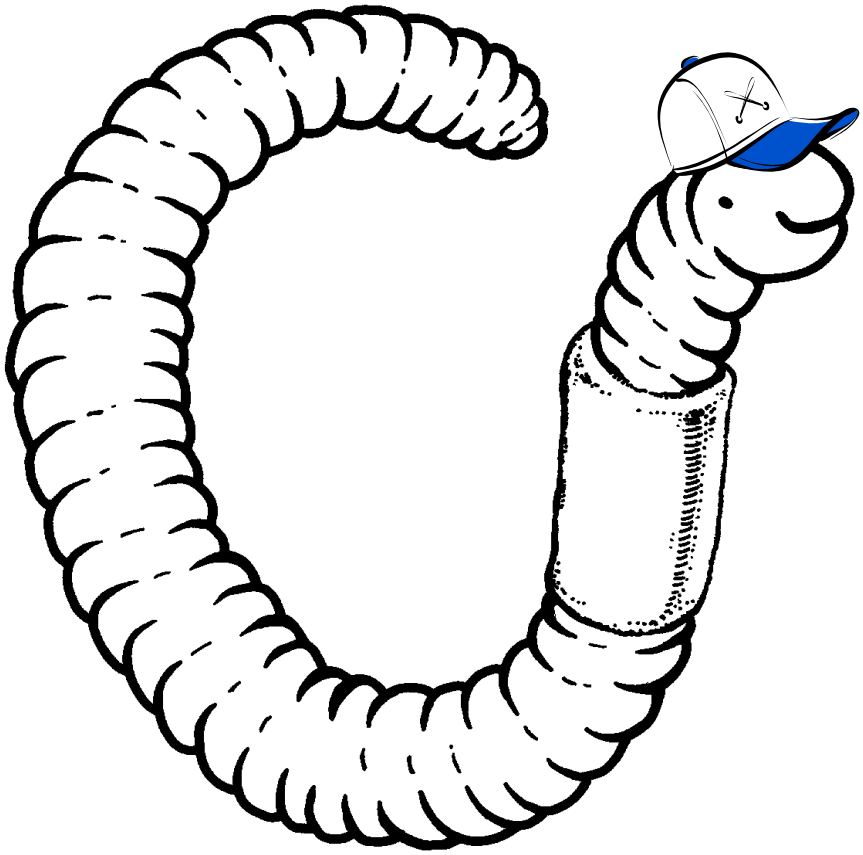
"RW" GOES TO SCHOOL

A Teachers Guide



RED WORMS IN THE CLASSROOM

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Potential Cross-Curricular Applications of a Worm Bin

Language Arts:
- library work to research information/books about worms and recycling
- read/write stories about worms
- worm bin journals
- create newsletter/information sheet on worm composting
- vocabulary development
- write to your municipality's recycling coordinator requesting information on recycling

Math:
- count worms, measure and weigh worms, food scraps
- sort worms (by size, color, etc.)
- graph worm data
- metric measurements/conversions measure bin, three dimensional measuring, calculate area
- ratios (worms to garbage, big worms to small worms, etc.)
- averages (how much food per day, week, month)

Science:
- worm anatomy and habitats
- worm life cycle and reproduction
- scientific classification
- scientific method/worm experiments
- different types of worms
- other worm bin animals (e.g. sowbugs, ants, mites, millipedes, centipedes)
- organic vs. non organic
- rate of decomposition of different types of materials, mold
- food chain/ecology

Geography and Social Studies:
- climate and worms (redworms are native to the South)
- farming techniques/crops around the world
- garbage - around the world (how much do other countries produce?)

Horticulture:
- soil composition
- compost, compost piles
- plant parts/needs
- planting lessons and experiments (do plants grow better in compost?)

Other Potential Topics:
- waste reduction: reduce, reuse, recycle
- landfills

What Is Worm Composting (Vermicomposting)?

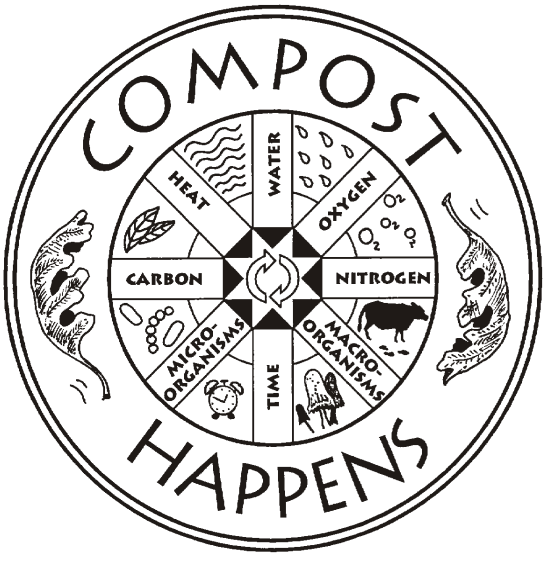
Vermicomposting means composting with worms. Worm composting is using worms to recycle organic waste, specifically food scraps, into a valuable soil conditioner called vermicompost. For millions of years worms have been hard at work breaking down organic materials and returning nutrients to the soil. With a worm bin you can harness "worm power" in your classroom. Simply obtain some redworms (Eisenia fetida), put them in a container and make sure they have air, moisture, darkness and food (your old banana peels, apple cores, carrot peels, etc.). Over the course of three to five months, the worms will transform your garbage into a usable soil enhancer. A worm bin is a hands-on way to bring composting, recycling and nature right into your life and classroom. The worm castings (compost) improve the soil's water retention capability, structure, and nutrient storage/ availability and helps fight plant diseases.

Who Can Worm Compost?

Anyone, really! Homeowners and apartment dwellers can give worm composting a try. Only a small space is required for a worm bin. However, this guide is directed toward teachers and their students. It is one way to reduce the amount of organic waste sent to your community landfill and/or incinerator.

Why Should I Let Worms In My Classroom?

Worms provide a simple means to convert organic wastes into a nutrient-rich material. Worms can process organic materials where it is produced. This on-site technique is simple, effective, and convenient. It saves water, energy, soil and most importantly, landfill space. This guide will show you all the potential for cross-curricular applications found in worm composting. Best of all, it is a fun, hands-on learning experience. The students learn the responsibility and care for a fellow life form. Everyone involved contributes in a positive way to our environment.



A worm bin can provide many valuable and exciting experimental opportunities for students. Worms are very popular with children, and most are fascinated by these creatures. Worms in the classroom can be a catalyst for a variety of educational experiences. A

classroom worm bin can introduce the concept of biodegration, or enhance a recycling unit. Worms have been recycling natural materials such as decaying leaves, plants and fruits by eating these organic materials and turning them into compost. By feeding worms fruit and vegetable scraps that normally get thrown away, students can watch worms eat their garbage and thus identify composting as one method to reduce the amount of waste sent to overburdened landfills.

We do not need to spend nearly as much money to purchase fertilizers since our worm friends can make a nutrient rich and free compost right before our eyes. Worm bins present a "win-win" solution for the health of our environment.

A classroom worm composting project can stimulate curiosity about composting, recycling, waste reduction and gardening. By starting and maintaining their own bin, and using the compost produced in their bin, students can become part of nature's cycle of life. With the knowledge gained from their classroom composting experience, students can then educate their families about this exciting school project, and maybe even start a worm bin at home.

When Can I Start To Worm Compost?

At any time, as soon as there is a home set up for our friends and "food" is handy.

Where Can I Have A Worm Bin?

