Investigating Plants Needs with Wisconsin Fast Plants®

A Next Generation Science and Common Core Standards Aligned Unit for Kindergarten through Second Grade
Investigating Plants Needs with Wisconsin Fast Plants®

This first series of lessons are designed for students to develop an evidence based explanation that answers the question: “Do plants need water to grow?” Initially, the teacher brings in a bouquet of flowers to engage students’ prior knowledge of plants and build curiosity about what causes there to be less water in the vase after a weekend. This sets the stage for recognizing the value of having carefully recorded observations to use for comparison and leads to introducing the questions, Do plants need water to grow?. Students then engage in a sequence of two experiments and read a story from which evidence is gathered to answer the driving question. Three experiments are planned and carried out in this set of lessons because students are being supported to learn science practices, also. The first experiment engages students in interactive, teacher-guided experimental design. Then, the same strategies that students engaged with when designing the first experiment are used in designing the second experiment about plants using water and a third about plants needing light, allowing the teacher to gradually release responsibility to students for planning experiments. Students also pay attention in these lessons to when they are “learning like scientists” (i.e. engaging in science practices).

In designing the first experiment to gather evidence relevant to the question, Do plants need water to grow? the teacher gives explicit guidance for setting up an investigation focused on one variable at a time and uses appropriate scientific language. Then, students are guided to collect data (measuring the water level) then use those data to compare water levels in the reservoirs of their wicking growing systems (which contain growing Fast Plants) with reservoirs of growing systems that do not contain Fast Plants. The experiment is designed to generate evidence that students can clearly observe that plants use water when they grow (causing there to be less water in the reservoir of growing systems with plants compared to the growing systems without seeds/plants).

For the second experiment, students work collaboratively to design another way to test if plants need water to grow. With a little less direct guidance than in the first experiment, students plan a fair test between two growing systems that both have seeds, but one has no water. Observations from this experiment are added to data gathered in the first experiment, plus information obtained through close reading of a story about the importance of the Nile River for plants in Egypt. The students are guided to collect and share data, compare data sets. Then, students make very simple claims about whether plants need water to grow, based on patterns found in all data combined.

Next, a third experimental design opportunity provides students with a little more autonomy to design a similar investigation driven by the question, Do plants need light to grow?. Students use the same scaffolds as used in designing fair tests to learn if plants need water to grow, taking more responsibility in this third opportunity to apply their understanding of the practice. Similarly, this is the third opportunity to use the practices involved in making careful observations and using them as evidence to develop and communicate explanations. This iterative approach to experimental design makes the most of growing Fast Plants and supporting a logical cluster of Standards-based learning outcomes.

As students’ Fast Plants begin to flower, attention is turned to flower and bee structures and their functions. Students use bee sticks (dried bees glued on toothpicks) to pollinate flowers and learn about the important role that bees play in pollination. Then, students use what they have learned to develop a solution to a problem they are presented with: What if I could no longer get bees like we used to make our bee sticks? How could you make a model that would work like a bee does? Then, students design and later build models that can successfully pollinate Fast Plants, using a variety of materials made available. After the models are built and tested, students present their solutions, using argumentation practices to make a case for the success of their designs.

This set of lessons concludes with students continuing to observe their plants periodically as they complete the flowering plant life cycle, producing seed pods and seeds. The formation of flowers, seed pods, and seeds are all opportunities to reinforce the cross-cutting concept of structure and function.

Throughout the lesson, the teacher makes use of formative assessments – in the form of pictures on exit slips – and T charts to clearly show similarities and differences. The lessons also include procedures to chart (and acknowledge and value) the preknowledge and questions that the students bring to the classroom from home and community. The lesson takes advantage of the opportunity to review a key core disciplinary idea from 1st grade regarding the parts of a plant, emphasizing how the shape of a structure is directly connected to its function.
This calendar shows the recommended start dates for lessons and can be modified to meet your own classroom requirements. For additional details about Wisconsin Fast Plants (planting, tending, troubleshooting, producing seed, and more) visit our website at www.fastplants.org.

Set up lighting system and prepare planting materials prior to Lesson 2.

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By Week 5 pods develop, seeds form, and students can experience the full flowering plant life cycle.

Reading Green Story 4 describes the structure and function of seeds.
Lesson 1 Snapshot Page

Key Concepts
• Plants have external parts.
• The shape of structures are related to their functions (introduction to the idea).
• Questions in science are based on observations and lead to investigations to find out more information.

Science & Common Core Standards
• CCSS.ELA-Literacy: SL.K1f; SL.1.1; SL.2.1;

Evidence of Student Understanding
Students will be able to:
• ask questions based on their observations of flowers.
• actively participate in producing a class drawing that represents what they notice about a bouquet of flowers.
• relate the structures present in cut flowers to the structures present in whole plants.

Time Needed
50 minutes

Materials
For the class:
• 1 bouquet of flowers (e.g. cut fresh or purchased from a grocery store or florist) of the right size and stem length to work in a “vase” made from a 1 quart, clear plastic deli-container (the water reservoir section of a Fast Plants deli-container growing system).

A bouquet of flowers
1. Introduce the idea of investigating plants by bringing out your bouquet of flowers, and asking the class: What parts of a plant do I have in my bouquet?
2. Draw for the class as they direct you to record their observations of a flower from the bouquet (you may have students first draw what they see when they look closely at one flower from your bouquet).
   a. Use students’ words to name parts of plants at this time.
   b. Keep this drawing for later reference.
3. Now ask, What parts of a plant are missing from the flowers in my bouquet? and discuss as a class.
4. Place the bouquet of flowers in a “vase” made from the water reservoir of a Fast Plants deli-container water reservoir.
   • Fill the “vase” with water while students are watching so they are likely to notice how much water is added.
5. Take a picture of the flowers in their vase if possible or make a sketch of the vase that clearly shows the water level in the vase.

Key Terms
• bouquet, vase, deli-container
Lesson 1, Friday before Week 1 (Day 1)
A bouquet of flowers

In this first lesson, a bouquet of flowers is used to provide context for learning about plants' needs for growth and stimulate students' prior knowledge of plants.

Advance Preparations
In preparation for the first two weeks, gather all growing materials (see Teachers Page 1, Growing Fast Plants).

a) Prepare a flower bouquet that has only flowers on stems (without leaves) for use during Lesson 1. Include at least twelve fresh flowers in the bouquet, so they will use enough water over the weekend that it will be easily observed.

b) Check to be sure the bouquet can be placed in a "vase" made from a 1-quart, clear plastic deli container exactly like the one that will be used as the water reservoir when planting Fast Plants. This is purposely done to support students in understanding that the drop in water level they will be able to see in the "vase" is like what they will be looking for in the experiment they will be conducting.

Implementation Outline

Day 1 begins on a Friday intentionally.
1. Introduce the idea of investigating plants by bringing out your bouquet of flowers, and asking the class: What parts of a plant do I have in my bouquet?

2. Draw for the class as they direct you to record their observations of a flower from the bouquet (you may have students first draw what they see when they look closely at one flower from your bouquet).

   a) Acknowledge the names for plant parts that students use on their own from prior knowledge. However, this is not yet time for labeling students' observations with academic terms. Instead, use students' words, including those from everyday language. The class drawing will include a stem and a flower, and it may also include some parts of the flower (e.g. petals, pollen), and thorns (if present).

   b) Keep this drawing to refer back and add to throughout the investigation.

3. Now ask students, What parts of a plant are missing from the flowers in my bouquet?

4. Hold a short discussion about what to do with the bouquet to engage students' prior experiences, and conclude by placing the flowers in a deli-container "vase." Make it obvious that the "vase" is full of water.

   • NOTE: Elementary students are frequently engaged in science lessons that involve categorizing objects and organisms as "living" or "nonliving," and the bouquet of flowers in this lesson demonstrates one of the problems with that practice. Deciding how to categorize cut flowers is challenging. Although cut flowers are no longer whole beings because they are not attached to the plants that produced them, they continue for several days (even weeks) to do processes that are necessary for life. For example, cut flowers continue using matter and energy that is stored in molecules that make up their tissues, and if green tissue is present (as in leaves) and light is available, they can conduct photosynthesis. Eventually, stem tissues drown and the flowers die because they lack the other important plant structures (e.g. roots, leaves) and their functions. However, as long as cut flowers continue with life processes, they use (and need) water, which causes the water level in the vase to drop.

   We recommend avoiding this exercise of categorizing things as living and nonliving because some things (like cut flowers or leaves) are confusing, and the categories can be offensive to children who's cultures regard many or all physical elements in nature as living.

5. If possible, take a picture of the vase of flowers for use on Monday. Alternatively, make a careful sketch that clearly shows the water level.
Lesson 2, Wk 1 Snapshot Page
Monday (Day 4)

Key Concepts
• Scientific questions can arise from wondering about an event that is observed.
• Some scientific questions can lead to investigations that include experiments for gathering information that may help answer the question.

Science & Common Core Standards
• NGSS: K-LS1-1, 1-LS1-2, 2-LS2-1 Science Practices: 1, 3, 4, 8
• CCSS.ELA-Literacy: SLK.1-6; SL1.1-6; SL2.1-6

Evidence of Student Understanding
Students will be able to:
• Compare and contrast the conditions of the flowers and vase before and after the weekend, using appropriate words to identify what is the same and what is different.
• Ask questions based on observations that might lead to more information related to the difference in the water level in the flower vase.
• Work with a partner, using prior experiences and observations to sequence the Planting Puzzle in an order that makes sense.
• Participate in a collaborative process to order the Planting Puzzle correctly.

Time Needed
60-90 minutes

Materials
For each student:
• 1 exit slip card
For each pair of students:
• 1 copy of the Planting Puzzle on Teacher Page 1, all pieces cut apart (placed in an envelope or paper clipped together for easy distribution)
For the class:
• Bouquet of flowers in the deli container vase from Lesson 1 (with dropped water level)
• Equipment to project the picture taken of the bouquet in its vase from Lesson 1, or printed copies of the photo for students to share, or the sketch made if no picture was taken
• Wall space or chart that is titled We are learning like scientists when we . . .

Do plants need water?
Experiment 1
1. Re-engage students in this plant investigation by asking: What looks the same and what looks different about our bouquet, now?
   • Write class lists on a t-chart or in two columns, including all students' ideas about similarities and differences that are noticed.
2. Engage students in wondering about what might have caused the differences.
   • Encourage interest in looking at the picture or sketch of the bouquet and vase from Lesson 1 for comparison.
3. Help students recognize the value in having a picture or sketch (that accurately recorded the starting conditions) for comparison.
   • Write on a sentence strip: record, use, and share pictures of observations, explain that is what the class is doing, and then post on the chart or wall space that is titled We are learning like scientists when we . . .
4. Focus attention on the difference in vase water levels to pose the question: Do plants need water to grow?
   a. Post this on the Question Wall along with other student-generated questions.
   b. Also, add a new entry to the We are learning like scientists when we . . . chart: "Ask questions."
5. Use the class picture that was drawn during Lesson 1 (showing the parts of a plant) to recall how plants that are growing differ from cut flowers (e.g. different structures, still growing).
6. Introduce the class’s Fast Plants investigation that will seek answers to the question, Do plants need water to grow?
7. Explain and distribute the Planting Puzzles to teach students how to plant Fast Plants, while also giving sequencing practice.
   • After student-pairs decide on a sequence, hold a whole-class discussion to reach consensus about the correct order.
8. Conclude the lesson by having students draw arrows on an exit slip to show how they expect the amount of water in the bouquet's vase will continue to change: Will the amount of water in our bouquet's vase become less, more, or stay the same by tomorrow morning?

Key Terms
• same, different, record, scientists, investigation, puzzle, less, more, arrow
Lesson 2, Week 1: Monday (Day 4)
Do plants need water? Experiment 1

In lesson 2, students are guided to notice that the water level has decreased in the vase holding the bouquet of flowers from Friday. This observation is used as the basis for asking the question, *Do plants need water to grow?* and designing an experiment to gather information that may help answer that question. With this lesson, students also begin to pay attention to when they are "learning like scientists" (i.e. engaging in science practices).

