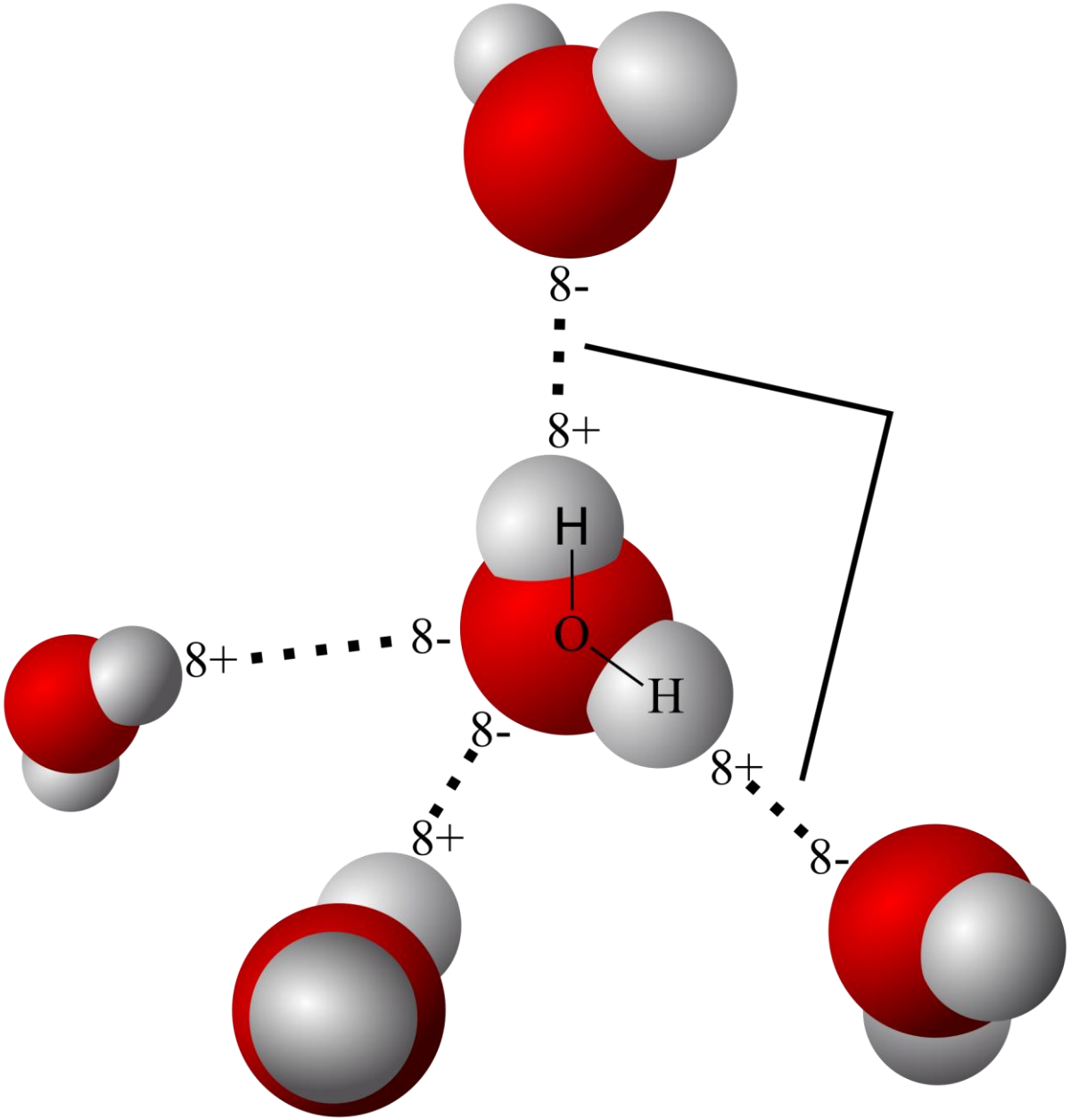
Properties of Water

Water is polar

Uneven electron sharing (dipoles).

Capable of forming H-bonds.


