Soil Solutions

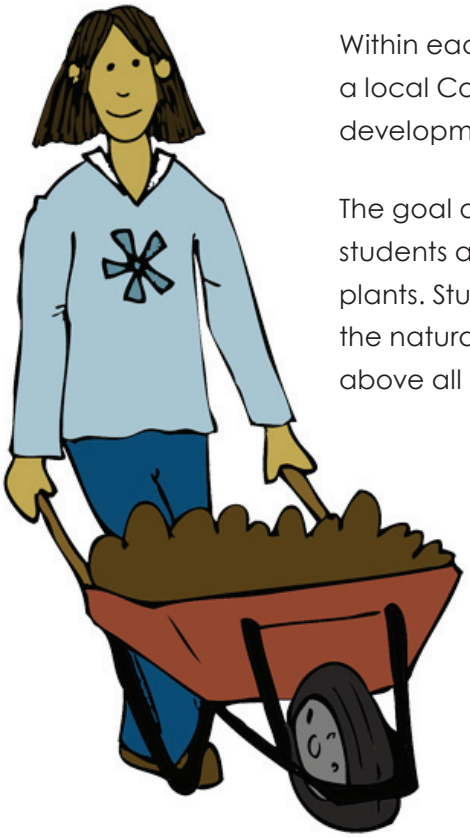
North Carolina State University
4-H Plant and Soil Sciences

Soil Solutions

Introduction

Soil Solutions brims with hands-on science lessons that utilize the local school landscape to connect students to the world of soils and plants in an inviting and relevant way. Students will discover the soil beneath their feet, watch as a basil seed germinates before their eyes and nibble on nutritious and delicious salad greens they have grown themselves. Activities are structured to foster wonder and curiosity and encourage ways to turn student questions into investigations. The teacher's role becomes one of a collaborator and a partner in inquiry with their students. Aligned to meet the North Carolina's third grade science standard course of study in plant and soils, the curriculum draws from current research and knowledge in crops, horticulture and soil sciences.

Each lesson includes background information for teachers, questions to focus student thinking and activities that emphasize observation and problem solving. Using the 4-H Experiential Learning Model as a framework, the curriculum seeks to further life skills like communication, teamwork, critical thinking, and more, by engaging students to learn by doing, sharing their experience with each other, reflecting on their results and generalizing and applying what they know to new situations.

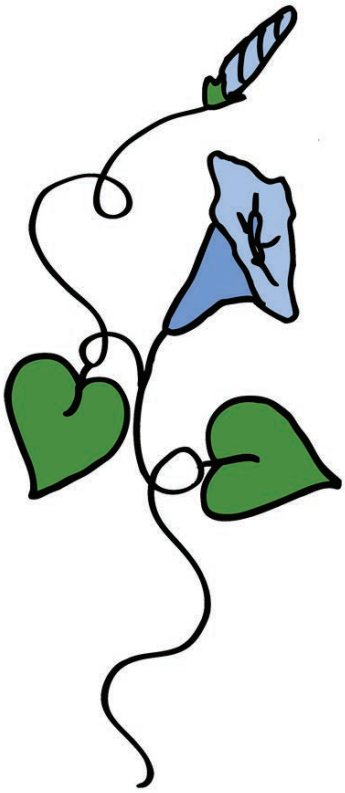


Within each community across the state of North Carolina, there exists a local Cooperative Extension office that can provide content, youth development support and resources to educators.

The goal of Soil Solutions is offer a contextual framework that enables students and teachers to dig deep and uncover the stories of soils and plants. Students will begin to hold a greater appreciation and respect for the natural world, gain confidence in their abilities to solve problems and above all have a lifelong interest and enthusiasm for exploring and learning.

Soil Solutions

Table of Contents



Lesson 1 Soil Properties

Duration: 1.5 hours or two 45-minute sessions

Purpose:

Using skills of observation, comparing, classifying, and communicating, students will discover the different characteristics of soil and how soil properties impact their daily life.

North Carolina Essential Science Standards:

Clarifying Objectives

3.L.2.4 Explain how the basic properties (texture and capacity to hold water) and components (sand, clay and humus) of soil determine the ability of soil to support the growth and survival of many plants

Vocabulary Acquisition and Use

Common Core Language Arts

L.3.4. Determine or clarify the meaning of unknown and multiple-meaning word and phrases based on grade 3 reading and content, choosing flexibly from a range of strategies.

- Use sentence-level context as a clue to the meaning of a word or phrase.
- Determine the meaning of the new word formed when a known affix is added to a known word (e.g., agreeable/disagreeable, comfortable/uncomfortable, care/careless, heat/preheat).
- Use a known root word as a clue to the meaning of an unknown word with the same root (e.g., company, companion).
- Use glossaries or beginning dictionaries, both print and digital, to determine or clarify the precise meaning of key words and phrases.

Life Skills:

Learning to Learn: Is curious, asks questions, learns how to do the process, how to observe, learns by doing.

Problem Solving: Seeks solutions to simple problems and is able to consider a few selected alternatives.

Critical Thinking: Ask questions before, during, and after acquiring information.

Communication: Engages in group discussion.

