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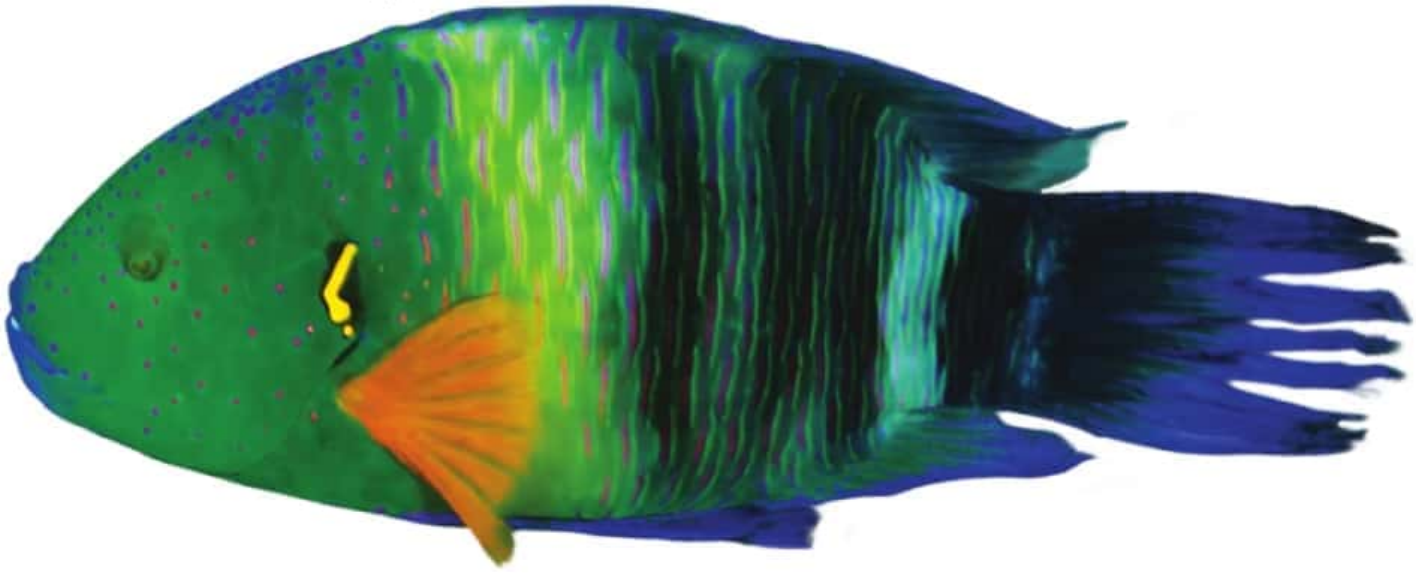


Mc Graw Hill Education

CHAPTER 7

Classifying and Exploring Life

The BIG Idea

Page Keeley SCIENCE PROBES

CHAPTER 8

Cell Structure and Function

The BIG Idea

Page Keeley SCIENCE PROBES

CHAPTER 9

Our Planet—Earth

The BIG Idea

Page Keeley SCIENCE PROBES

CHAPTER 10

Earth in Space

The BIG Idea

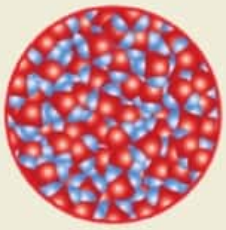
Page Keeley SCIENCE PROBES

Science Content Background

Lesson 1

Substances and Mixtures

Matter: Substances and Mixtures Scientists often put materials into categories in order to understand how they are similar to each other and different from other materials. Elements and compounds are two examples of substances. A substance has a fixed composition, which means it is always made of the same things that combine in the same way. This differs from a mixture, which contains two or more substances that have not bonded together. A mixture has a variable composition, which means the substances used to make it don't always combine in the same way. There are two types of mixtures—homogeneous mixtures are evenly mixed and heterogeneous mixtures are not.



How do compounds and mixtures differ? Mixing is a physical change, not a chemical change. The substances that make up a mixture do not chemically bond together. As a result, they retain their properties in the mixture and can be separated from each other using physical methods. In contrast, a chemical change occurs when elements bond together to form compounds. The properties of the elements are not observable in the compound and the compound cannot be separated into elements using physical methods.

Lesson 2

Properties of Solutions

Parts of Solutions A homogeneous mixture is also known as a solution. Solutions have two different types of parts—the solvent and the solute(s). A solvent is the substance that exists in the greatest quantity in a solution. All the other substances in a solution are called solutes.

Types of Solutions Students often think that solutions are always liquids. However, solutions can exist in all three states of matter. They can be solids, liquids, or gases. The state of the solvent determines the state of the solution.

Water as a Solvent In nature, water almost always exists as an aqueous solution. Water often acts as a solvent. The reason many solutes dissolve in water has to do with the fact that water is made of polar molecules. Each water molecule has a positive end and a negative end.

Like Dissolves Like Water dissolves many substances, but it can't dissolve everything. Polar compounds, such as rubbing alcohol, easily dissolve in water. This is because "like dissolves like." When rubbing alcohol and water mix, the positive ends of the water molecules attract the negative ends of the alcohol molecules. Also the negative ends of water molecules attract the positive ends of alcohol molecules. Ionic compounds, such as table salt, which have alternating negative and positive ions, also mix with water in a similar way. However, nonpolar molecules, such as vegetable oil, do not dissolve in water.

Concentration—How much is dissolved? Concentration is the amount of a particular solute in a solution—the greater the amount of solute, the higher the concentration. When a solution is composed of a solid solute and a liquid solvent, concentration is the mass of solute in a given volume of solution. Any unit of mass or volume can be used to express the concentration. When a solution contains only liquids or gases, concentration is the volume of solute in a given volume of solution. In this case, the units of volumes must match and the concentration can be expressed as a percentage.

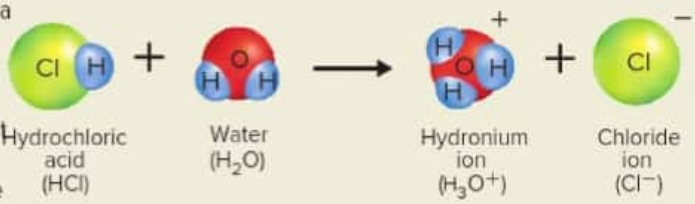
Solubility—How much can dissolve? Solubility is the maximum amount of solute that can dissolve in a given amount of solvent at a given temperature and pressure. The higher the solubility, the more of the solute can dissolve. A saturated solution contains the maximum possible amount of solute that can be dissolved. An unsaturated solution is able to dissolve even more of a solute. Changing temperature or pressure can affect the solubility of a substance. Many solid solutes become more soluble when the temperature increases. Conversely, many gas solutes become less soluble at higher temperatures, but more soluble under pressure. However, pressure does not affect the solubility of a solid solute in a liquid solution.

How Fast a Solute Dissolves When the particles of a solvent and a solute come into contact with each other more frequently, the solute dissolves faster. There are different ways to increase the speed of dissolving, including stirring the solution, crushing the solute, and increasing the temperature of the solution. However, the only way to change the solubility of a solute is to change the temperature or pressure. Stirring or crushing has no effect on solubility.

Lesson 3

Acid and Base Solutions

What are acids and bases? An acid is a substance that produces a hydronium ion when it dissolves in water. A base is a substance that produces a hydroxide ion in water. Acids and bases are found in many everyday items, including the foods we eat.



Hydrochloric acid (HCl) | Water (H_2O) | Hydronium ion (H_3O^+) | Chloride ion (Cl^-)

What is pH? pH is an inverse measurement of hydronium ions in a solution. As the concentration of hydronium ions increases, the pH decreases. Acids have a pH below 7 on the pH scale (because they have a higher concentration of hydronium ions) and bases have a pH above 7 on the pH scale (because they have a lower concentration of hydronium ions). Solutions that are neutral measure exactly 7 on the pH scale. When the pH decreases by 1, for example, the acidity increases 10 times.

How is pH measured? Test kits used to measure pH include chemicals called indicators that cause a change in color when an acid or a base is added. To perform the test, place a drop or two of the indicator into the solution and watch it change color. Different indicators will change the solution into different colors, depending on the pH value of the solution tested. You can also perform a similar test using pH strips. Simply dip the testing strip into the solution and watch as the strip changes color. The pH testing strips will have a color correlation chart to give the approximate pH value. The most accurate way to measure pH is to use a pH meter, which is an electronic device that is sensitive to the hydronium ion concentration in a solution.

Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

* A lot of different material can be made from the same basic materials.

* All materials have certain physical properties, such as strength, hardness, flexibility, durability, resistance to water and fire, and ease of conducting heat.

* Atoms may stick together in well-defined molecules or may be packed together in large arrays. Different arrangements of atoms into groups compose all substances.

* When a new material is made by combining two or more materials, it has properties that are different from the original materials.

* The temperature and acidity of a solution influence reaction rates. Many substances dissolve in water, which may greatly facilitate reactions between them.

* Substances can be identified by properties such as density, boiling point and solubility.

Lesson 1 Properties of Solutions

1 Substances have a fixed composition. The composition of mixtures can vary.

2 Solutions and heterogeneous mixtures are both types of mixtures. Solutions are mixed at the atomic level.

3 Mixtures contain parts that are not bonded together. These parts can be separated using physical means, and their properties can be seen in the solution.

Lesson 2 Acid and Base Solutions

4 Substances dissolve other substances that have a similar polarity. In other words, like dissolves like.

5 Concentration is the amount of substance that is dissolved. Solubility is the maximum amount that can dissolve.

6 Both temperature and pressure affect the solubility of solutes in solutions.

7 Acids contain hydrogen ions that are released and form hydronium ions in water. Bases are substances that form hydroxide ions when dissolved in water.

8 Hydronium ion concentration changes inversely with pH. This means that as hydronium ion concentration increases, the pH decreases.

9 pH can be measured using indicators or digital pH meters.

Identifying Mixtures

Find Out What Students Think

Students may think that...

... the difference between a mixture and a substance is always visible under an ordinary microscope. They might mistake a solution for a substance because the mixture appears homogenous.

Discussion

Remind students that atoms make up all matter. This includes elements, compounds, solutions, and mixtures. The difference between a mixture and a substance is seen at the atomic level. If matter is chemically bonded together, it is a substance. If matter only physically mixes, it is a solution or a mixture.

Explain to students that atoms are too small to be seen without a high-powered microscope. You cannot visually inspect matter with an ordinary microscope and determine if it is a substance or a mixture. A sample of matter that appears to be a substance can be a mixture. The parts of a heterogeneous mixture are detectable with a microscope. The parts of a homogenous mixture cannot be seen with a microscope. **Ask:** What is the difference between a substance and a mixture? **The matter in a substance is chemically bonded; in a mixture, it is physically combined. Ask:** Why might a homogenous mixture look like a substance? **When matter is evenly blended at the atomic level, you cannot see the different parts. Ask:** Why can't an ordinary microscope be used to determine if a sample of matter is a solution or a substance? **An ordinary microscope cannot magnify at the atomic level.**

Promote Understanding

Activity Use this demonstration to engage students about how the magnification of an item does not necessarily reveal its composition. Mix two colors of sand in a beaker. It should be blended well enough that from a few meters away it appears one color. In a second beaker layer the two colors of sand so they are distinguishable from a distance. Fill a third beaker with just one sand color.

1. Have students stand far from the beakers. Explain that their position is like viewing matter without a microscope.
2. Display the first two beakers. **Ask:** Which beaker represents a mixture? Which beaker represents a substance?
3. Have students come close to the beakers. Explain that this is like viewing matter with a microscope. Ask the questions again. Students should note that both are mixtures.
4. Place the third beaker on the table. Ask the questions again. Students should note that it is impossible to say if it is a mixture or a substance. Explain to students that the same problem exists when trying to use an ordinary microscope to distinguish a solution from a substance. The magnification level is too low to see if the matter is chemically bonded or just mixed.

Solutions

Find Out What Students Think

Students may think that...

... the atoms that make up homogenous mixtures are smaller than those that make up heterogeneous mixtures and that is why you can make out the parts of a heterogeneous mixture. Use this discussion and activity to clarify that all atoms are far too small to be seen with a microscope. Homogenous and heterogeneous mixtures are distinguished not by their atomic size but rather by the uniformity of mixing.

Discussion

Remind students that while some atoms are bigger than others, all atoms are too small to be seen under an ordinary microscope. Usually the different parts in a heterogeneous mixture are visible because they do not mix evenly. This can be seen in the picture of granite and the microscopic view of blood in **Figure 4.** In a homogenous mixture, matter is mixed evenly throughout the mixture. A good example of this is salt or sugar dissolving in water. **Ask:** Do the size of atoms help distinguish a heterogeneous mixture from a homogenous one? **no** What does? **how the different types of matter are distributed in the mixture and if they dissolve Ask:** Can you distinguish a heterogeneous sample just with your eyes? **Not always; sometimes you need a microscope.**

Promote Understanding

Activity Remind students that the difference between homogeneous and heterogeneous mixtures is the uniformity of mixing and not the size of the atoms. Then show them this demonstration. Place two empty 250-mL beakers on a table. Add 100 mL of room-temperature water to each. Next, add 50 g of table salt to the first beaker. Add 10 g of table salt to the second beaker. Stir both beakers for a minute. The first solution should have undissolved salt at the bottom. In the second beaker all the salt should dissolve. Since the same solute, salt, was used in both solutions, students can be assured that the size of the atoms is irrelevant to the type of mixture formed. **Ask:** Which solution is the homogeneous mixture and which is the heterogeneous mixture? **The second solution is the homogeneous mixture, and the first solution is the heterogeneous mixture.**

LESSON

6.1 Properties of Solutions

INQUIRY

Stairs? These stair-like formations, called terraces, are located in Mammoth Hot Springs, a part of Yellowstone National Park in Wyoming. Hot spring water is a mixture of water and dissolved carbon dioxide and limestone. When this mixture reaches Earth's surface, the pressure on the mixture is reduced. This causes the limestone to leave the mixture, forming the terraces.

Write your response in your Science notebook.

188 Chapter 6

Explore Activity

How are they different?

If you have ever looked at a bottle of Italian salad dressing, you know that some substances do not easily form solutions. The oil and vinegar do not mix, and the spices sink to the bottom. However, the salt in salad dressing does mix evenly with the other substances and forms a solution. How can we describe the difference quantitatively?

1. Read and complete a lab safety form.
2. Label one **beaker** *A* and another **beaker** *B*.
3. Measure 100 mL of water and pour it into beaker A.
4. Measure 100 mL of water and pour it into beaker B.
5. Add 10 g of **baking soda** to beaker A, and stir with a **plastic spoon** for 2 min or until all the baking soda dissolves, whichever happens first.
6. Add 25 g of **sugar** to beaker B and stir with a plastic spoon for 2 min or until all of the dissolves, whichever happens first.
7. Observe the mixtures in each beaker. Record your observations in your Science Journal.

Think About This

1. What substance dissolved better in water? How do you know?
2. Predict what would happen if you were to use 200 mL of water instead of 100 mL.
3. Do you think more baking soda might dissolve if you stirred the solution longer?
4. **Key Concept** Why do you think one substance dissolved more easily in water than the other substance? What factors do you think contribute to this difference?

Essential Questions

- How do concentration and solubility differ?
- How can the solubility of a solute be changed?

Vocabulary

solvent
solute
polar molecule
concentration
solubility
saturated solution
unsaturated solution

189

INQUIRY

About the Photo **Stairs?** Limestone is made up mostly of the mineral calcite, or calcium carbonate. At Mammoth Hot Springs, calcium carbonate from limestone deep underground that formed millions of years ago is dissolved in hot water. When the water comes to the surface, the calcium carbonate comes out of the solution, and forms new limestone.

Guiding Questions

AL	What substance forms the terraces in the photo?	*limestone*
OL	What is one way to make a mixture?	*Answers may vary. Students may respond that you can stir or blend two liquids together, smash two solids together, and so on.*
BL	Why is the hot spring water in this photo an example of a mixture?	*The water has carbon dioxide and calcium carbonate dissolved in it.*

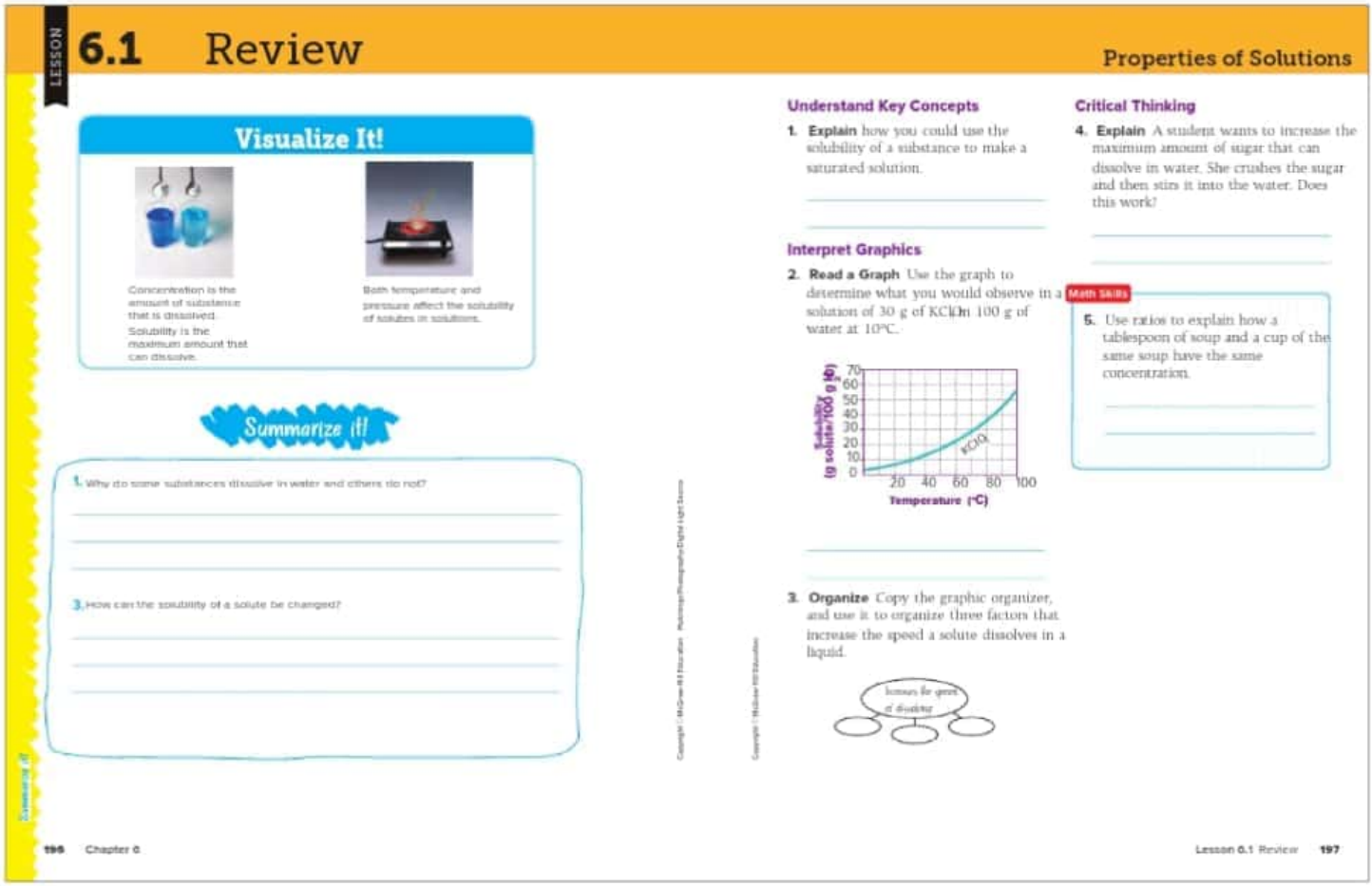
Essential Questions

After this lesson, students should understand the Key Concepts and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Create Classroom Flash Cards

1. Have students work in pairs to create one flash card for each vocabulary term in this lesson.
2. At the beginning of the lesson, have them locate the vocabulary terms on the lesson opener page. Then ask them to write each term on the front of an index card.
3. As they complete the lesson, student partners should work together to write a definition for each vocabulary term in their own words on the back of their index cards.
4. At the end of the lesson, collect flash cards and organize them by vocabulary word.
5. Pin the index cards on a bulletin board. Create a column for each vocabulary word.
6. Have students select the best definition for each term. Ask them to explain their choices.



LESSON 6.1 Review

Properties of Solutions

Visualize It!

Concentration is the amount of substance that is dissolved. Solubility is the maximum amount that can dissolve.

Both temperature and pressure affect the solubility of solutes in solutions.

Summarize it!

1. Why do some substances dissolve in water and others do not?

3. How can the solubility of a solute be changed?

Understand Key Concepts

1. **Explain** how you could use the solubility of a substance to make a saturated solution.

Interpret Graphics

2. **Read a Graph** Use the graph to determine what you would observe in a solution of 30 g of KClO$_3$ in 100 g of water at 10°C.

3. **Organize** Copy the graphic organizer, and use it to organize three factors that increase the speed a solute dissolves in a liquid.

Critical Thinking

4. **Explain** A student wants to increase the maximum amount of sugar that can dissolve in water. She crushes the sugar and then stirs it into the water. Does this work?

Math Skills

5. Use ratios to explain how a tablespoon of soup and a cup of the same soup have the same concentration.

196 Chapter 6

Lesson 6.1 Review 197

Use Vocabulary

1. A polar molecule has a slightly positive end and a slightly negative end. Polar molecules have an uneven distribution, or separation, of charge. DOK 1

Understand Key Concepts

2. The solubility of a substance is the maximum amount of solute that will dissolve in a given volume of solvent. If this amount or more is placed in the given volume, the solution will be saturated. DOK 2

3. Because ions are charged particles, they will behave like polar substances, and will not dissolve in a nonpolar solvent. DOK 2

Interpret Graphics

4. The solubility of $KClO_3$ at 10°C is about 5 g per 100 g of water. Therefore, you will observe most of the solute (25 g) on the bottom of the container. DOK 2

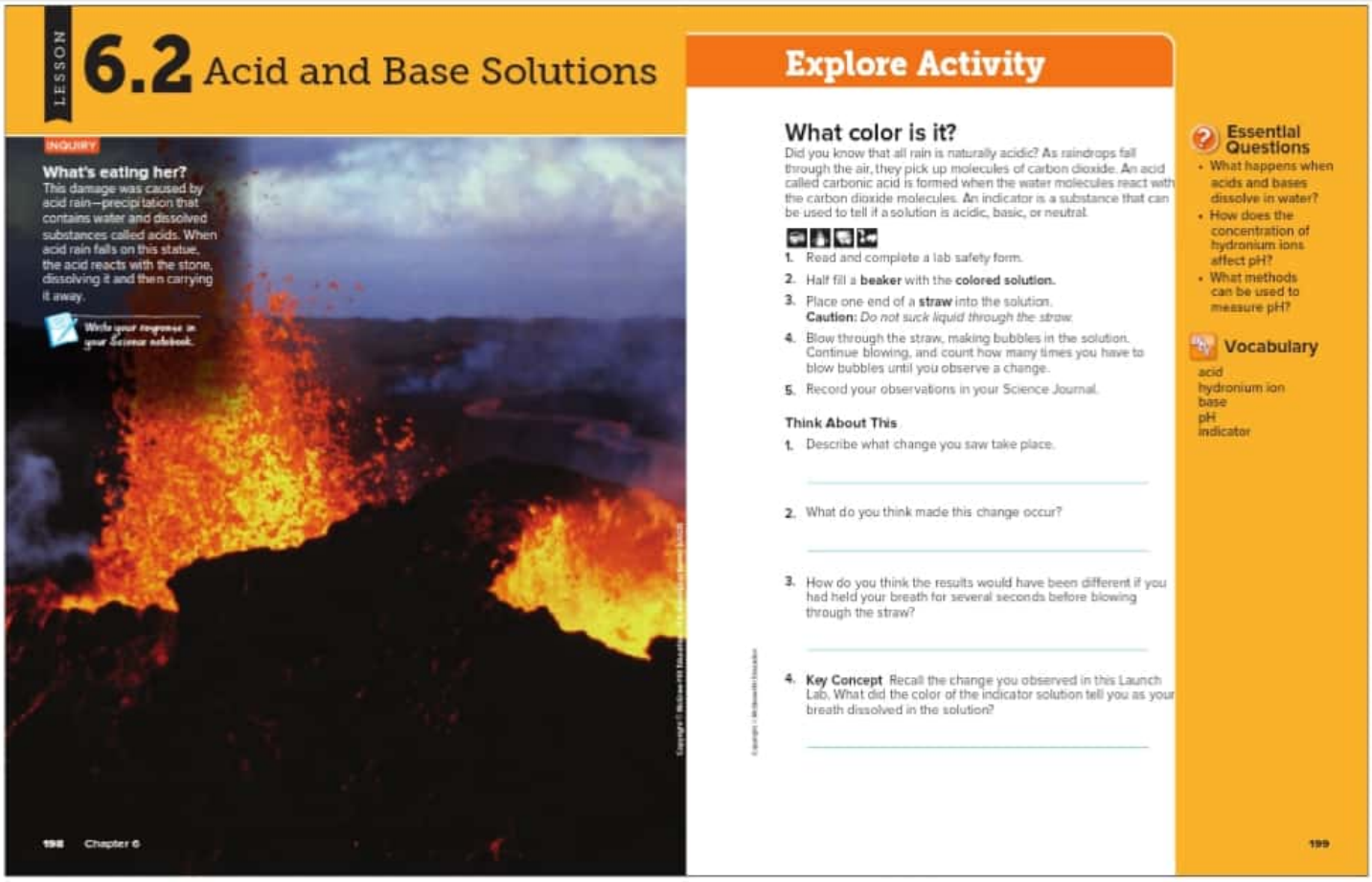
5. increasing the temperature, crushing the solute, stirring the solution (in any order) DOK 2

Critical Thinking

6. Breaking the solute into smaller pieces and stirring will make it dissolve faster, but it won't make more of it dissolve. Increasing temperature of a solution will make more solute dissolve. DOK 3

Math Skills

7. Concentration is m/V. A tablespoon has less mass and less volume. A cup has more mass and more volume. However, the ratio of mass to volume is the same for both, therefore, they have the same concentration. DOK 3



LESSON 6.2 Acid and Base Solutions

INQUIRY

What's eating her?
This damage was caused by acid rain—precipitation that contains water and dissolved substances called acids. When acid rain falls on this statue, the acid reacts with the stone, dissolving it and then carrying it away.

Write your response in your Science notebook.

198 Chapter 6

Explore Activity

What color is it?
Did you know that all rain is naturally acidic? As raindrops fall through the air, they pick up molecules of carbon dioxide. An acid called carbonic acid is formed when the water molecules react with the carbon dioxide molecules. An indicator is a substance that can be used to tell if a solution is acidic, basic, or neutral.

1. Read and complete a lab safety form.
2. Half fill a **beaker** with the **colored solution.**
3. Place one end of a **straw** into the solution. **Caution:** *Do not suck liquid through the straw.*
4. Blow through the straw, making bubbles in the solution. Continue blowing, and count how many times you have to blow bubbles until you observe a change.
5. Record your observations in your Science Journal.

Think About This

1. Describe what change you saw take place.
2. What do you think made this change occur?
3. How do you think the results would have been different if you had held your breath for several seconds before blowing through the straw?
4. **Key Concept** Recall the change you observed in this Launch Lab. What did the color of the indicator solution tell you as your breath dissolved in the solution?

Essential Questions
- What happens when acids and bases dissolve in water?
- How does the concentration of hydronium ions affect pH?
- What methods can be used to measure pH?

Vocabulary
acid
hydronium ion
base
pH
indicator

199

INQUIRY

About the Photo This statue is made out of a type of rock, such as marble, that reacts easily with acids. Make sure students understand that the statue is very old and that the damage shown occurred over many years.

Guiding Questions

AL	How old do you think the statue is?	*Students might suggest that the statue is hundreds of years old or more.*
OL	Do you think the statue is most likely in a city or in the country?	*Students might suggest that it is most likely in a city, since there is more pollution in cities than in the country.*
BL	What do you think might happen to the statue if it continues to be affected by acid rain?	*Students might suggest that the marks on the statue would become bigger or that the statue might crumble apart.*

Essential Questions

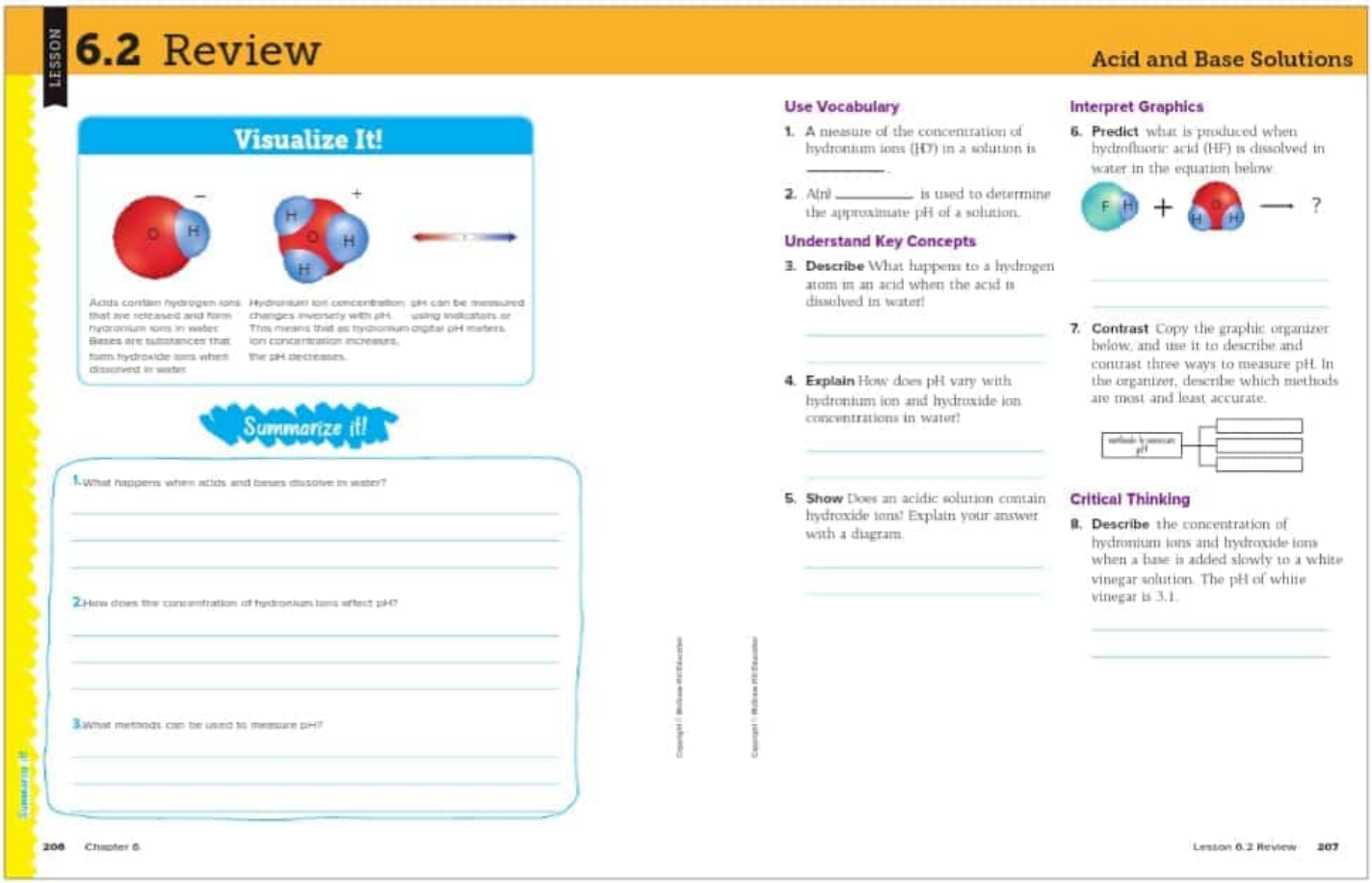
After this lesson, students should understand the Key Concepts and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Create a Dictionary Entry

Associating words with images can help students understand and recall scientific words.

1. Write the word base on chart paper or on the board. Have students look up the different meanings of the word in the dictionary. Discuss how they might use the word in an everyday context.
2. Have students work together as a class to create a dictionary entry for the term, writing two or three of the definitions they found in their own words.
3. Have students record the dictionary entry in their Science Journal. After they have completed the lesson, have them compare their definitions to the scientific definition of the term base. Ask students to consider how the scientific definition is different from the everyday definitions.



LESSON

6.2 Review

Acid and Base Solutions

Visualize It!

Acids contain hydrogen ions that are released and form hydronium ions in water. Bases are substances that form hydroxide ions when dissolved in water.

Hydronium ion concentration changes inversely with pH. This means that as hydronium ion concentration increases, the pH decreases.

pH can be measured using indicators or digital pH meters.

Summarize it!

1. What happens when acids and bases dissolve in water?

2. How does the concentration of hydronium ions affect pH?

3. What methods can be used to measure pH?

Summarize it!

Use Vocabulary

1. A measure of the concentration of hydronium ions (H_3O^+) in a solution is _____.

2. A(n) _____ is used to determine the approximate pH of a solution.

Understand Key Concepts

3. **Describe** What happens to a hydrogen atom in an acid when the acid is dissolved in water?

4. **Explain** How does pH vary with hydronium ion and hydroxide ion concentrations in water?

5. **Show** Does an acidic solution contain hydroxide ions? Explain your answer with a diagram.

Interpret Graphics

6. **Predict** what is produced when hydrofluoric acid (HF) is dissolved in water in the equation below.

7. **Contrast** Copy the graphic organizer below, and use it to describe and contrast three ways to measure pH. In the organizer, describe which methods are most and least accurate.

Critical Thinking

8. **Describe** the concentration of hydronium ions and hydroxide ions when a base is added slowly to a white vinegar solution. The pH of white vinegar is 3.1.

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: Which Key Concept does each image relate to?**

Use Vocabulary

1. pH **DOK 1**

2. indicator **DOK 1**

Understand Key Concepts

3. The hydrogen atoms separates from the acid molecules and reacts with water molecules forming hydronium ions. **DOK 2**

4. As the concentration of hydroxide ions increases, relative concentration of hydronium ions decreases, and the pH increases. As the concentration of hydroxide ions decreases, the relative concentration of hydronium ions increases, and the pH decreases. **DOK 2**

5. Yes; but it contains more hydronium ions than hydroxide ions. Accept student diagrams that show hydroxide ions and hydronium ions. **DOK 2**

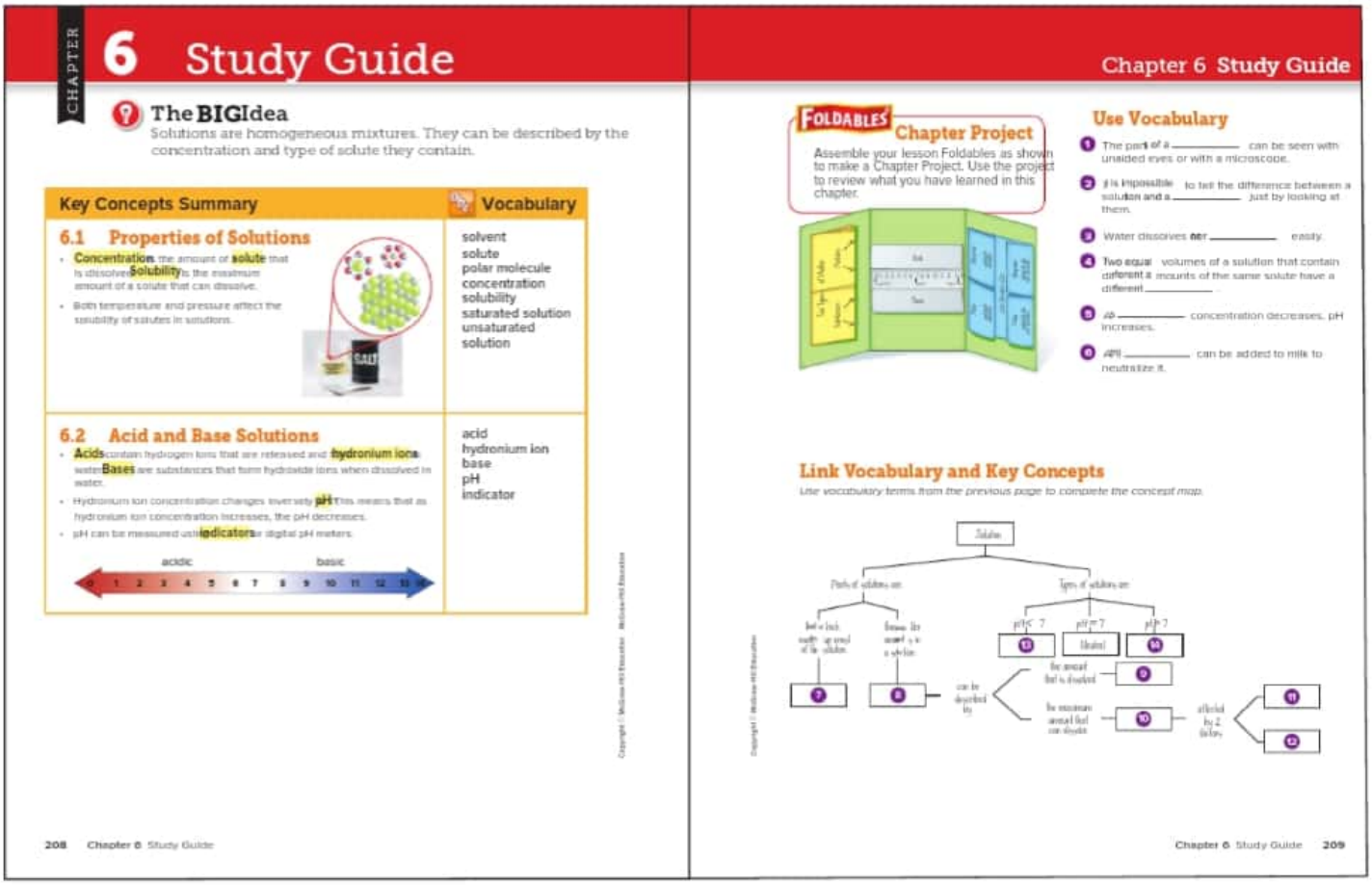
Interpret Graphics

6. H_3O^+ and F^- **DOK 2**

7. (in any order) pH meter, pH testing strips, pH indicators **DOK 3**

Critical Thinking

8. As a base is added, the hydronium ion concentration decreases and relative to the hydroxide ion concentration. The pH of the vinegar increases until the concentrations of hydronium and hydroxide ions are equal, the pH equals 7. **DOK 3**



CHAPTER 6 Study Guide

The BIG Idea

Solutions are homogeneous mixtures. They can be described by the concentration and type of solute they contain.

Key Concepts Summary

6.1 Properties of Solutions

- Concentration is the amount of solute that is dissolved in a solvent.
- Solubility is the maximum amount of a solute that can dissolve.
- Both temperature and pressure affect the solubility of solutes in solutions.

Vocabulary

solvent
solute
polar molecule
concentration
solubility
saturated solution
unsaturated solution

6.2 Acid and Base Solutions

- Acids contain hydrogen ions that are released and hydronium ions in water.
- Bases are substances that form hydroxide ions when dissolved in water.
- Hydronium ion concentration changes inversely with pH. This means that as hydronium ion concentration increases, the pH decreases.
- pH can be measured using indicators or digital pH meters.

acidic ... basic

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

acid
hydronium ion
base
pH
indicator

208 Chapter 6 Study Guide

Chapter 6 Study Guide

FOLDABLES Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. The part of a _____ can be seen with unaided eyes or with a microscope.
2. It is impossible to tell the difference between a solution and a _____ just by looking at them.
3. Water dissolves **ionic** _____ easily.
4. **Two equal** volumes of a solution that contain different amounts of the same solute have a different _____.
5. As _____ concentration decreases, pH increases.
6. An _____ can be added to milk to neutralize it.

