Name _____ Per: _____

AP Biology Summer Assignment 2017-2018

AP Biology is a fast paced course that often requires learning a chapter or two a day from our textbook. Summer is a great time to be able to casually read an interesting science book other than a textbook! To get you thinking about science and the AP Biology curriculum, your summer assignment will involve reading a book of your choosing (from a given list) and making connections between the book and our AP Biology curriculum. This is Part 1 of the assignment.

Part 2 consists of reviewing/learning some important biochemistry material prior to the start of class. You will be responsible for actually knowing this material! We will be having a graded assessment on this material (date announced on the first day of school).

Do not wait until the end of the summer to start this! All requirements are clearly laid out for you. Follow the required formats and adhere to the given due dates. The end of this document has a checklist of items that must be complete for the assignment.

Part 1 of 2: Summer Reading and Curriculum Connections

Your 2 book choices include:

1. *The Inner Fish* by Neil Shubin
2. *Survival of the Sickest* by Dr. Sharon Moalem

The AP Biology curriculum has gone through a complete overhaul since 2012-2013. The course is focused around 4 Big Ideas:

Big Idea 1: The process of evolution drives the diversity and unity of life.

Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.

Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes.

Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.

Within each Big Idea are several Enduring Understandings, which are described further into numerous Essential Knowledge concepts. The new organization of the curriculum provides students explicit benchmarks in the enduring of biology as a systematic science. All four books address the 4 Big Ideas in a personal and intriguing nonfiction platform.

1. *Read* one of the 2 books listed

2. Choose passages from the book that *demonstrates* TWO (2) different Enduring Understandings per Big Idea. Since there are 4 Big Ideas, you must choose 8 passages (2/Big Idea) for 8 different Enduring Understandings. Please see the attached charts for explanation of the 4 Big Ideas, 17 Enduring Understandings and 55 Essential Knowledge's. This is the framework of our curriculum! The AP Biology Core Curriculum can also be accessed on the College Board website. Tip-it may be helpful to read through these items PRIOR to reading your book so that you understand what you are looking for! Here is the online link to the core curriculum: http://media.collegeboard.com/digitalServices/pdf/ap/10b_2727_AP_Biology_CF_WEB_110128.pdf

   Please use the attached sample format for your typed responses:
   The **heading** on your document must include the following:

   Name: _____
   Date of Submission: _____
   Teachers Name: _____
   Period: _____
   AP Biology Summer Assignment
   Name of Book: _____

3. *Explain* how each passage relates to the Enduring Understandings and the Big Ideas. Be specific and use examples within the reading to back up your explanations.

4. *Submit* your document on Turnitin.com. This requires you to have access to the class ID and password. This information will be posted on your teachers E-Board under the "Summer Assignment" tab. Follow the directions carefully for signing up and submission. Turnitin.com checks for plagiarism, a serious academic offense. Please keep in mind that your academic integrity and honesty is just as important as a grade. Points will be deducted if a certain level of plagiarism is picked up through Turnitin. **Students will receive a zero for the assignment if an unreasonable amount of work is copied from sources without proper citation**

Reading Assignment Format

***Note-line length is not an indicator for how long your response should be! They should be thought out and well written!**

Big Idea 1: The process of evolution drives the diversity and unit of life.

Passage 1:

_____

_____

Enduring Understanding (Number and Letter): _____
Explanation:

_____

_____

Passage 2:

_____

_____

Enduring Understanding (Number and Letter): _____
Explanation:

_____

_____

Complete this format for each of the 4 Big Ideas

Part 2 of 2: Learn About the Properties of Water!

The chemistry covered in this course, according to the College Board, is now considered prior knowledge. We expand on the chemistry you have learned in the past during our properties of water and biochemistry discussions. It will be up to you to learn/review Chapter 3 of our text book "Water and the Fitness of the Environment". *Note, it would be helpful for you to obtain our text book PRIOR to the summer to help you with this assignment! Although there are plenty of resources out there to help you, the text-book is your best guide! A text book may be signed out, just see an AP Biology teacher.

