2 Lesson Plan
The Chemistry of Life

TEACHING FOCUS

To fully understand the life processes, students must understand the basic principles of chemistry and how they apply to anatomy and physiology. This chapter provides information that will help students understand the basic biochemical processes involved in life processes at every level of organization.

Students will be exposed to the terms *atom, element, molecule*, and *compound,* along with the structure of the atom. Other topics include chemical bonding, organic and inorganic chemical compounds, the chemistry of water, and the concept of pH. The chapter concludes by focusing on the structure and function of organic molecules: carbohydrates, lipids, proteins, and nucleic acids.

MATERIALS AND RESOURCES

☐ textbook

LESSON CHECKLIST

Preparations for this lesson include:

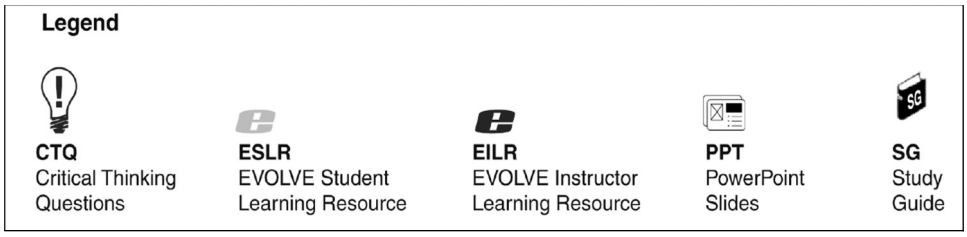
- Lecture
- Guest speakers: biochemist, medical assistant, dietitian
- Student performance evaluation of all entry-level skills required for student comprehension and application of the principles of basic chemistry including:
  - The chemical basis of the structure and function of human physiology.
  - The structure of basic compounds and the process by which they bond to form building blocks of the human physiology, including nucleic acids.
  - The fundamental components of the essential structures of the body.

KEY TERMS

acid (p. 28)
adenosine triphosphate (ATP) (p. 38)
amino acid (p. 34)
anabolism (p. 26)
atom (p. 22)
atomic number (p. 23)
atomic weight (p. 23)
base (p. 28)
buffer (p. 29)
carbohydrate (p. 30)
catabolism (p. 26)
chemical bond (p. 24)
chemical reaction (p. 26)
compound (p. 22)
covalent bond (p. 24)
decomposition reaction (p. 26)
deoxyribonucleic acid (DNA) (p. 37)
disaccharide (p. 30)
electrolyte (p. 28)
electron (p. 22)
element (p. 21)
energy level (p. 23)
enzyme (p. 35)
exchange reaction (p. 26)
fat (p. 32)
functional group (p. 27)
functional protein (p. 35)
high-energy bond (p. 38)
hydrogen bond (p. 25)
inorganic (p. 27)
ion (p. 24)
ionic bond (p. 24)
isotope (p. 23)
lipid (p. 31)
matter (p. 21)
metabolism (p. 26)
molecule (p. 26)
monosaccharide (p. 30)
neutron (p. 22)
nucleotide (p. 37)
nucleus (p. 22)
octet rule (p. 23)
organic (p. 27)
peptide bond (p. 35)
pH (p. 29)
phospholipid (p. 32)
polar (p. 25)
polysaccharide (p. 30)
primary structure (p. 36)
prostaglandin (p. 34)
protein (p. 34)
proton (p. 22)
quaternary structure (p. 36)
reversible reaction (p. 26)
ribonucleic acid (RNA) (p. 37)
secondary structure (p. 36)
solvent (p. 27)
steroid (p. 33)
structural protein (p. 34)
synthesis reaction (p. 26)
tertiary structure (p. 36)
triglyceride (p. 32)
valence electron (p. 23)

ADDITIONAL RESOURCES

PowerPoint slides (DVD, Evolve)
Study Guide
A&P Online – Asset Library – Animations



Class Activities are indicated in ***bold italic***.

LESSON 2.1

PRETEST

1. All matter is composed of:
   a. mass.
   b. peptides.
   c. atoms.
   d. cells.

2. What determines the atomic number?
   a. number of electrons
   b. number of protons
   c. number of protons and electrons
   d. number of protons and neutrons

3. Which of the following is formed when atoms share electrons?
   a. covalent bond
   b. hydrogen bond
   c. ionic bond
   d. hydrolysis

4. Which of the following is an example of an inorganic compound?
   a. lipid
   b. salt
   c. carbohydrate
   d. nucleic acid

5. A chemical capable of neutralizing an acid or a base is called a(n):
   a. indicator.
   b. buffer.
   c. catalyst.
   d. neutralizer.

