# LET'S TALK SCIENCE

## Seeding Argumentation About Cells and Growth

*by Deena Gould*

What's the best way to start an argument? As teachers, we can imagine the benefits of engaging students in shared discourse about the meaning and results of data, but it's a challenge to get them started. How do we convince our students to care enough to actually argue about science? This article shows how curiosity and disagreement about the germination and growth of a seed can be used to lead students to collaboratively build understandings about growth through cell division.

To begin a scientific argument, students need a topic, a good amount of data, a difference of interpretation of the data, and some language or discourse tools. What follows is a sequence of lessons I developed to help middle-grade students learn and argue about the core concept of how a plant root grows at the cellular level. These lessons support the scientific and engineering practice of engaging in argument from evidence as laid out in the *Framework for K–12 Science Education* (NRC 2012) and the core life-science concept that multicellular organisms grow when individual cells expand and then divide repeatedly. This core concept is to be central in disciplinary core idea 1 of the life sciences at the middle school level in the K–12 Framework and the *Next Generation Science Standards* (Bybee 2013, p. 14).

This sequence of lessons has three activities that are each done in groups consisting of three students each. The groups stay the same throughout the activities.

The sequence begins with an initial engagement with corn-seed germination and plant growth that elicits students' conceptions and differing ideas and launches their inquiry. This initial lesson takes three full class sessions and requires brief daily checks of plants over a period of approximately three weeks.

In the second activity, students collect data about the cellular nature of root growth using classroom microscopes and commercially prepared slides. Onion mitosis root tip slides can be purchased from online vendors (see Resources); the cost ranges from $3 to $6 for each of the 10 to 12 slides needed. The slides are stained and mounted, so they last through multiple class uses and several years. If microscopes are not available, the investigation can be done with

**FIGURE 1** Sample classroom line used to probe student ideas about seeds


images found online (see Micropolitan Museum in Resources).

In the third part in the sequence, students construct their understandings and come to consensus about the best explanation for how plant roots grow at the cellular level. These second and third lessons take four or five class periods each during the fourth and fifth weeks of the sequence.

I have successfully used this sequence of lessons to move the class dynamics away from a direct-instruction format to more student-led discourse. These lessons work very well during the first month of school to develop a foundation of understanding about cells and begin the essential scientific practice of engaging in argument from evidence.

## Differing ideas: Seeding the argument

To begin the first activity, all students are handed two kernels of unpopped popcorn as they enter the classroom. Students can see that the kernels come from a bag of ordinary grocery-store popcorn (approximate cost is $4 for six classes of 30 students each). The question "Is a seed alive?" is written prominently on the board or otherwise displayed at the front of the classroom. Students are directed to position themselves on a line drawn across the floor

**FIGURE 2** A student displays his team's seed-germination apparatus

**FIGURE 3** Role playing for group science talk

Directions: Use the phrases in Figure 4 to tell what you could say if . . .

- you see something you are unsure about but think it might be important.
- you don't understand what somebody said.
- you don't understand why somebody thinks a certain way.
- somebody in your group says, "I think some seeds are still dead."
- you have an idea that might be evidence, but you aren't very confident.
- somebody makes a suggestion that seems really bizarre to you.
- someone's idea doesn't make sense to you.
- you feel like someone has a good idea, but you don't understand it.
- you want to disagree, but you want to be respectful.

of the classroom to indicate their level of agreement in response to the question. Figure 1 shows an example of how the line might look.

Student positions on the line typically indicate a diversity of thinking. I use their positions to form groups of students with differing ideas about seeds and what it means to be alive. This diversity of thinking is a good place from which to develop a classroom community that supports argumentation. More student-initiated science talk happens when students are connected with peers who have opposing perspectives (Clark and Sampson 2007).

Students then write about their thinking and reasoning for their responses on their Activity Worksheets and discuss with their peers. (See the Activity Worksheet on pages 53–55 for activity details and connections to the Common Core language-arts standards.) Student talk typically includes statements such as "Seeds are not alive because they don't move. They don't breathe. They can't do anything." There are also students who think that the seeds are alive because they can grow into plants or because they can reproduce. Some students believe the seeds are neutral or that they are not alive yet but will be if they sprout. Other students say that to have enough evidence to conclude that the seeds are alive, they would need the seeds to show a combination of features. At the conclusion of this first day, students individually reflect in their notebooks, offering justifications for their own ideas and comparisons of their ideas to those of their teammates. Many students revise their thinking and writing after talking with other students.