All responses must be handwritten. You may attach a separate sheet if you need more room for your answers. This section gets PRINTED OUT, STAPLED, AND HANDED IN on the FIRST DAY OF CLASS. All assignments for this part are attached

Appendix

AP Biology Concepts at a Glance

Big Idea 1: The process of evolution drives the diversity and unity of life.

Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution.	**Essential knowledge 1.A.1**: Natural selection is a major mechanism of evolution.
	Essential knowledge 1.A.2: Natural selection acts on phenotypic variations in populations.
	Essential knowledge 1.A.3: Evolutionary change is also driven by random processes.
	Essential knowledge 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics.
Enduring understanding 1.B: Organisms are linked by lines of descent from common ancestry.	**Essential knowledge 1.B.1**: Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
	Essential knowledge 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
Enduring understanding 1.C: Life continues to evolve within a changing environment.	**Essential knowledge 1.C.1**: Speciation and extinction have occurred throughout the Earth's history.
	Essential knowledge 1.C.2: Speciation may occur when two populations become reproductively isolated from each other.
	Essential knowledge 1.C.3: Populations of organisms continue to evolve.
Enduring understanding 1.D:The origin of living systems is explained by natural processes.	**Essential knowledge 1.D.1**:There are several hypotheses about the natural origin of life on Earth, each with supporting scientific evidence.
	Essential knowledge 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.

Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.	**Essential knowledge 2.A.1:** All living systems require constant input of free energy.
	Essential knowledge 2.A.2: Organisms capture and store free energy for use in biological processes.
	Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.
Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.	**Essential knowledge 2.B.1**: Cell membranes are selectively permeable due to their structure.
	Essential knowledge 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
	Essential knowledge 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.
Enduring understanding 2.C: Organisms use feedback mechanisms to regulate growth and reproduction, and to maintain dynamic homeostasis.	**Essential knowledge 2.C.1**: Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.
	Essential knowledge 2.C.2: Organisms respond to changes in their external environments.
Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.	**Essential knowledge 2.D.1**: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
	Essential knowledge 2.D.2: Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.
	Essential knowledge 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis.
	Essential knowledge 2.D.4: Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.
Enduring understanding 2.E: Many biological processes involved in growth, reproduction and dynamic homeostasis include temporal regulation and coordination.	**Essential knowledge 2.E.1**:Timing and coordination of specific events are necessary for the normal development of an organism, and these events are regulated by a variety of mechanisms.
	Essential knowledge 2.E.2:Timing and

	coordination of physiological events are regulated by multiple mechanisms.
	Essential knowledge 2.E.3:Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.

Enduring understanding 3.A: Heritable information provides for continuity of life.	**Essential knowledge 3.A.1:** DNA, and in some cases RNA, is the primary source of heritable information.
	Essential knowledge 3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.
	Essential knowledge 3.A.3:The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.
	Essential knowledge 3.A.4:The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.
Enduring understanding 3.B: Expression of genetic information involves cellular and molecular mechanisms.	**Essential knowledge 3.B.1**: Gene regulation results in differential gene expression, leading to cell specialization.
	Essential knowledge 3.B.2: A variety of intercellular and intracellular signal transmissions mediate gene expression.
Enduring understanding 3.C:The processing of genetic information is imperfect and is a source of genetic variation.	**Essential knowledge 3.C.1**: Changes in genotype can result in changes in phenotype.
	Essential knowledge 3.C.2: Biological systems have multiple processes that increase genetic variation.
	Essential knowledge 3.C.3: Viral replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.
Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals.	**Essential knowledge 3.D.1**: Cell communication processes share common features that reflect a shared evolutionary history.
	Essential knowledge 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.
	Essential knowledge 3.D.3: Signal transduction

	pathways link signal reception with cellular response.
	Essential knowledge 3.D.4: Changes in signal transduction pathways can alter cellular response.
Enduring understanding 3.E:Transmission of information results in changes within and between biological systems.	**Essential knowledge 3.E.1**: Individuals can act on information and communicate it to others.
	Essential knowledge 3.E.2: Animals have nervous systems that detect external and internal signals, transmit and integrate information, and produce responses.

Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.

