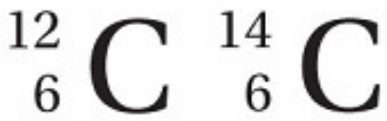
Chapter 02
The Molecules of Cells

Multiple Choice Questions

1. The two isotopes shown below differ in the number of



A. electrons.
B. protons.
C. neutrons.
D. carbon atoms.
E. ionic bonds.

Carbon 12 and carbon 14 are different isotopes of the element carbon; this means they have the same number of protons and electrons, but they differ in the number of neutrons. The number of bonds an isotope can form is not determined by its neutrons.

Bloom's Level: 1. Remember
Learning Outcome: 02.01.03 Describe how variations in an atomic nucleus account for its physical properties.
Section: 02.01
Topic: Atomic Structure

2. If an element has an atomic number of 12, how many electrons are in its outermost shell?
A. 1
B. 10
C. 8
D. 2
E. 12

Two electrons fill the innermost shell and eight fill the next, leaving two for the outermost shell.

Bloom's Level: 3. Apply
Learning Outcome: 02.01.01 Describe how protons, neutrons, and electrons relate to atomic structure.
Section: 02.01
Topic: Atomic Structure

3. If an element has an atomic number of 15, then
A. the atomic mass must also be 15.
B. the atom has 15 electrons.
C. there are 7 electrons in the outermost shell.
D. the atom has 15 neutrons.
E. the atom must have only one orbital.

In an electrically neutral atom, the number of protons (the atomic number) is the same as the number of electrons. The atom would need three orbitals to accommodate 15 electrons, and there would be 5 electrons in its outermost shell. The atomic mass includes the protons and the neutrons; the number of neutrons is not specified in this question.

Bloom's Level: 3. Apply
Learning Outcome: 02.01.02 Understand how to interpret the periodic table of elements.
Section: 02.01
Topic: Atomic Structure

4. The chemical reactivity of an element is dependent on
A. the number of protons.
B. the arrangement of neutrons.
C. the number of electrons in the outermost shell.
D. the number of protons and neutrons.
E. the number of electrons in the inner shell.

It is the outermost shell of an atom that can potentially react with electrons in the outermost shells of other atoms. The protons and neutrons remain in the nucleus and do not engage in chemical reactions.

Bloom's Level: 1. Remember
Learning Outcome: 02.01.03 Describe how variations in an atomic nucleus account for its physical properties.
Section: 02.01
Topic: Chemical Reactions

5. The atomic mass of an element
A. is determined by the number of protons and neutrons it contains.
B. equals the number of protons plus the number of electrons.
C. equals the number of neutrons.
D. changes after each reaction.
E. depends on the number of electrons in the outermost shell.

The atomic mass is essentially the sum of protons and neutrons in the nucleus; it is not changed by chemical reactions. The mass of electrons is negligible.

Bloom's Level: 1. Remember
Learning Outcome: 02.01.02 Understand how to interpret the periodic table of elements.
Section: 02.01

6. The nucleus of an atom contains
A. neutrons and electrons.
B. electrons only.
C. protons, neutrons, and electrons.
D. protons and neutrons.
E. neutrons only.

The nucleus contains protons and neutrons; electrons orbit the nucleus.

Bloom's Level: 1. Remember
Learning Outcome: 02.01.01 Describe how protons, neutrons, and electrons relate to atomic structure.
Section: 02.01
Topic: Atomic Structure

7. Isotopes of a given element have
A. the same number of protons but differ in atomic mass.
B. the same atomic mass but a different number of protons.
C. a different number of electrons.
D. the same number of protons and atomic mass.
E. the same number of neutrons.

Isotopes are atoms of the same element that differ in the number of neutrons only; thus, they have the same atomic number but different atomic masses.

Bloom's Level: 2. Understand
Learning Outcome: 02.01.02 Understand how to interpret the periodic table of elements.
Section: 02.01
Topic: Atomic Structure

8. The isotope shown below has
A. 14 electrons.
B. 6 neutrons.
C. 8 protons.
D. 8 neutrons.
E. 8 electrons.

Carbon 14 has eight neutrons, 6 protons (and thus 6 electrons), and an atomic mass of 14.

Bloom's Level: 2. Understand
Learning Outcome: 02.01.02 Understand how to interpret the periodic table of elements.
Section: 02.01
Topic: Atomic Structure

9. To measure the activity of the human brain during certain thought processes, a short-lived radioactive sugar is injected in the carotid artery and is utilized by those cells that are most active. This shows up on a PET scan and demonstrates the detection of
A. ionic bonds.
B. high levels of radiation.
C. covalent bonds.
D. neutrons.
E. isotopes.

The isotopes used in PET scans constitute a low level of radiation used for beneficial purposes. Types of chemical bonds are not registered by this procedure. Although isotopes of a given element differ in their numbers of neutrons, neutrons are not detected by PET.

Bloom's Level: 1. Remember
Learning Outcome: 02.01.04 Identify the beneficial and harmful uses of radiation.
Section: 02.01
Topic: Atomic Structure

10. Which of the following molecules is NOT a compound?
A. H_2O
B. HCl
C. H_2
D. $C_6H_{12}O_6$
E. NaOH

A compound consists of atoms of two or more different elements bound together; H_2 is two molecules of the same element (hydrogen) bound together.

Bloom's Level: 2. Understand
Learning Outcome: 02.02.01 Describe how elements are combined into molecules and compounds.
Section: 02.02
Topic: Chemical Reactions

11. Which of the following statements is NOT true of chemical bonds?
A. Both ionic and covalent bonds involve electrons in the outer shell.
B. Covalent bonds share electrons between two atoms.
C. An atom involved in an ionic bond has an unequal number of electrons and protons.
D. Salts are covalently bonded.
E. The atoms in a molecule of water (H_2O) are covalently bound together.

Salts, such as sodium chloride (NaCl), are ionic compounds. All the other answer choices are accurate statements.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

12. An ion is an atom that
A. exists in a gaseous state.
B. has a net charge.
C. does not have a net charge.
D. shares electrons with other atoms.
E. shares neutrons with other atoms.

An ion has more or less electrons than a neutral atom of the same element, so it has a net positive or negative charge.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

13. If neutral atoms become positive ions, they
A. gain electrons.
B. lose electrons.
C. gain protons.
D. lose protons.
E. do not change.

