CHAPTER 2
LIFE'S CHEMICAL BASIS

Multiple-Choice Questions

IMPACTS, ISSUES: WHAT ARE YOU WORTH?

M **1.** Toxic elements such as mercury and arsenic are found in the human body because
a. of contamination from the environment.
b. trace amounts of these elements have vital biological functions.
c. they are needed to kill bacteria.
d. they may be ingested with food but inactivated by cells.
e. in small amounts they are biologically inactive and tolerated by cells.

Answer: b
Bloom's Taxonomy: Bloom's Taxonomy: Comprehension

M **2.** The collection of elements that make up the human body are worth approximately
a. 46 thousand dollars.
b. 30 million dollars.
c. 118 dollars.
d. 5 thousand dollars.
e. none of these.

Answer: c
Bloom's Taxonomy: Knowledge

M **3.** Whether one atom will bond with another depends on the element and the number and arrangement of its
a. protons.
b. neutrons.
c. electrons.
d. neutrinos.
e. pions.

Answer: c
Bloom's Taxonomy: Knowledge

E **4.** The atom found in the greatest amount in the human body is
a. hydrogen.
b. carbon.
c. nitrogen.
d. oxygen.
e. phosphorus.

Answer: a
Bloom's Taxonomy: Knowledge

START WITH ATOMS

M **5.** Which is the smallest unit of an element that retains the properties of the element?
a. atom
b. compound
c. ion
d. molecule
e. mixture

Answer: a
Bloom's Taxonomy: Knowledge

M **6.** Which is NOT an element?
a. water
b. oxygen
c. carbon
d. chlorine
e. hydrogen

Answer: a
Bloom's Taxonomy: Comprehension/Analysis

E **7.** The atomic number refers to the
a. mass of an atom.
b. number of protons in an atom.
c. number of both protons and neutrons in an atom.
d. number of neutrons in an atom.
e. number of electrons in an atom.

Answer: b
Bloom's Taxonomy: Knowledge

M **8.** Atoms of isotopes
a. are electrically unbalanced.
b. behave the same chemically and physically but differ biologically from other isotopes.
c. are the same physically and biologically but differ from other isotopes chemically.
d. have the same number of protons but a different number of neutrons.
e. are produced when atoms lose electrons.

Answer: d
Bloom's Taxonomy: Knowledge

M **9.** Which of the following historical figures came up with the idea of the periodic table?
a. Demitri Medeleev
b. Niels Bohr
c. Louis Pateur
d. Robert Koch
e. None of these

Answer: a
Bloom's Taxonomy: Knowledge

E **10.** The subatomic particle(s) with a negative charge is(are)
a. the neutron.
b. the proton.
c. the electron.
d. both the neutron and proton.
e. both the proton and electron.

Answer: c
Bloom's Taxonomy: Knowledge

E **11.** The subatomic particle(s) with a positive charge is(are)
a. the neutron.
b. the proton.
c the electron.
d. both the neutron and proton.
e. both the proton and electron.

Answer: b
Bloom's Taxonomy: Knowledge

E **12.** The subatomic particle(s) with no charge is(are)
a. the neutron.
b. the proton.
c. the electron.
d. both the neutron and proton.
e. both the proton and electron.

Answer: a
Bloom's Taxonomy: Knowledge

E **13.** The nucleus of an atom contains
a. neutrons and protons.
b. neutrons and electrons.
c. protons and electrons.
d. protons only.
e. neutrons only.

Answer: a
Bloom's Taxonomy: Knowledge

E **14.** Which components of an atom have negative charges?
I. electrons
II. protons
III. neutrons
a. I only
b. II only
c. III only
d. I and II
e. II and III

Answer: a
Bloom's Taxonomy: Knowledge/Analysis

E **15.** Which components of an atom do not have a charge?
I. electrons
II. protons
III. neutrons
a. I only
b. II only
c. III only
d. I and II
e. II and III

Answer: c
Bloom's Taxonomy: Knowledge/Analysis

M **16.** The atomic mass (mass number)of an atom is determined by the combined masses of its
a. neutrons and protons.
b. neutrons and electrons.
c. protons and electrons.
d. protons, neutrons, and electrons.
e. neutrons, nucleus, and electrons.

