

## 2

*Basic Chemistry*

Everything in the universe is composed of one or more elements, the unique building blocks of all matter. Although over 100 elemental substances exist, only four of these (carbon, hydrogen, oxygen, and nitrogen) make up over 96% of all living material.

The student activities in this chapter consider basic concepts of both inorganic and organic chemistry. Chemistry is the science that studies the composition of matter. Inorganic chemistry studies the chemical composition of nonliving substances that (generally) do not contain carbon. Organic chemistry studies the carbon-based chemistry (or biochemistry) of living organisms, whether they are maple trees, fish, or humans.

Understanding atomic structure, bonding behavior of elements, and the structure and activities of the most abundant biologic molecules (proteins, fats, carbohydrates, and nucleic acids) is tested in various ways. Mastering these concepts is necessary to understand how the body functions.

**CONCEPTS OF MATTER AND ENERGY**

1. Select *all* phrases that apply to each of the following statements and insert the letters in the answer blanks.

- \_\_\_\_\_ 1. The energy located in the bonds of food molecules:
- |                                  |   |
|----------------------------------|---|
| A. is called thermal energy      | C. causes molecular movement              |
| B. is a form of potential energy | D. can be transformed to the bonds of ATP |
- \_\_\_\_\_ 2. Heat is:
- |                       |                       |
|-----------------------|-----------------------|
| A. thermal energy     | C. kinetic energy     |
| B. infrared radiation | D. molecular movement |
- \_\_\_\_\_ 3. Whenever energy is transformed:
- |  |                             |
|--|-----------------------------|
| A. the amount of useful energy decreases | C. some energy is created   |
| B. some energy is lost as heat           | D. some energy is destroyed |

2. Use choices from the key to identify the energy *form* in use in each of the following examples.

**Key Choices**

- A. Chemical      B. Electrical      C. Mechanical      D. Radiant

- \_\_\_\_\_ 1. Chewing food  
 \_\_\_\_\_ 2. Vision (two types, please—think!)  
 \_\_\_\_\_ 3. Bending your fingers to make a fist  
 \_\_\_\_\_ 4. Breaking the bonds of ATP molecules to energize your muscle cells to make that fist  
 \_\_\_\_\_ 5. Lying under a sunlamp

**COMPOSITION OF MATTER**

3. Complete the following table by inserting the missing words.

Particle	Location	Electrical charge	Mass
		+ 1	
Neutron			
	Orbitals		

4. Insert the *chemical symbol* (the chemist's shorthand) in the answer blank for each of the following elements.

- \_\_\_\_\_ 1. Oxygen      \_\_\_\_\_ 4. Iodine      \_\_\_\_\_ 7. Calcium      \_\_\_\_\_ 10. Magnesium  
 \_\_\_\_\_ 2. Carbon      \_\_\_\_\_ 5. Hydrogen      \_\_\_\_\_ 8. Sodium      \_\_\_\_\_ 11. Chloride  
 \_\_\_\_\_ 3. Potassium      \_\_\_\_\_ 6. Nitrogen      \_\_\_\_\_ 9. Phosphorus      \_\_\_\_\_ 12. Iron

5. Using the key choices, select the correct responses to the following descriptive statements. Insert the appropriate answers in the answer blanks.

**Key Choices**

- A. Atom      C. Element      E. Ion      G. Molecule      I. Protons  
 B. Electrons      D. Energy      F. Matter      H. Neutrons      J. Valence

- \_\_\_\_\_ 1. An electrically charged atom or group of atoms  
 \_\_\_\_\_ 2. Anything that takes up space and has mass (weight)

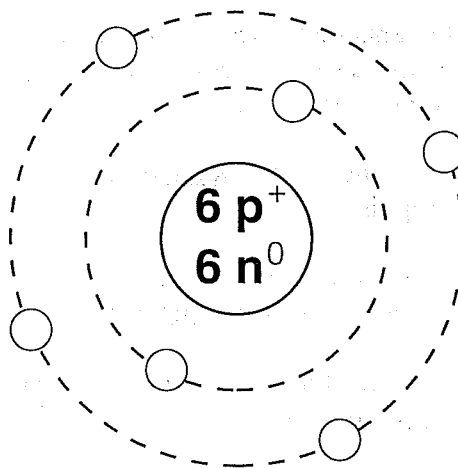
## MOLECULES, CHEMICAL BONDS, AND CHEMICAL REACTIONS

7. Match the terms in Column B to the chemical equations listed in Column A. Enter the correct letter or term in the answer blanks.

