Getting the Dirt on Decomposition

Grade Level:	**Total Time Required:**
5	3 – 50 minute sessions or 5 – 50 minute sessions with optional lessons.

Prepared By: Brenda Capobianco, Chelsey Dankenbring, David Eichinger, and Seth Barry

Lesson Objectives:

In this lesson, students will develop a procedure or protocol to make compost. Students will explore the properties of organic materials and make observations of commercially prepared compost; create a compost column that will store ingredients selected by the students and make observations over time; and, discover that the procedure can make the difference between good compost and bad compost.

Students will be able to:

1. Define decomposition.
2. Identify three different examples of decomposers (e.g., insects, bacteria, and fungi).
3. Differentiate between aerobic and anaerobic decomposers.
4. Explain what decomposers do (i.e., the role they play in the ecosystem).
5. Use evidence to explain how certain factors (e.g., abiotic and biotic) influence decomposition.
6. Develop a compost protocol or procedure for good compost.

Indiana Standards:

5.LS.2 Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

6.LS.4 Investigate and use data to explain how changes in biotic and abiotic components in a given habitat can be beneficial or detrimental to native plants and animals.

3-5.E.1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

3-5.E.3 Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Next Generation Science Standards:

Discipline Core Ideas

3-5.ETS1-1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

Science/Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence

Crosscutting Concepts
2. Cause and effect: Mechanism and explanation.

Common Core Mathematics:

Common Core English and Language Arts:

Concepts and Vocabulary

Term	***Defined by a scientist or engineer***	***Defined by a student***
Decomposer	Organisms that break down the dead or decaying organisms, and in doing so carry out the natural process of decomposition An organism which gains energy by breaking down the final remains of living things. Predominantly bacteria and fungi, decomposers are important in freeing the last of minerals and nutrients from organics and recycling them back into the food web	Something that breaks down something
Abiotic (factor)	A non-living chemical or physical factor in the environment, such as soil, pH, forest fire, etc. Abiotic factors may be grouped into the following main categories: • climatic factors - include sunlight, humidity, temperature, atmosphere, etc. • edaphic factors - include the nature and type of the soil, geology of the land, etc. • social factors - include land use, water resources, etc.	
Biotic (factor)	A factor created by a living thing or any living component within an environment in which the action of the organism affects the life of another organism, for example a predator consuming its prey. Biotic factors are factors resulting from the activities of a living thing or any living component in an environment, such as the actions of an organism affecting the life of another organism. For instance, in a quail's environment, the biotic factors are the living elements of the environment such as the quail's prey (e.g., insects, seeds, etc.) and the quail's predators (e.g., coyotes, foxes, and skunks).	May confuse biotic with bionic → robot-like

Decomposition	Process by which tissues of a dead organism break down into simpler forms of matter (e.g., plant, animal, and food decomposition).	Decay
Aerobic decomposer	A decomposer requiring air or a form of oxygen for life or survival (e.g., bacteria, fleas, beetles, worms).	Something that needs to exercise to break down something
Anaerobic decomposer	A decomposer that can function without air or a form of oxygen (e.g., bacteria).	

Equipment, Materials, and Tools

Materials		
1 to 2 Liter bottles	Brown and green leaves	Water
Soil	Red worms	Grass/lawn cuttings
Food scraps (i.e., fruit rinds)		

Tools		
X-acto knife	Rulers	Thermometers
Scissors		

Preparation

In an effort to save class time, cut the bottles in advance. See *Bottle Biology 2nd Edition (Chapter 2 - Building a Compost Column, pp. 14-17)* for set up (See Appendix).

Determine a location in the classroom where students can store their columns.

Science Content - Basics

The following explanation of the composting process is from the University of Illinois Extension "Composting in the Home Garden" program developed by Beth Smith, former Unit Educator, Horticulture, Macon Unit, https://extension.illinois.edu/compost/process.cfm, accessed December 10, 2011.

The composting process

The composting process involves four main components: organic matter, moisture, oxygen, and bacteria.

Organic matter includes plant materials and some animal manures. Organic materials used for compost should include a mixture of brown organic material (dead leaves, twigs, manure) and green organic material (lawn clippings, fruit rinds, etc.). ***Brown materials supply carbon, while green materials supply nitrogen***. The best ratio is 1 part green to 1 part brown material. Shredding, chopping or mowing these materials into smaller pieces will help speed the composting process by increasing the surface area.

Moisture is important to support the composting process. Compost should be comparable to the wetness of a wrung-out sponge.

If the pile is too dry, materials will decompose very slowly. Add water during dry periods or when adding large amounts of brown organic material.

