LIFEPAC®

SCIENCE

STUDENT BOOK

10th Grade | Unit 2

Alpha Omega
PUBLICATIONS

SCIENCE 1002

Basis of Life

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

Author:
A. Kenneth Moore, Ph.D.

Editor:
Richard W. Wheeler, M.A.Ed.

Consulting Editor:
Harold Wengert, Ed.D.

Revision Editor:
Alan Christopherson, M.S.

Media Credits:
Page 45: © Bilhagolan, iStock, Thinkstock; **47:** © Airdone, iStock Thinkstock; **50:** © Neyro2008, iStock, Thinkstock.

Alpha Omega PUBLICATIONS

804 N. **2nd Ave. E.**
Rock Rapids, IA 51246-1759

Basis of Life

Introduction

The importance of the chemical elements to life is brought to our attention in the book of Genesis. We read that God took the "dust of the earth" (or elements) to create man through His own miraculous process. The same point is made clear when we read that after death our bodies decompose into the "dust of the earth" from which we were created. A third reference to life being composed of the elements from the earth is made when Jesus took dirt, spat in it, and anointed the eyes of the blind man. Everything we eat and drink to keep us alive and healthy is made up of chemical elements from the earth.

All living things share this property: They are composed of matter and energy. In this LIFEPAC® you will learn something about the function of life-forming chemicals. Fundamental in this study is an introduction to basic chemistry and chemical processes.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC.® When you have finished this LIFEPAC, you should be able to:

1. Diagram an atom.
2. Identify and write the names and symbols of principal chemical elements found in living organisms.
3. Define and describe a molecule.
4. Describe electron shells and the arrangement of electrons within them.
5. Explain how atoms combine to form compounds.
6. Describe water as a solvent, transport medium, chemical reactant, and heat absorber.
7. Describe and compare acids, bases, and salts.
8. Explain how a constant pH level is maintained in living organisms.
9. Identify and describe the different kinds of chemical reactions.
10. Define chemical equilibrium and the factors that alter it.
11. Describe the role of activation energy in driving a chemical reaction.
12. Distinguish between inorganic and organic compounds.
13. Describe and compare the composition and function of carbohydrates, lipids, and proteins.
14. Compare dehydration synthesis and hydrolysis in the forming and breaking down of organic molecules.
15. Compare the DNA and RNA molecules.
16. Describe the function of nucleic acids.
17. Define enzyme and describe how an enzyme acts as a regulator of chemical reactions in living organisms.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. MOLECULAR BASIS OF LIFE

All living and nonliving physical objects are composed of matter; that is, they occupy space and have mass. Matter can exist in four phases - solid, liquid, gas, or plasma - and is composed of building blocks, the chemical elements. At present 118 different elements have been identified. Ninety-two of these occur in nature, and the remainder are manmade. Only 25 elements are found in living organisms and of these only four are found in great abundance in plants and animals. Carbon, hydrogen, nitrogen, and oxygen are the most abundant and comprise approximately 95% of living things. The rest of the elements are found in small amounts or tiny amounts referred to as "trace elements."

Elements are symbolized by abbreviations of their English names or Latin names. The abundance of each element varies.

In the late eighteenth century, a French scientist named Antoine Lavoisier, the "Father of Modern Chemistry," showed that organisms are composed of the same chemical elements as nonliving things. He demonstrated that carbon, hydrogen, oxygen, and nitrogen are the principal elements of living things. We have since learned that organisms contain substantial amounts of sulfur, phosphorous, calcium, potassium, iron, sodium, magnesium, and chlorine. Trace amounts of additional elements have also been found.

Section Objectives

Review these objectives. When you have completed this section, you should be able to:

1. Diagram an atom.
2. Identify and write the names and symbols of principal chemical elements found in living organisms.
3. Define and describe a molecule.

Vocabulary

Study these words to enhance your learning success in this section.

atom	**atomic number**	**atomic mass**	**compound**
diatomic	**electron**	**energy level**	**matter**
mixture	**molecule**	**neutron**	**nucleus**
proton	**shell**		