The electron transfer is what will determine if an atom becomes a positive or negative ion. To become a positive ion an atom will need to lose electrons so there are more protons than electrons.

Bloom's Level: 2. Understand
Learning Outcome: 02.02.01 Describe how elements are combined into molecules and compounds.
Section: 02.02
Topic: Chemical Reactions

14. When an ionic bond forms, electrons are
A. lost from both atoms.
B. gained by both atoms.
C. shared equally by both atoms.
D. totally lost from the paired atoms.
E. transferred from one atom to another.

Ionic compounds form when one atom gives up an electron, which is accepted by the other member of the pair. Now that one atom is a positively charged ion and the other is a negatively charged ion, the two atoms are attracted to one another.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

15. Calcium chloride, $CaCl_2$, is an ionic compound in which
A. one chlorine atom transferred an electron to the other chlorine atom.
B. each chlorine atom has lost electrons.
C. calcium has two extra electrons in its innermost shell.
D. calcium has gained two electrons.
E. calcium has lost two electrons.

In the ionic compound $CaCl_2$, calcium has transferred two electrons from its outermost shell, becoming a calcium ion (Ca^{2+}). One of the electrons has been accepted by each chlorine atom, so they become chloride ions (Cl^-).

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

16. A covalent bond is
A. a type of bond that results in ionic compounds.
B. the transfer of electrons from one atom to another.
C. a sharing of electrons between two atoms.
D. an attraction of charged atoms.
E. a sharing of protons between two atoms.

A covalent bond results when two atoms share electrons in such a way that each atom has eight electrons in its outermost shell. In contrast, ionic compounds result from the complete transfer of electrons between bonded atoms.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

17. Potassium, a metal with one electron in the outermost shell, will react with how many chlorine atoms? (Chlorine is a nonmetal with seven electrons in the outermost shell.)
A. 5
B. 7
C. 1
D. 2
E. 3

Potassium will attain stability by transferring the one electron in its outermost shell to chlorine, which needs only one more electron in its outermost shell to become stable. The result will be a potassium ion (K^+) and a chloride ion (Cl^-). The two oppositely charged ions will be attracted to one another, thus forming an ionic compound.

Bloom's Level: 2. Understand
Learning Outcome: 02.02.01 Describe how elements are combined into molecules and compounds.
Section: 02.02
Topic: Chemical Bonds

18. Polar covalent bonds result from
A. unequal sharing of electrons in a covalent bond.
B. equal sharing of electrons in a covalent bond.
C. equal sharing of electrons in an ionic bond.
D. unequal sharing of electrons in an ionic bond.
E. hydrogen bonding between molecules.

Covalent bonds result from the sharing of electrons between bound atoms; when the sharing is unequal, it is a polar bond, and when the sharing is equal, it is a nonpolar bond. Ionic bonds are a different type of chemical bond from covalent bonds; in an ionic bond, one or more electrons are completely transferred from one member of the compound to the other(s). Hydrogen bonding is a relatively weak attraction between hydrogen in one molecule and a highly electronegative atom (such as O or N) in an adjacent molecule.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

19. Which of the following statements about hydrogen bonding is incorrect?
A. Hydrogen bonding occurs only between water molecules.
B. Hydrogen bonds are easily broken.
C. Hydrogen bonding can occur between different molecules or within the same molecule.
D. Most hydrogen bonds involve hydrogen and oxygen or nitrogen.
E. The structure of a large, complex molecule can be influenced by hydrogen bonding.

Hydrogen bonding is not limited to bonding between adjacent water molecules. For example, hydrogen bonds can form between hydrogen in water and nitrogen in ammonia, or between the two strands of a DNA molecule. Hydrogen bonds are important in determining the shape of large, complex molecules such as proteins. Even so, hydrogen bonds are relatively weak when compared to ionic or covalent bonds, and are easily broken.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.02 List the different types of bonds that occur between elements.
Section: 02.02
Topic: Chemical Bonds

20. Which of the following is not a property of water that results from hydrogen bonding?
A. The temperature of water changes very slowly.
B. Many polar substances dissolve in water.
C. Water molecules have cohesiveness.
D. Ice melts at -100°C.
E. Water has a high surface tension.

Due to its hydrogen bonding, water melts at 0°C instead of -100°C. All the other answer choices are accurate statements.

Bloom's Level: 1. Remember
Learning Outcome: 02.03.01 Evaluate which properties of water are important for biological life.
Section: 02.03
Topic: Properties of Water

21. Water is a liquid at room temperature. This is due to
A. ionic bonding of the atoms in the water molecule.
B. covalent bonding in the water molecule.
C. covalent bonding between water molecules.
D. hydrogen bonding within the water molecule.
E. hydrogen bonding between water molecules.

Hydrogen bonding between water molecules keeps water in a liquid state at temperatures typically found on the Earth's surface, including room temperature. Water molecules do not covalently bond to one another, and the water molecule is too small to permit intramolecular hydrogen bonds to form. Water molecules do ionize, but this does not influence the fluid nature of water.

Bloom's Level: 3. Apply
Learning Outcome: 02.03.01 Evaluate which properties of water are important for biological life.
Section: 02.03
Topic: Properties of Water

22. The moon lacks life and varies dramatically in temperature. If we could keep a layer of water spread on the surface of the moon, what effect would it have?
A. Life would be possible but it would have to withstand these extremes in temperature.
B. Water would absorb and hold heat and moderate the temperature extremes.
C. The temperatures would drop to the lower extremes.
D. Because water has a high heat of vaporization, the temperatures would rise to the upper extremes.
E. Physical conditions would remain the same.

Water has a high heat capacity; this serves to moderate temperature changes. Although water does have a high heat of vaporization, this also has a moderating effect, and would prevent temperatures from rising to the highest extremes.

Bloom's Level: 4. Analyze
Learning Outcome: 02.03.01 Evaluate which properties of water are important for biological life.
Section: 02.03
Topic: Properties of Water

23. In water, a weak hydrogen bond occurs between hydrogen in one molecule and
A. an oxygen atom in the same molecule.
B. an oxygen atom in a different molecule.
C. a hydrogen atom in the same molecule.
D. a hydrogen atom in a different molecule.
E. either hydrogen and oxygen atoms of different molecules.

