SAMPLER
Grades 2 and 4

NATIONAL GEOGRAPHIC

Exploring Science

NATIONAL GEOGRAPHIC LEARNING | CENGAGE

NATIONAL GEOGRAPHIC
Exploring Science

Secure Success for the NGSS

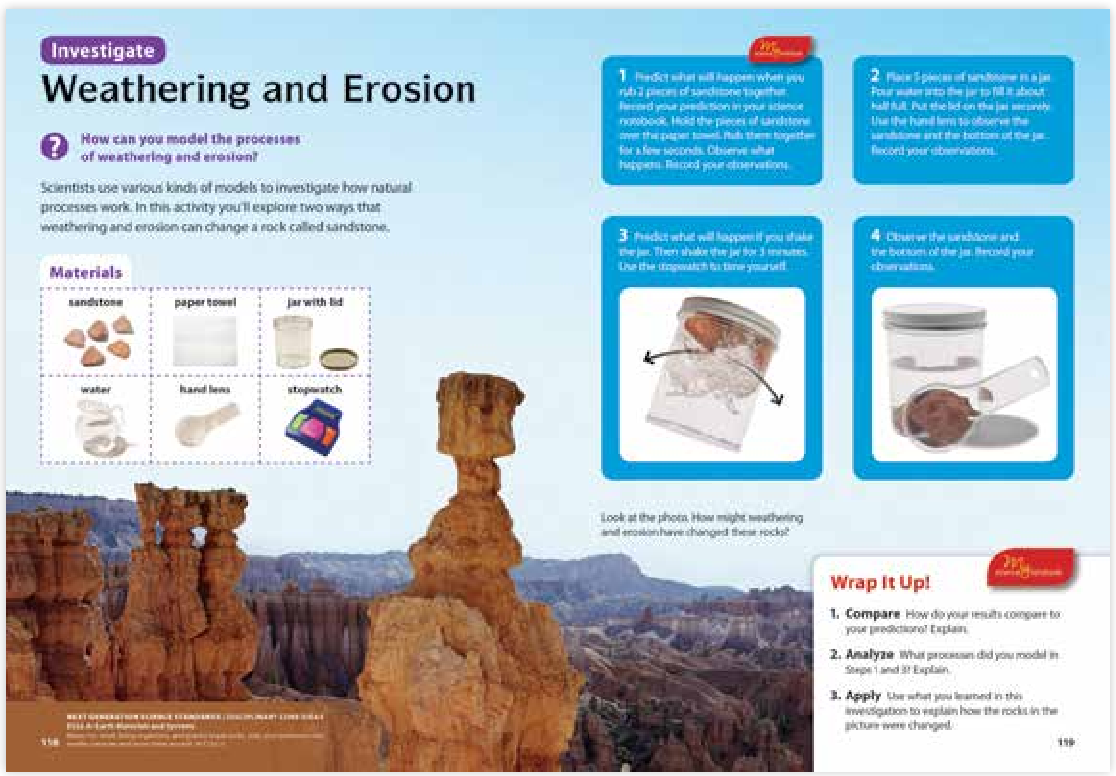
English and Spanish

National Geographic Exploring Science helps teachers transition to the Next Generation Science Standards, and helps students master the three dimensions of the NGSS.

One Program for Content and Hands-on STEM Practice

Students need accessible content and hands-on experiences to ensure success in the NGSS. *Exploring Science* delivers with targeted text for the Disciplinary Core Ideas and a variety of activity types to apply those core ideas:

- Science in a Snap
- Investigate activities
- STEM Projects
- Interactive digital activities including Virtual Labs



Interactive Technology

Turn the NGSS into an engaging student experience with MindTap, the most interactive and powerful digital program available.

MINDTAP From Cengage

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GRADE 2 | STUDENT EDITION

Physical Science Unit

NATIONAL GEOGRAPHIC | **Explorer**

Asha de Vos Marine Biologist
National Geographic Explorer

Let's Explore!

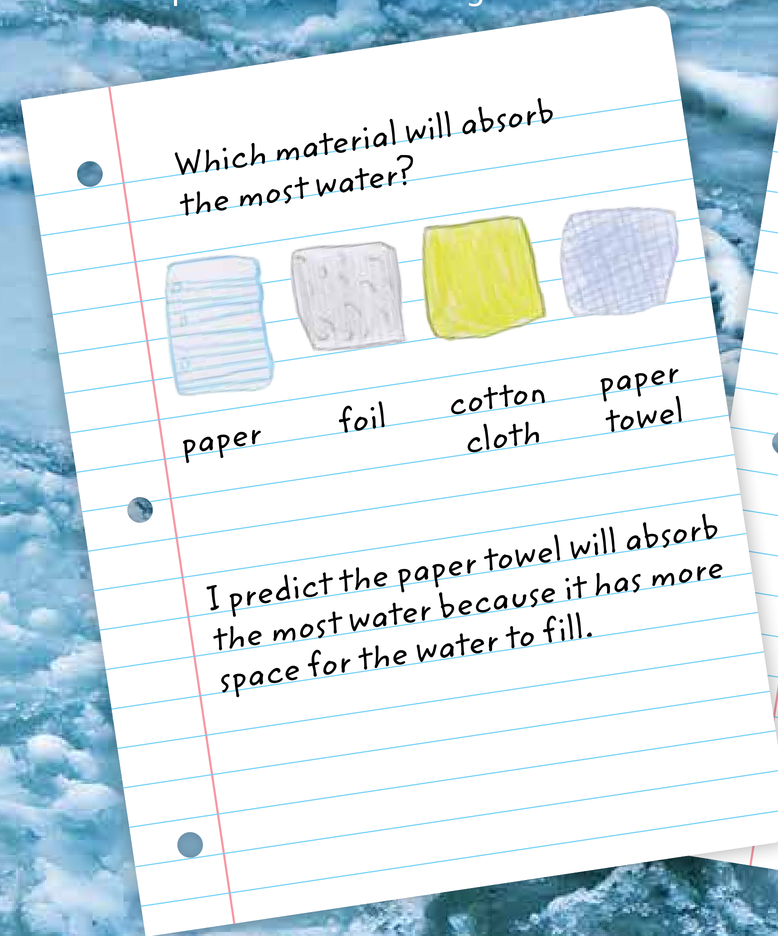
In *Nature of Science*, you learned that scientists and engineers design tools to solve problems. Human-made objects and technology help me study whales. I use digital cameras to take photos of whales. The photos help me and my team and identify each whale based on its skin markings.

Physical science is the study of nonliving objects and systems. Here are some questions you might investigate in *Physical Science*:

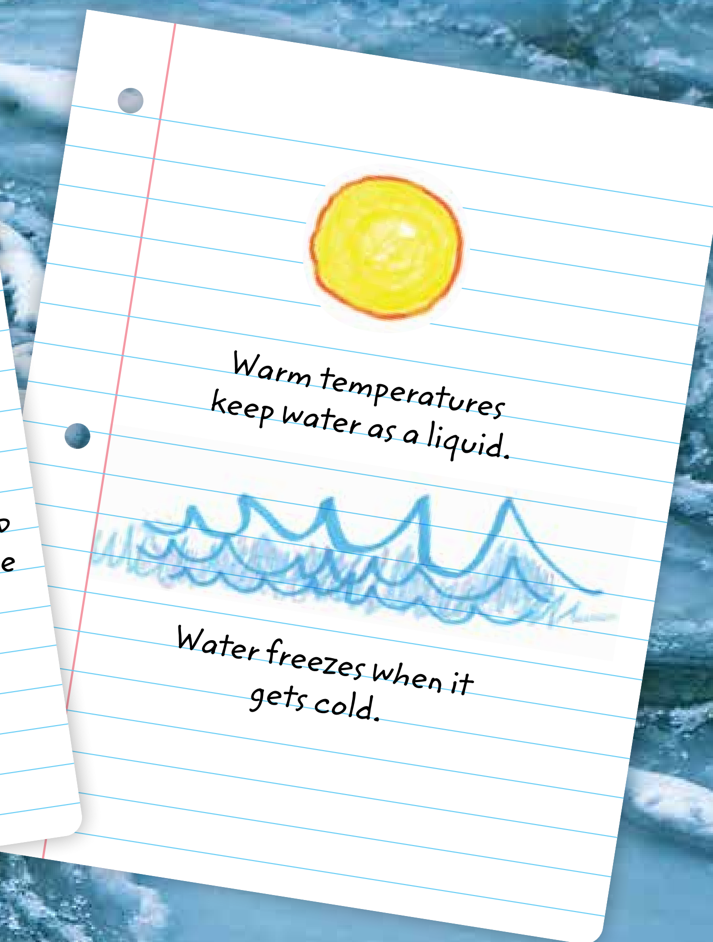
- What is matter?
- How are liquids and solids different?
- How can you describe matter?
- How does water change from a liquid to a solid?
- How do eggs change when they are cooked?

As you read and investigate, ask your own questions and look for answers. Let's check in later to review what you have learned.

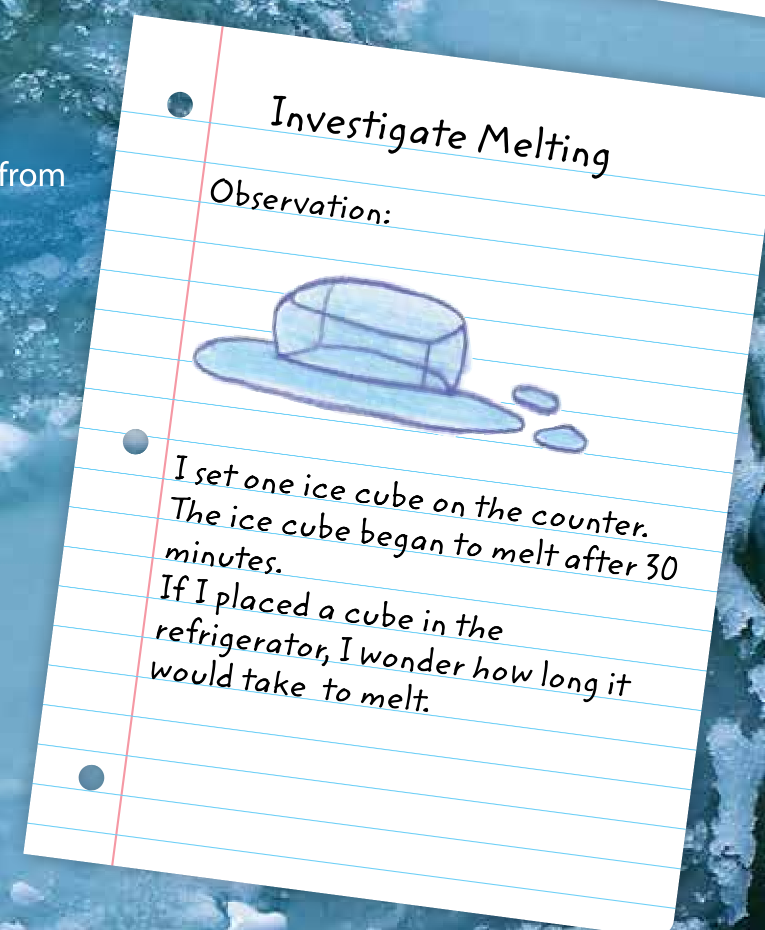
Use your notebook to make predictions in investigations.



Include captions and drawings to explain what you have learned.



Record notes from observations.



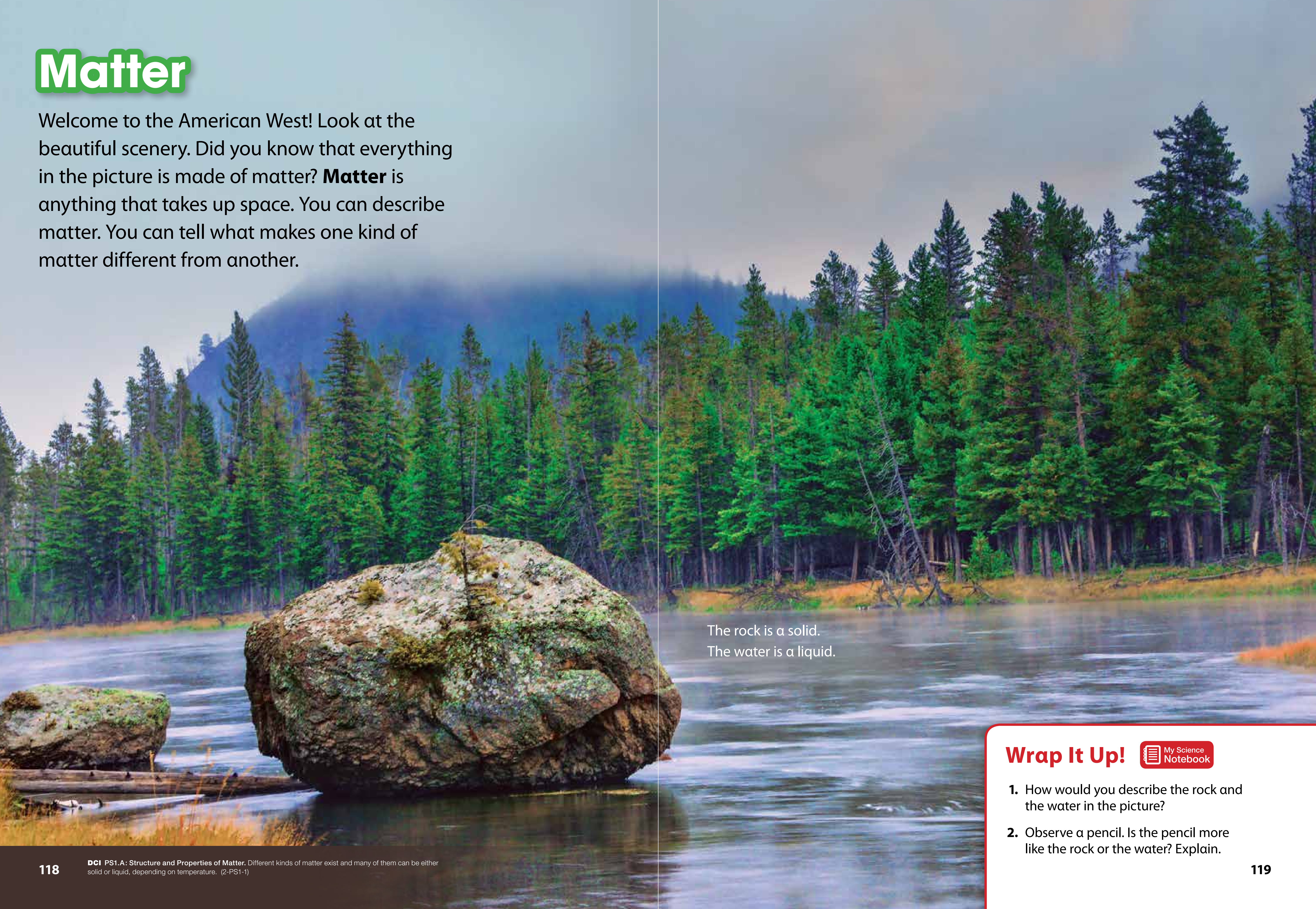
Physical Science

Structure and Properties of Matter

Everything you see in this picture is matter.

Matter

Welcome to the American West! Look at the beautiful scenery. Did you know that everything in the picture is made of matter? **Matter** is anything that takes up space. You can describe matter. You can tell what makes one kind of matter different from another.



The rock is a solid.
The water is a liquid.

Wrap It Up!

My Science Notebook

1. How would you describe the rock and the water in the picture?
2. Observe a pencil. Is the pencil more like the rock or the water? Explain.

DCI PS1.A: Structure and Properties of Matter. Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. (2-PS1-1)

Liquids

Water is a liquid when its temperature is above freezing. A **liquid** takes the shape of its container. It does not have a shape of its own.

What happens if a liquid doesn't have a container? It spreads out. A liquid does not have a definite shape when it's not in a container.

This water takes the shape of the trough that contains it.

Water takes the shape of the river bed.

Wrap It Up!

My Science Notebook

1. What is one property of liquids?
2. Honey is in a bottle shaped like a bear. What shape does the honey have?

DCI PS1.A: Structure and Properties of Matter. Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. (2-PS1-1)

Solids

When the temperature is below freezing, water freezes. It becomes solid. This is a pattern of liquid water at low temperatures. A **solid** is matter that has its own shape. It also takes up space.

Ice is solid water. Ice will stay solid as long as the temperature stays cool enough.

Wrap It Up! My Science Notebook

1. What is a solid?
2. How are solids and liquids different from each other?

DCI PS1.A: Structure and Properties of Matter. Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. (2-PS1-1)
CCC Patterns. Patterns in the natural world can be observed. (2-PS1-1)

Investigate

Solids and Liquids

? How is a liquid different from a solid?

Shape is one property of solids and liquids. In this investigation, you will observe the shape of a liquid. You will also observe the shape of a solid.

Materials

two plastic cups

cylinder of water

marble

My Science Notebook

1 Observe the shape of the water in the cylinder. Record your observations.

2 Pour the water from the cylinder into one of the cups. Record your observations.

3 Observe the shape of the marble. Record your observations.

4 Put the marble into the cylinder and then into the empty cup. Observe the marble's shape each time. Record your observations.

Explore on Your Own

What would happen if you tested other solids and liquids? Make a plan. Use different materials. Record your observations. Compare the results of your investigations.

Wrap It Up! My Science Notebook

1. What kind of matter is water? How do you know?
2. What kind of matter is a marble? How do you know?

PE 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Properties

You can describe the objects you see. When you describe something, you talk about its properties. A **property** is something about an object you can observe with your senses.

Shape is one property of matter. These bolo ties have different shapes. Like other objects, the shape of the bolo ties makes them useful.

Wrap It Up! My Science Notebook

1. What is a property?
2. Why is shape a property?

DCI PS1.A: Structure and Properties of Matter. Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)

Color

Color is another property of matter. You can use color to tell one object from another. The color of an object can connect to how it is used. Boots that are darker colors might be used for work. Lighter colored boots might be used for dressing up.

Color can be used to sort or classify objects. You can place objects into groups by their colors.

Wrap It Up!

My Science Notebook

1. How can you describe one boot to tell it from the others?
2. Which of your senses do you use to describe color?

DCI PS1.A: Structure and Properties of Matter. Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)

Texture

Look at all the objects in the raft. What do these different objects feel like? **Texture** is a property. It is the way an object feels. Touch the paddle, and it feels smooth. It has a smooth texture. Touch the rope, and it feels rough. It has a rough texture. An object's texture can be helpful for how it is used.

Look at the picture. What else has a rough or smooth texture?

DCI PS1.A: Structure and Properties of Matter. Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)

SCIENCE in a SNAP

Time to Sort

1 Find objects like these in your classroom.

2 Sort the objects by texture. Are they rough or smooth?

? **Tell what other objects in your classroom have a rough or smooth texture.**

Wrap It Up!

My Science Notebook

1. What is texture?
2. Choose an object in your classroom. Describe its texture.

Hard and Soft

You can tell whether objects feel hard or soft. Some things have both hard parts and soft parts.

Look at the picture. The horse's hair feels soft. The horse has hard hooves. The horse's saddle has hard and soft parts, too. This is helpful for how the saddle is used.

Can you find other objects that are hard or soft in the picture?

DCI PS1.A: Structure and Properties of Matter. Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)

SCIENCE in a SNAP

Sort Some More

1 Find objects like these at home.

2 Sort the objects by texture. Are they hard or soft?

? **Tell what other objects in your home are hard or soft or both.**

Wrap It Up!

My Science Notebook

1. Describe the properties of objects that are hard.
2. In your home, what objects do you want to be soft? Why?

Bend and Stretch

Look at the rope in this picture. It is flexible. **Flexible** materials can bend without breaking. The rope bends easily. These climbers can loop it through hooks in the rock as they climb.

Some materials can stretch, too. The climbers pull the rope to stretch it tight.

Bending and stretching are properties.

The cowboy's rope can bend into a loop.

DCI PS1.A: Structure and Properties of Matter. Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)

SCIENCE in a SNAP

Bend and Stretch

1 Rubber bands are very flexible. They bend and stretch. Stretch and bend a rubber band to see what a flexible object feels like.

2 Find other objects in your classroom that are flexible. Which objects bend? Which objects stretch?

? **Tell what objects in your home are flexible.**

Wrap It Up! My Science Notebook

1. What does it mean to be flexible?
2. Is paper flexible? Explain why or why not.

Sink and Float

Objects can sink or float in liquids. Whether something sinks or floats is a property. If you throw a heavy rock into a pond, it will sink to the bottom of the pond. This is a pattern that can be observed. Other objects may float. The boat floats on top of the water.

The anchor sinks to the bottom of the water.

The boat floats because of the material it is made of and its shape.

Wrap It Up! My Science Notebook

1. Explain what sink and float mean.
2. List two things that float.
3. List two things that sink.

DCI PS1.A: Structure and Properties of Matter. • Matter can be described and classified by its observable properties. (2-PS1-1) • Different properties are suited to different purposes. (2-PS1-2), (2-PS1-3)
CCC Patterns. Patterns in the natural and human designed world can be observed. (2-PS1-1)

Plan and Investigate

You have observed properties of matter. When you classify objects, you sort them into groups. In this investigation, you will sort objects. You will classify the objects by their properties.

1 Ask a question. My Science Notebook

How can you classify materials by their observable properties?

2 Plan and carry out an investigation.

Make a plan. Write down your plan in your science notebook. Gather materials.

Now carry out your plan. Record your data in a chart.

3 Analyze and interpret data.

Look at your data. What properties did you observe? How did you classify objects by those properties?

4 Share and explain your results.

Tell others how your investigation worked. Explain how your results answer the question.

PE 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Investigate

Materials That Absorb

? **Which materials absorb the most water?**

If you spill water on a table, the water sits on the surface. If you wipe up the spill with a towel, the water soaks into the towel. The towel **absorbs** the water. In this investigation, you will compare how materials absorb water.

Materials

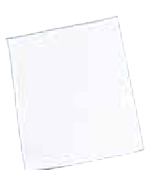
water

measuring cup

four labeled cups

timer

paper



foil

cotton cloth

paper towel

My Science Notebook

1 Use the measuring cup to pour 50 mL into the cup labeled **paper.**

2 Observe the paper. What do you think will happen when you dip a corner of the piece of paper into the water for 30 seconds? Record your prediction.

3 Dip a corner of the paper into the water for 30 seconds.

Use a timer to measure the time. Then take the paper out of the cup.

