ALL for Science™
Authentic Literacy and Language for Science

Baylor College of Medicine
CENTER FOR EDUCATIONAL OUTREACH

DAY 12: How Else Can We Dispose of Waste?

STARTING THE CULMINATING ACTIVITY

Teacher introduces the two-part culminating project for the unit: the scientific report and the letter of recommendation to a school official.

GUIDED SCIENCE INVESTIGATIONS

Teams analyze waste decomposition and disposal methods in preparation for the culminating activity.

ABBREVIATED STANDARDS

- ELA and Reading TEKS: 5.11(A)
- CCSS: W.5.2(A)(D)
- NGSS: LS2.B
- TEKS: 5.1(A)(D)(E), 5.3(B), 5.5(E)(G), 5.11, 5.12(A)(B)(C)

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Day 12: How Else Can We Dispose of Waste?

Literacy Strategy: Writing scientific reports

Science Concept: There are many methods of waste disposal, each with beneficial and negative impacts on the environment. The successful cycling of matter and transfer of energy in the decomposition of organic waste depends on the conditions imposed by the different methods.

Science and Literacy Connection: As scientists, learners will begin writing scientific reports about a method of food disposal.

Starting the Culminating Activity (45 minutes)

SUMMARY OF WORK THUS FAR

During this unit, learners have been reading about schools around the U.S. that are reducing their food waste. Learners have worked in inquiry circles to investigate different methods for disposing of food waste and how matter cycles and energy is transferred within these food-disposal methods. They have also conducted science investigations to explore how microorganisms participate in the cycling of matter and transfer of energy in living systems. By this point, teams have already completed their Inquiry Charts, organized their reference lists, and collected useful information in their Investigation Journals. They have also a begun a diagram detailing matter cycling and energy transfer in their food-disposal method. Today, teams will begin drafting a scientific report on the food-disposal method they have been investigating and their ideas for reducing food waste at their school; they will also compete their diagrams and consider where to place these diagrams in their science reports.

OVERVIEW OF THE CULMINATING PROJECT

The culminating project for this unit consists of two parts: (1) each team will create a scientific report on the food-waste disposal method they have been investigating and their ideas their ideas for reducing food waste at their school, and (2) learners will participate in a whole-class discussion to combine their knowledge about existing solutions to food waste and make a recommendation about reducing food waste in their school; they will send this recommendation letter to the school principal (or other appropriate school official).

Learners will spend today and tomorrow working on their reports and diagrams and making connections between their text-based inquiry and science investigation. About 45 minutes of work time is recommended for today (the same amount of time you would normally spend on a mini-lesson followed by Inquiry Circle time). Tomorrow, about 90 minutes of work time is recommended. After the two days of preparation, there will be one day for presentation of the reports and one additional day for a whole-class discussion and drafting of a recommendation letter to a school leader.

GUIDING QUESTIONS FOR THE CULMINATING PROJECT

Here are some guiding questions you might want to pose for the teams to respond to:

- How are schools around the U.S. transferring organic matter (food scraps) from the school to somewhere else so that its stored energy can be used by living things?
- What did you learn about your food-disposal method that might help reduce food waste at their school?

MATERIALS NEEDED

- Investigation Journals with all documents, notes, etc.
- team Inquiry Charts
- access to materials for handwriting or typing a report
- access to materials for drawing diagrams or creating diagrams digitally

PROCEDURE

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

Getting Started: Revisiting the Culminating Project

1. *Over the past few weeks, you have been becoming experts on the cycling of matter and energy through living systems. Your expertise will help you design a solution to reduce the food waste at our school.*
2. *During this unit, we have been reading about schools around the U.S. that are reducing their food waste. In your teams, you have been investigating one method for transferring food scraps from the school to somewhere else so that other living things can use the energy stored in the food scraps. You have also been participating in science investigations about microorganisms and how they contribute to the cycling of matter and transfer of energy in living systems. You are ready to begin writing a report describing what you learned about your method of disposing of food scraps and your ideas for reducing food waste at our school. Then as a class, we will combine our knowledge about existing solutions to food waste and will make a recommendation about reducing food waste in our school; we'll send the recommendation to our principal* (or other appropriate school official)*.*

