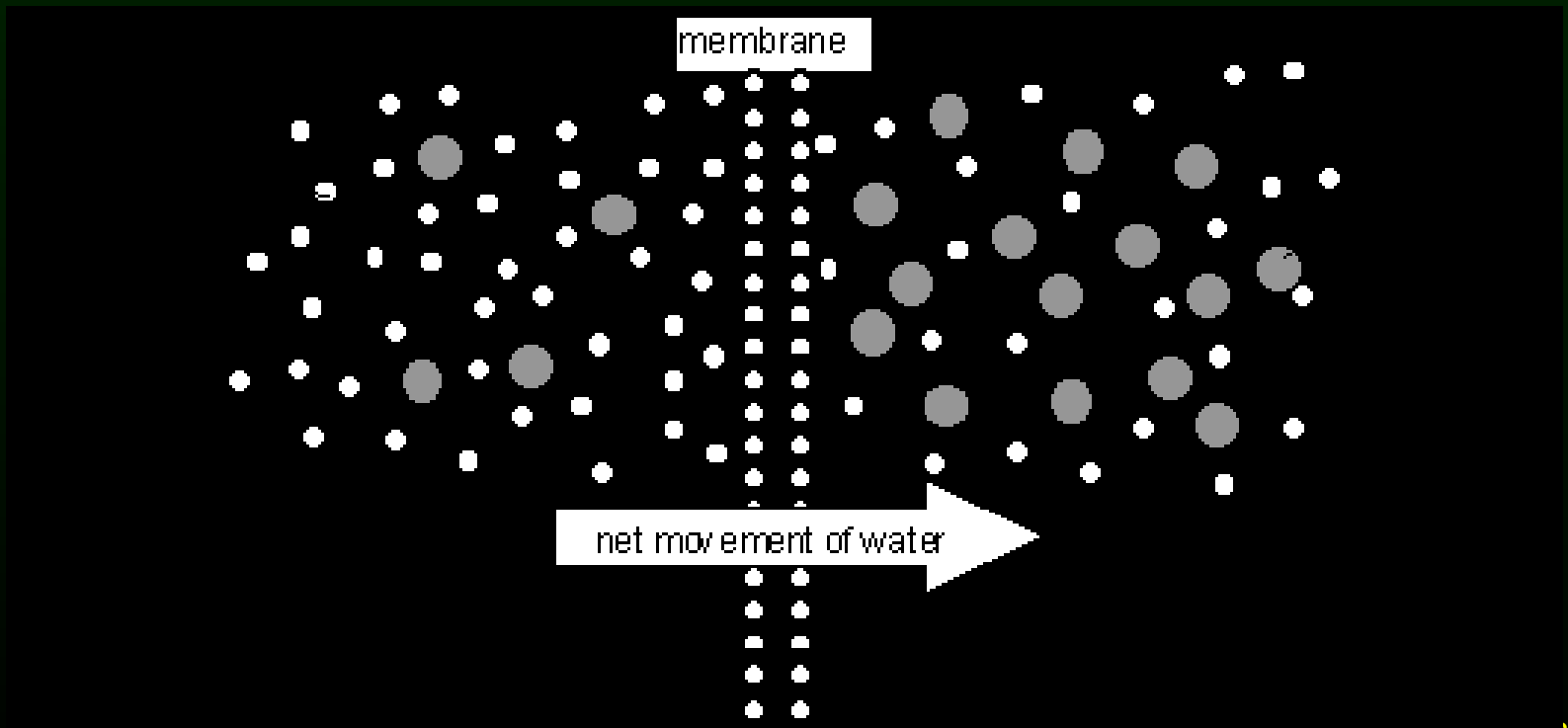
- Concentration gradients influence the movement of water between an organism and its environment



How much water is there in the environment?

