Chemical Compounds in Cells

Key Concepts

- What are elements and compounds?
- How is water important to the function of cells?
- What are the main kinds of organic molecules in living things?

An element is any substance that cannot be broken down into simpler substances. The smallest unit of an element is called an atom. The elements found in living things include carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur. **When two or more elements combine chemically, they form a compound.** The smallest unit of many compounds is called a molecule.

Water is a compound made up of hydrogen and oxygen. **Most chemical reactions within cells could not take place without water.** Water also helps cells keep their size and shape and keeps the temperature of cells from changing rapidly.

Many of the compounds found in living things contain the element carbon. Most compounds that contain carbon are called organic compounds. **Carbohydrates, proteins, lipids, and nucleic acids are important groups of organic compounds in living things.** Compounds that do not contain the element carbon are called inorganic compounds.

A **carbohydrate** is an energy-rich organic compound made of the elements carbon, hydrogen, and oxygen. Sugars and starches are examples of carbohydrates. Carbohydrates are important components of some cell parts, including cell walls and cell membranes.

Fats, oils, and waxes are all **lipids.** Lipids are energy-rich organic compounds made of carbon, hydrogen, and oxygen. Lipids contain more energy than carbohydrates. Cells store energy in lipids for later use.

Proteins are large organic molecules made of carbon, hydrogen, oxygen, nitrogen, and, in some cases, sulfur. Protein molecules are made up of smaller molecules called **amino acids.** Proteins make up much of the structure of cells. An **enzyme** is a type of protein that speeds up a chemical reaction in a living thing. Without enzymes, many chemical reactions that are necessary for life would either take too long or not occur at all.

Nucleic acids are very long organic molecules made of carbon, oxygen, hydrogen, nitrogen, and phosphorus. Nucleic acids contain the instructions that cells need to carry out all the functions of life. There are two kinds of nucleic acids: DNA and RNA. Deoxyribonucleic acid, or **DNA,** is the genetic material that carries information about an organism that is passed from parent to offspring and directs all of the cell's functions. Ribonucleic acid, or **RNA,** plays an important role in the production of proteins. RNA is found in the cytoplasm as well as in the nucleus.

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Chemical Compounds in Cells

This section identifies the basic building blocks of cells. It also explains the importance of water to cells.

Use Target Reading Skills

As you read, compare and contrast carbohydrates, proteins, and lipids in the table below.

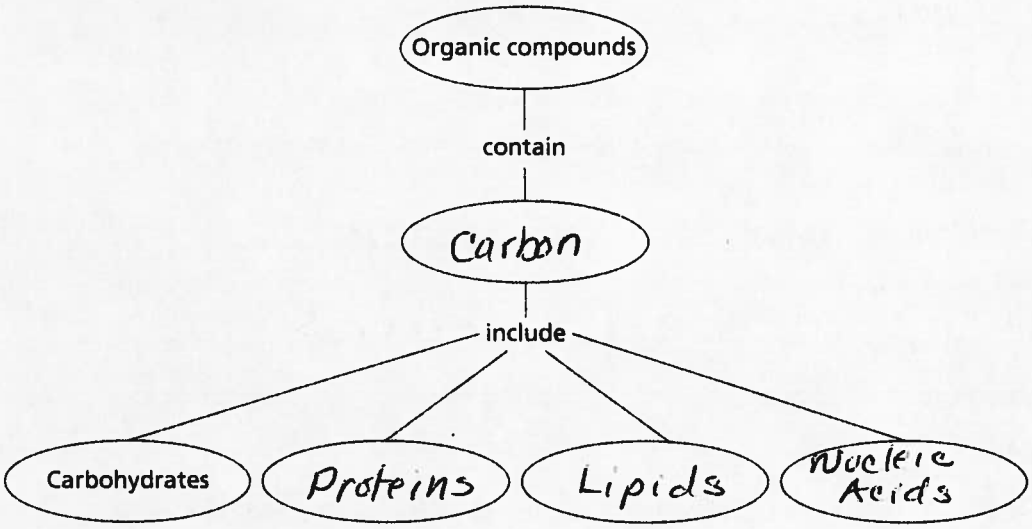
Type of Compound	Elements	Functions
Carbohydrate	Carbon, hydrogen, oxygen	Store and provide energy and make up cellular parts
Protein	Carbon Hydrogen Oxygen Nitrogen + Sometimes Sulfur	Make up much of the structure of cells and speed up chemical reactions
Lipid	Carbon Hydrogen Oxygen	Store energy

Elements and Compounds

1. A(n) element is any substance that cannot be broken down into simpler substances. Its smallest unit is the atom.
2. When two or more elements combine chemically, they form a(n) compound. Its smallest unit is usually called a(n) molecule.
3. Most chemical reactions within cells could not take place without water.

