

# 2

## The Chemistry of Life

**FOCUS:** Chemistry is the study of the composition and structure of substances and the reactions they undergo. Matter is composed of atoms which consist of a nucleus (protons and neutrons) surrounded by electrons. The chemical bonds between atoms of molecules include ionic,

covalent, and hydrogen bonds. A chemical reaction is the process by which atoms or molecules interact to form or break chemical bonds. Important large organic molecules in humans are carbohydrates, lipids, proteins, and nucleic acids.

### CONTENT LEARNING ACTIVITY

#### Basic Chemistry

“Matter is anything that occupies space.”

A. Match these terms with the correct statement or definition:

Atom  
Electron  
Element  
Nucleus

Neutron  
Orbital  
Proton

- \_\_\_\_\_ 1. Smallest particle into which an element can be divided using conventional chemical means.
- \_\_\_\_\_ 2. Matter composed of atoms of only one kind.
- \_\_\_\_\_ 3. Subatomic particle with no electrical charge.
- \_\_\_\_\_ 4. Subatomic particle with a negative charge; moves around nucleus.
- \_\_\_\_\_ 5. Region where each electron is most likely to be found.



The number of protons in an atom is called its atomic number.

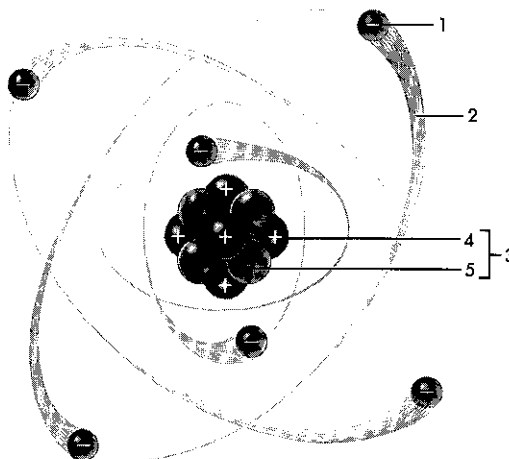


B. Match these terms with the correct parts labeled in Figure 2-1:

Electron  
Nucleus  
Neutron

Orbital  
Proton

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_



## Electrons and Chemical Bonds

“Chemical bonds form when the outermost electrons are transferred or shared between atoms.”

Using the terms provided, complete these statements:

Covalent  
Double  
Electrons  
Hydrogen  
Ionic

Ions  
Nonpolar  
Polar  
Triple

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

Much of an atom's chemical behavior is determined by the (1) in its outermost orbitals. Atoms that have donated or accepted electrons are called (2). (3) bonds result when oppositely charged ions are attracted to each other. (4) bonds result when two atoms share a pair of electrons. If two pairs of electrons are shared, a (5) covalent bond is formed, and atoms that share three pairs of electrons form (6) covalent bonds. Unequal sharing of electrons produces a (7) covalent bond, such as in water molecules. (8) bonds result when molecules with polar covalent bonds are weakly attracted to ions or other polar covalent molecules.



A combination of atoms held together with chemical bonds is called a molecule; a molecule with two or more different kinds of atoms is called a compound

## Chemical Reactions

“A chemical reaction is the process by which atoms or molecules interact to form or break chemical bonds.”

Using the terms provided, complete these statements:

ATP	Reactants
Decomposition	Released
Exchange	Stored
Heat	Synthesis
Products	

The atoms or molecules present before the chemical reaction occurs are the (1) and those produced by the chemical reaction are the (2). When two or more atoms, ions, or molecules combine to form a new and larger molecule, the process is called a (3) reaction, whereas in a (4) reaction, larger molecules are broken down into smaller molecules, ions, or atoms. A(n) (5) reaction is a combination of a decomposition and a synthesis reaction. Energy exists in chemical bonds as (6) energy. If the products of a chemical reaction contain less energy than the reactants, energy is (7). Most of the energy released from a chemical reaction is released as (8). Almost all of the chemical reactions of the cell that require energy use (9) as an energy source.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_

## Rate of Chemical Reactions

“The rate at which a chemical reaction proceeds is influenced by several factors.”

