Lesson 4-2
What causes changes in landfill bottles?

Lesson Overview
1. Timeframe: 4 class periods 2. Learning Performances Students construct an explanation using evidence from the investigation that microbes provide the process that causes the break down (rotting) of food materials in a landfill bottle system. Students revise a model of the landfill bottle that includes the flow of matter into and out of the landfill bottle system, and identify the cause and effect relationship of microbes and changes in properties of food materials such as rotting and smell. Students obtain information about the cause and effect relationship of microbes and changes in properties of food materials such as decomposing and smell. **SEP *Planning and carrying out an investigation***: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.* **SEP *Developing and using models***: *Develop and/or use models to describe and/or predict phenomena.* **SEP *Obtaining, evaluating and communicating information***: *Compare and/or combine information across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.* **SEP *Constructing an explanation***: *Identify the evidence that supports particular points in an explanation.* **DCI *LS2.A*** *(partial DCI): Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants (sic) parts and animals) and therefore operate as "decomposers..."* **CCC *Systems and system models***: *A system can be described in terms of its components and their interactions.* **CCC *Cause and effect - Mechanism and prediction***: *Cause and effect relationships are routinely identified, tested, and used to explain change.*

3. Overview

Day 1

- Students view a video and make observations about a rotting watermelon.
- Students make a prediction about the cause of changes in the landfill bottles.
- Students plan and complete Investigation 4-2: Agar Plate.
- Students read Article: *Decomposers in Our Environment*.

Day 2 (after allowing microbe multiplication for 2-3 days)

- Students construct an explanation about the cause of changes in the landfill bottles, including a claim, evidence, and reasoning.

Day 3

- Groups revise Model: Landfill Bottle.
- Groups present revised models to the class.
- The class revises the Class Consensus Model: Landfill Bottle.
- Students answer the DQ, *What happens to our garbage?*

Day 4

- Students think about their experiences in the unit.

Materials

For each student:

- 1 Science and engineering notebook (SEN)
- 1 Pencil
- 1 Copy of Investigation 4-2: Agar Plate (Days 1-2)
- 1 Copy of Article: *Decomposers in Our Environment* (Days 1-2)
- 1 Pair of plastic gloves
- 1 Pair of safety goggles
- 1 Copy of Self and Peer Check! Group Model of Landfill Bottle Systems (Day 3)
- 1 Copy of Thinking About *What Happens to Our Garbage?* (Day 4)

For each group:

- 1 Cotton swab
- 1 Agar plate
- 1 Plastic baggie
- 1 Permanent marker to mark the agar plates
- Food material(s) from landfill bottle
- Nonfood material(s) from landfill bottle
- Paper towels/newspaper to cover desks
- 1 Piece of masking tape to label agar plates
- Group Landfill Bottle Models from Lesson 3-3

For the class:

- Antiseptic wipes to clean desks after handling agar plates. Most bacteria in the environment are not harmful, but it's always a good idea to take precautions.

- A flat surface to hold agar plates during the 2-3 days of the investigation. (Note: If space is a problem, the agar plates can be stacked on the flat surface.)
- 1 Trash bag to dispose of the used agar plates
- Class Consensus Model from Lesson 3-3
- Video Lesson 4-2: Decomposing Watermelon (Day 1)
- Video Lesson 1-1: Virtual Landfill Field Trip (Day 3)
- Optional: A snack to share in celebrating the end of the unit

Preparation

- Provide newspaper or other paper to cover desks.
- The investigation should be timed so that students can observe the growth of microbes in the agar plates over 2-3 days.
- The agar plates are stored in the refrigerator until it's time to grow microbes. The refrigeration keeps the agar from drying out.
- For the investigation, place the agar plates upside down in a warm location (e.g., near heat or under a desk lamp, if available). A suitable location is no warmer than 98°F (37°C) and not by a window.

Safety

- Wash hands each time after handling landfill bottles, food materials, and agar plates.
- Clean desks with wipes each time after handling agar plates.
- Do not eat or drink anything while handling agar plates.
- Dispose agar plates, gloves, and swabs in the biohazard bag provided.

Introducing the Lesson

Reviewing What We Figured Out and Connecting to DQ

Ask students what new questions they added to the DQ Board last class. Call on a few students. Possible questions: *What causes changes in landfill bottles? How did the fruit change or appear to vanish? What causes the changes in smell in food materials?*

Review:

1. *We argued that matter was conserved even when food materials appeared to vanish.*
2. *We argued that the evidence that matter moved out of the landfill bottle was the smell leaving the landfill bottle and the decrease in weight of the open system landfill bottle.*
3. *We argued that materials that are mixed can react and may make a new substance like a gas.*

Remind the students that the properties of food material changed over two weeks (see Lessons 2-1, 3-1, and 3-3). Elicit student experiences with rotting food or other materials. Student observations may include food rotting, plants on the ground that are mushy, and leaves in the fall that seem to vanish.

Obtaining Information about Rotting from Video of Rotting Watermelon

Describe that people make time-lapse videos of rotting materials. Tell students that they will watch a video to answer the question, *What evidence is there that the watermelon is changing?*

Show Video Lesson 4-2: Decomposing Watermelon

Solicit student observations after the time-lapse video. Ask, *How does your observation remind you of the landfill bottle observations?* Record observations on the board.

Carrying Out the Lesson

SEN Entry: Making Predictions about the Cause of Changes in Landfill Bottle

Ask the class, *What's your prediction of the cause of changes in the food materials in the landfill bottle?*

Tell students to record their predictions about the causes of the changes in the landfill bottles in their SEN.

