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4-H Plant , Soils, and Entomology Curriculum

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Exploring the World of Plants and Soils

Project Book 1

It's More Than Just Dirt



Virginia Cooperative Extension
Virginia Tech • Virginia State University

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It's More Than Just Dirt

Table of Contents

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Table of Contents	Inside Front Cover
Note to Project Helpers	1
What's Inside	2
Project Guidelines	3
Activity 1: It's all about Minerals.....	5
Activity 2: How Much Does Organic Matter Matter?.....	9
Activity 3: Soil is Alive!.....	12
Activity 4: What Goes in the Spaces?	15
Activity 5: The Ways of Water in Soil	18
Activity 6: Nature's Nutrients	21
Activity 7: Help! I'm Drowning!.....	24
Activity 8: Soil Lends a Hand	27
Activity 9: Holding Things Together	30
Activity 10: Picky Plants	33
Activity 11: Is Your Soil a Lemon or an Egg White?.....	36
Activity 12: How Does Your Garden Grow?.....	38
Word Power Glossary.....	40

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Exploring the World of Plants and Soils: 4-H Plant and Soil Science Project Series.
National 4-H Council, Chevy Chase, Md.

Stern, L.R. (2000). *Introductory Plant Biology*. McGraw Hill: Boston, Mass.

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It's More Than Just Dirt

Note to Project Helpers

It's More Than Just Dirt is the second Project Book in the Exploring the World of Plants and Soils series. This Project Book looks at environmental and internal factors that affect plant growth. It is written to interest youth aged 12 to 14.

The *Exploring the World of Plants and Soils* Project Books include:

It's More Than Just Dirt

Stems and Stamens

Sprouting Out and Growing Up

Exploring the World of Plants and Soils Project Goals

The objectives of this series are to give young people the opportunity to:

- Learn basic facts about plants and soils including plant growth factors, plant reproduction, plant characteristics, how people utilize plants, and the function and characteristics of soil.
- Gain knowledge about plants and soils through experimentation and exploration.
- Stimulate an interest in gardening, plants, soils, and the natural world.
- Appreciate human accountability towards responsible earth stewardship and environmental decision making.
- Relate to life cycles and other cycles found in nature.

Project Helper's Role

For youth to gain the most from this learning experience you should:

- Review the *It's More Than Just Dirt* Project Book.
- Support the youth as he or she sets goals and completes each activity.
- Play a proactive role in selecting activities, assisting in activity completion, and answering questions.
- Help the young person to think about what they are experiencing and learning through active listening and open-ended questioning.
- Encourage the youth to keep a Project Journal to document activity recordkeeping requirements, answer activity questions, and record personal thoughts and ideas.
- Serve as a resource person to help connect the young person with the community, resource materials, and others knowledgeable about plants and soil.

These experiences can be fun and educational for both you and the young person who takes on this challenge. You don't have to be an authority on plant and soil science to be a leader in this project, but you do need the enthusiasm and desire to help youth learn and grow as they explore the world of plants and soils.

What's Inside

As you participate in the *It's More Than Just Dirt* project activities you will have many interesting and exciting experiences learning about plants and the many internal and external factors that affect their growth.

Here is a look at the various sections found in each activity:

Skills: The 4-H life and science process skills practiced as you do the activity. You will also have many opportunities to share what you learned with others.

Educational Standards: The Virginia Standards of Learning (SOL) for life sciences (LS), mathematics (Math), and language arts (LA) and the National Science Standards (grades 5 to 8) addressed by the activity.

Achievement Check: The skill you should learn by finishing this activity. Keep working on the activity until you have mastered each skill.

Materials: The supplies and equipment needed for each activity.

Let's Investigate: The exploration or experiment you carry out to learn about plants and soil.

The following information is found in each activity:



Diggin' In

Diggin' In: The information needed to help you complete the activity.



Considering Plants
and Soil

Considering Plants and Soil: Questions you answer and discuss with your helper that are related to what you have learned about plant parts, plant life cycles, and plant reproduction.



Branching Out

Branching Out: Additional activities to help you utilize and understand what you learned in the activity.



Cool Connections

Cool Connections: Interesting facts about plants and soil.



Word Power

Word Power: New words to learn and use. New words are found in bold print in the activities. Definitions are found in the glossary at the end of this book.

Project Guidelines

To complete the *It's More Than Just Dirt* project you must:

- Select a 4-H Project Helper
- Complete a minimum of four Required Activities and four Optional Activities in the *It's More Than Just Dirt* Project Book
- Participate in a minimum of two Leadership Experiences
- Participate in a minimum of one Service Learning activity
- Keep a Project Journal

4-H Project Helper

Select an adult project helper to support and assist you with these activities. This person may be a parent, family member, 4-H project leader, teacher, neighbor, or friend. The choice is yours. As you do the activities, discuss the activity process and your conclusions with your helper. Ask your helper to assist you throughout this project. Your helper can assist you as you set your project goals, discuss activity questions with you, and help you locate resources.

Name _____ Phone _____ Email _____

Project Activities

Carry out at least four Required Activities located under *Let's Investigate*. Ask your helper to date and initial this log as you complete the activities.

Required Activity	Date Completed	Helper's Initials	Required Activity	Date Completed	Helper's Initials
It's All About Minerals	_____	_____	Help! I'm Drowning!	_____	_____
How Much Does Organic Matter Matter?	_____	_____	Soil Lends a Hand	_____	_____
Soil is Alive!	_____	_____	Holding Things Together	_____	_____
What Goes in the Spaces?	_____	_____	Picky Plants	_____	_____
The Ways of Water in Soil	_____	_____	Is Your Soil a Lemon or an Egg White?	_____	_____
Nature's Nutrients	_____	_____	How Does Your Garden Grow?	_____	_____

Optional Activities

Carry out at least four Optional Activities located under **Branching Out** and list them here.

	Date Completed	Helper's Initials
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Leadership Experiences

Select and participate in at least two of these leadership experiences or devise one of your own. A leadership activity requires the organization of and the participation in an event, presentation, or tour.

Leadership Experience	Date Completed	Helper's Initials
Give a soil testing demonstration	_____	_____
Teach someone something about soil	_____	_____
Teach someone something about soil testing	_____	_____
Attend a gardening demonstration	_____	_____
Give a speech on a soil subject	_____	_____
Exhibit a soil project	_____	_____
Plan a tour of a soil testing lab	_____	_____
My own activity:		
_____	_____	_____
_____	_____	_____
_____	_____	_____

Service Learning Experience

Select and participate in at least one of these service learning experiences or devise one of your own. A service learning experience requires that you do something for someone in your community.

	Date Completed	Helper's Initials
Plant something to improve the environment	_____	_____
Share something you have grown with someone	_____	_____
Plant a vegetable garden and share the produce with a food bank, neighbor, or family	_____	_____
Gather flowers to share with an elderly person	_____	_____
My own activity:		
_____	_____	_____
_____	_____	_____
_____	_____	_____

Project Journal

Keep a Project Journal to document activity record-keeping requirements, answer activity questions, and record personal thoughts and ideas.

Activity 1. It's All About Minerals

Have you ever thought about soil and where it comes from? Most people do not give much thought to soil, yet it is the foundation upon which plants grow and as a result is vital to our existence here on earth!

Soil itself is made up of very small rocks, mineral particles, living organisms, air, organic matter, and water. The small rocks and mineral particles found in soil are derived from weathered larger rocks. In fact, rock is called the parent material of soil. The weathering of different types of rocks by heat, cold, water, wind, and the movement of living organisms makes every soil unique.

Let's Investigate

Soil Layer Cake

The mineral components of different soil types are made up of different amounts of sand, silt, and clay mineral particles. This soil activity demonstrates the different types and proportions of mineral particles that make up different soils. Compare two or more topsoils from diverse locations to see the differences in soil types found in your neighborhood. Topsoil is specifically the upper 2 to 6 inches of the land surface in which plant roots grow.

1. From two or more areas, collect a quart of topsoil from a garden, flowerbed, woodland, or field. Label each sample by location.
2. Predict which site will have the most sand and which will have the most clay. Write down your predictions in your journal.
3. Empty the soils onto an old newspaper to dry. Crush lumps between your thumb and fingers as the soil dries.
4. After removing trash, rocks, and roots from the soil, label quart jars for each site and fill them $\frac{1}{4}$ full with dry soil from that site.

Activity: Compare the mineral make-up of different soils

Life Skill: Acquiring and Evaluating Information – selects and interprets information

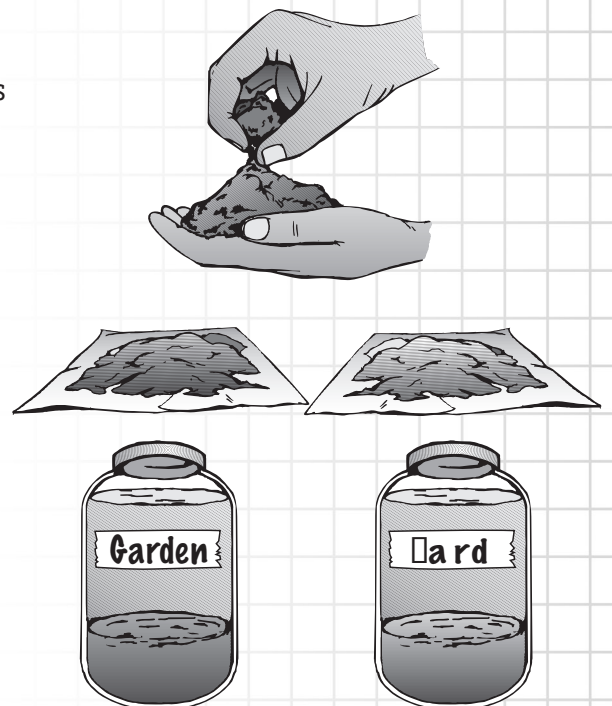
Science Process Skill: Organizing, gathering, and analyzing data

Achievement Check: You can describe the mineral components of different soils

Virginia SOL: LS.7; Math 6.1, 6.9, 7.1; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: two or more soil samples, newspaper, quart jars, masking tape, marker pen, non-foamy detergent (e.g. Dishwasher soap), measuring spoons, index cards, pencil



5. Add water until each jar is $\frac{3}{4}$ full.
6. Add a tablespoon of non-foamy detergent to each jar.
7. Close the lids and shake hard for about three minutes. Keep shaking until particles are separated from each other.
8. Set the jars on a table and watch very closely for a few minutes. Describe and write down what you observe.
9. Do not disturb the jars for two days.
10. Place an index card along side the jars. Mark off the depth of the clay, silt, fine sand and coarse sand. Label a card for each layer as illustrated. Fasten the card to the jar with tape. Draw a picture of the layers that have settled out in the jar. Be sure to label each card for the correct sample site.
11. Compare the soils. How are they the same? How are they different? Discuss your observations with your helper.
12. What percentage of the soil is clay? Silt? Sand? (example: # mm sand / # mm total soil sample = decimal fraction of the sand. Now convert the decimal fraction into a percentage).
13. Record your observations and calculations in your journal.
14. How do the results compare with your predictions? Discuss what you learned about the components of soil with your helper.



Diggin' In

Where Does Soil Come From?

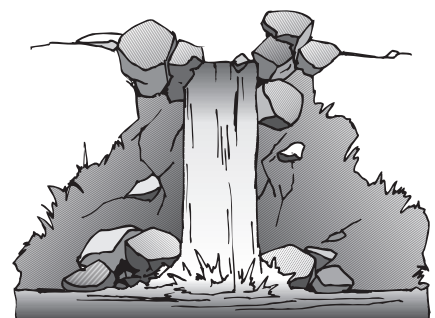
Many factors contribute to the development of soil from rock. The combined action of these factors is called the weathering of the parent material. The methods for breaking rock into mineral particles include:

- **Heat and cold**

The sun warms rocks during the day causing the rocks to expand, or get larger. At night the rocks cool and shrink, or get smaller. The expanding and shrinking of rock causes small pieces to break off. These small pieces become the mineral particles in a soil.