On the second day, I give a mini-lesson about scientific observations, measurements, and inferences. Then I challenge the groups to design an apparatus that will enable them to observe, measure, and make inferences about the seeds over the next three weeks. There are clear plastic cups, soil (use only store-bought soil for safety), paper towels, water, and rulers out for students to use in designing an apparatus they will use for their investigation (approximate cost of materials is $15). We have a brief discussion about how a scientist might design the apparatus differently from how a gardener or farmer might plant the seeds. Each group uses its six to eight seeds and two or three plastic cups to assemble the apparatus. Groups engineer the materials in a variety of ways so they can see and measure the seeds as they germinate and begin to grow (Figure 2). On day 3, each group also begins its investigation by designing a chart or note-taking format to record observations, measurements, and inferences over time.

Student groups observe and measure their seeds daily, and individual students write about their interpretations and inferences. This should only take a few minutes each class period; the remaining time could be used to keep pace with the rest of the curriculum. Students intuitively begin talking about what counts as evidence in their investigations, however they might need guidance in writing inferences based on facts and reasoned judgment as articulated in the Common Core language-arts standards. The popcorn seeds usually germinate in 5 to 10 days, although students see changes as

**FIGURE 4** Phrases to scaffold argumentation

- What do you think this means? Why do you think that?
- Here's another way to think about that…
- Why do you think that would count as evidence?
- What else could we measure or describe to make a claim about the seeds?
- Do you mean…?
- What else could have caused that?
- I've noticed that…
- Have you thought about…?
- I don't understand what you're saying; will you explain more?
- Why is that important?
- I don't understand why you think that. Will you tell me your reasoning?
- How can we use that to make a case for our idea?
- How will we explain this?
- Good idea, but what about this?
- What other evidence could go with that?
- This is what I think…
- Sounds good, tell me more.

early as the first day, when the seed begins to swell or the seed coat breaks. This first day the seeds are planted, day 4 of part 1, is a good time to introduce the language scientists might use to talk with each other about investigations. See Figure 3 for a role-playing scenario and Figure 4 for phrases that can serve as scaffolds to help students take the lead in directing their discourse. These scaffolds can be placed in sturdy, clear, plastic picture frames to post with the groups at their workstations .

Some students suggest that the seed swelling could be used as evidence of life because the seeds have changed in size, or have "grown." Others counterargue that this is not evidence of life, because nonliving things can swell up when filled with water. Teachers need to move among groups and take notice of and respond to what students are doing, what they are saying, and the evidence and reasoning they discuss. An essential first step in building a climate that will lead students to the scientific practice of

**FIGURE 5** **Phrases for talking about cells**

- Why do you think that? What is your reasoning?
- What is the evidence for that?
- Why do you think that counts as evidence?
- What claim can we make about how the root is growing?
- Do you agree? Do you disagree? Why?
- What is the pattern here?
- That's only one piece of data; what about all the data together?
- What about these other cells?
- What is happening inside the cell?
- Why do you think that will support our claim?
- What exactly is our claim?
- What about this example?
- I agree because…
- I don't agree because…
- Look at this cell. What's happening in this cell? Why?
- How is that related to what is happening in the other cells?
- Do we have enough evidence to say that? What kind of evidence do we need?
- How can we explain this one over here?
- How often is that happening? Why?
- What reasons do you have for saying that?
- We don't have to keep that claim. We could change our claim.
- If we change our claim to…
- This makes sense to me…
- This doesn't make sense to me…
- How about this example? How does that support our claim?
- Here's a different one. What can we say about it?
- I just thought of something about what we said earlier…
- Can we make that claim even with this…?
- Good idea, but what about this…?
- How can we change the claim so we use the data from more cells?
- What does that mean?
- This doesn't make sense to me.
- I think we need to change our argument.
- I think this means that…
- These cells show that…
- How do these go together?
- Do you agree?
- Why do you think that makes sense?
- This doesn't make sense to me…
- Here's another way to think about it…

argumentation requires that teachers acknowledge and respond to student use of evidence and reasoning, however current studies report that this behavior is rare in American classrooms (Levin et al. 2012; Michaels, Shouse, and Schweingruber 2008).