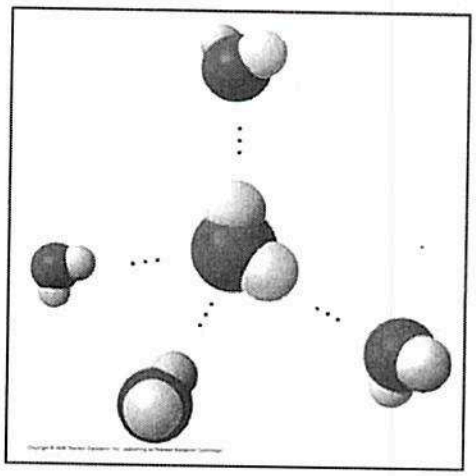
Enduring understanding 4.A: Interactions within biological systems lead to complex properties.	**Essential knowledge 4.A.1:** The subcomponents of biological molecules and their sequence determine the properties of that molecule.
	Essential knowledge 4.A.2:The structure and function of subcellular components, and their interactions, provide essential cellular processes.
	Essential knowledge 4.A.3: Interactions between external stimuli and regulated gene expression result in specialization of cells, tissues and organs.
	Essential knowledge 4.A.4: Organisms exhibit complex properties due to interactions between their constituent parts.
	Essential knowledge 4.A.5: Communities are composed of populations of organisms that interact in complex ways.
	Essential knowledge 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.
Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems.	**Essential knowledge 4.B.1**: Interactions between molecules affect their structure and function.
	Essential knowledge 4.B.2: Cooperative interactions within organisms promote efficiency in the use of energy and matter.
	Essential knowledge 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.

	Essential knowledge 4.B.4: Distribution of local and global ecosystems changes over time.
Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.	**Essential knowledge 4.C.1**: Variation in molecular units provides cells with a wider range of functions.
	Essential knowledge 4.C.2: Environmental factors influence the expression of the genotype in an organism.
	Essential knowledge 4.C.3:The level of variation in a population affects population dynamics.
	Essential knowledge 4.C.4:The diversity of species within an ecosystem may influence the stability of the ecosystem.

Name_____ Period_____

Chapter 3: Water and the Fitness of the Environment

Concept 3.1 The polarity of water molecules results in hydrogen bonding



1. Study the water molecules at the right. On the central molecule, label oxygen (O) and hydrogen (H).
2. What is a *polar molecule*? Why is water considered polar?
3. Now, add + and – signs to indicate the charged regions of *each* molecule. Then, indicate the hydrogen bonds.
4. Explain *hydrogen bonding*. How many hydrogen bonds can a single water molecule form?

Concept 3.2 Four emergent properties of water contribute to Earth's fitness for life

Hydrogen bonding accounts for the unique properties of water. Let's look at several.

Cohesion

5. Distinguish between *cohesion* and *adhesion*.
6. What is demonstrated when you see beads of water on a waxed car hood?
7. Which property explains the ability of a water strider to walk on water?

Moderation of Temperature

8. The calorie is a unit of heat. Define *calorie*.
9. Water has high *specific heat*. What does this mean? How does water's specific heat compare to alcohol's?
10. Explain how hydrogen bonding contributes to water's high specific heat.

11. Summarize how water's high specific heat contributes to the moderation of temperature. How is this property important to life?

12. Define *evaporation*. What is *heat of vaporization*? Explain at least three effects of this property on living organisms.

Expansion upon Freezing

13. Ice floats! So what? Consider what would happen if ponds and other bodies of water accumulated ice at the bottom. Describe why this property of water is important.

14. Now, explain *why* ice floats. Why is 4°C the critical temperature in this story?

Solvent of Life

15. Review and define these terms:
    solvent

    solution

    solute

16. Consider coffee to which you have added sugar. Which is the solvent? The solute?

17. Explain why water is such a fine solvent.

18. Define *hydrophobic* and *hydrophilic*.

19. You already know that some materials, such as olive oil, will not dissolve in water. In fact, oil will float on top of water. Explain this property in terms of hydrogen bonding.

20. Now, let's do a little work that will enable you to prepare solutions. Read the section on solute concentrations carefully, and show the calculations here for preparing a 1-molar solution of sucrose. Steps to help you do this follow. The first step is done for you. Fill in the rest.