- **Water**

Water gets into small cracks in rocks. When the water freezes it expands, forces the cracks to get wider, and breaks the rock into small pieces. This process continues until the pieces of rock become the mineral particles in the soil. Water can also dissolve minerals into smaller particles, which eventually become a part of the soil. In addition, rocks tumble in streams and rivers. The force of moving water causes rocks and pebbles to rub together, knocking off rough parts. The rubbed-off mineral particles become part of the soil.

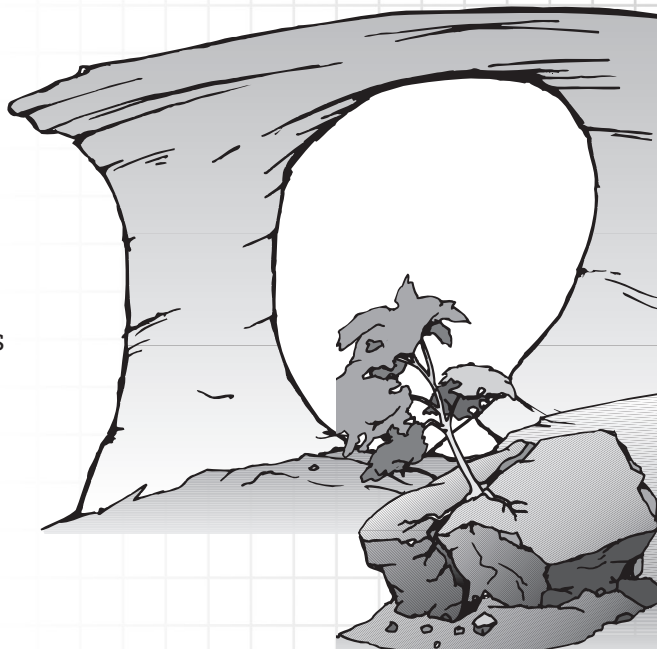


- **Wind**

Wind helps break rocks into smaller pieces that eventually become the mineral particles in the soil. The wind also picks up soil particles and carries them from one place to another.

- **Plants**

Plant roots spread and grow into cracks and crevices of rocks, forcing the rocks to split into smaller rocks and mineral particles.



Soil Structure and Texture

Not all soils are the same. Soils vary between countries, states, cities, towns and even between backyards. The minerals that make up different topsoils are dependent on the type of parent material that lies below. Soil has many properties that help us identify different types of soil, but it is primarily identified by soil structure and texture (how the soil looks and feels). A soil's texture is dependent on the size of the mineral particles of which it is composed. Particle sizes are classified as:

Sand Large particles that can be seen with the naked eye; coarse feeling

Silt Medium particles that are best seen with the aid of a microscope. Dry silt particles feel smooth like flour when rubbed between the fingers.

Clay Smallest particles that are sticky and slick when wet, and extremely smooth like talcum powder when dry; cannot be seen without the aid of a very powerful microscope.



Considering Plants and Soil

Let's Talk

How does the soil sample's original location affect the soil's composition?

Why do you think there are differences in the mineral composition of the soils you tested?

Let's Reflect

Plant roots grow in the topsoil level of a soil profile. Why do farmers spend a large amount of time taking care of the topsoil layer at their farms?

Why does it take hundreds of years for the topsoil layer to form? How would erosion affect this process?

Let's Use It

How would you prepare your garden plot for planting if it had so much clay that water could not seep in?

Pretend you are a farmer. What would you do to protect and maintain your topsoil?



Branching Out

1. Repeat this activity using soil samples from the topsoil and the subsoil layers of the same garden. Explain to your helper why you think the topsoil has different proportions of sand, silt, and clay than the subsoil.
2. Look at the banks of road cuts, excavations, and other places where soil depth is exposed. Describe what differences you observe between the topsoil, subsoil, and parent material. Share your observations with your helper.
3. You can demonstrate some of the physical forces of nature that break up rocks to form soils:
 - Using tongs, hold a piece of limestone over a flame or stove (BE CAREFUL. HOT TONGS. DO NOT BURN YOURSELF). Drop the hot rock into a pan of cold water. Record what happens. From what you observed, explain how the heat and cold of summer and winter can break rocks into smaller pieces.
 - Fill a small jar with water and screw the lid on tightly. Wrap a towel around the jar. Place the jar in a zip-lock plastic bag. Place the bag in a freezer. Record the effect of freezing on the glass. What happened? Why?
 - Rub two soft stones or rocks together. Record how rubbing stones together helps make soil.
 - Sodium chloride is a mineral element found in table salt. Put one tablespoon of table salt in a glass of water and stir. Explain the effect water has on minerals.
 - In your own words, explain the term "weathering."



Cool Connections

Rainfall is considered the most influential climatic factor in soil development. More topsoil is formed in areas of high rainfall, such as a deciduous forest, than in areas of low rainfall, such as a desert.



Word Power

Clay	Erosion	Parent material	Sand	Silt
Soil	Soil structure	Subsoil	Topsoil	Weathering

Activity 2. How Much Does Organic Matter Matter?

Plant and soil scientists, farmers, and gardeners know that organic matter improves a soil's ability to provide water and nutrients to plants. Organic matter 1) enhances soil water retention, 2) is a source of plant nutrients, and 3) improves air movement within the soil. Let's find out about this key component of soil.

Let's Investigate

Organic Matter in the Soil

Organic matter (OM) is the decayed or decaying remains of living things, and is a major component of most soils. Bacteria, fungi, and other decomposers in the soil break down dead plants and animals resulting in the production of humus. Humus mixes with the mineral portion of the soil, improving the soil's water holding ability and providing nutrients for plants growing in the soil. This activity helps you identify soils by texture and demonstrates how organic matter affects the texture and water-holding ability of a soil.

Feeling a Soil's Texture

1. To determine soil texture by feel, start by rubbing some sand between your thumb and finger. Note that it feels distinctly gritty. Next, feel some flour between your thumb and finger. This is the way a silt soil feels. Modeling clay will show the sticky slick feel of clay.
2. Collect several soils from different areas. Feel them between your thumb and finger. Classify them as mostly sand, mostly silt, mostly clay or a combination of the three. You should now have the "feel" of soils and be ready to classify soils by texture.

Organic Matter in Action

1. To demonstrate the effect of organic matter on the ability of soil to hold water, collect two cups of clay soil and one cup of sawdust. You can tell it is a clay soil because it will stick together without crumbling easily.

Activity: Demonstrate how organic matter affects soil texture and water holding capacity

Life Skill: Interpreting Information – analyzes information

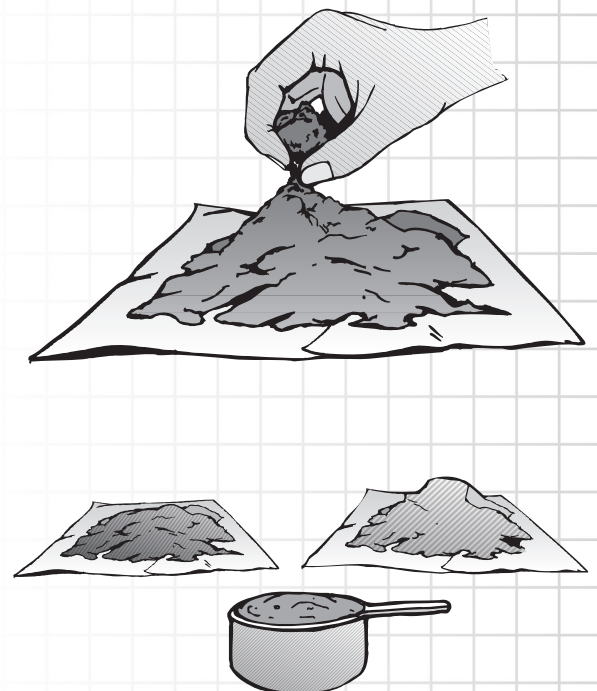
Science Process Skill: Observing and looking for evidence

Achievement Check: You can explain the important role of organic matter in a soil

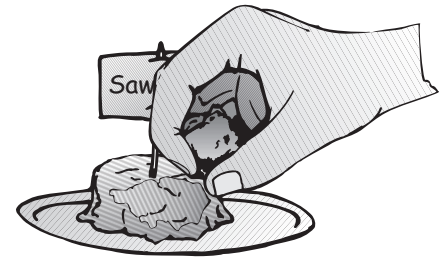
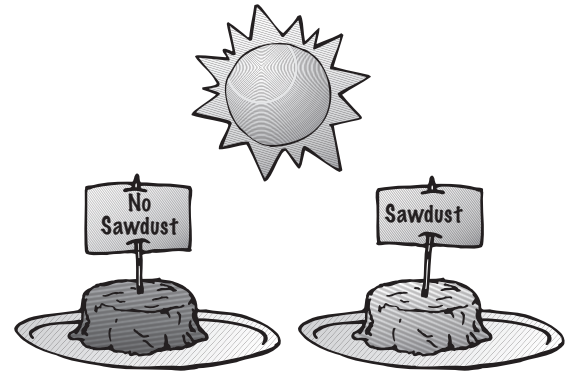
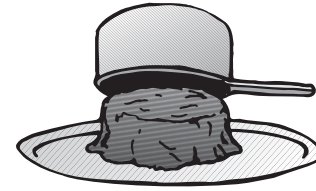
Virginia SOL: LS.7; LA 6.2, 6.6, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: sand, flour, modeling clay, clay soil, sawdust, paper plate, pencil



2. Label one paper plate "sawdust" and another "no sawdust."
3. Moisten 1 cup of soil until it makes a mud cake with up to $\frac{1}{4}$ cup water. (If the soil does not hold together, use a soil with more clay.) Place the mud cake on the plate labeled "no sawdust."
4. Mix thoroughly $\frac{3}{4}$ cup of soil and $\frac{1}{4}$ cup of sawdust with the same amount of water as above and make a mud cake. Place the mud cake on the plate labeled "sawdust."
5. Predict which soil cake will hold water longer. Write down your prediction in your journal.
6. Place both plates in the sun and let the mud cakes dry. Record the time it takes for each mud cake to dry.
7. Break the mud cakes with your hands. Which mud cake held the water for the longer period of time? How would you explain this? Which cake crumbled easier? What else could be used to improve water retention in a soil other than sawdust? Compare the results with your prediction.
8. Explain the differences that you observe to your helper. Be sure to record your observations in your journal.



Diggin' In

A Profile of Soil

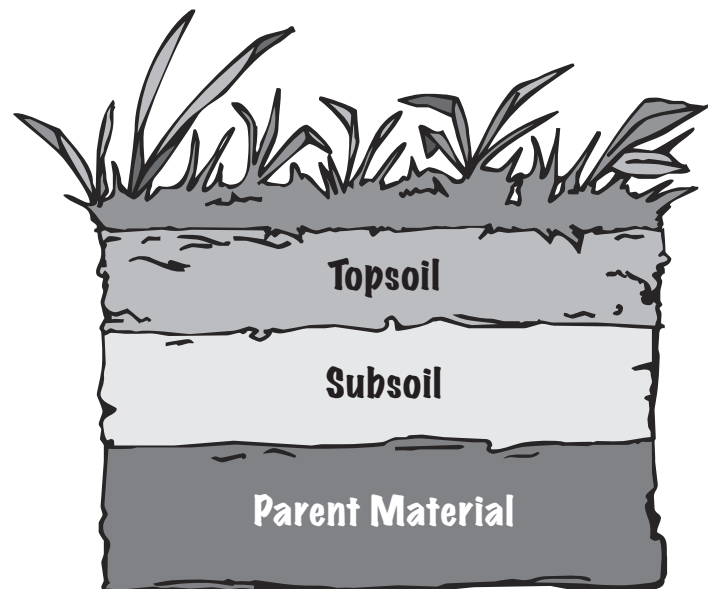
A cut-away look at the earth, called a soil profile, would expose the soil and rock layers that make up the earth's crust. These layers are:

Topsoil The uppermost layer. The topsoil layer extends from the ground surface down to the subsoil.