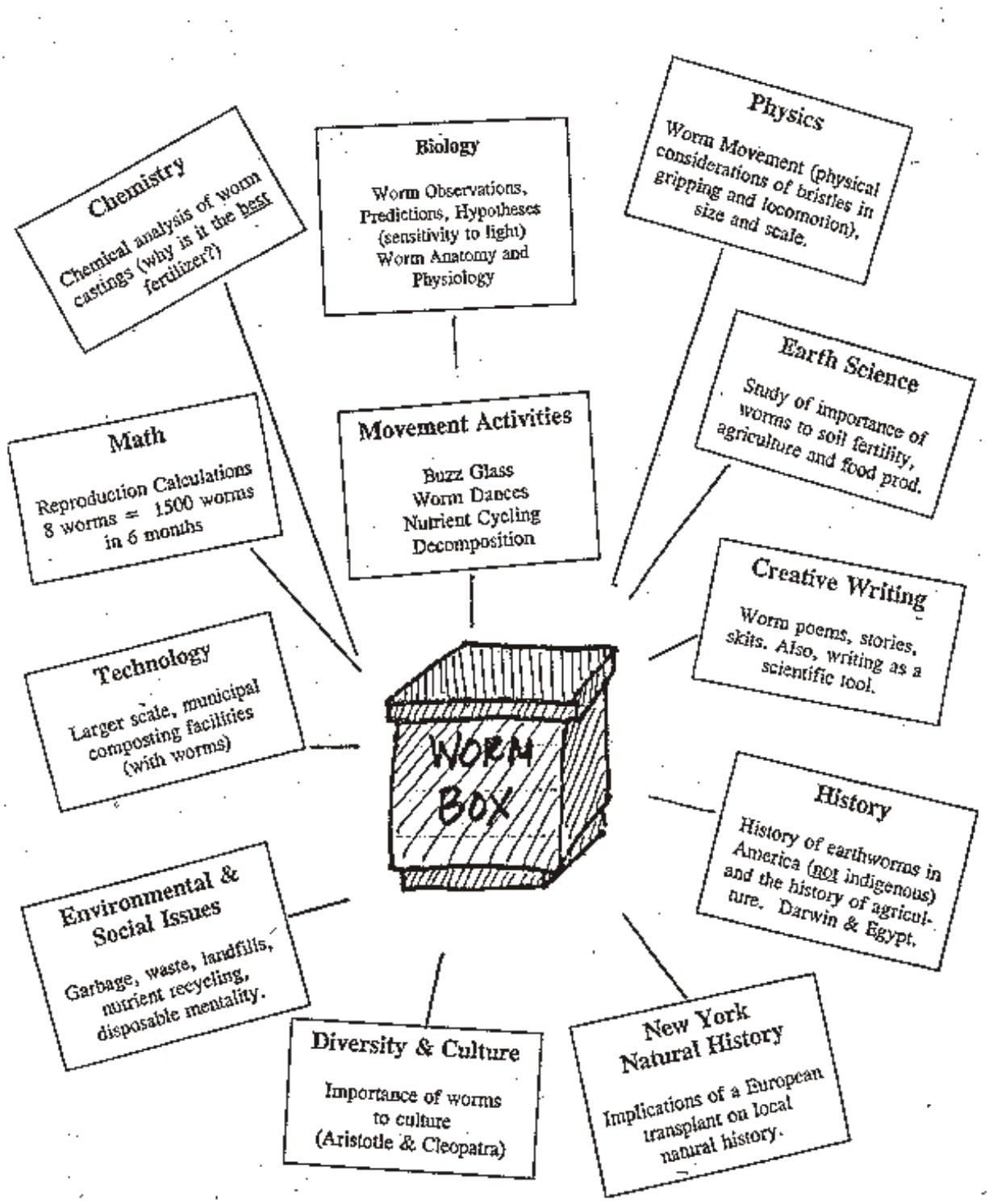
In any shaded area of your classroom. Just follow the guidelines in this booklet.

How Can I Set Up A Worm Bin?

By following the six easy steps listed in this booklet.

Aristotle called worms "the guts of the soil."

Earthworms are the true tillers of the soil, digging tunnels, carrying leaves down into their burrows and mixing and shifting the dirt. The soil is the ultimate source of all our food. In fact the word "human" comes from the Latin word *humus*, which means earth.



A Model Of Integration

Six Easy Steps to Setting Up a Worm Bin

Follow these six easy steps to set up a worm bin. Soon worms will be recycling food scraps into a healthy, nutrient- rich material called compost.

1. Acquire a bin. Build a box out of wood, find or buy a plastic bin, or even reuse an old dresser drawer or fish tank. The approximate size is 16" x 24" x 8" or 10 gallons. Make sure the bin is clean by rinsing it with tap water to remove any residues which may be harmful to the worms.

2. Prepare the bedding. In place of soil, composting redworms can live in moist newspaper bedding. Like soil, wet newspaper strips provide air, water, and food for the worms.

A. Using about 50 pages, tear newspaper into ½ " to 1 " strips.
B. Place newspaper strips into a large plastic garbage bag or container. Add water until bedding feels like a damp sponge, moist but not dripping. Add dry strips if it gets too wet.
C. Add strips to bin, making sure bedding is fluffy (not packed down) to provide air for worms.
D. Bin should be 3/4 full of wet newspaper strips.
E. Sprinkle 2-4 cups of soil in bin. The soil introduces beneficial bacteria, fungi and other microorganisms to bin. These organisms aid in the composting process. Gritty soil particles will also aid the worms' digestive process. Soil from outdoors is fine.

3. Add the worms. Before adding the worms, find out how many worms you are starting with. The easiest method is to weigh the worms. If you do not have access to a scale, determine the worms' volume. The amount of worms is important for knowing how much food to feed them and for record keeping. One pound of worms is enough to get you started.

4. Bury food scraps under bedding. The food scraps should be fruit and vegetable scraps that normally get thrown away, such as peels, rinds, cores, etc. Limit the amount of citrus fruits that you place in the bin. **No meats, bones, oils or dairy products** due to potential odor problems.

A. Cut or break food scraps into small pieces - the smaller, the better.
B. Watch for excessive moisture as many vegetables, such as tomatoes, are primarily water.
C. Measure amount of food. Feed worms approximately three (3) times their weight

per week. Monitor bin every week to see if worms are or are not eating the food. Adjust feeding levels accordingly.

D. Bury food scraps in the bin. Lift up the bedding and add food scraps. Cover food with bedding.

5. Place a full sheet of dry newspaper on top of the bedding. This will help maintain the moisture balance, keep any possible odors in the bin, and help prevent fruit flies from making a home in the bin. Replace this sheet frequently if fruit flies are present or if bin gets too wet. See page 9 for fruit fly troubleshooting.

6. Cover and choose a spot for the bin. Cover the bin with a plastic lid, plywood or cloth, but leave the lid ajar so the bin receives some air. It's necessary to drill holes into the bin for aeration. Place the bin away from windows and heaters.

FEED, WATER AND FLUFF!!! To keep worms happy, feed them about once a week. If bedding dries up, spray with water. (If bedding gets too wet, add dry newspaper strips.) Fluff up bedding once a week so the worms get enough air.

Worm Bins

Here's a simple design for an indoor worm bin that you can make out of materials available at your local building supply center. This setup is large enough to handle a steady supply of kitchen scraps and produce plenty of worm castings for your house and garden plants.

- Metal knitting needle, sharp awl, ice pick or, best yet, a drill
- 10 - 13 gallon plastic tote container, with lid
- Water
- Gravel or several layers of plastic mesh netting
- Scrap wood
- Plastic dishpan or a sheet of plywood covered with plastic

For another plastic bin system design, go to
www.home.maine.rr.com/wormmainea/Worm_Bin_Instructions.pdf

1. If you are using the knitting needle, heat its tip by holding it over a stove burner. Be sure to use a pot holder to protect your fingers. If using the awl or ice pick, you do not need to heat them. This should be done by an adult.

2. Use the knitting needle, awl, ice pick or drill to poke about 24 holes into the lid of the container and the same number around the bottom of the container about three (3) inches

from the base. Air will enter through the holes in the lid, and water will drain from holes above the base. If using the knitting needle, open a window or do this step outdoors and avoid breathing the fumes created when the hot needle pierces the plastic. This should be done by an adult.

3. Fill the plastic toter with two (2) inches of gravel.

4. Lay a piece of garden fabric cloth (used to keep weeds down) This barrier will prevent mixing gravel with the compost when you harvest your compost.

5. Place the plastic toter on the plastic dishpan or on a tray of plastic- covered plywood to catch any spills.

Worm Care and Feeding

Once you have a container for your worms, you'll want to prepare their bedding. Use shredded newspaper. Using about 50 pages, tear newspaper into ½ " to 1 " strips. Place newspaper strips into a large plastic garbage bag or container. Add water until bedding feels like a damp sponge, moist but not dripping. Add dry strips if it gets too wet. Add strips to bin, making sure bedding is fluffy (not packed down) to provide air for worms. Bin should be 3/4 full of damp newspaper strips. Sprinkle 2-4 cups of soil in bin.


Cleopatra decreed the earthworm was a sacred animal.

When the bedding is ready, it's time to add the worms. Ordinary earthworms (lumbricus terrestris) are not the best species for making compost because they prefer temperatures cooler than those found within most compost piles. Worms commonly sold for fish bait - redworms (lumbricus rubellus) and brandling worms (Eisenia fetida) - are better. (To find out where to buy worms locally see page 39). One pound of worms, which can number up to 1,000 is enough to get you started.

Release the worms on top of the bedding. Once they've burrowed in, feed them some kitchen leftovers, going easy on onions, garlic and other strong seasonings. Remember, no meat scraps or heavy grease. Worms always appreciate coffee grounds and grains. Feed lightly - a few cups at a time - until you get a sense of how quickly they consume what you give them. Putting the food scraps under the newspaper will reduce the risk of fruit flies.

Gee Whiz Worm Facts

- A nightcrawler can move a stone that is 50 times it's own weight.
- There are approximately 2,700 different kinds of earthworms.
- In just one acre there can be over a million earthworms.
- Baby worms are not born, but hatch from cocoons smaller than a grain of rice.
- The largest earthworm ever found was in South Africa and measured 22 feet from its nose to the tip of it's tail.