Steps to prepare a solution:

a. Write the molecular formula. $C_{12}H_{22}O_{11}$

b. Use your periodic table to calculate the mass of each element. Multiply by the number of atoms of the element. (For example, O has a mass of 16. Therefore one mole of O has a mass of 16 x 11 = 176 g/mole.)

c. Add the masses of each element in the molecule.

d. Add this mass of the compound to water to bring it to a volume of 1 liter. This makes 1 liter of a 1-M (1 molar) solution.

21. Can you prepare 1 liter of a 0.5-molar *glucose* solution? Show your work here.

22. Define *molarity*.

Concept 3.3 Acidic and basic conditions affect living organisms

23. What two ions form when water dissociates?

You should have answered "hydronium (H_3O+) and hydroxide ions ($OH–$)" in the preceding question. However, by convention, we will represent the hydronium ion as $H+$.

24. What is the concentration of each ion in pure water at 25°C?

25. Water has a pH of 7. *pH* is defined as the negative log of the hydrogen ion concentration [H+]. Can you now see how water is assigned a pH of 7?

26. To go a step further, the product of H+ and OH– concentrations is constant at 10^{-14}.

$$[H+]\{OH–\} = 10^{-14}.$$

Water, which is neutral with a pH of 7, has an equal number of H+ and OH– ions. Now, define

acid

base

27. Because the pH scale is logarithmic, each numerical change represents a 10X change in ion concentration.

a. So, how many times more acidic is a pH of 3 compared to a pH of 5?

b. How many times more basic is a pH of 12 compared to a pH of 8?

c. Explain difference between a pH of 8 and a pH of 12 in terms of H+ concentration.

28. On the pH chart, label pH 1–14. Label *neutral, acid, base*. Indicate the locations of pure water, urine, gastric juice, and bleach.

29. Even a slight change in pH can be harmful! How do *buffers* moderate pH change?

30. Exercise will result in the production of CO_2, which will acidify the blood. Explain the buffering system that minimizes blood pH changes.

31. *Acid precipitation* is increasing. Explain its sources.

32. Discuss how CO_2 emissions affect marine life and ecosystems.

Testing Your Knowledge: Self-Quiz Answers
Now you should be ready to test your knowledge. Place your answers here:

1._____ 2._____ 3._____ 4._____ 5._____ 6._____ 7._____ 8._____

Chapter 3

Water and Life

Key Concepts

3.1 **Polar covalent bonds in water molecules result in hydrogen bonding**

3.2 **Four emergent properties of water contribute to Earth's suitability for life**

3.3 **Acidic and basic conditions affect living organisms**

Framework

Water makes up 70% to 95% of the cell content of living organisms and covers 75% of Earth's surface. Its unique properties make the planet's environment suitable for life and the internal environments of organisms suitable for the chemical and physical processes of life.

Hydrogen bonding between polar water molecules creates a cohesive liquid with a high specific heat and high heat of vaporization, both of which help to regulate environmental temperature. Ice floats and protects oceans and lakes from freezing. The polarity of water makes it a versatile solvent. The $[H^+]$ in a solution is expressed as pH and determines if a solution is acidic, neutral, or basic. Buffers regulate an organism's pH.

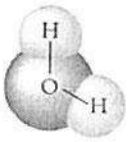
Chapter Review

3.1 Polar covalent bonds in water molecules result in hydrogen bonding

A water molecule consists of two hydrogen atoms, each bonded to a more electronegative oxygen atom by a **polar covalent bond.** This **polar molecule** has a shape like a wide V with a partial positive charge on each hydrogen atom ($\delta+$) and a partial negative charge ($\delta-$) associated with the oxygen. Hydrogen bonds, electrical attractions between the hydrogen atom of one water molecule and the oxygen atom of a nearby water molecule, create a structural organization that leads to the emergent properties of water.

INTERACTIVE QUESTION 3.1

Draw the four water molecules that can hydrogen-bond to this water molecule. Label the bonds and the partial negative and positive charges that account for the formation of these hydrogen bonds.