Preparing for the Culminating Product: Review the Genre of Scientific Reports

1. *Let's remember what we learned about how scientists write scientific reports.* (Refer back to the "Exploring the Genre of Scientific Reports" anchor chart from the mini-lesson on the genre of scientific reports). *Scientists write reports to share their investigations. When scientists write reports, they . . .* (elicit responses from learners that approximate the three genre features below):
    - *use technical vocabulary to describe scientific information;*
    - *use visual representations to help the reader understand their investigation; and*
    - *organize their reports into sections with headings.*
2. *Let's review what scientists include in scientific reports. As we talk about each section, think about your own investigation.*
    - *An introduction is where the author explains the topic of the investigation and the research questions the author wants to answer.*
        - *What can you tell us about food waste, matter cycling, and energy transfer?*
        - *What were your inquiry questions?* (These are listed on their Inquiry Charts.)

- A methods section is where the author describes how they conducted their investigation and collected their data.
    - *How did your team collect data (e.g., reading, observing, recording, measuring)?*
    - *What were your data sources (e.g. eBooks, websites, articles, videos, your science investigation)?*
- *The results section is where the author makes claims that answer the research questions and gives evidence to support those claims.*
    - *What claims can you make that answer your inquiry questions? It would be helpful to look back at your synthesis statements from Day 10.*
    - *What evidence from your reading and your science investigation supports your claims?*
- *The discussion is where the author interprets the data collected and draws conclusions about how the data answers the research questions.*
    - *What conclusions can you draw about how schools around the U.S. transfer organic matter (food scraps) from the school to somewhere else so that its stored energy can be used by living things?*
- *A conclusion where the author makes a final statement about why the study is important and what the reader should learn from the report.*
    - *What did you learn about your food-disposal methods that might help reduce food waste at our school?*
    - *What would you like leaders at our school to know about ways to reduce food waste?*

NOTE: Many scientific reports also include an abstract at the very beginning of the report: the abstract is a short summary of the report. If time allows, you might invite learners to write an abstract to summarize their report.

Starting Work on the Culminating Project

1. *As a team, you will work together to write one report. You will want to make sure that your report demonstrates what you know about your method of food disposal and how matter cycles and energy is transferred within food disposal methods.*
2. *You have also been working on a diagram that explains how matter is cycled and energy is transferred in your chosen food-disposal method. You should also plan to finish your diagram showing matter cycling and energy transfer in your food disposal method and include this in your report. Consider where in your report you would like to include your diagram when it is complete. You have time to work on your report and your diagram today and tomorrow. In two days, you will share your report, including your diagram, with the class.*
3. *Remember that scientists use technical (or scientific language) because this language allows them to be specific and accurate. Scientists also translate their expertise in ways that nonexperts can understand. One way they do this is by explaining the scientific words and concepts they include so that everyone can understand what they mean. As you begin writing your reports, think about all of the scientific language you read in your inquiry circles and used when talking about your science investigations—this might be language you use in your writing.*
4. *As you start your reports, you have some decisions to make:*
    - *What information will you include in the report?*

- *What technical words and phrases might you need to include in your report? How will you explain what these words and phrases mean so that your audience can understand?*
- *What claims will you make and what evidence from text-based inquiry or science investigations can support the claims?*
- *How will work be shared in your team? Who will do what?*

5. *As you begin working on your reports, I expect you to work as a scientific team. Be sure to use the data you collected in your inquiry circles and science investigations, including your Inquiry Charts, Investigation Journals, and any resources you used during your investigations.*
6. *Also include your Reference List Graphic Organizer with your report.*
7. After the project has been explained and questions have been answered, learners should be working on their reports during the time remaining.
8. As learners work on their reports, move among the teams to offer support and guidance as needed and ask questions about their work.