Cooperation: Has cooperative group experiences.

Leadership: Learns to be a group member, learns to listen when others speak.

Materials (For 30 Students):

- 30 paper cups
- 8 trowels (or soil probes)
- 30 magnifying glasses
- Newspaper (to limit the mess)
- Paper, pencils
- 30 clear, 20-oz. soda bottles
- 2 cups powdered dish detergent
- Rulers
- 1 basketball, 1 golf ball, 1 BB pellet
- 1 water spray bottle
- Funnel
- Masking tape
- Overhead projector & Dissecting Microscopes

Background Information:

Soils are important, from the growing of our food and favorite ornamental plants, to providing the materials to build the houses we live in, filtering impurities out of our water, helping us recycle wastes, and providing recreational activities we enjoy. Soils contain four parts: **weathered minerals**, organic matter, water, and air.

Soil texture refers to proportion of sand, silt, and clay particles. Texture affects many fundamental soil properties, such as fertility, erosion, water-holding capacity, pollution, and **compaction**. Soil color can reflect the different mineral content, **aerobic** or **anaerobic** conditions, and the presence of organic matter.

Humus is the organic part of the soil that results from highly decomposed plant and animal matter. Humus contributes to nutrient exchange with plants and helps bind soil particles into **aggregates**. Humus also holds water well and, therefore, improves drought tolerance.

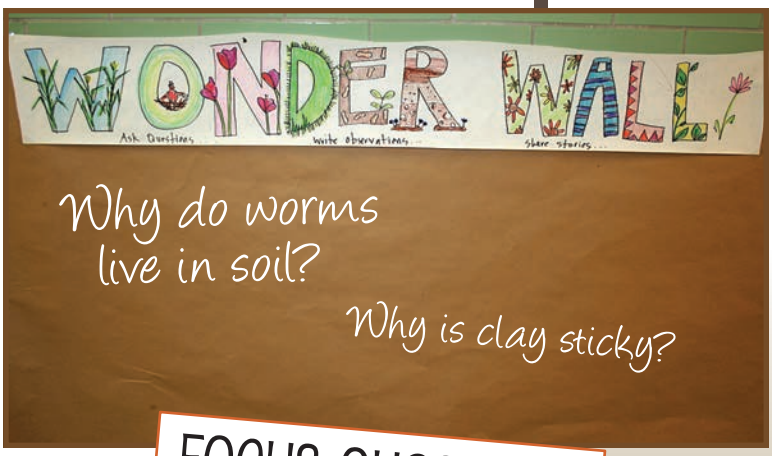
Lesson 1: Soil Properties

Scratching the Surface:

Begin with a brainstorm about soil's importance. Have pairs of students list as many ideas as they can on how soil is important in our daily lives. After a few minutes of cooperative brainstorming, ask for volunteers to voice their ideas.

Collect the ideas by writing them down on a piece of large paper hanging on the wall or a bulletin board. Use this as your "Soil Wonder Wall." Students will use this space to add to their initial list of ideas and as a place to record questions.

Think about engaging students in recognizing their work together as a group. Leading questions might be: Do you think you get more ideas working alone or a group? Why? How did you decide what roles your group members would play? What did you learn about communicating with others?



FOCUS QUESTIONS:

WHY IS SOIL IMPORTANT?
WHAT IS SOIL?
WHAT DOES IT LOOK AND FEEL LIKE?
WHY ARE THERE DIFFERENCES BETWEEN SOILS?

Digging in:

Break the class into teams of three. Go outdoors and ask the students to help you identify three unique spots for soil samples. Ask them why a location may have different soils. You may want to define a unique spot as the edge of the playground where wildflowers grow, a compacted place beneath play equipment, on the soccer field, etc. Demonstrate how to take a soil sample (www.soil.ncsu.edu/publications/Soilfacts/AG-439-30/AG-439-30.pdf).

At each stop, have one teammate fill a paper cup with soil. Bring the samples into the classroom and pour the samples onto pieces of newspaper for observation. (Students may also want to share soil samples brought from home.) Use magnifying glasses and **dissecting microscopes** for a closer look.

Have students record their descriptions and sketches of each soil. What does the soil feel like? What does the soil look like? Is it heavy? What color is it? Is there evidence of plant material or other living materials?

Encourage students to write down questions or interesting things they find in their soil explorations and put it on the Soil Wonder Wall. Take time for reflection about student findings and their questions.

Lesson 1: Soil Properties

Digging Deeper:

Hand Texturing

Hand texturing is a field exercise soil scientists use to determine soil texture, or whether the soil is made up of sand, silt, or clay.

Have students take an egg-sized soil sample, and spray it with water to lightly moisten it. Have them knead the soil. If it is too dry, and completely falls apart, spray more water. Conversely, if it is too wet, add dry soil.

