OpenSciEd Massachusetts Standards Guidance
7th Grade: Matter Cycling & Photosynthesis

This document is to provide guidance to Massachusetts 7th grade teachers who are implementing OpenSciEd. This guidance assumes the OpenSciEd curriculum is being implemented across grades 6-8, following the MA coherent sequence by grade level *(download)*. The following guidance identifies the MA standards addressed in the *Matter Cycling & Photosynthesis* unit, and the most effective use of the OpenSciEd materials for 7th grade teachers.

Scope and Sequence Recommendation

Implement the *Matter Cycling & Photosynthesis* unit in 7th grade after the *Thermal Energy* and *Contact Forces* units, and before the *Ecosystem Dynamics & Biodiversity* unit. The *Thermal Energy* unit lays a foundation about the particulate nature of matter that supports understanding in *Matter Cycling and Photosynthesis, w*hich in turn begins a content arc on energy flow in organisms and ecosystems that is continued by *Ecosystem Dynamics & Biodiversity. Matter Cycling & Photosynthesis* addresses one 7th grade and one 6th grade life science standard, and partially addresses one additional 8th grade physical science standard. Refer to the MA coherent sequence by grade level *(download)* for the complete scope and sequence recommendation.

7th Grade Standards in Matter Cycling & Photosynthesis

Standards in unit	Lessons building towards standards
7.MS-LS2-3. Develop a model to describe that matter and energy are transferred among living and nonliving parts of an ecosystem and that both matter and energy are conserved through these processes. Clarification Statements: Cycling of matter should include the role of photosynthesis, cellular respiration, and decomposition, as well as transfer among producers, consumers (primary, secondary, and tertiary), and decomposers. Models may include food webs and food chains. State Assessment Boundary: Cycling of specific atoms (such as carbon or oxygen), or the biochemical steps of photosynthesis, cellular respiration, and decomposition are **not expected** in state assessment.	Lesson 1-9, 11-15

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Additional Standards in Photosynthesis & Matter Cycling

Standards in unit	Lessons building towards standards
6.MS-LS1-2. Develop and use a model to describe how parts of cells contribute to the cellular functions of obtaining food, water, and other nutrients from its environment, disposing of wastes, and providing energy for cellular processes. Clarification Statement: Parts of plant and animal cells include (a) the nucleus, which contains a cell's genetic material and regulates its activities; (b) chloroplasts, which produce necessary food (sugar) and oxygen through photosynthesis (in plants); (c) mitochondria, which release energy from food through cellular respiration; (d) vacuoles, which store materials, including water, nutrients, and waste; (e) the cell membrane, which is a selective barrier that enables nutrients to enter the cell and wastes to be expelled; and (f) the cell wall, which provides structural support (in plants).	Lesson 1, 3, 5-9, 11-15
8.MS-PS1-2. **[partial]** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. Clarification Statements: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with HCl. Properties of substances include density, melting point, boiling point, solubility, flammability, and odor. • **Why partial?** While students analyze data to support the idea that a chemical reaction (photosynthesis and cellular respiration) occurs in plants, they do not specifically look at changes in the properties of substances in this example. This standard is completed in the units ***Metabolic Reactions*** and ***Chemical Reactions,*** and does not need supplementation within this unit.	Lessons 4, 10-11

See recommendations below for addressing these 8th and 6th grade standards.

