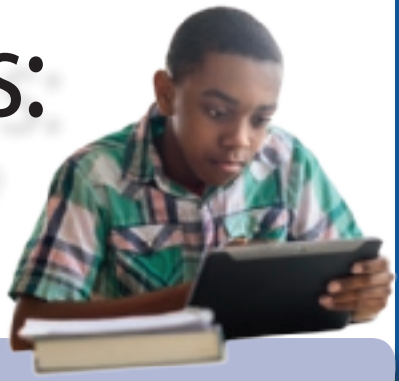
# Cells and Systems:
## How do living things heal?

Science Literacy



**Teacher Guide**

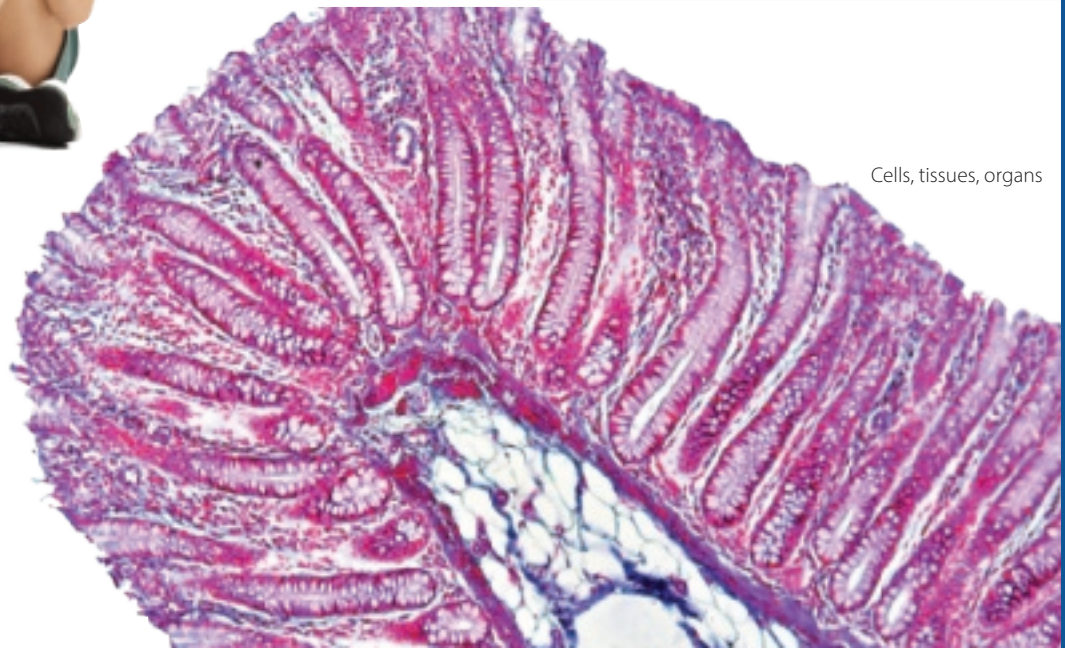
Injury and healing



Medical imaging



Cells, tissues, organs



GRADE 6 Core Knowledge Science®

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This unit is a modified version of a unit that has earned the NGSS Design Badge. The sole instructional modification is the addition of Core Knowledge Science Literacy content. The modification has not been reviewed.

# Cells and Systems:

## How do living things heal?

### Teacher Guide



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# Cells and Systems:

## How do living things heal?

### Table of Contents


**Unit Introduction**

Unit Overview ..... 1
Unit Storyline ..... 3
Teacher Background Knowledge ..... 12

**Learning Plans**

Reading: Science Literacy Routine, Preface ..... 30
Lesson 1: What happened in the student's foot so they could walk again? .. 34
Lesson 2: What do our bones, skin, and muscles do for us? ..... 71
Reading Collection 1: Body Parts (and Breaking Them) ..... 98
Lesson 3: How can medical images and diagrams help us figure out more about the structures in our body? ..... 106
Lesson 4: Why is there blood in all of these places in the body? ..... 122
Lesson 5: What do nerves do, and why are they in different parts of the body? ..... 156
Reading Collection 2: Inside the Body ..... 181
Lesson 6: What will we see if we look at skin, bone, and muscle with the microscope, too? ..... 188
Lesson 7: Are all things made of cells? ..... 204
Lesson 8: What happened as the skin on top of the foot healed? ..... 216
Lesson 9: What is happening at the site of an injury to fill the gap? ..... 228
Lesson 10: What do cells need to grow and make more of themselves? ... 243
Reading Collection 3: Cells, Health, and Healing ..... 268
Lesson 11: How do cells get what they need to grow? ..... 275
Lesson 12: How do the structures and systems in the body work together to heal the injury? ..... 293
Lesson 13: How is the process of growing similar to healing? ..... 309
Lesson 14: How can shifting our perceptions of ability and disability allow us to be more thoughtful about how we make our environments more accessible? ..... 318
Reading Collection 4: Growth, Development, and Difference ..... 344

**Teacher Resources**

Teacher Reference Materials ..... 351
Lesson-Specific Teacher Materials ..... 365
Acknowledgments


**Cells and Systems**
**Teacher Guide**
Core Knowledge Science™ 6

# BEFORE YOU BEGIN

Before introducing the unit, please become fully acquainted with the program instructional model and classroom routines by reading the online resource **Teacher Handbook: Overview of the Core Knowledge Middle School Science Program**.

| | |
|---|---|
| **Online Resources**  | Use this link to download the **CKSci Online Resources Guide** for this unit, which includes specific links to:<br>• the unit's comprehensive materials list<br>• a full unit pacing snapshot<br>• lesson guidance slides<br>• all other recommended resources.<br>**www.coreknowledge.org/cksci-online-resources** |
| **Student Work Pages**  | All student handouts and exercise pages are included in the consumable Student Work Pages book so that there is no need to print copies of these resources. |
| **Student Books**  | All student handouts and exercise pages are included in the consumable Student Work Pages book so that there is no need to print copies of these resources. Students also will use the Student Procedure Guide and the Science Literacy Student Reader throughout the unit. |

# UNIT OVERVIEW

## How do living things heal?

This unit on cells and systems begins with students reflecting about activities they do with their bodies and a time when something happened inside their body that prevented them from doing those activities. Students then obtain information from doctor's notes and images about an injury and recovery of a middle school student. This prompts them to develop an initial model to explain: What happens during the healing process so the student was able to use his foot again to walk, run, jump, and dance? This initial work sets students up to ask questions about "How does the foot (or body) heal?"

Students begin by investigating the structures impacted by injury in the foot which leads them to figure out that when one part of the system is injured or broken, the whole system is affected and can't function the way it used to. This leads students to look closer at the parts of the foot, using medical images and cross sections, to figure out more about how the parts of the foot interact. In doing so, students discover that blood and nerves are present in each of the parts of the body they investigated. Students spend the next two lessons investigating the structure and function of blood and nerves, down to the cellular and subcellular level gathering evidence for what is happening inside the healed or uninjured body. Students investigate the structure and function of skin, bone, and muscle at the cellular and subcellular level which leads them to figure out that even though the structures and functions of each of these smaller structures within each body part is unique (which dictates their function), there are similarities in cells across tissue type. In their first putting the pieces together lesson, students use evidence to make a claim about whether other things in our world are also made up of cells. Through analyzing microscopic images, students figure out that the parts of living things they have looked at are made of cells while the parts of non-living things they look at are not made of cells.

Students then launch into their questions about healing at the cellular level as the focus of the second lesson set. They develop and use a model of what is happening as cells grow and split to fill the gap from the injury with new cells. This motivates students to wonder about what cells need to grow and make more of themselves. Students analyze secondhand data about bacterial cell growth and obtain information about single-celled organisms to figure out that not only are cells living, but they can also exist on their own as single cells. This leads them to wonder how what cells need gets into and out of the cell, so they once again use microscopes to see what is happening at the cell and subcellular level.

Through these investigations, students will do the following:

- Ask questions that arise from careful observation of an example of healing to seek additional information about how healing happens.

- Carry out investigations to observe the microscopic structures of cells and what is happening inside living systems and subsystems, at different scales.
- Critically read scientific texts adapted for classroom use to obtain information about the structure and function of and interactions between and within systems in the human body as well as unicellular organisms.
- Develop and use models to describe the healing process and other related phenomena.
- Engage in argument from evidence that single-celled organisms grow and split in similar ways to animal cells.
- Apply science ideas from the evidence collected by investigating healing to construct an explanation for how growth is happening at the bones in growth plates.

## Building Toward NGSS Performance Expectations

MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells.

MS-LS1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

MS-LS1-3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

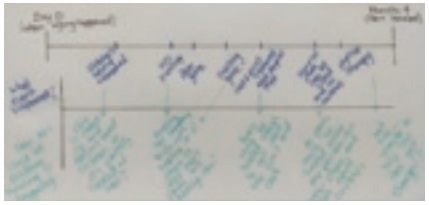
MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

# UNIT STORYLINE

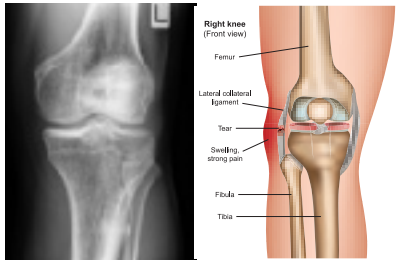
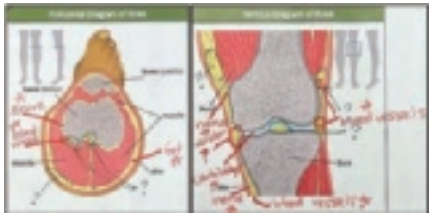
How students will engage with each of the phenomena

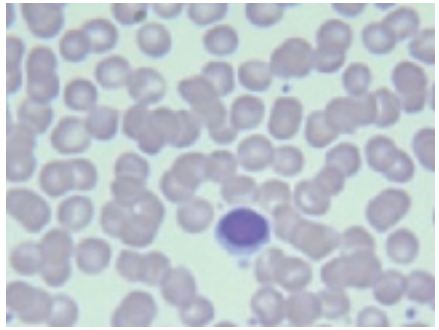
HANDS-ON/ LAB ACTIVITIES | VIDEOS OR IMAGES | DATA SETS | READINGS | COMPUTER INTERACTIVES

## How do living things heal?

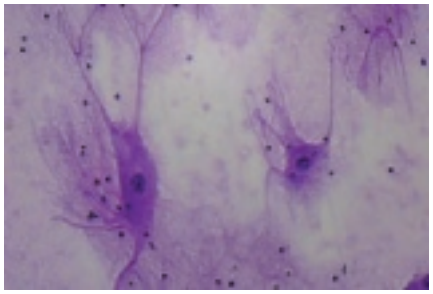
| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 1**<br>**4 days**<br>**What happened in the student's foot so they could walk again?**<br>Anchoring Phenomenon |  <br>*A middle school student injured his foot and could not walk. Over the next 4 months, the foot healed and the student could walk again.* | We share our experiences moving our bodies and times when we were unable to. We read doctor's notes and see images of an injury. We create a timeline of important events that show evidence of healing. We develop models to show how the parts of the foot work together so the patient can walk again. We brainstorm related phenomena of other times we have seen healing in humans and other living things. We figure out these things:<br>• A student who was previously able to walk was injured in an accident and could no longer walk.<br>• Some of the injured parts of the foot needed outside supports during the healing process.<br>• Over time, the injured parts of the foot were able to heal; some took longer than others.<br>• The injury caused gaps between the damaged structures in the foot. |  |

⇩ **Navigation to Next Lesson:** We want to know more about how parts of the foot work in an uninjured foot before we can figure out why they are not working in an injured foot.

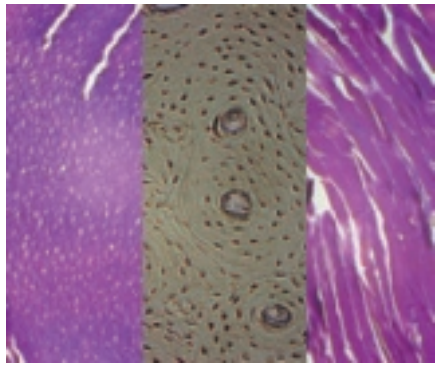
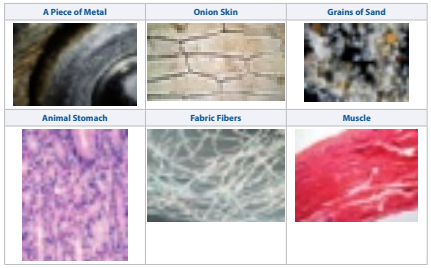
| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 2**<br>**2 days**<br>**What do our bones, skin, and muscles do for us?**<br>Investigation |  <br>*A chicken wing shows the interactions between skin, muscle, and bone during movement. When the bone in the wing is damaged and broken, it cannot function the same as in an uninjured wing.* | We investigate the parts that make up a chicken wing and how they work together when moving by watching a video of the dissection of its skin, muscle, and bone. We map the parts of the chicken wing to the parts of the human foot to make sense of how these parts work together in similar ways in each. Then, we revise the investigation to figure out how function can be affected because of an injury. We figure out these things:<br>• Skin is attached to the muscle underneath it, and the muscle is attached to bones.<br>• Bones move when the muscles attached to them move.<br>• The muscles and bones are both parts of the wing system (or foot system) and interact for the wing (or foot) to move.<br>• When one part of the system is broken or injured, the whole system is affected and can't function the way it used to. |  |
| ⇩ **Navigation to Next Lesson:** We want to look more closely at the different parts of the foot to figure out more about how they interact so we can figure what happens for them to heal. | | | |
| **LESSON 3**<br>**1 day**<br>**How can medical images and diagrams help us figure out more about the structures in our body?**<br>Investigation |  <br>*Medical images and scientific diagrams can be cross-referenced to identify structures within the body.* | We decide we need to see the different structures inside a body. We observe different types of medical images of a body. We analyze various scientific diagrams to help us interpret the different structures within the images we observed. We figure out that<br>• There are blood vessels in the different parts of the bone, muscle, and skin.<br>• There are nerves that run through the layers of the skin, the muscle, and the bone. |  |
| ⇩ **Navigation to Next Lesson:** We figured out that the skin, muscles, and bone in our body are very similar to the ones we observed in the chicken wing we looked at in the previous lesson. We also noticed that when we looked closer at these parts, there were other parts, like blood vessels and nerves, and we wonder what their role is inside the body. | | | |

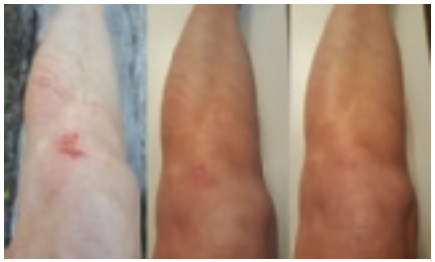
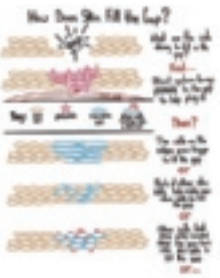
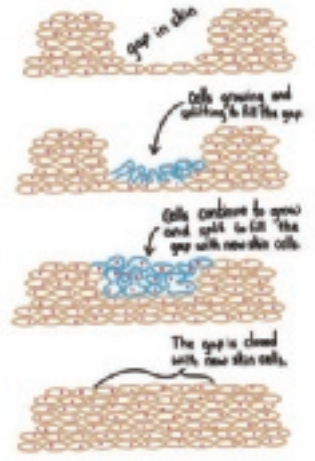
| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 4**<br>**3 days**<br>**Why is there blood in all of these places in the body?**<br>Investigation |  <br>*A blood sample that looks homogenous when newly drawn separates into distinct layers after being left to stand. When viewed with a microscope, blood smears from humans and other mammals contain three different round components.* | We view an image of blood vessels to determine that blood circulates everywhere in the body, and we notice that blood in a test tube settles into layers. We use microscopes to investigate human and mammal blood on pre-prepared slides, observing that blood is composed of several different smaller structures. We read an article to make sense of the patterns we saw, considering how the structures of the blood and its components support their functions in the body. We figure out:<br>• As a whole, the blood's function is to travel around the body carrying the things the body needs.<br>• The blood's flowy liquid nature (structure) allows it to perform its function.<br>• Blood vessels in a body help blood get to where it needs to go throughout the body.<br>• Blood is composed of a mixture of components that we cannot see without a microscope.<br>• Blood is made of red blood cells, white blood cells, platelets, and blood plasma.<br>• The structure of blood cells relates to their function: their round shape helps them travel easily through the tubular blood vessels.<br>• Platelets' structure relates to their function: their branching arms and stickiness help them plug damaged parts of the blood vessels to stop leaks. |  |

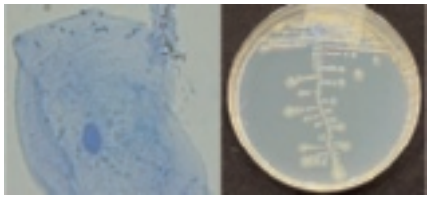
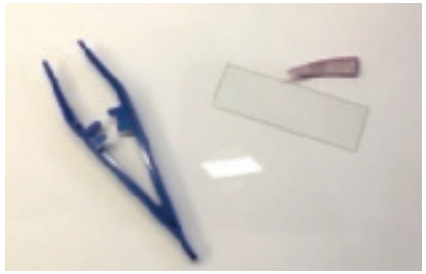
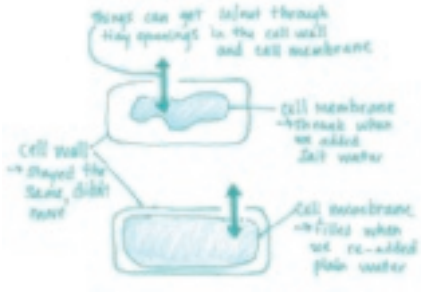
⇩ **Navigation to Next Lesson:** We figured out that blood and blood vessels run throughout the body to bring the body things it needs, and blood has microscopic structures that support its functions. Like blood vessels, we also saw nerves in skin, muscle, and bone, and we wonder why there are nerves all over the body, too.

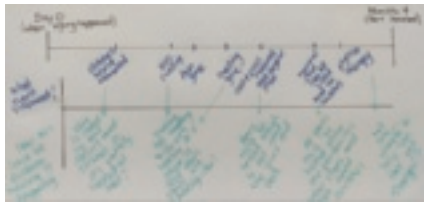
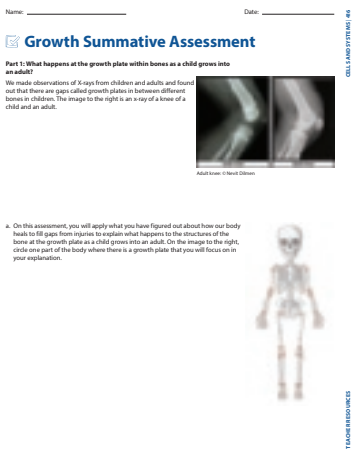
| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 5**<br>**2 days**<br>**What do nerves do, and why are they in different parts of the body?**<br>**Investigation** |  <br>*Nerve cells branch out all over the body to create a system that allows signals to travel throughout the body, including to and from the brain.* | Nerves, like blood vessels, are found throughout the body. We investigate nerves under a microscope and we notice that nerves have a unique and intricate structure. We read about nerves and learn that the nerve cell's structure suits its function. We engage in a few quick experiences that help us understand the role that nerves play in our bodies. Then we revisit the foot injury and think about how we can leverage what we now know about the function of nerves to better understand how the foot works and the healing process of the skin, muscles, and bones affected by the injury to the foot. We figure out:<br>• Nerve cells have a very unique structure—they have long, thin "branches" or "tentacles" extending from a central portion.<br>• Nerve cells branch out and connect to other nerve cells, forming a network of nerves that carry signals between all parts of the body and the brain.<br>• The structure of nerve cells is perfectly suited for their function—they branch out and connect with all parts of the body so that they can carry signals back and forth between the body and the brain. |  |

⇩ **Navigation to Next Lesson:** We figured out that the structure of nerve cells is perfectly suited for the function that they carry out, but there is more that we need to figure out about the role of nerves in healing.

| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 6**<br>**1 day**<br>**What will we see if we look at skin, bone, and muscle with the microscope, too?**<br>Investigation |  <br>*Slides of human skin, bone, and muscle samples look different when viewed with a microscope, but each is composed of smaller structures arranged in repeating patterns.* | We investigate pre-prepared slides of bone, skin, and muscle and then use our observational data to come to consensus around how cells' unique structures support their functions in the body. We figure out:<br>• Bone, muscle, and skin are made up of repeating patterns of microscopic structures called cells, and groups of these cells form tissues.<br>• Cells that make up different tissues are structured differently, depending on their function in the body.<br>• Structure is the characteristic of something (the shape or way it's made or arranged) that supports its function. |  |
| ⇩ **Navigation to Next Lesson:** Now that we have figured out what the different parts of the foot system are made of when they're functioning correctly, we will go back to our timeline and capture what we have figured out. What else do we need to know about the foot to explain how it heals? | | | |
| **LESSON 7**<br>**1 day**<br>**Are all things made of cells?**<br>Putting Pieces Together |  <br>*We analyze multiple microscopic images of some living and non-living things as data to determine whether they are all made of cells.* | This lesson marks the end of the first lesson set. Students take an individual assessment where they plan an investigation to collect data to determine if other things are made of cells. They analyze microscopic images of living and non-living things as data to look for evidence of cells. They use these data to argue from evidence that parts of living (or formerly living) things are made of cells—not things that were never living are not made of cells. We figure out:<br>• Microscopic samples from living things that we analyze are made of cells.<br>• Microscopic samples from things that were never living are not made of cells. | |
| ⇩ **Navigation to Next Lesson:** We figured out that not all things are made of cells but the parts of the things we looked at that were once living are made of cells. Now we wonder, What happens to these cells when an injury occurs? | | | |

| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 8**<br>**1 day**<br>**What happened as the skin on top of the foot healed?**<br>Problematizing, Investigation |  <br>*A time-lapse video of skin healing after a bike crash shows the formation of new skin over time.* | We revisit the healing timeline and Driving Question Board to connect what questions we have answered, like what the foot is made of and how these parts work together to help us function. We revise our definition of *healing* to include that healing must involve filling in the gaps in the injury with cells, but we do not know how. We observe a time-lapse video of a skin wound healing to gather more information about what must be happening in the healing process. We revise our model to specifically focus on and predict what happens with cells for skin to heal. We figure this out:<br>• New skin (which is made of cells) forms as the site of the injury gets smaller and smaller. |  |
| ⇩ **Navigation to Next Lesson:** We figure out that as a skin wound heals, the opening in the skin gets smaller and smaller, and there is new skin where there was not skin before. We wonder how the cells that make up the skin fill the gap. | | | |
| **LESSON 9**<br>**1 day**<br>**What is happening at the site of an injury to fill the gap?**<br>Investigation |  <br>*A gap in skin, muscle, or bone is filled in by the formation of new cells from old cells of the same type, but what do cells need in order to make more cells?* | We analyze a video and microscopic images of cells splitting and growing in different organisms. By observing this process at different spatial (zoomed-in/out video and images) and time scales (full/half-speed video), we make sense of how our body fills a gap at the site of an injury, such as broken skin or bone. We figure out these things:<br>• New cells come from old cells, which grow and split through a repeated and nonrandom process.<br>• When cells grow and split, they make new cells of the same type (e.g., skin cells make new skin cells and bone cells make new bone cells).<br>• A gap in the skin, muscle, or bone is filled by new cells as a result of cells growing and splitting. |  |
| ⇩ **Navigation to Next Lesson:** Because our body fills a cut in the skin or a break in the bone by making new cells, we want to know what the cells require to do this. We know that our body requires food and energy to grow, so we wonder if cells need something similar to split and grow. | | | |

| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 10**<br>**2 days**<br>**What do cells need to grow and make more of themselves?**<br>**Investigation** |  <br>*Bacteria, an organism made of one cell, make more of themselves when given nutrients. The more nutrients, the more the bacteria cells make.* | We recall what we (humans) need to grow and wonder if cells also need the same things to grow, since they are living, too. Since we can't easily study cells from our bodies, we investigate single-celled organisms. We look at data from a scientist, who grew bacteria on agar plates with different nutrient levels. We analyze the data and notice that the quantities of bacteria made increased with increasing nutrient levels. We read about other unicellular organisms and figure out that they are living things that need food to make more of themselves. We figure out:<br>• Cells need food to make more cells.<br>• More cells grow when they have more food around them.<br>• There are single-celled (unicellular) and many-celled (multicellular) living things.<br>• Cells are living things.<br>• All living things are made of cells. | |
| ⇩ **Navigation to Next Lesson:** We figured out that living things can be made of one or many cells and those cells need food to grow, like humans. We wonder how those cells get what they need in order to make new cells. | | | |
| **LESSON 11**<br>**1 day**<br>**How do cells get what they need to grow?**<br>**Investigation** |  <br>*Onion cell membranes shrink and expand in the presence of salt water and plain water, respectively.* | We observe onion cells using microscopes. We add salt water, then plain water, to the onion skin and observe changes in the cells. We use our observations to explain how plant cells let water out of and into the cell. We figure out:<br>• Plant cells have a cell wall and a cell membrane.<br>• The cell wall is a structure that is unique to plants and helps the cell maintain its shape.<br>• The cell membrane and cell wall act as a barrier and allow things the cell needs (food, nutrients, etc.) into and out of the cell. |  |
| ⇩ **Navigation to Next Lesson:** We think we have enough information to explain healing—let's do that, and revisit our DQB to see what we're still wondering about. | | | |

| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 12**<br>**2 days**<br>**How do the structures and systems in the body work together to heal the injury?**<br>Putting Pieces Together |  <br>*Systems in the body interact and work together for the body to be able to heal from injuries.* | We revisit the timeline of healing from Lesson 1 and develop explanations for how healing happens based on each event we had listed. We come to consensus about how the healing in the foot happened, developing a list of key science ideas. We use what we have figured out about healing so far to see if we can explain how the systems in our body interact to support the healing process. We figure out:<br>• The body reacts to an injury by swelling, which increases blood flow and brings extra fluid to injured tissue to help it heal.<br>• The healing process for the foot is similar to how other body parts and other living things heal as well. | |
| ⇩ **Navigation to Next Lesson:** We know that the systems and structures in the body work together to heal injuries, but how is this similar or different from growing? | | | |
| **LESSON 13**<br>**1 day**<br>**How is the process of growing similar to healing?**<br>Putting Pieces Together |  <br>*Children have smaller bones than adults and have growth plates in bones that fill in over time and become bone.* | We apply what we have figured out about healing to explain a related phenomenon, growth. We revisit the Driving Question Board and discuss all of our questions that we have now answered, which leads us to revise our main question to include growth. We reflect on and celebrate our experiences in this unit and this year of science. We figure out:<br>• Children have growth plates in their skeletons which are gaps between their bones.<br>• Growth in humans is similar to healing.<br>  • Cells fill a gap in each tissue/body part.<br>  • The same structures and systems that are needed to heal are needed to grow. |  <br>Name: _____ Date: _____<br>**Growth Summative Assessment**<br>**Part 1: What happens at the growth plate within bones as a child grows into an adult?**<br>We made observations of X-rays from children and adults and found out that there are gaps called growth plates in between different bones in children. The image to the right is an x-ray of a knee of a child and an adult.<br>Adult knee: © Nevit Dilmen<br>a. On this assessment, you will apply what you have figured out about how our body heals to fill gaps from injuries to explain what happens to the structures of the bone at the growth plate as a child grows into an adult. On the image to the right, circle one part of the body where there is a growth plate that you will focus on in your explanation.<br>CELLS AND SYSTEMS | 4th<br>TEACHER RESOURCES |
| ⇩ **Navigation to Next Lesson:** We figured out that human growth is similar to healing. We wonder if we can investigate other living things to see how they heal and grow. | | | |

| Lesson Question | Phenomena or Design Problem | What we do and figure out | How we represent it |
|---|---|---|---|
| **LESSON 14**<br>**3 days**<br>**How can shifting our perceptions of ability and disability allow us to be more thoughtful about how we make our environments more accessible?**<br>Investigation |  <br>*People with different disabilities may have different ways of functioning but everyone has needs and our world should be accessible by all.* | We revise our definition of healing to include thinking about the impacts on the way our body functions. Then we consider how we are still able to achieve our goals even when the way our body functions changes. We read and hear about five stories from people with disabilities, the challenges they face, as well as their perception of their disability. We brainstorm ways to adapt and redesign our environment in order to make it more accessible to people with disabilities. We figure out:<br>• A person could be healed, but that part of the body may have a different function than before.<br>• Some disabilities are temporary and some are permanent.<br>• Some disabilities are visible and some are invisible.<br>• Many disabled people count disability as an important part of their identity. It is something to celebrate and take pride in.<br>• It's important for environments to be designed to be more accessible for all people. |  |
| **LESSONS 1–14**<br>25 days total | | | |

# TEACHER BACKGROUND KNOWLEDGE

## Lab Safety Requirements for Science Investigations

It is important to adopt and follow appropriate safety practices within the context of hands-on investigations and demonstrations, whether this is in a traditional science laboratory or in the field. In this way, teachers need to be aware of any school or district safety policies, legal safety standards, and better professional practices that are applicable to hands-on science activities being undertaken.

Science safety practices in laboratories or classrooms require engineering controls and personal protective equipment (e.g., wearing safety goggles, non-latex aprons and gloves, eyewash/shower station, fume hood, and fire extinguishers). Science investigations should always be directly supervised by qualified adults and safety procedures should be reviewed annually prior to initiating any hands-on activities or demonstrations. Prior to each investigation, students should also be reminded specifically of the safety procedures that need to be followed. Each of the lessons within the units includes teacher guidelines for applicable safety procedures for setting up and running an investigation, as well as taking down, disposing, and storing materials.

Prior to the first science investigation of the year, a safety acknowledgment form for students and parents or guardians should be provided and signed. You can access a model safety acknowledgment form for middle school activities. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

Disclaimer: The safety precautions of each activity are based in part on the use of the specifically recommended materials and instructions, legal safety standards, and better professional safety practices. Be aware that the selection of alternative materials or procedures for these activities may jeopardize the level of safety and therefore, is at the user's own risk.

## Please follow these lab safety recommendations for any lesson with an investigation:

1. Wear safety goggles (specifically, indirectly vented chemical splash goggles), a non-latex apron, and non-latex gloves during the set-up, hands-on investigation, and take down segments of the activity.
2. Immediately wipe up any spilled water and/or granules on the floor, as this is a slip and fall hazard.
3. Follow your *Teacher Guide* for instructions on disposing of waste materials and/or storage of materials.
4. Secure loose clothing, remove loose jewelry, wear closed-toe shoes, and tie back long hair.
5. Wash your hands with soap and water immediately after completing the activity.
6. Never eat any food items used in a lab activity.
7. Never taste any substance or chemical in the lab.



Specific safety precautions are called out within the lesson using this icon and a callout box.

## What is the anchoring phenomenon and why was it chosen?

The anchoring phenomenon of this unit is a case study of a middle school student who suffered an injury in PE class when he dropped a weight on his foot. The impact of this injury resulted in two bones in his foot breaking. Due to this injury, the student had pins put in his foot to line up the bones, stitches to close up the skin that had broken open, and a cast to support the foot as the bones healed. It took four months for the student's injury to heal which included physical therapy once his cast was off to support strengthening his foot and leg.

Students are experts in their lived experiences which makes these experiences educational resources for the science classroom. Students' experiences with their own healing of common childhood injuries, such as scraping a knee on a sidewalk, allow students to engage in the anchoring phenomenon of healing and to describe the healing process they witnessed. While students may not initially describe all of the components and interactions of healing, their macroscopic understanding of personal healing can be leveraged to motivate the need to understand the microscopic structures and multi-system and subsystem components and interactions of healing, that might not be directly visible from the outside of the body with just their eyes.

Each unit's anchoring phenomenon is chosen from a group of possible phenomena after analyzing student interest survey results and consulting with external advisory panels. We chose this case study around an injury that heals over time as the anchoring phenomenon for this unit for these reasons:

- The PE bundles for this unit center around cells, connections between cell and cell parts and their functions, and thinking about the body as a system of interacting parts. To fully explain the healing process the body goes through, all of these ideas are necessary components of this story.
- An injury of a broken bone is not foreign to most students, whether they experienced one themselves or saw a classmate or peer who had experienced one.
- We want students to develop the understanding through investigations at different scales that the body is made up of very small parts before naming these parts cells. In working to figure out how the body heals, this idea is accessible for students.
- In analyzing and investigating the different parts of the body involved in this injury and the healing process, students will need to figure out the body is a system that is made up of other systems within it. These systems interact and work together during the healing process. The smallest of these systems is the cell.
- In addition, they will figure out that cells can make more cells when provided food particles that are moved around the body through the blood vessels and therefore, systems need to interact for the student's body to be able to heal and more generally so that all our bodies can heal and function.

## What are the NGSS Dimensions developed in this context?

This unit is guided by the key idea that our body is made of cells, that a cell is the smallest living thing, that cells can make more cells, and for more cells to be made in our body, the different systems that the cells make up need to interact. In the anchor, students analyze a case where a student's foot was broken due to an injury. They find out that it took 4 months for his foot to heal so that he could walk on it again. In this unit, students will develop, refine, and apply models to first explain what is happening in the body when it is injured and then explain how the body heals down to the cellular level. As students analyze technical and medical images and obtain and evaluate information from medical professionals and research scientists, they see that the body is made up of different systems, that these systems interact for our body to function, that when there is a gap in any parts (tissues) of these systems, our body can't function, or functions differently. In addition, students figure out that our body can heal by making more cells to fill these gaps from an injury. Students also apply this model of healing to begin thinking about growth and how it is similar and different from healing.

### This unit builds toward these performance expectations:

**MS-LS1-1.** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

**MS-LS1-2.*** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

**MS-LS1-3.*** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

**MS-LS1-8.*** Gather ~~and synthesize~~ information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior ~~or storange as memories.~~

*PEs marked with an asterisk are partially developed in this unit and shared with other units, as explained in the DCI column. Also, regarding the strike through in LS1.D—"and synthesize… or storage as memories"—this PE is revisited in multiple units in In order to support students in having a genuine need to figure out things about each of the different receptors, they will engage with this PE in the *Unit 6.1: Why do we sometimes see different things when looking at the same object? (One-way Mirror Unit)* unit in reference to receptors in the eye, in the *Unit 7.1: How can we make something new that was not there before? (Bath Bombs Unit)* unit in reference to receptors in your nose, in the *Unit 8.1: Why do things sometimes get damaged when they hit each other? (Collisions Unit)* unit in reference to receptors in your skin and brain, and in the *Sound Unit* in reference to the receptors in your ears. In this unit, students will be engaging with this PE as they gather more information about nerves in general—what they do, how they look, and how they function.

| Focal DCIs** | Focal Science and Engineering Practices | Focal Crosscutting Concepts |
|---|---|---|
| **LS1.A: All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).** Through investigations including a dissection and bacteria lab (Lessons 2, 10), analyzing medical images and videos (Lessons 3, 5, 8, 9) looking at slides under the microscope (Lessons 4, 5, 6, 7, 9, 10) and reading informational texts (3, 4, 5, 10), students figure out that our body is made up of cells. Throughout these lessons, in addition to investigating different parts of our body to figure this out, students also look at parts of mammalian (cat blood, ox nerve, pig kidney, rat liver) and non-mammalian animals (green anole, sea star) and plants (tomato, mustard plant) and figure out that not only humans, but all living things are made of cells. In Lesson 10, when students investigate what cells need to grow through analyzing data from a bacteria lab, they figure out that bacteria, which are made of only one cell, are living things. Students read about other single-celled organisms and figure out that **all** living things are made of cells, either one cell or many.<br><br>**LS1.A: Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.** By lesson 4, students have figured out through looking at a blood sample under the microscope that our blood is made up of different small structures called red blood cells, white blood cells, and platelets. In Lessons 5 and 6, they discover that nerves, bone, skin and muscle are also made up of cells. Through comparing the structures of these different types of cells, students notice that they all have definite shapes with an outer structure or boundary, the cell membrane. By Lesson 11 students figure out that the cell membrane is actually porous and lets things such as food get into the cell to make more cells during the healing process, and lets other things out of the cell that the cell doesn't need, like waste. Other | **Developing and Using Models:** This unit **intentionally develops** this practice. While students engage in aspects of the modeling practice they have explored in prior units, this is a different context. This is the first biological system context that students investigate in the program, and is their first experience tying physical mechanisms to phenomena that occur in living things. Beginning in Lesson 1, students are developing a model for healing. They revise this model throughout the unit, and use their elaborated model to explain how the body heals from an injury (Lesson 12). In Lessons 2 through 6, the class develops a model of the structure and function of the different parts of the body. In Lesson 8, students apply what they have figured out about the different parts of the body to develop a model for how skin heals from a scrape at the cellular level. In Lessons 9 through 11, students continue to revise the healing model to include what is happening at the cellular level.<br><br>**Planning and Carrying Out Investigations:** This practice is **key to the sensemaking** in this unit. Students plan and carry out investigations across multiple lessons to help figure out how healing occurs. Students watch a demonstration of a chicken wing dissection in Lesson 2. They brainstorm how they would revise this dissection to "injure" the chicken wing in a similar manner to the injury the student in Lesson 1 had incurred. In Lesson 4, students carry out an investigation using microscopes to look at a blood sample. In Lesson 7, students plan for an investigation that could provide evidence as to whether other things in our world are made of cells. In Lesson 11, students carry out an investigation to figure out if things, like food particles, can get into an onion cell. | **Scale, Proportion, and Quantity:** This crosscutting concept is **key to the sensemaking** in this unit. Students use different spatial scales to observe and make sense of phenomena, from macroscopic (parts of the body, systems within the body) to the microscopic (cell level). They also consider different temporal scales (4 months of healing for the student in Lesson 1 to the quick timelapse in Lesson 8) to figure out what the body is made of and how the different structures in the body are interconnected (i.e., cells are part of tissues).<br><br>**Systems and System Models:** This crosscutting concept is **key to the sensemaking** in this unit. Beginning in Lesson 2, the class develops a poster titled *Our Body as a System*. Students incrementally revise and extend the systems model poster in the next four lessons as they figure out more about the different systems and subsystems within our body ranging from our body as a whole down to the system of the cell. |

| Focal DCIs** | Focal Science and Engineering Practices | Focal Crosscutting Concepts |
|---|---|---|
| structures of the cell will be discovered in future units: *Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit)*—mitochondria and chloroplasts; and *Unit 8.5: Why are living things different from one another? (Muscles Unit)*—nucleus and chromosomes.<br><br>**LS1.A: 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.** Students begin developing a poster in Lesson 2 called *Our Body as a System*, by adding the skin, bone, and muscle to this poster as those are the structures that were injured for the student they hear about in Lesson 1. At this point in the unit, students are still at the macroscopic level of analysis of these parts of the body. They analyze images of the muscular, skeletal, and skin system of the body to figure out where else in the body these structures are found and add this to the poster.<br><br>At the end of this lesson, students are beginning to think about the body as a system. As students continue investigating through Lessons 3, 4, 5 and 6, they figure out that each of these parts of the body are made up of smaller parts, the smallest being the cell. At the end of Lesson 6, students have added to the poster the macroscopic and microscopic levels of each of these parts and figured out that there are multiple systems **within** the body. In addition, they have figured out that the cells that make up the different parts of the body interact with the cells around them (tissues) so that the larger structure in the body can function. Students will figure out by Lesson 12, that the different systems in the body interact and work together when our body goes through the healing process. Students will continue to build on this idea of the multiple systems and subsystems (tissues and organs) interacting for our body to be able to carry out specific functions in the 7th grade unit: *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)*. | **Analyzing and Interpreting Data:** This unit **intentionally develops** this practice. While students have engaged with this practice in earlier units, in this unit students analyze different kinds of data (including images at different scales) in a different type of context, living things. Students identify the macro-level functions of skin, bone, and muscle, and figure out that the microscopic structures (cells) in blood and nerves support the functions of those body parts. Students analyze and interpret observational data, videos, and images to provide evidence that cell growth occurs. Students analyze second-hand data from an investigation of E. coli to collect evidence that the bacteria need food to make more cells and the more food the bacteria are provided, the more the bacteria make more cells.<br><br>**Engaging in Argumentation:** This practice is **key to the sensemaking** in this unit. Students engage in argumentation many times throughout the unit as they explain what is happening in the body for it to heal. In Lesson 2, they argue orally for the interactions between the bone and muscle and skin for a part of the body to function. In Lesson 7, students argue from evidence whether the living things they analyzed are made of cells or not. In Lesson 10, students argue for what human cells need to grow and make more cells and argue for what bacteria need to grow and make more of themselves. In Lesson 12, students argue from evidence for what caused the different healing events on the *Healing Timeline* from Lesson 1. In Lesson 13, students argue for whether the healing process is similar or different from the growth process and why.<br><br>The following practices are also **key to the sensemaking** in the unit:<br>• Asking Questions and Defining Problems<br>• Constructing Explanations and Designing Solutions<br>• Obtaining, Evaluating, and Communicating Information | **Structure and Function:** This crosscutting concept is **key to the sensemaking** in this unit. As students figure out how parts of the body heal, they investigate the way different parts are structured, how these parts function and how the way these parts are structured is related to the function of the part. Students look at structures both macroscopically in the body as well as microscopically down to the cell. Students figure out that the different parts of the body are made of cells that are unique in shape and composition to that part of the body and that the structure of the cell is related to the structure and function of the part of the body the cell comes from.<br><br>The following crosscutting concepts are also **key to the sensemaking** in this unit:<br>• Patterns<br>• Cause and Effect<br><br>*See **Development of the Our Body as a System poster** found in the Teacher Guide of Lesson 2 for detailed information about how these Crosscutting Concepts are built in this unit.* |

| Focal DCIs** | Focal Science and Engineering Practices | Focal Crosscutting Concepts |
|---|---|---|
| **LS1.D: Information Processing ~~Each sense receptor responds to different inputs (electromagnetic,mechanical, chemical), transmitting them as~~ signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors ~~or memories~~.**<br><br>In Lesson 5, through analyzing microscopic images and reading scientific text, students will figure out that nerves are made of cells. These cells have specialized structures to perform their function of sending signals to the brain. There are different types of nerve cells and each has different functions. In Lesson 12, students explain how the student's foot healed including in their explanation the interactions occurring between the different body systems for the foot to heal, including the nerves. Other aspects of this PE are developed in additional units, beginning their initial work on **MS-LS1-8** in the *One-way Mirror Unit*. The current version of this unit, *Unit 6.6: How do living things heal? (Healing Unit)*, primarily addresses the role of nerve cells in sending signals to the brain. Students will revisit and expand on their understanding of this DCI in later units in the program, including returning to it in the *Unit 7.1: How can we make something new that was not there before? (Bath Bombs Unit)* unit in 7th grade and the *Sound Unit* in 8th grade. | | |

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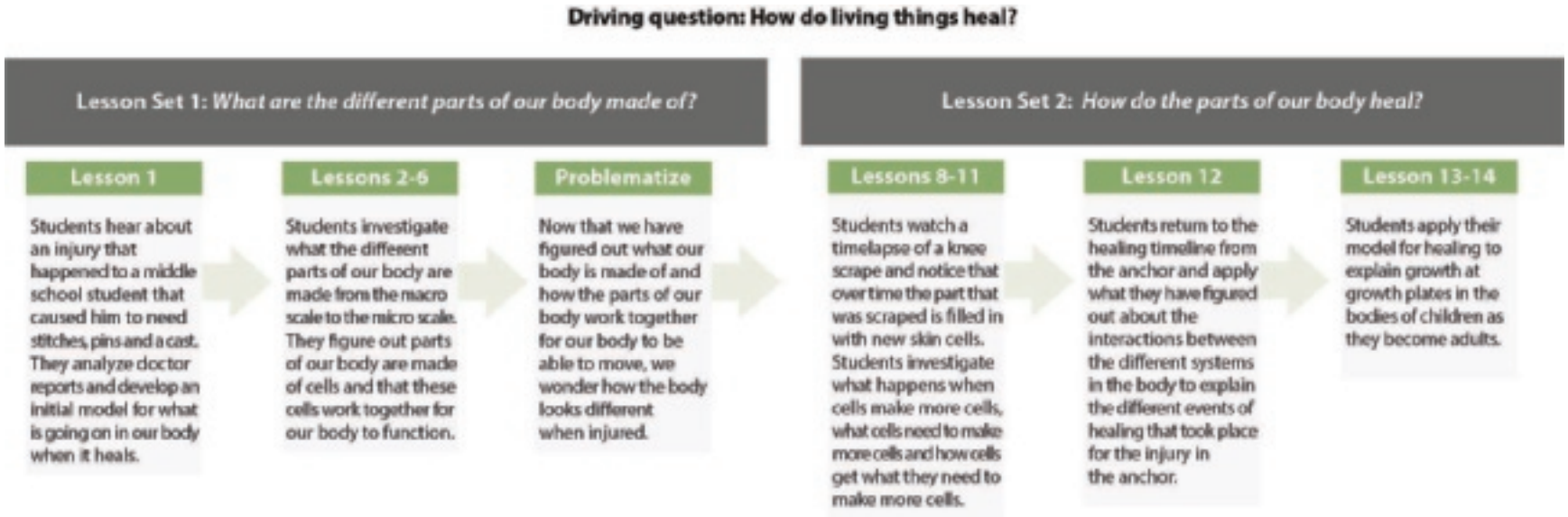
## Connections to the Nature of Science

| Which elements of NOS are developed in the unit? | How are they developed? |
|---|---|
| • Science investigations use a variety of methods and tools to make measurements and observations. (NOS-SEP)<br>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (NOS-CCC) | • Students make observations about the structure and function of different parts of the body at different scales through watching a dissection and then using microscopes to see the cellular level.<br>• Students use microscopes to make observations of what different parts of living things are made up of. Through a small sample on a slide, they find these parts are made of cells and conclude the entire body part is made of the same type of cells. |

## How is the unit structured?

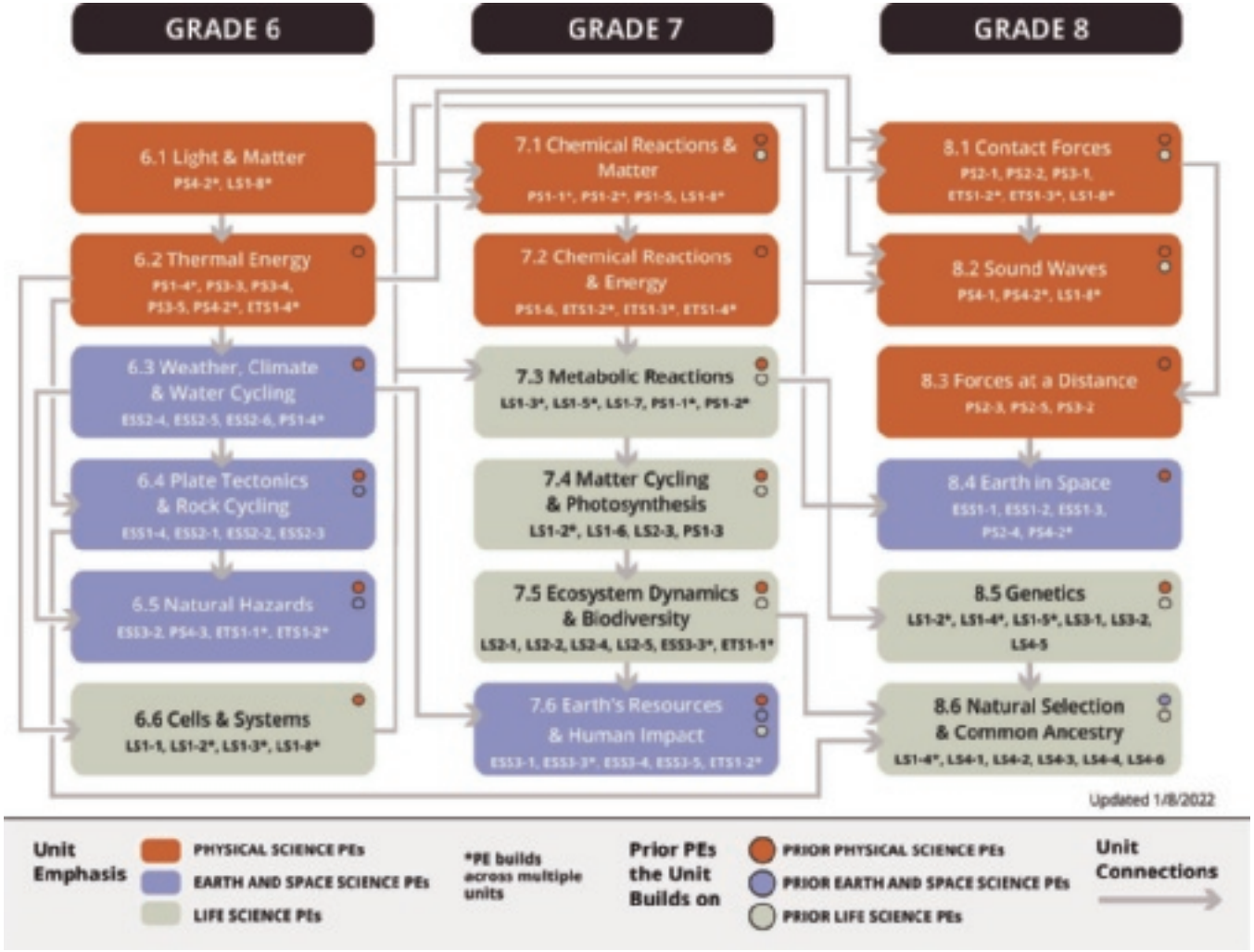
The unit is organized into two lesson sets.

- Lesson Set 1 consists of Lessons 1-7. The anchor lesson is about an injury case that happened to a middle school student. The class hears about his story and then analyzes some different images representing people with disabilities. Using these images, students reflect on and think about what is meant by disability and how both the injury and some of these disabilities can affect how a person can function or do things. The class decides at the end of Lesson 1 to focus on figuring out more about the parts of the body that were injured in the case of the student with the broken foot. In this first lesson set we carry out investigations and critically read articles while incrementally changing spatial scales to figure out that the body can be thought of as a system, that there are different systems within the body that interact, and that all these systems are made up of cells. This first lesson set also serves to help students shift scales from the macro scale of the body to the micro scale of the cells that make up the parts of the body.
- Lesson Set 2 consists of Lessons 8-14. The class remains at the microscopic scale at the beginning of this lesson set and then shifts from the micro back to the macro to explain the healing process. The focus of this lesson set is to explain that in order for our body to heal from an injury, it needs to make more cells. In order to make more cells, our cells need nutrients or food just like we do. We figure out that the structure of our cells is such that food particles which are carried around our body through our blood vessels can get into our cells and be used to make more cells. In the last lesson we engage with five disability stories through audio and video to reflect on what the word disability means and how it relates to our healing story. Students brainstorm areas in the classroom and school that could be adapted or redesigned to make them more accessible to people with different disabilities.



## Where does this unit fall within the Scope and Sequence?

This unit is designed to be the first life science focused unit in This unit will serve to set a foundation for students around the ideas of cells, body systems, and the interactions between these systems for the body to function. These ideas will be built upon and revisited in future units: *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)*, *Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit)*, and *Unit 8.5: Why are living things different from one another? (Muscles Unit)*. Students will use and build on Systems and System Model supports that were established in *Cup Design Unit* and *Storms Unit*. In addition, they will build upon supports for Structure and Function that were established back in *Cup Design Unit*.



## What additional ideas will my students have or know from earlier grades or units?

Students may come to this unit with prior knowledge and experiences that can be leveraged to your advantage. Some of these ideas include the following:

| Previous unit or grade-level DCIs | How it is leveraged in this unit |
|---|---|
| Building upon external and internal structures:<br>• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (Boundary: Stress at this grade level is on understanding the macroscale systems and their function, not microscopic processes.) | While students might understand that there are different parts inside the body, students might not connect those parts to different microscopic functions. Students can build off the work they did in grades K-5, understanding macroscale systems and their function in living things, to support their work figuring out the microscopic structures within living things during this unit. |
| Building upon Matter and Energy Flow in Organisms<br>• Animals and plants alike generally need to take in air and water, animals must take in food, and plants need light and minerals; anaerobic life, such as bacteria in the gut, functions without air. Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need to maintain body warmth and for motion. Plants acquire their material for growth chiefly from air and water and process matter they have formed to maintain their internal conditions (e.g., at night). | In this unit, students figure out cells can make more cells and that the process the cells go through is to first grow bigger until double in size and then to split into two cells of about the same size. We also figure out that a single cell can be a living organism when we investigate bacteria. This leads students to wonder what cells need in order to grow and if cells need food like we do. Students know from earlier grades that one thing living things need to be able to grow is food.<br>The other ideas included here about plants and matter cycling of matter and energy will be explored in *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)* and *Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit)*. |
| Building on Scale, Proportion, and Quantity<br>• Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. | In earlier grades, students engage with the scale of objects in space and time at levels they can see with their eyes to make sense of phenomena they are investigating. In this unit, students will build on the development in earlier grades of using different scales, both spatially and temporally, to move between the macro and micro scale in order to figure out what is going on inside our body when it heals. Students have a deep understanding of how the large-scale structures of their body move to complete daily tasks. This understanding can be leveraged when students investigate the body's microscopic structures of cells and the structures within cells in coordination with their particular functions. |
| Building on Systems and System Models<br>• A system can be described in terms of its components and their interactions. | Students will be using system thinking extensively in this unit, building on elements they have engaged with in earlier grades and earlier units in 6th grade, to think about how the different parts within the system interact and work together. |

| Previous unit or grade-level DCIs | How it is leveraged in this unit |
|---|---|
| Building on Structure and Function<br>• Different materials have different substructures, which can sometimes be observed.<br>• Substructures have shapes and parts that serve functions. | Students will deepen their thinking around structure and function from earlier grades to expand it beyond just thinking about structure in terms of the part or parts that serve a function, to consider why ***how*** a part is structured allows the part to function. This interconnectedness between the way a part is structured results in the way it functions is a new way of engaging with this crosscutting concept. |
| Building on Developing and Using Models<br>• Develop and/or use models to describe and/or predict phenomena.<br>• Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.<br>• Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. | Students have been engaging with this science and engineering practice extensively in all the prior 6th grade units around phenomena representing physical and earth science. In this unit, they will be utilizing the elements they have engaged with to develop and use models to explain what they figure out about a phenomena based in life science. |

The placement of this Unit 6.6 and associated units are shown in the Scope and Sequence document.

## How will I need to modify the unit if taught out of sequence?

This is the sixth unit in 6th grade in the Scope and Sequence and the first life science unit. 7th grade units *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)*, *Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit)*, and 8th grade unit *Unit 8.5: Why are living things different from one another? (Muscles Unit)* will all build off the Disciplinary Core Ideas (DCIs) that students develop by working on the following NGSS performance expectations MS-LS1-1, MS-LS1-2, MS-LS1-3 in this unit. If this unit is taught later in the sequence, be mindful that elements of these DCIs might need additional scaffolding in the other life science units.

Given this placement, several modifications would need to be made if teaching this unit earlier in the middle school curriculum. These include:

- If taught before Unit 6.1 or at the start of the school year, supplemental teaching of classroom norms, setting up the Driving Question Board, and asking open-ended and testable questions would need to be added. (These supports are built into 6.1.)
- In this unit, students will build on the crosscutting concepts of system thinking, scale and proportion (moving from macroscopic to microscopic), and patterns from earlier 6th grade units.
  - If taught before 6.1 and 6.2, students will benefit from additional scaffolding for structure and function.
  - If taught before, 6.4, students will benefit from additional scaffolding for scale, proportion, and quantity.
  - If taught before, 6.2 and 6.4, students will benefit from additional scaffolding for systems and system models.
- In this unit, students will build on the science and engineering practices of modeling, planning and carrying out investigations, and engaging in argument from evidence from earlier 6th grade units.
  - If taught before 6.1 students will benefit from additional scaffolding for developing and using models.

- If taught before, 6.2 and 6.3, students will benefit from additional scaffolding for planning and carrying out investigations.
- If taught before, 6.2 students benefit from additional scaffolding for engaging in argument from evidence.

## How do I shorten or condense the unit if needed? How can I extend the unit if needed?

The following are example options to shorten or condense parts of the unit without completely eliminating the important sensemaking for students.

- Lesson 4: If you do not have microscopes available, you can shorten this lesson by one day by taking out the orientation to the microscopes.
- Lesson 6: This is a two day lesson that includes using the microscopes to look at skin, bone and muscle slides. These images are in the Link on Interactive website. If you have the technology available, you could have students make observations of the images as home learning and do the sensemaking over the course of one day afterwards.
- Lesson 7: This is meant as a mid-point assessment to gauge where students are at in their thinking about whether all living things are made of cells. It could be done as home learning which could gain you a class period. In addition, this assessment only begins to build towards this key science idea at this point in the unit but is more deeply built upon and assessed in Lesson 10.
- Lesson 13: This lesson is used as a transfer task in which students apply what they have figured out about how our body heals from a biological perspective through making new cells to repair the injured tissues, to a growth scenario. Students look at images of growth plates and think about whether a similar process to healing might also be what is happening when we grow. Since the anchoring phenomena and the PEs will have been fully addressed and assessed prior to this unit you could choose to delete this lesson.

To extend or enhance the unit, consider the following:

- Lesson 2: If you wish, you could conduct the dissection as a demonstration investigation with your students instead of watching the video of the dissection. This would allow students to make closer observations and ask questions about the structures of the chicken wing that might be able to be answered through closer investigations of the parts of the chicken wing.
- Lesson 5: Instead of sharing microscopic images of nerves with students, if you have slides of nerve smear available, you could allow students to use the microscopes and look at them with a partner to make observations.
- Lesson 7: The first part of the assessment asks students to plan for an investigation that would help them figure out whether other things in their world are made of cells. Due to the open-ended nature of this question, in the second part of the assessment students analyze microscopic images of 6 different objects to look for evidence of whether they are made of cells or not. If you have the materials and time, you could allow students to carry out the investigation they plan for in part 1 of the assessment.

## What mathematics is required to fully access the unit's learning experiences?

In Lesson 4, students calculate the total magnification of their microscope's view, such as a 40x objective times a 10x eyepiece is 400x total magnification. In Lesson 4, students also use millimeter graph paper to help gain perspective about how close-up they're seeing things with the microscope and to estimate the field of view at different magnifications. Prerequisite math concepts that may be helpful include the following:

- CCSS.MATH.CONTENT.4.NBT.B.5: Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations.
- CCSS.MATH.CONTENT.5.NBT.A.2: Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.
- CCSS.MATH.CONTENT.4.MD.A.1: Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit.

Also in Lesson 4, you may choose to take time to explore the mathematics of ratios of blood cells based on the percentages of each type mentioned in the reading. If you choose to extend the investigation in this way, the prerequisite math concepts that may be helpful include the following:

- CCSS.MATH.CONTENT.6.RP.A.1: Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
- CCSS.MATH.CONTENT.6.RP.A.3.C: Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.

## What additional strategies are available to support equitable science learning in this unit?

Units are designed to promote equitable access to high-quality science learning experiences for all students. Each unit includes strategies which are integrated throughout the routines and are intended to increase relevance and provide access to science learning for all students. Units support these equity goals through several specific strategies such as: 1) integrating Universal Design for Learning (UDL) Principles during the unit design process to reduce potential barriers and provide more accessible ways in which students can engage in learning experiences; 2) developing and supporting classroom norms that provide a safe learning culture, 3) supporting classroom discourse to promote students in developing, sharing, and revising their ideas, and 4) specific strategies to supporting emerging multilingual students in science classrooms.

Many of these strategies are discussed in the teacher guides in sidebar callout boxes titled "Attending to Equity" and subheadings such as "Supporting Emerging Multilingual Learners" or "Supporting Universal Design for Learning." Other callout boxes with strategies are found as "Additional Guidance," "Alternate Activity," and "Key Ideas" and various discussion callouts. Finally, each unit includes the development of a Word Wall as part of students' routines to "earning" or "encountering" scientific language. For more information about each of these different strategies with example artifacts, please see the Teacher Handbook.

## What are recommended adult-level learning resources for the science concepts in this unit?

The instructional model focuses on the teacher being a member of the classroom community, supporting students to figure out scientific ideas motivated by their questions about phenomena. Students iteratively build their understanding of phenomena as the unit unfolds. To match the incremental build of a full scientific explanation across the unit, the science content background necessary for you to teach individual lessons incrementally builds too. Throughout the unit, we provide just-in-time science content background for you that is specific to the Disciplinary Core Ideas (DCIs) that will be figured out in a lesson. Places to look for this guidance include the "Where we are going" and "Where we are not going" sections for each lesson. Additionally, the expected student responses, keys, and rubrics have illustrated important science ideas that should be developed in each lesson. In addition to this information, the *K-12 Science Framework* is a great resource to learn more about the DCIs in this unit (LS1.A; LS1.D), including what students have learned previously and where they are headed in high school. In addition to the science content background information embedded in the lesson resources, below we provide recommended resources that can help build your understanding of phenomena and Performance Expectations bundle for this unit:

- how a wound heals itself.
- the connection of structure and function of cells in living things.
- how to support information processing in our body via the nervous system.
- resources (and how to use them) that can be used to support your students in discussing disabilities.

(See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

## Supporting Disability, Inclusion, and Social Emotional Learning

This unit focuses on how parts of our body systems work together to perform functions, such as healing. In this unit, teachers and students will be exploring the ways that injury impacts the human body and how the body recovers from injury. Related to this phenomenon of healing is the topic of disability. Many students and teachers have not had the opportunity to learn about disability in any formal way despite the fact that many students have directly experienced a temporary or lifelong visible or invisible disability.

This unit makes an intentional effort to support students' and teachers' approach to this topic with sensitivity and confidence when you discuss disability, as it pertains to injury and healing with your students. Additionally, injury and healing can trigger trauma for some students. Therefore, be sure you plan ahead and consider how to support your students before and during the unit to ensure that they feel comfortable discussing, viewing, and figuring out what is happening as the body heals from injury. Please see *Disability and Inclusion Awareness* and *Pre-Unit Letter Home* for additional guidance in supporting students in this work. Additionally, we have included a few novels below that students may enjoy reading about people living with disabilities while still navigating all the common tween and teen challenges, like making friends, what to wear to school, etc. The books we have included here were chosen to support students in continued reevaluation of their perceptions of people with disabilities and the challenge at the end of the unit to rethink the design aspects of our world both concrete and relational in nature. This list is by no means exhaustive and you are encouraged to reach out to your ELA team counterpart, your school library media specialist, and special service support staff for other suggestions of novels, reading materials or videos that may be of interest to your students.

1. *Out of My Mind* by Sharon M. Draper
2. *The State Of Grace* by Rachael Lucas
3. *Mockingbird* by Kathryn Erskine
4. *Ruled* by Cynthia Lord
5. *Insignificant Events in the Life of a Cactus* by Dusti Bowling
6. *Wonder* by R.J. Palacio

## Alternate Activities to Using Living or Once-living Organisms

| Lesson | Activity Type | Description |
|---|---|---|
| 1 | Viewing images of injury | The images on *Post-Operation Report* could be traumatic for some students. Please use at your discretion. They are purposely not on the slide and have been printed in black and white to make them less shocking. Please discuss the unit topic with a school social worker, psychologist, or counselor and send home *Pre-Unit Letter Home* before starting the unit. If needed, you can just share the first page of *Post-Operation Report* and skip sharing the images. Instead, describe that the student had a cut across the top of his foot which was then stitched up in surgery into a somewhat t-shape, and pins were put in. |
| 2 | Viewing chicken wing dissection videos | If students have concerns about watching the chicken wing demonstration, you could show anatomical drawings of a chicken wing that indicate how the chicken wing moves when the muscles are contracted or extended before and after injury. |
| 3 | Viewing images of the human body taken by medical professionals | If students have concerns about looking at X-ray or MRI images of the real human body, provide them with unlabeled illustrations of only the bones in the hands, knee, and foot. Then provide an illustration that shows bones and soft tissues such as muscle in the knee. |
| 4 | Observing blood | If students have concerns about using the human and animal tissue samples on the prepared slides, you may use the provided micrograph images instead. If there is still concern about using the micrographs, an illustration could be used instead, but the limitations of the illustration would need to be discussed. |
| 5 | Observing nerves | If students have concerns about using the tissue samples on the prepared slides, you may use the provided micrograph images instead. If there is still concern about using the micrographs, an illustration could be used instead, but the limitations of the illustration would need to be discussed. |

| Lesson | Activity Type | Description |
|---|---|---|
| 6 | Observing bone, skin, and muscle | If students have concerns about using the human tissue samples on the prepared slides, you may use the provided micrograph images instead. However, you can also remind students that tissue samples like these came from people who willingly underwent a procedure called a biopsy to remove them for study. In a biopsy, doctors cut very thin and small slices of tissue from a patient and observe it under a microscope to try to discover the presence, cause, or extent of a disease. If there is still concern about using the micrographs, an illustration could be used instead, but the limitations of the illustration would need to be discussed. |
| 8 | Viewing skin healing time-lapse video | If you are worried that the images in the Knee-Scrape Time-Lapse Video will bring trauma for your students, you can just have them view the images on *Time-Lapse Video of Skin Healing Observations* to make their observations. If that is still too much, consider asking students to think of a time they have had a scrape and what happened as it healed. |
| 10 | Viewing images of human cheek cells | The human cells used in this lesson were taken directly from the lesson investigation writer (labeled "scientist" in the lesson). They were not harmed during the collection of the cells. If there is still concern for using the prepared slide images, an illustration could be used instead, but the limitations of the illustration would need to be discussed. |
| 11 | Investigating onion skin | If a student has allergies to onions or otherwise cannot participate in the preparation and viewing of the onion skin slides in person, a video of the investigation and images are provided in the lesson materials, as well. |
| 12 | Viewing images of swelling | The images on **slides B** and **C** show images of injuries: **slide B** shows the same images students saw in the doctor's notes in Lesson 1, and **slide C** shows examples of body parts that are swollen due to injury. Show them at your discretion. Ask your school social worker, psychologist, or counselor for support if you anticipate that these images will be traumatic for any of your students. *Images of Swelling Due to Injury* is available if you think your students would be more comfortable viewing these images on a handout instead of on the slides. If needed, you may choose to briefly describe each image in words and ask students to find patterns in the descriptions. |

# GUIDANCE FOR DEVELOPING YOUR WORD WALL

This unit refers to two categories of academic language (i.e., vocabulary). Most often in this unit, students will have experiences with and discussions about science ideas before they know the specific vocabulary word that names that idea. After students have developed a deep understanding of a science idea through these experiences, and sometimes because they are looking for a more efficient way to express that idea, they have "earned" that word and can add the specific term to the class Word Wall. These "words we earn" should be recorded on the Word Wall using the students' own definition whenever possible. On the other hand, "words we encounter" are "given" to students in the course of a reading, video, or other activity, often with a definition clearly stated in the text. Sometimes, words we encounter are helpful only in that particular lesson and need not be recorded on the Word Wall. However, if a word we encounter will be frequently referred to throughout the unit, it should be added to the Word Wall. As such, the Word Wall becomes an ongoing collection of words we will continue to use, including all the words we earn in the unit and possibly a few key words we encounter.

It is best for students if you wait and create cards for the Word Wall in the moment, using definitions and pictorial representations that the class develops together as they discuss their experiences in the lesson. When they co-create the posted meaning of the word, students "own" the word—it honors their use of language and connects their specific experiences to the vocabulary of science beyond their classroom. It is especially important for emergent multilingual students to have a reference for this important vocabulary which includes an accessible definition and visual support.

Sometimes creating Word Wall cards in the moment is a challenge. The *Teacher Guide* provides a suggested definition for each term to support you in helping your class develop a studentfriendly definition that is also scientifically accurate. If you keep one Word Wall in your classroom for several sections of students, you might choose to record each class's definition separately and then propose at the next class meeting to post an "official" definition that captures the collected meaning.

The words we earn and words we encounter in this unit are listed in this document and in each lesson to help prepare and also to avoid introducing a word before students have earned it. They are not intended as a vocabulary list for students to study before a lesson, as that would undermine the authentic and lasting connection students can make with these words when they are allowed to experience them first as ideas they're trying to figure out.

The words we encounter and earn in this unit are not always found just on the Word Wall. Some of the academic vocabulary developed in this unit will be found on the Our Body as a System poster and/or on extra posters around the room such as in Lesson 6, when cell, cell membrane, and cytoplasm are labeled on a drawing of a cell and posted next to the Our Body as a System poster. Since many of the words developed in this unit are connected to conceptual models, the Word Wall will look less like the Word Wall in previous units.

| Lesson | Words we earn | Words we encounter | Words we reinforce or apply from previous units |
|---|---|---|---|
| 1 | healing (2x) | | |
| 2 | function | | structure |
| 3 | | | cross-section |
| 4 | focus | red blood cell, white blood cell, platelet, plasma | |
| 5 | | nerve cell | |
| 6 | cells, tissue, structure | cell membrane, cytoplasm, bone cell, muscle cell, skin cell | |
| 8 | healing | | |
| 9 | | cell membrane, nucleus, chromosomes | |
| 10 | single-celled organism, multiple-celled organism | | |
| 11 | | cytoplasm, cell membrane, cell wall | |
| 12 | | | |
| 14 | healing | | |

## HOME COMMUNICATION

Dear Parents, Guardians, and Caregivers,

IIn our upcoming science unit, students will learn about the biological process of healing that takes place in the human body after it sustains an injury. This unit focuses on how parts of our body systems work together to perform functions such as healing. Students will follow the healing journey of one individual to delve into the science behind this process. Additionally, they will have the opportunity to reflect on their own experiences with injury.

Injuries can be traumatic, and recalling past injuries or learning about others' injuries can be triggering. If your child or someone close to your child has sustained an injury that was in any way traumatic for your child, please contact me at _____, if you are comfortable doing so. By knowing about these experiences in advance, we can be sensitive to students' needs and provide support if they experience any strong emotions during this unit.

Another topic related to injury that we will explore in this unit is disability. Injury can result in short-term or long-

term disability, so it is important that students have an understanding of disability as a natural and expected part of human diversity. In this unit we will teach about disability as a neutral part of a person's identity. Disability is not inherently good or bad; not a tragedy, nor an inspiration. Students will learn that a person with a disability is no less healed than a non-disabled person. Instead, the body's biological healing process has stopped and the body's functionality has changed, resulting in the need to adapt. Students will also learn about adaptive equipment that allows disabled individuals to complete the daily tasks of life, often with greater independence.



Furthermore, since this unit is based on living things, there will be times in the unit when students will view living things (or once-living things) in a variety of ways. This might include dissection of animal parts such as chicken wings and the examination of once-living animals, plants, and bacteria. If you feel this will be challenging or upsetting for your child, please let me know so that I can be sensitive and supportive. I encourage you to let your child know that if they feel discomfort with any part of a lesson, they can share that with me privately and we will make other arrangements for their learning during that moment.

If you have any questions about the content of this unit or would like to discuss anything further, I encourage you to reach out to me at _____.

# TEACHING SCIENCE LITERACY

## How does the Core Knowledge Science Literacy routine integrate with the unit investigations?

The Core Knowledge Science Literacy Student Reader and the weekly Science Literacy routine layer varied reading opportunities into the science unit. In their lives after graduating from high school, most students will not become scientists. They will no longer routinely participate in guided investigations to figure out how phenomena work. They will, however, read text about science and scientific claims, day in and day out. The ability to learn and think about science through reading is a skill unto itself and is important in tandem with investigative learning. It is natural to primarily associate emerging literacy with reading and writing instruction at the elementary level, but middle school is an important time to hone literacy skills—specifically in science in the era of politicization of science topics, polarization among adults, and proliferation of misinformation on social media. Detection and construction of well-reasoned explanations are important not just in science, but throughout everyday life. Using claims and evidence in reasoning is the way that thoughtful people think about things, and writing is thinking in print. Students become voters as they emerge from high school, so it is important that they acquire skills for detection of faulty information and practice legitimate communication about scientific issues in the years leading up to that civic benchmark.

Throughout the course of the unit's investigative lessons, students write in their science notebooks in some fashion almost daily, and significant emphasis is placed on the speaking and listening communication threads of the CCSS. The instructional design of the investigations is deliberately light on having students access disciplinary core content through text. NGSS emphasis is on students investigating phenomena along the storyline, so students' interaction with text within lessons is minimal and in service to the unit's storyline. The Science Literacy routine is integrated to exercise students' ability to interact with text about science topics. The routine presents students with short reading selections in a variety of styles, all related to the unit in which students are engaged. Each reading selection is accompanied by a brief but thoughtful writing exercise.

The subject matter of the reading selections ties back to the unit, but the timing for the assigned readings is such that students do not read about specific facets of the subject before they have completed the lessons to investigate that content. In other words, the reading enhances and reinforces the knowledge that students have built in previous lessons; the reading does not reveal beforehand the key takeaways that students are intended to learn through lesson interactions.

## When is it done within a unit?

The Core Knowledge Science Literacy Student Reader includes one reading collection per week for every week of the unit. A week's reading collection relates to the lessons completed in the previous week. The reading is assigned at the beginning of the week with the accompanying writing exercise due at the end of the week.

The reading and writing exercises are designed to be completed by students independently, with brief, supporting, teacher-facilitated discussions at the beginning, midpoint, and end of the week.

## How do students typically represent their thinking as part of the routine?

Students generate a written product associated with each reading selection. The products are varied in form, and include graphic organizers, concept maps, cartoons, memes, infographics, storyboards, outlines, and paragraphs. The complexity of the products increases from week to week, with the final product for the unit being a single, thoughtfully reasoned, and well-constructed paragraph.

# Put Yourself in This Scene

## Literacy Objectives

✓ Initiate thinking about the need to evaluate information in text and images.

## Literacy Exercises

- Read a brief scenario to pique interest, launch discussion, and begin to frame expectations.

## Instructional Resource




**Science Literacy Student Reader, Preface**
"Put Yourself in This Scene"

## No Prerequisite Investigations

The reading of the Preface is appropriate during the first week of unit instruction. The reading does not preemptively tell students facts about the topic that they are intended to learn throughout the course of their investigations.

## Standards and Dimensions

### NGSS

**Disciplinary Core Idea 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. (MS-LS1-3)

**Science and Engineering Practice:** Asking Questions and Defining Problems

**Crosscutting Concepts:** Structure and Function; Connections to Engineering, Technology, and Applications of Science

### CCSS

**English Language Arts**

**RST.6-8.2:** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

**RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

## Core Vocabulary

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During facilitation of learning, expose students repeatedly to these terms. No Core Vocabulary terms are highlighted in the Preface.

**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.

**prosthetic** **science literacy** **skepticism**

A Glossary at the end of the Science Literacy Student Reader lists definitions for Core Vocabulary and selected Language of Instruction.

## 1. Plan ahead.

Determine your pacing to introduce the reading selections, check in with students on their progress, and discuss the reading content and writing exercise. If you are performing Science Literacy as a structured, weekly routine, you might implement a schedule like this:

- Monday: Designate a ten-minute period at the beginning of the week to introduce students to the Science Literacy Student Reader.
- Friday: Set aside time at the end of the week to facilitate a brief discussion about the reading.

You'll proceed with the in-class lesson investigations during this week.

## 2. Preview the assignment and set expectations. (Monday)

- Let students know that for the Science Literacy routine, they will read independently and then complete short writing assignments. The reading selections relate to topics they will be exploring in their Cells and Systems unit science investigations.
- The reading and writing will typically be completed outside of class (unless you have available class time to allocate).
- The first week's reading is a short introductory segment in the book, and there is no accompanying writing exercise as the unit is getting started.
- The class will discuss the reading together at the end of the week.

**SUPPORT**—The Preface about a girl with one hand is written at approximately Lexile 1100–1200, which leans toward the high end of the expected text complexity band for middle school. You may wish to introduce a word identification and comprehension convention into your routine to support struggling readers. Hang an envelope near the door with the label, "When we talk about the next reading selection, I could use a little more help understanding the word(s). . . " Encourage students, as they are reading, to jot words, phrases, or sentences that they are unclear about onto small scraps of paper and tuck them into the envelope at any time preceding the discussion of the reading. Whenever you facilitate class discussion about a reading selection, check the envelope first, and layer in added examples and repeat definitions to help students build comprehension and fluency for terms or complex sentences about which they have revealed they are uncertain.

## 3. Facilitate discussion.

(FRIDAY)

Facilitate a brief class discussion about the Science Literacy Student Reader Preface, entitled "Put Yourself in This Scene."

Student Reader



Preface

| Pages 2–3<br>Suggested prompts | Sample student responses |
|---|---|
| *How would you summarize the "scene" referred to in the title?* | *It describes a father's thoughts on the pros and cons of having his daughter try to play baseball with one hand versus getting her an artificial limb.* |
| *Restate the situation as an engineering problem to solve. (This means reword it as a question.)* | *What type of prosthetic hand would be best for playing baseball?* |
| *If Maddy's father plans to call several companies that make prosthetic hands, what kinds of questions should he ask to help weigh his options?* | *At what age are children fitted for your device?*<br>*What happens to the fit as the child grows?*<br>*How long does it take to learn to use the device?*<br>*Is the device breakable if used to play sports such as baseball?*<br>*Are there any rules that would not allow robotic hands to be used in sports?*<br>*What are the disadvantages of kids using prosthetic hands?* |
| *Should Maddy's father practice skepticism when gathering information from a company that makes prosthetic limbs? Explain.* | *He should be skeptical about most of the information because the company wants to sell as many devices as it can.* |

**SUPPORT**—If you are using the recommended word envelope convention, check the envelope to see if it contains any words, phrases, or sentences that students need help understanding. Read key sentences aloud, and provide concise explanation.

| Pages 2–3<br>Suggested prompts | Sample student responses |
|---|---|
| *What other reliable sources could he use to decide whether or not to get Maddy a prosthetic hand?* | *He should ask Maddy what she thinks.*<br>*He could talk to her doctor.*<br>*He could read scientific reports about prosthetic devices.*<br>*He could talk to other people with children who have prosthetic hands.*<br>*He could talk to an engineer who designs prosthetic hands.* |
| *What do you already know about how a human hand works? What's inside a hand, under the skin? How do other body structures support hand function?* | *I know that the skin on the fingers has sense receptors for touch, including for pressure and pain, and that the signals are processed in the brain.*<br>*Movement of the fingers and the rest of the hand is controlled by nerves that send signals from the brain and spinal cord to the muscles that pull on hand bones.*<br>*I know there is something called eye-hand coordination that is important for catching a baseball.* |
| *What other questions do you have about this scenario?* | *What other body parts can be replaced with prosthetic devices?*<br>*Can people do things with a prosthetic limb that they could not do with a real limb?*<br>*How fast are robotic prosthetic limbs improving?*<br>*Is it possible to regrow some body parts that are not present?*<br>*Does it hurt to wear a prosthetic hand?* |
| *How can a person use social media responsibly to learn about a medical condition?* | *They can join or start a support group for people who have the condition in their family and share possible solutions to problems.*<br>*They can follow companies or scientists involved in helping people with the condition.* |

**Key Idea:** Point out that to be scientifically literate, Maddy's parents will probably need to check with several reliable sources of information before deciding if and when to get a prosthetic hand for their daughter, including learning how an artificial hand works with living human body parts. They will also want to consider how Maddy feels about having a prosthetic limb. Both the investigations and the reading selections in the unit ahead will help students advance to a place where they have more knowledge to apply to the scenario, and they will circle back to the topic of children and prosthetic or robotic limbs at the end of the unit.

LESSON 1

# What happened in the student's foot so they could walk again?

## Previous Lesson

*There is no previous lesson.*

## This Lesson

**Anchoring Phenomenon**

**4 DAYS**



We share experiences of moving our bodies and also times when we were unable to. We read doctor's notes about an injured patient and see images of his foot injury and the healing process. We create a timeline of important events that show evidence of healing. We develop models to explain how parts of the foot work together to allow the patient to walk. We brainstorm related phenomena of other times we have seen healing in humans and other living things. We develop questions for our Driving Question Board (DQB) and ideas for possible investigations to answer these questions.

## Next Lesson

*We will investigate how the parts of a chicken wing work together when moving. We will map the parts of the chicken wing to the parts of the human foot to compare how they function together. We will revise the investigation to figure out how the wing's function is affected due to an injury.*

## Building Toward NGSS

MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8

## What Students Will Do

**1.A** Obtain information from images and doctor's notes to identify patterns between the relationship of important events (effect) and the evidence of interacting subsystems healing (cause).

**1.B** Develop an initial model of the healing process that occurs within and between multiple interacting systems and subsystems and restores the foot's function.

**1.C** Ask questions that arise from observations of injuries to multiple subsystems that result in the loss of function of the foot (larger complex system).

## What Students Will Figure Out

- A student who was previously able to walk was injured in an accident and could no longer walk.
- More than one part of the patient's foot was injured in the same accident.
- Some of the injured parts of the foot needed outside supports during the healing process.
- Over time, the injured parts of the foot were able to heal; some took longer than others.
- The injury caused gaps between the damaged structures in the foot.

## Lesson 1 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 10 min | **NAVIGATION**<br>Share about experiences when students were moving their bodies and times when they were unable to. | A-B | |
| 2 | 15 min | **EXPLORE AN INTERESTING PHENOMENON**<br>Introduce a similar phenomenon to notice and wonder about—a middle school student injured in PE and his journey to recovery. | C-F | *Emergency Room Report*, *Post-Operation Report*, *Recovery Reports*, chart paper, marker |
| 3 | 10 min | **RECORD EVIDENCE FOR HEALING**<br>Co-construct a definition of what it means to heal, and identify events in the injured foot's healing process. | G-H | *Recovery Reports*, *Evidence for Healing*, sticky note, marker, tape, Word Wall poster, chart paper |
| 4 | 10 min | **CREATE A TIMELINE FOR HEALING**<br>Facilitate a Building Understandings Discussion to organize our ideas about important events in the healing process that provide evidence that the foot is healing. | I | Healing Timeline poster, markers, sticky notes |
| | | | | *End of day 1* |
| 5 | 3 min | **NAVIGATION**<br>Revisit the Healing Timeline to recall the parts of the foot impacted by the injury. | J | Healing Timeline poster, markers |
| 6 | 10 min | **DEVELOP AN INITIAL MODEL OF HEALING**<br>Students individually develop models of the injured and healed foot to explain what they think happens during the healing process. | K | *Healing Initial Model* |
| 7 | 5 min | **REVISIT CLASSROOM NORMS/COMMUNITY AGREEMENTS**<br>Review the classroom norms and set expectations for students' work together on a consensus model. Prompt students to pick one norm to focus on for today. | L-M | Classroom Norms poster or slide |
| 8 | 5 min | **COMPARE INITIAL MODELS**<br>Students work in partners to compare their initial models and record similarities and differences. | N | *Healing Initial Model*, chart paper, markers |

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 9 | 20 min | **DEVELOP AN INITIAL CONSENSUS MODEL OF HEALING**<br>Facilitate a Consensus Discussion to develop the class's initial consensus model of healing. | O | Healing Timeline poster, markers, 2 copies of *Printouts of the Foot*, tape, chart paper, Communicating in Scientific Ways poster or handout |
| 10 | 2 min | **PREPARE FOR HOME LEARNING ABOUT RELATED PHENOMENA**<br>Give students their home learning assignment to gather stories of related phenomena similar to the healing case we have been working with/observing/examining. | P | *Healing Phenomena Stories* |
| | | | | *End of day 2* |
| 11 | 30 min | **EXPLORE DIFFERENT ASPECTS OF VISIBLE AND INVISIBLE DISABILITY**<br>Create lists of different ways people complete everyday tasks. Describe adaptive equipment that can assist in daily tasks. Revise the class definition of healing. | Q-BB | *Healing Phenomena Stories*, markers, Word Wall poster |
| 12 | 10 min | **SHARE RELATED PHENOMENA OF HEALING**<br>Record students' ideas of related phenomena and experiences they have had, either like those in the doctor's notes or any other phenomena that they think might have happened due to similar causes. | CC-DD | *Healing Phenomena Stories*, chart paper, markers |
| 13 | 5 min | **DEVELOP QUESTIONS FOR THE DRIVING QUESTION BOARD**<br>Students develop questions individually for the DQB. | EE | sticky notes, marker, Noticings and Wonderings – Post Operation poster, How Does the Foot Heal over Time? poster, Related Phenomenon poster |
| | | | | *End of day 3* |
| 14 | 30 min | **BUILD OUR DRIVING QUESTION BOARD**<br>Convene a Scientists Circle to construct a DQB about what is causing the phenomena students have been observing and working with over the previous days of this lesson. | FF | sticky notes with questions, sticky notes, larger sticky notes (to label cluster or categories of questions) tape, chart paper, markers |
| 15 | 10 min | **GENERATE IDEAS FOR FUTURE INVESTIGATIONS**<br>Elicit students' ideas for future investigations that could help us answer our questions. Make a public record of these ideas as they are shared with the class. | GG–HH | chart paper, markers |
| 16 | 5 min | **NAVIGATION**<br>Discuss where we are headed next to investigate this phenomenon. | II | |
| | | | | *End of day 4* |

## Lesson 1 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• Pre-Unit Letter Home<br>• *Emergency Room Report*<br>• *Post-Operation Report*<br>• *Recovery Reports*<br>• *Evidence for Healing*<br>• marker<br>• *Healing Initial Model*<br>• *Healing Phenomena Stories*<br>• sticky notes<br>• sticky notes with questions | • tape | • chart paper<br>• marker<br>• Word Wall poster<br>• Healing Timeline poster<br>• markers<br>• sticky notes<br>• Classroom Norms poster or slide<br>• 2 copies of *Printouts of the Foot*<br>• tape<br>• Communicating in Scientific Ways poster or handout<br>• Noticings and Wonderings – Post Operation poster<br>• How Does the Foot Heal over Time? poster<br>• Related Phenomenon poster<br>• larger sticky notes (to label cluster or categories of questions) tape |

**Materials preparation (30 minutes)**

**Online Resources** 

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Review the *Disability and Inclusion Awareness* reference before teaching the lesson and send the *Pre-Unit Letter Home* to students' parents/guardians.

Prepare chart paper to make the following posters:

- Noticings and Wonderings about the Injury
- Noticings and Wonderings Post-Operation
- What Do We Mean by Healing?
- Word Wall
- Healing Timeline: Prepare 2 large pieces of chart paper for the timeline (see image of sample timeline in teacher guide corresponding with slide I). Create the timeline on the bottom two-thirds of the chart, leaving room for foot diagrams to be taped above it. On the left end of the timeline, write "When Injury Happened". On the right end of the timeline, write "Foot Healed". Just above the line, evenly spaced, write "Recovery Report 1", "Recovery Report 2", "Recovery Report 3", and "Recovery Report 4".

- How Does the Foot Heal over Time? (initial consensus model):
  - On a separate sheet of paper, write the question "How Does the Foot Heal over Time?" Be ready to place this paper above the initial consensus model as a title.
  - The initial consensus model will consist of annotated diagrams of the injured foot and healed foot above the Healing Timeline, with the question "How Does the Foot Heal Over Time?" above it.
  - Print two large copies of Printouts of the Foot. Tape one of these on each side of the chart paper above the Healing Timeline.
- Related Phenomena
- Driving Question Board
- Ideas for Future Investigations and Data We Need

Determine where to set up the DQB and posters so students can gather around them. If you have not already done so, make and post a Classroom Norms poster near your DQB space.

Be sure you have a blank piece of paper or sticky note ready to add *healing* to the Word Wall. Do not post this word on the wall until after your class has developed a shared understanding of its meaning.

## Lesson 1 • Where We Are Going and NOT Going

### Where We Are Going

Students begin this lesson by considering a phenomenon directly connected to their personal experience: a time when a part of their body was hurt or injured, which prevented them from being able to do a favorite activity for a short or long period. They are next presented with a case study of a middle school student's multisystem foot injury, and they follow his healing journey by analyzing doctor's notes and images.

In this lesson, students develop an initial definition for the word *healing* based on their prior experiences. Over the course of the unit, the definition is expanded and revised as students figure out more about the structure and function of different body parts and whether functions return to their original state prior to injury. Students explore different ways in which individuals experience or accomplish daily tasks. They begin to develop social-emotional skills around how people may have different abilities than themselves; they learn that sometimes these abilities are a result of an injury, but that it doesn't mean the person isn't healed or otherwise healthy. Although this unit builds off the systems thinking developed in other units, this is the first life science unit in that considers living body systems.

As injury sometimes results in disability, this unit introduces students to the concept of disability as a natural and expected part of human diversity. The language in this unit reflects the idea that disability is neutral: neither tragic nor bad, nor inspirational. More information about disability to support teachers' instruction is given in *Disability and Inclusion Awareness*.

### Where We Are NOT Going

This unit focuses on how the parts of the body work together as a system to function (move, grow, and the like) and restore function (heal), and how macro- and microlevel structures (and their corresponding functions) are involved in both. In this lesson, students begin this exploration by analyzing a case study of a middle school student who broke his foot.

It is **not** necessary for students to consider what is happening at the microscopic level in Lesson 1. They remain at the macroscopic level in the first three lessons and consider the parts of the foot from different perspectives, orientations, and interactions. In Lesson 4, students shift to microscopic exploration as they examine microscopic images or slides of different parts of the body. Motivation for this shift is built into the storyline toward the end of Lesson 3.

This unit does not explore the mechanisms of the immune system, or the body's immune response to injury, in any greater detail than identifying the different components of blood (in Lesson 4). Additionally, though Lesson 1 presents data indicating that different parts or systems of the body heal at different rates (i.e., skin heals faster than bone, which heals faster than nerves), the differential lifespan of various cells is not addressed until Lesson 10.

Finally, Lesson 1 does not focus on how the injury occurred, nor on the patient's surgical procedure or external supports (cast, pins). These are merely shared so students can deduce what parts of the foot were injured and how the injury affected the foot's function, and to help analyze data that could be evidence of healing over time.

# LEARNING PLAN FOR LESSON 1

## 1. Navigation

10 MIN

**Materials:** science notebook

**Elicit students' experiences of moving their bodies.** Display **slide A**. Begin by asking students to stop and jot in their notebooks about their favorite activities that involve moving their body, and what parts of their body they use in that activity. **Slide A** is meant to elicit an array of movement experiences from students with diverse backgrounds. Take the opportunity to localize this phenomenon by revising the slide with images of activities in which your students may have more interest.* However, be mindful to include students with different abilities and interests.*

After giving students a couple of minutes to write and process their ideas, have them share out with the class. Use the prompts below to guide the discussion.

| Suggested prompts | Sample student responses | Follow-up questions |
|---|---|---|
| *What is your favorite activity that involves moving your body?* | *Accept all answers. For example:*<br>*dancing*<br>*riding a bike*<br>*painting*<br>*playing video games*<br>*jumping on a trampoline*<br>*climbing a tree*<br>*yoga* | *What are some of your daily activities that involve moving your body?* |
| *What parts of your body do you use when doing this activity?* | *Accept all answers related to parts of the body. For example:*<br>*hands*<br>*feet*<br>*arms*<br>*leg(s)*<br>*head*<br>*eyes*<br>*nose and mouth* | *How is this body part useful for supporting the activity?* |

*** Attending to Equity**
When selecting images to include in **slide A**, be sure that individuals with disabilities are represented. This will help students understand that disability is an aspect of human diversity and that individuals with disabilities have a range of interests and participate in a variety of activities.

*** Attending to Equity**
**Supporting Emergent Multilingual Students:** A science notebook gives students a space in which to reflect and communicate their developing understandings about science ideas and to track changes in those understanding. Encourage students to record their ideas using linguistic (written words) and nonlinguistic modes (photographs, drawings, tables, graphs, mathematical equations, measurements). This is especially important for emerging multilingual students because making connections between written words and nonlinguistic representations helps students generate richer explanations of scientific phenomena.

| Suggested prompts | Sample student responses | Follow-up questions |
|---|---|---|
| *Are there other parts of your body that we **can't** see that support you doing this activity?* | *Accept responses that are internal body structures. For example:*<br>*muscles*<br>*bones*<br>*joints*<br>*tendons*<br>*ligaments*<br>*brain*<br>*heart*<br>*core or abs*<br>*lungs* | *How are these body parts that we can't see useful for supporting the activity?* |
| *How do these body parts work together to do your activity?* | *Accept all answers. For example: When I dance, I use my core and my arms and my feet to move around. I use my mouth, nose, and lungs to breathe and my eyes to see where I am moving.* | *Can anyone else think of how other body parts might be helpful for _____'s activity?* |

## Science Notebook



This is the unit's first use of the science notebook. You may need time to organize a new section. How to set it up varies depending on how you've structured the components of your notebooks, such as the table of contents and how to note the start of a new unit. It is recommended to have students do the following:

- Reserve a blank page at the start of the unit for writing the unit question on day 3 of this lesson.
- After the title page, reserve 2 pages (4 pages front-to-back) for the table of contents (unless all tables of contents are at the front of the notebook).
- Reserve 10 pages (20 pages front-to-back) for the Progress Tracker pages.
- After the Progress Tracker pages, begin numbering pages (start with 1) so everyone begins the unit's first investigation on the same page number.

Remind students that the notebook is their tool for recording their observations, evidence, and ideas to share with the classroom community. They should see it as a space to brainstorm and record their thinking, as well as a place to show how their thinking changes as they learn more.

## Additional Guidance

In this unit, the Progress Tracker uses a 3-column format. Similar to previous units, students record the lesson question in the first column and explain what they figured out in the second column. The third column extends their thinking by connecting what they figured out to the concept of healing. Unlike in previous units, the third column also supports students in generating further questions that can be added to the DQB and inform or motivate future investigations.

## Additional Guidance

Be mindful that sharing or hearing stories of past injuries can bring up past or recurring trauma for students. It is advised to send home communication to parents, letting them know the subject of the lesson in advance so they can let you know of any topics that may be sensitive for students. There is a *Pre-Unit Letter Home* provided that can be edited and sent home to parents. We also recommend seeking the assistance of a school psychologist, social worker, mental health specialist, or counselor to support discussions that may be challenging for some students.

**Elicit students' experiences of being unable to do an activity.**** Display **slide B**. Using the slide and the prompts below, have students share out about times when something made them unable to use part of their body. Ask follow-up questions to push them to think more deeply about what was happening inside their body during that time, and whether other body parts were impacted, even if not directly affected by the injury.

| Suggested prompts | Sample student responses |
|---|---|
| *Why was your body not physically able to do this activity?* | *Accept all answers. For example:*<br>*I broke my leg.*<br>*I sprained my ankle.*<br>*I had stitches.*<br>*My finger was swollen.*<br>*It hurt too much.* |
| *How long was it before you could do this activity again?* | *Accept all answers. For example:*<br>*days*<br>*weeks*<br>*months*<br>*never* |

### * Strategies for This Initial Ideas Discussion

Middle school students are learning a lot about science, but it is important to honor the fact that they are already experts in their own experiences and that these are legitimate ways of knowing about the world. During this discussion, validate and encourage students as they share meaningful observations from their own lives by saying things like, *That is very perceptive, has anybody else noticed that?*

### * Attending to Equity

**Supporting Emergent Multilingual Students:** For students who are learning English or who need support following a class discussion, it can be helpful to use gestures in addition to talking. For example, as students describe their injuries, have them point to the body part and move their body to describe what they were unable to do. Keep in mind that you may have students with current injuries. Ask them to explain what they can't currently do with their body. As appropriate, revoice what is shared while demonstrating the described actions with your own body.

| Suggested prompt | Sample student responses |
|---|---|
| *What were some things you had to do so your body could heal and you could do the activity again?* | *Accept all answers. For example:*<br>*I had to rest.*<br>*I healed.*<br>*I had to do certain exercises or stretches.* |

Ask, *When your body was able to do the activity again, were you able to do it in the same way you could before the injury, or was there anything different about how you could engage in this activity?* Have students talk about this briefly with an elbow partner.

Let a few students share out their experiences. Here are some possible student responses:

- I couldn't lift as much for a long time.
- I was slower.
- I still hurt a little bit.
- I had to wear a brace.

### Additional Guidance

**Connections to Me and My Community: Inclusion**

As students are sharing their experiences, be mindful of ability-diversity. Disabled students may experience injury and healing in different ways than their non-disabled peers, so it is important to welcome and honor all experiences. Listen for language that construes disability in a negative light; remind students that individuals who become disabled after an injury learn to adapt to their body's new way of functioning and are able to complete the daily tasks of life, if a little differently. It is important that students understand that disabled individuals often take a great deal of pride in their disability and consider it a key part of their identity.

## 2. Explore an interesting phenomenon.

15 MIN

**Materials:** science notebook, *Emergency Room Report*, *Post-Operation Report*, *Recovery Reports*, chart paper, marker

**Introduce the phenomenon.** Display **slide C**. *Say, I am going to tell you the story of a middle school student. Today, this student can walk, run, and jump! However, a while ago, he had an injury that prevented him from being able to do these things. He dropped a heavy weight on his foot during PE class. After this happened, he was not able to stand, walk, or run and had lots of pain.*

Use the prompts below to elicit experiences and ideas about what happened from student volunteers.* Accept all responses.

- *Have you ever experienced something like this where you dropped something on your foot or another part of your body?*
- *Why do you think he was not able to do these activities with his body after the injury?*
- *What happened in his body to allow him to get back to these activities?*
- *What are you wondering about with his injury and journey to recovery?*

Say, *I had lots of questions as well. Let's take a look at some of the notes his doctor took along the way. We are going to notice and wonder about several time points, including when the patient was injured and during his recovery. Once we have all had a chance to record our noticings and wonderings, we will share our ideas as a class.*

**Notice and wonder about the injury.** Display **slide D**. Distribute the *Emergency Room Report* to each student. Tell students to read, annotate, and mark up their handout. If they ask what the word *metatarsal* refers to, ask them what they think that is based on what they read in the report. They should say that because it says two metatarsals are broken, and the X-ray shows two broken bones, metatarsals are two of the bones in the foot. After 2 minutes, bring the class together to share out what they noticed and wondered. Record this on a piece of chart paper titled "Noticings and Wonderings about the Injury".

**Notice and wonder about what was done to the foot.** Display **slide E**. Distribute the *Post-Operation Report* to each student. Have students read, annotate, and mark up their handout as before. After 2 minutes, bring the class together to share out what they noticed and wondered. Record this on a piece of chart paper titled "Noticings and Wonderings—Post Operation".

## Additional Guidance

The images on the *Post-Operation Report* could be traumatic for some students. Please use at your discretion. They are purposely not on the slide and are printed in black and white to make them less shocking. Please discuss the unit topic with a school social worker, psychologist, mental health specialist, or counselor, and send the *Pre-Unit Letter Home* to students' parents/guardians before starting the unit.

**Notice and wonder about the foot's recovery process.** Display **slide F**. Distribute the *Recovery Reports*. Give students 4 minutes to read, annotate, and mark up their handout for noticings and wonderings about steps in the healing process over time. After 4 minutes, bring the class together to share. You don't need to make a record for the whole class, as you will use some of these noticings in the next activity.

## Additional Guidance

The term *gap*, or "distance between bones at the fracture sites," is used throughout the *Emergency Room Report*, *Post-Operation Report*, and *Recovery Reports*. This intentionally seeds the idea that gaps, or empty spaces where cells once existed, are created by the injury and need to be filled in during the healing process. It's important for students to consider this gap at this point in Lesson 1. However, it's not essential for them to think about cells yet, or to know that cells are involved in healing. In Lesson 1, **there is only evidence that a gap exists due to injury**, with no evidence yet that cells are involved. Evidence for cells comes later.

## Alternate Activity

### Jigsawing the Hospital and Doctor's Reports

Rather than have students share out noticings and wondering with the class after each handout, you might consider jigsawing this activity in the following way:

*** Supporting Students in Engaging in Asking Questions and Defining Problems**
Initial questions about a phenomenon are intended to clarify what information is known and not known; there are often more questions than answers when scientists begin their investigations. Develop a safe and supportive space for students' uncertainty, and focus on the need to ask and answer questions in order to address the uncertainty that may require the entire unit to resolve.

1. Provide a packet containing all three handouts for each student.
2. Prompt students to skim all three handouts in chronological order.
3. Assign groups of students to focus their noticings and wonderings on only one handout or report (the third handout contains four short recovery reports—these can be further jigsawed so groups focus on only one or two).
4. Be sure to assign at least one group to each resource—multiple groups looking at each resource is preferable, as this ensures the essential details from each report are captured.
5. After groups record their noticings and wonderings on their handouts, facilitate a class share out in which groups discuss their assigned resource.

If students struggle to make sense of the reports, consider reading and annotating the first handout as a class, then allow groups to read and annotate the rest. You might instruct them to annotate the reports in these ways:

- *Underline things you notice or that grab your attention.*
- *Circle things you wonder about.*
- *Add question marks to places where you are unsure of the information.*

Note: If the resources are jigsawed in this activity, be sure all assigned resources carry over into the next activity, when students look for and record evidence of healing. It may be easier and more efficient for students to continue examining the same resource in the next activity.

## 3. Record evidence for healing. 10 MIN

**Materials:** science notebook, *Recovery Reports*, *Evidence for Healing*, sticky note, marker, tape, Word Wall poster, chart paper

**Co-construct a definition of healing.*** Display **slide G**. *Say, I keep hearing you use the word "healing," and we saw this word in the doctor's notes to describe what happened to the student's foot over time. What do we mean by that? Grab a sticky note and write your ideas about what you think healing is.*

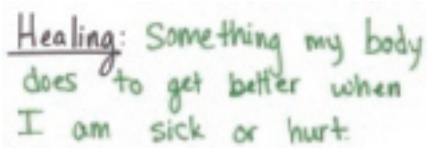
Title a piece of chart paper "What Do We Mean by Healing?" and have students post their sticky notes on it. Instruct students to read through other sticky notes after posting their own. As they post, read some of their responses aloud. Once all students are seated, use the prompts below to facilitate a discussion around what they think it means to heal.