Link Vocabulary and Key Concepts

Use vocabulary terms from the previous page to complete the concept map.

Solution

Parts of solutions are: Solute, Solvent

Types of solutions are: pH < 7, pH = 7, pH > 7

7 8 11 12 13 14

can be described by: the amount that is dissolved; the maximum amount that can dissolve

9 10

affected by 2 factors

Chapter 6 Study Guide 209

Key Concepts Summary

Study Strategy: Write a Quiz

Students are often nervous about assessments because they are unsure of what will be on the test. When students write possible test questions from the key concepts they have explored, it takes some of the mystery out of the assessment and allows them to focus on studying the concepts they have learned.

1. Organize students into groups of four.
2. Have each student develop a ten-question quiz from information in the key concepts summary. Encourage students to include a variety of question types including true-false, matching, fill in the blank, multiple choice, and short answer.
3. Have each student exchange papers with another member of the group, who will complete the quiz.
4. Instruct each student to exchange papers with another member of the group, who will grade the quiz and give it back to the person who took the quiz.
5. Encourage groups to discuss how writing questions helped them complete a quiz.

Vocabulary

Study Strategy: In Your Own Words

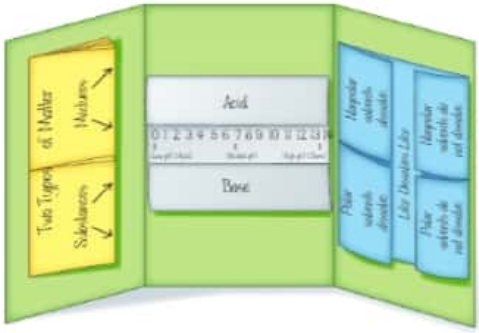
Ask students to create vocabulary definitions using their own words. Connecting vocabulary words to students' own language promotes understanding more effectively than pure memorization.

1. Have students create a two-column table like the one below in their Science Journal.
2. Have them write the vocabulary words in the Study Guide in the left column.
3. Ask students to describe what they know about the chapter's vocabulary words using their own words (without referring to the textbook).

Example:

Vocabulary Word	My Definition
substance	A substance is something that always has the same kinds of atoms that are arranged in the same way. Substances can be elements or compounds.

FOLDABLES® Chapter Project



Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

Use Vocabulary

1. mixture
2. substance
3. polar molecules
4. concentration
5. hydronium ion
6. base

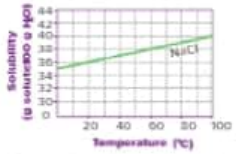
Link Vocabulary and Key Concepts

7. Solvent
8. Solute(s)
9. Concentration
10. Solubility
11–12. Temperature, Pressure
13. Acids
14. Bases

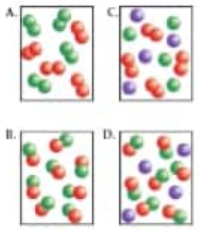
Teacher Notes

Understand Key Concepts

1. Which is a solution?
   - A. copper
   - B. vinegar
   - C. pure water
   - D. a raisin cookie
2. The graph below shows the solubility of sodium chloride (NaCl) in water.



What mass of sodium chloride must be added to 100 g of water at 80°C to form a saturated salt solution?
   - A. 36 g
   - B. 39 g
   - C. 40 g
   - D. 100 g
3. What would you add to a solution with a pH of 1.5 to obtain a solution with a pH of 7?
   - A. milk (pH 6.4)
   - B. vinegar (pH 3.0)
   - C. lye (pH 13.0)
   - D. coffee (pH 5.0)
4. Which can change the solubility of a solid in a liquid?
   - A. crushing the solute
   - B. stirring the solute
   - C. increasing the pressure of the solution
   - D. increasing the temperature of the solution
5. Which ions are present in the greatest amount in a solution with a pH of 8.5?
   - A. hydrogen ions
   - B. hydronium ions
   - C. hydroxide ions
   - D. oxygen ions
6. Which best describes a solution that contains the maximum dissolved solute?
   - A. It is a concentrated solution.
   - B. It is a dilute solution.
   - C. It is a saturated solution.
   - D. It is an unsaturated solution.
7. Which is a mixture of two elements?

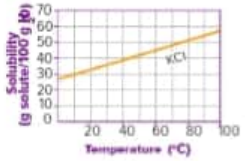


8. Which explains why a soft drink bubbles when the cap is released?
   - A. The gas becomes less soluble when temperature decreases.
   - B. The gas becomes more soluble when temperature decreases.
   - C. The gas becomes less soluble when pressure decreases.
   - D. The gas becomes more soluble when pressure decreases.

Critical Thinking

9. **Infer** How can you tell which component in a solution is the solvent?

10. **Predict** The graph below shows the solubility of potassium chloride (KCl) in water.



Imagine you have made a solution that contains 50 g of potassium chloride (KCl) in 100 g of solution. Predict what you would observe as you gradually increased the temperature from 0°C to 100°C.

11. **Organize** The pH of three solutions is shown below.
    Milk (pH 6.7)
    Coffee (pH 5)
    Ammonia (pH 11.6)
    Place these solutions in order of
    a. most acidic to least acidic
    b. most basic to least basic
    c. highest OH^- concentration to lowest OH^- concentration
12. **Explain** The pH of a solution is inversely related to the concentration of hydronium ions in solution. Explain what this means.
13. **Design** a method to determine the solubility of an unknown substance at 50°C.

Writing in Science

14. **Write an article** .write a scientific article about uses of acids in industry
15. What are solutions? List at least three ways a solution can be described.
16. How do solutions differ from other types of matter?

Math Skills

Calculate Concentration

17. Calculate the concentration of sugar in g/L in a solution that contains 40 g of sugar in 100 mL of solution. There are 1,000 mL in 1 L.?
18. There are many ways to make a solution of a given concentration. What are two ways you could make a sugar solution with a concentration of 100 g/L?
19. A salt solution has a concentration of 200 g/L. How many grams of salt are contained in 500 mL of this solution? How many grams of salt would be contained in 2 L of this solution?

Understand Key Concepts

1 **B.** vinegar
2 **B.** 40 g
3 **C.** lye (pH 13.0)
4 **D.** increasing temperature of the solution
5 **C.** hydroxide ions
6 **C.** It is a saturated solution.
7 **A.** mixture of two elements
8 **C.** The gas becomes less soluble when pressure decreases.

Critical Thinking

9 The component that exists in the greatest amount is the solvent. Also, the state of the solution is the same as the state of the solvent.

10 At 0°C, only about 28 g of KCl will dissolve. As the temperature increases, more solute dissolves. At about 80°C, the last of the KCl dissolves. Above 80°C, all of the solute remains in solution.

11 a. most acidic to least acidic: coffee, milk, ammonia
b. most basic to least basic: ammonia, milk, coffee
c. highest OH^- concentration to lowest OH^- concentration: ammonia, milk, coffee

12 This means that as the hydronium concentration increases, the pH of a solution decreases.

13 Possible method: Heat 100 g water to a temperature of 50°C. Measure the mass of a few grams of substance. Add small amounts of the substance until the point where a few crystals of substance do not dissolve. Measure the mass of the remaining substance and subtract from the mass of the starting amount. The difference is the mass of substance that dissolves in 100 g of solution—the unknown's solubility.

Writing in Science

14 Check that answers follow the definition of a haiku and accurately describe the formation of a hydronium ion.

The BIG Idea

15 Solutions are the same as homogeneous mixtures—two or more substances mixed together on the atomic level but not bonded together. A solution can be described as dilute or concentrated; by how much solute it contains; as saturated or unsaturated; as acidic, neutral, or basic; or by its pH.

16 Solutions are different from heterogeneous mixtures in that they are mixed on the atomic level. Solutions are different from substances in that they have a variable composition and substances have a fixed composition.

Math Skill

Calculate Concentration

17 40 g/100 mL × 1,000 mL/ 1 L = 400 g/L

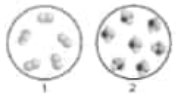
18 Answers may vary but should result in a concentration of 100 g/L. Possible answers include: Add 100 g of sugar to a graduated cylinder or vessel and then add water to the 1,000 mL mark. Or add 10 g of sugar to a graduated cylinder or vessel and then add water to the 100 mL mark.

19 100 g; 400 g

Standardized Test Practice

Multiple Choice aligned with TIMMS

Use the figures below to answer question 1.



1 Which statement describes the two figures?
- A Both 1 and 2 are mixtures.
- B Both 1 and 2 are substances.
- C 1 is a mixture and 2 is a substance.
- D 1 is a substance and 2 is a mixture.

2 Which statement is an accurate comparison of solutions and homogeneous mixtures.
- A They are the same.
- B They are opposites.
- C Solutions are more evenly mixed than homogeneous mixtures.
- D Homogeneous mixtures are more evenly mixed than solutions.

3 A worker uses a magnet to remove bits of iron from a powdered sample. Which describes the sample before the worker used the magnet to remove the iron?
- A The sample is a compound because the iron was removed using a physical method.
- B The sample is a compound because the iron was removed using a chemical change.
- C The sample is a mixture because the iron was removed using a chemical change.
- D The sample is a mixture because the iron was removed using a physical method.

4 A beaker contains a mixture of sand and small pebbles. What kind of mixture is this?
- A compound
- B heterogeneous
- C homogeneous
- D solution

5 Which type of substance would best dissolve in a solvent that was made of nonpolar molecules?
- A a water-based solvent
- B an ionic compound
- C a solute made of polar molecules
- D a solute made of nonpolar molecules

Use the figure to answer question 6.

Water molecule

6 The figure shows how water molecules surround an ion in a solution. What can you conclude about the ions?
- A It is negative because the negative ends of the water molecule are attracted to it.
- B It is negative because the positive ends of the water molecule are attracted to it.
- C It is positive because the negative ends of the water molecule are attracted to it.
- D It is positive because the positive ends of the water molecule are attracted to it.

7 A girl makes two glasses of lemonade using a powder mix. She pours one cup of water into each glass. She adds one spoonful of powder to the first glass and two spoonfuls of powder to the second glass. How do the solutions in the two glasses compare?
- A The first glass has a greater concentration of powder mix.
- B The first glass has a greater solubility.
- C The second glass has a greater concentration of powder mix.
- D The second glass has a greater solubility.

Use the table below to answer question 8.

Sample solution	Change in blue litmus	Change in red litmus
1	turns red	no change
2	no change	turns blue
3	turns red	no change
4	no change	no change

8 A scientist collects the data above using litmus paper. Blue litmus paper is a type of pH indicator that turns red when placed in an acidic solution. Red litmus paper is an indicator that turns blue when placed in an basic solution. Neutral solutions cause no change in either color of litmus paper. Which sample solution must be a base?
- A solution 1
- B solution 2
- C solution 3
- D solution 4

Constructed Response aligned with TIMSS

9 Explain how the concentration of hydronium ions and the concentration of hydroxide ions change when a base is dissolved in water.

10 A researcher mixes a solution that is 40 percent helium gas and 60 percent nitrogen gas. Which gas is the solute and which is the solvent? What would the mixture look like through a microscope? What would the mixture look like at the atomic level?

11 A student is dissolving rock salt in water. Describe three ways to increase the rate of dissolving.

Use the figure to answer questions 12 and 13.

12 The figure shows what happens when hydrogen iodide (HI) dissolves in water. Is hydrogen iodide an acid, a base, or a neutral substance? Explain.

13 What can you conclude about the pH of the aqueous solution of hydrogen iodide?

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13
Go to Lesson...	1	1	1	1	2	2	2	2	3	3	1	2	3

Multiple Choice

1 B—Correct. Both 1 and 2 are substances. 1 shows an element. 2 shows a compound. Both of these are substances. A, C, and D include mixtures in the descriptions.

2 A—Correct. They are the same. *Solution* is another word for homogeneous mixture. B does not accurately describe different types of mixtures, and C and D assume differences between solutions and homogeneous mixtures.

3 D—Correct. The sample is a mixture because the iron was removed using a physical method. The removal of iron using a magnet is a physical method. Only mixtures can be separated using physical methods. A and B state the sample is a compound, and C states the removal of the iron is a chemical method.

4 B—Correct. A, compounds are substances, not mixtures. C, the mixture contains visibly different components and is not uniform, or homogeneous. D, the mixture contains visibly different components and is not uniform.

5 D—Correct. Like dissolves like. Nonpolar dissolves nonpolar. A and C are polar substances and would not dissolve a nonpolar molecule. B dissociates into positive and negative ions which are attracted to the negative and positive ends (respectively) of a water molecule.

6 C—Correct. It is positive because the negative ends of the water molecules are attracted to it. The end of the water molecule with the oxygen atoms is negative and is interacting with the ion. The ion has an opposite charge—positive. A is a wrong characterization of the ion and how water molecules interact with negative ions. B is a wrong characterization of the ion but a correct characterization of how water molecules interact with negative ions. D is a correct characterization of the ion but a wrong characterization of how water molecules interact with positive ions.

7 **C—Correct.** The second glass has a greater concentration than the first glass. A gives the opposite relative concentrations, and B and D describe solubility, which is the same for both glasses. The solubility for the powder mix is dependent on the interaction with water and not on the quantities of either.

8 **B—Correct.** A and C are acids, and D is a neutral substance.

Constructed Response

9 The concentration of hydroxide ions increases relative to the concentration of hydronium ions

10 Nitrogen is the solvent because there is more of it. The mixture is a solution, so the particles of gas are mixed evenly throughout the solution at the atomic level.

11 Sample answer: Crush the rock salt into a finer powder, heat up the water, or stir the water vigorously.

12 Hydrogen iodide must be an acid, because it produces hydronium ions when dissolved in water.

13 Because hydrogen iodide is an acid, the aqueous solution must have a pH lower than 7.

Answer Key

Question	Answer
1	B
2	A
3	D
4	B
5	D
6	C
7	C
8	B
9	See extended answer.
10	See extended answer.
11	See extended answer.
12	See extended answer.
13	See extended answer.

Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

* The way in which cells function is similar in all living organisms.

* Similarities among organisms are found in internal anatomical features and patterns of development, which can be used to infer the degree or relatedness among organisms.

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

Lesson 1
Characteristics of Life

1 All living things share certain characteristics.

- **1a** Are organized
  - **1b** Maintain certain internal conditions
    - **1c** Reproduce
- **1d** Grow and develop
  - **1e** Use energy
    - **1f** Respond

Lesson 2
Classifying Organisms

2 Systematics uses all the evidence known about organisms to classify them.

3 Scientific names allow people all over the world to identify an organism because each scientific name is unique and applies to only one type of organism.

- **2a** Domains
  - **2b** Kingdoms

Lesson 3
Exploring Life

4 The invention of microscopes allowed scientists to view cells, which enabled them to further explore and classify life.

5 There are two main types of microscopes.

- **5a** A light microscope uses light and has one or more lenses to enlarge an image up to 1,500 times its original size.
- **5b** An electron microscope uses a magnetic field in a vacuum to direct beams of electrons and enlarges an image 100,000 times or more.

Classification System

Find Out What Students Think

Students may think that...

... the classification system is difficult to remember and is used only by scientists.

Discussion

Review the classification system by first making a series of taxonomic group cards with the largest card labeled *Domain* and the smallest card labeled Species. Place the cards on chart paper. There should be a visual image of the cards becoming smaller as the taxonomic groups become more specific. **Ask:** Which taxonomic group holds the most species? **Domain** Which is specific to only one species? **Species** Take down the cards. Hold up a picture of an interesting animal. **Ask:** How can we label this animal so everyone knows which animal we are identifying? Repost each taxonomic group as students identify it. Have them brainstorm which animals might be a part of each group. List them as they are identified. Talk about the traits that are common among the animals within the group. Discuss how the traits in each group become more specific as the classification system narrows. **Ask:** Where might the classification system be commonly used? **at a zoo, arboretum, museum**

Promote Understanding

Activity Use the following activity to help students remember the sequence of taxonomic groups in the classification system of living things.

1. Divide the class into groups of three. Have each group write the names of the taxonomic groups found in the classification system.
2. Have students circle the first letter of the eight taxonomic groups: Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species (D, K, P, C, O, F, G, S).
3. Each group should use the letters to create a saying for the acronym, such as *Ducks Keep People Coming On Flowing Grassy Streams*. Encourage students to be creative.
4. Have groups share their sayings.

Cellular Respiration and Photosynthesis

Find Out What Students Think

Students may think that...

... if something is magnified enough, then its resolution will be clear. Some students may not understand that magnification and resolution are separate characteristics of a microscope.

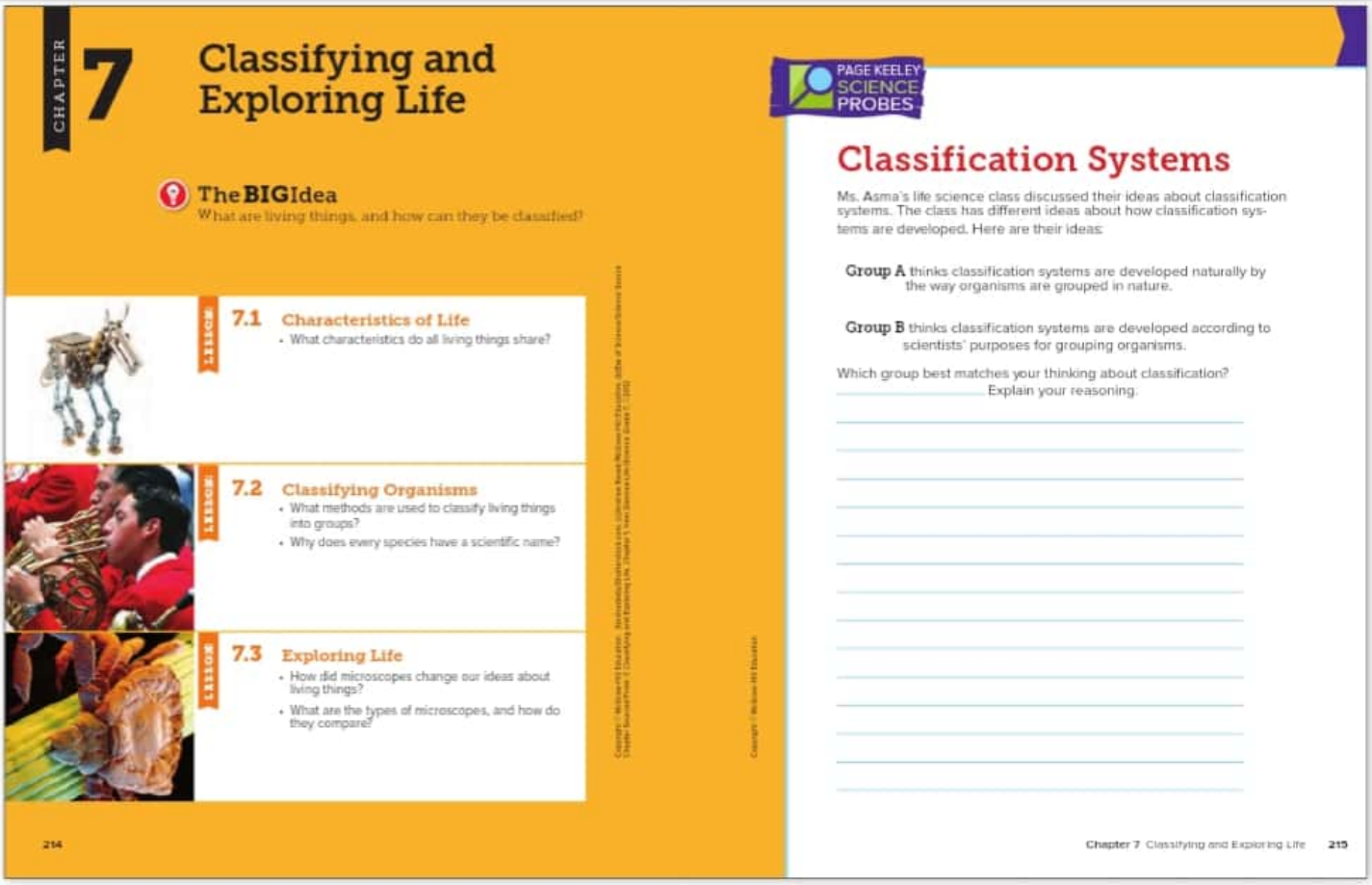
Discussion

Create a Venn diagram on the board with two overlapping circles. In the left circle, write *magnification*. In the right circle, write resolution. In the center overlap, write *microscopes*. **Ask:** What does a microscope do? **enlarges images of things, makes them clearer to see** Explain that microscopes have two characteristics: they magnify, or make images of things larger, and they make things clearer to see. Both magnification and resolution are needed. Give each student a magnifying lens, or divide the class into small groups. Have students look at an object at different distances. **Ask:** What does the magnifying lens do? **magnifies objects** **Ask:** Did the magnifying lens make the object clearer at different distances? **no** What did you do to make the object look clear? **adjusted where the magnifying lens was held** Explain that a microscope not only magnifies, it also adjusts the resolution so that the object appears clear. It does more than a simple magnifying lens.

Promote Understanding

Activity Divide the class into student pairs. Give each student pair a photo of a living thing.

1. Have each group identify ten things they would like to observe more closely.
2. Have them list which of those ten things they could successfully learn more about by using the magnifying lens and which would be so small that a microscope would be needed to both enlarge and make it clearer to see.
3. To extend the activity, have students then identify three ways an electron microscope would be useful.
4. Have students share their ideas.


CHAPTER 7

Classifying and Exploring Life

The BIG Idea

What are living things, and how can they be classified?

LESSON 7.1 Characteristics of Life

- What characteristics do all living things share?

LESSON 7.2 Classifying Organisms

- What methods are used to classify living things into groups?
- Why does every species have a scientific name?

LESSON 7.3 Exploring Life

- How did microscopes change our ideas about living things?
- What are the types of microscopes, and how do they compare?

214

PAGE KEELEY SCIENCE PROBES

Classification Systems

Ms. Asma's life science class discussed their ideas about classification systems. The class has different ideas about how classification systems are developed. Here are their ideas:

Group A thinks classification systems are developed naturally by the way organisms are grouped in nature.

Group B thinks classification systems are developed according to scientists' purposes for grouping organisms.

Which group best matches your thinking about classification? _____ Explain your reasoning.

Chapter 7 Classifying and Exploring Life 215

Classifying and Exploring Life

The BIG Idea

There are no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL	What are living things?	*This question helps students start to think about the characteristics that all living things have and that separate living things from nonliving things. Start by asking students what animals have in common. Then ask what animals and plants have in common. Then ask how animals and plants are different from nonliving things.*
OL	What are some different kinds of living things you know about?	*This question initiates students' thinking about the variety of living things. If students don't mention any microscopic living things, ask them if there are living things that are too small to see.*
BL	How can living things be classified?	*This question helps students start to think about how living things are classified by their differences. Start by asking how plants and animals are different.*

Get Ready to Read

What do you think?

Use this anticipation guide to gauge students' background knowledge and preconceptions about oceans. At the end of the chapter, ask students to read and evaluate their earlier responses. Students should be encouraged to change any of their responses.

Anticipation Set for Lesson 1

1. All living things move.

Disagree. Movement is not a characteristic of all living things.

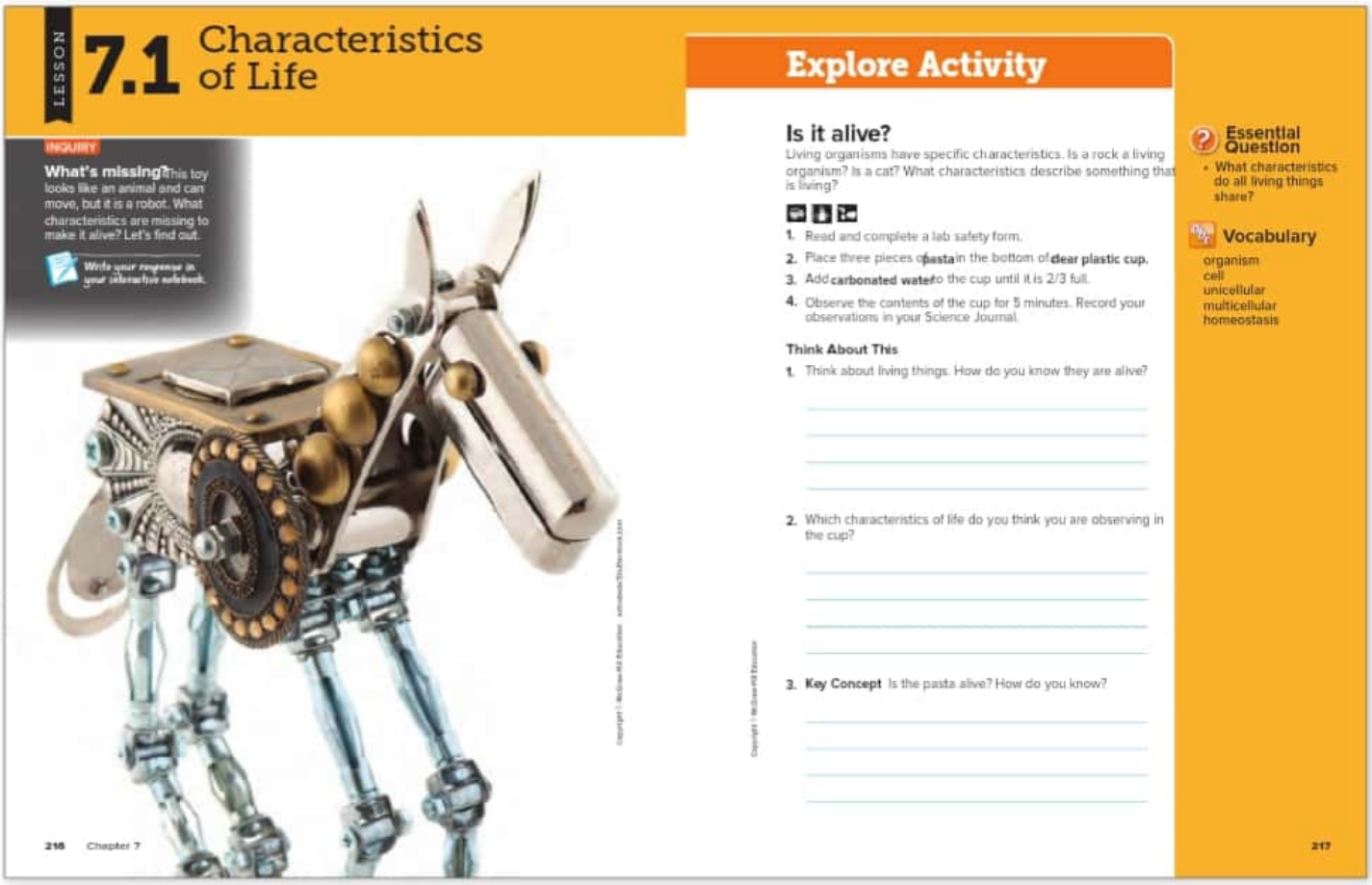
2. The Sun provides energy for almost all organisms on Earth.

Agree. Most organisms use energy from the Sun for all the processes they perform.

Anticipation Set for Lesson 2

3. A dichotomous key can be used to identify an unknown organism.

Agree. The series of questions in a dichotomous key leads to an organism's identity.


LESSON 7.1 Characteristics of Life

INQUIRY

What's missing? This toy looks like an animal and can move, but it is a robot. What characteristics are missing to make it alive? Let's find out.

Write your response in your interactive notebook.

216 Chapter 7

Explore Activity

Is it alive?

Living organisms have specific characteristics. Is a rock a living organism? Is a cat? What characteristics describe something that is living?

1. Read and complete a lab safety form.
2. Place three pieces of pasta in the bottom of clear plastic cup.
3. Add carbonated water to the cup until it is 2/3 full.
4. Observe the contents of the cup for 5 minutes. Record your observations in your Science Journal.

Think About This

1. Think about living things. How do you know they are alive?

2. Which characteristics of life do you think you are observing in the cup?

3. **Key Concept** Is the pasta alive? How do you know?

Essential Question

- What characteristics do all living things share?

Vocabulary

organism
cell
unicellular
multicellular
homeostasis

217

INQUIRY

About the Photo **What's missing?** Although the robotic animal resembles a real animal, it is obviously just a mechanical toy. But what if it looked and moved exactly like a real animal and even had an artificial heartbeat? How would we tell that it isn't really alive? Start the lesson with questions about the characteristics of life.

Guiding Questions

OL	How could we determine whether an advanced, lifelike robot was alive? What's missing to make it alive?	*We might have to observe whether it performs biological functions, such as growing, eating, or reproducing.*
BL	If a robot were made of biological materials and performed biological functions, would it be alive?	*Yes, we would have to consider it to be a living organism. And robots of this type are a staple of science fiction. They are called androids (though that term is flexible and also includes humanlike robots made of synthetic materials).*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.Vocabulary

Vocabulary

Thinking About Umbrella Words

1. Write the word *organism* on chart paper or the board and review the definition of *organisms* given in the lesson: things that have all the characteristics of life..
2. Explain that an organism can be an animal, a plant, a fungus, or even something microscopic, such as an amoeba. If we want to discuss living things as a group, we can simply say "biological organisms" rather than "animals, plants, fungi, and microorganisms." The word *organism* can thus be considered an umbrella word, a term that encompasses two or more groups.
3. With students, think of some other umbrella words. For example, *siblings* means "brothers and sisters" and *aircraft* includes all kinds of flying machines.

ExploreActivity

Is it alive?

Prep: *5 min* **Class:** *15 min*

Purpose
Students will observe and identify characteristics that can be attributed to both living and nonliving things, recognizing that only those things that possess all the characteristics of life are considered living.

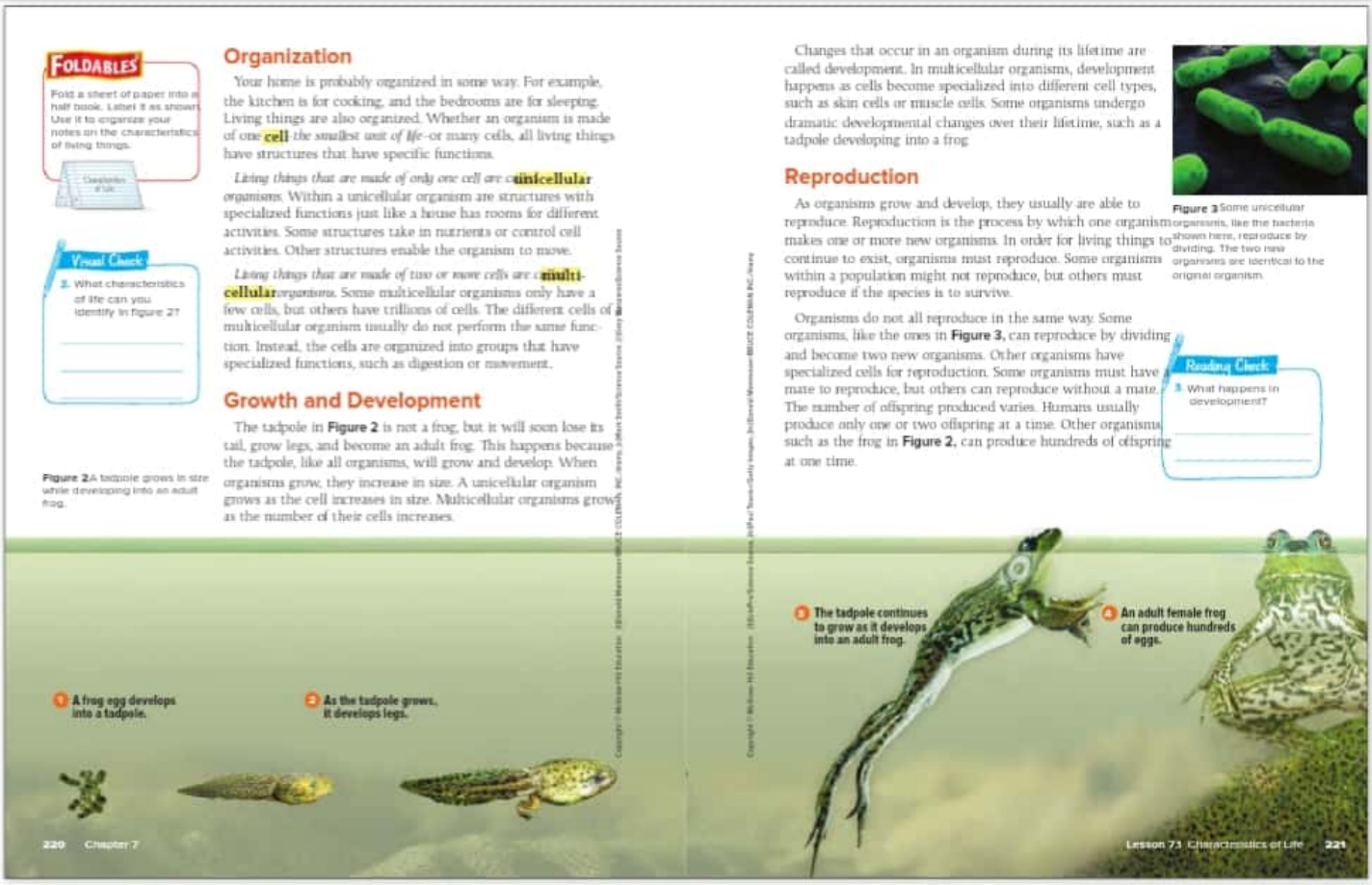
Materials
Teacher: small pasta (elbow macaroni, bowtie), carbonated water (club soda), clear plastic cups, paper towels

Before You Begin
Remind students to bring Science Journals. Test the pasta in advance to guarantee that it is light enough to be lifted by the bubbles that form on its surface.

Guide the Investigation
- Have students individually answer the introductory questions at the beginning of the lab, then share answers and brainstorm a list of characteristics of living things.
- ⚠ Have students wear goggles and aprons.
- **Troubleshooting** Be sure to use unopened bottles in subsequent classes to ensure that no carbonation is lost from the club soda.

Think About This
1. Living things are organized, grow and develop, reproduce, respond, maintain certain internal conditions, and use energy. Students may also include or substitute characteristics such as the ability to move, require food, and other simpler terms.
2. When the bubbles form on the pasta, the pasta rises through the liquid. The bubbles burst and the pasta sinks. This appears as movement, so students may suggest that the pasta is using energy to move or that the pasta is responding to its environment.
3. No, the object is not alive. I know this because the pasta shows only some, not all, of the characteristics that living things possess.

Have students identify other nonliving things and the characteristics of life which they possess. Use something lifelike as an example, such as a doll that moves or talks.



Organization

Organisms can be either unicellular or multicellular. Have students make note of that fact as they create a Foldable on the characteristics of life. Use the questions below to assess students' understanding of the text.

Guiding Questions

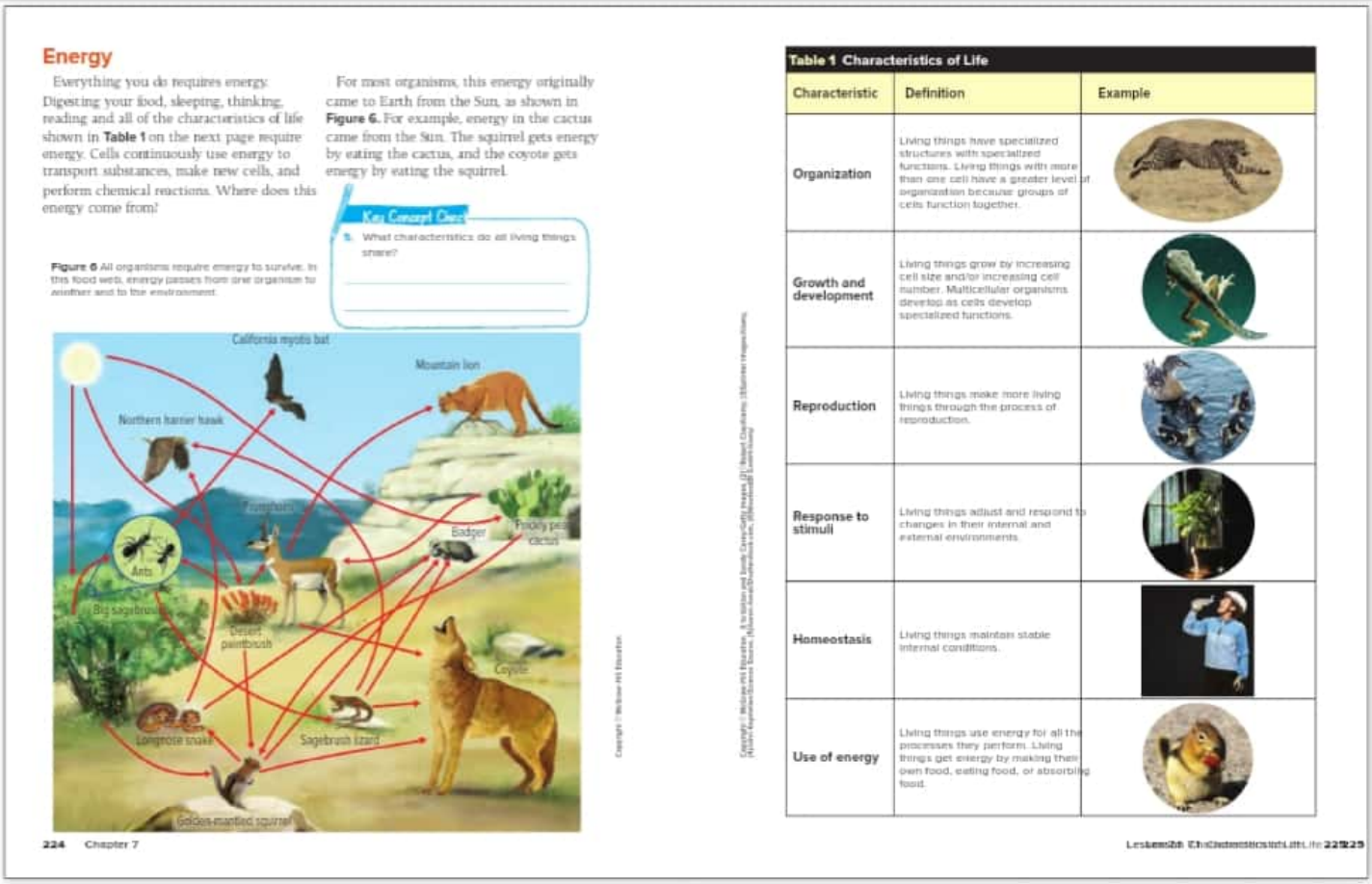
AL	What is the smallest unit of life?	*The smallest unit of life is the cell.*
OL	In what way is a unicellular organism like a house with various rooms for various functions?	*A unicellular organism has structures that perform specialized functions. Those structures can be likened to the rooms of a house.*
BL	Why do you think a unicellular organism needs structures that perform specialized functions?	*A unicellular organism needs structures that perform specialized functions so it can survive.*

Growth and Development

Explain to students that growth can occur in one of two ways. A unicellular organism grows as the cell increases in size. In a multicellular organism, growth is caused by an increase in the number of cells. Explain that when an organism grows, it experiences changes called development. Ask students to think about the following questions.

Guiding Questions

AL	What characteristics of life can you identify in Figure 2?	*The tadpole grows, develops into a frog, and reproduces.*
OL	What developmental changes does a tadpole go through in becoming a frog?	*It loses its tail and develops legs.*
BL	What happens in development?	*In multicellular organisms, cells become specialized into different cell types.*



Energy

Everything you do requires energy. Digesting your food, sleeping, thinking, reading and all of the characteristics of life shown in **Table 1** on the next page require energy. Cells continuously use energy to transport substances, make new cells, and perform chemical reactions. Where does this energy come from?

For most organisms, this energy originally came to Earth from the Sun, as shown in **Figure 6.** For example, energy in the cactus came from the Sun. The squirrel gets energy by eating the cactus, and the coyote gets energy by eating the squirrel.

Key Concept Check

5. What characteristics do all living things share?

Figure 6 All organisms require energy to survive. In this food web, energy passes from one organism to another and to the environment.