It is the upper 2 to 6 inches of the land surface. Topsoil can be shallow or deep and good topsoil is loose enough to plow for planting crops. There is a distinct difference in color and texture between the topsoil and the subsoil. Plant roots grow in the topsoil layer.

Subsoil The middle layer. Subsoil is the layer between the topsoil and parent material (usually between 12 to 30 inches beneath the surface). It is different in color and texture from the topsoil.

Rock The deepest layer is the rock, or parent material, that is broken up to make the higher levels of soil.





Considering Plants and Soil

Let's Talk

How does organic matter help soil hold water? What types of organic matter (other than sawdust) could be used to improve the soil?

How is organic matter added to soil every year under natural conditions?

Let's Reflect

Why is organic matter important to the plants growing in a soil? What effect does it have on soil when we bag our leaves and lawn clippings?

How does the creation of soil organic matter fit into the cycle of nutrients in nature?

Let's Use It

What could you do to enhance the organic matter in your garden this year?

Why do you think people buy compost rather than making their own?



Branching Out

1. Repeat this activity using soils from a bare school play yard and soils from along a fence or wall that has been growing grass for several years. Explain how organic matter improves the physical condition of this soil. Record your observations.
2. Find out what provides organic matter to the soil in a forest, grassland, tropical rain forest, and desert. How do the soils differ based on the climate and the plant life growing in these areas? How does climate affect organic matter availability?
3. Learn more about composting garden and lawn clippings. Why is composting an important step in lawn and garden care? Construct a compost pile in your yard for your family.



Cool Connections

"Vermiculture" is the process of using earthworms to help make compost from old garden plants and table scraps. Earthworms are great decomposers!



Word Power

Compost	Crop	Decomposer	Humus
Nutrient	Organic matter	Soil profile	Texture

Activity 3. Soil is Alive!

Soil is the home of a multitude of living creatures. A closer look at soil finds everything from earthworms and beetles to busy little moles and voles burrowing through the soil. In fact, soils are teeming with such a large number of bacteria, fungi, and other life forms that the soil itself is often referred to as "alive!"

Let's Investigate

Who's Living in My Garden?

This project introduces you to the many creatures that call soil their home.

1. Collect samples of soil from different areas. Collect 4 to 5 cups of soil each from home gardens, the schoolyard, forests, roadsides, or any other local area. Label each soil sample with information on its collection site.
2. Predict which sample will have the most visible life. Write your prediction in your journal.
3. Dump each soil sample on a large sheet of newspaper. Spread the soil out over the paper.
4. Label the newspaper with soil sample collection site information.
5. Describe each soil sample: What color is it? How does it smell? How does it feel? (Roll some in your fingers). What do the largest soil particles look like? The smallest?
6. Using a hand lens, explore the soil samples and remove any living organisms that are found. Record what you find according to sample site.
7. Mix water and soil from each sample. Observe the soil and water mixes under a microscope or hand lens. Describe the soil organisms seen in these samples to your group or leader.
8. In your journal, list the soil locations and the animal and insect life that is found in each sample. Compare the samples. How did it match up with your predictions?

Activity: Compare soils by collecting and describing the various forms of animal life present

Life Skill: Acquiring and Evaluating Information – Obtains and interprets information

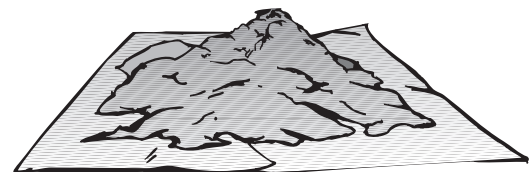
Science Process Skill: Organizing and classifying data

Achievement Check: You can describe the different organisms living in a soil

Virginia SOL: LS.7; LA 6.2, 6.6, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: soil samples (4 to 5 cups) from various locations, newspaper, marker pen, hand lens, microscope (optional), paper, pencil





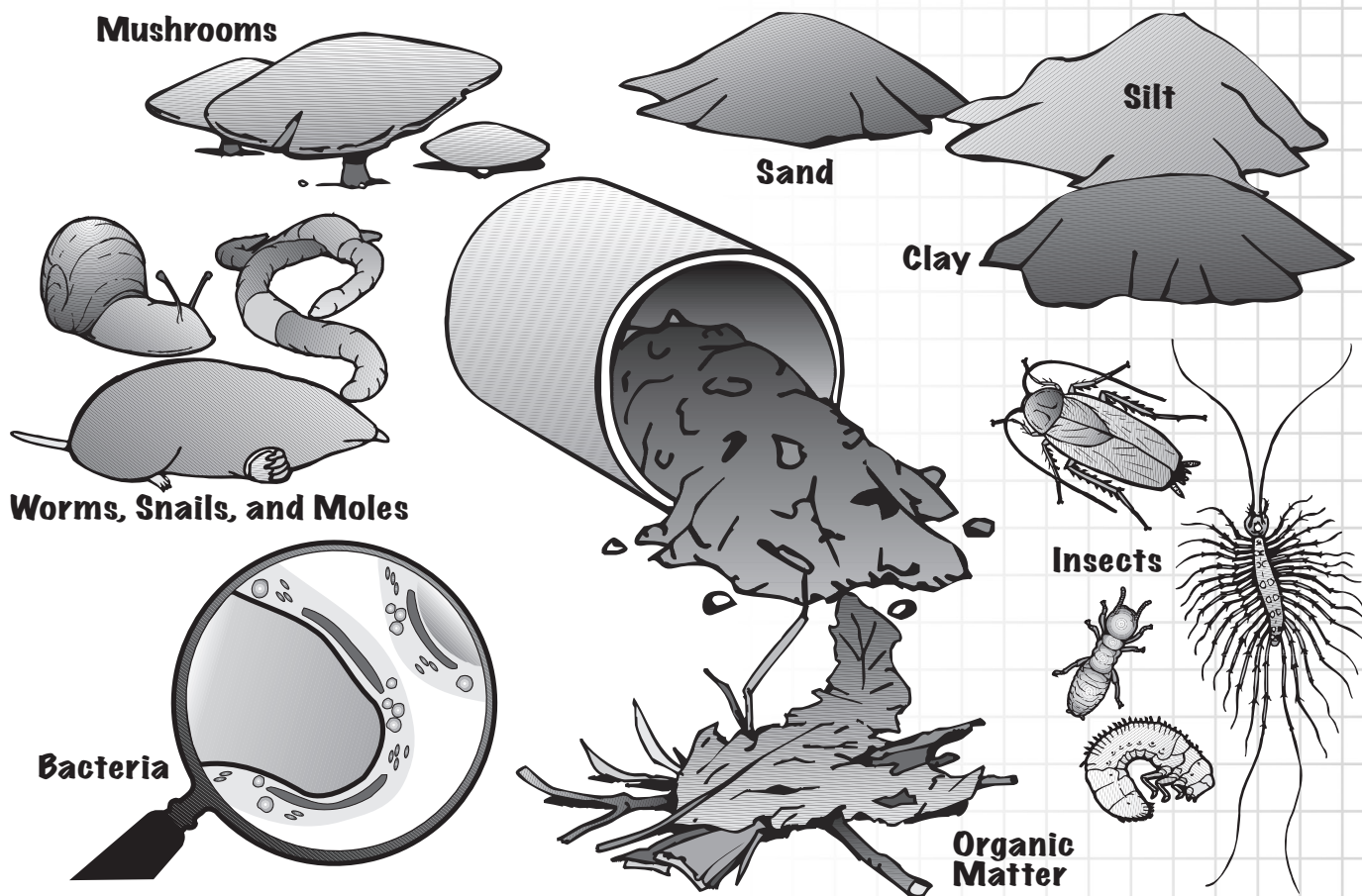
Diggin' In

A Busy Day in the Life of Soil

The topsoil is the soil layer where plants roots grow. The mixture that makes up the topsoil layer consists of:

- Mineral particles: sand, silt, and clay particles
- Organic matter: decayed plant and animal matter
- Water
- Air
- Microorganisms
- Animals: snails, worms, insects, moles, etc

This soil layer is where plants grow to provide us with the food that we eat, fiber for the clothes that we wear, wood to construct our homes, and many other products important to our health and survival. The soil itself is a storehouse of decaying vegetation and animal matter, moisture, air, and plant nutrients. The soil is also the dwelling place for insects, microorganisms, and other plants and organisms. Bacteria, fungi, molds, and protozoa are some of the plants and organisms living in the soil. They help dead plants and animals decay into small particles, which become part of the soil.





Considering Plants and Soil

Let's Talk

What was the most interesting creature you observed in your soil samples? Why?

Explain why soil animals and insects are considered part of a soil.

Let's Reflect

How should differences in soil texture and organic matter between the samples in this activity influence the presence of animal and insect life?

Which topsoil do you think is healthier, one with lots of living things in it or one with very few? Explain.

Let's Use It

"Soil" is made up of many components ranging from mineral particles to earthworms. How is soil similar to other areas in your life where many seemingly unrelated components constitute a whole?

Minerals, water, air, or soil organisms alone cannot support plant growth; however all of these components working together do support plant growth. How does the concept that many different things working together can provide successful results relate to both soil and other areas of your life?

Branching Out



1. List 10 ways in which soil is important to us. Consider such things as how we use soils to grow lawns and shade trees for our homes; grow food for animals and people; or how soils support houses and roadbeds. Share your list with your helper.

2. Research to find out more about one of the animals you found in your samples or one you wished you found. Share what you learned about this animal with your helper.

3. Make a list of the different types of creatures that live in the soil such as fungi, bacteria, mammals, and insects. Draw a picture of an example from each group in your journal. Label your drawings and put together a "Creatures of the Soil" portfolio.

Soil is important for...



Cool Connections

Some helpful bacteria growing in plant roots are able to remove nitrogen from the air and share it with the plant. In return, the roots provide a place for the bacteria to live....a symbiotic relationship in action!



Word Power

Organic Matter

Symbiotic

Topsoil

Vegetation

Activity 4. What Goes in the Spaces?

If you look at a sample of soil under a microscope, you see a mixture of mineral particles, organic matter, and living organisms. What you will not “see” are the air spaces between these different components. The air spaces, called pore spaces, are an equally important soil feature. Plant roots grow into the pore spaces and absorb the water they find in these spaces. Having air in these spaces is also important to healthy root growth. Remember that plants are living organisms, and all living things need air to live.

Let's Investigate

Air and Water in the Soil

Both air and water are components of soil. This activity demonstrates the presence of pore spaces in soil, and the relationship between pore space size and the water holding capacity of a soil.

Collect soil samples of about 2 cups from four different locations. Try to use at least one sample with high clay content. Predict which sample has the most pore space. Write your prediction in your journal.

Follow these steps for each sample collected:

1. Dry out soil by spreading it on newspaper to dry for one to two days. Break up any big clumps.
2. Measure $\frac{1}{2}$ cup of dry soil and put it in a glass jar.
3. Record the weight of the jar with the soil in grams.
4. Pour water into the jar very slowly until water reaches the top edge of the soil.
5. Weigh the container again.
6. Determine the weight of the water that filled up the air spaces in the soil (weight of jar with soil and water minus weight of jar with just soil).