*** Attending to Equity**

The term *healed* can have a loaded meaning in the English language. In this unit, we use it to refer to the biological process that takes place in the body in response to an injury. Sometimes injuries result in permanent disability after the body's biological healing process has concluded. A person who becomes disabled as a result of an injury is no less healed than a person whose body fully returns to prior functionality.

| Suggested prompts | Sample student responses | Follow-up questions |
|---|---|---|
| *Are there any other words in English or other languages that we also use to mean "healed" or "healing"?* | *Accept all relevant answers. For example:*<br>*repair*<br>*recovered*<br>*restored*<br>*mended*<br>*cure*<br>*curar or sanar (Spanish)* | *So, when we use these words, do they mean the same thing as when we use the word "heal"?* |
| *Can someone explain to me what we think it means to heal?* | *Fixing the broken parts.*<br>*The process that happens when your body puts itself back together.*<br>*When gaps in your body get filled in—like between broken bones or cut skin.*<br>*How the body fixes itself.*<br>*What happens in the body when it fixes the parts that are injured or hurt.* | *Can you say more about why you think that?*<br>*What is evidence of healing from your own experiences?* |

Add *healing* and the co-constructed definition to the Word Wall. Your definition might be something like "the body trying to return to doing the things it was able to do before."* Remind students that the Word Wall is a place to record our growing understanding of the word, and we will come back to it frequently to add more words or revise our definitions based on what we figure out in class.




## Alternate Activity

If you have enough space in your classroom, consider displaying the What Do We Mean by Healing? poster throughout the unit and post your healing definition there. The definition will be developed at this moment in Lesson 1, revised later in Lesson 1, and revised again in Lessons 8 and 14. Using the poster rather than a typical Word Wall entry gives you space to document each revision as your class deepens their understanding. If you choose to post your definition on the poster, you can start the Word Wall in Lesson 2 rather than now.

**Record important events that could be evidence of healing.*** Display **slide H**. Distribute *Evidence for Healing* to each student and have them tape it into their science notebook.

*** Attending to Equity**

**Supporting Emergent Multilingual Students:** When developing new vocabulary, strategies that may benefit emergent multilingual learners are to use student-friendly definitions, make connections to cognate words when possible, and include a visual representation of the word. Use these strategies throughout the unit for both "words we earn" and "words we encounter."

*** Attending to Equity**

**Supporting Emergent Multilingual Students:** When students are tasked with expressing their ideas, allow them to do so through linguistic (oral and written language) and nonlinguistic (drawings, graphs, symbols, gestures) modes. For example, for a student who is having trouble articulating evidence from the images and doctor's report, you might suggest sketching a picture on the handout. Providing emerging multilingual students with such opportunities allows them to use all their resources to express meaning.

Assign each pair of students one of the four recovery reports in *Recovery Reports*. Pairs will review their assigned report and work together to record clues they notice that could be indicators that the foot was healing. Explain that some clues will be the doctor's observations about what is happening with the patient's body, both externally (such as the skin closing where the stitches were) and internally (such as reduced swelling or the image on an X-ray). Other clues will be the doctor's actions in caring for the patient, such as removing stitches.

As you listen to students discuss with their partners, push them to think about how each clue is supported by evidence of something happening related to healing in the body. After each pair has completed the *Evidence for Healing* handout for their assigned recovery report, ask all pairs to share out with the class. The clues from all four reports will be combined in the next activity to make a timeline of the healing process.

### Assessment Opportunity

**Building towards: 1.A** Obtain information from images and doctor's notes to identify patterns between the relationship of important events (effect) and the evidence of interacting subsystems healing (cause).

**What to look/listen for:** During the discussion, listen for students who are using doctor's notes and images, such as stitches being removed or the cast coming off, to describe evidence of part of the system healing.

**What to do:** If students struggle to identify events or evidence, ask them to compare the *Emergency Room Report* with the *Post-Operation Report* and the *Recovery Reports*. Ask what was different about the foot, what was done to the foot, or what activities the injured student was able to do over time. Prompt them to find evidence that healing was happening in the body and to describe what happened that led to the milestone.

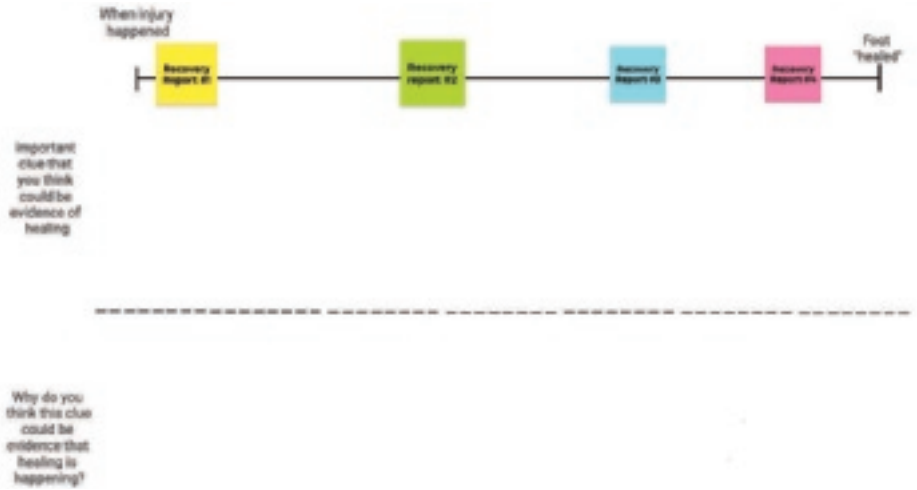
## 4. Create a timeline for healing.

10 MIN

**Materials:** science notebook, Healing Timeline poster, markers, sticky notes

**Create a timeline of the foot's healing process.** Display **slide I**. Gather students in a Scientists Circle. Begin discussing Recovery Report #1. Ask a student from each partner pair that was assigned this report to share a clue that healing occurred from their *Evidence for Healing* handout. As students share, record the clue on a sticky note in large, bold writing. Next, ask them and/or the class to explain the evidence supporting how the clue is an indicator for healing happening in the body. Record that evidence on the sticky note using a different color sticky note (if available) or using a different color marker on the same sticky note. Affix the sticky note(s) onto the Healing Timeline under Recovery Report #1.

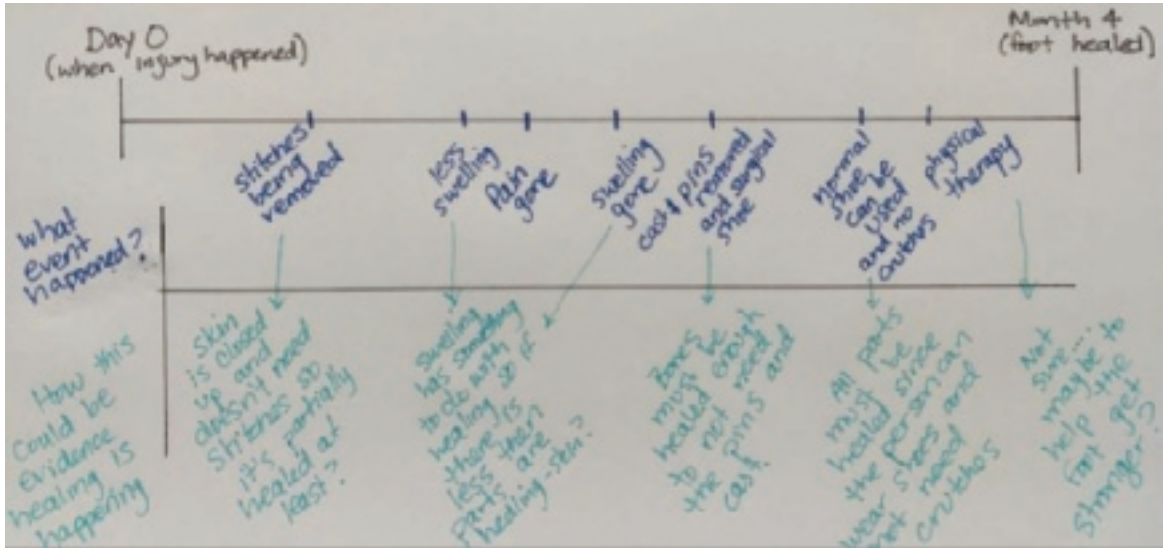
*** Supporting Students in Developing and Using Scale, Proportion, and Quantity**
Creating a timeline in this first lesson helps to map out the sequential events in the foot's healing process. Over the course of the unit, students realize that different parts of the body take differing amounts of time to heal. In addition, they figure out what is happening at a microscopic scale during the healing process for each of these body parts. Students begin to connect the crosscutting




concept of Scale, Proportion, and Quantity in regard to time and scale, and continue to develop this concept throughout the unit through additional investigations, models they develop, and explanations they construct.

Continue until the timeline contains all the clues with evidence for Recovery Report #1. Then repeat this process for Reports #2-4.*

See a suggested way to set up your timeline below.




## Additional Guidance

Make sure to leave the top two-thirds of the Healing Timeline poster open to build the class consensus model on day 2. When you make the consensus model, you will print out two copies of *Printouts of the Foot* and tape them above the timeline along with the question for the model, "How Does the Foot Heal over Time?"

Include on your timeline only the clues we have evidence for—the timeline should not include every note on the reports. If students feel adamant that an event from the report needs to be included but you feel that the evidence is insufficient, you might choose to include it with a question mark. See some suggested events and evidence on the following page.

| | Recovery Report #1 | Recovery Report #2 | Recovery Report #3 | Recovery Report #4 |
|---|---|---|---|---|
| ***Skin*** | ***Stitches removed*** *- The stitches were removed, so the skin must be closed up enough that the stitches aren't needed.* | ***Skin closed*** *- No more opening in the skin, so it is healed.* | | |
| ***Bones*** | ***X-ray shows bones lined up*** *- If the bones are lined up, it seems they are on the way to healing and functioning.* | ***Pins removed*** *- Bones are lined up, so they are on the way to healing and functioning.*<br>***Cast removed and post-op shoe used*** *- This must mean the bone is stronger and healed.*<br>***X-ray image*** *- It is hard to see the fracture site - if we can't see the break anymore, it's probably healing.* | ***Bones lined up*** *- Fracture lines are harder to see, so the bone has been put back together somehow.* | ***Fracture no longer visible*** *- If the fracture can't be seen, then the bone must be back together again.* |
| ***Muscles*** | | | ***More range of motion*** *- The foot can move more, which might also be related to swelling and that it has healed more.* | ***Improved range of motion*** *- The foot can move even more, which is a sign of healing.* |
| ***Blood*** | | | ***Adequate blood flow*** *- This wasn't mentioned before, but we saw it bleed when injured, so the amount of blood flow in the area must be important.* | ***Strong blood flow*** *- Maybe because some blood got out of the body, the blood had to somehow come back, and now it is "strong" where before it was just "adequate."* |

| | Recovery Report #1 | Recovery Report #2 | Recovery Report #3 | Recovery Report #4 |
|---|---|---|---|---|
| ***Swelling*** | ***Swelling went down*** - *The swelling began when the injury happened, so the swelling going down seems to indicate that the area is less injured.* | ***Minimal swelling*** - *Not sure what swelling does, but it is mentioned in almost all the notes, so it must be a clue of healing if the doctor was paying such careful attention to it.* | ***Minimal swelling*** - *Not sure what swelling does, but it is mentioned in almost all the notes, so it must be a clue of healing.* | ***No swelling*** - *There isn't any swelling anymore, so the foot must be healed and whatever the swelling did for the injury isn't needed.* |

To ensure all evidence of healing is included on the timeline, use prompts such as these:

- *Take a moment and look back at the recovery report you analyzed. Do we have every clue with evidence from that report up on our timeline?*
- *Are there any other clues from our recovery reports that we want to make sure are included on our timeline?*
- *Are we missing any pieces of the progression for any types of events, like changes in swelling and so forth?*

### Additional Guidance

The table above shows the key clues and evidence you will likely collect on your timeline. Note that the exact words your students use will likely be slightly different, and that is OK. The gist of the timeline is that healing takes time and not everything heals at the same rate. If students suggest adding a clue that is not one of these key clues, ask how it is evidence of healing. For example, if students suggest an important clue is that the patient could wiggle his toes, you might push back by referring to the *Post-Operation Report* and ask, *How is the wiggling toes evidence of healing happening? Do we know if he could wiggle his toes before surgery? It could be something, but we don't know.*

**Navigation.** Say, *Now that we have captured the different clues we think are part of the healing process, in our next class we'll try to figure out what is happening within the body that could explain these events.*

**End of day 1**

## 5. Navigation

**3 MIN**

**Materials:** science notebook, Healing Timeline poster, markers

**Revisit the timeline for healing.** Display **slide J**. Walk over to the timeline and ask students to remind you about the parts of the foot that were impacted by the injury and needed to heal. List those parts (skin, bone, muscle) on the side of the Healing Timeline poster or highlight them. This is an important move to support students in developing their models in the next step. Say, *It is important for us to remember what parts were damaged and needed to heal so we can explain what happens during the healing process so the student was able to use his foot again to walk, run, jump, and dance.*

## Additional Guidance

In helping students list the parts of the foot that were impacted by the injury, you do not need to press them to think beyond the large parts (bone, skin, and muscle). In subsequent lessons, they investigate more about these parts, including how they interact to allow a body part to function (Lesson 2); common structures found in bone, muscle, and skin (blood vessels and nerves, in Lesson 3); components of blood (Lesson 4); components of nerves (Lesson 5); and components of skin, muscle, and nerves (Lesson 6). At this point, students only need to understand that several structures inside the foot were impacted. If students suggest that nerves or blood (or blood vessels) were also impacted and need to heal, you might add them to the Healing Timeline with question marks, indicating that our evidence for the healing of those parts is less conclusive than our evidence concerning the bones, skin, and muscle.

After students share out about the parts of the foot we are looking at to explain its healing, say, *We just identified that in order for the foot to have healed so the student can start doing activities again, its bone, skin, and muscle need to be repaired. Let's start thinking about what is happening with these different parts and the interactions between them during the healing process.*

## 6. Develop an initial model for healing.

10 MIN

**Materials:** science notebook, *Healing Initial Model*

**Develop an initial model of the student's healing process.** Say, *Let's try to develop a model to explain "What happens during the healing process so the student was able to use his foot again to walk, run, jump, and dance?"* Display **slide K**.*

Distribute a copy of *Healing Initial Model* to each student. Tell students to put their name on their handout but not to add it to their notebooks yet, as you want to collect it at the end of class to get a sense of what they are thinking. Remind them that models allow us to view a system from different perspectives and scales. Ask students to recall moments from previous units where it was useful to look at something from a different perspective or scale; see the prompt below.

| Suggested prompt | Sample student responses |
|---|---|
| *Does anyone remember how looking at something from a different perspective helped us figure more things out in an earlier unit?* | *Yeah! Like in the Everest Unit, when we moved from the top-down view to the side view of Earth's crust, we could see that earthquakes occurred at different depths.*<br><br>*I think in the Tsunami Unit, we looked at different wave models because each one had certain strengths and limitations, but when examined together we could figure out more. Sometimes we can understand more by looking at different perspectives at the same time.* |

Explain that we can draw the foot from various angles to examine it externally, but we can also think about what we might see under the skin and inside the foot, thanks to the X-rays in the reports. Regarding scale, we can zoom in to the site of the injury to help us better understand what we cannot normally see under the skin, and how these normally invisible changes might affect the whole foot.**

At the end, have students hand in *Healing Initial Model* as a formative assessment.

### * Supporting Students in Engaging in Developing and Using Models

Remind students that in this classroom, a *model* is a picture and/or description that helps us explain something that happens in the world. As in previous units, such models should try to do more than just show what we can see; they should also try to represent any unobservable mechanisms and interactions that we think might be at work in the system to explain what we observe happening. Also, remind students that it's OK if they don't know the "right" answer when drawing models. At this stage, there are no "correct" ideas or questions—all are welcome. The goal of making an initial model is to make their thinking visible to others. Have students try to put any ideas down on paper using labels, pictures, symbols, and/or words.

## Assessment Opportunity

**Building towards: 1.B** Develop an initial model of the healing process within and between multiple interacting systems and subsystems that restores the foot's function.

**What to look for/listen for:** Students' first models on *Healing Initial Model* are more representative of what they see happening with the foot at a macroscopic level. As the handout suggests using close-up diagrams, and because students have practiced using them in previous 6th-grade units, you may notice some students adding these diagrams to their models to show what is happening under the skin (for example, that parts of the bone and muscle may no longer be connected underneath the broken skin). However, it's not necessary for students to include cells or microscopic interactions at this time. Later in the unit, they investigate the structure and function of each part at the cellular level. Also, they are likely to suggest using a microscope to examine the injury at the microscopic level later in this lesson, during the Generate Ideas for Future Investigations activity. We want to be sure that students motivate the need to explore this phenomenon at different scales.

Look for inclusion of parts or interactions within the foot system that explain how the foot heals, aside from any aid from external processes or factors such as a cast or pins. Look for the following elements across their models and explanations to see if they bring these ideas to the table with the prompts for the task as written:

- Parts of the foot (system): bone, skin, muscle
  - Might also include: blood and nerves
- How the parts of the foot (system) worked together (interacted) to heal so the student could walk

**What to do:** If students need support in choosing what to put in their models, refer them back to the Healing Timeline we developed as a class. Ask what they think might be happening with each part of the foot between when the injury happened until the student could walk again. Ask what was different in the parts of the foot right after the injury and after it was healed.

Students might include parts of the foot without representing how the parts interact or work together. If you notice this, remind them that we can also think about what's going on inside the foot and underneath the skin because X-rays allow us to see some internal structures. Prompt them to include how the parts were interacting during the events in the Healing Timeline, and what we might see if we could look inside the foot at these interactions.

*Healing Initial Model* handouts can be collected (at the end of the class) and used as a formative preassessment. They can help identify what science ideas students are bringing into this unit and where students are in their development of the practice of modeling.

*** Attending to Equity**
**Supporting Universal Design for Learning:** In this unit, Developing and Using Models is a focal SEP. Therefore, numerous scaffolds exist to support this practice in the context of cells and healing. If you believe your students are ready to proceed with less support, we recommend first removing scaffolding related to practices that are not focal in this unit. For example, analyzing and interpreting data is likely a familiar practice, as students have engaged with it in previous units. Therefore, consider asking them to use their own methods to note similarities and differences when comparing images, or to organize and present evidence for a phenomenon, without offering them supplemental data tables, graphic organizers, or handouts (often provided throughout this unit). However, take caution when removing scaffolding, as it is designed to ensure greater access and to help remove barriers to understanding complex phenomena.

## 7. Revisit classroom norms/community agreements. 5 MIN

**Materials:** science notebook, Classroom Norms poster or slide

**Revisit classroom norms established in previous units.*** Display **slide L**. Take this opportunity to remind the class how we listen to one another, press on one another's ideas, and ask questions of one another. Note that it's OK to disagree with ideas but it's important to be respectful.

Mention that it will be particularly important for us to be mindful of language we use when describing individual people's bodies, experiences, and differences. Say, *Let's take a look back at our norms to see which one will help us most to create a classroom culture where we can share different experiences openly, make each other feel safe, and respect everyone's personal experiences.*

You can use **slide M** to remind students of the Classroom Norms (if you have developed your own set of norms, replace this slide with your norms). Ask students to choose one norm to personally work on for the rest of the class period.

### Additional Guidance

Establishing norms is an important focus early in the school year. This brief reminder about norms assumes that your classroom norms have already been established in a previous unit. For more information about norms and how to establish them in your classroom, refer to the *Teacher Handbook*.

## 8. Compare initial models

5 MIN

**Materials:** science notebook, *Healing Initial Model*, chart paper, markers

**Share initial models of the foot's healing process.** Show **slide N**. Tell students to make a table in their notebook to record similarities and differences, titled "Comparing Our Models."*

Explain that they will now work with an elbow partner to compare initial models. Each student will talk about their own model for 1 minute. Then, in their table, they will record similarities and differences they notice about the ideas represented. Students should be prepared to share their own or their partner's ideas with the class.

*** Supporting Students in Developing and Using Systems and System Models**

Systems and Systems Models is a focal crosscutting concept for this unit. A *system* is an organized group of related objects or components. Here we refer to the different structures of the foot that are injured as "parts." Scientists use models to understand and predict the behavior of systems. The first step in modeling a system is to set its boundary, and then to figure out the important parts. This allows scientists to study how the parts within a system interact to produce specific results. Help students set up their initial models as systems models by identifying the important parts of each system and thinking about how those parts work together (interact).

## 9. Develop an initial consensus model of healing.

20 MIN

**Materials:** science notebook, Healing Timeline poster, markers, 2 copies of *Printouts of the Foot*, tape, chart paper, Communicating in Scientific Ways poster or handout

**Form a Scientists Circle.** Ask students to assemble their chairs in a circle and bring their science notebooks and something to write with. Students will remain in the circle for the remainder of class. Ideally, they should be able to see the slide and the Healing Timeline and have access to chart paper, but if that is not possible, use only the chart paper, which is where the more critical sensemaking will occur.

### Scientists Circle

If this is your first time forming a Scientists Circle, you will need longer than 15 minutes to coordinate it. If your class is familiar with it from previous units, the movement in and out of the circle should happen fairly quickly. Setting up the norms and logistics for forming, equitably participating in, and breaking down that space is

important to do if this is your first time. A Scientists Circle includes these important features:

- students sitting so they face one another to build a sense of shared mission and a community of learners working together
- celebrating progress toward answering students' questions and developing more-complete explanations of phenomena
- focusing on where students need to go next and how they might go about the next steps in their work

Returning to this Scientists Circle throughout the unit to take stock of what we have figured out and where we need to go next is an important tool in helping the class take on greater agency in steering the direction of their learning. This circle also helps build a sense of pride in their work. You may want to inform students that professional scientists also collaborate with one another to brainstorm, discuss, and review their work.

**Revisit the Communicating in Scientific Ways sentence starters.*** Make certain a Communicating in Scientific Ways poster or handout is visible. Emphasize that each individual has contributions to make to their community of learners. Ask students which sentence starters (see examples below) they might want to use to help them talk to one another.

Say, *To help you explain an idea, claim, prediction, or model to explain your data and observations, you could say:*

- *My idea is …*
- *I think that …*
- *We could draw it this way … to show ...*

Say, *To help you give evidence for your idea or claim:*

- *My evidence is …*
- *The reason I think that this evidence supports this is …*

Other examples of sentence starters could come from (1) listening to others' ideas and asking clarifying questions, (2) agreeing or disagreeing with others' ideas, and (3) adding onto others' ideas.

**Initiate a Consensus Discussion.** Tell students that the class is now ready to have a Consensus Discussion.* Say, *Remember, the goal of this discussion is to figure out areas of agreement and disagreement in our initial models. Knowing where we agree and disagree will help us figure out what is happening in the healing foot phenomenon. We also want to practice using our norms.*

## Additional Guidance

Build the consensus model on the Healing Timeline poster. Print out two copies of *Printouts of the Foot* and tape one foot diagram above the right and left sides of the timeline. Add drawings and annotations for the consensus model to each foot and, if prompted by students, you can add more feet in between to show how the healing process progresses. Refer to this consensus model and Healing Timeline jointly as the How Does the Foot Heal over Time? poster.

**Capture similarities and differences in students' initial models.** Display **slide O**. Use prompts such as those on **slide O** to develop an initial consensus model.*

*** Attending to Equity**
**Supporting Universal Design for Learning:** Use classroom norms to support *engagement* by fostering an equitable learning community that promotes trusting and caring relationships. The norms should reinforce to students the value of (1) the diversity of thought among all classroom community members in pushing our learning forward and (2) providing a safe learning environment that ensures fair participation. In addition, classroom norms should interrupt cultural norms or stereotypes that could make science experiences feel uncomfortable for some students (e.g., someone may feel they are not intelligent enough to think like a scientist or may be unable or unconfident with sharing their thinking).

*** Attending to Equity**
**Supporting Universal Design for Learning:** It is important to create opportunities to support student *engagement* in meaningful, accountable talk by emphasizing socially safe activity structures, such as conducting small group or partner work before a class discussion. This is especially

## Key Ideas

**Purpose of the discussion:**

- Develop an initial class consensus model to capture the ideas we agree and disagree on, or are more uncertain about, to explain what happened as the foot went from being injured with nonfunctioning parts to being healed and able to walk again.
- This initial model lays the groundwork for what students want to figure out about what is going on with the structures of the foot and their function, and also supports and encourages them to look closer at how the parts of the foot interact and work together as a complex system for both healing and walking.

**Listen for these ideas:**

- Possible areas of agreement:
  - Many parts of the foot were involved in the injury:
    - skin, bone, muscle
    - Students may also add nerves, blood, and the like, especially if focusing on what's happening under the skin (e.g., blood must be inside the foot because it came out when the skin was cut open, nerves might be under the skin in this part of the foot because the student lost feeling).
  - There is a break/cut/opening between the skin and bone.
  - There is swelling.
  - Something happens to stop the bleeding.
  - The foot is not working and the bone/skin/muscle has to come back together (filling the gap) before it can work again.
- Possible areas of disagreement/controversy:
  - What is happening in the gaps, or spaces, that form due to the break/cut/opening in the bone and skin as the foot heals?
  - How are the parts of the foot working together?
  - Where is the new skin/bone/muscle coming from?

Note: **We don't have evidence to support that cells are present** using information solely from the doctor's reports. If students bring up the idea of cells in their zoom-in drawings, be sure to ask for evidence of where they see this. Though there is none at this point, if more than one student brings up cells, you might write this idea at the side of the model with a question mark. It can be revisited during Lesson 4 when there is clearer motivation to make microscopic observations of the structures inside the foot.

Consider using a round-robin format to give every student a chance to either share something they wrote in their own model or comment respectfully on something someone else has shared. As students share out, use their ideas to draw an initial consensus model on the printouts of the feet above the timeline.

Work through the locations in the model in this strategic order by starting with the healed foot and/or an uninjured foot, using the prompts below.

beneficial to emergent multilingual students. Partner talk or small group talk gives students an opportunity to share their ideas with one or two peers before "going public" with the whole class.

### * Attending to Equity

**Supporting Emergent Multilingual Students:** Scaffolds such as sentence starters can model and facilitate particular oral or written language production skills such as formulating questions, hypotheses, explanations, or arguments based on evidence (see Communicating in Scientific Ways poster). Such scaffolds may be of particular benefit for emerging multilingual students to help them develop language skills to write or communicate their ideas to peers. It is important that scaffolds be used purposefully and **removed when no longer needed**.

### * Strategies for This Consensus Discussion

Because this is our initial consensus model, we want to capture our competing ideas. For example, what is happening in the space, or gap, created after the bone and skin separated, as the foot heals? How is each part of the foot connected, allowing it to function when uninjured but not function immediately after the injury?

| Suggested prompts | Sample student responses | Follow-up questions |
|---|---|---|
| *Let's start by modeling the healed/uninjured foot. What parts, or structures, should we include on the healed/uninjured foot?* | *skin, bone, muscle (Students might also add blood and nerves.)* | *Are there any other parts of the foot or body we might need to include?* |
| *If we could see inside the foot, what would we see?* | *We would see the bone.*<br>*We would see the muscle.*<br>*There should be blood inside the foot.*<br>*The skin would not be opened up anymore, but it might have a scar.* | *What about the skin? Does the skin count as something "inside the foot"?* |
| *How would we represent each of these parts of the foot in our model?* | *I think the skin should be closer to the outline of the foot, then the muscle, and the bone on the inside. It feels like the bone is more inside than the skin or muscle.*<br>*Maybe the skin could be made to look like a thin layer, because it seems really easy to break this layer and for blood to come out.*<br>*Maybe the bones could look thicker, because they are hard and difficult to break—otherwise we would probably break our bones more often.* | *Great! Let's write that down as something we want to know about, and we can leave it as a question mark in our model.* |

Use question marks in the consensus model to show where we have some different ideas or uncertainty. Be careful not to favorably respond to any one idea over others so as not to give away what might be going on in the phenomenon. The class can revisit and evaluate their initial competing ideas as they gather more evidence throughout the unit.

*** Attending to Equity**

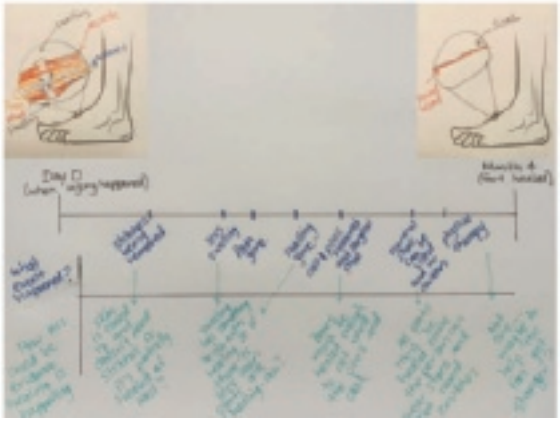
**Supporting Universal Design for Learning:**

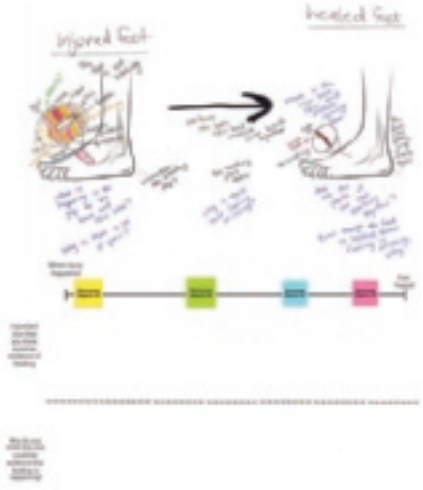
Use *representations* like color coding and/or letter or number coding to foreground parts of the model. Create a key to track the coding you use. Although color coding is a useful way to quickly reference the parts of the model, letter or number coding helps ensure accessibility for any student who may be color blind. If color coding is used, consider a palette of orange, blue, black, and/or dark brown.

| Suggested prompts | Sample student responses | Follow-up questions |
|---|---|---|
| *How do these parts look different on the injured foot right after the injury occured?*<br><br>*Note: The three parts of the foot that should be represented on the consensus model are skin, bone, and muscle. Feel free to include other parts the class agrees upon and any parts there might be disagreement or questions about. For example, some students may mention nerves, so your model might include nerves with a question mark.* | *The skin was opened up from the injury, and there was dried blood on the skin.*<br><br>*The X-rays showed two of the bones in the foot were broken and crooked (not lined up anymore).*<br><br>*There was lots of swelling, so maybe the skin is puffy or something happened to the muscle in the foot.*<br><br>*The muscle was stitched back together, but we don't really know how it looked.*<br><br>*There was dried blood on the skin of the foot, so blood must have come out of the foot.* | *If we were to zoom in on the injured and healed/uninjured foot, do you think we would see anything different than with just our eyes?* |
| *What did you notice was common in how other people represented the different parts of the foot and their interactions in the injured foot compared to the healed/uninjured foot?* | *We had gaps/holes/breaks between the bone/skin/muscle in the injured foot, but they were connected in the healed/uninjured foot.* | *Is this something everyone showed?* |
| *OK, we have a model for the foot right after the injury and a model for the foot when it's fully healed. If we could see what happens over the 4 months it took for this person's foot to heal, what do you think we would see during the healing process?* | *We saw swelling, and then it went down, but we don't really know why.*<br><br>*We would see the skin growing back together or closing up somehow.*<br><br>*We might see a scab or scar on the skin.*<br><br>*We would see the bone lined back up, and the crack in the bone would be filled in.*<br><br>*We would see something happening with the muscle that was opened up, growing back so it was together, but we don't really know how.* | *What do you think was happening inside the body to cause those events?* |

| Suggested prompt | Sample student responses | Follow-up question |
|---|---|---|
| *Were there areas where you disagreed with your partners?* | *Yes! We didn't agree about what was happening in the gap(s) as the foot healed.*<br>*We know there is blood, but we do not know how it is there or why!*<br>*We are not sure how the nerves are involved.* | *It sounds like we have some questions about what is happening as the foot heals! Write those down in your notebook on the same page where you compared initial models with a partner, and we can come back to them.* |

Examples of the How Does the Foot Heal over Time? poster are shown below.





## 10. Prepare for home learning phenomena.

2 MIN

**Materials:** *Healing Phenomena Stories*

**Present the home learning assignment.*** Display **slide P**. The purpose of the home learning is to have students hear about other people's experiences related to healing that were similar to what happened in the healed foot. Distribute the *Healing Phenomena Stories* handout to each student.

Say, *You are going to talk with trusted members of your community and ask them to tell you their stories of healing or stories they have heard from others. Use the question prompts on Healing Phenomena Stories to help you ask questions as they tell their stories.*

**End of day 2**

## 11. Explore different aspects of visible and invisible disability.

**30 MIN**

**Materials:** *Healing Phenomena Stories*, science notebook, markers, Word Wall poster

**Navigation.** Display **slide Q**. Have students reflect independently on their responses to the *Healing Phenomena Stories*, but do not ask them to share their ideas of related phenomena with the class yet (that is the next step). Ask, *As you were coming up with examples of healing and other related phenomena in your home learning, did you have any questions about whether or not someone was healed?*

Individually read each prompt on the slide (shown below) and accept all student responses.

- *Did you have any questions about whether or not something counted as "healed"?*
- *Did you have any questions about people whose bodies might work or function differently after their injury?*
- *Did you have any questions about how healing might be similar or different for individuals?*

**Set up a chart in the science notebook for brainstorming.** Say, *Everyone is different in various ways, and all of us can function to complete the daily tasks of life. Let's explore some of these everyday things and think about the different ways people do them. Open up your notebook and set up a two-column chart.*

Display **slide R**. Have students title the left side of their chart "Task". This is where they will write an aspect of daily life, such as communicating, perceiving/sensing, eating, and moving, as you discuss them. Have them title the right side "How it is completed". Here, they will brainstorm different ways a person could communicate, perceive/sense, eat, and move.

### Additional Guidance

Avoid using the word *normal* in this discussion. If you want to refer to the ways that non-disabled people complete tasks, state how the task is completed without a qualifier. For example, when describing how nondisabled people see, state simply "with their eyes" rather than "normally." If a student uses the word *normal* during this discussion, ask them what they mean and guide them toward more accurate/precise language.

**Prepare to explore differences in how people experience the world.** Say, *We'll think about and discuss a few examples of daily tasks to help us explore the wide variety of ways that people complete them. People with and without disability do these things, sometimes with the help of adaptive equipment.*

*** Attending to Equity**

Framing students' families and communities as legitimate funds of knowledge serves multiple purposes. It can (1) help students feel like they belong in the science classroom by situating their family and community knowledge as productive resources for science, (2) engage students' families in conversations about what is happening in the classroom, and (3) help students make connections between the science classroom and their everyday lives.

## Additional Guidance

The words *disability* and *disabled* carry a great deal of stigma in our society, but they are neutral words associated with the rights and protections provided by laws such as the Americans with Disabilities Act (ADA) and the Individuals with Disabilities Education Act (IDEA). *Disability* is the term preferred by adults who are fighting for disability rights. It's important to note that these words are generally preferred over euphemisms such as "special needs" or "differently abled", which stigmatize that which is different. "Special needs" fell out of fashion when advocates pointed out that there's nothing "special" about needing health care, education, safety, and access to public accommodations.

## Supporting Students in Making Connections in ELA

Many great novels are written for teens and young adults in which the main character has a disability. In most of these, the focus is not the disability but rather the character's everyday life experiences. This is a great opportunity to reach out to your ELA counterpart on your team to share what your students are doing in science class, in case any cross-curricular connections can be made. In addition, you may wish to ask if there are novels or other books they would recommend making available to students during this unit. There is an extensive list of beautifully written novels that will provide students a new way of viewing the challenges faced by people with disabilities, and their common struggles that all students face (such as finding friends). Here are a few:

- *Out of My Mind* by Sharon Draper
- *Restart* by Gordan Korman
- *Break the Mould* by Sinéad Burke

Explain that for each daily task, students will have 1 minute to brainstorm in their notebook about the ways a person might complete that task. Then they will share out what they wrote. After students share, you will move to the next slide to show images of adaptive equipment that individuals with disabilities may use as they complete that task.

**Brainstorm ways people communicate.** Display **slide S**. Give students 1 minute to write in their notebook chart about different ways people might communicate.

**Share out ways people communicate.** Have students share their ideas about different ways people complete the task of communicating. Then display **slide T** to see images of some ways people communicate, including some types of adaptive equipment. Some of these images will be similar to what the students shared. Explain how the adaptive equipment works and ask students if they have any questions.

| Adaptive Equipment | Purpose |
|---|---|
| AAC device | AAC stands for "augmentative and alternative communication." An AAC device is a piece of technology or even an iPad with software (or an app) that contains a variety of words such as verbs, nouns, and adverbs. The person using the device selects the word (or picture) they want, and the device says the word out loud. This can be done by physically touching the buttons or with eye-gaze technology. They can communicate single words, phrases, and even full sentences. An AAC device may be used by individuals who do not use verbal speech or who need language support. Other tools, such as letter boards, can also be used to communicate. |
| American Sign Language | American Sign Language (ASL) is a complete, natural language that has the same linguistic properties as vocally spoken languages, with grammar that differs from English. ASL is expressed by movements of the hands and face. It is the primary language of many North Americans who are deaf and hard of hearing and is used by many hearing people as well.<br>(See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |
| Gestures | Gestures are woven into the fabric of our daily lives. You may wave, point, beckon, or use your hands when arguing or speaking animatedly, often expressing yourself with gestures without thinking. However, the meaning of some gestures can be very different across cultures. While the "OK" sign, for example, usually conveys a positive message in English-speaking countries, it's considered offensive in countries such as Germany, Russia, and Brazil. So, it's important to be careful of how you use gestures to avoid misinterpretation. |
| Facial expression | The human face is extremely expressive, able to convey countless emotions without saying a word. And unlike some forms of nonverbal communication, facial expressions are universal. The facial expressions for happiness, sadness, anger, surprise, fear, and disgust are the same across cultures. |

**Brainstorm ways people perceive the environment.** Display **slide U**. Give students 1 minute to write in their chart about different ways that people might see, hear, or understand their surroundings.

**Share out ways people perceive the environment.** Have students share their ideas about different ways people perceive the environment around them. Then display **slide V** to see images of some ways people might do this, including some adaptive equipment for this purpose. Some of these images will be similar to what the students shared. Explain how the equipment works and ask students if they have any questions.

| Adaptive Equipment | Purpose |
|---|---|
| Eyeglasses or contact lenses | People who experience nearsightedness, farsightedness, or astigmatism may use eyeglasses or contact lenses to correct their vision. |
| Magnifier | A magnifier is a tool that makes things appear larger. There are physical handheld magnifying tools as well as digital tools that magnify text on a screen. People with low vision who may not be able to make things out at a typical distance, even with glasses or contact lenses, may benefit from a magnifier. |
| Cane | People who are blind may not see using their eyes, but they do use tools and other senses to perceive their environment. A cane is a tool that blind people can use to perceive any obstacles or hazards in front of them as they move from place to place. |
| Hearing aids | Hearing aids are devices used by deaf and hard-of-hearing individuals to regain a portion of hearing by amplifying sound. |
| Cochlear implants | A cochlear implant is a small electronic device that electrically stimulates the cochlear nerve (nerve for hearing). The implant has external and internal parts. The external part sits behind the ear and picks up sounds with a microphone. It then processes the sound and transmits it to the internal part of the implant. |
| Braille | Braille is a system of raised bumps that allows blind individuals to read text with their fingers. Braille is a code of language and not a language in itself. |
| Alerting devices | Alerting devices are assistive devices that connect with doorbells, telephones, and other alarm devices. These devices add a specific alarm based on one's disability. For instance, a deaf individual can have a doorbell that blinks a light instead of making a noise to indicate someone is at the door. |

**Brainstorm ways people eat.** Display **slide W**. Give students 1 minute to write in their chart about different ways people eat.

**Share out ways people eat.** Have students share their ideas as before. Display **slide X** to see images of adaptive equipment for eating. Some will be similar to what the students shared. Explain how the equipment works and ask students if they have any questions.

| Adaptive Equipment | Purpose |
|---|---|
| G-tube | "G-tube" is a nickname for a gastronomy tube. It is a small tube that goes from the outside of the body directly to the stomach. It's a way to make sure someone gets all the fluid and nutrients they need. |
| Adaptive plates, bowls, spoons, forks, knives | Adaptive feeding tools like specialized mugs, plates, utensils, and more make it possible for individuals to eat with increased independence. These include things like plate guards, partitioned plates, and weighted utensils to help with tremors or weak grip strength, rocker knives to decrease wrist strain, and many types of cups.<br>(See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |

**Brainstorm ways people move.** Display **slide Y**. Give students 1 minute to write in their chart about ways people move around.

**Share out ways people move.** Have students share their ideas. Display **slide Z** to see images of adaptive equipment. Some will be similar to what the students shared. Explain how the equipment works and ask students if they have any questions.

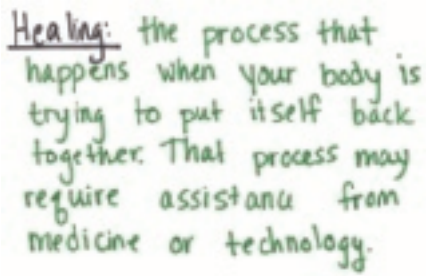
| Adaptive Equipment | Purpose |
|---|---|
| Wheelchair | A wheelchair is a tool individuals use to move from place to place. People use wheelchairs for many different reasons. Some individuals use a manual wheelchair that is pushed, or they propel the chair themselves using their hands and arms. Power wheelchairs have motors and joysticks and are controlled by switches. Some wheelchair users control their chairs with switches near their heads or by using other body parts. Some people use their wheelchairs exclusively to get around. Other wheelchair users occasionally walk or use other adaptive equipment to move from place to place in addition to using a wheelchair. |
| Stander | A stander is a piece of equipment that helps muscles and bones stay strong. Typically, individuals who use wheelchairs for all of their movement use a stander for some time during the day to give them a change of position and help keep their bones and muscles from weakening. The person gets into the stander (with or without help) and safety straps are engaged and tightened. |
| Braces | Braces are worn on different parts of the body that need extra support or positioning. |
| Prosthetics | Prosthetics are devices that simulate a body part a person may not have, like an arm or a leg. Prosthetics often work similarly to the body part they simulate. |
| Crutches or walkers | Crutches or walkers are devices used to transfer the body's load from the lower body to the upper body. Crutches and walkers are used when a person's lower body is not completely immobilized, but impaired. |

## Alternate Activity

If time permits, hang 4 pieces of chart paper in different places in your classroom. At the top of each piece, write the title "Brainstorm different ways people …" and complete each title with a different task: communicate, eat, perceive/sense, and move. Have students move around the room in a silent carousel activity in which they each write one idea on each poster. Then you or a student can read each list aloud before you show and discuss the images of adaptive technology for the corresponding daily task.

**Synthesize and expand our understanding of healing and body function.** Display **slide AA**. Say, *Now that we have expanded our knowledge of the many different ways people complete the daily tasks of life, let's refine our definition of healing.*

Have students begin by doing a Quick Write in their notebook. These prompts are shown on **slide AA**: *I used to think healing was _____. Now I think healing is _____.*




Ask students to share their ideas with a partner and then share out with the class.

**Revise the Word Wall's definition of healing.** Add a definition similar to this, but created by your class: "Healing is the process that happens when your body is trying to put itself back together. That process may require assistance from medicine or technology."

## Additional Guidance

It's important to note that there are many homeopathic techniques and family remedies that may arise from indigenous medical practices, which, though largely ignored or devalued by western medicine, are still rooted in medicine. What is commonly referred to as Complementary and Alternative Medicine (CAM) is often chosen for social, cultural, philosophical, and personal factors.

For the purposes of this unit, and in alignment with our call for equity, it's important to listen to and include all forms of medicine or remedies described by students. More importantly, to help value indigenous and traditional medical techniques, consider using the term "complementary" rather than "alternative" when describing them. "Alternative" denotes something unusual, not normal, or outside of accepted practice. "Complementary" signifies something used in conjunction with other medical practice, which is most often the case with illnesses regardless of culture, location, or belief.

(See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

**Connect what we have figured out about disability to the related healing phenomena.** Display **slide BB**. Say, *Thinking about how we expanded our understanding of the different ways people can function, look back at what you wrote on your home learning handout, Healing Phenomena Stories. Is there anything you would want to change or share differently? How might our revised definition of healing change what you were going to share about related phenomena?*

Here are some sample student responses:

- Healing is more complicated than we thought at first!
- We have more ideas to add to our related phenomena.

## 12. Share related phenomena of healing.

10 MIN

**Materials:** science notebook, *Healing Phenomena Stories*, chart paper, markers

**Share related phenomena and experiences.** Display **slide CC**. Have students take out *Healing Phenomena Stories*. Have several students share with the class. Encourage students to snap their fingers if a phenomenon is mentioned that they also have observed.

Consider using the following prompts to begin this conversation:

- *What other experiences have you or the members of your community had that this student's journey to recovery reminds you of? What parts were impacted? How long did it take to heal?*
- *What other situations might involve similar ways of healing that occurred within the student's body?*
- *When have you ever seen or heard of healing from injuries that affected the ability to sense (smell, feel, taste) something in one's surroundings?*
- *When have you ever seen or heard of other living things, besides humans, healing from an injury?*

Use chart paper titled "Related Phenomena" to record a bulleted list of what students share. After making this list, link it back to the classroom consensus model. Display **slide DD**. Say, *As we refine our model to try to explain what is happening with the student's recovery, let's keep other phenomena in mind too, so we can see if our model can be used to explain any of these as well.*

Ask students to tape *Healing Phenomena Stories* into their science notebooks.

## 13. Develop questions for the Driving Question Board.

5 MIN

**Materials:** sticky notes, marker, science notebook, Noticings and Wonderings – Post Operation poster, How Does the Foot Heal over Time? poster, Related Phenomenon poster

**Write initial questions for the DQB.** Make sure the Noticings and Wonderings – Post Operation poster, the How Does the Foot Heal over Time? poster, and the Related Phenomenon poster are visible at the front of the room. Present **slide EE**. Say, *We have looked at the foot injury healing, as well as other instances of injuries healing. In thinking about what we could investigate as a class, what kinds of questions do we have about these systems, and the interactions between the parts of these systems that cause them to heal?* Listen for students to suggest questions about other things healing, other body parts healing, what is happening in the different parts of the system where healing is happening, how the parts are connected, and so forth.

Then distribute 3-4 sticky notes and a marker to each student. Ask students to write up to three questions about healing and at least one about other related phenomena. They should write one question per sticky note, big and bold, so they can be clearly seen.

Have students stick their questions temporarily on the inside cover of their science notebook to keep them safe until we share them in the next class period.

## Additional Guidance

Students may have these kinds of questions: "Why did the skin heal first?" "Why did he need stitches?" "Why did he have pins or a cast?" These questions are valid and acceptable, but to keep the focus on natural phenomena within body systems rather than external supports for healing, remind students to think about what was happening inside the student's body or other living things' bodies.

**End of day 3**

# 14. Build our Driving Question Board.

**30 MIN**

**Materials:** science notebook, sticky notes with questions, sticky notes, larger sticky notes (to label cluster or categories of questions) tape, chart paper, markers

**Gather in a Scientists Circle around the DQB.** Project **slide FF**. Put up a piece of chart paper to build the DQB. Instruct students to bring their sticky notes and science notebook, along with a chair, to a Scientists Circle around the DQB. The How Does the Foot Heal over Time? poster and the Related Phenomena poster should be visible.

## Additional Guidance

The DQB is central to this unit's sensemaking. It can be set up in various ways depending on your classroom resources, use of technology, and number of students. What works for some will not work for others. Most important is that the DQB is visible to students each day and represents "our shared mission." Students will use it to assess what they've figured out and identify next steps. You can choose to have students put their sticky notes directly onto the Healing Timeline or you can make a separate DQB poster.

**Post questions to the DQB.** Explain how you will create the DQB:

- The first student reads their question aloud to the class and then posts it on the DQB.
- Students who are listening should raise their hand if one of their questions relates to the question that was just read aloud.
- The first student selects the next student whose hand is raised.
- The second student reads their question, says why or how it relates, and posts it near the question it most relates to on the DQB.
- That student selects the next student, who may have a related question or a new question.
- We will continue until everyone has at least one question on the DQB.

If the question is a new question and doesn't fit with any that are already on the board, students should create a new cluster.

**Organize questions into categories.** Questions will naturally cluster into similar areas. Once students finish sharing, ask them to look at the questions for any additional organization that can be done. Use larger sticky notes to label these clusters. Some clusters that may emerge include: the parts of the foot (bone, skin, muscle, blood, nerves), recovery, things done to the foot after the injury, healing/repair, when things heal or how long it takes, and so forth.

**Develop an initial driving question.** Point out that many of the questions are connected to how and why certain things happened in the healing process. Suggest that encompassing them under a single driving question could remind us of how the work on any one question is in the service of all our questions. Ask, *Now that we have written our questions, what main driving question should we put at the top of our DQB?*

Feel free to offer slight changes to students' wording or combine questions. For example, if one student suggests, "How do the parts of the foot work together to heal?" and another suggests, "What is happening inside the foot so the student can walk again?" you can say, *I heard one person asking about how the parts of the foot work together and one person asking about what is happening that we can't see. Can someone combine these into a single question?* Once an idea is on the table that meets the criteria and/or looks like the example above, revoice it.

If students struggle to construct a driving question for the unit, propose "How does the foot (or body) heal?" as a single driving question that most of our questions could fit under. Then ask, *Does everyone agree on this for our initial driving question?*

Once the class agrees on one driving question, write it in large letters on a half-piece of chart paper and hang this banner over the top of the entire DQB. Remind students that we can revise this question as we continue to figure out new things in future lessons.

## Assessment Opportunity

**Building towards: 1.C** Ask questions that arise from observations of injuries to multiple subsystems resulting in loss of a particular body function to the larger complex system of the foot.

**What to look for/listen for:** When students generate questions on sticky notes, look to see that they are including questions about multiple parts of the foot or body working together whether to function or to heal. You should also notice that students are asking questions about specific events from the Notice and Wonder–Post Operation poster, the How Does the Foot Heal over Time? poster, and/or the Related Phenomena poster. You may also want to look through student notebooks to see their individual ideas for future investigations to pursue.

**What to do:** It is important that *all* questions posed be placed on the DQB, whether open-ended or closeended. As students ask questions, have them reflect on any related phenomena about other living things or important events or evidence in the How Does the Foot Heal over Time? poster that have few or no corresponding questions posted on the DQB. Prompt students to generate more questions in this space so we are motivated to investigate several subsystems of the body and other living things.

## Additional Guidance

If your DQB is not already in a digital form easily referenced by all students, you will want to type up the questions after your final class develops their DQB, and then share them with students in later lessons. This list will first be used in Lesson 8 and again in several lessons thereafter. Revisiting the DQB questions to see which ones can be answered at different points in the unit can also be an individual activity if students finish other activities early. Having this list in digital form makes it more accessible to students to think through which questions they can answer over time.

## 15. Generate ideas for future investigations. 10 MIN

**Materials:** science notebook, chart paper, markers

**Stay in the Scientists Circle to brainstorm investigations and data we need.** Show **slide GG**. Now that the class has created a DQB, tell students it is time to really dig into the hard work of figuring out what is going on! Have them title a new notebook page as shown in the slide. Ask, *What kind of information or data will we need to be able to figure out what is going on inside our body at these times:*

- *when it is performing a specific function,*
- *when it is injured, and*
- *as it heals?*

Give students about 5 minutes to individually record in their notebooks some ideas for future investigations or data we need. Meanwhile, create a new poster titled "Ideas for Future Investigations and Data We Need." Put this right next to the DQB.

Tell students you are going to record their ideas and you want everyone's ideas to be represented. Have students turn and talk with a partner about their ideas.

**Make a class record of these ideas.** Display **slide HH**. Have partners share their ideas with the class. Make sure that all partner pairs get to offer at least one idea. Create a class record of these ideas on the new poster. You may also want to prompt students to keep a record in their science notebooks. As they share, underline or add check/tally marks to repeated statements to keep track of common ideas. Emphasize that we are listing what we think might help us answer our questions, and that we may need to add to this list and update our DQB throughout the unit.

Here are some ideas for possible investigations or data:

- Look more closely at the foot using magnifying glasses.
- Zoom in using microscopes or pictures.
- Look more closely at X-rays.
- Get more information from a doctor or surgeon.
- See more pictures over time of injuries healing.
- Look at some other injuries.

### Scientists Circle

One way to ensure that all student ideas are shared and recorded on the Ideas for Future Investigations and Data We Need poster is to pass a marker to the student nearest you in the circle. Have that student share one idea. Write it on the poster. When you have almost finished writing it, have that student pass the marker to the next student, who then shares an idea. If the idea is on the poster already, the student should say which idea is similar and how it is similar. Underline or put a tally mark next to that idea. In this way, the marker continues to be passed and all students have their thinking represented. Remind students that if they have additional ideas that don't end up on the poster, they should jot them down now; then, after the marker makes it all the way around the circle, they can raise a hand to share.

## 16. Navigation

5 MIN

**Materials:** None

**Prioritize what to investigate first.** Display **slide II**. Say, *We have a lot of questions about how the boy's foot healed, and some ideas about what to investigate next. We saw from the doctor's notes that the main parts of his foot that were impacted were the bone, muscle, and skin. If we could look more closely at these three parts, how might this help us with some of our questions? Which of our ideas for investigation involve the bone, muscle, or skin?*

Prompt students to turn and talk with their neighbor. After 2 minutes, ask students to share their responses. Here are some sample student responses:

- Before the injury, all these parts seemed to work together. Maybe by looking at the parts closely, we can see how they are connected, and then figure out why the foot works differently when they're not connected.
- If we can figure out how the bone, muscle, and skin work together for someone to walk, then maybe we can figure out why the boy couldn't walk when these parts were injured.
- We said that we wanted to use a magnifying glass or microscope to look more closely at the different parts.

Say, *It sounds like in our next class we might want to look more closely at these parts of the foot to figure out more about how they work together for the foot to function.*

# ADDITIONAL LESSON 1 TEACHER GUIDANCE

## Supporting Students in Making Connections in ELA

**CCSS.ELA-Literacy.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.**

On day 1, students gather additional information from doctor's reports and images of an injury, from which they record important events and evidence that those events indicate healing is happening on *Evidence for Healing*, and then add these to a class timeline.

**CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.**

When the class is building the DQB, if a student forgets to explain why or how their question is linked to someone else's, press that student to try to talk through their own thinking. This is a key way to emphasize the importance of listening to and building off of one another's ideas and to help scaffold student thinking.

If students can't figure out which question connects to theirs, encourage them to ask the class for help. After an idea is shared, ask the original presenter if there is agreement and why, and then post the question.

This lesson's activities rely on students communicating and articulating their thinking. One tool that supports classroom discussion is the *Communicating in Scientific Ways* sentence starters. This 1-page document can be blown up and printed as a class poster, printed on 8.5-x-11 paper and posted near students' desks, and/or scaled down and taped into students' science notebooks. Reference the sentence starters and encourage students to use them as they communicate. The sentence starters can be especially useful for helping students engage in scientific talk, particularly students who may feel reluctant to contribute.

LESSON 2

# What do our bones, skin, and muscles do for us?

## Previous Lesson

*We shared experiences of when we could and could not move our bodies. We read doctor's notes about an injured patient, analyzed injury images, and created a timeline of evidence of healing. We developed models explaining how parts of the foot work together, enabling the patient to walk again. We generated a list of related phenomena, a Driving Question Board (DQB), and possible investigation ideas.*

## This Lesson

**Investigation**

**2 DAYS**



We investigate how skin, muscle, and bone work together when moving by watching a video of the dissection of a chicken wing. We map the parts of the chicken wing to the parts of the human foot to make sense of how these parts work together in similar ways. Then, we revise the investigation to figure out how an injury can affect the wing's function.

## Next Lesson

*We observe medical images and scientific diagrams of the knee to analyze the structures inside the body. We notice that there are some structures we can't identify so we look at close-up diagrams of skin, muscle, and bone. We discover that blood vessels and nerves are found throughout the skin, muscles, and bone.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**2.A** Analyze and interpret data to highlight the interactions between subsystems (skin, muscle, bone) within the larger system (foot or wing).

**2.B** Revise the experimental design and conduct an investigation to predict the change in function of the chicken wing (effect) when parts are injured (cause).

## What Students Will Figure Out

- Skin is attached to the muscle underneath it, and the muscle is attached to bones.
- Bones move when the muscles attached to them move.
- The muscles and bones are both parts of the wing (or foot) system and interact for the wing (or foot) to move.
- When one part of the system is broken or injured, the whole system is affected and can't function the way it used to.

## Lesson 2 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 5 min | **NAVIGATION**<br>Observe how our foot moves and figure out how to investigate the parts of the foot working together by using a chicken wing. | A-C | computer, projector |
| 2 | 20 min | **INVESTIGATE SKIN, MUSCLES, AND BONES IN A CHICKEN WING**<br>Watch a video of a chicken wing being dissected to see what is inside and how parts work together for the wing to move. | D-G | computer, projector, whiteboard (optional), Investigate Skin, Muscles, and Bones in a Chicken Wing |
| 3 | 10 min | **MAP THE CHICKEN WING STRUCTURES TO THE FOOT MODEL**<br>Use a mapping tool to analyze how parts of a chicken wing could represent similar parts in the human foot. | H | *Mapping the Chicken Wing to the Human Foot*, computer, projector, whiteboard |
| 4 | 10 min | **DEVELOP A POSTER OF PARTS, OR STRUCTURES, OF THE BODY**<br>Create a class poster to include what we have figured out about the structures and functions of muscles, bones, and skin. | | *Mapping the Chicken Wing to the Human Foot*, tape, chart paper, markers, Word Wall |
| | | | | *End of day 1* |
| 5 | 5 min | **BRAINSTORM HOW TO REVISE THE INVESTIGATION**<br>Brainstorm how we could revise our investigation to see how injuries affect the chicken wing's function. | I-K | *Mapping the Chicken Wing to the Human Foot*, as-yet untitled poster of the different parts of the body from day 1 |
| 6 | 15 min | **INVESTIGATE SKIN, MUSCLES, AND BONES IN AN INJURED CHICKEN WING**<br>Watch a video of a chicken wing being injured and dissected to see what parts are damaged and how this affects the way they work together for the wing to move. | L-M | computer, projector, Investigate Skin, Muscles, and Bones in an Injured Chicken Wing |
| 7 | 5 min | **COMPARE THE INJURED WING TO THE INJURED FOOT**<br>Discuss how the parts of the chicken wing compare to the parts in the human foot and how using the wing can help us figure out more about how the foot works. | N | *Mapping the Chicken Wing to the Human Foot*, chart paper, markers |
| 8 | 15 min | **CONDUCT A BUILDING UNDERSTANDINGS DISCUSSION TO BEGIN THINKING ABOUT A BODY AS A SYSTEM**<br>Facilitate a Building Understandings Discussion to review students' prior use of systems thinking, and begin thinking about the body as a system of subsystems. | O-P | *Mapping the Chicken Wing to the Human Foot*, as-yet untitled poster of the different parts of the body from day 1, markers, images cut out from *Skin, Muscle, and Bone Systems*, tape or stapler, optional: *Chicken Wing Structures* |

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 9 | 5 min | **CREATE A PROGRESS TRACKER FOR THE UNIT**<br>Set up a new three-column Progress Tracker and record what we have figured out about skin, muscles, and bones and what they do. Reflect on what we want to figure out next. | Q | |
| | | | | *End of day 2* |
| | | **SCIENCE LITERACY ROUTINE**<br>Upon completion of Lesson 2, students are ready to read Student Reader Collection 1 and then respond to the writing exercise. | | Student Reader Collection 1: *Body Parts (and Breaking Them)* |

## Lesson 2 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Investigate Skin, Muscles, and Bones in a Chicken Wing materials | | | • Intact Chicken Wing Investigation video at 6.6 Lesson 2 Intact Chicken Wing (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |
| Investigate Skin, Muscles, and Bones in an Injured Chicken Wing materials | | | • Injured Chicken Wing Investigation video at 6.6 Lesson 2 Injured Chicken Wing (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Mapping the Chicken Wing to the Human Foot*<br>• tape | | • computer<br>• projector<br>• whiteboard<br>• chart paper<br>• markers<br>• Word Wall<br>• as-yet untitled poster of the different parts of the body from day 1<br>• images cut out from *Skin, Muscle, and Bone Systems*<br>• tape or stapler<br>• optional: *Chicken Wing Structures* |

**Materials preparation (30 minutes)**

Online Resources



Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Have materials ready to add the following words to the Word Wall: *structure*, *function*. Do not post these words until after your class has developed a shared understanding of their meaning. This will be done during day 1 of this lesson.

Print out the images on *Chicken Wing Structures* and *Skin, Muscle, and Bone Systems* for the discussion on day 2.

See *Teacher Instructions for Chicken Wing Dissections* if you would like to demonstrate this investigation yourself rather than using the video.

Before the lesson, watch the Intact Chicken Wing Investigation video 6.6 Lesson 2 Intact Chicken Wing (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) and the Injured Chicken Wing Investigation video 6.6 Lesson 2 Injured Chicken Wing (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) .

Be prepared to play the first video on day 1 and the second video on day 2, pausing at designated places so students can discuss what they're seeing.

On day 1, have chart paper ready to create the Our Body as a System poster as a class. Wait to add the title to this poster until this is developed with your students.

On day 2, have chart paper ready to record similarities and differences between the injured chicken wing and the injured human foot.

## Lesson 2 • Where We Are Going and NOT Going

**Where We Are Going**

From earlier grades, students know that animals have internal and external structures that help them function (**4-LS-1-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.**). In this lesson, we want to use this knowledge to press students to figure out how these parts (structures) interact and work together for the body to move (function). By taking a closer look at some of the internal parts (muscles and bones) of a skinned chicken wing, we observe how these parts of the wing are connected and interact when the wing is moved. Students extrapolate what they figure out to consider how these structures work together in a human foot. In this lesson, we focus on how the bones, skin, and muscles work together in a chicken wing and human foot to support their functions.

In this lesson, we use the word *structure* to refer to the **parts** of the wing or the foot and also to refer to **how** the parts are put together or arranged. This is an intentional choice because students will figure out things about structure in terms of both the shape and the arrangement of parts over the course of the unit. This word is added to the Word Wall in this lesson and then continually refined over the next few lessons. See the *Development of the Our Body as a System poster* reference for how structure/function is developed over the course of the unit.

### Where We Are NOT Going

Although other parts or structures affect how the chicken wing (and human foot) move, this lesson only focuses on the role of the muscles, skin, and bones because those parts were identified when describing the foot injury in Lesson 1 (e.g., doctor's notes, X-rays, and images). Because nothing is mentioned in the doctor's notes about tendons, ligaments, or joints, we do not include these parts in this investigation. In addition, the joint of the injured foot was not impacted, so we do not focus on how joints work in this lesson.

# LEARNING PLAN FOR LESSON 2

## 1. Navigation

5 MIN

**Materials:** computer, projector

**Brainstorm how the different parts of the foot work together.** Say, *Last class we analyzed a case where a student couldn't use their foot to walk after an injury. Can anyone remind us what major parts of the foot were injured?* Students should say the bone, muscle, and skin.

Continue by saying, *At the end of the last class, we looked at our questions and our investigation ideas, and based on all the questions we had about the injured parts of the foot and how it heals, what did we decide we want to investigate today?* Here are some sample student responses:

- We want to figure out more about the muscle, bone, and skin and how they work together to support the foot's function.
- If we can figure out how these parts of the foot work, then we can figure out why the foot doesn't work when any of these parts are injured.
- If we can figure out why these parts don't work when injured, then we can begin thinking about what needs to heal for the foot to function.

Display **slide A**. Say, *Okay, let's begin by figuring out a little bit about how different parts of our body function and how they work together.* Elicit student ideas with the prompt below.

| Suggested prompt | Sample student responses |
|---|---|
| *If you look at and feel your foot, or your calf or your hand or your forearm, what can you feel or see?* | *I can see skin.*<br>*I feel my bones in my foot or the front of my calf.*<br>*If I push a little bit, I can feel bones in my fingers, in my hand, and in my arm.*<br>*The back of my calf feels less hard than the front. I can feel there is muscle or stuff inside there. On the front I can feel bone under the skin.*<br>*My forearm feels like there is muscle or stuff inside. I can feel my bone if I press a little.* |

***Attending to Equity**

Some cultures or traditions may not accept or allow the use of an animal that was once alive. Prior to this lesson, confirm that students and their families are okay with this; if any are not, excuse them from this part of the lesson.

Whether you show the video of the dissection or demonstrate live the dissection, be aware of your students' ethnic, religious, cultural, and social practices, as well as food insecurities, that would cause them to take issue with this dissection.

Say, *Cool. So there are these different parts (muscles, bones, and skin) in our arms, legs, and feet. As we continue to explore, feel free to use any of these body parts as you think about how parts of the body work together or interact.* Continue the discussion with the prompts below.

| Suggested prompts | Sample student responses |
|---|---|
| *Okay, so you can feel your bones and maybe your muscles, but you can't see them. We can see our skin. Now move your foot up and down or back and forth, or move your hand up and down or side to side. What can you feel when you do this?* | *I can see and feel my calf get tighter and less tight as I move my foot.*<br>*The front of my calf, or shin, also gets tighter or less tight as I move my foot up and down.*<br>*I can see my skin shift or stretch in different ways when I move my foot or my hand.*<br>*I can see and feel the skin shift and get more or less tight in my arm as I move my hand up and down.* |
| *Can anyone feel anything different with their bones when they move their foot or hand?* | *Not really, but I can feel and see that my ankle area looks a little different when I flex and unflex my foot.*<br>*No, but when I move my hand or fingers, they take a different shape when they bend or extend. When I extend my fingers, they are all straight, but when I bend them, they have a hook shape. Does that mean the bone bends too?* |

**Discuss how looking at muscle and bone could help answer our questions.** Display **slide B**. Say, *So we can see that our skin changes when we move our foot or hand or arm around, but we can't see what is happening to the muscles or bones in our foot or hand or arm. If we can figure out how our muscles and bones function together when we move our foot, how might that help us figure out why the student with the injured foot couldn't walk on it? Turn and talk with a neighbor about this question.*

Ask a couple of volunteers to share their ideas with the class. Here is a sample student response:

- Maybe if we know how they work together when they're not injured, then we can figure out how they function differently when they are injured.

Say, *So if we want to know how these parts of the foot or arm or hand work together, it seems like we would want to be able to see inside the foot, arm, or hand as it moves. Although we can't look inside a living human body in our classroom, there are other things that have muscles, skin, and bones that we might be able to use to figure out more about how they interact and work together.*

**Introduce the use of a chicken wing to see how body parts work.** Display **slide C**. Use the prompts in the following table to motivate students in thinking about how we could use a chicken wing to help us figure out what is going inside of our body.

## Additional Guidance

Students watch two video investigations (or live demonstrations, if you choose) to collect data about a chicken wing. Students are encouraged to think about the muscles, bones, and skin of the wing, how they work together for the wing to move, and how this relates to the way these parts work in our body for our limbs to move. If some students do not feel comfortable watching the dissection, you may need to provide them a space to sit outside of the classroom during this time. If they don't watch the dissection to see how different muscles affect the movement of the wing, you might ask them to record what they notice about their own arm or leg when they flex one muscle, like the bicep or tricep. Then ask them to compare their noticings of their own limb with a partner who did watch the dissection. You may also encourage this student to share their observations of the dissection with the student(s) who didn't watch it.

| Suggested prompts | Sample student responses |
|---|---|
| *So we know we want to figure out more about muscle and bone and skin. Do other organisms have these parts? Which ones?* | *Yes!*<br>*Dogs, cats, horses, whales, dolphins, maybe snakes?* |
| *If we could observe these parts up close in another organism that was once living, how might that help us figure out how they work together or function in our body?** | *Maybe we could see their shape or how they are connected.*<br>*Maybe we try moving the different structures and see how they work.* |
| *Let's think about how using a chicken wing could help us find out more about muscles, skin, and bone. Does a chicken wing have skin and bones and muscle?* | *It has skin and bones for sure, but not sure about muscle.*<br>*I think it has all three, and the meat is the muscle.* |
| *If we were to use a chicken wing to try to figure out how these parts work together, how might this help us eventually figure out how our foot works?* | *If we can look under the skin, then we might be able to see what is under there and how it moves or functions.*<br>*If we can look inside the wing, we can see if there are similar parts, like bone and muscle. Then we can try to figure out how they work or function.* |

## ADDITIONAL GUIDANCE

In this lesson, we begin laying the groundwork to master MS-LS1-1 (Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.). The class begins by discussing how observing the interaction of structures in a chicken wing could help us make sense of how similar structures in our body work together. This leads to analyzing a chicken wing dissection to see how the bone, muscle, and skin work together. Students notice that when muscles move and contract, the bone and skin move as well. They make observations of how an injured wing moves compared to an uninjured wing. Then the class discusses how characteristics of the parts allow them to function the way they are supposed to.

This connection between the structure and function of body parts attends to the 3-5 grade band of the CCC. In this unit, we capitalize on what students should have already figured out in earlier grades about various external and internal structures, including connections between the parts and their functions. We build on this understanding as we continue to change the scale we are using to analyze the structure and function of different parts in the body. For example, in Lesson 6, students will look at skin, bone, and muscle under the microscope and find that there are smaller repeating structures within each part. We will then add to our conceptual understanding of "structure" to include thinking about the macroscopic (e.g., muscle systems found throughout the body) and microscopic structures (e.g., muscle cells) found in muscle, skin, and bone and how they contribute to the function of these parts of the body.

## 2. Investigate skin, muscles, and bones in a chicken wing. 20 MIN

**Materials:** Investigate Skin, Muscles, and Bones in a Chicken Wing, science notebook, computer, projector, whiteboard (optional)

### ADDITIONAL GUIDANCE

If you prefer to dissect an actual chicken wing in class, refer to the *Teacher Instructions for Chicken Wing Dissections* for a list of materials needed and step-by-step instructions. It is highly recommended that you use a document camera, if available, to clearly project the wing as you dissect it so students can observe the relevant details. Note that carefully removing the skin so as not to damage the muscle tissue can be time consuming, extending the investigation time beyond 20 minutes. Be sure to practice on your own prior to conducting the dissection during class.

**Orient students to the chicken wing dissection.** Display **slide D**. Say, *We are going to watch a video of a chicken wing dissection to take a closer look at how the muscle and bone interact. Let's think about how what we're looking at compares to the human body. Look at the image on the slide. How does the chicken wing resemble a human arm? What parts look similar?*

Conduct a brief discussion comparing the chicken wing to the human body, relating and pointing to different structures of your arm that correspond to the wing:

- Upper arm muscles (bicep, tricep) and bone
- Elbow joint that bends
- Forearm with two smaller bones
- Hand corresponds to wing tip

If the slide is projected onto a whiteboard, it might be helpful to have students come up to the whiteboard and point to the structure(s) they think are similar in the two images.

### Additional Guidance

Before observing the dissection, take a couple minutes to compare the human arm to the chicken wing to support students in thinking about how we can use the wing to understand what is going on inside our own bodies. Specifically, students will see in the video how moving different muscles within the wing affects the movement of

other parts. Most students are probably familiar with the human bicep and tricep muscles from physical education courses and/or health class. Using these terms to describe analogous parts within the wing will help when sharing observations of the dissection. In addition, some students might bring up other structures, such as the humerus or ulna. At this point it is okay to make space for them to share these ideas, but there is no need to press for naming any structures beyond the bicep and tricep.

Display **slide E**. Say, *Let's set up a notebook page and title it "Chicken Wing Dissection" and then make a two-column chart. Title the left column "Part of the chicken wing." Title the right column "Observations."*

## Additional Guidance

Because we are using another organism that was once alive to make sense of how our body works, it is important to have a conversation about the need to be respectful and serious when making our observations. We are fortunate that we can use this organism in the science classroom. In addition, the researchers who made the video for us ensured the chicken wings were then used as nourishment. If you have students who are vegetarian and/or cannot handle seeing this dissection, reference the previous guidance for suggestions of how to support them.

**Prepare to watch the dissection.** Display **slide F** and watch the Intact Chicken Wing Investigation video at 6.6 Lesson 2 Intact Chicken Wing (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), pausing for about 30 seconds when it shows a prompt. Be prepared to pause at the following times: 0:35, 1:53, and 3:35. Tell students to record the timestamp in case they want to watch it again, and then give them more time as needed to record their thoughts. Additionally, there is some guidance in the video, but you may need to point out that the researcher alternately *pulls* on the bicep and then the tricep; the researcher does not *push* on either muscle intentionally.

Use the suggested prompts to discuss students' observations:

| Video prompts | Sample student responses |
|---|---|
| *What do you notice about the appearance of the skin on the front and back of the chicken wing?*<br>*(pause at 0:35)* | *The skin on the front looks thicker than the skin on the back.*<br>*The skin on the underside is a little more see-through. I can see the muscle and bone.* |
| *What do you notice about the skin?*<br>*(pause at 1:53)* | *It seems like it's connected to the muscle underneath.*<br>*There's some stretchy connected material under it.* |
| *What do you notice about the bones and muscles in the skinned wing?*<br>*(pause at 3:35)* | *One muscle bent the wing one way. The other muscle straightened the wing out.*<br>*The bones were inside/underneath the muscles.*<br>*The bones moved when the muscles moved.* |

| Video prompt | Sample student responses |
|---|---|
| *Compared to when the skin was on the wing, how would you describe the wing's motion after the skin was removed? (pause at 3:35)* | *The wing could move faster and more freely when the skin was gone.*<br>*The wing stretched farther out when the skin was removed.* |

Display **slide G**, showing the whole wing, the skinned wing, and the wing with most of the muscles removed. Have students write down any further questions and observations about the size and shape of the muscles and bones.

## 3. Map the chicken wings structures to the foot model.

10 MIN

**Materials:** science notebook, *Mapping the Chicken Wing to the Human Foot*, computer, projector, whiteboard

**Preface mapping the chicken wing structures to the human foot.** Say, *We figured out a lot about how the parts of the chicken wing work together for the wing to move, but a chicken wing isn't a human foot. How can we use what we observed to figure out more about how the human foot works? Using a mapping tool, let's think through how this could help us.*


Name: _____ Date: _____

Mapping the Chicken Wing to the Human Foot

| This part of the chicken wing ... | is like this part of the human foot ... | because ... | and not like it because ... |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

Hand out a copy of *Mapping the Chicken Wing to the Human Foot* to each student, but do not have them tape it into their notebooks at this time. Project **slide H** onto a whiteboard. Facilitate a discussion to decide how to map the wing to the foot. Remind students we used a similar mapping tool in the *Storms Unit* to consider how magnetic marbles representing water particles could help us figure out what is happening as water vapor heats up and cools down. Talk through the handout's columns and what we will record in each box. As you facilitate this discussion, it will be helpful to record on the whiteboard what the class agrees upon.

### ADDITIONAL GUIDANCE

If you cannot project the slide onto a whiteboard but you have a document camera, you can print an extra copy of the handout and fill it in as students share. If neither option is available, you can replicate the table on chart paper. It will be important to have a public record of what the class agrees on. The table in *Mapping the Chicken Wing to the Human Foot* has more rows than are needed for skin, muscle, and bone. Feel free to include another part if students suggest it, and/or tell them that they may not need all the rows.

**Select a part of the chicken wing to begin mapping.** Say, *What is one of the parts of the human foot we want to find out more about that is similar to a part of the chicken wing?* Students may say the skin, bone, or muscle. Although the description below starts with mapping the skin, the order your class chooses does not matter.

Tell students to fill in "chicken skin" and "human skin" (or whichever part they chose) in the first two boxes of the first row. Then ask, *How are human skin and chicken skin like each other, or similar? How are they not similar?* Accept responses such as these:

- Chicken and human skin both cover the outside of the body.
- The skin on a chicken and a human stretches or wrinkles up as different parts of the body are moved.
- The skin of the chicken is a different color than human skin.

Ask, *What other parts of the injured foot do we want to figure out more about in this investigation?*

Students should say the muscle and the bone (or whichever two parts are left). Say, *Record these parts in the second column of your handout, one part per box. Take a couple of minutes with a partner and fill in the rest of the table.*

After about 5 minutes, ask for volunteers to share, while you add their ideas to the class table. An example of how the filled-in table might look is below:



| This part of the chicken wing … | is like this part of the human foot … | because … | and not like it because … |
|---|---|---|---|
| chicken skin | human skin | It moves and stretches as the wing moves just like our skin moves and stretches when our foot (or other limb) moves.<br>Skin covers everything in our body like the skin covering all the parts of the chicken wing. | It looks a little different in color, like paler and a little pinkish.<br>It seems thicker and tougher than human skin.<br>The chicken skin has lines or pockmarks and human skin does not. Human skin has smaller divots or pores. |
| chicken muscle (or the meat part) | muscle | It contracts and extends, causing different parts of the wing to move, like when a foot flexes or extends. | A wing is not a foot, so the types of muscle might be different. |
| chicken bone | bone | The bones move when the muscles move in both the foot and the wing. | The bones in the wing seem to be shaped differently than the bones in the foot. |

## Assessment Opportunity

**Building towards: 2.A** Analyze and interpret data to highlight the interactions between subsystems (skin, muscle, bone) within the larger system (foot or wing).

**What to look for/listen for:** Students analyze a demonstration dissection of a chicken wing to make sense of how the different parts of the wing–specifically, the skin, muscles, and bones–work together for the wing to move. Their observations focus on visible interactions between these three parts and how they work together to support the wing's function. Using their recorded observations, students will compare chicken parts with analogous human parts to make inferences about how the parts within the foot look and work together to move. Look/listen for these ideas:

- The skin on the foot stretches and moves as the foot moves up and down or back and forth, like the skin moved and stretched as the wing moved.
- The skin is attached to the muscle below it, which allows the skin to move when the muscles move.
- When the researcher pulls on the muscles in the upper part (upper arm) of the wing, the lower part (forearm) of the wing moves. For that to happen, the muscles in the upper part must be connected to the lower part.
- The muscles in the wing must be attached to the bones, because when the muscles are moved, the bones that are attached to them move also.
- When the bicep on the upper arm, or wing, is pulled one way, the tricep on the opposite side of the upper arm, or wing, straightens out. This makes the wing able to flex and extend.
- Although we cannot see them, we think the muscles and bones in the human foot work in similar ways to the chicken wing, because when the muscles move, the bones in the foot also move.

**What to do:** The class watches this chicken wing dissection to look more closely at the different parts. Some students may struggle with recording observations while watching. Make (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) available to students to rewatch on their own outside of class so they have enough time to make sense of how the different parts look, move, and interact. Another option, if the technology is available, is to watch the video as a class once and then have students play it again in small groups on devices to make their observations. As an alternative to the video, if you have the time and materials, use *Teacher Instructions for Chicken Wing Dissections* to conduct a live demonstration for students to gather around and make their observations.

Say, *Often in science as we try to figure things out, we use models or representations to help us explain a phenomenon. Sometimes those models look different from the original phenomenon. Here we used a chicken wing to figure out how the different parts in our foot work together for it to function. Would you say this dissection of a chicken wing is an appropriate and useful model for this purpose?*

Student responses should be something like these:

- This model is mostly helpful. A chicken wing is different from a human foot, but because a chicken wing and human foot both have muscles, skin, and bones, we can figure out a lot about how these parts work together in the wing, and we think it is probably pretty similar in the foot from Lesson 1.
- We saw that the human arm and the chicken wing have similar parts (or structures), and the foot had muscles and bones that were injured, so it seems like there might be similar movement or function in the foot.

### Additional Guidance

It might not be obvious to students that the wing is a model for explaining the foot system. You might need to provide some guidance to talk first about how this is a model: (1) *What question were we trying to answer?* (2) *How did we use this wing to help us answer the question? We manipulated various things to explore how things worked and to help us reason about how the parts of the human foot worked.*

## 4. Develop a poster of parts, or structures, of the body.

10 MIN

**Materials**: science notebook, *Mapping the Chicken Wing to the Human Foot*, tape, chart paper, markers, Word Wall

**Conduct a discussion relating the parts of the chicken wing to the parts of the foot.** Post a piece of chart paper where all the students can see it. Say, *We have figured some things out about the structures of skin, muscles, and bones in a chicken wing and how they relate to structures in the human body. We also made connections to how these three parts in our body might be interacting when we move our arm or foot. Let's begin by recording what the different parts or structures are that we investigated today.*

### Additional Guidance

Set up your poster in landscape orientation. After its initial creation in this lesson, it will be returned to multiple times over the course of the unit to add new findings and make connections. For a summarized progression of its development, refer to *Development of the Our Body as a System poster*. Be sure to leave some space at the top for its eventual title. On day 2, the poster will be titled something similar to Our Body as a System, but wait to title it until the point in the lesson that the class begins thinking about the body as a system.

Ask a volunteer or two to share what the parts are. They should say muscles, skin, and bone. List these on the left side of the poster. Leave some space at the top to come back and title this at the end of this discussion. An example of what this might look like is included here, but use whatever order your class suggests for the three parts.

Ask students to share some of their observations of how each part looks or is made. Here are some sample responses:

Skin:

- It is stretchy and can change shape around the part of the body it covers.
- It is solid and pliable.

Muscle:

- It can stretch and contract or bunch up.
- It looks like thick, springy or elastic material.

*** Attending to Equity**

**Supporting Emergent Multilingual Students:** When developing new vocabulary, strategies that may benefit emergent multilingual learners are to use student-friendly definitions, make connections to cognate words when possible, and include a visual representation of the word. Use these strategies throughout the unit.

In addition, as the class works together to develop these two ways of using the word *structure*, it may help emergent multilingual students to include a definition in their native language on the Word Wall for each use of this word.

Bone:

- It is solid and hard.
- It doesn't bend or stretch.

Add a column to the right of the poster and record these shared observations.

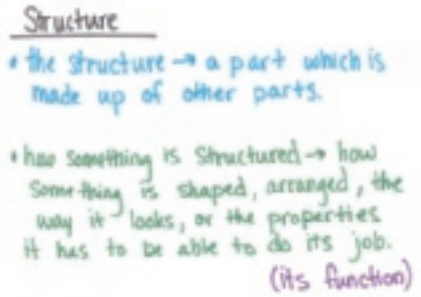



**Make sense of how we will be using the word *structure*.** Say, *If we look at the two columns on our poster so far, we have identified the parts of the body that we are investigating and the way these parts are formed or are arranged. The word "structure" can be used to refer to the ideas in both of these columns, but the way we use this word means something different in each context. So let's look at the first column where we listed the parts of the body.*

Point to the first column and say, *We have been referring to these as parts of the chicken wing or parts of the foot, but we can also refer to them as structures in the body. In this case, we are using the word "structure" as a noun to name a part of the body. Let's capture this idea by titling this column "Structures (parts) in the body".*

Point to the next column and say, *In the next column, we recorded **how** these parts, or structures, are formed and arranged, or "structured". In this case, we are using the word "structure" as a verb referring to how something is put together. Let's record this idea in the title of this column, "How this part is structured (what it looks like or how it is arranged)". As we continue to figure out more about our body over the course of the unit, let's continue to think about how the different parts are structured, or put together, to help us figure out how they might be working together as part of the healing that is occurring.*

**Add *structure* to the Word Wall.*** Say something like, *Because we will use this word "structure" very often in this unit, it would be helpful to have it on our Word Wall. Let's include both ways we are going to use it. As we figure out more, we can revise our definitions.*




Include both ways *structure* will be used on the Word Wall. Here is an example:

- The structure (noun)–a part which is made up of other parts
- How something is structured (verb)–how something is arranged or shaped, the way it looks, or the properties it has to be able to do its job (function)

## Supporting Students in Making Connections in ELA

Students may mention how the word *structure* is used in other ways, such as these:

- In ELA, we talk about text structure–the way an author organizes (or shapes or forms) their writing, like problem-solution or cause-effect.
- Buildings are called structures–we learned in ELA that "struct" means "to build."

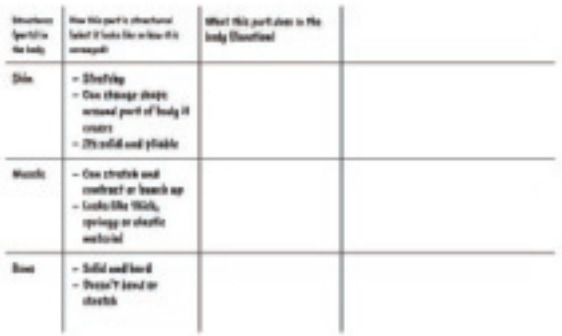
If your students suggest these ideas, use them to help support a deeper understanding of the word, but keep the focus on how it's used in science.

## Additional Guidance

In this unit, students will use the word *structure* as a noun and as a verb. : as a noun, mostly in the context of something related to a DCI component of the unit; as a verb, usually when engaging with it through a crosscutting concept lens. Both uses are important as students figure out what happens with the structures in our body when it heals.

Due to the complexity of the context of this word, we add it to the Word Wall during this lesson to support students in keeping track of words we use throughout the unit. In addition, we will capture the different ways we are using this word on the Our Body as a System poster, including examples and images, to support students as they continue to develop conceptual understandings of those different uses.

**Continue building the poster.** Reorient students to the poster by saying, *Let's think about what we saw each of these parts doing in the chicken wing dissection and record what we think the part's function is.* Add another column to the right titled "What this part does in the body (function)". Be sure to leave space on the right-hand side of the poster to make a third column on day 2, for how the structure of each part relates to its function.



Ask students to share some of their observations of what they saw each part doing in the chicken wing, or their foot or arm. Here are some sample responses:

Skin:

- It covers the muscles and the bones.
- It protects the parts that are inside.

Muscle:

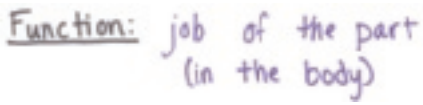
- It contracts to move different parts of the body, like arms and legs.
- It is attached to the bones somehow.

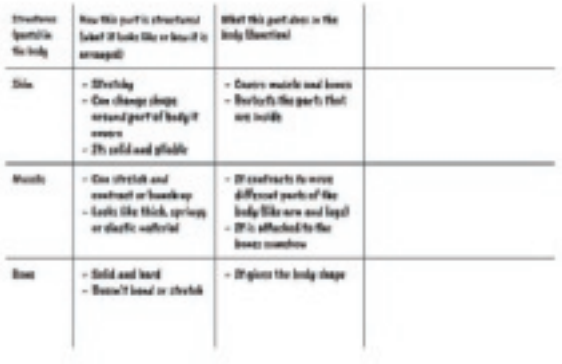
Bone:

- It gives the body shape.

An example of what the poster might look like at this point is shown below:

**Add *function* to the Word Wall.** Your definition might be something like "job of the part (in the body)." Say, *We've used the word "function" in earlier units and earlier grades. We have been using the word a lot today as we talk about what the different parts in the chicken wing do, or how the different parts behave. Let's add it to our Word Wall, but first let's agree on what we mean when we use it in relation to the different structures we are analyzing in our body. Could someone share with us how we might define "function"?* Ask for a few students to share, and then come to agreement as a class on how to define this word before adding it to the Word Wall.



## Additional Guidance

Throughout this unit, we use the terms *structure* and *function* to refer to both DCIs and CCCs. At this point, we begin by thinking about the function of the key parts of the injured foot, and then later we build on this by making connections to the structures that make up the parts that contribute to their function. We will investigate the arrangement of the different part(s) of living things and how this allows these parts to work (CCC), **and** the structures (cells and cell parts) found within these parts and the function these structures serve for the part of the body they make up (DCI). In this lesson, we begin using the word *structure* to refer to the macroscopic structures of the skin, bone, and muscles, and we use *function* to refer to what we figure out about the job this part does for a limb in a living organism.

Before the end of class, tell students, *Please make sure you have taped Mapping the Chicken Wing to the Human Foot into your notebook. We will want to be able to refer to this later as we continue figuring out more about these different parts in the body.*

**End of day 1**

## 5. Brainstorm how to revise the investigation.

5 MIN

**Materials:** science notebook, *Mapping the Chicken Wing to the Human Foot*, as-yet untitled poster of the different parts of the body from day 1

**Brainstorm how to do a dissection to see how an injured chicken wing functions.** Display **slide I**. Say, *Okay, so now we have some data from the investigation in our last class about how muscles and bones work together for a limb or extremity–like the chicken wing or human foot–to move. In Lesson 1, the bone, skin, and muscles of the student's foot were injured. How could we revise the chicken wing dissection to figure out more about how the injury affected the different parts of the foot and prevented him from being able to walk?*

Here are some sample student responses:

- We could drop a weight or some heavy object on the chicken wing to imitate the same type of injury.
- We could cut the skin and muscle to show it broken open like the foot.
- We could use a chicken leg and foot instead of a wing.

**Elicit ideas about how to investigate the chicken wing next.** Show **slide J**. Say, *Today we will revise our investigation to include an injury and analyze data to help us understand how the student's injuries prevented him from being able to walk. Turn to the next page in your notebook and use what you recorded on Mapping the Chicken Wing to the Human Foot and the poster we made on day 1 to explain how an injury to one of the chicken wing's parts or structures could affect the wing's function. You can use words and/or pictures to capture your predictions.* Students will use their answers to navigate to the next investigation and prepare them to watch for changes to how the wing moves.*****

**Discuss your predictions with a partner.** Display **slide K** and direct students to turn and talk with a partner about their predictions of how the function of the wing would be affected. Ask them to share any pictures they drew in their notebook with each other.

*** Attending to Equity**

**Supporting Universal Design for Learning:**

The goal in this moment is two-fold: (1) to support *engagement* by optimizing choice of how students would proceed with the investigation and (2) to allow them to *express* their ideas using multiple modalities. This supports student ownership of their learning by giving them choice, access, and control in navigating their own understanding around the science ideas. All versions of responses can productively contribute to the next day's discussion.



Have one or two students briefly share out predictions with the class, making sure not to indicate whether any of those predictions describe what's going to happen. Say, *The researcher continued their investigation by damaging part of the wing in a similar manner that the foot in Lesson 1 was injured. We're going to make observations from that investigation to see whether our predictions are accurate and if we notice anything else that we hadn't thought of before.*

### Assessment Opportunity

**Building towards: 2.B** Revise the experimental design to predict the change in function of the chicken wing (effect) under various conditions (cause) and conduct the investigation.

**What to look for/listen for:** At the beginning of day 2, the class brainstorms ideas for how to revise the dissection to figure out more about how the injury in Lesson 1 affected different parts of the student's foot and prevented him from being able to walk. Look for the verbal sharing of ideas around similarly injuring the wing, such as dropping a heavy weight on it.

At the beginning of day 2, students record predictions in their notebooks about how an injury to one part of the wing will affect its function. Students share those predictions with a partner and then the class. Look and listen for ideas that include a change in function as a result of injury to a part, as in the following examples:

- If the muscles are broken, the wing might not be able to move at all.
- When the bone is broken, the muscles can still move, but not in the same way.
- If only the skin is cut, the wing will probably still be able to move, and it may move even more, because the skin would be less able to hold it back.

**What to do:** If students struggle to come up with ideas around mimicking an injury in a manner similar to how the foot was injured, ask them to revisit *Mapping the Chicken Wing to the Human Foot* and think of additional ways that the chicken wing in the video differs from the foot. Ask them to recall what happened to the foot that caused the student's inability to walk.

Look at students' notebooks as they record their predictions. Listen to partner pairs as they share. If students struggle to make cogent predictions, ask them questions such as these:

- *If the bone is broken in the wing, like the bone was broken in the foot, what do you think will be similar or different about the wing's ability to move?*
- *If the muscle is impacted and torn somehow, do you think the wing will be able to move in the same way? Why?*

## 6. Investigate skin, muscles, and bones in an injured chicken wings. 15 MIN

**Materials:** Investigate Skin, Muscles, and Bones in an Injured Chicken Wing, science notebook, computer, projector

**Orient students to the chicken wing dissection.** Display **slide L**. Say, *To see how an injury affects the parts of a chicken wing and its movement, we are going to make observations again. In the beginning of the video, you will see the wing being damaged in a way that is similar to the foot injury from Lesson 1. As you watch, think about how the structures are affected by the injury and how it will alter the wing's function, if at all. Like before, we will pause the video at various times to*

*record our observations. To prepare to collect this evidence, let's set up a new notebook page. Title it "Injured Chicken Wing Dissection." Then make another two-column chart like the last one, with the left column titled "Part of the chicken wing" and the right column titled "Observations".*

## Additional Guidance

Some students may have difficulty observing a demonstration that includes the chicken wing being injured by a heavy object. You may wish to let them know ahead of time what they will be observing. You may need to allow students who share they are uncomfortable with viewing this to sit out the demonstration. If students do choose not to observe the demonstration, have them partner with a peer afterward to discuss what happened to the function of the wing after it was injured.

Display **slide M** and watch the Injured Chicken Wing Investigation video at (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), pausing for about 30 seconds when it shows a prompt. Be prepared to pause at the following times: 0:34, 1:50, 3:12, 3:34, and 4:10. Give students more time as needed to record their thoughts.

In the video, the humerus bone of the chicken wing is broken by placing the curved end of a pry bar on the upper arm and striking the other end of the pry bar with a hammer to mimic the force of a weight dropping on a foot. The striking of the pry bar is not visible in the video, so you may have to explain it to students. This approach was taken to focus the force on the bone so it would break in a controlled manner.

The right-hand image in the video at 3:34 is a pseudo-cross-sectional view to show what is inside the bone in the left-hand image. Explain the differences in these two images if students are confused.

The prompts in the video may elicit the following student observations:

| Video prompts | Sample student responses |
|---|---|
| *What parts of the wing, if any, do you think were damaged by the impact?*<br>*(pause at 0:34)* | *It seems like the bone broke, because the wing moved up while it was being hit.*<br>*The pry bar might have damaged the skin?*<br>*It's hard to tell if muscles were damaged.* |
| *What do you notice about the motion of the injured wing?*<br>*(pause at 1:50)* | *When hands on either end move it, the elbow joint starts to bend offcenter.*<br>*It's hard to see a difference when the muscles are pulled.* |
| *What do you notice about the bones and muscles in the injured wing?*<br>*(pause at 3:12)* | *One of the muscles near where it was hit seems to be looser near the elbow.*<br>*I think I saw a broken bone!* |

| | |
|---|---|
| *What do you notice about the motion of the injured wing when the skin is removed? (pause at 3:12)* | *The wing was flopping around a lot beyond just the elbow bend, it was flopping to either side.*<br>*It looked like the muscle was also split or opened up from the injury.*<br>*Like with the uninjured wing, it stretched farther out and moved more when the skin was removed.* |
| *What do you notice about the injured wing? (pause at 3:34)* | *The bone is definitely broken!*<br>*The inside of the bone has red, mushy-looking stuff.*<br>*The muscle seems damaged near the bone break.* |
| *When looking at the uninjured and injured wings side by side, do you notice any additional differences? (pause at 4:10)* | *Compared to the uninjured wing, the injured wing moves around in more directions, more out of control.* |

## 7. Compare the injured wing to the injured foot.

5 MIN

**Materials:** science notebook, *Mapping the Chicken Wing to the Human Foot*, chart paper, markers

**Facilitate a brief Building Understandings Discussion.** Display **slide N**. Say, *We've been using a chicken wing as a model to figure out how the parts of the human foot work together for a person to be able to walk, and how the student's injury affected his foot's function. Let's take a couple of minutes to make sense of what we have figured out about how an injury can affect a body part's function, and to see what we still need to figure out. Talk with an elbow partner about the question on the slide:*

- *Compare the injured chicken wing to the injured foot.*
- *Was there anything from our timeline or from the doctor's notes that we didn't see in the injured chicken wing? Look back in your notebook at the doctor's notes if needed.*
- *Be ready to share.*

Title a piece of chart paper "How Is the Injured Chicken Wing Similar and Different from the Injured Human Foot?" Use the prompts below to facilitate this discussion, and record students' ideas on the poster.

| Suggested prompt | Sample student responses |
|---|---|
| *What were some things that were similar between the injured chicken wing and the injured human foot?* | *Both had a broken bone.*<br>*Both had muscle that was damaged or torn.*<br>*Both could not function the same way it could before it was injured–the student couldn't walk on his foot, and the chicken wing didn't extend and contract the same.* |

*** Supporting Students in Developing and Using Systems and System Models**

This chicken wing model has limitations, as the wing is no longer part of a living organism, so it is challenging to see how the parts' interactions and injuries affect the part's function. In addition, there are things missing after injuring the wing, such as the presence of blood or swelling, that were present with the injured foot. Students will reflect on how the wing is limited in how it can help us figure out how parts of living things heal.

| Suggested prompt | Sample student responses |
|---|---|
| *What were some things that were different between the injured chicken wing and the injured human foot?* | *The foot had dried blood on it, but the chicken wing didn't have any visible blood near the injury.*<br>*The human foot was still part of a living thing, but the chicken wing was not.*<br>*There was swelling on the foot when the injury happened and it lasted for a little while, but the chicken wing didn't swell.* |

Say, *So it seems like we were able to figure out a few things about how parts of a foot or arm (or wing) interact for that limb to move, or function. Though the chicken wing helped us figure some things out, there are some limitations to using it as a model for the injured foot. Looking at the things we have recorded on this poster, what are some of these limitations?** Here are some sample student responses:

- The chicken wing isn't part of the chicken anymore. So we can't see how it functions when the chicken is living.
- Though we are only trying to figure out how the foot healed, it is still part of a body, so there must be more parts that are important for it to heal than just the muscles, skin, and bones.
- The chicken wing helps us see how the muscles, bones, and skin move and work together, but because it wasn't living anymore, there wasn't any visible blood, so we couldn't see why or how blood is affected or part of an injury.
- The chicken wing didn't swell up like the foot did, so we couldn't figure out anything about swelling or why it happens.
- The chicken wing didn't have anything added to it to help it heal.
- The chicken wing won't heal because it is not living or part of a chicken anymore.

Say, *Although the chicken wing as a model helps us figure out a few things about how these different parts work, we still have a lot of questions to answer.*

## 8. Conduct a Building Understandings Discussion to begin thinking about a body. 15 MIN

**Materials:** science notebook, *Mapping the Chicken Wing to the Human Foot*, as-yet untitled poster of the different parts of the body from day 1, markers, images cut out from *Skin, Muscle, and Bone Systems*, tape or stapler, optional: *Chicken Wing Structures*

**Facilitate a Building Understandings Discussion.** Be sure students can see the poster that was made at the end of day 1. Display **slide O**. Say, *In many of our units, we've broken down complex phenomena into various systems or subsystems that interrelate to give rise to a phenomenon. In the Cup Design Unit, for example, we were trying to figure out how to keep a drink cold longer, and we studied the different parts of the cup system to figure how a cup keeps a drink cold. We also looked at systems in the Storms Unit when we were trying to figure out why there are different types of precipitation events, and we figured out what the different parts of the weather system are and how they interact.*

Use the prompts below to press students to continue to consider how systems are a useful lens for examining this phenomenon of injury and healing.

| Suggested prompts | Sample student responses |
|---|---|
| *In the Cup Design Unit, when we were trying to figure out how to keep our drink cold longer, we analyzed different cup systems. What were some of the parts of the cup system?* | *The cup system was made up of the wall of the cup, the lid of the cup, the material of the cup, and possibly a straw.* |
| *What did we figure out were parts of a system in the Storms Unit?* | *We figured out that weather is affected by heat from the sun heating the ground, which then heats the air. So the sun would be a part, and the ground and the air would also be parts of the system.*<br>*Water vapor was also part of this system.* |
| *How could thinking about the body as a system help us in figuring out what happens in our body when it heals?* | *Maybe if we can figure out how different parts work together for our body to move, then we can figure out what needs to heal for our body to move.*<br>*Yeah, like in the cup system, we figured out the lid and the double walls worked together to keep the drink cold longer, so maybe if we could figure out what parts in the body work together, then we can figure out how they work together for our body to heal or move.*<br>*We need to figure out what the different parts of the body are and which of these parts help the body heal.* |

**Continue the discussion from a systems perspective.** Display **slide P**. Say, *Great, okay. So if we think of the body as a system, what would be some of the parts of this system? Turn and talk with a partner about the question on the slide.* After a minute or two, use the prompts below to continue the discussion.

| Suggested prompt | Sample student responses |
|---|---|
| *Thinking back to the dissections we observed, if we think of the body as a system, what are some parts of this system?* | *Accept all reasonable responses. For example:*<br>*the foot*<br>*the toes*<br>*the skin*<br>*the bones*<br>*The muscles could be one part.* |

***Supporting Students in Developing and Using Systems and System Models**

It's important to make students aware of the crosscutting concepts they learn about and use in the same manner and to the same degree that students learn about and use disciplinary core ideas and science and engineering practices. Over the course of the unit, students will incrementally build a system model of the body and how the different parts interact to help it heal. In this lesson, we begin to explore how we can use the systems thinking we have already practiced in earlier units in 6th grade, such as the Cup Design Unit, to make sense of how different parts in a system interact for that system to function. By titling this poster something similar to Our Body as a System, we support students in applying the systems thinking from earlier units to a new phenomenon.

| Suggested prompts | Sample student responses |
|---|---|
| *In the dissection videos, we observed a few of these parts and how they interact and work together. Thinking about the foot from Lesson 1 and how it has similar parts to the chicken wing, could we consider the foot as a system?* | *The foot is also a part of the whole body, so yes, I think so.*<br>*Yeah, and it has muscles, bones, and skin.* |
| *Using what we figured out from the dissection of the chicken wing and how it relates to the human foot, what have we figured out about how the different parts in the foot or wing work together?* | *We figured out that the muscles help the limbs move and that the bones are attached somehow to the muscles, so they move when the muscles move.* |
| *And, what did we figure out about what happens to the foot system if one part is impacted or damaged?* | *We figured out the parts work together for the foot to be able to walk, so if one part is damaged, then the whole foot is impacted, because it can't do its function.* |

## Key Ideas

**Purpose of the discussion:**

- Review how systems thinking was used in prior units to make sense of complex phenomena by breaking larger systems down into smaller subsystems.
- Identify the body as a larger system consisting of distinct interacting parts, (skin, muscle, bone).