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.*

TABLE 1: ESSENTIAL ELEMENTS IN LIVING ORGANISMS

ELEMENT	SYMBOL	ATOMIC NUMBER	FUNCTION
MOST ABUNDANT			
Hydrogen	H	1	water and organic compounds
Carbon	C	6	all organic compounds
Nitrogen	N	7	all amino acids
Oxygen	O	8	water; cell respiration; organic compounds
LESS ABUNDANT			
Sodium	Na	11	membrane polarization
Magnesium	Mg	12	chlorophyll; cofactor
Phosphorous	P	15	energy transfer; many organic compounds
Sulfur	S	16	some amino acids; some organic compounds
Chlorine	Cl	17	membrane polarization
Potassium	K	19	membrane polarization
Calcium	Ca	20	bone and teeth; muscle contraction and
Iron	Fe	21	cofactor hemoglobin; cofactor
TRACE AMOUNTS			
Boron	B	5	plant metabolism
Fluorine	F	9	teeth and bone growth
Silicon	Si	14	growth; diatom structure
Vanadium	V	23	growth factor
Chromium	Cr	24	insulin function
Manganese	Mn	25	cofactor
Cobalt	Co	27	vitamin B_{12} structure, cofactor
Copper	Cu	29	hemocyanin; oxidative enzymes
Zinc	Zn	30	cofactor
Selenium	Se	34	liver function
Molybdenum	Mo	42	cofactor
Tin	Sn	50	role? but essential
Iodine	I	53	thyroid hormone

STRUCTURE OF ELEMENTS

Elements are made up of building blocks called **atoms**. Each element contains only one type of atom. For example, a tank of helium gas contains only helium atoms; and a piece of pure gold contains only gold atoms. Atoms are extremely small. If fifty million of the largest atoms were placed side by side, the estimated measure would be one inch.

Atoms are composed of smaller structural units. An inner **nucleus** makes up most of the mass of the atom and is composed of two primary particles: **protons** (p^+), positively charged particles, which give the nucleus a positive charge; and **neutrons** (n), neutral particles. Protons are responsible for giving the element its chemical properties. Outside the centralized nucleus are small negatively charged particles, **electrons** (e^-). These electrons revolve around the nucleus in energy levels sometimes referred to as **shells**. The number of electrons in an atom equals the number of protons, balancing the charge and making the atom electrically neutral. The electrons are those parts of an atom that participate in chemical reactions, and their distribution determines the kind of chemical creations in which elements will participate.

The model of atomic structure (Figure 1) illustrates the distribution of subatomic particles. The nucleus of hydrogen contains one proton; helium, two protons; carbon, six protons; nitrogen, seven; oxygen, eight; and so on. The number of protons in the nucleus is called the **atomic number** and is specific to that element.

That the majority of the mass in an atom is found in the nucleus results from the relatively large mass of protons and neutrons and the extremely small mass of electrons. The number of protons and neutrons in the nucleus is referred to as the **atomic mass** of the atom. (Sometimes this number is referred to inaccurately as the atomic *weight*.) As mentioned previously, electrons are present in the same number as protons.

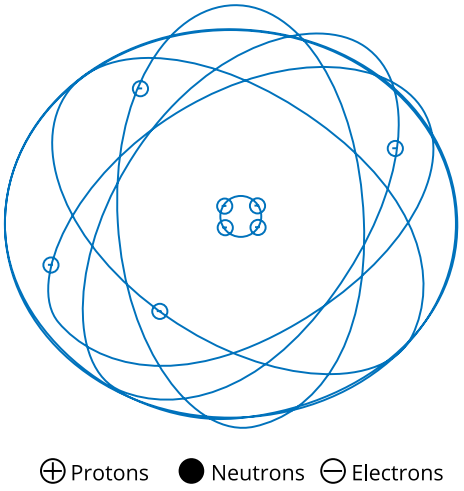

Figure 1 | Model of Atomic Structure

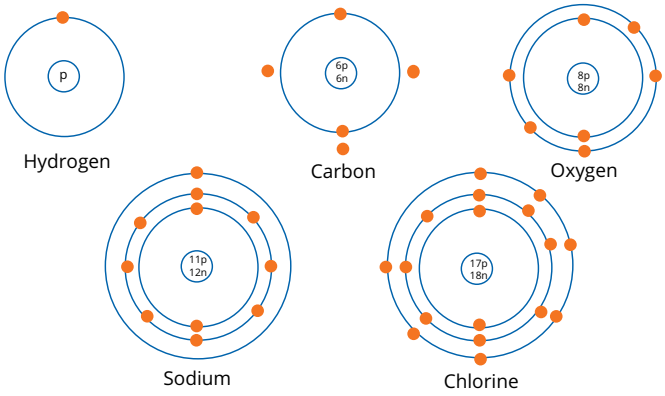

Figure 2 | Examples of Atomic Structures

Electrons are neither fixed in a stationary position nor wander at random, but they move in predictable manners. The energy levels in which the electrons travel are separated in space to reduce the repulsive force of other electrons, but are close enough to the nucleus to be within the attractive force of the protons.

Notice from Figure 2 that electrons have a definite distribution. The energy level nearest the nucleus never contains more than two electrons. The second shell contains a maximum of eight electrons. We shall deal with electron distribution in detail in Section 2.

