A Study of Matter and Energy in Systems

Lesson 1: A Phenomenal Garden System

Grade 9-10 General Biology

Length of lesson: 75 minutes

Placement of lesson: Lesson 1 of 7

Unit Overarching Goal

In a closed system, matter is conserved and cycles within the system. Energy is conserved, but can enter and leave a closed system, thus flowing through the system. Through the processes of photosynthesis and cellular respiration, carbon molecules cycle between living and nonliving components. Through biological processes, carbon atoms are fixed into organic molecules that are rearranged into other organic molecules by organisms. Energy is transferred and transformed from solar to chemical energy during photosynthesis. Through the process of cellular respiration, chemical energy is transformed into kinetic and heat energy by living organisms. Because heat energy leaves the system, a continual input of solar energy is required to sustain the system. Using models, we can predict how changes in components affect the systems.

Unit Central Question

How do matter and energy move through a system as living things interact with each other and the environment?

Lesson 1 Main Learning Goal

Within a system, there are identifiable boundaries, components, interactions, and inputs and outputs of matter and energy.

Lesson 1 Focus Question

What are the characteristics of a system?

Ideal student response

A system has boundaries, components, interactions, and inputs and outputs. The terrarium is a system because the glass bottle creates a boundary between what's inside the terrarium and the outside world. The components of the terrarium are soil, the water, the plant, and the air inside the bottle. The plant interacts with the water, soil, and air to do photosynthesis. The input to the terrarium is sunlight. There are no outputs of matter since the terrarium is sealed, some light may enter the terrarium and then leave since the bottle is clear glass.

The Phenomenon

A terrarium sealed for 47 years is still sustaining plant life and soil organisms.

Background on the terrarium

On Easter Sunday, 1960, David Latimer started a bottle garden, or terrarium "out of idle curiosity." Latimer, a retired electrical engineer said, "At the time the chemical industry had changed to transporting things in plastic bottles so there were a lot of glass ones on the market. Bottle gardens were a bit of a craze and I wanted to see what happened if you bunged [stoppered] the thing up."

He poured some compost into a clean ten-gallon carboy, which once contained sulfuric acid, and then carefully lowered in a spiderwort (Transcantia) seedling using a piece of wire. He added about a half cup of water. In 1972, he opened the plant terrarium again and added another half cup of water. He greased the stopper and wedged it in tightly.

The sealed garden has been in the same exact spot for 27 years in the Latimer's home in Surrey, England. "It's six feet from a window so gets a bit of sunlight. It grows towards the light, so it gets turned around every so often, so it grows evenly."

The terrarium is an example of a closed system in which matter cycles and through which energy flows. Light energy enters the system and is transferred through organic molecules through the chemical processes of photosynthesis and cellular respiration. Energy leaves the system as heat. Matter, including carbon, hydrogen, and oxygen cycle between the living organisms in the system (plant and soil organisms) and the environment.

Science Content Storyline

A system has boundaries, components, interactions, and inputs and outputs. In a closed system, you can identify the inputs and outputs as matter or energy. The terrarium represents a closed system with all identifiable characteristics of a system.

Materials

- Video clip from https://weather.com/home-garden/news/thriving-garden-bottle
- Computer access to watch video, either as a class or per student
- Headphones (optional, if students are watching the video individually)
- Chart papers, 1 per team
- Chart markers
- PowerPoint: Content Connections: A Study of Matter and Energy in Systems

Advance Preparation

- Determine how students will access the video (individually or as a whole class)
- Make sure you have all the materials prepared for use and distribution before class to be efficient with time. You may not be able to complete the lesson in one class period because students will need time to talk, read, think, or write.
- Identify where students can find a definition of *ecosystem* so you can point them to it if they are unsure about the word during the introduction of the module. We expect students have learned the term in the previous ecology unit, but they may need to be reminded of the definition.
- Dedicate space on the wall to hang teams' chart paper drawings of the terrarium.

