Vermicomposting

K - 8 Curriculum

Habitat

Food Waste

IF YOU DON'T EAT IT

They Will

Anatomy

Harvesting

Nutrients

Ecosystem

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EPA United States Environmental Protection Agency

This Vermicomposting Curriculum was developed under Assistant Agreement No. X1-00J49401-0 awarded by the U.S. Environmental Protection Agency. It has not been formally reviewed by EPA. The views expressed are solely those of Sustainable Living Center and U.S. EPA does not endorse any products or commercial services mentioned.

Introduction Letter

October 2013

Dear Teachers:

The Sustainable Living Center (SLC) is a 501c3 organization which was created to inform and educate consumers about the benefits of conserving resources. Using a variety of sustainable practices and or renewable energy sources, promotes community awareness of these processes and practices through education, outreach and partnerships. In November of 2011, SLC was awarded a grant from the Environmental Protection Agency to fund one of our programs. This program was called the, "Life-cycle Food Waste Management (LFWM) program."

The Life-cycle Food Waste Management (LFWM) program sought to reduce the amount of food waste sent to the landfill from the Walla Walla Community College (WWCC) campus and throughout the Walla Walla valley. LFWM took a low-cost, life-cycle approach to address food and organic waste issues on campus. This program established a campus food waste management system, which built the capacity to manage food waste and organic materials in the future. Through a hands-on classroom, workshops, and educational brochures SLC promoted efforts to recycle food waste on a life-cycle basis and reduce the amount of waste going to the landfill.

In the Life-cycle Food Waste Management (LFWM) program the Sustainable Living Center (SLC) bought and started a vermicompost bin. Nine hundred and seventy eight (978) pounds of Red Wigglers were used in our 5' x 8' vermicomposting bin. SLC collected over 3,000 pounds of pre and post consumer food waste (over a period of 13 months) from the Walla Walla Community College Titus Creek Café, and fed to the worms. Each week, food was collected, weighed and added to bin, temperature and moisture content was monitored regularly. Worm castings (approximately 300 lbs.) were harvested and added to the WWCC campus garden which was built by SLC, to grow produce and flowers. The produce grown in the campus garden was then used in the WWCC Titus Creek Café. The cycle of food waste to compost bin, to garden and finally back to kitchen, continues today at Walla Walla Community College. The culinary department at the WWCC with the help of other clubs and departments in June of 2013 took over the responsibility of continuing the LFWM program.

An additional goal in the Life-cycle Food Waste Management program, was for Sustainable Living Center to develop a K - 8 Curriculum on Vermicomposting as an educational tool that can be used in our local schools. The attached curriculum is a fulfillment of that goal. We believe that educating students on this fun and simple method of recycling food waste will be beneficial for our community. With the popularity of backyard gardening, school gardens and community gardens in Walla Walla, it is very likely that many community members will implement vermicomposting as one of their gardening activities. It is our hope at the Sustainable Living Center, that students and teachers alike will enjoy these lessons and activities as they learn about vermicomposting (composting with worms) - nature's way of recycling!

P.S.: Please contact us via our information below if you have any questions or feedback regarding this curriculum.

Sincerely,

Sustainable Living Center

SustainableLivingCenter

Address: 500 Tausick Way Walla Walla, WA 99362 ● **Phone:** 509-524-5218 ● **Fax:** 509-524-5209
Email: info@sustainablelivingcenter.com ● **Website:** www.sustainableivingcenter.com

How to Use this Curriculum

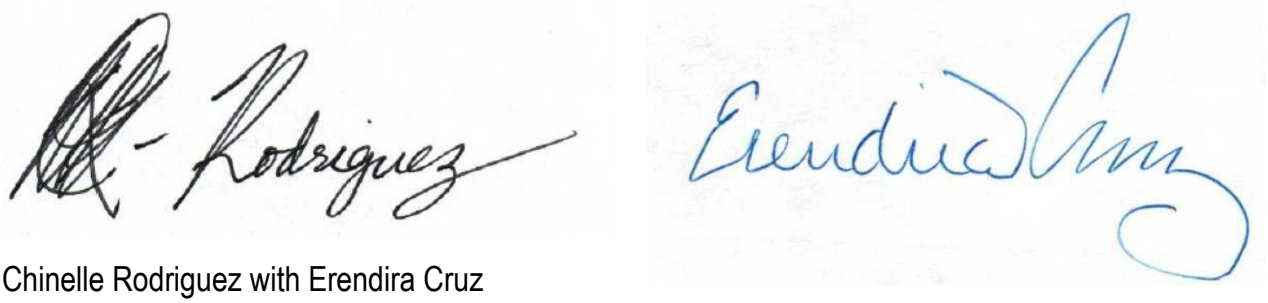
Thank you for choosing this curriculum to teach your students about vermicomposting! This curriculum is designed for use in Kindergarten, Elementary School and Middle School. The information herein was taken from a variety of reputable resources, which were combined to develop simplified lessons and activities that students can enjoy as they learn about vermicomposting and the different scientific areas surrounding it.

Each lesson lists the following:

1. An **Objective** for Lessons & Activities
2. **Method** to Use for Lessons & Activities
3. **Materials** Needed for Lessons & Activities
4. **Background** Information for Lessons & Activities
5. **Subject Area** of Lessons & Activities
6. **Duration** of Lessons & Activities
7. **Group Size** suggested for Lessons & Activities
8. **Setting** suggested for Lessons & Activities
9. **Key Terms** suggested for Lessons & Activities
10. **Procedures** for teaching the Lessons
11. **Visual Aid References** for teaching the Lessons

This curriculum is in PDF form, which allows for you to print your class lesson and visual aid cards if you would like. We suggest projecting the visual aid cards for your lesson in your classroom to provide a bigger picture that the students can see well. Kindergarten through 5th grade lessons are adapted to fit the objective of the lesson as stated. 2nd, 3rd and 4th grade lessons and activities were designed for ages 7 to 10; you can choose which is most appropriate for your class, or complete multiple lessons. 6th, 7th and 8th grade is compiled into one lesson and one activity that will take about one school year to complete. We suggest adapting the curriculum lessons, materials, and procedures to best work with your students as necessary. We highly recommend that you bring in as many materials and objects as possible when teaching the lessons and doing the activities, if the resources are available. We also encourage open discussion with your students as you teach the lesson and ask the questions as outlined in the procedures. The visual aid cards are very important tools to use while teaching the lessons, especially if you are not able to bring in real samples of the materials.

We look forward to hearing about the learning that has taken place as a result of you using this curriculum in your classroom. Enjoy!



Chinelle Rodriguez with Erendira Cruz

Kindergarten
Vermicomposting Lesson

Objective: Students will scientifically compare and contrast Red Wigglers' anatomy to the human anatomy.

Method: using a diagram of the Red Wiggler and the human body, students will identify which body parts we share in common and which are different from our wiggly friends.

Materials: Earthworms' Anatomy Visual Aid Card No. 10 , Human Anatomy Visual Aid Card No. 11, pencils and coloring supplies.

Background: Although at first sight, worms are structurally different from humans, students can recognize that humans share some similarities to worms body parts.

Subject Area: Science, Environmental Education

Duration: Two, 30 – 45 minute sessions.

Group Size: Small groups of three to four students each

Setting: Classroom

Key Terms: anatomy, anterior, clitellum, posterior, segment, setae.

Vermicomposting Overview

What is Vermicomposting?

Vermicomposting, or composting with earthworms, is a great way to be friendly to our environment. This is nature's way of recycling. Worms such as red wigglers eat organic matter such as dead leaves and flowers or food waste such as fruits and vegetables, and turn it into nutrient–rich compost! The organic matter can be found right in your backyard. Food waste can come straight from your kitchen! Instead of having your food waste go to the landfill, you can collect it and add it to a vermicomposting bin. The end result is a soil amendment that is crumbly, damp and high in nutrients that will help plants grow healthy and strong!

What is Vermicompost made up of?

Vermicompost is made up of the following:

- soil
- worms at various stages of development (cocoon, hatchling, juvenile, adult)
- worm castings (manure)
- bedding materials (shredded newspapers, mulched leaves, saw dust, dead plants, grass, straw/hay, and peat moss)
- various organic waste at different stages of decomposition
- various micro/macro organisms (millipedes, isopods, enchytraeids, springtails, centipedes, bacteria, fungi & mites) These creatures are decomposer organisms that help to break down the organic matter into simpler forms. Some microorganisms are predators and eat our friendly worms!

Types of Earthworms

There are different types of earthworms. The most common types are brandling worms, redworms (red wigglers) and field or garden earthworms. Some worms are deep burrowers, but they are not good for composting because they like to go deep underground where it is cool. Other worms are soil mixers, they are also not good for composting because they like to stay in the root zone, eating organic matter and mixing the soil layers. Worms that are surface dwellers like red wigglers eat organic matter that falls onto the soil surface and are adapted to clean up waste.

Anatomy of Earthworms

Earthworms have long rounded bodies with a pointed head or anterior and a slightly flattened posterior. Their bodies are soft and moist allowing them to burrow through the soil easily since they don't have a backbone! Earthworms have 5 hearts that pump blood through their blood vessels! Earthworms move by contracting and relaxing their muscles. They have no real legs, but setae/bristles which move back and forth, making it possible for them to crawl. Unlike humans, earthworms breathe through their skin. They ingest food through their mouth, which goes to their stomach (crop) and then passes through the gizzard. In the gizzard the food is ground up by ingested grit. Next the food is digested in the earthworm's intestines. The remains then pass through the anus.

Earthworm babies come in the form of cocoons. Cocoons are lemon-shaped and approximately 1/8 of an inch long. Two or more babies can hatch from one cocoon. Cocoons mature and hatch in 5 to 11 weeks. Baby worms, or hatchlings, are whitish or almost transparent and are only 1/2 inch to 1 inch long. Hatchlings are thread like creatures and in about 8 hours after hatching they gain hemoglobin and change color from white, to pale pink to brick red. Hatchlings take 53 to 75 days to become Juveniles. Juveniles take 56 to 72 days to become mature adult worms with a clitellum. The clitellum is the wide band that surrounds an adult worm. Healthy adult worms can live for five or more years.

Earthworms Habitat

In nature, earthworms can be found in soil that is not too dry or too moist. Red Wigglers natural habitat has leaves, manure and other decaying materials. Vermicomposting can be done indoors or outdoors in a composting bin. Bins come in various shapes and sizes. The compost bin is a reconstruction of the worm's natural habitat. Red wigglers are kept in these bins to help humans make lots of nutrient rich soil that you can put into your garden to grow healthier produce and better flowers and plants. Bedding materials are used to make the worms feel at home. It helps produce the right temperatures for the worms to live in and helps the worms breathe. The bedding materials need to be kept thoroughly moist (like a wrung out sponge). Red Wigglers can survive in a wide range of temperatures (40 - 80 degrees Fahrenheit).

In order to process food waste and have babies at an optimum rate, their bins should be kept in a temperature range of 55 - 77 degrees Fahrenheit. In hot weather bins should be kept in a cool dry place such as the pantry, under the kitchen sink, or in the garage. In cold weather bins can be kept by a hot water heater, or in the garage to keep warm. Outdoor bins need to be insulated with straw to keep the worms from freezing in the winter. Earthworms are night crawlers, they like their habitat to be dark, they do not like light. Bins should always be a dark color and have a lid that keeps the bin covered and dark.

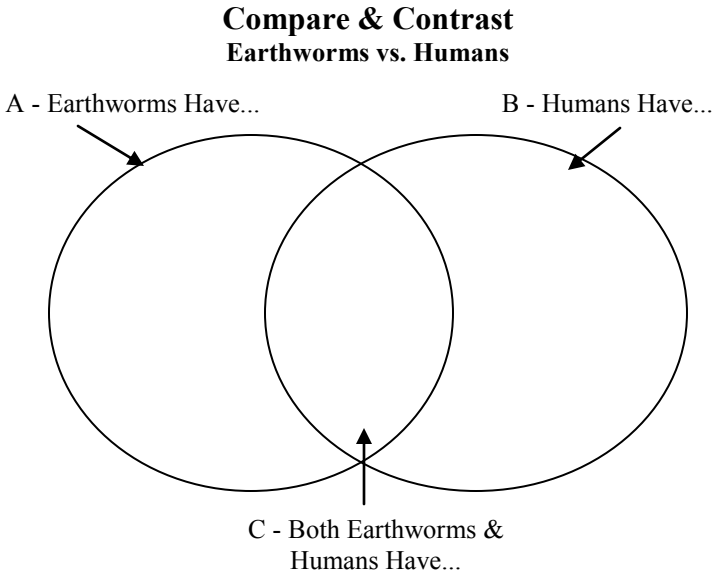
Earthworms Diet

Earthworms eat all kinds of food and yard waste. Red Wigglers' diet consist of fruit peelings, vegetable peelings, cereal & oatmeal, cornmeal, crushed eggshells, coffee grounds, tea bags and newspaper. Things that should not be fed to red wigglers are: animal bones, meat, poultry & fish, cheese, butter, salad dressing, mayonnaise, glossy colored paper and greasy foods.