Best Foods for Your Classroom Worm Bin

Classroom worms love:

- banana peels
- apple cores
- carrot shavings
- insides of pepper
- potato peelings
- crushed eggshells
- old lettuce
- ends of celery
- pear cores
- melon rinds
- greens

Classroom worms will eat some:

- tea bags
- Coffee grinds

Classroom worms could eat, but prefer not to eat:

- citrus fruits can harbor fruit fly eggs and if you overload your bin, can kill your worms by turning your bin environment to acidic.
- onions and broccoli have a strong odor.
- dairy products, meats, and oils can putrefy and can produce nasty odors.

Note: Classroom worms prefer their food cut into tiny pieces but it's not necessary.

Your compost system can utilize any organic waste but requires a regular input of food scraps for it's occupants. Redworms are perfect for worm composting because they eat half their weight in food every day and are surface feeders. A pound of worms can eat a half-pound of food scraps per day.
Vermiculture keeps food scraps out of garbage disposal which eases the load on overburdened sewage treatment plants.

Trouble Shooting Your Worm Bin

Odor Problem

If your worm bin has an unpleasant odor, one of the following may be the culprit:

• **Bin is too wet**. Solve the problem by not adding any water or foods with a high percentage of water (e.g. melons) and by adding more dry bedding.

• **Bin does not get enough air**. Anaerobic bacteria (bacteria which thrives without air are smelly. To aerate, add fresh bedding and mix bin contents daily.

• **The food in bin is naturally smelly**. For instance, we have found that onions and broccoli do not smell very pleasant when they decompose in the worm bin. Simply remove any food source that smells bad from the bin.

• **Bin contains difficult biodegradables**. Meat, bones, dairy and oil products should not be used in your bin because these items become rancid when decomposing.

Worm Death

If you notice the worm population dwindling, or worms crawling all over the bin to escape, check for the following:

• Bin is too wet and worms are drowning.

• Bin is too dry and worms dry out.

• Bin does not get enough air and worms suffocate.

• Worms do not get enough food. Once the worms devour all their food and newspaper bedding, they will start to eat their own castings which are poisonous to them. **TIME TO HARVEST**.

• The bin is exposed to extreme temperatures. The worms thrive in temperatures from 55 to 85 degrees fahrenheit.

Note: Dead worms decompose rather quickly. If you do not monitor the above conditions you can have a worm bin without any worms before you even realize it.

Fruit Flies

Though fruit flies do not pose any health hazards, these little creatures can be a nuisance in the classroom. To help prevent these potentially prolific pests, do the following:

- **Avoid putting rotting or rotten food in your worm bin**. Fly larvae are more likely to be present on rotten food.

- **Cut food scraps into small pieces.** Worms will be able to eat smaller pieces more quickly, thereby limiting the possibility of fruit flies thriving on decomposing food.

- **Don't overfeed worms**. Ripe food that sits around in the bin attracts (and may contain) flies.

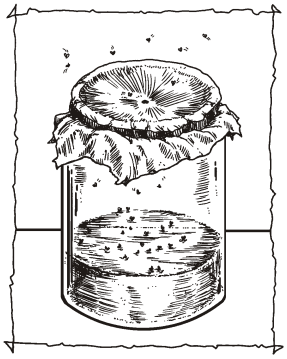
- **Bury food**. Burying the food will help keep unwanted pests and pets from intruding on your bin.

- **Keep bedding material moist, but not too wet**. Overly wet conditions encourage the proliferation of fruit flies. Wet conditions might also cause an odor problem, as anaerobic bacteria thrive when it is too wet.

- **Feed worms a varied diet.**

- **Loosely place a piece of plastic or a sheet of newspaper inside the bin on top of the worm bin contents.** This plastic or newspaper cover will create a barrier to help prevent flies from getting in (or out) of the bin. Hay or straw, a foam pad or interfacing fabric can also be used as a barrier to keep the eggs from hatching.

- **Limit citrus fruits.** If citrus foods dominate the bin, the bin may become too acidic, which may attract fruit flies.



To help control an existing fruit fly problem, try the following:

- Tape or staple flypaper strips on the inside of the bin lid, and/or hang a strip near the bin. Flypaper catcher strips can be purchased cheaply at most hardware stores.

- Create a fly trap to put in or next to the bin. A bowl of apple cider vinegar with a drop of dish detergent, placed near the bin, will attract and kill flies. Change liquid regularly to keep fly trap potent.

• Place a whole sheet of newspaper on top of bin contents. Change this top layer regularly as flies tend to congregate on the newspaper.

• Add finely crushed eggshells to help neutralize excessively acidic conditions.

• For temporary relief, take bin outside and leave uncovered for up to four hours to air out the bin (out of direct sunlight).

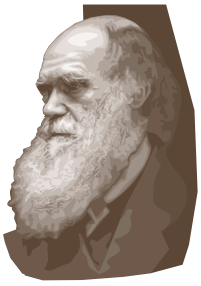
If the problem cannot be controlled, have your class analyze the problem, and speculate about what is causing it. The best solution may be to harvest the worms and start a new bin from scratch, using what you have learned from your past experience to create a better bin. Do not hesitate to call us at NYSDEC with any problems. Also, please share with us any other fly prevention tips that you discover.

Other Critters

Another critter that can be a nuisance in the worm bin is the red mite or earthworm mite.

Red mites are about the size of a poppy seed and are reddish brown. They help with decomposition and are usually a welcome animal in a worm bin. However, if there are too many of them, they can inhibit the worms' ability to consume food scraps. Worms will not approach food scraps that contain many mites. These mites proliferate in very moist conditions or when too many fruit scraps have been added to the bin. They often congregate on choice wet pieces of fruit that have started to ferment. These items can be removed with the mites attached (they move quite slow). Adding shredded newspaper will help dry up the worm bin. Some of the mites can be "trapped" using a piece of bread. Place the bread in the bin. Several days later remove the bread and the mites that have migrated to it.

Charles Darwin considered worms an animal of greater value than the horse, more powerful than the elephant and more important to humanity than the cow!



Harvesting Worm Compost

If you tend to your worms' needs and create a favorable environment for them, the worms will work tirelessly to eat your garbage and produce compost. As time progresses you will

notice that there is less and less bedding and more and more compost in your bin. After your bin is filled with compost (and very little bedding), it is time to harvest the bin. Harvesting the bin means removing the finished compost from the bin. When the bin is filled with castings it is important that the worms and their castings are separated because it is unhealthy for the worms to live in concentrated amounts of their own castings.

When harvesting you can try one of two methods:

Hands-off Method: Push all of the worm bin contents to one half of the bin, removing any large undecomposed food or newspaper pieces. Put fresh bedding and food in empty side of the bin. Continue burying food waste only in freshly bedded half. To facilitate worm migration, cover only the new side of the bin. Over the next 2- 3 weeks the worms will move over to the new pile of the worm bin, conveniently leaving their compost behind in one section. When this has happened, remove the compost and replace it with fresh bedding.

Hands-on Methods: Dump the entire contents of the worm bin onto a sheet of plastic or paper. Make individual cone- shaped piles. Each pile will contain worms, compost and undecomposed food and bedding. As the piles are exposed to light, the worms will migrate towards the bottom of the pile. Remove the top layer of compost from the pile, separating out pieces of undecomposed food and newspaper. After removing the top layer, let pile sit under light for 10 minutes, and then remove the next layer of compost. Repeat this process until all of the worms are left at the bottom of the pile. Collect the worms, weigh them (for your record keeping) and put them back in their bin with fresh bedding. Divide your students into teams and let them sift through their own pile. The kids love it!

What To Do With Your Compost

You can use your compost immediately, or you can store it and use it in the spring, or whenever. The compost can be directly mixed with your potting soil or garden soil as a natural fertilizer. Two parts soil to one part compost works well. Or, the compost can be used as a top dressing for your indoor and outdoor plants. One quarter of an inch of castings every 2-3 months will make your plants very happy and healthy.
You can also make "compost tea" with your compost. Simply add one (1) to two (2) inches of compost to your water can. Allow compost to sit, mixing occasionally, for a day. Then just water your plants as you normally would. The nutrients from the compost will seep into your water supply, giving your plants a special treat. Use remaining compost residue as a dressing for indoor or outdoor plants.

Let your students take the compost home for use on their household plants and/or in their garden. Have them observe the difference in growth on plants that got the compost and those that didn't.

Fascinating Facts ... And Related Classroom Activities

■ Over one (1) million worms may be present in one acre of soil, and these worms can produce 700 pounds of castings each day. Two thousand redworms in a worm bin can produce seven (7) pounds of castings in one month.
Ask children to estimate how much food waste they produce each day. What happens to it? What ways can food waste and other waste be recycled?