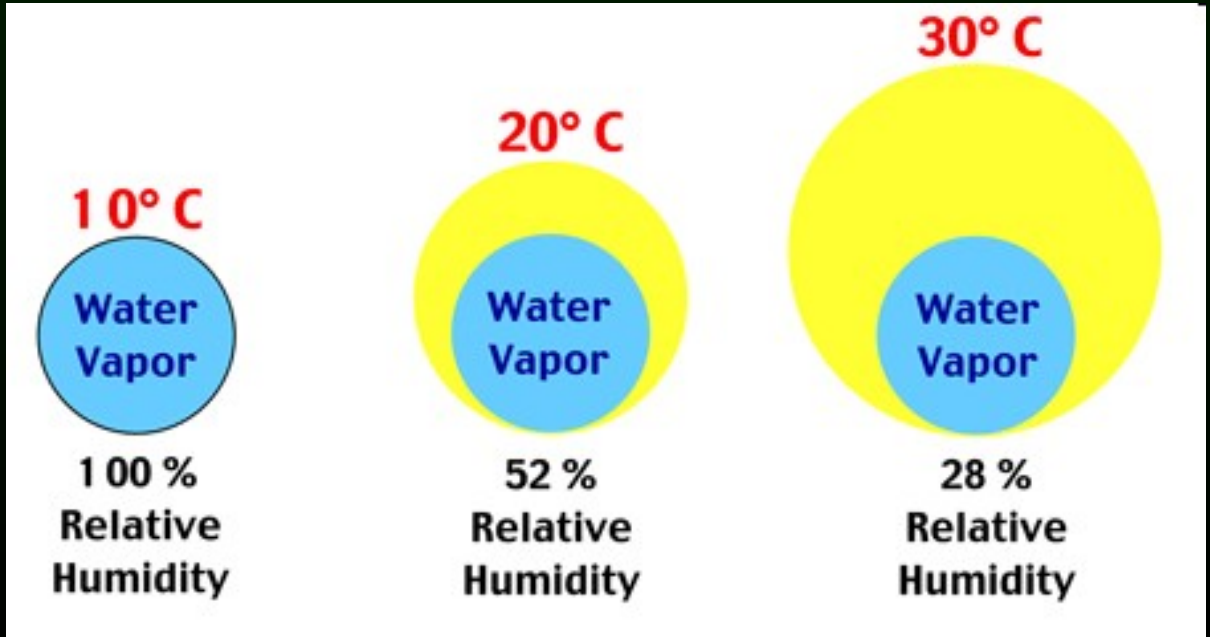
Water Content of Air

- Evaporation accounts for much of water lost by terrestrial organisms.
  - As water vapor in the air increases, the water concentration gradient from organisms to air is reduced, thus evaporative loss is decreased.



Water Content of Air

- Relative Humidity: a measure of water content in the air
  - defined as the amount of water in the air relative to the saturation amount the air can hold at a given temperature multiplied by 100.
  - Air with a relative humidity of 50% contains half of the water vapor it could hold at a particular temperature.



$$\text{Relative humidity} = \frac{\text{Water vapor density}}{\text{Saturation water vapor density}} \times 100$$

mg H_2O/liter of air

- the amount of water in the air relative to the saturation amount the air can hold at a given temperature multiplied by 100.

Let's do a problem!!!

- If there is 20 mg of water in air that can hold 50 mg of water, what's the relative humidity?

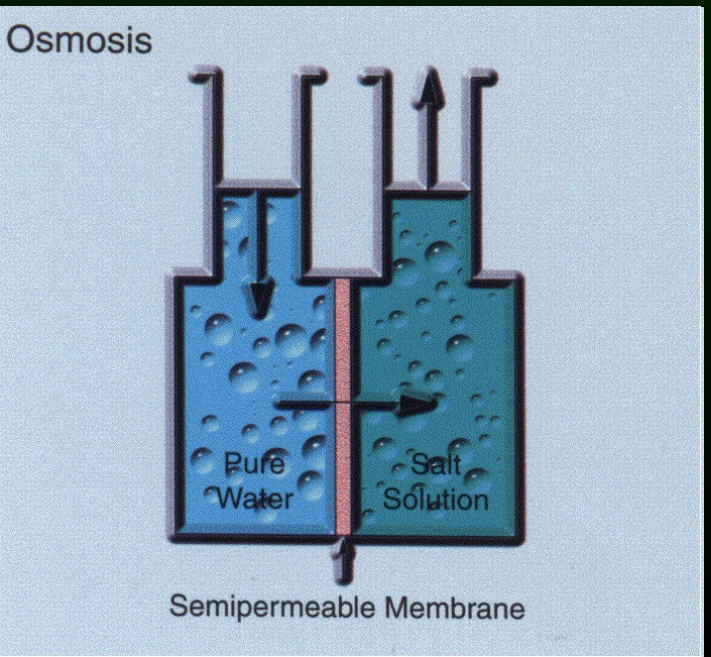
$$\frac{\text{Water vapor density}}{\text{Saturation water vapor density}} \times 100$$

It's easy!

20/50 X 100 = 40% relative humidity

Water Movement in Aquatic Environments

- If two environments differ in water or salt concentrations, substances will tend to move down their concentration gradients (high to low).
  - Diffusion
    - Osmosis: Diffusion of water through a semipermeable membrane.