Advance preparations:
- a) Check that the water level has dropped sufficiently in the "vase" that it can be easily noticed. If it is not (perhaps cold temperatures over the weekend or older flowers), pour out some of the water before class begins.
- b) Prepare to project the picture of the vase that was taken on Friday or make a few prints of the picture (or sketch) for the class to observe.
- c) Prepare one copy of the planting puzzle (Teacher Page 1: Planting Puzzle) for each pair of students.
- d) Choose a wall space or create a chart that can remain posted for at least the next four weeks, and title it: *We are learning like scientists when we . . .*

Implementation Outline

1. Re-engage students in this plant investigation by asking the class: *What looks the same and what looks different about our bouquet, now?*
   - Write lists on a t-chart or in two columns that include all students' ideas about similarities and differences.

2. Begin to encourage students to wonder about what might have caused the differences observed. Write "wonderings" in a separate list as they arise (do this in a way that questions can later be transferred to the question wall).

3. Try to elicit from students a suggestion that it would be helpful to see the picture of what the vase looked like on Friday to compare with the vase today. Show the photograph (or sketch), and allow time for students to add to the class lists of similarities and differences.
   - If necessary, guide students to notice the difference in water levels, now.

4. Recall and draw attention to all examples where an additional difference was noticed or more detail could be described about a difference because of having the picture as a record of the original conditions. Explain and write on a sentence strip that the following are important for learning in science: *record, use, and share pictures of observations.*
   - Use this sentence strip to begin a class chart or wall space that will be added to during this investigation (and beyond, if you choose) that is titled: *We are learning like scientists when we . . .*

5. Return to gathering students' questions about the bouquet and vase. Record all questions, and focus attention on any that involve the change in water level (without discounting the other questions).

6. Use the difference in vase water levels to pose the following question: *Do plants need water to grow?* Post this question on the Question Wall along with the other student-generated questions, and add a new entry to the *We are learning like scientists when we . . .* chart: *Ask questions.*

7. Hold a short discussion, using the class picture that was drawn on Day 1 (showing the parts of a plant) to recall how plants that are growing are different than cut flowers (they have different structures and are still growing and developing).
8. Explain how answering a question like *Do plants need water to grow?* in science can be done through an investigation, and one way would be to use plants that are growing in the classroom. In this case, the class will be planting Wisconsin Fast Plants for the investigation. This means all students need to learn how to plant Fast Plants.

9. Distribute the planting instruction puzzles. With students working in pairs, have them assemble the instructions in a sequence that they think is the correct order.

10. Once all the groups have placed the steps in sequence, hold a whole-class discussion to reach consensus about the correct order. You may wish to have students glue their puzzle in the correct order to use during planting in the next lesson.

11. Conclude this lesson with an exit slip using a prompt like the following: Draw an arrow that shows what you expect will happen to the water in the vase with the bouquet overnight. *Will the amount of water in our bouquet's vase become less, more, or stay the same by tomorrow morning?*

   - Review exit slips, looking for any students who said the water level will stay the same or increase; this may indicate some confusion. The choice that water will decrease may show which students have a general idea that since the water level decreased over the weekend and no water was added, it is likely to continue decreasing. Based on students' responses plan how much time to spend at the start of the next lesson to review the observation that the amount of water in the vase has been decreasing since it was first added.
<table>
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<tr>
<th>Measure the length of the wick.</th>
<th>Sprinkle water over the top of the soil until you see water drip from the wick.</th>
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<tr>
<td>Push the wick through the hole in the bottom of the small deli container.</td>
<td>Carefully place 10 Fast Plants seeds in a circle on top of the soil.</td>
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<tr>
<td>Pour ½ cup soil into the small deli container.</td>
<td>Lightly cover the seeds with a sprinkle of soil.</td>
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<tr>
<td>Spread 18 pellets of fertilizer on top of the soil.</td>
<td>Pour 2 cups of water into the large deli container.</td>
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<tr>
<td>Pour another ½ cup soil into the small deli container.</td>
<td>Gently water the top of the soil covering your seeds. Put together your growing system with the wick floating in water.</td>
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Lesson 3, Wk 1 Snapshot Page
Tuesday (Day 5)

Key Concepts
- An experiment can be planned and conducted to gather information to determine if plants need water to grow.
- Events have causes that generate observable patterns.
- Introduction to the idea that a well-designed experiment involves comparing two or more instances in which all conditions (factors) are kept the same except one.

Science & Common Core Standards
- NGSS: 2-LS2-1; LS2.A; 2-LS2-1; Science Practices: 1, 3, 4, 8
- CCSS: ELA-Literacy.SL.K.1, 1.1, 2.1; Math.Content.K.CC.B.4

Evidence of Student Understanding
Students will be able to:
- with guidance, plan and begin conducting an investigation collaboratively to produce data to serve as the basis for evidence to answer the question, Do plants need water to grow?
- with guidance, predict their own ideas about the causal relationship between plant growth and water use.
- count to answer "How many?" factors are kept the same or made different, and explain aloud and ask for clarification about why the "seeds" used are different in this experiment.

Time Needed
90 minutes

Materials
For each group of 2-3 students:
- 1 deli container growing system, planting materials, and seeds

For the class:
- 1 set of laminated cards made from Teacher Page 3 Designing an Experiment
- 4 deli container growing systems and planting materials
- Lighting system that will provide adequate light for all of the groups' and class' deli container growing systems

Planting Fast Plants
1. Briefly review the events that led to the class's investigation into the question, Do plants need water to grow? and the plan to grow Fast Plants to learn more.
2. Hold an interactive discussion, using the Designing an Experiment cards (Teacher Page 3).
   a. Place the question Do plants need water to grow? on the rug or at the top of the board where you will manipulate the Designing an Experiment Cards during this discussion.
   b. Spread all the cards out (except the cards Same, Different, and Watch) and engage students in making sense of how each one can be traced to the steps for planting Fast Plants.
   c. Ask the class to identify which of the factors on the cards are part of the question, Do plants need water to grow?
3. Model how reasoning is used to design an experiment. Make clear and concise statements that show cause and effect thinking:
   a. If plants need water to grow, then they will use water when they grow.
   b. If we plant Fast Plants and give them water in a container with a wick (between the water and the soil), then the plants will use water if they need it.
   c. If the plants use water, then we will see the water level go down as it is being used.

Show a sample deli container growing system with water and a wick to give a concrete example.
   d. If we measure the water we give our Fast Plants, then we will know if the plants use water when they begin to grow.
   e. Because of what we saw happen to the water in the vase with our bouquet, I have a prediction about what I think will happen.
4. Ask students to make predictions about what they think will happen to the water in the deli container and say why they think so.
5. Continue using the Experimental Design Cards as you model with if...then... statements the thinking in designing an experiment:
   a. If we want to know if plants need water to grow, then we need to compare what happens to the water when there are plants growing and when there are not. So we will need to have some growing systems with plants and some without.
b. If we see a difference in the water level in growing systems with and without plants, then we can be pretty sure it was caused by the plants using water if everything else in the growing systems was just the same.

c. Next, sort the Factors cards and explain how only one factor can be different in a fair test (seeds, in this case) and all else must be the same. Then, have students count the factors that will be the same.

6. Review and demonstrate the correct planting procedure, including how to make the measurements. Then, divide the class into groups to plant their own Fast Plants.

7. Conclude with a new entry to the **We are learning like scientists when we . . . chart:**

*Plan and carry out an investigation.*

**Key Terms**

- factor (i.e. element), notice, same, different, water reservoir, prediction, experiment, experimental design
Lesson 3, Tuesday (Day 5)
Planting Fast Plants

In this lesson students carry out the experiment that the class designed in Lesson 2 to help answer the question, *Do plants need water to grow?* Using deli container growing systems, each student group plants one growing system with 10 seeds. In addition, two class-shared growing systems are prepared for comparison without any seeds. The experiment is designed to generate evidence that students can clearly observe that plants use water when they grow (causing there to be less water in the reservoir of growing systems with plants compared to the growing systems without seeds/plants). A second experiment that will generate additional information that can be used as evidence that plants need water to grow is designed and started in Lesson 6.

Advance preparations:
a.) Decide in advance what size student groups will work best for your class. Groups of 2-3 students are recommended.
b.) Prepare planting materials and one deli container growing system for each group as described in Teacher Page 2: Planting Fast Plants. Prepare enough materials to also plant 3 deli containers for the class to share (two will have no seeds at this time because they will be the control for the water experiment, one will have seeds to grow plants that will be used later for a light experiment in Lesson 7).
c.) Practice the planting procedures in preparation for modeling how to plant the deli container growing systems (see www.fastplants.org for videos and planting procedures). Make one sample deli container with soil, wick and water in place to use as an example in Step 2 (this can then become one of the three class-shared growing systems).
d.) Prepare a set of the cards from Teacher Page 3 Designing an Experiment (print on cardstock and laminate). These will be used in this lesson and again in later lessons of this unit, and they can be used with other investigations.
e.) Prepare the lighting system that will be used for the Fast Plants. This could be a bank light system made with 4 – 6 fluorescent light tubes or light boxes made with large, 40-watt equivalent CFL bulbs. See the Wisconsin Fast Plants Program's website for detailed information about lighting requirements and free plans for constructing simple light systems that will work for your classroom situation (www.fastplants.org).

Note: During the next few lessons, students learn how to design a controlled experiment through a teacher-guided experiment to test if plants need water to grow. Then, in Lessons 6 and 7, students will be ready to take more responsibility in designing and carrying out two other experiments.

Implementation Outline

1. Begin by engaging students in giving a short recap of what has been happening to the water in the flower vase. Then, point out the question wall and reconnect the drop in the vase's water level (which students observed) with wondering if the flowers were somehow involved, with wondering more broadly: *Do plants need water to grow?* and with growing Fast Plants to investigate the question.

2. Use an interactive discussion about designing an experiment that could help to answer the question *Do plants need water to grow?* using the key component cards in Teacher Page 3 Designing an Experiment.
   a) Place the question *Do plants need water to grow?* on the rug or at the top of the board where you will manipulate the Designing an Experiment Cards during this discussion.
   b) Spread all the cards out (except the cards Same, Different, and Watch) and engage students in making sense of how each one can be traced to the steps for planting Fast Plants.
c) Ask the class to identify which of the factors on the cards are part of the question, Do plants **need water to grow**? Explain that factors are the parts of the experiment that are especially important because they matter to the results. Guide students as needed to recognize that water and plants are in the question and that seeds grow into plants after they are planted.

d) Next, model how reasoning is used to design an experiment. Make clear and concise statements that show cause and effect thinking.

1. If plants need water to grow, then they will use water when they grow.
2. If we plant Fast Plants and give them water in a container with a wick between the water and the soil, then if the plants need water, they will use it. Show a sample deli container growing system with water and a wick to give a concrete example.
3. If we measure the water we give our Fast Plants, then we will know if the plants use water when they begin to grow.
4. Because of what we saw happen to the water in the vase with our bouquet, I have a prediction about what I think will happen.

3. Ask students to make predictions about what they think will happen to the water in the deli container and say why they think so.

4. Put the NOTICE card on the board or rug, and ask the class, What factors are we going to notice carefully to answer the question, Do plants **need water to grow**? Guide students to recognize that the water level in the reservoir and plant growth are the main factors in the experiment they will be watching.

5. Move all the cards to the side and make a 2-column chart on the board or space on the carpet where all students can see. Label one column Same and one Different. Explain how a science experiment is carefully designed to make it possible to compare results between two conditions that test only one factor.

   a) Use if, then statements to model the thinking that goes into designing a controlled experiment, deciding which factor will be changed and which will stay the same.
      i. If we want to know if plants need water to grow, then we need to compare what happens to the water when there are plants growing and when there are not. So we will need to have some growing systems with plants and some without.
      ii. If we see a difference in the water level in growing systems with and without plants, then we can be pretty sure it was caused by the plants using water if everything else in the growing systems was just the same.

   b) Move the factors on the cards into the two columns (Same and Different) with students’ help.

   c) Explain first that the one different factor will be seeds because growing systems with seeds will have plants and growing systems without seeds will not have plants. Put the seeds card in the Different column, and have students help put all the other factors in the Same column.

6. Ask students to count aloud to each other in pairs or small groups to find out “How many?” and compare the number of factors that are kept the same and the number of factors that will be different.

   a) Bring the class back together again to emphasize the importance of changing only one factor in a science experiment so that it is a “fair test.” Have students explain aloud their understanding of the purpose of the experiment to confirm their understanding.

   b) Provide opportunities and encouragement for students to build on each others’ explanations, and ask for clarification or further explanation.

7. Review and demonstrate the correct planting steps from the previous lesson, showing students the materials and emphasizing the importance of keeping factors the same when students measure...
factors during planting.

