

Where does food come from and where does it go next? EQIP Rubric for Science Evaluation

Developer/Curriculum: OpenSciEd

Unit Name: Matter Cycling and Photosynthesis: Where does food come from and where does it go next?

Grade: Middle School

Date of Review: January 2020

Overall Rating (N, R, E/I, E): E

Category I: NGSS 3D Design Score (0, 1, 2, 3): 3

Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 3

Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3

Total Score (0–9): 9

[Click here to see scoring guidelines](#)

This review was conducted by the [Achieve](#) Peer Review Panel using the [EQIP Rubric for Science](#).

Category I Criteria Ratings		Category II Criteria Ratings		Category III Criteria Ratings	
A. Explaining Phenomena/Designing Solutions	Extensive	A. Relevance and Authenticity	Extensive	A. Monitoring 3D Student Performances	Extensive
B. Three Dimensions	Extensive	B. Student Ideas	Extensive	B. Formative	Extensive
C. Integrating the Three Dimensions	Extensive	C. Building Progressions	Extensive	C. Scoring Guidance	Adequate
D. Unit Coherence	Extensive	D. Scientific Accuracy	Extensive	D. Unbiased Tasks/Items	Extensive
E. Multiple Science Domains	Extensive	E. Differentiated Instruction	Extensive	E. Coherence Assessment System	Extensive
F. Math and ELA	Extensive	F. Teacher Support for Unit Coherence	Extensive	F. Opportunity to Learn	Extensive
		G. Scaffolded Differentiation Over Time	Extensive		

Summary Comments

Thank you for your commitment to students and their science education. Achieve is glad to partner with you in this continuous improvement process. It is obvious that this unit was thoughtfully crafted and revised. Its many strengths are apparent from the ratings. Strengths of the unit include:

- Three-dimensional design – the unit is designed so that students make sense of phenomena (maple syrup is used as an anchoring phenomenon) by engaging in student performances (developing and

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using models, planning and carrying out investigations, and constructing explanations) that integrate the three dimensions of the NGSS.

- Unit coherence – student questions drive each lesson to build an understanding of core ideas.
- Multiple science domains – disciplinary core ideas from the physical and biological sciences are used together to explain phenomena. The usefulness of crosscutting concepts to make sense of phenomena *across science domains* is highlighted.
- Mathematics and ELA-Literacy – grade-appropriate mathematics and ELA-Literacy are purposefully incorporated into lessons with teacher support to help students make these connections.
- Relevance and authenticity – students experience phenomena directly (e.g., categorize foods they ate for breakfast, taste maple sugar, grow plants hydroponically, document decomposers in their backyards), are provided opportunities to connect with the phenomena on a personal level, and answer questions generated by them.
- Student ideas – student ideas drive the instruction.
- Building progressions – the unit builds on students’ prior learning in all three dimensions at the middle school level with suggestions for adaptations if students are above or below that level.
- Scientific accuracy – the unit uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students’ three-dimensional learning.
- Differentiation – the unit provides guidance for teachers to support differentiated instruction by including:
 - Appropriate reading, writing, listening, and speaking alternative (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below grade level.
 - Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.
 - Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.
- Teacher support for unit coherence – strategies are provided for linking student engagement across lessons and for ensuring student sense-making.
- Scaffolded differentiation over time – supports are provided to help students engage in the practices as needed and are gradually adjusted over time, so that students are increasingly responsible for making sense of phenomena.
- Monitoring 3D student performances – direct, observable evidence of three-dimensional learning is elicited; students are using practices and crosscutting concepts to make sense of phenomena.
- Formative assessment – the unit embeds formative assessment processes throughout that evaluate student learning to inform instruction.
- Unbiased tasks/items – the unit assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.
- Coherent assessment system – the unit includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

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- Opportunity to learn – multiple opportunities are provided for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts.

During revisions, the reviewers recommend paying close attention to the following areas:

- Consider including a table of the Disciplinary Core Ideas (DCIs) similar to the one for the SEPs and Crosscutting Concepts (CCCs).
- In the “Teacher Background Knowledge,” consider including the DCI codes within the paragraphs to more clearly show the progression of knowledge.
- Consider including specific language from the DCI elements and identifying which parts of the elements are found in which lessons.
- Consider including scoring guidance for all dimensions being assessed and their use together. Ensure that the assessment targets are clearly stated and incorporated into the scoring guidance.
- Consider providing a range of student responses and interpretation guidance to support score interpretation.
- Consider providing guidance to teachers to purposefully provide opportunities for students to demonstrate learning based on peer and teacher feedback.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that the criterion was not met.

Category I. NGSS 3D Design

Score: 3

3: At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C

2: At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C

1: Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C

0: Inadequate (or no) evidence to meet any criteria in Category I (A–F)

I.A. Explaining Phenomena/Designing Solutions: Making sense of phenomena and/or designing solutions to a problem drive student learning.

Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A Explaining Phenomena/Designing Solutions: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that learning is driven by students making sense of phenomena or designing solutions to a problem because the unit is grounded in a clear anchor phenomenon, which

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promotes generation of questions that drive student sense making and the investigation of subsequent phenomena.

The phenomenon is sufficient to drive student learning, and all of the student learning, across the three dimensions targeted by the unit, is in service of students making sense of phenomena. Students regularly return to the phenomenon to add layers of explanation based on learning.

- Lesson 1 introduces the anchoring phenomenon that drives the rest of the unit: students taste maple sap and discuss the inputs or molecules needed by plants to make the sap.
- Lesson 1 starts by building students' background knowledge around the idea of maple syrup. Students explore the food that they ate today, taste maple sap, watch a video about how sap is collected from maple trees, predict which food molecules are found in plants, develop initial models about how plants get the food molecules that they need, and then they discuss questions related to how plants get their food molecules (Teachers' Guide pages 40–41).
- Students ideas for investigation are clearly used to determine the flow of the lessons: "Once this 'Ideas for Investigation' poster is built, help students realize (and get excited) that they created a joint mission and proposed action plan to guide the work of our learning community for weeks to come as we conduct investigations to figure out how plants get their food molecules." The teacher is directed to say, "...let's take a moment to think about how starting with one specific investigation idea could help us make progress on our questions. It seems like we have some ideas about the components of the plant system that we want to investigate. We also have a group of questions around the inputs that plants use and where these food molecules come from. It feels like this would be a productive place to start in trying to figure out more about where food molecules come from" (Teachers' Guide page 66).
- To figure out how plants could be making these food molecules and where they are getting the matter and energy to do that, students conduct a series of investigations to:
 - develop a model to track the inputs and outputs of plants;
 - carry out experiments to figure out how leaves and seeds interact with the gases in the air around them in the light and the dark;
 - develop and evaluate arguments from their evidence to figure out where plants are getting the energy and matter they need to live;
 - construct an explanation for the central role of photosynthesis in all food production, including synthetic foods;
 - obtain and communicate information to explain how matter gets from living things that have died back into the system through processes done by decomposers; and
 - develop and use a model to explain that the major atoms that make up food (carbon, hydrogen, and oxygen) are continually recycled between living and nonliving parts of a system.
- Lesson-level phenomena, orchestrated to build on questions anticipated by the use of driving question board, inspire and guide sense making throughout the unit. These lesson-level phenomena are outlined in the Lesson Storyline (Teachers' Guide, pages 3–13).

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- Students regularly return to the maple sap phenomenon throughout the unit.
 - After Lesson 8, students have “put the pieces together to explain that plants do chemical reactions using the inputs of carbon dioxide, water, and light to make glucose and oxygen. This made us wonder if this is what is happening when the maple tree makes sap and how plants that don’t have all their inputs could survive” (Teacher’s Edition, page 9).
 - After Lesson 9, students have figured “out that maple trees have food (sap) in them even when there are no leaves on the tree. This makes us wonder whether trees can make food when they don’t have leaves and if they do have leaves can they make food in the dark? (Teacher’s Edition, page 9).
 - After Lesson 11, students have “figured out that the maple tree is not producing syrup for us to eat for breakfast, but is producing it so it can use it as an input for cellular respiration so it can have energy and matter to live and grow through the winter. Now we want to revisit our breakfast food poster and see if we can now explain where some of our breakfast foods come from” (Teacher’s Edition, page 11).
 - After Lesson 14, students have “figured out how atoms are cycled through different levels of a system. We’ve figured out so much! Now we are ready to revisit our DQB to show what we have learned by answering many of our questions” (Teacher’s Edition, page 13).
- Additionally, students return to the phenomenon throughout the unit, when they revise their consensus models in Lesson 3 (part 7, page 105), Lesson 4 (step 7, page 122), Lesson 5 (step 5, page 141), Lesson 6 (step 8, page 157), Lesson 7 (step 5, page 176), Lesson 8 (step 4, page 188), Lesson 11 (steps 9 and 10, page 242), Lesson 12 (steps 10 and 11, page 279), Lesson 13 (step 8, page 292), Lesson 14 (step 3, page 304), and Lesson 15 (steps 2 and 3, page 327).

Student questions about the phenomenon create a need for the students to engage throughout the materials. Materials provide structured support for teachers to draw out these connections from students and use these connections to motivate student learning.

- Very detailed instructions are given to the teacher about how to engage students in an effective brainstorming session to build and share their questions (Teachers’ Guide page 63). A sample Driving Question Board (DQB) is included (page 64) with sample student questions that are grouped into main ideas.
- After developing the DQB, students individually brainstorm “ideas for investigation” to determine how to answer the various questions (Teachers’ Guide page 65).
- Students also add to the DQB in Lesson 9 step 4 by considering new ‘big’ questions: “How can plants have food molecules in them when all the inputs or structures needed to make food molecules aren’t present? Why do plants need food molecules?” (page 207).

Suggestions for Improvement

Consider including a very specific statement (one sentence rather than an entire paragraph) of what the phenomenon is in Lesson 1. For example, “trees make sweet maple sap that we can eat.”

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I.B. Three Dimensions: Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

Provides opportunities to *develop and use* specific elements of the SEP(s).

Provides opportunities to *develop and use* specific elements of the DCI(s).

Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions: Extensive (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions, because the core of the grade-appropriate elements that students are engaged in are in service of students making sense of phenomena.

Science and Engineering Practices (SEPs): Extensive

The reviewers found extensive evidence that students have the opportunity to use and develop the SEPs in this unit, because specific SEP elements are developed and revisited repeatedly throughout the unit. A clear pattern is apparent throughout the unit in which a phenomenon is presented or elaborated, questions are generated, models developed, evidence collected and analyzed, models revised, and new questions emerge. Students are using the practices at the grade-band appropriate level.

Evidence related to this criterion includes:

- The unit very clearly lists within the Teachers' Edition and in the document "Developing and Using Science and Engineering Practices (by Lesson)" the specific elements that are addressed within each lesson. For example,
 - In Lesson 1, *Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.*
 - In Lesson 3, *Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.*
 - In Lesson 8, *Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.*
- The unit very clearly describes within the Teachers' Edition and in the document "Developing and Using Science and Engineering Practices (by Lesson)" HOW the specific elements are addressed within each lesson. For example,
 - In Lesson 1, *"Students ask questions that arise from careful observations of maple sap and syrup and the nutrition labels that show that plants contain food molecules. They craft questions about the phenomenon while focusing on different parts of the system.*

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Students group their questions into similar clusters and reflect on how these questions relate to the phenomenon and the initial models they developed to explain it.”

- In Lesson 3, “Students remove air and light from their candidate list of sources for whole food molecules based on the evidence from their composition. Since students have already removed hydroponic plant food and water from their candidates list this leads them to believe that no whole food molecules are entering the plant. Their evidence pushes students to look for parts of food molecules instead of whole.”
- In Lesson 8, “Students revise their initial individual and class consensus models to explain how a plant can make food molecules that provide both matter and energy from light, carbon dioxide, and water.”

Disciplinary Core Ideas (DCIs): Extensive

The reviewers found extensive evidence that students have the opportunity to use and develop the DCIs in this unit, because grade-appropriate DCI elements are in service of students making sense of phenomena.

For example, students are building understanding towards the DCI element *PS3.D: 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.*

- In Lesson 3, students question their consensus model by revisiting what they know about light and the components of air and “problematize that sunlight seems an important component to plant growth, but it isn’t made of matter. Later in the unit, we will discover the role of light for plant growth. Later in this lesson, the class will revisit the consensus model and add “light” with a ? and “energy” if it isn’t there already to keep track of this idea that plants need light, but light can’t be a source of molecules since it isn’t made of matter” (page 98).
- In Lesson 4, students draw conclusions based on the evidence they collected that above the surface, plants are taking in carbon dioxide and releasing water, and raise questions about what other gases might be entering or exiting plants through the leaves. From data they collect, they determine that carbon dioxide levels in the air around plant leaves decrease over time. Water levels in the air around plant leaves increase over time. Since carbon dioxide levels decrease in this closed system, it is probably going into the plant leaves. Since water levels increase in this closed system, water is being released from the plant leaves. Plant leaves do not take in water. There are other gases in air that have parts of food molecules. Maybe some of those are going into the plant leaves.
- In Lesson 6, they will figure out that plants are building sugars (food molecules) by using energy from light and carbon dioxide and water.
- In Lesson 7, they will figure out that this chemical reaction, photosynthesis, requires an energy input to occur (e.g., light from the sun).