Because water molecules are polar, and each oxygen has slight negative charge and the hydrogen a slight positive charge, hydrogen bonding occurs between a hydrogen atom of one water molecule and the oxygen of another.

Bloom's Level: 1. Remember
Learning Outcome: 02.02.03 Compare the relative strengths of ionic, covalent, and hydrogen bonds.
Section: 02.02
Topic: Properties of Water

24. You notice that rain water forms "beads" on your car. This is an example of what property of water?
A. cohesion
B. dissociation
C. high heat of vaporization
D. adhesion
E. solvent

The formation of water beads on the surface of a car is due to the cohesiveness of water molecules for one another, thanks to hydrogen bonding. Adhesion is attraction of water molecules for a surface—a property that is not demonstrated here, since the surface of the car (especially a freshly waxed car) repels the water. The high heat of vaporization and solvent capabilities of water are not apparent in this example. Water does dissociate into ions, but this does not manifest in the formation of beads.

Bloom's Level: 1. Remember
Learning Outcome: 02.03.01 Evaluate which properties of water are important for biological life.
Section: 02.03
Topic: Properties of Water

25. Hydrogen bonding produces which of the following properties of water?
A. Water boils at a lower temperature than expected.
B. Water is less dense as ice than as liquid water.
C. Water absorbs heat with a large change in temperature.
D. Water releases heat with a large change in temperature.
E. Water can be more dense as ice than as liquid water.

Due to the increased stability of hydrogen bonding at lower temperatures, water is less dense as ice than as liquid water. Water can absorb and release heat, but with a relatively small change in temperature. Due to hydrogen bonding, water boils at 100°C; without hydrogen bonding, it would boil at -91°C.

Bloom's Level: 1. Remember
Learning Outcome: 02.03.01 Evaluate which properties of water are important for biological life.
Section: 02.03
Topic: Properties of Water

26. The water strider is an insect that skates across the water without sinking. The tips of its feet must be coated with molecules that are
A. ions.
B. hydrophilic.
C. hydrophobic.
D. basic.
E. acidic.

The water strider's feet should be coated with hydrophobic molecules to repel water; a hydrophilic coating would cause the insect to stick to the surface of the water and sink. Ions, acids, and bases are hydrophilic.

Bloom's Level: 3. Apply
Learning Outcome: 02.03.01 Evaluate which properties of water are important for biological life.
Section: 02.03
Topic: Properties of Water

27. The lower the pH
A. the lower the hydrogen ion (H^+) concentration.
B. the more acidic the solution.
C. the higher the pH.
D. the greater the hydroxide ion (OH^-) concentration.
E. the closer the hydroxide ion (OH^-) concentration comes to equaling the hydrogen ion (H^+) concentration.

The pH scale is based on hydrogen ion (H^+) concentration. The higher the concentration of H^+ (and the lower the concentration of OH^-, hydroxide), the lower the pH, and the more acidic the solution.

Bloom's Level: 1. Remember
Learning Outcome: 02.03.02 Identify common acidic and basic substances.
Section: 02.03
Topic: Acids and Bases

28. Since pure water is neutral in pH, it contains
A. no hydrogen ions (H^+).
B. no hydroxide ions (OH^-).
C. neither hydrogen ions (H^+) nor hydroxide ions (OH^-).
D. an equal number of hydrogen ions (H^+) and hydroxide ions (OH^-).
E. seven times more hydrogen ions (H^+) than hydroxide ions (OH^-).

Pure water is neutral, with a pH of 7 (midway between 0 and 14 on the pH scale), meaning that it has equal concentrations of hydrogen ions (H^+) and hydroxide ions (OH^-).

Bloom's Level: 2. Understand
Learning Outcome: 02.03.02 Identify common acidic and basic substances.
Section: 02.03
Topic: Acids and Bases

29. The pH of blood is slightly basic. Which of the following would therefore be an expected pH for blood?
A. 6.4
B. 4.6
C. 4.7
D. 7.4
E. 13.8

The pH scale ranges from 0 to 14, with 7 being neutral. Numbers lower than 7 are acidic, and those higher than 7 are basic. Thus, a pH of 7.4 would be slightly basic.

Bloom's Level: 3. Apply
Learning Outcome: 02.03.02 Identify common acidic and basic substances.
Section: 02.03
Topic: Acids and Bases

30. Potassium hydroxide (KOH) almost completely dissociates in aqueous solution into K^+ and OH^-, which means it is a
A. strong acid.
B. strong base.
C. weak base.
D. weak acid.
E. nonpolar covalent molecule.

Because potassium hydroxide dissociates completely and adds hydroxide ions (OH^-) to an aqueous solution, it is a strong base. A weak base would not dissociate so completely. An acid would contribute hydrogen ions (H^+) to an aqueous solution. Potassium hydroxide is an ionic compound; a nonpolar covalent molecule would not dissociate or dissolve in an aqueous solution.

Bloom's Level: 4. Analyze
Learning Outcome: 02.03.02 Identify common acidic and basic substances.
Section: 02.03
Topic: Acids and Bases

31. Which statement regarding acids and bases is correct?
A. Acids increase the pH, and bases decrease the pH.
B. Acids increase the proportion of hydrogen ions (H^+), and bases reduce the proportion of H^+.
C. Acids are harmful, but bases are not harmful.
D. Acids combine with bases to form buffers.
E. Acids combine with bases to form sugars.

Acids raise the hydrogen ion (H^+) content of a solution, while bases reduce the proportion of H^+. The lower the pH, the more acidic the solution, and the higher the pH, the more basic the solution. Strong acids and bases are both harmful. When acids combine with bases, salts result.

Bloom's Level: 1. Remember
Learning Outcome: 02.03.02 Identify common acidic and basic substances.
Section: 02.03
Topic: Acids and Bases

32. Buffers
A. are strong acids or bases.
B. keep the pH within normal limits.
C. release large amounts of hydrogen ions (H^+).
D. will only lower the pH.
E. will only increase the pH.

Buffers are the chemicals or combinations of chemicals that keep pH within normal limits. Weak acids and bases may be used as buffers, not strong ones, which would greatly influence the H^+ concentration of the solution and thereby raise or lower the pH.