Recommendations for Addressing Standards in *Photosynthesis & Matter Cycling*

Include, and teach 6.MS-LS1-2 and 8.MS-PS1-2 with *Photosynthesis & Matter Cycling* as planned in the unit. The work that students do toward these standards supports their understanding of the flow of matter and energy between living and non-living parts of an ecosystem. **Excluding these standards would require substantial redesign of the unit, which is not recommended.**

Changes may be necessary throughout to support coherence between units**.** This lesson was originally written to follow ***Metabolic Reactions*** and ***Chemical Reactions***, which were written to solidify the concepts of molecules, atoms, and reactions. However, if the units are taught following the recommended sequence for Massachusetts, these foundational units will come after ***Photosynthesis & Matter Cycling***. Suggestions for how to provide just-in-time supports for students are listed below:

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Lesson	Support for maintaining content coherence

Lesson 1: Where does this stuff come from?	Add to the Learning Plan in the Teacher Guide:
	Part 1 – Explore the Food We Ate Today
	• When you encounter the maple syrup food label, students will likely notice the term "sugar" and suggest that is why the syrup tastes sweet.
	• Do not use the suggested prompts framing Slide D in the teacher guide. Rather, support the students in ***asking questions*** about the words on the label. Students may be nominally familiar with "protein", "fat" and "carbohydrates", but you can push them to wonder about what those actually are, and why some substances are classified under other substances (i.e., sugar -> carbohydrates).
	• Proceed to Parts 2 and 3 (the syrup tapping video and tasting activity) as written.
	
	Part 4 – Recall What Happens to the Food We Eat
	• This activity should **be reframed**. Rather than having students "recall" the food they eat, leverage their experiences with the ***Thermal Energy*** unit.
	  ○ Modify Slide H to prompt students to remember that all materials – such as cups, air, and liquids – are made of smaller particles.
	  ○ Foods are also made of these particles, and we call them **food molecules**.
	  ○ When you distribute the food molecule cards, give students additional time to notice and wonder about them. They may note that each item on the card is made of smaller things, which we can call atoms, but for now have students focus on the fact that these molecules make up our food.
	  ○ Proceed to Slide I and continue the rest of this part of the lesson as written.

Lesson 2: Do plants get their food molecules by taking them in?	**Part 7 – Navigation** • You will need to modify the framing around slide M as the student will not have had the experience of using food indicators. Accept the students' ideas, and then introduce the idea of indicators. • You may want to add a slide between M and N that shows how food indicators work and that a color change indicates the presence of a food molecule.
Lesson 3: What other inputs could be sources of food molecules for the plant?	**Part 3 – Discuss What We Already Know About the Composition of Air** • Students will not have had any of the units listed in this prompt in Massachusetts. Do not refer to previous OpenSciEd units to support understanding. • You should modify slide C to say "What do we already know is in the air that we breathe?" rather than referring to previous units. • Prompt students to turn and talk about what they know/think is in the air. Then you might say that scientists have measured the composition of the air, provide them with the Composition of Air chart and proceed with the lesson as described. **Part 4 – Problematize Candidate Sources for Plant Food Molecules** • Follow the additional guidance and allow students more processing time and support to compare food molecule components. Ask questions to get them to look at the atoms within the molecules and encourage questioning along those lines. • The rest of the lesson can be continued as written.