If the pile is too wet, turn the pile and mix the materials. Another option is to add dry, brown organic materials.

Oxygen is needed to support the breakdown of plant material by bacteria. To supply oxygen, you will need to turn the compost so that materials at the edges are brought to the center. Turning is important for complete composting and for controlling odor.

Wait at least two weeks before turning the pile, to allow the center of the pile to "heat up" and decompose. Once the compost has cooled in the center, decomposition of the materials has taken place. Frequent turning will help speed the composting process.

Bacteria and other microorganisms are the real workers in the compost process. By supplying organic materials, water, and oxygen, the already present bacteria will break down the plant material into useful compost for the garden. As the bacteria decompose the materials, they release heat, which is concentrated in the center.

You may also add layers of soil or finished compost to supply more bacteria and speed the composting process. Commercial starters are available but should not be

necessary for compost piles that have a proper carbon to nitrogen ratio (1 part green organic material to 1 part brown organic material).

In addition to bacteria, larger organisms including insects and earthworms (red) are active composters. These organisms break down large materials in the compost.

Synopsis of Engineering Design Activity

Synopsis of the Design Activity:

Problem:	Approximately 2/3 of Haitians depend on agriculture as both a source of income and food; their soil quality, however, is poor. Due to deforestation, drought, and soil erosion caused from hurricanes and flooding catastrophes Haitians are unable to cultivate their land and produce crops.
Goal:	Haiti would like to hire your design team to develop an efficient compost column to restore the soil and enhance agricultural productivity.
Who is the client:	Haitian government
End-User:	Residents of Haiti
What is the design:	Develop an efficient compost column.
Criteria:	• You may include up to 5 ingredients • The total mass of your ingredients must be between 20g and 40g • You must add water, between 200ml and 400ml, every few days
Constraints:	• May only use the materials available • Time

Lesson Plan #1
Guiding Question – Why an apple on the ground rots away and eventually disappears?

Time: One 50 minute class session

Procedure:

1. Distribute "The Rotting Apple" prompt (see *Uncovering Student Ideas in Science, Vol 3, p. 139*). Instruct students to read the prompt individually. Then instruct students to share their responses with members of the group.

   Ask: Which student does your group most agree with? Why?

2. Instruct students to complete a K-W-L chart.

   Ask: What do you KNOW about decay, decomposers, and decomposition?
   How do you know if something had decayed?
   What does it look like? What does it smell like?

3. Distribute one set of images that illustrate evidence of decomposition over time (See Appendix).

4. Instruct students to work in teams to sort and organize the images from first stage to last stage of decomposition.

   Ask: How did you organize the images?
   Why did you organize them in that manner?
   Looking at this image, what are signs of decomposition?
   How can you tell the materials have decomposed in one image rather than another?
   Describe for me what the pile looked like at the very beginning?

Homework: Encourage students to conduct a web search on making your own compost bin/pile. Instruct students to come to class with 3 to 5 facts/tips/suggestions for making your own compost. (Alternatively, create a library experience where students can conduct preliminary research on composting).