Bloom's Level: 1. Remember
Learning Outcome: 02.03.03 Describe how buffers are important to living organisms.
Section: 02.03
Topic: Acids and Bases

33. Aspirin is acetyl salicylic acid and can therefore pose a problem to people who have ulcers. Bufferin is an alternative to aspirin that uses a buffer to neutralize this effect by
A. substituting another ingredient for the acetyl salicylic acid.
B. adding a drug to stimulate the immune system.
C. adding salts to neutralize the acid.
D. adding an equal amount of hydroxide (OH^-) ions.
E. adding chemicals that take up excess hydrogen (H^+) ions.

Bufferin contains a buffering system to bind the excess H^+ from the aspirin (acetyl salicylic acid). This would not be a salt; salts form when acids and bases react.

Bloom's Level: 3. Apply
Learning Outcome: 02.03.03 Describe how buffers are important to living organisms.
Section: 02.03
Topic: Chemical Reactions

34. Rain falling in the northeastern U.S. has a pH between 5.0 and 4.0. Normally, rainwater has a pH of about 5.6. Which of the following statements is not correct?
A. The pH of the rainwater has changed from neutral to acidic.
B. The pH of the rainwater has become more acidic.
C. The hydrogen ion (H^+) content of the rainwater has increased.
D. The proportion of hydroxide ions (OH^-) in the rainwater has declined.
E. The rainwater with a pH of 4.0 is ten times more acidic than the rainwater with a pH of 5.0.

The pH of rainwater is normally acidic (5.6) not neutral (7). All the other answer choices are accurate statements.

Bloom's Level: 2. Understand
Learning Outcome: 02.03.02 Identify common acidic and basic substances.
Section: 02.03
Topic: Acids and Bases

35. Organic molecules
A. always contain carbon.
B. always contain hydrogen.
C. always contain carbon and hydrogen.
D. are found only in organisms, hence their name.
E. are always food molecules.

Organic molecules, by definition, must contain both carbon and hydrogen. They are found in organisms and in food, but can also be made in a laboratory.

Bloom's Level: 1. Remember
Learning Outcome: 02.04.01 Compare inorganic molecules to organic molecules.
Section: 02.04
Topic: Chemical Reactions

36. Which of the following molecules is inorganic?
A. CH_4
B. CO_2
C. $C_6H_{12}O_6$
D. $C_{12}H_{22}O_{12}$
E. C_6H_6

Carbon dioxide (CO_2) is inorganic because, although it contains carbon, it does not contain hydrogen. All the other molecules contain both carbon and hydrogen and are therefore organic.

Bloom's Level: 2. Understand
Learning Outcome: 02.04.01 Compare inorganic molecules to organic molecules.
Section: 02.04
Topic: Chemical Bonds

37. One carbon atom can form covalent bonds with up to ___ other atoms to form an organic molecule.
A. 2
B. 3
C. 4
D. 6
E. 8

Carbon, with an atomic number of 6, has 4 electrons in its outermost shell. Thus, carbon can form 4 single covalent bonds with other atoms.

Bloom's Level: 1. Remember
Learning Outcome: 02.04.01 Compare inorganic molecules to organic molecules.
Section: 02.04
Topic: Chemical Bonds

38. Two molecules of glucose combine to form a disaccharide molecule during a(n) _____ reaction.
A. dehydration
B. hydrolysis
C. hydrogen bond
D. ionic bond
E. inert

The glucose molecules are monomers; forming a covalent bond between them requires a dehydration reaction. A hydrolysis reaction could be used to break the disaccharide apart into individual glucose monomers. An inert material would not react at all.

Bloom's Level: 1. Remember
Learning Outcome: 02.04.03 Recognize how monomers are joined to form polymers.
Section: 02.04
Topic: Chemical Reactions

39. DNA codes for the sequence of amino acids in the primary structure of a protein, but not for sugars or lipids. This is because
A. only proteins are involved in living metabolic reactions.
B. sugars and lipids code for their own replication.
C. sugars and lipids are ever present in the living environment and are not used in living structures.
D. other hereditary molecules code for sugars and lipids.
E. proteins are the main structural and functional components of cells.

Proteins are the main structural and functional components of cells. As enzymes, proteins catalyze the synthesis and degradation of other biological molecules, including sugars and lipids.

Bloom's Level: 3. Apply
Learning Outcome: 02.07.03 Compare the four levels of protein structure.
Section: 02.07
Topic: Proteins

40. A genetic mutation can cause a change in the sequence of the 20 amino acids used to build proteins. Such a change is a change to the protein's
A. primary structure only.
B. secondary structure only.
C. tertiary structure only.
D. primary structure, but this will likely alter higher levels of structure as well.
E. quaternary structure only.

A mutation (a change in a DNA sequence) may directly alter the primary structure of a protein, since this is the sequence of amino acids in the chain. However, the primary level of structure dictates the higher levels of structure—secondary, tertiary, and even quaternary—so these may be indirectly affected as a result of the mutation.

Bloom's Level: 3. Apply
Learning Outcome: 02.07.03 Compare the four levels of protein structure.
Section: 02.07
Topic: Proteins

41. Glycogen is a
A. monosaccharide used for quick energy.
B. protein found in cell membranes.
C. polysaccharide used to store glucose/energy.
D. fat found in margarine.
E. nucleic acid found in the nucleus of a cell.

Glycogen (a polysaccharide) is the storage form of glucose (a monosaccharide). It is rich in chemical bond energy, found in animal tissues such as liver and skeletal muscle. DNA would be a nucleic acid found in the nucleus of a cell, and trans fats are found in margarine.

Bloom's Level: 1. Remember
Learning Outcome: 02.05.02 List several examples of important monosaccharides and polysaccharides.
Section: 02.05
Topic: Carbohydrates

42. Maltose is classified as a
A. nucleic acid.
B. fatty acid.
C. protein.
D. carbohydrate.
E. lipid.

Maltose is classified as a carbohydrate due to its carbon and hydrogen backbone.

Bloom's Level: 1. Remember
Learning Outcome: 02.05.02 List several examples of important monosaccharides and polysaccharides.
Section: 02.05
Topic: Carbohydrates

43. All carbohydrate molecules
A. contain amino acids.
B. contain nitrogen and phosphate.
C. are organic acids.
D. are composed of atoms of C, H, and the functional group -OH.
E. are composed of atoms of C, H, O, and N.

