CH. 2A WARM-UP

- List 1 trace mineral found in living things and its purpose in the body.
- What is the difference between a polar and nonpolar substance? Name an example of each.
- What types of molecules can form hydrogen bonds? Explain.
- Draw a possible chemical structure diagram of $c_6h_{12}o_6$.

CH. 2B WARM-UP

1. Explain how a water strider can seem to "walk" on water.
2. Name 3 examples of polar substances.
3. Name 3 examples of nonpolar substances.
4. Explain what is the meant by the phrase: "structure dictates function" in your own words. (Give an example of this in biology – don't use the morphine example from lecture)

CH. 2B WARM-UP

1. What property of water allows a water strider to "walk" on water?

2. Contrast adhesion and cohesion. Give an example of each.

3. Contrast hydrophobic and hydrophilic substances. Give an example of each.

Properties of Water

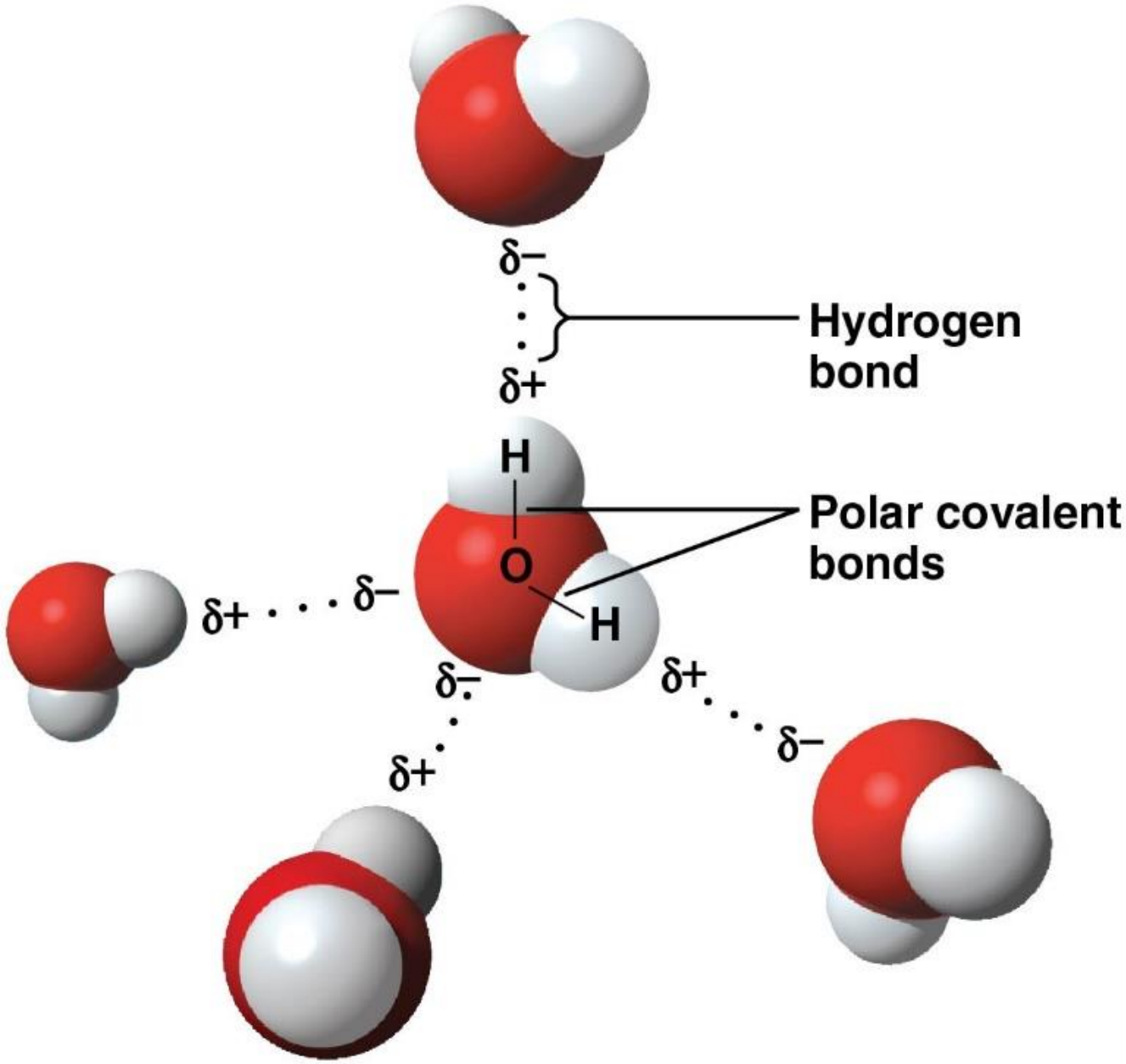
CHAPTER 2 – PART B

YOU MUST KNOW:

- The importance of hydrogen bonding to the properties of water.
- Four unique properties of water and how each contributes to life on earth.
- How to interpret the pH scale.
- How changes in pH can alter biological systems.
- The importance of buffers in biological systems.

