ALL for Science™
Authentic Literacy and Language for Science

Baylor College of Medicine
CENTER FOR EDUCATIONAL OUTREACH

DAY 5: How Is Matter Recycled in an Ecosystem?

MINI-LESSON

Teacher introduces the features of a diagram and how to interpret the information a diagram contains.

SCIENCE INQUIRY CIRCLES

Teams work on answering their Inquiry Chart questions about their food-disposal method.

GUIDED SCIENCE INVESTIGATIONS

Learners use their Soil Dwellers game cards and Tracking Log to explore how matter is transferred in soil ecosystems.

ABBREVIATED STANDARDS

- ELA and Reading TEKS: 5.10(C)
- CCSS: W.5.7
- NGSS: 5-LS2-1, LS2.A, LS2.B
- TEKS: 5.1(A)(D)(E), 5.3(B), 5.5(D)(E)(F), 5.12(A)(B)

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Day 5: How Is Matter Cycled in an Ecosystem?

Literacy Strategy: Identifying and interpreting diagrams

Science Concept: Food chains provide the mechanism for matter to cycle through complex food webs.

Science and Literacy Connection: Scientists often read diagrams (e.g., food chains and webs) created by other scientists to represent complex processes and systems.

Mini-Lesson (15 minutes)

OVERVIEW

A *model* is a representation of a system of interrelated ideas, events, or processes. The representation may take many forms. For example, models may be diagrams, mathematical formulas, chemical equations, computational programs, or physical models. In this lesson, we focus on one common type of model used to convey information in scientific texts: the diagram. A *diagram* is a model that represents a complex process or system. For example, a food web is a model that represents the complex process of energy transfer among various organisms in an ecosystem.

Scientists use diagrams to represent complex processes and systems within the scientific texts they write. As such, reading scientific texts involves making sense of diagrams. Yesterday we learned how to synthesize written words and visual representations in a scientific text. Today, children learn to recognize the features of a diagram and interpret the information a diagram contains.

MATERIALS

Teacher needs:

- chart paper
- marker(s)
- "Identifying and Interpreting Diagrams" anchor chart as a model
- model Inquiry Chart

PROCEDURE

The *italicized statements* below offer suggested wording the teacher may choose to use in the lesson.

Tell what the strategy is (declarative knowledge)

1. *Today we're going to learn how to recognize the features of a diagram and interpret diagrams. Diagrams are types of models that we often encounter when reading scientific texts.*

Tell when and why to use the strategy (conditional knowledge)

1. *When I see a visual representation in a scientific text, I look for features of a diagram to determine if the visual is, in fact, a diagram or if it is something else.*
2. *This is an important strategy because I interpret a diagram differently than I would interpret another kind of visual, such as a labeled drawing or a photo. I have to recognize diagrams before I can use my strategies for interpreting them.*
3. *If I am sure that the visual representation is a diagram, I can interpret the diagram: I ask myself, what is this diagram telling me about a complex process or system?*

Tell how to use the strategy (procedural knowledge)

1. *When I am reading and I see a reference to a visual element or I see a visual element that might be a diagram, the first thing I do is stop to look more closely.*
2. *Then I look for the features of a diagram:*
    - *Diagrams sometimes include titles and captions.*
    - *Diagrams usually include labels.*
    - *Diagrams often include arrows to represent a process. This is different from when an arrow is used to point to or identify something, as in a labeled drawing.*
    - *Diagrams can be two dimensional (flat, 2D) or three dimensional (3D).*
3. *If the visual element includes labels and arrows that represent a process, it is probably a diagram.*
4. *Then I think about what each of the elements of a diagram are and how I use them to help me understand the diagram and the information it is conveying to me.*
    - *What do the title and captions tell me?*
    - *What do the labels tell me?*
    - *What do the arrows represent?*

Model the Strategy

Use page 1 of this text to model the strategy: How Can We Recycle Plastic Sustainably?