Procedure

Preparing for the Lesson:

1. Read the "Vermicomposting Overview" for your background information.
2. You can bring in a sample of Red Wigglers for the lesson. These worms can be bought at a local worm ranch or find them in your backyard garden!
3. On your classroom board, write "Compare & Contrast" and below it write "Earthworms vs. Humans." Draw a venn diagram like the one shown below/



Procedure Cont'd

Teaching the Lesson:

1. Divide the class into groups of three or four each.
2. Read "Wiggles the Worm" to your class.
3. Allow students to hold sample worms if you brought them in.
4. Let the class know that they will focus on the anatomy of the Red Wiggler and will compare them to humans.
5. Show the students the diagram of Earthworms' Anatomy, Visual Aid Card No. 10.
6. Show the students the diagram of the Human Anatomy, Visual Aid Card No. 11.
7. Ask the students to identify the body parts that are common in both worms and humans. Write answers on the board in section C of the venn diagram.
8. Ask the students to identify the body parts that are different in the worms and humans. Write answers on the board in their respective sections on the venn diagram (A for earthworms & B for humans). ***See suggested answers on page 56.***
9. Ask the students what color do they think worms usually are. Show the students the picture of red wiggler, ask them what color is it.
10. Distribute Handout titled "Color Me Pink?" to the students, have them color it. Students can add grass, soil, leaves etc. to their picture as they like!
11. Read the sentence to the students, have students complete the sentence by writing in numbers to make the sentence correct. ***Answer - Worms have 5 hearts, but humans only have 1 heart.***

Visual Aids Reference

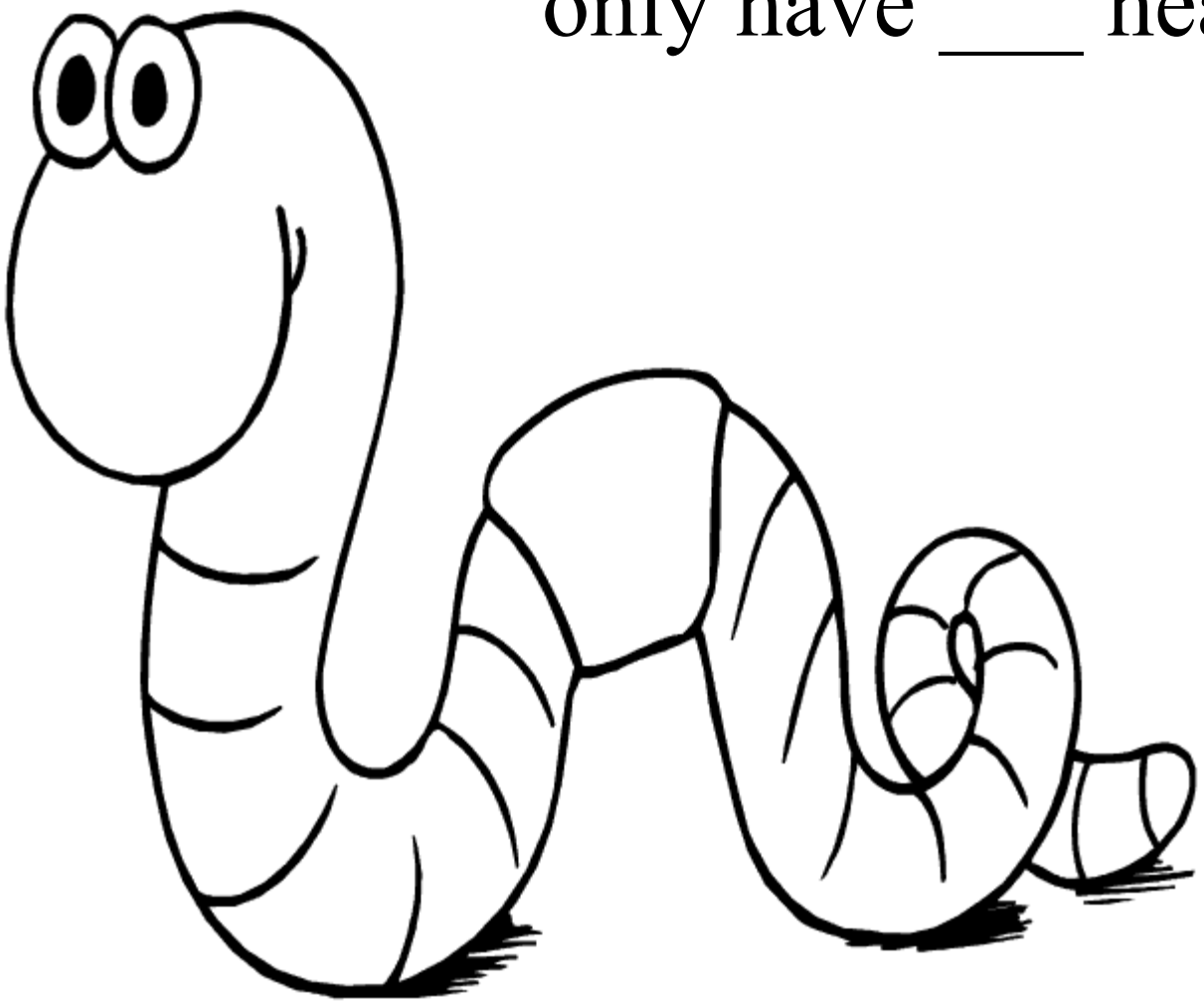
- Card No. 10 - Anatomy of Earthworms **Page 50**
- Card No. 11 - Anatomy of Humans **Page 51**

Teacher's Notes

Kindergarten Activity

Name:_____ **Date:** _____

Worms have ____ hearts but humans only have ____ heart.



Color Me Pink?

1st Grade
Vermicomposting Lesson

Objective: Students will scientifically analyze Red Wigglers' diet.

Method: using a diagram of the Red Wiggler diet and the pH scale, students will identify the pH of foods that can be fed to worms.

Materials: Earthworms' Diet Visual Aid Card No. 13, pH Scale diagram Visual Aid Card No. 14, pencils and coloring supplies.

Background: Worms enjoy a variety of foods, from soil to fruits, to newspapers! Some foods however are harmful to worms and should be avoided.

Subject Area: Science, Environmental Education

Duration: Two, 30 – 45 minute sessions.

Group Size: Small groups of three to four students each

Setting: Classroom

Key Terms: acidic, basic (alkaline), diet, food waste, organic matter, pH scale

Vermicomposting Overview

What is Vermicomposting?

Vermicomposting, or composting with earthworms, is a great way to be friendly to our environment. This is nature's way of recycling. Worms such as red wigglers eat organic matter such as dead leaves and flowers or food waste such as fruits and vegetables, and turn it into nutrient–rich compost! The organic matter can be found right in your backyard. Food waste can come straight from your kitchen! Instead of having your food waste go to the landfill, you can collect it and add it to a vermicomposting bin. The end result is a soil amendment that is crumbly, damp and high in nutrients that will help plants grow healthy and strong!

What is Vermicompost made up of?

Vermicompost is made up of the following:

- soil
- worms at various stages of development (cocoon, hatchling, juvenile, adult)
- worm castings (manure)
- bedding materials (shredded newspapers, mulched leaves, saw dust, dead plants, grass, straw/hay, and peat moss)
- various organic waste at different stages of decomposition
- various micro/macro organisms (millipedes, isopods, enchytraeids, springtails, centipedes, bacteria, fungi & mites) These creatures are decomposer organisms that help to break down the organic matter into simpler forms. Some microorganisms are predators and eat our friendly worms!

Types of Earthworms

There are different types of earthworms. The most common types are brandling worms, redworms (Red Wigglers) and field or garden earthworms. Some worms are deep burrowers, but they are not good for composting because they like to go deep underground where it is cool. Other worms are soil mixers, they are also not good for composting because they like to stay in the root zone, eating organic matter and mixing the soil layers. Worms that are surface dwellers like red wigglers eat organic matter that falls onto the soil surface and are adapted to clean up waste.

Anatomy of Earthworms

Earthworms have long rounded bodies with a pointed head or anterior and a slightly flattened posterior. Their bodies are soft and moist allowing them to burrow through the soil easily since they don't have a backbone! Earthworms have 5 hearts that pump blood through their blood vessels! Earthworms move by contracting and relaxing their muscles. They have no real legs, but setae/bristles which move back and forth, making it possible for them to crawl. Unlike humans, earthworms breathe through their skin. They ingest food through their mouth, which goes to their stomach (crop) and then passes through the gizzard. In the gizzard the food is ground up by ingested grit. Next the food is digested in the earthworm's intestines. The remains then pass through the anus.

Earthworm babies come in the form of cocoons. Cocoons are lemon-shaped and approximately 1/8 of an inch long. Two or more babies can hatch from one cocoon. Cocoons mature and hatch in 5 to 11 weeks. Baby worms, or hatchlings, are whitish or almost transparent and are only 1/2 inch to 1 inch long. Hatchlings are thread like creatures and in about 8 hours after hatching they gain hemoglobin and change color from white, to pale pink to brick red. Hatchlings take 53 to 75 days to become Juveniles. Juveniles take 56 to 72 days to become mature adult worms with a clitellum. The clitellum is the wide band that surrounds an adult worm. Healthy adult worms can live for five or more years.

Earthworms Habitat

In nature, earthworms can be found in soil that is not too dry or too moist. Red Wigglers natural habitat has leaves, manure and other decaying materials. Vermicomposting can be done indoors or outdoors in a composting bin. Bins come in various shapes and sizes. The compost bin is a reconstruction of the worm's natural habitat. Red wigglers are kept in these bins to help humans make lots of nutrient rich soil that you can put into your garden to grow healthier produce and better flowers and plants. Bedding materials are used to make the worms feel at home. It helps produce the right temperatures for the worms to live in and helps the worms breathe. The bedding materials need to be kept thoroughly moist (like a wrung out sponge). Red Wigglers can survive in a wide range of temperatures (40 - 80 degrees Fahrenheit).

In order to process food waste and have babies at an optimum rate, their bins should be kept in a temperature range of 55 - 77 degrees Fahrenheit. In hot weather bins should be kept in a cool dry place such as the pantry, under the kitchen sink, or in the garage. In cold weather bins can be kept by a hot water heater, or in the garage to keep warm. Outdoor bins need to be insulated with straw to keep the worms from freezing in the winter. Earthworms are night crawlers, they like their habitat to be dark, they do not like light. Bins should always be a dark color and have a lid that keeps the bin covered and dark.

Earthworms Diet

Earthworms eat all kinds of food and yard waste. Red Wigglers' diet consist of fruit peelings, vegetable peelings, cereal & oatmeal, cornmeal, crushed eggshells, coffee grounds, tea bags and newspaper! Things that should not be fed to red wigglers are: animal bones, meat, poultry & fish, cheese, butter, salad dressing, mayonnaise, glossy colored paper and greasy foods. Meats, dairy products and animal bones can attract pests. Limited amounts of citrus (oranges, grapefruit, lemons etc.) can be added. Having too much citrus makes the compost too acidic. Scientists use a pH scale to measure how acidic or basic (alkaline) a substance is. Acids and bases are chemicals. A substance is an acid or base depending on the type of ions in it. If it has a lot of hydrogen ions, then it is an acid. If it has a lot of hydroxide ions, then it is a base. pH is a number from 0 to 14. From 0 to 6 are acids, with 0 being the strongest. From 8 to 14 are bases with 14 being the strongest base. If a liquid has a pH of 7, it's neutral. This would be something like distilled water. The compost should be kept at a pH of 6.5 if possible, with upper limits at 7.0 and lower limits at 6.0. If the compost becomes to acidic, the pH can be lowered by adding crushed eggshells.

Chemicals (including insecticides), metals, plastics, glass, soaps, pet manures, poisonous plants, or plants sprayed with insecticides should never be added to the worm bin. Food wastes should be added to the bin by pulling back the bedding material and burying it. Covering or burying the food waste will help to avoid attracting flies and other pests. Successive portions of food waste should be buried at different locations in the bin to keep the them from accumulating. Chopping or grinding the food waste in a food processor speeds the composting time considerably.

Procedure

Preparing for the Lesson:

1. Read the "Vermicomposting Overview" for your background information.
2. Ask students to bring in small samples of food waste that they collected from home or at lunch that day.

Teaching the Lesson:

1. Divide the class into groups of three or four each.
2. Read "Flame the Red Wiggler" to your class.
3. Let the class know that they will focus on the diet of the Red Wiggler .
3. Show the students the diagram of Earthworms Diet, Visual Aid Card No. 13. Have them divide their food waste into two groups, foods worms can eat & foods worms should avoid.
4. Show the students the diagram of the pH Scale, Visual Aid Card No. 14.

Procedure Cont'd

Teaching the Lesson Cont'd:

6. Ask the students to identify the numbers on the pH scale that are acidic. ***Answer - 3 to 6***
7. Ask students on which side of the scale does most of the foods that worms can eat fall? ***Answer - Alkaline (Basic)***
8. Ask the students to identify the numbers on the pH scale that are Basic/Alkaline. ***Answer - 8 to 10***
9. Ask students on which side of the scale does most of the foods that worms can not eat fall? ***Answer - Acidic***
10. Ask the students to identify the number on the pH scale that is neutral. ***Answer - 7***
11. Distribute Handout titled "Help Wiggles Find Food!"
12. Have students write "Yes" or "No" next to the list of the foods that can/cannot be fed to the worms. ***See answers on page 56.***

Visual Aids Reference

- Card No. 13 - Earthworms' Diet **Page 53**
- Card No. 14 - pH Scale Diagram **Page 54**

Teacher's Notes

1st Grade Activity

Worm Food

Name:_____

Date: _____

Write **Yes**, if the food listed in one that Red Wigglers can eat.
Write **No**, if the food listed in one that Red Wigglers cannot eat.

Apples ____

Lettuce ____

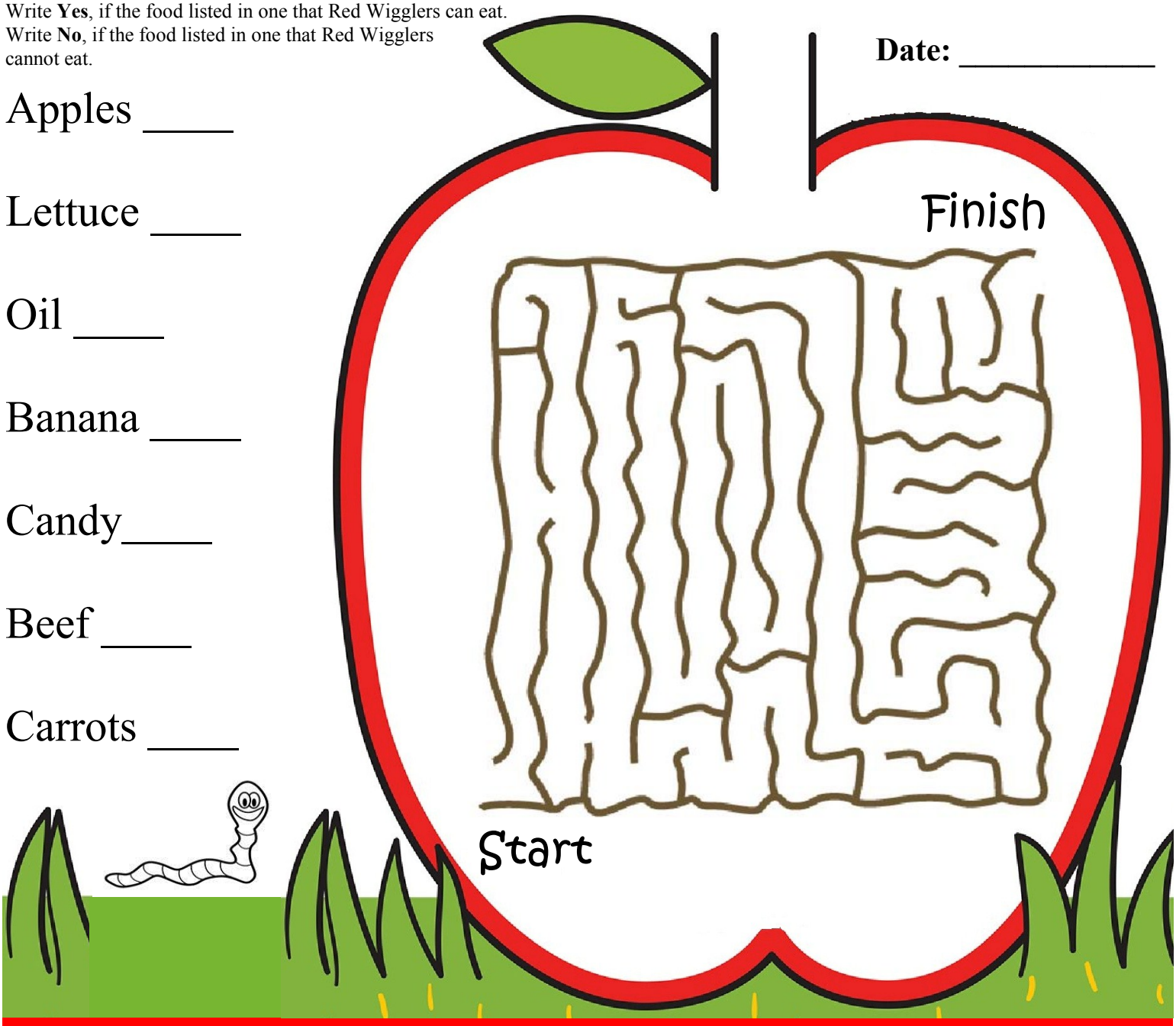
Oil ____

Banana ____

Candy____

Beef ____

Carrots ____



Help Wiggles Find Food?