Students are always excited when they see popcorn kernels germinate and grow into plants. They typically suggest that the seeds are alive because they grow, mature, and change over time. They make claims that the seeds are growing and use their measurements and observations to support these claims.

**FIGURE 6** Claim, evidence, and reasoning framework with example student responses

**Claim: What is the best explanation?**
Cells grow and grow until they divide into more cells, so the root and plant grow as long as they get water and energy. The nucleus of the cell splits to start the next part of the root as long as it has the right stuff from water and energy. More cells build up on each other when it grows.

**Evidence: The observations, information, or data analysis that support the claim.**
The evidence came from the microscope at x400 magnification. When you zoom in, the cells don't look the same. Some cells are stretching bigger. Some cells stretched apart, and it looked like they came apart into twins. The pattern is that the nucleus swells, the nucleus comes apart, and then the whole cell comes apart. Cells are only making one other cell at a time. There are lots of cells changing, but not all of them. The plant and root didn't grow when they didn't get water or energy.

**Reasoning: The justification that tells why the data support the claim.**
The cells are doing more than just swell up. In some of the cells, you can actually see it stretch apart. There's more happening in the nucleus, and it is where it starts to split up. The splitting up makes one cell become two, so that would make it get more cells. That's how it makes sense the most. More cells would probably make it grow, but the plants were dying without the right water or energy. It makes sense that the nucleus does this, but only if the seed gets water and stuff, because it didn't grow without the water. You can see dots and stuff in the nucleus that must be making it happen.

From interactions with their peers, many students change their thinking and writing about what it means to be alive. They realize that there's a wide range of reasonable and acceptable answers to many scientific questions. They talk about what it means to be alive and disagree about whether or not they have enough evidence to claim that the seeds were alive before they germinated. Students often suggest that scientific explanations of growth can go deeper than the macroscopic measurements and observations they are collecting. When students see microscopes set up around the room, the group talk usually turns to the idea of looking at cells. They notice that the roots are growing fast and are excited at the prospect of being able to observe root cells under a microscope.

## The microscope investigation: Data and reasoning

After the germination, students begin to talk about what might be happening at the cellular level that enables the seeds, particularly the roots, to grow. Students typically hypothesize that the individual cells are swelling and enlarging to make the organism grow, but many have the misconception that the cells themselves or the number of cells remains the same. Alternately, some students believe that the cells make more cells, but they don't have a concept of where the cells get the information to do so. Students usually have misconceptions about the roles of the nucleus, chromosomes, DNA, and cell cycle. Many students imagine cells as little organisms in-

**FIGURE 7** Enlarged root-cell slides

stantly stamping out duplicates, and they suggest that moving water or soil might be the driving force.

During the fourth week, students use compound microscopes to look at the commercially prepared slides of onion root tips. These slides have been stained to highlight the structures inside the cells as they undergo mitosis and cell division. Root tips are a good choice for this lesson because they contain cells that are growing and dividing rapidly. Students are able to clearly observe the chromosomes of the nuclei in various stages of mitosis and cell division at 250 or 400 times magnification. This collection of cells offers a jigsaw puzzle the groups can use to figure out what might be happening at the cellular level that leads to the rapid root growth they observed earlier.

Groups work together to observe, analyze, and make inferences about the data on the slides. Students are directed to sketch and label their observations,

**FIGURE 8** Rubric for engaging in argument from evidence

Socially constructed meaning develops over time, and as such should be assessed by observations of students in collaborative contexts (both oral and written).