Column A	Column B
_____ 1. $A + B \rightarrow AB$	A. Decomposition
_____ 2. $AB + CD \rightarrow AD + CB$	B. Exchange
_____ 3. $XY \rightarrow X + Y$	C. Synthesis

8. Figure 2-1 is a diagram of an atom. Select two different colors and use them to color the coding circles and corresponding structures on the figure. Complete this exercise by responding to the questions that follow, referring to the atom in this figure. Insert your answers in the answer blanks provided.

- Nucleus
- Electrons



**Figure 2-1**

1. What is the atomic number of this atom? \_\_\_\_\_
2. What is its atomic mass? \_\_\_\_\_
3. What atom is this? \_\_\_\_\_
4. If this atom had one additional neutron but the other subatomic particles remained the same as shown, this slightly different atom (of the same element) would be called a(n) \_\_\_\_\_
5. Is this atom chemically active or inert? \_\_\_\_\_
6. How many electrons would be needed to fill its outer (valence) shell? \_\_\_\_\_

11. Figure 2-3 illustrates five water molecules held together by hydrogen bonds. First, correctly identify the oxygen and hydrogen atoms both by color and by inserting their atomic symbols on the appropriate circles (atoms). Then label the following structures in the figure:

- Oxygen
- Hydrogen
- Positive pole (end)
- Negative pole (end)
- Hydrogen bonds

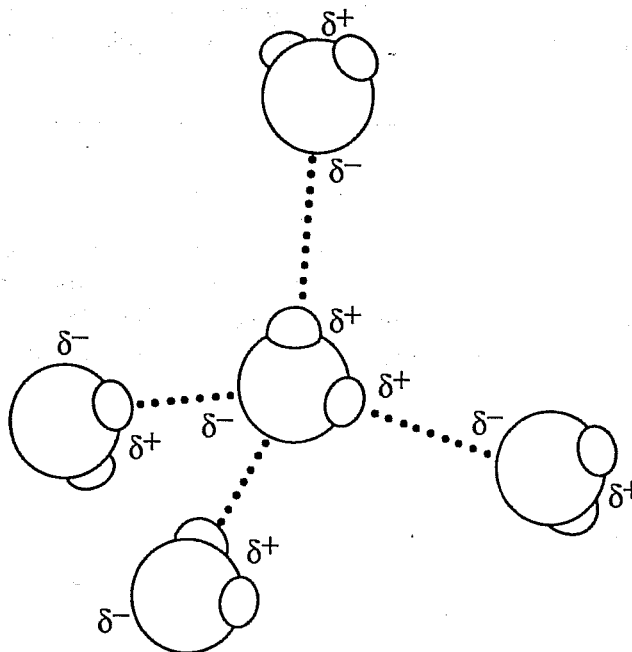
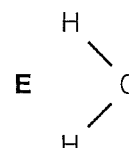
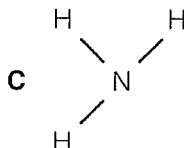
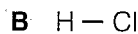
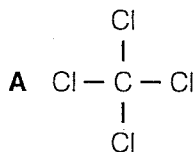


Figure 2-3

12. Circle each structural formula that is *likely* to be a polar covalent compound.



13. Respond to the instructions following the equation:



1. In the space provided, list the chemical formula(s) of compounds. \_\_\_\_\_
2. In the space provided, list the chemical formula(s) of ions. \_\_\_\_\_
3. Circle the product(s) of the reaction.
4. Modify the equation by adding a colored arrow in the proper place to indicate that the reaction is reversible.

- \_\_\_\_\_ 17. Include collagen and hemoglobin
- \_\_\_\_\_ 18. Class that usually includes cholesterol

19. Using key choices, correctly select *all* terms that correspond to the following descriptions. Insert the correct letter(s) or their corresponding term(s) in the answer blanks.

