# Chapter 2: The Chemical Context of Life

***2.1 Describe matter, chemical elements, and chemical compounds.***

***2.2 Use examples to illustrate how the structure of an element's atoms determines its properties.***

***2.3 Identify and describe the types of strong and weak chemical bonds, and use examples to show how bonds affect molecular shape.***

***2.4 Given an example of a chemical reaction, describe its meaning in words.***

This chapter covers the basics that you may have learned in your chemistry class. Whether your teacher goes over this chapter or assigns it for you to review on your own, the questions that follow should help you focus on the most important points. It will be assumed that you have this basic material mastered in future topics, so review if necessary!

**Study Tip:** How much time you spend with this chapter depends on your chemistry background. The *Study Tip* table on p. 28 is a great idea if you are uneasy with the fundamentals of chemistry. If you have a good chemistry background and can, for example, visualize the electron distribution diagrams of the elements listed in the table, the table will not be necessary. The ideas in this chapter are fundamental to understanding the text, so do the work you need. Everyone should review Figure 2.1 as an introduction to the chapter.

## *Concept 2.1 Matter consists of chemical elements in pure form and in combinations called compounds*

### *LO 2.1: Describe matter, chemical elements, and chemical compounds.*

1. Define and give an example of the following terms:

   **matter**

   **element**

   **compound**

2. What four elements make up 96% of all living matter?

3. What is the difference between an essential element and a trace element?

   **essential element**

   **trace element**

## *Concept 2.2 An element's properties depend on the structure of its atoms*

***LO: 2.2: Use examples to illustrate how the structure of an element's atoms determines its properties.***

4. Sketch a model of an atom of helium, showing the electrons, protons, neutrons, and atomic nucleus.

5. What is the atomic number of helium? _____What is the atomic mass? _____

6. Here are some more terms that you should firmly grasp. Define each term.

   **neutron**

   **proton**

   **electron**

   **atomic number**

   **atomic mass**

   **isotope**

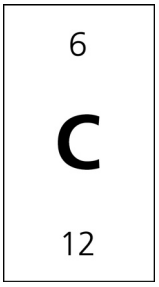
   **electron shells**

   **energy**

7. Consider the entry in the periodic table for carbon, shown below.

   What is the atomic mass? _____ What is the atomic number? _____

   How many electrons does carbon have? _____ How many neutrons? _____



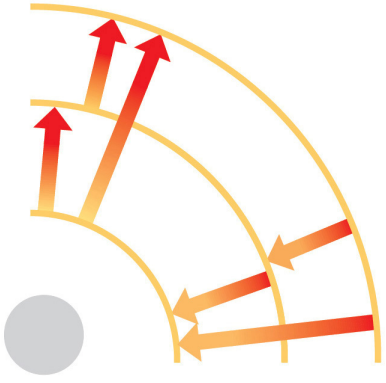

8. What are *isotopes*? Use carbon as an example in your explanation.

9. What are radioactive isotopes? Give one medical application that uses them.

10. **Application:** *Radiometric dating* uses the rate of decay of certain radioactive isotopes, such as carbon-14 to date relics of past life. The *Scientific Skills Exercise* on p. 33 explains this process. The half-life of carbon 14 is 5730 years. How old would a piece of ancient wood be if only ¼ of this isotope remains? (*Hint*—how many half-lives have passed? How long is each half-life?) You can check your answer at the end of this chapter.

11. What is the only subatomic particle that is directly involved in the chemical reactions between atoms?

12. Label the diagram as shown in Figure 2.6. The cellular processes of photosynthesis and cellular respiration center on the movement of electrons. How is the movement of electrons shown in the diagram related to photosynthesis?