| Undeveloped (1 pt.) | Beginning (2 pts.) | Progressing (3 pts.) |
|---|---|---|
| | **Claim** | |
| Claim is not clearly defined or remains vague. | Claim becomes more descriptive over time. Claim uses scientific language. | Clarity of claim increases over time. Claim may begin to have predictive or model-like qualities. |
| | **Evidence** | |
| Evidence remains anecdotal or stays at the level of personal experience. Evidence over time remains irrelevant. | Labeled and relevant data, facts, or scientific observations are offered and described as evidence supporting claim. | Patterns and connections among evidence are explained. Evidence over time becomes more relevant, sufficient, and coherent. |
| | **Reasoning** | |
| Focus remains on being right or wrong instead of the thinking and reasoning. | Thinking is made visible or explained. Inferences and reasoning make sense and have logical or scientific qualities. | Reasoning justifies why or how the evidence supports the claim. Reasoning is based on scientific principles; is convincing or persuasive; and may address counterarguments, exceptions, or doubts. |
| | **Socially constructed meaning** | |
| Group collaboration remains limited to dividing work, turn taking, or distributing tasks. | Students listen to, question, and respond to each other about the science content. Groups consider more than one interpretation of evidence. Groups use collaborative scientific discourse. | Students socially reconstruct, alter, fine-tune, and defend their scientific ideas repeatedly over time. Students initiate, direct, and fluently use the language and discourse of science. |

Ideas for this rubric were gleaned from Berland and McNeill (2010). The final rubric reflects the author's own interpretation, which has been made applicable to these lessons.

count occurrences of variables they deem relevant, look for patterns, and collect evidence so they can make claims about what is happening at the cellular level that enables roots to grow. Teachers can lead students to role-play discourse situations using the phrases in Figure 5.

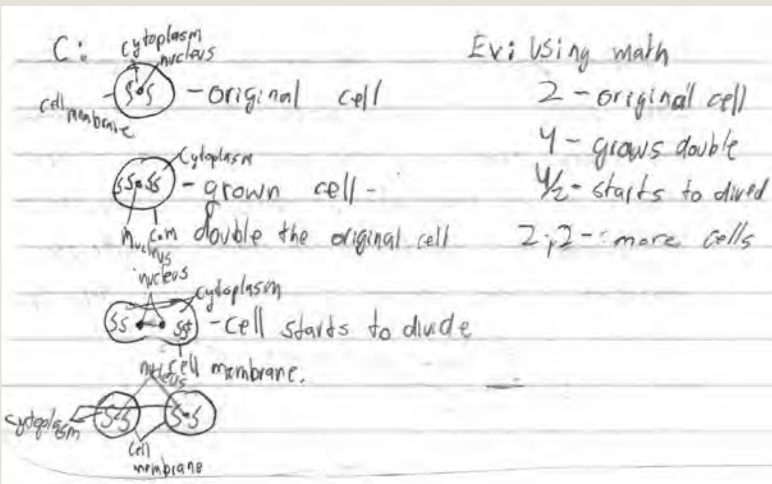
Listening to students talk during this activity is similar to listening to students putting together a jigsaw puzzle: Some suggest that they found cells that go together in a pattern, followed by a group conversation about how, why, and if the cells fit together or a student locating a newly found piece to fit into the puzzle. Groups that seem unsure about how to proceed are prompted to use the phrases and questions posted around the room (Figure 4). The prompts also help students reinterpret data or consider parts of the data that don't fit with their original thinking. For example, students who find "evidence" confirming their original thinking about swelling of cells sometimes miss the clues inside the nuclei until other students point them out. Teachers should circulate among the groups to notice, acknowledge, and respond to student use of evidence and reasoning. The prompts in Figure 5 are useful both to teachers and to students.

## The argument: Making and defending claims

Groups use the structural framework shown in Figure 6 to form a claim that they will later share with another group. This framework originated from the work of Toulmin (1958) and has been used in many science classrooms and current research (Berland and McNeill 2010; Clark and Sampson 2007; Michaels, Shouse, and Schweingruber 2008). The framework includes a claim, evidence, and reasoning (see Figure 6). As a group, students discuss and decide on the best claim to explain how the root grew based on the data analyzed. Some groups make bold claims and even suggest a sequence that the cells undertook. Other groups' claims are more modest, such as that cells divide up the nucleus in order for an organism to grow or that roots grow when cells expand and then split into two more cells. Ask groups to revisit and revise their claims the next day and offer them enlarged photos of the microscopic slides that they can quickly reference (Figure 7).