■ Worms do not have teeth. Their food is softened by moisture or by microorganisms which break it down. Food is further broken down in the worms' gizzard, which contains hard particles and muscles which grind ingested food.
Observe which food wastes decompose the fastest, and try to explain why. What are your worms' favorite foods? Do worms like dry or wet garbage best? Why?

■ Worms are not the only living organisms in the worm bin. All sorts of microorganisms (in fact, billions of them!) live in the worm bin. These microorganisms are introduced to the bin from the skin of the worm and from soil added to the bedding. Added garbage introduces more microorganisms, as do fungal and bacterial spores that land in the bin from the air.
Are other creatures besides worms present in your classroom worm bin? Look for composting critters outside, in piles of decaying leaves. Where else can you find them?

■ Worms do not have eyes, but they can sense light, especially at their front end. They move away from light, and will become paralyzed if exposed to light for too long (approximately one hour). If a worm's skin dries out, the worm will die.
Observe worms' reactions to light. Why do worms stay inside your covered worm bin?

■ While worms need moisture to survive, too much moisture will kill them. Have you ever noticed worms on the sidewalk after a rainstorm? That's because the worms' homes in the soil got flooded, and the worms came to the surface in search of less soggy conditions. Once on the pavement, worms often get disoriented and never make it back to the soil. They then dry up and die when the sun comes back out.
After a heavy rainstorm, go out on a worm hunt. What should you do when you see worms on the pavement? (Stepping on them is not the right answer!) Be a worm

rescuer - put them back in the soil where they belong and can survive. Why do we want worms to survive?

■ Worms are hermaphrodites; each worm has both male and female organs. Worms mate by joining their clitella (the swollen area near the head of the mature worm) and exchanging sperm. Then each worm forms an egg capsule in its clitellum; after 7- 10 days, this is shed into the castings. Egg capsules are lemon- shaped and about the size of a sesame seed. After 14- 21 days baby worms hatch from the eggs. One to five worms emerge from each egg. In 60- 90 days, the young worms are mature.
Try to find mature worms, young worms and worm eggs in your worm bin.

■ Worms can live as long as four years. When worms die in the bin, their bodies decompose along with the food scraps.
Why should a worm bin be harvested at least twice a year? Harvest your own bin when it is filled with compost.

■ Contrary to popular belief, worms cannot reproduce by being cut into small pieces. However, they do have amazing healing powers. If you cut a worm in half, both sides will continue wiggling. The portion with the head may grow a new tail if the cut is after the segments that contain vital organs. The tail portion will continue to wiggle until the nerve cells die. The tail end will never grow a new head.
What other animals can regenerate parts of their bodies ?

■ Worm castings contain nitrogen and other nutrients necessary for plant growth. When added to soil, worm compost increases nutrient availability and improves soil structure and drainage.
Transplant a few plants, seedlings or seeds in a potting mix with worm compost added, and transplant other plants or seeds into pure potting mix. Observe what plants grow the best, and try to explain why.

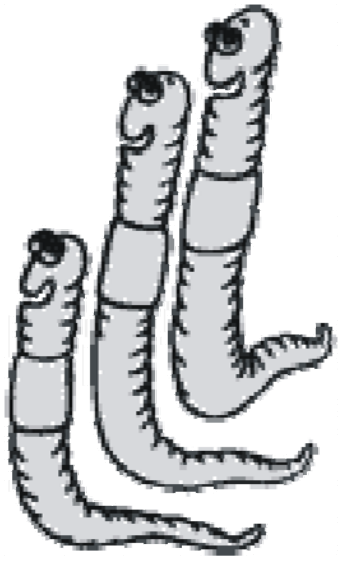
■ In addition to making soil, worms are natural soil tillers. They mix layers of soil while producing tunnels in the soil to help air and water to reach plant roots. Tiny feeler-like bristles on worms' bottom side help worms to move through the soil. These bristle-like hairs are called setae.
Put worms into a glass container with soil, and watch them make tunnels in the soil. Put layers of different types of soil into the glass container, and watch the worms mix the soil.

■ There are over 3,000 species of earthworms in the world. Redworms (Eisenia fetida) are best for a worm bin because they are natural surface feeders that do not burrow as

nightcrawlers do. Thus, living in a worm bin is not as confining to redworms as it would be to nightcrawlers. Redworms for worm composting can be purchased from worm farms. Composting worms are usually sold by the pound.
Look for worms in garden soil, vacant lots, etc. How many kinds of worms did you find? Where did you find the most worms? Research worms from around the world. Where in the world can you find worms several feet long?

■ Many people mistakenly believe that organic waste sent to landfills decomposes quickly, like it does in a worm bin or compost pile. However, this is not at all true because the key ingredients, air and moisture, are missing or minimal in a landfill environment. This will slow down or even halt the decomposition process. Additionally, worms and other important decomposers can not live or function in such conditions.
Put some worm food in an airtight bag. Compare what happens to this food to what happens to food in a worm bin.

Keeping food and yard waste out of the landfills reduces foul smells, groundwater contamination, the formation of weak acids and the generation of methane gas.



CLASSROOM ACTIVITIES

1. Mini-Landfill

Introduction: Every day, garbage is dumped into landfills. After being dumped and compacted, the garbage is covered with clean soil. The process of covering garbage with soil actually contributes to breaking it down into smaller and smaller pieces. The only types of garbage that will decay in the landfill are biodegradable.

Objectives:
- Students will learn the process of decomposition in a landfill.
- Students will learn which items are biodegradable and which will not deteriorate over time.

Materials: Two identical pieces of each of the following:
- food scraps
- newspaper
- cloth
- glass
- cardboard
- aluminum foil
- plastics
- copper wire

AND
- cardboard shoe boxes, one (1) per student or one (1) per group of students
- foil or plastic to line the shoe boxes
- toothpicks, about 20 per shoe box
- index cards, about 20 per shoe box
- water
- soil from outside (NOT POTTING SOIL, it is sterilized)
- "Mini Landfill" worksheet, two (2) per student
- "Mini Landfill" discussion questions (see following)

Activity:
1. Students line the shoe boxes with aluminum foil or plastic.

2. Students fill the shoe boxes half-full with soil (not potting soil, it is sterilized).

3. Students bury two identical rows of waste, marking the location of each item with index

card labels on toothpicks.

4. Students water the soil and put the boxes in a sunny location. Keep the soil moist but do not soak.

5. Distribute 1 worksheet per student. Have students use the back of the worksheet to write down the date and items placed in their landfill.

6. After 10 days, have students carefully remove the waste items from one row of the landfill and examine them. Students answer questions on worksheet.

7. Students continue to maintain mini- landfill for 10 more days.

8. Students carefully remove the waste items from the remaining row of the landfill and examine them. Students answer questions on worksheet.

9. Follow up investigation with "Mini Landfill Discussion Questions."

Finished compost

Mini-Landfill Worksheet

Name:_____

1. The items which decomposed the most are:

2. The following items decomposed a little:

3. These items did not change at all:

4. Why do you think some items are decomposing more quickly than others?

Mini-Landfill Discussion Questions

1. Which items in the mini landfill decomposed the most?
List will vary.

2. Were the decomposed items natural or manmade?
Natural.

3. What characteristics are shared by the items which decomposed quickly?
Answers will vary, they are natural, organic...

4. Some items did not decompose. What do you think will happen to them?
They are not biodegradable, decomposition will take a very long time.

5. What are, the alternatives to burying these non-decomposable items in a landfill?
Don't buy them, practice reuse, and/or recycle.

6. Did mold form on the landfill? If yes, why did this occur?
Mold spores are present in the soil. The landfill provided the necessary environment (warmth, moisture, food source) for their growth.

7. What do you think happens to waste left out in the desert?
Unless it is eaten by scavengers (crows, vultures etc.) it is preserved. Without moisture, there are no microorganisms to decompose the waste.

8. Suppose that your landfill was made with sterilized potting soil. Would waste have decomposed so quickly? Why or why not?
No, sterilized soil contains no micro-organisms.

9. Did you notice any spaces around the waste items as you dug them up? What caused the spaces to form? If this happened in a real landfill, how could it affect the future use of the land after the landfill closed?
Decomposition of the waste items resulted in the formation of the spaces. Some of the waste material is converted into food energy by the organisms that eat it. Therefore the end product of decomposition contains less matter (and takes up less space) than the waste items.

2. Compost - A New Beginning

Objective: Students will learn the basics of composting. Students will learn how composting reduces the weight and volume vegetative waste and turns it into a useful soil amendment for the garden.

