Test Bank to accompany Jay Phelan's What Is Life? A Guide to Biology with Physiology, Third Edition

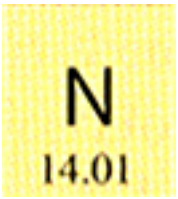
Chapter 2
Chemistry

Multiple-Choice Questions

1. An atom of iron has the atomic number 26. This means that it has:

a) 52 protons.
b) 13 neutrons.
c) an atomic mass of 26.
d) 26 protons.
e) 13 electrons.
Answer: d
Section: 2.1
Bloom's level: 1

2.



What is missing from this cell of the periodic table?

a) the atomic number for nitrogen, 6
b) the atomic number for nitrogen, 14
c) the atomic number for nitrogen, 28
d) the atomic number for nitrogen, 8
e) the atomic number for nitrogen, 7
Answer: e
Section: 2.1
Bloom's level: 1

3. Carbon-14 has the same:

a) atomic number and atomic mass as carbon-12.
b) atomic number and, therefore, the same number of neutrons as carbon-13.
c) atomic mass as both carbon-12 and carbon-13.
d) number of protons but more neutrons than carbon-12.

e) atomic mass and, therefore, the same number of neutrons as carbon-12.
Answer: d
Section: 2.1
Bloom's level: 3

4. The four most abundant elements in living organisms are:

a) carbon, nitrogen, oxygen, and calcium.
b) carbon, nitrogen, potassium, and oxygen.
c) sodium, nitrogen, carbon, and silicon.
d) hydrogen, nitrogen, oxygen, and carbon.
e) carbon, hydrogen, nitrogen, and phosphorus.
Answer: d
Section: 2.1
Bloom's level: 1

5. _____ is the smallest chemical unit of a type of pure substance.

a) A cell
b) A molecule
c) An amino acid
d) An atom
e) A proton
Answer: d
Section: 2.1
Bloom's level: 1

6. All matter on earth, both living and non-living, is made up of:

a) cells.
b) DNA.
c) carbohydrates.
d) phospholipids.
e) atoms.
Answer: e
Section: 2.1
Bloom's level: 2

7. Of all the elements that occur on earth, how many are found in your body?

a) 116
b) 4

c) 90
d) 10
e) 25
Answer: e
Section: 2.1
Bloom's level: 1

8. Relative to protons, electrons have:

a) significantly greater mass.
b) significantly less mass.
c) approximately the same mass.
d) a significantly stronger positive charge.
e) None of the above is correct. Electrons have no mass.
Answer: b
Section: 2.1
Bloom's level: 1

9. Which of the following elements have four electrons in their outer shells?

a) oxygen and sulfur
b) nitrogen and phosphorus
c) boron and aluminum
d) fluorine and chlorine
e) carbon and silicon
Answer: e
Section: 2.2
Bloom's level: 1

10. Helium is not a reactive molecule because its:

a) first-level shell is full with two electrons.
b) first-level shell is full with two protons.
c) second-level shell is full with two electrons.
d) first-level shell is full with two neutrons.
e) Helium is a reactive molecule.
Answer: a
Section: 2.2
Bloom's level: 3

11. One important difference between covalent and ionic bonds is that:

a) ionic bonds are much stronger than covalent bonds.
b) in ionic bonds two atoms share electrons, whereas in covalent bonds one atom gives one or more electrons to the other atom.
c) in covalent bonds two atoms share electrons, whereas in ionic bonds one atom gives one or more electrons to the other atom.
d) in ionic bonds both protons and electrons can be shared, whereas in covalent bonds only electrons can be shared.
e) ionic bonds only occur among water-soluble elements.
Answer: c
Section: 2.3
Bloom's level: 4

12. Which of the following molecules is NOT formed by covalent bonding?

a) H_2O
b) NaCl
c) CH_4
d) O_2
e) H_2
Answer: b
Section: 2.3
Bloom's level: 3

13. Multiple atoms linked together are called:

a) a reactant.
b) an isotope.
c) a substrate.
d) a molecule.
e) an element.
Answer: d
Section: 2.3
Bloom's level: 1