Students continue to build understanding toward PS3.D: *Cellular respiration in plants and animals*

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involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.

- In Lessons 10 and 11, students will figure out that plants, like humans, release energy through a chemical reaction with sugars (food molecules) and oxygen, and produce carbon dioxide and water.

The last part of the unit has students building understanding toward LS2.B: *Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.*

- In Lesson 12, students analyze nutrition labels from a variety of foods and determine that everything we eat contains matter that came from either plants or animals. Some foods we eat have been processed either physically or chemically, but we can still trace them back to originally coming from plants. Most animals, including humans, eat plants, other animals that once ate plants, or both. Most animals, including humans, use the food molecules they eat to build up larger molecules for growth, to get energy by burning glucose through cellular respiration, or to store for later use.
- Obtaining evidence from video analysis in Lesson 13, students determine that many decomposers take in oxygen and food molecules and give off carbon dioxide and water. Decomposers recycle dead plant and animal matter and energy back into the system. Decomposers use matter for food that humans (and many animals) cannot use for energy and matter.
- In Lesson 14, students review photographs of decomposers and revisit their consensus model to conclude that the outputs of living things become the inputs of other living things and part of the nonliving components of the system. Ecosystems consist of living (producers, consumers and decomposers) and nonliving (air and water) components where atoms are continuously recycled between these components.

Crosscutting Concepts (CCCs): *Extensive*

The reviewers found extensive evidence that students have the opportunity to use or develop the CCCs in this unit, because there are sufficient CCC elements and time that students are engaged in the CCCs for the length of the materials. Students are using the targeted CCCs at the element level for middle school. The CCCs that are claimed and the evidence of CCCs development and use in the materials (especially with the elements that are being developed) are a direct match.

Evidence related to this criterion includes:

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- The unit very clearly lists within the Teachers' Edition and in the document "Developing and Using Crosscutting Concepts (by Lesson)" the specific elements that are addressed within each lesson. For example,
 - In Lesson 6, *Models can be used to represent systems and their interactions-such as inputs, processes and outputs-and energy, matter, and information flows within systems.*
 - In Lesson 8, *Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.*
 - In Lesson 10, *Graphs, charts, and images can be used to identify patterns in data.*
- The unit very clearly describes within the Teachers' Edition and in the document "Developing and Using Crosscutting Concepts (by Lesson)" HOW the specific elements are addressed within each lesson. For example,
 - In Lesson 6, "This lesson supports students in using the crosscutting concept of models being used to represent systems. Students use a simulation to represent a plant system. The simulation allows students to control different inputs into this system such as carbon dioxide and water. Students watch what happens when these inputs interact within the plant cell and how this affects the amount of food made by the plant."
 - In Lesson 8, "Students model and show the transfer of energy from the sun to the plant making food molecules using chemical reactions, which take the inputs of matter from carbon dioxide and water when there is light energy present and rearranges the atoms to create oxygen and glucose, which provides caloric energy and matter."
 - In Lesson 10, "This lesson supports students in using the crosscutting concept of patterns by using tables and graphs of data to identify different gases as plant inputs or outputs. This data is analyzed to look for patterns in the amounts of carbon dioxide, water, and oxygen surrounding plant leaves over time in the dark."
- In Lesson 1, suggested prompts for the teacher include,
 - "What did you notice about the inputs and outputs of the system?" (Teachers' Edition page 50).
 - "What patterns do you see in the foods we eat that come from plants?" (Teachers' Edition page 56).
- Teachers are provided with specific suggestions for developing students' use of the CCC of **Systems and System Models** in Lesson 1. "Systems and systems models are a focal crosscutting concept for this unit. A system is an organized group of related objects or components. Here we refer to those objects or components as parts. Scientists use models to understand and predict the behavior of systems. The first step in modeling a system in order to understand it is to figure out the important parts of the system. This allows scientists to study how the parts interact to produce the emergent behavior of the system as a whole. Help students set up their initial models as systems models by identifying the important parts of each system and thinking about how those parts work together (interact)" (page 57).
 - *Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.*

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- A section is included entitled Supporting Students in Developing and Using **Systems and System Models**: “Students may have been listing various components of the plant system. It is OK to start pushing them to describe if any of the matter is moving into the plant as an input for food molecules. You can also ask students if there are any components of the system or inputs that are invisible to us with just our eyes that might be important in the system” (page 60). “By the end of the lesson, students want to continue to look for other inputs into plants that could be sources of food molecules. This serves to broaden inputs for the plant system. Over the course of the next few lessons, students will begin to see other inputs and outputs of this system” (page 82).
 - *Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.*
- In Lesson 3, teacher prompts include, “Look for **patterns** between Food Molecule Cards and Composition of Air. Show slide F. Work with your partner to find patterns that might help us figure out whether plants could be putting together parts of food molecules (page 100).
 - *Macroscopic patterns are related to the nature of microscopic and atomic-level structure.*
- In Lesson 5, “[we] observe the surface of real leaves along with microscopic leaf images and a video. We see small openings on the leaf surface and discuss how these could allow plants to “breathe,” by letting gases in and out. Inside the leaves, we see moving green circles inside repeating structures. We gather information from a reading that the repeating structures are plant cells, and the green circles, or chloroplasts, are moving in response to light. We discuss how light and chloroplasts fit in our plant model and review the other inputs and outputs. We discuss how a simulation could help us figure out what exactly is happening inside plant leaves” (Teacher’s Edition, page 135).
 - *Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.*

Suggestions for Improvement

SEPs

- In the document “Developing and Using Science and Engineering Practices (by Lesson), consider including the science and engineering practice that is addressed in each lesson in addition to the element.
- There are 17 different SEP elements listed in this unit plan (there are 51 total MS elements). It was unclear to reviewers whether students are expected to be able to “do” each of these at the appropriate 6–8 grade band depth by the end of the unit. Reviewers also wondered whether some of the elements are more important than others and whether some elements are of secondary

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importance. Consider clarifying the intent of student outcomes for these elements and whether teachers would need to intentionally choose which elements to place more emphasis on.

DCIs

- Consider constructing a DCI table similar to the SEP and CCC tables. This could include the elements from the DCIs and which lessons connect to which elements.
- In the “Teacher Background Knowledge,” consider including the DCI codes within the paragraphs to more clearly show the progression of knowledge.
- While the Assessment portion of the Teacher Guide does a great job of outlining the SEP and CCC connections, alignment to the DCIs is very vague. Consider including specific language from the DCI elements and identifying which parts of the elements are built in which lessons.

CCCs

- In the document “Developing and Using Science and Engineering Practices (by Lesson),” consider including the crosscutting concept that is addressed in each lesson in addition to the element.
- Elements from five of the seven crosscutting concept categories are used in this unit; this may be too high of an expectation for students. Ten of the twenty-five 6–8 grade band elements are used in this unit. It was unclear to reviewers whether students are expected to be able to “do” each of these at the appropriate 6–8 grade band depth by the end of the unit. Reviewers also wondered whether some of the elements are more important than others and whether some elements are of secondary importance. Consider clarifying the intent of student outcomes for these elements and whether teachers would need to intentionally choose which elements to place more emphasis on.

I.C. Integrating the Three Dimensions: Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions: Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena or designing solutions to problems because the three dimensions intentionally work together to help students adequately explain a phenomenon. There are numerous events where all students are expected to figure something out (a phenomena) in a way that requires grade-appropriate elements of all three dimensions of the standards.

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The Unit Overview states, “To figure out how plants could be making these food molecules and where plants get the matter and energy to do that, students conduct a series of investigations. Through these investigations, students:

- Develop a model to track the inputs and outputs of plants;
- Carry out experiments to figure out how leaves and seeds interact with the gases in the air around them in the light and the dark;
- Develop and evaluate arguments from their evidence to figure out where plants are getting the energy and matter they need to live;
- Construct an explanation for the central role of photosynthesis in all food production, including synthetic foods;
- Obtain and communicate information to explain how matter gets from living things that have died back into the system through processes done by decomposers;
- Develop and use a model to explain that the major atoms that make up food are continually recycled between living and nonliving parts of a system” (Teacher Edition, page 1).

The Unit Storyline identifies integration of three dimensions in each lesson across the unit. For example:

- “Obtain, evaluate, and communicate information to show the relationships among matter and energy between the inputs and outputs for the process by which plants use energy from light to make sugars from carbon dioxide and water (photosynthesis). Engage in argument from evidence and scientific reasoning to support the claim that plants use sunlight for energy to convert carbon dioxide and water into sugar that provides a form of energy the body can use.” (Teacher Edition, page 30).
- “Students will analyze the images of food molecules, of the plant food label with chemical formulas included, of air molecules, and of water molecules. Using what they notice about similarities between atoms types of the potential inputs and of the food molecules, help students verbalize and consider that it is possible that parts of food molecules come from these different inputs” (Teacher Edition, page 101).
- “Students should be able to argue from evidence that carbon dioxide and water aren’t sources that can provide us with energy. Once the class has agreed that glucose can be a source of calories (energy for us) and that carbon dioxide and water are not sources of energy for us, add the label “Energy” next to glucose in the model” (Teacher Edition, page 173).

In the “Assessment System Overview, “Lesson-Level Performance Expectations” are included. These expectations include all three dimensions as evidenced by the color coding of the statements. For example,

- “Plan and carry out an investigation collaboratively by identifying controls to produce data as evidence to determine whether hydroponic plant food contains food molecules as inputs. Engage in argument from evidence to support or refute possible inputs of where plants get their food molecules from, such as hydroponic plant food or soil” (Lesson 2, page 25).

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- “Obtain information from scientific texts to describe how **chloroplasts** (**microscopic leaf structures**) respond to **light** (an external stimuli)” (Lesson 5, page 28).
- “Ask questions to refine our model of plants to show the inputs and outputs, and energy and matter flows over time to explain **how food molecules can be present during times that plants do not have leaves or chloroplasts**” (Lesson 9, page 32).

Performance opportunities throughout the unit require that students demonstrate their understanding using all three dimensions. For example,

- The Exit Ticket for Lesson 2 asks students to “Reflect on your own about where else the plant could be getting food molecules from. And, what new questions do you have now? Fill out the exit slip with your answers to these two questions and turn it in as you leave” (page 85).
- The Midpoint Assessment in Lesson 8 requires students to complete and use a model to explain how a lettuce plant gets its food molecules, including components and interactions within the system model (page 193).
- The Exit Ticket for Lesson 10 asks students to write “on a note card, have students generate ideas about how to investigate whether plants are using stored food as fuel when they don’t have leaves or don’t have any water. Prompt students to think about:
 - How could we investigate if plants are using food as fuel like we do in cellular respiration?
 - How would we know? What evidence would we look for?”

The End of Unit Assessment in Lesson 15 asks students to “Use a model to explain how the snot worms make it possible for the system to access all this new matter and energy from the whale fall. Include inputs and outputs of each component of the system in your model. In the zoom-in, show what changes or processes you would expect to see happening in the water or snot worms that you couldn’t see with just your eyes” (page 335). This requires students to utilize the practice of modeling at the element level, (*Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.*) the CCCs of system and system models (*Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.*) and matter and energy (*The transfer of energy can be tracked as energy flows through a designed or natural system. Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.*) at the element level as well as the DCIs concerning LS1.C, LS2.B, and PS3.D.

Suggestions for Improvement

N/A

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I.D. Unit Coherence: Lessons fit together to target a set of performance expectations.

Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

The lessons help students develop toward proficiency in a targeted set of

Rating for Criterion I.D. Unit Coherence: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that lessons fit together coherently to target a set of performance expectations because student questions drive each lesson to build an understanding of core ideas and concepts.

Students revisit the driving question/unit phenomenon multiple times, taking stock of how well they can explain the phenomenon, creating key linkages across the unit. Students revisit their original questions while also having the opportunity to develop new questions. Guidance/instruction is provided to support the cultivation of new questions arising from related phenomena or prior experiences. Guidance/instruction is provided on how to recognize what students figure out in a lesson but also what questions are left unanswered. New questions motivate the next investigation.

Evidence related to this criterion includes:

- This unit is broken down into 15 lessons. At the beginning of the unit, students post their questions on the DQB. Each lesson then focuses on resulting student-generated questions. Lesson 1 starts by asking “where does this stuff come from?”, then students explore plant inputs in the next several lessons, how molecules interact, the role of light, why plants don’t die at night, and the unit ends with “Where does food come from, and where does it go next?”
- Each of the 15 lessons, except lesson one, begins with students using their Progress Trackers to recap what they figured out in the previous lesson. To the right is an example from Lesson 4, page 27 in the Student’s Edition.
- Students may revisit the Progress Tracker more than once during a lesson, and the question is driving the sense-making.
- In Lesson 9, students are prompted to “Take stock of questions we’ve answered from the Driving Question Board. Have students relocate into a Scientists Circle around the Driving Question Board (DQB) and show slide A to take stock of questions answered. Have students select two questions from the DQB to answer. Have students record their answers to the questions in their science notebooks” (Teacher’s Edition, page 203).

