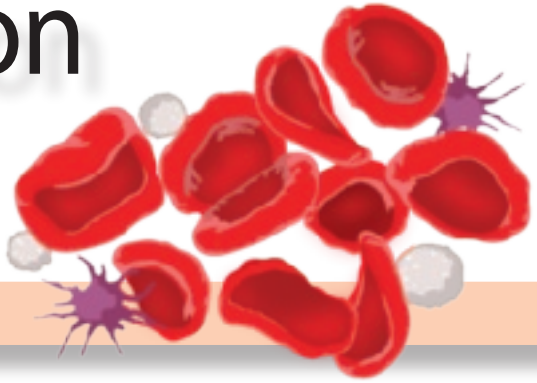
Core Knowledge® Science

Human Respiration and Circulation

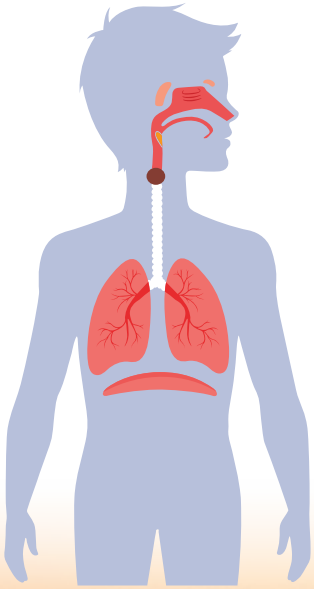
Components of blood



Teacher Guide

Exercise

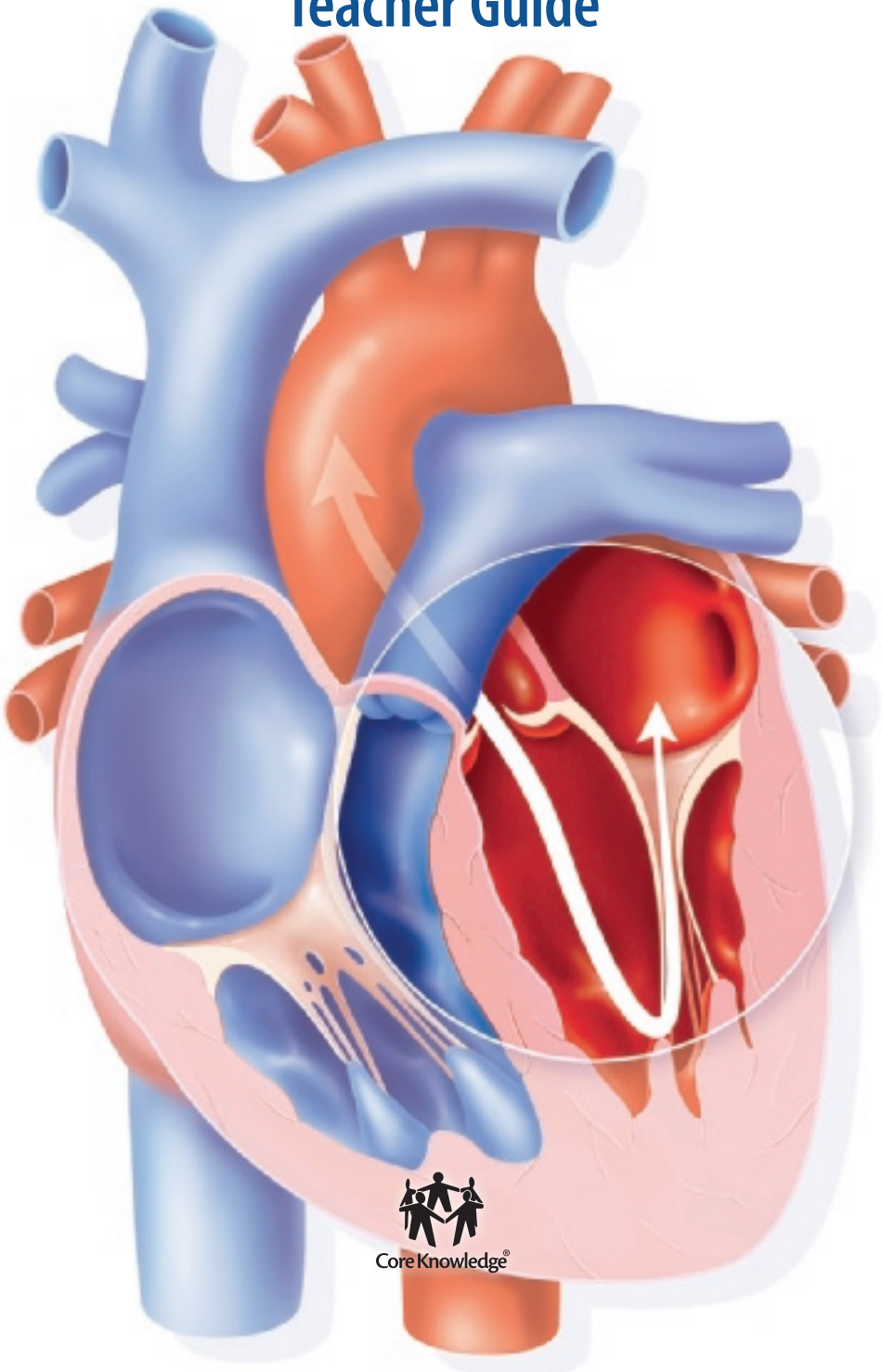
Respiratory system



Air quality

Human Respiration and Circulation

Teacher Guide



Core Knowledge®

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Human Respiration and Circulation

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Teacher Guide

Core Knowledge Science™ 4

UNIT 6

Introduction

About this Unit

The Big Idea

This unit focuses on the introductory scientific concepts related to respiratory and circulatory functions of the human body.

Students will be familiar with the relationship between senses and movement—that most of the time when they move a body part, that movement is initiated or guided by their senses. What they may not be familiar with are the changes that movement brings about in the circulatory and respiratory systems in the body. With every movement, the circulatory and respiratory systems of the human body will respond to supply the body with oxygen and other nutrients.

In this unit, students will consider the respiratory and circulatory systems and the role those systems play when students participate in a fun run. The circulatory system will move blood and oxygen through the bloodstream, where blood and oxygen are needed. The respiratory system will exchange the oxygen for the waste product carbon dioxide.

Students will also build on their understanding from previous grades about human body structures and their functions. Students also discover technologies that aid people when respiration and circulation are compromised.

Note to Core Knowledge Teachers

Thanks to ongoing research in the field, our understanding of how children learn continues to evolve. In the subject area of science, students benefit not just from reading about concepts and ideas, but from hands-on experiences. Following the release of the Next Generation Science Standards (NGSS), the Core Knowledge Foundation used this opportunity to update and enhance the science portion of the *Core Knowledge Sequence*.

While there have been some shifts in the grade levels at which certain topics are recommended, the fundamental principles of pedagogy inherent to the Core Knowledge approach, such as the importance of building a sequential, coherent, and cumulative knowledge base, have been retained.

Although the NGSS guidelines do not reference teaching about the human body, the Core Knowledge Foundation considers student knowledge of this topic, and health, an important part of students' instruction and learning. As a result, this unit can be used in conjunction with the other CKSci units at this grade level or on its own.

Online Resources

To learn more about the changes and to access resources for this unit, please use the links found in the Online Resources Guide:

www.coreknowledge.org/cksci-online-resources

This science unit embodies Core Knowledge's vision of best practices in science instruction and knowledge-based schooling, such as the following:

- building students' knowledge of core ideas in life, physical, and Earth sciences, as well as engineering design
- developing scientific practices that give students firsthand experience in scientific inquiry, engineering, and technology
- connecting scientific learning to concepts across various disciplines, such as mathematics and literacy

Related NGSS Dimensions*

This unit, *Human Respiration and Circulation*, provides the opportunity to further reinforce the following NGSS Dimensions:

Science and Engineering Practices:

- Asking questions (for science) and defining problems (for engineering)
- Engaging in argument from evidence
- Planning and carrying out investigations

Crosscutting Concepts:

- Structure and function
- Systems and system models

Online Resources

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

*NEXT GENERATION SCIENCE STANDARDS (NGSS) is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of this product, and their endorsement is not implied.

Sources:

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

National Research Council. 2012. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K–12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Building Science Knowledge

What Students Should Already Know

The concept of progressions, articulated in the National Research Council's *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, is very much aligned to the Core Knowledge principle of building new knowledge on prior knowledge. According to the NRC, students build "progressively more sophisticated explanations of natural phenomena" over the course of many years of schooling. "Because learning progressions extend over multiple years, they can prompt educators to consider how topics are presented at each grade level so that they build on prior understanding and can support increasingly sophisticated learning." In schools following NGSS recommendations, teachers can build on the "prior understandings" captured in the following summaries of NGSS Disciplinary Core Ideas:

LS1.A: Structure and Function

- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

What Students Need to Learn

For this unit, the Core Knowledge Science Sequence specifies the following content and skills. Specific learning objectives are provided in each lesson throughout the unit.

Lesson 1: Rest and Run

- Observe the effects on the body of starting to run, and identify the body functions associated with those effects.

Lesson 2: Respiration

- Identify parts of the respiratory system.
- Classify parts of the respiratory system.
- Describe ways the body protects the respiratory system.

Lesson 3: A Closer Look at Lungs and Breathing

- Differentiate structures in the lungs.
- Explain lung function in respiration.
- Explain the effect of air quality on lung health.

Lesson 4: Circulation

- Identify parts of the circulatory system.
- Explain the function of circulatory organs.
- Describe how changes affect circulation.

Lesson 5: A Closer Look at the Heart

- Differentiate structures in the heart.
- Relate cardiac structures to the process of circulation.

Lesson 6: A Closer Look at Blood

- Differentiate components in blood.
- Differentiate between oxygenated and deoxygenated blood.
- Relate blood components to the functions of materials transfer and disease resistance.

Lesson 7: Wellness of the Heart and Lungs

- Describe lifestyle-related decisions that positively affect the respiratory and circulatory systems.
- Characterize the importance of cardiovascular fitness to health and longevity.
- Characterize the dangers of exposure to smoking and other sources of particles in the air.

Lesson 8: Helpful Technology

- Describe medical and other science advancements related to respiration and circulation.
- Define a problem related to protecting the respiratory and circulatory systems.

What Teachers Need to Know

Supportive information on the content standards and the science they address is provided throughout the lessons at points of relevance:

Know the Standards: These sections, found later in this Teacher Guide, explain what to teach and why, with reference to NGSS and Core Knowledge expectations, as well as connections to relevant math and reading language arts standards.

Know the Science: These sections provide supporting, adult-level, background information or explanations related to specific science concepts, examples, or Disciplinary Core Ideas.

Using the Student Reader

Student Reader

The *Human Respiration and Circulation* Student Reader has eight chapters and a student Glossary providing definitions to Core Vocabulary words. Engaging text, photographs, and diagrams encourage students to draw upon their own experiences and the world around them to understand scientific concepts. In addition to Core Vocabulary, the Student Readers include a feature called Word to Know, which provides background information to help students understand key terms, and may sometimes include additional informational boxes, such as Think About.

Independent reading or group read-aloud: While the text in the Student Readers is written for independent reading, we encourage group read-alouds and engagement with the text. The Teacher Guide provides Guided Reading Supports to prompt discussion, clarify misconceptions, and promote understanding in relation to the Big Questions.

Using the Teacher Guide

Pacing

The *Human Respiration and Circulation* unit is one of six units in the Grade 4 CKSci series. We encourage teachers who are using the full series to complete all units during the school year. Each Core Lesson requires thirty to forty-five minutes of instruction time. The time it takes to complete a full lesson depends on class size and individual circumstances. Each lesson concludes with a Check for Understanding, providing the teacher with an opportunity for formative assessment.

At the end of this unit introduction, you will find a blank Pacing Guide on page 10, which you may use to plan how you might pace the lessons, as well as when to use the various other resources in this unit. We strongly recommend that you preview the unit in full before beginning and create your pacing guide before teaching the first lesson. As a general rule, we recommend that you spend no more than thirteen days teaching the *Human Respiration and Circulation* unit so that you have time to teach the other units in the Grade 4 CKSci series.

If you are familiar with the previous units at this grade level, you may notice that this unit differs slightly in organization from the NGSS units in the CKSci program. Lessons in the NGSS CKSci units are comprised of multiple segments that build to students' demonstration of a complex Performance Expectation. Because *Human Respiration and Circulation* is not designed to support any specific NGSS Performance Expectation, the instructional episodes are not grouped into multipart lessons. As such, they are identified simply as *lessons* instead of *lesson segments*.

The Core Lessons

- Lesson time: Most Core Lessons constitute one classroom session of thirty to forty-five minutes. Some activities and performance tasks might require setting aside a longer block of time.

- Lesson order: The lessons are coherently sequenced to build from one to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

Unit Big Question: What happens to your breathing and heartbeat when you run?		**Lesson Big Questions**
Lesson 1	Rest and Run	What happens to your breathing and heartbeat when you run?
Lesson 2	Respiration	What is respiration?
Lesson 3	A Closer Look at Lungs and Breathing	What are the parts inside lungs, and how do they work?
Lesson 4	Circulation	What is circulation?
Lesson 5	A Closer Look at the Heart	What are the parts that make up the heart, and how do they work?
Lesson 6	A Closer Look at Blood	What are the parts that make up blood, and how do they work?
Lesson 7	Wellness of the Heart and Lungs	How can we maintain healthy respiratory and circulatory systems?
Lesson 8	Helpful Technology	How can science and technology help the respiratory and circulatory systems?

