the Giving Grove

CLASSROOM LEARNING ACTIVITES FOR SECONDARY STUDENTS

NUTRITION FROM TREES

ENVIRONMENTAL BENEFITS OF TREES

SOIL BIOLOGY FOR GROWING HEALTHY TREES

TREE BIOLOGY FOR MAINTAINING HEALTHY TREES

Curriculum provided by Kansas City Community Gardens
and sponsored by EPA Region 7

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SECTION ONE: SOIL BIOLOGY

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TYPES OF SOIL

Lesson Objective: The Learner will classify soils and make predictions about soil characteristics.

Key Questions: What is soil composed of? What are the sample soil types? What characteristics will they have?

Background Information:

All soil is made up of minerals and organic matter. The proportion of each determines the texture of the soil. There are 3 basic categories of particles that exist in soils:

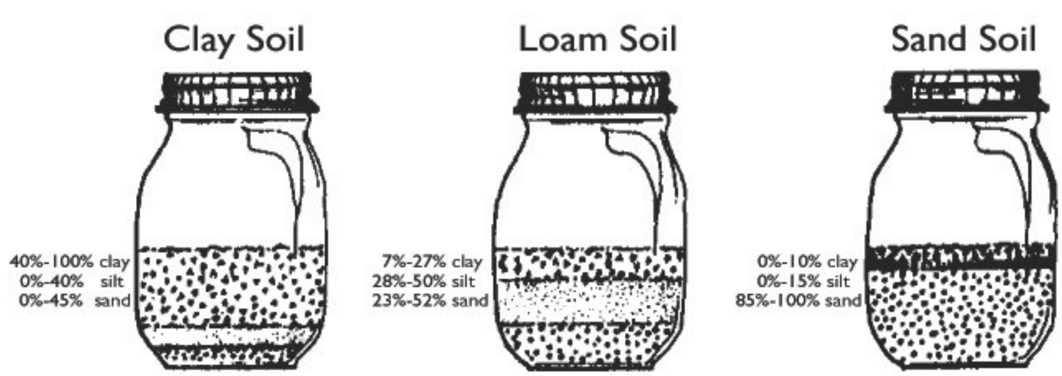
Clay particles are the smallest (less than 1/12,500 of an inch). Clay soils are sticky and difficult to work with. Clay soil holds water tightly but drains poorly. Plants growing in clay suffer from a lack of air around the roots because the tiny clay particles pack together so tightly that there are few air spaces in the soil.

Silt particles are larger than clay but smaller than sand (between 1/12,500 and 1/500 of an inch). Silt is created when rock is eroded by water and ice. Silt is a solid, dust-like sediment that is transported by wind/ice/water and deposited into the soil. Silty soil is slippery when wet, not grainy or rocky.

Sand particles are the largest (between 1/500 and 1/12 of an inch). Sandy soils provide an ample air supply to roots. They are much easier to work with because the large particles do not pack tightly together. However, sand does not hold water well. Water drains quickly through the loosely packed particles and is not available to the plant's roots. Plants in sandy soil need frequent watering.

Soil composition impacts the plant root's ability to breathe air, absorb /hold water, and uptake nutrients. This affects the overall health and survival of plants.

In this lesson, students will compare the composition of various soil samples to the composition of ***Loam Soil***. Loam soil is a mixture of soil that is the ideal plant-growing medium. It is actually a combination soil, normally equal parts of clay, silt, and sand, which gives the benefits of each with few of the disadvantages.



Materials:

Straight-sided jars and lids

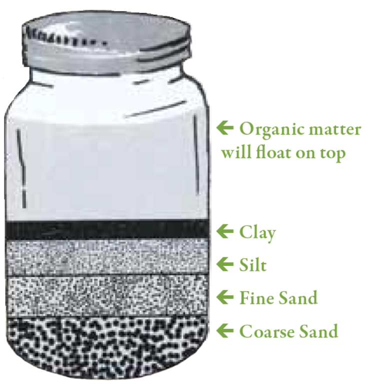
Metric rulers

Soil Samples

Handouts (Master Soil Chart and Student Record Chart)

Learning Activity:

- Have students fill jars 2/3 full of water
- Gather soil samples from the ground where you wish to plant (or soil samples from a variety of areas)
- Pour soil into jar until water is nearly to the top
- Place a lid tightly on the jar and shake it until all the soil is suspended
- Allow the contents to settle, undisturbed—overnight is best. The soil layers will fall out in roughly the following order (from bottom to top)—gravel, sand, silt, clay, organic material (which will be a top layer on the soil and/or floating on the top of the water). Not all material may be present in each sample.



- Observe the layers of sediment
- Measure the total depth of sediment and the width of each layer
- Record these figures on the chart
- Compute the percentage of sand, silt and clay found in the sample
- Classify the soil sample by comparing its chart and percentages to the master chart
- Describe the qualities of the soil sample as they would compare to the qualities of loam soil. Does your soil have better, worse or the same drainage, water capacity, airiness and ease of handling as loam? Justify your answers. How could the soils be improved for cultivation purposes?

