





different elements.

- b. Ionic bonds hold together compounds that do not dissolve in water, whereas covalent bonds hold together molecules that dissolve in water.
- c. Ionic bonds hold together oppositely charged atoms, whereas covalent bonds hold together atoms that share electrons.
- d. Ionic bonds consist of atoms with partial charges, whereas covalent bonds consist of atoms with full positive and negative charges.

ANS: C                      DIF: Medium                      REF: WorldofWater

OBJ: 2.2                      MSC: Remembering

15. When calcium ( $\text{Ca}^{++}$ ) and chloride ( $\text{Cl}^-$ ) interact with one another they bond using \_\_\_\_\_ bonds.

- a. hydrogen
- b. peptide
- c. covalent
- d. ionic

ANS: D                      DIF: Medium                      REF: WorldofWater

OBJ: 2.2                      MSC: Applying

16. Which of the following types of bonds hold hydrogen and oxygen atoms together within an individual water molecule?

- a. hydrogen bond
- b. peptide bond
- c. polar covalent bond
- d. ionic bond

ANS: C                      DIF: Medium                      REF: WorldofWater

OBJ: 2.2                      MSC: Remembering

17. Which of the following is likely to participate in ionic bonding?

- a.  $\text{Li}^+$
- b.  $\text{H}_2\text{O}$
- c. He
- d.  $\text{C}_6\text{H}_{12}\text{O}_6$

ANS: A                      DIF: Medium                      REF: WorldofWater

OBJ: 2.2                      MSC: Analyzing

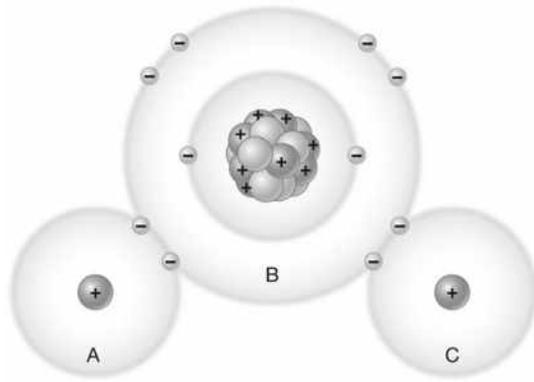
18. Which of the following is correct about hydrogen bonds?

- a. Individually, hydrogen bonds are very strong.
- b. They form between neighboring oxygen atoms.
- c. They do not involve binding with a hydrogen atom.
- d. They form due to partial positive and partial negative charges on atoms.

ANS: D                      DIF: Difficult                      REF: WorldofWater

OBJ: 2.2                      MSC: Remembering

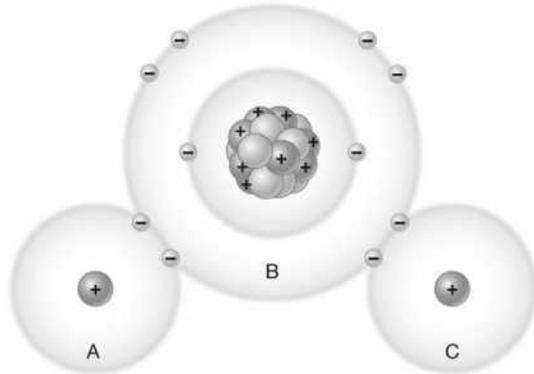
19. Based on the water molecule pictured below, which of the labeled areas possesses a partial negative charge?



- a. A only  
 b. B only  
 c. C only  
 d. A and C

ANS: B                      DIF: Medium              REF: WorldofWater  
 OBJ: 2.3                      MSC: Remembering

20. If iodide ions ( $I^-$ ) were dissolved in water, they would be attracted to



- a. A only  
 b. B only  
 c. C only  
 d. A and C

ANS: D                      DIF: Medium              REF: WorldofWater  
 OBJ: 2.3                      MSC: Understanding

21. Neighboring water molecules are held together with hydrogen bonds because

- partially negatively charged oxygen atoms and partially positively charged hydrogen atoms on separate water molecules are attracted to one another.
- the hydrogen and oxygen atoms within a single water molecule share electrons equally.
- the oxygen and hydrogen atoms that participate in hydrogen bonding are sharing electrons within a single valence shell.
- ionic interactions repel water molecules from hydrophobic oils that may be present in a solution.

