General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

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OER

Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:

Exams (4): 20% Each
Quizzes: 20% Average

Recap: Lecture 4

1. Atomic Structure: P, N, E

Atomic Number (# of Protons)
Atomic Mass (# of Protons + Neutrons)
Atomic Charge (# of Protons- # Electrons)

$^{15}_{7}N$

2. Electron spacing

1) Valence Electrons – Outer most electrons
2) First Orbital – up to 2 electrons (H, He)
3) Following Orbitals (Octet) – up to 8 Electrons

3. Molecules

1) Two or more elements combine H_2O, $C_6H_{12}O_6$
2) Ionic bond is formed from the transfer of electron
3) Covalent bond is formed from sharing of electrons

4. Redox – Reduction/Oxidation

1) LEO/GER
2) Reduction – Gain of Hydrogen (H^-)
3) Oxidation – Loss of Hydrogen (H^-)
4) Oxidation – Addition of Oxygen $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
5) Reduction – Loss of Oxygen $CO_2 + 2H_2 \rightarrow CH_4 + O_2$

5. Periodic Table: Dmitri Mendeleev (1860's)

Fox breeding: Dmitri Belyaev (1950's)

Pauling Electronegativity Values

1 **H** 2.20																
3 **Li** 0.98	4 **Be** 1.57											5 **B** 2.04	6 **C** 2.55	7 **N** 3.04	8 **O** 3.44	9 **F** 3.98
11 **Na** 0.93	12 **Mg** 1.31											13 **Al** 1.61	14 **Si** 1.90	15 **P** 2.19	16 **S** 2.58	17 **Cl** 3.16
19 **K** 0.82	20 **Ca** 1.00	21 **Sc** 1.36	22 **Ti** 1.54	23 **V** 1.63	24 **Cr** 1.66	25 **Mn** 1.55	26 **Fe** 1.83	27 **Co** 1.88	28 **Ni** 1.91	29 **Cu** 1.90	30 **Zn** 1.65	31 **Ga** 1.81	32 **Ge** 2.01	33 **As** 2.18	34 **Se** 2.55	35 **Br** 2.96
37 **Rb** 0.82	38 **Sr** 0.95	39 **Y** 1.22	40 **Zr** 1.33	41 **Nb** 1.6	42 **Mo** 2.16	43 **Tc** 1.9	44 **Ru** 2.2	45 **Rh** 2.28	46 **Pd** 2.20	47 **Ag** 1.93	48 **Cd** 1.69	49 **In** 1.78	50 **Sn** 1.96	51 **Sb** 2.05	52 **Te** 2.1	53 **I** 2.66
55 **Cs** 0.79	56 **Ba** 0.89	57 **La** 1.1	72 **Hf** 1.3	73 **Ta** 1.5	74 **W** 2.36	75 **Re** 1.9	76 **Os** 2.2	77 **Ir** 2.20	78 **Pt** 2.28	79 **Au** 2.54	80 **Hg** 2.00	81 **Ti** 1.62	82 **Pb** 2.33	83 **Bi** 2.02	84 **Po** 2.0	85 **At** 2.2
87 **Fr** 0.7	88 **Ra** 0.9															

