Name _____ Class _____ Date _____

2.3 Carbon Compounds

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 ($–PO_4$) 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 ($–NH_2$) on one end and a carboxyl group (–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 Water Molecule Water molecules (H_2O) are polar because of an uneven distribution of electrons, creating a slight negative (–) charge in the oxygen atom and a slight positive (+) charge in each hydrogen atom. The attraction between a hydrogen atom of one water molecule and the oxygen atom of another water molecule is called a **hydrogen bond**.

- **Cohesion** is an attraction between molecules of the same substance. It causes water molecules to be drawn together, producing surface tension
- **Adhesion** is an attraction between molecules of different substances. It causes capillary action, an effect that causes water to rise in a narrow tube against the force of gravity.

Solutions and Suspensions A **mixture** is a material composed of two or more elements or compounds that are physically mixed together but not chemically combined. A **solution** is a mixture in which all the components are evenly spread out: the substance dissolved is the **solute**; the substance that causes the dissolving is the **solvent**. Mixtures of water and undissolved materials are **suspensions**.

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?

_____

Compare/Contrast Table Use a compare/contrast table when you want to see the similarities and differences between two or more objects or processes. Complete the table below comparing and contrasting carbohydrates, lipids, nucleic acids, and proteins.

	Carbohydrates	Lipids	Nucleic Acids	Proteins
Elements that compose the macromolecule	***carbon, hydrogen, and oxygen (1:2:1 ratio)***			
Use of the macromolecule	***used in living things as the main source of energy and some organisms use it for structural purposes***		***store and transmit hereditary information***	

Examples of the macromolecule	***polysaccharides such as glycogen, starch, cellulose***		***DNA, RNA***	

Macromolecules

Amino acids are the monomers of proteins. Each amino acid has three distinct parts: an amino group, an R group, and a carboxyl group. An amino group has the formula $–NH_2$, a carboxyl group is –COOH, and the R group varies from one amino acid to another. Two amino acids are joined in a chemical reaction that links them by a peptide bond.

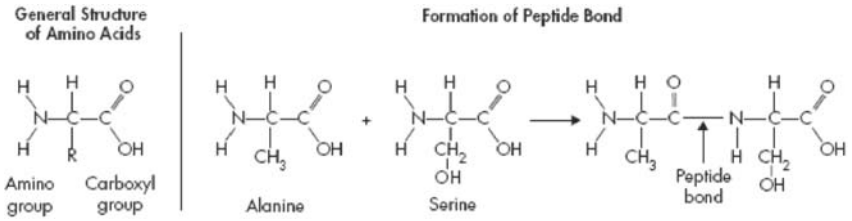
Follow the directions. Then answer the questions.

1. Look at the diagram of the general structure of an amino acid. Color the amino group green.

2. Color the carboxyl group blue.

3. Color the R group red.

4. Color the same groups in the amino acids alanine and serine.



5. How many oxygen atoms are found in the carboxyl group?

A. 1 **C.** 3

B. 2 **D.** 4

6. What is the R group found in alanine?

A. CH_3 **C.** H_2O

B. CH_2OH **D.** COOH

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.

The Water Molecule

For Questions 1–4, write True or False on the line provided.

_____ **1.** Water is a polar molecule.

_____ **2.** Hydrogen bonds are an example of adhesion.

_____ **3.** Covalent bonds give water a low heat capacity.

_____ **4.** A hydrogen bond is stronger than a covalent bond.

Solutions and Suspensions

5. Complete the table

Substance	Definition	Example(s)
	Physical combination of two or more substances	Cinnamon sugar
Solute		Salt in saltwater
	Mixture of water and nondissolved substance	Blood
Solution		

Venn Diagram A Venn diagram is made up of overlapping circles. It is a useful tool for comparing two or even three topics. In each circle, write one of the topics that you want to compare. In the space where the circles overlap, write the features that the topics share. In the space where the circles do not overlap, write the features that are unique to each topic.

Use the Venn diagram to compare solutions and suspensions.