

Microworlds Pacing Guide¹

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 50 to 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 Notebooks Program in order to further develop students' science understandings, as well as their scientific thinking and writing skills. To implement the science-writing curriculum requires, for most lessons, 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.

Lessons and Common Assessments (See corresponding lesson in Instructional Guide for lesson plan.)	Recommended Number of Periods	GLEs Addressed/Big Idea(s) of the Lesson	Considerations for Planning	Recommended Applications and Extensions
<p>Lesson 1: Observing a Penny</p> <p>Students observe a penny using a hand lens and begin practicing their observational skills. Students share prior knowledge and questions about magnification, create a hay infusion, and predict its changes over time.</p>	2	<p>GLE 3.2.2: Understand that people have invented tools for everyday life and for scientific investigations.</p> <p>Big Idea: Nonliving objects have physical properties that can be observed and identified by using magnifying tools.</p>	<ul style="list-style-type: none"> Use modified student sheet in Instructional Guide (IG) instead of Activity Sheet 1 in teacher's manual (TM). Have students trade new pennies for any old pennies provided in the kit. Newer pennies are easier to observe. Start hay infusion now. Do not use tap water in your infusion. See IG and p.63 of TM. 	<ul style="list-style-type: none"> Set up a penny-polishing center in the classroom (see p.12 of TM). Vinegar and salt are provided in the kit. Have students compare "scientific" drawings and "artistic" drawings to emphasize the importance of careful observation.
<p>Lesson 2: Communicating Your Observations</p> <p>Students continue observing nonliving objects to determine their physical properties. They learn to distinguish observations, inferences, and opinions.</p>	1	<p>GLE 2.1.2: Understand how to plan and conduct simple investigations following all safety rules. Identify and use simple equipment and tools (such as magnifiers) to gather data and extend the senses.</p> <p>GLE 2.1.5: Understand how to report investigations and explanations of objects, systems, and processes. Report observations or data of simple investigations without making inferences.</p> <p>Big Idea: Nonliving objects have physical properties that can be observed and identified by using magnifying tools.</p>	<p>This lesson has been modified slightly so students can better understand the difference between an observation, inference, and opinion.</p> <ul style="list-style-type: none"> Have students create their own data tables using the sample in the IG. Do not use Activity Sheet 2 in the TM. 	

¹ Pacing Guide for use with the *MICROWORLDS* Teacher's Manual, National Academy of Sciences (1991)

<p>Lesson 3: Learning About Lenses</p> <p>Students observe several objects, including a drop of water, to determine the physical properties of magnifiers.</p>	1-2	<p>GLE 1.1.1: Understand how to use properties to sort natural and manufactured materials and objects. Big Idea: Nonliving objects have physical properties that can be observed and identified by using magnifying tools.</p>	<ul style="list-style-type: none"> • Use the student instruction sheet provided in the IG. Have students create their own data tables using the sample in the IG. Do not use Activity Sheet 3 in the TM. • Fill the plastic jar $\frac{3}{4}$ full with water to prepare for the demonstration. 	<ul style="list-style-type: none"> • Show students the plastic jar filled with water to observe it magnify. See Final Activities on p.23 of TM. • Add students' new ideas and questions about magnifiers to KWL chart.
<p>Lesson 3.5: Water Drops and Magnification</p> <p>Students plan and conduct a controlled investigation to determine the effect of the size of a water drop on magnification.</p>	1	<p>GLE 2.1.1: Understand how to ask a question about objects, organisms, and events in the environment. GLE 2.1.2: Understand how to plan and conduct simple investigations following all safety rules. GLE 2.1.3: Understand how to construct a reasonable explanation using evidence. Big Idea: Lenses must be transparent and convex to magnify. The more convex a lens, the more it will magnify.</p>	<p>This lesson has been added to the unit to give students an opportunity to plan and conduct a controlled investigation. Make laminated wall charts of the “Planning Your Own Controlled Investigation” template using the sample charts in the IG. Use these to plan this investigation as well as those in Lessons 11.2 and 16.</p>	
<p>Lesson 4: Looking Through Lenses</p> <p>Students continue to practice observation skills and review properties of magnifiers.</p>	1	<p>GLE 1.1.1: Understand how to use properties to sort natural and manufactured materials and objects. Big Idea: Nonliving objects have physical properties that can be observed and identified by using magnifying tools.</p>	<p>Do not use Activity Sheet 4 in TM; give CBA A instead (see below).</p>	
<p>Classroom-Based Assessment A: Identifying the Properties of Magnifiers</p>	1	<p>GLE 1.1.1: Understand how to use properties to sort natural and manufactured materials and objects.</p>	<p>Consider placing your order for live organisms now. You must order two weeks in advance and will need them for lessons 11.4 through 14. See p.48 in IG.</p>	
<p>Lesson 5: Learning to Use the Microscope</p> <p>Students learn the microscope is a system with interrelated parts and begin observing nonliving objects with it.</p>	1	<p>GLE 1.2.1: Analyze how the parts of a system go together, and how these parts depend on each other. Big Idea: A microscope is a system consisting of lenses, focusing knobs, and a light source. All of these parts must work together in order for the system to function and magnify objects.</p>	<p>Reading integration: Students read articles on Leeuwenhoek (p.32 of TM and others).</p>	<ul style="list-style-type: none"> • Students brainstorm words that contain “micro” or “scope” in them. See IG. • Reading integration: Students read related articles in <i>Microworlds</i> nonfiction text: Part 1, <i>Seeing the World with New Eyes</i>, pp.6-25. These can be read at any time after Lesson 5 and before Lesson 10.
<p>Lesson 6: Practicing with the Microscope</p> <p>Students use the microscope to observe printed pictures.</p>	1		<p>This lesson is considered optional.</p>	
<p>Lesson 7: The Field of View</p> <p>Students further develop their understanding of field of view.</p>	1		<p>This lesson is considered optional.</p>	<p>Math integration: students convert metric measurements to micrometers (see p.26 of TM).</p>

