



The Hidden World of Worm Composting

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Subject:	Science
Grades:	K-6
Length:	45 - 60 minutes
Focus:	Soil microbiology, composting, biomimcry

Rationale:

Although we often can't see some of them, there are a number of creatures all around us that help recycle things in nature without our even knowing it. By utilizing these creatures, we can keep more materials out of the landfill and put them to good use in the garden.

Objectives:

This lesson is designed to introduce the concept of decomposition to students. By understanding how the decomposition process works, students will learn that they can use this process to reduce waste through composting.

Students will:

- Learn what portion of our waste can be composted.
- Understand that the soil is alive and actively recycling.
- Learn about some of the major organisms involved in organic decomposition.
- Recognize that organic materials can be returned to the soil ecosystem.
- Learn how to create and maintain a worm compost bin.

Background:

The Environmental Protection Agency (EPA) estimates that almost one quarter (about 23%) of our municipal solid waste contains materials that can be composted, such as yard waste and food waste. By composting such materials, people can reduce the waste that is either sent to landfills or burned, while at the same time, creating a healthy, nutrient-rich soil amendment. As a general rule, waste that goes into a landfill usually takes a very, very long time to decompose due to dry, anaerobic (without oxygen) conditions in the landfill. By composting, we can help certain things decompose fairly quickly.

As living things **decompose** or break down, compost is made. In nature, all living things will eventually decompose, returning important nutrients into the soil and ecosystem. For

instance, in a forested area, the leaves or needles that fall onto the ground provide essential nutrients for the trees as they decompose. This is what we call a **nutrient cycle**.

In the decomposition process, there are several things that are taking place. First, there are the **primary decomposers** such as **bacteria**, **fungi** (molds), and **actinomycetes**. Primary decomposers are the organisms that are the first at the scene and do the majority of decomposing. Primary decomposers are almost all **microscopic**, meaning that we can only view them with the aid of a microscope. Secondary decomposers also help in the process. **Secondary decomposers** can include **mites**, **nematodes**, **springtails**, **worms** and various other types of **insects**.

In one gram of soil (a pinch), there may be up to:

- 10 billion bacteria
- 1 billion actinomycetes
- 10 million fungi
- 1 million algae
- 1 million protozoa
- 1000 nematodes
- 10 mites
- 10 springtails (collembola)

Humans can utilize the process of decomposition to help recycle materials that aren't normally recyclable. Essentially, anything organic can be composted. **Organic** materials are things that are either alive, were once alive, or were part of a living organism. Plants and animals are all organic. Paper and wood are organic also because they come from trees.

Composting must have **four essential elements for success**. First, critters that live in a compost pile must have the right kinds of **food**. That is, the right materials must be put in the compost pile in the first place. The basic rule is that all things in a compost pile must come from a plant. The only exception to this is eggshells, which are safe to add to the compost. As stated before, anything organic will eventually decompose, but certain things might cause problems in your compost pile. Any animal products such as meat, cheese or other dairy products will result in unpleasant odors and can contribute to unwanted diseases in your compost. Secondly, the compost pile needs **water** to sustain all of the decomposers. Third, those critters also need an adequate **oxygen** supply, so the pile must be turned or aerated in some way. This is what we call an aerobic compost process, when there is adequate oxygen supply. Fourth, the composting critters must have adequate **space** to do the work that they need to do.

Worm composting (also known as vermicomposting) is a great way to compost at home. Worm composting uses Red Wiggler worms to break down fruit, vegetables, and eggshells. Red Wigglers are a special type of worms that work best for composting. The activities in this lesson focus mainly on worm composting. **Note: Worms are not necessary for composting. Many people compost without worms, but worms can speed up the decomposition process given the right conditions.**

Worm facts:

- Worms have bristly hairs that help them grip the ground and move.
- Worms have five hearts.
- Worm babies develop in tiny lemon-shaped cocoons.
- Worms breathe by taking in oxygen through their moist skin.
- Worms don't have teeth – they grind their food into tiny pieces in their gizzards.
- A worm can eat half of its body weight in one day.
- Worms don't really have eyes, but are very sensitive to light.
- Worms don't have bones; their bodies are made up of little rings called segments.
- Worms are hermaphrodites—they have both female and male parts.