Guided Science Investigation (30–45 minutes)

OVERVIEW

Learners take a critical look at the different methods of waste decomposition and disposal in preparation for a culminating activity.

GUIDING QUESTIONS

How do different waste disposal methods decompose matter? What is anaerobic digestion? What is the best disposal process for the transfer of energy from organic matter to consumers and the environment?

BACKGROUND INFORMATION FOR THE TEACHER

In a process called *anaerobic digestion*, bacteria break down organic matter in the absence of oxygen. Anaerobic digestion occurs in nature and in landfills, but the process can be optimized and controlled using an airtight vessel called a reactor, or digester. In this way, anaerobic digestion can more efficiently recycle organic materials into usable products.

A complex microbial community breaks down, or digests, organic waste material in the reactor to convert it into biogas and digestate. Biogas is a mixture of methane, carbon dioxide, and small quantities of other gases. Biogas can be used to produce heat and electricity. It can also be refined into a renewable natural gas (RNG) and used in place of fossil natural gas to provide fuel for vehicles.

Digestate is a solid and liquid material that remains after the digestion process. It can be used as fertilizer, reducing the need for chemical fertilizers, and as livestock bedding or soil amendments. Importantly, digestate contains all the recycled nutrients present in the original organic material in a form more readily available for plants and soil improvement. The raw materials, or feedstock, added to the digester determine the nutrient content and composition of the resulting biogas or digestate. These materials include animal waste, wastewater sludge or sewage, food waste, and other organics. Raw materials can be digested together or by themselves.

The benefits of anaerobic digestion include reducing the amount of greenhouse gases and the risk of pollution to waterways from animal waste. However, there are disadvantages to using anaerobic digesters, including their high cost to build and maintain, the large space and ongoing maintenance they require, the lengthy decomposition process that must be carefully controlled, the potential health risks for those who service them, and the possibility of environmental pollution and toxic spills.

DAILY OBSERVATIONS

Teams will make their last daily observations of their bottles and record information in their Investigation Journals. Observations can be made at any time of the day.

SAFETY

- Remind learners not to shake the bottles during observations 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:

- 1 copy of "Anaerobic Digestion " infographic
- Managing Waste Chart

Teacher needs:

- "Anaerobic Digestion" infographic
- "Apple" image

SETUP

- Prepare to project the "Anaerobic Digestion" infographic and the "Apple" image at the appropriate times.

PROCEDURE

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

Engage

1. On the whiteboard, write the word "anaerobic." *Where have we used or seen this word before?* Accept responses and listen for mention of decomposition, an environment without oxygen, or layers in the bottles they have been observing. Validate or clarify responses as needed.
2. Ask learners to revisit the model diagram of their bottles made on Day 8. *Where in the bottles does an anaerobic environment exist?* (Toward the bottom.) Explain that the concentration of oxygen is highest in the overlying air at the top of the bottle and decreases as you move down the bottle, where only anaerobic bacteria can live.
3. *Is there evidence that bacteria and other microorganisms are alive in this environment*? (Yes, the presence of gas bubbles provides evidence of life processes occurring even in the absence of oxygen.)

4. Ask them to identify the energy source in their bottles (organic matter, e.g. egg yolk, newspaper) and the consumers (bacteria and other microorganisms) that are obtaining from it. State that the bottles are microenvironments where the byproducts of decomposition from one group of organisms supports the growth of another. In other words, there is a transfer energy and cycling of matter both between consumers and their environments with or without the presence of oxygen.
5. *In what type of waste management on your Waste Management Chart can we find anaerobic decomposition?* (Landfills.) *How can energy transfer occur in a landfill?* (By capturing methane gas and using it to generate energy at a power plant.)