**Listen for these ideas:**

- The function of the whole foot changes when one part of the foot is injured, like when a bone is broken.
- Each part of the foot has a specific function.
- The parts of the foot interact to make the foot function (move).
- In this investigation, we looked at a part of the chicken (the wing) and saw that it was made up of other parts (skin, bone, muscle). From Lesson 1, we know that the injured foot also has skin, muscle, and bone, and the foot is a part of our body. So maybe the big system we are working with is the body.

**Reorient the class to our poster from day 1.** Say, *In our last class, we identified different parts, (or structures) of the body we investigated in the dissection, how they look (or are structured), and the function (or purpose) of these parts. All of these parts of the body system have different structures and functions, which we saw when we analyzed the dissection. Let's add to our poster what we have figured out so far about how the different structures, or parts, relate to the function, or job, of that body part. What about each part makes it particularly useful or necessary to its function?*

Add a new column to the right of the "What this part does in the body (function)" column, and label it "How the way the part is made, or structured, relates to its job, or function". Facilitate a discussion by asking students how structure is related to function for each part (skin, muscle, bone). When the class agrees about a relationship, add it to the poster. An example of what the poster might look like at the end of this discussion is included in the Key Ideas box below. Refer to the *Development of the Our Body as a System poster* for an overview of how this poster evolves over the course of the unit.

## Key Ideas

### Building Understandings

**Purpose of the discussion:** To support students in using the crosscutting concept lens of structure/function to make sense of the way the structures in the body are formed or arranged and how this relates to their function. Prior to this point in the lesson, students have figured out what the different parts look like and how they work, or function. Now they are putting these together to think about why the way these parts are made allows them to do the job they do in the body.

**Listen for these ideas:** The prompt/responses below begin with asking students about the skin, then the muscle, and then the bone. If these parts are in a different order on your class poster, organize the discussion to follow the progression on your poster.

Listen for similar ideas as listed below about the relationship between the function of the different parts and how they can do this function due to their structure:

Skin:

- Connected to the muscle with a thin layer
- Stretchy
- Moves with the part it's attached to
- Covers everything on the inside of a chicken or human

Muscle:

- Stretchy
- Is attached somehow to the skin and the bone, so it is able to move those parts when it moves
- Can bunch up or stretch out when moved

Bone:

- Solid and hard
- Attached to muscles somehow, and moves when the attached muscles move
- Holds up/gives shape to the whole body
- Makes the whole system not like jelly/wobbly

At the end of this section, your poster might look like this:



Say, *Okay, now that we have thought about each of these structures and their functions based on what we saw happen with the chicken wing and human foot, let's think about other places in a body.* Continue the discussion with the prompts below.

| Suggested prompts | Sample student responses |
|---|---|
| *Besides our foot or arm, do we have skin anywhere else on our body?* | *Yes! Everywhere on the outside!* |
| *What about the chicken? Does it have skin anywhere else besides the wing?* | *Yes! It also has skin everywhere on the outside of its body.* |
| *(Hold up the image of the body covered in skin from Skin, Muscle, and Bone Systems.)*<br>*Okay, so thinking about how there is skin everywhere on the outside of our body, what does the skin do for us? What is its job?* | *It keeps all the parts inside our body in!*<br>*Maybe it also keeps other things out, because when we get a cut we are supposed to clean it out from germs.* |
| *And, if we think about what the skin looked like on the chicken wing and how it functions or moves, how does the way the skin is structured, or made, help the skin do these jobs of keeping some things in and some things out?* | *Well, it is stretchy, so it can stay on our body when the muscles or bones move.*<br>*It also is pretty solid, like there aren't openings in it.* |

Add these ideas to the poster on the row for skin in the column titled "How the way the part is made relates to its job". To the left of the row for skin, tape or staple the image of the skin covering the body that you cut out from *Skin, Muscle, and Bone Systems*.

## Additional Guidance

The image included on *Skin, Muscle, and Bone Systems* for the skin covering the body was designed to represent a neutral version of skin. You may not need an image to represent where we find skin on our body, as we can all see our skin. But, if your class would like a representation on the poster, and if this image isn't representative of your student population, please include an image of a person in which the skin is somewhat visible and is displayed as a representation of this large part of our body.

Say, *When we consider the relationship between how the structure (the form or arrangement) of a part of the body allows it to function or do its job, we are using the crosscutting concept of structure and function. As we continue to work to make progress in figuring out how our body heals, let's keep practicing using this crosscutting concept to see how it can support us in explaining healing.*

Then say, *Let's think about the other structures we investigated. What about the muscles?* Elicit student ideas using the prompts below.

| Suggested prompt | Sample student responses |
|---|---|
| *Besides our arm or foot, would we find muscles anywhere else in our body?* | *Yes! We have muscles in our stomach—our abs.*<br>*Yes … we have muscles in our chest and in our legs and in our back.* |

Hold up the image of the muscle system from *Skin, Muscle, and Bone Systems*. Say, *We do have muscles in other places. In fact, we have muscles everywhere that are colored on this image of where all the muscles are in our body.*

| Suggested prompts | Sample student responses |
|---|---|
| *Looking at the image of everywhere in our body that we have muscles, what do our muscles do for us?* | *They help us move our body.*<br>*They help us lift things.*<br>*They move our bones around.* |
| *And, if we think about what the muscle looked like in the chicken wing and how it functions or moves, how does the way the muscle is structured help the muscles do their job?* | *They are stretchy and connected to parts all over our body that need to move, so their stretchy structure allows them to bunch up or stretch out and move parts of our body.* |

## Alternate Activity

You may wish to also print out and cut apart the images on *Chicken Wing Structures*. There are three images from the chicken wing dissection: one of the wing with the skin on, one focused on the muscles of the wing, and one focused on the bone. These could be used in this discussion to support students in continuing to make the connection between these three parts in the chicken wing and these three parts in the human foot (or body), as reference images while you discuss the connection between the part's structure and how this structure allows it to do its function.

As you fill in the last column on the poster, tape or staple this image of where muscles are found to the left of the row for muscle. See an example image in the Key Ideas box at the beginning of this section.

Continue the discussion by saying, *We also have bones listed on our poster. Let's consider the structure and function of this body part next*. Elicit student ideas using the prompts below.

| Suggested prompt | Sample student response |
|---|---|
| *Besides our arm or foot, would we find bones anywhere else in our body?* | *Yes! We have bones in lots of places like our head, our hands, our ribcage, our legs, our toes.* |

Hold up the image of where bones are found from *Skin, Muscle, and Bone Systems*. Say, *We do have bones in other places. In fact, we have bones in all the places represented on this image of the body.*

| Suggested prompt | Sample student responses |
|---|---|
| *Looking at the image of everywhere in our body that we have bones, what do our bones do for us?* | *They help us be able to stand up because they are sturdy and straight and strong.*<br>*They help our body have a shape or form. If we didn't have bones, we would just have everything mushed up.* |

| Suggested prompt | Sample student response |
|---|---|
| *And, if we think about what the bone looks like in the chicken wing and how it functions or moves, how does the way the bone is structured help the bones do their job?* | *They are hard and solid so our body can have a shape.* |

As you fill in the last column on the poster, tape or staple this image of the bones to the left of the row for bone. See an example image in the Key Ideas box at the beginning of this section. If you also printed out the alternate handout of *Chicken Wing Structures*, you may wish to tape them on your poster as well for a reference.

**Reflect on what is captured on the poster and agree on a title.** Say, *Let's take a moment to title this poster. If we are going to use this to continue recording what we figure out about the different parts, or structures, in our body that allow it to function and move, and we are going to think about our body as a system with these as the parts of that system, let's title our poster to capture this idea. Does anyone have an idea for a title?* Ask a few volunteers to share. Come to agreement as a class to title the poster something similar to Our Body as a System.*

An example of this revised poster is included here:



## 9. Create a Progress Tracker for the unit.

5 MIN

**Materials:** science notebook

**Help students recall what we have figured out by using the Progress Tracker.** Introduce the Progress Tracker. Present **slide Q**. Have students draw a three-column chart in **landscape orientation** directly in their science notebooks in the section set aside for Progress Trackers. Explain that as we investigate healing and how it happens, we are going to keep track of how our model changes and develops over time in our Progress Tracker.

Say, *Just as in other units this year, we will use this tool to help us keep track of ideas we figure out from each lesson. In the "What we figured out in words/pictures" column, you can draw pictures or write in words, bullet points, or whatever way is*

*most meaningful for you. The "This makes me think or wonder about healing" column helps us think about the big picture of how healing happens, as we figure out new things or what questions we might have that we want to learn more about. Initially, we may have more questions in this section or partial ideas, but that is okay because questions help us figure out what we still need to know. Individually take 3 minutes to think about what we figured out from our last classes. You can draw from anything we've done so far.*

By using a landscape orientation and having no structured box, students can take up a lot of space or a little space in their Progress Trackers. Whenever they are done writing, they can draw a line after their work to make space for the next time they are instructed to write in their tracker.*

| Question | What we figured out in words/pictures | This makes me think or wonder about healing ... |
|---|---|---|
| What do our skin, muscles, and bones do for us? | • Muscles help us move our body parts because they can contract and expand.<br>• Bones move when the muscles attached to them move.<br>• Skin is stretchy and covers our bones and muscles, protecting them.<br>• Skin is connected to muscle.<br>• Bones are solid and give our body shape. | When the foot is injured, the muscles and bones aren't working properly, and they can't move very well. But what needs to happen so it can function again?<br>When one part of the system is broken or injured, the whole system is affected and can't function the way it used to.<br>How do skin, muscle, and bone become functional again?<br>Do the structures all heal at the same time? |

**Reflect on what we want to figure out next.** Say, *It seems like we can only learn so much from examining the chicken wing, but we need to know more about these parts of the body so we can learn more about what is needed for the foot to heal. We saw the skin is attached to the muscle and the muscle is attached to the bone, and because of this, all these parts move together. But what else is part of the foot or chicken wing as a system? Next class, let's see if we can look more closely at these parts of the foot as a system to see if we can figure out more about how they work together.*

*In this lesson we were able to use a chicken wing to figure out more about the muscle, skin, and bone because the wing wasn't living anymore. But when an injury happens to a living thing, medical professionals use other ways to see inside the body safely without doing it harm. Maybe we could figure out more about these ways in our next class. Turn and talk with an elbow partner about this question: How could looking more closely at these different parts of the body help us figure out more about how they work together?*

If there is time, ask a few students to share their ideas. Accept all responses.

*** Attending to Equity**
**Universal Design for Learning:**

This example Progress Tracker serves as teacher guidance for what students might say at various points throughout the unit. However, some students may say more and others may say less. It is important that what they write in the three-column tracker reflects their own thinking at that particular moment in time. This is an opportunity to *express* their understanding and reasoning in their own way. Encourage students to express what they've learned using a mode that makes sense for them. For some emergent multilingual students, encourage them to use this space to make sense in the language that they feel most comfortable using. The individual Progress Tracker is a space for students to be creative and to synthesize learning in their own words. It is not supposed to follow a prescriptive plan or structure, and should be a low-stakes opportunity for students to make sense of what they are learning without the worry and anxiety that comes with knowing their work will be graded. Use the Progress Tracker for formative assessment only.

# Body Parts (and Breaking Them)

1 **Robots: Helpers or Competitors?**
2 **Skeleton Diversity**
3 **Living with Ehlers-Danlos**
4 **No Pain, No Gain**
5 **Mending Broken Bones**

## Literacy Objectives

- ✓ Summarize key points related to body parts related to motion.
- ✓ Distinguish cause(s) and effect(s) related to the skeleton and related organs.
- ✓ Organize related details about the skeleton and other organs.
- ✓ Distinguish between credible and non-credible sources.
- ✓ Translate text to visual/graphic representation of ideas.

## Literacy Exercises

- Read varied text selections related to the topics explored in Lessons 1 and 2.
- Evaluate the reading selections according to provided prompts and criteria.
- Compare and contrast information gained from reading text with information gained from class investigation.
- Prepare a graphic organizer that identifies the most interesting facts in response to the reading.

## Instructional Resources

Student Reader



Collection 1

**Science Literacy Student Reader, Collection 1**
"Body Parts (and Breaking Them)"

Exercise Page



EP 1

**Science Literacy Exercise Page**
EP 1

## Prerequisite Investigations

Assign the Science Literacy reading and writing exercise *after* class completion of this lesson group:

- Lesson 1: What happened in the student's foot so they could walk again?
- Lesson 2: What do our bones, skin, and muscles do for us?

## Standards and Dimensions

### NGSS

**Disciplinary Core Idea 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. (MS-LS1-3).

**Science and Engineering Practice:** Obtaining, Evaluating, and Communicating Information

**Crosscutting Concepts:** Cause and Effect; Structure and Function

### CCSS

**English Language Arts**

**RST.6-8.2:** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

**RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

**RST.6-8.6:** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

## Core Vocabulary

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

**healing**

**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.

**amputation**
**analogous**
**collagen**
**connective tissues**
**exoskeleton**
**genetic**
**hydraulic**
**muscle fiber**
**sensory system**

A Glossary at the end of the Science Literacy Student Reader lists definitions for Core Vocabulary and selected Language of Instruction.

## 1. Plan ahead.

Determine your pacing to introduce the reading selections, check in with students on their progress, and discuss the reading content and writing exercise. If you are performing Science Literacy as a structured, weekly routine, you might implement a schedule like this:

- Monday: Designate a ten-minute period at the beginning of the week to introduce students to the assignment.
- Wednesday: Plan to touch base briefly with students in the middle of the week to answer questions about the reading, to clarify expectations about the writing exercise, and to help students stay on track.
- Friday: Set aside time at the end of the week to facilitate a discussion about the reading and the writing exercise.

You'll proceed with the in-class lesson investigations during this week.

## 2. Preview the assignment and set expectations. (Monday)

- Let students know they will read independently and then complete a short writing assignment. The reading selection relates to topics they are presently exploring in their Cells and Systems unit science investigations.
- The reading and writing will be completed outside of class (unless you have available class time to allocate).
- Preview the reading. Share a short summary of what students can expect.
  - *First, you will read an article about robots and the interacting systems that engineers design to make them function.*
  - *Next, you'll read a comparison of three types of skeletons in animals.*
  - *Then, you'll read a fictional diary of a 12-year-old with a condition that affects multiple body systems, called Ehlers-Danlos syndrome.*
  - *You'll also read a simulated social media conversation between three teens who plan to try out for their school's football team, followed by science facts that will help you determine if the teens know what they are talking about.*
  - *Finally, you'll read a photo essay showing four solutions for dealing with a severely broken bone.*
- Distribute Exercise Page 1. Preview the writing exercise. Share a summary of what students will be expected to deliver. Emphasize that Science Literacy exercises are brief. The focus is on thoughtful quality of a small product, not on the assignment being big and complex.
  - *For this assignment you will be expected to generate a graphic organizer sharing one interesting fact you learned in each reading selection.*
- Remind students of helpful strategies they can employ during independent reading. Offer the following advice:
  - *The reading should take approximately 30 minutes to complete.* (Encourage students to break reading into smaller sections over multiple short sittings if their attention wanders.)
  - *A good reading strategy is to scan through the collection first to see the titles, section headers, graphics, and images to see what the selections are going to be about before fully reading.*
  - *Next, "cold read" the selections without yet thinking about the writing assignment that will follow.*
  - *Then, carefully read the Exercise Page to understand the expectations for the writing part of the assignment.*
  - *Revisit the reading selections to complete the writing exercise.*
  - *Jot down any questions for the midweek progress check in class.* (Be sure students know, though, that they are not limited to that time to ask you for clarification or answers to questions.)

**Exercise Page**



**EP 1**

## 3. Touch base to provide clarification and address questions. (Wednesday)

Touch base midweek with students to make sure they are on track while working independently. You may choose to administer a midweek minute-quiz to give students a concrete reason not to postpone completing the reading until the last minute. Ask questions such as these, and have students jot answers on a half sheet of paper:

| Suggested prompts | Sample student responses |
|---|---|
| *What are some of the interacting parts of a dancing robotic dog?* | *sensors, computer, 3D skeleton, hydraulic limbs, battery* |
| *What kinds of animal, shown in this reading, have exoskeletons?* | *crabs* |
| *What might a doctor see that would lead her to do a genetic test for Ehlers-Danlos syndrome?* | *a baby who has trouble walking and very stretchy skin* |
| *What kinds of sporting events require lots of slow-twitch muscle fibers?* | *endurance events, like running or swimming long distances* |

Ask a few brief discussion questions related to the reading that will help students tie the text content to students' classroom investigations.

| Suggested prompts | Sample student responses |
|---|---|
| *What parts of the chicken leg you dissected function similarly to the hydraulic system on the dancing robotic dog?* | *the muscles attached to the bones that stretch and contract* |
| *What did you notice about the chicken wing that confirms it is made of connective tissues?* | *We saw that the skin is connected to the muscle underneath it.* |
| *How is healing involved in resistance training?* | *When you lift weights, it causes small tears in muscle fibers, which later heal.* |

- Refer students to the Exercise Page 1. Provide more specific guidance about expectations for students' deliverables due at the end of the week.
  - *The writing expectation for this assignment is to create a graphic organizer to share one fascinating fact with a cause-and-effect relationship that you learned in each of the five readings in Collection 1.*
  - *That means the facts you personally choose will very likely be different from the facts chosen by other students.*
  - *Don't worry about drawing a perfect skeleton. A sketch that approximates the one shown on your Exercise Page will be fine.*
  - *Communicate the fascinating fact in your own words, and reread it to make sure it is scientifically accurate.*
  - *The important criterion for your work are that you clearly and accurately communicate five interesting cause-and-effect relationships about the health of bones and the tissues and organs that are connected to them.*
- Answer any questions students may have relative to the reading content or the exercise expectations.

Exercise Page



EP 1

## 4. Facilitate discussion.

(FRIDAY)

Facilitate class discussion about the reading collection and writing exercise. The collection begins with a news-style article about a dancing robotic dog that compares its structures with analogous ones in the human body. The remaining four selections explore living systems, including bones, muscles, and connective tissue and organs.

Student Reader



Collection 1

Online Resources



| Pages 4–7<br>Suggested prompts | Sample student responses |
|---|---|
| *What is the general purpose of the first selection, "Robots: Helpers or Competitors?"* | *It describes what a dancing robot can do and how it does it.* |
| *How did this selection help you better understand the story about Maddy and her missing hand in the Preface?* | *The Preface says that Maddy's dad is thinking about whether she should get a robotic hand, and this selection explains how the parts of a robot work to move.* |
| *What human body system is analogous to the robot's sensors and computer? Explain.* | *The human nervous system senses internal and external changes and processes them in the brain.* |
| *What is the general purpose of the second selection, "Skeleton Diversity"?* | *It compares and contrasts four different types of systems animals have to hold their shape and for movement.* |
| *How did the subheadings in this selection help you understand the differences among the skeletons?* | *There are three subheadings, and four types of skeletons were described, so that means that two of the types are endoskeletons.* |

**SUPPORT**—If you are using the recommended word envelope convention, check the envelope to see if it contains any words, phrases, or sentences that students need help understanding. Read key sentences aloud, and provide concise explanation.

**SUPPORT**—Explain to English learners that many science and medical terms have Greek or Latin prefixes and that the prefixes *exo-* and *endo-* are from Greek words meaning "outer" and "inner."

| Pages 6–11<br>Suggested prompts | Sample student responses |
|---|---|
| *What scientific questions did you have as you read this selection?* | *How is a human skeleton different from the cat skeleton shown in the illustration?*<br>*Does the shark have bones shaped like those in a bony fish, or is the cartilage in some other shapes?*<br>*How does the worm pressurize the fluids inside its body?*<br>*What is chitin? Where else is it found?* |
| *What reputable sources can be used to find answers?* | *a reference librarian, an encyclopedia, articles on Google Scholar or other science search engines, websites from science museums and universities* |
| *What is the general purpose of the third article, "Living with Ehlers-Danlos"?* | *It explains what Ehlers-Danlos syndrome is and how it affects one teen.* |
| *What is the author's conclusion about having Ehlers-Danlos syndrome?* | *People with the syndrome can do most activities that other teens do, but they make certain accommodations to deal with the condition.* |
| *What questions might readers of this selection have about collagen?* | *What is the source of the collagen that some people get as injections?*<br>*How does the human body make collagen?*<br>*Do certain foods help the body have enough collagen?*<br>*Do humans lose collagen as they get older? Is that why older people have wrinkled skin?* |
| *What is the general purpose of the fourth article, "No Pain, No Gain"?* | *It tries to persuade the reader that easing into resistance training is the safest way to go.* |

**EXTEND**—Have students watch online videos to see how engineers are designing exoskeletons for humans to wear—to make workers stronger or to allow those who are physically disabled to move on their own.

**CHALLENGE**—Some sources describe Ehlers-Danlos (EDS) as a cluster of syndromes, each with its own name, symptoms, pattern of inheritance, and treatments. Challenge students to do some online research to determine which human body systems are affected by EDS and how. Have them organize their findings by creating a spider diagram that can be shared with classmates.

**EXTEND**—Students can watch an online video of the dancing dog robot featured in the photo on page 4. However, note that this is no foxtrot. Preview the video and decide if "twerk" dancing is appropriate for your students.

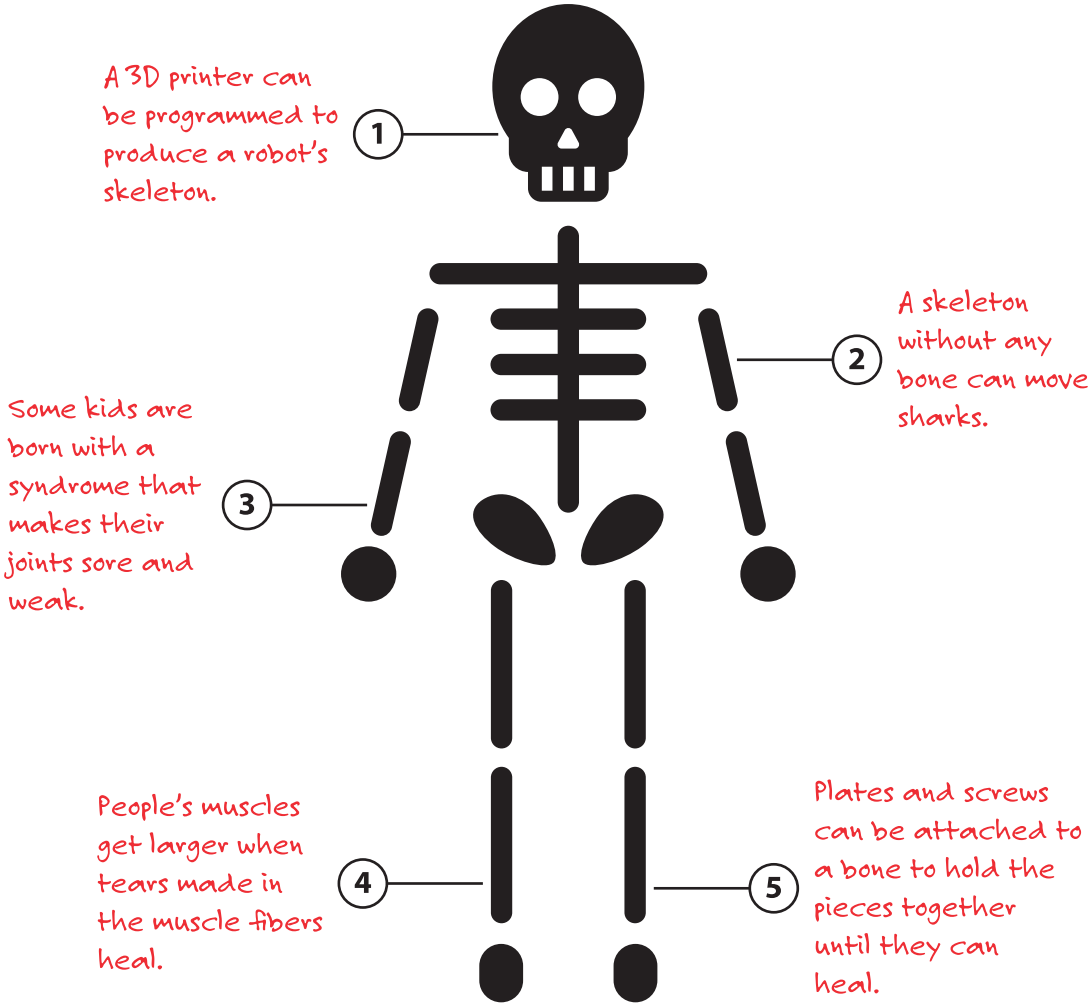
| Pages 10–13<br>Suggested prompts | Sample student responses |
|---|---|
| *What does the author mean by saying something is based heavily on genetics?* | *I think it has something to do with inheriting information from your parents.* |
| *Take a look at the "Spot the BS" box. Can you spot who has their scientific facts straight and who doesn't?* | *Grant is wrong that it cannot hurt your muscles to jump right into lifting heavy weights.*<br>*Keenan is right that it is better to ease into resistance training so that the muscles don't get injured.* |
| *What is the general purpose of the fifth article, "Mending Broken Bones"?* | *It describes four ways of dealing with people's broken bones, some older than others.* |
| *How hard or easy was it to find a "fascinating fact" from this reading for your writing exercise? Explain.* | *It was easy, because when I saw all the screws in the X-ray, I was amazed and a little nauseated.*<br>*It was easy. All I could think of was how all those thousands of Civil War soldiers managed for the rest of their lives.* |
| *How can you find out why amputations are much less common today than they were during the U.S. Civil War in the 1860s? What clues are in the reading?* | *I could do online research or ask a medical doctor.*<br>*The big clue is that when the wounds got infected, amputations increased.*<br>*I need to find out why there are fewer infections today than in the 1860s.* |

## 5. Check for understanding.

**Evaluate and Provide Feedback**

For Exercise 1, students should copy the template provided to construct a graphic organizer in response to reading Collection 1. For each of the five selections, there should be a complete sentence describing a cause-and-effect relationship that the student found interesting. Look for language that indicates causes and effects, and look for evidence that the statements students write are scientifically accurate, original, and address all five readings. A sample completed graphic organizer is show below, but students' responses are likely to vary.

## Five Fascinating Facts




Use the rubric provided on the Exercise Page to supply feedback to each student.

LESSON 3

# How can medical images and diagrams help us figure out more about the structures in our body?

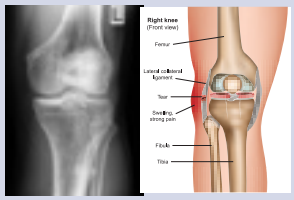
## Previous Lesson

*We investigated how the parts of a chicken wing work together when moving. We mapped the parts of the chicken wing to the parts of the human foot to compare how they function together. We revised the investigation to figure out how an injury can affect the wing's function.*

## This Lesson

**Investigation**

**1 DAY**




We observe various images that medical professionals use to view inside a body. These images provide some information, but we're not sure of everything we're seeing. Realizing we don't have the training or experience to interpret these images, we use cross-sectional scientific diagrams of a knee to help us make sense of what we are observing. Noticing that there are some other structures inside the knee that we still can't identify, we look at close-up diagrams of skin, muscle, and bone. By looking at close-up diagrams, we discover that blood vessels and nerves are found throughout the skin, muscles, and bone.

## Next Lesson

*Using microscopes and images, we will figure out that blood is a mixture of smaller components. We will read an article to help us consider how the structure of the components of the blood support their functions in the body.*

## Building Toward NGSS

MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8

## What Students Will Do

**3.A** Critically read and interpret scientific texts (images and diagrams) adapted for classroom use to describe patterns to figure out that blood and nerves are present in skin, muscle, and bone of a human body.

## What Students Will Figure Out

- There are blood vessels in the different parts of the bone, muscle, and skin.
- There are nerves that run through the layers of the skin, muscle, and bone.

## Lesson 3 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 5 min | **NAVIGATION**<br>Reflect on what we figured out from observing the chicken wing. | A-B | Our Body as a System poster |
| 2 | 7 min | **COMPARE MEDICAL IMAGES FOR PARTS OF THE BODY**<br>Compare and discuss X-rays and MRIs of human feet, knees, and hands. | C-F | *Reference: A Medical Professional's View Inside the Body*, transparent tape |
| 3 | 3 min | **DISCUSS CROSS-SECTIONAL IMAGES**<br>Discuss how we have used cross-sectional images in the past and how looking at cross-sectional images from different perspectives might help us figure out what else we see in the MRI. | G | |
| 4 | 7 min | **EXAMINING CROSS-SECTIONAL IMAGES OF THE KNEE**<br>Compare MRIs of the knee with scientific diagrams in order to interpret and identify structures that are present. | H-I | *Reference: Interpreting MRI*, transparent tape |
| 5 | 7 min | **LOOKING CLOSER AT THE SKIN, MUSCLE, AND BONE**<br>Interpret close-up diagrams of the skin, muscle, and bones to look for patterns and identify other structures in the knee. | J-K | *Reference: Interpreting MRI*, *Reference: Close-Up Diagrams of Skin, Muscle, and Bone*, transparent tape |
| 6 | 10 min | **DISCUSS AND RECORD OBSERVED STRUCTURES**<br>Share observations of structure found in the knee from analyzing MRIs and diagrams. | L-M | *Reference: Interpreting MRI*, *Reference: Close-Up Diagrams of Skin, Muscle, and Bone* |
| 7 | 3 min | **NAVIGATION**<br>Motivate the need to take a closer look at blood and nerves in the next two lessons. | | Driving Question Board, Healing Timeline poster |

*End of day 1*

## Lesson 3 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br><br>**Student Procedure Guide**<br>  <br><br>**Student Work Pages**<br>  | • science notebook<br>• *Reference: A Medical Professional's View Inside the Body*<br>• *Reference: Interpreting MRI*<br>• *Reference: Close-Up Diagrams of Skin, Muscle, and Bone* | • transparent tape | • Our Body as a System poster<br>• Driving Question Board<br>• Healing Timeline poster |

## Materials preparation (20 minutes)

**Online Resources**



Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

When using *Interpreting MRI* and *Close-up Diagrams of Skin, Muscle, and Bone*, be sure to make color printouts or have students refer to the color images in the student procedures as they annotate a black-and-white copy.

## Lesson 3 • Where We Are Going and NOT Going

### Where We Are Going

In this lesson, students will be looking at two different types of images that medical professionals use to look at the structures found in skin, muscle, and bone. Cross-sectional images (X-ray and MRI) allow students to see skin, muscle, and bone in a living organism ***and*** figure out that there are blood vessels and nerves in all of these parts of the body. In Lesson 2, we looked beyond the foot to think about how other parts of our body work. Because our arms, legs, and feet all have muscles, bones, and skin, we convinced ourselves that we could use the chicken wing, which is representative of the human arm, to make observations about how muscles and bones move and work together. To help students interpret what they see in X-rays and MRIs, they will compare what they see with cross-sectional diagrams of a knee in two different planes—which are the same axial (horizontal) and coronal (vertical) planes that they see in the knee MRIs. To help identify structures within the skin, muscle, and bone, students look at close-up diagrams and discover that blood vessels and nerves are found throughout these parts. This motivates students to want to understand the role of blood and nerves and how they work together with skin, muscle, and bone in order to facilitate healing.

### Where We Are NOT Going

Although we zoom in on skin, muscle, and bone structures in the close-up diagrams, we are not zooming in closely enough to identify cells in this lesson. In the next few lessons, students will discover different types of cells (blood cells in Lesson 4 and nerves in Lesson 5) and develop a general working definition of what cells are and why various types look different in Lesson 6. We notice blood vessels and nerves throughout the other structures we've previously identified, but by the end of this lesson, we will not be figuring out what the functions of these structures are or how they work together with the skin, muscle, and bone.

## LEARNING PLAN FOR LESSON 3

### 1. Navigation

5 MIN

**Materials:** science notebook, Our Body as a System poster

**Reflect on what we figured out from observing the chicken wing**. Display **slide A.** As students come into class, have them reflect on the last lesson by looking at their Progress Tracker in their science notebooks. Refer students back to the *Our Body as a System* poster that we revised in the last lesson, using the body systems images (muscular and skeletal) as needed. Begin by saying, *Last lesson, we used a chicken wing to investigate how the muscles, bones, and skin interact and work together.*

Facilitate a short discussion to elicit student ideas about what they have figured out.

| Suggested prompt | Sample student responses |
|---|---|
| *What did we figure out about how the skin, muscles, and bones interact for a part of the body to move?* | *The skin covers the outside of our body and is stretchy so it can keep covering our body as we move. It keeps everything inside and we think keeps things like germs out.*<br><br>*The bones are solid and do not bend.*<br><br>*When the muscles move, the bones that are attached to them move too, because the bones are attached to the muscles somehow.*<br><br>*The skin is connected somehow to the muscle underneath it, and seems to cover and protect everything inside our body. Skin, muscles, and bones are found throughout the body.* |

**Motivate using other types of medical imaging to look inside a living human body.** Display **slide B**, and continue the discussion with the following prompts.

| Suggested prompts | Sample student responses |
|---|---|
| *We are trying to figure out more about how our foot works to help us figure out how the injured foot healed. How did observing the movement of a chicken wing instead of a foot help us figure out some things about the different parts in our body?* | *We saw that the chicken wing has similar structures to our arms, so we thought we could use it to see how the muscles and bones work together.*<br>*Yeah, and we said we can't really bring in just a foot to move the parts of the foot or leg around like we could the chicken wing, and then injure parts to see how things change.* |
| *We can't see inside our foot, nor can we open up our foot to see inside to figure out how the different parts work together but there are tools that medical professionals use to do just this, see inside our body. Does anyone know what some of these tools are? Has anyone experienced this?* | *I've had X-rays taken of my arm when I broke it. Maybe X-rays can be used for looking at bones throughout the body.*<br>*Yeah. . .and there are other tests or scans they can do like MRIs, CT scans, or ultrasounds.*<br>*I had an MRI of my leg.* |
| *If we could look at images from scans of these body parts, how do you think that could help us figure out more about how they work together?* | *We could see what we can't see from the outside.*<br>*We might be able to see different parts more clearly… like we could see the bones in the X-rays. Maybe we'll be able to see different body parts in the other images.*<br>*Maybe one of the tools can see more than one part and how it is connected.* |

Say, *Maybe reading some of these medical test results and images could help us figure out how parts of the body (like skin, muscle, and bone) work together. Let's analyze and compare some images of human body parts that were obtained using different medical technologies.*

## 2. Compare medical images for parts of the body.

7 MIN

**Materials:** science notebook, *Reference: A Medical Professional's View Inside the Body*, transparent tape

**Compare and discuss the different images of the body taken by medical professionals.** Display **slide C**. Say, *There are two images on the slide of the machines used to capture images of different parts of the body. The first image is of*

*an X-ray machine, and the second image is of an MRI machine. Have any of you had an X-ray or MRI? What did the X-ray or MRI show?* Accept all responses.

## Additional Guidance

The science behind how X-rays and MRIs produce their images is beyond the scope of sixth grade and this unit. However, if your students ask how these images are produced, you could say something like the following: MRI stands for magnetic resonance imaging and uses magnets, radio waves, and computers to create images. X-rays are called that because they use beams of energy called X-rays to pass through that part of the body onto a detector on the other side, creating the image. X-rays are a type of 2D image, while MRIs produce 3D images, of which we can look at 2D slices in various planes. We will be discussing cross-sectional images in the next section. Students will not be examining CT or CAT scans in this lesson, but if asked, CTs can be thought of as a type of 3D X-ray.

**Analyze and annotate X-rays and MRIs of human feet, knees, and hands.*** Display **slide D**. Say, *Here are two images of the foot. The one on the left was taken using an X-ray machine, and should be familiar because we saw X-rays in Lesson 1. The image on the right was taken using an MRI machine.*

Have students locate their copy of *Reference: A Medical Professional's View Inside the Body*. Give students time to individually compare and annotate the different pairs of images (foot, knee, and hand) with the following directions (also on **slide D**).

- Observe each pair of X-rays and MRIs.
- Draw arrows to label the parts you can identify. (Refer to our "Our Body as a System" poster if that's helpful.)
- Circle parts of the images you have questions about.

Say, *Compare these images and annotate the handout to capture what you notice. What parts of a body are visible (or not) in each image?*

*A Medical Professional's View Inside the Body* in their student edition also contains the X-ray and MRI images.

*** Supporting Students in Engaging in Obtaining, Evaluating, and Communicating Information**

Students annotate the body part images that have been adapted for classroom use to indicate what they notice and wonder. This work gives students practice in interpreting scientific and technical images to find patterns (similarities and differences) in different views of common parts of the body. For example, students may notice that x-rays mainly show bones, whereas the MRIs show bones and other structures. It's not essential for students to reach consensus on any relevant patterns, as they will have additional opportunities to engage in this practice later in the lesson. For now, it's sufficient for students to become accustomed to ways in which imaging can be used to see beneath the skin.

## Additional Guidance

Note that the images of the foot on *Reference: A Medical Professional's View Inside the Body* and on slide D are both of a left foot. The X-ray was taken looking down at the foot, and this MRI cross section is an axial (or transverse) plane looking up at the left foot.

**Turn and talk with a partner to discuss image observations.** Display **slide E**. Have students work with a partner to discuss and summarize their ideas from annotating *Reference: A Medical Professional's View Inside the Body* and share out what the x-ray and MRI helped us see inside each part of the body. As students are working, walk around and listen to their discussions for ideas to bring out in the whole-class share-out.*

Display **slide F**. Bring the class back together and share what they figured out from these images.

***Attending to Equity**

Prior to the whole class discussion, circulate while students are working with a partner to share their ideas about what X-rays and MRIs help us see inside the body. Recruit a student who participates less frequently in whole-group conversations to share an idea they heard in their partner conversation.

| Suggested prompts | Sample student responses |
|---|---|
| *What did you and your partner notice about the different body parts using the MRIs and X-rays? What could you identify that was not originally visible from the outside?* | *X-rays helped us see the bones. On the MRI, I think we're seeing bones, but I'm not sure about whether we can see muscle or skin.*<br>*We think the MRI is showing us other parts of the body, like maybe muscles or something, but we're not really sure.*<br>*There are a lot of structures we can see in the MRI of each body part, especially the foot and the hand!* |
| *Did the X-rays and MRIs show us what we wanted to know about the muscles, skin, and bones?* | *The X-ray only showed us bones.*<br>*The MRIs showed more detail than the X-rays, but we weren't quite sure what we were looking at in those images.*<br>*Both images didn't show us much about the skin.*<br>*These were cool, but we need a way to get more information about what these parts are and how they help the body function and heal.* |
| *What similarities did you notice between what you could see in the images?* | *In both images we could tell where the bones are located in the body.*<br>*Yeah, but in the MRI we could see more than just the bones. It looks like there is something on top of the middle bones in the MRI where there is darker shading.*<br>*In both images we could tell the shape of the foot and where the different parts are, like the toes and the ankle.* |

You can quietly let the student you want to call on know about your intent in advance so they can think through their response ahead of time, or let you know that they don't feel comfortable sharing. For example, you might say, *When we come back together as a class, I'd like to ask you to share this idea you discussed with your partner about the features that you saw with the MRIs. Would you be willing to go public with this really productive idea?*

Say, *OK, so it sounds like we are seeing more than just bones in the MRI, and we want more information about the parts that we're seeing on the MRI. One cool thing about MRIs and how they're different from X-rays is that they are actually three-dimensional images composed of many cross sections, so parts of the body can be viewed from lots of different angles.*

## Additional Guidance

The images presented are produced using different technologies that are designed to highlight specific structures inside the body. Parts of the body that may be visible using one type of technology may not be visible using the other types. It's important to help students understand that just because a structure may not be visible does not mean it's absent. Later in this unit, students will be looking more closely at parts of the body and the structures within them using microscopic images to figure out that these body parts are made of cells. Students will see some structures clearly, while other structures may not be visible with the classroom microscope.

## 3. Discuss cross-sectional images.

3 MIN

**Materials:** None

**Discuss how cross-sectional images have been useful in earlier units.** Display **slide G**. Remind students of previous units that involved using cross-sectional views to study complex phenomena. Say, *Remember in earlier units when we looked at side views of air masses in Unit 6.3: Why does a lot of hail, rain, or snow fall at some times and not others? (Storms Unit) or when we were figuring out what was happening below Earth's surface that led to mountain change in Unit 6.4: What causes Earth's surface to change? (Everest Unit)? Those were examples of cross-sectional views of different systems. Why did we look at those images that cut across the Earth like that?*

Students should say that cross sections helped us figure out more about the parts of the systems, or visualize patterns that we could not see just from viewing the system from the top or outside.

Refer back to *Our Body as a System* poster and remind students that we have agreed that thinking about our body in terms of systems is helpful. Say, *In our last lesson we began to develop this poster around the different structures in the body and their functions.*

| Suggested prompt | Sample student responses |
|---|---|
| *We titled it Our Body as a System. What did we decide about why we might want to think about our body as a system?* | *Because we know that it's made of different parts that work together to perform various functions.*<br>*This could help us figure out how these parts work together for the body to heal.* |

**Motivate how we could use MRIs to help us understand parts of our body.** Continue by saying, *Because these parts or components of the body are often complex and hard to study, it's sometimes helpful to use different perspectives or scales to be able to figure out more about the structure and relationships between parts of these systems. How can cross sections help us make sense of the body? Which view from an MRI would help us understand more about the structures in our body?*

Sample student responses:

- *They might let us see things we couldn't see from the outside.*
- *Maybe the different views from the MRIs will show us something different from the X-rays.*
- *Maybe there's something else in there that can only be seen from a certain direction/view.*
- *A view that shows us the center of the bone or foot might help.*
- *A view that shows us a slice through the part that was injured could also help.*

Say, *Okay, let's begin by looking at two different MRIs of a person's knee. We are going to focus on the knee, rather than the foot, because it has all of the same types of parts (skin, muscle, and bone), but it's simpler.*

## ALTERNATE ACTIVITY

**Building prerequisite understandings:** If your students have not been through *Unit 6.3: Why does a lot of hail, rain, or snow fall at some times and not others? (Storms Unit)* and *Unit 6.4: What causes Earth's surface to change? (Everest Unit)* or they are unfamiliar with the spatial reasoning involved in using cross sections to explain phenomena, they may benefit from this additional activity.

Bring out the two apples (or two of the same kind of other fresh fruit or vegetable), a cutting board, and a knife. Ask, *What are some different ways we could cut this apple? In what directions could we slice it to see what's inside?*

Sample student responses include:

- *Through the stem, vertically, like longitude on the globe.*
- *Crosswise, horizontally, like in half between the stem and flower ends, like latitude on the globe.*
- *Just cut off a slice you might want to eat, avoiding the core.*
- *Diagonally, maybe? There are lots of different ways we could slice it!*

Say, *Okay, let's try some and see what we can see.*

Cut each apple in different directions and show the students the cut sides. *Ask, What can we see differently in each of these cross sections?* Accept all responses, calling attention to the fact that the different sections allow us to see different parts and patterns (such as the location of the seeds, how the stem joins the flesh, how the core meets the flesh, etc.). If you think it will be helpful, you can add cross section to your World Wall, with a definition that might be something like "a slice through an object to allow us to see the inside parts of that object."

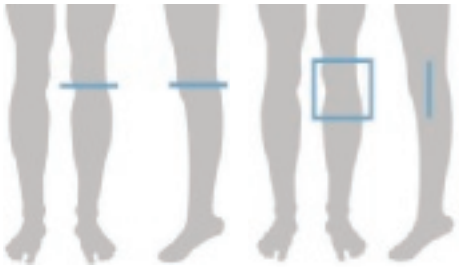
You can now leverage your apple slices and discussion in order to help students visualize the vertical and horizontal cross sections of MRIs.

## 4. Examining Cross-sectional Images of the Knee

7 MIN

**Materials:** *Reference: Interpreting MRI*, transparent tape

**Observe horizontal and vertical MRIs of a knee.** Display **slide H.** Ask students to share what they notice and wonder about these two MRIs. Use gestures with your own knee to help illustrate where the two sections were "cut." The horizontal MRI of the knee shows a slice taken toward the top of the kneecap, while the vertical MRI of the knee shows a slice just behind the kneecap (see *Interpreting MRI* for a graphic).* These two images come from an MRI data set of a single knee.

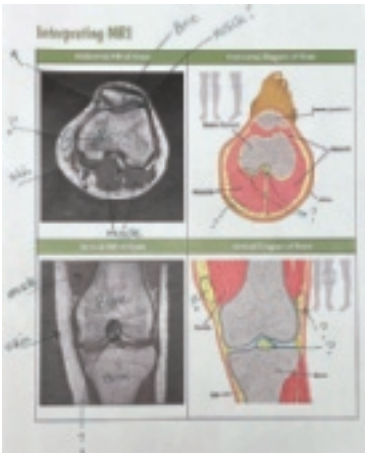


Ask students to look at the images on the slide individually for a few minutes to identify what they notice and wonder about the images. Then bring the class back together to discuss their ideas.

Medical professionals sometimes identify cross-sectional images based on the plane they are taken from: a horizontal slice parallel to the floor (if a human is standing) is called an *axial* or *transverse image*; a vertical slice perpendicular to the floor separating the front side from the back side is called a *coronal image,* and a vertical slide separating the left side from the right side is called a *sagittal image.*

| Suggested prompts | Sample student responses |
|---|---|
| *What are some things that you notice and wonder about the MRIs?* | *We are looking at the same part of the body, but with a different view.*<br>• *Is this the same knee? Same person?*<br>• *Did they have to cut the knee open to get these views?*<br>*There are areas that are darker and lighter than others.*<br>• *What are the darker areas? Is that the muscle?*<br>• *What's the lighter part in the center? Is that the bone?* |
| *What similarities between the two images do you notice?* | *We can see where the bone is in each image.*<br>*We can also see there is stuff around the bone—I wonder if this is the muscle like we saw in the chicken wing.*<br>*The whitish edge is probably the skin in both.* |

**Interpret the knee MRI using scientific diagrams.*** Say, *I have some scientific diagrams that are similar to those that medical professionals use, which we can use to help us make sense of these different images of the knee, similar to how we would read scientific text. These diagrams were created by professional artists based on research from doctors who have conducted investigations and surgeries on actual human bodies to help students and doctors in training understand what they are looking at inside the body. These diagrams often use different colors to distinguish between different parts of the body. These colors do not necessarily represent the actual color of that part of the body! Let's see how we can use these diagrams to interpret the MRIs.*



Display **slide I**. Have students compare the MRI images and the scientific diagrams, drawing lines between these two representations of the knee, labeling structures that can be identified and adding "?" next to those that cannot be identified yet.

**Facilitate a brief discussion.** Have students share and discuss what they figured out from looking at the MRIs alongside the scientific diagrams.

## Key Ideas

**Purpose of this discussion:** Summarize as a whole group what we are able to identify, what we still need to identify, and ways to figure out what other structures we observe.

### *Attending to Equity

**Universal Design for Learning:** If students are interested in medical technology like MRIs, you can support their *engagement* by expanding the discussion of cross-sectional images in an MRI to learn the names for the particular cross-sectional views. Students do **not** need to know this terminology, and for our purposes, we will identify the axial knee images and diagrams as "horizontal" and the coronal knee images and diagrams as "vertical."

Medical professionals sometimes identify cross-sectional images based on the plane they are taken from: a horizontal slice parallel to the floor (if a human is standing) is called an axial or *transverse image*; a vertical slice perpendicular to the floor separating the front side from the back side is called a coronal image; and a vertical slide separating the left side from the right side is called a *sagittal image*.

**Listen for these ideas:**

- We were able to identify the skin and some of the muscles and bones.
- There are some other parts of the knee that are not labeled in the scientific diagram and MRI. We don't have agreement on what they could be.
- We could find a diagram with more labels, or we could zoom in to look closer at these areas to help us identify these other structures.

In attempting to make visual connections between MRIs and the scientific diagrams of the knee, students once again practice interpreting scientific and technical diagrams looking for patterns between the images. Here, students will use scientific diagrams to help identify the skin, muscle, and bone visible in the MRIs. As students then consider the other visible structures, they begin to wonder what the role of these structures may be, thus motivating the need to observe them more closely for potential patterns.

| Suggested prompts | Sample student responses |
|---|---|
| *How did the diagrams help you better interpret the MRI images?* | *Although the MRIs were clear, I couldn't always tell what I was looking at. The scientific diagram made it easier to identify some of the parts because of the colors.*<br><br>*In the scientific diagram, the colors and the markings helped us tell one part from another (like muscle from bone) and made it easier to see where one part ends and another begins.* |
| *What parts of the MRI or scientific diagram do you have questions about?* | *We could see where there are muscles and bones, but there were also other parts of the knee, and we're not sure what they are.*<br><br>*I don't know what the parts between the skin and muscle are or what they do.* |
| *How might we get a better look in order to figure out more about which parts we are observing in the knee?* | *Can we look at more MRIs above and below the knee so we can see where the muscles or bones begin and end?*<br><br>*Can we look at a close-up or a different scientific diagram that shows the other structures we were not able to identify in this same area of the knee?* |

Summarize, *So far, we have used MRIs to look inside the knee and we have been able to identify skin, muscles, and bones, but we also see other parts that we have not been able to identify. Let's take a closer look to see if we can figure out what these other unidentified structures are and think about what they might be doing in the body.*

**Supporting Students in Engaging in Obtaining, Evaluating, and Communicating Information**

In attempting to make visual connections between MRIs and the scientific diagrams of the knee, students once again practice interpreting scientific and technical diagrams looking for patterns between the images. Here, students will use scientific diagrams to help identify the skin, muscle, and bone visible in the MRIs. As students then consider the other visible structures, they begin to wonder what the role of these structures may be, thus motivating the need to observe them more closely for potential patterns.

## 5. Looking Closer at the Skin, Muscle, and Bone

7 MIN

**Materials**: *Reference: Interpreting MRI* or *Interpreting MRI* in student editions, *Reference: Close-Up Diagrams of Skin, Muscle, and Bone*, transparent tape

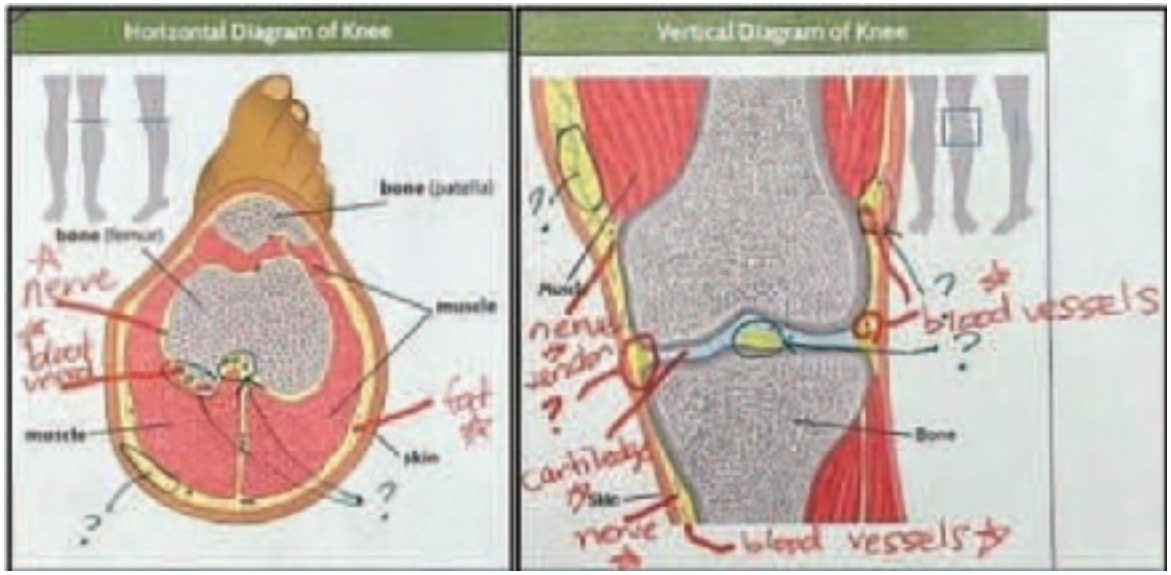
**Introduce close-up diagrams to look for patterns.** Say, *Here are some close-up diagrams of the skin, muscle, and bone. Let's use them to help us understand these different structures in a little more detail.* Distribute the student edition or color images of *Close-up Diagrams of Skin, Muscle, and Bone.* You can also provide students with *Reference: Close-Up Diagrams of Skin, Muscle, and Bone* as a black-and-white handout to annotate and tape into their science notebook.

Display **slide J.** Have students observe close-up diagrams of skin, muscles, and bone, and discuss their observations with a partner. Encourage students to look for similarities, differences, and patterns among the close-up images.*

Display **slide K.** Allow students to individually compare *Close-up Diagrams of Skin, Muscle, and Bone* and *Interpreting MRI* to look for patterns. Tell students that they should create additional labels on their own copy of *Reference: Interpreting MRI* to identify new parts. Ask students to mark the new labels they add with a star.

Say, *Now that you have had a chance to analyze these new close-up diagrams, go back to Reference: Interpreting MRI and add any new information from Close-up Diagrams of Skin, Muscle, and Bone. If you identified any additional parts, add labels to Reference: Interpreting MRI and mark them with a star. Remember, we might all interpret what we're seeing slightly differently.*

See one example here:




*** Supporting Students in Developing and Using Scale, Proportion, and Quantity**

These diagrams help support students' transition to considering body parts at a microscopic scale. Students will develop their understanding of "zooming in" at different scales over the next three lessons, as they use microscopes and microscopic images to investigate blood, nerves, skin, bone, and muscle. Zooming in at different scales will help students gain a rich understanding of the structure-function relationship within each of these parts. As such, do not yet call attention to the idea of microscopic scale here; simply continue to use the idea of getting closer and seeing inside. In Lesson 6, after students have seen these structures magnified 40,100, or even 1,000 times, you can revisit these diagrams to notice that the artist may not have represented in these diagrams exactly what we actually see at the various scales. The artist's purpose here was instead to show what we cannot see from outside the body and provide clarity using color to differentiate structures.

## Assessment Opportunity

**3.A Building towards:** Critically read and interpret scientific texts (images and diagrams) adapted for classroom use to describe patterns to figure out that blood and nerves are present in skin, muscle, and bone of a human body.

**What to look for/listen for**: Annotations or ideas about (1) how we can use multiple sources of information (images taken with different tools and from different perspectives) together in order to gain a more complete representation of a structure or system, and (2) how this more complete representation can be used to figure out patterns within a system (in this case, to notice that blood vessels and nerves are located throughout the skin, muscle, and bone of the body system).

**What to do:** Encourage students to share their observations and questions as they compare the images and diagrams from *Interpreting MRI* with the diagrams from *Close-up Diagrams of Skin, Muscle, and Bone.* Encourage students by asking, "What did the diagrams from *Close-up Diagrams of Skin, Muscle, and Bone* help us understand about the images in *Interpreting MRI?"* and "What kinds of questions do you have about the skin, muscle, and bone after seeing the diagrams from *Close-up Diagrams of Skin, Muscle, and Bone*?"

## 6. Discuss and record observed structures. 10 MIN

**Materials:** *Reference: Interpreting MRI* or *Interpreting MRI*, *Reference: Close-Up Diagrams of Skin, Muscle, and Bone*

**Discuss observations from knee images.** Say, *Let's take stock of what we figured out about the parts of the knee after looking at the MRIs and different diagrams and think about how these parts might be involved in healing.*

Tell students to turn to a partner and share one thing they found in all three close-up diagrams of the skin, muscle, and bone. Give students one minute to share with a partner.

Display **slide L**. Say, *I noticed many of you were able to learn more about the different parts of the knee, such as details in the skin, muscle, and bone. What were some of the things you noticed about the skin, muscle, and bone from looking at the close-up diagrams?*

## KEY IDEAS

**Purpose of this discussion**: For students to highlight how they were able to use close-up diagrams to help them identify different structures in the body on the knee diagrams.

Additionally, we want students to collectively observe that blood vessels and nerves are visible in all of the close-up diagrams of skin, muscle, and bone. How blood vessels and nerves work together in each of these parts of the body is still unknown and is what we will figure out in the next few lessons.

**Listen for these ideas**:

- Blood vessels and nerves were found throughout the skin, muscle, and bone. We wonder why they are found in all these structures.
- By carefully comparing the colors of labeled structures in the close-up diagrams to the knee diagrams, we were able to identify blood vessels and nerves in the knee diagrams (and possibly in the MRIs).
- In the knee diagrams, we found different sized blood vessels and nerves.

Ask for a student volunteer to share what their partner identified in the close-up diagrams. Ask other students in the class whether they also noticed something similar to this in the knee MRIs and knee diagrams. Gain agreement among students that we have identified blood and nerves within each of the knee diagrams and potentially in the MRIs (knee and/or the hand and foot).

| Suggested prompts | Sample student responses |
|---|---|
| *What parts of the knee were we able to identify more clearly by looking at these close-up diagrams?* | *There were a lot of different structures that we were able to identify and label, like the bone, cartilage, tendons, fat, blood vessels, and nerves.* |
| *Were there some common structures or parts you noticed in the images and diagrams that could help us understand how these parts work together?* | *We noticed that blood vessels and nerves were found in all three of the close-up diagrams, whereas some of the other structures were not.*<br>*Yeah, we saw tendons only in the muscle close-up and fat only in the skin close-up.*<br>*We saw cartilage, but it was only on the end of a bone.* |

Display **slide M** to continue the discussion about the role the blood and nerves might play in the body.

| Suggested prompts | Sample student responses |
|---|---|
| *Why do you think blood vessels and nerves are found in structures like skin, muscles, and bone? What do you think blood vessels and nerves do?* | *Accept all answers.*<br>*We think blood vessels are tubes that carry blood throughout the body.*<br>*Nerves, we think, help us feel, but we are not sure why bones have nerves in them.* |
| *OK. So we were mostly just focusing on these knee MRIs. Do you think that we would see similar things in other places in the body?* | *Yes, we went back and looked at the hand MRIs and noticed some things that might have been blood and nerves there.*<br>*The close-up diagrams weren't just the knee; they could be anywhere since we have those structures throughout our bodies.* |

| Suggested prompt | Sample student responses |
|---|---|
| *If blood vessels we've identified carry blood, then why do all these areas in our body need blood? What does blood do?* | *Accept all answers.*<br>*We aren't quite in agreement about why we need blood in all these places in the body.*<br>*Some people mentioned that blood carries oxygen to different parts of the body, but we are not sure what the different parts of our body do with this oxygen.*<br>*Maybe the blood was there before the injury, but maybe it also helped to heal it after the injury.* |

### Additional Guidance

Some students might bring to the class a number of different ideas about what our blood and/or nerves do inside our body. When a student puts these ideas on the table, affirm their contribution and ask the student to say more about why our body needs this structure in all three of these areas: the skin, muscle, and bone. The goal is to recognize and affirm that students may bring ideas to the table, but also to help students identify gaps in their thinking to help motivate the next lesson.

## 7. Navigation

3 MIN

**Materials:** Driving Question Board, Healing Timeline poster

**Navigate to the next lesson.** Say, *Today we saw that there are blood vessels and nerves in all these parts (skin, muscle, bone) of the knee and think this must be true of the foot that had been injured, too.*

| Suggested prompts | Sample student responses |
|---|---|
| *If we think back to the injury in Lesson 1 we know two bones were broken and we saw the skin was opened up, but do we have any information or evidence about either blood or nerves being parts that were injured?* | *Yes! We saw in the images that there was a scab or blood on the top of the foot before the surgery.*<br>*I am not as sure about the nerves, there were some notes about feeling he had in his foot, but I don't know if that means the nerves were injured?* |
| *How might investigating to figure out more about what is happening with the blood during an injury help us in figuring out more about how our body heals from an injury?* | *Well … maybe if we can figure out what the blood does for our body we might be able to figure out how it is involved in healing.*<br>*Yeah, I agree, because when I get cuts I also get scabs afterwards like in the image of the injured foot.* |

Say, *So it seems like we have some more we want to figure out about what blood is and what it does in our body so we can figure out what role it plays in helping parts of the body function and heal.*

## Additional Guidance

We make the navigation to look at blood for two reasons. First, as explained to students, blood is generally the most visible indicator that bodily injury has occurred. Most students will have some experience with this phenomenon. Second, in the next two lessons, students will observe cells with the aid of a microscope, and blood cells have a more easily recognizable cell boundary than nerves. After observing blood cells under a microscope, students may find it easier to identify other types of cells, such as nerve, bone, muscle, and skin.

# ADDITIONAL LESSON 3 TEACHER GUIDANCE

## Supporting Students in Making Connections in ELA

**CCSS.ELA-LITERACY.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.**

In this lesson, students viewed several images and diagrams to make sense of some of the structures inside a human body—where they're located and how they're arranged. In order to support their claims that blood vessels and nerves are found in the bone, skin, and muscles, students must compare various scientific diagrams with MRIs and cite evidence about how the structures that they can identify support their claims.

LESSON 4

# Why is there blood in all of these places in the body?

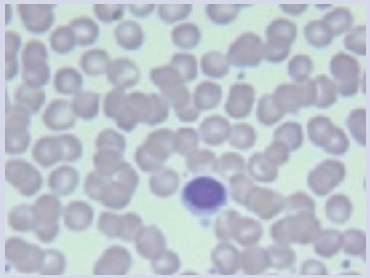
## Previous Lesson

*We observed various medical images as well as scientific diagrams of the knee to analyze the structures inside the body. We noticed that there were some structures that we still couldn't identify, so we looked at close-up diagrams of skin, muscle, and bone. From these, we discovered that blood vessels and nerves are found throughout the skin, muscles, and bone.*

## This Lesson

Investigation

3 DAYS



We view images to determine that blood circulates everywhere in the body through blood vessels and that blood is a mixture of different things. We use microscopes and images to investigate human and non-human, mammal blood. We notice patterns in our observations and establish that blood is composed of several different components that cannot be seen without a microscope. We read an article to make sense of the patterns we observed, including how the structure of the components in the blood (plasma, red blood cells, white blood cells, and platelets) support the blood's functions in the body.

## Next Lesson

*To understand why nerves are present throughout the cross section of the foot, we will observe images of nerve cells. We will read about nerve cells to understand the relationship between structure and function. We will engage in activities to experience how nerves work, and then consider how we can leverage what we learn about nerves to better understand the healing process.*

## Building Toward NGSS

MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8

## What Students Will Do

**4.A** Collect data at different scales to answer scientific questions about the components found in blood.

**4.B** Critically read scientific text to make sense of patterns within structures we observe in the blood related to their function in the body.

## What Students Will Figure Out

- As a whole, the blood's function is to travel around the body carrying the things the body needs.
- The blood's flowy liquid nature (structure) allows it to perform its function.
- Blood vessels are structures that allow blood to move throughout the body.
- Blood is composed of a mixture of components that we cannot see without a microscope.

- Blood is made of red blood cells, white blood cells, platelets, and blood plasma.
- The structure of blood cells relates to their function: their round shape helps them travel easily through the tubular blood vessels.
- Platelets' structure relates to their function: their branching arms and stickiness help them plug damaged parts of the blood vessels to stop leaks.

## Lesson 4 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 8 min | **CONSIDER WHERE BLOOD IS IN OUR BODIES**<br>View an image of blood vessels in the human body to determine that blood circulates everywhere in the body. Compare images of blood samples in test tubes to determine that blood is a mixture. | A-E | Our Body as a System poster |
| 2 | 10 min | **PREPARE TO PRACTICE USING MICROSCOPES**<br>Elicit prior knowledge about lenses, and identify what we need to figure out about using microscopes. | F-J | |
| 3 | 12 min | **PRACTICE USING MICROSCOPES**<br>Use a microscope to view millimeter graph paper at various objectives and record observations; practice focusing and moving other parts of the microscope slowly and carefully. | K | Investigating Microscopes |
| 4 | 15 min | **BUILDING UNDERSTANDINGS DISCUSSION ABOUT SCALE**<br>Share what we figured out about using microscopes to see at a microscopic scale; create a class poster for future reference. | L-M | chart paper, markers |
| | | | | *End of day 1* |
| 5 | 10 min | **PREPARE TO INVESTIGATE BLOOD WITH A MICROSCOPE**<br>Consider the human and animal samples we'll observe today (on pre-prepared slides) and set up data tables to record observations. | N-Q | |
| 6 | 15 min | **INVESTIGATE BLOOD WITH A MICROSCOPE**<br>Observe samples of human and other mammal blood to investigate what is in blood, and record observations of the structures visible at various objectives. | R-S | Investigate Blood with a Microscope |
| 7 | 20 min | **SHARE OBSERVATIONS OF BLOOD**<br>Discuss patterns in observational data with a partner and then with the whole class. Establish that blood is composed of several different smaller structures that cannot be seen without a microscope. | T-W | 1 sheet of blank 8.5x11 inch paper, markers, Our Body as a System poster |
| | | | | *End of day 2* |

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 8 | 14 min | **READ ABOUT BLOOD**<br>Read an article to find out what structures are in blood and what they do for the body. | X-Y | *Guidance for Reading about Blood*, *Reading: What Is Blood?* |
| 9 | 14 min | **BUILDING UNDERSTANDINGS DISCUSSION ABOUT BLOOD**<br>Use ideas from the reading to make sense of the patterns we saw in the blood samples and consider how the structures of the blood and its components support their functions. | Z-BB | *Guidance for Reading about Blood*, *Reading: What Is Blood?*, Our Body as a System poster including the blood cells drawing from step 7, markers, image of blood system from *Blood System Image* |
| 10 | 14 min | **UPDATE THE PROGRESS TRACKER AND REVISIT THE DQB**<br>Reflect on and record what we figured out about blood, how that helps us understand healing, and what questions we have answered (or need to add) on our Driving Question Board. | CC-DD | |
| 11 | 3 min | **BRAINSTORM WHY NERVES ARE FOUND THROUGHOUT THE BODY**<br>Analyze an image of where nerves are found in the body and brainstorm why they are found throughout the body. | EE | Our Body as a System poster |

*End of day 3*

## Lesson 4 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Investigating Microscopes materials | | • microscope<br>• 2 cm × 4 cm piece of mm graph paper cut from *mm Graph Paper* | |
| Investigate Blood with a Microscope materials | | • microscope<br>• *Procedures for Investigating Blood with a Microscope*<br>• pre-prepared slide of human blood<br>• mammalian blood images from *Microscopic Images of Animal Blood* | |
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Guidance for Reading about Blood*<br>• *Reading: What Is Blood?* | | • Our Body as a System poster<br>• chart paper<br>• markers<br>• 1 sheet of blank 8.5×11 inch paper<br>• Our Body as a System poster including the blood cells drawing from step 7<br>• image of blood system from *Blood System Image* |

**Materials preparation (30 minutes)**

**Online Resources** 

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

In this and future lessons, students use microscopes to look at different samples on pre-prepared slides. The materials (slides, handouts, discussion prompts) all assume your microscopes have a 10x eyepiece lens and 4x, 10x, and 40x objective lenses. If the microscopes your class will be using are different, modify the materials accordingly or call students' attention to the differences.

If you do not have microscopes for your class to use, here are some options:

- A partner high school may have microscopes that you could borrow for this unit. Order the slides included in the unit materials list.

- We have included images of what students would see when zooming in on the blood with a microscope in *Microscopic Images of Animal Blood* and *Microscopic Images of Human Blood*.
- Access the Virtual Microscope interactive (See the **Online Resource Guide** for a link to this resource.). From there, copy the link for viewing **blood** and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson.
- If you plan to purchase microscopes for your classroom, they need to be light microscopes that provide enough detail for students to see the cells that make up the parts of the body. Consider purchasing one of the following:
  - *standard light microscopes for your class,*
  - *digital light microscopes that can be used with students' computers, or*
  - *a single digital light microscope that can be connected to your computer so that you can project different samples for sense-making as a whole class.*

If you don't have access to any microscopes, skip the microscope orientation activities in steps 2, 3, and 4. You may want to make a copy of the "What we can see at microscopic scale" poster in **step 4** to reference the various magnification powers of the microscope. In **step 5**, have students use *Microscopic Images of Animal Blood* and *Microscopic Images of Human Blood* to make their observations.

On *Microscopic Images of Animal Blood, Microscopic Images of Human Blood,* and in future lessons where microscopic images are provided, images are labeled as "low," "medium," or "high" magnification. The low magnification was photographed using the 4x objective, medium magnification using the 10x objective, and high magnification using the 40x objective, but the total magnification varies depending on how large the images are printed or projected. For the majority of the images printed in this unit, the magnification from the camera-plus-computer setup is about 30x. So, "low" total magnification is about 120x, "medium" is about 300x, and "high" is about 1200x. Print out enough color copies of *Microscopic Images of Animal Blood* for each small group OR use the color images in the Student Edition. Students will be recording their data in their notebooks, so color copies can be reused between classes.

Also, the images taken with the microscope camera are rectangular because the camera's sensor is rectangular and does not capture the microscope's entire field of view (see the image above). If you worry that your students will be overwhelmed with the task of drawing everything they see in these rectangular images, you may choose to have them draw circles of the same size (tracing a cup or lid would work well) on each image to help them concentrate on a subset of the data.



Each lab group will need a 2 cm × 4 cm piece of millimeter graph paper to fit under the slide clips on the microscope stage. Print *mm Graph Paper* or use pre-printed millimeter graph paper.

The lesson is written to use microscope images for looking at non-human mammal blood, but you may choose to have students investigate (non-human) mammal blood using a microscope and slides. If you choose to do the alternate activity, you may wish to use one or more examples of non-human mammal blood. If you have multiple types, each group only needs to observe two slides (human blood and one other mammal). When groups are paired up to share their observations, ensure that they are paired with a group that observed a different type of blood so that they can compare observations.

Be sure you have materials (e.g., blank piece of paper, sticky note, or note card) to add the following word to the Word Wall: **focus.** Do not post this word until your class has developed a shared understanding of its meaning.

**Day 1: Investigating Microscopes**

- **Group size:** Divide your class by the number of microscopes available.
- **Setup:** Be sure all microscopes have access to an outlet (or other power source) for their light.
- **Notes for during the lab:** Students should plug in and/or turn on the microscope. Have students sanitize microscopes between turns.
- **Safety:** There are no safety concerns.
- **Disposal:** Keep all materials for future use.
- **Storage:** Unplug and/or turn off and cover microscopes when not in use to avoid dust.

**Day 2: Investigate Blood with a Microscope**

- **Group size:** Divide your class by the number of microscopes available.
- **Setup:** Plan how students will access *Microscopic Images of Animal Blood* for the animal blood images (in the Student Edition and/or printed separately in color). Be sure all microscopes have access to an outlet (or other power source for their light). Or, if you are using *Microscopic Images of Human Blood,* plan how students will access those images (in the Student Edition and/or printed separately in color). If you are using the Virtual Microscope interactive, share the link for blood found on Interactive website.
- **Notes for during the lab:** Be sure that students sanitize microscopes between turns.
- **Safety:** Glass slides are fragile. Have ready an appropriate receptacle to dispose of broken glass, as well as a broom and dustpan specifically reserved for cleaning up broken glass. Remind students to handle the slides carefully and ask you for help if one happens to break.
- **Disposal:** Keep all materials for future use.
- **Storage:** Keep slides in their case. Unplug or turn off and cover microscopes when not in use to avoid dust.

## Lesson 4 • Where We Are Going and NOT Going

### Where We Are Going

Students have investigated phenomena that involve different scales. For example, in *Unit 6.4: What causes Earth's surface to change? (Everest Unit)*, students identified patterns in regional and global earthquake data at different spatial (zooming in/out) and temporal (short and longer time periods) scales. In this lesson, students investigate phenomena using a microscope and quantitative scale (magnification).

Previously, in sixth grade, students used "zoom-ins" to consider what they cannot see, such as considering differences in particle movement at different temperatures. In this lesson, rather than only modeling non-visible parts and processes, students will use a tool (a microscope) to actually see things at the microscopic scale. If your students already have experience using microscopes, make sure you discuss or revisit the idea of microscopic scale when considering how microscopes can help us investigate blood in step 5.

This lesson references students' prior knowledge from *Unit 6.1: Why do we sometimes see different things when looking at the same object? (One-way Mirror Unit)*: lenses refract light and change what we can see. If your class did not read *How do eyeglasses help people see better?* as home learning in Lesson 6 of that unit, you might want them to read it as home learning between days 1 and 2 of this lesson.

If you're using *Microscopic Images of Human Blood* instead of microscopes, note that the magnification levels are labeled as "low," "medium," or "high" magnification. The low magnification was photographed using the 4x objective, medium magnification used the 10x objective, and high magnification used the 40x objective, but the total magnification will vary, depending on how large the images are printed or projected. The same labels are used for all images provided in this unit. For the majority of the images printed in this unit, the magnification from the camera-plus-computer setup is about 30x. So, "low" total magnification is about 120x, "medium" is about 300x, and "high" is about 1200x.

**Where We Are NOT Going**

In this lesson, we will only be naming specific cell types (red and white blood cells) as names for components found in the blood, rather than coming to consensus about what it means for something to be a cell. In Lesson 5, students will observe and identify nerve cells, and then in Lesson 6 they will observe cells in bone, muscle, and skin samples. By the end of Lesson 6, students would have seen enough examples of cells to add that general term to our Word Wall and define them as "microscopic structures that make up different parts of our bodies."

In this lesson, we continue to build on our understanding of how structure refers to the shape and features that contribute to an object's function. Through additional examples in this lesson and the next two, we will continue to develop our understanding of structure, as it relates to the crosscutting concept.

In this lesson, we will be figuring out what the blood does for an uninjured body. Although this lesson mentions the role of platelets and plasma, how these components are involved in healing will be investigated in Lesson 12.

The reading about blood includes mention that white blood cells aid the body in responding to disease and infection. However, the immune system itself is beyond the grade band of this unit. Therefore, the reading does not go into detail about the white blood cells' role in immune or inflammatory responses.

On day 1, students figure out how to use microscopes and how much the different objectives magnify what they can see. Students will discover for themselves the different parts of the microscope, some of which the teacher will provide names for (but not all). A labeled diagram of a microscope was intentionally left out of this lesson to allow students to explore how the parts work themselves, rather than spending time memorizing specific vocabulary.

# LEARNING PLAN FOR LESSON 4

## 1. Consider where blood is in our bodies.

8 MIN

**Materials:** Our Body as a System poster

**Navigate into today's work.** Display **slide A.** Say, *Last time we were together, we looked at MRIs and diagrams and found there were blood vessels in the muscles, skin, and bones. Where else do you think blood is in the body? In your finger, in your nose, in your hair? What experiences have you had that make you think blood is in those locations?*

Sample student responses include:

- *I think there's blood throughout the body.*
- *I got a paper cut and my finger bled.*
- *Once I got a nosebleed, so blood must have come from somewhere inside my head.*
- *There isn't blood in my hair. When I got my hair cut, my hair didn't bleed.*

### Alternate Activity

The upcoming **slide B** shows a front view and a side view of the blood vessels preserved from a human body for a museum exhibit. If you are concerned that your students will be distracted by the frontal view of the male body, **slide B—Alternate** is provided with only the side view.

**Discuss an image of blood vessels.** Display **slide B,** which shows two photos of the same museum exhibit of blood vessels in a human body. Use the following prompts to conduct a brief discussion.

| Suggested prompt | Sample student responses |
|---|---|
| *These images on the slide came from a museum exhibit about the different parts in the human body. These two images show where blood vessels are found in a human body. What do you notice and wonder?* | *They go all over! We can see the whole outline or shape of the body with just the blood vessels!*<br>*There are so many so close together around the chest area (lungs) and stomach. Why would we need more there?*<br>*It's darker red around the head and fingertips. Are there more blood vessels there? Why?*<br>*Some are bigger/thicker, while some are smaller/narrower. Why is that?* |

Point to the images on the *Our Body as a System* poster and say, *So, like the skin, muscle, and bone systems, blood vessels are found throughout the body. Last time we were wondering about blood, what it actually does in the body, and whether it plays a role in healing.*

*** Attending to Equity**
**Universal Design for Learning:**

To support all students' *perception* of microscopic images in this lesson and throughout the rest of the unit, you might adapt the tools your class is using in a few ways. Students with low vision may be able to see microscopic images on a screen instead of through the eyepiece, so having a USB-connected digital light microscope available might be helpful. Students who are blind should be provided with models or raised-line images so they can participate in the exploration of graph paper and the investigation of blood.

**Observe and discuss blood samples in test tubes.** Ask, *Has anyone ever had a blood test where a doctor takes a sample of blood in a test tube? Let's look at an image of two test tubes of blood and see if we can figure out more about blood.* Display **slide C.** Say, *The sample on the left was just taken from a patient, and the sample on the right was taken from the same patient a few hours earlier. The tube has been standing still since then. What do you notice?*

Ask students to turn and talk with a partner and use prompts such as the following to discuss ideas with the class.

| Suggested prompts | Sample student responses |
|---|---|
| *What do you notice about these blood samples?* | *The "fresh" one is all one color, but the "older" one is two different colors.*<br>*The blood doesn't look as red as I expected.*<br>*The "standing" one has a yellowy-orange layer and a layer that looks maybe even darker than the "new" one. Does it have bubbles around the top?*<br>*The one on the right looks a little bit like salad dressing that my family eats—the vinegar and oil separate and you have to shake it really well to mix it up again before you put it on your salad. (Optional slide D is provided if it's helpful to look at an image of vinegar-and-oil salad dressing.)* |
| *Why do you think the test tube that has been sitting for a while has two different layers?* | *Maybe there are different types of things in the blood and some are heavier or denser than the others.*<br>*The yellowish stuff is lighter (less dense) and the darker red stuff is heavier (more dense) because it sunk to the bottom.* |
| *What do you think these observations tell us about what blood is made of?* | *There are different things or substances in the blood.*<br>*It seems like blood is a mixture—not all the same stuff throughout.* |

**Propose using microscopes to observe blood samples.** Display **slide E**. Say something like, *So we are thinking that blood is a mixture, but what is it a mixture of? How could we figure out what's in the blood?*

Sample student responses:

- *We could look closer at the blood to see if we can see what it is made of.*
- *We could use a microscope (and possibly a hand lens).*

## Additional Guidance

If your students suggest using a hand lens to look at the blood up close, have them use hand lenses along with the microscopes when they're looking at the graph paper and the blood samples on slides. Compare the magnification

level of the hand lens to that of the microscopes and ask students to record the observational data they make with the hand lens as well.

Say, *How could microscopes (and maybe hand lenses) help us figure out what the blood is made of?**

Sample student responses include:

- *We can use microscopes to see the blood up close.*
- *We can zoom in on/magnify the blood to be able to see what's in it.*
- *We can look at the different layers under the microscope.*

## Alternate Activity

If you do not have access to microscopes, you can use the provided images or interactives to investigate the blood. After asking how students could investigate what the blood is made of, say something like, *Did you know the word* microscope *is composed of two word roots from Greek that mean "small" and "see"? A microscope is a tool we can use to observe things at a much smaller scale than our eyes alone can see. I have some photos of blood that were taken using a microscope at different magnifications, and we can use them to observe what the blood looks like very close up to see if we can answer our question about what's in blood.*

Skip the microscope orientation activities in steps 2, 3, and 4, and proceed to step 5. You may want to make a copy of the "What we can see at microscopic scale" chart in **step 4** for a reference on the various magnification powers of the microscope.

Students can use *Microscopic Images of Animal Blood* to make their observations. You might point out to students that the images taken with the microscope camera are rectangular, rather than the round field of view they would see through the eyepiece. If you worry that your students will be overwhelmed with the task of drawing everything they see in these rectangular images, you may choose to have them draw circles of the same size (for instance, tracing a cup or lid) on each image to help them concentrate on just a subset of the data to record in their drawing.

Alternatively, you can access the Virtual Microscope interactive. From there, copy the link for viewing **blood** and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson.

## Alternate Activity

If your students are already familiar with microscopes, skip Steps 2-4. Be sure to have an explicit discussion of scale when you consider How Microscopes Could Help Investigate Blood at the beginning of Step 5.

## 2. Prepare to practice using microscopes.

10 MIN

**Materials:** science notebook

**Establish investigation questions for exploring microscopes.** Display **slide F.** Say, *We haven't used microscopes yet this year, and when you have a new tool, it's a good idea to practice and get familiar with it. What do we need to figure out about microscopes so we can use them to understand what's in the blood? Turn and talk with a neighbor, and then we'll share ideas with the whole class.*

Sample student responses include:

- *There are lots of dials and things on a microscope. What do they do and how do we use them?*
- *How does the microscope work to help us see objects close up?*
- *How close up will we be able to see things with the microscope? How "zoomed-in" can it get?*

Say, *OK. We will work today to figure out the answers to our questions about microscopes. We want to find out:*

1. *How do you use the different parts of the microscope?*
2. *How does the microscope work to help us see so closely?*
3. *How close up can we see things with the microscope?*

**Consider how the microscope lenses help us see objects close up.** Display **slide G**. Say, *Raise your hand to show us: How many of you remember using magnifying glasses (hand lenses) in earlier units? How many of you wear glasses, or know someone who does?* Those tools use lenses. We learned in the One-way Mirror Unit that lenses change the direction of or refract light, which changes how we see things. When you use a microscope, you're not just looking through a single lens. Microscopes have two lenses that refract light and help us see things many times closer than a hand lens or glasses.*

Ask, *While you're working with the microscopes today, be sure to turn or adjust the lenses using the metal edges so you don't get fingerprints on the lenses themselves. Why might it be helpful to keep fingerprints off the lenses?*

Sample student responses include:

- *When my glasses get dirty, I can't see as clearly through them. We don't want the microscope lenses to be dirty, or they'll be harder to see through.*
- *If we get fingerprints on the lenses, we'll be looking at fingerprints with the microscope instead of the blood (or anything else)!*

### Additional Guidance

You may wish to point out to students that not all microscopes look exactly like the image used on these slides. For instance, sometimes the eyepiece is rotated in the other direction, away from the arm.

**Calculate the total magnification for each objective.** Display **slide H.** Help students notice the magnification of each lens and how to calculate the total magnification, which accounts for the combined magnification of the eyepiece and objective lens. Note: If your class microscopes' objectives and/or eyepiece lenses are different than those mentioned here, be sure to modify this wording and the slide accordingly. Say, *When you get to work with your*

*** Attending to Equity**

Take this opportunity to remind students that we all perceive things in our environment. Some of us do it with our eyes, others with a combination of other senses, and many of our eyes are aided by corrective lenses to see clearly. If your students did not already read *How do eyeglasses help people see better?* during Lesson 6 of the *One-way Mirror Unit*, it is suggested as home learning between days 1 and 2 of this lesson.

As with all things pertaining to ability, it's important to remember to be sensitive with your language. When speaking about a visual impairment, keep your language neutral. Disability isn't good or bad.

*microscopes, you'll notice that you can rotate through to use each objective lens. The objective lenses are labeled with their magnification and a color. In addition, they're different sizes. The shortest one is labeled 4x (with a red ring around it), the medium one is 10x (with a yellow ring), and the longest objective is 40x (with a blue ring). We could also refer to our objectives as low (red), medium (yellow), and high (blue) magnification. Since you're also looking through the eyepiece lens, the magnification you're seeing is 10 times more than the objective's magnification alone.*

*To find the total magnification, multiply the eyepiece magnification times the magnification of the objective you're using. For example, when using the 4x objective, you're also looking through the 10x eyepiece, so the total magnification is 4 × 10 = 40x, meaning you can see objects 40 times closer than you could with your eyes alone.*

Ask, *What is the total magnification with the 10x objective lens?* (10 × 10 = 100x). *With the 40x objective?* (10 × 40 = 400x).

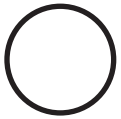
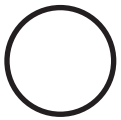
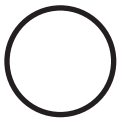
**Prepare a data table in science notebooks.** Display **slide I.** Say, *Let's record what you can see with each objective lens. I have millimeter graph paper for you to explore with today. Make a table like this in your science notebook to record how much of the graph paper you can see at each magnification. When looking through the microscope, your view will be a circle, so drawing circles for each row in your table can help you more accurately draw what you observe. In the "measurement" column, tell how many millimeters or squares you are able to see when you look through the lens at that magnification.*

## Additional Guidance

If your students haven't had much experience with graph paper, you might choose to show them a whole sheet and discuss how it would be used for drawing or graphing before handing out the smaller pieces to look at under the microscope.

As students fill in the total magnification column, remind them of the calculations they just did to arrive at those totals.

**Observations of mm graph paper with a microscope**

| Total Magnification | Drawing | Measurement in mm |
|---|---|---|
| 40x (red/low) |  | |
| 100x (yellow/medium) |  | |
| 400x (blue/high) |  | |

Say, *You may choose to write notes or draw in your notebook outside this table about other things you figure out about the microscope, especially if you think those ideas will be helpful in our discussion later or when we're using the microscopes to look at blood.*

Use prompts, such as those that follow, to review the idea that we are collecting scientific data when we record observations as drawings.

| Suggested prompts | Sample student responses |
|---|---|
| *How will the scientific drawings you make in your data table differ from drawings you might create as an artist?* | *We'll draw what we see and the way we see it—an artist might use their imagination to add things or change sizes or change how things are arranged.*<br>*We won't worry too much about colors or shading or things like that. We're not trying to have pretty drawings; we just need them to show what we observed.*<br>*Artists might not use words on their drawings, but if it's helpful to us to label parts of our drawings, we could.* |
| *Why would we call this a data table when it has drawings and not just numbers or words?* | *We're trying to figure out how a microscope helps us see close up and what looks different when we change the magnification. We use data as evidence to answer those questions.*<br>*When we record data using a tool like a microscope, our drawings are records of what we observe. We can use them to figure out what things look like up close.*<br>*Data is the information we collect when we're doing an investigation. The information we collect from the microscope might be difficult to describe with just words and numbers, so drawings will help.* |

**Introduce the idea of focus.** Display **slide J.** Say, *When you are looking through lenses, like the ones in a microscope, what you see might appear blurry or clear. Sometimes it might be so blurry you can't even tell that there's anything there to see! Obviously, we want to be able to see clearly. We use the word "focus" to describe how clear an object appears, or as a verb to describe steps you can take to make an image clearer. When an image is "in focus," you can see it clearly. If it's blurry, you can focus the microscope to make it more clear. Bringing an image into focus is often the trickiest part of using a microscope. When you get your microscope, take time to figure out and practice how to use the knobs to adjust the focus of your microscope so you can see clearly, in the sharpest detail.*

## 3. Practice using microscopes. 12 MIN

**Materials:** Investigating Microscopes, science notebook

**Give final directions before beginning the investigation.** Display **slide K.** Say, *Use the questions on the slide to help you investigate how microscopes work. I want to remind you to use this tool carefully—move it and its parts slowly and gently. If you try to focus too quickly, everything will keep looking blurry. You will need to be slow and intentional about finding a point when the graph paper is in focus—nice and clear.*

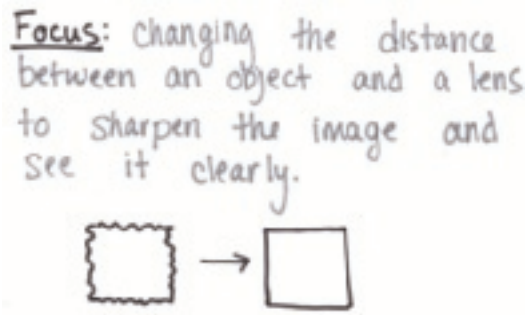
Distribute small pieces of millimeter graph paper. Direct students to work with their groups or partners to find the answers to the questions they raised earlier (posted on **slide K**).

1. How do you use the different parts of the microscope?
   a. Where do you put the graph paper to be able to see it with the microscope?
   b. Where and how do you look through the microscope?
   c. How do you focus the microscope to see clearly?
   d. Does the light help you see the paper differently?
2. How does the microscope work to help us see so closely?
   a. Where are the lenses?
   b. How do the lenses change what you can see?
   c. How do the lenses move while someone is focusing?
3. How close up can we see things with the microscope?
   a. How much of the graph paper can you see with each objective? Record your observations in your notebook.

**Give students about 10 minutes to explore the microscope.** Circulate and assist as needed, supporting students in their own figuring out, rather than telling them what to do. Asking the following questions might be helpful:

- *Where can light come in and out of the microscope?*
- *Which parts of the microscope can you move or adjust (slowly and gently)? How does that change what you can see?*
- *If you can't see anything in your eyepiece, how could you move around your mm graph paper so you could find part of it under the lens?*
- *What part of the microscope could help you hold the paper in place while you look at it?*

**Add "focus" to the Word Wall.** Say, *What did you figure out about focusing the microscope? What parts of the microscope moved while someone was focusing?* Discuss briefly with your students, making sure to note that as the focus knobs are turned, the distance between the objective and the object (paper) changes. You might write something like "changing the distance between an object and a lens to sharpen the image and see it clearly."



## 4. Building Understandings Discussion About Scale

15 MIN

**Materials:** science notebook, chart paper, markers

**Gather the class in a Scientists Circle with their science notebooks to discuss what they figured out.** Display **slide L**. Lead a Building Understandings Discussion about the scale at which we can see with the microscope. Record these ideas on chart paper for future reference (see the sample poster below the discussion prompts).

### Key Ideas

**Purpose of this discussion:** Students share what they figured out about using microscopes to help them see very close up, at a microscopic scale.

**Listen for these ideas:**

- *We can use the microscope to see things that we could not see with just our eyes alone (microscopic scale).*
- *We could see more detail at higher objectives.*
- *Using a higher objective lens decreases the field of view. (We could see less space.)*
- *We can use the knob(s) on the side(s) of the microscope to adjust the focus.*
- *We can adjust the amount of light entering the lens on the microscope to help see better.*

### Assessment Opportunity

**Building towards: 4.A.1** Collect data at different scales to answer scientific questions about the components found in blood.

**What to look for/listen for:** See the key ideas listed on the previous page.

**What to do:** Take note of any students who seem confused or unsure about how to use the microscope, and be sure to check in with them first during the Investigate Blood with a Microscope lab on day 2. Also take note of any students who struggled to draw or describe specific differences they could see with the microscope versus without it or using different objectives. These students may need more practice and support with focusing the microscope before or during the lab on day 2. Consider rearranging groups who share microscopes for the lab on day 2 if you can pair more confident microscope users with those who are less confident.

| Suggested prompt | Sample student response |
|---|---|
| *What did you notice about what you could (or couldn't) see with and without the microscope?* | *(Accept all responses.)* |

| Suggested prompts | Sample student responses |
|---|---|
| *How did changing the objectives change what you could see? Why?* | *The higher the objective's number, the closer we were zoomed in.*<br>*We know the total magnification changes with the different objective lenses. We could see much more detail at the higher numbers.* |
| *When you were looking at that millimeter graph paper at each of those magnifications, how much of it could you see?* | *At 40x/low magnification, we could see about 4 or 5 mm.*<br>*At 100x/medium magnification, we could see only 1 or 2 mm.*<br>*At 400x/high magnification, we could see less than ½ mm.* |
| *The amount of space you can see at one time is called your "field of view." How does the field of view change at different magnifications?* | *At higher magnifications, there's a smaller field of view—we can see less space but in more detail.*<br>*At lower magnifications, there's a larger field of view—we can see more space but in less detail.* |

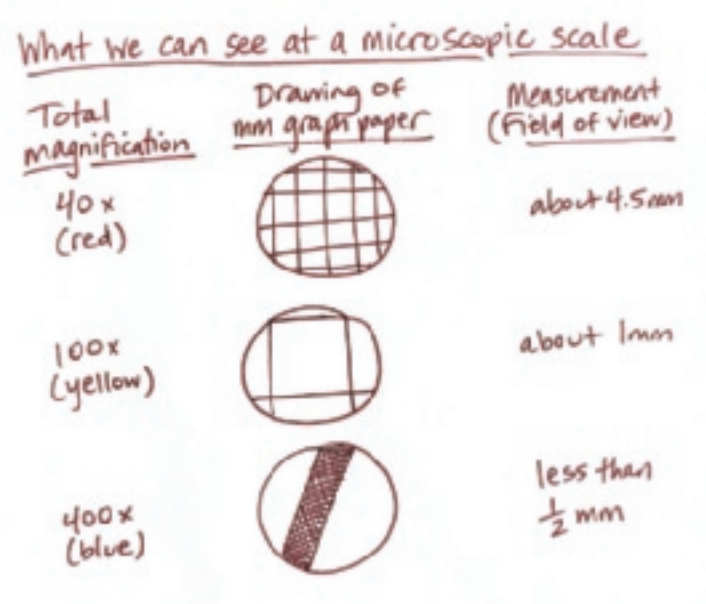
Summarize this discussion by saying something like, *We can use this information to help us understand the scale of what we're seeing when we're looking at blood (or anything else) with the microscope.*

See sample poster on the right.

Ask, *What else did you figure out about using the microscopes that we'll want to keep in mind while we're observing blood (or other things)?*

Sample student responses might include:

- *The knob(s) on the side(s) of the microscope adjust the focus—they raise and lower the place you're looking at.* (Teacher may choose to name the stage.)
- *You could see better by adjusting the light on the microscope. There is a dial you can turn to make the light brighter or dimmer.*
- *You really do have to move slowly, or even back and forth a little bit, to find the clearest view.*



## Supporting Students in Making Connections in ELA

Some students might confuse "microscope" with "telescope." If you have a moment, ask students to try to infer what the "tele" in "telescope" means based on what they know about what microscopes and telescopes do (from Greek: "tele" means "far" or "at a distance"). You might also ask students to list other words that use "micro" and consider what part of their meaning is "small."

**Conclude today's work.** Display **slide M.** Say something like, *Today we explored with the microscope because we were thinking using this tool might help us figure out more about what is in the blood. How could using the microscope help us figure out more about what is in the blood?*

Sample student responses:

- *We can see really close up what is in the blood.*
- *Since the blood is found in all the different parts of the foot that was injured, maybe we can see what is in the blood so we can figure out what it does in each of these parts.*

Say, *Let's plan to use this tool to look closely at some samples of blood next class and see what we can find out.*

## Home Learning Opportunity

If your class did not read *How do eyeglasses help people see better?* from Lesson 6 of the *One-way Mirror Unit,* you might want them to read it as home learning now.



**End of day 1**

## 5. Prepare to investigate blood with a microscope.

10 MIN

**Materials:** science notebook

**Navigate into today's work considering the blood samples we'll use.** Display **slide N**. Say, *Now that we know how to use microscopes, we're ready to use them to investigate blood samples. I'm sure some of you have had blood taken for tests before, but we can't do that here in our classroom. So we will use samples of human blood that have already been preserved and prepared for us on slides. You'll notice that the slides are made of glass and a very thin smear of blood is on the slide under a clear glass cover slip. The smear was made from freshly drawn blood.*

*** Attending to Equity**

**Universal Design for Learning:** In order to support students who might benefit from other options for *representation,* you may choose to print *Microscopic Images of Animal Blood* and direct them to annotate those images with ideas about how they compare to what students see in their microscopes and/or ideas about the patterns they notice in the structures they see across the samples.

Use prompts such as the following to navigate into looking at human blood samples and other animal blood samples.

| Suggested prompts | Sample student responses |
|---|---|
| *Someone remind us: Why do we want to look close up at a sample of blood under the microscope?* | *We saw there were blood vessels all over the body, so the blood must be important.*<br>*Yeah, and we saw the injured foot had dried blood on it, so maybe there is something about the blood that helps the foot heal.*<br>*We wondered why there were blood vessels everywhere in our body, and we wanted to see what is in our blood and if anything in it helps things heal.* |
| *Besides humans, do you think any other living things also have blood? What evidence can you share to support your ideas?* | *Yes! I think all living animals have blood.*<br>*When my dog got a cut on his paw, it bled.*<br>*I've seen footage of an injured animal being cared for. There was blood.*<br>*When I go fishing with my uncle, we bleed the fish when we're cutting the fillets to cook them.* |
| *I also have some images that were taken of slides that have been prepared with blood from another animal. How could looking at an animal's blood along with human blood help us figure out more about what blood is made of?* | *We can compare the animal blood to human blood and see if they're the same or different.*<br>*If we find the same things in animal and human blood, then it's probably important.* |

Display **slide O** and briefly discuss how the images of non-human, animal blood were taken with a digital camera connected to a microscope and a computer. For the images students are using in this lesson, the camera-plus-computer setup provides about 30x magnification. See the "Materials Preparation" section of this lesson for more details.

Say, *To figure out what is in animal blood we will be using some images of animal blood taken from a microscope slide. When the camera and computer take those images, the computer enlarges them and the camera magnifies by about 30x. This might cause us to see some differences between what we see when using the microscopes and what we see in the images.*

## Alternate Activity

If you have access to high-quality animal blood slides, you can extend the microscope activity to include those slides. To keep the discussion on track, it is important to use enucleated mammalian cells (those without a nucleus) that have their rounded edges preserved. The blood cells of some other animals like frogs and birds still have the nucleus present. Depending on the stain used, the edges of the red blood cells can appear polygonal instead of rounded, which may alter the structure and function conversation later. If your slides show red blood cells with straight edges, have an explicit discussion with your students about the possibility of stains affecting the shape of cells after reading *Reading: What Is Blood?*. The reading indicates that blood cells have rounded shapes.

**Plan how to record observations.*** Say, *Okay, so when we are using the microscopes to observe human blood samples and when we are using images to observe animal blood, we want to collect data about what we see. We are trying to answer our question about what is in the blood. What kinds of information should we take note of so we can use this data—our observations—to figure out what's in the blood? How should we record this data?*

Sample student responses include:

- *We'll want to record what we see through the microscope—like everything we can see in the field of view.*
- *We can sketch or draw what we see, but we might need to use some words to explain details or things that are hard to draw.*
- *We'll need to write down what magnification we're using so we know how closely we were zoomed in.*

Summarize by saying something like, *Okay, so we want to draw what we can see because that will help us communicate about the sizes and shapes of what we're seeing. In addition, we may need to use some words and numbers to describe what we are seeing in our sketches.*

**Prepare data tables in science notebooks.** Display **slide P**. Direct students to create a data table like the first table on the next page (also shown on **slide P**) on a whole page in their science notebooks to record their observations of human blood under the microscope. They should be sure to have enough room in each row to draw a circle for the field of view of what they will see. If your class microscope's objectives and/or eyepiece lenses are different magnifications than those listed below, be sure to modify the total magnifications accordingly.

Display **slide Q**. Say, *If the microscope camera magnifies the image by 30x, what is the total magnification for each animal sample if they were taken with the same objectives (4x, 10x, 40x)?* Have students calculate the total magnification for each animal sample. Students should respond that the animal images are viewed at 120x, 300x, and 1200x. Then, have them create a second table on the next whole page in their science notebooks to record their observations of the images of animal blood, including these updated magnification amounts. See the second table (also shown on **slide Q**) on the next page for an example.

| Blood sample from: Human | |
|---|---|
| **Total magnification** | **Observations** |
| None (just looking at the slide with eyes) | |
| 40x (red/low) | |
| 100x (yellow/ medium) | |
| 400x (blue/high) | |

| Blood sample from: Animal | |
|---|---|
| **Total magnification** | **Observations** |
| None (just looking at the slide with eyes) | |
| 120 x (low) | |
| 300 x (medium) | |
| 1200 x (high) | |

## Alternate Activity

If no microscopes are available, images of human blood at low, medium, and high magnifications are also provided in *Microscopic Images of Human Blood*. Students can observe these images and record their observations in their notebooks (with magnifications noted in their data tables accordingly).

You might point out to students that the images taken with the microscope camera are rectangular, rather than the round field of view they would see through the eyepiece themselves. If you worry that your students will be overwhelmed with the task of drawing everything they see in these rectangular images, you may choose to have them draw circles of the same size (tracing a cup or lid would work well) on each image to help them concentrate on just a subset of the data to record in their drawing.

You can also access the Virtual Microscope interactive. From there, copy the link for viewing **blood** and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson. Students can observe these images and record their observations in their notebooks (with magnifications noted in their data tables accordingly).

Alternatively, you could print consumable copies of the *Procedures for Investigating Blood with a Microscope* and *Microscopic Images of Human Blood*, and direct students to annotate the images with their thoughts about patterns and scales. If you choose to have students annotate images, it will likely take less time than if students are recording observations in their notebooks.

## 6. Investigate blood with a microscope. 15 MIN

**Materials:** Investigate Blood with a Microscope, science notebook

**Give directions and reminders about using the microscope to view slides.** Say, *While half your group is using the microscopes to observe human blood, the other half will use the images to observe animal blood.* Display **slide R.** Review the following procedures for using the microscope and slides, which are also available in *Procedures for Investigating Blood with a Microscope*.

1. Slides are fragile, so handle them gently.
2. Hold slides by the edges.
3. Put the slide under the clips to hold it still.
4. Start at the lowest objective (40x, red/low).
5. Focus slowly! If you only see a blur of one color across your view, that's not what you're looking for.
6. Adjust the amount of light coming in through the slide to help you see better.
7. Draw what you see in the whole field of view in the corresponding section of your data table.
8. Be sure everyone in your group has a chance to see (and adjust the focus if needed).
9. Switch to the next highest objective (10x, yellow/medium) and repeat the process from step 5 (and then again for the highest objective (40x, blue/high)).

Hand out *Microscopic Images of Animal Blood*. When students are not using the microscopes, make sure they are analyzing the animal blood images in the same way that they analyzed the microscope field of view. Ensure that each student gets a turn with the microscope.

