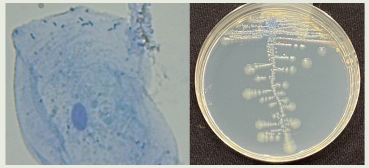
LESSON 10: What do cells need to grow and make more of themselves?

PREVIOUS LESSON *We analyzed videos and 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 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 scientists, who grew bacteria on agar plates with different nutrient levels. We analyze their data and notice that 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.

NEXT LESSON *We will use microscopes to observe structures (cell wall and cell membrane) in onion cells and changes to those cells when water and salt 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 live 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.
- More cells grow when they have more food around them.
- There are single-celled (unicellular) and many-celled (multicellular) living things.
- Cells are living things.

Lesson 10 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	5 min	**NAVIGATION** Recall our conversation from the end of Lesson 9 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** 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** 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 https://www.teachersopensciedfieldtest.org/healing, Properties of Cooled Agar video at https://www.teachersopensciedfieldtest.org/healing, Streaking E. coli onto Agar Plates video at https://www.teachersopensciedfieldtest.org/healing
4	10 min	**ANALYZE SECOND-HAND DATA FOR E. COLI GROWTH** Small groups use the Identify and Interpret strategy to analyze second-hand data for the growth of *E. coli* on agar with different nutrient levels.	L-M	*Reference: Second Hand Data for E. coli Grown on Agar with Different Nutrient Levels*, tape
5	12 min	**READ ABOUT DIFFERENT SINGLE-CELLED ORGANISMS** Students read and interpret one of four texts about single-celled organisms.	N-P	*Lesson 10: Obtaining Information from Scientific Text*, *Reading: Archaea* or, *Reading: Bacteria* or, *Reading: Yeast* or, *Reading: Algae*
				End of day 1
6	10 min	**DISCUSS THE READINGS IN JIGSAW GROUPS** Follow a jigsaw approach to discuss different single-celled organisms based on information from the readings.	Q	*Lesson 10: Obtaining Information from Scientific Text*, *Reading: Archaea* or, *Reading: Bacteria* or, *Reading: Yeast* or, *Reading: Algae*
7	13 min	**BUILDING UNDERSTANDINGS DISCUSSION ABOUT MULTI- AND UNICELLULAR ORGANISMS** Use information from the readings and the investigation data to compare and contrast the structures and functions of unicellular and multicellular organisms. Add to the Word Wall.	R	*Lesson 10: Obtaining Information from Scientific Text*, *Reading: Archaea* or, *Reading: Bacteria* or, *Reading: Yeast* or, *Reading: Algae*
8	10 min	**READ ABOUT THE LIFESPAN OF CELLS** Read about the lifespan of various cell types.	S	*Reading: Lifespan of Cells*
9	5 min	**UPDATE PROGRESS TRACKER** Reflect on and record what we figured out about what cells need to make more cells, whether they are single-celled or multi-celled organisms.	T	

Part	Duration	Summary	Slide	Materials
10	10 min	**WRITE AN ARGUMENT ABOUT WHAT CELLS WOULD NEED TO HEAL THE WOUND** Students construct a written argument as an exit ticket.	U	*What do bacteria need to make more of themselves?*

End of day 2

Lesson 10 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • *Reference: Second Hand Data for E. coli Grown on Agar with Different Nutrient Levels* • tape • *Lesson 10: Obtaining Information from Scientific Text* • *Reading: Archaea* or • *Reading: Bacteria* or • *Reading: Yeast* or • *Reading: Algae* • *Reading: Lifespan of Cells* • *What do bacteria need to make more of themselves?*		• Pouring Agar video at https://www.teachersopensciedfieldtest.org/healing • Properties of Cooled Agar video at https://www.teachersopensciedfieldtest.org/healing • Streaking E. coli onto Agar Plates video at https://www.teachersopensciedfieldtest.org/healing

Materials preparation (20 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.

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 others 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 word to the Word Wall: **single-celled (unicellular) organism, multiple celled (multicellular) 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 3 of this lesson.