14. Three principal types of bonds hold multiple atoms together. These are:

a) phosphate bonds, disulfide bonds, and hydrogen bonds.
b) hydrogen bonds, ionic bonds, and glycosidic linkages.
c) covalent bonds, ionic bonds, and disulfide bonds.
d) ionic bonds, hydrogen bonds, and ester bonds.
e) covalent bonds, ionic bonds, and hydrogen bonds.
Answer: e
Section: 2.3

Bloom’s level: 1

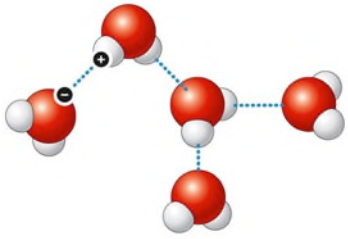
15. Which of the following statements about chemical bonds is NOT true?

a) Covalent bonds are formed through electron sharing and are quite strong.
b) Ionic bonds result from the attraction between two oppositely charged atoms.
c) Methane (CH_4) is the result of an ionic bond between two oppositely charged atoms of carbon and hydrogen.
d) O_2 is the result of a covalent bond where two oxygen atoms share two electrons.
e) Hydrogen bonds are formed from the attraction between a hydrogen atom and another atom with a slight negative charge.
Answer: c
Section: 2.3
Bloom’s level: 2

16. Water molecules form which type of bond with other water molecules?

a) covalent bonds
b) van der Waals bonds
c) disulfide bridges
d) hydrogen bonds
e) ionic bonds
Answer: d
Section: 2.4
Bloom’s level: 1

17.



How many hydrogen bonds are explicitly represented in this graphic?

a) 1
b) 8
c) 0
d) 4
e) 10
Answer: d
Section: 2.4
Bloom’s level: 2

18. The tendency of molecules to stick together, called cohesion, is stronger in water than other liquids because the polarity of water allows a(n):

a) hydrogen atom from one water molecule to form an ionic bond with the oxygen atom of another water molecule.
b) hydrogen atom from one water molecule to form a hydrogen bond with the hydrogen atom of another water molecule.
c) hydrogen atom from one water molecule to form a covalent bond with the oxygen atom of another water molecule.
d) oxygen atom from one water molecule to form a hydrogen bond with the oxygen atom of another water molecule.
e) hydrogen atom from one water molecule to form a hydrogen bond with the oxygen atom of another water molecule.
Answer: e
Section: 2.4
Bloom's level: 5

19. Evaporation from the leaves of a tree will pull water up through the roots as an unbroken column throughout the entire height of the tree. This feat is possible because of which characteristic of water?

a) surface tension
b) cohesion
c) absorption
d) kinetic energy
e) vaporization
Answer: b
Section: 2.5
Bloom's level: 3

20. Why do coastal areas have milder, less variable climates than inland areas?

a) Large bodies of water have high salt concentrations and salt absorbs a large proportion of the light energy that would have warmed the land.
b) Coastal areas are concentrated near the equator, which varies less than other parts of the globe in the angle at which the sun's light hits it.
c) Large bodies of water, especially oceans, can absorb huge amounts of heat from the sun during warm times of the year, reducing temperature increases on the land. Similarly, during cold times of year the ocean slowly cools, giving off heat that reduces the temperature drop on shore.
d) Because water is a good solvent, it is able to dissolve the photons in light, reducing their ability to heat or cool the land.

e) None of the above is correct. No one knows why coastal areas have milder, less variable climates than inland areas.
Answer: c
Section: 2.5
Bloom's level: 6

21. The fact that water is less dense as a solid than as a liquid explains why:

a) ice floats on top of liquid water.
b) water is such a good solvent.
c) water can resist temperature changes.
d) ice cubes sink when placed in a glass of water.
e) oil never dissolves in water.
Answer: a
Section: 2.5
Bloom's level: 2

22. The pH of a fluid is a measure of:

a) its capacity to function as soap.
b) its enzymatic stability.
c) the concentration of phosphate groups.
d) the amount of adenosine triphosphate (a-pH) in it.
e) how acidic or basic it is.
Answer: e
Section: 2.6
Bloom's level: 1

