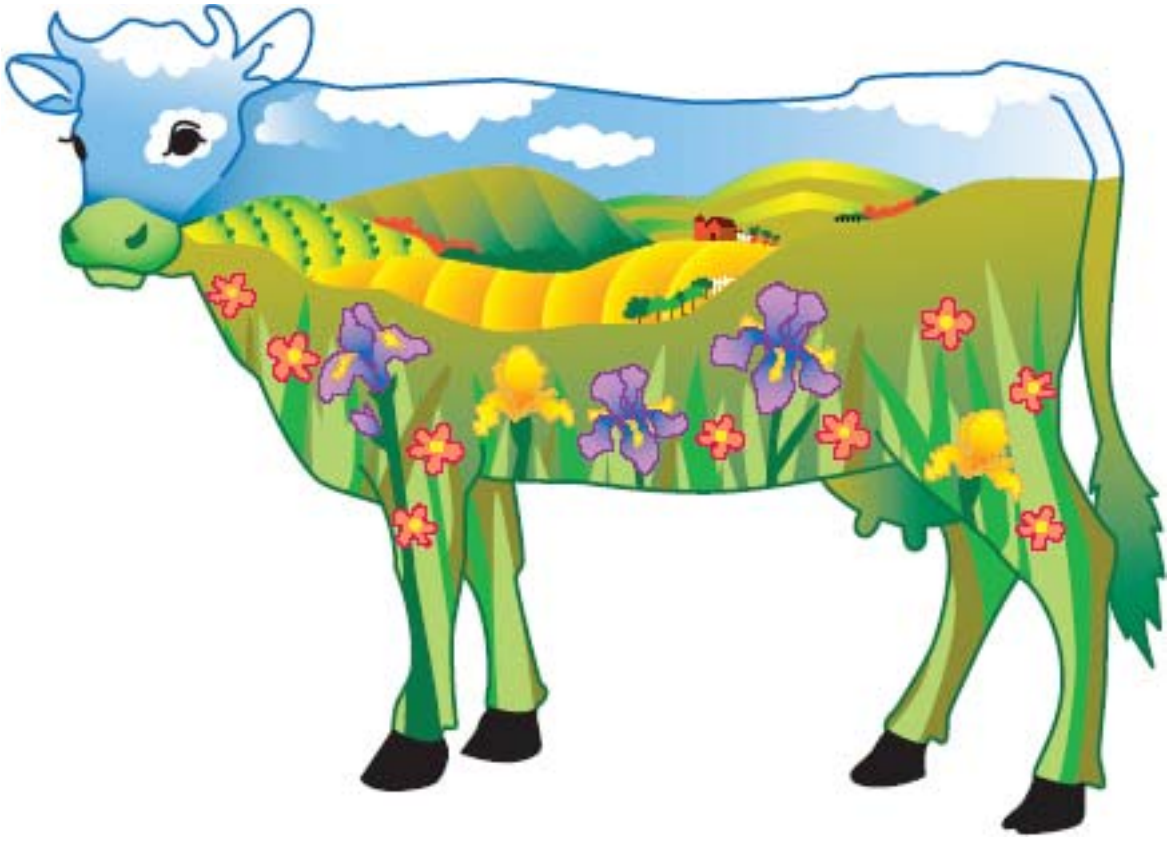
SOLE
Sciences of Life Explorations:
Through Agriculture
Grades 4 and 5



Teacher Guide
Unit: What's Living in My Soil?

UNIT PLAN

UNIT TITLE
What's Living In My Soil?

GOAL
In this lesson, students will learn that soil is full of life and activity, and will discover some of the small creatures that inhabit the soil community. They will learn to draw a soil community incorporating what they've learned.

OBJECTIVES
Students will:

1. Draw a representation of their school grounds, town, or county. (NYS Learning Standard 3, Mathematics: Elementary 4 and 5)
2. Locate on a map the places where soil samples were taken. (NYS Learning Standard 3: Geography, Elementary 1)
3. Observe and inquire about the soil environment and plant life. (NYS Learning Standard 1: Communication Skills, Checkpoint A, Modern Languages 1-- Standard 1: Analysis, Inquiry and Design, Elementary 1, Scientific Inquiry; Standard 3a: Universal Foundation Skills, Elementary 2)
4. List characteristics of soil in samples. (NYS Learning Standard 1: Analysis, Inquiry and Design, Intermediate 3, Scientific Inquiry)
5. Identify why certain types of soil would support crop growth better than others. (NYS Learning Standard 1: Analysis, Inquiry and Design, Elementary 1, Sci. Inquiry, and Intermediate 1, Scientific Inquiry)
6. Draw a representation of the soil community. (NYS Learning Standard 1- Language for Information and Understanding, Elementary 2)
7. Explore cultural myths of agriculture through reading comprehension. (NYS Learning Standard 2 – Language for Literary Response and Expression Elementary 1; and Standard 2– World History, Elementary 1)
8. Plant marigold seeds in a combination of soil substrates to demonstrate an ability to estimate and understand fractions. (NYS Learning Standard 3 – Mathematics, Elementary 5)
9. Measuring plant height over time. (NYS Learning Standard 3 – Mathematics, Elementary 5)
10. Weigh soil samples and explore why earthworms are more numerous in some samples than others. (NYS Learning Standard 4:Language for Social Interaction,Elementary 1; Analysis, Inquiry, and Design, Elementary 1, Scientific Inquiry; and Standard 3: Mathematics, Elementary 5)
11. Identify and research a member of the soil community through an interview with peers or parents. (NYS Learning Standard 1 – Communication Skills Checkpoint A Modern Language 1 and Checkpoint B Modern Language 1; Standard 1 – Language for Information and Understanding, Elementary 2; and Standard 2 – Language for Literary Response and Expression, Elementary 2)
12. Identify the natural resources used to provide people's basic needs, listing ways that land contributes to world agricultural productions. (Food and Fiber Systems Literacy I: Understanding Food and Fiber Systems, 4-5A)

13. Describe the role of natural resource management in Food and Fiber Systems. They will
14. explain the importance of managing soil to agricultural production. (Food and Fiber Systems Literacy I. Understanding Food and Fiber Systems, 4-5B)
15. Explain how soil geography influences food and fiber production. They will analyze regional geographic characteristics of the soil influencing food, clothing, and shelter choices. (Food and Fiber Systems Literacy II. History, Geography, and Culture; 6-8D)
16. Explain how soil ecosystems regenerate. (Food and Fiber Systems Literacy III. Science, Technology, and Environment; 4-5A)
17. Identify natural resource-management practices that limit pollution. They will cite agricultural practices used to manage and conserve the soil. (Food and Fiber Systems Literacy III. Science, Technology, and Environment; 2-3C)

TERMS

These terms highlighted in bold throughout the lesson pages

bacteria - simple organisms that break down organic matter; some are good, some can cause disease

casts - small soil clumps, high in nutrients and beneficial bacteria, expelled by earthworms as they break down organic debris

chlorophyll - green pigment found in plants, which they use to make energy

fungi - organisms similar to plants, except they don't make their own food; ex. mushrooms

humus - a layer of compost material just under the surface, made of plant and animal residues that are partly decayed, providing organisms with the majority of their nutrients.

inorganic - soething that is not alive and never has been

magnification - using a lens to make small things easier to see

micro-organisms - organisms which are too small to see without magnification

mites - small, spider-like animals that live in the soil and break down organic matter for their food

nematodes - tiny, worm-like organisms that live off other soil organisms

nutrification - a runoff process by which water and soil become overloaded with nutrients

organic - material resulting from plant or animal sources

organisms - a life form that is made up of body parts which help it function

parasites - organisms that have all their needs met by other organisms, without giving anything back

parent material - rocks an other materials that break down into soil

pH - the acidity or alkalinity of a soil, which determines what plants can grow in it

pores - small pockets in soil that hold air and water and provide homes for small soil creatures

respiration - the process that allows plants to take in oxygen from soil and release carbon dioxide

soil community - made up of soil and the life it supports (plants, animals, fungi, bacteria. etc.)

soil food web - a process that makes soil healthier by breaking down plant materials, forming humus, and recycling carbon and other nutrients

Integrated Pest Management is a specialized form of environmental management wherein scientific research and real world application work together to reduce pests such as insects, diseases or weeds.

1. Properly identify pests
2. Learn the pest/ host biology
3. Sample the environment for pests
4. Determine an action threshold
5. Choose the best tactic
6. Evaluate results

SAFETY

General school safety practices. Caution when exploring soil communities. Yellow jackets like to build their nests in the ground. Teacher may choose to give students plastic or gardening gloves to use when handling soil. Teacher should demonstrate shovel/trowel safety.

