Module 5 • Overview • What Happens to Dead Stuff?

Brief Overview

This module introduces the process of decomposition. Children will learn about the process of decomposition and the important ecological role decomposers play in the environment. They will begin to understand the interconnectedness of all biotic things big and small, dead and alive. Worms and ants will be introduced as two types of decomposers. Students will perform an extensive investigation: 1) How does land cover affect earthworm population?

Time

14 – 15 sessions (Each session is 1-1.5 hours)

Desired Outcomes

Students will:

- Develop an understanding of the decomposition process.
- Be able to indentify decomposers (ants and earthworms) in the environment.
- Perform and analyze the results of a scientific investigation.

What You'll Need

Materials

- Journals for each student
- Pens and pencils

- Crayons and/or markers
- Drawing paper
- Paper shopping bags
- Dead leaves, grass clippings, twigs
- Old newspapers
- Clipboards with pencil attached
- Pipe cleaners (approx. 2 per student)
- Hand lenses
- Masking tape
- Clear tape
- Permanent markers
- Glue
- Posterboard
- 1 large plastic trash bag
- Book: Wiggling Worms at Work
- Earthworm Kit for Lesson 3 Part 2
- 2 10-gallon Rubbermaid containers (Roughneck-style, not allowing any light in)
- 2 bricks or small garden pavers
- a newspaper
- 1 lb. of red wiggler worms (less can be use, as the worms multiply quickly)
- a cup of soil or dirt (can be taken from a garden area in the schoolyard)

Worksheets and Handouts

- *Ants in the Schoolyard!*
- *An Earthworm Is . . .*
- *Fascinating Facts About the Amazing Earthworm*
- *Aerial Photo of Schoolyard*
- *Dr. Szlavez's letter*

Journals

- *What Do You Know About Ants?*
- *A Day in the Life of an Ant*

Posters

- Abiotic/Biotic
- Earthworm Investigation Summary Chart
- Dead Leaf Story Board Challenge

People Power

- Adult volunteers would be useful during Lesson 3: Where Will We Find Earthworms on the Schoolyard? And Part 2: Conducting the Investigation.

- Contact the Parks and People Foundation to have a staff member assist with the Culminating Activity (making a worm bin).

New Vocabulary

Abdomen
The rear section of an insect's body.

Analyze
To examine, closely study, and evaluate in order to better understand

Antennae
Sensory organs on the head of ants used to pick up signals and communicate with other ants.

Break down
The process where something larger is made into smaller pieces

Burrow
A worm's shelter under the ground

Burrowing
Moving through the soil by twisting and turning

Castings
Worms' waste product or poop that is full of nutrients for plants

Clitellum (Cli-tell-um: Long I, cli sounds like spy)
A thickened band that wraps around an adult worm's body. It is used for reproduction

Colleague
A person who one works closely with on a project or in a profession

A fellow member of a profession, staff, academic faculty or other organization; an associate

Colony
A distinguishable localized population within a species.

Compost
A mixture of decomposed organic matter used for fertilizing and conditioning garden soil or other land

Control
The item that stays unchanged in an experiment

Decomposer
An animal or microbe that uses dead plants and animals as food

Decomposition
The natural process of dead things breaking down into the basic materials they are made of; the breakdown of matter into simpler compounds

Exoskeleton
The protective outer covering on the body of an insect.

Guess
An opinion about something made WITHOUT information or evidence

Hypothesis
A statement that can be tested. It often states an action as well as a predicted result

Interpret
To explain or tell the meaning of information or data

Invertebrate
A living thing that does not have a backbone

Leaf Litter
A layer of fallen leaves, small twigs, seeds, and other woody debris that falls and collects on the ground under trees and shrubs

Matter
The substance that something is made of

Midden
A pile of worm castings in front of their burrows

Nutrient
A substance that does not provide energy, but supplies minerals that living things need to stay healthy

Organic
Something that comes from plants and animals

Organism
A single individual living thing; plant, animal, or microbe

Pheromone
A chemical produced by an animal that serves as a means to communicate with other members of its species.

Plot
An area of land or ground

Population
A group of the same kind of organism living in the same place

Prediction
A forecast or declaration of what is going to happen (it is NOT necessarily expressed as a testable statement)

Quadrant
A square measuring area used to sample living things in a given site

Slurry
A watery mixture (in our case made up of water and mustard powder)

Soil Ecologist
An ecologist who studies the interactions among soil organisms and interactions between biotic and abiotic aspects of the soil environment

Thorax
The middle section of an insect's body.

Vegetation
Plant life, or total plant cover

Vermicompost
The cultivation of worms for the use of compost.

Careers

- **Soil Ecologist**

Preparing for the Lessons

Leaders will:

- Review the lesson sequences and the lesson preparation directions
- Prepare areas in the classroom and hallways for hanging student work
- Clean/remove "unsafe" objects from outdoor areas where students will investigate
- Review the information found in Leader Tools including sample answer sheets
- Prepare posters for lesson
- Identify potential parent or school adult volunteers
- Identify possibilities for a culminating activity and arrange for any field trips or classroom visitors
- Gather materials for the Investigations

Module 5 • Lesson 1 • Pre-Assessment: What Happens to Dead Stuff?

Action Synopsis

Students express their ideas about what happens to dead stuff. Students will examine dead leaves and make conclusions about why dead leaves seem to disappear over time.

Time

1 – 2 sessions

Desired Outcomes

The pre-assessment will be completed and will serve as a measure of student thinking about decomposition.

What You'll Need

For Each Student

□ Journal
□ Pens and pencils

For Each Small Group

□ Large paper shopping bag
□ Dead leaves, grass clippings, twigs

For Whole Class

□ Old newspapers to cover small group tables
□ Poster: Abiotic/Biotic (make two headings, one labeled "Abiotic" and one labeled "Biotic")
□ 1 large plastic trash bag

Preparing for the Lesson

Leaders will:

- Read background material on decomposition found in Leader Tools
- Check the schoolyard for and remove "unsafe" objects such as broken glass, needles, bottles, etc
- Check the schoolyard for dead leaves and, based on availability, decide on leaf collection plan.
- Collect and bag leaves (if decision is that children will not collect leaves)
- Collect old newspapers

- Gather all other materials for lesson

New Vocabulary

Vegetation
Plant life or total plant cover

Assessments

- Drawings and descriptions of what happens to vegetation after it dies

Lesson Sequence

1. Ask if there are any students who were in KidsGrow before this year. If so, ask if they remember the lessons where they inventoried what was in the classroom, the schoolyard and the neighborhood (this activity may have been completed this school year if Module 1 was taught). If anyone participated, ask them to try to explain the activity to the group. If no one participated or remembers the details explain to the children that the class used their observation skills to observe and list things that were in the classroom, the schoolyard and the neighborhood. Then they used a sorting system to classify things as either: **P = People**, **O = Other Living Things**, **D = Things That Were Alive but Are Now Dead, and N = Things That Are Not Alive and Were Never Alive.** You may also choose to do this activity with your students. The activity is a good introduction to the terms biotic and abiotic.

2. Things that are alive, or used to be alive are called *biotic.* Things that were never alive are called *abiotic.* (Leader Note: Vocabulary words from Module 1: Overview.) Quickly have the children list some things that can be found in the classroom or schoolyard that are biotic. Then have them list things that are abiotic. Use your poster "Abiotic/Biotic." Once you're comfortable that the children understand the difference between biotic and abiotic, move on. Save the chart paper to refer to in Lesson 5.

3. Explain that KidsGrow is beginning a study of what happens to stuff! We are starting with one particular kind of stuff; plants, leaves, and flowers. These make up a category called *vegetation*. We will NOT be talking about what happens to people or other living things (animals) that die.

4. Pick a few kinds of vegetation to talk about in more detail. For example, trees, grass, leaves, etc. Ask the children: Does grass live forever? What happens to a rose after it blooms? If you plant lettuce seeds and harvest the lettuce what happens to the plant? What happens to the leaves that change color and fall from the trees in the autumn?

5. Ask the children to take out their journals. Have them write across a clean page the title: *What Happens to Plants After They Die?* (You can write the title on the board for the children to copy.) Explain to the children that you would like them to think a few minutes about this question. Then you would like them to draw a picture of some type of vegetation that is dying; a plant, grass, flower, etc. Ask them to also write a few sentences to describe what is happening in their picture. Encourage them to use descriptive words to note changes in color, size, texture, odor, etc.

6. When the children have finished ask for volunteers to come up and read their journal entries. If you would like to have all of the children read their entries that's great too!

7. Pass out a large paper bag to each small group of students. Explain that the class will be going outside in the schoolyard to collect leaves from the ground. If you don't think there will be enough leaves on the schoolyard you have a few options: (1) Bring leaves in from somewhere else, (2) Take the children to a nearby park to collect leaves, (3) Collect just one bag of leaves rather than one bag per small group.

8. Back in the classroom pass out old newspapers to each small group and have them lay the newspapers over their work tables. Then have them empty their bag of leaves on top of the newspaper. Have the children touch and smell the leaves. Ask them to take out their journals and choose 1 – 2 leaves to draw a picture of (in their journals). Have them write a description of the leaves using four of their senses – sight, hearing, touch, and smell. (No tasting please!) If you like you can provide writing cues:

   My leaf looks _____.

   When I handle my leaf it sounds _____ .

   When I touch my leaf it feels _____ .

   My leaf smells _____.

9. When the group is finished choose a volunteer to go around the room with a large plastic trash bag to collect the leaves. Then collect the newspapers for recycling. Either take the children outside to put the leaves back in the schoolyard or explain to them that you will do it later.