Answer: a
Bloom's Taxonomy: Knowledge

E **17.** The periodic table of the elements was devised by
a. Henri Becquerel.
b. Demitri Mendeleev.
c. Melvin Calvin.
d. Marie Curie.
e. Becquerel and Mendeleev.

Answer: b
Bloom's Taxonomy: Knowledge

E **18.** The atomic number is the number of
a. neutrons and protons.
b. neutrons and electrons.
c. protons and electrons.
d. protons only.
e. neutrons only.

Answer: d
Bloom's Taxonomy: Knowledge

M **19.** Which of the following is false concerning the atom in the figure?

a. The number of protons and the number of electrons are equal.
b. It has an atomic mass of 4.
c. Electrons are moving around the nucleus.
d. It has an atomic number of 2.
e. The number of electrons exceeds the number of protons.

Answer: e
Bloom's Taxonomy: Comprehension/Application/Synthesis

E **20.** All atoms of an element have the same number of
a. ions.
b. protons.
c. neutrons.
d. electrons.
e. protons and neutrons.

Answer: b
Bloom's Taxonomy: Knowledge

D **21.** Which of the following statements is NOT true?
a. All isotopes of an element have the same number of electrons.
b. All isotopes of an element have the same number of protons.
c. All isotopes of an element have the same number of neutrons.
d. We refer to isotopes by mass number.
e. ^{12}C and ^{13}C are isotopes.

Answer: c
Bloom's Taxonomy: Comprehension/Analysis

M **22.** In the chemical shorthand ^{14}C, the 14 represents the number of
a. excess neutrons.
b. protons plus neutrons.
c. electrons.
d. protons plus electrons.
e. radioactive particles.

Answer: b
Bloom's Taxonomy: Knowledge/Application

PUTTING RADIOISOTOPES TO USE

M **23.** Radioactive isotopes have
a. excess electrons.
b. excess protons.
c. excess neutrons.
d. insufficient neutrons.
e. insufficient protons.

Answer: c
Bloom's Taxonomy: Knowledge

E **24.** _____ molecule(s) can be detected as it (they) pass(es) through the human body and is (are) used for diagnosis.
a. A decay
b. A tracer
c. An electron
d. An atomic
e. Both the proton and electron

Answer: b
Bloom's Taxonomy: Knowledge

D **25.** Tracers are elements that
a. are used in minute amounts in plants.
b. can be monitored through biochemical reactions.
c. must be inert.
d. have an unbalanced electrical charge.
e. must have a stable nucleus.

Answer: b
Bloom's Taxonomy: Knowledge

M **26.** Which statement concerning radioisotope ^{14}C is false?
a. It can be substituted for ^{12}C in glucose and the body will still be able to use the compound.
b. It has a different number of protons than ^{12}C.
c. It has more neutrons than ^{12}C.
d. It behaves the same chemically as ^{12}C.
e. It has six carbons and eight neutrons.

Answer: b
Bloom's Taxonomy: Comprehension/Analysis

M **27.** The radioactive decay of ^{14}C produces
a. carbon 12.
b. carbon 13.
c. more carbon 14.
d. nitrogen 14.
e. oxygen 14.

Answer: d
Bloom's Taxonomy: Knowledge

WHY ELECTRONS MATTER

E **28.** Which is NOT a compound?
a. salt (NaCl)
b. a carbohydrate (contains C, H and O)
c. carbon (C)
d. a nucleotide (contains P, C, H, and O)
e. methane (CH_4)

Answer: c
Bloom's Taxonomy: Comprehension/Analysis

M **29.** By analogy, the orbitals and atomic nucleus may be said to most resemble
a. a merry-go-round.
b. a sundial.
c. a multilevel apartment building.
d. a nest of mixing bowls.
e. ripples in a pond.