Materials:

- 5-gallon buckets (4)
- grass clippings
- vegetable and fruit peels
- leaves
- thermometer

Activity:

1. Have the class research composting.
2. Drill or poke holes in the sides of 3 of the 4 buckets (Buckets A, C and D) near the bottom.
3. Set up the following conditions in each bucket (keep buckets on newspaper or protective floor covering):

Compost Bucket A - Compost which is low in nitrogen.

- Place mostly leaves and some vegetable and fruit peels in the bucket.
- Keep moist but do not soak. Turn over regularly, once every three days for the first two weeks, then once a week.

Compost Bucket B - Compost without moisture.

- Place a mixture of grass clippings (high in nitrogen) which are not very wet, leaves, vegetables and fruit peels in the bucket.
- Do not moisten.
- Turn over regularly, as described in A above.

Compost Bucket C - Compost without adequate air circulation.

- Place a mixture of grass clippings (high in nitrogen), leaves, vegetable and fruit peels in the bucket.
- Keep moist, but do not soak.
- Do not turn.

Compost Bucket D - Compost with adequate nitrogen, moisture and air circulation.

• Place a mixture of grass clippings (high in nitrogen), leaves, vegetable and fruit peels in the bucket.
• Keep moist, but do not soak.
• Turn over regularly as described in A above.

4. Keep a daily record of the temperature of each pile.

5. After a few weeks discuss the results:

- Which finished compost is dark and crumbly with much of the original appearance no longer visible?
- What are the essential ingredients to proper composting?
- How does composting reduce the amount of waste?
- Which compost piles became anaerobic (and smell)?

Pictures of worm bins here!

Bin with newspaper bedding.

Bin almost ready to harvest.

3. Meet A Red Wiggler - Anatomy

Objective: Students will learn basic worm anatomy.

Materials:

- Red wigglers, 1 per student
- Worm containers, 1 per student (any container with a low lip which can hold water. For example: petri dish, plastic coffee can lid, the bottom of a carton of milk)
- Water
- Teaspoons, several
- Rulers, 1 per student
- "Meet A Red Wiggler - Anatomy" worksheet, 1 per/student
- Magnifying glasses (optional), 1 per student
- Binocular microscope (optional)

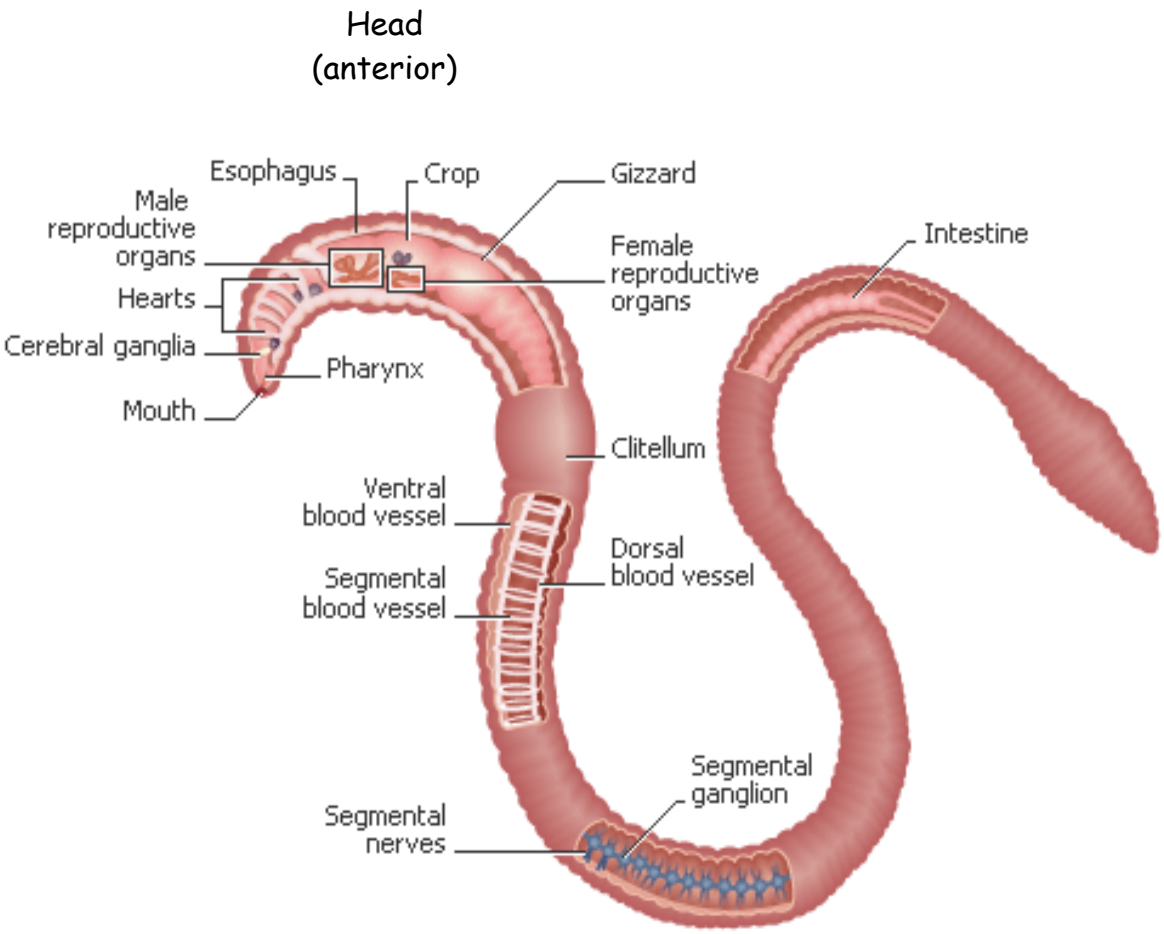
Activity:

1. Put about a teaspoonful of water and a worm in a container for each student.
2. Rulers are needed for only one of the observations, so they can be shared if necessary.
3. Optional: magnifying glasses can be used to aid the students in their observations.
4. Optional: binocular microscope can be used to view the dorsal blood vessel of the worm. This blood vessel is an unbroken line running along the top side of the worm. Blood flows from tail to head in it, and then back again to the tail through a ventral blood vessel (bottom side).

Meet a Red Wigger - Anatomy Worksheet Answers

1. No answer, just setting up activity.
2. Dark reddish purple, pinkish with yellow.
3. Light pink or white.
4. Variable.
5. Yes, the ventral side is pale in color compared to the dorsal side. If the worm is turned onto its back side (dorsal) it will turn itself over again.
6. The head. Thickened section of worm, paler in color than the rest of the worm.
7. The head or the mouth. The tail end.
8. Longer worm. As a worm gets older, it gets longer and has more segments.
9. Variable.
10. See below

Worm Anatomy



Meet A Red Wiggler - Anatomy Worksheet

Name:_____

1. Collect a red wiggler, a worm container, a teaspoonful of water, a ruler and a magnifying glass (if available) from your teacher. If you have a magnifying glass, use it to help you make your observations. The worms must be kept moist at all times during your observations. If the water dries up, ask your teacher for another teaspoonful of water.

2. The red wiggler has a narrower head end (anterior) and a rounder tail end (posterior). What is the color of the head?_____ The tail? _____

3. At the tip of the head end of the worm is the prostomium. It is a flap which covers the mouth of the worm. What color is it? _____

4. Measure the length of the worm when it is at its shortest. _____

5. Does the worm have a top (dorsal) side and a bottom (ventral) side? _____

6. Find the swollen section of the worm. This is the clitellum. The clitellum is necessary for worm reproduction. (If your worm is immature, it may not have a visible clitellum. Look at another student's worm if necessary). Which end is the clitellum, closer to? _____
Describe the clitellum: _____

7. Turn the worm over. You will be able to see a row of dark splotches. This is the intestine where food is digested. Where does the intestine begin? _____
Where does the intestine end? _____

8. Each worm is made up of many rings called segments. Look at another student's worm which is either longer or shorter than our own. Which worm appears to have more segments (longer or shorter worm)? _____

9. Describe the way a worm feels to you when you touch it. _____

10. Draw a worm on the back of this worksheet. Label the head (anterior), tail (posterior), clitellurn, and segments.

Remember: The worm you are observing is a living creature. Treat it gently. Carefully return it to the worm bin when you have completed your observations.

4. Meet A Red Wiggler - Behavior

Objective: Students will learn worm behavior as a response to environmental stimuli.

Materials: • Red wigglers, 1 per student
• Worm containers, 1 per student (see "Meet A Red Wiggler - Anatomy")
• Water
• Teaspoons, several
• Flashlights, several
• "Meet A Red Wiggler - Behavior" worksheet, 1 per student

Activity:
1. Put about a teaspoonful of water and a worm in a container for each student.
2. Ask students to take their time with this activity.