Maryland SC Standards (2nd and 3rd Grade): *Standards are presented in the following format:* *(Grade)Standard.Topic.Indicator.Objective – Objective Statement*	
Science	
Standard 1.0 Skills and Processes: Students will demonstrate the thinking and acting inherent in the practice of science.	**Constructing Knowledge** (2)(3)1.A.1.a – Describe what can be learned about things by just observing those things carefully and adding information by sometimes doing something to the things and noting what happens. (2)(3)1.A.1.b – Seek information through reading, observation, exploration, and investigations. **Applying Evidence and Reasoning** (2)(3)1.B.1.b – Develop reasonable explanations for observations made, investigations completed, and information gained by sharing ideas and listening to others' ideas. **Communicating Scientific Information** (2)(3)1.C.1.a – Describe things as accurately as possible and compare observations with those of others. (2)(3)1.C.1.c – Draw pictures that correctly portray at least some features of the thing being described and sequence events. (2)(3)1.C.1.d – Have opportunities to work with a team, share findings with others, and recognize that all team members should reach their own conclusions about what the findings mean. (2)(3)1.C.1.e – Recognize that everybody can do science and invent things and ideas.
Standard 3.0 Life Science: Students will use scientific skills and processes to explain the dynamic nature of living things, their interactions, and the results from the interactions that occur over time.	**Ecology** (3)2.E.1.d – Ask and develop possible answers to questions about what happens to the materials that living things are made of when they die.

Module 5 • Lesson 2 • Amazing Ants!

Action Synopsis

Students express their knowledge about ants. They will identify the role of ants as decomposers while locating ant populations in their schoolyard ecosystem. Finally, students will model the social behavior of ants and discuss the importance of communication and teamwork among a population of organisms.

Time

2 sessions

Desired Outcomes

Students will:
- Identify the ecological role of ants as it relates to decomposition.
- Identify the social characteristics of ants that make them effective decomposers.

What You'll Need

For Each Student

□ Journal
(Session 1 Sheet: *What Do You Know About Ants?*; Session 2 Sheet: *A Day in the Life of an Ant*)
□ Pens and pencils

For Each Small Group

Session 1:
□ Worksheet: *Ants in the Schoolyard!*
□ Clipboard with a pencil attached
□ Hand lens

For Whole Class

□ Pipe cleaners (at least 2 per student; twisted into different shapes/styles to represent food resources)

Preparing for the Lesson

Leaders will:
- Read background material on ants using the student handout.

- Copy Journal sheets for Sessions 1 and 2 (Make enough copies for each student.)
- Copy Handout: *Amazing Ants!* (Make enough copies for each student.)
- Gather supplies & materials
- Session 2: You will have to locate a large area in the schoolyard in which you will play a game. Spread the twisted pipe cleaners (i.e. food resources) throughout the area prior to the students arriving. You will also need to select a specific location in this area where the queen ant will be located for the duration of the game.

New Vocabulary

Abdomen
The rear section of an insect's body.

Antennae
Sensory organs on the head of ants used to pick up signals and communicate with other ants.

Colony
A distinguishable localized population within a species.

Decomposer
An animal or microbe that uses dead plants and animals as food

Exoskeleton
The protective outer covering on the body of an insect.

Thorax
The middle section of an insect's body.

Pheromone
A chemical produced by an animal that serves as a means to communicate with other members of its species.

Assessments

- Session 1 Journal: *What Do You Know About Ants?*
- Session 2 Journal: *A Day in the Life of an Ant*

Lesson Sequence

1. Journal activity: What Do You Know About Ants? Allow several minutes for the students to write and draw what they know about ants in their journals.

2. Explain that today we are going to explore ants. Ask the students to share some of the things that they've written in their journals to describe ants.

3. Distribute the handout *"Amazing Ants!"* to the students and read this aloud with the group. When finished, ask the students what new information they've learned about ants that they did not know before. *Students may not have heard of the term pheromone, or the fact that ants behave much like humans do in how they communicate with one another.*

4. Ask the students to restate how ants act as decomposers. Further explain that decomposers are necessary in every ecosystem in order to maintain a healthy ecosystem and recycle dead/dying materials.

5. Explain to the students that they will be going outside to investigate ant colonies in their schoolyard. Divide students into groups and distribute clipboards and investigation sheets to each group.

   Review the investigation sheets with the class, explaining all questions that students will answer. **Remind the students that they should look for ants and ant colonies (hills) without disturbing their homes or activities.**

6. Take the students outside and allow ample time (20 – 30 minutes) for students to complete the activity.

7. When students have finished their investigations, gather the students together and discuss their findings. Some questions to ask may include:
   - "Where in the schoolyard did you see the most ant colonies?"
   - "Why do you think you found them in some places but not others?"
   - "If no ant colonies were found, why do you think this was the case?"

- "What do you think needs to be available for ants in order for them to live in a particular place?"

Session 2:

1. Briefly review the previous day's activity and handout about ants. Be sure to explain the importance of communication among ant colonies in order for them to do their jobs as decomposers.

2. Explain to the students that they will be going outside to act like ants by playing a game.

3. Bring the students outside in the schoolyard and play the game "Ants at Work!" Directions for the game are found in the Leader Tools at the end of the module.

4. When students have played the game for an ample amount of time (20 – 30 minutes), gather the students to review the activity. Some questions to ask the students may include:
   - "What did you find hard about the game?" *(Some answers may include being unable to speak to one another, only being able to use gestures to communicate, having to work together to get food from one place to the other…)*
   - "What did you have to do well in order to get food to your queen?" *(Students may suggest good communication as being an important factor in order to play the game successfully.)*
   - "What can this game and the life of ants teach you about communicating with others in your own lives?" *(Answers will vary.)*

5. Have the students walk through the playing area and collect any remaining pipe cleaners.

6. Bring the students inside and have them reflect on ants by completing the Journal activity: *A Day in the Life of an Ant.*

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Standard 3.0 Life Science: Students will use scientific skills and processes to explain the dynamic nature of living things, their interactions, and the results from the interactions that occur over time.	**Ecology** (2)3.F.1.b – Explain that organisms live in habitats that supply their basic needs. • Food • Water • Air • Shelter (3)2.E.1.d – Ask and develop possible answers to questions about what happens to the materials that living things are made of when they die.

Module 5 • Lesson 3 • Earthworms Do What?

Action Synopsis

Students express their ideas about earthworms.

Time

1 session

Desired Outcomes

Students will:
- Describe their thoughts about earthworm attributes
- Describe their thoughts about what earthworms do for the environment

What You'll Need

For Each Student
□ Journal
□ Pens and pencils
□ Worksheet: *An Earthworm Is…*
□ Handout: *Fascinating Facts about the Amazing Earthworm*

For Whole Class
□ Book: Wiggling Worms at Work

Preparing for the Lesson

Leaders will:
- Read background material on earthworms
- Copy Worksheet: *An Earthworm Is…* (Make enough copies for each student.)
- Copy Handout: *Fascinating Facts About the Amazing Earthworm* (Make enough copies for each student.)
- Gather supplies & materials

New Vocabulary

Burrow
A worm's shelter under the ground

Burrowing
Moving through the soil by twisting and turning

Castings
Worms' waste product or poop that is full of nutrients for plants

Clitellumm
A thickened sack on a mature worm in which eggs are fertilized

Decomposer
An animal or microbe that uses dead plants and animals as food

Midden
A pile of worm castings in front of a worm's burrow

Assessments

- Drawings and descriptions of earthworms
- Responses on worksheet: *An Earthworm Is …*

Lesson Sequence

1. Explain that today we are going to explore earthworms. Further explain that earthworms are a type of decomposer. Ask if anyone knows what a decomposer is. Try to elicit responses from the students. When the students stop offering answers, read the New Vocabulary definition of a decomposer and explain that we will be learning more about this word later on. Continue with the earthworm discussion by asking if anyone has ever seen an earthworm. Continue with a series of questions based on the children's responses. What did it look like? What did it feel like? Where did you see it? What was it doing?

2. Ask the children to take out their journals. Give them the following challenge: *Draw a picture of an earthworm. Under your drawing write a brief description of an earthworm. Be sure to use good adjectives (describing words).*

3. When the children have finished pass out the Worksheet: *An Earthworm is ….* When the children have finished collect the Worksheets.

4. Have the children take turns sharing their journal descriptions of earthworms.

5. Read the book Wiggling Worms at Work aloud. When you are finished ask the children to share one thing they think is really neat about worms.

6. Pass out *Fascinating Facts About the Amazing Earthworm*.

7. Have the students work in pairs to choose what they think is the most fascinating fact about earthworms. Then have them make up a RAP of at least 4 lines. Be sure they write their RAP down and practice it a bit.

8. Have each group perform their RAP for the other children. Collect a copy of each group's RAP as the RAPs will make an excellent performance for the next KidsGrow Open House.

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Standard 3.0 Life Science: Students will use scientific skills and processes to explain the dynamic nature of living things, their interactions, and the results from the interactions that occur over time.	**Ecology** (2)3.F.1.b – Explain that organisms live in habitats that supply their basic needs. • Food • Water • Air • Shelter (3)2.E.1.d – Ask and develop possible answers to questions about what happens to the materials that living things are made of when they die.

Module 5 • Lesson 4 • Where Will We Find Earthworms on the Schoolyard?