Standards Matrix for this Lesson:

		Standards:								
Month	**Unit**	**Math/Science/ and Technology**	**English Language Arts**	**Social Studies**	**HEALTH**	**ARTS**	**Food & Fiber Literacy**	**CDOS**	**Other Languages**	**Interconnectedness**
10	What's living in my soil?	1:7 e1	1:3 e2	2:15 e1			I A 4-5			
		1:7 i1	1:6 A1	3:16 e1			I B 4-5			
		1:7 i3	1:6 B1				II D 6-8			
		3:9 e4	2:4 e1				III A 4-5			
		3:9 e5	2:4 e2				III C 2-3			
			3a:2 e2							
			4:5 e1							

Matrix Key:

NYS Learning Standards arranged by Standard: Category, Level
e = elementary i = intermediate
Categories:

1 Career Development
2 Universal Foundation Skills
3 Language for Information and Understanding
4 Language for Literary Response and Expression
5 Language for Social Interaction
6 Communication Skills
7 Analysis, Inquiry, and Design
8 Information Systems
9 Mathematics
10 Science
11 Technology
12 Interconnectedness: Common Themes
13 Interdisciplinary Problem Solving
14 History of the United States and NY
15 World History
16 Geography
17 Economics

ADDITIONAL RESOURCES

Brady, N.C. & Weil, R.R. (2002). *Elements of the Nature and Properties of Soils* (2nd Ed.). New York: Prentice Hall.
Davidson, R.H. & Lyon, W.F. (1987). *Insect Pests of Farm, Garden, and Orchard* (8th Ed.). New York: John Wiley & Sons.
http://www.fcps.k12.va.us/StratfordLandingES/Ecology/home.htm
http://www.amonline.net.au/factSheets/ground_spider.htm
http://en.wikipedia.org/wiki/Ground_spiders

SUPPLIES AND EQUIPMENT

Pen, pencil, coloring supplies
Trowel or spoon and something to collect soil in
1 liter plastic freezer bags
Plastic mayonnaise jars
Magnifying glasses
Permanent marker
Samples of soil from different areas (geographically and by elevation)
Journals
Map of school builldings, if available
Local map of schools, town, or county
Potting soil
Marigold seeds
4” plastic pots

BACKGROUND FOR TEACHERS

Soil is the result of the erosion of parent material (different types of rocks, like sedimentary, igneous, and metamorphic). Therefore soil is full of various minerals like calcium, iron, nitrogen, phosphorous and potassium. “NPK” (Nitrogen, Phosphorous and Potassium) are characteristic nutrients needed by plants in large amounts (macronutrients) and make up most commercial plant fertilizers. These inorganic substances are necessary to support soil life. Soil organisms make these nutrients available to plants, supporting plant health. Unless we consume those plants (getting our necessary vitamins and minerals from their fruits, stems, or leaves) they break down into the soil as organic matter when they die, re-supplying those nutrients to the soil. They then become humus (compost) after being broken down partially by the soil community. These contributions can be seen in three key functions of soil: supporting plant growth, maintaining water quality, and recycling life.

Soil supports life in many ways. It provides an anchor for plants’ roots, keeping the plants from falling over. Through respiration, the process that allows plants to “breathe,” roots bring in oxygen from the soil and the plant produces carbon dioxide. This is sometimes called ventilation. Pockets of air or water in soil are called pores and harbor many creatures like mites, earthworms, and small insects like ants. Soil pores make water available to these creatures, and plants and other animal life like nematodes and roundworms. Pores have unique environments, such as variations in pH (acidity or alkalinity), humidity, and mineral composition. Because of the variety of environmental conditions found right next to each other, many types of soil life can be found within a small amount of space, and different plants thrive in different soil types.

Soil protects water through filtration, using the soil community of plants, animals, fungi, and bacteria to recycle it. Soil can also contaminate water if it is high in toxic minerals and metals due to pollution like pesticide and fertilizer buildup. Soil can also hold water for plant use or to support the soil community, or soil can contribute to the loss of moisture, due to its surface (bare or planted), structure, parent material, and organic matter.

Soil is rarely devoid of life. Soil which supports plant life is teeming with many soil organisms, the majority of which are too small to see. Some examples of soil organisms are fungi, bacteria, nematodes, diatoms (algae), earthworms, ants, centipedes, millipedes, beetles, snails, and slugs. All these soil creatures and more make up the soil community. Most fungi and bacteria are supported by relationships with plant roots, so they stay close to plants. Any creatures that live on fungi and bacteria also stay close to the roots. Other larger herbivores, like beetles, ants, centipedes, and termites, feed closer to the surface where more plant debris is located. By virtue of where the food is located, most soil creatures live within a few inches of soil closest to their food sources.

This community of organisms is deeply involved in the soil food web. It's basically a recycling program, where plant and animal residues are broken down by a chain of soil consumers (nematodes, bacteria, fungi, mites, earthworms, etc), who are then consumed by birds and other mammals, cycling carbon and essential nutrients. (See diagram that follows background information.)

Soil protects soil organisms from harsh sun, wind and, rain, while still providing air, water, and nutrients essential to life. When soil organisms break down plant and animal debris they change the structure of the soil. Creatures like earthworms break down larger vegetative clumps into smaller clumps of organic matter, making the soil structure finer. In a good plant debris-based soil (wooded soils), the actions of earthworm, as well as the amount of organic matter, greatly increases the soil's ability to hold nutrients and water, as well as structure (pores).