Lesson 1 General Outline

Time (min)	Phase of lesson	How the science content storyline develops
10	**How Do Matter and Energy Move Through a System as Living Things Interact with Each Other and Their Environment? (unit central question)** Introduce the central question for the unit and link to previous unit(s). The teacher makes student thinking visible by recording student answers to the unit central question.	
45	**Life in a Bottle** <u>Activity Setup</u> Students focus on a terrarium that has been sealed since 1972 in preparation for considering the lesson focus question: What are the characteristics of a system? They watch a short video and read about the terrarium, introducing key components of the terrarium system. The focus question is introduced. <u>Activity</u> Student teams draw a picture (model) of the terrarium on chart paper. The teacher leads a discussion of the charts and components included in the charts. Students complete a short reading on systems, and the teachers leads a class discussion of key ideas about systems. <u>Activity Follow-up</u> Students complete an analogy map to consider the terrarium as a system. The teacher leads a class discussion about how the terrarium represents a system.	A system has boundaries, components, interactions, and inputs and outputs. In a closed system, you can identify the inputs and outputs as matter or energy. A terrarium represents a closed system with all identifiable characteristics of a system.
15	**Synthesize and Summarize** Students revise and add to their initial model drawing, adding labels showing the key features of a system. They revise and add to their initial response to the focus question.	
5	**Summarize and Link to Next Lesson** In this lesson, students have considered the characteristics of a system and how a terrarium represents a system. In the next lesson, students will consider how matter moves through the terrarium's plant, and how the plant represents a subsystem of the terrarium.	

Lesson 1: A Phenomenal Garden System

Phase of Lesson: *How do matter and energy move through a system as living things interact with each other and their environment?*

Main Learning Goal: Within a system, there are identifiable boundaries, components, interactions, and inputs and outputs of matter and energy.

Focus Question: What are the characteristics of a system?

Unit Overarching Goal:

In a closed system, matter is conserved and cycles within the system. Energy is conserved, but can enter and leave a closed system, thus flowing through the system. Through the processes of photosynthesis and cellular respiration, carbon molecules cycle between living and nonliving components. Through biological processes, carbon atoms are fixed into organic molecules that are rearranged into other organic molecules by organisms. Energy is transferred and transformed from solar to chemical energy during photosynthesis. Through the process of cellular respiration, chemical energy is transformed into kinetic and heat energy by living organisms. Because heat energy leaves the system, a continual input of solar energy is required to sustain the system. Using models, we can predict how changes in components affect the systems.

Notes:

Time: 10 Minutes

STeLLA Strategies

- ❖ Strategy 1: Ask questions to elicit student ideas and predictions.
- ❖ Strategy 2: Ask questions to probe student ideas and predictions

Science Ideas

- A system is an organized group of related objects or components that form the whole. Systems have boundaries, components, processes, and inputs and outputs. Often parts of a system are interdependent, and each one depends on or supports the functioning on the system's other parts.
- A terrarium can be considered a closed system in which matter cycles and through which energy flows.

Common Student Ideas

- Photosynthesis occurs during the day and cellular respiration occurs at night.
- During photosynthesis, energy from sunlight is transformed into sugar.
- Plants increase mass by taking up chemicals from the soil.
- Fertilizer is food for plants.
- Plants undergo cellular respiration to provide CO_2 to make sugars.
- Photosynthesis takes place in plants while cellular respiration takes place in animals.
- Cellular respiration is the opposite of photosynthesis.
- Cellular respiration and breathing are the same thing.
- Cellular respiration and fermentation are unrelated to each other.
- Energy is released whenever chemical bonds are broken.
- Energy is fuel.
- Energy can be recycled.

Lesson 1: A Phenomenal Garden System

Introduction

In this unit, you will have a chance to figure out how matter and energy interact in a system. You will analyze and interpret data and develop models to explain how organisms interact with each other and their environment to stay alive. Like scientists currently working with similar models, you will evaluate evidence about the effects of changing components of a system.

To help you learn more about these ideas, the unit will focus on the question below.

Unit Central Question

How do matter and energy move through a system as living things interact with each other and their environment?

Process and Procedure

1. Write your best ideas about the unit central question in the space below. Leave space to revise your ideas as you learn more in later lessons. As you have new ideas, record them in a different color.