- Depending on grade level and experience, students may need to learn or review how to measure volume with a cup and tablespoon.

8. Explain that you will prepare two classroom growing systems without seeds that will have the different factor changed for comparison to their growing systems with seeds (and so plants).

9. Divide students into groups as planned, and proceed with planting. Prepare the 2 class-shared growing systems that have no seeds, and plant seeds in 1 class-shared growing system that will be used in the light experiment that students will design in Lesson 7.

- Have students carefully mark the water level in the reservoir by taping short piece of masking tape (~half inch) that has "0" written in pencil on it (for Day 0)

10. Gather students together as a class, and ask for several volunteers to say aloud why they will be carefully noticing the water level in their experiment.

11. Conclude the lesson by adding a new entry to the We are learning like scientists when we ... chart: Plan and carry out an investigation.
Teacher Page 2: Planting Fast Plants (page 1 of 3)

Day 0: Planting Seeds
A seed contains a tiny plant, the embryo. A seed can remain dormant (inactive) for years, as long as it stays dry and cool. When it gets wet and warm, the seed expands until the seed coat cracks and the embryo begins to grow.

Day 1–3: Germination
Under the soil, the Fast Plants seeds germinate (begin to grow) a day or two after planting. During germination, the seed takes up water and swells until the seed coat cracks. The root comes out first; then, the stem and two cotyledons, or seed leaves, appear.

Day 4–5: Thinning
Plants, like people, need certain amounts of space and nutrients to live and be healthy. Each of the plants needs one compartment (cell) of a quad in order to grow and be as healthy as possible. By having its own cell, the plant will have enough space, food, light, water, and air circulation. If another plant were in the same space, the two would compete for the things that they need to grow.

Day 7–11: Growth and Development
Plants develop new parts, and then the parts grow bigger. Above ground, new leaves and flowers originate from the growth tip. The stem lengthens at the internodes, the sections between the nodes (the nodes are where the leaves attach). This increase in height allows the plant to spread out the leaves and flowers so that they are in the best position to do their jobs. Food, water, and minerals move through the stem to and from the roots, leaves, and flowers. A leaf contains surface pores called stomata, through which the plant takes in carbon dioxide (CO2) from the air and releases oxygen. The green pigment chlorophyll captures energy from light, which the plant uses to combine carbon dioxide and water to make sugar (the plant’s food) in a chemical reaction called photosynthesis. Where does the water come from? Growing roots anchor the plant into the soil and absorb water and minerals, which are conducted through the plant. Some of the water is used in photosynthesis, but it also serves in cooling the plant by evaporation from the leaves, conducting chemical products and raw materials through the plant, and contributing to structural support.

Day 14–18: Pollination
At the growth tip, new flower buds begin to appear. Each bud is protected by four green sepals. Once a flower opens, the sepals are hidden beneath four bright yellow petals. The flower’s center holds a single pistil, the female part of the flower. The pistil is surrounded by six yellow stamens, the male parts of the flower. Each stamen produces powdery yellow pollen. The bright yellow petals attract not only your attention but that of insects. The petals form a beacon, letting insects know that food is available deep in the flower’s nectaries. (Nectar is a sugary liquid that some insects eat.) While the insects are feeding on nectar, pollen sticks to their body hairs. As the insects move from flower to flower, this pollen moves with them. When a pollen grain from one flower’s stamen lands on the tip of another flower’s pistil, the grain develops a tube down into the pistil to the ovary, where eggs are housed. Sperm (from inside the pollen) are then able to move down the tube until they reach the eggs and fertilize them. The fertilized eggs then become new seeds. (Some flowers can be fertilized by pollen from the same plant and are called self-fertile. Fast Plants and many others are called self-infertile; these flowers must receive pollen from a different plant of the same species in order to produce seeds.)

Day 21–Day 39: Seed Production
As the fertilized eggs grow into seeds, the pistil swells to become the seedpod. The seedpod grows longer and fatter as the seeds ripen inside. Meanwhile, the leaves and flowers slowly wilt and fall off, one by one.

Day 44: Seed Harvesting
After the seeds have dried out completely, they are ready to be planted or stored. Inside each seed is a tiny embryo, waiting for water and warmth to stimulate its development into a new plant, beginning another generation.
DELI-CONTAINER GROWING SYSTEM

The Deli-container Growing System is a stable growing system that is easy to construct for all age learners growing Wisconsin Fast Plants. Made from recycled deli-containers, these growing systems can be cleaned and reused for multiple years.

MATERIALS
- one 8 oz plastic deli-container
- one 32 oz plastic deli-container
- wicking material (cotton or polyester macrame cord or thick string)
- planting medium (a soilless seed starter mixture)
- fertilizer: solid pellets (Osmocote™)—added during planting
- Wisconsin Fast Plants seeds
- water

Step 1 – Poke a hole with scissors in the bottom of the smaller, 8 oz deli-container. Cut 12–14 centimeters of wick.

Step 2 – Wet the wick thoroughly with water. Push 1–2 centimeters of one end of the wick into the hole in the bottom of the smaller container.

Step 3 – Pour 1/2 cup of soil into the smaller container.

Step 4 – Spread around 18 pellets of fertilizer on top of the soil.

Step 5 – Add 1/2 cup of soil on top of the fertilizer pellets.

Note: The deli container will be full of soil at this point. Do not pack the soil.
In Step 6, the water will settle the soil enough to make room to add & cover seeds.

Step 6 – Sprinkle water over the top of the soil until you can see the water dripping from the wick underneath the cup.

Step 7 – Carefully place 10 Fast Plant seeds in a circle pattern on top of the soil.

Continued on next page
Teacher Page 2: Planting Fast Plants (page 3 of 3)

Step 8 – Lightly cover the seeds with soil.

Step 9 – Pour 2 cups of water into the larger container.

Step 10 – Set the smaller container into the larger container with the ends of the wick floating in the water. Lightly sprinkle water over the top of the soil covering your seeds.

Growing Your Plants

The last step is to place your Deli-container Growing System under a fluorescent light with the soil mix surface approximately 10 cm from the light bulb. Adjust as the plants grow to also keep their growing tips 10 cm from the light bulb.

NOTE: As your plants grow, you may begin to see algae growing in the water reservoir. Two solutions to this that we recommend:

1. Cut a piece of black plastic trash bag into strips the width of the height of your water reservoir, and tape the plastic around the reservoir to prevent light from getting to the water.

2. Rinse and clean out the water reservoirs approximately once a week to prevent a build up of the algae.
Teacher Page 3: Designing an Experiment (page 1 of 2)

- Water
- Soil
- Growing system
- Wick
- Fertilizer
- Seeds
Teacher Page 3: Designing an Experiment (page 2 of 2)

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<td>plants</td>
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SAME

DIFFERENT
Lesson 4, Wk 1-2 Snapshot Page
Wednesday-Friday, and Monday-Wednesday (Days 6-13)

Key Concepts
• An experiment can be planned and conducted to gather information to determine if plants need water to grow.
• Events have causes that generate observable patterns.
• Practice with the idea that a well-designed experiment involves comparing two or more instances in which all conditions (factors) are kept the same except one.
• Some types of observations/measurements can reveal patterns that show if plants need water to grow.

Science & Common Core Standards
• NGSS: K-LS1-1, LS1.A, 2-LS2-1; Science Practices: 1, 3, 4, 5, 8
• CCSS: ELA-Literacy:SL.K.1, K.6, 1.1, 1.6 2.1, 2.6; W.K.2, 1.2, 2.2; CCRA.SL.4; Math.Content.K.MD.A.1, K.MD.A.2, 1.MD.A.1, 1.MD.A.2, 2.MD.A.1, 2.MD.A.2

Evidence of Student Understanding
Students will be able to:
• with guidance, conduct the collaborative investigation designed in previous lessons to produce data that will serve as the basis for evidence to answer the question, Do plants need water to grow?
• with guidance, see the pattern in the Class Results data that water levels drop much more in growing systems that contain growing plants.

Time Needed
50 minutes the first day, then ~15 minutes each day after when observations are made

Materials
For each student:
• 1 science notebook
• rulers or other measuring device (optional)
For each group of 2-3 students:
• 1 deli container growing system, planted (from Lesson 3)
For the class:
• Teacher Page 4 Class Results on chart paper
or projected
• 4 deli container growing systems without seeds planted (from Lesson 3)
• masking tape
• Evidence chart
• Reading Green Story 1 The Good Flood

Gathering and Recording Information

Wednesday
1. Revisit the investigation question: Do plants need water to grow? Review experimental design and reasons for keeping all but one factor in the growing systems the same.
2. In their science notebooks, have students individually record their predictions about what will happen during the next week to the water level in the reservoirs.
3. Discuss how all groups will use masking tape to mark the water level on their reservoirs, then measure/record what they notice.
4. Distribute the class’s growing systems for student groups to observe and mark levels.
   • If grade-level appropriate, have students use subtraction to calculate how much the water level has dropped.
5. Gather and record all water level data on a chart (see Teacher Page 4 Class Results).
   • Encourage students to use descriptive words like “less” and “more” to describe how the amount of water changed.
6. Hold an interactive discussion to look for patterns in the Class Results data.
   • Guide students to notice the small change in water levels at this time (also that no plants are visibly growing, yet).
7. Use an exit slip and prompt: Draw a picture of the two different growing systems that we are comparing in this experiment to test if plants need water to grow.

Thursday through Week 2, Wednesday
NOTE: Seeds planted on Tuesday and kept above 72°F (22°C) night and day should show signs of seedlings emerging by Friday. Expect some water loss through evaporation in all growing systems while seeds germinate. Water loss increases with growth.
1. Thursday - Friday, students continue making/recording observations. Keep adding to the Class Results chart.

2. Make a new entry to the We are learning like scientists when we... chart: Gathering and recording information in an investigation.

3. Week 2, after students can see evidence from their experiment that water is used by plants, read aloud Story 1 The Good Flood.

4. Help students identify information/evidence about water and plants, and add it to the Evidence wall.

Key Terms
- observe, record, data, results, less, more, gather (gathering), evidence
Lesson 4, Week 1: Wednesday - Friday and
Week 2: Monday - Wednesday (Days 6-13)

Gathering and recording information

This lesson provides strategies for supporting students to carry out the first experiment in the unit, making careful observations, recording and communicating information that is obtained from the experiment, and using mathematics skills (as grade level appropriate).

Advance preparations:

a.) Plan how students will record their predictions and observations. A science notebook that is organized sequentially is recommended. Student Page 1 Water Experiment provides some structure to guide both drawing and written observations (for use after students' Fast Plants have germinated). It can be copied and used in a binder or glued into a spiral notebook. Using colored pencils or crayons is recommended on days when students record observations by drawing their plants and growing systems.

b.) Plan for how students will notice, measure, record, and compare water level data each day. Prepare a class chart where student groups report their data and the class control data is recorded for comparison. Teacher Page 4 Class Results can be drawn on chart paper or projected for this purpose.

Align the measurement method that students will use with the sophistication of methods being learned in mathematics. For example, you may choose to have Kindergarten students report if there is less or more water than the previous day to be recorded on the class chart (without a measurement). Alternatively, for second grade students it would be applicable for students to choose the appropriate tool to measure the water level (i.e. select from choices that include a ruler that is short enough to work well, a yard stick, a tape measure). Also, plan for students to discuss and record the units of measurement being used as appropriate for mathematics standards at their grade level.

c.) Plan ahead to have a chart or space on the wall that can be labeled Evidence where you and students will be able to write or post sentence strips that state the results from the water experiment and from the first Reading Green story (read during Week 2).

Implementation Outline

Wednesday

1. On the first day after planting and before students look at their growing systems carefully, revisit the question that is driving this Fast Plants investigation, and review the experimental design and reasons for keeping all but one factor in the growing systems the same.
   a) Use an interactive strategy to have students reconstruct the Same and Different chart. Then, review how and why this experiment is about comparing what happens in growing systems with seeds (and plants) and without seeds (and plants) to answer the question, Do plants need water to grow?
   b) Use a strategy like think-pair-share to check students' understandings about what is being carefully noticed (water level and plant growth) and why.

2. In their science notebooks, have students individually record their predictions about what will happen during the next week to the water level in the reservoir and why. This can be done as a drawing with or without words.

3. Have students include both of the factors that are being noticed carefully in this experiment (plants and water) in their predictions.