23. Certain molecules act like bank accounts for H+ ions because they can absorb excess H+ ions to keep a solution from becoming too acidic and release H+ ions to keep the solution from becoming too basic. Such molecules are called:

a) enzymes.
b) oxidating agents.
c) reducing agents.
d) buffers.
e) catalysts.
Answer: d
Section: 2.6
Bloom's level: 2

24. Pure water and aqueous solutions that are neither acidic nor basic are said to be:

a) transparent.
b) buffers.
c) translucent.
d) neutral.
e) alkaline.
Answer: d
Section: 2.6
Bloom's level: 2

25. A chemical compound that releases OH^- into a solution is called:

a) a hydroxide ion.
b) a solvent.
c) a salt.
d) a base.
e) an acid.
Answer: d
Section: 2.6
Bloom's level: 1

26. Urine, with a pH of 6, is _____ times more acidic than seawater, with a pH of 8.

a) 1000
b) 10
c) 6
d) 100
e) 8
Answer: d
Section: 2.6
Bloom's level: 3

27. A solution's acidity is a measure of:

a) the H^+ (free-floating protons) it contains.
b) the number of all dissolved molecules in a solution.
c) the number of nucleotide bases in the solution.
d) the amount of buffer molecules in the solution.
e) its negative charge (the stronger the negative charge, the more acidic the substance).
Answer: a
Section: 2.6
Bloom's level: 2

28. A buffer is a chemical that:

a) can quickly absorb excess H+ ions to keep a solution from becoming too acidic.
b) can quickly release H+ ions to counteract any increases in the OH− concentration in a solution.
c) is identical to baking soda.
d) restores the pH of a solution to 7.0.
e) Both a and b are correct.
Answer: e
Section: 2.6
Bloom's level: 1

29. Pure water has a pH of 7.0. Cola has a pH of about 3.0. That means cola is:

a) 10,000 times more basic than water.
b) 10,000 times more acidic than water.
c) about 40 times more acidic than water.
d) about 40 times more basic than water.
e) about 4 times more acidic than water.
Answer: b
Section: 2.6
Bloom's level: 2

30. Carbohydrates:

a) in the form of oligosaccharides are often covalently bonded to proteins and lipids on the outer cell surface, where they serve as cell recognition signals.
b) are a good source of sustained energy when they come in the form of polysaccharides.
c) serve as carbon skeletons that can be rearranged to form other molecules that are essential for biological structures and functions like nucleic acids.
d) act as a relatively fast available source of fuel.
e) All of the above are correct.
Answer: e
Section: 2.8
Bloom's level: 4

31. Energy derived from cellular respiration can originate from:

a) carbohydrates, proteins, and fats.
b) carbohydrates only.
c) carbohydrates and proteins only.
d) proteins only.
e) fats only.

Answer: a
Section: 2.9
Bloom’s level: 2

32. Which of the following are all monosaccharides?

a) glucose and maltose
b) glucose, fructose, and galactose
c) fructose and cellulose
d) glycogen and glucose
e) starch, cellulose, and glycogen
Answer: b
Section: 2.9
Bloom’s level: 2

33. Glycogen belongs in the class of molecules known as:

a) polysaccharides.
b) monosaccharides.
c) amino acids.
d) proteins.
e) nucleic acids.
Answer: a
Section: 2.10
Bloom’s level: 1

34. Which of the following is a polysaccharide?

a) insulin, the chief blood sugar regulator
b) cellulose, the primary component of plant cell walls
c) fructose, one of the most important blood sugars
d) glucose, the chief cellular energy source
e) All of the above are polysaccharides.
Answer: b
Section: 2.10
Bloom’s level: 1

35. Sucrose (table sugar) and lactose (the sugar found in milk) are examples of:

a) simple sugars.
b) disaccharides.
c) monosaccharides.

d) naturally occurring enzymes.
e) polyunsaccharide sugars.
Answer: b
Section: 2.10
Bloom's level: 1

36. Which of the following statements about cellulose is FALSE?

a) Although it is not digestible, cellulose is still important to humans' diets.
b) The cellulose we eat passes right through our digestive system unused.
c) Cellulose and starch are made from similar molecules.
d) Cellulose has a slightly different three-dimensional structure from starch.
e) All of the above statements about cellulose are TRUE.
Answer: e
Section: 2.11
Bloom's level: 3

