# MOLECULES OF BIOLOGICAL IMPORTANCE

Carbon, oxygen, nitrogen, and hydrogen are four elements that combine in many ways to form many of the molecules in organisms. In some organisms, these elements make up over 90% of the weight of the organisms. Other elements are present in organisms but in smaller amounts.

Hydrocarbons constitute a large group of organic compounds. They contain the elements hydrogen and carbon. Often another atom, other than carbon or hydrogen, or a group of atoms is substituted on the hydrocarbon molecule. This substitute group of atoms is called a functional group.

The chemical properties of an organic molecule are determined by the functional group. $CH_4$ is a gas called methane. By removing one hydrogen atom and adding a hydroxyl group (—OH), the substance becomes $CH_3OH$, methyl alcohol. Methyl alcohol is a liquid.

For convenience, biochemists use the letter “R” to represent the part of a molecule other than the functional group. The R can also be used to show the location of the functional group in a molecule. For example, $CH_3OH$ could be written R—OH where R stands for $CH_3$. In this way, the complete structural formula does not have to be written.

Although you may be unfamiliar with the synthesis of organic molecules by organisms, this knowledge will become more important as you continue your study of biology.

Given the molecular formulas of nine molecules of biological importance, you are to determine the two-dimensional structural formulas of the molecules and write the two-dimensional formula for each compound in your lab notebook. You will also build three-dimensional models of these compounds.

**Materials** *(per student)*

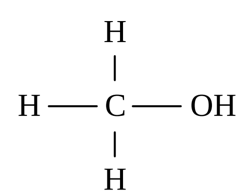
polystyrene balls (black, red, blue, green)
toothpicks

**Procedure**

With the help of Tables 7-1, 7-2, and 7-3, use the molecular formulas of the following compounds to write two-dimensional structural formulas of each compound.

1. $C_2H_5OH$ ethyl alcohol
2. $H_2O$ water
3. $C_3H_5(OH)_3$ glycerol
4. $CH_3COOH$ acetic acid
5. $NH_2CH_2COOH$ glycine (amino acid)
6. $CO(NH_2)_2$ urea
7. $CH_3COCOOH$ pyruvic acid
8. $CH_3CHO$ acetaldehyde
9. $CH_3CH_2CH_2COOH$ butyric acid

**Example:** $CH_3OH$, methyl alcohol




| TABLE 7-1. NUMBER OF BONDS PER ELEMENT |
| --- |
| carbon (C) = 4 |
| hydrogen (H) = 1 |
| oxygen (O) = 2 |
| nitrogen (N) = 3 or 4 (usually 3) |

| TABLE 7-2. ALKANE HYDROCARBONS | |
|---|---|
| **Name** | **Molecular Formula** |
| methane | $CH_4$ |
| ethane | $C_2H_6$ |
| propane | $C_3H_8$ |
| butane | $C_4H_{10}$ |
| pentane | $C_5H_{12}$ |
| hexane | $C_6H_{14}$ |
| heptane | $C_7H_{16}$ |
| octane | $C_8H_{18}$ |
| nonane | $C_9H_{20}$ |
| decane | $C_{10}H_{22}$ |

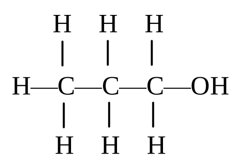
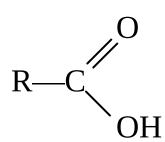
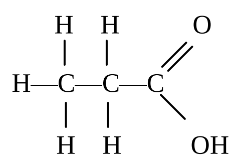
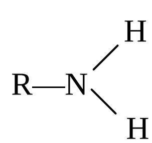
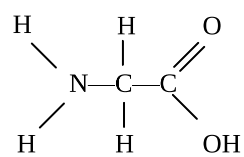
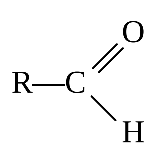
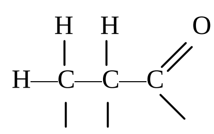
Build three-dimensional models of each compound. Use different colored balls to repreent specific atoms and toothpicks to represent chemical bonds.

Color code for balls:

| | |
|---|---|
| C = black | H = white |
| O = red | N = blue |

**Formulating Generalizations**

1. Which element forms the "backbone" of most two-dimensional organic compounds?
2. What same functional groups are present on the molecules of pyruvic acid, butyric acid, and acetic acid?
3. How are the pyruvic acid, butyric acid, and acetic acid molecules different from each other?
4. Look at the formulas of the hydrocarbons in Table 7-2. What do the prefixes pent-, hex-, hept-, oct-, and dec- mean?
5. Using the structural formula and names of functional groups, tell why glycine is called an amino acid.
6. What does the prefix of each of the hydrocarbon molecules tell you about those molecules?

| TABLE 7-3. FUNCTIONAL GROUPS | | | |
|---|---|---|---|
| **GROUP NAME** | **FORMULA** | **STRUCTURAL FORMULA** | **EXAMPLE** |
| alcohol | R—OH | R—OH |  |
| carboxylic acid (organic acid) | R—COOH |  |  |
| amine | R—$NH_2$ |  |  |
| aldehyde | R—CHO |  |  |