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Lesson 4: Are any parts that make up food molecules coming to the plant from above the surface?	At some point in this lesson, you should find it appropriate to introduce the term "chemical reaction." If students begin to suggest that the plant is somehow changing the substances, that would be a good point to introduce the term and add it to the word wall. You will reinforce it in later lessons. **Part 2 - Planning and investigating above the surface sources** • Plan to spend some extra time allowing the students to think about ways to collect gases from the leaves of the plant, and introduce the term *closed system* as a new word wall word since they will not have been exposed to it in ***Metabolic Reactions***. **Part 8 – Next Steps** • Follow the "additional guidance" for this part and allow students time to test out the CO2 detector with themselves to make the connection between human and plant respiration.
Lesson 5: How are these gases getting into and out of leaves?	**Part 4 – Make Sense of Investigation A** • Plan to allow extra time to reinforce the term "chemical reaction" to describe photosynthesis, where substances are broken apart and rearranged to form new substances.
Lesson 7: Why do plants need light?	**Part 1- Navigation** • As you navigate into this lesson, students will not have had the experiences with burning food and analyzing food labels that was provided in ***Metabolic Reactions***. Because you looked at the syrup food label in an earlier lesson, you might be able to bring that back as something that could give a clue as to how much energy is in foods that we eat. The reading in part 2 will help students make connections between calories and energy. • Continue to lean on the *Additional Guidance* in the teacher's guide for suggestions on how to steer conversations without the ***Metabolic Reactions*** background.
Lesson 10: Why don't plants die at night?	**Part 6 – Building Understandings Discussion** • Focus on the data that show that in the dark, plants take in oxygen and release CO2. Although students may not know the term "cellular respiration", they likely have some familiarity with the idea that humans need to take in oxygen, and may compare what plants do in the dark to what humans do. • It is recommended to remove slide Q. Modify slide R so that it asks students to consider what might be happening inside the plant as it takes in oxygen and releases CO2. Don't introduce the term cellular respiration yet – it will come up in the next lesson when students have more evidence. Push students to think about what the plant could be doing with the sugar that we know it has inside after the photosynthesis reaction. • Modify slide S. Rather than using the term "cellular respiration", prompt students to make a simple model of what they know so far happens in a plant cell, and what they think it might be doing at night. • Modify slide T and the exit ticket prompt. "How could we investigate whether plants are using the sugar that they make during photosynthesis?"

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Lesson	Support for maintaining content coherence
Lesson 11: Why don't plants die when they can't make food?	**Part 1 - Navigation** • Throughout the beginning of this lesson, rather than saying "cellular respiration like we do", push students to think about what the plant might be doing with the sugar (glucose) molecules it has made, and whether it might be giving off CO2 like we did (using the CO2 detectors in Lesson 4). Motivate the investigation with the seeds by indicating that we could use more evidence to see whether seeds do the same thing that "grown" plants do at night. Modify slide A as you have not yet introduced the term "cellular respiration". • Modify slide D to say "how could we determine if sprouting seeds are doing the same reaction that grown plants do at night?" • Modify slide E to introduce, rather than remind students about, BtB. **Part 3 – Plan the BtB Bean Sprout Investigation** • You will have to allocate more time to explain that BTB is an indicator for carbon dioxide, and can demonstrate using carbonated water. **Part 7 – Make Connections About Similarities Between Plant and Animal Cells Doing Cellular Respiration** • Omit part 7 and slide L. This is building connections back to the ***Metabolic Reactions*** unit. When you do ***Metabolic Reactions***, you may choose to refer back to ***Photosynthesis***. **Part 8 – Read the Article How do Plant (and Animal) Cells Use Food?** • The navigation here should refer back to the arguments students were making that plants used their glucose and released CO2 when they can't do photosynthesis. • The prompt for the reading should be "How do plants use food?" You may want to bold the word "cellular respiration" in the reading. Once the reading is done, you will want to add that to your word wall along with mitochondria. **Part 9 – Consensus Discussion about how Plants Stay Alive When They Can't Make Food** • Use the reading to develop the full model focusing primarily on the plant cell. The human component of the model may be quite simple at this stage, simply showing that air goes in and CO2 comes out. Modify slide R to reflect this.
Lesson 12: Where does the rest of our food come from?	**Part 10 -Remember what animals do with food molecules** • Refer back to the reading from Lesson 11 to support students in thinking about cellular respiration in animals. Modify Slides S and T as needed to reflect your students' understanding at this point.

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Lesson	Support for maintaining content coherence
Lesson 13: What happens to food that doesn't get eaten?	**Part 5 – Navigation** • For this building understandings discussion, focus on prompting students to compare the bread mold to cellular respiration that we've seen in plants and read about in animals. • To get students to think about "opening the system", you can wonder aloud if anything would change if the bag of bread were opened up. What gases might start coming in and interacting with the bread mold? **Part 8 – Revise our Consensus Model to Include Decomposers** • Revise Slide H as needed to reflect whatever level of understanding of human respiration that students have. Deeper exploration into cellular respiration in humans will occur in ***Metabolic Reactions***.