22. In the progress tracker section of your notebook, create the 3-box Progress Tracker shown (shown below).

Progress Tracker	
Question	Source of evidence
Are any parts that make up food molecules coming into the plant from above the surface?	
What I figured out in words/pictures	

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- Later in Lesson 9, after students have revised the consensus model using additional evidence from a reading and a video, they are directed to “Post the new “big” questions to the DQB: “How can plants have food molecules in them when all the inputs or structures needed to make food molecules aren’t present? Why do plants need food molecules?” Generate new questions for the DQB. Show slide G and have students write down new questions they are now thinking about. Students should write down one or two questions on sticky notes with large, bold writing so that everyone can see.

Remind students to write only one question per sticky note. Ask students to briefly share their questions with a partner” (Teacher’s Edition, page 207).

Suggested prompts	Sample student responses
<p><i>What are you unsure of or what new questions does this raise for you?</i></p> <p><i>(If students don't bring up oxygen, ask) So we have some evidence that photosynthesis might not be happening because carbon dioxide levels are going up instead of down. What other gases change when photosynthesis is happening that could give us more evidence?</i></p>	<p><i>Why is carbon dioxide going up now?</i></p> <p><i>Why are plants producing water in the light and the dark?</i></p> <p><i>What's happening with oxygen? Is it also changing in the dark? It's an output of photosynthesis.</i></p> <p><i>Oxygen levels go up during photosynthesis.</i></p>

- Students add to their findings about inputs and outputs for plants in light from Lesson 4, by determining inputs and outputs when there is no light in lesson ten. This investigation leads to a sense-making discussion, and teachers are prompted to elicit additional questions from students, which necessitate the second investigation concerning oxygen (Teacher’s Edition, page 218).
- Students use the “Notice and Wonder” strategy for generating new questions to investigate, when watching a video about what happens to food that doesn’t get eaten (Lesson 13, Teacher’s Edition, page 287).
- The use of student-generated questions is brought full circle in the final lesson (15), when teachers are guided to:

Have students work in pairs to evaluate what questions the class has answered from the DQB. Display slide A. Provide students with *Reviewing Our Driving Question Board* which you created to contain all of the student questions from the DQB, and have students tape it into their science notebook. Have students work with a partner to mark questions they think the class has answered:

- We did not answer this question or any parts of it yet: 0
- Our class answered some parts of this question, or I think I could answer some parts of this question: ✓
- Our class answered this question, or using the ideas we have developed, I could now answer this question: ✓+

Review and share the questions that students think we have answered. Present slide B and have students mark on the class DQB with sticky dots the questions that they think we have made progress on.*

(Teacher’s Edition, page 327).

The lessons help students develop toward proficiency of these targeted performance expectations:

MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

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.

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MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Evidence suggesting students are building towards MS-LS1-6:

By Lesson 8, students have figured out that:

- Plants use energy from the sun to make sugars (food) from carbon dioxide and water.
- Plants release oxygen as an additional output in this process. This process is called photosynthesis.
- During the process of photosynthesis, energy is transferred from the sunlight the plant.
- All plants make their own food molecules through the process of photosynthesis. Photosynthesis occurs in the chloroplasts of plant cells (Teacher's Edition, page 9).

By Lesson 11, students have figured out that:

- Plants do cellular respiration. This is how their cells (and our cells) get energy to survive and grow.
- If plants make sugar (through photosynthesis) faster than their cells use it for energy (through cellular respiration), they store up that extra food by converting it to starches (or fats). These can be used later for fuel or building blocks.
- Plants use their stored food as building blocks by reassembling the atoms in that food to make new substances (e.g., cellulose for cell walls) (Teacher's Edition, page 11).

Evidence suggesting students are building towards MS-PS1-3:

In Lesson 12, through readings and investigations, students figure out that:

- Everything we eat contains matter that came from either plants or animals.
- Some foods we eat have been processed either physically or chemically, but we can still trace them back to originally coming from plants.
- Most animals, including humans, eat plants, other animals that once ate plants, or both.
- Most animals, including humans, use the food molecules they eat to build up larger molecules for growth, to get energy by burning glucose through cellular respiration, or to store for later use (Teacher's Edition, page 12).

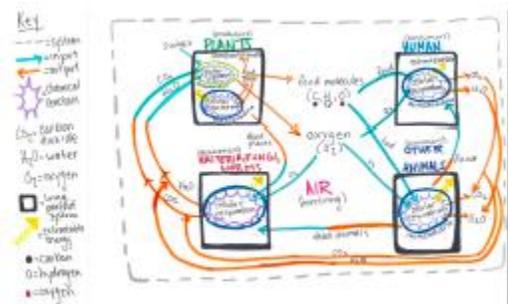
Evidence suggesting students are building towards MS-LS2-3:

In Lesson 13 and 14, students have developed a consensus model that shows:

- Many decomposers take in oxygen and food molecules and give off carbon dioxide and water.
- Decomposers recycle dead plant and animal matter and energy back into the system.
- Decomposers use matter for food that humans (and many animals) cannot use for energy and matter (Teacher's Edition, page 12).
- The outputs of living things become the inputs of other living things and part of the nonliving components of the system.
- Ecosystems consist of living (producers, consumers and decomposers) and nonliving (air and water) components where atoms are continuously recycled between these components (Teacher's Edition, page 13).

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Consensus Model example (Teacher's Edition, page 13):



Suggestions for Improvement

Consider adjusting the sequence of lessons later in the unit. It might be clearer for students to ask why plants don't die at night after Lesson 8 when students have identified light as a source of energy to make carbohydrates. They could then ask where trees get their food when they do not have leaves.

I.E. Multiple Science Domains: When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

Disciplinary core ideas from different disciplines are used together to explain phenomena.

The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains: Extensive (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that links are made across the science domains when appropriate, because the unit focuses on core ideas from two or more disciplines and clearly conveys how ideas from different domains together are required to explain the phenomenon. Crosscutting concepts are intentionally and explicitly used to make connections across the science disciplines addressed in the lesson.

The unit includes two different science domains - Physical Science and Life Science. Specifically, the unit includes:

- PS1.A: Structure and Properties of Matter (this element is identified under those that students should already know before this unit)
- PS1.B: Chemical Reactions (Lesson 6)
- PS3.D: Energy in Chemical Processes and Everyday Life (Lessons 7 and 11)

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- LS1.C: Organization for Matter and Energy Flow in Organisms (Lessons 4, 7, and 11)
- LS2.B: Cycle of Matter and Energy Transfer in Ecosystems (Lesson 14)

Evidence related to using DCIs from multiple disciplines includes:

- “Whether students decide to keep sunlight on the candidates or remove it at this point isn’t important. It is more important for them to be problematizing that sunlight seems an important component to plant growth, but it isn’t made of matter. Later in the unit, we will discover the role of light for plant growth. Later in this lesson, the class will revisit the consensus model and add “light” with a ? and “energy” if it isn’t there already to keep track of this idea that plants need light, but light can’t be a source of molecules since it isn’t made of matter” (Teacher’s Edition, Lesson 3, page 93).
- “Analyze the composition of air to look for food molecules. Show slide D” (Teacher’s Edition, Lesson 3, page 99).
- The photosynthesis simulation in Lesson 6 addresses the domain of chemistry. “At this point, students should have figured out the inputs and outputs to photosynthesis and understand that a chemical reaction is happening inside the chloroplasts (Teacher’s Edition, Lesson 6, page 157).
- Biochemistry: “In the dark, plants do not do photosynthesis. Instead, they do some kind of chemical reaction that takes in oxygen and releases carbon dioxide and water (cellular respiration)” (Teacher’s Edition, Lesson 10, page 209).

Lessons 13 and 14 address matter and energy cycling, and students utilize elements from the CCC of matter and energy (*Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. Matter is conserved because atoms are conserved in physical and chemical processes.*):

- “The decomposers we investigated took in oxygen and food molecules and gave off carbon dioxide and water (cellular respiration). Decomposers recycle dead plant and animal matter and energy back into the system. Decomposers use matter for food that humans (and many animals) cannot use for energy and matter” (Teacher’s Edition, page 283).
- “The outputs of living things become the inputs of other living things and part of the nonliving components of the system. Atoms are continuously recycled between living (producers, consumers, and decomposers) and non-living (air and water) components in our world” (Teacher’s Edition, page 297).
- “Display slide D. Say. Up until now we have been trying to figure out where whole food molecules come from and go next. Our new question now is, could one of the atoms in one of these examples of foods we can’t eat and decomposers can, end up back in the food we can eat? Take a moment to talk to a partner about these questions. Could something in what that bread mold ate that we looked at in our last lesson end up inside us? Could one of the exact same atoms from the mold get inside you?” (Teacher’s Edition, page 307).
- The table below (Teacher’s Edition, page 309) shows how teachers are prompted to help students utilize the CCC of Energy and Matter cycling at the MS element level:

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Question	What I figured out in words/pictures
Where does our food come from, and where does it go next?	<p>Food comes from plants, even the food that comes from animals can be traced back to plants because they eat plants.</p> <p>Food that isn't or can't be eaten by animals and humans is eaten by decomposers.</p> <p>Decomposers break down the foods we can't eat and recycle the atoms back into the system.</p> <p>The outputs of living things become the inputs of other living things and part of the nonliving components of the system.</p> <p>Atoms are continuously moved between living and nonliving things.</p> <p>Atoms are continuously recycled. Nothing is really "new." The atoms that make up an organism (or any living or nonliving thing) have been a part of something else before.</p>

Suggestions for Improvement

N/A

I.F. Math and ELA: Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

Rating for Criterion I.F. Math and ELA: Extensive (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide grade-appropriate connections to mathematics, English language arts (ELA), history, social studies, or technical standards, because grade-appropriate mathematics and ELA-literacy content is purposefully incorporated into lessons with teacher support to help students make these connections.

Evidence related to ELA-Literacy connections includes:

- Reading materials go beyond textbooks and include news articles, journal articles, infographics, websites of scientific entities.
- Students read food labels, which requires them to obtain information and interpret data from reading a scientific text. "Record results from the *Nutrition Labels: What is in food?* investigation. Show slide M. Distribute *Nutrition Labels: What is in food?* to each group. Each group should write down the foods they have decided to investigate on *What's in the foods we eat that come from plants?*" (Teacher's Edition, Lesson 1, page 55).
- In *Comparing and Critiquing Arguments about Water in Plants* students are asked to provide suggestions for students in another class to help them build strong claims supported with evidence. This work contributes to CCSS.ELA-LITERACY.WHST.6-8.1.B as students are practicing

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the skills needed to craft a strong argument by supporting claims (Teacher’s Edition, Lesson 4, page 124).

- In Lesson 5, students are asked to “read Plant Cells and answer questions in pairs. Project slide H and have students find Plant Cells in the student edition and use Reading Plant Cells to make notes on. Students should work with a partner to read the reference and discuss the questions as they go” (Teacher’s Edition, page 139). Students practice CCSS.ELA-LITERACY.RST.6-8.1. by first reading to understand the text, then they use evidence from the text to answer questions about patterns of movement within plant cells. Students combine the information from this reading with prior knowledge to make predictions about the role of light in plant cells (Teacher’s Edition, page 146).
- Lesson 7 has teachers distribute “How do scientists measure energy in food?” Teachers are prompted to, “Say, I came across this article that explains how food scientists make food labels. Let’s take a few minutes to use what we see and read about food labels to help us clarify our claims about matter and energy for our inputs and outputs of plants doing photosynthesis” (Teacher’s Edition, page 170).
- Also, in Lesson 7, “Students engage with short text to learn more about calories as a measure of the amount of energy the body can use when it takes in nutrients through food, which also includes images of food labels. Students practice CCSS.ELA-LITERACY.RST.6-8.7 (Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table), because they must integrate what they read in the text to correctly read and interpret the content of the food label. Information from both sources must be used to answer the reflection questions” (Teacher’s Edition, page 177).
- Students use their observations from re-watching a video and then reading an article to generate additional questions to investigate that will help them figure out the anchor phenomenon for the unit in lesson nine (Teacher’s Edition, pages 207–208).
- In Lesson 11, students are provided with a set of close reading strategies to accompany ‘How do plant (and animal) cells use food?’ which will assist as they gather information from a complex scientific text. These close reading strategies help to address CCSS.ELA-LITERACY.RST.6-8.2 by recommending that students summarize the text and tease out any questions they have that relate to their prior knowledge (Teacher’s Edition, page 245).
- Throughout Lesson 12, students must integrate information from a range of sources to come to conclusions about where food molecules come from, ultimately concluding that all foods, natural and synthetic, some from plants. CCSS.ELA-LITERACY.RST.6-8.9 is addressed as students integrate information from video, texts, data tables, and other media to come to these conclusions. In the jigsaw activity, students address CCSS.ELA-LITERACY.RST.6-8.1 by reading a text, synthesizing the information and reporting it out to their peers to answer specific questions (Teacher’s Edition, page 281).
- Lesson 13 addresses CCSS.ELA-LITERACY.RST.6-8.7 and CCSS.ELA-LITERACY.RST.6-8.9 as students must integrate information from a variety of sources to build their understanding of the role and function of decomposers in matter cycling. With each video, reading, and examination of images

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from experiments, students compare the information and build on their initial ideas (Teacher's Edition, page 300).