WATER IS A **POLAR** MOLECULE

- Unequal sharing of e^- between O and H
- **Hydrogen bond**: slightly negative o attracted to slightly positive h of nearby molecule
- H_2o can form up to 4 bonds



FOUR EMERGENT PROPERTIES OF WATER

1. COHESIVE BEHAVIOR

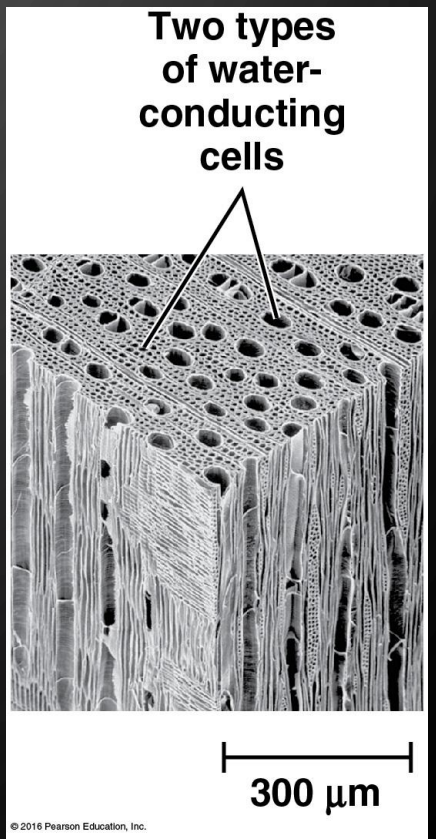
COHESION = H-bonding between like molecules

- **Surface tension** = measure of how difficult it is to break or stretch surface of liquid

ALSO… ADHESION

ADHESION = bonding between <u>unlike</u> molecules

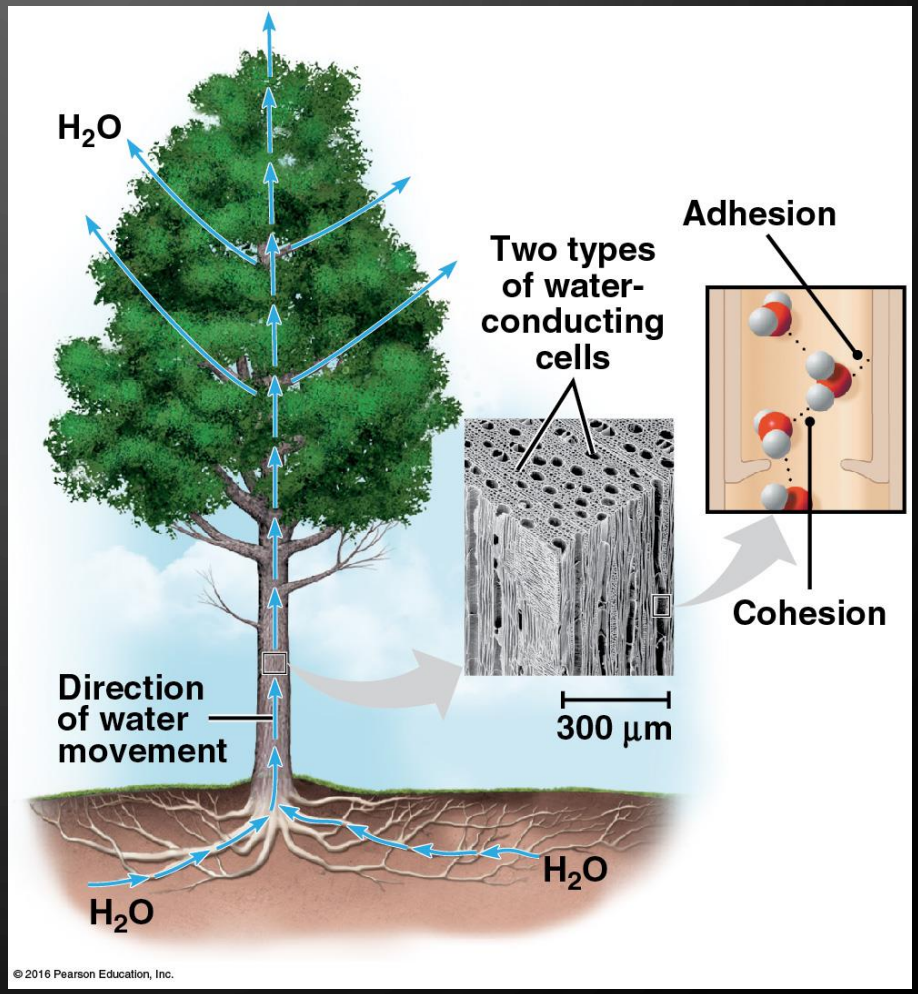
- Adhesion of H_2O to vessel walls counters ↓ pull of gravity