Part 1 – Designing the Investigation

Action Synopsis

Students design a schoolyard investigation about earthworm populations on the schoolyard

Time

1-2 sessions

Desired Outcomes

Students will:
- Demonstrate understanding of how to set up an investigation
- Develop a hypothesis about which of two areas in the schoolyard will have more earthworms

What You'll Need

For Each Student
□ Journal
□ Pens and pencils
□ Copy of aerial photo of schoolyard
□ Copy of Dr. Szlavecz's letter

For Each Small Group
□ Clipboard (with pencil attached)

For Whole Class
□ Large aerial photo of schoolyard

Preparing for the Lesson

Leaders will:
- Request 8 ½ by 11 aerial photo of your schoolyard from Parks and People
- Make copies of aerial photos (Make enough copies for each student)
- Request heavy poster size aerial photo of your schoolyard from Parks and People

- Make copies of Dr. Szlavecz's letter (Make enough copies for each student) found in Worksheets and Handouts
- Gather supplies & materials
- Write hypothesis starter on the board

New Vocabulary

Colleague
A person who one works closely with on a project or in a profession

Guess
An opinion about something made WITHOUT information or evidence

Hypothesis
A statement that can be tested. It often states an action as well as a predicted result.

Plot
An area of land or ground

Population
A group of the same kind of organism living in the same place

Prediction
A forecast or declaration of what is going to happen (it is NOT necessarily expressed as a testable statement)

Assessments

- Were children's hypotheses stated in such a way as to be testable

Lesson Sequence

1. Introduce the investigation with the following explanation:

   A very important scientist has sent KidsGrow a letter. This scientist, Dr. Kathy Szlavecz, is known all over the world for her studies of earthworms. She does these studies right here in Baltimore City and Baltimore County. Believe it or not she has also gone to Poland, where she grew up, and studied earthworms there. She is a professor at Johns Hopkins University, which is right here in Baltimore.

Dr. Szlavecz wants to know more about earthworm populations in Baltimore City schoolyards so she contacted KidsGrow for help.

2. Read Dr. Szlavecz's letter. Encourage the children to reach the decision to help out in this research.

3. Now get started with your investigation of earthworms in the schoolyard. The investigation will involve students working together in their small groups. Each group will be identifying two areas in the schoolyard to do their investigation. They will return to their 2 areas to count the number of earthworms in each area.

4. Share your enthusiasm, interest and excitement about the investigation. Explain that the group will be going through the investigation step by step.

5. Begin by passing out the aerial maps to students. Explain what the children are looking at. Start by identifying the front, back and sides of the school and surrounding street names. (If for some reason you aren't able to get a large aerial map draw your own map on the board or on poster paper.)

6. For the purpose of this activity, you want to guide the children to classify land cover on the schoolyard in the following broad categories. As each classification is discussed list it on the board under the heading *"Types of Land Cover"* (see definition of land cover from Module 2).

   building
   asphalt
   lawn (grassy)
   trees
   shrubs
   dirt

7. Ask the children to stop and think a bit about these different kinds of land cover. Elicit and make a list of their ideas about how land cover types could affect how

many earthworms they might find? You can get the children thinking by asking what kind of habitat earthworms live in? What are their basic survival needs? Where can they find the things that meet these needs? Probe the WHY behind their thinking/responses.

8. When the students have shared their thoughts, explain that the class will be going outside to walk around the schoolyard and identify areas with different kinds of land cover. While it is ideal to do this in small groups, each with an adult leader, it can be done with the whole class together. Each group should go outside with one copy of the aerial photo, on a clipboard with a pencil attached.

9. Outside, walk around the entire schoolyard once without stopping for too much discussion. (Explain to the children that they'll have time to come back and look at specific areas.) However, do stop long enough in each area to briefly talk about the land cover type. After you have walked around the schoolyard once, explain to the group that you will now go around again more slowly. Ask each small group to identify two areas (plots) with different kinds of land cover in which to do their earthworm studies. (For example, an area with soil but no vegetation and a lawn area under a tree; or an area under a bush and an open lawn area.) It is fine if more than one group is using the same areas for their investigation, just as long as there is enough room for everyone to work. Ask the children to mark on their aerial photos where they would like to do their studies. Also have them note land cover characteristics of these areas. (Try to accommodate everyone if you can. Depending on physical space, the number of children and the number of adults you may need to make some adjustments.)

10. When everyone has finished return inside. Walk around the class and look at each small group's plot selections and make any adjustments necessary. Then have each group mark their two plots on their aerial map with a plot number. (Plot 1 & Plot 2). Ask the children to take out their journals and write a brief description of each of their plots. Remind them to use the list of *Types of Land*

Cover on the board. Other descriptions should include sunny/shady, what's around it, wildlife seen, etc.

11. When the children are finished, write these three words on the board (Guess, Prediction, and Hypothesis) leaving enough space to capture student ideas about their meaning.

12. Ask the students what they think each word means. When all responses are on the board, pull what you can from the children's' responses to elicit the correct definitions and the difference between each of these words.

13. After the discussion, ask the small group members to work together to create a group hypothesis about their two study plots. Give all groups time to finish.

14. You can provide hypothesis building blocks, based on the needs of your class. For example, you can write the following *Hypothesis Starter* on the board and have the children fill in the blanks.

    Hypothesis Starter:
    There will be more earthworms in Plot Number _____ than in Plot Number _____. I think this will happen because _____
    _____ .

15. Ask the children to think about the definition of a hypothesis again for a moment. **A statement that can be tested.** Then ask, what is the next thing we need to do? We need to have a plan as to how we will test our hypotheses. Ask for ideas of how to do this. Encourage the children to share their ideas. Hopefully, they will quickly realize that they need to count the number of earthworms that are in each plot during a set amount of time.

16. Explain that in the next lesson they will be going outside to do their investigations.

Standards alignments follow Part III of this activity.

Module 5 • Lesson 4 • Where Will We Find Earthworms on the Schoolyard?

Part 2 – Conducting the Investigation

Action Synopsis

Students conduct a schoolyard investigation of earthworm populations in two different plots on the schoolyard

Time

1 session

Desired Outcomes

Students will:

- Demonstrate ability to follow an investigation protocol

What You'll Need

For Each Student

□ Pencils
□ Copy of aerial photo of schoolyard from previous lesson
□ *Procedures* Worksheet
□ *Record* Worksheet

For Each Small Group

□ Copy of their small group aerial photo with plots identified
□ Clipboard (with pencil attached)
□ Earthworm Kit (All materials to be placed in a large bucket)
    □ large bucket
    □ plot Boundaries (4 pvc tubes and 4 pvc corners)
    □ 2 Eco-Spout Attachments
    □ 2 Gallon Size Plastic Beverage Containers (Rinsed Out)
    □ 4 tablespoons Mustard Powder
    □ Paper towels for wiping off pvc tubes
    □ Enough gloves for Each Small Group Member
    □ Stopwatch
    □ Small plastic container
    □ Tablespoon measure
    □ Plastic funnel
    □ Enough Record Sheets for Each Small Group Member
    □ Enough Procedures Worksheets for Each Small Group Member

For Whole Class

□ Large aerial photo of schoolyard

Preparing for the Lesson

Leaders will:

- Gather all required supplies and make up a supply bucket for each small group
- Seek adult volunteers
- Copy Procedures found in Worksheets and Handouts (Make enough copies for each student)
- Copy Record Sheet found in Worksheets and Handouts (Make enough copies for each student)
- Review Sample Answers to Record Sheet found in Leader Tools

New Vocabulary

Quadrant
A square measuring area used to sample living things in a given site

Slurry
A watery mixture (in our case made up of water and mustard powder)

Assessments

- Children's implementation of study procedures

Lesson Sequence

1. Begin the lesson by reminding the children that they will be conducting their earthworm investigations today. Have them take out their small group's aerial map with their study plot drawings and descriptions. Walk around the room and be sure that each small group knows the location of their two plots.

2. Hand out the *Procedures* Worksheet and read through it aloud with the children following along. Explain to the students that it is very important to follow the procedures exactly. This is a science investigation and everyone needs to follow the same procedures at each of their study plots. Being very careful and consistent is one of the hallmarks of being a scientist. It may be particularly

helpful to go over the *Record* worksheet with the students at this time. Show them how to fill it out to minimize confusion once they are outside.

3. Demonstrate how to put the pvc tubes together to make up a square. Remind the students that this square will be their study quadrat. Assign the following responsibilities: (1) supply specialist (2) mustard slurry applicator (3) water specialist (4) location specialist (5) recorder (6) counter and (7) timer. These roles can be switched and/or shared, changing at each plot site. Depending on the size of your small groups you may need to assign some children more than one role.

4. If you've been successful in recruiting adult volunteers assign one to each small group. If possible, your role should be as a floater so that you can check to be sure everyone is on task once your students are outside.

5. Before leaving the classroom, have the supply specialist get their team's bucket which will hold all of the supplies that are needed. (Remind the children to put on gloves before touching, picking up, or holding the earthworms!) Have the water specialist fill the two gallon containers with water and put the tops back on. (He/she might ask another group member to carry one of the water containers outside.)

6. When outside, monitor the students as they follow the study procedures. Have fun alongside them!

7. When everyone is finished be sure to remind the students to take apart their quadrat and wipe off the pvc tubes and elbows. Emphasize the importance of picking up all supplies and trash to take back inside.

8. When the lesson is over, please be sure that the supplies (tubes, corners & gallon containers) are clean.

Module 5 • Lesson 4 • Where Will We Find Earthworms on the Schoolyard?