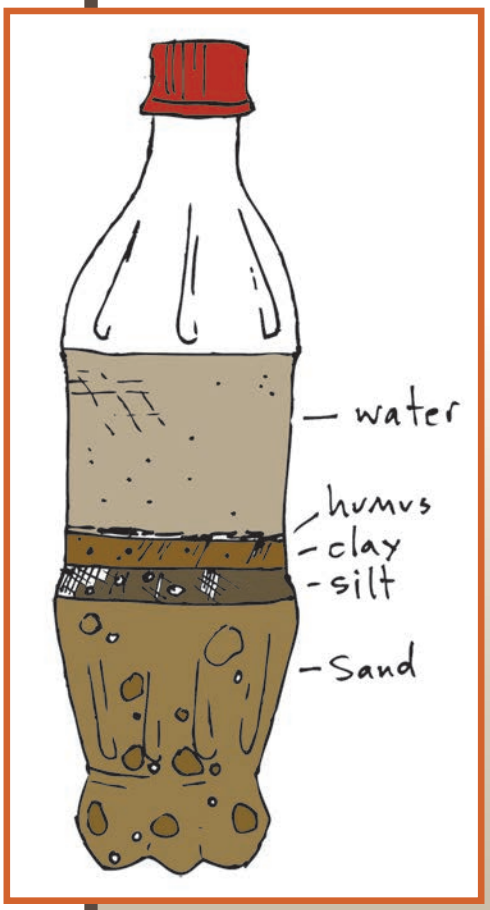
Sand tends to have a gritty texture, like salt or sugar, and it falls apart when squeezed into a ball. Soil with a lot of silt has a silky feel, similar to flour. Clay tends to be sticky and greasy, and it easily forms a ball. Most soils have varying amounts of these particles, and will have a combination of the properties. Once you have a moist soil ball, gently press your thumb and push the soil over your forefinger into a ribbon.

The longer you can make your ribbon, the higher the clay content. Clayey soil can ribbon out or three-fourths of an inch or greater. If your ribbon is short (less than three-fourths of an inch) and cracks, the soil is considered to have a loamy texture (usually containing varying amounts of sand, silt, and clay).

Project the soil texture key (found at the end of the lesson) onto the overhead.

As a whole class, work together to figure out the soil texture. Does it match with previous finding? Why is soil texture important?

Rarely are soils ever composed of one size of soil particle, but if a teacher has access to separate samples of sand, silt, clay, and humus, the students can further their soil sample observations by feeling and looking closely. Students should record any descriptions and sketches they make.

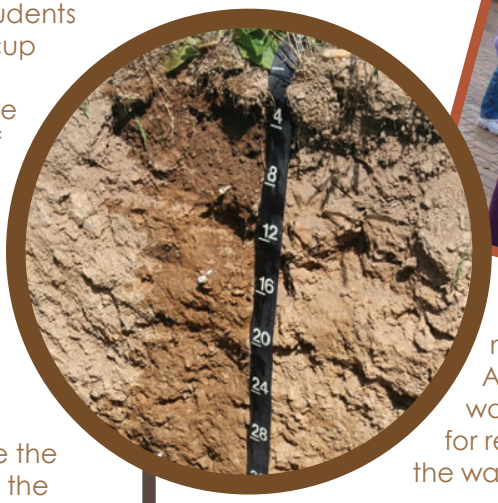


Soils are composed of particles of different sizes:

- **Sand** (.05 to 2 mm)
- **Silt** (.002 to .05 mm)
- **Clay** (smaller than .002 mm)
- **Humus** (decomposed organic matter)

What does the soil feel like?

Lesson 1: Soil Properties



The Soil Shimmy

1. To determine what soil particles make up the collected samples, have students use a funnel to put at least a half cup of soil into clear 20-ounce plastic soda bottles. You may want to have them put their name on a piece of masking tape and adhere it to the bottle.

2. Have them add a tablespoon of powdered dish detergent in with the soil, and fill the bottle with water. (Dish detergent clings to the soil particles, helping to separate them.)

3. Secure the bottle cap, and have the students dance around and shake the bottle vigorously for at least two minutes.

4. Have them place their bottles in a location where they can sit undisturbed for 24 hours. The soil should settle out from bottom to top in layers of sand, silt, clay, and organic matter, respectively.

5. Ask the students what they observe. Which layer has the most? Which layer has the least? How does this compare to when you hand textured? Why is some water still murky?

Soil Particle Play

Each soil particle is a different size. To show the differences between a sand particle, silt particle, and a clay particle, start with a basketball, golf ball, and a BB pellet. Tell students that the basketball represents a sand particle, the golf ball symbolizes the silt, and the BB denotes a clay particle.

1. To illustrate the relationship between particle size and the pore spaces or places between the soil particles, tell the students they will be performing in the great Soil Particle Play!

2. Begin by having the students stand up in a cluster and spread their arms out and position themselves fingertip to fingertip. Have the students drop their arms and tell them that they are sand particles. Explain that all the room in between them is occupied by air, which allows plants and animals to thrive and also allows water to travel through soil.

3. Set the scene and tell students that you, as the gardener, need to water the soil and must pick a student to be a water drop. Ask the student volunteer to wind his or her way through the students. Ask the students for responses on how easy or hard it was for the water drop to make its way through the soil.

4. Next, have the students spread themselves out elbow to elbow and then drop their arms. This scenario shows the smaller spaces between silt particles. Ask the students what they observed and how this might be important. Have the water drop, wind his or her way through again.