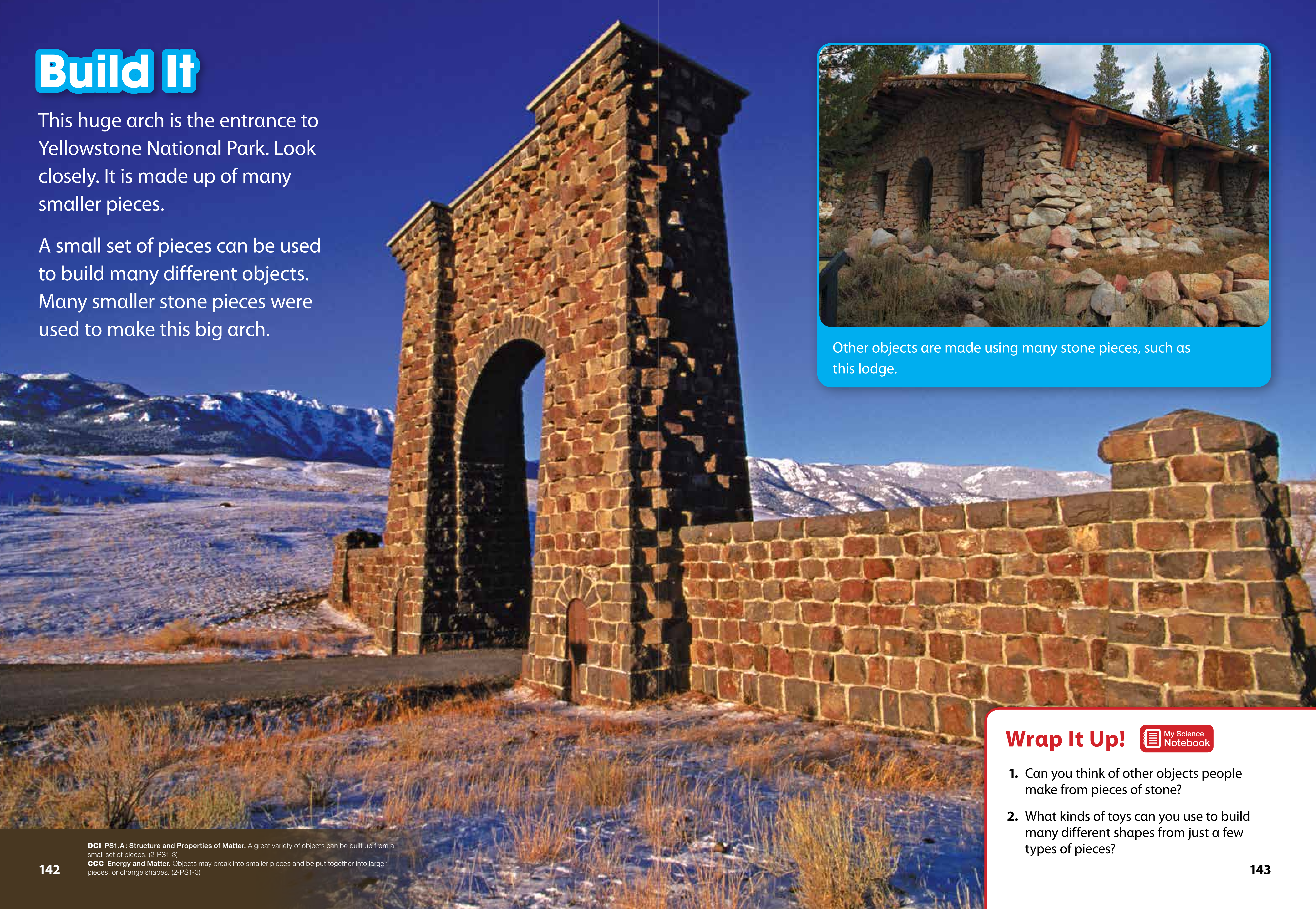
4 Repeat steps 1–3 with each labeled cup and each of the other materials. Then put the cups in order from least amount of water to most amount of water. Record your observations.

Wrap It Up! My Science Notebook

1. Which cup had the least water left in it? Which cup had the most water left in it?
2. Which material would work best for cleaning up spilled liquid? Explain.
3. Did your results support your predictions? Explain.

PE 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Build It



This huge arch is the entrance to Yellowstone National Park. Look closely. It is made up of many smaller pieces.

A small set of pieces can be used to build many different objects. Many smaller stone pieces were used to make this big arch.

Other objects are made using many stone pieces, such as this lodge.

Wrap It Up!

My Science Notebook

1. Can you think of other objects people make from pieces of stone?
2. What kinds of toys can you use to build many different shapes from just a few types of pieces?

DCI PS1.A: Structure and Properties of Matter. A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
CCC Energy and Matter. Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

Make Observations

Look closely at the objects all around you. You can see that the objects are made of smaller parts. Some of those smaller parts might be alike. You can find similar parts used to build different, bigger things.

1 Ask a question. My Science Notebook

How can the same materials be used to make different objects?

2 Carry out an investigation.

Gather materials. Use the materials to build an object. Observe what you have made.

Record your observations in your science notebook.

3 Observe and record.

Trade objects with a partner. Observe what he or she has built. Record your observations.

Take the object apart. Build something new with the parts. Observe what you have built. Record your observations.

4 Analyze and interpret data.

Look at your observations. How did you and your partner use the same materials differently?

5 Use evidence.

How do your results answer the question?

6 Share and explain your results.

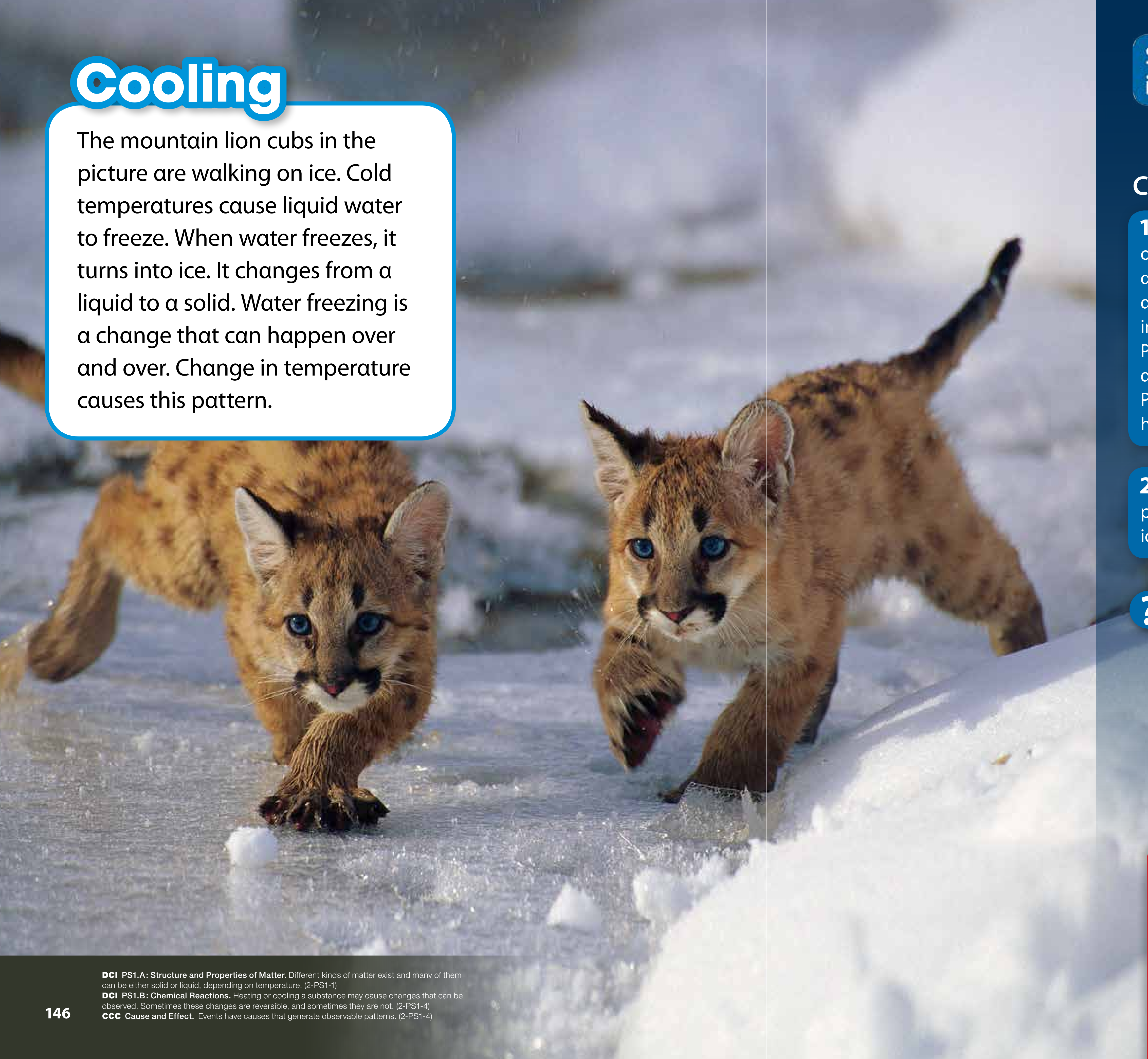
Tell others how your investigation worked. Give evidence to explain how your observations help you answer the question.

How could you use the same type of pieces to build a fence around the cabin?

PE 2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

Cooling

The mountain lion cubs in the picture are walking on ice. Cold temperatures cause liquid water to freeze. When water freezes, it turns into ice. It changes from a liquid to a solid. Water freezing is a change that can happen over and over. Change in temperature causes this pattern.



DCI PS1.A: Structure and Properties of Matter. Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. (2-PS1-1)
DCI PS1.B: Chemical Reactions. Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)
CCC Cause and Effect. Events have causes that generate observable patterns. (2-PS1-4)

SCIENCE in a SNAP

Cooling Water

1 Observe the shape of water in a cup. Use a piece of clay to make a container. Pour water into the clay container. Put the container into a freezer for 4 hours. Predict what will happen to the water.

2 Take the ice out of the container and put it in a cup. Observe the shape of the ice in the cup.

? **Did your results support your prediction? How is the ice different from the liquid water?**

Wrap It Up!

My Science Notebook

1. How does water change when it is cooled to freezing?
2. Describe what a cup of water would look like if it were halfway frozen.

Heating

Warm temperatures can also cause matter to change. When water freezes into ice, heat can cause it to melt into a liquid again. When ice melts into water, cooling can freeze it into solid ice again. The change can happen over and over. Temperature changes cause this pattern.

Warming will change this frozen snow to liquid water droplets.

SCIENCE in a SNAP

Heating Ice

1 Make a small container out of foil. Place an ice cube in the container.

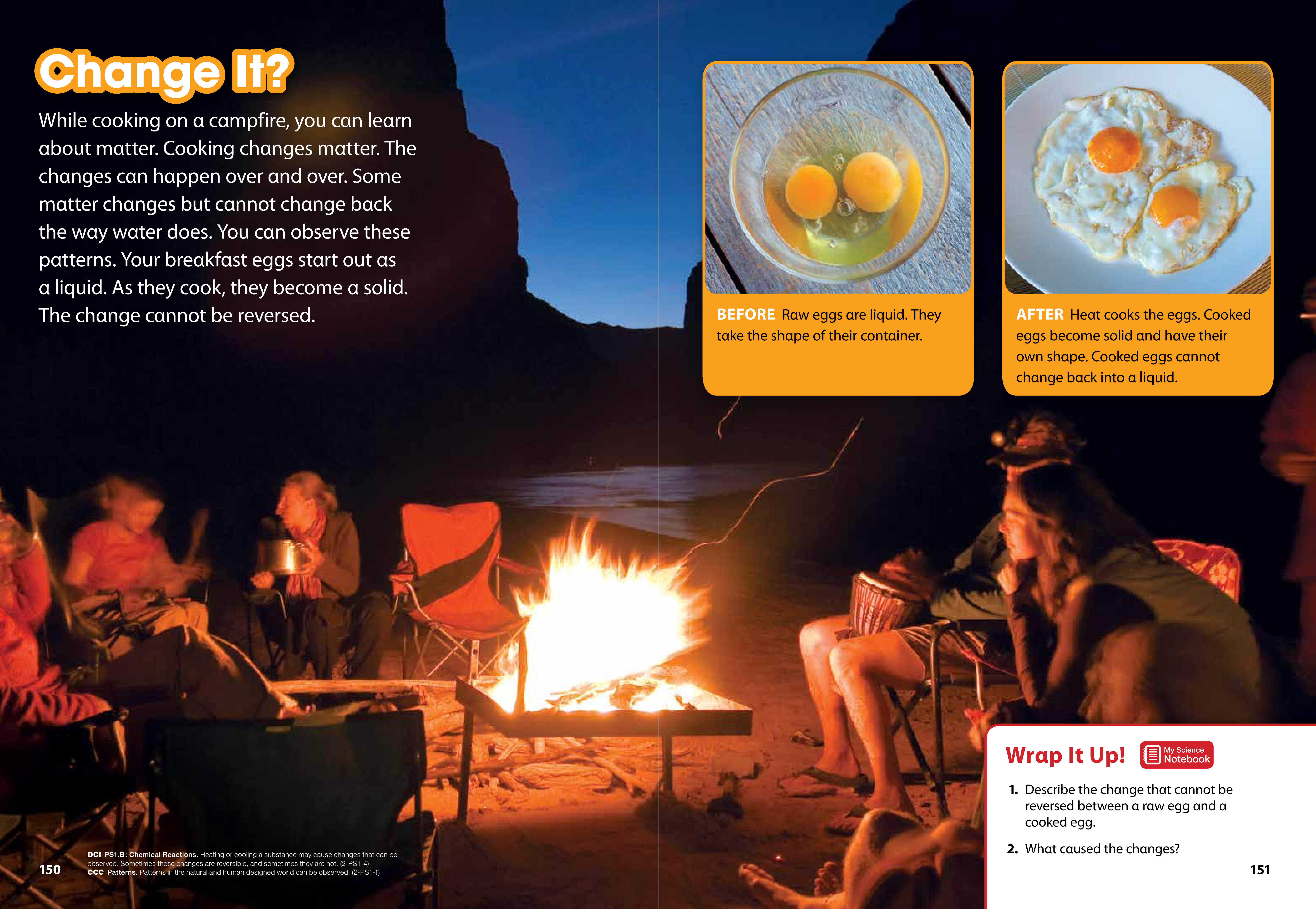
2 Predict what will happen to the ice cube. Record your prediction. After 1 hour, observe the ice cube.

? **Do your results support your prediction? How has the shape of the ice cube changed?**

Wrap It Up! My Science Notebook

1. Explain how ice changes when it is heated.
2. What would happen if you put the foil container at the end of your Science in a Snap investigation into the freezer?

DCI **PS1.B: Chemical Reactions.** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)
CCC **Cause and Effect.** Events have causes that generate observable patterns. (2-PS1-4)



Change It?

While cooking on a campfire, you can learn about matter. Cooking changes matter. The changes can happen over and over. Some matter changes but cannot change back the way water does. You can observe these patterns. Your breakfast eggs start out as a liquid. As they cook, they become a solid. The change cannot be reversed.

BEFORE Raw eggs are liquid. They take the shape of their container.

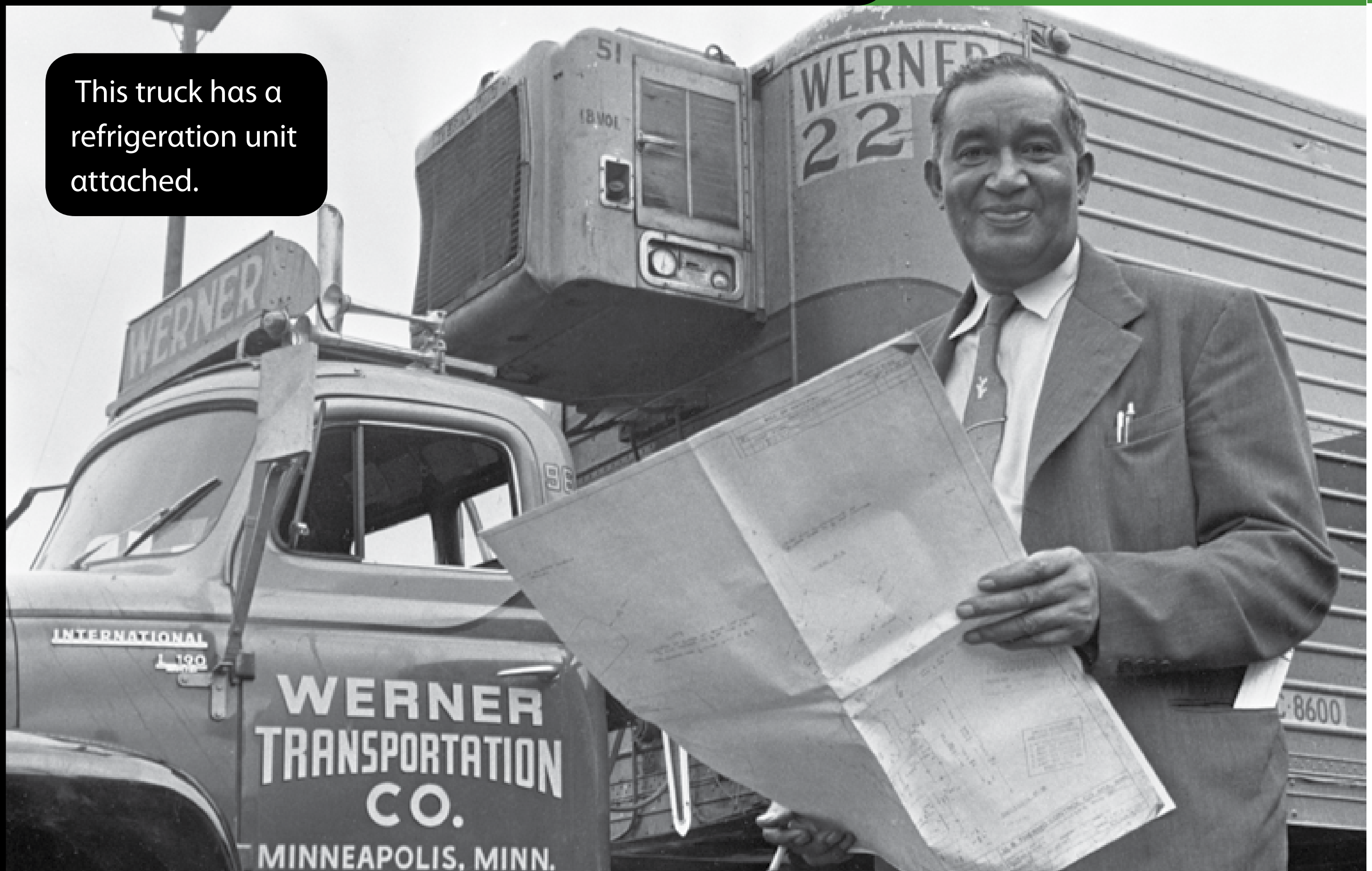
AFTER Heat cooks the eggs. Cooked eggs become solid and have their own shape. Cooked eggs cannot change back into a liquid.

Wrap It Up!

My Science Notebook

1. Describe the change that cannot be reversed between a raw egg and a cooked egg.
2. What caused the changes?

DCI **PS1.B: Chemical Reactions.** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)
CCC **Patterns.** Patterns in the natural and human designed world can be observed. (2-PS1-1)



This truck has a refrigeration unit attached.

Frederick drew sketches to plan how he would build his inventions.

DCI **ETS1.A: Defining and Delimiting Engineering Problems.** A situation that people want to change or create can be approached as a problem to be solved through engineering. (K–2-ETS1-1)
NS **Science Addresses Questions About the Natural and Material World.** Scientists study the natural and material world.(2-ESS2-1)
CETS **Influence of Engineering, Technology, and Science on Society and the Natural World.** Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. (2-PS1-2)

King of Cool

Frederick McKinley Jones had a hard life growing up. His father died when he was nine, and he had to drop out of school. Hardships did not stop him, though. He read and observed. He learned everything he could about how machines work.

Frederick became an inventor. He tried to fix problems. He invented a mobile x-ray machine and a sound system for movie theaters. He also changed daily life for people everywhere. He invented a way to keep food cool. This made it possible to ship foods over long distances.

Keeping foods cool prevents foods from spoiling. Important grocery items could be shipped across the country. Refrigeration didn't change the food by freezing it. It kept food in the same state but chilled. This kept food fresh. And this was very cool!

Wrap It Up!

My Science Notebook

1. What were some problems that Frederick McKinley Jones solved through his inventions?
2. Describe the effect of refrigeration on food.

Make an Argument

Heating and cooling materials can change them. Look at the pictures on these pages. Each shows something that has changed because of heating or cooling. Read the labels and follow the steps below to use evidence to make an argument.

1 Ask a question. My Science Notebook

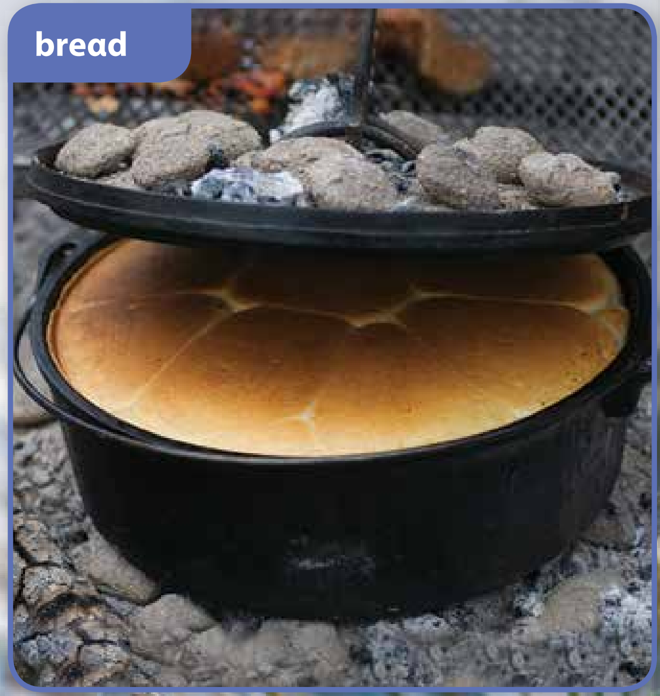
How can heating or cooling change materials?

2 Gather information.

Describe the change in each of the photos. List the changes in a chart. State which changes can be reversed and which cannot be reversed.

3 Make an argument.

Explain how heating or cooling changed each material. Give evidence by describing what you see in each photo.


bread


popcorn


ice

Explore on Your Own

You've observed properties of different materials. Select another material, solid or liquid, and make an argument using evidence that some changes can be reversed and some cannot. Make a chart in your science notebook. Record the characteristics of the material before and after heating and cooling. Include characteristics when the heating or cooling is reversed. Share your results.

PE 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

STEM SCIENCE TECHNOLOGY ENGINEERING MATH

SPACE STATION PROJECT

Design Flavor Cubes

A quick snack is no problem on Earth. But to eat and drink in space takes a lot of planning and knowledge about food's properties. Many scientists, designers, and health experts work in the NASA Space Food Systems Lab. They figure out how to store and package foods. Astronauts need their food packaged for the conditions in space. On Earth, people also want food that is easy to eat. And the more delicious the food is, the better it is to eat or drink.

A NASA research scientist tests food and plans for how food can travel into space.

PE K–2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
DCI Structure and Properties of Matter. Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)

The Challenge

Your challenge is to design a product that will flavor water. Your product must be able to be frozen.

1 Define the problem.

My Science Notebook

Your teacher will give your materials. These are the only materials you can use. Write the problem you need to solve.

2 Design a solution.

Think about a solution and sketch your product design. Build your product.

3 Test your solution.

Test your product. Does it add flavor as it melts? If not, change it. What happened during heating or cooling? Record your observations. Can you improve the product?