2nd Grade
Vermicomposting Lesson

Objective: Students will scientifically analyze Red Wigglers' habitat.

Method: Using a diagram of different types of bins and bedding materials, students will try to create the correct moisture of the Red Wigglers' habitat.

Materials: Different Types of Bins Visual Aid Card No. 12 & Bedding Materials Visual Aid Card No. 5 pencils and coloring supplies. **Optional** - bedding materials, 6 containers, 6 sponges, 6 one pint bottles of water.

Background: In order for Red Wigglers to thrive in their environment, compost bins need to have certain bedding materials, be within a specific temperature range and be just moist, not to wet or too dry!

Subject Area: Science, Environmental Education

Duration: Two, 30 – 45 minute sessions.

Group Size: Small groups of three to four students each

Setting: Classroom

Key Terms: bedding, compost bin, Fahrenheit, habitat, moist, temperature.

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Procedure

Preparing for the Lesson:

1. Read the "Vermicomposting Overview" for your background information.
2. You can bring in samples of bedding materials (enough to make small samples for each group in your class).

Teaching the Lesson:

1. Divide the class into groups of three or four each.
2. Read "Flame the Red Wiggler" to your class.
3. Let the class know that they will focus on the habitat of the Red Wiggler.
4. Show the students the Different Types of Bins, Visual Aid Card No. 12
5. Show the students the Bedding Materials, Visual Aid Card No. 5
6. Ask students why the bedding materials shown would help worms feel at home in the compost bin?

Procedure Cont'd

Teaching the Lesson Cont'd:

Answer to No. 6. - Most of the bedding materials are found in the worms natural environment.

7. Ask the students to identify the two bedding materials that are not found in nature. ***Answer - newspaper & sawdust***
8. Have the students write down which temperature range that they feel most comfortable in?
9. **Optional Activity** - divide the bedding materials among the groups in your class. Give each group a container, a sponge and a bottle of water. First have the groups soak the sponge and wring it out. Then have each group mix the materials and add small amounts of water until they think it feels like a wrung out sponge.
10. Distribute Handout titled "Wiggly Worm Word Search!"
11. Have students write true or false for each statement and then find the bolded words in the word search.
    See answers on page 56.

Visual Aids Reference

- Card No. 5 - Bedding Materials **Page 43**
- Card No. 12 - Different types of Bins **Page 52**

Teacher's Notes

2nd Grade Activity

Name:_____

Date: _____

True or False

1. _____ Red Wigglers' natural habitat has leaves, manure and other **decaying** materials.
2. _____Worms are **night crawlers** so they like their **habitat** to have lots of sunlight.
3. _____ Grass, **peat moss**, straw, hay, **newspaper**, saw dust, **soil** & **leaves** are all bedding materials.
4. _____ The **optimum** temperature range for worms is 55 - 77 degrees **Fahrenheit**.

S S G V U I U N Q T F U N R M

S A E N C E P H I I W P E D U

N E W V I G N C P E C C Q E M

B E R D A D B Z L H O N J C I

H C W U U E D B D N P H I A T

B I P S T S L E S E F A F Y P

S O I L P A T T B R S B C I O

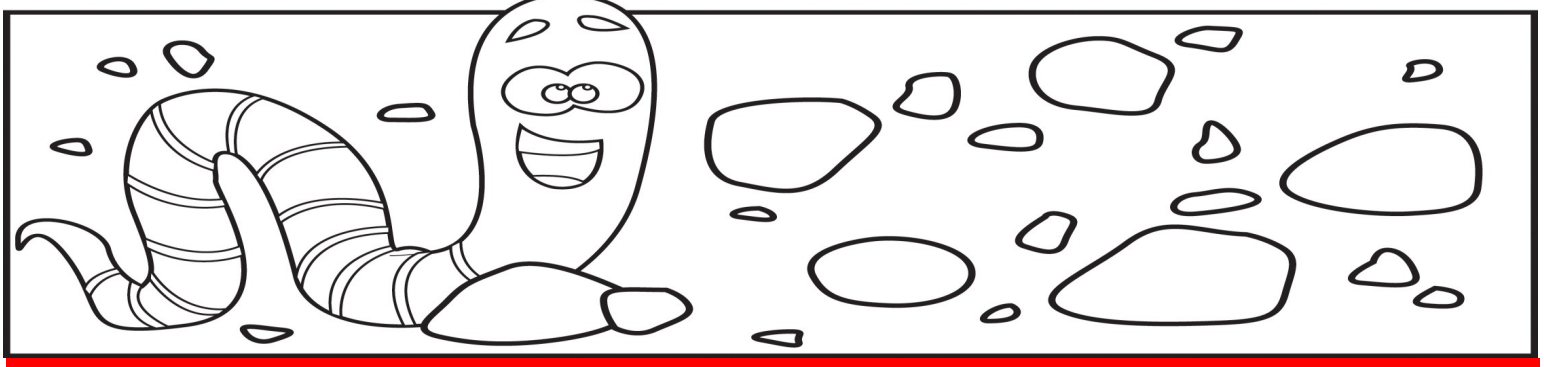
S R E L W A R C T H G I N N C

J Z L A L U P E T A R T H G P

E B R U C S X E P F C A B A Q

S T S T P G I C R M C T S W Y

S N I J S S O M T A E P S Q W



Fill in the Hole!

3rd Grade
Vermicomposting Lesson

Objective: Students will scientifically analyze the Red Wigglers' ecosystem.

Method: Using diagrams of microorganisms students will identify which ones are a helpful part of the compost bin ecosystem and which ones are not.

Materials: Compost Bin Community, Visual Aid Card No. 7A, 7B, 7C, pencils and coloring supplies.

Background: A compost bin contains many creatures other than earthworms. Each microorganism has their own unique role to play in that dark, moist pile of compost!

Subject Area: Science, Environmental Education

Duration: Two, 30 – 45 minute sessions.

Group Size: Small groups of three to four students each

Setting: Classroom

Key Terms: decaying, ecosystem, food chain, macro organisms, microorganisms, predators

Vermicomposting Overview

What is Vermicomposting?

Vermicomposting, or composting with earthworms, is a great way to be friendly to our environment. This is nature's way of recycling. Worms such as red wigglers eat organic matter such as dead leaves and flowers or food waste such as fruits and vegetables, and turn it into nutrient–rich compost! The organic matter can be found right in your backyard. Food waste can come straight from your kitchen! Instead of having your food waste go to the landfill, you can collect it and add it to a vermicomposting bin. The end result is a soil amendment that is crumbly, damp and high in nutrients that will help plants grow healthy and strong!

What is Vermicompost made up of?

Vermicompost is made up of the following:

- soil
- worms at various stages of development (cocoon, hatchling, juvenile, adult)
- worm castings (manure)
- bedding materials (shredded newspapers, mulched leaves, saw dust, dead plants, grass, straw/hay, and peat moss)
- various organic waste at different stages of decomposition
- various micro/macro organisms (millipedes, isopods, enchytraeids, springtails, centipedes, bacteria, fungi & mites) These creatures are decomposer organisms that help to break down the organic matter into simpler forms. Some microorganisms are predators and eat our friendly worms!

Types of Earthworms

There are different types of earthworms. The most common types are brandling worms, redworms (Red Wigglers) and field or garden earthworms. Some worms are deep burrowers, but they are not good for composting because they like to go deep underground where it is cool. Other worms are soil mixers, they are also not good for composting because they like to stay in the root zone, eating organic matter and mixing the soil layers. Worms that are surface dwellers like red wigglers eat organic matter that falls onto the soil surface and are adapted to clean up waste.

Anatomy of Earthworms

Earthworms have long rounded bodies with a pointed head or anterior and a slightly flattened posterior. Their bodies are soft and moist allowing them to burrow through the soil easily since they don't have a backbone! Earthworms have 5 hearts that pumps blood through their blood vessels! Earthworms move by contracting and relaxing their muscles. They have no real legs, but setae/bristles which move back and forth, making it possible for them to crawl. Unlike humans, earthworms breathe through their skin. They ingest food through their mouth, which goes to their stomach (crop) and then passes through the gizzard. In the gizzard the food is ground up by ingested grit. Next the food is digested in the earthworm's intestines. The undigested food then passes through the anus.

Earthworm babies come in the forms of cocoons. Cocoons are lemon-shaped and approximately 1/8 of an inch long. Two or more babies can hatch from one cocoon. Cocoons mature and hatch in about 5 to 11 weeks. Baby worms, or hatchlings, are whitish or almost transparent and are only 1/2 inch to 1 inch long. Hatchlings are thread like creatures and in about 8 hours after hatching they gain hemoglobin and change color from white, to pale pink to brick red. Hatchlings take 53 to 75 days to become Juveniles. Juveniles take 56 to 72 days to become mature adult worms with a clitellum. The clitellum is the wide band that surrounds an adult worm. Healthy adult worms can live for five or more years.

Earthworms Habitat

In nature, earthworms can be found in soil that is not too dry or too moist. Red wrigglers natural habitat has leaves, manure and other decaying materials. Vermicomposting can be done indoors or outdoors in a composting bin. Bins come in various shapes and sizes. The compost bin is a reconstruction of the worm's natural habitat. Red Wigglers are kept in these bins to help humans make lots of nutrient rich soil that you can put into your garden to grow healthier produce and better flowers and plants. Bedding materials are used to make the worms feel at home. It helps produce the right temperatures for the worms to live in and helps the worms breathe. The bedding materials need to be kept thoroughly moist (like a wrung out sponge). Red wigglers can survive in a wide range of temperatures (40 - 80 degrees Fahrenheit).

In order to process food waste and have babies at an optimum rate, their bins should be kept in a temperature range of 55 - 77 degrees Fahrenheit. In hot weather bins should be kept in a cool dry place such as the pantry, under the kitchen sink, or in the garage. In cold weather bins can be kept by a hot water heater, or in the garage to keep warm. Outdoor bins need to be insulated with straw to keep the worms from freezing in the winter. Earthworms are night crawlers, they like their habitat to be dark, they do not like light. Bins should always be a dark color and have a lid that keeps the bin covered and dark.

Earthworms Ecology

In the compost bin, there are other creatures that share the environment. Some of these creatures are predators (usually macro organisms) that eat earthworms and other micro-organisms in the vermicompost. A food chain shows the relationship between organisms, based on who eats whom! In the compost bin, there are three levels of consumers. The first level is made up of organisms like bacteria, fungi, earthworms, millipedes, enchytraeids and isopods that eat the dead organic matter. The second level is made up of organisms like springtails, mites and feather-winged beetles which eat first level consumers. Third level consumers are made up of organism like centipedes, ants and ground beetles. Third level consumers eat second and first level consumers. Predators in a compost bin might include centipedes, rove beetles, ants and predatory mites.

Earthworms Diet

Earthworms eat all kinds of food and yard waste. Red Wigglers' diet consist of fruit peelings, vegetable peelings, cereal & oatmeal, cornmeal, crushed eggshells, coffee grounds, tea bags and newspaper! Things that should not be fed to Red Wigglers are: animal bones, meat, poultry & fish, cheese, butter, salad dressing, mayonnaise, glossy colored paper and greasy foods. Meats, dairy products and animal bones attract pests. Limited amounts of citrus (oranges, grapefruit, lemons etc.) can be added. Having too citrus makes the compost too acidic. Scientists use a pH scale to measure how acidic or basic (alkaline) a substance is. Acids and bases are chemicals. A substance is an acid or base depending on the type of ions in it. If it has a lot of hydrogen ions, then it is an acid. If it has a lot of hydroxide ions, then it is a base. pH is a number from 0 to 14. From 0 to 6 are acids, with 0 being the strongest. From 8 to 14 are bases with 14 being the strongest base. If a liquid has a pH of 7, it's neutral. This would be something like distilled water. The compost should be kept at a pH of 6.5 if possible, with upper limits at 7.0 and lower limits at 6.0. If the compost becomes to acidic, the pH can be lowered by adding crushed eggshells.

Chemicals (including insecticides), metals, plastics, glass, soaps, pet manures, poisonous plants, or plants sprayed with insecticides should never be added to the worm bin. Food wastes should be added to the bin by pulling back the bedding material and burying it. Covering or burying the food waste will help to avoid attracting flies and other pests. Successive portions of food waste should be buried at different locations in the bin to keep the them from accumulating. Chopping or grinding the food waste in a food processor speeds the composting time considerably.

Procedure

Preparing for the Lesson:

1. Read the "Vermicomposting Overview" for your background information.
2. As a heading on the classroom board write "Earthworms Ecosystem."
3. Draw a table with 2 columns and 4 rows. Write the name of one of the organisms from Visual Card No. 7A in a box.