At this point in the set of lessons, students have a topic, a good amount of analyzed data, a classroom community that focuses on thinking (and makes it ok to be wrong), some discourse tools, and a meaningful reason to engage in argumentation from evidence. Then I select groups with opposing ideas to meet with each other to present and defend their claims. Students are still new to this scientific practice, so the phrases to scaffold the discourse (Figure 5) remain posted around the room, and students are reminded to keep the experience respectful by sticking to the phrases and questions on the posters.

**FIGURE 9** Student work sample




Many of the groups are shy about presenting their claims publically, and there can still be hesitation to disagree. There is usually talk that leads students to reconsider the meaning of data as evidence and to consider different perspectives. I ask students to take notice of and comment on the justifications and reasoning of their peers rather than the accuracy of their claims.

## Assessment

It's important that teachers use classroom observations and interpretations of student behaviors as formative assessments. When students are new to the practice of argumentation, there is often better evidence of learning in these observations than in a single example of student writing (Berland and

McNeill 2010). It's also important to consider a collection of observations over time. Figure 8 offers a rubric for assessment appropriate for this sequence of lessons. When assessing students, keep in mind that they need time to reflect, discuss, disagree, recheck, and revisit data multiple times in different contexts to demonstrate the practice of argumentation from evidence. Students also need a climate where it is safe to be wrong and where the focus is on reasons for ideas rather than only on the accuracy of ideas. Teachers might also consider student sketches as evidence of learning (Figure 9).

## Conclusion

Students emerge from these lessons with enthusiasm for doing real science, new skills in "talking" science, novice but authentic experiences in the practice of engaging in argument from evidence, and a good foundation for thinking at the cellular level. Throughout the rest of the school year, my students and I called on our collective memory of the onion root mitosis slides to remind ourselves about cells and chromosomes. When we began learning about genetics, and later evolution, it was easy for students to imagine these topics at the cellular level, and they themselves directed the conversation there. Additionally, students continued to use the talk stems and phrases in the posters to build on the argumentation skills they'd learned.

If there had been more time, I would have helped students build skills for reaching consensus and require that they prepare a formal public poster for a wider audience. In following lessons, it was useful to ask groups to imagine a situation where another team disagreed with them; they were able to role-play how they would respond.

I have used this sequence of lessons with classes that include English language learners, special education students, and advanced honors students. The quest to figure out how a seed grows into a seedling at the cellular level motivates diverse groups of students to look for patterns of evidence and to interact with peers to develop a coherent claim. We, as teachers, need to remember that students argue when they have a strong interest in a topic, when they are able to gain enough evidence to build a coherent claim, and when they have contributed to building a community that values thinking, reasoning, and genuine scientific pursuits. ■

### References

Berland, L.K., and K.L. McNeill. 2010. A learning progression for scientific argumentation: Understanding student work and designing supportive instructional contexts. *Science Education* 94 (5): 765–93.

Bybee, R.W. 2013. The *Next Generation Science Standards* and the life sciences: The important features of life science standards for elementary, middle, and high school levels. *Science Scope* 36 (6): 13–20.

Clark, D.B., and V.D. Sampson. 2007. Personally-seeded discussions to scaffold online argumentation. *International Journal of Science Education* 29 (3): 253–77.

Levin, D., D. Hammer, A. Elby, and J. Coffey. 2012. *Becoming a responsive science teacher: Focusing on student thinking in secondary science.* Arlington, VA: NSTA Press.

Michaels, S., A.W. Shouse, and H.A. Schweingruber. 2008. *Ready, set, science! Putting research to work in K–8 science classrooms.* Washington, DC: National Academies Press.

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards for English language arts & literacy in history/social studies, science, and technical subjects*. Washington, DC: NGAC and CCSSO. *www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf.*

National Research Council (NRC). 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

Toulmin, S. 1958. *The uses of argument.* Cambridge: Cambridge University Press.

### Resources

Carolina Biological Supply—*www.carolina.com*

Micropolitan Museum images of onion root tip—*www.microscopy-uk.org.uk/micropolitan/botany/frame4b.html*

Nasco (scientific supply company)—*www.enasco.com*

**Deena Gould** (*DNAmartin@cox.net*) was a science and language teacher in Mesa Public Schools from 1987 to 2012. She is currently a graduate student in the Mary Lou Fulton College of Education at Arizona State University in Tempe, Arizona.