6. Which of the following is a monosaccharide or simple sugar?
   a. glucose
   b. glycogen
   c. starch
   d. amino acid

7. Which essential nutrients are converted into proteins in the body?
   a. nucleic acids
   b. amino acids
   c. monosaccharides
   d. fatty acids

8. Lipids are hydrophobic. This means that they are:
   a. insoluble in water.
   b. polar.
   c. soluble in water.
   d. insoluble in alcohol.

9. Which of the following function as a catalyst in chemical reactions?
   a. steroids
   b. prostaglandins
   c. nucleotides
   d. enzymes

10. The molecule that contains high-energy bonds and is considered the fundamental immediate energy-storage molecule of all cells is:
    a. DNA.
    b. RNA.
    c. ADP.
    d. ATP.

Answers

1. c	3. a	5. b	7. b	9. d
2. b	4. b	6. a	8. a	10. d

BACKGROUND ASSESSMENT

Question: What are the four major organic macromolecules?
Answer: Carbohydrates, protein, lipids, and nucleic acids.
Question: Identify the different properties of water.
Answer: The properties of water are strong polarity, high “specific heat” (water absorbs and releases heat very slowly), high heat of vaporization, and cohesion.

CRITICAL THINKING QUESTION

What are the three parts of the body that are not composed of atoms?
Guidelines: Everything is made of atoms.

OBJECTIVES	CONTENT	TEACHING RESOURCES
1. Describe protons, electrons, and neutrons according to their charge, mass, and relative location in the atom.	■ Basic Chemistry (p. 21) □ Atoms and Their Characteristics (p. 22)	PPT: 5, 6 SG questions: 10-12, 20, 27, 34 (pp. 14-15) EILR TB: T/F: 2, 3; MC: 2, 43, 44, 52; MATCH: 1, 2, 4-6, 8; S/A: 1 **Book Resources** Figure: 2-3 (p. 23) Quick Check questions: 1-2 (p. 23) Chapter Summary: Basic Chemistry (p. 40) Review Question: 2 (p. 42)
2. Discuss the importance of the octet rule concerning the stability and reactivity of an atom.	■ Basic Chemistry (p. 21) □ Chemical Interactions (p. 23)	PPT: 10 SG questions: 21-23 (p. 14) EILR TB: T/F: 6, 69; MC: 44, 45, 66; S/A: 6 **Book Resources** Figure: 2-5 (p. 24) Quick Check question: 4 (p. 26) Chapter Summary: Basic Chemistry (p. 40) CTQ 1 (p. 42)
3. Distinguish among atomic weight, atomic number, and mass number.	■ Basic Chemistry (p. 21) □ Atoms and Their Characteristics (p. 22)	PPT: 7-9 SG questions: 10, 11 (p. 14) EILR TB: T/F: 2, 38, 39, 55, 56; MC: 3, 53, 65; S/A: 4 **Book Resources** Figure: 2-1 (p. 22) Quick Check question: 3 (p. 23) Chapter Summary: Basic Chemistry (p. 40) Review Question: 3 (p. 42)
4. Compare and contrast these terms: *elements, atoms, isotopes, molecules*, and *electrolytes*.	■ Basic Chemistry (p. 21) □ Atoms and Their Characteristics (p. 22) – Elements and Compounds (p. 21)	PPT: 5-7 SG questions: 9, 14, 16, 17, 44 (pp. 14, 16) EILR TB: T/F: 8, 53, 64, 66-68; MC: 9-12, 26, 28, 42, 51, 55, 57 **Book Resources** Figure: 2-4 (p. 23) Quick Check questions: 4, 9 (p. 26) Chapter Summary: Basic Chemistry (p. 40) Review Questions: 1, 4, 9 (p. 42) ***Class Activity*** ***Make certain that students understand the difference among atoms, compounds, and molecules before proceeding. Ask students to break into groups of two or three and write definitions of each of these terms and explanations of how they differ.*** ***Class Activity*** ***As you discuss atoms, use***

