"What is Biodegradable?"
Composting by Microbes

Science in the Real World
Microbes In Action

"What is Biodegradable?" is a curriculum unit developed as part of the Science In The Real World: Microbes In Action Program. The curriculum units were developed with support from the National Science Foundation, The Coordinating Board for Higher Education, Sigma Chemical Company, Pfizer Foundation and the Foundation for Microbiology.

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At a Glance

Description

In this lab students will observe the decomposition of organic and inorganic materials, and the microorganisms that are responsible for decomposition.

Time Requirements

This lab will require one class period for setup, 5-10 minutes daily for observation and one class period for microscopic observation of microbes, analysis and conclusions.

Curriculum Placement

This lab would fit well into a microbiology unit, or an ecology unit.

Equipment

microscope (can be optional)

Materials (per group)

Scissors and/or knife for cutting materials
Two clear plastic cups (one 9 oz, one 10 oz)
Marking pens
Razor blades or exacto-knives
1 small graduated cylinder
1 metric ruler
Transfer pipettes (can be optional)
1 petri dish containing nutrient agar (can be optional)
Cotton tipped applicators (can be optional)
Microscope slides and coverslips (can be optional)
Forceps (can be optional)

Name _____

Date _____

Hour _____

What Is Biodegradable?

Observing Decomposition of Inorganic and Organic Materials

Background

What happens to our trash after we throw it away? Well, it rots and decomposes. There are two different kinds of decomposition: physical and chemical. Physical decomposition is when materials are broken down into smaller pieces, but the material remains unchanged. Erosion of soil and rock is an example of physical decomposition. Chemical decomposition occurs when materials are chemically changed in a reaction, and the products differ from the original compounds chemically. Biodegradation is an example of chemical decomposition performed by living organisms.

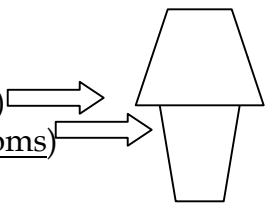
You may have noticed that trash doesn't always smell very good…why? As we learned above, chemical decomposition changes the food into a new substance. These products may smell different than the original food (your food doesn't come out smelling very nice either), and sometimes organisms give off gases as byproducts that are particularly unpleasant to the nose. All organisms need food for energy. Our food is converted to different molecules that will help our bodies' function. Food is organic, that is, it is a molecule of carbon and hydrogen that was made inside of a living organism. When an organism dies, (or we throw away part of one, like a banana peal for example), the organic substances need to be broken down into smaller molecules so that it can be used. Decomposers are a special group of organisms that break down and absorb nutrients from dead organisms. This process is performed by an easily overlooked group of organisms: Fungi, Protists and Bacteria. If these tiny microorganisms didn't eat these materials, our world would be overcome with piles dead material, and the plants would run out of raw materials needed for photosynthesis, the process on which all life relies to convert inorganic molecules into useable organic food.

Purpose

1. To observe the decomposition of organic and inorganic materials, and the microorganisms that are responsible for decomposition.

Part A-Procedure- Day 1

1. Obtain the following materials. Each group will need:
    a. 3 clear 9 oz plastic cups (these are shorter, and will be the lids)
    b. 3 clear 10 oz plastic cups (these are taller, and will be the bottoms)
    c. Marking pen.
    d. Razor blade or exacto-knife. Be careful, the blades are sharp!!



e. Scissors.
f. Supply of biodegradable and non-biodegradable trash brought in by the students.

2. Organize your trash into two separate piles, biodegradable and non-biodegradable. List your items below:

Biodegradable	Non-biodegradable

3. Cut your items into small pieces (approximately 2 cm squares. Make a separate pile for each different item.
4. Label the top of the 3 lids: 1, 2 and 3. Label the upper edge of the bottoms: 1—biodegradable, 2—non-biodegradable and 3—mixture.
5. Start to fill your cups with the appropriate items. Start by adding a little bit of one of your biodegradable items to cup 1. Add some of this same item to cup 3, but add less since cup 3 is going to get both types. Keep filling your cups with your various items until cup 1 is full, and cup 2 is half full. Following the same technique for filling cup 2, and fill cup 3 to the top with non-biodegradable items. Make sure all 3 cups are filled to the rim.
6. Place your "lid: (the smaller cup) upside down on top of the larger cup "bottom". Make sure you match your labels correctly. Holding both cups securely (this can be tricky, because the tops don't stay on well) shake the cups to mix the contents. Shake until you are satisfied that they are mixed well. It also helps if you can make out a few of the items from the outside of the cup for observation purposes. If the cups are no longer full, add items to make them full, but DO NOT PACK DOWN THE MATERIALS.
7. Add water to cup 1, 5 ml at a time, until the water level is 1 cm up from the bottom of the cup. Record the amount of water used here._____
8. Add the same amount of water to cups 2 and 3.
9. Observe your decomposition cups. On a separate sheet of paper, create a data table to hold three weeks worth of observations of your three cups. Include the following:
    a. Date
    b. Smell
    c. Water line height
    d. Contents height
    e. Appearance