Have the following videos loaded and ready to play for the class:

- Pouring Agar at https://www.teachersopensciedfieldtest.org/healing
- Properties of Cooled Agar at https://www.teachersopensciedfieldtest.org/healing
- Streaking *E. coli* onto Agar Plates at https://www.teachersopensciedfieldtest.org/healing

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* yourself as a teacher demonstration with your students rather than using second-hand 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 second-hand dataset 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 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, this second-hand data allows students to notice that more bacteria grows as the nutrient level of the gel is increased.

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 a single-celled organism we can investigate. Also, when we explore community supports for healing in Lesson 13, we can connect back to this investigation of bacteria to help us make sense of the use of antibacterial or cleansing cream or soap in our anchoring phenomenon foot injury and examples from our related phenomena poster. Using bacteria here helps us figure out that there are organisms made of one cell that require food to make more cells and that there are some types of bacteria that we don't want in our body or wounds.

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. We discuss how single-celled organisms are different from multiple-celled (multicellular) organisms, whose cells need to function together as part of the larger body system in order to make more cells. 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 the agar with nutrients here 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. 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 in 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 5th 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 growth of our body. They are comparing growth of cells before they split to the growth of a child as they age. In Lesson 14, students will apply 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 *OpenSciEd Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)* and *OpenSciEd Unit 8.5: Why are living things different from one another? (Muscles Unit)*.

After a minute or two of partner talk, 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 prompts	Sample student responses
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 the cells were active and moving around 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.*
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.* *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... maybe.* *Maybe. If we didn't have our cells, then we wouldn't be living, either?*

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 that are not preserved on a microscope slide. It would be really hard to investigate these predictions inside a living body or animal, so maybe we could find a way to figure out whether cells do need food to make more cells if we could investigate cells outside of a body.*

2 · INTRODUCE BACTERIA AND SHARE INITIAL IDEAS ABOUT THEM

8 min

MATERIALS: science notebook

Say, *So we want to investigate whether cells also need things like food and water to make new cells, but we won't be able to investigate that inside a body that's made of cells all working together in tissues. Do we think that there are other living things made of cells that we could use?* Accept all responses.

Say, *Those are all great ideas. There are even some things in the world that are made of just one cell. Think about that for a minute... they're not part of a whole body, just one cell. We could watch them to see what they need to make new cells. Has anyone ever heard of these single-celled things?* Accept all responses and then say, *Right, one of the most common of these single-celled things 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, if anything, do we 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 13 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 fluid moment for students to share their observations and consider their initial explanations 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 guts.* • *Bacteria are found in our mouth.* • *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 response
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.* *The bacteria cells seem to be more spread out in the images.* *The bacteria are just kind of randomly arranged - they don't have a structure. That makes me think they work together.* *The bacteria are way smaller than most of the human cells in these images.*
If there was only one skin cell all by itself, would it be able to function? Or one single muscle cell? One bone cell?	*No. The way skin works is that all the cells have to be working together to cover and protect the body. Just one cell wouldn't be able to do that.* *Just one muscle cell wouldn't be able to work together with others to contract and stretch to move us.* *One bone cell wouldn't be able to form that ring-like pattern that we think helps bones stay strong and sturdy to support us.*

Summarize by saying, *So these bacteria, being just one cell each, don't form tissues like we have seen in humans. They carry out all their functions by themselves. This means we can investigate them outside of a body. So let's think about how we could use them to figure out what cells need.*

Turn and Talk to propose investigation ideas. Display **slide E.** Have students turn and talk with a partner about these questions.

- Do we think bacteria are living? How would we know if they were?
- How could we get evidence to convince us that bacterial cells 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 think bacteria are living, but we would know for sure if they use food to grow and make more of themselves - that's what living things do.
- We could give them food and see if they "eat" it (use it).