Worm questions and answers: Source - www.learner.org/jnorth/search/WormNotes1.html

Q. How can you tell the head of an earthworm from the tail end?

A. The head of the worm is always located on the end of the worm closest to the clitellum. Place a worm on a rough piece of paper and observe which direction it travels. Earthworms usually extend their "head" first when crawling.

Q. What is the collar or band in the middle of the earthworm?

A. The band is the clitellum. This saddle-shaped, swollen area is about 1/3 of the way back on a worm's body. The clitellum secretes mucus to form the cocoon which will hold the worm embryos.

Q. How can you determine if an earthworm is an adult?

A. The presence of the clitellum is the sign of a sexually mature worm.

Q. What are earthworm casts?

A. Worm casts are the earthworm's undigested waste (worm poop). Casts are composed of organic matter mixed with soil. They are held together with "gum" produced by many active bacteria and mucus.

Q. How do earthworms move?

A. Earthworms have bristles or setae in groups around or under their body. The bristles, paired in groups on each segment, can be moved in and out to grip the ground or the walls of a burrow. Worms travel through underground tunnels or move on the soil surface by using their bristles as anchors, and pushing themselves forward or backward using strong stretching and contracting muscles.

Q. Can worms crawl forward and reverse?

A. Yes. Even though worms can move both forward and backward they tend to travel forward more.

Q. If you cut an earthworm in two, will it live?

A. The rear half will always die, and the front half may live to become another whole worm. This is called regeneration. The front part must be long enough to contain the clitellum and at

least 10 segments behind the clitellum. This makes up about half the length of the worm. The new posterior segments grown will be slightly smaller in diameter than the original segments and sometimes a bit lighter in color.

Q. Do earthworms have eyes?

A. They do not have eyes but they have light- and touch-sensitive organs (receptor cells). These cells help them sense differences in light intensity and to feel vibrations in the ground.

Q. How do earthworms breathe?

A. Earthworms breathe through their skin. They need humid conditions to prevent drying out.

Q. Why are worms slimy?

A. They coat themselves in mucus, which enables dissolved oxygen to pass into their bloodstream

There are many different ways to compost at home. It is recommended that educators seek out additional resources on home composting. Background resources are listed at the end of the lesson plan. Additional resources are abundant over the Internet or at a library. Attached is information on building and maintaining a worm compost bin

Materials:

- Props to hold up in the introduction—things that can and cannot be composted including a banana peel, apple core, paper, metal can, etc.
- Book – Diary of Worm
- Small bin of worm compost with worms or complete worm bin (contact The Environmental Center for this, if needed)
- Diagram of Nutrient Cycle
- Petri dishes
- Spoons
- Magnifying lenses

Procedure:

I. Introduction – 5 minutes

- Go over basics of recycling in your community. Ask students what can be recycled. Ask – can things like banana peels or eggshells be recycled? Props to show students are always helpful.

II. Is Dirt Dead or Alive? – 10 – 15 minutes

- Ask students...what lives in dirt? Worms, ants, bugs, spiders, moles, and bacteria are some answers they may say.
- Go over the word microscopic. What does that mean?
- What do these critters eat? Has anyone ever been hiking in the woods and come across the bones of an animal? Where did the rest of it go?

- Introduce the word DECOMPOSE.
- Emphasize that we can get these critters to help us recycle. Why? How? These creatures love to eat our old food such as banana peels, orange rinds, even broccoli!
- Does anyone know what we call this? COMPOST.
- Anything that was once alive (trees, grass, bananas, animals, etc.) is something that will eventually decompose.
- Things in a landfill do not decompose very quickly, if at all (due to dryness and lack of oxygen). Why might this be a problem? Show pictures of 10-year-old garbage that was buried in a landfill.
- What do these composting critters need to survive? AIR, WATER, FOOD, SHELTER.
- Have students help you make a list of the materials that are okay to put in a compost pile as well as materials that should be kept out of a compost pile.

