

## Plant Growth and Development Pacing Guide<sup>1</sup>

Use the information below to assist you in determining the amount of time needed to complete the entire unit. These recommendations assume the **average science class period is 45-60 minutes in length**. We recommend teaching science a minimum of three sessions per week in order to maintain consistency and keep students engaged. Many teachers accomplish this by rotating a science unit with a social studies unit, enabling you to teach more science sessions in one week and finish the unit in fewer weeks. We highly recommend that all teachers participate in the Expository Writing and Science Notebook Program in order to more fully develop students' science understandings, as well as their scientific thinking and writing skills. To implement the science-writing curriculum requires a separate 20 to 30 minutes for a science-writing mini-lesson and independent writing time. Time for these mini-lessons is not included in this pacing guide.

Lesson and Common Assessments (See corresponding lesson in Instructional Guide (I.G.) for lesson planning)	Recommended Number of Periods	Big Idea(s) of Lesson	Considerations for Planning	Recommended Applications and Extensions
<p><b>Lesson 1: What do you know about plants?</b> Teacher activates students' prior knowledge and records on class charts. Students observe and examine a dry bean seed.</p>	1	<p><b>GLE 1.1</b> Understand how properties are used to identify, describe, and categorize living things. <b>GLE 1.1.6</b> Understand the characteristics of living organisms. <i>Identify observable characteristics in the bean seed.</i> <b>GLE 2.1.5</b> Understand how to report investigations and explanations of objects, events, systems, and processes. <b>Big Idea:</b> A seed is the beginning of a plant's life cycle.</p>	<ul style="list-style-type: none"> <li>Timing is important: Refer to the sample calendar on pg. iv of the instructional guide for help with the pacing of this unit.</li> <li>You will need to soak the beans for the next lesson. Make sure you soak enough so there are extras.</li> </ul>	<ul style="list-style-type: none"> <li>The extensions on page 12 of the teacher's manual are quick and engaging. They work great as a homework assignment or as an engagement activity before the unit begins.</li> <li>Language Arts integration: Use the multiple copies of the <i>Plant Growth and Development</i> book, which comes in the kit, to read pages, 7-8, "Celebrate with Food".</li> </ul>
<p><b>Lesson 2: What is Inside a Seed?</b> Students observe and examine a soaked bean seed, record observations, draw and label parts of the seed. Students discuss the bean as a system.</p>	1	<p><b>GLE 1.1</b> Understand how properties are used to identify, describe, and categorize living things. <b>GLE 1.1.6</b> Understand the characteristics of living organisms <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on each other. <i>Identify parts of the bean seed and describe the seed as a system.</i> <b>GLE 2.1.5</b> Understand how to report investigations and explanations of objects, events, systems, and processes. <b>Big Ideas:</b> A seed is the beginning of a plant's life cycle. A seed has everything within it that is needed to grow a new plant.</p>	<ul style="list-style-type: none"> <li>This lesson has been modified to address the GLEs about systems.</li> </ul>	<ul style="list-style-type: none"> <li>Model making a Box and T-Chart. Then model how to write a paragraph comparing and contrasting a dry and soaked bean seed.</li> <li>You may want to plant some of the soaked bean seeds in soil.</li> <li>You may also want to make "pocket beans". See page 4 in the instructional guide for directions.</li> </ul>
<p><b>Lesson 3: Planting the Seed.</b> Students set up their planters and plant the seeds. Students record their observations on an 11X17 data table.</p>	1-2	<p><b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations. <b>GLE 3.2.2</b> Understand that people have invented tools for everyday life and for scientific understanding. <i>Understand that the Wisconsin Fast Plant was a tool invented for everyday life and for scientific understanding.</i> <b>Big Ideas:</b> Plants have certain basic needs that must be met in order to survive. Plants need light energy, water, air, and mineral nutrients from the soil.</p>	<ul style="list-style-type: none"> <li>A Monday is recommended for this lesson. Three days are needed, for seeds to sprout, between Lessons 3 &amp; 4.</li> </ul>	<ul style="list-style-type: none"> <li>Language Arts integration: Read, "Fast Plants for Fast Times" on page 25 in the teacher's manual with students.</li> </ul>