Table 1 Characteristics of Life

Characteristic	Definition	Example
Organization	Living things have specialized structures with specialized functions. Living things with more than one cell have a greater level of organization because groups of cells function together.	
Growth and development	Living things grow by increasing cell size and/or increasing cell number. Multicellular organisms develop as cells develop specialized functions.	
Reproduction	Living things make more living things through the process of reproduction.	
Response to stimuli	Living things adjust and respond to changes in their internal and external environments.	
Homeostasis	Living things maintain stable internal conditions.	
Use of energy	Living things use energy for all the processes they perform. Living things get energy by making their own food, eating food, or absorbing food.	

Energy

Everything that a person—or any organism—does requires energy. The Sun is the source of energy for almost all life on Earth. Use the questions below to check students' understanding.

Guiding Questions

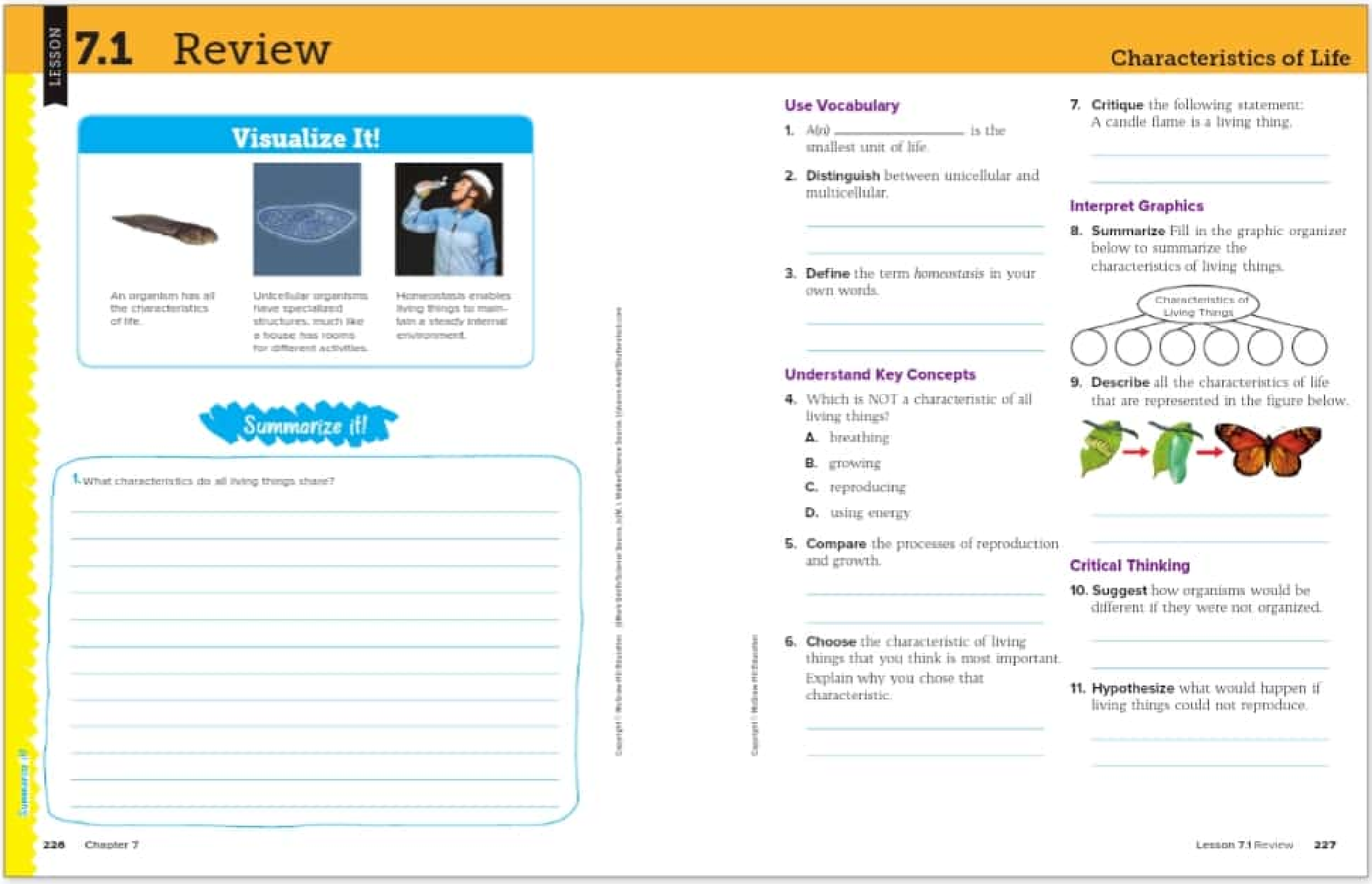
AL	What do cells use energy for?	*They use energy to transport substances, make new cells, and perform chemical reactions.*
OL	Which organisms get their energy directly from the Sun? Which organisms get the Sun's energy indirectly, and how do they get it?	*Plants get their energy directly from the Sun. Animals get the Sun's energy indirectly by either eating plants or eating other animals.*
OL	What characteristics do all living things share?	*All living things are organized, grow and develop, reproduce, respond to stimuli, maintain homeostasis, and use energy.*
OL	From which food sources does the badger in **Figure 6** get energy?	*The badger gets energy from the snake, lizard, and squirrel.*

Visual Literacy: Characteristics of Life

Discuss the six characteristics of life presented in the lesson and summarized in **Table 1** and below. Use the Guiding Questions on the next page to test students' understanding.

Table 1 Characteristics of Life

Characteristic	Definition
Definition	Living things have specialized structures with specialized functions. Living things with more than one cell have a greater level of organization because groups of cells function together.
Growth and development	Living things grow by increasing cell size and/or increasing cell number. Living things develop as cells develop specialized functions.
Reproduction	Living things make more living things through the process of reproduction.
Response to stimuli	Living things adjust and respond to changes in their internal and external environments.
Homeostasis	Living things maintain stable internal conditions.
Use of energy	Living things use energy for all the processes they perform. Living things get energy by making their own food, eating food, or absorbing food.



LESSON 7.1 Review

Characteristics of Life

Visualize It!

An organism has all the characteristics of life.

Unicellular organisms have specialized structures, much like a house has rooms for different activities.

Homeostasis enables living things to maintain a steady internal environment.

Summarize it!

1. What characteristics do all living things share?

Use Vocabulary

1. A(n) __________ is the smallest unit of life.

2. **Distinguish** between unicellular and multicellular.

3. **Define** the term *homeostasis* in your own words.

Understand Key Concepts

4. Which is NOT a characteristic of all living things?
 A. breathing
 B. growing
 C. reproducing
 D. using energy

5. **Compare** the processes of reproduction and growth.

6. **Choose** the characteristic of living things that you think is most important. Explain why you chose that characteristic.

7. **Critique** the following statement: A candle flame is a living thing.

Interpret Graphics

8. **Summarize** Fill in the graphic organizer below to summarize the characteristics of living things.

Characteristics of Living Things

9. **Describe** all the characteristics of life that are represented in the figure below.

Critical Thinking

10. **Suggest** how organisms would be different if they were not organized.

11. **Hypothesize** what would happen if living things could not reproduce.

226 Chapter 7 Lesson 7.1 Review 227

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Characteristics of Life

Use Vocabulary

1. cell **DOK 1**

2. Unicellular organisms are made of only one cell. Multicellular organisms are made of more than one cell. **DOK 2**

3. Sample answer: Homeostasis is keeping an organism's internal conditions stable when external conditions change. **DOK 1**

Understand Key Concepts

4. A. breathing **DOK 1**

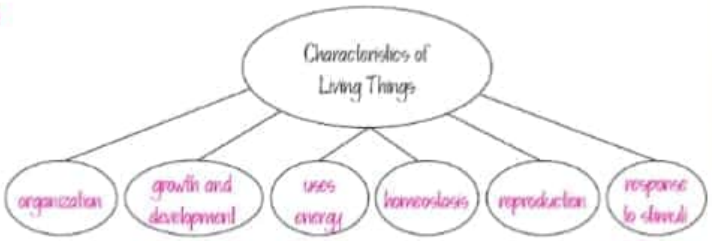
5. Reproduction is the production of a new cell or cells and results in a new organism. Growth usually involves the production of more cells but does not produce a new organism. **DOK 2**

6. Student answers will vary. Sample answer: Energy is the most important characteristic of living things. Without energy, organisms would not be able to perform any other process necessary to live. **DOK 3**

7. A candle flame is not a living thing. A candle flame can respond to wind and can use energy, but it is not organized and cannot reproduce, grow and develop, or maintain homeostasis. **DOK 3**

Interpret Graphics

8.



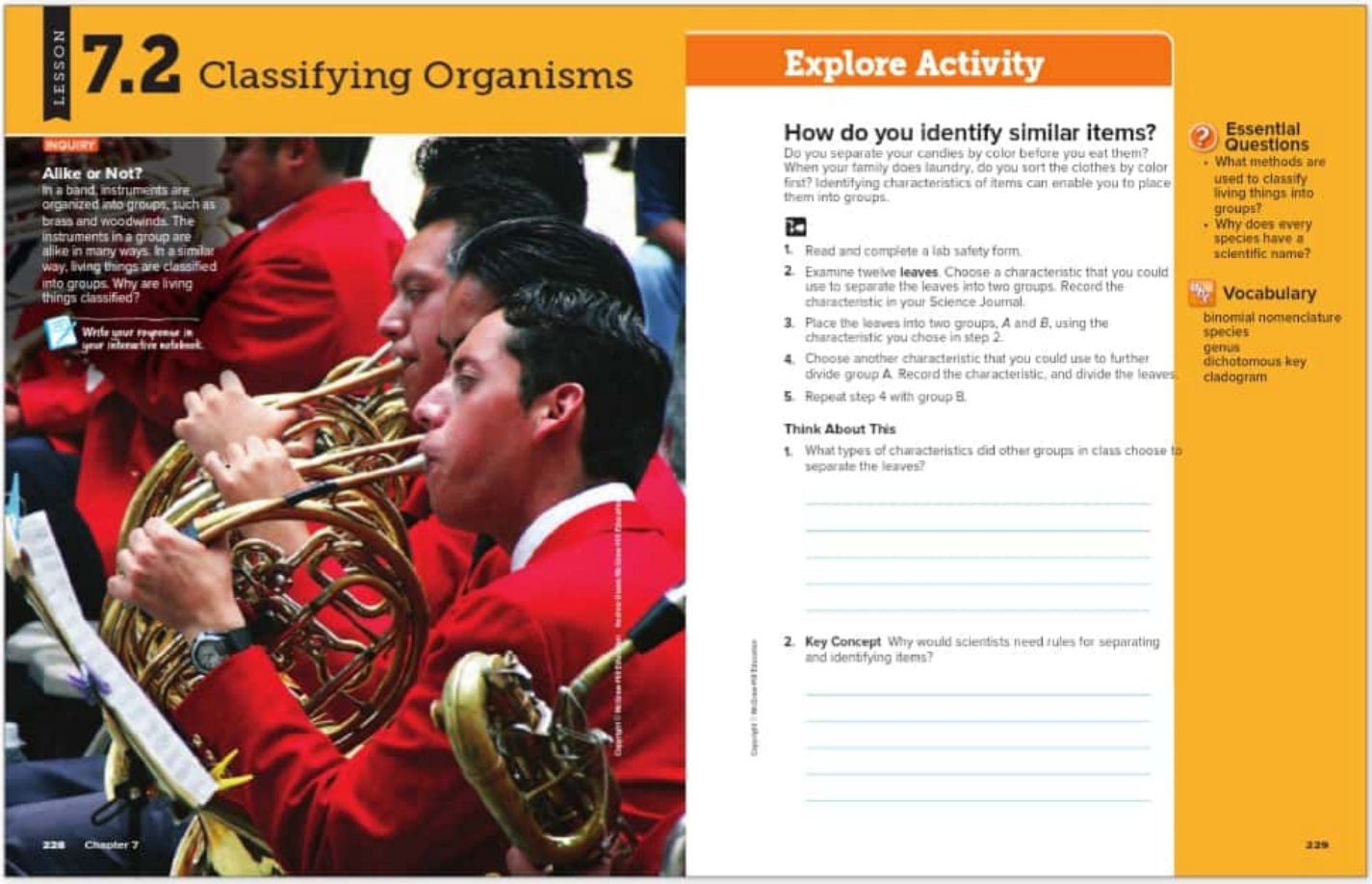
DOK 2

9. growth because the caterpillar increases in size; development because the caterpillar develops into a butterfly; and energy use because the caterpillar is eating food and all these processes require energy **DOK 2**

Critical Thinking

10. Sample answer: Organisms, even unicellular organisms, probably would not be as a complex if organisms did not have specialized structures for carrying out specialized functions. **DOK 3**

11. If living things could not reproduce, then eventually there would not be any living things. **DOK 3**



LESSON 7.2 Classifying Organisms

INQUIRY

Alike or Not?
In a band, instruments are organized into groups, such as brass and woodwinds. The instruments in a group are alike in many ways. In a similar way, living things are classified into groups. Why are living things classified?

Write your response in your interactive notebook.

228 Chapter 7

Explore Activity

How do you identify similar items?

Do you separate your candies by color before you eat them? When your family does laundry, do you sort the clothes by color first? Identifying characteristics of items can enable you to place them into groups.

1. Read and complete a lab safety form.
2. Examine twelve **leaves**. Choose a characteristic that you could use to separate the leaves into two groups. Record the characteristic in your Science Journal.
3. Place the leaves into two groups, *A* and *B*, using the characteristic you chose in step 2.
4. Choose another characteristic that you could use to further divide group A. Record the characteristic, and divide the leaves.
5. Repeat step 4 with group B.

Think About This

1. What types of characteristics did other groups in class choose to separate the leaves?

2. **Key Concept** Why would scientists need rules for separating and identifying items?

Essential Questions
- What methods are used to classify living things into groups?
- Why does every species have a scientific name?

Vocabulary
binomial nomenclature
species
genus
dichotomous key
cladogram

229

INQUIRY

About the Photo **Alike or Not?** Have students identify the instruments shown in the photo. Discuss which instruments are alike in some way, and which are different.

Start the lesson with students generating a list of musical genres, such as jazz, classical, country western, hip hop, and so on. Discuss how each type of music is different from the other, but that they share similar sounds, although the sounds are arranged differently.

Guiding Questions

AL In what way are the instruments in the photo alike? In what way are they different?	*Students should recognize that the instruments require the player to blow into them in order to make a sound, but that they are shaped differently and make different sounds.*
OL What characteristic would you use to group these instruments?	*Students might suggest grouping the instruments by sound or composition.*
BL Why are living things classified?	*Students should recognize that different groups of organisms have unique characteristics.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Be a Word Detective

1. Write the word *nomenclature* on the board or chart paper. Explain that *nomenclature* means "a system or set of names," and comes from the Latin meaning "calling by name." There are sets of nomenclature in art, science, math, and every other subject.
2. Write three subjects as headings, such as *Music, Computers, Fashion* on the board or on chart paper. Have students suggest different nomenclature for each subject. Discuss how the words are specific to that subject. Divide students into small groups. Have each group choose a subject and develop a set of nomenclature for the subject. Encourage students to think creatively.

3. Have each group share its set of nomenclature with the class. Create a list of the words on the board or on chart paper as they are generated by each group. Point out that the words on the vocabulary list are science nomenclature.

ExploreActivity

How do you identify similar items?

Prep: *30 min* **Class:** *15 min*

Purpose
To introduce students to the concept of classification by comparing leaf samples.

Materials
Teacher: 12 leaves from different trees for each student or student group
Optional/Alternate: Any grouping of items that have multiple characteristics can be used. If real leaves are not available, silk leaves from a craft store could be used. Images of leaves and animals are readily available online.

Before You Begin
Remind students to bring their Science Journals. Separate leaf samples into groups of 12 for each student group.

Guide the Investigation
- When students choose the characteristic to use for separation, items in one of the groups should have the characteristic while the items in the other group should not have the characteristic (e.g., blue v. not blue).
- ⚠ Make sure that you can identify poisonous leaves so that you do not select those. Have students wash hands thoroughly with soap and water when finished.

Think About This
1. Answers will vary but will likely include characteristics such as leaf margins (edges), branching or parallel veins, lobes (indents), and so on.
2. Scientists use rules for separating and identifying items so all scientists arrive at the same result if they were classifying the same organism.

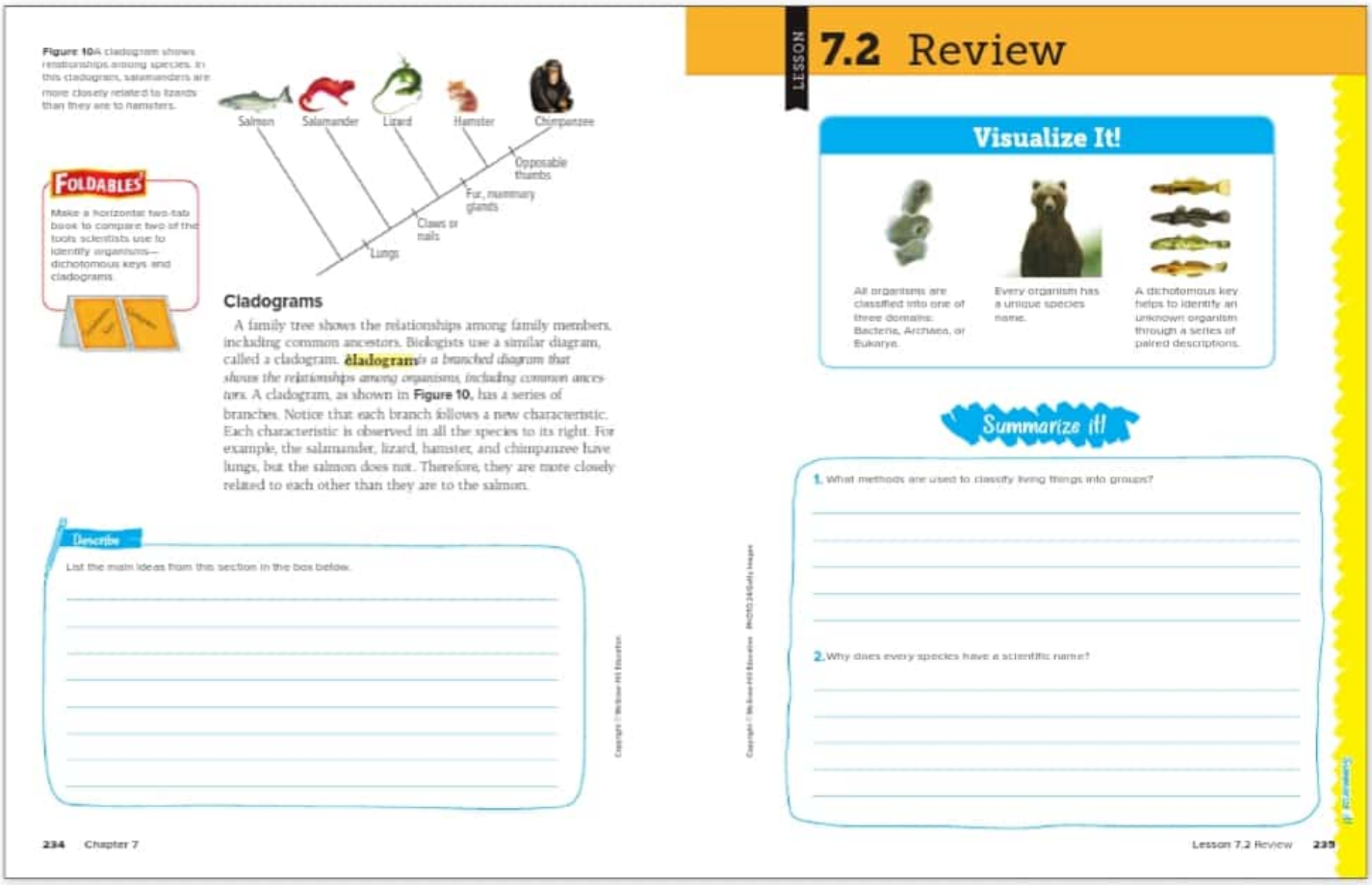


Figure 10 A cladogram shows relationships among species. In this cladogram, salamanders are more closely related to lizards than they are to hamsters.

FOLDABLES

Make a horizontal two-tab book to compare two of the tools scientists use to identify organisms—dichotomous keys and cladograms.

Cladograms

A family tree shows the relationships among family members, including common ancestors. Biologists use a similar diagram, called a cladogram. **cladogram** *is a branched diagram that shows the relationships among organisms, including common ancestors.* A cladogram, as shown in **Figure 10**, has a series of branches. Notice that each branch follows a new characteristic. Each characteristic is observed in all the species to its right. For example, the salamander, lizard, hamster, and chimpanzee have lungs, but the salmon does not. Therefore, they are more closely related to each other than they are to the salmon.

Describe

List the main ideas from this section in the box below.

LESSON 7.2 Review

Visualize It!

All organisms are classified into one of three domains: Bacteria, Archaea, or Eukarya.

Every organism has a unique species name.

A dichotomous key helps to identify an unknown organism through a series of paired descriptions.

Summarize it!

1. What methods are used to classify living things into groups?

2. Why does every species have a scientific name?

Cladograms

After students read the first paragraph, use the scaffolded questions below to connect the information in the paragraph to **Figure 10**.

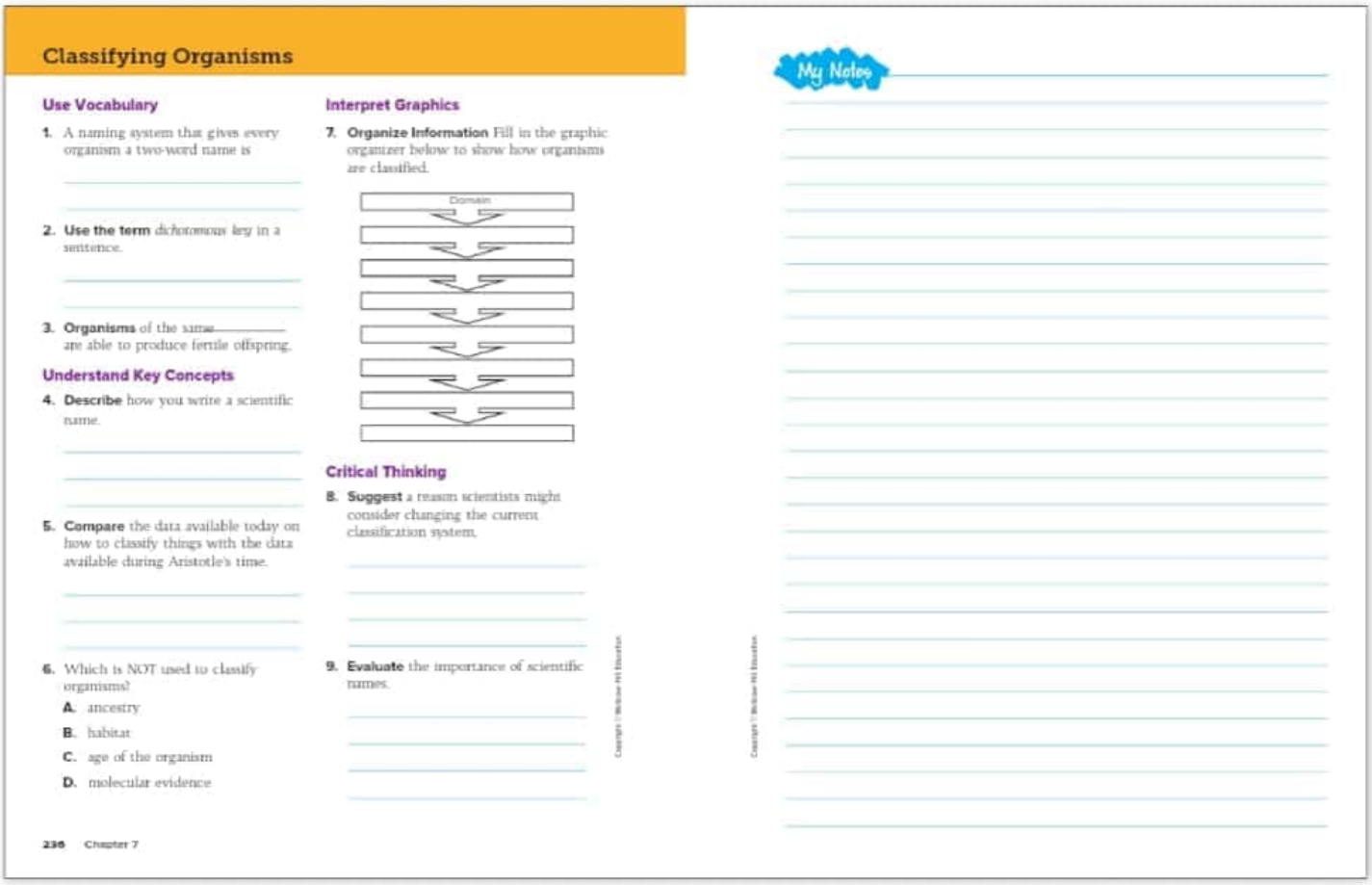
Guiding Questions

AL	What is a cladogram?	*A cladogram is a branched diagram that shows how organisms are related.*
OL	How is a cladogram read?	*All organisms to the right of a characteristic noted on the cladogram have that characteristic. Those organisms to the left do not.*
BL	Which animals on a cladogram are closely related to each other?	*Organisms to the right of a characteristic noted on the cladogram are more closely related.*

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Determining Kingdoms and Determining Domains
- Scientific Names



Classifying Organisms

Use Vocabulary

1. A naming system that gives every organism a two-word name is _____
2. **Use the term** *dichotomous key* in a sentence.
3. **Organisms** of the same _____ are able to produce fertile offspring.

Understand Key Concepts

4. **Describe** how you write a scientific name.
5. **Compare** the data available today on how to classify things with the data available during Aristotle's time.
6. Which is NOT used to classify organisms?
   - A. ancestry
   - B. habitat
   - C. age of the organism
   - D. molecular evidence

Interpret Graphics

7. **Organize Information** Fill in the graphic organizer below to show how organisms are classified.

Critical Thinking

8. **Suggest** a reason scientists might consider changing the current classification system.
9. **Evaluate** the importance of scientific names.

My Notes

Use Vocabulary

1. binomial nomenclature **DOK 1**

2. Sample answer: I used a *dichotomous* key to identify two different trees at my school. **DOK 1**

3. species **DOK 1**

Understand Key Concepts

4. The first word in a scientific name is the genus of the organism. The second word might describe the organism's appearance or its behavior. **DOK 2**

5. Physical and molecular data are available today that were not available during Aristotle's time. **DOK 3**

6. C. age of the organism **DOK 2**

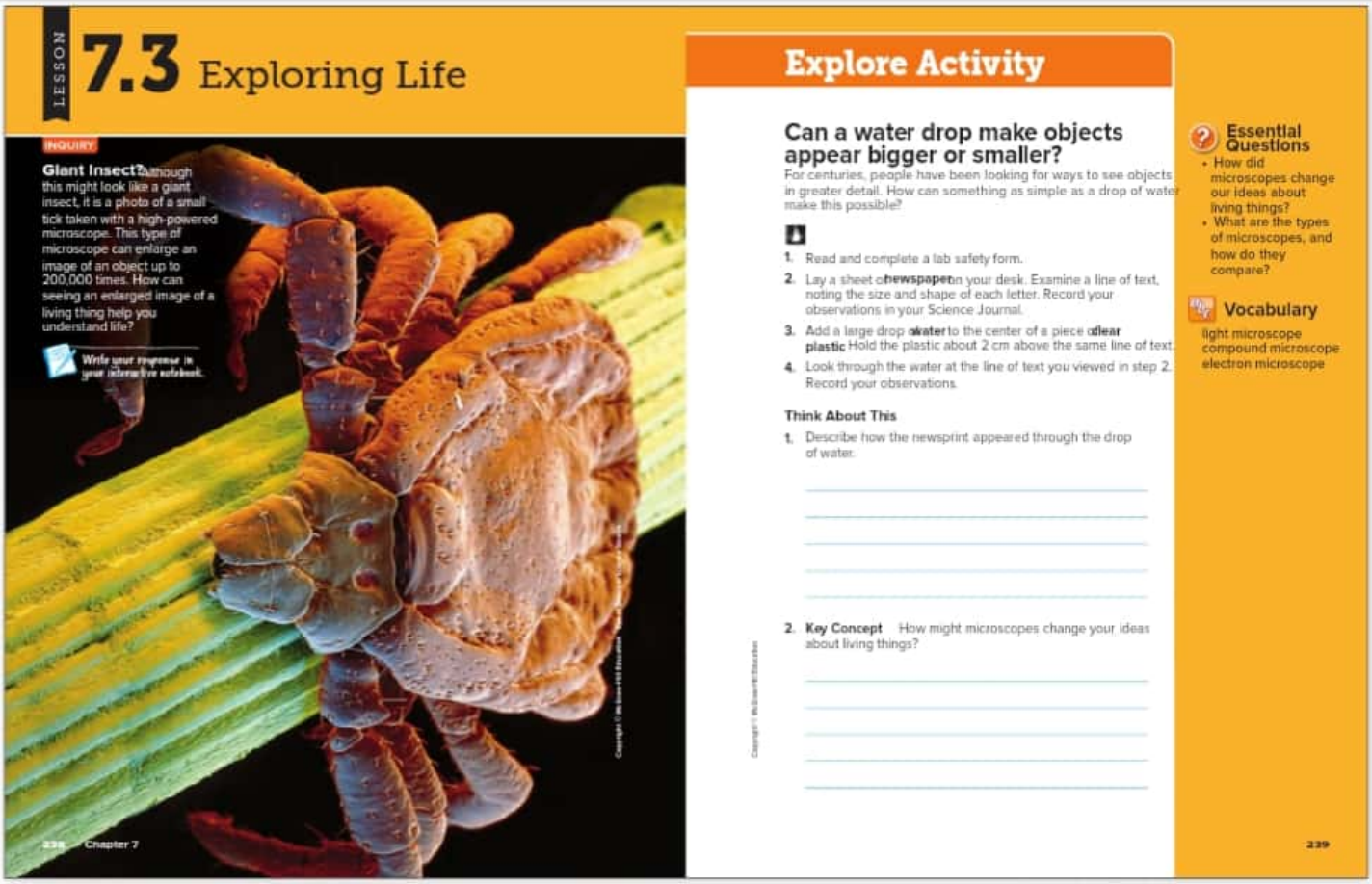
Interpret Graphics

7. From top to bottom: domain, kingdom, phylum, class, order, family, genus, species **DOK 2**

Critical Thinking

8. Answers will vary. Accept any reasonable response. **DOK 3**

9. Scientific names are important because people worldwide use the same name for the same species. **DOK 4**



INQUIRY

About the Photo **Giant Insect?** Ticks are arthropods in the same class as spiders—the arachnids. They are animal parasites and feed on blood. Many of the detailed features of this arachnid would not be visible without a microscope.

Start the lesson with questions about the tick in the photo. Point out some of its external features. Have students count the legs. Tell students that most ticks are 2–6 mm long.

Guiding Questions

AL	What features of the tick can be seen in the microscopic image??	*head, mouthparts, flat body, hairs, and eight legs*
OL	Do you think this image was seen through a magnifying lens or a microscope? Explain.	*The image was seen through a powerful microscope. A magnifying lens isn't powerful enough to show details such as hairs.*
BL	How can seeing an enlarged image of a living thing help you understand life?	*Answers will vary. Some will reply that it makes living things more interesting.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Exploring Life with a Magnifying Lens

1. Students should notice that the three vocabulary words all are kinds of microscopes. Explain that *compound* means "more than one" and that a compound microscope has more than one lens. A simple microscope, such as a magnifying lens, has only one lens.
2. Pair students and give each pair a magnifying lens. Have them choose one living thing or part of a living thing, such as their skin, a strand of hair, or an insect. Have students examine their chosen item with the lens.
3. Have students write in their Science Journals one detail about the item that they learned only by observing it under magnification.

ExploreActivity

Can a water drop make objects appear bigger or smaller?

Prep: *2 min* **Class:** *15 min*

Purpose
To compare an object viewed with the unaided eye and through a water drop.

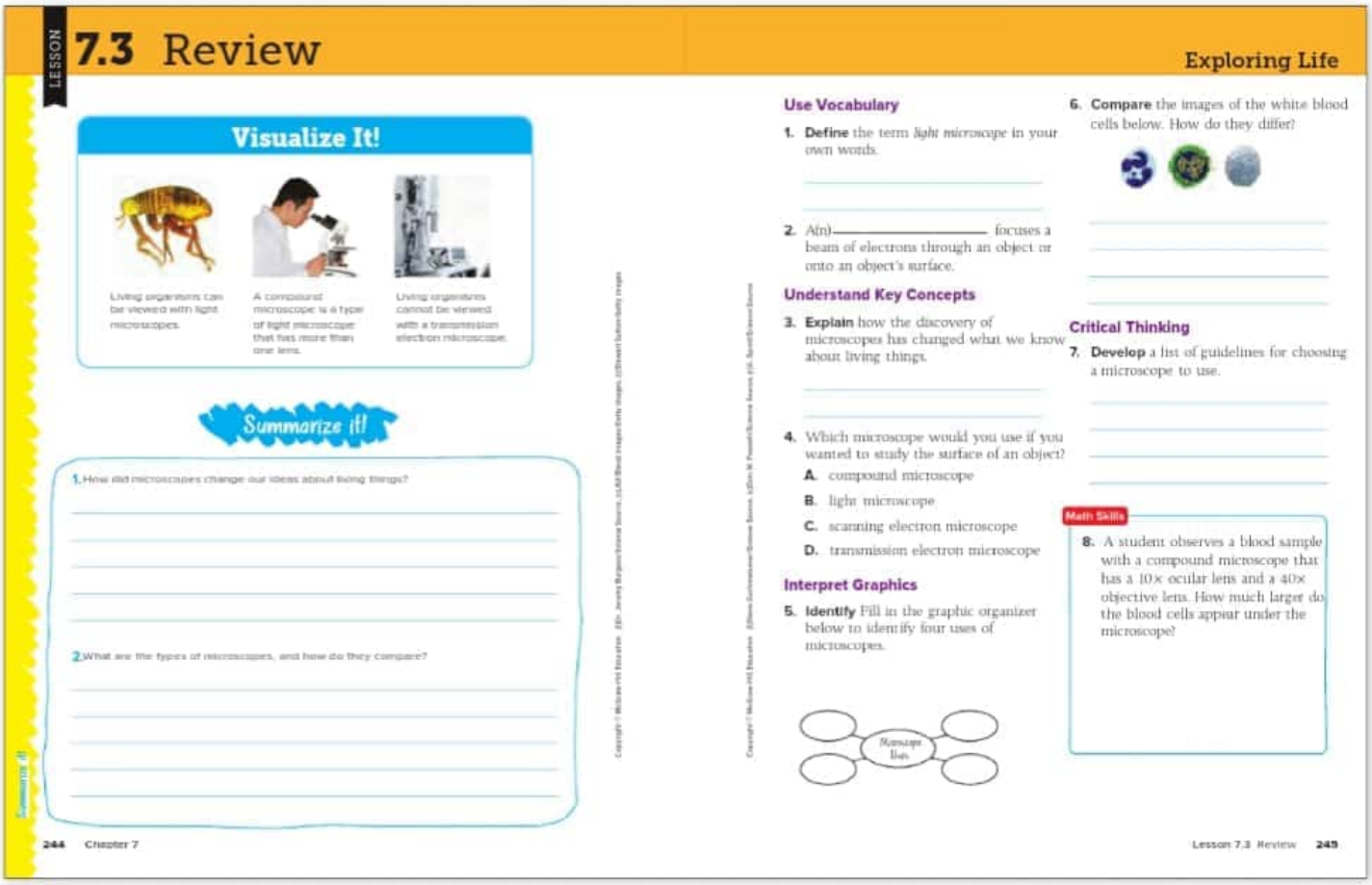
Materials
newspaper, water, clear plastic wrap, dropper

Before You Begin
Gather printed items before the activity. Have paper towels available for spills.

Guide the Investigation
Students will need only a small drop of water. Using too much will cause the water to run off the plastic. A sheet of acetate works as well as plastic.

Think About This
Do not expect students to determine the correct answer. Students should be encouraged to speculate. Use the answer set to guide students' reasoning.

1. The letters looked bigger.
2. Answers will vary, but might include that microscopes enable us to see more details about living things.



LESSON 7.3 Review

Exploring Life

Visualize It!

Living organisms can be viewed with light microscopes.

A compound microscope is a type of light microscope that has more than one lens.

Living organisms cannot be viewed with a transmission electron microscope.

Summarize it!

1. How did microscopes change our ideas about living things?

2. What are the types of microscopes, and how do they compare?

Use Vocabulary

1. **Define** the term *light microscope* in your own words.

2. A(n) _____ focuses a beam of electrons through an object or onto an object's surface.

Understand Key Concepts

3. **Explain** how the discovery of microscopes has changed what we know about living things.

4. Which microscope would you use if you wanted to study the surface of an object?
   - A. compound microscope
   - B. light microscope
   - C. scanning electron microscope
   - D. transmission electron microscope

Interpret Graphics

5. **Identify** Fill in the graphic organizer below to identify four uses of microscopes.

Microscope Uses

6. **Compare** the images of the white blood cells below. How do they differ?

Critical Thinking

7. **Develop** a list of guidelines for choosing a microscope to use.

Math Skills

8. A student observes a blood sample with a compound microscope that has a 10× ocular lens and a 40× objective lens. How much larger do the blood cells appear under the microscope?

244 Chapter 7

Lesson 7.3 Review 245

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: Which key concept does each image relate to?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- The Development of Microscopes
- Types of Microscopes

Use Vocabulary

1. Sample answer: A light microscope uses light and lenses to enlarge an image of an object. **DOK 1**

2. electron microscope **DOK 1**

Understand Key Concepts

3. The invention of microscopes led to the discovery that all living things are made of cells. Microscopes also allow us to study objects and living things in great detail. **DOK 2**

4. **C.** scanning electron microscope **DOK 2**

Interpret Graphics

5. Center oval: *Microscope Uses;* Branches: Student answers may vary and may include surgery, forensic science, study fossils, steel analysis, jewel analysis. **DOK 1**

6. The left image is from a light microscope and shows a stained image of a white blood cell. The center image is from a TEM and shows more detail than the light microscope image. The right image is from an SEM and shows the surface of a white blood cell. **DOK 2**

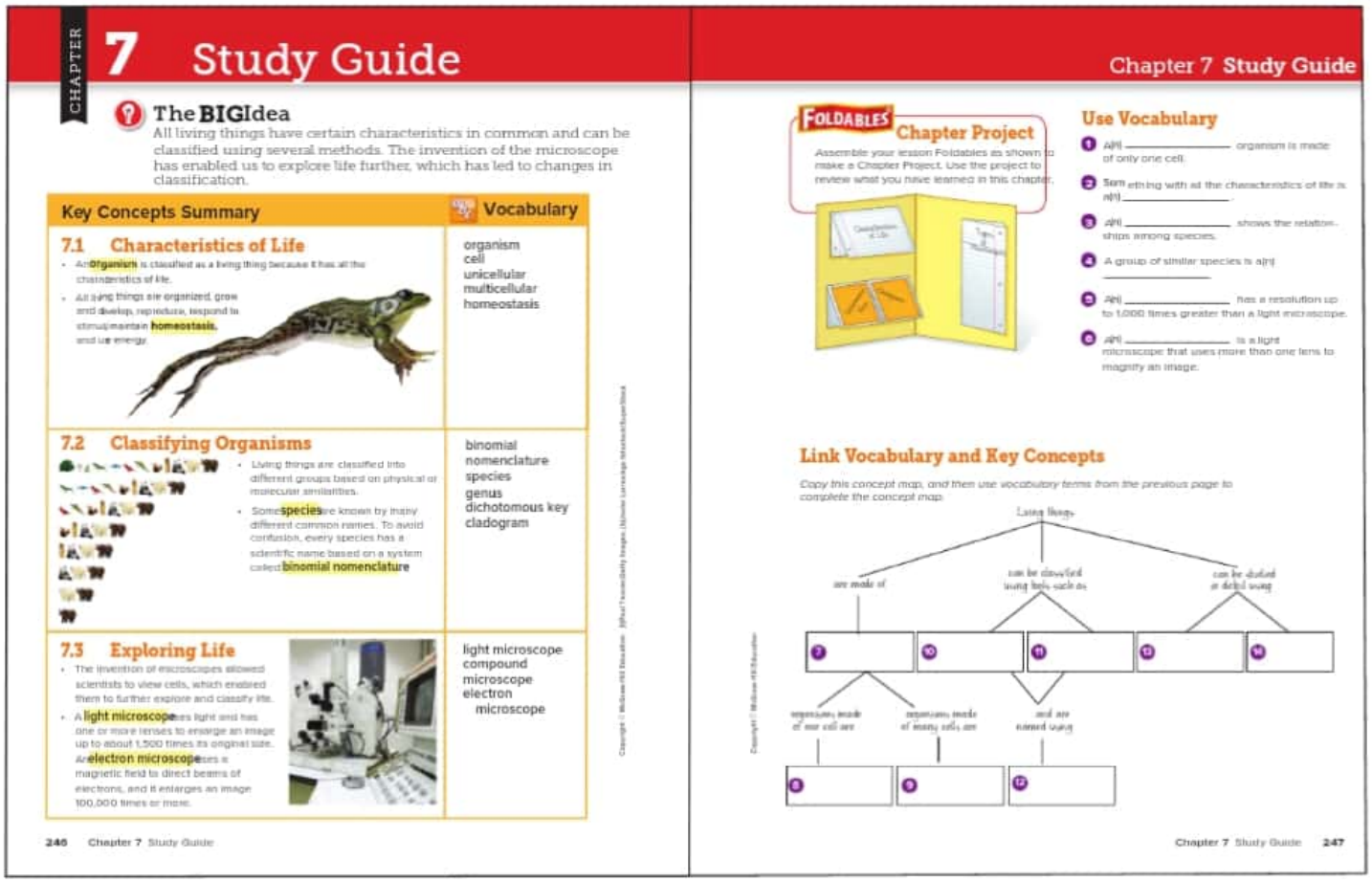
Critical Thinking

7. Sample answers might include the type of object, whether the object is living or dead, whether the inside or the surface of the object is to be studied, or the level of magnification needed. **DOK 3**

Math Skill

Use Multiplication

8. 10 × 40 = 400, so the image is 400 times larger **DOK 1**



CHAPTER 7 Study Guide

The BIG Idea

All living things have certain characteristics in common and can be classified using several methods. The invention of the microscope has enabled us to explore life further, which has led to changes in classification.