δ-
δ+
H
O
H
δ+
δ-
δ-
δ+
δ+
δ-

1 – Cohesion/adhesion

Water constantly forms, breaks, reforms H-bonds.

- With water, with other molecules

Water is highly structured

- Majority always bonded to neighbors

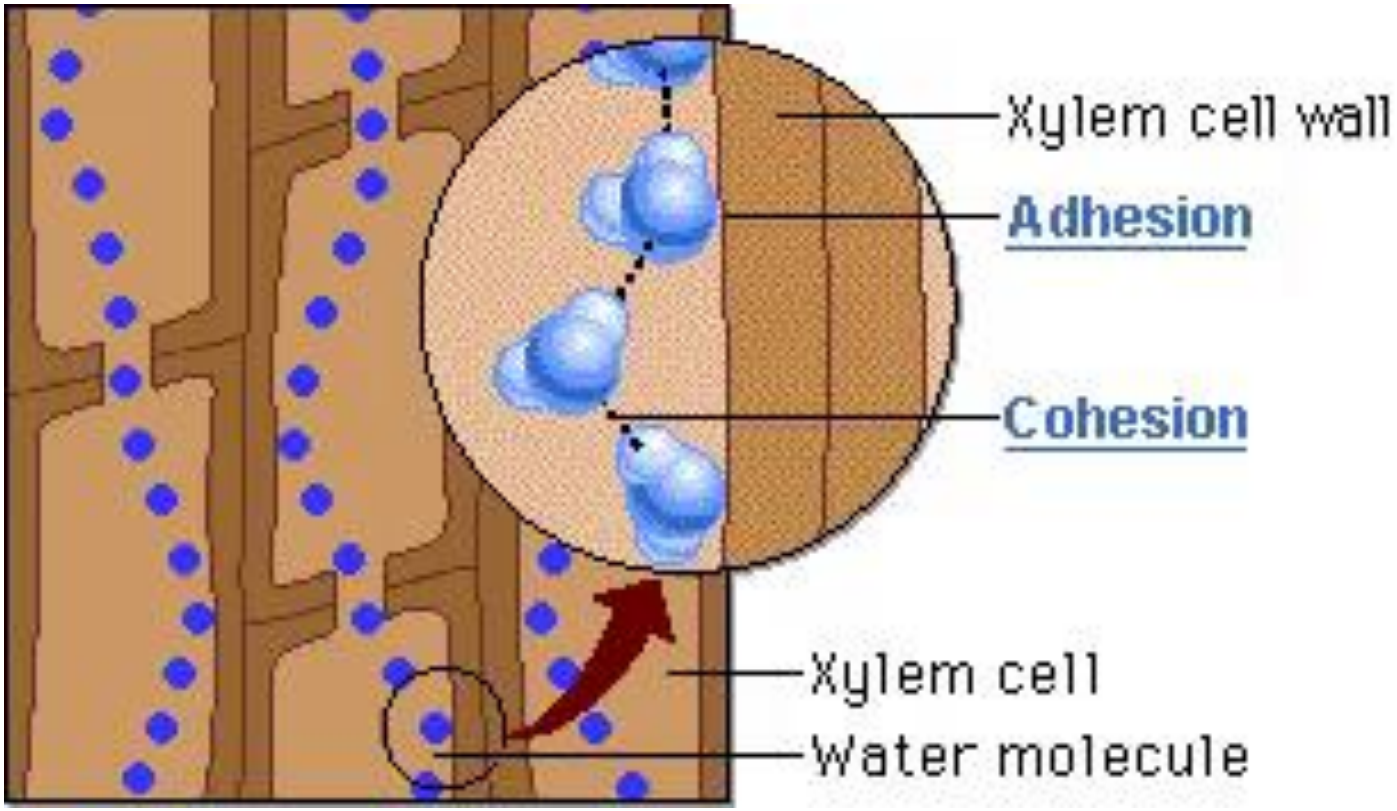
Cohesion

The ability for like molecules to bind together (via H-bonding).

Adhesion

Ability for one substance to cling to another (via H-bonding).