Part 3 – Analyzing Our Results

Action Synopsis

Students analyze and interpret the results of their schoolyard investigation of earthworm populations in two different plots on the schoolyard

Time

1 – 2 sessions

Desired Outcomes

Students will:
- Demonstrate ability to analyze investigation results
- Demonstrate ability to interpret investigation results

What You'll Need

For Each Student
□ Journal
□ Pens and pencils

For Each Small Group
□ Copy of their small group aerial photo with plots identified
□ Copy of their small group Record Sheet

For Whole Class
□ Large Investigation Summary Chart (poster size)

Preparing for the Lesson

Leaders will:
- Prepare Large Investigation Summary Chart or request from Parks and People
- Hang Large Investigation Summary Chart
- Gather supplies & materials
- Write Hypothesis Completer on the board

New Vocabulary

Analyze
To examine, closely study, and evaluate in order to better understand

Interpret
To explain or tell the meaning of information or data

Assessments

- Children's journal entry on investigation results

Lesson Sequence

1. Begin the lesson by complimenting the children on their excellent work during the earthworm investigation. Ask for any thoughts or reactions to the investigation. Did they like it? Ask them how easy or hard it was to follow the Procedures Sheet. Explain that the children will now be analyzing and interpreting their findings. Discuss the definitions of both terms and explain the difference between analyzing and interpreting.

2. Give each group their *Investigation Record* Sheet from the previous lesson. Ask them to total their earthworm counts and complete the *Investigation Record* Sheet. Ask them to take out their journals and find their entries which include their Investigation Hypothesis Statement. Explain that they will be analyzing their individual data by doing the hypothesis completer.

3. Discuss the hypothesis completer with the children.

   My hypothesis was ____ right ____ wrong
   We found more earthworms in:
   (Fill in type of landcover) _____
   Than in (Fill in type of landcover) _____

4. Have the small group members work together. However, have each child write the hypothesis completer in their own journal.

5. Emphasize that it is just as valuable to have a "wrong" hypothesis as a "right" hypothesis. What makes an investigation valuable is beginning with a hypothesis (a statement that can be tested) testing it and learning something from the results.

6. Once everyone has finished their hypothesis completer SHIFT GEARS. Explain that next the class will combining each of the small groups' data together. Point out the Large Investigation Summary Chart.

7. Call on the recorder of each group; one by one. Have the recorder come to the front with their completed Group Record Sheet with the earthworm numbers recorded and the journal entries with the Hypothesis starter and Hypothesis completer.

8. When the recorder has finished, help him/her record their earthworm numbers on the Large Investigation Summary Chart in the appropriate boxes by type of land cover and group number.

9. Now it is time for some math work. Depending on the abilities of your class, the work can either be left to them or you will need to do it. As a class we want to find the average number of earthworms by type of land cover. (Add data in each row. Then divide by the number of small groups that did plots in that type of land cover. The resulting number will give you the average number of earthworms found in each type of land cover. In the last column on the right assign the number from most to fewest earthworms for each type of land cover (See leader tool for example).

10. When this is completed, work with the children to interpret their results. Discussion questions can include: Are your small group's results the same or

different from the class results taken together? If they are different, what can you say about why this could happen? (Answers: errors, groups not following the procedures exactly, groups doing one or more of the procedures differently, plots in the same type of land cover category having some differences, etc.)

11. Discuss how the results can be interpreted. In what type of land cover did your class find the most earthworms? Does this result match what you thought would be the best habitat for earthworms. Do you think you would get the same results if you did your investigation after a big rain? After a drought? In the spring? In the summer? In the winter?

12. When you have completed the interpretation of results explain to the class that they now need to report their findings to Dr. Szlavecz. Hand out lined paper and have the students write a letter to Dr. Szlavecz. You can decide if you want to use this as an opportunity to go over the correct format for a letter or just have the children write as they choose. Ask them to include the following:

    - Their small group hypothesis
    - Their small group findings
    - Whether their hypothesis was right or wrong
    - For the whole class, in what type of land cover were the most earthworms found
    - For the whole class, in what type of land cover were the fewest number of earthworms found
    - The most fascinating fact that they learned about earthworms
    - What they most liked about doing the investigation
    - What they didn't like so much about doing the investigation
    - Drawings related to the investigation would be great to include

13. Collect the children's letters and make copies for them to keep. Arrange to mail some or all of the letters to Dr. Szlavecz

Maryland SC Standards (2nd and 3rd Grade): *Standards are presented in the following format:* *(Grade)Standard.Topic.Indicator.Objective – Objective Statement*	
Science	
Standard 1.0 Skills and Processes: Students will demonstrate the thinking and acting inherent in the practice of science.	**Constructing Knowledge** (2)(3)1.A.1.a – Describe what can be learned about things by just observing those things carefully and adding information by sometimes doing something to the things and noting what happens. (2)(3)1.A.1.b – Seek information through reading, observation, exploration, and investigations. **Applying Evidence and Reasoning** (2)(3)1.B.1.b – Develop reasonable explanations for observations made, investigations completed, and information gained by sharing ideas and listening to others' ideas. **Communicating Scientific Information** (2)(3)1.C.1.a – Describe things as accurately as possible and compare observations with those of others. (2)(3)1.C.1.c – Draw pictures that correctly portray at least some features of the thing being described and sequence events. (2)(3)1.C.1.d – Have opportunities to work with a team, share findings with others, and recognize that all team members should reach their own conclusions about what the findings mean. (2)(3)1.C.1.e – Recognize that everybody can do science and invent things and ideas.
Standard 3.0 Life Science: Students will use scientific skills and processes to explain the dynamic nature of living things, their interactions, and the results from the interactions that occur over time.	**Ecology** (2)3.F.1.b – Explain that organisms live in habitats that supply their basic needs. • Food • Water • Air • Shelter (3)2.E.1.d – Ask and develop possible answers to questions about what happens to the materials that living things are made of when they die.

Module 5 • Lesson 5 • The Story of Leaves

Action Synopsis

Students create a story board to communicate what happens to leaves after falling to the ground. This lesson will pull together the concepts discussed in all previous lessons.

Time

1 – 3 sessions

Desired Outcomes

Students will:

- Demonstrate how a leaf looks at points over time
- Explain that decomposition happens because of microbes eating dead things
- Understand that matter never vanishes, it just changes form

What You'll Need

For Each Small Group (3 – 4 children)

□ poster board
□ markers
□ paints
□ construction paper
□ leaves
□ glue
□ tape

For Whole Class

□ Poster: Dead Leaf Story Board Challenge

Preparing for the Lesson

Leaders will:

- Gather all materials
- Prepare *Dead Leaf Story Board Challenge* Poster (See Leader Tool: Dead Leaf Story Board Challenge)

New Vocabulary

Matter

The substance that something is made of

Assessments

Student poster designs.

Lesson Sequence

1. Explain to the children that they have a new challenge to begin today. This challenge will give them a chance to show off their understanding of decomposition as well as their creativity and teamwork

2. Read the *Challenge Poster* to the children and leave it hanging in a place where the children can refer back to it.

3. Talk a bit about what a story board is. Explain that it is a display that usually has written information or a story and pictures or samples of things. Ask them if they have seen any story boards before. (You can probe by asking about things your group has seen together, or ask about a visit to the Science Center or African American History Museum.) The combination of words and pictures is a very good way to express your ideas to other people.

4. Show the children the materials they will have to use. Suggest that they talk with their team about planning their group story board. Suggest they bounce ideas off each other. There are some questions your group can try to answer to start the process.
    - **Who knows what a decomposing leaf looks like as it becomes more and more decomposed?**
    - **What makes leaves decompose?**
    - **Where does the stuff the leaf was made of end up?**

    While the teams are brainstorming circulate around the room and check to be sure the children are thinking, exchanging ideas and planning.

5. Give the children newsprint and have them do a layout of what they want to show on their poster. Then they can divide up sections and work on individual pieces. For example if the first part will show a tree with a leaf falling to the ground; one child can draw and label a picture on a separate sheet of paper. You might want them to work on small sheets of paper which are then pasted/taped in sequence on the poster board.

6. Have the children work on their boards.

7. When the children have finished give each team an opportunity to share their story boards with their classmates. Complete any other Open House, displays, invited guest sessions that you have planned.

8. After presentations have been completed, lead a closing discussion:

   What changes in decomposing leaves do the storyboards show?
   Leaves change a lot. They might dry up, wither, get holes in them, get nibbled around the edges, have just the veins and stems left, break into smaller and smaller pieces, turn brown, get black spots, get slimy, get white fuzz on them, smell rotten or strong or bad.

   What did the storyboards show as the causes of decomposition?
   The main cause of decomposition is the organisms that use dead leaves as food. Invertebrates are one kind of decomposer; like earthworms, termites, beetles, sow bugs, and millipedes. They are called soil organisms. They eat leaves and also sometimes chew leaves and leave these on the ground.

   Microbes and fungi are another kind of decomposer. They eat the particles of leaves in the soil organism's droppings (poop) and chewed leaf leftovers. They break these down even more into smaller pieces.

Wind, rain and trampling are also a factor. But their role in decomposition is TINY compared to the biological (living) decomposers like soil organisms and microbes and fungi. Other physical factors, like moisture and heat make it a little easier for microbes to eat dead material.

Do the materials that a decomposed leaf was made of still exist?

This is the $64,000 question that gets to the concept of the conservation of matter. You'll probably have some students who don't completely understand this concept; that matter can neither be created or destroyed. Some may still think that the leaf pieces that have gone into the soil still exist, but that the rest of the leaf disappears.

Do dead leaves really disappear?

You might not be able to still see a decompose leaf, but the material it was made of does not stop existing. Decomposition is an example of the conservation of matter. This means that the matter is conserved or stays. In our example, the leaf matter becomes part of the organisms that ate it. Or it is released from that organism's waste (poop) into the soil, water or air. All matter can be accounted for. Nothing has vanished.