<p>Lesson 8: Preparing Slides</p> <p>Students continue using the microscopes and learn different techniques for preparing microscope slides.</p>	1	<p>GLE 2.1.2: Understand how to plan and conduct simple investigations following all safety rules. Big Idea: Nonliving objects have physical properties that can be observed and identified by using magnification tools.</p>	<ul style="list-style-type: none"> • Have students create their own data tables using the sample in the IG. • Do not have students bring in objects from home as we recommend a modified lesson for lesson 10. See IG. 	<ul style="list-style-type: none"> • Have students try to identify the objects in the black-line masters from the TM, Appendix D. See p.53 in TM. • Have students bring spice seeds from home to view with microscopes. See p.53 in TM.
<p>Lesson 9: What Is It?</p> <p>Students observe physical properties of unknown objects and identify them based on their properties.</p>	1	<p>GLE 1.1.1: Understand how to use properties to sort natural and manufactured materials and objects. GLE 1.2.3: Know that substances are made of small particles. GLE 3.2.2: Understand that people have invented tools for everyday life and for scientific investigations. Big Idea: Nonliving objects have physical properties that can be observed and identified by using magnifying tools. The physical properties of an object enable identification.</p>	<ul style="list-style-type: none"> • Have students create their own data tables using the sample in the IG. • Have students read about the substances after they have finished their observations and completed the first two columns in their data tables. 	<ul style="list-style-type: none"> • Have students prepare mystery slides with combinations of the substances. See TM p.58, #7.
<p>Lesson 10: Exploring Common Objects</p> <p>Students observe living things and begin to consider the difference between living and nonliving.</p>	1	<p>GLE 1.1.6: Understand how to distinguish living organisms from nonliving objects. Big Idea: Living organisms share common characteristics that distinguish them from nonliving objects. All living things are made up of cells, need constant energy and matter, have a life cycle, and respond to changes in their environment.</p>	<p>This lesson has been significantly modified to activate students’ prior knowledge of living things and better prepare them for subsequent lessons.</p> <ul style="list-style-type: none"> • You will need to provide flowers and fruit for students to observe. See IG. • Be sure to order live organisms ASAP if you haven’t already. See p.48 in IG. 	<p>Reading integration: Students read “Taking a Look with Robert Hooke” (p.65 in TM). This can be read anytime between Lesson 5 and Lesson 10.</p>
<p>Lesson 11: Looking Inside an Onion</p> <p>Students observe onion tissue with their microscopes. They learn the onion is a system with many parts, including cells.</p>	2	<p>GLE 1.1.6: Understand how to distinguish living from nonliving and how to use characteristics to sort common organisms into plant and animal groups. GLE 1.2.1: Analyze how the parts of a system go together, and how these parts depend on each other. GLE 1.2.2: Understand that energy can be transferred from one object to another and can be transformed from one form of energy to another. GLE 1.2.6: Understand that organisms can be a single cell or many cells that form parts with different functions. GLE 1.3.8: Understand that living things need constant energy and matter. Big Ideas: Cells are systems with inputs and outputs of energy, matter, and/or information. The parts of the cell that are visible under the microscope are the nucleus, cell wall, cell membrane, and chloroplasts. Living organisms share common characteristics that distinguish them from nonliving objects. All living things are made up of cells, need constant energy, and matter, have a life cycle, and</p>	<p>This lesson has been modified to increase student understanding of critical life science GLEs on energy and matter in living things. See the lesson plan in the IG for all modifications, including additional life science content.</p> <ul style="list-style-type: none"> • You will need to provide a white onion, cutting board, and knife. • Use the <i>Microscopic Life</i> DVD provided in the kit to show students onion cells at a greater magnification. You may request a VHS tape from the SMC if needed. See p.62 in IG. • Use the energy transformation template from CBA B as part of your instruction on energy transfer and transformation in the onion plant system. 	

