

2.3 Carbon Compounds

Lesson Objectives

-  Describe the unique qualities of carbon.
-  Describe the structures and functions of each of the four groups of macromolecules.

Lesson Summary

The Chemistry of Carbon Organic chemistry is the study of compounds with bonds between carbon atoms. Carbon atoms have four valence electrons, allowing them to form strong covalent bonds with many other elements, including hydrogen, oxygen, phosphorus, sulfur, and nitrogen. Living organisms are made up of molecules made of carbon and these other elements.

- ▶ One carbon atom can bond to another to form chains and rings.
- ▶ Carbon can form millions of different large and complex structures.

Macromolecules Many of the carbon molecules in living things are so large they are called macromolecules. Macromolecules form by polymerization, in which smaller units called **monomers** join together to form **polymers**. Biochemists sort the macromolecules in living things into groups based on their chemical composition.

- ▶ **Carbohydrates** (starches and sugars) are composed of carbon, hydrogen, and oxygen. Carbohydrates are the main energy source for living things. Plants and some animals also use carbohydrates for structural purposes. Molecules with one sugar monomer are **monosaccharides**. A disaccharide is made of two monosaccharides.
- ▶ **Lipids** (fats, oils, and waxes) are made mostly of carbon and hydrogen atoms. Lipids can be used to store energy and form parts of biological membranes and waterproof coverings. Steroids manufactured by the body are lipids as well.
- ▶ **Nucleic acids** contain hydrogen, oxygen, nitrogen, carbon, and phosphorus. They are polymers of **nucleotides**. A nucleotide has three parts: a 5-carbon sugar, a phosphate ($-\text{PO}_4$) group, and a nitrogenous base. Nucleic acids store and transmit hereditary (genetic) information. There are two kinds of nucleic acids: DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).
- ▶ **Proteins** are made up of nitrogen, carbon, hydrogen, and oxygen. Proteins are polymers of **amino acids**. An amino acid molecule has an amino group ($-\text{NH}_2$) on one end and a carboxyl group ($-\text{COOH}$) on the other end. Proteins control the rate of reactions, regulate cell processes, form cellular structures, carry substances into or out of cells, and help fight disease.
 - More than 20 different amino acids are found in nature. Any amino acid can bond with any other.
 - Covalent bonds called peptide bonds link amino acids together to form a polypeptide.
 - Amino acids are assembled into polypeptide chains according to instructions coded in DNA.

The Chemistry of Carbon

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

2. What gives carbon the ability to form chains that are almost unlimited in length?

Macromolecules

For Questions 3–5, complete each statement by writing the correct word or words.

3. Many of the molecules in living cells are so large they are called _____.

4. _____ is the process that forms large organic molecules.

5. When two or more _____ join together, a polymer forms.

6. Create a table in which you compare the components and functions of the following macromolecules: carbohydrates, lipids, nucleic acids, and proteins.

Apply the Big idea

7. How did organic compounds get their name? How is the word related to its meaning?