Additional Resources

https://www.soils4kids.org/about

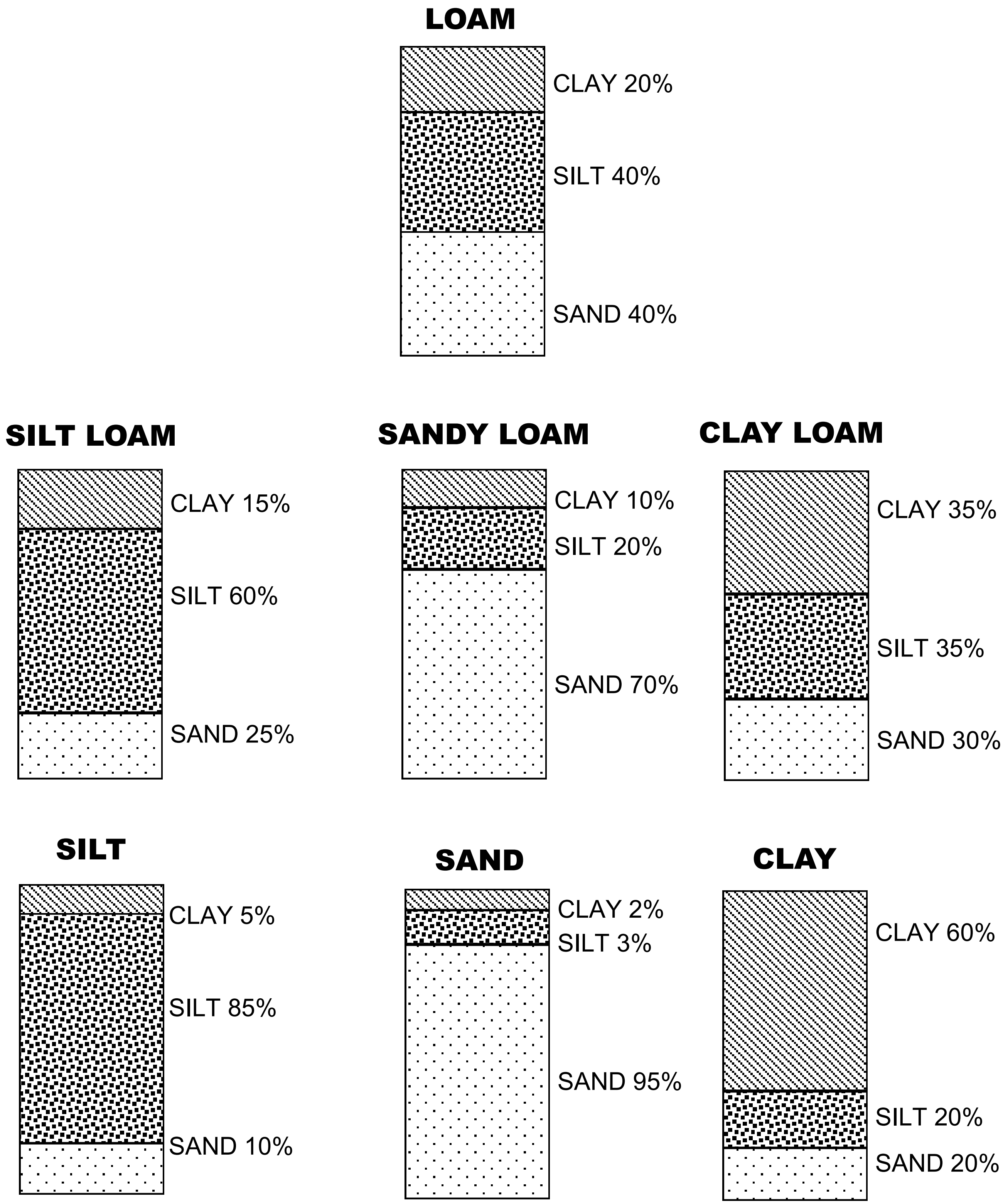
https://www.regenerative.com/magazine/five-elements-healthy-soil-composition

https://www.holganix.com/blog/what-are-the-components-of-healthy-soil

http://www.harvestpower.com/soil-apartments-the-4-key-components-of-healthy-soil-structure/

(activity adapted from AIMS Education Foundation)

MASTER SOIL CHART



Compare your soil sample percentages to the percentages in the Master Soil Chart. What is the best classification for your soil sample based on these percentages?

NAME ___________________________

SHOW ME YOUR SOIL CHART

	A	B	B÷A	C	C÷A	D	D÷A	
	TOTAL DEPTH OF SEDIMENT	DEPTH OF SAND LAYER	% SAND	DEPTH OF SILT LAYER	% SILT	DEPTH OF CLAY LAYER	% CLAY	TYPE OF SOIL
SAMPLE A								
SAMPLE B								
SAMPLE C								

Directions:

⇒ Fill jars 2/3 full of water.

⇒ Pour soil sample into jar until water is almost to top.

⇒ Place lid on jar and shake vigorously until all soil is suspended.

⇒ Wait 24 hours.

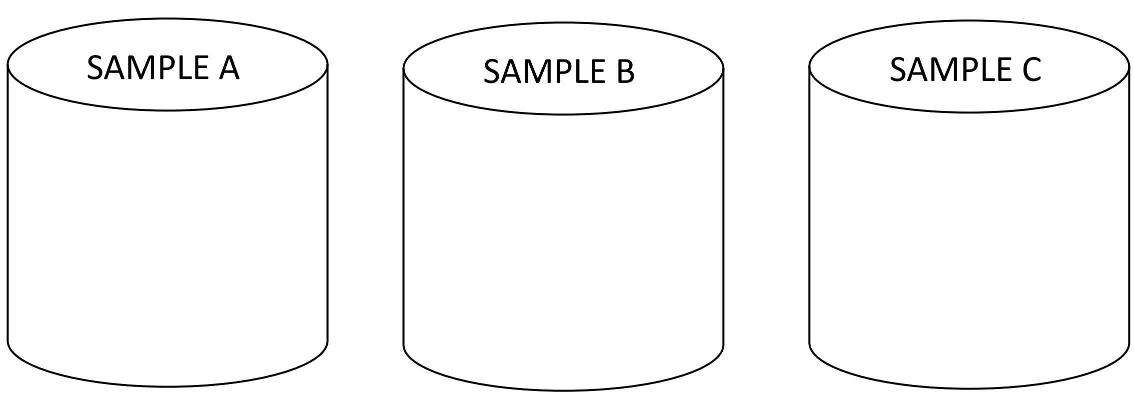
⇒ Observe layers of sediment. Measure the total depth of sediment. Measure the depth of each separate layer (sand, silt, clay). Record measurements on chart.

⇒ Compute the percentages of sand, silt, and clay.

⇒ Classify the sample by comparing its percentages to the Master Soil Chart.

⇒ Describe the qualities of the soil sample as they would compare to the qualities of loam soil. Does your soil have better, worse or the same drainage, water capacity, airiness and ease of handling as loam? Justify your answers. How could the soils be improved for cultivation purposes?

Draw in the layers of sediment observed in each soil sample



SOIL HORIZONS

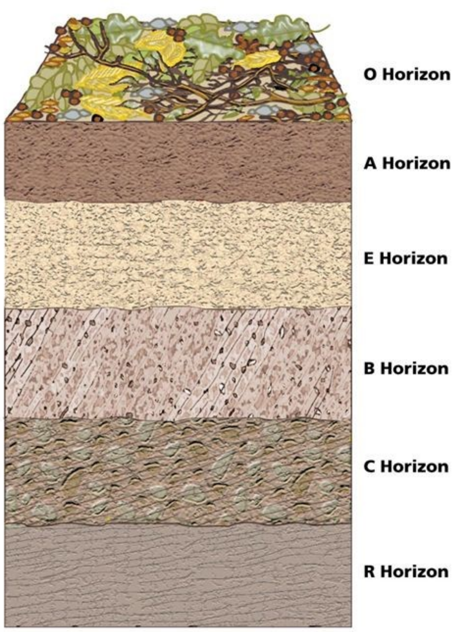
Lesson Objective: The Learner will observe and describe soil profiles and soil horizons to classify and interpret the soil for various uses.

Key Questions: What is a soil horizon? How does a soil horizon create a soil profile? How does a soil profile tell a story about the life of a soil?

Background Information:

If you look in a soil pit or on a roadside cut, you will see various layers in the soil. These layers are called soil horizons. The arrangement of these horizons in a soil is known as a soil profile. Soil scientists, called ***pedologists***, observe and describe soil profiles and soil horizons to classify and interpret the soil for various uses.