Say, *Remember we are using the microscope and microscopic images to see if we can find out what is in blood, or what blood is made up of. A good clue that you're seeing something significant is if you're noticing repeats. For example, if you're seeing patterns that occur at different magnifications, that's likely a significant observation. If you and your partner(s) are seeing similar patterns, that's likely something to take note of. It will also be interesting to notice if you see similar patterns (or not) between the human blood and animal blood.*

**Direct students to begin their observations.** Circulate among groups to support students as they work.

## Alternate Activity

If you have a classroom microscope whose view can be projected (rather than a class set of microscopes for students to use themselves), you may carry out this lab as a whole-class demonstration. You might invite different students to focus the microscope while everyone records what they see in their data tables. It is still important for students to draw their observations so they can compare patterns across magnifications and samples.

## Additional Guidance

Depending on the quality of the prepared slides, it is possible that students will see bubbles in their slides during this lesson and throughout the unit. Take a moment to identify bubbles if you notice they are confusing or distracting students' observations. Bubbles may be especially noticeable at high magnification, where they will look like small, colorless circles about the same size as platelets.



**Individually consider how what we can see changes at different scales.** Display **slide S.** After students have had time to observe and record data about both of their group's blood samples, have them complete this reflection to prepare to make sense of their observations. Direct students to write their response to this question in their notebooks: *What structures were evident that were not visible without the use of a microscope? Compare what you could (or couldn't) see with the microscope to what you could (or couldn't) see without it.*

## Assessment Opportunity

**Building towards: 4.A.2** Collect data at different scales to answer scientific questions about the components found in blood.

**What to look for**: When skimming what students have written in their notebooks, look for ideas such as:

- With the microscope, I could see different parts of the blood (circles, dots, blobs, different colors).
- With the microscope, I can tell that blood is a mixture because I can see the different components that make it up.
- Without the microscope, the slide just looks like pink glass.
- Without the microscope, blood looks like it's all the same throughout.

**What to do:**

- Take note of any students who are struggling to describe these differences in what they could see with the microscope versus without. Support those students in the Building Understandings Discussion in the next step. For instance, you might choose to have students talk with a partner before sharing their ideas, and make intentional decisions about pairing these students with others who have clearer understandings about what they observed. You might also ask these students to help scribe or draw what the class is describing during the discussion that follows. Those students should realize that blood (in humans and other animals) is composed of a mixture of things we cannot see without a microscope.

## 7. Share observations of blood.

20 MIN

**Materials:** science notebook, 1 sheet of blank 8.5x11 inch paper, markers, Our Body as a System poster

**Gather the class together to share their data with a partner.** Assign each student a partner to talk with who was not in their microscope group. Have students use the data they recorded in their notebooks to discuss each of the following questions with their partner.

### Additional Guidance

If you have a microscope that can be plugged into a computer, it may be helpful to project that while the class reports out what they found. This way, students can come up to the screen and point out what they found or are referring to in their explanations.

Display **slide T** and give student pairs about 2 minutes to compare their observations of human blood. What did they see that was the same and different? What patterns do they notice?

Display **slide U** and give student pairs about 2 minutes to compare their observations of another animal's blood. What is the same between the blood samples they observed? What's different? How does the animal blood compare to the human blood? What patterns do they notice?

Display **slide V** and give student pairs about 2 minutes to compare their observations about what they could see at different scales. How did changing objectives/magnifications change what they could see?

**Discuss the colors we observed.** Tell students that you're going to record the patterns they noticed in their observations to add to a "zoom in" on our *Our Body as a System* poster, and you're considering what colors (marker or digital pen) we should use to draw the structures we observed.

Ask, *What colors did you observe in the blood samples you investigated with the microscope?* Accept all responses.

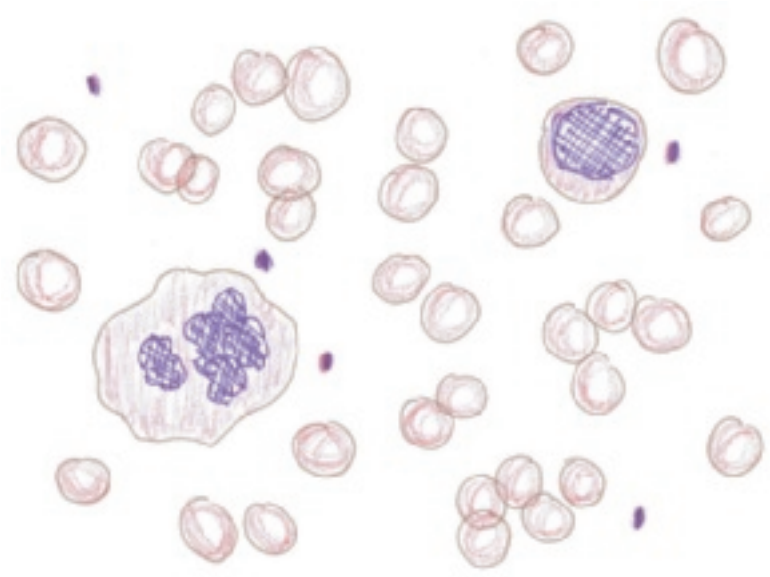
Ask, *Based on the samples we looked at in the test tubes (image) or your own experiences with blood, what colors did you expect to see?* Sample student responses likely include shades of red and yellow.

Say, *The colors we see on most slides are different from the original actual colors of those samples because they have been stained. The stain is added when the slide is being prepared, so we can see the structures in the sample more clearly. Different stains are used for different types of samples to help us see structures of the components in the blood.*

**Share observation patterns with the whole class.** Display **slide W.** Use prompts such as those shown below to invite students to share the patterns they noticed with the whole class. Add a row to keep track of students' ideas about blood. Create a column on the far-right side of the *Our Body as a System* poster and label it "What this part looks like close up." Record students' ideas in drawings (possibly with words) on a piece of 8.5x11 inch paper and attach it to the *Our Body as a System* poster as a "zoom in" on the blood. Note that we are not naming these structures yet; students will read about that on day 3, and you can add labels to these notes after that.

| Suggested prompts | Sample student responses |
|---|---|
| *What patterns did you and your partner find in your observational data?* | *We saw little pink circles—many look paler pink or maybe open in the center.*<br>*We saw some bigger circles with dark purple blotches or spots in them.*<br>*Blood from these animals looked similar to the blood from humans.*<br>*When we zoomed in really close, we could see some solid pinkish-purple dots that were smaller than the other circles.*<br>*We saw some whitish-gray perfectly round circles. Maybe those were bubbles?* |
| *What can we conclude about blood based on these patterns in your observations?* | *It's a mixture—I saw different things in the same blood sample.*<br>*What's on the slide is all blood, but it's made of different parts or components.* |
| *How similar or different was the blood on the slide, just looking at it with your eyes compared to when you saw it at the microscopic scale?* | *We could see way more details in the blood with the microscope.*<br>*With eyes alone, the slide just looks like it's pink glass.*<br>*At lower objective(s), we could see that there were mostly tiny pink dots, some purple dots, and some space in between.*<br>*At higher objective(s), we could see that the pink dots looked like rings with a darker pink edge. And the larger circles have a pink edge around them with dark purple blobs inside them.*<br>*We couldn't see the tiny solid purple specs until we were zoomed into a really high magnification.* |
| *Let's make some predictions: Why do you think the blood and the components found in the blood are structured in this way?* | *Maybe the circle shape helps them fit in the blood vessel tubes.*<br>*Maybe like all the ingredients in salad dressing make it taste better than just one by itself, all the different parts of the blood do something for it more than just one by itself could.* |

See the sample drawing shown here, based on human blood at high magnification.



**Close today's work by looking forward to next time.** Say something like, *Your observations at the microscopic scale answered some of our questions about what makes up blood. We saw the smaller structures that make up that mixture. But we didn't yet get to answer our questions about what those parts do for the body or answer our new questions about what these structures are. That will be our focus next time.*

**End of day 2**

## 8. Read about blood.

**14 MIN**

**Materials:** *Guidance for Reading about Blood, Reading: What Is Blood?*

**Navigate into today's work.** Display **slide X.** Ask, *What were some of the patterns we noticed when we looked at blood at a different scale than our eyes can see alone?* Sample student responses include:

- *Human blood and blood from other animals are similar.*
- *Blood is a mixture of tiny little circles.*
- *Most of the circles are pink (darker around the edges), but some had pale pink edges and dark purple blobs inside, and some were super tiny and solid purple.*

Say something like, *Thanks for that summary of the data we collected about blood. We saw those components that the blood is made of, but we are still wondering what blood—and all those separate parts—do for the body. What are their functions, and how might the way they are structured help with their functions? Why is it so important that the blood goes everywhere? What does this have to do with healing? So, I have an article for you to read today.*

**Plan to read closely.** Display **slide Y.** Distribute *Guidance for Reading about Blood* for students to complete during and after their reading. Say, *Remember as you read this article to keep our questions in mind: What are all those parts of the mixture doing for the body? Why is blood so important that it goes everywhere? Underline or highlight key ideas in the text that help you answer these questions about the components of the blood and their functions. Also jot down any questions that come up during your reading. If we don't get them answered today, we can add them to our Driving Question Board.*

**Give students time to read independently.** Direct students to *What Is Blood?* in their Student Edition book. Display **slide Y** while students read and complete the handout for 10-12 minutes. You may choose to collect *Guidance for Reading about Blood* as an assessment.



### Assessment Opportunity

**Building towards: 4.B** Critically read scientific text to make sense of patterns within structures we observed in the blood related to their function in the body.

**What to look for:** On the last question of *Guidance for Reading about Blood,* look for students to respond with any one of the following examples of how structure and function are related in the blood:

- The blood plasma is a liquid that flows easily through the blood vessels to move blood cells, nutrients, and so on around the whole body (or throughout the circulatory system).
- Red and white blood cells have round shapes. Red blood cells are shaped like a donut without a hole, while white blood cells are shaped more like spheres. Their round shapes allow them to move through blood vessels without getting caught or stuck.
- Red blood cells have a flat, flexible shape that lets them bend so they can fit in small blood vessels.
- Platelets have arms that help them create plugs to prevent blood from leaking out of damaged blood vessels. They do so by sticking to one another and to the sides of a damaged blood vessel.

**What to do:** If students struggle to answer this question on the handout, first make sure they know the terms "structure" and "function." You may want to rephrase the question to ask, "What is one way the shape of a blood cell helps it do its job?" You may also want to offer a sentence frame using a specific structure of the blood, such as "The function or job of the platelets is to _____. Their structure or shape helps them do this because _____." Refer students to the images in the reading as well. They may be more comfortable making inferences about the structure/function relationship of the blood parts based on images rather than what they read in the text. Finally, it may help students to consider, "What if the opposite were true?" For example, "What if the blood plasma was really thick and sticky? How would that make it hard to do its job?" or "What if the blood cells were square-shaped? Would they be able to do their job well?"

## 9. Building Understandings Discussion About Blood

14 MIN

**Materials:** *Guidance for Reading about Blood, Reading: What Is Blood?* science notebook, Our Body as a System poster including the blood cells drawing from step 7, markers, image of blood system from *Blood System Image*

**Lead a Building Understandings Discussion.** Display **slide Z.** Gather the class together in a Scientists Circle with their articles, handouts, and science notebooks. Use prompts such as those that follow to discuss the structures and functions of the blood. Update the *Our Body as a System* poster during and/or after this discussion to summarize these ideas.

## Key Ideas

**Purpose of this discussion:** Students share what they figured out from the reading about the functions of blood and its components, and connect these ideas to their observational data from last time. They make sense of the patterns they saw and consider how the structures of the blood and its components support their functions.

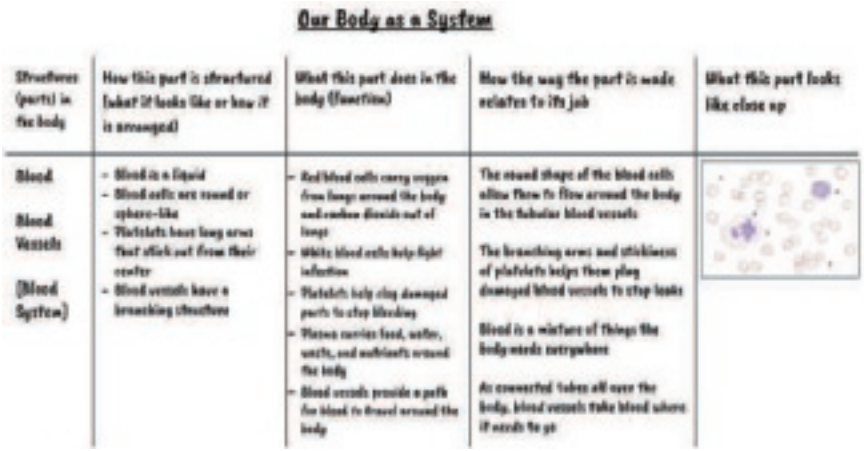
**Listen for these ideas:**

- Blood (in humans and other animals) is made of
  - Red blood cells—carry oxygen to the body parts
  - White blood cells—help respond to disease and infection
  - Platelets—clot blood so it doesn't leak out of injuries
  - Blood plasma—brings water, food particles, vitamins, and electrolytes to the body parts and carries waste away
- Blood cells' structure relates to their function: their round shape helps them travel easily through the tubular blood vessels.
- Platelets' structure relates to their function: their arms and stickiness help them plug damaged parts of the blood vessels to stop leaks.
- Blood's function as a whole is to travel around carrying many different things the body needs, so its structure (flowy liquid mixture) allows it to do that.
- Blood vessels contain the blood and allow it to travel throughout the body to do its various functions.

*** Attending to Equity**

**Universal Design for Learning:** Students are likely familiar with the word **nutrients** from previous health and science classes. Support *representation* by accessing students' prior knowledge by asking, *What do we mean when we say nutrients? Have you seen or used that terminology before?* Leverage these prior understandings and ask students to relate them to what was in the reading. Students may understand nutrients as things that are in "healthy" foods or the important parts of food that help them grow and thrive. *Reading: What Is Blood?* describes nutrients as **food particles, vitamins, and electrolytes**.

By the end of this discussion, the *Our Body as a System* poster might look like

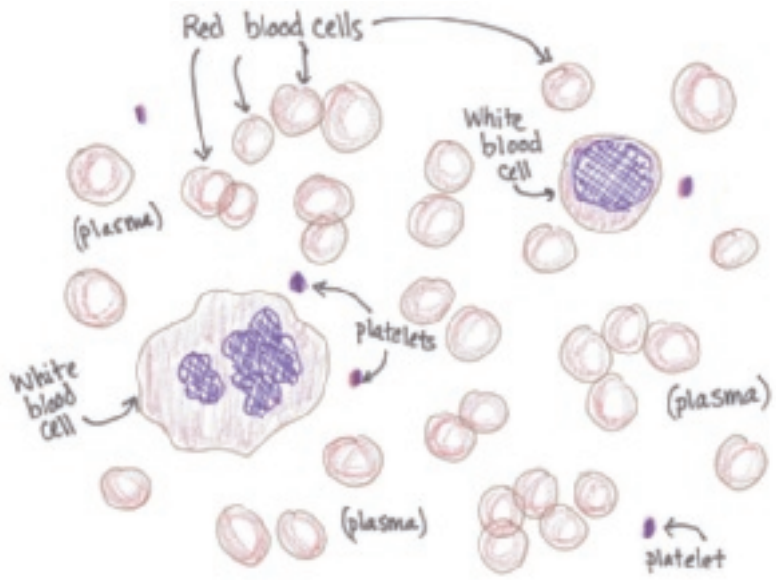



| Suggested prompts | Sample student responses |
|---|---|
| *When we observed blood at the microscopic scale, we noticed that blood is made up of different components. What did you figure out from the reading about these components?* | *All those different circles we saw are blood cells, and there are different kinds that do different things.*<br>*There are red blood cells and white blood cells and platelets.*<br>*Each of these parts of the blood has a different job.*<br>*The blood is a mixture of different things!* |
| *What did you find out about what these different parts do?* | *The red blood cells carry oxygen from the lungs to all the body parts. They carry carbon dioxide back to the lungs.*<br>*The white blood cells help your body fight infections.*<br>*The platelets help clog any damaged parts so the blood doesn't keep leaking out.*<br>*The blood plasma is the liquid that all those cells move around in—it's mostly water! The plasma also carries food particles, other nutrients, and waste around the body.**|
| *On our slides, could we see all of these parts?* | *We could see the red and white blood cells and the platelets.*<br>*I don't think we could see the plasma.*<br>*Maybe it is the stuff all around the cells.* |

| Suggested prompts | Sample student responses |
|---|---|
| *Thinking about the shape or the structure of the different blood cells, how do you think these shapes help them function?* | *They're all circular or round (even though they're different sizes). That shape probably helps them flow easily through the blood vessels, which are round tubes.* |
| *So how does the structure of the blood itself relate to its function?* | *The blood has to be able to move around the whole body in little tubes, so it makes sense that it's a liquid that can flow around.*<br>*It's a mixture of different parts or components that each have a different purpose or function for the body.* |

**Label the parts of the blood on our drawings.** Display **slide AA.** After naming the parts of the blood on the slide image, take a moment to label the red and white blood cells, platelets, and plasma in the drawing you made in step 7 (which is now attached to your *Our Body as a System* poster). Direct students to annotate one of the drawings they made of their observations in their science notebooks, as well. Be sure to include the components in the blood plasma (i.e., water, food particles, vitamins, electrolytes), even though they are too small to see.

See example annotated drawing here.



## Additional Guidance

If students in your class have raised the idea of cells already in this unit, they may have more questions now about what cells are and where they are found since reading about white blood cells and red blood cells. Take time during this lesson to add those questions to the Driving Question Board.

Students will observe different cells in the next two lessons, and the class will have enough evidence to define cells generally at the end of Lesson 6.

## Supporting Students in Making Connections in Math

You may choose to take time to explore the mathematics of ratios of blood cells, given the percentages of each type in the reading. If those percentages are true for the samples we have on our slides, and we can see X white blood cells in the field of view, how many red blood cells might we estimate are in that same field of view? If the total volume of a blood sample is 10 mL, how much of that sample would we expect to be blood plasma?

This math extension would support CCSS.MATH.CONTENT.6.RP.A.1: *Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities* and/or CCSS.MATH.CONTENT.6.RP.A.3.C: *Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.*

## Alternate Activity

The upcoming **slide AA** shows a front view and a side view of the blood vessels preserved from a human body for a museum exhibit. If you are concerned that your students will be distracted by the frontal view of the male body, **slide BB—Alternate** is provided with only the side view.

**Discuss the function of blood vessels and blood as a system.** Display **slide BB**, and update the *Our Body as a System* poster during and/or after this discussion to summarize these ideas about blood vessels and the blood system.

Say, *We've been looking at blood on a microscopic scale, and we figured out what blood is doing in our bodies. Let's take a step back to a bigger scale, like we did at the beginning of this lesson with the museum exhibit.*

| Suggested prompts | Sample student responses |
|---|---|
| *Where in our body is blood found based on what you can see on the slide and what you read in the article?* | *It looks like it is found everywhere in our body!*<br>*Blood is in all the tubes or blood vessels throughout the body.* |
| *What role do the blood vessels play in the body?* | *The blood vessels are tubes that are like a highway that allow the blood to move all around the body.* |

| Suggested prompts | Sample student responses |
|---|---|
| *How do blood and blood vessels work together in the body so that blood can serve its purpose?* | *Blood, the liquid, needs to get all around the body to provide it with nutrients, water, and oxygen, so the blood vessels provide blood a path to get to places all over the body.* |
| *If the blood vessels were injured and not able to function, how would that affect the blood's ability to do its job?* | *If the blood vessels break open, then the blood can leak out and not get to the different parts of the body that need it.* |
| *As we think about the parts, or structures, found in the blood and the blood vessels that we see all over our body, could we think of this as a system, like the blood system?* | *Yes! The blood and the blood vessels would be different parts or components of the blood system in our body!* |
| *How might thinking about blood and blood vessels in terms of a system help us figure out things about how our body heals?* | *We could see how the system works throughout the body; like maybe some of the things we need for healing are carried by the blood.*<br>*Maybe just looking at one system can help us narrow down what we need to know.* |

Add the blood system image from *Blood System Image* to the *Our Body as a System* poster. Say, *OK, it seems like thinking about the blood system as a whole might help us figure out how healing works in our bodies. It's probably important that we keep track of what we've observed at different scales—like the whole body and the microscopic scales. I have this image of the blood system that we can add to our* Our Body as a System *poster, so we can remember that blood vessels are found all throughout the body AND what the components of blood look like on a microscopic scale.*

See example of the updates to the *Our Body as a System* poster here.



**Our Body as a System**

| Structures (parts) in the body | How this part is structured (what it looks like or how it is arranged) | What this part does in the body (function) | How the way the part is made relates to its job | What this part looks like close up |
|---|---|---|---|---|
| Blood<br><br>Blood Vessels<br><br>[Blood System] | - Blood is a liquid<br>- Blood cells are round or sphere-like<br>- Platelets have long arms that stick out from their center<br>- Blood vessels have a branching structure | - Red blood cells carry oxygen from lungs around the body and carbon dioxide out of lungs<br>- White blood cells help fight infection<br>- Platelets help clog damaged parts to stop bleeding<br>- Plasma carries food, water, waste, and nutrients around the body<br>- Blood vessels provide a path for blood to travel around the body | The round shape of the blood cells allow them to flow around the body in the tubular blood vessels<br><br>The branching arms and stickiness of platelets helps them plug damaged blood vessels to stop leaks<br><br>Blood is a mixture of things the body needs everywhere<br><br>As connected tubes all over the body, blood vessels take blood where it needs to go | |

## Additional Guidance

Your students may want to use the term "circulatory system" instead of "blood system" at this point in time. We are being intentional in this unit about incrementally building our understanding of the body, and our goal is **not** to create a traditional "human body systems" diagram. We want students to think in terms of systems, and thus far, we have not had any conversations about why this is traditionally called the "circulatory system." If your students insist on using this terminology instead, be sure to have a discussion about why scientists and medical professionals would use this terminology. Body systems and hierarchy will be addressed again in *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit).*

Refer to the Building Understandings Discussion in Lesson 2 about thinking of the body as a system if your students need additional support around systems thinking.

## 10. Update the Progress Tracker and revisit the DQB. 14 MIN

**Materials:** science notebook

**Update Progress Trackers in science notebooks.** Display **slide CC**. Direct students to the Progress Tracker section of their notebooks (landscape orientation) and have them add rows for what we've figured out about blood. Remind students that this tracker is their space to process and record their thoughts while we're working to figure out how an

injury can heal. Give students 5-8 minutes to add to their Progress Trackers. See the sample student responses shown below.

| Question | What we figured out in words/ pictures | This makes me think or wonder about healing. . . |
|---|---|---|
| Why is there blood in all these places? | • The blood's structure (flowy liquid mixture) allows it to perform its function.<br>• Blood vessels help the blood get where it needs to go throughout the body.<br>• Blood (in humans and other animals) is made of:<br>◦ Red blood cells (which carry oxygen to the body parts)<br>◦ White blood cells (which fight disease and infection)<br>◦ Platelets (which clot blood so it doesn't leak out of injuries)<br>◦ Blood plasma (which brings water, food particles, vitamins, and electrolytes to the body parts and carries waste away)<br>• The structure of blood cells relates to their function: their round shape helps them travel easily through the tubular blood vessels.<br>• Platelets' structure relates to their function: their branching arms and stickiness help them plug damaged parts of the blood vessels to stop leaks.<br>• Parts of the blood system (blood cells and blood vessels) work together to perform their functions. | The platelets might help make the scab on the skin—they're blocking the blood from leaking out.<br>When everything's healthy, blood brings the body what it needs. When parts are injured, can the blood still get there?<br>Does blood have to bring more or different things to help healing happen?<br>If I lose blood in an injury, how do I make more? |

**Revisit the Driving Question Board.** Display **slide DD**. If time allows, revisit the DQB and identify questions the class can now answer about blood. (Lesson 5 includes more specific directions about how the class could document their

answers.) However, it is more likely that students have additional questions to add to the DQB from their reading today or considerations about how blood and healing are related. Take time to add these questions now.

### Alternate Activity

If your class has a lot of questions about blood that are answered in this lesson, consider recording all the Driving Question Board questions and sending them home with students. Have students highlight questions they think they have made progress on and pick one or two to answer as home learning.

## 11. Brainstorm why nerves are found throughout the body. 3 MIN

**Materials:** Our Body as a System poster

**Brainstorm where nerves are found.** Say, *Wow! We figured out a lot about the blood system and have some ideas about why it is in all of these parts of the body. In addition to blood, what other structures did we also see in the skin, muscle, and bone in Lesson 3?* Students should remember we also found there are nerves in all these parts as well. (Point at the blood system image on the *Our Body as a System* poster.) Say, *If we were to look at a similar image for where nerves are located in the body, where do you think you would find nerves?*

Allow a few students to answer, and then display **slide EE** to share an image of where nerves are found in the body. Have students turn and talk with a partner about the questions on **slide EE**:

- What similarities do you notice about where blood and blood vessels are found in the body and where nerves are found in the body?
- Why do you think both blood and nerves are found all over the body?

After they have discussed briefly, ask a few students to share their ideas.

# ADDITIONAL LESSON 4 TEACHER GUIDANCE

### Supporting Students in Making Connections in ELA

**CCSS.ELA-LITERACY.RST.6-8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases, as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.**

The informational text students read about blood in this lesson is the first time they're introduced to cells. Determining the similarities and differences among red blood cells, white blood cells, and platelets will set a foundation for students to continue refining their definition of cells and the variety of structures they can have, all related to specific functions they carry out.

LESSON 5

# What do nerves do, and why are they in different parts of the body?

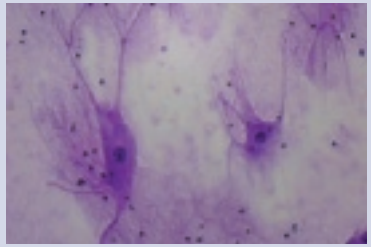
## Previous Lesson

*We used microscopes and images to investigate blood. We observed that blood is composed of several different components that cannot be seen without a microscope. We read an article to make sense of the patterns we saw, and considered how the structure of the components in the blood support their functions in the body.*

## This Lesson

Investigation

2 DAYS



Nerves, like blood vessels, are found throughout the body. In Lesson 3, we observed nerves in the cross section of the foot and wondered why they are present. We investigate nerves by first analyzing images of them, and we notice that nerves have a unique and intricate structure. We read about nerves and learn that the nerve cell's structure suits its function. We engage in a few quick experiences that help us understand the role that nerves play in our bodies. Then we revisit the foot injury, and think about how we can leverage what we now know about the structure and function of nerves to better understand how the foot works and the healing process..

## Next Lesson

*We will use microscopes to help us figure out what makes up skin, bone, and muscle. We will investigate pre-prepared slides and use our observational data to come to consensus around how cells' unique structures support their functions in the body.*

## Building Toward NGSS

MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8

## What Students Will Do

**5.A** Gather and synthesize information from scientific text and other sources to describe the basic structure of nerves and nerve cells and explain how its structure supports both the function of those cells within the nervous system and the interactions that occur between nerves and other parts of the body (e.g., skin, bone, muscle).

## What Students Will Figure Out

- There are nerve endings in skin, bones, muscles, and other parts of the body.
- Nerve cells have a very unique structure—they have long, thin "branches" or "tentacles" that extend from the center.

- Nerve cells connect to other nerve cells, forming a network of nerves that carry signals between all parts of the body and the brain.
- The structure of nerve cells is perfectly suited for their function—they branch out and connect different parts of the body so that they can carry signals between the body and the brain.

## Lesson 5 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 10 min | **NAVIGATION**<br>Revisit what we have figured out about the role of blood in the body, and motivate the need to look closely at nerves. | A-E | Driving Question Board, How Does the Foot Heal Over Time? poster (Consensus Model), Our Body as a System poster, image of the nerve system from *Nerve System Image* |
| 2 | 10 min | **DETERMINE NEXT STEPS**<br>Determine if the same tools and processes used to investigate blood can be used to figure out the role of nerves in the body. | F | sticky notes, markers, Driving Question Board |
| 3 | 20 min | **OBSERVE MICRO-SCALE NERVE IMAGES**<br>Use images to observe the basic structure of nerve cells. Document and share observations, and make comparisons to the structure of blood cells. | G-J | *Microscopic Images of Nerves*, Driving Question Board, markers, 1 sheet of blank 8.5x11 inch paper, Our Body as a System poster |
| 4 | 5 min | **NAVIGATION**<br>Summarize what we have observed and determine next steps. | K | |
| | | | | *End of day 1* |
| 5 | 4 min | **NAVIGATION**<br>Review our observations of nerves and motivate the need to obtain additional information about nerves and their role in the body. | L | |
| 6 | 18 min | **OBTAIN INFORMATION FROM SCIENTIFIC TEXT**<br>Use a scaffolding tool to help gather information from a reading about the structure and function of nerves and the nervous system. | M | *Reading: The Body's Nervous System*, *Obtaining Information from Scientific Text*, chart paper, markers |
| 7 | 16 min | **CONDUCT A BUILDING UNDERSTANDINGS DISCUSSION**<br>Use information from a reading, and engage in two short activities to make sense of the structure of the nerves we observed and how it supports the function of nerves in the body. | N-P | *Reading: The Body's Nervous System*, *Obtaining Information from Scientific Text*, two small paper clips per pair of students, Our Body as a System poster, How Does the Foot Heal Over Time? poster, markers, 6x8 sticky notes, tape, one timing device, one whistle or noise-making device |

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 8 | 7 min | **UPDATE PROGRESS TRACKER AND REVISIT DRIVING QUESTION BOARD**<br>Reflect on and record what we figured out about nerves and how that helps us understand healing. Revisit the Driving Question Board to determine which questions we have answered and add new questions. | Q-R | Driving Question Board, 3x3 sticky notes, 6x8 sticky notes or 5x8 index cards, markers<br>*End of day 2* |
| | | **SCIENCE LITERACY ROUTINE**<br>Upon completion of Lesson 5, students are ready to read Student Reader Collection 2 and then respond to the writing exercise. | | Student Reader Collection 2: *Inside the Body* |

## Lesson 5 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebooks<br>• sticky notes<br>• markers<br>• *Microscopic Images of Nerves*<br>• *Reading: The Body's Nervous System*<br>• *Obtaining Information from Scientific Text* | • *Microscopic Images of Nerves*<br>• two small paper clips per pair of students | • Driving Question Board<br>• How Does the Foot Heal Over Time? poster (Consensus Model)<br>• Our Body as a System poster<br>• image of the nerve system from *Nerve System Image*<br>• markers<br>• 1 sheet of blank 8.5×11 inch paper<br>• science notebooks<br>• chart paper<br>• How Does the Foot Heal Over Time? poster<br>• 6x8 sticky notes<br>• tape<br>• one timing device<br>• one whistle or noise-making device<br>• 3×3 sticky notes<br>• 5×8 index cards |

**Materials preparation (10 minutes)**

**Online Resources** 

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Rather than use a microscope to observe nerve cells, students will examine microscopic images of nerves in this lesson. Nerve cells tend to be less uniform in size and shape, and thus their cell membranes may be more difficult to identify

as compared to blood cells. By using images rather than a microscope, we save time here during the investigation, which we devote instead to uncovering the potential relationship between the nerve cell's structure and its function in the body generally, and during healing more specifically.

If you have the time, and access to microscopes and slides of nerve cells, you might consider allowing students to directly observe them. If you decide to use microscopes in this lesson, be sure to follow the lab preparation and safety protocols listed in Lesson 4.

Prepare chart paper to make the *How Does the Foot Heal Over Time?* poster.

Be sure to have standard sticky notes ready for students to add more questions to the DQB, as well as larger (6" × 8") sticky notes available for students to record responses to DQB questions.

Be sure to have a blank piece of 8.5" × 11" for recording students' ideas after observing images of nerves, which is then posted to the *Our Body as a System* poster.

For the two activities to better understand nerve function, be sure to have 2 paper clips per pair of students, one whistle or other noise-making device for the class, and one timing device for the class.

## Lesson 5 • Where We Are Going and NOT Going

### Where We Are Going

In Lesson 3, students observed blood vessels and nerves in the cross section of the foot, which motivated further investigation of the role of both blood and nerves in the body. In Lesson 4, students observed blood using microscopes or microscopic images and engaged in activities to figure out the blood's function within the body. In addition, students discovered there are blood vessels found throughout the body and begin predicting why this is the case. At the end of Lesson 4, students compare where blood vessels and nerves are found in the body, and brainstorm ideas about why nerves are also found throughout the body. This leads students to take a closer look at nerves under the microscope.

In *Unit 6.1: Why do we sometimes see different things when looking at the same object? (One-way Mirror Unit)*, students explored the role of the brain in processing inputs or signals from the body. They investigated the structures that make up the human eye, how those structures receive light inputs and change those inputs into electrical signals, and then send those signals along the optic nerve to the brain, where they are processed into what we see.

In this lesson, students further explore the relationship between the structure and function of nerves to understand the role of nerves in the body. They use microscopic images to observe nerves, discovering that nerve cells have a unique structure. As students model what they observe, they wonder about the structure of nerve cells. Using a scaffolding tool for SEP 8 Obtaining, Evaluating, and Communicating Information, students read a scientific text to obtain additional information about nerve cells, which helps them figure out that the nerve cells' distinctive structure makes them perfectly suited for their functions (Lexile reading estimate: 1100L-1300L). Students learn that nerve cells branch out and connect with all parts of the body and with one another, allowing signals to flow to and from the brain. This enables the brain to keep track of processes throughout the body, including voluntary processes, like the movement of the arms and legs, as well as involuntary processes, like breathing and the continuous beating of the heart.

**Where We Are NOT Going**

This lesson focuses on building a strong understanding of the relationship between structure and function without focusing on memorizing the parts of nerve cells or the nervous system. In addition, the lesson does not focus on describing the specific processes by which signals move between the body and the brain.

In *Unit 8.1: Why do things sometimes get damaged when they hit each other? (Collisions Unit)*, students will discover how nerves help us learn about the world around us through our senses and the relationship between nerve cells, nerves, the spinal cord, and the brain. They will also learn more about the structural components aiding nerves in fulfilling this role. Finally, students will model the component parts of nerve cells while describing the general processes that allow information to flow between nerves and the brain.

# LEARNING PLAN FOR LESSON 5

## 1. Navigation

10 MIN

**Materials:** science notebooks, Driving Question Board, How Does the Foot Heal Over Time? poster (Consensus Model), Our Body as a System poster, image of the nerve system from *Nerve System Image*

**Revisit what we figured out and motivate next steps.** Say, *Let's take a few minutes to think about what we have figured out over the last few lessons. Feel free to look at your notes and Progress Trackers in your science notebooks to help you.*

### Additional Guidance

Although the conversation prompted by slides A-E may take a few minutes longer than having the teacher review what students figured out, it is critically important that students drive the discussion. This will serve a number of important purposes:

- Students can solidify their understanding of concepts and terms from previous lessons.
- The teacher can assess students' understanding by listening to their partner or small group conversations and to the information shared with the whole group.
- The teacher can plan instruction and scaffolding, if needed, based on the responses that students share. For example, the teacher can use questions to help students connect what they know to the bigger picture of healing.
- The teacher can also help students continue to make explicit connections between structure and function, which should occur throughout this unit.

Show **slide A** and say, *In Lesson 3, we looked at a cross section of the foot. What did we notice? What did we decide that we needed to figure out?*

Give students a minute to turn and talk with a partner; then ask a few students to share. In sharing, students will likely summarize many of the things they noticed about the muscle, bone, and skin. To push them to think more about the nerves, ask the following prompts:

| Suggested prompts | Sample student responses |
|---|---|
| *So, we definitely noticed lots of things about the muscle, bone, and skin. What else did we see?* | *We saw blood vessels scattered throughout the different parts.*<br>*We also saw nerves scattered throughout these parts.* |
| *What did we decide we needed to figure out?* | *We decided that we needed to figure out why blood vessels and nerves are found throughout the foot.* |

If students are struggling to remember that nerves and blood vessels were also visible in the diagrams from Lesson 3, display **slide B**. Say, *In Lesson 3 we examined a number of closeup images from inside the body. What structures were found in all the closeup images of the skin, muscle, and bone?* Students will likely respond by saying all the images commonly showed both blood vessels and nerves.

Display **slide C**. Say, *In Lesson 4, we saw these images of where the blood and blood vessels are located in the body. How does the location of blood and blood vessels around the body compare to the location of nerves?* Students will likely respond by saying that the nerves also seem to be located all around the body.

Guide students back to the DQB and the *How Does the Foot Heal Over Time?* poster to further motivate the need to look at the nerves next. Say, *It seems like we have evidence from the last two lessons that nerves, like blood vessels, seem to be located all around the body. Let's start a new row on the* Our Body as a System *poster for nerves and add an image of the nerve system.* Label the row "Nerve" and add the nerve system image from *Nerve System Image* to the *Our Body as a System* poster.

Display **slide D**. Point to the DQB and the *How Does the Foot Heal Over Time?* poster displayed in the classroom. Ask students to review any ideas developed, or questions generated related to feeling, or lack of feeling in the foot from the DQB and the *How Does the Foot Heal Over Time?* poster. Use the prompts and responses below to return to the DQB and the *How Does the Foot Heal Over Time?* poster to begin thinking about how nerves might be involved in injury and healing.

| Suggested prompts | Sample student responses |
|---|---|
| *Where on our DQB and How Does the Foot Heal Over Time? poster did we include ideas or questions related to nerves?* | *Anywhere we talked about pain, feeling, or sensations in the foot.* |
| *From our How Does the Foot Heal Over Time? poster, what ideas have we developed related to feeling in the student's foot?* | *The hospital reports said the student had no feeling on the top of his foot before and immediately after surgery.*<br>*Recovery Report #1 said the patient felt no more pain and still didn't have feeling on the top of his foot.*<br>*Recovery Report #2 is the first time feeling started to return to the top of the foot—there was tingling but not full feeling.*<br>*Recovery Reports #3 and #4 both talk about how the foot is no longer tender, so maybe it doesn't hurt anymore when you touch the foot?* |

| Suggested prompt | Sample student responses |
|---|---|
| *From our DQB, what are some questions we have related to feeling in the student's foot?* | *Why did the feeling take so long to return to the foot?*<br>*The skin and bones seemed to heal, but he still didn't have feeling in his foot. Why?*<br>*Why could the student feel on all sides of the foot except for on the top?*<br>*Did the student feel pain right after the accident?*<br>*Why did the pain go away later?*<br>*Why did the feeling in the foot not return when the pain went away?* |

Show **slide E** and ask, *What did we do to figure out the blood's function in the body? What did we figure out?*

Give students another minute to talk to a partner; then ask for responses. Students will likely mention that

- The microscope allowed them to look more closely at the structure of blood and to distinguish between different types of blood cells.
- From a reading, they found how each type of blood cell functions.
- They figured out how the structure of the blood cells was related to their function by combining information from the reading with observations of blood cells under the microscope.

## 2. Determine next steps.

10 MIN

**Materials:** science notebooks, sticky notes, markers, Driving Question Board

Show **slide F** and say, *So, in addition to the parts of the injured foot that we have been investigating, we said we wanted to figure out more about the blood and the nerves because we saw that blood and nerves were found in the muscles, bones, and skin. Similar to how we investigated the blood, what could we do to figure out the structure and function of nerves in the body?*

Give students a minute or two to turn and talk with a partner to discuss this question on the slide. Remind them that they can use their notes and Progress Trackers in their science notebooks. When students come back to the whole group, call on a few pairs to share out. Listen for the following ideas:

| Suggested prompt | Sample student responses | Follow-up question |
|---|---|---|
| *Similar to how we investigated the blood, what could we do to figure out the structure and function of nerves in the body?* | *We could use microscopes to take a zoomed-in look at nerves. This would help us see what nerves look like, and that might give us an idea about the function of nerves.*<br><br>*We could also look at zoomed-in pictures of nerves. That might also help us see the structure of nerves.*<br><br>*Maybe we could do some research—we could read about nerves to get more information about nerves and what they do in the body.*<br><br>*We could talk to people who know about nerves and how they work—maybe a doctor or a scientist.* | *What are some questions you have about nerves?* |

Be sure that the DQB is visible to the class. As students share how they might investigate nerves, encourage them to also share questions they have about nerves. After a student shares their question, prompt them to record the question on a sticky note and add it to the DQB. Guide students to place their new questions together and ask a student volunteer to label this cluster of new questions with the term "Nerves." Use those questions to help students think about additional ways they might investigate their questions.

Sample student questions might include:

- Why are nerves found in the muscles, bones, and skin?
- Are nerves found everywhere in the body, like we saw with the blood?
- What do nerves do?
- What do nerves look like under the microscope?
- Are nerves tubes, like blood vessels, with cells inside?
- Are nerves made up of different kinds of cells, like those we observed in blood?
- Will the structure of the nerves help us figure out what they do in the body?
- Are nerves related to pain somehow?
- Will looking at nerves under the microscope help us find out how they are designed to make us feel things?

Let students know that we will revisit their nerve-related questions at the end of the lesson.*

*** Supporting Students in Engaging in Asking Questions and Defining Problems**

Although asking questions is not a focal practice for *Unit 6.6: How do living things heal? (Healing Unit)*, this is an opportunity for students to generate questions that can guide investigations, observations, and student thinking. Encourage students to ask questions about the nerves they observed in Lesson 3 when examining the cross section of the foot and use what they learned in Lesson 4 about blood, blood cells, and blood vessels to generate even more questions. These questions should be written on sticky notes and added to the Driving Question Board as time permits.

In addition, when you acknowledge and display students' questions (in their own words), you are validating their thinking and positively promoting equity in your classroom.

**Propose using a similar process to investigate nerves as blood.** Say, *Listening to your responses and looking at the questions we have generated, it sounds like we want to look more closely at nerves to see what they look like. Some of you also mentioned that we might want to do some research on nerves to figure out what they do in our body. Let's begin by looking at nerves more closely to see what we can figure out.*

Tell students that you have some images of nerves taken from under a microscope, and they will analyze these microscope images to figure out what they look like. Share with students that since they already understand how to use a microscope, using these images allows us to annotate the image and permits us to pay greater attention to studying the structure of nerves, in order to try and figure out more about their function. In addition, there will be other opportunities later in the unit to use a microscope.

### Alternate Activity

Option A—If you prefer to use microscopes, or are looking to challenge your students, and you have the time and slides available, then have students follow similar procedures and safety protocols as Lesson 4 to view nerve cells under a microscope.

Option B—If you have a classroom microscope whose view can be projected (rather than a class set of microscopes for students to use themselves), you may carry out this lab as a whole-class demonstration. You can invite different students to focus the microscope while everyone records what they see in their data tables. It is important for students to record their own observations so they can compare across magnifications.

During the class discussion, it may be helpful to have a microscope plugged into a computer to project what is observed to allow students to point out what they found or refer to the images while explaining their ideas.

Option C—If you teach this lesson virtually, you can also access the Virtual Microscope interactive. From there, copy the link for viewing **nerve smear** and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson.

## 3. Observe micro-scale nerve images. 20 MIN

**Materials:** science notebooks, *Microscopic Images of Nerves*, Driving Question Board, markers, 1 sheet of blank 8.5x11 inch paper, Our Body as a System poster

**Share what we know about nerves.** Show **slide G** and say, *Before we look at images of nerves, let's share some things we think we already know about nerves.* Give students a few moments to think about the question on the slide; then ask them to share out their ideas.

**Make predictions.** Show **slide H**, and say, *Now that we have shared what we know about nerves, take a few moments to make a prediction. When we look at the images of nerves, what do you think we will see? How will it compare to what we saw in the blood sample? Write your prediction in your notebook, and explain your thinking.*

Give students time to write down their predictions along with their reasoning. When students finish, call on a few to share.

**Investigate nerves using images from a microscope.** Pass out *Microscopic Images of Nerves* to each student. If the student handout is printed is black and white, then also distribute *Microscopic Images of Nerves* to each group so students may observe the colors associated with each image. A set of *Microscopic Images of Nerves* could be made and reused between classes.

Show **slide I** and explain that these images were taken with a camera attached to a microscope. Ask, *How can images taken using a microscope help us figure out more about nerves?* Tell students that we will analyze images of nerves at different magnifications, just like when we observed blood. Have them take a minute or two to follow the directions on the slide to write the investigation question at the top. This will focus students' attention on what we are trying to figure out. Students should be sure to have a pencil or pen to annotate the nerve images in their handout.

Explain to students that some of the images are of nerves from a human, while others are nerves found in other organisms. Tell students they will observe a *nerve smear*, meaning that in each case a small sample of the organism's body was spread out on a slide before viewing it under the microscope. Encourage students to pay close attention to the label accompanying each image, as it contains information about the type of organism and the magnification.

Prompt students to work in small groups as they examine the nerve images, and share and discuss what they notice in their group. Ask students to circle, label, and highlight parts or details that seem interesting in each image about the structure of the nerves, such as their shape or arrangement. Encourage students to write any questions they have about what they see directly on the handout.

As students work, walk around the room and listen and observe. Make note of the things that you hear and see them documenting on their handout. Use the following questions to help guide their observations and small group discussions:

- What similarities and differences do you notice between nerves from different organisms?
- How does what you see change as you move from low to high magnification?
- What structures do you see?
- How does the structure of nerves compare to the structure of red blood cells? White blood cells? Platelets?
- How might the structure that you see support what we think the nerves do for our body? (Note: This prompt is meant to push students to make predictions about the nerves' functions. Students will read more about nerve function on day 2.)

As you listen to students, remind them to revisit the new questions added to the DQB regarding nerves to see if they can answer any as they make their observations. Encourage students to discuss possible responses to those questions with their small groups, and to record these responses in their notebook in preparation for a whole-group share-out.

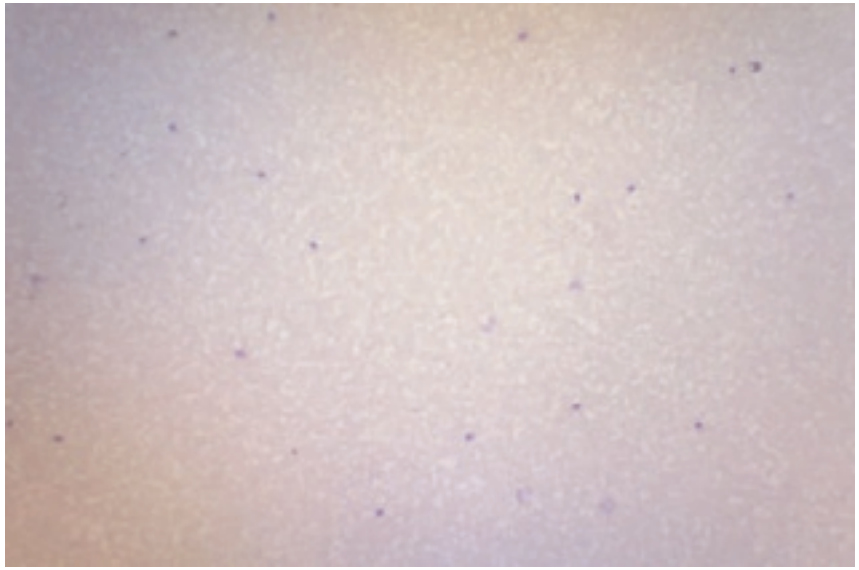
**Share initial observations.** When students finish annotating the nerve images, bring everyone back to the whole group. Show **slide J** and ask them to read the questions on the slide. Use the questions to guide students in sharing their initial observations before moving to the next activity. Possible student responses are found below.

During this discussion, ask the class if any questions related to nerves on the DQB can be answered. If there is general agreement regarding the question and answer, place a check or sticky note on the answered question. Be sure to also permit students to add additional questions to the DQB regarding nerves.

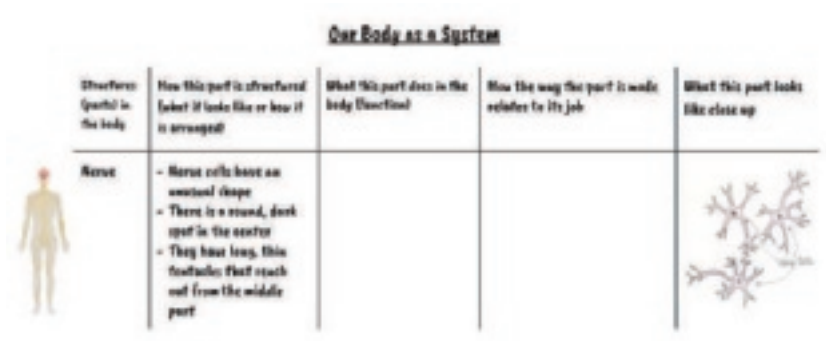
| Suggested prompts | Sample student responses | Follow-up questions |
|---|---|---|
| *What did you notice about how the nerves were structured?* | *We noticed that they were made of smaller structures like blood cells, but these had an unusual shape.*<br>*There was a darker spot in the middle, and it was much wider or fatter than the rest.*<br>*We also noticed a number of smaller, dark spots outside the nerves.*<br>*Nerves also had what looked like fingers reaching out, but longer and thinner than fingers. They reached out from the middle part, similar to platelets.*<br>*They were almost like the branches on a tree, with some branches splitting into more branches.*<br>*They reminded me of jellyfish with lots of thin long tentacles floating around them, but the tentacles spread out—they didn't hang down like a jellyfish in the ocean.* | *Do you think the structures you saw might be cells too?*<br>*Why might they be shaped the way they are?* |
| *In what ways did changing the scale, or zooming in, affect what you observed?* | *Nerves seem really small, just like blood cells!*<br>*As we looked from low to medium and then to high magnification, we could see more details in the nerves.*<br>*We could see that the dark spot seems to be in a rounder, thicker part of the nerve.*<br>*We could see that dark spot even seemed to have a smaller, darker spot inside it!* | *What did this tell you about nerves?* |

| Suggested prompt | Sample student responses | Follow-up question |
|---|---|---|
| | *When we zoomed out, we could see that some of the tentacles spread out until they touched the tentacles of another nerve.*<br>*When we zoom in, we mostly see where the tentacles connect to the darker, thicker area in the middle of the nerve.*<br>*We could see that some tentacles are long and thin, while others are thicker or shorter.*<br>*We could also better describe what we saw as the magnification increased.* | |
| *How does the structure of nerves compare to blood?* | *They did not look round like red blood cells. They looked more like platelets, which had tentacle-like arms that stretched out.*<br>• *However, the tentacles of the nerves seem longer than in platelets.*<br>*Nerves are very small like blood cells. Their shape is more like platelets than like red or white blood cells.*<br>• *However, the long tentacles make it harder to tell apart one nerve from another as compared to the platelets.*<br>*Nerves have a cool structure. It's similar to platelets, but the tentacle-like arms are really long and branch out farther, just like the branches on a tree.*<br>• *However, unlike platelets, the tentacles or branches of one nerve seem to touch the tentacles or branches of another nerve.* | *What does this make you wonder about now?* |

Record students' ideas in drawings (possibly with words) on a piece of 8.5x11 inch paper and attach it to the *Our Body as a System* poster as a "zoom in" on nerves under the zoomed-in blood cell drawing. See the sample drawing shown here, based on human nerves at medium magnification. Rather than focus on what a single nerve cell looks like, the drawing should show several cells together to reinforce the idea that the system is made up of many cells working together.



An example of what the *Our Body as a System* poster might look like at this point can be found here:



## 4. Navigation

5 MIN

**Materials:** science notebooks

**Summarize our thinking and share next steps.** Show **slide K** and say, *Who would like to summarize what we have figured out today and what our next step will be?* Call on a few students, and look for the following responses:

- We have figured out the nerves have a structure that is different from red blood cells or white blood cells, but does have similarities with platelets. They seem to have a larger center and tentacles that stretch out from the center like branches on a tree.
- Next we need to figure out how the structure of nerves relates to what they do, or their function.

**End of day 1**

## 5. Navigation

4 MIN

**Materials:** None

**Review previous observations of nerves and motivate our next steps.** Show **slide L** and say, *What did we observe about the structure of nerves when we examined images of them taken using a microscope? And, in general, what do we know about the relationship between the structure of something and its function or job? Take a minute or two to talk to a partner, and be prepared to share with the class.*

When students come back to the whole group, call on some to share what they discussed with their partners.

- Regarding the structure of nerves, listen for students to share that the structure of nerves is very different from other structures they've seen thus far. Nerves appear to have thin tentacle-like arms that branch out from the larger center portion.
- Regarding the relationship between structure and function, listen for students to say that an object's structure may help it carry out its function. They may give examples from the previous lesson, such as the shape of blood cells enabling them to move easily through blood vessels, and the shape of blood vessels suited for transporting blood throughout the body. They may also discuss how the tentacle-like arms of the platelets might help them link up to form clots to stop cuts from bleeding.

Remind students that similar to the previous lesson with blood, our next step is to figure out what nerves do and how their structure helps them carry out their function. If we can figure this out, then we can think about why nerves are present nearly everywhere in the body (including near the bone, muscle, and skin, as seen in Lesson 3) and what role they may play in the process of healing.

## 6. Obtain information from scientific text.

18 MIN

**Materials:** science notebooks, *Reading: The Body's Nervous System*, *Obtaining Information from Scientific Text,* chart paper, markers

**Examine a tool for obtaining information from scientific text.*** Show **slide M** and ask students to look at *Obtaining Information from Scientific Text* in their handbook. Tell them that this tool will help them find key information to answer our questions as they read about nerves. Direct them to look at the left column of the table. Explain that in the left column, there are strategies that we can use to help us find the information we need when we read text to get information. These strategies include:

- Read for the gist (or central idea) by skimming the title, headings, and captions on images.
- Markup the text by keeping track of questions we have in the margins, circling key words, putting question marks by words we want to learn more about, and underlining main ideas.
- Examine images, graphs, and tables, and look for the central point of each.
- Identify the ideas from the text that support what you've figured out so far.

Point out that there is space on the handout to fill in the information students find in the text as they read.

**Read about the structure and function of nerves**. Direct students to *Reading: The Body's Nervous System* (printed for students so they can mark up the text).



Ask, *What are we trying to figure out from the information we get from this reading?* Look for students to say that we are trying to figure out what nerves do and why they are in different parts of the body. Students might also say that we are trying to figure out more about the structure of nerve cells and how this is connected to what nerves do in our body, or what their function is.

Remind students to follow the strategies outlined in *Obtaining Information from Scientific Text,* since they will be asked to share where they found the information used to support their thinking. Also, remind them that they can refer to the observations documented on their handout as they read. Give students 10-12 minutes to read while following the strategies outlined in *Obtaining Information from Scientific Text.*

## Additional Guidance

When discussing the reading, keep in mind that it is not important for students to know the names of different types of nerve cells or even to distinguish the different specialized functions of each. Students should note that all nerve cells share the same basic structure and that the structure is well suited for its function—receiving and transmitting signals between the body and the brain.

## Assessment Opportunity

**Building towards 5.A**: Gather and synthesize information from scientific text and other sources to describe the basic structure of nerves and nerve cells and explain how the structure supports both the function of nerves within the nervous system and the interactions that occur between nerves and other body systems (e.g., skin, bone, muscle).

### * Attending to Equity

Some students, particularly students with learning differences, those who are below grade-level reading, or students who are emergent multilingual learners, may require more support to successfully gather information from the reading (Lexile reading estimate: 1100L-1300L). *Obtaining Information from Scientific Text* is a tool that provides the kind of support these students may need. In addition, you could read the titles, subtitles, and image captions together and allow students to ask clarifying questions. You might also consider providing extra time for students to read or allow students to read with a partner. Finally, as is the case with all resources, this handout is editable, and so you are encouraged to modify it to meet the needs of your students.

If you have students who need these kinds of additional support, they will benefit from using *Reading: The Body's Nervous System,* which is a handout, rather than *The Body's Nerves* in the student edition, so that they can annotate the text in ways that are meaningful to them.

If you find that your students are looking for a challenge, or tend not to struggle as they make sense of scientific texts, consider reducing the number of scaffolds or not providing *Obtaining Information from Scientific Text.* Exercise caution when eliminating scaffolds, as they are designed to help remove barriers to accessing information.

**What to look for:** As students use the prompts and strategies outlined on *Obtaining Information from Scientific Text* while reading *Reading: The Body's Nervous System*, they should highlight and document information in the reading that supports the following ideas:

- There are nerves in skin, bones, muscles, and other parts of the body.
- Nerve cells have a very unique structure—they have long, skinny "branches" or "tentacles" protruding from a central portion.
- The structure of nerve cells is perfectly suited for their function.
- Nerve cells branch out and connect to other nerve cells throughout the body, forming a network of nerves that carry signals between all parts of the body and the brain.

**What to do:** If students struggle to find the information they need in the reading, call attention to the strategies and prompts in *Obtaining Information from Scientific Text*.* Remind them to:

- Read for the gist (or central idea) by skimming the title, headings, and captions on images.
- Markup the text by keeping track of questions we have in the margins, circling key words, putting question marks by words they want to learn more about, and underlining main ideas.
- Examine images, graphs, and tables, and look for the central point of each.
- Identify the ideas from the text that support what we have figured out so far.

If students struggle to identify ideas from the text to support what they've figured out so far, cue them to think about the structure and function of nerves. Remind them about how the structure of blood cells supports their function, and ask them to point to ways in which the structure of nerve cells helps them perform their job. Alternatively, ask students first how the reading describes the job that nerves perform. Then ask what it is about the nerve cell's shape that allows them to perform this job well.

If students continue to struggle with the reading, allow students to read and discuss with a partner.

*** Supporting Students in Engaging in Obtaining, Evaluating, and Communicating Information**

As students move into higher grade levels, they are increasingly expected to obtain information from scientific texts. Students often need support as they learn to engage in science practices in an authentic way. *Obtaining Information from Scientific Text* provides support by giving students strategies that they can use to read scientific texts, gather relevant information, and document what they find using the strategies outlined in the tool.

Additional modifications can be made to the tool to consider other aspects of the practice, such as assessing the validity and reliability of the information obtained through the reading. However, we are using the tool specifically to support students in obtaining relevant information from the text.

## 7. Conduct a Building Understandings Discussion. 16 MIN

**Materials:** science notebooks, *Reading: The Body's Nervous System*, *Obtaining Information from Scientific Text*, two small paper clips per pair of students, Our Body as a System poster, How Does the Foot Heal Over Time? poster, markers, 6x8 sticky notes, tape, one timing device, one whistle or noise-making device

**Lead a Building Understandings Discussion about nerves.** Ask students to gather together in a Scientists Circle. They should each bring the reading, handout and their science notebook. As students are getting settled (and not necessarily watching you), slam a heavy book onto a desk or table to make a loud noise. After students settle down, ask them to raise their hand if they flinched, jumped, blinked, or reacted to the noise in a similar way. Say something like, *I wonder if we can find evidence from today's reading that can help explain why so many of us reacted so quickly after detecting that loud noise? Let's take our seats and share what we've figured out.*

Show **slide N** and use the prompts on the slide, as well as the additional prompts below, to surface information that students gathered from the reading and discuss the structure and function of nerves. As students share, make sure

to ask them to refer to where they found the information that they are using to support their thinking. Update the *Our Body as a System* poster during and/or after this discussion to summarize these ideas. (A sample updated poster is shown below the discussion prompts.)

## Key Ideas

**Purpose of this discussion:** Students share what they figured out as they gathered information from the reading about the function of nerves in the body and made connections to the unique structure of the nerve cells they observed in the microscope. They also identify the two other main components that primarily interact with nerves (brain and spinal cord), and describe the basic interactions that occur between each component and across other parts of the body.

**Listen for these ideas:**

- There are nerves in every part of the body.
- Nerves are made up of nerve cells.
- Nerve cells branch out and connect to other nerve cells throughout the body, forming a network of nerve cells that carry signals between all parts of the body and the brain.
- Nerve cells have a very unique structure that is suited for their function—they have long, skinny "branches" or "tentacles" protruding from a central portion that allow them to make connections to other nerve cells.

| Suggested prompt | Sample student responses |
|---|---|
| *What did you find out from the reading that helped you make sense of what you observed when looking at nerve images?* | *Nerves interact with the spinal cord and the brain.*<br><br>*Nerves, the spinal cord, and the brain are made up of billions of nerve cells. Sometimes the nerves are all bunched up like near the spinal cord, and sometimes they are spread out like when they are far from the spinal cord.*<br><br>*All the components work together like the electrical system in a house—it connects every part of the body to the brain, and signals travel between the body and the brain.*<br><br>*The signals travel so fast, we don't even notice any delay between a signal coming from the body to the brain and back to the body.*<br><br>*The nerves take in signals from our senses so that we can see, smell, taste, and feel the things around us.*<br><br>*The nerves, brain, and spinal cord also control body processes that we don't even have to think about, like breathing, blinking, and our heartbeat.* |

| Suggested prompts | Sample student responses |
|---|---|
| *So, what is the function of nerve cells?*<br>*And how does the structure of a nerve cell support its function?* | *Nerve cells branch out to form connections between one another and with all parts of the body. Signals are picked up from the body by the nerve cells; then the signals travel along the network of nerve cells to the spinal cord and brain.*<br>*The brain also sends signals back along the same network of nerves to the body.*<br>*Since each nerve is connected to one or more nerves, that must be how the brain communicates with every part of the body—even parts that are far away like the foot!* |
| *Does the structure of a nerve cell help us better understand and describe its function? Explain your thinking.* | *The "branches" or "tentacles" that spread out from each nerve cell allow them to branch out in the body and toward other nerve cells.*<br>*Since there are billions of these cells, they form a network of connections that spreads throughout the body.* |
| *As we continue to try to figure out how healing happens in our body, how does what we have figured out about nerves connect to healing?* | *Nerve cells branch out to all parts of the body and help the brain keep track of how the body is doing.*<br>*If there is an injury in the body, even one that is far away, the nerve cells will immediately let the brain know that an injury has occurred and cause a reaction to minimize further injury and facilitate the healing process.*<br>*The brain would get a signal that the skin has been cut open, bones have been broken, and muscles have been damaged because nerves are found throughout all these areas of the body.* |

**Engage in activities to observe nerve function.** Guide students through two short activities designed to help them better understand how nerves help the body detect and quickly react after an injury has occurred.

Activity #1—Sensing Touch should take approximately 5 minutes and is designed to help students understand how nerves detect stimuli, or something detectable occurring in their environment, such as something that may cause pain. Display **slide O**, and review instructions with the class.

For this activity:

- Students will work in pairs.
- Student A closes their eyes.
- Student B lightly touches the back of Student A's hand with the tips of two paper clips, approximately 1 cm apart.
- If Student A senses both paper clips, move the paper clips slightly closer together and touch the hand again.
- Continue until Student A cannot distinguish between the two paper clips, or when it feels like only one paper clip is touching.
- Switch partners and repeat.
- Try other parts of your body. (Be sure to wear safety goggles for this.)

Following the activity, say, *Some parts of our body have more nerves than other parts*.

Engage students in a brief discussion about the areas that were most sensitive and why they think this is. Students may say that there may be more nerves in areas where they could feel two separate paper clips because these areas would be more sensitive. Similarly, those parts where the two paper clips felt like a single paper clip may be areas with fewer nerves and are thus less sensitive.

Activity #2—Nerve Speed should take approximately 5 minutes and is designed to help students understand how quickly nerves can transmit information. Display **slide P**, and review instructions with the class.

For this activity:

- Students will work as a class.
- Students stand in a line and join hands.
- The first student holds a timer.
- The last student holds a whistle or other noise-making device.
- The first student starts the timer with one hand and squeezes the next person's hand with their other hand.
- The next person squeezes the hand of the next person, and so on.
- When the last student feels their hand squeezed, they blow the whistle and the first student stops the timer.

Following the activity, engage students in a brief discussion about how far and how fast the signal is transmitted. Ask, *What might happen to the speed of the signal if we add more students or take away students from the line? What might happen if two people in the line are separated and their hands are no longer joined?*

Students may share that when there are more students, the signal will take longer to reach the last student, and that it will take less time when there are less students in the line. Help students make the connection to parts of the body that are far from the brain versus parts that are closer, and how long those signals take to reach the brain.

Students may also share that when there is a break in the line, creating a gap in the network of nerves, the signal may take longer or, if the gap is too large, be unable to reach its intended target. Remind students that gaps between the tentacles of nerve cells were seen in the microscope images, and so perhaps the gaps are normal. Then push students

to think about what might happen if the gaps become larger, and ask students to connect this to what we know about the student with the injured foot. Say, *How might what we experienced just now with sending a signal along a line of people connect to what the student with the injury in Lesson 1 experienced? How might this help us figure out more about the connection between nerves and the healing process?*

| Suggested prompt | Sample student responses |
|---|---|
| *How might this be connected to what the student in Lesson 1 experienced when his food was injured?* | *Since the student didn't feel anything on the top of his foot, maybe some of the nerves in that area were injured or damaged, sort of like the skin and bone.*<br><br>*Maybe the nerves in that part of the foot were no longer connected, and so no signal could be sent to the brain. So, the brain didn't sense any feeling from that area.* |

Connect these activities back to students' reactions to the book you slammed on the desk. Share with students that these quick reactions are further facilitated because of a network of nerves that are designed to work quickly and automatically—even without us thinking about it. Reflex reactions protect our body automatically. Reflexes cause us to move away from anything that might hurt us. Signals that travel through a reflex arc often bypass the brain, and may therefore reach their intended target more quickly than typical pathways that involve the brain.

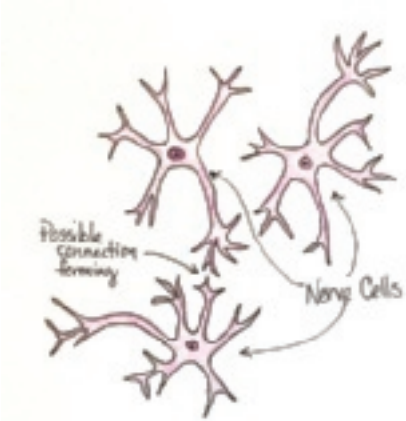
## Additional Guidance

If students struggle to grasp the idea of reflex reactions:

- Try using an example like this: If you put your hand on a hot stove, you immediately remove your hand. You don't wait to think, "Hey, my hand is on a hot, burning stove. I think I better move it!" When the nerves in your fingers feel that heat, the signal travels immediately to the muscles in your arm and tells them to contract in order to move your hand away from the stove. If the signal instead traveled to your brain first and then to the muscles in your arm, this would travel a greater distance and therefore take longer, leading to a more severe burn on your hand.
- Remind students that we figured out in the *One-way Mirror Unit* about how our eyes detect light. Explain to students that this is similar to how quickly light signals that enter our eyes are changed to electrical signals by the retina, then travel along the optic nerve to the brain, and are interpreted by the brain into what we "see." This also happens so quickly that we don't even notice the process.

**Source:** Nervous System Experiments for Kids. (2016, February 6). Retrieved November 9, 2020, from https://study.com/academy/popular/nervous-system-experiments-for-kids.html.

**Update the *Our Body as a System* poster.** If you have not already done so, update the *Our Body as a System* poster and the "zoom in" nerve image. See the example nerve system row and labeled "zoom in" below.






## 8. Update Progress Tracker and revisit Driving Question Board.

7 MIN

**Materials:** science notebooks, Driving Question Board, 3×3 sticky notes, 6×8 sticky notes or 5×8 index cards, markers

**Update Progress Trackers.** Show **slide Q**. Direct students to the Progress Tracker section of their notebooks. Have them turn their notebooks to landscape orientation and draw a 3-column progress tracker like the one on the slide. Remind students that the Progress Tracker is a space for them to process and record their thoughts while we're working to figure out how an injury can heal. Give students time to add to their Progress Trackers. See the sample student responses shown on the next page.

| Question | What we figured out in words/ pictures | This makes me think or wonder about healing. . . |
|---|---|---|
| What do nerves do and why are they in different parts of the body? | • There are nerve endings in skin, bones, muscles, and other parts of the body.<br>• Nerve cells have a very unique structure—they have long, skinny "branches" or "tentacles" that extend from the center. | Since it seems like nerves help keep track of what is happening throughout the body, So I wonder. . . |

| Question | What we figured out in words/ pictures | This makes me think or wonder about healing. . . |
|---|---|---|
| | • Nerve cells connect to other nerve cells, forming a network of nerves that carry signals between all parts of the body and the brain.<br>• The structure of nerve cells is perfectly suited for their function—they branch out and connect different parts of the body so that they can carry signals between the body and the brain. | • When an injury happens, how are signals sent to the brain?<br>• How does the brain respond?<br>• Does the brain signal different parts of the body (like the blood) to do certain things when an injury happens? If so, what?<br>• What happens if nerves are damaged in the injury?<br>• Do nerves heal? How?<br>• If nerves are damaged, how do signals get back to the brain from the injured area? |

## Assessment Opportunity

**Building towards 5.A.2:** Gather and synthesize information from scientific text and other sources to describe the basic structure of nerves and nerve cells and explain how the structure supports both the function of those cells within the nervous system and the interactions that occur between nerves and other body systems (e.g., skin, bone, muscle).

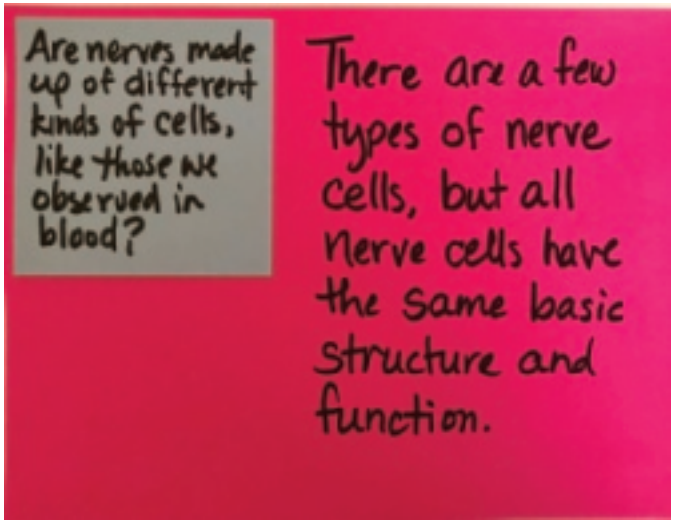
**What to look for:** Students' completed Progress Trackers give an opportunity to assess what they have figured out during this lesson. Look for the ideas called out in the sample Progress Tracker above. Specifically look for students to be including what they figured out about the structure and function of nerve cells and the nerve system.

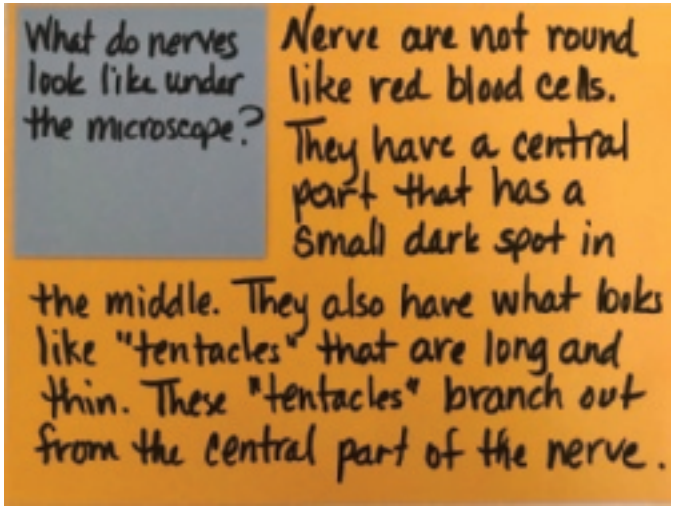
**What to do:** If students have incomplete or missing ideas in their Progress Trackers, remind them to review the reading *Reading: The Body's Nervous System* and the *Obtaining Information from Scientific Text* handout to look for and document the information they found in the reading. They can also revisit the *How Does the Foot Heal Over Time?* poster and the *Our Body as a System* poster for additional support.

Student explanations approaching, but not yet reaching proficiency, might not include what they figured out about the structure of the nerve cells, the function of the nerve cells, or how the structure supports this function. In these cases, prompt students to think back to the activities they did with a partner using the paper clips and ask them what they experienced. In addition, you could ask them to think back to the activity they did with the class squeezing hands and what this helped us figure out about how the structure of nerves helps them perform their function.

**Revisit the Driving Question Board.** If your students added questions about nerves to the DQB that they are now able to answer, take a few minutes to revisit the DQB. Read through the questions we added, as well as those in other

categories that we have worked through in previous lessons, and mark those that we can answer with a checkmark. When time allows, either this day or another day, have students work in groups to document answers to these questions on 5x8 index cards or 6x8 sticky notes.




It is also likely that students have additional questions to add to the DQB from their reading today or about the role of nerves in the process of healing. Take time to let students add these questions now.

**Discuss possible next steps.** Show **slide R** and ask for student volunteers to respond to the prompts:

- What have we figured out about nerves? What do they do and why are they in different parts of the body?
- What do we need to figure out next?

Affirm student ideas and listen for students to say something about the structure and function of nerves. Say, *We have figured out that they are made of lots of nerve cells that transmit signals through tentacle-like arms throughout the body. But, as we think about the role of nerves in healing, we know that there is more that we need to figure out. If we revisit our healing timeline on the* How Does the Foot Heal Over Time? *poster, what do we see as evidence about how the nerves healed?* Encourage students to look back at the timeline component of the *How Does the Foot Heal Over Time?* poster for any moments when "feelings" are mentioned.

If the timeline is missing information regarding "feelings," revisit the doctor's notes regarding the nerves. Suggest to students that they look for instances where the doctor mentions "feeling." As students share, point to various points on the timeline to highlight moments from the doctor's notes.

Listen as students share and then say, *We know from the doctor's notes that feeling in the foot doesn't completely return, even when the skin, muscle, and bone have healed. And, let's also remember from the images in this lesson that there are gaps between nerve cells. Could it be that these gaps between nerves in the injured student's foot got bigger, or that some of the nerve cells were destroyed and he now has to wait for them to come back?* Give students a moment to think and respond to this prompt.

Sample student responses:

- Yes! Like when we did the activity where we were holding and squeezing hands. When we let go, the signal stopped. It's like the gap between two people was too large.
- Maybe with the injured foot, the nerves are still there, but now they are too far apart. This doesn't let any feeling travel from the foot to the student's brain.
- Or, it could be like with the skin where we need to wait for new skin to form where there was an open cut. Maybe we need to wait for new nerves to fill in the opening or gap?

After students share, say, *It seems like the nerve cell's structure helps contribute to its function, similar to how blood cells help the blood to function. If we were to go back and look closely at the structures in the body that were injured in the foot from Lesson 1, what do we think we might see in the muscle, bone, and skin? How might this help us figure out more about these different structures in our body?*

Sample student responses:

- We might see other types of cells if we look at skin, muscle, and bone under a microscope.
- This may tell us more about what skin, muscle, and bone are made of, and how they are structured to perform their functions.
- If we can find out more about the structure of skin, muscle, and bone, and how this helps them function.
- We should look at skin, muscle, and bone under the microscope too!

Say, *It sounds like you have some ideas of what we might see if we could zoom in and look more closely at muscle, bone, and skin. Let's see what this helps us figure out!*

# ADDITIONAL LESSON 5 TEACHER GUIDANCE

## Supporting Students in Making Connections in ELA

**CCSS.ELA-Literacy.SL.6.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.**

There are a number of opportunities in this lesson for students to engage in discussions in pairs, in small groups, and as a class. Some discussions are teacher-led, but not all. Students should be encouraged to share their prior understandings, observations, and current thinking while working collaboratively with their peers to figure out the role of nerves and nerve cells in the body and how their function is served by the unique structure of nerve cells and the network they create throughout the body to receive and send signals between the body and brain. As much as possible, questions and prompts are used by the teacher to allow students to lead discussions, giving students multiple opportunities to share their current thinking and build on the thinking of others. Additional strategies that can be used include:

- Strategically pair and group students, keeping individual student needs in mind.
- Provide numerous opportunities for students to respond to questions and share their thinking (in pairs before class discussion, for example).
- Allow students to use drawings, symbols, writing, and gestures to express their ideas.

**CCSS.ELA-Literacy.SL.6.1.A: Come to discussions prepared, having read or studied required material; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.**

In this lesson, students obtain information from a reading and are expected to use that information to support their thinking. During a Building Understandings Discussion, students are asked to specifically show where they found information in that text to support their ideas as they work together to figure out whether or not the structure of nerve cells supports the function of those cells. To support students in this process, they are given a tool, *Obtaining Information from Scientific Text*, that gives strategies for annotating the text, which will help them quickly find and use the information they need to support their thinking during the class discussion and while updating their Progress Trackers at the end of the lesson.

**CCSS.ELA-Literacy.SL.6.2 Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally), and explain how it contributes to a topic, text, or issue under study.**

The focal practice for this lesson is SEP 8 Obtaining, Evaluating, and Communicating Information. Students obtain information from a reading and use that information to figure out how the structure of nerve cells supports their function in the body. *Obtaining Information from Scientific Text* is provided to support students in obtaining information from scientific text. The tool includes strategies, such as skimming the title, subtitles, and captions to get the gist of the reading, marking up the text in a number of ways, and documenting the ideas that support our purpose for engaging in text. Additional suggestions are provided in the lesson, such as paired reading of the text, to further support students in obtaining the information they need.

## SCIENCE LITERACY: READING COLLECTION 2

# Inside the Body

1 **Imaging Injuries**
2 **Threatened—and Saved—by the Cold**
3 **Blood Doping**
4 **Copper as Pain Reliever**

## Literacy Objectives

- ✓ Distinguish cause(s) and effect(s) related to conditions inside the human body.
- ✓ Argue a position on the issue of athlete blood doping.
- ✓ Distinguish between credible and non-credible sources.

## Literacy Exercises

- Read varied text selections related to the topics explored in Lessons 3–5.
- Evaluate the reading selections according to provided prompts and criteria.
- Compare and contrast information gained from reading text with information gained from class investigation.
- Prepare a two-part meme in response to the reading.

## Instructional Resources

Student Reader



Collection 2

**Science Literacy Student Reader, Collection 2**
"Inside the Body"

Exercise Page



EP 2

**Science Literacy Exercise Page**
EP 2

## Prerequisite Investigations

Assign the Science Literacy reading and writing exercise *after* class completion of this lesson group:

- Lesson 3: How can medical images and diagrams help us figure out more about the structures in our body?
- Lesson 4: Why is there blood in all of these places in the body?
- Lesson 5: What do nerves do, and why are they in different parts of the body?

## Standards and Dimensions

### NGSS

**Disciplinary Core Idea 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. (MS-LS1-3).

**Science and Engineering Practice:** Obtaining, Evaluating, and Communicating Information

**Crosscutting Concepts:** Cause and Effect; Systems and System Models

### CCSS

**English Language Arts**

**RST.6-8.2:** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

**RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

**RST.6-8.5:** Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.

**RST.6-8.8:** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

## Core Vocabulary

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

**red 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.

| | | |
|---|---|---|
| **avalanche** | **compression** | **CT scan** |
| **metabolism** | **MRI** | **placebo** |
| **tissue** | **X-ray** | |

A Glossary at the end of the Science Literacy Student Reader lists definitions for Core Vocabulary and selected Language of Instruction.

## 1. Plan ahead.

Determine your pacing to introduce the reading selections, check in with students on their progress, and discuss the reading content and writing exercise. If you are performing Science Literacy as a structured, weekly routine, you might implement a schedule like this:

- Monday: Designate a ten-minute period at the beginning of the week to introduce students to the assignment.
- Wednesday: Plan to touch base briefly with students in the middle of the week to answer questions about the reading, to clarify expectations about the writing exercise, and to help students stay on track.
- Friday: Set aside time at the end of the week to facilitate a discussion about the reading and the writing exercise.

You'll proceed with the in-class lesson investigations during this week.

## 2. Preview the assignment and set expectations. (Monday)

- Let students know they will read independently and then complete a short writing assignment. The reading selection relates to topics they are presently exploring in their Cells and Systems unit science investigations.
- The reading and writing will be completed outside of class (unless you have available class time to allocate).
- Preview the reading. Share a short summary of what students can expect.
  - *First, you will read a fictitious diary entry about a car accident. It includes callouts that explain some of the medical technologies mentioned.*
  - *Next, you'll read a comic about a snowboarder's not-so-funny encounter with an avalanche. You'll learn some of the details about how the snowboarder survived.*
  - *Then you'll read how dishonest athletes cheat in sports competitions with some performance-enhancing techniques.*
  - *Finally, you'll analyze an ad for a compression sleeve that contains copper and then read a rebuttal from a medical doctor who lays down the facts.*
- Distribute Exercise Page 2. Preview the writing exercise. Share a summary of what students will be expected to deliver. Emphasize that Science Literacy exercises are brief. The focus is on thoughtful quality of a small product, not on the assignment being big and complex.
  - *For this assignment you will be expected to generate a two-part meme in response to reading one of the selections in Collection 2. The first part tells what people think happens to the body, and the second part tells what really happens.*
- Remind students of helpful strategies they can employ during independent reading. Offer the following advice:
  - *The reading should take approximately 30 minutes to complete.* (Encourage students to break reading into smaller sections over multiple short sittings if their attention wanders.)
  - *A good reading strategy is to scan through the collection first to see the titles, section headers, graphics, and images to see what the selections are going to be about before fully reading.*
  - *Next, "cold read" the selections without yet thinking about the writing assignment that will follow.*
  - *Then, carefully read the Exercise Page to understand the expectations for the writing part of the assignment.*
  - *Revisit the reading selections to complete the writing exercise.*
  - *Jot down any questions for the midweek progress check in class.* (Be sure students know, though, that they are not limited to that time to ask you for clarification or answers to questions.)

**Exercise Page**



**EP 2**

## 3. Touch base to provide clarification and address questions. (Wednesday)

Touch base midweek with students to make sure they are on track while working independently. You may choose to administer a midweek minute-quiz to give students a concrete reason not to postpone completing the reading until the last minute. Ask questions such as these, and have students jot answers on a half sheet of paper:

| Suggested prompts | Sample student responses |
|---|---|
| *What can CT scan technology show about the brain?* | *if there is swelling or a concussion* |
| *What happens to a person's metabolism when their body is very cold?* | *It slows down, and the body uses less oxygen.* |
| *What is the effect of increasing the number of blood cells in an athlete's body?* | *The body can deliver more oxygen to muscles, enhancing performance.* |
| *What is the effect of compression on an injured joint?* | *It reduces swelling.* |

Ask a few brief discussion questions related to the reading that will help students tie the text content to students' classroom investigations.

| Suggested prompts | Sample student responses |
|---|---|
| *What can an MRI show that cannot be seen on an X-ray?* | *It can show injuries to body parts that are not bones, such as ligaments and muscles.* |
| *You learned in Lesson 4 that blood is a system. What part of the system functions to carry oxygen to the body?* | *red blood cells* |
| *How might a medicine that increases blood flow to the heart improve an athlete's performance?* | *If more blood travels to the heart, the heart can pump more blood and more oxygen to the muscles used in the sport.* |

Refer students to the Exercise Page 2. Provide more specific guidance about expectations for students' deliverables due at the end of the week. See the Online Resources Guide for a link to examples of memes if that would be helpful.

- *Recall that there was a meme writing task in Unit 1. Since then, you have probably seen many more examples of memes shared as texts or on social media.*
- *The writing expectation for this assignment is to create a two-part meme that demonstrates a change in understanding of the human body in a visual way and with a minimal amount of text.*
- *Since you have several topics and many ideas to choose among, your meme should be very different than those of your classmates.*
- *Think about the audience for your meme as being other students in your school. The meme expresses your response to reading, but it should also be interesting to people with whom you share it.*

Exercise Page



EP 2

- *While most internet memes have photos, this assignment only requires a drawing. Drawing skill is not required—stick figures and simple outlines can work, too.*
- *The important criterion for your meme are that it shows off your new understanding of people and their health with just a picture and a few words.*

- Remind students that many internet memes use foul language or are offensive in other ways. Their product must avoid this problem.
- Answer any questions students may have relative to the reading content or the exercise expectations.

## 4. Facilitate discussion.

(FRIDAY)

Facilitate class discussion about the reading collection and writing exercise. The collection begins with a young person's journal entry about a family car accident that is supported with science and medical explanations.

Student Reader



Collection 2

| Pages 14–21<br>Suggested prompts | Sample student responses |
|---|---|
| *What is the general purpose of the first selection, "Imaging Injuries"?* | *It compares and contrasts three technologies for seeing inside the human body.* |
| *What do the three technologies described have in common?* | *All three use electromagnetic waves to make images.* |
| *Which works better for hard tissues—X-rays, MRIs, or CT scans? Soft tissues?* | *X-rays work better on hard bones. MRIs and CT scans work better on soft tissues.* |
| *What is the general purpose of the second selection, "Threatened—and Saved—by the Cold"?* | *It describes what happens to a person's body when they are buried in snow by an avalanche.* |
| *How is metabolism affected when the heart stops?* | *When the heart stops pumping, it means that blood stops flowing throughout the blood vessels, and oxygen, water, and other nutrients cannot reach the cells that need them to function.* |
| *What did you think about the author's choice to present this story as a comic?* | *I thought it was an odd choice because when I see a comic, I expect humor or fantasy and this reading had neither.*<br><br>*It was a good choice, because more people are willing to learn science if it is in the form of a comic with lots of pictures and a small amount of text.* |
| *What is the general purpose of the third article, "Blood Doping"?* | *It describes some ways athletes can "dope" their blood to gain an advantage in sports competitions.* |

**SUPPORT**—If you are using the recommended word envelope convention, check the envelope to see if it contains any words, phrases, or sentences that students need help understanding. Read key sentences aloud, and provide concise explanation.

**SUPPORT**—Give students some examples of the cellular functions that fall under the general term *metabolism* Explain that inside cells chemical reactions produce molecules needed for growth and repair, assembling amino acids to make proteins. Other chemical reactions break apart sugar and fat molecules to release energy needed for the organism to make muscles contract.

| Pages 19–23<br>Suggested prompts | Sample student responses |
|---|---|
| *How did the subheadings affect your understanding of the science in this selection?* | *The subheadings are like an outline and let me know that there are different ways of blood doping and what the effects can be.* |
| *From what you read about the 15-year-old skater Kamila Valieva, do you think she is at fault for cheating?* | *The excuse about sharing a glass with her grandfather seems like it was invented—it's a stretch.*<br>*On the other hand, she is only 15 and still a kid, so should she be punished if her adult coaches and parents made her take performance-enhancing drugs?* |
| *What is the general purpose of the fourth article, "Copper as Pain Reliever"?* | *The first page is an ad that tries to persuade people to buy a product that uses copper to heal joint pain. The second page is an article that explains why the product in the ad is not worth buying.* |
| *Which of the two sources of information in this selection is more credible? Explain how you know.* | *The medical doctor seems more credible because she refers to scientific and medical evidence to back up her claim that the sleeves probably do not help reduce joint pain.* |
| *Which claim in the ad is confirmed in the doctor's article?* | *that compression limits swelling* |
| *What would the placebo consist of in a scientific study of the effectiveness of copper-infused sleeves?* | *It would consist of a sleeve that performs compression but does not have the copper in it.* |
| *Take a look at the "Spot the BS" box. Can you detect the fishy claims being made?* | *Calling copper a "magical" metal seems like any science in the ad is just made up and not real.*<br>*"Do you wish you had more energy?" also seems suspect. How can copper on your knee give your whole body more energy? Doesn't our energy come from the foods we eat?* |

## 5. Check for understanding.

**Evaluate and Provide Feedback**

For Exercise 2, students should create a two-part meme in response to reading Collection 2. In the first box, they should write a misconception or lack of understanding of the human body or health issue related to one of the selections. In the second box, they should communicate the accurate science that explains or resolves the issue. In this exercise, students need only address one of the four selections. For example, the meme below is a response to reading the fourth selection. Provide feedback to students on their choice of topic, the accuracy of the science, and the design of the image and text elements.

**Online Resources**



## What People Think Happens



Wearing a copper compression sleeve for 60 days gets rid of knee pain.

## What Really Happens



After 60 days the knee pain goes away by itself.

Use the rubric provided on the Exercise Page to supply feedback to each student.

**EXTEND**—If students want to publish digital versions of their memes, allow them to use a drawing or slide-making application, or point them to smartphone or online meme generators. Meme tools have templates students can edit and step-by-step directions for creating, downloading, and sharing their memes. Some allow GIF or video clips instead of using an image. Check the age requirements, content for vulgarity, and privacy policy of any tool before students use it to make sure it conforms with your school district's internet-use policies.

LESSON 6

# What will we see if we look at skin, bone, and muscle with the microscope, too?

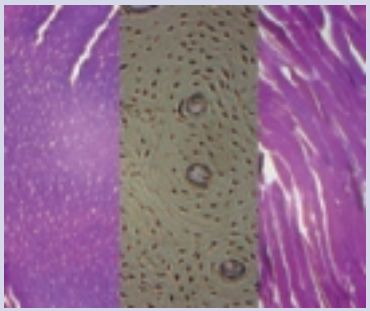
## Previous Lesson

*We noticed nerves in the cross section of the foot and wondered why they were present. We observed images of them and noticed they have a unique structure. We read about nerve cells and learned how their unique structure relates to their function. We engaged in activities to experience how nerves work and then considered how we can leverage what we know about nerves to better understand the healing process.*

## This Lesson

**Investigation**

**1 DAY**



We recall how microscopes helped us investigate blood and nerves, so we think microscopes can also help us figure out what makes up skin, bone, and muscle. After predicting what we think we will see, we investigate pre-prepared slides of human skin, bone, and muscle. Then, we use our observational data to come to consensus around how cells' unique structures support their functions in the body.

## Next Lesson

*Students will take an individual assessment where they plan an investigation to collect data to determine if other things are made of cells. They will analyze microscopic images of living and non-living things as data to look for evidence of cells and use these data to argue from evidence that other things are made of cells, mainly parts of things that are (or used to be) living—not things that were never living.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**6.A** Analyze and interpret observational data of microscopic structures of skin, bone, and muscle, relating those structures to the functions of those parts of the body.

## What Students Will Figure Out

- Bone, muscle, and skin have repeating patterns of microscopic structures called *cells*.
- The unique structures of the cells that make up these different parts of the body are related to their function:

    - Bone cells form ring-like patterns close together to provide structure and strength for the body.
    - Skin cells squish together to create protective layers that keep things in or out of the body.
    - Muscle cells are long and stringy so that they can stretch and contract, allowing parts of the body to move.
- Many cells work together to form tissues in the body.
- Structure is the characteristic of something (the shape or way it's made or arranged) that supports its function.

## Lesson 6 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 5 min | **NAVIGATION**<br>Reflect on how analyzing images at a microscopic scale has helped us figure out some things about the blood and nerves and how looking at skin, bone, and muscle at a microscopic scale might help us. | A-B | Our Body as a System poster |
| 2 | 20 min | **INVESTIGATE SKIN, BONE, AND MUSCLE WITH A MICROSCOPE**<br>Students work in groups to investigate pre-prepared slides of human skin, bone, and muscle to see what these body parts are made of. | C-F | *Investigating Skin, Bone, and Muscle with a Microscope*, Investigate Skin, Bone, and Muscle with a Microscope |
| 3 | 17 min | **CONSENSUS DISCUSSION ABOUT STRUCTURE AND FUNCTION**<br>Students use their observational data to come to consensus around how the structure of cells that make up different parts of the body support their functions in the body. | G-I | *Investigating Skin, Bone, and Muscle with a Microscope*, Our Body as a System poster, markers, 3 sheets of blank 8.5×11 inch paper |
| 4 | 8 min | **UPDATE PROGRESS TRACKERS AND REFLECTION**<br>Reflect on and record what we figured out about cells and their structure/function relationship. | J-K | |

*End of day 1*

## Lesson 6 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Investigate Skin, Bone, and Muscle with a Microscope materials | | • microscope<br>• pre-prepared slide of human skin<br>• pre-prepared slide of human bone (compact)<br>• pre-prepared slide of human muscle (striated) | |
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Investigating Skin, Bone, and Muscle with a Microscope* | | • Our Body as a System poster<br>• markers<br>• 3 sheets of blank 8.5x11 inch paper |

**Materials preparation (30 minutes)**

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

In this lesson, students use microscopes to look at different samples on pre-prepared slides. The materials (slides, handouts, discussion prompts) all assume your microscopes have a 10x eyepiece lens and 4x, 10x, and 40x objective lenses. If the microscopes your class will be using are different, modify the materials accordingly or call students' attention to the differences. If you do not have microscopes for your class to use, here are some options:

- A partner high school may have microscopes that you could borrow for this unit. Order the slides included in the unit materials list.
- We have included images of what students would see when zooming in on different body parts with the microscope in *Microscopic Images of Muscle, Bone, and Skin*, and they can use these to make their observations.
- Access the Virtual Microscope interactive. From there, copy the link for viewing **skin, bone, and muscle**, and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson.

Be sure you have materials (e.g., blank piece of paper, sticky note, or note card) to add the following words to the Word Wall: **cell, tissue, structure.** Cell membrane and cytoplasm are labeled on the cell word wall image, but not defined. Do not post these words until your class has developed a shared understanding of their meaning.

**Online Resources**



If students have concerns about using the human tissue samples on the prepared slides, you may use the micrograph images provided on *Microscopic Images of Muscle, Bone, and Skin* or access the Virtual Microscope interactive instead. However, you can also remind students that tissue samples like these came from people who willingly underwent a procedure called a *biopsy* to remove them for study. In a biopsy, doctors cut very thin slices of tissue from a patient and observe it under a microscope to try to discover the presence, cause, or extent of a disease. If there is still concern about using the micrographs, an illustration could be used instead, but the limitations of the illustration would need to be discussed.

## Investigating Skin, Bone, and Muscle with a Microscope

- **Group size:** Divide your class by the number of microscopes available.
- **Setup:** Be sure all microscopes have access to an outlet (or other power source for the light).
- **Notes for during the lab:** Students should plug in the microscope. Have students sanitize microscopes between turns.
- **Safety:** Glass slides are fragile. Have an appropriate receptacle ready for disposing of broken glass, as well as a broom and dustpan specifically reserved for any glass cleanup. Remind students to handle the slides carefully and ask you for help if one happens to break.
- **Disposal:** Keep all materials for future use.
- **Storage:** Unplug or turn off and cover microscopes when not in use to avoid dust.

**Lesson 6 • Where We Are Going and NOT Going**

**Where We Are Going**

In this lesson, students synthesize all the evidence they've been gathering from their microscope investigations. They will collect more data about the microscopic structures (cells) that make up parts of the body, and relate the patterns they find to the parts' function. By the end of this lesson, students will develop general definitions of cells and tissues.

**Where We Are NOT Going**

While we will add "cells" to the Word Wall in this lesson, we will not be identifying or naming key parts until later lessons: Lesson 9 (nucleus, chromosomes, cell membrane) and Lesson 11 (add to cell membrane). Other parts of a cell, such as the mitochondria or chloroplasts for plants, will not be added in this unit, as they are not needed to explain our healing story; rather, they will be added in later units—students will add mitochondria when they investigate cellular respiration in *Inside Our Bodies Unit* and add chloroplast as a structure found in plant cells structure when they figure out photosynthesis in *Maple Syrup Unit*.

The recommended slides for today's investigation (as well as the images provided on *Microscopic Images of Muscle, Bone, and Skin* and the Virtual Microscope interactive) are of compact bone and skeletal muscle. However, this unit will not discuss or investigate the different types of bone (e.g., cancellous or spongy) or muscle tissue (e.g., smooth or cardiac). The focus of the unit is not on discovering the different names and types of bones and muscles in the body; rather, the focus is on supporting students in figuring out that our bodies are made up of cells and that parts of the body are made of different types of cells that are structured differently depending on the part's function. In addition, we will discuss how there are many cells of similar types found in each sample. These cells work together, allowing that part of the body to function. We will refer to groups of cells of similar type as a *tissue* (e.g., skin or bone tissue).

# LEARNING PLAN FOR LESSON 6

## 1. Navigation

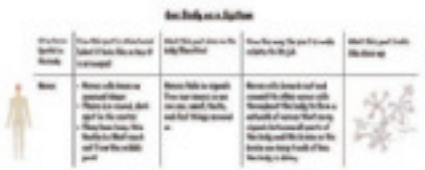
5 MIN

**Materials:** Our Body as a System poster

**Navigate into today's work.** Display **slide A.** Say, *In our last two lessons, we have been analyzing images of different parts of our body at a microscopic scale. What did analyzing blood and nerves at the microscopic scale help us figure out?*

Sample student responses include:

- *Blood is made of a mixture of a liquid called* blood plasma *and some very tiny structures called* red blood cells, white blood cells, *and* platelets.
- *Nerves are made of nerve cells that have branch-like arms that reach out and stretch to carry signals all over the body.*
- *The blood cells' round shape helps them move easily through the blood vessels and travel around the body.*
- *The platelets have arm-like structures on them to do the job of sticking together when there's damage, and they need to plug a hole so blood doesn't keep leaking out.*



Refer back to ***Our Body as a System* poster.** Say, *If we look back at* Our Body as a System *poster, we have some ideas about the different parts of the body that were injured in Lesson 1. Looking just at the blood and nerves for now, we looked at where both blood/blood vessels and nerves are located in the body and what they look like up close. What did looking at these parts at different scales help us figure out?*

Students should mention that we figured out each of these are made up of smaller structures called *cells*. And that there are blood vessels all over our body just like there are nerves all over our body. We have figured out that there are smaller components that make up the blood and nerves that we can only see with a microscope, and those components have shapes or characteristics that help them do their specific jobs.

Say, *How could looking at the skin, bones, and muscles closer up using microscopes possibly help us figure out how these different parts function and heal?* Sample student responses include:

- We can use the microscope to see what skin, bone, and muscles are made of.
- We could see if they also have smaller structures that we can only see close up.
- If we can see what these parts of the body are made of, it might help us figure out what needs to heal at this scale so that the foot can move again.

### Additional Guidance

Prior to this point in the unit, your students most likely will have suggested that parts of the body (other than blood and nerves) are made of cells. Students may argue at this point that the other parts of our body are also made of cells and that we could use microscopes to help us see if these other body parts are also made of cells. By the end of this lesson, we will add "cells" to the Word Wall, but at this point we still need evidence that we see cells in other areas in the body when we look close up with a microscope.

**Make predictions about what we might see with the microscopes.** Display **slide B.** Direct students to turn and talk with a neighbor about these questions.

- *What do you think we will see when we look at muscle, skin, and bone with the microscope?*
- *Will it look like blood? Will it look like nerves? Will it look like something different? Why do you think this will be so?*

After a moment of partner talk, ask students to share their ideas with the class. Accept all responses.

## 2 . Investigate skin, bone, and muscle with a microscope.

20 MIN

**Materials:** Investigate Skin, Bone, and Muscle with a Microscope, science notebook, *Investigating Skin, Bone, and Muscle with a Microscope*

**Establish our investigation questions.** Display **slide C.** Ask, *What will looking at bone, skin, and muscle under the microscope help us figure out about these parts of the body?*

Sample student responses include:

- *We want to see if there are cells that make up these parts of the body too.*
- *If there are cells, will they look like either of the other two types of cells we saw?*

**Recall what we know about cross sections.** Distribute *Investigating Skin, Bone, and Muscle with a Microscope* and direct students to write the questions the class agrees on at the top of the page. Students can affix this page into their science notebooks now or after today's investigations. Display **slide D.** Say, *In Lesson 3, we used cross sections to investigate what parts inside of the body look like. The samples of skin, bone, and muscle that we are going to investigate today are also cross sections. They're very, very thin slices of those body parts that have been stained, allowing us to see how they are structured.*

### Additional Guidance

You may want to tell students that tissue samples like these came from people who willingly underwent a procedure called a biopsy to remove them for study. In a biopsy, doctors cut very thin and small slices of tissue from a patient and observe it under a microscope to try to discover the presence, cause, or extent of a disease.

**Review our procedure for looking at slides.** Display **slide E.** Direct students to read the steps listed on the slide (also listed on *Investigating Skin, Bone, and Muscle with a Microscope)* to themselves.

*** Attending to Equity**

**Universal Design for Learning:** In order to support students who might benefit from other options for *representation,* you may choose to print *Microscopic Images of Muscle, Bone, and Skin* and direct them to annotate those images with ideas about how they compare to what students see in their microscopes and/or ideas about the patterns they notice in the structures they see across the samples.

## Safety Precautions



Glass slides are fragile. Have ready an appropriate receptacle for disposing of broken glass, as well as a broom and dustpan specifically reserved for glass cleanup. Remind students to handle the slides carefully and ask you for help if one happens to break.

Say, *We've had some practice now handling slides in this unit, adjusting the microscopes' focus and light, and changing objectives. Why is it helpful to observe a slide at all of the possible objectives before you decide which observation to record?*

Sample student responses include:

- *Sometimes we need a wider field of view—it's not helpful to be too close to see everything that's there.*
- *But sometimes we can see more detail at a higher magnification, looking closer.*
- *Different magnifications could allow us to see how something is structured more clearly.*

## Alternate Activity

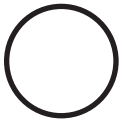
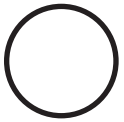
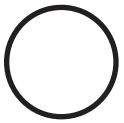
If no microscopes are available, you have these options:

- Use the images provided on *Microscopic Images of Muscle, Bone, and Skin*.
- Access the Virtual Microscope interactive. From there, copy the link for viewing **skin, bone, and muscle**, and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson.

Students can document their observations on *Investigating Skin, Bone, and Muscle with a Microscope* while using either of these materials.

Alternatively, you could print consumable copies of *Microscopic Images of Muscle, Bone, and Skin*, and direct students to annotate the images with their thoughts about patterns and scales. If you choose to have students annotate images, it will likely take less time than if students are recording observations on the handout.

