Chapter 2: The Chemistry of Life

Section 2-1 The Nature of Matter (pages 35-39)

Key Concepts
- What three subatomic particles make up atoms?
- How are all of the isotopes of an element similar?
- What are the two main types of chemical bonds?

Atoms (page 35)

1. The basic unit of matter is called a(an) ______ atom ______.

2. Describe the nucleus of an atom. It is the center of an atom, made up of protons and ______ neutrons ______.

3. Complete the table about subatomic particles.

<table>
<thead>
<tr>
<th>Particle</th>
<th>Charge</th>
<th>Location in Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>Positive</td>
<td>Nucleus</td>
</tr>
<tr>
<td>Neutron</td>
<td>Neutral</td>
<td>Nucleus</td>
</tr>
<tr>
<td>Electron</td>
<td>Negative</td>
<td>Surrounding nucleus</td>
</tr>
</tbody>
</table>

4. Why are atoms neutral despite having charged particles? Atoms have equal numbers of ______ electrons and protons, and these subatomic particles have equal, but opposite, charges.

Elements and Isotopes (page 36)

5. What is a chemical element? A chemical element is a pure substance that consists entirely of ______ one type of atom ______.

6. What does an element’s atomic number represent? It represents the number of protons in ______ an atom of the element ______.

7. Atoms of the same element that differ in the number of neutrons they contain are known as ______ isotopes ______.

8. How are isotopes identified? Isotopes are identified by their mass number.

9. Why do all isotopes of an element have the same chemical properties? They have the ______ same chemical properties because they have the same number of electrons ______.
**Chemical Compounds**  (page 37)

10. What is a chemical compound? A chemical compound is a substance formed by the chemical combination of two or more elements in definite proportions.

11. What does the formula for table salt indicate about that compound? The formula for table salt, NaCl, indicates that the elements from which table salt forms—sodium and chlorine—combine in a 1:1 ratio.

**Chemical Bonds**  (pages 38-39)

12. What holds atoms in compounds together? Chemical bonds

13. Complete the table about the main types of chemical bonds.

**CHEMICAL BONDS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Formed when ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covalent bond</td>
<td>Electrons are shared between atoms</td>
</tr>
<tr>
<td>Ionic bond</td>
<td>One or more electrons are transferred from one atom to another</td>
</tr>
</tbody>
</table>

14. What is an ion? An ion is an atom that is positively or negatively charged because it has lost or gained electrons.

15. Is the following sentence true or false? An atom that loses electrons has a negative charge.  

16. The structure that results when atoms are joined together by covalent bonds is called a(an) molecule.

17. Circle the letter of each sentence that is true about covalent bonds.
   - a. When atoms share two electrons, it is called a double bond.
   - b. In a water molecule, each hydrogen atom forms a single covalent bond.
   - c. Atoms can share six electrons and form a triple bond.
   - d. In a covalent bond, atoms share electrons.

18. The slight attractions that develop between oppositely charged regions of nearby molecules are called ____________ van der Waals forces.
Section 2–2 Properties of Water  (pages 40–43)

Key Concepts

- Why are water molecules polar?
- What are acidic solutions? What are basic solutions?

The Water Molecule  (pages 40–41)
1. Is the following sentence true or false? A water molecule is neutral. _____ true
2. Why is a water molecule polar? There is an uneven distribution of electrons between the oxygen and hydrogen atoms.

3. Circle the letter of each sentence that is true about hydrogen bonds.
   a. A hydrogen bond is stronger than an ionic bond.
   b. The attraction between the hydrogen atom on one water molecule and the oxygen atom on another water molecule is an example.
   c. A hydrogen bond is stronger than a covalent bond.
   d. They are the strongest bonds that form between molecules.

4. Complete the table about forms of attraction.

<table>
<thead>
<tr>
<th>Forms of Attraction</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohesion</td>
<td>Attraction between molecules of the same substance</td>
</tr>
<tr>
<td>Adhesion</td>
<td>Attraction between molecules of different substances</td>
</tr>
</tbody>
</table>

Solutions and Suspensions  (pages 41–42)

5. What is a mixture? A mixture is a material composed of two or more elements or compounds that are physically mixed together but not chemically combined.

6. A mixture of two or more substances in which the molecules of the substances are evenly mixed is called a(an) _____ solution _____.