3.2 Four emergent properties of water contribute to Earth's suitability for life

Cohesion of Water Molecules Liquid water is unusually cohesive due to the constant forming and re-forming of hydrogen bonds that hold the molecules close together. This **cohesion** creates a more structurally organized liquid and helps water to be pulled upward in plants. The **adhesion** of water molecules to the walls of plant vessels also contributes to water transport. Hydrogen bonding between water molecules produces a high **surface tension** at the interface between water and air, making the surface unusually difficult to break.

Moderation of Temperature by Water **Thermal energy** is a measure of the **kinetic energy** (the energy of motion) associated with the random movement of atoms and molecules. **Temperature** measures the *average* kinetic energy of the molecules in a body of matter; thermal energy reflects the *total* kinetic energy in that matter, which relates to the volume of the body of matter. The thermal energy that transfers from a warmer to a cooler body of matter is defined as **heat.**

How is heat measured? A **calorie (cal)** is the amount of heat it takes to raise 1 g of water 1°C. A **kilocalorie (kcal)** is 1,000 calories, the amount of heat required or released to change the temperature of 1 kg of water by 1°C. A **joule (J)** equals 0.239 cal; one calorie is 4.184 J.

Specific heat is the amount of heat absorbed or lost when 1 g of a substance changes its temperature by 1°C. Water's specific heat of 1 cal/g·°C is unusually high compared with other common substances. Why does water absorb or release a relatively large quantity of heat as its temperature changes? Heat must be absorbed to break hydrogen bonds before water molecules can move faster and the temperature can rise, and conversely, heat is released when hydrogen bonds form as water molecules slow down when the temperature of water drops. The high proportion of water in the environment and within organisms keeps temperature fluctuations within limits that permit life.

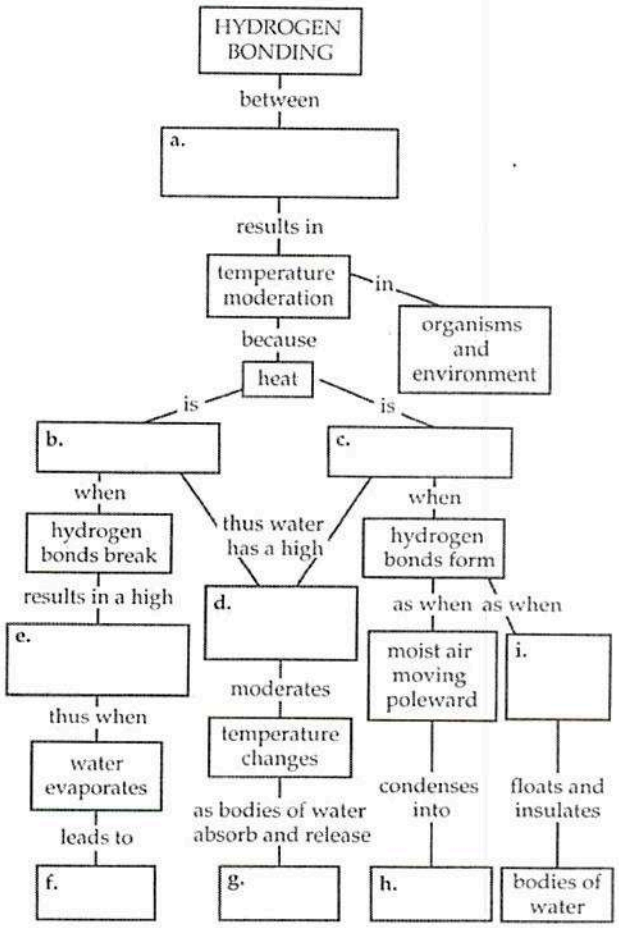
Vaporization or evaporation occurs when molecules of a liquid with sufficient kinetic energy overcome their attraction to other molecules and escape into the air as gas (vapor). The **heat of vaporization** is the quantity of heat that must be absorbed for 1 g of a liquid to be converted to a gas. Water has a high heat of vaporization (580 cal/g at 25°C) because a large amount of heat is needed to break the hydrogen bonds holding water molecules together. Water helps moderate Earth's climate as solar heat absorbed by tropical seas is dissipated during evaporation, and heat is released as moist tropical air moving poleward condenses to form rain.

