That's Rubbish!

Examples of Possible Academic Science Standards to Incorporate:

1st Grade:

- HLE 14.1 describe different types of pollution and their environmental affects;
- HLE 14.2 identify the importance of "reduce, reuse, recycle" practices,
- HLE 14.3 identify ways the environment affects a person's emotional, social and physical health;
- 7.7.2 Sample areas of the school grounds to identify where different materials are found.
- 7.4.1 Observe, describe, and record the life cycle of a particular animal.
- 7.3.2 Describe what plants and animals need in order to grow and remain healthy.

2nd Grade:

- SPI 7.7.3 Identify and categorize items in the classroom made from renewable or nonrenewable resources.
- SPI 7.7.4 Identify simple methods for reusing the earth's resources.
- 7.2.2 Investigate ways that plants and animals depend on each other.
- 1.5.1 Distinguish between fact and opinion.
- HLE 14.1 describe different types of pollution and their environmental affects;
- HLE 14.2 identify the importance of "reduce, reuse, recycle" practices,
- HLE 14.3 identify ways the environment affects a person's emotional, social and physical health;
- 2.3.02 Recognize the interaction between human and physical systems around the world.
    - a. Analyze how individuals and populations depend upon land resources.
    - d. Understand the rudimentary elements to the hydrologic cycle.
    - e. List earth's natural resources such as minerals, air, water, and land.

3rd Grade:

- SPI 7.7.4 Determine methods for conserving natural resources.
- 7.T/E.1 Explain how different inventions and technologies impact people and other living organisms.
- 1.5.2 Distinguish between fact and opinion.
- 1.5.3 Compare and contrast two ideas.
- HLE 14.1 identify the causes and effects of different types of pollution on health;
- HLE 14.2 apply the practices of "reduce, reuse, and recycle";
- HLE 14.3 evaluate and select environmentally safe products;
- CU 7.7.4 Design and evaluate a method for reusing or recycling classroom materials.
- CU 7.5.4 Determine how changes in an environmental variable can affect plants and animals of an area.
- 3.3.02 Recognize the interaction between human and physical systems around the world.

- a. List the similarities and differences of local places and regions with other places and regions.
    - c. Understand the concept of an ecosystem.
    - e. Understand how technology allows people to adapt the environment to meet their needs.
- 3.6.01 Recognize the impact of individual and group decisions on citizens and communities.
    - a. Give examples of conflict, cooperation and interdependence among individuals, groups, and nations.
    - b. Examine the relationships and conflict between personal wants and needs and various global concerns, such as use of imported oil, land use, and environmental protection.
    - c. Give examples of economic, social, or political changes that result from individual or group decisions.

4th Grade:

- 7.T/E.1 Explain how different inventions and technologies impact people and other living organisms.
- SPI 7.7.2 Analyze how different earth materials are utilized to solve human problems or improve the quality of life.
- CU 7.7.4 Use data from a variety of informational texts to analyze and evaluate man's impact on non-renewable resources.
- CU 1.5.1 Distinguish between fact/opinion and cause/effect.
- SPI 1.5.1 Locate information to support opinions, predictions, and conclusions.
- 4.3.02 Recognize the interaction between human and physical systems around the world.
- HLE 14.1 identify the causes and effects of different types of pollution on health;
- HLE 14.2 apply the practices of "reduce, reuse, and recycle";
- HLE 14.3 evaluate and select environmentally safe products;
- 4.2.03 Understand fundamental economic concepts.
    - a. Explain and demonstrate the role of money in daily life.
    - b. Describe the relationship of price to supply and demand.
    - c. Use economic concepts such as supply, demand, and price to help explain events.

5th Grade:

- 7.T/E.1 Explain how different inventions and technologies impact people and other living organisms.
- SPI 7.2.3 Use information about the impact of human actions or natural disasters on the environment to support a simple hypothesis, make a prediction, or draw a conclusion.
- 1.5.1 Locate information to support opinions, predictions, and conclusions.
- SPI 1.5.3 Distinguish between fact/opinion and reality/fantasy.
- 1.5.6 Make inferences and draw appropriate conclusions from text.
- HLE 14.1 identify the causes and effects of different types of pollution on health;
- HLE 14.2 apply the practices of "reduce, reuse, and recycle";
- HLE 14.3 evaluate and select environmentally safe products;
- 5.2.03 Understand fundamental economic concepts.
    - a. Explain how supply and demand affects production and consumption
- 5.3.02 Recognize the interaction between human and physical systems around the world.
    - b. Explain human modifications of the physical environment.

6th Grade:

- HLE 14.1 identify major environmental health concerns that impact human health (e.g. air, water and noise pollution; negative social-emotional environment);

- HLE 14.2 demonstrate ways to reduce, reuse, and recycle solid waste;
- HLE 14.3 evaluate and critique products and their effects on the environment;
- HLE 14.4 demonstrate understanding of ways to promote a healthful environment;
- 6.2.02 Discuss economic connections, conflicts, and interdependence.
  - d. Appraise the relationship among scarcity of resources, economic development, and international conflict.

7th Grade:

- T/E.1 Explore how technology responds to social, political, and economic needs.
- CU 7.7.8 Determine the impact of man’s use of renewable and nonrenewable resources on future supplies.
- CU 7.7.9 Evaluate how human activities affect the condition of the earth’s land, water, and atmosphere.
- SPI 7.7.7 Analyze and evaluate the impact of man’s use of earth’s land, water, and atmospheric resources.
- Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- 7.2.01 Understand fundamental economic concepts and their application to a variety of economic systems.
- 7.2.02 Understand global economic connections, conflicts, and interdependence.
  - a. Recognize that resources, goods, and services are exchanged worldwide.
  - b. Explain the interactions between domestic and global economic systems.
  - c. Explain the economic impact of improved communication and transportation.
  - d. Appraise the relationship among scarcity of resources, economic development, and international conflict.
  - f. Apply economic concepts to evaluate contemporary [and future] developments.
- 7.3.08 Understand how human activities impact and modify the physical environment.
  - a. Describe effects of human modification on the physical environment including global warming, deforestation, desertification, and urbanization.
  - b. Explain the ways in which human induced changes in the physical environment in one place can cause changes in other places.
  - c. Analyze the environmental consequences of humans changing the physical environment.
- 7.3.09 Understand the nature, distribution and migration of human populations on Earth's surfaces.
  - d. Analyze contemporary population issues.
  - e. Predict the consequences of population changes on the Earth's physical and cultural environments.
- 7.4.02 Understand how cooperation and conflict among people influence the division and control of resources, rights, and privileges.
  - a. Identify international and multinational organizations of cooperation.
  - b. Describe the current struggles over energy resources and how different governments resolve these problems.
  - c. Describe conditions and motivations that contribute to conflict, cooperation, and interdependence among groups, societies, and nations.
  - e. Describe ideas and mechanisms governments develop to meet needs and wants of citizens, regulate territory, manage conflict, and establish order and security.

8th Grade +:

- SPI 0.2.2 Interpret the relationship between environmental factors and fluctuations in population size.

- SPI 0.2.4 Predict how various types of human activities affect the environment.
- SPI 0.4.3 Investigate the impact of the green revolution on world food production and on the environment.
- CU 0.4.1 Differentiate between renewable and nonrenewable resources.
- CU 0.3.5 Use the concept of the ecological footprint to predict the ecological consequences of human population growth.
- CU 0.3.4 Understand the search for a balance between effective usage of land and other natural resources and environment concerns.
- 8.2.02 Understand global economic connections, conflicts, and interdependence.
  - b. Apply economic concepts to evaluate historic, contemporary, and future developments.
  - c. Explain the economic impact of improved communication and transportation on the world economy.
  - d. Analyze the impact of national and international markets and events on the production of goods and services.

Examples of Possible Academic Vocabulary to Incorporate:

For the Academic Vocabulary we encourage you to use as many of these words as possible, not simply pick one or two. The following are a sampling of ones that may apply. The more words we can introduce in a setting that makes sense to our students, the better.

1st Grade:

- Balance
- Classify
- Environment
- Equality
- Future
- History
- Information
- Invent
- Investigate
- Living/Non-Living
- Life cycle
- Location
- Matter
- Mixed
- Past
- Planet
- Prediction
- Present
- Property
- Property
- Responsibilities
- Rights
- Technology

2nd Grade:

- Compare/Contrast
- Conflict
- Consumer
- Decision
- Depend
- Discussion
- Distance
- Duty
- Earth Resource
- Economy
- Edit
- Energy
- Equivalent
- Events
- Goods
- Government
- Growth
- Habitat
- History
- Infer
- Investigate
- Natural Resources
- Observation
- Producer
- Reasoning
- Renewable/Non-Renewable
- Rural
- Scientific Inquiry
- Scientist
- Similarities/Differences
- Symbol
- Type

3rd Grade:

- Borders
- Cause
- Conservation
- Cross Section
- Distribution
- Economy

- Effect
- Exports
- Force
- Geography
- Global
- Imports
- Summarize
- Tools
- Industry
- Landforms
- Manufacturing
- Natural Resources
- Opinion
- Population
- Primary Source
- Product
- Rural
- Scarcity

4th Grade:

- Compare
- Contrast
- Ecosystem
- Expansion
- Exploration
- Mass
- Political
- Population
- Range
- Supply and Demand
- Weathering

5th Grade:

- Credit
- Debt
- Gravity
- Implied
- Main Ideas
- Bias
- Historian
- Surface Area

6th Grade:

- Middle Ages
- Bias
- Cause And Effect
- Control
- Criteria
- Globalization
- Interdependence (economic)
- Plague
- Scavengers
- Relevant
- Relevancy
- Sample
- Simulation
- Technological
- Variable

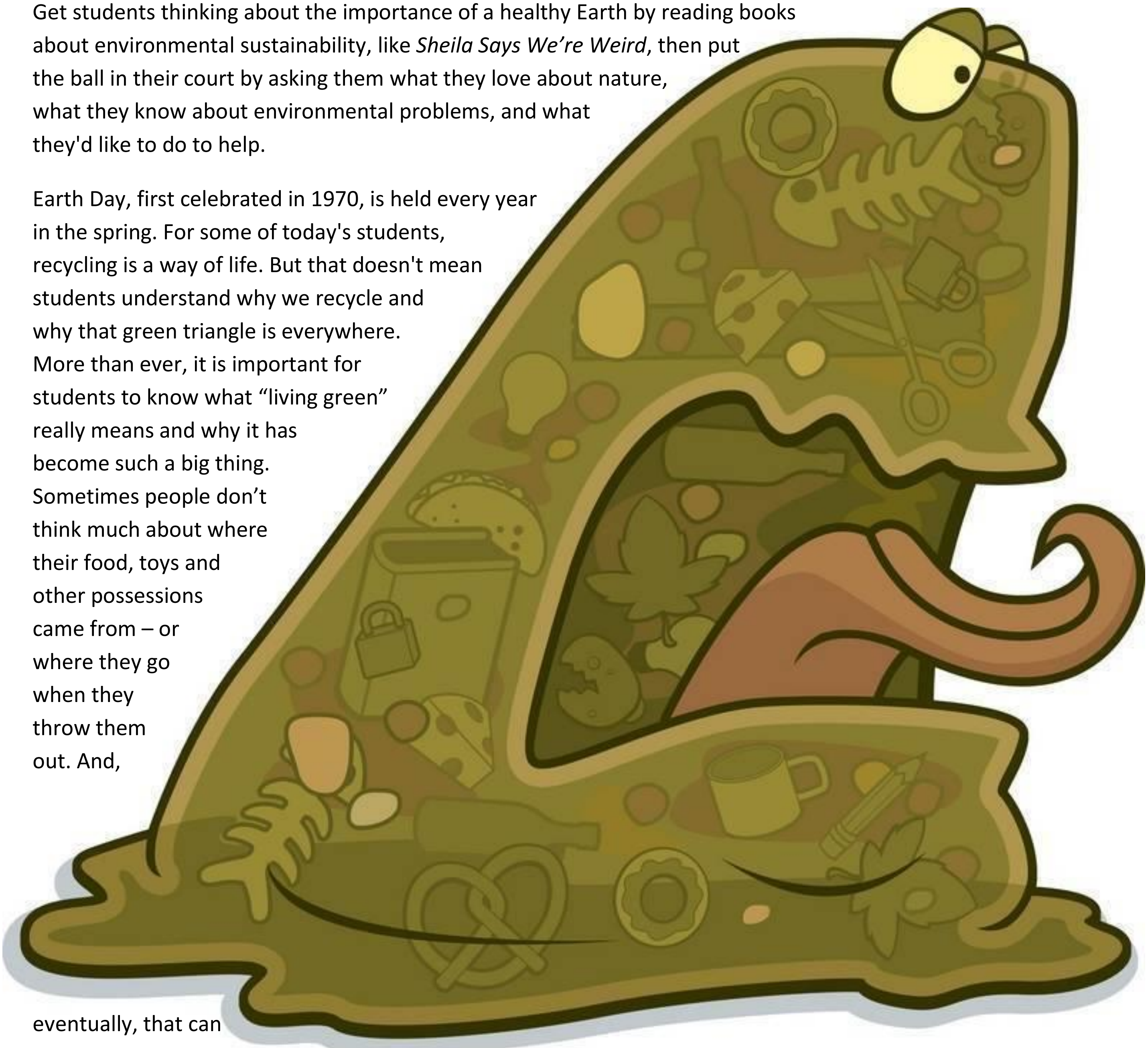
7th Grade:

- Acceleration
- Function
- Impact
- Minerals
- Phenomenon
- Physical Processes

8th Grade:

- Bias
- Commerce
- Consumption
- Contract
- Debate
- Density
- Element
- Exchange
- Human Impact
- Interdependence
- International
- Jargon
- Product
- Variation
- Vernacular

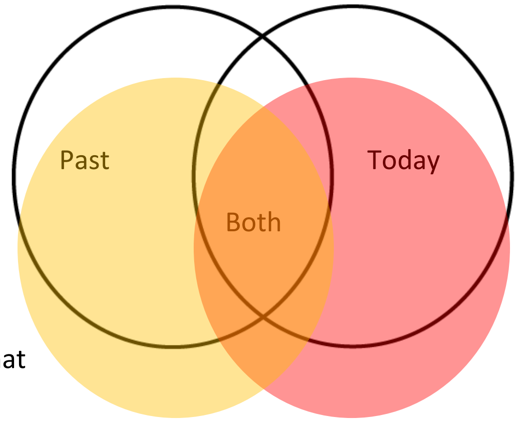
That's Rubbish!