Activity Pages

Activity Pages

AP 1.1
AP 2.1
AP 3.1
AP 5.1
AP 6.1
AP 7.1
AP 8.1

Black line reproducible masters for Activity Pages, as well as an Answer Key, are included in Teacher Resources on pages 52–61. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

Lesson 1—Investigating Changes in Breathing and Heartbeats (AP 1.1)

Lesson 2—Structures of the Respiratory System (AP 2.1)

Lesson 3—Investigating Air Quality (AP 3.1)

Lesson 5—The Heart Is a Puzzle (AP 5.1)

Lesson 6—Draw a Visual Fraction Model of Blood (AP 6.1)

Lesson 7—How Clean Is the Air You Breathe? (AP 7.1)

Lesson 8—A Better Mask (AP 8.1)

Online Resources for Science

Online Resources

For each CKSci unit, the Teacher Guide includes references to online resources (including external websites and downloadable documents) to enhance classroom instruction. Look for the icon on the left.

Use this link to download the CKSci Online Resources for this unit:

www.coreknowledge.org/cksci-online-resources

Teaching Strategies

Start with the familiar.	Lead with an experience. Begin each lesson with a demonstration, activity, or question about a phenomenon to engage students and focus their attention on the topic. Start with the familiar. Every science topic introduced to students relates in some way to their known world and everyday experiences. The purpose of every lesson is to build a bridge between what is familiar to students and broader knowledge about the way the world works.
Ask driving questions.	The unit is governed by a Big Question, and each lesson poses a more specific subquestion as students are introduced to new science content. Use these questions to engage students in conversation and help them think about how their own real-world experiences relate to the topic.
Encourage scientific thinking.	Approach the lessons with students not as learning about science but as learning about the world with a scientific mind. Science learning models science practice. Throughout the lessons, encourage students to ask questions about what they observe, do, and read. Record relevant questions in a prominent place in the classroom. Guide students back to these questions as opportunities to answer them emerge from readings, demonstrations, and activities.
Use continuous Core Vocabulary instruction.	During instruction, emphasize Core Vocabulary terms and their meanings in context rather than relying on isolated drill for memorization of definitions. Through scaffolded questioning, encourage students to come up with definitions in their own words and to use the words in their own sentences. Core Vocabulary words for each lesson, as well as Language of Instruction, other key terms teachers are encouraged to use in discussing topics with students, are provided at the start of each lesson. You can find Core Vocabulary and Language of Instruction definitions in the Glossary on pages 62–63.
Emphasize observation and experience.	Lessons employ various ways for students to learn, including watching, listening, reading, doing, discussing, and writing.

Use science practices.	Give students opportunities to discover new content knowledge through investigation and to use their new knowledge both in problem-solving exercises and as evidence to support reasoning. Students learn what science and engineering practices are by engaging in those same practices as they learn.
Make frequent connections.	Use a combination of demonstrations and reading materials, rich with examples, to help students recognize how the science concepts they are learning apply in their everyday lives. Prompt students to relate lesson content to their own experiences, to relate the new and unfamiliar to the familiar, and to connect ideas and examples across disciplines.
Monitor student progress.	Use verbal questioning, student work, and the Check for Understanding assessments at the end of each lesson to monitor progress during each lesson and to measure understanding at the conclusion of the unit. Many lessons provide tips to help you support students who need further explanations or clarifications.

Effective and Safe Classroom Activities

Online Resources

Conducting safe classroom demonstrations and activities is essential to successful elementary science education. The following resources provide Core Knowledge's recommendations for developing effective science classroom activities.

These resources, included at the back of the Teacher Guide on pages 64–68, consist of the following:

- Classroom Safety for Activities and Demonstrations
- Strategies for Acquiring Materials
- Advance Preparation for Activities and Demonstrations
- What to Do When Activities Don't Give Expected Results

These resources may also be accessed within the CKSci Online Resources Guide for this unit, available at

www.coreknowledge.org/cksci-online-resources

Materials and Equipment

The unit requires a large variety of materials to support various ways of learning (including doing, discussing, listening, watching, reading, and writing). Prepare in advance by collecting the materials and equipment needed for all the demonstrations and hands-on investigations.

- Roll paper, poster board, or a bulletin board should be dedicated at the beginning of the unit to serve as a question board to cumulatively document and return to student questions. The question board is referred to in the materials for lessons in which it is used but is not repeated in the materials listed here.
- Internet access and the means to project images/videos for whole-class viewing are also required in many lessons but are not repeated below.

Lesson 1 Rest and Run

- clock or stopwatch
- poster paper
- markers
- sticky notes

Lesson 2 Respiration

- utility knife (teacher use)
- clear plastic drink bottles, 12–20-ounce size (1 per pair)
- party balloons (2 per pair)
- drinking straws (1 per pair)
- elastic bands (1 per pair)
- scissors (1 per pair)
- modeling clay or dough (a walnut-sized piece per pair)

Lesson 3 A Closer Look at Lungs and Breathing

- white paper plates (4)
- petroleum jelly
- duct tape, 12-inch lengths (4)
- wood blocks or bricks (4)
- camera
- markers

Lesson 4 Circulation

- balloons, identical (2)

Lesson 5 A Closer Look at the Heart

- poster paper
- markers
- scissors (1 per pair)
- unlined sheets of paper (1 per student)
- glue (1 per pair)
- colored pencils (1 set per pair)

For Differentiation:

- plastic water bottles (3)
- bendable drinking straws (4)
- water bottle cap, with two holes straws can fit through
- water bottle cap, with one hole a straw can fit through and another smaller hole
- masking tape
- modeling clay or dough
- pitcher with three cups of water

Lesson 6 A Closer Look at Blood

no materials needed

Lesson 7 Wellness of the Heart and Lungs

- permanent marker
- bricks or wood blocks (4)
- white paper plates
- duct tape loops (4)
- petroleum jelly

Lesson 8 Helpful Technology

- surgical masks (1 per student)

Human Respiration and Circulation Pacing Guide

_____**'s Class**

Note to Teacher: When using *Human Respiration and Circulation* as part of the Grade 4 CKSci series, this unit is intended to be taught as the sixth unit of Grade 4 CKSci.

Week 1

Day 1	Day 2	Day 3	Day 4	Day 5

Week 2

Day 6	Day 7	Day 8	Day 9	Day 10

Week 3

Day 11	Day 12	Day 13	Day 14	Day 15

UNIT 6

Human Respiration and Circulation

Overview

Big Question: What happens to your breathing and heartbeat when you run?

Lessons	Lesson Questions	Advance Preparation
1. Rest and Run	What happens to your breathing and heartbeat when you run?	Read Student Reader, Chapter 1.
2. Respiration	What is respiration?	Read Student Reader, Chapter 2. Gather materials for student investigation. (See Materials and Equipment, page 9.)
3. A Closer Look at Lungs and Breathing	What are the parts inside lungs, and how do they work?	Read Student Reader, Chapter 3. Gather materials for student investigation.
4. Circulation	What is circulation?	Read Student Reader, Chapter 4. Gather materials for demonstration.
5. A Closer Look at the Heart	What are the parts that make up the heart, and how do they work?	Read Student Reader, Chapter 5. Gather materials for student investigation.
6. A Closer Look at Blood	What are the parts that make up blood, and how do they work?	Read Student Reader, Chapter 6. Gather materials for student investigation.
7. Wellness of the Heart and Lungs	How can we maintain healthy respiratory and circulatory systems?	Read Student Reader, Chapter 7. Gather materials for student investigation.
8. Helpful Technology	How can science and technology help the respiratory and circulatory systems	Read Student Reader, Chapter 8. Gather materials for student investigation.

What's the Story?

The human body, in response to physical activity, will change its rate of respiration (breathing) and circulation to meet the needs brought on by the activity. The respiratory system is made up of organs and tissues that move gases into and out of the body. The circulatory system is made up of organs and tissues that move blood throughout the body. During changes in the level of physical activity, the body

will respond by increasing or decreasing oxygen flow into the body through the respiratory system as well as increasing or decreasing blood flow through the circulatory system. Most of these changes will happen automatically as the body monitors and responds the changing environment brought on by exercise.

In Lessons 1–8, students read about the respiratory and circulatory systems and how those two systems interact and provide life functions. Specifically, students read about the body structures and functions as they relate to circulation and respiration while running. Reading about these body structures and functions in this context is reinforced by student investigations into changes in their own respiratory and circulatory systems.

LESSON 1

Rest and Run

Big Question: What happens to your breathing and heartbeat when you run?

Tie to the Anchoring Phenomenon: This lesson introduces the phenomenon that breathing and pulse rates change as a person runs and change again after they come to a rest after running.

At a Glance

Learning Objectives

- ✓ Observe changes in respiration and heart rate as a result of strenuous activity.
- ✓ Document changes in respiration and heart rate before and after strenuous activity.

Instructional Activities (2 days)

- hands-on investigation and data analysis
- reading, video, and discussion
- creative/explanatory writing

Core Vocabulary

Core Vocabulary: Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

breathe **heartbeat**

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

pulse **rate** **vital**

Instructional Resources

Student Reader

Ch. 1

Activity Page

AP 1.1

Student Reader, Chapter 1
"Rest and Run"

Activity Page
Investigating Changes in Breathing and Heartbeats (AP 1.1)

Make copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- clock or stopwatch
- poster paper
- markers
- sticky notes
- internet access and the means to project images/video for whole-class viewing

The Core Lesson two days, 45 min each

1. Day 1: Focus student attention by investigating a phenomenon. 45 min

Activity Page

AP 1.1

- Distribute Investigating Changes in Breathing and Heartbeats (AP 1.1).
- Have students complete Step 1. Students will need about ten minutes for their breathing and heartrate to return to resting rates.
- During this time, have students look at Step 2 on their Activity Pages, and teach them how to locate their pulse on the inside of their wrist. To do this, have them hold one hand palm up on their lap and use the index finger and middle finger from the opposite hand to lightly feel the wrist near the thumb until they find the thumping pulse.
- Using a clock or stopwatch, have students begin counting and stop counting after fifteen seconds.
- Explain that there are four fifteen-second intervals in a minute, so they will have to multiply the number they counted by four to find the number of beats for a whole minute. Have students record that number in the table in Step 2 under "At Rest."

  SUPPORT—Explain the need to multiply by restating as a word problem, and have students make drawings or write equations with a symbol for the unknown to represent the problem.

- Next, have students run another two minutes and, when they stop, count the number of pulses for fifteen seconds again, multiply by four, and record in the same table.

  SUPPORT—For students who cannot run, consider having them perform some other physical activity which can raise their heart rate, such as clapping very fast for two minutes or waving their arms in the air.

- When students read Step 3, explain that inhaling and exhaling count as one breath, and have them follow the directions.
- Finally, give students time to analyze their data and answer the question in Step 4. (See **Know the Science**.)

Know the Science

What are healthy resting heart and breathing rates for children? At rest, Grade 4 students aged 9–11 years of age have a normal resting heart rate of 70–110 beats per minute. In contrast, a normal adult resting heart rate is 60–95 beats per minute. The normal resting breathing rate for children aged 9–11 is 15–20 breaths per minute.

1. Day 2: Read and discuss "Rest and Run." 15 MIN

Student Reader

Ch. 1

Read together, or have students read independently, the Student Reader Chapter 1, "Rest and Run." The selection introduces the unit on respiration and circulation.

Preview Core Vocabulary

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read.

breathe **heartbeat**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 1

Invite students to share their experiences running, for example on the playground, in a game, when playing basketball or soccer, or in a relay race.

Ask students: How do you feel after running as fast as you can?

» Sample answer: sweaty, out of breath, tired

Ask: If the heartbeat is faster while running, how does that affect the blood?

» Sample answer: It makes the blood move throughout the body faster.

Page 2

Prompt students to look at the photo of the children right after a run. Ask: What signs can you see that running was hard work for their bodies?

» Sample answer: The boys' bodies look tired, they have pained expressions on their faces, and their faces look red.

CHALLENGE—While students may not be asked to solve mathematics problems using the concept of *unit rate* until Grade 6, you can introduce the concept with other familiar examples such as miles per hour, hourly wages, and prices per pound for fruits in a grocery store. Give students simple word problems to solve, such as *If peaches cost 50 cents per pound, how much will four pounds of peaches cost?*

Point out that one key meaning of the word *vital* is "necessary for life." Vital signs (body temperature, pulse, breathing rate, and blood pressure) are functions of the body that doctors and nurses measure to help them identify medical problems in their patients.

Make sure students understand that, in addition to running, many other forms of exercise increase their breathing and heart rates. These include cycling, swimming, jumping jacks, using motorless scooters, martial arts, and jumping rope.

2. Teach Core Vocabulary. 5 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

breathe **heartbeat**

Word Work

breathe: Make sure students understand that breathing has two phases—inhaling and exhaling. Have students place their hands on their chests to feel the chest move when they inhale and exhale.

heartbeat: Point out that the heart is made of muscle that contracts and relaxes. Ask students to recall how they counted their heartbeats in the investigation (counting their pulse).

3. Introduce the unit Big Question. 10 MIN

Online Resources

Show students a video about Wilma Rudolph, a famous athlete who represented the United States in the 1956 Olympics when she was just a teenager and again in the 1960 Olympics. To run in the Olympics, Rudolph had to overcome a serious illness called polio. Explain that polio is caused by a virus and that, in the early 1940s, when five-year-old Wilma contracted polio, scientists had not yet developed a vaccine to prevent it.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Stop the video so that students can read and discuss the inspiring quotations. Explain that while people may have illnesses and injuries, some may be overcome to perform amazing physical feats of skill, strength, and endurance. Invite students to share their own related experiences.

Share this Big Question with your class—**What happens to your breathing and heartbeat when you run?** Write the question on poster paper, and display it where students can refer to it throughout the unit. Invite students to ask supporting questions, such as the following samples:

- What body parts are used for breathing?
- What does breathing do for my body?
- What does my heart do for my body?
- What does my body need when I run?