Answer: c
Bloom's Taxonomy: Comprehension/Synthesis

M **30.** Magnesium has 12 protons. How many electrons are in its third energy level?
a. 2
b. 4
c. 6
d. 8
e. 10

Answer: a
Bloom's Taxonomy: Application

M **31.** Magnesium has 12 protons. How many electrons are in its first energy level?
a. 2
b. 4
c. 6
d. 8
e. 10

Answer: a
Bloom's Taxonomy: Application

M **32.** Magnesium has 12 protons. How many electrons are in its second energy level?
a. 2
b. 4
c. 6
d. 8
e. 10

Answer: d
Bloom's Taxonomy: Application

M **33.** Which statement is NOT true?
a. Electrons closest to the nucleus are at the lowest energy level.
b. No more than two electrons can occupy a single orbital.
c. Electrons are unable to move out of the assigned orbital space.
d. The innermost orbital holds two electrons.
e. At the second energy level there are four possible orbitals with a total of eight electrons.

Answer: c
Bloom's Taxonomy: Comprehension/Analysis

E **34.** Water is an example of a(n)
a. atom.
b. ion.
c. compound.
d. mixture.
e. element.

Answer: c
Bloom's Taxonomy: Knowledge

E **35.** Which includes the other four?
a. atoms
b. molecules
c. electrons
d. elements
e. protons

Answer: b
Bloom's Taxonomy: Knowledge

M **36.** Which statement is false?
a. A molecule is made of at least two atoms.
b. Compounds are made of elements.
c. Two atoms of oxygen make a molecule of oxygen.
d. Proportions of elements in compounds vary according to their source in nature.
e. Elements are found in compounds and molecules.

Answer: d
Bloom's Taxonomy: Comprehension/Analysis

M **37.** A molecule is
a. a combination of two or more atoms.
b. a mixture of atoms.
c. electrically charged.
d. a carrier of one or more extra neutrons.
e. none of these.

Answer: a
Bloom's Taxonomy: Knowledge

E **38.** An atom that gains or loses electrons becomes
a. more stable.
b. an ion.
c. a molecule.
d. unable to form bonds.
e. radioactive.

Answer: b
Bloom's Taxonomy: Knowledge

D **39.** Which of the following is NOT accurate concerning ionization?
a. When one atom loses electrons, another must gain electrons.
b. When an atom loses an electron, it becomes negatively charged.
c. Ionic bonds form between ionized atoms.
d. In the compound NaCl, Na loses an electron to become positive.
e. In an ion, the number of protons and electrons is unequal.

Answer: b
Bloom's Taxonomy: Comprehension/Analysis

WHAT HAPPENS WHEN ATOMS INTERACT?

D **40.** Nitrogen has an atomic number of 7. How many hydrogen atoms are necessary to join with the nitrogen to form a stable compound?
a. 1
b. 2
c. 3
d. 4
e. 5

Answer: c
Bloom's Taxonomy: Application

D **41.** Oxygen, with an atomic number of 8, has _____ electrons in the first energy level and _____ electrons in the second energy level.
a. 1; 7
b. 2; 6
c. 3; 5
d. 4; 4
e. 5; 3

Answer: b
Bloom's Taxonomy: Application

M **42.** The bond in table salt (NaCl) is
a. polar.
b. ionic.
c. covalent.
d. double.
e. nonpolar.

Answer: b
Bloom's Taxonomy: Knowledge

D **43.** In _____ bonds, both atoms exert the same pull on shared electrons.
a. nonpolar covalent
b. polar covalent
c. double covalent
d. triple covalent
e. coordinate covalent

Answer: a
Bloom's Taxonomy: Knowledge

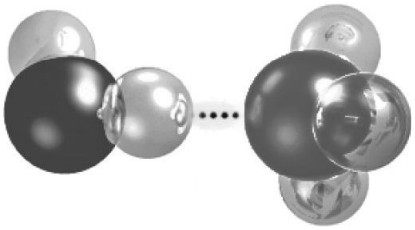
M **44.** Which of these statements is false concerning covalent bonds?
   a. Atoms share electrons.
   b. Molecules may possess many covalent bonds.
   c. Water contains polar covalent bonds.
   d. Covalent bonds may be "double bonds."
   e. In polar covalent bonds, electrons are shared equally.

Answer: e
Bloom's Taxonomy: Knowledge, Synthesis

E **45.** Electrons are shared in bonds that are
   a. covalent.
   b. polar.
   c. nonpolar.
   d. covalent, polar, or nonpolar.
   e. covalent, but not polar or nonpolar.