OBJECTIVES	CONTENT	TEACHING RESOURCES
		structures that the students can visualize, such as Figures 2-9 to 2-11. Diagram a hydrogen atom, showing the nucleus of the atom and the electron. Then diagram an oxygen atom. Next, diagram two hydrogen atoms and one oxygen atom, and show how the pair of electrons is shared. This allows students to visualize how the atoms are shaped and the concept of electron sharing. Since hydrogen and oxygen share electrons unequally, you can demonstrate the hydrogen bond by drawing another water molecule.
5. Compare ionic bonds with covalent bonds.	■ Basic Chemistry (p. 21) □ Chemical Bonds (p. 24)	PPT: 11-13 SG questions: 6, 7, 19, 25, 35, 41 (pp. 14-16) EILR TB: T/F: 4, 12, 32; MC: 13, 46, 47, 54, 80; MATCH: 3, 9; S/A: 2 **Book Resources** Figures: 2-6, 2-7 (pp. 24-25) Quick Check question: 6 (p. 26) Chapter Summary: Basic Chemistry (p. 40) CTQ 2 (p. 42)
6. Describe and discuss the significance of hydrogen bonds to macro-molecules.	■ Basic Chemistry (p. 21) □ Polar Molecules and Hydrogen Bonds (p. 25)	PPT: 14-16 SG questions: 8, 24, 35, (pp. 14-15) EILR TB: T/F: 9, 70; MC: 71; MATCH: 7 **Book Resources** Figure: 2-9 (p. 25) Quick Check question: 7 (p. 26) Chapter Summary: Basic Chemistry (p. 40)

2.1 Homework/Assignments:

2.1 Instructor's Notes/Student Feedback:

LESSON 2.2

CRITICAL THINKING QUESTION

Explain why water is a polar molecule. What do the polarity and shape of water molecules have to do with their ability to form hydrogen bonds?

Guidelines: When electrons are not shared equally, the covalent bond is a polar covalent bond. In water, the oxygen atom is more negative than the hydrogen atoms and the bond is polar. A hydrogen bond is the attraction of a slightly positive hydrogen atom to a negative atom in the vicinity. The shape of a water molecule and its polarity makes hydrogen bonding possible. Water molecules will attract one another

because of their polarity. These interactions are due to the negative side of one molecule (oxygen) being attracted to the positive side (hydrogen) of the other.

OBJECTIVES	CONTENT	TEACHING RESOURCES
7. Identify the properties of water that make it physio-logically important.	■ Inorganic and Organic Compounds (p. 27) □ Inorganic Molecules (p. 27) – Water (p. 27)	PPT: 22 SG question: 43 (p. 16) EILR TB: T/F: 12, 15; MC: 20, 23, 39, 71; S/A: 7 **Book Resources** Figure: 2-8 (p. 25) Chapter Summary: Inorganic and Organic Compounds (p. 41) Review Question: 8 (p. 42) *Class Activity* ***Have students take a penny and, using a small dropper, have them add drops of water to the penny. Ask the students to count the drops and stop when a "dome" of water forms on the penny. This exercise demonstrates cohesion (water forming a dome) and adhesion to a polar surface (water staying on the penny). Adding oil to the surface of the penny would demonstrate how polar and nonpolar molecules react. Water (polar) would not adhere to the oily (nonpolar) surface of the penny.***
8. Distinguish between solvents and solutes.	■ Inorganic and Organic Compounds (p. 27) □ Inorganic Molecules (p. 27) – Water (p. 27)	SG questions: 36, 42, 43 (p. 16) EILR TB: MC: 15 **Book Resources** Figure: 2-12 (p. 27) Quick Check question: 13 (p. 30) Chapter Summary: Inorganic and Organic Compounds (p. 41) *Class Activity* ***To demonstrate the relationship between a solute and a solvent, take a crystal of dye and place it in a small beaker of water. After several minutes, students will observe the dissolving of the solute (dye) and the distribution of it throughout the beaker.***
9. Define pH, acid, base, and buffers, and give their physiological significance.	■ Inorganic and Organic Compounds (p. 27) □ Inorganic Molecules (p. 27) – Acids and Bases (p. 28) – pH Scale (p. 29) – Buffers (p. 30)	PPT: 23-27 SG questions 37-40 (p. 16) EILR TB: T/F: 13, 14, 19, 20, 34, 35, 44, 59, 74, 75; MC: 16-19, 24, 58, 62, 63, 72, 79; MATCH: 12, 14; S/A: 8 **Book Resources** Figure: 2-13 (p. 29) Quick Check questions: 15-17 (p. 30) Chapter Summary: Inorganic and Organic Compounds (p. 41)