Give students sticky notes on which to write their supporting questions, and attach the notes to the poster paper under the Big Question.

4. Check for understanding. 15 MIN

Direct students to think about what they read in Chapter 1, and ask: How were Wilma Rudolph's pulse and breathing affected when she ran races? Then have students write a paragraph to explain how Rudolph felt before, during, and after a big race in the Olympics. Encourage creative writing, such as a first-person view by Rudolph, that is fun to read. (See **Know the Standards**.)

» Writing sample answer: I'm sitting on a bench and lacing up my running shoes before the big race. My pulse is normal for resting. Bang! The race starts. I take off like the wind! As the race goes on, I am breathing faster and faster. I win! When I take my pulse at the finish line, I learn that my heart is beating very fast. My heart worked hard to help me run the race.

Point out to students that the rest of the chapters in this unit will provide more details about how body parts function at rest and during exercise.

EXTEND—Offer students children's picture books on the topic of Wilma Rudolph to inspire their creative writing, and invite them to illustrate their paragraphs. Try *Wilma Unlimited: How Wilma Rudolph Became the World's Fastest Woman,* written by Kathleen Krull and illustrated by David Díaz, or *The Quickest Kid in Clarksville*, written by Pat Zietlow Miller and illustrated by Frank Morrison.

Know the Standards

Language Arts Connection: Writing about scientific explanations does not have to be dry writing! Students can make their explanations more memorable by creating narratives. This exercise combines two clusters of Grade 4 writing standards: *Write informative/explanatory texts to examine a topic and convey ideas and information clearly;* and *Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences*. Be on the lookout for other creative writing activities throughout this unit. (**CCSS.ELA-Literacy.W.4.2** and **CCSS.ELA-Literacy.W.4.3**)

LESSON 2

Respiration

Big Question: What is respiration?

Tie to the Anchoring Phenomenon: This lesson describes the structures in the human respiratory system, giving students the concepts to explain where inhaled and exhaled air moves in the body.

At a Glance

Learning Objectives

- ✓ Identify parts of the respiratory system.
- ✓ Classify respiratory organs as parts of the upper or lower respiratory systems.
- ✓ Describe ways the body protects the respiratory system.

Instructional Activities (2 days)

- constructing physical models
- class discussion
- labeling a diagram

Core Vocabulary

Core Vocabulary: Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

carbon dioxide **oxygen** **respiration** **respiratory system**

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

function **involuntary** **organ** **structure**

trachea **voluntary**

Instructional Resources

Student Reader

Ch. 2

Activity Page

AP 2.1

Student Reader, Chapter 2
"Respiration"

Activity Page
Structures of the Respiratory System (AP 2.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- utility knife (teacher use)
- clear plastic drink bottles, 12–20-ounce size (1 per pair)
- party balloons (2 per pair)
- drinking straws (1 per pair)
- elastic bands (1 per pair)
- scissors (1 per pair)
- modeling clay or dough (a walnut-sized piece per pair)

Advance Preparation:

- Prior to class, cut each bottle in half horizontally, and discard the bottoms.

The Core Lesson TWO DAYS, 45 MIN EACH

1. Day 1: Focus student attention by constructing a model. 45 MIN

- Arrange teams of two students, and give each team a cut bottle half.
- Give each team a walnut-sized lump of clay or dough and a straw. Show students how to wrap the clay or dough around the straw to seal the bottle.
- Give out a balloon. Show students how to place the neck of the balloon over the bottom of the straw and snuggly wrap the elastic band around both.
- Next, give each team a second balloon and pair of scissors. Have students cut off the bottom of the balloon and make a knot in the neck of the balloon. **SAFETY: Caution students not to put the balloons in their mouths and to dispose of the cut bottoms.**
- Have students place the open end of the balloon over the open end of the bottle.

- Have students take turns holding the bottle in one hand and using their other hand to gently pull down and release the knot of the bottom balloon. Ask: How does this affect the other parts of the model?
  - » Sample answer: Pulling down makes the balloon inside the bottle fill with air, and releasing it makes the air move out of the balloon.

SUPPORT—If models are not working as expected, troubleshoot by checking that the modeling dough has sealed the hole in the bottle top and the balloon is attached to the straw tightly but is not collapsing the straw.

Share the Big Question with your class—**What is respiration?** Display this question where students can refer to it throughout the lesson. Tell students that the model they just built has something to do with respiration. (See **Know the Science 1**.)

1. Day 2: Read and discuss "Respiration." 15 MIN

Student Reader

Ch. 2

Read together, or have students read independently, the Student Reader Chapter 2, "Respiration." This selection explains the function of the respiratory system. it identifies the parts of this system and categorizes them as upper and lower subsystems. Students will also read how related structures function to protect respiratory organs.

Preview Core Vocabulary

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read.

carbon dioxide **oxygen** **respiration** **respiratory system**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 3–4

Have students take some slow, deep breaths, inhaling through their noses and exhaling through their mouths. When students exhale, have them hold one hand in front of their mouth. Ask: What did you feel when you exhaled?

- » Sample answer: air coming out of my mouth

Know the Science

1. How is cellular respiration different from breathing respiration? In the context of this lesson, *respiration* is a synonym for *breathing*. It refers to the process of inhaling gases from the atmosphere and exhaling gases from the body. *Cellular respiration* is the term for the chemical reactions inside a cell in which glucose molecules are broken down, with or without oxygen, to produce carbon dioxide and water and release useful energy. Some of that energy is lost as heat, but the rest is stored for later use in ATP molecules.

Direct students to look at the circle graph. Ask: About what fraction of air is oxygen?

» Sample answer: about one-fourth or one-fifth

Ask: How does the amount of carbon dioxide and other gases in air compare to the amount of oxygen?

» Sample answer: There is much less carbon dioxide and other gases than oxygen.

Page 5

Remind students that an organ is distinct part of a body system. Explain that all organs in a system work together to keep the body alive.

Pages 6–7

Point out that sneezing and coughing are ways dust and dirt are removed by the body. Explain that germs are also expelled this way. Ask: Why is it a healthy practice to use a tissue when you sneeze or cough?

» Sample answer: because a tissue can catch the germs so that they are not spread to other people

Remind students of the model they made of parts of the respiratory system. Ask: Which part of the model is related to the lung? Which part is related to the diaphragm?

» Answer: The whole balloon hanging inside the bottle represents a lung. The cut balloon on the bottom of the bottle represents the diaphragm.

Allow students to use their models to show how movement of the diaphragm causes the lung to expand and contract.

Ask students: Which structure in the respiratory system is the most important one?

» Answers will vary, but students should note that all the parts are necessary for the respiratory system to work properly.

Page 8

Explain to students that dust and dirt may be in the air due to storms, farming practices, motor vehicle exhaust, and heating and electricity production.

EXTEND—Have students learn more about the importance of clean air to health. Invite a community leader to school to explain how local government helps keep air clean.

2. Teach Core Vocabulary. 10 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

carbon dioxide **oxygen** **respiration** **respiratory system**

Word Work

oxygen: Remind students that oxygen in the air is a gas (O_2). (See **Know the Science 2**.)

carbon dioxide: Remind students that carbon dioxide (CO_2) is a gas that they exhale, or get rid of as air leaves the lungs.

respiration: Point out to students that this word has a suffix, *-tion*, attached to the root word *respirate* and that adding this suffix changes the verb into a noun.

respiratory system: Point out that this system moves all gases in the air into and out of the body but most importantly oxygen gas and carbon dioxide gas.

3. Check for understanding. 20 MIN

Activity Page

AP 2.1

Have students look at their models again and, using what they have learned, explain what part of the respiratory system each part of the model represents.

Distribute Structures of the Respiratory System (AP 2.1) to students, and have them follow the directions to complete the diagram and table. Have students refer to Chapter 2 as needed. See the Activity Pages Answer Key for sample student responses.

Formative Assessment

Return students' attention to the Big Question for this lesson—**What is respiration?** Have students refer to the model they built and used, along with what they read and discussed in Chapter 2, when answering the question.

Review students' work on Structures of the Respiratory System (AP 2.1), and look for evidence that they can identify organs of the respiratory system, distinguish between the upper and lower respiratory tracts, and understand the functions of those organs.

Know the Science

2. What is difference between oxygen as a gas and oxygen as an element? The oxygen in the air we breathe is a molecule, O_2, made up of two oxygen atoms bound to each other. It is less reactive due to the covalent bond shared between the two atoms making up the molecule. Elemental oxygen is a single atom of oxygen. Elemental oxygen is highly reactive and exists in the atmosphere only in minute amounts, as it will bind quickly to other atoms, forming other molecules.

LESSON 3

A Closer Look at Lungs and Breathing

Big Question: What are the parts inside lungs, and how do they work?

Tie to the Anchoring Phenomenon: Runners need very good lung functioning. Students will learn that this is because the lungs are the site of gas exchange and that running requires more oxygen for the body than resting.

At a Glance

Learning Objectives

- ✓ Differentiate structures in the lungs and their functions.
- ✓ Explain the effects of air quality on lung health and how data are used to compare air quality.

Instructional Activities (2 days)

- hands-on investigation and data analysis
- class discussion

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

alveolus **bronchial tube** **bronchiole** **pollutant**

Instructional Resources

Student Reader

Ch. 3

Activity Page

AP 3.1

Student Reader, Chapter 3
"A Closer Look at Lungs and Breathing"

Activity Page
Investigating Air Quality (AP 3.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- white paper plates (4 per class)
- petroleum jelly
- duct tape, 12-inch lengths (4 per class)
- wood blocks or bricks (4 per class)
- hand lens (4 per class)
- camera (optional)
- markers
- internet access and the means to project images/video for whole-class viewing

Advance Preparation:

- Make sure there will be no precipitation for the twenty-four hours needed for the data collection. If it does rain or sleet, you may redo the testing or check a plate to see if particles have washed off the plates.
- Decide if you will use a camera for closer viewing of the particles on the plates.

The Core Lesson TWO DAYS, 45 MIN EACH

1. Day 1: Focus student attention with an investigation. 25 MIN

- In this investigation, students will test outdoor air quality. In the investigation for Lesson 7, students will investigate and compare indoor and outdoor air quality.
- Make a duct tape loop, and use it to attach a paper plate to a block or brick. Repeat to make three more testers.
- Write a letter (A–D) on the rim of each plate for identification.
- Spread a thin coating of petroleum jelly over the center of each plate, leaving the rim untouched.
- Brainstorm with students where to test the air quality—how clean or safe the air is for people to breathe—choosing two outdoor and two indoor locations. Consider where the testers can be positioned for twenty-four hours and not be disturbed.

Activity Page

AP 3.1

- Distribute Investigating Air Quality (AP 3.1) to students. Have students complete Steps 1 and 2.
- Place the four testers in the locations agreed upon by the class. The two that are outdoors should be in the open air, not under building overhangs or trees.
- Leave the testers in place for twenty-four hours.

Share this lesson's Big Question with your class—**What are the parts inside lungs, and how do they work?** Display this question where students can refer to it throughout the lesson. Tell students to also start thinking about how air quality might affect the health of their lungs. (See **Know the Science**.)

Know the Science

How does poor air quality affect the respiratory system? Air pollution, both indoor and outdoor, is one of the top ten causes of deaths around the world. Children are especially vulnerable because 80 percent of the alveoli in human lungs develop after birth. There are many substances that contribute to poor air quality. Among outdoor pollutants is ground-level ozone, a gas that causes inflammation of respiratory organs that affects their functioning, including causing asthma. Indoors, cigarette smoke contributes to chronic obstructive pulmonary disease in nonsmokers, through secondhand smoke. In addition to indoor cigarette smoke, lung cancer is caused by other indoor air pollutants and the outdoor air pollutant nitrogen dioxide (NO_2), a product of burning fuels. In the United States, the federal Clean Air Act of 1970 led to a 73 percent reduction of major outdoor air pollutants.

2. Read and discuss "A Closer Look at Lungs and Breathing." 20 MIN

Student Reader

Ch. 3

Read together, or have students read independently, the Student Reader Chapter 3, "A Closer Look at Lungs and Breathing." The selection describes the substructures within the lungs and their functions and explores factors that affect breathing and the health of the respiratory system.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 9–10

Draw students' attention to the Word to Know box before reading. Point out that the word *exchange* is used as a verb in this chapter. Have students suggest sentences that show they understand the meaning of the word.

Make sure students understand that *bronchi* is the plural form of the singular noun *bronchus*. Point out that other words ending in *-us* have a plural form ending in *-i* and that one example is *cactus/cacti*.

Have students deconstruct the word *bronchiole* into the root *bronchi* and the suffix *-ole*. Explain that this suffix means "little."

Ask students: How are the words *alveolus/alveoli* related? What spelling rule do they follow?

» Sample answer: *Alveolus* is singular, and *alveoli* is plural. They follow the rule for some words ending in *-us*.

Page 11

Have students point to the parts of the diagram corresponding to the text.

Ask students: Where is gas exchanged between the blood and the lungs?

» Sample answer: where the blood vessels touch the walls of the alveoli

Page 12

After reading the page, ask students: What would you expect to find if you counted your resting breaths per minute in different kinds of weather?

» Sample answer: We might find that the numbers go up or down, depending how hot or cold and dry or humid it is.

Online Resources

EXTEND—Explain to students that there is less oxygen available at high elevations because there is less air pressure the higher one moves above sea level. Have interested students watch a video illustrating the effects of less air pressure due to high altitudes/elevations on the body.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Pages 13–14 Make sure students understand that air quality is how healthy the air is for people to breathe and that pollutants are substances in the air that make the air less healthy to breathe.