Get students thinking about the importance of a healthy Earth by reading books about environmental sustainability, like *Sheila Says We're Weird*, then put the ball in their court by asking them what they love about nature, what they know about environmental problems, and what they'd like to do to help.

Earth Day, first celebrated in 1970, is held every year in the spring. For some of today's students, recycling is a way of life. But that doesn't mean students understand why we recycle and why that green triangle is everywhere. More than ever, it is important for students to know what "living green" really means and why it has become such a big thing. Sometimes people don't think much about where their food, toys and other possessions came from – or where they go when they throw them out. And, eventually, that can become a very BIG problem...

Venn Here Yesterday, Today, and Tomorrow



Access student's prior knowledge by having them work as a group, in small groups, or individually, to create a graphic organizer/Venn diagram about differences they see between today and 100-200 years ago. Explore what they know. What do we have that they didn't in the past? What did they have that we don't? What things do we have in common? What about in relation to trash?

Trash in the Past

Long, long ago there was no rubbish on Earth. Gradually, plants and animals developed and created their own natural waste. Dead leaves, animal droppings, harmless things that broke into little pieces and became part of the soil. No big deal. Then came humans. At first they were always on the move and all they left behind were ash, poo, bones, and rotten fruit. Not very much impact. When humans decided to settle down and become farmers they used their rubbish. Leftover food got fed to the animals, poo makes great fertilizer, dried animal skins were used as clothes, stones and sticks make handy tools and clay and dirt made jugs and bowls. Everything [because it took so much work to make] was treasured and looked after and used over and over again. Only when something was completely beyond repair was it thrown away.

Then towns popped up around the world and lots of people in one place means lots of rubbish. Dry rubbish was burned at home but there wasn't an easy way to deal with the sludgy waste like rotting food and too much poo. So food and toilet waste literally piled up in the streets and smelled horrible, pulling in rats and creating disease, but people kept moving to towns, helping them and the piles of waste grow and grow. Traders came and set up businesses and dumped their rubbish in the street. Names of streets were given according to what was on them and one in London was named "Stinking Lane" because of the horrible stench of rotting meat left in the streets by the butchers.

Image Credit: Recycling by Mike Moran, Copyright 2011 by Mike Moran http://illobook.com/mikemoran/files/2011/02/caveman4.jpg. "Illustration was done for the fine Scout Leaders at Boys Life Magazine. " All Rights Reserved.

People threw toilet waste out of windows on the street, and splattering people below. Polite men let women walk on the side closer to the street, so they would be less likely to be splashed by falling…waste.

Rats and rubbish mean trouble and diseases spread, like the Black Death and cholera, millions have died because humans couldn't find the best way to deal with garbage. The numbers of people have grown and so has our rubbish. We may not throw it out of windows, but we still throw a lot out the door.

Trashy Today

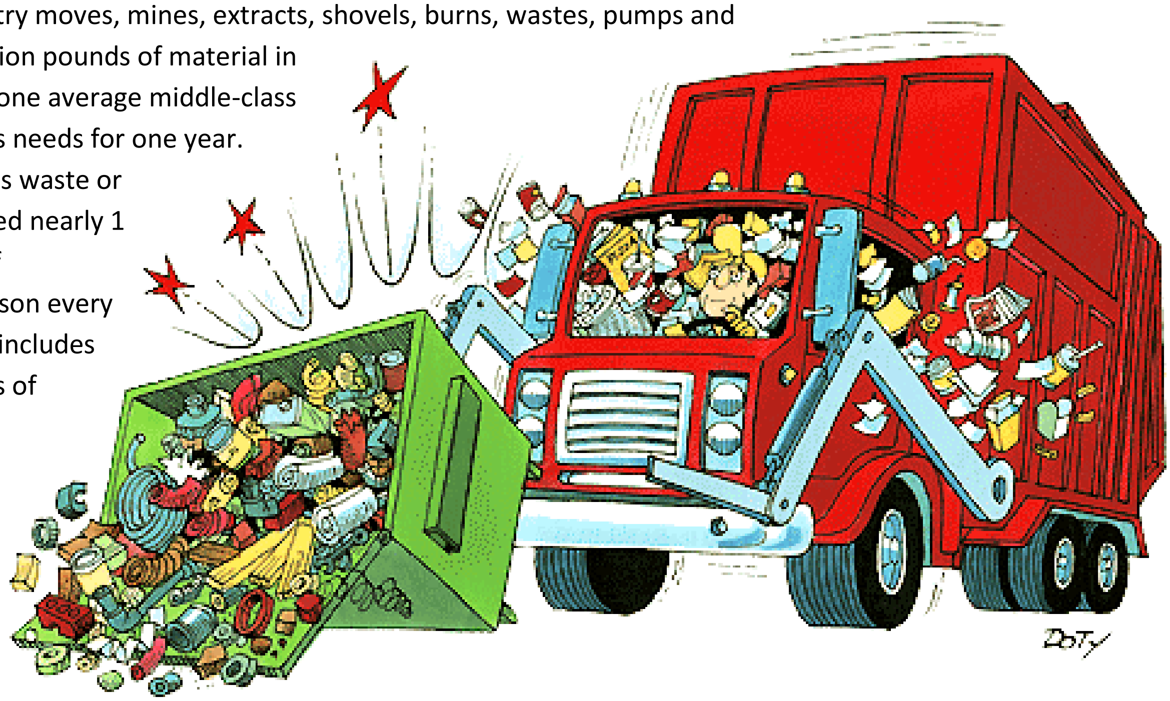
Let's take a look at waste, in America.

Ask students the following questions:

- What is litter?
- What do students think gets thrown away?
- What do they throw away every day?
- Do they have to take the garbage out?
- How much do they take out every day?
- Have students estimate how much trash the class uses.
- What is garbage
- Where have you seen litter around the school or near where you live?
- What types of litter do you find outside? List possibilities. Suggestions might include newspaper, food wrappings, soda cans, bottles, plastic straws, cigarette butts, etc.
- What types of materials is this litter made of? List possibilities. Suggestions might include plastic, paper, cardboard, newsprint, rubber and metal, etc.

Americans represent 5% of the world's population, but generate 30% of the world's garbage.

In the U.S., industry moves, mines, extracts, shovels, burns, wastes, pumps and disposes of 4 million pounds of material in order to provide one average middle-class American family's needs for one year. In sum, Americans waste or cause to be wasted nearly 1 million pounds of materials per person every year. This figure includes 3.5 billion pounds of carpet, 19 billion pounds of polystyrene [packing] peanuts from everything we ship [and want to keep safe], 28 billion pounds of food thrown out that no one is eating but rats and bugs, 360 billion pounds of chemicals used for making things, 710 billion pounds of hazardous [dangerous] waste and 3.7 trillion pounds of construction materials. If wastewater is added in, the total annual flow of waste in the American Industrial system is 250 trillion pounds. Less than 2% of the total waste stream in the United States is recycled [have students calculate 2% of 250,000,000,000,000 lbs]. For every person in the world to live like an American we would need two more Earths; three more if the Earth's population should double and twelve Earth's altogether if worldwide standards of living doubled in the next forty years.



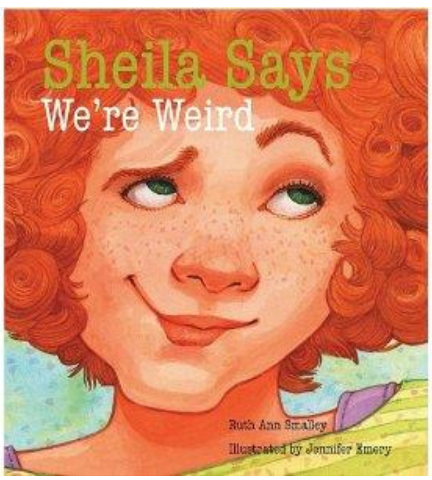
To put it another way…

Americans throw away enough garbage every single day to fill 63,000 garbage trucks, which if lined up end to end for an entire year would stretch half way to the moon. In a lifetime, the average American will personally throw away in the garbage can 600 times his or her body weight, which for an average adult would leave a legacy of 90,000 pounds of trash at the end of their lifetime. Of the garbage Americans throw out, half could be recycled, which is enough to fill a football stadium from top to bottom every day. Of these recyclables, Americans throw away enough aluminum to rebuild the entire commercial air fleet [every plane we all use to

fly on] every three months, enough steel to rebuild a city as big as Nashville all over again, and enough wood to heat 5 million homes for 200 years. We all talk about saving money, U.S. waste disposal costs exceed $100 billion annually [every year].

And that's only one country. The world is facing an ever-increasing garbage problem, one aspect of which is the amount of solid waste we produce is always growing. When improperly handled it poses a threat to our environment. But there are solutions to this problem if everyone participates. What exactly is "waste?" Waste is anything we throw away or get rid of, that doesn't get used. Most people throw away about 6lbs of garbage a day. Americans as a whole produce 200 million tons every single year. That is a lot of garbage—more than 1,000 fully-loaded airplanes!

The best way to protect the Earth and its people is to stop creating pollution in the first place –that realization became America's official policy in 1990 with the Federal Pollution Prevention Act's, declaration that, "Pollution should be prevented or reduced at its source, whenever possible." But, no matter how well-intentioned our laws, solutions to the garbage problem can only work with a combination of efforts. No single measure, law, or method will be enough to solve the problem.



The state of the natural environment impacts everything. In order to live a healthy life, and to provide a healthy life for future generations, we need a healthy environment. Even the simplest choices that we make from day to day can have a lasting impact.

It's sort of natural to label something or someone you are unfamiliar with as "weird." But, often, with time, you figure out that what you thought was weird is actually pretty cool. You may wish to introduce the topic with a book about "green living" like, *Sheila Says We're Weird* by Ruth Ann Smalley. Place the book you have selected for read aloud on the ledge of the chalkboard or in front of the students and have the students look at the picture and title on the cover and use their schema to make predictions about the story [model this procedure for your students]. They can write a word or a complete thought. After they have settled in for read aloud discuss what is written and make predictions as a group about the story.

Trash Bash! Litter Bug Hunt

Ask students the following questions:

- What is litter?
- Where have you seen litter around the school or near where you live?
- What types of litter do you find outside? List possibilities. Suggestions might include newspaper, food wrappings, soda cans, bottles, plastic straws, cigarette butts, etc.
- What types of materials is this litter made of? List possibilities. Suggestions might include plastic, paper, cardboard, newsprint, rubber and metal, etc.

Have students search for commonly “dropped” items such as, bottle caps, plastic bottles, chip bags, paper, wrappers, plastic grocery bags, etc.
Have students play individually or group them into small teams and give each child a glove and each team/child a bag for collecting.
Each category of trash has a different value according to its damage level (highest points being the worst, lowest points being the most “earth friendly”) and the team with the most points wins the Trash Bash.

- 5 points per piece of plastic
- 4 points for aluminum cans and metal
- 3 points for wrappers (ex. candy bar, chip bags)
- 2 points for paper
- 25 point bonus for the group with the most pieces of litter

When they have finished collecting (within the specified time) have each group spread out newspapers and sort their collection into categories. If you wish have the students choose their own category titles (such as Paper, Metal, Plastic, etc.) Have groups count up the total # of pieces of litter that was found and count the items in each category. Which category had the most items?

Discuss the problem of "what to do with our trash." Ask them what they think should be done with all of the trash/litter they found. Listen to all of their ideas and consider each suggestion. Help them to understand the larger problem. Should it all go to the same place?

If a student suggests putting it in a trash can or a larger can, talk about what will happen if the can or a second can is full. How many cans of trash can the classroom hold? Will the trash begin to smell bad or attract insects?

If a student suggests taking the full cans outside for the garbage collectors to pick up (some children may know that local garbage is picked up by a garbage truck), talk about where the garbage truck takes the garbage. Ask if anyone has been to a landfill and ask them to describe it. Have the children imagine a large hole in which everyone's garbage is dumped. Show them the landfill picture.

Consider what would happen if the landfill became full and had to be closed. Explain that landfills are getting too full just like our trash cans can.

Ask your students if anyone knows what the word "recycle" means. Does it sound like any other words they know?.

To recycle means to collect and remake an item into the same thing or something else. For example, old newspapers can be used to make new newspapers; old glass jars can be used to make new glass jars; metal cans can be made into new metal cans; and some plastic bottles can be made into new plastic things.

A Wonderfully Rotten Core

Nature recycles things too. When nature can recycle something it is called "biodegradable." What would happen if we could turn some of that garbage we make into rich soil that grew nice juicy fruits and vegetables? We can, and it is possible.

Decomposition occurs everywhere. If everything existed forever, we would be buried in our waste. Our waste products are varied: some are made of easily degradable materials while others will last for thousands of years. Biodegradable means t hat the earth can recycle that thing all on its own.