**Discuss our plans for recording data.*** Display **slide F**, which shows the data table that's also on *Investigating Skin, Bone, and Muscle with a Microscope* and is shown below for your reference.

| Sample being observed | Total magnification of the best view | Drawing of the whole field of view at the best magnification | Use words and/or drawings to describe any patterns you see |
|---|---|---|---|
| | |  | |
| | |  | |
| | |  | |

Say, *Okay, so you see that the data table on your handout has space to record the magnification that you can find the best view—that means you're at a high enough magnification to closely see the structures that make up this tissue and you're able to focus clearly on them. We'll be comparing our data later. Why will it be important for you to record the magnification at which you made your drawings?*

Sample student responses include:

- *If we're looking for similarities and differences, we'll need to know whether something is actually structured differently, or whether it just looks different because we were viewing them at a different magnification than others.*

Say, *Also notice that this data table has space for you to record with drawings what you see in the field of view. Choose the magnification that provides you the clearest view to use for what you draw. Then describe any patterns that you see. Why are we looking to identify patterns here? How could noticing patterns help us find answers to our investigation questions?*

Sample student responses include

- *Noticing patterns might help us figure out what the different parts look like close up.*
- *We might notice a pattern between how a part looks with our eyes and how it looks close up.*
- *Noticing patterns in how things are arranged or structured may give us insight into how the part functions, like when we noticed how nerve cell branches extend to reach other nerves, allowing signals to be passed throughout the body.*

**Direct students to begin their observations.** You might choose to flip back to **slide E** to display the investigation procedure**.** Circulate among groups to support students as they work.

## Additional Guidance

Students will likely notice that the samples they're observing today have been stained, similar to the blood and nerves, and they may even notice similar colors among the different slides. But they will know that their skin doesn't look the same color as the sample on the slide. If they are confused by the colors they see on the slides, remind them about why samples are stained. Scientists and doctors use dye when looking at samples under the microscope so they can more clearly see different structures in a sample.

## 3. Consensus Discussion About Structure and Function

17 MIN

**Materials:** science notebook, *Investigating Skin, Bone, and Muscle with a Microscope*, Our Body as a System poster, markers, 3 sheets of blank 8.5x11 inch paper

**Bring the class together to share their data with a partner.** Display **slide G.** Assign each student a partner to talk with who was not in their microscope group. Give students 2-3 minutes to discuss these questions, using their data to support their responses.

1. What similarities did you see (between the same body parts and across different ones)?
2. What differences did you see?
3. How do you think the structure of the various parts of the body you saw help it do its function? What makes you think that?

**Lead a Consensus Discussion about structure and function.** Display **slide H**. Gather in a Scientists Circle with their science notebooks and *Investigating Skin, Bone, and Muscle with a Microscope*. Use prompts that follow to discuss the microscopic structures seen in these body parts. Update the *Our Body as a System* poster during and/or after this discussion to summarize these ideas.

During or after the discussion, ask for volunteers or choose students to make "zoomed in" drawings on 8.5x11 paper for bone, skin, and muscle to add to the *Our Body as a System* poster on the right. Sample updated poster and drawings after the discussion prompts.

### * Supporting Students in Developing and Using Scale, Proportion, and Quantity

This question requires students to think about the body parts at different spatial scales—they've zoomed in with the microscopes and now they have to think about what's happening in the larger body parts to consider how each structural unit contributes to the tissue structure and function within the body part.

You might choose to revisit the cross-sectional diagrams on *Close-up Diagrams of Skin, Muscle, and Bone* from Lesson 3 and notice with students that the artist may not have represented in these diagrams exactly what we actually see at the microscopic scale. The artist's purpose with the diagrams was to show what we cannot see from outside the body and the ways these structures are connected. Now that we've seen these structures with the microscope, we might appreciate how difficult it would be to illustrate those connections while trying to show the structures at a microscopic scale.

## Additional Guidance

If you have a microscope that can be plugged into a computer, it may be helpful to project that while the class reports out what they found. This way students can come up to the screen and point out what they found or are referring to in their explanations.

## Key Ideas

**Purpose of this discussion:** Students share the differences they observed in the bone, skin, and muscle cross sections. They name those structures *cells* (like in the blood and nerves), but the cells found in these parts of the body are packed together (called tissue).

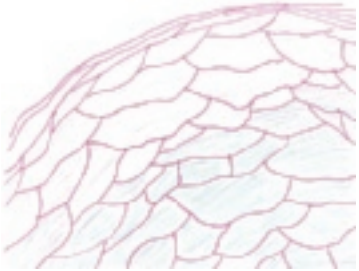
**Listen for these ideas:**

- There are patterns of small structures in each of these samples that we can only see with a microscope. These microscopic structures are called *cells*.
- Repeating patterns of cells working together form tissues in the body.
- Bone, muscle, and skin tissue are structured differently for them to perform a function.

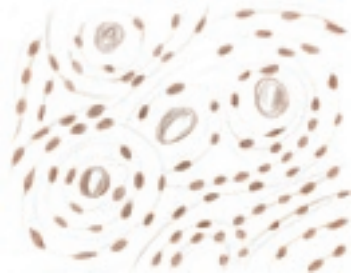
| Suggested prompts | Sample student responses |
|---|---|
| *What similarities did you notice when you compared what you saw in the muscle, skin, and bone cross sections?* | *We saw a pattern in each that was of similar smaller structures.*<br>*Each cross section is made of smaller structures because we can see where each individual one is.*<br>*The structures in the skin looked rectangular or flaky shaped and were all up against each other.*<br>*The structures in the muscle looked long and stretchy.*<br>*The structures in the bone looked like rings.* |
| *How were each of the cross sections different?* | *The structures in each one had different shapes and different patterns.* |
| *How do the structures that we saw today compare to those that we saw in the blood and nerves?* | *We saw patterns of tiny structures that repeated themselves in the blood and nerves, but they were spread out with distance between each of them. In the bone, skin, and muscle, the structures are packed together.*<br>*The structures we saw today were all right next to each other.*<br>*In some, we could see individual structures like the skin and muscle, but it was hard to see in the bone.* |
| *What did we call those structures in the blood and nerves?* | *cells* |
| *So let's keep referring to these small structures that we see at the microscopic scale as cells. Going back to the bone, skin, and muscle, did we see evidence of microscopic structures in these parts of the body?* | *Yes!* |

| Suggested prompts | Sample student responses |
|---|---|
| *When you analyzed these samples on the slides, how many cells would you say you could see for each?* | *Lots!*<br>*Hundreds or millions!* |
| *How could you tell there was more than one cell?* | *For each one, they looked very similar…. Like for the skin sample, the cells all looked like squished rectangles, or for the muscle cells they all looked like stretchy long strands.*<br>*Yeah, and there are many of them on the slide.* |

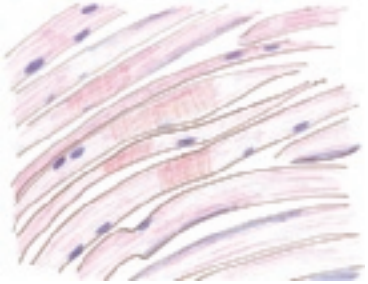
At this point, add the images of the microscopic drawings of the skin, bone and muscle to the right side of *Our Body as a System.* See examples here:



Skin at high magnification

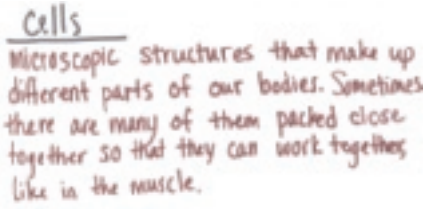


Bone at medium magnification



Muscle at medium magnification

Add "cells" to **the Word Wall.** Display **slide I.** Say, *For each of our samples, we were able to see that there are many cells because they all look very similar to each other when they come from the same location in the body. Let's add the word "cell" to our Word Wall.* Your definition might be something like "microscopic structures that make up different parts of our bodies. These all look different in the different parts of the body. Sometimes there are many of them packed close together so that they can work together, like in the muscle."

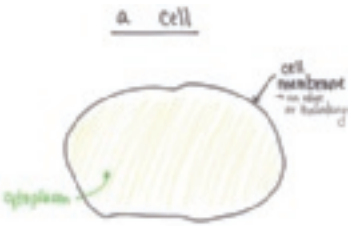



Use **slide I** to discuss how to tell one cell from another. You might even ask student volunteers to come up the board and point to where there is one cell in each of the samples projected. They may even use a marker to outline one or two different cells.

| Suggested prompt | Sample student responses |
|---|---|
| *We also have seen that the different types of cells all look different from each other if they come from different locations, but what would you say is similar between the different types of cells?* | *They all have a definite shape.*<br>*They all have an outer edge or boundary.*<br>*They all have stuff inside of them that is sometimes colored by the dye used for slides.* |

Say, *Let's add this to our definition of the cell by making an image of a cell on a paper and labeling what you all said is similar between the cells. This might help us later as we continue to figure out more about what things are made of cells.*

Draw an image of a cell on a separate piece of paper. Then say, *The edge, or boundary, that you all noticed in your samples is called a* cell membrane *by scientists, so let's label the edge as the* cell membrane. *And the stuff inside is called the* cytoplasm. At this point, you might also choose to add cards for "red blood cells," "white blood cells," "nerve cells," "skin cells," "muscle cells," and "bone cells" as examples underneath the word "cells," on the Word Wall, or connect the definition of "cells" to the drawings of them on your *Our Body as a System* poster. It is suggested that you place the drawing of the cell that you just created next to the Our Body as a System poster to help students generalize the similarities between cells while also having the actual structure of each type of cell we have been investigating.

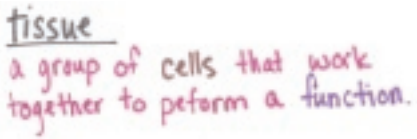



This idea of a cell having a definite boundary—the cell membrane, and stuff inside this boundary, cytoplasm, will be useful for your students as they move through the rest of the unit and figure out that living things are made of cells. These two structures of a cell will provide something students can look for when analyzing other microscopic images of other things, both living and non-living.

## Additional Guidance

You may choose to take a moment and connect what we've figured out about cells to the nature of science: Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge. Cells were named by an English scientist named Robert Hooke, who observed them in 1665. He was familiar with monasteries—religious buildings that have small individual rooms called *cellula* for the monks who live there. See the **optional slide** for images of monasteries so your students can connect those little rooms to the patterns of cells they've seen in their investigations. The Latin word *cella* ("small room," "storeroom," or "chamber") is related to the Latin word *celare,* which means "to hide" or "conceal."

Say, *Let's make note that cells look very similar when they are from the same part of the body and they look different when taken from different parts of the body. Many cells from a particular part of the body are referred to as a* tissue. *A tissue is a group of cells that work together to perform a function.* **Add "tissue" to the Word Wall.**




Say, *Do you think if you had only one muscle cell by itself, it could still do its function to move the bones and skin of the body?*

Sample students responses:

- No, the cell is so small compared to the bone or the skin.
- There were so many cells on the slides we looked at, and that was just a very thin little piece of that part of the body, so I think it takes millions of muscle cells to move the bones around.

Say, *Right, it takes many cells working together for a part of the body to be able to perform its function.*

**Continue the discussion.** Say, *How might the structure of these cells that make up the skin, bone, or muscle help contribute to their function? Do we have evidence to support our claims about this connection to the function—that the structure of the cell from a part of the body is arranged the way it is so that it can perform its function in that part of the body? To consider this, we're going to be thinking about the microscopic scale (what we just saw in these cross sections), and we also need to zoom back out and think about these parts at the scale we can see (our body parts).**

Use prompts, such as those that follow, to support the class in finding consensus about how characteristics or structures of these cells, when arranged in a tissue, contribute to the function of the body part.

## Key Ideas

**Purpose of this discussion:** Students come to consensus about how the shape and composition of the cells found in each tissue contribute to its function.

**Listen for these ideas:**

- The unique structures of these cells are related to their function (and that tissue's function) in the body:
- Bone cells are hard to see, but there are regular circular rings close together to provide structure and strength for the body.
- Skin cells squish together and overlap one another to create a protective layer that keeps things in or out of the body.
- Muscle cells are long and stringy so that they can stretch and contract, allowing the body to move.

| Suggested prompts | Sample student responses |
|---|---|
| *Let's remind ourselves—what did we say are the functions of these parts? Skin, bone, and muscle?* | *We said the skin protects the body—it keeps things out and keeps other things in.*<br>*The job of the bones is to support our bodies—working with the muscles to hold us up and move us.*<br>*The muscles' function is to stretch and move our bodies.* |
| *OK, so let's think about each of these body parts and see if we have evidence for this claim that the cells' structure supports their function. If we start with the skin, for instance, how would you describe the pattern of skin cells you saw in that tissue?* | *The skin cells were very close together—like squished together and stacked on top of each other with no space between them.*<br>*The shape looked a little like fish scales—kind of rounded, kind of jagged where the edges of one met another one.* |
| *So how does the way the skin cells look and the way they are arranged allow them to do their job?* | *Skin's job is to cover the body and protect it—keep things out and keep things in. So having closely packed, flat-looking cells that layer up on top of each other makes sure nothing gets into the body through the skin.* |

| Suggested prompts | Sample student responses |
|---|---|
| *Does the structure of muscle cells support their function? What's your evidence?* | *Muscles stretch and move our bodies—they can stretch out and back like rubber bands, right? So, the muscle cells are long and stringy-looking (but all going the same direction, not like a pile of spaghetti).*<br>*At really high magnification, I could see stripes or ridges or something on the stringy muscle cells—I wonder if those help them stretch out and come back, like a spring does.* |
| *Does the structure of bone cells relate to their function? Why do you think so?* | *Bones have to be really strong to support our bodies—that's their job. The patterns in the bone were circular, like the rings of a tree. That shape might help them be strong.* |

**Reflect on how the use of scale has helped us figure out more about structure and function.** Say, *So now we have looked at different parts of our body at different scales, both macroscopic and microscopic. Open to the next blank page in your notebook, title it "Using different scales" and answer this question, "How has looking at these different body parts using different scales helped you figure out more about the structure and function of these parts?"*

**Begin thinking about interactions between different parts in our body.** Position yourself near the Our Body as a System poster and say, *Back in Lesson 4 when we added to this poster what we had figured out about the blood and blood vessels, we had agreed that we could think about them as a system in our body, like the Blood System.*

| Suggested prompts | Sample student responses |
|---|---|
| *Looking at what we have figured out about these other parts in our body, could we think of any of them as systems in our body, like the muscle system?* | *Yes! I think so.* |
| *What would be the components or parts of the muscle system?* | *The different muscles in our body and the cells that make up the muscles.* |
| *And, using our system thinking then, how are these parts or components interacting in this muscle system?* | *The muscles need to work together to move the body. If just one muscle is working, the whole part of the body won't be able to move. And the cells that make up the muscles need to work together.* |
| *What about the bones? Could we think about them as a system?* | *Yes! There are different bones in the body, and these bones are made of cells too!* |
| *Okay, and what are we thinking about the skin and the nerves?* | *They also could be systems!* |

Say, *Let's label this on our poster for each of these systems.* See an example of the updated *Our Body as a System* poster here.

| Suggested prompt | Sample student response |
|---|---|
| *In Lesson 2, we titled this poster Our Body as a System. Do you think we can keep this title still?* | *Yes! Our body has many parts that interact!* |

Say, *So it seems like we have systems within our body, that is also a system. Maybe if we can figure out more how these systems within our body work on their own and together within our body, then we will be able to figure out more about how our body heals.*



## 4. Update Progress Trackers and reflection.

8 MIN

**Materials:** science notebook

**Update Progress Trackers in science notebooks.** Display **slide J.** Direct students to the Progress Tracker section of their notebooks (landscape orientation) and have them add rows for what we've figured out about cells today. Remind students that this tracker is their space to process and record their thoughts while we're working to figure out how an injury can heal. (This is a moment for formative assessment but not for scoring or grading.) Give students about 5 minutes to update their trackers. See the sample student responses shown below.

| Question | What we figured out in words/ pictures | This makes me think or wonder about healing. . . |
|---|---|---|
| What will we see if we look at the skin, bone, and muscle with a microscope, too? | The parts of the body are made of cells, and those cells are structured differently to allow them to perform their function in the body.<br>• Bone has ring-like patterns close together to provide structure and strength for the body.<br>• Skin cells squish together and overlap one another to create a protective layer that keeps things in or out of the body.<br>• Muscle cells are long and stringy so that they can stretch and contract, allowing the body to move. | If I know how something is structured, I can figure out what needs to get fixed in order for it to heal.<br>We know how the parts of the foot (a body) are structured and how that supports their function when they're not injured. |

## Assessment Opportunity

**Building towards: 6.A** Analyze and interpret observational data in the microscopic structures of skin, bone, and muscle, relating those structures to the functions of those parts of the body.

**What to look for**: See the sample responses shown above.

**What to do:** When using the Progress Tracker as a formative assessment opportunity, recall that it should not be scored or graded. You are simply checking to see if your students were able to summarize the main takeaways from today's work and then directing your instruction accordingly. If students struggled to refer to patterns they saw in their investigation data to support their ideas about structures and functions, you may choose to have them use a copy of *Microscopic Images of Muscle, Bone, and Skin* and annotate it to highlight the repeating structures they see. Ask them to describe those structures and/or patterns in words. Then, refer back to the Parts of a Body poster and connect those descriptions to what the class figured out about the functions of the bones, skin, and muscles.

**Conclude today's work and look ahead to next time.** Display **slide K.** Ask students to turn to the next blank page in their notebook and reflect on how using different scales has helped them figure out more about the structure and function of the different parts of the body we have been investigating. If any new questions have been raised today, be sure to add them to the Driving Question Board. Then say something like, *Now that we have figured out what makes up the different parts of the foot system so that they can function correctly, let's go back to our* How the Foot Heals Over Time? Timeline *next time and capture what we have figured out there.*

LESSON 7

# Are all things made of cells?

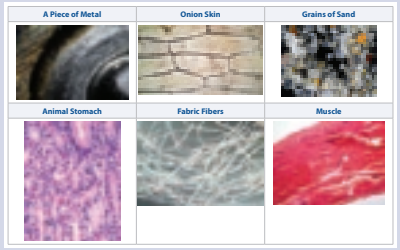
## Previous Lesson

*We wanted to figure out what makes up skin, bone, and muscle, and we thought microscopes could help us do that. We made some predictions, and we observed pre-prepared slides of human skin, bone, and muscle to come to consensus around how cells' unique structures support their functions in the body.*

## This Lesson

**Putting Pieces Together**

**1 DAY**




This lesson marks the end of the first lesson set. Students take an individual assessment where they plan an investigation to collect data to determine if other things are made of cells. They analyze microscopic images of living and non-living things as data to look for evidence of cells. They use these data to argue from evidence that parts of living (or formerly living) things are made of cells—not things that were never living are not made of cells.

## Next Lesson

*We will revisit the healing model from Lesson 1 and Driving Question Board to identify questions we have answered. We will revise our definition of healing to include that it involves cells filling in the gaps caused by an injury. We will observe a time-lapse video of a skin wound healing. We will revise our model to predict what happens with cells for skin to heal.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**7.A** Plan an investigation and construct an argument using evidence from the microscopic scale that all things are not made of cells.

**7.B** Develop a model at a zoomed-in scale to describe what changes happen to the structure and function of skin cells at the time of injury.

## What Students Will Figure Out

- Microscopic samples from living things that we analyze are made of cells.
- Microscopic samples from things that were never living are not made of cells.

## Lesson 7 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 3 min | **NAVIGATION**<br>Connect what we figured out last time to our work today. | A | How Does the Foot Heal Over Time? poster from Lesson 1 |
| 2 | 5 min | **WHAT ELSE IS MADE OF CELLS?**<br>Students brainstorm what else could be made of cells in our world. | B | Our Body as a System poster |
| 3 | 17 min | **ANALYZE MICROSCOPIC IMAGES** | C | *Part 2: Are Other Things Made of Cells?*, you might also want *Microscopic Images of Various Objects* for a color version |
| 4 | 10 min | **BUILDING UNDERSTANDINGS DISCUSSION**<br>Facilitate a discussion about what students figured out from the assessment. Come to consensus that all things are not made of cells. | D | chart paper, markers |
| 5 | 5 min | **NAVIGATION** | E | |
| 6 | 5 min | **HOME LEARNING**<br>Explain that for home learning, students will be analyzing a copy of the questions on the DQB to look for ones that can be answered. | F | A copy of the DQB questions from Lesson 1, *DQB Questions or Parts of Questions We Have Answered* |

*End of day 1*

## Lesson 7 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Part 1: Are Other Things Made of Cells*<br>• *Part 2: Are Other Things Made of Cells?*<br>• you might also want *Microscopic Images of Various Objects* for a color version<br>• A copy of the DQB questions from Lesson 1<br>• *DQB Questions or Parts of Questions We Have Answered* | | • How Does the Foot Heal Over Time? poster from Lesson 1<br>• Our Body as a System poster<br>• chart paper<br>• markers |

**Materials preparation (minutes)**

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

In this lesson, students analyze secondhand data of microscopic images to look for evidence of cells. These images are included in part 2 of *Part 2: Are Other Things Made of Cells?*. If you are unable to print these in color, there is a color reference of the images alone in the Student Edition. Students may benefit from using the color version for reference when annotating a black-and-white copy. If you are not using the Student Edition, these can also be printed in color (*Microscopic Images of Various Objects*) as a non-consumable class set for student reference. Have paper ready at the end of the lesson to add to the *Our Body as a System* poster, if needed, as the class will be adding a new science idea to the poster.

**Online Resources**



## Lesson 7 • Where We Are Going and NOT Going

### Where We Are Going

All students' ideas generated during Lessons 1-6 will be relevant in this lesson. This lesson is a putting the pieces together lesson. It includes a midpoint assessment, along with a scoring guide for the assessment.

Students will analyze images of multiple items at a microscopic scale to look for evidence of repeating microscopic structures that have the cellular structure of the cell membrane (definite edge) with stuff inside this boundary.

### Where We Are NOT Going

Though some of the images show parts that are made of similar structures that students have investigated in previous lessons, the focus of this assessment is not on identifying common structures among the parts (i.e., human skin and tomato skin); rather, the focus is on students working toward meeting MS-LS1-1 (Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.).

Students will not yet be able to argue by the end of this lesson that **all** living things are made of cells; rather, they will be able to argue that all things are NOT made of cells and parts of living things are made of cells. At the end of this lesson, the class will hold a discussion to make noticings about how the images of objects that are living have cells while the images of objects that were never living do not have cells. They will continue to build on this idea in later lessons so that by Lesson 10, they will be able to argue that all *living* things are made of cells, whether they are uni- or multicellular.

# LEARNING PLAN FOR LESSON 7

## 1. Navigation

3 MIN

**Materials:** How Does the Foot Heal Over Time? poster from Lesson 1

**Revisit the *How Does a Foot Heal?* poster to help us connect our work in the unit back to the anchoring phenomenon.** Display **slide A.** Say, *Last time we used a microscope to investigate skin, bone, and muscle tissue, and so far we have figured out a lot about the parts that make up a foot and how they interact and work together. But we still have more to figure out about how the foot healed from the injury. Let's begin by taking stock of what we have figured out about the healed foot.*

It might be helpful to position yourself near the *How Does a Foot Heal* poster, so that you can refer to different points on the timeline as you facilitate this brief discussion.

| Suggested prompts | Sample student responses |
|---|---|
| *The last few classes when we looked at samples of blood, nerve, bone, skin, and muscle under the microscope, what did we figure out about those parts?* | *Bone, skin, muscle, blood, and nerve cells all looked different.*<br>*Yeah, and the tissues, or repeating pattern of cells, looked different from each other too.*<br>*It makes sense that they look different because they all have different functions.*<br>*Each type of tissue had a repeating pattern of cells that supported its function.*<br>*There are lots of cells that make up each part; we can see by looking for the edges of the repeating patterns of the cells.* |
| *Can someone remind us why we were learning more about the bone, skin, muscle, nerve, and blood?* | *We wanted to know how those parts function and work together when they're not injured and how they are structured to perform their functions, so that we can figure out what has to heal for the injured foot to work again.* |

Say, *OK, so if we look at our* How Does the Foot Heal Over Time? *poster, we have figured out a lot about the different parts, or structures, of an uninjured foot. Let's see if we can apply what we have figured out so far to some other objects or materials.*

## 2. What else is made of cells?

5 MIN

**Materials:** science notebook, Our Body as a System poster

**Brainstorm what else could be made of cells.** Point to the *Our Body as a System* poster and say, *We looked at some different parts of our body, and of other organisms (like cat blood), under the microscope and have evidence these parts are all made of cells.*

| Suggested prompts | Sample student responses |
|---|---|
| *What about other parts of our body? Do you think they are also made of cells?* | *I think so!*<br>*I have heard of brain cells.*<br>*Yes, I've heard of heart cells.* |
| *What about other parts of other animals? Do you think they are also made of cells?* | *I think animals are made of cells too!*<br>*We saw that ox have nerve cells and cats have blood cells.*<br>*And we saw that chickens also have muscles, skin, and bone—I think those are made of cells too, like our bodies.* |
| *What about other things we see around our classroom? If we look at other things around us under the microscope, would we see cells?* | *Hmm. . . I am not sure.*<br>*No, I think only things that are alive have cells.*<br>*Maybe. . .* |
| *What would we be looking for to determine if something is made of cells?* | *We would want to see repeating patterns of the same structure with an edge or cell membrane to them and the stuff inside.* |

Display **slide B** and say, *Read the question on the slide silently to yourself. This is what you will think about today, and you will use what we have figured out so far to help you look for evidence of whether other things are made of cells.* Distribute *Part 1: Are Other Things Made of Cells?*. Orient students to what they are going to record here. Say, *Think about other things you predict would also be made up of cells. List these at the top of Part 1: Are Other Things Made of Cells? in the first part titled "Brainstorm".* Give students about two minutes to record their ideas.

**Explain the rest of Part 1 of the assessment.** Say, *Now that you have some things listed that you think might be made of cells, record how you would collect the data that could be used as evidence for whether all things are made of cells. Begin by making a claim about whether you think other things are made of cells. Then choose one of the things you brainstormed and recorded as having cells and use the prompts in the next question to help you record a plan about how you would investigate whether the thing you listed is made of cells.*

Give everyone about five minutes to record how they would design this investigation. As students are working, walk around and make silent observations over their shoulder about what objects they are recording as having cells. This will help with the next part of the lesson.

## Assessment Opportunity

**Building towards: 7.A.1** Plan an investigation and construct an argument using evidence from the microscopic scale that all things are not made of cells.

**What to look for/listen for:** Students who want a closer look at the objects using cross sections and samples under the microscope.

**What to do:**

If students are having trouble getting started, ask, *What kind of investigation could you do to figure out what the items you listed at the top of your paper look like close up? How could you figure out if the items you listed at the top of the page are made of cells? What have we done in class that helped us figure out some parts of our body are made of cells?* Encourage students to look back in their notebook and at the *Our Body as a System* poster to help them remember what they did in class to figure out that parts of our body are made of cells.

## Additional Guidance

Over the course of the unit, students will continue to collect evidence to help them meet MS-LS1-1 (Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.). This is the first time they will have an opportunity to think about whether other parts of our body, or other parts of things around them in the world, are made up of cells. In this lesson, the purpose for this assessment is for them to have an opportunity to think about how to investigate whether other things are made of cells. Students will not have enough evidence at this point in the unit to argue whether all living things are made of cells; however, by the end of this lesson, they will be able to argue:

- All things around us are NOT made up of cells.
- Parts of living things are made up of cells, while parts of things that were never living are not made up of cells.

This science idea will be returned to in Lesson 10 when we investigate unicellular organisms (bacteria). At that point, we will revise this idea from "All things are not made up of cells" to "All living things are made up of cells, whether single-celled or multicellular." There is no need at this point in the unit to steer students toward this big idea; we will return to this later.

## Additional Guidance

Students will not be carrying out the investigation they plan but instead will be given some secondhand data to analyze. The purpose of asking students to plan the investigation is to gain feedback about where students are at in thinking about how using different scales can help us figure out more about the structure of materials. We developed this first part of the assessment so that it was more open, allowing students to brainstorm about any material they think might be made up of cells. It is not realistic to predict what students will brainstorm, nor is it necessary for students to take the time to create slides to analyze from scratch. Thus, after students have developed a plan for ***how***

they would investigate whether different materials are made of cells, they are given microscopic images as data from an investigation that was done by others. They can then use these images to look for evidence of cells, using what they have figured out so far about what cells look like.

## 3. Analyze microscopic images. 17 MIN

**Materials:** science notebook, *Part 2: Are Other Things Made of Cells?*, you might also want *Microscopic Images of Various Objects* for a color version

**Share with students that they will get some secondhand data.** Say, *As I was walking around, I saw you all had great ideas about how we could investigate this question about whether all things have cells and what materials to use. We wanted to see a whole bunch of different things under the microscope. Currently, I don't have all the tools and supplies for us to be able to make these slides in our classroom of all of these things you have brainstormed, but I do have some images of different items under the microscope that were done by others. I am going to share a copy of images taken from these other investigations to use as secondhand data—feel free to write on it, mark it up, and make it your own as you use it to find evidence to support or refute your claim from Part 1 of the assessment.*



**Analyze data from microscopic images.** Show **slide C.** Distribute *Part 2: Are Other Things Made of Cells?* to each student. Say, *Record your claim from Part 1 of the assessment at the top of Part 2. Then take some time analyzing the microscopic images. Think about what we have figured out about what a cell looks like and how we have identified cells on our Word Wall and on the* Our Body as a System *poster. As you analyze the images, feel free to annotate and mark up the images as you look for evidence of the different materials being made up of cells or not. Using this evidence, write an argument supporting or refuting your claim.*

Give students about 15 minutes to complete this part of the assessment. When they are finished, they should turn in both *Part 1: Are Other Things Made of Cells?* and *Part 2: Are Other Things Made of Cells?*.

### Assessment Opportunity

**Building towards: 7.A.2** Plan an investigation and construct an argument using evidence from the microscopic scale that all things are not made of cells.

**What to look for/listen for**: Students arguing that all things are not made of cells because some of the images they analyze do not have evidence of cells.

**What to do:**

If students are still not sure whether all things are made of cells, ask them to look back at the images on the *Our Body as a System* poster to articulate what cells look like, or how we know there are cells in the examples. Then encourage them to compare the images on the assessment to the images included on the class poster. Ask them to include in writing this comparison and then, using this comparison, explain what they can conclude about whether all things are made of cells.

## 4. Building Understandings Discussion

10 MIN

**Materials:** chart paper, markers

**Facilitate a discussion about whether all things are made of cells.** If possible, convene a Scientists Circle where the class can see the slides, and the two posters *How Does a Foot Heal Over Time?* and *Our Body as a System*. If this is not possible, then ensure students can see all of these. Display **slide D** so that the class can see the images from the assessment. Say, *Based on the data you saw of the different microscopic images represented on the slide from the assessment, what did you figure out about how they were structured? Do you think those things were made of cells?*

| Suggested prompts | Sample student responses |
|---|---|
| *Are all things made of cells?* | *No!*<br>*All the images didn't have repeating patterns with definite edges and the same type of stuff in the middle.* |
| *Which of the images had evidence of being made up of cells?* | *the tomato skin*<br>*the cow muscle*<br>*the rat liver* |
| *What did you notice about things not made of cells?* | *They didn't have any small repeating cells.*<br>*The metal and water didn't look any different than when we look at them at regular magnification.*<br>*The sand had small pieces that look like rocks, but they aren't repeating, with the same type of edge and stuff in the middle, like the cells we looked at.* |
| *So if we wanted to think about the differences between the objects on the slide that are made of cells and the objects that aren't made of cells, how might we categorize the things you analyzed that are made of cells versus not made of cells?* | *The three things we analyzed are things that are (or used to be) living.*<br>*Yeah, cows and rats are animals and tomatoes come from a plant.*<br>*The other things that we looked at, the water and metal and sand, are not living.* |
| *Do you think if we looked at other living things, we might also find they have parts that are made of cells?* | *Yes!*<br>*I think so. We found that parts of our body are made of cells, and we saw cat blood cells and ox nerve cells.* |

Say, *OK, so it sounds like we have a new science idea. Let's record it onto or next to the images of the cells we found in the different parts of our body.* On the *Our Body as a System* poster or on a new chart paper added to the right of this,

negotiate with the class how to capture this new idea in wording that makes sense for your students that is something similar to:

- "Parts of living things are made of cells."
- "Parts of non-living things are not made of cells."

### Additional Guidance

The purpose of recording this new science idea near the *Our Body as a System* poster is to support students in incrementally figuring out that *all* living things are made of cells. At this point in the unit, they are not ready to generalize out to all living things, but they do have evidence that parts of living things are made of cells and that parts of things that were never living are not made of cells. By Lesson 12, they will be able to make the generalization to all living things after investigating unicellular organisms and figuring out the interaction between body systems at the cellular level.

There is no need to probe or push the students toward this generalization about all living things being made of cells at this point.

## 5. Navigation

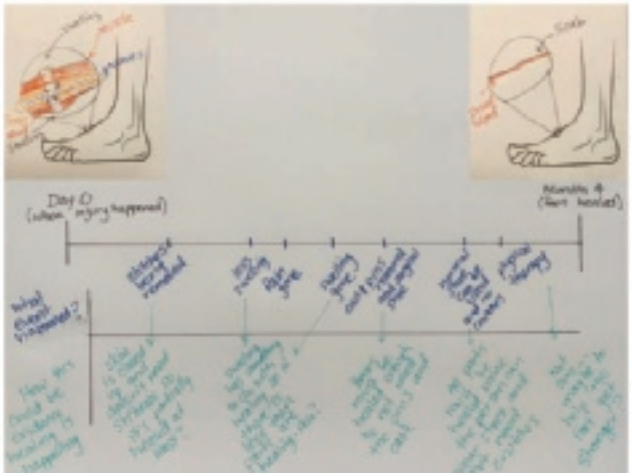
5 MIN

Materials: science notebook



**Brainstorm what we should figure out next by revisiting the poster *How Does the Foot Heal Over Time?*** Remain in the Scientists Circle if the class is there and display **slide E.** Point in the model to the left of the injured foot and say, *Everything we have figured out so far refers to the parts of the foot before our timeline begins. We have been figuring out a lot about what is happening in our body for it to move and function prior to an injury. Now that we have figured out what these parts look like close up, and how these parts move and function, let's return to our case from Lesson 1.*

Point to the class model of the injured foot. Tell students to open a new page in their science notebook and title it, "What does it look like close up when a part of our body is injured?" Say, *Using what you now know about what these different parts look like close up at the cellular level, choose one of the parts to develop a model of what you think they would look like right at the point of injury when the gap appears in the foot—or in other words right after the weight landed on the foot. If we could look close up at the gap or injury site right when it happened, how do you think it would look similar or different from what it looked like prior to the injury? How would these changes be connected to the change in function of the foot after the injury?*



Tell students to only choose **one** of the parts included on the slide, that we know was injured, to model—skin, bone, or muscle. Give them a few minutes to develop their model in their notebook.

## Assessment Opportunity

**Building towards: 7.B** Develop a model at a zoomed-in scale to describe what happens to the structure and function of skin cells at the time of injury.

**What to look for/listen for**: The purpose of this assessment is formative in nature. Students have now figured out a lot about how the different parts of the body are made of cells and that all of these cells are unique to that part of the body. Now we need to begin to shift and make sense of what happens at the cell level for the body to heal from an injury. At this point in the unit, this assessment is formative in the sense that students should include cells in their models, specifically the type of cell that corresponds to the body part they chose to model in their notebook. They should also include how the injured part results in a change in the function of the foot. Students may represent the injured part at the cellular level in many different ways, such as:

- Cells damaged or missing
- Cells pushed apart but not broken

**What to do:** For students who are hesitant to brainstorm what this might look like at a cellular level, use probing questions such as the one below to help support them in incrementally developing this model:

- What do you already know about how the (part of the body they chose to model) looks under the microscope?
- When the weight fell on the student's foot and injured it, what did the (part of the body they chose to model) look like in the images from the doctor?
- Now imagine you could zoom in on (part of the body they chose to model) after the weight injured it. What do you think the cells would look like?

## 6. Home Learning

5 MIN

Materials: A copy of the DQB questions from Lesson 1, *DQB Questions or Parts of Questions We Have Answered*

**Explain Home Learning.** Display **slide F.** Distribute to each student a copy of *DQB Questions or Parts of Questions We Have Answered* and a digital copy of the questions from the Driving Question Board using the record you made at the end of Lesson 1. Using the instructions on *DQB Questions or Parts of Questions We Have Answered*, tell students to read through the questions and identify which ones can be answered now and which ones we still need to make progress on. If there is time, read through the instructions in case students have any questions.

### Additional Guidance

Revisiting the DQB at pivotal points over the course of the unit is important for students to have time to take stock of what they have figured out so far in order to support their sense-making. At this point in the unit, students should be able to answer many of the questions around what parts of our body are made of while still having a lot of the questions around the healing of these parts unanswered. Many times the revisit of the DQB is done as a whole class to identify which questions can be answered.*

*** Attending to Equity**

For some students, processing which questions can be answered with evidence may take longer than others, and when this is done in a whole group, certain students may struggle to follow all the answered questions. By giving this activity as home learning, students will have an opportunity to process all the questions the class has, which will allow more to be ready to share the next day in class. In addition, taking the questions from class home to read through and identify which can be answered will potentially allow students to share with their trusted adults what they have been doing in class.

LESSON 8

# What happened as the skin on top of the foot healed?

## Previous Lesson

*Students took an individual assessment where they planned an investigation to collect data to determine if other things are made of cells. They analyzed microscopic images of living and non-living things as data to look for evidence of cells. They used these data to argue from evidence that parts of living (or formerly living) things are made of cells; things that were never living are not made of cells.*

## This Lesson

**Problematizing, Investigation**

**1 DAY**



We revisit the How Does the Foot Heal over Time? poster and Driving Question Board to connect the questions we have answered, such as what the parts of the foot are and how they work together to help it function. We revise our definition of healing to include that it involves cells filling in the gaps caused by an injury, but we do not know how. We observe a time-lapse video of a skin wound healing to gather more information about what happens during the healing process. We revise our model to predict what happens with cells at the microscopic scale for skin to heal.

## Next Lesson

*We will analyze a video and microscopic images of cells growing and splitting in different organisms. Observing this process at different spatial and time scales will help us figure out how our body fills a gap at the site of an injury.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**8.A** Develop a model to predict how the interacting systems and subsystems of groups of skin cells work together to form or repair new tissues and organs.

## What Students Will Figure Out

- New skin cells form from existing skin cells at the site of the injury, causing the wound to get smaller and smaller.

## Lesson 8 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 10 min | **REVISIT THE DQB TO IDENTIFY WHAT QUESTIONS CAN BE ANSWERED**<br>Revisit the DQB and How Does the Foot Heal over Time? poster to take stock of what we have figured out so far. | A | *DQB Questions or Parts of Questions We Have Answered* (from Lesson 7), How Does the Foot Heal over Time? poster, DQB, chart paper, markers |
| 2 | 10 min | **OBSERVE A TIME-LAPSE VIDEO OF SKIN HEALING**<br>Observe a time-lapse video of a wound healing after a bike crash. Record noticings and wonderings about the healing process. | B-D | *Time-Lapse Video of Skin Healing Observations*, pen or pencil, tape, Knee-Scrape Time-Lapse video 6.6 Lesson 8 Knee-Scrape Timelapse (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), chart paper, markers, Our Body as a System poster |
| 3 | 10 min | **REVISE OUR MODEL OF SKIN HEALING**<br>Individually model what we think happens to skin cells as they close the gap at the site of the injury. Share ideas in small groups using a modified talking stick protocol. | E-F | pencil or pen, chart paper, markers |
| 4 | 10 min | **REVISE OUR DEFINITION OF HEALING**<br>Revise our definition of *healing* based on what we have figured out. | H | Word Wall (or What Do We Mean by Healing? poster), How Does the Foot Heal over Time? poster, Related Phenomena poster |
| 5 | 5 min | **NAVIGATION**<br>Share new questions about how cells fill in the gap in the skin or foot. | I | sticky notes, markers |

*End of day 1*

## Lesson 8 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *DQB Questions or Parts of Questions We Have Answered* (from Lesson 7)<br>• *Time-Lapse Video of Skin Healing Observations*<br>• pen or pencil<br>• pencil or pen | • tape<br>• pencil or pen | • How Does the Foot Heal over Time? poster<br>• DQB<br>• chart paper<br>• markers<br>• Knee-Scrape Time-Lapse video 6.6 Lesson 8 Knee-Scrape Timelapse (See the **Online Resources Guide** Guide for a link to this item. **www.coreknowledge.org/cksci-online-resources**)<br>• Our Body as a System poster<br>• Word Wall (or What Do We Mean by Healing? poster)<br>• Related Phenomena poster<br>• sticky notes |

**Materials preparation (10 minutes)**

**Online Resources**



Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Gather materials for the Driving Question Board (DQB): chart paper, large sticky notes or notecards, and markers, for students to attach answers to questions that can be removed from the DQB.

Test the Knee-Scrape Time-Lapse video at 6.6 Lesson 8 Knee-Scrape Timelapse (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**).

Create two posters with these titles: "Mini Timeline of Skin Healing" and "How Does Skin Fill the Gap?"

Have materials (e.g., a blank piece of paper or sticky note) to revise the definition of *healing* on the Word Wall. If you have been using the What Do We Mean by Healing? poster from Lesson 1 to keep track of the class's definition, then feel free to use that instead of the Word Wall. Do not post the revised definition until your class has developed a shared understanding.

Other posters from previous lessons that will be referred to in this lesson include: Our Body as a System poster (Lesson 2), How Does the Foot Heal over Time? poster (Lesson 1), Related Phenomena poster (Lesson 1).

## Lesson 8 • Where We Are Going and NOT Going

### Where We Are Going

This lesson is a return to Lesson 1's anchor phenomenon of a foot injury healing with the lenses we have subsequently developed, to think about the body as a system composed of interacting subsystems and how body parts are structured to allow them to perform their functions. This lesson motivates us to look deeper at healing and conduct future investigations to figure out how healing works at a cellular level. These investigations are spread out over the next four lessons, and then the pieces are put together to fully revise the students' foot healing model in Lesson 12.

### Where We Are NOT Going

In this lesson, we observe healing at the visible level with just our eyes to brainstorm what would be happening at the cellular level. We will investigate how cells make more cells during the next lesson.

# LEARNING PLAN FOR LESSON 8

## 1. Revisit the DQB to identify what questions can be answered. 10 MIN

**Materials**: science notebook, *DQB Questions or Parts of Questions We Have Answered* (from Lesson 7), How Does the Foot Heal over Time? poster, DQB, chart paper, markers

**Convene a Scientists Circle to review the DQB.** Display **slide A**. Gather students into a Scientists Circle around the DQB and How Does the Foot Heal over Time? poster. Make sure students bring the handout *DQB Questions or Parts of Questions We Have Answered* and their science notebooks along with chairs. Say, *Let's take stock of what we have figured out and what we still want to know about how living things heal.**

**Share out DQB questions and students' responses.** Create a new poster titled "Questions We Have Answered" and hang it next to the DQB. As students share their responses to questions on the DQB, have the class decide whether the DQB question was fully answered or partially answered. If it was fully answered, move the sticky note to the new poster. If the question was partially answered, put a check mark on the sticky note to keep track of what still requires more work, and leave it on the DQB. When time allows, either this day or another day, have students work in groups to document answers to the questions that have been moved to the new poster. Students can use 5-x-8 notecards or large sticky notes to record their answer and post it on the poster next to the question, similar to what they did in Lesson 5.

Use the prompts below to guide the discussion. Students will realize that we have answered a lot of questions about the foot, its structures, and how it functions. However, we are missing ideas about the healing process and other living things.

| Suggested prompt | Sample student responses |
|---|---|
| *How does what we've figured out about healing in the foot injury from Lesson 1 connect to questions on the DQB?* | *We wanted to know what skin, bone, and muscle are made of and what kept them from functioning in the injured foot.*<br><br>*We know that there are skin cells, muscle cells, and bone cells—they are all different.*<br><br>*We know that how a cell is shaped contributes to the function that it does in the body.*<br><br>*We know that cells form tissues, and these tissues (skin, muscle, and bones) work together to help the body to function.*<br><br>*When we break or injure body parts, there are gaps that cause the body part to lose its overall function. In Lesson 2, the function of the muscles in the chicken wing was not the same after the injury.*<br><br>*We know there are parts of the Healing Timeline we don't know much about, like what happened with the skin right after it was cut or what happened with the bone between X-rays.* |

*** Supporting Students in Engaging in Asking Questions and Defining Problems**
Revisiting the DQB helps students track the class's progress toward answering questions that were important to them. This helps build and sustain student buy-in, keeps learning relevant to students, and can generate new questions that may continue to motivate new directions to pursue.

| Suggested prompt | Sample student responses |
|---|---|
| *Where do we still have questions?* | *We want to know how the systems of the body work to heal the site of the injury where there are gaps in bone, skin, and muscle. We need to rethink how those gaps are filled.*<br>*We still don't really know what happened when his foot went from injured to healed.*<br>*We don't know how the parts reconnected so he could walk again.* |

**Revise our driving question and summarize topics of unanswered questions.** Say, *Currently, our main driving question for our DQB is focused on how the foot from Lesson 1 healed.* Use the prompts below to guide revision of the driving question.

| Suggested prompts | Sample student responses |
|---|---|
| *Do you think answering our questions would help us understand how other types of injuries heal?* | *Yes!* |
| *Do you think some of these same questions could be about other types of injuries that happen to our bodies?* | *Yes, because different parts of our bodies are made of cells, so similar things might happen to heal other parts besides bone or skin.* |
| *How could we revise our main driving question to capture this idea that we are figuring out more than just how a foot heals?* | *Maybe we could change it to "How does our body heal?"* |

Once the class comes to an agreement on how the driving question could be revised, edit it on the DQB. An example of what students might suggest is "How Does Our Body Heal?" Use the prompts below to help students connect the unanswered DQB questions to the How Does the Foot Heal over Time? poster.

| Suggested prompt | Sample student responses |
|---|---|
| *We think we still need to know more about healing, so let's look back at our How Does the Foot Heal over Time? poster. What parts on the poster are showing evidence of healing in the foot?* | *We know he got his stitches out, so the skin on his foot must have healed.*<br>*We know he got the cast off, so we think that the bone was healed.*<br>*It says he was able to do some exercises again, so we think his muscles have healed.* |

| Suggested prompts | Sample student responses |
|---|---|
| *Do we always need things like casts and stitches for the body to heal? Explain.* | *No, sometimes the body can heal itself, but maybe stitches or cast help it heal faster or in a certain way.*<br>*Maybe for injuries that aren't as bad, the body can heal the injured part without extra things–just on its own.* |
| *How might we be able to observe the body healing itself?* | *We could see the bone on an X-ray at different points in time.*<br>*We could look at a lesser injury to the skin because that is what healed first and we can see it from the outside.*<br>*Maybe we can look at a time-lapse video of a part of the body healing over time to see the changes that happen.* |

Say, *Okay, let's look more closely at what is happening as injured skin heals over time to see what more we can figure out about how a gap in the skin gets filled in.* Tell students to return to their seats.

## 2. Observe a time-lapse video of skin healing. 10 MIN

Materials: science notebook, *Time-Lapse Video of Skin Healing Observations*, pen or pencil, tape, Knee-Scrape Time-Lapse video 6.6 Lesson 8 Knee-Scrape Timelapse (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), chart paper, markers, Our Body as a System poster

**Watch a time-lapse video of skin healing after a bike crash.** Display **slide B**. Say, *Okay, let's see if we can figure out what happens when skin heals over time after an injury, without the help of stitches or something else outside the body. We will do this by looking at a time-lapse video of a surface-level scrape to the skin, and then see if we can use what we figured out to explain what happened when the injured foot healed.*

Distribute the handout *Time-Lapse Video of Skin Healing Observations* to each student. Show the Knee-Scrape Time-Lapse video at 6.6 Lesson 8 Knee-Scrape Timelapse twice. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) During the first playing, have students watch without recording any information. During the second playing, have them record 2-3 noticings on their handout in the row "What I can see with my eyes" for each time point. Ask students if there are any parts of the video they need to see again. Then have them complete the row "What I think might be happening at the microscopic scale". If time permits, ask students to share ideas in small groups.

**Create a class timeline of noticings and wonderings.** Display **slide C**. Ask students to share what they noticed and wondered about as they watched the video. As they share, create a Mini Timeline of Skin Healing on chart paper, similar to the one made in Lesson 1, to document students' ideas about what they saw happening. Use the prompts below to elicit ideas about the healing process.

| Suggested prompts | Sample student responses |
|---|---|
| *What did you notice first as the skin healed?* | *There was dark dried blood.*<br>*The skin was open.*<br>*There was bright blood.*<br>*It was red around the scrape.* |
| *What happened next in the process as the skin healed?* | *The skin scabbed, but there was still a large scrape area.*<br>*As time passed, the scab got smaller.* |
| *What happened toward the end of the skin healing?* | *The scab was gone and skin covered the scraped area.* |
| *What do you think was happening that was not visible with our eyes at these time periods?* | *(Accept all answers.)*<br>*We don't know!* |
| *What do you think was happening in the time between each image?* | *Maybe there are new cells because there is new skin.*<br>*Maybe cells came from somewhere else.*<br>*By the end it was all skin, and we know skin is made of cells, so somehow it got filled in with skin cells.* |
| *Look back at the Our Body as a System poster. Which body parts do we need to keep track of when we think about how the skin healed from the scrape?* | *Cells: Skin cells especially should be a part of this, because we know that skin is made up of cells. And blood cells, like platelets, because there was blood and a scab.*<br>*Skin: Obviously we see new skin filling the gaps.*<br>*Blood: We observed blood and then noticed the dried blood on the wound falling off.*<br>*Maybe nerves: Although we may not have direct evidence for this, from my experience I know having a scrape like this hurts a lot, so the nerves might have some role too.*<br>*We don't have any evidence for muscle or bones in this time-lapse video, but we think they are important for explaining how the foot healed.* |

Say, *Now that we have a better idea of what is visibly happening with the skin as it heals and the gap gets closed up, let's see if we can capture our ideas for what we think is happening at a microscopic level with the* ***cells***.

Display **slide D**. Have students tape *Time-Lapse Video of Skin Healing Observations* onto a left-hand page in their science notebooks and title the page "Time-Lapse of Skin Healing". Then tell them to title the opposite right-hand page "Initial Model of Skin Healing".

## 3. Revise our model of skin healing. 10 MIN

**Materials:** science notebook, pencil or pen, chart paper, markers

**Individually develop an initial model for what is happening with the cells to fill the gap.** Display **slide E**. Say, *Let's see if we can capture these ideas in a model. Use the page you just titled "Initial Model of Skin Healing." Take 5 minutes to develop a model that represents what you think was happening with the cells at the site of injury in the time-lapse so that the gap in the skin was filled, or healed, over time. As you develop your model, use what we have figured out about the different parts or structures of our body, what these structures do, and how they interact with other systems in our body, to show what parts are involved in this process of closing the gap from the scrape. Include these structures as part of your model.* Give students about 5 minutes to complete this model.

### Assessment Opportunity

**Building towards: 8.A** Develop a model to describe the unobservable mechanisms of interacting systems and subsystems of groups of skin cells that work together to form tissues and organs.

**What to look for/listen for:** This formative assessment has multiple purposes: (1) As a model to see students' initial ideas about how skin cells could fill in a gap caused by an injury. (2) To see how students integrate what they figured out about the skin being made of cells. They should draw many cells when depicting the intact skin tissue. (3) To see what initial connections students make about interactions between the different parts of the body. For example, look for inclusion of blood and blood cells, because there was blood and a scab in the time-lapse. Also look for students to draw any blood or other cells differently than skin cells (because they have a different function) from the skin cells.

**What to do:** Accept all responses. Push students to refer to their Progress Trackers, Our Body as a System, and what they noticed in *Time-Lapse Video of Skin Healing Observations* to show what is happening to the skin cells in their model. If students are stuck, ask them to first describe what they observed in the Knee-Scrape Time-Lapse video, and then explain what happened to the skin cells.

**Share models in small groups.** Display **slide F**. Tell students to use the directions on the slide to do a modified talking stick protocol with their group.

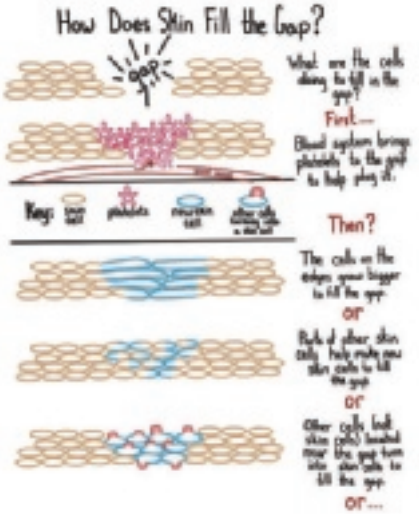
Small Group Talking Stick Round 1:

- Take your model with you and meet with the small group you are assigned to.
- When given the start signal, pass around a pencil as a talking stick and take turns, each person using their model to explain how skin cells form new skin on the foot (1 minute per person).
- As each person shares, think about how their idea compares with other models you've seen (including your own).

Small Group Talking Stick Round 2:

- Pass the talking stick around again to have each person share at least one similarity, difference, or question they noted about the models that were shared (1 minute per person).
- Students may also choose to share what they would revise about their initial model based on what they heard from their peers about their models.

**Facilitate an Initial Ideas Discussion about how skin cells fill the gap from an injury.** Display **slide G**. Use the prompts below to discuss how to look closer at what is happening in the gap as the injury decreases in size and new skin fills the gap. During the discussion, create a poster titled "How Does Skin Fill the Gap?" Include multiple examples on this poster, as your class will not be in consensus. Documenting numerous ideas will help us look for evidence in subsequent lessons of what is happening at the cellular level. Your poster might include some of the ideas seen here.




| Suggested prompts | Sample student responses |
|---|---|
| *What do we know about what is happening as the skin heals?* | *We know that the size of the gap in the skin decreased over time and that there was skin where the injury/gap was before.*<br>*We know that there is skin at the site of the injury and that skin is made of cells.* |
| *What don't we know about what is happening as new skin develops in the gap?* | *We don't know how more skin is made.* |
| *What are some of the different ideas you and your small group have for how this healing works?* | *(Accept all responses.)*<br>*The cells get bigger and fill in the gaps.*<br>*We make more skin cells to fill in the gaps, but we don't know what this looks like close up.*<br>*Maybe the blood cells or other cells turn into the cells that are needed.* |
| *How could we figure which of these ideas are correct?* | *We need to zoom in on what the cells are doing in the gap!*<br>*Could we use a microscope like when we looked at the bone, skin, muscle, and blood?* |

## 4. Revise our definition of healing.

10 MIN

**Materials:** science notebook, Word Wall (or What Do We Mean by Healing? poster), How Does the Foot Heal over Time? poster, Related Phenomena poster

**Revise our current definition of *healing*.** Display **slide H**. Walk over to the Word Wall or What Do We Mean by Healing? poster. Say, *Let's return to our definition of "healing". Now that we have figured out more about how parts of the body are structured and what might be happening as these parts heal, let's revise or update our definition.*

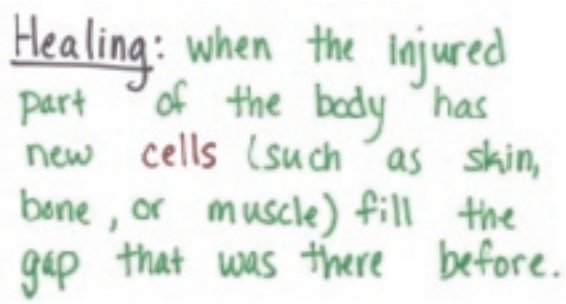
Have students stop and jot in their notebooks about what they think *healing* means, using what they have figured out about cells and how body parts are structured, with this prompt: "I used to think healing was … Now I think healing is …"

After 2 minutes, bring the class together to share out their ideas for revising our definition, using the prompts below.

| Suggested prompts | Sample student responses |
|---|---|
| *What did we used to think "healing" meant?* | *From the Lesson 1 Word Wall: Healing is the process that happens when your body is trying to put itself back together. That process may require assistance from medicine or technology.* |
| *How might we use what we've learned about cells and how parts of the body function to add to our definition of healing?* | *We know the healed parts of the body are made of cells, but when there is an injury, there is a gap in the body part that needs to be healed. So maybe healing means something about these parts of the body being connected again by cells.*<br>*Because we know that there are different structures at the microscopic scale called cells that make up parts of the body, we need to figure out more about how to make new cells to heal injured parts of the body.* |
| *What do we still need to figure out about healing?* | *We still don't really know about how the body part heals, but we do know that there are skin cells after the wound is healed. We think that healed bone must be made of new bone cells and healed muscles must be made of muscle cells. But we don't know how we get that new skin, bone, muscle, or bone.* |

**Post the revised definition of *healing*.** Your revision might be something like "when the injured part of the body has new cells (such as skin, bone, or muscle) filling the gap that was there before." Say, *Great, let's add our new definition of "healing" to our Word Wall (or the What Do We Mean by Healing? poster).*

**Revise the title of the How Does the Foot Heal over Time? poster.** Reference the poster. Say, *Up until now, we have been working to figure out how the injured foot from Lesson 1 healed over time. Today we saw a time-lapse of another injury, a skin scrape, healing over time.*



| Suggested prompts | Sample student responses |
|---|---|
| *If we can figure out more about how the gap in the skin from the scrape gets filled in, how might this help us explain how the gap in the foot heals over time? And vice versa–if we can figure out how the gap in the foot heals, how will it help us explain how the gap in the skin heals?* | *We figured out the different parts of our body are made of cells, so I think it might be very similar–how skin heals or how bone heals.* |
| *And what about some of the other injuries we have up on our Related Phenomena poster? Do you think if we figure out how the gap from the scrape heals and the gap from the foot heals, it will help us explain other related injuries?* | *Probably, if it has to do with parts that are made of cells.* |

Say, *So if we are thinking that the way different injured parts of our body heal over time is the same, then could we think of our How Does the Foot Heal over Time? poster maybe as How the Body Heals over Time? or How Does the Body Heal over Time?* Students should say yes.

## 5. Navigation

5 MIN

**Materials:** sticky notes, markers

**Share new questions about healing.** Display **slide I**. Say, *Do you have any new questions about the healing process in humans or other living things?*

Have a set of sticky notes and markers situated next to or near the DQB. Ask for volunteers to share their questions. After a student shares a question, ask them to write it on a sticky note with a marker and add it to the DQB. They can be doing this as the next person shares.

Student questions may include the following:

- Are there special cells whose job is to help the body heal?
- How different are the new cells from the cells that they are replacing?
- There are different types of cells, so do skin, muscles, and bone all heal the same way?
- What parts of the body are involved in the healing process, and how do they work together?
- Does the job of a cell change during the healing process?
- How does the healing process start?
- How do we know that the healing process has ended?

**Preface the next lesson.** Within the last minute, say, *Wow! We still have a lot of questions about healing, and more specifically now, about cells and healing. It seems like next time we need to take a closer look to see what's happening with the cells in the gap.*

LESSON 9

# What is happening at the site of an injury to fill the gap?

## Previous Lesson

*We revisited the healing model from Lesson 1 and Driving Question Board to connect questions we have answered. We revised our definition of healing to include that it involves filling in gaps where cells have been damaged or removed due to an injury. We observed a time-lapse video of the healing of a skin wound to gather more information. We revised our model to predict what happens with cells at the microscopic level for skin to heal.*

## This Lesson

**Investigation**

**1 DAY**



We analyze a video and microscopic images of cells growing and splitting in different organisms. By observing this process at different spatial (zoomed-in/out video and images) and time scales (full/half-speed video), we make sense of how our body fills a gap at the site of an injury, such as broken skin or bone.

## Next Lesson

*We will wonder whether cells need the same things to grow as humans do. We will investigate how single-celled organisms grow by analyzing data from a scientist who grew bacteria on agar plates with different nutrient levels. We will notice that the quantity of bacteria increases with increasing nutrient levels. We will read about other unicellular organisms to figure out that they all need food to grow and make more of themselves.*

## Building Toward NGSS

MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8

## What Students Will Do

**9.A** Analyze and interpret data from a video and microscopic images at varying spatial and time scales to conclude that new cells come from old cells following a predictable pattern of repeated steps.

## What Students Will Figure Out

- New cells come from old cells, which grow and split through a repeated and nonrandom process.
- When cells grow and split, they make new cells of the same type (e.g., skin cells make new skin cells and bone cells make new bone cells).
- A gap in the skin, muscle, or bone is filled by new cells as a result of cells growing and splitting.

## Lesson 9 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 7 min | **NAVIGATION**<br>Review our ideas from the previous lesson for what is happening in the gap in the skin. Guide students to think about what might be happening in the gap at the cellular level. | A-B | *Observations to Evaluate Claims*, How Does Skin Fill the Gap? poster (from Lesson 8), Needed Evidence Chart poster, markers |
| 2 | 8 min | **WATCH VIDEO OF CELLS SPLITTING**<br>Observe a video of mammalian cells splitting. Record observations about cells splitting. | C-E | *Observations to Evaluate Claims*, computer with internet access, 6.6 Lesson 9 Non-human, mammalian cells (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), How Does Skin Fill the Gap? poster (from Lesson 8) |
| 3 | 10 min | **LOOK CLOSER AT WHAT HAPPENS WHEN NEW CELLS ARE MADE**<br>Zoom in and observe microscopic images of whitefish embryo cells and onion root tip cells splitting. Record noticings and wonderings about cells splitting under higher magnification. | F-H | *Microscopic Images of Cells Splitting*, How Does Skin Fill the Gap? poster (from Lesson 8), Needed Evidence Chart poster, markers |
| 4 | 8 min | **MODEL WHAT WE OBSERVED AS NEW CELLS WERE MADE**<br>Co-construct a model summarizing what happens as new cells are being made. | | cell drawing from Lesson 6, chart paper, markers |
| 5 | 7 min | **ADD TO PROGRESS TRACKER**<br>Reflect on and record what we figured out about what happens at the site of injury to fill a gap. | I | |
| 6 | 3 min | **NAVIGATION**<br>Reflect on what we have figured out about cells and consider what ideas and questions we have about how cells are made. | J | New Cells Being Made poster |

*End of day 1*

## Lesson 9 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • *Observations to Evaluate Claims*<br>• computer with internet access<br>• science notebook<br>• *Microscopic Images of Cells Splitting* | | • How Does Skin Fill the Gap? poster (from Lesson 8)<br>• Needed Evidence Chart poster<br>• markers<br>• cell drawing from Lesson 6<br>• chart paper<br>• New Cells Being Made poster |

**Materials preparation (15 minutes)**

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Before the lesson, draw the Needed Evidence Chart poster from the table in Part 1 of *Observations to Evaluate Claims* on a piece of chart paper.

**Online Resources** 

Before the lesson, have the following video loaded and ready to play:

- Video: Human Skin Cells at 6.6 Lesson 9 Non-human, mammalian cells (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

If students do not have access to computers, project the video on a screen.

Have the How Does Skin Fill the Gap? poster from Lesson 8 ready during the opening navigation.

## Lesson 9 • Where We Are Going and NOT Going

### Where We Are Going

This lesson focuses on how cells grow and make more of themselves, specifically to fill a gap in tissue such as skin, muscle, or bone. This builds upon an idea students began developing earlier in this unit that the body is made of cells, and if a part is injured and we see that the healed part is made of cells, then the gap is likely also filled with cells.

A cell is a complete living system, because we have evidence that cells can grow and reproduce (grow and split).

In this lesson, we purposefully use the terms *growing* and *splitting* when referring to what we see the cells doing in the video and images. We want to support students in seeing that cells do get bigger–up to double in size–before they split into two cells. In Lessons 10 and 11, students add to this model as they figure out that cells need nutrients to grow and make more parts before splitting, and that the cell membrane lets in these nutrients to help the cells make more parts.

### Where We Are NOT Going

This lesson is not a time to name the phases of cell division or refer to this process as *mitosis*, as this information is above the grade band and will be discussed in greater detail in high school. Students do not have enough evidence from this lesson to conclude that the new cells are identical to the old cells; instead, they simply figure out that before a new cell is made, each part of the cell needs to be copied before splitting into two.

The purpose of this lesson is to identify which model from Lesson 8 of how the gap in the skin gets filled in best explains at a high level how an injured part of the body biologically heals.

Back in Lesson 6, we added an image of a cell that included the cell membrane and cytoplasm next to the Our Body as a System poster. In this lesson, students encounter two new cell parts: nucleus and chromosomes. The cell drawing from Lesson 6 is updated with these parts to support students in thinking of the cell as a system of components working together to perform a function. However, we do not investigate the function of these parts in detail. That will occur in later units and higher grade bands.

We intentionally avoid using the terms *dividing* and *multiplying* when referring to what we see the cells doing in the video and images. *Dividing* is a multiple-meaning word and implies a mathematical pattern by which the number of cells might be decreasing. This meaning is avoided by using the term *splitting* to indicate to students that you have more cells in the end.

# LEARNING PLAN FOR LESSON 9

## 1. Navigation

7 MIN

**Materials:** *Observations to Evaluate Claims*, How Does Skin Fill the Gap? poster (from Lesson 8), Needed Evidence Chart poster, markers

**Review ideas about how skin cells fill the gap from an injury.** Display the How Does Skin Fill the Gap? poster from the previous lesson. Display **slide A**. Say, *Last time, after watching the time-lapse of skin healing, we had some questions: How did the scab form? and what made the new skin? We came up with some initial claims for how the skin makes more skin to fill in the gap. Let's look at the poster where we recorded those ideas.*

Here are sample student ideas from the poster:

- The skin cells around the injury grew larger to fill the gap.
- More skin cells were made near the injury to fill the gap.
- Other cells, like blood cells or bone cells, turned into skin cells and filled the gap.

**Discuss evidence needed from the cell video to evaluate claims.** Call on volunteers to read ideas from the poster. Then say, *It sounds like we have some different claims. If we could zoom in and look at the cells near the injury, we could collect evidence to evaluate the accuracy of these claims. I have a video clip and some images that zoom in to see what cells are doing. What should we pay attention to while we watch the video and observe the images to help us collect the evidence we need to evaluate each claim?*

Display **slide B**. Distribute a copy of *Observations to Evaluate Claims* to each student. Use the prompts below to have the class share what evidence they might see if the claims from the poster were true. As they discuss the evidence they need to collect, record these ideas on the Needed Evidence Chart poster you created before class. Have students record these ideas in the claims and evidence columns in Part 1 on their handout.

| Suggested prompts | Sample student responses |
|---|---|
| *What should we see if the skin cells around the injury grow larger?* | *The number of skin cells would stay the same, but they would just keep getting larger until they all pushed up against one another to fill the gap.* |
| *What observations would we need to collect to evaluate this?* | *We would need to keep track of the number of cells.*<br>*We would need to observe if the size of the cells is changing.* |
| *What should we see if more skin cells are made to fill in the gap?* | *Maybe the skin cells would split and make more of themselves until they filled the gap.* |
| *What observations would we need to collect to evaluate this?* | *We would need to see more cells.*<br>*We would need to see new cells coming from other similar cells.* |

| Suggested prompts | Sample student responses |
|---|---|
| *What would we see if cells that are not skin cells turned into skin cells to fill the gap?* | *We might notice that the cells around the gap changed the way they looked until they looked more like skin cells. They would keep changing until enough new skin cells filled the gap.* |
| *What observations would we need to collect to evaluate this?* | *We should see different types of cells.*<br>*The number of cells should be the same.*<br>*We should see one type of cell turn into another type of cell.* |

## 2. Watch video of cells splitting.

8 MIN

**Materials:** *Observations to Evaluate Claims*, computer with internet access, 6.6 Lesson 9 Non-human, mammalian cells (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), How Does Skin Fill the Gap? poster (from Lesson 8)

**Introduce a video showing cells growing and splitting.** Display **slide C**. Tell students that the video we are about to watch shows cells from human skin.*

Ask, *How might watching a time-lapse video of what happens to skin cells over time help us figure out what is happening when new cells are being made?* Accept all reasonable responses.

**Watch the cell video.** Display **slide D**. Make the video available for students to view more closely on their own device or computer to provide *access* for students who may struggle with seeing what is happening if the video were projected on a screen.* Organize students to work with a partner. Inform students that they will record their observations on *Observations to Evaluate Claims*. In addition, encourage students to rewatch the video as many times as they wish to make sense of what is happening at the cellular level.

When students have finished recording their observations from the video, move to the next step.

*** Supporting Students in Developing and Using Scale, Proportion, and Quantity**
By shifting to the microscopic scale, we can observe processes (cells splitting) that are invisible at the macroscopic scale (gap in skin closing). At the scale shown in the video, students should notice that the number of cells is increasing, but the overall size of each cell is not changing.

### Alternate Activity

If you do not have access to enough computers for students to use, project and watch this video multiple times for the class. The first time, have the students focus on just watching the video. This is particularly important, as the events occur quickly and can be missed if students are trying to take notes simultaneously. During the second viewing, have students record their observations on *Observations to Evaluate Claims*. After the second viewing, ask students if slowing down the video or pausing it at certain points would be helpful in capturing other observations. Then use student feedback to show the video for a third time as they continue to record their observations.

*** Attending to Equity**
**Supporting Universal Design for Learning:** Having the video for students to view more closely on their own device provides *access* for students by allowing them to rewatch, pause, and slow down the video so that they can make sense of what is happening at the cellular level.

**Direct students to use their observations to evaluate Part 1.** Direct students to the How Does Skin Fill the Gap? poster (from Lesson 8) and number the claims your class developed in the previous step of this lesson (e.g., claim 1, claim 2, etc.).

Display **slide E**. Say, *Remember we wanted to zoom in and look at what the cells might be doing to evaluate each claim. Before watching the video, we created a list of needed evidence and recorded our claims in Part 1 on Observations to Evaluate Claims. Let's continue to work with our partner to see how the observations we recorded align with what we identified in the "Evidence" column. Then discuss with your partner whether your observations support each claim, following the steps on the slide:*

- *Highlight any of the claims in Part 1 that have evidence from the video to support them. Circle any evidence you were expecting to see in the right column that you observed in the video.*
- *If you saw any new evidence in the video that supports a claim, add it in a new color to the right column of Part 1 of your handout.*

## Assessment Opportunity

**Building towards: 9.A.1** Analyze and interpret data from a video and microscopic images at varying spatial and time scales to conclude that new cells come from old cells following a predictable pattern of repeated steps.

Students will have multiple opportunities to work toward this Lesson Level Performance Expectation. This is the first checkpoint. The main thing to listen for here is students noticing that new cells are made, and that when this happens the cells don't just split into two, but rather the cell grows first, so when it splits into two cells they are about the same size as the original cell.

**What to look for:** In *Observations to Evaluate Claims*, look for students' connections between their observations and the evidence the class recorded on the evidence chart as evidence we would expect to see to support each claim. Look and listen for student evaluation of the different claims in light of their observations from the video and images. Students should be able to describe or reference their drawings or written explanations on *Observations to Evaluate Claims* to describe how cells grow and split to make more cells to fill the gap. The size and shape of the old and new cells should remain the same. (The actual type of cell used in the drawing or description is not important here.)

**What to do:** If students struggle with evaluating the different claims, remind them that we are trying to figure out what is happening at the injury site to fill the gap. Ask them to describe what they observed the cells doing in the video and differences they see in the microscopic images of the whitefish and onion root. If necessary, have students replay the video and help them connect how their observations involve old cells splitting and filling the gap with new cells. Then have them return to the images and claims on the How Does Skin Fill the Gap? poster to assess which claims best describe what we observed and which ones don't. Have students explain their reasoning.

Bring the class together and facilitate a brief discussion using the prompts below.

| Suggested prompts | Sample student responses |
|---|---|
| *What are some things you noticed in the video?* | *There seemed to be way more cells at the end than at the beginning.*<br>*All the cells looked the same, they had a similar shape and size.*<br>*The cells that were produced looked the same as the original cell after the split.* |
| *In Lesson 8, we watched a zoomed-out view of skin healing. Using what we figured out from this first video, what could be happening in the gap where the skin was injured?* | *Maybe it means that more cells are being made and that these new cells are filling the gap.*<br>*After the split, these new cells just sort of pull together or clump up to close the gap.* |
| *Were all the new cells being made at the same time?* | *No, each cell split at different times.*<br>*We would see some light up and split apart at different times than others.* |
| *What are some of your ideas for why the new cells aren't all made at the same time?* | *Maybe because different parts of our body need cells at different times … like the gap in the foot needed more cells to close up and heal, but parts of the skin that weren't injured don't need to be making all those cells.* |
| *So if we want to figure out more about what is happening when new cells are being made from original cells, what might help us see this process?* | *I think we need to look closer up at what is happening when new cells are made.*<br>*Yeah, I agree. The cells in the video were so small and everything happened so fast it was hard to see exactly what was happening.* |

## 3. Look closer at what happens when new cells are made.

10 MIN

**Materials:** science notebook, *Microscopic Images of Cells Splitting*, How Does Skin Fill the Gap? poster (from Lesson 8), Needed Evidence Chart poster, markers

**Distribute *Microscopic Images of Cells Splitting* to each student.** Display **slide F**. Say, *In the video we saw human skin cells making more skin cells. Now we are going to look at some microscopic images of other types of cells. On the document you will see microscopic images taken from a whitefish embryo and an onion root tip. Do you think other cells, besides skin cells in our body, also make new cells?* Students should say yes. Ask, *What about cells in other living things? Do you think they also make new cells?* Students should say yes, because they also might need to heal.

Say, *Work with your partner again to analyze these microscopic images of cells from a whitefish and from an onion root tip. Look for anything in the images that could help us better understand the process they go through when they make new cells. Record these observations in Part 3 of Observations to Evaluate Claims. Note anything you see that could be additional evidence to support any of our claims.*

Give the partners about 8 minutes to do this analysis. Encourage them to annotate and mark up the images on *Microscopic Images of Cells Splitting* around any pieces that could be evidence of what happens when cells make new cells. There is a color copy of this document in the student edition.

**Facilitate a consensus discussion.** Display **slide G**. Once partner groups have finished analyzing the images on *Microscopic Images of Cells Splitting* and recording their findings in Part 3 of *Observations to Evaluate Claims*, gather the class into a Scientists Circle. Be sure to have the Needed Evidence Chart poster and the How Does Skin Fill the Gap? poster visible. Tell students to be ready to share their observations while you record their thinking on the Needed Evidence Chart poster. Use prompts such as those below to facilitate a Consensus Discussion.

## Key Ideas

**Purpose of this discussion:** To establish what is happening to fill the gap of an injury. Several cells split in two to make new cells that grow (get bigger) and clump together to fill the gap.

**Listen for these ideas:**

- All the cells look the same, they have a similar shape and size.
- Some cells seem to split into two new cells.
- Right after the split the cell size gets slightly smaller, but then it seems to grow to the size of the original cell.
- The number of cells is increasing.
- When groups of cells get closer, "arms" of cells seem to pull the groups of cells together.
- There is material inside the cell that seems to change shape and get bigger.
- A new cell boundary (cell membrane) forms, splitting the cell, once the material moves to opposite sides.

| Suggested prompts | Sample student responses |
|---|---|
| *How did looking at these microscopic images of cells help us figure out more about what we saw happening in the video?* | *We could see the structures inside the cells in the images, and we couldn't see them in the video.* |
| *What structures helped you identify one cell from another in the image?* | *Cells have cell membranes, or edges, and we saw that in each image.* |

Display **slide H**. This slide contains an image of the whitefish and the onion root tip. Ask, *Can someone come up to the board and trace around or point to where you see cells in each of these images?* Have a volunteer or two come up to identify where there are cells. Keep this slide projected, and as the discussion continues, encourage students to come up and point out examples of cells in the image they are referring to or that they and their partner noted on their handout.

| Suggested prompts | Sample student responses |
|---|---|
| *Do all of these cells look exactly the same? In what ways are they similar and in what ways are they different?* | *No. They have a similar shape, but they aren't all the same size.* |
| *(Note: have students point out examples from the images on the slide.)* | *Some of them have stuff inside that looks very different from each other.* |
| *In using these images to help us make sense of what happens as new cells are being made, why might they be different sizes?* | *Well, it looks like cells get bigger.* |
| *(Note: have students point out examples from the images on the slide.)* | |
| *Why do you think they are getting bigger?* | *Because it looks like the stuff inside also gets bigger, and then in some of them it looks like the stuff inside is splitting into two.* |
| *(Note: have students point out examples from the images on the slide.)* | |
| *What new things were we able to see looking at the zoomed-in images of whitefish cells and onion root tip cells?* | *Inside the cell, there is a blob that seems to change shape, and it was in different places inside the cell before the cell split.* |

Say, *The video and the microscopic images have really helped us figure out a lot about what is happening to fill the gap at the site of an injury. We now have more evidence that a gap in the skin likely closes as new cells are made from old cells growing and splitting repeatedly. Let's discuss how these observations can help us evaluate each of our claims.*

| Suggested prompts | Sample student responses |
|---|---|
| *One of our original claims was that cells get larger to fill the gap. What does our evidence suggest about this claim?* | *The cells didn't appear to get larger to fill in the gap.* |
| *Were there any observations that support our claim that new cells are made from old cells?* | *Yes. We saw that the area seems to be filled with more cells over time, and not with the same cells just growing in size.*<br>*Also, all the new cells looked the same as the original cell, because they had a similar shape and size.*<br>*It seems more likely that the gap in the skin is filled by new cells that form from old cells splitting, because part of the old cells made the new cells.* |

| Suggested prompt | Sample student responses |
|---|---|
| *Another claim suggests that other cells, like blood cells or bone cells, turned into skin cells to fill the gap. What does our evidence suggest about this claim?* | *All the cells we observed looked the same.*<br>*All the new cells looked like the original cell, suggesting that it is the same type of cell.* |

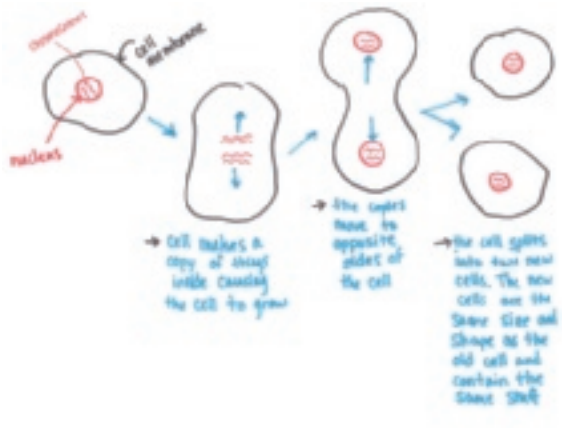
## 4. Model what we observed as new cells were made.

8 MIN

**Materials:** science notebook, cell drawing from Lesson 6, chart paper, markers

**Continue the discussion by creating a summary model.** Bring out a new piece of chart paper and title it "New Cells Being Made". Suggest that now that we know that gaps from injuries are filled with new cells, we should draw a summary of what happens when new cells are made. Draw an arrow across the top of the paper from left to right and label it "Time". Then draw a circle on the left side of the paper underneath the arrow and label it "Original cell". Here is an example of a completed model.*

You will add to this drawing with labels as the discussion continues. Use the following prompts to elicit student ideas.




*** Supporting Students in Developing and Using Scale, Proportion, and Quantity**
Students should now recognize the shift in spatial scale as the video and microscopic images magnify the cell further. However, the shift in time scale may be less obvious. Similar to why zooming in (shift in spatial scale) allows us to observe microscopic events, slowing them down (shift in time or temporal scale) also allows us to observe very rapid events. In this case, zooming in while slowing down the process of cell splitting lets us notice that cells can make more copies of themselves, a fundamental concept in understanding how our body heals.

| Suggested prompts | Sample student responses |
|---|---|
| *We need to add the new cells that were made from the original cell. What do we know about these new cells?* | *These cells are the same as the original.* |
| *How should we represent these new cells in our model?* | *We should draw them the same shape and size as the original.* |

| Suggested prompts | Sample student responses |
|---|---|
| *What else are we missing about these cells that we observed in the microscopic images?* | *There was dark stringy stuff inside the cells. In some cells this stringy stuff was sometimes seen together, and in other cells it was found at the opposite sides of the cell right before the cell was about to split.* |
| *How might we represent these in our model? Where should we put them?* | *We need to add these wavy lines inside the original cell as well as the two new cells.* |

**Label cell structures in the model.** Students will likely talk about how the cell seems to have something dark stringy stuff at the center, and that this center area splits when the cell splits. Introduce these structures and add the labels "Nucleus" and "Chromosomes" to the model. Students will also have likely noticed that all the cells appear dark inside but are surrounded by a lighter boundary, identified previously in Lesson 6. Label this boundary "Cell membrane".

For now, knowing the function of the nucleus and the chromosomes is not necessary for helping students understand how healing works in the context of this unit. However, knowing that these structures are inside a cell, and knowing that each cell has a cell membrane as the boundary separating one cell from another, will support students in looking for these structures to be present when new cells are made. These ideas will help them discuss and understand that they should look for these parts as evidence that healing involves the formation of new cells.

Use the prompts below to continue co-constructing the summary model.

| Suggested prompts | Sample student responses |
|---|---|
| *If both new cells have chromosomes in them, where did the extra chromosomes come from?* | *The original cell must have made more chromosomes so that both new cells would have them.* |
| *How should we describe and add this to our model?* | *We should maybe add some middle stages between the original cell and the new cells that show double chromosome lines.* |
| *We observed in the video that the size of the original cell and the cells produced were about the same. What had to happen to allow them to be similar sizes?* | *The original cell had to increase in size.* |
| *How might we represent this in our model?* | *Draw a step where the original cell gets bigger.* |
| *What has to happen to the original cells to create two new cells that are the same?* | *The original needs to make copies of all the stuff inside the cell in order for each new cell to have the same stuff.*<br>*The stuff needs to move to opposite sides of the cells to make sure each new cell has the same stuff.* |
| *How might we show this in our model?* | *Draw steps where this is shown in the cell.* |

**Update the cell drawing from Lesson 6.** Conduct a brief discussion to add what we've figured out to our cell drawing. Add and label a "Nucleus" in the cell drawing, and add and label "Chromosomes" if your students choose to. An example of what this might look like is shown here. Elicit student ideas using the prompts below.




| Suggested prompt | Sample student responses |
|---|---|
| *Back in Lesson 6, we added a cell drawing next to the Our Body as a System poster and labeled some of the parts of the cell. How should we revise this based on what we now know?* | *We should add the nucleus, because it seems like we have seen it in a lot of cells.*<br>*We should add the chromosomes, because they seem to be present when the cells grow and split.* |

Continue the discussion to think about what observing the changes to the cells at different scales helped us figure out.

| Suggested prompts | Sample student responses |
|---|---|
| *We have figured out a lot about what is happening at the site of an injury. How did zooming in help us do this?* | *Zooming in helped us better see and explain what was actually happening to fill the gap at an injury.* |
| *What are some things you noticed today that remind you of previous lessons where we zoomed in and out to examine cells at varying scales?* | *I remember that by zooming in you could see the details of what's inside a cell. With the video and microscopic images today we could see the stuff inside the cell!* |
| *How has including part of the video in slow motion helped us in our understanding of what was happening?* | *At first it was all happening so fast, it was difficult to see what was going on. During the slowed-down sections, we were able to actually see what the cells were doing.* |

## 5. Add to Progress Tracker.

7 MIN

**Materials:** science notebook

**Update Progress Trackers.** Display **slide I**. Have students return to their desks. Direct students to the Progress Tracker section of their notebooks. If they need to start a new page, remind them that we are making this unit's Progress Tracker in landscape orientation. Instruct them to add rows for what we've figured out about what happens at the site of an injury to fill the gap. Reiterate that this tracker is their space to process and record their thoughts while we're working to figure out how an injury can heal.



Suggest that students try to draw what they think is happening in the gap. To help those struggling to construct this drawing, consider drawing a gap in skin cells on the board such as the one shown here. Additionally, if students mentioned after the video that groups of cells may connect together, ask them to show how that would work using this starting picture. You could ask them to draw the image in their notebooks and then draw what happens in the gap. Give students 5-8 minutes to add to their Progress Trackers.

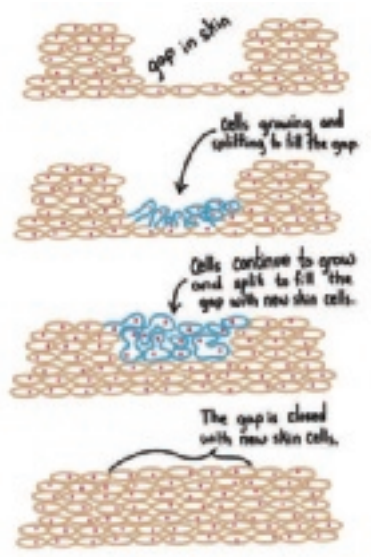
A sample Progress Tracker is shown below.

| Question | What we figured out in words/pictures | This makes me think or wonder about healing ... |
|---|---|---|
| What is happening at the site of injury to fill the gap? | • When we change the time scale and slow down the video, we see that new cells don't just appear. Instead, they seem to come from old cells that split.<br>• When we zoom in, we see that cells growing and splitting isn't a random process, but rather it follows certain repeating steps that result in the same type of cell. For example, skin cells make more skin cells and not other types of cells.<br>• A gap in the skin, muscle, or bone can be filled by new cells resulting from cells growing and splitting and not from the old cells growing larger in size. | How do the cells get what they need to keep splitting and making new cells?<br>Where do the cells get their food or energy from? |

### Assessment Opportunity

**Building towards: 9.A.2** Analyze and interpret data from a video and microscopic images at varying spatial and time scales to conclude that new cells come from old cells following a predictable pattern of repeated steps.

**What to look for:** In the Progress Tracker, look for students' drawings or written explanations to describe how cells split to make more cells to fill the gap. The size and shape of the old and new cells should remain the same. (The actual type of cell used in the drawing or description is not important here.) A complete drawing might look something like the image here.




Keep in mind that the Progress Tracker should not be used as a summative assessment, but rather as a formative assessment to understand what students are thinking at this point. We recommend that you provide feedback in the form of questions to probe student thinking and push for more sensemaking.

**What to do:** If students struggle to show how the gap is filled by new cells that result from old cells splitting, consider making a separate handout with an image similar to the one at the top of this step. Then direct students to draw 2-3 more blank boxes below and draw what is happening in these steps for the gap to be filled in the end. You could also replay the video at this point, and then ask them to fill in the diagrams.

## 6 . Navigation

3 MIN

**Materials:** science notebook, New Cells Being Made poster

**Reflect on what we know and what we still need to figure out about making more cells.** Display **slide J**. Point at the New Cells Being Made poster and say, *We have figured out today that old cells make new cells by growing and splitting to fill in the gaps, but how is this happening? Take a few minutes to jot down some of your thoughts in your science notebook. Then turn and talk with a partner to share your ideas and questions you still have about this.*

Allow students the remaining time to discuss the questions on the slide and record ideas from their conversation with their partner. Before they leave, remind them to be prepared to share these ideas and questions with the rest of the class at the next lesson.

### Additional Guidance

At the end of this lesson, consider posting the New Cells Being Made poster next to the Word Wall to display some of the labeled cell structures. Keeping this model visible next to the Word Wall is an effective strategy to support all students. Call attention to words that students use that are on the model, and if students struggle to find the right word to use, have them look at the Word Wall and/or model to see if there are words that will help them.

LESSON 10

# What do cells need to grow and make more of themselves?

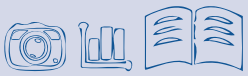
## Previous Lesson

*We analyzed a video and microscopic images of cells growing and splitting in different organisms. After observing this process at various spatial and time scales, we made sense of how our body fills a gap at the site of an injury.*

## This Lesson

**Investigation**

**2 DAYS**





We recall what we (humans) need to grow, and we wonder if cells also need the same things to grow too. Since we can't easily study cells from our bodies, we investigate how single-celled organisms grow. We look at data from scientists, who grew bacteria on agar plates with different nutrient levels. We analyze their data and notice that the quantity of bacteria increased as nutrient levels increased. We read about other single-celled organisms and figure out that they are also alive and need food to grow and make more of themselves.

## Next Lesson

*We will use microscopes to observe changes to onion cells when salt water and plain water are added to the onion skin. We will use observations as evidence of the function of the cell membrane and cell wall in helping the cell get what it needs to grow.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**



## What Students Will Do

**10.A** Analyze and interpret data for patterns to identify the relationship between the amount of food (cause) and the amount of bacteria made (effect) to provide evidence that cells need food to grow and make more of themselves.

**10.B** Construct a written argument using cause-and-effect relationships to conclude that the cells that make up multicellular organisms need food to make more cells, as do the cells of unicellular organisms.

## What Students Will Figure Out

- Cells need food to make more cells.
- Cells grow more and make more cells if they have access to more food.
- There are single-celled (unicellular) and many-celled (multicellular) living things.
- Cells are living things.
- All living things are made of cells.

## Lesson 10 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 5 min | **NAVIGATION**<br>Recall previous conversation about what cells might need to grow and make new cells, and consider where they might get those things. | A | |
| 2 | 8 min | **INTRODUCE BACTERIA AND SHARE INITIAL IDEAS ABOUT THEM**<br>Suggest investigating single-celled bacteria to see what they need to make more of themselves. Surface prior knowledge that students may have about bacteria. | B-E | |
| 3 | 10 min | **REVIEW A PROCEDURE TO INVESTIGATE HOW BACTERIA RESPOND TO DIFFERENT NUTRIENT LEVELS**<br>See how a scientist set up an investigation of how well *E. coli* grows on agar plates with various levels of nutrients. | F-K | Pouring Agar video at 6.6 Lesson 10 Properties of Cooled Agar, Properties of Cooled Agar video at 6.6 Lesson 10 Pouring an Agar Plate, Streaking E. coli onto Agar Plates video at 6.6 Lesson 10 Streaking E. coli onto Agar Plates (See the **Online Resources Guide** for links to these items. **www.coreknowledge.org/cksci-online-resources**) |
| 4 | 10 min | **ANALYZE E. COLI GROWTH DATA**<br>Small groups use the Identify and Interpret strategy to analyze secondary data for the growth of *E. coli* on agar with different nutrient levels. | L-M | *Reference: Secondary Data for E. coli Grown on Agar with Different Nutrient Levels*, tape, chart paper or whiteboard, markers |
| 5 | 12 min | **READ ABOUT DIFFERENT SINGLE-CELLED ORGANISMS**<br>Students read and interpret one of four texts about single-celled organisms. | N-P | *Lesson 10: Obtaining Information from Scientific Text*, one of these readings: *Reading: Archaea* or *Reading: Bacteria* or *Reading: Yeast* or *Reading: Algae* |

*End of day 1*

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 6 | 10 min | **DISCUSS THE READINGS IN JIGSAW GROUPS**<br>Follow a jigsaw approach to discuss different single-celled organisms based on information from the readings. | Q | *Lesson 10: Obtaining Information from Scientific Text*, one of these readings: *Reading: Archaea* or *Reading: Bacteria* or *Reading: Yeast* or *Reading: Algae* |
| 7 | 13 min | **BUILDING UNDERSTANDINGS DISCUSSION**<br>Use information to compare and contrast the structures and functions of unicellular and multicellular organisms. | R-S | sticky notes, markers |
| 8 | 10 min | **READ ABOUT THE LIFESPAN OF CELLS**<br>Read about the life span of various cell types. | T | *Reference: Lifespan of Cells* |
| 9 | 5 min | **UPDATE PROGRESS TRACKER**<br>Reflect on what we figured out about what cells need to make more cells, whether they are single-celled or multi-celled organisms. | U | |
| 10 | 10 min | **WRITE AN ARGUMENT ABOUT WHAT CELLS WOULD NEED TO HEAL THE WOUND**<br>Students construct a written argument as an exit ticket. | V | *What do bacteria need to make more of themselves?*, optional *Self-Assessment and Peer Feedback*, optional *Peer Feedback Guidelines* |
| | | | | *End of day 2* |
| | | **SCIENCE LITERACY ROUTINE**<br>Upon completion of Lesson 10, students are ready to read Student Reader Collection 3 and then respond to the writing exercise. | | Student Reader Collection 3: *Cells, Health, and Healing* |

## Lesson 10 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Reference: Secondary Data for E. coli Grown on Agar with Different Nutrient Levels*<br>• tape<br>• *Lesson 10: Obtaining Information from Scientific Text*<br>• one of these readings: *Reading: Archaea* or *Reading: Bacteria* or *Reading: Yeast* or *Reading: Algae*<br>• *Reference: Lifespan of Cells*<br>• *What do bacteria need to make more of themselves?*<br>• optional *Self-Assessment and Peer Feedback*<br>• optional *Peer Feedback Guidelines* | | • Pouring Agar video at 6.6 Lesson 10 Properties of Cooled Agar (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)<br>• Properties of Cooled Agar video at 6.6 Lesson 10 Pouring an Agar Plate (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)<br>• Streaking E. coli onto Agar Plates video at 6.6 Lesson 10 Streaking E. coli onto Agar Plates (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)<br>• chart paper or whiteboard<br>• markers<br>• sticky notes |

**Materials preparation (20 minutes)**

**Online Resources** 

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Make copies of *Reading: Archaea*, *Reading: Bacteria*, *Reading: Yeast*, and *Reading: Algae* so that students can write on them, take notes while reading, and respond to the questions. Students will not each read all four articles—print enough so that you have one article per student. Students will read one of them and then jigsaw with their peers to share what they have figured out. Form groups of four and pass out one reading of each to one student in each group of four. Each student will only need **one** of the aforementioned readings. You may also refer to the readings in the Student Edition for color versions.

Be sure you have materials ready to add the following words to the Word Wall: **single-celled organism, multiple-celled organism**. Do not post these words on the wall until after your class has developed a shared understanding of their meaning. This will be done after the Building Understandings Discussion on day 2 of this lesson.

Have the following videos loaded and ready to play for the class:

- Pouring Agar at 6.6 Lesson 10 Properties of Cooled Agar (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)
- Properties of Cooled Agar at 6.6 Lesson 10 Pouring an Agar Plate (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)
- Streaking *E. coli* onto Agar Plates at 6.6 Lesson 10 Streaking E. coli onto Agar Plates (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

See *Procedure for growing E. coli on agar with different levels of nutrients as a wet lab* if you would like to plate and grow K-12 *E. coli* as a teacher demonstration with your students rather than using secondary data. If you choose to do this wet lab, be sure to note that the *E. coli* will take time to grow, so you will need to prepare the plates and streak them a few days in advance of when you plan to analyze the data. Although students would certainly enjoy the opportunity to conduct the experiment in their own classroom, we advise you to use the secondary data set for the following reasons:

- The added materials cost
- The additional prep, classroom, and incubation time
- The possibility of contamination
- The need for reproducible plate inoculation

## Lesson 10 • Where We Are Going and NOT Going

### Where We Are Going

In previous lessons, students figure out that the human body contains different types of cells and that the structure of a cell is related to its function. They also see that these cells can grow and split to make more cells. In this lesson, students will not yet be delving into the middle-school level understanding the growth of our body. They are comparing growth of cells before they split to the growth of a child as they age. In this lesson, students share initial ideas about bacteria and analyze data from an investigation to confirm that cells need nutrients to grow and split to make more cells. Although they do not conduct the investigation themselves, these secondary data allow students to notice that more bacteria grows as the nutrient level of the gel is increased. Later, in Lesson 13, students will use their model of healing to argue that the process of growth in the body is a similar process to healing. In addition, as students apply their healing model to the process of growth, they will connect this to how this results in their body also growing as new cells are made.

Bacteria are used here to investigate what cells need to make more cells for a few reasons. So far in this unit, we have been investigating multicellular organisms, and bacteria are the first single-celled organism we investigate. Using bacteria here helps us figure out that there are organisms made of just one cell that require food to make more cells. Also, when we explore community supports for healing in Lesson 13, we can connect back to this investigation of bacteria to help us understand that there are some types of bacteria that we don't want in our body or wounds, and why antibacterial or cleansing cream or soap are used in the foot injury from Lesson 1.

Students obtain information from readings about different single-celled organisms to discover that there are other single-celled organisms other than bacteria and that they also use some kind of nutrients to make more cells. (Range

of Lexile reading estimates for all articles: from 810L up to 1600L.) We discuss how single-celled organisms are different from multiple-celled organisms, whose cells need to function together as part of the larger body system. However, single-celled organisms can perform all necessary functions within the one cell.

**Where We Are NOT Going**

In this lesson, and unit, we are not going to investigate or figure anything out about how tissue cultures can be grown in the lab. The purpose of using this data is to support students in figuring out whether food is needed for cells to make new cells, not *how* cells can be grown outside the body.

In this lesson, we do not distinguish between prokaryotic and eukaryotic cells, nor do we explore the ability of some single-celled organisms to become multicellular, depending on their environment or the fact that some cells have more than one nucleus. Also, we do not take the time to explain how and why organisms are categorized into different groups (i.e., kingdoms, phylla, orders, etc.). These ideas are above grade band and beyond the scope of this unit.

# LEARNING PLAN FOR LESSON 10

## 1. Navigation

5 MIN

**Materials:** None

**Turn and talk with a partner about what cells might need to make more cells.** Display **slide A.** Say, *Last class we saw some videos showing us how cells can grow and split to make more cells. We saw there was a lot of movement within the cells as they were growing and splitting, and were curious about what cells need to be able to make more of themselves. We said last time that in order for us to grow, move, or do activities, we get what we need for that from the things we eat. Turn and talk with a partner about these questions:*

- *What do cells need to be able to make more cells?*
- *Where do you think they get the stuff they need to make new cells?*

### Additional Guidance

In this unit, we are building on the fifth-grade prerequisite knowledge of growth. Specifically in this lesson, we are building on what we have figured out in Lesson 9 about how cells grow bigger before they split and form a new cell. In this lesson, students will not yet be delving into the middle school level understanding of the growth of our body. They are comparing the growth of cells before they split to the growth of a child as they age. In Lesson 13, students will use their model of healing to argue that the larger scale of growth in the body is a similar process to healing. In addition, as students apply their healing model to the process of growth, they will connect this to how this results in their body also growing as new cells are made. Furthermore, students will build on their knowledge from this unit to figure out the elements of the performance expectation MS-LS 1-5 in *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)* and *Unit 8.5: Why are living things different from one another? (Muscles Unit)*.

After a minute or two of partner discussion, use prompts such as these to lead a brief discussion about what cells might need to be able to make more of themselves and where that might come from.

| Suggested prompt | Sample student response |
|---|---|
| *In our last lesson, we saw that cells that are part of a living thing can make new cells by growing bigger and splitting. We also saw that there was a lot of activity as they did this process. What do we think those cells needed in order to grow and make more of themselves?* | *They probably need water and food, just like we do.* |

| Suggested prompts | Sample student responses |
|---|---|
| *Where do you think cells get the stuff they need to make new cells?* | *Maybe they can take food and make new cell parts somehow.*<br>*Yeah, and they were cells from an animal, so maybe the cells get what they need from the blood in their body, like we figured out the blood in our body brings food particles around.* |
| *So if cells make up our body, and we are a living thing, and we are thinking our cells need food of some kind to make more cells, then do you think our cells are living, too?* | *Not sure…*<br>*Maybe. If we didn't have our cells, then we wouldn't be living, either.*<br>*If we took a cell out of our body, would it live on its own with food and water?* |

Say, *I heard that we think cells might be living things, and that they probably need things like water and food or nutrients to be able to grow bigger and split to make more cells. We figured out earlier that our blood carries those types of things all around our body, even to our cells. So it sounds like we need a way to look at what is happening with cells.*

## 2. Introduce bacteria and share initial ideas about them.

8 MIN

**Materials:** science notebook

Say, *Previously, we investigated cells by looking at them preserved on a microscope slide, but that won't help us investigate what's happening with cells that are inside a living body or animal. We need to find a way to look at cells that are outside of our bodies. There are some living things in the world that are made of just one cell—they're not part of a whole body but instead are just one celled organisms. We could use these one celled, or single-celled, organisms to investigate what they need to make more one celled organisms which can help us figure out how new cells are made. Has anyone ever heard of these single-celled organisms?* Accept all responses and then say, *Right, one common type of single-celled organism is bacteria.*

**Stop and jot our initial ideas about bacteria.** Display **slide B.** Say, *I think most of us have heard of bacteria before, but I'm wondering what we already know about them. Let's stop and jot down some of our initial ideas about bacteria. Feel free to include where you might have heard about them, or how you think it relates to our healing story.*

**Conduct an Initial Ideas Discussion about bacteria.** After students have taken a minute to gather their thoughts, display **slide C**, and conduct a whole-class discussion, making space for all students to get their ideas on the table and surfacing prior knowledge that students may have. It may be useful to record our ideas in a public space, like chart paper or a projected electronic document.

## Additional Guidance

Students might raise the idea that we often clean cuts and other injuries with antibacterial products, like the doctor's notes in Lesson 1. We will come back to this idea during Lesson 14 when we explore things our communities do to support healing, so you can encourage students to add any questions about that to the DQB.

## Key Ideas

**Purpose of this discussion:** This Initial Ideas Discussion should be a moment for students to share their initial ideas and questions. The discussion should elicit prior knowledge or conceptions about bacteria. The emphasis should be on getting ideas on the table without pushing for consensus.

**Common student ideas**

- *Bacteria are everywhere and grow on lots of things.*
- *Bacteria are bad and can make us sick.*
- *Bacteria and viruses are similar.*
- *Bacteria are a kind of germ.*
- *There are bacteria in our mouths and guts.*
- *Some bacteria can be killed with antibiotics, but some are resistant to antibiotics.*

Ask, *What are some things you have heard about bacteria? What do we think we know about bacteria?*

Sample student responses:

- *I've heard there are bacteria all over everything, like our bathrooms and kitchens, even on or in our body.*
- *Are bacteria germs? I've heard of germs before, and we wash our hands to get rid of them.*
- *I know we wash our hands and disinfect things to kill bacteria. I think bacteria can make us sick.*
- *I've heard about bacteria being in your gut and that those are good bacteria.*
- *I've heard that yogurt has good bacteria in it.*

**Compare bacteria cells to human cells.** Display **slide D**. Direct students to turn and talk with a partner about what they notice when they compare these images of bacteria cells to the human cells we've already seen. You may need to remind students that samples on slides are often stained to help us see clearly, so the colors of the bacteria in these images may not be their actual colors.