37. On food packages, "insoluble fiber" refers to plant material that we cannot fully digest but is important for maintaining a healthy digestive tract. This substance refers to a(n):

a) nucleic acid.
b) carbohydrate.
c) protein.
d) lipid.
e) amino acid.
Answer: b
Section: 2.11
Bloom's level: 3

38. Which of the following statements about fiber is FALSE?

a) Fiber in the diet slows the passage of food through the intestines.
b) The cellulose of celery stalks and lettuce leaves is fiber.
c) Fiber passing through the digestive system scrapes the wall of the digestive tract, stimulating mucous secretion, and aiding in the digestion of other molecules.
d) Humans are unable to extract any caloric value from fiber.
e) Dietary fiber reduces the risk of colon cancer.
Answer: a
Section: 2.11
Bloom's level: 3

39. When you put a piece of chocolate on your tongue, your brain registers a sensation of sweetness. What aspect of molecules is responsible for their having a particular taste?

a) the total number of electron shells in the atoms of the molecule
b) the total number of protons in the molecule
c) the ratio of covalent bonds to ionic bonds joining the atoms of the molecule
d) the amount of hydrogen bonds in the molecule (more hydrogen bonds = sweeter taste)
e) the molecule's shape
Answer: e
Section: 2.11
Bloom's level: 2

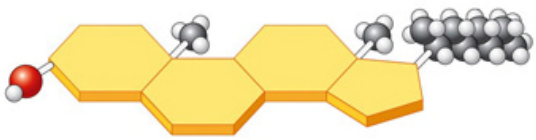
40. Which of the following is NOT an important biological function of lipids?

a) insulation
b) energy storage
c) protection of internal organs and tissues
d) regulation of growth and development
e) All of the above are important biological function of lipids.
Answer: e
Section: 2.12
Bloom's level: 1

41. All lipids are:

a) triglycerides.
b) not soluble in water.
c) polar.
d) hydrophilic.
e) polymers of fatty acids.
Answer: b
Section: 2.12
Bloom's level: 2

42.



The diagram above represents which class of chemical compounds?

a) sterols
b) proteins

c) carbohydrates
d) acids
e) fats
Answer: a
Section: 2.12
Bloom's level: 2

43. Organic molecules consisting of only hydrogen and carbon are called:

a) carbohydrates.
b) hydroxyls.
c) enantiomers.
d) fats.
e) hydrocarbons.
Answer: e
Section: 2.13
Bloom's level: 1

44. An unsaturated fatty acid is one in which:

a) carbon-carbon double bonds are present in the hydrocarbon chain.
b) an odd number of subunits are present in the hydrocarbon chain.
c) an even number of subunits are present in the hydrocarbon chain.
d) carbon-carbon double bonds are not present in the hydrocarbon chain.
e) not all of the carbons in the hydrocarbon chain are bonded to hydrogen atoms.
Answer: a
Section: 2.13
Bloom's level: 1

45. Saturated fatty acids have _____ than unsaturated fatty acids, which is why they exist as a _____ at room temperature.

a) fewer hydrogen atoms; solid
b) more double bonds; liquid
c) more carbon atoms; solid
d) more glycerol molecules; liquid
e) fewer double bonds; solid
Answer: e
Section: 2.13
Bloom's level: 3

46. Human sex hormones are classified as which type of biological molecule?

a) enzyme
b) lipid
c) nucleic acid
d) protein
e) carbohydrate
Answer: b
Section: 2.14
Bloom's level: 3

47. The principal components of cell membranes are:

a) carbohydrates.
b) proteins.
c) nucleic acids.
d) lipids.
e) glycoproteins.
Answer: d
Section: 2.14
Bloom's level: 1

48. Phospholipids assemble spontaneously into bilayers driven by the attraction of their "tail" portions to each other and of their "head" portions to each other. The tail regions are:

a) hydrophilic.
b) molecularly charged.
c) hydrophobic.
d) adhesive.
e) cohesive.
Answer: c
Section: 2.14
Bloom's level: 2