- Writing assignments are varied in structure and purpose and are rigorous.
 - Students develop and use a Scientific Notebook in every lesson. They are prompted to record ideas, developing and consensus models, data and analysis, Progress Trackers, and additional questions and responses to prompts.
 - Formative assessments used to assess student's progress toward key learning require students to communicate their understanding through writing and modeling (Teacher's Edition, Lessons 4, 8, 11, and 14).
 - Students craft a news release and are encouraged to incorporate visuals to enhance readers' comprehension of the text, which addresses CCSS.ELA-LITERACY.WHST.6-8.2.A. By working with both written language and visuals such as graphs or pictures, students also increase their own capacity for sense-making (Teacher's Edition, Lesson 10, page 221).
 - To help students synthesize their learning, they are asked, in Lesson 14, to take one of their original breakfast foods from lesson one and use ideas from their Gotta-Have-It Checklist and the model they developed over the last few lessons to write the story of what happens to that food in a system on The Story of A Food Atom. To help support students in giving each other feedback, the materials contain Peer Feedback Guidelines (Teacher's Edition, pages 310–311 and 317).
- Students have multiple opportunities for high-level verbal discourse in a variety of formats and scenarios (partners, small group, formal presentations, technology-enhanced).
 - Students have opportunities for high level verbal discourse when the class is building their DQB in Lesson 1. Students are using "CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion. Students verbally share their questions and explain their thinking to their classmates. "This is a key way to emphasize the importance of listening to and building off one another's ideas and to help scaffold student thinking." Additionally, sentence starters are included that may help students organize their ideas (Teacher's Edition, page 67).
 - Students begin to use a discussion strategy called Scientist Circle in Lesson 1 (page 63), then reconvene in the Scientist Circle to sense-make or problematize throughout the unit. For example, students argue from evidence in the Scientist Circle in Lesson 7 (page 163), discuss findings from readings in Lesson 12 (page 269), build understanding from an investigation in Lesson 13 (page 289), and update the class consensus model in Lesson 14 (page 304).
 - In addition to the Scientist Circle, different protocols are used to help ensure that all students get a voice and to provide opportunities for students to practice listening. In Lesson 6, students use Talking Sticks to share their claims from investigations (page 156) and as a differentiation strategy in Lesson 7 (page 240).
 - Classroom Norms for Discussion have been established in previous units, but they are revisited as needed throughout this unit.

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- Various sentence starters for communicating in scientific ways are utilized throughout the unit. For example, in Lesson 1, students are asked which sentence starters they think would be appropriate for developing a consensus model (Teacher’s Edition, page 59) and are prompted to use either the classroom poster or handout, *Communicating in Scientific Ways*.
- Support for developing classroom norms for discussion can be found in the *Open SciEd Teacher Handbook* (pages 32–35). The *Handbook* also contains strategies for supporting discussion, including sentence starters for different types of discussions (pages 36–41).

Evidence related to mathematics connections includes

- Students interpret data from tables and graphs in Lesson 4 using the handout *Data from Leaves in the Light*. “Have students make observations of the graph using “What I see” comments. As they review the data, prompt students to first discuss WIS comments in their small groups. After 4–5 minutes, bring students together to discuss their observations of the graphs (e.g., What did you notice? Did anybody else notice something similar?). Project slide Q. Focus the discussion initially on patterns of increasing and decreasing substances, but then broaden it to other observations students made, such as noise in the oxygen data. Record some of the WIS comments on a white board or in an online document in a table similar to the one below” (Teacher’s Edition, Lesson 4, page 120).
- In Lesson 6, students use a computer simulation to investigate how the amounts of different inputs into a plant system affect the amount of sugar, or food, a plant makes. The simulation includes a graph representation of what happens over time to the amount of inputs (carbon dioxide) and outputs (food). Though the mathematical relationship between the amount of carbon dioxide and water that a plant takes in and the amount of food a plant produces is not a linear relationship, students can describe the relationship in terms of comparisons (as the amount of ___ increases/decreases, the amount of ___ increases/decreases) using the numeric and graphical representations in the simulation. (CCSS.MATH.CONTENT.6.SP.B.5 Describing the nature of the attribute under investigation, including how it was measured and its units of measurement) (Teacher’s Edition, page 159).

Suggestions for Improvement

N/A

Overall Category I Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category I

Criteria A–F

3: At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C

2: At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C

1: Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C

0: Inadequate (or no) evidence to meet any criteria in Category I (A–F)

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Category II. NGSS Instructional Supports

Score: 3

Criteria A-G:

3: At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria

2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

1: Adequate evidence for at least three criteria in the category

0: Adequate evidence for no more than two criteria in the category

II.A. Relevance and Authenticity: Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authenticity: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world, because compelling lines of student inquiry come from students' own experience. The materials are structured in a way that values the fund of knowledge that students bring to school from their homes as a launching point for learning, balanced with a common, firsthand opportunity to experience the phenomenon in the classroom.

The materials provide support to teachers or students for connecting students' questions to the targeted learning: Student questions, prior experiences, and diverse backgrounds related to the phenomenon are used to drive the lesson and the sense-making.

Evidence related to this criterion includes:

- Students are directly engaged in trying to answer the central question, "Where does food come from, and where does it go next?" Students are asked to list the foods that they have eaten today and then categorize them based on whether they come from plants, animals, or both plant and animal sources. "Students taste maple syrup and maple sap and watch a video of sap being extracted from a tree. This motivates us to review nutrition labels for the foods we ate. All the plants have some food molecules like carbohydrates, proteins, or fats. We know we get our food from eating (this was figured out in a previous unit), but how do plants get their food? Where is the food in plants coming from? We develop a model to try to explain this and come up with questions to form a DQB (Teacher's Edition, page 3).

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- To wrap up Lesson 1, students are given a reading, “*What do kids around the world eat for breakfast?*”, which is an ‘opportunity for students to leverage their own experiences with food in the classroom and emphasize that each individual has contributions to make to their community of learners’ (Teacher’s Edition, page 54).
- After developing the DQB, students individually brainstorm “ideas for investigation” for how to answer the various questions. (Teacher’s Edition, page 65). Students’ ideas for investigation are clearly used to determine the flow of the lessons. “Once this ‘Ideas for Investigation’ poster is built, help students realize (and get excited) that they created a joint mission and proposed action plan to guide the work of our learning community for weeks to come as we conduct investigations to figure out how plants get their food molecules.” The teacher is directed to say, “...let’s take a moment to think about how starting with one specific investigation idea could help us make progress on our questions. It seems like we have some ideas about the components of the plant system that we want to investigate. We also have a group of questions around the inputs that plants use and where these food molecules come from. It feels like this would be a productive place to start in trying to figure out more about where food molecules come from” (Teacher’s Edition, page 66).
- An “Alternate Activity: To make this phenomenon even more locally or culturally relevant, you could search the internet for plant based syrups (or other products) from saps produced in your state or region, such as agave, birch, corn, or palm. If you find one to include, it is recommended that you also change TBD to a local phenomenon, in the next activity” (Teacher’s Edition, Lesson 1, page 46).
- Teachers are provided guidance throughout the unit with “Suggested Prompts”, which often promote connections to students’ lives and backgrounds.
- Lesson-level questions, which come from the students, inspire and guide sense making throughout the unit. The provided Storyline shows the progression of student ideas, questions, and possible revisions to their models as their knowledge changes.

Suggestions for Improvement

N/A

II.B. Student Ideas: Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

Rating for Criterion II.B. Student Ideas: **Extensive**

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because the teacher is supported to act as an expert facilitator, drawing out student ideas while coordinating forward movement toward

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targeted learning. Students use their ideas and cite shared ideas of others to build upon prior understanding.

Student artifacts include elaborations of reasoning behind their answers, and shows how students' reflective thinking has changed/evolved over time. Students may have used others' ideas that were shared in class to improve or change their own thinking and explained why they chose to incorporate those ideas. Supports provided throughout the unit that facilitate this are:

- Progress Tracker: “a formative and self-assessment tool that is designed to help students keep track of important discoveries that the class makes while investigating the phenomena, and to help them figure out how to prioritize and use those discoveries to focus on explaining the phenomenon they’re working on. Students will refer back to the tracker regularly to revise or build on their models, explanations, and/or designs for their current thinking about the phenomenon. Furthermore, students, and the class as a whole, will use the tracker as a way to think with others about what is important in their models, explanations and/or designs” (Teacher Handbook, page 28).
- OpenSciEd Routines provide teachers with eliciting students’ ideas and helping them build on them and clarify their thinking. This chart summarizes the routines that are used throughout the unit (Teacher Handbook, page 11).
- Specific instructions for helping teachers make peer feedback productive are included in the Teacher Materials in lesson fourteen of the Teacher Edition (pages 315–317). Peer Feedback Guidelines include suggestions, strategies, sentence starters, and self-assessment rubrics.

Routine	Purpose
Anchoring Phenomenon routine	Develop curiosity to drive learning throughout the unit based on a common experience of a phenomenon and connections to any related phenomena students have experienced.
Navigation routine	Establish and reinforce the connections between what we have previously done in a unit, what we are about to do, what we will do in the future, and what our driving purpose is in the context of the unit.
Investigation routine	Use scientific practices to investigate and make sense of a phenomenon.
Putting Pieces Together routine	Take the pieces of ideas we have developed across multiple lessons and figure out how they can be connected together to account for the phenomenon we have been working on.
Problematising routine	Evaluate the adequacy of our scientific ideas to explain a phenomenon in order to identify what we still need to understand.

The unit provides supports to teachers for eliciting student ideas. Students provide supports to others and through discourse elicit additional ideas which students build upon to develop a deeper understanding. The following examples are from Lesson 1, but these supports are utilized throughout the unit:

- **Stop and Jots:**
 - “Ask students to Stop and Jot (on a new page) in their notebooks the list of foods they ate” (Teacher’s Edition, page 45).
 - “Stop and Jot about what happens to the food we eat” (Teacher’s Edition, page 50).
- **Turn and Talk** “Have students Turn and Talk to a student next to them about where the food originally came from—before it got to the grocery store, cafeteria, or vending machine” (Teacher’s Edition, page 45).
- **Going Public:**

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- “Share out initial ideas as a whole group. Have students go public with their thoughts about what happens to the food we eat and drink” (Teacher’s Edition, page 51).
- “Have students explain their own model to an elbow partner at their table” (Teacher’s Edition, page 58).
- **Responding to student ideas:** “This is an important opportunity to emphasize that each individual has contributions to make to their community of learners. It is through differences in thinking that the class will grow their knowledge together. Throughout this unit, students will be asked to be open to sharing knowledge products that depict their current thinking and to be open to learning from classmates who share their knowledge too” (Teacher’s Edition, page 58).
- **Scientist Circle:** “Your students may be familiar with the Scientists Circle from a previous unit. Remind students of the norms for participation and the logistics for forming and breaking down that space. A Scientists Circle includes these important features:
 - Students sitting so they face one another to build a sense of shared mission and a community of learners working together;
 - Celebrating progress toward answering students’ questions and developing more complete explanations of phenomena;
 - Focusing on where students need to go next and how they might go about the next steps in their work” (Teacher’s Edition, page 59).

Students demonstrate new thinking based on peer and teacher feedback as well as personal reflection.

- This is most apparent in Scientist Circles when students build consensus based on evidence such as that documented in the Progress Trackers. Students provide support to others through discourse and elicit additional ideas which students build upon to develop a deeper understanding. This is evident through model sharing, argument from evidence, driving question board discussions, posters, turn and talks, and consensus building that are consistent throughout the unit.
- In Lesson 6 at the end of day one, teachers are prompted to, “Have students turn in their investigation plans...so you can assess their progress in the science and engineering practice of planning and conducting investigations.
 - **ASSESSMENT OPPORTUNITY** Students need multiple opportunities and feedback to refine their abilities to identify independent and dependent variables and controls, how measurements will be recorded, and how much data are needed to support a claim. Here is an opportunity to provide feedback before they conduct their investigations in the next period to help them refine their plans” (Teacher’s edition, page 156).
 - Teachers are prompted to “Remind students, I was excited to review your investigation plans from last time. If I provided some feedback on your plan, please review it before conducting your investigation. If I did not, then prepare to conduct your investigation by reading through your plan again...Pass back Planning and carrying out investigations annotated with the feedback you provided students” (Teacher’s edition, page 156).

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- Although the teacher is prompted to provide feedback to students on the mid-point assessment using the modeling rubric, (“Use this rubric to provide feedback to students as they explain the components and interactions involved when a plant gets its food molecules” Teacher’s Edition, page 191) **no guidance is provided on having students act on the feedback.**
- Personal reflection opportunities are provided at the end and beginning of some lessons, when students complete an exit ticket, then share ideas and questions to begin class the next day.
 - For example, at the end of Lesson 2, the teacher prompt includes, “Exit Ticket. Project slide S. Say, Take a few minutes to reflect on your own about where else the plant could be getting food molecules from. And, what new questions do you have now? Fill out the exit slip with your answers to these two questions and turn it in as you leave. We will share out ideas at the beginning of our next class” (Teacher’s edition, page 85). Then, at the beginning of Lesson 3, teachers are prompted to have students “Gather around the consensus model. Show slide A. Have students gather in a standing Scientists Circle around the consensus model from Lesson 1. Ask students to open their science notebooks to their Progress Trackers to help us look back at our thinking from the end of the previous lesson. Give students 1 minute to turn and talk with a partner before sharing out with the whole class” (Teacher’s edition, page 96).

