2.3 Culturing Bacteria and Fungi Decomposers

Action Synopsis

Students do a controlled experiment to culture microbes living on items they collected outside.

Session 1		40 minutes
1. Write predictions for growth of microbes in Jello culture when microbes from non-living items are added.		*generating ideas & questions*
2. Introduce fair test methods and rationale.		*introducing new information*
3. Set up culture dishes of Jello and non-living items.		*investigating*

Session 2		40 minutes
1. Discuss class predictions.		*reflecting*
2. Label list of non-living items as biotic or abiotic.		*applying knowledge*
3. Observe culture dishes and record results.		*observing & recording*

Continued

Sessions 3–5		20–40 minutes
1. Observe microbe growth and record results.		*observing & recording*
2. Evaluate weaknesses of experiments described in "Science Fair Stories."		*applying knowledge*

Session 6		40 minutes
1. Share and discuss results of investigations.		*processing findings*
2. Compare findings to predictions of microbe growth.		*reflecting*

Desired Outcomes

Throughout the lesson, check that students:

✓ Are able to explain what a fair test is and why scientists use controlled experiments.

✓ Are developing the habit of using their journal for recording observations and questions.

✓ Can relate experimental evidence back to their predictions and give possible reasons for the outcomes.

✓ Understand that microbes grow on their food source, causing decomposition as they consume it.

What You'll Need

Session 1

For the class:
- ❑ newsprint sheets for class lists
- ❑ 1–2 3-oz. boxes of flavored Jello (lemon, lime, or orange)
- ❑ bowl
- ❑ spoon
- ❑ boiling water
- ❑ paper towels
- ❑ measuring cup

For each pair of students:
- ❑ 3 petri dishes or other clear containers with flat bottoms and covers
- ❑ clear tape
- ❑ masking tape

Session 2

For each pair of students:
- ❑ 2 hand lenses

Continued

Sessions 3–5

For each pair of students:

- ❑ 2 hand lenses
- ❑ copy of "Science Fair Story #1" (page 206)
- ❑ copy of "Science Fair Story #2" (page 207)

Vocabulary

CONTROL - The unchanged item or group in an experiment.

FAIR TEST - An experiment in which everything is kept the same except for the one condition being tested.

MEDIUM - A substance in which an organism lives.

TREATMENT - The item or group that has been manipulated in an experiment.

VARIABLE - Something that is changed in a fair test.

Getting Ready

Session 1

♦ Prepare petri dishes with Jello as follows:

1. Sterilize the dishes, bowl, measuring cup, and spoon using boiling water. Place them upside down on paper towels until you're ready to use them.
2. Add 1 box of Jello to the bowl, then add 1 cup of boiling water and stir until Jello dissolves.
3. Add 1 cup of cold water.
4. Pour or spoon the liquid into the petri dishes to fill them half way (about 3–4 mm deep). Cover them immediately. [There should be enough for about 25 dishes (8 cm in diameter).]
5. Keep the filled dishes in a cool place (a refrigerator is best) until students are ready to set up their experiments.
6. If necessary, repeat the procedure to make enough for each pair of students to have three dishes.

Action Narrative

Session 1

Today we're going to culture the microbes on the non-living items we collected. We'll put the items into a culture MEDIUM that gives the microbes on them extra food. We're using Jello which has a lot of sugar in it — a product of plants that were once alive — as well as protein, minerals, and water that microbes need.

What do you think will happen when you put extra food in with a non-living item that has a lot of microbes, and with an item that has fewer microbes?

Students' expectation will probably be that the microbes that are on both items will grow and multiply, but those that started with more microbes will show more overall microbe growth than those that started with fewer. Help them consider that the amount of microbe growth could turn out to be the same, either because the items had the same amount of microbes on them to begin with, or because microbe growth expands to the same level once extra food is added. It could also turn out to take longer for microbe growth on some items to reach the density of that on other items. Another possible result is that students will see different kinds, rather than different amounts of microbes.

Before we start, write your predictions in your journal.

