

# 1 Chemistry and Life

## I. Behavioral Objectives

Students should be able to

1. name the subatomic particles of an atom and describe their charge, weight, and location in the atom;
2. state the atomic symbol, number, and weight of any atom when viewing the Periodic Table of Elements;
3. draw a diagram of any of the first twenty atoms in the periodic chart and place correctly the proper number of protons, neutrons, and electrons;
4. predict whether a reaction between atoms will be ionic or covalent and if
  - a. ionic, show the proper charge of the resulting ions
  - b. covalent, indicate the proper placement of the bonds;
5. recognize which atom in an oxidation-reduction reaction has been reduced and which has been oxidized;
6. state five differences between inorganic and organic compounds;
7. discuss in general the chemical properties of water, acids, and bases;
8. explain and use the pH scale;
9. explain the formation of macromolecules by synthesis and degradation of macromolecules by hydrolysis;
10. explain the primary, secondary, and tertiary structure of proteins;
11. give examples and explain the structure of monosaccharides, disaccharides, and polysaccharides;
12. explain the structure of neutral fats, soaps, and phospholipids;
13. recognize the difference between saturated and unsaturated fatty acids;
14. recognize the primary structure of a nucleic acid strand;
15. name the molecules that make up a nucleotide.

## II. Pretest

1. The atomic number for carbon is six; therefore, carbon has \_\_\_\_\_ protons and \_\_\_\_\_ electrons.
2. Two isotopes of carbon are  $^{13}_6\text{C}$  and  $^{14}_6\text{C}$ . The first of these has \_\_\_\_\_ neutrons and the second has \_\_\_\_\_ neutrons.
3. The compound  $\text{K}^+\text{Cl}^-$  is an \_\_\_\_\_ compound and  $\text{K}^+$  and  $\text{Cl}^-$  are \_\_\_\_\_.
4. Which of the ions in question 3 has lost an electron? \_\_\_\_\_ Which has been oxidized? \_\_\_\_\_
5. The compound  $\text{CH}_4$  is an \_\_\_\_\_ compound, in which the atoms \_\_\_\_\_ electrons.
6. Acids have a pH that is \_\_\_\_\_ than 7, and bases have a pH that is \_\_\_\_\_ than 7.
7. At pH 7,  $[\text{H}^+] = [\text{OH}^-]$ . Below pH 7, which of these is greater? \_\_\_\_\_
8. The primary structure of a protein is a polymer of \_\_\_\_\_, the secondary structure is a \_\_\_\_\_, and the tertiary structure is its final \_\_\_\_\_ shape.
9. Monosaccharides, disaccharides, and polysaccharides may be compared as to the number of \_\_\_\_\_ molecules they contain.
10. An unsaturated fatty acid contains less \_\_\_\_\_ than a saturated one.

11. When glycerol combines with three fatty acids, a \_\_\_\_\_ molecule results.
12. Both DNA and RNA are polymers of \_\_\_\_\_, each of which contains a \_\_\_\_\_, a \_\_\_\_\_, and \_\_\_\_\_ acid.

### III. Definitions

Define these terms:

1. atom (p. 19) \_\_\_\_\_
2. isotope (p. 21) \_\_\_\_\_
3. ion (p. 22) \_\_\_\_\_
4. formula (p. 25) \_\_\_\_\_
5. compound (p. 24) \_\_\_\_\_
6. oxidation-reduction (p. 25) \_\_\_\_\_
7. hydrogen bond (p. 26) \_\_\_\_\_
8. dissociation (p. 28) \_\_\_\_\_
9. pH (p. 28) \_\_\_\_\_
10. synthesis (p. 30) \_\_\_\_\_
11. polymer (p. 30) \_\_\_\_\_
12. hydrolysis (p. 30) \_\_\_\_\_
13. amino acid (p. 31) \_\_\_\_\_
14. peptide bond (p. 31) \_\_\_\_\_
15. sugar (p. 34) \_\_\_\_\_
16. fat (p. 36) \_\_\_\_\_
17. emulsification (p. 37) \_\_\_\_\_
18. phospholipid (p. 37) \_\_\_\_\_
19. nucleotide (p. 38) \_\_\_\_\_
20. ATP (p. 39) \_\_\_\_\_