- Counter gravity's pull in plants


Xylem cell wall
Adhesion
Cohesion
Xylem cell
Water molecule

Kinetic energy = energy of motion

Heat = a measure of the *total* amount of kinetic energy due to molecular motion in a body of matter

Temperature = measures the intensity of heat due to the *average* kinetic energy of the molecules.

Calorie = the amount of heat it takes to raise the temperature of 1 g of water by 1ºC.

- The amount of heat that 1 g water gives off when it cools.

Kilocalorie = heat required to raise 1 kg of water by 1ºC.

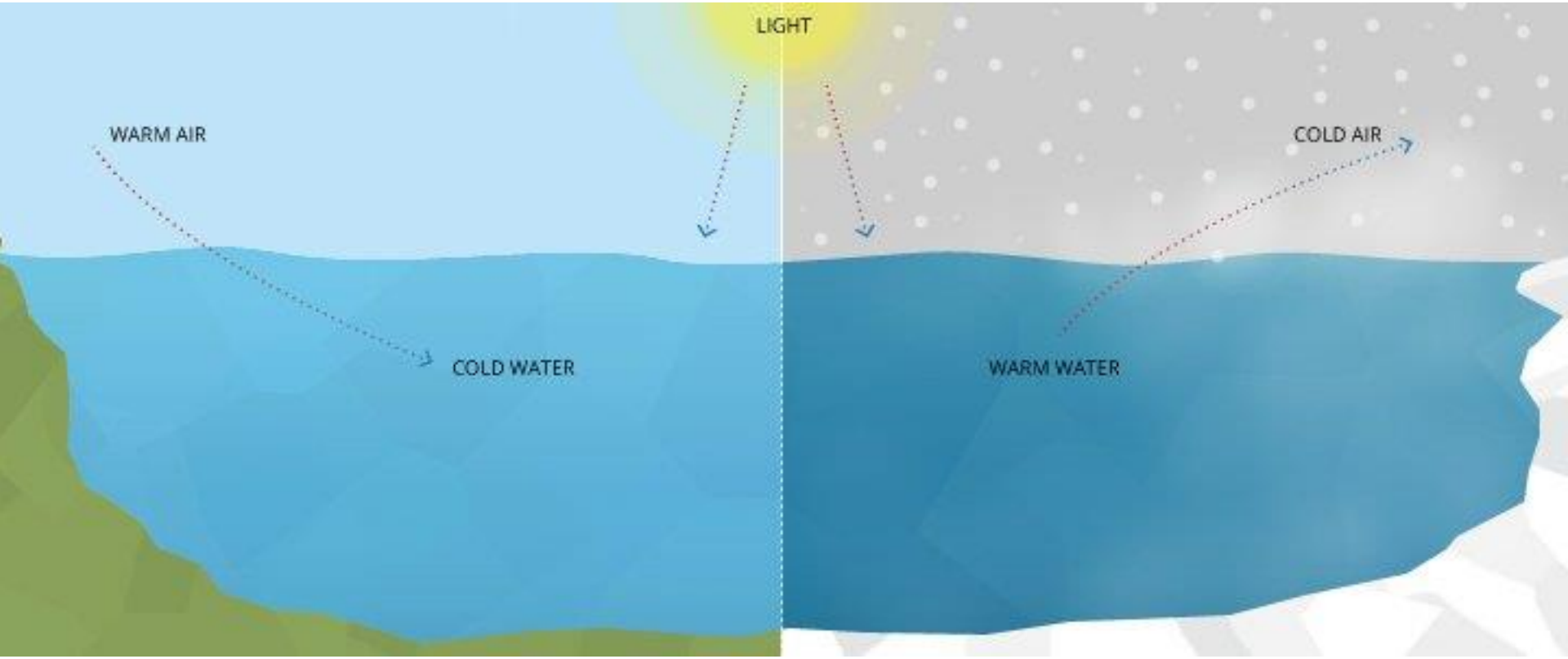
- Food “calories” are kilocalories

2 – Water has a high specific heat

Specific heat = the amount of energy required to raise the temperature of 1 g by 1ºC.

Water resists changes to its temperature.

- The heat absorbed breaks H-bonds before it moves water molecules faster.
- Heat is released when H-bonds form.