As a liquid vaporizes, the surface left behind loses the kinetic energy of the escaping molecules and cools down. **Evaporative cooling** helps to protect terrestrial organisms from overheating and contributes to the stability of temperatures in lakes and ponds.

Floating of Ice on Liquid Water As water cools below 4°C, it expands. By 0°C, each water molecule is hydrogen-bonded to four other molecules, creating a crystalline lattice that spaces the molecules apart. Ice is thus less dense than liquid water and so it floats, insulating the water below and providing a solid substrate for some animals.

INTERACTIVE QUESTION 3.2

The following concept map is one way to show how the breaking and forming of hydrogen bonds are related to temperature moderation. Fill in the blanks and compare your choice of concepts to those given in the answer section. Or, even better, create your own map to help you understand how water stabilizes temperature.



Water: The Solvent of Life A **solution** is a liquid homogeneous mixture of two or more substances; the dissolving agent is called the **solvent,** and the substance that is dissolved is the **solute.** Water is the solvent in an **aqueous solution.** The positive and negative regions of water molecules are attracted to oppositely charged ions or partially charged regions of polar molecules. Thus, solute molecules become

surrounded by water molecules (a **hydration shell**) and dissolve into solution.

Ionic and polar substances are **hydrophilic;** they have an affinity for water due to electrical attractions and hydrogen bonding. Nonpolar and nonionic substances are **hydrophobic;** they will not easily mix with or dissolve in water.

Most of the chemical reactions of life take place in water. A **mole (mol)** is the amount of a substance that has a mass in grams numerically equivalent to its **molecular mass** (the sum of the mass of all atoms in the molecule). A mole of any substance has exactly the same number of molecules—6.02×10^{23}, called Avogadro's number. The **molarity** of a solution (abbreviated *M*) refers to the number of moles of a solute dissolved in 1 liter of solution.

INTERACTIVE QUESTION 3.3

a. How many grams of lactic acid ($C_3H_6O_3$) are in 1 liter of a 0.5 *M* solution of lactic acid? (^{12}C, ^{1}H, ^{16}O)

b. How many molecules of lactic acid are in the solution in *a*?

Possible Evolution of Life on Other Planets with Water The emergent properties of water support life on Earth. In the search for extraterrestrial life, *astrobiologists* look for evidence of water, as has been recently confirmed on Mars.

3.3 Acidic and basic conditions affect living organisms

A water molecule can dissociate into a **hydrogen ion,** H^+ (which binds to another water molecule to form a **hydronium ion,** H_3O^+), and a **hydroxide ion,** OH^-. In pure water at 25°C, the concentrations of H^+ and OH^- are the same; both are equal to 10^{-7} *M*.

Acids and Bases When acids or bases dissolve in water, the H^+ and OH^- balance shifts. An **acid** adds H^+ to a solution, whereas a **base** reduces H^+ in a solution by accepting hydrogen ions or by adding hydroxide ions (which then combine with H^+ and thus remove hydrogen ions). A strong acid or strong base dissociates completely when mixed with water. A weak acid or weak base reversibly dissociates, either releasing or binding H^+ until its equilibrium ratio is reached.

The pH Scale In an aqueous solution, the *product* of the $[H^+]$ and $[OH^-]$ is constant at 10^{-14}. Brackets, [ ], indicate molar concentration. If the $[H^+]$ is higher, then the $[OH^-]$ is lower, because the increased hydrogen ions combine with the hydroxide ions in solution and form water. Likewise, an increase in $[OH^-]$ causes an equivalent decrease in $[H^+]$.

The **pH** of a solution is defined as the negative log (base 10) of the $[H^+]$: $pH = -\log [H^+]$. For a neutral aqueous solution, $[H^+]$ is 10^{-7} *M*, and the pH = 7. As the $[H^+]$ increases in an acidic solution, the pH value decreases. (This inverse relationship makes sense because the exponent becomes smaller: 10^{-4} is a larger number than 10^{-7}.) The difference between each unit of the pH scale represents a tenfold difference in the concentration of $[H^+]$ and $[OH^-]$.

INTERACTIVE QUESTION 3.4

Complete the following table to review your understanding of pH.