Soil lacking in oxygen, water, and organic matter would be very bare and devoid of biodiversity. The area would consist only of a few, very specific kinds of soil organisms and specific plants that could tolerate these challenging environmental conditions.

Examples of Soil community Creatures

1. Ants: Ants are known for their highly organized underground colonies and nests. Colonies can occupy a wide area of land. Some ants consume other soil creatures like centipedes, spiders, and mites, others prefer a vegetarian diet, and others live on animal and plant debris. The building of underground tunnels and nests can improve the soil's capacity to hold air and water, and cause changes in soil pH.

2. Termites: Termites are less involved in soil processes than ants, but there has been more research done on them. They can be found in many locations, but are most common in grasslands and tropical forests (both humid and arid). Their main contribution to the health of soil is through churning - bringing lower soil layers to the surface while taking surface layers deeper. The surface layers contain plant residues, which the termites use for food. This mixing of soil layers affects how the soil is formed and the overall health of the soil community.

3. Nematodes: The nematode is a unique soil creature, highly diverse in its feeding habits and size. These non-segmented worms are found in almost all soil types, but most are too small to see without some sort of magnification. They usually feed on fungi and bacteria, but some are plant parasites that attack plant roots. Still others are cannibalistic. As nematodes digest a bacterial population, a lot of nitrogen is released, increasing the amount of that valuable nutrient available to plants. However, those nematodes that feed on plants create puncture wounds that can quickly lead to infection by fungal and bacterial cultures. Nematodes move mainly by swimming, so they are most often found in wet, sandy soils.

3. Slugs and snails: Slugs and snails do not directly contribute to the health of the soil, but are still members of the soil community. Both feed on plant roots and tender new leaves and stems, although most snails don't do significant damage. During cold New York State winters, these creatures hibernate in the sheltered soil layers, but in warmer areas they are active all year long.

4. Centipedes and Millipedes: These soil organisms also feed on plant roots. They are most common in moist soils that are high in organic matter, like forest soils. They spend the winter in the subsoil (below the surface), but the majority of their time is spent near plant roots and near the surface in plant debris.

5. Spiders: While we usually think of spiders as living in webs, there are quite a number of spiders that live and hunt on the ground. These are broadly called ground spiders, all of which reside in one taxonomic family (*Gnaphosidae*). Found in all sorts of climates, they are commonly located in leaf and bark litter on the soil surface, although some construct very specialized dens in the upper layers of the soil. They are usually very neutral in color to blend in with their surroundings. These dens serve as traps to catch other soil creatures, the spider's main food source. None of the spiders in the ground spider family have been discovered to be seriously harmful to humans, even though there are more than 200 species.