Carbohydrates are organic molecules, thus, they contain both carbon and hydrogen atoms. They are further characterized by the hydroxyl (-OH) functional group. Although some carbohydrates do contain nitrogen, this is not a requirement in order to be classified as a carbohydrate. Amino acids are the monomers of proteins, not carbohydrates. Carbohydrates do not release H^+ in aqueous solutions, so they are not organic acids.

Bloom's Level: 2. Understand
Learning Outcome: 02.05.01 Identify the structural components of a carbohydrate.
Section: 02.05
Topic: Carbohydrates

44. When two glucose molecules combine they form a disaccharide molecule and
A. another glucose molecule.
B. another disaccharide molecule.
C. a dipeptide molecule.
D. a lipid molecule.
E. a water molecule.

Glucose is a monosaccharide (a carbohydrate monomer); two glucose molecules combine to form a disaccharide, not a dipeptide or a lipid. In the process, a water molecule is released, which is why this is called a dehydration reaction.

Bloom's Level: 1. Remember
Learning Outcome: 02.04.03 Recognize how monomers are joined to form polymers.
Learning Outcome: 02.05.01 Identify the structural components of a carbohydrate.
Section: 02.04
Section: 02.05
Topic: Carbohydrates

45. ____ is a polysaccharide that is found in plant cell walls and accounts for their strength.
A. Cellulose
B. Chitin
C. Glycogen
D. Starch
E. Cholesterol

Cellulose is a structural polysaccharide found in plant cell walls. Starch and glycogen are storage forms of glucose found in plants and animals, respectively. Chitin is a polysaccharide found in the cell walls of fungi and the exoskeletons of arthropods. DNA is a nucleic acid, not a polysaccharide, and is found in cell nuclei.

Bloom's Level: 1. Remember
Learning Outcome: 02.05.02 List several examples of important monosaccharides and polysaccharides.
Section: 02.05
Topic: Carbohydrates

46. Hydrolysis of a fat results in
A. glycerol only.
B. fatty acids only.
C. glucose only.
D. two monosaccharides.
E. both glycerol and fatty acids.

A triglyceride molecule (commonly known as a fat) is composed of three fatty acids covalently bonded to glycerol. No monosaccharides, including glucose, make up a triglyceride.

Bloom's Level: 2. Understand
Learning Outcome: 02.06.01 Compare the structures of fats, phospholipids, and steroids.
Section: 02.06
Topic: Lipids

47. A long chain of carbon atoms with hydrogen atoms attached, ending in the acidic group -COOH would be a(n)
A. triglyceride.
B. amino acid.
C. fatty acid.
D. nucleic acid.
E. monosaccharide.

A fatty acid is a hydrocarbon chain ending with a -COOH group, which is acidic; a triglyceride is composed of three fatty acids bound to glycerol. Amino acids are the monomers of proteins, and monosaccharides are carbohydrates. Nucleic acids are polymers of nucleotides such as DNA and RNA.

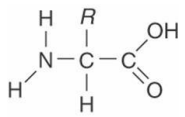
Bloom's Level: 1. Remember
Learning Outcome: 02.06.01 Compare the structures of fats, phospholipids, and steroids.
Section: 02.06
Topic: Lipids

48. Nucleic acids are polymers of
A. amino acids.
B. nucleotides.
C. glycerol.
D. monosaccharides.
E. fatty acids.

Nucleic acids such as DNA and RNA are polymers of nucleotides. Polysaccharides are polymers of monosaccharides, triglycerides are made up of fatty acids bound to glycerol, and proteins are composed of amino acids.

Bloom's Level: 1. Remember
Learning Outcome: 02.08.01 Compare the structure and function of DNA and RNA.
Section: 02.08
Topic: Nucleic Acids

49. The molecular structure shown here is



A. a glucose molecule.
B. a fatty acid molecule.
C. a glycerol molecule.
D. a protein molecule.
E. an amino acid.

An amino acid has a central carbon bonded to a hydrogen atom, an amino ($-NH_2$) group, a carboxyl (-COOH) group, and an *R* group where *R* stands for the remainder of the molecule. Amino acids are the monomers of proteins. Glucose is a monomer for certain polysaccharides, and a triglyceride is composed of fatty acids and a glycerol molecule.

Bloom's Level: 1. Remember
Figure: 02.24
Learning Outcome: 02.07.03 Compare the four levels of protein structure.
Section: 02.07
Topic: Proteins

50. Enzymes are organic compounds classified as
A. nucleic acids.
B. carbohydrates.
C. lipids.
D. steroids.
E. proteins.

Enzymes are proteins that speed chemical reactions in living things. Their function is very dependent upon their structure. Steroids and other lipids do not function as enzymes, nor do carbohydrates. With a very few exceptions, neither do nucleic acids.

Bloom's Level: 1. Remember
Learning Outcome: 02.07.01 Describe the functions of proteins in cells.
Section: 02.07
Topic: Proteins

51. The _____ structure of a protein consists of the sequence of the amino acids joined together by peptide bonds.
A. primary
B. secondary
C. tertiary
D. quaternary
E. molecular

Amino acids joined together by peptide bonds constitute the primary level of protein structure. In secondary structure, hydrogen bonding between amino acids causes the polypeptide to form an alpha helix or a beta pleated sheet. In tertiary structure, interactions such as covalent bonds between *R* groups cause the polypeptide to fold and twist. When two or more polypeptides join together, this represents a quaternary level of structure. There is no level of protein structure termed the molecular level.

Bloom's Level: 1. Remember
Learning Outcome: 02.07.03 Compare the four levels of protein structure.
Section: 02.07
Topic: Proteins

52. Hemoglobin is a protein composed of two pairs of polypeptide chains. What is the highest level of protein structure represented by hemoglobin?
A. primary
B. secondary
C. tertiary
D. quaternary
E. molecular

Amino acids joined together by peptide bonds constitute the primary level of protein structure. In secondary structure, hydrogen bonding between amino acids causes the polypeptide to form an alpha helix or a beta pleated sheet. In tertiary structure, interactions such as covalent bonds between *R* groups cause the polypeptide to fold and twist. When two or more polypeptides join together, this represents a quaternary level of structure. There is no level of protein structure termed the molecular level.