https://www.youtube.com/watch?v=LcUNYGdNKlo&list=RDLcUNYGdNKlo#t=10

Bio 1101-Lecture 5

Fall 2017

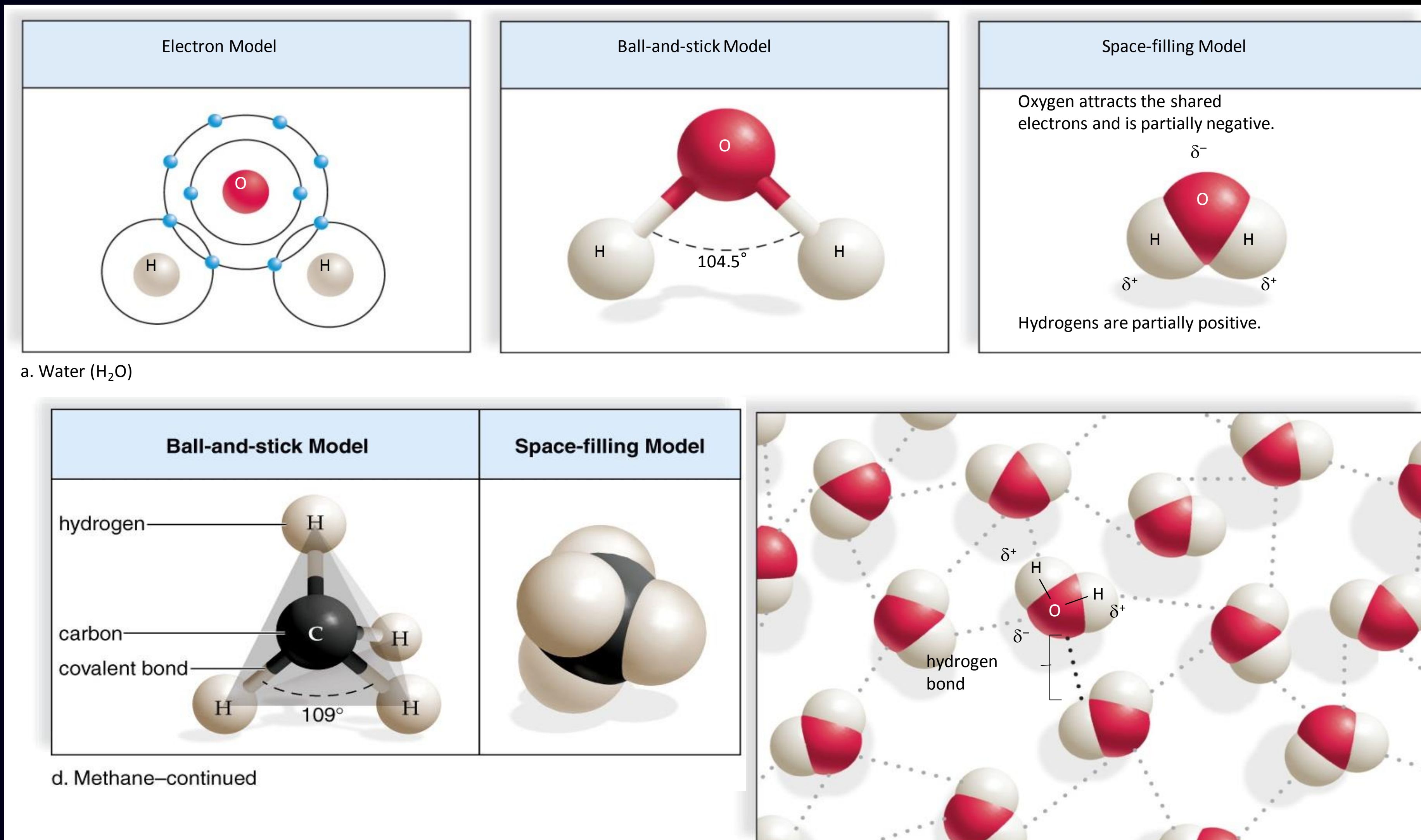
WATER & pH

The Molecule that supports Life

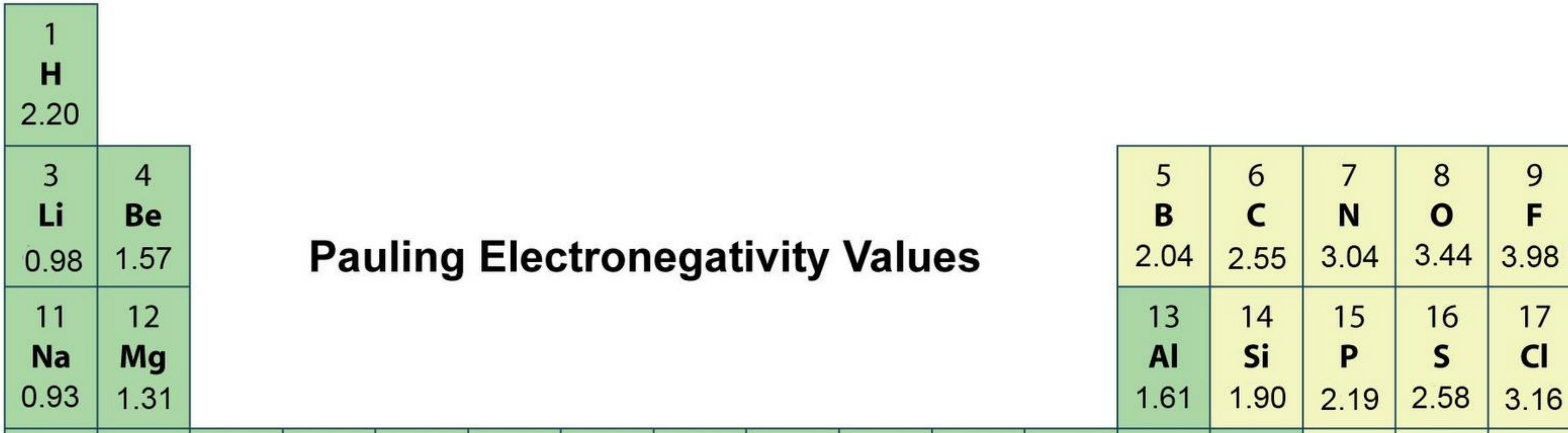
- H_2O – dihydrogen monoxide
- 70-75% of earth's surface is under water!
- 70-95% of all cells are water!
- The abundance of water is the main reason the Earth is habitable
- The polarity of water allows hydrogen bonding

http://www.dhmo.org/facts.html

Water Molecule, H_2O



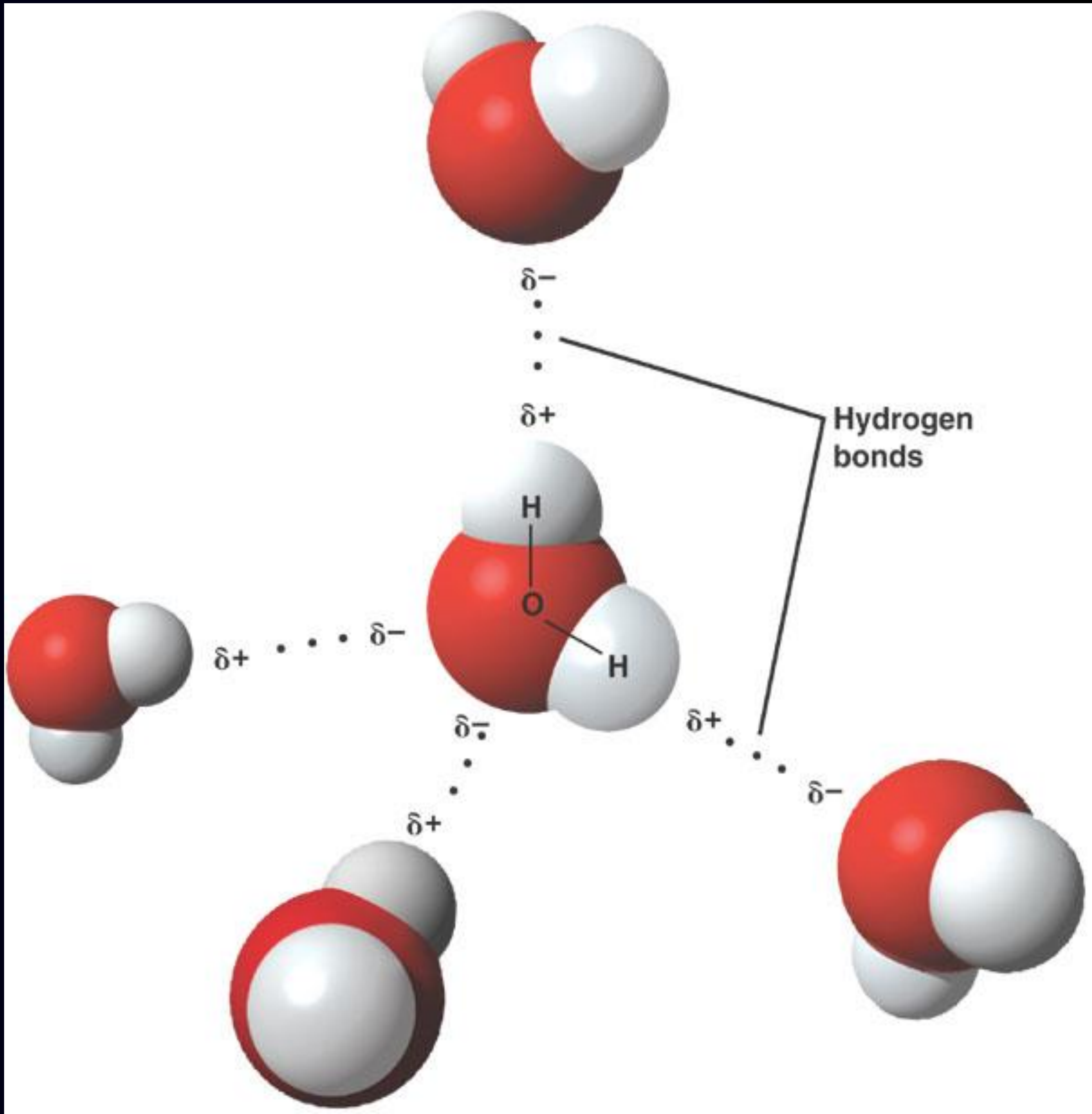
Review of Hydrogen bonding



- The oxygen atom is more **electronegative** than the hydrogen atom, so the electrons are "pulled" more towards the oxygen.
- The oxygen atom has a partial negative charge, the hydrogens have a partial positive charge
- This causes weak, temporary attraction between molecules

