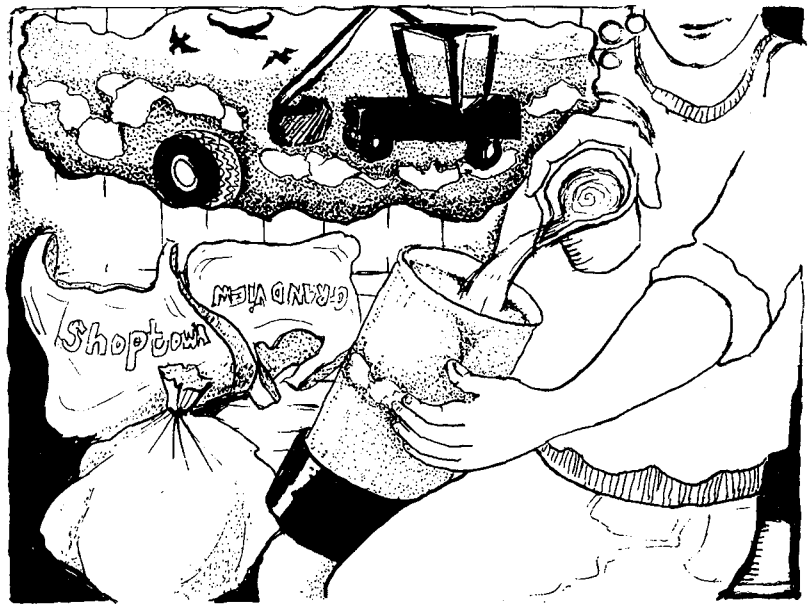
2.6 The Bag That Wouldn't Go Away—Performance Assessment



Action Synopsis

Students design and set up model waste disposal systems that will help biodegradable plastic bags decompose.

Session 1	40 minutes
1. Discuss whether trash decomposes.	*examining prior ideas*
2. Discuss biodegradable bags and trash disposal systems.	*generating ideas & questions*
3. Set up a model landfill.	*demonstrating methods*
4. Present the challenge of becoming engineers to design waste disposal systems.	*posing a challenge*
5. Discuss criteria for high quality work.	*setting standards*
6. Work in groups to plan waste disposal systems.	*planning*

Continued

Session 2		1 hour
1. Set up model waste disposal systems in soda bottles.		*applying knowledge*
2. Complete design specifications and present designs to the class.		*communicating*
3. Summarize and discuss waste disposal and the garbage crisis.		*reflecting*

Desired Outcomes

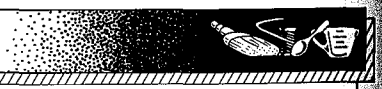
By the end of this assessment activity, students should:

✓ Be able to explain why biodegradable items don't always decompose after they're thrown out, and suggest ways to promote their decomposition.

✓ Be able to communicate and support their ideas using a model and written design specifications.

✓ Be aware of the complexity of the garbage crisis, and the potential roles of technology and citizens in solving it.

What You'll Need



Sessions 1 & 2

For each student:

- ❑ copy of "Challenge Sheet" (page 243)
- ❑ copy of "Design Specs Sheet" (page 245)
- ❑ copy of "Scoring Sheet" (optional—page 244)

Session 1

For the class:

- ❑ several non-biodegradable plastic bags
- ❑ several biodegradable plastic bags (see "Getting Ready")
- ❑ 1-liter plastic soda bottle
- ❑ 2 cups of soil
- ❑ watering device (see "Getting Ready")
- ❑ piece of a biodegradable plastic bag, approximately 13 x 20 cm

For the teacher:

- ❑ pushpin
- ❑ pair of sharp, pointed scissors
- ❑ pair of plastic gloves (optional)

Session 2

For the class:
- ❑ large bag of soil (see "Getting Ready")

For each group of 2–4 students:
- ❑ 2-liter soda bottle
- ❑ pair of scissors
- ❑ piece of a biodegradable plastic bag, approximately 13 x 20 cm
- ❑ cup for scooping soil

For each student:
- ❑ copy of "Portfolio Cover Sheet" (page 39)
- ❑ copy of "Group Work Evaluation" (page 42)

Vocabulary

BIODEGRADABLE - The ability to be broken down by being consumed by living things.

ENGINEER - A person who uses scientific knowledge to make products and solve problems for people.

SPECS - Short for "specifications" that provide design details.