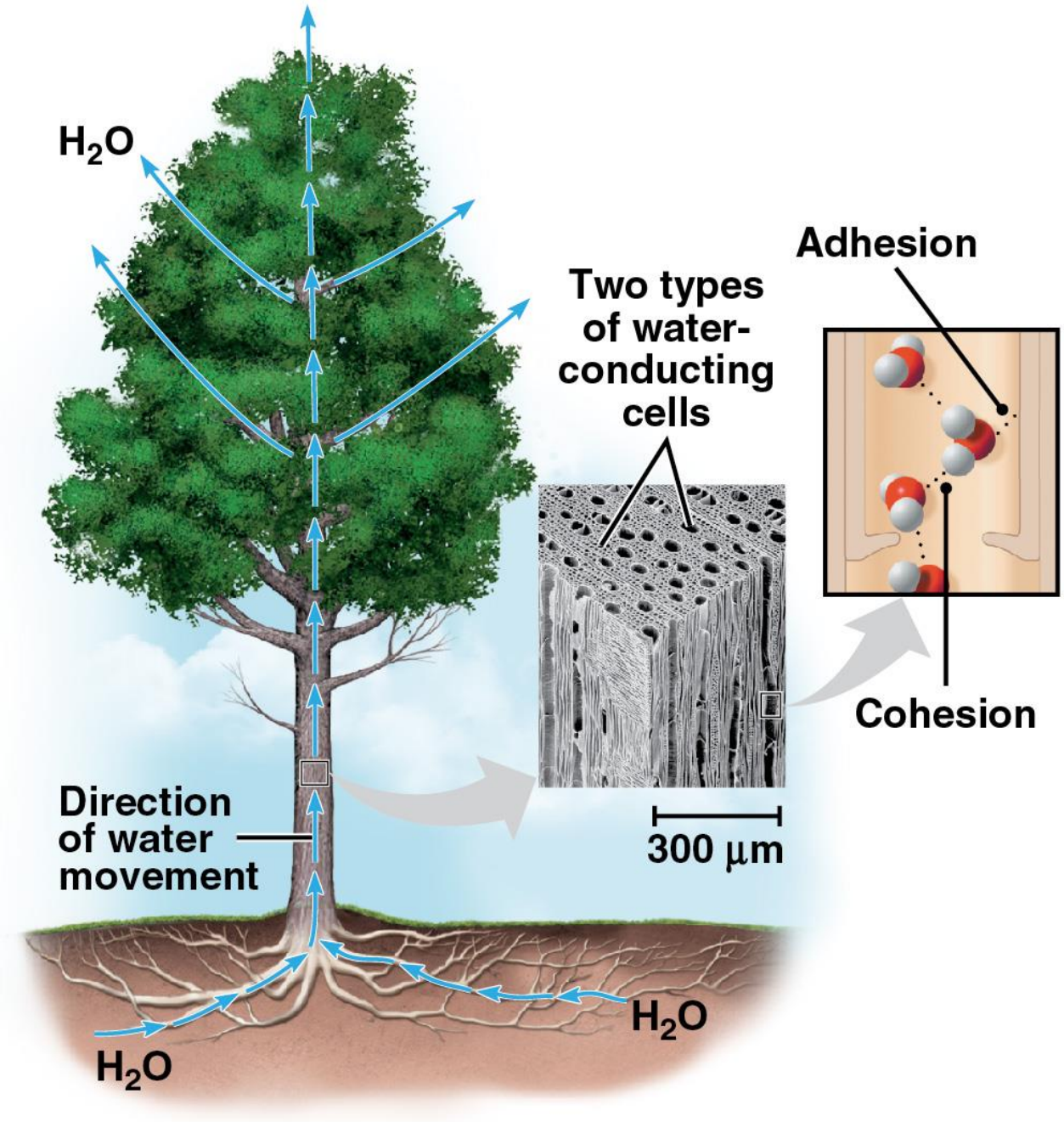


IN ACTION:

TRANSPIRATION = MOVEMENT OF H_2O UP PLANTS

H_2O molecules cling to each other by **cohesion**; they cling to xylem tubes by **adhesion**





BIOFLIX: WATER TRANSPORT IN PLANTS

2. MODERATION OF TEMPERATURE

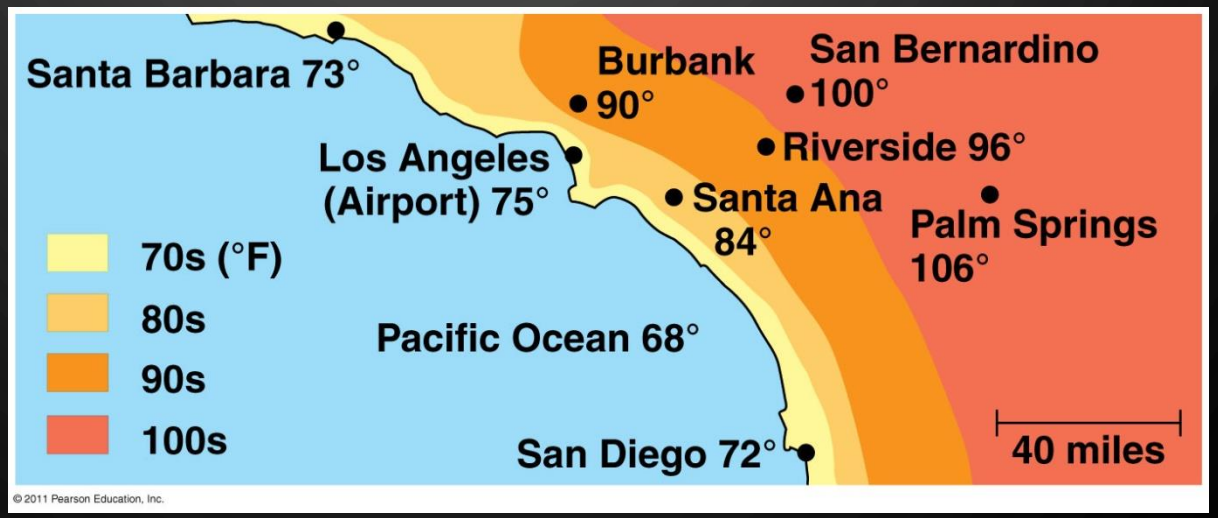
- **Thermal energy (heat)** = total amount of kinetic energy (KE) in system
- **Temperature** = measures ***intensity*** of heat due to average KE of molecules

Which has higher temp?

More thermal energy?

HIGH SPECIFIC HEAT

- Change temp less when absorbs/loses heat
- Large bodies of water absorb and store more heat → warmer coastal areas
- Create stable marine/land environment
- Humans ~65% H_2O → stable temp, resist temp. Change



EVAPORATIVE COOLING

- Water has high heat of vaporization
- Molecules with greatest KE leave as gas
- Stable temp in lakes & ponds
- Cool plants
- Human sweat

3. EXPANSION UPON FREEZING

Insulation by ice

- less dense, floating ice insulates liquid H_2O below
- Life exists under frozen surface (ponds, lakes, oceans)
- Ice = solid habitat (polar bears)

4. THE SOLVENT OF LIFE

- **Solution** = liquid, homogeneous mixture of 2+ substances

- **Solvent** = dissolving agent (liquid)