5. Finally, the students should stand almost shoulder to shoulder, showing clay particle spacing. One can notice that water would have to move much slower to make it through the pore spaces and that clay creates a challenging situation for plant roots to grow.

As a final act in the Soil Particle Play, divide the students into groups based on the average soil particle findings from the Soil Shimmy exercise. For example, if most of the soil was three-fourths sand, take three-fourths of the students and assign them to be sand particles.

The remaining particle percentage might have been one-eighth clay, one-eighth silt. Divide the remaining students accordingly. Have the students space themselves and make comments on the arrangement. Is there space for roots to grow? Will the plants get enough air?

You may decide to do other scenarios, like demonstrating compacted soil or how compost can help soil structure. (Compost creates clumps or aggregates of soil with space between.)

Ask students what they learned through this activity. Why was this a fun way to learn about soils? How does having fun help you learn?

To summarize the soil properties exercise, reflect with students on the experience. Why is it important to know about soils? How have soils been important in your life? What did you learn from this activity that you didn't know before? What made this a good activity? How can the things you learned be use in other situations? What other ways could you apply the skills you gained in this activity?

Lesson 1: Soil Properties

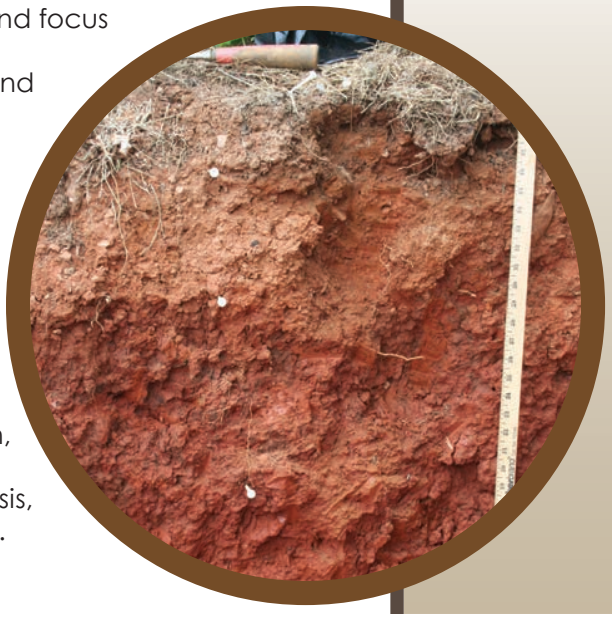
Assessment:
Soil Wonder Wall Questions

Student-generated questions allow you to make judgments about the number, quality, and range of questions produced. Questions reveal student understanding about the topic. They show what students are interested in knowing more about, and they also reveal the level of thinking required to ask the question. Encouraging students to write down individual and group questions on the wonder wall gives you a permanent record of their thoughts. You may also include the questions they ask out loud.

Using Bloom's taxonomy, questions can be separated into categories from simple basic information questions to higher-level wonderment questions. Basic information questions include knowledge or factual questions, which usually only require a recall of information and are often closed questions, usually based on an observation they made. Questions like, "Why is this soil red?" are basic information questions.

Procedural questions seek clarification about how a given task or procedure was carried out (Chin, et al, 2002). Examples might include: How do I take a soil sample? How do I set up the Soil Shimmy?

Wonderment questions are pitched at a conceptually higher level. According to Chin, (et al., 2002), "They require an application or extension of taught ideas, and focus on predictions, explanations, and causes instead of facts, or on resolving discrepancies and gaps in knowledge." These questions fall into Bloom's categories of comprehension, application, analysis, synthesis, and evaluation.



Why is it important to know about soils?

When trying to evaluate the questions, use the following:

- Comprehension questions typically seek explanations of things not understood (Chin, et al, 2002). Example: Why is clay stickier than sand?
- Application questions use previously learned information in new and concrete situations to solve problems that have single or best answers (Krumme, 2003). Example: If sand doesn't hold much water, how does it support plant growth?
- Analysis questions break down and organize information into its component parts and develop conclusions by recognizing patterns and finding evidence to support generalizations. Example: I know clay soils can be hard for plants to grow in, yet plants still do. Are there plants for clay soils?
- Synthesis questions creatively apply existing knowledge and skills to produce an original whole.
- Evaluation questions judge the value of material based on personal opinions and values.

Questions can reveal student understandings and curiosity and can play a significant role in encouraging further scientific discovery.

Beyond the Garden Gate:

Activities to try at home

Dirt Shirts

Find a clean, washed, white t-shirt that you won't get you into trouble when you dye it with dirt. Gather enough soil to fill the bottom of a bucket. Red clay works very well, but you may want to try other soils, like a humus-rich black or gray soil. Make a mud slurry by adding some water to your soil in the bucket. You want it to be a little thinner than a mud pie.

To make a tie-dyed dirt shirt, tie rubber bands tightly onto the shirt. Put your shirt into the mud-pie mixture, and mix it in really well. Let it soak for at least four hours or even overnight. Take your shirt out of the bucket and wash it off, preferably outside using a garden hose. Let your shirt dry outside, and then rinse it again in cold water. Dry the shirt in a hot dryer to set the color. The color will fade over time, but you should end up with a glorious shirt from the garden!