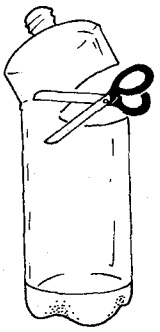
Getting Ready

Session 1

- ♦ Look for biodegradable plastic trash or sandwich bags in the grocery store. Make sure that the bags you choose are biodegradable (contain an additive such as cornstarch), and not photodegradable (made with chemicals that break down when exposed to the sun's ultraviolet rays).

  If you can't find biodegradable plastic bags, use paper grocery bags instead. Although paper decomposes more readily than plastic, landfill conditions inhibit its decomposition, so this lesson's challenge to improve landfills will still be appropriate.

- ♦ To prepare to make a model landfill for a class demonstration, cut off the top of a plastic soda bottle by piercing it with a pushpin, and then inserting sharp scissors into the hole for cutting. Set aside a few cups of soil to use for your model landfill as well.



- For a landfill watering device, locate a watering can with a sprinkler head or a spray bottle. You can also make a sprinkler by punching holes in the metal top of a soda bottle with a pushpin.
- Plan student groups. Decide whether you'll have them hand in one "Design Specs Sheet" for a group grade, or individual sheets describing their group's model.

Session 2

- Each group will need a minimum of 3 cups of soil for its landfill. Bring in a small trash bag of outdoor soil, or have on hand a few large bags of potting soil, plus a small amount of soil from outdoors. Since potting soil may be sterile, you'll need to add outdoor soil to it to inoculate it with microbes.

Action Narrative

Session 1

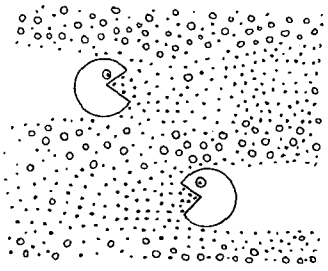
We've explored how things decompose in nature. Now let's think about the trash we throw away. Does it decompose?

Students usually predict that organic trash items like food scraps will be more likely to decompose than inorganic or manufactured items like toys. Have them think about things they've thrown out in the past 24 hours, or look through the classroom wastebasket (wearing plastic gloves), to see what percentage of items they throw away are likely to decompose.

People manufacture a lot of things that aren't good food for decomposers. Plastic is one of those things. When people started getting concerned about the "garbage crisis" — too much trash and no place to put it — manufacturers decided to make BIODEGRADABLE plastic bags. What do you think biodegradable means?

The definition for biodegradable — the ability to be broken down (degraded) by being consumed by living things (bio) — should make sense to students who now understand that decomposition is a biological process.

Since not many microbes can eat plain plastic, some manufacturers started adding cornstarch to their plastic bags to make them biodegradable. Cornstarch is a powdery substance made from the sugars that corn plants produce during photosynthesis. The idea is that when cornstarch is added to plastic bags, microbes will eat the cornstarch after the bag is thrown out. Scientists are still trying to figure out if microbes eat the plastic, too. If not, maybe the bags break into tiny pieces that stay in the soil or water where they were buried.



Pass around the biodegradable and regular plastic bags so students can see and feel how they differ.

Will It Rot or Not?

Claims that plastics biodegrade are hotly debated among scientists. In one study done at Cornell University, scientists put plastic household products labeled biodegradable (e.g., diapers, garbage bags, and magazine mailers) into "bioreactors" full of bacteria so potent that they could reduce a paper bag to carbon dioxide and water within a day. The scientists concluded that the plastic in the products did not break down into natural elements, although it may have broken into smaller pieces. The amount of mass lost was equal to the amount of cornstarch or sugar that had been added to the products. Meanwhile, some plastic companies report that their tests have shown that the actual plastics do break down into their basic elements.

So maybe manufacturers are onto something by making plastic bags out of material that microbes can use as food. But as we found out, microbes work best when their surrounding conditions, as well as their food, are just right for them to grow. Does anyone know in what conditions our trash ends up after it is thrown away?

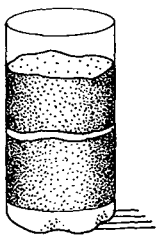
Some students might know how trash is disposed of in your community. If not, ask them to find out and report back to the class during the next session. Typically, trash is either buried between layers of soil in a landfill, burned (and the ash buried), or dumped into the ocean or a big lake.