49. The silk of a spider's web is remarkably strong, and its tensile strength is comparable to that of steel. Spider silk is a:

a) lipid.
b) non-carbon-containing molecule.
c) protein.
d) carbohydrate.
e) nucleic acid.
Answer: c

Section: 2.15
Bloom's level: 1

50. All of the following are components of a single amino acid EXCEPT a(n):

a) carboxyl group.
b) nitrogen-containing amino group.
c) variable side chain.
d) alpha carbon.
e) All of the above are components of a single amino acid.
Answer: e
Section: 2.15
Bloom's level: 1

51. All of the following are proteins EXCEPT:

a) hemoglobin.
b) an enzyme.
c) an antibody.
d) insulin.
e) cholesterol.
Answer: e
Section: 2.15
Bloom's level: 1

52. A polypeptide chain is a linear polymer of amino acids. Peptide bonds are present between which of the two following groups?

a) the carbon atom of the carboxyl group and the nitrogen atom of the amino group
b) the carbon atom of the carboxyl group and the adjacent carbon atom of the chain's backbone
c) the carbon atom of the carboxyl group and the oxygen atom double-bonded to it
d) the carbon atom of the carboxyl group and the OH bound to it
e) All of the above are correct.
Answer: a
Section: 2.15
Bloom's level: 2

53. A complex polymer built of amino acids is called a(n):

a) monosaccharide.
b) polypeptide.

c) fatty acid.
d) polysaccharide.
e) amine.
Answer: b
Section: 2.17
Bloom's level: 1

54. Glycoproteins are membrane proteins with bound:

a) signaling peptide sequences.
b) cofactors.
c) carbohydrates.
d) phospholipids.
e) nucleic acids.
Answer: c
Section: 2.17
Bloom's level: 2

55. The secondary structure of a protein refers to the:

a) three-dimensional folded structure of the protein.
b) configuration of the folded protein when bound to other proteins.
c) linear assembly of amino acids into a chain.
d) twisting of the amino acid chain into a corkscrew-like shape or into a zigzag folding pattern.
e) None of the above is correct.
Answer: d
Section: 2.17
Bloom's level: 1

56. Figuratively, the primary structure of proteins is often described as amino acids connected like "beads on a string." In this same vein, which of the following images BEST describes protein quaternary structure?

a) threads in a cloth
b) coils in a spring
c) rungs on a ladder
d) needle in a haystack
e) links on a chain
Answer: a
Section: 2.17
Bloom's level: 5

57. Enzymes:

a) sometimes increase the amount of energy necessary to initiate a reaction.
b) increase the rate at which a reaction occurs.
c) catalyze reactions that release energy, but not those that consume energy.
d) are always consumed by catalyzing a reaction.
e) reduce the energy released by a reaction by one of four different mechanisms.
Answer: b
Section: 2.18
Bloom's level: 2

58. Lactose is a combination of:

a) glucose and ribose.
b) glucose and fructose.
c) glucose and maltose.
d) glucose and galactose.
e) sucrose and fructose.
Answer: d
Section: 2.18
Bloom's level: 1

59. Phenylketonuria is an inherited disorder. Affected individuals have a defective enzyme called phenylalanine hydroxylase. The substance these individuals cannot break down is a(n):

a) carbohydrate.
b) nucleic acid.
c) amino acid.
d) protein.
e) lipid.
Answer: c
Section: 2.19
Bloom's level: 1

60. What can happen if an enzyme is altered, even slightly?

a) It will continue to catalyze reactions, but at a slower rate.
b) It will still catalyze reactions, but only at a higher temperature.
c) Its active site may change, causing the enzyme to stop functioning.
d) The amount of activator required to "turn on" the enzyme will need to increase.
e) It will catalyze reactions too quickly, potentially causing illness for the individual.