Soil Crayons

Soils across the country and even in the state of North Carolina come in different colors. Some Native American cultures used colorful soil for pottery, makeup, and paint pigments. You can create your own artistic expressions with soil crayons. The U.S. Natural Resources Conservation Service has created a procedure that is easy to follow with an adult's help. Visit this Web site: www.soils.usda.gov/education/resources/k_12/lessons/crayons/.

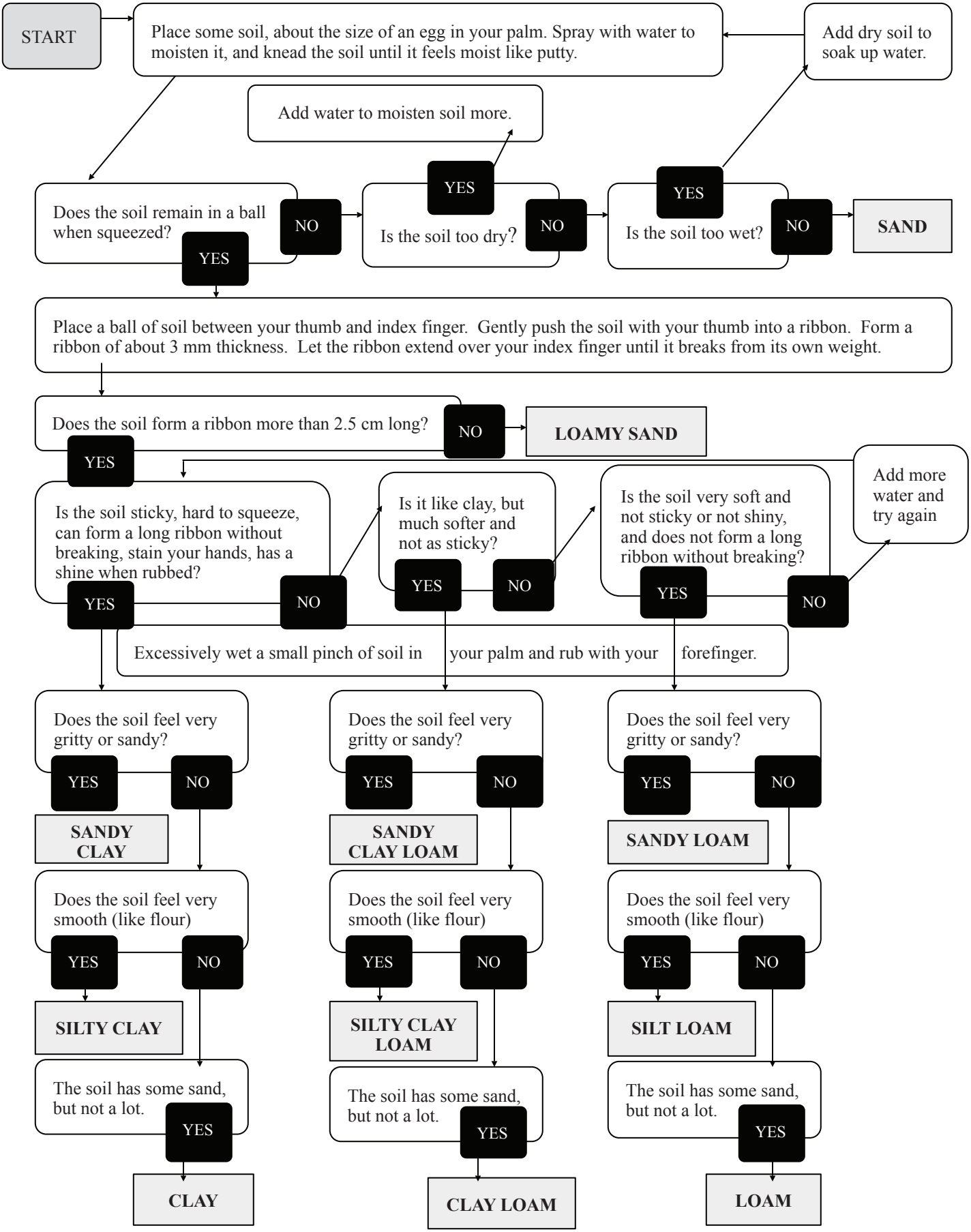
Soil Observation Record

Group Names:_____

Date:_____

Soil Location:	Soil Sketch:
Describe what the soil looks like: (Color, size, other)	
What does it feel like? (Smooth, silky, gritty, sticky, etc.)	
Give your soil a sniff. What does it smell like?	
What other observations can you make about your soil?	
What questions do you have about your soil?	

Soil Texture by Feel Key



Adapted from Modified from S.J. Thien. 1979. *A flow diagram for teaching texture by feel analysis.* Journal of Agronomic Education. 8:54-55 & http://soils.usda.gov/education/resources/k_12/lessons/texture/

Soil Solutions Glossary

Actinomycetes: Soil-dwelling bacteria that decompose organic materials.