ANS: A                      DIF: Difficult              REF: WorldofWater  
 OBJ: 2.3                      MSC: Evaluating

22. Which of the following explains why ice floats on water?

- The crystal structure of ice is more regular than that seen in liquid water.
- The distance between water molecules in ice is greater than in liquid water.
- The cool temperature of ice reduces the extent of molecular motion relative to liquid water.

- d. When ice forms, the hydrogen bond in the water molecule becomes nonpolar; ice behaves like oil.

ANS: B                      DIF: Difficult                      REF: WorldofWater  
OBJ: 2.3                      MSC: Understanding

23. When sodium chloride ( $\text{Na}^+\text{Cl}^-$ ) is dissolved in water, the sodium ion
- is attracted to the hydrogen atoms of water molecules.
  - is repelled by the oxygen atoms of water molecules.
  - is attracted to other sodium ions that are being dissolved.
  - is attracted to the oxygen atoms of water molecules.

ANS: D                      DIF: Medium                      REF: WorldofWater  
OBJ: 2.4                      MSC: Analyzing

24. Oil and water do not mix together well because
- water is polar and oil is nonpolar.
  - only identical molecules of the same chemical can easily mix together.
  - water has hydrogen bonds and oil is polar.
  - water and oil are covalently bonded together.

ANS: A                      DIF: Medium                      REF: WorldofWater  
OBJ: 2.4                      MSC: Applying

25. You are given an unknown substance and asked to determine whether it is polar or nonpolar. The easiest way to do this would be to
- determine whether the compound is held together by hydrogen bonds.
  - determine the number of electrons in the compound's outer shell.
  - mix the compound with an ionic substance to see whether its bonds can withstand the pressure.
  - determine whether the compound dissolves in water.

ANS: D                      DIF: Medium                      REF: WorldofWater  
OBJ: 2.4                      MSC: Understanding

26. In making your morning tea, you drop a sugar cube into the hot water. You stir the mixture but no longer see the sugar cube at the bottom of your mug. In this scenario, the sugar is
- nonpolar.
  - the solvent.
  - an acid.
  - a solute.

ANS: D                      DIF: Medium                      REF: WorldofWater  
OBJ: 2.4                      MSC: Applying

27. In making your morning tea, you drop a sugar cube into some hot water. You stir the mixture but no longer see the sugar cube at the bottom of your mug. Based on your observation of sugar dissolving in hot water, you properly conclude that the sugar is
- hydrophobic.
  - nonpolar.
  - hydrophilic.
  - inert.

ANS: C                      DIF: Medium                      REF: WorldofWater  
OBJ: 2.4                      MSC: Applying

28. A carwash attendant offers to treat your windshield with a protective agent. This substance coats the glass, causing beads of water to easily roll off during a rain shower. Which of the following must be correct about the protective agent?
- It resists temperature changes well.
  - It is a polar substance.



- b. leaves behind an  $\text{OH}^-$  ion.
- c. accepts hydrogen ions from the solution.
- d. donates hydrogen ions to the solution.

ANS: D                      DIF: Easy                      REF: GettingtheRightMix  
OBJ: 2.4                      MSC: Applying

36. A solution with a pH of 3 is
- a. acidic.
  - b. basic.
  - c. nonpolar.
  - d. neutral.

ANS: A                      DIF: Easy                      REF: GettingtheRightMix  
OBJ: 2.4                      MSC: Applying

37. Of the following values, which indicates the most basic pH?
- a. 5
  - b. 7
  - c. 8
  - d. 10

ANS: D                      DIF: Easy                      REF: GettingtheRightMix  
OBJ: 2.4                      MSC: Applying

38. Which of the following solutions has the highest concentration of free  $\text{H}^+$  ions?
- a. pH 1
  - b. pH 4
  - c. pH 7
  - d. pH 14

ANS: A                      DIF: Medium                      REF: GettingtheRightMix  
OBJ: 2.4                      MSC: Applying

39. After adding a small amount of Solution A to Solution B, the pH of Solution B declines from 8 to 3. Solution A must contain
- a. a salt.
  - b. a base.
  - c. water only.
  - d. an acid.