$[H^+]$	$[OH^-]$	pH	Acidic, Basic, or Neutral?
10^{-8}			
	$[10^{-7}]$		
		1	

Most cells have an internal pH close to 7. **Buffers** within the cell maintain a stable pH by accepting excess H^+ or donating H^+ when H^+ concentration decreases. Weak acid-base pairs that reversibly bind hydrogen ions are typical of most buffering systems.

INTERACTIVE QUESTION 3.5

The carbonic acid/bicarbonate system is an important biological buffer. Label the molecules and ions in this equation, and indicate which is the H^+ donor (acid) and which is the H+ acceptor (base).

$$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$$

In which direction will this reaction proceed

a. when the pH of a solution begins to fall?

b. when the pH rises above normal level?

Acidification: A Threat to Water Quality Fossil fuel combustion releases CO_2 to the atmosphere. The oceans absorb about 25% of this CO_2, which lowers the pH of seawater. The resulting **ocean acidification**

decreases the concentration of carbonate ions (CO_3^{2-}), an important ion needed for coral reef calcification.

INTERACTIVE QUESTION 3.6

a. Add to the formula in Interactive Question 3.5 to show how increasing [CO_2] dissolving in water leads to a lower pH.

b. Use this formula to explain how a lower pH would affect the [CO_3^{2-}] in the ocean.

$$HCO_3^- \rightleftharpoons CO_3^{2-} + H^+$$

c. Assuming a fairly constant [Ca^{2+}] in the ocean, how would a change in [CO_3^{2-}] affect the calcification rate—the production of calcium carbonate ($CaCO_3$)—by the coral in a reef ecosystem?

Word Roots

kilo- = a thousand (*kilocalorie:* a thousand calories; the amount of heat energy required to raise the temperature of 1 kg of water by 1°C)

hydro- = water; **-philos** = loving; **-phobos** = fearing (*hydrophilic:* having an affinity for water; *hydrophobic:* having no affinity for water)

Structure Your Knowledge

1. Fill in the following table, which summarizes the emergent properties of water that contribute to the fitness of the environment for life.

Property of Water	Explanation of Property	Example of Benefit to Life
a.	Hydrogen bonds hold molecules together and adhere them to hydrophilic surface.	b.
High specific heat	c.	Temperature changes in environment and organisms are moderated.
d.	Hydrogen bonds must be broken for water to evaporate.	e.
f.	Molecules with high kinetic energy evaporate; remaining molecules cooler.	g.
Less dense as a solid	h.	i.
j.	k.	Most chemical reactions in life involve solutes dissolved in water.

2. To become proficient in the use of the concepts relating to pH, develop a concept map to organize your understanding of the following terms: pH, [H^+], [OH^-], acidic, basic, neutral, buffer, 0–14, acid-base pair. Remember to label connecting lines and add additional concepts as you need them. *A suggested concept map is given in the answer section, but remember that your concept map should represent your own understanding. The value of this exercise is in organizing these concepts for yourself.*

Test Your Knowledge

MULTIPLE CHOICE: *Choose the one best answer.*

1. Each water molecule is capable of forming
   a. three ionic bonds.
   b. four hydrogen bonds.
   c. two covalent bonds and two hydrogen bonds.
   d. four polar covalent bonds.
2. The polar covalent bonds of water molecules
   a. promote the formation of hydrogen bonds.
   b. help water to dissolve nonpolar solutes.
   c. lower the heat of vaporization and lead to evaporative cooling.
   d. do all of the above.
3. What accounts for the movement of water up the vessels of a tall tree?
   a. cohesion
   b. hydrogen bonding
   c. adhesion
   d. all of the above

4. Climates tend to be moderate near large bodies of water because
   a. a large amount of solar heat is absorbed because the temperature of water rises rapidly.
   b. water absorbs heat from the environment as it cools.
   c. the high specific heat of water helps to moderate air temperatures.
   d. a great deal of heat is absorbed as hydrogen bonds form and released as hydrogen bonds break.

5. You have three flasks containing 100 mL of different liquids. Each is warmed with 100 calories of heat. The temperature of the liquid in flask 1 rises 1°C; in flask 2 it rises 1.5°C; and in flask 3 it rises 2°C. Which of these liquids has the highest specific heat?
   a. the liquid in flask 1
   b. the liquid in flask 2
   c. the liquid in flask 3
   d. You cannot tell unless you know what liquid is in each flask.