LIGHT
WARM AIR
COLD AIR
COLD WATER
WARM WATER


Santa Barbara 73°
Burbank
90°
San Bernardino
100°
Riverside 96°
Los Angeles
(Airport) 75°
Santa Ana
84°
Palm Springs
106°
70s (°F)
80s
90s
100s
Pacific Ocean 68°
San Diego 72°
40 miles

2 – Water has a high specific heat

Coastal areas have milder climate.

Stabilizes fluctuations on land/water to within limits for life.

Organisms more easily resist changes in own temperatures.

3 – Water has a high heat of vaporization

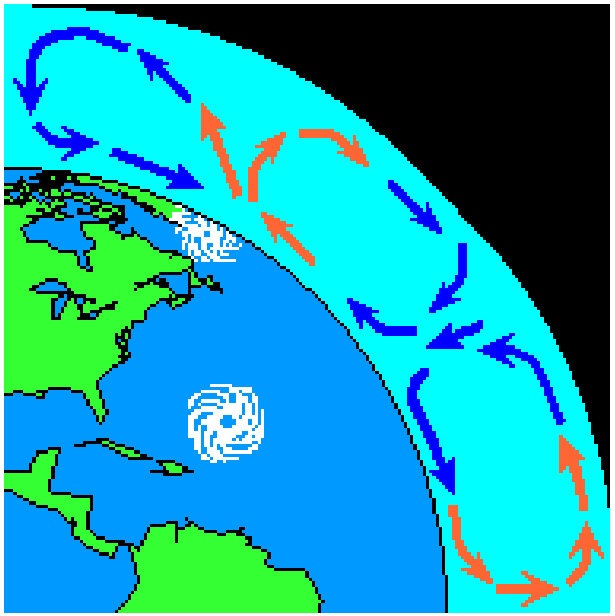
Heat of vaporization = the amount of heat water must absorb for 1 g of it to be converted from a liquid to a gas.

H-bonds must absorb energy before they can be broken and before water molecules can move fast enough to change states.

3 – Water has a high heat of vaporization

Helps to moderate Earth's climate

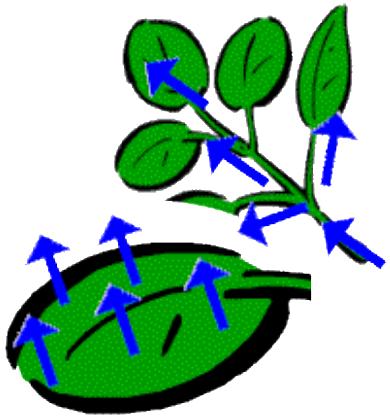
- Solar heat causes ocean water to evaporate → warm, moist air moves toward poles
- Warm, moist air cools and condenses into rain → heat is released



