Return to Seedling Growth Models 7.6

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Anchoring Phenomenon

Tiny seedlings grow and transform into trees with a great quantity of matter.

Lesson Concept

Develop a model to explain where all the matter in from the Sun to a tree comes from when it begins as a small seedling.

Investigative Phenomenon

Return to the Anchoring Phenomenon: Tiny seedlings grow and transform into trees with a great quantity of matter.

Standards

Refer to Appendix 7.6 for NGSS, CCSS (ELA), and California ELD Standards.

Storyline Link

This lesson follows Lesson 7.5: Matter Model lesson where students gained an understanding of the role of photosynthesis and the processes that occur at small scales that are relevant to the overall phenomenon. Students will apply their understanding of matter conservation and how the transfer of energy drives the motion of matter to a final model of the phenomenon. This is the final lesson of the sequence. Students will revise their initial individual models from Lesson 7.1: Tree Matter and apply the learning they gained from the previous lessons. Students will reflect on their own learning as they share their final models with others and provide/receive feedback. At this point in the sequence, students should develop models that indicate both visible and invisible components and how those components interact within the system to produce the growth and increase of mass seen in the video.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

80–110 minutes

Two 40- to 55-minute sessions

Materials

Whole Class

- The growing tree video https://www.youtube.com/watch?v=RjnKAWxCK3k

Individual

- Science notebook
- 7.1.H1: Giant Sequoia Tree Probe (from Lesson 7.1: Tree Matter)
- 7.1.H2: Make a Model (from Lesson 7.1: Tree Matter).

Teacher Use

- 7.6.R1 Model Rubric

Advance Preparation

None

Procedure

Evaluate (80–110 minutes)

Develop a model to explain where all the matter in a tree comes from when it begins as a small seedling.

Review Previous Learnings (50 minutes)

1. Show the growing tree video from Lesson 7.1: Tree Matter (5 minutes)
2. Direct students to take out their **7.1.H2: Make a Model** (from Lesson 7.1: Tree Matter) and review their initial ideas about how seedlings gain mass. In particular, ask the students to think of the tree as a system and to reflect on where the energy for this system comes from and where it goes. Then, ask the students to think about where the matter comes from in this system and where it goes. Students should also review the feedback received from you and consider what feedback they want to use to improve their model and what feedback is not clear. Walk around the room checking in with each student and answering any questions about the feedback you provided.
3. Tell the students that they will be revising their model to include the ideas they have gained through the series of previous lessons. Remind them to include the parts of the process that are not visible, including parts of the system or processes that are too small to be seen. The goal is three-dimensional models that include:
    a. concepts about modeling (SEP) such as developing and revising a model to show the relationships among the variables of photosynthesis, including those that are not observable but predict the observable phenomenon of tree growth and to describe the unobservable mechanisms that drive photosynthesis.
    b. concepts related to the DCIs LS1.C (Organization for Matter and Energy Flow in Organisms) and PS3.D (Energy in Chemical Processes and Everyday Life) to demonstrate an understanding that plants use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which releases oxygen. These sugars can be used immediately or stored for growth or later use AND the chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur.
    c. concepts related to the crosscutting concept of Energy and Matter (CCC) to demonstrate an understanding that matter is conserved. Atoms are conserved in the physical and chemical processes within the natural system of a plant, the transfer of energy drives the motion and/or cycling of matter, and the transfer of energy can be tracked as energy flows through the natural system of the plant.

    As students work, ask them to think about how their model represents the interactions of the tree system. How does their model represent the flow of matter into, within, and out of the tree?
4. Allow about 20 minutes for students to revise their models independently. Students may need support to identify areas in their science notebooks that contain evidence or reasoning that can be used to support the details of their models. Students should also cite specific evidence from the photosynthesis reading in Lesson 5: Matter Models to support their claims or provide reasoning.

5. Ask students "How has your model changed?" Tell students to find their initial models from **7.1.H1: Giant Sequoia Tree Probe** and **7.1.H2: Make a Model** (from Lesson 7.1: Tree Matter). Tell students to record their thinking in their science notebook.
6. Next, instruct students to share their new models with another student. Tell students that when they share they should explain how their models show what inputs, processes, and outputs are occurring. Emphasize that students should explicitly explain how their model describes what they saw in the video of a tree seedling growing into a large tree. Students should also discuss: What aspects of the phenomenon does your model represent? Are there other parts or processes that are not in your model?
7. As students are listening to their partner's share, encourage students to provide feedback to each other. If necessary, provide sentences as a table handout or on a chart to support student discussion and feedback. You may choose to use the sentence frames from earlier lessons as well. This type of linguistic support might be necessary for English Learners or struggling students. Possible sentence stems include:
   - I agree with your idea about _____ because _____.
   - Can you tell me more about _____?
   - I disagree with _____ because _____.
   - I want to build on your idea about_____.
8. After students have shared their individual models, tell the students to create a consensus group model on chart paper or a dry-erase board. The consensus models should represent the thinking of everyone in the group. (10 minutes)
9. As they work on their models, ask students to consider how the rearrangement of molecules in this phenomenon relates to previous lessons on atoms and molecules. Ask students to review their previous questions. Were there any questions that our understanding of atoms and molecules helped us to answer? What other phenomena relate to the flow of matter through a system? As they respond to your questions, remind them to add those ideas to their models.
10. After the groups have finished with their consensus model, ask the class to identify what makes a model "good" or effective for explaining this phenomenon. (Consider asking students to discuss their ideas with a partner if you have significant numbers of English Learners or students who need additional processing time in the class). Remind students that they have made several models over the last few days, and they should review those models in their science notebook.
11. Ask students to share their ideas about effective models for this phenomenon. After confirming that the whole class agrees with a suggestion, record these ideas on a class chart. Listen for ideas such as:
    - the model includes things like such as light, water, carbon dioxide;
    - the model shows how the tree rearranges the matter;
    - the model shows how trees collect sunlight and use it to rearrange matter;
    - the model should be based on evidence we have collected;
    - the model explains HOW the tree adds mass clearly;
    - the model can be used to predict growth in other plants under certain conditions.