OBJECTIVES	CONTENT	TEACHING RESOURCES
		Review Questions: 11, 12 (p. 42) *Class Activity* ***Hair products frequently advertise their effects on pH. Use similar examples to help students grasp the definition of pH as it affects body acids, bases, and salts.***

2.2 Homework/Assignments:

2.2 Instructor's Notes/Student Feedback:

LESSON 2.3

CRITICAL THINKING QUESTION

Explain the difference between a saturated and an unsaturated fatty acid.
Guidelines: A *saturated* fatty acid is one that has all of its available carbon bonds taken up by hydrogen atoms. For this reason, we say all bonds are saturated in this type of fatty acid. An *unsaturated* fatty acid has one or more *double bonds* in the chain and therefore does not have a carbon chain that is saturated with hydrogen atoms.

OBJECTIVES	CONTENT	TEACHING RESOURCES
10. Outline the differences between inorganic and organic molecules.	■ Inorganic and Organic Compounds (p. 27)	PPT: 20 SG questions: 41, 45-54, 57-59 (pp. 16-17) EILR TB: T/F: 17, 58; MC: 17, 25, 29-35, 68 **Book Resources** Chapter Summary: Inorganic and Organic Compounds (p. 41) Review Question: 7 (p. 42) *Class Activity* ***After completing the presentation of this topic, have students construct a table listing various inorganic and organic molecules.***
11. Give examples of dehydration synthesis and hydrolysis in biochemical reactions.	■ Basic Chemistry (p. 21) □ Metabolism (p. 26)	PPT: 17, 18 SG questions: 1, 3, 28-32 (pp. 13, 15) EILR TB: T/F: 5, 33, 42, 76; MC: 14, 15, 2721, 22, 37, 38, 48, 56, 67; MATCH: 10; S/A: 5 **Book Resources** Figures: 2-10, 2-15 (pp. 26, 31) Quick Check questions: 8, 10, 11 (p. 26)

OBJECTIVES	CONTENT	TEACHING RESOURCES
		Chapter Summary: Inorganic and Organic Compounds (p. 41) Review Question: 22 (p. 42)
12. Identify the monomers and polymers of carbohydrates, proteins, lipids, and nucleic acids.	■ Inorganic and Organic Compounds (p. 27) □ Organic Molecules (p. 30) – Carbohydrates (p. 30) – Lipids (p. 32) – Proteins (p. 34) – Nucleic Acids and Related Molecules (p. 37)	PPT: 27-45 SG question: 57 (p. 17) EILR TB: T/F: 22-26, 28, 29, 36, 37, 45-52, 60-62, 73-84; MC: 40, 49, 50, 60, 61, 64, 69, 73-77; MATCH: 11, 13, 15-17, 19; S/A: 3, 9-11, 14; OTHER: 1 **Book Resources** Figures: 2-14, 2-16, 2-21, 2-24 (pp. 30, 32, 35, 37) Quick Check questions: 18-23 (pp. 34, 38) Chapter Summary: Inorganic and Organic Compounds (p. 41) Review Questions: 13-16 (p. 42) CTQ 3 (p. 42) ***Class Activity** As you discuss each macromolecule, relate it to the labels on food packaging. Ask the students to read these labels. Explain that each of these foods is a unique arrangement of atoms, held in place mainly by covalent bonds.* ***Class Activity** To demonstrate the presence of macromolecules in different foods, simple reagent tests (iodine, biuret solution, and Benedict solution) can indicate to the students what nutrients are present in the foods they eat.* ***Class Activity** Place round beads or other beads on a string to demonstrate how small molecules such as monosaccharides or amino acids are hooked together to form a primary structure. This same chain of beads can be used to demonstrate secondary and tertiary protein structure. Using two bead chains, you can demonstrate quaternary structure. Arrange the beads in the desired shape, then have the students pretend that the chain is frozen in this shape.*
13. Distinguish DNA from RNA.	■ Inorganic and Organic Compounds (p. 27) □ Organic Molecules (p. 30) – Nucleic Acids and Related Molecules (p. 37)	PPT: 43-48 SG questions: 55, 56 (p. 17) EILR TB: MC: 36, 41, 70, 78; MATCH: 18, 20; S/A: 12, 13 **Book Resources** Quick Check questions: 24, 25 (p. 38) Review Questions: 17-20 (p. 42) CTQ 4 (p. 42)