I'm going to make a model of a landfill to show you the conditions that many plastic bags end up in after they're thrown away. Does anyone know how a landfill is constructed?

After students have shared what they know about landfills, make a model landfill in the soda bottle you've prepared. Put about a cup of soil in the bottom, then a piece of a plastic bag, then another cup of soil on top. As you make the model, explain that landfills often start as big pits in the ground. They are sometimes lined so that nothing leaks out. Workers use dump trucks, tractors, bulldozers, and other machinery to cover new trash with soil every day. Eventually, the pit fills up with layers of trash and soil, until in some cases the landfill becomes the tallest mountain around.

What else should I do to imitate landfill conditions?

When students suggest that landfills are exposed to weather, sprinkle some water on top to simulate rain.



Your challenge is to become ENGINEERS to create a waste disposal system that is better at helping biodegradable plastic bags decompose than this typical landfill. You can also think of ways to alter the bag itself so it is more likely to decompose.

Make sure that students understand that engineers are people who use scientific knowledge to make products or solve problems. Discuss examples of what engineers do.

Here is a description of your challenge.

Give each student a copy of the "Challenge Sheet" and talk about the activity.

Every group will get one soda bottle and a piece of a biodegradable plastic bag. There will also be soil and water available. You may ask my permission to use other materials in the classroom or school, and you can bring things from home.

Hand out and discuss the "Design Specs Sheet," explaining that SPECS is short for "specifications". Emphasize that students might come up with ideas for conditions that are impossible to include in their classroom model. They should sketch and explain these ideas on their "Design Specs Sheet." Tell students whether you want each person to complete a sheet or if they will submit one per group.

Your disposal system design will be evaluated using several criteria.

Discuss how students' work will be scored, either by giving them a copy of the "Scoring Sheet," or by having them decide on scoring criteria.

Start talking over ideas in your groups, then tomorrow you can make your models and fill out your "Design Specs Sheet."

If some groups don't know where to begin, suggest that they discuss why the landfill model you made might not be the best place for microbes to grow. Remind them to stay focused on what they know causes decomposition. Each time someone suggests a landfill improvement, the group should discuss how it will help make the bag decompose. Recommend that at least one person in each group take notes.

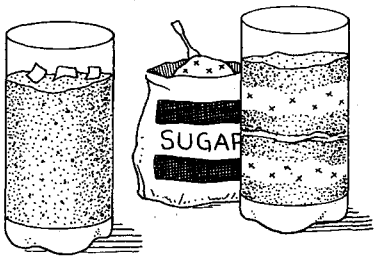
Session 2

Today you'll have time to make your biodegradable bag disposal system models and complete your "Design Specs Sheet." Near the end of the period we'll share our designs with one another.

Help students cut their bottles by using a pushpin to make a hole, then insert sharp scissors into the hole to start the cut for them. Students can finish cutting the bottle using blunt scissors.

Circulate as students make their models to get a sense of the rationale behind their designs.

Now let's share our designs with one another.



After each group explains its model, have students attach the "Scoring Sheet" (unless you're using other criteria) to their "Design Specs Sheet" to hand in for your review and feedback.

Conclude with a discussion of questions such as:

Would your solutions be practical for dealing with tons of trash?
Help students analyze whether their disposal systems would be effective when plastic bags are mixed in with other types of garbage. They should also consider the cost of materials and labor required to handle garbage in the ways they suggested.

Would any of the designs create new problems?
Students might suggest ideas such as leaving bags unburied could increase odors and rats.

If microbes are everywhere, why don't the biodegradable plastic bags degrade right on the grocery shelf?
Have students think about the conditions within a box of plastic bags, and compare these to the conditions they know favor growth of microbes (e.g., moisture). Even after biodegradable bags get moist and are filled with food scraps that have microbes attacking them, it takes a very long time for the microbes to consume the cornstarch in the bags to the point where the bag falls apart.

Even if the bags decompose, do they really "go away"?
The bags might disappear from sight, but the material they were made of does not disappear from existence. The tiny particles of matter that the bags were made of become part of decomposers' bodies, or enter the soil, water, or air. Matter is recycled through decomposition, not destroyed.

Some scientists are trying to create new kinds of microbes that can eat all kinds of plastic, using a technique called genetic engineering. What are the pros and cons of this work?
Students might suggest that one benefit is that the microbes could help reduce the build-up of garbage. A negative aspect is that it's hard to predict what will happen once the microbes are let loose in the environment. Also, some of the particles the microbes release from the plastic bags could harm the environment.