3 – Water has a high heat of vaporization

Evaporative cooling maintains temperature stability

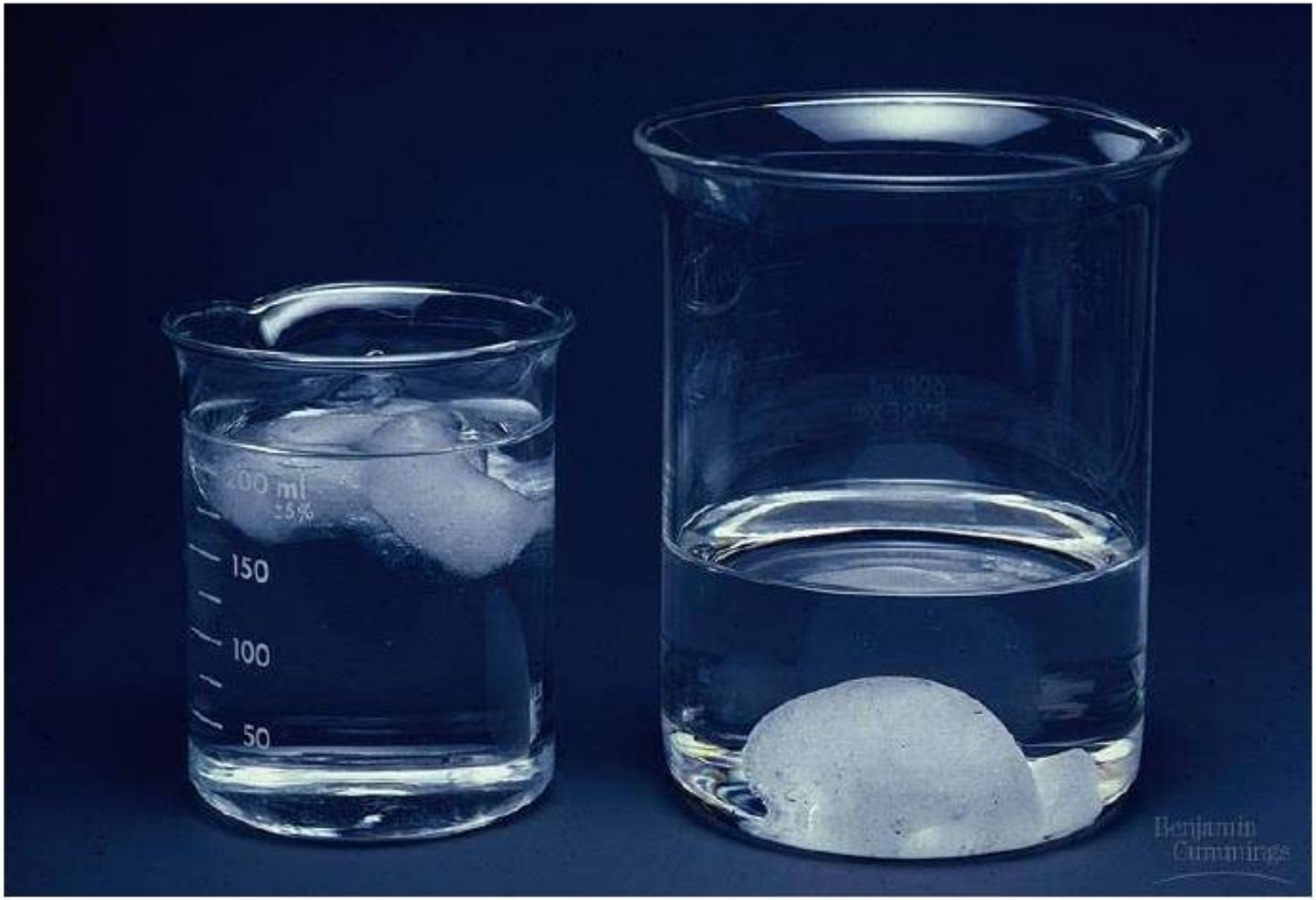
- "Hottest" molecules (have the greatest energy) leave the water's surface as gas.
- Water left behind is cooler



