12.1: Organic Chemistry

How many carbon-containing molecules are there? The current estimate is that there are around 20 million different known organic compounds. Why the uncertainty? Every day, scientists are coming up with new compounds. Some of these materials are of interest for a research project, while others are destined to be developed for a commercial market. As soon as we think we know how many organic compounds exist, more are discovered and our number quickly becomes out of date. The molecule gallery in Figure 12.1.1 below shows just 12 of the 20,000,000 or so organic compounds. So, what exactly is an organic compound and why are there so many different possibilities?

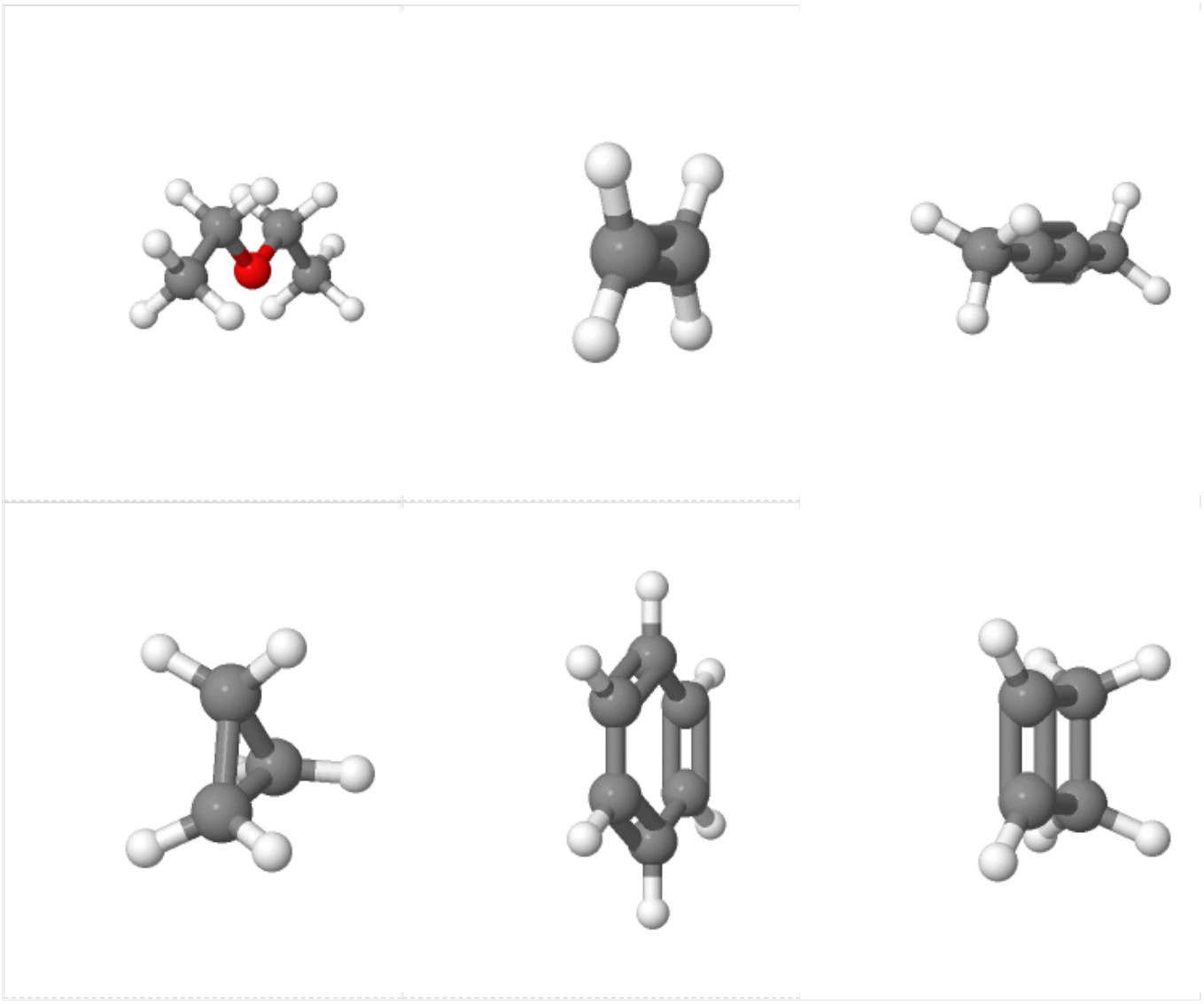

Figure 12.1.1: Row 1 (top row): methane, ethane, octane. Row 2: acetone, acetic acid, ethanol. Row 3: diethyl ether, ethylene, 2-butyne. Row 4: cyclopropane, benzene, cyclobutene. Carbon atoms are shown in gray, hydrogen in white, and oxygen in red.