- Could we see if the food goes away? Then we'd know they were using it?
- Could we see if the bacteria make more cells when there's food around?
- 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, *Okay, it sounds like we think we will be able to investigate bacteria to see if cells do need food of some kind to make more of themselves. Unfortunately, we cannot investigate bacteria ourselves in the classroom, so we're going to analyze data from another scientist who set up an investigation using E. coli bacteria. Has anyone heard of that before? If so, what do you know?*

Briefly have students share a few ideas about *E. coli,* if they have any.

3 · REVIEW A PROCEDURE TO INVESTIGATE HOW BACTERIA RESPOND TO DIFFERENT NUTRIENT LEVELS

10 min

MATERIALS: Pouring Agar video at https://www.teachersopensciedfieldtest.org/healing, Properties of Cooled Agar video at https://www.teachersopensciedfieldtest.org/healing, Streaking E. coli onto Agar Plates video at https://www.teachersopensciedfieldtest.org/healing

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...

- simple
- easy to use in the lab
- there are non-disease causing versions (strains)
- shares some similar features to other cells

If students have heard of *E. coli* because of food recalls, beach closures, etc., reassure them that while some kinds (strains) of *E. coli* can make people sick, the particular one used in this investigation does not.

Consider how we could test *E. coli*. Say something like, *We think cells might need the same kinds of things, like food, which we figured out in elementary science that living things like humans need to grow. Some of you suggested seeing if bacteria make more cells with food. So, we need a way to give the bacteria food, and in a way that will make sure we can control the amount they get and that it's all the same kind of nutrients so it's a fair test, right?*

Introduce agar. Display **slide G.** Say, *Scientists often use a gel called agar when they're trying to grow cells in a lab.* Share the information about agar from the slide.

- Agar is a dry powder made from red algae.
- It only dissolves in boiling water.
- When the agar solution cools, it forms a semi-solid jelly.
- Scientists create agar plates by pouring hot agar solution into a petri dish and cooling it.

Watch the Pouring Agar video at https://www.teachersopensciedfieldtest.org/healing and the Properties of Cooled Agar video at https://www.teachersopensciedfieldtest.org/healing 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.

Explain that agar can contain food and other nutrients or not. Say, *We want to be able to give our bacteria some kind of food to see if they make more of themselves. Scientists can add food and other nutrients to the agar plates.*

✱ SUPPORTING STUDENTS IN ENGAGING IN USING MATHEMATICAL 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. It will be easier for students to visualize how much more nutrient agar each plate contains when considering percentages.

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 show us for sure that cells need food and other nutrients to grow.*

Calculate percentages to more easily compare nutrient levels. Display **slide H.** Say, *Here's how the scientist set up 5 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. Thenthe 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 so easy at first glance to see what amounts of food each of the plates has in it. 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 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 the class calculates them, you may choose to type the percentages directly into your copy of the slides, or create a simple chart on a whiteboard. In the investigation's images that follow, the agar plates are labeled by percentage of nutrient agar.

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 try testing 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 nutrient agar we put in the plate - how much food is available to them.*
What would be our dependent variable? What would we be observing?	*How much bacterial growth we can see on that plate.*

Suggested prompts	Sample student responses
What control variables would we need to keep the same to make sure that our investigation is fair?	*The amount of bacteria we put on the agar plate to start should be the same* *All the bacteria should come from the same place.* *They should keep all of the plates in the same conditions (like temperature, light, amount of water).* *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.*

Show how bacteria were introduced to the agar plates. Display **slide I.** Explain that once the plates were cooled, a metal loop was used to transfer and spread the *E. coli* stock solution onto the plates. The loop was sterilized and cleaned by holding it in a flame until it glowed. The loop was then cooled by touching it to the agar on one side of the plate. This procedure was repeated for each plate with the different amounts of nutrient agar. Play the Streaking *E. coli* onto Agar Plates video at https://www.teachersopensciedfieldtest.org/healing to show students this process.

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 to keep the bacteria at. What data would that give us about these bacteria?

Predict outcomes of this investigation. Display **slide K.** Have students do a quick write in their science notebooks in response to these questions.