1. *First I start by reading the text. I was reading this scientific report about finding better ways to recycle plastic. In the introduction, the authors told me that melting plastic down and reshaping it isn't the best way to recycle plastic because you can only recycle it a few times. The authors said they were investigating a better way to recycle. They call it "closed loop recycling." At the end of the introduction, I see "(Fig. 1)" written in the text. This is the author telling me to read Figure 1. Scientists often refer to visual representations in their writing as "figures." I find Figure 1 on the page and stop and look more closely at the visual representation.*
2. *I recognize the features of a diagram.*
    - *I notice a caption at the bottom.*
    - *I notice labels: "enzyme breakdown," "broken down molecules," "plastic production," and "plastic."*
    - *I notice arrows that represent a process—steps in a recycling process.*
    - *I notice that this representation is two dimensional.*
3. *I conclude that this representation is a diagram because it has several features of a diagram.*
4. *Then I interpret the diagram. I think about each element of the diagram and ask myself what information they convey to me.*

- *The caption at the bottom explains what the image is showing me: The image shows me a certain kind of process for recycling plastic. This kind of recycling is called "closed-loop recycling."*
- *The images and labels together show me what the material looks like at each step in this process of recycling plastic. At one point in the process, plastic molecules are packed closely together to form an object, like a plastic food container. At another point in the process, plastic molecules are broken down into separate molecules.*
- *The arrows show me the direction of the steps in the recycling process and, because the arrows point in a circle, I understand that this process happens as a cycle—over and over. This recycling process involves plastic items being produced, enzymes breaking down plastic into separate plastic molecules, and combining those molecules again to produce new plastic items.*

5. *After I interpret the diagram, I might also use my strategy for intratextual synthesis to make sense of the diagram and the words in the report together.* (Direct learners to "Intratextual Synthesis" anchor chart from the previous mini-lesson and remind them of the strategy, if needed).

Optional Practice

If learners need more practice recognizing the features of a diagram, you can provide either of the texts below and invite them to assess the visual representations using criteria from the mini-lesson. In each text, there is only one visual representation that is a diagram. They might also read the reports and practice interpreting diagrams.

- Can We Use Bacteria to Make Renewable Rocket Fuel? (Figure 1 is a diagram)
- How Do Some Fungi Turn Insects into Zombies? (Figure 1 is a diagram)

Science Inquiry Circles (30 minutes)

OVERVIEW

Scientists often work in teams when conducting inquiry and investigations. Today learners will work in inquiry circles to investigate different questions about their food-disposal method, how schools reduce their food waste using this method, and what happens to the organic matter and stored energy in the food scraps. Prior to starting the inquiry circle work, be sure to have texts and technology available for your learners. Remember, the "Food Waste Resources" spreadsheet contains a list of suggested books and media, but feel free to use other resources.

You may need to provide learners with specific instructions on how to access websites within your school district, or you may want to create a click sheet of approved websites for learners to be distributed through your learning management system (Google Classroom, Schoology, etc.).

MATERIALS

Each team needs:

- team Inquiry Chart
- pencils

- preselected informational texts/media

Teacher needs:

- "Food Waste Resources" spreadsheet for ideas

PROCEDURE

The *italicized statements* below offer suggested wording the teacher may choose to use in the lesson.

Before Inquiry Circles (5 minutes)

1. *It is time to get into our inquiry circle teams. You will be with the same team as yesterday, but we will rotate the science roles.* (Assign roles at your discretion and have the Equipment Directors gather the Inquiry Chart for their teams).
2. *You are already familiar with the Inquiry Chart and your inquiry questions. Today we will answer more questions or add additional information to a question you've already answered.*
3. *Keep in mind that you might develop new questions as you are working today. If your team develops a new question, add it to your Inquiry Chart as a new column.*
4. *As you look for answers to your questions, you will practice your roles as scientists. As scientists, you will make sure to carefully record your findings and sources on your Inquiry Chart.*

During Inquiry Circles (20 minutes)