### IV. Study Questions for Inorganic Chemistry

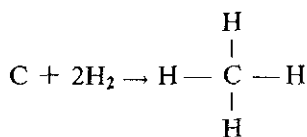
1. Periodic Table. On the simplified table (p. 3) do the following:

- a. Circle the atomic numbers.
- b. Underline the atomic weights.
- c. Check the figure that gives you the number of protons.
- d. Put an *X* beside the figure that tells you the number of electrons.
- e. Calculate and add to each block the number of neutrons.

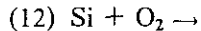
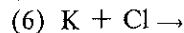
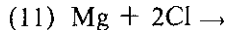
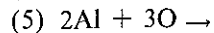
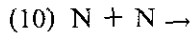
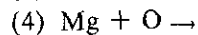
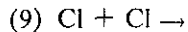
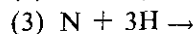
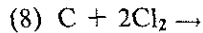
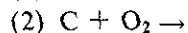
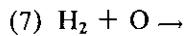
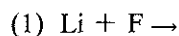
2. To the left draw a diagram of oxygen, putting in the nucleus and shells. Add to your diagram the number of protons and number of neutrons. Put in dots to indicate the electrons. To the right draw a diagram of magnesium using the same directions.

c. Complete the following reactions by giving the product. Indicate ionic bonds by giving the proper charges. Indicate covalent bonds by drawing straight lines.

Examples:

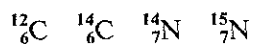


Practice reactions:



d. Oxidation-reduction. For each of the reactions in (c), underline the atom that was oxidized and circle the atom that was reduced upon completion of the reaction.

5. Isotopes. Circle the heavy isotopes below:



6. pH.

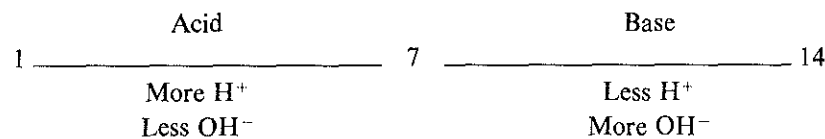
a. Define an acid, base, salt.

acid \_\_\_\_\_

base \_\_\_\_\_

salt \_\_\_\_\_

b. The pH scale can be represented as follows.



c. If the hydrogen ion concentration of [H<sup>+</sup>] of 10<sup>-7</sup> is a pH of 7, what is the pH of the following concentrations?

| [H <sup>+</sup> ] | pH | Acid or Base |
|-------------------|----|--------------|
| 10 <sup>-4</sup>  | 4  |              |
| 10 <sup>-6</sup>  | 6  |              |
| 10 <sup>-10</sup> | 10 |              |
| 10 <sup>-14</sup> | 14 |              |

d. Which of the above numbers represent the largest [H<sup>+</sup>]? \_\_\_\_\_

e. What is the importance of pH to biological systems? \_\_\_\_\_

f. How do living things prevent rapid and drastic changes in pH? \_\_\_\_\_

7. If a description below is true of inorganic compounds, place an *I* in the space provided. If it is true of organic compounds, place an *O* in the space provided.

- \_\_\_ a. contain a small number of atoms
- \_\_\_ b. are often associated with living organisms
- \_\_\_ c. always form covalent bonds
- \_\_\_ d. isomers are possible
- \_\_\_ e. usually contain metals and nonmetals
- \_\_\_ f. always contain carbon and hydrogen