Teaching the Lesson:

1. Divide the class into groups of three or four each.
2. Read "Wiggles the Earthworm" to the class.
3. Let the class know that they will focus on the micro/macro organism that live in red wiggler ecosystem.
4. Show the students the Microorganism, Visual Aid Card No. 7A.
5. Ask students to guess which two microorganism are predators or harmful to worms in the bin? Take a tally on the classroom board.
6. Show the students the Microorganisms, Visual Aid Card No. 7B and 7C.
7. Ask the students to identify the two microorganisms that are predators or harmful to worms and compare to their first answers. ***Answer - centipedes & mites***
8. Distribute Handout titled "Worm Friend or Foe!" and have students complete it. ***See answers on page 56.***

Visual Aids Reference

- Card No. 7A- Compost Bin Community **Page 45**
- Card No. 7B - Compost Bin Community **Page 46**
- Card No. 7C - Compost Bin Community **Page 47**

Teacher's Notes

3rd Grade Activity

Name:_____ **Date:** _____

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
1	14	2		3	16	4		5	18	6	19		20		21	9	22	10		11	24	12	25		26

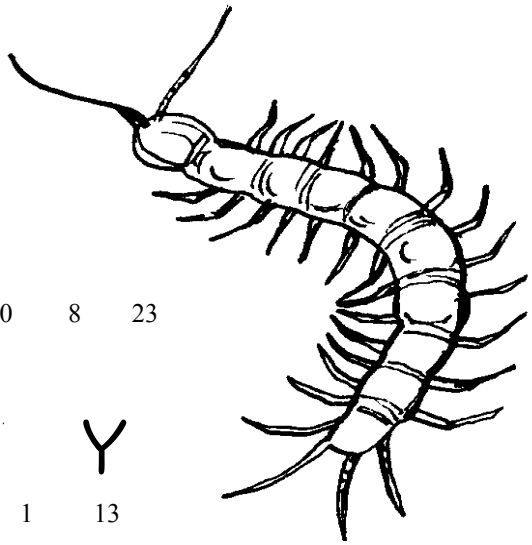
_ _ E _ _ E E _ Y,
23 17 3 2 22 3 3 21 13

_ _ _ _ _ Y
2 22 1 12 19 13

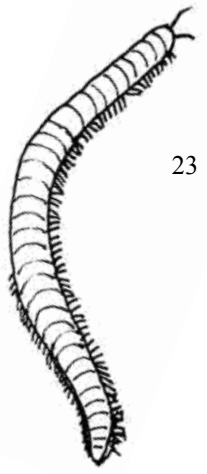
_ E _ _ I _ E _ E _ I _ _
2 3 20 23 5 21 3 15 3 5 10 20 8 23

_ Y _ _ I E _ _ .
7 13 16 22 5 3 20 15

_ _ E _ _ _ _ _ _ _ _ _ _ Y
10 17 3 7 11 10 23 4 8 1 12 1 13



Millipede VS. Centipede



_ E _ _ E _ _ Y, _ _ _ _ E _ _ _ _
23 17 3 7 3 22 22 13 7 1 22 24 3 19 8 11 10

_ I _ _ I _ E _ E _ I _ _ Y
7 5 19 19 5 21 3 15 3 5 10 7 13

_ _ I E _ _, _ _ _ _ _ E I _
16 22 5 3 20 15 1 20 15 10 17 3 5 10

_ E _ _ _ _ E _ _ _ _ _ Y!
12 3 21 2 8 7 3 23 8 10 23 1 13

Worm Friend or Foe?

4th Grade
Vermicomposting Lesson

Objective: Students will scientifically analyze the Red Wigglers' developmental stages.

Method: Using the diagram, Developmental Stages of Earthworms, students will learn how Red Wigglers grow.

Materials: Microorganisms Visual Aid Card No. 5, pencils and coloring supplies.

Background: A compost bin contains earthworms in various stages of development.

Subject Area: Science, Environmental Education

Duration: Two, 1 hour or 45 minute sessions.

Group Size: Small groups of three to four students each

Setting: Classroom

Key Terms: developmental stages, cocoons, hatchlings, transparent, hemoglobin, juveniles, clitellum

Vermicomposting Overview

What is Vermicomposting?

Vermicomposting, or composting with earthworms, is a great way to be friendly to our environment. This is nature's way of recycling. Worms such as red wigglers eat organic matter such as dead leaves and flowers or food waste such as fruits and vegetables, and turn it into nutrient–rich compost! The organic matter can be found right in your backyard. Food waste can come straight from your kitchen! Instead of having your food waste go to the landfill, you can collect it and add it to a vermicomposting bin. The end result is a soil amendment that is crumbly, damp and high in nutrients that will help plants grow healthy and strong!

What is Vermicompost made up of?

Vermicompost is made up of the following:

- soil
- worms at various stages of development (cocoon, hatchling, juvenile, adult)
- worm castings (manure)
- bedding materials (shredded newspapers, mulched leaves, saw dust, dead plants, grass, straw/hay, and peat moss)
- various organic waste at different stages of decomposition
- various micro/macro organisms (millipedes, isopods, enchytraeids, springtails, centipedes, bacteria, fungi & mites) These creatures are decomposer organisms that help to break down the organic matter into simpler forms. Some microorganisms are predators and eat our friendly worms!

Types of Earthworms

There are different types of earthworms. The most common types are brandling worms, redworms (Red Wigglers) and field or garden earthworms. Some worms are deep burrowers, but they are not good for composting because they like to go deep underground where it is cool. Other worms are soil mixers, they are also not good for composting because they like to stay in the root zone, eating organic matter and mixing the soil layers. Worms that are surface dwellers like red wigglers eat organic matter that falls onto the soil surface and are adapted to clean up waste.

Anatomy of Earthworms

Earthworms have long rounded bodies with a pointed head or anterior and a slightly flattened posterior. Their bodies are soft and moist allowing them to burrow through the soil easily since they don't have a backbone! Earthworms have 5 hearts that pumps blood through their blood vessels! Earthworms move by contracting and relaxing their muscles. They have no real legs, but setae/bristles which move back and forth, making it possible for them to crawl. Unlike humans, earthworms breathe through their skin. They ingest food through their mouth, which goes to their stomach (crop) and then passes through the gizzard. In the gizzard the food is ground up by ingested grit. Next the food is digested in the earthworm's intestines. The undigested food then passes through the anus.

Earthworm babies come in the form of cocoons. Cocoons are lemon-shaped and approximately 1/8 of an inch long. Two or more babies can hatch from one cocoon. Cocoons mature and hatch in about 5 to 11 weeks. Baby worms, or hatchlings, are whitish or almost transparent and are only 1/2 inch to 1 inch long. Hatchlings are thread like creatures and in about 8 hours after hatching they gain hemoglobin and change color from white, to pale pink to brick red. Hatchlings take 53 to 75 days to become Juveniles. Juveniles take 56 to 72 days to become mature adult worms with a clitellum. The clitellum is the wide band that surrounds an adult worm. Healthy adult worms can live for five or more years.

Earthworms Habitat

In nature, earthworms can be found in soil that is not too dry or too moist. Red wrigglers natural habitat has leaves, manure and other decaying materials. Vermicomposting can be done indoors or outdoors in a composting bin. Bins come in various shapes and sizes. The compost bin is a reconstruction of the worm's natural habitat. Red wigglers are kept in these bins to help humans make lots of nutrient rich soil that you can put into your garden to grow healthier produce and better flowers and plants. Bedding materials are used to make the worms feel at home. It helps produce the right temperatures for the worms to live in and helps the worms breathe. The bedding materials need to be kept thoroughly moist (like a wrung out sponge). Red wigglers can survive in a wide range of temperatures (40 - 80 degrees Fahrenheit).

In order to process food waste and have babies at an optimum rate, their bins should be kept in a temperature range of 55 - 77 degrees Fahrenheit. In hot weather bins should be kept in a cool dry place such as the pantry, under the kitchen sink, or in the garage. In cold weather bins can be kept by a hot water heater, or in the garage to keep warm. Outdoor bins need to be insulated with straw to keep the worms from freezing in the winter. Earthworms are night crawlers, they like their habitat to be dark, they do not like light. Bins should always be a dark color and have a lid that keeps the bin covered and dark.

Earthworms Ecology

In the compost bin, there are other creatures that share the environment. Some of these creatures are predators (usually macro organisms) that eat earthworms and other micro-organisms in the vermicompost. A food chain shows the relationship between organisms, based on who eats whom! In the compost bin, there are three levels of consumers. The first level is made up of organisms like bacteria, fungi, earthworms, millipedes, enchytraeids and isopods that eat the dead organic matter. The second level is made up of organisms like springtails, mites and feather-winged beetles which eat first level consumers. Third level consumers are made up of organism like centipedes, ants and ground beetles. Third level consumers eat second and first level consumers. Predators in a compost bin might include centipedes, rove beetles, ants and predatory mites.

Earthworms Diet

Earthworms eat all kinds of food and yard waste. Red Wigglers' diet consist of fruit peelings, vegetable peelings, cereal & oatmeal, cornmeal, crushed eggshells, coffee grounds, tea bags and newspaper! Things that should not be fed to Red Wigglers are: animal bones, meat, poultry & fish, cheese, butter, salad dressing, mayonnaise, glossy colored paper and greasy foods. Meats, dairy products and animal bones attract pests. Limited amounts of citrus (oranges, grapefruit, lemons etc.) can be added. Having too citrus makes the compost too acidic. Scientists use a pH scale to measure how acidic or basic (alkaline) a substance is. Acids and bases are chemicals. A substance is an acid or base depending on the type of ions in it. If it has a lot of hydrogen ions, then it is an acid. If it has a lot of hydroxide ions, then it is a base. pH is a number from 0 to 14. From 0 to 6 are acids, with 0 being the strongest. From 8 to 14 are bases with 14 being the strongest base. If a liquid has a pH of 7, it's neutral. This would be something like distilled water. The compost should be kept at a pH of 6.5 if possible, with upper limits at 7.0 and lower limits at 6.0. If the compost becomes to acidic, the pH can be lowered by adding crushed eggshells.

Chemicals (including insecticides), metals, plastics, glass, soaps, pet manures, poisonous plants, or plants sprayed with insecticides should never be added to the worm bin. Food wastes should be added to the bin by pulling back the bedding material and burying it. Covering or burying the food waste will help to avoid attracting flies and other pests. Successive portions of food waste should be buried at different locations in the bin to keep the them from accumulating. Chopping or grinding the food waste in a food processor speeds the composting time considerably.

Procedure

Preparing for the lesson

1. Ask students to bring in pictures of themselves or family members of different age groups. Only one person should be in a picture unless the persons shown are about the same age.
2. On the classroom board write the heading "Developmental Stages of Earthworms vs. Humans.
3. Draw a table with 2 rows and 4 columns. Label the top row "Earthworms" and label the bottom row "Humans."
4. Label the first box in the top row, "Cocoons" the second box "Hatchlings," the third box "Juveniles" and the forth box "Adults."
5. Label the first box in the bottom row, "Infants & Toddlers" (0 - 3 yrs. Old) the second box "School Age Children," (4 - 12 yrs. Old) the third box "Adolescents" (13 - 19 yrs. old) and the forth box "Adults" (20+ yrs. old).

Teaching the Lesson:

1. Divide the class into groups of three or four each.
2. Read the "Vermicomposting Overview" with your class. Have students take turns reading one paragraph at a time. Use the picture cards provided as visual aids.
3. Let the class know that they will focus on the developmental stages of the red wiggler.
4. Show the students the Developmental Stages of Earthworms, Visual Aid Card No. 5.
5. Have the students stick their pictures into the correct boxes for humans.
6. Discuss why in society and in the compost bin, there are humans and earthworms at different levels of development..
7. Go over the key terms with the students.
6. Distribute Handout titled "What's in a Worm?" and have students complete it. ***See answers on page 56.***

Visual Aids Reference

- Card No. 1 - Red Wiggler **Page 39**
- Card No. 2 - Organic Matter **Page 40**
- Card No. 3 - Food Waste **Page 41**
- Card No. 4 - Vermicompost **Page 42**
- Card No. 5 - Bedding Materials **Page 43**
- Card No. 6 - Phases of Decomposition **Page 44**
- Card No. 7A, 7B & 7C - Compost Bin Community **Pages 45 - 47**
- Card No. 8 - Types of Earthworms **Page 38**
- Card No. 9 - Developmental Stages of Earthworms **Page 39**
- Card No. 10 - Anatomy of Earthworms **Page 50**
- Card No. 11 - Anatomy of Humans **Page 51**
- Card No. 12 - Different types of Bins **Page 52**
- Card No. 13 - Earthworms' Diet **Page 53**
- Card No. 14 - pH Scale Diagram **Page 54**
- Card No. 15 - Compost Bin Food Chain **Page 55**

Teacher's Notes

4th Grade Activity

Name:_____ **Date:** _____

Unscramble the words & then fill in the blanks.

1. m l i t u c l e l _ _ _ _ _ _ _ _ _
2. o n s o c c o _ _ _ _ _ _ _
3. e o l g b n h i o m _ _ _ _ _ _ _ _ _
4. i a g h c l s t h n _ _ _ _ _ _ _ _ _
5. e u v i e n l s j _ _ _ _ _ _ _ _
6. p r a t s a t a e n r _ _ _ _ _ _ _ _ _ _

Earthworms' Developmental Stages

Earthworms start off as _____ that are released by adult worms. When the baby worms have developed they emerge _____ in color and are now called _____. Eight hours after hatching, they gain _____ and change color from white, to pale pink to brick red! _____ are young worms that don't have a _____. Adult worms can live for five years or more.

What's in a Worm?

5th Grade
Vermicomposting Lesson

Objective: Students will scientifically analyze the Red Wigglers' habitat.

Method: Using measuring tapes and various sizes of bins, students will calculate how much bedding material and water are needed to make a compost bin just right for worms.

Materials: Different types of Bins, Visual Aid Card No. 12, pencils. **Optional:** measuring tape and storage totes, scale, shredded newspapers and water.

Background: A worm's body is 75% to 90% water. In order for the worm to respire, its surface must be moist. The worms' home must have the same 75% moisture content, making it not too dry or too wet.

Subject Area: Science, Math & Environmental Education

Duration: Two, 1 hour or 45 minute sessions.

Group Size: Small groups of three to four students each

Setting: Classroom

Key Terms: habitat, reconstruction, respire, moisture, bedding, volume, cubic foot.

Vermicomposting Overview

What is Vermicomposting?

Vermicomposting, or composting with earthworms, is a great way to be friendly to our environment. This is nature's way of recycling. Worms such as red wigglers eat organic matter such as dead leaves and flowers or food waste such as fruits and vegetables, and turn it into nutrient–rich compost! The organic matter can be found right in your backyard. Food waste can come straight from your kitchen! Instead of having your food waste go to the landfill, you can collect it and add it to a vermicomposting bin. The end result is a soil amendment that is crumbly, damp and high in nutrients that will help plants grow healthy and strong!

What is Vermicompost made up of?

Vermicompost is made up of the following:

- soil
- worms at various stages of development (cocoon, hatchling, juvenile, adult)
- worm castings (manure)
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- various organic waste at different stages of decomposition
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Types of Earthworms

There are different types of earthworms. The most common types are brandling worms, redworms (Red Wigglers) and field or garden earthworms. Some worms are deep burrowers, but they are not good for composting because they like to go deep underground where it is cool. Other worms are soil mixers, they are also not good for composting because they like to stay in the root zone, eating organic matter and mixing the soil layers. Worms that are surface dwellers like red wigglers eat organic matter that falls onto the soil surface and are adapted to clean up waste.