Key Concepts Summary

7.1 Characteristics of Life

- An **organism** is classified as a living thing because it has all the characteristics of life.
- All living things are organized, grow and develop, reproduce, respond to stimuli, maintain **homeostasis**, and use energy.

Vocabulary: organism, cell, unicellular, multicellular, homeostasis

7.2 Classifying Organisms

- Living things are classified into different groups based on physical or molecular similarities.
- Some **species** are known by many different common names. To avoid confusion, every species has a scientific name based on a system called **binomial nomenclature**.

Vocabulary: binomial nomenclature, species, genus, dichotomous key, cladogram

7.3 Exploring Life

- The invention of microscopes allowed scientists to view cells, which enabled them to further explore and classify life.
- A **light microscope** uses light and has one or more lenses to enlarge an image up to about 1,500 times its original size. An **electron microscope** uses a magnetic field to direct beams of electrons, and it enlarges an image 100,000 times or more.

Vocabulary: light microscope, compound microscope, electron microscope

246 Chapter 7 Study Guide

Chapter 7 Study Guide

FOLDABLES Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. A(n) _____ organism is made of only one cell.
2. Something with all the characteristics of life is a(n) _____.
3. A(n) _____ shows the relationships among species.
4. A group of similar species is a(n) _____.
5. A(n) _____ has a resolution up to 1,000 times greater than a light microscope.
6. A(n) _____ is a light microscope that uses more than one lens to magnify an image.

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.

Living things

are made of | can be classified using traits such as | can be divided or dated using

7 | 10 | 11 | 13 | 14

organisms made of one cell are | organisms made of many cells are | and are named using

8 | 9 | 12

Chapter 7 Study Guide 247

Key Concepts Summary

Study Strategy: Self-Assessment

Students often complete a reading without thinking about their understanding of the concepts. Self-assessment helps students practice metacognition, increasing their awareness of their understanding.

1. Ask students to draw in their Science Journals a table like the one below, listing the Key Concept questions found on the first page of each lesson.
2. Prompt students to read the Key Concept Summary for each Key Concept question.
3. For each Key Concept question, have them self-assess their understanding and make an x in the appropriate column in the table.
4. Ask students to review any concepts they did not mark I understand.

Example:

Key Concept	I understand	I somewhat understand	I don't understand
What characteristics do all living things share?	X		

Vocabulary

Study Strategy: In Your Own Words

Ask students to write sentences that use the vocabulary words in context. Using words in sentences requires students to understand the meaning of the words and be able to use them correctly.

1. Have students create a two-column table like the one below in their Science Journals.
2. Have them write the vocabulary words in the Study Guide in the left column.
3. Ask students to describe what they know about the chapter's vocabulary words using their own words (without referring to the textbook).

Example:

Vocabulary Word	My Sentence
organism	An organism I didn't recognize jumped into the tall grass.

FOLDABLES®

Use the Foldables® Chapter Project as a way to connect Key Concepts.

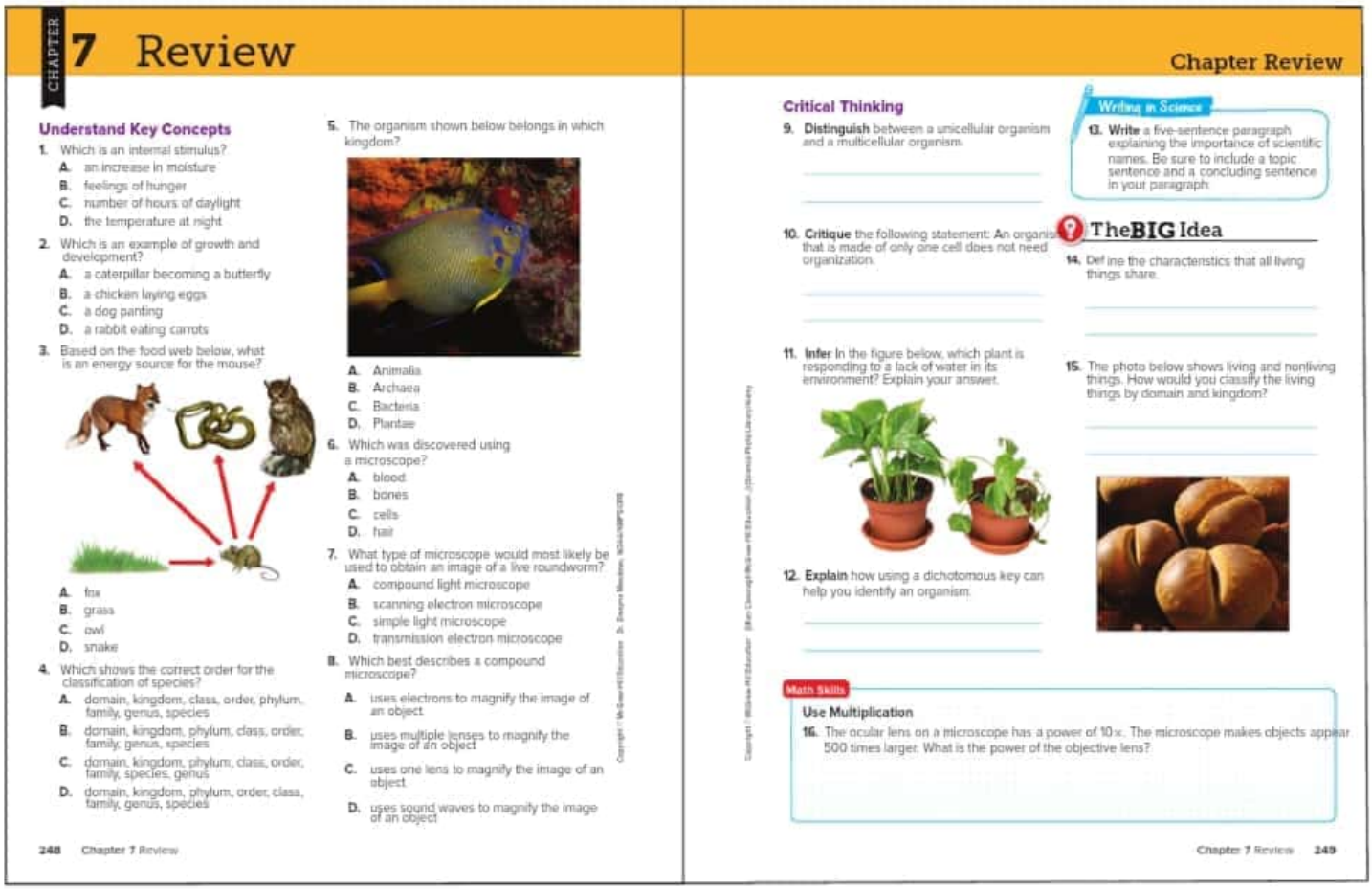
1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

Use Vocabulary

1. unicellular
2. organism
3. cladogram
4. genus
5. electron microscope
6. compound microscope

Link Vocabulary and Key Concepts

7. cells
8. unicellular
9. multicellular
10. **11.** dichotomous keys; cladograms
12. binomial nomenclature
13. **14.** light microscopes; electron microscopes



CHAPTER 7 Review

Understand Key Concepts

1. Which is an internal stimulus?
   - A. an increase in moisture
   - B. feelings of hunger
   - C. number of hours of daylight
   - D. the temperature at night
2. Which is an example of growth and development?
   - A. a caterpillar becoming a butterfly
   - B. a chicken laying eggs
   - C. a dog panting
   - D. a rabbit eating carrots
3. Based on the food web below, what is an energy source for the mouse?

   - A. fox
   - B. grass
   - C. owl
   - D. snake
4. Which shows the correct order for the classification of species?
   - A. domain, kingdom, class, order, phylum, family, genus, species
   - B. domain, kingdom, phylum, class, order, family, genus, species
   - C. domain, kingdom, phylum, class, order, family, species, genus
   - D. domain, kingdom, phylum, order, class, family, genus, species
5. The organism shown below belongs in which kingdom?

   - A. Animalia
   - B. Archaea
   - C. Bacteria
   - D. Plantae
6. Which was discovered using a microscope?
   - A. blood
   - B. bones
   - C. cells
   - D. hair
7. What type of microscope would most likely be used to obtain an image of a live roundworm?
   - A. compound light microscope
   - B. scanning electron microscope
   - C. simple light microscope
   - D. transmission electron microscope
8. Which best describes a compound microscope?
   - A. uses electrons to magnify the image of an object
   - B. uses multiple lenses to magnify the image of an object
   - C. uses one lens to magnify the image of an object
   - D. uses sound waves to magnify the image of an object

248 Chapter 7 Review

Chapter Review

Critical Thinking

9. **Distinguish** between a unicellular organism and a multicellular organism.
10. **Critique** the following statement: An organism that is made of only one cell does not need organization.
11. **Infer** In the figure below, which plant is responding to a lack of water in its environment? Explain your answer.

12. **Explain** how using a dichotomous key can help you identify an organism.

Writing in Science

13. **Write** a five-sentence paragraph explaining the importance of scientific names. Be sure to include a topic sentence and a concluding sentence in your paragraph.

The BIG Idea

14. Define the characteristics that all living things share.
15. The photo below shows living and nonliving things. How would you classify the living things by domain and kingdom?

Math Skills

Use Multiplication

16. The ocular lens on a microscope has a power of 10×. The microscope makes objects appear 500 times larger. What is the power of the objective lens?

Chapter 7 Review 249

Understand Key Concepts

1 B. feelings of hunger

2 A. a caterpillar becoming a butterfly

3 B. grass

4 B. domain, kingdom, phylum, class, order, family, genus, species

5 A. Animalia

6 C. cells

7 C. simple light microscope

8 B. uses multiple lenses to magnify the image of an object

Critical Thinking

9 Unicellular organisms have only one cell. Multicellular organisms contain multiple cells. The cell in a unicellular organism contains structures that perform specialized functions, whereas the cells in a multicellular organism perform specialized functions.

10 A unicellular organism must be organized because the organism has to perform all the functions needed to survive. These functions must be performed by different structures that are specialized for each function.

11 The plant on the right is responding to a lack of water in its environment as evidenced by the wilting leaves.

12 Student answers will vary. Answers should reflect students' understanding of what a dichotomous key is and how to use one to identify an object/organism.

Writing in Science

13 Answers will vary. Sample answer: Scientific names allow persons across the world to communicate about an organism. The scientific name of an organism is specific to that organism. A common name may be used to refer to many similar organisms, or an organism may have more than one common name. The scientific name avoids any confusion that may come from using the common name.

The BIG Idea

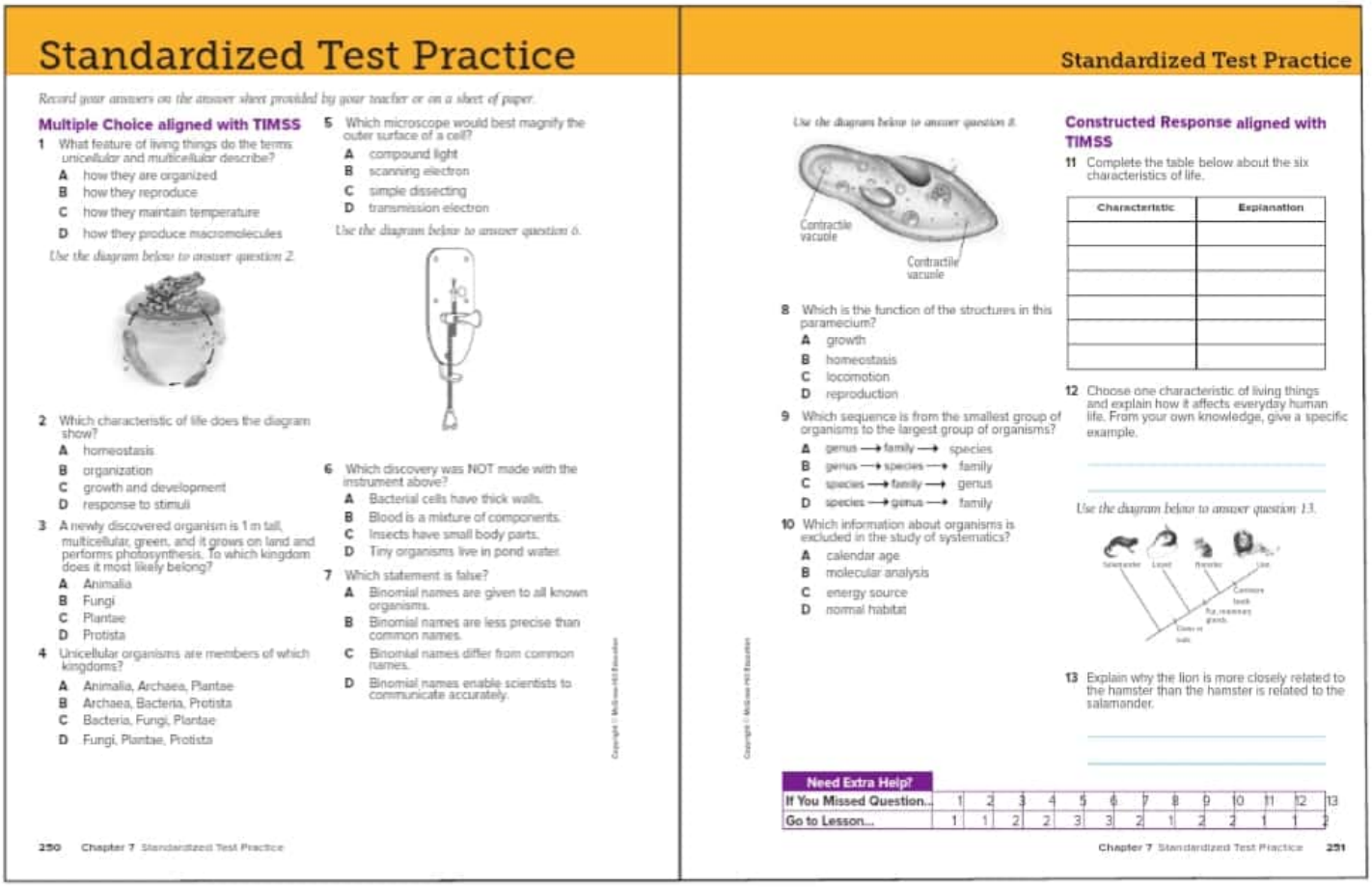
14 All living things share the characteristics of organization, growth and development, reproduction, response to stimuli, homeostasis, and energy use. Organization refers to cells or structures within a cell that are specialized to perform specific functions. Growth refers to the organism increasing in size as the number of cells increases. Development is the series of changes that occurs in an organism during its lifetime. Reproduction is the formation of a new organism. All living things respond to internal or external stimuli. Maintaining homeostasis means that the organism's internal conditions change in response to changes in external conditions. And all living things use energy to perform tasks.

15 Domain Eukarya, kingdom Plantae

Math Skill

Use Multiplication

16 10 × 500 = 5,000, so it looks 5,000 times larger



Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice aligned with TIMSS

1 What feature of living things do the terms *unicellular* and *multicellular* describe?
A how they are organized
B how they reproduce
C how they maintain temperature
D how they produce macromolecules

Use the diagram below to answer question 2.

2 Which characteristic of life does the diagram show?
A homeostasis
B organization
C growth and development
D response to stimuli

3 A newly discovered organism is 1 m tall, multicellular, green, and it grows on land and performs photosynthesis. To which kingdom does it most likely belong?
A Animalia
B Fungi
C Plantae
D Protista

4 Unicellular organisms are members of which kingdoms?
A Animalia, Archaea, Plantae
B Archaea, Bacteria, Protista
C Bacteria, Fungi, Plantae
D Fungi, Plantae, Protista

5 Which microscope would best magnify the outer surface of a cell?
A compound light
B scanning electron
C simple dissecting
D transmission electron

Use the diagram below to answer question 6.

6 Which discovery was NOT made with the instrument above?
A Bacterial cells have thick walls.
B Blood is a mixture of components.
C Insects have small body parts.
D Tiny organisms live in pond water.

7 Which statement is false?
A Binomial names are given to all known organisms.
B Binomial names are less precise than common names.
C Binomial names differ from common names.
D Binomial names enable scientists to communicate accurately.

Use the diagram below to answer question 8.

8 Which is the function of the structures in this paramecium?
A growth
B homeostasis
C locomotion
D reproduction

9 Which sequence is from the smallest group of organisms to the largest group of organisms?
A genus → family → species
B genus → species → family
C species → family → genus
D species → genus → family

10 Which information about organisms is excluded in the study of systematics?
A calendar age
B molecular analysis
C energy source
D normal habitat

Constructed Response aligned with TIMSS

11 Complete the table below about the six characteristics of life.

Characteristic	Explanation

12 Choose one characteristic of living things and explain how it affects everyday human life. From your own knowledge, give a specific example.

Use the diagram below to answer question 13.

13 Explain why the lion is more closely related to the hamster than the hamster is related to the salamander.

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13
Go to Lesson...	1	1	2	2	3	3	2	1	2	2	1	1	2

Multiple Choice

1 A—Correct. B, C, D—The cell is the smallest unit of life. Living things are organized according to their cellular structures. Unicellular organisms consist of just one cell, while multicellular organisms contain from a few to trillions of cells. **DOK 2**

2 C—Correct. A, B, D—The diagram shows the growth and development of a frog. A frog begins as an egg and grows into a tadpole with a tail and gills. The tadpole develops into a frog, it loses its tail and gills and grows legs and lungs. The adult frog then reproduces by laying eggs, and the cycle begins again. **DOK 2**

3 C—Correct. A, B, D—Of the kingdoms listed, only organisms in the Kingdom Plantae are multicellular and are able to produce their own food. The organism's size and ability to grow on land are also consistent with this kingdom. **DOK 2**

4 B—Correct. A, C, D—Kingdoms Bacteria, Archaea, and Protista contain only unicellular organisms. Kingdom Fungi contains both unicellular and multicellular organisms. Kingdoms Plantae and Animalia contain only multicellular organisms. **DOK 2**

5 B—Correct. A, C, D—A scanning electron microscope (SEM) produces a highly detailed, three-dimensional image of an object by bouncing electrons off the object's surface. While light microscopes can also reveal a cell's outer surface, the images are far less detailed than those provided by SEMs. **DOK 2**

6 A—Correct. B, C, D—The diagram is of one of the first microscopes, a single-lens device capable of magnifying objects to about 270 times their original size. Although its magnification would have allowed scientists to observe organisms in pond water, blood cells, and tiny insects, it would not have been capable of revealing the nature of cell walls. **DOK 1**

7 B—Correct. A, C, D—Linnaeus' system of binomial nomenclature gives each organism a specific name. A binomial (two-word) name precisely denotes an organism's species. The first word names the organism's genus, and the second might describe the organism's appearance or behavior. **DOK 2**

8 B—Correct. A, C, D—Because the paramecium lives in a freshwater environment, water continually enters the cell. The contractile vacuoles collect and pump excess water out of the paramecium, which helps to maintain homeostasis. **DOK 2**

9 D—Correct. A, B, C—In the scientific naming system, species is the smallest group of organisms, followed by genus, and then family. A genus contains similar species, and a family contains similar genera. **DOK 2**

10 A—Correct. B, C, D—Using systematics, scientists classify organisms by considering several pieces of evidence, including an organism's habitat, the way it obtains food and energy, and its molecular analysis. Calendar age is not a criterion for classification within systematics. **DOK 2**

Constructed Response

11 Answers may vary. Sample answers:

Characteristic	Explanation
Organization	Organisms have specialized structures with specialized functions.
Growth and development	Living things grow by increasing cell size/ cell number and develop as cells develop specialized functions.
Reproduction	Living things make more living things through reproduction.
Response to stimuli	Living things adjust and respond to changes in their internal/ external environments.
Homeostasis	Living things maintain stable internal environments.
Use of energy	Living things use energy for everything they do. They get energy by eating, absorbing, or making their own food.

DOK 3

12 Answer may vary. Possible answer: Organization: The human body has many parts organized into several systems with different functions. Some parts are external and some are internal. Example: The digestive system digests the food that people eat and gets rid of waste. **DOK 3**

13 Answers may vary. Possible answer: The lion and the hamster differ by one trait on the cladogram, carnivore teeth. The hamster and the salamander differ by two traits. Although there are many other differences between the animals, the two points of difference are enough to separate them by a greater distance. **DOK 3**

Answer Key

Question	Answer
1	A
2	C
3	C
4	B
5	B
6	A
7	B
8	B
9	D
10	A
11	See extended answer.
12	See extended answer.
13	See extended answer.

Science Content Background

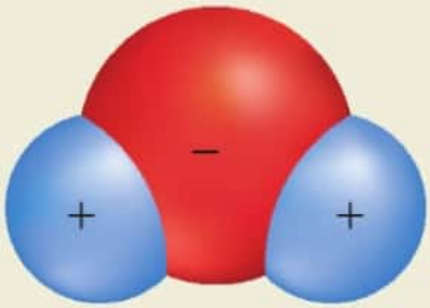
Lesson 1

Cells and Life

The Discovery of Cells The study of cells got its start more than 300 years ago with an English scientist, Robert Hooke, who looked at cork under a microscope. The honeycomblike openings in the cork reminded Hooke of monks' monastery cells, so he called them cells.

The Cell Theory Three German scientists later followed up on Hooke's work and developed the cell theory. This theory states that all living things are made of one or more cells and that all cells come from preexisting cells.

Basic Cell Substances Cells contain a number of components, including water and various large molecules called macromolecules. There are four kinds of macromolecules in cells: nucleic acids, proteins, lipids, and carbohydrates.



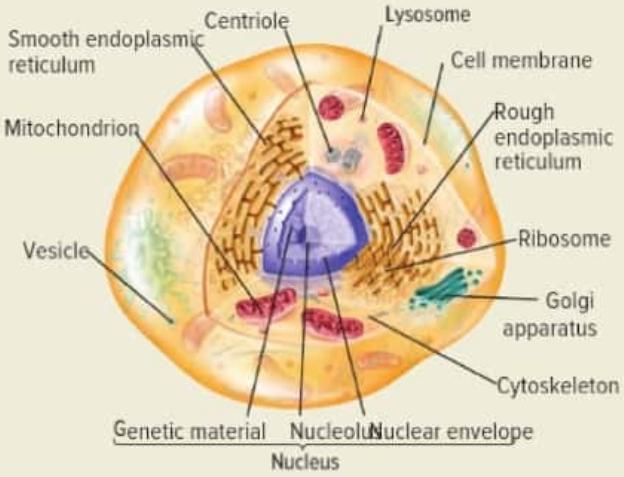
Lesson 2

The Cell

Cell Shape and Movement A cell is made of different structures that perform various functions necessary for the life of the cell. These structures include the cell membrane, the cell wall (in plant cells and bacteria), and cell organelles.

Cell Types There are two kinds of cells—prokaryotic cells and eukaryotic cells. Most prokaryotic cells are unicellular organisms, such as bacteria. Plants and animals are all made of eukaryotic cells, which, with few exceptions, have genetic material surrounded by a membrane.

Cell Organelles Eukaryotic cells contain organelles—structures with specific purposes. A cell's organelles include the nucleus, which contains the cell's genetic material; ribosomes, centers of protein production; and mitochondria, where energy is generated.



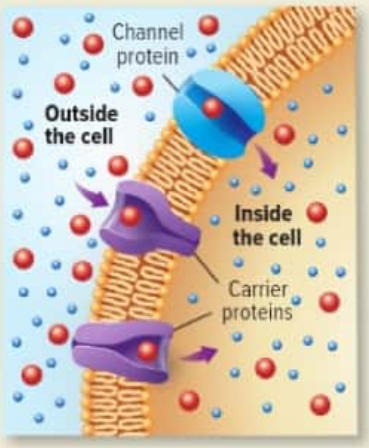
Lesson 3

Moving Cellular Material

Passive Transport This is the movement of substances through a cell membrane without using the cell's energy. Passive transport depends on the amount of a substance, such as oxygen, on each side of a membrane.

Diffusion Diffusion is a type of passive transport involving the movement of substances from an area of higher concentration to an area of lower concentration. One type of diffusion is osmosis, the diffusion of water molecules across a semipermeable cell membrane.

Active Transport This is the transport of a substance through a cell membrane in a way that uses the cell's energy. In contrast with passive transport, active transport involves the movement of substances from areas of lower concentration to areas of higher concentration.



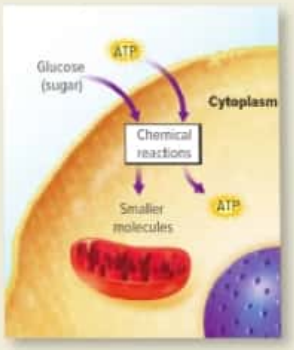
Lesson 4

Cells and Energy

Cellular Respiration This is a series of chemical reactions in which the energy in food molecules is converted into a molecule called ATP, which provides energy to the cell.

Fermentation Fermentation is a process that cells use to obtain energy from food when oxygen levels are low. Because no oxygen is used, fermentation makes less ATP than cellular respiration does.

Photosynthesis Plants use the energy of sunlight to produce the sugar glucose from water and carbon dioxide in a series of chemical reactions called photosynthesis. Oxygen is produced as a by-product of these reactions.



Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

* All living things are composed of cells, from just one to many millions, whose details are usually visible only through a microscope.

* Within cells, many of the basic functions of organisms—such as extracting energy from food and getting rid of waste—are carried out.

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

Lesson 1
Cells and Life

1 The invention of the microscope led to discoveries about cells.

2 Cells are composed mainly of water, proteins, nucleic acids, lipids, and carbohydrates.

Lesson 2
The Cell

3 How are prokaryotic and eukaryotic cells similar and how are they different?

3a A prokaryotic cell lacks a nucleus and membrane-bound organelles.

3b A eukaryotic cell has a nucleus and membrane-bound organelles.

4 Cell structures have specific functions, such as supporting or moving a cell, processing energy and transporting molecules.

Lesson 3
Moving Cellular Material

5 Materials enter and leave a cell through the cell membrane using passive transport or active transport endocytosis, and exocytosis.

6 Because a cell has a high surface-area-to-volume ratio, materials can easily move to all parts of a cell.

Lesson 4
Cells and Energy

7 A cell obtains energy from food molecules through cellular respiration and/or fermentation.

8 Some cells make food molecules using light energy, water, and carbon dioxide through the process of photosynthesis.

Identifying Misconceptions

Prokaryotic and Eukaryotic Cells

Find Out What Students Think

Students may think that...

... prokaryotic cells are plant cells and eukaryotic cells are animal cells.

Discussion

Review the difference between prokaryotic cells and eukaryotic cells by helping students build a model cell. Using three sheets of chart paper, draw a large oval on each sheet of paper. Label one shape *prokaryotic* and the other two shapes *eukaryotic*. Prepare shapes from construction paper to represent the following organelles: nucleus, mitochondrion, endoplasmic reticulum, chloroplast, and Golgi apparatus. Have pieces of yarn cut to represent the DNA found in prokaryotic cells. Finally, have colored markers for adding the cell wall to the prokaryotic and plant cells and the cytoplasm to all three cells. **Ask:** What is found in a prokaryotic cell? Add items to the cell drawn on the chart paper as students respond. **Ask:** What is found in a eukaryotic plant cell? Add the term *plant* to the chart paper and build the cell as students respond. **Ask:** What is found in a eukaryotic cell that is not a plant cell? Build the eukaryotic cell as students respond. Remind students that most prokaryotic cells are unicellular organisms, and that plants, fungi, animals, and protists are made from eukaryotic cells.

Promote Understanding

Activity Help students understand the similarities and differences between prokaryotic cells and eukaryotic cells.

1. Divide the class into groups of three. Give each group a set of markers, card stock, various colors of construction paper, scissors, and glue.
2. Explain that each group is to design two puzzles—one for a prokaryotic cell and one for a eukaryotic cell. Students should create each cell, laminate their cells if possible, and then cut them into puzzle shapes of their choosing.
3. Student groups should exchange puzzles for reconstruction.
4. As a group, discuss the differences between prokaryotic and eukaryotic cells.

Cellular Respiration and Photosynthesis

Find Out What Students Think

Students may think that...

... cellular respiration and photosynthesis occur in both plant and animal cells.

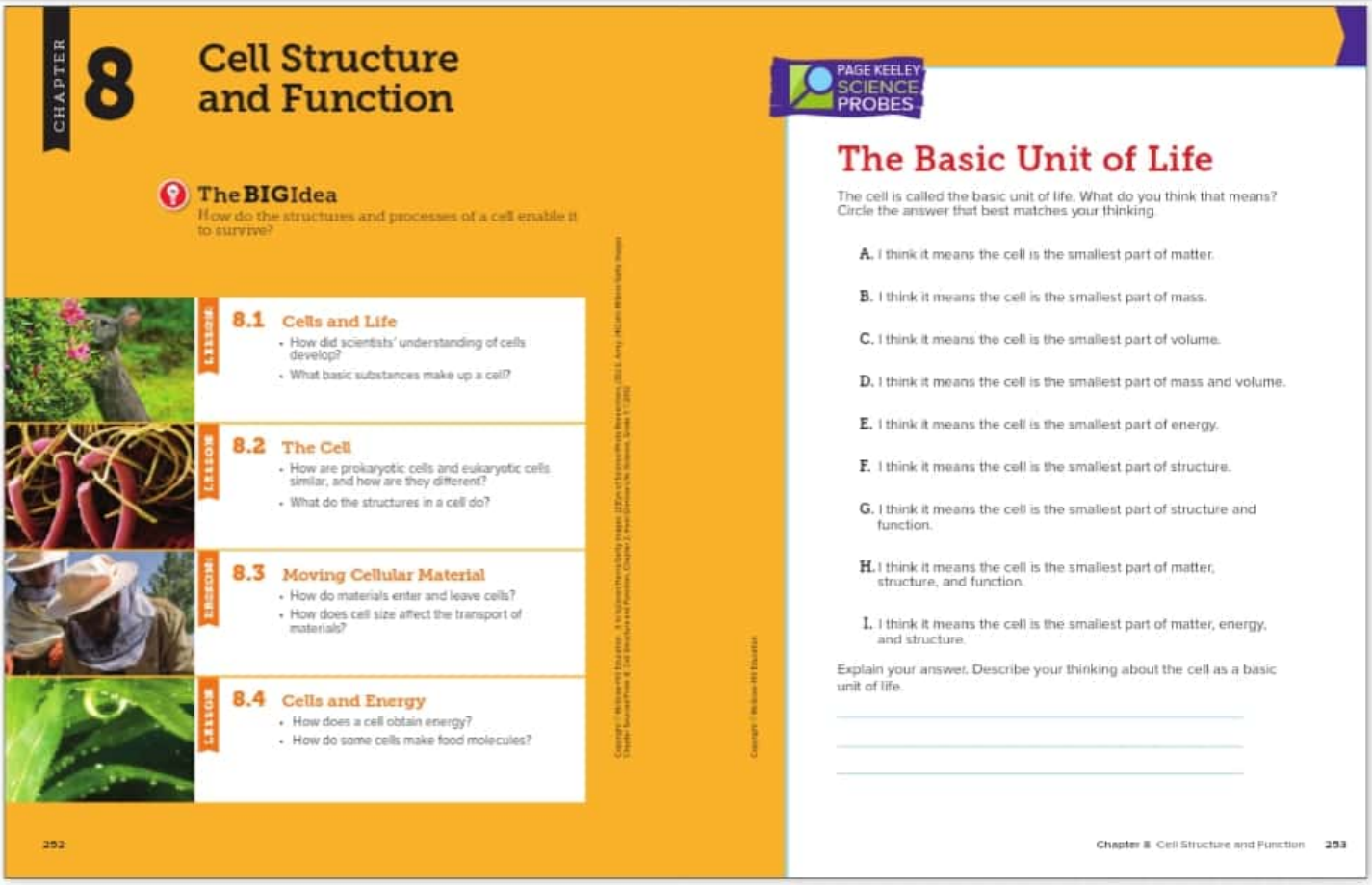
Discussion

Have on hand two containers with lids—one container marked *mitochondrion* and the second container marked *chloroplast,* and different-colored objects (such as interlocking blocks) to represent glucose, ATP, oxygen, carbon dioxide, sunlight, and water. Place objects representing ATP, water, and carbon dioxide in the container marked *mitochondrion.* **Ask:** What is needed for cellular respiration to occur? As students respond, place objects representing glucose molecules and oxygen in the mitochondrion container. **Ask:** What is formed as a result of cellular respiration? As students respond, take out the objects representing ATP, water, and carbon dioxide. **Ask:** What happened to the glucose molecules and oxygen? **They were used to form ATP, water, and carbon dioxide.** Using the carbon dioxide removed from the *mitochondrion,* repeat the exercise for photosynthesis using the *chloroplast* container. Then take the oxygen produced by photosynthesis and place it in the *mitochondrion* container and repeat both examples. Discuss the production of energy in animal and plant cells, and the interchange of oxygen and carbon dioxide.

Promote Understanding

Activity Hand out one of the following to each student: a large C, H, O, +.

1. Write *cellular respiration* on the board or chart paper. Ask the class what is needed for cellular respiration (one glucose molecule and six O_2). Have students come to the front of the room to create a molecule of glucose and six O_2.
2. Have students regroup to form the products of cellular respiration—carbon dioxide, water, and energy.
3. Write *photosynthesis* on the board or chart paper. Repeat the activity beginning with oxygen and water.
4. Discuss the similarities and differences between the two processes.



CHAPTER 8

Cell Structure and Function

The BIG Idea

How do the structures and processes of a cell enable it to survive?

LESSON 8.1 Cells and Life
- How did scientists' understanding of cells develop?
- What basic substances make up a cell?

LESSON 8.2 The Cell
- How are prokaryotic cells and eukaryotic cells similar, and how are they different?
- What do the structures in a cell do?

LESSON 8.3 Moving Cellular Material
- How do materials enter and leave cells?
- How does cell size affect the transport of materials?

LESSON 8.4 Cells and Energy
- How does a cell obtain energy?
- How do some cells make food molecules?

252

PAGE KEELEY SCIENCE PROBES

The Basic Unit of Life

The cell is called the basic unit of life. What do you think that means? Circle the answer that best matches your thinking.

A. I think it means the cell is the smallest part of matter.

B. I think it means the cell is the smallest part of mass.

C. I think it means the cell is the smallest part of volume.

D. I think it means the cell is the smallest part of mass and volume.

E. I think it means the cell is the smallest part of energy.

F. I think it means the cell is the smallest part of structure.

G. I think it means the cell is the smallest part of structure and function.

H. I think it means the cell is the smallest part of matter, structure, and function.

I. I think it means the cell is the smallest part of matter, energy, and structure.

Explain your answer. Describe your thinking about the cell as a basic unit of life.

Chapter 8 Cell Structure and Function 253

Cell Structure and Function

The BIG Idea

There are no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL	What processes are necessary for a plant or animal to stay alive?	*This question gets students thinking about the processes of consuming food, converting food to energy, respiration, and removing wastes as necessary for survival.*
OL	How do you think the structures and processes of a cell enable it to survive?	*This question initiates students' thinking about the many functions a cell must perform in order to survive and relates the importance of individual cell functions to the survival of the plant or animal.*
BL	Why is it important for some molecules to move in and out of a cell?	*This question helps students understand that a cell is not a closed environment, but that it must interact with its outer environment in order to survive.*

Get Ready to Read

What do you think?

Use this anticipation guide to gauge students' background knowledge and preconceptions about cell structure and function. At the end of each lesson, ask students to read and evaluate their earlier responses. Students should be encouraged to change any of their responses.

Anticipation Set for Lesson 1

1. Nonliving things have cells.

Disagree. Cells are found only in living things.

2. Cells are made mostly of water.

Agree. Water makes up more than 75 percent of a cell's volume.