Focus on Student Thinking

- Use STeLLA Strategy 1: Ask questions to elicit students' initial ideas and predictions to get a variety of ideas out. Make it clear to students that you are not going to tell which ideas about matter and energy in a system are right or wrong at this point; the activities of this series of lessons will help support or challenge the ideas they share now. The purpose is to reveal several student ideas, so you and students get a sense of the different ideas in the class. The goal is not to surface every idea each student has.
- Question: How do matter and energy move through a system as living things interact with each other and their environment? Sample student responses follow:
    - The matter and energy move to new organisms when one organism eats another organism.
    - Plants in an ecosystem get their energy from the sun and their matter from water and soil.
    - The matter/energy output of the system is feces.
    - Energy gets used up, and matter gets passed around.
- Use SteLLA Strategy 2: Ask questions to probe student ideas and predictions. Examples of questions include the following:
    - Tell us more about ….
    - I wonder what you mean when you say…?
    - Could you give me an example of that idea?

  If many students use the words matter and energy interchangeably or only focus on one of the two, ask probe questions to determine students' understanding of these ideas. Often, students have a general understanding of these ideas, but may have some common student ideas that accompany their understanding.

Implementation	Notes
Introduce the Unit Central Question and Link to Previous Units • Let students know that, in this unit, they will learn more about matter and energy - and how it moves through systems. Ask students to think about what they already know about matter, energy, and systems. This prior knowledge could come from a previous biology unit or a previous course. Then invite students to turn to a partner and share their ideas. • It is important to note that the purpose of this lesson is not to have students arrive at a right answer, but to make their thinking about matter and energy visible by having them get out as many ideas as possible and probing for specificity in what they say. Remind students to use Strategy 4: Engage students in communicating in scientific ways by using their CSW charts and sentence stems. • Ask students to read the introduction to the lesson quietly or ask one student to read it aloud. *Unit Central Question* • STEP 1: Introduce the unit central question: "How do matter and energy move through a system as living things interact with each other and their environment?" Note that this question is printed in the box to help them find it more easily later. Ask students to write their best ideas about the unit central question in the space under the box. • Lead a whole class discussion to allow students to share their ideas. ○ It is important to note that the purpose of this lesson is NOT to have students arrive at the right answer, but to make their thinking about matter and energy visible by getting as many of their ideas out as possible and probing their ideas. Use the information in "Focus on Student Thinking" in the SE key to see examples of ways to elicit and probe student ideas.	

Lesson 1: A Phenomenal Garden System

Phase of Lesson: *Life in a Bottle*

Main Learning Goal: Within a system, there are identifiable boundaries, components, interactions, and inputs and outputs of matter and energy.

Focus Question: What are the characteristics of a system?

Unit Overarching Goal:

In a closed system, matter is conserved and cycles within the system. Energy is conserved, but can enter and leave a closed system, thus flowing through the system. Through the processes of photosynthesis and cellular respiration, carbon molecules cycle between living and nonliving components. Through biological processes, carbon atoms are fixed into organic molecules that are rearranged into other organic molecules by organisms. Energy is transferred and transformed from solar to chemical energy during photosynthesis. Through the process of cellular respiration, chemical energy is transformed into kinetic and heat energy by living organisms. Because heat energy leaves the system, a continual input of solar energy is required to sustain the system. Using models, we can predict how changes in components affect the systems.

Notes:

Time: 45 Minutes

STeLLA Strategies

- Strategy 1: Ask questions to elicit student ideas and predictions.
- Strategy 2: Ask questions to probe student ideas and predictions
- Strategy 3: Ask questions to challenge student thinking
- Strategy 6: Engage students in developing and using content representations and models

Science Ideas

- A system is an organized group of related objects or components that form the whole. Systems have boundaries, components, processes, and inputs and outputs. Often parts of a system are interdependent, and each one depends on or supports the functioning on the system's other parts.
- A terrarium can be considered a closed system in which matter cycles and through which energy flows.

Common Student Ideas

- Photosynthesis occurs during the day and cellular respiration occurs at night.
- During photosynthesis, energy from sunlight is transformed into sugar.
- Plants increase mass by taking up chemicals from the soil.
- Fertilizer is food for plants.
- Plants undergo cellular respiration to provide CO_2 to make sugars.
- Photosynthesis takes place in plants while cellular respiration takes place in animals.
- Cellular respiration is the opposite of photosynthesis.
- Cellular respiration and breathing are the same thing.
- Cellular respiration and fermentation are unrelated to each other.
- Energy is released whenever chemical bonds are broken.
- Energy is fuel.
- Energy can be recycled.