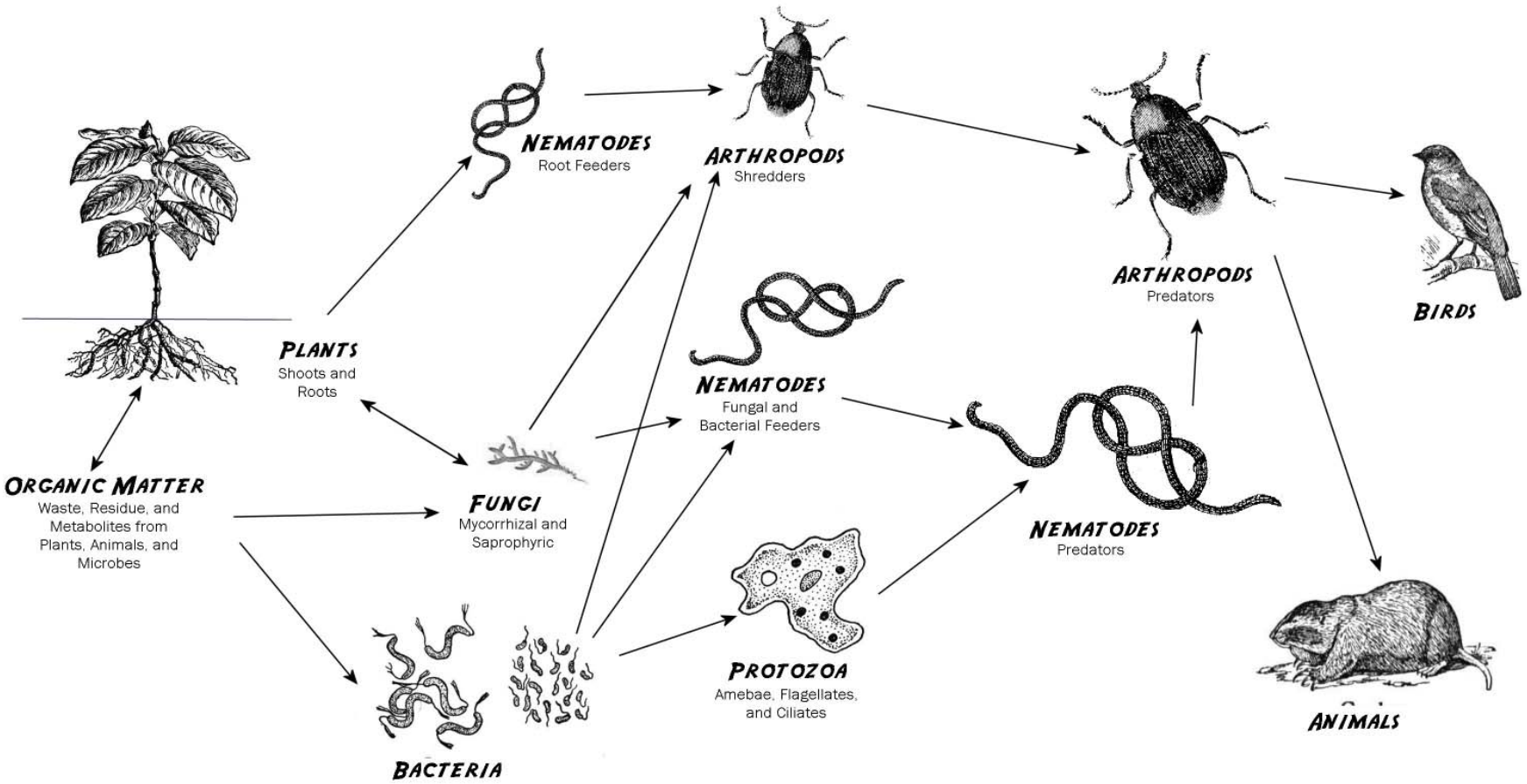
6. Earwigs: A common soil pest, the earwig devours the flowers and foliage of many garden and greenhouse plants. Like many other soil creatures, earwigs spend the winterwinter in the subsoil. They do not directly contribute to the health of the soil except for adding their organic residues.

7. Beetles: The dung beetle is the most influential soil contributor in the beetle family. The female beetle creates dung balls to house her eggs; the nutrients from these are not added to the soil right away but are conserved for later. This prevents nutrification, or overloading water with more nutrients than the ecosystem needs.

8. Toads and Frogs: Contrary to popular belief, toads and frogs are not really different, taxonomically speaking. Toad and frogs are all members of the order *Anura*.They use the litter layer (leaves, sticks and other organic residues) and sometimes the subsoil to live, digging burrows for nests. Their main purpose in the soil food web is recycling organic matter.

9. Earthworms: Worms may be the most important contributors to soil health, as well as deeply involved in the recycling of organic matter for nutrients. Earthworms break down organic debris and expel waste material called casts or castings, which are high in nutrients and beneficial bacteria. Plants use these nutrients to maintain health and growth, while the bacteria help to stabilize and improve the structure of the soil. These casts can be seen with the naked eye and appear as small globular clumps, generally located on the soil surface in plant litter where the worms reside. Because worms are so important to the soil community and the soil itself, there is a whole separate unit devoted to them.

THE SOIL FOOD WED



FIRST TROPHIC LEVEL	SECOND TROPHIC LEVEL	THIRD TROPHIC LEVEL	FOURTH TROPHIC LEVEL	FIFTH TROPHIC LEVEL AND UP
Photosynthesizers	Decomposers Mutualists Pathogens Parasites Root Feeders	Shredders Predators Grazers	Higher-level Predators	Higher-level Predators

QUESTIONS FOR STUDENTS

Can you think of any other examples of food webs?

What are some reasons why a soil would not have a layer of organic matter or humus near the surface?

What would be some environmental stratgies to remedy such a soil?

What would happen if a group from the soil food web (fungi, animals, plants, insects, arthworms) suddenly disappeared?

INTEREST APPROACH ACTIVITIES

The Soil's Alive

Goal:
To discover more about what lives in the soil.