### V. Study Questions for Organic Chemistry

1. What atoms are most often found in organic molecules?

\_\_\_\_\_

\_\_\_\_\_

2. Which of the atoms in question 1 is unique to amino acids and nucleotides?

3. What are the four classes of organic compounds?

\_\_\_\_\_

\_\_\_\_\_

4. Of the classes in answer 3,

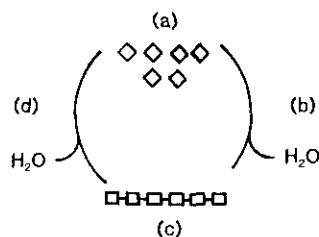
a. which are *most* concerned with energy? \_\_\_\_\_

b. which one forms enzymes? \_\_\_\_\_

c. which one makes up genes? \_\_\_\_\_

5. a. When many glucose molecules are joined together, the macromolecule \_\_\_\_\_ results. When many amino acids are joined together, the macromolecule \_\_\_\_\_ results. When glycerol and fatty acids are joined together, \_\_\_\_\_ results. When nucleotides join together, the macromolecule \_\_\_\_\_ results.

b. Associate the molecules mentioned in (5a) with this diagram:

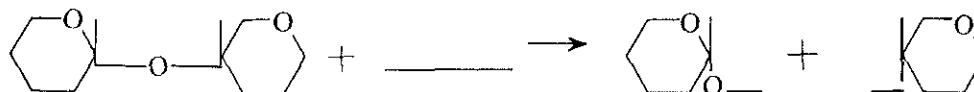


Which molecules should be associated with (a) in the diagram? \_\_\_\_\_  
 \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_, \_\_\_\_\_

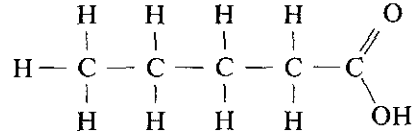
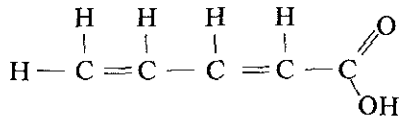
Which molecules should be associated with (c)? \_\_\_\_\_  
 \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_

At (b) and (d) indicate the proper direction of the arrows.

6. In this hydrolytic reaction, write in the molecule required on the left and the atoms required on the right.



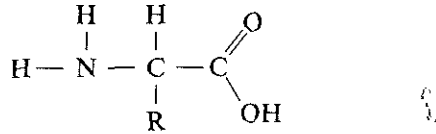
7. Write the words saturated and unsaturated beneath the appropriate structure.



a. \_\_\_\_\_

b. \_\_\_\_\_

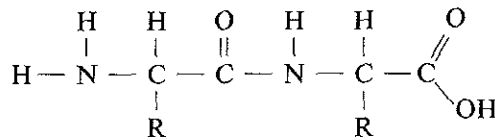
8. This is an amino acid. Write the word *amino* and the word *acid* on the appropriate line.



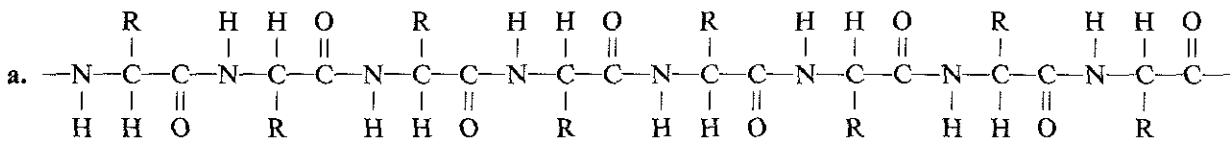
a. \_\_\_\_\_

b. \_\_\_\_\_

9. This is a dipeptide. Circle the peptide bond.



10. Levels of protein structure.



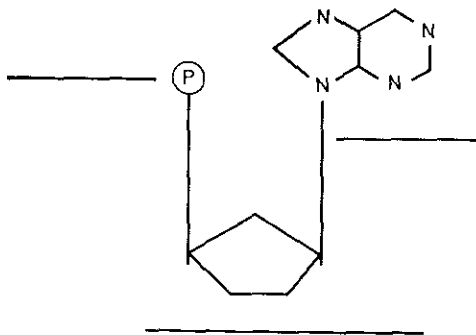
This is the \_\_\_\_\_ structure of a protein. What type of bond links the amino acids together? \_\_\_\_\_ What atoms make up the backbone of this structure? \_\_\_\_\_