Soil horizons differ in a number of easily seen soil properties such as color, texture, structure, and thickness. There are different types of soil, each with its own set of characteristics. The differences are developed from the interaction of such soil-forming factors as parent material, slope, native vegetation, weathering, and climate. Dig down deep into any soil, and you'll see that it is made of layers, or horizons (O, A, E, B, C, R). Put the horizons together, and they form a soil profile. Like a biography, each profile tells a story about the life of a soil. Most soils have three major horizons (A, B, C) and some have an organic horizon (O). The horizons are:



O -(humus or organic) Mostly organic matter such as decomposing leaves. The O horizon is thin in some soils, thick in others, and not present at all in others.

A -(topsoil) Mostly minerals from parent material with organic matter incorporated. A good material for plants and other organisms to live.

E - (eluviated) - Leached of clay, minerals, and organic matter, leaving a concentration of sand and silt particles of quartz or other resistant materials – missing in some soils but often found in older soils and forest soils.

B - (subsoil) Rich in minerals that leached (moved down) from the A or E horizons and accumulated here.

C - (parent material) The deposit at Earth's surface from which the soil developed.

R - (bedrock) A mass of rock such as granite, basalt, quartzite, limestone or sandstone that forms the parent material for some soils – if the bedrock is close enough to the surface to weather. This is not soil and is located under the C horizon.

As a soil ages, horizontal layers develop and changes result. The causes of these changes are classified as four processes. Each process occurs differently at various depths in the soil.

Addition: This process occurs as materials such as fallen leaves, windblown dust, or chemicals from air pollution are added to the soil.

Loss: This process occurs when materials are lost from the soil because of deep leaching or erosion from the surface.

Translocation: This process involves the movement of materials within the soil. It can occur with deeper leaching into the soil or with upward movement caused by evaporating water.

Transformation: In this process, materials are altered in the soil. Examples are organic-matter decay, weathering of minerals to smaller particles, and chemical reactions.

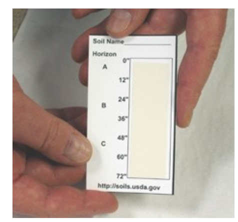
<u>Materials:</u>

Vertical cross sections of soil (or soil cores) from various locations

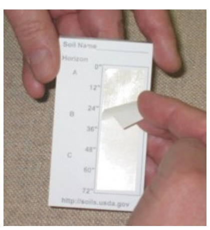
Soil profile cards   Double-sided tape (1 inch)   Soil core sampler to 6 ft. deep

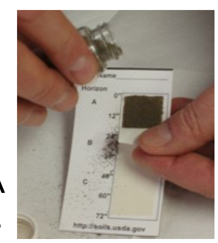
<u>Learning Activity:</u>

- Print the soil profile cards onto cardstock paper or draw your own design on a 3" x 5" note card.
- Attach a short strip of double-sided tape to the card. One-inch tape is adequate.

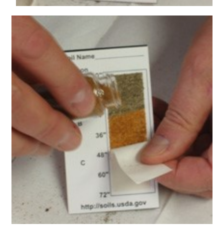


- Pull back the tape at the top to expose some of the sticky tape and place soil from the surface horizon to represent the depth of this soil.
- Pull back the tape for each additional layer one at a time following the same procedure.





- The card can now be placed in an envelope to protect it.
- You might also collect a little surface vegetation to keep with your soil type for learning about plant-soil relations.
- You can demonstrate erosion severity by altering the depth of the A horizon or display various types for soils found in different locations.



- Displays can be made of several soils on a drawing of a hill slope or other landscape by using the tape on a larger card or poster.
- What story does this soil profile tell about the life of this soil?

<u>Additional Resources:</u> (Information and activity adapted from:)

https://www.soils4teachers.org/soil-horizons
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054308)
https://casoilresource.lawr.ucdavis.edu/

SOIL HORIZONS PROFILE CARDS

Soil Name_______________

Horizon

0"
A
12"
24"
B
36"
48"
C
60"
72"

http://soils.usda.gov

Soil Name_______________

Horizon

0"
A
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24"
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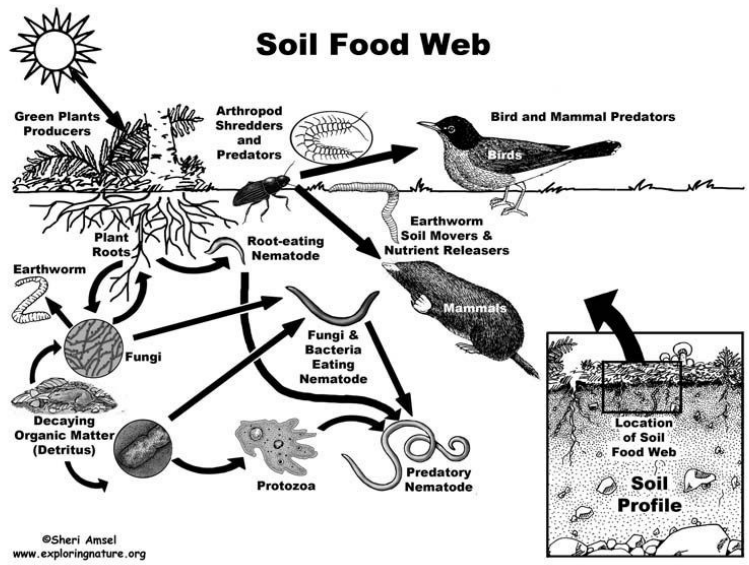
http://soils.usda.gov

SOIL IS ALIVE

Lesson Objective: The Learner will investigate components of healthy soil and create a Berlese Funnel.

Key Questions: What components are necessary for healthy soil? What lives in healthy soil (i.e. microbes, soil insects, worms, and soil fungi)?. How do soil organisms help break down the organic and inorganic matter in the soil, providing nutrients for plants?

Background Information:



The creatures living in the soil are critical to soil health. They affect soil structure and therefore soil erosion and water availability. They can protect crops from pests and diseases. They are central to decomposition and nutrient cycling and therefore affect plant growth and amounts of pollutants in the environment. The soil is home to a large proportion of the world's genetic diversity.

In a simplified overview, plant roots give off exudates that consist of carbohydrates produced by the plant through the process of photosynthesis. These exudates become food for bacteria and fungi in the soil. These microscopic organisms are consumed by slightly larger life forms (although in most cases still too small to see with the naked eye), such as nematodes, protozoa, and some arthropods. These organisms are eaten in turn by larger creatures that can be seen without a microscope, such as larger arthropods (like millipedes and sow bugs) and earthworms. Finally, near the top of the web, small soil creatures become a buffet for even larger animals, such as moles.

In addition to eating each other, many of these underground dwellers also consume dead and decaying organic matter (both plant and animal) that has made its way down to the soil.

Just as they do for life above the ground, plants provide the base for the food chain in the soil. An interesting point to consider: Plants could probably survive without aboveground animals, but they are dependent on the food web below the ground to recycle the nutrients they need to live.