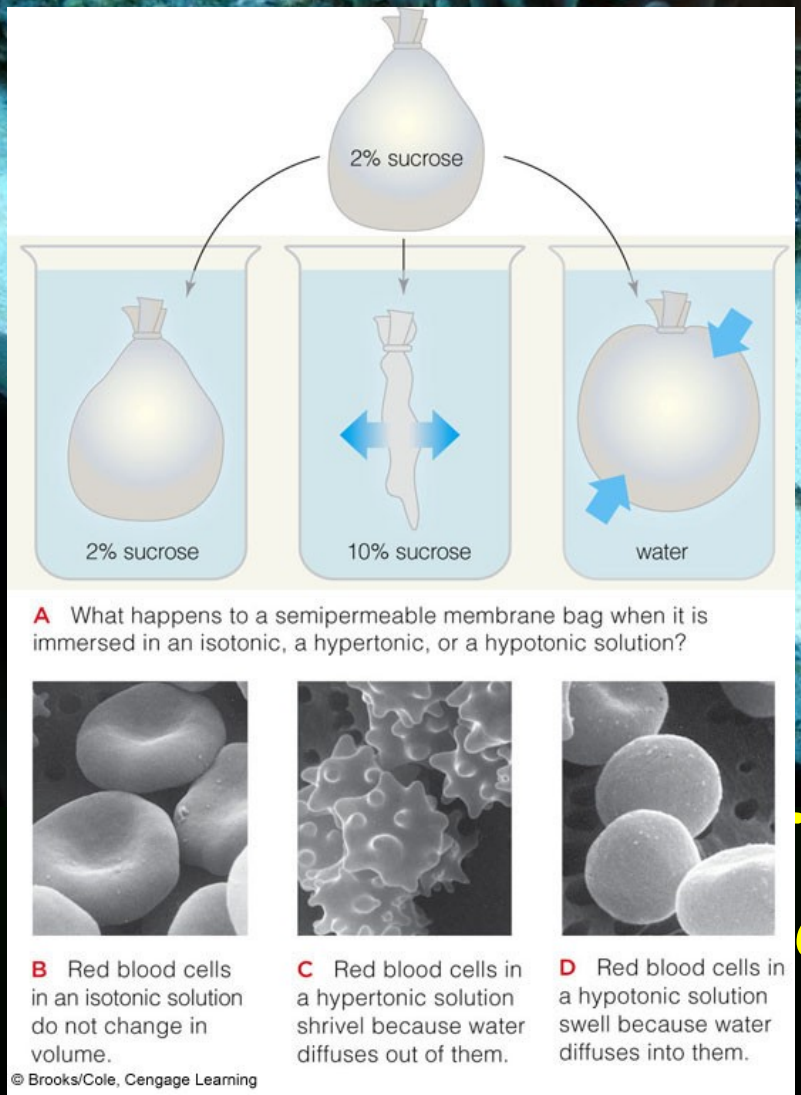


Why does fresh water move to the salt water solution? Where is water concentration higher?

More importantly, how does this affect organisms?

Water Movement in Aquatic Environment

- Isosmotic: Body fluids and external fluid are at the same co
- Hypoosm
  concentra t.
- Hyperosm ncentration than the



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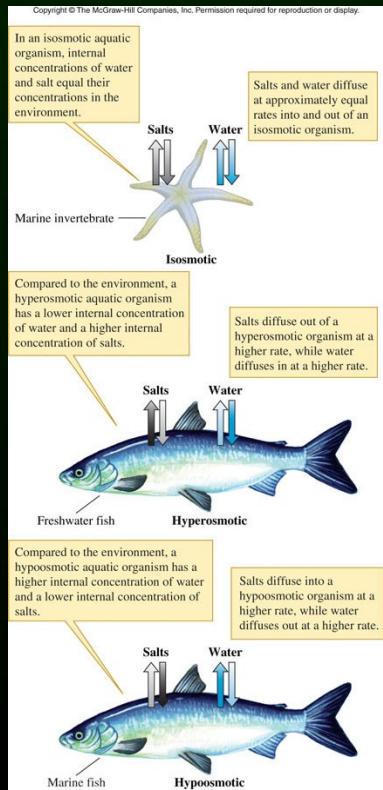
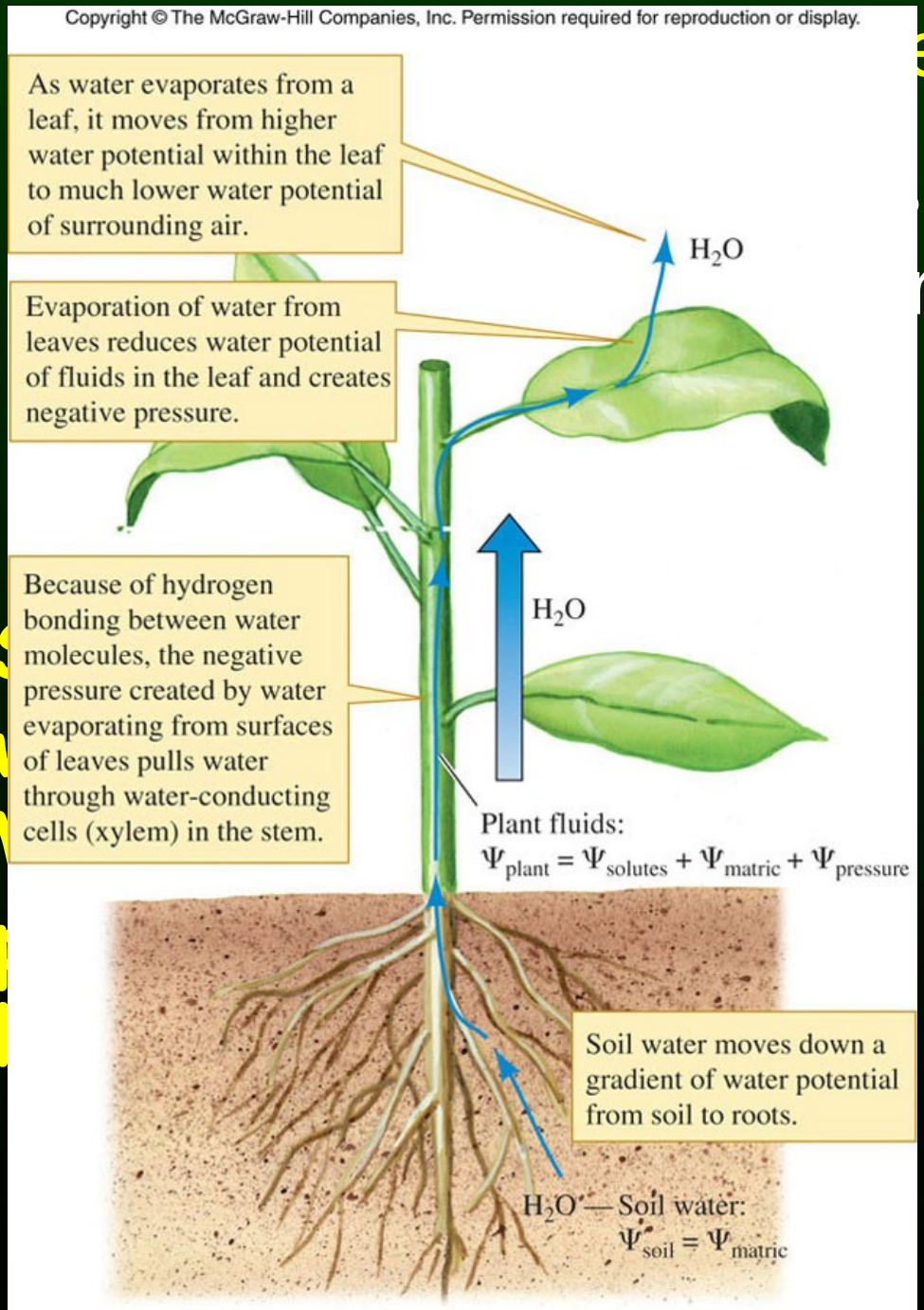
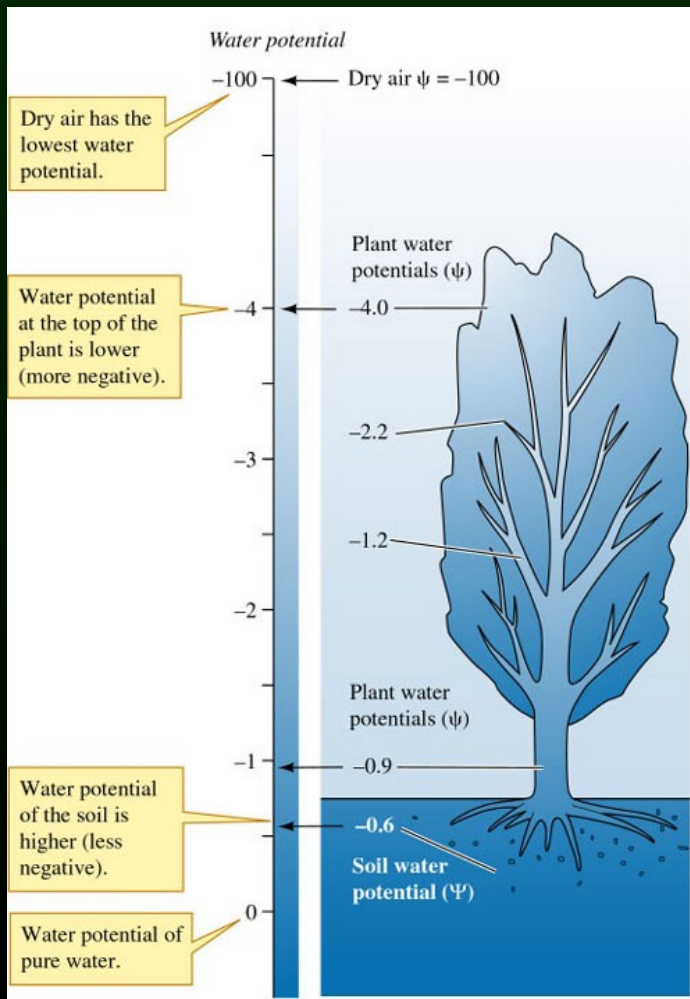