III. **Diary of Worm 10-15 minutes, for students K-3**

- In nature there is no waste. Everything is food for something else. What kinds of animals will eat rotten leaves and apples? Worms are one of nature's greatest recyclers!
- To learn a bit about a worm, read the *Diary of a Worm*. As you are reading stop often to touch on important worm facts, such as: Worms will eat paper and anything that came from a plant, They do not have legs like spiders but move by stretching out their segments, which are circular muscles. Worms do not have eyes, worms cannot breathe under water, Worms are slimy because they breathe through their skin, Worms do not have eyes, Worms are not boys and girls.
- Worms are Nature's great Decomposers. Have the students practice saying the word and write it on the board. Decomposers eat dead plants and animals and put nutrients into the soil for plants to grow.

IV. **The Worm Bin 15-20 minutes**

- Bring out the worm bin and tell students this is an example of how we can create compost. Do they know what living creatures can help decompose things and make compost? WORMS
- To set up the bin, we add some shredded newspaper. Will worms eat newspaper? Yes because it came from a tree. Then we add a special composting worm called a red wiggler. We get them from special worm farmers. The worms go in the bin and then they need to be fed different, fruits and veggies. What are some examples of things we feed the worms?
- The worms then eat the fruit and veggie scraps and turn them into compost. Ask the students if they know how the worms turn food into compost. They eat food and then the worm poop is compost. It has a special name called worm castings.
- Now it is time to explore the critters in the compost bin. Explain to students that they may hold and touch the worms, but may not hurt them. The tooth picks are

to use to dig through the compost, not to pock or hurt the worms. For every group of 2-3 students they will get a petri dish, a scoop of compost and two tooth picks.

- Remind them that worms do not like being outside their home so we cannot keep them out for too long and they do not like loud noises.
- Pass out compost samples to students and give them time to explore. If you would like to use a paper towel for ease of clean up, make sure it is damp.

V. Worm Compost Activity – 10 - 15 minutes

- Now it is time to explore the critters in the compost bin. Explain to students that they may hold and touch the worms, but may not hurt them. The tooth picks are to use to dig through the compost, not to pock or hurt the worms. For every group of 2-3 students they will get a petri dish, a scoop of compost and two tooth picks. Pass out magnifying lenses for students to view compost up close
- Remind them that worms do not like being outside their home so we cannot keep them out for too long and they do not like loud noises.
- Pass out compost samples to students and give them time to explore. If you would like to use a paper towel for ease of clean up, make sure it is damp.
- Ask students what they found in the compost. Students might list things such as seeds, worms, paper, insects, etc. Any other observations?

VI. Assessment/Conclusion

- Ask students some review questions. What is compost? How can we use the decomposition process to reduce garbage that is sent to the landfill? What are the four essentials that are needed for a successful compost pile? What kinds of things can be composted? What are some creatures that might live in a compost pile?

Enrichment Options for Hidden World

Enrichment #1

Allow the students to experiment with the nutrients provided by worm castings using seedlings of tomato plants. Using three solutions and three plants per solution let the students come up with a hypothesis and measure the plant growth over the period of a month. Plant seeds in equal amount of soil, per planter, cover with wet newspaper and allow sprouting over several days. Then water each seedling with a different solution, using the same amount per plant and record observation for 4 weeks. Solutions= 100% water, 50% water and 50% castings, 100% castings.

Enrichment #2

Have the students research how to create a worm bin then allow them to have one in your classroom to reduce food waste from your classroom garbage bins.

Enrichment #3

Set time in the library to research worms on the computer using the internet resources below. Have them learn about worms and then create a presentation for younger students. Ideas could be Dioramas, puppet shows, plays and skits that they act out.

Enrichment #4

As a class, go through the alphabet, naming things that can be composted. For example, A=apple cores, B=blueberries, C=carrot peels, etc.