This list will become a checklist for students to use in the next part of the lesson, which is the evaluation. End the discussion by asking students to review the list. It is fine if there are missing elements on the checklist right now. Clarify any questions students still have.

Day 2 (30–50 minutes)

12. Before students return, review the model checklist and transfer it to a document. If there are components that were missing from the class list, add them to the checklist now if you think they will support students' thinking during the final evaluation. At the beginning of class, distribute your model checklist to each student. Direct students to discuss the checklist in pairs by discussing areas that make sense, that are unclear or are new. If you added any components, review them with the class now and explain why you thought it was a useful idea to add to the checklist. Note: do not add more than one element to the checklist. The checklist is supposed to be useful, not overwhelming. It is also important that students feel that they were the ones who developed it.

13. ▶ It is now time to individually assess student understanding of the phenomenon. Provide students with the following prompts and tell them to answer the prompts individually OUTSIDE their science notebook. Students are allowed to use anything in their science notebook to develop their response:

    a. Record your final model to show how matter moves through the plant system to develop small seedling into a large tree.

    b. Add a brief description of your model and how your model shows how a tree gains mass to develop into a large tree.

       This individual assessment allows students the opportunity to reflect on their learning. It also provides an individual piece of student work, separate from the science notebook, that can be assessed for student understanding of developing and using models (SEP), Energy and Matter (CCC) and Energy and Matter flow in organisms, and Chemical Processes and Everyday Life (DCI). **7.6.R1 Model Rubric** Part I can be used to provide feedback to students and assess their individual progress towards the unit objectives.

    c. There is an optional third part of the assessment. This optional portion could be used to extend the assessment for an advanced class of students. The optional portion could also be used as an extension to the unit. If you choose to use part C as an extension, use **7.6.R1: Model Rubric** Part II only for informing instruction and not for evaluation/grading purposes.

       Use your model to predict what would happen to the tree growth if a large store was built next to the tree, blocking the sunlight for a large portion of the day. How is your model accurate and useful in predicting the outcome?

14. English Learners or students who are not currently at grade level may benefit from a few sentence starters to complete the description. These can be provided as table cards or on a sheet attached to the model checklist. Examples are provided here:
    - My model shows _____ because _____.
    - The evidence from _____ shows that _____.
    - The _____ causes _____.
    - The effect of _____ was _____.
    - The _____ enters the system and _____ leaves.
    - _____ happens _____.
15. Collect the assessments. End the learning sequence with a class discussion about how the models have changed in the three dimensions of the modeling practice (SEP), the core science idea of photosynthesis (DCI), and the crosscutting concept of Energy and Matter (CCC).
16. An optional ending to the unit is to assign a writing prompt that students complete individually.
    - Return the model and explanation collected in Lesson 7.1: Tree Matter to the students.
    - Have them respond to the following prompt: Look at both your models. Analyze your thinking and understanding. Describe the changes you made and why you made these changes.
17. After you have collected the final model and descriptions, ask the students to review the question chart. Review the questions together one last time and discuss which questions remain unanswered. Move these questions to a "parking lot" chart. Explain to students that scientists often generate more questions than answers, and confirm that this is a normal part of doing science. If fact, you should always have more questions. Tell students that their remaining questions will be displayed on the parking lot chart during the year. Many questions may get answered later in the year. More questions will be added after other investigations. Parking lot questions can also be selected by students, one or many, for additional research if students want to pursue questions on their own.

References

Muviag. (2011, March 2). The growing tree/Time lapse Animation. Retrieved from https://www.youtube.com/watch?v=RjnKAWxCK3k.