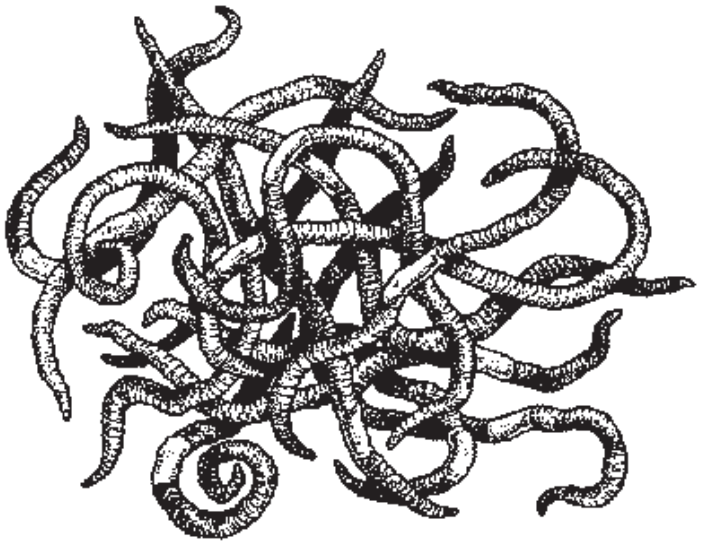
Outcomes:
Students will:
1. Observes relationship by comparing and contrasting soil samples
2. Note differences in soil texture, color, and moisture content
3. Describe living creatures in the soil

Materials:

Small shovel(s) or trowel(s)	1-liter plastic freezer bags
Plastic jars	Magnifying glasses
Permanent marker	Journals
Samples of soil from different areas (geographically and by elevation)	Map of school grounds, town, or county

Procedure:
1. Preparation
   - A. Do a survey walk
     - i. Take note of locations that the students would be interested in taking samples from.
     - ii. Be sure to have a variety of locations.
     - iii. Suggestions:
       - a. Garden or flower bed
       - b. Wooded area
       - c. Near a parking lot
       - d. Near a sidewalk
       - e. Turf (grassy area)
   - B. Have a table in the classroom ready for observing soils
   - C. If students will be drying soil, you'll need a place where soils can be left for several days
   - D. Have students draw a map of the school grounds

2. Digging Soil
    A. At each area, have students:
    B. Observe location and vegetation
    C. Describe location and vegetation orally
    D. Write about location and vegetation in journals
    E. Use trowel or shovel to collect several clumps of soil
    F. Place soil in freezer bags
3. Observations
    A. Place soil samples on table in classroom
    B. Divide students into groups
        i. One soil sample bag per group
    C. Students observe characteristics of the soil
        i. Characteristics may include:
            a. Gravel
            b. Rocks
            c. Sand
            d. Earthworms
            e. Ants
            f. Other soil creatures
            g. Color
            h. Moisture
            i. Texture
        ii. Chart observations by location
        iii. Predict from chart which soils might be best for growing crops.



Sample chart:

	Example	Wooded	Hillside	Near Parking	Near Sidewalk	Etc.
Texture	Sticky					
Color	Reddish Brown					
Living Creatures	Worms Spider					
Moisture Content	Not Very Wet					
Gravel	None					

Growing Marigolds

Materials:
Soil from sample sites in previous activity
Marigold seeds
Plastic jars (such as mayonnaise jars)
Gravel

Goal:
Discover which soil will grow seeds best

Procedure:

1. Distribute one jar for each soil sample
   A. Place soil in bottom 2/3 of jar
   B. Label with site the soil came from
   C. Add 1¼" of gravel.
   D. Add more soil, filling to near top of jar.
   E. Plant five marigold seeds ¼" deep.
2. Hypothesize:
   A. How will the marigolds grow in their soil samples?
   B. Will there be differences between soils?
3. Water every other day, the same amount for each jar.
4. Observe after 10 days
5. Start taking daily measurements of plant growth.
6. Evaluate:
   A. Were there differences in growth?
   B. Why or why not?

Sample chart:

	Day 10	Day 11	Day 12	Day 13	Day 14	Day 15
Height	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"

SUMMARY OF CONTENT	TEACHING-LEARNING ACTIVITES
I. Introduction: What's Going On in There? A. Encourages students to consider the amount of actual life going on in the soil community. B. Students introduced to slugs, sowbugs, earwigs, toads, ants, beetles, centipedes, spiders, and earthworms	I. Introduction: What's Going On in There? Students are introduced to the terms organisms, magnification, and microorganisms and encouraged to consider what's going on in the soil and what micro-organisms do. Students identify the soil creatures in each picture.
I. What are microorganisms? A. Students are introduced to fungi, cholorphyll, bacteria, nematodes, parasites, and mites. A. Provides a brief description and picture of each type of organism.	I. What are microorganisms? Students will learn about the micro-organisms in soil. This page can be read individually by students or aloud as a class.
III. A Soil community A. Using the soil organisms they have learned about in this lesson, students will create a drawing of a soil community, with layers that are full of life.	IV.A Soil community Students think of three animals that live in the soil and the homes they build. Students draw a soil community that includes small creatures, creatures above the soil, and plants.
IV. Writing Activity A. Students choose one soil organism to write about and relate to its role in the soil community.	V. Writing Activity A. Students choose a soil organism to write a paragraph about i. Name ii. Appearance iii. Role iv. Supporting detail v. Conclusion B. Additional research may be done
V. Vocabulary	V. Vocabulary

name _____

Student Lesson: What's Living in My Soil?
Introduction: What's Going On in There?