Enrichment #5

Allow the students to experiment with the nutrients provided by worm castings using seedlings of tomato plants. Using three solutions and three plants per solution, let the students come up with a hypothesis and measure the plant growth over the period of a month. Plant seeds in equal amount of soil per planter, cover with wet newspaper and allow sprouting over several days. Then water each seedling with a different solution, using the same amount per plant, and record observation for 4 weeks. Solutions= 100% water, 50% water and 50% castings, 100% castings.

Internet resources

Follow the adventures of Vermi the worm with an online game about vermiculture:

<http://www.ciwmb.ca.gov/Vermi/Game/menu.html>

Fun internet worm discoveries

<http://kids.discovery.com/tell-me/animals/bug-world/worm-world>

Worm info and anatomy for teachers

<http://www.naturewatch.ca/english/wormwatch/>

Herman the worm takes you through basic anatomy of a worm

<http://www.urbanext.uiuc.edu/worms/index.html>

Cheap and easy worm bin

<http://whatcom.wsu.edu/ag/compost/Easywormbin.htm>

Local Bend worm merchant, bins information and worms
<http://wonderworman.com/>

Great comprehensive slides on worms and vermicomposting
<http://aggie-horticulture.tamu.edu/kindergarden/kidscompost/compostingforkids.pdf>

CalRecycle facts, games, and further resources
<http://www.calrecycle.ca.gov/organics/worms/>

Great Q&A on composting for kids
<http://www.kidsgardening.org/lesson-and-activity-ideas/term/7>

The Edible Schoolyard Project
www.edibleschoolyard.org

All-in-one worm farm resources
www.happydranch.com

Waste Free Lunch- Reduce at school
<http://www.wastefreelunches.org/index.html>

Recycling with worms- Vermicomposting
<http://www.wackywild.com/lfstuff/articles>

Print to assemble vermicomposting infographic puzzle
<http://jenhallyburton.blogspot.com/2011/01/vermicomposting-infographic-puzzle.html>

Vegetables Composting time lapse video:
<http://webiocosm.blogspot.com/2008/12/fruit-and-vegetables-decomposing-time.html>

Great video!
<http://curiosity.discovery.com/question/what-is-vermicomposting>

Books

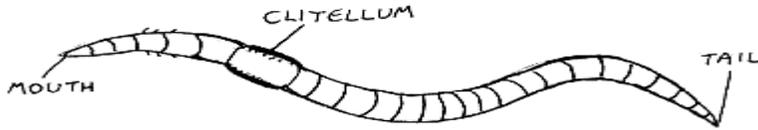
Worms Eat Our Garbage, Mary Applehof, Kalamazoo, Michigan: Flower Press, 1993.

The Worm Café – Mid-Scale Vermicomposting of Lunchroom Wastes, Binet Payne, Kalamazoo, Michigan: Flower Press, 1999.

Let It Rot – The Gardeners Guide to Composting, Stu Campbell, Storey Publishing, 1990

The Worm Guide: A Vermicomposting Guide for Teachers, available from the California Integrated Waste Management Board in PDF format at www.ciwmb.ca.gov/Schools/Curriculum/Worms/

Name _____



1. What is the basic shape of a worm? _____
2. Does a worm have arms or legs? _____
3. Does a worm have a mouth? _____
4. Does a worm have eyes? _____
5. What is the name of the band around the worm? _____
6. What are the rings on a worm's body called? _____

Ester got mixed up when she tried to set up her worm bin. Put the steps in the correct order. The first one is done for you. Write out the steps in the logical order at the bottom of the page.

- | | |
|--|----------------------------------|
| __1__ Determine the size of the worm bin | ___ Bury garbage in the worm bin |
| ___ Harvest the castings to feed your plants | ___ Add worms to the worm bin |
| ___ Build the worm bin | ___ Put bedding in the worm bin |

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Imagine that you are a worm. Complete the sentences below to write your own story

One night I went to sleep and awoke the next morning as a worm. I did not know which end was my head. I tried to _____

I slithered out of the bed and then _____

Before going to school, I wanted a big breakfast. I had a special craving for _____