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Science	
Standard 1.0 Skills and Processes: Students will demonstrate the thinking and acting inherent in the practice of science.	**Constructing Knowledge** (2)(3)1.A.1.a – Describe what can be learned about things by just observing those things carefully and adding information by sometimes doing something to the things and noting what happens. (2)(3)1.A.1.b – Seek information through reading, observation, exploration, and investigations. **Applying Evidence and Reasoning** (2)(3)1.B.1.b – Develop reasonable explanations for observations made, investigations completed, and information gained by sharing ideas and listening to others' ideas. **Communicating Scientific Information** (2)(3)1.C.1.a – Describe things as accurately as possible and compare observations with those of others. (2)(3)1.C.1.c – Draw pictures that correctly portray at least some features of the thing being described and sequence events. (2)(3)1.C.1.d – Have opportunities to work with a team, share findings with others, and recognize that all team members should reach their own conclusions about what the findings mean. (2)(3)1.C.1.e – Recognize that everybody can do science and invent things and ideas.
Standard 3.0 Life Science: Students will use scientific skills and processes to explain the dynamic nature of living things, their interactions, and the results from the interactions that occur over time.	**Ecology** (2)3.F.1.b – Explain that organisms live in habitats that supply their basic needs. • Food • Water • Air • Shelter (3)2.E.1.b – Identify what happens to materials when they are recycled. (3)2.E.1.c – Observe and record the sequence of changes that occur to plants and animals that die and decay. (3)2.E.1.d – Ask and develop possible answers to questions about what happens to the materials that living things are made of when they die.

Module 5 • Lesson 6 • Culminating Activity: Making a Worm Compost

Backround Information for Teachers

(From the University of Nebraska at http://lancaster.unl.edu/pest/resources/Vermicompost107.shtml)

Many gardeners compost both yard waste and kitchen waste with compost piles, sheet composting or some other method during the growing season. Fortunately, very little yard waste is generated during winter months when cold temperatures make composting difficult. However, usable kitchen waste is constantly being generated and must be disposed of. Vermicomposting is the process of using worms and micro-organisms to turn kitchen waste into a black, earthy-smelling, nutrient-rich humus.

Action Synopsis

Students learn about vermicompost by creating and maintaining a worm compost bin for the classroom.

Time

2 - 3 sessions

Desired Outcomes

Students will:
- Demonstrate understanding of vermicompost as it relates to decomposition.
- Develop a worm compost bin for the classroom.

What You'll Need

For Each Student
- ☐ Journal
- ☐ Pens and pencils
- ☐ Drawing paper
- ☐ Crayons and markers

For Whole Class
- ☐ 2 10-gallon Rubbermaid containers (Roughneck-style, not allowing any light in)
- ☐ 2 bricks or small garden pavers
- ☐ a newspaper
- ☐ 1 lb. of red wiggler worms (less can be use, as the worms multiply quickly)

 a cup of soil or dirt (can be taken from a garden area in the schoolyard)

Preparing for the Lesson

Leaders will:

- Contact the Parks and People Foundation and a staff member to bring a drill to the school – OR – arrange for a staff member at the PPF to drill holes in your containers ahead of time.
- Contact the Parks and People Foundation about ensuring that all supplies (i.e. red worms) are ordered for the project.

New Vocabulary

Vermicompost

The cultivation of worms for the use of compost.

Assessments

Student flyers and drawings about the importance of decomposers.

Lesson Sequence

1. Explain to the students that they are going to apply what they know about earthworms and decomposers and create a worm bin!

2. On the chalkboard or a sheet of chart paper, briefly brainstorm with the students what they've learned about earthworms and decomposition. Write the word "vermicompost" on the board and explain the meaning of the word to the students.

3. Use the information in the Leader Tools to construct a worm compost for the classroom. Optional: Students can use butcher paper to create a sign for the worm compost and display it in the classroom where the bin will be located.

4. When the worm bin has been constructed, ask the students relate the word on the board to the activity they will be doing. *Students should understand that they participated in the process of vermicomposting by creating a worm compost.*

5. Have students create signs to explain the importance of decomposers to display around the school.

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Module 5:

Decomposition

Worksheets and Handouts

Grades 2 and 3

Amazing Ants!

Ants are very interesting creatures with many different jobs.

Like all insects, the bodies of ants have three parts: head, abdomen, and thorax. Ants also have six legs and compound eyes with many lenses attached together. They have an exoskeleton for protection, which means that their skeleton is on the outside of their body.

A very important part of an ant's body is its antennae which are used to communicate with other ants. Like people, ants live in societies where they must work together. Ants give off chemicals called pheromones that send messages to other ants. These messages are picked up by the antennae. Ants must use their antennae to tell other ants where to find the food and where there is danger!

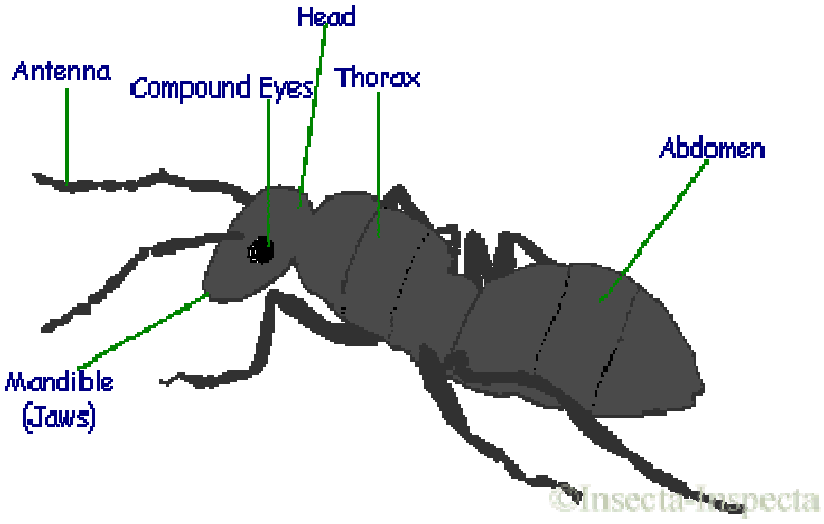

Image from: http://www.insecta-inspecta.com/ants/leafcutter/ant.gif

Like all societies, ants have different jobs. Most ants are worker ants, whose jobs are to find food and keep the ant colony safe. Other worker ants take care of the queen and the developing eggs inside the ant colony. Every ant colony has one queen whose job is to lay eggs and add more ants to the society.

Ants are helpful to our ecosystem. First, ants work as decomposers, feeding on many things including dead plants and animals as well as leftover food. Without ants, the surface of our earth would be cluttered with dead plants and animals! Another way that ants are helpful is that they put air into soil by building tunnels underground. This helps keep the soil fluffy in order for plant roots to spread. Ants keep our ecosystem clean and green!

Ants in the Schoolyard!

Module 5 – Lesson 2

Names: _____

Directions: 1. Locate an ant colony or ants working in your schoolyard.

2. Record your observations by answering the questions below.

3. Draw a picture of what you found.

1. Where did you find the ants in the schoolyard?

_____

_____

2. How many ants were there?

_____

3. What were the ants doing?

_____

Draw what you observed:

Module 5 - Lesson 4

Name _____ **Date** _____

An Earthworm Is…

Please fill in the blanks as best as you can.

1) A worm looks _____

_____

2) A worm moves by _____

_____

3) A worm eats _____

_____

4) A worm lives in _____

_____

5) One thing I think is neat about earthworms is _____

_____

_____

Module 5 - Lesson 4

FASCINATING FACTS ABOUT THE AMAZING EARTHWORM!!!!!

Earthworms Are

- **Found:**
  - all around the world
  - in all kinds of soils
  - in rivers, lakes and seashores

- **Related to:**
  - bloodworms
  - leeches

Earthworm Bodies

- **Are:**
  - usually 1 - 12 inches long, but can stretch to twice their normal length
  - segmented, this lets them stretch and recoil
  - pink, brown, reddish, or greenish
  - protected by a layer of mucus

Earthworms DON'T

- **Have:**
  - Eyes
  - Legs
  - Lungs

Earthworms DO

- **Have:**
  - heads sensitive to light
  - cells all over their bodies that detect chemicals and touch
  - bristles on each segment that grab soil as they pull their body through

- a soft flap that sweeps food into the mouth
- skin that absorbs oxygen
- five hearts

Earthworms Affect the Soil

- **By:**
  - pulling fallen leaves, dead roots, and other things underground
  - breaking down the dead stuff into chemicals
  - mixing soils by bringing castings to the surface
  - making spaces for air and water to stay in soil, rather than run off

Earthworms Help Plants Because

- **Their:**
  - castings contain nutrients that fertilize plants
  - burrows allow air and water to reach roots

Dr. Katalin Szlavecz
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3400 North Charles Street
Baltimore, Maryland 21218

Dear KidsGrow Student Scientists:

The Baltimore Ecosystem Study would like to know more about the soil and what lives in the soil around your school. We are particularly interested in earthworm populations and whether habitat features affect how many earthworms live in a place. We would like your class to help us by studying earthworms in your schoolyard.

My colleagues and I have been studying soil and earthworms in Baltimore since 1999. Soil is very important for living things. We know that earthworms only like to live in healthy soil, so counting your earthworm population will help us determine if the soils around your school are healthy. The more we understand about the soil in Baltimore, the better we can keep it and the plants that grow in it healthy.