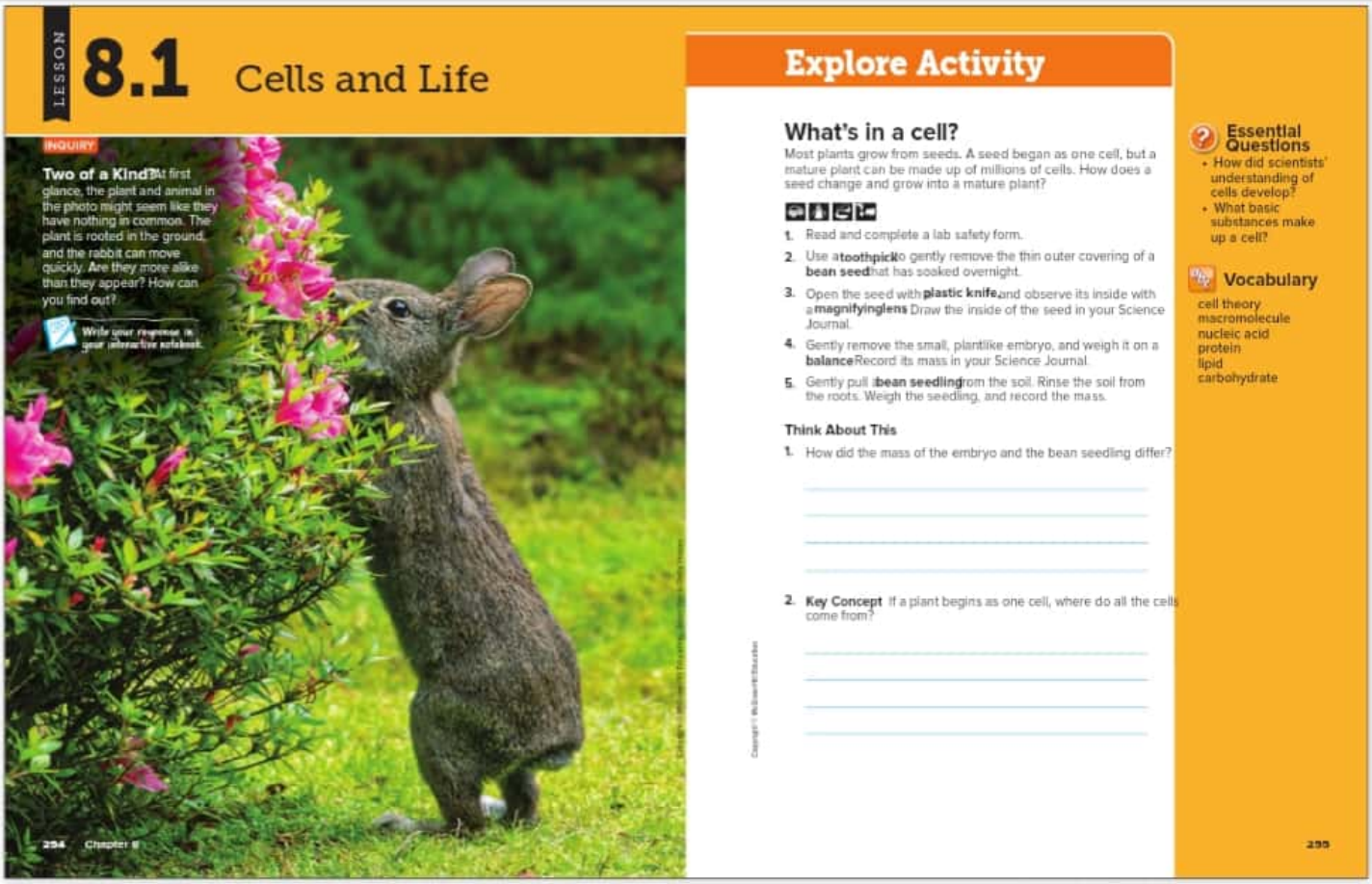
Anticipation Set for Lesson 2

3. Different organisms have cells with different structures.

Agree. Two cells with two different functions will also have different structures.

4. All cells store genetic information in their nuclei.

Disagree. Prokaryotic cells do not have nuclei. DNA is located in the cytoplasm.



INQUIRY

About the Photo **Two of a Kind?** Although the rabbit is an animal and the azalea is a plant, both are biological organisms composed of cells. Start the lesson with questions about the nature of cells.

Guiding Questions

AL	In what ways are plants and animals different?	*Students should be able to name some obvious differences between the two, including mobility, or the lack of it, and the fact that many animals eat plants.*
OL	In what fundamental way are plants and animals the same?	*Explain that both plants and animals are made up of cells that have many similarities, including the same kinds of genetic material—DNA and RNA.*
BL	Do the similarities between plants and animals outweigh the differences, or vice versa?	*Explain that the answer depends on what level of organization you are considering. At the level of the entire organism, differences predominate. At the microscopic level, plants and animals are more similar than different.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Build a Class Definition

1. Write the word *cell* on chart paper or the board.
2. **Ask: What are some common nonbiological uses of this word?** *cell phone, prison cell, storm cell, spy cell.* Explain to students that a cell is an individual unit within a large collection of identical, or similar, units.
3. Ask students how this general definition of a cell relates to the cells of organisms. Develop a class definition for *cell*. Students should record the agreed-on definition in their Science Journals.

ExploreActivity

What's in a cell?

Prep: *5 min* **Class:** *10 min*

Purpose
To compare one cell of a plant (a seed) to many cells of a plant (a seedling).

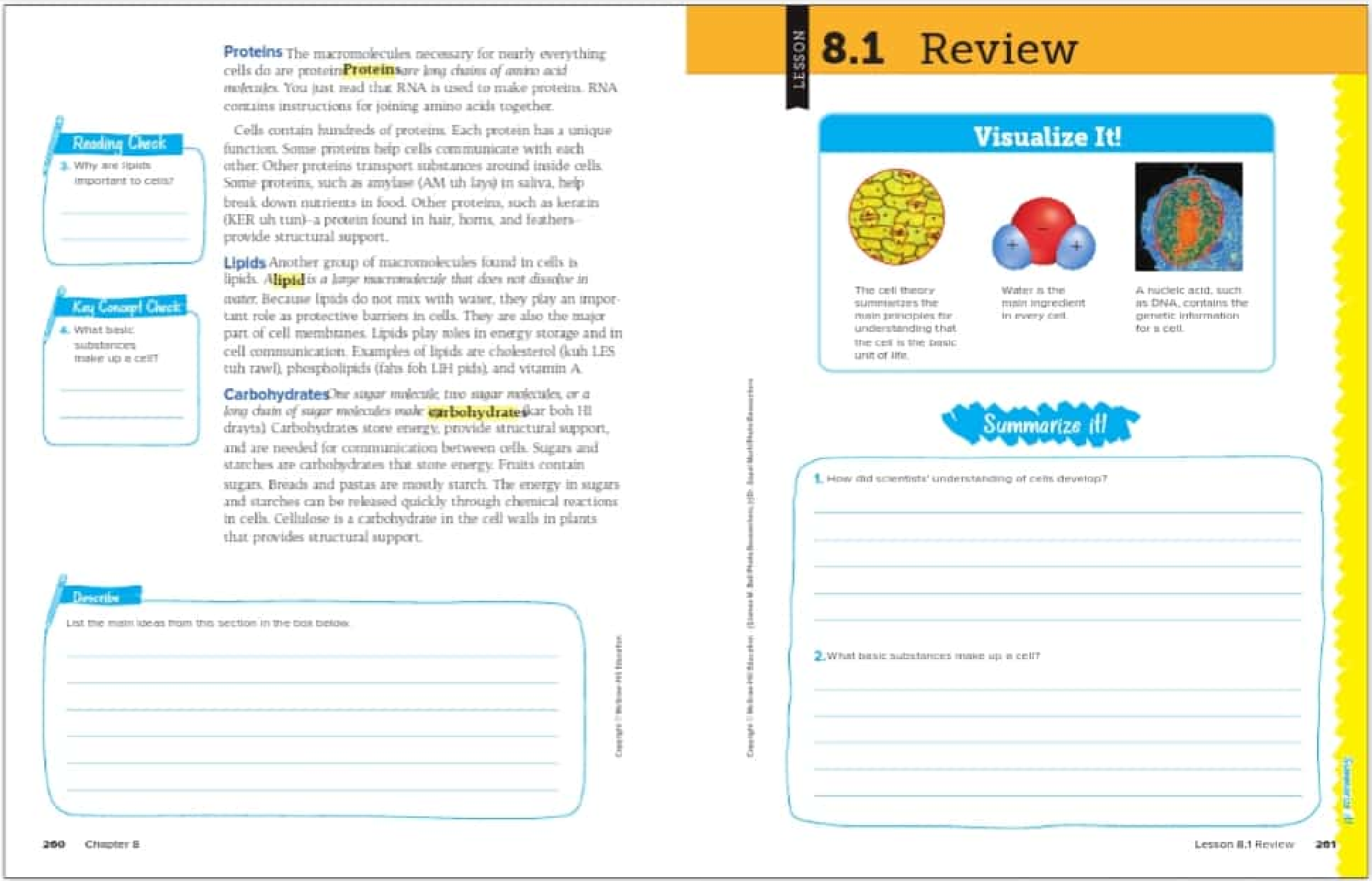
Materials
bean seed, bean seedling, toothpick, plastic knife, magnifying lens, sheet of paper, balance, self-sealing plastic bag

Before You Begin
- Lima beans work well for this activity. If using dry beans, soak in water overnight. Use toothpicks and plastic knives to gently remove the coat and open up the seed.
- Bean seedlings can be grown in small pots or cups. Seedlings can also be grown in a clear self-sealing plastic bag. Moisten a paper towel and place in bag. Place bean seed on moist paper towel inside bag. Seal bag and place in sunny area. Make sure to add water to the paper towel if it dries out.

Guide the Investigation
- Ask students to define the word *embryo* and discuss examples of embryos in the animal world. Talk about whether or not students had been aware that plant seeds contain embryos.
- **Troubleshooting** Emphasize the need to gently and carefully pull apart the seed so the interior of the seed is not destroyed.

Think About This
Do not expect students to determine the correct answer. Students should be encouraged to speculate. Use the answer set to guide students' reasoning.

1. Student answers will vary. The mass of the bean seedling will be much greater than the mass of the bean embryo.
2. Student answers will vary. Possible answer: All the cells in the plant came from the original cell in the seed.



Proteins The macromolecules necessary for nearly everything cells do are proteins. **Proteins** *are long chains of amino acid molecules.* You just read that RNA is used to make proteins. RNA contains instructions for joining amino acids together.

Cells contain hundreds of proteins. Each protein has a unique function. Some proteins help cells communicate with each other. Other proteins transport substances around inside cells. Some proteins, such as amylase (AM uh lays) in saliva, help break down nutrients in food. Other proteins, such as keratin (KER uh tun)–a protein found in hair, horns, and feathers–provide structural support.

Reading Check

3. Why are lipids important to cells?

Key Concept Check

4. What basic substances make up a cell?

Lipids Another group of macromolecules found in cells is lipids. A **lipid** *is a large macromolecule that does not dissolve in water.* Because lipids do not mix with water, they play an important role as protective barriers in cells. They are also the major part of cell membranes. Lipids play roles in energy storage and in cell communication. Examples of lipids are cholesterol (kuh LES tuh rawl), phospholipids (fahs foh LIH pids), and vitamin A.

Carbohydrates *One sugar molecule, two sugar molecules, or a long chain of sugar molecules make* **carbohydrates** (kar boh HI drayts). Carbohydrates store energy, provide structural support, and are needed for communication between cells. Sugars and starches are carbohydrates that store energy. Fruits contain sugars. Breads and pastas are mostly starch. The energy in sugars and starches can be released quickly through chemical reactions in cells. Cellulose is a carbohydrate in the cell walls in plants that provides structural support.

Describe

List the main ideas from this section in the box below.

260 Chapter 8

LESSON **8.1 Review**

Visualize It!

The cell theory summarizes the main principles for understanding that the cell is the basic unit of life.

Water is the main ingredient in every cell.

A nucleic acid, such as DNA, contains the genetic information for a cell.

Summarize it!

1. How did scientists' understanding of cells develop?

2. What basic substances make up a cell?

Lesson 8.1 Review 261

Proteins, Lipids, and Carbohydrates

These are the main constituents of cells, along with nucleic acids. Students should learn that each substance has important functions.

Guiding Questions

AL How are proteins manufactured in a cell?	*RNA makes them by linking together building blocks called amino acids.*
AL What basic substances make up a cell?	*nucleic acids, proteins, lipids, and carbohydrates*
OL Why are lipids important to cells?	*Because lipids don't mix with water, they act as protective barriers in cells. They also make up cholesterols and hormones that play important roles in our bodies.*

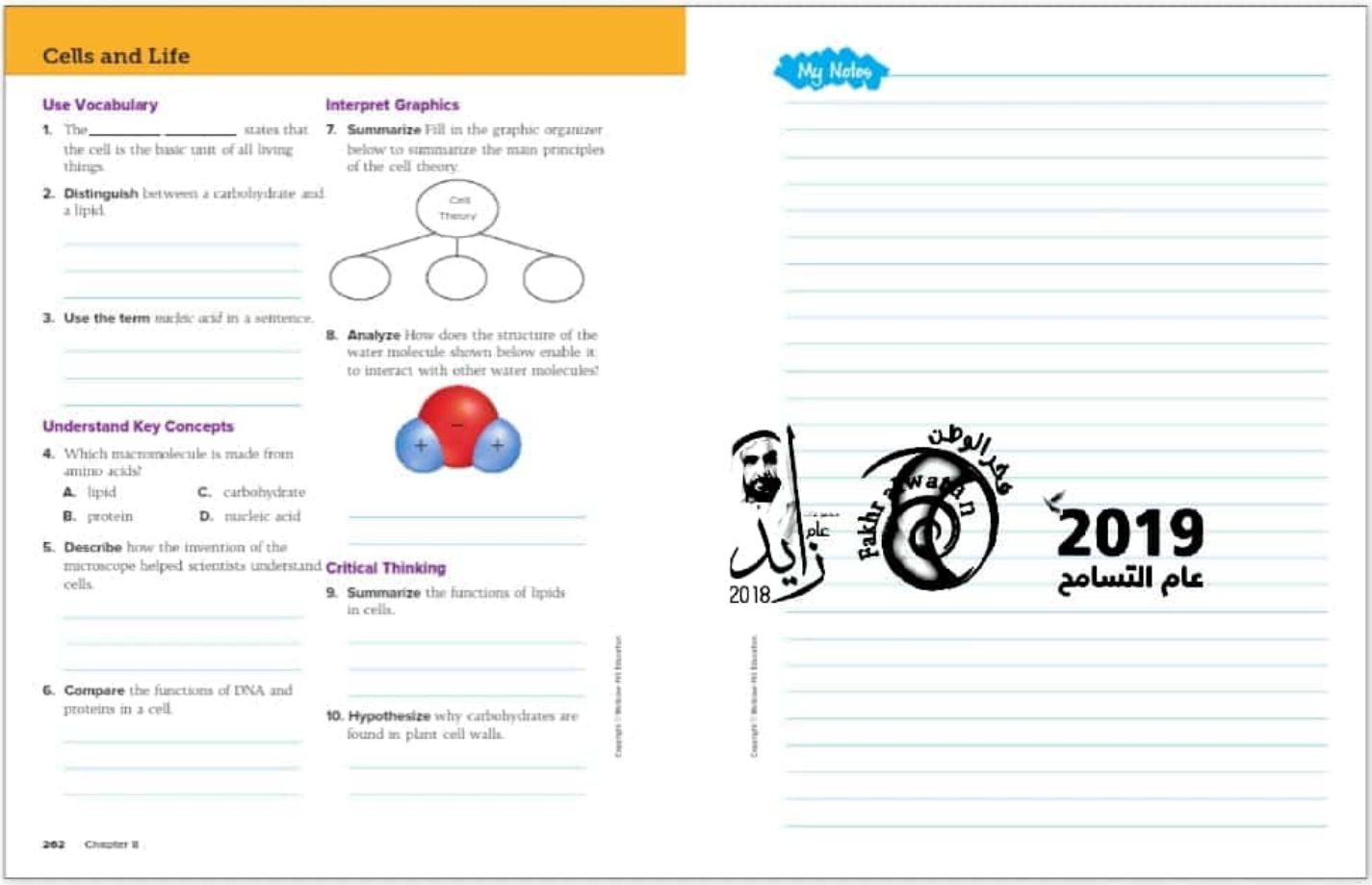
Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask**: **To which Key Concept does each image relate?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Understanding Cells
- Basic Cell Substances



Cells and Life

Use Vocabulary

1. The _____ _____ states that the cell is the basic unit of all living things.
2. **Distinguish** between a carbohydrate and a lipid.
3. **Use the term** nucleic acid in a sentence.

Understand Key Concepts

4. Which macromolecule is made from amino acids?
   A. lipid C. carbohydrate
   B. protein D. nucleic acid
5. **Describe** how the invention of the microscope helped scientists understand cells.
6. **Compare** the functions of DNA and proteins in a cell.

Interpret Graphics

7. **Summarize** Fill in the graphic organizer below to summarize the main principles of the cell theory.

8. **Analyze** How does the structure of the water molecule shown below enable it to interact with other water molecules?

Critical Thinking

9. **Summarize** the functions of lipids in cells.
10. **Hypothesize** why carbohydrates are found in plant cell walls.

My Notes

Use Vocabulary

1. cell theory **DOK 1**
2. Carbohydrates are sugars that store energy, provide structural support, and are needed for communication between cells. Lipids are fats which are not soluble in water and act as protective barriers in cells. **DOK 2**
3. Sample answers might include: DNA and RNA are nucleic acids. Nucleic acids are made up of nucleotides. Nucleic acids contain genetic information. **DOK 1**

Understand Key Concepts

4. **B**. protein **DOK 1**
5. The invention of the microscope enabled scientists to see the structure and function of cells. **DOK 1**
6. DNA stores genetic information, whereas proteins are used for many functions, such as communication between cells, transport of materials, structural support, and the breaking down nutrients. **DOK 3**

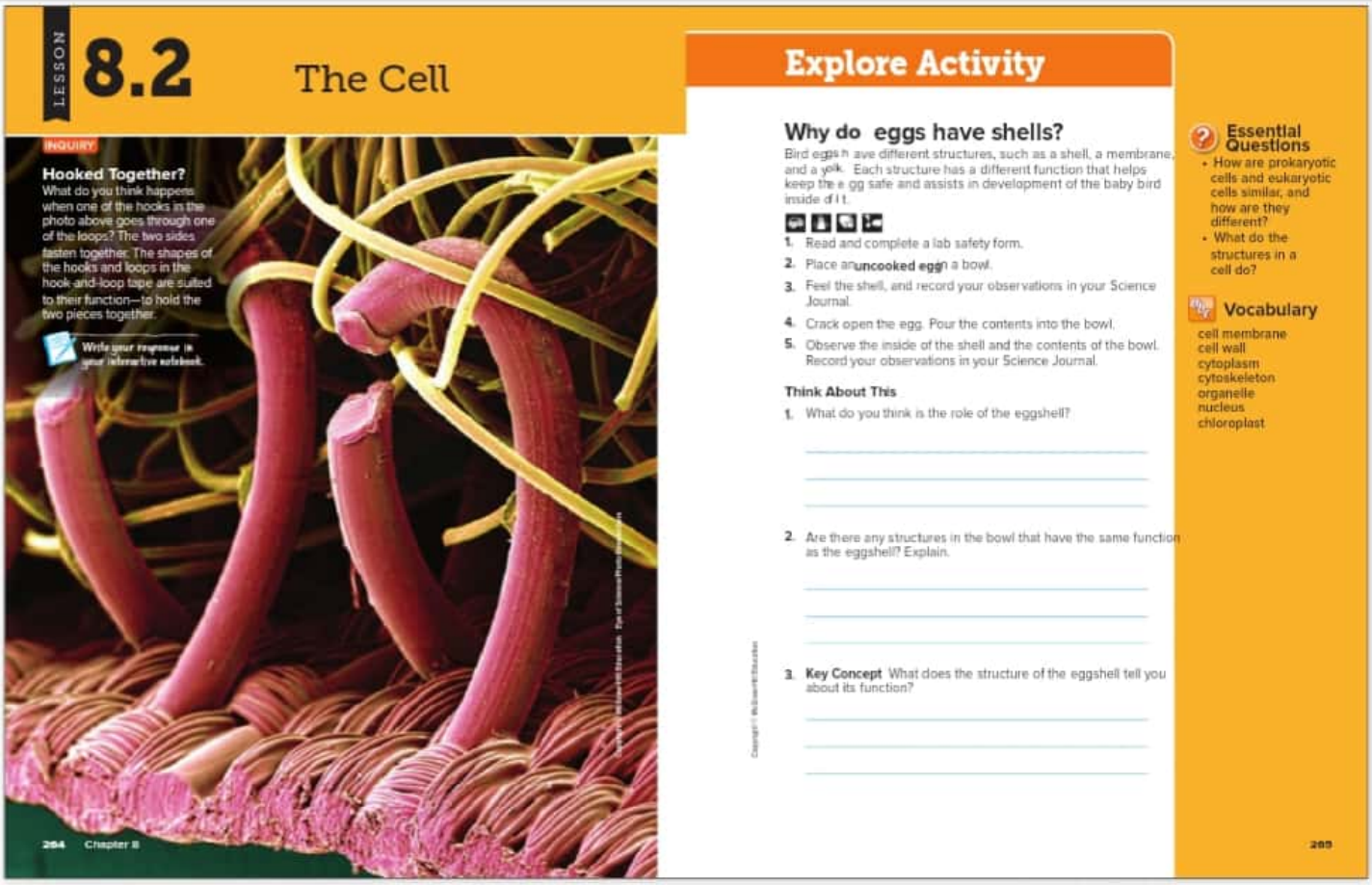
Interpret Graphics

7. DOK 2

8. Each water molecule has an area that is more negative and an area that is more positive. The negative oxygen areas can attract positive hydrogens on other nearby water molecules. The hydrogens in the positive area of the water molecule can attract oxygens in negative areas of other water molecules. DOK 4

Critical Thinking

9. Lipids provide protective barriers around cells and play roles in energy storage and cell communication. **DOK 2**
10. Carbohydrates are found in plant-cell walls because they provide structural support. **DOK 3**


LESSON 8.2 The Cell

INQUIRY

Hooked Together?
What do you think happens when one of the hooks in the photo above goes through one of the loops? The two sides fasten together. The shapes of the hooks and loops in the hook-and-loop tape are suited to their function—to hold the two pieces together.

Write your response in your interactive notebook.

Explore Activity

Why do eggs have shells?
Bird eggs have different structures, such as a shell, a membrane, and a yolk. Each structure has a different function that helps keep the egg safe and assists in development of the baby bird inside of it.

1. Read and complete a lab safety form.
2. Place an uncooked egg in a bowl.
3. Feel the shell, and record your observations in your Science Journal.
4. Crack open the egg. Pour the contents into the bowl.
5. Observe the inside of the shell and the contents of the bowl. Record your observations in your Science Journal.

Think About This
1. What do you think is the role of the eggshell?
2. Are there any structures in the bowl that have the same function as the eggshell? Explain.
3. Key Concept What does the structure of the eggshell tell you about its function?

Essential Questions
- How are prokaryotic cells and eukaryotic cells similar, and how are they different?
- What do the structures in a cell do?

Vocabulary
cell membrane
cell wall
cytoplasm
cytoskeleton
organelle
nucleus
chloroplast

264 Chapter 8

289

INQUIRY

About the Photo **Hooked Together?** If possible, show a piece of hook-and-loop tape. Point out that hook-and-loop tape is designed to hold things together, such as pockets, the tops of shoes, and the openings of bags. Emphasize that each of the two parts that make up hook-and-loop tape have a different function, yet the parts of the tape must work together in order for the tape to work.

Start the lesson with questions about the shapes and connections shown in the photo.

Guiding Questions

AL	How is the hook-and-loop tape able to hold together?	*The hooks on the tape hold the loops in a random order, holding the two sections of the tape together.*
OL	Why must the hooks in a hookand-loop tape be rigid?	*The hooks must be rigid to add strength to the tape.*
BL	What is another example of an object that has two differently structured parts that together perform a task?	*Students may suggest something as simple as a button and buttonhole to a bike chain and wheel or a nut and bolt.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Be a Word Detective

1. Write the word *organelle* on chart paper or the board. Explain that the word *organelle* refers to a specialized cell part.
2. **Ask: What word can you find in the word *organelle*?** *organ* **What word part comes after *organ*?** *-elle* Explain that the suffix *-elle* means "very small" or "tiny." Write the following words on the board: *gazelle, mademoiselle, novella,* and *roselle*. Have students guess the meaning of each word. *gazelle—small antelope, mademoiselle—a young woman (French language), novella—a short story, roselle—a type of short, bushy plant* Explain that just as a body's organs perform special functions and are vital for survival, a cell's organelles also perform specialized functions and are vital to the survival of a cell.

3. Have students add the lesson's vocabulary words to their Science Journals. Remind them to write the definition after each word as they read the lesson.

ExploreActivity

Why do eggs have shells?

Prep: *15 min* **Class:** *10 min*

Purpose
To demonstrate that an eggshell acts as a protective barrier for an egg.

Materials
uncooked egg, bowl

Before You Begin

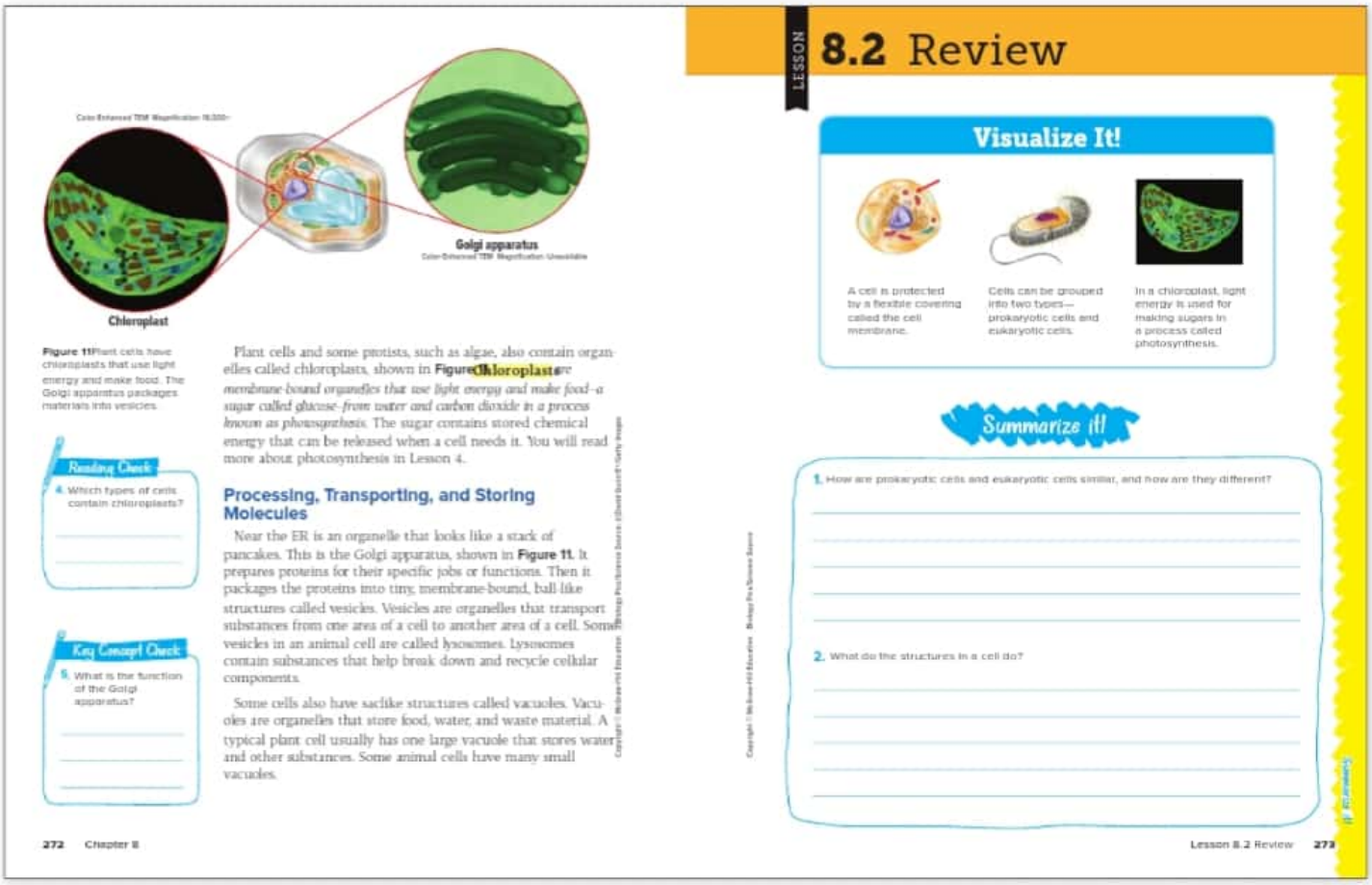
- Purchase eggs a day or two before the activity.
- Make sure you have enough gloves for every student who will be touching the egg or the egg contents.
- If you do not have a sink in your classroom, have hand-sanitizing gel available.
- To clean up spills, it would be advantageous to have a bottle of bleach cleaner or bleach solution. Remind students that bleach can ruin clothing.

Guide the Investigation

- Make sure students handle the eggs carefully.
- As soon as the activity is complete, have students wash their hands thoroughly.

Think About This
Do not expect students to determine the correct answer. Students should be encouraged to speculate. Use the answer set to guide students' reasoning.

1. The eggshell works as a barrier between the inside of the egg and the environment.
2. No. No other part of the egg is solid or able to provide structure or protection to the egg.
3. The eggshell is hard and surrounds the rest of the egg. This structure functions to protect the rest of the egg from the environment.



Processing Energy

Students may find reading the chemical terms challenging. Write the terms on the board and read them for students. Have students read the three paragraphs. Write *ATP* on the board. Have students who have difficulty remembering the chemical terms think of three words beginning with *A*, *T*, and *P* that will help them remember the function of ATP in a cell.

Guiding Questions

AL	What do all living things need to survive?	*All living things need energy.*
OL	Which types of cells contain chloroplasts?	*Plant cells and some protists, such as algae, contain chloroplasts.*
BL	How do plant cells make food?	*Plant cells make food through a process called photosynthesis in which chloroplasts use light energy to convert water and carbon dioxide into glucose.*

Processing, Transporting, and Storing Molecules

Have students read the section and look at **Figure 11**. Write *Golgi apparatus*, *vesicles*, *vacuoles*, and *lysosomes* on the board or chart paper. Have students provide facts to write under each heading. Then have students identify as many cell functions as they can recall. Write these on the board as they generate them. Review the cell structures that perform the functions.

Guiding Questions

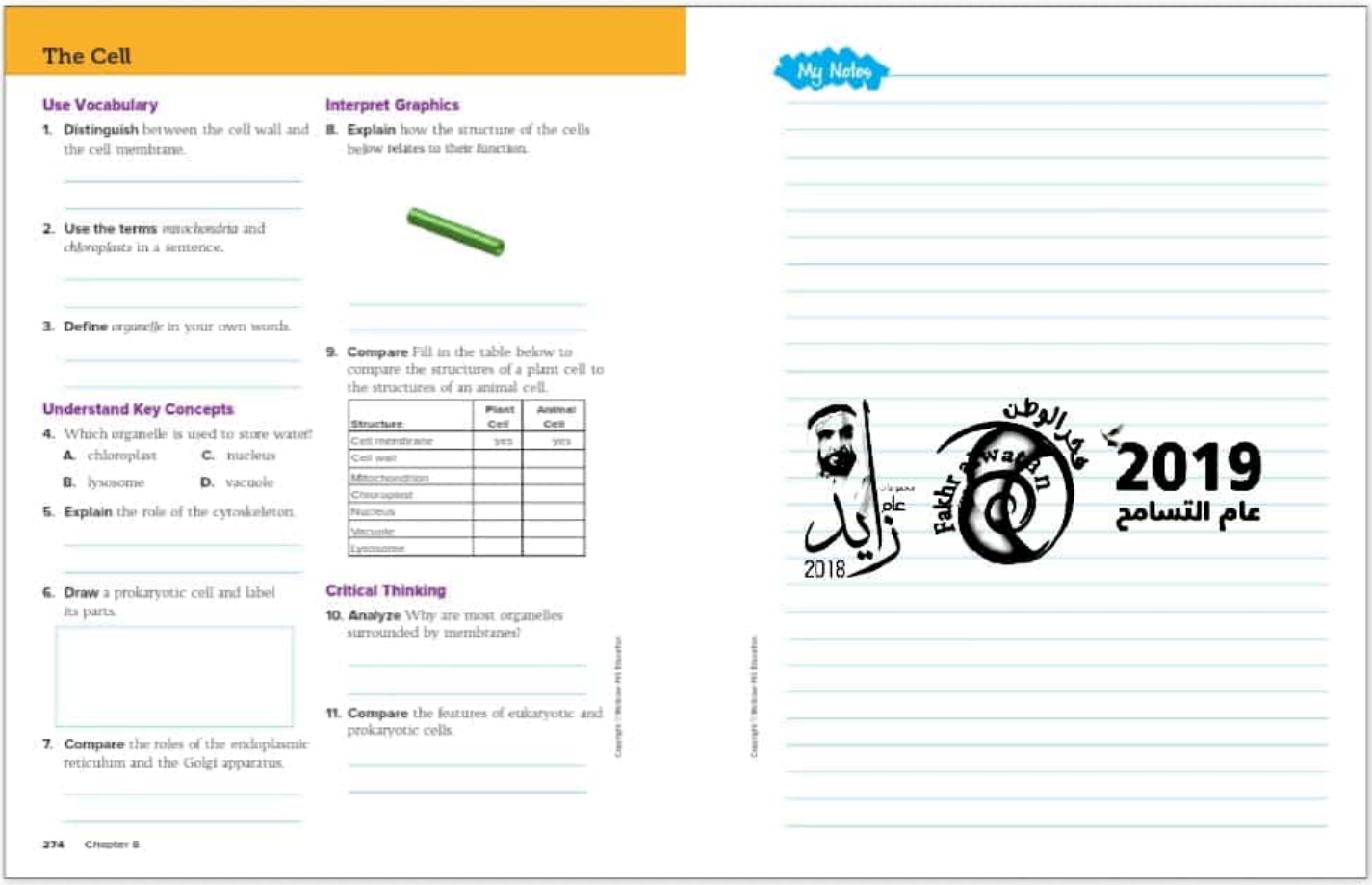
AL	In what way are vesicles like trucks on a highway?	*Both trucks and vesicles transport "cargo" from one area to another.*
OL	What is the function of the Golgi apparatus?	*It prepares proteins for their specific functions and packages them into vesicles for transport.*
BL	Why is removing wastes an important cell function?	*Students may suggest that the cell environment would become toxic if wastes were not removed, resulting in cell death.*

Visual Literacy: Figure 11

To help students understand energy production in eukaryotic cells, have them refer to **Figure 11**. Have students draw a chloroplast, a vesicle, a vacuole, and the Golgi apparatus in their Science Journals and add a notation under each drawing that explains the function of the organelle.

Ask: What are chloroplasts? *Chloroplasts are energy-producing organelles found in plant cells and in some protists.*

Ask: What is the Golgi apparatus? *The Golgi apparatus is an organelle that is shaped somewhat like a stack of pancakes. It prepares proteins in the cell for their specific functions.*



The Cell

Use Vocabulary

1. **Distinguish** between the cell wall and the cell membrane.

2. **Use the terms** *mitochondria* and *chloroplasts* in a sentence.

3. **Define** *organelle* in your own words.

Understand Key Concepts

4. Which organelle is used to store water?
   A. chloroplast C. nucleus
   B. lysosome D. vacuole

5. **Explain** the role of the cytoskeleton.

6. **Draw** a prokaryotic cell and label its parts.

7. **Compare** the roles of the endoplasmic reticulum and the Golgi apparatus.

Interpret Graphics

8. **Explain** how the structure of the cells below relates to their function.

9. **Compare** Fill in the table below to compare the structures of a plant cell to the structures of an animal cell.

Structure	Plant Cell	Animal Cell
Cell membrane	yes	yes
Cell wall		
Mitochondrion		
Chloroplast		
Nucleus		
Vacuole		
Lysosome		

Critical Thinking

10. **Analyze** Why are most organelles surrounded by membranes?

11. **Compare** the features of eukaryotic and prokaryotic cells.

My Notes

Use Vocabulary

1. The cell wall is a rigid structure that provides support and protection in plants and some bacteria, whereas the cell membrane is a flexible covering that is found around all cells. **DOK 2**
2. Possible answer: Mitochondria and chloroplasts are used to process energy. **DOK 1**
3. An organelle is a structure in a cell that is surrounded by a membrane and used for a specialized task. **DOK 1**

Understand Key Concepts

4. **D.** vacuole **DOK 1**
5. The cytoskeleton provides structural support to the cell. **DOK 2**
6. Cell drawing should lack organelles and show DNA without a membrane around it. **DOK 1**
7. The endoplasmic reticulum makes proteins and lipids, whereas the Golgi apparatus prepares proteins for their specific functions and packages them into vesicles for transport. **DOK 3**

Interpret Graphics

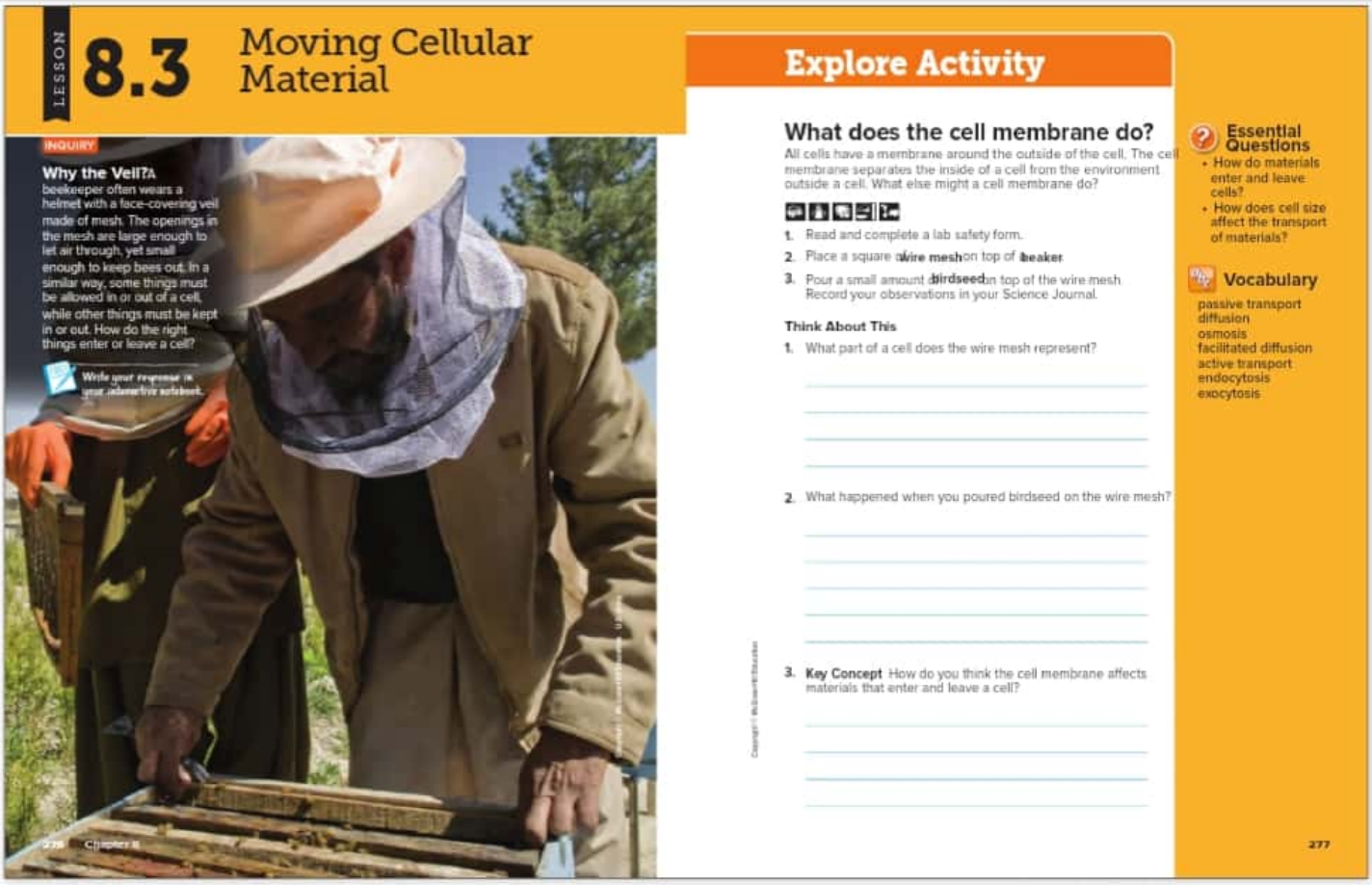
8. These tubelike cells are hollow and transport materials in plants. **DOK 2**
9.

Structure	Plant Cell	Animal Ce
Cell membrane	yes	yes
Cell wall	yes	no
Mitochondrion	yes	yes
Chloroplast	yes	no
Nucleus	yes	yes
Vacuole	yes	no
Lysosome	no	yes

DOK 3

Critical Thinking

10. to perform functions without interference from other organelles **DOK 4**
11. A prokaryotic cell lacks a nucleus and most other organelles, while a eukaryotic cell has a nucleus and many other organelles. **DOK 3**


LESSON 8.3 Moving Cellular Material

INQUIRY

Why the Veil? A beekeeper often wears a helmet with a face-covering veil made of mesh. The openings in the mesh are large enough to let air through, yet small enough to keep bees out. In a similar way, some things must be allowed in or out of a cell, while other things must be kept in or out. How do the right things enter or leave a cell?