Suggestions for Improvement

Consider providing guidance to teachers to purposefully provide opportunities for students to demonstrate learning based on peer and teacher feedback. There were some missed opportunities to do this throughout the unit. Consider building in specific opportunities for students to reflect on new learning throughout the unit.

II.C. Building Progressions: Identifies and builds on students’ prior learning in all three dimensions, including providing the following support to teachers:

Explicitly identifying prior student learning expected for all three dimensions

Rating for Criterion II.C. Building Progressions: **Extensive**

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials identify and build on students’ prior learning in all three dimensions, because the materials make clear the expected level of proficiency students should have with all three dimensions for the core learning and clearly articulate the connections to prior learning and how the prior learning will be built upon.

The overview explicitly identifies prior student learning needed for the unit in all three dimensions (Teacher’s Edition, pages 15–16):

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- “This unit uses Disciplinary Core Ideas (DCIs) that students should have previously learned by working on the following NGSS performance expectations: MS-LS1-1 and MS-LS1-2.
 - LS1.A: Structure and Function: *All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.*
 - LS1-C: Organization for Matter and Energy Flow in Organisms: *Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.*
- The materials mention that students would benefit from having prior experience doing the following focal science and engineering practices (SEPs) at the 3–5 grade-band level. However, the students should already have previous experience with those elements in the previous grade where they should have used Grade 3-5 elements to progress towards Grade 6-8 elements. The Grade 3-5 elements include:
 - Asking Questions and Defining Problems
 - *Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.*
 - Developing and using models
 - *Develop and/or use models to describe and/or predict phenomena.*
 - *Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.*
 - Planning and Carrying Out Investigation
 - *Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.*
 - Analyzing and interpreting data
 - *Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.*
- Having students familiar with using focal crosscutting concepts (CCCs) for this unit at the 3–5 grade-band level would be helpful. However, just as mentioned above, the students should already have previous experience with those elements in the previous grade. The Grade 3-5 elements include:
 - Systems and system models
 - *Students understand that a system is a group of related parts that make up a whole and can carry out the functions that its individual parts cannot.*
 - *A system can be described in terms of its components and their interactions.*
 - Energy and Matter: Flows, Cycles, and Conservation
 - *Matter is made of particles.*
 - *Matter flows and cycles can be tracked in terms*

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- Prerequisite math concepts that may be helpful include:
 - CCSS.MATH.CONTENT.6.NS.C.8: Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane.
 - CCSS.MATH.CONTENT.6.SP.B.5.B Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
 - CCSS.MATH.CONTENT.6.SP.B.5.C: Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.”

The materials note prior knowledge expected within a lesson. For example:

- “This matter cycling and photosynthesis unit is explicitly connected to the Inside our Bodies Unit. Students need to recall what they learned about chemical reactions in the body that breakdown food and cellular respiration as they visualize what happens to the maple syrup we put in our mouths. Students should have worked with the food molecule cards for carbohydrates, proteins, and fats” (Teachers Edition, Lesson 1, page 51).
- “In the next few activities students will be recalling what they know from previous units and then connecting those ideas to what we know about food molecules. You may wish to have students record what they know about light, air, and food molecules in their notebooks before they formally look for patterns between the two toward the end of the lesson” (Teachers Edition, Lesson 3, page 97).

Materials are designed to build upon the typical levels of proficiency that students at this grade level have with each of the three dimensions. This information is clearly identified and explained for teachers in callouts in the Teacher’s Edition.

- Examples of how the SEPs become more sophisticated include:
 - In Lesson 3, the teacher prompts the students with “How could we represent this on our model?” (page 105).
 - Students regularly return to their consensus models to engage in deeper understanding of the Disciplinary Core Ideas. Students are using the science and engineering practice of modeling to explain their ideas. Students revise their models in Lesson 3 (page 105), Lesson 4 (page 122), Lesson 5 (page 141), Lesson 6 (page 157), Lesson 7 (page 176), Lesson 8 (page 188), Lesson 11 (page 242) , Lesson 12 (page 279), Lesson 13 (page 292), Lesson 14 (page 304), and Lesson 15 (page 327).
- Examples of how the DCIs become more sophisticated include:
 - In Lesson 4, students should state that carbon dioxide levels decrease around the plant over time, water levels in the air increase over time, and oxygen levels in the air increase over time (page 121). In Lesson 6, students are asked “What are some of your observations from the simulation about how the inputs interact within the plant?”

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Students should start to understand that carbon dioxide and water are interacting to form glucose (page 157).

- In Lesson 5, students are asked “We know plants need sunlight. How do plants use sunlight?” (page 140). In Lesson 6, a student might state that ‘zap - glucose was made’. (page 157) In Lesson 7, students should start to understand that the sun must be the energy source for plants, but that sunlight does not contain any of the atoms found in the food (page 174).
- Examples of how the CCCs become more sophisticated include:
 - In Lesson 5, when students are revising their consensus model, the teacher prompts students to think about patterns by asking “How are plant and animal cells similar and different?” (page 140).
 - In Lesson 3, the teacher asks students “What inputs from our candidates list that contain parts of food molecules are entering the plants?” (systems) (page 121).
 - In Lesson 7, students should begin to understand that “light provides the energy needed for chemical reactions to happen in the chloroplast, carbon dioxide and water provide matter needed to make glucose and oxygen, and glucose provides energy that the body can use (page 174).
 - In Lesson 11, students should convey that plants and animals use cellular respiration to get the energy they need to live and grow; more glucose is produced by plants than is needed; and stored food molecules are used to build new plant parts (page 242).

Expected levels of proficiency are detailed in each lesson. The materials provide suggestions for adaptation if students are above or below the expected level of proficiency in the Lesson-by-Lesson Assessment Opportunities (Teacher’s Edition, pages 24–38). This information is provided for each lesson.

An example for Lesson 3 includes:

Constructing Explanations; Patterns

- **When to check for understanding:** Throughout the lesson students will be looking to see patterns between food molecules and the matter that makes up candidate sources of food molecules like air, light, hydroponic plant food, and water. At the end of the lesson, students will construct an explanation to explain these patterns on the exit ticket.
- **What to look/listen for:**
 - Air, water, hydroponic plant food, and light do not contain any whole food molecules.
 - The air composition chart shows that air contains carbon dioxide (carbon and oxygen) and oxygen molecules that are parts of each food molecule’s structure.
 - Water has hydrogen and oxygen atoms.
 - Hydroponic plant food has nitrogen and sulfur, which are atoms found in proteins and amino acids.
 - We have confirmed in Lesson two investigations that water and hydroponic plant food go into the plant but have yet to confirm that air enters the plant.
- **What to do:** If your students struggle with identifying why the question needs to be revised

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to include parts instead of just (whole) food molecules have your students revisit the air composition chart and student reference Unknown material with identifier: mr.l1.ref1. Cue students to look for similarities in the atoms present in air and food molecules. You can also cue them to look back at their Progress Trackers from Lesson two to confirm that soil is not needed for plants to grow and that hydroponic plant food and water do go into the plant as it gets bigger. Then they can revisit the nutrition labels for plant food and water to see what parts of food molecules are found in the ingredients.”

Suggestions for Improvement

N/A

II.D. Scientific Accuracy: Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students’ three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy: **Extensive** (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials use scientifically accurate and grade appropriate scientific information, because all science ideas included in the materials are accurate and there is strong support for teachers to clarify potential alternate conceptions that they (or their students) may have.

The sections in the Teacher’s Guide, “Where we are Going (and NOT going) and Common Student Ideas, included in each lesson, not only address the issue of scientific accuracy but also allow for the fact that students will express scientifically inaccurate ideas as they are learning.

- An example of Where we are going (and NOT going) from the Teacher’s Edition (page 44):
“In this lesson, students are introduced to the anchoring phenomenon of a maple tree producing sap that humans can drink (eat). By the end of the lesson, students figure out that their agreed-upon inputs for plants include water and perhaps sunlight, which leaves the class wondering, so then where did the food molecules in plants come from? This lesson elicits students’ initial ideas about the system of how a plant can come to have food molecules such as carbohydrates, proteins, and fats, inside of it. “Students may come to this unit with prior knowledge and experiences that can be leveraged. Students might come into the unit thinking they understand how plants get food, namely, plants “make” their food using energy from the sun. Students might even call that process “photosynthesis.” However, this unit pushes students to develop a conceptual model for this process. Where exactly are plants getting the inputs from to make their food? We—and plants—can’t just make stuff out of nothing. So where are the inputs coming from to make the food molecules like carbohydrates, proteins, and fats that we find in the foods we

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eat that come from plants? Where do these food molecules go after they are made in the plant? How can the matter in animals, processed food, and synthetic food, be traced all the way back to plants? What happens to the matter when living things die? Throughout this unit, students will be reminded of what they figured out in the Inside our Bodies Unit about the inputs and outputs of chemical reactions that happen to food molecules inside the body, related to these two NGSS performance expectations: MS-LS1-5: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

“Where We Are NOT Going

“As students share their ideas, you may hear them say plants get what they need to grow from soil, rocks, or fertilizer. Although plants take in minerals from the soil, the amount of these minerals is very small compared to carbohydrates, proteins, and fats that make up most of a plant’s structures. Encourage students to share their thinking, but avoid pushing back on any of these ideas at this point in the unit. Subsequent lessons will draw upon students’ prior knowledge regarding inputs plants need to make food molecules. Over the course of the unit, students will notice that there are atoms that are in all the food molecule and in all of the inputs. These observations will be used to support students figuring out that carbon is an important atom in the cycle of plant growth and the food we eat. Students will see that carbohydrates, fats, and proteins all have a large amount of carbon in the structure, so carbon atoms make up the majority of a plant’s mass. Plants get carbon from carbon dioxide in the atmosphere, not from carbon in the soil. The cycling of nitrogen is beyond the NGSS boundary for middle school and found in the high school grade band. Additionally, the biochemical mechanisms of photosynthesis are beyond the assessment boundary for the NGSS PE, MS-LS1-6.

Additional guidance concerning alternate conceptions and key ideas to listen/look for are provided to teachers throughout each lesson. For example, in Lesson 6 in the Key Ideas section, teachers are provided with the critical learning and Listen “Fors” during the discussion (Teacher’s Edition page 154):

KEY IDEAS Purpose of this discussion: Facilitate a discussion with students to summarize what was figured out from the simulation. They should then argue that the result of this chemical reaction is the glucose molecules that are made.

Listen for these ideas:

The atoms that make up the things the plant takes in (inputs) such as carbon dioxide and water go through a chemical reaction in the chloroplasts when light is shined on the plant. Oxygen molecules and glucose molecules are being produced (outputs) as a result of that chemical reaction.

Included in each lesson are Suggested Prompts and Sample Student Response charts that guide sense-

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making discussions. Often Additional Guidance is provided concerning places where students might struggle, and suggested questions or prompts are given. This is an example from Lesson 6:

“Students may struggle to suggest ways to figure out how different inputs and outputs in the model have energy. If they do, focus specifically on data they have collected in previous units, by burning food and analyzing food labels such as in Inside our Bodies. Guide students to examine food labels to determine whether the input/output provides energy.”

Further support can be found in the Where We Are (Not) Going sections and in the Assessment System information. For example:

- In Lesson 13’s Where We Are Not Going section, teachers are alerted to a potential misconception, “This lesson addresses the common misconception that decomposers, like fungi, are plants (which are able to make their own food) when they are actually more similar to animals, because they must take in energy and matter from an outside source for food, rather than make it themselves” (Teacher’s Edition, page 286).
- Under the Assessment Purpose column for Lesson 4, a possible misconception is noted, “Students may have the misconception that molecules cannot be destroyed so therefore water passes through unchanged” (Teacher’s Edition, page 20).

The Teacher Background Knowledge section (Teacher’s Edition, pages 16 and 17) contains a nice overview of common ideas that students might hold:

“Students may come to this unit with prior knowledge and experiences that can be leveraged to your advantage. Some of these ideas include the following:

- Students might come into the unit thinking they understand how plants get food, namely, plants “make” their food using energy from the sun. Students might even call that process “photosynthesis.” However, this unit pushes students to go a level deeper. Where exactly are plants getting the inputs from to make their food? We—and plants—can’t just make stuff out of nothing. So where are the inputs coming from to make the food molecules like carbohydrates, proteins, and fats that we find in the foods we eat that come from plants?
In previous units, students should have become familiar with the idea that matter cannot spontaneously appear or disappear. They will bring the idea that since food molecules are not entering the plant, then plants must be making them from other inputs that have the same atoms in them.
- Students can bring to this lesson the ideas that gases can enter into and move out of cells through permeable membranes and that chemical reactions take place in human cells.
- In previous units, students should have seen cells under the microscope and should be familiar with the idea that animals and humans are made of cells. Students will have ideas that gases can enter into and out of cells through permeable membranes and that chemical reactions take place in human cells.
- Students will need to recall previous knowledge that all matter (and thus atoms) in our

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- world is conserved and cannot be created or destroyed.
- Remember not to assume from words or representations in students' models that they have an understanding of how plants get their food on a deep mechanistic level.
 - A very common partial understanding is that plants get their matter to grow from the nutrients in the soil. This is why, instead of just eliminating soil and plant food from the class "candidate list" by using the hydroponic system, we also look for more evidence by testing the hydroponic water with food indicators. This drives the point that the major source of food molecules is not soil and plant food. Plants take in small amounts of atoms from the hydroponic plant food like nitrogen, phosphorus, and sulfur, but they are not the main source of building blocks to make plants grow. The main source comes from CO₂ in the air.
 - Students may have ideas that sunlight is a form of matter that can be used by the plant to make food.
 - Students will likely have intuitive ideas that sunlight gives plants energy, though students may not necessarily know how matter and energy interact.
 - Students may think that processed foods are made of "chemicals" or stuff that isn't "natural." They will figure out that the main ingredients in processed foods are actually from plants and that some ingredients also come from animals. However, they will also figure out that chemically processed synthetic foods also come from plants.
 - Students may have ideas that when food rots it is the food that is causing the changes and not separate, initially unobservable organisms living on the food."