Answer: c
Section: 2.19
Bloom’s level: 2

61. Which type of macromolecule is an informational molecule?

a) monosaccharide
b) DNA
c) protein
d) polysaccharide
e) fatty acid
Answer: b
Section: 2.20
Bloom’s level: 2

62. DNA is made of:

a) fatty acids.
b) amino acids.
c) glucose molecules.
d) four interconnected carbon rings.
e) nucleotides.
Answer: e
Section: 2.20
Bloom’s level: 1

63. A nucleotide consists of a phosphate group, a pentose sugar, and a _____, all linked together by covalent bonds.

a) potassium-containing base
b) polypeptide
c) phosphorus-containing base
d) nitrogen-containing base
e) triglyceride
Answer: d
Section: 2.20
Bloom’s level: 1

64. Phosphate groups are important components of:

a) nucleic acids.
b) structural polysaccharides.

c) amino acids.
d) triglycerides.
e) All of the above are correct.
Answer: a
Section: 2.20
Bloom's level: 1

65. All macromolecules important in living systems contain:

a) potassium.
b) nitrogen.
c) polymers.
d) aldehydes.
e) carbon.
Answer: e
Section: 2.20
Bloom's level: 2

66. An amino acid is to a polypeptide as:

a) glycogen is to glucose.
b) a nucleotide is to a nucleic acid.
c) a phospholipid is to a plasma membrane.
d) a nucleic acid is to DNA.
e) testosterone is to a steroid hormone.
Answer: b
Section: 2.20
Bloom's level: 5

67. Which of the following nucleotide bases are present in equal amounts in DNA?

a) adenine and guanine
b) adenine and cytosine
c) thymine and cytosine
d) adenine and thymine
e) thymine and guanine
Answer: d
Section: 2.21
Bloom's level: 4

68. In DNA, adenine from one strand binds to _____ in the complementary strand.

a) thymine
b) adenine
c) uracil
d) cytosine
e) guanine
Answer: a
Section: 2.21
Bloom's level: 1

69. The Russian-American biochemist Phoebus Levene was the first to determine that nucleotides may contain one of four different nitrogen-containing bases. Levene believed that the nitrogen-containing bases occurred in equal amounts in DNA. What is the actual proportion of these bases?

a) DNA contains twice as much of adenine and thymine as guanine and cytosine.
b) All four do actually occur in equal amounts. Levene was right.
c) DNA contains equal amounts of guanine and thymine, and equal amounts of adenine and cytosine.
d) DNA contains equal amounts of adenine and guanine, and equal amounts of thymine and cytosine.
e) DNA contains equal amounts of adenine and thymine, and equal amounts of guanine and cytosine.
Answer: e
Section: 2.21
Bloom's level: 4

70. One of the four nucleotide bases in DNA is replaced by a different base in RNA. Which base is it, and what is it replaced by?

a) adenine, replaced by uracil
b) thymine, replaced by uracil
c) guanine, replaced by cytosine
d) thymine, replaced by guanine
e) cytosine, replaced by guanine
Answer: b
Section: 2.22
Bloom's level: 1

Short-Answer Questions

71. Describe the three types of particles that comprise all atoms in terms of charge, mass, and location within the atom.

Answer: The nucleus of an atom contains the positively charged protons and the neutrally charged neutrons, both of which have significant mass. The negatively charged electrons are present outside of the nucleus. Electrons have almost no mass.

72. What is the "atomic number" of an element? What is the "atomic mass" of an element?

Answer: The "atomic number" of an element is the number of protons found in the atom's nucleus. The "atomic mass" is the combined mass of the atom's protons and its neutrons.

73. How is a hydrogen bond similar to an ionic bond? How are they different?

Answer: Both hydrogen bonds and ionic bonds involve an interaction between a positively charged atom and a negatively charged atom. In the case of an ionic bond, however, these atoms have full electrical charges; in the case of a hydrogen bond, they have only partial electrical charges. As a result, hydrogen bonds are weaker and more easily broken than ionic bonds.

74. List two simple sugars, two digestible complex carbohydrates, and two structural carbohydrates not digestible by humans.

Answer: Glucose, fructose, and galactose are examples of simple sugars. Starch and glycogen are digestible complex carbohydrates, whereas cellulose and chitin are structural carbohydrates not digestible by humans.

75. Why can virtually everyone digest sucrose (table sugar), while many adults cannot digest lactose, and nobody can digest cellulose?

Answer: The ability to digest such compounds requires specific enzymes. Virtually all humans possess the enzyme *sucrase*, which digests sucrose. Many adults lack the enzyme *lactase*, which helps digest lactose. All humans lack the enzyme *cellulase*, which digests cellulose.