Write your response in your interactive notebook.

Explore Activity

What does the cell membrane do?

All cells have a membrane around the outside of the cell. The cell membrane separates the inside of a cell from the environment outside a cell. What else might a cell membrane do?

1. Read and complete a lab safety form.
2. Place a square of wire mesh on top of a beaker.
3. Pour a small amount of birdseed on top of the wire mesh. Record your observations in your Science Journal.

Think About This

1. What part of a cell does the wire mesh represent?
2. What happened when you poured birdseed on the wire mesh?
3. Key Concept How do you think the cell membrane affects materials that enter and leave a cell?

Essential Questions
- How do materials enter and leave cells?
- How does cell size affect the transport of materials?

Vocabulary
passive transport
diffusion
osmosis
facilitated diffusion
active transport
endocytosis
exocytosis

277

INQUIRY

About the Photo **Why the Veil?** Although students might not be familiar with beekeepers, they can relate to being surrounded by bees that might sting and the importance of a veil that keeps the bees away from the beekeeper's face while letting air and light in.

Start the lesson with questions about materials entering and leaving a cell.

Guiding Questions

AL	What does the veil of mesh keep in and keep out? How?	*The veil of mesh keeps the bees out. It lets light and air in. Openings in the mesh are small enough to keep bees out but large enough to let air in.*
OL	How do you think materials move in and out of a cell?	*Students might propose that cells have tiny openings that let materials in and out.*
BL	What cell structures might let some materials into the cell but keep other materials out? How do you think they might do this?	*Students might propose that cell walls and cell membranes have tiny openings that allow some materials to enter the cell but keep other materials out.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Build Class Definitions

1. Write the words *active transport* and *passive* transport on chart paper or the board.
2. **Ask: What things do you transport or carry from home to school each day? When do you need to use more energy or be more active to transport these things?** *when walking to school or riding bike* **When do you need to use less energy or be more passive to transport these things?** *when riding on a bus or in a car* Help students connect these words with the transport of materials into and out of a cell.
3. Build a class definition for active transport and passive transport in cells. Students should record the accepted definitions in their Science Journals.

ExploreActivity

What does the cell membrane do?

Prep: *5 min* **Class:** *5 min*

Purpose
To model a cell membrane using wire mesh and to observe the size of materials that can pass through the membrane.

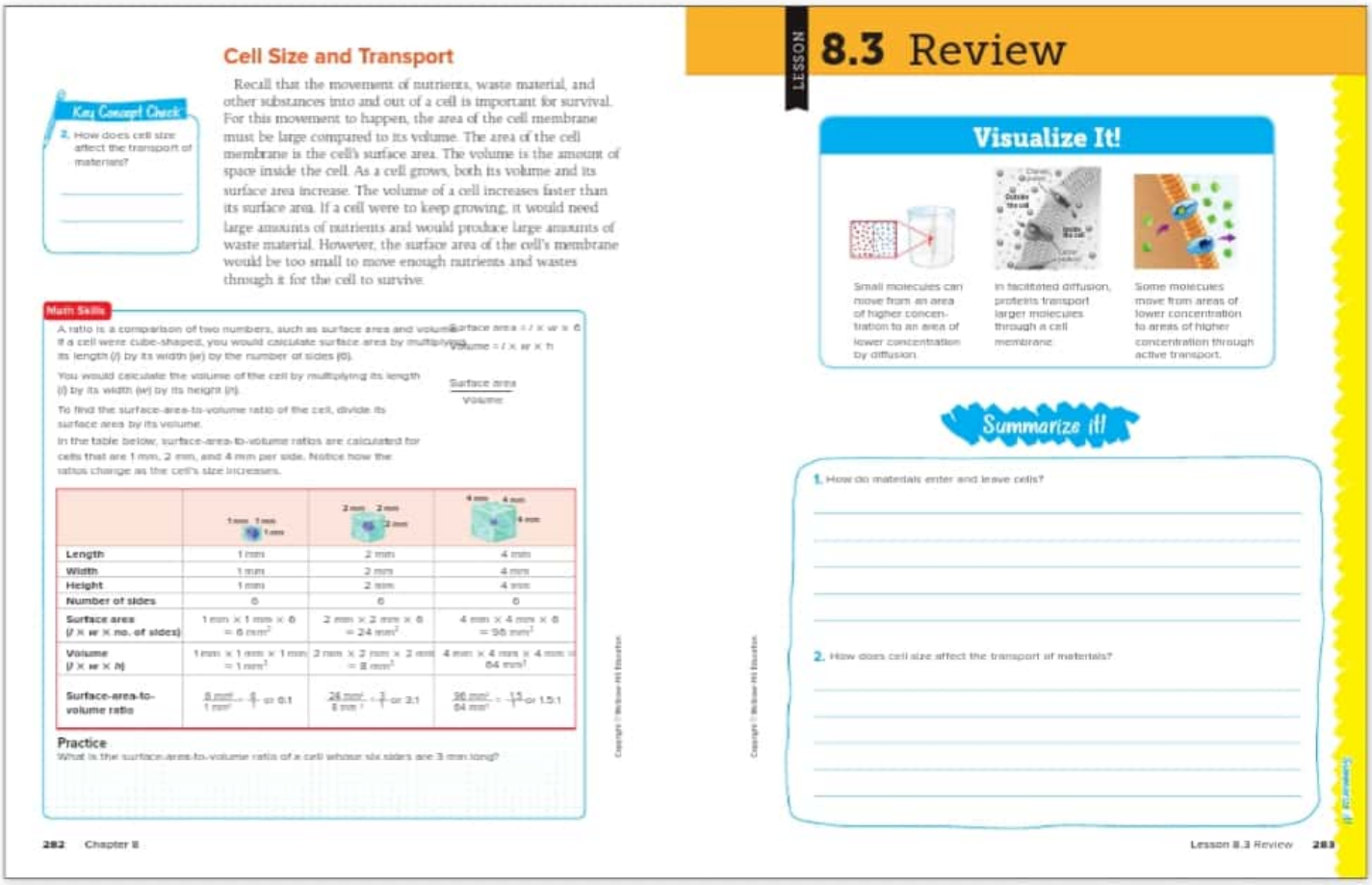
Materials
piece of wire mesh, beaker, birdseed

Before You Begin
- Make sure that the birdseed mix has a variety of sizes—some that are small enough to fit through a square of wire mesh and some that are too large to fit through the mesh.
- Provide a bucket or other container for collecting the birdseed after the lab. A broom and dustpan might also be needed for cleanup.

Guide the Investigation
- Encourage students to observe the properties of the birdseed that moves into the beaker and compare them to the properties of the birdseed that does not move into the beaker.
- **Troubleshooting** Caution students to pour the birdseed carefully and to avoid spills. Have students clean up spilled birdseed immediately after the lab.

Think About This
Do not expect students to determine the correct answer. Students should be encouraged to speculate. Use the answer set to guide students' reasoning.

1. the cell membrane
2. The smaller pieces of birdseed went through the mesh, but the larger pieces stayed on top of the mesh and were not able to pass through.
3. The cell membrane allows some things into the cell and keeps other things out of the cell.



Cell Size and Transport

Before students read about cell size and transport, review the importance of transport for cell survival. Then help students make the connection between a cell's size and transport.

Guiding Questions

AL	What is a cell's surface area, and what is a cell's volume?	*The area that the cell membrane covers is the cell's surface area. The amount of space inside the cell membrane is the cell's volume.*
OL	How does cell size affect the transport of materials?	*As a cell becomes larger, its volume increases faster than its surface area, making the transport of enough materials to support the cell more difficult.*
BL	Why is transport more difficult as a cell's volume increases faster than its surface area?	*Students might propose that the larger volume needs more nutrients and creates more wastes than the smaller surface area can move into and out of the cell.*

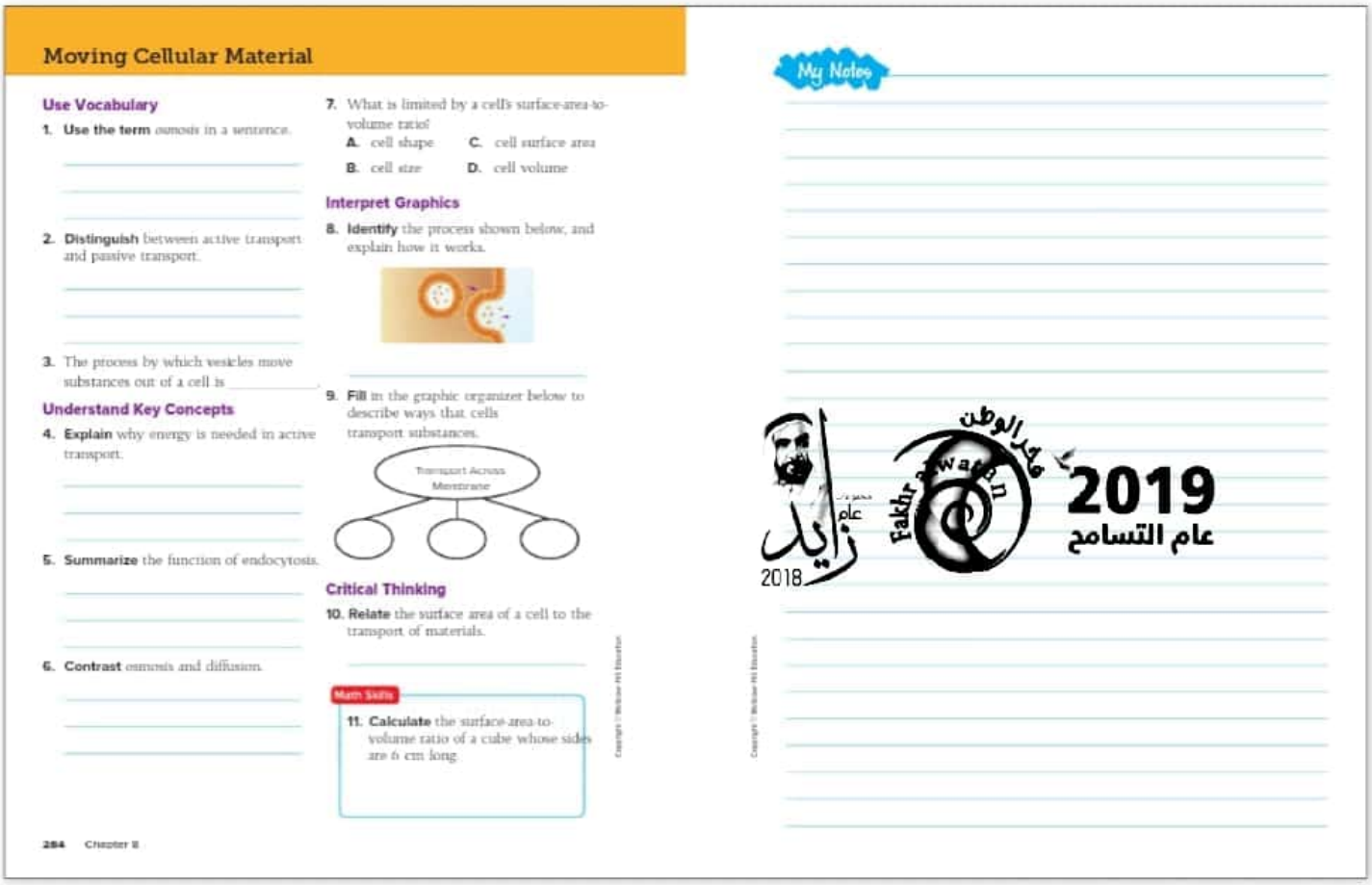
Math Skills

Use Ratios

Explain to students that they will be calculating the surface-area-to-volume ratio of a cell.

Practice

Ask students to answer the practice question. The surface-area-to-volume ratio of a cell whose sides are 3 mm long is 2:1.



Moving Cellular Material

Use Vocabulary

1. **Use the term** osmosis in a sentence.

2. **Distinguish** between active transport and passive transport.

3. The process by which vesicles move substances out of a cell is _____.

Understand Key Concepts

4. **Explain** why energy is needed in active transport.

5. **Summarize** the function of endocytosis.

6. **Contrast** osmosis and diffusion.

7. What is limited by a cell's surface-area-to-volume ratio?
   A. cell shape C. cell surface area
   B. cell size D. cell volume

Interpret Graphics

8. **Identify** the process shown below, and explain how it works.

9. **Fill** in the graphic organizer below to describe ways that cells transport substances.

Transport Across Membrane

Critical Thinking

10. **Relate** the surface area of a cell to the transport of materials.

Math Skills

11. **Calculate** the surface-area-to-volume ratio of a cube whose sides are 6 cm long.

284 Chapter 8

My Notes

Use Vocabulary

1. Sample answers might include: Water moves across membranes by osmosis. **DOK 1**
2. Active transport requires energy and moves substances from areas of lower concentration to areas of higher concentration, whereas passive transport does not require energy and moves substances from areas of higher concentration to areas of lower concentration. **DOK 2**
3. exocytosis **DOK 1**

Understand Key Concepts

4. Active transport requires the use of a cell's energy because materials are being moved from areas of lower concentration to areas of higher concentration. **DOK 2**
5. Endocytosis is used to move substances that are too large to pass through the cell membrane through diffusion or by using transport proteins into cells. **DOK 2**
6. Osmosis is the movement of water across a semipermeable membrane, whereas diffusion is the movement of small molecules from higher to lower concentrations and does not always involve a membrane. **DOK 3**
7. **B.** cell size **DOK 1**

Interpret Graphics

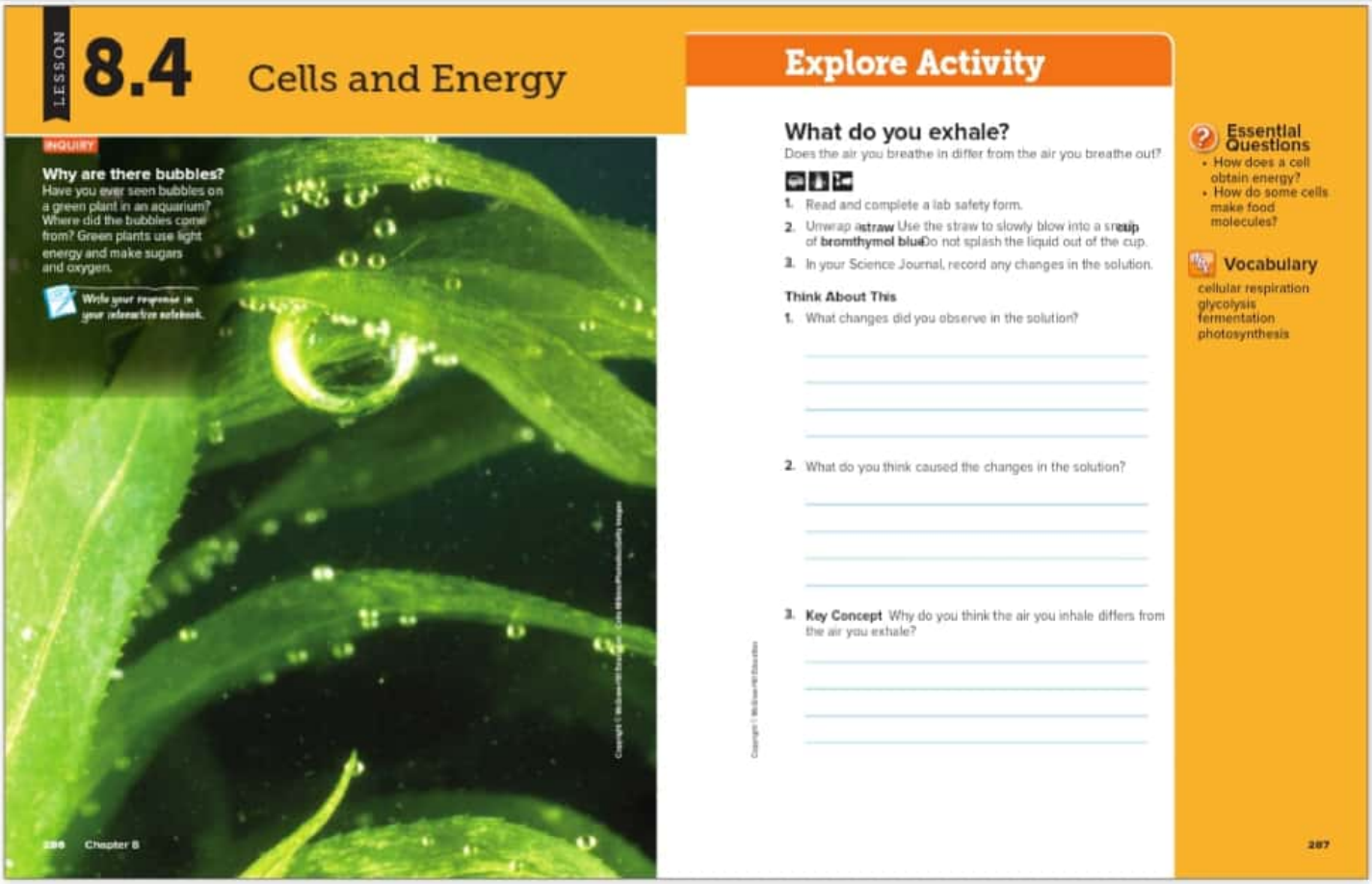
8. Exocytosis is the process during which a cell's vesicles join with the cell membrane and release substances outside the cell. **DOK 1**
9. diffusion, facilitated diffusion, active transport **DOK 1**

Critical Thinking

10. The larger the surface area, the more transport that can occur. **DOK 2**

Math Skills

11. 1:1 **DOK 1**



INQUIRY

About the Photo **Why are there bubbles?** The leaves of terrestrial plants contain stomata, tiny openings through which oxygen and carbon dioxide are exchanged. In most of these plants, stomata are found on the lower surface of the leaves. The stomata of aquatic plants that float are often found on the upper surface of the leaves, which are exposed to the air. Aquatic plants that are completely submerged usually lack stomata.
Start the lesson with questions about the production of gas bubbles by aquarium plants.

Guiding Questions

AL	What process is taking place in the photo? How do you know?	*Students should realize that photosynthesis is taking place because gas bubbles are forming. They may not recognize that plants undergo cellular respiration as well as photosynthesis.*
OL	Do you think the aquarium plants in the photo are being grown in light or in dark? How do you know?	*Students should know that photosynthesis requires light. Explain that plants use the energy in sunlight to power photosynthesis. Without light, photosynthesis cannot occur.*
BL	Why do plants need to photosynthesize?	*Students may suggest that plants must make food because they have no way of capturing and eating it.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Build Class Definitions

1. Write the term *cellular respiration* on chart paper or the board. Explain that the word *respiration* commonly refers to breathing.
2. **Ask: What happens during breathing?** *Air (containing oxygen) moves into the lungs, and air (containing carbon dioxide) moves out of the lungs.* **Do cells breathe?** *Cells do not have lungs and cannot breathe. However, oxygen and carbon dioxide move into and out of cells.* Have students read the definition of *cellular respiration* on the next student page and try to connect the processes of cellular respiration and breathing.

3. Have students hold a piece of paper in front of their nostrils as they inhale and exhale deeply. Have them pay close attention to what happens as they breathe. *Their chests expand and air moves into their noses with inhaling; their chests contract and air is expelled with exhaling.*

ExploreActivity

What do you exhale?

Prep: *5 min* **Class:** *5 min*

Purpose
To observe that the air humans inhale differs from the air humans exhale.

Materials
wrapped straws, small transparent plastic cups, bromthymol blue solution

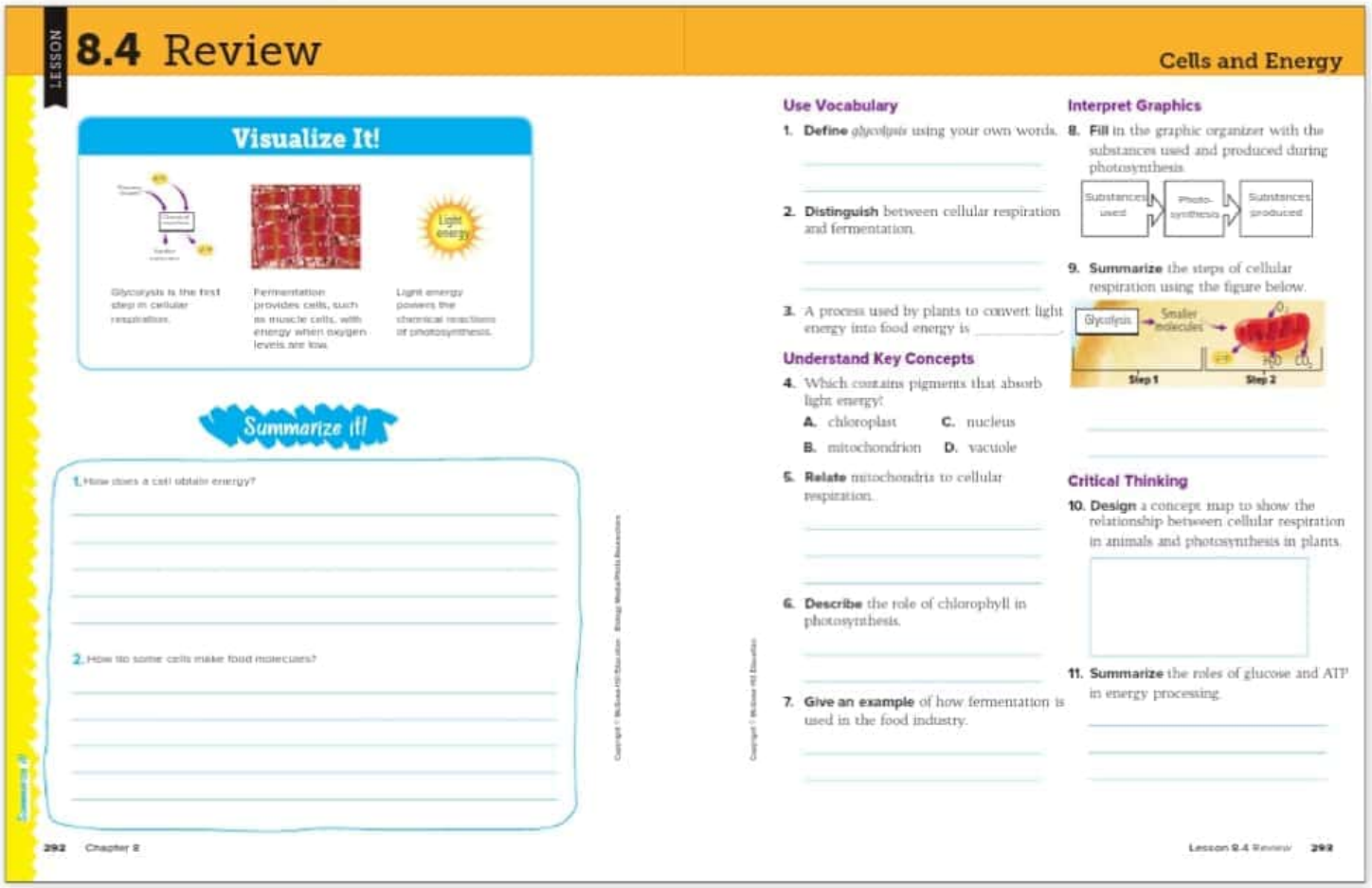
Before You Begin
Prepare the cups before class. Pour enough bromthymol blue solution in each cup to cover the bottom of the straw (approximately 1 cm of liquid). The bromthymol blue solution should be light blue in color. If the solution does not turn to green/yellow when blown into, try adding a little water to the solution.

Guide the Investigation

- Direct students to lightly blow into the liquid until it begins to change color. The liquid should change to a yellow/green color with a few breaths. Again, if the solution is not changing, add a little water to the cup.
- Have students use only wrapped straws, and remind them not to share used straws or suck liquid through the straws.
- **Troubleshooting** Bromthymol blue can stain clothing. Tell students to be careful with the liquid, and remind them not to force the liquid out of the cup.

Think About This
Do not expect students to determine the correct answer. Students should be encouraged to speculate. Use the answer set to guide students' reasoning.

1. The color changed from blue to yellow.
2. The color of the solution changed when carbon dioxide was added.
3. Oxygen is used to release energy for cell processes.



LESSON 8.4 Review

Cells and Energy

Visualize It!

Glycolysis is the first step in cellular respiration.

Fermentation provides cells, such as muscle cells, with energy when oxygen levels are low.

Light energy powers the chemical reactions of photosynthesis.

Summarize it!

1. How does a cell obtain energy?

2. How do some cells make food molecules?

Use Vocabulary

1. **Define** *glycolysis* using your own words.

2. **Distinguish** between cellular respiration and fermentation.

3. A process used by plants to convert light energy into food energy is _____.

Understand Key Concepts

4. Which contains pigments that absorb light energy?
   A. chloroplast C. nucleus
   B. mitochondrion D. vacuole

5. **Relate** mitochondria to cellular respiration.

6. **Describe** the role of chlorophyll in photosynthesis.

7. **Give an example** of how fermentation is used in the food industry.

Interpret Graphics

8. **Fill** in the graphic organizer with the substances used and produced during photosynthesis.

Substances used → Photosynthesis → Substances produced

9. **Summarize** the steps of cellular respiration using the figure below.

Glycolysis → Smaller molecules → O_2 H_2O CO_2

Step 1 Step 2

Critical Thinking

10. **Design** a concept map to show the relationship between cellular respiration in animals and photosynthesis in plants.

11. **Summarize** the roles of glucose and ATP in energy processing.

292 Chapter 8

Lesson 8.4 Review 292

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: Which Key Concept does each image relate to?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Cellular Respiration
- Photosynthesis

Use Vocabulary

1. Sample answers might include: Glycolysis is a stage of cellular respiration where glucose is broken down into smaller parts and some ATP is generated. **DOK 1**
2. Cellular respiration and fermentation are used to release energy (ATP) from food; however, cellular respiration requires oxygen and fermentation does not. Fermentation takes place in cytoplasm and respiration takes place in mitochondria. **DOK 2**
3. photosynthesis **DOK 1**

Understand Key Concepts

4. A. chloroplast **DOK 1**
5. The second stage of cellular respiration occurs in mitochondria, where the products of glycolysis are converted into ATP, water, and carbon dioxide. **DOK 2**
6. Chlorophyll absorbs light energy. **DOK 1**
7. Sample answers might include: Fermentation is used to make cheeses, yogurt, and breads. **DOK 1**

Interpret Graphics

8. Substances used: light energy, carbon dioxide (CO_2), water (H_2O); Photosynthesis; Substances produced: glucose (food energy), oxygen (O_2). **DOK 1**

9. During step 1, the reactions of glycolysis occur in the cytoplasm and break down glucose into smaller molecules and some ATP. During step 2, the reactions in the mitochondria use oxygen and convert the smaller molecules made during glycolysis into carbon dioxide (CO_2), water, and large amounts of ATP. **DOK 2**

Critical Thinking

10. Students' concept maps will vary. Concept maps should show that animals require oxygen and glucose for cellular respiration, whereas plants use the carbon dioxide produced by animals for photosynthesis. **DOK 4**

11. Animal cells convert the energy in glucose to ATP, whereas plant cells store energy in the form of glucose. **DOK 2**

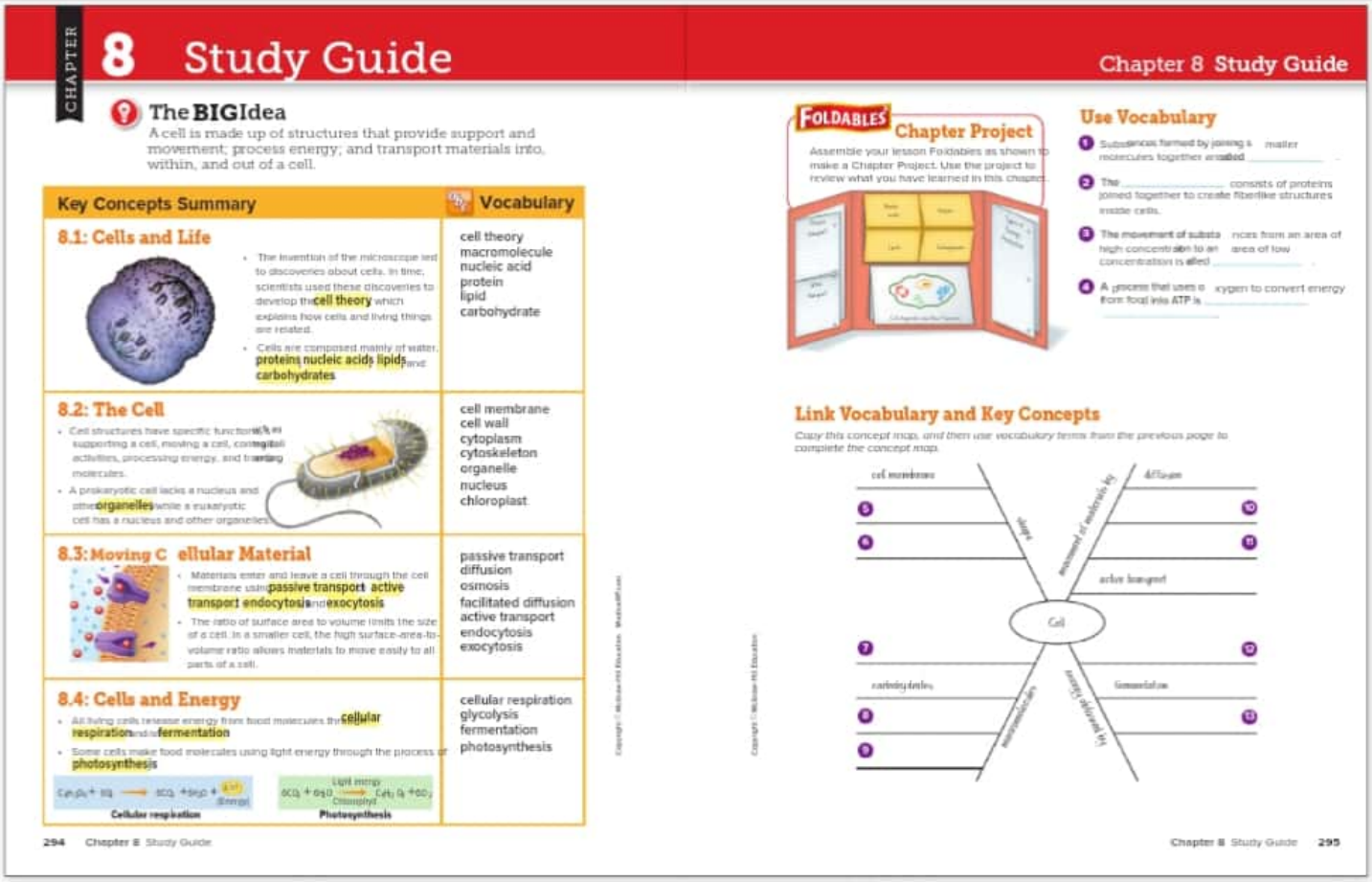
Teacher Toolbox

Careers In Science

Baker Some people might not think bakers need to understand science to do their job, but they do! Bakers use yeast to make bread, rolls, and some pastries. They must understand the process of alcohol fermentation and know how yeast cells grow and perform life processes. Do you know the best temperature to grow yeast cells? With on-the-job training, you can become a master baker.

Fun Fact

Van Helmont Got It Wrong Jan Baptista van Helmont, a Belgian scientist (1577–1644), performed the first scientific experiment on plant life processes. He planted a willow sapling weighing 5 lb in a pot containing 200 lb of soil and covered the soil to keep out dust and dirt. For 5 years, he added only water to the tree. Then, van Helmont re-weighed the tree and soil. He found that the tree had gained 164 lb, but the soil had lost only 2 oz. He concluded wrongly, that plants use only water to grow. Now we know that the tree grew because it made food by photosynthesis using carbon dioxide in the air.



CHAPTER 8 Study Guide

Chapter 8 Study Guide

The BIG Idea

A cell is made up of structures that provide support and movement; process energy; and transport materials into, within, and out of a cell.

Key Concepts Summary

8.1: Cells and Life

- The invention of the microscope led to discoveries about cells. In time, scientists used these discoveries to develop the cell theory which explains how cells and living things are related.
- Cells are composed mainly of water, proteins, nucleic acids, lipids, and carbohydrates.

8.2: The Cell

- Cell structures have specific functions, such as supporting a cell, moving a cell, controlling cell activities, processing energy, and transporting materials.
- A prokaryotic cell lacks a nucleus and other organelles while a eukaryotic cell has a nucleus and other organelles.

8.3: Moving Cellular Material

- Materials enter and leave a cell through the cell membrane using passive transport, active transport, endocytosis, and exocytosis.
- The ratio of surface area to volume limits the size of a cell. In a smaller cell, the high surface-area-to-volume ratio allows materials to move easily to all parts of a cell.

8.4: Cells and Energy

- All living cells release energy from food molecules through cellular respiration and fermentation.
- Some cells make food molecules using light energy through the process of photosynthesis.

Cellular respiration

Photosynthesis

Vocabulary

cell theory
macromolecule
nucleic acid
protein
lipid
carbohydrate
cell membrane
cell wall
cytoplasm
cytoskeleton
organelle
nucleus
chloroplast
passive transport
diffusion
osmosis
facilitated diffusion
active transport
endocytosis
exocytosis
cellular respiration
glycolysis
fermentation
photosynthesis

294 Chapter 8 Study Guide

FOLDABLES Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. Subunits formed by joining small molecules together are called _____.
2. The _____ consists of proteins joined together to create fiberlike structures inside cells.
3. The movement of substances from an area of high concentration to an area of low concentration is called _____.
4. A process that uses oxygen to convert energy from food into ATP is _____.

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.

Chapter 8 Study Guide 295

Key Concepts Summary

Study Strategy: Self-Assessment

Students often complete a reading without realizing they failed to understand it. Self-assessment helps students practice metacognition, increasing their awareness of their understanding.

1. Ask students to draw in their Science Journals a table like the one below, listing each Key Concept in the left column.
2. Prompt students to read the Key Concepts Summary.
3. For each Key Concept, have them self-assess their understanding of the Key Concept and record it in their table.
4. Ask students to review any concepts they did not mark *I understand*.

Example:

Key Concept	I understand	I somewhat understand	I don't understand
A prokaryotic cell lacks a nucleus.	X		

Vocabulary

Study Strategy: In Your Own Words

Ask students to create vocabulary definitions using their own words. Connecting vocabulary words to students' own language promotes understanding more effectively than pure memorization.

1. Have students create a two-column table like the one below in their Science Journals.
2. Have them write the vocabulary words in the Study Guide in the left column.
3. Ask students to describe what they know about the chapter's vocabulary words using their own words (without referring to the textbook).

Example:

Vocabulary Word	My Definition
macromolecule	It's what forms when smaller molecules combine.
lipid	This is a macromolecule that does not dissolve in water and is important in cell communication, energy storage, and cell membrane structure.

FOLDABLES®

Use the Foldables® Chapter Project as a way to connect Key Concepts.

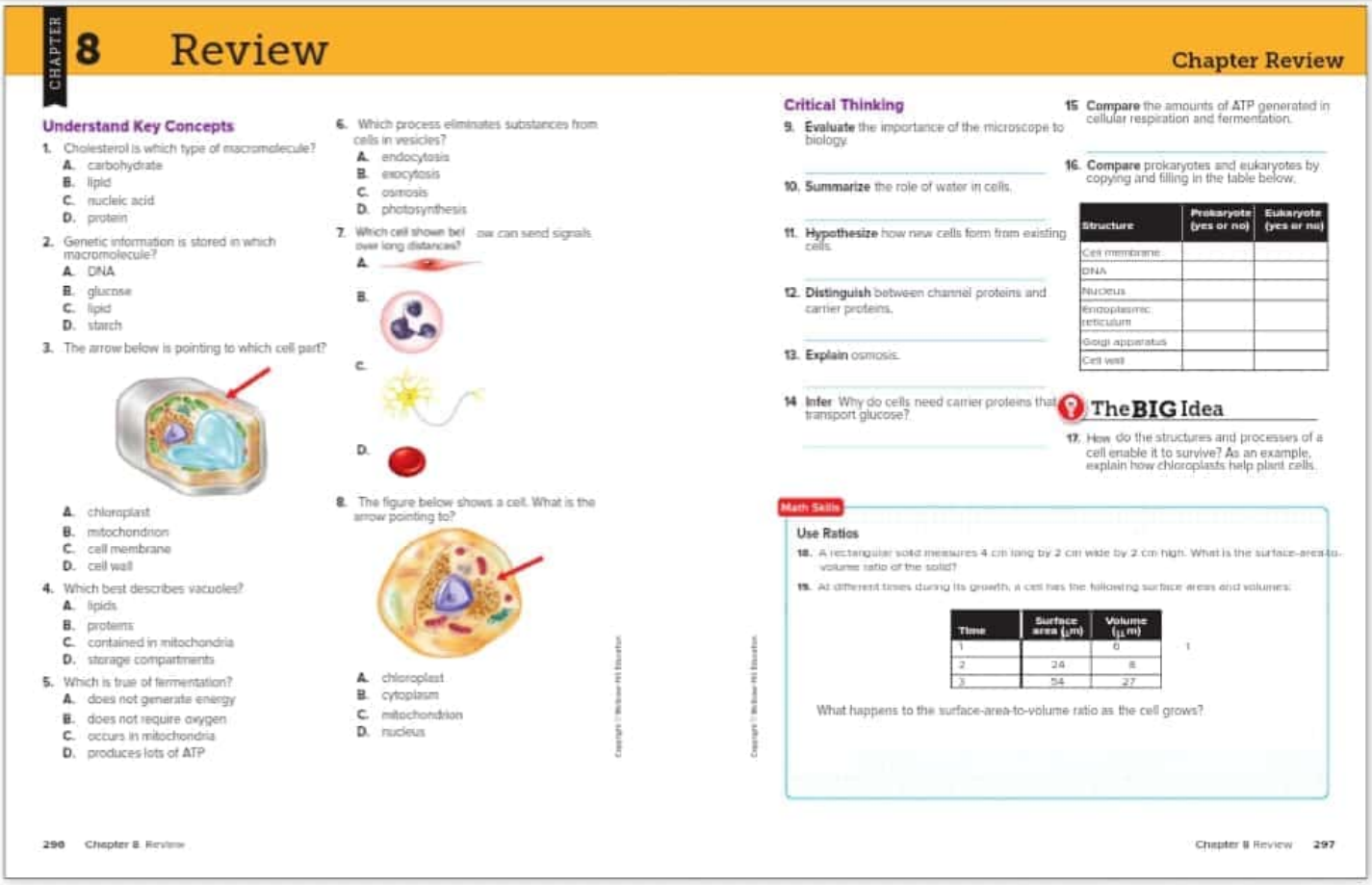
1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

Use Vocabulary

1. macromolecules
2. cytoskeleton
3. diffusion
4. cellular respiration

Link Vocabulary and Key Concepts

5. cell wall
6. cytoskeleton
7. nucleic acids
8. proteins
9. lipids
10. osmosis
11. facilitated diffusion
12. cellular respiration
13. photosynthesis



CHAPTER 8 Review

Chapter Review

Understand Key Concepts

1. Cholesterol is which type of macromolecule?
   A. carbohydrate
   B. lipid
   C. nucleic acid
   D. protein
2. Genetic information is stored in which macromolecule?
   A. DNA
   B. glucose
   C. lipid
   D. starch
3. The arrow below is pointing to which cell part?

   A. chloroplast
   B. mitochondrion
   C. cell membrane
   D. cell wall
4. Which best describes vacuoles?
   A. lipids
   B. proteins
   C. contained in mitochondria
   D. storage compartments
5. Which is true of fermentation?
   A. does not generate energy
   B. does not require oxygen
   C. occurs in mitochondria
   D. produces lots of ATP
6. Which process eliminates substances from cells in vesicles?
   A. endocytosis
   B. exocytosis
   C. osmosis
   D. photosynthesis
7. Which cell shown bel ow can send signals over long distances?
   A.
   B.
   C.
   D.
8. The figure below shows a cell. What is the arrow pointing to?