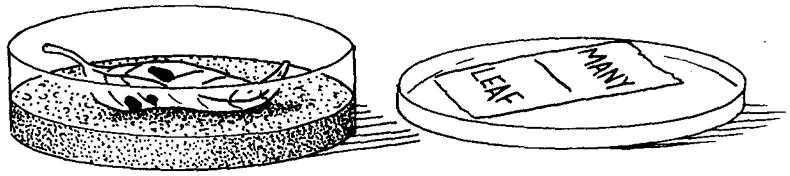
I predict that more microbes are on the leaf than on the rock.

You might want to have students record their predictions on a class chart as well.

Predictions

Pairs' Initials	Items with <u>Many</u> Microbes	Items with <u>Few</u> Microbes
L.M. & B.J.	lollipop stick	dry leaf
K.L. & A.M.	surface soil	deep soil
T.H. & K.T.	twig	pine needle
J.T. & J.L.	dead grass	bottle cap

Here is the procedure. Each pair will get three dishes of Jello. Put an item from your baggie labeled "Many" on top of the Jello in one dish without touching your fingers on the item, the inside of the dish, or the Jello. Make sure the item touches the Jello completely. Tape down the cover with clear tape. Then label the dish "Many" and write the name of the item on masking tape. Repeat the process with an item from your baggie labeled "Few". The third dish doesn't get anything added to it.



Why do you think you need a dish with just Jello in it?

Introduce the notion of an experimental CONTROL if students are not familiar with it. The control dish is needed since there might be microbes in the dish, the air, or the Jello itself. If microbes grow in this dish, students will know that they can't attribute all of the microbe growth in the other dishes to the non-living items they added.

Another name for an experiment is a FAIR TEST. To make an experiment fair, you have to do everything the same to the control as you do to the TREATMENT, except for the one VARIABLE you are testing. What is the variable in our test?

The non-living items are the variables.

Should we do anything to the control dish to make sure we treat it just like the other dishes except for adding the item we're testing?

Help students realize that they should expose the Jello in the control dishes to the air for the same amount of time the Jello in the treatment dishes are open to air while they add their items.

Have students get their dishes of Jello and baggies of items, then set up their experiments. Keep the dishes in a warm, but not hot and sunny, location to encourage microbe growth.

Once they've set up their tests, have students record their activities, new observations, and ideas as a dated journal entry. Also have them add what they think will happen in the dish of plain Jello to the predictions they wrote earlier.

March 26th
We added a leaf to the "Many" dish of Jello.
Then we put a rock in the "Few" dish. We have
one more dish that has nothing but Jello. Keisha
timed how long we opened each lid for 5 seconds.
I think something like mold will grow on the plain
Jello, too.

An interesting sideline experiment is to boil several of the items collected outdoors to sterilize them. Then students can compare the growth of microbes on a sterile and non-sterile sample of each item in Jello culture dishes.

Session 2

Before you observe your experiments today, let's talk about the predictions you recorded on the class chart yesterday.

Ask focusing questions such as:

What types of items appear in the "Many" decomposer microbes category?

What appear in the "Few" category?

Do some appear in both?

Ask students to share the reasoning behind their predictions. As they consider the validity of reasoning that differs from their own, cultivate and reinforce their habits of open-mindedness and critical reflection (e.g., *José said something that makes me think something new. Putting the bottle cap in the "Many" microbes category doesn't make sense to me because I don't think microbes eat metal.*).

Let's label each thing on our chart as biotic or abiotic.