76. What is the normal pH of blood? What happens when blood gets too acidic or too basic?

Answer: The normal pH of blood is 7.4. When blood becomes too acidic or too basic, buffers in the body stabilize the pH by absorbing or releasing hydrogen ions. When the blood is too acidic, a buffer absorbs excess hydrogen ions, and when the blood becomes too basic, a buffer releases hydrogen ions to return the pH to normal.

77. What are the differences between saturated and unsaturated fats?

Answer: Saturated and unsaturated refer to the hydrocarbon chain in the fatty acids. In saturated fats, each carbon atom in the hydrocarbon chain of a fatty acid is bonded to two hydrogen atoms. This means the fat molecule carries the maximum number of hydrogen atoms. When saturated, the hydrocarbon tails of the fatty acids line up very straight, and the fat molecules can be packed together tightly, causing them to be solid at room temperature.
In unsaturated fats, however, at least one carbon in the hydrocarbon chain is bound to just one hydrogen, causing the fatty acid to have a crooked shape. When unsaturated, the fatty acids have kinks in the hydrocarbon tails and the fat molecules cannot be packed together as tightly. As a result, unsaturated fats are liquid at room temperature.

78. How is a fishing spider able to "walk on water"?

Answer: Water has the unique property of cohesion, and the V-shaped molecules are held together by hydrogen bonds. The bonds are just strong enough to give water a surface tension with net-like properties. This allows the fishing spider to walk on water!

79. Why does table salt quickly dissolve when placed in water?

Answer: Table salt dissolves in water, meaning that the sodium and chloride ions that were ionically bound together become separated from one another. This occurs because water is able to pull them apart due to its charge and polarity. The positively charged sodium ions are attracted to the negatively charged side of the water molecule, and the negatively charged chloride ions are attracted to the positively charged side. Water surrounds each ion, dissolving the table salt.

80. Why do most people experience rapid weight loss when they first begin dieting? How does this involve glycogen?

Answer: If a person reduces his/her caloric intake such that his/her body is burning more calories than it is consuming, the body must use stored energy. The first molecules that can be broken down for energy in the absence of sufficient sugar in the bloodstream are glycogen molecules stored in the muscles and liver. Glycogen is bound to large amounts of water, and as the glycogen is removed from the tissues of the body, the water is removed, too. The loss of water leads to the initial dramatic weight loss that occurs.

81. Discuss the basic steps of how an enzyme catalyzes a reaction, using lactase as an example.

Answer: Each enzyme has an active site that is a perfect fit for its substrate. The substrate, lactose in this example, fits in the active site of the enzyme, lactase. The chemical reaction occurs, and the bond between the simple sugars is then broken. The two simple sugars making up lactose, glucose and galactose, are then released.

82. What can happen if an enzyme is altered even slightly?

Answer: If an enzyme is altered even slightly, the structure of the active site is changed, and the ability to bind with substrate is blocked or reduced. This is how non-competitive inhibitors function, by slightly altering the structure of the enzyme; however, this alteration can also function to activate an enzyme that has been "turned off."

83. What is radioactivity? Outline what happens when Uranium-238 breaks down.

Answer: Radioactivity refers to the fact that in the process of decomposition, certain atoms release, at a constant rate, a tiny, high-speed particle that carries a lot of energy. The particle can be a proton, neutron, electron, or just energy. For instance, when Uranium-238 breaks down, it spontaneously loses a particle containing two protons and two neutrons, turning it into thorium-236. Thorium is also radioactive and decays into another radioactive element, until finally producing the stable element lead.

84. What are the three components of a deoxynucleotide? Which of these components make up the backbones of a DNA double-helix? Which of these components hold these two strands together?

Answer: Nucleotides and deoxynucleotides are composed of a sugar, a phosphate, and a nitrogen-containing base. The backbone of each strand of a DNA double-helix consists of alternating sugar and phosphate groups, and the nitrogen-containing bases projecting from the backbones of both strands interact with each other through hydrogen bonds to connect the two strands.