Suggestions for Improvement

N/A

II.E. Differentiated Instruction: Provides guidance for teachers to support differentiated instruction by including:

Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.

Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction: Extensive

(None, Inadequate, Adequate, Extensive)

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The reviewers found extensive evidence that the materials provide guidance for teachers to support differentiated instruction because differentiation adds to the experience for the individual student in a way that is meaningful, respectful, relevant, and engaging.

The unit provides multiple differentiation strategies with examples and guidance that support reading, writing, listening, and speaking supports resulting in the whole lesson being accessible for all students. Each lesson contains Attending to Equity call-outs that explicitly address the needs of English language learners, learners with special needs, learners who read well below grade-level, struggling students, and students who have already met the performance expectation. For example, in Lesson 2, the Attending to Equity call-out provides suggestions for struggling learners, English language learners, as well as students who may have already met the performance expectation:

- “This example Progress Tracker serves as teacher guidance for what students might say at various points throughout the unit. However, some students may say more and others may say less. It is important that what the students write in the two-column tracker reflects their own thinking at that particular moment in time. This is an opportunity for students to express their understanding and reasoning in their own way. Encourage students to express what they’ve learned using a mode that makes sense for them. For some emergent multilingual students, encourage them to use space to make sense in the language that they feel most comfortable using. The individual Progress Tracker is a space for students to be creative and to synthesize learning in their own words. It is not supposed to follow a prescriptive plan or structure and should be a low-stakes opportunity for students to make sense of what they are learning without the worry and anxiety that comes with knowing their work will be graded. Use the Progress Tracker for formative assessment only” (Teacher’s Edition, page 74).

In Lesson 13, two different Attending to Equity call-outs suggest support for struggling readers, reluctant speakers, and students looking for a challenge:

- “Each of the four readings is designed for students of different reading capabilities to access. If a student struggles with reading complex text, assign them the Dung Beetle which relies more on images. If a student is looking for a challenge, assign them Bacillus Subtilis, which relies more heavily on text” (Teacher’s Edition, page 291).
- “Before students engage in whole class discussions, it can be helpful to first provide them with the opportunity to work with others, (either in pairs, triads, or small groups) focusing on ideas related to their reasoning. These smaller group structures can be especially helpful for your emerging multilingual students, as they give students a chance to engage in rich sense-making with their peers, and also offers them the space to use their linguistic and nonlinguistic resources to express their ideas (and learn from other students’ uses of these resources too)” (Teacher’s Edition, page 287).

Several different supports for speaking and writing are present throughout the unit. For example:

- In Lesson 1, teachers are prompted to “direct students to the Communicating in Scientific Ways

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poster or handout. Tell students that they will be developing a consensus model together. Ask them which sentence starters they might want to use to help them talk to one another. Examples include these:

- Think of an idea, claim, prediction, or model to explain your data and observations:
My idea is ...
I think that ...
We could draw it this way ... to show ...
Give evidence for your idea or claim:
My evidence is ...
The reason I think that is (Teacher’s Edition, page 59).”
- In Lesson 10, students are asked to work with a partner to use the “‘Communicating in Science Checklist.’ Students are asked to choose a communication medium (e.g., text, images, tables, diagrams, graphs, equations) and consider what each medium communicates, which gives opportunities for students to use linguistic (oral and written language) and nonlinguistic (drawings, graphs, symbols) modes to engage in sense-making. These opportunities allow multilingual students to create greater meaning than just using one mode over another and demonstrate their knowledge in less language-embedded tasks” (Teacher’s Edition, page 221).
- A Word Wall for the unit is started in Lesson 1, and the Attending to Equity call-out provides a rationale and best practice for use (Teacher’s Edition, page 51).
 - “When new scientific words, like food molecules, are introduced, it can be helpful for emergent multilingual students to see a reference to those words added to a word wall. Add these words to the word wall as they emerge in the discussion, rather than before. You can assign a student to create an entry for the word wall.”
- Support for building and using a Word Wall are included throughout the unit (e.g., Lesson 5, page 138 and 140; Lesson 6, page 157; Lesson 11, page 240 and 242; Lesson 12, page 269; Lesson 13, 293).

Extra support is provided throughout the lesson for students who are struggling to meet performance expectations with guidance on how to determine their understanding at that point in the lesson and how the suggested support will help students demonstrate progress towards understanding the PEs.

- Alternate Activity and Additional Guidance call-outs in every lesson provide suggestions for teachers concerning adjusting an activity in the lesson or addressing specific needs of students. These are some examples:
 - Lesson 4: “You can also have students work with a partner to provide feedback. Struggling students can also choose 1 or 2 claims to work with” (Teacher’s Edition, page 118).
 - Lesson 5: “Instead of writing in their science notebooks, you can have partners jot down ideas on a small whiteboard. This is a good way to keep the activity focused but not let students get bogged down on answering every question fully in writing. Having notes in their science notebooks or on a whiteboard will give students something to refer to as they share out during the whole-class discussion that follows” (Teacher’s Edition, page

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139).

- Lesson 6: “As a strategy for differentiation, encourage students to use the graph produced by the simulation to verbally explain the relationships they see occurring between the amounts and types of inputs they start with and the outputs they end up with. Mathematically, though, the relationship between any input and any output are piecewise functions as each input serves at one point as a limiting factor in the system, and therefore explaining a quantitative relationship between inputs and outputs is beyond grade band. But analyzing and verbalizing how the graph is changing and how one line decreases while the other increases based on inputs and outputs is another way students can share their findings” (Teacher’s Edition, page 154).
- Lesson 7: “It may help students to keep track of the carbon (C), hydrogen (H), and oxygen (O) atoms (i.e., matter inputs and outputs) either by color coding or writing out the letters. Although color coding is a useful way to quickly reference the parts of the model, letter or number coding also helps ensure accessibility for any student who may be color-blind. Create a key to track what colors, symbols, numbers, or letters represent different parts of the model. If students are able to keep track of the Cs, Hs, and Os, they may start to develop some of the ideas related to the conservation of energy and mass” (Teacher’s Edition, page 167).
- Lesson 8: “This lesson is intended to fit within one 45-minute class period, which does not allow time for students to update their individual two-column Progress Trackers. If your class moves through the learning activities faster and/or you have a longer class period available to you, consider giving students the opportunity to complete this update to their Progress Trackers in their science notebooks. Slide F is an optional slide provided to you for this purpose. Have students write and draw what they have figured out about the lesson question, Where are plants getting food from?” (Teacher’s Edition, page 188).

Suggestions for Improvement

Consider providing more extensions for students who are motivated and ready to move beyond.

II.F. Teacher Support for Unit Coherence: Supports teachers in facilitating coherent student learning experiences over time by:

Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

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Rating for Criterion II.F. Teacher Support for Unit Coherence: Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time, because students have an opportunity to engage in asking questions about phenomena that they feel they need to address in upcoming lessons, and future investigations are focused on answering these student-generated questions.

The Unit Storyline provides users with clear, concise navigation guides that link lessons. For example:

- Navigation to Next Lesson: “In this lesson, we figured out that plants have food molecules in them. This made us wonder ‘How do plants get their food molecules? Where are they coming from?’” (Teacher’s Edition, Lesson 1, page 3).
- Navigation to Next Lesson: “We figured out that inputs of the hydroponic plant system below the surface do not contain whole food molecules and we conclude these can’t be sources of food molecules. We want to investigate what inputs above the surface of the plant system could be sources of food molecules. We also thought it could be useful to look more closely at what atoms food molecules are made of and what atoms inputs to the plant system are made of and see if there are any similarities.” (Teacher’s Edition, Lesson 2, page 4).

In all lessons, students make progress towards elements of each dimension that help the student also make progress on the questions connected to the phenomena. Each lesson begins with links to the previous lesson, the key learning outcomes for the current lesson, and connections to the next lesson. For example:

- In Lesson 3, students are prompted to “revise the main question on the candidates list. Show slide G. Use a colored marker and add FOR PARTS to the already existing question. The new question should now read, “What are the possible sources FOR PARTS of food molecules in plants?” (Teacher Edition, page 102).
- In Lesson 4, when students are revising their consensus model, the teacher prompts students to reflect by asking “What new questions do we have that might help us move forward?” (page 122). Similar questions are asked in Lesson 5 (page 140) and Lesson 10 (page 222).
- Students regularly return to their consensus models to engage in deeper understanding of the Disciplinary Core Ideas. Students use the science and engineering practice of modeling to explain their ideas. Students revise their models in Lesson 3 (page 105), Lesson 4 (page 122), Lesson 5 (page 141), Lesson 6 (page 157), Lesson 7 (page 176), Lesson 8 (page 188), Lesson 11 (page 242), Lesson 12 (page 279), Lesson 13 (page 292), Lesson 14 (page 304), and Lesson 15 (page 327).
- In Lesson 4, there are “Tips for teachers on the CO₂/RH detector experiment” (page 127).
- In Lesson 9, students are intentionally asked to “generate new questions for the DQB” (page 207).
- In Lesson 10, students are asked to “...generate ideas about how to investigate...” (page 225).

Suggestions for Improvement

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N/A

II.G. Scaffolded differentiation over time: Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Rating for Criterion II.G. Scaffolded Differentiation Over Time: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time because the instructional materials provide specific guidance to create learning experiences targeting students with diverse needs so they can make progress over time toward common learning goals of engaging in the practices and making sense of phenomena. Supports are provided for all students to engage in the SEPs in ways that not only integrate the other two dimensions, but also explicitly build an understanding and proficiency in the SEPs over time through a variety of student approaches over the course of the unit.

Every lesson has multiple call-outs for supporting students in developing and using specific SEPs. Developing and using models is a key practice for sense-making in this unit. This is an example of the guidance provided:

- Lesson 1: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS
Tell students it’s OK if they don’t know the “right” answer when drawing models. At this stage, there are no “correct” ideas to think or questions to ask. All ideas and questions are welcome. The goal of making an initial model is to make their thinking visible to others. Have students try to put any ideas they are thinking down on paper. They can use pictures, symbols, and words. Make sure they label any drawings” (Teacher’s Edition, page 57).
- Lesson 1: Teachers are prompted to have students, “Develop an initial model of the plant system. Show slide N and explain the following: Hand out one copy of How Plants Get Food Initial Model to each student. Tell students to choose one of the plants we’ve investigated so far on our list of Related Phenomena (e.g., maple tree, banana, avocado, beans, apple, or one of the plants they read about last night). Have them work individually to develop an initial model of the system to explain the following: How did this plant get its food molecules? Where did the food molecules come from?
 - Additional suggestions for teachers are offered in a call out: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS Describe examples and non-examples by using a productive comparison. For example, a similarity might be that both students put water going into their plants. If one student colored the water blue and another student didn’t color the water at all, that is a difference. But this difference might not be as helpful for understanding as the differences between students’ ideas” (Teacher’s

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Edition, page 58).

- Lesson 1: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS
Although it will take a bit more time, help students generalize their specific examples to apply to all plants. When modeling, scientists have to continue mapping specific examples to a more generalized version of what’s occurring. Allowing students to do this work here will help them more broadly develop their practice of modeling” (Teacher’s Edition, page 60).
- Lesson 6: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS
It is important that students don’t perceive simulations as illustrations of factual truth, but rather a model constructed by people to highlight particular aspects of a phenomenon. The home learning can help students weigh the advantages of the representations they saw in the simulation against those of a diagram of photosynthesis. By comparing the advantages of different representations, students engage in evaluating the limitations of a model for a proposed object or tool, which is a target element of Developing and Using Models in middle school in appendix F of NGSS” (Teacher’s Edition, page 158).
- Lesson 8: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS
Individual time gives students an opportunity to synthesize evidence and formulate their ideas. As students work, circulate among them, prompting them to defend their models (or part of their models) using evidence collected during investigations in Lessons 1–7. This can help students think through where their models may have a hole before the upcoming assessment” (Teacher’s Edition, page 188).
- Lesson 8: Teachers are prompted to have students, “Develop an initial model of the plant system. Show slide N and explain the following: Hand out one copy of How Plants Get Food Initial Model to each student. Tell students to choose one of the plants we’ve investigated so far on our list of Related Phenomena (e.g., maple tree, banana, avocado, beans, apple, or one of the plants they read about last night). Have them work individually to develop an initial model of the system to explain the following: How did this plant get its food molecules? Where did the food molecules come from?
 - SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS Students are provided pieces of the model (such as the drawing of the plant and the zoom in boxes) to help focus on the components and interactions and not get distracted by drawing non-essential components of the model (such as the plant shape)” (Teacher’s Edition, page 189).
- Lesson 10: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS
The consensus model the class developed in Lesson 8 is a useful tool because students can apply it to make predictions. Help students recognize that the models they are developing are helpful thinking tools by saying, Let’s use our consensus model to help us think about when a plant might stop making food molecules” (Teacher’s Edition, page 210).
- Lesson 14: “SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS An alternative to doing the Gotta-Have-It checklist in partners is to construct the checklist together as a class with a public representation of the ideas the class agrees should be part of the consensus

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model. If you make a modification to the current activity, keep in mind the following important components to make this activity a productive one: The process should be collaborative and involve students arguing from evidence for their ideas. There should be a public record, or artifact, of the ideas students agree to include in their models” (Teacher’s Edition, page 309).