<sup>1</sup> Pacing Guide for use with the *PLANT GROWTH AND DEVELOPMENT* Teacher's Manual, National Academy of Science (1991)

<p><b>Lesson 4: Thinning and Transplanting.</b> Students discuss purpose for thinning and transplanting and learn how to do these two tasks. Students make a scientific illustration of an uprooted seedling.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.3.8</b> Understand that living things need constant energy and matter. <i>Identify sources of energy and matter used by plants to grow and sustain life (e.g., air, water, light, food, and mineral nutrients).</i> <b>Big Ideas:</b> Plants have distinct stages in their life cycle. Plants have certain basic needs that must be met in order to survive.</p>	<ul style="list-style-type: none"> <li>• Timing is important: teach this lesson about 3 days after Lesson 3. Close observation required for next 18 days.</li> </ul>	<ul style="list-style-type: none"> <li>• Language Arts integration: Read the reading selection on page 13A of the instructional guide aloud to your students.</li> <li>• If you choose to have students compare their seedling with another student’s seedling use the box and T-chart graphic organizer described in lesson 2.</li> <li>• You might also choose to have a discussion on the differences between the bean seed embryo and the <i>Brassica</i> seedling.</li> </ul>
<p><b>Lesson 5: How Does Your Plant Grow?</b> Students learn how to measure their plants and begin keeping records of their plant growth. They also make a scientific illustration of their plant and observe it and record data.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations. <b>GLE 2.1.5</b> Understand how to report investigations. <b>Big Idea:</b> Plants have distinct stages in their life cycle where they grow and change.</p>	<ul style="list-style-type: none"> <li>• It is recommended that for your class plant, you create a large poster sized observation data table and time-series line plot like the ones students will be using in their own notebooks.</li> <li>• Do not use the black line master on page 43 or 48 in the teacher’s manual. Instead use the 11x17 table and 11x17 graph, included with the instructional guide.</li> </ul>	<ul style="list-style-type: none"> <li>• Math integration: Students use time-series line plot to record plant growth over time.</li> <li>• Students read and record fractions to the nearest ½ cm. They also count from 1½ cm to 4 cm (for instance).</li> </ul>
<p><b>Lesson 6: Observing Leaves and Flower Buds.</b> Students observe two developments: true leaves and flower buds. They record observations and review the life cycle of a plant through this stage of development. Students also discuss the plant as a system.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on each other. <i>Identify the parts of a system and how the parts go together. Describe the function of a part of that system.</i> <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations. <b>GLE 2.1.5</b> Understand how to report investigations. <b>Big Ideas:</b> Plants have distinct stages in their life cycle where they grow and change. A <i>Brassica</i> plant is a system with interconnected parts. Each part has a function to perform that is necessary for survival.</p>	<ul style="list-style-type: none"> <li>• Lesson 6 is a continuation of lesson 5. These two lessons extend over a period of several days. Sometime during the next couple of days, before too many buds appear, we recommend that you use this lesson to discuss the plant as a system.</li> </ul>	<ul style="list-style-type: none"> <li>• Language Arts integration: Use the multiple copies of the <i>Plant Growth and Development</i> book, which comes in the kit, to read pages, 22-23, “It Takes Teamwork” and pages 24-25, “Getting to the Root of It”.</li> </ul>
<p><b>Lesson 7: Observing the Growth Spurt.</b> Students measure plant height and record. They also make predictions about plant growth and analyze their data on the growth spurt.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations. <b>GLE 2.1.1</b> Understand how to ask a question about organisms. <i>Ask and develop new questions that can be investigated.</i> <b>GLE 2.1.5</b> Understand how to report investigations. <b>Big Idea:</b> Plants have distinct stages in their life cycle where they grow and change.</p>	<ul style="list-style-type: none"> <li>• It is important that students record data on their 11”X17” data table and graph every day for the next 10 days approximately.</li> </ul>	