OBJECTIVES	CONTENT	TEACHING RESOURCES
		Class Activity ***Using either purchased models or hand-made models, have students construct DNA and RNA strands. These models can be of various lengths and must consist of the phosphate group, sugar, and all four nitrogen bases. This could be a group project. After completion, have students explain the differences in their DNA and RNA models.***
Performance Evaluation		SG questions: 1-59 (pp. 13-17) EILR TB Test Bank questions **Book Resources** Figures: 2-1 – 2-26 (pp. 22-38) Quick Check questions: 1-25 (pp. 23, 2, 30, 34, 38) Review Questions: 1-22 (p. 42) CTQ 1-4 (p. 42)

2.3 Homework/Assignments:

2.3 Instructor's Notes/Student Feedback:

ANSWERS TO CHAPTER 2 TEXTBOOK QUESTIONS

INTRODUCTORY STORY QUESTIONS

1. C – Your stomach contents are acidic. When you vomit, you are losing that acid content to the outside. Your overall body fluid is usually well balanced between acids and bases (your blood is just on the basic side at a pH of about 7.36 to 7.41). A decrease in acid content body-wide (as with prolonged vomiting) could possibly lead to alkalosis, or the body chemistry being too basic. Many reactions cannot occur when the pH is unbalanced; that is, the body cannot function properly, regardless of whether the imbalance is too acidic or too basic.
2. D – The concentration of hydrogen ions is reflected in the pH measure. More hydrogen ions translate to more acidic—a **lower** number on the pH scale. Fewer hydrogen ions translate to more basic and a **higher** number on the pH scale. A pH of 7.0 is neutral.
3. A – Remember your body is not simply a bag of water; it is a vessel containing specifically calibrated fluids in a number of different compartments. If you lose electrolytes (e.g., sodium, potassium, chloride) through vomiting, sweating, or any other means, you need to replace them in appropriate amounts.
4. B – Carbohydrates are the body's primary source of energy. Simple sugars (monosaccharides) can be absorbed and used immediately by the body. Even polysaccharides can be easily broken apart. Proteins, on the other hand, require the body to expend much more energy to unwind and break down their component amino acids, which only then can be absorbed by the body. The same is true of lipids.

REVIEW QUESTIONS

1. *Element:* A substance that cannot be broken down into two or more different substances.
   Compound: A substance that can be broken down or decomposed into the elements within it.
   Atom: The smallest particle of an element that retains the properties of that element.
2. *Protons:* Positively charged particles found in the nucleus.
   Neutrons: Neutral particles found in the nucleus.
   Electrons: Negatively charged particles that move around the nucleus in a cloud or field.