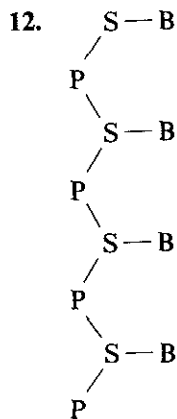
What groups are the side chains? \_\_\_\_\_

b. The secondary shape of a protein has what shape? \_\_\_\_\_ What type of bond is required to hold this shape? \_\_\_\_\_ Draw a dotted line on the structure above to indicate this bond.

c. The tertiary shape of a protein requires bonding between the \_\_\_\_\_ groups.

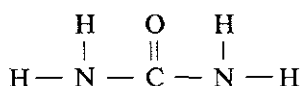
11. This is the structure of a nucleotide. Write in the words *base*, *sugar*, and *phosphoric acid* beside the appropriate structures.





- a. This is the primary structure of a \_\_\_\_\_ strand. What is the backbone? \_\_\_\_\_  
 \_\_\_\_\_ What are the side molecules? \_\_\_\_\_
- b. What molecule would *S* be? \_\_\_\_\_ What specific molecule is *S* in DNA? \_\_\_\_\_  
 \_\_\_\_\_ What specific molecule is *S* in RNA? \_\_\_\_\_ Which  
 nucleic acid would require a double strand? \_\_\_\_\_

13.

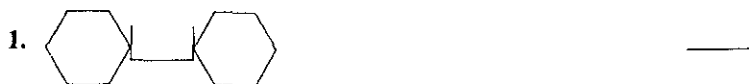


- a. Is this an organic compound? \_\_\_\_\_ How do you know? \_\_\_\_\_  
 \_\_\_\_\_
- b. The double bond between the carbon and oxygen signifies that the carbon and oxygen are sharing \_\_\_\_\_  
 pairs of electrons.
- c. This molecule is not an amino acid. Does it have an amine group? \_\_\_\_\_ Does it have an acid group?  
 \_\_\_\_\_
- d. Does this molecule have a long carbon-hydrogen chain like a fatty acid? \_\_\_\_\_  
 Is it a fatty acid? \_\_\_\_\_
- e. Is this molecule a sugar molecule? \_\_\_\_\_ How do you know? \_\_\_\_\_  
 \_\_\_\_\_
- f. Is this molecule an enzyme? \_\_\_\_\_ How do you know? \_\_\_\_\_  
 \_\_\_\_\_
- g. This molecule is urea, an amine compound of some significance in the body.

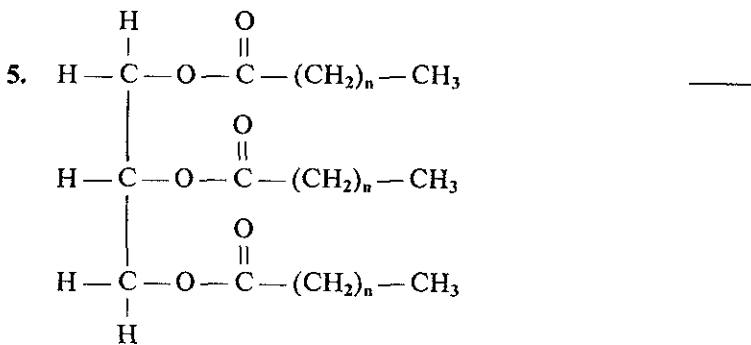
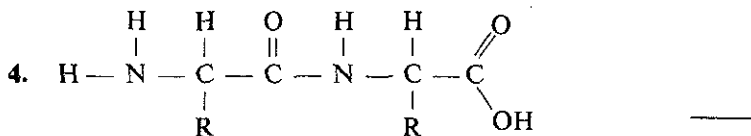
## VI. Organic Chemistry Quiz