1. *Today you will use a different book, eBook, website, or video to find answers to the question you're investigating about your food-disposal method or add information to a question you've already answered.* (You may want to show or project a blank sample Inquiry Chart or your model Inquiry Chart. Also, you may choose to be more explicit for your class and only allow them to answer one question at a time daily. Use your judgement on the level of guidance, especially in the first few days.)
2. *We have anchor charts to help guide your thinking. Do not forget to use them while working.* (Refer to today's anchor chart and the other anchor charts already introduced. Remind learners that they can use any of the reading strategies taught so far.)
3. *The Lead Scientist will guide all inquiries for the day by picking which question(s) will be answered. The Data Scientist will record on the team Inquiry Chart all source information and the answers to your inquiry questions.*
4. *Remember, it is important to record on your Inquiry Chart where you found the information (the source). You will need to carefully keep track of your sources because you will create a list of your sources at the end of your inquiry.* (Point out to learners where sources are located on the Inquiry Chart and how one source may answer multiple questions. Remind learners to record the title, author, publisher, and year of publication for all sources and to include the URL for websites and videos.)
5. At this point, teams might have information under multiple questions and from multiple sources. You may need to remind teams that **information in the same row is from the same source and information in the same column pertains to the same question**. One source might answer multiple questions.
6. *Everyone should help find the answers to the questions online and in texts.* (Remind learners how the Inquiry Chart will organize their progress.)

7. *My role is to help guide the inquiry circles, but I expect you to work as a science team to solve your problems together.* (While teams are working, walk around the room to facilitate as needed.)

After Inquiry Circles (5 minutes)

1. *As we conclude our inquiry circles for today, each team will have a chance to share the information they found related to their questions, what they accomplished, and what literacy strategies they used. The Lab Director will lead the discussion about today's results. What has the team learned? What problems did the team encounter? How did the team resolve those problems? Did the team use a reading strategy? Which one and how did it help? What new questions does the team have?*
2. After you have allowed the teams to gather their thoughts, have the Data Scientists share with the class. Try to encourage teams to share a variety of things—you do not want just facts about food waste, just reading strategies, or just cooperative learning strategies.
3. After all learners have shared, thank them for their hard work, and point out any practices of scientists you observed. If you saw an outstanding example of using a reading strategy or collaborative work, explicitly point it out. If you notice any problems in the teams during the lessons, take a moment to point them out, and explain your expectations for all future inquiry circles. Collect all Inquiry Charts or have learners put them in their normal classroom place for ongoing work so they can easily access them.

Guided Science Investigation (30–45 minutes)

OVERVIEW

Learners use the Soil Dwellers game from the previous day to explore and discuss how matter is transferred in soil ecosystems.

GUIDING QUESTIONS

How do producers and consumers cycle matter through an ecosystem? Why is decomposition important to a soil ecosystem? Who does the decomposing?

BACKGROUND INFORMATION FOR THE TEACHER

Today, learners take a closer look at how producers and consumers form food chains, which facilitates the cycling of matter through complex soil food webs. While food chains allow energy to flow and matter to cycle through ecosystems, it's the work of decomposers that transforms matter back into inorganic forms, making it available for recycling within an ecosystem. Decomposition occurs as decomposers break down organic matter, carcasses, and feces by feeding on them. This recycling of energy and matter (nutrients) in the soil is vital for sustaining terrestrial plants and important bacteria, and, in turn, most food webs.

In nature, scavengers like birds and mammals consume the larger portions of dead animal and plant material, breaking it down into smaller pieces. Macroorganisms you can see, such as centipedes, ants, snails, and earthworms, are detritivores that grind, tear, and chew materials into smaller particles. Other

microorganisms, such as bacteria and fungi, are decomposers that play a key role in breaking down organic material through metabolic processes.

The focus for today will be on how matter is cycled through food chains and food webs. Energy transfer will be discussed in the next lesson.

DAILY OBSERVATIONS

Each day, teams will examine their bottles and record observations in their Investigation Journals. Observations can be made at any time of the day.

SAFETY

- Remind learners not to shake the bottles or move them in a way that disturbs the layering.