When I got to school no one recognized me because _____

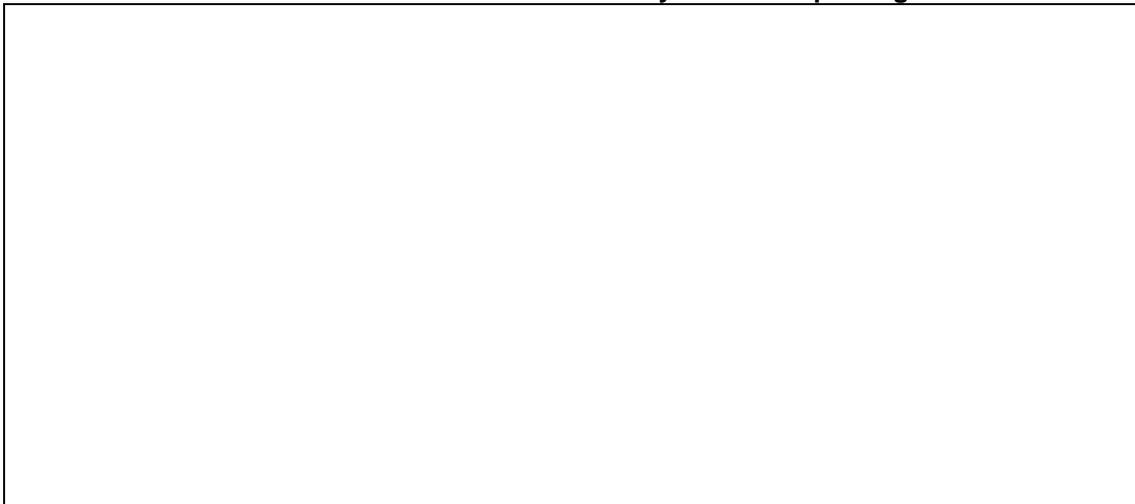
The teacher saw me wiggling in my seat and said " _____

_____ "

After school it was raining so I _____

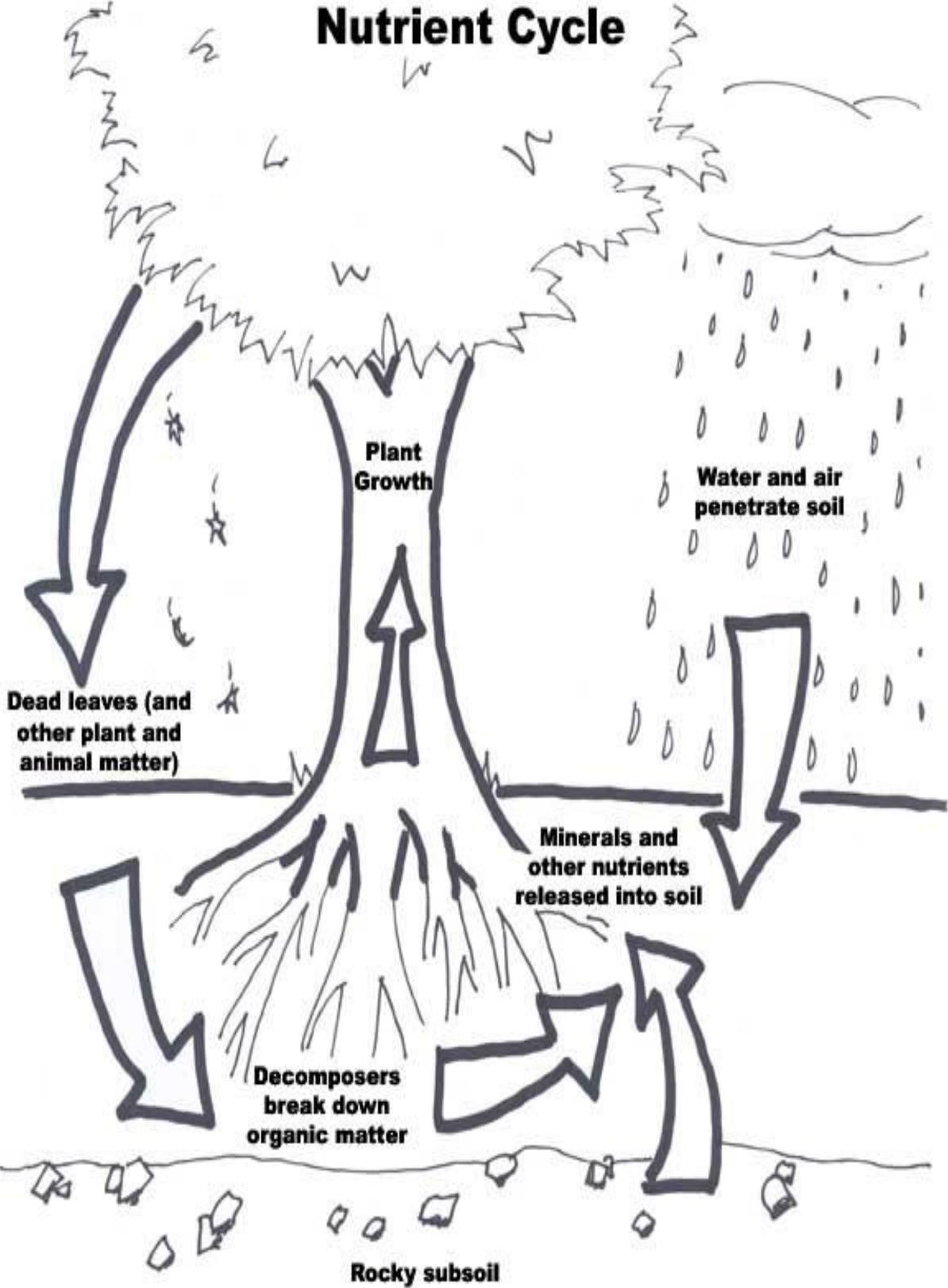
When I awoke the next morning I was a child again. Whenever I see a worm I will _____