## Activity Worksheet: Seeding Argumentation About Cells and Growth

### Activity 1: Is a seed alive?

**Day 1**

1. What was your position on the continuum? Mark your position with an X.

Is a seed alive?

Yes, definitely _______________ No, definitely not

2. What was your thinking? What ideas did you have about the seeds that explain your thinking? What information or evidence would convince you to move further along the continuum? Write your main topic statement and supporting details in complete sentences.

Vocabulary: *seed, alive, thinking, reasoning, justification*

[Common Core connection—CSS.ELA-Literacy. WHST.6-8.2d: Use precise language and domain-specific vocabulary to inform about or explain the topic (NGAC and CCSSO 2010).]

3. What different ideas were discussed in your group? Which ideas were similar to yours? Which ideas were different from yours? What justifications did you share with the group? What justifications did you hear from others in your group? Did you change your thinking? Why or why not? What information or evidence would your team need to make a claim about whether or not these seeds are alive?

Vocabulary: *seed, alive, thinking, reasoning, justification, claim, evidence*

[Common Core connection—CCSS.ELA-Literacy. WHST.6-8.10: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks and purposes (NGAC and CCSSO 2010).]

**Day 2: Designing the apparatus**

*Materials (per group)*:

- 2 clear plastic cups
- Paper towels
- 2 cups of soil
- 2 rulers
- 6 popcorn seeds
- Water
- Graduated cylinder or other tool for measuring volume
- Permanent marker to label cups
- Chemical splash safety goggles

*Directions*

Design an apparatus that will enable your team to observe, measure, and make inferences about the seeds over the next three weeks. Design your apparatus for making scientific observations. Make a labeled sketch of your design in your lab notebook. Construct your device and plant your seeds.

Vocabulary: *apparatus, volume, mL, soil, seed, scientific observations*

**Day 3: Designing the chart**
Design a chart or note-taking format that your team will use to record observations, measurements, and inferences over the next three weeks. Discuss the answers to the following questions with your group:

- What main headings will you use?
- What variables could you observe and measure?
- What units of measurement will you use?
- What data will you record?
- What measurements and observations might help you determine if the seeds are alive?

After discussing the answers to these questions with your group, prepare your chart, table, or note-taking format.

Vocabulary: *measurement, inferences, facts, reasoned judgment, speculation, unit of measurement, decimal*

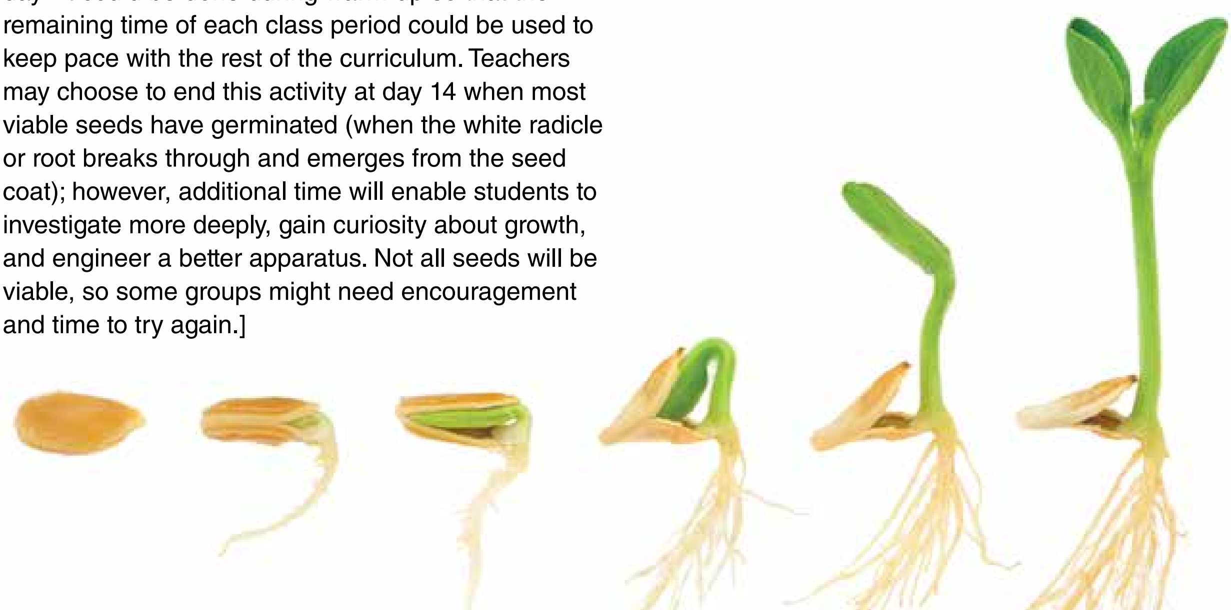
[Common Core connection—CCSS.ELA-Literacy.WHST.6-8.2a: Organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), when useful to aiding comprehension (NGAC and CCSSO 2010).]

