How Matter Moves in an Ecosystem

Summary: In this lesson, students take a deep dive into exploring how energy and matter move through a garden ecosystem. Students start by defining and observing examples of matter in the garden ecosystem. Then they think critically about where the matter in a garden ecosystem comes from, and whether it could ever run out. This lesson forms the foundation for lesson 11, *Compost*, in which students will explore the role of compost and decomposition in a garden ecosystem.

This is the tenth of a 12-lesson series in which students will explore the basic ecological principle of interdependence through the lens of common organic farming practices.

Time: 30-45 minutes

Teacher Notes:

- For sections that instruct students to READ, you can record yourself reading aloud and send it to students. Invite them to read along with the recording. This is a helpful strategy for differentiating learning that supports all students.
- If you are teaching this lesson in the garden, we suggest completing the sections as a whole glass or in small groups. The garden is a great place for discussion-based lessons.
- This lesson is designed both to help students start to wrap their heads around this project in a more structured way, but also to prompt excitement and enthusiasm about the driving question. Encourage students to really get all their thinking on the table here, especially during the brainstorm section. At this stage in the process, the more possibilities the better! You never know what kind of creative solutions or ideas may arise from something that at first seems completely unrealistic or “out there”.

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Teacher Notes Continued:

- The "READ" section of this lesson may feel a little dense to some students without the proper support. We suggest the following strategies for supporting students to engage fully with the text:
    - Instruct students to find a quiet place to sit and encourage them to observe their surroundings before and after they read. This helps them engage with their surroundings in a different way and can also support their engagement with the text.
    - Assign sections of the reading as a jigsaw: Assign small groups a different topic each, and then have groups report back to one another after they have finished reading with their topic in mind.
    - Remind students that the Talk to the Text or T4 strategy can be used when reading texts to help track their thoughts, questions, and reactions to a text. In these strategies, students write notes and ask questions in the margins, underline words, and use symbols to react to the text.
    - Read the article aloud and have students take notes as they listen. It might be helpful to stop frequently as you read to write down keywords, phrases, or ideas on chart paper. Take your time through the reading and ask your students their thoughts along the way.
- The first PAIR SHARE in this lesson asks students to track the source of matter in their own bodies, and in crops. Students should have a basic idea about how to answer these questions based on things they learned in elementary school science classes. However, we recommend you use this pair-share as a way to gauge your students' level of prior knowledge, and identify any significant misconceptions. Science instruction in elementary school tends to be inconsistent, and so there may be less background knowledge for some students than others.
- At some point during this lesson, have students return to the garden bed in which they are conducting the plant start investigation (Lesson 3). They should record their observations about the plants and soil on the Plant Start Investigation worksheet.

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Vocabulary

- **Matter:** a material substance—the "stuff" the universe is made of. Although matter may change forms, it cannot be created or destroyed.

READ: Everything in the universe is made of "matter"—that includes your body, the furniture in your classroom, the walls of the classroom itself, and the air you're breathing. **Matter** is any material substance, or the "stuff" the universe is made of. In the garden, examples of matter include leaves, rocks, water, air, kitchen scraps, and all the "stuff" that makes up the various organisms that live there (muscle, skin, tree bark, cell membranes etc.). Today we are going to explore where the matter in the garden comes from and how it got there. Understanding the science behind where the matter in your crops come from will help you better plan for how to help them grow.

OBSERVE: Start by taking some time to wander through the garden.

- Where do you observe examples of matter? How many different forms of matter can you observe?
- Do you think there are any forms of matter in the garden you cannot observe?
- Choose one *abiotic* factor and one *biotic* factor to focus on.
    - Where do you think the matter in each of these factors came from? Where did it come from before that? How far back can you track the matter in each factor?
    - Do you think the matter in either of these factors will ever disappear? Explain your reasoning.

PAIR-SHARE: Discuss the questions below with a partner and then the full class.

- What *biotic* factor did you observe?
    - Where do you think the matter that makes it up came from?
    - Where do you think its matter will go when it dies? Will the matter that makes it up ever disappear?
- What *abiotic* factor did you observe?
    - Where do you think the matter that makes it up came from?
    - Do you think the matter that makes it up will ever disappear? Explain your reasoning.

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How Matter Moves in an Ecosystem

READ: Read the articles Where Do Plants Get Their Matter? and The Law of the Conservation of Matter. You may want to do this as a jigsaw activity, where you work in small groups. Half the group reads one article, and the other half reads the other. Then share with one another what you learned. As you read, you may want to Talk to the Text in order to help you understand the main ideas and track your questions.

MODEL: Return to your food web diagram. Use arrows to indicate the flow of matter through the food web. In other words, where does the matter that makes up each organism come from? Where does it go after that? See how complete you can make your diagram.