Draw a cartoon below to teach other kids about why worm composting is so cool!



Taken from Worms Eat our Garbage Appelhof, Fenton, Harris

Nutrient Cycle



Worm Eggs Photo



Is it Organic or Not? (adapted from Ohio Department of Natural Resources' Windows on Waste Curriculum Guide)

Directions: Identify the following list by placing a B (*browns*) next to each of the organic-carbon items and a G (*greens*) next to each of the organic-nitrogen items. **Circle** all of the inorganic items.

_____ Twigs, brush

_____ Corncobs, pine needles

_____ Grass

_____ Cotton rag

_____ Cereal box

_____ Paper

_____ Plastic

_____ Coffee grounds, egg shells

_____ Styrofoam package

_____ Pine cones

_____ Weeds, brown leaves

_____ Newspaper

_____ Brown leaves

_____ Bark

_____ Wool sock

_____ Wax paper cup/milk carton

_____ Dung

_____ Brown paper bag

_____ Fruit peelings

_____ Hickory nuts, acorns

_____ Banana peel

_____ Plastic shopping bag

_____ A piece of wood

_____ Rope

_____ Plastic six pack holder

_____ Sawdust, straw

_____ Peanut Shell

_____ Soil

_____ Traffic ticket

_____ Vegetable peelings

_____ Tree branches

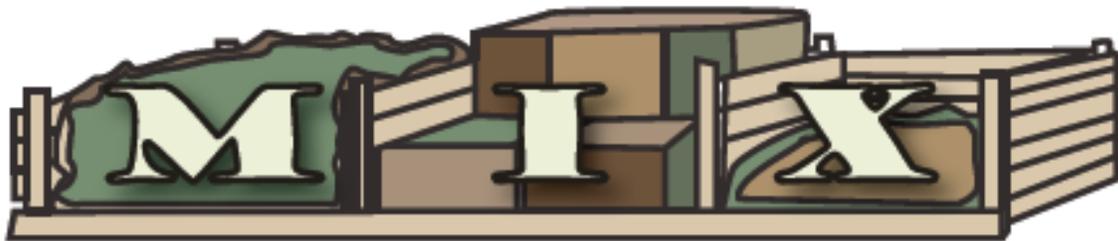
_____ Green leaves

_____ Steel food can

_____ Disposable diaper

_____ Aluminum beverage can

_____ Cigarette filter



MULTIPLICATION

BROWN



Ashes, wood	25:1
Dried leaves	60:1
Pine needles	90:1
Newspaper	125:1
Sawdust	625:1

GREEN



Food Scraps	15:1
Grass clippings	18:1
Coffee grounds	20:1
Horse manure	25:1
Alfalfa:	12:1

Directions: Using your knowledge of ratios and multiplying fractions, complete the statements on the included worksheet about compost heap ratios.