4 Share.

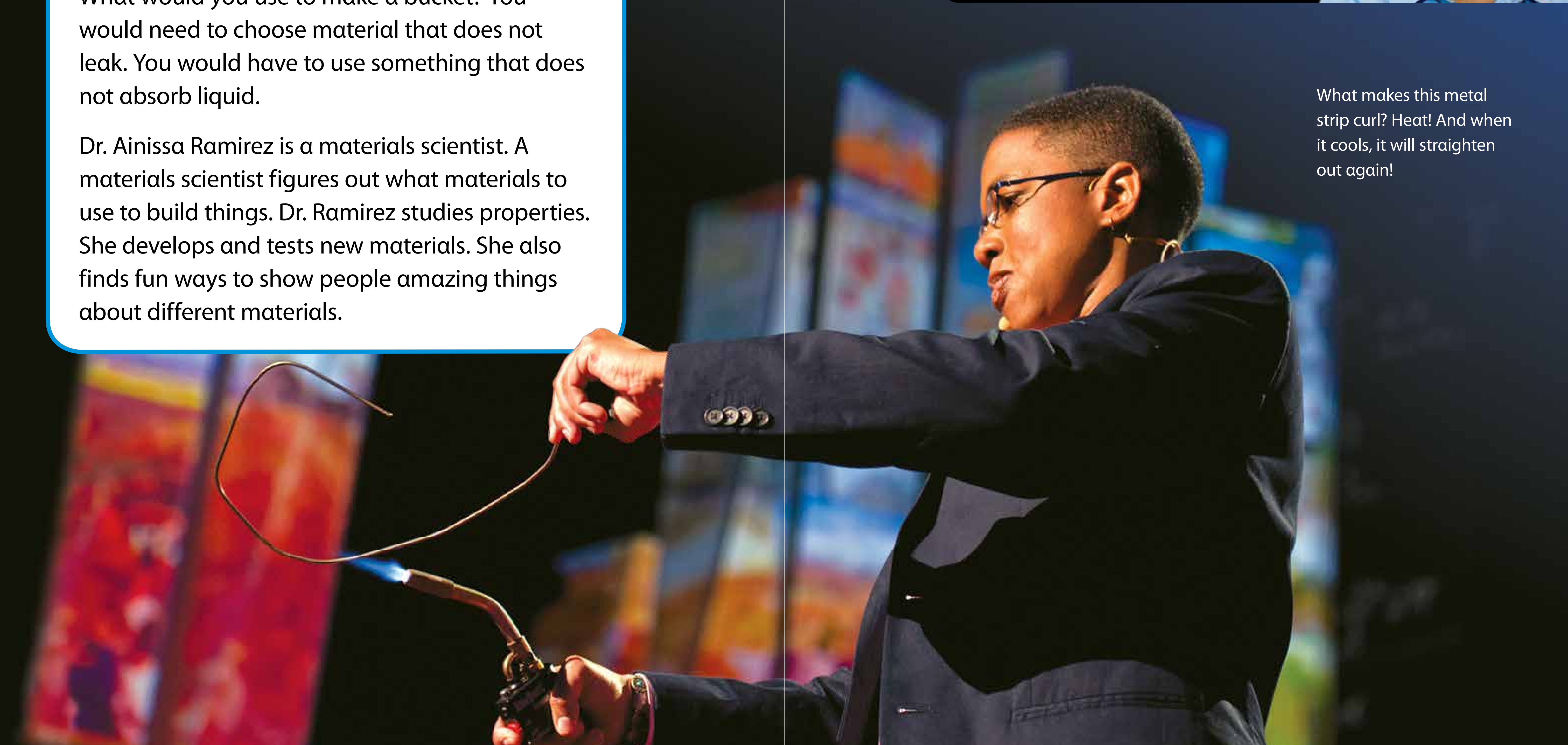
Describe what worked well and what did not. Answer any questions.

Materials Scientist

What would you use to make a bucket? You would need to choose material that does not leak. You would have to use something that does not absorb liquid.

Dr. Ainissa Ramirez is a materials scientist. A materials scientist figures out what materials to use to build things. Dr. Ramirez studies properties. She develops and tests new materials. She also finds fun ways to show people amazing things about different materials.

Dr. Ainissa Ramirez makes fun videos for young people. She shows neat examples of the properties of materials!



What makes this metal strip curl? Heat! And when it cools, it will straighten out again!

NS Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena. Scientists search for cause and effect relationships to explain natural events. (2-PS1-4)
CETS Influence of Engineering, Technology, and Science on Society and the Natural World. Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (2-PS1-2)

Check In (My Science Notebook)

Congratulations! You have completed *Physical Science*. Let's reflect on what you have learned. Here is a checklist to help you reflect on your progress. Look through your science notebook to find examples of the items on the checklist. What could you do better? Write about it in your science notebook.

Read each item in this list. Ask yourself if you think you did a good job of it.

For each item, select the choice that is true for you: A. Yes **B.** Not Yet

- I defined and made drawings of new science words and main ideas.
- I labeled drawings. I wrote to explain ideas.
- I collected photos, news stories, and other objects.
- I used tables, charts, or graphs to record observations.
- I recorded reasons for explanations and conclusions.
- I wrote how scientists and engineers answer questions and solve problems.
- I asked new questions.
- I did something else. (Tell about it.)

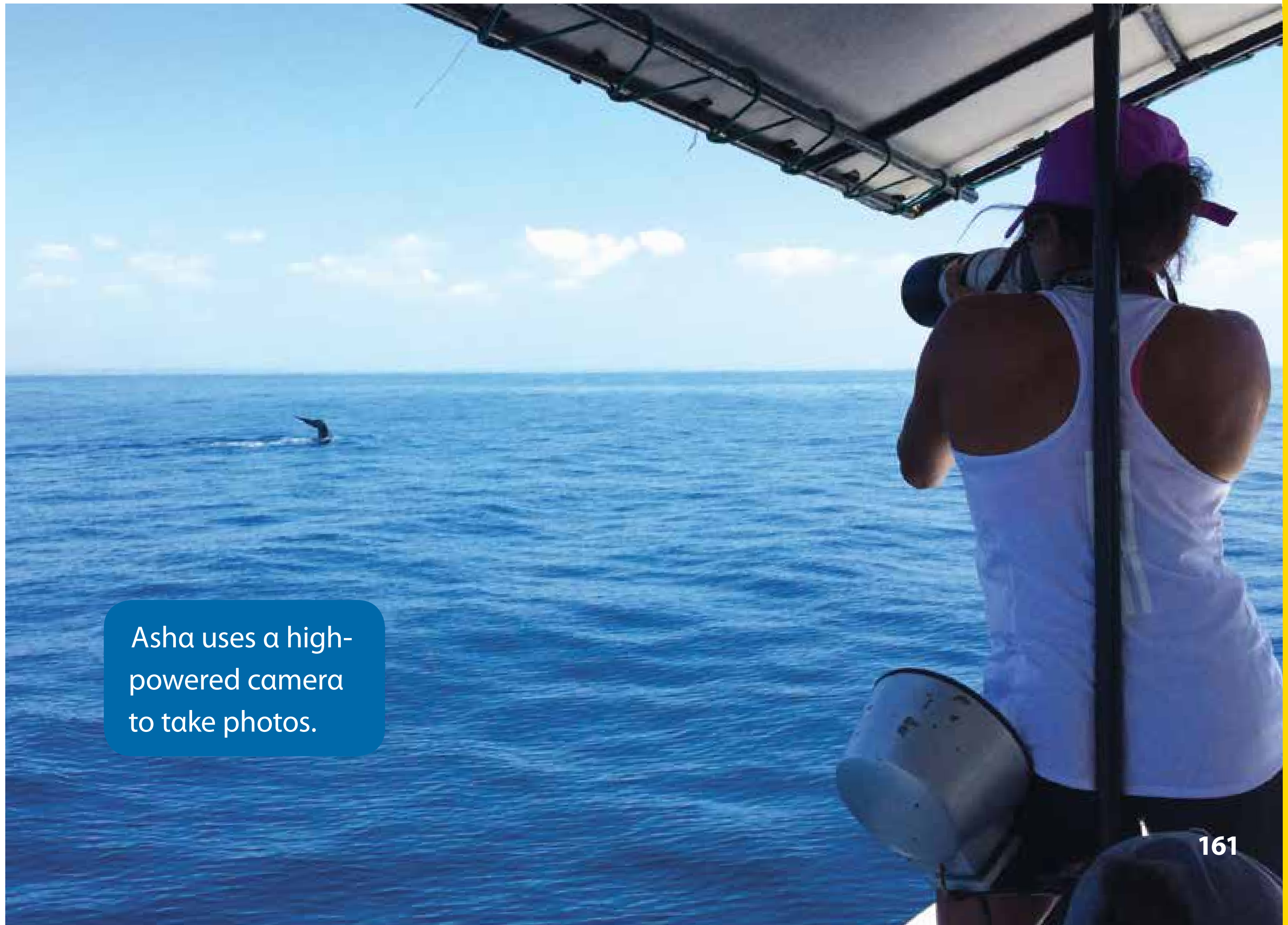
Reflect on Your Learning (My Science Notebook)

1. Which investigation interested you the most? Explain why you liked it.
2. Think about all that you've learned. How have your ideas about the world around you changed?

More to Explore

As a marine biologist, I have learned to always be curious and ask questions. I also work with other scientists to learn more about technology and how I can use it in my work. I love learning new things. I also love sharing stories about my work through social media. The more people know about these whales, the better chance we have of keeping the whales safe.

Look back in your science notebook. What are some of the most important things you have learned? What patterns did you record? What surprised you? Share your thoughts with your classmates. As you continue learning in *Exploring Science*, remember to ask and answer new questions. Always be curious!



Asha uses a high-powered camera to take photos.

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Nature of Science

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Life Science: Ecosystems: Interactions, Energy, and Dynamics/ Biological Evolution: Unity and Diversity

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Physical Science: Structure and Properties of Matter

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GRADE 2 | TEACHER'S EDITION

Physical Science Unit (excerpt)

Unit 4 Planning Guide

Structure and Properties of Matter

Building on Prior Learning

This Grade 2 unit provides students first experience with learning about matter and its properties. The focus here is on observable properties—all materials have properties, and those properties make some materials better suited for particular purposes. Students also learn that a variety of objects can be made from the same set of small pieces. In Grade 5, students will build on this knowledge as they begin to develop the concept that matter is made of particles too small to see.

- Use the Unit Pre-Assessment and Unit Opening Activity (Assessment Guide, pp. 34–36) to determine students' level of familiarity with properties of matter and to assess their readiness for applying the SEP Planning and Carrying Out Investigations and Analyzing and Interpreting Data standards.

Selecting an Anchoring Phenomenon

You may wish to use a variety of classroom objects to anchor students' explorations in this unit. Students can describe the properties of the objects, classify objects by their properties, and make predictions about how heating or cooling might change some of the objects.

Advance Planning

The investigations and engineering activities in this unit all use inexpensive and readily available materials. You will want to plan ahead for the STEM Space Station Project (pages 157a–157d) to make sure you have prepared a variety of fruits and vegetables for students to use in the activity.

Assessment Resources

The following assessment tools are available for this unit.

Self-Assessment
Students can use their science notebooks along with the rubrics in the *Science Notebook Companion* for reflection and self-assessment throughout the unit.

Formative Assessment
- Unit Pre-Assessment (Assessment Guide, pp. 34–35)
- Checkpoint Quizzes (Assessment Guide, pp. 37–38)
- Rubrics for all Investigates, STEM Projects, and Think Like a Scientist lessons (Assessment Guide, pp. 60–66)

Summative Assessment
- Unit Test (Assessment Guide, pp. 39–42)
- Unit Performance Task (Assessment Guide, pp. 43–44)

3-D Instructional Progression

This unit prepares students to demonstrate proficiency on this bundle of Performance Expectations: 2-PS1-1, 2-PS1-2, 2-PS1-3, and 2-PS1-4. The following two Lesson Sequence charts provide a roadmap to instruction in this unit.

Lesson Sequence 1	**Student Edition pp. 115–141**	**Pacing: 20 days**

PERFORMANCE EXPECTATIONS

2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that best suited for an intended purpose.

Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Analyzing and Interpreting Data	**PS1.A Structure and Properties of Matter.** Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. **PS1.A Structure and Properties of Matter.** Different properties are suited to different purposes.	Patterns Cause and Effect **Connections to Engineering, Technology, and Applications of Science** Influence of Engineering, Technology and Science on Society and the Natural World

OVERVIEW
This lesson sequence begins with students investigating some observable properties of liquids and solids. Next, they explore a variety of bulk properties of matter, such as color, texture, hardness, flexibility, and whether a material floats or sinks. In the Think Like a Scientist activity, students plan and carry out an investigation to classify materials by their observable properties. Finally, in the Investigate, students test a variety of materials to determine which would work best for cleaning up spilled liquid.

	Student Pages	**Teacher Pages**	**MindTap Digital Resources**
Matter	118–119	119a–119b	Explorer Video: Caleb Harper, Structure and Properties of Matter
Liquids	120–121	121a–121b	
Solids	122–123	123a–123b	
INVESTIGATE: Solids and Liquids	124–125	125a–125d	
Properties	126–127	127a–127d	
Color	128–129	129a–129d	Video Clip: Celebrating Holi Festival in India Physical Science Gallery
Texture	130–131	131a–131b	
Hard and Soft	132–133	133a–133d	Physical Science Gallery
Bend and Stretch	134–135	135a–135b	Video Clip: Jumping on Trampoline
Sink and Float	136–137	137a–137d	Video Clip: Throwing Safety Buoy into Water
Think Like a Scientist: Plan and Investigate	138–139	139a–139d	
INVESTIGATE: Materials That Absorb	140–141	141a–141b	

(continued)

Lesson Sequence 2	Student Edition pp. 142–159	Pacing: 20 days

PERFORMANCE EXPECTATIONS

2-PS1-3 Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

2-PS1-4 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Engaging in Argument from Evidence **Connections to Nature of Science** Science Laws, Models, Mechanisms, and Theories Explain Natural Phenomena	**PS1.A Structure and Properties of Matter.** Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces. **PS1.B Chemical Reactions.** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	Energy and Matter Cause and Effect **Connections to Engineering, Technology, and Applications of Science** Influence of Engineering, Technology, and Science on Society and the Natural World

OVERVIEW

In this lesson sequence, students first observe how different objects can be made from the same set of pieces. Next they explore changes caused by cooling and heating. In Think Like a Scientist, they construct an argument to explain which changes can be reversed and which cannot. Stories in Science enriches instruction as students learn about inventor Frederick McKinley Jones and his invention of a technology to keep food cold during shipment. Then in the STEM Space Station Project, students have the opportunity to design and test fruit flavor cubes. Finally, in the Science Career, students meet materials scientist Ainissa Ramirez.

	Student Pages	Teacher Pages	MindTap Digital Resources
Build It	142–143	143a–143d	Virtual Lab: Build It
Think Like a Scientist: Make Observations	144–145	145a–145d	
Cooling	146–147	147a–147b	
Heating	148–149	149a–149d	
Change It?	150–151	151a–151b	Video Clip: Muffins Baking
Stories in Science	152–153	153a–153b	
Think Like a Scientist: Make an Argument	154–155	155a–155d	
STEM: Space Station Project	156–157	157a–157d	NASA Video: Peanut Butter and Jelly in Space
Science Career	158–159	159a–159b	Physical Science Gallery

Notes

Build It

This huge arch is the entrance to Yellowstone National Park. Look closely. It is made up of many smaller pieces.

A small set of pieces can be used to build many different objects. Many smaller stone pieces were used to make this big arch.

Other objects are made using many stone pieces, such as this lodge.

Wrap It Up!

My Science Notebook

1. Can you think of other objects people make from pieces of stone?
2. What kinds of toys can you use to build many different shapes from just a few types of pieces?

DCI PS1.A: Structure and Properties of Matter. A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
CCC Energy and Matter. Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

Build It

NEXT GENERATION SCIENCE STANDARDS
DCI PS1.A: Structure and Properties of Matter. A great variety of objects can be built up from a small set of pieces. (2-PS1-3)
CCC Energy and Matter. Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

Objective Students will be able to:
- Describe how large objects can be built from many small pieces.

ENGAGE

Introduce the Phenomenon

Use Photography Show students a photograph of a large ancient Roman aqueduct. Explain that the Romans built aqueducts over 1,000 years ago and many still stand today. Ask: **How do you think the Romans were able to build so long ago something that still stands today?** *(Students should understand that the Romans built and planned carefully and used strong materials, such as stone and brick.)*

Tap Prior Knowledge

Think-Pair-Share Ask students to describe buildings and other structures, such as bridges and monuments, in their neighborhoods or communities. Allow a few minutes for students to think about what they know or have learned. Then pair students with partners to share their thinking and discuss ideas and questions. Encourage pairs to talk about different features of the structures, such as their size and shape. Have students record their responses to the following questions. Ask:

- **What are some different parts of the structures?** *(Possible answers: doors, roof, windows)*
- **What materials are the structures made from?** *(Possible answers: brick, wood, stone, glass)*

Finally, come back together as a class and allow pairs to share their ideas and responses.

ACADEMIC VOCABULARY

Arch* and *Arc
Display the words *arch* and *arc,* and have the class say the words aloud. Point to the picture of the arch. Ask: **Have you noticed parts of buildings or homes with this type of shape?** Allow students time to share any relevant examples, such as doorways at schools or libraries. Explain to students that an *arc* is similar to an *arch* in that it is curved, but an arc is made by a moving object while an arch is a curved structure. Connect to the lesson concept and point out that it takes multiple pieces to construct a secure arch.

EXPLORE

Build It

Partner Talk Pair students with partners. Have pairs look at the photos in the lesson of structures, and then read the captions. Ask:

- **How are the two structures alike?** *(Possible answer: The structures are alike in that they are made from many smaller pieces.)*
- **How they are different?** *(Possible answer: The structures' shapes and functions are different.)*
- **Can you tell what they are made from?** *(Possible answer: brick and stone)*
- **Where have you seen structures like these?** *(Answers will vary.)*

Students should take turns talking and listening while discussing the questions. Invite pairs to share their responses with the class.

Set a Purpose and Read

Focus Question Use this question to focus students and guide their reading: *How can materials be put together to build larger structures?* Have students read the lesson.

EXPLAIN

Describe Structures

Point out the photo of the arch in the lesson. Ask:

- **Where can you find this structure?** *(at the entrance to Yellowstone National Park)*
- **How would you describe its shape?** *(an arch)*
- **What is the arch made from?** *(Possible answer: many rocks or stones)*
- **Why do you think the builder chose rocks to make this arch?** *(Possible answer: The rocks are strong and won't break easily.)*

Next, call students' attention to the smaller photo of the lodge. Ask:

- **How would you describe the lodge's shape?** *(Possible answer: rectangle)*
- **How is the lodge used?** *(Possible answer: for shelter)*
- **What are the walls of the lodge made from?** *(Possible answer: many large rocks)*
- **What is the roof made from?** *(wood or logs)*
- **How do the rocks fit together?** *(Possible answer: They are stacked one on top of the other.)*
- **Why do you think the builder chose these materials?** *(Possible answer: They are strong materials; they might have been easily found nearby.)*

Describe Materials

Turn and Talk Have students turn to partners and discuss times they have used small objects to build larger structures. Ask:

- **What kinds of pieces can you build with?** *(Possible answers: plastic, wooden, or foam blocks; snap-together blocks; log-shaped blocks; plastic cubes)*
- **What can you build?** *(Answers will vary. Possible answers: tower, castle, house, fort, space ship, car)*
- **What happens if you use only a few small pieces to build something?** *(Possible answer: It will be small.)*
- **How can you build something larger?** *(Possible answer: I can use more or bigger pieces.)*
- **Why do you think the lodge and the arch are made of so many rocks?** *(Possible answers: The builders needed the arch and the lodge to be big. The rocks are small, so the builders needed to use a lot of them.)*

ELL Support

Starting Help students to use nouns and noun phrases when discussing how smaller pieces can be used to build different objects. Model how blocks can be used to build a wall. Ask the following questions, providing support as needed: **Can you build a house with smaller pieces?** *(yes)* **Can smaller pieces fit together to make a bigger object?** *(yes)* **Do the smaller parts need to be made of the same material?** *(no)*

Developing Have students complete these sentence frames to practice using nouns and noun phrases to describe how smaller pieces can be used to build objects. Encourage them to work with partners and to add adjectives to the nouns.

Small *(metal, plastic, wooden, stone, brick)* pieces can be put together to make *(bigger)* objects.

Small pieces can be put together to build *(large walls, small homes, big arches, large buildings)*.

Bridging Have students complete the following sentence starters to explain how smaller pieces can be used to make objects that are larger. Challenge them to add two adjectives to the nouns in their sentences.

People can build . . .

Small pieces are made up of materials such as . . .

Different objects can be made from. . .

Build It (continued)

Teach the Dimensions

CCC Energy and Matter. Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

Hands-on Demo Continue the discussion of the concept of assembling many pieces into a larger object. Lead students in a hands-on demonstration. Give pairs sheets or half sheets of paper. Provide tape and glue. You might wish to provide paper plates or trays for this activity, too.

Hold up a sheet of paper. Have students tell the shape of the paper. Then begin to tear the paper, first in half and then into smaller pieces. Think aloud as you work, saying that the paper was one piece at first. Now it is becoming many pieces. Point out how the shape has changed. Next, invite students to tear their paper sheets, as well. Encourage students to tear pieces of any size or shape.

Next, ask: **How might the individual pieces form one large object?** Have pairs discuss this and begin to find ways to create something new from their torn pieces. Circulate and encourage students. There is no limitation on the manner in which students reform, reconnect, or reshape the smaller pieces into one larger piece. Students might glue the papers together, tape pieces along a line, create a cylinder with long strips of paper, or create a vertical tower.

After students have had time to reassemble their paper pieces, post a T-chart to help guide students' explanations.

Ask students to describe the shape the paper was before and in what form the paper pieces are now. Record students' answers on the T-chart. In their science notebooks, have students write what they discovered about breaking an object into many pieces.

Virtual Lab

Have students carry out the virtual lab, "Build It," to help them conceptualize building something from many small pieces.

Time 5 minutes

Teaching Tips Help students connect the simulation to the core content of the lesson. Ask: **What happened in this lab?** *(Possible answer: I built a robot, I took apart a vehicle, I moved blocks, I used small pieces to build something bigger.)*

What to Expect Students will manipulate the arrow keys to move the block pieces. First they will disassemble a vehicle, then they will use those pieces to build a robot. Students should recognize the smaller pieces being joined together to make something larger from them.

ELABORATE

Many Parts, One Device

The area of electronics is a good source for examples of devices and machines built from many pieces. Begin a discussion with students about the idea of many parts within one device. Post students' ideas and questions where they can be viewed. Then send pairs of students on a hunt for more information about the number of parts in common electronics. Options for research might include cell phones, blenders, toasters, coffee makers, tablets, or even drones.

LITERACY CONNECTION

Use Images

RI.2.7 Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.

Guide students in recognizing the importance of using images to contribute to their understanding and to help clarify the text. For example, in the EXPLAIN section, students are asked to describe the shapes of the structures in the photos as well as identify the materials they are made from. Ask:

- **How do the photos add to the information in the text?** *(Possible answer: They show examples of what the text talks about.)*

Have students contribute to a bulletin board in a school hallway. Students might draw pictures of the devices they researched or print images from the Internet. Ask students to include key facts on a notecards that are posted next to their illustrations or photos. Guide them to list:

- name of device
- number of parts
- anything about how it is assembled

Find Out More About Buildings

Tell students that the arch in the lesson photo is called Roosevelt Arch and that it is located at the north entrance to Yellowstone National Park. Roosevelt Arch is just one of many historic structures found at Yellowstone. Yellowstone was the first national park, created in 1872. The National Park Service was created 44 years later to protect the park lands, guard cultural resources, and advocate for the environment.

Step 1: Organize students in small groups and help them find out more about Roosevelt Arch or another structure in the park such as the ones located in historic Fort Yellowstone. Tell students to focus on the size and shape of the chosen structures as well as the materials used to build them.

Step 2: Have students prepare short presentations to share their findings with the class.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. **LIST Can you think of other objects people make from pieces of stone?** *(Answers will vary. Possible answer: castles, churches, houses)*

2. **RELATE What kinds of toys can you use to build many different shapes from just a few types of pieces?** *(Possible answers: snap-together blocks, building blocks, log-shaped blocks, plastic cubes, magnets)*

Heating

Warm temperatures can also cause matter to change. When water freezes into ice, heat can cause it to melt into a liquid again. When ice melts into water, cooling can freeze it into solid ice again. The change can happen over and over. Temperature changes cause this pattern.

Warming will change this frozen snow to liquid water droplets.

DCI PS1.B: Chemical Reactions. Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)
CCC Cause and Effect. Events have causes that generate observable patterns. (2-PS1-4)

SCIENCE in a SNAP

Heating Ice

1 Make a small container out of foil. Place an ice cube in the container.

2 Predict what will happen to the ice cube. Record your prediction. After 1 hour, observe the ice cube.

? **Do your results support your prediction? How has the shape of the ice cube changed?**

Wrap It Up!