Explore/Explain

1. Announce there is another way to manage waste under anaerobic conditions. Project the "Anaerobic Digestion" infographic. Explain that this special form of waste disposal, anaerobic digestion, is conducted by different types of bacteria and other microorganisms in special containers or vessels called digesters.
2. Emphasize that in this type of waste management system, bacteria and other microorganisms are the consumers that "digest" the organic matter that contains stored energy.
3. Point out the different types of waste that can be put either together or alone into a digester: animal waste, wastewater solids (sewage), food waste, and other organics, such as fats, oils, grease, crop residue (materials left in agricultural fields or orchards after crops have been harvested), and brewing waste. All of these are considered feedstock, or the raw materials that are added to the digester and decomposed by the microorganisms.
4. Add that the good news is that, unlike landfills, anaerobic digesters can transfer energy and cycle matter back into the environment in the form of biogas and digestate. Describe how this occurs using the "Anaerobic Digestion" infographic.
5. End with a discussion of the disadvantages of anaerobic digestion, including the large space and ongoing maintenance they require, the lengthy decomposition process that must be carefully controlled, the potential health risks for those who service them, and the possibility of environmental pollution and toxic spills.
6. Then, on the whiteboard, write "SO WHAT?" *What are your thoughts about anaerobic digestion? Looking over all the different methods of waste disposal, what do you now think are the best options available?* Accept responses from volunteers and ask them to justify their answers.

Elaborate

1. On the whiteboard, write "WHAT ELSE?" Project the "Apple" image. *Looking at this image, which apple do you expect would end up in the garbage? What if the apple on the left was a leftover from a school lunch, a grocery store, or a restaurant? What else could you possibly do with it? What is the best way to transfer the energy stored in the apple?*
2. Instruct learners to pair up with a partner, think and talk about these questions, then be prepared to share in 2–3 minutes.
3. When time is up, ask for their solutions. Did they consider giving the apple to someone or to an animal? If so, ask them what they should consider about food safety. *Is the "good apple" showing any signs of spoiling or decay yet? Who has handled the apple? Did they practice good hygiene? What has the apple come in contact with?* Explain that these are all valid concerns they should think about to ensure the safety and health of the recipient.

Evaluate

1. End by writing "NOW WHAT?" on the whiteboard. Explain that teams have 3–5 minutes to do a brain dump about the best way to solve the problem of food waste at their school. What options do they have? What resources do they already have to make a good decision? What other resources will they need?
2. Let them know they will spend the next several days working on their solutions to the issue of food waste at their school.
3. Remind them to consider what they have learned about the cycling of matter and transfer of energy in the process of decomposition.
4. *What has the action of bacteria and other decomposers in your bottle helped you to understand about the cycling of matter and transfer of energy? Write your answer in your Investigation Journal.*

Science Language

- **Anaerobic digestion** is a form of waste disposal conducted without the presence of oxygen by different types of bacteria and other microorganisms in special containers or vessels called digesters.
- **Biogas** is a carbon-based fuel produced when organic matter is broken down by microorganisms in a process called anaerobic digestion.
- **Feedstock** are the raw materials added to an anaerobic digester and decomposed by the microorganisms.
- A **scientific report** describes all aspects of a science investigation and research.
- Scientific **diagrams** are drawings or representations that can help us understand an object, relationship, or a process, such as the cycling of matter and flow of energy.

Expanded Standards

English Language Arts and Reading TEKS

5.11(A) plan a first draft by selecting a genre for a particular topic, purpose, and audience using a range of strategies such as brainstorming, freewriting, and mapping.

CCSS

W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. **(A)** Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. **(D)** Use precise language and domain-specific vocabulary to inform about or explain the topic.

NGSS

5-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(E)** investigate how energy flows and matter cycles through systems and how matter is conserved; **(G)** explain how factors or conditions impact stability and change in objects, organisms, and systems; **5.11** The student understands how natural resources are important and can be managed. The student is expected to design and explain solutions such as conservation, recycling, or proper disposal to minimize environmental impact of the use of natural resources; **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; **(C)** describe a healthy ecosystem and how human activities can be beneficial or harmful to an ecosystem.