Predictions

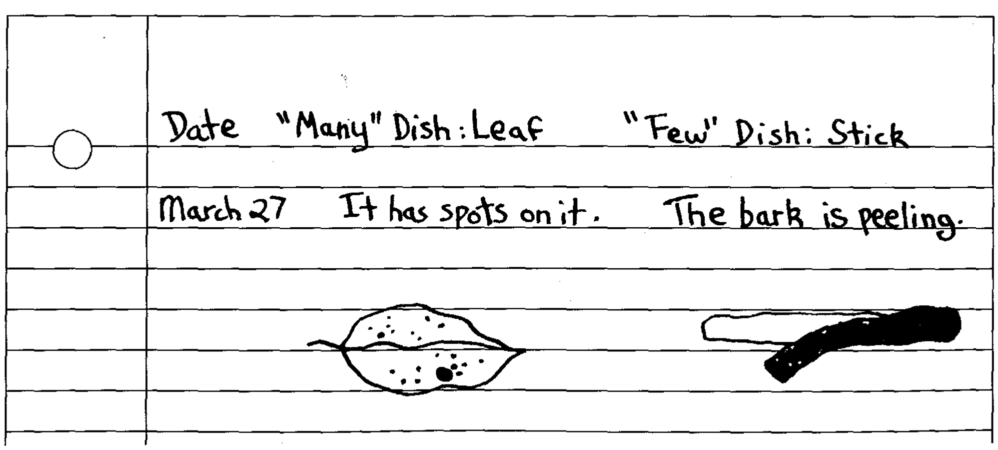
Pairs' Initials	Items with Many Microbes	Items with Few Microbes
L.M. & B.J.	lollipop stick - B	dry leaf - B
K.L. & A.M.	surface soil - A and B	deep soil - A and B
T.H. & K.T.	twig - B	pine needle - B
J.T. & J.L.	dead grass - B	bottle cap - A

Soil and water (except for tap water) can be considered both biotic and abiotic because they contain living and dead plants and animals, as well as minerals.

Once everything is labeled, have the class notice whether or not there is a trend for biotic items to be in one category and abiotic in another.

Get your culture dishes and hand lenses to make observations. Make a chart in your journal for recording what you see.

Each pair can come up with its own format for recording observations, or you can suggest a format. Also encourage students to make drawings, and to write ideas and comments as well as observations.



Sessions 3–5

Observe your culture dishes and keep a record of your observations in your journals. Hold the dishes up so you can see through the bottom, where the microbe growth might look different than it does from the top.

Give students 10–15 minutes for observations and notetaking each day for three to five days. If you have a weekend break during the experiment, make sure students observe their dishes on Friday and Monday since a lot of microbe growth can occur during the two days that they are away.

What to Expect

For the first few days, changes will be subtle. There might be clear, circular patterns around the items that are the beginning of microbe colonies. By the third day, students should see white fuzzy growth of fungi at the point of contact between the organic items and Jello. From the fourth to seventh days, the white fuzz will thicken, cover the entire item, and extend beyond it. Shades of green, black, gold, and grey will appear as the fungi begin to produce spores. Dark specks of bacterial colonies might be visible as well. If you let the experiment run for an eighth day, the Jello could begin to liquify, so will no longer be a firm substrate for the colonies.

There will also be microbe growth in the control dishes, but in small, neater-looking, round colonies. The amount of microbes from abiotic items will depend on how "dirty" they were (i.e., whether they had plant, soil, sugar, or residues on them).

Each day when you're done taking notes on your experiments, work with your partner on these "Science Fair Stories." They are about students your age who are doing science fair projects, and your job is to help them improve their experiments.

Give each pair of students "Science Fair Story #1" and "Science Fair Story #2" to work on together and/or complete on their own for homework. Here are some things to look for in their responses, and to go over in a class discussion:

Science Fair Story #1: Sam's Soil (Focus: Specifying a Plan)

1) Each funnel could have 1 cup of material total (e.g., a half cup of soil plus a half cup of other material), or 1 cup of soil to match the amount of soil in the first funnel, plus a measured amount of additional material. Either approach is acceptable, so long as students standardize the amount of each ingredient across treatments.
2) Other things Sam should do include making sure he tamps down each one the same amount, pouring the same amount of water in each funnel, and waiting the same amount of time after pouring the water in each before measuring how much water came through.
3) Sam should measure the amount of water that came through the funnel and subtract it from the amount of water he added to the funnel.
4) Students' suggestions for improvements will vary. Be sure to ask them why each of their ideas improves the experiment, such as by making it more accurate or by increasing the amount of information Sam will gain.