   A. chloroplast
   B. cytoplasm
   C. mitochondrion
   D. nucleus

Critical Thinking

9. **Evaluate** the importance of the microscope to biology.
10. **Summarize** the role of water in cells.
11. **Hypothesize** how new cells form from existing cells.
12. **Distinguish** between channel proteins and carrier proteins.
13. **Explain** osmosis.
14. **Infer** Why do cells need carrier proteins that transport glucose?
15. **Compare** the amounts of ATP generated in cellular respiration and fermentation.
16. **Compare** prokaryotes and eukaryotes by copying and filling in the table below.

Structure	Prokaryote (yes or no)	Eukaryote (yes or no)
Cell membrane		
DNA		
Nucleus		
Endoplasmic reticulum		
Golgi apparatus		
Cell wall		

The BIG Idea

17. How do the structures and processes of a cell enable it to survive? As an example, explain how chloroplasts help plant cells.

Math Skills

Use Ratios

18. A rectangular solid measures 4 cm long by 2 cm wide by 2 cm high. What is the surface-area-to-volume ratio of the solid?
19. At different times during its growth, a cell has the following surface areas and volumes:

Time	Surface area (μm)	Volume (μm)
1		8
2	24	8
3	54	27

What happens to the surface-area-to-volume ratio as the cell grows?

296 Chapter 8 Review

Chapter 8 Review 297

Understand Key Concepts

1 A. lipid.
2 A. DNA
3 D. cell wall
4 D. storage compartments
5 B. does not require oxygen
6 B. exocytosis
7 C.

8 B. cytoplasm

Critical Thinking

9 The microscope was important to biology because it enabled scientists to discover and study the structure of the cell, which is the foundation of all living things.

10 Water is the most abundant component of a cell, making up 75 percent of a cell's volume. Water provides a stable environment inside and outside a cell. Many substances can be dissolved in water.

11 Existing cells produce new cells by dividing.

12 Channel proteins form pores in the cell membrane to allow smaller molecules to pass through the membrane. Carrier proteins carry larger molecules through the cell membrane.

13 Osmosis is the movement of water molecules across a membrane from an area where there is a lot of water to an area where there is less water.

14 Cells need carrier proteins that carry glucose because the glucose molecule is too large to pass through the cell membrane by diffusion, but the cell needs glucose as fuel for cellular respiration.

15 Both cellular respiration and fermentation generate ATP; however, since cellular respiration uses oxygen, it generates more ATP than fermentation.

16

Structure	Prokaryote (yes or no)	Eukaryote (yes or no)
Cell membrane	yes	yes
DNA	yes	yes
Nucleus	no	yes
Endoplasmic reticulum	no	yes
Golgi apparatus	no	yes
Cell wall	yes (some bacteria)	yes (plants)

The **BIG** Idea

17 Structures and processes enable a cell to survive by providing support and fuel for the cell. Chloroplasts help a plant cell survive by absorbing light energy, then using that energy to turn water and carbon dioxide into food energy and releasing oxygen through photosynthesis. The food energy made through photosynthesis provides fuel for the cell and for other organelles to function.

Math Skills

Use Ratios

18. 2.5:1

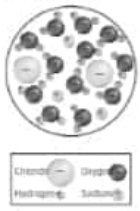
19. As the cell grows, the surface-area-to-volume ratio decreases.

Standardized Test Practice

Multiple Choice aligned with TIMSS

1 Which process do plant cells use to capture and store energy from sunlight?
- A endocytosis
- B fermentation
- C glycolysis
- D photosynthesis

Use the diagram below to answer question 2.



2 The diagram shows salt dissolved in water. What does it show about water molecules and chloride ions?
- A A water molecule consists of oxygen and chloride ions.
- B A water molecule is surrounded by several chloride ions.
- C A water molecule moves away from a chloride ion.
- D A water molecule points its positive end toward a chloride ion.

3 Which transport process requires the use of a cell's energy?
- A diffusion
- B osmosis
- C active transport
- D facilitated diffusion

4 Diffusion differs from active cell transport processes because it
- A forces large molecules from a cell.
- B keeps a cell's boundary intact.
- C moves substances into a cell.
- D needs none of a cell's energy.

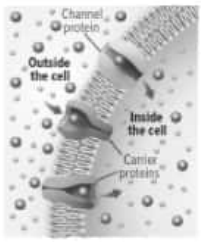
Use the diagram below to answer questions 5 and 6.

5 Which structure does the arrow point to in the eukaryotic cell?
- A cytoplasm
- B lysosome
- C nucleus
- D ribosome

6 Which feature does a typical prokaryotic cell have that is missing from some eukaryotic cells, like the one above?
- A cytoplasm
- B DNA
- C cell membrane
- D cell wall

7 Which explains why the ratio of cell surface area to volume affects the cell size? Cells with a high surface-to-volume ratio
- A consume energy efficiently.
- B produce waste products slowly.
- C suffer from diseases frequently.
- D transport substances effectively.

Use the diagram below to answer question 8.



8 Which statement is NOT true of carrier proteins and channel proteins?
- A Carrier proteins change shape as they function but channel proteins do not.
- B Carrier proteins and channel proteins extend through the cell membrane.
- C Channel proteins move items inside a cell but carrier proteins do not.
- D Channel proteins and carrier proteins perform facilitated diffusion.

Constructed Response aligned with TIMSS

9 Complete the table below using these terms: *cell membrane, cell wall, chloroplast, cytoplasm, cytoskeleton, nucleus.*

Cell Structure	Function
	Maintains the shape of an animal cell
	Controls the activities of a cell
	Traps energy from the Sun
	Controls the materials going in and out of a cell
	Holds the structures of a cell in a watery mix
	Maintains the shape of some plant cells

10 Name the kinds of organisms that have cells with cell walls. Name the kinds of organisms that have cells without cell walls. Briefly describe the benefits of cell walls for organisms.

11 Draw simple diagrams of an animal cell and a plant cell. Label the nucleus, the cytoplasm, the mitochondria, the cell membrane, the chloroplasts, the cell wall, and the central vacuole in the appropriate cells. Briefly describe the main differences between the two cells.

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11
Go to Lesson...	4	1	3	3	2	2	3	3	2	2	2

Multiple Choice

1 D—Correct. A, B, C—Endocytosis is the process by which a substance is taken into the cell by surrounding it with the cell membrane. Fermentation is the proceess that cells can use to obtain energy from food when little oxygen is available. Glycolysis is the process by which sugar molecules are broken down into smaller molecules. **DOK 1**

2 D—Correct. A, B, C—A water molecule consists of oxygen and hydrogen atoms. Several water molecules surround each chloride ion. The positive end of water molecules are attracted to sodium chloride's negative end. **DOK 2**

3 C—Correct. A, B, D—Diffusion, osmosis, and facilitated diffusion are all forms of passive transport and do not use cellular energy to move substances through a cell membrane. **DOK 1**

4 D—Correct. A, B, C—During diffusion, only small molecules are transported. Small openings in the cell's boundary allow for materials to move into or out of the cell. Both diffusion and active cell transport enable substances to move into a cell. **DOK 2**

5 A—Correct. B, C, D—DNA is located in the nucleus of the cell. The cell membrane and cell wall are both boundaries that cover the outside of the cell. **DOK 1**

6 D—Correct. A, B, C—Both eukaryotic cells and prokaryotic cells have cytoplasm, DNA, and a cell membrane. **DOK 2**

7 D—Correct. A, B, C—The size of a cell is not related to a cell's efficiency when using energy, production of waste products, or frequency of contracting diseases. **DOK 2**

8 C—Correct. A, B, D—Both carrier proteins and channel proteins change shape and move substances from outside a cell to inside a cell. **DOK 2**

Constructed Response

9

Cell Structure	Function
Cytoskeleton	maintains the shape of an animal cell
Nucleus	controls the cell's activities
Chloroplast	traps energy from the Sun
Cell membrane	controls the materials going into and out of a cell
Cytoplasm	holds the structures of a cell in a watery mix
Cell wall	maintains the shape of some plant cells

DOK 2

10 Plants, fungi, bacteria, and some protists have cells with cell walls. Animals and some protists do not have cells with cell walls. Cell walls provide support for the cells. Cell walls also provide some protection for the cells from viruses and other organisms that can cause diseases and injury. **DOK 3**

11 The diagram should show the correct locations and relative sizes of the nucleus, cytoplasm, mitochondria, cell membrane, chloroplasts, cell wall, and central vacuole. The main differences between the two cells are that the plant cell has a rigid cell wall that gives a fixed shape to the cell, chloroplasts that perform photosynthesis, and a central vacuole that holds water and other substances. **DOK 3**

Answer Key

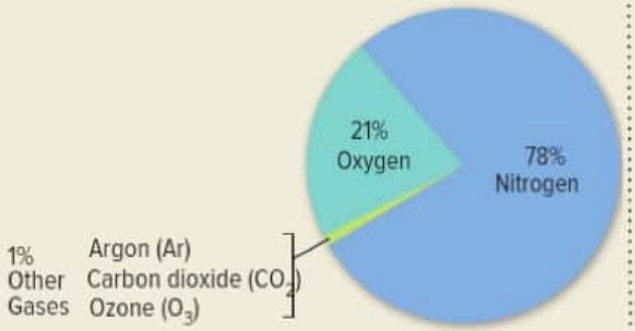
Question	Answer
1	D
2	D
3	C
4	D
5	A
6	D
7	D
8	C
9	See extended answer.
10	See extended answer.
11	See extended answer.

Science Content Background

Lesson 1

Earth Systems

The Atmosphere Earth's atmosphere is critical to life on Earth. It contains the gases needed by many organisms to survive, including oxygen and carbon dioxide. A layer of ozone in the stratosphere protects the biosphere from harmful ultraviolet radiation from the Sun. Also, thermal energy trapped by the atmosphere helps regulate Earth's surface temperature, making life on Earth possible.

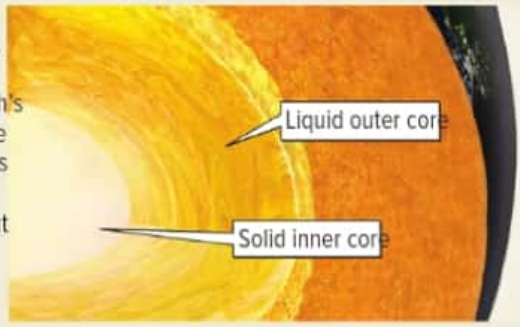


The Hydrosphere and the Cryosphere The hydrosphere consists of all of the water on Earth, which is found at Earth's surface in oceans, lakes, and rivers, as well as underground and in the atmosphere. Water exists as a solid, a liquid, and a gas on Earth. Water is solid in glaciers and polar ice caps, and it is gas (water vapor) in the atmosphere. Liquid water exists on and below Earth's surface. About 97 percent of water on Earth is salt water, and the remaining 3 percent is freshwater. Only 1 percent of freshwater is at Earth's surface in lakes, rivers, and streams. The majority of freshwater—79 percent—is stored in glaciers and ice caps. About 20 percent is groundwater.

Materials in the Geosphere The geosphere consists of minerals, rocks, soil, and metals. Minerals are naturally occurring inorganic solids that have crystal structures and definite chemical compositions. "Inorganic" means that minerals are not biologic in origin.

Rocks Rocks are made of minerals and other materials, including organic matter. Rocks are classified into three main categories—igneous, metamorphic, and sedimentary. These categories are based on how the rocks form. Igneous rock forms when magma or lava cools. Metamorphic rock forms when high temperatures and pressure change existing rock into new rock. Metamorphic rock can form from igneous rock, sedimentary rock, or other metamorphic rock. Sedimentary rock forms when layers of sediment are compressed and cemented together.

Structure Earth's structure consists of three main layers—the crust, the mantle, and the core. Compared to the other layers, the crust is thin. Oceanic crust is usually 5–10 km thick. Continental crust is 35–70 km thick. The mantle extends from the bottom of the crust and is about 2,900 km thick. The outer and inner core together are about 3,500 km thick. The layers of Earth are often compared to the layers of a hard-boiled egg or a peach. Each has a thin outer layer, comparable to Earth's crust; a middle layer, like the mantle; and an inner layer, similar to the core.

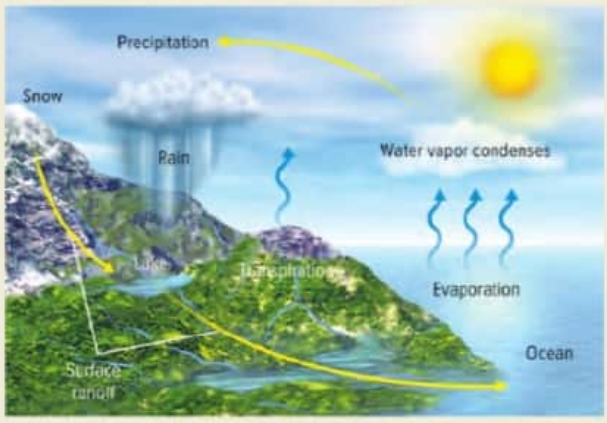


Lesson 2

Interactions of Earth's Systems

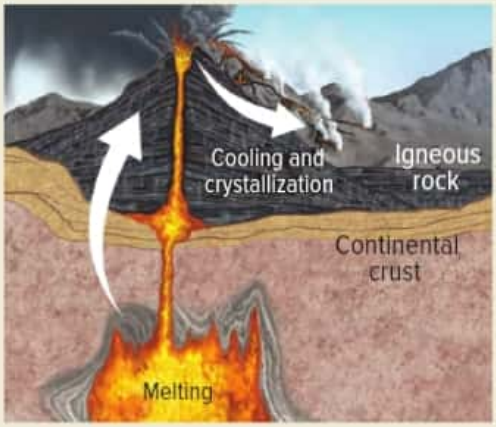
The Water Cycle Rates of evaporation and precipitation vary from one location to another. But globally, the amount of water evaporated from Earth's surface is about equal to the amount of water that falls back to Earth as precipitation. It takes about 10 days for a water molecule that has been evaporated to fall back to Earth's surface.

Evaporation and Transpiration Factors that affect rates of evaporation include temperature and wind. The higher the temperature of water, the faster the evaporation rate. Increased wind speed also leads to an increase in evaporation rates. Transpiration rates are also affected by several factors including air temperature, wind, relative humidity, and the type of plant. Increased temperature and wind lead to increased transpiration rates. Increased relative humidity leads to decreased transpiration rates. Different types of plants transpire at different rates. For example, desert plants, such as cacti, transpire less than other types of plants in order to help conserve water in dry conditions.



Changes in the Atmosphere One example of an interaction between the geosphere and the atmosphere is the rain-shadow effect. *Orographic lifting* is the term used to describe the rising of air due to contact with an elevated barrier, such as a mountain. The windward sides of mountains usually have high levels of precipitation. The leeward sides of mountains, under the influence of a rain-shadow, are usually deserts. The Great Basin Desert in the western United States was created by the rain-shadow effect.

The Rock Cycle The rock cycle connects processes at Earth's surface with those in Earth's interior. Weathering and erosion break rocks at Earth's surface into sediment. When layers of sediment are deposited on top of each other, enough pressure is eventually applied to the bottom layers that the sediment changes to sedimentary rock. If sedimentary rock is exposed to the extreme temperatures and pressure in Earth's interior, it will eventually become metamorphic rock. The term *metamorphosis* means "to change physical form or structure." When igneous, metamorphic, or sedimentary rock are subjected to intense heat and pressure, each can change into a new metamorphic rock.



Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

*The world contains a wide diversity of physical conditions, which creates a wide variety of environments: freshwater, marine, forest, desert, grassland, mountain, and others. In any particular environment, the growth and survival of organisms depends on the physical conditions.

*Earth is mostly rock. Three-fourths of Earth's surface is covered by a relatively thin layer of water (some of it frozen), and the entire planet is surrounded by a relatively thin layer of air.

*When liquid water disappears, it turns into a gas (vapor) in the air. It can reappear as a liquid when cooled and then as a solid if cooled below the freezing point of water. Clouds and fog are made of tiny droplets or frozen crystals of water.

*Rock is composed of different combinations of minerals. Smaller rocks come from the breakage and weathering of bedrock and larger rocks. Soil is made partly from weathered rock and partly from plant remains, and it also contains many living organisms.

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

Lesson 1
Earth Systems

3 Earth is made up of the biosphere, the atmosphere, the hydrosphere, the cryosphere, and the geosphere.

1 The atmosphere has a layered structure that includes the troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere. It is made of nitrogen, oxygen, and trace gases.

2 Water is found on Earth in oceans, lakes, rivers, and as ice and groundwater. Small amounts of water are also found within the atmosphere and the biosphere.

4 The geosphere is made of soil, metal, and rock. It has a layered structure that includes the crust, the mantle, and the core.

Lesson 2
Interactions of Earth Systems

5 The water cycle shows how water moves between reservoirs of the hydrosphere, the atmosphere, the geosphere, and the biosphere.

6 Weather and climate are influenced by transfers of water and energy among the atmosphere, the geosphere, and the hydrosphere.

7 Rocks continually change form as they move through the rock cycle. Processes such as weathering and erosion are examples of interactions among the Earth systems.

Earth's Ocean

Find Out What Students Think

Students may think that...

... because oceans have different names—Atlantic Ocean, Pacific Ocean, Arctic Ocean, Indian Ocean, and Southern Ocean—each is a separate body of water that does not interact with other oceans.

Discussion

Although the word *oceans,* plural, is commonly used when discussing Earth's salt water, most of Earth is covered by a single large ocean. The water masses within each ocean basin have slightly different characteristics in terms of salinity, oxygen levels, and other water chemistry qualities. The water temperature varies as well. However, the basins are connected and water does move from one basin to another.

Promote Understanding

Activity Provide students with a map that shows the great ocean conveyor belt. Explain to students what the "conveyor belt" illustrates. The conveyor belt model shows how deep-water currents and surface currents move water (and thermal energy) around the globe.

1. Have students place an *x* along the conveyor belt in the North Atlantic Ocean at the point where the warm surface current changes to a cold deep-water current. Explain that as surface water in the North Atlantic cools, it increases in density and eventually sinks.
2. Have students track the deep-water current on the conveyor belt into the South Atlantic Ocean and the Southern Ocean. Explain that deep-water currents move the water that sank in the North Atlantic to the south, eventually reaching the Southern Ocean.
3. Have students continue to follow the conveyor belt to the Pacific Ocean. **Ask:** What will happen to water that sinks in the North Atlantic when it reaches the North Pacific Ocean? **It will resurface, and surface currents will carry it back toward Australia.**
4. Have students track the water through the Indian Ocean and back to the North Atlantic where it began. Explain that it takes about 1000 years for water to circulate throughout all ocean basins.
5. **Ask:** How could surface water that sank near Antarctica in the Southern Ocean circulate through other ocean basins to reach its starting point? **Possible answer: Students should track the water from the deep-water current in the Southern Ocean to the North Pacific, where it resurfaces. Surface currents will move the water through the Indian Ocean and back down into the Southern Ocean. The water could travel around Antarctica to reach its starting point.**

Composition of the Atmosphere

Find Out What Students Think

Students may think that...

... Earth's atmosphere contains only gases. Students learn that the atmosphere is made up of mostly nitrogen and oxygen, along with small amounts of other gases. Liquids and solids exist in the atmosphere as well.

Discussion

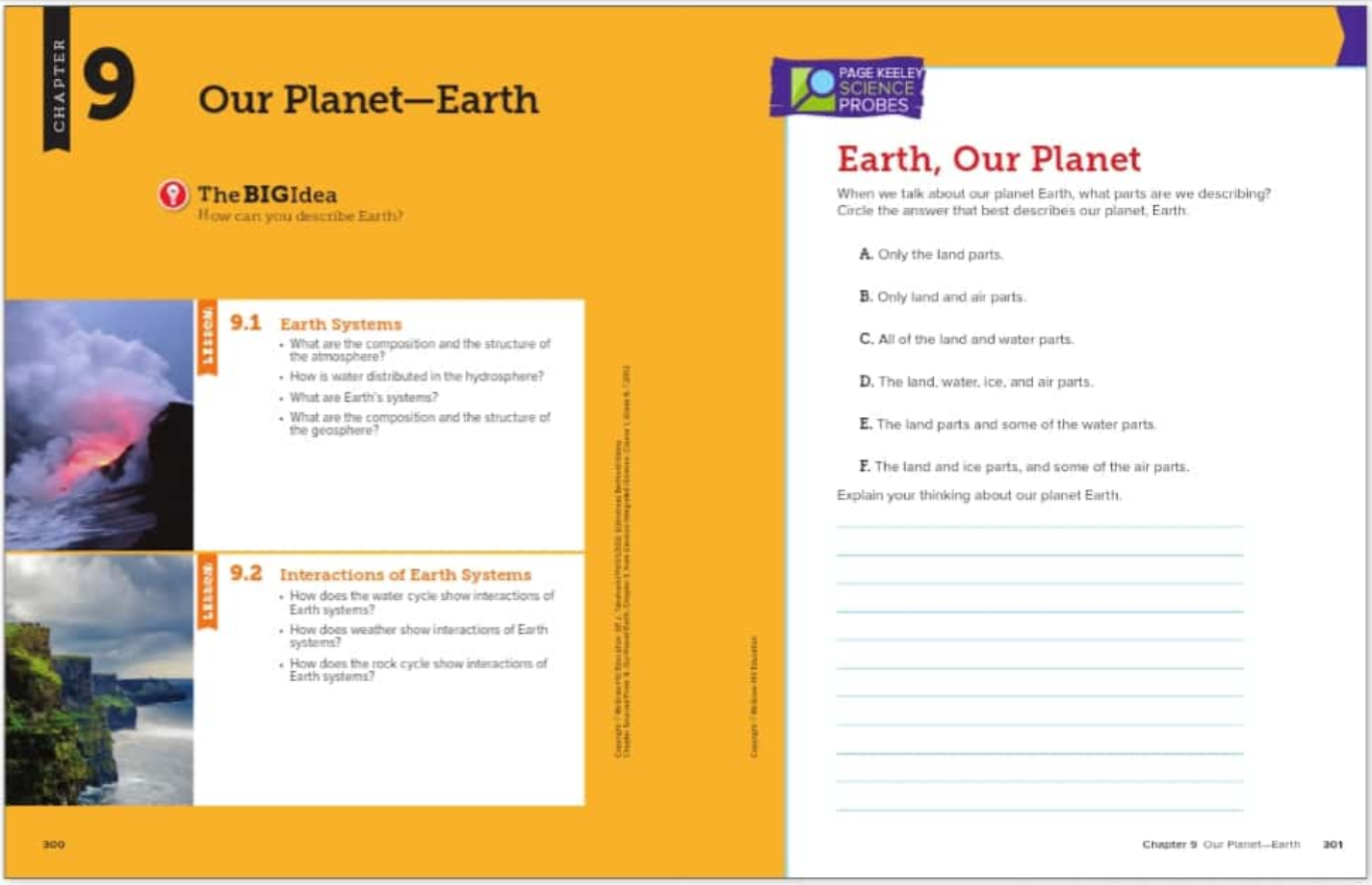
If asked what makes up the atmosphere, the reply of most students will likely be nitrogen and oxygen. The atmosphere is composed mainly of gases; however, liquids and solids also exist suspended in the atmosphere. **Ask:** Give an example of a liquid in the atmosphere. **Students should recognize that clouds consist of condensed water droplets; raindrops that fall from clouds as precipitation are liquid. In this activity students will collect samples of solids in the atmosphere.**

Promote Understanding

Activity Provide students with Petri dishes (or lids from plastic containers) and petroleum jelly. Explain to students that they will be testing the air for solids in the atmosphere.

1. Have students spread a layer of the petroleum jelly in the dish.
2. Have students cover the dish and walk to an outdoor location. Uncover the dish and leave it in the chosen location for 30 minutes.
3. Retrieve the dishes, covering them before moving back to the classroom. Then have students use a magnifying lens to examine the materials stuck in the petroleum jelly.
4. **Ask:** Describe the solid materials collected on your dish. **Materials might include dust, pollen, soil, salt from the ocean, soot from a fire, or ash from a volcanic eruption.**
5. Have students use the examples of solids in the atmosphere to explain how the atmosphere interacts with Earth's other systems. **Ask:** How does the atmosphere interact with rocks and other parts of Earth's crust? **Wind can carry sediment from one area to another.** **Ask:** How does the atmosphere interact with living things? **Wind carries pollen from flowers from one location to another.**

PAGE KEELE SCIENCE PROBES



How can you describe Earth?

The BIG Idea

There a re no right or wrong answers to these questions. Write studentgenerated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL **How is life on Earth linked to water at Earth's surface and oxygen in Earth's atmosphere?**

Use this question to get students thinking about Earth's different systems and how they are linked. Students should recall that all living organisms need water to survive. Many organisms, including animals, need oxygen to survive as well.

OL **What are some features that make Earth different from other planets in our solar system?**

Use this question to get students thinking about Earth's different systems and their characteristics. Possible answer: Earth is the only planet that has life as we know it. Earth's atmosphere contains oxygen. The temperatures on Earth are not as extreme as they are on other planets. Earth has liquid water. Earth has a solid surface.

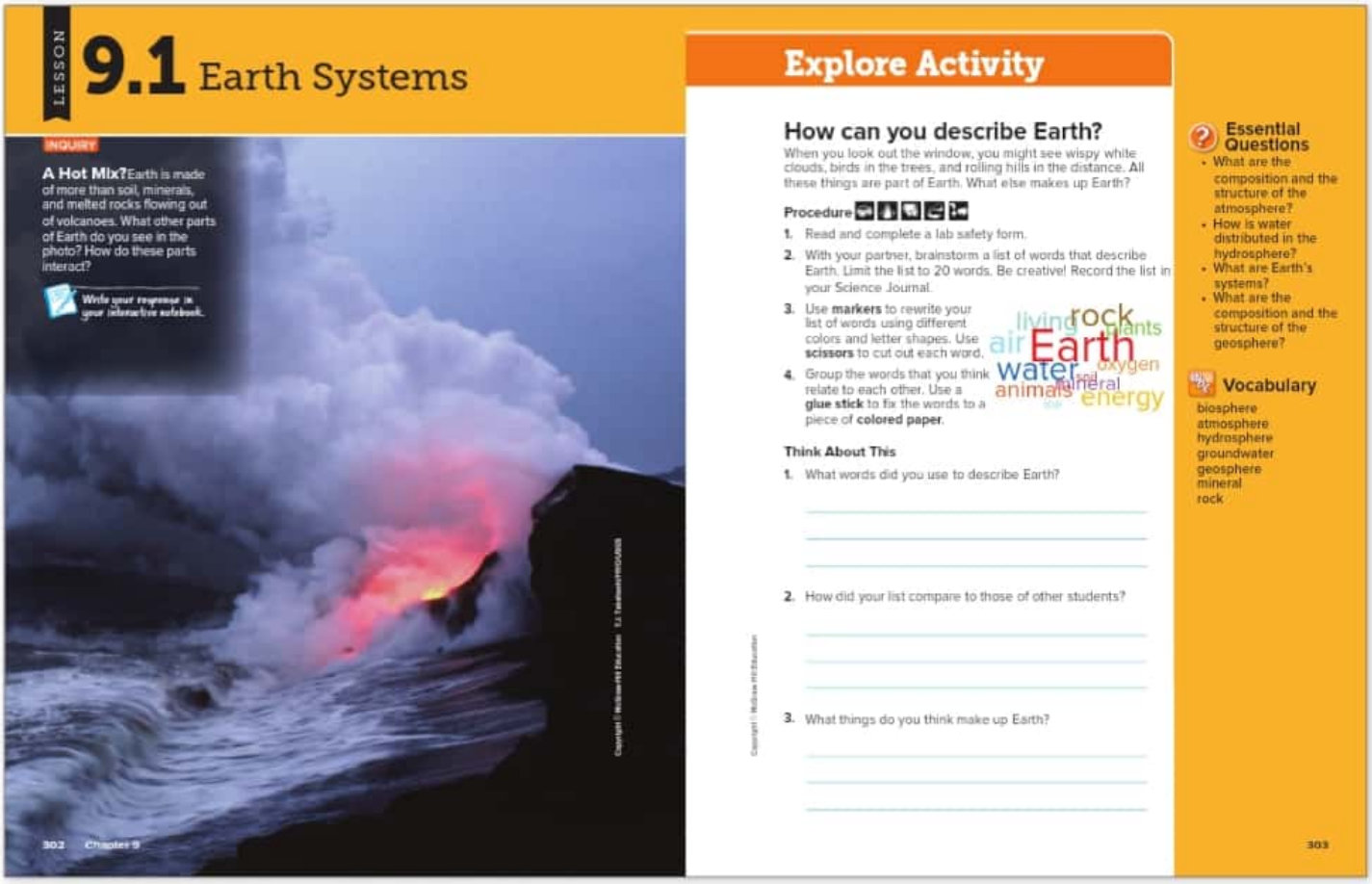
BL **Give one example of how water at Earth's surface is linked to the atmosphere.**

Students should recall interactions between the hydrosphere and the atmosphere as part of the water cycle. Possible answer: Water at Earth's surface evaporates into the atmosphere. It later condenses and forms clouds.

PAGE KEELEY SCIENCE PROBES

Earth, Our Planet

Answers to the Page Keeley Science Probe can be found in the Teacher's Edition of the *Activity Lab Workbook*.



LESSON 9.1 Earth Systems

INQUIRY

A Hot Mix? Earth is made of more than soil, minerals, and melted rocks flowing out of volcanoes. What other parts of Earth do you see in the photo? How do these parts interact?

Write your response in your interactive notebook.

302 Chapter 9

Explore Activity

How can you describe Earth?

When you look out the window, you might see wispy white clouds, birds in the trees, and rolling hills in the distance. All these things are part of Earth. What else makes up Earth?

Procedure

1. Read and complete a lab safety form.
2. With your partner, brainstorm a list of words that describe Earth. Limit the list to 20 words. Be creative! Record the list in your Science Journal.
3. Use **markers** to rewrite your list of words using different colors and letter shapes. Use **scissors** to cut out each word.
4. Group the words that you think relate to each other. Use a **glue stick** to fix the words to a piece of **colored paper**.

living rock plants air Earth water oxygen soil mineral animals energy

Think About This

1. What words did you use to describe Earth?

2. How did your list compare to those of other students?

3. What things do you think make up Earth?

Essential Questions

- What are the composition and the structure of the atmosphere?
- How is water distributed in the hydrosphere?
- What are Earth's systems?
- What are the composition and the structure of the geosphere?

Vocabulary

biosphere
atmosphere
hydrosphere
groundwater
geosphere
mineral
rock

303

INQUIRY

A Hot Mix? About the Photo The photo shows the interaction between the geosphere, the hydrosphere, and the atmosphere. Hot, molten lava that has erupted from Earth's interior is oozing into the ocean, creating steam as the water heats up. The lava will eventually harden and form igneous rock. Have students think about how a volcanic eruption might affect the biosphere and the atmosphere.

Guiding Questions

AL	Describe Earth's water system.	*Possible answers: Most of the water on Earth is salt water in the oceans. Freshwater is found in rivers and lakes and is stored in ice, including glaciers. Some water is in the atmosphere in a gaseous state.*
OL	Where did the lava in the photo come from? How might the interior of Earth differ from conditions at Earth's surface?	*Possible answers: The lava came from Earth's interior. Temperatures in Earth's interior are hot enough to melt rock. But at Earth's surface, where temperatures are lower, rock is solid.*
BL	Give an example of an interaction between any two of Earth's systems.	*Answers will vary. Students might point out the interaction between the hydrosphere and the atmosphere, which leads to weather; or the interaction between the biosphere and the atmosphere, in which organisms exchange gases, such as oxygen and carbon dioxide.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Prefixes and Root Words

1. Have students look up meaning of the root *sphere*. Sphere means *"globe" or "ball."*
2. Have students look up the definition of each of the following prefixes: *bio-, atmos-, hydro-, geo-*. Bio- *means life,* atmos- *means "vapor,"* hydro- *means "water," and* geo- *means "earth" or "ground."*
3. Have students write their own definitions for the terms *biosphere, atmosphere, hydrosphere,* and *geosphere* in their Science Journals. *Answers will vary but should be based on the meanings of the prefixes and word root.* Have students compare their definitions to those provided in the text as they read Lesson 1.

ExploreActivity

How can you describe Earth?

Prep: *15 min* **Class:** *20 min*

Purpose
To recognize that Earth is a complex system made of different sub-systems.

Materials
colored markers, scissors, glue stick, colored cardboard or stiff paper, plain white paper, examples of word clouds

Before You Begin

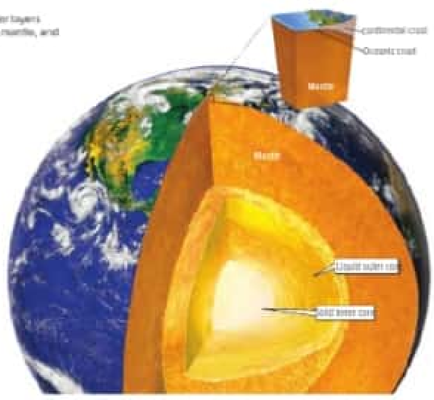
- Provide each group of students with a piece of colored cardboard, a glue stick, and several sheets of plain white paper.
- Explain the concept of a Wordle©. A Wordle is a "word cloud" in which words from a given text are grouped together. Show students several examples. To create your own Wordle, go to http://www.wordle.net. Some words in a Wordle are written in different colors or sizes based on how frequently they appear in a given piece of writing. Students do not need to reflect the frequency of usage of each word in their word clouds.

Guide the Investigation
Stress that there is no right way or wrong way to assemble a word cloud. Encourage students to be creative and inventive with their word cloud designs.

Think About This

1. Sample answer: water, air, round, rocks, planet, people, trees, mountains
2. Answers will vary. Students might find that each group used similar words to describe Earth. Some words that were not used by all groups might provide opportunities for discussion.
3. Sample Answer: Earth is made of living things, air, water, soil, and rocks.

Teacher Notes



Structure

Earth's internal structure is layered like the layers of a hard-cooked egg. The three basic layers of the geosphere are shown in **Figure 9**. Similar to an egg, each layer of the geosphere has a different composition.

Crust The brittle outer layer of the geosphere is much thinner than the inner layers, like the shell on a hard-cooked egg. This thin layer of rock is called the crust. The crust is found under the soil on continents and under the ocean. Oceanic crust is thinner and denser than continental crust. This is due to their different compositions. Continental crust is made of igneous, sedimentary, and metamorphic rocks. Oceanic crust is made of only igneous rock.

Mantle The middle and largest layer of the geosphere is the mantle. Like the crust, the mantle is made of rock; however, mantle rocks are hotter and denser than those in the crust. In parts of the mantle, temperatures are so high that rocks flow, a bit like partially melted plastic.

Core The center of Earth is the core. If you use a hard-cooked egg as a model of Earth, then the yolk would be the core. Unlike the crust and the mantle, the core is not made of rock. Instead, it is made mostly of the metal iron and small amounts of nickel. The core is divided into two parts. The outer core is liquid. The inner core is a dense ball of solid iron.

Key Concept Check

9. What are the composition and the structure of the geosphere?

312 Chapter 9

LESSON 9.1 Review

Visualize It!

Earth is made of interacting systems: the atmosphere, the hydrosphere, the cryosphere, the geosphere, and the biosphere.

The atmosphere is made mainly of gases and has a layered structure. The geosphere is made of rock, soil, and metal and also has a layered structure.

Most water in the hydrosphere is in the world ocean.

Summarize it!

1. What are the composition and the structure of the atmosphere?

2. How is water distributed in the hydrosphere?

3. What are Earth's systems?

4. What are the composition and the structure of the geosphere?

Lesson 9.1 Earth Systems 313

Structure

The three basic layers of the geosphere are the crust, the mantle, and the core. While the crust and mantle are made of rock, the core is made of iron and nickel. The outer core is liquid and the inner core is solid iron and nickel. The text compares the layers of Earth's internal structure to the layers of a hard cooked egg. Complete the Teacher Demo using a hard-cooked egg to help students visualize the layers. **Ask: What other analogies can you make about layers in the geosphere?** *Possible answers: a peach, which has a thin outer skin, a fleshy layer, and a pit in the center*

Guiding Questions

AL What is the difference between the crust and the mantle?	*The mantle material is hotter and denser than the rocks of the crust.*
Key Concept Check: What are the composition and the structure of the geosphere?	*The crust is solid and is made of rock, including igneous, sedimentary, and metamorphic rock. The mantle is made of partially melted rock. In parts of the mantle, rocks flow like melted plastic due to high temperature. The core is made of iron and nickel. The outer core is liquid, and the inner core is solid.*
BL Infer how the layers of the geosphere formed.	*They resulted from their different densities. As Earth formed, the denser materials sank, and the less dense material rose.*

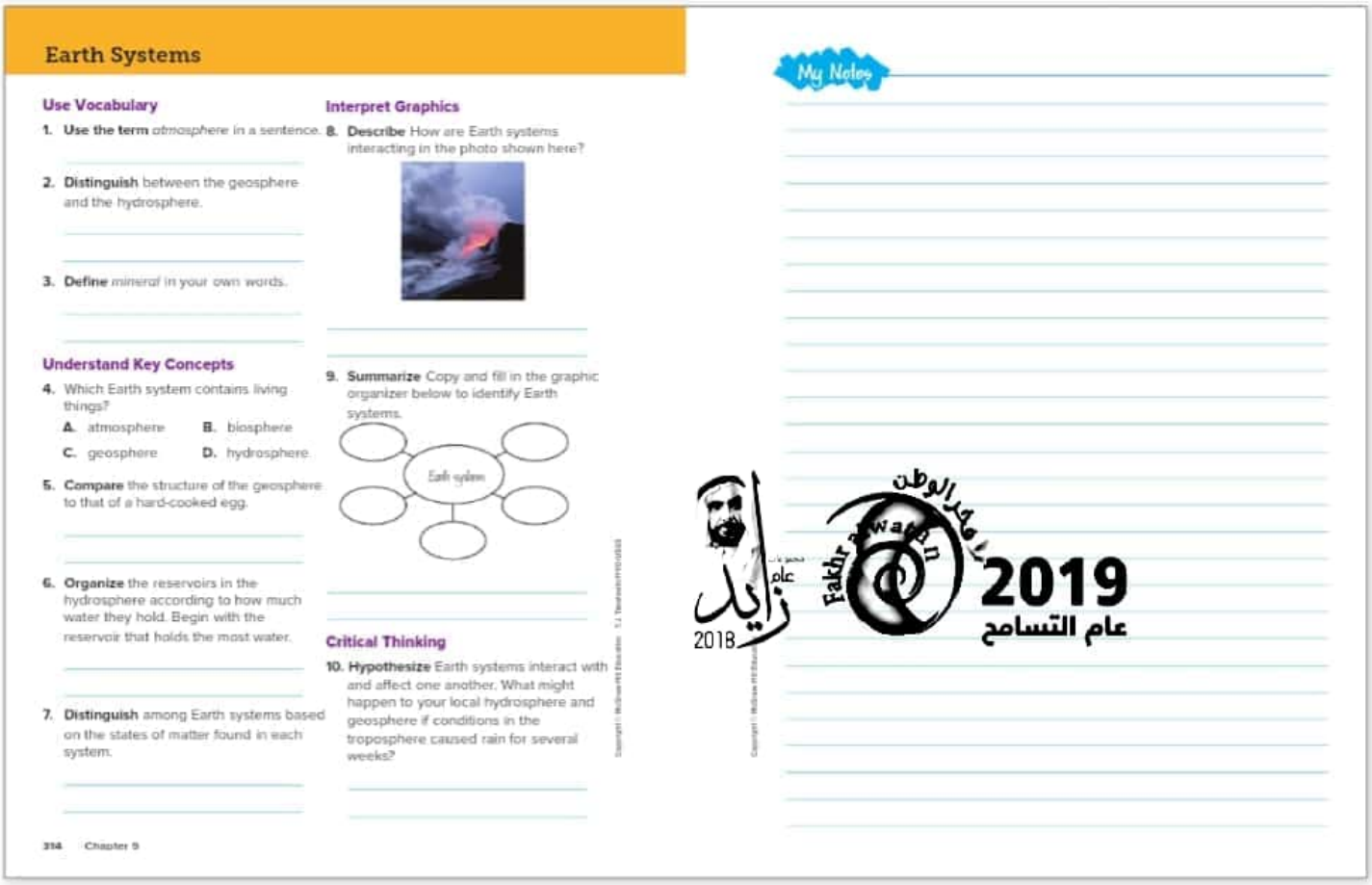
Visual Literacy: Structure of the Geosphere

Figure 9 shows the layers of the geosphere. Relate material from the figure to student's lives.