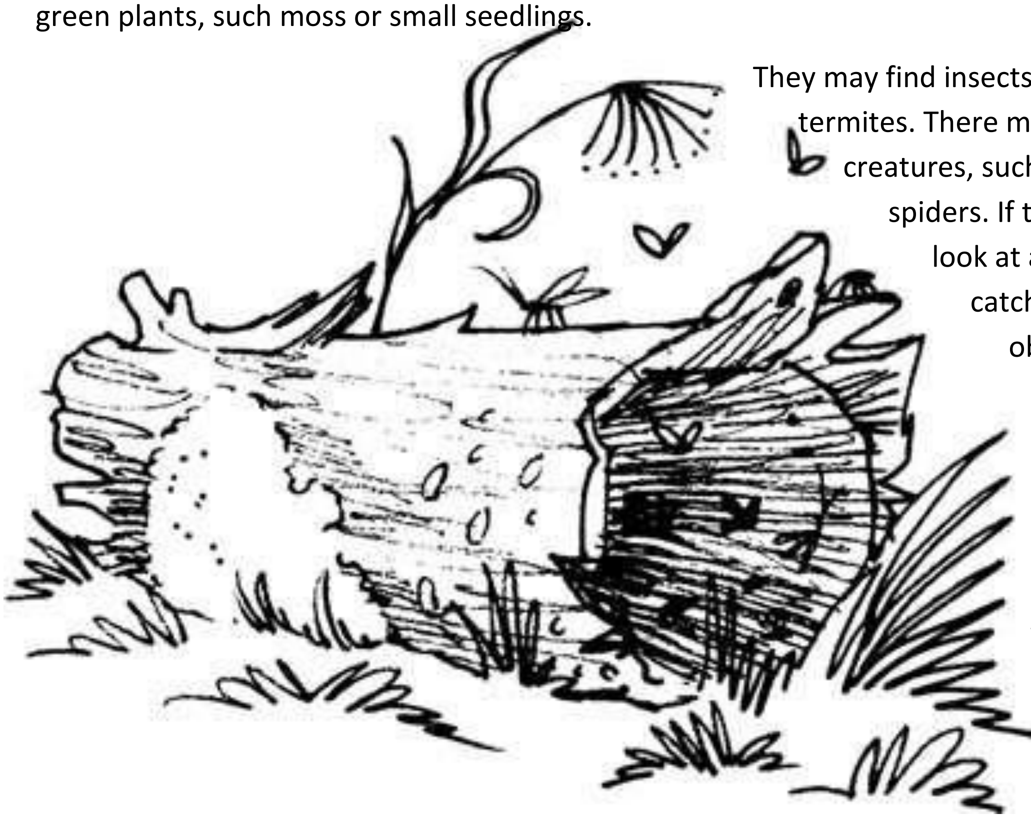
Looking for Rot in all the Right Places

If there is a wooded area nearby take the class to a place where there is a rotting log or tree stump. When you find a soft, decaying log, spend time discovering the organisms that live there.

Materials:

- Medical gloves (optional)
- Magnifying glasses
- Small clear plastic jars
- Notebooks
- Pencil or pen per student

Have students put on gloves and get down on their hands and knees. Using their magnifying glass for a better look at the surface, have students look to see what lives there. They may find green plants, such moss or small seedlings.



They may find insects, such as beetles or termites. There may be other small creatures, such as wood lice and spiders. If they want a closer look at a small creature, catch it in the jar and observe it. (Have students let it go when they are done.)

Have them record their discoveries in their notebook. If they don't know the name of something they've found, they can draw its picture. If the wood is soft, break off a piece to see what kinds of creatures live inside. Termites, ants, and wood-boring beetles often live in logs. The nutrients that made up the tree's tissue are being returned to the soil for other plants to use. Lots of organisms here are associated with decay, such as millipedes that eat dead plant material, insects that also feed on the dead wood, and earthworms. Ask students to describe what they see, and then ask what they think will happen as time continues. Let them gently poke at the log with sticks to get a better idea of what is happening beneath the visible surfaces. If the log is well rotted, they should notice that it is becoming more soil-like and less wood-like in composition. They should also see several insects or other invertebrates living within the rotting log, and many strands of thread-like fungus. Both the invertebrates and fungus are important decomposer organisms.

Replace the wood when they are done. Record what they find in their notebook. Now turn the log over and see what lives underneath. The wood may be so rotten that it resembles soil. This is nature's way of recycling.

Biodegradable materials are those that can break down from larger molecules to smaller ones, much like in the process of rotting. Usually bacteria, worms, fungus, and other organisms (living things) like little tiny microorganisms in the earth (which are so small that you can't see them) are what break apart these molecules and turn them into soil. It looks like the thing disappears, but it just becomes part of the dirt.

Biodegradables are good because they are able to turn back into things like soil and help make the earth healthy. Through decomposition, minerals and nutrients, once useful to their plant or animal hosts, are released and recycled to help another plant or animal.

Making "biodegradable" work for us.

Nature's waste and remains don't just pile up. They decompose. Humans have capitalized on the work and abundance of decomposers for centuries, if not millennia. Why do we need to understand how this works? Well, one example is that engineers

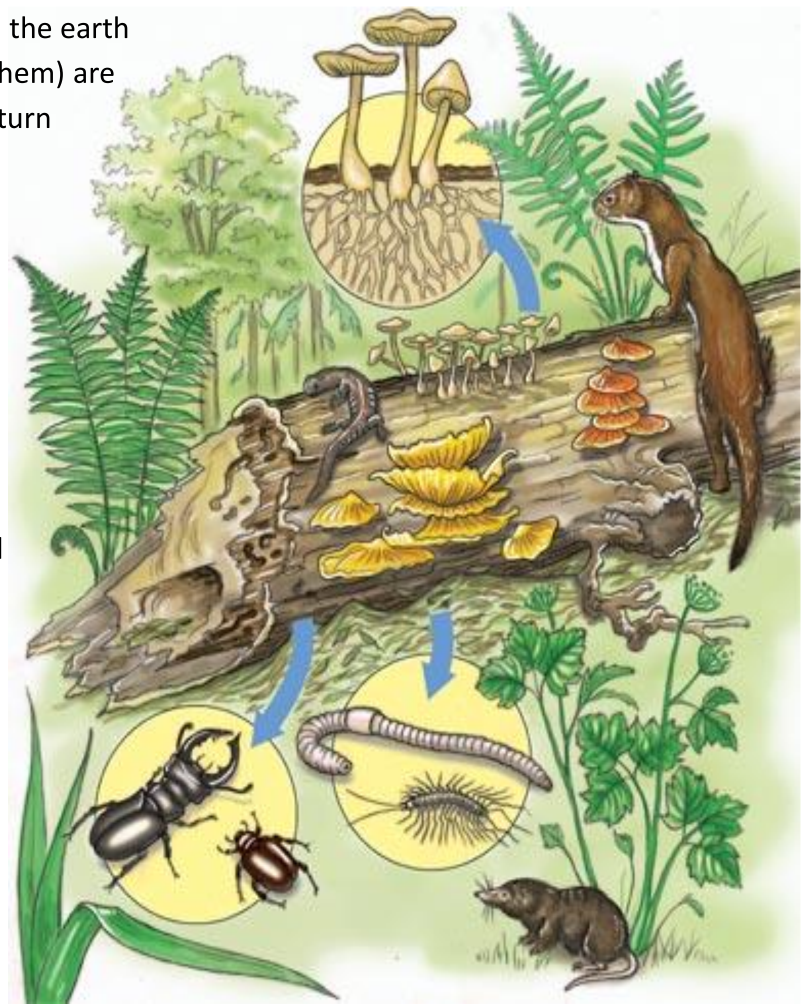


Image Credit: http://www.science-art.com/gallery/52/52_9232008101348.jpg.

must understand what causes vegetables to decompose in order to develop methods for transporting and preserving them from the field to the grocery store. Also, farmers spread manure on their fields to fertilize them, and suburban gardeners use composted grass clippings to enrich their flowerbeds and vegetable patches.

Nature's recyclers—scavengers, fungi, and bacteria—feed on dead organisms and waste. They carry out the process of decomposition. We use the term "nutrient cycle" to encompass the recycling of elements essential to life. Nutrients are substances, like vitamins and minerals, which all living things need for healthy growth and life. Plants get their nutrients from the air, water, and soil. The nutrients they get are called inorganic nutrients. Animals, fungi, and bacteria get their nutrients from food. The nutrients they get are called organic nutrients.

All living things need nutrients, but only a limited amount of nutrients can be found on Earth. If organisms used every nutrient only once, then Earth would run out of nutrients. Then no more plants and animals could live. But the nutrients on Earth can be used over and over again. They move between living things and the physical environment. They change from organic forms to inorganic forms, and then back again. Nutrients are recycled.

All of the nutrients essential to life are available in limited amounts on Earth. Organisms take up these nutrients from the atmosphere, soil, or water, and release them back again in ongoing cycles. Nutrients continue to exist even when they change from one form to another. They don't get lost when they are passed from one link to another in a food chain. Nutrients are simply passed from one organism to the next, constantly being reused in different combinations. . It begins with plants. Plants take up inorganic nutrients and change them into organic nutrients. Plants get nutrients from the air, water, and soil. They trap light energy from the sun to help them make their own food.

FYI: Biodegradable Barbie

Have you ever played with a Barbie? Well, now Barbie is biodegradable, too. Her manufacturer, Mattel, decided in 1999 to switch how they made the plastic for Barbie's body. Now instead of using a petroleum (oil) based plastic called polyvinyl chloride (PVC), they use oils made from plants and vegetables. This means that if you buried Barbie, in a long, long time, she would become soil—because she is biodegradable.

Did you know that there are many new inventions made from biodegradable things? Now some plastics and CDs are made from corn. We said before in our definition that things made from food are biodegradable, so these inventions are interesting to many people because they are made from food and can biodegrade. What would you want to invent that could be biodegradable? What supplies would you use?

Plants are called producers, because they produce their own food. Animals are called consumers. Animals get their nutrients and energy from the plants (and other animals) they eat, or consume.

The nutrients in grass pass to the bison that eats it. The nutrients in a bison pass to the wolf that eats it. The nutrients become parts of their bodies.

Plants and animals produce waste, and they die. Even then, the nutrients in their bodies don't disappear. Nature's recyclers break down their organic remains. Decomposers are incredibly important. Decomposers are the organisms that work to bring nutrients from the living environment (animals) into the physical environment (soil). Both the air and the soil contain bacteria and fungi that feed on dead tissues. This is not surprising, because the bacteria and fungi are essential to preserving life on earth. One of their main jobs is to decompose dead or discarded biological materials, breaking them down into simple chemicals that can be used as plant nutrients.

Fungi and bacteria use some of the organic nutrients for their own bodies. They leave the rest as inorganic nutrients in the soil or water. Then plants take in the inorganic nutrients. The nutrients get passed to consumers, and back again to nature's recyclers. This is how nutrients get recycled.

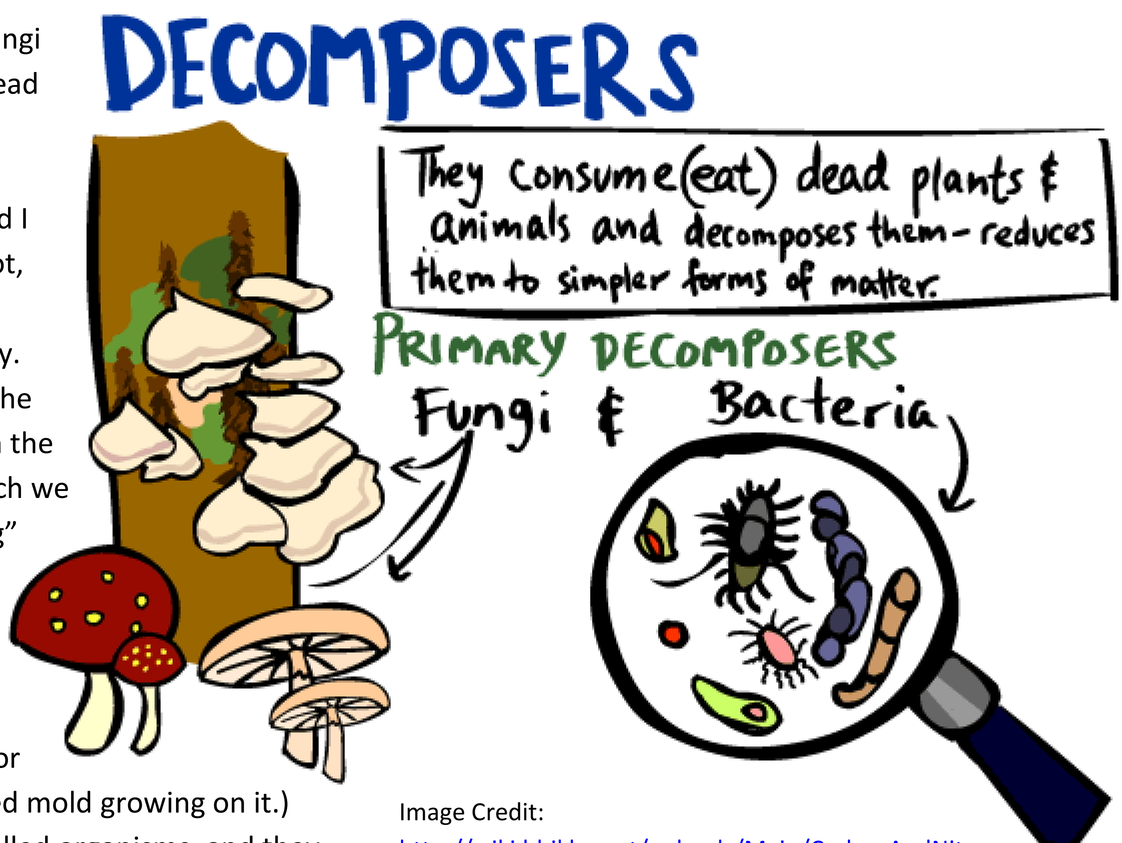


Image Credit: http://wiki.bhikku.net/uploads/Main/CarbonAndNitrogenCycles/decomposers.gif.

The bacteria and fungi don't exactly eat dead plants or animals, chewing them into chunks, like you and I would chew a carrot, but they do digest them, at least partly. Both bacteria and the fungi get food from the dead material, which we describe as "rotting" once they have gone to work on it. (That's when the material gets slimy, smelly, and/or has fuzzy stuff called mold growing on it.) Bacteria are one-celled organisms, and they can produce special proteins, called enzymes, that will come into contact with the dead materials and break them down into liquids. Then the bacteria take the liquid back into themselves as a source of food. The fungi do basically the same thing, although some of the details are a little different.

What is especially useful, though, is that while the bacteria and fungi are getting their nutrition, some of the [chemical] parts of the rotting material are left behind in the soil. The parts left behind contain minerals that living plants can use to help them grow. So the decomposers are important ecologically [for the environment] because they cause natural recycling to occur. The minerals that were once in a living plant or animal get returned to the soil by decomposers when the plant or animal dies.