4. Discuss as a class how all groups will record what they notice about plants growing in their growing systems.
a) Explain that it will be important that all groups record what they notice in the same way so that all of the results noticed in growing systems with seeds can be easily compared to the three growing systems without seeds.

b) Decide as a class what is possible to notice when plants grow and what students will record during this experiment. (Teacher Note: Number of leaves is a quick and easy observation to make and record without damaging plants. In this experiment students could count the total number of leaves in their growing system or follow individual plants, marked with a colored toothpick or similar method of identification. Plant height or the number of plants growing in the system are also good options.)

c) Facilitate a collaborative conversation in which students take turns linking their comments to the factors in the experimental design to evaluate different ways of observing and/or measuring changes in all the growing systems. The goal of the conversation is to determine which ways can help answer the investigation question Do plants need water to grow? (e.g. measuring the water level and observing plant growth will be useful, but observing the color of the leaves or water is not related to the question).

5. Explain your plan for how all groups will record what they notice about the water level in the reservoir of their growing systems. Introduce the measurement approach that will be used according to your plan (see Advance Preparations section).

a) Review how students will use a short piece of masking tape (~half inch) taped on the reservoir (with the straight edge of the tape lined up with the water level) to record levels (in addition to measuring it, if they are using measurement).

b) Each time students measure, the tape should be added so that it almost touches and is to the right of the last measurement so that it is easy to compare the water level sequentially. Use one of the control growing systems (without seeds) to demonstrate how to record with tape the next water level and write in pencil the number of days since planting.

6. Distribute the class's growing systems and have student groups notice and mark their water levels.

• Return growing systems to the lights after observations are made. During this time when the plants will soon emerge, it is especially important to have the soil surface no more than two inches from the light source so the plants grow strong stems.

7. Gather and record the water level data from student groups in the class chart made from Teacher Page 4 Class Results. If grade-level appropriate, have students use subtraction to calculate how much the water level has dropped. Each time students make observations, encourage the use of descriptive words like "less" and "more" to communicate with the class about how the amount of water in the water reservoir changed since the start of the experiment and/or the last observation.

8. Hold an interactive discussion to look for patterns in those data collected so far.

9. Use prompts as needed to help students notice that there is little or no change in water levels and no plant growth showing yet (remember that plants are beginning to grow and use water beneath the surface, but their use of water is much less now than it will be when they are larger).

10. Use an exit slip strategy as a formative assessment of students' understandings about what is being compared in this experiment. Use a prompt similar to the following: Draw a picture of the two different growing systems that we are comparing in this experiment to test if plants need
water to grow.

- If some students do not yet understand what is being compared in this experiment, plan to begin the next lesson with a review that emphasizes the importance of comparing a growing system without plants and a growing system with plants to learn information about whether growing plants use water.

**Week 1 Thursday through Week 2, Wednesday**

Fast Plant Seeds planted on Tuesday and kept at a temperature above 72°F (22°C) through the night and day should show signs of seedlings emerging by Friday.

**Note:** Expect some water loss through evaporation in all growing systems while seeds germinate. Water loss increases with growth. Use this as an opportunity to introduce the idea of evaporation and emphasize the importance of having both the growing system with and without seeds to compare. The water loss will be most noticeable when Fast Plant seedlings have several true leaves.

1. On Thursday and Friday, students can make and record observations as described in Steps 5 – 8 above.

2. Using Student Page 1 Water Experiment, students should, by Friday, have some evidence of plant growth to record (by drawing) along with their water level observations. Also, record each group’s data on a class chart (see Teacher Page 4 Class Results).

3. During Week 2, add a new entry to the We are learning like scientists when we... chart: Gathering and recording information in an Investigation.

4. Late in Week 2, after students have successfully gathered evidence from their experiment that water is used by plants, read aloud Story 1 The Good Flood.

   a. Use appropriate reading strategies to help students listen closely and identify information that could help answer the question *Do plants need water to grow?*

   b. Evidence obtained from the story can be added to the Evidence wall at this time or on Day 14, Thursday (of week 2) when students gather their final observations from the experiment.
Teacher Page 4: Class Results
Add the units of measurement (optional) and what characteristic is being measured to indicate plant growth (e.g. Total Number of Leaves). Use a new table each day that observations are made, and record how many days after planting it is when the observations were made.

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<thead>
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This drawing shows what I saw today when I observed our Fast Plants.

It has been ___ days since we planted our Fast Plants.

The height of the water line in our deli container is:

Since the last day we looked, our water level has . . .

Since the last day we looked, our plants have . . .
Lesson 5, Week 2 Snapshot Page
Thursday (Day 14)

Key Concepts
- Plants depend on water to live and grow.
- Events have causes that generate observable patterns.
- Some types of observations/measurements can reveal patterns that show if plants need water to grow.
- Argumentation in science is a process for reaching agreements about explanations.

Science & Common Core Standards
- NGSS: K-LS1-1, LS1.A, 2-LS2-1; Science Practices 1, 3, 4, 5, 6, 7, 8
- CCSS: ELA-Literacy.SL.K.1, K.4, K.6, 1.1, 1.4, 1.6, 2.1, 2.4, 2.6; W.K.2, 1.2, 2.2; CCRA.SL.4; Math.Content.K.MD.A.1, K.MD.A.2, 1.MD.A.1, 1.MD.A.2, 2.MD.A.1, 2.MD.A.2

Evidence of Student Understanding
Students will be able to:
- with guidance, see the pattern in the Class Results data that water levels drop much more in growing systems that contain growing plants.
- construct an explanation that answers the question Do plants need water to grow? that includes a claim, evidence, and reasoning.
- actively participate in collaborative conversations, following agreed-upon rules for engaging in argument from evidence to evaluate claims, evidence, and reasoning.

Time Needed
60 - 80 minutes

Materials
For each student:
- science notebook

For the class:
- all records from observations that students have gathered
- Evidence chart
- Sentence strips and markers or crayons

Explanations, Experiment 1
1. Have students give a short recap of what has happened in the water experiment, referring to the Question Wall, the early observation of the vase's water level change, and the observations students have made to date.
2. As in the previous lessons, distribute the class's growing systems and have student groups notice and mark their water levels and record the plant growth they observe on Student Page 1 Water Experiment.
3. Gather and record the water level data from student groups in the class chart made from Teacher Page 4 Class Results.
4. Facilitate an interactive discussion to look for patterns across all data collected. As students report patterns in the results, add them to the chart or wall space that is titled Evidence (see the Implementation Outline).
5. Explain how a scientific explanation is made up of claims, evidence, and reasoning. Make a Claims chart or wall space where students can post sentence strips with their claims and reasoning about the answer to the investigation question, Do plants need water to grow? Discuss and develop with students definitions for claim and reasoning. Guide the discussion towards definitions like:
   a. A claim is something you believe to be true because of the evidence that you have gathered.
   b. Reasoning is the type of thinking that you use to figure out how the evidence that you choose is connected to your claim.
6. Have pairs of students use sentence strips to write responses (with help, as needed) to the prompt What claim do you think answers our question, Do plants need water to grow? and How do you know? (i.e. What evidence are you using to support your claim?)
   a. Use sentences stems to guide student-pairs in writing their two sentence strips: I think the answer to our question is . . . and I think this because . . .
   b. Demonstrate how to make a claim and use evidence to support it.
   c. Have student-pairs post both of their sentence strips together (I think the answer is . . . and I think this because) on the Claims chart or wall space as they are finished.
7. Engage students in argument from evidence to compare the claims and reasoning that
student-pairs posted.

a. Focus students in the discussion to listen actively to arguments and indicate if they agree or disagree based on the reasoning and evidence (see Implementation Outline for strategies).

b. Add to the class *We are learning like scientists when we ...* chart that students are: *Using argumentation.*

8. Guide the class as needed to close the lesson with an evidence-based claim that is aligned with the following: *I think plants need water to grow, and I think this because there was a lot less water in the growing systems with plants, and those without plants lost only a little water.*

9. Conclude the lesson with a review of how evidence is used in supporting a claim by asking the following:

- Tell me if this statement is true or false: *Fast Plants grow in soil.* When one student responds, ask another student who agrees: *How do you know? What evidence can you point to that supports your claim that the statement is true (or false)?* For example, the evidence supporting that this is a true statement could be: *because we grew them in soil,* or: *the planting directions said they do.*

**Key Terms**
- claims, reasoning, patterns, argumentation
Lesson 5, Week 2: Thursday (Day 14)
Explanations, Experiment 1

In this lesson, students learn about making evidence-based claims or explanations (in this unit, an explanation is considered to be a set of evidence-based claims that can be logically connected to answer a question). We focus at this level on shifting students from opinion-based or fanciful claims to claims that can be directly supported by evidence. At this point, students have their experiences with and observations from experiment 1, information from Reading Green story 1, and other life experiences from which to draw evidence to support claims about whether plants need water to grow or not.

Advance Preparations:
- Prepare to have all records from observations that students have gathered displayed so that students can look for patterns in those data.
- Plan for wall space or a chart where students can post sentence strips. Plan how students will post their sentence strips (e.g., with tape or magnets).
- Make or obtain sentence strips and arrange for additional support as available and needed to help students write their claims and reasoning on sentence strips.

Implementation Outline

1. Use an interactive discussion to re-engage students with the water experiment they are conducting. Facilitate all students to participate in giving a short recap of what has been happening in the water experiment. Be sure that students refer to the question wall and reconnect the originally observed drop in the vase’s water level, with wondering Do plants need water to grow? with growing Fast Plants to investigate the question, and with the carefully designed experiment and the observations the class has been recording.

2. As in the previous lessons, distribute the class’s growing systems and have student groups notice and mark their water levels and record the plant growth they observe on Student Page 1 Water Experiment.
   - Again, return growing systems to the lights after observations are made, and position them so that the surface of the soil is less than two inches from the light source.
   - Gather and record the water level data from student groups in the class chart made from Teacher Page 4 Class Results.

3. Facilitate an interactive discussion to look for patterns across all data collected. As students report patterns in the results, add them to the chart or wall space that is titled Evidence.
   - Use the Experimental Design Cards to review how the experiment was designed and the Experimental Results Chart to review what observations and measurements were taken and why (because it was information related to the investigation question, so likely to become evidence).
   - Demonstrate what evidence looks like and how it will be stated, using the original vase observations as an example. The observation that led to the question, Do plants need water to grow? is also evidence: there was a lot less water in the vase with cut flowers in it after the weekend.
   - Expect results such as:
     i. There is less water in the growing systems with plants than in the growing systems that had no seeds.
     ii. Fast Plants grew larger over the weekend.
     iii. Evidence obtained from Reading Green Story 1 The Good Flood, such as: Plants couldn’t grow without the water from the Nile River.

4. Explain that a scientific explanation is how scientists describe what they think is happening in nature, and they must convince others who read their explanation that they are right. Answers, in science, are not convincing or "strong" unless they are a complete explanation about how we arrived at the
answer: what evidence we think is important and why we think that evidence is important.

5. Make space on a wall or chart where students can post sentence strips with their claims about the answer to the investigation question Do plants need water to grow? Discuss and develop with students definitions for claim and for reasoning. Guide the discussion towards definitions like:
   a) A claim is something you believe to be true because of the evidence that you have gathered.
   b) Reasoning is the type of thinking that you use to figure out how the evidence that you have is connected to your claim. Reasoning explains what evidence was used and why it was chosen to form the claim.

6. Have pairs of students use sentence strips to write responses (with help, as needed) to the prompt What claim do you think answers our question, Do plants need water to grow? and How do you know? (i.e. What evidence are you using to support your claim?)
   a) Use two sentences stems like the following: I think the answer to our question is . . . and I think this because . . . to guide student-pairs in writing two sentence strips.
   b) Demonstrate how to make a claim and use evidence to support it. For example:
      Claim: I think the flowers in the vase were using water.
      Reasoning: I think this because the amount of water in the vase was much less after the weekend than I would expect if there had been no flowers in the vase.
   c) Have student-pairs post both of their sentence strips together (I think the answer is . . . and I think this because) on the Claims chart or wall space as they are finished.