ANS: D                      DIF: Medium                      REF: GettingtheRightMix  
OBJ: 2.4                      MSC: Applying

40. When ammonia ( $\text{NH}_3$ ) is dissolved in a solution, it accepts hydrogen ions from its surroundings. Ammonia is therefore
- a. a base.
  - b. an isotope.
  - c. a salt.
  - d. an acid.

ANS: A                      DIF: Medium                      REF: GettingtheRightMix  
OBJ: 2.4                      MSC: Applying

41. Carbon atoms are bound to each other by
- a. ionic bonds.
  - b. polar bonds.
  - c. hydrogen bonds.
  - d. covalent bonds.

ANS: D                      DIF: Medium                      REF: LifesFirstSteps  
OBJ: 2.5                      MSC: Remembering

42. Which of the following factors explains carbon's prominence in living systems?
- a. Carbon forms weak reversible bonds.
  - b. Carbon bonds with up to three other atoms.
  - c. Carbon-based molecules can form long chains and rings.
  - d. Carbon does not form small molecules.

ANS: C                    DIF: Difficult            REF: LifesFirstSteps  
OBJ: 2.5                    MSC: Remembering

43. Which of the following statements is true of proteins, carbohydrates, and nucleic acids?
- All three are used to store genetic information.
  - None of these macromolecules mixes well with water.
  - Each of these molecules is built from a common set of monomers.
  - All of these molecules are primarily used as energy-storage molecules.

ANS: C                    DIF: Medium            REF: LifesFirstSteps  
OBJ: 2.6                    MSC: Remembering

44. In the laboratory you identify protein in a food item that you've tested. Which of the following must the food item also contain?
- glucose
  - lipids
  - amino acids
  - nucleotides

ANS: C                    DIF: Difficult            REF: LifesFirstSteps  
OBJ: 2.6                    MSC: Understanding

45. Macromolecules are typically formed by repetitively adding small monomers together. Which macromolecule is properly matched with the appropriate monomer?
- polypeptide—amino acid
  - nucleic acid—amino acid
  - polysaccharide—nucleotide
  - triglyceride—cholesterol

ANS: A                    DIF: Easy                REF: FiftyMoreYears  
OBJ: 2.6                    MSC: Applying

46. A disaccharide consists of two
- sugars.
  - hydrocarbons.
  - fatty acids.
  - amino acids.

ANS: A                    DIF: Easy                REF: FiftyMoreYears  
OBJ: 2.6                    MSC: Remembering

47. Nucleotides
- are the building blocks of proteins.
  - are involved in every chemical reaction in the cell.
  - form physical structures such as hair.
  - are the building blocks of nucleic acids.

ANS: D                    DIF: Easy                REF: FiftyMoreYears  
OBJ: 2.6                    MSC: Remembering

48. The genetic material found in all living things is made of building blocks called
- nucleotides.
  - monosaccharides.
  - phospholipids.
  - steroids.

ANS: A                    DIF: Medium            REF: FiftyMoreYears  
OBJ: 2.6                    MSC: Understanding

49. Which of the following are composed of the same monomers?
- proteins and DNA
  - RNA and cellulose
  - starch and cellulose
  - cholesterol and sucrose

ANS: C                    DIF: Medium            REF: FiftyMoreYears

OBJ: 2.6 MSC: Applying

50. Which of the following is the largest in size?
- a. glucose
  - b. protein
  - c. carbon atom
  - d. nucleotide

ANS: B DIF: Difficult REF: FiftyMoreYears  
OBJ: 2.6 MSC: Understanding

51. Which of the following could be built solely from glucose molecules?
- a. fatty acids
  - b. DNA
  - c. oils
  - d. starch

ANS: D DIF: Difficult REF: FiftyMoreYears  
OBJ: 2.6 MSC: Remembering

52. A scientist observed a chemical that changes to bright red in the presence of organic compounds containing nitrogen and phosphorus. To test this chemical, a set of test tubes each containing a purified sample of one of the following organic compounds is prepared. The chemical is then added to each tube. Which test tube will always turn bright red?
- a. the tube containing nucleic acids
  - b. the tube containing proteins
  - c. the tube containing carbohydrates
  - d. the tube containing phospholipids