Using the terms provided, complete these statements:

Catalyst	Enzymes
Concentration	Increases
Decreases	

Chemical reactions are influenced by several factors, including the ability of substances to react with other substances. If the concentration of reactants increases, the rate of a chemical reaction (1). When the temperature decreases, the speed of chemical reactions (2). A (3) is a substance that increases the rate at which a chemical reaction proceeds without itself being permanently changed or depleted. Protein molecules in the body that act as catalysts are called (4). Regulation of chemical events in the cell occur primarily because of mechanisms that control either the (5) or the activity of enzymes.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_



At normal body temperatures, most chemical reactions would take place too slowly to sustain life if it were not for the body's enzymes.

## Reversible Reactions

“Some reactions can proceed from reactants to products and from products to reactants.”

Match these terms with the correct statement or definition:

Equilibrium  
Reversible reaction

\_\_\_\_\_

\_\_\_\_\_

1. Chemical reaction that can proceed from reactants to products and from products to reactants.
2. At this point the rate of product formation is equal to the rate of reactant formation.

## Acids and Bases

“The chemical behavior of many molecules changes as the pH of the solution in which they are dissolved changes.”

A. Match these terms with the correct statement or definition:

Acids  
Bases

Buffers  
Salts

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

1. Substances that are proton ( $H^+$ ) donors.
2. Substances that accept hydrogen ions.
3. Molecules consisting of a positive ion other than hydrogen and a negative ion other than hydroxide.
4. Chemicals that resists changes in pH when acids or bases are added.

B. Match these terms with the correct statement or definition:

Acidic solution  
Alkaline (basic) solution

Neutral solution

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

1. pH of 7 (e.g., pure water).
2. pH less than 7.
3. Greater concentration of hydroxide ions than hydrogen ions.

## Water

“A water molecule consists of one oxygen atom joined by covalent bonds to two atoms of hydrogen.”

Using the terms provided, complete these statements:

Digestion  
Dissociate  
Heat

Lubricant  
React  
Transport

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

Water has many important properties for living organisms. Water can absorb large amounts of (1) and remain at a stable temperature. Water also acts as an effective (2); for example, tears protect the surface of the eye. Water is necessary in many chemical reactions, such as the (3) of food. Water is necessary for (4) of nutrients, gases, and waste products in the body. When ionic substances dissolve in water, the positive and negative ions separate, or (5), allowing the ions to stay in solution and (6) with other molecules.

## Organic Molecules

“Organic molecules are those that contain carbon.”

Match these terms with the correct statement or definition:

Inorganic molecules  
Organic molecules

\_\_\_\_\_  
\_\_\_\_\_

1. Include carbohydrates, lipids, proteins and nucleic acids.
2. All molecules that do not contain carbon (except carbon dioxide).

## Carbohydrates

“Carbohydrates are small to very large molecules that are composed of carbon, hydrogen, and oxygen atoms.”

Match these terms with the correct statement or definition:

Disaccharides  
Monosaccharides

Polysaccharides

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

1. Simple sugars (e.g., glucose) that are the building blocks for other carbohydrates.
2. Sucrose and other double sugars.
3. Many monosaccharides bound in long chains, e.g., glycogen and starch.

## Lipids

“Lipids dissolve in nonpolar solvents such as alcohol or acetone, but not in water.”

Match these terms with the correct statement or definition:

Fatty acids  
Glycerol  
Lipids

Saturated  
Triacylglycerol  
Unsaturated

- \_\_\_\_\_ 1. Fats, phospholipids, and steroids.
- \_\_\_\_\_ 2. Building blocks of fats.
- \_\_\_\_\_ 3. Most common type of fat molecule, with three fatty acids bound to a glycerol molecule.
- \_\_\_\_\_ 4. Fatty acid that contains only single covalent bonds between the carbon atoms.
- \_\_\_\_\_ 5. Believed to be the best type of fat in the diet.

## Proteins

“All proteins contain carbon, hydrogen, oxygen, and nitrogen, and most have some sulfur.”

Using the terms provided, complete these statements:

Activation energy  
Amino acid  
Contraction  
Denaturation  
Enzymes

Essential  
Lock and key  
model  
Shape  
Structural

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_

The building blocks of proteins are 20 basic types of (1) molecules. Humans can synthesize 12 of these from simple organic molecules, but the remaining eight are called (2), and must be included in the diet. The ability of proteins to perform their functions depends on their (3). (4) occurs when hydrogen bonds that maintain a protein's shape are broken, and the protein becomes nonfunctional. Proteins perform many important functions. (5) are proteins that regulate the rate of chemical reactions, (6) proteins provide the framework for many of the body's tissues, and muscles contain proteins that are responsible for muscle (7). Enzymes increase the rate of chemical reactions by lowering the (8) necessary to start a chemical reaction. According to the (9) of enzyme action, the shape of enzymes and reactants allows them to bind together easily.