Aeration: The process of air being circulated through a substance, in this instance, compost. Compost must have sufficient amounts of oxygen in order for the decomposition process to occur.

Aerobic: The presence of oxygen, specifically in reference to soil.

Aggregates: Clumps of soil particles massed together.

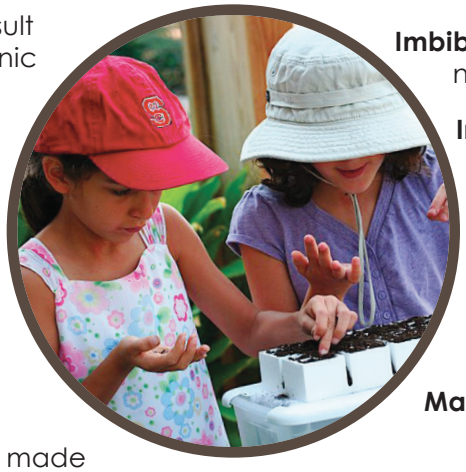
Agronomic: Referring to the science of field crop production. Agronomic crops are generally grown in large-scale production like corn, soybean, cotton, peanuts, wheat, rye, barley, oats, and forage crops.

Amendment: The addition of compost to the soil to promote healthy plant growth by improving soil structure, moisture retention, nutrient amount and availability.

Anaerobic: Without oxygen. As related to soil, anaerobic conditions occur in wet soils and are sometimes related to compaction.

Authentic Inquiry: To perform the same or similar activities and experiments that actual plant scientists do.

Castings: Worm manure, the result of the breakdown of organic materials by certain species of worms. Can be used like compost, as a soil amendment to improve soil structure, fertility, and water retention.



Cellulose: A complex carbohydrate found in the cell walls of plants.

Cold Frame: A structure, usually made of a wood frame covered with plastic, that extends the growing season for plants by allowing the sun's rays to raise the temperature inside the cold frame.

Compaction: What occurs when soil particles have been compressed and the pore space between them reduced. Some causes include driving heavy machinery over the soil and over tillage.

Decomposition: The breakdown or decay of organic or once-living materials.

Dissecting Microscope: A kind of microscope that enables users to closely examine the surface of various specimens, like flowers, leaves, or insects.

Dormancy: A stage in plant development when the plant rests or the stopping of growth until favorable environmental conditions are available.

Embryo: The young plant contained within the seed.

Genetics: The study of differences and similarities between organisms due to genes and the influence of the environment.

Germination: The process of a seed starting to sprout and grow.

Imbibe: To soak up and absorb water. Seeds need to imbibe water to germinate.

Invertebrates: Describes any animal without a spinal column, and includes organisms that aid in the composting process like worms and insects.

Lignin: Fibers found in woody plant tissue usually in connection with cellulose. Lignin strengthens the cell walls of plants.

Manipulate: To change. In the case of Fast Plants, to vary the amount of what plants need to grow in order to observe a difference in plant development.

Microbes: Small organisms like bacteria.

Nectar: Sugar-rich liquid found in many flowers to attract pollinators. Pollinators use nectar as a source of energy or food.

Soil Solutions Glossary (continued)

Nectary: Glands in the flowers that produce nectar.

Non-biodegradable: Materials that cannot be decomposed by living organisms. For example, plastic and Styrofoam are non-biodegradable materials.

Organic: Referring to the materials of once-living organisms (like plants, animals, or fungi).

Ovary: The ovary holds the ovules and mature into fruit once fertilization has happened.

Ovule: The eggs or female gamete of the plant. The ovules are contained within the ovary and mature into seeds or plant embryos once fertilization from pollen has occurred.

Pistil: The female reproductive structure of the plant, made up of the stigma, the style, the ovary, and the ovules.

Pollen: The male gamete of a plant. Pollen originates within the male reproductive structure of the stamen, specifically in the anther.

Pollination: The transfer process of the pollen from the male stamen to the female pistil, which contains the eggs. Occurs in the flower.

Proboscis: The sucking mouthpart of an insect. Butterflies, moths, and bees commonly use a proboscis to suck nectar from a flower.

Qualitative: A research method (for our purposes) that is based on personal reasoning and understanding.

Quantitative: Research from which the data is based on numerical measurements, like plant height, number of leaves, width of flowers, etc.

Radicle: The primary root of a germinating seed.

Scarification: The process of physically removing part of the seed coat in order to promote seed germination. Methods of scarification are performed on seeds with hard coats and include soaking in water, the use of acid, sandpaper, or a file.

Stamen: The stamen is the male reproductive organ found in flowering plants and including the pollen-producing anther and the filament.

Stewardship: The management and conservation of earth's natural resources.

Stratification: A moist chilling requirement needed to coax seeds out of dormancy into germination.

Variables: The changing quantities within the context of an experiment. For example if you are trying to find out how temperature affects how fast something will compost, your variables would be the different temperatures.

Viable: Able to live and grow. Viable seeds are seeds that are alive.

Wicking: For Fast Plants, wicking refers to the action of water traveling from a reservoir up through a piece of wick (felt or cotton fabric) into the soil to deliver moisture to plant roots. Wicking occurs as the result of capillary action.