<p><b>Lesson 8: Why Are Bees Important?</b> Students share information about bees, ask questions, and draw a picture of what they think a bee looks like. Students then use hand lens to observe dried bees and make a</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <i>Identify observable characteristics of the bee.</i> <b>Big Ideas:</b> Animals and plants are interdependent. Bees play an important role in the pollination of plants. A bee is a system made up of parts that are interconnected.</p>	<ul style="list-style-type: none"> <li>• It is recommended that you follow the instructional guide for this lesson instead of the teacher’s manual.</li> <li>• A Monday is recommended for</li> </ul>	<ul style="list-style-type: none"> <li>• Language Arts integration: Students can read and discuss the modified teacher Background information sheet included in the instructional guide on page 21C.</li> </ul>

scientific illustration of a bee.			<p>this lesson. Lessons 8-11 need to be taught this week. Pollinating needs to happen when pollen is visible on the flowers.</p> <ul style="list-style-type: none"> <li>• Make sure your bees aren't moldy. Then, hydrate the bees in a relaxing jar (a bee spa) a couple of hours before they are to be used.</li> </ul>	
<p><b>Lesson 9: Getting a Handle on Your Bee.</b> Students make bee sticks to use as a tool for pollination. Students discuss the bee as a system and describe the functions of the parts of the bee.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on one another. <i>Describe the functions of the parts of the bee.</i> <b>Big Ideas:</b> Animals and plants are interdependent. Bees play an important role in pollination of plants. Each part of the bee system has a function which helps the bee to survive.</p>	<ul style="list-style-type: none"> <li>• Lesson 9 is a continuation of lesson 8. It is designed to be Session 2.</li> <li>• It is recommended that you follow the instructional guide for this lesson instead of the teacher's manual.</li> <li>• This lesson has been modified to address the GLEs about systems.</li> </ul>	
<p><b>Lesson 10: Looking at Flowers.</b> Students observe details of a flower's anatomy and identify major parts, then learn more about the crucifer family.</p>	1-2	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <i>Identify observable characteristics of the flower.</i> <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on one another. <i>Describe the functions of the parts of the flower.</i> <b>GLE 1.2.7</b> Understand the life cycles of plants and the differences between inherited and acquired characteristics. <i>Describe inherited characteristics of plants. (e.g., leaf shape)</i> <b>Big Ideas:</b> A flower is a system made up of parts that are interconnected. Each part of the flower has a function that helps the plant to survive and reproduce.</p>	<ul style="list-style-type: none"> <li>• Follow the instruction guide instead of the teacher's manual for this lesson.</li> <li>• For this lesson it is recommended that you buy a larger flower, such as Peruvian Lilies (<i>Alstromerias</i>), for each student to look at in addition to the <i>Brassica</i> flower since their <i>Brassica</i> flowers are too tiny for the parts to be observed.</li> </ul>	<ul style="list-style-type: none"> <li>• Language Arts integration: Have students read, "The Crucifer Family" on page 61 of the teacher's manual.</li> <li>• Language Arts integration: Use the multiple copies of the <i>Plant Growth and Development</i> book, which comes in the kit, to read pages, 39-41, "Making New Plants".</li> <li>• While you are having students pull apart the flower have them tape the parts into their notebook, label the parts and their functions.</li> </ul>
<p><b>Lesson 11: Pollinating Flowers.</b> Students use the bee sticks to cross-pollinate their plants; they read more about the interdependence of bees and flowers.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on one another. <i>Describe the function of the parts of the flower and the bee and how they depend on one another.</i> <b>Big Ideas:</b> Flowering plants must be pollinated in order to produce seeds. A flower's pollen sticks to a bee, but some rubs off when the bee feeds at another flower. Bees and flowers have an interdependent relationship because they both need each other to survive.</p>	<ul style="list-style-type: none"> <li>• Be aware that the pollen will move from flower to flower just by moving the quads and the plants and will usually pollinate each other with or without the use of the bees.</li> </ul>	<ul style="list-style-type: none"> <li>• Language Arts integration: Have students read, "The Bee and the Brassica: Interdependence" on pg. 68-69 in the teacher's manual and discuss.</li> <li>• Language Arts integration: Use the multiple copies of the <i>Plant Growth and Development</i> book, which comes in the kit, to read pages, 42-43, "On the Road with Beekeepers".</li> </ul>