7. Engage students in argument from evidence to compare the claims and reasoning that student-pairs posted.
   a. Focus students in the discussion to listen actively to arguments and indicate if they agree or disagree based on the reasoning and evidence. You may wish to provide sentence stems to support students’ participation during discussion. For example, a chart with the following sentence stems can be posted for ready-reference during the discussion:
      I agree with your claim because____(evidence)____
      I don’t agree with your claim because____(evidence)____
      What is your evidence that_______?
   b. Establish the active-listening habit during class discussions that students frequently retell the main points of the argument or idea being explained.
   c. Help students identify claims that are supported by evidence by probing with the question How do you know? as needed to distinguish between claims that are opinion-based and claims that are evidence-based.
   d. Have students distinguish between explanations that account for all gathered evidence and those that do not. Use “more” and “less” language to describe how much evidence the claims refer to specifically.
   e. Help students recognize that they are engaging in a particular style of discussion by adding to the class We are learning like scientists when we . . . chart that students are: Using argumentation.

8. Guide the class as needed to close the lesson with an evidence-based claim that is aligned with the following: I think plants need water to grow, and I think this because there was a lot less water in the growing systems with plants, and those without plants lost only a little water.

9. Conclude the lesson with a review of how evidence is used in supporting a claim by asking the following:
    Tell me if this statement is true or false: Fast Plants grow in soil. When one student responds, ask another student who agrees: How do you know? What evidence can you point to that supports your claim that the statement is true (or false)? For example, the evidence supporting that this is a true statement could be: because we grew them in soil, or the planting directions said they do.
    • Remember that even a false claim can be correctly supported by evidence (although it would be difficult to find evidence in this case to support the claim that Fast Plants don’t grow in soil).
Lesson 6, Wk 2 Snapshot Page
Friday (Day 15)

Key Concepts
• An experiment can be planned and conducted to gather information to determine if plants need water to grow.
• Events have causes that generate observable patterns.
• (Growing understanding) A fair test in science involves comparing two or more instances in which all conditions (factors) are kept the same except one.

Science & Common Core Standards
• NGSS: 2-LS2-1; LS2.A; 2-LS2-1; Science Practices: 1, 3, 8
• CCSS: ELA-Literacy.SL.K.1, 1.1, 2.1; Math.Content.K.CC.B.4

Evidence of Student Understanding
Students will be able to:
• with greater independence than in the first experiment, plan and begin conducting an investigation collaboratively to produce data to serve as the basis for evidence to answer the question, Do plants need water to grow?
• make predictions about the causal relationship between plant growth and water use.
• explain aloud and ask for clarification about different ideas for this experiment, evaluating different ways of testing and observing/measuring deli container growing systems with Fast Plants to answer the question, Do plants need water to grow?

Time Needed
50 minutes

Materials
For the class:
• 1 set of laminated cards made from Teacher Page 3 Designing an Experiment
• 4 deli container growing systems and planting materials
• Lighting system that will provide adequate light for the additional deli container growing systems that are planted for the class in this experiment

Do plants need water to grow?
Experiment 2
1. Briefly review the previous experimental design in an interactive discussion, using the Designing an Experiment cards. Use prompts such as the following:
   a) What question were we trying to figure out? (Do plants need water to grow?)
   b) What did we want to notice carefully? (water and plants)
   c) What did we decide to make different in the growing systems we planned to compare? (seeds, because they would grow into plants)
   d) What did we keep the same so that we would know if it was the plants causing any differences between our growing systems? (every factor other than seeds)

2. Show the two class’ deli container growing systems that were used for comparison in the first experiment. Pose the question: How could we—using these two growing systems—plan and conduct another experiment that might give more evidence related to the claim that plants need water to grow?
   • Ask students if they have any ideas how a different factor could be changed to run a second fair test that could help answer the question Do plants need water to grow?

3. Have students arrange the factor cards to show and orally explain various plans for another experiment.

4. Guide the class to adopt a plan Carry out the class experiment as a demonstration:
   a) Place 10 seeds in a circle on top of the soil in the two deli-container growing systems.
   b) Lightly sprinkle on the top enough soil to cover the seeds.
   c) For the “control” growing system, add water to the top and reservoir as needed.
   d) For the test growing system, add no water to and pour out any water in the reservoir.
   e) Place both planted growing systems under the lights as before.

5. Conclude this with an exit slip (see Teacher Page 5): Draw a picture of what you think each of the deli-container growing systems will look like in three days (Friday).

Key Terms
• factor (i.e. element), notice, same, different, water reservoir, prediction, fair test
Lesson 6, Week 2: Friday (Day 15)
Do plants need water to grow? Experiment 2

In this lesson, students design a second experiment to gather additional information about the question: *Do plants need water to grow?* In addition to adding more evidence to support understanding that plants need water, this lesson is an opportunity to release more responsibility to students for planning and conducting an investigation to determine if plants need water to grow, aligned with the Grade 2 performance expectation in NGSS 2-LS2-1.

Advance preparations:

a) Print and cut apart copies of Teacher Page 5 *Experimental Design Exit Slips* enough for each student. There are two versions of the exit slips that are different sizes; choose the size best suited for your students.

b) Prepare to add Fast Plant seeds, a sprinkle of soil, and water (in one instance) to the two deli-container growing systems that were prepared without seeds for the previous experiment (looking at water levels in the reservoir).

Implementation Outline

1. Begin by using the cards from Teacher Page 3 *Designing an Experiment* (see Lesson 3) to support students in building on their understanding of experimental design as described below. Notice that this second experimental design process is, like the first, relatively teacher guided. Later, more responsibility will be released to students when they design an experiment to investigate if plants need light to grow. Using similar steps and the same Experimental Design Cards during the three experimental planning lessons in this unit supports students to build understanding over time of experimental design and progressively develop skills with science and engineering practices.

   a) First, use the Experimental Design Cards and the question (from the question wall) to review the original experimental design. Call upon different students to show and explain orally—while using the cards—how the first experiment was set up to be a fair test. Use prompts like the following:

      i. What question were we trying to figure out? (*Do plants need water to grow?*)

      ii. What did we want to notice carefully? (water and plants)

      iii. What did we decide to make different in the growing systems we planned to compare? (seeds, because they would grow into plants)

      iv. What did we keep the same so that we would know if it was the plants causing any differences between our growing systems? (every factor other than seeds)

   b) Now, show the two class’ deli container growing systems that were used for comparison in the first experiment. Pose the question: *How could we—using these two growing systems—plan and conduct another experiment that might give more evidence related to the claim that plants need water to grow?*

      • Although there are several options that could work, the easiest fair test to conduct that will not harm any of the students’ plants would be to plant Fast Plants in both of the growing systems and give one water as before, and give no water to the other. If plants grow in the container with water and not in the other, that additional evidence would strengthen the claim that plants need water to grow. Explain that you want students to keep growing their Fast Plants without an interruption, so you are interested in using the two growing systems that are now extra.

   c) Ask students if they have any ideas how a different factor could be used instead of “seeds” to run a second test that could help answer the question *Do plants need water to grow?*
I. Provide time for and encourage students to ask clarifying questions and evaluate the different plans suggested (critiquing how well each plan abides by the rule that all but one factor must be kept the same and aligns with the question).

II. Have students arrange the factor cards to show and orally explain various plans for another experiment.

III. Hold students accountable for keeping their suggestions aligned with the experimental design rule that there must be only one factor that is different and the plan for what will be noticed needs to fit the question (in this case, the plan must be designed so that plants and/or water will be the important factor to notice).

d) If the class gets stuck, prompts such as the following can offer additional guidance:

I. Remember what is important for us to notice (plants and water) because of our question? In our first experiment, we chose to change whether there were plants in the growing system or not for the test we just finished.

II. What if we were to keep the plants the same and change the water?

III. Can you think of a way we could do plan another fair test that may help us answer the question?

e) The final plan needs to include all of the factors, and all of the factors need to be kept the same (as before) except that "seeds" (the one Different factor in the previous experiment) are replaced with "water."

2. Check for understanding by asking students to count aloud to find out "How many?" and compare the number of factors that are kept the same and the number of factors that will be different.

3. Carry out the class experiment as a demonstration:
   a) Place 10 seeds in a circle on top of the soil in the two deli-container growing systems.
   b) Lightly sprinkle on the top enough soil to cover the seeds.
   c) For the "control" or "standard" growing system, sprinkle water over the top of the soil covering the seeds and add water to the reservoir as needed.
   d) For the test growing system, add no water to the top container and pour out any water remaining in the reservoir. (Note: It will be okay if the soil mix is a little moist if no additional water is added—the seeds may germinate, but the plants will not survive without water.)
   e) Place both planted growing systems under the lights as before.

4. Conclude this lesson with an exit slip (see Teacher Page 5 Experimental Design Exit Slips response to the following: Draw a picture of what you think each of the deli-container growing systems will look like in three days (Friday).

5. Review the exit slips, looking for any students who have not sufficiently connected the information from The Good Flood reading, with the results from the experiment with water levels, and the idea that plants need water to grow to anticipate that plants will not grow without water in the growing system (and will grow if they have water). Plan to check in with these students Keep students' exit slips to use during the final analysis of evidence related to the question Do plants need water to grow? during Week 4.
Teacher Page 5: Experimental Design Exit Slips (small size)

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________

Name ____________________________
Lesson 7, Wk 3 Snapshot Page

Monday (Day 18)

Key Concepts

- Observations and other evidence gathered during an investigation can be used to describe patterns and answer the scientific question, *Do plants need water to grow?*
- An investigation/fair test can be used to answer the question, *Do plants need light to grow?*
- Scientists look for patterns and order when making and recording observations.
- Argumentation is a process for reaching agreements about designing experiments.

Science & Common Core Standards

- NGSS: K-LS1-1, K-LS2-1; 2-LS2-1; LS2.A; 2-LS2-1; Science Practices: 1, 3, 4, 6
- CCSS: ELA-Literacy.SL.K.1, 1.1, 2.1; Math.Content.K.CC.B.4; K.MD.A.2

Evidence of Student Understanding

Students will be able to:

- directly compare the two deli container growing systems from Experiment 2, counting the number of germinated seeds in each to see which has "more"/"less," and describe the difference.
- carefully observe and record observations, using measurements, descriptive words and sketches as appropriate.
- with greater independence than in the first and second experiments, collaboratively plan, refine, and begin conducting an investigation to produce data/evidence to answer the question, *Do plants need light to grow?*

Time Needed

60-90 minutes

Materials

For each student:

- 1 copy of Student Page 2 *Fast Plants Observations*
- colored pencils
- 1 exit slip (see Teacher Page 7)

For the class:

- 1 set of laminated cards made from Teacher Page 3 *Designing an Experiment*
- the deli container growing system (containing 13-day old Fast Plants) shared by the class that was planted during Experiment 1
- space where one deli container growing system can be placed in total darkness

Do plants need light to grow?

Experiment 3

1. Use the Experimental Design cards and the question, *Do plants need water to grow?* (from the question wall) to review the new experiment that was planned and started on Friday to gather more evidence about plants' need for water.
2. As a class, record observations from Experiment 2 in a version of a data table (see Lesson Outline, #2). These data will be analyzed in Lesson 8.
3. Working in groups, provide time for students to observe the Fast Plants planted 13 days ago. Look for early signs of a shift from development to reproduction (bud formation will likely be visible).
4. Gather students back around the Experimental Design cards, and introduce a new question about plants: *Do plants need light to grow?*
5. Show students the two growing systems with Fast Plants growing that are the same age, and explain how you want the class to design a new experiment that could help answer this new question.
6. Facilitate a collaborative, student-centered planning discussion with the Experimental Design Cards to plan a fair test to answer the question, *Do plants need light to grow?* Use prompts like the following only as needed, and encourage students to use argumentation to challenge others' design ideas.
   a) What question are we trying to figure out? *(Do plants need light to grow?)*
   b) What do we want to notice carefully? *(light and plants)*
   c) What do we want to make different? *(light, because we want to see if plants will grow without light this time)*
   d) What do we need to keep the same so that we would know if it is light causing any differences between the plants we will compare? *(every factor other than light)*
   e) Finalize the new experimental design by deciding where the growing system that will be placed in the dark can be put so it will be in total darkness *(e.g. a well-sealed cupboard or drawer)*
7. Follow the experimental design, and place the class' growing systems in the dark as planned.
8. Revisit the *We are learning like scientists when we . . .* chart, and reflect on how students
participated in this lesson.

9. Have students record predications on an exit slip: What do you think will happen to the plants in two weeks? (see Teacher Page 7).

Key Terms
- factor, condition, observations, sketch, blossoms, buds
Lesson 7, Week 3: Monday (Day 18)
Do plants need light to grow? Experiment 3

In this lesson, a new question about plants' needs is introduced: Do plants need light to grow? With this third opportunity to design an experiment, even more responsibility can be released to students for planning and conducting an investigation to determine if plants need light to grow, aligned with the Grade 2 performance expectation in NGSS 2-LS2-1.