To increase our data on earthworms in Baltimore, we would appreciate it if you could use the same techniques we use in our research. We have given your leader everything you need to do the investigation. Remember; please follow the procedures exactly so we can learn the most from your work.

I hope you will accept this request. Once you have completed the investigation, please write me a letter about your findings. Thank you for your help and good luck with your research! I'm happy to have each of you as a colleague!

Sincerely,

Dr. Katalin Szlavecz
Module 5 - Lesson 3 - Part 2

Earthworm Investigation Procedures (Outside)

It is very important, as a student scientist, that you follow these procedures very carefully! Look at the Role in bold and quotes **( )** after each task to tell who should do it! If you have any questions, be sure to ask your leader!

1. Everyone should put their gloves on. Set up a sample boundary in your first habitat. Put the tubes and elbows (corners) together just like your teacher demonstrated. **(Location Specialist)**

2. Remove everything loose from the ground inside your boundary square. This means leaves, long grass, trash and sticks. You want to be able to see the ground so you can see the worms as they come out. **(Timer)**

3. Pour about ½ inch of water in your empty plastic container and set it next to your habitat. When worms come out of the ground, put them in this container and keep them there. **(Recorder)**

4. Measure out 2 tablespoons of the mustard and use the funnel to put it carefully into the gallon container. Put the top on and shake it very well. Remove the top and screw the eco-spout onto your jug. You now have a jug of mustard slurry. The slurry irritates the worms' skin and makes them come out of the ground. Don't worry though; it does not hurt the worms. **(Mustard Slurry Applicator)**

5. Slowly pour some of the slurry in your quadrat. Start your stopwatch. Add 10 minutes to start time and yell STOP after 10 minutes **(Timer)** GO SLOW!! Wait for the mustard water slurry to be absorbed into the ground before you pour more!! Do not let water run out of your plot boundaries. If the water starts to puddle or run-off, wait 30 seconds for all of the water to soak in before you start pouring again. Remember to pour slowly!! It should take you about 5 minutes to empty your jug. **(Water Specialist)**

6. Watch for worms to start coming out of the ground! Wait until the worms are completely out of the ground before you try to pick them up. The worms are pretty strong and will pull back if you try to pull them out too soon. It may hurt the worms if you pull too hard. **(ALL)**

7. As the worms come out, put them gently in the small container with the water. **(Counter)**

8. For the first couple of minutes, do not play with the worms. Observe your habitats until worms stop coming out of the ground. You should observe for 10 minutes. **(All)**

9. After worms have stopped coming out of the ground count them. **(Counter)** Write the number on the record sheet. **(Recorder)** See if you can tell which end is the head and which end is the tail.

10. Fill out the rest of the record sheet being sure to include details on site location and description. **(Recorder)**

11. When you are finished, return your worms to a shady area on the ground. Do not put them back in the area where you poured the slurry. **(Supply Specialist & Timer)**

12. Wipe off all of the mud on the habitat boundaries with your paper towels. Return all of the materials to the kit and make sure you have everything that you started with! **(Supply Specialist)**

13. Repeat Steps 1 – 12 at your second location! Use the second container of water.

Module 5 - Lesson 4 -Part 2

RECORD SHEET

Date _____

Team Members _____

HABITAT 1

# Of Earthworms (Use hatch marks to record) _____ _____ _____ **Total # _____**	**Site Description** 1) Location Description (in relation to school building; front, back, side close to _____ Street, etc.) _____ _____ _____ 2. Landcover Description from prior lesson _____ _____

HABITAT 2

# Of Earthworms (Use hatch marks to record) _____ _____ _____ **Total # _____**	**Site Description** 1) Location Description (in relation to school building; front, back, side next to _____ Street, etc.) _____ _____ _____ 2. Landcover Description from prior lesson _____ _____

Module 5:

Decomposition

Journals

Grades 2 and 3

Lesson 2 Journal 1:

What do you know about ANTS?

Name: _____

Directions: Write or draw everything you know about ants.

_____

_____

_____

_____

_____

_____

Drawing:

Lesson 2 Journal 2:

A Day in the Life of an Ant

Name: _____

Directions: Imagine that you have spend your day as an ant. Where did you go? What did you do? Write and draw about your day!

_____

_____

_____

_____

_____

_____

Drawing:

Module 5:

Decomposition

Leader Tools

Grades 2 and 3

Background Information on Decomposition

When plant die, bacteria break down the dead leaves and stems through a process known as **decomposition**. The left over decomposed matter is then available to other animals in a form they can eat. Decomposition is nature's way to recycle organic, or living, material. Organic material is broken down into nutrients that can be reused by plants as they grow. Some inorganic, or nonliving, material is broken down as well, but usually at a slower rate. Bacteria, fungi, worms, and microorganisms all help to break down these materials.

Worms in particular help to speed up the process of decomposition. They make extensive networks of tunnels that help air and water reach the roots of plants. The tunnels also provide air and water for other soil-dwelling insects and small organisms that help with the process of decomposition. Worms also turn the soil by moving deep soil up to the surface and by dragging plant materials underground. One cup (250 ml) of soil may contain more than 5 billion living creatures!

Module 5 – Lesson 2 – Session 2

Game: "Ants at Work!"

Objective: Students will learn the importance of effective communication by working together as ants in an ant colony.

Goal: To get as much food to the queen ant as possible. (The more food eaten by the queen, the more energy she has to lay eggs and add more ants to the colony.)

Players:

- The queen – One student is selected to remain at the colony and store the food.
- Worker ants – One student remains with the queen, while the rest of the students are **scouts** and roam throughout the game area (to be determined by the teacher) looking for food and bringing it to the colony.

Rules:

1. NO TALKING. Ants use their antennae and pheromones to communicate (see handout from previous lesson). Students may use their hands and bodies to gesture to each other in order to communicate.

2. Worker ants searching for food (scouts) may only walk 10 STEPS with their food at a time. That means they must signal to another scout and work together by taking turns carrying the food to the colony.

3. Worker ants may only carry ONE PIECE OF FOOD AT A TIME.

4. The queen and her worker cannot move from the colony. They must stay in one place throughout the game.

5. The queen must receive food from her worker ant only, not the scouts foraging for food. In other words, the scouts must bring the food to the queen's worker FIRST. The queen's worker may then pass it to the queen.

Allow students plenty of time to play the game. Students may want to play several rounds and take turns in different roles. If you would like to make the game more challenging, you may add rules such as:

- Students must use at least two other students to move the food (having to work together as a team instead of partners).

- Hand gestures only

- Set a certain amount of food a goal for students to achieve in order for the colony to survive.

Module 5 - Lesson 3 - Part 1

Dr. Katalin Szlavecz
Dept. of Earth and Planetary Sciences
Johns Hopkins University
3400 North Charles Street
Baltimore, Maryland 21218

Dear KidsGrow Student Scientists:

The Baltimore Ecosystem Study would like to know more about the soil and what lives in the soil around your school. We are particularly interested in earthworm populations and whether habitat features affect how many earthworms live in a place. We would like your class to help us by studying earthworms in your schoolyard.

My colleagues and I have been studying soil and earthworms in Baltimore since 1999. Soil is very important for living things. We know that earthworms only like to live in healthy soil, so counting your earthworm population will help us determine if the soils around your school are healthy. The more we understand about the soil in Baltimore, the better we can keep it and the plants that grow in it healthy.

To increase our data on earthworms in Baltimore, we would appreciate it if you could use the same techniques we use in our research. We have given your leader everything you need to do the investigation. Remember; please follow the procedures exactly so we can learn the most from your work.

I hope you will accept this request. Once you have completed the investigation, please write me a letter about your findings. Thank you for your help and good luck with your research! I'm happy to have each of you as a colleague!

Sincerely,

Dr. Katalin Szlavecz

Module 5 - Lesson 4 - Part 2

Earthworm Investigation Procedures (Outside)

It is very important, as a student scientist, that you follow these procedures very carefully! Look at the Role in bold and quotes **( )** after each task to tell who should do it! If you have any questions, be sure to ask your leader!

14. Everyone should put their gloves on. Set up a sample boundary in your first habitat. Put the tubes and elbows (corners) together just like your teacher demonstrated. **(Location Specialist)**

15. Remove everything loose from the ground inside your boundary square. This means leaves, long grass, trash and sticks. You want to be able to see the ground so you can see the worms as they come out. **(Timer)**

16. Pour about ½ inch of water in your empty plastic container and set it next to your habitat. When worms come out of the ground, put them in this container and keep them there. **(Recorder)**

17. Measure out 2 tablespoons of the mustard and use the funnel to put it carefully into the gallon container. Put the top on and shake it very well. Remove the top and screw the eco-spout onto your jug. You now have a jug of mustard slurry. The slurry irritates the worms' skin and makes them come out of the ground. Don't worry though; it does not hurt the worms. **(Mustard Slurry Applicator)**

18. Slowly pour some of the slurry in your quadrat. Start your stopwatch. Add 10 minutes to start time and yell STOP after 10 minutes **(Timer)** <u>GO SLOW!! Wait for the mustard water slurry to be absorbed into the ground before you pour more!!</u> Do not let water run out of your plot boundaries. If the water starts to puddle or run-off, wait 30 seconds for all of the water to soak in before you start pouring again. <u>Remember to pour slowly!!</u> It should take you about 5 minutes to empty your jug. **(Water Specialist)**

19. Watch for worms to start coming out of the ground! Wait until the worms are completely out of the ground before you try to pick them up. The worms are pretty strong and will pull back if you try to pull them out too soon. It may hurt the worms if you pull too hard. **(ALL)**

20. As the worms come out, put them gently in the small container with the water. **(Counter)**

21. For the first couple of minutes, do not play with the worms. Observe your habitats until worms stop coming out of the ground. You should observe for 10 minutes. **(All)**

22. After worms have stopped coming out of the ground count them. **(Counter)** Write the number on the record sheet. **(Recorder)** See if you can tell which end is the head and which end is the tail.