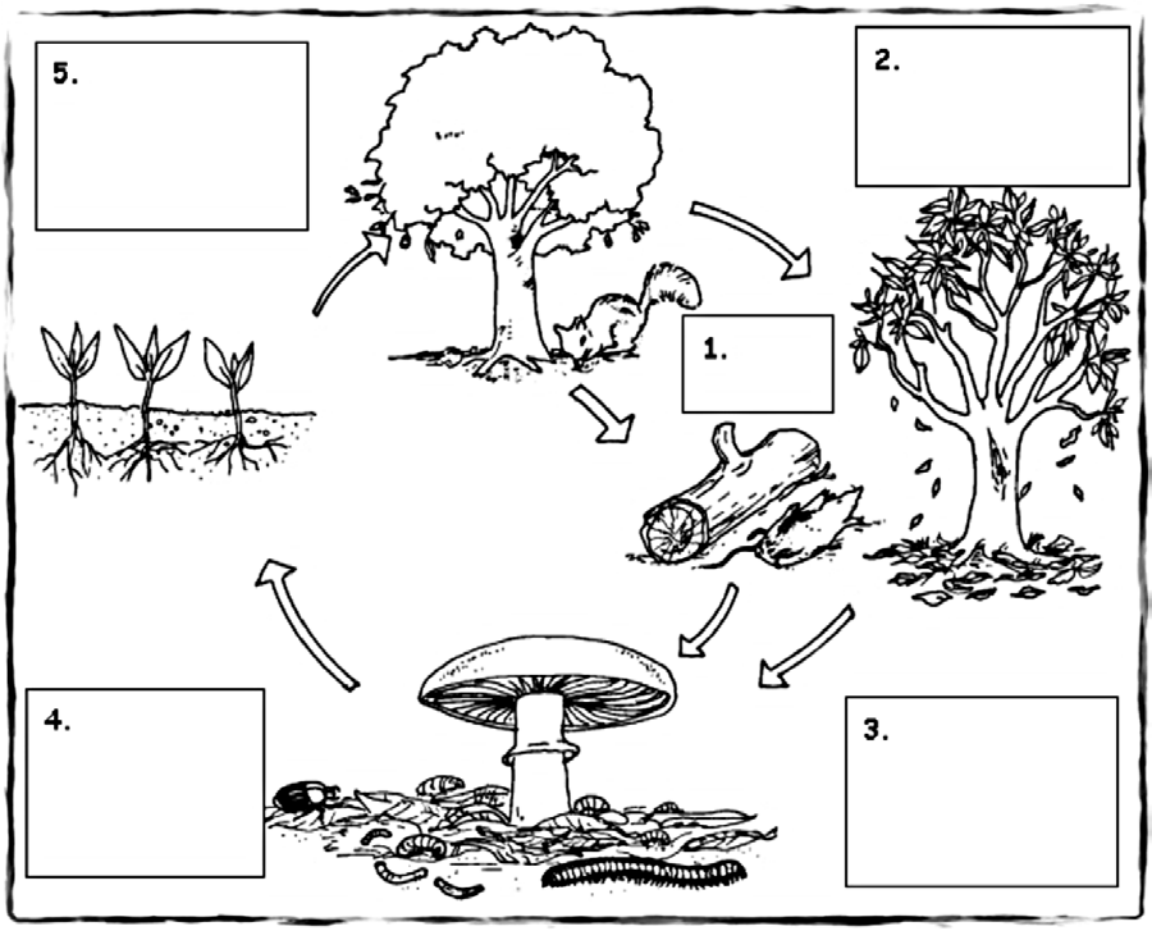
Lesson Plan #2
Guiding Question – Can you design and build a compost column?

Time: Two 50 minute class periods

Procedure:

1. Describe the process of decomposition and the compost cycle. Explain the various organisms involved in the compost cycle and their role in the process.

    - Plants and animals die. (1)
    - Plants and animals produce waste material (e.g., leaves). (2)
    - Decomposers break down the waste material and use part of it as food. (3)
    - Other parts are broken down into chemicals and are released into the air or the soil. (4)
    - The chemicals are absorbed by other plants and are again taken up into the food chain. (5)



Ask: Using your own words, describe what is happening at each stage?
What organisms are involved in decomposition in Stage 3 and what are their roles?
[Note: these are "decomposers" and they include bacteria, insects and fungi]
What do you think are the benefits of decomposition?
Looking at Stages 2, 3, or 4 what factors affect decomposition?
What can be used in a compost pile?

2. Display the various materials to the class that can be used in the compost column. These materials include the following:

   Soil, food scraps, grass, brown leaves, green leaves, red worms, grass cuttings, water

3. Discuss the properties of each material

   Ask: Please pick one material and describe its properties. (Encourage students to describe its color, size (estimate its weight), smell, and texture)
   Do you think this material would be good in a compost pile? Why or why not?
   How long do you think it would take to decompose?
   How do the various items in compost pile affect decomposition?

4. Distribute the *Design Challenge – Can you design a compost column?*

5. Instruct students to list the materials that want to use and the procedure for making good compost. Record this in their notebooks.

6. Instruct students to work as a team to share their plans/procedures and decide on one procedure for their compost column. Each student must record the procedure in his/her notebook. The procedure (or compost column) should include a list of materials, how much of each material, the order in which the materials will be placed and the rationale for selecting these materials and arranging them in a particular order.

7. Students work together to construct their compost column.

8. Once each team has constructed his/her compost column, instruct students to select one representative from each to team to report out and share the design of their column.

9. Discuss with the whole class general maintenance of his/her compost column (i.e., weekly rainstorms).

Lesson Plan #3
Guiding Question – What can you measure when observing your compost column?

Time: One 50 minute class period

Procedure:

1. Instruct each student team to observe their compost columns.

   Ask: How will we know if our compost columns are working? In other words, what can you predict will happen and what will this look like?
   What do you predict will happen each week?

2. Instruct students to write their predictions in their notebooks. Instruct students to share their predictions and a rationale for their predictions.

   Ask: What should we measure? Or what can we measure?

3. Instruct students to discuss with their team members any three to five things they can measure on a weekly basis (refer to the Design Challenge, second paragraph).

