

Who's in my soil!! ...and just what do they think they're doing there?

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Objective of the Lesson:

This lesson is designed to introduce students to:

- ✧ The organisms that inhabit the soil
- ✧ The roles these organisms play (both beneficial and detrimental).
- ✧ The interactions between the organisms and their environment and other organisms.

This lesson is broken up into three activities in which students will learn about soil microbes (*Make a Mycorrhizal Model*), microarthropods (*Crawlin' Critters Ecotainer*) and microfauna (*Earthworm Factory* and *Earthworm Hunter*). Each activity will be discussed separately in the sections below.

Standards Addressed:

Science

K-3	4-5	6-8
Standard 1 <i>Nature and Application of Science and Technology</i> A-1, A-2, A-3	Standard 1 <i>Nature and Application of Science and Technology</i> A-1, A-2, A-3	Standard 1 <i>Nature and Application of Science and Technology</i> A-1, A-2
Standard 6 <i>Life Processes</i> A-1	_____	_____
Standard 8 <i>Ecology</i> A-1, A-2 B-1	Standard 8 <i>Ecology</i> B-1, B-2	Standard 8 <i>Ecology</i> A-1 B-1

Agriscience

6-8
Standard 4 <i>Animal Science Careers</i> B-7

Materials Needed:

Make a Mycorrhizal Model

- ✧ Tissue paper to make flowers
- ✧ Florist tape
- ✧ Pipe cleaners
- ✧ Yarn (in shades of brown, tan, pink, white or black)
- ✧ School glue or craft glue

Crawlin' Critters Ecotainer

- ✧ soil
- ✧ suspended large holiday light bulb or 35 watt appliance bulb
- ✧ 2 L empty soda bottle
- ✧ rigid wire screen (1/4" mesh) cut to fit inside bottle
- ✧ pint or quart sized plastic container with lid (like a margarine container)
- ✧ plaster of paris
- ✧ dry yeast

- ✧ magnifying glass (or preferably a dissecting scope)

Earthworm Hunter

- ✧ shovel
- ✧ sheet of plastic (4' x 4')

Earthworm factory

- ✧ 1 to 2 dozen starter earthworms (red worms or "red wigglers" (*Eisenia foetida*), NOT NIGHTCRAWLERS—the system is too small for them and they will die)
- ✧ 1 large plastic bin with lid and drilled drainage holes (1.5 ft. H x 2 ft. D x 3 ft W)
- ✧ bedding (see below)
- ✧ worm food (kitchen scraps)
- ✧ paper cups with lids (at least 12oz.)
- ✧ sheet of plastic (4' x 4')

Teaching Tips

- ✧ Ask students what kind of things they know that live in the soil (answers will probably include worms, bugs, moles, snakes, plant roots). Let them know that living things in the soil range from the tiniest microscopic organisms like bacteria, viruses, fungi, protozoa and nematodes to medium-sized things like mites and springtails, to larger things like earthworms, insects, rodents and snakes.
- ✧ Ask students what they think these living things do in the soil, what do they eat? Many of us have heard that soil does wonderful things for us like filtering our water and recycling nutrients, but it is the organisms in the soil, not the soil, performing these tasks! Different living things in the soil eat dead plant and animal material, living plant roots, each other and even some harmful chemicals. By doing this they recycle and convert nutrients into the forms that we need, sometimes cause plant diseases, sometimes help protect plants against diseases, and even clean our water of chemical pollutants!

Procedure:

Make a Mycorrhizal Model

- ✧ Here the students should become familiar with mycorrhizal fungi, specifically how they live, their interactions with the soil and other living and non-living things in their environment and what can affect them.
- ✧ Mycorrhizal fungi (*myco* means fungus, and *rhizae* means root) are fungi that form a special relationship with some plants called a "symbiotic" relationship (*sym* means together, and *biotic*

means living—these two organisms are living together). The fungus infects the plant roots and then grows out into the soil much farther than the plant's roots would reach.

- ✧ Ask students how this may help the plant, and then ask them what the fungus gets in return for its efforts. Many plants have this type of relationship, in fact, many of the mushrooms you see in the woods are actually attached to nearby pine trees in this manner!
1. Attach pieces of pipe cleaner to the tissue paper flowers by winding floral tape around the pipe cleaner and stem (this can be done ahead of time for each student).
 2. Bend pipe cleaners so that the plant looks like it has “roots”.
 3. Cut one piece of yarn for each root, about 3 times the length of the root.
 4. Attach the yarn to the root by running a thin bead of glue along the length of the root, starting about halfway up the root and running to the end of the root.
 5. Wrap a piece of yarn (the “mycorrhizal hypha”) around the root until you’ve covered the entire length where the glue is. You should have a lot of yarn left hanging at the end of each root.