CHALLENGE—Explain that science investigations show that children learn better when the air is cleaner. Invite students to research actions people can take to improve air quality inside homes and schools (e.g., keeping homes smoke free, reducing moisture that encourages growth of molds, using nontoxic cleaning products, and using air filtering machines to remove dust, dander, and germs). Have students make posters or infographics to share what they learned.

1. Day 2: Elicit arguments from evidence. 25 MIN

Activity Page

AP 3.1

Complete the investigation begun on Day 1 of this lesson.

- After twenty-four hours, retrieve the four air quality testers.
- Place all four testers on the same table or window ledge so that they will have the same light conditions. Caution students not to touch the plates.
- Have students follow Step 3 on AP 3.1, using pencils to draw their observations.

  SUPPORT—If students are struggling to see differences in the particles on the four plates, consider using a camera to make digital images. Project these images large enough for the class to see and compare subtle details. Then have students revise their drawings on AP 3.1.

- For Step 4 on AP 3.1, have students talk about their rankings in small groups. If there are differences of opinion, invite the students to check the four testers again to compare the amount of particles on them.
- Have students complete the rest of their Activity Page, applying claim-evidence-reasoning strategies that are familiar to your students. (See **Know the Standards**.)
- For the final writing task, encourage students to take a couple of minutes to reflect before writing. Encourage students to make specific references to the data they recorded and the arguments they made.

Know the Standards

SEP: Engaging in Argument from Evidence—NGSS encourages instruction in claim-evidence-reasoning (CER) thinking that many schools already teach across the curriculum. In the investigation students have just completed, they construct arguments using evidence, use data to evaluate claims about causes and effects, and compare and refine arguments based on scientific evidence.

2. Check for understanding. 20 MIN

Return to this lesson's Big Question—**What are the parts inside lungs, and how do they work?** Direct students to think about what they read in Chapter 3 to answer this question. Look for evidence in a class discussion that students recognize the following:

- Inside the lungs are branching tubes called *bronchi*.
- Bronchi tubes split into smaller tubes, called *bronchioles*.
- At the ends of the smallest tubes are sac called *alveoli*, where oxygen and carbon dioxide are exchanged with the blood.
- Air quality affects the ability of the lungs to perform their functions.

Ask students: How did you collect data on air quality, and what did you find out by comparing data?

» Sample answer: We collected data by putting paper plates in four locations and comparing the amount of particles stuck on the plates in the four locations. We found out that the outdoor locations have more particles in the air than indoor locations.

Ask students: How would air with pollutants in it affect a runner?

» Sample answer: The runner would have trouble breathing because they would also be breathing the pollution in and their body would have to remove the pollutants as they run, like coughing up small particles.

Point out to students that the next chapter in this unit will make it clearer where oxygen from the lungs goes once it moves into the blood.

Formative Assessment

Review students' responses to Investigating Air Quality (AP 3.1), including the open-ended writing task at the end.

See the Activity Pages Answer Key for sample student responses.

Refer students to this unit's Big Question—**What happens to your breathing and heartbeat when you run?** Invite students to share what they learned in this lesson that helps them answer the question. Students should recognize that when a person is running, they need more oxygen to move from the alveoli in their lungs into blood vessels. This is why they breathe faster.

LESSON 4

Circulation

Big Question: What is circulation?

Tie to the Anchoring Phenomenon: This lesson provides details about how the human circulatory system responds to internal and external changes and will support students as they develop explanations of how and why a person's pulse increases when they are running.

At a Glance

Learning Objectives

- ✓ Identify parts of the circulatory system.
- ✓ Explain the functions of circulatory organs.
- ✓ Describe how body changes affect circulation.

Instructional Activities

- reading and class discussion
- model pressure
- write narratives

Core Vocabulary

Core Vocabulary: Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

blood **blood vessel** **circulation** **circulatory system**

heart **pulse**

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

artery **blood pressure** **capillary** **pressure**

transport **vein**

Instructional Resources

Student Reader

Ch. 4

Student Reader, Chapter 4
"Circulation"

Materials and Equipment

Collect or prepare the following items:

- balloons, identical (2 per class)
- internet access and the means to project images/video for whole-class viewing

The Core Lesson 45 min

1. Focus student attention on the Big Question. 5 min

Online Resources

Show a video of some of the fastest male and female sprinters in Olympics history running and winning 100-meter events.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Point out that the Olympic gold-medalist Wilma Rudolph was also a sprinter, meaning that she competed in short distance races. Her events were the 100-meter, 200-meter relay, and 4 x 100-meter relay races. Explain that sprinting is one form of exercise that makes the organs of the circulatory system stronger.

Share the Big Question with your class—**What is circulation?** Display this question where students can refer to it throughout the lesson, and tell students that they will be able to answer it at the end of this lesson.

2. Read and discuss "Circulation." 15 min

Student Reader

Ch. 4

Read together, or have students read independently, the Student Reader Chapter 4, "Circulation." The selection describes the structures of the circulatory system and their functions, as well as the effects of internal and environmental changes on pulse and blood pressure.

Preview Core Vocabulary

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read.

blood **blood vessel** **circulation** **circulatory system**

heart **pulse**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 15

Ask students: What are some substances in blood?

» Sample answer: oxygen, carbon dioxide, sugar

Explain that while some of these substances are picked up from the lungs, others come from the food they eat or other organs in their body.

Pages 16–17

Have students point to the heart and blood vessels on the diagram on page 16. Ask: To what body structures does the heart send the blood it pumps?

» Sample answer: the feet, fingers, brain, and lungs

Explain that cells are the very tiny structures that are the building blocks of all living things and that they need the materials transported by blood to carry on their functions, among them making materials and releasing energy the body needs to stay alive.

Make sure students understand that veins and arteries vary in size but are all larger than capillaries. Have students look back at the illustration on page 10. Point out that capillaries surround each alveolus and that these capillaries are so narrow that blood cells must pass through them in single file.

Pages 18–19

Remind students that they learned to feel their pulse in Lesson 1, when they counted their heartbeats per minute before and after running.

The photo on page 19 shows someone counting their pulse in their neck. Explain to students that there are many locations on the body where a pulse can be felt.

CHALLENGE—Encourage students to locate online numerical data about *target heart rates while exercising* (they can search for this phrase). Challenge students to analyze the data in the charts to answer the question "How should a person's target exercising heart rate change as they age?"

Page 20

Make sure students understand that blood pressure is the pressure exerted on the walls of blood vessels by moving blood. (See **Know the Science**.)

Online Resources

EXTEND—Show students a video about blood pressure, and stop it as often as needed to ask clarifying questions and identify details not included in Chapter 4.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Know the Science

What is pressure? Pressure is the force exerted on a surface. It is caused by the collisions of molecules, and the closer molecules are to one another and the faster they move, the more collisions there are. A familiar example is atmospheric pressure—the force on Earth's surface due to the action of air molecules. Air pressure can also be detected by feeling an inflated balloon. Blood pressure works similarly, but instead of a molecules in a gaseous state, molecules in a liquid state exert the pressure on the elastic walls of blood vessels. When the heart contracts to pump blood, the pressure increases; after each contraction, the heart relaxes and blood pressure lowers. This is why blood pressure readings have two measurements (systolic and diastolic).

3. Teach Core Vocabulary. 5 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

blood **blood vessel** **circulation** **circulatory system**

heart **pulse**

Word Work

blood: Make sure students understand that blood carries waste materials, such as carbon dioxide, as well as materials the body needs.

blood vessel: Explain that the word *vessel* means a hollow container for liquids, such as a barrel. Have students discuss why the arteries, veins, and capillaries are called blood *vessels*.

circulation: Remind students that the *-tion* suffix means "the action of" and changes the verb *circulate* into a noun meaning "the action of circulating."

circulatory system: Ask students to recall other body systems they have explored in this unit (the respiratory system) and in previous science units (examples: the skeletal system, the muscular system, the nervous system).

heart: Have students use one hand to make a fist, and explain that their fist is approximately the same size and shape as their heart. Guide students to model the contracting and relaxing of the heart by clenching and relaxing their fist.

pulse: Point out to students that this word is used as a noun in Chapter 4 but that it has a related meaning as a verb. Have students use a dictionary to define the verb *pulse* and explain how it is related to the noun form.

4. Model blood pressure. 5 MIN

Show students two identical balloons. Blow air into one balloon until it is somewhat firm, and then knot it. Blow up the other balloon until it is considerably firmer than the first balloon, and then knot it. Allow students to pass around the two balloons to compare how they feel.

Explain that the molecules blown into the balloons each press on the inside walls of the balloon. This makes them stretch and makes the balloon feel firm.

Ask students: How do these balloons model blood pressure?

» Sample answer: The balloons are stretchy like the sides of blood vessels, and the air presses on the inside of the balloon, like blood presses against the insides of blood vessels.

Ask: What does comparing the two balloons model about blood pressure?

» Sample answer: One balloon shows a lower blood pressure, and the other balloon shows a higher blood pressure.

4. Check for understanding. 15 MIN

Have students write a story about how it feels to win an Olympic gold medal in running. Ask them to tell a story that is fun to read and explain how getting the medal affects the circulatory system. Students' stories should include the following:

- an introduction to the characters and situation
- descriptions of how someone felt
- explanations of how their body reacted
- a concluding sentence

Point out that their writing should do two things: explain something about how circulation works and be creative and interesting so that other people will want to read it.

> **SUPPORT**—Have each student write a draft, share it with another student for peer feedback, and then edit to produce a final version. Tell peer reviewers to look for science explanations and the use of science vocabulary, as well as a good story.

Invite students who wish to share what they wrote with the class.

Return to the Big Question for this lesson—**What is circulation?** Direct students to think about what they read in Chapter 4 to answer the question. Look for understanding of the following concepts:

- The heart and blood vessels are parts of the circulatory system.
- The heart pumps blood through the blood vessels to all parts of the body.
- The pulse and blood pressure change in response to changes outside and inside the body.

Point out to students that in the next lesson they will explore the parts of the heart that work together to pump blood.

Formative Assessment

Review students' writing to determine how well they understand the core science concepts of this lesson as well as the direction to write creatively.

LESSON 5

A Closer Look at the Heart

Big Question: What are the parts that make up the heart, and how do they work?

Tie to the Anchoring Phenomenon: At the completion of this lesson, students will have a better understanding of the inner workings of the heart as it supplies an adequate amount of oxygen to the body parts needed for running a race. Recognizing that the heart must carry out a coordinated series of contractions continuously for an entire lifetime will help impress upon students the need to keep this organ healthy and strong.

At a Glance

Learning Objectives

- ✓ Differentiate structures in the heart.
- ✓ Relate cardiac structures to the process of circulation.

Instructional Activities

- app simulation
- reading and discussion
- vocabulary instruction
- write to explain

Core Vocabulary

Core Vocabulary: Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

aorta **atrium** **ventricle**

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

chamber **pulmonary artery** **valve**

Instructional Resources

Student Reader

Ch. 5

Activity Page

AP 5.1

Student Reader, Chapter 5
"A Closer Look at the Heart"

Activity Page
The Heart Is a Puzzle (AP 5.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- poster paper
- markers
- scissors (1 per pair)
- unlined sheets of paper (1 per student)
- glue (1 per pair)
- colored pencils (1 set per pair)
- index cards for Core Vocabulary (3 per student)
- internet access and the means to project images/video for whole-class viewing

For Differentiation:

- plastic water bottles (3 per class)
- bendable drinking straws (4 per class)
- water bottle cap, with two holes straws can fit through
- water bottle cap, with one hole a straw can fit through and another smaller hole
- masking tape
- modeling clay or dough
- pitcher with three cups of water

The Core Lesson 45 min

1. Focus student attention with an app simulation. 10 min

Online Resources

Have students explore an app that animates the actions of the circulatory system as a whole and inside the heart.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Then share the Big Question for this lesson with your class—**What are the parts that make up the heart, and how do they work?** Display this question where students can refer to it throughout the lesson. Have students report what they saw using the app that may help them answer this question.

Draw on poster paper a K-W-L chart to record students' current understanding of the Big Question and pinpoint misconceptions. Have students suggest what they already know about how the heart works and what they would like to learn. (See **Know the Science**.) If students need prompting to get started, ask the following:

- What's inside the heart?
- In what direction does blood move in blood vessels?
- How does blood move between the lungs and heart?

2. Read and discuss "A Closer Look at the Heart." 10 MIN

Student Reader

Ch. 5

Read together, or have students read independently, the Student Reader Chapter 5, "A Closer Look at the Heart." The selection provides details about the heart's substructures and how their functions are coordinated to pump blood in two circuits—to the lungs and back to the heart and then from the heart to the rest of the body and back again.

Preview Core Vocabulary

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read.

aorta **atrium** **ventricle**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 21–22

Make sure students understand that a chamber is an enclosed space, like a room in an apartment.

Ask students: Why are the right atrium and right ventricle on the left side of the illustration?

» Sample answer: because those chambers are on the person's right side when they are thinking about their own heart

Know the Science

How can teachers deal with student misconceptions about the circulatory system? Learning research confirms that students at all levels through college introductory biology have only partly accurate understanding of how the heart works. For example, many young students think that circulation is a single circuit instead of a two-phase circuit in which blood is pumped from the heart to the lungs and back to the heart before being pumped to all other parts of the body. Such conceptions provide a framework on which students integrate new learning, making the original misconceptions difficult to change. Using preteaching strategies—such as allowing time for students to talk, draw, map, and write about their ideas—can help inform instruction that may correct misconceptions.

Explain to students that a heart valve is made of two or three structures that work together to prevent the backward flow of blood. (See **Know the Standards**.)