Hydrogen bonding and water

One molecule of water can be involved in 4 hydrogen bonds

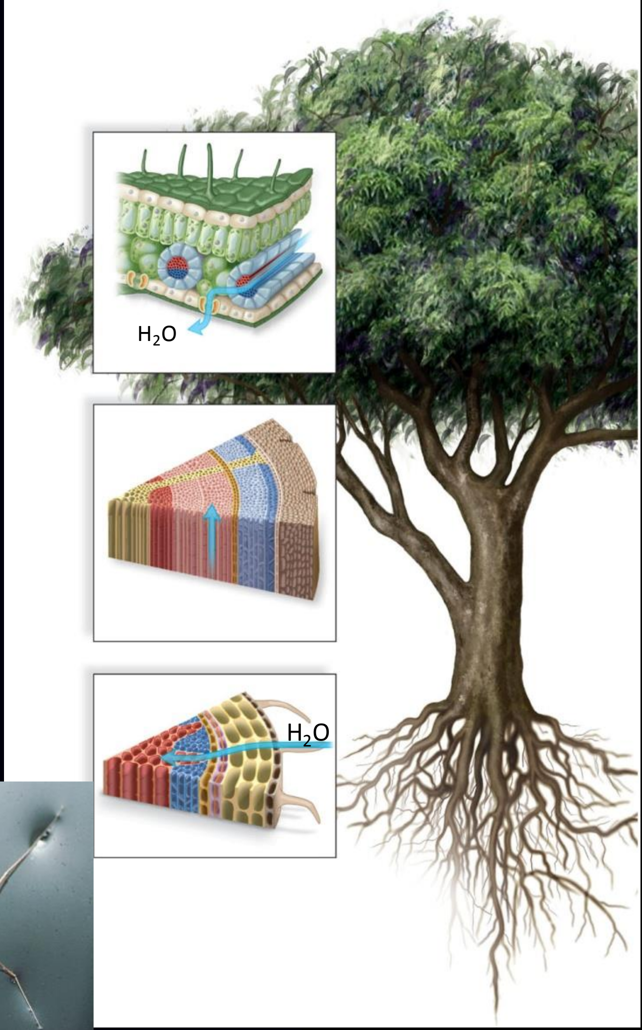


The Molecule that supports Life

- Four central properties of water that allow life:
  - Cohesion & Adhesion
  - Moderation of Temperature
  - Ice Floats!
  - Polar Solvent

Properties of Water
Cohesion & Adhesion

- Collectively, hydrogen bonds hold water molecules together, a phenomenon called **cohesion**
- Cohesion helps the transport of water against gravity in plants
  - Capillary Action
- **Adhesion** of water to plant cell walls also helps to counter gravity
- **Surface tension** is a measure of how hard it is to break the surface of a liquid
- Surface tension is related to cohesion



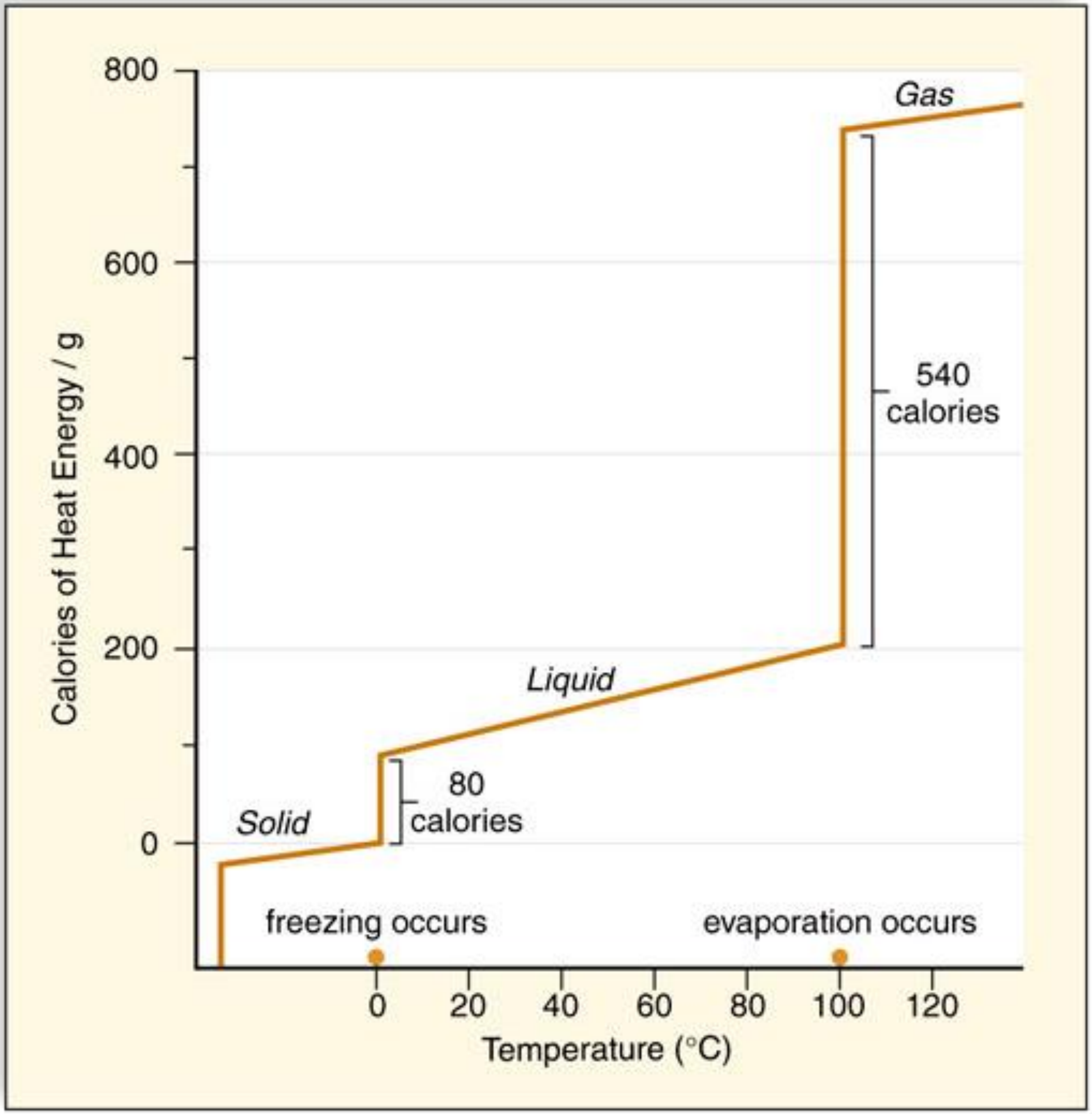
Unique Properties of Water
Moderation of Temperature