		respond to changes in their environment. All living things depend on the sun for energy.	
<p>Lesson 11.2: A Controlled Investigation</p> <p>Students plan and conduct a controlled investigation on the effect of sunlight on the movement of plants.</p>	2-3	<p>GLE 2.1.2: Understand how to plan and conduct simple investigations following all safety rules.</p> <p>GLE 2.1.3: Understand how to construct a reasonable explanation using evidence.</p> <p>GLE 2.1.5: Understand how to report investigations and explanations of objects, events, systems, and processes.</p> <p>GLE 2.2.3: Understand why similar investigations may not produce similar results.</p> <p>GLE 2.2.4: Understand how to make the results of scientific investigations reliable.</p> <p>Big Idea: Living organisms share common characteristics that distinguish them from nonliving objects. All living things are made up of cells, need constant energy and matter, have a life cycle, and respond to changes in their environment.</p>	<p>This lesson is not in the TM. Follow the lesson plan provided in the IG to give students more experience planning and conducting a controlled investigation.</p> <ul style="list-style-type: none"> • Seeds, soil, and cups are provided in the kit. • Use the laminated wall charts from Lesson 3.5 to plan the investigation with students. • Once seeds are planted, move on to subsequent lessons until seeds have grown sufficiently for students to observe meaningful results.
<p>Lesson 11.3: Making a Model of a Cell</p> <p>Students make a physical model of an onion cell and explore how cells are organized in the human body to make tissue, organs, and systems.</p>	1	<p>GLE 1.2.6: Understand that organisms can be a single cell or many cells that form parts with different functions.</p> <p>GLE 1.2.8: Understand the organization and function of human body structures and organs and how those structures and organs interconnect.</p> <p>GLE 2.1.4: Understand how to use simple models to represent objects, events, systems, and processes.</p> <p>Big Ideas: Cells are systems with inputs and outputs of energy, matter, and/or information. The parts of the cell that are visible under the microscope are the nucleus, cell wall, cell membrane, and chloroplasts. In animals, cells are arranged into tissues, organs, and systems that are interconnected, resulting in a functioning organism.</p>	<p>This lesson is not in the TM. Follow the lesson plan provided in the IG to develop student understanding of how body structures are organized in the human body.</p>
<p>Lesson 11.4: Observing <i>Elodea</i></p> <p>Students observe <i>Elodea</i> with the microscope and further develop their understanding of characteristics of living things. Students observe chloroplasts and learn that producers create their own food energy using inputs of energy and matter.</p>	2	<p>See Lesson 11 for GLEs.</p> <p>Big Ideas: Cells are systems with inputs and outputs of energy, matter, and information. Living organisms share common characteristics that distinguish them from nonliving objects. All living things are made up of cells, need constant energy & matter, have a life cycle, and respond to changes in their environment. All living things depend on the sun for energy. Some organisms are producers because they produce their own food using light from the sun. Others are called consumers because they eat other organisms. Plants & animals are multi-cellular.</p>	<p>This lesson is not in the TM. This lesson has been added in order for students to observe green plant cells with the microscopes. This lesson is critical for student understanding of the characteristics of producers.</p> <ul style="list-style-type: none"> • Once you receive your live organisms order, proceed with lessons 11.4 and 12-14 immediately. See p.48 of IG. • Use the <i>Microscopic Life</i> DVD provided in the kit to show students <i>Elodea</i> cells at a greater magnification.