> **EXTEND**—Allow students to watch an online video showing how to make and use a model of heart chambers and valves. Provide the materials students will need in a learning station, including a bucket or sink to catch accidental spills. Make the holes in the bottle caps in advance using an awl or electric drill.

Online Resources

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Pages 23–24

Make sure students understand that the heart moves blood through two overall pathways. The first pathway goes to the lungs and back to the heart. The second pathway goes to the rest of the body and back to the heart from the rest of the body.

Have students point to the pulmonary arteries on the illustrations while you point out that *pulmonary* means "related to the lungs."

> **SUPPORT**— Show students an online video that uses microscopic video of the circulatory system at work to make the functions of the heart clearer.

Online Resources

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

3. Teach Core Vocabulary. 5 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

aorta **atrium** **ventricle**

Know the Standards

CCC Structure and Function: NGSS specifies that Grades 3–5 students learn that *substructures have shapes and parts that serve functions*. In Lesson 3, students learned that each lung has substructures, such as bronchioles and alveoli, that can be described by their shapes and functions. Lesson 5 parallels this theme as it explores the substructures of the heart, including chambers and valves. This concept will be developed again in Lesson 6, when students explore the substructures of blood, and in Lesson 8, as students solve an engineering problem and learn that *different materials have different substructures, which can sometimes be observed*.

Word Work

aorta: Revisit the diagram on page 22, and explain that the aorta is longer than shown here. This blood vessel curves around and behind the heart and extends as far down their bodies as their waists.

atrium: Point out to students that there are two plural words for *atrium*—*atriums* or *atria*. Have students draw a simplified heart with four chambers on their vocabulary card and label each of the upper two chambers *atrium*.

ventricle: Make sure students understand that one ventricle pumps low-oxygen blood to the lungs and that the other pumps high-oxygen blood to the rest of the body.

4. Guide diagramming heart functions. 15 MIN

Activity Page

AP 5.1

Distribute to students The Heart Is a Puzzle (AP 5.1), and provide students with paper, scissors, glue, and colored pencils. Tell students that understanding how the heart works is challenging—not only for Grade 4 students graders but for students in middle school, high school, and college.

Have students use reliable references, such as their Student Reader, to complete the sheet.

> **CHALLENGE**—If students seem confident in their ability to identify heart substructures, challenge them to use a pencil to complete as many of the labels as they can without references. Then have them check references and make edits.

4. Check for understanding. 5 MIN

Return to discuss the Big Question—**What are the parts that make up the heart, and how do they work?** Next, return to the K-W-L chart you made in Step 1. As a class, complete the Learn column. Then compare what students learned to what they knew before the lesson. Look for opportunities to celebrate more accurate understanding of the heart.

Formative Assessment

Review students' work on The Heart Is a Puzzle (AP 5.1), and give feedback as needed to have students correct any misunderstandings. See the Activity Pages Answer Key.

LESSON 6

A Closer Look at Blood

Big Question: What are the parts that make up blood, and how do they work?

Tie to the Anchoring Phenomenon: During a race, a runner's breathing and heart rates increase. The increase in breathing provides more oxygen to the blood, and the increased heart rate pumps the blood faster to the muscles that need plenty of oxygen to function. Students will learn which part of blood carries the oxygen needed to win the race.

At a Glance

Learning Objectives

- ✓ Differentiate components in blood.
- ✓ Differentiate between oxygenated and deoxygenated blood.
- ✓ Relate blood components to the functions of materials transfer and disease resistance.

Instructional Activities

- reading and discussion
- using fraction models

Core Vocabulary

Core Vocabulary: Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

plasma **red blood cells** **white blood cells**

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

antibody **blood type** **clot** **platelet**

transfusion

Instructional Resources

Student Reader

Ch. 6

Student Reader, Chapter 6
"A Closer Look at Blood"

Activity Page

AP 6.1

Activity Page
Draw a Visual Fraction Model of Blood (AP 6.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- index cards for Core Vocabulary (3 per student)

The Core Lesson 45 min

1. Focus student attention on the Big Question. 5 min

Share the Big Question with your class—**What are the parts that make up blood, and how do they work?** Display this question where students can refer to it throughout this lesson. Elicit students' ideas on what the answer might be.

Remind students of their exploration of the parts of the heart in Lesson 5 and how it functions to pump blood to all parts of the body. Ask: Why does the heart send blood to the lungs before it sends it to the arms, legs, and other body parts? If students are unsure how to answer, remind them that blood pumped to the lungs drops off carbon dioxide and picks up oxygen. Explain that in this lesson, students will learn which part of blood has this job.

2. Read and discuss "A Closer Look at Blood." 15 min

Student Reader

Ch. 6

Read together, or have students read independently, the Student Reader Chapter 6, "A Closer Look at Blood." The selection introduces students to the four main components of blood, clotting, blood types, and how damaged blood cells are removed from the bloodstream.

Preview Core Vocabulary

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read.

plasma **red blood cells** **white blood cells**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 25–26

Make sure students understand that each red blood cell can carry both carbon dioxide and oxygen. (See **Know the Science**.)

Point out to students that the word *clot* is used both as a verb and a noun.

Make sure students understand that when they bruise, blood vessels are broken under the skin but the skin itself is not broken.

SUPPORT—Show students how to identify the red and white blood cells in the illustration by their shapes. Have students explain the differences in cell shapes.

Online Resources

EXTEND—Invite students to take an online virtual tour of a blood donor center. Students will learn that prospective donors are screened and their blood is tested to make sure it is safe to donate. The video also reviews the components of blood and explains that the center can collect whole blood or just platelets.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

Pages 27–28

Point out to students that the blood for transfusions may come from a family member, a friend, or a stranger who has donated blood at a blood center.

Explain that a person can also be their own donor—if they know in advance that they may need blood during a scheduled surgery. In this case, the patient has blood taken a few weeks before surgery, and it is stored until the patient has surgery.

Students may wonder if the number of red blood cells in their bodies decreases if red blood cells last only 120 days. Explain that the body makes new red blood cells inside large hollow bones such as the sternum, hips, skull, and shoulder blades.

3. Teach Core Vocabulary. 10 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

plasma **red blood cells** **white blood cells**

Know the Science

Are red blood cells really cells? A developing red blood cell has a nucleus and other internal structures (organelles) like a typical cell. However, as it matures, a red blood cell pushes out the nucleus and other organelles to maximize the space available for hemoglobin, the protein to which oxygen and carbon dioxide bind. Consequently, mature red blood cells are unable to reproduce. For this reason, these structures are sometimes referred to as red blood *corpuscles* (meaning "minute particles") and not *cells*.

Word Work

plasma: Make sure students understand that plasma is the liquid in which all the solid blood cells and platelets are contained.

red blood cells: Have students describe the shape of a healthy red blood cell. Point out that unlike most things we call cells, a red blood cell does not have any of the internal parts of a normal cell. Instead it is only a fluid-filled membrane. Though not technically a cell, the term *red blood cell* is commonly used.

white blood cells: Remind students that these blood cells fight germs such as bacteria and viruses.

4. Draw a visual fraction model of blood. 10 MIN

Activity Page

AP 6.1

Give each student a copy of Draw a Visual Fraction Model of Blood (AP 6.1). Have students discuss their ideas for completing the model in pairs, but make sure each student completes their own sheet.

Remind students that they will draw a fraction model based on percentages and that percentages are based on fractions of 100.

Ask students: How did you decide to represent the parts of blood that are less than 1/100?

» Sample answer: by splitting one of the 100 squares into two halves

4. Check for understanding. 5 MIN

Return to the Big Question—**What are the parts that make up blood, and how do they work?** Direct students to think about what they read in Chapter 6 before answering the question.

» Sample answer: Blood is made up of red blood cells, white blood cells, platelets, and plasma. Red blood cells carry oxygen and carbon dioxide. White blood cells protect the body from bacteria and viruses. Platelets cause blood to clot. Plasma is the fluid that carries the other parts through the blood vessels.

Point out to students that the next lesson in this unit will provide more details about how to keep their hearts and lungs healthy.

Formative Assessment

Review students' responses to Draw a Visual Fraction Model of Blood (AP 6.1). See the Activity Pages Answer Key for sample answers.

LESSON 7

Wellness of the Heart and Lungs

Big Question: How can we maintain healthy respiratory and circulatory systems?

Tie to the Anchoring Phenomenon: After completing this lesson, students should be able to infer that the increased pulse and breathing associated with running is beneficial to their health and longevity.

At a Glance

Learning Objectives

- ✓ Describe lifestyle-related decisions people can make that positively affect the respiratory and circulatory systems.
- ✓ Characterize the importance of cardiovascular fitness to health and longevity.
- ✓ Characterize the dangers of exposure to smoking and other sources of particles in the air.

Instructional Activities (2 days)

- hands-on investigation
- reading and discussion
- data analysis

Core Vocabulary

Core Vocabulary: Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

diet **exercise** **health**

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

cancer **cardiovascular**

Instructional Resources

Student Reader

Ch. 7

Activity Page

AP 7.1

Student Reader, Chapter 7
"Wellness of the Heart and Lungs"

Activity Page
How Clean Is the Air You Breathe? (AP 7.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- permanent marker
- bricks or wood blocks (4 per class)
- white paper plates (4 per class)
- duct tape loops (4 per class)
- petroleum jelly
- internet access and the means to project images/video for whole-class viewing

The investigation in Step 1 should be done when no precipitation is forecast for 24 hours.

The Core Lesson TWO DAYS, 45 MIN EACH

1. Day 1: Focus student attention with an investigation. 25 MIN

Share the Big Question with your class—**How can we maintain healthy respiratory and circulatory systems?** Display this question where students can refer to it throughout the lesson. Explain that one way to keep the respiratory system healthy is to avoid breathing air containing particles.

Activity Page

AP 7.1

Give each student a copy of How Clean Is the Air You Breathe? (AP 7.1).

Set out the bricks or blocks, paper plates, and duct tape. Invite volunteers to follow Step 1 on AP 7.1. Have students use a permanent marker to label the plates, make the four tape loops, and attach each to the bottom of a plate and the top of the brick or block. Then have them spread a thin layer of petroleum jelly over the plate (but not on the rim). NOTE: If students handle the petroleum jelly with their bare hands, they will need to wash up when done.

Make sure students understand that the testers are intended to catch air pollution particles. Explain that they must be placed in locations that are open to the sky (not below buildings or tree overhangs) and where they will not be disturbed by people.

Ask students: Where indoors might be the most and least particles?

» Sample answer: the most—in the kitchen; the least—in the nurse's office

Ask: Where outdoors might be the most and least particles?

» Sample answer: the most—next to the driveway; the least—on the playground

Have students write the four locations on the chart, and then lead your class to complete Step 3. **SAFETY:** Make sure the locations the testers are placed in are safe for students to approach. (See **Know the Standards**.)

2. Read and discuss "Wellness of the Heart and Lungs." 20 MIN

Student Reader

Ch. 7

Read together, or have students read independently, the Student Reader Chapter 7, "Wellness of the Heart and Lungs." The selection describes how diet, exercise, and other lifestyle factors affect health and longevity.

Preview Core Vocabulary

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read.

diet **exercise** **health**

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 29–30

About 8 percent of US children ages five to fourteen have asthma. This makes it likely that one or more students in your class are affected. Be sensitive to the fact that some students may not want to share details of what it is like to have this disease while others may offer to do so.

Make sure students understand that *heath* refers to mental health as well as the health of the lungs, heart, and other body parts.

Page 31

Point out that many people may also live to be 100 years old in other parts of the world but that these are the places scientists have identified so far.

Ask students: What do these cities have in common in their relationship to water on Earth?

» Sample answer: They are all near the ocean or a large sea.

Know the Standards

SEP Planning and Carrying Out Investigations: In this investigation, students will provide evidence based on the observed appearance of the testers after twenty-four hours to support their explanations. This addresses the Grades 3–5 NGSS goal to *make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution*. If you wish to introduce the concept of controlling variables, another goal in Grades 3–5, consider setting up a fifth tester and placing it inside a clean, dry cabinet in the classroom. When students bring in the four other testers, they can compare their appearance to that of the control.

Ask students: How could living near a large body of water affect the ways people live?

» Sample answer: It could mean that the people here enjoy walking on the beach in the sunshine, swimming, boating, and fishing. It could also mean they can eat seafoods most of the year.

Page 32

Analyze the adjective *cardiovascular* for students. Explain that *cardio-* refers to the heart and *vascular* is a word that refers to blood vessels. Together, the word can be used as a synonym for *circulatory*.

Point out that foods that come in packages with ingredient lists often have too much fat, sugar, and salt. This is why eating processed foods and fast foods with a lot of meat and fried items should be only a small part of a healthy diet.

CHALLENGE—Invite students to plan a Blue Zone lunch menu, in which plants prepared with little fat are the main dishes. Students may draw upon traditional foods from their family cultures, such as beans, tofu, leafy greens, yams, fresh fruits, nuts, and seeds.

Pages 33–34

Use the map on page 31 to show students that all Blue Zones are in the same latitude and that all are near the coastline of the ocean or a sea. Point out that the climate tends to be warm year-round in these locations. Ask students: How does this kind of climate make it easier to live more active lives?

» Sample answer: It makes it more fun to play and do sports outdoors all year long, and people can take care of their homes and work in their gardens all year, too.

The topic of cancer can be scary for children. Make sure your students understand that kids rarely get cancer and that when they do, it can often be cured.

EXTEND—Changes in public policy that can result in more Blue Zones has become an initiative in many communities in the United States. Have students write a letter to city leaders encouraging them to make their own community a Blue Zone and explaining how this can help respiratory and cardiovascular health and increase longevity.

