Big Thick Pumpkins & Where They Get Their Mass

Unit: **Strand BIO.2: Structure and Function of Life** **Photosynthesis**	**Utah SEEd Standard / NGSS Performance Expectation: (Core Guides)** **Standard BIO 2.3** **Develop and use a model** to illustrate the cycling of matter and flow of energy through living things by the processes of photosynthesis and cellular respiration. Emphasize how the products of one reaction are the reactants of the other and how the energy transfers in these reactions. (LS1.C)	**Time:** **One class period of about 60 minutes**

Access to all materials for this lesson: https://byu.box.com/s/6xlzoizjdpqy948audbtm93yzxwrg8bu

Anchor Phenomenon	A video showing the growth of a giant pumpkin.
Driving Question(s)	Where do pumpkins get their mass?
Performance Task	Scholars will model the inputs and outputs of photosynthesis and identify where the inputs came from and where the outputs will go.

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Lesson Summary:			
	Time	**Guiding Question / Learning Objective**	**How are students answering the guiding question or meeting the learning objective?** (Highlight the SEPs, DCIs, and CCCs in the corresponding color.)
 **Engage**	20 minutes	Where do pumpkins get their mass?	Students start to question where the pumpkin gets its mass. Students think about where our food comes from and recognize that it provides matter and energy to our bodies.
 **Explore**	30 minutes	What are the inputs and outputs of photosynthesis? Where do the inputs come from, and where do the outputs go?	Using the formula for photosynthesis, students solidify that CO_2 and H_2O come into the plant through leaves and roots. They are used to make sugar, $C_6H_{12}O_6$, and O_2.
 **Explain**	10 minutes	Where do plants get their mass?	Students refine their models showing that most of the mass of a plant will come from the intake of CO_2 and H_2O and the creation of glucose which provides energy for cellular activities.
 **Elaborate**	5 minutes	Optional activity: Have students research which plant pulls the most CO_2 out of the air.	Teacher may provide sources, or students may find their own. Students could look at house plants, trees, or plants in general.
 **Evaluate**	5 min	Where do plants get their mass?	The teacher moves around the room to check on the final models of the students and helps students fix errors in their models or confirm that their models are correct.

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Three Dimensions Focused on in This Lesson		
Disciplinary Core Idea: **NGSS Appendix E** Photosynthesis and cellular respiration provide most of the energy for life processes. Only a fraction of matter consumed at the lower level of a food web is transferred up, resulting in fewer organisms at higher levels. At each link in an ecosystem, elements are combined in different ways and matter and energy are conserved. Photosynthesis and cellular respiration are key components of the global carbon cycle. **This lesson focuses on photosynthesis.**	**Science and Engineering Practices:** **NGSS Appendix F** **Developing and using models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	**Crosscutting Concept:** **NGSS Appendix G** **Energy and Matter** In grades 9-12, students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
Learning Objectives 1. Scholars will be able to model the inputs and outputs of photosynthesis and identify where the inputs came from and where the outputs will go.		
Related Knowledge and Skills from Prior Grades		
Disciplinary Core Idea: **NGSS Appendix E** The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Food webs model how matter and energy are transferred among producers, consumers,	**Science and Engineering Practices:** **NGSS Appendix F** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.	**Crosscutting Concept:** **NGSS Appendix G** In grades 6-8, students learn matter is conserved because atoms are conserved in physical and chemical processes. They also learn within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. Energy may take different

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and decomposers as the three groups interact within an ecosystem.		forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system.

Connections to Mathematics and ELA/Literacy Standards	
ELA/Literacy Standards: **RST.11-12.7:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.	**Mathematics Standards:** **HSN.Q.A.2**: Define appropriate quantities for the purpose of descriptive modeling.

Materials

Handouts	**Lab Supplies**	**Other Resources**
Student Worksheet		Teacher PowerPoint Time-lapse video Amoeba Sisters video: Photosynthesis Updated

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ENGAGE

Where do pumpkins get their mass?	Students start to question the source of the pumpkin's mass. Students think about where our food comes from and recognize that it provides matter and energy to our bodies.

The teacher shows PowerPoint slide 2 and plays the video showing the time-lapse video of the growth of a giant pumpkin.

- *Students* will complete #1 on their student worksheet to individually model a 3-step sequence of what happens to the plant as it grows.
- *Students* will individually complete #2 on the student worksheet to write down at least one question they have from the video and their drawings.

Teacher asks students to share questions with the class while the teacher writes them on the board. (Students could also come to the board and write them.)

- *Students* will individually complete #3 by explaining what the plant needs to grow that big.
- *Students* complete #4, which is to draw and label a diagram modeling how a pumpkin plant gets matter and energy, including as much detail as possible.

Teacher displays 100% orange juice, whole wheat bread, a pumpkin, a cucumber, and an apple.
Teacher shows PowerPoint slide 3 and invites students to show thumbs up or thumbs down or share verbal answers to the questions posed on the slide.
Teacher shows PowerPoint slide 4, which shows the same products.
Teacher asks students, "What is the original source of each of these products?"

- *Students* answer question #5 individually on their worksheets.

Teacher invites students to share answers with their partners. Then ask *students* to share with the class.
Teacher asks, "What do these foods provide for our bodies?"

- *Students* answer question #6 individually on their student worksheets.
- *Students* discuss their answers with each other and then are invited to share them with the class.

Teacher guides the students to the answer that food provides matter and energy to our bodies.

