AP Biology **Name:** **P:**

Chapter 2 Reading Guide: The Chemical Context of Life

How to use this reading guide: Look over the entire reading guide—read each question to prepare yourself for reading the chapter. Read the chapter carefully and thoroughly. Make sure to look at all of the figures and pictures and read their captions. Then…answer the questions posed below.

Chemical Foundations of Biology

1. Why is an understanding of chemistry (and physics) fundamental to the study of biology? Use the example of the "Bombardier Beetle" to explain.

2. What themes from chapter 1 will come into play in the study of the chemistry of life? (think about structure and function and regulation as well).

Matter consists of chemical elements in pure form and in combinations called compounds

3. Compare and contrast elements and compounds.
    a. What are the "essential elements?" How do these differ from trace elements?

4. Complete the chart below with the appropriate information.

Elements	In what abiotic (nonlife) chemical forms are these elements often found?	In what chemical forms do animals need to obtain these elements?	In what chemical forms do plants need to obtain these elements?
Carbon			
Oxygen			
Hydrogen			
Nitrogen			

An element's properties depend on the structure of its atoms

5. Describe atomic structure, using the terms proton, neutron, electron, mass number and orbital.

6. What information do you need to calculate or determine the following?
    a. The atomic number of an element

    b. the mass number of an element

c. the weight in Daltons of one atom of an element

7. Explain what an isotope is and give two important physical properties of isotopes that make them useful in biological research.
    a. Describe how an isotope might be used in research (read figure 2.5)

8. Indicate what is meant by an electron's "excited" state and "ground" state.
    a. How is this related to potential energy and electron shells?
    b. Use a diagram to help you explain.

9. What determines the chemical behavior of an atom?
    a. Describe why lithium and/or chlorine is "reactive" and neon would be "unreactive".
    b. Why are unpaired electrons important?

<u>The formation and function of molecules depend on chemical bonding between atoms</u>

10. Describe a covalent bond. What holds a covalent bond together?
    a. What influence does electronegativity have on covalent bonds?
    b. Distinguish between polar and non-polar covalent bonds. What element will tip you off to a polar covalent bond?

11. Using diagrams, explain what an ion is, and how it forms. Describe an ionic bond and how it is different from a covalent bond.

12. Explain the important role of weak chemical bonds in the organization of living things. Give 2 examples of weak bonds.

13. One of the themes is “Structure & Function.” Molecules definitely exhibit this relationship. Discuss how a molecules structure is established and how it is related to its function.
    a. Cite at least two examples of how molecular shape and function is crucial to biology. Explain what is happening in each example.

Chemical reaction make and break chemical bonds

14. What do chemical reactions do? Why is this important to life?
    a. Use the photosynthesis reaction to describe how matter is rearranged.

15. Explain how product concentration affects chemical reactions.

16. What is meant by “dynamic equilibrium”?

The polarity of water molecules results in hydrogen bonding

1. Draw a water molecule which shows the polarity of the molecule. Explain they the “pole” exist (make sure to relate this to the electronegativity of the elements involved).
    a. What would hole two water molecules together?
    b. How many other water molecules could form bonds with the one water molecule you drew? (include them in your picture).

Four emergent properties of water contribute to Earth’s fitness for life

Cohesion and Adhesion

2. Compare and contrast cohesion and adhesion. How are they similar and how are they different?

3. Explain surface tension. How is surface tension related to life?

Moderation of Temperature

4. Describe the difference heat and temperature.

5. What is specific heat? How is the specific heat of water related to hydrogen bonds?

6. What is the heat of vaporization? How does hydrogen bonding explain the high heat of vaporization?
    a. How does the high heat of vaporization facilitate life?

7. Explain what happens to the structure of water as it freezes.
    a. What does it do when it freezes?
    b. How does this act as insulation.
    c. What would happen if ice sank?

8. Complete the chart below with the properties of water, the description of the property, and an example of why it is important to life.

Property	Explanation of Property	Example of Benefit to Life
A.	**Hydrogen bonds hold molecules together and adhere them to hydrophilic**	
B. High Specific Heat		**Temperature changes in environment and organisms are moderated.**
C.	**Hydrogen bonds must be broken for water to evaporate**	
D.	**Water molecules with high kinetic energy evaporate remaining**	
E. Ice Floats		
F.		**Most chemical reactions in life involve solutes dissolved in water**

9. Using the letters from the chart above, write the letter of the property that is correctly associated with each of the following statements.
    a. During winter, air temperatures in the northern United States can remain below 0°C for months; however, the fist and other animals living in the lakes survive.
    b. Many substances –for example, salt (NaCl) and sucrose—dissolve quickly in water.
    c. When you pour water into a 25 mL graduated cylinder, a meniscus forms at the top.
    d. Sweating and the evaporation of sweat from the body surface help reduce a human's body temperature.
    e. A bottle contains a liquid mixture of equal parts of water and mineral oil. You shake the bottle vigorously and then set it on the table. Although the law of entropy favors maximum randomness, this mixture separates into layers of oil over water.
    f. Water drops that fall on a surface tend to form rounded drops or beads.
    g. Water drops that fall on your car tend to bead or round up more after you polish (or wax) the car than before you polished it.
    h. If you touch the edge of a paper towel to a drop of colored water, the water will move up into (or be absorbed by) the towel.

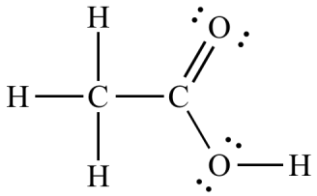
The Solvent of Life

10. Water is an excellent solver for ionic and polar substances. How does this work?
    a. What is a "hydration shell."

11. Detail the differences between "hydrophilic" and "dissolving".

12. What does "hydrophobic" mean? What types of molecules are hydrophobic? How is chemical bonding involved in this "emergent property"?

13. Is the molecule in the picture hydrophilic or hydrophobic? Explain your answer.



<u>Dissociation of water molecules leads to acidic and basic conditions that affect living organisms</u>

14. Describe what happens when water is dissociated. Include a chemical reaction for the dissociation.
    a. What ions are formed?
    b. Why is dissociation so important in the chemistry of life? Give specific examples.

15. Contrast acids with bases. What do each do in an aqueous solution?
    a. What two types of bases are there?

16. Explain what is meant by pH. Why is a solution with a pH of 5 ten times more acidic than a solution with a pH of 6?

17. Complete the chart below.

$[H^+]$	$[OH^-]$	pH	Acidic, Basic, or Neutral
	10^{-11}	3	acidic
10^{-8}			
	10^{-7}		
		1	

18. Why are buffers important to living things? Explain how a buffer system works.
    a. Describe IN DETAIL the carbonic acid/bicarbonate buffer system

19. Ocean acidification is devastating to the natural ecosystem. What is the cause of ocean acidification? What are the consequences of ocean acidification?