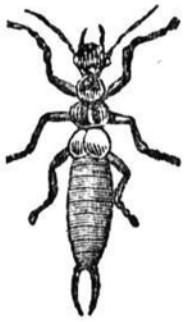
Have you ever dug in the soil and seen little creatures moving around? Soil is full of living things. You probably recognize earthworms when you see them, but what else lives in there?

Many creatures and organisms are large enough to see with your eyes, but some are too small to see without magnification. They are called mirco-organisms. Soil is full of living things.

Why do some soil creatures scurry away when we uncover them? Most soil creatures like a dark, damp environment.

Use the hints we've given you to identify the soil organisms in the pictures below. You'll find the slug, sowbug, earwig, toad, ant, centipede, spider, earthworm, and beetles.

1.


2.


3.


4.


5.


6.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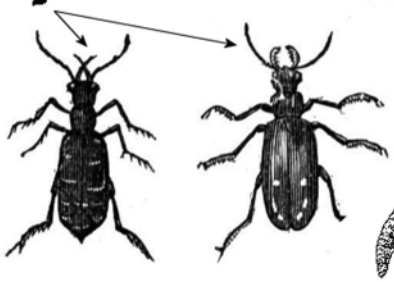

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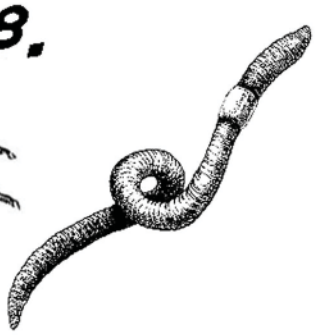


1. _ O _ _ _ _
2. _ _ R _ _ _
3. _ _ _ G
4. _ _ A
5. _ N _
6. _ _ _ _ I _ _ _ _
7. _ _ _ _ _ _ S
8. _ _ _ _ _ _ _ _ M
9. S _ _ _ _ _

9.

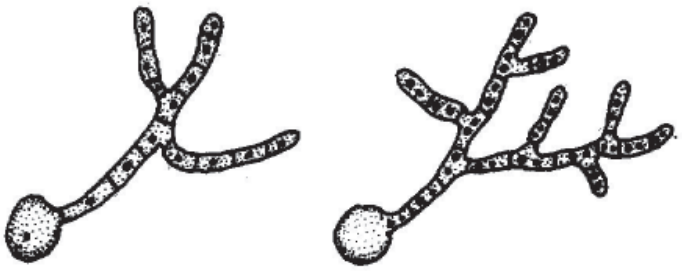

name _____

Student Lesson: What's Living in My Soil?
What are Micro-organisms?

Micro-organisms are living things that we normally can't see without the help of magnification. You can use a magnifying glass or a microscope.

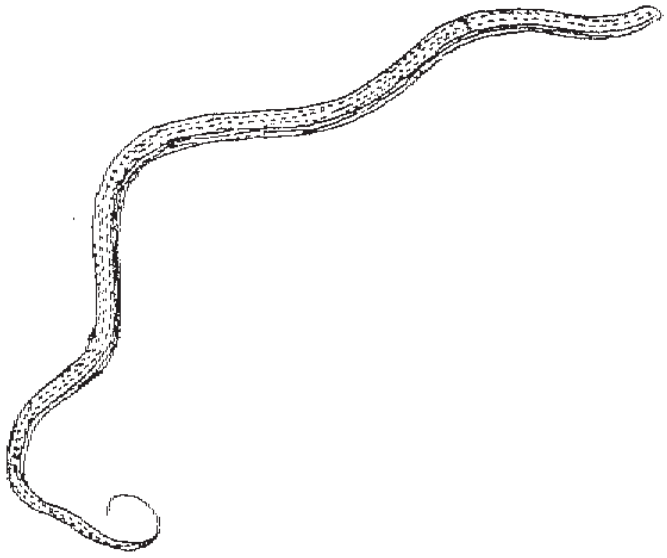
Some of the things in the soil are plants or animals. Some, like fungi and bacteria are neither.