Describe, *Understanding the relationship between cause and effect is an important scientific idea. Cause and effect is a crosscutting concept. What are the changes that you observe in the landfill bottles?* (the smell, some materials appear to vanish, mold grows, the properties of the food materials change). *Our new question, What causes changes in landfill bottles?, is about the cause of these changes. When we figure out the cause, we can explain why these changes to garbage materials happened.*

Teacher Background: Microbes Are Everywhere, Not Just On Food Materials

 Non-food materials from the landfill bottle are also covered in microbes and start a colony on the agar plate, but more slowly than food materials. The reason some non-food materials like paper do not rot within the timeframe of this unit is that they rot more slowly than food materials under the conditions of the landfill bottle.

The idea that microbes break down dead organisms is important to this lesson and also foundational to ecosystems in Unit 2. Unit 1 builds towards constructing explanations. In prior

lessons, students made inferences from evidence and engaged in arguments. In this lesson, students construct an explanation that microbes cause food to rot or decompose.

Planning the Investigation: Agar Plate

Ask the class, *Is it possible that something very small is causing the rotting process? Something we can't see directly?*

Display the agar plate as you inform the students about the investigation. *We know that something is causing the food materials to rot. Scientists have a tool for studying what you see on the food. The tool that scientists use is called an agar plate. In fact, most people don't use it until high school. Because you are such incredible scientists, you will use it in your investigation today. We have to be very careful when we use this tool. The agar plate contains agar, a nutrient that is a food source.*

Guide students to think about the purpose of the investigation. Ask, *What is the purpose of our investigation? (Our purpose is to observe what appears on agar plates.)*

Describe the tools students will use in their investigation. *Our plan is to use an applicator* (hold up the applicator to the class) *to swab or wipe some materials and then use the same applicator to swab or wipe the materials on the agar plate. Anything growing on the food is picked up by the applicator and is transferred to the agar plate when we swab the applicator on the agar.* Ask, *What do you think we will observe on the agar plate?*

The class will determine the conditions for the investigation (below), and then each group will choose one condition. There will be an agar plate for the class to use as a control.

Possible conditions:

- Food material from landfill bottle
- Nonfood material from landfill bottle
- Finger, desk, door knob, or other objects in the classroom

Assign each group one condition to swab for Investigation 4-2: Agar Plate. Have each group record their condition on Investigation 4-2: Agar Plate.

In this investigation, place the agar plate in a baggie to minimize the agar's exposure to anything other than the swab.

As you describe the plan for the investigation, demonstrate the method for swabbing the surface of the material, e.g., soil, food material, doorknob, etc., and then swabbing the agar. See the picture sequence above.

Carrying Out Investigation 4-2: Agar Plate

Guides students through the investigation directions, as needed.

Direct students to complete Investigation 4-2: Agar Plate.

Call the students by group to the supervised teacher table to swab their landfill bottle (or other condition) and swab their labeled agar plate.

As the microbes multiply, direct students to observe the changes in the agar plate.

Teacher Background: Microbe Multiplication


Be careful about the language you use to describe the microbes. The microbes "multiply to a large number." They do not grow! What grows is the colony, which is a collection of microbes. We can see the collection of microbes, even though each individual microbe is much too small to see.

Obtaining Information from an Article: *Decomposers in Our Environment*

Ask, *How do you explain that the orange in our landfill bottles appeared to vanish? We found out that matter is conserved, so the orange vanishing is interesting. Where did it go? What is causing the orange to vanish? The article you are going to read next has information about the orange that vanished in our landfill bottles and the watermelon that rotted in the video.*

Pass out Article: *Decomposers in Our Environment*.

Have students preview the questions at the end of the article, and then read the article alone or with a partner. Provide students time to read and respond to questions posed at the end of the article.

Guide the class to the observations that:

1. decomposers break down food, like the food in the landfill bottles
2. they did not see any animal decomposers
3. microbes are causing the food to break down
4. when microbes break down food, some of the food turns into a gas and microbes produce gases

Remind the students that they are looking for the cause of the smell and the changes in properties of the rotting food materials.

Break – end of class period 1

Resume during the next class period (after allowing microbe multiplication for 2-3 days):

Comparing Microbe Conditions to Make Observations

Direct students to take out Investigation 4-2: Agar Plate. Call on students to share how they might compare and record their observations of the agar plate.

Guide students to:

- Count the number of separate blobs on the agar plate.
- Observe the differences in properties of the blobs, such as color, shape, and texture.
- Record in Investigation 4-2: Agar Plate.

Teacher Background: Constructing an Explanation


Writing a claim is a difficult task. Students may restate the plan of the investigation rather than make a claim. As students write the claim and evidence, they may include reasoning that links the evidence to the claim without realizing (see description of reasoning below).

An explanation is about cause and effect, or how or why something happened. For example, the claims developed earlier in the unit were inferences about **what** happened, not the causal relationship of **how** or **why** it happened. The goal in much of science is to develop explanations based on evidence from observations or measurements and supported by arguments using that evidence. First, we observe, record, and discuss what happens. Then, we explain how or why it happens.

In Lesson 4-2, students observe a causal agent, which allows them to construct an explanation that microbes caused the effect of breaking down food.

Constructing an Explanation: Claim, Evidence, and Reasoning

Inform students that we are going to work in groups to explain the cause of the changes based on our evidence from the investigation and the information we obtained from the article. Describe that in science when we suggest an explanation of something that we have observed in an investigation, we are making a claim.