Anatomy of Earthworms

Earthworms have long rounded bodies with a pointed head or anterior and a slightly flattened posterior. Their bodies are soft and moist allowing them to burrow through the soil easily since they don't have a backbone! Earthworms have 5 hearts that pumps blood through their blood vessels! Earthworms move by contracting and relaxing their muscles. They have no real legs, but setae/bristles which move back and forth, making it possible for them to crawl. Unlike humans, earthworms breathe through their skin. They ingest food through their mouth, which goes to their stomach (crop) and then passes through the gizzard. In the gizzard the food is ground up by ingested grit. Next the food is digested in the earthworm's intestines. The undigested food then passes through the anus.

Earthworm babies come in the forms of cocoons. Cocoons are lemon-shaped and approximately 1/8 of an inch long. Two or more babies can hatch from one cocoon. Cocoons mature and hatch in about 5 to 11 weeks. Baby worms, or hatchlings, are whitish or almost transparent and are only 1/2 inch to 1 inch long. Hatchlings are thread like creatures and in about 8 hours after hatching they gain hemoglobin and change color from white, to pale pink to brick red. Hatchlings take 53 to 75 days to become Juveniles. Juveniles take 56 to 72 days to become mature adult worms with a clitellum. The clitellum is the wide band that surrounds an adult worm. Healthy adult worms can live for five or more years.

Earthworms Habitat

In nature, earthworms can be found in soil that is not too dry or too moist. Red wrigglers natural habitat has leaves, manure and other decaying materials. Vermicomposting can be done indoors or outdoors in a composting bin. Bins come in various shapes and sizes. The compost bin is a reconstruction of the worm's natural habitat. Red wigglers are kept in these bins to help humans make lots of nutrient rich soil that you can put into your garden to grow healthier produce and better flowers and plants. Worms require a certain amount of space (volume) to work in to process food waste. A rule of thumb is to set up a compost bin with about 1/4 pound of worms for every cubic foot. Bedding materials are used to make the worms feel at home. It helps produce the right temperatures for the worms to live in and helps the worms breathe. A worm's body is 75% to 90% water. In order for the worm to respire, its surface must be moist. The worms' home must have the same 75% moisture content, making it not too dry or too wet. Red Wigglers can survive in a wide range of temperatures (40^0 - 80^0 Fahrenheit).

In order to process food waste and have babies at an optimum rate, their bins should be kept in a temperature range of 55^0 - 77^0 Fahrenheit. In hot weather bins should be kept in cool dry place such as the pantry, under the kitchen sink, or in the garage. In cold weather bins can be kept by a hot water heater, or in the garage to keep warm. Outdoor bins need to be insulated with straw to keep the worms from freezing in the winter. Earthworms are night crawlers, they like their habitat to be dark, they do not like light. Bins should always be a dark color and have a lid that keeps the bin covered and dark.

Earthworms Ecology

In the compost bin, there are other creatures that share the environment. Some of these creatures are predators (usually macro organisms) that eat earthworms and other micro-organisms in the vermicompost. A food chain shows the relationship between organisms, based on who eats whom! In the compost bin, there are three levels of consumers. The first level is made up of organisms like bacteria, fungi, earthworms, millipedes, enchytraeids and isopods that eat the dead organic matter. The second level is made up of organisms like springtails, mites and feather-winged beetles which eat first level consumers. Third level consumers are made up of organism like centipedes, ants and ground beetles. Third level consumers eat second and first level consumers. Predators in a compost bin might include centipedes, rove beetles, ants and predatory mites.

Earthworms Diet

Earthworms eat all kinds of food and yard waste. Red Wigglers' diet consist of fruit peelings, vegetable peelings, cereal & oatmeal, cornmeal, crushed eggshells, coffee grounds, tea bags and newspaper! Things that should not be fed to Red Wigglers are: animal bones, meat, poultry & fish, cheese, butter, salad dressing, mayonnaise, glossy colored paper and greasy foods. Meats, dairy products and animal bones attract pests. Limited amounts of citrus (oranges, grapefruit, lemons etc.) can be added. Having too citrus makes the compost too acidic. Scientists use a pH scale to measure how acidic or basic (alkaline) a substance is. Acids and bases are chemicals. A substance is an acid or base depending on the type of ions in it. If it has a lot of hydrogen ions, then it is an acid. If it has a lot of hydroxide ions, then it is a base. pH is a number from 0 to 14. From 0 to 6 are acids, with 0 being the strongest. From 8 to 14 are bases with 14 being the strongest base. If a liquid has a pH of 7, it's neutral. This would be something like distilled water. The compost should be kept at a pH of 6.5 if possible, with upper limits at 7.0 and lower limits at 6.0. If the compost becomes to acidic, the pH can be lowered by adding crushed eggshells.

Chemicals (including insecticides), metals, plastics, glass, soaps, pet manures, poisonous plants, or plants sprayed with insecticides should never be added to the worm bin. Food wastes should be added to the bin by pulling back the bedding material and burying it. Covering or burying the food waste will help to avoid attracting flies and other pests. Successive portions of food waste should be buried at different locations in the bin to keep the them from accumulating. Chopping or grinding the food waste in a food processor speeds the composting time considerably.

Procedure

Preparing for the lesson

1. Bring in three different sizes of compost bins. If you are not able to bring these bins for the lesson, just give the students the suggested size measurements.

Suggested sizes are:

- 19.25" x 14" x 13.5" plastic tote (small)
- 15.9" x 23.9" x 16.5" plastic tote (medium)
- 30.75" x 20.5" x 14.37" plastic tote (large)

Teaching the Lesson:

1. Divide the class into three groups.
2. Read the "Vermicomposting Overview" to your class. Have students take turns reading one paragraph at a time. Use the picture cards provided as visual aids.
3. Let the class know that they will focus on the Red Wigglers' Habitat.
4. Show the students the Different types of Bins, Visual Aid Card No. 12.
5. Discuss why the compost bins may come in various shapes and sizes.
6. Assign one bin (or measurements) to a group. Ask students to round decimals to the nearest whole number.
7. Distribute Handout titled "Inch Worm or Red Worm?" and have students complete it. ***See answers on page 56.***
   If you brought the optional materials have students use their answers to create a moist environment for worms in their bins.

Visual Aids Reference

- Card No. 1 - Red Wiggler **Page 39**
- Card No. 2 - Organic Matter **Page 40**
- Card No. 3 - Food Waste **Page 41**
- Card No. 4 - Vermicompost **Page 42**
- Card No. 5 - Bedding Materials **Page 43**
- Card No. 6 - Phases of Decomposition **Page 44**
- Card No. 7A, 7B & 7C - Compost Bin Community **Pages 45 – 47**
- Card No. 8 - Types of Earthworms **Page 48**
- Card No. 9 - Developmental Stages of Earthworms **Page 49**
- Card No. 10 - Anatomy of Earthworms **Page 50**
- Card No. 11 - Anatomy of Humans **Page 51**
- Card No. 12 - Different types of Bins **Page 52**
- Card No. 13 - Earthworms' Diet **Page 53**
- Card No. 14 - pH Scale Diagram **Page 54**
- Card No. 15 - Compost Bin Food Chain **Page 55**

Teacher's Notes

5th Grade Activity

Name:_____ **Date:** _____

1. Measure the length, width and height of your worm bin.
   (round to the nearest whole number)
   length _____inches
   width _____inches
   height _____inches

2. Calculate the cubic inches of your worm bin.

_____inches X _____inches X _____inches = _____cubic inches
length width height

3. Calculate how many cubic feet in your worm bin by dividing the number of cubic inches by 1,728. *(There are 1,728 cubic inches in one cubic foot.)*

_____cubic inches ÷ 1,728 cubic inches per cubic foot = _____cubic feet in worm bin

4. For every cubic foot in your worm bin, you will need 2.5 pounds of bedding materials. How many pounds will you need?

_____pounds of bedding materials

5. To determine how much water is needed to make the bedding 75% moist, multiply the ____ pounds of bedding materials by three (3). How many pounds of water will you need?

Inch Worm or Red Worm?

6th, 7th & 8th Grade

Vermicomposting Lesson

Objective: Students will scientifically test the Red Wigglers castings by growing produce.

Method: Using a variety of materials, students will make their own compost bin, collect & weigh food waste, track feedings and harvest worm castings. Students will also test the worm casting amended soil in growing tomatoes, against a store bought fertilizer and compare the results.

Materials: compost bin, bedding materials, food waste, soil, thermometer, store bought fertilizer, tomato seeds.

Background: Worm castings are said to be excellent natural fertilizers, which work better than store bought fertilizer. Students will test this theory after harvesting worm castings, by growing tomatoes and comparing the results.

Subject Area: Science, Math, Reading & Environmental Education

Duration: 6 months to 10 months.

Group Size: entire class

Setting: Classroom

Key Terms: municipalities, aerobic, nitrogen, phosphorus, potassium, medium, accumulate, cellulose, consistency, pulverized

Procedure

Teaching the Lesson:

1. Read "Vermicomposting" Guide H-164 by George W. Dickerson, with your class. Have students take turns reading one paragraph at a time.
2. Let the class know that they will test the harvest worm castings as fertilizer against a store bought fertilizer
3. Follow the instructions to:
   - A. Construct a Worm Bin
   - B. Add Bedding Materials
   - C. Add the Worms
   - D. Add Food Waste
   - E. Control the Temperature & Moisture in the Bin
   - F. Maintain the Bin
   - G. Harvest the Compost and Worms
4. Use the charts provided to help with monitoring and measurements throughout the school year.
5. Have students collect and weigh food waste and track feedings weekly for first 6 months.
6. Have students monitor temperature and moisture of compost bin weekly for first 6 months.
7. Have students harvest the compost and worms after 6 months.
8. Have students do experiment on Activity Sheet No 5. to compare worm casting amended soil to store bought fertilizer.
9. Have students observe the plants weekly and note their observations.
10. In the last month, have students discuss which plant produced the better tomatoes.

How to use the Project Planning Calendar

This calendar show the dates in any given year. Use this calendar to help you determine your project start and ending dates, and which days actions should be taken. To use this calendar:

1. Find the number for the day you start your project. Ex. If you started on **Sep. 10**, look at the Day of the Month Column and find **10**, look across to September column, you will find **Day 253.**
2. If you want to look at your project again in 30 days, add 30 to **Day 253,** you will get **Day 283**.
3. To find the day and the month of day 283, look up the column to find the month and across the column to find the day.
4. The chart tells you to look at your project again on **October 10**.

Vermicomposting

Cooperative Extension Service
College of Agriculture and Home Economics
New Mexico State University

Guide H-164

George W. Dickerson, Extension Horticulture Specialist

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Yard and food waste make up a major component of solid waste in most municipalities throughout the United States. Although much of this organic waste can be recycled in the backyard using traditional aerobic backyard composting techniques, these techniques are not appropriate for apartment dwellers and are often inconvenient, particularly during bad weather in the winter.[1]

Vermicomposting, or composting with earthworms, is an excellent technique for recycling food waste in the apartment as well as composting yard wastes in the backyard. Worm bins located near a hot water heater in the garage during the winter will save many a trip through the snow to the backyard compost bin. Letting worms recycle your food waste also saves your back, because you don't have to turn over the compost to keep it aerated.

TYPES OF EARTHWORM

The most common types of earthworms used for vermicomposting are brandling worms (*Eisenia foetida*) and redworms or red wigglers (*Lumbricus rubellus*). Often found in aged manure piles, they generally have alternating red and buff-colored stripes. They are not to be confused with the common garden or field earthworm (*Allolobophora caliginosa* and other species).

Although the garden earthworm occasionally feeds on the bottom of a compost pile, they prefer ordinary soil. An acre of land can have as many as 500,000 earthworms, which can recycle as much as 5 tons of soil or more per year.

Redworms and brandling worms, however, prefer the compost or manure environment. Passing through the gut of the earthworm, recycled organic wastes are excreted as castings, or worm manure, an organic material rich in nutrients that looks like fine-textured soil.

WHAT IS VERICOMPOSTING?

Vermicompost contains not only worm castings, but also bedding materials and organic wastes at various stages of decomposition. It also contains worms at various stages of development and other microorganisms associated with the composting processing.

Earthworm castings in the home garden often contain 5 to 11 times more nitrogen, phosphorous, and potassium as the surrounding soil. Secretions in the intestinal tracts of earthworms, along with soil passing through the earthworms, make nutrients more concentrated and available for plant uptake, including micronutrients.

Redworms in vermicompost act in a similar fashion, breaking down food wastes and other organic residues into nutrient-rich compost. Nutrients in vermicompost are often much higher than traditional garden compost (see table 1).

Table 1. Chemical characteristics of garden compost and vermicompost, 1994.

Parameter*	Garden compost[1]	Vermicompost[2]
pH	7.80	6.80
EC (mmhos/cm)**	3.60	11.70
Total Kjeldahl nitrogen(%)***	0.80	1.94
Nitrate nitrogen (ppm)****	156.50	902.20
Phosphorous (%)	0.35	0.47
Potassium (%)	0.48	0.70
Calcium (%)	2.27	4.40
Sodium (%)	< .01	0.02
Magnesium (%)	0.57	0.46
Iron (ppm)	11690.00	7563.00
Zinc (ppm)	128.00	278.00
Manganese (ppm)	414.00	475.00
Copper (ppm)	17.00	27.00
Boron (ppm)	25.00	34.00
Aluminum (ppm)	7380.00	7012.00

[1]Albuquerque sample [2]Tijeras sample

*Units- **ppm**=parts per million **mmhos/cm**=millimhos per centimeter

** EC = electrical conductivity is a measure (millimhos per centimeter) of the relative salinity of soil or the amount of soluble salts it contains.

*** Kjeldahl nitrogen = is a measure of the total percentage of nitrogen in the sample including that in the organic matter.

**** Nitrate nitrogen = that nitrogen in the sample that is immediately available for plant uptake by the roots.

[1]For more information on composting, see Backyard Composting (nmsu) Extension Guide H-110). Request this publication by calling (505) 646-3228. You can download this and other publications from our World Wide Web site at http://www.cahe.nmsu.edu. Click on Resources, then Gardeners.

Finished vermicompost should have a rich, earthly smell if properly processed by worms. Vermicompost can be used in potting soil mixes for house plants and as a top dressing for lawns. Screened vermicompost combined with potting soil mixes make an excellent medium for starting young seedlings. Vermicompost also makes an excellent mulch and soil conditioner for the home garden.

ANATOMY OF EARTHWORMS

The earthworm has a long, rounded body with a pointed head and slightly flattened posterior. Rings that surround the moist, soft body allow the earthworm to twist and turn, especially since it has no backbone. With no true legs, bristles (setae) on the body move back and forth, allowing the earthworm to crawl.

