The historical origins of the terms *organic* and *inorganic* involve the following conceptual pairings:

*org*anic—living *org*anisms
*in*organic—*in*animate materials

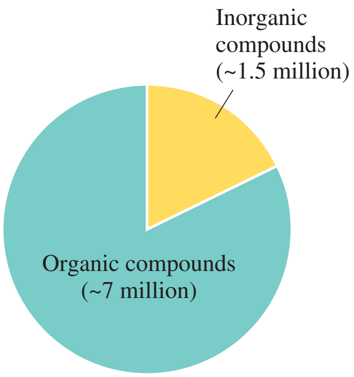


Figure 12.1 Sheer numbers is one reason why organic chemistry is a separate field of chemical study. Approximately 7 million organic compounds are known, compared to "just" 1.5 million inorganic compounds.

Some textbooks define organic chemistry as the study of carbon-containing compounds. Almost all carbon-containing compounds qualify as organic compounds. However, the oxides of carbon, carbonates, cyanides, and metallic carbides are classified as inorganic rather than organic compounds. Inorganic carbon compounds involve carbon atoms that are not bonded to hydrogen atoms (CO, CO_2, Na_2CO_3, and so on).

Carbon atoms in organic compounds, in accordance with the octet rule, always form four covalent bonds.

Soon other chemists had successfully synthesized organic compounds from inorganic starting materials. As a result, the vital-force theory was completely abandoned.

The terms *organic* and *inorganic* continue to be used in classifying compounds, but the definitions of these terms no longer reflect their historical origins. **Organic chemistry** *is the study of hydrocarbons (compounds of carbon and hydrogen) and their derivatives.* Nearly all compounds found in living organisms are still classified as organic compounds, as are many compounds that have been synthesized in the laboratory and have never been found in a living organism. **Inorganic chemistry** *is the study of all substances other than hydrocarbons and their derivatives.*

In essence, organic chemistry is the study of the compounds of one element (carbon), and inorganic chemistry is the study of the compounds of the other 116 elements. This unequal partitioning occurs because there are approximately 7 million organic compounds and only an estimated 1.5 million inorganic compounds (Figure 12.1). This is an approximately 5:1 ratio between organic and inorganic compounds.

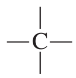
12.2 BONDING CHARACTERISTICS OF THE CARBON ATOM

Why does the element carbon form five times as many compounds as all the other elements combined? The answer is that carbon atoms have the unique ability to bond to each other in a wide variety of ways that involve long chains of carbon atoms or cyclic arrangements (rings) of carbon atoms. Sometimes both chains and rings of carbon atoms are present in the same molecule.

The variety of covalent bonding "behaviors" possible for carbon atoms is related to carbon's electron configuration. Carbon is a member of Group IVA of the periodic table, so carbon atoms possess four valence electrons (Section 4.2). In compound formation, four additional valence electrons are needed to give carbon atoms an octet of valence electrons (the octet rule, Section 4.3). These additional electrons are obtained by electron sharing (covalent bond formation). The sharing of *four* valence electrons requires the formation of *four* covalent bonds.

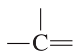
Carbon can meet this four-bond requirement in three different ways:

1. *By bonding to four other atoms.* This situation requires the presence of four single bonds.



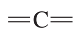
Four single bonds

2. *By bonding to three other atoms.* This situation requires the presence of two single bonds and one double bond.

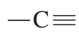


Two single bonds and one double bond

3. *By bonding to two other atoms.* This situation requires the presence of either two double bonds or a triple bond and a single bond.



Two double bonds



One triple bond and one single bond

12.3 HYDROCARBONS AND HYDROCARBON DERIVATIVES

The field of organic chemistry encompasses the study of hydrocarbons and hydrocarbon derivatives (Section 12.1). A **hydrocarbon** *is a compound that contains only carbon atoms and hydrogen atoms.* Thousands of hydrocarbons are known. A **hydrocarbon derivative** *is a compound that contains carbon and hydrogen and one or more additional*