7. The greatest solvent in the world is _____ water _____.

8. What is a suspension? A suspension is a mixture of water and nondissolved substances that are so small they do not settle out.
9. Complete the table about substances in solutions.

**SUBSTANCES IN SOLUTIONS**

<table>
<thead>
<tr>
<th>Substance</th>
<th>Definition</th>
<th>Saltwater Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solute</td>
<td>Dissolved</td>
<td>Table salt</td>
</tr>
<tr>
<td></td>
<td>In the solvent dissolves</td>
<td>Water</td>
</tr>
</tbody>
</table>

**Acids, Bases, and pH (pages 42-43)**

10. Why is water neutral despite the production of hydrogen ions and hydroxide ions? The number of positive hydrogen ions produced is equal to the number of negative ions.

11. What does the pH scale indicate? It indicates the concentration of H⁺ ions in solution.

12. On the pH scale below, indicate which direction is increasingly acidic and which is increasingly basic.

```
<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
</table>
Stomach acid | Lemon juice | Normal rainfall | Pure water | Human blood | Sea water | Soap | Bleach |
```

13. How many more H⁺ ions does a solution with a pH of 4 have than a solution with a pH of 5? 

14. What is an acid? ________ 

15. Is the following sentence true or false? Strong bases have pH values ranging from 11 to 14. ________

16. What are buffers? ________
Section 2–3 Carbon Compounds (pages 44–48)

Key Concept

- What are the functions of each group of organic compounds?

The Chemistry of Carbon (page 44)

1. How many valence electrons does each carbon atom have? Each carbon atom has four electrons.

2. What gives carbon the ability to form chains that are almost unlimited in length? A carbon atom can bond to other carbon atoms.

Macromolecules (page 45)

3. Many of the molecules in living cells are so large that they are known as macromolecules.

4. What is the process called by which macromolecules are formed? Polymerization

5. When monomers join together, what do they form? Polymers

6. What are four groups of organic compounds found in living things?
   a. Carbohydrates
   b. Lipids
   c. Nucleic acids
   d. Proteins

Carbohydrates (pages 45–46)


8. Circle the letter of each sentence that is true about carbohydrates.
   a. Starches and sugars are examples of carbohydrates.
   b. Living things use them as their main source of energy.
   c. The monomers in sugar polymers are starch molecules.
   d. Plants and some animals use them for strength and rigidity.

9. Single sugar molecules are also called monosaccharides.

10. Circle the letter of each monosaccharide.
    a. galactose    c. glucose
    b. glycogen    d. fructose
11. What are polysaccharides? They are large macromolecules formed from monosaccharides.

12. How do plants and animals store excess sugar? Plants use a polysaccharide called plant starch, whereas animals use a polysaccharide called glycogen.

**Lipids (pages 46–47)**

13. What kinds of atoms are lipids mostly made of? They are made mostly of carbon and hydrogen atoms.

14. What are three common categories of lipids?
   a. Fats
   b. Oils
   c. Waxes

15. Many lipids are formed when a glycerol molecule combines with compounds called fatty acids.

16. Circle the letter of each way that fats are used in living things.
   a. As parts of biological membranes
   b. To store energy
   c. To give plants rigidity
   d. As chemical messengers

17. Complete the table about lipids.

<table>
<thead>
<tr>
<th>Kind of Lipid</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated</td>
<td>Each carbon atom in a lipid's fatty acid chain is joined to another carbon atom by a single bond.</td>
</tr>
<tr>
<td>Unsaturated</td>
<td>There is at least one carbon-carbon double bond in a fatty acid.</td>
</tr>
<tr>
<td>Polyunsaturated</td>
<td>A lipid's fatty acids contain more than one double bond.</td>
</tr>
</tbody>
</table>

**Nucleic Acids (page 47)**

18. Nucleic acids contain what kinds of atoms? They contain hydrogen, oxygen, nitrogen, carbon, and phosphorus atoms.

19. The monomers that make up nucleic acids are known as nucleotides.

20. A nucleotide consists of what three parts? It consists of a nitrogenous base, a phosphate group, and a 5-carbon sugar.
21. What is the function of nucleic acids in living things? Nucleic acids store and transmit hereditary, or genetic, information.