Science Fair Story #2: Alyssa's Algae (Focus: Controlling Variables)

1) The weaknesses of Alyssa's experiment are that the amount of pond water and algae was not the same in the different size jars, and they were not kept in the same conditions.

2) Alyssa should set up her test in equal size jars, and measure everything she puts into the jars so she can make them all the same. She should keep them all the same place — probably in sunlight since real ponds are exposed to sun.

Session 6

Take a few minutes to review your notes, then we'll share our findings with one another.

Display all of the dishes so everyone has a chance to see and compare them. Encourage pairs to share their results with the class. Students can put symbols such as plus and minus signs next to the items on the class predictions chart to show the relative amount of microbe growth on the items each pair tested. Also have students describe the different kinds of microbe growth they observed — this might be a more obvious result than the amount of microbe growth.

Help them process their findings with questions such as:

Did anything grow on the plain Jello in the control dishes? If so, why?
Since students did not do their experiments in sterile conditions, the plain Jello dish most likely had microbes that came from the air, fingers, or the dishes themselves. Students can consider the type and amount of microbe growth in the control dishes as the "background" amount of microbe growth for all the dishes. In order to attribute microbe growth to the decomposers on the non-living items they collected, the growth in the dishes with these items should look different from the growth in dishes with plain Jello. Students should also notice whether the microbes started growing on Jello in parts of the dish far away from the item, rather than spreading there.

What kinds of items do you think had the most microbes on them when you put them in the dishes, and why?
Decomposer microbes should have been more abundant on items that are high in energy and nutrients, and are easy to digest. For instance, Jello to which tender plant tissues were added should show more microbe growth than Jello with tough, woody items. Jello to which plastic and metal items were added should show no microbe growth, unless the items had sugars, oils, or other residues on them. Help students understand that microbes are similar to all living things — they thrive best on high quality food.

How did your results compare to your predictions?
Fifth and sixth graders often have a hard time with results that don't turn out as they expected, in part because they don't like being "wrong". For instance, they are often surprised and disappointed that microbes grew on Jello to which abiotic items were added. But when they see that a lot of microbes also grew in their control dishes, they realize that they would need to improve their experiment

(e.g., by using sterile conditions) before they could draw conclusions. Asking students to explain why they think things turned out differently than they predicted is a good way to explore their understanding of the concepts that underlie the experiment. Help them understand that results that are contrary to a prediction are just as helpful to a scientist as positive results, and are often more thought provoking.

Does it look like different kinds of microbes grew on different items? If so, why?

Students will most likely see different shapes and colors of microbes on Jello to which different items were added, since the kinds of microbes differ in different locations and on different types of food sources. However, one dominant type of microbe might have thrived on the Jello regardless of the type of item added, masking the different kinds of microbes suited to digesting different materials.

What would happen to the items on which the microbes are growing after a long time?

Hopefully students will predict that the microbes will "eat them all up." This is true. After the microbes consume the Jello, the process of consuming the items themselves will slow down. Different kinds of microbes will take over at different stages of decomposition, as some are best suited to consuming fresh material, and others attack the more difficult to digest leftovers. Eventually, however, the materials that were once alive should get so small that they are no longer visible. The basic chemicals they were made of will be inside the microbes, or in the wastes the microbes have released.

The most important thing to make sure students come away with from this investigation is that dead things decompose because microbes use them as food. They should also understand that the matter the materials were made of may disappear from sight, but not from existence. It is just in different forms and in different places.

Either throw out the petri dishes without opening them, or if you want to save them, submerge them unopened in a bucket filled with hot water and about 2 cups of bleach. After they've soaked for a day or two, remove them and wash with hot water.

Ongoing Assessment

Student Reflections

Have students send a C-Mail message, or record thoughts in their journals. Optional writing prompts include:

A result of the experiment that surprised me was...