23. Fill out the rest of the record sheet being sure to include details on site location and description. **(Recorder)**

24. When you are finished, return your worms to a shady area on the ground. Do not put them back in the area where you poured the slurry. **(Supply Specialist & Timer)**

25. Wipe off all of the mud on the habitat boundaries with your paper towels. Return all of the materials to the kit and make sure you have everything that you started with! **(Supply Specialist)**

26. Repeat Steps 1 – 12 at your second location! Use the second container of water.

More about Earthworms

Investigations in Urban Soils: Earthworm Populations

Earthworm Background for Teachers

Earthworm Structure

Earthworms are adapted for life under the soil. Two sets of muscles inside each segment extend and contract the body. Each segment also has sets of tiny outer bristles, called setae, which anchor the worm in the soil so it can contract the rest of the body forward. You can see the setae with a hand lens, and can often feel them by running a moist finger gently lengthwise on the earthworm's body. Different species are often differentiated by the number and position of setae on each segment. (For example, Asian worms have setae all the way around each segment.) Earthworms have no eyes but have light-sensitive cells in their skin that makes them sensitive to UV radiation; over-exposure to sunlight can be fatal. Earthworms also have chemical- and touch-sensitive cells along their bodies.

The internal digestive, circulatory, and neural features run down the center of the segments. (See Figure 1) Food enters through the mouth, gets physically ground by sand grains in the gizzard, and chemically decomposed and neutralized in the intestine before being extruded from the anus as castings. Two major blood vessels carry blood; one is along the belly and can be seen well when the digestive tract is empty. Nerve endings connect to each setae and the skin surface, making earthworms sensitive to vibrations. Earthworms absorb oxygen through their moist skin. Earthworms risk their lives by coming to the surface during a rainstorm because rainwater lacks dissolved oxygen.

The clitellum plays a role in reproduction. Earthworms are hermaphroditic and can produce both male and female sex cells. When the worms mate each worm deposits sperm in the other's mucous sac around the clitellum. The sac slides down the earthworm past the ovary, which deposits eggs to be fertilized. The fertilized eggs are then deposited in the soil in the mucous egg sac, and two to three weeks later, young earthworms emerge.

The Roles of Earthworms

Earthworms play a number of roles in soil ecosystems, including:

1. Earthworms help decompose organic matter in the soil:
   - They pull plant residue underground where it can decompose.

- Inside the worms' intestines organic matter is broken down into compounds rich in nitrogen, phosphorus, hydrogen, and sulfur.
- Worms mix organic and mineral components of the soil.

2. Earthworms interact with soil microorganisms:
   - They move microorganisms from one part of the soil to another.
   - Worm castings promote the growth of soil bacteria.

3. Earthworms alter soil properties:
   - Worm burrows allow water to penetrate the subsoil, reducing runoff and making water more available to plants.
   - Burrows also help oxygenate the soil, supporting aerobic respiration by plant roots and other soil organisms.
   - Burrows reduce compaction and break up hardpans in the soil.
   - As it passes through worm intestines, soil pH is neutralized, making acidic or basic soil less so.
   - Worm castings improve availability of nutrients and minerals to plants, reducing the need for chemical fertilizers.

4. Earthworms serve as food for other organisms:
   - Worms are eaten by birds, frogs, salamanders

5. Earthworms are important predators:
   - Worms eat harmful nematodes and create soil conditions that discourage their presence.

Earthworm Species

There are at least 3,000 species of earthworms living all over the world. Scientists use sometimes-microscopic external and internal structures to identify species. Only mature earthworms are used in identification because sexual structures, present only in adults, are often unique and thus critical to species classification. Color and behavior are rarely used by scientists to identify species because they can vary even within a species due to age, diet, and stimulation. A few very general tips may be used by students, but sparingly. Very wiggly, dark red worms found near the soil surface are most likely Asian. The mature individuals can be 4 inches or larger. There are wiggly dark red worms, which are much smaller: those are most likely the common compost or manure worms. Common, large, pink worms are usually European; these often dig deep burrows, but any earthworm will retreat in cold or dry weather. Native worms may be paler and smaller; but students in urban Baltimore are not likely to find native worms, unless they dig along stream beds, very moist forest patches, or look under the bark of decaying logs (K Szlavecz, pers comm, 2003).

Exotic species of any kind are sometimes introduced by accident. Some species blend in to the native environment without disrupting it. Others initiate short-term or long-term changes. Whatever the outcome, successful colonization

depends on the life history of the organisms (reproductive needs and speeds, dietary selectiveness, life span), and human influence (land use change, further dispersion, creation of favorable habitats).

Current Scientific Research on Earthworms

BES and other scientists studying earthworms in urban and suburban areas have made some interesting discoveries:

- Urban forests support high populations of exotic earthworms, compared to similar rural forests (Steinberg, 1997).
- Exotic earthworms may enhance nitrogen cycling processes even with low-quality leaf litter typical in urban forests (Steinberg, 1997).
- Most exotic species are from the Atlantic region of Europe, accidentally introduced in soil used as ships' ballast, or purposefully introduced by Dutch farmers. The other exotic worms come from Southeast Asia, likely introduced accidentally in ornamental plant stock (Szlavecz and Pouyat).
- Land management practices affect earthworm abundance: high-management areas (e.g., residential garden/lawn) or disturbed areas (urban forest) yield relatively higher worm biomass (Szlavecz).
- Of the eighteen species of earthworm found so far in the Baltimore-Washington metro area, twelve are European, two Asian and four native. (Szlavecz et al, BES).

BES scientists are asking a number of questions about earthworms in the Baltimore-Washington area:

- What is the effect of habitat diversity on species diversity?
- To what extent do soil temperature, pH, and moisture and vegetation cover affect earthworm species composition?
- Why are non-native species more prevalent in urban than rural forest stands?
- What is the significance of non-native earthworm species in the Greater Baltimore Metropolitan Area?
- What effects do various species of earthworm have on soil processes?
- What is the effect of earthworms on the movement of water in soil?

BES research is addressing the overall hypothesis:
Suburban and urban habitats provide favorable conditions for earthworms compared to rural habitats because of access to a variety of food sources (compost piles), and human-assisted dispersal (anglers). Furthermore, due to suburban and urban land management practices (housing, lawn maintenance); there is usually always a warm, moist place in urban areas, so worms are less subject to seasonal cycles of dryness and cold.

Sources of Background Information on Earthworms

Johnson, E. and K. Catley. 2002. *Life in the Leaf Litter*. American Museum of Natural History, Center for Biodiversity and Conservation.

