Chapter 4: Carbon and the Molecular Diversity of Life

4.1 Explain what organic compounds are, and how they might have arisen on Earth.

4.2 Use examples to demonstrate how carbon's atomic structure results in a wide range of molecular structures.

4.3 Identify the key chemical groups that affect the function of biological molecules.

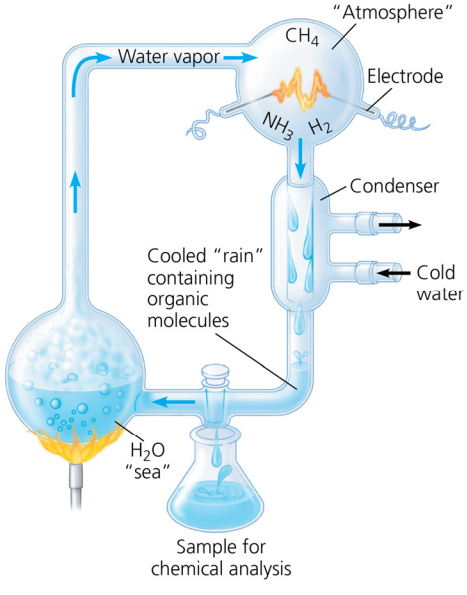
This chapter prepares you for understanding organic compounds. Functional groups determine the properties and activity of various molecules. Note how Stanley Miller's experiment provides an important link to evolution. Before starting this chapter, check the opening page to appreciate the intent of the Study Tip and then take a minute to review the unique abilities of carbon.

Study Tip: As you begin this chapter, note that the intent of the text's *Study Tip* is for you to be able to identify chemical groups on different molecules. Keep that in mind as you work through the chapter. Also, since carbon is the basis for all biological molecules, take a minute to review the unique properties of carbon illustrated in the opening figure.

Concept 4.1 Organic chemistry is key to the origin of life

LO 4.1: Explain what organic compounds are, and how they might have arisen on Earth.

1. Study this figure of Stanley Miller's experiment to simulate conditions thought at the time of the experiment to have existed on early Earth. Explain the elements of this experiment, using arrows to indicate what occurs in various parts of the apparatus.



2. What was collected in the sample for chemical analysis? What was concluded from the results of this experiment?

Concept 4.2 Carbon atoms can form diverse molecules by bonding to four other atoms

LO 4.2: Use examples to demonstrate how carbon's atomic structure results in a wide range of molecular structures.

3. Make an electron distribution diagram of carbon.

   a. How many valence electrons does carbon have? _____

   b. How many bonds can carbon form? _____

   c. What type of bonds does it form with other elements? _____

4. Carbon chains form skeletons of organic molecules. How can the carbon skeletons differ?

5. What is a *hydrocarbon*? Name two. Are hydrocarbons hydrophobic or hydrophilic?

6. In Chapter 2 you learned about *isotopes*. Because students often confuse this word with *isomer*, define each term here and give an example.

	Definition	Example
Isotope		
Isomer		

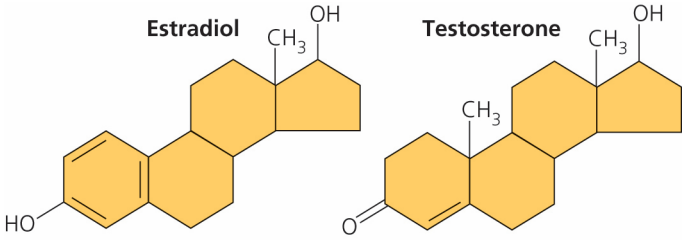
7. Variation in the architecture of molecules can cause variable biological effects. Give an example of how isomers can vary in their pharmacological effects.

Concept 4.3 A few chemical groups are key to molecular function

LO 4.3: Identify the key chemical groups that affect the function of biological molecules.

8. Define *functional group.*

9. Here is an idea that will recur throughout your study of the function of molecules: *a change in structure will change the function*. You see this in *enantiomers*, you will see it in proteins and enzymes, and now we are going to look at testosterone (a male sex hormone) and estradiol (a female sex hormone). Despite the similarities between these two molecules, you know what a vastly different effect each has. Label each functional group in the following sketch and circle the differences.



10. There are seven chemical groups important in biological processes that you should know. Using Figure 4.9 in your text, complete the following chart.

	Hydroxyl	Carbonyl	Carboxyl	Amino	Sulfhydryl	Phosphate	Methyl
Structure							
Group properties							
Example							

11. Using the chemical groups above, see if you can answer the following prompts:

    a. $-NH_2$:

    b. Can form covalent cross-links that stabilize protein structure:

    c. Key component of ATP:

    d. Can affect gene expression:

    e. $-CH_3$:

    f. Is always polar:

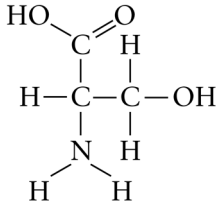
    g. Determines the two groups of sugars:

    h. Has acidic properties:

    i. COOH:

    j. Acts as a base:

    k. Circle and identify three functional groups in the molecule shown above.



12. ATP is an important molecule in the cell because it releases energy that can be used for cell work. Draw and label the overall reaction of ATP being converted to ADP with the release of energy.

Test Your Understanding, p. 65

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

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