een Soils and Plants

- oil and plants flows radient.

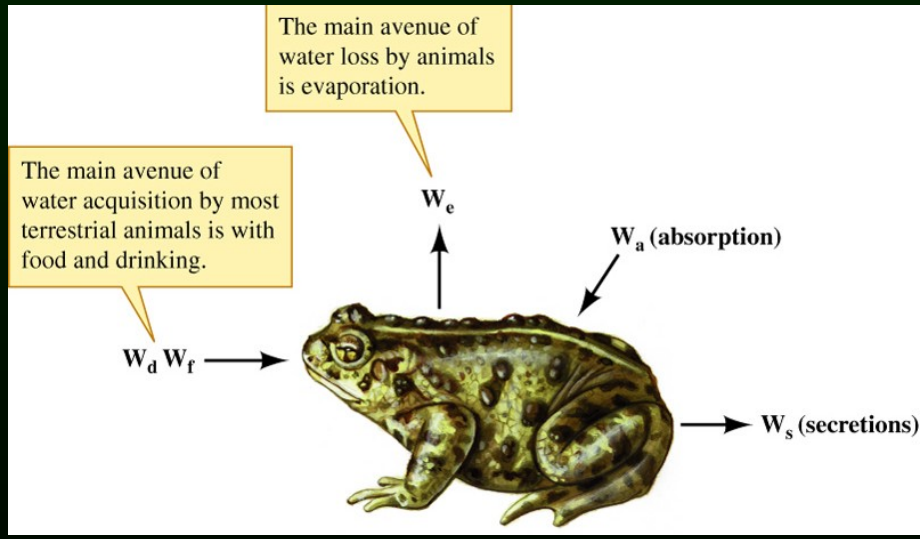




Water Regulation on Land

- Terrestrial organisms face (2) major challenges:
  - Evaporative loss to environment.
  - Reduced access to replacement water.
- $W_{ia} = W_d + W_f + W_a - W_e - W_s$