4 – Solid water is less dense

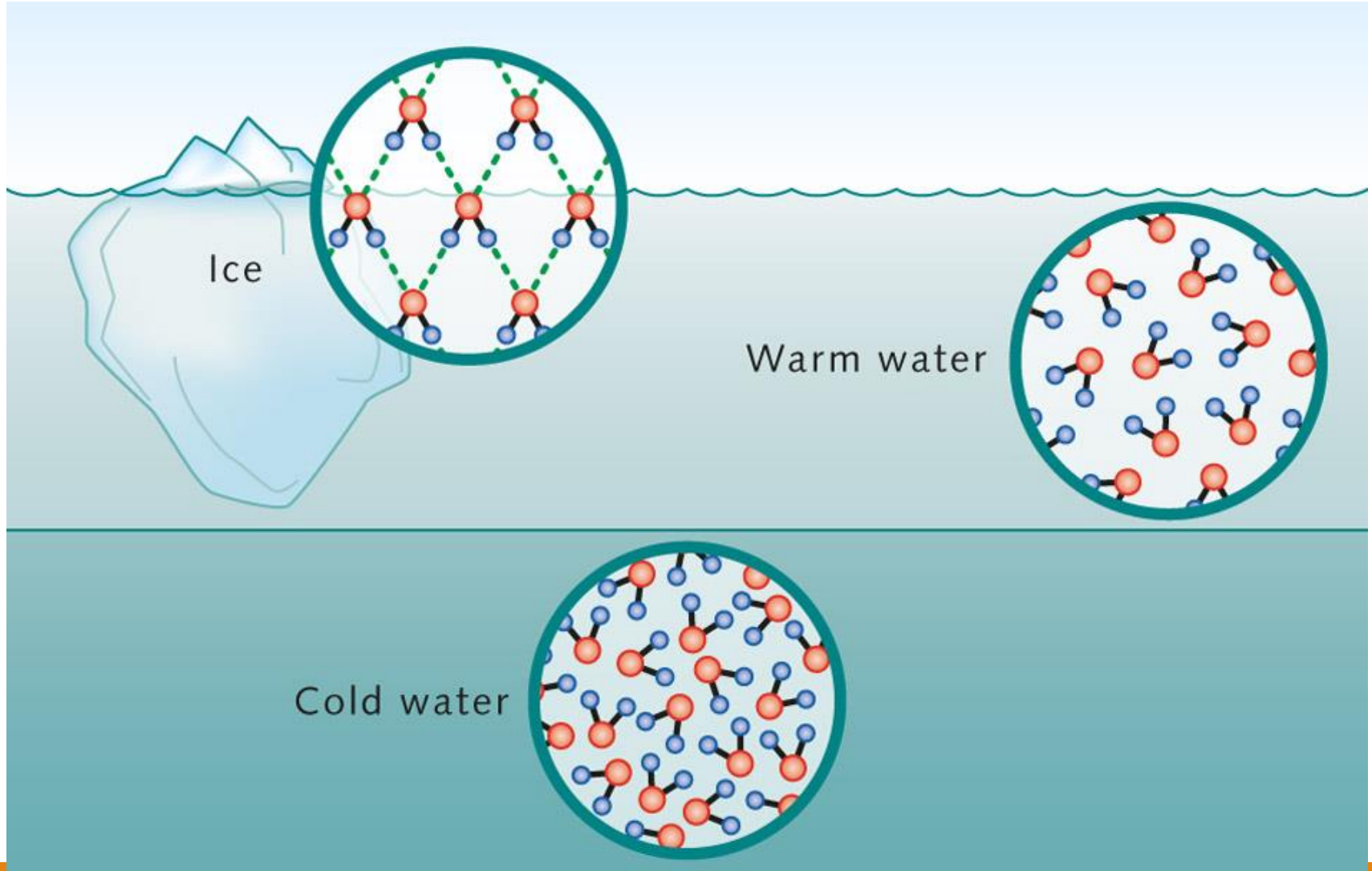
Most substances are more dense when they are solid.