<p><b>Assessment A: Plant and Animal Interdependence.</b> Students answer questions about plant and animal interdependence.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on one another. <b>GLE 1.3.8</b> Understand that living things need constant energy and matter. <i>Explain how animals obtain food (e.g., animals obtain food from other living things [the bee obtains nectar and pollen from flowers]).</i> <b>GLE 1.3.10</b> Understand how interactions within and among systems cause changes in matter and energy. <i>Describe the characteristics of organisms that allow them to survive in an ecosystem.</i></p>	<ul style="list-style-type: none"> <li>Implement after students have been pollinated for about 2-3 days</li> </ul>	
<p><b>Lesson 12: Observing Pods.</b> Students observe the development of the fertilized pod and record their observations by drawing, writing, and graphing. Students discuss the story of their graph.</p>	1	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on one another. <b>Big Idea:</b> After a flowering plant is pollinated, a seed pod forms.</p>	<ul style="list-style-type: none"> <li>Approximately 1.5 weeks need to go by before teaching this lesson. Lesson 12.5 could be taught in the meantime.</li> </ul>	
<p><b>Lesson 12.5: Fair Test.</b> Students generate testable questions and choose one testable question to investigate. Students plan and conduct a fair test.</p>	2+	<p><b>GLE 1.3.8</b> Understand that living things need constant energy and matter. <b>GLE 2.1.1</b> Understand how to ask a question about organisms in the environment. <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations. <b>GLE 2.1.3</b> Understand how to construct a reasonable explanation using evidence. <b>GLE 2.1.5</b> Understand how to report investigations and explanations of objects, events, systems, and processes. <b>GLE 2.2.3</b> Understand why similar investigations may not produce similar results. <b>Big Ideas:</b> 1. Scientists plan and conduct investigations in order to answer their questions. These investigations are designed to be fair tests where all variables are kept the same except the one that is being tested. Observations are detailed and carefully recorded so that the investigative question can be answered. Scientists use their data and observations as evidence to support their thinking. 2. Plants use light energy from the sun or a lamp to make their own food. The green color of a plant is evidence that it is making its own food. Soil and fertilizer are NOT food for plants. Soil and fertilizer provide mineral nutrients that plants use. Plants are one of the few organisms on earth that can make food from light energy.</p>	<ul style="list-style-type: none"> <li>This is a vital lesson that addresses GLEs not otherwise addressed in this unit.</li> </ul>	<ul style="list-style-type: none"> <li>If, after 2-3 weeks, students think they have enough data to answer the investigative question, you might consider cleaning out the quads and allowing student groups to choose other testable questions on the chart to investigate more independently. Urge them to follow the fair test model that they used in their first planned investigation.</li> </ul>
<p><b>Lessons 13/14: Making a Brassica Model.</b> Making a Bee Model. Students apply skills learned to construct an accurate model of the Brassica plant and of a bee.</p>	2-3	<p><b>GLE 1.1.6</b> Understand the characteristics of living organisms. <b>GLE 1.2.1</b> Analyze how the parts of a system go together, and how these parts depend on one another. <b>GLE 2.1.4</b> Understand how to use simple models to represent objects, events, systems and processes. <i>Create a simple model to represent systems and processes (e.g., bee and flower interdependence).</i> <b>Big Ideas:</b> Scientists create and use models to better understand common objects, systems and processes.</p>	<ul style="list-style-type: none"> <li>Remove quads from the watering system so that seed pods begin to dry out.</li> </ul>	<ul style="list-style-type: none"> <li>Once students complete the models, they can get into small groups and act out the process of cross-pollination and interdependence. Make sure the students use the correct language. A version of this activity is outlined on page 90 under Extensions in the teacher's manual.</li> </ul>