Use prompts such as the following to lead a brief discussion about multiple-celled and single-celled organisms.

| Suggested prompt | Sample student responses |
|---|---|
| *What do you notice about bacteria cells compared to human cells? What is similar and/or different?* | *The human cells are really tightly packed—they work together. We know their specific structures help them carry out their functions in the body.*<br>*The bacteria cells seem to be more spread out in the images, compared to the skin, bone, and muscle cells.*<br>*The bacteria are just kind of randomly arranged—they don't seem to have a structure. That makes me wonder if they work together.*<br>*The bacteria are way smaller than most of the human cells in these images.* |

Summarize by saying, *Scientists like to work with bacteria, because they are really simple—they are just made of one cell and can carry out all the functions they need by themselves. In contrast, animals, which are made of lots of cells, are much more complex, and need lots of different types of cells that work together to perform very specific functions. So, sometimes, studying simpler organisms that are made of cells can give us some insight into what might be happening in our own cells.*

**Turn and talk to propose investigation ideas.** Display **slide E.** Have students turn and talk with a partner about the following question:

- So, if bacteria are alive, how could we get evidence to convince us that these single-celled bacteria need nutrients to grow and make more cells?

After a minute or two of partner talk, ask students to share their ideas.

Sample student responses include:

- *We could give them food and see if they "eat" it (use it).*
- *Could we see if the food goes away after we give them some? Then maybe we'd know they were using it.*
- *Could we see if the bacteria grow and make more cells when there's food around, because my parent/guardian tells me I need to eat more so that I can grow? And less when there's less or no food?*
- *We could put some bacteria in a container with food and put some in a container without food, and see which container they make more of themselves in.*

Say, *OK, it sounds like we want to investigate bacteria to see if food of some kind helps cells grow and make more of themselves. Since growing our own bacteria takes time and requires materials we don't have, it will be difficult to investigate bacteria ourselves in the classroom. But, we do have data from another scientist! We can analyze data from an investigation they set up using* E. coli *bacteria. Has anyone heard of* E. Coli *before? If so, what do you know?*

Give students a brief moment to share any prior knowledge or ideas they have about *E. coli*. Accept all ideas at this point.

## 3. Review a procedure to investigate how bacteria respond to different nutrient levels.

10 MIN

**Materials:** Pouring Agar video at 6.6 Lesson 10 Properties of Cooled Agar (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), Properties of Cooled Agar video at 6.6 Lesson 10 Pouring an Agar Plate (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), Streaking E. coli onto Agar Plates video at 6.6 Lesson 10 Streaking E. coli onto Agar Plates (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

**Share why scientists like to use *E. coli* in their investigations.** Display **slide F** and have students read this information about *E. coli*. Scientists use *E. coli* because

- they are easy to use in the lab
- there are non-disease causing versions (strains)
- they share some similar features with other cells

If students have heard of *E. coli* because of food recalls, beach closures, and so on, reassure them that while some kinds (strains) of *E. coli* can make people sick, there are actually many types of *E. coli*, like the particular one used in this investigation, that do not.

**Consider how we could test *E. coli*.** Say something like, *Some of you suggested investigating whether bacteria made more cells with more food. So, we need a way to give the bacteria food, but in a way where we can control the amount they get and that it's all the same kind of food, or nutrients, so it's a fair test, right?*

**Introduce agar.** Display **slide G.** Say, *Scientists often use a gel called agar on which to grow cells in a lab.* Share the information about agar from the slide.

- Agar is a dry powder made from red algae commonly found throughout the world's oceans.
- As a powder, it dissolves in boiling water.
- When an agar solution cools, it forms a semi-solid jelly.
- Scientists create agar plates by pouring hot agar solution into a petri dish and letting it cool.

Watch the Pouring Agar video at 6.6 Lesson 10 Properties of Cooled Agar (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) and the Properties of Cooled Agar video at 6.6 Lesson 10 Pouring an Agar Plate (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) so students can see how agar plates are prepared.

### Additional Guidance

Students with vegetarian or vegan diets may be familiar with agar (often sold as agar-agar) since it is a plant-based gelatin used as an alternative to animal-derived gelatin. Students of Asian descent may also be familiar with it, as it is commonly used in Asian desserts. Do not call out specific students about their prior knowledge of agar, but ask the whole class if they have ever heard of, used, or eaten agar before.

*** Supporting Students in Engaging in Using Mathematics and Computational Thinking**

Use this opportunity to have students apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific situations.

To help students visualize how much more nutrient agar each plate contains, we use percentages. For every plate, we will pour agar that either has or does not have any nutrients mixed in. We will always mix the same amount of water with a certain amount of agar to make each plate. We start by seeing if bacteria can grow on a plate without food—this gives us the starting point or baseline of 0% nutrient solution to indicate a regular agar solution with no nutrients added. Then when we say that a plate has a higher percentage (%), this indicates that there are more nutrients mixed into that agar solution as compared to the regular agar solution.

It's important that students understand what the percentages represent, and that they see purpose in labeling percentages. Without this understanding, students may see the labels as arbitrary.

**Explain that agar can contain food and other nutrients or not.** Say, *We want to be able to give our bacteria some food to see if they make more of themselves. Scientists can add food and other nutrients to the agar plates.*

**Consider using various amounts of food and nutrients in different agar plates.** Ask, *How would using different amounts of food and nutrients help us figure out whether or not cells need food to grow?*

Sample student response:

- *If the bacteria make more of themselves with more food, and less of themselves with less food, that would provide evidence that cells need food and other nutrients to grow.*
- *If we don't provide any food, and we don't see any bacteria growing, then this probably means that they need food to grow and make more of themselves.*

**Calculate percentages to more easily compare nutrient levels.** Display **slide H.** Say, *Here's how the scientist set up five agar plates to use in this investigation. The scientist weighed out different amounts of plain agar and agar with nutrients, added them to a bottle with distilled water, and heated them on a hot plate to dissolve everything. Then, the hot agar solutions were poured into labeled petri dishes and cooled. You can see that different masses of plain agar, and the agar that contains food and nutrients ("nutrient agar" for short), were used in each of the five plates. However, it's not easy just by looking to see what amount of food each of the plates has in it in order to compare plates. One way we can tell how much food is on each plate is by knowing the concentration of nutrients in the agar on each plate. To know this, let's calculate the percentages of how much nutrient agar is in each plate so we can compare them more easily. Where should we start—are any of these pretty simple to find percentages for?*****

Work with the students to find percentages for the first plate, which has no nutrient agar, and the last plate, which is all nutrient agar. They may also recognize the 50% plate because each agar type is used in nearly even amounts. After that, you may choose to have them use calculators to divide the mass of the nutrient agar by the total mass (1.15 grams) for each plate. The percentages are shown in the table below. As students calculate the percentages, you may choose to type the percentages directly into your copy of the slides or create a simple chart on a whiteboard. In the images on the handout and in the slides, the number on each plate represents the percentage of nutrient agar on the plate.

| Mass of nutrient agar | Mass of plain agar | % nutrient agar |
|---|---|---|
| 0 g | 1.15 g | 0% |
| 0.29 g | 0.86 g | 25% |
| 0.58 g | 0.57 g | 50% |
| 0.86 g | 0.29 g | 75% |
| 1.15 g | 0 g | 100% |

**Consider the controls needed in this investigation.** Use prompts such as the following to help students consider the independent, dependent, and controlled variables for our investigation of bacteria on agar plates with different amounts of nutrient agar.

| Suggested prompts | Sample student responses |
|---|---|
| *So if we want to test what happens to the bacteria growth on different amounts of agar, what would be our independent variable? What would we be changing?* | *The amount of agar we put in the plate. We are changing how much food is available to the bacteria, so we are changing the amount of nutrient agar compared to regular agar.* |
| *What would be our dependent variable? What would we be observing or measuring?* | *We are looking to see how much bacterial growth we can see on that plate.* |
| *What control variables would we need to keep the same to make sure that our investigation is fair?* | *Every plate should start with the same amount of bacteria.*<br>*All the bacteria should come from the same place.*<br>*They should keep all of the plates in the same conditions (like temperature, light, and amount of water).*<br>*They should start them at the same time and look at them all after a set amount of time—so they all have the same amount of time to make more of themselves.* |
| *Why is it important to do that, to control the other variables?* | *If all these things are done, then we know that any differences in bacteria growth come from the difference in how much food we gave them because that was the only thing that was changed.* |

*** Supporting Students in Developing and Using Scale, Proportion, and Quantity**

Though bacterial cells themselves are microscopic, the process of bacterial growth can become visible at the macroscopic level when the bacterial cells grow and reproduce to the point at which the colony they form becomes large enough to see. It's useful to point this out as an example of a phenomenon that is observable at the macroscale because of changes occurring at the microscale.

**Show how bacteria were introduced to the agar plates.** Display **slide I.** Explain that bacteria were put onto the plates using the following steps:

1. Allow the plates to cool and the agar becomes jelly-like.
2. Sterilize and clean a metal loop by holding it in a flame until it glows.
3. Cool the metal loop by touching it to the agar on one side of the plate.
4. Use the metal loop to transfer and spread the *E. coli* stock solution onto the plates.
5. Repeat the above steps for each plate with the different amounts of nutrient agar.

Play the Streaking *E. coli* onto Agar Plates video 6.6 Lesson 10 Streaking E. coli onto Agar Plates (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) to show students these steps. Point out that after streaking each plate with bacteria, there is nothing visible on the plates. Consider freezing the video towards the end to point this out more clearly.

Display **slide J**. Explain that all the plates were covered and placed in the same heated incubator. The temperature was set to 37°C / 98.6°F, which the students may notice is the generally accepted average body temperature for humans. If they point this out, ask why that might be a good temperature for the bacteria. What data would that give us about these bacteria?

Students will likely respond by saying that keeping them at the same temperature as our body helps to imitate what happens in our body—the cells in our body will be at 37°C / 98.6°F, and they will likely receive varying amounts of food or nutrients. So, looking at the bacteria under these conditions may tell us something about what happens to the cells inside our body.

Since the topic of body temperature is being discussed, students may ask if bacteria grow in our body as well. You might ask students to elaborate on their thinking, and then prompt students to record new questions related to this on the DQB.

Explain to students that the bacteria used in this investigation are microscopic, and that individual bacterial cells are only visible under the microscope. Remind students that when the plates were streaked with bacteria, no bacteria was visible to the eye at this time. However, when bacterial cells grow and make more of themselves, they tend to form large clumps called bacterial colonies. When the bacterial colonies become large enough, when many bacteria cells are present and share the same space, they are visible without a microscope. Tell students that we will examine the plates to check for the presence of bacterial colonies over time.

**Predict outcomes of this investigation.** Display **slide K.** Have students briefly respond to these questions in their science notebooks.

- When the bacteria are on the agar plate with no nutrients, what do you predict we will observe on the plate?
- When the bacteria are on the plates with more nutrients, what do you predict we will observe on the plate?

After a few minutes of writing time, ask students to share their predictions with the class.

Sample student responses:

- *If there are no nutrients, I think the bacteria will not be getting what they need. I don't think we would see any bacterial colonies on the plate.*
- *If there are no nutrients, maybe the bacteria won't even be able to survive with no food at all. Maybe we will see less bacteria than we started with.*
- *With 100% nutrients, I think the bacteria will make lots more of themselves—we'll be able to see a lot of them—like lots of visible colonies.*
- *I think the more food there is on the plate, the more bacteria will be able to make more of themselves.*

## Alternate Activity

Although students would certainly enjoy the opportunity to conduct the experiment, it is advised that you use the secondary data set for the following reasons:

- The added materials cost
- The additional prep, classroom, and incubation time
- The potential for contamination
- The need for reproducible plate inoculation

If you have the time, resources, and inclination, you might consider conducting the investigation as a whole class, where you would prepare a set of plates for each section ahead of time and inoculate them during class. Detailed instructions for doing this can be found in *Procedure for growing E. coli on agar with different levels of nutrients as a wet lab*.

## 4. Analyze E. coli growth data.

10 MIN

**Materials:** science notebook, *Reference: Secondary Data for E. coli Grown on Agar with Different Nutrient Levels*, tape, chart paper or whiteboard, markers

**Introduce and prepare for the Identify and Interpret ($I^2$) sensemaking strategy.** Present **slide L** to students and inform them that they will use the $I^2$ strategy to analyze and interpret data. With this strategy, students will share what they notice about the data as "What I See" (WIS) statements and their interpretation of that data as "What It Means" (WIM) statements. They will share their WIS and WIM comments with their small group first and then with the whole class.

Arrange students in groups of three. Hand out a copy of the *Reference: Secondary Data for E. coli Grown on Agar with Different Nutrient Levels* handout to each student and have students tape this into their science notebooks. If students would like to see a color version of these images, *Secondary Data for E. coli Grown on Agar with Different Nutrient Levels*, is available in their Student Edition.

### Additional Guidance

If the $I^2$ sensemaking strategy is new to your students, you may want to model how it works using the images on **slide M** involving an observation that does not involve the key science ideas from the investigation. For example, a WIS statement could be, *I see some white fur on the black background in the images*, and a corresponding WIM statement could be, *This means the scientists may have a pet!* After modeling this strategy, remind students to use the same strategy to think about observations that may be relevant for explaining the effect of nutrient levels on bacteria growth.

**Have students make observations of the images using "What I See" comments.** As they review the data, prompt students to discuss WIS comments first in their small groups. After 2-3 minutes, bring students together to discuss their observations of the images (e.g., *What did you notice? Did anybody else notice something similar?*). Project **slide M**. Focus the discussion initially on the patterns involving the size and density of the bacterial growth before broadening it to other observations. Record some of the WIS comments on a whiteboard, chart paper, or in a shared electronic document in a table similar to the one shown below.

**Interpret observations using "What It Means" statements.** Have students discuss "What It Means" (WIM) for each of their WIS statements. These ideas are students' initial explanations of what they think is happening to **cause** the change in bacterial growth (**effect**) as observed in the data. Give groups 3–4 minutes to interpret their observations before asking several groups to share. To help ensure that students see the relevant patterns in the data, probe their interpretations involving how the % nutrients are related to the observed bacteria growth. Record some of the WIM

*** Supporting Students in Engaging in Analyzing and Interpreting Data**

Encourage students to discuss larger patterns as well as what variation within these data means. Encourage students to think about how these data are produced and what might cause that variation. Also encourage students to consider how they could use technological tools to more precisely describe the differences they observe with increasing nutrient levels. An example of this might be photo analysis of the plate to determine what percentage was covered with bacteria.

comments on a whiteboard, chart paper, or in an shared electronic document. As students develop evidence for causal relationships between nutrient levels and bacteria growth across the data set, support students in turning their statements into cause-and-effect statements. For example, if the WIM comment reads, "I think more bacteria can grow when there is more food and nutrients present," this can be rephrased as "When there is more food and nutrients present, more bacteria will grow." Encourage students to connect this causal statement to explain the patterns observed in the data.*

The table below shows sample WIS and WIM comments that the class might come up with.

| WIS | WIM |
|---|---|
| *Previously you couldn't see anything on the petri dishes. Now it looks like sort of fuzzy, whitish-yellowish spots—almost like frost on a window.* | *So many bacteria cells were making new cells that we can see clumps of them without even using a microscope.* |
| *No visible spots or changes occurred on the plate with no nutrients.* | *The bacteria doesn't grow on agar with zero nutrients.*<br>*The bacteria must need some food and nutrients to grow and make more cells.*<br>*There is no food for the bacteria to grow.* |
| *Overall it looks like the bacteria spots get larger as the % of nutrients increases and less space between dots.* | *Maybe bacteria can grow more when there is more food and nutrients.* |
| *As the nutrient level increases, there seem to be more bacteria spots.* | *More bacteria can grow when there is more food and nutrients present.* |
| *The pattern of growth on each plate (except 0%) seems to follow the streak pattern, or where the scientist put the loop we saw in the video.* | *Bacteria grew where they were streaked, or spread, on the agar.*<br>*If there was no bacteria present before, we wouldn't see more growing there. Bacteria need to come from other bacteria.* |

Once students have shared their WIS and WIM statements, and you're satisfied that they've voiced ideas similar to the ones in the WIS/WIM sample table, say, *It sounds like what we've figured out is that nutrients are needed for cells to grow and make more of themselves.*

*** Supporting Students in Developing and Using Cause and Effect**

As students share the meanings (WIM) behind the patterns they notice (WIS), encourage them to use language that highlights the cause-and-effect relationships between the nutrient conditions and the amount of bacterial growth. For example, if students share that "It seems like no bacteria grows when there are no nutrients available," you can point out that the effect they mentioned is that "no bacteria grows." Then, ask what might be the cause for this. Students will likely respond with "no nutrients available," to which you can explain that the lack of nutrients is the **cause**, and the lack of bacterial growth is the **effect**.

## Assessment Opportunity

**10.A** Analyze and interpret data for patterns to identify the relationship between the amount of food (cause) and the amount of bacteria made (effect) to provide evidence that cells need food to live and make more of themselves.

**What to look for:** Students are able to identify that as the amount of food available on the agar plates increased (as indicated by an increase in percentage of nutrients on the agar plate, or concentration), the bacteria increased. They should be able to interpret these data as an indication that the bacteria do need food (and other nutrients) to make more of themselves.

**What to do:** If students are struggling to identify patterns in the data, it may help to have them trace the streaks they can see on each plate with a highlighter. Ask, *Which plate has the most highlighting? What was different about that plate?* It may help to refer back to the independent, dependent, and control variables in these investigations. Say, *How does changing _____ affect _____?*

If students are struggling to use cause-and-effect language when discussing patterns in the data, point out that it helps to identify the **effect** by thinking about what happened or what was one finding from the investigation (i.e., lack of bacterial growth). Then, you can identify the **cause** by looking at what was done in order to produce that effect, or obtain that outcome (i.e., provide no nutrients). As additional support, consider offering sentence starters to help students discuss cause and effect, such as the following:

- *When there was/were _____ (cause), the result was _____ (effect).*
- *If _____ nutrients were used (cause), then we see _____ (effect).*
- *As a result of _____ (cause), we see _____ (effect).*

## 5. Read about different single-celled organisms.

12 MIN

**Materials:** *Lesson 10: Obtaining Information from Scientific Text*, one of these readings: *Reading: Archaea* or *Reading: Bacteria* or *Reading: Yeast* or *Reading: Algae*

**Consider other single-celled organisms.** Say, *When we've been investigating healing and cells, we've looked at samples from humans and other animals. We've said that looking at other organisms helps us figure out what we need to know. We've concluded from these data that bacteria need food to make more of themselves. It turns out there are lots of single-celled organisms that are alive, and we can learn more about them and how they are similar to or different from bacteria and our own cells.*

Display **slide N.** Say, *Each of you is going to read about a different kind of single-celled organisms, and then next time we're together, we will share what we've figured out in small groups. What are some questions we can try to answer by reading about these other single-celled things?* Sample student responses:

- *Are they like bacteria or different?*
- *Are they like us and other animals or different?*
- *Do they have similar structures and functions as we do?*
- *Are they living things?*

*** Supporting Students in Engaging in Obtaining, Evaluating, and Communicating Information**

Note that while the scientific information in each of these readings is equally rigorous, they are written at four different reading levels to support differentiation. You may choose to group students strategically so that students who need more support with obtaining information from scientific texts work with mixed-expertise groups

**Remind students of the tool for obtaining information from scientific texts**. Show **slide O.** Ask students to look at the *Lesson 10: Obtaining Information from Scientific Text* page in their workbook. Tell them that this is the same tool we used when we read about nerves. If needed, reiterate the strategies we used by directing them to look at the left column of the table. Explain that in the left column, there are strategies that we can use to help us find the information we need when we read text to get information. These strategies include:

Read for the gist (or central idea) by skimming the title, headings, and captions on images.

- Markup the text by keeping track of questions we have in the margins, circling keywords, putting question marks by words we want to learn more about, and underlining main ideas.
- Examine images, graphs, and tables and look for the central point of each.
- Identify the ideas from the text that support what you've figured out so far.

Point out that there is space on the handout to fill in the information students find in the text as they read.

**Use a jigsaw approach to read about different single-celled organisms.** Display **slide P.** Groups of students will use different readings to obtain information about various single-celled organisms and then synthesize this information during the Building Understandings Discussion on day 2.* You may want to assign specific readings to specific students or allow students to choose what text they read.* Distribute *Reading: Archaea*, *Reading: Bacteria*, *Reading: Yeast*, or *Reading: Algae* (printed for students so they can mark up the text) to each student, or alternately direct students to the corresponding reading in their Student Edition book.

Remind students to follow the strategies outlined in *Lesson 10: Obtaining Information from Scientific Text* as they read, since they will be asked to share about their single-celled organism and not everyone is reading about the same organisms. Give students the rest of today's class time to read and respond to the questions.

## Additional Guidance

**Importance of reducing scaffolding over time**: We offer resources and handouts such as the *Lesson 10: Obtaining Information from Scientific Text* to support students who may struggle to make meaning from scientific text. However, please remember that this is a scaffold that can be removed when your students show proficiency in identifying relevant ideas and information from the reading.

Just as it's important to provide scaffolding to help students attain proficiency, keeping the scaffolding in place indefinitely can be problematic and ultimately inequitable for the learner. Our aim is for students to be able to apply their knowledge and skill in new situations, for example to explain related phenomena, and for them to do so without being dependent on the explicit routines and procedures they've come to rely upon in the scaffolding. By allowing the scaffolding to fade away gradually and strategically, we offer students a chance to become independent learners and thinkers. At this point, the scaffolds become internalized and can be applied in the appropriate context without prompting.

Assign the reading and responses as home learning if needed.

assigned specific readings according to grade-level complexity, while students who are looking for a challenge are in groups assigned readings at a higher level. If your entire class would benefit from being at the sixth- and seventh-grade level, you can use only the *Algae: What's making my fish tank look so green?* and *What Are Bacteria?* readings, and the content will still be coherent and aligned to the NGSS.

*** Attending to Equity**

**Universal Design for Learning**: Providing students the opportunity to choose the level of perceived challenge can support *engagement* and help develop self-determination, pride in accomplishment, and increase the degree to which they feel connected to their learning.

Readings by order of increasing difficulty:

- *Yeast: Why are there holes in my bread?*—Lexile reading estimate: 810-1000L; just below grade level
- *Algae: What's making my fish tank look so green?*—Lexile reading estimate: 1010L-1200L; on grade level
- *What Are Bacteria?*—Lexile reading estimate: 1010-1200L; on grade level
- *Archaea: Extreme Living*—Lexile reading estimate: 1410-1600L; above grade level

## Home Learning Opportunity

If students are struggling with the information or need more time to read and process, either assign the rest of the reading for home learning or give them some time at the beginning of the next class to finish.



**End of day 1**

## 6. Discuss the readings in jigsaw groups. 10 MIN

**Materials:** *Lesson 10: Obtaining Information from Scientific Text*, one of these readings: *Reading: Archaea* or *Reading: Bacteria* or *Reading: Yeast* or *Reading: Algae*

**Discuss single-celled organisms in jigsaw groups.** Arrange groups so that each group includes students who read about different organisms (ideally, groups of four students, one student for each different article). Display **slide Q.** Direct students to share their responses to the questions that guided their reading (listed below, in their readings, and on the slide) with the goal of finding similarities and differences among the different organisms.

- What do you notice about this organism that's similar to or different from the other organisms and cells we've seen?
- How does this organism's structure and function relate to where it lives? Why do you think it lives where it does?
- Do they relate to our healing story? If so, how?

## 7. Building Understandings Discussion 13 MIN

**Materials:** science notebook, Sticky notes, markers

**Lead a Building Understandings Discussion about multicellular and unicellular organisms.** Display **slide R.** Ask students to gather in a Scientists Circle with science notebooks, articles, and *Lesson 10: Obtaining Information from Scientific Text*.

## Key Ideas

**Purpose of this discussion:** Students will use what they figure out from the articles that they read and discussed in small groups that there are living organisms that are made of only one cell. They will also establish that cells are the smallest living things, whether in a multicellular or unicellular organism, and that cells need food to make more of themselves.

**Listen for these ideas:**

- There are many types of single-celled organisms, including bacteria, yeast, algae, and archaea.
- Both multiple-celled and single-celled organisms need food and nutrients to make more of themselves.
- Multiple-celled organisms have different types of cells that work together as a system of subsystems that rely upon one another to live and make more of themselves.

- The systems in multiple-celled organisms work together to carry out all the necessary life processes (e.g., the circulatory system is used to carry what the body's cells need).
- Single-celled organisms can live and do all of their functions without relying on other cells.

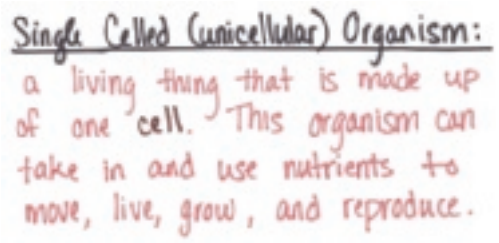
Conduct a Building Understandings Discussion using the following prompts.

| Suggested prompt | Sample student responses |
|---|---|
| *So based on our readings, would we find all single-celled organisms everywhere?* | *No, they need an environment where they can get the nutrients they need to make more of themselves.*<br>*Different types of single-celled organisms are found in different environments because they need different food and nutrients.* |
| *What did you figure out that your single-celled organisms had in common?* | *They can all make more of themselves using other things like food and nutrients, like the archaea use toxic waste, yeast cells eat sugar, bacteria eat already-dead stuff on the ground, and algae use light and water and minerals to make more of themselves.* |
| *We're calling them organisms. Do we have enough evidence that bacteria and other single-celled creatures are living things? What makes you think so?* | *Yes, they're alive!*<br>*Living things eat and grow and make more of themselves and eventually die.*<br>*Even though these are just single cells, they can do all of those things on their own.* |
| *How do bacteria and other single-celled organisms compare to human cells? What is similar and different about them?* | *Human cells are bigger. Bacteria cells are smaller.*<br>*Human cells are part of something else, like the skin, bone, or muscle.* |
| *When comparing bacteria to human cells yesterday, we said that we didn't think single human cells (like a skin cell or bone cell) would be able to live by themselves like these single-celled organisms can. Why not?* | *The cells in our bodies get what they need from the blood. We need those systems all working together to bring them what they need.*<br>*The bacteria seem to get everything they need directly from their environment.* |

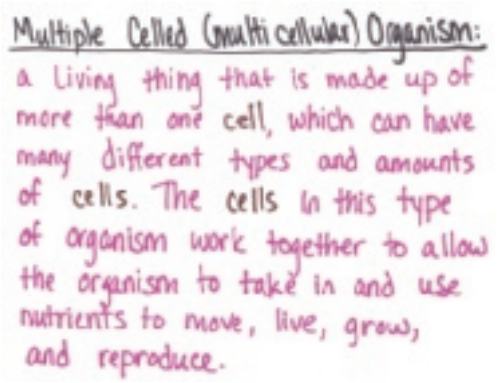
| Suggested prompts | Sample student responses |
|---|---|
| *Can someone put those pieces together for me about how bacteria and humans can both be living?* | *Bacteria and other single-celled organisms do not need to be a part of a body or body part made of many cells, like human cells do. So even though they are small and not connected to other cells, they can live on their own as single cells and still get food and nutrients from their environment to grow and make more of themselves.* |
| *If we say that bacteria, other single-celled organisms, and humans are living things, based on what we have figured out, what does that mean? (In other words, what does it mean in terms of what they can all do?)* | *They can grow.*<br>*They take in food.*<br>*They can live.*<br>*They can die.*<br>*They can make more of themselves.* |
| *OK, so if these are living things, and we call bacteria single-celled organisms, what would we call organisms that have different types of cells that work together, like our body?* | *Multiple-celled?*<br>*Many-celled?* |

**Add "single-celled organism" and "multiple-celled organism" to the Word Wall.** Say, *I think we've gained a pretty good understanding of what single-celled and multiple-celled organisms are. Who can help us define these terms for our Word Wall?*

Your definition for a single-celled organism might be something like, "A living thing that is made up of one cell. This organism can take in and use food and nutrients to move, live, grow, and reproduce, or make more cells." Your definition for multiple-celled organisms might be something like, "A living thing that is made up of more than one cell, which can have many different types and amounts of cells. The cells in this type of organism work together to allow the organism to take in and use nutrients to move, live, grow, and reproduce, or make more cells."




It's important for students to walk away from this knowing that one key characteristic of life is that all living organisms, whether they are made of one cell or multiple cells, get food and nutrients from their environment in order to grow and make more of themselves.




**Add the idea that all living things are made of cells.** Remind students that in Lesson 7, they figured out that parts of living things are made of cells, and that the non-living things we looked at did not have cells. Display **slide S**. Push students to consider whether all living things are made of cells. Say, *If we think back to Lesson 7, what did we figure out about non-living versus living things regarding cells?*

After students recall that non-living things are not made of cells, and that the parts of living things we have looked at are made of cells, ask, *Do you think that we could revise our key science idea from Lesson 7 to read "All living things are made of cells" from "Parts of living things are made of cells"? What evidence would you use to support your answer?*

Sample student responses:

- Yes! All the things we looked at in this lesson were living things, and they were made of one cell. And all the living things we looked at earlier, like muscle, bone, skin, blood, and nerves, were also made of cells.
- I think that if something uses food to grow and make more of themselves, like bacteria or skin cells, then it's a living thing. And when we look at these things under the microscope, we see cells.
- If something does not use food to grow and make more of themselves, then it's probably not a living thing. We already know from Lesson 7 that non-living things don't have cells.

## 8. Read about the lifespan of cells.

10 MIN

**Materials:** *Reference: Lifespan of Cells*

**Problematize how long cells can live.** Say, *We just said that if bacteria, other single-celled organisms, and humans are living things, we think that in order to be living that also means they can die. Let's take a few minutes to analyze an infographic to see if this is the case.*

Display **slide T.** Introduce *Reference: Lifespan of Cells*. Explain that the image of the person is representative of a mature adult over 30 years old. Give students a few minutes to analyze the image with a partner and annotate or highlight anything that they read that will help us answer this question about how long cells live.

*Reference: Lifespan of Cells* can be printed in black and white or color for students to use and annotate. There is a color version in the student edition, *Lifespan of Cells*.

When students have finished gathering information from analyzing the infographic, bring the class back together and discuss the question we are trying to figure out: *Do cells live and then die?*

| Suggested prompts | Sample student responses |
|---|---|
| *How did the life span of cells of human cells compare to those we read about in the single-celled organism readings?* | *Some types of human cells live longer than other types of cells.*<br>*Algae can live for 24 hours to six days.*<br>*Bacteria live on average for 12 hours but can make new cells in as little as 20 minutes. So it seems like bacteria form new bacteria much faster than humans!* |
| *Why do you think some cells live longer than others?* | *I think it has to do with the function of the cell, or what the cell does. Like we read that skin cells only live 2-3 weeks, but lung cells live for years.* |

| Suggested prompt | Sample student responses |
|---|---|
| *OK, so how is the function related to the life span of the cells?* | *Well…skin cells are on the outside of the body and interact with stuff in the environment all the time, so they need to be able to make more of them more often because they can be damaged easily.*<br>*Yeah…but your heart that is on the inside of your body doesn't interact with stuff outside the body, so they might not get damaged.* |

Say, *OK, now we know cells grow, take in food, and have a life span (meaning they live and die), like other living things. Let's take a few minutes to process our ideas in our Progress Trackers.*

## 9. Update Progress Tracker.

5 MIN

**Materials:** science notebook

**Update Progress Trackers in science notebooks.** Display **slide U**. Direct students to the Progress Tracker section of their science notebooks (landscape orientation), and have them add rows for what we've figured out about what cells need to make more of themselves. Remind students that this tracker is their space to process and record their thoughts while we're working to figure out how an injury can heal. Give students 5-7 minutes to add to their Progress Trackers. See the sample student responses shown below.

| Question | What we figured out in words/pictures | This makes me think or wonder about healing... |
|---|---|---|
| What do cells need to grow and make more of themselves? | • Cells are living things, whether they are part of a single-celled organism or multiple-celled organism.<br>• Cells need food and nutrients (like we do) to make new cell parts to make more of themselves.<br>• Cells can only live for a certain amount of time. Not all cells have the same life span. | • Can bacteria get in the way of healing? Why do we have to wash wounds and injuries?<br>• Can single-celled organisms get hurt?<br>• Can single-celled organisms get injured?<br>• Do single-celled organisms heal?<br>• How do single-celled organisms heal?<br>• Do cells in our body heal? Or die when they are injured? |

## 10. Write an argument about what cells would need to heal the wound. 10 MIN

**Materials:** *What do bacteria need to make more of themselves?*, optional *Self-Assessment and Peer Feedback*, optional *Peer Feedback Guidelines*

**Construct an evidence-based argument about what bacteria and other cells need to make more of themselves.** Display **slide V.** Distribute *What do bacteria need to make more of themselves?* to each student. As students are writing their ideas, walk around to observe what ideas emerge. Collect these from students as they leave class. Say, *Let's take a few minutes to individually process what we have figured out about* what *cells need in order to make more of themselves.**

### Additional Guidance

Alternate: Self-Assessment & Peer Feedback

Before scoring individual assessments, scan a sampling of student work to look for patterns in how they use evidence to support an argument, and in how they use cause-and-effect language. If you notice students struggling to do either, or both, consider returning the work and providing students with an opportunity to selfassess and to receive peer feedback, following similar guidelines below.

If you decide to do self-assessment and peer feedback...

- Explain that students will have a chance to self-assess their argument first and then they'll engage in peer feedback. After all this feedback, they'll have an opportunity to revise their argument.
- Distribute a copy of *Self-Assessment and Peer Feedback* to each student. Review as a class the three key elements of the argument and the individual self-assessment task. Share instructions for how to self-assess using a pen or pencil.
  - Underline places where you state a claim.
  - Circle evidence that you used.
  - Highlight places where you use cause-and-effect language.
- Explain that during the self-assessment, students should add notes directly to their argument about what they want to revise. Tell students they'll have a chance to record a new argument at the end of class, so these notes do not need to be perfect.
- While students self-assess their argument, circulate among the students and probe them for places where they could include additional science ideas, evidence, and cause-and-effect language.
- Distribute 1 copy of *Peer Feedback Guidelines* to each student. Review elements of quality peer feedback. Give examples of productive and unproductive feedback.
- While students provide peer feedback, circulate the class and probe students for places where they think their peers could include additional science ideas, evidence, and cause-and-effect language.

*** Attending to Equity**

This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far through multiple modalities, as they construct an argument. Some students may benefit from using multiple modalities to show their thinking for any or all of the questions on this assessment. You may consider allowing some students to present their answers verbally with you, with another student acting as a scribe to record their thinking on paper, or through the use of a recording device such as those freely available on most smartphones. Other students may benefit from using gestures rather than images to describe parts of their models. Some students might also benefit from using manipulatives to support a written or verbal argument. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency.

## Assessment Opportunity

**Building towards: 10.B** Construct a written argument using cause-and-effect relationships to conclude that the cells that make up multicellular organisms need food to make more cells, as do the cells of unicellular organisms.

**What to look/listen for:** See *Key: What do bacteria need to make more of themselves?* for scoring guidance.

**What to do:** The purpose of this assessment is to see if students can use evidence for what they have figured out about bacterial cells and apply it back to the healing phenomenon. If students struggle to support the claim with evidence, encourage them to look back at what they figured out in Lesson 9 about how cells make new cells. Then, students should think about what they figured out about what happened with the bacteria in this lesson when they were given food and nutrients. Using these pieces of data, ask them what they think: Do human cells need similar things to the bacteria to grow and split to make more of themselves? What do we know about human cells and bacteria or other single-celled organisms cells?

Additionally, if students struggle to use cause-and-effect language to state a claim, consider using the self-assessment and peer feedback as described in the alternative callout.

## SCIENCE LITERACY: READING COLLECTION 3

# Cells, Health, and Healing


1 Cell Types
2 The Rise and Fall of Cells
3 Extreme Cells
4 Healing Tissues and Replacing Cells
5 Wellness and Health


## Literacy Objectives

- ✓ Determine the meaning of words and phrases as used in a text.
- ✓ Distinguish between credible and non-credible sources.
- ✓ Evaluate sources of information for potential bias.

## Literacy Exercises

- Read varied text selections related to the topics explored in Lessons 6–10.
- Evaluate the reading selections according to provided prompts and criteria.
- Compare and contrast information gained from reading text with information gained from class investigation.
- Prepare a three-question graphic organizer in response to the reading.

## Instructional Resources

Student Reader



Collection 3

**Science Literacy Student Reader, Collection 3**
"Cells, Health, and Healing"

Exercise Page



EP 3

**Science Literacy Exercise Page**
EP 3

## Prerequisite Investigations

Assign the Science Literacy reading and writing exercise *after* class completion of this lesson group:

- Lesson 6: What will we see if we look at skin, bone, and muscle with the microscope, too?
- Lesson 7: Are all things made of cells?
- Lesson 8: What happened as the skin on top of the foot healed?
- Lesson 9: What is happening at the site of an injury to fill the gap?
- Lesson 10: What do cells need to grow and make more of themselves?

## Standards and Dimensions

### NGSS

**Disciplinary Core Idea LS1.A: Structure and Function:** All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)

**Science and Engineering Practice:** Obtaining, Evaluating, and Communicating Information

**Crosscutting Concepts:** Structure and Function; Scale, Proportion, and Quantity

### CCSS

**English Language Arts**

**RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts.

**RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

**RST.6–8.10:** By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

**RI.6.8:** Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.

## Core Vocabulary

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

**apoptosis**

**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.

**sperm cell** **stem cells** **zygote**

A Glossary at the end of the Science Literacy Student Reader lists definitions for Core Vocabulary and selected Language of Instruction.

## 1. Plan ahead.

Determine your pacing to introduce the reading selections, check in with students on their progress, and discuss the reading content and writing exercise. If you are performing Science Literacy as a structured, weekly routine, you might implement a schedule like this:

- Monday: Designate a ten-minute period at the beginning of the week to introduce students to the assignment.
- Wednesday: Plan to touch base briefly with students in the middle of the week to answer questions about the reading, to clarify expectations about the writing exercise, and to help students stay on track.
- Friday: Set aside time at the end of the week to facilitate a discussion about the reading and the writing exercise.

You'll proceed with the in-class lesson investigations during this week.

## 2. Preview the assignment and set expectations. (Monday)

- Let students know they will read independently and then complete a short writing assignment. The reading selection relates to topics they are presently exploring in their Cells and Systems unit science investigations.
- The reading and writing will be completed outside of class (unless you have available class time to allocate).
- Preview the reading. Share a short summary of what students can expect.
  - *First, you will read about a few of the more than 200 kinds of cells in the human body—such as zygotes and stem cells—and examine illustrations to compare their structures.*
  - *Then, you'll read and interpret a diagram explaining why and when cells break down and die.*
  - *Next, you'll read about some record holders in the world of cells.*
  - *In the fourth selection, you'll read a journal entry from a fictitious Peace Corps volunteer. Alongside it is a scientist's summary of an experiment with plants. You'll have to make the connection between the two!*

- *Finally, you'll read a mock magazine article recommending some "wellness" products to buy. On the facing page is a simulated editorial with a stern warning to consumers.*

- Distribute Exercise Page 3. Preview the writing exercise. Share a summary of what students will be expected to deliver. Emphasize that Science Literacy exercises are brief. The focus is on thoughtful quality of a small product, not on the assignment being big and complex.
  - *For this assignment you will be expected to generate the answers to three questions about one of the readings in this collection. These are questions you can and should ask anytime you read for information.*

Exercise Page



EP 3

- Remind students of helpful strategies they can employ during independent reading. Offer the following advice:
  - *The reading should take approximately 30 minutes to complete.* (Encourage students to break reading into smaller sections over multiple short sittings if their attention wanders.)
  - *A good reading strategy is to scan through the collection first to see the titles, section headers, graphics, and images to see what the selections are going to be about before fully reading.*
  - *Next, "cold read" the selections without yet thinking about the writing assignment that will follow.*
  - *Then, carefully read the Exercise Page to understand the expectations for the writing part of the assignment.*
  - *Revisit the reading selections to complete the writing exercise.*
  - *Jot down any questions for the midweek progress check in class.* (Be sure students know, though, that they are not limited to that time to ask you for clarification or answers to questions.)

## 3. Touch base to provide clarification and address questions. (Wednesday)

Touch base midweek with students to make sure they are on track while working independently. You may choose to administer a midweek minute-quiz to give students a concrete reason not to postpone completing the reading until the last minute. Ask questions such as these, and have students jot answers on a half sheet of paper:

| Suggested prompts | Sample student responses |
|---|---|
| *What are some shapes that different human body cells have?* | *Some are round or spherical; some have dents or are flattened; some are long; some have tiny fingerlike parts that stick out.* |
| *Where in nature is the biggest single cell?* | *an ostrich egg* |
| *Why don't foot wounds heal properly in people with diabetes?* | *because their blood does not circulate as well as in healthy people* |

Ask a few brief discussion questions related to the reading that will help students tie the text content to students' classroom investigations.

| Suggested prompts | Sample student responses |
|---|---|
| *How did your learning about cells in Lesson 10 support the main idea of "The Rise and Fall of Cells"?* | *In Lesson 10 we learned that cells are living things, and in this selection we learned that cells die. That makes sense because all living things eventually die.* |
| *Based on our discussion in Lessons 8 and 9, what details can you fill in about how Sammy's toe healed after it was injured by boiling water?* | *We think that when a wound heals, new skin cells are made to fill in the gap.*<br>*We think that cells split in two and that the new cells start off small and get bigger, to fill in the gap slowly.* |
| *The scientific abstract in the fourth selection uses the term* tissue *several times. Explain what a tissue is based on our discussion in Lesson 6.* | *A tissue is a repeating pattern of cells that work together to perform a function.* |

- Refer students to the Exercise Page 3. Provide more specific guidance about expectations for students' deliverables due at the end of the week.
  - *The writing expectation for this assignment is to complete a concept map about one of the selections by answering three questions.*
  - *First, read the entire collection. Then choose one selection to reread and answer the questions.*
  - *These are the kinds of questions you can ask yourself when you read any informational text. They will help make your reading more meaningful.*
  - *Don't be surprised if you realize there is quite a lot that you did not understand. Reading about science is challenging!*
  - *Don't worry about your classmates reading your responses. It is not necessary to share your organizer with anyone except me. So, you can be honest about what you didn't understand.*
  - *Remember that each reader brings their own background knowledge to reading. Authors don't know what any one reader will find familiar and what will be completely new to them.*
  - *The important criterion for your work are that you answer the three questions clearly and honestly.*
- Answer any questions students may have relative to the reading content or the exercise expectations.

Exercise Page



EP 3

## 4. Facilitate discussion.

(Friday)

Facilitate class discussion about the reading collection and writing exercise. The collection begins with three selections about differences in the structure and function of cells. The final two are about healing and health.

Student Reader



Collection 3

| Pages 24–31<br>Suggested prompts | Sample student responses |
|---|---|
| *What is the general purpose of the first selection, "Cell Types"?* | *It describes several kinds of human body cells and shows how each kind looks in an illustration.* |
| *What are some ways the types of cells illustrated differ in appearance?* | *They differ in shape—some are round, and others are oblong.*<br>*They differ in whether they have protrusions or appendages—some do, and some don't.* |
| *What do you think is the function of that appendage on the sperm cell? How do you know?* | *The sperm cell looks like a frog tadpole, and I know tadpoles use their tails to swim. So maybe, the sperm cell can also swim.* |
| *What is the general purpose of the second selection, "The Rise and Fall of Cells"?* | *It explains that cells die for various reasons but that it often has something to do with their DNA.* |
| *If you had chosen to answer the three questions on the Exercise Page about this selection, what would you say was most difficult to understand?* | *why people would have webbed fingers*<br>*I didn't understand what "programmed death" meant.*<br>*how a cell can recycle itself but not die* |
| *What reputable expert sources could you use to learn more about the topic of cell death?* | *a medical doctor; a biologist who studies cell death; a website from a laboratory, hospital, or university that does research on cell death* |
| *What is the general purpose of the third article, "Extreme Cells"?* | *It is kind of a Guinness-World-Records-type of article about unusual cells.* |
| *How does the third selection help you build knowledge on top of what you learned in the second selection?* | *The second selection explained that all cells die, and this one explains that some cells live for decades and others last only three days.*<br>*The second selection shows a picture of a nerve cell, and it has one long part. This selection names that part—an axon.* |
| *What was one thing you read about in this selection that you already knew?* | *I already knew that ostriches lay the biggest bird's eggs.* |
| *What is the general purpose of the fourth article, "Healing Tissues and Replacing Cells"?* | *It explains how antibiotics can help in wound care and describes an experiment on the effect of fluid pressure on plant wounds.* |

**SUPPORT**—If you are using the recommended word envelope convention, check the envelope to see if it contains any words, phrases, or sentences that student need help understanding. Read key sentences aloud, and provide concise explanation.

**SUPPORT**—A good practice for readers of challenging informational text is to ask themselves the three questions on the Exercise Page for any selection they read. List the three questions on the board, and explain to students they should think about or jot down their answers for each selection. If students are using a printed version of the Student Reader, pass out sticky notes so that they can affix their answers to the relevant parts of the reading.

**SUPPORT**—Point out to English learners and others that the suffix *-sis* is often added to science nouns to turn them into indicate an action, process, or state of being. In the second selection, apoptosis is a process of programmed death; necroptosis and necrosis are other processes that control cell death.

| Pages 31–33<br>Suggested prompts | Sample student responses |
|---|---|
| *What are some of the main points made by the author of the Peace Corps journal?* | *People in the United States take antibiotic ointments for granted.*<br>*Foot injuries to diabetics can lead to amputation.*<br>*Wound care using antibiotics can prevent amputations.*<br>*Everyone should have access to the treatments needed to heal these infections.* |
| *How does the second part of this selection help you build knowledge on top of what you learned in the first part?* | *It tells how injured plants heal themselves by increasing fluid pressure in the cells around the injury. Maybe the same thing happens when people injure their skin.* |
| *What is the general purpose of the fifth article, "Wellness and Health"?* | *The first part is to convince readers to buy certain products for their health. The second part is to convince readers that these wellness products make unscientific claims.* |
| *How can looking at ads tell you when a print magazine or an online magazine might be biased?* | *If the magazine sells many ads for products similar to the ones they write about, they are likely biased in recommending those products.* |
| *Take a look at the "Spot the BS" box. Which of the claims about the products seem hardest to believe? Explain.* | *The amethyst crystal–infused water bottle seems like a wild claim, because glass water bottles are supposed to keep water pure. So, I don't see how the bottle could affect your brain.* |

## 5. Check for understanding.

**Evaluate and Provide Feedback**

For Exercise 3, students should use the three questions in the graphic organizer to make sense while they are reading. The directions say to apply the three questions to one of the five reading selections. Look for evidence that students have copied the template and three questions accurately, that they have answered the questions clearly and with honesty, and that any terms or concepts they write about are accurately stated. A sample level 3 response is shown below.

**Title:** Healing Tissues and Replacing Cells

**What did I already know?**

I knew that antibiotic ointments were used for killing bacteria that cause infections in wounds.

**What was new to me?**

I hadn't known that in some countries people cannot get these antibiotic ointments to prevent infections.

**What was difficult to understand?**

I had a hard time understanding the description of an investigation with plants. For one thing, what's the connection to wound care in diabetic people? Also, there were a lot of scientific words that I didn't know.

Use the rubric provided on the Exercise Page to supply feedback to each student.

LESSON 11

# How do cells get what they need to grow?

## Previous Lesson

*We wondered if cells need the same things to grow as humans do. To investigate this question, we analyzed data from a scientist who grew bacteria on agar plates with different nutrient levels. We noticed that the quantity of bacteria increased as nutrient levels increased. We read about other unicellular organisms and figured out that they also need food to grow and make more of themselves.*

## This Lesson

**Investigation**

**1 DAY**



In this lesson, we use microscopes to observe onion cells. We use salt water and plain water to cause observable changes in the cells. We notice that onion cells have a cell membrane, like other cells we have observed. We also notice a cell wall, which is a structure we did not see previously in blood, nerve, muscle, or bone cells. This structure provides support for plant cells and is not found in animal cells. We use models to show that the cell membrane and cell wall allow water into and out of the cell. We use our observations as evidence to argue that the cell membrane (and cell wall) are structures that allow what the cell needs into the cell, and allow whatever the cell does not need to leave the cell.

## Next Lesson

*We will revisit the timeline of healing from Lesson 1 and develop explanations for how healing happens based on each event we had listed. We will use what we have figured out about healing so far to see if we can explain how the systems in our body interact to support the healing process.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**11.A** Construct an explanation to show that the structure of cell membranes and cell walls (tiny openings) let certain things in and out of cells (function).

## What Students Will Figure Out

- Plant cells have a cell wall and a cell membrane.
- The cell wall is a structure that is unique to plants and helps the cell and the plant maintain its shape.
- The cell membrane and cell wall are structures that act as barriers and allow things the cell needs (food, nutrients, etc.) or does not need into or out of the cell through tiny openings.

## Lesson 11 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 5 min | **NAVIGATION**<br>Revisit what we have figured out about what cells need to grow and to make more cells. | A-B | |
| 2 | 5 min | **COLLABORATIVELY PLAN AN INVESTIGATION TO OBSERVE HOW THINGS CAN GET IN AND OUT OF CELLS**<br>Think about and discuss previous investigations to determine ways to investigate how things can get in and out of cells. | C | chart paper, markers |
| 3 | 14 min | **INVESTIGATE STRUCTURES IN RED ONION CELLS**<br>Observe changes in cells when plain water and salt water are added to the red onion cells. Document observations to use as evidence to figure out how things get in and out of cells. | D-F | tape, Investigate Structures in Red Onion Cells |
| 4 | 14 min | **CONDUCT A BUILDING UNDERSTANDINGS DISCUSSION**<br>Use observations from the investigation to make sense of what happened when plain water and salt water were added to red onion cells. Add to the New Cells Being Made poster. | G-J | *Data from Investigating Red Onion Cells*, chart paper, markers, cell image from Lesson 9 |
| 5 | 7 min | **UPDATE PROGRESS TRACKERS**<br>Update our Progress Trackers to show what we figured out about how cells get what they need to grow. | J | |

*End of day 1*

## Lesson 11 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Investigate Structures in Red Onion Cells materials | • *Procedure to Investigate Structures in Red Onion Cells*<br>• *Data from Investigating Red Onion Cells* | • microscope<br>• pre-prepared red onion cell slide<br>• cup of salt water with disposable pipette<br>• cup of plain water with disposable pipette<br>• pieces of paper towel<br>• toothpick | • optional investigation procedure video at 6.6 Lesson 11 Investigating Red Onion Skin (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Data from Investigating Red Onion Cells* | • tape | • chart paper<br>• markers<br>• cell image from Lesson 9 |

**Materials preparation (60 minutes)**

**Online Resources** 

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

In this lesson, students will observe teacher-prepared wet-mount slides of red onion skin with microscopes. If no microscopes are available, you have these options:

- Show the video of this investigation, which is available at 6.6 Lesson 11 Investigating Red Onion Skin (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**). The total magnification shown in the video is 120x, which is comparable to what students use with the medium magnification objective (100x total magnification). This video demonstrates the procedure students will follow in *Procedure to Investigate Structures in Red Onion Cells*. The following video timestamps may be helpful to note:
  - Viewing the plain water slide, 0:06-0:43
  - Switching from plain water to salt water, 0:44-2:10
  - Viewing the salt water slide, 2:12-3:05

    - Switching from salt water back to plain water, 3:06-4:30
    - Viewing the return to plain water, 4:32-5:50
        - It is possible to observe expansion of the pigmented area from 5:27 to 5:50.
- Although microscope images are visible in the video, students should make their observations using the images provided on *Reference: Red Onion Investigation Images*.
- Access the Virtual Microscope interactive. From there, copy the link for viewing **red onion skin** and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this part of the lesson.
- There are two other Virtual Microscope interactive links available for use in this lesson:
    - One has microscopic images of two other plants.
    - One has access to all the microscopic images used over the course of the unit.

Students can document their observations in *Data from Investigating Red Onion Cells* while using any of these alternates.

*Procedure to Investigate Structures in Red Onion Cells* can be reused for each class period. It may be helpful to laminate the student copies of this reference so it does not get damaged by any water used in the lab.

Be sure you have materials (e.g., blank piece of paper, markers) to add to the cell image created in Lesson 6 and updated in Lesson 9. You may also want to add a second image of a plant cell to highlight the similarities and differences between these cells. The following cell structures will be highlighted and their functions will be described: **cell membrane, cell wall**.

### Investigate Structures in Red Onion Cells

- **Group size:** Divide your class by the number of microscopes available. Each group will make observations of a prepared red onion skin slide with the microscopes.
- **Setup:**
    - You will use approximately one liter of distilled water to set up the lab for several classes. If you do not have access to distilled water, you may use tap water if it does not contain significant impurities.
    - Prepare salt water by mixing about 35 grams of salt into 500 mL of distilled water.
    - Use a permanent marker to label 2 disposable pipettes for each group: "water" (or just "W") and "salt water" (or just "S").
    - Label a cup for each group "salt water." Pour about 60 mL of salt water into these cups, and add a disposable pipette labeled "salt water."
    - Label a cup for each group "plain water." Pour about 60 mL of distilled water into these cups, and add a disposable pipette labeled "water" to each cup.
    - Cut paper towels into smaller pieces (~3" x 3" square). Each group will need 4 pieces.
    - Provide each group with a toothpick to use for manipulating the coverslip and onion skin.

- *Prepare one red onion wet mount slide per group no earlier than the morning of the investigation to minimize evaporation of water from under the coverslip. Use Alternate—Preparing Red Onion Skin Slides for specific guidance on creating these wet mount slides. This procedure is also demonstrated in 6.6 Lesson 11 Slide Preparation* (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**).
  - Each group will need 1 prepared slide though you may want to have some extra slides on hand in case the onion skin is damaged during the investigation.
  - One red onion should be enough for multiple sections.
- Be sure all microscopes have access to an outlet or that their batteries are fresh.
- Use lens paper to clean the microscope lenses between classes, as needed.

- **Notes for during the lab:**
  - If you would like to watch a video of this lab in order to help you prepare to facilitate it, it is available at 6.6 Lesson 11 Investigating Red Onion Skin (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**). The following timestamps may be helpful to note:
    - Viewing the plain water slide 0:06-0:43
    - Switching from plain water to salt water 0:44-2:10
      - Moving the onion skin from the coverslip to the slide 1:20-1:40
    - Viewing the salt water slide 2:12-3:05
    - Switching from salt water back to plain water 3:06-4:30
    - Viewing the return to plain water 4:32-5:50
      - It is possible to observe the expansion of the pigmented area from 5:27 to 5:50.
  - Students should plug in and/or turn on the microscope.
  - Have students sanitize microscopes between turns.
  - Remind students to keep the droppers separate for each of their cups so they don't contaminate the tap or distilled water with salt water.
- **Safety:** Glass slides and coverslips are fragile. Have ready an appropriate receptacle to dispose of broken glass and used coverslips, as well as a broom and dustpan specifically reserved for the cleanup of broken glass. Remind students to handle the slides carefully and ask you for help if one happens to break.
- **Disposal:**
  - Depending on the resources in your classroom, you may choose to have students wash and dry their slides for reuse.
  - We recommend disposing of the coverslips in an appropriate receptacle because they can break during cleaning.
- **Storage:**
  - Cleaned and dried slides and unused coverslips can be saved for future use.
  - Unplug and/or turn off and cover microscopes when not in use to avoid dust.

## Lesson 11 • Where We Are Going and NOT Going

### Where We Are Going

In this lesson, students investigate two cell structures (the cell membrane and cell wall), one of which is only found in plant cells: the cell wall. Using findings from the investigation, they figure out that the cell wall and cell membrane allow things, like water, in and out of plant cells.

For this investigation, students observe red onion cells on slides under the microscope. Since we cannot easily investigate how things enter and leave human cells, we use plant cells. The skin of a red onion contains naturally occurring pigments so students will be able to see cells without staining them.

To help students figure out that animal cells do not have cell walls, students will revisit images of cells previously investigated, including skin, muscle, bone, blood, and nerve cells, and compare them to the red onion cells. This comparison helps students figure out that animal cells only have cell membranes, which also have the function of letting things in and out of the cell.

Students will use what they have figured out about how cells are able to create new cells (Lesson 9) by getting what they need (nutrients, water, etc. from Lesson 10) through the cell membrane (Lesson 11) and relate it to our healing story in the following lessons. They will use systems thinking to explain how the body is able to heal itself and function again in Lesson 12.

### Where We Are NOT Going

The purpose of this lesson is **not** to name other parts of the cell (organelles). Students may observe nuclei in their cell samples, but they do not need to identify or understand the function of the nucleus in this lesson or this unit.

The pigment in red onion epidermal cells is contained within the vacuole of the cell, and students will see boundaries of the vacuole as well as the cell membrane when it contracts in salt water; we are purposefully omitting, naming, and focusing on the vacuole and other structures contained within the plant cell, so that we can focus on the how cells get what they need to grow and reproduce, which is central to our healing story.

Students will not figure out the exact processes for how water and food particles enter the cell and how waste, water, or other things leave the cell. We only focus on the fact that the cell membrane and cell wall have tiny openings that allow water (and other things) in and out of the cell.

# LEARNING PLAN FOR LESSON 11

## 1. Navigation

5 MIN

**Materials:** science notebook

**Revisit what we figured out and determine next steps.** Show **slide A** and say something like, *Let's take a few minutes to review what we figured out in the last lesson. Remember to use your science notebooks to help you.*

Have students read the question on the slide, then turn and talk with a partner. Call on a few students to respond and look for the following ideas to surface.

| Suggested prompts | Sample student responses |
|---|---|
| *What did we figure out in our last lesson through our bacteria investigation that cells need to grow and to make more cells?* | *Cells need nutrients to grow and make more of themselves.* |
| *What evidence did we collect to support this idea that cells need nutrients to grow and make more of themselves?* | *We saw that when bacteria were provided nutrients this led to more bacteria being made.*<br>*When more nutrients were provided, more bacteria grew.* |
| *And does this also happen in our body to make more cells?* | *We found out that our blood plasma contains nutrients and the blood goes all over our body and that our cells grow.* |

**Share ideas about how cells get what they need to grow and make new cells.** Show **slide B** and say, *So we know that cells need food and water to grow and to make new cells. How do you think cells actually get the things they need to grow and make more of themselves?**

Sample student responses:

- *Maybe the cells have mouths like we do, maybe in the cell membrane to take in or eat the nutrients.*
- *Maybe there are little doors or openings in the cell membrane to let food in.*

If time permits, call on a few students to share their ideas with the class.

**Summarize the discussion.** Say, *There must be a way for water, food, and nutrients to get into cells (and anything the cell doesn't need to get out of cells). It seems like we think these things would have to go through the boundary of a cell, or cell membrane.*

### * Supporting Students in Engaging in Constructing Explanations and Designing Solutions

At this point in the lesson, it will be important for you to carefully listen to students' ideas for how cells get the things they need or remove things they don't need. Use prompts to encourage students to support their ideas with evidence from previous lessons. Some suggested prompts include:

- What have you observed in previous investigations to make you think that?
- How might you use what we have figured out about cells to support your thinking?
- What have you learned from the readings in this unit to support your ideas and/or your prediction?
- What evidence can you use to support your ideas?

## 2. Collaboratively plan an investigation to observe how things can get in and out of cells. 5 MIN

**Materials:** science notebook, chart paper, markers

**Surface ideas from previous investigations to collaboratively plan an investigation.** Show **slide C**, and lead a discussion around the question, "How can we use what we have done in previous investigations to help us figure out how cells get what they need?"

Ask students to take a few moments to think about the investigations we have conducted in previous lessons in this unit as they consider the question on the slide. Encourage them to look back in their notebooks to get ideas for how they can figure out how cells get what they need.

After allowing time to think, ask students to share their ideas. Use chart paper to document ideas. Look for the following ideas to surface:

- We will need to use microscopes to observe cells.
- We need something we can investigate in the classroom easily.
- We might need something to help us see cells under the microscope, like the stains that were used with some of the things we looked at earlier.
- We need to be able to get a very thin layer of whatever we use.
- We need examples of things that cells need, like food or water.
- We need to figure out a way to add something that the cells need, like food particles or water, so that we can observe the cells letting it in.

As students' ideas are shared, suggest using plant cells, as they are easily accessible and viewable under a microscope. Say, *So it seems like we want to use our microscopes to look at some cells and test our ideas, like whether food or water can get into the cells. I was thinking that we could use plant cells, because we can get them easily and use them in the classroom.*

### Additional Guidance

As you plan this investigation, be considerate of your students who may experience food insecurity. Remind the class to be respectful of the materials they're going to use and to not be wasteful. Depending on your number of students/classes, you might not need to use an entire onion, so only cut what you need for each class and store the remainder for a future use, such as a meal at your home. After the investigation, collect used onion pieces and dispose of them in the trash after students have left the room. Note that the remainder of the onion used in the making of the video was also used for nourishment.

Use prompts such as the following to continue planning the investigation.

| Suggested prompts | Sample student responses |
|---|---|
| *We are going to use plant cells on a slide, but we'll be able to add things to the slide to test whether things can get in or out of the cell. What things or types of things do we think might need to get into or out of our cells? Plant cells?* | *Since blood carries food particles, vitamins, and electrolytes all around the body, maybe those things can get into our cells. Maybe plants need similar things.*<br>*The blood carries water all around too, and I know there is water in our body and in plants, so water probably needs to be able to get into and out of cells.*<br>*The blood also carries waste away, so maybe waste can get out of cells.* |
| *How might we observe whether these things get into a plant cell or not?* | *We could look at the edges of the cell really close to see if anything moves in or out.*<br>*If the stuff we're adding was dyed, we could see parts of the cell changing color.*<br>*The cells might get bigger when something is going in or smaller when something is going out.*<br>*The cells might change shape, not just size. We saw evidence of cells changing size and shape, as we were learning about what happens in the gap where the skin is cut.* |

**Summarize our ideas and suggest using salt water in our investigation.** Say, *OK, I think we could use some of our ideas here to investigate plant cells. I'm not sure how we could get food particles small enough so that we can't see them, but from our reading about blood, we found out that electrolytes are just salts. We also know that we can add salt to water and it dissolves. It would be really easy to use salt water to investigate this, so let's see if we can gather some evidence, like a change in size or shape, which will tell us whether water or salt water is able to get into and/or out of our plant cells.*

## 3. Investigate structures in red onion cells. 14 MIN

**Materials:** Investigate Structures in Red Onion Cells, science notebook, tape

**Prepare to observe onion skin slides.** Say, *We are going to conduct our investigation using a sample from a red onion. Red onions are naturally pigmented, so the color in the onion will allow us to better see its cells under the microscope, like the stains that we used to visualize cells in previous lessons. It's also easy to peel a very thin layer off an onion.*

Show **slide D**. Distribute *Procedure to Investigate Structures in Red Onion Cells* and ask students to take a few minutes to read through the procedure, so that they are aware of the steps we will follow to investigate the onion skin slide.*

After students have read through the procedure, remind them that we will first look at the onion in plain water, then salt water, and finally plain water again, and we will watch what happens after adding each. Ask if there are any questions about the procedure, and answer students' questions. Then ask, *What are we trying to figure out about cells from this investigation?*

Students should respond that we are looking for changes to the cells, such as changes in shape, size, and/or color, as evidence of something going into and out of the cells.

**Conduct the investigation in small groups.** Show **slide E** and distribute *Data from Investigating Red Onion Cells* and direct students to tape it into their notebooks. Tell students to use the handout to record their observations using pictures and words and to document their thinking. Students will need to calculate the total magnification at which they are observing (e.g., (objective, 10X)*(lens, 10X)=total magnification, 100X) and record it on their handout.

Display **slide F.** Direct students to conduct their investigation in small groups. Remind them that they need to use a fresh piece of paper towel each time they soak up liquid from the onion slide to avoid cross-contamination.

As students conduct the investigation, assist as needed. Students may need help adjusting the focus and finding the most deeply colored and unwrinkled area of the sample. Although students will be given prepared onion slides, they may need help removing and replacing the coverslip or using a toothpick to transfer the onion skin from the coverslip to the slide when they change from plain water to salt water, and back. Remind students to allow the onion to soak in the salt water or plain water for at least 1 minute prior to replacing the coverslip. Challenge them to make detailed observations, which will help us figure out what is going on when salt water or plain water is added. Encourage students to use pencils, so that they can make adjustments to their work, as needed.

### Additional Guidance

Your students may observe cells in various states, including by not limited to many overlapping layers, cells without pigment, and air bubbles or other artifacts. See *Guidance for Viewing Red Onion Cells with the Microscope* for more information on what these might look like so that you can help your students make productive observations.

If many in the class are struggling to conduct the investigation at once, it may be useful to have a backup slide prepared to use with the whole class. Connect a digital microscope camera to a computer and project the results of the demonstration. Direct students to indicate observations and answer questions on *Data from Investigating Red Onion Cells* as you go.

#### * Attending to Equity

At this point in the lesson, some of your students may need further support. Some options that will help ensure equity and access for students can include one or more of the following:

- Allow students to read through the procedures with a partner or read the procedures aloud as a class.
- Use consumable copies of *Procedure to Investigate Structures in Red Onion Cells* and remind students to use strategies for obtaining information from text, including
  - highlighting important ideas or directions;
  - examining images;
  - taking notes in the margins; and
  - documenting any questions they might have.
- Demonstrate the procedures of the investigation showing how to remove the coverslip, blot the liquid and add salt water or plain water to the side.
- Remind students of the microscope strategies we used previously in Lessons 4 and 6, including how to focus on the slides.

Use these supports, as needed, to ensure that all students can conduct the investigation.

## Assessment Opportunity

**11.A.1** Construct an explanation to show that the structure of cell membranes and/or cell walls (tiny openings) let certain things in and out of cells (function).

**What to look for/listen for**: See the sample student response on *Data from Investigating Red Onion Cells*, specifically question 4.

**What to do:** If students had trouble seeing the changes caused in the cells by the salt water and plain water, you might want to have them carefully look at the images in *Reference: Red Onion Investigation Images* and have them identify specific changes they see in the cells. If students struggle with not knowing how exactly the plain water and salt water got in and out of the cell membrane and cell wall, you can support them in that wondering—it is a curious phenomenon! It's good to have questions that we still want to figure out when we get to high school (or college). For now, we have evidence that the water does get in and out, even if we're not sure how.

Direct students to clean up after the lab before the Building Understandings Discussion. Collect *Procedure to Investigate Structures in Red Onion Cells* and reuse with subsequent classes.

## Alternate Activity

Preparing the red onion slides can be time-consuming and challenging for students, but if you have the time and students are interested, you could have them each prepare their own slide to use for the investigation. These supports may be used as needed:

- Use *Alternate—Preparing Red Onion Skin Slides* and provide time for students to analyze the preparation procedure.
- Show the video which demonstrates how to prepare the slide with onion skin. You can access the video at 6.6 Lesson 11 Slide Preparation (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**).

## Alternate Activity

If no microscopes are available, you have these options:

- Show the Investigating Red Onion Skin video to demonstrate the procedure, which is available at 6.6 Lesson 11 Investigating Red Onion Skin (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**). The following timestamps may be helpful:
  - Viewing the plain water slide, 0:06-0:43
  - Switching from plain water to salt water, 0:44-2:10
  - Viewing the salt water slide, 2:12-3:05
  - Switching from salt water back to plain water, 3:06-4:30
  - Viewing the return to plain water, 4:32-5:50
    - It is possible to observe expansion of the pigmented area from 5:27 to 5:50.

- Use the images provided on *Reference: Red Onion Investigation Images*.
- Access the Virtual Microscope interactive. From there, copy the link for viewing **red onion skin** and share it with your students so they can access it on their own devices. By sharing this direct link, your students will only have access to the images needed for this lesson.

Students can document their observations in *Data from Investigating Red Onion Cells* while using either of these alternates.

## 4. Conduct a Building Understandings Discussion. 14 MIN

**Materials:** science notebook, *Data from Investigating Red Onion Cells*, chart paper, markers, cell image from Lesson 9

**Lead a Building Understandings Discussion.** Ask students to gather together in a Scientists Circle. They should each bring their copy of *Data from Investigating Red Onion Cells* and their science notebook.

Show **slide G** and ask students to share the data they gathered from their initial observations of the onion skin cells. As students share, encourage them to show their drawings and to use evidence from their investigation to support their thinking. Use the following prompts to help guide the discussion.

### Key Ideas

**Purpose of this discussion:** Students share what they observed and documented about the onion cells and discuss how their structures compare to other cells we've seen.

**Listen for these ideas:**

- The red onion cells look boxy and block-like. They are "stacked" in a regular pattern that is unlike other cell structures we have observed.
- The boundaries around the red onion cells are much thicker and more noticeable than the outer boundaries of other cells we have observed.

| Suggested prompt | Sample student responses |
|---|---|
| *What did you notice about the structure of the red onion cells?* | *The red onion cells look a little bit like a brick wall or Legos stacked together.*<br>*They're so rigid and rectangular. They didn't move when we added plain water.*<br>*The edges or boundaries around each red onion cell were much easier to see than other cells we've looked at—they seem thicker.* |

| Suggested prompt | Sample student responses |
|---|---|
| *Hmm… I wonder if other plant cells have similar structures? Or if they are similar to other cells we have observed? How could we figure that out?* | *We should look at the pictures of the other types of cells that we have observed.*<br>*We could also look in our notebooks because we drew these cells and described them.*<br>*Yes! And we could look at the ideas we recorded on our timeline and consensus model to help us, too.* |

**Look at images of a variety of cells and observe differences between animal cells and plant cells.** Say something like, *OK, those are great ideas! Let's look at some images we have of other cells, including other plant cells, to keep investigating their structures.*

Distribute *Reference: Animal and Plant Cell Images*. Show **slide H** and ask,

- *What is similar or different about how the plant cells are structured?*
- *What is similar or different between how plant cells and animal cells are structured?*

## Alternate Activity

Students will likely benefit from having all the images of plant and animal cells in front of them at once in order to make side-by-side comparisons. However, it may be useful to distribute a single page from *Reference: Animal and Plant Cell Images* to each student and have them pair up with a partner who has different images. This may help reduce cognitive load and yield a richer discussion between the partners.

Additionally, the plant examples, as well as all of the animal cells we have looked at, are also available via the Virtual Microscope interactive. From there, copy the link for viewing **plant cells,** and any other cells, and share it with your students so they can access it on their own devices.

Give students a minute to look at the images. Then give students another minute or two to talk with a neighbor to discuss the questions on the slide. After that, bring the class back together and ask what they noticed about the plant cells' structures.

Sample student responses:

- *The allium cells look even more brick-like than the red onion cells—they are very boxy.*
- *Some of the pitcher plant leaf cells are stacked close together, but they are rounder.*
- *All of the plant cells have very thick boundaries—it's really easy to tell where each individual cell is, even though they're all stacked together.*
- *I can clearly see some boundaries around human cells, but the plant cell boundaries are even easier to see.*
- *Blood cells and nerve cells aren't really close together like the plant cells were.*

**Continue the Building Understandings Discussion.** Say something like, *Let's go back to the data we collected during today's investigation and continue our conversation about how the cells are structured to allow things to go in and out (function).*

Show **slide I** and use the prompts on the slide, as well as the additional prompts below to surface data that students gathered from the investigation. As students share, encourage them to show their drawings and to use evidence from their investigation to support their thinking. You might also want to use chart paper to create representations of the changes students observed in the cells as plain water and salt water were added to the microscope slides. If needed, use *Reference: Red Onion Investigation Images* to allow students to observe changes to the red onion cells again.

## Key Ideas

**Purpose of this discussion:** Students share what they observed and documented from their investigation of changes that occurred as salt water and plain water were added to red onion cells. These observations are used as evidence to support explanations for how things get in and out of cells.

**Listen for these ideas:**

- Plant cells have two types of boundaries—the inner boundary was most clearly visible when we added salt water.
- The outer boundary (cell wall) doesn't move and is rigid, helping the cell maintain its shape.
- The inner boundary (cell membrane) is similar to the boundary that animal cells have.
- The inner boundary (cell membrane) surrounds the stuff inside the cell (cytoplasm).
- The inner boundary (cell membrane) moved when we added salt water and plain water.
- The two boundaries (cell membrane and cell wall) allow water (and maybe other things) into the cell when plain water is added to the microscope slide, and allow water (and maybe other things) to leave the cell when salt water is added to the slide.

## Assessment Opportunity

**11.A.2** Construct an explanation to show that the structure of cell membranes and/or cell walls (tiny openings) let certain things in and out of cells (function).

**What to look for/listen for**: Students should connect the changes in the pigmented part of the cell to the movement of water through the cell boundaries (cell wall and cell membrane). Refer to the Key Ideas above.

**What to do:** If students had trouble seeing the changes caused in the cells by the salt water and plain water, you might want to have them carefully look at the images in *Reference: Red Onion Investigation Images* and have them identify specific changes they see in the cells. If students struggle with not knowing how exactly the plain water and salt water got in and out of the cell membrane and cell wall, you can support them in that wondering—it is a curious phenomenon! It's good to have questions that we still want to figure out when we get to high school (or college). For now, we have evidence that the water does get in and out, even if we're not sure how.

| Suggested prompts | Sample student responses |
|---|---|
| *What did you notice about how the red onion cells were structured when you first looked at them with plain water on the slide?* | *The onion cells looked like pink/purple bricks stacked together.* |
| *What did you observe when you replaced the plain water with salt water? What was different? What stayed the same?* | *When we added salt water to the onion skin on the slide, we noticed that the pink/purple stuff on the inside of the cells got smaller and it changed shape.*<br>*The stuff on the inside also changed color—it got darker as it got smaller.*<br>*The thick boundary (the box-shaped one) did not change its shape or size. It stayed the same as it was before.* |
| *What can you infer about the onion cells' boundaries from those observations?* | *There are two different boundaries!*<br>*One boundary didn't change, but the other one on the inside still was holding the stuff inside the cell.* |
| *How would you describe the two boundaries?* | *The inside boundary seems flexible because it changed shape when the inside stuff was shrinking, but the outside boundary must be more stiff or sturdy because it did not change—it kept its shape.*<br>*The outer boundary is much easier to see than the inner boundary—it's thicker.*<br>*The outer boundary is more rigid, but the inner boundary moves around, kind of like a rubber band.* |
| *What did you notice when you replaced the salt water with plain water?* | *When we went back to plain water, the outer boundary still did not change—it stayed the same shape and size as it had been the whole time.*<br>*The inner boundary seemed to stretch as the stuff inside the cell got larger, eventually filling up the space inside the outer boundary.*<br>*Sometimes the color of stuff inside the cell lightened as it got larger.* |
| *How do the cells compare after adding plain water to how they looked before we added anything?* | *The cells look about the same now that we have added plain water as they did at the beginning of our investigation.*<br>*It's easier to see some of the inner and outer boundaries now—the stuff inside is almost back to the same size and shape for most of them, but some still have a gap between those boundaries.* |

**Discuss the cause and effect of adding salt water and plain water to the onion cell slide.** Transition the discussion to the cause of the changes we observed.

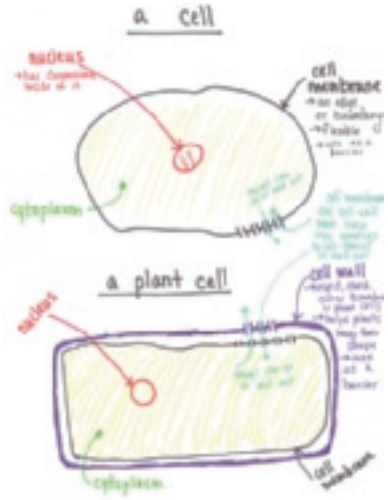
| Suggested prompts | Sample student responses |
|---|---|
| *What do you think happened to cause what you saw? What evidence supports your thinking?* | *Well, we think something came out of the cell after we added the salt water. We know this because the inner boundary and the stuff inside got smaller and pulled away from the outer boundary.*<br><br>*When we added plain water a second time, we think something went into the cell. We know this because the inner boundary and the stuff inside got larger, until it filled the space inside the outer boundary of the cell.*<br><br>*It must have been water that was going into the cell after we added plain water the second time, because that's all we added. It had to be water!*<br><br>*Maybe. If water went into the cell when we added plain water to the slide after the salt water, then that must be what came out of the cell when we added salt water. We aren't sure why, but it would make sense that it was water going out since that is what went back in.* |
| *How do you think stuff gets into or out of the cells?* | *The things that cells need must be tiny, because we can't see it, but stuff has to be moving through both boundaries, the cell wall and cell membrane, because we saw the cell membrane move.*<br><br>*Maybe there are tiny holes or some kind of opening that allows only certain things in and out, depending on what the cell needs and what the cell needs to get rid of.* |

**Focus on the function of cell boundaries.** Continue the discussion to synthesize students' ideas about the functions of the cell membrane and cell wall.

| Suggested prompts | Sample student responses |
|---|---|
| *So we have evidence that things like water can move in and out of a red onion cell through its boundaries. Do you think the same could be true for other cells? Why?* | *We know that plants all need water, so it makes sense that other plant cells would let things like water in (or out), too.*<br><br>*We saw that animal cells need food and water to live and make new cells, so it makes sense that their cells would also allow water and other things they need in (and let out what they don't need).* |

| | |
|---|---|
| *We heard the term "cell membrane" when we were watching videos of cells growing and splitting. It's that outer, flexible boundary around animal cells, and now we've seen it inside plant cells, too. What can we add to our understanding about the key functions of the cell membrane?* | *The cell membrane holds the stuff inside the cell.*<br>*It lets in what the cell needs and lets out what it does not need.* |
| *The red onion cells had another boundary outside of the cell membrane though. We also noticed this thick structure in other plant cells. What do you think that outer boundary's function is in plant cells?* | *That thick outer boundary probably has a different job than the cell membrane because its structure is different. Maybe these walls act like bones do in humans in plants to keep them upright.*<br>*The outer boundaries did not change shape. They are stiff like boxes or blocks, and they all stay stacked up together. When they're all together like that, they're working together in a plant part, right?*<br>*Those outer boundaries probably help the plant parts form their shape or keep their shape.* |

**Add to the cell drawing from Lesson 9.** Collaboratively add new structures and their functions and update previously identified structures with what we've figured out today. It may be useful to create a second drawing of a plant cell next to the initial cell drawing. See an example update at right. Say, *We investigated the structures inside red onion cells to help us figure out how cells get what they need. Let's keep track of this on our cell drawing that we made before.*



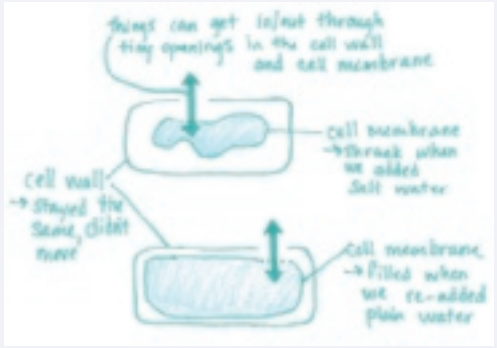
## 5. Update Progress Trackers.

7 MIN

**Materials**: science notebook

**Update Progress Trackers in science notebooks.** Display **slide J**. Direct students to the Progress Tracker section of their notebooks (landscape orientation) and have them add rows for what we've figured out from today's investigations of the onion skin cells. Encourage students to use pictures and words (not just words) to explain how cells can get what they need.

Remind students that this tracker is their space to process and record their thoughts—you will be looking at their work to see what progress the class has made, but you will not be scoring or grading their work. Give students 5-8 minutes to add to their Progress Trackers. See the sample student responses shown below.

| Question | What we figured out in words and pictures | This makes me think or wonder about healing... |
|---|---|---|
| • How do cells get what they need to grow? | • Plant cells have a cell wall and a cell membrane.<br>• The cell wall provides a rigid boundary for plant cells.<br>• The cell membrane and cell wall allow things in and out of the cell. We know that this happens because we observed evidence of water moving into and out of the red onion cells. For what we observed to happen, we know the water has to go through the cell membrane and cell wall. There must be tiny holes or openings in those structures that let certain things in and out of the cell.<br>  | • If the cells can get what they need to grow through the cell membrane, then they can grow and split to make more of themselves and fill the gap so the person's injury can heal! |

**Look forward to next time.** Say something like, *We have found lots of answers about how cells can grow, and I think we're ready to explain healing. We'll do that next time, and also revisit our DQB to see what else we're still wondering.*

LESSON 12

# How do the structures and systems in the body work together to heal the injury?

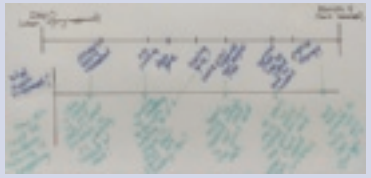
## Previous Lesson

*We used microscopes to observe structures (cell wall and cell membrane) in onion cells and changes in onion cells when salt water and plain water were added to the onion skin. We noticed that water moved out of and into the onion cells, and we used our observations as evidence that the cell membrane and cell wall are structures that allow the cell to get the things it needs to grow.*

## This Lesson

**Putting Pieces Together**

**2 DAYS**



We revisit the timeline of healing from Lesson 1 and develop explanations for how healing happens based on each event we had listed. We come to consensus about how the healing in the foot happened, developing a list of key science ideas. We use what we have figured out about healing so far to see if we can explain how the systems in our body interact to support the healing process.

## Next Lesson

*We will apply what we have figured out about healing to explain a related phenomenon, growth of body parts and organisms. We will share what we have figured out in our unit with our family and then ask about other modes of healing they have experienced.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**12.A** Apply scientific ideas and evidence to construct an explanation for how systems of the body interact to support the healing process in the foot at different scales.

## What Students Will Figure Out

- The body reacts to an injury by swelling, which increases blood flow and brings extra fluid to injured tissue to help it heal.
- The healing process for the foot is similar to how other body parts and other living things heal as well.

## Lesson 12 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 8 min | **NAVIGATION**<br>Decide as a class which events on our timeline we think we can now explain. | A | How Does the Foot Heal Timeline, Our Body as a System, sticky notes |
| 2 | 5 min | **INITIAL IDEAS DISCUSSION ABOUT SWELLING**<br>Use images of swelling to prompt ideas about what we have observed and think we know about swelling. | B-C | optional *Images of Swelling Due to Injury*, Related Phenomena Poster |
| 3 | 7 min | **BUILDING UNDERSTANDINGS DISCUSSION ABOUT SWELLING**<br>Use notes from a doctor visit along with what we know about body systems to make sense of how swelling is related to healing. | D-F | *Doctor Report re: Swollen Finger* |
| 4 | 15 min | **DEVELOP EXPLANATIONS FOR HOW HEALING HAPPENS**<br>Work with a partner to explain a few of the events on our timeline and prepare to share evidence to support those explanations. | G | *How Healing Happened Chart*, tape, Healing Timeline, Our Body as a System poster |
| 5 | 10 min | **SHARE HOW HEALING HAPPENS EXPLANATIONS WITH A DIFFERENT PARTNER**<br>Switch partners to share and defend their thinking about how healing happened for each of the events they explained on the timeline. | H | *How Healing Happened Chart*, Healing Timeline, Our Body as a System poster |
| | | | | *End of day 1* |
| 6 | 10 min | **CONSENSUS DISCUSSION ABOUT HEALING**<br>The class works together to notice patterns they have in their *How Healing Happened Chart* and come to consensus about the structures and systems that support healing. | I | *How Healing Happened Chart*, Healing Timeline, Our Body as a System poster, chart paper, markers |
| 7 | 10 min | **CONSTRUCT AN EXPLANATION ABOUT HOW THE DIFFERENT BODY SYSTEMS INTERACT DURING THE HEALING PROCESS**<br>Individually, use the key science ideas to explain how the different systems in the body interact when the body is healing. | J | *How do the systems in the body interact during the healing process?* |
| 8 | 5 min | **REVISIT RELATED PHENOMENA AND CONSIDER HOW WE COULD EXPLAIN OTHER HEALING**<br>Consider which of the examples of healing on our Related Phenomena poster we think we can now explain. | K | Related Phenomena poster, How does healing happen? poster, sticky notes |
| 9 | 17 min | **ANALYZE ANOTHER CASE OF HEALING FOR A LIZARD AND SEA STAR**<br>Read about and analyze images of two injury cases where the organism (a lizard and a sea star) lost an appendage and grew one back. Brainstorm ideas about how this is similar to or different from the healing process of filling a gap with new cells. | L | *Lizard and Sea Star Injury Cases* |

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 10 | 3 min | **EXIT TICKET LEARNING**<br>Ask students to brainstorm how the process of healing and growing are similar and different. | M | piece of paper or notecard |

*End of day 2*

## Lesson 12 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • optional *Images of Swelling Due to Injury*<br>• *Doctor Report re: Swollen Finger*<br>• *How Healing Happened Chart*<br>• science notebook<br>• tape<br>• *How do the systems in the body interact during the healing process?*<br>• *Lizard and Sea Star Injury Cases*<br>• piece of paper or notecard | | • How Does the Foot Heal Timeline<br>• Our Body as a System<br>• sticky notes<br>• Related Phenomena Poster<br>• Healing Timeline<br>• Our Body as a System poster<br>• chart paper<br>• markers<br>• Related Phenomena poster<br>• How does healing happen? poster |

**Materials preparation (20 minutes)**

**Online Resources** 

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Copy the 2 pages of *How Healing Happened Chart* single-sided so students can attach them side-by-side in their notebooks and see the entire table (with the events in sequence matching the Healing Timeline). You may also choose to make a digital version of the chart for students to type their explanations.

In the first step of day 1 and then again on day 2, you will use sticky notes with checkmarks on them to mark places on your class Healing Timeline and your Related Phenomena poster. You may choose to prepare sticky notes with checkmarks on them in advance.

## Lesson 12 • Where We Are Going and NOT Going

### Where We Are Going

In this lesson, students will put the pieces together that they've figured out since Lesson 2, and bring everything together to explain how the foot injury from our anchor healed. Then, in Lesson 13, they will apply all of these ideas in a transfer task, and in Lesson 14, students will explore the other supports used to support healing.

### Where We Are NOT Going

This lesson supports students in figuring out how swelling helps the healing process. However, we do not explicitly explore inflammation as an immune response. This lesson also does not explicitly explain bruising, but if your students are curious about it, you could spend time reasoning through how broken blood vessels leak blood into an injured area.

If students raise questions about what happens to the extra fluid or how the body knows to send extra blood and fluid to an injured area, encourage them to record these questions and put them on the DQB. We will not be addressing these questions in this unit, but it is important to support and encourage student questions. If time allows, you might ask about their ideas related to those questions. In the next lesson, students will revisit the DQB to reflect on the questions that can be answered. Asking questions is an important science practice and one that students will continue to use through middle school and beyond—as we figure some things out, that will lead to more questions. Additionally, some of these questions students still have at the end of this year will be investigated and satisfied during their work in 7th and 8th grade units.

# LEARNING PLAN FOR LESSON 12

## 1. Navigation

8 MIN

**Materials:** How Does the Foot Heal Timeline, Our Body as a System, sticky notes

**Reflect on our recent work.** Display **slide A.** Ask, *Okay, let's go back to the case from Lesson 1 and see what we can now explain. Before we do, let's take stock of the key science ideas we've figured out about cells that can help us explain how living things heal?*

Sample student responses:

- We know cells can fill in a gap or opening in an injured gap in the tissue by growing and making more of themselves.
- Cells need food and water to live and make new cells, and the blood brings these things to them.
- The cell membrane lets in what cells need and lets out what they don't—that's how they can get what they need to live and make new cells.

Say, *We have figured out so much. Let's start today by revisiting our timeline that is part of the "How Does the Foot Heal" poster of the foot injury to see which events in the healing process we can explain now.*

**Revisit the Healing Timeline from Lesson 1 to decide which events we can now explain.** Direct the class's attention to the Healing Timeline. Point to each event on the timeline and ask the class to show you a thumb up for yes or a thumb down for no while you ask, *Do you think we can explain how healing happened around this event?*

For each "yes" response, place a sticky note with a checkmark near that event on the timeline.

Sample student responses:

- Can we explain why stitches are no longer needed? *Yes.*
- Can we explain why swelling lessened and then is gone? *No.*
- Can we explain why pain is gone and feeling has returned? *Yes.*
- Can we explain why the cast and pins could be removed? *Yes… and maybe no.*
- Can we explain why the student is able to walk with a regular shoe and no crutches? *Yes.*

**Briefly discuss the timeline events that students are still wondering about.** Use prompts such as the following to discuss remaining questions about our timeline events.

| Suggested prompts | Sample student responses |
|---|---|
| *What are you still wondering about around these events that don't have a checkmark yet?* | *We didn't know what was going on with the swelling—we are assuming that the swelling disappears as the injury heals, but why or how is it there to begin with?*<br><br>*We still don't know exactly how the pins and cast help the injury heal. We figured that the bones were healed when those could come off/out, but if the body is making new cells to repair the bones itself, why are the cast and pins needed?*<br><br>*What does physical therapy do to help the injury heal? If the person can wear a normal shoe and walk again without crutches, aren't they healed? We know that physical therapy includes doing exercises, but can't the person do those now that they're healed?* |
| *Which of those pieces of this healing story (swelling, pins and cast, or physical therapy) is something the body did by itself?* | *I think swelling happens "automatically" when there's an injury.* |

Navigate to the next step by saying something like, *OK, since swelling is one more thing the body is doing itself when it's injured, let's figure that part out now. Then, we can explore more later about how other things people are doing might help the body heal.*

## 2. Initial Ideas Discussion About Swelling

5 MIN

**Materials:** optional *Images of Swelling Due to Injury*, Related Phenomena Poster

### Additional Guidance

The images on the upcoming **slides B** and **C** show images of injuries: **slide B** shows the same images students saw in the doctor's notes in Lesson 1, and **slide C** shows examples of body parts that are swollen due to injury. Show them at your discretion. Ask your school social worker, psychologist, or counselor for support if you anticipate these images being traumatic for any of your students. *Images of Swelling Due to Injury* is available if you think your students would be more comfortable viewing these images on a handout instead of on the slides. We recommend printing these in black and white for students to view close up and having the color images ready if anyone requests them to analyze more closely. If needed, you may choose to briefly describe each image in words and ask students to find patterns in the descriptions.

**Gather students' initial ideas about swelling.** Display **slide B.** Use prompts, such as those that follow, to facilitate a brief Initial Ideas Discussion about swelling.

## Key Ideas

**Purpose of this discussion:** To gather ideas students already have about swelling.

**Listen for these ideas:**

- Swelling makes an area of the body look puffy.
- Swelling goes away as an injury heals.
- Swelling often appears along with bruising and/or increased redness.

| Suggested prompts | Sample student responses |
|---|---|
| *What differences do you notice in the pictures of the student's injured foot and healed foot?* | *The skin was broken, then stitched up, then healed (it's closed now—there's a scar, but it's all covered with skin again).*<br>*When it was injured, the top of the foot and even the toes looked puffy. It's swollen.*<br>*Now that it's healed, you can see the blood vessels and bones in the foot through the skin, but when it was injured, it was harder to tell those parts were there.* |
| *Let's make sure we're all on the same page: What do we mean when we say "swelling?"* | *It's that puffiness around the injured area.*<br>*Swelling is when the area gets bigger—the skin stretches out and the area feels extra soft and squishy.* |
| *Did any of the injuries we listed on our Related Phenomena poster involve swelling? If so, can you describe what that looked like or felt like?* | *Answers vary.* |

**Make some generalizations about swelling.** Display **slide C.** Say, *These are some other examples of swelling around injured ankles and knees (swelling is easy to see in those areas). What do we usually notice about swelling in these examples and others we've mentioned?*

Sample student responses:

- *Body parts often swell if/when they are injured.*
- *The swelling goes away when/as the body part heals.*
- *Swelling makes a body part look puffy.*
- *There might also be redness and/or bruising (darker areas of skin that might include other colors) along with the swelling.*
- *Swollen areas are usually uncomfortable, tender, and/or painful.*

**Consider using reports from medical professionals to help understand swelling.** Say something like, *We have lots of ideas about swelling. I have a doctor's note about a patient who was dealing with a swollen finger and a physical therapist's report from a patient who is recovering from a shoulder injury. How could analyzing these reports help us figure out more about swelling?*

Sample student responses:

- *The reports might tell us what's making the area swollen, like is it blood or something else?*
- *The notes might say how the swelling will go away.*
- *We want to figure out why swelling helps the body heal.*

## 3. Building Understandings Discussion About Swelling

7 MIN

**Materials:** *Doctor Report re: Swollen Finger*

**Read a note from a doctor visit to obtain information about swelling.** Display **slide D.** Distribute *Doctor Report re: Swollen Finger* or have students find it in their Student Editions. Direct students to read the doctor's note and look for key ideas that can help us understand swelling. The report is shown for reference on **slide E.**

**Lead a brief Building Understandings Discussion about swelling.** Display **slide F.** Suggested prompts are shown below.

### Key Ideas

**Purpose of this discussion:** Synthesize ideas about swelling from the doctor report with what we already know about healing to make sense of how swelling is helpful to healing.

**Listen for these ideas:**

- Swelling is helpful to healing because there is more blood near the injured area to bring what the cells need to make new cells.
- Swelling is helpful to healing because the extra fluid can help the body get rid of waste (such as old cells) so that undamaged cells can make new cells.

| Suggested prompts | Sample student responses |
|---|---|
| *What causes injured body parts to swell? What's making that area look puffed up?* | *Some more blood goes to the area and also extra fluid is there.* |
| *Why do you think it is helpful to the body to have extra blood (and blood cells) at the site of an injury?* | *Blood brings all kinds of things that the cells will need to make new cells and heal the injury. The plasma carries food and water that the cells need.*<br>*We know the platelets help plug up damaged parts of blood vessels so the blood doesn't keep leaking out.*<br>*Maybe the white blood cells help, too, because they can fight infections.* |
| *I remember we figured out that blood plasma also carries away waste material. What are examples of wastes that the cell may produce or other things that the body needs to get rid of?* | *Maybe pieces of cells that got broken when the injury happened.*<br>*Maybe germs that the body was able to fight off.*<br>*Whatever comes out of the cells (through the cell membrane) that they don't need.*<br>*Cells that are not functioning anymore.*<br>*Cells that are not living anymore.*<br>*When cells are making more cells, the cell membrane also lets waste out of the cells which go into the blood.* |
| *Throughout our body, in injured and uninjured parts, we have fluids like the blood plasma that carry away waste, such as cells that are no longer functioning. Why would it be helpful to have extra fluid around an injury? How does that support healing?* | *Maybe the area needs more nutrients too in order to make new cells.*<br>*Having extra liquid provides more space for stuff to be carried away from the injured region. The doctor's note said the swelling would go away as that body part heals—that's the extra fluid leaving those tissues and bringing the waste away.* |

## Additional Guidance

If students raise questions about what happens to the extra fluid or how the body knows to send extra blood and fluid to an injured area, encourage them to record these questions and put them on the DQB. If time allows, you might also ask what their thoughts are about what happens in the body. We will not be addressing these questions in this unit, but it is important to support and encourage student questions.

In the next lesson of this unit, students will revisit the DQB to answer as many questions that are left on the board as possible and reflect on the fact that we may still have questions despite finishing the last unit of the year. Asking questions is an important science practice and one that students will continue to use through middle school and beyond—as we figure some things out, that will lead to more questions. Additionally, some of these questions students still have at the end of this year will be investigated and satisfied during their work in 7th and 8th grade units.

**Connect back to the timeline to transition to our next step.** Say something like, *Now that we have figured out a little more about swelling, we are ready to put all these pieces together and explain what happened in the person's body to heal the foot injury from Lesson 1.*

## 4. Develop explanations for how healing happens.

**15 MIN**

**Materials:** *How Healing Happened Chart*, science notebook, tape, Healing Timeline, Our Body as a System poster

**Give directions for the jigsaw work we'll do to explain the events on our timeline.** Display **slide G.** Say, *Now we are going to get to work on explaining the events in our Healing Timeline. Since there are several events to explain, we are going to split the class into two groups and divide up the events. First, you will work with a partner to explain two events in the Healing Timeline using evidence. Second, you will share your explanations with someone from the other group and hear theirs. Then you and that new partner will work together to explain how healing happened for the final event in the chart.*

### Alternate Activity

You may choose to have students type their explanations on digital versions of *How Healing Happened Chart*, if that's easier.

Distribute *How Healing Happened Chart*. Students should attach these two pages side by side in their science notebooks (they can fold the pages in when it's time to close the notebooks) so they can see the whole chart in the same sequence as the events on the Healing Timeline. Explain that we'll use this chart to record our explanations and evidence for how healing is happening at each of these events on our timeline.

Divide the class into two groups. Group A will work to explain the first two events on the timeline (page 1), and group B will work to explain the second two events (page 2). In the next step of the lesson, students will explain what they wrote to a student from the other group, and also fill in the final event on the chart with that new partner. Within groups A and B, assign students a partner and give them 10-12 minutes to work together on explaining their first two assigned events. They should also include evidence for their explanation so that when they meet with a student from the other group in the next step, they can defend their explanation well.

## 5. Share how healing happens explanations with a different partner.

**10 MIN**

**Materials:** *How Healing Happened Chart*, Healing Timeline, Our Body as a System poster

**Give directions for explaining the events on our timeline in small groups.** Display **slide H.** Rearrange partnerships so that each student who worked in group A has a partner from group B. Direct them to share their explanations with their new partner, including the evidence they found. As they listen to their partner's explanations, students

should jot some notes into the event columns they still have empty. They may also ask questions and seek evidence to be sure the explanation is complete. Students should also be looking for what their explanations have in common. When they're finished sharing, have these pairs use what they have explained about the first four events to write an explanation for the final event.

As students work with their partners, circulate to listen in and assess students' ideas. You might also choose to collect *How Healing Happened Chart* at the end of class today to use as an assessment.

A sample completed chart is provided in *Sample Responses for How Healing Happened Chart* for your reference, but recall that your students' ideas may be phrased differently from those shown here, and the columns students completed first will likely have more detail than those in which they jotted notes while listening to their partner share.

**End of day 1**

## 6. Consensus Discussion About Healing

**10 MIN**

**Materials:** *How Healing Happened Chart*, Healing Timeline, Our Body as a System poster, chart paper, markers

**Lead a Consensus Discussion about healing and co-construct a list of Key Science Ideas.** Display **slide I.** Gather the class together in a Scientists Circle and use prompts, such as those that follow, to discuss the systems and structures that support healing. Title a piece of chart paper "How does healing happen?" and during the discussion, record the key science ideas we need to answer this question. Students will use this list of key science ideas when they explain the interactions that occur between the different systems in the body during the healing process in the next step. See the Key ideas callout box for ideas that students might suggest as key science ideas.

### Key Ideas

**Purpose of this discussion:** Notice patterns in our explanations of healing in the foot to come to consensus about what happens inside the body as it heals.

**Listen for these ideas to be suggested to include on the poster:**

- Many interacting systems in the body work together to make healing happen.
- Blood (through the blood vessels) brings cells what they need to be able to live and make more cells. Increased blood flow to an injury gets the cells in those tissues more of what they need to repair themselves.
- Those things the blood brings (such as water and food particles) can cross the cell membrane to get into the cell. What cells don't need can get out through the cell membrane and be carried away. Extra fluid from swelling carries away waste, such as damaged cells from the injured tissues.
- Nerves send pain signals from the injured area to the brain so the body reacts to what happened. Nerves also send signals back to the muscles to move them.
- Cells grow and split to make more cells to fill the gaps in the tissues where an injury occurred.
- Different tissues require different amounts of time to heal.

- As the body repairs its subsystems (such as bone, skin, and muscle), the cells in those tissues are able to work together again to support their function in the body.
- The body is a system of cells and tissues working together to function—we are multicellular living things.
- The class may also include questions about parts, areas, or processes that they cannot fully explain or that require inferences we haven't confirmed as a class.

| Suggested prompts | Sample student responses |
|---|---|
| *When you and your partner were sharing about how healing happened in the skin, muscles, and bone, what did your explanations have in common?* | *We both said the cells in those tissues made more of themselves to fill the gap and repair the injured area.*<br>*The cells were able to make more of themselves because the blood brought them what they needed (and took away what they didn't).*<br>*The cells could get what they needed from the blood into the cell through the cell membrane.* |
| *You mentioned the blood, and we read that's a component of the body's blood and blood vessel system. What other systems of the body are involved with healing?* | *The nerve system sends pain signals to the brain to let the person know to take care of the injured area (or remind them to keep taking care of it), and the pain gets less and less as the area is more and more healed.* |
| *What other evidence supports this idea that the gaps in the tissues of the systems—of the body—were healing at different rates?* | *The doctor removed the stitches in the skin at an earlier appointment, and the doctor could still see the fracture on the X-rays after that, so the skin healed faster than the bones did.* |
| *As these tissues heal because the cells are making new cells, what's happening to the cells that were damaged in the injury?* | *The extra fluid from the swelling will carry that waste away—the swelling will go down as the injury is more and more healed.* |
| *You and your partner worked to explain the final event in our timeline, too. How did healing happen for the student to be able to walk again in regular shoes and without crutches?* | *Since there is no more gap in the cells of the bone, skin, and muscle they are all working again and can function together as subsystems that are part of the whole body system to move the student around. The skin, muscle, and bone are attached so that the bones move when the muscles attached to them move. The skin fully covers the injured area.* |

## 7. Construct an explanation about how the different body systems interact during the healing process.

10 MIN

**Materials:** *How do the systems in the body interact during the healing process?*

**Individually construct an explanation about healing.** Display **slide J.** Say, *Now that we have this list of key science ideas to explain how healing happens, you will use them to individually explain how the different systems of the body **interact**, or work together, for the body to be able to heal. You can use your resources in your notebook, Progress Tracker, and from the artifacts around our classroom to help you if needed.* Distribute a copy of *How do the systems in the body interact during the healing process?* to each student. Give them about 10 minutes to complete this. Tell them to turn it in when finished.