Activity: Demonstrate the presence and importance of pore spaces in soil

Life Skill: Acquiring and Evaluating Information – Creates data gathering processes

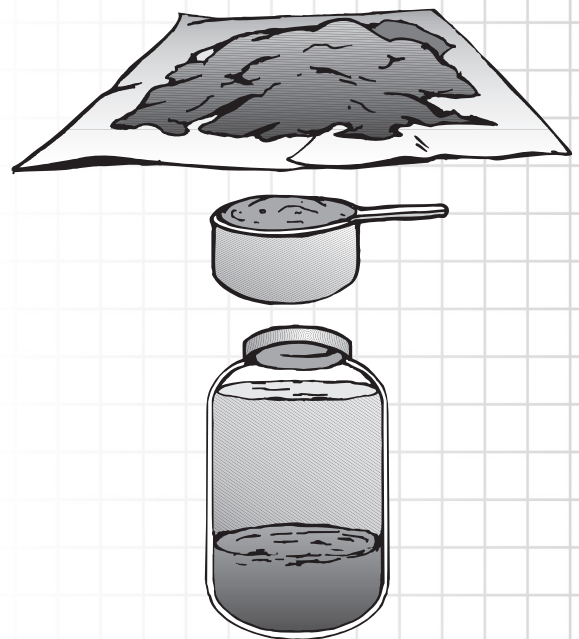
Science Process Skill: Solving problems through experimentation

Achievement Check: You can explain why pore spaces are a key characteristic of healthy soil

Virginia SOL: LS.7; Math 6.1, 6.9, 7.1; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

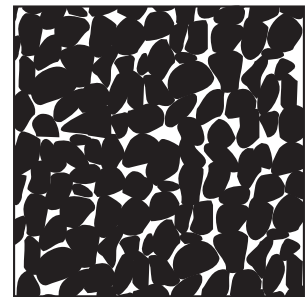
Materials: Soil samples (2 cups) from different locations, newspaper, glass jars, liquid metric measuring cup, gram scale, calculator



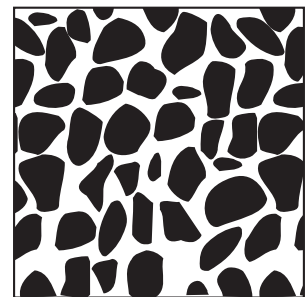
7. Because 1 gram of water displaces 1 milliliter of air, you can estimate the volume of air (ml) in each soil sample. Record your calculations in your journal.
8. Compare the air holding capacity of the different soils. What types of soil held the most air? Did the air capacity of the soil increase or decrease with the clay content of the soil? Why do you think this happened? Compare your results with your prediction and share what you observed with your helper.



Sandy Soils



Clay Soils



Silt Soils



Diggin' In

The Great Water Hunt

The ability of soil to hold water is dependent on the mineral particle size, and the presence of organic matter. Sandy soils are comprised of large mineral particles which create large pore spaces. Farmers add organic matter to sandy soils to fill in those large pore spaces, thereby increasing the water holding capacity of the soil. Clay soils are comprised of very small mineral particles which create very small pore spaces. In fact, these particles are so small that farmers add organic matter to clay soils just to break up "clumps" of clay particles, leaving room for air and water. Silt soils have medium-sized mineral particles resulting in medium-sized pore spaces. These soils are optimum for plant growth because they efficiently hold water and air in the pore spaces. Farmers add organic matter to these soils to provide a source of plant nutrients to the soil.



Considering Plants and Soil

Let's Talk

What is the relationship between the size of the pore spaces found in a soil, and the amount of water the soil is able to hold?

How does the size of the soil particles influence the size of the pore spaces?

Let's Reflect

What would happen to plant roots if all of the pore spaces were always filled with water?

Why is understanding the relationship between pore spaces, mineral size, and water holding capacity of a soil important to understanding soil and plant relationships?

Let's Use It

How will your knowledge of the relationship between pore spaces, mineral size, and water holding capacity of a soil help make you a better gardener?

Soil is composed of a variety of components that affect each other. How do the actions of other people affect the things that you can do? How is this similar to soil component relationships?



Branching Out

-
1. Sandy soils have very large pore spaces. After a rainfall, gravity easily pulls the water out of these large pore spaces and little water is held for the plants growing in this soil. Find out how farmers provide water to crop plants grown in sandy soil. Share what you learn with your helper.
 2. Homeowners are notorious for overwatering their houseplants. Find out why overwatering is the number one cause of houseplant death. Explain to your helper why understanding the importance of pore spaces is critical to understanding this overwatering problem.
 3. Draw a picture representing a grouping of mineral particles and the corresponding pore spaces in a sandy soil, a silt soil, and a clay soil. How does mineral size affect the size of the pore spaces? Using your drawings, explain to your helper how mineral particle size and corresponding pore space size affects plant root growth.



Cool Connections

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In a healthy topsoil, atmosphere humidity is most often near 100 percent.

There is more carbon dioxide than oxygen in the soil atmosphere due to the decomposition of organic matter in the soil....a process that uses up oxygen.



Word Power

.....

Pore space

Water holding capacity

Activity 5. The Ways of Water in Soil

Water makes up 90% of a plant's body! Plants rely on water to keep their cells turgid, which in return allows plants to maintain their form and structure. They also rely on water to transport food and minerals from one body component to another, and to regulate their body temperature. Plants obtain the water they need from the soil through their roots, therefore, plant growth and health is directly related to the water holding capacity of the soil in which they are growing.

As discussed in Activity 4, the water holding capacity of a soil is related to mineral size and the corresponding size of the pore spaces. Soils hold different amounts of water for different amounts of time depending on the amount of clay, silt, sand, and organic matter mixed in the soil.

Let's Investigate

Soil Drainage

This activity demonstrates the differences in the water holding capacity of different soils, by comparing the differences in the rate that water drains from different soils.

1. Select two or more soils that differ in color or texture. Try to select a sandy soil and a clay or silt soil.
2. Predict which soil will hold the most water. Write down your prediction in your journal.
3. Collect two glass lamp chimneys, or two aluminum drink cans with both ends removed or cans with one end removed and holes punched in the other end.
4. Fasten a piece of cotton cloth over the ends of the lamp chimneys using a string or a rubber band. Be sure it is held tight. If using cans with the holes, fit a piece of cloth or paper towel over the holes so the soil won't block them.
5. Fill the containers with equal amounts of soil (same kind of soil per container).

Activity: Demonstrate how soil composition affects the retention of water in a soil

Life Skill: Acquiring and Evaluating Information – Acquires and evaluates information

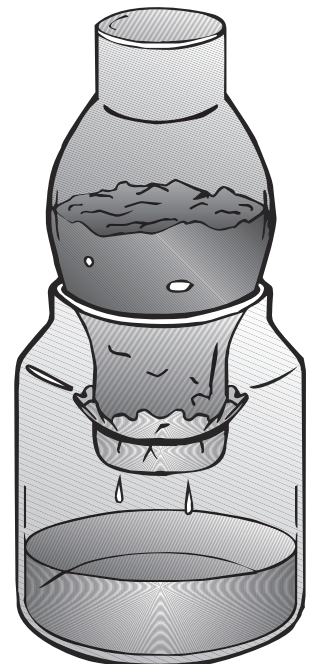
Science Process Skill: Organizing, gathering, and analyzing data

Achievement Check: You can explain how soil composition affects water retention in a soil

Virginia SOL: LS.7; Math 6.9, 7.4; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: Two or more soil sample from different locations, two glass lamp chimneys or aluminum or tin cans, cotton cloth, string or rubber bands, cloth or paper towels



- Place them as illustrated over jars of equal size.
- Add equal amounts of measured water to each container – about $\frac{1}{2}$ the volume of the soil. Avoid pouring water into the jar below.
- Note and record the rate that water is added and the time when water stops coming out of the bottom of the lamp chimneys. This time interval indicates the rate that water moved through the soil (soil permeability)
- Determine the amount of water held by each soil and compare. Record your calculations in your journal. With your helper, discuss the differences you observed and compare your results with your predictions.



Diggin' In

Soil Water

There are three kinds of water in soil:

- The water held tightly to soil particles. This water is not available to plants (hygroscopic water).
- The water held loosely by soil particles. This water is readily available to plants (capillary water).
- The free water pulled easily through the soil by gravity into the ground water. This water is not available to plants (gravitational water).

After rain or irrigation, the water in a soil drains away by the force of gravity. The water remaining in the soil after such draining is called capillary water. Because of surrounding partial pressures, this water is held against the force of gravity in the pores of the soil. Plant roots can take up capillary water and use it to meet the plant's water needs. The structure and organic matter content of a soil determines how much capillary water it can hold. In addition, plants must compete amongst themselves for the existing capillary water. Plants that have deep root systems have an advantage over those with shallow root systems.



Considering Plants and Soil

Let's Talk

How could you change a soil's ability to hold water?

How could you change the rate at which water moves through a soil?

Let's Reflect

Describe the relationship between the water holding capacity of a soil and the availability of air in that same soil. Are they the same or different? Why?

How would the building of a dirt road affect that soil's water holding capacity?

Let's Use It

Compare the relationship of roots to capillary water with our body cells relationship to our capillaries.

Why do people living in urban areas worry more about storm runoff than those living in rural areas?



Branching Out

1. Select a variety of plants that are similar in size. Include a broad leaf plant such as the bean, a narrow leaf plant such as a pine seedling, and a succulent plant such as a cactus. Plant them in gallon containers filled to the same height using the same soil. Water as needed until well established. Stop watering the plants (Record the date). Look for signs of wilting, leaf shedding or death of the plant. Explain how different plants differ in their need for water. Differences observed are related to the ability of the plant to conserve water, and the ability of the plant's roots to extract the water from the same soil. Share your observations with your helper.
2. A few days after a rainfall, gently dig up a scoop of soil with a hand trowel from a home or school garden. Brush away any mulch or plant matter from the soil sample. Put the soil into your hand and give it a squeeze. If the soil clumps together and stays in a ball, it has a high clay content. If the soil clump falls apart, it is a silt soil or has low clay content. Which of these two soils would hold the most water? Why? Share your insights with your helper.



Cool Connections

Every plant cell contains water in varying amounts. A peanut seed is 3% water, wood from a tree trunk is 40% water, and a watermelon fruit is 95% water!



Word Power

Capillary water Drains Gravitational water Hygroscopic water
Irrigation Permeability Turgid

Activity 6. Nature's Nutrients

Although plants use the process of photosynthesis to produce sugars and starches for energy, they also need many nutrients for building strong leaves, roots, and stems. Plants get their nutrients from the soil. Plant roots take up nutrients along with soil water and deliver them to other plant parts to be used in growth and reproduction.

Let's Investigate

Soil Provides Plant Nutrients

This activity demonstrates the importance of soil nutrients to healthy plant growth by comparing the growth of fertilized plants to that of unfertilized plants.

1. Select 5 pots or cut-off milk cartons or soda bottles that hold 2 cups of soil. Punch holes in the bottom for drainage if needed.
2. Use masking tape to label the containers with 0 tsp., $\frac{1}{2}$ tsp., 1 tsp., 2 tsp., and 4 tsp. This is how much fertilizer is mixed with your growing medium or "soil."
3. Select vermiculite or a fine sand for your "soil." These products contain no nutrients of their own.
4. Place 2 cups of "soil" in each of the five numbered containers.
5. Obtain a small amount of fertilizer (8 teaspoons). This fertilizer should have three numbers such as 5-10-10, 5-20-20, 10-10-10, etc. These numbers stand for the amount of "nitrogen - phosphorus - potassium" (important plant nutrients) in the fertilizer.
6. Select the container marked $\frac{1}{2}$ tsp. Dump the "soil" out on a large piece of paper. Add $\frac{1}{2}$ teaspoon of fertilizer and mix thoroughly. Replace in the container marked $\frac{1}{2}$ tsp.