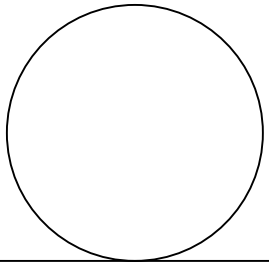
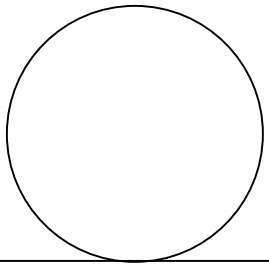
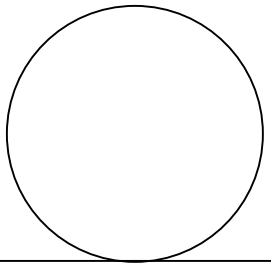
10. Using your marking pen outline a few items that are noticeable through the side. If possible outline one of each item you used. You can use these outlines to look at changes in appearance and location of the items as they decompose.
11. Using your razorblade or exacto-knife, make several slits in the sides of the lids for all three cups.
12. Observe your cups and record the information in your data table. Place cups in location as directed by your teacher. Perform steps A-C below.
    A) In your list of items above, underline the item that you think will decompose the fastest.
    B) In your list of items above, circle the item that you think will decompose the slowest.
    C) In your list of items above, put a star by all of the items you don't think will change in 3 weeks.
13. Make daily observations at the beginning of each class for three weeks. Then go on to part B.

Part B: Observing The Microbes.

(students will need access to microscopes, coverslips, forceps, transfer pipettes, sterile cotton tipped applicators, 1 nutrient agar plate and marking pens to complete part B)

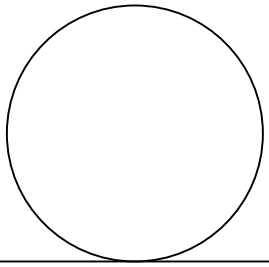
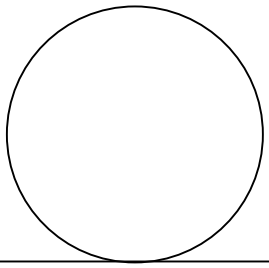
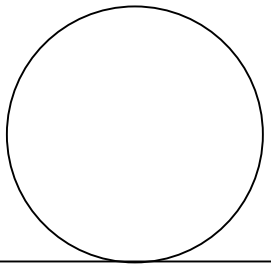
I. Microscopic Observation:

1. Using a transfer pipette, remove some of the liquid from the bottom of the cup. Add one drop of this liquid to a clean microscope slide label your slide (1, 2 or 3). Add a coverslip. Make one slide with liquid from each cup.
2. Focus your sample under high power (400X is required to see most organisms)
3. Draw and describe what you see below. Protists will appear as bigger cells with a nucleus. Bacteria are much smaller, and there will be a variety of shapes. You may see them "swimming" around under the slide. Fungal spores may be present as well; these will look like small dots…bigger than the bacteria, but smaller than most of the protists.

Sample #1	Sample #2	Sample #3
		
Description:	Description:	Description:

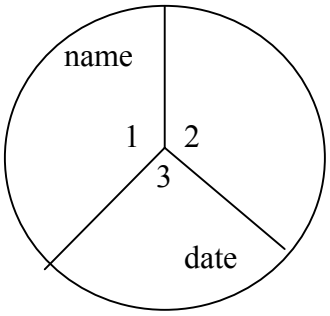
4. Now using forceps remove a small amount of mold from cup 1 and add it to a microscope slide. Add a drop of water to the sample and cover with a coverslip. Observe under the microscope at 100X. Draw and describe what you see below.
5. Repeat with cup 2, and with cup 3 if there is mold.

6.

Sample #1	Sample #2	Sample #3
		
Description:	Description:	Description:

II. Macroscopic Observation:

1. Label the bottom of a petri dish containing nutrient agar like the picture to the right.
2. Moisten a cotton swab with some liquid from the bottom of cup 1.
3. On the surface of the agar, gently rub the moistened swab in a zigzag fashion in the area marked 1.
4. Place the swab in the 10% bleach waste container.
5. Repeat steps 2 and 3 for cups 2 and 3.
6. Allow the petri dishes to grow for 24-48 hours at room temperature.
7. Observe and draw the microbial growth. Bacteria will look like a cloudy, slimy film growing on the surface, whereas fungi will look more hairy, like mold.