1. If our class wants to use newspaper in the compost heap, we need to put in _____ times as much horse manure.
2. The class has two compost ingredients: Food scraps (green) and dried leaves (brown). For the ingredients to be in balance with each other, the class needs to use _____ times as much food scraps.
3. _____ (brown) and _____ (green) are the only two ingredients that don't need an extra amount for the heap to be in balance.
4. *True or False:* If the class only has a small amount of alfalfa, the students should use newspaper to put the heap in balance.
5. *True or false:* The class has collected pine needles for their compost heap. Next, they want to add grass clippings. One student says they need to use 5 times as much grass clippings as pine needles for it to be in balance.

Decomposer Tag

Description

Students play a freeze tag game where death tries to tag and freeze the nutrients in plants and animals. The decomposers unfreeze the nutrients trapped in dead bodies, allowing them to return to the cycle of life.

Grade: 2-6

Time: 20-30 minutes

Materials: Two light colored and one dark colored bandanas.

Procedure

1. One student is “Death” and wears a dark colored bandana.
2. Two or three students are decomposers and wear light colored bandanas. All other students are plants or animals.
3. Death kills plants and animals by tagging them. If plants or animals are tagged, they are frozen in place until one of the decomposers unfreezes them by running around them three times. The decomposers unfreeze the plants and animals as fast or faster than death freezes them.
4. The game has no natural end. You should let students play long enough to experience the concept, and stop the game well before students get exhausted and/or lose interest.

Variation

To demonstrate that life would stop without decomposers recycling dead things, you can allow “Death” to tag and freeze the “Decomposers” along with the plants and animals. The game, and life on Earth, ends when everyone is frozen except “Death.”

Source: Marin County Office of Waste Management, 3501 Civic Center Drive, Room 403, San Rafael, CA 94903

RETHINK WASTE: Worm Bin Composting

Composting at home is good for your garden and good for the earth. Approximately 35% of all household garbage in the US is organic waste that can be composted in your backyard. By composting your food scraps you can prevent waste and greenhouse gas emissions, have healthier plants, conserve water and use fewer chemicals in your yard and garden.



RETHINK WASTE
DESCHUTES COUNTY

Why Compost with Worms?

Worms are natural composting machines. Worm composting, also known as vermicomposting, uses "red wiggler" worms to turn leftover food into a dark, rich soil amendment. Composting with worms doesn't take up much space and can be done inside or outside.

Worm compost is an excellent soil amendment. It can be used directly in the garden, either dug into the soil or used as mulch. The compost can also be mixed with potting soil and used for houseplants and container gardening. If screened down to fine particles, it can be added to potting mixes for seedlings or finely sprinkled on a lawn as a conditioner.

Worm Bin Ecology

A worm bin contains more than just worms! They work most efficiently when there is a diverse web of organisms working together to decompose the organic material. In addition to worms, you may discover other creatures such as potato bugs, mites, millipedes, tiny white worms, and springtails.

Containers and Bedding

Your worms can live in a homemade wooden bin, a store bought plastic bin, or a special stackable bin. If you use a plastic bin, be sure to wash it and let it air dry before starting.

Buy or make a loose fitting lid for your bin. For aeration and drainage, drill 8 to 10 holes in the bottom of the bin. Place a plastic tray or sheeting under the bin to collect any excess moisture.

The size of the bin depends on how much food you think you will put in it each week. For every pound of food scraps generated per week, you should have a square foot of area in the bin. A typical family of four would suffice with a 3 foot by 4 foot bin. The bin should be shallow - no deeper than 18 inches.