- When the bacteria are on the agar plate with no food or nutrients, what do you predict we will see happen with those bacteria?
- When the bacteria are on the plates with more food and nutrients, what do you predict we will see happen with those bacteria?

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 more bacteria than we started with (and maybe they won't even be able to survive with no food at all - even the ones we started with might die).*
- *With 100% nutrients, I think the bacteria will make lots more of themselves - we'll be able to see a lot of them.*
- *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 second-hand dataset 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

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 SECOND-HAND DATA FOR E. COLI GROWTH

10 min

MATERIALS: science notebook, *Reference: Second Hand Data for E. coli Grown on Agar with Different Nutrient Levels*, tape

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: Second Hand 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, *Second Hand 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** without giving anything away. For example, a WIS statement could be, *I see a lot of fur on the black background in the images*, and a corresponding WIM statement could be, *These scientists must have a pet.*

Have students make observations of the images using "What I See" comments. As they review the data, prompt students to first discuss WIS comments 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 pattern of increasing size and density of the area of bacterial growth, but then broaden it to other observations students made. Record some of the WIS comments on a white board, chart paper, or in an 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 data. Give groups 3–4 minutes to work on their interpretations and then have several groups share some of their interpretations aloud. Probe deeper into a few of the interpretations, specifically about the lack of growth at 0% nutrients and size, of the area of bacterial growth or how many bacteria there are. Record some of the WIM comments on a white board, chart paper, or in an shared electronic document.✱

✱ 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 level. An example of this might be photo analysis of the plate to determine what percentage was covered with bacteria.

The table below shows example WIS and WIM comments that the class might come up with.

WIS	WIM
We are not using a microscope to see what's on these plates, but we can see stuff on them! It looks like kind 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. That's a lot of bacteria!*
The bacteria doesn't grow on agar with zero nutrients.	*The bacteria need some food and nutrients to grow and make more cells.* *The bacteria can't use the agar alone for food.*
Overall it looks like the bacteria spots get larger as the % of nutrients increases.	*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.*

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 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 _____?*

5 · READ ABOUT DIFFERENT SINGLE-CELLED ORGANISMS

12 min

MATERIALS: *Lesson 10: Obtaining Information from Scientific Text*, *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 things helps us compare them and better figure out what we want to discover. So we have seen that bacteria need food to make more of themselves. But are bacteria the only single-celled things on Earth? There are more! Looking at examples of other things that are just one cell might help us figure out more about them and better understand whether we can consider them living things.*

Display **slide N.** Say, *Since there are many different kinds of one-celled things on Earth, we're going to share the job of investigating them. Each of you will get to read about a different one, 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 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?*

Remind students of the tool for obtaining information from scientific texts. Show **slide O.**
Distribute *Lesson 10: Obtaining Information from Scientific Text* and ask students to look at the handout. 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 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.

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.

Assign the reading and responses as home learning if needed.

✱ 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 are distributed among mixed-expertise groups assigned readings of 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 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 increase in difficulty:

- *Yeast: Why are there holes in my bread?* - just below grade level
- *Algae: What's making my fish tank look so green?* - on grade level
- *What are Bacteria?* - on grade level
- *Archaea: Extreme Living* - 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*, *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 who read 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 or different to the other organisms and cells we've seen?
- Do they relate to our healing story? If so, how?
- How does this organism's structure and function relate to where it lives? Why do you think it lives where it does?

7 · BUILDING UNDERSTANDINGS DISCUSSION ABOUT MULTI- AND UNICELLULAR ORGANISMS

13 min

MATERIALS: science notebook, *Lesson 10: Obtaining Information from Scientific Text*, *Reading: Archaea* or, *Reading: Bacteria* or, *Reading: Yeast* or, *Reading: Algae*

Lead a Building Understandings Discussion about multicellular and unicellular organisms. Display **slide R.** Convene 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 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:

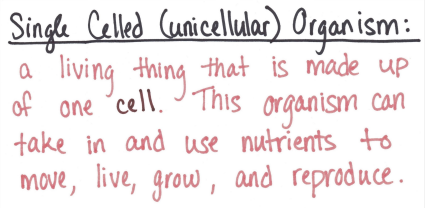
- There are many types of single-celled organisms, including bacteria, yeast, algae, and archaea.
- Both multiple-celled and single-celled organisms need food and nutrients to make more of themselves.
- Multiple-celled organisms have different types of cells that work together as a system of subsystems 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.

