

Name: _____ Date: _____ Hour: _____

General Biology

3.1 Composition of Matter

INTRODUCTION

Everything in the universe is made up of matter. This includes all living things, from amoebas to whales, from bacteria to giant sequoias. **Matter** is anything that occupies space and has mass. **Mass** is the quantity of matter an object has. The SI unit of mass is grams. The pull of gravity on the mass of an object gives the object the property of weight, the unit for weight being pounds.

Changes in matter are essential to all life processes. For example, when an organism takes in food, it alters the physical and chemical properties of the food. Such changes allow the organism to make use of the nutrients in the food. By learning how changes in matter occur you will gain an understanding of organisms and how they adapt to the environment.

1. What is matter? _____

2. What is mass? _____

3. What is weight? _____

ATOMS

The **atom** is the fundamental unit of matter. The nature and properties of atoms determine the structure and behavior of matter. Atoms are about 10 nm in diameter. Thus they can be observed only with a very powerful electron microscope, and even then the internal structure cannot be observed. However, through experimentation, scientists have developed models that describe the structure and behavior of the atom.

The various components that make up an atom are called subatomic particles. The central core, or nucleus, consists of two kinds of subatomic particles. One, the **proton**, has a positive electrical charge. The other, the **neutron**, has no electrical charge. Most of the mass of the atom is concentrated in the nucleus. **Electrons** are particles with a negative electrical charge that move about the nucleus at tremendous speeds. An atom has an equal number of protons and electrons. The electrical charges of these particles offset one another, so that the net electrical charge of the atom is zero.

4. What type of microscope is used to observe an atom? _____
5. The three subatomic particles are neutron, electron, and proton. What is the charge of each and where is each found in an atom?
 - a. Proton-Charge: _____; Location: _____
 - b. Electron-Charge: _____; Location: _____
 - c. Neutron-Charge: _____; Location: _____

ELEMENTS

Elements are substances that cannot be broken down chemically into simpler kinds of matter. Each element has a unique chemical symbol. More than 100 elements have been identified. Ninety-two elements occur in nature. The rest have been synthesized in physics laboratories.

Each atom of any element has the same number of protons. The number of protons in an atom is called the atomic number of the element. For example, since each atom of the element carbon has six protons, the atomic number of carbon is 6.

6. What is an element? _____

7. The number of protons in an atom is called the _____ of the element.

COMPOUNDS

Compounds consist of atoms of two or more elements that are joined by chemical bonds. In a compound the proportions of individual atoms are fixed. For example, in the compound water the atoms of hydrogen (H) and oxygen (O) are always in a proportion of 2 to 1. A chemical formula shows the kind and proportion of atoms that form a particular compound. The chemical formula for water is H_2O . A compound differs in physical and chemical properties from the elements that compose it. For example, in nature the element oxygen is usually found as a gas (O_2) and the element hydrogen is usually found as a gas (H_2). However, when oxygen gas and hydrogen gas combine, they form the compound water (H_2O), a liquid.

How elements combine to form compounds depends on the number and arrangement of the electrons in the atoms. Experiments show that higher-energy electrons are located at a greater distance from the nucleus than lower-energy electrons are. Thus scientists have developed a model of the atom in which electrons occupy discrete energy levels at varying distances from the nucleus.

8. What is a compound? _____

9. How elements combine to form compounds depends on what? _____

Ionic Bonds

Ionic bond is a bond due to electrical attraction of two atoms which have transferred electrons from one element to another. Sodium and Chlorine bond to form table salt. Note that the sodium atom has one electron in its outer energy level and that the chlorine atom has seven electrons in its outer energy level. Remember that most atoms are stable when their outer energy level contains eight electrons. When sodium and chlorine interact, the outer electron of the sodium atom moves to the chlorine atom. Afterward sodium and chlorine each have eight electrons in their outer energy level. In this process each atom becomes an ion—an atom or a polyatomic particle with an electrical charge.

10. What is an ionic bond? _____

11. Sodium and chlorine combine to form what common household item? _____
12. How many electrons does sodium have? _____
13. How many electrons does chlorine have? _____
14. When you add the electrons from sodium and chlorine together, what number do you have? _____
15. An atom is stable when their outer energy level contains _____.

Covalent Bonds

A **covalent bond** forms when two atoms share one or more pairs of electrons. Water is made up of one oxygen atom and two hydrogen atoms held together by covalent bonds. Since hydrogen has one electron, it needs another to give it the stable arrangement of two electrons in its outer energy level. Since oxygen has six

electrons in its outer energy level, it needs two more electrons to give it the stable arrangement of eight electrons. The hydrogen and oxygen atoms gain stability by sharing pairs of electrons.

A **molecule** is a group of atoms held together by covalent bonds. Many substances important in Biology are molecules including carbon dioxide and water. A molecule can be represented either by a chemical formula, such as H_2O , or by a structural formula, such as H—O—H . The structural formula shows the arrangement of atoms in a molecule.

16. What is a covalent bond? _____

17. What is an example of a compound held together by a covalent bond? _____

18. What is a molecule? _____

19. What is the chemical formula for water? _____

20. What is the structural formula for water? _____