Plants rely on various bacteria and fungi to release nutrients from decaying plant and animal material, as well as from the breakdown of inorganic matter such as minerals. And in many cases these microorganisms also facilitate the availability of the nutrients to the plants. Nutrients as they naturally exist in the soil are not always in a form that plants can use. Plants depend on soil-dwelling microorganisms to convert certain nutrients into accessible forms that are available for uptake. Some microorganisms even play an active role in helping roots with the process of absorption. There is also evidence that plants form beneficial partnerships with organisms like mycorrhizal fungi to increase their access to water.

Materials:

5-10 Soil Samples in Jars	Window Screen to cover Jars	Jar Labels	Science Journal
Chart Paper	Trowels or Spoons	Microscope	Magnifying Glasses

Materials for Berlese Funnel (see handout "Soil is Alive Berlese Funnel)

Learning Activity:

- Collect 5-10 soil samples from different locations at your school or in your community. This can be a class activity, or the students and/or the instructor can collect them ahead of time. Collect samples from diverse locations where you might expect to find different soil life populations. For example, collect some samples from areas where plants are thriving (and thus you would expect to find healthy soil life populations) and some from areas where the soil is bare or has poor plant growth (where you would expect to find little to no soil life).

- Collect each soil sample in a jar or other vessel with an open top, and then cover it securely with a piece of window screen to allow airflow and to keep any larger life from escaping before you can explore it. Plan to use the samples as soon as possible so the soil doesn't dry out, which may kill the organisms inside.

- Label the samples and take careful notes about where each was collected, as well as the conditions of the surrounding area; for example, what type of plant life is present, is it close to water, does the area experience heavy foot traffic, etc. If possible, take photos of the sites to help with later discussions.
- Begin by asking students to list everything that lives in the soil. Record their responses on a sheet of chart paper so that you can compare it to what they learn about soil life in this lesson. Next, as an introduction to life underground, watch the video "The Science of Soil Health: Changing the Way We Think About Soil Microbes" from the U.S.D.A Natural Resources Conservation Service. This video offers amazing imagery of microscopic life in action and an overview of the importance of the soil food web. After watching the video, add to your list.
- Explore your soil samples. Have students begin their investigations by digging through the samples with small trowels or spoons to look for gastropods (slugs and snails) and large arthropods (invertebrates such as insects, mites, and centipedes). Students can work individually or in small teams. Have students keep an inventory of what they find.
- Next, set up a Berlese funnel to look for smaller organisms. A magnifying glass is helpful for close observation. Have students add this information to their inventory.
- Finally, if you have microscopes available, students can look for any microorganisms present in their samples.
- With inventories in hand, ask students to develop a way to present and compare the data they have collected, such as through graphs or charts.
- Discuss the results, asking students what they have discovered about the soil health at each sample's location. Based on the data, can you draw any conclusions about how humans impact soil life?

Additional Resources

Lesson adapted from https://kidsgardening.org/lesson-plan-soil-is-alive/
and http://www.diggingintosoil.org/

https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/

Video "The Science of Soil Health: Changing the Way We Think About Soil Microbes" found at https://www.youtube.com/watch?v=EyKfpOso8q8

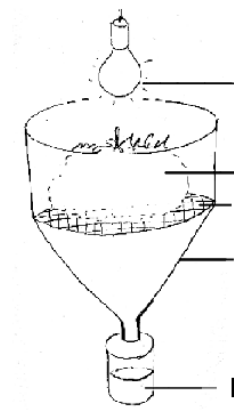
SOIL IS ALIVE BERLESE FUNNEL

A berlese funnel is a device that is used to extract insects from soil samples. It uses a heat source (in this case a light bulb) to dry the sample, forcing the insects through a screen (optional) and into a jar of preserving fluid.

Materials:

- 1-Gallon Plastic Jug (milk jug or soda bottle)
- Jar (1-qt canning jar)
- Mesh Screen (1/4-1/2" hardware cloth)
- Ethanol (70–95%) or Isopropanol (70%)
- Lamp with Moveable Neck (and incandescent bulb, for heat)
- Scissors, Ruler, Tape
- Collected Soil Sample

Berlese Funnel



Procedure:

⇒ Cut the bottom out of the soda bottle and turn it upside down over the jar to make a funnel (or use a funnel).

⇒ Bend down the corners of the hardware cloth so it fits snugly inside the wide end of the funnel. If using window screen, cut and pinch numerous slits so larger animals can crawl through. If the leaf litter/humus is large enough you may be able to skip the wire mesh.

⇒ Collect several handfuls of humus or leaf litter and put them on top of the wire mesh.

⇒ Pour alcohol into the jar/cup to a depth of 1-2 cm.

⇒ Carefully set the funnel on top of the jar.

⇒ Leave the funnel in a warm, quiet place where it won't be disturbed.

⇒ Set a lamp over the funnel. Keep the lightbulb at least 10 cm away from the funnel.

Extension:

Set up several Berlese funnels. Have students collect a variety of soil samples to analyze separately, comparing density and diversity data. Some ideas for comparisons include the following:

- Samples collected in sunny areas versus those from shaded areas
- Samples exposed to pesticides or fertilizers versus those not exposed
- Samples with varying pH
- Samples from moist areas versus those from dry areas
- Samples from disturbed sites (e.g., compost piles, gardens) versus those from undisturbed sites
- Samples collected from the same site during different seasons

Students may choose to compare total invertebrate density, or they may choose a specific, common, local soil invertebrate and compare its density between sites. After collecting data, students can use several calculations to compare density and/or diversity data between sites.

Adapted from https://www.soils4teachers.org/files/s4t/lessons/berlese-funnel.pdf

HEALTHY SOIL

Lesson Objective: The Learner will investigate the relationship between plants and soil, describe components of healthy soil, and test soil pH levels.

Key Questions: Why is healthy soil important? Why do plants need soil? Why does soil need plants? How do plants and soil depend on each other? How does the pH level affect soil health?

Background Information:

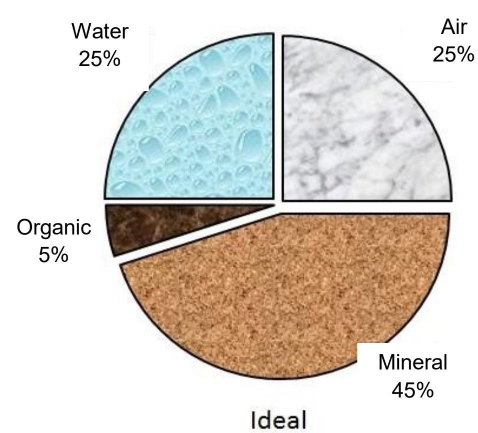
Although many factors contribute to a thriving garden, any seasoned gardener will stress the importance of good soil. In addition to anchoring roots, soil provides life-sustaining water and nutrients. Plants in poor soils will struggle to grow, even if optimal water and light are available. In contrast, plants in good soils will grow to their fullest potential and experience fewer problems with insects and disease.