- Water absorbs heat from warmer air and releases stored heat to cooler air
- Water can absorb or release a large amount of heat with only a slight change in its own temperature

- **Thermal inertia** – resistance to temperature change
  - More heat required to raise water one degree than most other liquids (1 calorie per gram)
  - 1 **calorie** = amount of heat energy needed to raise the temp. of 1 gram of water 1° C per gram)

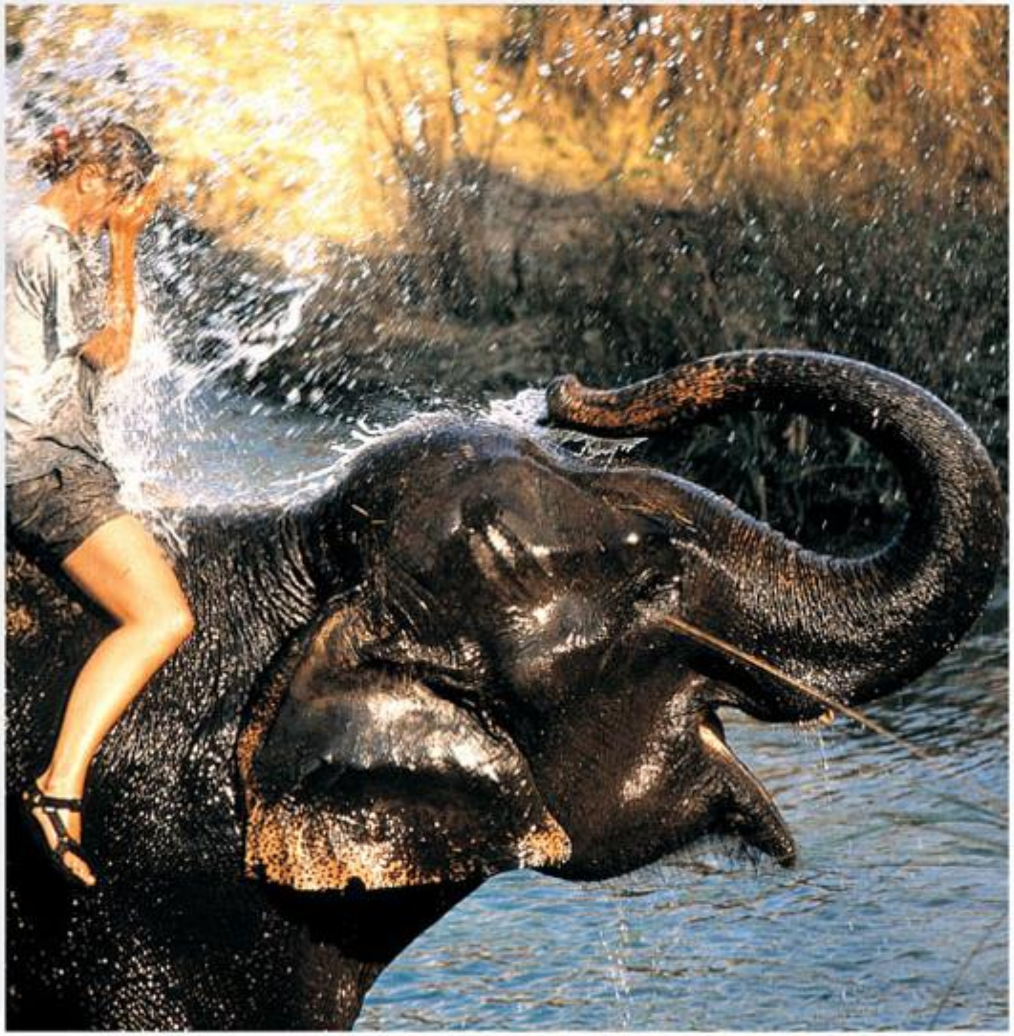
Water's High Specific Heat

- The **specific heat** of a substance is the amount of heat that must be absorbed or lost for 1 gram of that substance to change its temperature by 1ºC (in calories/g/ºC)
- Water's high specific heat (1 cal/g/ºC) minimizes temperature fluctuations to within limits that permit life
  - Heat is absorbed when hydrogen bonds break
  - Heat is released when hydrogen bonds form



a. Calories lost when 1 g of liquid water freezes and calories required when 1 g of liquid water evaporates.