Connect explanations to arguments, *You have made several claims as we have investigated many questions to help us answer our DQ, What happens to our garbage? For those claims you engaged in argument. Explanations, like arguments, also have claims with evidence and reasoning.*

Briefly remind the students about how to write an argument. *A claim is an answer to a question. A claim is supported with evidence. Evidence is connected to the claim when you state why you selected the evidence. With an explanation your reasoning includes the cause and its effect.*

Direct groups to write a claim and evidence for the explanation in the explanation graphic organizer in Investigation 4-2: Agar Plate. Check for sufficiency of evidence. Ask the class, *Do you have enough evidence to support the claim?* (We have enough evidence. We could test another material like an empty Mason jar. We could test nonfood materials. We could test food materials from our lunch. We could test materials that are rotting outdoors.)

Give groups time to finish writing the claim and evidence. As groups work, remind them to focus on data that can be used as evidence for their claims. Coach each group to clarify differences between claim, evidence, and purpose of the investigation. Claims are not a description of the investigation or the purpose of the investigation.

Choose an exemplar (excellent example) claim and evidence from one of the groups to share with the class.

Call the class to attention. Display the exemplar that you chose. As you copy the exemplar on the board, ask the class, *Does this claim answer the question? Does this evidence link to the claim?*

Tell the class, *An explanation is about cause and effect or why something happened. In this case, the claim you have developed is an explanation of why certain materials in the landfill bottles broke down. The explanation is based on your observations of the landfill bottles and of microbe colonies growing on the agar plates. It is an evidence-based explanation of a process. Rotting or decomposing is a process. Microbes decomposing food materials is a process.*

Now let's see if we can connect our claim to the evidence to support our explanation of why certain materials in the landfill bottle broke down. Facilitate a class discussion of how the evidence supports the claim. Ask, *How does your evidence support your claim*?

Direct students to write their own version of this reasoning in Investigation 4-2: Agar Plate. By this point in the unit, some students may no longer require the graphic organizer as support. Allow these students to write their explanations in the SEN.

INDIVIDUAL CHECK! Explaining Changes to Materials in the Landfill Bottles
Collect graphic organizer in Investigation 4-2: Agar Plate. Use the criteria outlined in Teacher Rubric 4-2 to provide specific comments to students on the feedback form at the bottom of the graphic organizer. For students who wrote their explanations in the SEN, provide the same type of feedback.

Question: What causes changes in the food materials in the landfill bottles?	
Claim: Microbes cause changes in the food materials in the landfill bottles.	
Evidence:	**Why did you include these data?**

When we swabbed the rotting food materials on the agar plate, there were blobs.	We think these blobs are microbes that multiplied to a large number.
We also read an article about how microbes that are too small to see break down food materials, causing them to decompose and produce smelly gases.	We think that microbes are what caused the food materials to decompose and produce smelly gases.
Reasoning: Since we observed blobs on the agar plate and we know that microbes break down food materials, we conclude that the blobs must be microbes that multiplied to a large number. These microbes were one of the causes of changes to food materials in the landfill bottles.	

Connecting Sub-Question to Answer the Driving Question

Ask students to connect the sub-question in this lesson to the driving question of the unit, *What did we figure out that helps answer the driving question of the unit, What happens to our garbage?*

Possible student responses:

- We just figured out that microbes break down food materials, and one of the effects is smell coming from the landfill bottles.
- We found direct evidence of microbes by observing the changes in the agar plates.
- We found indirect evidence of microbes by observing property changes in materials in the garbage, such as smell and appearance (e.g., color, texture).
- The properties of food materials changed significantly, and the materials even appeared to vanish, but they did vanish.
- Microbes cause changes we have observed in some of the garbage materials.
- Some materials, like plastic spoons and aluminum foil, do not decompose.

Break – end of class period 2

Resume during the next class period:

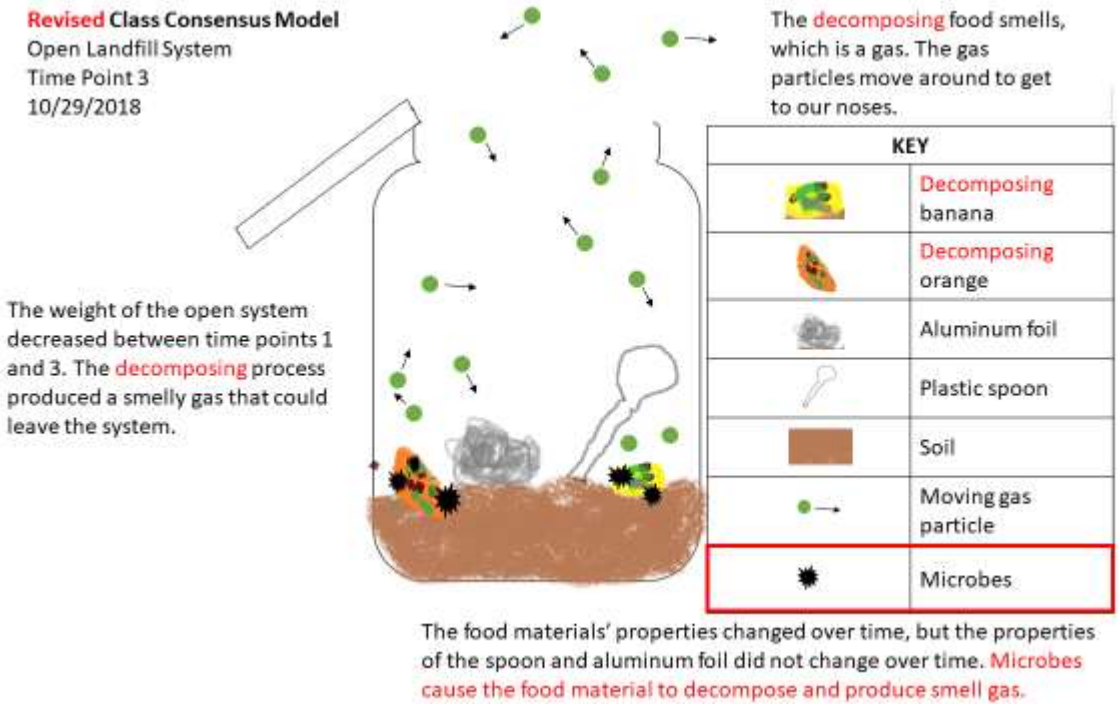
Revising Group Models to Include Microbes
Distribute group models from Lesson 3-3. Direct students in their groups to revise their landfill bottle models by including what they know about microbes' effect in the landfill bottle, including the process that microbes break down food materials. Possible teacher prompts to help students include microbes and reactions: - *How will you show microbes in your model?* - *How will you show the size of microbes?* - *How will you show that microbes cause changes in the landfill bottles?* Also, remind students about the process of the microbes. *In our model, it is important to think about the process. The cause is microbes. The effect is the decomposition of food materials.*
Presenting Group Models to Another Group
Tell students that groups will be sharing their models with each other. Each member of the group will have a part of the model to describe. Remind students, *We are all working together to reach a common understanding. Disagreements are useful because they help us think more carefully about what each person is saying. If you disagree with the claim or the evidence, state your claim and your evidence. You might have to look again at the observations you made of the landfill bottle or the agar plate.* Provide an obvious example that would lead to disagreement, *Our model shows that air is causing decomposition*. Ask for a student volunteer to suggest a way to resolve the disagreement. (Our evidence shows we had a lot of microbe growth on our food material. Let's take a look at the agar plates.) **SELF AND PEER CHECK! Group Model of Landfill Bottle Systems** Pair the groups so that one group presents to another group, e.g., group 1 presents to group 2, group 3 presents to group 4, group 5 presents to group 6. After each group presents, students complete Self and Peer Check 4-2: Group Model of Landfill Bottle Systems. Allow enough time for groups to provide feedback, resolve any disagreements, and make changes to their models, as needed.
Revising Class Consensus Model
Display Class Consensus from Lesson 3-3 and remind students that a class consensus model should take into account all the evidence from the investigations throughout the unit.

Ask groups, *Did anything surprise you in your group presentations?* Discuss unresolved arguments from the group presentations.

Next, call on students to identify additions to the class consensus model. Give students opportunities to argue. If a student presents a claim about the landfill bottle that is not supported by evidence, ask the student about the evidence for the claim.

Possible additions to the class consensus model:
- Microbes cause the changes in the food materials in the landfill bottles.
- Gas (e.g., smell) may be produced when substances mix together.
- In the open system, weight decreases because gas leaving the bottle has weight.
- In the closed system, even when properties of materials change, matter is conserved.

Sample Class Consensus Model (new additions in red):



Closing the Lesson

Answering Driving Question, *What Happens to Our Garbage?*

Call on a few students to answer the question, *Have we answered our Driving Question of the unit, What happens to our garbage?* (Yes, we found out that microbes break down or decompose food materials. We found out that some materials do not change.)

Show Video Lesson 1-1: Virtual Landfill Field Trip to review characteristics of a landfill.