The earthworm breathes through its skin. Food is ingested through the mouth into a stomach (crop). Later the food passes through the gizzard, where it is ground up by ingested stones. After passing through the intestine for digestion, whats left is eliminated.

Earthworms are hermaphrodites, which means they have both male and female sex organs, but they require another earthworm to mate. The wide band (clitellum) that surrounds a mature breeding earthworm secretes mucus (albumin) after mating. Sperm from another worm is stored in sacs. As the mucus slides over the worm, it encases the sperm and eggs inside. After slipping free from the worm, both ends seal, forming a lemon-shape cocoon approximately 1/8 inch long. Two or more baby worms will hatch from one end of the cocoon in approximately 3 weeks. Baby worms are whitish to almost transparent and are 1/2 to 1 inch long. Redworms take 4 to 6 weeks to become sexually mature.

HOW TO CONSTRUCT A WORM BIN

Bins can be made of wood or plastic, or from recycled containers like old bathtubs, barrels, or trunks. They also can be located inside or outside, depending on your preferences and circumstances.

As red wigglers tend to be surface feeders, bins should be no more than 8 to 12 inches deep. Bedding and food wastes tend to pack down in deeper bins, forcing air out. Resulting anaerobic conditions can cause foul odors and death of the worms.

The length and width of the bin will depend on whether it is to be stationary or portable. It also depends on the amount of food waste your family produces each week. A good rule of thumb is to provide one square foot of surface area per pound of waste in your bin.

Wooden bins have the advantage that they're more absorbent and provide better insulation. Do not use redwood or other highly aromatic woods that may kill the worms. Plastic tends to keep the compost too moist. Plastic, however, tends to be less messy and easier to maintain. Be sure containers are well cleaned and have never stored pesticides or other chemicals. Drilling air/drainage holes (1/4- to 1/2-inch diameter) in the bottom and sides of the bin will ensure good water drainage and air circulation. Place the bin on bricks or wooden blocks in a tray to catch excess water that drains from the bin. The resulting compost tea can be used as a liquid fertilizer around the home landscape.

Each bin should have a cover to conserve moisture and exclude light. Worms prefer darkness. Bins can be covered with a straw mulch or moist burlap to ensure darkness while providing good air ventilation. Outside bins may require a lid to exclude scavengers and other unwanted pests.

Outdoor bins should be insulated from the cold to protect the worms. One option is to dig a rectangular hole 12 inches deep and line the sides with wooden planks. The bottomless box can then be filled with appropriate bedding material, food wastes, and worms. Food wastes can be continually added as they accumulate. The pile should be kept damp and dark for optimum worm activity. During the winter, soil can be piled against the edges of the bin and straw placed on top to protect the worms from cold weather. Do not add food waste to outdoor bins during the winter because this could expose the worms to freezing weather.

BEDDING MATERIALS

Bedding for bins can be made from shredded newspapers (non-glossy), computer paper, or cardboard; shredded leaves, straw, hay, or dead plants; sawdust; peat moss; or compost or aged (or composted) manure. Peat moss should be soaked for 24 hours in water, then lightly wrung out to ensure it is sufficiently moist. Grass clippings should be allowed to age before use because they may decompose too quickly, causing the compost to heat up. Bedding materials high in cellulose are best because they help aerate the bin so the worms can breathe. Varying the bedding material provides a richer source of nutrients. Some soil or sand can be added to help provide grit for the worms digestive systems. Allow the bedding material to set for several days to make sure it doesn't heat up (and allow to cool before adding worms).

The bedding material should be thoroughly moistened (about the consistency of a damp sponge) before adding the worms. Fill the bin three-quarters full of moist bedding, lifting it gently afterwards to create air space for the worms to breathe and to control odors.

ADDING THE WORMS

Under optimum conditions, redworms can eat their own weight in food scraps and bedding in one day. On the average, however, it takes approximately 2 pounds of earthworms (approximately 2,000 breeders) to recycle a pound of food waste in 24 hours. The same quantity of worms requires about 4 cubic feet of bin to process the food waste and bedding(1 cubic foot of worm bin/500 worms).

Composting worms can be purchased from dealers listed in the ad sections of many garden magazines. Some dealers sell worms as pit-run worms, which consist of worms of all ages and sizes. Add worms to the top of the moist bedding when they arrive. The worms will disappear into the bedding within a few minutes.

ADDING FOOD WASTE

Earthworms eat all kinds of food and yard wastes, including coffee grounds, tea bags, vegetable and fruit waste, pulverized egg shells, grass clippings, manure, and sewage sludge. Avoid bones, dairy products, and meats that may attract pests, and garlic, onions, and spicy foods. Limited amounts of citrus can be added, but too much can make the compost too acidic. The compost should be kept at a pH of 6.5 if possible, with upper and lower limits at 7.0 and 6.0, respectively. Overly acidic compost can be corrected by adding crushed eggshells.

Avoid adding chemicals (including insecticides), metals, plastics, glass, soaps, pet manures, and oleanders or other poisonous plants, or plants sprayed with insecticides to the worm bin.

Food wastes should be added to the bin by pulling back the bedding material and burying it. Be sure to cover it well to avoid attracting flies and other pests. Successive loads of waste should be buried at different locations in the bin to keep the food wastes from accumulating. Grinding or blending the food waste in a food processor speeds the composting time considerably.

CONTROLLING TEMPERATURE AND MOISTURE IN THE BIN

Redworms can survive a wide range of temperatures (40-80°F), but they reproduce and process food waste at an optimum bedding temperature range of 55-77°F. The worms should never be allowed to freeze. Bins kept outside may have to be insulated with straw in the winter to keep the worms from freezing. Portable bins can be kept by a hot water heater in the garage during the winter to keep them warm.

The bin contents should be kept moist but not soaked. Do not allow rainfall to run off a roof into the bin. This could cause the worms to drown. A straw covering may be needed in exposed sites to keep the bin from drying out during hot summer weather.

MAINTAINING THE BIN

Food scraps can be continually added to the bin for up to 2 to 3 months, or until you notice the bedding material disappear. When the bedding disappears, harvest the worms and finished compost, then refill the bins with new bedding material.

Overloading the bin with food wastes can result in foul odors. If you notice these odors, stop adding the waste until the worms have a chance to catch up. Overly moist food waste and bedding also cause odors. To relieve this problem, fluff up the bedding to add air and check the drainage holes. As a general rule of thumb, keep the bedding material moist, but never soggy. Make sure the food waste is buried properly in the bedding. Exposed food wastes can attract fruit flies, house flies, and other pests. Keeping the bin covered with straw or moist burlap also deters these pests.

Garden centipedes can be a problem in the worm bin, especially outside. These predators should be destroyed. Overly wet beds also can attract the earthworm mite, which may cause the worms to stop eating.

HARVESTING THE COMPOST AND WORMS

There are three basic ways to separate the worms from the finished compost. One way involves moving the finished compost and worms over to one side of the bin and adding new bedding material and food waste to the other side. Worms in the finished compost should move over to the new bedding with the fresh food waste. The finished compost can then be removed.

A second way to remove the worms is to build a small harvester frame of 2 x 4s with a 3/16-inch mesh bottom. Place the worm compost on the frame and sift the worms out. Larger pieces of compost can be returned to a new batch of bedding and worms.

The compost also can be placed in small piles on a tarp in the sun (or under bright lights inside). Because worms don't like light, they will wiggle to the bottoms of the piles. After waiting 10 minutes, remove the upper inch or more of finished compost from each pile until you run into the worms. Allow the worms to again wiggle to the bottom of the pile and repeat the process. Combine whats left of the small piles into one big pile and again repeat the process. You should eventually end up with a pile of finished compost and a ball of worms. The worms can be added back to a new bin of bedding and food waste. Larger worms also can be used as bait for fishing.

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To find more resources for your home, family, or business, visit the College of Agriculture and Home Economics on the World Wide Web at http://www.cahe.nmsu.edu.

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5C

Compost Bin Checklist

6th, 7th & 8th Grade Activity Sheet 1

- ☐ Select size of compost bin needed and build or purchase it.
- ☐ Determine amount of worms you need.
- ☐ Mail order or collect the worms you need.
- ☐ Prepare the correct volume of bedding material and place in compost bin before worms arrive.
- ☐ Mix a small amount of soil with the bedding in the compost bin.
- ☐ Add worms to bedding.
- ☐ Add food waste weekly.
- ☐ Monitor bin temperature and maintain bin moisture.
- ☐ Observe worms, cocoons and other organisms in compost bin weekly.
- ☐ When the worm bin is full of castings (about 6 months after starting bin) remove castings and replace with new bedding.
- ☐ Use castings to grow your plants.

Project Planning Calendar

6th, 7th & 8th Grade Activity Sheet 2

		JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Day of the Month	**1**	1	32	60	91	121	152	182	213	244	274	305	335
	2	2	33	61	92	122	153	183	214	245	275	306	336
	3	3	34	62	93	123	154	184	215	246	276	307	337
	4	4	35	63	94	124	155	185	216	247	276	308	338
	5	5	36	64	95	125	156	186	217	248	278	309	339
	6	6	37	65	96	126	157	187	218	249	279	310	340
	7	7	38	66	97	127	158	188	219	250	280	311	341
	8	8	39	67	98	128	159	189	220	251	281	312	342
	9	9	40	68	99	129	160	190	221	252	282	313	343
	10	10	41	69	100	130	161	191	222	253	283	314	344
	11	11	42	70	101	131	162	192	223	254	284	315	345
	12	12	43	71	102	132	163	193	224	255	285	316	346
	13	13	44	72	103	133	164	194	225	256	286	317	347
	14	14	45	73	104	134	165	195	226	257	287	318	348
	15	15	46	74	105	135	166	196	227	258	288	319	349
	16	16	47	75	106	136	167	197	228	259	289	320	350
	17	17	48	76	107	137	168	198	229	260	290	321	351
	18	18	49	77	108	138	169	199	230	261	291	322	352
	19	19	50	78	109	139	170	200	231	262	292	323	353
	20	20	51	79	110	140	171	201	232	263	293	324	354
	21	21	52	80	111	141	172	202	233	264	294	325	355
	22	22	53	81	112	142	173	203	234	265	295	326	356
	23	23	54	82	113	143	174	204	235	266	296	327	357
	24	24	55	83	114	144	175	205	236	267	297	328	358
	25	25	56	84	115	145	176	206	237	268	298	329	359
	26	26	57	85	116	146	177	207	238	269	299	330	360
	27	27	58	86	117	147	178	208	239	270	300	331	361
	28	28	59	87	118	148	179	209	240	271	301	332	362
	29	29		88	119	149	180	210	241	272	302	333	363
	30	30		89	120	150	181	211	242	273	303	334	364
	31	31		90		151		212	243		304		365

Observation Chart

6th, 7th & 8th Grade Activity Sheet 3

Items to Observe

	Date: ___/___/___ Time: AM/PM	Date: ___/___/___ Time: AM/PM	Date: ___/___/___ Time: AM/PM
1.			
2.			
3.			
4.			
5.			
6.			

Compost Bin Record

6th, 7th & 8th Grade Activity Sheet 4

Month: ______________________________ **Year:** _______________________

Day	**Amount of Food Waste in lbs.**	**Temperature (°F)**		**Moisture**	**Burying location**	**Comments**
		Room	Bin			
253	1 lb.	72°	65°	0	1	First day of project

Totals lbs. of Food Waste

Moisture Key:
-1 - Too Dry
0 - Just Right
1 - Too Wet

Burying locations:

1	**8**	**4**
7	**5**	**6**
3	**9**	**2**

Note: *Food waste should be buried in a different location each time to avoid accumulation and to help the work the soil evenly.*

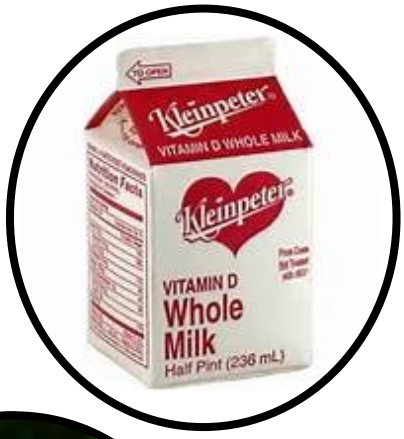
One Tomato, Two Tomato

6th, 7th & 8th Grade Activity Sheet 5

Set up this experiment to test worm castings against store bought fertilizer.

Materials:

- 12 recycled half pint milk cartons
- 2 Shallow boxes, 2 - 3 inches deep
- 2 large Containers (for mixing soil)
- Measuring cup
- Aluminum foil
- Newspaper
- Worm castings
- Tomato seeds
- Garden or flower bed soil—with no fertilizers added
- Store bought fertilized garden or flower bed soil
- Peat moss
- Measuring tapes or rulers
- Camera



Directions:

1. Punch 5 – 6 holes on one side of the milk cartons.
2. Cut out the rectangular side of each of the milk cartons opposite the side with the holes.
3. Line the shallow boxes with aluminum foil to keep the boxes from leaking.
4. Soil Mixture 1(SM1) – Add 4.5 cups of worm castings with 4.5 cups of garden/flower bed soil and 3 cups of peat moss in a container and mix well.
5. Add 2 cups of SM1 to one half pint carton.
6. Fill a total of 6 cartons with SM1 and label them SM1.
7. Soil Mixture 2 (SM2) – Add 4.5 cups of fertilized soil with 4.5 cups of garden/flower bed soil and 3 cup of peat moss in the second container
8. Add 2 cups of SM2 to one half pint carton.
9. Fill the other 5 cartons with SM2 and label them SM2.
10. Place Soil Mixture 1 in one row and Soil Mixture 2 in another row.
11. Plant 2 - 3 seeds about 1/4 inch deep in each carton.
12. Cover all cartons with wet newspaper until the first seeds sprout.
13. Check daily for signs of seeds sprouting. (Sprouting takes place in about three days if the temperature in the cartons is 65^{o} - 70^{o} F)
14. Water each plant regularly with 1/4 to 1/2 cup of water per carton. (Avoid over watering plants, water the plants when the soil looks noticeably dry)
15. Record your observations each week (take some pictures also) for 4 weeks on the Observation Chart.
16. Measure the height of each plant and count the number of leaves on the plants each week.
17. At the end of four weeks, discuss your observations and decide if the worm casting amended soil grew better tomato plants than the store bought fertilized soil.