Life in a Bottle

2. To begin to explore ideas about how matter and energy interact in a system, you will consider a terrarium, or bottle garden, that has been sealed since 1972. It represents a *natural phenomenon* that will help you understand what might happen in any closed system. A natural phenomenon is an observable event or process in nature that makes you ask questions like, *what happened?* Or *why did that happen?*

   Watch the video about the terrarium. You can watch the video more than once if needed. As you are watching, ask yourself questions such as, *"How does the plant stay alive?"*

3. To learn more about the terrarium, read the following article. As you read, underline ideas that might help you begin to answer your questions.

This Sealed Garden Was Only Watered Once Since 1960

For the last forty-five years, David Latimer's terrarium has been completely sealed from the outside world. On Easter Sunday in 1960, Mr. Latimer began an experiment that is still continuing today. He added compost and a small spiderwort plant to a ten-gallon round bottle. Then he added a half cup of water and sealed the bottle with a plastic stopper.

In 1972, he opened the bottle and added another half cup of water. Then he greased the stopper, wedged it in tightly, and has not opened it since. Mr. Latimer said the bottle sits under the stairs in the hallway of his home in England. "It's six feet from a window, so it gets a bit of sunlight. It grows toward the light, so it gets turned around every so often, so it grows evenly."

Despite being isolated from the rest of the world, the spiderwort is thriving, filling the bottle with healthy foliage. As leaves die, they fall to the bottom of the bottle where they rot. As the plant uses sunlight to photosynthesize, it also returns moisture to the air. The moisture builds up inside the bottle and 'rains' back down on the plant.

In 2013, Mr. Latimer submitted a photograph of his terrarium to a gardening segment on a British radio station. The radio station hosts were amazed by the miniature ecosystem, exclaiming, "This is a great example of… the cycle of life. The only input to this whole process has been solar energy, that's the thing it has needed to keep it going. Everything else, every other thing in there has been recycled. That's fantastic!"

Implementation	Notes

Activity Setup
• Tell students that in this lesson they will learn more about a bottle garden, or terrarium, that has been sealed off from the rest of the world since 1972. To find out more about this garden, they will watch a video, read a short article, and create a visual representation of what is happening in the terrarium.
• **STEP 2:** Have students read the directions for Step 2 silently.
• Show students the video to introduce them to the phenomenon that will be the focus of the unit. Remind students to think about questions they have about the terrarium as they watch the video.
  ○ It may be helpful to show the video more than once.
  ○ The purpose of the video is to give students some background on the terrarium. Before moving to the next step, be sure students understand how the terrarium was set up and that it has been completely sealed since 1972.
• Invite students to think about questions they have about the terrarium. Have students turn and talk to share their questions with their team. Invite teams to share their questions with the whole class. Create a question board by charting their questions on chart paper in the front of the class.
• **STEP 3**: Invite students to read the short article. Use a literacy strategy such as having one student read the first paragraph out loud and having the team discuss the key ideas of the paragraph. As students read the article, they should underline ideas that might help them answer the questions charted on the question board.
  ○ After reading the article, invite teams to share key ideas with the whole class. As students share their ideas, use STeLLA Strategy 2: Ask questions to probe student thinking.
  ○ Invite students to share any additional questions that arose from their reading of the article that should be added to the question board. Chart these questions on the question board.	

4. To think about the question, *"How does the plant stay alive?"* a scientist would consider Mr. Latimer's terrarium to be a system. A system is an organized group of related objects or components that form the whole.

   Write the focus question for the lesson in the box below. Then, write your best ideas about the question under the box. Be sure to leave space to revise your answer as you learn more.

What are the characteristics of a system?

Focus on Student Thinking

Use STeLLA strategies 1 and 2 to elicit and probe student ideas about systems. The purpose is to reveal student thinking about systems and the characteristics of a system. Ask elicit questions to get a variety of ideas out and learn about students' prior knowledge and misconceptions. If you have already taught ecology and ecosystems, look for common student ideas that may still exist. Be clear that you are just getting ideas out at this time and that they will add to, revise, and eliminate ideas as they learn more in this unit.

As you work to surface students' ideas about the characteristics of a system, ask elicit and probe questions while recording their answers. Example teacher and student responses follow:

S1: I think systems have to have parts.