- **Solute** = dissolved substance

- **Water is the universal solvent**
  - **Remember: "LIKE DISSOLVES LIKE"**

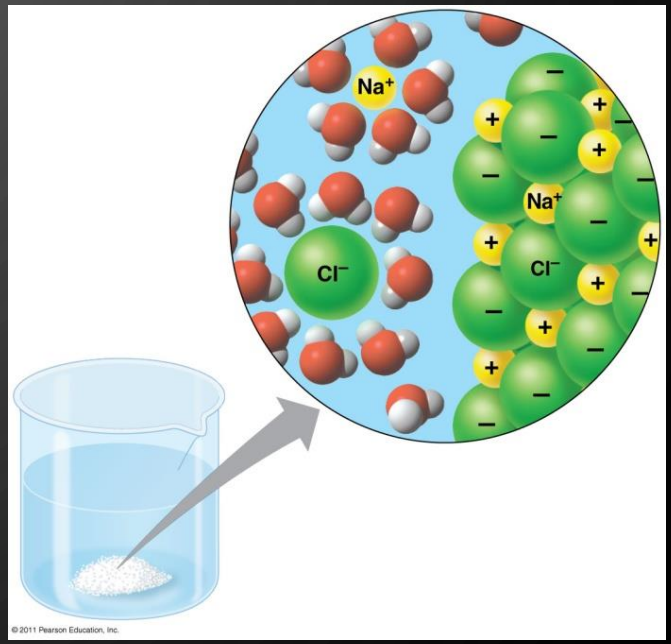
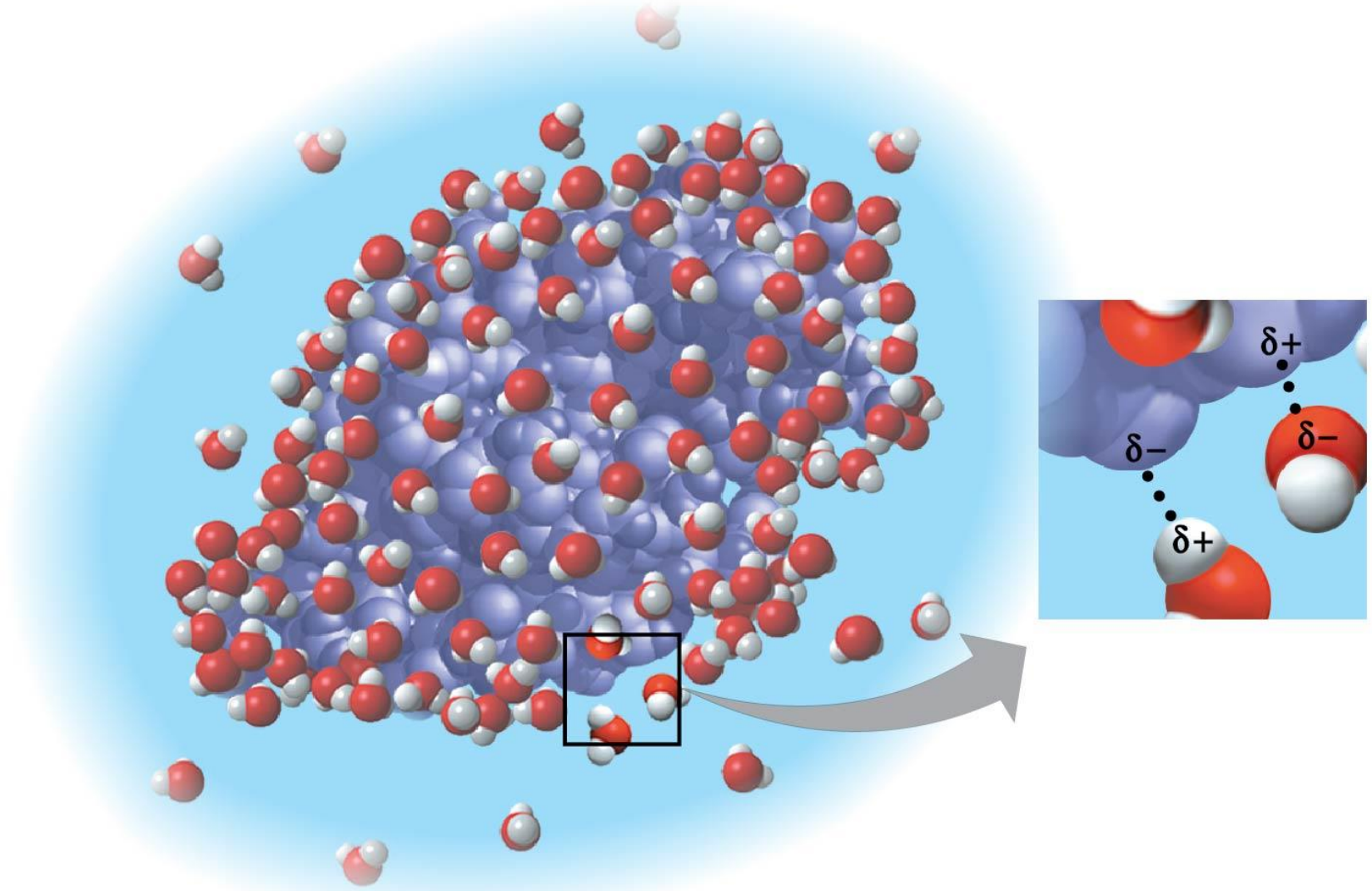