Evaporative Cooling of Animals

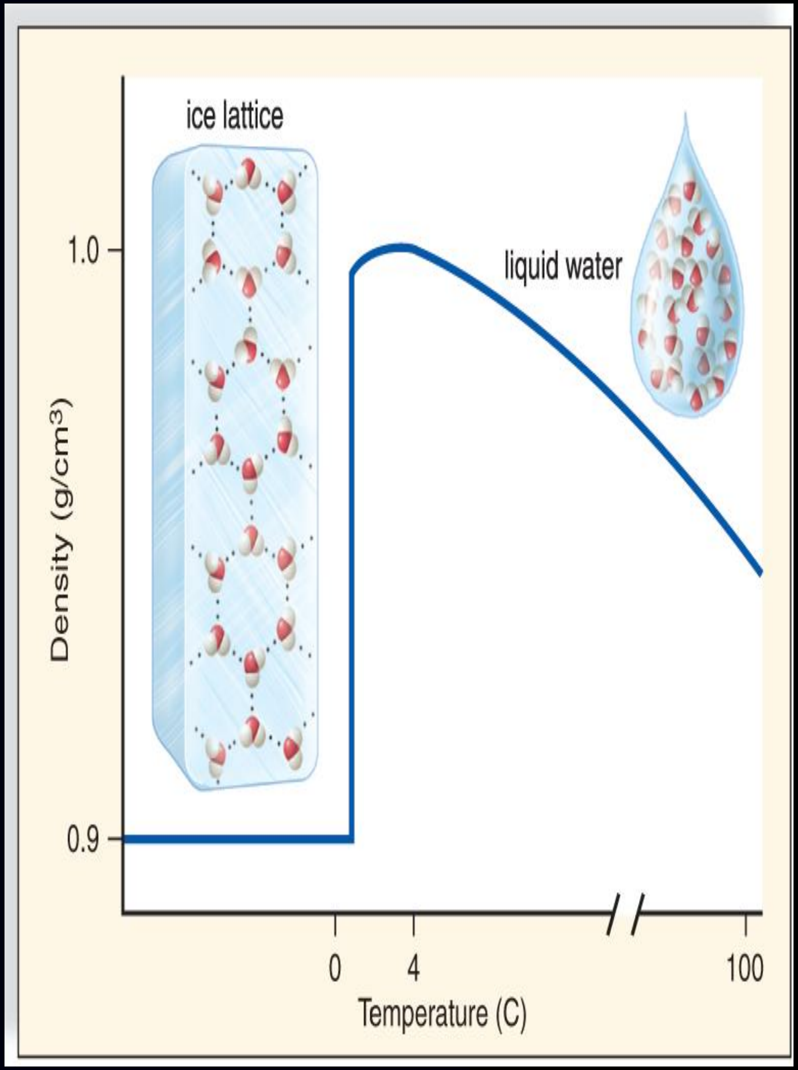


b. Bodies of organisms cool when their heat is used to evaporate water.

- As a liquid evaporates, its remaining surface cools, a process called **<u>evaporative cooling</u>**

Properties of Water: **Uniqueness of Ice**

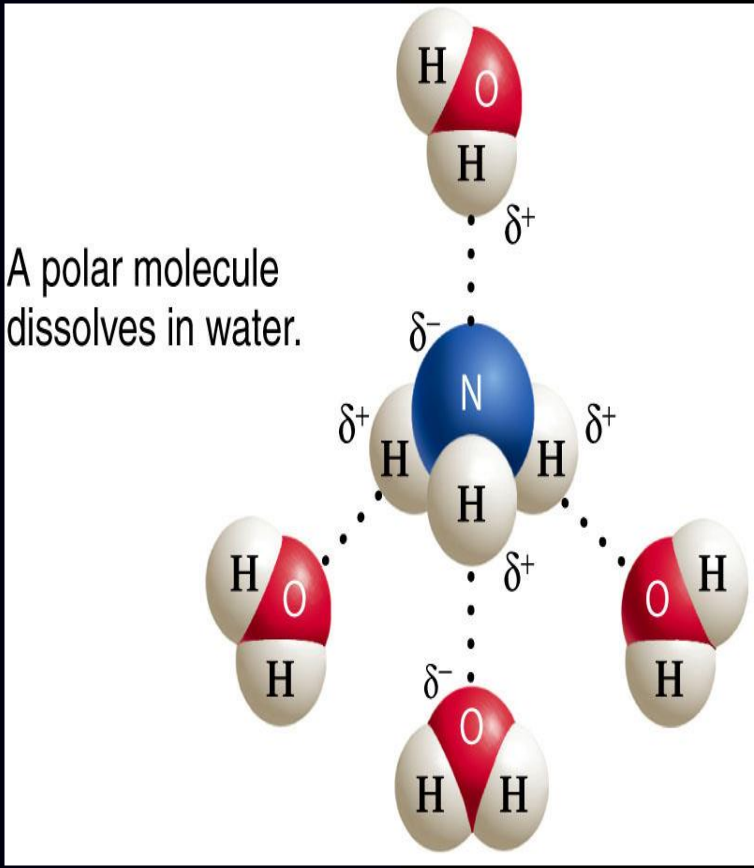
- **Frozen water less dense than liquid water**
  - Below 4ºC, water begins to form a “lattice” that is LESS dense than liquid water = hydrogen bonds in ice are more “ordered,” making ice less dense
- Otherwise, oceans and deep lakes would fill with ice from the bottom up
- Ice acts as an insulator on top of a frozen body of water
- Melting ice draws heat from the environment



Unique Properties of Water: **Solvent of Life**

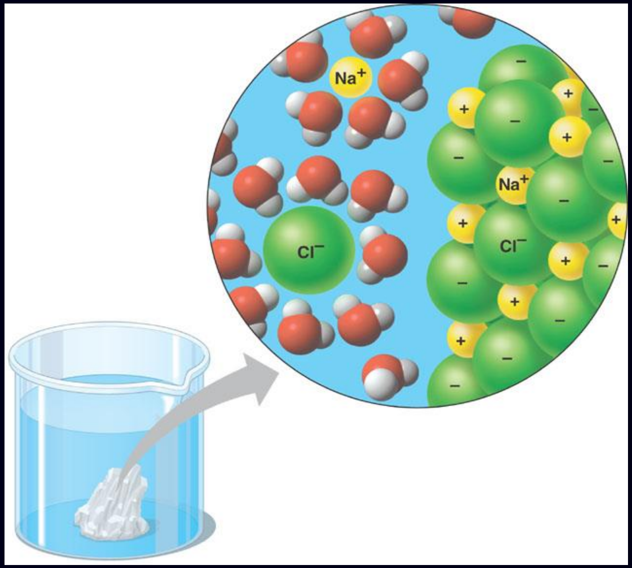
Definitions

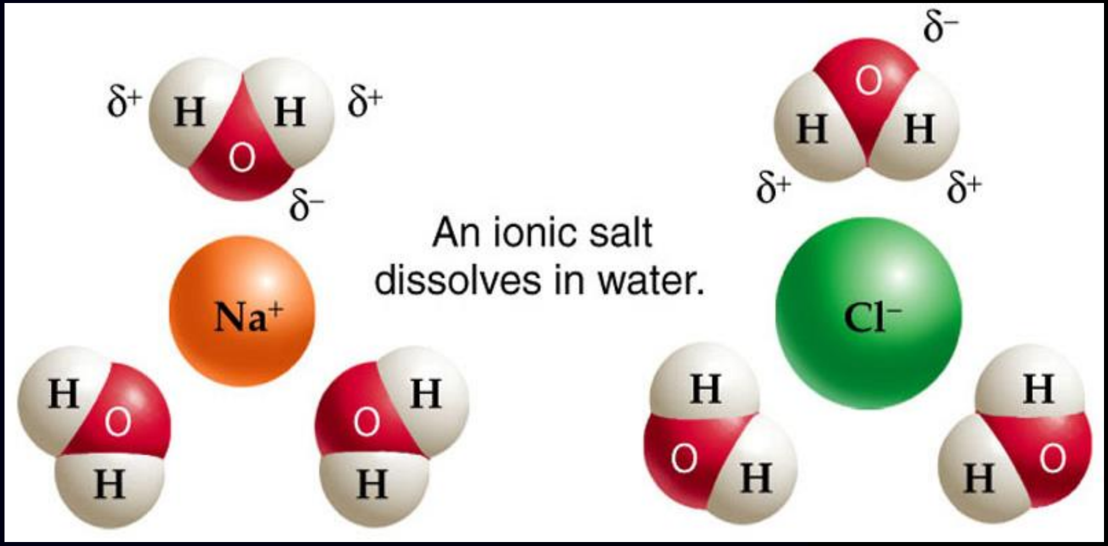
- A **solution** is a liquid that is a homogeneous mixture of substances
- A **solvent** is the dissolving agent of a solution
- The **solute** is the substance that is dissolved
- An **aqueous solution** is one in which water is the solvent
- Polar compounds readily dissolve; **hydrophilic**
- Nonpolar compounds dissolve only slightly; **hydrophobic**