T: Can you tell me what you mean by 'parts'? (PROBE)

S1: Like a lot of smaller pieces that are all working together to achieve something. And then that gets repeated.

T: Thank you for clarifying your idea. Do others want to add to that or share their ideas? (ELICIT)

S2: I said that systems have to be a cycle or a process. In cycles and processes everything that moves will support another thing.

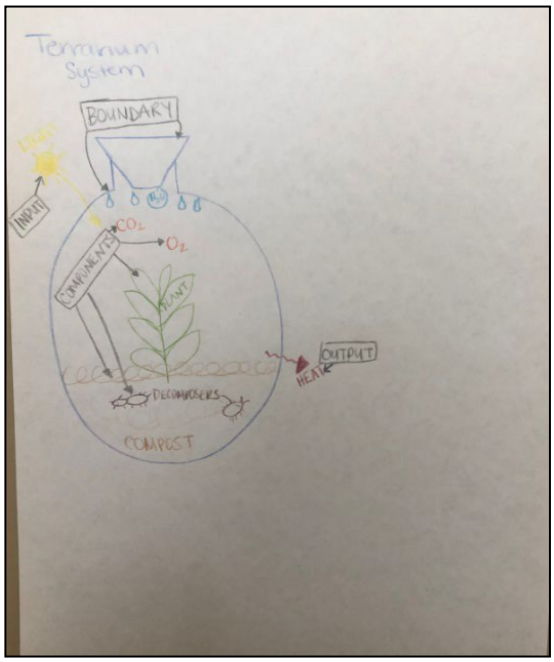
T: Could you give me an example of a system that does that? (PROBE)

S: Well, in ecology we learned that flowers are pollinated by bees. So bees support flowers, but bees are also supported by a flower's pollen. And that process keeps happening.

T: Thank you for that example. What can others add? (ELICIT)

Implementation	Notes
Focus Question • **STEP 4:** Introduce the Lesson 1 focus question, "What are the characteristics of a system?" • Ask students to write the focus question in the box in their notebooks. After they have written the lesson focus question in the box, they should write their best ideas about the question underneath the box, leaving room to add to and revise their ideas as they learn more information during the lesson. • Ask several students to share their ideas with the entire group. Use STeLLA Strategy 1: Ask questions to elicit student ideas and predictions to get a variety of ideas out. • Use STeLLA Strategy 2: Ask questions to probe student ideas and predictions to make student thinking visible. Use the information in "Focus on Student Thinking" in the SE key to see examples of ways to elicit and probe student ideas.	

5. Draw a picture of your terrarium. Be sure to label the parts, or components, of the terrarium. Include any inputs into or outputs from the terrarium.



6. To learn more about systems, read the information below. Underline important ideas as you read.

Systems and System Models: A Way of Thinking in Science and Engineering

A part of the natural or designed world that a scientist or engineer wants to investigate can be referred to as a system. A system is an organized group of related objects or components that form the whole. Systems have boundaries, components, processes, and inputs and outputs. Often parts of a system are interdependent, and each one depends on or supports the functioning of the system's other parts.

A model of the system a scientist is studying is a useful tool not only for understanding the system, but also for sharing their ideas with others. Models of a system can be as simple as a sketch or as complicated as detailed computer simulations or functioning prototypes.

A good model of a system specifies the components of the system as well as how they interact with each other. It also shows the boundaries of the system and any inputs and outputs.

Implementation	Notes

Activity
• **STEP 5:** Share directions about how teams should draw a labeled picture of the terrarium. Refer to the student work samples in the SE for spacing. Note that teams will add additional drawings in the spaces remaining.
• Provide each team chart paper and markers. As teams work on their drawings, circulate through the room making sure students are labeling important parts of their drawing and asking probe questions to make their thinking visible.
• **STEP 6:** Have students read the passage, Systems and System Models: A Way of Thinking in Science and Engineering. As students read, they should underline important ideas that can be used to add detail to their drawing. After students have had a chance to read the passage individually, they should discuss the key ideas with their team.
• Invite teams to share key ideas about systems and system models with the whole class. Key ideas to highlight in the whole class discussion include:
  ○ Because the natural and engineered world is too complex to study all at once, scientists and engineers define the part of the natural or engineered world they want to investigate as a system.
  ○ Systems are made up of components that form the whole. These components are often interdependent, and each component depends on or supports the functioning of the system's other components.
  ○ A component of one system may be a system in and of itself at another scale.
  ○ In addition to components, a system has boundaries, processes, and inputs and outputs.
  ○ Scientists often use models to better understand the system, make predictions about what will happen to the system if a component, input, or outputs changes, and to communicate their ideas with others.	