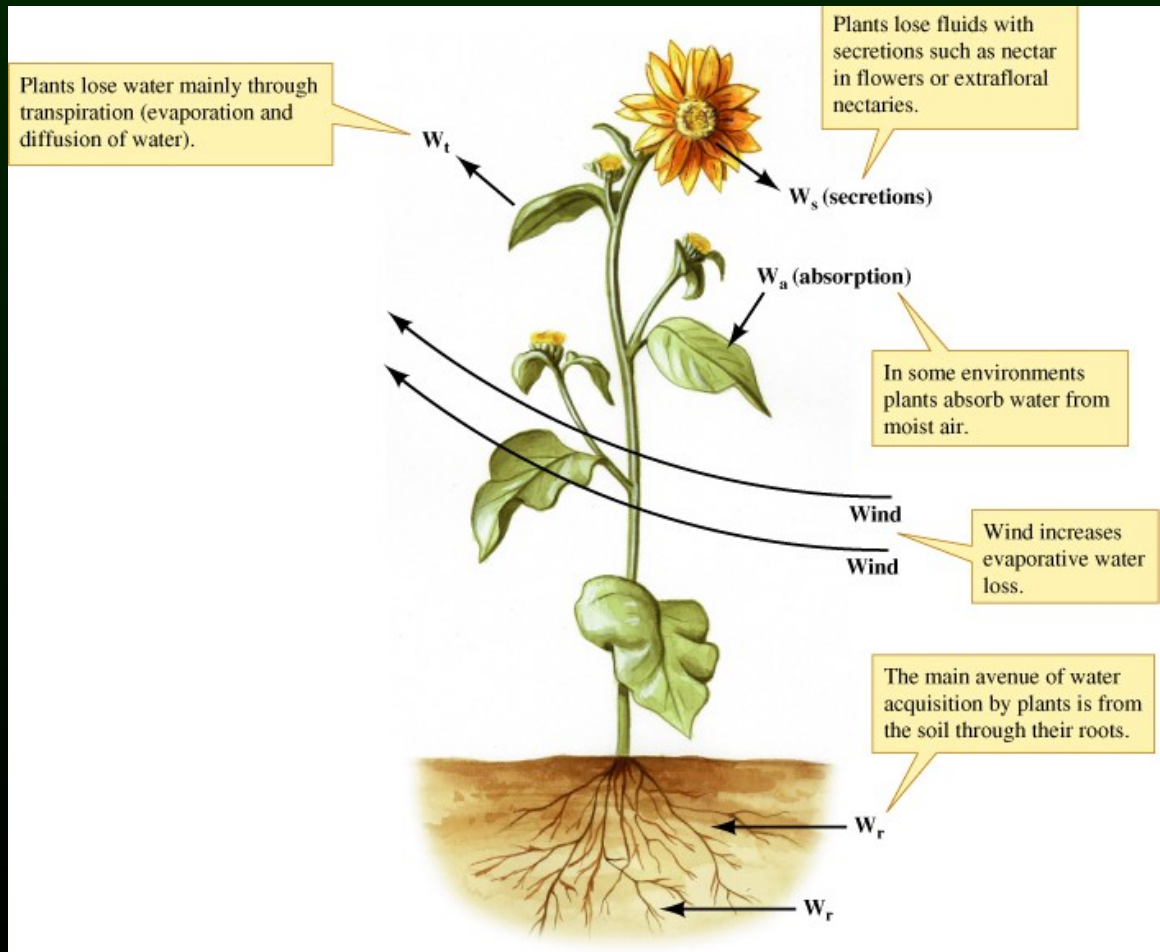
- W_{ia} = Animal's internal water
- W_d = Drinking
- W_f = Food
- W_a = Absorbed by air
- W_e = Evaporation
- W_s = Secretion / Excretion



Water Regulation on Land - Plants

- $W_{ip} = W_r + W_a - W_t - W_s$

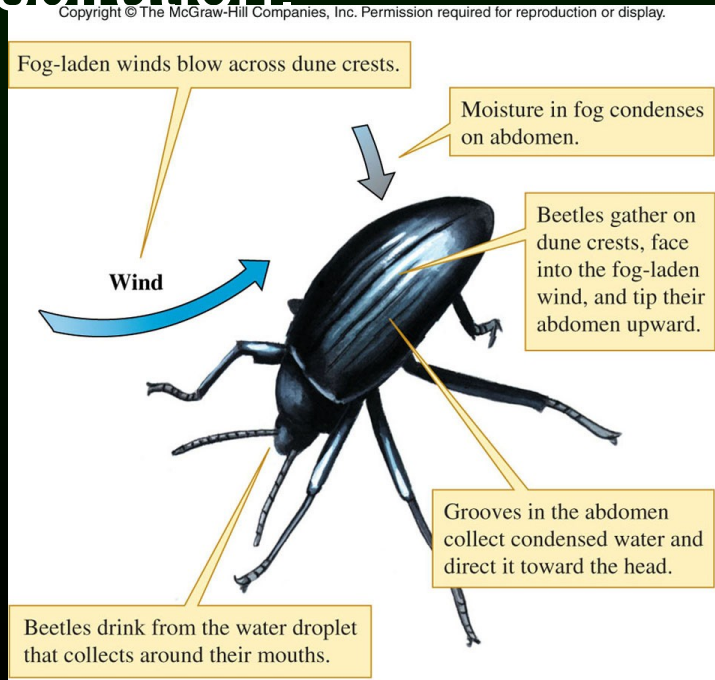
- W_{ip}= Plant's internal water
- W_r =Roots
- W_a = Air
- W_t = Transpiration
- W_s = Secretions



Water Acquisition by Animals

- Most terrestrial animals satisfy their water needs via eating and drinking.
  - Can also be gained via metabolism through oxidation of glucose (i.e. cellular respiration):
    - $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
      - Metabolic water refers to the water released during cellular respiration.

Here's a cool way that this desert beetle gets water!!!