**Days 4–21: Recording data and making inferences**
[Recording data should only take a few minutes each day. It could be done during warm-up so that the remaining time of each class period could be used to keep pace with the rest of the curriculum. Teachers may choose to end this activity at day 14 when most viable seeds have germinated (when the white radicle or root breaks through and emerges from the seed coat); however, additional time will enable students to investigate more deeply, gain curiosity about growth, and engineer a better apparatus. Not all seeds will be viable, so some groups might need encouragement and time to try again.]

Use the chart your group designed to record data. Make close, detailed, and careful observations. Some changes may be very small. If possible, use a magnifying lens or stereo-microscope to aid in making your observations. What do you think the observations mean? Include a section or column for inferences. What do you think counts as evidence that the seeds are or are not alive? What inferences can you make about the changes you observe? Does your apparatus enable you to observe and measure the seeds? How could you improve your apparatus? If time allows, change your apparatus and acquire more seeds. Role-playing science talk with your group will give you ideas for your interpretations or inference section.

Vocabulary: *inference, interpretation, evidence, seed coat, embryo, root, shoot, germination, grow, seedling, change over time, facts, reasoned judgment, speculation*

[Common Core connections—CCSS.ELA-Literacy.WHST.6-8.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. CCSS.ELA-Literacy.RST.6-8.8: Distinguish among facts, reasoned judgment based on research findings, and speculation (NGAC and CCSSO 2010).]



## Activity 2: Microscope investigation

[This activity typically takes four full class periods and begins around day 20, when many seeds have germinated and begun to grow, however it could begin as early as day 14 and as late as day 25.]

*Before using the microscope:*
The compound microscope can enlarge your view 250 to 400 times. How could the microscope aid you in understanding the changes in your seeds? What do you think is happening at the microscopic level that enables your seeds to grow? Write your main topic statement and supporting details in complete sentences. Explain your reasoning.

[Common Core connection—CCSS.ELA-Literacy. WHST.6-8.10: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences (NGAC and CCSSO 2010).]

*Using the microscope:*
Materials (per group)

- Compound microscope,
- Prepared slide of onion root mitosis

*Directions:*
Observe the prepared slides of onion root tips. Make labeled sketches of at least five cells. Label the structures inside the cells. What do you think is happening at the cellular level that enables the root to grow? Record data, observations, and inferences in an organized format. What variables could you count or measure to figure out what is happening? How might the cells or data relate to each other? How could you organize your data to make sense of what it means? Role-play discourse situations with your group to give you ideas for recording your observations, inferences, and analysis.

[Common Core connection—CCSS.ELA-Literacy. WHST.6-8.2a: Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), when useful to aiding comprehension (NGAC and CCSSO 2010).]

## Activity 3: Scientific argument from evidence

[This activity requires three or four class periods.]

Use the format below and the discussion with your group to prepare an argument.

Claim: What is the best explanation?

Evidence: What observations, information, or data analysis support the claim?

Reasoning: What is the justification that tells why the data support the claim?

[Common Core connections—CCSS.ELA-Literacy. WHST.6-8.1: Write arguments focused on discipline-specific content. CCSS.ELA-Literacy.WHST.6-8.1b: Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic. CCSS.ELA-Literacy.WHST.6-8.1c: Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence. CCSS.ELA-Literacy.WHST.6-8.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience (NGAC and CCSSO 2010).]