Organic Chemistry

At one time in history, it was thought that only living things were capable of synthesizing the carbon-containing compounds present in cells. For that reason, the term organic was applied to those compounds. Eventually it was shown that carbon-containing compounds could be synthesized from inorganic substances, but the term "organic" has remained. Currently, **organic compounds** are defined as covalently bonded compounds containing carbon, excluding carbonates and oxides. By this definition, compounds such as carbon dioxide, CO_2, and sodium carbonate, Na_2CO_3, are considered to be inorganic compounds. **Organic chemistry** is the study of all organic compounds.

Organic chemistry is a very vast and complex subject. There are millions of known organic compounds – far more than the number of inorganic compounds. The reason lies within the uniqueness of carbon's structure and bonding capabilities. Carbon has four valence electrons, and therefore makes four separate covalent bonds in compounds. Carbon has the ability to bond to itself repeatedly, making long chains of carbon atoms, as well as ringed structures. In addition, the bonds may be single, double, or triple covalent bonds.

Carbon readily makes covalent bonds with other elements. While Figure 12.1.1 showed compounds comprised of only carbon, hydrogen, and oxygen, Figure 12.1.2 shows organic compounds that include nitrogen, sulfur, and chlorine. Other organic compounds commonly include the remaining halogens or phosphorus.

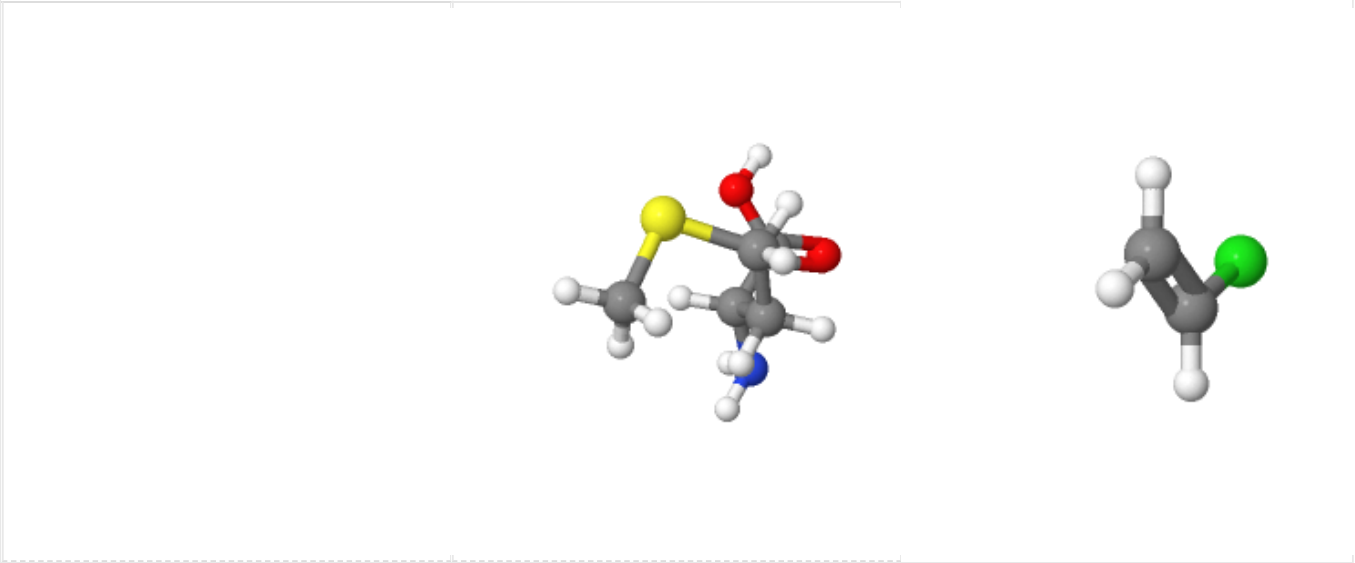

Figure 12.1.2: Caffeine (left), methionine (center, an essential amino acid), and vinyl chloride (right, a monomer of PVC plastic). Nitrogen atoms are shown in blue, sulfur in yellow, and chlorine in green.

The related field of biochemistry overlaps to some extent with organic chemistry. **Biochemistry** is the study of the chemistry of living systems. Many biochemical compounds are considered to be organic chemicals. Caffeine and methionine shown above are biochemical materials in terms of their use in the body, but organic chemicals in terms of their structure and chemical reactivity.

Summary

- Organic compounds are defined as covalently bonded compounds containing carbon, excluding carbonates and oxides. (By this definition, compounds such as carbon dioxide, CO_2, and sodium carbonate, Na_2CO_3, are considered to be inorganic.)
- Organic chemistry is the study of all organic compounds.
- Biochemistry is the study of the chemistry of living systems.