Activity: Demonstrate the importance of soil nutrients for healthy plant growth

Life Skill: Acquiring and Evaluating Information – Creates data gathering processes

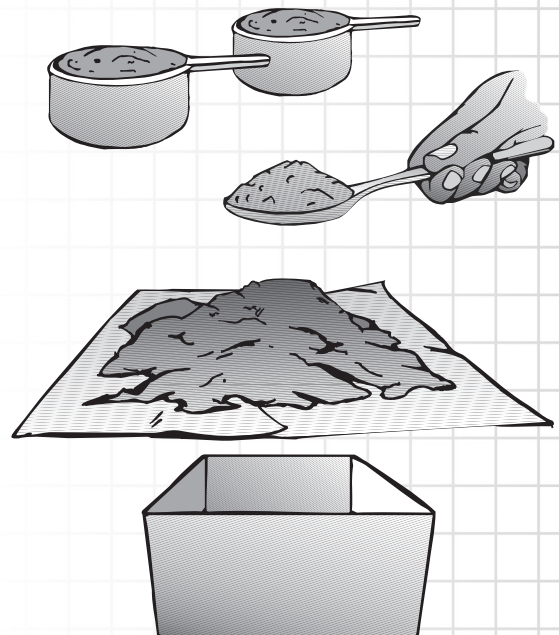
Science Process Skill: Solving problems through experimentation

Achievement Check: You can explain the importance of soil nutrients to plant growth

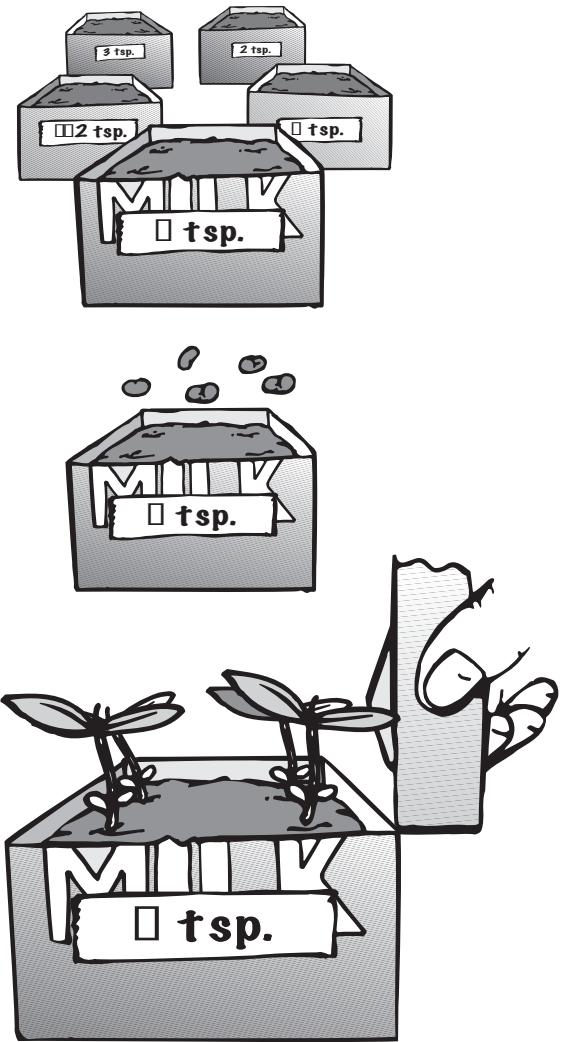
Virginia SOL: LS.7; Math 6.9, 7.5; LA 6.2, 6.6, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: 5 pots or milk cartons/soda bottles, masking tape, marker pen, fertilizer, vermiculite or fine sand, seeds (corn or beans)



- Repeat step 6, adding the specific amount of fertilizer indicated by the number on the container for each. Do not add any fertilizer to the container marked 0 tsp.
- Plant five seeds such as corn or beans 1-½ inches deep in the “soil.”
- Moisten the soils until water just starts to run out of the holes in the bottom.
- Predict which plant will grow best and which will grow tallest. Record your predictions in your journal.
- Keep the containers in a warm, well-lighted place and water as needed.
- Record the height of the plants from the rim of the container at least once a week for five weeks. Also, write down your observations on the color and general appearance of the plants. Answer these questions:
 - Did the fertilizer increase the size of the plants?
 - Did you observe any unfavorable effect of the fertilizer, such as seeds that failed to germinate?
- Compare your results with your predictions. Share what you learned about plants and soil nutrients with your helper.



Diggin' In

Soil Nutrients

Roots take up water containing nutrients from the soil. Soil nutrients are used as “building blocks” for the many compounds needed for plant growth and reproduction. Most plants need fifteen (15) elements from the soil to sustain healthy growth. The mineral elements plants need are put into two categories:

- **Macronutrients** - used in greater amounts; these elements are nitrogen, potassium, calcium, phosphorus, magnesium, and sulfur. The first four of these elements make up 99% of the nutrient total that a plant needs.
- **Micronutrients** – used in very small amounts; these elements are iron, sodium, chlorine, copper, manganese, cobalt, zinc, molybdenum, and boron.

When any of these elements are deficient in the soil, the plants show signs and symptoms of the nutrient deficiency. The same is true when an element is found in excess in the soil. The symptoms disappear when the situation is corrected.



Considering Plants and Soil

Let's Talk

How do fertilizers help plants grow? What nutrients do chemical fertilizers usually contain?

What precautions do you think should be taken when using fertilizer?

Let's Reflect

What happens to soil from which crops are grown and harvested year after year without replenishment of the soil nutrients? How do farmers replenish soil nutrients?

Why don't native plants need to be fertilized in the wild?

Let's Use It

From where do people obtain most of the nutrients they need for growth and good health?

What are the similarities between a plant's nutrient needs and the nutrient needs of people? What are the differences?



Branching Out

1. Build a terrarium to watch plants grow. To build a terrarium, place gravel or small rocks in the bottom of a clean, clear, gallon-sized, glass container. Mix one teaspoon of fertilizer with some soilless potting mix (potting media composed of peat moss and perlite and/or vermiculite). Use less fertilizer for a small terrarium. Place the mix on top of the gravel or rocks. Plant moss and some small plants in the potting mix to make an interesting arrangement. Loosely cover the container with a piece of glass to decrease loss of moisture. Water as needed, and watch the plants grow.
2. Read about "hydroponics" and discover how plants can obtain nutrients and grow without soil. Share what you learn about this interesting growing method with your helper.
3. Find out how often your houseplants should be fertilized. Plan and carry out an experiment to see if they need these nutrients re-supplied more or less often. Share the results of your experiment with your helper.
4. Many people buy manure to put in their garden. Using the Internet and other resources, find out the nutrient content of different types of manure. Share your research with your helper.



Cool Connections

Most of a plant structure, 92 to 95%, is made up of carbon, hydrogen, and oxygen. Carbon is supplied from carbon dioxide from the air; hydrogen, from water; and oxygen from water and air. The remaining 5 to 8% is made up of the 15 mineral elements from the soil!



Word Power

Fertilizer Hydroponics Nutrients

Activity 7. Help! I'm Drowning!

The previous activities discuss how the mixture of mineral particles, organic matter, and water that make up a soil results in a large amount of pore spaces that hold air. In addition, plant root growth and the movements of animals living underground turn the soil and keeps it loosely assembled. These activities provide and maintain areas where air exists between soil particles. Soil air is essential to plant root growth and the survival of all organisms living in the soil.

Let's Investigate

Soil Provides Air

This activity demonstrates what happens to plant growth when all the soil pore spaces are filled with water.

1. Select 4 pots or cut-off milk cartons or soda bottles that hold 2 cups of soilless potting mix. Punch holes in the bottom for drainage if needed.
2. Label 2 of the containers with "air" and 2 of the containers with "no air."
3. Fill the containers with potting mix within 2 inches from the top.
4. Place 3 bean seeds in each container. Cover with 1 inch of soil. Water thoroughly. Place in a sunny windowsill and water whenever the soil begins to feel dry.
5. Allow the bean plants to grow until they have developed their first set of true leaves.
6. When the plants are fully developed, water the 2 containers labeled "air" whenever the soil begins to feel dry and remove any water that flows from the container into the drain pan. This watering method allows for the removal of gravitational water, the retention of capillary water, and the opening up of soil air pores.

Activity: Demonstrate the importance of soil air to healthy plant growth

Life Skill: Acquiring and Evaluating Information - Acquires and evaluates information

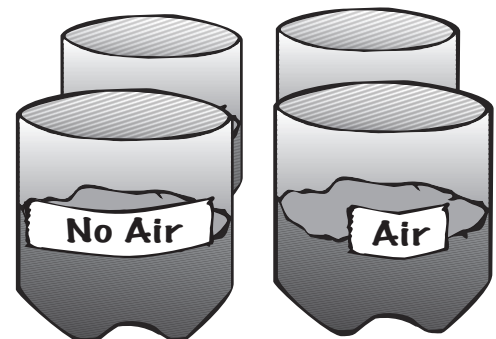
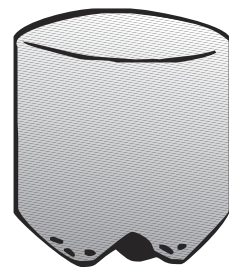
Science Process Skill: Solving problems through experimentation

Achievement Check: You can describe the importance of soil air to healthy plant growth

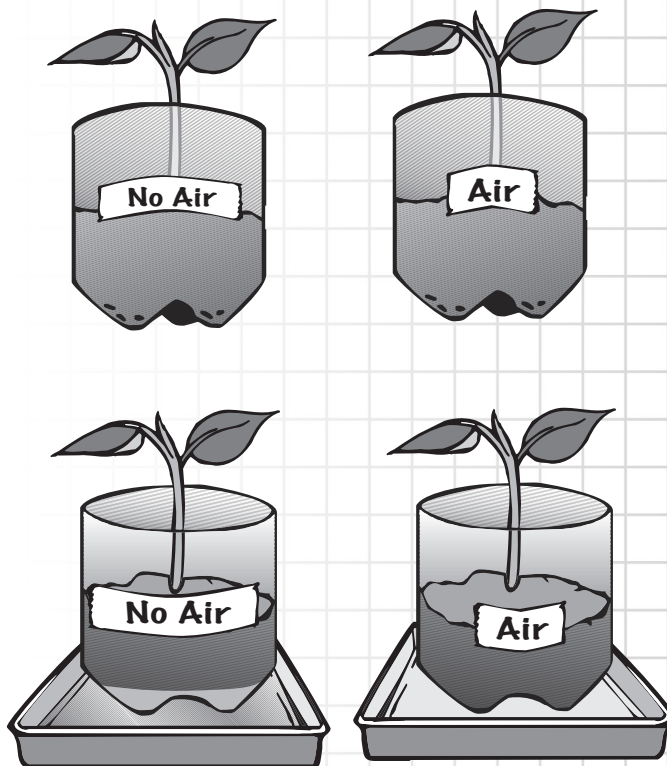
Virginia SOL: LS.7; Math 6.9, 7.5; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: 4 pots or cut-off milk cartons/soda bottles, soilless potting mix, bean seeds, 2 drain pans, masking tape, marker pen



7. Water the 2 containers labeled “no air” thoroughly three times a day and leave the gravitational water in the drain pan (you may have to remove some of this water so that the drain pan doesn’t overflow). This watering method keeps the soil pores filled with water.
8. Predict how plant growth will be affected by the different watering treatments. Write down your predictions in your journal.
9. Observe, measure, and record in your journal the growth of the plants for four weeks. Describe the differences in plant growth. How does root growth and health affect plant growth? Why do you think it is important for roots to grow in soil with adequate aeration?
10. Compare your results with your predictions. Share what you learned about the relationship between plant growth and soil air with your group or helper.