My Science Notebook

1. Explain how ice changes when it is heated.
2. What would happen if you put the foil container at the end of your Science in a Snap investigation into the freezer?

Heating

NEXT GENERATION SCIENCE STANDARDS

DCI PS1.B: Chemical Reactions. Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)

CCC Cause and Effect. Events have causes that generate observable patterns. (2-PS1-4)

Objectives Students will be able to:
- Describe how ice changes when it is heated.
- Recognize that freezing and melting can happen over and over again.

ENGAGE

Introduce the Phenomenon

Use Photography Show students a photo of a hot spring in winter. Explain that hot springs are groundwater that has been heated by the earth and is bubbling up in an area. Show students how the warm water keeps the snow melted, though the land surrounding the spring is cold and snow covered.

Tap Prior Knowledge

Sketch-to-Stretch Have students think about the ice they put into a beverage to cool it. Have students draw quick sketches to help them answer the questions below. Students should also caption and label their sketches. Ask:

- **Is the ice a liquid or a solid? How do you know?** *(Possible answer: It is a solid because it has its own shape.)*
- **How did the water that makes up the cubes change to a solid?** *(Possible answer: It was put in a cold freezer.)*
- **What happens to ice that is left out on the kitchen counter?** *(Possible answer: It melts and forms a puddle.)*

EXPLORE

Heating

Think-Pair-Share Invite a volunteer to read the title of the lesson. Then have students look at the photo of the melting snow. Ask: **In the last lesson, you learned about how cooling changes water. What do you think this lesson is about?** *(Answers will vary. Possible answer: How heating changes ice back to a liquid.)* Allow students time to think about the questions. Have partners discuss their ideas and allow volunteers to share predictions aloud.

Concept Web Display the concept web that was started in a previous lesson. Extend a line to a new oval. Within that oval, write the title of this lesson, Heating. Use the web to capture students' understanding of this lesson's concepts and to make comparisons between the lessons.

Set a Purpose and Read

Focus Question Use this question to focus students and guide their reading: *How does heating cause ice to change into a liquid?* Have students read the lesson.

EXPLAIN

Describe the Effects of Heating

Have students look at the lesson photo. Confirm that they can identify the image as a close up photo of needles on the branch of a pine tree holding a small pile of snow. Ask:

- **What kind of matter is snow?** *(a solid)*
- **What kind of matter was the snow before it froze?** *(liquid water)*
- **How did the liquid water change to snow?** *(Possible answer: Cooling changed it from a liquid to a solid.)*
- **What is happening to the snow in the photo?** *(Possible answer: It is changing from a solid to a liquid.)*
- **What is it called when ice changes to a liquid?** *(melting)*
- **What can you infer about the weather in the photo? How do you know? (***Possible answer: It is getting warmer. Heating from the air is making the snow change back to a liquid.)*

Have students picture a puddle on a street or sidewalk. In the morning, the puddle is solid ice. In the afternoon, it has changed back to liquid water.

- **Why did the water in the puddle change?** *(Possible answer: The air temperature got warmer during the day.)*
- **Suppose the night is cold again. Predict what the puddle will look like in the morning. How do you know?** *(Possible answer: It will change back to solid ice because the cold air will cool the water in the puddle.)*

2-1-1 Have students complete the Science in a Snap activity to observe how heating can cause ice to change back to liquid water. After they have completed the activity, ask them to answer the following questions in their science notebook. Ask:

- **What are TWO things that you learned?** *(Answers will vary.)*
- **What is ONE question you still have?** *(Answers will vary.)*
- **What is ONE aspect of the activity you enjoyed?** *(Answers will vary.)*

Teach the Dimensions

CCC Cause and Effect. Events have causes that generate observable patterns. (2-PS1-4)

Have students refer back to the hot springs in Introduce the Phenomenon. Remind students that an effect is something that happens and the cause is why that thing happened. Ask: **What would be the effect to the hot springs landscape if the spring water was no longer heated?** *(Possible answer: The water would become cold and possibly frozen.)*

Guide students through the *SCIENCE in a SNAP* activity.

SCIENCE in a SNAP Heating Ice

Materials ***For groups of 4:*** 20 cm (8 inch) square of foil; small paper plate; ice cube; clock or timer (for class use)

Advance Preparation Precut foil squares for each group. Make the ice cubes ahead of time and store them in a small cooler until students are ready for them.

Teaching Tips In their science notebook, have students write the title of the investigation. Below the title, tell them to write and underline the words *Prediction* and *Observations.* If necessary, review that a prediction is a statement that tells what might happen based on observations or prior knowledge. Observations are things that are noticed using the senses. Stress that although students will be making their observations in the investigation with their sense of sight, observations can also be made with other senses.

What to Expect Students will observe that some or all of their ice cubes will have melted, or changed from a solid to a liquid, over the course of the hour.

ELL Support

Starting Help students to use verbs and verb phrases when discussing how heating causes matter to change. Ask the following questions, providing support as needed: **Can heating a solid like snow change it to a liquid?** *(Yes.)* **What did the snow do when it changed from a solid to a liquid?** *(It melted.)* **What other verb can you use for "heat"?** *(warm)*

Developing Have students complete these sentence frames to discuss heating with partners:

The warm air temperature *(heated)* the snow, which caused it to *(melt)*.

As the snow *(warmed)*, it *(changed)* from a solid to a liquid.

Bridging Have students complete the following sentence starters to explain how heating changed a solid into a liquid, using different verb tenses.

Cooling had caused the liquid snow . . .

The liquid snow . . .

When the air temperature . . .

Heating (continued)

Quick Questions Ask: **Do your results support your prediction?** *(Answers may vary. Some students may have predicted that all or part of the ice cube would melt, while others may have predicted that some melting would occur, but that some of the ice would still be intact.)* **How has the shape of the ice cube changed?** *(Answers will vary depending on the degree of melting. Any resulting liquid will have taken the shape of the foil container.)* Tell students, if needed, that melting is the process by which a solid changes to a liquid. Say: **Explain what caused the ice to melt.** *(Possible answer: The ice melted, or changed from a solid to a liquid, because of heating from the air.)* **Infer how the liquid water in the foil container can be changed back to a solid.** *(Possible answer: The container can be put back in the freezer.)*

Concept Web After completing the Science in a Snap activity, ask students to share any details they might want to add to the concept web about how their thinking changed, what surprised them, and what they understand about how matter can change from heating.

LITERACY CONNECTION

Demonstrate Understanding

RI.2.1 Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text.

Remind students to ask themselves questions as they are reading. Explain that this will help students know if they are comprehending important ideas. Point out that in a science text that tells about a process, such as heating, the questions to ask will more often be "what?" "how?" and "why?" Suggest that when students finish reading a paragraph or a few detailed sentences, they stop and ask themselves a series of questions. They could use and modify such questions when reading other lessons, too. For example, **what happened to ice?** *(It melted.)* **How did the ice melt?** *(Warm temperatures caused ice to melt.)* If students are unable to answer a question, return to the text and reread. Instruct them to talk with partners about what is confusing and test out different answers, using the text, photos, and captions as resources.

ELABORATE

Extend Your Thinking About Heating

Explain to students that some materials, called insulators, can help keep objects either warm or cold. Organize students into small groups. Have groups brainstorm a list of materials that could insulate ice, or keep it from melting. Encourage students to tap prior knowledge by thinking about ways in which ice and other objects are kept cool in the summer. Have students predict which material would be the best insulator and write their ideas in their science notebook.

Literacy Through Science

Read and Compare Multiple Texts

RI.2.9 Compare and contrast the most important points presented by two texts on the same topic.

Continue to engage students with the phenomenon of heating by providing secondary reading options that discuss heat and its effects. Articles could focus on weather topics, such as temperature and snow melt. Have students observe current weather conditions in your location. Ask:

- **How might warmer temperatures cause changes to any of the rain puddles/snow piles currently outdoors?** (Answers will vary. Guide students to understand that if the temperature increases, heat will affect puddles or snow piles. Puddles could dry up. Snow could melt.)

You might also turn to the topic of food and cooking to examine simple recipes where heating is required. Look up recipes for heating liquids to make a hot beverage, such as hot cocoa or hot cider. Read the recipe text together. Have pairs work together to identify the language in the text that tells about heat. Ask:

- **What part of this text tells us that heating is needed? What steps are needed to complete the process?**

Confirm correct answers from pairs and return to the lesson text. Say: **Our lesson, Heating, stated information about how temperature can change matter. Point out the sentences that explain how heating and cooling can cause a pattern.** Guide students to point out and re-read the last three sentences in the paragraph.

If possible, set up a time to follow the recipe and conduct a hands-on experience heating liquids. Refer to the Science Safety pages to guide the procedure set up. Have students make a prediction about what will happen when heat is applied. Present segments of time for their predictions, such as heating after 5 minutes and 15 minutes.

You might extend these reading and hands-on opportunities across this lesson and the next, Change It? After students learn more about observing how heating or cooling changes a substance, add a second recipe text to students' collection. An example might include a recipe for using tomatoes to make tomato soup. Discuss how the heat changes the tomatoes. Have students meet in small groups to generate other food-related examples of how heating or cooling can change solids or liquids. Refer back to these experiences and texts when students develop arguments in the Think Like a Scientist: Make an Argument lesson.

DIFFERENTIATED INSTRUCTION

Gifted and Talented Learners

For students who can pursue the topic more deeply, present gases as another state of matter. Provide resources, such as a graphic found on the Internet and a secondary article. Provide a question to guide their study: **What happens when water is heated to boiling?** Have pairs seek out the answer to this question and report back. Invite students to create visuals that show all three states of matter.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. EXPLAIN **Explain how ice changes when it is heated.** *(Possible answer: It changes back to liquid water.)*
2. CAUSE AND EFFECT **What would happen if you put the foil container at the end of the *SCIENCE in a SNAP* investigation into the freezer?** *(Possible answer: Any liquid water will change back to ice.)*

Make an Argument

Heating and cooling materials can change them. Look at the pictures on these pages. Each shows something that has changed because of heating or cooling. Read the labels and follow the steps below to use evidence to make an argument.

1 Ask a question. My Science Notebook

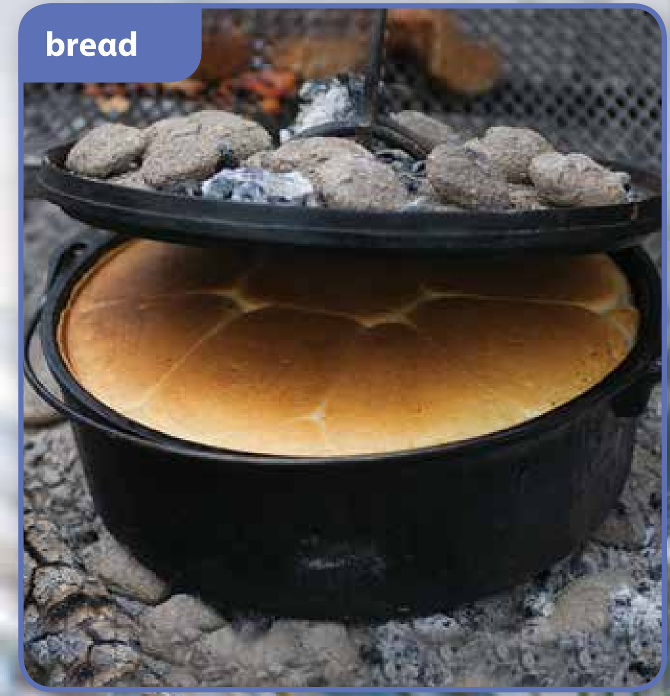
How can heating or cooling change materials?

2 Gather information.

Describe the change in each of the photos. List the changes in a chart. State which changes can be reversed and which cannot be reversed.

3 Make an argument.

Explain how heating or cooling changed each material. Give evidence by describing what you see in each photo.


bread


popcorn


ice

Explore on Your Own

You've observed properties of different materials. Select another material, solid or liquid, and make an argument using evidence that some changes can be reversed and some cannot. Make a chart in your science notebook. Record the characteristics of the material before and after heating and cooling. Include characteristics when the heating or cooling is reversed. Share your results.

PE 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

NATIONAL GEOGRAPHIC | **Think Like a Scientist**

Make an Argument STEM

NEXT GENERATION SCIENCE STANDARDS

PE **2-PS1-4.** Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

SEP **Engaging in Argument from Evidence.** Construct an argument with evidence to support a claim.

Objective Students will be able to:

- Construct an argument based on evidence that some changes caused by heating or cooling can be reversed and some cannot.

BEFORE YOU BEGIN

Time 30 minutes

Teaching Tips Organize students into small groups. Review with students the words *reversible* and *nonreversible* and how these terms relate to changes in matter caused by heating and cooling. To help students become comfortable constructing and defending arguments, you may wish to have students construct mock arguments about common, everyday occurrences. For example, you might have students make arguments about the day's weather and defend it with observations and prior knowledge.

What to Expect In this activity, students will construct arguments about whether the changes shown in each photo can be reversed. When supporting their arguments, students should rely on observations, prior knowledge, what they have read in this text, and the outcomes of investigations they have completed. Students should argue that the popcorn cannot be un-popped and the bread cannot be unbaked, making those changes nonreversible, but that the ice can be thawed and frozen over and over again. Students should support their arguments with valid data and information from various sources, including this textbook and their science notebook.

ENGAGE

Introduce the Phenomenon

Use Photography Show students an image of cooked pancakes. Remind students that pancakes are cooked on a stove in a pan. Have students offer explanations about what a "before" photo would look like. Have students share their ideas, using background knowledge. *(Possible response: Before pancakes are cooked, the material is not solid. The batter can be dropped by the spoonful.)*

Tap Prior Knowledge

Remind students that in previous lessons, they learned about heating and cooling and how these processes can cause matter to change. Ask:

- **What is one way heating can change matter?** *(Possible answer: It can cause it to melt.)*
- **What is one way cooling can change matter?** *(Possible answer: It can cause it to freeze.)*
- **What is an example of a change to matter that cannot be changed back?** *(Possible answer: A cooked egg cannot be uncooked.)*

EXPLORE

Read aloud the first page of *Make an Argument*. Discuss the activity with students and address any questions they have. Then have students study the photos of ice, bread, and popcorn across both pages. Ask: **What changes do you see in the photos?** *(Possible answer: Water changed to ice; bread dough changed to bread; popcorn seeds changed to popcorn.)*

EXPLAIN

Make Arguments

Explain that students will make arguments about whether the changes shown in the text can be reversed. Have students talk to partners about what an argument is in science. Say: **Evidence is what you have observed in an investigation and what you already know. Evidence can support a conclusion.** Ask:

- **What kind of evidence can you use?** *(Possible answers: I can use what I already know about matter and what I have read in this book; I can use data from my science notebook and the results and observations from investigations I have done; I can use what I already know about how bread dough changes when it is baked.)*
- **What argument will you make about the ice?** *(Possible answer: I will argue that heating can melt the ice back into water and then cooling can freeze it into ice again.)*
- **What evidence supports your argument?** *(Students should cite evidence from the text as well as the investigations and Science in a Snap activities. Possible answer: I read that cooling changes liquid water into ice and that heating can change the ice back to water. I observed water freezing and an ice cube melting during Science in a Snap activities.)*
- **In what ways did you think like a scientist as you completed this activity?** *(I used evidence to make an argument the way scientists do.)*

Teach the Dimensions

SEP **Engaging in Argument from Evidence.** Construct an argument with evidence to support a claim.

Share that scientists construct arguments with evidence to support a claim. Remind students that in this activity you observed that matter can change form with a change in temperature. Observations and data become evidence. Have students think back to other observations they've done in *Physical Science*. Ask students to look through their science notebooks for examples of data gathered, which can be used as evidence.

ELABORATE

Plan an Investigation

Explore on Your Own Offer time for students to complete the Explore on Your Own activity. Use the checklist provided in the *Student Notebook Companion*.

ACADEMIC VOCABULARY

Argument

Support the discussion of the word *argument*, as it is used in science. Point out the word in the lesson title and have students say it together. Review that words can have different meanings or subtleties depending on the context in which they are used. Share that a scientist's argument is a statement of how something works or what something is in the world, such as how matter changes, how plants grow, or how rocks change.

You might extend the activity with group work. Organize students and tell groups to suppose that they have to design an investigation that will prove that one of the changes in the photos on this spread either can or cannot be reversed. Have groups work together to plan and write the investigation. Remind students that the first thing they must do is make an argument that the change is reversible or not reversible.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. **DESCRIBE Describe the change in each picture that was caused by heating or cooling.** *(Cooling changed water into ice; heating caused the popcorn kernels to pop; heating caused the bread dough to bake.)*
2. **IDENTIFY Which changes can be reversed? Which changes cannot be reversed?** *(The change to water can be reversed, but the changes to the popcorn and the bread cannot be reversed.)*
3. **EVALUATE Give evidence to support your answer for each picture.** *(Students should give appropriate evidence for each picture, including evidence from the text, prior knowledge, and investigations.)*

Rubrics

Have students evaluate their work using the rubric in their *Science Notebook Companion*. Use students' completed rubrics and the teacher rubric provided to guide your assessment of their work.

MATH CONNECTION

Quantitative Thinking

MP.2 Use appropriate tools strategically.

Explain that heating and cooling to change matter may be done at specific temperatures. Ask students for real life examples of how temperature readings are used in this way. *(Possible answers: setting an oven temperature, seeing water boil, using a thermometer)* Write student ideas on the board.

GRADE 4 | STUDENT EDITION

Life Science Unit

NATIONAL GEOGRAPHIC | **Explorer**

David Moinina Sengeh
Biomedical Engineer
National Geographic Explorer

Let's Explore!

There are many ways of doing science. In *Nature of Science,* you learned that scientists analyze data to develop evidence. They often look for patterns and make inferences to form explanations. I look for patterns that show how the shape of an artificial limb affects its function. I make inferences to improve my designs. As you read, look for ways that scientists analyze data for patterns and make inferences. That includes you, too!

My investigation of the human body relates to life science. Life science is the study of living things and their environments. Here are some questions you might investigate as you read *Life Science*:

- Which parts of a flowering plant produce seeds for new plants to grow?
- How do the internal structures of plants help them reproduce?
- What surprising thing can an elephant do with its feet?
- Why is an animal's brain so important for the animal's survival?

Look at the notebook examples. Do they bring other questions to mind? Write them down. Also, write down your own questions and try to answer them as you read. Let's check in later to review what you have learned!

Collect photos related to main ideas.

Parts of a Flower

Stamens make pollen. Petals can attract insects that carry pollen to a pistil. The pistil develops into a fruit with seeds. Each seed can grow into a new plant.

Summarize important science ideas in your own words.

Animal Senses

I learned that animals use senses to learn about their environment. This helps them survive.

Example: A clouded leopard has sound receptors in its ears. It detects vibrations of a moving ground squirrel. Signals go to the brain. The brain interprets the signals as sound. The leopard can use the information and its memory to catch and eat the ground squirrel!

Connect important science ideas to your world.

My Five Senses

I use my five senses to interact with my environment.

Smell – I use my nose to smell flowers.
Hear – I use my ears to hear birds.
Sight – I use my eyes to see people.
Touch – I use my hands to feel heat.
Taste – I use my tongue to taste apples.

Life Science

Structure, Function, and Information Processing

The Borneo orangutan finds fruit for its next meal.

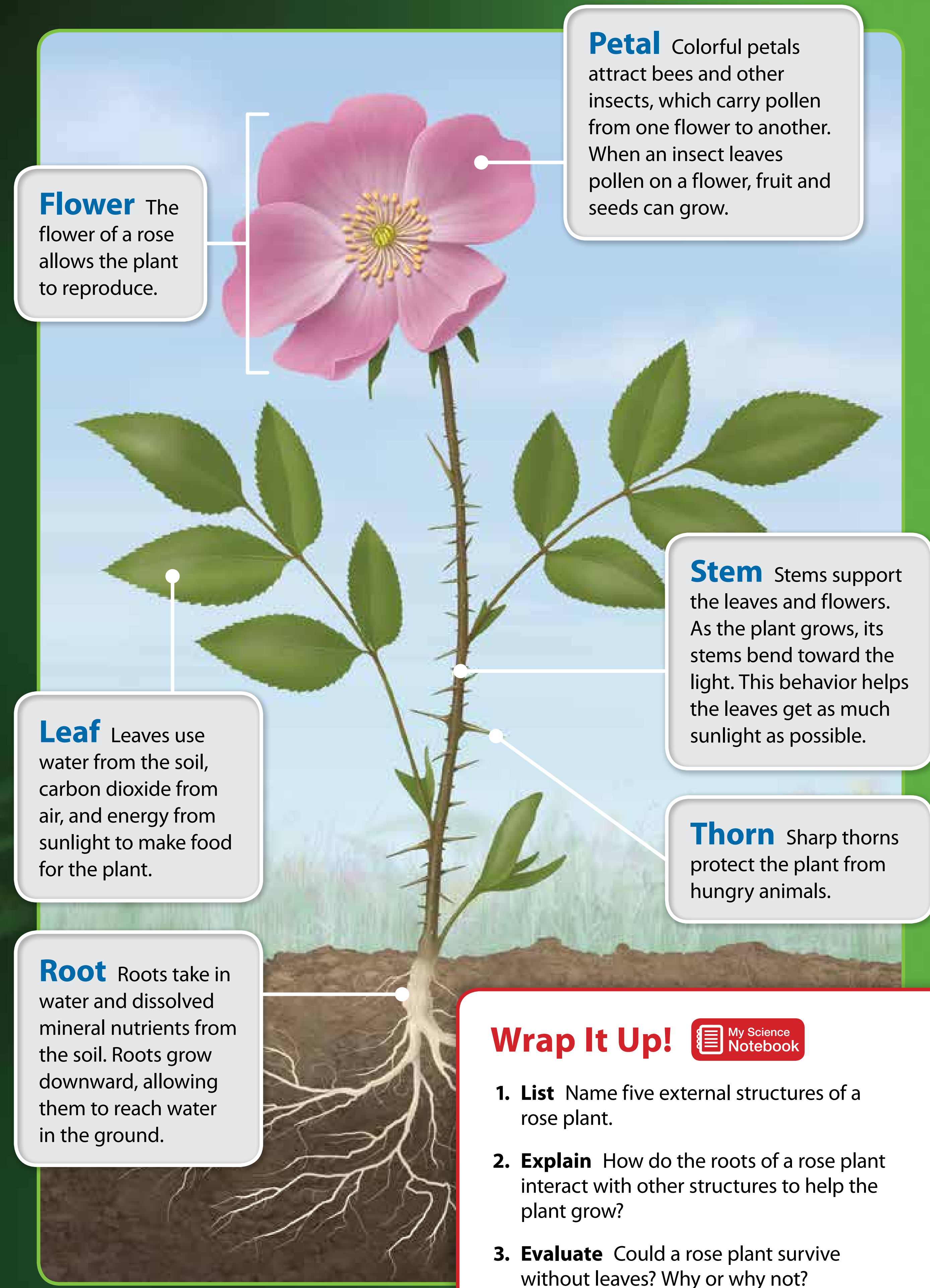
External Structures of a Wild Rose

Have you ever seen a wild rose plant like the one in the photo? The rose is a type of plant that produces flowers. Its flowers are beautiful, but they are also important to the plant. Like all plants, the wild rose is made up of different kinds of structures. Its external structures are the parts that you can see on the outside of the plant. They include leaves, stems, roots, and flowers.

Leaves, stems, and roots have important functions in the growth and survival of the plant. The wild rose plant also has structures that allow it to reproduce—its flowers. Flowers produce seeds, which can grow into new plants.

Both the color and scent of the wild rose plant's flowers attract insects.

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)



Wrap It Up! My Science Notebook

1. **List** Name five external structures of a rose plant.
2. **Explain** How do the roots of a rose plant interact with other structures to help the plant grow?
3. **Evaluate** Could a rose plant survive without leaves? Why or why not?