Figure 2.22 A water-soluble protein

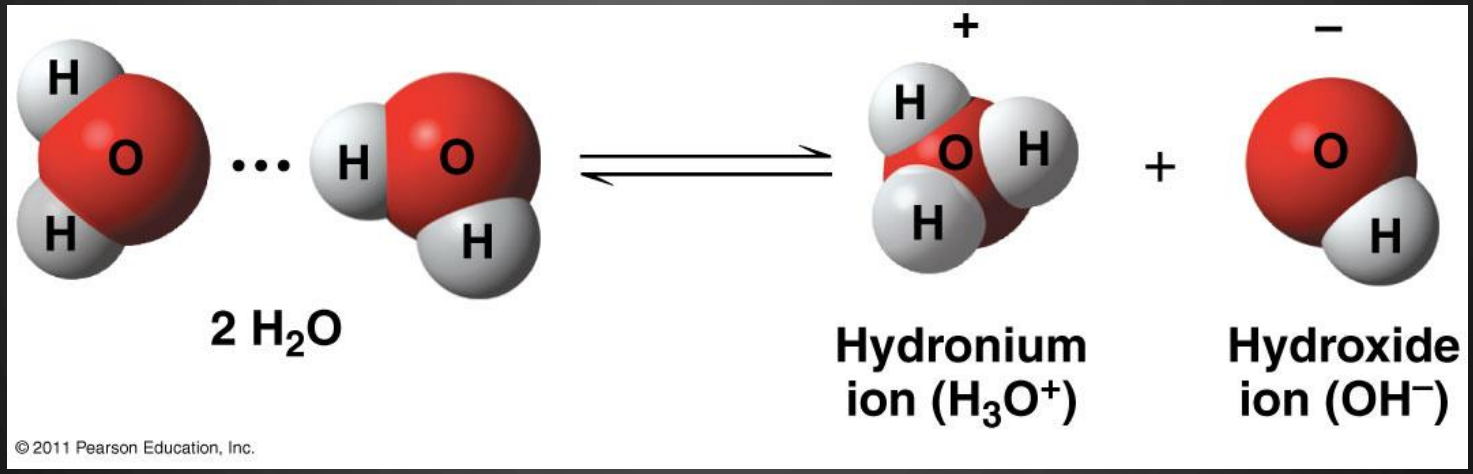


4. SOLVENT OF LIFE

HYDROPHILIC	HYDROPHOBIC
Affinity for H_2O	*Repel H_2O*
Polar, ions	Non-polar
Cellulose, sugar, salt	Oils, lipids
Blood	Cell membrane

WATER CHEMISTRY

ACIDS AND BASES



$$H_2O \rightleftharpoons H^+ + OH^-$$

(GAINS PROTON) $H^+ + H_2O \rightarrow H_3O^+$ (HYDRONIUM ION)

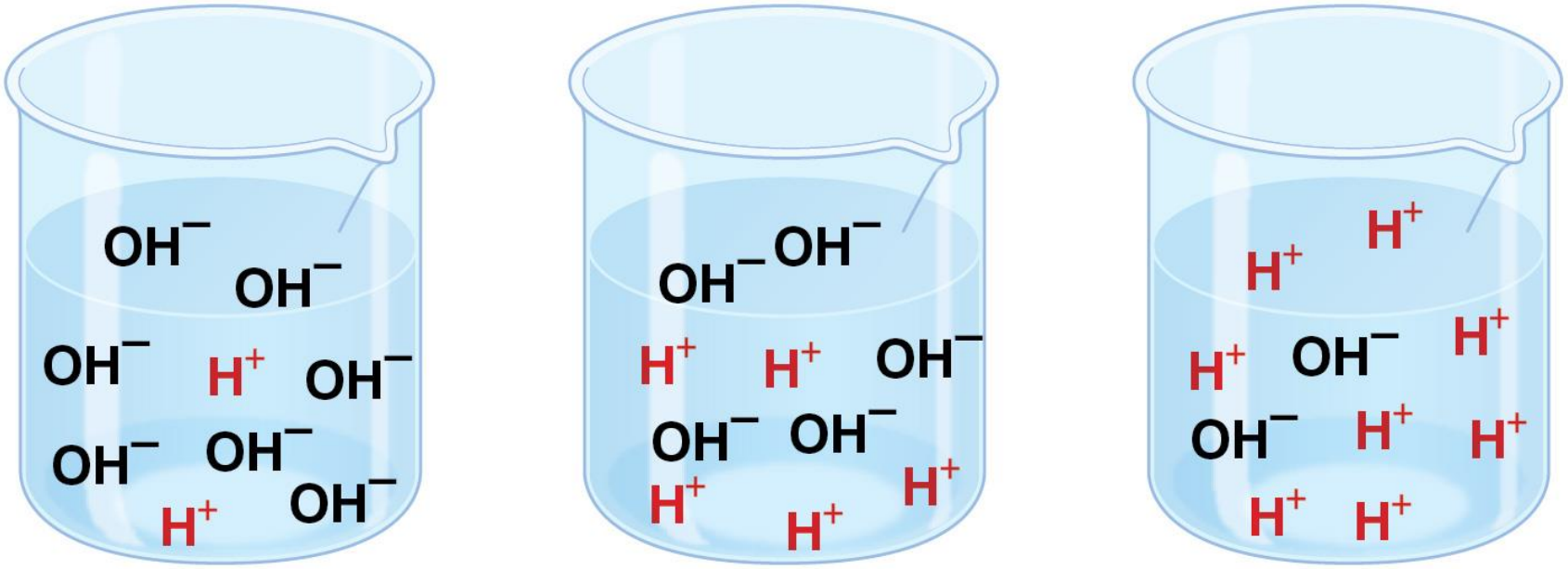
(LOSES PROTON) $H_2O - H^+ \rightarrow OH^-$ (HYDROXIDE ION)