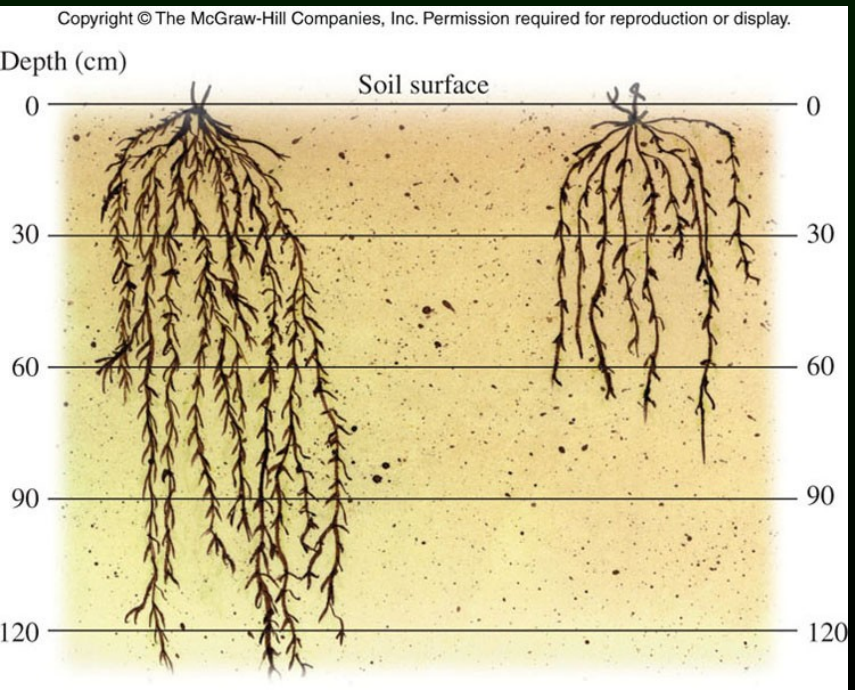
Water Acquisition by Animals

In kangaroo rats, pretty much all the water is metabolic water!

http://www.youtube.com/watch?v=40XVaaZgE5k&feature=related

Water Acquisition by Plants

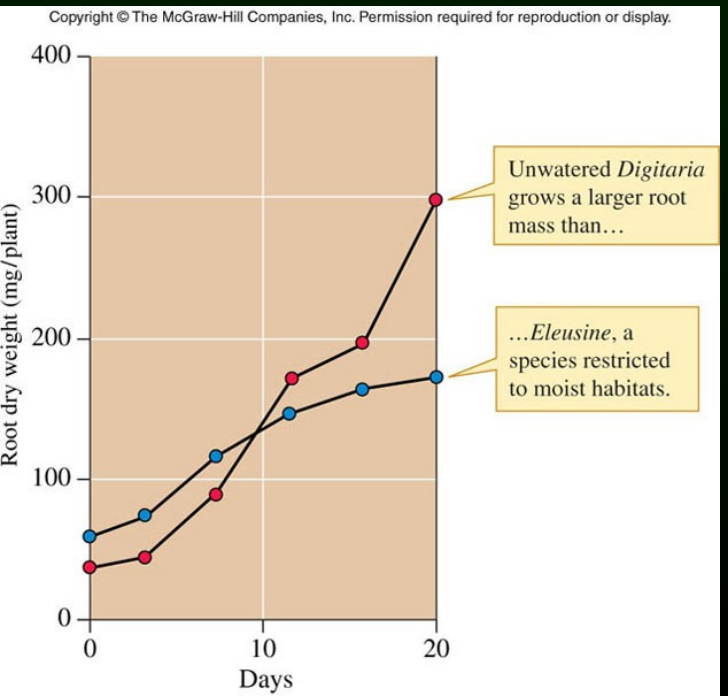
- Extent of plant root development often reflects differences in water availability.
  - Where would you expect to find more root development in a plant?
    - Drier habitats or Moister habitats? Why?



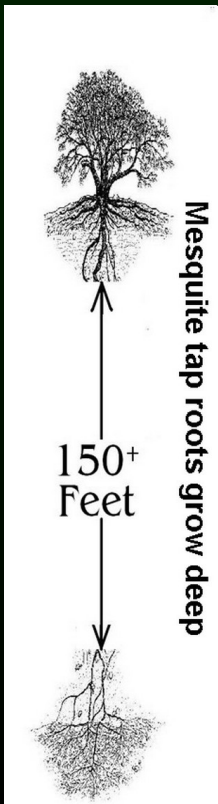
Same plant, different habitats!

Some cool facts!

- Roots in desert plants can extend up to 30 m down in the soil!
- Roots can account for up to 90% of plant biomass in deserts (compared to 25% in coniferous forests)

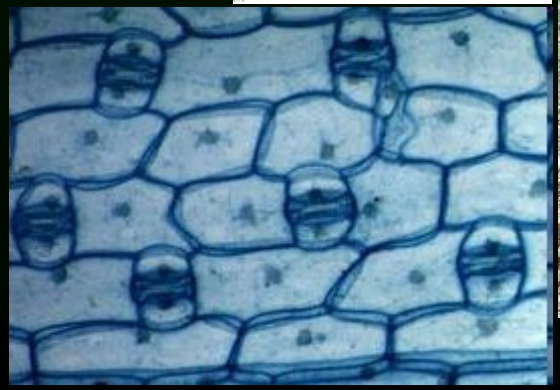


So, we know how organisms get water…now, how do they conserve it???