22. What are two kinds of nucleic acids?
   a. Ribonucleic acid (RNA)
   b. Deoxyribonucleic acid (DNA)

Proteins (pages 47–48)
23. Proteins contain what kinds of atoms? They contain nitrogen, carbon, hydrogen, and oxygen atoms.

24. Proteins are polymers of molecules called amino acids.

25. What are four roles that proteins play in living things?
   a. Some control the rate of reactions and regulate cell processes.
   b. Some are used to form bones and muscles.
   c. Some transport substances into or out of cells.
   d. Some help to fight diseases.

Reading Skill Practice
You can often increase your understanding of what you've read by making comparisons. A compare-and-contrast table helps you to do this. On a separate sheet of paper, make a table to compare the four groups of organic compounds you read about in Section 2–3. You might use the heads Elements, Functions, and Examples for your table. For more information about compare-and-contrast tables, see Organizing Information in Appendix A.

Students' tables should include the basic information about carbohydrates, lipids, nucleic acids, and proteins.
Section 2–4 Chemical Reactions and Enzymes  (pages 49–53)

Key Concepts
- What happens to chemical bonds during chemical reactions?
- How do energy changes affect whether a chemical reaction will occur?
- Why are enzymes important to living things?

Chemical Reactions  (page 49)
1. What is a chemical reaction?  It is a process that changes one set of chemicals into another 
   set of chemicals.

2. Complete the table about chemicals in a chemical reaction.

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactants</td>
<td>The elements or compounds that enter into a chemical reaction</td>
</tr>
<tr>
<td>Products</td>
<td>The elements or compounds produced by a chemical reaction</td>
</tr>
</tbody>
</table>

3. Chemical reactions always involve changes in chemical bonds.

Energy in Reactions  (page 50)
4. What is released or absorbed whenever chemical bonds form or are broken?  Energy

5. What do chemical reactions that absorb energy need to occur?  They need a source of energy.

6. Chemists call the energy needed to get a reaction started the activation energy.

7. Complete the graph of an energy-releasing reaction by adding labels to show the energy of the reactants, the energy of the products, and the activation energy.

![Energy-Releasing Reaction Graph]

22 Chapter 2
Enzymes (pages 51–52)

8. What is a catalyst? A catalyst is a substance that speeds up the rate of a chemical reaction.

9. Proteins that act as biological catalysts are called ________ enzymes ________.

10. What do enzymes do? Enzymes speed up chemical reactions that take place in cells.

11. From what is part of an enzyme's name usually derived? It is derived from the reaction it catalyzes.

Enzyme Action (pages 52–53)

12. The reactants of enzyme-catalyzed reactions are known as ________ substrates ________.

13. Why are the active site and the substrates in an enzyme-catalyzed reaction often compared to a lock and key? The active site and the substrates have complementary shapes, and the fit is very precise.

14. The binding together of an enzyme and a substrate forms a(an) ________ enzyme-substrate complex ________.

15. How do most cells regulate the activity of enzymes? Most cells contain proteins that help turn key enzymes "on" or "off" at critical stages in the life of the cell.
Chapter 2  The Chemistry of Life

Vocabulary Review

Crossword Puzzle  Use the clues below to fill in the spaces in the puzzle with the correct words.

Across
1. element or compound that enters into a chemical reaction
4. process that changes one set of chemicals into another
7. positively charged subatomic particle
8. substance formed by the chemical combination of two or more elements in definite proportions
11. positively or negatively charged atom
12. carbon compound that stores and transmits genetic information
14. the center of an atom
16. bond formed when electrons are shared between atoms
17. macromolecule formed when monomers join together

Down
2. negatively charged subatomic particle
3. compound that produces hydroxide ions in solution
5. bond formed when one or more electrons are transferred from one atom to another
6. monomer of nucleic acid
9. monomer of protein
10. compound that forms hydrogen ions in solution
13. atom of same element that differs in number of neutrons compared with other atoms of the element
15. basic unit of matter

Across
1. r e a c t a n t
4. c h e m i c a l r e a c t i o n
7. p r o t o n
8. c o m p o u n d
11. i o n
14. n u c l e u s
16. c o v a l e n t b o n d
17. p o l y m e r

Down
2. b
3. u
4. s
5. e
6. c
9. a
10. a
12. n u c l e i c a c i d
13. n
15. d