Soil is composed of minerals and organic matter. Sand, silt, and clay are the mineral particles derived from rock broken down over thousands of years by climatic and environmental conditions (rain, glaciers, wind, rivers, animals, etc). Organic matter is the decayed remains of once-living plants and animals. Good plant growth and development depends on the mineral and nutrient content of soil, as well as its structure.

The proportion of these different-sized particles affects the amount of air, water, and nutrients available to plants, and how the soil 'behaves.' The smaller the soil particles, the more they stick together when wet. Thus clay soils can be sticky and difficult to work. Having fewer air spaces, they drain poorly and roots may suffer from a lack of oxygen, but clay soils can be rich in minerals. In contrast, sandy soils can drain water too quickly and be low in nutrients, but they are easier to work. Adding organic material can offset many of the problems associated with either extreme.

Soil is teeming with life, including microorganisms like bacteria and fungi (billions in a single teaspoon!) and larger animals such as worms and beetles. Many of these underground inhabitants feed on remains of plants and animals, breaking down their tissues. In the process, they create pore space and release nutrients that plants need and the cycle begins again.

Pore space -- the arrangement of soil particles in relationship to each other -- is an important component of soil structure. In an optimal situation about 50 percent of the volume of the soil would be pore space, with half of that filled with water and half filled with air. The other 50 percent would be sand, silt, clay, and organic matter. Roots need air as much as they need water; plants can actually suffocate or drown if they are completely submerged in water for extended periods of time.



Not only is soil important to plants, plants are also important to soil formation. Without plants, the earth would be barren, its surface unprotected from the effects of sun, wind, and rain, and its soil composition too poor to sustain life. Plant roots help to prevent erosion, and when plants die, they become the raw material for worms, insects, and microbes to build the nutrient-rich humus that supports robust food webs and promotes good soil structure.

Healthy soil is dark and rich. Water drains out of it, but not too quickly. Healthy soil has a lot of organic matter, such as old leaves, manure and worm castings in it. Manure – or animal waste – makes a nutrient rich fertilizer for plants. Dig it into the soil and watch those plants grow. Fresh manures smell bad and they can burn plants. Manure should be composted first. Composting is a great way to keep food and garden scraps out of the trash can. Spread these composted scraps on your garden to build healthy soil.

Another factor that contributes to healthy soil is the soil pH.

What is soil pH? Soil pH is the measure of the acidity (sourness) or alkalinity (sweetness) of a soil. A simple numerical scale is used to express pH. The scale goes from 0.0 To 14.0, with 0.0 being most acid, and 14.0 being most alkaline. The value, 7.0 is neutral--i.e., neither acid or alkaline.

- ⇒ Acidity: having a pH of less than 7
- ⇒ Alkalinity: having a pH of greater than 7
- ⇒ Buffering Capacity: a soil's ability to maintain its pH when changes are being made to the soil
- ⇒ Soil pH: a measure of the soil's acidity or alkalinity

Why is pH important? Soil pH is important because it influences several soil factors affecting plant growth, such as (1) soil bacteria, (2) nutrient leaching, (3) nutrient availability, (4) toxic elements, and (5) soil structure. Bacterial activity that releases nitrogen from organic matter and certain fertilizers is particularly affected by soil pH, because bacteria operate best in the pH range of 5.5 to 7.0. Plant nutrients leach out of soils with a pH below 5.0 much more rapidly than from soils with values between 5.0 and 7.5. Plant nutrients are generally most available to plants in the pH range 5.5 to 6.5. Aluminum may become toxic to plant growth in certain soils with a pH below 5.0. The structure of the soil, especially of clay, is affected by pH. In the optimum pH range (5.5 to 7.0) clay soils are granular and are easily worked, whereas if the soil pH is either extremely acid or extremely alkaline, clays tend to become sticky and hard to cultivate.

- ⇒ Soil pH is an indicator of soil health.
- ⇒ Soil pH affects crop yields, crop suitability, plant nutrient availability and soil microorganism.
- ⇒ Soil pH can be managed by applying nitrogen and lime, and by using cropping practices that increase soil organic matter and overall soil health.

A pH determination (soil test) will tell whether your soil will produce good plant growth or whether it will need to be treated to adjust the pH level. For most plants, the optimum pH range is from 5.5 to 7.0, but some plants will grow in more acid soil or may require a more alkaline level.

How to correct pH: Normally, lime or dolomite is used to increase the pH, or "sweeten" the soil. Lime contains mainly calcium carbonate and dolomite contains both calcium carbonate and magnesium carbonate. Ground limestone and dolomite are less likely to "burn" plant roots than hydrated lime and are therefore recommended for home use. The amount of these materials necessary to change the pH will depend on the soil. In Kansas City, we add Sulphur to most planting sites to lower the pH to a desired level of 6.0 for berries and 6.5 for fruit trees.

Materials:

Soil probe	Plastic bucket	pH test strips	Measuring scoop	Chart paper
Shaking vial	Squirt bottle	Distilled water	Science journal	

Learning Activity:

- Place 3 chart papers around the room, each with one of these 3 words: Climate, Mineral Content, Soil Texture
- Instruct students to write on the papers how they believe each of the factors affect soil pH. Ask a student to read the class ideas out loud and discuss the responses.
- Inform students that the three factors they discussed are known as "inherent factors" that affect soil pH; these are factors that cannot be changed. Write down notes in science journals.

Climate

- ⇒ Increased temperature and rainfall cause increased leaching rates and increased soil mineral erosion rates
- ⇒ Increased leaching yields lower pH
- ⇒ Decreased leaching and rain cause pH to either increase or remain steady

Mineral Content

⇒ High organic matter content yields a higher buffering capacity
⇒ Organic matter amount can be changed through management practices

Soil Texture

⇒ High clay content yields a higher buffering capacity due to slower leaching rates
⇒ Clay content amount cannot be changed
⇒ High sand content yields a lower buffering capacity due to large pore spaces and fast leaching rates
⇒ High sand content means the organic matter content is low, which means the buffering capacity is low, percolation rate is high and the pH is low

- Facilitate a discussion with students about the soil in your area. Here are a few guiding questions to use during the discussion:

    ⇒ What are the pH characteristics of the soil in our area?
    ⇒ How does that affect our farms, yards and gardens?
    ⇒ How does the pH correction affect our environment and maintenance costs?

- Show students pictures of forest, grassland, and crop field. Have students discuss what they know about soil pH and inherent factors to determine how the pH might vary between each of the three types of lands.