Toolbox Table of Contents

Model Rubric

Part I

A. Record your final model to show how cycles matter to develop from a small seedling into a large tree.

B. Add a brief description of your model and how your model shows how a tree gets mass to develop into a large tree.

	EMERGING	APPROACHING	MEETING	ADVANCED
Description of the Model	States that photosynthesis is the cause of the tree growth but does not include a clear statement about what matter is involved or statement contains inaccuracies, such as mass is obtained from water or soil.	States that photosynthesis is the cause of tree growth. Includes a clear statement that matter is cycling [states that plant gathers matter from the air and/or water and converts that matter to add mass] but response lacks specifics about how the matter is conserved [CO_2 is taken from the air and with water is reorganized into sugar and oxygen] OR does not describe the role of energy in the cycling of matter [does not specify that solar energy is needed to reorganize CO_2 and water].	States that photosynthesis is the cause of the cycling of matter and specifies that CO_2 from the air and water is converted into sugar and oxygen AND describes the role of light energy in the rearrangement of CO_2 and water into sugar and oxygen for growth and energy for the tree.	States that photosynthesis is the cause of the cycling of matter and specifies that CO_2 from the air and water is converted into sugar and oxygen AND describes the role of light energy in the rearrangement of CO_2 and water into sugar and oxygen for growth and energy for the tree AND describes specific pathways for carbon [converted to sugar for immediate energy or cellulose for growth].
Developing a Model	Constructs a model (drawing, words, symbols) that is relevant, but the model is lacking major conceptual components (sunlight, CO_2), has major errors, or is composed of irrelevant details.	Constructs a model to represent the process of photosynthesis but minor errors or omissions are present. For example, the cycling of carbon is incomplete AND information about how energy was used to change matter into new tree mass is missing.	Constructs an accurate model but the model has some vague information about how matter was converted to form new tree mass. For example, only the conversion of CO_2 to glucose is discussed but fails to address the role of water or resulting O_2 in the process. [model is missing some necessary variables in the photosynthesis process]. OR The model does not show how the transfer of energy drives the cycling of matter [develop a model to describe unobservable mechanisms]	Constructs an accurate and complete model that includes the necessary components of photosynthesis (sunlight, CO_2, water, sugar) and indicates how matter from the air (CO_2) and water is rearranged to form oxygen and new tree mass and energy for the tree (sugar and cellulose) [develop a model to show the relationships among variables, including those that are not observable but predict observable phenomena]. AND The model shows how the transfer of energy drives the cycling of matter [develop a model to describe unobservable mechanisms].

Model Rubric (continued)

Part II

C. Use your model to predict what would happen to the tree growth if a large store was built next to the tree, blocking the sunlight for a major portion of the day. How is your model accurate and useful in predicting the outcome?

	EMERGING	APPROACHING	MEETING	ADVANCED
Prediction of Model: Strengths and Limitations	Prediction is inaccurate AND The model's ability to provide an accurate prediction is not discussed.	Makes an accurate prediction (tree growth will likely be slowed since energy from the Sun is needed to rearrange the matter) BUT the prediction is not consistent with the model AND does not evaluate the accuracy of the system or process.	Makes an accurate prediction (tree growth will likely be slowed since energy from the Sun is needed to rearrange the matter) AND prediction is consistent with the model. BUT does not evaluate the accuracy of the system or process.	Makes an accurate prediction (tree growth will likely be slowed since energy from the Sun is needed to rearrange the matter) AND is consistent with the model AND evaluates the accuracy AND limitations of the system or process.

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [*Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis*.]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)

Developing and Using Models

- Develop and revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- Develop a model to describe unobservable mechanisms.

Constructing Explanations and Designing Solutions

- Construct an explanation using models or representations.

DISCIPLINARY CORE IDEAS (DCI)

LS1.C Organization for Matter and Energy Flow in Organisms

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.

PS3.D Energy in Chemical Processes and Everyday Life

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon based organic molecules and release oxygen.

Appendix 7.6

CROSSCUTTING CONCEPTS (CCC)
Energy and Matter
• Matter is conserved because atoms are conserved in physical and chemical processes. Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
Systems and System Models
• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Common Core State Standards (CCSS)

CCSS ELA SPEAKING AND LISTENING
ELA-LITERACY.SL.7.1.D
Acknowledge new information expressed by others and, when warranted, modify their own views.
ELA-LITERACY.SL.7.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS ELA WRITING
CCSS.ELA-LITERACY.W.7.4 (If optional individual assessment is done).
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

California English Language Development (ELD) Standards

CA ELD		
Part I 7.11a,b Justifying/arguing		
EMERGING	EXPANDING	BRIDGING
P1.7.11a,b a) Justify opinions by providing some textual evidence or relevant background knowledge with substantial support. b) Express attitude and opinions or temper statements with familiar modal expressions (e.g., *can*, *may*).	**P1.7.11a,b** a) Justify opinions or persuade others by providing relevant textual evidence or relevant background knowledge with moderate support. b) Express attitude and opinions or temper statements with a variety of familiar modal expressions (e.g., *possibly/likely*, *could/would/should*).	**P1.7.11a,b** a) Justify opinions or persuade others by providing detailed and relevant textual evidence or relevant background knowledge with light support. b) Express attitude and opinions or temper statements with nuanced modal expressions (e.g., *possibly/potentially/absolutely*, *should/might*).