Similar support is provided for the development and use of elements other SEP categories:

- Asking Questions (Lessons 1, 9, and 15),
- Planning and Carrying Out Investigations (Lessons 2 and 6),
- Arguing from Evidence (Lessons 2, 4, and 11).

Support for developing and integrating elements of the crosscutting concepts is provided in call-outs for:

- Systems and System Models (Lessons 1, 2, and 13),
- Matter and Energy (throughout Lesson 7).

Suggestions for Improvement

N/A

Overall Category II Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category II

Criteria A-G:

3: At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria

2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

1: Adequate evidence for at least three criteria in the category

0: Adequate evidence for no more than two criteria in the category

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Category III. Monitoring NGSS Student Progress

Score: **3**

Criteria A–F:

3: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion

2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

1: Adequate evidence for at least three criteria in the category

0: Adequate evidence for no more than two criteria in the category

III.A. Monitoring 3D student performances: Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances: **Extensive** (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena or design solutions because tasks are driven by well-crafted phenomenon-based scenarios that are able to elicit rich student performances.

The majority of scenarios are rich, based on specific, real-world, puzzling events or instances, and require grade-appropriate three-dimensional performances to address. They involve multiple modalities to present information in meaningful ways, and all information is appropriate to the grade. New information is presented as needed to keep the tasks sufficiently supported, engaging, and rigorous.

The unit is well grounded in an anchor phenomenon that inspires driving questions that create a need to consider a series of phenomena that drive sense-making tasks that all serve to ultimately figure out the anchor phenomenon. Tasks regularly require students to use all three dimensions together to sense-make, and the vast majority of tasks are focused on sense-making. No scientific inaccuracies were found.

The Teacher’s Edition contains an Assessment System Overview (pages 19–38) which details the key learning assessments (Lessons 1, 4, 8, 11, 13, 14, and 15) as well as opportunities to make student thinking visible in each lesson. Additionally, these opportunities are detailed in each lesson plan and are designated with an assessment icon and sample student responses. Assessment guidance is organized by the SEP and CCC that students are employing to make sense of the phenomenon, and specific “look fors/listen fors” at the element level are provided.

Suggestions for Improvement

N/A

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III.B. Formative: Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative: Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because the materials include many regular opportunities for formative assessment that are called out explicitly by the developer.

Teachers are provided support for using the ideas elicited from students to inform next instructional steps in the “what to do” section. Frequently, additional look fors/listen fors and what to dos are included in the Additional Guidance and Attending to Equity sections in the daily lesson plans. Formative assessments take varied forms, and are frequently built directly into instructional sequences (e.g., aren’t a “separate” assessment).

An Assessment System Overview (pages 19 to 24) is provided in the Teacher’s Edition: “Each OpenSciEd unit includes an assessment system that offers many opportunities for different types of assessments throughout the lessons, including pre-assessment, formative assessment, summative assessment, and student self-assessment. Formative assessments are embedded and called out directly in the lesson plans. Please look for the “Assessment Icon” in the teacher support boxes to identify places for assessments.” (page 19).

An example for Lesson 8 is provided below (Teacher’s Edition, page 21).

“Formative + Summative

This lesson offers students an opportunity to use their ideas to explain an adjacent phenomenon. We call this formative + summative because it offers a midpoint grading opportunity but should also be used to gain insight into student understanding and use that to inform subsequent instruction.

Developing and Using Models; Energy and Matter

When to check for understanding: (1) During the whole-class consensus model. (2) During the Individual Midpoint Assessment students will create individual models.

What to look/listen for: This midpoint assessment is important formatively to make sure the class is on the same page and ready to move forward in the unit. At this point, students should be comfortable with making the following claims:

- Plants have sugar and other food molecules in them (lesson one).
- Plants don’t take in any “whole” food molecules (lesson two).
- Plants take in parts of food molecules from below the surface (water and hydroponic plant food) (lesson three) and
- from above the surface (carbon dioxide) (lesson four).

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- Plants also give off outputs (oxygen and water) (lesson four).
- There are structures on the surface of leaves through which gases can enter and exit (lesson five).
- There are also structures in plant cells called chloroplasts that move around in response to sunlight (lesson five).
- Plants must do a chemical reaction or a series of chemical reactions in the chloroplasts to rearrange the molecules in water and carbon dioxide in order to make glucose and oxygen (lesson six).
- Plants must need sunlight to use as energy to make glucose (lesson seven).
- There are both matter and energy inputs and outputs (lesson seven).

What to do: If students are missing some of these claims during the consensus model discussion ask students to refer to their Progress Trackers for each lesson and to add those ideas to their Lesson 8: Gotta-Have-It Checklist.

A table with Lesson-by-lesson Assessment Opportunities (pages 24–38) is included in the Teacher’s Addition. “Every OpenSciEd lesson includes one or more lesson-level performance expectations (LLPEs). The structure of every LLPE is designed to be a three-dimensional learning, combining elements of science and engineering practices, disciplinary core ideas and crosscutting concepts. The font color used in the LLPE indicates the source/alignment of each piece of the text used in the statement as it relates to the NGSS dimensions: alignment to **Science and Engineering Practice(s)**, alignment to **Crosscutting Concept(s)**, and alignment to the **Disciplinary Core Ideas.**”

The Assessment System Overview table “summarizes opportunities in each lesson for assessing every lesson-level performance expectation (LLPE). Examples of these opportunities include student handouts, home learning assignments, progress trackers, or student discussions. Most LLPEs are recommended as potential formative assessments. Assessing every LLPE listed can be logistically difficult. Strategically picking which LLPEs to assess and how to provide timely and informative feedback to students on their progress toward meeting these is left to the teacher’s discretion” (page 24).

The following student-generated artifact examples demonstrate some of the ways that student thinking is made visible to the teacher:

- Stop and Jots in student notebooks: teachers are provided guidance for prompts and look-fors in student work.
 - Lesson 1: “Ask students where the food we ate came from. Show slide B. Ask students to do a Stop and Jot by drawing three bins in their science notebooks: “100% from plants,” “Mixture/Not Sure/Other,” and “100% from animals.” Then categorize the foods they listed above into these three bins. Tell students not to worry too much about the categorization at this point. If they are 100 percent sure a food is from a plant or animal, they should put it in the respective category. If they have doubts, they should place it in

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the Mixture/Not Sure/Other category” (Teacher’s Edition, page 45).

- Lesson 1: “Ask students where the food we ate came from. Show slide B. Ask students to do a Stop and Jot by drawing three bins in their science notebooks: “100% from plants,” “Mixture/Not Sure/Other,” and “100% from animals.” Then categorize the foods they listed above into these three bins. Tell students not to worry too much about the categorization at this point. If they are 100 percent sure a food is from a plant or animal, they should put it in the respective category. If they have doubts, they should place it in the Mixture/Not Sure/Other category” (Teacher’s Edition, page 65).
- Lesson 2: “Make observations of the hydroponic plant system. Present slide G. Have students make a Notice and Wonder Chart in their science notebooks. Gather students with their notebooks around the hydroponic boxes so everyone can see. Lift up the lid. There should be only roots hanging down in the water, no dirt, rocks, soil, and so on. Ask students to stop and jot down what they are noticing and wondering in their notebooks” (Teacher’s Edition, page 77).
- Lesson 10: “Have students stop and jot ideas, drawing on the consensus model from Lesson 8 and their initial explanations from Lesson 9 where they explained how plants can have food molecules in them when all the inputs or structures needed to make food molecules aren’t present” (Teacher’s Edition, page 213).
- Progress Trackers are used in most lessons
 - “The Progress Tracker is a thinking tool that was designed to help students keep track of important discoveries that the class makes while investigating phenomena and figure out how to prioritize and use those discoveries to develop a model to explain phenomena. It is important that what the students write in the Progress Tracker reflects their own thinking at that particular moment in time. In this way, the Progress Tracker can be used to formatively assess individual student progress or for students to assess their own understanding throughout the unit” (Teacher’s Edition, page 23). For example:
 - Lesson 4: “Remain in a Scientists Circle to update individual Progress Trackers. Slide S is provided for reference, but there is no need to project it. Since you are in a Scientists Circle for this update of the tracker, you will want to draw out the format, headings, and lesson question for the 3-column Progress Tracker (shown below) on chart paper for students to reference. Have students draw the 3-column Progress Tracker directly in their science notebooks in the section set aside for Progress Trackers. Ask them to list the sources of evidence from this lesson and use their own words and pictures to describe what we figured out” (Teacher’s Edition, page 122).
 - Lesson 6: “Before asking students to return to their seats, tell them to turn to the Progress Tracker section of their notebook and set up a 3-box tracker. As a class, fill in the question and the source of evidence. Then ask students to return to their seats and fill in the “What we figured out” section using words and/or pictures based on the discussion you just finished. Give students a few minutes

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to do this on their own so they can synthesize and make sense of their evidence from the simulation and from the discussion” (Teacher’s Edition, page 157).

- Lesson 11: “Individually update their 3-box Progress Trackers. Show slide S. Have students return to their seats. Say, take a few minutes to capture in your Progress Tracker what we just figured out. In their notebooks, students should draw a 3-box Progress Tracker using what the class came to consensus on in the previous discussion. First, have students write down the questions they have been trying to answer, why don’t plants die when they can’t make food? and How do plants use their food for fuel compared to us? Ask students what evidence they have been working with to answer these questions (e.g., the seedling investigation and reading on how plants and animals use food), the references to the sources of evidence, and what we have figured out in relation to each lesson questions” (Teacher’s Edition, page 244).
- Exit Tickets and suggestions for using the information are provided in the Teacher’s Edition. For example:
 - Lesson 2: “Exit Ticket. Project slide S. Say, take a few minutes to reflect on your own about where else the plant could be getting food molecules from. And, what new questions do you have now? Fill out the exit slip with your answers to these two questions and turn it in as you leave. We will share out ideas at the beginning of our next class. Assign students to fill out a notecard with their answers to the questions on the slide, as an exit ticket. Before Lesson 3, review students’ exit tickets. The exit ticket will provide valuable information about what other inputs students think could be a source of food molecules for the plant. The exit ticket can also provide insight about the types of questions students have about where plants get food molecules.” (Teacher’s Edition, page 85).
 - Lesson 3: “Have students complete an exit ticket to respond to the following prompts: Explain your reasoning using evidence: Why have we revised our question to be what candidates are possible sources for parts of food molecules found in plants? What else do we need to figure out about potential sources of food molecules?” (Teacher’s Edition, page 108).
 - Lesson 5: “Have students complete an exit ticket on to respond to the following prompts: If we could represent what is going on inside a plant using a simulation, what inputs and outputs of the plant system would we want to represent? What structures of the plant would we want to represent?” (Teacher’s Edition, page 145).
 - Lesson 10: “Exit ticket. Display slide T. On a note card, have students generate ideas about how to investigate whether plants are using stored food as fuel when they don’t have leaves or don’t have any water. Prompt students to think about: How could we investigate if plants are using food as fuel like we do in cellular respiration? How would we know? What evidence would we look for?” (Teacher’s Edition, page 225).

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N/A

III.C. Scoring guidance: Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance: Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because assessment targets--for all dimensions being assessed--are clearly stated and incorporated into the scoring guidance.

Clear guidance is provided for teachers to interpret student progress, in relation to both the instructional materials as well as the targeted standards/dimensions/parts of dimensions/learning performance. Exemplar student responses are included.