ANS: A DIF: Difficult REF: FiftyMoreYears  
OBJ: 2.6 MSC: Applying

53. Your supervisor provides you with lipids, carbohydrates, proteins, and nucleic acids and asks you to determine their chemical components. Which of the following elements would you NOT expect to find in these items?
- a. phosphorus
  - b. iron
  - c. hydrogen
  - d. nitrogen

ANS: B DIF: Difficult REF: FiftyMoreYears  
OBJ: 2.6 MSC: Remembering

54. Which of the following most commonly represents the shape associated with functional proteins?
- a. a long linear chain of amino acids
  - b. individual amino acids that are not covalently joined together
  - c. coils and sheets of joined amino acids
  - d. three-dimensional folded chains of amino acids

ANS: D DIF: Difficult REF: FiftyMoreYears  
OBJ: 2.6 MSC: Remembering

55. One of the symptoms of kidney disease is the presence of proteins in a patient's urine. To quickly test for kidney disease using a urine sample, a doctor might add a chemical that causes a color change when
- a. nitrogen, but not oxygen, is present.
  - b. nitrogen, but not phosphorus, is present.
  - c. only oxygen and hydrogen are present.
  - d. only carbon and hydrogen are present.

ANS: B DIF: Difficult REF: FiftyMoreYears  
OBJ: 2.6 MSC: Applying

56. We use soap to clean ourselves better than we could with water alone. Soaps contain phospholipids that are responsible for the cleansing action. Which of the following statements is the most likely explanation for how soaps work?
- Phospholipids are ions and therefore mix with both the water and oily dirt.
  - Phospholipids are completely hydrophilic, and therefore oily dirt takes the place of the phospholipid molecules that would be dissolved in the rinse.
  - The phospholipid tail attaches to the oily dirt while the phospholipid head interacts with the rinse water and carries the dirt (and soap) away with it.
  - The nonpolar fatty acid chains that make up the heads of the phospholipid are hydrophilic, and thus are repelled by the water.

ANS: C                      DIF: Difficult                      REF: FiftyMoreYears  
OBJ: 2.6                      MSC: Applying

## COMPLETION

1. The positively charged subatomic particle is located in the \_\_\_\_\_.

ANS: nucleus

DIF: Easy                      REF: 2.intro                      OBJ: 2.1                      MSC: Remembering

2. An instrument that identifies chemicals based upon their weights is the \_\_\_\_\_.

ANS: mass spectrometer

DIF: Easy                      REF: OnePictureAThousandExperiments  
OBJ: 2.6                      MSC: Remembering

3. An atom that becomes charged due to the gain or loss of an electron is called a(n) \_\_\_\_\_.

ANS: ion

DIF: Easy                      REF: WorldofWater                      OBJ: 2.2  
MSC: Remembering

4. Molecules with an uneven distribution of charge are described as \_\_\_\_\_.

ANS: polar

DIF: Medium                      REF: WorldofWater                      OBJ: 2.3  
MSC: Remembering

5. \_\_\_\_\_ molecules are nonpolar molecules that are repelled by water.

ANS: Hydrophobic

DIF: Medium                      REF: WorldofWater                      OBJ: 2.4  
MSC: Remembering

6. The number that represents neutrality on the pH scale is \_\_\_\_\_.

ANS: 7

DIF: Easy                      REF: SmellofSuccess                      OBJ: 2.4  
MSC: Remembering

7. The element \_\_\_\_\_ makes up the chemical backbone of most molecules on planet Earth.

ANS: carbon

DIF: Easy                      REF: LifesFirstSteps                      OBJ: 2.5  
MSC: Remembering

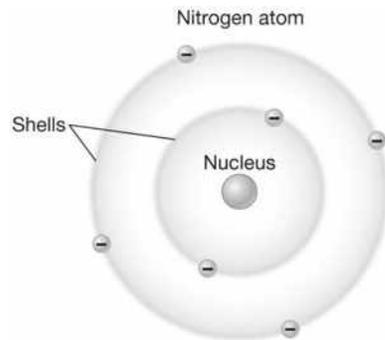
8. The class of macromolecules that do NOT form true polymers are the \_\_\_\_\_.

ANS: lipids

DIF: Easy                      REF: FiftyMoreYears                      OBJ: 2.6  
MSC: Remembering

### SHORT ANSWER

1. Nitrogen has an atomic number of 7 and an atomic mass number of 14. Using the image provided, diagram the location and number of protons, neutrons, and electrons in nitrogen.