Internal Structures of a Wild Rose

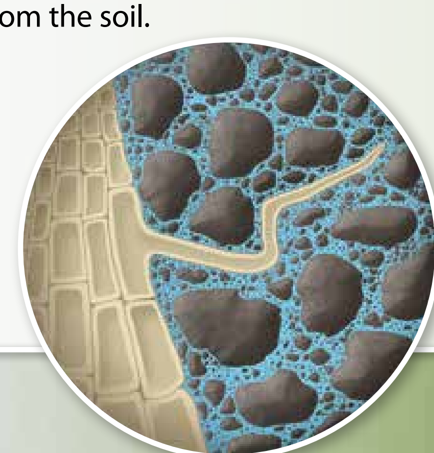
Plants have internal structures that help them grow, survive, and reproduce. These structures exist inside the plant. Many of these structures are hard to see without a magnifying glass or microscope.

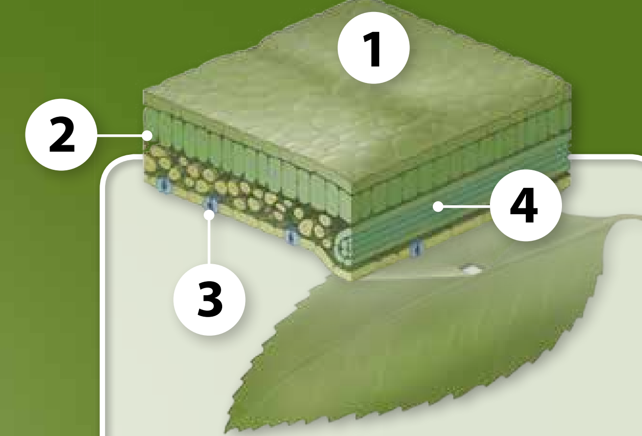
The many stamens of this wild rose flower surround the pistil in the center.

Flower In the center of the flower are the stamens and pistil. **Stamens** make pollen. For fruit to develop, pollen must be transferred to the pistil. Then the **pistil** develops into a fruit with seeds inside. Each seed can grow into a new plant.

Stem Inside each stem are bundles of tiny tubes. Some tubes carry water from the roots up to the leaves and flowers. Other tubes carry food from the leaves to the rest of the plant.

Roots Tiny hairs on the roots take in water and mineral nutrients from the soil.





Leaf Leaves use water from the soil, carbon dioxide from the air, and energy from sunlight to make food for the plant. Leaves are made up of several parts.

1. The outer layer protects the leaf and keeps it from drying out.
2. In the middle is the food-making layer.
3. Openings in the bottom of the leaf let air into the food-making layer.
4. Veins are made up of tiny tubes. Some tubes carry water to the leaf. Other tubes carry food from the leaves to the rest of the plant.

Wrap It Up! My Science Notebook

1. **Identify** What are the structures of a leaf? What are their functions?
2. **Cause and Effect** How do the stamens of a flower help a plant reproduce?
3. **Analyze** How is a plant's stem important to the function of the plant's other parts?

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Construct an Argument

A buttercup plant and a wild rose look very different. But a buttercup, like a wild rose, has external and internal structures that help it survive.

Use sticky notes to label the different external and internal structures of the buttercup plant. Then follow the process below.

1. **List.** My Science Notebook
   What external structures did you label? What internal structures did you label?

2. **Compare.**
   Work with a group. Compare your labels. Work together until everyone in your group has all the buttercup plant's structures labeled. Then compare the buttercup plant's structures to the wild rose's structures in the two previous lessons.

3. **Construct an argument.**
   Have each person in the group choose one labeled *external structure* and one labeled *internal structure*. Write an explanation arguing how, as with the wild rose, these structures help the buttercup plant grow, survive, or reproduce. Use evidence from the diagram to support your argument. Also use evidence from lessons on the internal and external structures of a wild rose.

4. **Generalize.**
   Come back together as a group. Present your arguments for the structures you labeled. Together, write a summary explaining how the structures of the buttercup plant and the wild rose help them survive.

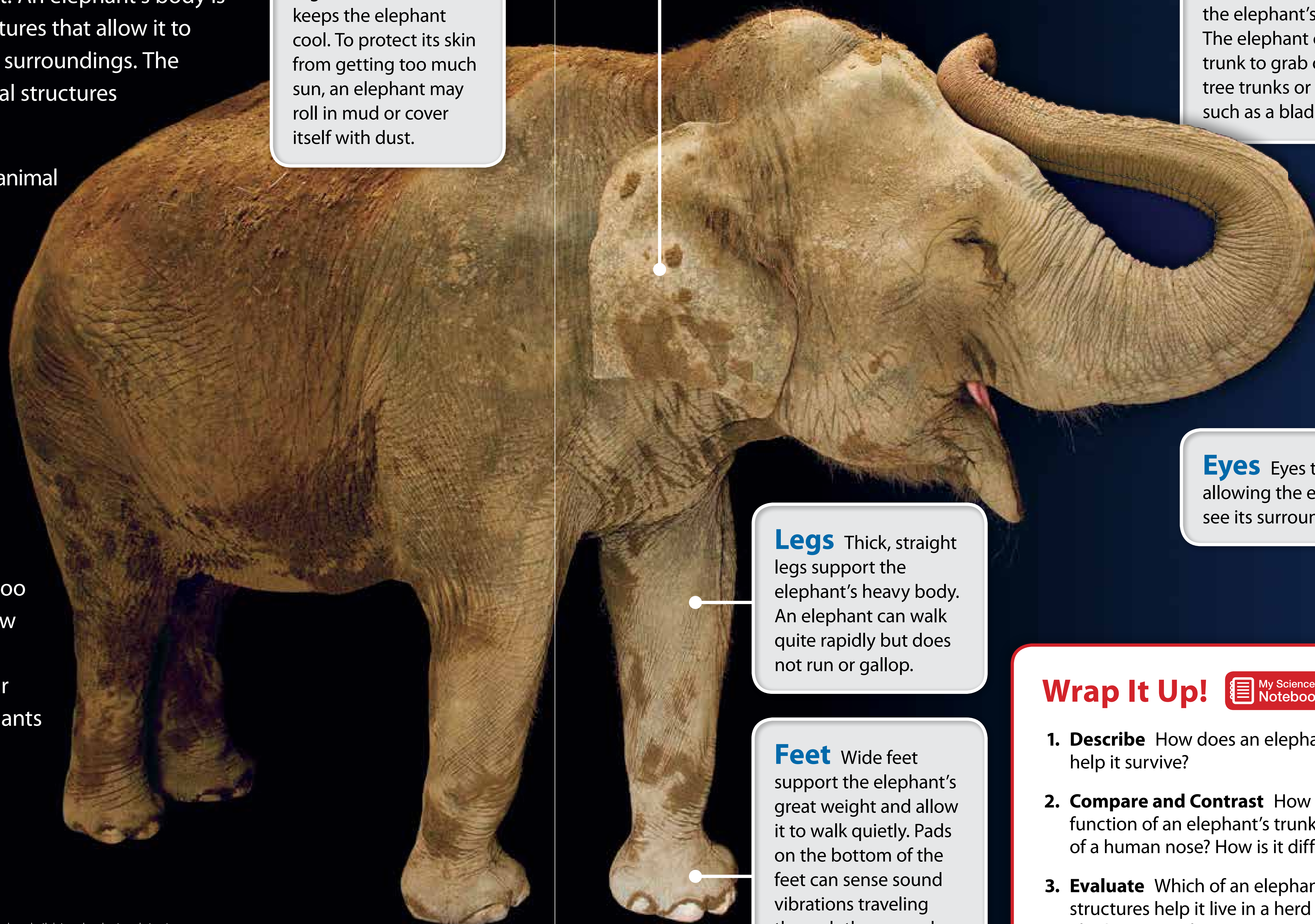
PE 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

External Structures of an Elephant

What animal uses its nose to put food in its mouth and its feet to sense sound? An elephant! An elephant's body is made up of many different structures that allow it to grow, survive, and respond to its surroundings. The photo shows some of the external structures of an Asian elephant.

The Asian elephant is the biggest animal in Asia. To get enough energy to survive, an elephant needs to eat an enormous amount of food. No wonder elephants spend most of their time looking for food. They eat grasses, leaves, roots, bark, and fruit.

Elephants use a wide variety of sounds to communicate—trumpeting, roaring, snorting, grunting, and barking. They also make rumbling sounds that are too low for humans to hear. These low sounds can travel through the ground for long distances—as far as 32 kilometers (20 miles). Elephants use their ears and feet to sense vibrations from sounds traveling through air and underground.



Skin Tough, wrinkled skin protects the elephant's internal organs. The skin also keeps the elephant cool. To protect its skin from getting too much sun, an elephant may roll in mud or cover itself with dust.

Ears The elephant's sensitive ears hear all sorts of sounds. Its big earflaps give off heat, which helps keep the elephant cool.

Trunk The long, muscular trunk is both the elephant's nose and its upper lip. The trunk has many different functions—smelling, breathing, trumpeting, and squirting water into the elephant's mouth. The elephant can use its trunk to grab onto big tree trunks or tiny objects, such as a blade of grass.

Eyes Eyes take in light, allowing the elephant to see its surroundings.

Legs Thick, straight legs support the elephant's heavy body. An elephant can walk quite rapidly but does not run or gallop.

Feet Wide feet support the elephant's great weight and allow it to walk quietly. Pads on the bottom of the feet can sense sound vibrations traveling through the ground.

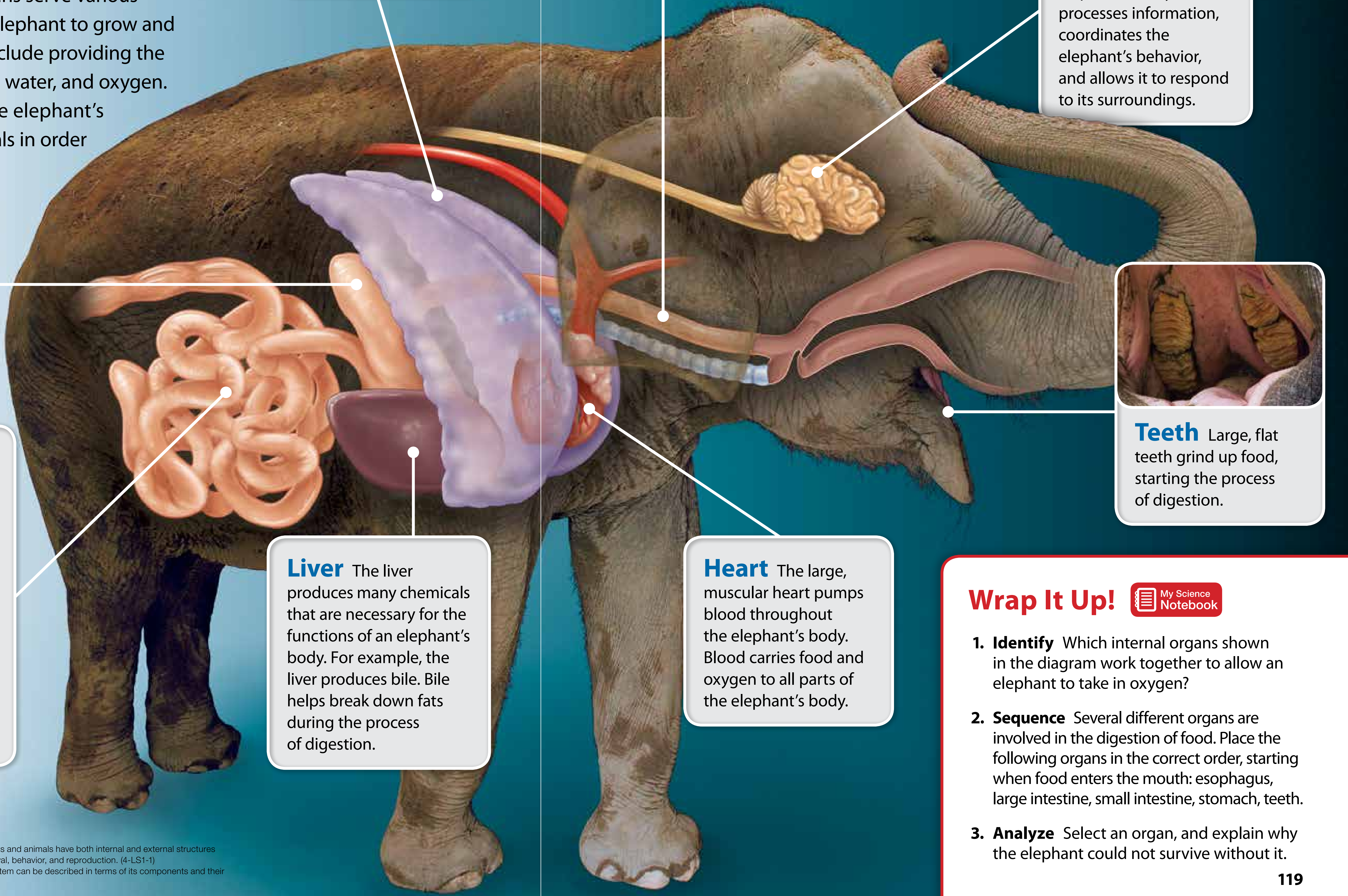
Wrap It Up! My Science Notebook

1. **Describe** How does an elephant's skin help it survive?
2. **Compare and Contrast** How is the function of an elephant's trunk like that of a human nose? How is it different?
3. **Evaluate** Which of an elephant's external structures help it live in a herd with other elephants? Explain.

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Internal Organs of an Elephant

An elephant's internal organs serve various functions. They allow the elephant to grow and survive. These functions include providing the elephant's body with food, water, and oxygen. All of the living parts of the elephant's body require these materials in order to survive.



Lungs The lungs take in oxygen from the air and release carbon dioxide. Blood traveling through the lungs picks up oxygen.

Esophagus The esophagus is the tube that carries food from the elephant's mouth to its stomach.

Brain The large and highly developed brain makes the elephant very intelligent. The brain controls all of the functions of the elephant's body. It processes information, coordinates the elephant's behavior, and allows it to respond to its surroundings.

Stomach The large stomach stores food and begins the process of breaking it down. Food then travels to the intestine.

Teeth Large, flat teeth grind up food, starting the process of digestion.

Intestines Most of an elephant's food is digested in the small intestine. Bacteria at the end of the small intestine help break down the food. Sugars and other chemicals from food are taken up by blood in the intestine walls. Undigested food moves from the small intestine to the large intestine.

Liver The liver produces many chemicals that are necessary for the functions of an elephant's body. For example, the liver produces bile. Bile helps break down fats during the process of digestion.

Heart The large, muscular heart pumps blood throughout the elephant's body. Blood carries food and oxygen to all parts of the elephant's body.

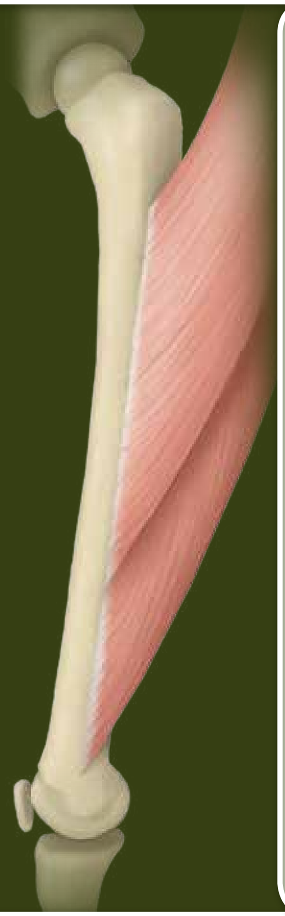
Wrap It Up! My Science Notebook

1. **Identify** Which internal organs shown in the diagram work together to allow an elephant to take in oxygen?
2. **Sequence** Several different organs are involved in the digestion of food. Place the following organs in the correct order, starting when food enters the mouth: esophagus, large intestine, small intestine, stomach, teeth.
3. **Analyze** Select an organ, and explain why the elephant could not survive without it.

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

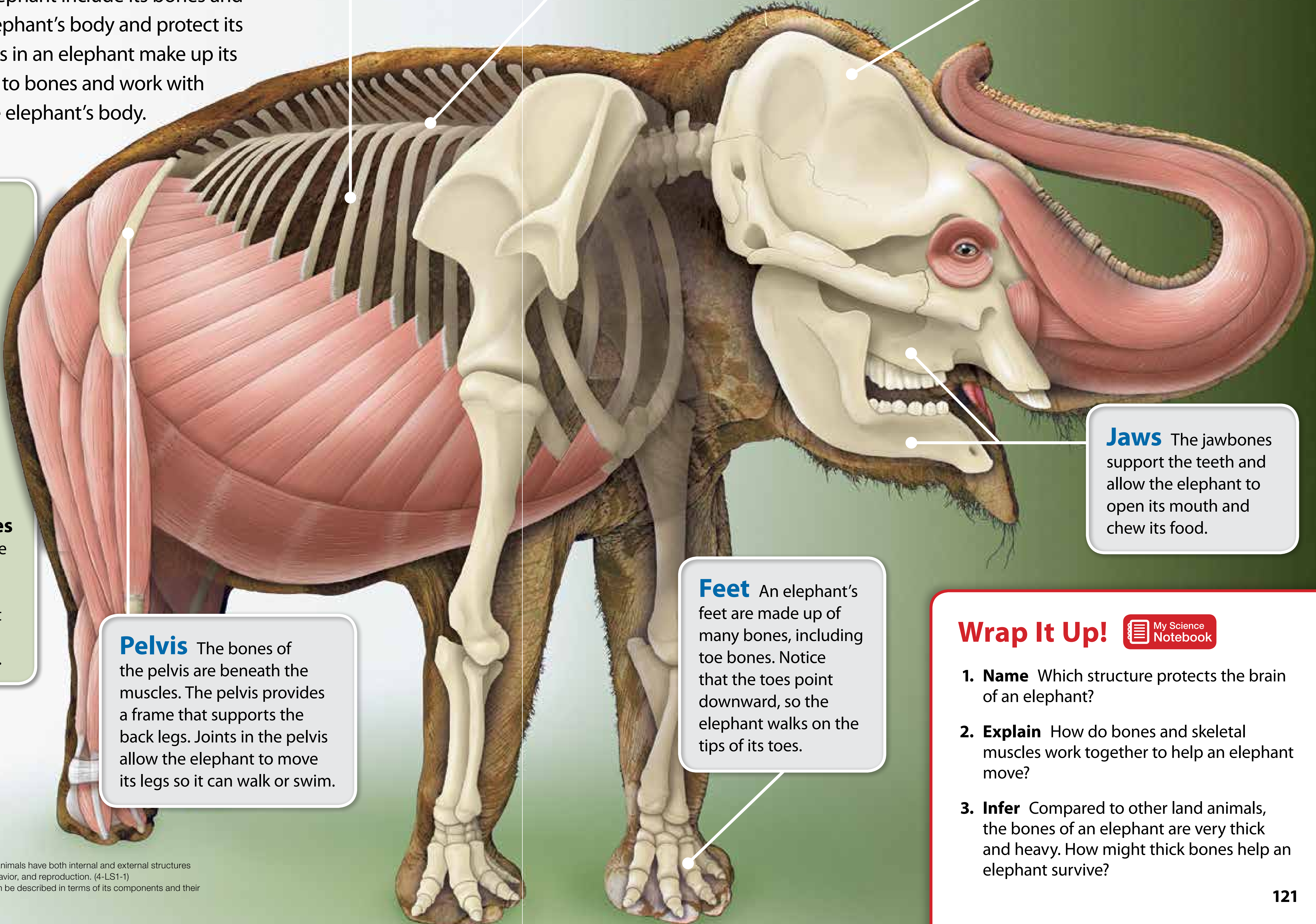
Bones and Muscles of an Elephant

The internal structures of an elephant include its bones and muscles. Bones support the elephant's body and protect its internal organs. All of the bones in an elephant make up its skeleton. Muscles are attached to bones and work with the bones to move parts of the elephant's body.



Structure of a bone
The outside of a long leg bone is hard and compact. The inside of the bone is spongy. Blood vessels in the spongy part of the bone bring nutrients and oxygen to the bone.

Skeletal muscles
Skeletal muscles are attached to bones. When a skeletal muscle contracts, it pulls on the bone and makes it move.



Ribs The ribs protect the heart and lungs.

Backbone The backbone supports the elephant's body and protects the nerve cord. The backbone can bend because it is made up of separate bones called vertebrae. The flexible backbone lets the elephant move in many different ways.

Skull The bones of the skull protect the elephant's brain.

Jaws The jawbones support the teeth and allow the elephant to open its mouth and chew its food.

Pelvis The bones of the pelvis are beneath the muscles. The pelvis provides a frame that supports the back legs. Joints in the pelvis allow the elephant to move its legs so it can walk or swim.

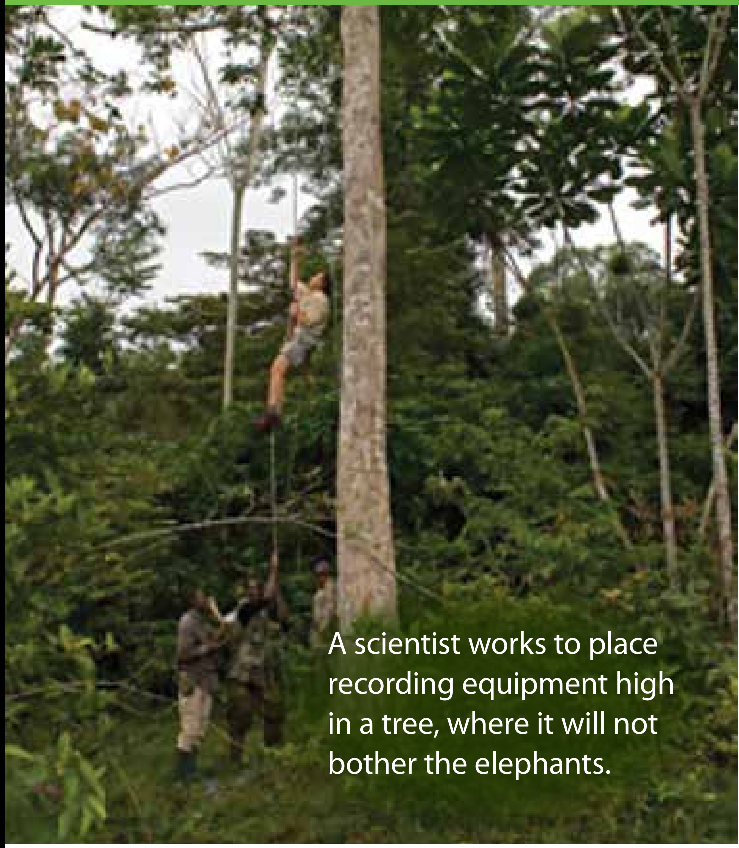
Feet An elephant's feet are made up of many bones, including toe bones. Notice that the toes point downward, so the elephant walks on the tips of its toes.

Wrap It Up! My Science Notebook

1. **Name** Which structure protects the brain of an elephant?
2. **Explain** How do bones and skeletal muscles work together to help an elephant move?
3. **Infer** Compared to other land animals, the bones of an elephant are very thick and heavy. How might thick bones help an elephant survive?