Essay Questions

85. Compare and contrast DNA and RNA in terms of structure, composition, and function.

Answer: The student should discuss the similar components of both of these nucleic acids as being made up of nucleotides. In both molecules, nucleic acids are linked in a series to form a ribbon-like strand that is the backbone of the molecule. A sugar molecule is attached to a phosphate group, and this repeats. In deoxyribonucleic acid (DNA), the nitrogen-containing molecule or sugar is deoxyribonucleic acid. In

ribonucleic acid (RNA), the nitrogen-containing molecule or sugar contains an extra atom of oxygen, known as ribonucleic acid. Both DNA and RNA are macromolecules that store their information in bases contained in nucleotides. DNA is a double-helix structure, with the nucleotides adenine, thymine, guanine, and cytosine. Adenine pairs to thymine and guanine pairs to cytosine. RNA, on the other hand, has only one sugar-phosphate backbone and is not a double helix. Instead of thymine, RNA has a base called uracil that binds to adenine. The student should also discuss the similarities and differences in function between RNA and DNA. DNA encodes RNA, which further encodes the amino acids necessary for the production of a protein.

86. Explain the differences among ionic, covalent, and hydrogen bonds and give an example of each type.

Answer: The student should explain the properties of each type of bond, giving the key characteristics of each. For ionic, some key elements would be that the bond occurs because atoms gain or lose electrons, forming negative or positive ions, and because opposites attract, the ions stay together. For covalent, key elements include that this bond is stronger than the ionic bond because the atoms share a pair of electrons and those electrons orbit around both nuclei. Covalent bonds also can occur with atoms sharing two pairs or even three pairs of electrons, and additional shared pairs of electrons make the bond between the atoms even stronger. For hydrogen bonds, key elements include that this type of bond occurs as a result of an unequal sharing of electrons in a covalently bonded molecule. These molecules are said to be "polar." Because the electrons are shared unequally, the molecule itself has a slight negative charge at one end and a slight positive charge at the other, thus causing adjacent molecules to line up positive to negative. A good example of this type of bond occurs in water, and even though this is by far the weakest of the three types of bonds, it is responsible for most of the structure and function of organic molecules.

87. Explain the properties of H_2O and how these properties make H_2O important for living systems.

Answer: In answering this question, the student should list and describe the following properties of water: **cohesion, large heat capacity, low density as a solid,** and **good solvent.** After each description, the student can give an example to illustrate how this property of water makes it important in living systems. For example, **cohesion** of water molecules to each other because of hydrogen bonds allows trees to draw water up from the ground to great heights because the adjacent water molecules, in effect, pull each other up. Water has a **large heat capacity** because as you heat it, the hydrogen bonds first break and reform before the actual movement of the molecules increases, so the temperature of the water takes a long time to increase. This is important for the absorption of heat from metabolic processes. The **low density** of water is also due to hydrogen bonding and causes water molecules to pack closer together as they get colder, which is why ice floats and lakes do not freeze clear to the bottom, which would kill the occupants. The **good solvent** property of water enables it to dissolve important ionic

compounds because of its own polar charges, and carry them to cells where they are needed.

88. Explain how the shapes of carbohydrates, lipids, and proteins relate to their functions.

Answer: The student can answer this question in one of two ways: 1) by describing each type of organic substance and then explaining how the varying molecular shapes lead to varying functions or 2) by a more generalized description of the connection between form and function. A good example to give for carbohydrate form and function would be the differences between glucose and fructose. Both have the same type and number of atoms ($C_6H_{12}O_6$), but their differing structures cause them to bond differently into polysaccharides, to be found in different organisms or parts of organisms, and to be used for different purposes in living systems. Another example in the carbohydrate area would be the difference between starch and cellulose. Where starch is digestible as a fuel source for most organisms, cellulose, due to its small structural difference, is indigestible by all but certain microbes.
For lipid form and function, one of the best examples that can be given is the difference between saturated and unsaturated fats. The difference can be as small as one hydrogen atom more or less, but the health differences of ingesting these are profound.
For protein form and function, it might be a good idea to detail the differences among primary, secondary, tertiary, and quaternary structures. The student can explain that the shape of a protein molecule, similar to an enzyme, for instance, determines what it can do, and how if a protein loses its shape through *denaturation*, it will also lose its function, but could still be broken down so the individual amino acids could be used for fuel.