    ⇒ Soil pH is affected by land use, management and vegetation
        ◊ Forests have a high level of organic matter
        ◊ Grasslands have a medium level of organic matter
        ◊ Croplands have the lowest level or organic matter of these three types of land
    ⇒ As land moves from forest to grassland and from grassland to cropland:
        ◊ Organic matter is lost
        ◊ Soil minerals are removed (during harvest)
        ◊ Erosion increases
        ◊ Nitrogen and sulfur are added to the soil
        ◊ pH decreases
    ⇒ Acidification can be limited or corrected by:
        ◊ Adding lime yields an increased pH
        ◊ Applying nitrogen and sulfur in the correct amounts and at the times when plants are using them
        ◊ Diversifying crop rotations
        ◊ Applying organic matter
        ◊ Using no-till practices and cover crops

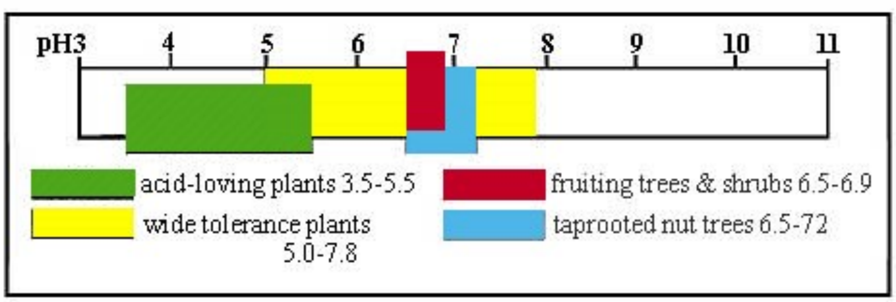
- Ask students to predict what happens if the pH level is too low or too high. It can cause:
    ⇒ Nutrient deficiencies because of leaching
    ⇒ A decline in microbial activity because of improper environment for the microbes
    ⇒ A decrease in crop yields
    ⇒ A deterioration of overall soil health
    ⇒ An inhibition of the nitrogen cycle (low pH)
    ⇒ Limited effectiveness of herbicide and insecticide degradation
    ⇒ Limited solubility of heavy metals
    ⇒ A lack of effectiveness and carry-over of herbicides

- Have students complete pH testing on various soil samples.

  Scenario: The Johnson's are planning to have a garden during the next spring and summer growing season. They recently moved to a new home in a new town and do not know much about the soil in the area. They take their gardening seriously, both for consumption of the food as well as for entering their crops competitively at county and state fairs. It's really important that the garden is successful. To help guarantee success, they plan to conduct tests to measure their soil's pH levels.

1. Using a soil probe, gather at least 10 small samples randomly from the area that represents the soil type and management history to be tested. Ensure that each sample is taken at a depth of eight inches.
2. Place each sample into the plastic bucket provided.
3. Remove large stones and plant residue from the sample.
4. Mix the soil together.
5. Rub wet soil across your palms to neutralize your hands. Discard this soil.
6. Place a scoop of mixed soil in your palm and saturate the soil with distilled water or rainwater.
7. Squeeze the wet soil gently until the water runs out of the cup of the hand and onto the side of the soil sample.
8. Touch the end of a 1-inch-long piece of pH test strip directly to the water so that the tip is barely wet and the solution can be drawn up the strip at least ¼ inch to ½ inch beyond the area masked by soil.
9. Compare the color of the pH test strip approximately 1/3 of the way up the colored portion of the strip to the color chart on the dispenser of the test strips.
10. Have students create a similar chart in their science journal and record their results:

Site	Soil pH	Soil pH Category (i.e. very acid)	Nutrients Impacted by Soil pH	Crops Impacted by Soil pH Level	Notes