Diggin’ In

Let the Fresh Air In

Good, fertile soils are highly granular and have pore spaces that constitute about half the total volume of the soil. The soil water is held in these pore spaces, as is the soil air. If every soil pore space is filled with water, the roots of the plants growing there will drown and die. As with any living thing, plant roots need air to stay healthy and function properly. The presence of soil air balanced with soil water is essential for healthy plant growth.



Considering Plants and Soil

Let’s Talk

What types of soils do you think hold the most water? Which soils have the best pores spaces for holding capillary water?

Can there be such thing as “too many” pore spaces? Why?

Let’s Reflect

How do you think that plants in nature would respond to five straight days of rainfall?

How would soil compaction affect pore spaces?

Why is it important to check soil moisture with your finger before watering your houseplants?

Let's Use It

What is the cause and effect relationship between soil moisture and plant health?

How does our understanding of cause and effect relationships help us make better decisions?



Branching Out

1. Find out how water lilies and cypress trees have adapted to living in water. Share what you learn with your helper.

2. Devise a chart in your journal that shows the differences in the water holding capacities of sand, silt, and clay soils. Use drawings to show the variability in pore space size between the different soil types. Share your chart with your group or helper.



Cool Connections

Plants only acquire about 20% of their carbon dioxide needs from the soil atmosphere. The rest must come from the air through the leaves. If the wind is not blowing, plant growth slows down!



Word Power

Fertile Pore Space Soilless potting mix Soil atmosphere Soil compaction

Activity 8. Soil Lends a Hand

Soil provides water, soil nutrients, and air to plants and plant roots to support the process of plant growth. In addition, soil holds most plants in place and provides physical support. Plant roots grow through the soil to hold the plant firmly in place. However, the structure of the soil determines how well a plant root system can grow through the soil and perform this function. Plant roots grow easily through a sandy soil, but may fall over during a windy storm because the soil is too loose. Plants roots may work a little harder to move through a silt soil, but have a better chance of withstanding the wind because the soil provides more stability and support.

Let's Investigate

Hold On Tight!

This activity looks at how a soil's structure affects its ability to provide physical support to a plant.

1. Select 3 pots or cut-off milk cartons or plastic, 2-liter soda bottles that hold 2 cups of soil. Punch holes in the bottom for drainage if needed.
2. Locate these three types of soil:
 - Sand
 - Silt
 - Clay
3. Fill a pot with each of these soils within 2 inches from the top. Label each soil type using the masking tape and marker pen.
4. Place 3 bean seeds in each container. Cover with 1 inch of soil. Water thoroughly. Place in a sunny windowsill and water whenever the soil begins to feel dry. Record how often each pot needs to be watered.
5. Predict which soil type will best anchor the plant's roots. Write down your prediction in your journal.

Activity: Demonstrate how soil composition affects the soil's ability to provide plant support

Life Skill: Acquiring and Evaluating Information – Acquires and evaluates information

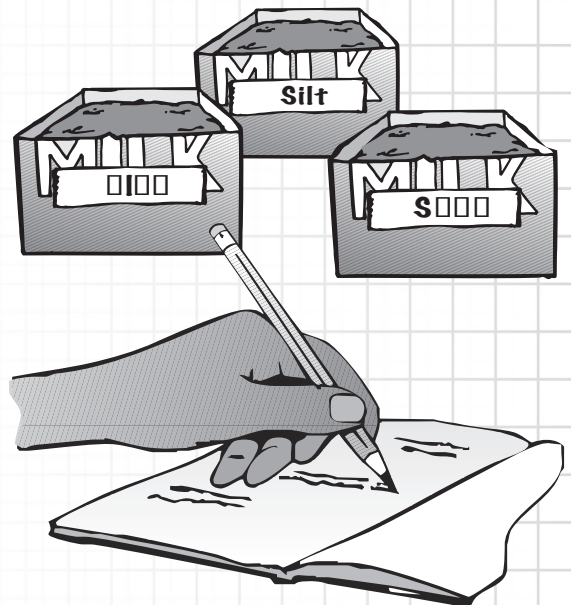
Science Process Skill: Observing and classifying information

Achievement Check: You can explain the relationship between soil composition and the physical support soil provides to plants

Virginia SOL: LS.7; LA 6.2, 6.6, 7.1

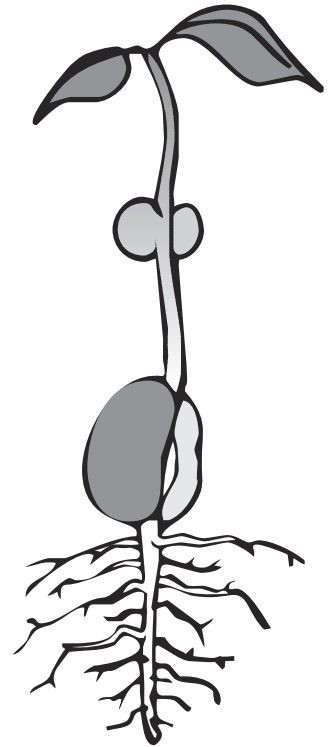
National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: 3 milk cartons or plastic, 2-liter soda bottles, sandy soil, silt soil, clay soil, masking tape, marker pen, bean seeds



6. Allow the bean plants to grow until they have developed their second set of true leaves.
7. When the plants are fully developed, do the following with the plants growing in each soil type:
 - Hold the base of a plant stem and gently pull on the plant. Does the plant pull free of the soil?
 - Gently remove the plants from the pots. Shake off the soil attached to the roots. Describe the root systems that have developed in each soil type. What differences in root growth do you observe?
 - Record your observations in your journal. Compare your results with your predictions. Discuss what you learned about root growth and soil type with your helper.

What you should see: Roots can grow easily through sandy soils due to the large mineral particles and resulting large pore spaces. However, as a result of this soil structure, sandy soils provide marginal physical support. Clay soils provide little support for plants because roots find it difficult to grow in the small clay pore spaces. Often plants grown in clay soils produce small and shallow root systems. The medium size particles and medium sized pore spaces in a silt soil allow for optimum root growth, resulting in excellent support for the plant.



Diggin' In

Soils Provide Support

Plant roots growing through soil form a strong, physical attachment to the soil. This relationship provides physical support for the plant. Soils with small pore spaces, such as clay soils, make root growth difficult resulting in a weakened attachment between the plant and the soil. Adding organic matter to this type of soil opens up the pore spaces. As a result, this amended soil allows for better root growth, and improves a plant's ability to stand strong against the forces of nature, such as wind or heavy rains that could pull a plant from the soil.



Considering Plants and Soil

Let's Talk

How does soil structure affect the physical support of a plant?

Why is structural support an important feature of the plant and soil relationship?

Let's Reflect

Many "weeds" can live in soils where other plants do not survive as well. What adaptations might these weeds have to help them succeed without good soil support?

How do climbing plants use other plants and objects for physical support? How might this improve their chances of survival?

Let's Use It

What do people rely on for support in other areas of their lives? (Emotional support, financial support, etc.)

How can you improve the ways that you support others? What can you do to make a positive difference in the lives of other people?



Branching Out

1. Make a list in your journal of plants that do not grow with their roots in soil. Find out how these plants obtain the water and nutrients that they need for growth. Share what you discovered with your helper.

2. The physical condition of a soil is called "tilth." Tilth is affected largely by the proportion of sand, silt, clay, and organic matter (OM) present, past management practices, soil moisture levels when the soil has been worked, and the overall rainfall rate. Dig up the top 6 inches of soil. Crumble some moist soil between your fingers. Write down your observation of the physical condition of the soil. Also, write down the cause of any problems observed, such as low OM, high clay content, poor drainage, etc. Find out the proper proportions of soil components for good tilth. Share your observations with your helper.

3. Plants require physical support. This can be provided by water, rocks, surface soil, subsoil, gravel, sand, or other vegetation. Examine and list several familiar types of plant supports. Indicate for each type whether it also appears to be supplying the necessary water and nutrients for good growth. Share what you discovered with your helper.

4. Go to your local plant nursery and look at the many soilless potting mixes available. List the different types of mixes and their ingredients. Explain how the mixes differ for various plant types such as air plants, cacti, and shrubs. Share your list with your helper.



Cool Connections

For some plants, the root system is bigger than the aboveground part of the plant. Some grasses have roots that grow 13 feet deep, and alfalfa plants have roots that can reach 30 feet deep. That's a good support!



Word Power

OM Subsoil Surface soil Tilth True leaves

Activity 9. Holding Things Together

When people remove vegetation from the land, wind and water may join forces to erode and destroy the soil. Since the topsoil layer is the smallest and most precious soil layer, it is important that we preserve and protect this valuable resource. Farmers invest considerable time and money protecting the topsoil in their fields using such methods as cover crops, contour plowing, and crop rotations.

Let's Investigate

Stopping Erosion

This activity demonstrates how water and wind erode and damage soil, and how plant roots prevent soil erosion.

1. Fill two plant flats with soilless potting mix.
2. Label one flat "no vegetation" and the other flat "vegetation."
3. Plant grass seed on the flat that is labeled "vegetation". Water the flat thoroughly and keep in a warm, sunny location. Water when necessary.
4. Predict which flat will show the least erosion. Write your predictions in your journal.
5. Once the grass has grown 1 inch high, gently water both flats so that the soil is moist, and then place both flats on an incline as shown.
6. Sprinkle water slowly over the tops of the flats. Observe the influence of the water on the soil. What happens to the soil with no vegetation? With vegetation?

Activity: Demonstrate how plants prevent soil erosion.

Life Skill: Acquiring and Evaluating Information – Evaluates relevance of data

Science Process Skill: Observing and experimenting

Achievement Check: You can explain how plants help prevent soil erosion

Virginia SOL: LS.7; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: Plant flats, soilless potting mix, labels, marker pen, grass seed



7. After the soil dries, use a fan to blow air over the flats. What happens to the soil with no vegetation? With vegetation?
8. How did your predictions compare with the actual results?
9. Using what you observed in this activity, explain to your helper how wind and rain can cause soil erosion in nature when plants are not present.

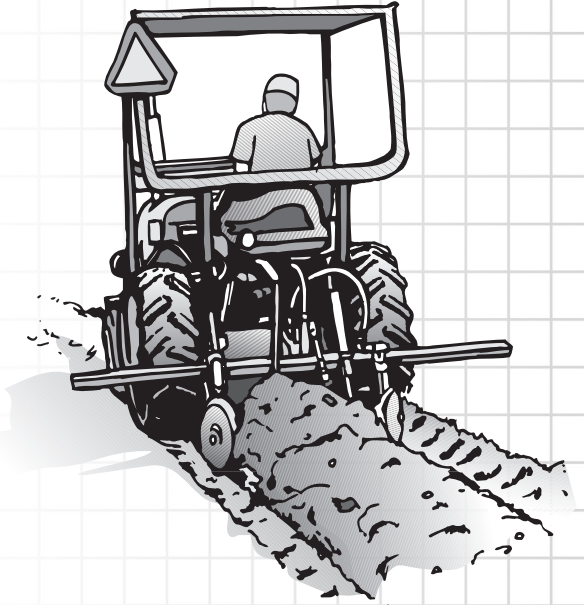


Diggin' In

Plants and Soil Working Together

In nature, plant roots hold soil in place and protect it from winds and weathering. The soil, in turn, provides support, nutrients, and water to the plants. If plants are not present, water and wind carry away the topsoil and expose the subsoil.