If you're feeling stuck as you work, see if the questions below can prompt your thinking:

- What happens to the *matter* in a carrot when a rabbit eats it?
- Where did the matter in the carrot originally come from? *(Hint: you may want to return to Mapping a Garden Food Web if you're having a hard time answering this question)*

PAIR-SHARE: Compare your food web diagram with a partner, including the flow of matter that you added to the diagram.

- How are your two diagrams similar?
- How are they different?
- Do either of you want to change anything about your diagrams after having had a chance to talk about it? If so, take a moment to make those revisions.

DISCUSS: As a class, discuss the following questions:

- Do you think that the *matter* in an ecosystem could ever run out?
    - If yes, what do you think that would mean? How would it happen?
    - If no, why not?
- What questions do you still have about where matter comes from or goes to in an ecosystem?

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The Law of Conservation of Matter

Although matter may change form, it can never be created or destroyed. This principle is called the **Law of Conservation of Matter**.

Consider this example: imagine you make scrambled eggs. You start by cracking the eggs and whisking them together. When you pour the egg mixture into a hot pan, it transforms from a runny liquid to a wobbly solid, letting off some steam as it does. The appearance and physical characteristics of the eggs changes when you heat them, but the *amount* of matter stays the same—if you were to count the number of atoms that make up the raw egg, and the cooked egg plus steam, you would get the same number of atoms.

This principle stays true as you eat the eggs. The matter changes even more dramatically now as it gets broken down by your teeth and saliva, then your digestive system, and eventually becomes a collection of nutrients in your bloodstream—but the *amount* of matter is still the same. The number of atoms has not changed.

This principle is very important to understanding how matter gets passed between organisms in an ecosystem. When a rabbit eats a carrot, all the matter in the carrot is transferred to the rabbit. Similarly, when a fox eats a rabbit, all the matter from the rabbit's body gets transferred to the fox. As the rabbit digests the carrot or the fox digests the rabbit, their bodies will absorb some of the nutrients, and pass the nutrients they don't use as feces (poop).

And what happens to the matter that leaves the fox or rabbit as poop? If it were never to transform again, eventually the ecosystem would be full of poop, and completely run out of nutrients. **Afterall, matter is never created or destroyed—it can only change forms.** In the next lesson, you will explore the process that allows matter to continue changing forms, and for nutrients to continue cycling through ecosystems.

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Where Do Plants Get Their Matter? Part One

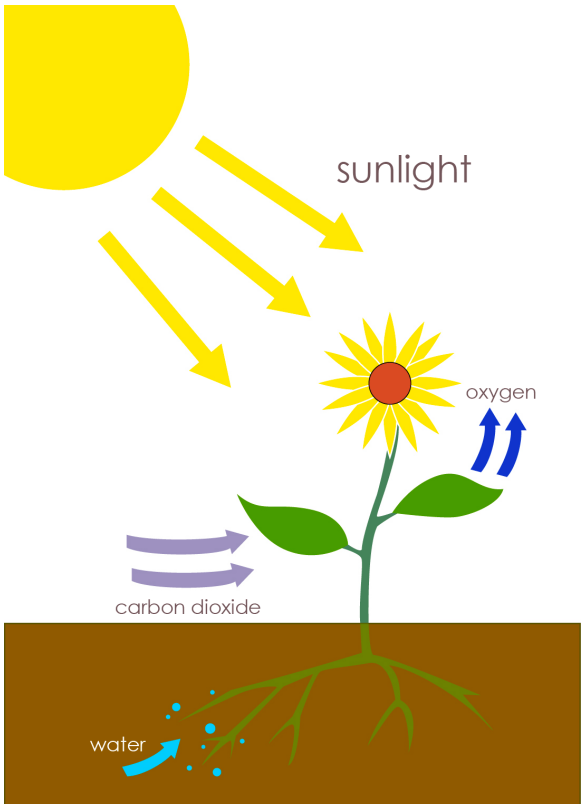
Almost every plant you've ever seen came originally from a seed*. Over time, they grew into seedlings, and then full-grown plants. Every plant will continue to grow until it dies. But where did the matter that makes up these plants come from? And where will the matter that makes up the plants go when they die?

A common misconception is that the matter in a plant comes from the soil. However, if this were true, wouldn't there be a big hole around every plant we, see? Wouldn't the soil around their roots be disappearing slowly as they grew? In fact, the matter that makes up plants is mostly carbon, taken from carbon dioxide in the air. Plants take in carbon dioxide through their leaves and transform it into glucose and oxygen through the process of *photosynthesis*.

Photosynthesis

$CO_2 + H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + O_2$

carbon dioxide + water + sunlight → glucose (sugar) + oxygen



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Where Do Plants Get Their Matter? Part Two

Plants use some of this glucose as a source of energy for the basic activities that keep them alive and allow them to reproduce. (This process is called *cellular respiration* and is something all living things do). But the rest of the glucose they don't use as energy gets broken down and recombined into complex molecules that form their structures, such as leaves, stems, branches, and roots, as well as fruits, seeds, nuts or vegetables.