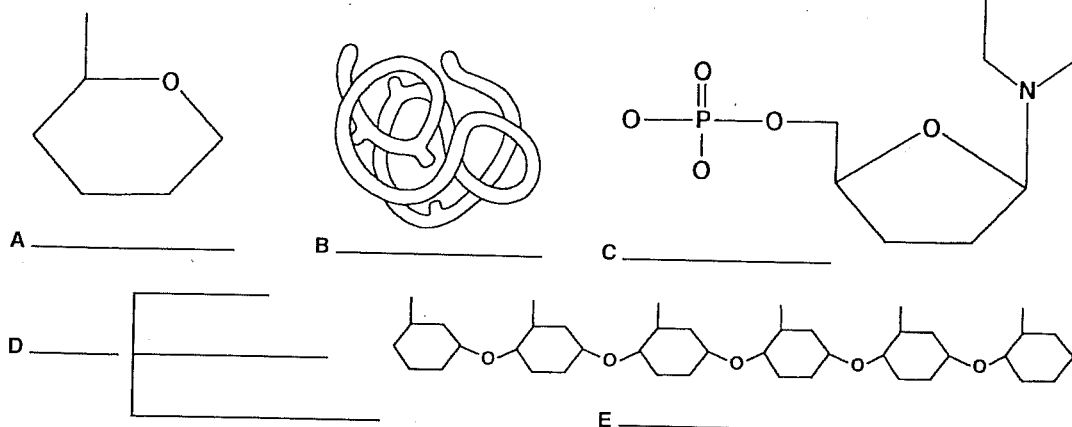
**Key Choices**

- |                |               |             |            |
|----------------|---------------|-------------|------------|
| A. Cholesterol | D. Enzyme     | G. Hormones | J. Maltose |
| B. Collagen    | E. Glycogen   | H. Keratin  | K. RNA     |
| C. DNA         | F. Hemoglobin | I. Lactose  | L. Starch  |

- \_\_\_\_\_ 1. Example(s) of fibrous (structural) proteins
- \_\_\_\_\_ 2. Example(s) of globular (functional) proteins
- \_\_\_\_\_ 3. Biologic catalyst
- \_\_\_\_\_ 4. Plant storage carbohydrate
- \_\_\_\_\_ 5. Animal storage carbohydrate
- \_\_\_\_\_ 6. The "stuff" of the genes
- \_\_\_\_\_ 7. A steroid
- \_\_\_\_\_ 8. Double sugars, or disaccharides

20. Five simplified diagrams of biological molecules are depicted in Figure 2-4. First, identify the molecules and insert the correct names in the answer blanks on the figure. Then select a different color for each molecule listed below and use them to color the coding circles and the corresponding molecules on the illustration.

- |  |                                      |                                      |
|--|--------------------------------------|--------------------------------------|
| <input type="radio"/> Fat                | <input type="radio"/> Nucleotide     | <input type="radio"/> Monosaccharide |
| <input type="radio"/> Functional protein | <input type="radio"/> Polysaccharide |                                      |



**Figure 2-4**

21. Circle the term that does not belong in each of the following groupings.

- |               |             |           |             |
|---------------|-------------|-----------|-------------|
| 1. Adenine    | Guanine     | Glucose   | Thymine     |
| 2. DNA        | Ribose      | Phosphate | Deoxyribose |
| 3. Galactose  | Glycogen    | Fructose  | Glucose     |
| 4. Amino acid | Polypeptide | Glycerol  | Protein     |
| 5. Glucose    | Sucrose     | Lactose   | Maltose     |

22. For each true statement, insert *T* in the answer blank. If any are false, correct the underlined term and insert your correction in the answer blank.