There are many factors that can affect the decomposition process. Like most living things, the decomposers usually do best when they have good supplies of air and moisture, and without both of these they can't very well break down our trash and garbage. So no matter how biodegradable it is, trash and garbage that gets taken to a landfill is quickly buried deep underground, away from air and moisture. As a result, if your students grandchildren were to go digging in your local landfill fifty years from now, they would be able to read the backs of the cereal boxes you ate from today!

Biodegradable Matters

The goal for this activity is to give the kids hands-on experience deciding what is biodegradable (and therefore, compostable) and what can and can't be recycled.

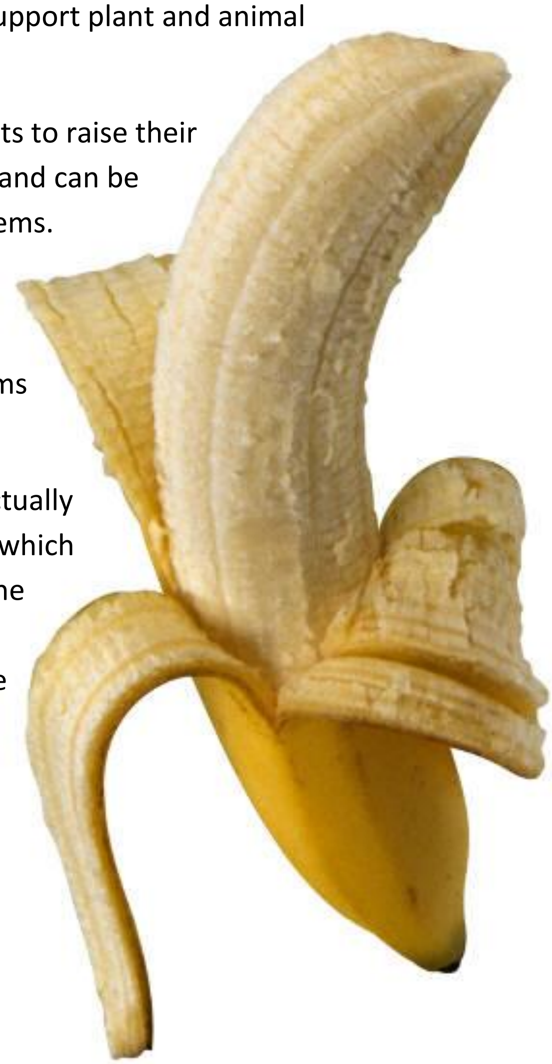
You'll want to have on hand different examples of "trash" or the stuff we throw away such as plastic soda bottles, aluminum foil, paper, grass clippings, food waste, leaves, clothing (100% cotton is compostable), and glass bottles. The ideal situation is to have each student bring in something that they've actually thrown away. However, the teacher may want to have additional items on hand to ensure there are enough examples for each category.

Materials:

- Biodegradable items that might normally be thrown away such as paper towels, paper cups, empty toilet paper rolls, cereals boxes (without the plastic insert), leftover food, leaves, grass clippings, etc.
- Non-biodegradable items that are normally thrown away such as aluminum cans, plastic soda bottles, and glass.
- Blackboard and chalk or a large piece of butcher-type paper and markers.

Using a blackboard or large sheet of paper, ask the students to name things that get thrown away daily at home and at school. Some time should be taken to let the students brainstorm. The teacher should list these suggestions on the blackboard so the they can see how surprisingly long the list becomes.

It should be explained to the class that materials made from things that once lived (plants and animals), are biodegradable. Talk about the natural cycle of death, and decay (decomposition). To expand on this, rebirth can be discussed as the decomposed materials that have become compost support plant and animal life.



The teacher can ask students to raise their hand if they see anything on the list that's biodegradable and can be added to a compost pile. Have one student circle those items.

Choose a different student go over to the table and remove all the compostable items. Although there's a written list on the board, the physical presence of the items hit home for kids more than just the words on the board.

Have a student circle the items on the board that don't actually decompose but can be recycled such as glass and plastic, which we'll discuss more later. Then remove those items from the garbage table. Now have everyone look at what's left on the table and written on the board. Ask students if they're surprised at how little is left there to actually "throw away". Did any of the compostable items surprise them (like the clothing)? Are the students using more biodegradable or non-biodegradable items daily?

Rot This! It's So Appealing

Teaching kids the difference between biodegradable and non-biodegradable materials is the first step to helping them understand reduce, reuse, recycle, and compost. Biodegradable trash can decompose with the help of a few natural elements bacteria, water, light, and air. How will each affect your lunch leftovers?

Divide the class into working groups of four. After your class discussion, each group should be able to come up with an idea for an experiment. The experiments are intended to identify physical characteristics of either the soil or the environment that can affect the decomposition rate of a banana peel. Examples of questions include, but are not limited to:

- How does temperature affect decomposition?
- Will wet soil cause faster decomposition than dry soil?
- Would the banana peel decompose faster in soil from the woods than it will in sandy soil from the playground?
- Does acid rain make decomposition occur faster?

These are only examples, however. Be sure to allow students enough time (at least ten minutes) to generate their own questions. If they need help you can ask leading questions such as, "Do you think an apple core tossed on the ground in northern Alaska will decompose at the same rate as one tossed on the ground in an Amazonian rainforest?"; or, "Do you think one left in the mud in the hot and wet Okeefenokee swamp will decompose faster or slower than one in the sand of the hot and dry Sahara desert?". Follow up these questions by asking for the reasoning behind their answers. Students should be able to make connections [and determine cause and effect relationships] such as the fact that we keep perishable foods in the refrigerator to prevent rotting, and that swampy places actually smell like they do because they contain rotting vegetation.

Testing the theory: The Banana Experiment

1. Have students divide the banana peels into 5 strips about the same size. Place each in a baggie and label them 1, 2, 3, 4, and 5.

Baggie 1 is the control, the standard for comparison in this experiment. Students will compare the other bags to this one. Have them squeeze out most of the air and seal the bag.

2. Students will add 237 ml (1 cup) dirt to baggie and squeeze the air out and seal the baggie.

3. Next they will Add 118 ml (1/2 cup) water to baggie 3 and carefully squeeze out the air and seal the baggie.

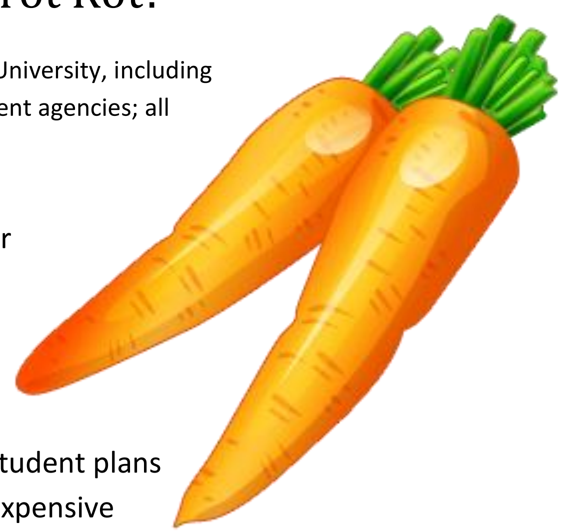
4. Then they will poke holes in baggie 4 with a sharp pencil. Leave it open.

5. With baggie 5, just squeeze out the air and seal it. This bag will be used to test the effect of light on the peel.

6. Students will place the first four bags in a dark place and place baggie 5 on a sunny windowsill.

7. Over the next week, have students observe the banana peels and record their observations.

The Carrot Variable: How Fast Can a Carrot Rot?



Materials:

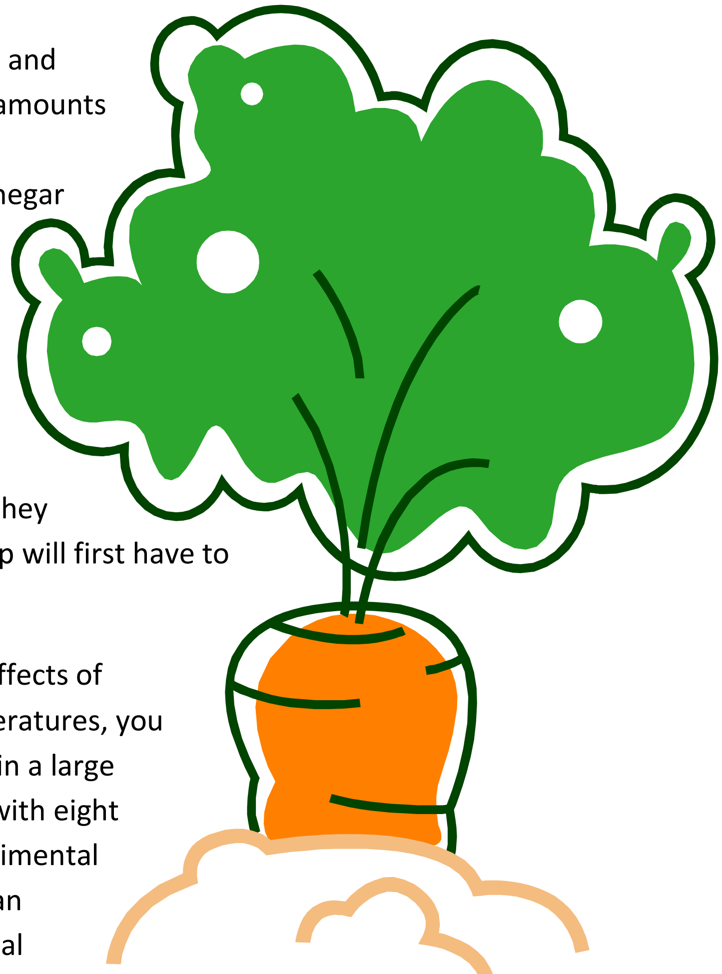
- several triple-beam balances accurate to at least 0.1g (or electronic balances)
- 2 one-pint plastic bags with zipper closures per student
- several permanent markers (for labeling the plastic bags)
- 8-20 pounds, more or less depending on class size and student plans for experiments, of good quality potting soil (the most expensive you can afford)
- several garden trowels, large spoons, or plastic cups for digging and scooping soil
- 10-12 large carrots, cut into pieces about 3-4 cm long and 2-3 cm in diameter
- inexpensive watercolor paintbrushes, one or two per group, for brushing dirt from the carrots prior to weighing

Depending on what questions the student groups decide to test, you may also need:

- other types of soil (e.g., soils with high clay or sand contents, topsoil from a nearby woods, garden, or inconspicuous area of lawn, etc.)
- refrigerator space
- incubator space (A makeshift incubator can be made from a large cardboard box, such as one that computer components are shipped in, which has been lined with aluminum

foil. A 25-Watt light bulb screwed into a base obtained for a few dollars at a hardware store serves as the heat source, or a very small desk lamp can be used. For safety reasons, it would be best to only use the incubator during the school hours, unplugging it overnight or running it off a timer. Monitor the temperature and try to maintain it at about 40 C or 100 F; you can open the box flaps slightly if the temperature gets too hot, or use a higher voltage light bulb if it is too cool.

- several thermometers
- several small beakers, graduated cylinders, and bowls for mixing soil, or adding measured amounts of water or other substances
- safe, acidic liquid such as lemon juice or vinegar



Have students design a simple experiment to test the effects of different environmental conditions on the decomposition of a carrot. By giving every student two plastic bags to use as the decomposition chambers, they will each have one experimental chamber and one control chamber. By working in a group of four students, they will have four trials for their experiment. The group will first have to agree on one question to test.

Temperature: If students want to test for the effects of temperature, including both warm and cold temperatures, you may need to combine two groups in order to obtain a large enough sample size for each condition. This way, with eight students participating, four could keep their experimental carrots in a refrigerator, four could keep theirs in an incubator, and all could compare their experimental carrots to their control carrots left at room temperature.

Moisture: If students want to test for different moisture levels, by combining two groups students could compare normally-moist potting soil, wet potting soil, and potting soil that has been dried out.

Each team should prepare a written proposal that answers the following seven questions:

1. What is the question you are asking?

2. How will you try to answer it?

3. How many trials will you do?

4. How will you record your data?

5. How will you report your results quantitatively?

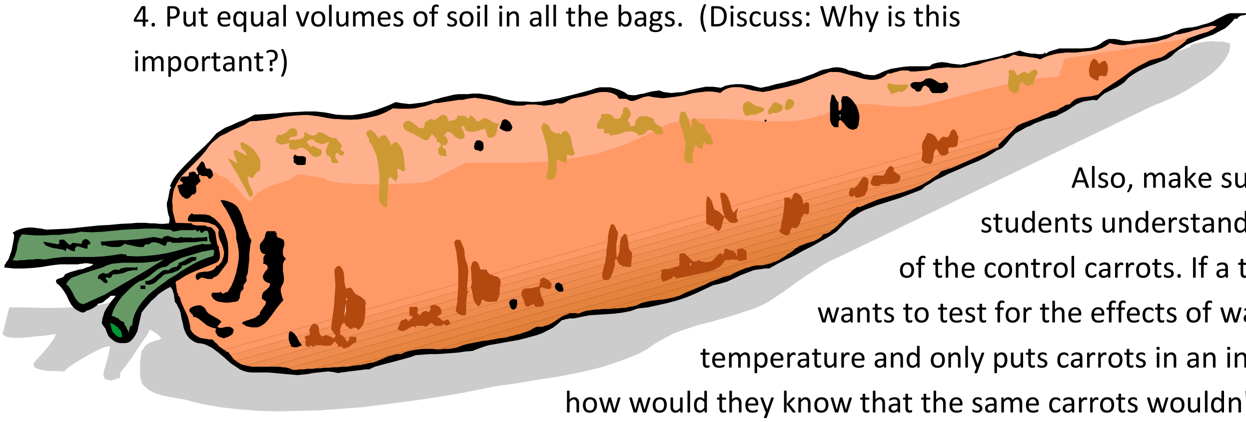
6. What will be your controls?

7. What is your hypothesis?

If they have trouble with number 5, Point out that in science, observations need to be quantified: it's not enough to say that the carrot got smaller each day, but instead, they need to be able to say exactly how much smaller. Thus, they can use balances or scales to find the masses of the carrots each day, and report their results in both a table of data and a graph that shows how much the carrot weighed each time it was checked. Older students (ex. 7^{th} and 8^{th} graders) can prepare scatter graphs that show how the mass of the carrots changed over the time of the experiment. Since the mass changed as a result of the decomposition that occurred over time, mass is the dependent variable and thus belongs on the y-axis. Time is the independent variable (time passes no matter what - it's independent of everything except the motion of the earth) and thus belongs on the x-axis.