Complete these statements.

1.1 Atoms are composed of a. _____ , b. _____ , and c. _____ .

1.2 The smallest particle of an element is a(n) _____ .

1.3 Atomic mass is determined by the a. _____ plus b. _____ .

1.4 Atomic number is the number of an atom's _____ .

Complete the chart using information from Figure 2.

	SYMBOL	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS	ATOMIC NUMBER	ATOMIC MASS
1.5 Hydrogen	H	a. _____	b. _____	c. _____	d. _____	e. _____
1.6 Carbon	C	a. _____	b. _____	c. _____	d. _____	e. _____
1.7 Oxygen	O	a. _____	b. _____	c. _____	d. _____	e. _____
1.8 Sodium	Na	a. _____	b. _____	c. _____	d. _____	e. _____
1.9 Chlorine	Cl	a. _____	b. _____	c. _____	d. _____	e. _____

Diagram an atom of each element and label the parts. Refer to the Periodic Table if needed.

1.10 Sodium (atomic number of 11)

1.11 Fluorine (atomic number of 9)

MOLECULES AND COMPOUNDS

Few elements exist as free atoms in nature. Most atoms are combined with others to form larger units called **molecules**. For example, the air we breathe contains oxygen in molecular form, which is the result of two oxygen atoms combining. Two or more atoms of different elements may combine to form a molecule of a substance entirely different from the atoms that make it up. New substances so formed are called **compounds**. For example, two atoms of hydrogen (H_2) joined with one atom of oxygen (O) form the compound water (H_2O).

Pure compounds are rarely found in nature; generally a **mixture** of several compounds is present. For example, the air we breathe is a mixture of molecular nitrogen (N_2), oxygen (O_2), water (H_2O), and other less abundant gases.

When more than one atom is present in a molecule, the number of atoms is represented by a subscript. For example, the molecule of water (H_2O) has two atoms of hydrogen and one atom of oxygen: H_2 and N_2 represent **diatomic** molecules of hydrogen and nitrogen, respectively.

Complete this activity.

1.12 Let's say that you are provided with a mixture of sand and sugar. Design a method to separate this mixture into its two component compounds. Write the method in the following space. _____

_____

_____

Complete these sentences.

1.13 The smallest unit of a compound is a _____ .

1.14 A molecule of one atom of carbon and two atoms of oxygen would be written_____ .

1.15 Water is an example of a _____ .

1.16 Few elements exist as free _____ .

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Complete these statements (each answer, 3 points).

1.01 The three subatomic particles are a. _____ , b. _____ , and c. _____ .

1.02 Of the three parts of the-atom, the _____ carries no electrical charge.

1.03 The part of the atom that carries a negative charge is the _____ .

1.04 The part of the atom that carries the positive charge is the _____ .

1.05 The mass of an atom is contained primarily in its _____ .

1.06 Atomic mass is determined by the a. _____ plus b. _____ .

1.07 The number of protons determines the _____ .

1.08 Atoms are electrically neutral because they have the same number of a. _____ as b. _____ .

1.09 The principal elements in living things are a. _____ , b. _____ , c. _____ , and d. _____ .

1.010 The number of hydrogen atoms in a molecule of NH_3 is _____ .

Define these terms (each answer, 4 points).

1.011 compound _____

_____

1.012 molecule _____

_____

1.013 energy level _____

_____

1.014 element _____

_____

1.015 mixture _____

_____

Write the letter of the correct answer (each answer, 2 points).

1.016 Of the following choices, the symbol for an element is _____ .

a. H b. H_2O c. CaO d. HCl

1.017 Four elements which comprise over 95% of the human body are _____ .

a. carbon, phosphorus, oxygen, hydrogen
b. calcium, phosphorus, hydrogen, nitrogen
c. carbon, hydrogen, oxygen, nitrogen
d. calcium, hydrogen, oxygen, nitrogen

1.018 Atoms of different elements may have identical _____ .

a. masses b. charges c. sizes d. nuclei

1.019 The atomic mass of an element whose atoms consist of eight protons, eight neutrons, and eight electrons is _____ .

a. 8 b. 12 c. 16 d. 24

Diagram an atom of each element and label the parts (each diagram, 5 points).

1.020 Hydrogen (atomic number of 1)

1.021 Carbon (atomic number of 6)

1.022 Oxygen (atomic number of 8)

75/94 **SCORE** _____ **TEACHER** _____ _____
initials date

Alpha Omega
PUBLICATIONS

804 N. 2nd Ave. E.
Rock Rapids, IA 51246-1759

800-622-3070
www.aop.com

SCI1002 – Apr '15 Printing

ISBN 978-0-86717-792-3