

SECTION

4

Organic Compounds

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- Why are there so many organic compounds?
- What are the names and the properties of organic compounds?
- What organic compounds are found in living things?

National Science Education Standards

PS 1a, 1b, 1c

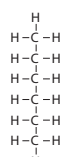
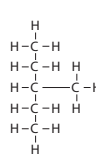
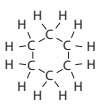
How Does Carbon Form Compounds?

Most of the chemical compounds that exist contain carbon. These compounds are called organic compounds. **Organic compounds** are compounds made of molecules in which carbon atoms are covalently bonded to other atoms.

Every organic compound contains carbon. Carbon atoms have four outer electrons. This means that each carbon atom can make four covalent bonds with other atoms. Most organic molecules have two or more carbon atoms linked to one another. ✓

The illustrations in the figure below are models of organic molecules. These models are called *structural formulas*. They show the order in which atoms in a molecule are connected to one another. A line between two element symbols represents a covalent bond, or one pair of shared electrons.

Models of Organic Molecules

		
Straight chain Carbon atoms are connected one after another.	Branched chain The chain of carbon atoms branches when a carbon atom bonds to more than two other carbon atoms.	Ring The chain of carbon atoms forms a ring.

Notice that these molecules have chains of carbon atoms linked to one another. Some organic molecules have hundreds or thousands of carbon atoms linked together to form a backbone of the molecule.

STUDY TIP

Brainstorm With a partner, write down the names of several of your favorite foods. After you have read about the carbohydrates, lipids, and proteins, identify which of these groups are in the foods.

READING CHECK

1. Identify What do most organic molecules have in them?

TAKE A LOOK

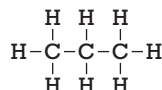
2. Identify What are three ways carbon atoms link together in organic molecules?

SECTION 4 Organic Compounds *continued***What Are Some Kinds of Organic Compounds?**

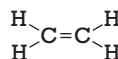
Many organic compounds contain atoms of several elements. The simplest organic compounds only contain two elements—carbon and hydrogen. Organic compounds that contain only carbon and hydrogen are called **hydrocarbons**. Hydrocarbons are grouped based on the covalent bonds between the carbon atoms, as shown in the figure below. ✓

READING CHECK

3. Describe What are hydrocarbons?

Three Types of Bonds Between Carbon Atoms**Single Bond**

The **propane** in a camping stove contains only single bonds.

Double Bond

Fruits make **ethene**, which is a compound that helps ripen the fruit.

Triple Bond

Ethyne is better known as **acetylene**. It is burned in miners' lamps and in welding torches.

TAKE A LOOK

4. Identify What are three types of hydrocarbons?

In some hydrocarbon molecules, each carbon atom shares one pair of electrons with each of four other atoms. This type of chemical bond is called a single bond. A hydrocarbon that has only single bonds is called a saturated hydrocarbon. It is also called an alkane.

In an unsaturated hydrocarbon, at least one pair of carbon atoms shares more than one pair of electrons. A double bond is a covalent bond with two pairs of shared electrons. A triple bond has three pairs of shared electrons. When unsaturated organic molecules react, part of the double or triple bond can be broken. Other atoms can then be added to the molecule. ✓

READING CHECK

5. Describe How do saturated and unsaturated hydrocarbons differ?

Hydrocarbons that contain a double bond are called alkenes. Hydrocarbons that contain triple bonds are called alkynes. Alkenes and alkynes are unsaturated hydrocarbons.

Benzene is a compound that has six carbon atoms in a ring shape. It is found in most of the compounds that are called *aromatic* compounds.

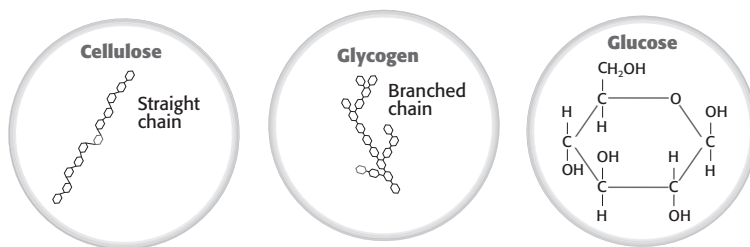
In addition to hydrocarbons, there are many other kinds of organic compounds. These compounds are made by adding atoms of other elements to hydrocarbons. The other elements include the halogens, oxygen, sulfur, and nitrogen.

SECTION 4 Organic Compounds *continued***What Organic Chemicals Are Important to Life?**

Organic chemicals that are made by living things are called *biochemicals*. There are four important groups of biochemicals: carbohydrates, lipids, proteins, and nucleic acids.

CARBOHYDRATES

Carbohydrates are biochemicals that are made of one or more simple sugar molecules. Living things use carbohydrates as an energy source. There are two types: simple carbohydrates and complex carbohydrates. The figure below shows how atoms and molecules form carbohydrates. ✓



Glucose is a simple carbohydrate. Cellulose and glycogen are complex carbohydrates made up of chains of glucose. Each hexagon in the diagram represents one glucose unit.