Figure 3.6x2 Ice floats and frozen benzene sinks

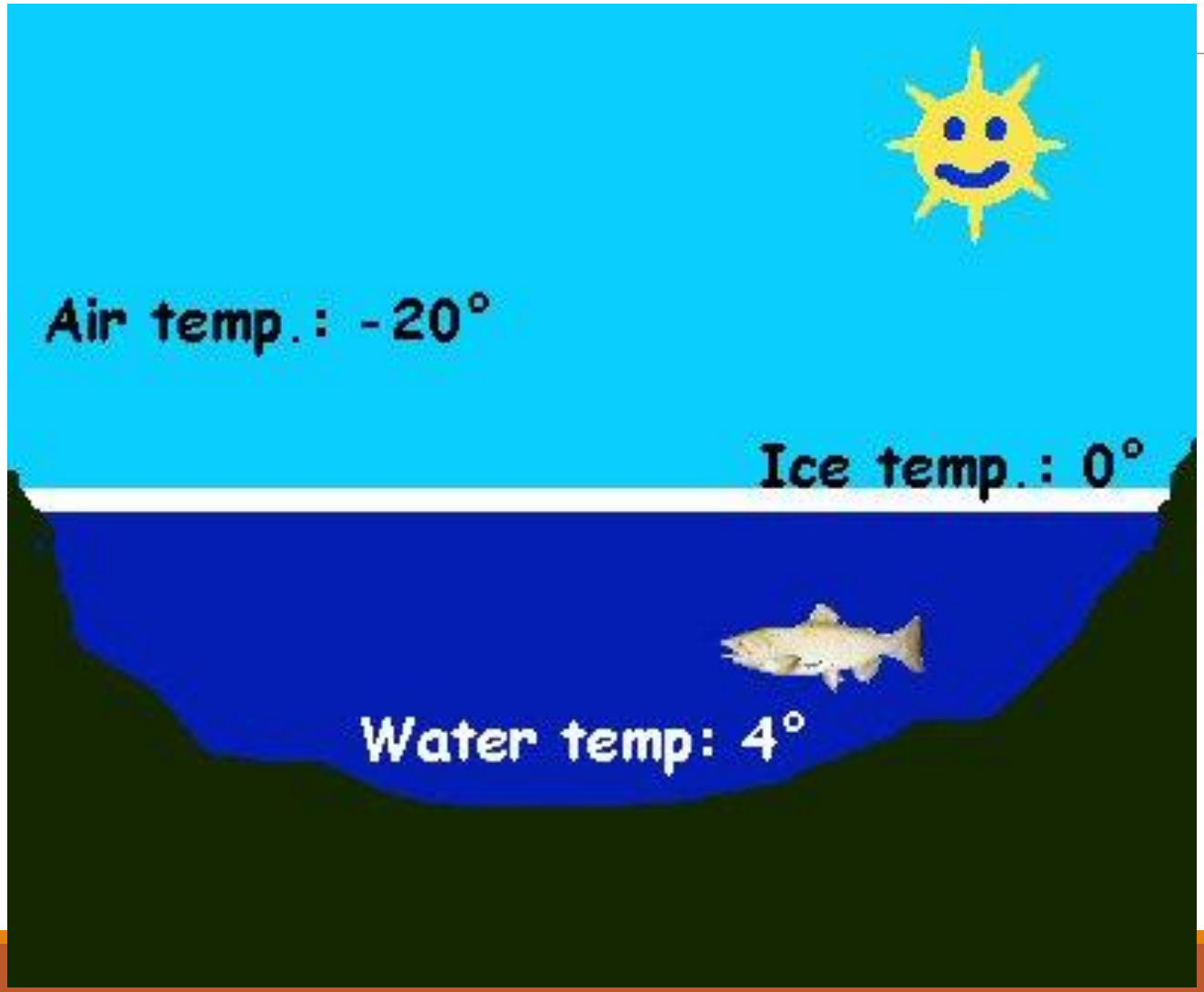


4 – Solid water is less dense

H-bonds form between water as it solidifies causing molecules to have more space between them.


Ice
Warm water
Cold water

Allows for aquatic life to survive the winter!



5 – Water is a polar solvent

Solvent = the dissolving agent of a solution.

Solute = the substance that is dissolved.

Solution = a liquid that is a homogenous mixture of two or more substances.