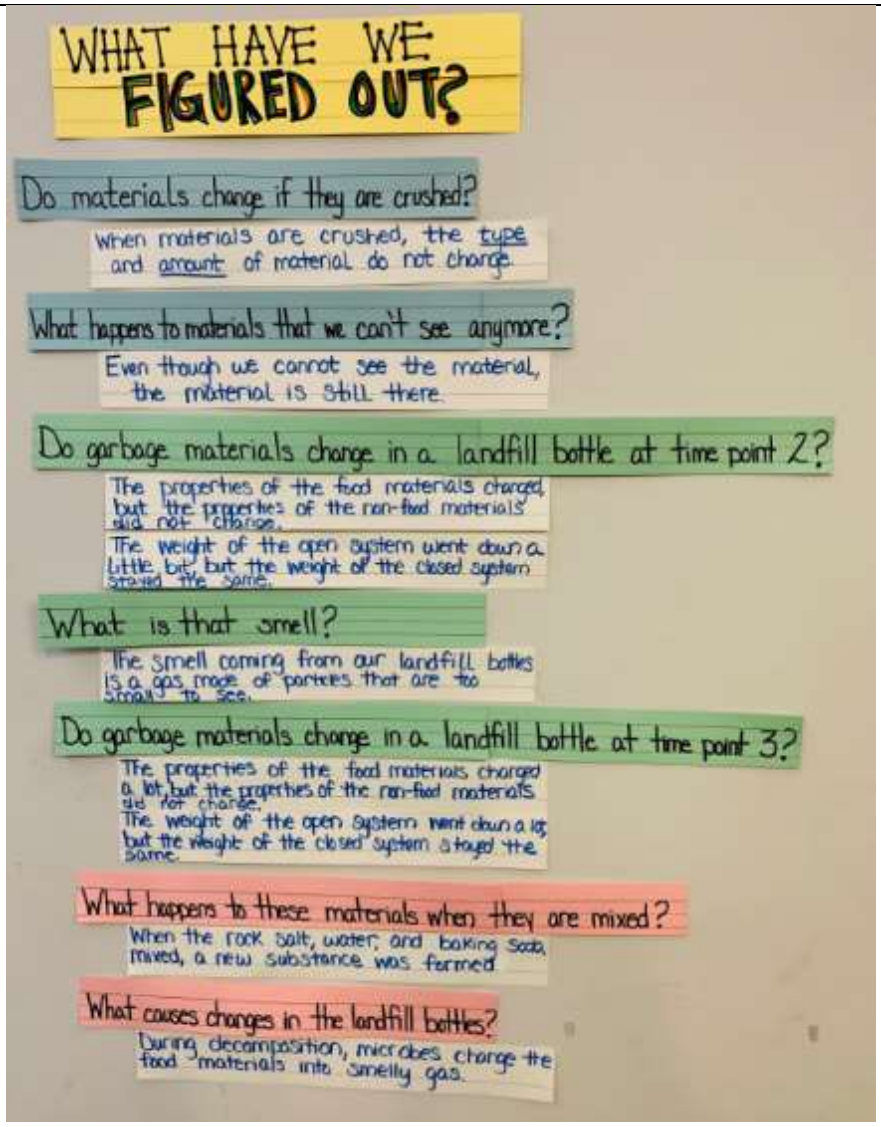
Describe that we can use the class consensus model of the landfill bottle as a thinking tool to connect what we learned with the landfill bottle to the actual landfill. Call on a volunteer to name a feature or process of the landfill bottle model. Then call on another student to describe the feature or process of the actual landfill. Fill out the chart below as students offer features or processes.

Landfill Bottle Model	Actual Landfill
Microbes break down banana and orange.	Microbes break down food.
The properties of plastic spoon and aluminum foil do not change.	The properties of plastics and metals do not change.
The landfill bottle smells because a gas is produced by microbes.	Landfills smell bad.
Materials do not vanish, but their properties may change.	Materials do not vanish, but their properties may change.

Celebrate! Tell students, *Here's something that is NOT going into the landfill today!* Pass out a snack.

Tracking What We Figured Out (optional)

Guide students to think about the sub-question of the lesson and what they have figured out so far. Create the class visual display using their responses. In addition to the class visual display, students may complete the individual graphic organizers (located in Lesson 2-2). Students can add to their graphic organizers after each lesson.



Break – end of class period 3

Resume during the next class period:

Student Culminating Activity
We are scientists who worked together to answer a very interesting and complicated question. Today we will have an opportunity to think and talk about what we have learned in this science unit, "What happens to our garbage?" First, you will write down your answers to the questions on the handout, Thinking About What Happens to Our Garbage. You do not need to use full sentences, but make sure you think about your answers carefully. After you fill out the handout you will have an opportunity to share your answers with your group, the class, and with me. Look through your SEN to remind yourself of our investigations and models. Distribute the handout and allow students time to answer the questions. *Now that you have finished writing your answers on the handout, share your answers with your group. One group member will read the first question and then each member will share their answer to that question. Then do the same for question 2.* Allow students time to share their answers with their group. When the groups have finished sharing, bring the class together and elicit responses from groups or individual students. Lead a discussion by prompting students to elaborate on their responses (e.g., *You said you learned X in this unit. Can you say more? What is cool about that?* OR *Why do you think X was your favorite activity? What did you like about it?)* End the discussion by emphasizing how much fun everyone had in science and how much they learned! Tell students to share what they learned with friends and family and that they will have an opportunity to show how much they learned in the upcoming end-of-unit assessment. ☺
Evidence Statements Lesson 4-2
LP4-2 ES Students construct an explanation: • Students make a claim that microbes cause changes in the food materials. • Students identify evidence that microbes multiply to a large number on the agar plate that is swabbed with the decomposing food material but not on the control agar plate. • Students reason that microbes break down the food materials in the landfill bottle system in the same way that the microbes consume agar. LP4-2 ES Students revise Landfill System Models to include components and processes: • Components: landfill bottle, soil, garbage materials, microbes, gas • Processes: (1) Properties of the food materials have changed, (2) These changes are caused by microbes, (3) When microbes break down food materials, gas (smell) leaves

the open system. Matter is conserved in both open and closed systems, but the open system weighs less than the closed system because gas leaves the open system.

Connections to Targeted 5th Grade NGSS Performance Expectations

5-LS2-1 (Partial) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Building Progressions

SEP *Planning and carrying out an investigation*: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*

K-2: Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.

3-5: *Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.*

Middle School: Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

SEP *Developing and using models*: *Develop and/or use models to describe and/or predict phenomena.*

K-2: Develop a simple model based on evidence to represent a proposed object or tool.

3-5: *Develop and/or use models to describe and/or predict phenomena.*

Middle School: Develop a model to describe unobservable mechanisms. Develop a model to describe phenomena.

SEP *Obtaining, evaluating and communicating information*: *Compare and/or combine information across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.*

K-2: Obtain and combine information from books and other reliable media to explain phenomena.

3-5: *Compare and/or combine information across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.*

Middle School: Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or now supported by evidence.