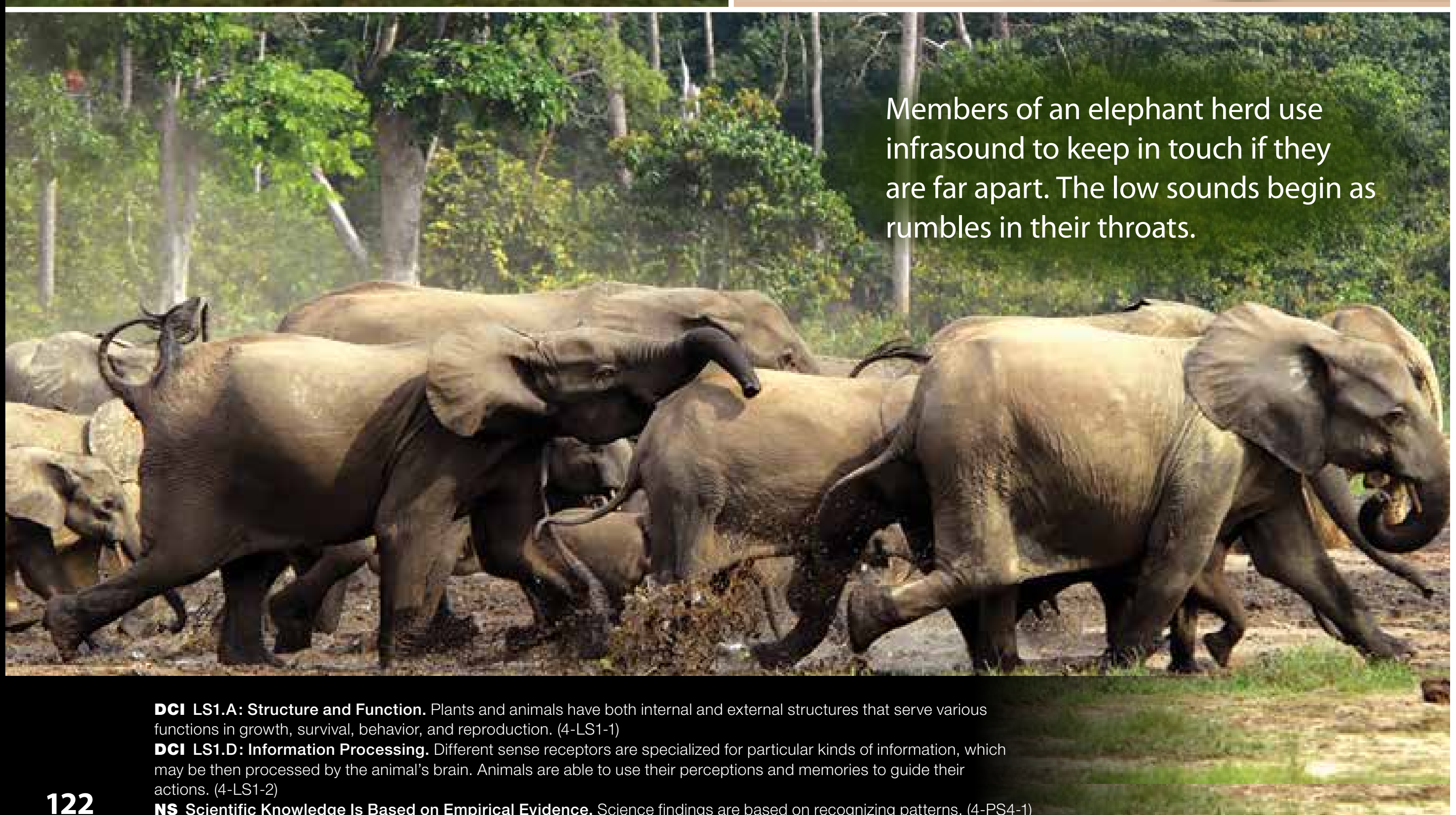
DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Listening to Elephants



A scientist works to place recording equipment high in a tree, where it will not bother the elephants.

Once this recording equipment is in place, it can record sound on its own for up to six months.



Members of an elephant herd use infrasound to keep in touch if they are far apart. The low sounds begin as rumbles in their throats.

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
DCI LS1.D: Information Processing. Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)
NS Scientific Knowledge Is Based on Empirical Evidence. Science findings are based on recognizing patterns. (4-PS4-1)

Elephants have a secret language . . .
Katy Payne is listening in.

One day in 1984, Katy Payne was at the Portland Zoo. She was near a concrete wall that separated two elephants. Katy didn't hear anything odd. But she did *feel* something odd: a rumbling in her body. She suspected it was a form of infrasound. Infrasound is sound that is too low for humans to hear, but it can be felt as vibrations. Katy wondered about the vibrations she felt. Were the elephants causing them?

Katy's life experiences uniquely prepared her to answer this question. Growing up, Katy spent lots of time outdoors. Then she studied music and biology at college. After college, she combined these two interests and became an acoustic biologist. She studied the science of sound.

Katy and her husband had already studied whale sounds. They discovered that whales sing! Whale songs contain different patterns of melodies, rhythms, and rhymes. Whales use the songs to communicate.

Katy went back to the zoo to see the elephants. This time she brought equipment that could record the low rumbling sounds. Katy was right! Elephants were using infrasound to communicate in some way.

Katy headed to Africa to study wild elephants. She began recording their rumbles as part of the Elephant Listening Project. Katy and her team have since collected thousands of hours of recordings.

Katy learned that elephants use infrasound to keep in touch when they are separated. Elephant rumbles cause sound vibrations that travel long distances through the ground. Elephants sense the vibrations with their feet. Family members can even recognize each other's rumbles!

Wrap It Up!

My Science Notebook

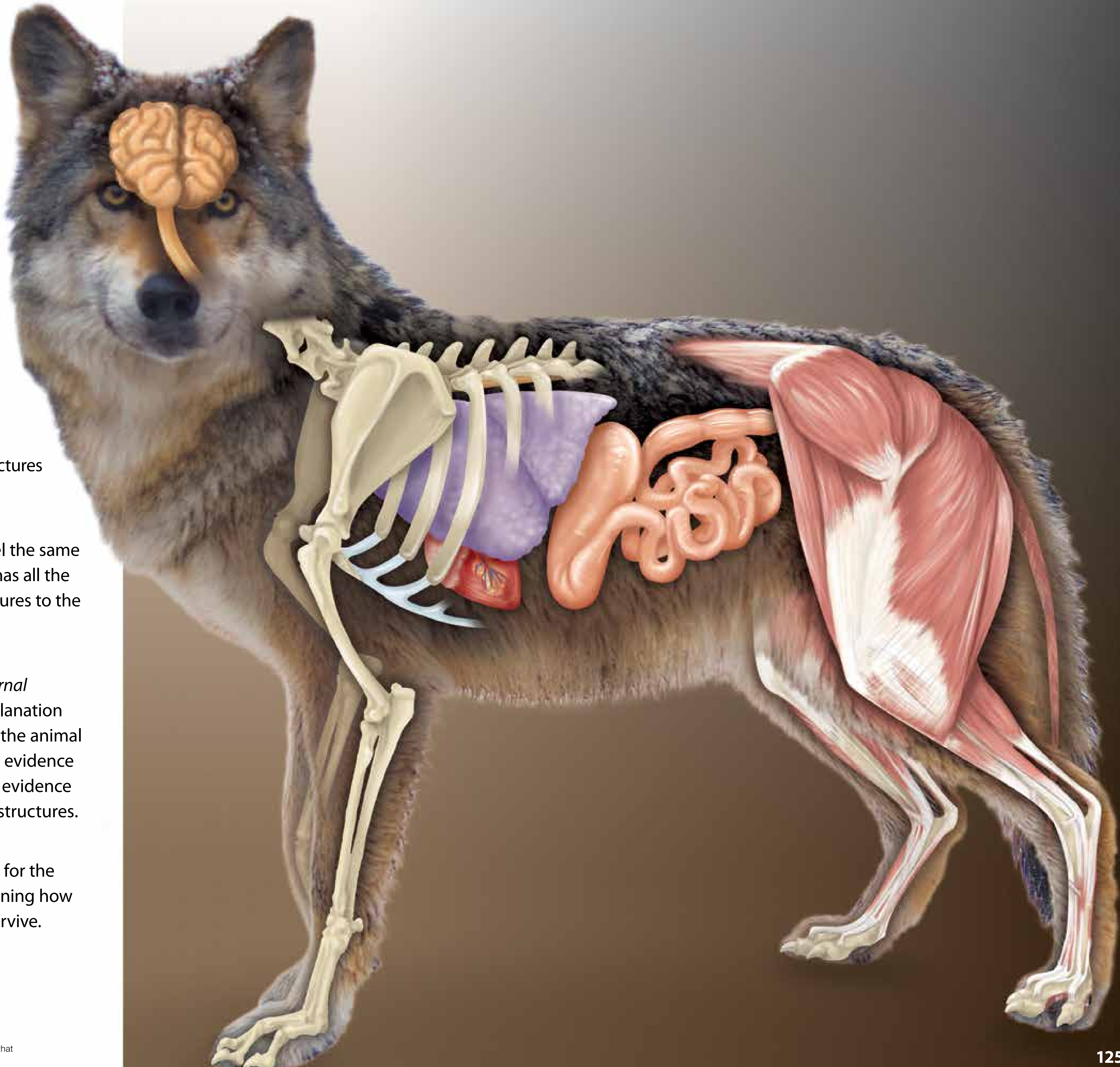
1. **Describe** How do elephants use infrasound to communicate?
2. **Explain** How do you think Katy's experience with music helps her work as an acoustic biologist?
3. **Infer** How might an elephant tell family members' rumbles apart?

Construct an Argument

A wolf and an elephant look very different. But a wolf, like an elephant, has external and internal structures that help it survive.

Use sticky notes to label the different internal and external structures of the wolf. Then follow the process below.

1. **List.** My Science Notebook
   What external structures did you label? What internal structures did you label?
2. **Compare.**
   Work with a group. Compare your labels. Did you all label the same structures? Work together until everyone in your group has all the wolf's structures labeled. Then compare the wolf's structures to the elephant's structures in the previous lessons.
3. **Construct an argument.**
   Have each person in the group choose one labeled *external structure* and one labeled *internal structure*. Write an explanation arguing how, as with an elephant, these structures help the animal grow, survive, behave in certain ways, or reproduce. Use evidence from the diagram to support your explanation. Also use evidence from the lessons on an elephant's internal and external structures.
4. **Generalize.**
   Come back together as a group. Present your arguments for the structures you labeled. Together, write a summary explaining how the structures of the wolf and the elephant help them survive.

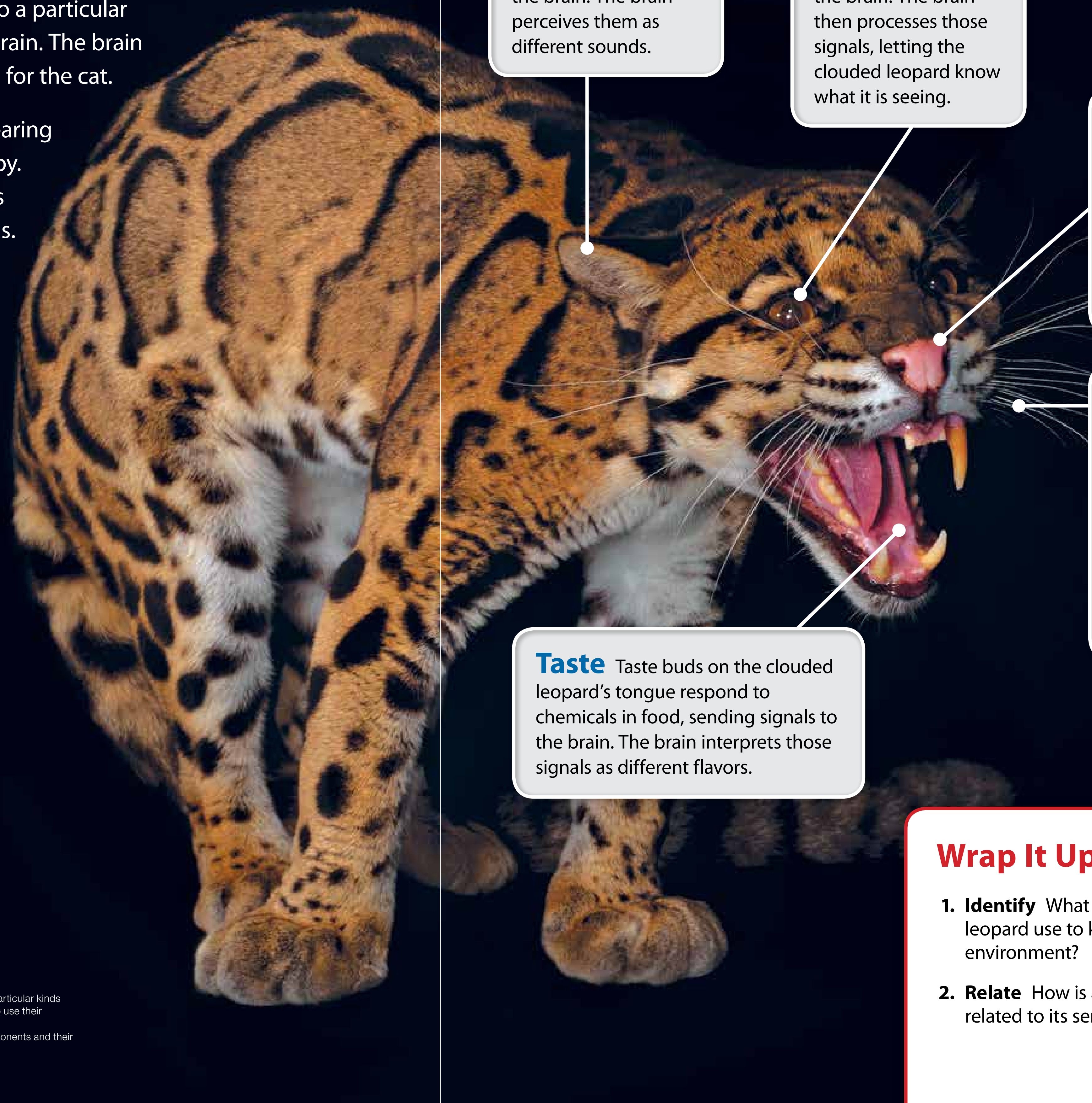


PE 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Animal Senses

The clouded leopard is a fierce cat that lives in the forests of Southeast Asia. It uses its senses to learn about its surroundings. Each sense receptor responds to a particular kind of information and sends signals to the brain. The brain processes those signals so they have meaning for the cat.

The clouded leopard uses its keen sense of hearing to learn when its predators and prey are nearby. For example, the sounds of a ground squirrel's movements travel through the air as vibrations. When those vibrations enter the cat's ears, sound receptors send signals to the cat's brain. The brain interprets those signals as the noises made by a ground squirrel. The cat uses that perception and its memories of hunting other animals to catch the ground squirrel. Read the captions to find out how the clouded leopard's other senses aid it in processing information.



Hearing Sound receptors in the ear respond to vibrations in the air, causing signals to travel to the brain. The brain perceives them as different sounds.

Sight Light receptors in the clouded leopard's eyes respond to light and send signals to the brain. The brain then processes those signals, letting the clouded leopard know what it is seeing.

Smell Smell receptors in the cat's nose are sensitive to chemicals in the air. Those receptors send signals to the brain, which interprets them as different odors.

Touch When the clouded leopard's whiskers brush against an object, touch receptors send signals to its brain, which processes them. This lets the cat know that its whiskers are touching something.

Taste Taste buds on the clouded leopard's tongue respond to chemicals in food, sending signals to the brain. The brain interprets those signals as different flavors.

Wrap It Up! My Science Notebook

1. **Identify** What senses does a clouded leopard use to know what is in its environment?
2. **Relate** How is a clouded leopard's brain related to its senses?

DCI LS1.D: Information Processing. Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-2)

Light and Sight

How does a clouded leopard see a ground squirrel? First, sunlight **reflects** from, or bounces off, the squirrel. The reflected light travels through the air. When the light enters the cat's eye, it hits light receptors at the back of the eyeball. Those receptors send signals to the brain. The brain processes the signals, so the clouded leopard understands that it is seeing a ground squirrel.

Trace the path of light from the sun to the leopard's eyes. The leopard's brain interprets signals from its eyes. Then the cat can pounce on its prey.

Clouded leopards have good eyesight. Their forward-facing eyes allow them to judge distances as they climb trees and hunt prey.

Wrap It Up! My Science Notebook

1. **Define** What does the word *reflect* mean?
2. **Explain** How does light from the sun allow an animal to see?
3. **Infer** Clouded leopards often hunt at night. How do you think they are able to see objects at night?

DCI PS4.B: Electromagnetic Radiation. An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)
DCI LS1.D: Information Processing. Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)

Investigate

How We See

How can you model the idea that light allows objects to be seen?

Most objects do not give off their own light. You can only see such objects when light from another source bounces off of them and enters your eyes. Buildings are full of lamps and other light sources that enable us to see objects in spaces that sunlight does not reach. In this activity, you will explore how you see objects using a light source.

Materials

flashlight	classroom objects	shoebox
		

My Science Notebook

1 Your teacher will give your group a shoebox with an object inside it. Then your teacher will turn out the lights in the room.

2 Open the shoebox. Shine a flashlight on the object in the box. Look at the object in the box. Then turn on the lights in the room.

3 Draw a model that shows how light reflecting from the object and entering your eye allows you to see the object. Write captions that explain how light allows the object to be seen.

4 Explain how you could revise your model so that you do not need to open the lid of the box to view the objects.

Explore on Your Own

How could you use a flashlight and a mirror to reflect light in order to view an object in the dark? Plan and carry out your own investigation. Record your observations. Compare the results of your investigations.

Wrap It Up!

My Science Notebook

1. **Explain** Use information from your model to explain how light from the flashlight reached your eye.
2. **Apply** Is it possible to see an object when there is no light? Why or why not? What about when you close your eyes?

PE 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

Use a Model

A beach mouse uses its senses to survive in the grassy sand dunes of Florida. It digs burrows into the sand. It uses the burrows to keep safe, raise young, and store seeds for food. The mice look for food mainly at night. The eastern diamondback rattlesnake preys on beach mice and other small animals. Imagine that this mouse has just come out of its burrow. It is late at night, and it is very dark. Suddenly, an eastern diamondback rattlesnake notices the mouse!

1. **Make a model.** My Science Notebook
   Design a model that shows how the mouse and the snake might receive information through several of their senses as they search for food. Include how the mouse and snake might process and respond to the information. Think about how some information might be stored as memories.

2. **Discuss your model.**
   Work with a partner. Use your models to talk about how the mouse and snake might receive, process, and react to information.

3. **Revise your model.**
   Do research to find out how the mouse and snake gather information from the environment. Then revise your model to show what information the mouse and the snake receive and process.

4. **Share your model.**
   Meet with another pair of students. Discuss how the models you made are the same and different. Take turns using your model to explain how the snake and the mouse shown in this scene would respond based on information from their senses.

The beach mouse spends little time outside its burrow during daylight hours.

The eastern diamondback rattlesnake preys on rats, mice, squirrels, and birds.

PE 4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

STEM RESEARCH PROJECT

SCIENCE
TECHNOLOGY
ENGINEERING
MATH

Animal Super Senses

Scientists have discovered that some animals have "super senses." These animals are especially good at seeing, smelling, hearing, touching, or tasting.

A chameleon is one animal with a super sense of sight. Its eyes can move and focus in different directions at the same time. In this way, it is able to see in nearly every direction at once. When a chameleon spots prey, it can respond by shooting out its long, sticky tongue to catch it. When a chameleon spots danger, it can quickly run to escape.

Now it is your turn to explore super senses. Work with a partner to identify two animals that have special ways of sensing the world around them. Research and write about how each animal uses its super sense to receive, process, and respond to information.

The Challenge

Your challenge is to identify and research two animals that have super senses. You will make a booklet, poster, or computer slide presentation and share it with your class.

A chameleon's eyes are located on opposite sides of its head. How might this help it get a better view?

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
DCI LS1.D: Information Processing. Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)
SEP Obtaining, Evaluating, and Communicating Information. Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)

STEM

RESEARCH PROJECT
(continued)

Gotcha! This chameleon's amazing eyes have helped it find an insect. It is responding by shooting out its long, sticky tongue to snap it up.

1 Select a topic. My Science Notebook

Work with your partner to brainstorm a list of animals you might research more about. Include any interesting animals you have learned about from books, TV, movies, or websites. Maybe you have even seen an animal use one of its senses in an unusual way.

Write down any ideas that come to you in your science notebook. If you have trouble coming up with animals to research, ask your teacher for ideas.

Choose two animals that you would like to research. Have your teacher approve them. What are some questions you want to research about these animals and their senses? Record your questions in your science notebook. Identify key words in your questions. You can use the key words to help guide your research.

2 Plan and conduct research.

Make a plan with your partner to do research using online and printed sources. Try to answer your questions from Step 1. Your research should also focus on these questions:

- What "super sense" does the animal use, and what structures are involved?
- How does the animal use its sense to receive, process, and respond to information? Does it respond right away or store memories?
- How does this animal's sensing ability compare to that of other animals, including humans?
- What is one more interesting fact about the animal?

Be sure to choose sources that have accurate information. Find at least two sources to support each fact. Record the information you find, including the source. Use outlining or graphic organizers to organize your notes.

3 Draft and finalize your report.

Your report will be in the form of a booklet, poster, or computer slide presentation. In your report, you should summarize the main ideas and the most important details of your research. The information you present should be in your own words.

Look back at your questions in Steps 1 and 2 to be sure you are including all the information you need. Organize the information in a way that is easy to follow. For example, you might divide the information into sections. Each section could explain one of the answers you found in your research. Include at least one picture of each animal, too.

Review and rewrite the draft of your report to make it the best it can be. Do more research to add information as needed. Make the final draft of your booklet, poster, or slide presentation.

4 Present your report.

You will present your report to the class. Work with your partner to decide who will give each part of the presentation. Decide how you will display pictures or other visual information.

Practice giving your part of the report aloud. Your oral presentation should express main ideas that are supported by important details. Ask your partner to give you feedback to help you improve your presentation.

With your partner, present your report to the class. Put information in a logical order. Use descriptions, facts, and details to describe the animals and their unique senses. Remember to give an additional interesting fact about each animal. Speak loudly and slowly. Answer any questions your classmates may have.

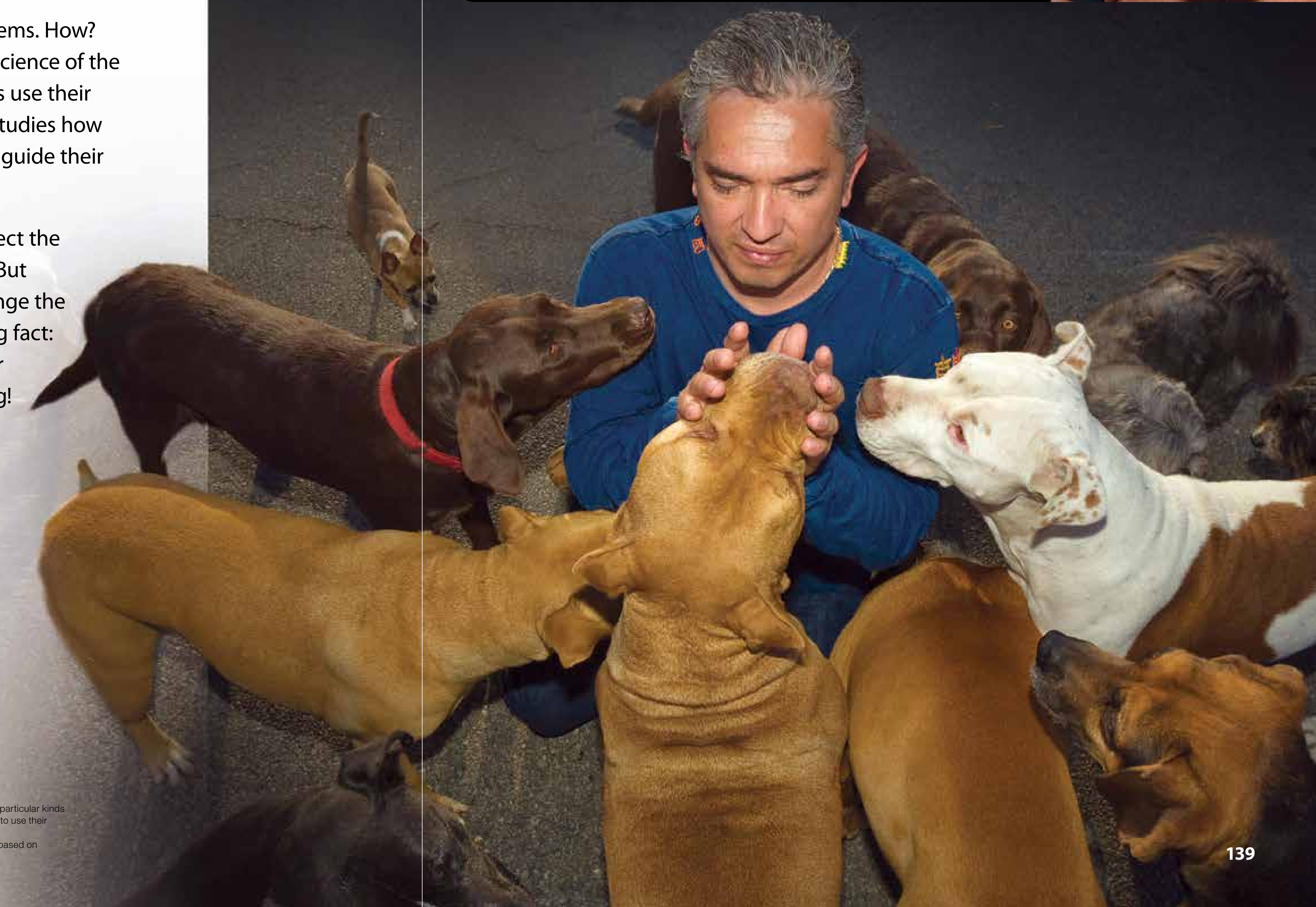
Listen as your classmates present their reports. How many different animal super senses did your classmates identify and report on?