Water as a solvent

- Water is a POLAR solvent
  - Water is an effective solvent because it readily forms hydrogen bonds
  - When an ionic compound is dissolved in water, each ion is surrounded by a sphere of water molecules





Na^{+}: Attracted to negative (O) end of H_2O
Each Na^{+} completely surrounded by H_2O

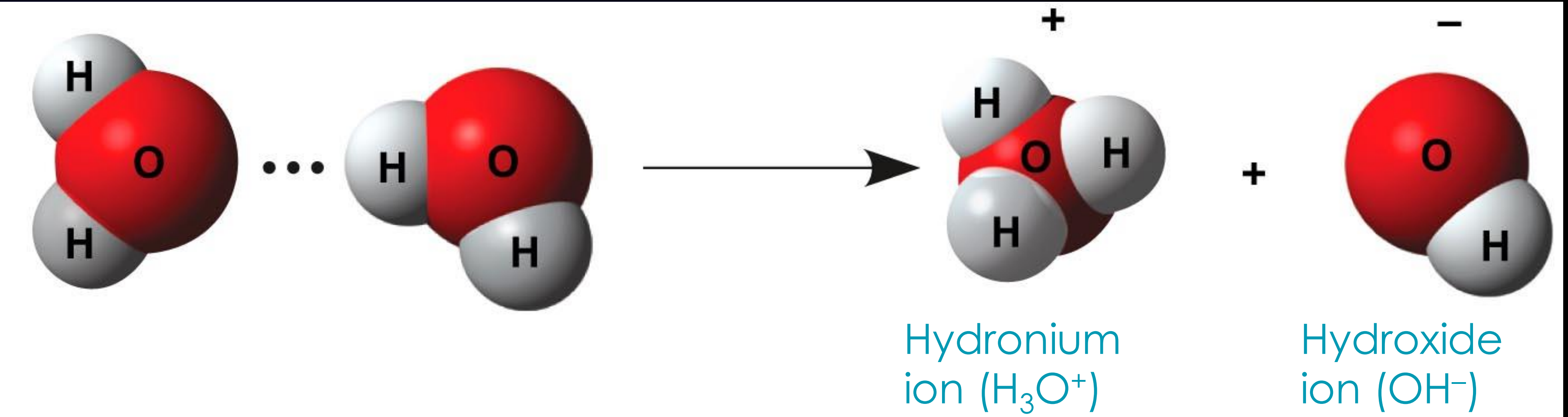
Cl^{-}: Attracted to positive (H_2) end of H_2O
Each Cl^{-} completely surrounded by H_2O

What is the pH scale?

- A measure of hydrogen ion (H^+) concentration
- Working scale is between 0 and 14 with 7 being neutral
- A pH below 7 is acidic and above 7 is basic
- The concentration of hydrogen (H^+) ions between each whole number changes by a factor of 10

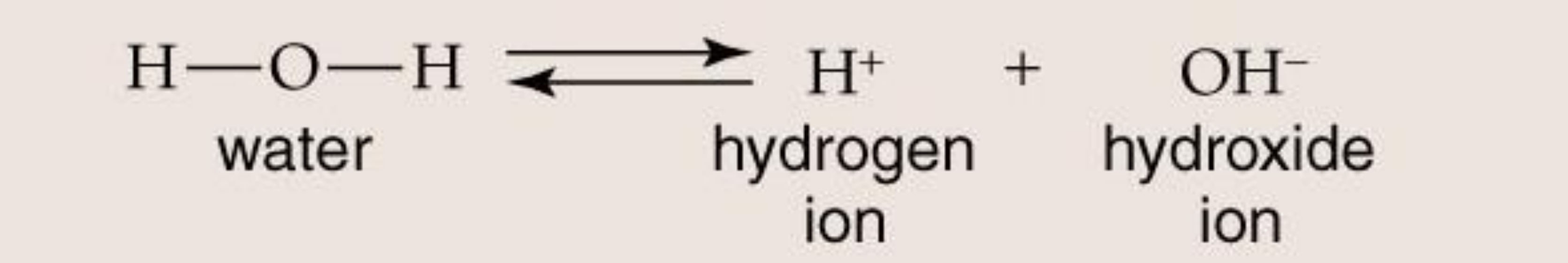
Water and pH

- In a solution, some water molecules dissociate into (OH^-) and (H^+) ions = A hydrogen atom in a hydrogen bond between two water molecules can shift from one to the other
  - The **hydrogen** atom leaves its electron behind and is transferred as **a proton, or hydrogen ion (H^+)**
  - Actually, the **H^+ ions** bind to another water and become **H_3O^+**, but we can ignore this.
  - The molecule that **lost the proton** is now a **hydroxide ion (OH^-)**



Water and pH

- The process can be described in a simplified way as the separation of a water molecule into a hydrogen ion (H^+) and a hydroxide ion (OH^-)