Name _____

Date _____

Analysis Questions:

1. What is the meaning of decomposition?

2. Compare and contrast chemical and physical decomposition.

3. You performed physical decomposition in this lab. What does that mean?

4. What is an example of physical decomposition in nature?

5. What is the meaning of biodegradable?

6. Which materials have changed the most since you started?

7. Which materials have changed the least since you started?

8. Compare your observations for all 3 cups. Which cups contents moved (settled) the most overall? The least? Explain a possible reason for this difference.

9. Describe the 3 cups in regards to the change in their smell over time.

    a. Cup 1

    b. Cup 2

    c. Cup 3

10. What causes the cups smell to change over time?

11. Why did the smell of cup 2 not change very much over time?

12. What organisms are responsible for the decomposition you observed?

13. Where did these organisms most likely come from and, what proof do you have that these organisms exist?

14. Why is chemical decomposition important to our environment and us?

15. Why is recycling of inorganic materials important to our environment and us?

Teacher's Guide

Overview

This lab is a great way to introduce the differences between inorganic and organic substances. It can also be part of an ecology unit or a microbiology unit. The students will observe the changes (or the lack thereof) in materials as they decompose over time. They will compare a cup of all biodegradable items, to one with all non-biodegradable items, to one with a mixture of both. They will observe smell, appearance and movement of the materials as they decompose over the course of 3 weeks. At the end of three weeks, they will observe the microbes growing in each cup in a microscope and/or on a petri dish.

Instructional Objectives

At the end of this activity, the students should be able to:

1. Demonstrate the following laboratory skills:
    a. Comparing and contrasting
    b. Following directions
    c. Constructing and compiling a data table.
    d. Using a microscope.

2. Demonstrate the methods of scientific inquiry by:
    a. Perform an experiment according to given directions
    b. Form hypotheses
    c. Gathering and organizing data
    d. Analyzing data

3. Demonstrate the understanding of the following scientific concepts:
    a. Organic materials can biodegrade, inorganic ones can't.
        a. Organic materials can be used as food for decomposers.
        b. Decomposers play a vital role in recycling nutrients.
        c. Bacteria, Protists and Fungi can be decomposers.
        d. Decomposition is the chemical breakdown of compounds.
        e. Chemical decomposition changes a substance into something new.
        f. Physical decomposition breaks something into smaller amounts.
        g. Bacteria, protests and fungi are everywhere.

Background

Environmental education is an area of renewed focus for science teachers, and standardized tests are filled with questions regarding treatment of hazardous waste, resource management and landfill issues. Decomposition and recycling are two key issues that can be address with

this lab. In this lab, students get the opportunity to collect their own trash, and to see the different properties of decomposition based on the material. In part B or this lab, decomposition is linked with ecology as microorganisms achieve the necessary job of biodegradation. You could use this activity in many different places in the curriculum. What is the difference between organic and inorganic material? What happens to trash after we throw it away? How do unused organic compounds get recycled for use by plants and other organisms to maintain the cycle of nutrients throughout our ecosphere? Where do bacteria, protist and fungi live and grow? What do bacteria, fungi and protists look like?

Sources of Supplies

Schnucks Supermarkets:

Solo brand clear plastic cups	"lids"	18	10 oz cups	$1.00
Solo brand clear plastic cups	"bottoms"	20	9 oz cups	$1.00

Preparation

- There is very little prep for this lab.

- A few days in advance, or on day one of the lab, students need to bring in both biodegradable trash and non-biodegradable trash. The non-biodegradable trash should be washed before using if it contained food.

Teacher's Hints and Troubleshooting

- You may want to have trash on hand for the students to use. Coffee grounds are an excellent biodegradable additive and it makes the contents look more like soil at the end. Try to get each group to bring in coffee grounds.

- Colored glass like from a beer bottle works well because you can see it easily. To break glass, wrap bottle in aluminum foil and two plastic supermarket bags. Hit against a hard surface. Be careful when using the pieces as some may be sharp.

- After the cups are shaken, it is sometimes hard to make any specific items out. You may want to have the students add a few extra items of particular interest. Place them along the edge of the cup to make observation easier.

- Be sure that the students make slits in the lids, not holes. Holes will let in fruit flies.

- Show the students how to waft the air toward their face to smell the cups. The cups get very stinky after a few days, but the smell does get better after about a week.

- Avoid having students who know they are allergic to mold (or just have a lot of allergies) smell the cups. Allow others in their group to take this observation.