Advance Preparations
a) Make a table large enough for the class to see (like the one shown in Step 2) for recording data from the second experiment that was started last lesson.
b) Copy Student Page 2 Fast Plants Observations or plan an alternative for students to observe their group-planted growing systems.
c) Make a large print question for the Question Wall: Do plants need light to grow?
d) This lesson uses the class-shared deli container growing system that was planted during Lesson 3. Have in mind potential classroom locations where the growing system that will be placed in the dark can be put so it will be in total darkness (e.g. a well-sealed cupboard or drawer).
e) Make copies and cut apart enough exit slips for the class, using Teacher Page 7 Light and Dark Experiment Prediction.

Implementation Outline
1. Use the Experimental Design Cards and the question, Do plants need water to grow? (from the question wall) to review the new experiment that was planned and started on Friday to gather more evidence about plants' need for water. Quickly set up the cards, similar to how they have been used previously, so that students become more and more familiar with the thinking that goes into planning an investigation:
   a) What question were we trying to figure out? (Do plants need water to grow?)
   b) What did we want to notice carefully? (water and plants)
   c) What did we decide to make different in the growing systems we planned to compare? (water, because we want to see if plants will grow from seeds without water this time)
   d) What did we keep the same so that we would know if it was the plants causing any differences between our growing systems? (every factor other than water)

2. As a class, observe the two deli container growing systems that were planted on Friday. Count the number of plants that have emerged and record the number in a simple table like the table below. Because this experiment involves sharing two growing systems among all students, this is the only observation to be made for this experiment.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Days after planting</th>
<th>Number of plants</th>
<th>Days after planting</th>
<th>Number of plants</th>
<th>Days after planting</th>
<th>Number of plants</th>
<th>Days after planting</th>
<th>Number of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>With water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional data will be gathered and recorded in this table throughout week 3, and explanations will be developed in Lesson 10. Discussion of the current observations can be kept brief at this time; although, it is important to acknowledge and make note of any student-generated questions or preliminary recognition of patterns (e.g. make additions to the class's Question or Evidence Walls).
3. Allow time for students to make and record observations of the Fast Plants they planted 13 days ago. Typically, there will be blossoms forming by now, and students may observe the buds.
   a) Student Page 2 Fast Plants Observations supports students to both draw and write observations. Encourage students to use colored pencils and make sketches as realistic as possible.
   b) If students have questions about the buds or any other questions related to their plants, add them to the class Question Wall.
   c) Refer back to the class's sketch from Lesson 1, showing the parts of a plant, and add to it as appropriate (based on what students are observing firsthand with their Fast Plants).
4. Gather students back around the Experimental Design Cards, and introduce a new question about plants: Do plants need light to grow?
5. Show students the two growing systems with Fast Plants growing that are the same age, and explain how you want the class to design a new experiment that could help answer this new question.
6. Release more responsibility for the planning process to students as they plan an appropriate investigation for the question about light, using the Experimental Design Cards. The process ought to look similar to the following:
   a) What question are we trying to figure out? (Do plants need light to grow?)
   b) What do we want to notice carefully? (light and plants)
   c) What do we want to make different? (light, because we want to see if plants will grow without light this time)
   d) What do we need to keep the same so that we would know if it is light causing any differences between the plants we will compare? (every factor other than light)
7. Engage students actively in critiquing others' ideas regarding the design of the experiment, engaging in the practice of argumentation similar to the discussion of claims that took place in Lesson 5. Use sentence stems like those used in Lesson 5 to support the discussion:
   I agree with your experimental design because_(evidence)_________
   I don't agree with your experimental design because_(evidence)_________
   What is your evidence that ________?
8. Finalize the new experimental design by deciding how light will be different for growing systems that will be compared. Although this experimental design experience has limited leeway for student input, it is a step towards releasing more responsibility to students and will help prepare students for more student-centered model design and construction in lesson 9.
   Involve students in deciding where the growing system that will be placed in the dark can be put so that it will be in total darkness (e.g. a well-sealed cupboard or drawer).
9. As designed by students, place the class growing systems in the dark where they will remain until Lesson 11 in Week 4 with occasional visits as you decide. This experiment is not mentioned again until Lesson 11 in Week 4 because Week 3 is busy with other learning, and the effects from being in the dark will only become more pronounced with time. NOTE: Water levels will need to be monitored, and students likely will want to look at the plants growing in the dark. Keep in mind that even a small exposure to overall classroom light will effect the experiment, so keep any visits as short as possible.
10. Revisit the We are learning like scientists when we . . . chart, and ask students to share examples of the ways they were learning like scientists during this lesson.
11. Wrap up this lesson by having students record their predictions on an exit slip (see Teacher Page 7 Light and Dark Experiment Prediction): What do you think will happen to the plants in two weeks?
   • Save students' predictions to hand back after results have been obtained and are being evaluated.
Teacher Page 7: Light and Dark Experiment Prediction (small size)
Teacher Page 7: Light and Dark Experiment Prediction (large size)

Name:

Name:
This drawing shows what I saw today when I observed our Fast Plants.

It has been ___ days since we planted our Fast Plants.

Since the last day we looked, our plants have ...
Lesson 8, Wk 3 Snapshot Page
Tuesday - Thursday (Days 19 - 21)

Key Concepts
- Plants have different parts (roots, stems, leaves, flowers) that help them survive and grow.
- Adult plants can have young plants.
- Plants depend on animals for pollination.

Science & Common Core Standards
- NGSS: 2-LS2-1; LS2.A; 2-LS2-1; Science Practices: 1, 2
- CCSS: ELA-Literacy.SL.K.1, K.2, 1.1, 1.2, 2.1, 2.2; RI.K.1, K.7, K.10, 1.1, 1.7, 1.10, 2.1, 2.4, 2.7, 2.10.

Evidence of Student Understanding
Students will be able to:
- make a bee stick and use it to model how a living bee transfers pollen among flowers.
- identify where pollen is carried on a bee's body and where it is located in a flower before and after pollination.
- participate in collaborative conversations with peers and adults in small and large groups about how a bee's body structures serve in the function of pollination and how a flower's structures function to distribute and receive pollen.

Time Needed
50 minutes the first day, then ~10 minutes every other day during the week for pollination

Materials
For each student:
- bee stick materials (see Teacher Page 8 Making Bee Sticks)
- 1 copy of Student Page 3 Honeybees
For each group of 2-3 students:
- Their deli container growing system with flowering Fast Plants
- Lily flower (optional)
For the class:
- Reading Green Story 3 Fast Plants

Bees and Pollination
1. Read with students Reading Green Story 3, Fast Plants to introduce pollination and the idea of making bee sticks.
   a. Discuss the story as it relates to the developmental stage that the class's Fast Plants are now reaching (flowering).
   b. Focus on how plants have structures shaped in ways that are related to their functions. Memorizing the names of plant parts is not a goal in these lessons.
2. At least every-other day give students time to observe their Fast Plants and record and/or talk as a class about their observations.
   a. Encourage students to look closely at the soil and wick, also.
   b. When visible, have students look closely at parts inside the flower. You may choose to bring in cut lilies, which have large structures
3. Make or provide bee sticks for the class, and discuss the relationship between bees and plants.
4. Explain how to pollinate by gently "flying" a bee stick among the flowers, carefully landing the bee inside of one flower, rolling it around a bit, then moving on to another flower.
5. After pollination, look closely again at the bees and flowers for signs of pollen in new places (e.g. stuck to various parts of the bees and on the stigma of the flowers).
6. Projecting a bee and flower for the class to look at together is helpful and offers another good opportunity for an interactive discussion about how structures are shaped for their functions (e.g. the hairs on bees pick up pollen well, the fat part of a bee's leg gives the bee more room to carry pollen, the bright yellow petals attract bees, etc.)
7. Distribute copies of Student Page 3 Honeybees for students to color, showing where they understand pollen can be found on Fast Plants flowers and on bees visiting flowers.

Key Terms
- flower, pollination, pollinate, pollen, bee stick
Lesson 8, Week 3: Tuesday - Thursday (Days 19 - 21)
Bees and pollination

During several days that are supported by this lesson, students observe flower and bee structures and connect how the shape of a structure is related to its function. Then, students make and/or use bee sticks to conduct pollination. Finally, students look closely at how pollen is carried on bee bodies and where pollen moves within the flower as examples of the relationship between structure and function.

Advance Preparations
a) Plan what will be the most effective strategy for reading aloud the Reading Green story 3, Fast Plants during these two days. (Note: Story 2 will be read during Week 4).

b) Prepare bee sticks in advance or prepare materials for students to make bee sticks on Tuesday so that they can dry and be ready for use on Thursday or Friday if flowers are open. See Teacher Page 8 Making Bee Sticks for instructions. The bees are less likely to break while making the bee sticks if they are placed in a sealed plastic bag with a moist tissue so they are less dry and brittle.

c) Obtain small magnifier boxes or other magnifiers that students can use to look closely at a dried bee. If possible, prepare a method to project a magnified view of a bee for the class to see and discuss.

d) Make a copy for each student of Student Page 3 Honeybee. Students will need either crayons or colored pencils to color this page (with plenty of green and yellow to go around).

NOTE: Plan for students to have at least three opportunities to pollinate the class’s Fast Plants with bee sticks while they are flowering so that enough seeds will be produced that students can learn what the purpose of pollination is (pollinating every other day or so for a week during flowering is fine).

Implementation Outline

1. Read with students Reading Green Story 3, Fast Plants. In this story, students learn about where Fast Plants originated and hear about students growing Fast Plants and making bee sticks.
   a. Hold discussions to relate the examples of flowering Fast Plants in the story to the developmental stage that the class’s Fast Plants are now reaching.
   b. Keep in mind that the learning goal for students at this age is to understand that plants have structures that are shaped in ways that are related to their functions. Memorizing the names of plant parts is not a goal in these lessons.

2. At least every-other day give students time to observe their Fast Plants and record and/or talk as a class about their observations.
   a. Encourage students to look closely at the soil and wick, also. There may be roots visible through the side of the deli-container or growing down along the wick.
   b. As soon as at least a few flowers open, have students look closely at the parts inside the flower.
   c. You may choose to bring in cut lilies from a florist for students to examine and compare to their Fast Plants’ flower structures (these are frequently available at little or no cost if you ask for flowers that are too old to sell). Lilies have large flowers with easy to see structures.

3. Make or provide bee sticks for the class. Reinforce the ideas that are presented in the Fast Plants story that explain the relationship between bees and plants.

4. Once bee sticks are made (one per student) and flowers are open, explain how students need to “fly” gently among the flowers on their plants, carefully landing their bee inside of one flower and rolling it
around a bit, then moving on to another flower.

a. Playing the song Flight of the Bumblebee and having students buzz as they pollinate are some of the many clever ways teachers have made pollination special in their classrooms.

b. Have students pollinate all flowers at least two days. Pollinating every-other day for a 7-10 days will result in better pod and seed production.

5. After pollination, look closely again at the bees and flowers for signs of pollen in new places (e.g. stuck to various parts of the bees and on the stigma of the flowers). Projecting a bee and flower for the class to look at together is helpful and offers another good opportunity for an interactive discussion about how structures are shaped for their functions (e.g. the hairs on bees pick up pollen well, the fat part of a bee’s leg gives the bee more room to carry pollen, the bright yellow petals attract bees, etc.)

• When students are finished looking at their bees, they can be safely stored by sticking the toothpick into the soil near their Fast Plants.

6. Distribute copies of Student Page 3 Honeybees for students to color. The purpose of adding color is for students to record where they understand pollen can be found on Fast Plants flowers and on bees visiting flowers.

• Circulate as students color to check for understanding, asking students to say how they think the shape of various structures relate to their functions.
Teacher Page 8: Making Bee Sticks

**Fast Plants and Bees**

In *Fast Plants*, bees and other insects distribute pollen. Fast Plant pollen is heavy and sticky—unable to be easily wind-borne. Bees are marvelously coevolved pollen vectors (transferring devices) for Fast Plants.

Bees depend on flowers for their survival. Sugars in the nectar provide carbohydrates to power flight and life activities. Pollen is the primary source of proteins, fats, vitamins, and minerals to build muscular, glandular, and skeletal tissues in bee larvae.