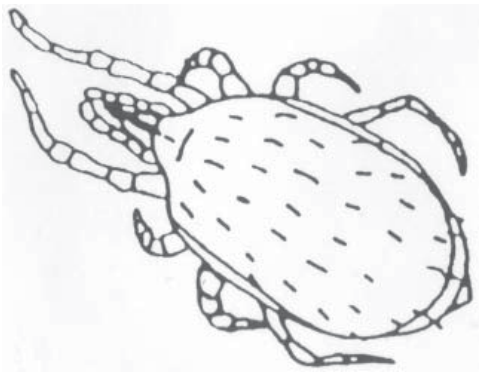
Fungi is the name of a kingdom of organisms similar to plants. Fungi do not make their own food like plants do, because they do not produce chlorophyll. Most fungi are helpers because they digest and recycle organic material. Some cause diseases.



Bacteria are in the air, water and soil. They are very simple organisms that break down organic material for their nutrition. Like fungi, most are helpful, but some cause diseases.

Nematodes are wormlke soil organisms. It is estimated there are thousands in every handful of soil, because most of them are so small. They are parasites, living off other organisms. Despite this, most do not cause problems for humans, but can affect some plants.





There are many types of soil mites, and the soil is full of them. They also break down organic matter. Mites are like spiders or ticks. They have 8 legs and are not insects.

name _____

Student Lesson: What's Living in My Soil?
The Soil community

We've talked about some very small things that live in soil. Many larger creatures also make their homes in soil. One example is the toad.

Can you think of three animals that live in the soil and what kind of homes they build in it?

1. _____ Kind of home: _____
2. _____ Kind of home: _____
3. _____ Kind of home: _____

Draw a soil community. Include at least two very small soil creatures, two that live above the soil, and two plants (include their roots). Try to create a soil community similar to what is found near your school or home.

above ground

below ground

name _____

Student Lesson: What's Living in My Soil?
My Soil Organism

Pick one of the soil organisms you placed in your soil community drawing.

What does it do? What is its role in the community?

Write a paragraph about the organism. Be sure to include the following:

1. Name the organism.
2. Describe how it looks.
3. Describe what it does and how that helps the soil community.
4. Give at least one supporting detail for your answer (How can we tell it is busy doing its job?)
5. Write a conclusion

name _____

Student Lesson: What's Living in My Soil?
Vocabulary

bacteria - simple organisms that break down organic matter; some are good, some can cause disease

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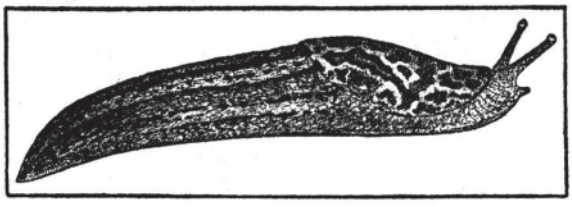

Integrated Pest Management is a specialized form of environmental management wherein scientific research and real world application work together to reduce pests such as insects, diseases or weeds.

1. Properly identify pests *4. Determine an action threshold*

Teacher Information for Student Worksheets

Student Worksheet 1

Introduction: What's Going On In There?

Students and teachers have varying interests in up-close encounters with soil creatures! Students may not think there is much going on in soil, other than earthworms and plant roots. This lesson encourages students to consider the amount of actual life going on in the soil community. Ask students to volunteer names for each of the soil creatures pictured.

Slugs and snails are very similar but snails are the ones who carry their shell on their back! Sowbugs and pillbugs are also similar, but pillbugs are able to completely roll up for protection. Many beetles live in the soil, and most are beneficial. They eat pest insects and other organic matter. Centipedes have very visible legs, while millipedes are shinier, with small legs, and appear more worm-like. Many spiders live in the soil community.

Student Worksheet 2

What are Micro-organisms?

Thousands of microscopic organisms are contained in soil. Bacteria are the largest population. Most soil organisms are beneficial, reducing organic matter and improving it for plants. There is a constant interaction of these microscopic organisms. They provide food for one another directly or indirectly. Active bacteria in the soil cause the odor associated with springtime in fields, gardens, and lawns.

Student Worksheet 3

The Soil community

By now, students should have a general idea of animals and other organisms that live in and around the soil and make up the soil community. A list is provided on the vocabulary page at the end of the lesson. Grasses, plants, weeds, rotting leaves, and wood may also be added.

Using the soil organisms they have learned about in this lesson, have students draw a soil community. Encourage them to add details like burrows, wood piles, leaves, plants and roots. Remind them that soil has layers, includes rocks, and is full of life.

Student Worksheet 4

My Soil Organism

Students may choose one of the soil community members they included in their drawing to complete this writing activity. Request as much or as little detail as you desire. This is a good opportunity for some research work!

The important part of the writing exercise is to relate the organism to its role in the community. Is it beneficial? Is it a predator? Can it be a problem for plants or animals? What would change if it were not involved in the community?

Student Worksheet 5

Vocabulary

Provided for student reference