MATERIALS

Each team member needs:

- Investigation Journal
- pencil
- colored pencils or crayons

Each team needs:

- bag of Soil Dwellers game cards (collected on Day 4)
- Tracking Log
- "Which Does Not Belong?" page

Teacher needs:

- Soil Dwellers game cards
- Soil Dwellers teacher key
- "Which Does Not Belong?" page
- "Which Does Not Belong?" teacher key
- index cards
- marker

SETUP

- Prepare an area or floor space where all can sit in a circle to view the game cards
- Label index cards as follows (1 each): PRODUCERS, PRIMARY CONSUMERS, SECONDARY CONSUMERS, and HIGHER-LEVEL CONSUMERS. Use the teacher key provided to list the organisms under each category on the appropriate card.
- Make copies of the "Which Does Not Belong?" page (enough for **pairs of learners**).

PROCEDURE

The *italicized statements* below offer suggested wording the teacher may choose to use in the lesson.

Engage

1. Gather the class on the floor in a circle. Begin by reminding them of the game they played in the previous class. *In the last class session, we used a model of a soil ecosystem to "meet" the producers and consumers that make up important food chains in the soil environment.*

2. Explain that models are used in science to help us understand objects, systems, or events that are difficult to observe directly in nature. In our investigations, we are using the modified Winogradsky columns as models. Add that models have limitations but can provide useful information in the form of physical, visual, or even mathematical representations.
3. The Soil Dwellers game modeled how food chains transfer matter (food) from one organism to another. This is something we cannot directly observe. By using images of the producers and consumers to "act out" how a food chain works, we can understand the process better.
4. *You were probably already familiar with many of the organisms in the game, but can anyone share the name of an organism that was new to them?* Accept responses and let learners know that they may learn more about these organisms in the days to come.

Explore/Explain

1. Ask the teams to make a row with their game cards in the order they collected them (L–R). They can use their Tracking Log to make sure they have the correct order. Explain that this will represent a food chain.
2. Let them know that if they went back to START, that begins a new food chain.
3. Ask the Lead Scientist for each team to describe what happened as the organisms moved through their food chain, beginning with the first organism in their chain.
4. As they share, ask, *how is "matter" being passed from one organism to the other?* (Organisms consuming each other.) *What other changes can matter undergo?* (Organisms can decompose or become waste.)
5. When all teams have shared, show them the "PRODUCERS" index card, and call out the names of the producers that belong on this level. *Can anyone explain why these organisms are called producers?* (Produces are capable of making their own food.) Lay the "Producers" index card down to begin a row.
6. Explain that with a few exceptions, most food webs are powered by the Sun. Most producers, like the plants in our game, make their own food for other organisms to consume. They are the base of the food chains in an ecosystem. In the soil food web, plants are available as decaying leaf litter or plant roots.
7. Hold up the index card labeled "PRIMARY CONSUMERS." *Why are these organisms called primary consumers?* (Because they eat producers or other consumers.)
8. Clarify that consumers cannot make their own food and must eat plants or animals. Herbivores are consumers that depend on plants for food; carnivores eat other living animals; and omnivores eat both plants and animals.
   Primary consumers in our soil ecosystem include decomposers and root feeders, the small organisms that primarily feed on the roots of plants. There are many primary consumers in the soil ecosystem. Identify the organisms listed on the card, then place the "PRIMARY CONSUMERS" card next to the "PRODUCERS" card.
9. Proceed to the "SECONDARY CONSUMERS" index card and identify the organisms by name. *What do these consumers eat?* (They primarily eat the decomposers and root feeders. Place the "SECONDARY CONSUMERS" card next to the "PRIMARY CONSUMERS" card.
10. Finally, show the "HIGHER-LEVEL CONSUMERS" index card and identify the organisms by name. *What do these consumers eat?* (They eat both primary and secondary consumers.) Place this card next to "SECONDARY CONSUMERS" card.