7. To think more about how a terrarium is a system, complete the chart below

Analogy Map

Feature of the Terrarium		Feature of a System	They are alike because…
Glass Bottle	**is like**	boundary	The glass bottle is a boundary that separates the plant, soil, and air from the rest of the world. System boundaries separate components from the rest of the world.
plant		component	The plant is a component or part of the terrarium.
Compost		component	The compost is a component or part of the terrarium.
water		component	The water is a component or part of the terrarium.
Sunlight		input	Sunlight enters the bottle from outside. Because the light crosses the boundary of the bottle, it is an input to the system.
Plant takes in water from the soil		interaction	The plant and water are each components of the terrarium. The plant interacts with the water when it takes it from the compost to stay alive.
Air (carbon dioxide and oxygen)		component	The air inside the bottle is a component or part of the terrarium.

Implementation	Notes
Activity Follow-up • **STEP 7:** Have students complete the analogy map in pairs, making sure that each member agrees on the ideas. You may choose to model the first line of the analogy map as a whole class. Note that the last column must be completed for each row. The last row is blank for any additional ideas they may have. • As pairs work to complete the analogy map, circulate among groups asking probe and challenge questions to make thinking visible. Lead a whole class discussion to allow groups to share any analogies they added to the blank row.	

Lesson 1: A Phenomenal Garden System

Phase of Lesson: *Synthesize and Summarize*

Main Learning Goal: Within a system, there are identifiable boundaries, components, interactions, and inputs and outputs of matter and energy.

Focus Question: What are the characteristics of a system?

Unit Overarching Goal:

In a closed system, matter is conserved and cycles within the system. Energy is conserved, but can enter and leave a closed system, thus flowing through the system. Through the processes of photosynthesis and cellular respiration, carbon molecules cycle between living and nonliving components. Through biological processes, carbon atoms are fixed into organic molecules that are rearranged into other organic molecules by organisms. Energy is transferred and transformed from solar to chemical energy during photosynthesis. Through the process of cellular respiration, chemical energy is transformed into kinetic and heat energy by living organisms. Because heat energy leaves the system, a continual input of solar energy is required to sustain the system. Using models, we can predict how changes in components affect the systems.

Notes:

Time: 15 Minutes

STeLLA Strategies

- Strategy 1: Ask questions to elicit student ideas and predictions.
- Strategy 2: Ask questions to probe student ideas and predictions
- Strategy 6: Engage students in developing and using content representations and models
- Strategy 9: Engage students in making connections by synthesizing and summarizing key science ideas

Science Ideas

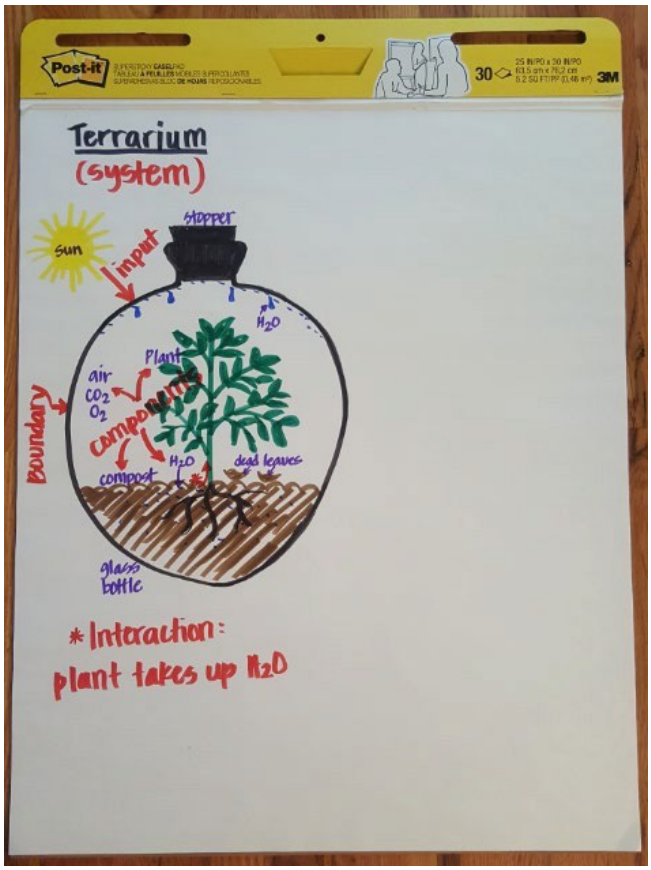
- A system is an organized group of related objects or components that form the whole. Systems have boundaries, components, processes, and inputs and outputs. Often parts of a system are interdependent, and each one depends on or supports the functioning on the system's other parts.
- A terrarium can be considered a closed system in which matter cycles and through which energy flows.