Bedding provides material in which the worms can burrow and provides cover for burying the food scraps. Bedding really can be any kind of moistened organic material such as shredded paper (no glossy paper), straw, decayed leaves, or peat moss.

Learn more options for reducing waste in Deschutes County at:

RETHINKWASTEPROJECT.ORG

Location

Worms prefer a dark, cool, damp environment. Ideally, your worm bin should be in a moderate temperature environment (between 50 and 75 degrees). A basement, garage, or utility room are all good places for a worm bin. A larger bin may withstand cold outside temperatures, but it is best to insulate the outside of the bin with foam blocks or other insulating materials in the cold winter months.

Helpful Hints

To discourage fruit flies, bury the food scraps under some dry bedding. You may also try putting a layer of plastic on top of the bedding. Bad odor can be the result of several things:

- o **Make sure you are putting the right type of foods in the bin.**
- o **Check the air holes to make sure they are clear for proper aeration. Fluff up the materials to aerate the bin.**
- o **You may be overfeeding the worms. Stop feeding for a few days and see if the odor stops.**

Worms

It is important to get the right type of worms for composting. Only "red wigglers" or "red worms" should be used for composting. Nightcrawlers or other worms dug up from the garden will typically not work.

Easy Bedding Recipe:

1 part shredded paper
1 part peat moss
Water

Combine peat moss and paper and soak until very moist. The peat moss will retain a lot of water.

RETHINK WASTE: Worm Bin Composting



DO feed your worms:

Any fruit or vegetables
Eggshells
Tea bags
Coffee grounds
Paper coffee filters
Shredded paper

DO NOT feed your worms:

Meat, poultry or fish
Bones
Dairy products
Greasy or oily foods
Fat
Pet or human manure

feeding

Harvesting Your Compost

As time progresses, you will notice less bedding and more dark, crumbly soil in your bin. This is the time to harvest, when there is mostly compost, and very little bedding or food. There are two good methods for harvesting your compost.

Migration Method

Slow down on feeding your worms for a week. Push all of the contents of the bin to one side of the bin, and add fresh, damp bedding to the other side. When you resume feeding, place food only on the "new" side.

Within the next few weeks, the worms will sense the food and migrate, leaving the finished compost on the other side. You can then remove the compost, and fill the empty space with bedding.

Dump, Divide and Sort Method

Dump the contents of your bin on a tarp under a bright light or sunlight. Mound the material into small coneshaped piles and wait 20-30 minutes. The worms will move down into the material, away from the light. Take the fresh compost off the top of the piles, and continue down, until you have mostly worms in each pile. Create new bedding and put the worms back in the bin to continue composting.



Additional Resources

Where To Buy Worms

Local:

Wonder Woman, Bend
www.wonderwoman.com, 541-390-7610

Rockton Ranch, Redmond
Toni Stephan and Rocky Bessette, 541-548-0789

State:

Three Tree Farms, Cottage Grove, OR
www.redwiggler.com, 541-942-9033

Helpful Websites

www.wonderwoman.com
www.acmewormfarm.com
www.cityfarmer.org/wormcomp61.html
www.wormwoman.com
www.howtocompost.org

Books

Worms Eat My Garbage Mary Applehof
Flower Press, Kalamazoo, MI, 1999

The Worm Book Loren Nancarrow and Janet Hogan
Taylor, Ten Speed Press, Berkeley, CA, 1998

Recycle with Earthworms: The Red Wiggler Connection
Shelley Grossman and Toby Weitzel, Shields Publications,
Eagle River, WI, 1997

The Rethink Waste Project provides tools and resources to help you reduce waste – and rethink the way you think about waste. From learning easy ways to reduce waste at home, such as composting and simple non-toxic alternatives, to purchasing greener products and understanding what it means to buy local, we can all take steps towards the same goal: reduce, reuse, recycle and rethink. Visit RethinkWasteProject.org to learn more.

Rethink Waste is a project of The Environmental Center. We translate sustainability into practical local action to create a healthy future for people and the planet.

18 NW Kansas Ave, Bend OR 97701
541.385.6908
www.envirocenter.org