The following suggestions should be given to help them design their experiment:

1. Use a chunk of carrot that is about 2 cm wide and about 3-4 cm long.
2. Put only one carrot chunk in each bag of soil.
3. Be sure to weigh the carrot chunks at the start of the experiment.
4. Put equal volumes of soil in all the bags. (Discuss: Why is this important?)



Also, make sure students understand the role of the control carrots. If a team wants to test for the effects of warm temperature and only puts carrots in an incubator, how would they know that the same carrots wouldn't decompose in exactly the same way if they simply left them at room temperature for the duration of the experiment?

Make sure they don't introduce additional variables into their experiment. For example, if a group wants to add a small amount of lemon juice to the soil of their experimental carrots to test for the effects of acidity, they would also need to add an equal amount of water to the soil of their control carrots. If they did not add water to the control carrots, the two soils would contain different moisture levels. In that case, at the end of the experiment it would be impossible to know if any differences observed were the result of acidity, or if they were simply the result of different moisture levels.

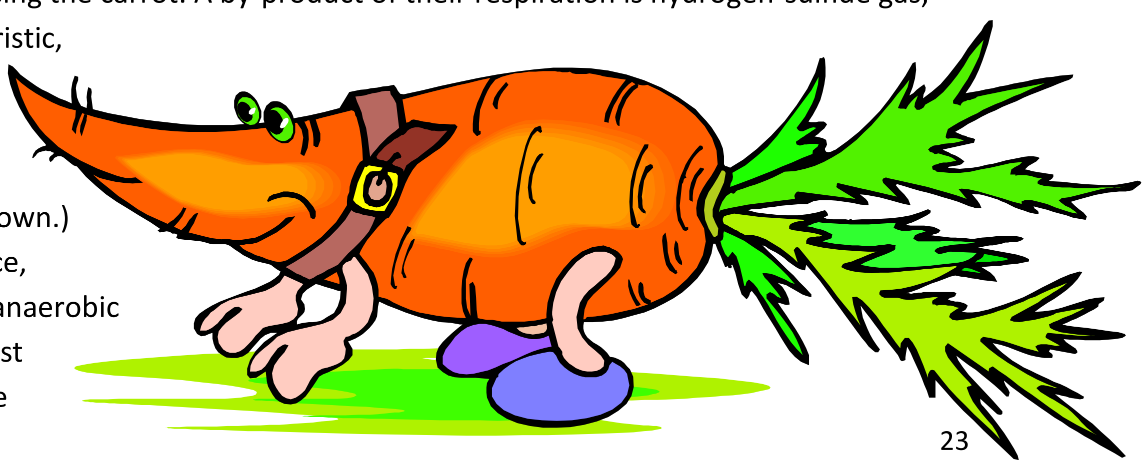
Once students have designed their experiments and you have approved their designs, they are ready to conduct their experiments. Make sure they:

1. weigh their carrots before beginning the experiments
2. Label their plastic bags with pertinent information such as the owner's name and whether it is an experimental or control carrot.

Allow about 10-15 minutes every 3 or 4 days for students to remove the carrots and weigh them again. You may need to caution them about returning their carrots promptly to the plastic bags to prevent mixing up control and experimental carrots.

Since their experiments will take several weeks to complete, ask each group to report on their observations periodically. Some of them may be surprising! For example, if students test the effects of cold temperatures on decomposition, they will probably find that refrigeration causes their carrots to increase in mass at first. If so, ask them why they think this happens. Most likely, it is because the carrots absorb moisture from the damp soil. After the first few days, however, the mass of the carrots will probably remain unchanged because the cold temperatures prevent the microbes from doing their job of decomposition. We keep fruits and vegetables in the refrigerator for the same reason.

If students saturated their soil with water at the beginning of the experiment, they will probably discover a very foul odor when they open their plastic bags a week or so later. In this case, the waterlogged conditions favor the anaerobic bacteria living within the soil, which then go to work decomposing the carrot. A by-product of their respiration is hydrogen-sulfide gas, which has a characteristic, swampy aroma. (Air-freshener spray may help keep the student complaints down.) Students should notice, however, that these anaerobic decomposers work just as quickly, if not more



quickly, than their aerobic counterparts.

Be sure to ask the class what the sources of error are in their experiments. For example, some dirt remains adhered to their carrots each time they weigh them, and depending on the conditions they test, this amount of dirt may vary throughout the experiment. Point out that they can get some idea of the amount of error from the difference between the initial and first experimental masses of their control carrots. Since the decomposers will not have had much effect in such a short period of time, any initial weight gain in the carrots is mainly due to dirt sticking to the carrot.

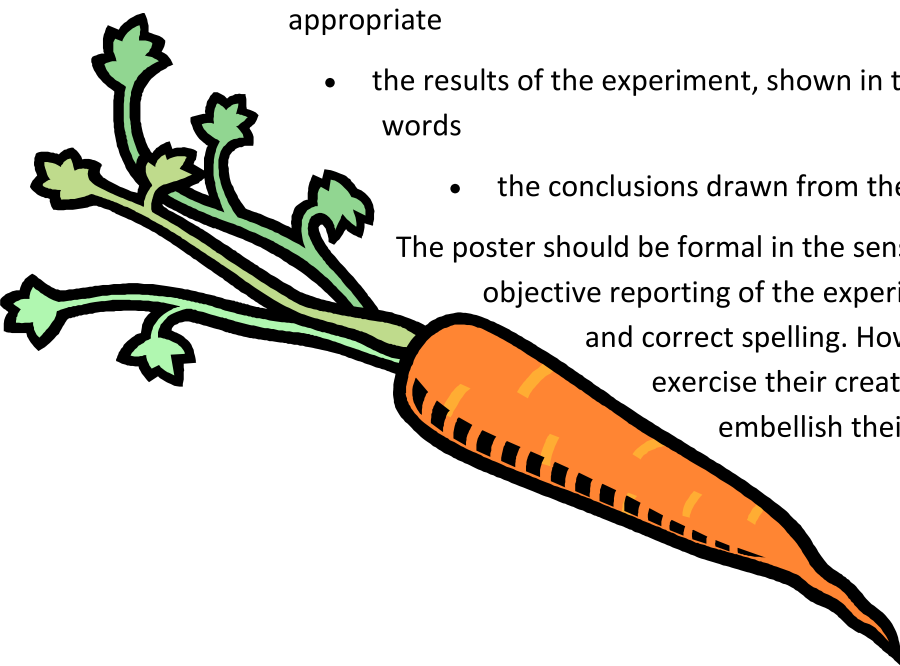
Later in the experiment, depending on the conditions tested, some carrots may break into several small pieces, and students must be sure to find all the pieces and weigh them together. In general, students should be able to recognize the major error sources as being measurement errors, errors due to adhering dirt, and later, errors due to overlooking small bits of carrots within the soil.

Have students continue weighing their carrots every three or four days until most of the experimental carrots are completely decomposed, or only very small bits remain. For students who test the effects of warm temperatures or wet conditions, this may only take two weeks or less, but for others, plan on letting the experiment continue for at least three weeks.

When most of the experimental carrots and bananas are nearly or completely decomposed, have each group share its findings with the rest of the class by preparing a poster. Their posters should contain the same type of information a formal paper published in a scientific journal would:

- a descriptive title
- a description of the methods used to conduct the experiment, including diagrams if appropriate
- the results of the experiment, shown in tables and graphs, and summarized in words
- the conclusions drawn from the data

The poster should be formal in the sense that it must give a succinct and objective reporting of the experiment, be neat, and use good grammar and correct spelling. However, students can still be allowed to exercise their creativity in the way they lay out and embellish their posters with color, illustrations, etc.



Rot This!

1. What evidence of decomposition did you see? What caused it?

2. How did each peel compare to the control?

3. How do each of these experiments compare to decomposition in a landfill?

4. What environment do you think would be the best for decomposition?

5. Design a baggie that would test this environment and compare it to a control. Draw a diagram of it below:

6. Which of the elements tested in the experiment were used to decompose your lunch leftovers?

7. Based on your observations in these two experiments, which do you think, composting or landfills, decompose biodegradable trash more effectively? Why?

Day:	Description of Peel	Evidence of Decomposition
Bag One		
Bag Two		
Bag Three		
Bag Four		
Bag Five		
Day:	Description of Peel	Evidence of Decomposition
Bag One		
Bag Two		
Bag Three		
Bag Four		
Bag Five		

What does composting mean and how does it work?

Many people take advantage of these organisms by composting their food scraps or yard waste. When a gardener makes a compost pile, he or she is providing good conditions for decomposition to occur, and the result is a dark, crumbly material that makes excellent fertilizer. Composting is the management of a natural process in which organic materials, such as grass clippings, food scraps, tree branches, and leaves, are gathered together in a big pile and left to decompose into a rich soil additive, or fertilizer, called humus.

Image Credit: http://www.openideo.com/open/localfood/inspiration/get-paid-for-your-biodegradable-food-waste/gallery/recomp.jpg/.

And while the material may smell strange for a while along the way, the finished compost looks and smells like rich, moist earth, which it is.

Food web of the compost pile

In the food web of the compost pile, just as in a spider web, each piece is connected and needs the other for support. It is very important to remember that if one piece is missing, none of the consumers can survive.

How does the compost pile work? Organic residues such as vegetables, fruits, breads, egg shells, coffee grounds and tea bags start to decay with the help of the first-level consumers, molds, bacteria and actinomycetes. Then along comes the second-level consumer, the earthworm. He eats mold, bacteria and actinomycetes. Next comes the third-level consumer, the centipede or ground beetle who eats the earthworm and so on. This is how the food web works. Each level of consumers survives by eating the organisms in the level below it. Remember, if one piece of this web is missing, none of the consumers can survive.

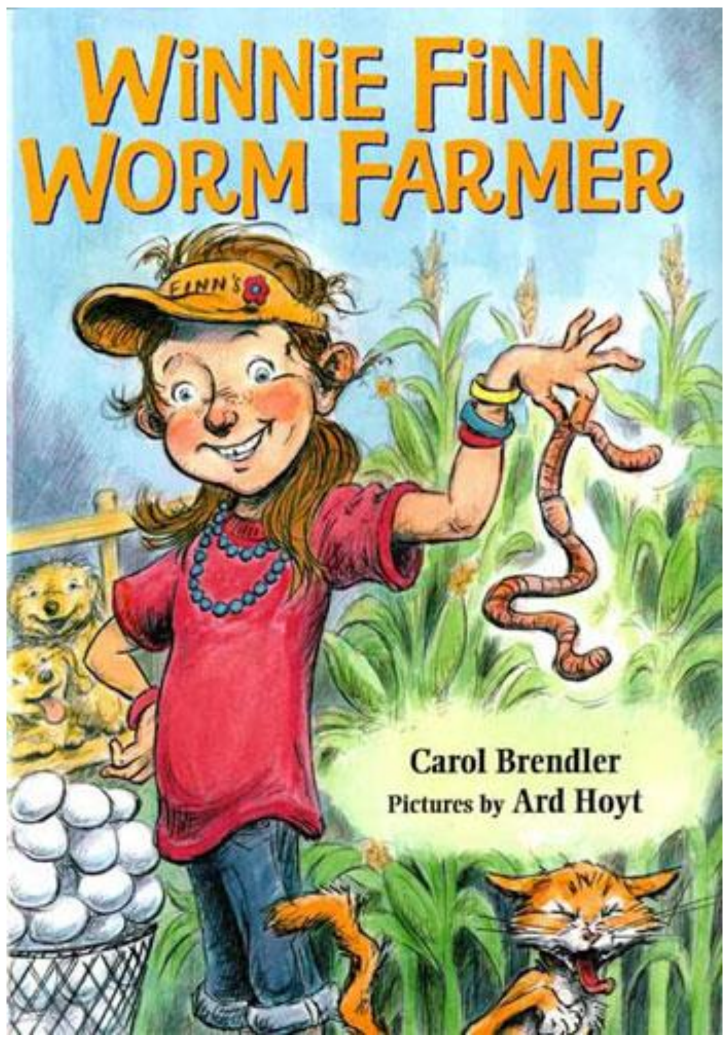
Vermiculture: Underground Adventures

Worms consume and recycle organic material and worms will show us all how to be eco-friendly and compost . . . in a wriggling wormy sort of way.

Fact or Opinion?

Start by having the kids tell you how they feel about worms - invariably someone will say "they're gross," and someone else will say "they're cool", which may spark an entire classroom "discussion."

Check students for prior understanding of fact vs. opinion. Hold up sentence strip defining opinion. Have the definition written on one side and the word 'opinion' on the other side. Read the definition and see if the students know whether you are defining fact or opinion. Do the same for the 'fact' sentence strip.