Meet a Red Wiggler- Behavior Worksheet Answers:
1. No answer, just setting up activity.
2. The behavior of the worm is variable, the following responses may be expected. Moving, stretching, exploring, trying to escape, etc.
3. Segments alternately relax and contract as the worm moves. As a segment contracts, it elongates. It becomes longer and thinner. As the segment relaxes, it looks shorter and fatter.
4. Contracts abruptly, contracts.
5. Turns itself right side up.
6. Yes, moves away from bright light.
7. No, no apparent reaction.
8. Yes, no.
9. Hides under the bedding material.

Meet A Red Wiggler - Behavior Worksheet

Name: _____

1. Collect a red wiggler, a worm container, a small piece of bedding material and a teaspoonful of water from your teacher. The worms must be kept moist at all times during your observations. If the water dries up, ask your teacher for another teaspoon of water.

2. Observe the worm for 1- 2 minutes in the container. Write a general description of the worms behavior.

3. Observe the segments of the worms as it moves around the container. Describe your observations of the size and shape of the segment while the worm moves.

4. What does the worm do when you lightly touch its head end? Its tail end?

5. Gently turn the worm over onto its back. Describe the worm's reaction.

6. Shine a flashlight at the worm. Is the worm sensitive to light? How can you tell?

7. Clap your hands near the worm. Is the worm sensitive to sound? How can you tell?

8. Does the worm move forward head first? Tail first?

9. Put the bedding material in the container near the worm. Watch the worm for 1- 2 minutes. Describe the worm's activity.

Remember: The worm you are observing is a living creature. Treat it gently. Carefully return it to the worm bin when you have completed your observations.

5. From Food To Fertilizer

Objective: Students will learn to design and conduct a scientific investigation to determine the effect of growing plants in vermicompost.

Materials:
• Seeds (e.g. beans) six (6) per student
• Soil from outside or the school grounds. Wherever you obtain your soil, make sure you use the same soil mixture throughout.
• vermicompost harvested from worm bin
• Paper cups for planting seeds (or pots, or bottom half of quart sized milk cartons, etc.) three (3) per student
• Cups for watering
• Scoopers for the soil mixtures (a metal coffee can that has its rim bent into a "V" works well for scooping and pouring soil)
• Newspaper for covering desks
• Clean trays (or cafeteria trays, or any flat container for catching water), one (1) per student
• Pens or markers for labeling paper cups and trays
• Nail

Getting Ready:
• Have students design an experiment for investigating the effect of growing plants in vermicompost or follow the activity below which provides an experimental design.
• Prepare mixtures of soil and vermicompost according to experimental design (For example: if the experiment calls for a mixture of 75 % soil and 25 % vermicompost, combine 3 parts of soil to 1 part of vermicompost and mix together).
• Use a nail to prick holes in the bottoms of your planting cups for water drainage.

Activity:
• Students will compare the growth of plants in a mixture of:
    a. 50% soil and 50% vermicompost (Variable)
    b. 75 % soil and 25 % vermicompost (Variable)
    c. 100% soil (Control)
• Students cover desks with newspaper.
• Each student collects: 3 cups, 1 tray and a marker. Student labels cups A, B, C, and writes his/her name on cups and tray.
• Student fills cups 2/3 full with appropriate soil mixture (ex. Cup A has 50:50 mix), plants 2 seeds in each cup, and covers with more of the appropriate soil mix (see seed package for depth of seed).

• Student places the three cups on a tray and waters the seed lightly until some water drains out from the bottorn of the cup.
• Student develops a hypothesis (makes a prediction) about the experimental results.
• Students observe their cups (plants) every day for a month and note changes. Soil needs to be kept moist but not soaking wet.
• Make a large chart like the one below (or students keep their own charts). Each day ask the students to check their cups for plant growth and make notations on chart.
• Using their experimental results, students draw conclusions about the effect of growing plants in vermicompost. Students compare their conclusions with their hypotheses.

From Food To Fertilizer Worksheet

Name: _____

OBSERVATIONS			
Day	**Control**	**50:50 Mix**	**75:25 Mix**
1			
2			
3			
4			
5			
6			
7			

Criteria to compare: date of seed germination, height of plants, number of leaves, and color of leaves and stems.

Note:
• Check your seed packets for "number of days" till seed emergence.
• Maintain all of the pots and plants under identical conditions. All plants in the experiment should be receiving equal light, heat and moisture.

Glossary

acid - A liquid that tastes sour and smells somewhat sharp. Acids help dissolve rock and break down food. Vinegar is an acid. It is a normal product of decomposition. Redworms do best in a slightly acid soil (pH less than 7) environment. Below pH 5 can be toxic. Addition of pulverized egg shells and/or lime helps to neutralize acids in a worm bin. See **pH**.

pH Scale 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
acid neutral alkaline

Actinomycetes - Fungi- like bacteria. New name for this group is Actinobacteria.

aggregation - Clustering, as when soil particles form granules that aid in aeration and/or water penetration.

aeration - Exposure of a medium to air which allows exchange of gases.

aerobic - Pertaining to the presence of free oxygen. Organisms that utilize oxygen to carry out life functions.

air - Mixture of atmospheric gases, including nitrogen, oxygen, carbon dioxide, and other gases in smaller quantities.

albumin - A protein in cocoons that serves as a food source for embryonic worms. Found in egg whites.

Allolobophora caliginosa - One of the early scientific names for the species of earthworm now known as Aporrectodea turgida, the pasture worm.

Allolobophora chlorotica - Scientific name for green worm . It may look green, but also may appear yellow, pink, or gray. Found in a wide variety of soil habitats, including gardens, fields, pastures, forest, clay, peat soils, lake shores and stream banks, and among organic debris. This species is generally a shallow burrower.

anaerobic - Pertaining to the absence of free oxygen. Organisms that can grow without oxygen present.

animal - A living being capable of sensing its environment and moving about. Animals live by eating the bodies of other organisms, whether plant or animal.

annelid - Term for a member of the Phylum Annelida containing segmented worms.

anterior - Toward the front.

Apporectodea trapezoides - Scientific name for southern worm, commonly found in earth around potted plants, gardens, forest soils, and banks of springs and streams. This worm lacks pigment. Its color is often lighter behind the clitellum, darkening to brown, brownish, or reddish brown towards the posterior. Flattening of body near posterior makes cross-section appear rectangular.

Apporectodea turgida - Scientific name for pasture worm, commonly found in gardens, fields, turf, compost, and banks of springs and streams. This worm lacks pigment. The anterior may be flesh pink, the remaining segments pale gray.

Aquatic - Living in or upon water.

Arctic - Pertaining to the region around the North Pole.

bacteria - Plural for bacterium, a one- celled organism which can be seen only with a microscope. Bacteria may be shaped like spheres, rods or twisted springs. Some bacteria cause decay; others may cause disease. Most bacteria are beneficial because they help recycle nutrients.

barrier - A geographic zone such as an ocean, desert, or glacier which would prevent the migration of an earthworm. Barriers may be different for other kinds of animals.

bedding - Moisture- retaining medium which provides a suitable environment for worms. Worm bedding is usually cellulose- based, such as newspaper, corrugated cartons, leaf mold, or compost.

bio-degradable - Capable of being broken down into simpler parts by living organisms.

biologist - A scientist who studies living things.

biological control - Management of pests within reasonable limits by encouraging natural predator/prey relationships and avoiding use of toxic chemicals.

blood - A liquid medium circulating in the bodies of many animals. Blood carries food and oxygen to the tissues and carries waste products, including carbon dioxide, away from the tissues. Earthworms and humans both have a red, hemoglobin- based blood for oxygen transport.

breathe - To carry on activities to permit gas exchange. Humans and land- dwelling vertebrates do this by expanding the lung cavity to draw air in, and reducing it to force air out. Worms conduct gas exchange through their moist skin, but do not actually breathe.

breeders - Sexually mature worms as identified by a clitellum.

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

burrow - Tunnel formed when an earthworm eats its way through soil, or pushes soil aside to form a place to live and move more readily through the earth.

carbon dioxide - Gas produced by living organisms as they utilize food to provide energy. Also produced through the burning of fossil fuels.

castings - See worm castings.

castings tea - A solution containing nutrients which dissolve in water in the presence of worm castings.

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

centipede - A predator sometimes found in worm bins. Centipedes have more than 8 jointed legs with one pair of legs attached to each of many segments.

classify - To organize materials, organisms, or information based upon a defined set of characteristics.

climate - The prevailing or average weather conditions of a place over a period of years.

clitellum - A swollen region containing gland cells which secrete the cocoon materials. Sometimes called a girdle or band, it is present on sexually mature worms.

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

cold-blooded - Having blood that varies in temperature approximating that of the surrounding air, land, or water. Fishes, reptiles, and worms are cold- blooded animals.

compost - Biological reduction of organic waste to humus. Used to refer to both the process and the end product. One composts (verb) leaves, manure, and garden residues to obtain compost (noun) which enhances soil texture and fertility when used in gardens.

consumer - An organism that feeds on other plants or animals.

contract - Action of muscle as it draws up, or gets shorter.

culture - To grow organisms under defined conditions. Also, the product of such activity, as a bacterial culture. Vermiculture is growing worms in culture.

cyst - A sac, usually spherical, surrounding an animal in a dormant state.