### Assessment Opportunity

**Building towards: 12.A** Apply scientific ideas and evidence to construct an explanation for how systems of the body interact to support the healing process in the foot.

**What to look for**: See sample student responses on *Key: How do the systems in the body interact during the healing process?*.

**What to do:** If students are struggling to fill in the event and provide evidence for their group, encourage them to look back at their Progress Tracker and the Our Body as a System poster to remind themselves what we figured out about how the different systems in the body work together when the body is healing.

**Connect to our related phenomena.** Once everyone has finished *How do the systems in the body interact during the healing process?*, propose using what we've figured out about healing to explain some of our related phenomena. Say something like, *Wow! Let's celebrate how much we can explain about how the foot healed! Now that we were able to explain how healing happens, let's see if we can go back to our list of related phenomena and see if we think we can explain the healing that happens in other body parts or other living things.*

## 8. Revisit related phenomena and consider how we could explain other healing.

5 MIN

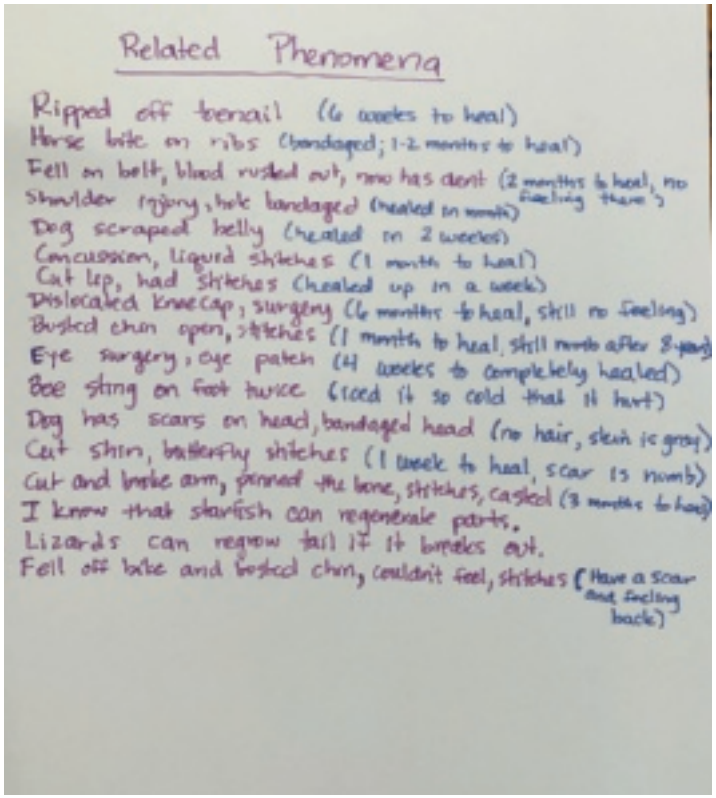
**Materials:** Related Phenomena poster, How does healing happen? poster, sticky notes

**Revisit our list of related phenomena.** Display **slide K.** Briefly read each example on your Related Phenomena poster and ask students to show you a thumb up if they think they have enough information to be able to explain that situation (or most of it) now, and a thumb down if not. Mark the "yes" responses using sticky notes with checkmarks on them.*

Your class will likely give "yes" responses for injuries to other human body parts and other animal injuries. The "no" responses will likely be around living things with structures and systems we might not understand as well, such as animals that can regrow lost appendages (the stem cells and genetics required for that kind of regeneration are beyond grade band) and plants (which have some structures that function in similar ways to those we've explored in this unit, but students may not be familiar with them). If students are unsure about situations where someone carries out life's daily tasks differently after the injury, you can remind them that this was something we still had questions

*** Attending to Equity**
**Universal Design For Learning:** Placing a checkmark next to the related phenomena students think they can now explain helps support student *engagement* as they see how their work over the course of the unit is relevant to making progress on their original questions and ideas. Returning to the list of related phenomena

about. In the last lesson of the unit, we are planning to explore how patients and medical professionals can use assistive devices or other technology to help achieve their goals post-injury.




at this late point in the unit to see what they can now explain can be very satisfying for students and helps to broaden their conceptual understanding of the content and practices they have been figuring out.

## 9. Analyze another case of healing for a lizard and sea star.

17 MIN

**Materials:** *Lizard and Sea Star Injury Cases*, science notebook

**Analyze images of two other living organisms.** Display **slide L**. Say, *We now think we can explain most of the related phenomena we have on our Related Phenomena poster using what we have figured out about the healing process in our body. Using our key science ideas, you will look at two other living organisms that have sustained an injury.* Distribute *Lizard and Sea Star Injury Cases* to each student, then say, *Work with a partner to analyze the images of the organism before the injury, right after the injury, and once healed again to look for evidence whether the healing process is similar or different from what we figured out is going on inside our body. Then answer the questions on the handout. Be ready to share with the class your ideas!*

## Assessment Opportunity

*How Healing Happened Chart* can be used as a formative assessment opportunity. At this point in the unit, students have figured out a lot about how the body heals from an injury all the way down to the cellular level. Now they are being asked to think about whether these processes could be the same for a lizard or sea star who is injured and loses an appendage. This handout can be used to gauge where students are at in their thinking about how cells make new cells to repair an injury and whether students think that happens in other organisms. Look for students to begin applying the conceptual model they have developed in this unit to the last question on the handout by explaining they would want to know if the lizard and sea star also have cells and have similar systems we have that can bring nutrients to the cells so that the injury can heal.

In addition, when students see that the appendage heals by regrowing from the place of injury, students will begin to think about how growing and healing can be similar. In the next lesson, students will analyze data about growth plates in younger people and what happens at these locations over the course of someone's life. You may see students begin to argue that these processes are the same.

Use of this handout as a formative assessment is for informing you of where your students are in their sensemaking prior to the next lesson and such shouldn't be graded.

Give students about 10 minutes to complete *Lizard and Sea Star Injury Cases*. Then bring the class together and discuss their ideas.

| Suggested prompts | Sample student responses |
|---|---|
| *What were some things you and your partner noticed about the two cases?* | *Both the lizard and the sea star can lose part of its body and then have it grow back as it heals.*<br>*Yeah, the injury to the lizard was that it lost its tail, but then the healing was that it grew a new tail! Same with the sea star—it lost an arm and grew a new arm as it healed.*<br>*It didn't just heal on the end where the tail or the arm came off like our skin would if it was scraped. It seemed to heal at the end and grow that part back.* |
| *So wait, both the lizard and sea star healed right?* | *yeah* |
| *But you are saying that it also grew somehow?* | *Yeah, both of them grew back a body part that they had lost when injured.* |
| *So then do you think healing and growing might be a similar process?* | *Maybe … since in order to grow we would need to make more cells.* |

## Additional Guidance

The purpose of having students analyze some images of organisms that can regenerate appendages is for them to begin thinking about how the process our body goes through to heal might be similar to the process our body goes through when we are growing. As students analyze the images of the lizard and sea star regrowing an appendage over time while thinking about the key science ideas we have about the healing process, they will be encouraged to begin thinking about growing at a cell level and how it might be similar to healing.

## 10. Exit Ticket Learning

3 MIN

**Materials:** piece of paper or notecard

**Brainstorm how healing and growing are similar.** Display **slide M.** Distribute a piece of paper or notecard to each student. Say, *Answer the question on the slide on a piece of paper and turn it in before the end of class.*

Give students the last few minutes of class to think about how healing and growing might be similar and to record their ideas.

LESSON 13

# How is the process of growing similar to healing?

## Previous Lesson

*We revisited the timeline of healing from Lesson 1 and developed explanations for how healing happens based on each event we had listed. We came to consensus about how the healing in the foot happened, developing a list of key science ideas. We used what we have figured out about healing so far to see if we could explain how the systems in our body interact to support the healing process.*

## This Lesson

**Putting Pieces Together**

**1 DAY**



We apply what we have figured out about healing to explain a related phenomenon, growth of body parts and organisms. We share what we have figured out in our unit with our family and then ask about other modes of healing they have experienced.

## Next Lesson

*We will revise our definition of healing to include how our body functions and consider how we are still able to achieve our goals even when changes occur in how our body functions. We will read/hear about multiple stories from people with disabilities, the challenges they face, as well as their perception of their disability. We brainstorm ways to adapt and redesign our environment to make it more accessible for people with disabilities.*

## Building Toward NGSS

**MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8**

## What Students Will Do

**13.A** Apply science ideas and evidence from classroom investigations to explain a common, real-world phenomenon in which the cells of living things serve particular functions as they interact with one another and other systems to make more cells and grow.

## What Students Will Figure Out

- Children have growth plates in their skeletons which are gaps between their bones.
- The process that occurs when a person grows is similar to healing because
  - cells fill a gap in each tissue/body part as it heals (or grows), and
  - the same structures and systems that are needed to heal, are needed to grow.

## Lesson 13 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 15 min | **DISCUSS HOW THE BONES OF YOUNG CHILDREN ARE DIFFERENT THAN OLDER CHILDREN AND ADULTS**<br>Introduce a context for a new phenomenon to investigate using what we have figured out so far about healing. | A-G | Noticings About Bones from Different-aged People poster, markers |
| 2 | 20 min | **APPLY KEY SCIENCE IDEAS TO EXPLAIN GROWTH**<br>Students individually apply what they figured out about healing to explain how the growth process may happen in the body. | H | *Growth Summative Assessment* |
| 3 | 7 min | **REVISIT THE DQB TO IDENTIFY QUESTIONS WE CAN'T YET ANSWER**<br>Look back at the DQB to see what category of questions we still need to make progress on. | I | DQB |
| 4 | 3 min | **HOME LEARNING**<br>Ask students to bring in stories from family and/or community members about how they have supported healing. | J | *Home Learning: How do we support healing?* |

*End of day 1*

## Lesson 13 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Growth Summative Assessment*<br>• *Home Learning: How do we support healing?* | | • Noticings About Bones from Different-aged People poster<br>• markers<br>• DQB |

**Materials preparation (20 minutes)**

Online Resources



Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Have chart paper and markers ready to create the poster Noticings About Bones from Different-aged People.

Make sure the DQB is displayed and space is available for the class to gather in a Scientists Circle. Display all previous classroom consensus models and other posters around the room for reference.

## Lesson 13 • Where We Are Going and NOT Going

### Where We Are Going

This lesson provides a transfer task for assessing students' ability to apply what they have figured out about the process of healing to a new process: growth. In this assessment, students will engage in all three dimensions of the NGSS when analyzing images of X-rays of children's and adults' hands and feet. They will look for patterns of similarities to discover that there are gaps in the bones of children, but not in adults' bones. Then, they explain how growth occurs using what they have figured out about how gaps in injured tissue heal.

### Where We Are NOT Going

We are not going into detail about the entire process of development from childhood to adulthood. We are only concerned with growth within an individual from the toddler years to physical maturity, specifically focusing on how bones grow during that time. In addition, we will not be comparing the difference in height growth between people which would lead into genetics. Students will investigate genetics in *Unit 8.5: Why are living things different from one another? (Muscles Unit)*.

Though we notice as a class that the gap, or space observed in the X-rays of the bones of children appear "empty" or "open," there is still a faint shading which leads us to conclude there is something there, it just isn't solid bone. The material that is part of the growth plates in children such as cartilage is not something we will investigate in this unit. The purpose of this transfer task is to see if students can apply their model of healing at the cellular level to growth as a cellular level using the types of cells we are already familiar with. Therefore, we are not naming or explaining cartilage.

# LEARNING PLAN FOR LESSON 13

## 1. Discuss how the bones of young children are different than older children and adults.

15 MIN

**Materials:** science notebook, Noticings About Bones from Different-aged People poster, markers

**Revisit the ideas shared on the exit tickets from the last lesson.** Say, *Last class we analyzed images of an injury that had occurred to two other living organisms, a lizard and a sea star to see if we could use our key science ideas to explain how these injuries healed over time. In both cases, the injury that occurred resulted in the organism losing a part of their body, the tail for the lizard and an arm for the sea star.*

| Suggested prompt | Sample student responses |
|---|---|
| *This led us to wonder about the healing process for these two organisms and growth. What were some of your ideas from your exit tickets at the end of the last class about how healing and growing might be similar processes?* | *We wondered if they are the same, or very similar since new cells have to be made for both healing and growth.*<br><br>*I think these could be the same process since a baby is much smaller than an adult so it must have to make a lot more cells to get bigger.*<br><br>*Yeah, I think for our body to grow, it must have to make more cells the same way our body makes more cells to fill in any gaps from injury.* |

**Introduce the assessment goal.** Display **slide A.** Say, *So it sounds like we think the process of healing and growing in our body, and the body of other living things, is similar. Ideally, we should be able to use and apply what we have figured out so far about healing then to explain growth. We don't always know the limitations of the science ideas we have figured out until we try using them to explain a wider range of phenomena. So, today is our chance to apply our key science ideas from healing to explain a new phenomenon. Today you'll work on an end-of-unit assessment to explain what is happening in a new scenario. This assessment will be an excellent opportunity for you to demonstrate everything you have figured out so far about living things from investigating healing.*

**Orient students to the context of the assessment by comparing human bones.** Display **slide B.** Say, *Before you start the individual portion of the assessment, let's start by thinking about how we can use our key science ideas about how bones healed in the injury from Lesson 1 to explain what's going on in this other situation.*

| Suggested prompts | Sample student responses |
|---|---|
| *In our unit we have figured out some things about bones through our investigations of looking at them at different scales using X-rays and microscope slide images to be able to analyze their structure and figure out more about their function. Think about a baby compared to an adult, how do the bones of an adult compare to the bones of a child?* | *Children's bones are smaller than adults' bones.*<br>*Children's bones are growing.*<br>*Adult bones don't grow—most adults stay the same height.*<br>*We learned bones are made of cells and have blood vessels and nerves. So I think the child bones and adult bones are both made of cells.* |
| *Many of you were saying that children are growing and so their bones must be growing too. If you think about how this happens, what are some initial ideas you have about how bones might grow?* | *Cells are making more cells.*<br>*Cells need things like food (that is brought by the blood) to make new cells, like how we have to eat healthy foods to grow when we are kids.*<br>*Cells make more cells when we are healing and we think this might be the same for growing.*<br>*Things might be going in and out of the cell.* |

**Make noticings about X-rays of bones from people of various ages.** Display **slide C.** Say, *Let's take a look at some bones in the hands of people of different ages. What are some things you notice? As you share, I will record your noticings on this poster.*

Title the poster, Noticings About Bones from Different-aged People, and record here as students share.

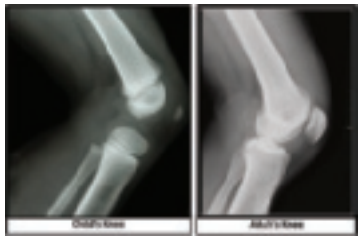
Note: you may need to remind your students we looked at X-rays back in Lesson 1 and Lesson 3 in order to help orient them to what the lighter and darker shading on the image represents by pointing out the bones on the images.



See the image on the slide of an X-ray of hands at different ages.

Some possible observations students may share include:

- There seem to be a lot of little bones in the smallest hand.
- It seems like there are places in the little hand where there are no bones and there are open spaces, where in the adult hand there are bones and no open spaces.
- The bones in the fingers of the second image look too short—there's so much space between them compared to how long and close together the bones are in the adult hand.
- In the third image, it looks like some of the areas between bones have started to fill in with more bone when compared to the 1-year-old or 3-year-old hand.



Adult knee: © Nevit Dilmen

Say, *OK, many of you are noticing that there are differences in the bones in an adult and child, particularly that there are smaller bones in the little hands and that there are spaces, or gaps between the bones in the hands of the children. Let's look at another image of an X-ray, this time taken of a child's knee and an adult's knee and see if we notice similar patterns between the child and adult bones.*

Project **slide D** which shows the image of the two knee X-rays.

| Suggested prompt | Sample student responses |
|---|---|
| *What similarities and differences do you notice between the hand images and these knee images?* | *Bones in the child are smaller in size for the hand and the knee.*<br>*The bones in the adult are bigger and look like they would be longer too in both the hand and the knee.*<br>*There seems to be more of a space in the knee of the child than the adult, but the space isn't as easy to notice as it was in the hand.*<br>*The two bones that meet where the knee bends look cracked or separated at the ends, but the adult bones don't seem to have that gap near the ends. Looking back at the hand images, I can see similar gaps or separations at the ends of some of the finger bones in the third-largest hand, but the adult hand does not have those either.*<br>*There are more bones in the hand than the knee, at least the part we see.* |

Say, *OK, in both the X-rays of the child's hand and knee, we are noticing there are spaces or gaps.*

## Additional Guidance

If kids push back that they think it is just empty space between the growth plates, then problematize this comment by referring to the X-rays and asking what they notice about the gaps. They will likely say that it appears foggy or hazy and not just clear. If there is still hazy stuff there, we are pretty sure it isn't just open space. You may also ask them that if there were just open spaces in between the bones, how might that affect how a child's body would function? Like if there wasn't anything in between the sections of bone, would the child still be able to stand, walk, move, have structure?

**Share that medical professionals call these spaces growth plates.** Display **slide E.** Say, *These spaces, or gaps, in the bones of children are called growth plates by medical professionals. We noticed on the X-ray that they're showing up as gaps, so it's not bone, but when we looked at the adult X-rays there was bone there without any gaps. So something must be happening in these gaps as children grow into adults.*

**Make predictions about growth plates.** Display **slide F.** Say, *Write two predictions in your notebook to answer these questions.*

- What do you think you would see happen in those spaces, or gaps, at the growth plates over time?
- Where else in the body, besides the hand or knee, do you think we would find these spaces (growth plates) in a baby or child's body?

Examine an image of growth plates throughout the body. Display **slide G.** Say, *It is hard to get an X-ray of growth plates for the whole body, so medical professionals make these scientific drawings based on X-rays of the body parts. Let's look at an image on the slide that shows all the places in the body that growth plates are located. Everywhere colored orange in the image is where medical professionals see growth plates in X-rays of children.*



| Suggested prompts | Sample student responses |
|---|---|
| *What do you notice about where the growth plates are found?* | *Growth plates are everywhere in a baby/child.*<br>*We see growth plates at the ends of the longer bones, but in the baby, it looks like most bones have a growth plate.* |
| *Think back to the X-rays we saw. What do you think we would see on an X-ray where we see orange lines in the diagrams?* | *There would be a gap between the bones at all of those places.* |
| *What do you think happens at these growth plates between the time someone is a baby until they are an adult?* | *Somehow they close up.*<br>*Yeah, it seems like the bones must grow because we know people get bigger or taller than when they are born.* |
| *What do we think needs to happen for the bone to grow?* | *We think for bones to grow, they need to make more cells.*<br>*We figured out bones are made of cells so maybe more need to be made.* |

Summarize, *We looked at growth plates in children as a class and we saw there was a gap between bones at the growth plate, and we figured out that for a bone to heal, new cells are made. It sounds like we think that for bones to grow, new cells also need to be made. We also noticed that growth plates are everywhere in a baby or small child. Let's see if we can apply what we have figured out about healing and what we notice and wonder about growth plates to explain the processes that might be happening at the growth plates.*

## 2. Apply key science ideas to explain growth.

20 MIN

**Materials:** science notebook, *Growth Summative Assessment*

**Provide time for students to work on *Growth Summative Assessment* individually**. Display **slide H.** Distribute one copy of *Growth Summative Assessment* to each student. This assessment will take students the remainder of the class period to complete. Once completed, students should turn in their assessment to you for feedback. Note to students that they have a choice in modality for sharing their answers, which include written or pictorial or a combination of the two.* Give students about 20 minutes to complete assessment.

*** Attending to Equity**

**Universal Design for Learning:** This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far through multiple modalities. Some students may benefit from using multiple modalities of *expression* to show their thinking

## Assessment Opportunity

**Building towards: 13.A** Apply science ideas and evidence from classroom investigations to explain a common, real-world phenomenon in which the cells of living things serve particular functions as they interact with one another and other systems to make more cells and grow.

**What to look for**: This assessment is a transfer task to give students an opportunity to use the three dimensions to make sense of a new scenario. For specific scoring guidance, see *Scoring Guidance: Growth Summative Assessment*. Allow students to choose how to share their understanding through written response, pictorial response, or a combination of both.

**What to do:** This is meant to be a summative assessment task for the unit, and it gives you a grading opportunity. The task includes a scoring guide located in *Scoring Guidance: Growth Summative Assessment*. Scoring guides are meant to highlight important ideas students should include in their responses. If students share these ideas elsewhere in the assessment, it is up to you to decide if that understanding is sufficiently demonstrated.

for any or all of the questions on this assessment. You may consider allowing some students to present their answers verbally with you or another student acting as a scribe to record their thinking on paper. Other students may benefit from using gestures rather than images to describe parts of explanations. Some students might also benefit from using manipulatives to represent parts of the system and to support a written or verbal explanation of what's happening in each part of their explanation. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, and equitable pathway for all students to demonstrate proficiency.

## 3. Revisit the DQB to identify questions we can't yet answer.

**7 MIN**

**Materials:** science notebook, DQB

**Briefly take stock of the DQB to see what category(ies) we still need to make progress on.** Display **slide I**. Have the students do a quick standing Scientists Circle around the DQB so that they can see the categories of questions.

| Suggested prompts | Sample student responses |
|---|---|
| *We have made a lot of progress over the course of our unit figuring out a lot about our Driving Question, How does our body heal? But there are still groups of questions we have yet to figure out. What are some of these that you see?* | *We still need to figure out more about the different supports that are used to help our body heal, like stitches and pins and casts.*<br>*Yeah, we also have bandaids and splints too that we have questions about.* |
| *What are some of your initial ideas for why these supports are needed?* | *Maybe to keep germs out?*<br>*Maybe to help keep things lined up so the body can heal, like the pins seemed to line up the bone from Lesson 1.* |

| Suggested prompt | Sample student responses |
|---|---|
| *Do you think the body would still heal if these supports were not used?* | *I think so because we saw the body healed from the scrape and there wasn't anything put on the scrape.*<br>*Yeah, I think the body would still make more cells to fill in the gap, but maybe it wouldn't heal lined up?* |

Say, *Let's see what more we can figure out about the healing process in our next class.* Tell students to return to their seats so they can hear about the home learning activity.

## 4. Home Learning

3 MIN

**Materials:** *Home Learning: How do we support healing?*

**Invite students to gather ideas about healing from their communities.** Display **slide J.*** Distribute *Home Learning: How do we support healing?*. Say, *When you go home today, talk with your friends and family about our class. First, share with them what we have been figuring out about healing. Describe an example of an investigation we did to answer one of our questions. Then share with them the different supports for healing that we have seen used in our unit and ask them these questions:*

1. *Ask whether they have ever experienced using any of the supports we have talked about to help their body heal from an injury.*
2. *Ask how these supports helped their body heal and allow them to participate in everyday life.*
3. *Ask about additional supports the people in your community have used to help their body heal from an injury that we haven't looked at in class.*

Explain the task with a few examples. For instance, you might say something like, *How do people in your family or community respond when someone gets hurt? What do you do to help the person who is injured? What are some practices people in your community use to support healing? Some people will clean a cut with soap and water, and then cover it with a bandage. Other people will clean a cut by pouring hydrogen peroxide on it, or swabbing it with rubbing alcohol. Others will put lime juice on a cut. All of these practices are different ways different people feel support healing, and we're curious to gather more ideas.*

Say, *There is space on your handout to record the ideas from your conversations so you can remember them for our next class. I hope you'll feel comfortable sharing some of what you talked about at home, but that will be your choice. The ideas you gather and share will help us answer our questions about what people do to help the body as it heals.*

*** Attending to Equity**

Framing students' families and communities as legitimate funds of knowledge can serve multiple purposes. It can (1) help students feel like they belong in the science classroom by situating their family and community knowledge as productive resources for science, (2) engage students' families in conversations about what is happening in the classroom, and (3) help students make connections between the science classroom and their everyday lives.

LESSON 14

# How can shifting our perceptions of ability and disability allow us to be more thoughtful about how we make our environments more accessible?

**Previous Lesson** *We applied what we have figured out about healing to explain a related phenomenon, growth of body parts and organisms. We shared what we figured out in our unit with our family and then asked about other modes of healing they have experienced.*

**This Lesson**

Investigation

3 DAYS






We revise our definition of healing to include thinking about how our body functions. Then we consider how we are still able to achieve our goals even when changes occur in how our body functions. We read and hear about multiple stories from people with disabilities—the challenges they face and their perceptions of their disabilities. We brainstorm ways to adapt and redesign our environment to make it more accessible for people with disabilities.

**Next Lesson** *There is no next lesson.*

## Building Toward NGSS

MS-LS1-1, MS-LS1-2, MS-LS1-3,* MS-LS1-8*



## What Students Will Do

**14.A** Analyze and interpret data to find similarities and differences in people's perceived abilities to function and meet their goals when having disabilities.

**14.B** Define a design problem (inaccessibility of our school environment for people with disabilities) that can be solved through the development of small changes to the current system (school environment) to improve its accessibility for many people, including those with disabilities.

## What Students Will Figure Out

- A person could be healed, but that part of the body may have a different function than before.
- Some disabilities are temporary and some are permanent.

- Some disabilities are visible and some are invisible.
- Many disabled people count disability as an important part of their identity. It is something to celebrate and take pride in.
- It's important for environments to be designed to be more accessible for all people

## Lesson 14 • Learning Plan Snapshot

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 1 | 12 min | **COMPARE HEALING STORIES**<br>Students reflect on different ways we can support the healing process, then share their ideas creating a class list. | A-B | *Home Learning: How do we support healing?*, What Do We Mean By Healing? poster, markers |
| 2 | 15 min | **REVISIT THE DOCTOR'S RECOVERY REPORT**<br>Revisit our ideas from the recovery report from Lesson 1. | C-D | *Recovery Reports*, *Transcript: Interview with student from Lesson 1*, highlighter, What Do We Mean By Healing? poster, How Does the Foot Heal Over Time? Consensus Model |
| 3 | 15 min | **HOW IS FUNCTION PART OF HEALING?**<br>Consider how function is an important part of the healing process. | E-F | Video (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), What Do We Mean By Healing? poster, poster paper or white board space |
| 4 | 3 min | **INTRODUCE HOME LEARNING**<br>Analyze images looking for how the images support different ways of thinking about disability. | G | *Wheelchair Icons* |
| | | | | *End of day 1* |
| 5 | 10 min | **SHARE OUR IDEAS FROM THE HOME LEARNING** | H-J | *Wheelchair Icons*, What Do We Mean By Healing? poster |
| 6 | 30 min | **LISTEN TO ROSIE KING'S STORY**<br>Watch a video to hear one person's disability story. Discuss the importance of perceptions around disability. | K-L | Rosie King's TED Talk (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) What Do We Mean By Healing? poster |
| 7 | 5 min | **EXPLAIN HOME LEARNING**<br>For home learning students will watch a TED Talk with Sinéad Burke. | M | *Transcript of Rosie King's TED Talk* |
| | | | | *End of day 2* |

| Part | Duration | Summary | Slide | Materials |
|---|---|---|---|---|
| 8 | 5 min | **SHARE OUR FINDINGS FROM THE HOME LEARNING**<br>Share what we found out about Sinéad Burke. | N-O | *Transcript of Rosie King's TED Talk*, Optional: (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |
| 9 | 15 min | **WORK WITH SINÉAD'S DESIGN CHALLENGE**<br>Work in small groups to brainstorm ways to redesign areas in the school that would be inaccessible for Sinéad. | P-Q | *Transcript of Rosie King's TED Talk* |
| 10 | 18 min | **EXPAND DESIGN THINKING TO CONSIDER ACCESSIBILITY CHALLENGES**<br>Consider other disabilities with mobility challenges and how the ideas we brainstormed to redesign areas in our classroom and school would help accessibility. | R-S | |
| 11 | 7 min | **REFLECT ON LEARNING**<br>Discuss how we can be considerate of others' needs and perspectives, and connect this learning to other designing we've done this year. | T | What Do We Mean By Healing? poster |
| | | | | *End of day 3* |
| | | **SCIENCE LITERACY ROUTINE**<br>Upon completion of Lesson 14, students are ready to read Student Reader Collection 4 and then respond to the writing exercise. | | Student Reader Collection 4: *Growth, Development, and Difference* |

## Lesson 14 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials<br>**Student Procedure Guide**  **Student Work Pages**  | • science notebook<br>• *Home Learning: How do we support healing?*<br>• *Recovery Reports*<br>• *Transcript: Interview with student from Lesson 1*<br>• highlighter<br>• *Wheelchair Icons*<br>• *Transcript of Rosie King's TED Talk* | | • What Do We Mean By Healing? poster<br>• markers<br>• How Does the Foot Heal Over Time? Consensus Model<br>• Video (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)<br>• poster paper or white board space<br>• Rosie King's TED Talk (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) |

**Materials preparation (20 minutes)**

**Online Resources**



Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

The *What We Mean by Healing?* poster will be revised again in this lesson. You will want a fresh piece of poster paper to develop this revision.

## Lesson 14 • Where We Are Going and NOT Going

### Where We Are Going

At this point in the unit, we have figured out that when our body goes through the healing process, interactions occur between different systems in our body so that more cells are made to fill gaps made as a result of the injury. We have been thinking about the structure and function of the different parts of our body and how the structure of these parts supports their function. This lesson brings us back to the anchoring phenomenon and healing story from Lesson 1 to think about the effects on the **function** of the student's foot after the injury was healed. We read that the doctor says the student is fully healed and can resume full physical activity, but we hear from the student himself that though he can play basketball after the injury, he has to wear an ankle brace now and can't play at the competitive level he could before the injury. He goes on to share that even though this is the case, he still gets the same enjoyment out of playing basketball. This leads us to revise our healing model to include how a body part can function differently before and after an injury. We continue the lesson by listening to or reading about other people's stories. From these stories, we personally reflect on how our view of disabilities has shifted over the course of the unit. We challenge ourselves to think about how we could adapt or redesign our classroom and school environment to be more accessible to all people.

Shifting our thinking about disabilities requires not only a three-dimensional lens, but also a compassionate and empathetic lens. Some students may become driven to figure out more ways to be inclusive in the classroom and in their world. Some resources that may be of use in supporting your students in developing or pursuing ways to support people with disabilities are included in this lesson:

1. CASEL Social Emotional Learning in a variety of contexts, including K-12 classrooms.
2. The Nora Project website contains a wealth of information about building inclusive classrooms. The link goes directly to resources targeted to adults wanting to learn more about disabilities.
3. A website site authored by Mitchell, a self described austistic teen who is a non-speaker. Mitchell's blog brings a first-person perspective to living with a disability.

(See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

**Where We Are NOT Going**

In this lesson, students define possible accessibility problems for people with disabilities. Students spend a short amount of time in small groups brainstorming possible adaptations or redesigns to the space that could lead to more accessibility for all. These actions can help shift students' perceptions about people with disabilities and empathize with challenges navigating environmental and structural barriers. This is not meant to be an engineering task and therefore, the activity only has students engage in design as a thought experiment.

# LEARNING PLAN FOR LESSON 14

## 1. Compare healing stories.

12 MIN

**Materials:** science notebook, *Home Learning: How do we support healing?,* What Do We Mean By Healing? poster, markers

**Reflect on supports that help the healing process**. Display **slide A**. Say, We *figured out that the structures in our body are working together to help the body heal, and we figured out similar processes occur when healing and growing happen in our body. Last lesson, you thought about some of the supports you and your family use to help support the healing of an injury.*

**Share findings with a partner**. Display **slide B**. Say, *Turn and talk with an elbow partner. Share some of what you found out about different things people do to support their body while it is healing from an injury.* Give students a couple minutes to share, then ask for a few volunteers to share their ideas.

| Suggested prompts | Sample student responses |
|---|---|
| *What are some things that people in our community have done to support healing?* | *Answers will vary. Accept all answers.* |
| *Did any of the trusted members of your community explain why they used those healing methods?* | *Answers will vary. Accept all answers.* |

**Pause and honor the importance of sharing our different lived experiences as resources for our classroom**. Say, *Thank you for sharing those great ideas. When we can hear different voices in our classroom, we become more aware of other perspectives. This may lead to more questions, inspire different ideas, and hopefully move our thinking forward together.*

**Return to our *What Do We Mean By Healing?* poster and revise it.** Refer to the *What Do We Mean By Healing?* poster that was started in Lesson 1 and revised in Lesson 8. Say, *Up until now, we defined "healing" as the process our body goes through to make new cells to fill in any gaps caused by an injury. Our focus has been on how the structure of the body heals so it can function again. Today, let's begin thinking about the* ***function*** *of the body and not only how this is affected when there is an injury, but even after the gap from the injury has been healed. Let's revisit our definition and develop a model we can use to explain what we have figured out about this process.* See the example image:



## Additional Guidance

The purpose of this discussion, over the next few prompt responses, is to support students in shifting to think about our healing explanation in terms of the way our body functions before and after an injury. We have been focusing on the structural changes that needed to occur to heal the foot, but now we want to think about the functional changes that occur and whether they also need to heal. We begin by revisiting the case from Lesson 1 to think about the student's body's ability before and after the injury. Then we will look back at the doctor's note to remind ourselves that the student can resume all physical activities which will lead us to think the student's foot is healed and all the function has returned. We will listen to an interview from the student and hear that while he can walk again and use his foot, he can't use it to the same ability as he could before the injury.

We will incrementally add to our new version of the *What Do We Mean By Healing?* poster.

| Suggested prompts | Sample student responses |
|---|---|
| *Let's think back to Lesson 1. We learned about a student who had injured his foot which healed over 4 months. Does our new representation of healing work for explaining how his foot healed?* | *Yes! His foot has a gap in the skin, and muscles and bone that needed to heal from new cells being made.* |
| *How did we know that the gap was filled in his foot once healed?* | *From the pictures we saw that the skin was all closed up and the bone didn't have gaps on the X-ray.* |
| *Now let's think about the function of the student's foot before and after the injury. Was he able to do the same functions before and after the injury based on what we know?* | *Yes, I think so. It said he couldn't walk due to the injury, but after his foot healed, he could walk again.* |
| *Was the student able to walk on it before the injury?* | *Yes. Because in Lesson 1 we read that he couldn't run or jump anymore after the injury, so he must have been able to before he was injured.* |
| *So on our poster for healing, we have represented what happens to heal the body structures from an injury, but how can we include what we are saying here about the function of the student's foot before and after the injury?* | *Well, we could include that he could run, walk and move before the injury and then he couldn't during the injury and then he could again after the injury.* |

Title this poster, *What Do We Mean by Healing?* Then add the body functioning ideas to the poster. An example image included here:




## 2. Revisit the doctor's recovery report.

15 MIN

**Materials:** *Recovery Reports*, *Transcript: Interview with student from Lesson 1*, highlighter, What Do We Mean By Healing? poster, How Does the Foot Heal Over Time? Consensus Model

**Return to the doctor's response to the foot healing.** Say, *Let's return to our foot injury case to see how and when the medical professional determined the foot injury was healed. We can then compare what we read to our generalized model for healing on this poster.*

*Let's return to look at Recovery Reports to see what the doctor said at the student's last appointment about the injured foot.* Display **slide C**, and encourage students to look back at the *How Does the Foot Heal Over Time?* Consensus Model and back in their notebook to remind themselves what was included on the recovery report for the case in Lesson 1. Ask, *What is recorded on the recovery report that is a clue that the doctor felt the student was healed and had full function restored to their foot?* Students should say they see a note about the student being able to resume all physical activities.

| Suggested prompts | Sample student responses |
|---|---|
| *Based on what is included on the doctor's note, does this match what we have on our healing model, that the function before is the same as the function after?* | *Yes, the note says he can resume all physical activities.* |
| *Based on this comment, do we know if this means the student could do everything to the same level he could do before the injury?* | *Not really…*<br>*I am not sure.* |
| *How could we figure out if the student could resume all the physical activities he could before the injury?* | *We could ask him?*<br>*Maybe there are other notes from the physical therapist.*<br>*Yeah or maybe he had some coaches we could ask.* |

*** Attending to Equity**

**Universal Design for Learning:** Students use multiple *representations* to engage with an interview with the student from Lesson 1. Audio recorded interviews are a great way to convey the emotion, intent, and the significance of information. While sound is a great way to convey impact, the content of audio recording may not be accessible for all students. Providing a transcript that students can annotate and allowing the class to hear the audio multiple times ensures that all students have access to learning.

**Listen to the student from Lesson 1 share about his injuries.** Say, *I have a recorded interview with the student from Lesson 1 who shares with us his experience. There is a lot of information that the student shares in the interview that connects to what we have figured out about healing and there is information about what we are still wondering about in relation to healing. We will pause at two different points so we don't lose track of these ideas. As you listen to the recording, use the transcript on* Transcript: Interview with student from Lesson 1 *to make noticings about what he says about what he could do before and after his injury. Include any questions that you have as you listen in the margin of your handout.*

Display **slide D**. Pass out *Transcript: Interview with student from Lesson 1** and encourage students to underline the parts of the transcript they find interesting, circle parts they have questions about, and highlight parts that refer to the things he could do before and after the injury. Play the first part of the audio recording (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**). In this piece of the interview, the student shares about the day of the injury and how it impacted his daily life. Pause here for a minute or two to allow students to make annotations on their transcript.

Next play the recording in which the student shares about getting back into activities and what he gets from participating in these activities. At the end, again let the students add notes to their transcript.

Lastly, play the recording in which the student shares about how his foot is today, years later (See the **Online Resources Guide** for links to these items. **www.coreknowledge.org/cksci-online-resources**).

**Facilitate a discussion about the student's function before and after the injury.** Use the sample prompts below to summarize what we learned from the interview.

| Suggested prompts | Sample student responses |
|---|---|
| *What were some things you heard the student say about what he liked to do before the injury?* | *He said before he liked to play basketball.* |
| *What did he say about whether he could do these activities again after the injury?* | *He said he still could do these activities, but when doing these activities his foot wasn't as strong and he didn't feel as confident.*<br>*He felt nervous about jumping on his foot.*<br>*He said he could shoot baskets, but not jump on his foot.* |
| *What were some of the things the student enjoyed about playing basketball?* | *He likes being part of a team and having fun with others.*<br>*He likes that he got to choose to do this activity.* |
| *What did the student say that they liked about studying design that relates to playing basketball?* | *He works with a team of people that help him create final design products that are better than he could create if he was working by himself.*<br>*Basketball helped prepare him for working with others on design projects.* |

| Suggested prompt | Sample student responses |
|---|---|
| *How has this injury impacted this student today?* | *The foot that was injured has more hair on it than the other foot.*<br>*The foot that was injured is more sensitive when something falls on it than the other one.*<br>*The student skateboards and plays basketball still and likes doing these activities.* |

**Update the *What Do We Mean By Healing?* poster to include the student's experiences.** Using the prompt and example images below, facilitate a discussion to use the healing model from our poster to understand what is happening with this student. As students share, add specific information to the *What Do We Mean By Healing?* poster similar to the image included:.



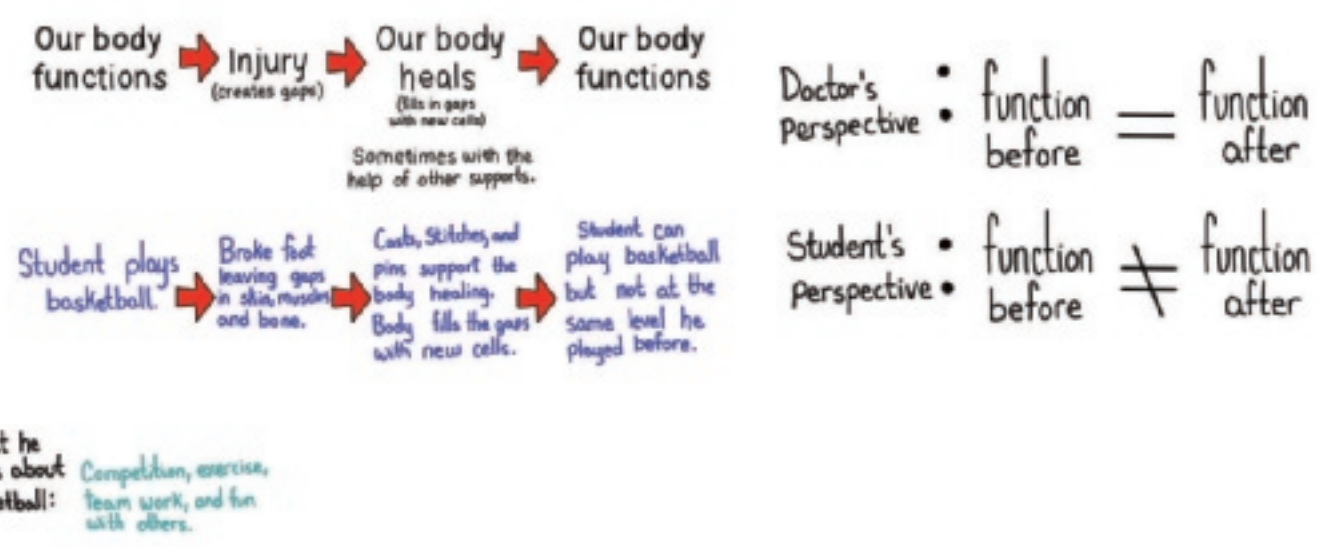

| Suggested prompts | Sample student responses |
|---|---|
| *Before the injury, what did this student enjoy doing that required using his foot?* | *He said he liked to play basketball and skateboard.* |
| *What do we know about the nature of his injury?* | *His foot was broken. The skin broke open and the bone broke.* |
| *What healing supports helped heal his foot?* | *The doctor used stitches, a cast, and pins to support his foot in healing so that the parts that broke open could make more cells and fill the gap over time.*<br>*He used crutches to get around, giving his foot time to heal and preventing him from injuring his foot more.* |
| *What kind of activities could the student do after he was healed?* | *He can still play basketball, but not competitively like he could before the injury, and he needs to wear a brace to help support his foot.* |

**Add student and doctor perspectives of function to the poster.** Using the prompts, continue facilitating a discussion to highlight the differences in perceived function from the doctor's report and the student's lived experience. Use the healing model from our poster to capture these different perspectives.

| Suggested prompts | Sample student responses |
|---|---|
| *Okay, let's go back to the recovery report. What would you say the doctor is looking for to say that the patient (this student) is healed?* | *That the supports can be removed.*<br>*There aren't any more gaps in the body.*<br>*The student doesn't need to use crutches to walk anymore.*<br>*The student can be active again.* |
| *So if this is the doctor's goal for healing for this student, was this goal reached?* | *Yes! The stitches and pins and cast were removed.*<br>*He said the student could resume activities again.* |
| *The student probably had some expectations about the healing of their injury. Based on the audio interview, what did the student want to be able to do after they were healed?* | *He wanted to play basketball competitively again.* |
| *Do you think that the student would feel they were healed?* | *Yes and no…*<br>*He said he could play again, but not in the same way he could before, so that doesn't meet the goal of healing.*<br>*But he also said the things he enjoyed most was the exercise, teamwork, and competition and that he still can get those through playing even if at a different level.* |
| *Thinking back to your stories on the related phenomena poster and the stories you heard as part of your home learning, were there cases where the function of what the body could do after the injury was different from before the injury?* | *Accept all responses.* |

| Suggested prompt | Sample student responses |
|---|---|
| *So why do you think the doctor's definition of healing isn't always the same as ours?* | *The doctor is mostly wanting to help your body get "fixed" or have the parts that were broken become "unbroken."*<br><br>*The doctor just wants to be sure that the parts of your foot are connected back together so that they work together as best as they can.*<br><br>*Maybe the doctor just wants to know if your cells are done trying to fill gaps. That's sort of like when your body has finished its job. Now it's up to you to figure out if you can do the same things as before in the same way, or if you need to do it differently.* |

Summarize student ideas and highlight that the function of the healed body part was not the same as it was before, even though it was physically healed. Add these different perspectives to the poster. Say, *According to the doctor, the function before equaled the function after. According to the student, the function before did not equal the function after. Over the course of the unit we have seen how the physical structures of our body can heal, and now it seems that healing is more than just filling the gap. Let's keep thinking about this as we look at other cases and maybe we will be able to add to our definition of healing.*



## 3. How is function part of healing?

15 MIN

**Materials:** science notebook, Video (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), What Do We Mean By Healing? poster, poster paper or white board space

**Continue considering how the functioning of our body is part of the healing process.** Display **slide E.** Say, *Up to this point in our unit, we have been focused on what is happening in our body for it to heal from an injury. We also just agreed that the doctor's perspective of healing can be different from our own perspective of healing. As we continue to work to better develop our model of healing to include the function piece, let's explore stories from two additional people, Jeremy and Matt, who have some similarities to the one we read about in Lesson 1. Jeremy and Matt also enjoy playing competitive basketball. Jeremy suffered an injury that affected how he could play basketball after the injury. Matt has spina bifida which is a condition he was born with where there is an incomplete closing in the spinal cord and limits his ability to use his legs.* Have students create a T-chart in their science notebooks labeling one side "Jeremy's story" and labeling the other side "Matt's story." After students have finished making the T-Chart in their science notebook, say, *As we listen to these two stories, be thinking about:*

- How is each person's story similar and different from the case we have been looking at since Lesson 1?
- What is Jeremy's view about the function of his body before and after his injury?
- What does Matt share about playing basketball?

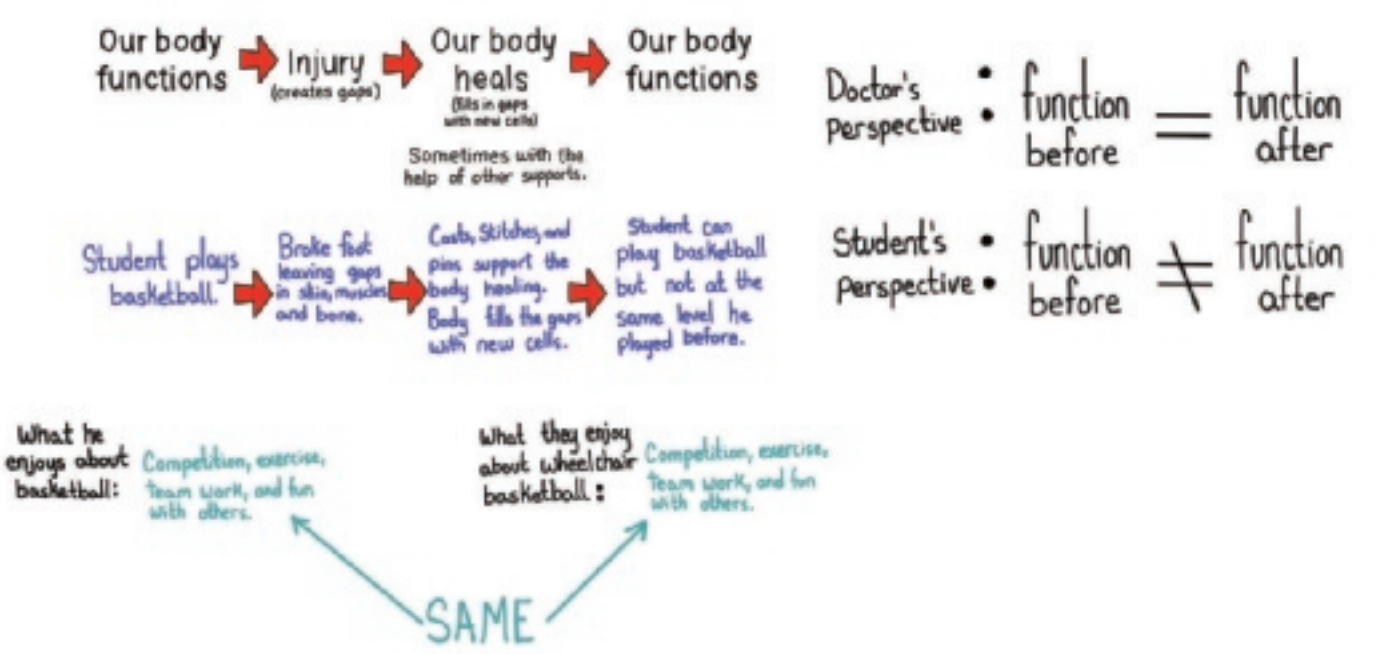
**Watch a video of wheelchair basketball.** Play the video once through telling students to capture ideas about Jeremy's story. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) After playing the video once, give students a minute or two to jot in the T-chart about Jeremy's story. Say, *We will watch the same video one more time so that we can focus on Matt's story.*

Play the video a second time. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**) When finished, tell students to be sure to jot down in the T-chart what they heard about each person's story. Then display **slide F** and tell students to turn and talk with a partner about the questions on slide. Ask for volunteers to share what they discussed with their partner. As students share, record their ideas about what is similar and different between Jeremy's story and the story from Lesson 1. You can record this on poster paper or the white board or another space that is visible to everyone.

| Suggested prompt | Sample student responses |
|---|---|
| *What are some of the similarities you and your partner noticed between these two stories?* | *Both the student in Lesson 1 and Jeremy had an injury that affected their legs or foot.*<br>*Both played basketball before and after their injury, but in a different way.*<br>*Both enjoyed playing basketball for the exercise, competition, and hard work it took.* |

| Suggested prompt | Sample student responses |
|---|---|
| *What are some of the differences you and your partner noticed between these two stories?* | *Their injuries were different. The student in Lesson 1 had dropped a weight on his foot, whereas Jeremy was in a car accident.*<br>*The student in lesson one could still play basketball. Jeremy has a wheelchair so he now plays wheelchair basketball.* |
| *What is Jeremy's view or feeling about the function of his body before and after his injury? What did you notice about Jeremy's thoughts about his disability?* | *Jeremy doesn't let his disability stop him from doing what he loves. He was going to school to be a PE teacher because he loves sports.*<br>*People with disabilities are not different, we just have a different way of doing things.*<br>*He believes he is inspirational because of the hard work he has put into being good at basketball, not because he has a disability that he has to overcome.* |
| *What did Matt share about playing basketball?* | *He initially didn't think he would want to play basketball in a wheelchair, but after trying it and realizing it is very competitive and takes a lot of hard work, he really loves it.* |

**Return to the *What Do We Mean By Healing?* poster.** Say, *Jeremy and Matt have a disability that affected how their legs functioned, but has not stopped them from doing the things they love, specifically playing basketball. On our poster, we have recorded that the student from Lesson 1 enjoyed playing basketball before and after the injury they incurred, but not for the sole purpose of playing basketball. Instead, he shared that more than playing the game, he enjoyed the competition, etc. How does what he gets out of playing basketball compare to what these two people shared about playing the game?* Add your students' ideas to the class poster. An example is below:




## 4. Introduce home learning.

3 MIN

**Materials:** *Wheelchair Icons*

**Identify shifts in perspective about disability.** Display **slide G,** and facilitate a brief discussion with the prompts on the slide.

| Suggested prompts | Sample student responses |
|---|---|
| *What did Jeremy share about how he feels about his disability?* | *He said that he said he doesn't want to be an inspiration for how he plays wheelchair basketball, but he would like to be thought of as inspiring for the hard work he puts in and for the PE program he supports.*<br>*He said he was in a car accident and that affected his legs, but doesn't really say anything else about that being a disability.* |
| *What did Matt share about how he feels about his disability?* | *He said that he didn't think he would want to play basketball in a wheelchair, but after trying it, he realized it is very competitive and takes a lot of hard work and he really loves it.* |

Distribute a copy of *Wheelchair Icons* to each student. Say, *As you work on Wheelchair Icons tonight, be thinking about different perspectives people have around disabilities and how these can change.*

### Assessment Opportunity

**Building towards: 14.A** Analyze and interpret data to find similarities and differences in the perceptions of the abilities of people with disabilities (structure) and their ability to function and reach their goals.

Use the responses to question 4 on *Wheelchair Icons*.

**What to look for/listen for**: Students to share ideas/perceptions being represented:

- The icon that says "handicapped" seems to support a perception that the person needs help and may not be able to do things for themselves.
- The icon that says "reserved" seems to support a perception that the person is able and eager to do things for themselves. It also supports a perception that they might need a reserved space to be able to access these things since they are in a wheelchair.

**What to do**: If students struggle to think about how these two icons support different perceptions, ask them questions such as:

- What is the person in the wheelchair in each icon doing?
- What does the way the person is positioned make it look like they are doing?
- We have figured out from Jeremy and Matt's stories that people in wheelchairs are very able. Which icon represents that best? Why does the other icon seem less representative?

**End of day 1**

## 5. Share our ideas from the home learning.

**10 MIN**

**Materials:** *Wheelchair Icons*, What Do We Mean By Healing? poster

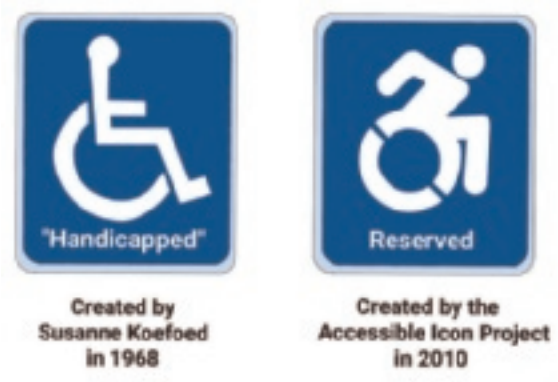
**Return to thinking about disability**. Refer to the *What Do We Mean By Healing?* poster. Say, *Last class, we noticed that after the foot injury from Lesson 1 healed, the student was not able to play basketball in the same manner as before the injury. Like we heard from Jeremy's experience, sometimes after an injury a person doesn't regain function to that part of the body in the same way, or a similar way it functioned before the injury causing that person to be disabled. Sometimes people like Matt are born with a disability. We also figured out that just because our body doesn't function the same way before and after an injury, that doesn't mean we can't still achieve our goals, like Jeremy and Matt's goal of playing competitive basketball.*

Display **slide H**. Say, *One of the first symbols in the late 1960s to spread awareness and access for people with disabilities is the wheelchair icon. While people who use wheelchairs only represent a small fraction of people with disabilities, this icon is widely used today. Let's review Wheelchair Icons where we looked at these familiar icons.*

**Discuss the wheelchair icons.** Display **slide I** and facilitate a brief discussion. Use sample prompts below.

| Suggested prompts | Sample student responses |
|---|---|
| *What things did you notice were similar between these icons?* | *Both of these icons each represent a person who is using a wheelchair.*<br>*The colors chosen for both icons were the same.*<br>*Both icons could represent any person—any age, any gender.* |
| *What did you notice was different between the two icons?* | *One icon just looks like the person is sitting there. Whereas the other icon looks like the person is actively moving because they are leaning forward and you can see their arms.*<br>*One icon is labeled "handicapped," while the other icon is labeled "reserved."* |
| *What do these two words make you think of in terms of someone who uses a wheelchair?* | *Handicapped seems to mean that person can't do as much and needs extra help.*<br>*Reserved seems more like there is a special space saved for this person in a wheelchair.* |
| *What do each of these icons suggest about people with disabilities?* | *The first icon looks like the person with disabilities is waiting to be helped.*<br>*The second icon looks like the person is able to do things themselves and that they just need designated spaces to be able to access things.* |
| *Can people who use wheelchairs still get around and do activities they want to do?* | *Yes! We saw them playing basketball.* |

**Discuss reasoning for differences in disability icons**. Display **slide J**. Say, *It turns out that these two icons were designed by different people and at different times. Here's some more information about who designed them and when they were designed.* Use sample prompts below to continue the discussion.




| Suggested prompts | Sample student responses |
|---|---|
| *Think about what you heard Jeremy and Matt say in the video about their disability of using a wheelchair to get around. Why do you think this icon was updated in 2010?* | *Because the old icons were sending incorrect messages and ideas about people with disabilities.*<br>*People might have thought with the 1968 icon that people with disabilities need help or that they can't do a lot of things, but we have seen that isn't the case.* |
| *Think back to what Matt said in the video about his disability and how he didn't want to play wheelchair basketball at first. How do the recent icon updates connect to what we observed with Matt's change in views of disabilities?* | *A lot of people's perceptions of people with disabilities are wrong and need to change to be more accurate and more inclusive.*<br>*Most people with disabilities don't need to be helped, they are very capable of taking care of their own needs as much as anyone else.* |

**Introduce background for updated disability icon**. Say, *We have only been thinking about the icons in terms of the population of people it represents, but these are also signs that have a deeper purpose. These signs are located near places where a space has been reserved or adapted or engineered for accessibility by people with different movement disabilities or needs. For example, you might have seen this icon near parking places closer to the front and/or near ramps at buildings. In this case, the icon is a representation for the reserved use of this space so that people with movement disabilities have the same access to a building as others.*

Say, *The Accessible Icon Project worked to redesign the handicap icon in 2010 with the goal of helping shift people's perspective towards disability. Some of the changes they were hoping to see shift is how people with disabilities view themselves and how people without visible disabilities view people with disabilities.*

Say, *This new icon was designed to represent or to aid people with certain disabilities. Sometimes people have disabilities that are not recognizable and able to be represented with a visual icon or symbol. Let's listen to another person share their experiences with their disability that is not visible.*

## 6. Listen to Rosie King's story.

30 MIN

**Materials:** Rosie King's TED Talk (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**), What Do We Mean By Healing? poster

**Prepare to watch Rosie King's talk.** Display **slide K.** Say, *Rosie King has a disability that is not visible. As she shares her story, think about:*

- What is her invisible disability?
- What are some things she shares about her disability?

Show the video.* It is just under 6 minutes long. After showing the video, redisplay **slide K** and prompt students to work with an elbow partner for a few minutes to record in their notebook what they heard Rosie say about her disability and how she feels, or what her perspective is of her disability.

**Facilitate a discussion about Rosie's disability and perceptions.** Use the sample prompts below to help guide the discussion:

| Suggested prompts | Sample student responses |
|---|---|
| *What is Rosie's disability?* | *She has autism.* |
| *What does she share with us about her disability?* | *She views her disability as an ability.*<br>*She says she feels it frees her to be herself.*<br>*Like, it's very easy for me to let my mind loose.*<br>*She has a very, very vivid imagination.* |
| *So in our unit we have been thinking about the healing process and how injuries can lead to our body functioning differently, but for Rosie, did she have an injury?* | *No, she was born with autism.* |
| *What were some things she shared about how her body functions differently than others around her?* | *When she gets excited, her body movements (rocking back and forth, screaming) show her excitement.* |
| *Why does Rosie say her disability makes her feel free?* | *She doesn't find it necessary to fit into a box, to be normal.*<br>*By not trying to fit into other people's perception of "normal" she feels she can be more imaginative and reach her goals. She is writing a book and said she did a video with the BBC.* |

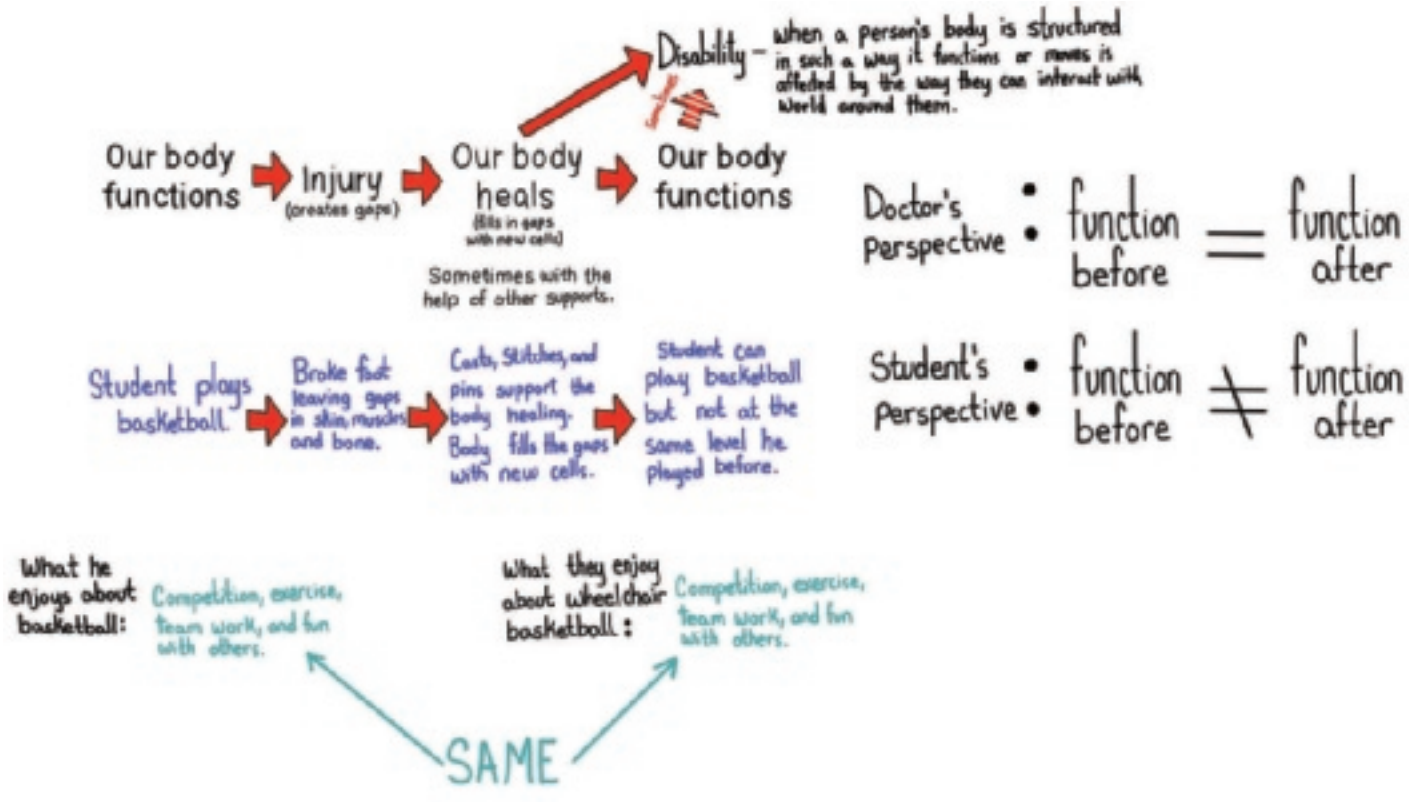
*** Attending to Equity**

**Universal Design for Learning**: Similar to having the student interview transcribed, some students may find more access to the TED Talk with a printed transcript. You can use the auto-generated transcript option in Youtube to download and print this for your students.

You are also encouraged to turn on closed captioning as you play the video. This will support students in having the option to read what Rosie is sharing in case they can not hear her clearly. In addition, some people process better visually when they can read what a speaker is saying.

| Suggested prompts | Sample student responses |
|---|---|
| *After hearing Rosie's story, is there anything she says about how she perceives how her body functions differently?* | *She embraces her disability as part of who she is!*<br>*She said she has two ways of thinking and that when she is bored in what she is doing, she can escape to her ...* |
| *The disability that Rosie has is considered an invisible disability—what might be some other disabilities that are considered invisible?* | *blindness*<br>*hearing*<br>*color blindness* |

**Reflect on our perception of disability.** Refer students back to the *What Do We Mean By Healing?* poster. Say, *We have looked at a number of different cases of people with disabilities. Let's consider how disabilities connect to our ideas about healing and how that might be represented in our model.* Facilitate a discussion to define disability, then add it to our *What Do We Mean By Healing?* poster. At the end of your discussion, your poster may look like this:



The following prompts may be useful in guiding this discussion:

| Suggested prompts | Sample student responses |
|---|---|
| *In all these cases what did people with disabilities have in common?* | *They all had some condition that affected their body.*<br>*Their disability affected how they could function in the world.*<br>*Often, but not always, disabled people use supports to help them.* |
| *How might we define disability?* | *When a person's body is structured in such a way that the way it functions or moves is affected by the way they can interact with the world around them.* |
| *How do our ideas about disabilities connect to the What Do We Mean By Healing? poster?* | *Our disability definition has the word* function *in it. We should add it to our poster and connect it to function.*<br>*Disability is sometimes an outcome from injury.* |
| *Thinking about the student in Lesson 1, based on our disability definition, would he have ever been considered to be disabled?* | *Maybe, but he was able to return back to a similar function that he had before.* |
| *Let's return to* Transcript: Interview with student from Lesson 1 *and see if there is evidence of whether or not the student from Lesson 1 ever fit our disability definition.* | *There is evidence that when he was injured and had to use crutches that he fit the criteria as a disabled person because using the crutches affected how his body could function in the world.* |

**Individually reflect on your perception of disability.*** Summarize by saying, *It is really interesting that disability affects people in a lot of different ways and even people who might return to the same function after an injury can be considered disabled while they are healing. We've come a long way in our thinking around disabilities. Let's take a few minutes to reflect on how your thinking has changed around disability. This individual reflection is for you; you don't need to share it with me or anyone else.*

Display **slide L**. Give students about 5 minutes to complete these prompts on the slide in their science notebooks.

- What I used to think about disability:
- What I now think about disability:

*** Attending to Equity**

People with disabilities have historically been viewed as tragedies, burdens on society, and/or sources of inspiration stories. All of these ideas about people with disabilities are harmful and lead people to focus on what they can't do rather than who they are. Having students engaging with these different stories and providing space for students to consider how their thinking has changed, allows students to be self-aware of their own misconceptions with a goal to lead them to be more empathetic and inclusive in their perspective. We want students to walk away realizing that they have a lot in common with people who have disabilities. Even though our bodies may function differently, we all want respect and to be seen for who we are, not based on what we can or cannot do.

## 7. Explain home learning.

5 MIN

**Materials:** *Transcript of Sinéad Burke's TED Talk*

**Explain the home learning task.** Display **slide M.** Say, *For home learning you will be watching a TED Talk with Sinéad Burke. The link to her TED Talk is included at the top of the Transcript of Sinéad Burke's TED Talk so that you can watch the video. As you watch tonight, highlight sections that answer the questions:*

- *What does Sinéad share about her disability?*
- *What parts of her environment does Sinéad say is challenging for her to navigate and why?*
- *What is Sinéad's design challenge to us towards the end of the video?*

*Be ready to share with the class next time your findings.*

**End of day 2**

## 8. Share our findings from the home learning.

5 MIN

**Materials:** *Transcript of Sinéad Burke's TED Talk*, Optional (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

**Share responses to home learning prompts.** Display **slide N**. Say, *Let's return to Sinéad's story and share what we found out.**

| Suggested prompts | Sample student responses |
|---|---|
| *What does she share about her disability?* | *She says that she inherited it from her dad.*<br>*Accept all responses about her experiences as she navigates her world.*<br>*She has achondroplasia.*<br>*She says that she is a little person.* |
| *What parts of her environment does Sinéad say is challenging for her to navigate and why?* | *She shared getting through the airport is difficult because there are far areas to walk and the restrooms have doors with locks too high for her to reach.*<br>*She said ordering coffee at a coffee shop is challenging because the counters are too high.*<br>*She says the security at the airport is hard to go through because the scanner is too high for her to lift her suitcase but the security people can't help her.* |

*** Attending to Equity**

If some of your students mentioned they struggled accessing the TED Talk at home, you may choose to take the time to watch it here.

(See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

Display **slide O.** Say, *Near the end of the TED Talk, Sinéad says she wants to offer us a new perspective and that she wanted "to challenge the idea that design is but a tool to create function and beauty. Design is a way in which we can feel included in the world, but it is also a way in which we can uphold a person's dignity and their human rights. Design can also inflict vulnerability on a group whose needs aren't considered."*

Give students two minutes to turn and talk with a neighbor about the prompts on the slide. Tell students to be prepared to share their responses with the whole class.

| Suggested prompts | Sample student responses |
|---|---|
| *What do you think she means when she says design is "a way in which we can feel included in the world?"* | *Maybe she means that when things are designed well or thoughtfully, more people can use those things.* |
| *What do you think she means when she says "design is a way to uphold a person's dignity and their human rights?"* | *I think she is saying that the way things are designed can support people in being able to do the things they need and want to.*<br>*Yeah, like when she was talking about ordering coffee but the clerk couldn't see her and then she couldn't reach the counter. That feels embarrassing and she shouldn't feel that way when buying her coffee.* |
| *Let's think about what she means when she says "design can also inflict vulnerability on a group whose needs aren't considered." First, what does the word* vulnerability *mean?* | *Vulnerable I think means that you might not feel safe, or you feel at risk.* |
| *Right. When someone feels vulnerable, they feel at risk or like they might be made fun of or not accepted. So using this idea of vulnerability, what do you think she means that design can inflict this on a group?* | *I think it is like how she talked about not being able to do something for herself, like reach the sink or the door latch in the bathroom.*<br>*Yeah, or any of the times she said she had to depend on the kindness of strangers to help her.* |

## 9. Work with Sinéad's design challenge.

15 MIN

**Materials:** *Transcript of Sinéad Burke's TED Talk,* science notebook

**Present Sinéad's design challenge to the class.** Display **slide P.** Say, *At the very end of the TED Talk, Sinéad shares a challenge she has for us. Let me read it to us aloud. "So today, I want your perceptions challenged. Who are we not designing for? How can we amplify their voices and their experiences? What is the next step? Design is an enormous privilege, but it is a bigger responsibility. I want you to open your eyes." We are going to spend a few minutes taking her up on this challenge and think about our classroom and school.*



Display **slide Q.** Say, *You will work with your small group on this challenge. One person in your small group should record your group's ideas so that you will have them ready to share. As you work with your small group, think about:*

- *What areas of our school would need to be redesigned so she could have access?*
- *What are some initial brainstorm ideas for how you could redesign this area?*
- *How would the ideas you brainstormed lead to more accessibility for Sinéad?*

Give student groups about 10 minutes to work together.

## Additional Guidance

Some students may ask for some reference around how tall 3'5" is. You may provide meter sticks to students as they brainstorm areas that might be inaccessible to someone of her height so they can measure the height of different areas in the classroom.

**Share out ideas from small groups**. Pull the class back together. Take a couple minutes to ask a few volunteers to share what their group brainstormed, allowing students to build upon one another's ideas.

## Assessment Opportunity

**Building towards: 14.B** Define a design problem (inaccessibility of our school environment for people with disabilities) that can be solved through the development of small changes to the current system (school environment) to improve its accessibility for many people, including those with disabilities.

**What to look for/listen for:** Students to share ideas similar but not limited to:

- areas in the school that would be too high for a person smaller in stature (i.e., counters, etc).
- distance between rooms in the school that are far apart and could lead to it taking too long to get to a class on time (if the school is large and/or has a lot of stairs).

**What to do:** If students are unsure how tall 3'5" is and what areas in the school are taller than this, provide them a meter stick to use and prompt them to measure different areas. If they struggle with ideas for redesigning or adapting, encourage students to look back at their notes in their science notebook or rewatch part of the TED talk, particularly to the examples given (i.e., airport, bathroom, coffee counter, chair), which might lead to some ideas based on what Sinéad said from her experiences that they can then apply to the school space.

The main purpose of this assessment is to support students to begin thinking about how they can have control over the aspects of the design of their environment, and how their decisions for adapting/redesigning their environment impacts its accessibility for others.

## 10. Expand design thinking to consider accessibility challenges. 18 MIN

**Materials:** None

**Remind students about the student from Lesson 1 and Jeremy and Matt from the Paralympics video.** Display **slide R.** Say, *Wow, you all have some great ideas for how we could redesign some of our school's spaces so that Sinéad could have more access. Let's think back to two other cases we studied of people who also had mobility adaptation needs. The student in Lesson 1 had to use crutches for a while as his foot was healing. And Matt and Jeremy from the Paralympics video use a wheelchair to get around. Both crutches and wheelchairs are not always easy to maneuver in all spaces. Consider with your small group, if these three people were to visit our school, what areas would need to be redesigned or adapted for them? Would the adaptations you brainstormed for Sinead work for these three? Be ready to share some of your group's ideas.*

Give students 7 minutes to discuss with their group and brainstorm some ideas. Then ask a few volunteers to share with the class.

Connect these mobility needs to Sinéad's challenge and say, *Were there any redesigns or adaptations that your group brainstormed that you think would help all four of these people have better access to areas around our school?* Ask a few volunteers to share. Accept all answers.

**Shift to thinking about accessibility for invisible disabilities.** Display **slide S.** Say, *Up until now we have been thinking about how to redesign our space for people with visible disabilities, specifically around mobility, or being able to get around. But we also heard about an invisible disability, as well, in Rosie's story. Her disability is not directly related to mobility or accessibility around the school based on movement.*

*So think about the adaptations you suggested so far, would they make our space more or less accessible for her? What other adaptations might make sense for Rosie if she visited our class? What could we adapt or revise in our environment to make it more accessible for Rosie and her needs? Take a few minutes with your small group to look over your redesign ideas and brainstorm new ones that might be needed to make our school and classroom space accessible for Rosie. Think back to Rosie's story and what she said was hard for her at school.*

Give small groups 7 minutes to work.

### Supporting Students in Making Connections in ELA

Some of your students may have read, or may be reading novels about people with disabilities as part of the novels they read for free reading or as part of their ELA class. They may pull from these novels with ideas for redesign based on adaptations they read about.

### Additional Guidance

As students spend a short amount of time brainstorming ways to make our school environment more accessible for people with disabilities, there may be a potential cross curricular connection with a STEM teacher at your school if there is a program supporting this. You may wish to share with this teacher that students will be considering ideas for redesigning the school environment. They may wish to include this as an option in their course where students could deepen this task to be thinking about criteria and constraints, etc.

## 11. Reflect on learning.

7 MIN

**Materials:** What Do We Mean By Healing? poster

**Take the time left in this class to reflect.** Refer back to *What Do We Mean By Healing?* poster. Display **slide T.** Say, *Over the course of this unit we have developed an understanding of how our bodies heal and return to function, and we have really expanded our perceptions around disabilities. We just finished thinking about how to adapt our space to make it more accessible for people with certain disabilities. Now let's broaden this and think about what else we might consider when we think about the needs of others, those with visible or invisible disabilities and those without. What are some needs we all have?*

- Sample student responses:
- Eating
- Moving
- Social interaction
- Quiet time
- Feeling cared for
- Feeling listened to

Say, *Based on your responses and what we figured out about healing, and how function can be different for different people, why is it important to be aware of and listen to other people's perspectives?*

Accept all responses. Celebrate and revel in any insights shared by students. Encourage students to continue thinking about accessibility and disability in the future.

**End the course/year.** Say, *Beyond thinking about healing, disabilities, and people's needs, we have also had many opportunities to engage in design thinking, such as redesigning a cup, or coastal protection barriers from tsunamis, and now thinking about how the way environments are designed can lead to accessibility challenges for some people. How cool! Now we have these new ways of thinking about things and how we can adapt, redesign, and reengineer things in our environment to make the world a better place that is accessible for everyone to be able to function! I can't wait to hear what you redesign or adapt in your future years!*

## SCIENCE LITERACY: READING COLLECTION 4

# Growth, Development, and Difference


1 **Will Humans Be Able to Regrow Limbs?**
2 **Spare Parts**
3 **Bum Ligament: Reconstruction or PRP?**
4 **Living and Thriving with Physical Disadvantages**


## Literacy Objectives

- ✓ Summarize key points related to regenerating and repairing body parts.
- ✓ Support a position on how to handle a missing limb with evidence.
- ✓ Contrast pros and cons of treatments for torn ACLs.

## Literacy Activities

- Read varied text selections related to the topics explored in Lessons 11–14.
- Evaluate the reading selections according to provided prompts and criteria.
- Compare and contrast information gained from reading text with information gained from class investigation.
- Prepare a well-reasoned paragraph in response to the reading.

## Instructional Resources

Student Reader



Collection 4

**Science Literacy Student Reader, Collection 4**
"Growth, Development, and Difference"

Exercise Page



EP 4

**Science Literacy Exercise Page**
EP 4

## Prerequisite Investigations

Assign the Science Literacy reading and writing exercise *after* class completion of this lesson group:

- Lesson 11: How do cells get what they need to grow?
- Lesson 12: How do the structures and systems in the body work together to heal the injury?
- Lesson 13: How is the process of growing similar to healing?
- Lesson 14: How can shifting our perceptions of ability and disability allow us to be more thoughtful about how we make our environments more accessible?

## Standards and Dimensions

### NGSS

**Disciplinary Core Idea**
**LS1.A: Structure and Function:**

- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)
- 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. (MS-LS1-3)

**Science and Engineering Practices:** Engaging in Argument from Evidence; Obtaining, Evaluating, and Communicating Information

**Crosscutting Concepts:** Systems and System Models; Cause and Effect

### CCSS

**English Language Arts**

**RST.6-8.2:** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

**RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

**RST.6-8.6:** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

**RST.6-8.9:** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

**WHST.6-8.1:** Write arguments focused on discipline-specific content.

## Core Vocabulary

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

**regenerate**

**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.

| | | |
|---|---|---|
| **blastema** | **ligament** | **vestigial structures** |
| **DNA** | **regeneration** | **cell differentiation** |

A Glossary at the end of the Science Literacy Student Reader lists definitions for Core Vocabulary and selected Language of Instruction.

## 1. Plan ahead.

Determine your pacing to introduce the reading selections, check in with students on their progress, and discuss the reading content and writing exercise. If you are performing Science Literacy as a structured, weekly routine, you might implement a schedule like this:

- Monday: Designate a ten-minute period at the beginning of the week to introduce students to the assignment.
- Wednesday: Plan to touch base briefly with students in the middle of the week to answer questions about the reading, to clarify expectations about the writing exercise, and to help students stay on track.
- Friday: Set aside time at the end of the week to facilitate a discussion about the reading and the writing exercise.

You'll proceed with the in-class lesson investigations during this week.

## 2. Preview the assignment and set expectations. (Monday)

- Let students know they will read independently and then complete a short writing assignment. The reading selection relates to topics they are presently exploring in their Cells and Systems unit science investigations.
- The reading and writing will be completed outside of class (unless you have available class time to allocate).
- Preview the reading. Share a short summary of what students can expect.
  - *First, you will read about how a water-living salamander grows a new limb where one is lost. Could humans someday learn how to regenerate lost or missing limbs?*
  - *Next, you'll read about how all humans are born with body parts that they don't seem to need—such as tailbones—and how some humans are born with extra parts such as ribs and fingers.*
  - *Then, in a fictitious journal entry, you'll read about the medical options available to a pro-basketball player with an injured knee.*
  - *Finally, you'll read a photo essay about some people with physical disabilities who perform at the tops of their chosen fields. You will also hear more from the father of Maddy, whom you met in the Preface.*
- Distribute Exercise Page 4. Preview the writing exercise. Share a summary of what students will be expected to deliver. Emphasize that Science Literacy exercises are brief. The focus is on thoughtful quality of a small product, not on the assignment being big and complex.
  - *For this assignment you will be expected to generate a well-reasoned paragraph in support of a claim about the young girl introduced in the Preface.*
- Remind students of helpful strategies they can employ during independent reading. Offer the following advice:
  - *The reading should take approximately 30 minutes to complete.* (Encourage students to break reading into smaller sections over multiple short sittings if their attention wanders.)
  - *A good reading strategy is to scan through the collection first to see the titles, section headers, graphics, and images to see what the selections are going to be about before fully reading.*
  - *Next, "cold read" the selections without yet thinking about the writing assignment that will follow.*
  - *Then, carefully read the Exercise Page to understand the expectations for the writing part of the assignment.*
  - *Revisit the reading selections to complete the writing exercise.*
  - *Jot down any questions for the midweek progress check in class.* (Be sure students know, though, that they are not limited to that time to ask you for clarification or answers to questions.)

Exercise Page



EP 4

## 3. Touch base to provide clarification and address questions. (Wednesday)

Touch base midweek with students to make sure they are on track while working independently. You may choose to administer a midweek minute-quiz to give students a concrete reason not to postpone completing the reading until the last minute. Ask questions such as these, and have students jot answers on a half sheet of paper:

| Suggested prompts | Sample student responses |
|---|---|
| *What types of cells need to develop and grow to regenerate a salamander's limb?* | *skin, muscle, cartilage, bone, and nerve cells* |
| *What are vestigial structures?* | *body parts that serve no apparent purpose, such as the little toe and the tailbone.* |
| *According to this author, what two choices does a person with a torn ligament in their knee have for treatment?* | *surgery to reconnect the ACL or an injection of blood parts into the knee* |
| *What do Jim Abbott and the young girl Maddy you read about in the Preface have in common?* | *He also played baseball and was born with one hand missing.* |

Ask a few brief discussion questions related to the reading that will help students tie the text content to students' classroom investigations.

| Suggested prompts | Sample student responses |
|---|---|
| *How does the article about the axolotl salamander support the idea that healing and growth are related processes?* | *The article says that when the salamander loses a limb, the wound starts to heal but then forms a structure that can differentiate into all the kinds of cells needed for a new limb.* |
| *How is the effect of a PRP injection to an injured knee similar to swelling that occurs when body parts are injured?* | *Both bring extra fluids and blood carrying food, water, and other materials needed for healing and carry away wastes.* |
| *How did the people with disabilities profiled in the fourth selection function in activities they were passionate about?* | *The drummer used his feet to help him drum.*<br>*The singer was able to learn to play piano by touch and ear.*<br>*The mathematician used a computer to communicate his enthusiasm about science.*<br>*The surfer used a handle added to her surfboard to control it.*<br>*The baseball pitcher threw and caught balls with the same hand.* |

Refer students to the Exercise Page 4. Provide more specific guidance about expectations for students' deliverables due at the end of the week.

- *The writing expectation for this assignment is to develop a well-reasoned paragraph that supports a claim of your choice about the fictitious girl from the Preface named Maddy.*
- *If you don't recall Maddy's story, refresh your memory of the scenario by rereading the Preface, called "Put Yourself in This Scene."*
- *Use what you know about Claims-Evidence-Reasoning to help you plan your argument.*
- *Also, pay special attention to the reading in Collection 4 that features Maddy and her father.*
- *But don't overlook evidence from other readings to support your argument.*
- *The important criterion for your work are that you support your chosen claim with scientific evidence and clear, logical reasoning.*

• Answer any questions students may have relative to the reading content or the exercise expectations.

Exercise Page



EP 4

## 4. Facilitate discussion.

(Friday)

Facilitate class discussion about the reading collection and writing exercise. This collection has several two-part selections, in which the style, topic, and point of view change. Have students look at the design, style of illustrations, and subheadings to predict where one part ends and the second part begins.

| Pages 34–37<br>Suggested prompts | Sample student responses |
|---|---|
| *What is the general purpose of the first selection, "Will Humans Be Able to Regrow Limbs?"* | *It explains how one kind of salamander is able to regenerate a limb that gets cut off.* |
| *How important was the illustration of limb regeneration to your understanding the text? Explain.* | *very important*<br>*The text was hard to understand, so I stopped and studied the pictures. Then when I read the text again, it made more sense.* |
| *How is a blastema different from a scar? Use the word* differentiate *in your answer.* | *A blastema can differentiate into many kinds of cells and tissues, and a scar just makes skin cells.* |
| *DNA is the substance that a cell's chromosomes are made from. What can you infer from this reading is the function of DNA?* | *DNA directs and conducts processes inside cells.* |
| *What is the general purpose of the second selection, "Spare Parts"?* | *It describes human body parts that all people have that are not functional and extra parts that some people have.* |

Student Reader



Collection 4

**SUPPORT**—If you are using the recommended word envelope convention, check the envelope to see if it contains any words, phrases, or sentences that students need help understanding. Read key sentences aloud, and provide concise explanation.

Online Resources



**CHALLENGE**—For students who wish to understand what DNA is in more depth, have them watch online videos produced by scientific organizations and institutions.

| Pages 36–43<br>Suggested prompts | Sample student responses |
|---|---|
| *How does the second selection help you build knowledge on top of what you learned about DNA in the first selection?* | *The first article reveals that DNA directs processes inside organisms. The second article explains how people can end up with more than one set of DNA in their cells.* |
| *What questions did you have after reading this selection?* | *Can people also donate their extra ribs or fingers to a person who has missing ribs or fingers?*<br>*Is it dangerous to have two sets of DNA?*<br>*How far back in time are the ancestors who used their fifth toes and tails?* |
| *What is the general purpose of the third article, "Bum Ligament: Reconstruction or PRP?"* | *It compares two treatments for people who tear their ACL.* |
| *How did what you learned about platelets in this selection build on what you learned in our lesson investigations and discussions?* | *In class, we learned that platelets are part of blood and that they plug up holes in blood vessels when an injury is bleeding. In this article, it says that platelets also help with cell division and tissue regeneration.* |
| *What are some pros and cons of each treatment?* | *A pro of reconstruction is that it has worked many times. A con is that it takes months to recover.*<br>*A pro of PRP is that surgery is not involved. A con is that it only works when the ACL is not torn all the way through.* |
| *What is the general purpose of the fourth article, "Living and Thriving with Physical Disadvantages"?* | *The first part describes some famous people who were physically disabled but still at the top of their professions. The second part is a follow-up to the unit preface scene about a one-handed girl who wants to play baseball.* |
| *Which of the accomplished people profiled impressed you the most? Explain.* | *the surfer who went professional with only one arm*<br>*She impressed me because she seemed to have no fear of getting bitten by a shark again.* |
| *How would you summarize Maddy's father's position about how to handle her disability?* | *Her father is going to let her play ball like Jim Abbott, without any prosthesis, and wait until robotic hands are more developed.* |

**Online Resources**



**EXTEND**—Have students watch one or more videos about the celebrities featured in the fourth selection. Have them focus on learning how each person dealt with a physical disability to perform at the top of their field.

## 5. Check for understanding.

**Evaluate and Provide Feedback**

For Exercise 4, students should, from a provided topic sentence that they select, write a well-constructed paragraph to argue how Maddy's life may change in the future. Look for evidence from one or more of the readings in this collection that supports students' reasoning.

Students who choose "Someday, Maddy may decide that it is time to get a new left hand" can use the following reasoning based on the readings:

- Someday, human cells might be programmed to form a blastema instead of a scar. Then the blastema can differentiate into all the kinds of cells needed for a new limb.
- If kidneys and parts of livers can be transplanted, maybe hands will be transplanted in the future.
- A robotic hand that can be controlled by the brain will eventually be available.

Students who choose "Someday, Maddy could benefit most from a human hand transplant" can use the following reasoning based on the readings:

- It may be too long for Maddy to wait for robotic hands to work well.
- It would take years to regenerate a new hand—even if scientists figured out how to do it.
- People donate kidneys and parts of livers, so there might be hand donations one day, too.

Students who choose "Tools, devices, and systems will help Maddy do the things she wants to do" can use the following reasoning based on the readings:

- A robotic hand that can be controlled by the brain will eventually be available.
- She can watch Jim Abbott play baseball to figure out his system for throwing and catching the ball.
- There may be special handles made for Maddy, like the one Bethany Hamilton's father made for her surfboard.

Use the rubric provided on the Exercise Page to supply feedback to each student.

# Teacher Resources

## Table of Contents


Pre-Unit Letter Home . . . . . 364
Lesson 1: Teacher Reference 1 . . . . . 365
Lesson 1: Teacher Reference 2 . . . . . 367
Lesson 2: Teacher Reference 1 . . . . . 368
Lesson 2: Teacher Reference 2 . . . . . 374
Lesson 2: Teacher Reference 3 . . . . . 377
Lesson 4: Teacher Reference . . . . . 384
Lesson 5: Teacher Reference . . . . . 385
Lesson 7: Part 1: Are Other Things Made of Cells? . . . . . 386
Lesson 7: Part 2: Are Other Things Made of Cells? . . . . . 388
Lesson 7: Answer Key . . . . . 390
Lesson 10: Teacher Reference . . . . . 395
Lesson 10: What do bacteria need to make more of themselves? . . . . . 401
Lesson 10: Answer Key . . . . . 402
Lesson 11: Teacher Reference . . . . . 404
Lesson 11: Answer Key . . . . . 407
Lesson 12: How do the systems in the body interact during the healing process? . . . . . 409
Lesson 12: Answer Key 1: Sample Responses for How Healing Happened Chart . . . . . 410
Lesson 12: Answer Key 2: How do the systems in the body interact during the healing process? . . . . . 412
Lesson 13: Growth Summative Assessment . . . . . 416
Lesson 13: Answer Key . . . . . 419

## Assessment System Overview

Each unit includes an assessment system that offers many opportunities for different types of assessments throughout the lessons, including pre-assessment, formative assessment, summative assessment, and student self assessment. Formative assessments are embedded and called out directly in the lesson plans. Please look for the "Assessment Icon" in the teacher support boxes to identify places for assessments. In addition, the table below outlines where each type of assessment can be found in the unit.

### Overall Unit Assessment

| When | Assessment and Scoring Guidance | Purpose of Assessment |
|---|---|---|
| Lessons 1 & 2 | Lesson 1 Handout 5: *Healing Initial Model*<br><br>Driving Question Board | **Pre-assessment**<br><br>The student work in Lesson 1 available for assessment should be considered a pre-assessment. It is an opportunity to learn where students are coming in and what ideas they have that you can build on in this unit. The more ideas in your classroom, the better. Specifically, look for students' initial understandings of modeling, asking questions, scale, structure and function, and systems and system models.<br><br>Collect students' initial models of what they see happening with the foot at a macroscopic level to pre-assess their fluency in three-dimensional learning. Look for students to include both macroscopic and microscopic elements in their initial models of the foot healing. See the related Assessment callout box in the Teacher Guide for additional guidance.<br><br>The Driving Question Board is another opportunity for pre-assessment. Listen for questions that are open (how/why) and testable versus closed (yes/no) in the classroom. Also listen for questions that are specific to the injured foot healing and questions that are about related phenomena. See the related Assessment callout box in the Teacher Guide for additional guidance. |
| Lesson 7 | Lesson 7: Two-Part Student Assessment | At the end of the first lesson set, students complete a two-part assessment. For the first part of the assessment, students make a claim about whether other things in their world are made up of cells. They plan for how they would carry out an investigation to find evidence whether other things in their world are made of cells. In the second part of the assessment, students analyze different microscopic images, looking for evidence whether or not the item in the image is made up of cells, by looking for the common structures the cells they have looked at up to this point have.<br><br>**Mid-point Assessment**<br><br>Collect student responses for the two parts of the assessment and use *Key: Are Other Things Made of Cells?* to see possible student responses and provide feedback to students. This assessment will provide evidence on the progress students are making towards *MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.* They will not yet be able to argue that all living things are made of cells, but they should be able to argue that parts of living things are made of cells while parts of non-living things are not made of cells. |

| When | Assessment and Scoring Guidance | Purpose of Assessment |
|---|---|---|
| Lesson 10 | Exit Ticket: Written Argument | In this exit ticket, students use what they figured out about the bacteria and other single celled organisms in this lesson to construct an argument: What do you think our (human) cells need to reproduce and make more of themselves?<br>**Formative Assessment**<br>Collect students' exit tickets; in student responses look for students to pull in evidence from the lesson that supports the claim.<br>Students share their argument with a peer to receive feedback using Self-Assessment and Peer Feedback. Using the feedback from their peers about this argument, students reflect on how they would revise their argument. |
| | Self-Assessment and Peer Feedback | On *What do bacteria need to make more of themselves?*, students develop an argument for what bacteria need to make more bacteria after engaging with a whole class investigation to see if more bacteria are made when they are given food. |
| | Explanation | |
| Lesson 11 | Explanation | **Formative Assessment**<br>Students construct an explanation from evidence for what is happening when stuff gets into and out of cells. Use *Data from Investigating Red Onion Cells* to assess where students are at in their thinking about the structure of the cell and how things could get in and out of the cell. |
| Lesson 12 | Explanation | Students develop explanations to explain how different parts of the body of the student from Lesson 1 heals over time.<br>**Summative Assessment**<br>Students use the different events from the Healing Timeline as pieces of evidence that different parts of the student's body had healed. In their explanation they include the interactions between the systems that need to occur for that part to heal. Collect *How do the systems in the body interact during the healing process?* and use the science ideas in *Key: How do the systems in the body interact during the healing process?* to assess student explanations and check for understanding they are bringing from their experience with the unit thus far. Provide students feedback on their explanations using the single point rubric found in the *Key: How do the systems in the body interact during the healing process?*. |

| When | Assessment and Scoring Guidance | Purpose of Assessment |
|---|---|---|
| Lesson 13 | Lesson 14 Student Assessment: Explaining Growth | Students apply their understanding of healing to explain a similar phenomenon—growth plates in children. In this assessment, students are expected to bring their ideas about how the body heals and think about how those same processes are similar during growth.<br>**Summative Assessment**<br>Collect student responses to the assessment and use *Scoring Guidance: Growth Summative Assessment* to review student responses and give students feedback using the single point rubric found in the key. The assessment includes both human growth and plant growth. |
| After each lesson | Lesson Performance Expectation Assessment Guidance—See below. | **Formative Assessment**<br>Use this document to see which parts of lessons or student activity sheets can be used as embedded formative assessments. |
| Occurs in some lessons | Progress Tracker | **Formative and Student Self-Assessment**<br>The Progress Tracker is a thinking tool that was designed to help students keep track of important discoveries that the class makes while investigating phenomena. This tool can also be used to figure out how to prioritize and use those discoveries to develop a model to explain phenomena. It is important that what the students write in the Progress Tracker reflects their own thinking at that particular moment. We strongly suggest it is not collected for a summative "grade" other than for completion. The Progress Tracker is added to in Lessons 2, 4, 5, 6, 9, 10, 11, and 14. |
| Anytime after a discussion | Student Self-Assessment Discussion Rubric | **Student Self-Assessment**<br>The *Student Self-Assessment Discussion Rubric* can be used anytime after a discussion to help students reflect on their participation in the class that day. Choose to use this at least once a week or once every other week. Initially, you might give students ideas for what they can try next time to improve, such as sentence starters for discussions. As students gain practice and proficiency with discussions, ask for their ideas about how the classroom and small-group discussions can be more productive. |
| After students complete substantial, meaningful work | Self-Assessment and Peer Feedback<br>Teacher Reference: Peer Feedback Guidelines | There will be times in your classroom when facilitating students to give each other feedback will be very valuable for their three-dimensional learning. The Teacher Reference: *Peer Feedback Guidelines* document is designed to give you options for how to support this in your classroom. It also includes student-facing materials to support giving and receiving feedback along with self-assessment rubrics where students can reflect on their experience with the process. Peer feedback is most useful when there are complex and diverse ideas visible in student work and not all work is the same. Student models or explanations are good times to use a peer feedback protocol. They do not need to be final pieces of student work, rather, peer feedback will be more valuable to students if they have time to revise after receiving the peer feedback. It should be a formative, not summative, type of assessment. It is also necessary for students to have experience with past investigations, observations, and activities where they can use these experiences as evidence for their feedback. Although Self-Assessment and Peer Feedback can be done in any lesson they are also explicitly done in Lesson 10. |

For more information about the approach to assessment and general program rubrics, visit the Teacher Handbook.

**Lesson-by-Lesson Assessment Opportunities**

Every lesson includes one or more lesson-level performance expectations (LLPEs). The structure of every LLPE is designed to be a three-dimensional learning, combining elements of science and engineering practices, disciplinary core ideas and cross-cutting concepts. The font used in the LLPE indicates the source/alignment of each piece of the text used in the statement as it relates to the NGSS dimensions: alignment to Science and Engineering Practice(s), alignment to Cross-Cutting Concept(s), and alignment to the Disciplinary Core Ideas.

The table below summarizes opportunities in each lesson for assessing every lesson-level performance expectation (LLPE). Examples of these opportunities include student handouts, home learning assignments, Progress Trackers, or student discussions. Most LLPEs are recommended as potential formative assessments. Assessing every LLPE listed can be logistically difficult. Strategically picking which LLPEs to assess and how to provide timely and informative feedback to students on their progress toward meeting these is left to the teacher's discretion.