Bees are members of the insect family Apidae, which are unique in that their bodies are covered with setae (feather-like hairs). The bright yellow petals of Fast Plants flowers act as both beacons and landing pads for the bees, attracting them to the flower and guiding them to the nectaries. The bee drives its head deep into the flower to reach the sweet nectar secreted by the nectaries. The transfer of pollen from an anther to a stigma is known as pollination. When pollen is transferred from one plant to another, the process is called cross-pollination.

**Making Bee Sticks**

- Put a drop of glue on the end of a round toothpick.
- Push the "glue" end of the toothpick into the top of the bee's thorax.
- Stick the toothpick into a piece of Styrofoam or similar material so the bee is undisturbed while the bee stick dries.
- Dry the bee sticks overnight (or at least for a couple of hours).
Student Page 3: Honeybees
Lesson 9, Week 3 Snapshot Page
Friday (Day 22) into Week 4

Key Concepts

• Plants depend on animals for pollination.
• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem’s solution to other people.
• The shape of structures of natural and designed objects are related to their functions.
• Argumentation is a process for reaching agreements about design solutions.

Science & Common Core Standards

• NGSS: K-LS1-1, 1-LS1-1; 2-LS2-1; 2LS2.1, 2LS2.A; 2-LS2-2, ETS1.B; Science Practices: 1, 2, 4, 6, 7, 8
• CCSS: ELA-Literacy SL.K.1, K.4, K.5, K.6, 1.1, 1.4, 1.5, 1.6, 2.1, 2.4, 2.5, 2.6; RL.K.3, K.10, 1.3, 1.10, 2.3, 2.10

Evidence of Student Understanding

Students will be able to:
• communicate their solution to the bee model challenge with others, using drawings that provide detail about how bee's and flower's structures are related to their functions.
• design, develop, and evaluate the effectiveness of a simple model that mimics the function of a bee in pollinating plants.

Time Needed
60-90 minutes

Materials
For each student:
• drawing materials
For the class:
• a wide variety of materials for model construction (see Advance Preparations)
• Reading Green Story 5 The Bee-less Beehives

Designing a bee solution

1. Pose a challenge to the class with a prompt such as: What if I could no longer get bees like we used to make our bee sticks? How could you make a model that would work like a bee does? That is the problem that I want you to solve by engineering a solution.
   a. Explain and add to the We are learning like scientists when we . . . chart that scientists and engineers Ask questions, make observations, and gather information to help think about solving problems.
   b. Begin an interactive discussion for students to define what the solution to this problem would need to include for it to replace the functions that bees provide. Ask: What do bees do for Fast Plants?

2. Add to the We are learning like scientists when we . . . chart that scientists and engineers also Define and develop solutions for problems.

3. Explain and provide a timeline for how students will work individually to develop possible solutions that could be built from the materials available.

4. Have students think and study the materials available, then work individually to draw a simple picture that shows their plan for a solution.
   a. Explain how drawings need to include color that shows which structures will serve the functions that are important for the solution to be successful. Use a prompt such as: Color your picture so that we know what part of your model you have designed to pick up pollen. Be ready to explain how your model solves the problem by replacing the bee’s role.
   b. Have students present their drawings to communicate their ideas for a solution to each other. Use active listening and argumentation prompts to guide students’ discussion participation.

5. Explain the class timeline for building and testing students’ models. Then, have students construct their bee replacement solutions, and give them time to dry as needed.

6. Follow your plan for having students test their solutions by using their models to pollinate plants.
   • Have students look closely for signs that pollen was successfully transferred from flowers to the model.

7. Provide opportunities for students to present the different solutions that were generated and tested.

8. Add to the We are learning like scientists when we . . . chart that scientists and
Engineers make and use models, and argue with words about explanations or solutions.

9. Use Reading Green Story 5, The Bee-less Beehives to reinforce students' understandings of the relationship between flowering plants and pollinators.

10. Conclude with a class reflection on how the shape of the materials they chose to use in their bee models (structures) influenced how well the solution worked (function).

Key Terms
- model, structure, function, pollinators
Lesson 9, Week 3: Friday (Day 22) into Week 4
Designing a bee solution

This lesson begins on Day 22 and could be done in a single long day or spread out over several days. Students have the opportunity to use a wide variety of materials to design a solution to a problem (no bees). The solution will be a simple model that mimics the function of a bee in pollinating plants. Students can test their models and compare them to bee sticks during Week 4.

Advance Preparations:

a) Read through this lesson, and plan a timeline for designing, building, and testing a solution as outlined in Steps 2-7. These activities can be carried out during Week 4 as needed and enriched by Reading Green story 5, The Bee-less Beehives.

b) For this lesson a wide variety of materials need to be available from which students can choose to make a model that mimics the function of a bee in pollinating Fast Plants. The following is a list of potential materials:

- cotton balls
- straws
- small pompons
- pencils
- small feathers
- glue
- Velcro (both hook and soft sides)
- tape
- pipe cleaners
- clay
- stir sticks
- string and/or macramé cord
- twigs

Implementation Outline

1. Begin this lesson by posing a challenge to the class with a prompt such as: What if I could no longer get bees like we used to make our bee sticks? How could you make a model that would work like a bee does? That is the problem that I want you to solve by engineering a solution.

   a) Explain and add to the We are learning like scientists when we . . . chart that scientists and engineers Ask questions, make observations, and gather information to help think about solving problems, and encourage students to do this, too.

   b) Begin supporting students to develop a solution with an interactive discussion for students to define what the solution to this problem would need to include for it to replace the functions that bees provide for Fast Plants. Begin by asking, What do bees do for Fast Plants?

The key idea that students need to grasp from this discussion is that a successful model needs to mimic the pollen transfer that bees accomplish for plants when they fly from flower to flower; however, the model does not need to mimic how bees walk or do many of the other things bees do for this particular solution.

Also guide the discussion to address that bees typically do very little damage to flowers as they spread pollen, and a successful solution in this case needs to do the same.

2. Add to the We are learning like scientists when we . . . chart that scientists and engineers also Define and develop solutions for problems. Explain and provide a timeline for how students will work individually like scientists and engineers to develop possible solutions that could be built from the materials available (you may also allow other materials, provided students check with you, first).

   a) The first step is for students to think and study the materials available.

   b) Then, students work individually to draw a simple picture that shows their plan for a solution.
Guide students to use color to show which structures in their plan are intended to accomplish the function that is important for the solution to be successful. Use a prompt such as: **Color your picture so that we know what part of your model you have designed to pick up pollen. Be ready to explain how your model solves the problem by replacing the bee's role.**

Circulate among students as they are making their drawings, asking how the shape of specific parts of their model help it function as needed to solve the problem.

c) Next, students present their drawings to communicate their ideas for a solution to each other. Feedback will be given at this time, and designs can be modified. **Note:** At this point students could be placed in groups to carry out their plans and build bee models; although, working individually can have advantages for some learners.

3. Explain the class timeline for building and testing students' models.

4. When ready to build the models, provide materials and space for building the models. Have students construct their bee replacement solutions, and give them time to dry as needed.

5. Follow your plan for having students test their solutions by using their models to pollinate plants.

   • Have students look closely for signs that pollen was successfully transferred from flowers to the model (it is reasonable to assume that if pollen is transferred to the model it will be transferred back to other flowers, too). Use a document camera or dissecting microscope if available (or hand lenses) to look closely with students at their models for signs of pollen transfer.

6. Provide opportunities for students to present the different solutions that were generated and tested. Guide students to use argumentation practices to present a case that their models were successful (or not), and evaluate which models seemed to meet the goals for mimicking a bee pollinating Fast Plants.

   a) Models that do not work as solutions for the problem are important, too. Students can learn from these "failures" that engineered solutions usually require multiple trials and refinement. Students can still present solutions that did not work out, using evidence-based claims to explain why they do not think the model was successful (same sentence stems as in "b").

   b) **Sentence stems like the following can be used to support students in formulating an argument in support of a model that they believe was successful in solving the problem:**

      - *I think this model is a good solution because ___(evidence)___*
      - *To make this model a better solution for the problem, I would ___ because ___(evidence)___*

   c) As students present their solutions and arguments, coach their classmates to critique each others claims about the success of their models, using statements such as:

      - *I agree with your claim about your model because ___(evidence)___*
      - *I disagree with your claim about your model because ___(evidence)___*

7. Add to the We are learning like scientists when we . . . chart that scientists and engineers **Make and use models, and argue with words about explanations or solutions.**

8. Use Reading Green story 5, *The Bee-less Beehives* to reinforce students' understandings of the relationship between flowering plants and pollinators.

9. Conclude this engineering experience with a class reflection on how the shape of the materials they chose to use in their bee models (structures) influenced how well the solution worked (function).
Lesson 10, Wk 4 Snapshot Page

Monday (Day 25)

Key Concepts
• Plants need water to live and grow.
• Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.
• Events have causes that generate observable patterns.
• The goal of scientific investigations is to generate information that can be evidence to support claims that answer the question being investigated.
• Argumentation in science is a process for reaching agreements about explanations.

Science & Common Core Standards
• NGSS: K-LS1-1; 1-LS1-1; 2-LS2-1; Science Practices 3, 4, 6, 7
• CCSS: ELA-Literacy: W.K.3; SLK.1a-c; SL1.1a-c; SL1.2; SL2.1a-c

Evidence of Student Understanding
Students will be able to:
• Compare predictions about plants needing water to grow with what occurred in the investigation.
• Use explanations, prior experiences, evidence, and ideas to construct evidence-based claims about plants needing water to grow.
• Use a combination of drawing, dictating, and writing to communicate an explanation (answer) to the investigation question, citing evidence in the order in which it occurred.
• Follow agreed-upon rules for the presentation of explanations and argumentation discussions (e.g., listening to others and taking turns speaking to present claims, evidence, and reasoning; asking and answering questions).

Time Needed
50 minutes to prepare, plus time for presentations

Materials
For the class:
• Experiment 2 class data chart
• a chart similar to Teacher Page 9 Claim-Evidence-Reasoning Graphic Organizer to guide student presentations

Do plants need water to grow?
Explanations and argumentation, Experiment 2

1. Review all the class's work investigating if plants need water to grow.
2. Have students use the Experimental Design Cards to review Experiment 2.
3. Use a strategy such as think-pair-share to reach consensus as a class about evidence to add to the Evidence Wall from Experiment 2.
4. Return students' Experiment 2 predictions.
5. Focus students on key cause and effect relationships, which may support or refute their predictions (see Lesson Outline #4).
6. Guide students to use the claims, evidence, and reasoning language to communicate their explanations in a presentation. Have students:
   a. Go to the question wall, and point to the investigation question and state the question.
   b. Use a sentence frame to state their claim: I think the answer to our question is ___. If students need more guidance, the sentence frame could be plants need ____ to grow.
   c. Explain the evidence that supports the claim, using a combination of words and pictures by walking to the class's Evidence Wall to point out (or bring to a designated place) all relevant evidence.
      • Emphasize that using multiple pieces of evidence to support a claim makes the claim stronger.
   d. Use the class's Learning like scientists ... Wall to choose statements or pictures that communicate how the evidence was gathered and analyzed.
   e. Be prepared to respond to other students' comments or questions (see Step 7) by finishing the statement: I think my (or our) answer is a good answer because ___.
7. Have students in the "audience" comment and/or asking questions, using sentence stems:
   (1) I agree with you because (evidence)___
   (2) I don't agree with you because (evidence)___
   (3) What is your evidence that ____?
8. Conclude this lesson with a reflection on science practices that students used in this lesson.

Key Terms
• argumentation, claims, evidence, reasoning
Lesson 10, Week 4: Monday (Day 25)

Do plants need water to grow? Argumentation and explanations, Experiment 2

In this lesson, students practice what was learned about developing evidence-based claims or explanations in Lesson 5. Using evidence gained from experiment 2, students strengthen (or refute) their previous claims about whether plants need water to grow.

Advance Preparations:

a) Get ready both of the deli-container growing systems that were planted in Lesson 6—one with water and one without—for students to make and analyze final observations.
b) Prepare to hand back students' exit slips that contained their predictions for what would happen to the deli-container growing systems planted with and without water.
c) Plan for supporting students with the claims, evidence, and reasoning framework, possibly projecting or making a chart with sentence stems like those on Teacher Page 9: Claim-Evidence-Reasoning Graphic Organizer.

Implementation Outline

1. Engage students in an interactive discussion about all the ways they have worked together to plan and carry out experiments and investigate through readings to figure out if plants need water to grow.

