AP Biology

Chemistry of Life

Properties of Water

Why are we studying water?

All life occurs in water
- inside & outside the cell

More about Water

Elixir of Life

• Special properties of water
  1. cohesion & adhesion
     • surface tension, capillary action
  2. good solvent
     • many molecules dissolve in H₂O
  3. lower density as a solid
     • ice floats!
  4. high specific heat
     • water stores heat
  5. high heat of vaporization
     • heats & cools slowly

Chemistry of water

• H₂O molecules form H-bonds with each other
  – +H attracted to –O
  – creates a sticky molecule

1. Cohesion & Adhesion

• Cohesion
  – H bonding between H₂O molecules
  – water is “sticky”
    • surface tension
• Adhesion
  – H bonding between H₂O & other substances
    • capillary action
    • menticut
    • water climbs up paper towel or cloth
    • Drinking straw

How does H₂O get to top of trees?

Transpiration is built on cohesion & adhesion

Ice! I could use more ice!
2. Water is the solvent of life

- Polarity makes H₂O a good solvent
  - polar H₂O molecules surround + & – ions
  - solvents dissolve solutes creating solutions

What dissolves in water?

- **Hydrophilic**
  - substances have attraction to H₂O
  - polar or non-polar?

What doesn’t dissolve in water?

- **Hydrophobic**
  - substances that don’t have an attraction to H₂O
  - polar or non-polar?

3. 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

- H bonds are stable

Why is “ice floats” important?

- Oceans & lakes don’t freeze solid
  - *surface ice insulates water below*
    - allowing life to survive the winter
  - if ice sank...
    - ponds, lakes & even oceans would freeze solid
    - in summer, only upper few inches would thaw
  - *seasonal turnover of lakes*
    - sinking cold H₂O cycles nutrients in autumn
4. Specific heat

- \( \text{H}_2\text{O} \) resists changes in temperature
  - high specific heat
  - takes a lot to heat it up
  - takes a lot to cool it down

- \( \text{H}_2\text{O} \) moderates temperatures on Earth

5. Heat of vaporization

- Water ionizes
  - \( \text{H}^+ \) splits off from \( \text{H}_2\text{O} \), leaving \( \text{OH}^- \)
    - if \([\text{H}^+] = [\text{OH}^-]\), water is neutral
    - if \([\text{H}^+] > [\text{OH}^-]\), water is acidic
    - if \([\text{H}^+] < [\text{OH}^-]\), water is basic

- \( \text{pH} \) scale
  - how acid or basic solution is
  - \( 1 \rightarrow 7 \rightarrow 14 \)

Ionization of water & \( \text{pH} \)

- Dissociation of water
  - \( \text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^- \)

Buffers & cellular regulation

- \( \text{pH} \) of cells must be kept \( \sim 7 \)
  - \( \text{pH} \) affects shape of molecules
  - shape of molecules affect function
  - \( \text{pH} \) affects cellular function

- Control \( \text{pH} \) by buffers
  - reservoir of \( \text{H}^+ \)
    - donate \( \text{H}^+ \) when [\( \text{H}^+ \)] falls
    - absorb \( \text{H}^+ \) when [\( \text{H}^+ \)] rises

- \( \text{H}^+ \) ion concentration & examples of solutions

- \( \text{pH} \) scale & examples of solutions

- Buffers & cellular regulation

- Tenfold change in \( \text{H}^+ \) ions

- \( \text{pH} \) scale & examples of solutions

- Buffers & cellular regulation
Do one brave thing today...then run like hell!

He's gonna earn a Darwin Award!

Any Questions?