SEP *Constructing an explanation*: *Identify the evidence that supports particular points in an explanation.*

K-2: Make observations (firsthand or from media) to construct and evidence-based account for natural phenomena.

3-5: *Identify the evidence that supports particular points in an explanation.*

Middle School: Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

DCI *LS2.A* *(partial DCI): Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants (sic) parts and animals) and therefore operate as "decomposers..."*

K-2: Plants depend on animals for pollination or to move their seeds around.

3-5: *Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants (sic) parts and animals) and therefore operate as "decomposers..."*

Middle School: Organisms, and populations or organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.

CCC *Systems and system models*: *A system can be described in terms of its components and their interactions.*

K-2: Systems in the natural and designed world have parts that work together.

3-5: *A system can be described in terms of its components and their interactions.*

Middle School: Systems may interact with other systems; they may have sub-systems and be part of larger complex systems. Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy and matter flows within systems.

CCC *Cause and effect - Mechanism and prediction*: *Cause and effect relationships are routinely identified, tested, and used to explain change.*

K-2: Simple tests can be designed to gather evidence to support or refute student ideas about causes.

3-5: *Cause and effect relationships are routinely identified, tested, and used to explain change.*

Middle School: Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Connections to CCSS for English Language Arts-Literacy

RI.5.1: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.5.2.E: Provide a concluding statement or section related to the information or explanation presented.

SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher- led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

SL.5.1.B: Follow agreed-upon rules for discussions and carry out assigned roles.

SL.5.1.C: Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

L.5.6: Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).

Name _____ Date _____

Article: Decomposers in Our Environment

Have you ever opened the refrigerator door and immediately smelled something bad? Oops! You forgot to throw out an apple. Now the apple is rotten. What happened to the apple?

Decomposition

When materials break down into smaller or simpler parts, scientists call this process *decomposition*. The decomposition of materials causes the properties of the materials to change. For example, when you first put the apple in the refrigerator, the apple was red and fresh-smelling. When the apple decomposed, or broke down, it turned brown and smelly. Scientists have observed the decomposition of many different types of materials, including watermelons, leaves, and bread. They have noticed a pattern of changes in the properties of these materials. All of these materials change color and start to smell bad when they decompose. What causes these materials to decompose?

Types of Decomposers

Organisms that break down materials are called *decomposers*. There are two different types of decomposers: animals and microbes.

Animals

When organisms die, some animals break down these dead organisms by eating them. These animals are decomposers because they eat dead plant and animal materials. Cockroaches, earthworms, and ants are all examples of decomposers.

Cockroach

Earthworms

Ants

Microbes

Another type of decomposer is microbes. Similar to animal decomposers, microbes break down plant and animal materials by eating them. Microbes decompose these materials into small pieces that end up in the soil or in the air as gases. When microbes

decompose plant and animal materials, they release gases that smell. Remember, it was the decomposing apple that caused the refrigerator to smell so bad.

Microbes are so small that we cannot see them unless there are many in one place. Scientists use a special tool called an agar plate to observe microbes that are too small to see. Microbes on an agar plate multiply to a large number and appear as a blob. Scientists refer to these blobs as colonies of microbes. When there are colonies on an agar plate, scientists have evidence that microbes are present. Bacteria and some fungi are both examples of microbes.

Agar plate with colonies of microbes

Microbes on food materials

Microbes enlarged under a microscope

Use the article to respond to the following questions:

1. What breaks down plants and animals?

_____

_____

_____

2. What are microbes? What do they do?

_____

_____

_____

3. What makes food materials decompose in the landfill?

_____

_____

_____

4. What causes the smell in the landfill bottles?

_____

_____

_____

Nombre _____ Fecha _____

Artículo: Descomponedores en Nuestro Ambiente

¿Alguna vez abriste el refrigerador e inmediatamente oliste algo feo? ¡Oops! Te olvidaste de tirar la manzana. Ahora la manzana está podrida. ¿Qué le paso a la manzana?

Descomposición

Cuando los materiales se reducen a partes más pequeñas, los científicos llaman este proceso *descomposición*. La descomposición de materiales hace que las propiedades de los materiales cambien. Por ejemplo, cuando pusiste la manzana en el refrigerador por primera vez, la manzana era roja y tenía olor fresco. Cuando la manzana se descompuso, o redujo, se volvió marrón y olorosa. Los científicos han observado la descomposición de muchos tipos de materiales diferentes, como sandías, hojas y pan. Han encontrado un patrón de cambios en las propiedades de estos materiales. Todos ellos cambian de color y empiezan a oler mal cuando se descomponen. ¿Qué hace que estos materiales se descompongan?

Tipos de Descomponedores

Los organismos que descomponen los materiales se llaman *descomponedores*. Hay dos tipos diferentes de descomponedores: animales y microbios.

Animales

Cuando los organismos mueren, algunos animales reducen estos organismos muertos al comerlos. Estos animales son descomponedores porque comen plantas muertas y materiales animales. Cucarachas, gusanos y hormigas son todos ejemplos de descomponedores.

Cucaracha

Gusanos

Hormigas

Microbios

Otro tipo de descomponedores son los microbios. Similar a los animales descomponedores, los microbios reducen los materiales vegetales y animales

comiéndolos. Los microbios descomponen estos materiales en pequeñas partes que terminan en la tierra o en el aire en forma de gases. Cuando los microbios descomponen los materiales vegetales y animales, liberan gases que huelen mal. Recuerda, era la manzana descomponiéndose la que causaba que el refrigerador oliera tan mal.

