Chapter 2.4
Water—The Elixir of Life!

Why are we studying water?
- All life occurs in water
  - inside & outside the cell

Chemistry of water
- Water is a polar molecule
  - + & – poles
  - remember polar covalent bonds

Chemistry of water
- H₂O molecules form H bonds with each other
  - + attracted to –
  - creates a sticky molecule

Cohesion
- H bonding between H₂O creates cohesion
  - water is “sticky”
  - surface tension
  - drinking straw
    - can you suck sugar up a straw?

How does H₂O get to top of tree?
- Transpiration
**Adhesion**
- H₂O molecules form H bonds with other substances
  - capillary action
  - meniscus
  - water climbs up fiber
    - ex. paper towel

**Water is the solvent of life**
- H₂O is a good solvent due to its polarity
  - polar H₂O molecules surround + & – ions
  - solvents dissolve solutes creating aqueous solutions

**Hydrophilic**
- Hydrophilic
  - substances have affinity for H₂O
  - polar or non-polar?
  - ionic

**Hydrophobic**
- Hydrophobic
  - substances do not have affinity for H₂O
  - polar or non-polar?
  - non-ionic

**The special case of ice**
- Most (all?) substances are more dense when they are solid
- But not water…
- Ice floats!
  - H bonds form a crystal with loose structure

**Why is “ice floats” important?**
- Oceans & lakes don’t freeze solid
  - if ice sank…
    - eventually all ponds, lakes & even ocean would freeze solid
    - during summer, only upper few inches would thaw
  - surface ice insulates water below
    - allowing life to survive the winter
  - seasonal turnover of lakes
    - cycling nutrients
Specific heat
- \(\text{H}_2\text{O}\) has high specific heat
  - due to H bonding
- \(\text{H}_2\text{O}\) resists changes in temperature
  - takes a lot to heat it up
  - takes a lot to cool it down
- \(\text{H}_2\text{O}\) moderates temperatures on Earth

Evaporative cooling
- Organisms rely on heat of vaporization to remove heat

Water forms ions
- Hydrogen ion (\(\text{H}^+\)) splits off from water to leave a hydroxide ion (\(\text{OH}^-\))
  \[\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-\]
- If concentration of 2 ions is equal, water is neutral
- If [\(\text{H}^+\)] > [\(\text{OH}^-\)], water is acidic
- If [\(\text{OH}^-\)] > [\(\text{H}^+\)], water is basic
- pH scale = how acidic or basic a solution is

pH Scale
- In neutral solution \([\text{H}^+] = 10^{-7}\) \(\rightarrow\) \(\text{pH} = 7\)
- Values for pH decline as [\(\text{H}^+\)] increase
- Acids
  - adding acid increases [\(\text{H}^+\)]
- Bases
  - adding base increases [\(\text{OH}^-\)]

pH & Biology
- pH of a neutral solution = 7
- Acidic solutions = pH < 7
- Basic solutions = pH > 7
- Most biological fluids have pH 6 – 8
  - pH values in human stomach can reach 2
- Each pH unit represents a 10-fold difference in [\(\text{H}^+\)] & [\(\text{OH}^-\)] concentrations.
  - Small change in pH actually indicates a substantial change in [\(\text{H}^+\)] & [\(\text{OH}^-\)]

Importance of Water
- Water is a polar molecule
- The special properties of water make life on Earth possible
- The chemical behavior of water governs how organisms function