Bloom's Level: 2. Understand
Learning Outcome: 02.07.03 Compare the four levels of protein structure.
Section: 02.07
Topic: Proteins

53. The proposed cause of CJD and kuru in humans, mad cow disease, and scrapie in sheep is a change in a brain protein. Disease victims appear to have a protein that should normally contain alpha helices but instead they have changed into a protein made of beta pleated sheets. The disease appears to spread when the abnormal protein comes into contact with the normal protein, causing it to become deformed. Which level of protein structure is associated with these diseases?
A. primary
B. secondary
C. tertiary
D. quaternary
E. molecular

Amino acids joined together by peptide bonds constitute the primary level of protein structure. In secondary structure, hydrogen bonding between amino acids causes the polypeptide to form an alpha helix or a beta pleated sheet—this is the level affected in CJD and similar brain diseases. In tertiary structure, interactions such as covalent bonds between *R* groups cause the polypeptide to fold and twist. When two or more polypeptides join together, this represents a quaternary level of structure. There is no level of protein structure termed the "molecular level."

Bloom's Level: 3. Apply
Learning Outcome: 02.07.01 Describe the functions of proteins in cells.
Learning Outcome: 02.07.03 Compare the four levels of protein structure.
Section: 02.07
Topic: Proteins

54. Which of these combinations would be found in a nucleotide?
A. base-acid-salt
B. adenine-thymine-uracil
C. base-sugar-phosphate
D. DNA-RNA-nucleus
E. sugar-protein-fat

A nucleotide is composed of a nitrogenous base, a pentose sugar, and a phosphate group. Adenine, thymine, and uracil are bases. Combining an acid and a base yields a salt. Sugars, proteins, and fats are all biological organic molecules. DNA and RNA are nucleic acids composed of nucleotides. Both are made in the nucleus of a cell.

Bloom's Level: 2. Understand
Learning Outcome: 02.08.01 Compare the structure and function of DNA and RNA.
Section: 02.08
Topic: Nucleic Acids

55. The backbone of a nucleic acid strand is composed of
A. glycerol.
B. "R" groups.
C. nitrogenous bases.
D. alternating pentose sugars and phosphate groups.
E. alternating adenines and thymines.

The backbone of a nucleic acid such as DNA is composed of alternating pentose sugars and phosphate groups. Glycerol is the backbone of a triglyceride. Although nitrogenous bases such as adenine and thymine are part of DNA, they do not make up the backbone. R groups are part of amino acids, not nucleotides.

Bloom's Level: 1. Remember
Learning Outcome: 02.08.01 Compare the structure and function of DNA and RNA.
Section: 02.08
Topic: Nucleic Acids

56. In the search to discover the agents that cause mad cow disease, scrapie in sheep, and CJD and kuru in humans, diseased brain tissues were passed through a fine filter to remove bacteria. The filtrate was still infectious, indicating that something smaller than bacteria, either viruses or organic molecules, must be the causative agent. If a virus was responsible for these brain diseases, then the infectious agent would contain either RNA or DNA. Other possibilities were that the agent was a carbohydrate, fat, or protein. Tissue filtrates were treated with agents that destroyed just one of these chemicals and then injected into a healthy animal, with the results as follows. What is the infectious agent?

- Amylase digests carbohydrates; tissue filtrate still infects healthy test animal.
- Lipase digests fats; tissue filtrate still infects healthy test animal.
- Formaldehyde and/or heat denatures DNA and RNA; tissue filtrate still infects healthy test animal.
- Trypsin digests protein; tissue filtrate does not infect healthy test animal.

A. carbohydrate
B. fat
C. protein
D. DNA or RNA
E. Could be carbohydrate, fat, or DNA or RNA but not protein.

CJD, kuru, mad cow disease, and scrapie are caused by prions—infectious proteins. This was supported by the finding that only trypsin, which digests proteins, was able to deactivate the infectious agent.

Bloom's Level: 5. Evaluate
Learning Outcome: 02.07.01 Describe the functions of proteins in cells.
Section: 02.07
Topic: Proteins

57. The final shape of a protein is very important to its function. When proteins undergo an irreversible change in shape called _____ they _____ perform their usual functions.
A. naturation/can
B. naturation/cannot
C. denaturation/can
D. denaturation/cannot
E. dehydration reaction/cannot

Denaturation is when a protein loses its shape and cannot function. Although dehydration reactions do join amino acids together, this represents only the most basic (primary) level of protein structure.

Bloom's Level: 1. Remember
Learning Outcome: 02.07.02 Explain how a polypeptide is constructed from amino acids.
Section: 02.07
Topic: Proteins

58. The primary function of carbohydrates is
A. quick fuel and short-term energy storage.
B. structural reinforcement of plant and fungal cell walls.
C. encoding the hereditary information.
D. to speed chemical reactions in cells.
E. to transport molecules across cell membranes.

Carbohydrates are primarily fuel and short-term energy storage molecules, although some polysaccharides do reinforce cell walls in certain organisms. DNA, a nucleic acid, encodes hereditary information. Proteins can function as enzymes to speed chemical reactions, or as transporters to move molecules across cell membranes.

Bloom's Level: 1. Remember
Learning Outcome: 02.05.02 List several examples of important monosaccharides and polysaccharides.
Section: 02.05
Topic: Carbohydrates

59. Which of the following types of lipids is the most abundant constituent of cell membranes?
A. cholesterol
B. phospholipid
C. triglyceride
D. neutral fat
E. fat

Phospholipids are the most abundant type of lipids in cell membranes. Animal cells also have cholesterol in their membranes, but it is less abundant than phospholipids. Triglycerides, also known as neutral fats or simply fats, are energy-storage molecules, not structural molecules.

Bloom's Level: 1. Remember
Learning Outcome: 02.06.02 Identify the functions lipids play in our bodies.
Section: 02.06
Topic: Lipids

60. Which type of lipid molecule is characterized by a backbone of four fused rings?
A. DNA
B. phospholipid
C. triglyceride
D. steroid
E. amino acid

Only steroids are characterized by their backbone of four fused rings. Phospholipids and triglycerides are lipids, but they do not share the same structure as steroids. Amino acids and DNA are not lipids.