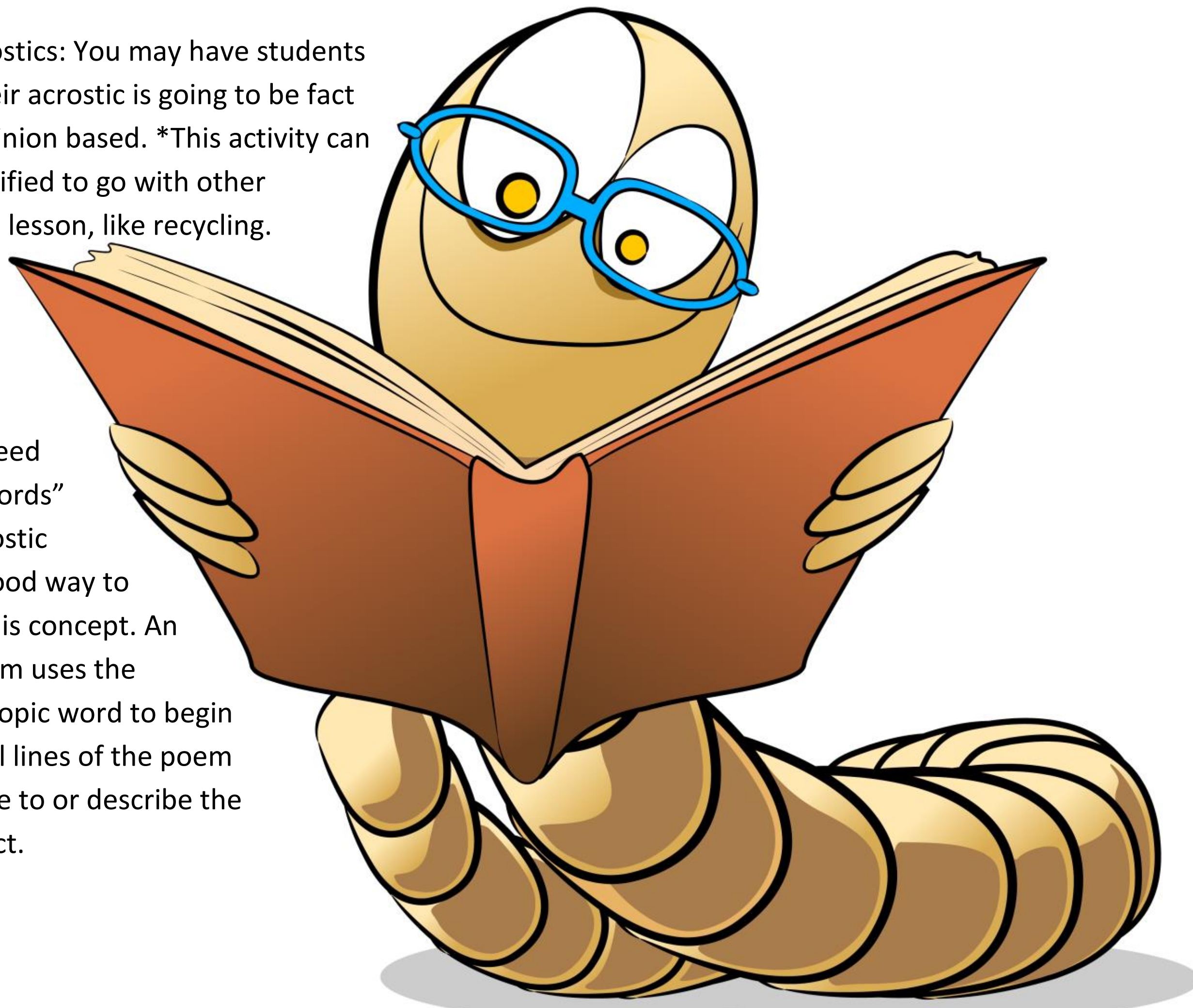
Now, garner a few opinions. Depending on your class this can be done different ways - one would be to start a group t-chart on chart paper - facts and opinions. Fill in the opinion side first. Talk about these opinions and how it's ok for one person to think one thing about spiders, and another to think something different. These are opinions - what people think. As you discuss have them try and figure out where the others will go based on the first one. After about 3 or 4 they will begin to realize that all the things in the Opinion column are how you might feel about something but it doesn’t have to be true for everyone, and things in the Facts column are things that are always true, for everyone. Have the kids make their own t-chart using the things the class has written down plus some of their own. What evidence do they have for their opinions? What evidence do they have to support their facts? Work together as a group to determine the relevance and quality of evidence given to support or oppose their argument.

Read a positive and fact based book about worms like *Winnie Finn, Worm Farmer* by Carol Brendler. What was Winnie Finn's opinion of worms? Other characters opinions of worms? Did anyone's opinions change during the story? What were some facts students learned from the story?

Extension: Have students make "pockets" by taping two squares of copy paper on half a sheet of construction paper - one pocket for facts and one for opinions. The children cut up their statements from their t-charts and file them in the correct pocket. They decorate the pockets and paper with pictures of worms, dirt, etc. This is a great reinforcement tool, as the children can switch sets with each other and file [and verify] each others' facts and opinions.

A Word in Edgewise

Worms Acrostics: You may have students decide if their acrostic is going to be fact based or opinion based. *This activity can also be modified to go with other topics in the lesson, like recycling.



What is an acrostic poem?

All poems need the "right words" and the acrostic poem is a good way to introduce this concept. An acrostic poem uses the letters in a topic word to begin each line. All lines of the poem should relate to or describe the poem subject.

Ex. SUN

Shining bright

Up in the sky

Nice and warm on my skin.

Too often acrostic studies are merely lists of descriptive words or phrases stacked on top of each other. Poetry they are not. But they can be. In acrostics, the words spelled out vertically range from single words to phrases and the poems are meant to serve as a complete thought about the subject with words that are economical and evocative. Good acrostic poems are a fun challenge to write. Students gain experience with word choice as they look for the right word to fit the letters of the subject of their poems.

Have students brainstorm a list of words or phrases that remind them of their topic word, "Worms" or describe it, ex. moist, outside, wet, wriggling, rain, grass, etc. While some of them may start with the letters in their topic word, or rhyme, make sure they don't simply look at those letters and try to think of single words to fit them. This is too limiting; poetry is about possibilities, not limitations. You may need to create a sample one as a group first, to help students get the idea.

The words they brainstormed will then be used to write their acrostic poem. The poem should be about the topic word and each line should start with a letter from that word.

SAMPLE(s):

With a sigh I step

Outside, just so that I can see the sky, the dripping sound of

Rain has totally stopped and fallen silent.

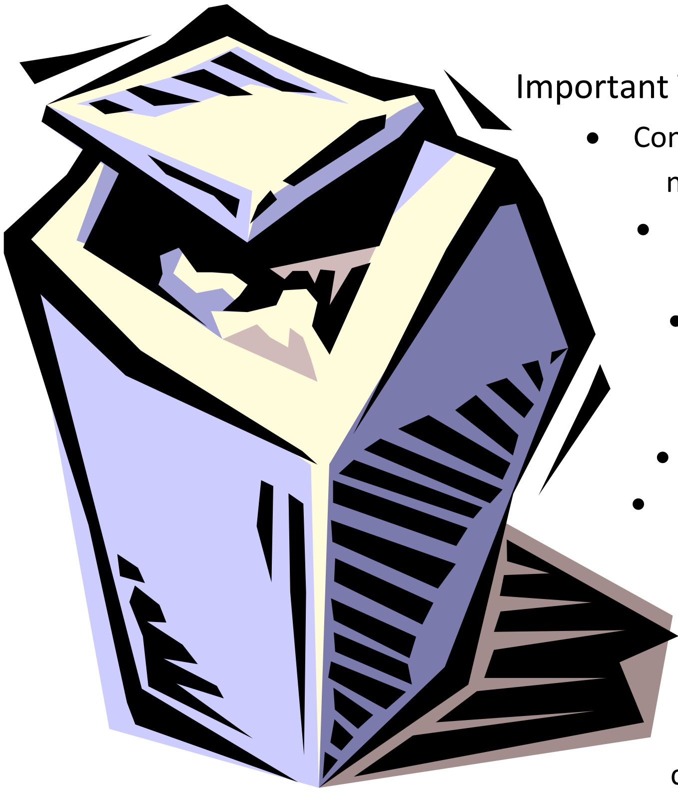
Moist grass, moist trees, but usually in the

Soft wet soil; more things wriggle than just my toes.

Word Count: 43

Trash Factor: Take out the rubbish and write it tight!

Some writers may faint at the thought of "slicing and dicing" their work. The thought of removing this or that could send them running for the hills! But poetry, like all writing, is meant to be clear, concise, relevant, and rubbish free. Producing rubbish free writing means stripping writing of all words that don't contribute to its "health." The point they are trying to make in their writing will be clearer if they say it directly and concisely, without extra words as padding.



Important Terms:

- Concise: being brief and to the point, using few words, not including extra or unnecessary information
- Brevity: the use of few words to say something, being short or brief
- Clarity: the quality of being clear, easily understood, and expressed, remembered, etc., in a very exact way.
- Accuracy: freedom from mistake or error
- Vivid: producing a strong or clear impression on the senses; specifically: producing distinct mental images.
- Relevant: important and relating to a subject in an appropriate way, having something to do with the matter being considered
- Rubbish: useless waste or rejected matter

Teach students to throw out the worthless intensifiers, such as very, totally and really, without remorse. Cut down on extra words like so, just, that, also, seriously, because, usually, and this. Teach them to approach their writing with the idea that "…when in doubt, leave it out!" If certain words don't make an impact on their poem or writing, they're just sitting there taking up space, take them out or replace them. It's better to have a short and well written piece with, clarity, accuracy, brevity, and vivid words instead of one filled with rubbish! Let the verbs do their job and show the action!

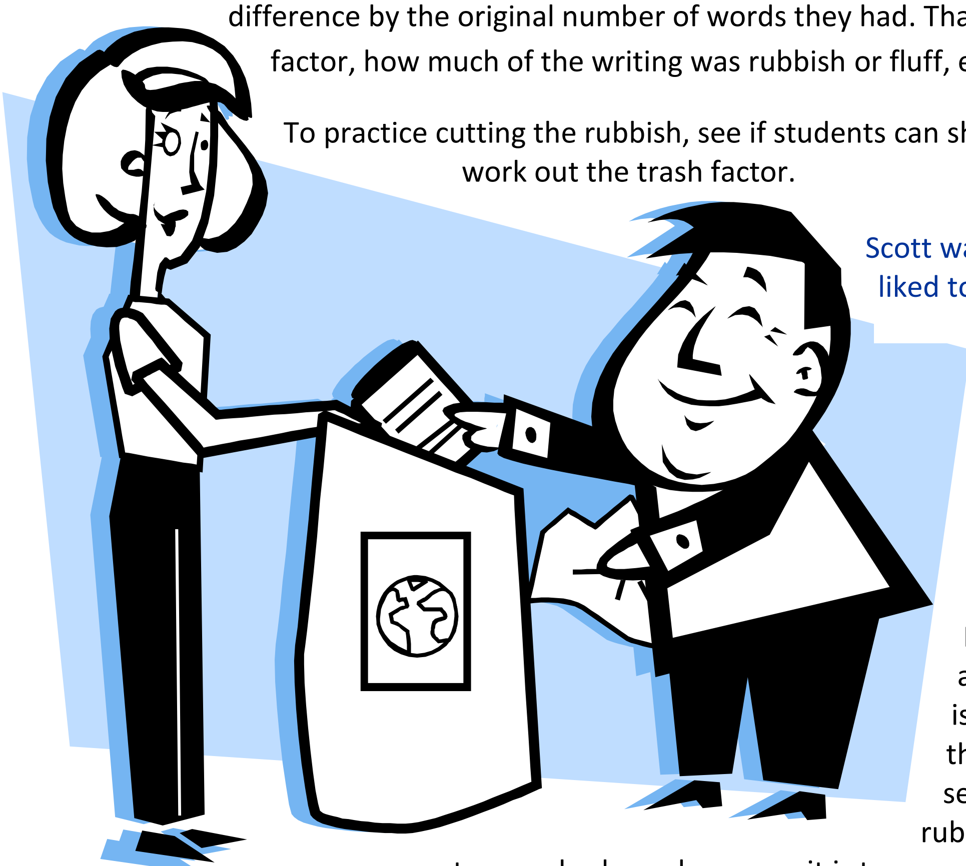
Example (poor): Owing to the fact that he was a man who looked seriously fresh and majorly excited, Mayor Gonzalez walked very quickly to the podium.

Example (better): Mayor Gonzalez raced to the podium

Sometimes it's easy to trim the trash from your sentence. Here are some common phrases that can be trimmed down to one word or two:

- "he is a man who" >> "he"
- "owing to the fact that" >> "since" or "because"
- "subsequent to" >> "after"
- "make contact with" >> "call" or "talk to"
- "on a daily basis" >> "daily"
- "this is a subject that" >> "this subject"

Students might think of words that are not adding anything to the meaning as rubbish that they want to trim from their paper. To find the trash factor in their writing, they count all the words in the original version, then remove as much padding as possible, then count again. Divide the difference by the original number of words they had. That number is their trash factor, how much of the writing was rubbish or fluff, extra unnecessary words.



To practice cutting the rubbish, see if students can shorten this sentence. Then work out the trash factor.

Scott was the type of person who liked to stay up late every night.

This sentence has 14 words. If they replace "Scott was the type of person who" with "Scott," the sentence reads "Scott liked to stay up late every night" -- eight words. Fourteen minus eight is six, and six divided by fourteen is .42. Their trash factor is thus 42%. 42% of that sentence was rubbish/unnecessary fluff! The next example shows how easy it is to repeat yourself when you are writing. Have students find the repetition, cut it, and then work out the trash factor.

The first semester really stressed me out and my grades showed it. I ended up not doing too well in my classes because of the stress.

If they look at these sentences carefully, they will notice that the second sentence contains exactly the same information as the first. Nothing new is added. Therefore, they only need one of these sentences, probably the first. Trash factor: The two sentences together have 26 words; the first sentence alone has 12. Twenty-six minus 12 is 14, and 14 divided by 26 is .53 or 53% rubbish.

It's important to remember, though, that words only count as rubbish if they do not convey any useful meaning. Getting rid of the trash doesn’t mean they have to strip everything down to the bare bones, it means we are wanting students to write with accuracy and clarity and make sure every word is important. Sometimes getting rid of the rubbish forces them to reconsider their whole sentence, and they end up with more words. For an example of this, have students look at the following sentence.

I spied a peculiar, eccentric-looking man in the lobby.

A first look at this sentence suggests that "peculiar" and "eccentric-looking" convey the same information. If you cut "eccentric-looking" you would have reduced your rubbish by 20%. But another look reveals more possibilities for improvement. Instead of telling the reader that the man is peculiar, it might be better for students to **show** it. How? By simply describe his peculiar looks or behavior.

I spied a man in the lobby who was wearing a pink polka-dotted jacket and bowing to passers-by.

They now have more words, but each word is conveying information -- they are not rubbish.
Discuss: Clarity is far and away the most important attribute of tight writing. If what you've written isn't clear, you might as well have written it in a foreign language that your audience can't read. So how do students determine whether their writing is clear? Simple: let someone else read it. Don't rely on your own intuition. Because you know what you meant to say, you'll likely be blind to any ambiguity that has crept in. What you meant to say doesn't matter—all that matters is what you wrote.