What would life as a microbe be like?

Teacher Reflections

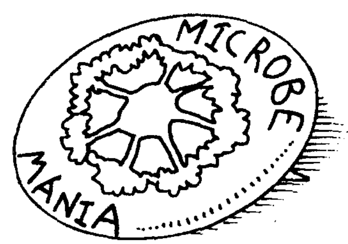
- ❑ Do students understand why a control helps make an experiment a fair test?
- ❑ How detailed were their observations and journal records?
- ❑ Were they able to respect evidence that didn't match their predictions, and offer possible explanations for their results?
- ❑ Do they understand that microbes grow on dead things that they are eating, and that this causes the dead things to decompose?

Extensions

Leaf Chambers. Have students gather different kinds of leaves, or the same kinds of leaves from different environments (e.g., a place with more and less air pollution — this could involve exchanging samples with students at a different school). Wrap the leaves in wet paper towels, then put them in baggies and keep them in a warm place. Check on them at one-week intervals to see which have more fungal hyphae growing on them.

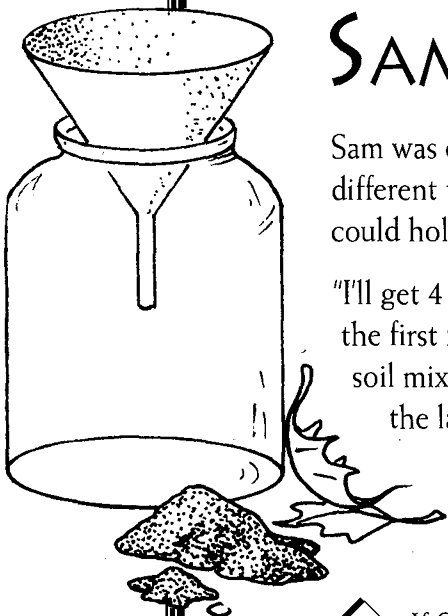
Micro Views. Put a small sample from a microbe culture dish in a drop of water on a microscope slide, cover it with a cover slip, and let students examine it under a microscope.

I Believe in Microbes! Students can have fun creating pins (with a pin-making machine if the school owns one, or with circles of white contact paper for stick-on buttons) that feature a drawing of a microbe and an appropriate slogan.



NAME(S)____ DATE__________

SCIENCE FAIR STORY #1



SAM'S SOIL

Sam was curious about soil. For his science fair project he decided to mix different things into garden soil, then compare how much water each mixture could hold. Here is the plan that Sam wrote:

"I'll get 4 funnels and put each one in a jar. Then I'll put some garden soil in the first funnel, some soil mixed with peat moss in the second funnel, some soil mixed with sand in the third funnel, and some soil mixed with leaves in the last funnel. I'll pour some water over each one, then see how much comes out the other end."

Sam's plan sounds pretty good, but it is not specific enough. Please help him be more specific.

1. If Sam put 1 cup of soil in the first funnel, how much soil, peat moss, sand, and leaves should he add to the other funnels?

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2. What else should Sam do exactly the same to make a fair test?

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3. What should he measure to find out which material held the most water?

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4. Can you suggest anything else Sam could do to improve his experiment? Explain.

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NAME(S)________________________________ DATE__________

SCIENCE FAIR STORY #2

ALYSSA'S ALGAE

Alyssa has a pond in the back of her house, so for her science fair project she decided to study algae. She heard people say that fertilizers from people's lawns got into the pond and made a lot of thick, green algae grow. Alyssa decided to test whether fertilizer helps algae grow.

She found six jars. Some were mayonnaise jars, some were peanut butter jars, and some were large pickle jars. Alyssa filled each jar with pond water and put in some strands of algae. Then she added 1 teaspoon of fertilizer to three of the jars. She put these three jars on her bedroom windowsill. Since there was no more room on her windowsill, she put the other three jars of pond water and algae on her bookshelf.

1. What is wrong with Alyssa's experiment?

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2. What should she do to make her experiment a fair test?

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