Although the majority of a plants' mass is made of carbon from carbon dioxide, it is also important to note that the water and nutrients from the soil are essential to a plants' growth. Water is a key ingredient in the process of photosynthesis, and the nutrients a plant gets from the soil are also essential building blocks for many of the molecules that allow a plant to survive. Finally, a soil acts as an anchor for the plant through its roots. However, while soil plays a critical role in a plants' ability to survive and grow, the majority of a plants' matter comes from carbon dioxide in the air.

*A few exceptions include: (1) plants like ferns and mosses, which grow from spores, (2) plants that grow from cuttings (like cacti and many vines), (3) plants that grow from tubers (like potatoes), and (4) plants that grow from rhizomes (like bamboo, ginger, and rhubarb).

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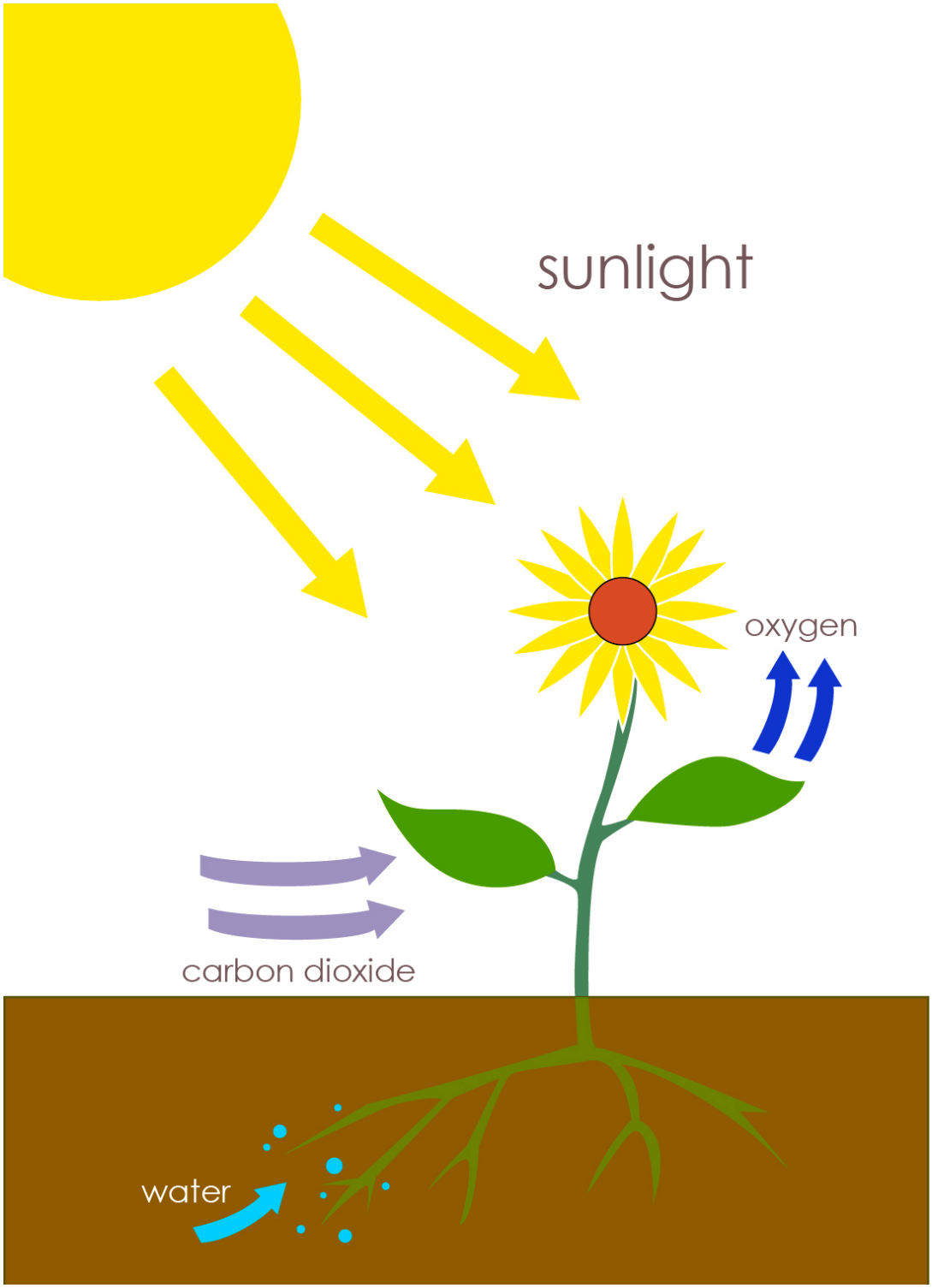

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