4. Instruct each student team to share their ideas and explain why they think these measures will be effective.

   Ask: What will you measure?
   How will you record these measurements?

5. Instruct students to create a series of data tables in their notebooks to organize their measurements on a weekly basis. Below are some examples.

Table 1: Temperature of materials over 6 weeks

Week	Temperature of materials	My Field Notes
1		
2		
3		
4		
5		
6		

Table 2: General appearance of compost materials over 6 weeks

Week	Appearance		
	Color	Odor	Presence of bugs, mold, or other
1			
2			
3			
4			
5			
6			

6. Instruct students that they will be responsible for recording three different measures each week.

Lesson Plan #4
Guiding Question – What do your observations of your compost column tell you?

Time: One 50 minute class period (preferably after ~6 weeks of data collection)

Procedure:

Preparation: Set up microscopes

1. Discuss observations made since construction of compost column
   Ask: What have you observed with your compost column?
   Which materials are decomposing?
   Which materials are not decomposing?
   Why do you think this is?
   Do you see any organisms?

2. Instruct students to graph the results from their observations.
   Ask: What is happening with the temperature of your compost column?
   What does your graph tell you?
   How does the temperature of compost column compare to the temperature of the room?
   Is there a difference? Why?
   What is happening with the general appearance of your compost column?
   What does your graph indicate?

3. Collect a sample of the "rain water" and observe samples under a microscope. Have students sketch the organisms they observe.
   Ask: What is happening with the water?
   Is there anything in the water? Where did it come from?
   What is its role in the decomposition process?

4. After 6 weeks, substantial changes should have taken place within each compost column. Instruct students to share their observations (data) and discuss whether or not their compost column met the initial goals of the design challenge.
   Ask: Which column design was most effective at making compost?
   What worked?
   What did not work?
   What is the procedure (protocol) for making a good compost?
   What are some common or basic principles or rules we can write in light of what we have learned about decomposition and composting?

5. Instruct students to return to their original K-W-L chart and complete the L – What have you learned about decomposers and decomposition.

Assessment

The following are possible sources of formative and summative assessment:

Formative assessment:

- Use a K-W-L chart to determine what students already know about decomposition.
- Use notebooks as a means of chronicling students' abilities to organize and record data over time.

Summative assessment:

- Encourage students to write a persuasive letter to the *Smell Like Dirt Company* describing how their compost would be most effective at helping out farmers of Haiti.

Lesson Extensions and Resources

Activity Extensions:

Design and construct a class-size compost bin using a 3 or 10 Gallon cooler. Make an H-bar apparatus using 2 x 4 pieces of wood. Add a crank to the apparatus. Encourage students to bring in organic material and feed the compost bin regularly. Record observations on a weekly basis. Let students document their efforts with photos. Later encourage students to make a multimedia documentary of their project. Use the compost for planting a school garden and/or donate the compost to a local co-op garden association.

Web Resources:

Teaching with Worms: http://yucky.discovery.com/teachercenter/pg000185.htm#sites
This site helps students discover why the result of an earthworm's work is known as "brown gold" to a gardener.

Making a Worm Compost Bin: http://www.csgn.org/images/pdf/MakingAWormCompostBin.pdf

Indoor Compost Bin:
http://www.greeneducationfoundation.org/index.php?option=com_content&view=article&id=210:build-an-indoor-compost-bin&catid=85:grades-3-5&Itemid=61

Producers, consumers, and decomposers:
http://www.teachersdomain.org/resource/tdc02.sci.life.oate.lp_energyweb/

Design and Build a Compost Column

Design Challenge: "How can we build an efficient compost column?"

The citizens of Haiti need your help. Haiti is a country located on the island Hispaniola and is one of the poorest countries in the Americas. Approximately 2/3 of Haitians depend on agriculture as both a source of income and food; however, their soil quality is poor. Due to deforestation, drought, and soil erosion caused from hurricanes and flooding catastrophes Haitians are unable to cultivate their land and produce crops. Compost bins are an efficient means of replenishing the soil with nutrients by decomposing organic matter. Haiti would like to hire your design team to develop an efficient compost column to restore the soil and enhance agricultural productivity.

You will work as a member of a small design team to design and construct a compost column. Your team will study what ingredients should be included, how long decomposition takes, and the best conditions for quick decomposition. You will need to observe the color, temperature, smell, and texture of the compost components, measure the mass of your compost, and sketch organisms present each week and record all observations in your design notebook. The organic material in your compost column should be organized in such a way to maximize rate of decomposition.

Constraints:

- You may include up to 5 ingredients
- The total mass of your ingredients must be between 20g and 40g
- You must add water, between 200ml and 400ml, every few days