Elaborate

1. After all the components in the food chains have been identified, have them check to see if they have laid out the images they collected in the correct order of a food chain.
2. *What do you think happens when organisms in the soil ecosystem are decomposed or become waste? What happens to the "matter"?* Accept responses and prompt them to justify their answers by asking, *Why do you think that? How do you know?*
3. Explain that in the soil ecosystem, plants are the producers. The primary consumers digest the decaying leaf litter and roots from these plants. Secondary consumers feed on the primary consumers, while higher level consumers feed on them. The parts of the food all consumers can't digest or do not use to carry out their life processes are eliminated as waste, which can be broken down or eaten by other organisms, who can get the nutrients they need from the matter contained in the waste. Decomposers or detritovores are special consumers that play a crucial role in the soil ecosystem by breaking down dead, decaying matter and organic waste. In the process of decomposition, valuable nutrients are recycled and returned to the soil re-use by producers.
4. Detritivores are animals that physically break down dead organic matter into smaller particles by eating it. Decomposers secrete substances to chemically dissolve organic matter to absorb and recycle nutrients. Saprophytic fungi are one good example of a decomposer. Chemicals released by thread-like hyphae break down organic matter and release important nutrients back into the soil. (**NOTE:** Some mushrooms are saprophytic fungi, but technically the term *mushroom* refers to the fruiting body part of the organism.)
5. Explain that in our model soil ecosystem, matter in the form of plant roots and decaying leaf litter gets broken down by primary consumers like decomposing bacteria and their relatives, or by detritivores like pill bugs. In turn, these organisms provide food (matter) for secondary consumers, and ultimately the higher-level consumers like birds or moles. In this way, matter (living or dead organisms and their waste) is cycled through the food chains that support each other and make up the soil food webs.
6. Through the decomposition of organisms, the soil is enriched and important nutrients are provided for plants, to continue the cycle of interdependence between the producers and consumers in the soil food web.

Evaluate

1. Instruct learners to find a partner for a Think, Pair, Share activity.
2. Distribute the "Which Does Not Belong?" page (1 for each pair of learners).
3. Explain that pairs are to read through the lists on the page, decide together what does not belong on each list, and cross it out.
4. Allow 2–3 minutes, then ask pairs to share and justify their answers.

Science Language

- A **food chain** describes the sequence of who eats whom that transfers energy between organisms.
- A **food web** is made up of many different food chains in a single ecosystem.
- **Producers** make their own food from simple substances and energy from the Sun. Plants are producers.

- **Consumers** cannot make their own food. They get their energy from eating producers and other consumers.
- **Bacteria** are organisms so small they can only be seen through a microscope. Some are decomposers that break down dead organisms. **Aerobic bacteria** need oxygen to live. **Anaerobic bacteria** do not.
- **Fungi** are a group of decomposers that feed on decaying matter. Mushrooms are a type of fungi.
- An **ecosystem** is a community of organisms that live and interact with each other and their nonliving environment.
- **Detritivores** are animals that physically break down dead organic matter into smaller particles as they eat it.
- **Decomposers** secrete substances to chemically break down organic matter and recycle nutrients from the decaying material.
- **Nutrients** are nourishments and substances found in food that help organisms survive and grow.
- **Models** in science help us understand objects, systems or events that are difficult to observe directly in the natural world.

Expanded Standards

English Language Arts and Reading TEKS

5.10(C) analyze the author's use of print and graphic features to achieve specific purposes.

CCSS

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

NGSS

5-LS2-1 A system can be described in terms of its components and their interactions; **LS2.A**: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. **LS2.B** Matter cycles between the air, water, and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

Science TEKS

5.1(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations; **(D)** use tools, including calculators, microscopes, hand lenses, metric rulers, Celsius thermometers, prisms, concave and convex lenses, laser pointers, mirrors, digital scales, balances, spring scales, graduated cylinders, beakers, hot plates, meter sticks, magnets, collecting nets, notebooks, timing devices, materials for building circuits, materials to support observations of habitats or organisms such as terrariums and aquariums, and materials to support digital data collection such as computers, tablets, and cameras to observe, measure, test, and analyze information; **(E)** collect observations and measurements as evidence; **5.3(B)** communicate explanations and solutions individually and collaboratively in a variety of settings and formats; **5.5(D)**examine and model the parts of a system and their interdependence in the function of the system; **(E) i**nvestigate how energy flows and matter cycles through systems and how matter is conserved**; (F)** explain the relationship between the structure and function of objects, organisms, and systems; **5.12(A)** observe and describe how a variety of organisms survive by interacting with biotic and abiotic factors in a healthy ecosystem; **(B)**predict how changes in the ecosystem affect the cycling of matter and flow of energy in a food web.