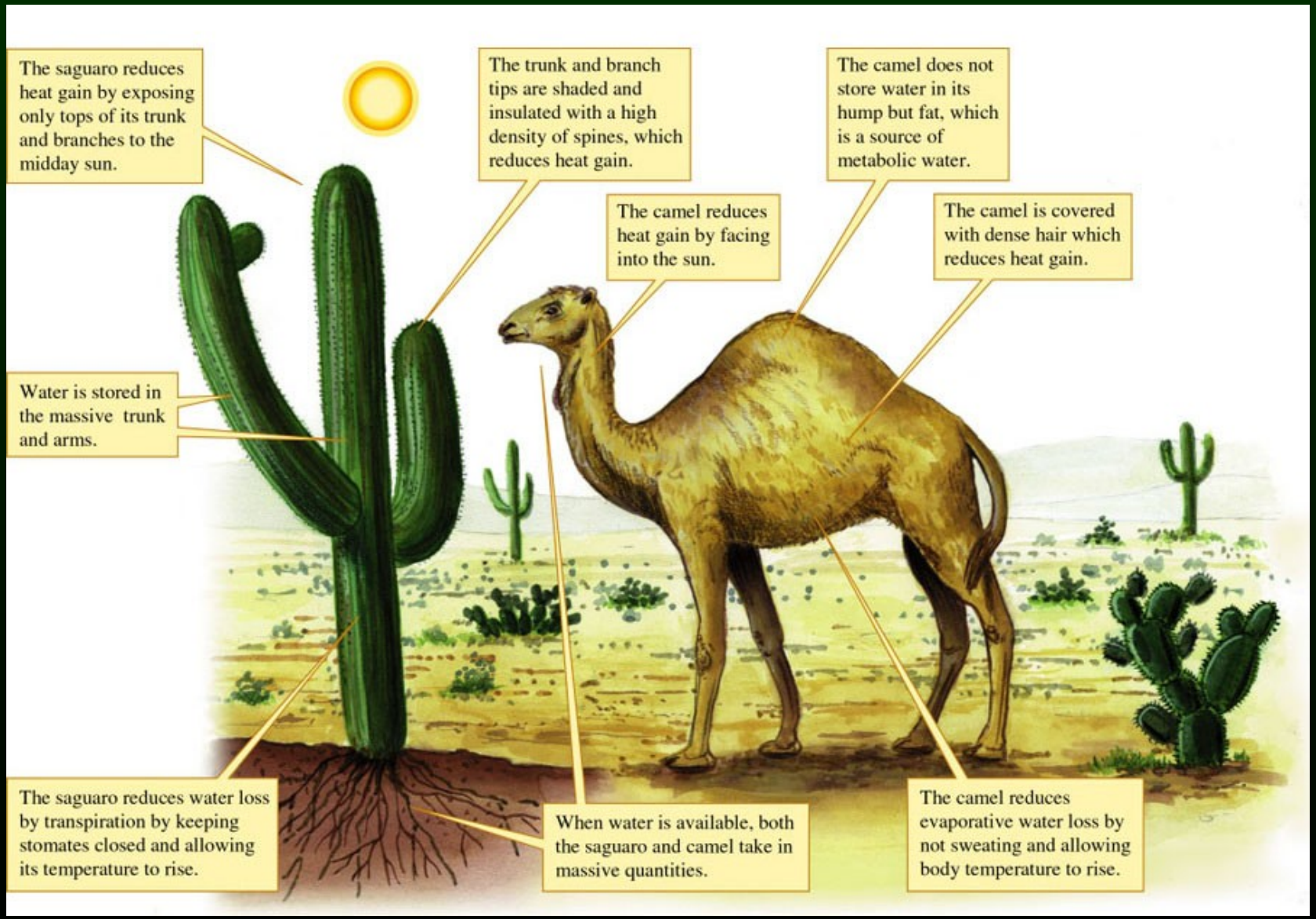


Water Conservation by Plants and Animals

- Waterproofed bodies
- Concentrated urine / feces
- Condensing water vapor in breath
- Behavioral modifications to avoid water-loss conditions
- Drop leaves in response to drought.
- Thicker leaves (less transpiration)
- Fewer stomata
- Periodic dormancy