Crawlin’ Critters Ecotainer

- ✧ In this activity soil arthropods will be introduced. How these organisms live, their interaction with soil material and other things in their environment and what affects them should be discussed.
 - ✧ Soil arthropods (*arthros* means jointed and *podos* means leg) are soil animals that can range from microscopic to several inches in length. They include insects (springtails, beetles, ants), arachnids (spiders, mites), crustaceans (sowbugs—often called “roly-polies” by kids), and myriapods (centipedes and milipedes).
1. Prepare plaster-of-paris according to manufacturer instructions and fill each plastic container halfway. Allow plaster to set. Sprinkle in just a little soil to provide places for your critters to hide, and a little dry yeast for them to eat. Make sure it is moist, but no free water. This will be your “ecotainer”.
 2. Cut the bottom off the plastic bottle and turn upside down so that it can be used as a funnel. Place wire screening inside the bottle so it acts as a platform.
 3. Half fill the funnel with soil and suspend above the plaster container (ecotainer).
 4. Suspend light bulb above the funnel about 4” over the soil. The light will dry out the soil and drive the critters downward and into your ecotainer.
 5. Leave the set-up up overnight
 6. To keep the humidity up, keep a lid on the ecotainer, but poke some holes in the lid for air.
 7. Observe your critters under a magnifying glass or dissecting microscope. You will be able to see many different types of microarthropods crawling around and interacting.

Earthworm Hunter

- ✧ In this activity how earthworms live, their interactions with the soil and other things in their environment and what may affect them should be discussed with the students.
1. Have students search an area around school (in groups of four or five) for signs of earthworms. Some things to look for are casts, mineral particles or organic matter at the soil surface.
 2. Where signs are found, dig up a shovelful of soil and dump onto plastic sheeting.

3. Have students sort through for earthworms.
4. To find the deep-burrowing species, pour a dilute mustard solution onto the soil—vertically burrowing worms should come to the surface in response to this irritant.

Earthworm factory

In a classroom, the Earthworm Factory can be done over a period of weeks to months, with students participating in raising the earthworms. Many people keep worms in this way all year long to create vermicompost (the nutrient-rich organic matter left behind after worms eat your kitchen scraps and bedding material) for the garden.

1. Use the plastic container to make a dark house for the worms. Make drain holes near the bottom.
2. Fill the bin with moist bedding. Bedding can be paper or newspaper shredded, leaves, straw, peat moss or sawdust or any combination of these. Make sure everything you add is non-toxic and don't use glossy paper (like magazines). Add a few handfuls of garden soil. Make sure the bedding is kept moist like a squeezed-out sponge. Change the bedding once or twice a year.
3. Feed the worms.
 - ✧ Yes! Fruit, vegetables, coffee grounds, bread, leaves, crushed eggshells (eggshells will keep the acidity nice and low)
 - ✧ No! Milk, oil, eggs, meat, fat, dog or cat feces.
 - ✧ Cut scraps into very small pieces (as small as you can—it will help worms break food down). Dig a hole in the bedding, dump the food in and cover it up with bedding. Pick a new spot each time you add food. Add about 3lbs. of food, once a week.
 - ✧ Keep them damp and at 55-77 degrees F. Add water if the bedding feels dry, but make sure the excess water can drain away. Cover the bin with lid. If your bin starts to smell, you've added too much food and should stop adding food for a while.
4. If the worms try to crawl out of the bin, it means conditions in the bin are not optimal. Check moisture and food levels. If they insist upon escaping, you can leave the lid off—they will not crawl upwards unless they sense darkness above them. Instead, use plexiglass or wire mesh for a lid.
5. At the end of the year (late springtime, or after the last danger of frost), you can arrange to have the children take the worms home to their gardens or backyards, along with some of the compost from the worm bin.
6. Prepare paper cups with labels that explain what vermicompost is, and instructions for what to do with the contents of the cup.
7. When you are ready to fill the cups with the children, spread out a large sheet of plastic, and dump the bin upside down on it. Since the worms like the bottom of the bin, they will now all be on top of your pile.
8. Sort through the pile with children to help them choose their worm. Add the worm to a cup, and fill the rest of the cup with the material from the bin (compost and remaining bedding) to keep the worm happy and moist before capping tightly with the lid. Add only one worm per cup.
9. Make sure children treat their worms gently (don't shake or leave in the heat), and understand that the worms are not pets. They should release the worm into their garden or

backyard as soon as they get it home since it will die if left in the cup. The worm and vermicompost will help their plants grow strong all year long!