1. Day 2: Teach Core Vocabulary. 10 MIN

Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

diet **exercise** **health**

Word Work

diet: Explain to students that *diet* can refer to what people eat on a regular basis or that it can refer to a change in what they eat for a specific reason, such as to lose or gain weight.

exercise: Point out that there are different ways to exercise. Two ways that make the circulatory system stronger, and therefore healthier, are to do a sport that increases the heart rate for thirty minutes (running, swimming, cycling) and resistance training with weights or bands or by doing push-ups.

health: Remind students that, since their brain is part of their body, healthy thinking is part of their overall well-being.

2. Analyze data from the investigation. 30 MIN

Activity Page

AP 7.1

Have students take out AP 7.1 again. If you have not already done so, take the class to retrieve the four testers. Make sure students don't touch the surfaces of the plates. Place all the testers on one table or windowsill in bright light so that observations will be under the same conditions.

Have students make observations, rank them, and answer the questions on their Activity Page.

Online Resources

Conclude by asking students: Where do all these particles come from? Show students an online graphic that summarizes the source. Discuss the role of human activities in some of these sources.

> **SUPPORT**—Students may need to be reminded of sources of air pollution to understand how the particles get into the air. If so, direct them to revisit Chapter 3 and read the section called "Air Quality and Breathing."

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

www.coreknowledge.org/cksci-online-resources

3. Check for understanding. 5 MIN

Return to the Big Question—**How can we maintain healthy respiratory and circulatory systems?** Direct students to think about what they read in Chapter 7 and look for understanding of the following in the discussion:

- avoiding smoking and other sources of poor air quality
- getting regular exercise
- eating a diet that is low in fats and sugar and is mostly plants
- managing stress with the help of friends and family

Activity Page

AP 7.1

Formative Assessment

Review students' data collection and responses to questions on How Clean Is the Air You Breathe? (AP 7.1).

LESSON 8

Helpful Technology

Big Question: How can science and technology help the respiratory and circulatory systems?

Tie to the Anchoring Phenomenon: This lesson explores some problems of the respiratory and circulatory systems and several technologies that can improve the lives of people with them. Look for opportunities to discuss with students how each technology helps the human body cope with changes in its needs to take in oxygen and get rid of carbon dioxide.

At a Glance

Learning Objectives

- ✓ Describe medical and other science advancements related to respiration and circulation.
- ✓ Define a problem related to protecting the respiratory and circulatory systems.

Instructional Activities (2 Days)

- reading and discussion
- engineering task
- writing for a purpose

Core Vocabulary

Language of Instruction: The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

inherited **technology**

Instructional Resources

Student Reader

Ch. 8

Student Reader, Chapter 8
"Helpful Technology"

Activity Page

AP 8.1

Activity Page
A Better Mask (AP 8.1)

Make sufficient copies for your students prior to conducting the lesson.

Materials and Equipment

Collect or prepare the following items:

- surgical masks (1 per student)
- internet access and the means to project images/video for whole-class viewing

The Core Lesson TWO DAYS, 45 MIN EACH

1. Day 1: Focus student attention on the Big Question of this lesson. 5 MIN

Share the Lesson 8 Big Question with your class—**How can science and technology help the respiratory and circulatory systems?** Display this question where students can refer to it throughout the lesson.

Remind students that Wilma Rudolph, the first American woman to win three gold medals in one Olympics, contracted a disease called polio when she was four years old. Explain that polio left her unable to move one of her legs properly but that her parents made sure Wilma went every week for therapy and continued the therapy at home. Wilma also had to wear a metal brace on her leg for much of her elementary school years. With the help of these technologies, Wilma was finally able to walk correctly when she was eleven years old. By age thirteen, she was winning every running event at school.

2. Read and discuss "Helpful Technology." 15 MIN

Student Reader

Ch. 8

Read together, or have students read independently, the Student Reader Chapter 8, "Helpful Technology." This selection introduces common disorders of the respiratory and circulatory systems and highlights some technologies that help people with these disorders.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 35–36

It's likely that students will want to share what they know about family members who have respiratory and circulatory disorders such as asthma, cystic fibrosis, high blood pressure, and heart murmurs.

Explain that *inherited* means a trait has been passed from parent(s) to child as the result of reproduction. Point out that eye color, hair color, and the ability to roll the tongue are examples of inherited traits.

Pages 37–38

Make sure students understand that the word *technology* covers a broad variety of science-based solutions to human problems, including machines, computer code, and methods of doing tasks.

Make sure that students respect the privacy of classmates with asthma, who may not want to answer questions.

Ask students: How is getting more oxygen helpful to people who need it?

» Sample answer: It makes it easier for the lungs to supply enough oxygen to the blood so that all the cells in the body can get enough.

Pages 39–40

Explain to students that high blood pressure, also called hypertension, is relatively rare in young people but that the chances of having it increases as people get older, with almost two-thirds of people over sixty years old having this disorder.

SUPPORT—Invite a school nurse or other nurse to visit your class and demonstrate use of a sphygmomanometer, the tool used to measure blood pressure. Emphasize that a technology such as this one is the best way to diagnose high blood pressure because there are few other observable symptoms.

Point out that even though heart-lung machines are considered a newer technology, it took decades to invent, test, and improve their design. Engineers and medical doctors are still working on improving the design to make them easier to move around and suitable for very young babies.

3. Guide defining engineering problems. 25 MIN

Activity Page

AP 8.1

Give each student a new surgical mask. Discuss how the mask can protect the wearer's health. Talk about the importance of wearing a mask in situations when there are dangerous particles in the air.

Remind students of the particles they observed when they tested the air in four locations in or Lesson 3. Ask students: What works well about this mask? What does not?

» Sample answers: Works well: It is lightweight on the face; it expands to cover from the nose to under the chin; it has a wire to fit around the bridge of the nose. Does not work well: There are gaps between the mask and face on the sides; the ear bands can feel too tight or too loose; they all look the same, so I might put on someone else's by mistake.

Distribute A Better Mask (AP. 8.1) to students. Guide students to answer the questions to define a problem that can be solved by inventing the best mask for each student. (See **Know the Standards**.)

CHALLENGE—For students who want to try to solve the problem they have defined, explain that they should make prototypes of several possible designs, test those designs, and make changes to improve them. Suggest that students first draw possible solutions and then gather materials to try to make the most promising one.

1. Day 2: Writing for a purpose. 35 MIN

Give students a short-term writing task that can be used to evaluate their understanding of this unit. Tell students that they are to write to convince a fictitious school principal, Ms. Brown, that the First Street School needs to start an after-school running club.

Have students write a letter or email to Ms. Brown using evidence from this unit to support starting the club. Tell students that Ms. Brown will have to find a teacher to coach the runners and the money to pay for a late bus to take the members of the club home after practices. Therefore, their arguments should be supported by plenty of evidence to convince her that starting the club is worth the effort and expense.

5. Check for understanding. 10 MIN

Revisit the Big Question for this lesson—**How can science and technology help the respiratory and circulatory systems?** Have students think about what they read in Chapter 8 to answer the question. In the discussion, look for understanding that when people know the science, they can design technologies to help those who have disorders of these systems.

Return students' attention to the Big Question of this unit posted in Lesson 1 (**What happens to your breathing and heartbeat when you run?**), along with the supporting questions on sticky notes. Direct students to think about what they read in Chapters 1–8 and about the Olympic gold-medal winner Wilma Rudolph running and winning races.

Know the Standards

SEP Asking Questions and Defining Problems: *Defining problems* is the focus of this activity and refers to one of the essential aspects of engineering design. In Grades 3–5, students should be able to *define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.* There are two other parts to the design process—generating multiple possible solutions and testing and improving those solutions. Should you wish to have students complete the entire process, NGSS has three performance expectations that can guide instruction.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found: **www.coreknowledge.org/cksci-online-resources**

Ask students: Why does a runner's breathing and heartbeat change before, during, and after a race? Look for understanding of the following:

- The body needs to take in oxygen and get rid of waste carbon dioxide before, during, and after a race, but the amount of oxygen needed is greater during the race.
- When someone breathes faster, more oxygen moves into the blood.
- When the heart beats faster, it can pump more blood to the cells all over the body.

EXTEND—Ask your students' physical education teacher to explain how training and conditioning slowly make body systems stronger and able to work harder and to teach students some of the basics about safely and successfully running timed sprints and longer events.

Formative Assessment

Review students' Writing for a Purpose work. Look for evidence that they wrote to the task, addressed the specified audience, and demonstrated their understanding of the respiratory and circulatory systems and healthy lifestyles.

Activity Page

AP 8.1

Invite students to share their responses to the questions on A Better Mask (AP 8.1). Determine how well students understand the importance of clearly defining a problem before trying to solve it.

UNIT 6

Teacher Resources

Activity Pages

Name _____ Date _____

Activity Page 1.1 Use with Lesson 1.

Investigating Changes in Breathing and Heartbeats

Follow the directions, and use the charts to record your data.

1. Do the exercise the teacher instructs you to do. How did the exercise affect your body?

_____

2. Learn how to find the number of times your heart beats in one minute. Record the number for when you are resting. Then run again, and record the number of beats.

Heart Rate (per minute)	
At Rest	After Running for 2 Minutes

3. Learn how to count your breaths for one minute. Record the number when you are resting. Then run again, and record the number of breaths.

Breathing Rate (per minute)	
At Rest	After Running for 2 Minutes

4. Compare the numbers in your charts. How does running affect your breathing and heart?

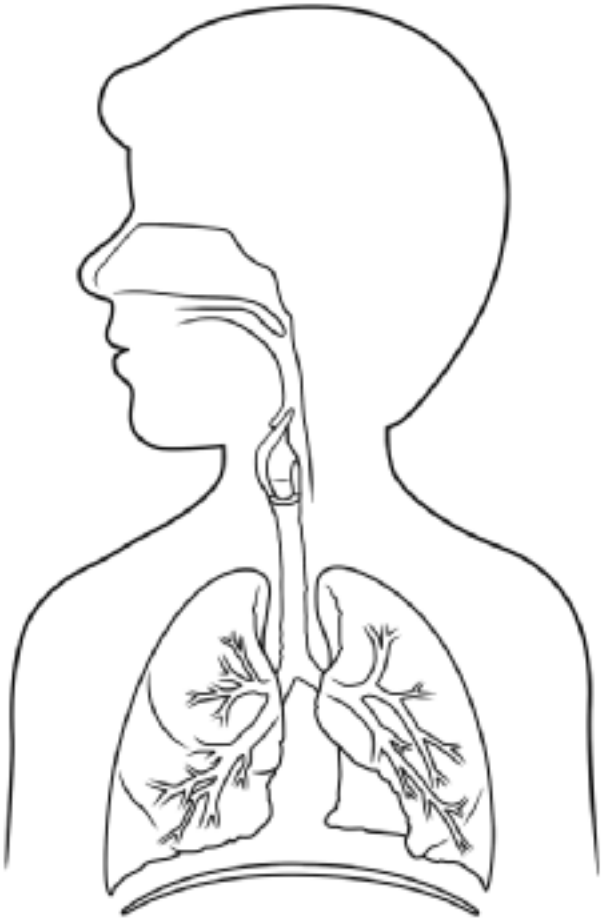
_____

Name _____ Date _____

Activity Page 2.1 Use with Lesson 2.

Structures of the Respiratory System

Label the main structures of the respiratory system. Next, draw and label the diaphragm where it is in the body. Then, draw a dashed line to separate the upper and lower part of this body system.



Organ	How Does It Function When You Inhale?
Diaphragm	
Lung	
Nose	
Sinus	
Throat	
Voice box	
Windpipe (trachea)	

Name _____ Date _____

Activity Page 3.1 Use with Lesson 3.

Investigating Air Quality

Clean air is healthier for people to breathe than dirty air. This is why knowing about air quality in your community is important.

1. On the line above each circle below, write the location the tester will be placed.

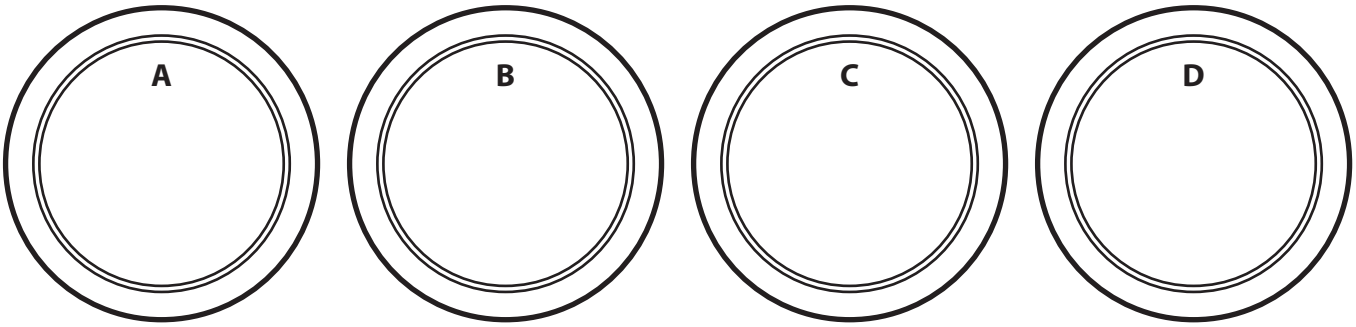
2. Make a claim about which locations will have the best and worst air quality.

_____

3. After twenty-four hours, compare the four plates. Draw what you see below.

4. Rank the four locations so that 1 is the cleanest and 4 is the dirtiest.

_____ _____ _____ _____



Rank: _____ Rank: _____ Rank: _____ Rank: _____

5. Use evidence from your test to support or change your claim.

_____

6. Write a reflection on this investigation. Include what surprised you, if evidence changed your claim, and whether you had fun.