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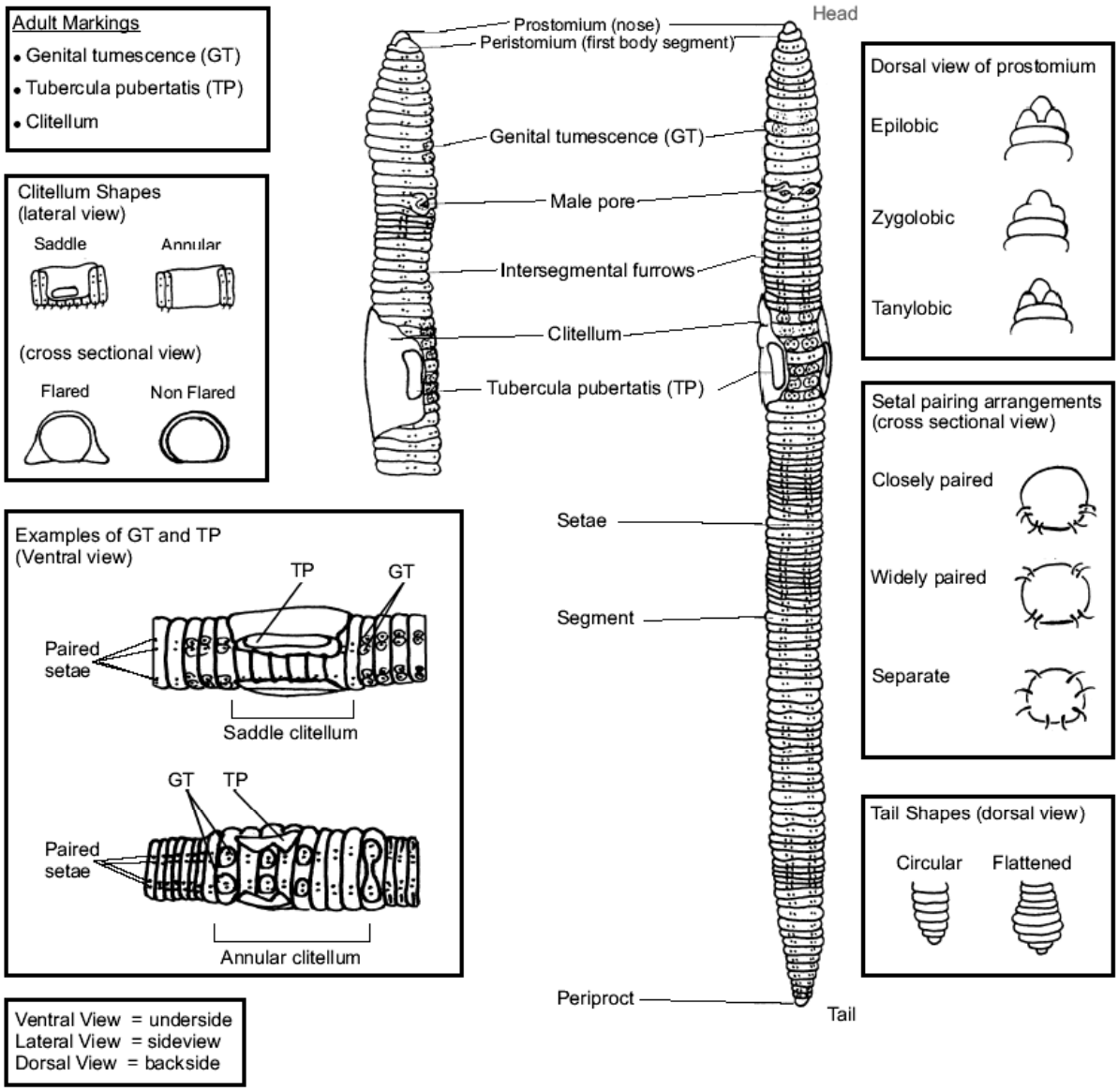
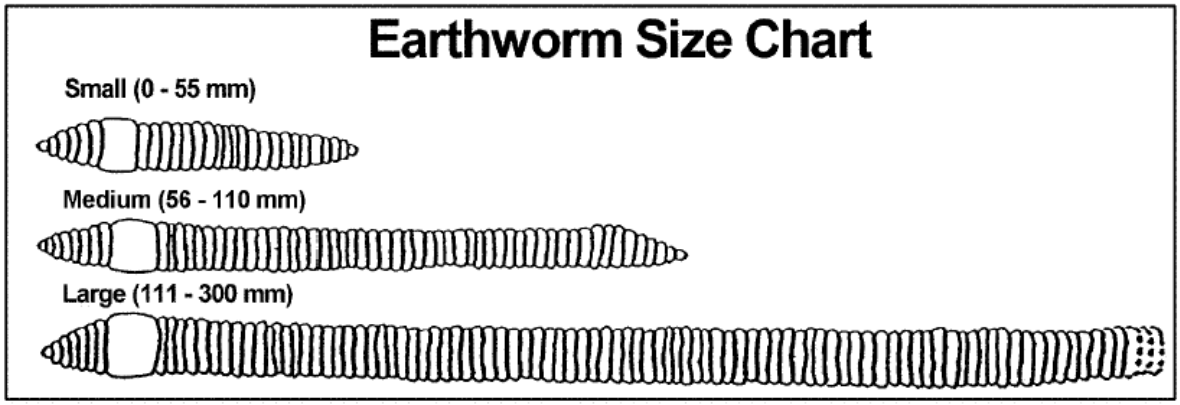
www.naturewatch.ca/english/wormwatch/ 2003. Worm Watch. Canada.

Figure 1: General Earthworm Diagram





Sending worms to Worm Watch
Remember to send in one representative of each type of adult earthworm you find, even the adults

Module 5 - Lesson 3 - Part 2

RECORD SHEET (Sample Answer Sheet)

Date _____

Team Members _____

HABITAT 1

# Of Earthworms (Use hatch marks to record)	**Site Description**
IIII	1) Location Description (in relation to school building; front, back, side close to _____Street, etc.)
_____	Front of school
_____	Corner of Stricker & Lexington
	2. Landcover Description from prior lesson
Total # 4	Grassy area (dry brown grass) sunny
	_____

HABITAT 2

# Of Earthworms (Use hatch marks to record)	**Site Description**
~~IIII~~ III	1) Location Description (in relation to school building; front, back, side next to _____ Street, etc.)
_____	Side of School
_____	Saratoga near Calhoun
Total # 8	2. Landcover Description from prior lesson
	plain soil, no grass, very dry
	_____

Module 5 - Lesson 4

Possible Student Responses To:
What Happens To Plants After They Die?

- they rot
- they get stepped on and crushed
- worms take them underground
- they blow away
- birds put them in nests
- rain and wind rip them into pieces
- they turn black
- they dissolve and go into the ground
- beetles make holes in them
- someone rakes them up and burns them
- dirt blows over them
- they get slimy, smelly and disgusting

A Sample of 5th & 6th Graders' Responses When Pressed:
Explain what Makes a Dead Thing Disappear

- Dead branches fall off of trees and you step on 'em and they break up
- When it's been dead a long time and gets real old it breaks up and disappears
- The dirt breaks it down. It's something I can't explain in words, but I know about it.
- When the rain and wind come the dead plant spreads out into the dirt.
- It takes a lot of years for a dead plant to disappear. Just like with a rock, the wind it hits it and breaks it down.
- When we die they put us in a coffin and bury us, and while we're in the coffin we dissolve.

Module 5 – Lesson 5

Dead Leaf Story Board Challenge

MANY PEOPLE THINK THAT DEAD LEAVES JUST "MAGICALLY" DISAPPEAR AFTER THEY DIE!!!!

Your Challenge:

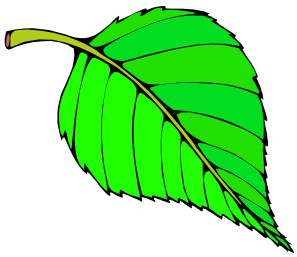
Make a story board that shows people what causes a dead leaf to break down.

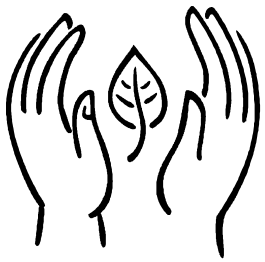
Your story board should have:

1) Drawings, paper cut-outs and/or samples to show how a dead leaf looks from the time it falls, until it is too tiny to see.

2) Words that explain what is making the leaf change.

HAVE FUN!





Cheap and Easy Worm Bin!

(Adapted from http://whatcom.wsu.edu/ag/compost/Easywormbin.htm)

Composting with redworms is great for composting indoors. Some kids like to keep worms for pets! By letting worms eat your food wastes, you'll end up with one of the best soil amendments available—worm castings.

Materials Needed to Make an Easy Harvester Worm Bin:

- Two 8-10 gallon plastic storage boxes (dark, not see through!) as shown in pictures Cost: about $5 each
- Drill (with 1/4" and 1/16" bits) for making drainage & ventilation holes
- Newspaper
- About one pound of redworms

Step 1 Drill about twenty evenly spaced 1/4 inch holes in the bottom of the first bin (this bin will be inserted into the second bin). In the second bin, place the bricks on two sides of the inside of the bin to provide space between the two stacked bins. Place the drilled bin into the second bin to stack them. The holes at the bottom of the first bin will provide drainage into the bottom bin.

Step 2

Drill ventilation holes about 1 – 1 ½ inches apart on each side of the bin
near the top edge using the 1/16 inch bit. Also drill about 30 small holes in the top of **one** of the lids.

Step 3

Prepare bedding for the worms by shredding Newspaper into 1 inch strips. Worms need bedding that is moist but not soggy. Moisten the newspaper by soaking it in water and then squeezing out the excess water. Cover the bottom of the bin with 3-4 inches of moist newspaper, fluffed up. If you have any old leaves or leaf litter, that can be added also. Throw in a handful of dirt for "grit" to help the worms digest their food.

Step 4

Add your worms to the bedding. An earthworm can consume about 1/2 of its weight each day. For example, if your food waste averages 1/2 lb. per day, you will need 1 lb. of worms or a 2:1 ratio. There are roughly 500 worms in one pound. If you start out with less than one pound, don't worry they multiply very quickly. Just adjust the amount that you feed them for your worm population.

Step 5

Cut a piece of cardboard to fit over the bedding, and get it wet. Then cover the bedding with the cardboard. (Worms love cardboard, and it breaks down within months.)

Step 6

Place your bin in a well-ventilated area such as a laundry room, garage, balcony, under the kitchen sink, or outside in the shade. Place the bin on top of blocks or bricks or upside down plastic containers to allow for drainage. You can use the lid of the second bin as a tray to catch any moisture that may drain from the bin. This "worm tea" is a great liquid fertilizer.

Step 7

Feed your worms slowly at first. As the worms multiply, you can begin to add more food. Gently bury the food in a different section of the bin each week, under the cardboard. The worms will follow the food scraps around the bin. Burying the food scraps will help to keep fruit flies away.

Feed your worms a vegetarian diet. Most things that would normally go down the garbage disposal can go into your worm bin (see the list below). You will notice that some foods will be eaten faster than others. Worms have their preferences just like us.

Feeding your worms:

Worms LOVE	Worms HATE
Breads & Grains Cereal Coffee grounds & filter Fruits Tea bags Vegetables	Dairy Products Fats Meat Feces Oils

You may need to empty the liquid that has drained into the bottom container periodically. This "worm tea" is rich in nutrients and can be poured directly into the garden beds. When the worm bin is full and there are no recognizable food scraps, dump the compost and worms outside in an area where you will be planting. Have the students collect as many worms from the pile(s) as possible to reuse. Place new bedding material in the bin and follow the previous steps to re-establish the worm bin. Add the worms collected from the compost.

Troubleshooting

Problem	Probable Cause	Solution
Worms are dying or trying to escape	Too wet Too dry Bedding is used up	Add more bedding Moisten bedding Harvest your bin
Bin stinks!	Not enough air Too much food Too wet	Drill more ventilation holes Do not feed for 1-2 weeks Add more bedding
Fruit Flies	Exposed food	Bury food in bedding