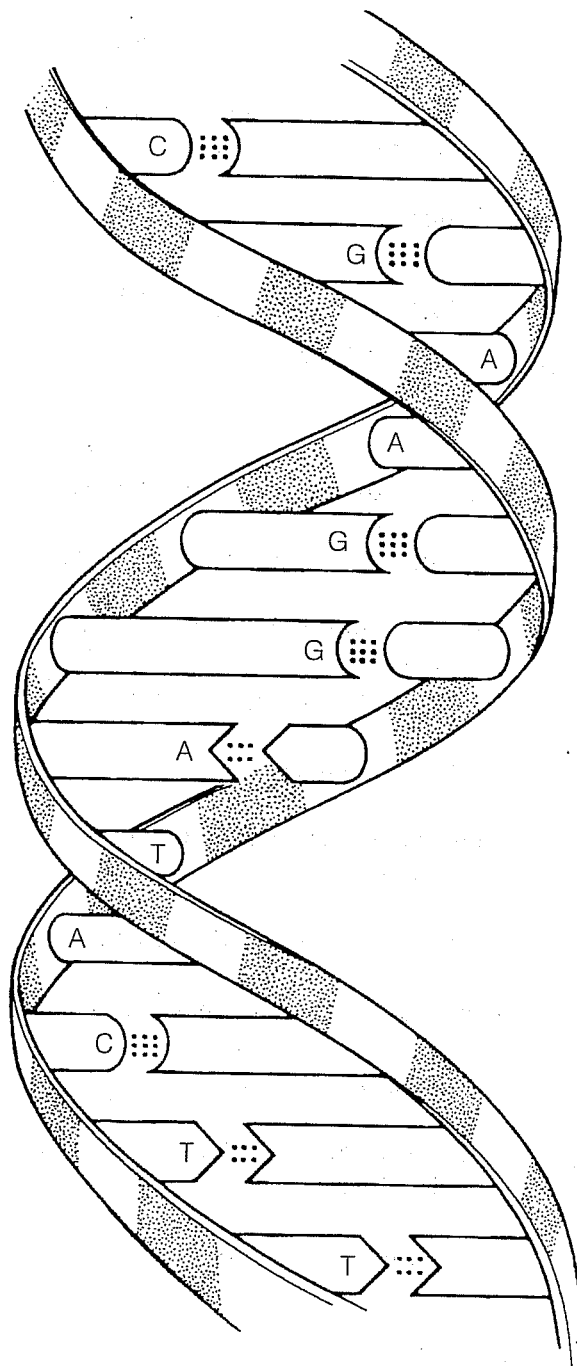
- \_\_\_\_\_ 1. Phospholipids are polarized molecules.
- \_\_\_\_\_ 2. Steroids are the major form in which body fat is stored.
- \_\_\_\_\_ 3. Water is the most abundant compound in the body.
- \_\_\_\_\_ 4. Nonpolar molecules are generally soluble in water.
- \_\_\_\_\_ 5. The bases of RNA are A, G, C, and U.
- \_\_\_\_\_ 6. The universal energy currency of living cells is RNA.
- \_\_\_\_\_ 7. RNA is single stranded.
- \_\_\_\_\_ 8. The four elements comprising over 90% of living matter are C, H, N, and Na.

23. Figure 2-5 shows the molecular structure of DNA, a nucleic acid.

- A. First, identify the two unnamed nitrogen bases and insert their correct names and symbols in the two blanks beside the color-coding circles.
- B. Complete the identification of the bases on the diagram by inserting the correct symbols in the appropriate spaces on the right side of the diagram.
- C. Select different colors and color the coding circles and the corresponding parts of the diagram.
- D. Label one d-R sugar unit and one P unit of the "backbones" of the DNA structure by inserting leader lines and labels on the diagram.
- E. Circle the associated nucleotide.

- |   |                                    |                                 |
|---|------------------------------------|---------------------------------|
| <input type="radio"/> Deoxyribose sugar (d-R) | <input type="radio"/> Adenine (A)  | <input type="radio"/> _____ ( ) |
| <input type="radio"/> Phosphate (P)           | <input type="radio"/> Cytosine (C) | <input type="radio"/> _____ ( ) |

Then answer the questions following Figure 2-5 by writing your answers in the answer blanks.



**Figure 2-5**

1. Name the bonds that help to hold the two DNA strands together. \_\_\_\_\_
2. Name the three-dimensional shape of the DNA molecule. \_\_\_\_\_
3. How many base-pairs are present in this segment of a DNA model? \_\_\_\_\_
4. What is the term that means "base-pairing"? \_\_\_\_\_