## Nucleic Acids

“Nucleic acids are composed of carbon, hydrogen, oxygen, nitrogen, and phosphorus.”

Match these terms with the correct statement or definition:

Chromatin  
Chromosomes  
DNA

Nucleotide  
RNA

- \_\_\_\_\_ 1. Building block for nucleic acids; contains a five-carbon sugar, a nitrogen base, and a phosphate group.
- \_\_\_\_\_ 2. Contains deoxyribose; nucleotides form a double helix.
- \_\_\_\_\_ 3. DNA molecules associated with protein.
- \_\_\_\_\_ 4. Formed when chromatin condenses during cell division.
- \_\_\_\_\_ 5. Single strand of nucleotides that contains the sugar ribose.
- \_\_\_\_\_ 6. Genetic material of the cell; controls cell activities.

### QUICK RECALL

1. List three subatomic particles and give their charge.
2. List three types of bonds between atoms.
3. List three types of chemical reactions according to the size of the reactant and product molecules.
4. List four influences on the rate of a chemical reaction.



5. Name the four types of large organic molecules found in living things. For each type of organic molecule, list its building block(s).
  
6. List three kinds of carbohydrates.
  
7. List three functions of lipids in the human body.
  
8. List six functions of proteins in the human body.
  
9. List three functions of nucleic acids in the human body.

## WORD PARTS

Give an example of a new vocabulary word that contains each word part.

WORD PART	MEANING	EXAMPLE
neutr-	neither	1. _____
iso-	equal; alike	2. _____
syn-	together	3. _____
poly-	many	4. _____
mono-	one	5. _____
sacchr-	sugar	6. _____

## MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

- \_\_\_\_\_ 1. The smallest particles into which an element can be divided using conventional chemical means are
- electrons.
  - molecules.
  - neutrons.
  - protons.
  - atoms.
- \_\_\_\_\_ 2. The number of electrons in an atom is equal to
- the number of neutrons.
  - the number of protons.
  - the atomic number.
  - b and c
- \_\_\_\_\_ 3. A polar covalent bond occurs when
- electrons are not shared equally between atoms.
  - two atoms share electrons equally.
  - an electron is lost from one atom and accepted by another.
  - the molecule becomes ionized.
  - a hydrogen atom is shared between two different atoms.
- \_\_\_\_\_ 4. Which of these would be a synthesis reaction?
- hydrochloric acid (HCl) and sodium hydroxide (NaOH) combine to form sodium chloride (NaCl) and water (H<sub>2</sub>O).
  - monosaccharides are combined to produce polysaccharides.
  - fats are broken down to fatty acids and glycerol.
  - all of the above
- \_\_\_\_\_ 5. In a decomposition reaction
- atoms are transferred to another molecule.
  - large molecules are broken down to smaller molecules.
  - large molecules are formed from smaller molecules.
  - all of the above
- \_\_\_\_\_ 6. The rate of chemical reactions is influenced by
- the concentration of the reactants.
  - temperature.
  - enzymes.
  - all of the above
- \_\_\_\_\_ 7. A solution with a pH of 5 is a (an) \_\_\_\_\_ and contains \_\_\_\_\_ hydrogen ions than a neutral solution.
- base, more
  - base, fewer
  - acid, more
  - acid, fewer
- \_\_\_\_\_ 8. A buffer
- slows down chemical reactions.
  - speeds up chemical reactions.
  - increases the pH of solutions.
  - maintains a relatively constant pH.
- \_\_\_\_\_ 9. Water
- is composed of two oxygen atoms and one hydrogen atom.
  - carries small amounts of heat from the body when it evaporates.
  - is composed of polar molecules into which ionic substances dissociate.
  - is not involved in most chemical reactions in the body.
- \_\_\_\_\_ 10. Which of these is an example of a carbohydrate?
- glycogen
  - phospholipid
  - steroid
  - DNA
  - none of the above