For example:

- Scoring guidance, keys, and rubrics are provided for assessments in Lessons 4, 8, 11, and 14, and the summative assessment in Lesson 15. Both holistic and analytical rubrics are employed. The latter using 1s or +s to generate a score.
- In addition, assessment guidance is embedded throughout the unit. Some examples include the following:
 - “The two questions in Part 5 of Which food molecules are in the hydroponic plant food? can provide evidence of students’ ability to argue with evidence. They should be able to argue that there are no food molecules found in the hydroponic plant food solution using evidence from the investigation. If students argue they found evidence of food molecules in the hydroponic plant food solution sample they tested, it might be helpful to talk through with them how they conducted their investigation and ask them for the data they collected (no color change or a color change when the food indicator was added to the solution)” (Teacher’s Edition, Lesson 2, page 82).
 - “At the end of the lesson, students should be able to argue with evidence that hydroponic plant food does not contain whole food molecules through the data they collect from the investigation. In addition, students should be able to argue that plain water also does not contain whole food molecules based on the investigation” (Teacher’s Edition, Lesson 2, page 83).
 - “As different students share what they figured out about the inputs that are below the surface and whether these can be sources of food molecules, listen for students to share ideas such as: There is not any soil in the hydroponic system. When the

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hydroponic plant food was tested with food indicators, there were not any of the food molecules. Plain water does not contain food molecules. None of the inputs we looked at that are below the surface contain food molecules” (Teacher’s Edition, Lesson 2, page 84).

- “At this point in the unit, students do not have any evidence about what happens to water inside the plant. In this assessment, we are really looking to see if students can cite evidence and reasoning for water as both an input and output; this is common to all three claims. The reasoning they use as they try to explain what happens to water inside the plant provides valuable insight into their thinking that can be leveraged in lessons six and eleven where students will be able to associate different inputs and outputs with photosynthesis and cellular respiration” (Teacher’s Edition, Lesson 4, page 118).
- The developers provide a Teacher Key for Student Assessment (Teacher’s Edition, Lesson 4, page 129).
- “The 3-box progress tracker is a great formative assessment to see if students are individually processing what was discussed in the Building Understandings Discussion. Walk around as students are writing and drawing. Students should label carbon dioxide, water, and oxygen as matter, sunlight as energy, and glucose as matter and energy in their Progress Trackers. They should explain that they know glucose provides energy for the plant to use because it has calories. If students struggle to label both matter and energy and explain how they know which inputs and outputs are energy, matter, or both, ask them what evidence they have for whether or not each input/output can provide (this should refer them to the Composition of Air and Food Molecule Cards)” (Teacher’s Edition, Lesson 7, page 176).
- Exemplar student responses are included for key-learning formative and summative assessments in Lessons 4, 8, 11, 14, and 15. However, a range of student responses and interpretive guidance for each of the key-learning formative and summative assessments is not always provided.

Suggestions for Improvement

Consider indicating which PE is being assessed with each rubric and include scoring guidance for all three dimensions.

III.D. Unbiased tasks/items: Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items: **Extensive** (*None, Inadequate, Adequate, Extensive*)

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The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because vocabulary (science and non-science) is grade level appropriate and the amount of text in tasks/items is frequently accompanied by other ways (visual representations, graphs, video, etc.) ways of communicating the expectations for student performance.

The Progress Tracker is introduced in Lesson 2 and provides structured variety in the modalities expected for student responses. Students are encouraged to express what they've learned using a mode that makes sense for them. Teachers are prompted to allow emergent multilingual students to use space to make sense in the language that they feel most comfortable using or in drawings. The individual Progress Tracker is a space for students to synthesize learning in their own way.

The unit includes nine different readings at a middle school reading level with grade appropriate support for helping students access the information. Support is provided for developing and using a Word Wall, which focuses on critical terminology and includes guidance for use with English language learners. A range of videos is incorporated throughout the unit and includes videos containing additional information about tapping maple trees to one showing the inside of a leaf. The Student's Edition contains a wide range of representations (e.g., food labels (several were included for cultural relevance), scatter plots, pie charts, photographs, tables, food molecule representations, and scientific drawings to name a few). The Teacher's Edition contains a slide deck for each lesson that includes the same representations found in the Student Edition plus additional supporting ones.

- In Lesson 13, there are four different readings designed to support a range of reading levels. For example, there is an extension reading about *Bacillus Subtilis* for students reading beyond grade level and a reading on Dung Beetles for students whose reading skills lend themselves better to less complex text. Furthermore, the readings represent decomposers from around the world and in different types of systems.

Representations or scenarios capitalize on the funds of knowledge that students bring with them to the classroom and materials provide clear pathways for students to make connections to their lives beyond the classroom. For example:

- In Lesson 1, students are provided an opportunity to find out more about the plants containing food molecules phenomenon by having students take home a reading about foods from plants around the world (Teacher's Edition, page 40). Teachers are prompted to "distribute What do kids around the world eat for breakfast? Students will read about kids in different countries and what they eat for breakfast. In the next class students can add these foods to their group's list to investigate which food molecules are in plant food" (Teacher's Edition, page 54).
- Also, in Lesson 1, student groups are encouraged to select the food labels they want to compare. A range of food labels is provided, and several labels are provided for foods from various countries (Teacher's Edition, pages 55–57).
- In Lesson 13, students draw and photograph decomposers in their community. This is an example

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of self-documentation, which can be used to help students see how the science ideas they have learned about in class relate to everyday phenomena in their lives.

There is structured variety in the modalities expected for student responses, including at least one significant task that provides students with a choice of responses across multiple modalities.

- For example, in Lesson 10 students are asked to work with a partner to create a one-minute news release to explain what they think is happening with photosynthesis in the dark to the principal and other teachers. Students use the Communicating in Science Checklist to plan their one-minute news release. The checklist asks them to choose a communication medium (e.g., text, images, tables, diagrams, graphs, equations) and consider what each medium communicates.
- The Lesson 15 assessment task provides several opportunities for students to express their understanding using different modalities. Students are encouraged to use a combination of words and diagrams to express their ideas. Lesson 15 includes an assessment with teacher guidance for introducing the task that focuses on making sure all students can access the scenario before engaging with the task and giving the class time to make sense of the video before the assessment. By using a video, modeling scaffold, and graphic representation, this supports students in a visual way not solely based on reading text.
- In addition, Lesson 15 allows students to choose an application of synthetic materials through which they demonstrate their understanding. Students are able to use their Gotta-Have-It checklists in both the Lesson 8 midpoint assessment and the Lesson 15 transfer task. This allows for students to basically “edit their rough drafts in much the same way that scientists and engineers circulate initial findings to colleagues before submitting a final draft for public consumption.” Additionally, in Lesson 14, students explain the story of an atom of food as a first draft explanation at the cycling of atoms within a system so that their transfer task is not the first time they are expressing their understanding.

Suggestions for Improvement

N/A

III.E. Coherent Assessment system: Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Rating for Criterion III.E. Coherent Assessment System: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because the materials include assessments that are consistently designed to connect to learning goals and require students to apply appropriate elements of the three dimensions to make sense of the phenomenon.

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All four of the assessment types mentioned in the criterion are present. The assessments use a variety of measures and provide multiple assessment opportunities so that students can demonstrate their understanding of the same learning goals in a variety of ways. Most or all tasks and items are multi-dimensional, there are significant tasks, and the measurement of the three dimensions proportionally matches up with the learning goals. For example:

- “The student work in Lesson 1 available for assessment should be considered a pre-assessment. It is an opportunity to learn where students are coming in and what ideas they have that you can build on in this unit. The more ideas in your classroom the better. Specifically, look for students’ initial understandings of modeling, asking questions, systems and systems models, and matter & energy.”
- Assessments are embedded throughout the unit. Self-assessments are called out in the Assessment Opportunities in Lessons 2, 5, 11, and 13 and are guided by a student assessment handout. For example, “This is a great opportunity for students to self-assess on their engagement in classroom discussions using Self-Assessment for Classroom Discussions. This discussion rubric can be used anytime after a discussion to help students reflect on their participation in the class that day” (Teacher’s Edition, Lesson 2, page 85).
- Although numerous formative assessment opportunities are specified in the Teacher’s Edition, there are five highly developed formative assessments in Lessons 4, 8, 11, 13, and 14, which include exemplar student work, scoring guidance, and possible next steps for instruction.
- “Lesson 15 includes a transfer task to give students an opportunity to use the three dimensions to make sense of a different phenomenon. It is meant to be a summative assessment task for the unit, and it gives a grading opportunity. The task includes a teacher reference with a scoring guide as well as a modeling rubric for scoring the modeling question. Scoring guides are meant to highlight important ideas students should be including in their responses to the prompts. They are listed as bullet points so you can decide how to score them appropriate to the norms in your classroom. If students share these ideas elsewhere in the assessment, it is up to the teacher to decide if that understanding is sufficiently demonstrated.”

The rationale is carefully mapped out over the course of the materials for why all three dimensions are taught and assessed, including how each task will measure student learning and provide feedback to teachers to inform instruction and students to inform learning. For example:

- The Lesson by Lesson Assessment Opportunity table “summarizes opportunities in each lesson for assessing every lesson-level performance expectation (LLPE). Examples of these opportunities include student handouts, home learning assignments, progress trackers, or student discussions. Most LLPEs are recommended as potential formative assessments. Assessing every LLPE listed can be logistically difficult. Strategically picking which LLPEs to assess and how to provide timely and informative feedback to students on their progress toward meeting these is left to the teacher’s discretion” (Teacher’s Edition, pages 24–38).
 - Notable is that the “What to Do” categories, which suggest feedback for students.

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Suggestions for Improvement

N/A

III.F. Opportunity to learn: Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback

Rating for Criterion III.F. Opportunity to learn: **Extensive** (None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts because for key, claimed learning in the unit, there are multiple, linked student performances that provide students with several opportunities to demonstrate understanding.

The Teacher’s Edition contains an Assessment System Overview (pages 19–38), which details the key learning assessments (Lessons 1, 4, 8, 11, 13, 14, and 15) as well as opportunities to make student thinking visible in each lesson. Additionally, these opportunities are detailed in each lesson plan and are designated with an assessment icon and sample student responses. Assessment guidance is organized by the SEP and CCC that students are employing to make sense of the phenomenon, and specific “look fors/listen fors” at the element level are provided.

Students utilize multi-modal feedback across a series of student performances to demonstrate new thinking based on peer and teacher feedback and personal reflection.

Each lesson includes assessment guidance. The assessment guidance is designed to check for understanding of the LLPEs, which are three-dimensional. Also, the assessment guidance includes strategies teachers can use to adapt instruction based on feedback from the students.

he LLPEs and description of assessment and guidance on how to use the assessment to inform instruction assessment guidance is included in the Assessment System Overview. An example from Lesson 11 is included below:

- “In Lesson 11 there is an assessment opportunity to monitor students’ progress on the DCIs, constructing explanations, and energy & matter as they write an explanation of how trees or saplings that do not have leaves can survive.
Constructing Explanations; Energy and Matter
When to check for understanding:
At the end of day 3 collect Maple Tree through the Seasons Explanation to see if students

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are putting pieces together pieces of what they've figured out about photosynthesis and cellular respiration in plants during various seasons.

What to look/listen for: Students can identify the following: The maple tree is doing photosynthesis and producing sugars when it has green leaves and sunlight available.

The maple tree converts excess sugars and stores them as food molecules. It extracts energy via cellular respiration from stored food molecules when it is unable to produce sugars via photosynthesis. This is how it gets its energy when its leaves fall off.

The maple tree is always doing cellular respiration and using sugars to get its energy, but when it has green leaves, it can use sugars from photosynthesis.

The maple tree and a maple tree seed use stored food molecules like fats, proteins, and starches by breaking them down and reassembling them into new parts of plant cells (e.g., cellulose) via chemical reactions. Since the tree has these food molecules stored, and the tree created a supply of food molecules for the seed, they each can make new cells (matter) even when they can't make new sugars through photosynthesis.

What to do: If students are struggling, ask them to think about the matter inputs and outputs of both photosynthesis and cellular respiration, carbon dioxide, water, sugar/food molecules. Thinking about the composition of food molecules (carbons, hydrogens, and oxygens, mostly) and the maple tree tapping may also help them recognize that trees are storing those molecules for the tree's benefit (not just so we can eat them!). It may be helpful to pull small groups of struggling students together and have them revisit their Progress Trackers (specifically rows for Lessons 9–11). If students still struggle with completing the assessment, it may be beneficial to allow students to redo Maple Tree through the Seasons Explanation after individual support from the teacher."

Suggestions for Improvement

N/A

Overall Category III Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category III

Criteria A–F:

3: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion

2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A

1: Adequate evidence for at least three criteria in the category

0: Adequate evidence for no more than two criteria in the category

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Overall Score

Category I: NGSS 3D Design Score (0, 1, 2, 3): **3**

Category II: NGSS Instructional Supports Score (0, 1, 2, 3): **3**

Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): **3**

Total Score: **9**

Overall Score (E, E/I, R, N): **E**

Scoring Guides for Each Category
<p>Unit Scoring Guide</p> <p>Category I (Criteria A–F): 3: At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C 2: At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C 1: Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C 0: Inadequate (or no) evidence to meet any criteria in Category I (A–F)</p> <p>Category II (Criteria A–G): 3: At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria 2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A 1: Adequate evidence for at least three criteria in the category 0: Adequate evidence for no more than two criteria in the category</p> <p>Category III (Criteria A–F): 3: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion 2: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A 1: Adequate evidence for at least three criteria in the category 0: Adequate evidence for no more than two criteria in the category</p>

Overall Scoring Guide
<p>E: Example of high quality NGSS design—High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)</p> <p>E/I: Example of high quality NGSS design if Improved—Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)</p> <p>R: Revision needed—Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)</p> <p>N: Not ready to review—Not designed for the NGSS; does not meet criteria (total 0–2)</p>