Soil scientists and agriculturists understand the importance of caring for the soil, since it must supply foodstuff for future generations. Farmers and gardeners use a variety of cultural practices to care for the soil. These practices include contour plowing, crop rotation, intercropping, allowing a field to lay fallow (rest), and using cover crops, manure, fertilizers, and compost to restore soil nutrients.



Considering Plants and Soil

Let's Talk

How do plants prevent soil erosion?

Using what you know about soil structure and root growth, what types of soil are most easily eroded?

Let's Reflect

Over time, what would happen to humankind if farmers did not care for the topsoil by reducing or preventing erosion?

Have you seen examples around your home where erosion has occurred? What caused the erosion? Where do you think all the eroded soil ends up?

Let's Use It

What can you do to help stop erosion in your neighborhood or town?

How does human development (new houses, roads, parks, etc.) affect erosion? Why is it important that we make good decisions concerning natural vegetation and erosion control?



Branching Out

1. Walk around your neighborhood or schoolyard with your helper. Identify areas where soil erosion has taken place. Discuss how human activity has sped up or slowed the erosion of soil in your hometown.
2. Find out about the plants used by your state's road department to prevent soil erosion along highways. Make a list of these plants in your journal. Include a description of the features of each plant that make it useful in preventing soil erosion. Share your list with your helper.
3. Find out about the methods used by farmers to care for the topsoil in their fields. Learn more about:
 - Contour plowing
 - Crop rotation
 - Intercropping
 - Fallow fields
 - Cover cropsShare what you found out about these methods with your helper.
4. Drive a white stake 3 inches wide into bare soil deep enough for it to stand. Drive a second white stake into a healthy lawn. Place a step ladder near one of the stakes. Stand on the step ladder, and using a hose with a nozzle set to sprinkle, water around the first stake for 30 seconds. Let the water fall from the hose to the ground. Repeat at the other stake. Observe splashing of soil onto the white stakes. Write down your explanation for any differences between the lawn and the bare soil. Discuss with your helper how rain can erode bare soil, and the role of plants in preventing soil erosion.



Cool Connections

In the 1930's the farmers in Oklahoma did not use good soil maintenance practices to prevent soil erosion. A tremendous drought prevented the growth of crop plants, resulting in the "Oklahoma Dust Bowl." The topsoil blew away and the farmers of Oklahoma lost their livelihood.



Word Power

Agriculturists

Contour plowing

Cover crop

Crop rotation

Fallow

Intercropping

Erosion

Vegetation

Activity 10. Picky Plants

The composition of a soil influences the growth of plants by directly impacting the soil's water and air holding capacity. Different plants have different soil, water, and air requirements. As an example, some plants such as cacti require dry soil, while others such as cattails and reeds need wet soil. Or, some plants such as blueberries require very acidic soil, while others such as beans and corn need a less acidic soil. It is important to remember that there is not one "best" kind of soil, as different plants have different soil needs.

Let's Investigate

Picky Growers

This activity demonstrates the differences in one plant's growth as it is grown in four different kinds of soil: Sand, topsoil, subsoil, and a garden soil.

1. Get four large pots (8 to 10 inches in diameter).
2. Label the pots #1, #2, #3, and #4 and do the following:
 - Fill #1 with topsoil from a field or garden.
 - Fill #2 with subsoil from the same area (taken from a depth below an observable change such as color, texture, or structure).
 - Fill #3 with sand.
 - Fill #4 with a well-fertilized garden soil.
3. Be sure the soil in each container has been crumbled and broken up into small particles. Remove stones and trash.
4. Plant six peas, beans, corn, or other seeds 1-1/2 inches deep in each container. Water thoroughly and then cover each container with a clear plastic bag. Set the containers in a warm, well-lighted place.

Activity: Compare the affect of different soil types on plant growth

Life Skill: Acquiring and Evaluating Information – Creates data gathering processes

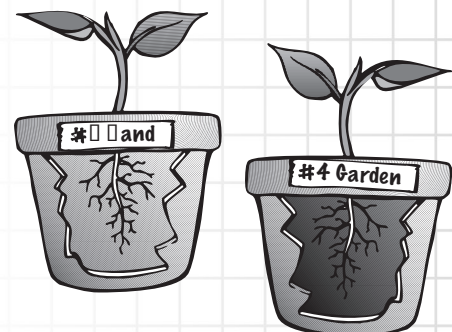
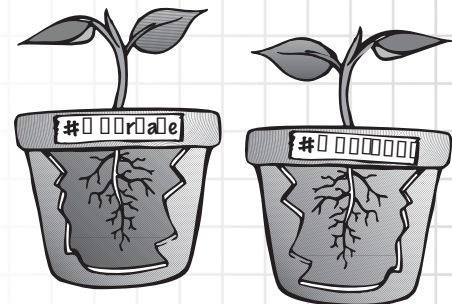
Science Process Skill: Predicting outcomes and analyzing results

Achievement Check: You can explain how soil type affects plant growth

Virginia SOL: LS.7; Math 6.9, 7.5; LA 6.2, 6.6, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: Four large pots, labels, four different soil types, seeds (corn, peas, or beans), plastic bags, ruler, pencil, paper



5. Make a prediction as to the outcome of this experiment. Write it down in your journal.
6. Remove the bag after the seeds sprout (germinate). Water when needed.
7. Record the height of the plants in each container once a week for at least 6 weeks.
8. Observe and write down your explanation of any differences you see in the number of seeds germinating. Record the rate of plant growth and describe the overall appearance of the plants. How do you think plant growth was affected by soil type?
9. Were your predictions accurate? Discuss your results with your helper.



Diggin' In

Soil's Importance to Man

Understanding the soil and its care is important to all of us. Soil is the foundation from which plants grow to produce our food, clothing, and shelter, which in turn sustains our lives. The study of soil is the basis for many of the plant, animal, and environmental sciences. There are many persons trained in areas related to the study of soils. Included are:

Soil Scientists	Study the physical, chemical, biological, and behavioral characteristics of soil. It includes research, soil testing, and laboratory work.
Plant Pathologists	Study plant diseases and ways to overcome crop losses caused by soil borne diseases.
Agronomists	Study how quality and crop yields can be improved by improving the soil.
Soil Conservationists	Study ways to protect and better use soils
Horticulturists	Study ways to improve crop quality and yields of garden plants, flowers, ornamental plants, vegetables, and orchards through improved soils.
Foresters	Study ways to improve tree quality and yields for the production of construction lumber, paper, and other wood products through improved soils.

Soil is important for the production of our food, clothes, and shelter. In addition, it is the foundation upon which we build our homes, businesses, and roads. Civil engineers study soil structure and characteristics as the base for any construction project.





Considering Plants and Soil

Let's Talk

Would you rather have a garden with sandy soil or clay soil? Why?

Using what you know about soil, why do you think most plants have some method to disperse their seeds to far away places?

Let's Reflect

Why is it beneficial to people that different plants have different soil needs?

How does understanding the different soil needs of plants help us become better gardeners?

Let's Use It

Just as plants are different in their soil needs, people are different in their life needs. How are your needs different from your best friend's needs?

How does recognizing and accepting differences help us to get along with others?



Branching Out

1. Find out more about the types of soil found in your community. Discuss with your helper how the local soil type also determines the types of agricultural crops grown in your community.

2. Contact your local USDA Service Center or Soil and Water Conservation District office. Ask to see a soil map of your community. If possible, make a copy of the map for your use. Using the map, tour the different soil areas with your helper. Discuss the differences in plant growth and human uses of the different soil areas.

3. Research to learn which soil types work best for building houses. Some communities will not allow building on certain types of soil. Share what you discover with your helper.



Cool Connections

The ancient Greeks recognized that some plants did not like growing next to others. Their observations were true! For example, corn and soybeans are best of friends because they share nitrogen. On the flip side, corn is very unhappy next to sugar beets because the sugar beet roots take up all of the soil's zinc and the corn is left without!



Word Power

Agronomists

Composition

Foresters

Germinate

Horticulturists

Plant pathologists

Soil conservationists

Soil scientists

Activity 11. Is Your Soil a Lemon or an Egg White?

The soil pH rating is a measure of the soil's acidity (a measure of the concentration of hydrogen ions present). A soil's acidity determines how easily soil nutrients are released into the soil water, which in turn determines the availability of soil nutrients to growing plants. The soil pH is measured on a scale from 0 to 14, with 7 being neutral (pure water), below 7 being acid (like a lemon) and above 7 being alkaline or basic (like an egg white).

Let's Investigate

What's the pH?

Most plants grow well in a soil pH range of 5.5 to 6.0. Of course there are always exceptions. For example, blueberries grow in very acid soils (pH 4.5), and cabbages grow in less acidic soil (pH 6 to 6.5). To determine the pH of a soil, scientists use one of many pH indicators. For this activity, anthocyanins found in red cabbage are used as a pH indicator.

1. Collect a number of soil samples (1/4 cup each) and samples of milk, lemon juice, and baking soda (which represents the pH of an egg white).
2. Slice a red cabbage into small pieces and simmer it in hot water. **CAUTION:** Make sure an adult helps you cut and cook the cabbage as the knife and hot stove are hazardous.
3. Remove the cabbage pieces and cool the solution.
4. First you must provide a scale from which you can compare your soil pH tests. Place 1/4 cup milk, lemon juice, baking soda in three jars respectively. Add 1/4 cup of the red cabbage pH indicator to each. The acid lemon juice is pink, the neutral milk is purple, and the basic baking soda is blue. Try to predict the pH of your soil samples before you do the next step. Write your predictions in your journal.
5. To test your soil samples, set a teaspoonful or more of the soils into small jars.
6. Using masking tape, label each container giving a description of the source of the soil.

Activity: Determine the pH of a substance using a pH indicator

Life Skill: Acquiring and Evaluating Information – Evaluates relevance of data

Life Skill: Learning to learn by experimentation

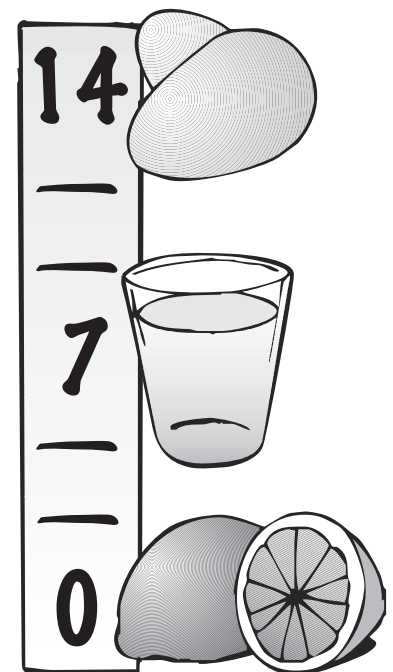
Science Process Skill: Organizing, gathering, and analyzing data

Achievement Check: You can explain the pH scale

Virginia SOL: LS.7, 12e; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: Soil samples, milk, lemon juice, baking soda, red cabbage, knife, small glass jars, masking tape, marker pen



7. Cover each sample with the cabbage solution, wetting the soil thoroughly. Use enough solution to suspend the sample particles (make some of the soil float).
8. Set the sample aside until the particles settle and the solution color can be seen clearly.
9. Compare your soil samples with the lemon juice, milk, and baking soda jars. Are your soils acidic, basic, or neutral? How is soil pH affected by the original location of the soil?
10. Compare your pH predictions with your results. Share what you have observed and learned about pH with your helper or group.



Considering Plants and Soil

Let's Talk

Fruit juices, such as lemon and cranberry juice, that have a low pH also have a very tart taste. Can you use this information to determine the approximate pH of a juice just by taste?

What was the hardest part of this experiment? How would you modify it if you did it again?

Let's Reflect

Most plants grow best with a soil pH of 5.0 to 6.5. How does knowing this help a grower select a place to locate a garden?

