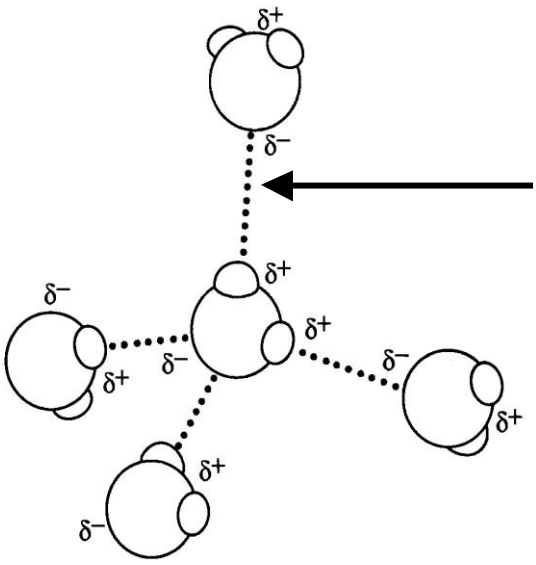
AP BIOLOGY NAME_____
BIOCHEMISTRY
Unit 2 Part 3 ACTIVITY #2 (Chapter 3) DATE_____PERIOD_____

WATER, ACIDS, BASES, BUFFERS

STRUCTURE AND GEOMETRY OF WATER:

Water is polar

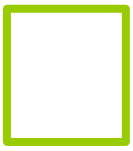
Maximum number of H bonds = 4
Each water molecule can form a max. of 4 hydrogen bonds with 4 other water molecules



PROPERTIES OF WATER:
Liquid water is **cohesive** Cohesion = H bonds between water molecules; H_2O molecules tend to stick together. Importance = Transport H_2O against gravity in plants Higher surface tension
Water has a **high specific heat** Takes a lot of energy to raise 1 gram of H_2O 1 ^oC Why? Must break H bonds Liquid H_2O can absorb large amounts of heat with small changes in temperature
Water has a **high heat of vaporization** Takes a lot of energy to convert liquid H_2O into vapor Why? Must break H bonds Keeps water in liquid state
Water expands with it freezes Solid H_2O is less dense than liquid H_2O Why? In solid state H_2O locked into max. number of H bonds; takes up more space
Water is a **versatile solvent** Will dissolve polar covalent and ionic compounds

DISSOCIATION OF WATER:

$H_2O + H_2O \leftrightarrow H_3O^+ + OH^-$



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

Hydronium ion Hydroxide ion

1 out of 554,000,000 water molecules dissociates

At equilibrium in pure water at 25°C

$[H^+] = [OH^-] = 1.0 \times 10^{-7}$ M

If add $[H^+]$ to pure water
- Removes OH-
- Equilibrium shifts left
- $[H^+] > [OH^-]$

If add $[OH^-]$ to pure water
- Removes H+
- Equilibrium shifts right
- $[OH^-] > [H^+]$
- reduces H+ indirectly

If add NH_3

$NH_3 + H^+ \rightarrow NH_4^+$

Reduces H+ directly

PH SCALE:

$pH = -\log_{10}[H^+]$

if $[H^+] = 10^{-7}$

then pH = 7

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

If $[H^+] = 10^{-9}$

Then $[OH^-] = 10^{-5}$

pOH=5 and pH = 9

BUFFERS:		
Description	**Function**	**Importance**
Weak acids or bases	Minimize changes in pH	Controls chemical reactions Maintains homeostasis

BICARBONATE BUFFER SYSTEM:

$$H_2O + CO_2 \leftarrow\rightarrow H_2CO_3 \leftarrow\rightarrow HCO_3^- + H^+$$

HCO_3- = Bicarbonate (weak base)
H_2CO_3 = Carbonic acid (weak acid)

Major buffer system in blood
Maintains blood pH between 7.38 and 7.42

Action:	**Effect:**
Increase $[H^+]$ How? Fat metabolism OD on acidic drug	Increase [H+] Equilibrium shifts left $H+ + HCO_3- \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$ Increase $[CO_2]$ Increase rate and depth of respiration
Increase Rate & Depth of Respiration Hyperventilate	Decrease $[CO_2]$ Equilibrium shifts left $H+ + HCO_3- \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$ Blood pH increases

QUESTIONS:

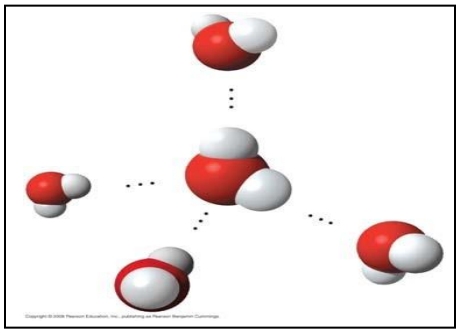
3.1

1. Explain why water is a polar molecule.

_____

_____

2. Explain how water is able to form 4 hydrogen bonds.



_____

_____

_____

_____

3. Add + and – signs to indicate the charged regions of *each water* molecule above. Then, indicate the hydrogen bonds.

3.2

4. List the 5 emergent properties of water.

_____

_____

_____

_____

_____

5. Define the following terms.

Cohesion	
Adhesion	

6. Why is water cohesive?

_____

_____

7. What is the biological importance of water's cohesive and adhesive properties?

_____

_____

8. Why does water have a greater degree of surface tension than most other liquids?

_____

_____

9. Why does water have a high specific heat?

_____

_____

10. What is the biological importance of water's high specific heat?

_____

_____

11. Why does water have a relatively high heat of vaporization?

_____

_____

12. What is the biological importance of water's relatively high heat of vaporization?

_____

_____

13. Why does water expand when it freezes?

_____

_____

14. Why does ice float?

_____

15. What is the biological importance of the expansion of water when it freezes?

_____

_____

16. Match the description/definition with the correct term.

A. Aqueous solution D. Solute
B. Hydrophilic E. Solution
C. Hydrophobic F. Solvent

_____ Homogenous mixture of 2 or more substances

_____ Dissolving agent

_____ Material being dissolved

_____ Solution where water is solvent

_____ Water loving; molecules with an affinity for water

_____ Water fearing; molecules that do not have an affinity for water

17. Why is water a versatile solvent?

_____

_____

18. In general, what kinds of materials will not dissolve in water?

_____

3.3

19. At equilibrium in pure water at 25°C:

    a. How does the $[H^+]$ compare to the [OH]? _____

    b. What is the $[H^+]$? _____

20. Each of the following will affect the equilibrium established in pure water during the dissociation of water. Describe what effect each will have on the equilibrium by completing the following chart.

Addition of:	Effect on $[H^+]$	Effect on $[OH^-]$	Direction Equilibrium Shifts
H_2SO_4			
KOH			
NH_3			

21. How does the $[H^+]$ compare to the $[OH^-]$ in each of the following:

    a. A neutral solution: _____

    b. An acidic solution: _____

    c. A basic solution: _____

20. Complete the following chart.

$[H^+]$	pH	$[OH^-]$	pOH
10^{-2}			
	4		
		10^{-4}	
			2

21. What is the pH range for most biological fluids? _____

    What fluid is the exception to this range? _____

22. A patient has been vomiting for a prolonged period of time.

a. What effect would this have on the $[H^+]$ in the blood? _____

b. How will the bicarbonate buffer system respond to this change?

_____

c. What effect will the buffer system response have on the rate of respiration?

_____

d. If the buffer system does not return the blood pH to within the normal range or if the vomiting continues, how will the kidneys respond?

Will the kidneys excrete or reabsorb H+?_____

Will the kidneys excrete or reabsorb HCO_3^-?_____

End of Chapter Synthesis and Evaluation Problems

Do problems 1-3, 5 and 16. Check and correct your answers to 1-3, 5

1._____
2._____
3._____
5._____

***__Question #16__ needs to be typed out, then answered in no more and no less than 100 to 150 words. Turn in separately to the tray. This is worth 20 points. Do not plagiarize. Use your own words and thoughts…but, use vocabulary terms and ideas taught in this chapter!

Study Guide/ISN (20 points)

In your study guide book, review pages 35-37. In your ISN, do the following: Title the page **Chapter 3 Water and Life Must Know!** In one color, copy down each of the must know items listed on page 34 in study guide leaving space underneath each to include in a different color a brief description, diagram, model or mnemonic device that will help you study for the unit test and more importantly the AP test in May.

Bozeman Science/Podcasts/ISN (See syllabus for format) **(20 points)**

1. Amoeba Sisters Properties of water
2. Bozeman Acids, Bases and pH.