ACIDS AND BASES

- ACID = INCREASES H^+ CONCENTRATION (HCl)
- BASE = REDUCES H^+ CONCENTRATION (NaOH)
- *Most biological fluids are pH 6-8*

pH Scale

H^+ AND OH^- IONS

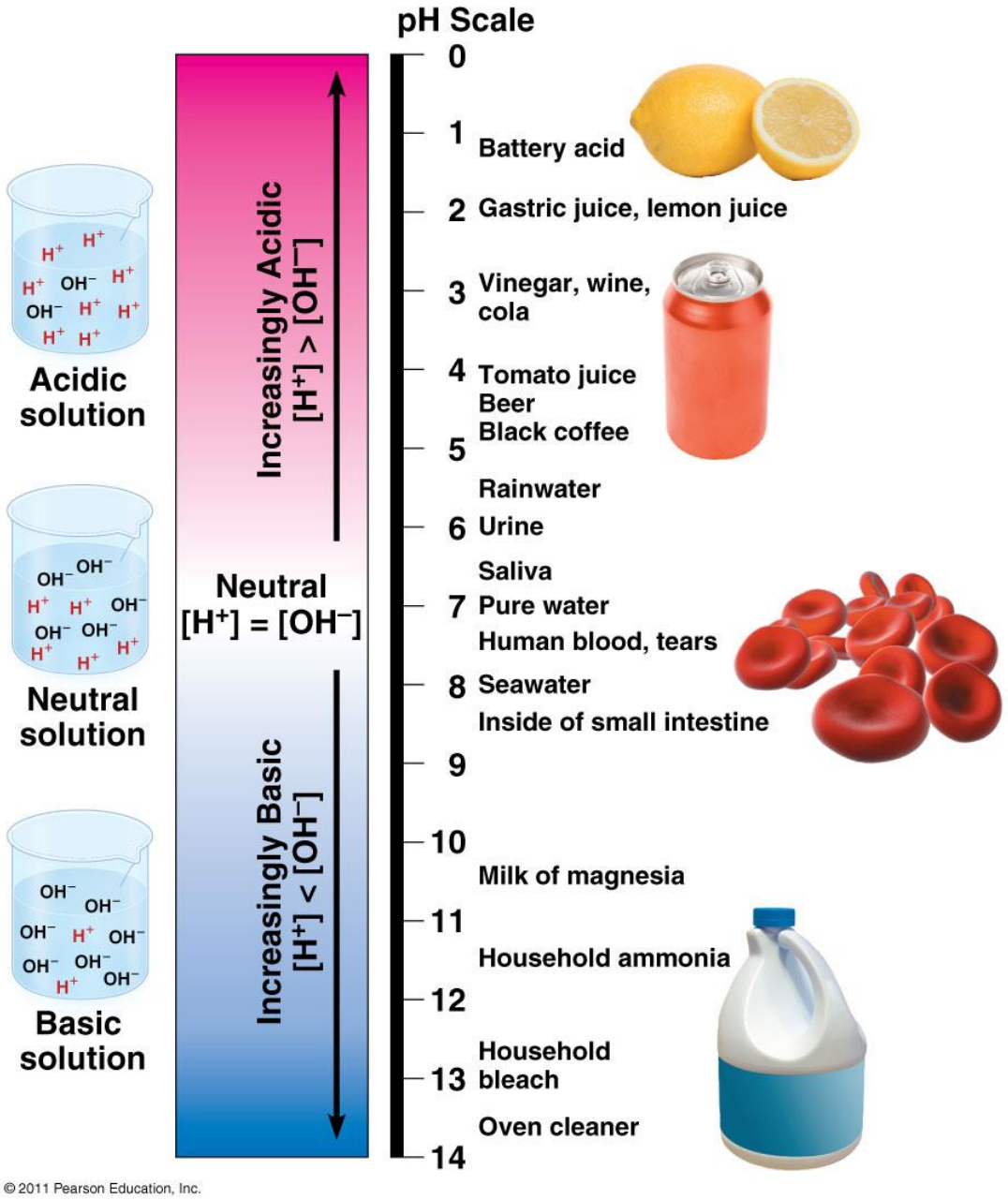


Basic solution

Neutral solution

Acidic solution

Figure 2.23 The pH scale and pH values of some aqueous solutions



CALCULATING pH

$$[H^+][OH^-] = 10^{-14}$$

* IF $[H^+] = 10^{-6}$ M, THEN $[OH^-] = 10^{-8}$

$$PH = -LOG\ [H^+]$$

1. IF $[H^+] = 10^{-2}$
   - $-LOG\ 10^{-2} = -(-2) = 2$
   - THEREFORE, pH = 2
2. IF $[OH^-] = 10^{-10}$
   - $[H^+] = 10^{-4}$
   - $-LOG\ 10^{-4} = -(-4) = 4$
   - THEREFORE, pH = 4

BUFFERS

BUFFERS: minimize changes in concentration of H^+ and OH^- in a solution (weak acids and bases)

- Buffers keep blood at ph ~7.4