_____

_____

_____

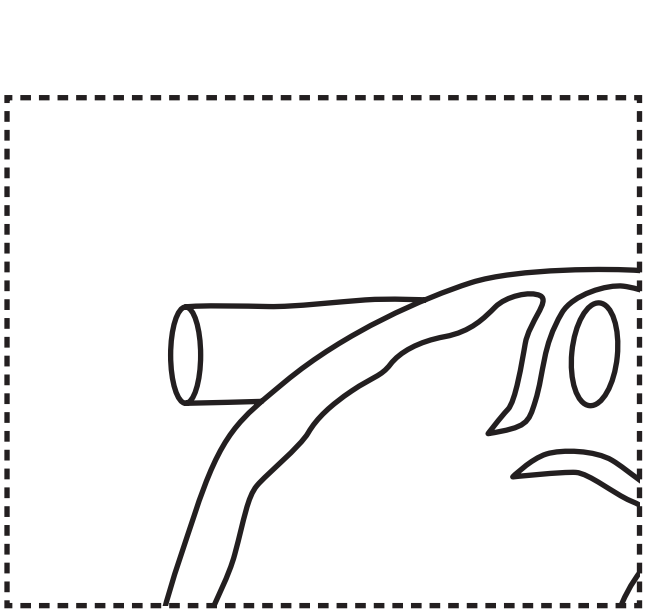
_____

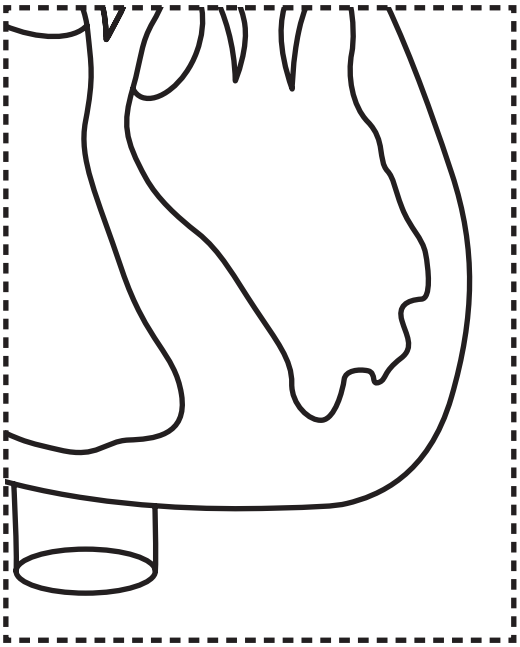
Name _____ Date _____

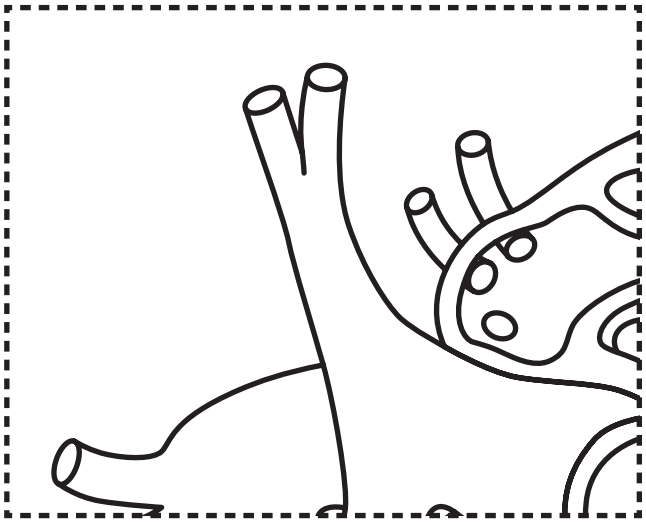
Activity Page 5.1 Use with Lesson 5.

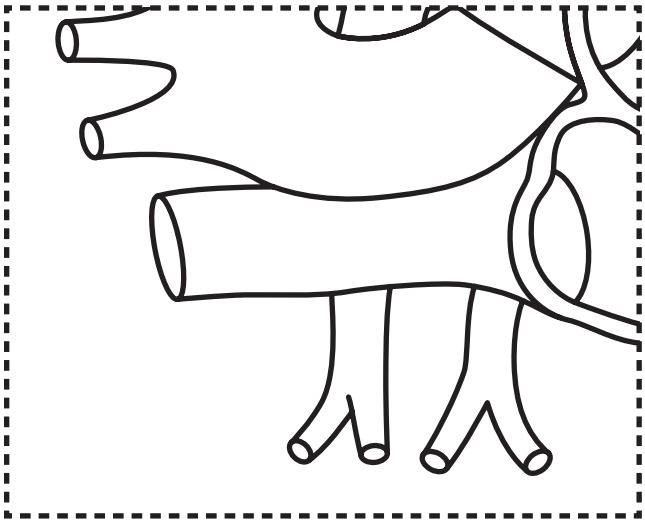
The Heart Is a Puzzle

Cut out the four puzzle pieces on the dotted lines. Arrange and glue them on another sheet of paper to show a complete human heart. Use resources to label the chambers, valves, and aorta. Then draw arrows and labels to show where blood flows.









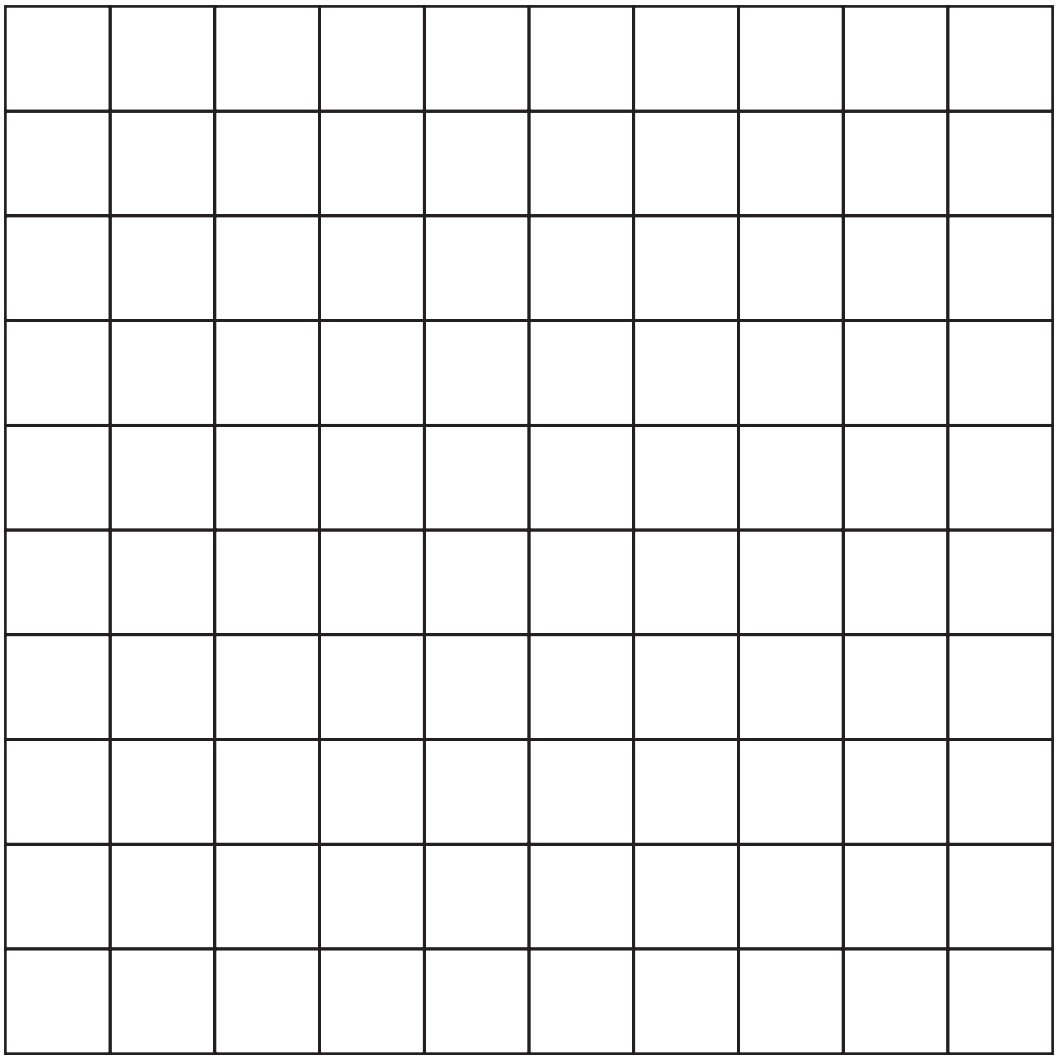
Name _____ Date _____

Activity Page 6.1 Use with Lesson 6.

Draw a Visual Fraction Model of Blood

Use the model to show the fraction of each part of blood in the human body. Plan how to show less than 1/100 on the model. Use a different color for each blood part. Fill in the table key.

Part of Blood	Fraction	Key (fill in color you use on the model)
Red blood cells	45/100	
White blood cells	Less than 1/100	
Platelets	Less than 1/100	
Plasma	54/100	



Name _____ Date _____

Activity Page 7.1 Use with Lesson 7.

How Clean Is the Air You Breathe?

Work in teams to carry out this investigation.

1. Write the letter A at the edge of a white paper plate. Tape the plate to a brick or block. Make three more air testers, labeling them B, C, and D. Spread a light coating of petroleum jelly on each plate.
2. Brainstorm nearby places to test the air, two indoors and two outdoors. Write the places in the chart.
3. With your teacher, place the testers in the four places for twenty-four hours.
4. The next day, carefully collect the testers. Place them side by side, and compare them. In the chart, rank them from the least particles (1) to the most particles (4).

Place	Rank from 1 to 4
A.	
B.	
C.	
D.	

5. Which place had the least particles?

_____

6. Which place had the most particles?

_____

7. How did the air indoors compare to the air outdoors?

_____

8. How do particles in air affect your respiratory system?

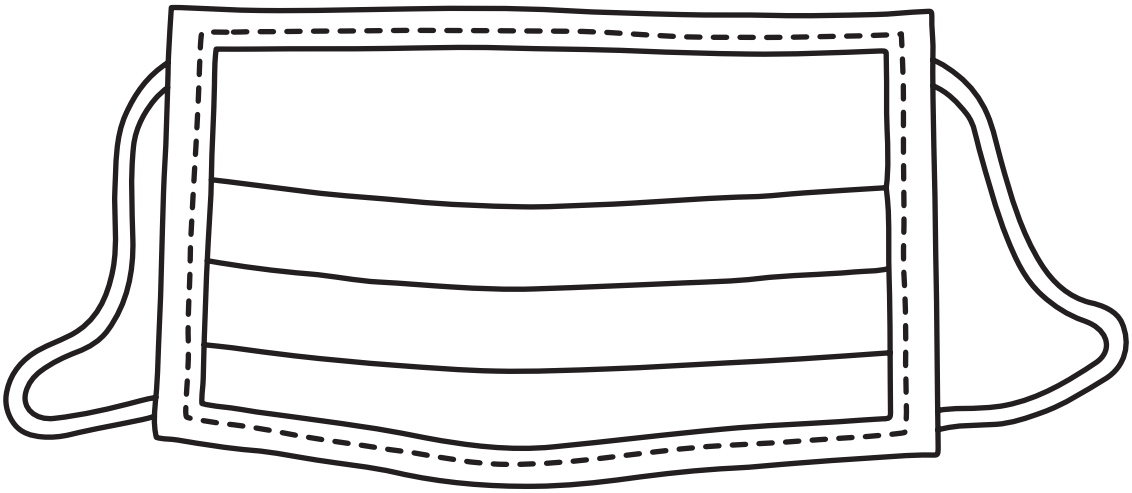
_____

Name _____ Date _____

Activity Page 8.1 Use with Lesson 8.

A Better Mask

There can be particles in air that can harm your respiratory and circulatory systems. A surgical mask can help. But a different mask might work better for you. How can you go about designing a better mask?



1. State the problem you want to solve as a question.

_____

2. State the criteria you have to meet to find a good solution. Criteria are the things the mask has to do to be successful.

_____

_____

3. What are the constraints, or limits, on your solution? These can be cost, time, or what materials can be used.

_____

_____

4. Why will each person's best mask be different from those of other people?

_____

_____

Activity Pages Answer Key: *Human Respiration and Circulation*

This answer key offers guidance to help you assess your students' learning progress. Here you will find descriptions of the expectations and correct answers for each Activity Page of this unit.

Investigating Changes in Breathing and Heartbeats (AP 1.1) (page 53)

Sample answer to first question: The exercise made me breathe faster and made my heart thump.

Student tables should show an increase in heart rate and breathing rate after running.

Sample answer to final question: Running made me breathe faster and made my heart beat faster.

Structures of the Respiratory System (AP 2.1) (page 54)

Answers in the table will vary. Sample labels and answers: diaphragm: contracts to allow the lungs to expand; lung: moves oxygen into the rest of the body; nose: takes in air and traps dust; sinus: makes mucus that traps dirt and dust; throat: allows air to move from the nose to the voice box; voice box: allows air to move into the trachea; windpipe (trachea): delivers air to the lungs and traps dust and dirt

Investigating Air Quality (AP 3.1) (page 55)

Students should note the locations of the testers.

Sample claim: I think the air will be dirtier outside near the teachers' parking lots and better inside in the main office.

Student drawings and rankings should reflect what is seen on their testers.

Sample evidentiary support or revised claim: The test showed that I have to change my claim to say that air quality near the teachers' parking lot is worst.

Sample reflection: I had a good time doing this investigation because I learned something new! I thought that the air outside was clean, but it is dirty near the teachers' parking lot. Because we did the tests, I had to change my claim and that surprised me.