The simple carbohydrates, including glucose, are made of carbon, hydrogen, and oxygen. The carbon atoms form a ring. Complex carbohydrates can have hundreds or thousands of sugar molecules held together by chemical bonds. Cellulose is part of the rigid structure of the cell walls of plants. Animals use glycogen to supply energy to muscles.

LIPIDS

Lipids are biochemicals that do not dissolve in water. Fats, oils, and waxes are examples of lipids. One of the functions of lipids in living things is to store energy. It can be unhealthy to eat too many lipids, but some fats and oils are part of a healthy diet. ✓

Lipids store extra energy in the body. This energy can be used later when the lipids take part in chemical reactions. As the lipid molecules break down, they release the stored chemical energy. In general, animals use fats for this purpose and plants use oils. When the organism has used up its carbohydrates, it can obtain energy from its lipids.

STANDARDS CHECK

PS 1c Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reactions with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.

Word Help: chemical of or having to do with the properties or actions of substances

Word Help: involve to have as a part of

6. Compare What are four groups of biochemicals important for living things?

READING CHECK

7. Describe What are carbohydrates?

READING CHECK

8. Describe What are lipids?

SECTION 4 Organic Compounds *continued*

Vegetable oil, meat, cheese, eggs, and milk are sources of lipids in your diet.

PROTEINS

Most of the biochemicals found in living things are proteins. **Proteins** are biochemicals that are made of chains of building blocks called amino acids. Amino acids are small molecules made of carbon, hydrogen, oxygen and nitrogen. Some amino acid molecules also have sulfur atoms. ✓

Protein molecules are made of hundreds or thousands of amino acid molecules. Chemical bonds hold them together in long chains or complex webs. The function of a protein molecule depends on its shape. The shape of the protein molecule is determined by the exact order of amino acids in its structure.

Proteins have many functions in living organisms. Enzymes are proteins that increase the rate of chemical reactions in a cell. Hemoglobin is a protein in red blood cells that carries oxygen to the cells of the body. Proteins help carry materials through cell membranes.

Some proteins provide structure and strength. Your hair and fingernails are made of protein molecules. The muscles that control the movement of your body are made primarily of protein molecules. Spiders use long chains of protein molecules to build light, but strong, silk webs.



Spider webs are made up of proteins that are shaped like long fibers.

 **READING CHECK**

9. Describe What are proteins?

 **Say It**

Research Find out how hemoglobin can pick up and carry oxygen to the cells of the body. Report your finding to the class.

SECTION 4 Organic Compounds *continued***NUCLEIC ACIDS**

The largest molecules made by living things are nucleic acids. **Nucleic acids** are biochemicals made up of nucleotides. Nucleotides are molecules made of carbon, hydrogen, oxygen, nitrogen and phosphorus atoms. ✓

There are only five different types of nucleotides. They are combined in chains of up to millions of units in nucleic acids. The order of the nucleotides determines the nucleic acid, just as the order of letters in a word determines the word.

One of the functions of nucleic acids is to store genetic information. They are sometimes called the blueprints of life because they contain all of the information a cell needs to work. The patterns of the nucleotides are used by a cell when it builds proteins and other nucleic acids.

DNA AND RNA

There are two kinds of nucleic acids: DNA and RNA. DNA molecules contain the genetic material of a cell. The DNA molecules in a single human cell contain millions of nucleotides and are about 2 meters long. This size allows the DNA molecules to store all of the information that a body's cells need to function. ✓

DNA molecules are shaped as a double spiral, as shown in the figure below. Each nucleotide in one spiral matches a specific nucleotide in the other spiral.

When a cell needs to make a particular protein, information is copied from part of the DNA molecule. A second kind of nucleic acid, called RNA, is built using this information. The RNA molecule contains the information that the cell needs to build the protein molecules. RNA is involved in the actual building of proteins. ✓



Two strands of DNA are twisted in a spiral shape. Four different nucleotides make up the rungs of the DNA ladder.

✓ READING CHECK

10. Describe What are nucleic acids?

✓ READING CHECK

11. Describe What is stored in a DNA molecule?

✓ READING CHECK

12. Describe What information does an RNA molecule contain?

Section 4 Review

NSES PS 1a, 1b, 1c

SECTION VOCABULARY

carbohydrate a class of energy-giving nutrients that includes sugars, starches, and fiber; contains carbon, hydrogen, and oxygen

hydrocarbon an organic compound composed only of carbon and hydrogen

lipid a type of biochemical that does not dissolve in water; fats and steroids are lipids

nucleic acid a molecule made up of subunits called nucleotides

organic compound a covalently bonded compound that contains carbon

protein a molecule that is made up of amino acids and that is needed to build and repair body structures and to regulate processes in the body

1. Identify Complete the following table.

Type of carbon backbone	Description
	The chain of carbon atoms forms a ring.
	All carbon atoms are connected in a straight line.
	The chain of carbon atoms separates into different directions.

2. Explain What group of hydrocarbons contains saturated compounds? What groups of hydrocarbons contain unsaturated compounds?

3. Identify Complete the following table.

Type of biochemical	Description
	made of hundreds or thousands of amino acid molecules
	one of the functions is to store genetic information
	made of one or more simple sugar molecules
	one of the functions in living things is to store energy

4. Identify and Describe What are two kinds of nucleic acids? What does each one do in living things?