- If blood drops to 7 or up to 7.8 → death

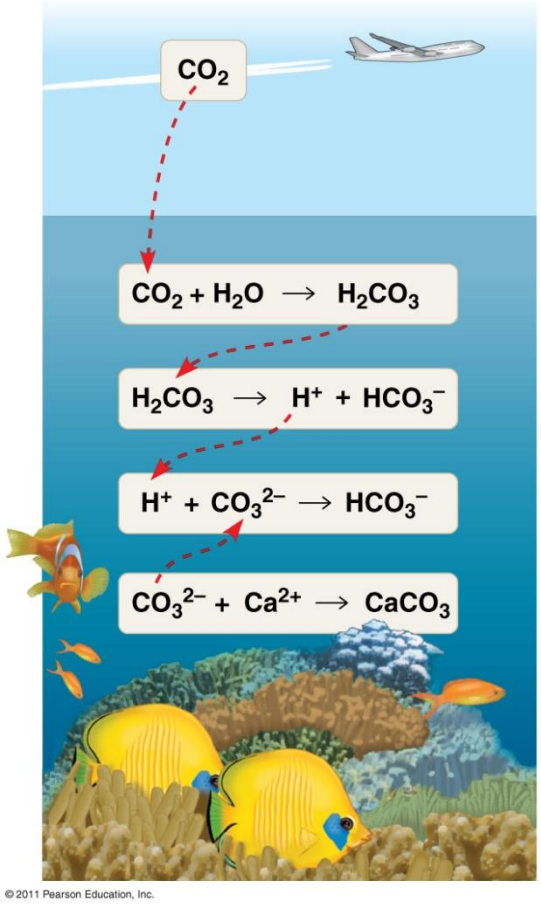
Carbonic acid – bicarbonate system:

- Important buffers in blood plasma

H_2CO_3 (CARBONIC ACID) → HCO_3^- (BICARBONATE) + H^+

OCEAN ACIDIFICATION:

Threat to Coral Reef Ecosystems



(a)

(b)

(c)

CO_2 + Seawater → Carbonic acid → Lowers ocean pH

H_2O Property	Chemical Explanation	Examples of Benefits to Life
Cohesion	•polar •H-bond •like-like	↑gravity plants, trees
Adhesion	•H-bond •unlike-unlike	plants→ xylem blood→veins
Surface Tension	•diff. in stretch •break surface •H-bond	bugs→water
Specific Heat	•Absorbs & retains E •H-bond	ocean→mod temp →protect marine life
Evaporation	•liquid→gas •KE	Cooling Homeostasis
Universal Solvent	•Polarity→ionic •H-bond	Good dissolver solvent