Dog Whisperer

What can you do if your dog won't behave? Maybe it barks all the time or chews up shoes. Maybe it fights with other dogs or jumps up on strangers.

Cesar Millan knows how to fix all these problems. How? By using dog psychology. Psychology is the science of the mind and behavior. Cesar observes how dogs use their senses to respond to their environment. He studies how these responses are stored as memories that guide their behavior.

Cesar uses his understanding of dogs to correct the behavior of pet dogs that are out of control. But mostly, Cesar shows dog owners how to change the way they treat their pets. Here's the surprising fact: When owners correct the way they treat their pets, their pets almost always stop misbehaving!



Cesar is called the "dog whisperer" because he has a special talent for interacting with dogs in ways that improve their behavior.

Cesar Millan is a dog trainer, author, and star of the National Geographic Channel program "The Dog Whisperer." Originally from Mexico, Cesar now lives in the United States. Cesar founded and runs the Dog Psychology Center in Los Angeles, where he rehabilitates dogs with severe behavior problems. Cesar has won many awards, including one from the Humane Society for his work with dogs from shelters.

DCI LS1.D: Information Processing. Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2).
NS Scientific Knowledge Is Based on Empirical Evidence. Science findings are based on recognizing patterns. (4-PS4-1)

NGL Science How do you rehabilitate dogs?

Cesar Millan I don't train dogs to respond to commands such as "sit" or "stay." Instead I try to connect with the dog's mind and how it naturally responds to its environment to help correct unwanted behaviors.

NGL Science How did you learn about dogs?

Cesar Millan As a child, I spent a lot of time on my grandfather's farm in Mexico. The working dogs on the farm were my true teachers in the art and science of dog psychology. I loved to watch dogs play with one another. The more hours I spent watching them, the more questions came into my mind. How did they coordinate their activities? How did they communicate with one another?

NGL Science How did you develop your methods of training dogs?

Cesar Millan My way of training came directly from my observations of dogs on my grandfather's farm. I interact with the dogs the way they interact with one another.

NGL Science Do you also work with the dog owners?

Cesar Millan The dog owner often thinks that the problem lies with the dog. But the problem is usually with the way the owner treats his dog. I often say, "I rehabilitate dogs, but I train people." My formula is simple: For a balanced, healthy dog, a human must share exercise, discipline, and affection, in that order!

Cesar plays with this dog as if he were a dog himself.

Check In My Science Notebook

Congratulations! You have completed *Life Science*. Let's reflect on what you have learned. Here is a checklist to help you judge your progress. Look through your science notebook to find examples for each statement in the checklist. What could you do better? Write it on a separate page in your science notebook.

Read each item in this list. Ask yourself if you think you did a good job of it.

For each item, select the choice that is true for you: A. Yes **B.** Not Yet

- I defined and illustrated science vocabulary, science concepts, and main ideas.
- I labeled drawings. I included captions and notes to explain ideas.
- I collected objects, such as photos and magazine or newspaper clippings.
- I used tables, charts, or graphs to record observations and data in investigations.
- I recorded evidence for explanations and conclusions in investigations.
- I described how scientists and engineers answer questions and solve problems.
- I asked new questions.
- I did something else. (Tell about it.)

Reflect on Your Learning My Science Notebook

1. Choose one science idea that you think was most important to learn about. Explain your thinking.

2. What is one way your understanding of a science idea changed? Describe how your thinking has changed.

This artificial limb is custom designed for a single person to wear. David studied a model of the person's own body to be sure the limb would fit perfectly.

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GRADE 4 | TEACHER'S EDITION

Life Science Unit (excerpt)

Unit 3 Planning Guide

Structure, Function, and Information Processing

Building on Prior Learning

This unit builds upon what students learned in Grade 1 about animal senses and about how plants and animals make use of external structures to meet their needs. In Grade 3, students also learned how the environment influences the structure and function of an organism's traits. Students now deepen and extend that knowledge as they learn about systems and system models and develop their own models to describe the function of animal senses. Students also develop models to describe how internal and external structures interact within plant systems and animal systems.

- Use the Unit Pre-Assessment along with the Unit Opening Activity (Assessment Handbook, pp. 27–29) to determine students' level of familiarity with plant and animal systems and to assess their readiness for applying the SEPs Developing and Using Models and Engaging in Argument from Evidence.

Selecting an Anchoring Phenomenon

You may wish to have the class or groups of students select an animal of interest to serve as the anchoring phenomenon for the unit. Students can then apply what they learn about systems and system interactions to their animal.

Advance Planning

The investigations and engineering activities in this unit all use inexpensive and readily available materials. You may wish to gather appropriate books to aid student research about animal senses for the STEM Research Project.

Assessment Resources

The following assessment tools are available for this unit.

Self-Assessment

Students can use their science notebooks along with the rubrics in the *Science Notebook Companion* for reflection and self-assessment throughout the unit.

Formative Assessment

- Unit Pre-Assessment (Assessment Handbook, pp. 27–28)
- Checkpoint Quizzes (Assessment Handbook, pp. 30–31)
- Rubrics for all Investigates, STEM Projects, and Think Like a Scientist lessons (Assessment Handbook, pp. 67–72)
- MindTap Virtual Lab: Mealworm Behavior. This self-contained learning module includes multiple-choice and open-ended assessment questions.

Summative Assessment

- Unit Test (Assessment Handbook, pp. 32–35)
- Unit Performance Assessment Task (Assessment Handbook, pp. 36–37)

3-D Instructional Progression

This unit prepares students to demonstrate proficiency on this bundle of Performance Expectations: 4-LS1-1, 4-LS1-2, 4-PS4-2. The following two Lesson Sequence charts provide a roadmap to instruction in this unit.

Lesson Sequence 1	**Student Edition, pp. 108–125**		**Pacing: 16 days**
PERFORMANCE EXPECTATION **4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.			
Science and Engineering Practices Engaging in Argument from Evidence	**Disciplinary Core Ideas** **LS1.A Structure and Function.** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.		**Crosscutting Concepts** Systems and System Models
OVERVIEW In the lessons in this sequence, students build on their knowledge of the external structures of plants and animals and also explore internal structures, using a wild rose and an elephant as representative organisms. In the Think Like a Scientist activities, they apply what they have learned to construct arguments about how internal and external structures support survival in other plants and animals. Stories in Science enhances students' learning with the story of how acoustic biologist Katy Payne studied elephants' use of infrasound to communicate with one another.			
	Student Pages	**Teacher Pages**	**MindTap Digital Resources**
External Structures of a Wild Rose	110–111	111a–111b	Video Clip: Time Lapse of Wild Rose Blooming
Internal Structures of a Wild Rose	112–113	113a–113d	Animation: Structure of a Flower Life Science Gallery
Think Like a Scientist: Construct an Argument	114–115	115a–115d	
External Structures of an Elephant	116–117	117a–117d	Video Clip: Elephant Using Trunk to Gather Food Life Science Gallery
Internal Organs of an Elephant	118–119	119a–119b	
Bones and Muscles of an Elephant	120–121	121a–121b	
Stories in Science	122–123	123a–123b	
Think Like a Scientist: Construct an Argument	124–125	125a–125d	

(continued)

Unit 3 Planning Guide (continued)

Lesson Sequence 2	Student Edition, pp. 126–141	Pacing: 12 days

PERFORMANCE EXPECTATIONS

4-LS1-2 Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

4-PS4-2 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models	**LS1.D Information Processing.** Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. **PS4.B Electromagnetic Radiation.** An object can be seen when light reflected from its surface enters the eyes.	Systems and System Models Cause and Effect

OVERVIEW

In the lessons in this sequence, students explore animal senses. They learn about the role light plays in making vision possible. In the Investigate, students do a simple hands–on activity and then make a model that describes how light reflecting from objects makes it possible for objects to be seen. In Think Like a Scientist, students apply what they have learned about animal senses and information processing to develop a model that explains the responses of two animals to cues from their environment. The STEM Research Project gives students the opportunity to research and report on the specialized senses used by two animals of their choice. Finally, in Science Career, students meet National Geographic 's Cesar Millan, who rehabilitates dogs with severe behavior problems at the Dog Psychology Center in Los Angeles.

	Student Pages	Teacher Pages	MindTap Digital Resources
Animal Senses	126–127	127a–127d	Virtual Lab: Mealworm Behavior Explorer Video: Shivani Bhalla on Information Processing Life Science Gallery
Light and Sight	128–129	129a–129b	
Investigate: How We See	130–131	131a–131d	
Think Like a Scientist: Use a Model	132–133	133a–133d	
STEM: Research Project	134–137	137a–137d	
Science Career	138–141	141a–141d	Explorer Video: Cesar Millan on Tips for Dog Owners

Notes

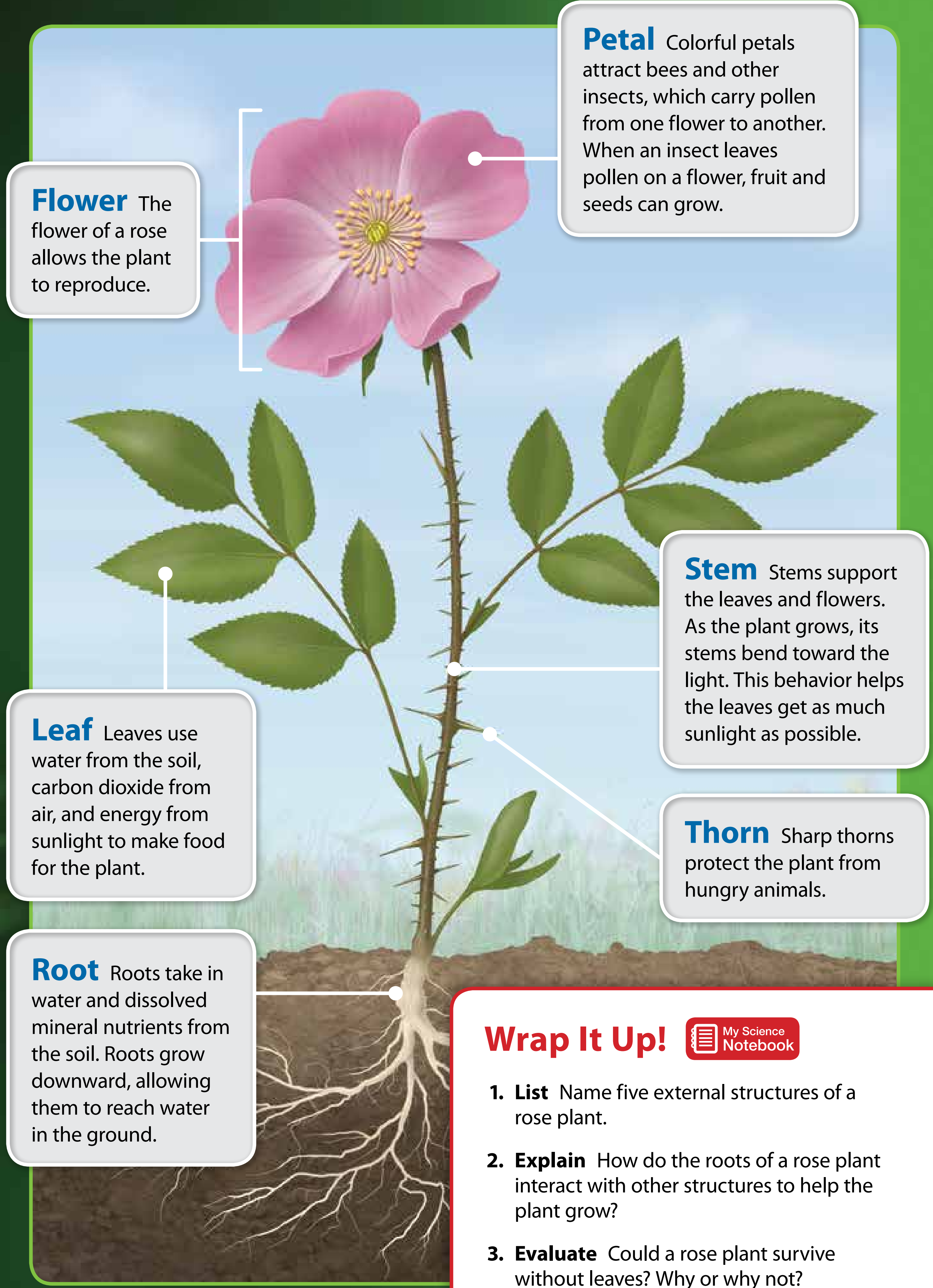
External Structures of a Wild Rose

Have you ever seen a wild rose plant like the one in the photo? The rose is a type of plant that produces flowers. Its flowers are beautiful, but they are also important to the plant. Like all plants, the wild rose is made up of different kinds of structures. Its external structures are the parts that you can see on the outside of the plant. They include leaves, stems, roots, and flowers.

Leaves, stems, and roots have important functions in the growth and survival of the plant. The wild rose plant also has structures that allow it to reproduce—its flowers. Flowers produce seeds, which can grow into new plants.

Both the color and scent of the wild rose plant's flowers attract insects.

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)



Wrap It Up!

My Science Notebook

1. **List** Name five external structures of a rose plant.
2. **Explain** How do the roots of a rose plant interact with other structures to help the plant grow?
3. **Evaluate** Could a rose plant survive without leaves? Why or why not?

External Structures of a Wild Rose

NEXT GENERATION SCIENCE STANDARDS

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Objectives **Students will be able to:**

- Identify the external structures of a wild rose.
- Describe the functions served by the external structures of a wild rose.
- Explain how the external structures of a wild rose interact to help the plant survive, grow, or reproduce.

ENGAGE

Introduce the Phenomenon

Teacher-Led Demo Obtain six cut white roses that still have leaves attached to their stems. You will use them in this lesson and the one that follows. Display the roses for students, and ask: **What do you call these?** *(Possible answers: roses, flowers)* Next ask: **What parts can you name?** *(Possible answers: flower, stem, leaves)*

Remind students these stems were cut from a complete plant, a rose bush. Ask: **Could a rose bush survive without any of the parts you see here? Explain.** *(Some students may think all of these parts are needed for the bush to survive. Others may say a rose bush could survive without its flowers.)*

Tap Prior Knowledge

Think-Pair-Share Ask: **What are some other flowering plants you know? How are they like a rose and different?** Have students share their thoughts with partners. *(Students may mention daisies, carnations, and sunflowers. They may note that flowering plants have similar parts but the parts may look different, or note differences in where plants may grow.)* Allow pairs to share their ideas with the class.

EXPLORE

Think About External Structures of a Wild Rose

Read aloud the lesson title. Have students observe the photograph. If students are using the Interactive E-book, they can watch the time-lapse video of a wild rose blooming. Ask: **How does a wild rose plant's flower compare to the rose flowers I showed you?** *(Possible answers: The color and shape of its flower are different. Its flower also has a scent.)*

Explain that the word *external* refers to the outside of something. The word *structure* describes a part that makes up something larger. Point to your nose. Say: **My nose is an external structure. It is part of my face.** Ask: **Where are the external structures of a wild rose located?** *(on the outside of the rose)*

Have a volunteer read the blue headings. Explain that these structures have important functions. Tell students *function* refers to what something does, how it works, or how it is used. Say: **One function of my nose is to breathe.** Read aloud the photo caption. Ask: **What is the function of the color and scent of the wild rose's flower?** *(to attract insects)*

Four-Square Diagram Have students make a full-page four-square diagram in their science notebook. In the top left square, have students write the title of the lesson, "External Structures of a Wild Rose." In the top right square, have students write a few sentences stating what they think they will learn in the lesson. Have students write in the lower left square what they learned after reading.

Set a Purpose and Read

Focus Question Use this question to focus students and guide their reading: *What are the functions of a rose plant's external structures?* Have students read the lesson.

EXPLAIN

Identify External Structures of a Wild Rose

After students have read the lesson, ask:

- **What are the external structures of a wild rose?** *(flowers, petals, leaves, roots, stems, thorns)*
- **Which structures grow underground?** *(roots)*
- **Which structure is part of a flower?** *(petal)*

Describe the Functions of External Structures of a Wild Rose

Partner Talk Have students think about these questions, then discuss them with a partner:

- **What is a flower's function?** *(Flowers allow plants to reproduce.)*
- **What is the petals' function?** *(to attract bees or other insects)* **How is this function important to the plant?** *(Insects carry pollen from flower to flower so that fruit and seeds can grow.)*
- **Which structure protects the plant?** *(sharp thorns)* **Why is this function important?** *(Sharp thorns help keep hungry animals from eating the plant.)*
- **How does a stem help a plant get as much sunlight as possible?** *(The stem bends toward the sun so that the leaves can get more light.)* **What is another function of the stem?** *(It supports the leaves and flowers.)*
- **How do roots help a rose plant survive?** *(by taking in water and nutrients from the soil)*
- **What is the function of leaves?** *(to make food for the plant)* **What do they use to make food?** *(water, carbon dioxide, and energy from sunlight)*

Have students write their answers to the Focus Question in their science notebooks.

ELABORATE

Graphic Organizer Explain to students that a concept web can help them organize their thinking.

DIFFERENTIATED INSTRUCTION

Extra Support

Below-Level Learners If needed, restate the questions in EXPLAIN about functions of structures as *yes/no* and *or* questions:

- **Does a flower help a plant make food?** *(No.)*
- **Do petals attract insects or carry pollen?** *(attract insects)*
- **Do thorns protect a plant?** *(Yes.)*
- **Do petals or stems help a plant get as much sunlight as possible?** *(stems)*
- **Do roots take in water and nutrients for a plant?** *(Yes.)*

Have them start three concept webs, one with "Food/Water" in the center circle, one with "Protection" in the center circle, and one with "Reproduction" in the center circle. Have small groups work to add connecting circles for any external structure that has a function related to the concept web topic. Students should name the structure and add supporting details from the text. Discuss students' completed concept webs as a class. *(Students should list leaf, roots, and stem in the "Food/Water" concept web; flower and petal in the "Reproduction" concept web; and thorns in the "Protection" concept web.)*

Investigate Further

If possible, lead students on a walk around your school campus to look for flowering plants. Be sure to point out trees or grasses that might be in flower. Encourage students to compare the plants' structures. As an alternative, provide a few potted flowering plants for students to observe.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. **LIST Name five external structures of a rose plant.** *(flower, leaf, root, stem, thorn, petals)*
2. **EXPLAIN How do the roots of a rose interact with other structures to help the plant grow?** *(The roots take in water that leaves use to make food. They take in nutrients that other parts of the plant need to grow.)*
   CCC Systems and System Models
3. **EVALUATE Could a rose plant survive without leaves? Why or why not?** *(No. Roses need leaves to make food.)*

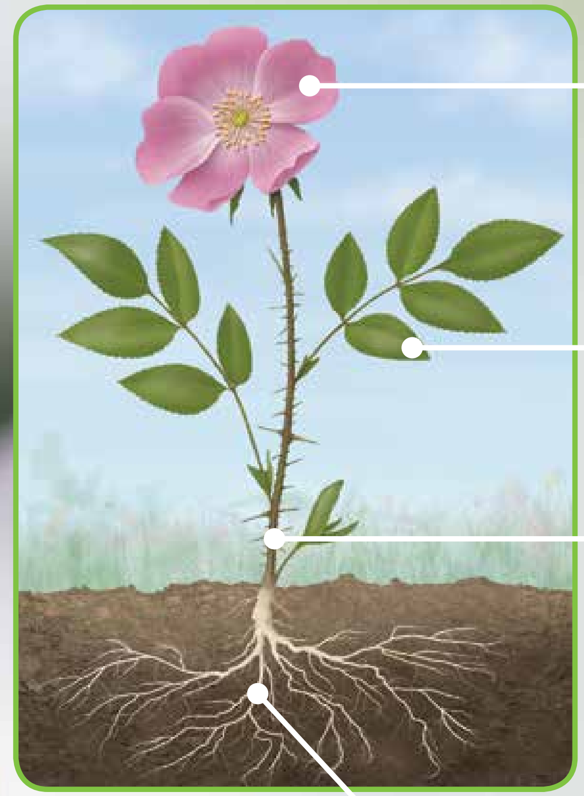
DIGITAL WRAP-UP Have students complete the interactive bonus assessment in the Interactive E-book.

Four-Square Diagram Have students return to their four-square diagrams and revise or elaborate on what they learned. In the lower right square, have students draw a simple picture that will help them remember the lesson's main ideas.

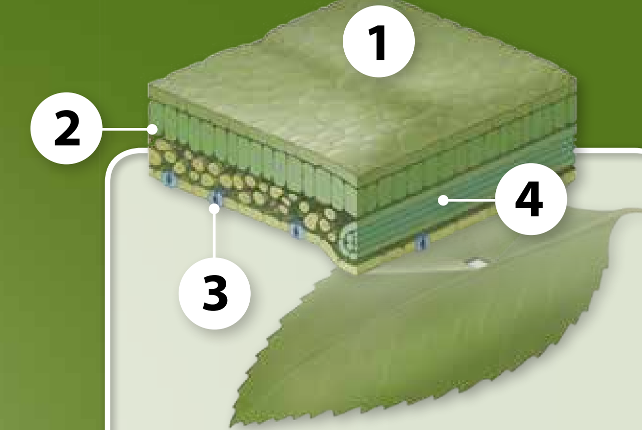
Internal Structures of a Wild Rose

Plants have internal structures that help them grow, survive, and reproduce. These structures exist inside the plant. Many of these structures are hard to see without a magnifying glass or microscope.

The many stamens of this wild rose flower surround the pistil in the center.



Flower In the center of the flower are the stamens and pistil. **Stamens** make pollen. For fruit to develop, pollen must be transferred to the pistil. Then the **pistil** develops into a fruit with seeds inside. Each seed can grow into a new plant.