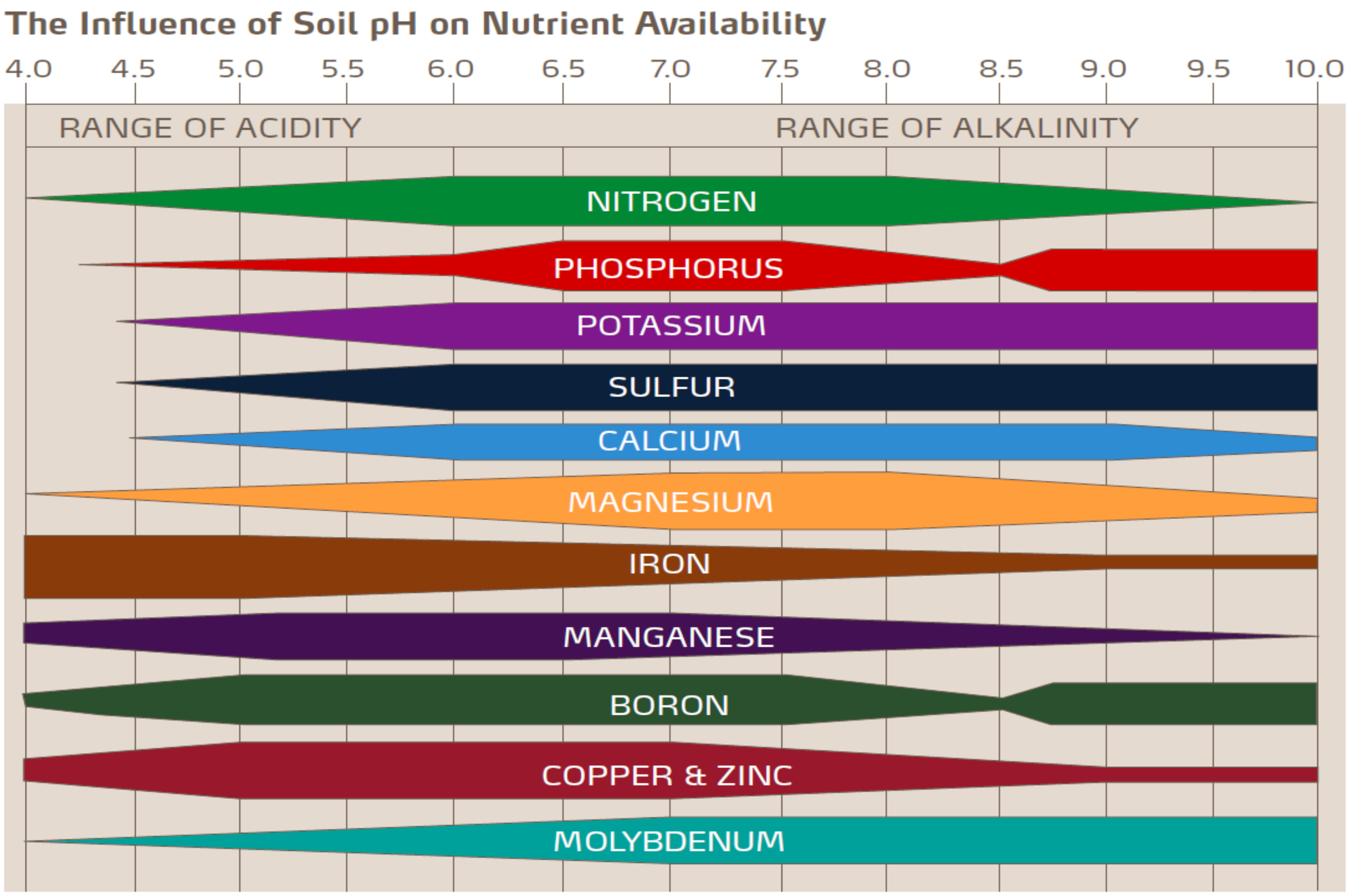


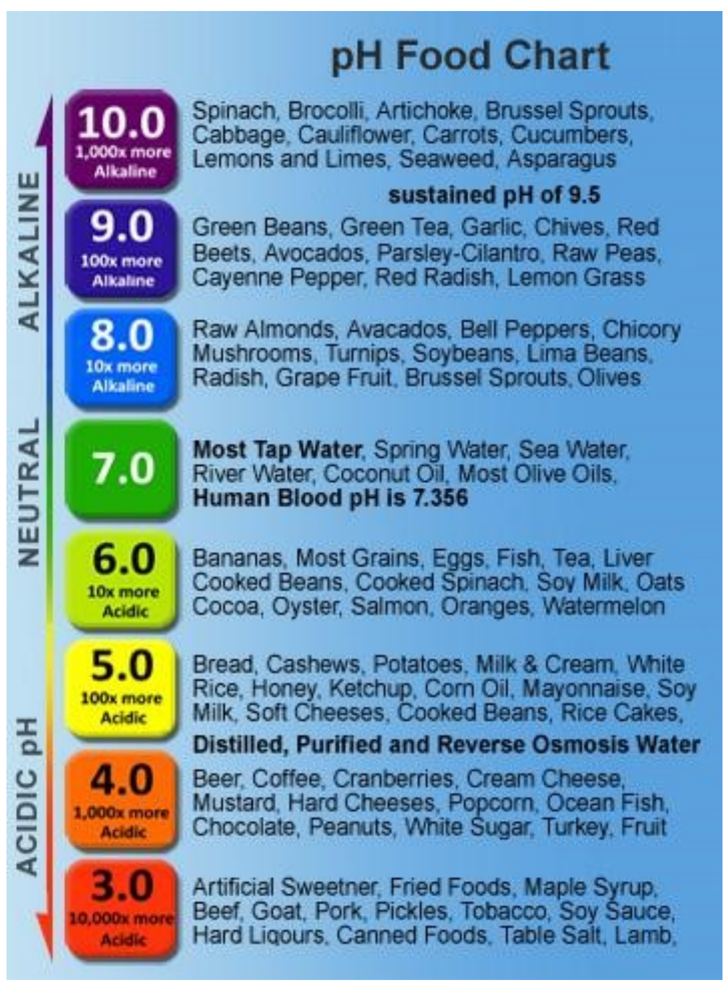
Additional Resources

https://cropwatch.unl.edu/youth-soil-quality-lessons-and-videos

http://pss.uvm.edu/ppp/pubs/oh34.htm

https://www.lifeisagarden.co.za/soil-erosion-experiment/


The Influence of Soil pH on Nutrient Availability
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
RANGE OF ACIDITY
RANGE OF ALKALINITY
NITROGEN
PHOSPHORUS
POTASSIUM
SULFUR
CALCIUM
MAGNESIUM
IRON
MANGANESE
BORON
COPPER & ZINC
MOLYBDENUM


pH Food Chart
ALKALINE
NEUTRAL
ACIDIC pH
10.0
1,000x more Alkaline
Spinach, Brocolli, Artichoke, Brussel Sprouts, Cabbage, Cauliflower, Carrots, Cucumbers, Lemons and Limes, Seaweed, Asparagus
sustained pH of 9.5
9.0
100x more Alkaline
Green Beans, Green Tea, Garlic, Chives, Red Beets, Avocados, Parsley-Cilantro, Raw Peas, Cayenne Pepper, Red Radish, Lemon Grass
8.0
10x more Alkaline
Raw Almonds, Avacados, Bell Peppers, Chicory Mushrooms, Turnips, Soybeans, Lima Beans, Radish, Grape Fruit, Brussel Sprouts, Olives
7.0
Most Tap Water, Spring Water, Sea Water, River Water, Coconut Oil, Most Olive Oils,
Human Blood pH is 7.356
6.0
10x more Acidic
Bananas, Most Grains, Eggs, Fish, Tea, Liver Cooked Beans, Cooked Spinach, Soy Milk, Oats Cocoa, Oyster, Salmon, Oranges, Watermelon
5.0
100x more Acidic
Bread, Cashews, Potatoes, Milk & Cream, White Rice, Honey, Ketchup, Corn Oil, Mayonnaise, Soy Milk, Soft Cheeses, Cooked Beans, Rice Cakes,
Distilled, Purified and Reverse Osmosis Water
4.0
1,000x more Acidic
Beer, Coffee, Cranberries, Cream Cheese, Mustard, Hard Cheeses, Popcorn, Ocean Fish, Chocolate, Peanuts, White Sugar, Turkey, Fruit
3.0
10,000x more Acidic
Artificial Sweetner, Fried Foods, Maple Syrup, Beef, Goat, Pork, Pickles, Tobacco, Soy Sauce, Hard Liqours, Canned Foods, Table Salt, Lamb,

PROTECTING THE LAND: HUMAN IMPACT ON SOIL

Lesson Objective: The Learner will investigate and present a persuasive presentation on the cause-and-effect cycle of soil health.

Key Questions: How do humans impact soil health? In what ways can we prevent the negative impacts of human activity on the soil? What is your personal responsibility in keeping the land healthy?

Background Information:

Despite being a fundamental resource that supports all life on Earth, soil often falls well below the radar as an important environmental issue. We hear about water or air pollution, but rarely about soil pollution. Yet, soil affects our everyday lives, from the food we eat and where we live to the natural functions and ecological services that it provides. Negative impacts to soils from human activity include: erosion, compaction, salinization, sealing by paving, pollution, and declines in organic matter content and biodiversity. The largest threat to soil—and therefore to us—is the loss of or damage to the productive topsoil, often caused by erosion and/or poor land use practices.

Erosion is a natural process caused by wind, water and ice that wears away the material on the land surface very slowly. The rate of erosion is dependent on a variety of factors, including the soil texture, the type of ground cover, and the intensity of the wind and/or precipitation. However, it can be greatly exacerbated by a wide variety of human activities, including poor farming or grazing methods, deforestation and urbanization.

In the 1930s, massive erosion caused by persistent winds, drought, and overuse resulted in huge dust storms that destroyed farmland in the South-central United States. It is estimated that 35 million acres of agricultural land were destroyed and another 125 million seriously damaged. This disaster, partly natural and partly man-made, became known as the Dust Bowl.

Today, intensive agricultural practices and the over-application of synthetic fertilizers and pesticides lead to the leaching of essential nutrients and excessive amounts of salts or heavy metals in the soil, which can reduce or even prevent plant growth. In addition to poor farming practices, soils can also become compacted by agricultural machinery or the grazing of livestock. Not only do these methods affect the amount of ground cover that is available, compacted soils cannot retain water as well.

In many developing countries, farming often involves slash and burn—where vegetation is stripped and cut, then eventually burned—in order to create agricultural fields and/or pastures. While this can release additional nutrients in the short term, soil fertility can decrease rather quickly. It is also at this time when soils are most vulnerable to erosion. Madagascar, with its barren high central plateau comprising nearly 10 percent of the country's land, is often looked to as an extreme example of where slash and burn has left an area completely unproductive.