Put it to action: Have students practice on the original worm acrostic, how much of a trash factor can they remove? Do they need to add any words?

ORIGINAL SAMPLE:
With a sigh I step
Outside, just so that I can see the sky, the dripping sound of
Rain has totally stopped and fallen silent.
Moist grass, moist trees, but usually in the
Soft wet soil; more things wriggle than just my toes.
Word Count: 43

SAMPLE (w/Rubbish Removed)
With a sigh I step
Outside, the patter of
Rain has fallen silent.

Moist grass,
Soft soil; more wriggles than just my toes.
Word Count: 23
Figuring out our Trash factor:
43-23 = 20
20/43= .46 or 46%
A trash factor of 46%!

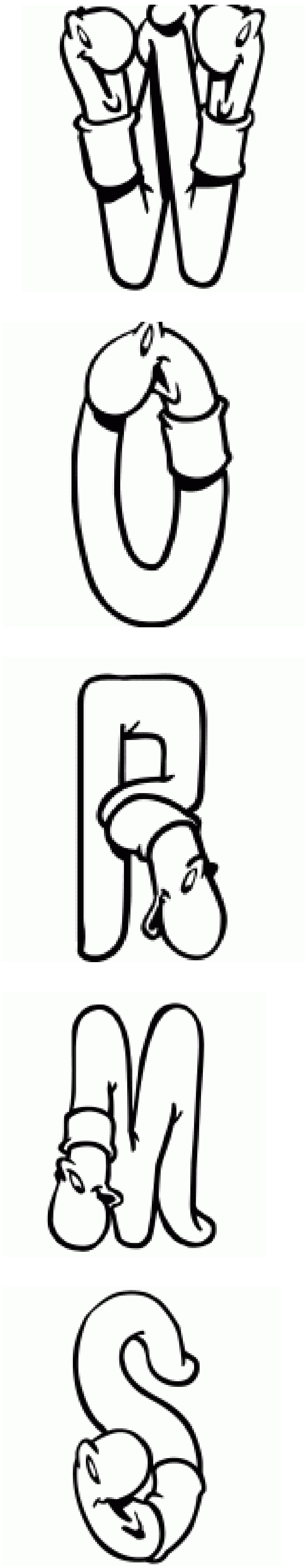
And sometimes re-writes lead to inspirations for new poems.

Wet, sweet, and succulent
Ordinary fish dreams of
Red wrigglers,
Moist snacks on
Sharp strings.

Word Count: 14
Is there a trash factor?

To inspire students in their acrostic writing you need strong mentor texts they can use as models, ones you create together & ones found in books. Ex. Spring: An Alphabet Acrostic, written by Steven Schnur and illustrated by Leslie Evans or Silver Seeds, written by Paul Paolilli and Dan Brewer with paintings by Steve Johnson and Lou Fancher

Students may use the included worm acrostic sheet for their final drafts.


WORMS

Vidi, Vici, Vermi!

What is Organic Matter?

Organic matter is anything made of living or once-living animals or plants. This can include paper, cotton socks, hair clippings, eggshells, wooden rulers, dead animals, corn husks, and leaves. IDEA: Have your students go around room and label items as organic or inorganic. Discuss what things are made from and what makes it "organic".

People Produce Garbage

Approximate 600 pounds of solid waste per year! An estimated 10%-20% is organic waste and can be recycled into a rich source of nutrients for plants and trees using vermi-composting (composting with worms!).

Have students chart how much garbage your household/classroom produces per day, week, and year. How much of that garbage is organic? Start weighing and keep track. What can your class do to recycle or cut down on waste?

Worms Eat Organic Matter and Help Plants Grow

Nature designed the worm to be a highly efficient recycling machine, gobbling up plant waste at one end and creating nutrient-rich fertilizer at the other (ensuring that the plants continue to grow, so the

FYI: Facts about Worms

- No worm diseases are communicable to humans.
- Worms have no bones, eyes, arms or legs.
- Worms are hermaphroditic – having the reproductive parts of both the male and female.
- In the wild, worms can consume up to their own weight in organic food every day.
- Eisenia fetida –the preferred composting worm, known as the red worm, is top feeder staying less than 12 inches below the ground. Worms breathe through their skin.
- Worms need a great deal of moisture but can't swim.
- Worms are nocturnal – and for a good reason. Direct sunlight can kill them in less than three minutes.
- The first 1/3 of a worm's body contains most of the vital organs, the rest 2/3 of a worm are the intestines.
- Salt is harmful, even fatal to worms.
- Worms can't hear but they respond to vibration, light, and temperature.
- Adult Red Worms have between 80-120 circular rings on it's body.
- Setae, little hair-like legs help the worm tunnel, move and grip onto objects. Satae is made from same thing as fingernails called chitin.
- Worms have 5 hearts (more to love!)
- Worms have a mouth but NO teeth. Repeat – NO TEETH!
- The worm produces enzymes (chemicals) which act as both insecticide (bug killer)and antibiotic (germ killer)for the worm. These are passed on to the plants as they absorb the worm castings. Worms and plants have a symbiotic relationship. DISCUSSION: What other animals have a symbiotic relationship?

worms can continue to eat). Worms eat and digest organic matter, burrow through the soil, and leave behind castings (manure) – a super source of nutrients for plants and trees. This is a SLOW-release, organic fertilizer, that will not burn plants.

Worms have a brain and five hearts. They have neither eyes nor ears but are extremely aware of vibrations such as thumps or banging on the composter. They have a well founded hereditary aversion to bright lights. Ultraviolet rays from the sun are very harmful to earthworms. One hour's exposure to strong sunlight causes partial-to-complete paralysis and several hours are fatal. A worm breathes when oxygen from the air or water passes through its moist skin into the blood capillaries. If the body covering dries up, the worm suffocates.

When a worm wants to move forward, its powerful muscles contract and it squeezes itself around the middle (sort of like when you squeeze a tube of toothpaste). The worm's front gets long and thin and burrows ahead. Then another set of muscles squeezes and makes the worm fat. It pushes its setae (hairy bristles) down and grips the burrow while the rear section catches up with the front section. Worms can force their way through soft earth; they must eat their way through harder soil. Earth they eat passes through their intestines and is deposited on the ground's surface as castings.

The Red Wiggler ingests waste at the front, through a soft mouth with a flexible lip that can seize or grasp whatever the worm is trying to eat. The throat, or "phraynx" can be pushed forward to help pull matter in. They have no teeth so they coat their food with saliva, which makes it softer and easier to digest. After the food is swallowed, it passes through the esophagus to the crop and then to the gizzard, where small stones grind it up. The food is passed into the intestine, which is almost as long as the worm itself. At the end of the intestine is the anus, for passing out the castings.

Within the gut of a worm, soil and decomposed organic material are mixed. The sand or soil in the worm's gut helps break down the organic particles and is mixed together with microscopic bacteria, fungi, and mold. When the worm excretes the castings (manure) the microorganisms in the castings add to the health of the soil. They are all held together in a mucus [slime] sheath that hardens when touched by air, acts like a binder (keeps it together), and dissolves slowly over time as food for plants. Cool. [To have your students see worms in "the wild" and to quickly get worms to come up out of the ground. Add some dry mustard (2 tsp to 1 Tbsp) to a tall glass of water. Stir to mix and then pour onto the ground. If any worms are in the area, they'll quickly surface! We don't know why it works... do your students have a hypothesis?]

A Nice Cup o' Tea

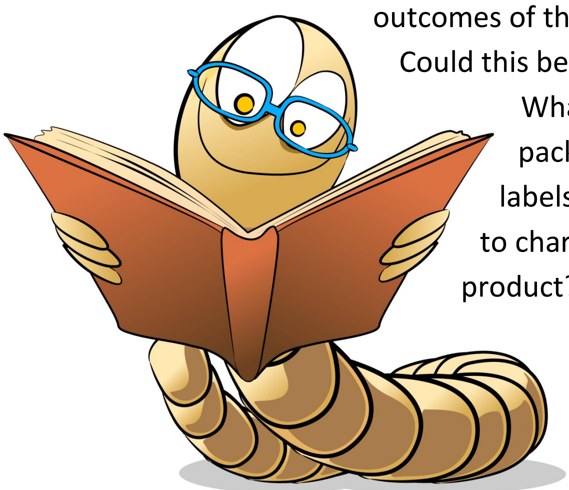
Our plants and even our soils can benefit greatly from a nice cup of tea when that tea is derived from a plant nutrition source like worm castings. In this activity students will see how easy it is to set up and maintain their own worm bin. It's engaging, educational, fun, and yes…creepy and crawly!

Objectives:

Students will:

- Learn about the important role worms play in nature.
- Perform the experiments and draw their own conclusions.
- Design their own experiments using the scientific method—posing an idea, forming a hypothesis, constructing an experiment, analyzing results, and presenting conclusions.
- Through direct observation, they will develop an understanding of the effects different organisms, including humans, have on one another.
- Strengthen children's problem solving skills and scientific methodology practice (even with young children).

Your students will discover how to keep, feed and maintain red wriggler worms while having numerous (almost endless) related science projects throughout the school year [and way into the summer]. Based on what they learn about worms, worm castings, and the types of food, discuss the possible outcomes of this project with your class. Ex. Could this be used as a fundraising project? What about designing your own packages of organic fertilizer with labels, etc? What would start up costs be? How much would they need to charge per package? How long before they could expect to have a product? One certain end result of having an indoor or outdoor worm bin is harvesting the worm castings (literally the world's greatest natural fertilizer).



Keeping Track of ze' Vermes

[vermes is Latin for worms] Throughout the project have students ask questions, hypothesize, and keep track of their hypotheses by maintaining a science notebook that includes observations, data, diagrams, and explanations. During discussion have students identify their purpose as a scientist/author and the purpose of their writing, (e.g., to entertain, to inform, to describe, to persuade, to share feelings, to share experiences), they may have more than one. Who is their audience? [ex. other students, themselves, their teacher] Are they writing fiction or non-fiction? Work as a group to identify and design specific investigations that could be used to answer a particular question the students come up with.

Option: Organize students into small, collaborative groups and match up with partner groups at another school/site. Collaborative groups of students collect and exchange data and observations related to the worm bins with their partner group. They will collect and share scientific data with students in another school, ex. by email, or mail. Emphasize the importance of students summarizing and indicating the sequence of events in their journals/writings as well as using appropriate time-order or transitional words [Ex. first, second, next, then, last, after that, later, later on, in a while, during, as soon as, soon, meanwhile, after, before, finally] so that other students can replicate their experiments and verify their results, just as professional scientists do. In their communications, have students use and create common text features [and use different software programs (word processor, spreadsheets, etc.] to help other students be able to make meaning from their text and experiment data (e.g., headings, tables, key words, graphics, captions, sidebars) as well as quickly locate the information that supports the students opinions, predictions, and conclusions.

Materials:

- Drill with 1/4- and 1/16-inch bits, or hammer with equivalent sized nails
- Opaque 8- 10-gallon gallon plastic storage bin with a lid
- Extra storage bin lid
  Note: Do not use a clear bin because worms like it dark! Drill ¼ holes approximately 4" apart in one of the lids and the bottom of the bin. These holes are for air flow and drainage.
- Shredded newspaper (non-glossy)
- Large piece of card-board, cut to fit flat into the bin
- 2 bricks or big stones
- Old cotton shirt or pillowcase
- Tub of red wigglers from a local bait store. Only use red wiggler worms known as Eisenia Fetida. The worms will need a few days to settle into their new digs.
- 1 cup of organic soil

- ½ cup of sand
- Vegetables or other organic items to serve as worm food. See notes below.
- Science Journals

Note: Bins can be made in miniature with large yogurt containers.

Prepare:

- Clean the container to remove any chemicals that might harm the worms.
- Soak the newspaper in water overnight so the chlorine will evaporate and will not harm the worms.

Do it!

1. Take an old cotton shirt or pillow case and soak it in water. Squeeze the water out and use it to cover the bottom. This allows excess moister to drain out while keeping the bedding in!
2. Fill half of the container with the shredded newspaper or worm bedding. The bedding should be damp but not wet! If you can squeeze more than two drops of water from the bedding it is too wet. Fluff the bedding and fill the bin almost to the top.

3. Worms need soil or sand to act as "grit" in their guts. Worms also need other organic matter to help break down food small enough for the worm to eat. A handful of organic potting soil (NO FERTILIZER) should have enough microorganisms to get the bin started. Add a tablespoon of soil and a half cup of sand to the bedding. Note: You can also use aged compost or manure from goats, cows, horses, rabbits, or chickens in place of potting soil but DO NOT use human, dog, or cat manure.
4. Finally, add the worms and a little food, keeping track of the exact number of worms in each bin, and weighing the worms prior to putting them in so you'll know how much food to place.

5. Make sure to bury all food at least 2 inches deep to deter fruit flies.
6. Dampen the cardboard and set it gently on top of the worms and the bedding. Cover the bin with the drilled lid (worms don't like light).
7. Place your bin outdoors in a spot that is sheltered from direct sun and rain or indoors in a well-ventilated area. [Indoors during the winter and outdoors during the summer, if it is too cold the worms will go into hibernation.] Set the undrilled bin lid, upside down, on the bricks or stones to serve as a catch tray (the runoff, or "worm tea," when mixed with water makes great fertilizer for house and outdoor plants, use diluted at the rate of 1 part liquid to 10 parts water.), and then set the bin on it.
8. Add food and spray with water regularly, having students keep track of the amounts/times/data in their journals.

The soil contains microscopic creatures and molds that will help the worms decompose the vegetables that you add to the worm bin. Adding the sand actually helps the worms digest their food. They store the sand in their gizzard, like a bird, and they use the sand to grind their food. Eventually you might find mold, fungi, bacteria, sow bugs [which aren't actually bugs, they're crustaceans, like lobsters and shrimps], spingtails (tiny bugs), grubs, and mites in your ecosystem that act as PRE-DIGESTERS. These are all part of your mini ecosystem.