Teacher Tips:

PowerPoint slide #4 is used in case teacher access to physical materials isn't possible. Other food products can replace the materials shown but must be organic, plant-based substances. The wheat used in the bread is the plant-based material.

Students will likely answer nutrients and energy rather than matter and energy. The teacher can help students by posing further questions and guidance until students say that matter and energy are what is provided.

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EXPLORE

What are the inputs and outputs of photosynthesis? Where do the inputs come from, and where do the outputs go?	Using the formula for photosynthesis, students solidify that CO_2 and H_2O come into the plant through leaves and roots. They are used to make sugar, $C_6H_{12}O_6$, and O_2.

The teacher explains the first part of the Matter and Energy Interview activity to students.

- *Students* will write their answers to the three interview questions on the data table in the student worksheet.
- *Students* then interview three classmates and write those answers on their student worksheets.

Teacher shows PowerPoint slide 5 and plays the Amoeba Sisters video titled "Photosynthesis Updated." Be sure to stop the video at 3:03 seconds after the video discusses the chloroplasts.

- *Students* answer question #7: "Where do plants get their energy?"
- *Students* answer question #8: "Write the chemical formula for the photosynthesis equation."
- **Teacher** then provides students with time to share answers to compare and fix.

Teacher should then clarify the answers to these questions and the formula for photosynthesis.

Teacher shows students PowerPoint slide #6 and discusses each energy source shown.
Teacher asks, "What is the fuel source for our human bodies?"

- *Students* answer question #9: "What fuel source do our cells require? Write the name and chemical formula."
- *Students* compare answers with one another; **teacher** asks for answers and clarifies the correct formula for glucose.

Teacher asks students, "What elements make up glucose?"

- *Students* individually list those elements as question #10 on their worksheet.
- *Students* answer question #11: "Where do plants get Carbon, Hydrogen, and Oxygen?"
- *Students* compare answers with a partner, then share with the class.

Before class **teacher** needs to arrange an area on the whiteboard for students to list the responses to each of the three interview questions; make columns for the 'yes' and 'no' answers for questions 2 and 3.

Teacher explains the second part of the Matter and Energy Interview activity.

The interview protocol:

Teacher Tips
This activity is a great chance to reach kinesthetic learners. Students can stand and move around the room to complete their three interviews.

We recommend arranging possible

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• *Students* will be excused from the classroom to interview 3 other individuals (2 adults and 1 additional student). They will ask each person the same three questions found on the data table on their student worksheet.
• **Teacher** explains that during the interview protocol, students must be respectful of other classes in session. They cannot be found outside designated areas, horse playing, or causing other disruptions.
• *Students* will return to the classroom within the designated time. They will then follow the protocol below.
  ○ List at least one of the answers received for interview question 1 on the whiteboard. If all their answers are already on the board, add a checkmark next to each one they received.
  ○ Add a tally mark under the 'yes' or 'no' column for interview question 2 on the whiteboard.
  ○ Add a tally mark under the 'yes' or 'no' column for interview question 3 on the whiteboard.
• *Students* are now allowed to leave for their interviews.
 	
Teacher discusses with students about their interviews and what kinds of answers they received and wrote on the board.
Teacher works with students to cross out answers on the board that they know are incorrect.
 	
Teacher asks students to complete **Model #2,** question #12 on their worksheet. In Model #2, they should revise their previous model, showing where the pumpkin plant gets its matter and energy.
 	
Teacher shows PowerPoint slide 7 and plays the Hydroponics of a Mango Tree video.
Students will individually complete questions #13 and #14 on their worksheets to list how the video **supports** or **challenges** their current model.
	individuals for your students to interview by discussing with office staff, administrators, counselors, student aids, custodians, or others who may be available for a short interview.
	
	Teachers can arrange to have students come into a colleague's classroom to ask their interview questions.
	
	Another option is for students to be permitted to text a couple of family members and ask questions by text.

EXPLAIN -

Where do plants get their mass?	Students refine their models showing that most of the mass of a plant will come from the intake of CO_2 and H_2O and that the creation of glucose provides energy for cellular activities.

Teacher shows PowerPoint slide 8: Veritasium video.

- *Students* will individually complete questions #15 and #16 on their student worksheets, answering where plants get their CO_2 and H_2O.
- *Students* will compare their answers with a partner and adjust as necessary.
- *Students* will refine Model #2 by completing Model #3, showing where a pumpkin plant gets its matter and energy. Students should be as complete and detailed as possible. This model will be completed on a full sheet of paper, so there is plenty of room to include everything needed.

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- *Students* will again partner with another student and compare their models. If there are differences, have students discuss them and refine their models as needed.
- *Students* answer question #17, identifying something they still wonder about matter and energy, plants, photosynthesis, or their food.

ELABORATE

Optional activity: Have students research which plant pulls the most CO_2 out of the air. Students are put into groups and given a post-it note to record their findings. Groups share what they learn.	Students can find their own sources, or teacher could provide any/all of the following sources: https://www.sciencefocus.com/nature/are-some-plants-better-than-others-at-sucking-up-carbon-dioxide/ https://getreprint.com/best-trees-absorb-co2/ https://www.thoughtco.com/which-trees-offset-global-warming-1204209

EVALUATE

Teacher moves around the room to check on the final models of the students and helps students fix errors in their models or confirm that their models are correct.
- *Students* turn in their student worksheets at the end of class.

POSSIBLE EXTENSION / ALTERNATIVE ADAPTATIONS

Have students research which plant pulls the most CO2 out of the air. See “Elaborate” section.

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