13. What is *potential energy*?

14. Explain which has more potential energy in each pair:

    a. boy at the top of a slide/boy at the bottom

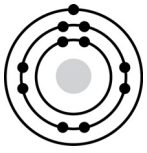
    b. electron in the first energy shell/electron in the third energy shell

    c. water/glucose

15. What determines the chemical behavior of an atom?

16. What are *valence electrons?*

17. Here is an electron distribution diagram for sodium:



a. How many valence electrons does it have? _____ Circle the valence electron(s).

b. How many protons does it have? _____

## *Concept 2.3 The formation and function of molecules and ionic compounds depend on chemical bonding between atoms*

***LO 2.3: Identify and describe the types of strong and weak chemical bonds, and use examples to show how bonds affect molecular shape.***

18. Define *molecule*.

19. Now, refer to your definition of a *compound* and fill in the following chart:

| | Molecule? (y/n) | Compound? (y/n) | Molecular Formula | Structural Formula |
|---|---|---|---|---|
| Water | | | | |
| Carbon dioxide | | | | |
| Methane | | | | |
| Oxygen | | | | |

20. What is the valence of hydrogen _____, oxygen _____,

nitrogen _____, and carbon _____?

21. In the formation of a water molecule why is the ratio two hydrogens to one oxygen?

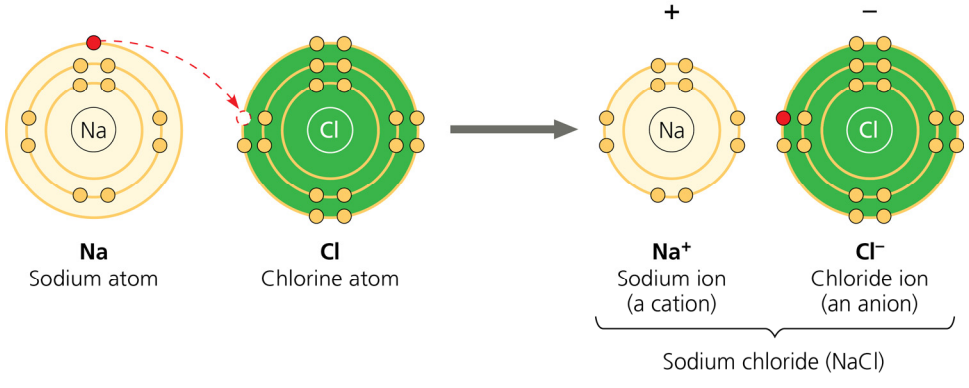
22. What type of bond is seen in $O_2$? Explain what this means.

23. What is meant by *electronegativity*?

24. Explain the difference between a *nonpolar covalent bond* and a *polar covalent bond*.

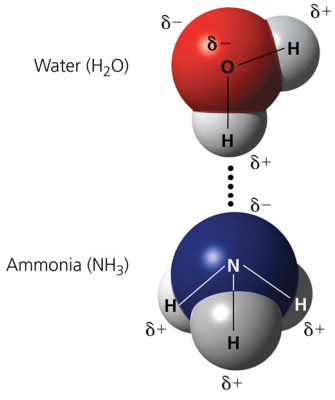
25. Make an electron distribution diagram of water. Which element is most electronegative? Why is water considered a *polar* molecule? Label the regions that are more positive or more negative. (This is a very important concept. Spend some time with this one!)

26. Another bond type is the *ionic bond*. Explain what is happening in the following figure.




27. Define *anion* and *cation*. In the preceding example, which is the anion?

28. What is a *hydrogen bond*? Indicate where the hydrogen bond occurs in the following figure.




29. Explain *van der Waals interactions*. Although they represent very weak attractions, when these interactions are numerous they can stick a gecko to the ceiling!

30. Here is a list of the types of bonds and interactions discussed in this section. Place them in order from the strongest to the weakest: hydrogen bonds, van der Waals interactions, covalent bonds, ionic bonds.


31. Use morphine and endorphins as examples to explain why molecular shape is crucial in biology.

## *Concept 2.4 Chemical reactions make and break chemical bonds*

***LO 2.4: Given an example of a chemical reaction, describe its meaning in words.***

32. Write the chemical shorthand equation for photosynthesis. Label the *reactants* and the *products*.

33. For the equation you just wrote, how many molecules of carbon dioxide are there? _____

    How many molecules of glucose? _____ How many elements in glucose? _____

34. What is meant by *dynamic equilibrium*? Does this imply equal concentrations of each reactant and product?

*Test Your Understanding*, p. 42

Now you should be ready to test your knowledge. Place your answers here:

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

Answer to Question 10: If ½ the of the original C-14 remains after one half-life, ½ of this, or ¼ would remain after 2 half-lives. The half-life for carbon-14 is 5730 years, so 11,460 years have elapsed.