Ask: When you are standing on the ground outside your house, which layer of the geosphere are you standing on? *the crust* **What type of crust?** *continental crust*

Ask: How does the thickness of Earth's crust compare to the thickness of the mantle and core? *The crust is very thin compared to the thickness of either the mantle and the core.*

Ask: What is the difference between the outer core and the inner core? *The outer core is liquid and the inner core is solid.*



Earth Systems

Use Vocabulary

1. **Use the term** *atmosphere* in a sentence.
2. **Distinguish** between the geosphere and the hydrosphere.
3. **Define** *mineral* in your own words.

Understand Key Concepts

4. Which Earth system contains living things?
   A. atmosphere B. biosphere
   C. geosphere D. hydrosphere
5. **Compare** the structure of the geosphere to that of a hard-cooked egg.
6. **Organize** the reservoirs in the hydrosphere according to how much water they hold. Begin with the reservoir that holds the most water.
7. **Distinguish** among Earth systems based on the states of matter found in each system.

Interpret Graphics

8. **Describe** How are Earth systems interacting in the photo shown here?

9. **Summarize** Copy and fill in the graphic organizer below to identify Earth systems.

Earth system

Critical Thinking

10. **Hypothesize** Earth systems interact with and affect one another. What might happen to your local hydrosphere and geosphere if conditions in the troposphere caused rain for several weeks?

My Notes

314 Chapter 9

Use Vocabulary

1 Sample answer: The hot air balloon floated up through the atmosphere. **DOK 1**

2 The geosphere is the solid Earth system made mostly of rock, and the hydrosphere is the system that contains Earth's water. **DOK 1**

3 Sample answer: A mineral is a solid that has a crystal structure, is inorganic, has a set composition, and forms naturally. **DOK 1**

Understand Key Concepts

4 B. biosphere **DOK 1**

5 Sample answer: The geosphere is layered like a hard-cooked egg. The crust of the geosphere is like the shell of the egg. The mantle is like the egg white. The core is like the yolk. **DOK 2**

6 The reservoirs listed from largest to smallest are: the ocean, ice, groundwater, lakes, and rivers. **DOK 2**

7 Sample answer: The atmosphere is composed mainly of gases, the hydrosphere is composed mainly of liquid, the geosphere is composed mainly of solids, and the biosphere is composed of solids and liquids. **DOK 2**

Interpret Graphics

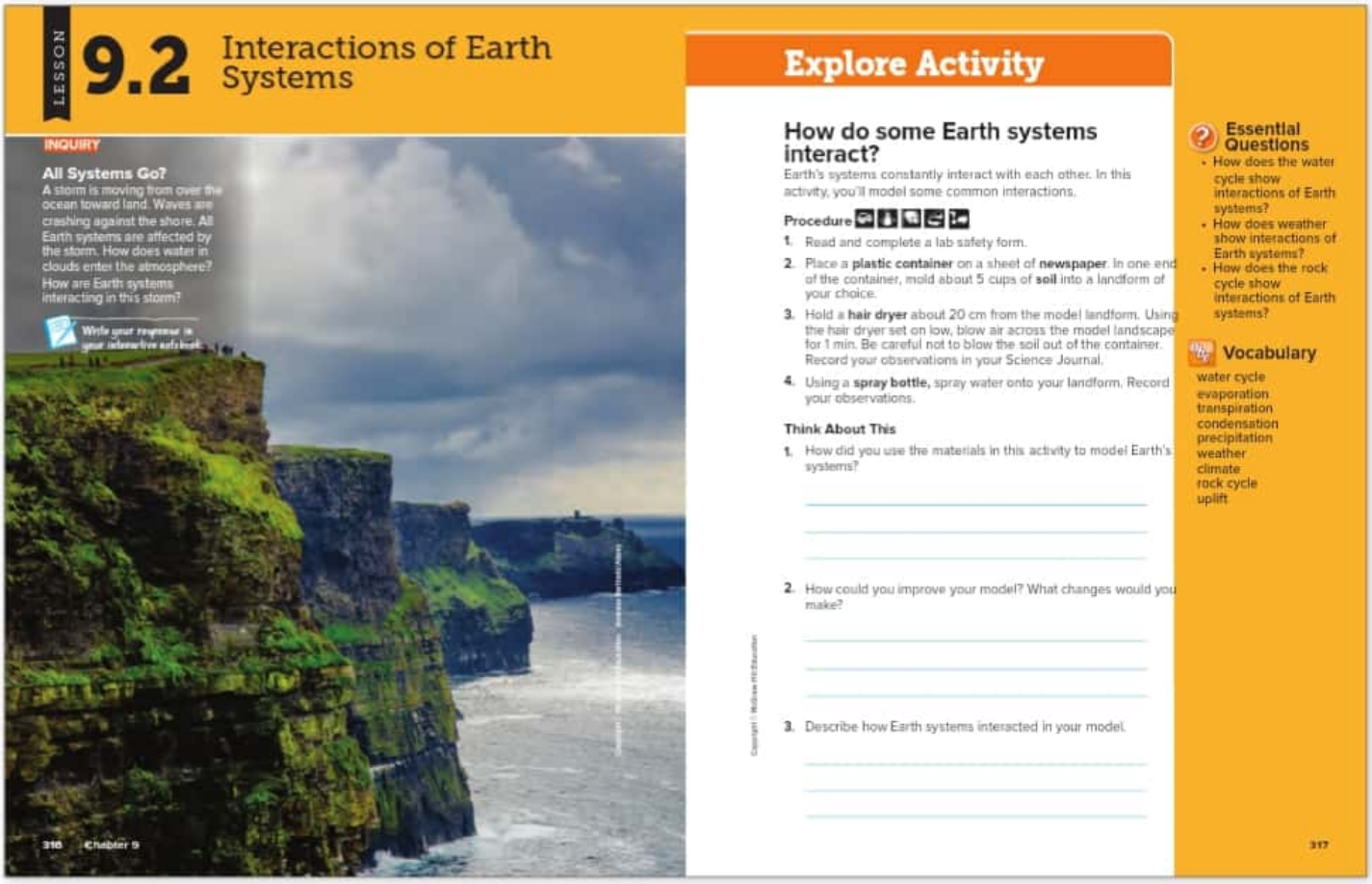
8 Lava from the geosphere is flowing into the ocean, which is part of the hydrosphere. The hot lava causes steam to form when it comes into contact with the ocean water, and the steam (water vapor) is released into the atmosphere. The ocean waves crash against the rocks, causing weathering and erosion. **DOK 3**

9 geosphere, hydrosphere, atmosphere, biosphere **DOK 3**

Critical Thinking

10 Sample answer: Rivers and streams might overflow their banks and cause widespread flooding. The heavy rains could increase soil erosion and might lead to mudslides. **DOK 4**

Desalination This feature can be found in the *Activity Lab Workbook*.


LESSON 9.2 Interactions of Earth Systems

INQUIRY

All Systems Go?
A storm is moving from over the ocean toward land. Waves are crashing against the shore. All Earth systems are affected by the storm. How does water in clouds enter the atmosphere? How are Earth systems interacting in this storm?

Write your response in your interactive notebook.

316 Chapter 9

Explore Activity

How do some Earth systems interact?
Earth's systems constantly interact with each other. In this activity, you'll model some common interactions.

Procedure

1. Read and complete a lab safety form.
2. Place a **plastic container** on a sheet of **newspaper**. In one end of the container, mold about 5 cups of **soil** into a landform of your choice.
3. Hold a **hair dryer** about 20 cm from the model landform. Using the hair dryer set on low, blow air across the model landscape for 1 min. Be careful not to blow the soil out of the container. Record your observations in your Science Journal.
4. Using a **spray bottle,** spray water onto your landform. Record your observations.

Think About This

1. How did you use the materials in this activity to model Earth's systems?
2. How could you improve your model? What changes would you make?
3. Describe how Earth systems interacted in your model.

Essential Questions
- How does the water cycle show interactions of Earth systems?
- How does weather show interactions of Earth systems?
- How does the rock cycle show interactions of Earth systems?

Vocabulary
water cycle
evaporation
transpiration
condensation
precipitation
weather
climate
rock cycle
uplift

317

INQUIRY

About the Photo **All Systems Go?** The photo can be used to start a discussion on how Earth's systems interact. In the photo, the interaction between the systems includes the waves hitting the cliffs (hydrosphere and geosphere), the clouds, which were formed with water from the hydrosphere (atmosphere and hydrosphere), the rain from the storm will provide water for plants and other organisms (hydrosphere, atmosphere, biosphere) and cause some soil erosion (hydrosphere, atmosphere, geosphere), and the plants are growing in the soil on top of and along the cliff (biosphere and geosphere).

Guiding Questions

AL	Which two Earth systems interact and form the clouds in the sky?	*The two systems are the hydrosphere and the atmosphere. Students might recall that clouds form when water from Earth's surface evaporates and then condenses in the atmosphere.*
OL	How do the waves from the hydrosphere interact with the cliffs from the geosphere?	*Possible answers: The waves will cause the rocks that make up the cliff to erode.*
BL	How does the storm interact with the biosphere?	*Possible answers: The rain will provide water for plants and other organisms. If the storm is severe, it might damage or destroy habitats.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Prior Knowledge

Students might be familiar with many of the vocabulary terms in this lesson.

1. Make several sets of index cards. For each term, write just the definition on an index card. Then make another index card with just the term written on the card.
2. Group students in small groups. Set up stations around the room for each group.
3. At each station, arrange the cards with the terms in rows so that there is enough room above each card for the definition card.
4. Have students match the definition cards with each term.
5. Review the answers with students.

ExploreActivity

How do some Earth systems interact?

Prep: *10 min* **Class:** *20 min*

Purpose
To model erosion, an interaction between the hydrosphere, atmosphere, and geosphere.

Materials
plastic shoe box, newspaper, five cups of soil, 100 mL beaker, water, hairdryer, spray bottle

Before You Begin
- Place the materials in a central location. Open a bag of soil and place a cup nearby.
- Tell students to scoop around five cups of soil into their plastic containers.

Guide the Investigation
- For best results, set the hairdryer on low. Suggest that students experiment with the height and distance at which to hold the dryer to obtain a steady breeze across the model landform.
- ⚠ Students should wear their safety goggles during this activity. Blowing soil might get into eyes. Take care not to trip over the cord for the dryer or any extension cords you might use. Taping the cord to the floor may help prevent tripping. Keep water away from the dryer.

Think About This
1. The fan represented the atmosphere. The water in the spray bottle represented the hydrosphere. The soil represented the geosphere.
2. Sample answer: I could compact the soil or add vegetation to help prevent erosion. Or I could insert sticks to simulate trees or structures.
3. **Key Concept** The wind from the atmosphere blew the soil; the rain from the hydrosphere washed away some soil.

Teacher Notes

LESSON

9.2 Review

Interactions of Earth Systems

Visualize It!

In the water cycle, water continually moves through the hydrosphere, the atmosphere, the geosphere, and the biosphere.

Weather and climate are influenced by interactions between the atmosphere and the other Earth systems.

In the rock cycle, rocks continually change from one form to another.

Summarize it!

1. How does the water cycle show interactions of Earth systems?

2. How does weather show interactions of Earth systems?

3. How does the rock cycle show interactions of Earth systems?

Use Vocabulary

1. **Distinguish** between weather and climate.

2. **Define** the *water cycle* in your own words.

3. The process that changes liquid water to water vapor is

Understand Key Concepts

4. Which is an example of an interaction between the atmosphere and the geosphere?
   - A. breathing
   - B. ocean currents
   - C. storms
   - D. weathering

5. **Outline** Make an outline about the rock cycle. Include information about processes, rock types, and interactions with Earth systems.

6. **Compare** how the hydrosphere affects weather and how it affects climate.

Interpret Graphics

7. **Organize Information** Copy and fill in the graphic organizer below. Identify the processes of the water cycle.

Critical Thinking

8. **Design** a model that shows an interaction between two Earth systems.

9. **Assess** Some gasoline was spilled in a driveway. Could the pollutant pose a problem for the hydrosphere? Why or why not?

Math Skills

10. Air at 20°C has a vapor density of 8.65 g/m³. The maximum amount of vapor density at that temperature is 17.3 g/m³. What is the relative humidity?

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: Which Key Concept does each image relate to?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- The Water Cycle
- Changes in the Atmosphere
- The Rock Cycle

Use Vocabulary

1. Weather is the state of the atmosphere at a particular time and place, and climate is the average weather over several decades. **DOK 1**

2. Sample answer: The water cycle shows how water moves through different Earth systems. **DOK 1**

3. evaporation **DOK 1**

Understand Key Concepts

4. D. weathering **DOK 1**

5. Outlines should include information about the processes of the rock cycle, the three main rock types, and interactions with Earth systems. Outline heads might be similar to those in the text. **DOK 2**

6. The hydrosphere provides the water for cloud formation and precipitation. The hydrosphere can also affect air masses. Surface currents in the ocean transfer thermal energy, modifying the climates of coastal regions. **DOK 2**

Interpret Graphics

7. In any order, the processes of the water cycle are evaporation, condensation, precipitation, transpiration, and respiration. **DOK 3**

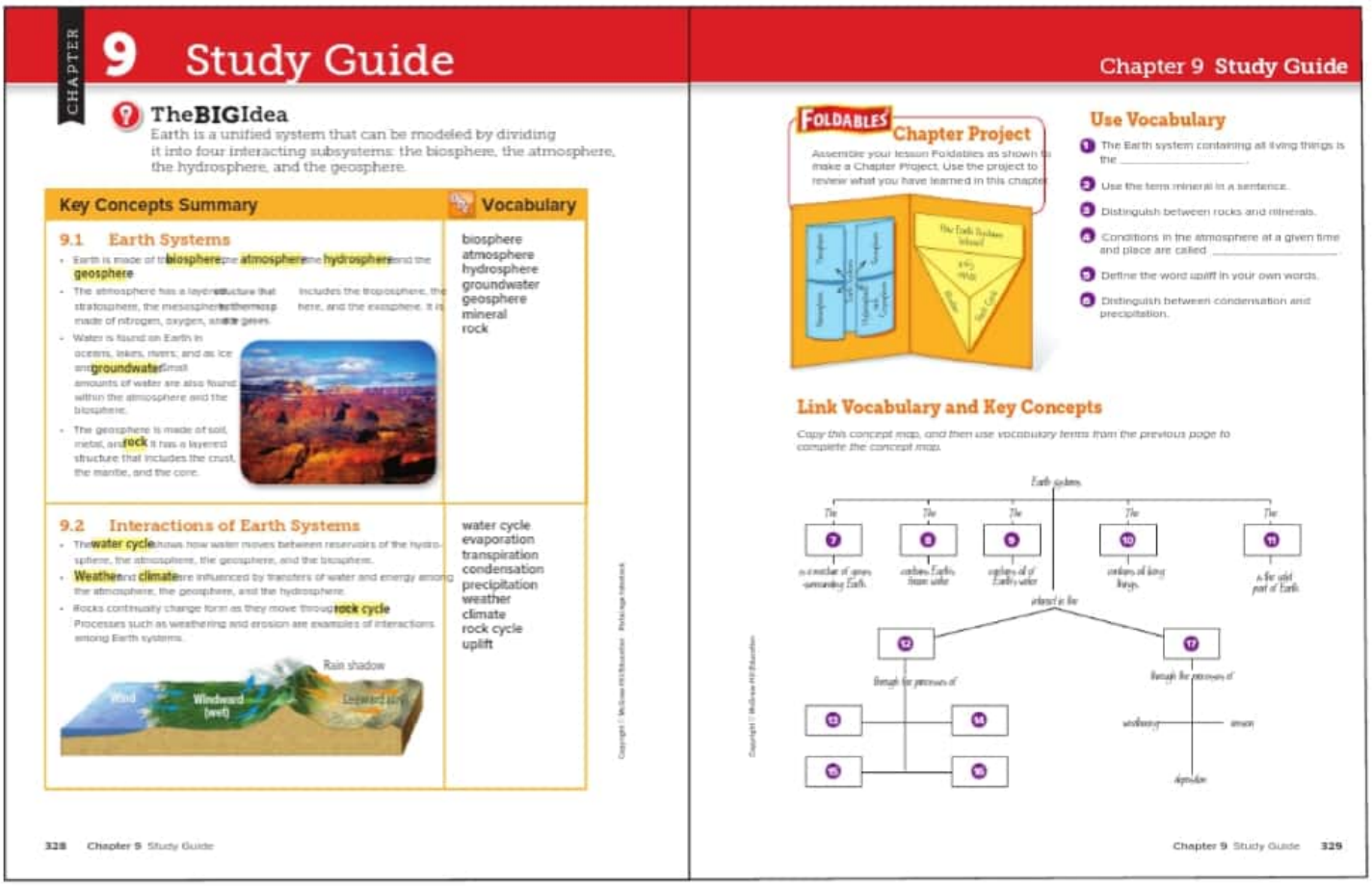
Critical Thinking

8. A model might be a terrarium that includes plants, soil, air, and water. **DOK 3**

9. Sample answer: Yes, it could pose a problem if rain washed the gasoline into a nearby lake or river, or if the gasoline soaked into the ground and polluted groundwater. **DOK 4**

Math Skills

10. RH = 8.65/17.3 = 0.50 × 100 = 50% **DOK 2**



CHAPTER 9 Study Guide

The BIG Idea

Earth is a unified system that can be modeled by dividing it into four interacting subsystems: the biosphere, the atmosphere, the hydrosphere, and the geosphere.

Key Concepts Summary

9.1 Earth Systems

- Earth is made of the **biosphere**, the **atmosphere**, the **hydrosphere**, and the **geosphere**.
- The atmosphere has a layered structure that includes the troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere. It is made of nitrogen, oxygen, and other gases.
- Water is found on Earth in oceans, lakes, rivers, and as ice and **groundwater**. Small amounts of water are also found within the atmosphere and the biosphere.
- The geosphere is made of soil, metal, and **rock**. It has a layered structure that includes the crust, the mantle, and the core.

9.2 Interactions of Earth Systems

- The **water cycle** shows how water moves between reservoirs of the hydrosphere, the atmosphere, the geosphere, and the biosphere.
- **Weather** and **climate** are influenced by transfers of water and energy among the atmosphere, the geosphere, and the hydrosphere.
- Rocks continually change form as they move through the **rock cycle**. Processes such as weathering and erosion are examples of interactions among Earth systems.

Rain shadow

Wind

Windward (wet)

Leeward (dry)

Vocabulary

biosphere
atmosphere
hydrosphere
groundwater
geosphere
mineral
rock

water cycle
evaporation
transpiration
condensation
precipitation
weather
climate
rock cycle
uplift

328 Chapter 9 Study Guide

Chapter 9 Study Guide

FOLDABLES **Chapter Project**

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. The Earth system containing all living things is the _____.
2. Use the term mineral in a sentence.
3. Distinguish between rocks and minerals.
4. Conditions in the atmosphere at a given time and place are called _____.
5. Define the word uplift in your own words.
6. Distinguish between condensation and precipitation.

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.

Earth systems

The 7 — a mixture of gases surrounding Earth.

The 8 — contains Earth's frozen water.

The 9 — contains all of Earth's water.

The 10 — contains all living things.

The 11 — is the solid part of Earth.

interact in the

12 — through the processes of

13

14

15

16

17 — through the processes of

weathering

erosion

deposition

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Chapter 9 Study Guide 329

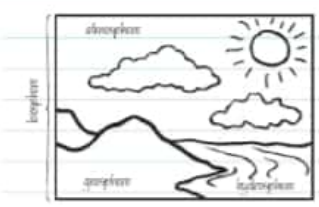
Key Concepts Summary

Study Strategy: Draw It

Students who are visual learners rather than verbal learners will benefit from using drawings to represent the meaning of key concept statements. Give visual learners in your class the following instructions.

1. Assign each student one of the sentences from the Key Concepts Summary.
2. Instruct students to draw a picture that represents the meaning of the sentence. Underneath the drawing, students should write the sentence.
3. Have students share their drawings with the class. If possible, make copies of all the student drawings and give them to students to use as a study guide.

Example:



Earth is made up of the biosphere, the atmosphere, the hydrosphere, and the geosphere.

Vocabulary

Study Strategy: Word Roots

Learning word roots will help students remember the meanings of difficult vocabulary terms. In addition, it will help students infer the meanings of other related terms. Give students the following instructions:

1. Have students create a chart like the one below in their Science Journals.
2. Instruct students to use a dictionary to find the roots (also called etymology) of the chapter's vocabulary terms. Demonstrate to students where this information can be found in a dictionary entry.
3. If time allows, have students find other English words that share common roots with the chapter's vocabulary terms.

Example:

Term	Word Part	Root
biosphere	bio	Greek, bios, meaning "life"
	sphere	Greek, sphaira, meaning "ball"
transpiration	trans	
	spira	
	tion	

FOLDABLES®

Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

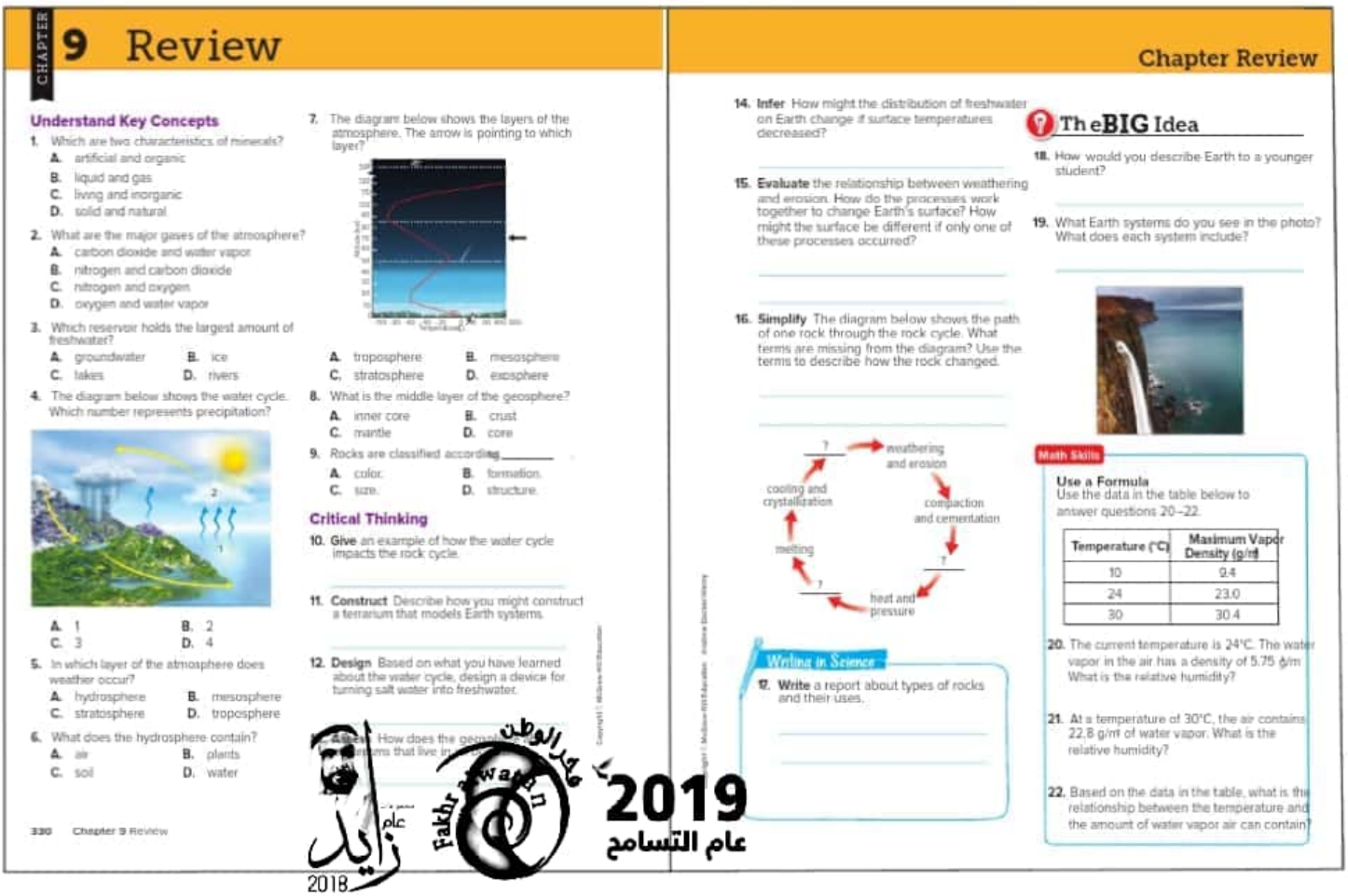
Use Vocabulary

1. biosphere
2. Sample answer: Rocks are made of minerals.
3. Rocks are naturally occurring solids composed of minerals, rock fragments, and organic matter or glass. Minerals are naturally occurring, inorganic solids that have crystal structures and definite chemical compositions.
4. weather
5. Sample answer: Uplift is the process that moves Earth materials to higher elevations.
6. Condensation occurs when a gas changes into a liquid. Precipitation occurs when water falls from clouds to Earth's surface.

Link Vocabulary and Key Concepts

7. atmosphere
8. hydrosphere
9. biosphere
10. geosphere
11. water cycle
12 13 14 15 evaporation/transpiration/ condensation/precipitation
16. rock cycle

Teacher Notes



CHAPTER 9 Review

Understand Key Concepts

1. Which are two characteristics of minerals?
   A. artificial and organic
   B. liquid and gas
   C. living and inorganic
   D. solid and natural
2. What are the major gases of the atmosphere?
   A. carbon dioxide and water vapor
   B. nitrogen and carbon dioxide
   C. nitrogen and oxygen
   D. oxygen and water vapor
3. Which reservoir holds the largest amount of freshwater?
   A. groundwater B. ice
   C. lakes D. rivers
4. The diagram below shows the water cycle. Which number represents precipitation?

   A. 1 B. 2
   C. 3 D. 4
5. In which layer of the atmosphere does weather occur?
   A. hydrosphere B. mesosphere
   C. stratosphere D. troposphere
6. What does the hydrosphere contain?
   A. air B. plants
   C. soil D. water
7. The diagram below shows the layers of the atmosphere. The arrow is pointing to which layer?

   A. troposphere B. mesosphere
   C. stratosphere D. exosphere
8. What is the middle layer of the geosphere?
   A. inner core B. crust
   C. mantle D. core
9. Rocks are classified according _____
   A. color. B. formation.
   C. size. D. structure.

Critical Thinking

10. **Give** an example of how the water cycle impacts the rock cycle.
11. **Construct** Describe how you might construct a terrarium that models Earth systems.
12. **Design** Based on what you have learned about the water cycle, design a device for turning salt water into freshwater.
13. **Explain** How does the geosphere [illegible] organisms that live in it?

330 Chapter 9 Review

Chapter Review

14. **Infer** How might the distribution of freshwater on Earth change if surface temperatures decreased?
15. **Evaluate** the relationship between weathering and erosion. How do the processes work together to change Earth's surface? How might the surface be different if only one of these processes occurred?
16. **Simplify** The diagram below shows the path of one rock through the rock cycle. What terms are missing from the diagram? Use the terms to describe how the rock changed.

   ? → weathering and erosion → compaction and cementation → ? → heat and pressure → ? → melting → cooling and crystallization → ?

Writing in Science

17. **Write** a report about types of rocks and their uses.

The BIG Idea

18. How would you describe Earth to a younger student?
19. What Earth systems do you see in the photo? What does each system include?

Math Skills

Use a Formula

Use the data in the table below to answer questions 20–22.

Temperature (°C)	Maximum Vapor Density (g/m³)
10	9.4
24	23.0
30	30.4

20. The current temperature is 24°C. The water vapor in the air has a density of 5.75 g/m³. What is the relative humidity?
21. At a temperature of 30°C, the air contains 22.8 g/m³ of water vapor. What is the relative humidity?
22. Based on the data in the table, what is the relationship between the temperature and the amount of water vapor air can contain?

Understand Key Concepts

1 D. solid and natural
2 C. nitrogen and oxygen
3 B. ice
4 C. 3
5 D. troposphere
6 D. water
7 B. mesosphere
8 C. mantle
9 B. formation

Critical Thinking

10 Sample answer: The water cycle impacts the rock cycle through precipitation, which contributes to weathering and erosion.

11 The terrarium should include materials that represent each Earth system, such as rocks, soil, plants, water, air, and a cover to allow water to evaporate and condense, remaining within the terrarium. The rocks and soil would represent the geosphere, the plants would represent the biosphere, the water would represent the hydrosphere, and the air would represent the atmosphere. Students might include adding a heat/light source to represent the sun, which would contribute to evaporation of the water. They might include an animal to represent the biosphere and include respiration. Students might describe how the "systems" in their terrarium would interact. Interactions should be consistent with content presented in the chapter.

12 A device for turning salt water into freshwater could be based on evaporation and condensation. The set-up could include a pot of boiling salt water and a slanted lid with a trough on the low side for collecting the condensed freshwater.

13 Sample answer: Dissolved minerals from the geosphere make ocean water salty, which marine organisms need to survive.

14 Sample answer: Cooler temperature might increase the size of glaciers and ice caps, reducing the amount of freshwater in other reservoirs.

15 Sample answer: Weathering and erosion work together to break down rocks and carry sediment to new locations. Over time, they can carve canyons and valleys or wear away tall mountains. If only one of these processes occurred, rocks would not be broken down into smaller pieces or sediment would remain in one place if it was not eroded by wind, ice, or water.

16 The missing terms, clockwise starting at the top: igneous rock, sedimentary rock, and metamorphic rock. Sample answer: An igneous rock is weathered and eroded. The sediment undergoes compaction and cementation and forms a sedimentary rock. The sedimentary rock is subjected to heat and pressure and forms a metamorphic rock. The metamorphic rock melts, forming magma. The magma cools and crystallizes, forming an igneous rock.

Writing in Science

17 Haikus will vary, but should include the correct number of lines and syllables. They should also include information about interactions among Earth systems.

The BIG Idea

18 Sample answer: Earth is a large system divided into smaller, interacting systems that include air, water, living things, and rocks and soil.

19 The photograph shows Earth's atmosphere, hydrosphere and geosphere. Students might identify vegetation on the landmasses as part of the biosphere. The atmosphere includes air and water vapor that surround Earth. The hydrosphere includes all of Earth's water. The geosphere includes the solid part of Earth. And the biosphere includes all living things on Earth.

Math Skills

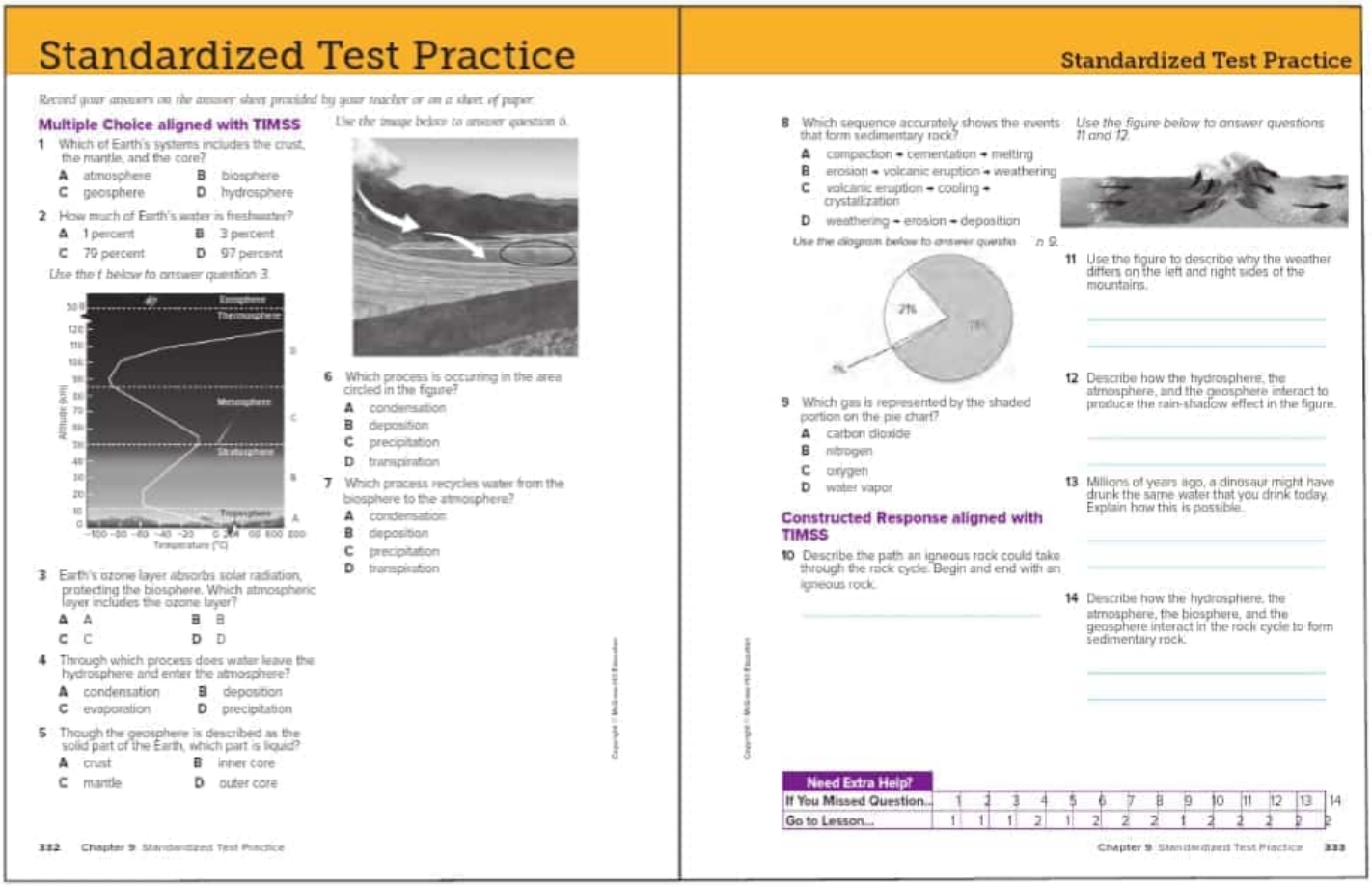
Use a Formula

20. RH $= \frac{5.75}{23.0} = 0.25 \times 100 = 25\%$

21. RH $= \frac{22.8}{30.4} = 0.75 \times 100 = 75\%$

22. The higher the temperature, the more water vapor the air can contain.

Teacher Notes



Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice aligned with TIMSS

1 Which of Earth's systems includes the crust, the mantle, and the core?
A atmosphere B biosphere
C geosphere D hydrosphere

2 How much of Earth's water is freshwater?
A 1 percent B 3 percent
C 79 percent D 97 percent

Use the f below to answer question 3.

3 Earth's ozone layer absorbs solar radiation, protecting the biosphere. Which atmospheric layer includes the ozone layer?
A A B B
C C D D

4 Through which process does water leave the hydrosphere and enter the atmosphere?
A condensation B deposition
C evaporation D precipitation

5 Though the geosphere is described as the solid part of the Earth, which part is liquid?
A crust B inner core
C mantle D outer core

Use the image below to answer question 6.

6 Which process is occurring in the area circled in the figure?
A condensation
B deposition
C precipitation
D transpiration

7 Which process recycles water from the biosphere to the atmosphere?
A condensation
B deposition
C precipitation
D transpiration

8 Which sequence accurately shows the events that form sedimentary rock?
A compaction → cementation → melting
B erosion → volcanic eruption → weathering
C volcanic eruption → cooling → crystallization
D weathering → erosion → deposition

Use the figure below to answer questions 11 and 12.

Use the diagram below to answer questio n 9.

9 Which gas is represented by the shaded portion on the pie chart?
A carbon dioxide
B nitrogen
C oxygen
D water vapor

Constructed Response aligned with TIMSS

10 Describe the path an igneous rock could take through the rock cycle. Begin and end with an igneous rock.

11 Use the figure to describe why the weather differs on the left and right sides of the mountains.

12 Describe how the hydrosphere, the atmosphere, and the geosphere interact to produce the rain-shadow effect in the figure.

13 Millions of years ago, a dinosaur might have drunk the same water that you drink today. Explain how this is possible.

14 Describe how the hydrosphere, the atmosphere, the biosphere, and the geosphere interact in the rock cycle to form sedimentary rock.

Need Extra Help?														
If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	1	1	2	1	2	2	2	1	2	2	2	2	2

Multiple Choice

1 **C—Correct.** A, B, and D are Earth's other systems and do not include the crust, mantle, and core. **DOK 1**

2 **B—Correct.** A is the amount of freshwater available on Earth's surface. C is the amount of freshwater in glaciers and ice caps. D is the amount of ocean salt water. **DOK 1**

3 **B—Correct.** A, C, and D are atmospheric layers that do not contain a layer of ozone. **DOK 2**

4 **C—Correct.** Water "leaves" the hydrosphere by evaporation, and the water vapor produced becaomse part of the atmosphere. A, B, and D are other processes that occur within the hydrosphere and atmosphere. **DOK 2**

5 **D—Correct.** A, B, and C are parts of the geosphere that are solid. The crust and inner core are solid. Rocks in the mantle flow because they are so hot, but they are considered a solid. **DOK 2**

6 **B—Correct.** A, C, and D are not processes of the rock cycle and are not shown in the diagram. **DOK 1**

7 **D—Correct.** A, B, and C are other processes in the water cycle and do not involve living things. **DOK 2**

8 **D—Correct.** A and B are sequences that do not occur in nature. C describes a sequence that forms ignous rock. **DOK 1**

9 **B—Correct.** A, C and D are gases that make up much less than 78 percent of Earth's atmosphere. **DOK 1**

Constructed Response

10 An igneous rock is uplifted to Earth's surface, where it weathers and produces sediment. The sediment is compacted and cemented together, forming sedimentary rock. The sedimentary rock is subducted. Deep below Earth's surface, the sedimentary rock is subjected to high temperatures and pressure and forms a metamorphic rock. The metamorphic rock is subjected to higher temperatures and melts, forming magma. If the magma cools below Earth's surface, it will crystallize and form an igneous rock. If the molten rock erupts as lava, the lava will cool and crystallize at Earth's surface and form an igneous rock. **DOK 2**

11 Moist air comes off the ocean and cools as it moves up over the coastal mountains. The cooled air drops precipitation on the left side of the mountains. The air, now dry, continues on to the right side of the mountains, causing a dry climate. **DOK 1**

12 Water evaporates from the surface of the hydrosphere, adding moisture to the atmosphere. The air cools as it travels over the mountains of the geosphere. The moisture condenses, forming precipitation on the windward side of the mountain (geosphere). The dry air creates the rainshadow effect as it moves down the leeward side of the mountain. **DOK 2**

13 The amount of water on Earth does not change but cycles continuously through the water cycle. Therefore, the water that was on Earth during times of the dinosaurs is the same water on Earth today. **DOK 2**

14 Water and ice (hydrosphere and cryosphere), wind (atmosphere), and plants and animals (biosphere), break down rocks (geosphere) into sediment through weathering. Erosion occurs when water and ice (hydrosphere) and/or wind (atmosphere) carry sediment to new locations. Deposition forms layers of sediment. The weight of sediment layers compacts them. Minerals from surrounding water crystallize in the sediment and cement the layers together, producing new sedimentary rocks. **DOK 2**

Answer Key

Question	Answer
1	C
2	B
3	B
4	C
5	D
6	B
7	D
8	D
9	B
10	See extended answer.
11	See extended answer.
12	See extended answer.
13	See extended answer.
14	See extended answer.