Is technology the only answer to the garbage crisis? What else can be done?
Have students consider the strengths and limitations of technological solutions. If students suggest that another approach would be reducing the amount of garbage entering landfills, ask them for ideas of what they personally could do to make this happen.

Students can keep their landfills in the classroom or at home to periodically check on how well the bags are decomposing.

Ongoing Assessment

Student Reflections

Have students fill out a "Group Work Evaluation" (page 42) to reflect on their group process. They could also fill out a "Scoring Sheet" for their group's disposal system model. This is also a good time to have them select work samples for a portfolio, and complete a "Portfolio Cover Sheet" (page 39). Review the purpose and structure of a portfolio, and set a due date.

Teacher Reflections

The main thing to look for in each "Design Specs Sheet" is evidence that students understand that: 1) microbes cause decomposition; 2) microbes grow best on materials that are easy to digest and provide lots of nutrients and energy; and 3) conditions such as warmth and moisture promote growth of microbes.

Examples of conditions students might have included in their models to favor decomposition are:

adding additional microbes;

adding sugar, protein, or nutrients to or around the bag;

adding moisture (but not too much water);

exposing decomposing bags to oxygen that most microbes need;

supplying warmth;

cutting the bag into smaller pieces so there is more surface area for microbes to attack; or

adding invertebrate decomposers.

When explaining how they could know if their system works better than a typical landfill, students might suggest:

comparing their results with research data about how long it takes things to decompose in a real landfill;

assessing the bag's strength, weight, or transparency before and after being in the landfill;

seeing if the bag is intact or in pieces;

looking at the bag under a microscope to see if microbes are growing on it; or

using the bag in the demonstration model landfill as a comparison.

NAME(S)_____ DATE_____

THE BAG THAT WOULDN'T GO AWAY

Do biodegradable plastic bags decompose? Some people don't think they do, especially in the landfills or large bodies of water where they usually end up.

YOUR CHALLENGE:

Design a disposal system that you think will give biodegradable plastic bags the best possible chance of decomposing. You can change the conditions of the place where the bag ends up, and/or change the bag itself. Make a model of your system, and complete the "Design Specs Sheet."

SCORING:

You will be scored on how well you put your knowledge of decomposition to use in your design, not on how well the bag decomposes — that would take too long!

GOOD LUCK!

NAME(S)_____ DATE_____

THE BAG THAT WOULDN'T GO AWAY

OBJECTIVES	POINTS				SCORE
	3 High Quality	**2** Meets Objectives	**1** Falls Short	**0** Not Done	
APPLICATION OF KNOWLEDGE					
1. Shows understanding of what causes decomposition.	_____	_____	_____	_____	____ x 2 =____
2. Shows understanding of physical conditions that favor microbe growth.	_____	_____	_____	_____	____ x 2 =____
3. Has ideas of how to judge the success of the design.	_____	_____	_____	_____	=____
CREATIVE THINKING					
4. Designed a clever, inventive solution.	_____	_____	_____	_____	=____
DOCUMENTATION/ COMMUNICATION					
5. Labeled drawing accurately to reflect entire design.	_____	_____	_____	_____	=____
6. Wrote a complete list of what was done.	_____	_____	_____	_____	=____
7. Thoroughly explains reasons for each action.	_____	_____	_____	_____	=____

COMMENTS:

FINAL SCORE: _____

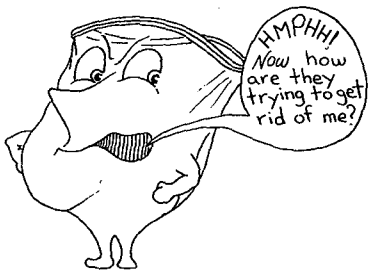
Total Possible Score: 27

Overall Achievement:

23–27 High
18–22 Sound
9–17 Limited
0–8 Inadequate

NAME(S)_____ DATE_____

DESIGN SPECS SHEET



1 Draw your biodegradable bag disposal system in the box below. Label everything you used or would like to use.

2 List everything you did to make a better disposal system, and explain why. Be sure that what you write shows how much you understand about decomposition.

What You Did:_____ Why:_____

_____ _____

_____ _____

_____ _____

_____ _____

3 Explain how you could know if your system works better than a typical landfill:

_____

_____