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 1 | **1.A** Obtain information from images and doctor's notes to identify patterns between the relationship of important events (effect) and the evidence of interacting subsystems healing (cause).<br><br>**1.B** Develop an initial model of the healing process that occurs within and between multiple interacting systems and subsystems and restores the foot's function.<br><br>**1.C** Ask questions that arise from observations of injuries to multiple subsystems that result in the loss of function of the foot (larger complex system). | **1.A Obtaining, Evaluating, and Communicating Information; Cause and Effect**<br><br>**When to check for understanding:** Day 1, as students record important events that indicate evidence of healing.<br><br>**What to look for/listen for:** Look for students who are using doctor's notes and images, such as stitches being removed or the cast coming off, to describe evidence of part of the system healing.<br><br>**1.B Developing and Using Models; System and System Models**<br><br>**When to check for understanding:** Day 2, as students develop and compare their *Healing Initial Model*.<br><br>**What to look for/listen for:** Students' *Healing Initial Model* represents what they see happening with the foot at a macroscopic level. Look for inclusion of parts or interactions within the foot system that can explain how the foot can heal itself independently without the use of external factors, such as a cast and pins. See the Assessment callout box for additional guidance.<br><br>**1.C Asking Questions; System and System Models**<br><br>**When to check for understanding:** Day 3, as students generate questions on sticky notes and brainstorm individual ideas for future investigations in their science notebooks.<br><br>**What to look for/listen for:** Use this as a pre-assessment to gauge how much your students already know about the structures and functions of human body parts and how those parts interact within a single system and between systems in the body. |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 2 | **2.A** Analyze and interpret data to highlight the interactions between subsystems (skin, muscle, bone) within the larger system (foot or wing).<br><br>**2.B** Revise the experimental design and conduct an investigation to predict the change in function of the chicken wing (effect) when parts are injured (cause). | **2.A Analyzing and Interpreting Data; Systems and Systems Models**<br><br>**When to check for understanding:** Day 1, when students complete *Mapping the Chicken Wing to the Human Foot* with a partner, comparing the parts of the chicken wing to the parts of the human foot.<br><br>**What to look for/listen for:** Listen for comparisons such as these:<br><br>• The muscles in the chicken wing move like the muscles in a human arm (e.g., the bicep contracts when the tricep extends).<br>• The bones in the chicken wing look straight and move when the muscles around them move.<br>• The chicken skin stretches and moves when the different parts it is attached to move.<br><br>**2.B Planning and Carrying Out an Investigation; Cause and Effect**<br><br>**When to check for understanding:**<br><br>1. At the end of day 1, when students suggest how to revise the investigation.<br>2. At the beginning of day 2, when students predict how an injury to the chicken wing will affect the wing's function.<br><br>**What to look for/listen for:**<br><br>1. Students should suggest injuring the wing in a way that is similar to how the foot in Lesson 1 was injured.<br>2. Students might say that when one part of the wing is injured, the whole wing can't function in the same way anymore. |
| Lesson 3 | **3.A** Critically read and interpret scientific texts (images and diagrams) adapted for classroom use to describe patterns to figure out that blood and nerves are present in skin, muscle, and bone of a human body. | **3.A Obtaining Information; Patterns**<br><br>**When to check for understanding:**<br><br>When students are comparing the structures they observe in the close-up diagrams of the skin, muscle, and bone from *Close-up Diagrams of Skin, Muscle, and Bone* and labeling similar structures they observed in the cross-sectional knee diagrams and MRIs from *Interpreting MRI*.<br><br>**What to look for/listen for:**<br><br>Observations or ideas about (1) how we can use multiple sources of information (images taken with different tools and from different perspectives) together to gain a fuller understanding of what other parts are in the body, (2) that scientific or technical information (images and diagrams) do not by themselves reveal patterns, and that interpretation may be needed to connect information from multiple sources (in this case, to notice that blood vessels and nerves are located throughout the skin, muscle, and bone). |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 4 | **4.A** Collect data at different scales to answer scientific questions about the components found in blood.<br><br>**4.B** Critically read scientific text to make sense of patterns within structures we observe in the blood related to their function in the body. | **4.A Planning and Carrying Out Investigations; Scale, Proportion, and Quantity**<br><br>**When to check for understanding:**<br><br>1. On day 1, during the Building Understandings Discussion about scale.<br>2. On day 2, at the end of the Investigate Blood with a Microscope lab, when students reflect in their notebooks.<br><br>**What to look for/listen for:**<br><br>1. We can use a microscope to see things that we cannot see with our eyes alone (microscopic scale). We could see the graph paper closer at higher objectives (there was a smaller field of view). The microscope has lenses in the eyepiece and the objectives. The total magnification is the product of the power of the objective lens times the power of the eyepiece lens.<br>2. With the microscope, we can see different parts of the blood (circles, dots, blobs, different colors). Without the microscope, the slide just looks like pink glass and/or the blood looks like it's all the same throughout. Blood is a mixture because I can see the different parts that make it up.<br><br>**4.B Obtaining, Evaluating, and Communicating Information; Patterns**<br><br>**When to check for understanding:** On day 2, on the final question of the *Guidance for Reading about Blood*.<br><br>**What to look for/listen for:** Any one of the following examples of how structure and function are related in the blood:<br><br>• The blood plasma is a liquid that flows easily through the blood vessels to move blood cells, nutrients, etc. around the whole body (or throughout the circulatory system).<br>• Red and white blood cells have round shapes. Red blood cells are shaped like a donut without a hole while white blood cells are shaped more like spheres. Their round shapes allow them to move through blood vessels without getting caught or stuck.<br>• Red blood cells have a flat, flexible shape that lets them bend so they can fit in small blood vessels.<br>• Platelets have arms that help them create plugs to prevent blood from leaking out of damaged blood vessels. They do so by sticking to one another and to the sides of a damaged blood vessel. |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 5 | **5.A** Gather and synthesize information from scientific text and other sources to describe the basic structure of nerves and nerve cells and explain how its structure supports both the function of those cells within the nervous system and the interactions that occur between nerves and other parts of the body (e.g., skin, bone, muscle). | **5.A Obtaining, Evaluating, and Communicating Information; Structure and Function**<br>**When to check for understanding:** On day 2 as students use *Obtaining Information from Scientific Text* to obtain information from the *Reading: The Body's Nervous System*, and as students complete their Progress Trackers.<br>**What to look for/listen for:** Students should use the strategies and prompts on *Obtaining Information from Scientific Text* to obtain and document information from *Reading: The Body's Nervous System* about the function of nerves in the body and how the structure of nerves supports their function. Students should also document what they figure out in their Progress Trackers. |
| Lesson 6 | **6.A** Analyze and interpret observational data of microscopic structures of skin, bone, and muscle, relating those structures to the functions of those parts of the body. | **6.A Analyzing and Interpreting Data; Structure and Function**<br>**When to check for understanding:** In students' Progress Tracker entries at the end of the lesson.<br>**What to look for:** Any of the following examples of how the microscopic structures we saw in our data indicate structure and function relationships:<br>• Bone cells form ring-like patterns close together to provide structure and strength for the body.<br>• Skin cells squish together to create protective layers that keep things in or out of the body.<br>• Muscle cells are long and stringy so that they can stretch and contract, allowing parts of the body to move. |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 7 | **7.A** Plan an investigation and construct an argument using evidence from the microscopic scale that all things are not made of cells.<br><br>**7.B** Develop a model at a zoomed-in scale to describe what changes happen to the structure and function of skin cells at the time of injury. | **7.A Planning and Carrying Out Investigations; Constructing Explanations and Designing Solutions; Scale, Proportion, and Quantity:**<br><br>**When to check for understanding:**<br><br>1. On Part 1 of *Part 1: Are Other Things Made of Cells?*, when students are planning their investigations.<br>2. On Part 2 of *Part 2: Are Other Things Made of Cells?*, when students argue from evidence whether other things are made of cells.<br><br>**What to look for/listen for:** See parts 1 and 2 of *Key: Are Other Things Made of Cells?* for guidance.<br><br>**7.B Developing and Using Models; Scale, Proportion, and Quantity:**<br><br>**When to check for understanding:**<br><br>On day 2, when students are developing their models about what one part of the foot would look like close up right at the time of injury.<br><br>**What to look for/listen for:**<br><br>Students including:<br><br>• Cells in their close-up model<br>• Different types of cells in their model<br>• How parts of the foot are impacted at different levels:<br>  • Skin, bone, and/or muscle broken apart<br>  • In the close-up, showing the tissue broken apart and cells damaged, removed, or pushed apart so that there is an opening. |
| Lesson 8 | **8.A** Develop a model to predict how the interacting systems and subsystems of groups of skin cells work together to form or repair new tissues and organs. | **8.A Developing and Using Models; Systems and System Models**<br><br>**When to check for understanding:** When students complete their initial model explaining what is happening at the cellular level as skin heals.<br><br>**What to look/listen for:** This formative assessment has multiple purposes: (1) As an initial model to see students' ideas for how cells could fill in a gap caused by an injury. (2) To see how students integrate what they figured out about cells making up the skin. They should draw many cells when representing intact skin tissue. (3) To see what initial connections students make about the interactions between body systems. In this case, given the blood in the images, students should include blood cells in their models. Any blood or other cells included should look different (because they have a different function) from the skin cells. |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 9 | **9.A** Analyze and interpret data from a video and microscopic images at varying spatial and time scales to conclude that new cells come from old cells following a predictable pattern of repeated steps. | **9.A Analyzing and Interpreting Data; Scale, Proportion, and Quantity**<br>**When to check for understanding:**<br>1. While students are discussing and evaluating each of the claims using the chart they filled out in Part 1 of *Observations to Evaluate Claims*.<br>2. When students are filling out their Progress Tracker.<br>**What to look for/listen for:**<br>1. In *Observations to Evaluate Claims*, look for students' connections between their observations and the evidence the class recorded on the Needed Evidence Chart poster. Look and listen for evaluation of the claims in light of their observations from the video and images. Students should be able to reference their drawings or written explanations on *Observations to Evaluate Claims* to describe how cells split to make more cells to fill the gap. The type of cell represented should remain the same; for example, if they begin with skin cells, the new cells made should also be skin cells. (The actual type of cell used in the drawing or description is not important here.)<br>2. In the Progress Tracker, look for students' drawings or written explanations to describe how cells split to make more cells to fill the gap. The size of the old and new cells should appear similar and the type of cell represented should remain the same (as noted above). |
| Lesson 10 | **10.A** Analyze and interpret data for patterns to identify the relationship between the amount of food (cause) and the amount of bacteria made (effect) to provide evidence that cells need food to grow and make more of themselves.<br>**10.B** Construct a written argument using cause-and-effect relationships to conclude that the cells that make up multicellular organisms need food to make more cells, as do the cells of unicellular organisms. | **10.A Analyze and Interpret Data; Patterns**<br>**When to check for understanding:** On day 1 when the students are using the Identify and Interpret ($I^2$) sensemaking strategy to make sense of the secondary *E. coli* growth data.<br>**What to look/listen for:** Students are able to identify that as the amount of food available on the agar plates increased, the amount of bacteria increased. They should be able to interpret these data as an indication that the bacteria do need food (and other nutrients) to grow and make more of themselves.<br>**10.B Engaging in Argument from Evidence; Cause and Effect**<br>**When to check for understanding:** When students complete the end of day 2.<br>**What to look/listen for:** See *Key: What do bacteria need to make more of themselves?* for scoring guidance. |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 11 | **11.A** Construct an explanation to show that the structure of cell membranes and cell walls (tiny openings) let certain things in and out of cells (function). | **Constructing Explanations and Designing Solutions; Structure and Function**<br>**When to check for understanding:**<br>On *Data from Investigating Red Onion Cells*, specifically question 4.<br>During the Building Understandings Discussion after the lab.<br>**What to look for:** Students should explain that the cell membrane and cell wall allow things into and out of the cell, including things the cell needs (water, food particles, other nutrients) and waste (or whatever the cell does not need). |
| Lesson 12 | **12.A** Apply scientific ideas and evidence to construct an explanation for how systems of the body interact to support the healing process in the foot at different scales. | **12.A Constructing Explanations; Systems and System Models**<br>**When to check for understanding:** At the end of day 1, during or after all of the partner work on *How do the systems in the body interact during the healing process?*.<br>**What to look for:** See the sample responses provided in *Key: How do the systems in the body interact during the healing process?*. |
| Lesson 13 | **13.A** Apply science ideas and evidence from classroom investigations to explain a common, real-world phenomenon in which the cells of living things serve particular functions as they interact with one another and other systems to make more cells and grow. | **13.A Constructing Explanations; Systems and System Models; Structure and Function**<br>**When to check for understanding:** During the individual assessment, *Growth Summative Assessment*.<br>**What to look for:** See scoring guidance in *Scoring Guidance: Growth Summative Assessment*. |

| Lesson | Lesson-Level Performance Expectation(s) | Assessment Guidance |
|---|---|---|
| Lesson 14 | **14.A** Analyze and interpret data to find similarities and differences in people's perceived abilities to function and meet their goals when having disabilities.<br><br>**14.B** Define a design problem (inaccessibility of our school environment for people with disabilities) that can be solved through the development of small changes to the current system (school environment) to improve its accessibility for many people, including those with disabilities. | **14.A Analyzing and Interpreting Data; Structure and Function**<br><br>**When to check for understanding:** At the beginning of day 2.<br><br>**What to look/listen for:** Students share perceptions about the meaning of common icons:<br>• The icon that says "handicapped" seems to support a perception that the person needs help and may not be able to do things for themselves.<br>• The icon that says "reserved" seems to support a perception that the person is able and eager to do things for themselves.<br>• It also supports a perception that they might need a reserved space to be able to access these things since they are in a wheelchair.<br><br>**14.B Asking Questions and Defining Problems; Stability and Change**<br><br>**When to check for understanding:** During day 3 during the discussion after small groups have brainstormed how they might adapt or redesign areas in the school to make it more accessible.<br><br>**What to look/listen for:** Students to share ideas similar to but not limited to:<br>• areas in the school that would be too high for a person smaller in stature (i.e., counters, etc).<br>• distance between rooms in the school that are far apart and could lead to it taking too long to get to a class on time (if the school is large and/or has a lot of stairs). |

## Pre-Unit Letter Home

Dear Parents, Guardians, and Caregivers,



In our upcoming science unit, students will learn about the biological process of healing that takes place in the human body after it sustains an injury. This unit focuses on how parts of our body systems work together to perform functions such as healing. Students will follow the healing journey of one individual to delve into the science behind this process. Additionally, they will have the opportunity to reflect on their own experiences with injury.

Injuries can be traumatic, and recalling past injuries or learning about others' injuries can be triggering. If your child or someone close to your child has sustained an injury that was in any way traumatic for your child, please contact me at _____, if you are comfortable doing so. By knowing about these experiences in advance, we can be sensitive to students' needs and provide support if they experience any strong emotions during this unit.

Another topic related to injury that we will explore in this unit is disability. Injury can result in short-term or long-term disability, so it is important that students have an understanding of disability as a natural and expected part of human diversity. In this unit we will teach about disability as a neutral part of a person's identity. Disability is not inherently good or bad; not a tragedy, nor an inspiration. Students will learn that a person with a disability is no less healed than a non-disabled person. Instead, the body's biological healing process has stopped and the body's functionality has changed, resulting in the need to adapt. Students will also learn about adaptive equipment that allows disabled individuals to complete the daily tasks of life, often with greater independence.

Furthermore, since this unit is based on living things, there will be times in the unit when students will view living things (or once-living things) in a variety of ways. This might include dissection of animal parts such as chicken wings and the examination of once-living animals, plants, and bacteria. If you feel this will be challenging or upsetting for your child, please let me know so that I can be sensitive and supportive. I encourage you to let your child know that if they feel discomfort with any part of a lesson, they can share that with me privately and we will make other arrangements for their learning during that moment.

If you have any questions about the content of this unit or would like to discuss anything further, I encourage you to reach out to me at _____.

# LESSON 1: TEACHER REFERENCE 1

## Disability and Inclusion Awareness

This unit focuses on how parts of our body systems work together to perform functions such as healing. In this unit, you and your students will explore the ways that injury impacts the human body and how the body recovers from injury. Related to this is the topic of disability, something that many students and teachers have not had the opportunity to learn much about in any formal way. The information in this guide is designed to prepare you to approach this unit with sensitivity and confidence as you discuss disability as it pertains to injury and healing.

Please note that the content of this unit relates most directly to a discussion of primarily physical disabilities. However, it is important to understand that the disability community is diverse and complex. People can experience other types of disability, such as intellectual and developmental disability, mental health issues, and a range of others. Physical disability is the focus in this unit, but it does not represent the full range of the disabled experience.

**Why include a discussion of disability in this unit?**

When a body sustains an injury, the biological process of healing begins. The concept of healing, however, carries a more loaded meaning. When we think about a person being "healed," we often think of them returning to the exact state they were in before their injury. Although this may happen for some individuals, the process is often more complex than that. Often a person's body completes the healing process, and while the body may return to some aspects of its former functionality, other aspects may be forever or fundamentally changed. This does not make a person less "healed"; it simply means that the biological healing process is over and they will need to adapt to the resulting changes.

An injury has the potential to result in a disability that is temporary or life-long. When talking about injury with students, it is important to normalize and demystify disability, because it carries a great deal of stigma in our society. By creating open discussion around disability, we can help students monitor their language so that they can be sensitive and respectful. We can also broaden their perspectives about disability and disabled people in their schools and communities.

It's very important that students do not conflate a change in the body's functionality with tragedy, helplessness, or even loss, necessarily. Disabilities caused by injury certainly have the power to alter a person's life, but the person may not resent their disability in the long term. Many individuals who experience disability due to injury come to count their disability as an aspect of their identity of which they are quite proud. It is best to remember that the disabled experience is complex and individual, and that learning a person's individual story, preferences, and beliefs is important, rather than making assumptions. Also important to remember is that individuals born with a disability or who develop their disability early in life may more readily count their disability as a part of their identity. It would be disrespectful of those individuals to assume that a disability is tragic, makes a life less valuable, or makes a life too difficult to bear.

**Key information about disability:**

- **Disability is a natural and expected part of human diversity.**
  - Disability is often left out of the diversity conversation, but disabled people comprise one of the largest marginalized groups, with about 20% of the world's population having a disability. Disability is as much a part of human diversity as race, gender identity, and religious beliefs.

    - Disability is a natural and expected part of human diversity. It is not a mistake, an anomaly, or a tragedy. There is nothing inherently wrong or, conversely, inspirational about having a disability.
    - Disability can be something that people identify with very strongly, while others don't consider it as a strong identity marker. The disabled experience is complex and often intersectional. It is important not to make assumptions about a person's experience based on their disability, but rather to talk to them directly to learn more about their preferences and needs.
- **The word "disability" is preferred over euphemisms.**
    - The terms "disability" or "disabled" are words associated with rights granted in the United States by the Americans with Disabilities Act (ADA) and the Individuals with Disabilities Education Act (IDEA). These laws provide rights and protections to people who identify as disabled. The adults fighting for justice in the disability community have identified disability as the preferred term over euphemisms such as "special needs" or "differently abled," which stigmatize that which is different. Bear in mind that there is nothing particularly "special" about needing health care, education, safety, and access to public accommodation.
- **Both Identity-First and Person-First language can be used.**
    - In the disability community, many people prefer Identity-First language (i.e., she is a disabled woman), while others prefer Person-First language (i.e., she is a woman with a disability).
    - Individuals should be consulted about their language preferences when referring to or speaking with them.
    - In this unit, you may see a mix of both Person- and Identity-First language to pay respect to all preferences.
- **Models of disability are tools that shape how people understand disability in society.**
    - Models of Disability are tools for defining disability and ultimately, for providing a basis upon which the government and society can devise strategies for meeting the needs of disabled people.
    - Many different models describe the ways in which people understand disability in society. However, three in particular are helpful in broadening our perspective about disability.
        - Medical Model: This paints disability as something that is purely biological and should be treated, healed, or "fixed." The Medical Model generally subscribes to the idea that a disability strays from the norm and needs to be addressed by the person with the disability through therapies and other treatments so that they can participate in "normal" society.
        - Social Model: This takes the viewpoint that disability is not a biological affliction, but rather something that society inflicts upon a person. A person is not disabled by a difference in their biology. Instead, they are disabled by society's lack of accessibility and acceptance. From this perspective, it's society that should change to accommodate a diverse range of needs, rather than the responsibility falling to the individual with a disability.
        - Biopsychosocial Model: This takes a more holistic view of disability, in which an individual can identify strongly with their disability as an aspect of their biology while also acknowledging that social and environmental factors can be disabling as well. It reflects the complexity of the disabled experience.

For a more thorough overview of this topic and additional information, you can view this video on inclusion, from The Nora Project. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

## Printouts of the Foot



## Teacher Instructions for Chicken Wing Dissections

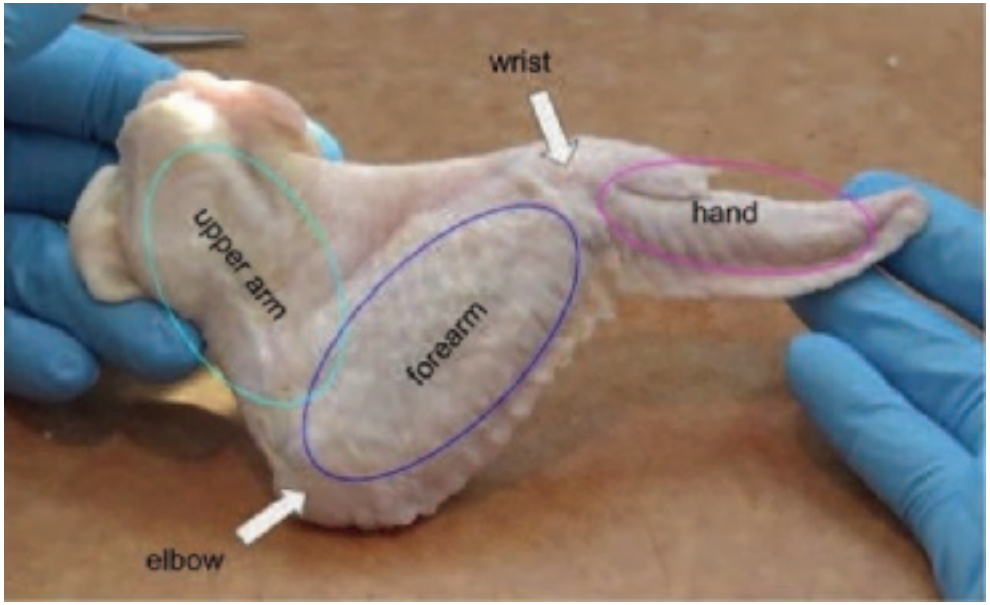
As an alternative to watching the dissection videos, you may wish to conduct the dissections in the classroom. It is highly recommended that you do these as demonstrations rather than allow students to do them, due to safety concerns about working with sharp objects and raw poultry. The use of a document camera to project your demonstration is encouraged so students can observe at a level of detail comparable to that in the Intact Chicken Wing Investigation and the Injured Chicken Wing Investigation at (See the **Online Resources Guide** for links to these items. **www.coreknowledge.org/cksci-online-resources**). Be sure to practice the dissection a few times prior to conducting it in class!

If you do this in your classroom, be aware of your students' ethnic, religious, cultural, and social practices, as well as food insecurities, that would cause them to take issue with this dissection.

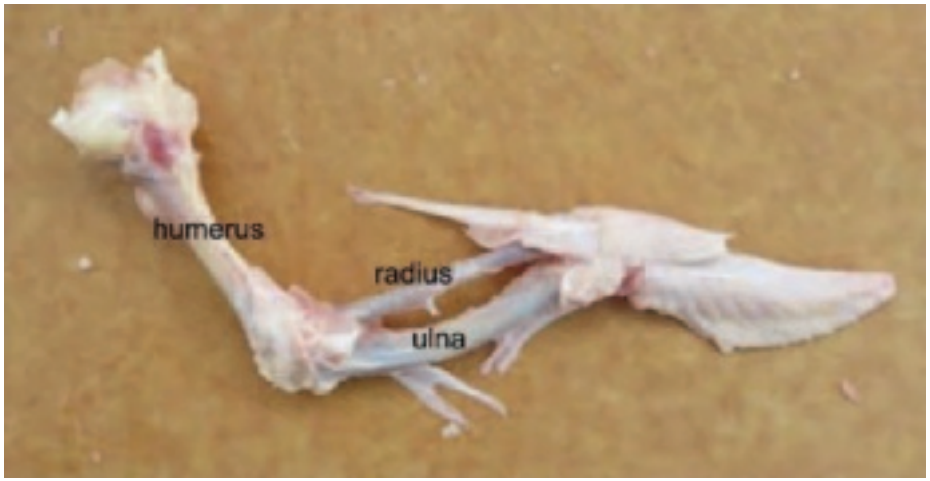
You will need the following materials:

- Two whole, fresh or thawed chicken wings.
  - It is critical to get whole wings that have not been cut into drumettes and wingettes.
  - Previously frozen wings are fine if they are thawed prior to dissection.
  - It is easier to move the parts during the dissection if the wings are left out at room temperature for an hour or two beforehand.
  - Rinsing the wings under running water and drying them with a paper towel prior to dissection makes them a bit easier to handle.
- Disposable gloves
- A scalpel
- A cutting board or other surface that you can cut on and sanitize
- A hammer and pry bar or similar heavy objects for breaking the bone
- Paper towels
- Optional: scissors to help cut away the skin

The dissection instructions refer to the parts of the chicken wing as depicted in the images below.


wrist
upper arm
forearm
hand
elbow


biceps
triceps

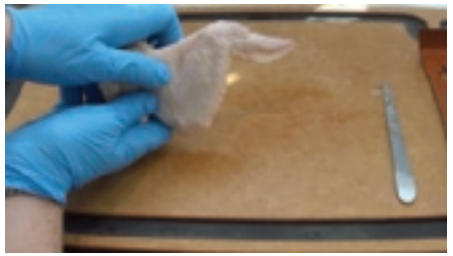

humerus
radius
ulna

**Day 1: Dissection of an intact chicken wing** (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

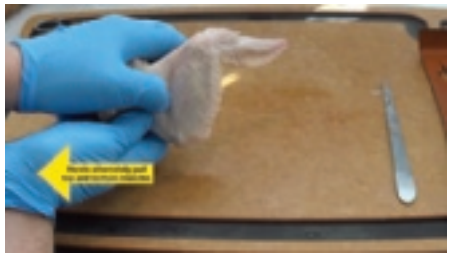
1. Begin by demonstrating the bending motion of the wing by holding onto the cut end and moving the hand (wing tip) toward and then away from the upper arm. Display the front and back of the whole wing. Ask students to record what they notice about the skin.



2. Position your hands on either side of the upper arm and grasp the bicep between the thumb and finger of one hand and the tricep between the thumb and finger of the other hand. Use the pads of your thumbs and fingers to avoid damaging the tissue with your fingernails.



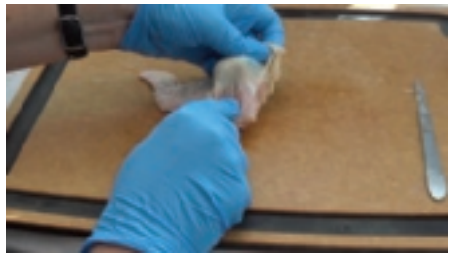
3. Alternately pull the bicep and tricep toward the top of the humerus (where the wing was attached to the body). As you pull on the bicep, the elbow joint will bend, and as you pull on the tricep, the elbow joint will straighten out. Demonstrate these motions so students can view it facing the chicken wing.



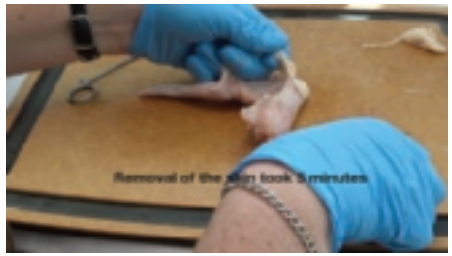
4. Demonstrate the same motions as in the previous step so students can view them from above (90˚ relative to the previous step).



5. Begin removing the skin at the top of the upper arm (where the wing was attached to the body). Use your fingers to carefully separate the skin from the muscle so as not to damage the delicate muscle tissue. Students should be able to observe that the skin is definitely connected to the muscle. Ask students to record what they notice about the skin as it is being removed.



6. Continue to use your fingers to carefully separate the skin from the muscles. As you loosen large pieces of skin, you may want to remove them with a box cutter or scissors. It may help to use tweezers or forceps to pull the skin away as you detach it with your fingers. Note that carefully removing the skin can take 5+ minutes.



7. Once the skin has been removed, repeat steps 3 and 4. The range of motion for the skinned wing should be much greater than with the skin. Ask students to record what they notice about the bones and muscles in the skinned wing, and what they notice about its motion.



8. Optional: You may want to place the skinned wing in plastic wrap or a baggie and put it in the fridge in case you want to have it to compare to the injured wing at the end of the day 2 investigation.

**Day 2: Dissection of an injured chicken wing** (as in (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**)

1. Although this is not in the video, you may want to re-demonstrate movement of the wing prior to injury as in steps 1-4 of the day 1 instructions.



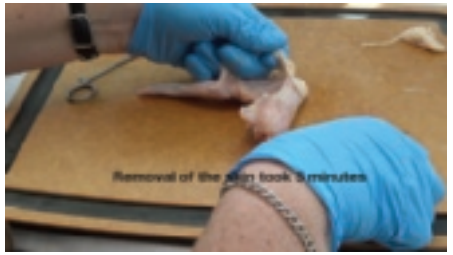
2. To injure the wing, place it front side down on a sturdy surface. Your goal is to break the humerus using a heavy blow that simulates the weight falling on the foot in Lesson 1. One way to do that is by placing the curved end of a pry bar on the wing while striking the other end with a hammer. You should be able to feel whether or not the bone breaks. Ask students to record what parts of the wing, if any, they think were damaged by the impact.



3. Demonstrate movement of the injured wing following steps 1-4 of the day 1 instructions. If the humerus is completely broken, the wing will flop around as you move it. Ask students to record what they notice about the motion of the injured wing.



4. Carefully remove the skin so as not to damage the muscle tissue as outlined in steps 5 and 6 of the day 1 instructions.



5. Once the skin has been removed, repeat the movements described in steps 1-4 of the day 1 instructions. This is where you should really notice a loss of controlled movement, as the wing will flop around when you try to move it by pulling on the bicep and tricep. Ask students to record what they notice about the bones and muscles in the skinned injured wing, and what they notice about its motion.



6. Separate the muscles on the upper arm to reveal the broken bone. This may be easy to do with your fingers if the broken bone has already started to damage the muscle tissue. If not, use the scalpel or box cutter. Show students the broken bone and be sure they see a cross-sectional view to observe the marrow. Ask them to record what they notice about the injured wing.



7. Optional: If you saved the skinned, uninjured chicken wing from day 1, you may want to re-demonstrate its movement for comparison to the movement of the skinned, injured wing. Ask students to record any additional differences they notice between the uninjured and injured wings.



## Chicken Wing Structures

It may be difficult for some students to map the different parts of the chicken wing to the similar parts in the human foot. As the class develops the Our Body as a System poster, use the images included on this page to help students think about the different structures and how the way they are structured is connected to their functions. These may be helpful to have as reference back to the dissections so students can connect what they saw happening with the parts in the chicken wing to what is most likely also happening in our body. If you choose to have these available as you facilitate the discussion around constructing the poster, it is suggested to cut them out ahead of time.

**Chicken wing skin**



**Chicken wing muscle**



**Chicken wing bone**



# LESSON 2: TEACHER REFERENCE 3

## Development of the Our Body as a System poster

Over the course of this unit, the class revises the poster Our Body as a System. This poster is first created in Lesson 2. It serves as a space for the class to keep track of what they figure out about the body through the lenses of three crosscutting concepts (CCCs):

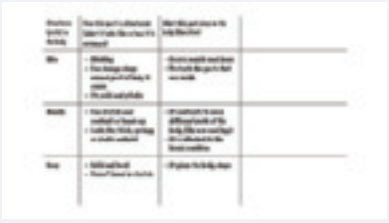
- Systems and System Models,
- Structure and Function, and
- Scale, Proportion and Quantity.

Use this poster to incrementally support students in developing their conceptual understandings about how the body heals. Using these three CCCs is integral for students as they figure out what is happening in our body for it to heal.

Students begin by looking at different structures, or parts of the body, and relating them to the function these structures perform. This conversation utilizes what students should already have figured out in grades 3-5. After we record the structures we are analyzing and their related function, we support students in thinking about **how** the structure of these parts relates to the function they perform. Students will think about and use *structure* as both a noun (e.g., "the muscles are structures in the body") and a verb (e.g., "muscle tissue is structured from bundles of long, stretchy, rope-like cells"). Using the word as a verb is especially helpful when using the CCC of structure and function. Examples of how students would engage with this CCC are captured in the image of the revised Our Body as a System poster below, in the columns labeled "How this part is structured (what it looks like or how it is arranged)", "What this part does in the body (function)'', and "How the way the part is made relates to its job".

The table that follows captures a thumbnail image of how this poster will be revised in each lesson. It also summarizes the CCCs that are integral to each lesson.

Over the course of the unit, students will use these CCC lenses to deepen their understanding of what they're figuring out. Specifically, systems thinking allows students to "chunk" the complex world in accessible ways–once students realize that they can think of everything in terms of systems, they can then identify how components are interacting to perform a function. Students will determine that particular parts of a system are associated because they work together to allow the system to perform a given function. Considering relationships between systems and how they contribute toward a larger function motivates the need to think about subsystems and their interactions, which are reflected in the system model students develop.

| Lesson | What happens: systems thinking | What happens: structure/ function | What happens: scale |
|---|---|---|---|
| **Lesson 1**: What happened in the student's foot so they could walk again?<br>The poster is not started in this lesson. | There is no explicit language about thinking about systems in Lesson 1; students may bring it up, but are not prompted to do so yet. | Students build on what they already know about structure/function from earlier grades as they consider the question, "How has the injury caused the foot not to work?" | Most students will stay at a macro level when developing their initial model of the injured foot. As the class develops the consensus model, they are encouraged to think about what they would see if they could zoom in on the injury. At this point, students build upon the use of scale in models to view something from different perspectives. |
| **Lesson 2**: What do our bones, skin, and muscles do for us?<br>  <br>  | Students begin thinking about the body as a system and the muscles, skin, and bones as parts of that system. They consider how these parts need to work together or interact for the body to function, which aligns with how we think about systems and their parts. They think about the muscle, skin, and bone in a specific location (foot or arm) and throughout the body (muscular or skeletal system). | Students concretely begin using what they have already figured out about structure/function in earlier units in 6th grade, such as *Cup Design Unit,* to apply this thinking to the structures in our body that support its function. They record how the structure of the three different parts seen in a chicken wing look, and how this is connected to the job or function they perform (e.g., muscles = stretchy looking).<br>The word *structure* is explicitly discussed to connect to prior learning around this word as a noun, such as the parts of the body they are investigating. In addition, the class begins to use *structure* as a verb when describing the way a part is structured, such as "the muscle looks stretchy." | Students continue to analyze the different parts of the body at the macro scale. Through the dissection of a chicken wing, they realize different parts of the body are also made up of parts—the wing is made up of muscle, bone, and skin—and for the wing to work, all three parts need to work together. By looking at each part separately at a macro level, students figure out more about the way the parts work together. |

| Lesson | What happens: systems thinking | What happens: structure/ function | What happens: scale |
|---|---|---|---|
|  | | | |
| **Lesson 3**: How can medical images and diagrams help us figure out more about the structures in our body?<br>The poster is not updated in this lesson. | We do not add any systems thinking in this lesson. | Through close-up images and diagrams, students discover other structures within the skin, bone, and muscle: nerves and blood. They will investigate the function of these two structures in the following lessons. | Students shift scales again to figure out more about the muscle, skin, and bone through MRI images, X-rays, and cross-section images of a knee. This leads them to figure out that there are other common structures (blood and nerves) within the skin, bone, and muscle. |
| **Lesson 4**: Why is there blood in all of these places in the body?<br>  <br>  | Students look at images of where blood and blood vessels are found across the body and look at blood close up using microscopes. They find there are very small structures or parts within the blood, called cells. The class agrees that the blood vessels and blood can be thought of as a system within the body because there are different parts within them that interact and work together. | Students look at images of where blood and blood vessels are found across the body and look at blood close up, using microscopes. They find there are very small structures or parts within the blood, called cells. There are multiple types of cells within the blood, and each type does a different job. Each of these blood cells is structured so it can move through the blood vessels (function). | Students shift scales from the macro level to the micro level, observing microscopic images of different types of blood cells, which allows them to figure out more about what blood is made of. |

| Lesson | What happens: systems thinking | What happens: structure/ function | What happens: scale |
|---|---|---|---|
| **Lesson 5**: What do nerves do and why are they in different parts of the body?<br>  | Students figure out that nerves send signals to the brain and that when there is a disruption in the signal from an injury, feeling goes away. There are nerves throughout the body that all connect to each other and to the brain. The class agrees that these nerves and the brain are another system within the body. | Students figure out that the way nerve cells are structured allow them to send signals across the body to the brain. There are nerves throughout the body, sometimes found in bundles, and they all connect to each other and to the brain, allowing them to transmit these signals. There are different types of nerve cells, each doing a different job. | Students again shift scales from the macro level (where nerves are found around the body) to the micro level (nerve cell), which allows them to figure out more about how the nerves are structured. |
| **Lesson 6:** What will we see if we look at skin, bone, and muscle with the microscope, too?<br>  | In Lesson 2, students thought of the body as made up of skin, bone, and muscle. After analyzing microscopic images of these three parts, they agree that where muscles are found could be another system within our body, and where bones are found could be another system, as well as skin. Students begin thinking about our body as a system with other systems within it.<br>This idea of the interaction between systems within the body will be further built upon in the *Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit).* | By looking at microscopic images of skin, bone, and muscles, students figure out that cells make up each of these parts of the body, and that the cells of each part look different from the cells of the other parts (e.g., the skin cells look different from the muscle cells). They connect the differences in cell structure to the different functions of the body parts the cells come from. | Students shift scales again from the macro scale to the micro scale to figure out more about what the different parts of the body look like. |

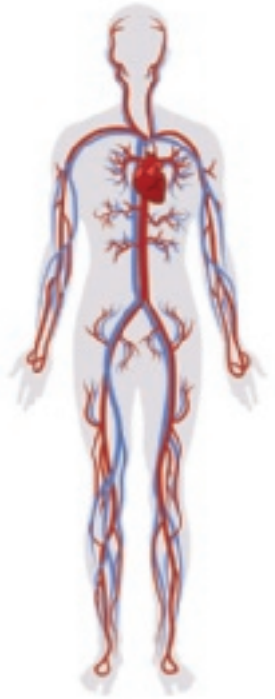
| Lesson | What happens: systems thinking | What happens: structure/ function | What happens: scale |
|---|---|---|---|
| **Lesson 7:** Are all things made of cells?<br>The poster itself is not revised from this point on, but notes and other thinking are added around it. | | Students apply what they have figured out about the different parts of the body being made up of cells to investigate whether all things are made of cells. Through a midpoint assessment, they use what they have figured out about the common structures all cells have (cell membrane and cytoplasm) to analyze microscopic images for evidence of these structures as support that an item is made up of cells. This work leads students to notice that the parts of living things they look at are made up of cells, whereas the parts of nonliving things they look at are not made up of cells. | Examining objects at the microscopic scale allows students to notice similarities and differences to differentiate between living and nonliving objects. |
| **Lesson 8**: What happened as the skin on top of the foot healed? | Students think about what different parts of the body system are interacting when skin heals from a scrape. This is their first opportunity to represent their thinking around how the blood and skin interact when the skin heals from a scrape. | | Students stay at the macroscopic spatial scale, but they use a different temporal scale (a time-lapse) to make sense of what is happening to the skin when a scrape heals over time. |
| **Lesson 9:** What is happening at the site of injury to fill the gap? | Students have evidence that cells can grow and split to make more cells, and thus are developing the idea that a cell is a system in its own right, with parts such as the cell membrane and cytoplasm. | Examining cells growing and making more of themselves at the microscopic scale permits us to identify certain repeating structures (i.e., cell membrane, chromosomes) that are always present when new cells are made.<br>The function of these structures is not discussed yet. Rather, their presence is used as evidence that new cells are being made from old cells, and that this process may be used by the body as it tries to fill gaps between cells that may have resulted from an injury. | By making observations at varying spatial scales (zooming in with a microscope to view cells growing and splitting) and temporal scales (slowing down video of a biological process), we see how the body fills gaps that may occur in between cells as a result of injury. |

| Lesson | What happens: systems thinking | What happens: structure/ function | What happens: scale |
|---|---|---|---|
| **Lesson 10**: What do cells need to grow and make more of themselves? | After investigating one-celled organisms, students see that they are different from multiple-celled organisms whose cells need to function together as part of a larger system (like the system of blood vessels or nerves in a body). | By further investigating one-celled organisms (i.e., yeast, archaea, algae, and bacteria), students consider how the organism's structure helps it function in a particular environment (e.g., thermophiles living near hydrothermal vents in the ocean).<br>The function of bacteria (cell growth and cell splitting in the presence of nutrients) is studied because its structure closely resembles the cells that make up our body. | As bacteria grow and make more of themselves in the presence of nutrients, they form bacterial colonies, which become visible to the eye. This is an example of a phenomenon that is observable at the macroscale because of changes that occur at the microscale. |
| **Lesson 11**: How do cells get what they need to grow? | Systems are not discussed explicitly in this lesson, but by understanding how nutrients move through a cell membrane, and by connecting this with how new cells are made and that cells grow when in the presence of nutrients, students develop a more complete idea of how healing works in the body. This lays a foundation for how we can use systems thinking to explain how the body is able to heal itself. | By closely investigating the behavior of specific cellular structures (cell walls and cell membranes), students infer how they must be structured in order to regulate what goes into and out of a plant cell (function). | By changing scale and observing plant cells under the microscope, students can observe how the cell membrane changes size and shape as water moves into and out of an onion cell. Observing this phenomenon at the microscopic scale allows them to understand how certain structures help perform specific functions. |
| **Lesson 12**: How do the structures and systems in the body work together to heal the injury? | Students see that the body acts as one larger system composed of smaller systems (subsystems). Using evidence, they explain how the body engages multiple systems when an injury occurs. For example, the foot reacts to an injury by swelling, which increases blood flow and brings extra fluid to the injured tissue to help it heal. As the injured tissue heals, the foot's bone, muscle, and skin are able to work together again so the injured person regains use of the foot. | Examining the body as a system comprising smaller systems, or subsystems (e.g., blood and blood vessels), allows us to consider particular structures within the systems (e.g., red blood vessels) and how they function to help the body heal itself. | Students can examine the structure and function of the body at different scales (i.e., system, subsystem, individual part, microscopic part) to understand how the body heals itself after an injury. |

| Lesson | What happens: systems thinking | What happens: structure/ function | What happens: scale |
|---|---|---|---|
| **Lesson 13**: How is the process of growing similar to healing? | By investigating how growth works in small children, students see that some of the systems involved in healing are also involved in growth, such as the blood and blood vessels bringing essential nutrients for cells to grow and make more of themselves. | In drawing parallels to the healing process, students see that growth also involves the generation of similar structures (e.g., bone, muscle, skin), which allow the body to function after growth has taken place. | Nothing new is explicitly built around scale. However, students remember that by examining the body at different scales (micro vs. macro, system vs. subsystem) and from different perspectives (external vs. X-ray view), they can figure out how the various structures inside the body function together to promote healing and growth. |
| **Lesson 14:** How can shifting our perceptions of ability and disability allow us to be more thoughtful about how we make our environments more accessible? | We consider the external structures (i.e., the use of casts, pins, splints, etc.) communities use to support the healing process within one or more subsystems of the body.<br>By the end of the unit, we conclude that though healing may look different for different people, and though the body may not function exactly as it once did prior to injury, the cells within body systems still work together to heal damaged tissue, and this healing can be supported through external methods as determined by each community. | Communities often use various external structures to aid the body in its function to heal after injury. | |

## Blood System Image

Add this image to your *Our Body as a System* poster in Step 9: Building Understandings Discussion about Blood.



## Nerve System Image

Add this image to your *Our Body as a System* poster in Step 1: Navigation.



Name: _____ Date: _____

# Part 1: Are Other Things Made of Cells?

**Brainstorm:** What other things do you think are made up of cells? List your ideas in the box below.

**Part 1: Plan your Investigation—How would you figure out if all things have cells?**

1. Make a claim: Do all things have cells?

   _____

2. Design an investigation to investigate your claim. You can use any or all of the following tools:
   - Microscope
   - Hand lens
   - Slide samples of materials you want to investigate to figure out if all things have cells.

2a. What materials from what you listed above do you want to use for your investigation?

2b. How will you use these materials to investigate your claim? In this section, include the steps you would follow to collect data using the materials you listed above and the tool(s) available to you as evidence to support or refute your claim.

2c. How will the tool(s) you are using for this investigation help you answer the question, "Do all things have cells?"

2d. What kind of data would be evidence that would support your claim? Complete the sentence below.

My claim is _____.

Examples of data I would see as evidence that supports my claim is….

2e. What kind of data would be evidence that would refute your claim? Complete the sentence below.

My claim is _____.

Examples of data I would see as evidence that refutes my claim is….

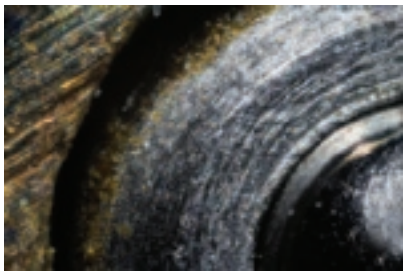
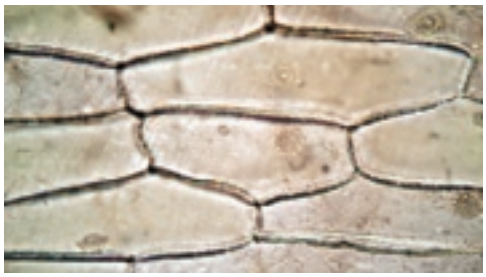
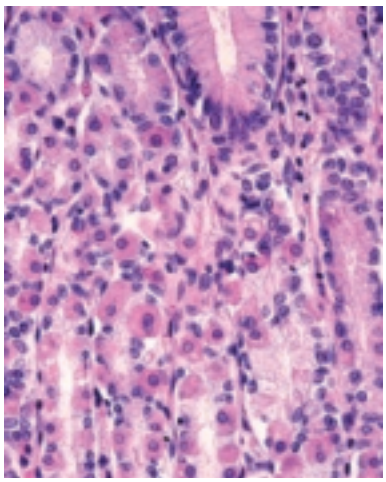
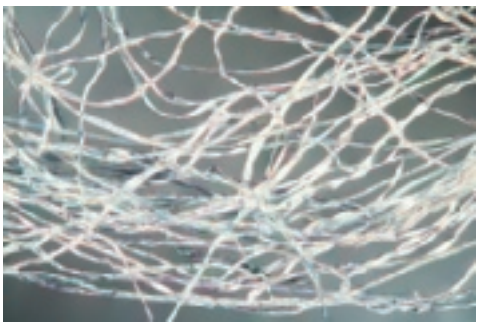
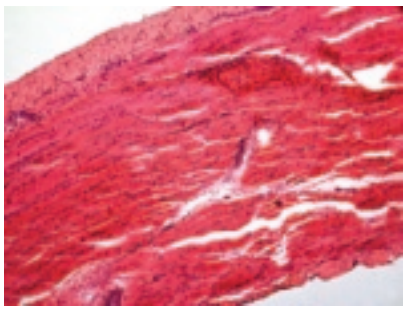
Name: _____ Date: _____

# Part 2: Are Other Things Made of Cells?

## Part 2: Analyzing Data and Arguing from Evidence

What is your claim from Part 1? _____

Here are some data from pictures of slides under a microscope for six different materials.

| A Piece of Metal | Onion Skin | Grains of Sand |
|---|---|---|
|  |  |  |
| **Animal Stomach** | **Fabric Fibers** | **Muscle** |
|  |  |  |

1. What patterns do you notice across all data?

2. How does the data support or refute your original claim in question 1?

3. Using the data as evidence, write an argument that answers our question, "Do all things have cells?"

4. How does looking at these things at a microscopic scale help you develop your argument?

## Key: Are Other Things Made of Cells?

**This key is for Student Assessment Parts 1 & 2.**

The following is scoring guidance for this student assessment. The Lesson Level Performance Expectation (LLPE) that this assessment reaches is: Plan an investigation and construct an argument using evidence from the microscopic scale that all things are not made of cells.

**7.A** Plan an investigation and construct an argument using evidence from the microscopic scale that all things are not made of cells.

| SEP Elements | DCI Elements | CCC Elements |
|---|---|---|
| 7.3 Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.<br><br>Students construct a written argument using data from microscopic images of living and non-living things as evidence to support or refute a claim about whether all things are made of cells.<br><br>In Part 1, scaffolds are provided for argumentation. In Part 2, the scaffolds are removed to support students' development of using data as evidence to both support and/or refute a claim.<br><br>3.4 Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.<br><br>Students use secondhand data from microscopic images of six different objects, three living and three non-living, to figure out if all things are made of cells. They use the data they analyze as evidence to answer the question about whether all things are made of cells. | LS1.A: All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).<br><br>This is the first engagement students have had with thinking about cells in relation to living things and whether all living things are made of cells. In this assessment, students will be arguing whether parts of living things are made of cells. They will build onto this idea in the next lessons to conclude *all* living things are made of cells by the end of Lesson 10. | 6.1 Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.<br><br>Students identify microscopic structures in multiple images of various objects looking for cell structures similar to samples they have seen in earlier lessons.<br><br>1.4 Graphs, charts, and images can be used to identify patterns in data.<br><br>Students compare images and cross sections from multiple objects to look for patterns similar to cells and tissues they have observed in previous lessons, from humans and animals. |

Below we have included sample student responses and what to look for in your students' responses. This should not be considered a verbatim type of key; instead, the examples included below are there to provide you the big picture of where student sense-making and conceptualization should be at this point in the unit.

**Brainstorm**: What other things do you think are made up of cells? List your ideas in the box below.

Accept all responses.

**Part 1: Plan Your Investigation—How Would You Figure Out If All Things Have Cells?**

1. Make a claim: Do all things have cells?

*Look for a reasonable claim made by students that answers the question. Example student responses:*

- *No, all things do not have cells.*
- *Yes, all things have cells.*

2. Design an investigation. You can use any or all of the following tools:
   - Microscope
   - Hand lens
   - Slide samples of materials you want to investigate to figure out if all things have cells

2a. What materials are you investigating?

***Accept all answers**. We want students to suggest a multitude of ideas to encourage them to begin thinking about what things in their environment will look like at a microscopic scale and whether they will see the repeating pattern of cells. Eventually, at the end of this lesson, the class will come to a consensus that the parts of living things that they looked at, are made of cells and the parts of things that have never been living are not made of cells. At this point, it doesn't matter what they suggest here.*

2b. What will you do in the investigation? In this section, include the steps you would follow to collect data using the materials you listed above and the tool(s) available to you, which could be used as evidence to support or refute your claim.

*Students should suggest they want to look at the materials they suggested in Part 2a under the microscope on a slide. Their steps here might include the following steps in a similar order:*

*1. Take a small sample of _____ and put it on a slide.*

*2. Place the slide under the microscope.*

*3. Focus the lens of the microscope to clearly see what the sample looks like at the different magnifications.*

*4. Record an image of what the material looks like.*

*5. Turn off the microscope and return the slide.*

*Students may also suggest using the hand lens.*

*1. Take a small sample of _____.*

*2. Using a hand lens, look at this material close up and record what it looks like.*

*3. Return the sample and hand lens when finished.*

2c. How do the tool(s) you are using for this investigation help you answer the question, Do all things have cells?

*The hand lens or the microscope lets me zoom in and see things at a small scale that I can't see with my eyes because I am looking for repeating patterns of cells in the materials.*

In student responses, look for:

- The need to zoom in
- The need to see things at a smaller scale

2d. What kind of data would be evidence that would support your claim? Complete the sentence below.

My claim is _____. In my data, I would see _____ as evidence that supports my claim.

*Option 1:*

*My claim is: All things are made up of cells. In my data, I would see repeating patterns of cells at a microscopic scale in all my materials.*

*Option 2:*

*My claim is: All things are **not** made of cells. In my data, I would see some things with repeating patterns of cells and other things that don't have these repeating patterns of cells.*

In student responses, look for students to match the evidence that would refute the claim to their claim. Student responses should mention repeating patterns of cells or similar wording that indicates what students would be looking for as evidence for the presence of cells.

2e. What kind of data would be evidence that would refute your claim? Complete the sentence below.

My claim is _____. In my data, I would see _____ as evidence that refutes my claim.

*My claim is: All things are made up of cells. In my data, I would see repeating patterns of cells under the microscope for only some of the materials and other materials would not have these repeating patterns as evidence that refutes my claim.*

*My claim is: All things are not made up of cells. In my data, I would see repeating patterns of cells at a microscopic scale in all my materials as evidence that refutes my claim.*

In student responses, look for students to match the evidence that would refute the claim to their claim. Student responses should mention repeating patterns of cells or similar wording that indicates what students would be looking for as evidence for the presence of cells.

**Part 2—Analyzing Data and Arguing from Evidence**

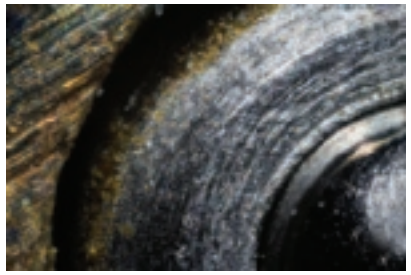
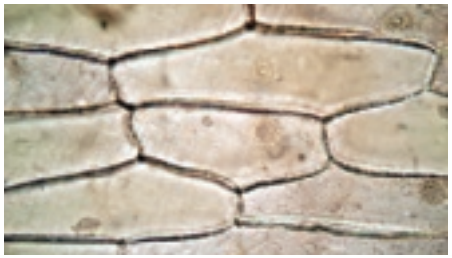
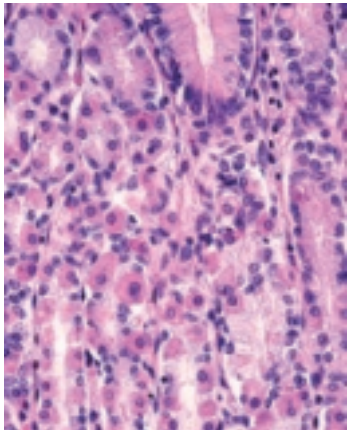
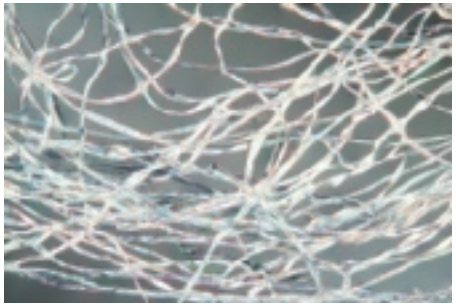
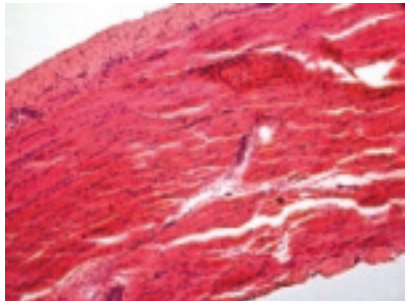
What is your claim from Part 1: _____

*Something similar to one of the two:*

*All things are made of cells.*

*All things are not made of cells.*

Here is the data from a similar investigation. It includes pictures of slides under a microscope for six different materials.

| A Piece of Metal | Onion Skin | Grains of Sand |
|---|---|---|
|  |  |  |
| **Animal Stomach** | **Fabric Fibers** | **Muscle** |
|  |  |  |

1. What patterns do you notice in the data?

*Look for students to make reasonable observations of patterns. Student responses may include:*

- *All the images are zoomed in.*
- *Some have color and some don't.*
- *In four of the materials, there are repeating shapes and in two there aren't any.*
- *In the onion skin, aimal stomach, and muscles, the repeating structures look like a flat shape but the sand looks like a 3-D shape.*

2. Does the data support or refute your original claim in question 1?

*If a student argues that all things are made of cells, then they should say something like:*

- *The data refute my claim because two (or three) of the images do not have repeating patterns of cells. Since all of the samples don't have these repeating patterns, my claim is not true.*

*If a student argues that all things are not made of cells, then they should say something like:*

- *The data support my claim because some of the images had repeating patterns of cells and some didn't. Since not all of the images had cells, my claim is true.*

3. Using data as evidence, write an argument that answers our question, "Do all things have cells?"

*Sample student argument:*

All things do not have cells. The data support this claim because three (or four) of the images had repeating patterns of cells, but the other three (or two) images did not have repeating patterns of cells. Therefore all things do not have cells.

*Student arguments should include:*

Students may pick up on some patterns here, such as how samples that have cells are from living things and samples that don't have cells are from non-living things. In the next part of this lesson, the class will discuss this and come to a consensus about what we know at this point in the unit—that the parts of the living things we have looked at so far have all had cells. But it is OK if students do not argue for this yet.

4. How does looking at these things at a microscopic scale help you develop your argument?

Students should explain that the only way we can figure out if things are made of cells is by looking at them under the microscope. They may include any of the following ideas in their response:

- *Cells are really small, so we have to use a microscope to see them at a really close-up scale.*
- *We are trying to figure out if certain things are made up of cells, but we can only do this by zooming in very closely using an instrument like a microscope.*

## Procedure for growing E. coli on agar with different levels of nutrients as a wet lab

This reference outlines the materials and procedures to follow if you choose to grow *E. coli* as a class wet lab. These instructions are for preparing, inoculating, and growing one set of plates per class (for 6 classes), as well as one extra set (7 sets total).

A major concern with this investigation is unwanted microbial contamination that will compete with *E. coli* for space and nutrients. To minimize this concern, wear gloves as you handle all materials. Try as best as you can to work in a draft-free area. Consider wearing a cotton or surgical mask to protect materials from microbes you may inadvertently expel.

An additional challenge is the fact that the ideal temperature for growing *E. coli* is 37°C (98.6°F). At lower temperatures, *E. coli* growth will be much slower, and it may take several days to see anything. For this reason, you may want to build your own incubator out of everyday materials like a styrofoam cooler or cardboard box and an incandescent light bulb or heating pad to help keep the plates at a temperature between room temperature and 37°C. If your homemade incubator gets fairly warm, place a container of water inside to maintain humidity and to prevent the bacteria from drying out. Plans for simple incubators can be found online; however, it may be challenging to build one large enough for 35 petri dishes. You may want to try growing the class sets in the warmest place in your classroom and then grow the extra set in a DIY incubator. If no growth is seen at room temperature, you can always use the extra set.

**Materials Needed**

You will need the following materials and supplies:

- Disposable gloves
- Surgical or cotton face mask
- 35 60mm sterile petri dishes (plastic)
- A permanent marker
- Scale or balance
- Weighing paper or parchment paper
- Two plastic spoons
- Plain agar, powdered, at least 4 g
- Nutrient agar, powdered, at least 4 g
- Glass jars or flasks that hold at least 150 mL (preferably one for each solution, 5 total)
- Distilled water
- Hot pad

- Hot plate or microwave
- Tape
- *E. coli*, K-12 strain (the scientist used a MicroKwik Culture® from Carolina Biological Supply Company)
- Disposable pipette
- Alcohol spray (>60% ethanol or >70% isopropanol)
- Disposable sterile inoculating loops (3 mm ID, 10 microliter volume), need 3 per plate OR one reusable nichrome inoculating loop (also 3 mm ID, 10 microliter volume)

If you choose to grow *E. coli* as a wet lab, you will need to prepare petri dishes of agar containing 5 different levels of nutrients. You will make 70 mL each of 5 agar solutions containing different nutrient levels: 0, 25, 50, 75, and 100%. The total amount of dry agar used for each solution is 1.6 g, and the nutrient level is based on the weight of nutrient agar that is used. The following table indicates the amounts of dry, powdered agar with nutrients and plain agar that you will need. Note that you may want to scale up the amount of nutrients and plain agar based on the quality of your scale or balance.

| Percent nutrient in agar | Weight of agar with nutrients (g) | Weight of plain agar (g) |
|---|---|---|
| 0 | 0 | 1.6 |
| 25 | 0.4 | 1.2 |
| 50 | 0.8 | 0.8 |
| 75 | 1.2 | 0.4 |
| 100 | 1.6 | 0 |

**Reactivate Your *E.coli***

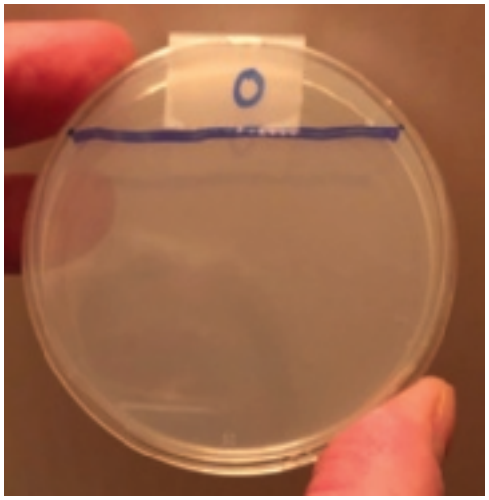
This should be done according to the manufacturer's instructions at least 2-3 days prior to use on day 3 of Lesson 10. If you decide to use the MicroKwik Culture® that the scientist used, please note that the solution will need to be reactivated for 24-48 hours at 37°C. If you do not build a DIY incubator, you can allow your culture to reactivate in a warm place, but note that it may take longer. When the culture is successfully reactivated, it should appear cloudy but not have large clumps.

**Instructions for the Preparation of Agar Plates**

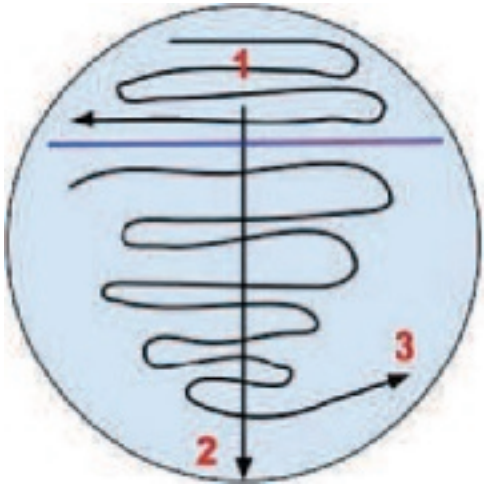
Ideally, agar plates should be prepared the day before you intend to inoculate them with *E. coli* (on day 2 of Lesson 10).

1. Wash five 150 mL flasks with soapy water, rinse thoroughly, and allow to air dry.
2. You will be pouring five 60 mm petri dishes (1 for each % nutrient agar solution) per class. Label the bottoms of the petri dishes near the edge with the nutrient levels (0, 25, 50, 75, and 100) using a marker. Draw a line across the dish under the label, about 1 cm from the top.

3. Find a protected, level, and draft-free place where your uncovered petri dishes can cool for a few hours after the hot agar solution is poured. This can be a cabinet or underneath a large cardboard box. The space should be large enough to prevent condensation from forming on the surface of the agar. Make sure that 35 60mm dishes will fit in that space; you may want to use a tiered rack.
4. Label each flask as follows: "Agar - x% nutrient." Label one flask for each nutrient level listed in the table above.
5. With a plastic spoon, weigh the appropriate amount of agar with nutrients onto a piece of parchment paper using a scale. Carefully add it to the corresponding flask. Do this for the flasks labeled 25, 50, 75, and 100%. You may reuse the same plastic spoon and piece of parchment paper.
6. With a new plastic spoon, weigh the appropriate amount of plain agar onto a new piece of parchment paper using a scale. Carefully add it to the corresponding flask. Do this for the flasks labeled 0, 25, 50, and 75%. You may reuse the same plastic spoon and piece of parchment paper.
7. Using either a graduated cylinder or a scale, measure out and add either 70 mL or 70 g of distilled water to each flask. Gently swirl each flask after the addition of water to disperse the powder.
8. Each flask will need to be heated to near boiling to dissolve the agar. This can be done in 2 ways:
    - The flasks can be heated on a hot plate. This is somewhat time-consuming and requires babysitting. If you choose to go this route, cover the top of each flask with some aluminum foil to minimize contamination. Using a hot pad, carefully swirl the contents of each flask as it heats up. Remove it from the hot plate as it just begins to boil. You should not be able to see any undissolved agar floating around. Set it aside to cool until it is 50-60°C or cool enough to handle without a hot pad. Depending on the size of your hotplate, you may be able to heat 3 flasks at a time.
    - The flasks can also be heated in the microwave. This approach is less time-consuming, but there is a danger of boil-over. Place the open flask in the microwave and heat it for no more than 30 seconds at a time. Watch the flask while it is in the microwave and stop the microwave as soon as you see the solution begin to bubble. Using a hot pad, carefully swirl the contents of the flask. Return the flask to the microwave, pull it out again when it starts to bubble, then swirl the contents to mix and evenly heat the solution. Consider it "done" when you can no longer see any undissolved agar floating around. Set it aside to cool until it is 50-60°C or cool enough to handle without a hot pad. It is recommended that you heat no more than two flasks at a time by this method.
9. Once the agar solutions have cooled to 50-60°C, you can begin pouring the plates. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci-online-resources**). It is recommended that you work with one solution and set of plates at a time. Place the petri dishes right side up on a level surface such as a counter. Uncover the dishes. Pour the hot agar solution into the dish until it covers the entire bottom surface. Carefully transfer the uncovered plates to the protected area you located in step 3. Try not to hover or pass any tools or arms over the plates to avoid contamination.
10. Repeat step 9 with the remaining agar solutions.
11. After a few hours, place the lids on the petri dishes and secure them with one piece of scotch tape as shown in the above image. Invert the petri dishes so that the lid is on the bottom. This way, any condensation that forms will not collect on the surface of the agar. If you will not be using the dishes in the next few hours, stack them and store them in a refrigerator to minimize the growth of any microbial contaminants. Allow the dishes to warm to room temperature before use.



**Instructions for Inoculating Agar Plates**




The chance for contamination at this stage is very high. You will need to be diligent about keeping the area and your tools as sterile as possible. It is highly recommended that you work in a draft-free area, wear gloves and a face mask, and spray down the area and tools with alcohol spray (spray and let things air dry instead of wiping them dry) prior to use. Wash your hands prior to gloving up and then spray your gloves with alcohol spray immediately before handling the loop and plates. To minimize contamination, try not to pass anything over an uncovered plate. For this reason, it would be best to project this process using a document camera rather than having students gather around.

There are two types of loops that you can use: disposable plastic loops or reusable nichrome loops that can be flame sterilized. If you do not have access to or are not able to use an alcohol burner or Bunsen burner, you will need to use 3 disposable loops per plate to obtain the desired dilution of *E. coli* during streaking. This can get expensive if you create a set of plates for each section. If you use a nichrome loop, you will be able to reuse it to obtain the desired dilution by sterilizing it in a flame between streaks.

Regardless of the type of loop you use, you will be streaking the plates in the pattern shown below in 3 steps. The arrows show the streak direction and are at the end where you would lift off the loop. Note that only light contact between the loop and the agar is required; you should not gouge the agar.

For reference, watch the video. (See the **Online Resources Guide** for a link to this item. **www.coreknowledge.org/cksci- online-resources**). You will follow the same procedure if you are using disposable loops, except instead of sterilizing the loop in a flame, you will switch to a new disposable loop as outlined below.

1. Before you begin, make sure you have everything you will need at hand and spray down the area with alcohol spray. Spray the test tube with the *E. coli* solution and the container you set it in prior to placing it on the sanitized surface. If using nichrome loops, be sure to spray the handle.

You will need:

- Agar plates at room temperature
- *E. coli* solution (place the tube in a small beaker or container for easy access)
- Inoculating loop or loops
- Flame source if using reusable nichrome loop

2. Bring the agar plate you intend to inoculate to your work area.
3. Follow these instructions to inoculate the plate **with the disposable loop:**
   - Unwrap a disposable loop and do not set it down until you are finished with it.
   - Uncap the *E. coli* solution.
   - Carefully dip the loop into the *E. coli* solution and withdraw it without touching the sides of the test tube.
   - Recap the *E. coli* solution.
   - Uncover the agar plate.
   - Gently touch the loop to the top section of the agar plate that you marked off with the marker, and gently streak the loop back and forth in that area. See **1** on the image.

- Gently lift the loop off the agar and place the lid on the plate.
- Throw away the disposable loop.
- Unwrap another disposable loop, remove the lid from the plate.
- Gently touch the loop to area **1**, draw it through that area and straight down to the opposite end of the dish as shown for **2** on the image. Gently lift the loop off the plate and cover the plate.
- Throw away the loop.
- Unwrap another loop.
- Remove the lid from the plate. Touch the loop to one side of the agar below the marker line and streak it back and forth across the straight line created in **2** as shown for **3**.
- Gently lift the loop off the agar, cover the plate and place it upside down.
- Throw away the disposable loop.

Repeat these steps for the remaining plates.

4. Follow these instructions to inoculate the plate **with the reusable loop:**
   - Place the entire nichrome loop in a flame until it all glows red.
   - Remove the loop from the flame and allow it to cool for a few seconds.
   - Crack open the lid and touch the loop to the edge of the agar to cool it. This should be a place on the agar that will not be streaked with E. coli.
   - Uncap the E. coli solution.
   - Carefully dip the loop into the E. coli solution and withdraw it without touching the sides of the test tube.
   - Recap the E. coli solution.
   - Uncover the agar plate.
   - Gently touch the loop to the top section of the agar plate that you marked off with the marker and gently streak the loop back and forth in that area. See **1** on the image.
   - Gently lift the loop off the agar and place the lid on the plate.
   - Repeat the first three steps to sterilize and cool the loop.
   - Remove the lid from the plate.
   - Gently touch the loop to area **1**, draw it through that area and straight down to the opposite end of the dish as shown for **2** on the image. Gently lift the loop off the plate and cover the plate.
   - Repeat the first three steps to sterilize and cool the loop.
   - Remove the lid from the plate. Touch the loop to one side of the agar below the marker line, and streak it back and forth across the straight line created in **2** as shown for **3**.
   - Gently lift the loop off the agar. Cover the plate and place it upside down.

Repeat these steps for the remaining plates.

5. Place the inoculated plates in either your homemade incubator or in a warm part of your classroom. Monitor the growth of your E. coli by checking on the plates periodically.

**Cleanup**

The K-12 *E. coli* strain is non-pathogenic, but you will need to dispose of the remaining *E. coli* and the plates by first killing the bacteria in a bleach solution. Allow plates and the test tube of *E. coli* to soak in a 1:4 bleach:water solution overnight prior to disposing of the agar in the garbage.

Name: _____ Date: _____

# What do bacteria need to make more of themselves?

In the following questions, you are going to construct an argument supported by evidence. In our efforts to figure out how cells in the human body can fill the gap to heal a wound, we found out that like mammal cells, bacteria cells can grow and split to reproduce and make more of themselves.

1. Based on the data you analyzed and the information you obtained in this lesson, what do bacteria and other single-celled organisms need to reproduce and make more of themselves? Use words or pictures (or a combination) to show your ideas.

2. Think back to when we saw mammal cells making more of themselves in the last lesson. Construct an argument: What do you think our (human) cells need in order to reproduce and make more of themselves? Use words or pictures (or a combination) in your argument.

**The following question will not be graded. Share your current thinking. Please explain your thinking in words and pictures.**

1. Make a prediction: How do bacteria, single-celled organisms, and the cells that make up other multicellular organisms get the food they need?

# LESSON 10: ANSWER KEY

## Key: What do bacteria need to make more of themselves?

In the following questions, you are going to construct an argument supported by evidence. In our efforts to figure out how cells in the human body can fill the gap to heal a wound, we found out that like mammal cells, bacteria cells can grow and split to reproduce and make more of themselves.

1. Based on the data you analyzed and the information you obtained in this lesson, what do bacteria and other single-celled organisms need to reproduce and make more of themselves? Use words or pictures (or a combination) to show your ideas.

Student responses should include:

+ Written text or other representations of food or nutrients

There is only one idea represented in this response so no guidance for a partial response is provided.

2. Think back to when we saw the mammal cells making more of themselves in the last lesson. Construct an argument: What do you think our cells need to reproduce and make more of themselves to heal the wound?

Look for the following ideas represented in written, oral, or pictorial form. Encourage students to use annotations and/or a key if choosing to use a pictorial form.

Student responses should include:

+ food or nutrients

+ I know my body needs food

+ I know my body is made of cells

+ We saw that bacteria cells are similar to the cells of the multiple cell organisms that we saw grow and split (**evidence**); they have similar structures, edges, or cell membranes.

+ I know that when bacteria have the proper food or nutrients (**cause**), they will grow and make more of themselves (**effect**).

+ I know that the bacteria reproduced or made more of themselves because there were none visible before being plated on the petri dish with the nutrients, and then after 2 days there were many bacteria—so many we could see clumps of them even without a microscope (**evidence**).

+ Since the single cells we investigated needed food to grow and make more of themselves, and I saw that cells in a mammal also grow and make more of themselves (**evidence**), I think my cells would also need food to grow and make more of themselves to heal the wound [fill the gap].

A complete and exemplary response should include some combination of the ideas listed above, including:

- At least one clear reference to evidence from the bacteria investigation in this lesson, and/or the cell growth videos from Lesson 9.
- At least one clear reference to cause and effect.

A partial response might include only one of the ideas above or multiple ideas without

- a clear reference to any specific evidence from the bacteria investigation or the cell growth videos from Lesson 9.
- a clear reference to cause and effect.

**The following question is non-graded. Share your current thinking. You may explain your thinking in words and pictures.**

3. Make a prediction: How do bacteria, single-celled organisms, and the cells that make up other multicellular organisms get the food they need?

Possible exemplary student response to a nongraded question:

+ Both bacteria and humans are made of cells, and we saw that the bacteria cells grow and split to make more of themselves when given more nutrients.

+ We also saw that cells within a mammal, or human, also grow and split.

+ So we think that human cells need food and nutrients to grow and reproduce.

+ It's likely that all cells seem to get the food they need from their surroundings, or in the case of multicellular organisms, the blood may bring the necessary nutrients for other cells.

A partial response may only make reference to the fact that all cells need food, but does not explain how the cells in multicellular organisms get their food differently (i.e., by relying on body systems such as the circulatory system to move nutrients around the body and to the cells).

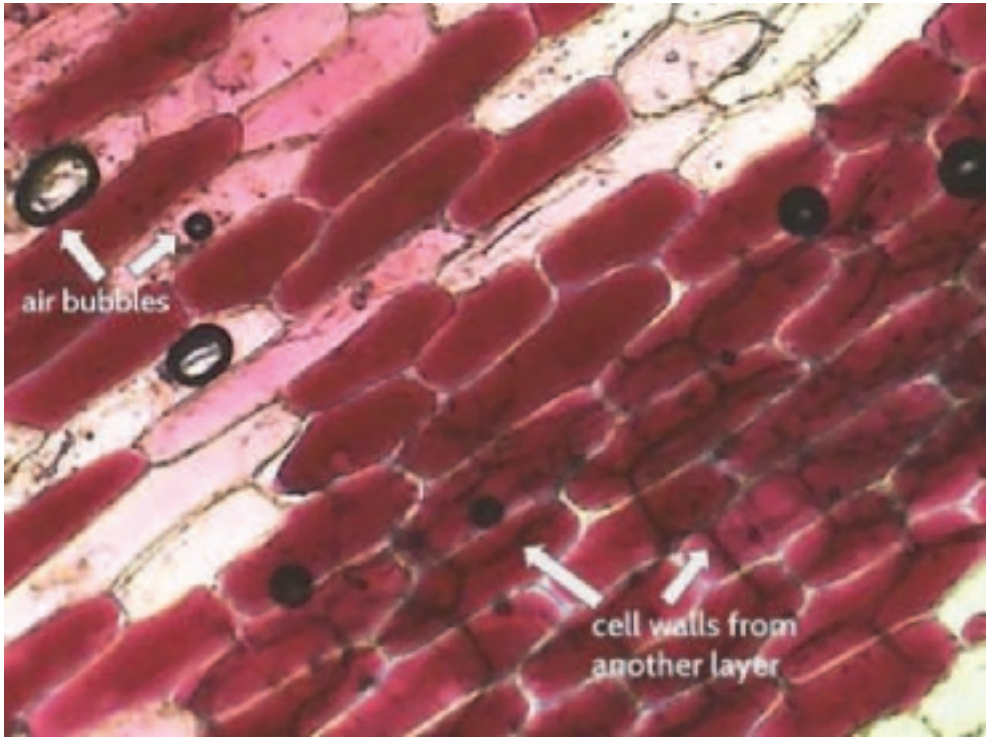
## Guidance for Viewing Red Onion Cells with the Microscope

In this investigation, students will receive red onion wet mount slides that consist of a layer of red onion and a drop of plain (distilled) water under a coverslip. Since it can be challenging to obtain intact single-cell layers as you prepare slides, this reference provides guidance on what students are likely to see with typical (less than perfect) red onion wet mount slides.

Note: If the pigment appears to diffuse through the water under the coverslip, leaving no visibly pigmented areas of cells, remake the slide with a slightly thicker piece of red onion skin. Fortunately, students should be able to observe shrinking of the cell membrane in salt water and its expansion upon the return to plain water with thicker samples.

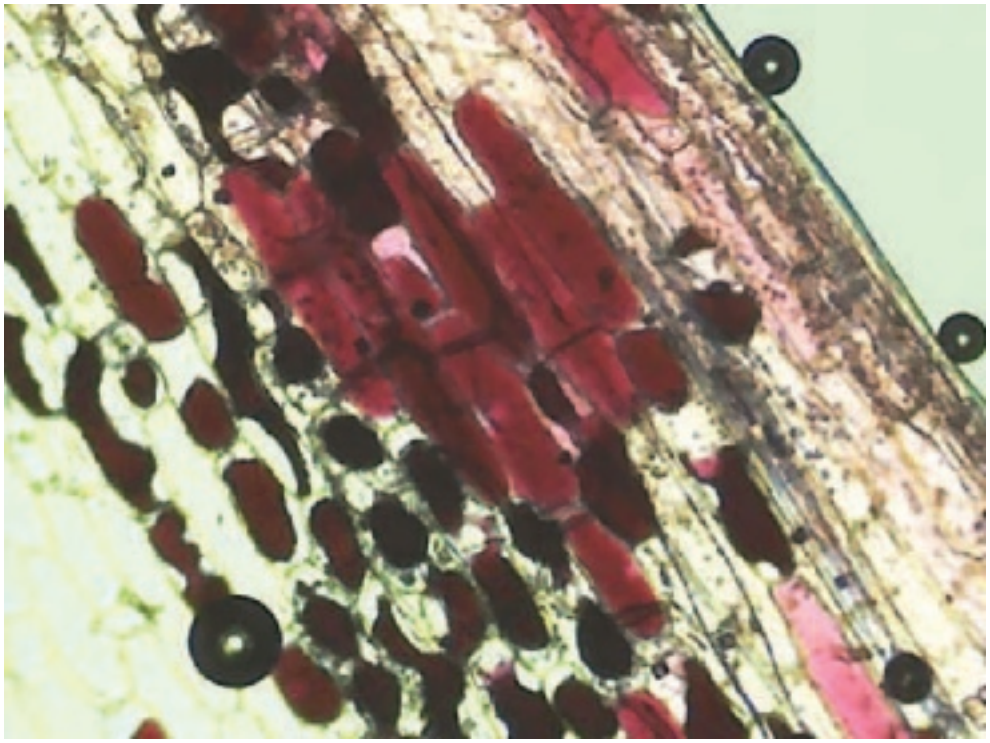
**Red Onion Cells in Plain Water**

An example of what students may observe for their as-received slide is shown below. In this image, air bubbles appear as round shapes with a thick, black outline. The black outline of cell walls from additional layers of onion are visible in the lower right corner. Students should seek out highly pigmented cells to observe for changes in salt water, but they will probably observe unpigmented or lightly pigmented cells as well. Those cells were likely damaged when the skin was removed from the onion; damaged cells can leach pigment. The leached pigment will probably be soaked up by the paper towel when students blot the onion skin, so those damaged cells may subsequently appear lighter in color, or have no pigment at all.



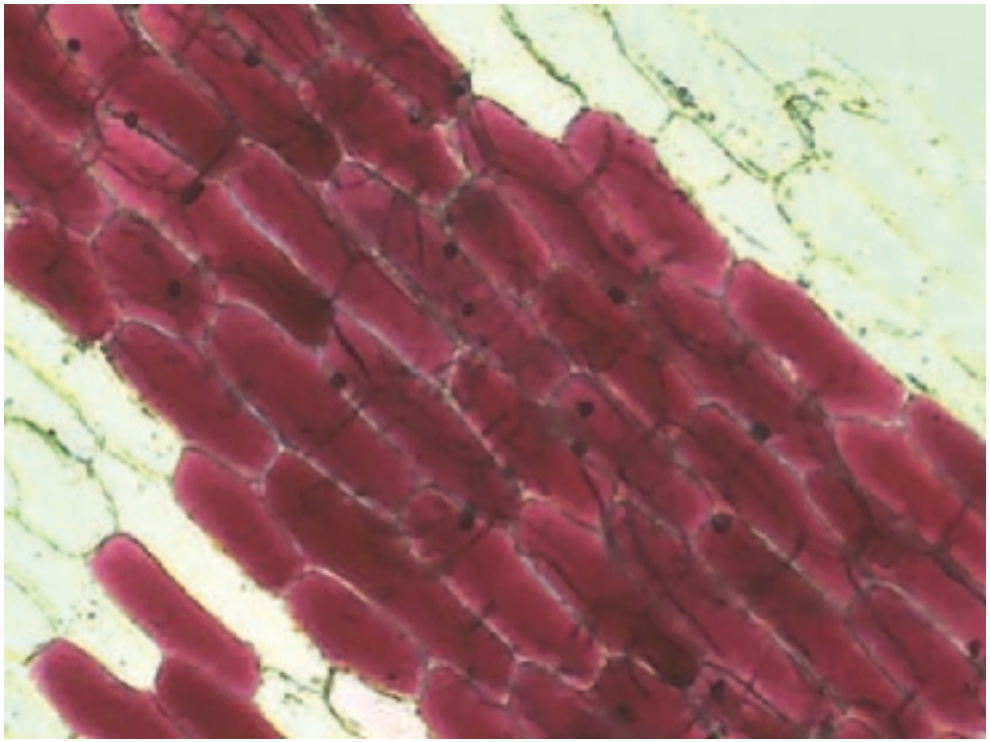
**Red Onion Cells in Salt Water**

The image below is an example of what students will observe for the onion cells in salt water. The pigmented area of the intact cells will appear to shrink away from the cell wall and become darker as water moves out of the cells. Since the pigmented area shrinks, students will need to adjust the light level to visualize cell walls. Some pigmented cells may appear not to shrink, presumably due to degradation of the cell membrane but not the cell wall. Although most of the changes will occur while the onion skin is allowed to sit in the salt water for 1 minute prior to replacing the cover slip, students may observe shrinking of the pigmented area in real time once the slide is placed under the microscope.



**Returning Red Onion Cells to Plain Water**

The image below is an example of what students will observe when the red onion cells are returned to plain water. The pigmented area of the intact cells will expand to fill the cell wall and become lighter as water moves into the cells. Since the pigmented area expands, students will need to adjust the light level to visualize cell walls. Although most of the changes will occur while the onion skin is allowed to sit in the plain water for 1 minute prior to replacing the cover slip, students may observe expansion of the pigmented area in real time once the slide is placed under the microscope.



## Data from Investigating Red Onion Cells

This key is provided for you to use as an example of what students might say for the different responses. This is by no means the only way a student may phrase or respond to the questions and shouldn't be used to assess right or wrong, but instead this key can be used as a guide for you toward the big ideas students should walk away from this investigation with. Use this as a formative assessment, specifically question 4, for the Building Understandings Discussion that follows. It will provide you information about where your students are and their sensemaking around the structure of a cell and whether things can get in or out of the cell. An example student response is as follows.

Follow the *Procedure to Investigate Structures in Red Onion Cells* for steps 1 to 8. Collect your data on this page and answer the questions on the following page.

| Sample | Draw what you observe | Describe in words what you observe |
|---|---|---|
| **Red onion skin + plain water**<br>at 100 total magnification | Drawings will vary. | Responses will vary. |
| **Red onion skin + salt water**<br>at 100 total magnification | Drawings will vary. | Responses will vary but should indicate that the interior purple portion shrank. |

1. What did you observe when you added plain water to the plant cells? What was different when you added the salt water?

The plant cells have a thick outer boundary and a thinner inner boundary. The inner boundary has a purple inside, and it shrank when we added the salt water.

2. Based on your observations so far, make a prediction: What do you think will happen if you now replace the salt water with plain water?

Since the inner purple part filled the thick outer boundary originally in plain water, I think that when we add plain water again, the inner purple will fill the outer thick boundary again.

Follow the *Procedure to Investigate Structures in Red Onion Cells* for steps 9 through 16. Collect your data and answer the questions on this page.

| Sample | Draw what you observe | Describe in words what you observe |
|---|---|---|
| **Red onion skin + plain water again**<br>at 100 total magnification | Drawings will vary. | Responses will vary, but should indicate that the interior purple portion returned or started to return to its original position. |

3. What changes did you observe after you added plain water again?

Example student response: The inner boundary looked like it filled up again when we added plain water again. The purple part got bigger and rounder the longer we waited, until it went to the edges of the thick outer boundary again.

4. Explain using evidence from above what is happening to cause the changes you've observed in these cells.

Example student response: It looks like things are getting into and out of the cells when we add these different types of water. Since the inner purple part shrank when we added salt water, I think that the inside part let something, maybe water, out of it. Then when we added water again, it looked like the inside part was able to let the water back in and make the purple part grow.

5. What do you notice about how the cells of this plant are structured compared to the cells of animals we've already seen? What similarities and differences did you observe?

Example student response: The plant cells look similar to the animal cells because there's a lot of them and they repeat. The plant cells also have boundaries that keep stuff inside of them, like we saw in the animal cells. The plant cells look different because they have this outer boundary that we didn't see when we looked at the animal cells. They also look more blocky, and these cells have a purple interior without being stained.

Name: _____ Date: _____

# How do the systems in the body interact during the healing process?

1. Using the ideas and evidence in *How Healing Happened Chart* that you put in your notebook, explain how the different systems in the body interact as the healing process occurs so that the person can resume physical activities. Think about how the student in Lesson 1 couldn't walk, move, jump or dance when the injury occurred, but after 4 months the body had healed to a level that the student could once again do these things.

| Event on the Timeline | Stitches removed and dissolved | Swelling lessened and gone | Pain gone and feeling returns to the foot | Cast and pins removed | Normal shoe, no crutches needed |
|---|---|---|---|---|---|
| Which body systems interacted for this event to happen? | | | | | |
| How did the body systems interact for this event to happen? | | | | | |

2. Read back through your responses and think about the ideas of scale and structure/function we developed in this unit.

Choose one of these ideas that you think is most helpful in explaining how body systems interact during the healing process.

Circle one: SCALE STRUCTURE/FUNCTION

3. Why is this idea helpful in explaining how body systems interact during the healing process?

## Sample Responses for How Healing Happened Chart

| Event on the Timeline | Stitches removed and dissolved | Swelling lessened and gone | Pain gone and feeling returns to the foot | Cast and pins removed | Normal shoe, no crutches needed |
|---|---|---|---|---|---|
| How did the body heal so that this event could occur? | The stitches were no longer needed because skin cells made more skin cells to fill the gap and close the skin. Muscle cells made more muscle cells to fill the gap and reconnect the muscles underneath the skin. | The swelling went away because the tissues healed as new cells filled the gaps. The extra fluid carried away the waste (cells that can no longer function) so the remaining cells can make new cells in that area. The extra blood isn't needed anymore to support making new cells once the gap is full. | The pain was gone because the nerves are no longer sending pain signals to the brain. The nerve cells healed and the student was able to feel the top of their foot. | The cast and pins were removed because bone cells filled the gaps/ cracks so the bones aren't broken anymore. | The student can wear a regular shoe and walk without crutches because the bone, muscle, and skin are all working again and can function together as a body system to move the student around. |

| Event on the Timeline | Stitches removed and dissolved | Swelling lessened and gone | Pain gone and feeling returns to the foot | Cast and pins removed | Normal shoe, no crutches needed |
|---|---|---|---|---|---|
| Evidence from investigations in the unit | We know that cells can grow and split because we saw a video of them doing that. We know those new cells can fill an injured area because we saw skin regrow and fill that area in the timelapse of the scraped knee. Since cells are living, we know that they need things like food to grow because the bacteria cells grow more with more food around them. We read in the article that blood brings food particles and water to all parts of the body. We know that those things from the blood can get into the cells through the cell membranes because we saw onion cells' membranes and cytoplasm shrink and expand when we added salt water and water. | We read in the report about the injured finger that the doctor said the swelling would go away on its own as the tissues healed. We know that blood plasma carries away waste, so it makes sense that the extra fluid in the swollen area can carry away waste (there's more fluid to carry away more than usual waste from the injury). Our bodies are not typically swollen—the usual amount of blood is enough for what our cells usually need, but the doctor said that the swelling reaction also brings extra blood to the area. That makes sense because lots of new cells need to be produced to repair the damaged tissue, so they'll need everything the blood can bring them. | We read in the article about nerves having long branches to send signals to the brain so we can feel things. We also read that nerves send pain signals to the brain to make us pay attention to the area that is injured so we're careful with it and try to help it heal. | We know that cells can make new cells because we saw a video of them doing that. We know those new cells can fill an injured area because in the timelapse of the scraped knee, we saw the skin regrow and fill in that area. We know that cells need things like food to grow because the bacteria cells grow more with more food around them. We read in the article that blood brings food particles and water to all parts of the body. We know that those things from the blood can get into the cells through the cell membranes because we saw onion cells' membranes and cytoplasm shrink and expand when we added salt water and water. | When we saw the chicken wing, all its parts had to interact for it to move. The chicken wing system did not function when the bone, muscle, and skin were broken. |

# LESSON 12: ANSWER KEY 2

## Key: How do the systems in the body interact during the healing process?

**Directions:** The alignment table shown here indicates how students' work on *How do the systems in the body interact during the healing process?* supports each element of this three-dimensional lesson-level performance expectation. The descriptors listed with the elements describe possible evidence that the element is used effectively in the student's explanation. The rubric that follows offers the same descriptors as the alignment table, but in a format that may allow you to more easily record student progress and/or communicate feedback to students. This rubric does not attempt to predict all the possible ways students may still show that they are developing their understandings and use of practices, nor does it attempt to forecast all the possible ways students may show they have advanced understanding and/or especially deep use of practices. Instead, you may mark examples of evidence you see and jot notes about where specifically a student has room for improvement or has shown above-and-beyond understanding. This feedback can then be shared with students (in writing or in a conversation) to support their learning.

This rubric is intended for teacher use, not for students to use as a checklist while developing their responses.

12.A Apply scientific ideas and evidence to construct an explanation for how systems of the body interact to support the healing process in the foot.

| SEP Elements | DCI Elements | CCC Elements |
|---|---|---|
| 6.4 Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.<br><br>Students explain how healing happened in the foot for each event on the timeline. Students apply key scientific ideas that they've figured out in earlier lessons and use evidence from their investigations to justify their explanations to a partner. | LS1.A: In multicellular organisms, the body is a system of multiple interacting subsystems.<br><br>These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.<br><br>Students should include in their explanation that the different systems in the body are made of cells and that the cells in these different parts of the body look similar to each other and different from cells in other parts of the body. They should also include that these different parts of the body have different functions which is why the cells look different for the different parts of the body.<br><br>Student explanations include specific examples of the different systems that are interacting for the different parts of the body to heal. For example, students should include in their explanation that the blood and blood vessel system brings nutrients throughout the body. These nutrients are used by cells in those different parts to make new cells in order to heal that part of the body. | 4.1 Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.<br><br>When putting together the pieces figured out about healing, students explain that the human body is a system of interacting subsystems that work together to heal injuries and carry out the body's functions.<br><br>4.2 Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.<br><br>Students explain how systems interact for the body to heal. For example, the body's circulatory system brings blood to the foot so its tissues can heal, and as they heal, the foot's bone, muscle, and skin are able to work together again so the injured person can walk without support. |

| Element of CCC, SEP, and DCI being assessed | Evidence that element is used effectively | Evidence of development or extension |
|---|---|---|
| 6.4 Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. | Students explain how healing happened in the foot for each event on the timeline. Students apply key scientific ideas that they've figured out in earlier lessons and use evidence from their investigations to justify their explanations to a partner. | |
| LS1.A: In multicellular organisms, the body is a system of multiple interacting subsystems.<br><br>These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. | Students should include in their explanation that the different systems in the body are made of cells and that the cells in these different parts of the body look similar to each other and different from cells in other parts of the body. They should also include that these different structures of the body have different functions which is why the cells that make up those structures look different for the different parts of the body.<br><br>Student explanations include specific examples of the different systems that are interacting for the different parts of the body to heal. For example, students should include in their explanation that the blood and blood vessel system brings nutrients through it all over the body. These nutrients are used by cells in those different parts to make new cells in order to heal that part of the body. | |
| 4.1 Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. | When putting together the pieces figured out about healing, students explain that the human body is a system of interacting subsystems that work together to heal injuries and carry out the body's functions. | |
| 4.2 Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. | Students explain how systems interact for the body to heal. For example, the body's circulatory system brings blood to the foot so its tissues can heal, and as they heal, the foot's bone, muscle, and skin are able to work together again so the injured person can walk without support. | |
| Students choose a CCC:<br>• Structure/Function<br>• Scale | Prompt three below gives students the opportunity to use an additional crosscutting concept lens (broadly, not aligned to a specific element) to explain how this CCC helps them deepen their understanding of the system interactions between the different parts of the body during the healing process. | |

**Scoring Guidance:**

1. Using the ideas and evidence in *How Healing Happened Chart* that you put in your notebook, explain how the different systems in the body interact as the healing process occurs so that the person can resume physical activities. Think about how the student in Lesson 1 couldn't walk, move, jump or dance when the injury occurred, but after 4 months the body had healed to a level that the student could once again do these things.

| Event on the Timeline | Stitches removed and dissolved | Swelling lessened and gone | Pain gone and feeling returns to the foot | Cast and pins removed | Normal shoe, no crutches needed |
|---|---|---|---|---|---|
| Which body systems interacted for this event to happen? | Skin<br>Muscle<br>Blood | Blood<br>Skin | Nerves & Brain<br>Blood | Blood<br>Bones<br>Muscle | Muscle<br>Bone<br>Skin |
| How did the body systems interact for this event to happen? | Blood moves all over the body through the blood vessels and brings the stuff cells need to grow and split to the muscle and skin so that they can create new cells to fill the gap of the injury. Once this is done, the stitches can be removed. | Extra blood cells and plasma liquid move to this area of the injury to make it puffed up. Then this blood carries away the injured cells and extra stuff that isn't needed as the area begins healing. | The nerves were sending pain signals to the brain to remind the student not to use that area while it was healing, but now that it's healed, the student can start using that body part again. The student feels tingling but cannot feel everything on top of the foot because the nerves are still healing; their structures aren't fully functioning to send those signals back to the brain. | New bone cells were able to form because these cells got the nutrients they needed through the blood. These nutrients were able to get into the cell through the cell membrane so that new cells could be made. When enough new cells are made so that the bones and muscles are healed and attached, they can work together. | The gaps in the skin, muscle, and bone are all filled in and now are attached so that when the muscles move, the bones and skin move with them. |

2. Read back through your responses and think about the ideas of scale and structure/function we developed in this unit.

Choose one of these ideas that you think is most helpful in explaining how body systems interact during the healing process.

Circle one: SCALE STRUCTURE/FUNCTION

3. Why is this idea helpful in explaining how body systems interact during the healing process?

Below are examples of what students might say to support the different CCCs. These are general big ideas students might bring. Students will most likely also bring in specific examples from other lessons. Look for students to be citing relevant experiences and ideas from the unit that connect back to the CCC they chose.

| SCALE | STRUCTURE/FUNCTION |
|---|---|
| Thinking about different scales helped me because we figured out that there are cells that make up the different parts of our body by looking at them through the microscope.<br><br>Looking at the cell **really close up** and how it behaved when water and salt water was added helped me figure out that food particles can get in and out of the cell through the cell membrane. | We figured out the different parts of our body are made of different types of cells and that the type of cell helps that part of the body function.<br><br>Looking at the cell really close up and how it behaved when water and salt water was added helped me figure out that **food particles can get in and out of the cell through the cell membrane.**<br><br>We figured out that the cells of a body part look similar to that part of the body which is connected to the function that part does. For example, muscle cells look long and stretchy like a muscle is. |

Name: _____ Date: _____

# Growth Summative Assessment

**Part 1: What happens at the growth plate within bones as a child grows into an adult?**

We made observations of X-rays from children and adults and found out that there are gaps called growth plates in between different bones in children. The image to the right is an x-ray of a knee of a child and an adult.




Adult knee: © Nevit Dilmen

a. On this assessment, you will apply what you have figured out about how our body heals to fill gaps from injuries to explain what happens to the structures of the bone at the growth plate as a child grows into an adult. On the image to the right, circle one part of the body where there is a growth plate that you will focus on in your explanation.



b. Using key science ideas from the unit, explain what you think happens to the structures of the bone at the growth plate as a child grows into an adult? Use words or pictures (or a combination) to explain your answer to this question. Think about what you have figured out about how the different parts and systems of the body work together. Use your key model ideas, science notebooks, the posters we have created together, and evidence from the growth plate images. Be sure to include the interactions between the different systems in our body that need to happen to support this.

c. Using words or pictures (or a combination), explain what happens in the different parts of the body (subsystems) that are around the growing bone you selected, as the bone grows.

d. Brainstorm and list other living things that you think might go through a similar process of growth and then explain why.



**Part 2: What is happening in this plant?**

1. What have we figured out in our unit about plants? Are they living? How do we know?

Analyze the images above taken of a small plant over the course of 5 days.

a. What changes do you notice in the structures of the plant?

b. State a claim for what you think is happening inside the plant between day 1 and day 5 to result in these changes in its structures.

c. What additional data would you need about this plant to find evidence that would support your claim? How would you investigate that?

## Scoring Guidance: Growth Summative Assessment

**Directions:** The alignment table shown here indicates how student's work on *Growth Summative Assessment* supports each element of this three-dimensional lesson-level performance expectation. The descriptors listed with the elements describe possible evidence that the element is used effectively in the student's explanation.

The rubric that follows offers the same descriptors as the alignment table, but in a format that may allow you to more easily record student progress and/or communicate feedback to students. This rubric does not attempt to predict all the possible ways students may still show that they are developing their understandings and use of practices, nor does it attempt to forecast all the possible ways students may show they have advanced understanding and/or especially deep use of practices. Instead, you may mark examples of evidence you see and jot notes about where specifically a student has room for improvement or has shown above-and-beyond understanding. This feedback can then be shared with students (in writing or in a conversation) to support their learning.

This rubric is intended for teacher use, not for students to use as a checklist while developing their responses.

**13.A** Apply science ideas and evidence from classroom investigations to explain a common, real-world phenomenon in which the specialized cells of living things serve particular functions as they work together to interact with each other and other systems to make more cells and grow.

| SEP Elements | DCI Elements | CCC Elements |
|---|---|---|
| 6.4 Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.<br><br>Students apply key science ideas using evidence they collected over the course of the unit to construct an explanation for real-world phenomena in which they must draw upon the science ideas related to the healing process to explain growth. | LS1.A All living things are made up of cells, which is the smallest unit that can be said to be alive.<br><br>Students explain how the different parts of the body are made up of cells with each part being made of a different type of cell.<br><br>LS1.A In multicellular organisms, the body is a system of multiple interacting subsystems.<br><br>Student explanation includes specific examples how different systems need to work together for new cells to be made. They should mention specifically that the blood carries nutrients around the body. These nutrients are used by different parts of the body to make new cells. | 6.1 Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.<br><br>Students consider what is happening at the growth plates is a similar process to what students have investigated, explained, and modeled about the healing process. Students will explain that in order for the body to function after growth (similar to how it did after healing), it needs to build similar structures like bone, muscle, and skin that were there before the growth. |

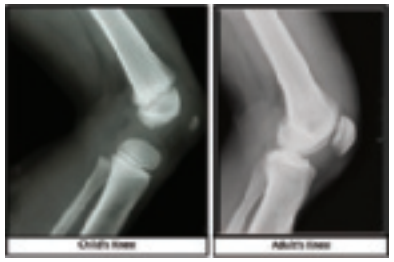
**13.A** Apply science ideas and evidence from classroom investigations to explain a common, real-world phenomenon in which the specialized cells of living things serve particular functions as they work together to interact with each other and other systems to make more cells and grow.

| SEP Elements | DCI Elements | CCC Elements |
|---|---|---|
| 6.4 Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.<br><br>Students apply key science ideas using evidence they collected over the course of the unit to construct an explanation for real-world phenomena in which they must draw upon the science ideas related to the healing process to explain growth. | LS1.A Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.<br><br>Students' explanation includes examples of how the structure of the cell, specifically the cell membrane, allows nutrients to get into the cell so it can make another cell. In addition, the cell membrane lets out the stuff the cell doesn't need, like waste, which is carried away in the blood.<br><br>Students explain how this process of nutrients getting into the cell so that more cells can be made happens for the growth plate in the bones to fill the gap or space as a child grows into an adult. They also explain how this happens to the other parts of the body around the bone, such as the skin and the muscle, so that these parts also grow along with the bone over time. | 4.1 Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.<br><br>In order for a living thing (like the plant or bone) to grow in size (and the growth plate to decrease), students will need to explain how growth is supported by multiple systems (or subsystems) such as the blood bringing what the cells need to grow and split or the nerve cells to send signals. |

| Element of CCC, SEP, and DCI being assessed | Evidence that element is used effectively | Evidence of development or extension |
|---|---|---|
| 6.4 Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. | Students apply key science ideas using evidence they collected over the course of the unit to construct an explanation for real-world phenomena in which they must draw upon the science ideas related to the healing process to explain growth. | |
| LS1.A All living things are made up of cells, which is the smallest unit that can be said to be alive. | Students explain how the different parts of the body are made up of cells with each part being made of a different type of cell. | |
| LS1.A In multicellular organisms, the body is a system of multiple interacting subsystems. | Student explanation includes specific examples how different systems need to work together for new cells to be made. They should mention specifically that the blood carries nutrients around the body. These nutrients are used by different parts of the body to make new cells. | |
| LS1.A Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. | Students' explanation includes examples of how the structure of the cell, specifically the cell membrane, allows nutrients to get into the cell so it can make another cell. In addition, the cell membrane lets out the stuff the cell doesn't need, like waste, which is carried away in the blood.<br>Students explain how this process of nutrients getting into the cell so that more cells can be made happens for the growth plate in the bones to fill the gap or space as a child grows into an adult. They also explain how this happens to the other parts of the body around the bone, such as the skin and the muscle, so that these parts also grow along with the bone over time. | |
| 6.1 Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. | Students consider what is happening at the growth plates is a similar process to what students have investigated, explained, and modeled about the healing process. Students will explain that in order for the body to function after growth (similar to how it did after healing), it needs to build similar structures like bone, muscle, and skin that were there before the growth. | |
| 4.1 Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. | In order for a living thing (like the plant or bone) to grow in size (and the growth plate to decrease), students will need to explain how growth is supported by multiple systems (or subsystems) such as the blood bringing what the cells need to grow and split or the nerve cells to send signals. | |

**Part 1: What happens to the structures of the bone at the growth plate as a child grows into an adult?**

We made observations of X-rays from children and adults and found out that there are gaps called growth plates in between different bones in children. The image to the right is an x-ray of a knee of a child and an adult.



Adult knee: © Nevit Dilmen

a. On this assessment, you will apply what you have figured out about how our body heals to fill gaps from injuries to explain what happens to the structures of the bone at the growth plate as a child grows into an adult. On the image to the right, circle one part of the body where there is a growth plate that you will focus on in your explanation.



Accept reasonable answers here. If you notice a student circling or notating a place where there isnt a growth plate, or an area where new cells will need to be made, you might ask them some guiding questions to help them identify a place where the bones are not closed up.

b. Using key science ideas from the unit, explain what you think happens to the structures of the bone at the growth plate as a child grows into an adult? Use words or pictures (or a combination) to explain your answer to this question. Think about what you have figured out about how the different parts and systems of the body work together. Use your key model ideas, science notebooks, the posters we have created together, and evidence from the growth plate images. Be sure to include the interactions between the different systems in our body that need to happen to support this.

Student responses should include:

+ The bone cells are making more bone cells to fill the gap in the baby's bone and this gap is gone in the adult bone.

+ Bone is made of bone cells which are structured so that the bone can function and do its jobs (to provide structure and strength for the body).

+ Bone cells are making more bone cells at the growth plate.

+ To do this, cells need blood to bring nutrients so more cells can be made. These nutrients enter the cell through the openings in the cell membrane so that one cell can make a new cell.

+ It must take a long time for the body to make enough cells to fill the gap in the growth plate because it looks like it isn't closed up until the 20-year-old X-ray image.

c. Using words or pictures (or a combination), explain what happens in the different parts of the body (subsystems) that are around the growing bone you selected, as the bone grows. Over time, as more bone cells are made and the bone becomes more solid, what other systems are affected and/or changed?

Student responses should include:

+ After/As the body makes the bigger/longer bone, each of the surrounding body parts (such as skin, muscle, and nerves) needs to grow, too, so that each system in the body can function individually and together.

+ The skin needs to be able to cover the larger bones and muscles so it must also grow as the bone gets bigger and longer.

+ The muscles also need to be bigger in order to be able to move the bigger bones, so more muscle is also made.

+ The skin and muscles also grow like the bones grow by taking nutrients into the cells through the cell membrane and using them to make more cells.

+ In order for these parts to grow, the body needs to make more nerve, skin, and muscle cells because each of these cells has a particular structure that serves a specific function needed to make up the body part (subsystem).

d. Brainstorm and list other living things that you think might go through a similar process of growth and then explain why.

Accept all responses that are living things.

If students are referring to items that are not living things, probe them with questions about what we figured out about the non-living item in Lesson 5 and what we figured out in Lesson 10 from the bacteria investigation.

**Part 2: What is happening in this plant?**



1. What have we figured out in our unit about plants? Are they living? How do we know?

Student responses should include:

+ Plants are also made of cells so they are living.

+ We saw cells of tomato skin and of onion skin which are both types of plants.

+ We also saw that plants have a cell wall as part of their cell which we don't have in our cells. These help the plant have a shape or structure.

Analyze the images above taken of a small plant over the course of 5 days.

a. What changes do you notice in the structures of the plant?

Student responses should include:

+ There is a part of the plant getting bigger outside of one of the seeds in the second picture.

+ By day 4, there are parts that are getting bigger and growing outside of the seed.

+ By day 5, one of the growths is beginning to look like a plant.

b. State a claim for what you think is happening inside the plant between day 1 and day 5 to result in these changes in its structures.

Possible student responses might include:

+ Plants are made of cells and when they grow, they make more cells like humans do.

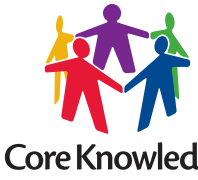
+ As plants grow, they make more and more cells.

+ Growth in plants is similar to growth in humans because they are made of cells, too.

c. What additional data would you need about this plant to find evidence that would support your claim?

Student responses should include:

+ Anything that the student has figured out about the structures and systems of humans that they would need to know about how the plant executes a similar task with plant structures and systems (e.g., how nutrients move through the plant) and/or whether plant cells have similar structure and function relationships that support the plant's ability to grow.




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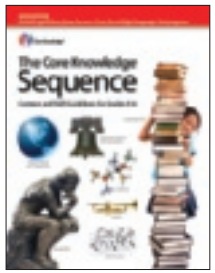
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