Los microbios son tan pequeños que no podemos verlos a menos de que haya muchos juntos en un lugar. Los científicos usan una herramienta especial llamada placa de agar para observar microbios que son muy pequeños para ver. En la placa de agar, los microbios se multiplican en gran número y se ven como una gota. Los científicos refieren a estas gotas como colonias de microbios. Cuando hay colonias en una placa de agar, los científicos tienen evidencia de que hay microbios presentes. Bacterias y algunos hongos son ejemplos de microbios.

Placa de agar con colonias de microbios

Microbios en comida

Microbios agrandados bajo un microscopio

Usa el artículo para responder a las siguientes preguntas:

1. ¿Qué hace que las plantas y los animales se reduzcan?

_____

_____

_____

2. ¿Qué son los microbios? ¿Qué hacen?

_____

_____

_____

3. ¿Qué hace que los materiales alimenticios se descompongan en las botellas de basura?

_____

_____

_____

4. ¿Qué causa el olor en las botellas de basura?

_____

_____

_____

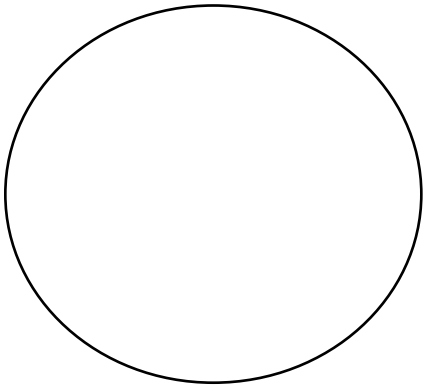
Name _____ Date _____

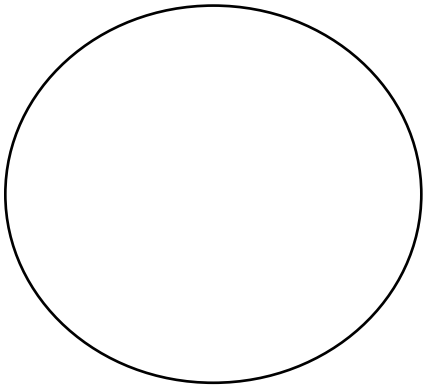
Investigation 4-2: Agar Plate

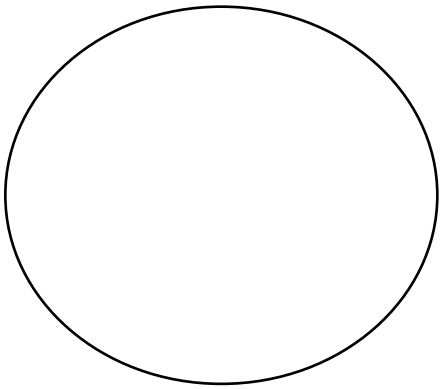
	Investigation plan	✓
1	Gather supplies for the group: ☐ Paper towels/Newspaper cover for desktop ☐ Plastic gloves (1 pair per student) ☐ Safety goggles (1 per student) ☐ Agar plates (1 per group) ☐ Cotton swabs (1 per group) ☐ Landfill bottle with food and nonfood materials ☐ 1 Permanent marker ☐ 1 Piece of masking tape ☐ 1 Plastic baggie (big enough to fit the agar plate) ☐ Antiseptic wipes	
2	Clear the desks and cover the desktop with newsprint.	
3	Put on plastic gloves.	
4	Observe the agar in the agar plate. Do not open. Draw a diagram of the agar plate below.	
5	Prepare agar plate: ☐ Take off the clear plastic lid of agar plate and lay it on the desk. The lid is the part without agar gel.  ☐ Use a cotton swab to swab the material your teacher has assigned to your group.  ☐ Gently move the swab back and forth on the agar plate to transfer the contents of the cotton swab to the agar plate. ☐ Place the cotton swab to the side. ☐ Put the lid back on the agar plate. 	

6	Label agar plate: □ Use the permanent marker to write on a piece of masking tape the: ○ Group number ○ Condition on the agar plate ▪ Example: Group #1 food □ Stick the label on the bottom of the agar plate. 	
7	Draw a second diagram of the agar plate in the investigation packet. Make sure to keep the agar plate closed.	
8	Place the agar plate into a baggie (upside down, and the label up) and close the baggie. 	
9	Place the baggie with the agar plate in a warm location (e.g., under a lamp, by a window).	
10	Clean up: □ Throw out the newsprint, cotton swabs, and plastic gloves in the hazardous waste bag. □ Clean the desks with antiseptic wipes.	

Investigation Observations:

Agar plate before swabbing:	
	Date: _____ Material Swabbed: _____ Observations:

Agar plate after swabbing:	
	Date: _____ Material Swabbed: _____ Observations:

Agar plate after 2-3 days:	
	Date: _____ Material Swabbed: _____ Observations:

Investigation Questions to Answer after Swabbing:

1. What do you predict will happen to the agar plate after 3 days?

_____

_____

_____

_____

Investigation Questions to Answer after 2-3 Days:

2. What is on the agar plate? How do you know?

_____

_____

_____

_____

3. What do your observations of the agar plate tell you about the landfill bottles?

_____

_____

_____

_____

Constructing an Explanation

Question:_____

_____

Claim: _____

_____

Evidence:	**Why did you use these data?**
_____ _____ _____	_____ _____ _____
_____ _____ _____	_____ _____ _____
_____ _____ _____	_____ _____ _____

Reasoning: _____

_____

_____

_____

Teacher Feedback:

	Comments
Claim	
Evidence	
Reasoning	

Article Answer Key

1. What causes plant and animal materials to break down?
   Decomposers cause animal and plant materials to break down.

2. What are microbes? What do they do?
   Microbes are a type of decomposer. Microbes break down animal and plant materials.