2. Have students use the Experimental Design Cards to quickly retell the purpose and design of the second experiment related to the question *Do plants need water to grow?* (testing if plants need water to germinate and grow).
   a. What question were we trying to figure out? *(Do plants need water to grow?)*
   b. What did we want to notice carefully? (water and plants)
   c. What did we decide to make different in the growing systems we planned to compare? (water, because we wanted to see if plants will grow from seeds without water)
   d. What did we keep the same so that we would know if it was the plants causing any differences between our growing systems? (every factor other than water)

3. Observe the two deli-container growing systems that were planted in Lesson 6, Use a strategy such as think-pair-share to reach consensus as a class about what evidence can be added to the Evidence Wall from this experiment. Expect that the evidence will be something like: *seeds planted without added water did not grow (or started to grow and then died)* and *seeds planted with water grew.*

4. Return students' predictions for what would happen to the deli-container growing systems planted with and without water (exit slips from Lesson 6).
   a. Have students reflect on what they predicted the outcome would be.
   b. Then, focus students' thinking on those key cause and effect relationships that they were able to observe in the two experiments, which may support or refute their predictions:
      i. The plants needed water to grow, and when they used water, it caused the
water reservoir to contain less water.

ii. When there was less water in the reservoir, the measured height of the water level (in the water reservoir) was less.

iii. When plants did not have any water, they were not able to grow; lack of water caused the seeds not to sprout.

5. Once students have all had a turn to talk about and evaluate their predictions in light of the results, bring the class back together to discuss and add two more ideas to the We are learning like scientists when we . . . chart that scientists analyze and interpret information and evaluate and communicate information.

6. Guide students to use a claims, evidence, and reasoning framework to communicate their explanations for the investigation question, Do plants need water to grow?
   
a. Have students use a combination of drawing, dictating, and writing to prepare their explanations to be presented as a narrative that includes reference to the events that led up to and include the two water investigations (in the order in which they occurred).

b. A graphic organizer projected or made on a whiteboard or chart can be used to guide students through this framework (see Teacher Page 9).

c. The following strategy uses the class’s “Walls” in supporting students to use this framework as they communicate their claims to the class. Have students individually or with a partner present their claims to the rest of the class, using these steps:
   
i. Go to the question wall, and point to the investigation question and state the question.
   
ii. Use a sentence frame to state their claim: I think the answer to our question is ________ If students need additional guidance, the sentence frame could be plants need __________ to grow.

iii. Explain the evidence that supports the claim, using a combination of words and pictures by walking to the class’s Evidence Wall to point out (or bring to a designated place) all relevant evidence.

• Emphasize that using multiple pieces of evidence to support a claim makes the claim stronger. An example explanation that uses multiple pieces of evidence would be: Plants need water to grow, and I know this because our Fast Plants used water out of the reservoir as they grew, and when we planted Fast Plants seeds without water, they did not grow. This is like the plants growing near the Nile River that we read about, they couldn’t grow without the water from the Nile.

iv. Use the class’s Learning like scientists... Wall to choose statements or pictures that communicate how the evidence was gathered and analyzed. This step can help students explain how the evidence supports the claim.

v. Be prepared to respond to other students’ comments or questions (see Step 7) by finishing the statement: I think my (or our) answer is a good answer because _________.

7. Create an opportunity for students to engage in the science practice of argumentation
like was done in Lesson 5. Have students who are in the “audience” be responsible for commenting and/or asking questions, using sentence stems similar to what was used in Lesson 5. Use these or develop alternate sentence stems that will push listeners to agree or disagree after they had considered what evidence was chosen or missing to support the claim. For example:

(1) I agree with your claim because___(evidence)__
(2) I don’t agree with your claim because___(evidence)___
(3) What is your evidence that________?

8. Conclude the lesson by having students reflect on what they have done in this lesson that was like learning as a scientist does. Suggest that students refer to the class We are learning like scientists when we . . . chart. For example, students may say they were learning like a scientist when they decided if the information from the second experiment made sense with the results from the first experiment, or shared science ideas with their classmates, evaluated their predictions, or communicated and argued for their claims.
Teacher Page 9: Claim-Evidence-Reasoning Graphic Organizer

Our question is:

CLAIM: I think the answer to our question is:

EVIDENCE: I think this because:

I think my answer is a good answer because:
Lesson 11, Wk 4 Snapshot Page

Anytime during Week 4

Key Concepts
• Plants need light to live and grow.
• Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.
• Events have causes that generate observable patterns.
• The goal of scientific investigations is to generate information that can be evidence to support claims that answer the question being investigated.
• Argumentation in science is a process for reaching agreements about explanations.

Science & Common Core Standards
• NGSS: K-LS1-1; 2-LS2-1; 2-LS2-2; Science Practices 3, 4, 6, 7
• CCSS: ELA-Literacy: W.K.3; SLK.1a-c; SL1.1a-c; SL1.2; SL2.1a-c

Evidence of Student Understanding
Students will be able to:
• Compare predictions about plants needing light to grow with what occurred in the investigation.
• Use explanations, prior experiences, evidence, and ideas to construct an evidence-based claim about plants needing light to grow.
• Recount the experimental design and results of Experiment 3, including relevant and descriptive details and relating how those details support or refute the predicted outcome.

Time Needed
50 minutes

Materials
For the class:
• Fast Plants in growing systems that have been kept in light and dark conditions
• a chart similar to Teacher Page 9 Claim-Evidence-Reasoning Graphic Organizer to guide student presentations

Do plants need light to grow?
Explanations and argumentation, Experiment 3
1. Review all the class's work investigating if plants need light to grow.
2. Have students use the Experimental Design Cards to review Experiment 3.
3. Observe the Fast Plants that were grown under different light conditions, and ask students what evidence they see. Ask what evidence could be added to the Evidence Wall that is related to the questions Do plants need light to grow?
4. Use a think-pair-share or similar strategy with a prompt such as What claim do you think is a good answer to our question, Do plants need light to grow? and How do you know? (What evidence are you using to support your claim?)
   • Use the same sentence stems used previously to support students to make evidence-based claims: I think the answer to our question is . . . and I think this because . . .
5. Return students' predictions for what would happen to the plants grown in the dark (exit slips from Lesson 7).
6. Depending on the accuracy of students' initial predications, have students work as a class, in pairs, or in small groups to explain to each other if the evidence gathered from this experiment supported their prediction and why.
   a. Listen during the discussion to learn more about what students were thinking if their predictions were incorrect.
   b. Use sentence stems as before to focus the discussion and employ argumentation practices.
      I agree with your claim because__________
      I don't agree with your claim because__________
      What is your evidence that__________?
7. Use a strategy that allows all students to briefly explain (individually) what they now know about what plants need to grow.
8. Pose a question for students to consider silently for a minute about what structures are used by plants to get the water and light that they need to grow.
9. Conclude the lesson by having an interactive discussion that includes labeling the plant in the original drawing that was made during the first lesson. Connect its structures with functions, including: roots and stems carry water throughout the plant, leaves collect sunlight, flowers produce pollen and seeds.

Key Terms
• roots, shoots, reproduction
Lesson 11, Week 4
Do plants need light to grow? Explanations and argumentation, Experiment 3

Lesson 11 can take place any time in Week 4 after all of Lesson 9 and 10 are completed. In this lesson, students continue to strengthen their understanding of evidence-based claim development by analyzing and interpreting the data from experiment 3 and applying the results to answer the question, *Do plants need light to grow?*

Advance Preparations:
a) Prepare to bring out the growing system with Fast Plants that was placed in the dark in Lesson 7 and one of the healthier growing systems that has been growing under lights for the class to use for comparison.
b) Prepare to hand back students’ exit slips that contained their predictions for what would happen to the Fast Plants growing in the dark (from Lesson 7). Review the predictions to see how many were correct. If it looks like 1/3 or more of the class predicted the plants in the dark would be fine, then plan to spend more time evaluating and discussing predictions in Steps 6 and 7.
c) Plan to read aloud *Reading Green* Story 2, *Lord of the Arctic* during the same day or soon after this lesson. This story emphasizes that plants need sufficiently warm temperatures and light to grow.

Implementation Outline
1. Similar to lesson 10, review with students how they worked together to plan and carry out an experiment to answer the question, *Do plants need light to grow?*
2. Have students use the *Experimental Design Cards* to quickly retell the purpose and design of the light experiment. Release more responsibility to students for explaining the purpose and procedures.
   a. What question were we trying to figure out? *(Do plants need light to grow?)*
   b. What did we want to notice carefully? (light and plants)
   c. What did we decide to make different in the growing systems we planned to compare? (light, because we wanted to see if plants will grow without light)
   d. What did we keep the same so that we would know if it was the plants causing any differences between our growing systems? (every factor other than light)
3. Observe the Fast Plants that were grown under different light conditions, and ask students what evidence they see. Ask what evidence could be added to the *Evidence Wall* that is related to the questions *Do plants need light to grow?*
   • Expect evidence such as: The plants in the light have dark green leaves that are held away from the stem. The plants in the dark have pale yellow leaves that are drooping. The plants in the dark have fewer flowers than the plants in the light. There may also be a dead plant in the dark growing system.
4. Use a think-pair-share or similar strategy with a prompt such as *What claim do you think is a good answer to our question, Do plants need light to grow?* and *How do you know?* (What evidence are you using to support your claim?)
5. Use the same sentence stems used previously to support students in making evidence-based claims, actively listen, and engage in argumentation from to identify the best explanation.
   *I agree with your claim because_(evidence)_*
   *I don’t agree with your claim because_(evidence)_*
   *What is your evidence that_____?*
6. An example claim might be: Plants need light to grow, and I think this because Fast Plants that were growing just like the others changed and became pale green and droopy when they were
put in the dark.

7. Return students' predictions for what would happen to the plants grown in the dark (exit slips from Lesson 7), and facilitate an evidence-based discussion about the accuracy of those predictions.
   a) If more than a third of the predictions were incorrect, then have students work in pairs or small groups and explain to each other if the evidence gathered from this experiment supported their prediction and why. Listen during the discussion to learn more about what students were thinking if their predictions were incorrect.
   b) If further discussion is needed, use sentence stems similar to those used in earlier lessons to guide the discussion:
      * My prediction agrees with my claim because ___(evidence)___
      * My prediction does not agree with my claim because ___(evidence)___
      * What is your evidence that your prediction agrees with your claim?

8. Use a strategy that allows all students to briefly explain what they now know about what plants need to grow.

9. Pose a question for students to consider silently for a minute about what structures are used by plants to get the water and light that they need to grow.

10. Conclude the lesson by having an interactive discussion that includes labeling the plant in the original drawing that was made during the first lesson. Connect its structures with functions, including:
    * roots and stems carry water throughout the plant
    * stems support the plant to grow tall
    * leaves collect sunlight
    * flowers produce pollen and seeds.
Lesson 12, Week 5
Completing the life cycle

By Week 5, pods will be developing from the Fast Plants flowers that were successfully pollinated. Tiny seeds inside the pods will then become visible. Students can continue making observations every few days to learn more about the complete flowering plant life cycle.

*Reading Green* Story 4, *The Longest Voyage*, describes the important function that seeds play in making future generations of plants and allowing plants to disperse to far away locations.

As the seed pods become plump with seeds, revisit the original flower drawing that the class made through consensus during Lesson 1, Step 2. Add to the drawing any structures that students now know about plants that were not included in the original drawing.

- If roots are absent in the drawing, use prompts such as, *How does the plant get the water it needs to grow if it is true they need water?* or *What keeps the plant from falling over like a cut flower from the bouquet would do if we put it in this soil?*
- Continue to label structures with their functions, and discuss how their shapes are well suited to their functions (e.g. pods are just the right size to hold a number of seeds as they develop, seeds are tiny and round, which makes them well suited for slipping into a small crack in the dirt where they can stay moist and germinate).

When talking with students about seeds, recall that seeds are not equivalent to eggs in animals. Plants do have eggs, but they are in the ovaries of the flower (microscopic, like animal eggs). A tiny plant (embryo) is produced when fertilization occurs (after pollination) is inside the seed, dormant. The embryonic plant and surrounding seed must grow long enough and in the right conditions to be viable, or able to germinate. Once mature, the seeds can be harvested and planted.

We highly recommend that students have an opportunity to harvest seeds from their plants and see how they are just like the seeds they started with in Lesson 3. Complete instructions for producing and harvesting Fast Plant seeds are available online at [www.fastplants.org](http://www.fastplants.org)

Conclude this unit with a celebration of life and plants!