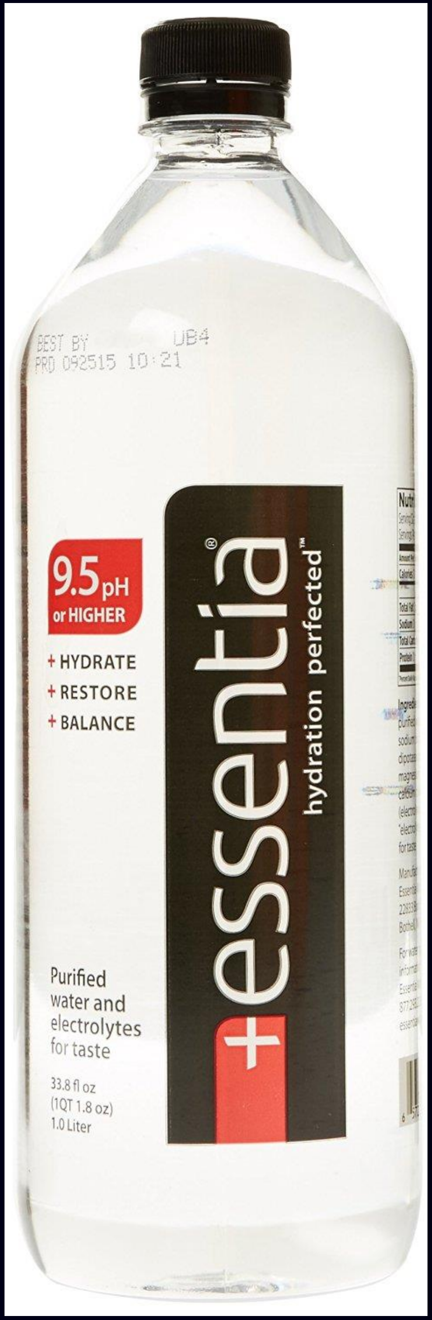
- These ions, OH- and H+, (while very rare) are EXTREMELY important
  - They are very reactive
  - They establish acid-base reactions **in** **aqueous solutions**
  - Changes in concentrations of H^+ and OH^- can drastically affect the chemistry of a cell

Water and pH

- Concentrations of H^+ and OH^- are equal in pure water
- In aqueous solutions, adding certain solutes, called **acids and bases**, modifies the concentrations of H^+ and OH^-
- Biologists use something called the **pH scale** to describe the concentration of these ions a solution
- The pH of a solution is dependent on H^+ ions:
  - **pH = -log[H $^+$] (in M),** **[H $^+$]** = 10^{-pH} or $1/10^{pH}$ AND…
  - $[H^+] \times [OH^-] = 10^{-14}$ M (M = mol/L)

	[H+] (moles per liter)	pH
0.000001	$= 1 \times 10^{-6}$	6
0.0000001	$= 1 \times 10^{-7}$	7
0.00000001	$= 1 \times 10^{-8}$	8

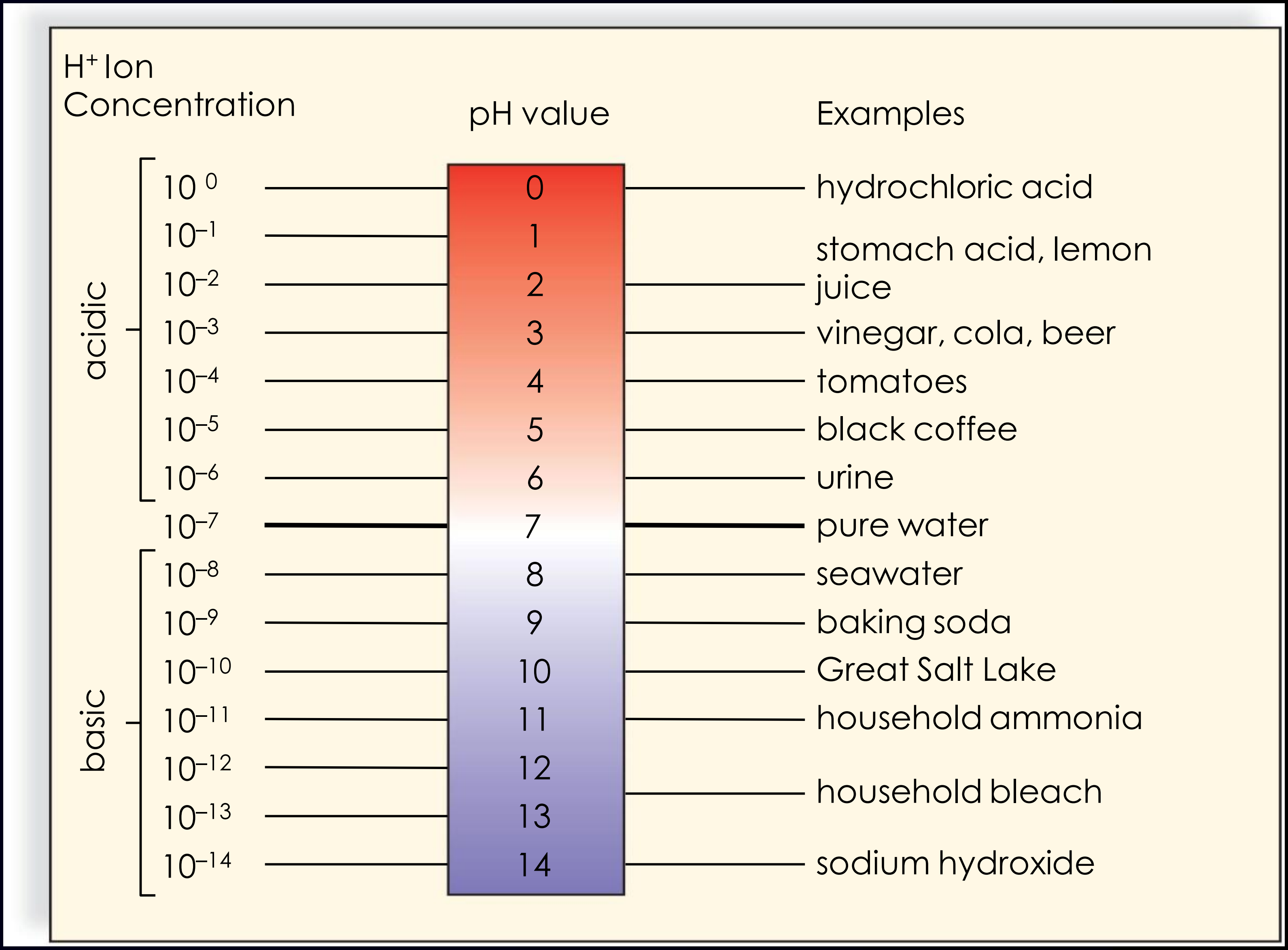
High or Low pH ?