3. *Atomic number:* The number of protons in an atom's nucleus.
   Atomic weight: The mass of the atom, which equals the number of protons plus the number of neutrons in the nucleus.
4. An *isotope* is an atom that contains the same number of protons as other atoms of the same element, but a different number of neutrons. The text includes examples of deuterium, tritium, and carbon-14.
5. A *chemical reaction* is an interaction between two or more atoms as a result of activity of electrons in their outermost shell.
6. In a *synthesis reaction*, two or more substances are combined to form a different, more complex substance. In a *decomposition reaction*, a complex substance is broken down into two or more simpler substances. In an *exchange reaction*, two different reactants exchange components and form two new products.
7. An *inorganic compound* is a compound that usually does not contain carbon, but never contains C-C or C-H bonds.
8. Water is said to be polar because the molecule has a partial positive side and a partial negative side. The four functions of water that are crucial to human survival are its strong polarity, its high specific heat, its high heat of vaporization, and the cohesion of the molecules.
9. *Electrolytes* are inorganic, charged particles that form when substances dissociate. An example would be NaCl dissociating into Na^+ and Cl^-. Any ionic compound that is water-soluble would be an example.
10. An *ion* is a charged atom or molecule. (Any charged particle can be used as an example.) A *cation* is a positive ion. (Any positive ion can be used as an example.) An *anion* is a negative ion. (Any anion can be used as an example.)
11. *Acid:* A substance that will release a hydrogen ion when in solution.
    Base: A substance that shifts the H^+/OH^- balance in favor of OH^- by increasing the number of OH^- ions or decreasing the number of H^+ ions.
    Salt: A substance that results from a reaction between an acid and a base.
    Buffer: A substance that minimizes changes in the concentration of the H^+ and OH^-.
12. A pH of less than 7.0 indicates the solution is an acid. The lower the value, the greater the hydrogen ion concentration. A pH of more than 7.0 indicates the solution is a base. The higher the value, the greater the concentration of the hydroxide ion. Each change of 1 unit on the pH scale represents a tenfold difference in the ion concentration.
13. The building blocks of proteins are amino acids. The building blocks of carbohydrates are monosaccharides. The building blocks of triglycerides are fatty acids and glycerol. The building blocks of DNA are nucleotides.
14. Proteins can perform some of the following functions: provide structure, catalyze chemical reactions (enzymes), transport substances in the blood (albumins), communicate information to cells (hormones), act as receptors (membrane binding sites), defend the body against harmful agents (immunoglobulins), and provide energy (protein catabolism).
15. Lipids are insoluble in water, contain nitrogen, and include prostaglandins and phospholipids.
16. Nucleotides are composed of a phosphate group; a pentose, or five-carbon, sugar; and a nitrogen base.
17. The pentose sugar deoxyribose is present in deoxyribonucleotide.
18. The DNA molecule is the largest molecule in the body. It is a polymer composed of many nucleotides. Two chains of nucleotides make up a single DNA molecule. The chains coil around each other to form a double helix.
19. Thymine is always paired with adenine, and guanine is always paired with cytosine in the DNA molecule.
20. The function of DNA is to act as the molecule of heredity—to pass the traits of one generation on to the next generation.
21. *Catabolism* consists of chemical reactions that break down relatively complex compounds into simpler ones. The function of catabolism is to release energy.
22. Catabolism breaks down large molecules that release energy. Anabolism builds large molecules from smaller molecules and requires energy. Metabolism encompasses all the reactions in the body—that is, the sum of anabolism and catabolism.

Critical Thinking Questions

1. Helium has two electrons in its outer shell. Hydrogen has only one electron in its outer shell. Since helium's outer shell is filled, helium is nonreactive. Hydrogen, however, has an incomplete outer shell and is very reactive.
2. In a single covalent bond, two electrons (one pair) are shared between two atoms. In a double covalent

bond, four electrons (two pairs) are shared between two atoms. In an ionic bond, electrons are transferred from one atom to another, and the bond is formed by the attraction of opposite electrical charges.

3. Amino acids are like letters of the alphabet. Just as the combinations of individual letters form words, different amino acid combinations form the many different protein chains.
4. ATP supplies the cells with energy by breaking the high-energy bonds between the second and third phosphates and releasing the energy from that bond. The outline should contain a representation of the ATP-ADP cycle.

ADDITIONAL PRACTICAL/CREATIVE LEARNING ACTIVITIES

Begin this unit by referring to the Evolve website for additional resource materials.

- Most students find chemistry difficult to understand because they cannot see—and have not seen—atoms and molecules. Therefore it is helpful to use models of molecules and atoms. It is equally important, however, to keep these models simple. Using models, have the students build molecules, or do this yourself as a demonstration for the class. Remember that some students learn best by touching and doing.
- Have the students create a list of the most abundant elements found in the body. Encourage them to include their corresponding symbols and the number of electrons in the outer shell of each element.
- As mentioned in this chapter, simple sugars (glucose) are a primary source of quick energy for the body. However, large amounts of simple sugars taken in the diet at one time can elevate blood sugar. This can create immediate problems for the body. Therefore, students should understand that they need to be very careful about the glucose content of the foods they eat. An activity that provides a simple way to look for glucose in various foods and beverages uses glucose test strips for urine sugar testing. Using spot wells, prepare various solutions (potato, grape, soda, meat, etc.). Have the students test each prepared solution using the glucose test strips. They can then compare any changes to the test strip with the color chart on the test-strip container. Follow up this activity with discussion questions: How much glucose is available in each substance? What were your expectations about the glucose content of each food? How would you use the information you obtained to help people make proper dietary choices?