Classroom-Based Assessment B: Describing Characteristics of Living Things	1	See Lesson 11 for GLEs.		
Lessons 12-14: Looking at Living Things Students observe microorganisms with the microscopes (<i>Volvox</i> , <i>Blepharisma</i> , and vinegar eels) and identify characteristics of life. Students learn that some organisms are members of the Protista kingdom and may have characteristics of both plants and animals.	3	GLE 1.1.6: Understand how to distinguish living from nonliving and how to use characteristics to sort common organisms into plant and animal groups. GLE 1.2.6: Understand that organisms can be a single cell or many cells that form parts with different functions. GLE 1.3.8: Understand that living things need constant energy and matter. Big Ideas: Plants and animals are multi-cellular. Many microorganisms cannot be classified as plants or animals because they are single-celled and/or have characteristics similar to both plants and animals; they are classified in the kingdom of Protista. The protist <i>Volvox</i> produces its own food energy, like a plant, but moves through locomotion, like an animal; it is also single-celled. The protist <i>Blepharisma</i> consumes other organisms and moves through locomotion, like an animal, but is single-celled. Vinegar eels are multi-cellular and are classified as animals.	This lesson has been modified to increase student understanding of characteristics and classifications of living things. See the lesson plan in the IG for all modifications. <ul style="list-style-type: none"> • Have students create their own data tables using the sample in the IG. • Use the <i>Microscopic Life</i> DVD provided in the kit to show students each organism at a greater magnification. • Reading integration: Students read articles on each organism provided in IG for background information. Be sure students complete readings after observing each organism. 	Reading integration: Students read articles on organisms in <i>Microworlds</i> nonfiction text: On <i>Volvox</i> : <i>Volvox</i> , pp.28-30 On vinegar eels: <i>Vinegar Eelworm</i> , pp.31-33 & <i>It's a Wormy World</i> , pp.34-36.
Classroom-Based Assessment C: Categorizing Characteristics of Plants and Animals	1	See Lessons 12-14 for GLEs.		
Lesson 15: Looking at Living Things – Hay Infusions Students observe hay infusion samples with their microscopes and discover living organisms as evidence that some organisms are able to come out of a dormant state when ideal environmental conditions return.	1-2	GLE 1.2.1: Analyze how the parts of a system go together, and how these parts depend on each other. GLE 1.3.8: Understand that living things need constant energy and matter. GLE 1.3.10: Understand that an organism's ability to survive is influenced by the organism's behavior and the ecosystem in which it lives. Big Ideas: All living things are made of cells. Cells are systems with inputs and outputs of energy, matter, and information. Living organisms share common characteristics that distinguish them from nonliving objects. All living things are made up of cells, need constant energy, and matter, have a life cycle, and respond to changes in their environment. All living things depend on the sun for energy. Some organisms are producers because they produce their own food using light energy from the sun. Other organisms are called consumers because they consume other organisms. Plants and	This lesson has been modified to increase student understanding of systems and energy and matter in living things. See the lesson plan in the IG for all modifications. <ul style="list-style-type: none"> • Reading integration: Students read an article on hay infusions from the TM (see IG). Be sure to have students read the article after observing their samples. • Use the <i>Microscopic Life</i> DVD provided in the kit to show students hay infusion organisms at a greater magnification. • Use the energy transformation template in IG as part of your instruction on 	<ul style="list-style-type: none"> • Reading integration: Students read related articles in <i>Microworlds</i> nonfiction text: Part 3, <i>Microorganisms and Microscopes in Our Lives</i>, pp.45-62. • Tiny Neighbors extension is highly recommended. This program includes a 3-hour teacher training, materials and support in planning three lessons, including a field trip to a local pond. See IG. • Field trips to labs at the University of Washington's School of Oceanography are recommended. See IG. • A four-day Life Science Content Course for teachers is offered every summer through the Seattle Aquarium. Contact Cherie Williams (206.386.4339 or

		animals are all multi-cellular. Many microorganisms live in a wetland or pond environment. When that environment dries up or freezes, some microorganisms are able to survive by going into a dormant state. When more ideal environmental conditions return, the microorganisms, such as <i>Volvox</i> , come out of their dormant state and are able to resume activity. Diversity of life in bodies of water is an indicator of good water quality and a healthy ecosystem.	energy transfer and transformation in the hay infusion system. <ul style="list-style-type: none"> See bibliography at end of IG for references on books students could use to identify hay infusion organisms. 	cherie.williams@seattle.gov) for more information.
Classroom-Based Assessment D: Describing a Suitable Environment for Survival	1	GLE 1.3.10: Understand that an organism’s ability to survive is influenced by the organism’s behavior and the ecosystem in which it lives. <i>Evidences of Learning:</i> 1) Describe the characteristics of organisms that allow them to survive in an ecosystem. 2) Describe how an organism’s ability to survive is affected by a change in an ecosystem.		
Lesson 16: A Student-Planned Investigation Students plan and conduct controlled investigations using questions about their hay infusions.	2	GLE 2.1.1: Understand how to ask a question about objects, organisms, and events in the environment. GLE 2.1.2: Understand how to plan and conduct simple investigations following all safety rules. GLE 2.1.3: Understand how to construct a reasonable explanation using evidence. GLE 2.1.4: Understand how to use simple models to represent objects, events, systems, and processes. See Lesson 15 for Big Ideas.	This lesson has been modified extensively to give students another opportunity to plan and conduct a controlled investigation. <ul style="list-style-type: none"> Use the laminated wall charts from Lesson 3.5 to plan the investigation with students. 	