Bloom's Level: 1. Remember
Learning Outcome: 02.06.01 Compare the structures of fats, phospholipids, and steroids.
Section: 02.06
Topic: Lipids

61. Which statement about the cellular nucleic acids DNA and RNA is incorrect?
A. DNA is double-stranded, and RNA is single-stranded.
B. The sugar in DNA is deoxyribose, and in RNA the sugar is ribose.
C. DNA has a helix shape; RNA does not.
D. RNA and DNA have the same four nitrogen-containing bases.
E. Both DNA and RNA are polymers of nucleotides.

In RNA, the base uracil replaces thymine. All the other answer choices are accurate statements.

Bloom's Level: 2. Understand
Learning Outcome: 02.08.01 Compare the structure and function of DNA and RNA.
Section: 02.08
Topic: Nucleic Acids

62. Which of the following radioactive isotopes are used to detect whether or not an individual has a healthy thyroid?
A. I^{131}
B. C^{14}
C. glucose
D. H_2
E. All of the above can be used.

I^{131} is a radioactive isotope that is used to detect whether the thyroid is healthy or not. C^{14} is used to date the age of fossils. Glucose is not taken up by the thyroid. H_2 is a gas commonly found in the atmosphere.

Bloom's Level: 4. Analyze
Learning Outcome: 02.01.04 Identify the beneficial and harmful uses of radiation.
Section: 02.01
Topic: Atomic Structure

63. Which of the following subatomic particles will be found within the nucleus of the atom?

A. protons and neutrons
B. protons and electrons
C. electrons and neutrons
D. only neutrons
E. only protons

The nucleus of an atom will contain the protons and neutrons. Electrons are found in the electron orbitals that circle the nucleus.

Bloom's Level: 2. Understand
Learning Outcome: 02.01.01 Describe how protons, neutrons, and electrons relate to atomic structure.
Section: 02.01
Topic: Atomic Structure

64. Which of the following radiation uses is the one that is most likely to have both beneficial and harmful consequences?
A. using radiation to treat a cancer patient
B. using radiation to sterilize mail
C. using radiation to sterilize surgical equipment prior to a surgery
D. radiating fruits and vegetables prior to storage
E. All of the answer choices will have beneficial and harmful consequences.

When using radiation on a person for cancer treatment, there is the possibility of destroying healthy cells along with the cancer cells. Sterilizing mail, surgical equipment, and fruits and vegetables tends not to have any type of consequence on people.

Bloom's Level: 4. Analyze
Learning Outcome: 02.01.04 Identify the beneficial and harmful uses of radiation.
Section: 02.01
Topic: Chemical Reactions

65. Which of the following sequences correctly lists the bonds in order of strongest to weakest?
A. double covalent - single covalent - ionic - hydrogen
B. single covalent - double covalent - ionic - hydrogen
C. ionic- double covalent - single covalent - hydrogen
D. hydrogen - double covalent - single covalent - ionic
E. double covalent - single covalent - hydrogen - ionic

The strongest bond listed here is the double covalent followed by the single covalent, ionic, and then hydrogen bonds.

Bloom's Level: 4. Analyze
Learning Outcome: 02.02.03 Compare the relative strengths of ionic, covalent, and hydrogen bonds.
Section: 02.02
Topic: Chemical Bonds

66. Which type of bond formation is responsible for the properties of water?
A. hydrogen
B. polar covalent
C. ionic
D. nonpolar covalent
E. None of these bonds play a role in the properties of water.

Hydrogen bonds are the attraction between the hydrogen of one water molecule and the oxygen of a second water molecule. This attraction sets up the properties of water. A polar covalent bond forms between the hydrogen and oxygen of a particular water molecule. Water doesn't form ionic or nonpolar covalent bonds.

Bloom's Level: 2. Understand
Learning Outcome: 02.02.03 Compare the relative strengths of ionic, covalent, and hydrogen bonds.
Section: 02.02
Topic: Chemical Bonds

67. Which functional groups are associated with a dehydration reaction?
A. H and OH
B. OH and NHH
C. OH and NHH
D. SH and OH
E. COOH and SH

H and OH are associated with the dehydration reactions.

Bloom's Level: 2. Understand
Learning Outcome: 02.04.02 Identify the role of a functional group.
Section: 02.04
Topic: Chemical Bonds

68. Which of the following functional groups is present in amino acids?
A. SH
B. NHH
C. COOH
D. OH
E. All of the answer choices are present in amino acids.

All of these functional groups are present in amino acids.

Bloom's Level: 2. Understand
Learning Outcome: 02.04.02 Identify the role of a functional group.
Section: 02.04
Topic: Proteins

69. Removal of the hydroxyl functional group would disrupt the structure of
A. sugars and some amino acids.
B. sugars.
C. fatty acids and amino acids.
D. nucleotides and phospholipids.
E. nucleotides and fatty acids.

Hydroxyl is a functional group found within both sugars and some amino acids. If it was removed it would disrupt their structure.

Bloom's Level: 4. Analyze
Learning Outcome: 02.04.02 Identify the role of a functional group.
Section: 02.04
Topic: Chemical Reactions

70. Which of the following reactions is most likely to occur if an individual was to ingest a large dose of lemon juice?
A. There would be an increase in the amount of carbonic acid within the bloodstream. If the carbonic acid didn't form, then the pH of the individual's blood could shift toward 7.2.
B. There would be a decrease in the amount of carbonic acid within the bloodstream. If the carbonic acid didn't form, then the pH of the individual's blood could shift toward 7.2.
C. There would be a decrease in the amount of carbonic acid within the bloodstream. If the carbonic acid didn't form, then the pH of the individual's blood could shift toward 7.2.
D. There would be a decrease in the amount of carbonic acid within the bloodstream. If the carbonic acid didn't form, then the pH of the individual's blood could shift toward 7.8.

Lemon juice is acidic so it contains large amounts H^+. When H^+ enters the bloodstream it combines with HCO_3^- to form H_2CO_3 (carbonic acid). The carbonic acid prevents the blood pH from shifting toward a more acidic or basic range. If it didn't form, in this case the individual's blood would become more acidic and shift toward 7.2.