Chemical Compounds in Cells *(continued)*

4. Complete this concept map on organic compounds.



5. Compounds that do not contain carbon are called inorganic compounds.

Carbohydrates

6. A carbohydrate is made of carbon, hydrogen, and oxygen.
7. Starch is a kind of carbohydrate. What foods have starch?
   Potatoes, noodles, rice, bread.
8. How do cells use carbohydrates?
   Cells use carbohydrates for energy and as components of some cell parts

Lipids

9. What are three examples of lipids?
   a. Fats
   b. Oils
   c. Waxes

10. How are lipids like carbohydrates?
Both are energy-rich organic compounds made of carbon, hydrogen, and oxygen.

11. Cells store energy in lipids to use later.

Proteins

12. Proteins form parts of cell membranes and many of the cell's organelles.

13. What small molecules make up proteins? amino acids

14. What do enzymes do?
Speed up chemical reactions

Nucleic Acids

15. Very long organic molecules that contain instructions that cells need to function are called nucleic acids.

16. Is the following sentence true or false? Cells use the instructions in nucleic acids to carry out all life functions. True

17. List the two kinds of nucleic acids.
a. DNA b. RNA

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Understanding Main Ideas

Fill in the blanks in the table below.

Organic Compounds		
Type of Compound	**Example**	**Major Roles in Living Things**
Carbohydrates	1. Sugars, starches	Help form cell walls and membranes; provide energy
2. Lipids	Fats	Help form cell membranes; 3. Provide energy
4. Proteins	Enzymes	Help form cell membranes and organelles; speed up chemical reactions
5. Nucleic Acids	DNA, RNA	Direct all the cell's functions; 6. help produce proteins

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the blank beside the term.

H 7. element
F 8. compound
I 9. carbohydrate
D 10. proteins
E 11. amino acids
G 12. enzyme
J 13. lipid
C 14. nucleic acids
B 15. DNA
A 16. RNA

a. type of nucleic acid that plays an important role in the production of proteins
b. type of nucleic acid that passes from parent to offspring and directs all the cell's functions
c. very large organic molecules made of carbon, oxygen, hydrogen, nitrogen, and phosphorus
d. large organic molecules made of carbon, hydrogen, oxygen, nitrogen, and, in some cases, sulfur
e. small molecules that make up proteins
f. the chemical combination of two or more elements
g. type of protein that speeds up chemical reactions in living things
h. any substance that cannot be broken down into simpler substances
i. an energy-rich organic compound such as sugar
j. an energy-rich organic compound such as fat

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Amino Acids and Proteins

Though there are only 20 common amino acids, they can be combined in different ways to produce thousands of unique proteins. Proteins that differ in the order or type of amino acids they contain may have very different structures and functions. In fact, a change in even a single amino acid can sometimes affect the way a protein works.

Suppose that proteins could consist of just two amino acids. To see how many unique proteins, each composed of just two amino acids, can be formed from five different amino acids, fill in the spaces in the table below. Some of the spaces have been filled in to show you how. Assume that each letter represents a different amino acid.

Amino Acids	*A*	*B*	*C*	*D*	*E*
A	*AA*	*AB*	*AC*	AD	AE
B	*BA*	BB	BC	BD	BE
C	CA	CB	CC	CD	CE
D	DA	DB	DC	DD	DE
E	EA	EB	EC	ED	EE

Answer the following questions in the spaces provided.

1. What does each letter pair in the table represent?
   Each letter pair represents a unique two amino acid protein.
2. Based on your completed table, how many unique proteins, each composed of just two amino acids, can be formed from five different amino acids?
   5x5= 25
3. How many unique proteins, each made up of just two amino acids, could be formed from six different amino acids? From 20 different amino acids?
   6x6= 36 20x20 = 400
4. Most proteins are made up of not just two, but hundreds or even thousands of amino acids. How does this affect the number of unique proteins that could be formed from just a few amino acids?
   Increasing the number of amino acids each protein contains greatly increases the number of unique proteins that could be formed from just a few amino acids

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Analyze and Conclude

1. **Observing** According to the information on the containers, which dips had 0% fat? Which dips were labeled "fat-free"?

2. **Interpreting Data** Did the result shown on the test square always agree with the information on the dip's container?

3. **Inferring** Based on your results, what can you conclude about the accuracy of labels indicating that foods are fat-free?

4. **Communicating** Write a report for consumers that summarizes your results. Summarize the processes you used.

Design an Experiment

Protein test strips indicate *how much* protein is present in a food sample. Design an experiment to rank five food samples in the order of least protein to most protein. *Obtain your teacher's permission before carrying out your investigation.*