ANS:

The atomic number tells us the number of protons, whereas the atomic mass is the sum of protons and neutrons. Therefore, nitrogen has 7 protons, 7 neutrons, and 7 electrons. In the diagram, students should demonstrate that there are 7 protons and 7 neutrons in the atomic nucleus. The 7 electrons should be drawn in the shells.

DIF: Easy                      REF: 2.intro                      OBJ: 2.1                      MSC: Understanding

2. Lithium, with an atomic number of 3, has a tendency to lose electrons when it chemically bonds to another atom. What type of chemical bonds does lithium usually form with other atoms? Explain how you determined your answer.

ANS:

When lithium loses electrons it becomes positively charged and participates in ionic bonding. Since lithium is positively charged it will interact with negatively charged atoms.

DIF: Medium                      REF: WorldofWater                      OBJ: 2.2  
MSC: Understanding

3. During a study session, a Biology classmate holds up a bottle of water and mentions that there are both hydrogen bonds and covalent bonds found within the liquid. Explain your classmate's statement by describing the types of bonds that are found within your bottle of water.

ANS:

Your classmate is correct in his or her assessment of the bonds in the water. Within a water molecule, the hydrogen and oxygen atoms are held together by covalent bonds. Hydrogen bonds attract neighboring water molecules due to partial positive and partial negative charges on the hydrogen and oxygen atoms, respectively.

DIF: Medium

REF: WorldofWater

OBJ: 2.3

MSC: Understanding

4. After giving a baby a bath, a new mom applies baby oil to her child's skin. How does the baby oil help the baby's skin to retain moisture throughout the day? Explain the chemical basis of water retention in this example.

ANS:

Because the oil is hydrophobic and the water is hydrophilic, the two substances do not mix well. Coating the baby's skin with baby oil surrounds the skin with a thin barrier that helps to prevent the loss of moisture since the two substances do not interact with each other. The two fail to mix because they do not share the same charged nature. Although water is electrically neutral, the oxygen and hydrogen ends of the molecule possess partial charges. The baby oil on the other hand is held together by nonpolar covalent bonds, so it has no partial charges.

DIF: Difficult

REF: WorldofWater

OBJ: 2.4

MSC: Understanding

5. There are four major classes of macromolecules that are found in living systems and each uses a carbon skeleton as its structural backbone. Why is carbon regularly assembled to make important biological molecules?

ANS:

All of the major biological molecules (macromolecules) of living systems are organic molecules. As such, these molecules are formed using a carbon skeleton. This element is a central player because its small size and need for four covalent bonds. Carbon readily participates in covalent bonding with other carbon atoms, forming single, double, and triple bonds. Carbon-carbon bonds may also branch or form rings. The carbon-carbon bond is also quite stable, which ensures the integrity of biological molecules in living systems.

DIF: Easy

REF: LifesFirstSteps

OBJ: 2.5

MSC: Remembering

6. For each of the major classes of macromolecules, indicate the basic subunits used to build it.

ANS:

Carbohydrates are composed of monomers called monosaccharides. When amino acids are joined together by peptide bonds they form proteins. Nucleic acids like DNA and RNA are built from nucleotide monomers. Lipids are not constructed in the same manner as the other three classes of macromolecules. This diverse class of macromolecules does not share a common monomer.

DIF: Easy

REF: LifesFirstSteps

OBJ: 2.6

MSC: Remembering

## MATCHING

Using the answer choices below (a through d), match the characteristic with its macromolecule class.

- a. lipids
- b. carbohydrates
- c. nucleic acids
- d. proteins

1. participate in nearly every chemical reaction in living systems
2. store and transmit genetic information
3. speed chemical reactions
4. act as short-term energetic molecules
5. form the major framework of biological membranes
6. exhibit various levels of structure
7. function energy storage and structural support
8. used to create steroid molecules like cholesterol

- |           |                  |                      |
|-----------|------------------|----------------------|
| 1. ANS: D | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 2. ANS: C | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 3. ANS: D | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 4. ANS: B | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 5. ANS: A | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 6. ANS: D | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 7. ANS: B | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |
| 8. ANS: A | DIF: Easy        | REF: LifesFirstSteps |
| OBJ: 2.6  | MSC: Remembering |                      |