The Heart Is a Puzzle (AP 5.1) (page 56)

Students should label the chambers and blood vessels of the heart as per the text on page 21 of the Student Reader. Valve locations can be found on pages 22 and 23 of the Student Reader.

Draw a Visual Fraction Model of Blood (AP 6.1) (page 57)

Sample answers should show that the white blood cells and platelets share one cell of the model, red blood cells are 45 of the cells of the model, and plasma is 54 of the cells of the model.

How Clean Is the Air You Breathe? (AP 7.1) (page 58)

Student ranking of air quality should reflect their test results.

Student answers to air quality will vary, but usually indoor air is cleaner than outdoor air.

Student answers should note that when particles are inhaled, they cause damage to the lungs and other body parts.

A Better Mask (AP 8.1) (page 59)

Student questions should be along the lines of "What kind of mask is best for me to wear to protect myself from particles in the air?"

Sample criteria: The mask has to be strong enough to wear all day, fit my head size, not leave any gaps where particles can get in my nose, easy to breathe through, and not press on my nose. It also has to be nice looking.

Sample constraints: It has to be inexpensive and use material I can find at home or school.

Sample answer to final question: because people are different sizes, have different-shaped faces, and like different colors and decorations

Appendix A

Glossary

Blue words and phrases are Core Vocabulary for the unit. **Bold-faced words and phrases** are Language of Instruction, additional vocabulary terms related to the unit that you should model for students during instruction. Vocabulary words are not intended for use in isolated drill or memorization.

A

alveolus, n. a tiny air sac inside the lung that moves gases into and out of the body's blood

antibody, n. a substance produced in the body to fight disease

aorta, n. the major blood vessel through which oxygen-rich blood leaves the heart

artery, n. a tube in the body that serve as pathways for blood flow

atrium, n. the upper chamber in the heart from which blood moves to the ventricle

B

blood, n. a body fluid that moves materials throughout the body

blood pressure n. the pressure exerted on the walls of blood vessels produced by the heart pumping

blood type n. the classification of blood based on antibodies and antigens on the surface of a blood cell

blood vessel, n. the tubelike structure in the body through which blood flows

breathe, v. to take air into the lungs and then to expel it from the lungs

bronchial tube, n. the tube connecting the trachea to the lungs

bronchiole, n. the branching tubes in the lungs which connect the main bronchial tubes to the alveoli

C

cancer, n. a disease that causes tissues of the body to grow without control

capillary, n. a very small branching blood vessel

carbon dioxide, n. a gas the body gives off as waste

cardiovascular, adj. relating to the heart and blood vessels

chamber, n. a natural or artificial space

circulation, n. the process of moving blood throughout parts of the body

circulatory system, n. the organ system that moves blood throughout the body

clot, n. a mass of blood cells which are coagulating together

D

diet, n. the combination of foods a person consumes

E

exercise, n. an activity that requires physical effort, done to improve health

exchange, v. to give or take one thing in return for another

F

function, n. the action or purpose for which a thing works

H

health, n. the degree of wellness of the body

heart, n. the muscular organ that pumps blood through the circulatory system

heartbeat, n. a beat caused by the heart contracting, or squeezing, and pushing blood throughout the body

I

inherited, adj. to receive from one's parents

involuntary, adj. done without choice

O

organ, n. a body part made up of related tissues that performs a specific function

oxygen, n. a colorless, odorless gas necessary for almost all life

P

plasma, n. the clear fluid part of blood

platelet, n. a small, flat disk found in blood

pollutant, n. an artificial or natural substance that contaminates air, water, or soil

pulse, n. the detectable surge in pressure as blood moves through an artery

pressure, n. a pushing force exerted in every direction

pulmonary artery, n. a blood vessel that carries blood from the right side of the heart to capillaries in the lungs

R

rate, n. the number of times something occurs in a specific period

red blood cells, n. the tiny structures in blood that carry oxygen to body tissues, at maturity these are simply the cell membrane

respiration, n. the exchange of gases between the body and air

respiratory system, n. the set of organs that function together to move gases into and out of the body

S

structure, n. a part of something that is organized for a specific purpose

T

technology, n. the use of science in solving problems

trachea, n. the tube connecting the larynx to the bronchial tubes

transfusion, n. the injection of new blood into the circulatory system of a person who needs more blood because of illness or injury

transport, v. to move something from one place to another

V

valve, n. a structure in the body that opens and closes, allowing the passage of materials

vein, n. a blood vessel that carries blood low in oxygen from the capillaries to the heart

ventricle, n. the main chamber in the heart that pumps blood to the arteries

vital, adj. necessary for life

voluntary, adj. done by choice

W

white blood cells, n. the blood cells that contain structures that fight infections

Appendix B

Classroom Safety for Activities and Demonstrations

In the Core Knowledge Science program (CKSci), activities and demonstrations are a vital part of the curriculum and provide students with active engagement related to the lesson content. The activities and demonstrations in this unit have been selected and designed to engage students in a safe manner. The activities and demonstrations make use of materials and equipment that are typically deemed classroom safe and readily available.

Safety should be a priority when engaged in science activities. With that in mind, observe the following safety procedures when the class is engaged in activities and demonstrations:

- Be aware of students who have food allergies, and adjust related activities or make materials substitutions as necessary. Check the ingredients of all food to make sure known allergies are not listed. Students with food allergies can still be affected even if they do not ingest the food item. Some common food allergies are peanuts, tree nuts (e.g., almonds, walnuts, hazelnuts, etc.), and cow's milk (rice milk is a good nut-free alternative).
- Report and treat any injuries immediately.
- Check equipment prior to usage, and make sure everything is clean and ready for use.
- Clean up spills or broken equipment immediately using the appropriate tools.
- Monitor student behavior to ensure they are following proper classroom and activity procedures.
- Do not touch your eyes, ears, face, or mouth while engaging in an activity or demonstration.
- Review each step of the lesson to determine if there are any safety measures or materials necessary in advance.
- Wear personal protective equipment (e.g., safety goggles, aprons, etc.) as appropriate.
- Check for allergies to latex and other materials that students may have, and take appropriate measures.
- Secure loose clothing, hair, or jewelry.
- Establish storage and disposal procedures for chemicals as per their Safety Data Sheet (SDS), including household substances such as vinegar and baking soda.

Copy and distribute the Student Safety Contract, found on the next page. Have a read-along, and have students agree to the expectations for students when engaged in science activities prior to the start of the first unit.

Online Resources

For additional support for safety in the science classroom, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Student Safety Contract

When doing science activities, I will do the following:

- Report spills, breakages, or injuries to the teacher right away.
- Listen to the teacher for special instructions and safety directions. If I have questions, I will ask the teacher.
- Avoid eating or drinking anything during the activity unless told to by my teacher.
- Review the steps of the activity before I begin. If I have questions, I will ask the teacher.
- Wear safety goggles when working with liquids or things that can fly into my eyes.
- Be careful around electric appliances and unplug them, just by pulling on the plug, when a teacher is supervising.
- Keep my hands dry when using tools and devices that use electricity.
- Be careful to use safety equipment like gloves or tongs when handling materials that may be hot.
- Know when a hot plate is on or off and let it cool before touching it.
- Roll or push up long sleeves, keep my hair tied back, and secure any jewelry I am wearing.
- Return unused materials to the teacher.
- Clean up my area after the activity and wash my hands.
- Treat all living things and the environment with respect.

I have read and agree to the safety rules in this contract.

_____ _____/_____/_____/

Student signature and date

_____

Print name

Dear Parent or Guardian,

During science class, we want to create and maintain a safe classroom. With this in mind, we are making sure students are aware of the expectations for their behavior while engaged in science activities. We are asking you to review the safety rules with your student and sign this contract. If you have any questions, please feel free to contact me.

_____ _____/_____/_____/

Parent or guardian signature and date

Appendix C

Strategies for Acquiring Materials

The materials used in the Core Knowledge Science program (CKSci) are readily available and can be acquired through both retail and online stores. Some of the materials will be reusable and are meant to be used repeatedly. This includes equipment such as scales, beakers, and safety goggles but also items such as plastic cups that can be safely used again. Often these materials are durable, can be cleaned, and will last for more than one activity or even one school year. Other materials are classified as consumable and are not able to be used more than once, such as glue, baking soda, and aluminum foil.

Online Resources

The Material Supply List for this unit's activities can be found online. Follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Ways to Engage with Your Community

The total cost of materials can add up for an entire unit, even when the materials required for activities and demonstrations have been selected to be individually affordable. And the time needed to acquire the materials adds up too. Reaching out to your community to help support STEM education is a great way to engage parents, guardians, and others with the teaching of science, as well as to reduce the cost and time of collecting the materials. With that in mind, the materials list can be distributed or used as a reference for the materials teachers will need to acquire to teach the unit.

Consider some of the following as methods for acquiring the science materials:

- School Supply Drive—If your school has a supply drive at any point in the year, consider distributing materials lists as wish lists for the science department.
- Open Houses—Have materials lists available during open houses. Consider having teams of volunteers perform an activity to show attendees how the materials will be used throughout the year.
- Parent-Teacher Organizations—Reach out to the local PTO for assistance with acquiring materials.
- Science Fair Drive—Consider adding a table to your science fair as part of a science materials drive for future units.
- College or University Service Project—Ask service organizations affiliated with your local higher education institutions to sponsor your program by providing materials.
- Local Businesses—Some businesses have discounts for teachers to purchase school supplies. Others may want to advertise as sponsors for your school/programs. Usually you will be asked for verifiable proof that you are a teacher and/or for examples of how their sponsorship will benefit students.

Remember: If your school is public, it will be tax exempt, so make sure to have a Tax Identification Number (TIN) when purchasing materials. If your school is private, you may need proof of 501(c)(3) status to gain tax exemption. Check with your school for any required documentation.

Appendix D

Advance Preparation for Activities and Demonstrations

Being properly prepared for classroom activities and demonstrations is the first step to having a successful and enriching science program. Advance preparation is critical to effectively support student learning and understanding of the content in a lesson.

Before doing demonstrations and activities with the class, do the following:

- Familiarize yourself with the activity by performing the activity yourself or with a team, and identify any issues or talking points that could be brought up.
- Gather the necessary materials for class usage. Consider if students will gather their materials at stations or if you will preassemble the materials to be distributed to the students and/or groups.
- Identify safety issues, such as food allergies, that could occur during an activity or demonstration, and plan and prepare how to address them.
- Review the Teacher's Guide before teaching, and identify opportunities for instructional support during activities and demonstrations. Consider other Support and/or Challenge opportunities that may arise as you work to keep students engaged with the content.
- Prepare a plan for postactivity collection and disposal of materials/equipment.

While engaged in the activity or demonstration, do the following:

- Address any emergencies immediately.
- Check that students are observing proper science safety practices as well as wearing any necessary safety gear, such as goggles, aprons, or gloves.
- When possible, circulate around the room, and provide support for the activity. Return to the Teacher Guide as students work, to utilize any Support and Challenge opportunities that will make the learning experience most meaningful for your students.

After the activity or demonstration, do the following:

- Use your plan for students to set aside or dispose of their materials as necessary.
- Have students wash their hands after any activity in which they could come in contact with any potentially harmful substances.

When engaging students in activities and demonstrations, model good science practices, such as wearing proper safety equipment, never eating during an investigation, etc. Good science practices at a young age will lead to students observing good science practices themselves and being better prepared as they move into upper-level science classes.

Appendix E

What to Do When Activities Don't Give Expected Results

Science activities and experiments do not always go according to plan. Microwave ovens, super glue, and X-rays are just some of the discoveries made when people were practicing science and something did not go according to plan. In your classroom, however, you should be prepared for what to do when activities don't give the expected results or when an activity doesn't work.

When going over an activity with an unexpected result, consider these points in discussion with your students:

- Was there an error in following the steps in order? You or the student may have skipped a step. To help control for this, have students review the steps to an investigation in advance and make a check mark next to each step as they complete it.
- Did students design their own investigation? Perhaps their steps are out of sequence, or they missed a step when performing the activity. Review and provide feedback on students' investigation plan to ensure the work is done in proper sequence and that it supports the lesson segment's guiding question.
- When measurements were taken, were they done correctly? It is possible a number was written down incorrectly; a measurement was made in error, such as a wrong unit of measure or quantity; or the starting or ending point of a measurement was not accurate.
- Did the equipment or materials contribute to the situation? For example, chemicals that have lost their potency or a scale that is not measuring accurately can contribute to the success or failure of an activity.

One of the greatest gifts a student can learn when engaged in science is to develop a curiosity for *why something happened*. Students may find it challenging or frustrating to work through a problem during an activity, but guiding them through the problem to figure out *why* something happened will help them to develop a better sense of how to do science.

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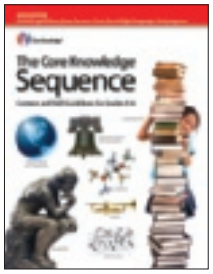
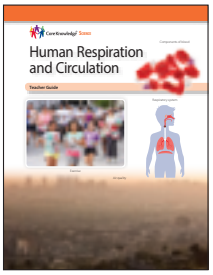


What is the Core Knowledge Sequence?

The *Core Knowledge Sequence* is a detailed guide to specific content and skills to be taught in Grades K–8 in language arts, history, geography, mathematics, science, and the fine arts. In the domains of science, including Earth and space, physical, and life sciences, the *Core Knowledge Sequence* outlines topics that build systematically grade by grade to support student learning progressions coherently and comprehensively over time.



For which grade levels is this book intended?

In general, the content and presentation are appropriate for students in the middle elementary grades. For teachers and schools following the *Core Knowledge Sequence*, this book is intended for Grade 4 and is part of a series of **Core Knowledge SCIENCE** units of study.

For a complete listing of resources in the
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