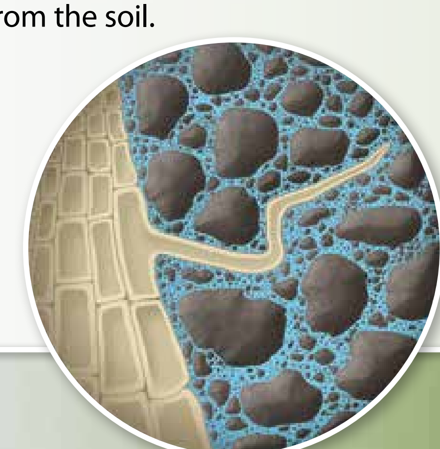


Leaf Leaves use water from the soil, carbon dioxide from the air, and energy from sunlight to make food for the plant. Leaves are made up of several parts.

1. The outer layer protects the leaf and keeps it from drying out.
2. In the middle is the food-making layer.
3. Openings in the bottom of the leaf let air into the food-making layer.
4. Veins are made up of tiny tubes. Some tubes carry water to the leaf. Other tubes carry food from the leaves to the rest of the plant.

Stem Inside each stem are bundles of tiny tubes. Some tubes carry water from the roots up to the leaves and flowers. Other tubes carry food from the leaves to the rest of the plant.

Roots Tiny hairs on the roots take in water and mineral nutrients from the soil.



Wrap It Up! My Science Notebook

1. **Identify** What are the structures of a leaf? What are their functions?
2. **Cause and Effect** How do the stamens of a flower help a plant reproduce?
3. **Analyze** How is a plant's stem important to the function of the plant's other parts?

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Internal Structures of a Wild Rose

NEXT GENERATION SCIENCE STANDARDS

DCI **LS1.A: Structure and Function.** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

CCC **Systems and System Models.** A system can be described in terms of its components and their interactions. (4-LS1-1)

Objectives Students will be able to:

- Identify the internal structures of a wild rose.
- Describe the functions served by the internal structures of a wild rose.
- Explain how the internal structures of a wild rose interact with each other, and with external structures, to help the plant survive, grow, or reproduce.

Science Vocabulary

pistil, stamens

ENGAGE

Introduce the Phenomenon

Teacher-Led Demo At least 24 hours before teaching this lesson, fill four cups halfway with water. Add food coloring to each cup, using a different color for each one. Place a white rose in each cup. On the day of the lesson, show the cups to students. Ask:

- **What do you notice about each flower?** *(The petals of each flower match the color of the water.)*
- **What caused this change?** *(Students may say colored water somehow soaked into each flower.)*

Tap Prior Knowledge

Have students recall what they learned about plant structures in the previous lesson. Ask:

- **What parts of a wild rose plant connect to the stem?** *(roots, leaves, flowers)*
- **Which structures take in water for a plant?** *(roots)*

Turn and Talk Ask: **How can water from roots reach other parts of the plant?** Have students think about the functions of external structures they have learned about as well as what they observed in ENGAGE. Then have them discuss their ideas in pairs. *(Possible answer: Water must travel through the stem. That is how colored water reached the rose petals.)* Have pairs share their ideas with the class.

EXPLORE

Think About Internal Structures of a Wild Rose

Have students read the lesson title and study the photo and illustrations. Ask probing questions to encourage exploration, such as: **How do the pictures and words on these pages compare to those in the lesson External Structures of a Wild Rose?** *(Possible answers: The photo shows a closer view of the center of a wild rose. The same diagram is shown in this lesson. The labels flower, stem, roots, and leaves are also listed in this lesson.)*

Explain that the word *internal* refers to the inside of something. Say: **Your heart is an internal structure. It is located on the inside of your body. It has a specific function that helps you survive.** Ask: **Where are the internal structures of a wild rose located?** *(They are on the inside of the rose.)*

Read aloud the definitions for *pistil* and *stamens.* Have a volunteer recall the meaning of the word *function. (the way something works or how it is used)* Ask: **What is the function of the pistil and the stamen?** *(They make reproduction possible.)*

Next ask: **Why is it important for plants to reproduce?** *(to make more copies of themselves that grow into new plants)*

Have a volunteer read the first paragraph aloud. Ask: **What is true about the size of most of the wild rose's internal structures?** *(Possible answer: The structures are very tiny because they are hard to see without a magnifying glass or microscope.)*

Four-Square Diagram Have students make a full-page four-square diagram in their science notebook. In the top left square, have students write the title of the lesson, "Internal Structures of a Wild Rose." In the top right square, have students write a few sentences stating what they think they will learn in the lesson. Have students write in the lower left square what they learned after reading.

Set a Purpose and Read

Focus Question Use this question to focus students and guide their reading: *What internal structures can be found inside flowers, leaves, stems, and roots?* Have students read the lesson.

DIFFERENTIATED INSTRUCTION

Extra Support

Students with Disabilities Be sure all students can participate in the lesson activities. Additional accommodations may be needed. For example, students who may have difficulty with drawing activities could perform the oral component of the activity with partners who complete the drawing component. The printed component of the assignment can be copied, so that each student will have a completed assignment for later study.

LITERACY CONNECTION

Interpret Information in a Diagram

RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

As you move through the EXPLAIN section, guide students in using and understanding the diagram. Say: **The structures in these diagrams are shown larger than actual size.** Ask: **Why is this helpful?** *(It shows details that might not be visible if structures were shown at actual size.)* Next say: **Each illustration shows a cutaway view that reveals the inside of each structure. This type of view is called a cross-section.** Ask: **What is shown in the cross-section view of the stem?** *(bundles of tiny tubes)* **What about the leaf?** *(leaf layers)*

ELL Support

Starting As you read aloud the prepositional phrases in the captions for the flower, stem, and roots, have students point to the correct part of each corresponding illustration. (flower: *in the center;* stem: *inside each stem;* roots: *on the roots;* leaf: *in the middle, in the bottom)* Then read aloud the sentences that contain these prepositional phrases and have students repeat after you, pointing to the correct part of each illustration.

Developing Have students answer the following questions using details from the text:

- Where are a flower's pistil and stamens located?
- Where are a stem's bundles of tiny tubes located?
- Where are a root's tiny hairs located?

Bridging Remind students that prepositional phrases can give details about location and include words such as *in* and *on*. Have students identify the prepositional phrases in the captions for the flower, stem, and roots. Have students use each phrase in an original sentence about the structures of a wild rose.

MATH CONNECTION

Find Symmetry

4.G.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. (4-LS1-1)

Review the concept of symmetry. Say: **A shape can be said to have symmetry if you can draw a line through the middle of the shape and both sides are mirror images of each other.** Use a cut-out heart or similar shape to demonstrate. Draw a line of symmetry, and fold the shape over on itself. Have students study the illustrations in the lesson. Ask volunteers to share where they see that lines of symmetry could be drawn, such as through one of the leaves in the illustration or the diagram of the flower stem. Have students sketch their own symmetrical leaf or flower shape in their science notebooks, along with a line of symmetry.

Internal Structures of a Wild Rose (continued)

EXPLAIN

Identify Internal Structures of a Wild Rose

After students have read the lesson, lead a discussion to answer the Focus Question. Ask:

- **What do we need to be able to see most of a plant's internal structures?** *(a microscope)*
- **What are the internal structures of a wild rose plant's flower?** *(The pistil and stamens are internal structures of a wild rose flower.)* Say: **In some plants, pistils and stamens grow on separate flowers or on flowers of separate plants.**
- **What are the internal structures of a leaf?** *(outer layer, middle, openings in the bottom, veins)*
- **What is inside a stem?** *(bundles of tiny tubes)*
- **What structures help roots absorb water and nutrients?** *(root hairs)*

Clarify for students that while the pistil and stamens grow inside the center of the flower, they are visible to the naked eye when the flower's petals are open. Also, root hairs grow on the external part of the plant, but many are not visible to the naked eye.

Describe the Functions of the Internal Structures of a Wild Rose

Ask students the following questions:

- **What is the function of the stamens and pistil?** *(Stamens make pollen. The pistil receives pollen from stamens. It develops into a fruit with seeds.)*
- **How do the bundles of tiny tubes in a stem serve the plant?** *(They transport water and nutrients to and from different parts of the plant.)*
- **Why is each layer of a leaf important?** *(The outer layer protects the leaf. The middle layer is where food for the plant is made. Openings in the bottom layer let in air that is necessary for the food-making process. Veins transport water and food to and from the leaf.)*
- **How does the function of the internal flower structures, the stamens and pistil, relate to the function of the external structure of the flower?** *(The petals, stamens, and pistil work together to aid reproduction. The colorful petals and the scent of the flower attract insects to the flower that can carry pollen away from the stamens. When the pollen is transferred to the pistil, a fruit forms with seeds that can create more plants.)*

Teach the Dimensions

CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Say: **Science and engineering often involve the study of systems. A system is a group of parts that interact to perform a function.** Write this definition on the board. Remind students of the definition you shared for *function* in the previous lesson (what something does, how it works, or how it is used). Say: **A bicycle is an example of a system. It has parts that interact to perform functions such as making the bike start, stop, or change direction.** Ask: **What parts of a bike work together to make the bike change direction?** *(handlebars, bike frame, wheels)*

Direct students' attention to the illustration of the wild rose. Ask: **Why might a plant be considered a system?** *(It has parts that interact to help it perform different functions.)* Next ask: **What are some functions carried out by a plant's structures?** *(Possible answers: taking in water, moving water and food, making food, providing support, reproduction)*

Divide students into small groups. Provide each group with an enlarged photocopy of the wild rose plant illustration from the lesson. Have groups work together to diagram the path water would take through the plant, beginning with the roots. Tell students to label the internal and external structures involved. Invite groups to share their diagrams. Ask: **How does your drawing show that a plant is a system of parts that interacts to perform a function?** *(Possible answer: My drawing shows that internal and external structures of a plant interact to move water to where it is needed in the plant.)*

Featured Photo

Have students study the "Plant Stem" photo within the Life Science Gallery and read the caption. Help students connect the image to the core content of the lesson by having them compare it to the matching illustration in the lesson. Ask: **Which structures shown in the photo carry water and food for the plant?** *(the red-colored tubes)*

Animation

Have students select the animation "Structure of a Flower" from the Resources menu. Tell students to listen for terms they already know as they view the animation and to consider how flowers shown compare to the flower of a wild rose.

Time 10 minutes

Teaching Tips Discuss the new content introduced in the animation. Define and discuss the term *fertilization*. Then use the illustration in the diagram to discuss the terms *filament* and *anther* and their location on the stamen. Do the same for the terms *ovary, style, stigma,* and *ovules,* all parts of the pistil.

What to Expect Students will recognize that flowers have certain structures in common and will better understand how pollen is transferred between flowers to allow for fertilization.

ELABORATE

Extend Thinking About Structure and Function

Graphic Organizer Have students add information to the concept webs they began in the previous lesson. Model how to add to the concept web. Draw a main circle labeled "Food/Water" and a connecting circle labeled "Stem." Then draw a circle labeled "Bundles of Tiny Tubes" and connect it to the "Stem" circle. Ask: **Why did I connect these circles?** *(The bundles of tubes are internal structures found inside stems.)* Have students work in small groups to add connecting circles for internal structures in order to show their locations and functions in a similar way. Discuss the updated concept webs as a class. *(Students should identify internal structures of leaves, roots, and stems in the "Food/Water" concept web and the internal structures of flowers in the "Reproduction" concept web. They may add the outer leaf layer in the "Protection" concept web.)*

Investigate Further

Revisit the Phenomenon Carefully cut a vertical slice from one of the rose stems you used in ENGAGE. Students will observe that the inside of the stem has changed color. Ask: **What can you conclude from this evidence?** *(The colored water moved through the stem.)* Carefully slice the bottom portion of a white rose stem to create two ends. Ask: **What do you predict will happen if I place each end of this stem in a separate cup of water with different colors?** *(Accept all reasonable predictions.)* Carry out the experiment and match the results to students' predictions. Students will observe that the rose takes on both colors. Guide them to understand that the tubes that transport water through the stem are separate from each other.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. **IDENTIFY What are the structures of a leaf? What are their functions?** *(The outer layer protects the leaf. The middle layer is where food is made. The bottom layer lets air in. The veins carry water and food.)*
2. **CAUSE AND EFFECT How do the stamens of a flower help a plant reproduce?** *(The stamens make pollen. Pollen is transferred to a pistil which forms into a fruit with seeds inside. The seeds can grow into new plants.)*
3. **ANALYZE How is a plant's stem important to the function of the plant's other parts?** *(Stems help transfer water and nutrients from roots to different parts of the plant.)* **CCC Systems and System Models**

DIGITAL WRAP-UP Have students complete the interactive bonus assessment found in the Interactive E-book.

Four-Square Diagram Have students elaborate on what they have learned in their four-square diagram. In the lower right square, have students explain how the external and internal structures of a wild rose work together.

Construct an Argument

A buttercup plant and a wild rose look very different. But a buttercup, like a wild rose, has external and internal structures that help it survive.

Use sticky notes to label the different external and internal structures of the buttercup plant. Then follow the process below.

1. **List.** My Science Notebook
   What external structures did you label? What internal structures did you label?

2. **Compare.**
   Work with a group. Compare your labels. Work together until everyone in your group has all the buttercup plant's structures labeled. Then compare the buttercup plant's structures to the wild rose's structures in the two previous lessons.

3. **Construct an argument.**
   Have each person in the group choose one labeled *external structure* and one labeled *internal structure*. Write an explanation arguing how, as with the wild rose, these structures help the buttercup plant grow, survive, or reproduce. Use evidence from the diagram to support your argument. Also use evidence from lessons on the internal and external structures of a wild rose.

4. **Generalize.**
   Come back together as a group. Present your arguments for the structures you labeled. Together, write a summary explaining how the structures of the buttercup plant and the wild rose help them survive.

PE 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

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Construct an Argument STEM

NEXT GENERATION SCIENCE STANDARDS

PE 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. (4-LS1-1) [Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin. [Assessment Boundary: Assessment limited to macroscopic structures within plant and animal systems.]

DCI LS1.A: Structure and Function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

SEP Engaging in Argument from Evidence. Construct an argument with evidence, data, and/or a model. (4-LS1-1)

CCC Systems and System Models. A system can be described in terms of its components and their interactions. (4-LS1-1)

Objectives Students will be able to:

- Construct an argument that plants have internal and external structures that function to support survival, growth, and reproduction.
- Explain how each structure carries out specific functions within its associated system.
- Use evidence and reasoning to support an argument.

BEFORE YOU BEGIN

Materials sticky notes

Time 20 minutes to introduce the activity, 15 minutes to list and compare, 30 minutes to construct an argument, 30 minutes to present and discuss.

Teaching Tips Organize the class into groups of four students. Direct students to work individually or with their groups at the appropriate times in the activity. Remind students to refer to the two previous lessons as they work. You may consider providing printed copies of the wild rose illustration to make it easier for students to compare the two plants.

What to Expect Students will construct an argument that a buttercup, like a wild rose, has structures to help it grow, survive, and reproduce. They will describe the specific function of each structure they identify as it relates to the overall health of the plant. Students may note differences between a buttercup and a wild rose, such as the fact that a buttercup does not have thorns. The purpose of this activity is for students to provide evidence in an argument that even though plants may have structural and aesthetic differences, they have internal and external structures with specific functions that support survival, growth, and reproduction.

ENGAGE

Introduce the Phenomenon

Use Photography Show students three images: a water lily, a cucumber plant, and a flowering tree. Have students work with partners to find commonalities between the three plants. As students find common links, have them compile their findings in a class list. Discuss the findings as a group. *(Students may say the plants all grow, survive, and reproduce. They may name common internal and external structures.)* Extend by asking: **What do these plants all need to survive, grow, and reproduce?** *(food, air, water, sunlight, a pollinator)*

Tap Prior Knowledge

Inside-Outside Circle Remind students that they learned about the external and internal structures of a wild rose in the two previous lessons.

Arrange students into two equal circles, one inside the other. Students should face the people they line up with in the other circle. Name a structure and have the inside circle students describe its specific function to their partners. After a set time, signal students to rotate five steps in one direction. Name another structure. Have outside partners describe its specific function to their inside partners. After a few rounds, reconvene and invite volunteers to share what they discussed. *(Possible answers: flower, reproduce; stem, transport water and nutrients; petal, attract insects; roots, soak up water and nutrients from the soil; thorns, protect plant; leaf, produce food)*

DIFFERENTIATED INSTRUCTION

Extra Support

Foster Youth Be conscious of the various challenges that group work presents for foster youth or other students who recently joined your class and may not have established friendships with many classmates. Arrange groups so that these students have at least one comfortable ally. As groups make plans for their investigations, emphasize that it is important to consider the ideas of each member of the group. Suggest that students take turns sharing ideas before any decisions are made. Repeat often that all ideas are valid, and that science works best when a diversity of opinions and personalities encourages deeper thinking.

EXPLORE

Make Observations

Have students look at the illustration of the buttercup. Ask: **What similarities do you notice between the buttercup and the wild rose?** *(Students may say that they both have a stem, roots, leaves, petals, a pistil, and stamens. They may notice the similarly shaped petals.)* Ask: **What differences do you notice between the buttercup and the wild rose?** *(Students may point out that the buttercup's roots are shorter or that the petals are a different color. They may notice the differently shaped leaves.)*

Read the introductory text together. Point out that although the buttercup and wild rose look different, they both have structures that help them survive.

Reinforce that students are to construct an argument that plants have external and internal structures that help them survive. Their argument should explain how these structures function and interact with other parts of the plant to support its survival. Have students read the remainder of the lesson before beginning the activity.

Teach the Dimensions

SEP Engaging in Argument from Evidence. Construct an argument with evidence, data, and/or a model. (4-LS1-1)

Explain to students that the word *argument* is used differently in science from the way it is used in everyday language. In everyday language, an argument means a disagreement or an angry conversation between two or more people. People may base their arguments on opinions or emotions and feel they need to win an argument by proving they are right. Say: **A scientific argument is an explanation about what you know and how you know it. It is supported by evidence and data. It may also be supported by a model that helps to explain or predict.**

Follow up during EXPLAIN by asking students to describe how they used the evidence in the text to construct an argument that each of the plant's internal and external structures helps it survive, carry out certain actions, or reproduce. *(Students should describe the process by which they evaluated the evidence to see if it supported their argument.)*

ACADEMIC VOCABULARY

Construct

Display the word *construct*. Ask students to find the term in the lesson *(lesson title, Step 3)* and to explain how it's used. *(construct an argument)* Ask: **What other words could be used in place of *construct*?** *(put together, build, make)* Discuss what students need to put together when they construct an argument in this lesson. *(an explanation of the ways plant structures help the plant grow, survive, or reproduce, using evidence from the diagram)* Ask: **How is this meaning similar to the use of the same word in a phrase such as "construct a building"?** *(Possible answer: Both the argument and the building need to be strong and hold together well.)*

LITERACY CONNECTION

Use Linking Words and Phrases

W.4.2.c Link ideas within categories of information using words and phrases (e.g., another, for example, also, because).

As students are drafting their arguments about how the internal and external structures of a buttercup help it to survive, point out that certain words and phrases can help make an argument stronger. Explain that linking words and phrases such as *another, for example,* and *also* help to show the connection between a claim and the details that support it. Provide this sentence as an example: *Thorns help a plant survive, for example by protecting it from hungry animals.*

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Construct an Argument (continued)

EXPLAIN

Step 1: List.

Have students work individually to label the internal and external structures of the buttercup.

Remind students to refer to the lessons on plant structures as they work. Because the names of some structures overlap, suggest that they write "external" or "internal" under each structure.

Step 2: Compare.

Have students work with their groups to compare their labels with the wild rose's structures. Ask: **Are there more differences or similarities between the buttercup and the wild rose?** *(There are more similarities.)*

Step 3: Construct an Argument.

After students have chosen their labeled structures, have them discuss the functions of those structures within their groups. Have students work individually, using reasoning and empirical evidence, to explain how the internal and external structures they chose help the buttercup grow, survive, or reproduce. Remind students they should use evidence from the diagram to support their arguments. They should also use evidence from lessons on the wild rose, including firsthand observations and any evidence collected during ELABORATE activities, to explain how their selected structures function.

Ask: **Why do you think the buttercup and the wild rose have many of the same structures?** *(Both plants have similar needs for survival, growth, and reproduction.)*

Step 4: Generalize.

Have students come back together as a group. Allow students to present their explanations and refine their claims based on group feedback. Then have students summarize how the internal and external structures of the buttercup and wild rose function together to help the plants survive. Ask:

- **What can you conclude about the external and internal structures of all plants?** *(I can conclude that all plants have similar external and internal structures that help them survive, grow, and reproduce.)*
- **In what ways did you think like a scientist as you completed this activity?** *(Possible answer: I used evidence and background knowledge to explain that internal and external structures of a plant have different functions that help the plant to grow, survive, and reproduce.)*

Think-Pair-Share Ask: **How did you construct an argument using evidence to show that a buttercup has structures to help it survive?** Give students time to think about the question and then discuss their processes with partners. Allow pairs to share differences and similarities in their processes with the class.

ELL Support

Starting To help students complete Step 1, provide them with sticky notes that contain the names of all internal and external structures. Work with students as a group to complete the remaining steps. Allow students to suggest words or phrases as they begin to work on constructing their arguments. Help them turn their ideas into complete sentences, reminding them to use the correct science terms and vocabulary.

Developing Work with students as a group to complete Steps 2 through 4. Provide sentence frames to help them construct their arguments in Step 3 and remind them to use the correct science terms and vocabulary:

A ______ is one internal/external structure of a buttercup. Its function is to ______. It is important to a plant because it ______.

Bridging As students present their arguments, help them identify strong examples of arguments that incorporate scientific concepts and vocabulary.

(Possible answer: I applied my knowledge of the wild rose to the buttercup to explain that the buttercup also has internal structures that help it survive, grow, and reproduce. This included thinking about the structures' specific functions.)

ELABORATE

Make Inferences

Partner Talk Have students extend their thinking about the differences in plants' internal and external structures by discussing this example with partners. Say: **Although the basic structures of the buttercup and the wild rose are similar, they also are different. Notice that the buttercup plant has shorter roots than the wild rose. Also, notice that the rose has thorns, but the buttercup plant does not.** Ask: **What might cause these differences?** *(Possible answer: A rose may have longer roots because the water in the soil is farther down in areas where it grows than in areas where the buttercup grows. The wild rose might also live in a harsher environment than the buttercup and need thorns to protect itself.)* Give students an adequate amount of time to process the question. Indicate which partner begins, and then have students take turns talking and listening. Circulate around the room to monitor discussion and clarify misunderstandings, asking simplifying questions as needed. Invite a few volunteers to share their thoughts with the class. Have students write what they learned in their science notebooks. Use their responses as a means of formative assessment.

Encourage More Research

Encourage students to conduct additional research to observe the broad variety within typical plant structures and to discover unusual plant structures. For example, the trunk of the largest tree is functionally a stem; some plants such as pitcher plants and Venus flytraps have leaves that can trap insects; and so on.

As a side project, students can compile their research into a class book. The pages can detail some of the interesting structures students discover through their research. Students should include a printout or drawing of each uncommon structure, as well as a written description of the structure and how it aids in the plant's growth, survival, or reproduction.

Students may be motivated to conduct further research on the plant itself and its environment to develop generalizations as to why plants growing in certain environments have certain structures in common, and why other plants have structures that are unique.

EVALUATE

Check to make sure students have recorded their observations and arguments in their science notebook. Then, present students with the following questions, and have them answer the questions in their science notebook.

Wrap It Up!

1. **IDENTIFY Which of the buttercup plant's structures attract insects that can carry pollen to another flower?** *(The colorful petals attract insects.)*
2. **INFER What do you think the inside of the buttercup plant's stem looks like?** *(It probably looks like the inside of the wild rose stem, with bundles of tiny tubes.)*
3. **GENERALIZE Do you think all plants have a way to take in water? Why or why not?** *(Yes. All plants must have a way to take in water because plants need water to survive.)*

CCC Systems and System Models

Rubrics

Have students evaluate their work using the rubric in their *Science Notebook Companion*. Use students' completed rubrics and the teacher rubric provided for this activity to guide your assessment of their work.

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