Bloom's Level: 5. Evaluate
Learning Outcome: 02.03.03 Describe how buffers are important to living organisms.
Section: 02.03
Topic: Chemical Reactions

Short Answer Questions

71. Briefly describe the major functions of lipids in the human body.

Answers will vary but should include the following information. Fats and oils function as energy storage molecules. Phospholipids form the cell membrane and inner compartments of the cell. Steroids include the sex hormones.

Bloom's Level: 6. Create
Learning Outcome: 02.06.02 Identify the functions lipids play in our bodies.
Section: 02.06
Topic: Lipids

Multiple Choice Questions

72. During the formation of a polymer, two monomers are joined by the removal of
A. OH and H.
B. OH and SH.
C. H and COH.
D. COOH and SH.
E. NHH and COOH.

Polymers are formed when H and OH are removed from the monomers during a dehydration reaction. COH, SH, NHH, and COOH are all functional groups.

Bloom's Level: 2. Understand
Learning Outcome: 02.04.03 Recognize how monomers are joined to form polymers.
Section: 02.04
Topic: Chemical Reactions

73. Cholesterol is a component of cell membranes and is an example of which type of lipid?
A. steroids
B. phospholipids
C. fatty acids
D. triglycerides
E. oils

Due to the structure of cholesterol it is classified as a steroid within the body.

Bloom's Level: 2. Understand
Learning Outcome: 02.06.02 Identify the functions lipids play in our bodies.
Section: 02.06
Topic: Lipids

74. What type of reaction is necessary to produce a dipeptide from individual amino acids?
A. dehydration reaction
B. hydrolysis reaction
C. denaturation
D. Dipeptides are not formed from amino acids.
E. None of the answer choices will form a dipeptide.

Two amino acids are joined during a dehydration reaction to form a dipeptide. Hydrolysis reactions will break apart a dipeptide into individual amino acids. Denaturation is the change in shape of a protein. Dipeptides are formed from amino acids.

Bloom's Level: 2. Understand
Learning Outcome: 02.07.02 Explain how a polypeptide is constructed from amino acids.
Section: 02.07
Topic: Chemical Reactions

75. Determine what would happen to an individual's proteins if they developed a fever of 103º F for several days.
A. The proteins would denature due to the increase in body temperature and would become unable to function correctly.
B. The proteins would increase in their ability to perform their functions because of the increase in body temperature.
C. Nothing would happen to the proteins as a result of the increase in temperature.
D. The proteins would denature due to the increase in body temperature and would increase in their ability to function correctly.
E. One protein would alter in shape which would then cause the next protein to alter in shape which would cause a third protein to alter in shape and so forth until all of the proteins were altered in shape.

An increase in body temperature for several days would cause the proteins to denature. Once they denatured they would not be able to function correctly. Proteins would not increase in their ability to function due to an increase in body temperature.

Bloom's Level: 5. Evaluate
Learning Outcome: 02.07.01 Describe the functions of proteins in cells.
Section: 02.07
Topic: Proteins

76. Which group of lipids will contain a barrier formed by hydrophilic heads that face outwards and hydrophobic tails that face inwards?
A. phospholipids
B. steroids
C. triglycerides
D. saturated acids
E. trans-fatty acids

Phospholipids have hydrophilic heads and hydrophobic tails that will form a barrier. Steroids have a backbone of four fused carbon rings. Triglycerides is formed from three fatty acids and a glycerol. Saturated acids and trans-fatty acids are both made from hydrocarbon chains with an acidic group on the end.

Bloom's Level: 2. Understand
Learning Outcome: 02.06.01 Compare the structures of fats, phospholipids, and steroids.
Section: 02.06
Topic: Lipids

77. Which nutrient source is the easiest one for humans to break down and form ATP?
A. glucose
B. protein
C. cellulose
D. phospholipids
E. chitin

Glucose is the easiest substance to break down into ATP. Proteins, cellulose, phospholipids, and chitin are not easily broken down into ATP.

Bloom's Level: 2. Understand
Learning Outcome: 02.08.02 Explain the role of ATP in the cell.
Section: 02.08
Topic: Nucleic Acids

78. Which of the following is not a function of ATP within the cell?
A. All of the answer choices are functions of ATP within the cell.
B. conduction of nerve impulses
C. contraction of muscle cells
D. synthesis of macromolecules
E. energy currency of the cell

All of the answer choices are functions of ATP within the cell.

Bloom's Level: 2. Understand
Learning Outcome: 02.08.02 Explain the role of ATP in the cell.
Section: 02.08
Topic: Nucleic Acids

Short Answer Questions

79. Briefly describe how ATP is broken down and turned into ADP.

Answers will vary but should include the following: The last two phosphate bonds in ATP are unstable and easily broken. The terminal phosphate bond is hydrolyzed, leaving ADP and an inorganic phosphate. Energy is released when the phosphate is broken off.

Bloom's Level: 6. Create
Learning Outcome: 02.08.02 Explain the role of ATP in the cell.
Section: 02.08
Topic: Nucleic Acids

Multiple Choice Questions

80. What type of bond will connect the amino acids in a protein?
A. peptide
B. triple covalent
C. polar covalent
D. ionic
E. double covalent

A peptide bond will connect the amino acids together to form a protein. The atoms associate with a peptide bond unevenly because the oxygen is more electronegative than nitrogen.

Bloom's Level: 1. Remember
Learning Outcome: 02.07.02 Explain how a polypeptide is constructed from amino acids.
Section: 02.07
Topic: Chemical Bonds

81. Determine which of the following components are required for a molecule to be classified as organic.
A. presence of carbon, hydrogen, four electrons in the outer orbital, and the attachment of a functional group
B. presence of sodium, chlorine, four electrons in the outer orbital, and the attachment of a functional group
C. presence of carbon, hydrogen, three electrons in the outer orbital, and the attachment of a functional group
D. presence of oxygen, hydrogen, four electrons in the outer orbital, and the attachment of a functional group
E. presence of carbon, hydrogen, four protons in the outer orbital, and the attachment of a functional group

Organic molecules will have carbon, hydrogen, four electrons in the outer orbital, and a functional group attached to it. Sodium, chloride, and oxygen are not necessary for organic molecules. Protons are not found in the outer orbitals.

Bloom's Level: 5. Evaluate
Learning Outcome: 02.04.01 Compare inorganic molecules to organic molecules.
Section: 02.04
Topic: Chemical Bonds