Resources & References

**NOTE: Brand and trade names were used in this publication for the convenience of the reader. The Cooperative Extension Service does not endorse products mentioned nor imply criticism of similar products not named.

Resources

Fast Plants: Specially bred mustard plants that complete their life cycle within 28 days. They are great for growing in a classroom under fluorescent lights and utilizing for experiments. They can be purchased through Carolina Biological Supply Company: http://www.carolina.com.

North Carolina 4-H Plant and Soils Web site: Contains supplementary Soil Solutions curriculum materials at http://www.ces.ncsu.edu/4hplantandsoils/

- Seed germination video
- Pollination photos
- Word document work sheets to download for experiments
- Other ideas to keep you growing

"Dirt Made my Lunch" by the Banana Slug String Band: Song available on the Banana Slug's CD entitled, Singing in our Garden. Also available as a single download from Apple's itunes http://www.apple.com/itunes/.

Folkmanis Bee Puppet: Produces a nice puppet that fits snugly on the hand. For ordering information contact Folkmanis, Inc. at http://www.folkmanis.com/.

Salad Green Seeds: Johnny's Selected Seeds has a diverse supply of salad greens. Their catalog is free at: http://www.johnnyseeds.com/.

Osmocote Slow Release Fertilizer: Osmocote and other similar branded fertilizers are pelleted and release their nutrients into the soil slowly. They can be found in stores that carry gardening supplies.

Nutrient Test Kits: Nutrient test kits can be found through Carolina Biological Supply Company's online store at http://www.carolina.com.

pH Paper: pH paper can be purchased through any science supply store including Carolina Biological Supply Company's online store at http://www.carolina.com.

Online Reference Publications:

Soil Sampling guide: http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-30/AG-439-30.pdf

Composting bulletin: http://www.ces.ncsu.edu/depts/hort/hil/pdf/ag-467.pdf

Vermicomposting: http://www.bae.ncsu.edu/topic/vermicomposting/pubs/worms.html

Natural Resource Conservation Service Soil Web Survey: http://websoilsurvey.nrcs.usda.gov/app/

Soil Ball: http://soils.usda.gov/education/resources/k_12/lessons/experiments/soil_air/

Soil Crayons: http://soils.usda.gov/education/resources/k_12/lessons/texture/

Cornell Composting in Schools: http://www.css.cornell.edu/compost/schools.html

North Carolina Department of Agriculture: http://www.ncagr.com/stats/codata/index.htm

For More Information, Contact:
Your local county Cooperative Extension center: http://ces.ncsu.edu/

References

Naylor, S., Keogh, B. and A. Goldsworthy. 2004. *Active Assessment: Thinking, Learning and Assessment in Science.* David Fulton Publishers, Ltd. UK.

Chin, C., Brown, D.E. and B.C. Bruce. 2002. Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education* 24(8):521-549.

Krumme, G. Accessed July 2, 2007: http://faculty.washington.edu/krumme/guides/bloom.html

Bartholomew, M. 2005. *Square Foot Gardening: A New Way to Garden in Less Space with Less Work*. Rodale Inc., PA

USDA Soil Texture Triangle: http://soils.usda.gov/technical/manual/images/fig3-16_large.jpg

NRCS Soil Texture by Feel Key: http://soils.usda.gov/education/resources/k_12/lessons/texture/

Raven, P. H., Evert, R.F., and S.E. Eichhorn. 2005. Biology of Plants. W.H. Freeman Publishing Company, NY.

Credits

Author:
Liz Driscoll – Extension Associate, Department of Crop Science, Horticultural Science, and Soil Science, North Carolina Cooperative Extension Service

Contributing Authors:
Salad Green Experiment
Kelli Berryhill – Teacher, San Jose, CA Public Schools

Many thanks to the reviewers:
Dr. Ed Maxa – Associate Professor & DEL, 4-H, NC State University
Dr. Joe Kleiss – Professor, Soil Science, NC State University
Dr. Lucy Bradley – Assistant Professor, Horticultural Science, NC State University
Erv Evans – Extension Associate, NC State University
Cindy Hall – Ag in the Classroom, Polk County, Iowa
Rhonda Sherman – Extension Solid Waste Specialist, Biological and Agricultural Engineering, NC State University

Special thanks to the following agents for their initial work of this project:
Millie Bruton – Retired 4-H Agent, Montgomery County
Beth Davis – 4-H Agent, Alamance County
Linda Gore – 4-H Agent, Moore County
Chris Reisinger – former Agriculture Agent, Anson County

Thank you to the exuberant Wake County Junior Master Gardeners for their willingness to be photographed, get dirty and play in the garden.