Visual Aid Card No. 1

Red Wiggler

Visual Aid Card No. 2

Organic Matter

Visual Aid Card No. 3

Food Waste

Visual Aid Card No. 4

Vermicompost

Visual Aid Card No. 5

Bedding Materials

Visual Aid Card No. 6

Phases of Decomposition

Visual Aid Card No. 7A

Millipede

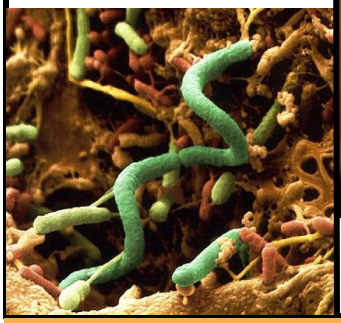
Isopods

Enchytraeids

Springtails

Centipede

Bacteria



Mites

Fungi

Compost Bin Community

Visual Aid Card No. 7B

Molly Millipede

I have so many legs you would have a hard time counting them. My name means “thousand legs,” but I don’t have that many. I am not fierce, but quite timid. I roll up in a ball to avoid danger. I am vegetarian. I eat soft, moist, decaying plants. I’m thick-skinned, dark red in color and 1 to 3 inches long.

I am an isopod, which means that I have 10 pairs of legs that look very similar to each other. The flattened plates on my body make me look like an armadillo. I am about 1/2 inch long. I roll up in a ball if I am disturbed. I eat vegetation and leaf litter.

Ida Isopod

Sarah Springtail

I am a tiny, white insect less than 1/16 inch long. I have a pointed prong folded beneath my abdomen. By quickly extending this “spring,” I jump high into the air. When thousands of us gather on well-decomposed worm bedding, it looks as if we are jumping all over the place. We feed on molds and decaying matter and are important producers of humus.

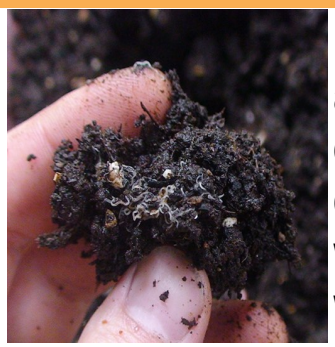
I’m tiny. It could take 25 of us to cover and inch long line. My body is so round and fat it’s hard to see my 8 jointed legs. Thousands of us live in a worm bin. Some of us eat plant material, such as mold and soft tissues of leaves. Others eat manure of other organisms. Some of us can harm earthworms, but not all compost bins have us.

Mickey Mite

Compost Bin Community

Visual Aid Card No. 7C

Ernie
Enchytraeids



I am a skinny, white worm also known as a pot worm. I am about an inch long, but I am so thin I look like a frayed piece of thread. I move like an earthworm. In fact, we're related. I don't have red blood like an earthworm has. I eat well-decomposed material. You might think of me as one who likes to "finish–off" the job of decomposition.

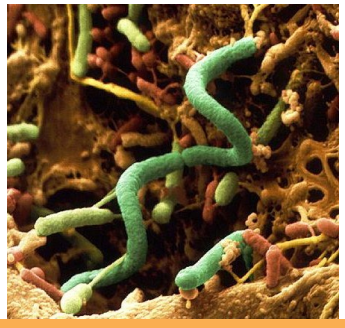
I am a fierce hunter! I am know as a predator because I prey on earthworms and eat them. I have a pair of poisonous claws to help keep my prey from getting away. I move quickly on my many legs. I have 1 pair of legs on my many segments. I am about 1 - 2 inches long.

Celia
Centipede

Flora
Fungi

I am a plant like organism, but I do not have any chlorophyll (gives plant their green color) or roots or leaves. You might know me better as a mold or mushroom. I sometimes look like a fuzzy white form on plants and soil that have been watered too much. There are about 1.5 million types of fungi in the world today, I am everywhere!

I am very, very tiny. I need to be observed under a microscope. If a million of us were laid side by side, we would stretch out to a length of one meter of 39.37 inches. We come in different shapes. I love to eat organic materials such as fruits and vegetables in the compost bin.



Bart
Bacteria

Compost Bin Community

Visual Aid Card No. 8

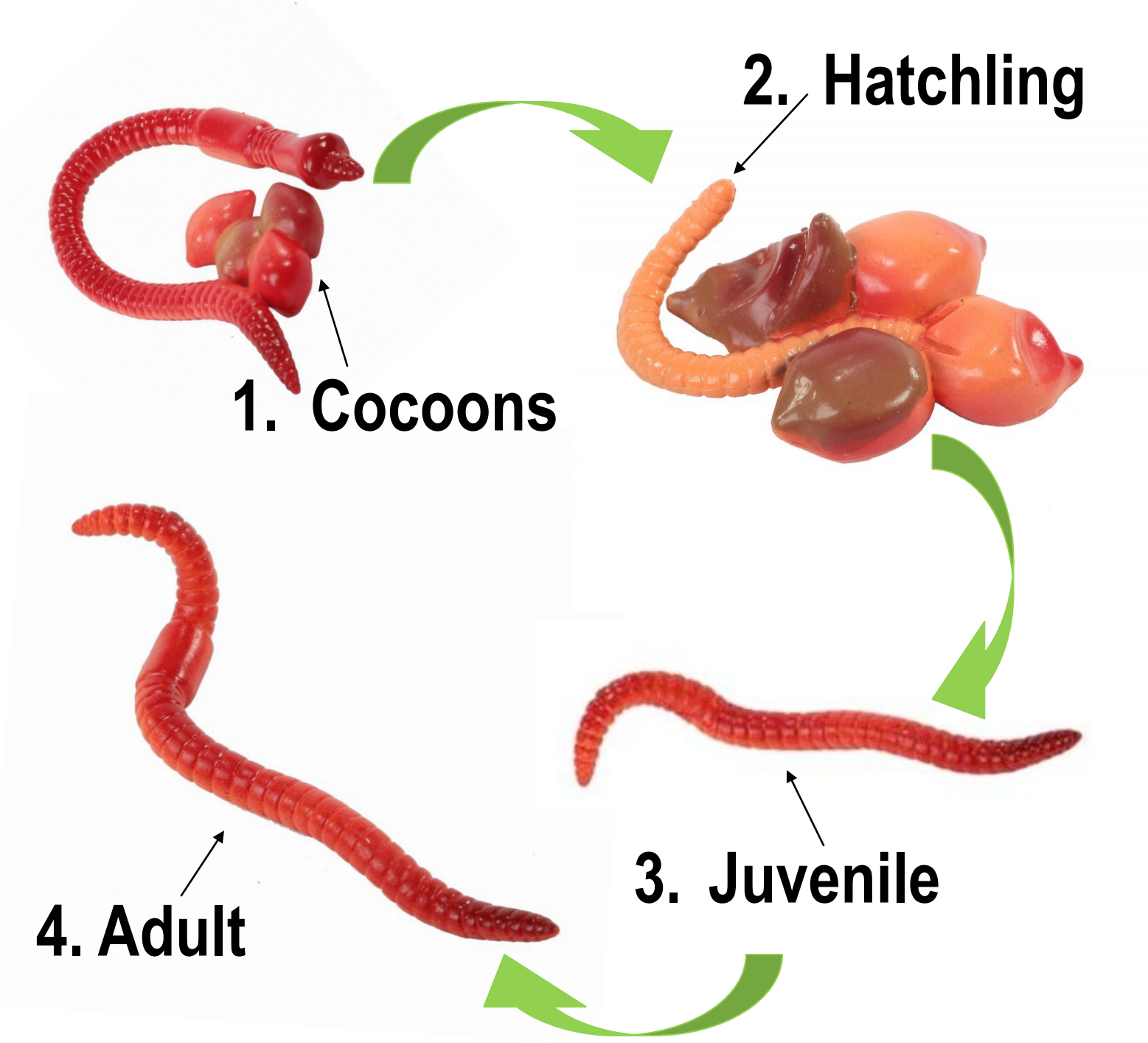
Brandling Worms

Garden Earthworms

Red Wigglers

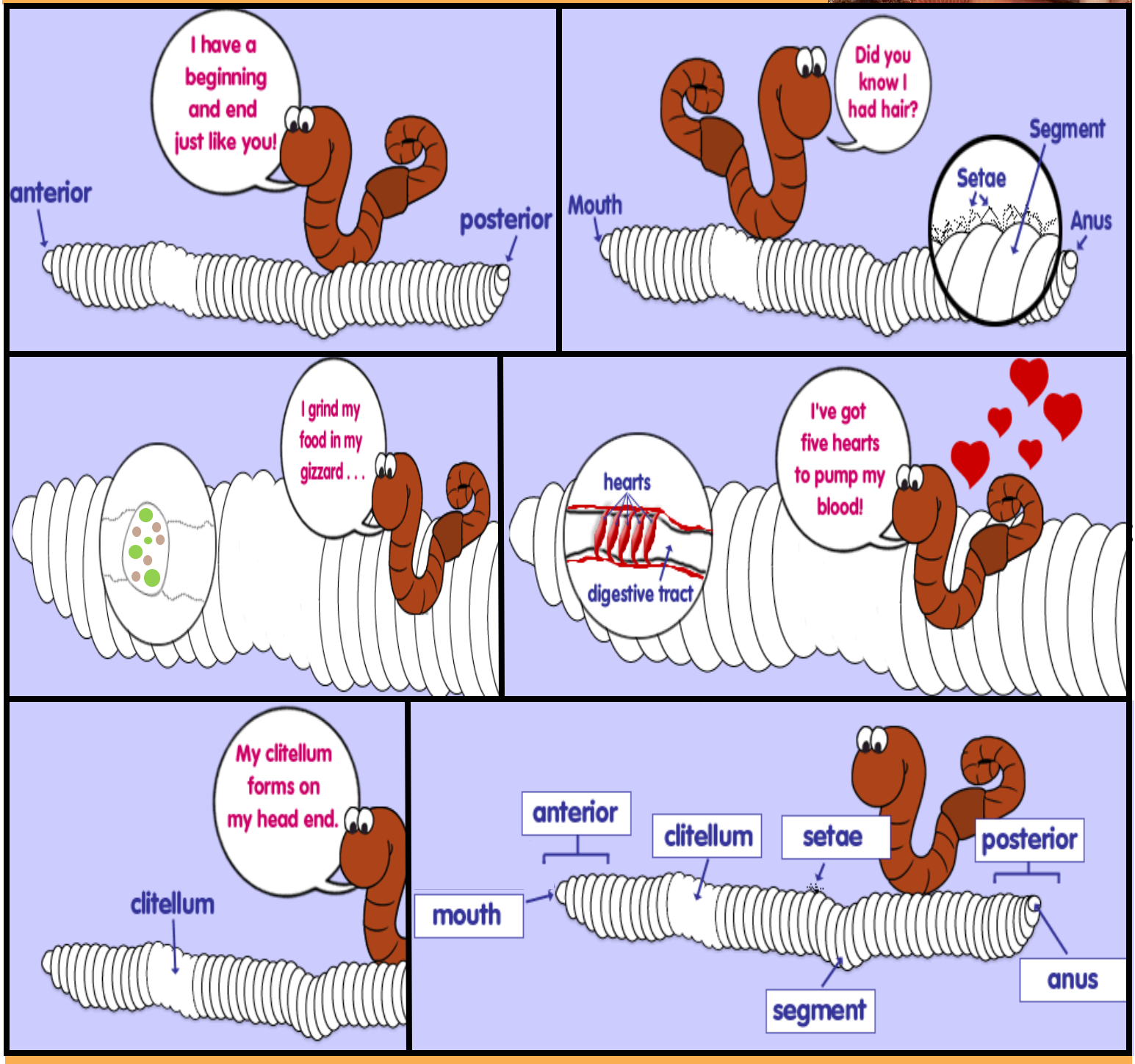
Types of Earthworms

Visual Aid Card No. 9



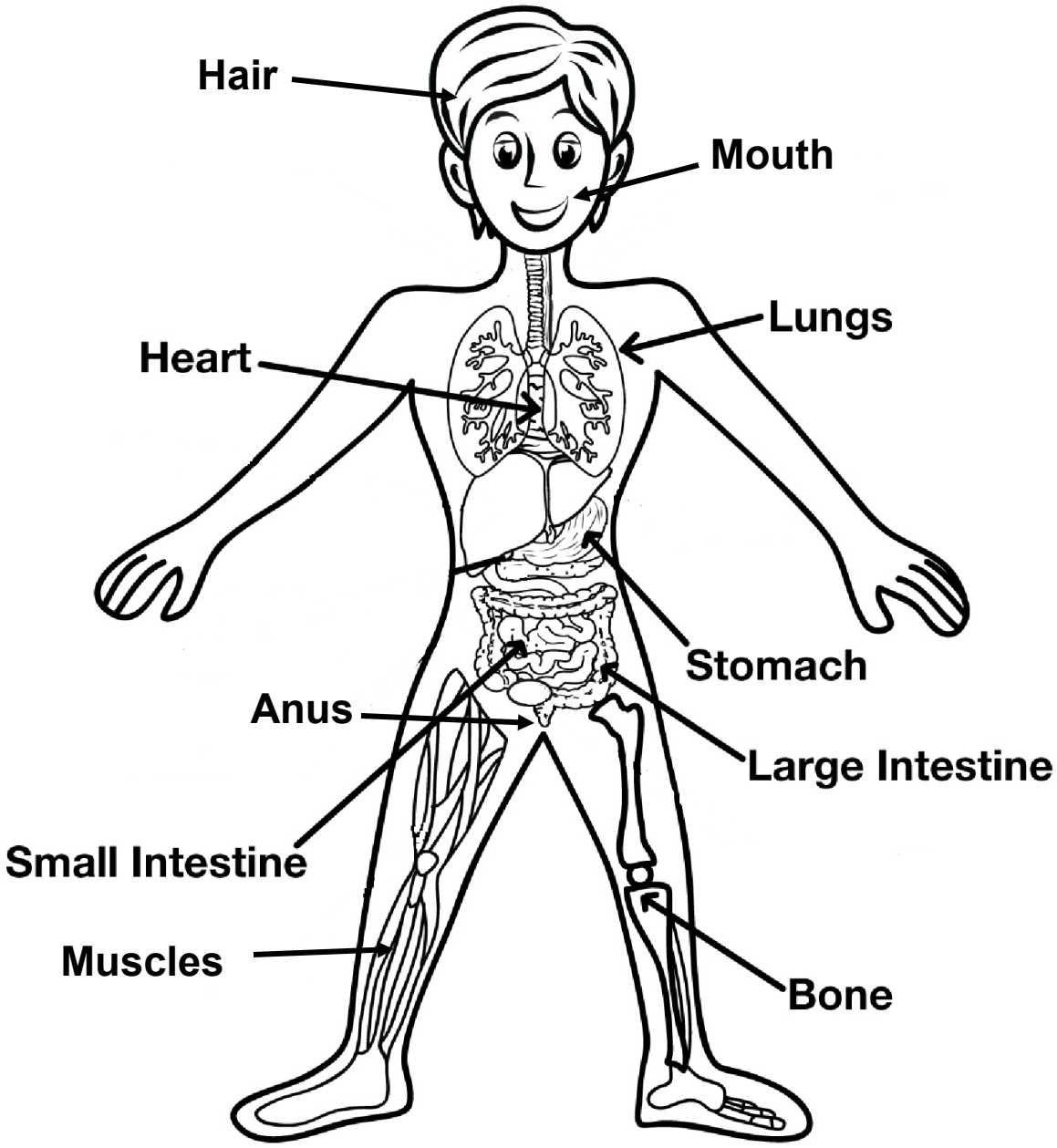
Developmental Stages of Earthworms

Visual Aid Card No. 10



Earthworm Anatomy

Visual Aid Card No. 11



Human Anatomy

Visual Aid Card No. 12

Different Types of Bins

Visual Aid Card No. 13

Food Waste to Feed to Worms:

- Fruits
- Vegetables
- Cereals & Grains
- Coffee Grounds
- Egg Shells
- Tea Bags
- Newspapers

Food Waste NOT to Feed to Worms:

- Animal bones
- Meat, Poultry & Fish
- Cheese, butter, oil
- Candy
- Greasy Food
- Glossy Paper

Earthworms' Diet

Visual Aid Card No. 14

3 Carbonated Water, Club Soda, Energy Drinks

4 Popcorn, Cream Cheese, Buttermilk, Prunes Pastries, Pasta, Cheese, Pork, Beer, Wine, Black Tea, Pickles, Chocolate, Roasted Nuts, Vinegar, Sweet and Low, Equal, Nutra Sweet

5 Most Purified Water, Distilled Water, Coffee, Sweetened Fruit Juice, Pistachios, Beef, White Bread, Peanuts, Nuts, Wheat,

6 Fruit Juices, Most Grains, Eggs, Fish,Tea, Cooked Beans, Cooked Spinach, Soy Milk, Coconut, Lima Beans, Plums, Brown Rice, Barley, Cocoa, Oats, Liver, Oyster, Salmon

7 Neutral pH
Most Tap Water, Most Spring Water, Sea Water, River Water

8 Apples, Almonds, Tomatoes, Grapefruit, Corn, Mushrooms, Turnip, Olive, Soybeans, Peaches, Bell Pepper, Radish, Pineapple, Cherries, Wild Rice, Apricot, Strawberries, Bananas

9 Avocados, Green Tea, Lettuce, Celery, Peas, Sweet Potatoes, Egg Plant, Green Beans, Beets, Blueberries, Pears, Grapes, Kiwi, Melons, Tangerines, Figs, Dates, Mangoes, Papayas

10 Spinach, Broccoli, Artichoke, Brussel Sprouts, Cabbage, Cauliflower, Carrots, Cucumbers, Lemons, Limes, Seaweed, Asparagus, Kale, Radish, Collard Greens, Onion

pH Scale

Visual Aid Card No. 15

Level 3 Consumer

Level 1 Consumers

Level 2 Consumers

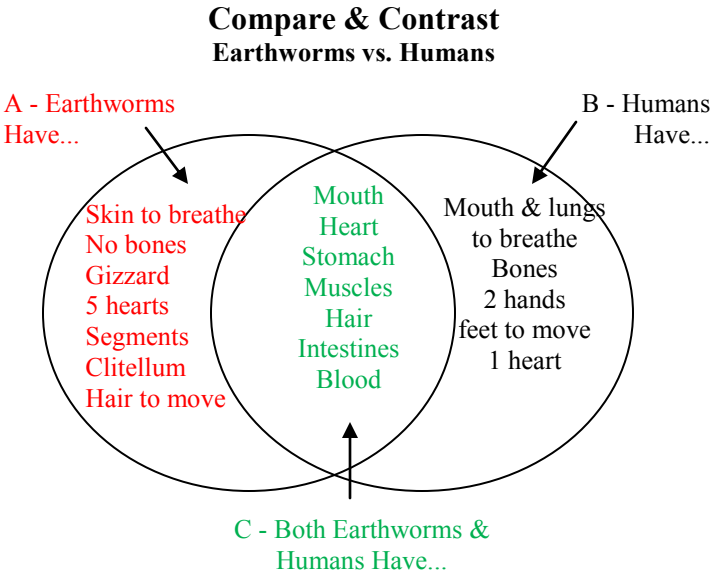
Organic Matter

Compost Bin Food Chain

Activity Answers

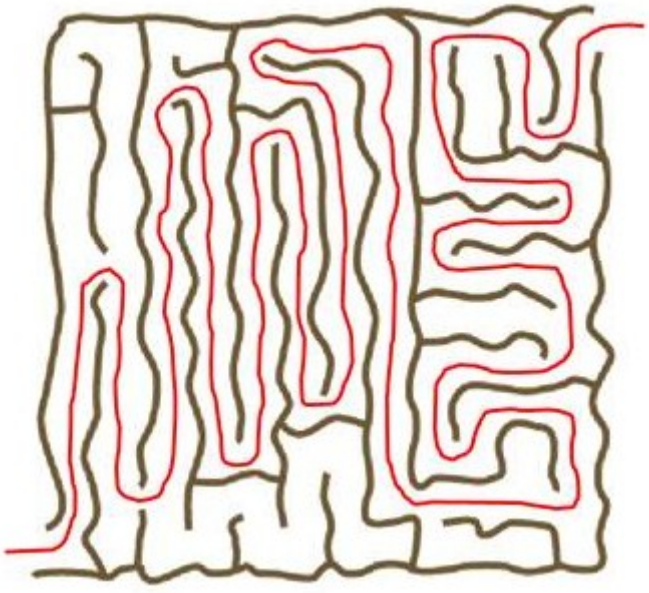
Kindergarten Lesson Answers

Below are some ideas for answers that students can give for the lesson. If they are having a difficult time answering, you can help them out with some of these answers.



1st Grade Activity Answers

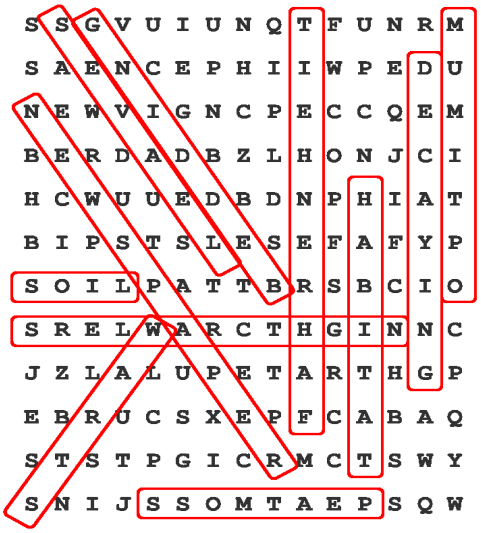
Apples - **Yes,** Lettuce - **Yes**, Oil - **No**, Banana - **Yes**, Candy - **No**, Beef - **No**, Carrots - **Yes**.



2nd Grade Activity Answers

1. **True**, 2. **False**, 3. **True**, and 4. **True**

2nd Grade Activity Answers Cont'd



3rd Grade Activity Answers

D - **15**, H - **17**, M - **7**, O - **8**, T - **23**, and Y - **13.**

The creepy, crawly centipede is not my friend. She must go away. The merry, marvelous millipede is my friend, and she is welcome to stay.

4th Grade Activity Answers

1. **Clitellum**, 2. **Cocoons**, 3. **Hemoglobin**, 4. **Hatchlings**, 5. **Juveniles** & 6. **Transparent**.

Earthworms start off as **cocoons** that are laid by adult worms. When the baby worms have developed they emerge **transparent** in color and are now called **hatchlings**. Eight hours after hatching, they gain **hemoglobin** and change color from white, to pale pink to brick red. **Juveniles** are young worms that don't have a **clitellum**. Adult worms can live for five years or more.

5th Grade Activity Answers

Small: 1. L-**19**, W-**14**, H-**14**, 2. **3,724 cu. in.**, 3. **2 cu. ft.**, 4. **5 lbs.** of bedding, 5. **15 lbs.** of water.
Medium: 1. L-**16**, W-**24**, H-**17**, 2. **6,528 cu. in.** 3. **4 cu. ft.**, 4. **10 lbs**. of bedding, 5. **30 lbs.** of water.
Large: 1. L-**31**, W-**21**, H-**14**, 2. **9,114 cu. in.** 3. **5 cu. ft.**, 4. **13 lbs.** of bedding, 5. **39 lbs.** of water.

Glossary A - C

Words in blue - SLC's definition
Words with asterisk (*) - Kids Wordsmyth.net definition
Words just bolded - Mary Applehof's definition

***accumulate:** To pile up, collect, or gather.

***acidic:** Like acid in taste, smell, pungency, or the like; acid.

aerobic: Pertaining to the presence of free oxygen.

alkaline (basic): Containing bases (hydroxides, carbonates) which neutralize acids to form salts.

***anatomy:** The science that studies the parts and structures of plants or animals.

anterior: Toward the front.

***anus:** In anatomy, the opening at the lower or rear end of the intestines, through which solid waste matter is excreted.

bedding: Moisture-retaining medium which provides a suitable environment for worms.

bristles: Tiny rigid structures on most segments of earthworms which serve as brakes during movement. Known as setae, they are a major distinguishing characteristic of earthworms.

cellulose: An inert compound containing carbon, hydrogen, and oxygen; a component of worm beddings. Cellulose is found in wood, cotton, hemp, and paper fibers.

clitellum: A swollen region containing gland cells which secrete the cocoon material. Sometimes called a girdle or band, it is present on adult worms.

cocoon: Structure formed by the clitellum which protects embryonic worms until they hatch.

***compost:** A mixture of decaying leaves, vegetables, or manure that is used to improve garden soil.

compost bin: A container or enclosure used to keep compost.

***consistency:** The degree of thickness, density, or viscosity.

***cubic foot:** The volume of a cube with sides of one foot in length.

Glossary D - J

***decaying:** to rot or become rotted.

decomposer: An organism that breaks down cells of dead plants and animals into simpler substances.

developmental stages: a period of time that shows growth from the earliest to the latest time.

diet: the food and drink usually eaten and drunk by a person or animal.

***digested:** to break down into materials that can be absorbed and used by the body.

ecosystem: a community of living things, together with their environment.

***environment:** Everything that surrounds a particular type of living thing and affects its growth and health.

***Fahrenheit**: Relating to a temperature scale on which water freezes at 32 degrees and boils at 212 degrees.

fertilizer: a natural or chemical substance added to soil to make it better for growing plants.

food chain: the sequence defined by who eats whom, starting with a producer (green plant).

food waste: parts of food that are not used for cooking, or food that is left over after cooking; food that is thrown out as garbage.

gizzard: Structure in the anterior portion of digestive tract whose muscular contractions help grind food in the presence of grit.

***habitat:** The natural environment of an animal or plant.

hatchlings: Worms as they emerge from a cocoon.

hemoglobin: Iron-containing compound in blood responsible for its oxygen-carrying capacity.

***ingest:** To take in to the body by mouth for digestion or absorption.

***intestines:** The lower part of the digestive system, below the stomach. The intestine is a long, coiled tube. It is divided into the small intestine and the large intestine.

juveniles: Adolescent worms characterized by their lack of a clitellum.

Glossary M - S

macro organism: Organism not requiring magnification for observation.

microorganism: Organism requiring magnification for observation.

***medium:** An instrument, means, agency.

***moisture:** A small amount of liquid in the air or on a surface.

***municipality:** An incorporated political unit or its government.

nitrogen: An odorless, colorless, tasteless gas which makes up nearly four fifths of the earth's atmosphere.

***nutrient:** Something in food that helps people, animals and plants live and grow.

organic matter: Material which comes from something which was once alive.

***organism:** an individual living thing, such as a plant, an animal, or a bacteria.

***phosphorous:** A chemical element that has fifteen protons in each nucleus, which is found naturally only in compounds.

pH Scale: A scale used to measure how acidic or alkaline a substance is.

posterior: Toward the rear, back, or tail.

***potassium:** A chemical element that has nineteen protons in each nucleus, which occurs naturally only in compounds, primarily salts.

***predator:** An animal that hunts other animals for food.

***pulverize:** To make into powder, as by crushing, grinding, or pounding.

***reconstruction:** The act or result of rebuilding.

***recycle:** To put through a process that allows used things to be reused.

respire: To exchange oxygen and carbon dioxide to maintain bodily processes.

segments: rings across the body of worms

setae: bristle on each worm segment used in locomotion.

Glossary T - Z

***temperature:** The degree of heat or cold of an object or an environment.

***transparent:** Letting light pass through and giving a clear view of objects on the other side.

undigested: Not broken down or absorbed by the body.

vermicomposting: using worms, usually Red Wigglers to decompose organic matter and food waste.

***volume:** Amount; quantity.

worm castings: undigested material, soil and bacteria deposited through the anus. Worm manure.

Resources

Books

- *Worms Eat Our Garbage Classroom Activities for a Better Environment*.
  By: Applehof, Mary., Frances Fenton, Mary., Loss Harris, Barbara.
  Kalamazoo: Flower Press, 1993.
- *Worms Eat My Garbage Second Edition*.
  By: Applehof, Mary.
  Kalamazoo: Flower Press, 1997.

Websites

- Abcteach. The educator's online resource.
  http://www.abcteach.com/search.php?q=worms
- Compost Guy
  http://www.compostguy.com/
- "The Adventures of Herman"
  By: *Urban Programs Resources Network University of Illinois Extension.*
  http://urbanext.illinois.edu/worms/
- Uncle Jim's Worm Farm
  http://unclejimswormfarm.com/index.php/UJ-University.html
- "Vermicomposting"
  By: Dickerson, George W.
  http://aces.nmsu.edu/pubs/_h/H164/welcome.html

Purchasing Composting Materials

- Worms Etc. http://www.wormsetc.com/

References

Books

- Applehof, Mary., Frances Fenton, Mary., Loss Harris, Barbara. *Worms Eat Our Garbage Classroom Activities for a Better Environment*. Kslamazoo: Flower Press, 1993. Print.

Websites

- “Compost-ology The Science of composting & Vermicomposting.” *The City of Euless Texas.* 2013. Web. 21 October 2013. <http://www.eulesstx.gov/composting/vc_reproduction.htm>
- Dickerson, George W., “Vermicomposting.” *New Mexico State University.* June 2001. Web. 17 October 2013. <http://aces.nmsu.edu/pubs/_h/H164.pdf>
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- Kids.wordsmyth.net 2013. Words identified by a asterisk (*)in glossary.
- Wolford, Ron., Stack, G., Scherer, J., Hawley, M. “My Anatomy Getting to Know Squirmin’ Herman from “Head” to “Toe”.” *Urban Programs Resources Network University of Illinois Extension.* Web. 16 October 2013. <http://urbanext.illinois.edu/worms/anatomy/index.html>

Notes

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