DDT - A toxic pesticide found to accumulate in the food chain and cause the death of animals which were only indirectly exposed.

decompose - To decay, to rot; to break down into smaller particles.

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

decomposition - The process of breaking down complex materials into simpler substances. End products of much biological decomposition are carbon dioxide and water.

Dendrobaena octaedra - Scientific name of earthworm known as the octagonal- tail worm. Found mostly in non-cultivated sites, such as in sod or under moss on stream banks, under logs and leafy debris, or in cool moist ravines. Also found in dung and in soil high in

organic matter. A surface-dwelling species. Posterior is octagonal in cross-section.

digestive tract - The long tube where food is broken down into forms an animal can use. It begins at the mouth and ends at the anus,

dissect - To cut open in order to examine and identify internal structures.

dissolve - To go into solution.

dorsal - The top surface of an earthworm.

earthworm - A segmented worm of the annelid group which contains some 4000 species. Most earthworms are terrestrial that is, they live in the ground. Earthworms have bristles known as setae which enable them to burrow in the soil. Earthworms help to aerate and enrich the soil.

ecology - The science of the interrelationships between living things and their surroundings.

egg - A female sex cell capable of developing into an organism when fertilized by a sperm.

egg case - See cocoon.

Eisenia fetida - Scientific name for one of several redworm species used for vermicomposting. Color varies from purple, red, dark red to brownish red, often with alternating bands of yellow in between segments. Found in manure, compost heaps, and decaying vegetation where moisture levels are high. Frequently raised in culture on earthworm farms. See also Lumbricus rubellus.

Eisenia rosea - Scientific name for worm known as the pink soil worm. Color is rosy or grayish when alive. During hibernation in cold winters and estivation during hot, dry summers, worm may be found in the soil tightly coiled in a small pink ball. Most common habitat is in soil under logs.

Eiseniella tetraedra - Scientific name for worm known as the square- tail worm. Body is cylindrical anterior to the clitellum, square in cross-section behind the clitellurn. The species shows a preference for damp habitats, having been found near wells, springs, underground waters, rivers, ponds, lakes and canals. It has been found in bottom deposits of streams, lakes and ponds.

enchytraeids - Small, white segmented worms common in vermicomposting systems. As decomposers, they do not harm earthworms. Also called pot worms.

environment - Surrounds, habitat.

excrete - To separate and to discharge waste.

experiment - To conduct research by manipulating variables to answer specific questions expressed as statements known as hypotheses.

feces - Waste discharged from the intestine through the anus. Manure. Worm castings.

fertilize - To supply nutrients to plants, or, to impregnate an egg.

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

food web - The sequence defined by who eats whom, starting with producers and progressing through various levels of consumers, including decomposers and predators. Many organisms may be more than one level of consumer, depending upon whether they eat a plant, a microorganism which has consumed a plant, or an animal which ate the microorganism which ate the plant. A food web describes more.. complex linkages and interrelationships than a food chain.

Fungi - A large group of organisms which reproduce by spores. The group includes mushrooms, toadstools, molds and mildew.

fungus - The plural of fungus is fungi.

genus - A category of classification which groups organisms with similar characteristics. These are more general than species characteristics.

girdle - See clitellum.

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

hatchlings - Worms as they emerge from a cocoon.

heart - Muscular thickening in blood vessels whose valves control the direction of blood flow. Earthworms have several (commonly 5 pairs) of these blood vessels which connect the dorsal to the ventral blood vessels.

heavy metal - Dense metal such as cadmium, lead, copper, and zinc which can be toxic in small concentrations. Build up of heavy metals in garden soil should be avoided.

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

humus - Complex, highly stable material formed during breakdown of organic matter.

hypothesis - A prediction or educated guess which is used to guide a scientist in designing an experiment.

immigrate - To move into a region.

inoculate - To provide an initial set of organisms for a new culture.

larva - Early form of any animal that changes structurally before becoming an adult. A caterpillar is an insect larva which becomes a moth or butterfly as an adult.

leach - To run water through a medium, causing soluble materials to dissolve and drain off.

leaf mold - Leaves in an advanced stage of decomposition.

lime - A calcium compound which helps reduce acidity in worm bins. Use calcium carbonate, ground limestone, egg shells, or oyster shells. Avoid caustic, slaked and hydrated lime.

litter (leaf) - Organic material on forest floor containing leaves, twigs, decaying plants, and associated organisms.

Lumbricidae - Name of family group to which several redworm and nightcrawler species of earthworms belong.

Lumbricus rubellus - Scientific name for a redworm species. Color is ruddy- brown or red- violet, iridescent dorsally, and pale yellow ventrally. It has been found in a wide variety of habitats, including under debris, in stream banks, under logs, in woody peat, in place rich in humus, and under dung in pastures. Grown in culture by worm growers.

Lumbricus terrestris - Scientific name for large burrow- dwelling nightcrawler. Also known as the nightcrawler, Canadian nightcrawler, or dew worm.

macro organism - Organism large enough to see by naked eye.

mate - To join as a pair; to couple.

Mecascolides australis - Scientific name of the Giant Gippsland Earthworm of Australia, one of the largest earthworm species in the world.

membrane - A tissue barrier capable of keeping some substances out and letting others in.

microorganism - Organism requiring magnification for observation.

microscope, dissecting - an instrument permitting magnification of organisms too small to see clearly with the naked eye, but too large for a light microscope.

mineral - A naturally occurring substance found on the earth which is neither animal nor plant. Minerals have distinct properties such as color, hardness, or texture.

mineral soil - Soil that is mainly mineral material and low in organic material. Its bulk density is greater than organic soil.

mold - A downy or furry growth on the surface of organic matter, caused by fungi, especially in the presence of dampness or decay.

molecule - The smallest particle of an element or compound that can exist by itself. Two atoms of oxygen make up a molecule of oxygen. Two atoms of oxygen and one atom of carbon make up a molecule of carbon dioxide.

mucus - A watery secretion, often thick and slippery, produced by gland cells. One function is to keep membranes moist.

muscle - Tissue made of specialized cells whose main function is to contract.

nematodes - Small (usually microscopic) roundworms with both free- living and parasitic forms. Not all nematodes are pests.

nightcrawler - A common name for the worm Lumbricus terrestris. Often called the Canadian nightcrawler in the United States, or dew worm in Canada.

nitrogen - An odorless, colorless, tasteless gas which makes up nearly four fifths of the earth's atmosphere. When it combines with oxygen through the action of nitrogen- fixing bacteria, it can become incorporated into living tissue as a major part of protein.

nocturnal - Coming out at night.

nourish - To promote or sustain growth.

Octolasion cyaneum - Scientific name for the woodland blue worm. Body is octagonal in the posterior. It is blue- gray or whitish, and found in damp locations, including under stones in water, in moss, and on stream banks.

Oligochaeta - Name of the class of annelids to which earthworms belong, characterized by having setae.

optimal - Most favorable conditions, such as for growth or for reproduction.

organic - Pertaining to or derived from living organisms.

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

organism - Any individual living thing.

ovary - Organ which produces eggs.

overload - To deposit more garbage in a worm bin than can be processed aerobically.

oxygen - Gaseous element in the earth's atmosphere essential to life as we know it.

pest - An organism which someone wants to get rid of.

pesticide - A chemical, synthetic or natural, which kills pests.

pH - An expression for degree of acidity and alkalinity based upon the hydrogen ion concentration. The pH scale ranges from 10'to 14, pH of 7 being neutral, less than 7 acid, greater than 7, alkaline.

plant - An organism which is green at some stage of its life and which uses the energy from sunlight to produce its own food. Plants do not move about on their own. An oak tree

is a plant.

pollute - To make foul or unclean, to contaminate.

population - The total number of individuals of a single species in a defined area.

population density - Number of specific organisms per unit area, e.g. 1000 worms per square foot.

posterior - Toward the rear, back, or tail.

potting soil - A medium for keeping potting plants in.

prostornium - Fleshy lobe protruding above the moth of an earthworm.

protein - Complex molecule containing carbon, hydrogen, oxygen, and nitrogen, a major constituent of meat. Worms are approximately 60% protein.

protozoa - Plural for protozoan, a one- celled organism belonging to the animal kingdom. Most protozoa live in water and can be seen only with a microscope. Some move by means of tiny hairs called cilia, others by a whip-like tail called a flagellum, and others by false feet called pseudopodia like amebas have.

ratio - A fixed relationship, expressed numerically, as in a worm:garbage ratio of 2:1.

redworms - A common name for Eisenia fetida and also Lumbricus rubellus. Eisenia fetida is a common worm used for vermicomposting, although in some parts of North America, Lumbricus rubellus is more common.

regenerate - To replace lost parts.