Answer: d
Bloom's Taxonomy: Comprehension/Analysis

E **46.** The dots in the figure represent a(n)



   a. covalent bond.
   b. ionic bond.
   c. hydrogen bond.
   d. polar covalent bond.
   e. hydrophobic interaction.

Answer: c
Bloom's Taxonomy: Comprehension

D **47.** A hydrogen bond is a(n)
   a. sharing of a pair of electrons between a hydrogen and an oxygen nucleus.
   b. sharing of a pair of electrons between a hydrogen nucleus and either an oxygen or a nitrogen nucleus.
   c. attractive force between a hydrogen atom and either an oxygen or a nitrogen atom that are in other molecules or within the same molecule.
   d. covalent bond between two hydrogen atoms.
   e. covalent bond between a hydrogen atom and either an oxygen atom or a nitrogen atom.

Answer: c
Bloom's Taxonomy: Knowledge

D **48.** Which of the following is NOT true of hydrogen bonds?
   a. They are quite weak.
   b. The hydrogen is slightly positive.
   c. They are common in macromolecules.
   d. They are difficult to form and break.
   e. They always involve hydrogen.

Answer: d
Bloom's Taxonomy: Comprehension/Analysis

WATER'S LIFE-GIVING PROPERTIES

E **49.** Hydrophobic interactions are exhibited with
   a. ions.
   b. nonpolar molecules.
   c. hydration ions.
   d. polar molecules.
   e. none of these.

Answer: b
Bloom's Taxonomy: Comprehension

M **50.** Water is important to the interactions of biological molecules because it
   a. promotes hydrophobic and hydrophilic interactions.
   b. stabilizes temperature.
   c. is an excellent solvent for polar and ionic substances.
   d. has strong cohesive properties.
   e. is all of the above.

Answer: e
Bloom's Taxonomy: Comprehension

M **51.** Hydrophobic molecules are _____ water.
   a. attracted to
   b. absorbed by
   c. repelled by
   d. dissolved by
   e. polarized by

Answer: c
Bloom's Taxonomy: Knowledge

D **52.** Which of the following is true of water?
   a. The oxygen end is slightly electropositive.
   b. Hydrogen bonds hold water molecules together.
   c. Water covers about one-half of the earth's surface.
   d. It participates in hydrophobic interactions with polar molecules.
   e. Its solvent properties are greatest with nonpolar molecules.

Answer: b
Bloom's Taxonomy: Comprehension/Analysis

D **53.** Which of the following is(are) true of water?
   a. It forms spheres of hydration around charged substances and can form hydrogen bonds with many substances.
   b. It has a high heat-containing property.
   c. It has cohesive properties.
   d. It is a liquid at room temperature.
   e. It is all of the above.

Answer: e
Bloom's Taxonomy: Comprehension/Analysis

D **54.** Which of the following statements is false?
   a. Ice is denser than liquid water.
   b. All living organisms require water.
   c. Water has cohesive properties.
   d. Water is a liquid at room temperature.
   e. All of the above are false.

Answer: a
Bloom's Taxonomy: Comprehension/Analysis

D **55.** The oil globules that result when a water and oil mixture is shaken are due to a(n) _____ interaction.
a. acidic
b. basic
c. hydrophilic
d. hydrophobic
e. ionic

Answer: d
Bloom's Taxonomy: Knowledge

D **56.** The most likely reason that glucose dissolves in water is that it is
a. an ionic compound.
b. a polysaccharide.
c. polar and forms many hydrogen bonds with the water molecules.
d. a very unstable molecule.
e. highly nonpolar.

Answer: c
Bloom's Taxonomy: Comprehension

D **57.** The solvent, cohesive, and temperature stabilization properties of water are due to its
a. ability to promote hydrophilic interactions.
b. ionic bonds.
c. hydrogen bonds.
d. ability to promote hydrophobic interactions.
e. nonpolar nature.

Answer: c
Bloom's Taxonomy: Knowledge/Evaluation

M **58.** The measurement of the temperature of a substance is directly related to
a. the nature of its chemical bonds.
b. its reactivity.
c. its thermal conductivity.
d. the motion of its molecules.
e. the mass of its molecules.