6. A burn from steam at 100°C is more severe than a burn from boiling water because
   a. the steam is hotter than boiling water.
   b. steam releases a great deal of heat as it condenses on the skin.
   c. steam has a higher heat of vaporization than does water.
   d. steam stays on the skin longer than does boiling water.

7. Evaporative cooling is a result of
   a. the release of heat during the breaking of hydrogen bonds when water molecules escape.
   b. the absorption of heat as hydrogen bonds form.
   c. the reduction in the average kinetic energy of a liquid after energetic water molecules enter the gaseous state.
   d. both a and c.

8. Ice floats because
   a. air is trapped in the crystalline lattice.
   b. the formation of hydrogen bonds releases heat; warmer objects float.
   c. it insulates bodies of water so they do not freeze from the bottom up.
   d. hydrogen bonding spaces the molecules farther apart, creating a less dense structure.

9. Why is water such an excellent solvent?
   a. As a polar molecule, it can surround and dissolve ionic and polar molecules.
   b. It forms ionic bonds with ions, hydrogen bonds with polar molecules, and hydrophobic interactions with nonpolar molecules.
   c. It forms hydrogen bonds with itself.
   d. It is liquid and has a high surface tension.

10. Which of the following are least soluble in water?
    a. polar molecules
    b. nonpolar molecules
    c. ionic compounds
    d. hydrophilic molecules

11. The molarity of a solution is equal to
    a. Avogadro's number of molecules in 1 liter of solvent.
    b. the number of moles of a solute in 1 liter of solution.
    c. the molecular mass of a solute in 1 liter of solution.
    d. the number of solute molecules in 1 liter of solvent.

12. Which of the following substances would you add to enough water to yield 1 liter of solution in order to make a 0.1 *M* solution of glucose ($C_6H_{12}O_6$)? The mass numbers for these elements are approximately C = 12, O = 16, and H = 1.
    a. 6 g C, 12 g H, and 6 g O
    b. 72 g C, 12 g H, and 96 g O
    c. 18 g of glucose
    d. 180 g of glucose

13. How many molecules of glucose would be in 1 liter of the 0.1 *M* solution made in question 12?
    a. 0.1
    b. 180
    c. 6×10^{22}
    d. 6×10^{23}

14. Adding a base to a solution would
    a. raise the pH.
    b. lower the pH.
    c. decrease $[H^+]$.
    d. do both a and c.

15. A buffer
    a. releases excess OH^-.
    b. releases excess H^+.
    c. is often a weak acid-base pair.
    d. always maintains a neutral pH.

Use the following pH values to answer questions 16–18: cola—2; orange juice—3; beer—4; coffee—5; human blood—7.4.

16. Which of these liquids has the *highest* molar concentration of OH^-?
    a. cola
    b. orange juice
    c. coffee
    d. human blood

17. Comparing the $[H^+]$ of orange juice and coffee, the $[H^+]$ of
    a. orange juice is 10 times higher.
    b. orange juice is 100 times higher.
    c. coffee is 2 times higher.
    d. coffee is 100 times higher.

18. What is the concentration of hydroxide ions in 1 liter of beer?
    a. 1.0×10^{-4}
    b. 1.0×10^{-10}
    c. 6.02×10^{19}
    d. 6.02×10^{-19}

AP BIOLOGY STUDENT SUMMER ASSIGNMENT CHECKLIST

- ✓ I carefully read one of the 2 suggested books
- ✓ I completed Part 1 of the assignment using the proper format
- ✓ I signed up for Turnitit.com using my teachers E-Board as a guide
- ✓ I submitted Part 1 on Turnitin.com by the due date: **Tuesday September 5th by midnight**
- ✓ I printed and stapled my Part 1 assignment to hand in the first day of school (September 5th)
- ✓ I completed the "Chapter 3: Water and Fitness of the Environment" questions, Part 2 of the summer assignment, printed out and handwritten.
- ✓ I will hand in both part 1 and part 2 separately on the first day of school!