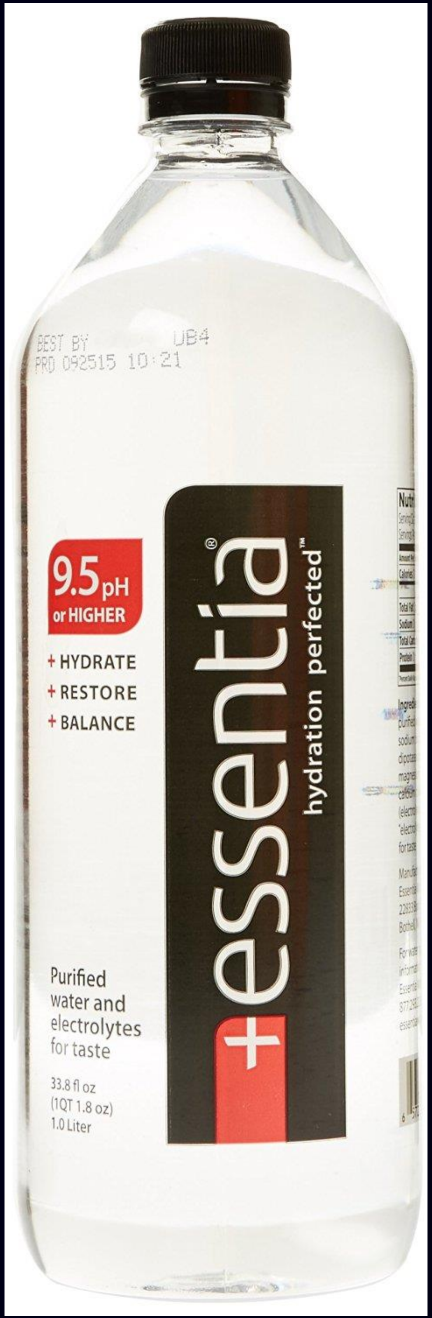
Water and pH

- The pH of a solution is dependent on H^+ ions:
  - pH = -log[H^+] (in M)   AND…   [H^+] x [OH^-] = 10^{-14} M (M = mol/L)
  - In pure water, [H^+] = 10^{-7} M, and [OH^-] = 10^{-7} M
  - Thus, pH of 7 means [H^+] = [OH^-]. We call this **neutral**.
  - [H^+] > [OH^-], then the **pH<7 = ACIDIC**
  - [H^+] < [OH^-], then the **pH>7 = BASIC**
  - Most biological fluids have pH values in the range of 6 to 8

The pH Scale



H+ Ion Concentration
pH value
Examples
acidic
basic
10 0
10–1
10–2
10–3
10–4
10–5
10–6
10–7
10–8
10–9
10–10
10–11
10–12
10–13
10–14
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
hydrochloric acid
stomach acid, lemon juice
vinegar, cola, beer
tomatoes
black coffee
urine
pure water
seawater
baking soda
Great Salt Lake
household ammonia
household bleach
sodium hydroxide



Acidic or Basic?

Acids and Bases

- Acid = something that increases $[H^+]$, lowers $[OH^-]$, and thus… lowers pH
- Base = something that increases $[OH^-]$, lowers $[H^+]$, and thus… raises pH
- A STRONG Acid or base COMPLETELY dissociates in solution
  - E.g. HCl (acid), NaOH (base)
- Weak Acid/base does NOT completely dissociate
  - e.g., acid… $H_2CO_3 \leftarrow\rightarrow H^+ + HCO_3^-$.
  - base… $NH_3 + H^+ \leftarrow\rightarrow NH_4^+$.

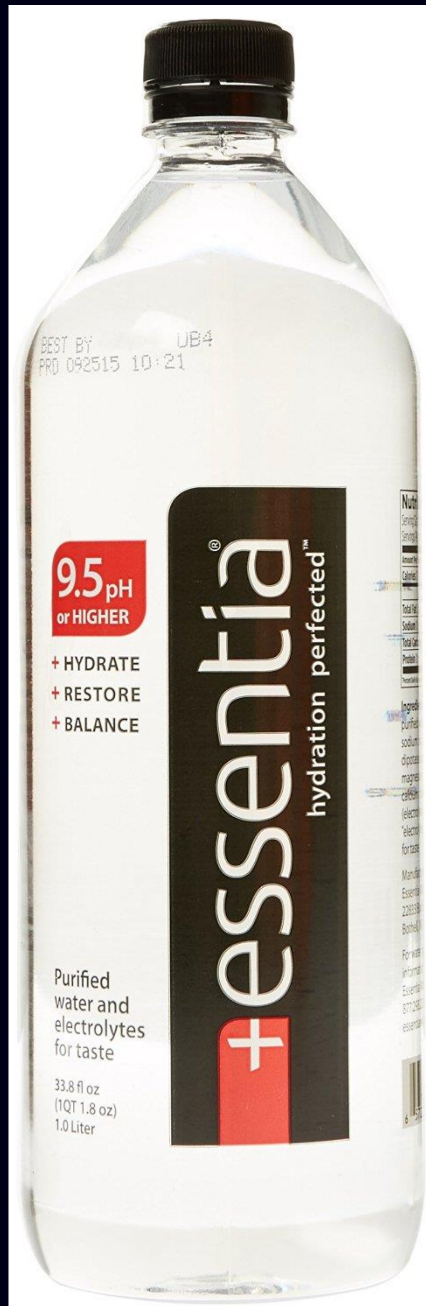
pH buffers

- Substances that resist pH changes in a solution
- Work by absorbing/donating H^+ ions
- A combination of weak acid and conjugate base (or vice versa) that have an "ideal" pH.
- Example: Carbonic Acid ←→ Bicarbonate
  - $H_2CO_3 \leftrightarrow H^+ + HCO_3^-$.
- Blood has several buffering agents that keep the pH at 7.4… it is VERY resistant to change!

Buffers in Biology

- Health of organisms requires maintaining pH of body fluids within narrow limits
  - Human blood normally 7.4 (slightly alkaline)
  - Many foods and metabolic processes add or subtract H^+ or OH^- ions
    - Reducing blood pH to 7.0 results in acidosis
    - Increasing blood pH to 7.8 results in alkalosis
    - Both life threatening situations
  - Bicarbonate ion ($^-HCO_3$) in blood buffers pH to 7.4

Is high pH water healthy?



The threat of Acid precipitation

- Acid precipitation refers to rain, snow, or fog with a pH lower than 5.6
- Acid precipitation is caused mainly by the mixing of different pollutants with water in the air
- Acid precipitation can damage life in lakes and streams
- Effects of acid precipitation on soil chemistry are contributing to the decline of some forests

Dangers of dihydrogen monoxide

- Dihydrogen Monoxide (DHMO) is a colorless and odorless chemical compound, also referred to by some as Dihydrogen Oxide, Hydrogen Hydroxide, Hydronium Hydroxide, or simply Hydric acid.
- 70-75% of earth's surface is covered by DHMO!
- Research conducted by award-winning U.S. scientist Nathan Zohner concluded that roughly 86 percent of the population supports a ban on dihydrogen monoxide.

What is DHMO and do you support this ban?

http://www.dhmo.org/facts.html