### Matching

- |                                  |                                  |
|----------------------------------|----------------------------------|
| a. amino acid (or more than one) | d. glycerol                      |
| b. glucose (or more than one)    | e. fatty acid                    |
| c. nucleotide (or more than one) | f. both glycerol and fatty acids |



3. sugar-base \_\_\_\_\_  
 |  
 phosphate

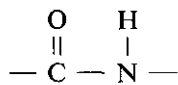


6. nucleic acid \_\_\_\_\_ , protein \_\_\_\_\_ , polysaccharide \_\_\_\_\_ , tripeptide \_\_\_\_\_ , disaccharide \_\_\_\_\_ , cellulose \_\_\_\_\_  
 7. gene \_\_\_\_\_ , quick energy \_\_\_\_\_ , enzyme \_\_\_\_\_ , long-term stored energy \_\_\_\_\_ , plant cell wall \_\_\_\_\_  
 8. peptide bond \_\_\_\_\_ , unsaturated \_\_\_\_\_ , straight chain of ring compounds \_\_\_\_\_ , hydrocarbon (only carbon and hydrogen) chain \_\_\_\_\_ , ribose \_\_\_\_\_ , glycogen \_\_\_\_\_ , hydrogen bond \_\_\_\_\_

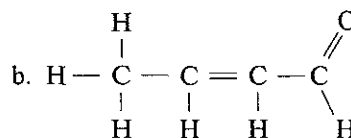
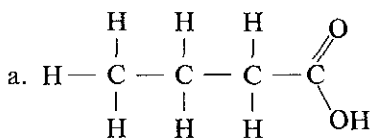
## VII. Posttest

1. Chlorine has an atomic number of 17. How many electrons are in the outermost shell?
  - a. one
  - b. seven
  - c. eight
  - d. it varies
2. When chlorine becomes the chloride ion, its charge is
  - a. plus one
  - b. plus seven
  - c. minus one
  - d. minus seven
3. When hydrogen chloride, a strong acid, is added to water, the pH
  - a. goes up
  - b. stays the same
  - c. goes down
  - d. cannot be determined
4. When two nonmetal oxygen (#8) atoms react with each other, they
  - a. each give up two electrons
  - b. each take two electrons
  - c. each need six electrons
  - d. share
5. In this reaction,  $\text{K} + \text{Cl} \rightarrow \text{K}^+\text{Cl}^-$ , chlorine has been reduced.
  - a. True
  - b. False

6. This bond between the carbon and nitrogen is a



- hydrogen bond
  - weak bond
  - peptide bond
  - all of these
7. Which one molecule would be used repeatedly to form a nucleic acid?
- nucleotide
  - amino acid
  - glucose
  - any one of these
8. The backbone of a nucleic acid would be composed of
- the bases
  - sugar-phosphate-sugar-phosphate, etc.
  - $\text{N}-\text{C}-\text{C}-\text{N}-\text{C}-\text{C}-\text{N}-\text{C}-\text{C}-\text{N}$
  - the "R" groups
9. Which molecule is unsaturated?



10. Which pair below is mismatched?
- amino acid—protein
  - glycerol—glycogen
  - glucose—starch
  - phosphoric acid—nucleotide
11. Which statement characterizes a hydrogen atom that is participating in a hydrogen bond?
- It must be covalently bonded to an oxygen atom.
  - It must have a small positive charge compared to the atom to which it is bonded.
  - It must be part of a water molecule.
  - It must be in its ionic form (i.e., a proton).
12. Proteins are polymers of \_\_\_\_\_ which sometimes function to \_\_\_\_\_
- amino acids; catalyze chemical reactions
  - nucleotides; convey genetic information
  - fatty acids; transport substances through membranes
  - nucleotides; provide energy for cellular processes

In questions 13–15, fill in each blank with the proper term.

13. \_\_\_\_\_ are lipids containing phosphorus that are particularly important in the formation of cell membranes.
14. \_\_\_\_\_ is the splitting of a bond within a larger molecule by the addition of water.
15. \_\_\_\_\_ is the act of dispersing one liquid in another, as fat in water.