DIFFICULT CONCEPTS

Bonding

Electrochemical attractions between ions and polar molecules are analogous to attractions between magnets of different forces. You might want to bring a box of magnets to show how ions stick together (in the absence of water). The same demonstration can be used to illustrate the cohesion of water (hydrogen bonds). Later, you can add nonmagnetic marbles to the box to show that when you shake the box, the magnets seem to seek one another out and stick together as a mass, separating themselves from the marbles. This is analogous to polar water molecules separating themselves from nonpolar lipid molecules.

Students must also understand the three types of bonds. There are various ways to explain these. One method is to use analogies. *Ionic bonds* are similar to two children playing when one child takes the other child's toy. Now the child who has the toy is the positive charge. The other child (negative charge) wants the toy and stays close to the child with the toy. They are bonded together. *Covalent bonds* are analogous to two children playing catch with two balls. Each child contributes to the game. They share the balls equally and are attracted to each other so that they can play. *Hydrogen bonds* are weak attractions caused by polar molecules being held close together. This relationship is similar to that of two friends, Joe and Jean, who buy a boat together. Jean ends up using the boat most of the time, whereas Joe ends up hiking most of the time instead. This is unequal sharing of the boat. Joe attracts friends who like to go hiking with him. Jean attracts friends who like to go boating with her. This unequal sharing between Jean and Joe results in a weak attractive force for friends who like to go hiking or boating, but do not have the strong bond of ownership. These weak bonds between Jean and her friends and Joe and his friends are like hydrogen bonds. The strong bond between Joe and Jean (boat ownership) is a covalent bond (with unequal sharing).

Protein Structure

To demonstrate the levels of complexity of protein folding, you can use a roll of plain cellophane tape. A quick pull on the roll, spreading the arms widely, will yield a rather unwieldy piece of tape with a static charge. This is analogous to the primary protein structure. It does not take much for the charged areas to attract one another to form folds—the secondary structure. A little more manipulation and one has a ball of tape—the tertiary structure. Once the various areas of tape touch, some "adhesive bonds" (analogous to disulfide bonds) stabilize the overall structure. Two or more balls of tape stuck together are analogous to the quaternary structure; you can use the four chains of hemoglobin as an example. Of course, proteins differ in

that for a particular sequence of amino acids, they always fold exactly the same way (unlike the chaotic folding of similar pieces of cellophane tape).

CLINICAL APPLICATIONS

The pH Unit

You may want to use pH paper strips to assay familiar compounds, such as foods, cosmetics, and soil, to help students see the concept of pH ranges in more concrete terms. See Lesson 2.2 for strategies in presenting this concept.

Aspirin and Prostaglandins

Explain the mechanism of action and the effects of prostaglandins in relation to how aspirin relieves inflammation.

Prostaglandins in Therapy

Obtain the label or package insert from a prostaglandin used to treat blood pressure. Use this material to discuss therapeutic uses and possible side effects of prostaglandins.

Heat of Vaporization

An analysis of water's high heat of vaporization can be clearly presented by discussing perspiration as a clinical response to exertion. Demonstrate the high heat of vaporization by wetting one hand and leaving the other hand dry. Hold both hands in front of a fan; the wet hand cools faster because of the heat energy needed to convert liquid water to water vapor.

Electrolytes

Discuss the administration of electrolytes to patients suffering from malabsorption or diarrhea.

Bottled or Tap? (Box 2-1)

This box exposes the myth that bottled water may be better than tap water. Have students discuss the advantages or disadvantages of drinking bottled water or tap water.

Blood Lipoproteins (Box 2-2)

Summarize this box, which provides an introduction to high-density lipoprotein and low-density lipoprotein – the "good" and the "bad" cholesterols – and their relationship to atherosclerosis.

Visualizing Proteins (Box 2-3)

This box describes a sophisticated computer modeling program that "builds" protein molecules.

Radioactivity (*A&P Connect*)

Use your discussion of radioisotopes to highlight the use (and risks) of radiation therapy in cancer patients.

Disulfide Linkages (*A&P Connect*)

To learn more about disulfide linkages and how they are important to your hair, check out *Disulfide Linkages* online at *A&P Connect.*