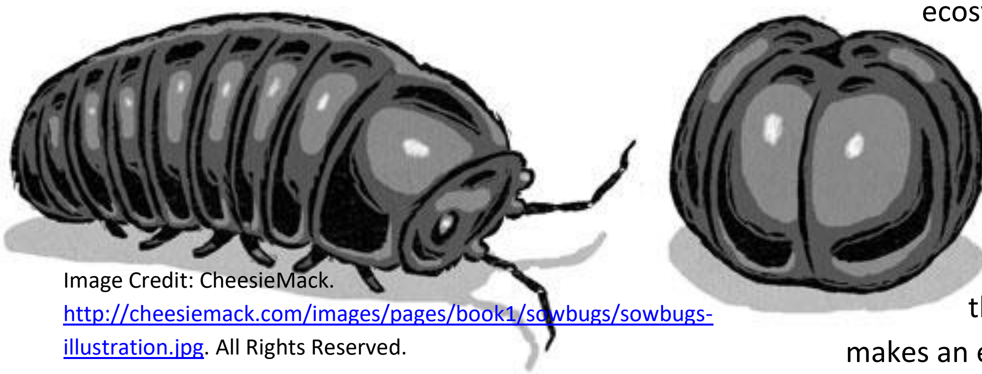
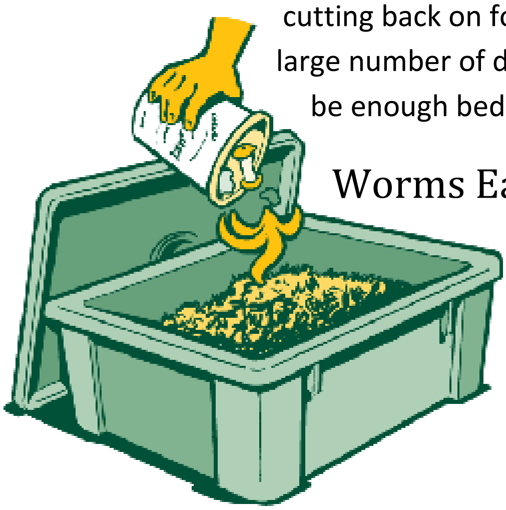


Image Credit: CheesieMack.
http://cheesiemack.com/images/pages/book1/sowbugs/sowbugs-illustration.jpg.

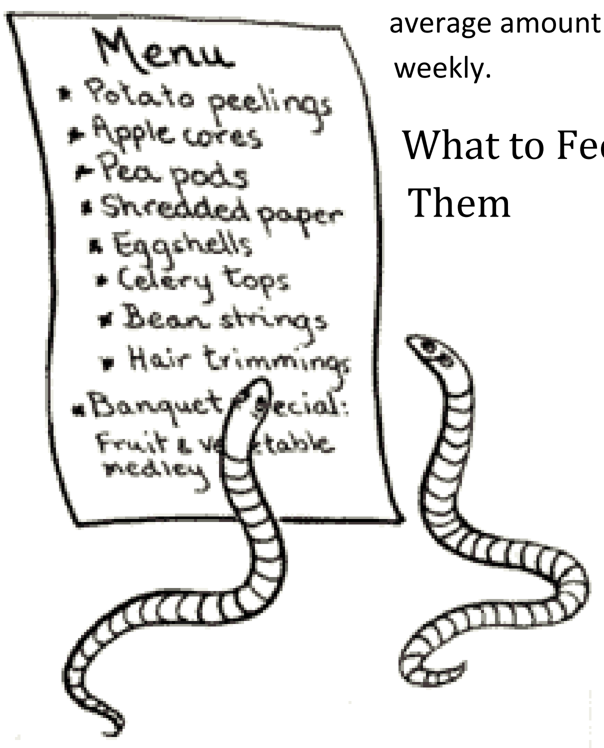
Periodically empty any liquid (the worm tea) that drains into the tray, it makes an excellent fertilizer when diluted. Have students monitor the worm bin daily at first and then at least several times a week to make sure that everything is in order, keeping notes in their science journals. It shouldn't have a strong smell; if it does, there may be too much food or moisture, or too little air. Try drilling additional holes for ventilation, cutting back on food for a week or two, or adding more bedding. If students see a large number of dead worms, the bin may be too dry or too wet, or there may not be enough bedding.



Worms Eat

How much to feed worms? In captivity they will only eat about one fourth to half their weight per day, so weigh the worms before you put them in to have a good idea of how much to feed, don't worry about the weekends if it's in your classroom. [For example: If you have 1lb of worms, the first few weeks, give the worms about 1/4 pound (or roughly a cup) of castoffs a day, then increase the amount gradually to match how much the worms seem to be eating daily.] Have students draw a diagram of the worm bin from an overhead view. Students divide bin into sections and number the sections. Students use this diagram for placing food waste in different sections of the bin. This will enable students to keep track of where and when the food waste is placed.

In a container collect kitchen scraps of organic matter listed below. Chopping and freezing waste aides in the molecular breakdown and smaller pieces (no larger than 2cm) will be eaten more quickly and prevent odors. Soaking cotton, paper towels & cardboard help too and add moisture to the bin. Each time they are fed, have students weigh the amount and type of food the worms are fed and record the data in a graph, finding the average amount of food fed weekly.



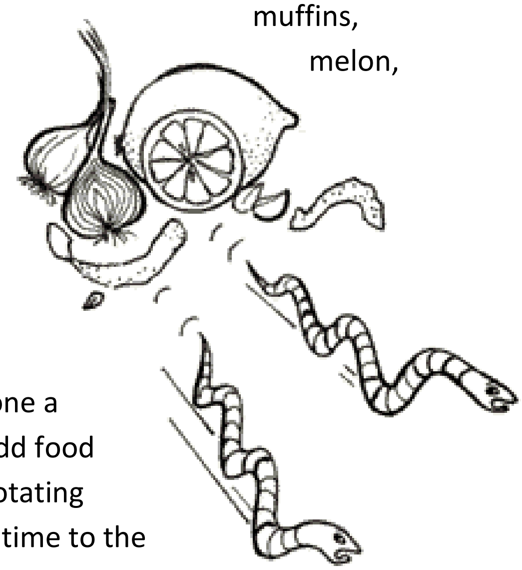
What to Feed Them

Trouble Shooting

Trouble is bound to happen, and that really is okay. After all this is a LIVING ecosystem with many variables to consider such as temperature, food, chemicals, bedding, and nature itself. Part of the learning process is for students to observe, come up with theories, experiment, take corrective action, adjust and make conclusions…they get to THINK!

- Too wet? Add dry cardboard to soak up some moisture.
- Have ants? It's too dry or exposed food. Add some water or frozen foods to bedding and bury the food just under the bedding.
- Have many mites? It could be too much wet or you may have too much food.
- It smells! Lack of air, too wet –try to fluff bin, bury food, add dry bedding, & check drainage. A healthy worm bin should have a pleasant earthy, forest smell. Anything else is a red flag that something is wrong.
- Have fruit flies? –You probably have exposed food – bury food just under bedding.
- Have white thread-like worms? These are natural. Do nothing.
- Worms try to escape? May be too wet, did you add salty foods, chemicals, maybe overpopulation is happening. Is the temperature too hot (do not keep over 84 degrees).

Apples, pears, banana peels, bread, corn cobs & husks, coffee grounds and filters, veggies or all types, egg shells (they need the calcium!!), tomatoes, melon rinds, onion peels, celery sticks, carrot tops, cardboard, paper, old cotton socks, oatmeal, muffins, strawberry tops, rotting lettuce, napkins, and honeydew melon, even eggshells (which also help to keep the worm farm alkaline and keep pests away).



For a multi-bin miniature variant: Make several small bins and add a certain kind of garbage to one corner of each bin. Label each bin so it is clear which type of garbage is to be added to that bin for the duration of the project. One bin should get eggshells, one coffee grounds, one vegetables, one fruits, and one a combination of all four of these. Check the bins each day and add food as needed. Try adding the food to each corner of the bin on a rotating basis; i.e.: one time, add food to the lower left corner, the next time to the lower right corner, etc.

What NOT to feed them

Salt or salty items such as potato chips, milk or creams, dairy items such as cheese, no meats, pressure treated wood, grass or leaves that may have been treated with pesticides, snack foods like fries, olives, no carbon paper, animal manure, citrus waste (oranges & lemons), vinegar, green grass (they create high temperature) alcohol, fruit pits, chemicals of any kind, or plastics.

Grow Baby, Grow

Worms are also excellent at reproducing. Students will find evidence of this right in the bin. After 40 days or so, they should have two to three times as many worms as they started with, and the population should keep on growing.

Keeping Track: Have students create a timeline in their science journal to depict the changes that occur during their worms life cycles, create a sequence of illustrations of the correct stages of a worm's life cycle, and draw conclusions about the similarities and differences between parents and their offspring. Do worms undergo complete or incomplete metamorphosis? Can they control the rate of worm reproduction?

Three basic conditions control the size of a worm population:

- availability of food
- space requirements

- fouling of their environment

The controls students exert over your worm population will affect this whole process. They may choose to feed an ever increasing population, in which case, they will need to provide them with more space and fresh bedding.

In time, you may want to divide the population between two bins. Worms can live for up to two years. In healthy bins, you probably won't spot many dead worms because their bodies are 75 to 90 percent water and they tend to disappear quickly. Students might, though, notice some eggs: A worm cocoon is small yellow lemon-shaped object about the size of an "O" that contains about four worms. The incubation period of the cocoon is about 23 days. The cocoons will gradually change its color from golden yellow to deep red. Hatchlings first appear white then turn pink and finally red after around eight hours. The little guys are HUNGRY and can eat!

An adult (3 month old) worm can produce 2-3 cocoons per week. 11 weeks later the cocoons hatch. Each cocoon produces around 3 hatchlings and in 2-3 months they are ready to reproduce. A population can double very quickly. Have students do the math to figure out how many worms you'll have in a year if you start with two, or eight, or twenty.

What they'll do

The worms will produce worm castings in the top layer of the soil or bedding in the miniature worm farm. This is their 'poo', which contains many essential nutrients and minerals to enrich the soil.

The worms will produce worm tea in the bottom layer of the worm farm. This is their 'wee', which also contains many essential nutrients and minerals to enrich the soil. Worm tea is used on plants as a liquid fertilizer, diluted 1:10 parts of water.

After two or three months, your worms will have turned the soil almost completely into worm castings. It's time to harvest!

Harvest Time!

In 8 to 12 weeks, the bin is filling up with material that looks like dark, crumbly soil. This is worm manure, otherwise known as vermicompost, and it's surprisingly clean smelling. It's also a terrific garden fertilizer. Farmers and growers prefer vermicasts to any other kind of fertilizer. Worm castings supply micro-nutrients in a very water soluble form that plants can readily use and worm castings help repel insects and other pests. Just scoop it out of the bin, worms included, and sprinkle up to an inch-deep layer at the base of any plants.

To harvest worm-free compost for indoor plants, wait until almost all the bedding in the bin is gone (about 12 to 16 weeks) and stop feeding the worms for a week. Don't worry; they've got plenty of stored-up energy. Remove any large scraps of food, and push everything that's left to one side of the bin. Then, add fresh bedding and food to the other side of the bin. In a couple of weeks, most of the worms will have migrated to the side containing the food, leaving behind a nice pile of compost to mix in with potting soil. A good ratio is one part compost to four parts soil.

Get a Wriggle On! Worm Activities:

- Have students observe the worm bin and record what happens. What changes do they notice over time? How long does it take the worms to consume the food you give them? Are there certain foods they seem to prefer over others?
- Have the students place various items inside the worm bin, such as plastic caps, pieces of wood, or peanuts in the shell. Observe what happens to these objects over time. Is there anything the worms won't eat?
- Place one or two worms on a Petri dish on top of a moist paper towel. Cover half of the dish with black paper, leaving the other side of the dish exposed. What happens? Do the worms move toward one side of the dish? Do they seem to prefer the light side or the dark side? Does this mean worms can see?

- Make one side of the Petri dish cold and the other side warm. Which side does the worm prefer?
- Try placing different foods on opposite sides of the Petri dish. Which does the worm prefer?

Colored Sand Collage

Worms may turn dirt and sand into a nearly magical fertilizer, but for people, this humble grit transforms into a magical art supply. Using salt shakers for the sand makes it easy to control and refill, and with just a bit of tape stuck to the lid, you can control the speed of the granules coming out of the bottle. *Label the bottles with the names of the colors to help your youngest students practice identifying the color words.* If working with larger groups it may be simpler to just pour the sand into bowls and let the kids take pinches of sand and sprinkle it where they want. It works just as well, if not better.

Materials

- Scissors
- Colored card stock or construction paper
- White and clear Con-Tact paper
- Colored sand (available at craft stores and large chains)
- Salt shakers (ex. available at a dollar store for $1 per pair) or other empty containers like bowls
- Tape

Instructions

1. Have students use scissors to create a frame by cutting out the center of the card stock, leaving a 1-inch border.

2. Next, have them trim the Con-Tact paper so that it's slightly smaller than the frame, then set the Con-Tact paper face down and peel off the backing. Carefully lay the frame over the sticky surface and press it in place.

3. Pour the sand into the salt shakers, then put on the lids and cover some of the holes with tape. Give your student the bottles and let him pour the sand over the sticky surface -- one color at a time.

4. Have students dump off the extra sand as they fills the space, conserving colors, ex. pouring it back into the bowl.

5. When they're done, they can set a piece of clear Con-Tact paper over the front to help preserve the design.

Variation: Mandalas, the world in a grain of sand

An updated version of an ancient skill. You may wish to get a book of mandala designs to inspire students.

Millions of grains of sand are painstakingly laid into place on a flat platform over a period of days or weeks, creating an overwhelmingly beautiful painting. In ancient times powdered precious and semi precious gems were also used. When finished, to symbolize the impermanence of all that exists, traditionally the colored sands are swept up and poured into a nearby river or stream where they believe the waters carry them throughout the world to help heal it.

Buddhist Monks first created this amazing style of art by carefully placing grains of different colored sand on the ground in patterns. Once you place sand on the ground, it's very difficult to pick up and take home with you! So instead, have students create symmetrical designs on cardstock and use glue to help keep the sand in place. Once students spread their glue in a pattern, the next step is to sprinkle different colored sand onto the picture. Let it dry and then they're done!