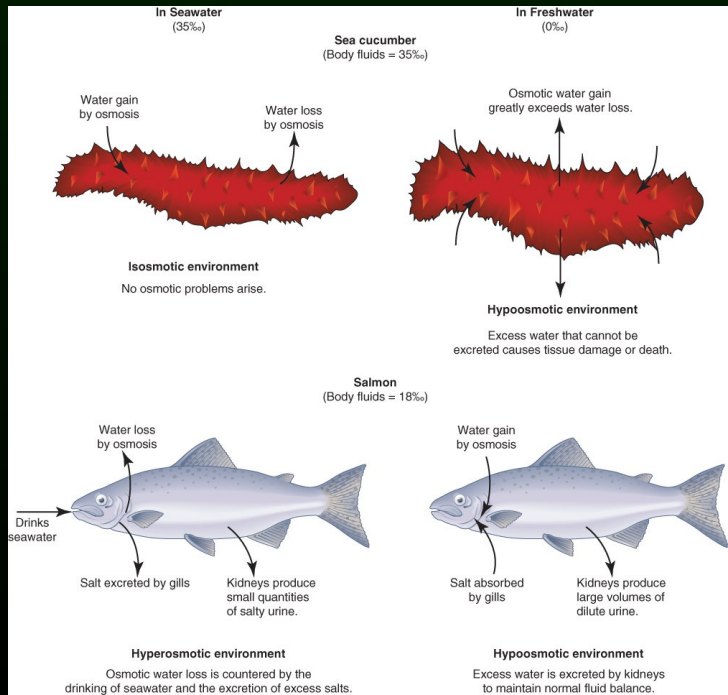


Dissimilar Organisms with Similar Approaches to Desert Life



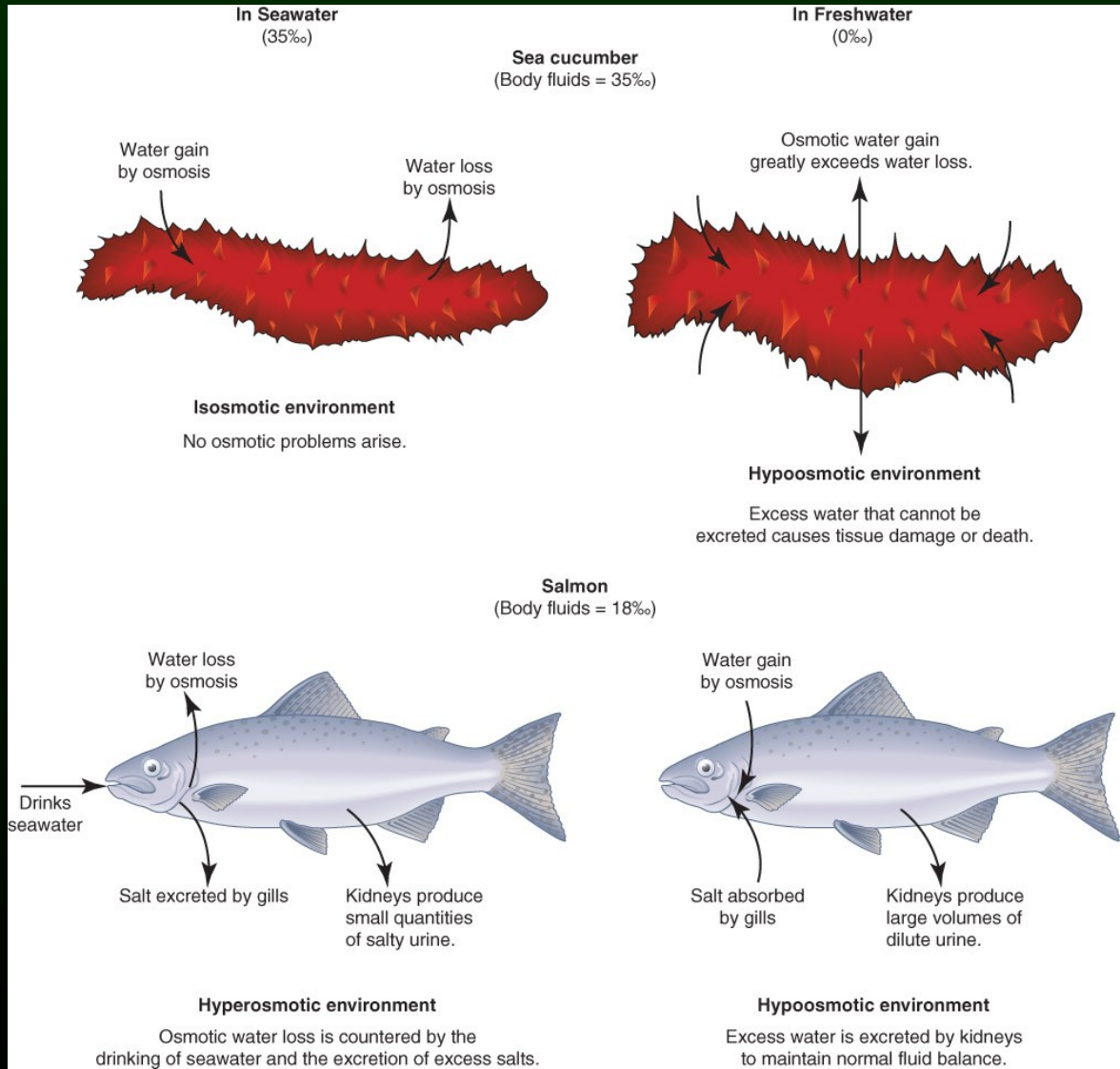
Water and Salt Balance in Aquatic Environments: Osmoregulation

- Fish and Invertebrates
  - Isomotic organisms do not have to expend energy overcoming osmotic gradient… that's great, right? Why is it great? Why isn't it so great???



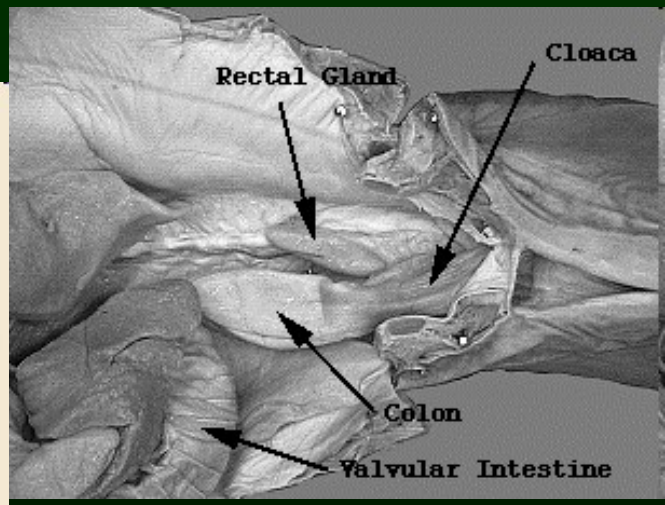
Osmoregulation by Aquatic Organisms – in Freshwater and Marine Habitats

- Urine concentration
- Salt excretion or absorption by gills
- Drinking seawater



Osmoregulation by Aquatic Organisms – Marine Habitats

- Specialized salt glands (sharks, marine birds, and reptiles)



- Small bladders & good kidneys (marine mammals)