3. What causes the food materials in the landfill bottles to decompose?
   Microbes in the landfill bottles cause the food materials to decompose.

4. What causes the smell in the landfill bottles?
   Microbes cause the smell. When microbes decompose food, they produce smelly gases.

Investigation 4-2 ANSWER KEY

Investigation Questions to Answer after Swabbing:

1. What do you predict will happen to the agar plate after 3 days?
   Answers will vary.

Investigation Questions to Answer after 2-3 Days ANSWER KEY

2. What is on the agar plate? How do you know?
   Microbes are on the agar plates. I know this because I read about microbes in the article.

3. What do your observations of the agar plate tell you about the landfill bottles?
   My observations show that microbes are everywhere including the landfill bottles.

Explanation Table ANSWER KEY

Question: What causes changes in the food materials in the landfill bottles?	
Claim: Microbes cause changes in the food materials in the landfill bottles.	
Evidence:	**Why did you include these data?**
When we swabbed the rotting food materials on the agar plate, there were blobs.	We think these blobs are microbes that multiplied to a large number.
We also read an article about how microbes that are too small to see break down food materials, causing them to decompose and produce smelly gases.	We think that microbes are what caused the food materials to decompose and produce smelly gases.
Reasoning: Since we observed blobs on the agar plate and we know that microbes break down food materials, we conclude that the blobs must be microbes that multiplied to a large number. These microbes were one of the causes of changes to food materials in the landfill bottles.	

Lesson 4-2 Teacher Rubric
Explaining Changes to Materials in the Landfill Bottles

	Claim	Evidence	Reasoning
0	Claim is incorrect, irrelevant, or missing. Examples: • *(None)* • *There are many types of decomposers.*	Evidence is incorrect, irrelevant, or missing. Examples: • *(None)* • *My evidence is that the food rotted.* • *The properties of the food materials changed, but the weight stayed the same in the closed system.*	Reasoning is incorrect, irrelevant, or missing. Examples: • *(None)* • *Microbes leave the open system, producing smelly gases.*
1	Claim is correct and answers the investigation question. Example: • *Microbes cause changes to food materials in the landfill bottles.*	Evidence supports claim using information obtained from the article OR data from the investigation. Examples: • *According to the article, microbes break down food materials, causing the food materials to decompose and produce smelly gases.* • *When we swabbed the rotting food materials on the agar plate, we observed blobs.*	Reasoning is correct and links evidence to claim. Examples: • *Since we observed blobs on the agar plate and we know that microbes break down food materials, we conclude that the blobs must be microbes that multiplied to a large number. These microbes were one of the causes of changes to food materials in the landfill bottles.*
2		Evidence supports claim using information obtained from the article AND data from the investigation. Example: • *According to the article, microbes break down food materials, causing the food materials to decompose and produce smelly gases. When we swabbed the rotting food materials on the agar plate, we observed blobs.*	

TOTAL: _____ out of 4

SELF AND PEER CHECK! Group Model of Landfill Bottle Systems
Lesson 4-2

Instructions: The purpose of this activity is to provide feedback to another group on their landfill bottle system model. As another group presents their model, check whether they have included the components, processes, and modeling conventions listed in the table below. Then, use this information to ask questions that will help the group revise their model.

> *Example:* If a group's model does not show microbes breaking down food materials, you might ask, "What causes changes in the food materials? What is your evidence?"

Does the model include the following components?	**YES**
Open and closed landfill bottles	☐
Garbage materials	☐
Microbes	☐
Gas particles (smell)	☐
Does the model include the following processes?	
The properties of the food materials changed over time.	☐
The weight of the closed system stayed the same, but the weight of the open system decreased over time.	☐
Microbes break down food materials.	☐
Gas particles (smell) are produced in both systems and move freely out of the open system.	☐
Does the model follow modeling conventions?	
Components and processes are clearly identified using labels and/or a key.	☐

Identify one area for improvement in your peer group's model.

_____

_____

_____

Name _____ Date _____

Thinking About What Happens to Our Garbage?

1. What did you learn in this science unit that you did not know before?

   _____

   _____

   _____

2. What was your favorite part of this unit? Why?

   _____

   _____

   _____

3. What did you think of each of the following investigations in the unit? Put an X under your rating for each investigation.

Investigation	Loved it!	It was okay	Did not like it much
Landfill bottle investigation			
Tear and crush investigation			
Mixing water and sugar investigation			
Syringe investigation			
Rock salt and baking soda investigation			
Microbes investigation			

4. What did you think of each of the following practices and crosscutting concepts you participated in? Put an X under your rating.

Practice	Loved it!	It was okay	Did not like it much
Developing models			
Planning and carrying out investigations			
Writing arguments and explanations			

Crosscutting Concept	Loved it!	It was okay	Did not like it much
Finding patterns			
Identifying system components and how they go together (landfill bottle, garbage collection)			
Finding the conservation of matter (weight) in investigations (landfill bottles, crush investigation, rock salt, baking soda, and water investigation)			

5. Which investigations and/or practices were most helpful for answering the Driving Question (*What happens to our garbage*)? Why?

_____

_____

_____

_____