Check for understanding:

Make a Mycorrhizal Model

Possible Questions

1. What happened to the size of your model when you added the yarn? What does this mean for the plant?
2. What do you think the fungus gets out of this relationship?
3. Does everyone have the same color (type of) mycorrhizae attached to the roots of their plants?
4. How do you think a plant with mycorrhizae would grow compared to one that doesn't have any?

Suggested Answers

1. The amount of soil that the root + fungus unit can reach is much greater than what the root would be able to reach on its own. This means that the fungus can reach water and nutrients that the plant wouldn't otherwise have access to and send them back to the plant roots. This can help the plant in times of drought and give it a competitive advantage over other plants in terms of nutrients.
2. The fungus receives a lot of the sugars (energy) that the plant makes from performing photosynthesis.
3. Not everyone should have the same color of fungal strings attached to their plant roots. This is because there are many different types of this fungus and several different types can infect the same plant.
4. A plant that has this type of relationship will probably grow bigger and be healthier than a plant without it, because it will have access to more water and nutrients.

Crawlin' Critters Ecotainer

Possible Questions

1. What do your critters look like?
2. What are they doing?
3. There are several different groups of arthropods that scientists call "shredders", "predators", "herbivores", and "fungal-feeders". What do you think they eat? What eats them?

Suggested Answers

1. There should be many different types of arthropods in your ecotainer. Do a search on the worldwide web under "soil arthropods" to see some pictures of what you can expect.
2. Most of the critters that you see will be crawling or running. You may tell your students that they are probably looking for food to eat, or trying to hide. Because these are soil creatures, they like the darkness of the soil and don't like to be exposed to light very much.
3. The shredders eat dead plant material and roots. If you've ever seen a leaf with just the veins left, this is probably the work of shredders. Predators eat other soil animals. Herbivores eat living plant material, and sometimes they can become pests. Fungal-feeders eat fungi. As soil arthropods eat their food, they mix up the soil (which helps to aerate it), keep populations of

other soil organisms from getting too high, and they break down organic material into smaller pieces so that microbes can work on it.

Earthworm Hunter

Possible Questions

1. Do they all look the same, or are there different colors and sizes?
2. What might this say about what they do in the soil?
3. What sorts of things might earthworms do that help their environment?

Suggested Answers

1. Hopefully you will find a variety of earthworms in your soil. They should be different sizes and slightly different colors. Don't confuse earthworms with grubs, which are the immature forms of beetles and other insects (these will almost always be white and fat with a distinct head region).
2. The smallest earthworms live in or near the surface plant litter. They are too small to move a great deal of soil. They can often be found in compost piles. The medium-sized worms live in the top several inches of soil and do not have permanent burrows. As they move through the soil, eating the soil and organic matter, the channel they leave behind gets filled with cast material. The largest earthworms (usually called "night crawlers") live in permanent burrows that may be several yards deep. They eat plant matter that they pull down into their burrows from the surface, and often plug the entrance to their burrows with organic matter or casts.
3. Earthworms shred, mix and bury dead plant material that would otherwise stay on the surface of the soil. Once they do this, the other organisms we talked about (microorganisms and arthropods) can use this material for food and release nutrients into the environment. Because of the channels that earthworms make in the soil, they help water to penetrate the soil instead of running off and causing erosion.

Earthworm factory

Possible Questions

1. Many people raise earthworms at their homes just like we are doing in class. Why do you think they do that?
2. What are the things that the earthworms need to stay alive and healthy?

Suggested Answers

1. Some do it so they always have bait ready when they want to go fishing. Others raise earthworms for the compost they produce. This is an easy way to turn your kitchen scraps into fertilizer for your plants.
2. Earthworms need food (dead plant material), roughage (some soil) to help them digest, a moist environment otherwise they dry up and can't breathe, and air so that they don't drown.

Summary of learned material:

There are many different kinds of organisms living in the soil that can be very small or large enough to see and hold. These organisms all play different roles like breaking down organic matter to release nutrients, cleaning our water, and keeping the numbers of other organisms low. The things that live in the soil are important for keeping our environment healthy and clean.

Resources:

- ✧ An excellent source of information to help educators and students understand this material is the Soil Biology Primer, published by the Soil and Water Conservation Society in cooperation with the USDA-NRCS. To obtain a copy, contact the Society at <http://www.swcs.org>; email: pubs@swcs.org; (800) THE-SOIL, extension 10; or 7515 Northeast Ankeny Road, Ankeny, IA 50021.

General Sites:

<http://www.ucc.ie/impact/agri2f.html>

<http://www.waite.adelaide.edu.au/school/Soil/mutual.html> - Mycorrhizal Fungi images.

<http://www.agric.nsw.gov.au/reader/15055> - How Earthworms Can Help Your Soil.

<http://www.mastercomposter.com/purpose/goodsoil.html#WORMS>