<p><b>Lesson 15: Interpreting Graphs.</b> Students interpret information on their graphs and apply math skills to reading graphs.</p>	1	<p><b>GLE: 2.1.3</b> Understand how to construct a reasonable explanation using evidence. <b>Big Ideas:</b> Plants have distinct stages in their life cycle. A plant’s growth rate varies throughout its life cycle. To live and grow, plants need light energy, water, air and mineral nutrients from the soil.</p>	<ul style="list-style-type: none"> <li>It is recommended that you follow the instructional guide for this lesson as opposed to the lesson in the teacher’s manual.</li> <li>Do NOT use the graph on pg. 96 of teacher’s manual. The bar graph is not appropriate for this data. The time-series line plot is appropriate to show growth over time.</li> </ul>	<ul style="list-style-type: none"> <li>Ask students what story they think their own graph tells about their plant.</li> </ul>
<p><b>Assessment B: Evidence and Explanation.</b> Students will write the story their graph tells about plant growth over time.</p>		<p><b>GLE 1.2.7</b> Understand the life cycle of plants and animals. <b>GLE 2.1.3</b> Understand how to construct a reasonable explanation using evidence. <b>Evidence of Learning:</b> Generate a scientific explanation of observed phenomena using data.</p>	<ul style="list-style-type: none"> <li>May be implemented as part of Lesson 15.</li> </ul>	
<p><b>Lesson 16: Harvesting and Threshing the Seed.</b> Students harvest and thresh seeds, count and compare the number of seeds harvested with the number of seeds planted; think of additional questions; design investigations to answer questions. Students discuss the plant as a system.</p>	1	<p><b>GLE 1.2.7</b> Understand the life cycle of plants and animals, and the differences between inherited and acquired characteristics. <i>Observe and describe the life cycle of a plant.</i> <b>GLE 1.3.8</b> Understand that living things need constant energy and matter. <i>Identify sources of energy and matter used by plants to grow and sustain life (e.g., air, water, light, mineral nutrients).</i> <b>GLE 2.2.3</b> Understand why similar investigations may not produce similar results. <b>Big Ideas:</b> One seed produces one plant; one plant can produce many seeds. Many plants follow a life cycle that begins with growth from a seed and proceeds through the production of seeds.</p>	<ul style="list-style-type: none"> <li>Harvest and thresh the seeds when pods are dry and brown (2-3 weeks after removing from watering system).</li> </ul>	<ul style="list-style-type: none"> <li>Once students have harvested and recorded the number of seed pods and seeds, display the data in a class line plot and discuss results. Then collect data harvested from another class and create another line plot. Compare the two line plots, or create a back-to-back line plot and discuss the results.</li> </ul>
<p><b>Assessment C-Summative:</b> Students put life cycle cards in order, label the parts of the plant, write an explanation of these parts and write about all the things plants need to make their own food.</p>	1	<p><b>GLE 1.2.7</b> Understand the life cycle of plants and animals, and the differences between inherited and acquired characteristics. <b>GLE 1.3.8</b> Understand that living things need constant energy and matter.</p>	<ul style="list-style-type: none"> <li>May be implemented after Lesson 16.</li> </ul>	
<p><b>Optional Extension: Plant Growth and Development Field Investigation in the Schoolyard.</b> Students plan, conduct, and report on a WASL-like controlled investigation outdoors. Teachers must attend a 3-hour class in order to receive the lesson plans and support with this field investigation.</p>	3-4	<p><b>GLE 1.2.7</b> Understand the life cycles of plants and the differences between inherited and acquired characteristics. <i>Describe inherited characteristics (e.g., leaf shape, [soil temperature for seed sprouting]).</i> <b>GLE 2.1.2</b> Understand how to plan and conduct simple investigations following all safety rules. <i>Generate a logical plan for, and conduct, a simple controlled investigation with the following attributes: prediction, variables kept the same, changed variable, measured variable; gather, record, and organize data using graphs; multiple trials.</i> <i>Identify and use simple equipment and tools (such as magnifiers, rulers, balances, scales, and thermometers) to gather data and extend the senses.</i> <i>Follow all safety rules during investigations.</i></p>	<ul style="list-style-type: none"> <li>Science coaches available to support the students when conducting the field investigation outdoors.</li> </ul>	<ul style="list-style-type: none"> <li>Check the <a href="#">Seattle Schools</a> professional development website for information on how to register for this Field Investigation class.</li> </ul>