As population growth continues to fuel development, urban erosion becomes an equally significant factor. Logging, road and building projects gouge the soil, strip away vegetation, and can significantly alter drainage patterns. In addition to the loss of soil, an increase in both nutrient and sediment runoff can cause deterioration in overall water quality.

Because of the importance of soils to agriculture, there is considerable research done in the U.S. and around the world to improve agricultural and soil management practices. As population increases, there is a greater demand for food resources and, therefore, maintaining productive soils is crucial.

Traditionally, farmers managed soils by rotating crops from one field to another, letting some acres lie fallow. However, most modern agricultural practices now include the use of fertilizers to increase the productivity of soils. It is important to begin by educating farmers about the negative effects of intensive agriculture and the over-application of synthetic fertilizers and pesticides.

Continual planting of crops can also reduce the nutrients available in soil ecosystems. Improved soil management practices, such as conservation tillage, contour plow-ing, terracing, and strip cropping are now used in many places to minimize erosion and maintain soil fertility. Organic farming methods—that don't use chemicals at all—are also becoming increasingly popular.

Development of our urban and suburban areas provides other opportunities for practicing soil conservation. The building of roads can incorporate aspects that mimic natural drainage patterns, thereby minimizing the potential for erosion. Building, housing, and other landscape projects can utilize trees, shrubs and additional groundcover for both runoff and erosion control.

How can you help to keep the land healthy?

- Wise waste management:
    - ⇒ **Composting**: In nature, fallen plants and animals decompose naturally. Composted waste is gradually processed and cleaned by soil, providing fresh nutrients for plants and animals.
    - ⇒ **Preventing waste**: When people make a commitment to using durable, reusable items and purchasing products with less packaging, they are reducing the amount of waste they produce.
    - ⇒ **Incineration or burning waste**: Used wisely, incineration can produce steam, which is processed as electricity.
    - ⇒ **Recycling**: Using recycled materials reduces the amount of greenhouse gases and pollutants that are put into the environment by traditional manufacturing plants. Recycling also conserves fossil fuels, saves energy, and reduces waste.
- Reduce pesticides: Encourage farmers to use organic, non-synthetic fertilizers to keep contaminants out of the soil.
- Prevent erosion: Plant a windbreak of trees or bushes around fields to reduce the chance that wind will blow the topsoil away into your water supply. Planting trees at water lines (like rivers and lakes) helps prevent erosion of the banks into the water bodies.

Materials:

Science journals

Access to research materials on cause-and-effect cycle of soil health

Materials to create persuasive presentations

Handout “Protecting the Land ”

Learning Activity:

- Ask students to Think-Pair-Share about how your own actions threaten the health of soil in your yard, community, and nation. Do you apply herbicides and pesticides to maintain a weed- and pest-free lawn? Do you have a paved rather than gravel driveway? If you have a septic system, do you maintain it and is it operating properly? Do you purchase food grown locally using sustainable agricultural practices? These are just a few of the actions you may take in your lives that preserve the health of soils. When soil is polluted, the entire ecosystem suffers.
- Healthy soil affects every other part of the environment. Ask: What are different ways that people can pollute the soil? Have students list ways that contaminated land and soil affect plants, animals, and humans.
- Separate students into groups of 5 to 8. Explain that each group is going to present a persuasive argument about the cause-and-effect cycle of soil health. Students will select one topic to focus on, conduct an investigation to discover the facts, and then inspire others to act.
- Instruct each group to choose a specific human action that could lead to soil contamination. Each group should then decide what it thinks the primary effect of that action will be (i.e. human actions like poor waste management, deforestation, and the use of pesticides can lead to effects such as soil erosion, animal and plant extinction, and food shortages).
- Distribute a copy of the "Protecting the Land" student reproducible. Student teams should use this reproducible to help guide their research.
- Provide class time for students to research and present their findings.
- Take a class poll to find out which group had the most compelling argument for action! Discuss what was most persuasive about each presentation.

Extension: **THE DUST BOWL: REAL-WORLD EXAMPLE**

- Illustrate the importance of healthy soil by discussing the Dust Bowl (1931–39) and how it led to the Soil Conservation Act of 1935.
- Explain that during the Dust Bowl, dry topsoil began blowing off farmland all across the United States. Without topsoil, farmers were unable to grow enough food and the agricultural economy collapsed. It affected not only the human population dependent on the crops but also the plants and animals that relied on the nutrient-rich soil to survive.

- Review the following sequence of events with students:

    a. In 1931, the United States entered into a drought that lasted until 1939. Crops across the country died in the fields.

    b. As farmers tried to farm dry land, they realized that excessive grazing and plowing had disturbed the natural soil-replenishment cycle. Dust clouds began to blow across the Midwest in 1932.

    c. By 1934, dust storms covered 74 percent of the United States.

    d. The government tried to correct the damage to the overused soil but wasn't able to. According to the 1934 Yearbook of Agriculture, "Approximately 35 million acres of formerly cultivated land have essentially been destroyed for crop production. . . . 100 million acres now in crops have lost all or most of the topsoil; 125 million acres of land now in crops are rapidly losing topsoil."

    e. In 1935, soil erosion was declared a "national menace" and farmers were paid to use soil-conservation farming methods such as strip cropping, terracing, crop rotation, contour plowing, and cover crops as part of the Soil Conservation Act.

    f. By the end of 1935, 850 million tons of topsoil had blown off the southern American plains.

    g. By the time it began to rain again in 1939, food riots and economic hardship had taken a harsh toll on the United States and the world.

Additional Resources

http://www.scholastic.com/browse/article.jsp?id=3747551

https://www.classzone.com/science_book/mls_grade7_FL/248_252.pdf

https://enviroliteracy.org/land-use/soil/threats-to-the-soil/

http://www.pbs.org/kenburns/dustbowl/

NAME: ________________

PROTECTING THE LAND

Life takes root in healthy soil, which filters toxins, creates new life-giving nutrients, and feeds the plants and animals that we depend on for food. Healthy soil affects every other part of the environment. With your group, brainstorm ways that humans can negatively impact soil health (i.e. farming practices, overgrazing, urban development, mining, deforestation, waste management, pesticides, human pollutants, etc.).

Get to the Root of This Problem!

1. Use available research materials to investigate the cause-and-effect relationship between humans and soil health.
2. Choose one topic to focus on (i.e. how human use of pesticides affects soil health). What is the negative impact? What action can be taken to reverse the effects?
3. Create a group presentation to share your findings. Be creative! Your presentation can include visual aids, songs/skits, audience participation, etc.
4. Be very persuasive! Back up your argument with facts to convince others that they should take action.

Topic: ____

Cause(s): ____

____

Effect(s): ____

____

Plan of Action (local and/or global): ________________________________

____

____

In what ways can humans positively impact soil health?