Common Student Ideas

- Photosynthesis occurs during the day and cellular respiration occurs at night.
- During photosynthesis, energy from sunlight is transformed into sugar.
- Plants increase mass by taking up chemicals from the soil.
- Fertilizer is food for plants.
- Plants undergo cellular respiration to provide CO_2 to make sugars.
- Photosynthesis takes place in plants while cellular respiration takes place in animals.
- Cellular respiration is the opposite of photosynthesis.
- Cellular respiration and breathing are the same thing.
- Cellular respiration and fermentation are unrelated to each other.
- Energy is released whenever chemical bonds are broken.
- Energy is fuel.
- Energy can be recycled.

Synthesize and Summarize Ideas

8. Revise and add to your initial drawing, or model, of the terrarium. Add labels showing characteristics, or key features of a system to your model.



9. Reread your initial response to the lesson focus question. Consider the ideas from the activities you completed. If you would like to add to or revise your ideas, do so in a different color.

Implementation	Notes
Synthesize and Summarize Science Ideas • **STEP 8:** Invite teams to use what they figured out about how the terrarium is a system and add to or revise their initial model of the terrarium. Teams should make sure they have added labels to show the characteristics of a system to their drawing. • As teams revise their drawing, circulate through the room asking probe and challenge questions to make student thinking visible. • When groups have finished revising their models, have teams hang their charts in a space where others can observe them. Provide directions for teams to complete a gallery walk to observe other teams' drawings. • **STEP 9:** Have students reread their initial response to the lesson focus question. After considering the activities they completed in this lesson, students should add to or revise their answer to the focus question in a different color. • Invite several students to share how their thinking changed over the course of the lesson.	

Lesson 1: A Phenomenal Garden System

Phase of Lesson: *Summarize and Link*

Main Learning Goal: Within a system, there are identifiable boundaries, components, interactions, and inputs and outputs of matter and energy.

Focus Question: What are the characteristics of a system?

Unit Overarching Goal:

In a closed system, matter is conserved and cycles within the system. Energy is conserved, but can enter and leave a closed system, thus flowing through the system. Through the processes of photosynthesis and cellular respiration, carbon molecules cycle between living and nonliving components. Through biological processes, carbon atoms are fixed into organic molecules that are rearranged into other organic molecules by organisms. Energy is transferred and transformed from solar to chemical energy during photosynthesis. Through the process of cellular respiration, chemical energy is transformed into kinetic and heat energy by living organisms. Because heat energy leaves the system, a continual input of solar energy is required to sustain the system. Using models, we can predict how changes in components affect the systems.

Notes:

Time: 5 Minutes

STeLLA Strategies

- Strategy I: Summarize key science ideas

Science Ideas

- A system is an organized group of related objects or components that form the whole. Systems have boundaries, components, processes, and inputs and outputs. Often parts of a system are interdependent, and each one depends on or supports the functioning on the system's other parts.
- A terrarium can be considered a closed system in which matter cycles and through which energy flows.

Common Student Ideas

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- Energy is released whenever chemical bonds are broken.
- Energy is fuel.
- Energy can be recycled.

Implementation	Notes
Link to the Next Lesson • Share that in this lesson, students considered the characteristics of a system and how the terrarium can be considered a system. Link to the next lesson by sharing that in the next lesson students will consider one component of the terrarium system – the plant. The next lesson will examine the plant as a system and consider how matter interacts through the plant system.	