How is soil pH preference another way plants have adapted to different soils?

Let's Use It

How might acid rain affect the growth of plants?

Concerning soil, why is it important to make good decisions about air pollution and the resulting acid rain?



Branching Out

1. Try testing other liquids with your red cabbage pH indicator. Write down your results on a pH scale graph. Share your graph with your helper or group.

2. Make a list of plants that grow in very acidic soils (below pH 5.0) and very alkaline (above pH 6.5) soils. It is surprising that very few plants can grow beyond a narrow pH range (pH 5.0 to 6.5). Since pH determines nutrient availability in the soil, discuss with your helper why your list is so short.



Cool Connections

Lime is applied to a soil to increase its pH and sulfur is added to soil to decrease the pH. Since most soils naturally turn acidic over time, lime is used regularly by farmers to keep the soil pH within healthy limits.



Word Power

Acid Alkaline Anthocyanins Basic Lime
 Indicators Neutral pH

Activity 12. How Does Your Garden Grow?

It is important for gardeners or farmers to know as much as possible about the soil. As you have seen, soils are different in every garden or field, and different plants have different soil needs. Soil testing is done to provide growers with basic information about the soil they'll be using as related to the type of crop they'll be growing. For example, a vegetable grower would add different nutrients to the soil than those added by a rose grower. Soil testing tells the grower what is currently in the soil, and what should be added to the soil based on a particular crop.

Let's Investigate

Soil Testing

Soil tests are used to analyze a soil and determine what a grower must do to improve the soil for use in growing a particular crop. Soil test results let you know your starting point so you can make good planting and gardening decisions. This activity shows you how to take a soil test.

1. Obtain a soil testing kit from your local Cooperative Extension Office.
2. Select a garden site for the soil test.
3. In 10 to 12 different places in this garden:
 - Spade out a V-shaped hole in the soil
 - Slice off a thin piece of soil on one of the sloped surfaces
 - Put the center of the slice in a pail
4. Mix the soil thoroughly in the pail.
5. Dump the mixed soil on a sheet of newspaper and allow the soil to dry over night.
6. Fill the soil test kit box with soil from the soil mix obtained from your garden.
7. Complete the soil testing information sheet. Provide as much information as possible concerning the history of the soil and the plans for future crops.
8. Send to the soil-testing laboratory listed on your soil test.

Activity: Learn how to do a soil test and how to understand soil test results

Life Skill: Acquiring and Evaluating Information – Creates data gathering processes

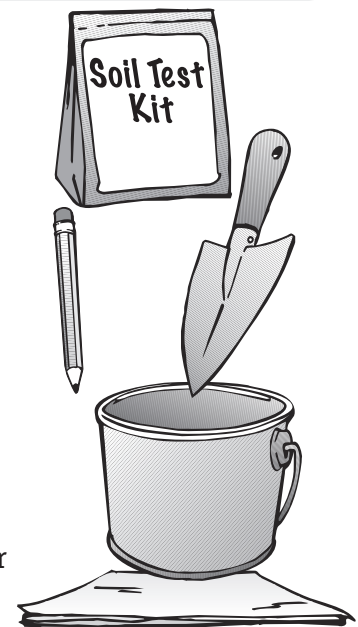
Science Process Skill: Organizing, gathering, and analyzing data

Achievement Check: You can demonstrate how to perform a soil test

Virginia SOL: LS.7, 12e; LA 6.2, 7.1

National Science Standard: The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as soil composition.

Materials: Soil testing kit, garden spade, pail, newspaper, pencil



9. When the results of the test are returned, study the suggested fertilizer and lime application procedures with your project helper or parent. Determine what needs to be done to the garden soil to prepare it for a new crop.



Considering Plants and Soil

Let's Talk

Why do you think garden soil needs additional nutrients added every year?

Where do all of the added nutrients go every year?

Let's Reflect

How does adding compost to a soil improve the fertility of the soil? How is compost similar to fertilizer?

Why does soil pH need frequent adjustments (every couple of years) when land is used for agriculture production?

Let's Use It

After reading your soil test results, discuss how the science of chemistry is used to solve real-life problems.

How could washing your car on your lawn affect your soil pH?



Branching Out

1. Perform a soil test from several different locations, but indicate on the test form that you plan to grow the same plant type in each area. Compare the results of the tests. How different were these soils? How did the differences affect the recommendations? Share your results with your helper.
2. The pH of the soil is important in determining the soil recommendations because soil pH affects nutrient availability. In this activity, what did the soil laboratory recommend you do to adjust the pH of the soil? Find out how farmers change soil pH on large farm acreages. Share what you learned with your helper.
3. Find out what other types of tests or services you can do through your cooperative Extension Office. Share what you learned with your helper.



Cool Connections

Minerals lifted up to the roots from the subsoil can endanger some plants. Aluminum and manganese can kill plants if the farmer plows too deep and brings these toxic minerals up to the topsoil.



Word Power

Nutrient availability pH Soil Test

Word Power Glossary

acid	usually sour; sharp and biting to the taste (vinegar). Having a pH of less than 7.0
alkaline	sometimes referred to as basic. Having a pH value greater than 7; mild to the taste
anthocyanins	a water-soluble pigment found in cell sap; vary in color from red to blue
capillary water	water held in the soil against the force of gravity. Plants can readily use this water
clay	very fine soil particles; plastic when moist; sticky when wet; hard when dry; used for brick, tile, clay sculptures, etc.
composition	what an object is made of; the sum of ingredients or qualities and the manner of their combination
compost	a mixture of decomposing vegetable refuse used for fertilizing and conditioning the soil
contour plowing	making of shallow trenches along the natural contour lines of the land so as to avoid erosion, as on a hillside
cover crop	a crop, such as vetch or clover, grown to protect soil from erosion and to keep it fertile
crop	a plant or plant product that can be grown and harvested extensively for subsistence
crop rotation	a system of growing successive crops that have different nutrient requirements to prevent the depletion of soil nutrients or break up a plant disease cycle
decomposer	an organism that breaks up or separates organic material into basic components or parts; an organism that rots organic material
drain	removal of water from the surfaces and/or through a soil
erosion	wearing away of the earth's surface by the forces of water or wind
fallow	land plowed but not seeded for one or more growing seasons, to kill weeds and to make the soil richer; this may add to erosion problems
fertilizer	plant nutrients that can be applied to help plants grow better
humus	a brown or black substance resulting from the partial decay of plant and animal matter; the organic part of the soil
hydroponics	the science of growing plants in solutions or moist inert material containing the necessary minerals, instead of in soil

intercropping	to grow one crop with another crop in the same field, as in alternate rows, to control plant diseases and insects, and to retain soil nutrients
irrigation	to supply with water by means of artificial ditches, channels, or sprinklers
lime	a white substance obtained by the action of heat on limestone, shells and other material containing calcium carbonate, used in neutralizing acid soil
manure	animal excrement put onto or into the soil to fertilize it
nutrient	a chemical substance that promotes growth or development
organic matter	fresh or partially decomposed plant or animal material
parent material	anything from which other things are derived; the source or origin; the parent material of soil is rock
permeability	the rate of circulation of a fluid through a porous body under standard conditions of area, thickness, and pressure
pH	a measure of acidity on a scale of 0 to 14. 7 is neutral; less than 7 is acid; more than 7 is basic
pore spaces	tiny openings between soil particles through which fluids may be absorbed or discharged and air is present
rock	mineral matter variously composed, formed in large quantities in the earth's crust by the action of heat, water, etc; a particular kind of stone
sand	the gritty-feeling, coarser soil particles
silt	relatively fine soil particles that are smooth to the feel and do not become slick and sticky when wet
soil	surface of the earth that supports life – the upper layer of earth that may be dug or plowed
soilless potting mix	a growing medium used for growing plants in peat moss composed containers and a component to enhance air circulation such as perlite or vermiculite
soil profile	a vertical section of soil exposing its various subsurface layers
soil structure	the arrangement of individual sand, silt, and clay particles into clusters, chunks or compound particles
subsoil	a layer of weathered material below the surface soil or topsoil
surface soil (topsoil)	layer of soil which extends from the ground surface down to the subsoil; can be shallow or deep and is sometimes absent
symbiotic	an intimate association between two dissimilar organisms that benefits both of them
texture	the arrangement of the particles of the soil as it affects the appearance or feel of the soil

topsoil (surface soil)	the upper layer of soil, usually darker and richer than the subsoil
true leaves	the first set of real leaves produced by a young seedling
turgid	swollen; expanded
vegetation	plant life or total plant cover (as of an area). The collective plant growth of an area
weathering	the physical and chemical effects of the forces of weather on rock surfaces, as in forming soil, sand, etc.

The Experiential Learning Model

The experiential learning model is used in each activity as a means to help the young person gain the most from the experience.

The five steps in this learning model encourage the young person to try to do the activity before being told or shown how. The Experiential Learning Model asks youth to:

1) Do the activity

Key Concept: Attention is on the learner.

Key Activity: Discovery

2) Share what they did

Key Concept: Response to learning and feeling.

Key Question: "What happened?"

3) Process what was most important about the experience

Key Concept: Analyze patterns.

Key Question: "What's important?"

4) Generalize the life skill to their own lives

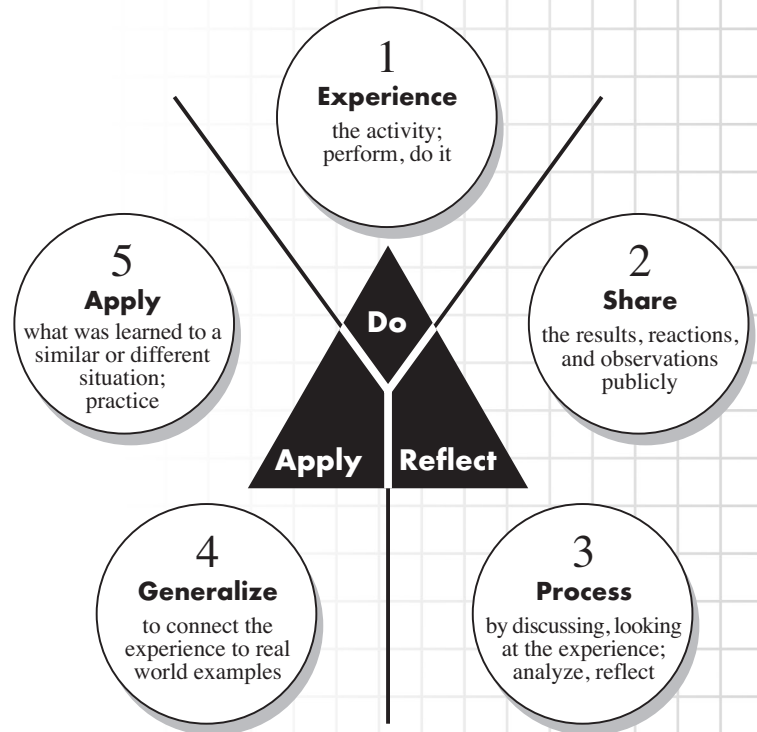
Key Concept: Inference.

Key Question: "So What?"

5) Apply the life skill or science process skill to a new situation

Key concept: Application.

Key Question: "Now What?"



To fulfill the experiential learning process, the youth must complete all the steps, including the review questions found in the *Considering Plants and Soil* section of each activity. Sharing answers with a helper and others enriches the youth's reflection process and learning. The experiential model enhances learning and adjusts to a wide variety of learning styles.

Evaluating the Experience

An *Achievement Check* assessment is located in the introduction of each activity. You will evaluate the achievement of the youth by their mastery of this indicator. Also, ask the questions under *Considering Plants and Soil* found in each activity to continue to improve your youth's understanding of the key concepts and life skills practiced in each activity.



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