Answer: d
Bloom's Taxonomy: Knowledge/Analysis

M **59.** The column of water extending in tubes from plant roots to leaves is maintained by
a. cohesion among water molecules.
b. ionic bonds.
c. covalent bonds.
d. hydrophobic interactions.
e. hydrophilic interactions.

Answer: a
Bloom's Taxonomy: Knowledge

D **60.** Sodium chloride (NaCl) in water can be described by any EXCEPT which of the following?
a. Na^+ and Cl^- form
b. a solute
c. ionized
d. forms a hydrophobic interaction
e. dissolved

Answer: d
Bloom's Taxonomy: Comprehension/Analysis

M **61.** A salt will dissolve in water to form
a. acids.
b. hydrogen bonds.
c. ions other than H^+ and OH^-.
d. bases.
e. buffers.

Answer: c
Bloom's Taxonomy: Knowledge

ACIDS AND BASES

E **62.** Most of the body's internal environment is at a pH between
a. 6.8 and 7.2
b. 7.0 and 7.2
c. 6.5 and 7.5
d. 7.3 and 7.5
e. 7.5 and 8.0

Answer: d
Bloom's Taxonomy: Knowledge

M **63.** "Acidic" is an appropriate description for all EXCEPT which one of the following?
a. excess hydrogen ions
b. the contents of the stomach
c. magnesium hydroxide
d. HCl
e. a pH less than 7

Answer: c
Bloom's Taxonomy: Comprehension/Analysis

D **64.** A pH of 10 is how many times as basic as a pH of 7?
a. 2
b. 3
c. 10
d. 100
e. 1,000

Answer: e
Bloom's Taxonomy: Application

D **65.** A solution with a pH of 8 has how many times fewer hydrogen ions than a solution with a pH of 6?
a. 2
b. 4
c. 10
d. 100
e. 1,000

Answer: d
Bloom's Taxonomy: Application

D **66.** Which of the following is NOT true?
a. Acids donate hydrogen ions.
b. In a neutral solution, the amounts of hydrogen and hydroxyl ions are equal.
c. Salts have no function in cells.
d. Bases accept hydrogen ions..
e. .7.0 represents a neutral pH.

Answer: c
Bloom's Taxonomy: Comprehension/Analysis

M **67.** Blood pH is kept near a value of 7.3-7.5 because of
a. salts.
b. buffers.
c. acids.
d. bases.
e. water.

Answer: b
Bloom's Taxonomy: Comprehension

Classification Questions

The various energy levels in an atom of magnesium ($^{24}_{12}Mg$) have different numbers of electrons. Use the following numbers to answer questions 68–70.

a. 1
b. 2
c. 3
d. 6
e. 8

D **68.** number of electrons in the first energy level

D **69.** number of electrons in the second energy level

D **70.** number of electrons in the third energy level

Answers: 68. b, 69. e, 70. b
Bloom's Taxonomy: Application

The following are types of chemical bonds. Answer questions 71–75 by matching the descriptions with the most appropriate bond type.

a. hydrogen
b. ionic
c. covalent
d. polar covalent
e. double bond

M **71.** the bond between the atoms of table salt (NaCl)

M **72.** the bond type holding several molecules of water together

M **73.** the bond between the oxygen atoms of oxygen gas (O_2)

M **74.** the bond that breaks when salts dissolve in water

M **75.** a bond in which connected atoms share electrons

Answers: 71. b, 72. a, 73. e 74. b, 75. c
Bloom's Taxonomy: Comprehension

Short Answer/Fill in the Blank

E **76.** Water surface tension is caused by the _____ bonds.

Answer: hydrogen
Bloom's Taxonomy: Knowledge

M **77.** Two pairs of electrons shared between two atoms is called _____.

Answer: double
Bloom's Taxonomy: Knowledge

E **78.** C^{14} is a radioactive isotope, and due to its predictable _____ rate it is used to date organic fossils.

Answer: decay
Bloom's Taxonomy: Knowledge

M **79.** An atom with more electrons than protons is called a(n) _____.

Answer: anion or ion
Bloom's Taxonomy: Knowledge

E **80.** _____ is a measure of an atom's ability to pull electrons from other atoms.

Answer: electronegativity
Bloom's Taxonomy: Knowledge