- **Aqueous solution =** water is the solvent

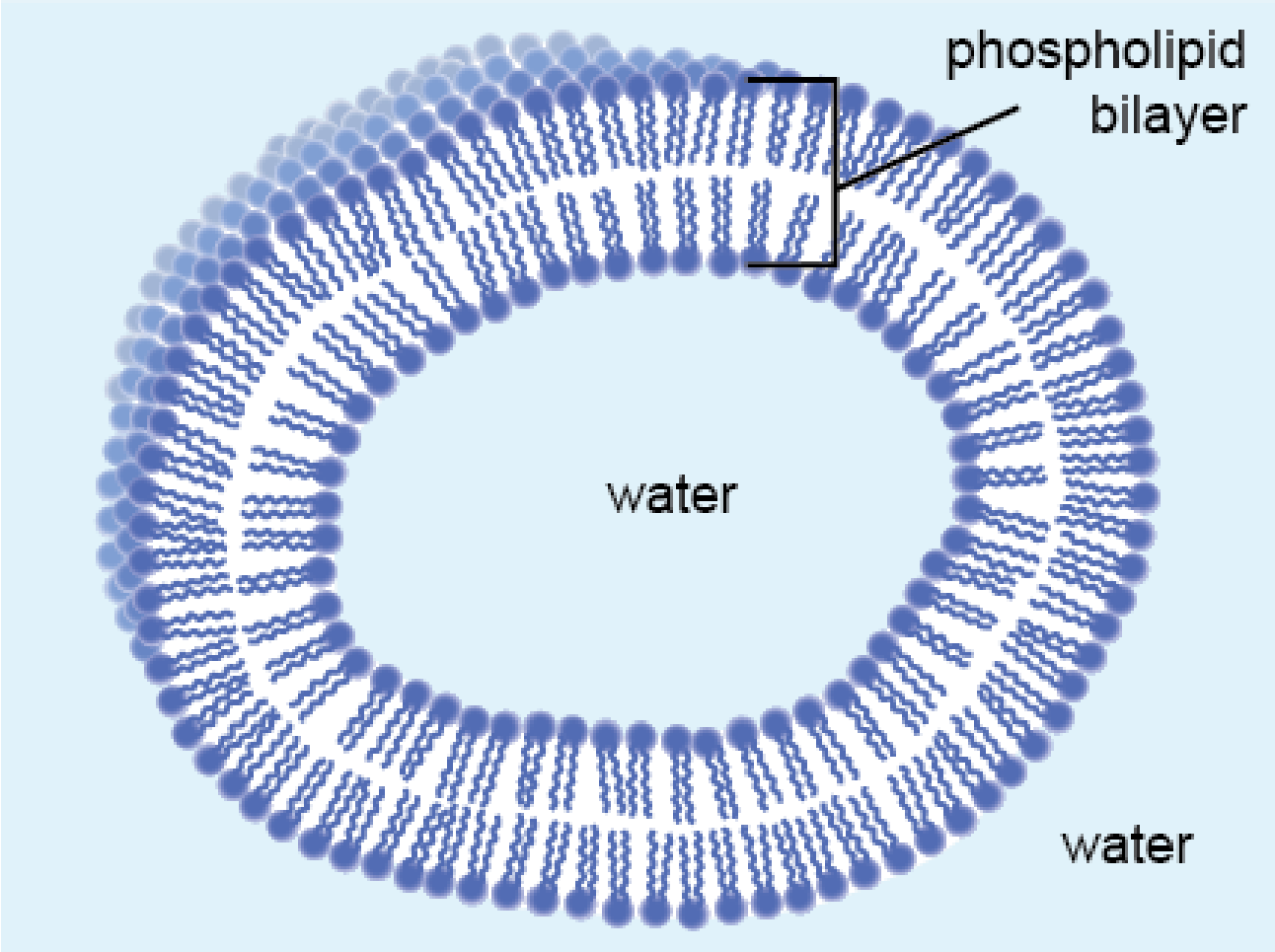
5 – Water is a polar solvent

Hydrophilic = attracted to water

- Ionic, polar molecules
- Can be attracted without dissolving (ex: cotton)

Hydrophobic = repelled by water

- Non-polar molecules


phospholipid
bilayer
water
water

Molarity (M)

The number of moles of solute per liter of solution.

1 M sucrose solution = 1 mole $C_{12}H_{22}O_{11}$/1 L

Weight of 1 mole = molecular mass in grams

Acids & Bases

Water can dissociate into H^+ and OH^-.

Water has a pH of 7 (neutral)

- Equal concentrations (10^{-7} M) of H^+ and OH^- ions

Acid

Substance that increases the hydrogen ion concentration of a solution.

Ex: $HCl \rightarrow H^+ + Cl^-$ (strong acids dissociate completely)

$H_2CO_3 <--> HCO_3^- + H^+$ (weak acids release & accept H^+)

Base

A substance that reduces the hydrogen ion concentration.

- Can accept H^+ ($NH_3 + H^+ <--> NH_4^+$, weak)
- Or can donate OH^- that binds with H^+ to create H_2O ($NaOH \rightarrow Na^+ + OH^-$, strong)

pH Scale

$pH = -\log [H^+]$

Greater concentration = smaller pH value

Buffers

Substances that minimize changes in pH.

- Accept and donate H^+ in response to pH changes.
- EX: Blood pH is maintained at pH = 7.4