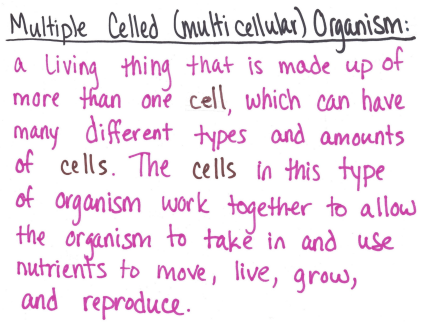
Conduct a discussion using the following prompts.

Suggested prompt	Sample student response
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.* *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!* *Living things eat and grow and make more of themselves and eventually die.* *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.* *Human cells are part of something else like the skin, bone or muscle.*
We said last time 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.*
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 the food and nutrients to grow and split to make more of themselves.*
Does anyone else agree with _____ that even though bacteria and other single-celled organisms are smaller organisms that are not part of a bigger organism made up of many cells, that they are still living? Can someone revoice that for me?	*Yes, bacteria and other single-celled living things can survive on their own without being part of a bigger organism.*
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?	*They can grow.* *They take in food.* *They can live.* *They can die.* *They can make more of themselves.*

Suggested prompt	Sample student response
Okay, 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?* *Many celled?*

Add "single-celled (unicellular) organism" and "multiple-celled (multicellular) 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?*


Single Celled (unicellular) Organism:
a living thing that is made up of one cell. This organism can take in and use nutrients to move, live, grow, and reproduce.


Multiple Celled (multi cellular) Organism:
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.

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 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 make more cells."

8 · READ ABOUT THE LIFESPAN OF CELLS

10 min

MATERIALS: *Reading: Lifespan of Cells*

Problematize how long cells can live. Say, *We just said that if bacteria and 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 S.** Introduce *Reading: 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 and read *Reading: Lifespan of Cells* with a partner. As they read, ask them to annotate or highlight anything that they read that will help us answer this question about whether cells live and die.

Reading: 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 reading the infographic, bring the class back together and discuss the question we are trying to figure out, *Do cells live and then die?*

Suggested prompt	Sample student response
What did you and your partner figure out about the lifespan of cells from the infographic and single-celled organism readings?	*Some types of human cells live longer than other types of cells.* *Algae can live for 24 hours to six days.* *Bacteria live on average for 12 hours but can make new cells in as little as 20 minutes.*

Suggested prompt	Sample student response
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 heart cells live for years.*
Okay so how is the function related to the lifespan 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.* *Yeah... but your heart that is on the inside of your body doesn't interact with stuff outside the body and you really need your heart to work all the time, so the cells last longer.*

Say, *Okay, now we know cells grow, take in food, and have a lifespan, or live and die, like other living things.*

9 · UPDATE PROGRESS TRACKER

5 min

MATERIALS: science notebook

Update Progress Trackers in science notebooks. Display **slide T**. Direct students to the Progress Tracker section of their 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. • Cells need food and nutrients (like we do) to make new cell parts to make more of themselves. • Cells can only live for a certain amount of time. Not all cells have the same lifespan.	• Can bacteria get in the way of healing? Why do we have to wash wounds and injuries? • Can single-celled organisms get hurt? • Can single-celled organisms get injured? • Do single-celled organisms heal? • How do single celled organisms heal? • 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?*

Construct an argument about what bacteria and other cells need to make more of themselves. Display **slide U.** 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 are emerging. 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 to make more of themselves.*✱

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 they 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?

✱ ATTENDING TO EQUITY

This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far through multiple different 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 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 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.