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

secrete - To release a substance that fulfills some function within the organism.

segments - Numerous disc-shaped portions of an earthworm's body bounded anteriorly and posteriorly by membranes. People identify earthworm species by counting the number of segments anterior to the position of structures such as the clitellum, ovaries, or testes. Segmentation is a characteristic of all annelids.

setae - Bristles on each segment used in locomotion.

sexually mature - Possessing a clitellurn and capable of reproducing.

silt - As a soil separate, individual mineral particles that range in diameter from the upper limit of clay to the lower limit of very fine sand. As a soil textural class, silt is 80% or more silt and less than 12% clay.

slime - Mucus secretion of earthworms which helps to keep skin moist so that gas exchange can take place.

soil - Soil is made up of mineral particles, organic matter, air, and water. The mineral particles are called sand, clay, or silt, depending on their size. Sand has large particles and feels gritty. Clay has fine particles and feels sticky or slippery when wet. Silt particles range between clay and very fine sand. Soil types have differing amounts of each of these particles. Loam is a mixture of sandy soil, clay, and organic matter. The organic matter acts like a sponge to hold water.

sow bug - A small crustacean with 10 pairs of legs which breathes with gills and lives in organic litter.

species - Basic category of biological classification, characterized by individuals which can breed together.

sperm - Male sex cells.

sperm - storage sacs- Pouches which hold sperm received during mating.

springtail - A small, primitive insect with a turned- under projection on its abdomen which causes it to spring about. Sprintails are often found in worm bins.

stress - To produce conditions which cause an organism to experience discomfort.

subsoil - Mineral bearing soil located beneath humus- containing topsoil.

taxonomist - A scientist who specializes in classifying and naming organisms,

terrestrial - Living on land.

testis (plural, testes) - Organ which produces male sex cells (sperm).

top dressing - Nutrient-containing materials placed on the soil surface around the base of plants.

toxic - Poisonous, life-threatening.

trash - Refers specifically to discards which are theoretically dry, such as newspapers, boxes, cans, and so forth. The term is commonly used to indicate anything we throw away, including organics. With increasing emphasis on recycling, less material should be thrown away as trash.

ventral - Term for the underneath surface of an earthworm.

vermicompost - Mixture of partially decomposed organic waste, bedding, worm castings, cocoons, worms, and associated organisms. As a verb, to carry out composting with worms.

vermiculture - The raising of earthworms under controlled conditions.

vibration - A rapid, rhythmic motion back and forth. Earthworms are sensitive to vibration.

worm bedding - The medium, usually cellulose- based, in which worms are raised in culture, such as shredded corrugated cartons, newspaper, or leaf mold.

worm bin - Container designed to accommodate a vermicomposting system.

worm casting - Undigested material, soil, and bacteria deposited through the anus. Worm manure.

worm:garbage ratio - Relationship between weight of worms and garbage used in a bin to convert the garbage to a useful end- product.

Bibliography

Try a web search or

For Teachers:

***Applehof, Mary (1982). Worms Eat My Garbage**
A comprehensive, yet concise guide to setting up and maintaining a worm bin. Provides all the how's and why's of worm composting. 100 pages. For anyone who wants to start a worm bin.
Flowerfield Enterprise,. Call (269) 327-0108 to order.

***Applehof, Mary, Mary Frances Fenton and Barbara Loss Harris (1993). Worms Eat Our Garbage Over 100** multidisciplinary activities to be used in conjunction with a classroom worm bin. 232 pages, including an appendix and glossary. For grades 2-8.
Flowerfield Enterprise, Call (269) 327-0108 to order.

*** Cornell Waste Management Institute. 2005. "Health & Safety Guidefor Composting in the School Setting."** www.cwmi.css.cornell.edu/health.pdf

Video Teacher Tools:

***Applehof, Mary, Billy B and the Brennan Kinds (1995). Wormania!**
Wormania features close-up scenes of live earthworms in their natural habitat. Songwriter and entertainer Billy B and his three children make this a fast- paced, educational and entertaining. A tad hokey but contains excellent worm footage. Time: 26 minutes. For grades 2 - 8. To order: See other Mary Applehof.

For Students:

Kalman, Bobbie and Janine Schaub (1992). Squirmy Wormy Composters
A MUST!!! A colorful book about worms and worm composting. Explains how to set up and maintain a worm bin using students in the illustrations. Also contains common questions about worms, a fictional story about worms' important role in nature, glossary and index. 32 pages. For grades 3 - 6 (younger students would love the illustrations). Crabtree Publishing Company, New York, Call (212) 496-5040 to order.

McLaughlin, Molly (1986). Earthworms, Dirt and Rotten Leaves
A hands-on, experimental approach to worms, emphasizing the use of scientific method to explore the world of worms. 86 pages, including a glossary and index. For grades 3 - 8.
Atheneum Macmillan Publishing, New York .

Pidgon, Keith and Marilyn Wooley (1989). Earthworms
Information book on worms. Excellent color illustrations with large print text. 26 pages, including a table of contents and index. For grades 2- 3, although the text is so clearly written and illustrated that it could be useful for any grade. *Modern Curriculum Press, Cleveland, $5.00.*

Roulston, Larraine (1988). **Pee Wee and the Magical Compost Heap**
Four children befriend a butterfly who shrinks them and introduces them to all of the organisms in an outdoor compost pile. 22 pages, including a dictionary. For grades 4- 6 (with background information or advance preparation on outdoor composting).
Recycling Council of Ontario, Canada, $3.95. Call (416) 960- 1025 to order.

Where To Buy Worms, Books, and Bins

This vendor list is by no means complete or comprehensive. Vendors listed are not endorsed by Cornell Cooperative Extension of Albany County, NY State Department of Environmental Conservation or any other agency or organization that contributed to this publication.

Outstanding Renewal Enterprise
Lower East Side Ecology Center
P.O. Box 20488
NY, NY 10009
(212) 420-0621

Mary Applehof
Flowerfield Enterprises
10332 Shaver Road
Kalamazoo, Michigan 49002
(616) 327-0108
Fax: 616-343-4505.
Contact: Mary James

Brenda Werner
Werner's Worms
22 Red Mill Road
Freeville, NY 13068
(607) 838- 3696; leave message to order worms

Manchester Worm Farm
1131 Tollend Turnpike
Manchester, CT 06040
(800) 497- 8067
(203) 647- 8067

Beaver River Associates
P.O. Box 94
West Kingston, RI 02892
(401) 782- 8747

• Manure piles at local horse and dairy farms and functioning compost heaps are other potential sources.

Sources

Contents reproduced with permission from:
Nelson, Cindy. "It's a Worm's World." The New Garden Journal, 1995. "Worms of Wisdom" (Pages 3, 9, 11), A Model of Integration (Page 4)

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Start with the Soil, Gershund, Grace, Rodale, Worm Barrel (Pages 10- 11)

Oscar's Options: Book 11. Bell, Carole 0. and Martha M. Schwartz. Rhode Island Solid Waste Management Corp., Providence, 1987, (Pages 18-20)

Education Program, Division of Solid Waste Management. Here Today, Here Tomorrow. New Jersey Dept. of Environmental Protection, Trenton. (Page 21)

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Appelhof, Mary. "Worms Eat My Garbage." Kalamazoo, MI: Flowerfield Enterprises, 1982, "Worms Eat Our: Garbage." Kalamazoo, MI: Flowerfield Enterprises, 1993. Glossary, Pages 28 - 35

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Nelson, Cindy. "It's A Worm's World." The New Garden Journal, 1995, A Model of Integration (Page 4), "Worms" of Wisdom (scattered throughout publication)

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Panel of Reviewers

Holly Johnson, LTW Cooperative Extension, Waste Reduction and Management Specialist, University of Wisconsin, Stevens Point. 715-346-2792.

Jean Bonhotal, Extension Associate, Waste Management Institute, Cornell Center for the Environment, Cornell University, Ithaca, NY 607-255-8444

Nancy Troutman, Extension Associate, Cornell Center for the Environment, Cornell University, Ithaca, NY. 607-255-9943

Betty Tomasik, Concerned Citizen and Parent, East Berne, NY.

For More Information

If you want to know more about composting and ways to make good compost, consult books or gardening magazines at your local library - or call your county **Cornell Cooperative Extension** office, listed in the telephone directory.

Call or write to:

NYS Department of Environmental Conservation
Division of Solid & Hazardous Materials
Bureau of Waste Reduction & Recycling
625 Broadway
Albany, NY
12233-7253
(518) 402-8705

or email us at:
dshmwrr@gw.dec.state.ny.us

and check out our web page at:
www.dec.state.ny.us/website/dshm/redrecy/index.htm

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