NC State University
A&T State University
COOPERATIVE EXTENSION
Empowering People · Providing Solutions

Cooperative Extension's Youth Development Program

NC STATE UNIVERSITY

COLLEGE OF AGRICULTURE & LIFE SCIENCES
ACADEMICS · RESEARCH · EXTENSION

Name: _____

Soil Solutions Cumulative Assessment

1. Why is soil important?
    a. It filters pollutants out of water
    b. It helps recycle waste
    c. It provides a space for plants to grow
    d. All of the above

2. Soil is made up of air, water, mineral soil particles, and decomposed organic material.
    a. True
    b. False

3. Which soil particle size is the smallest?
    a. Sand
    b. Silt
    c. Clay
    d. Humus

4. What does hand texturing tell you about the soil?
    a. The color of the soil
    b. How much clay, silt, and sand is in the soil
    c. The amount of water in the soil

5. Which kind of soil does water drain through quickly and is usually dry?
    a. Sand
    b. Silt
    c. Clay
    d. Humus

6. Which soil does water drain through the slowest?
    a. Sand
    b. Silt
    c. Clay
    d. Humus

7. What mostly fills the pore spaces in soil?
    a. Air and water
    b. Worms
    c. Insects
    d. Bacteria

8. Some plants are more adapted to grow in certain soils than others.
    a. True
    b. False

9. What kind of soil would you want in your garden? Why?

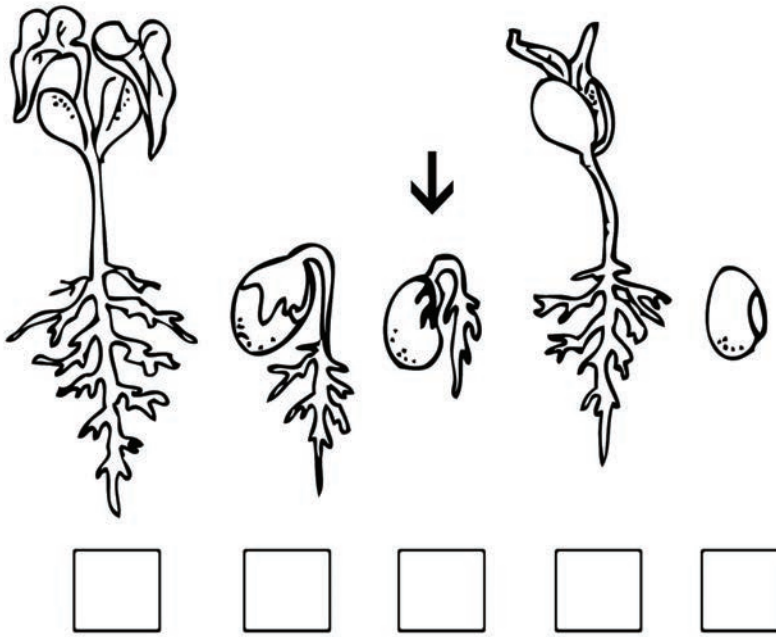
10. If you put soil and water in a jar and shake it up, what would happen?

11. Write down 5 different plants we grow for food in North Carolina.

12. Describe what happened to your plants that grew in different soils?

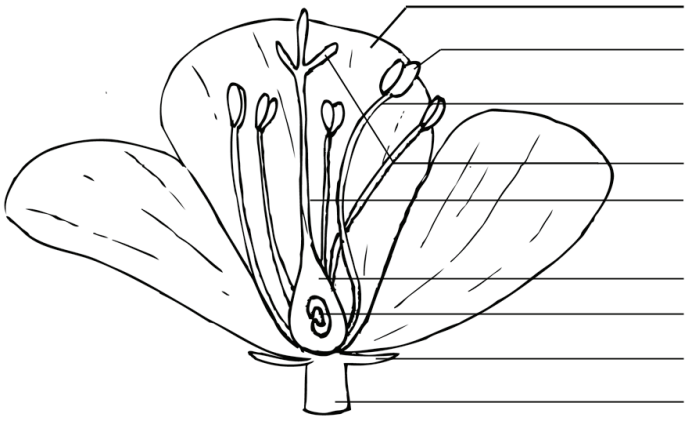
13. What is the most important in the process of germination?
    a. Water
    b. Air
    c. Light
    d. Soil

14. Below are some pictures of a seed growing. The pictures are not in order. Number the pictures in the order that shows the correct growth of the seed.



15. Look at picture with the arrow above it. Describe what is happening at that stage of the life cycle.

16. Look at the flower in front of you. Draw a picture of the flower and label any parts you can identify.



17. You would like to grow a corn plant in your garden. Describe what you would have to know in order for it to grow well.

18. Circle the materials you would put in your compost pile

Dead leaves	Hair	Newspaper
Eggshells	Fish scraps	Coffee grounds
Dryer lint	Weeds	Cheese
Ashes	Banana peels	Diseased plants

19. Composted materials can be put back into the garden to give plants the nutrients they need to grow.
    a. True
    b. False

20. Microorganisms are responsible for the rise in temperature in a compost pile as ingredients begin to decompose.
    a. True
    b. False

21. List 3 ways you could tell if a plant was growing well.

Vocabulary Matching
DIRECTIONS: Choose the word from the Word Box that matches each definition. Write the letter on the line.

22. ____ The process of a seed starting to sprout and grow.

23. ____ The process of pollen moving from the stamen to the pistil.

24. ____ A common pollinator of flowers.

25. ____ This plant part develops after the flower has been pollinated.

26. ____ Many flowers offer this sweet reward to pollinators.

27. ____ This flower part produces pollen.

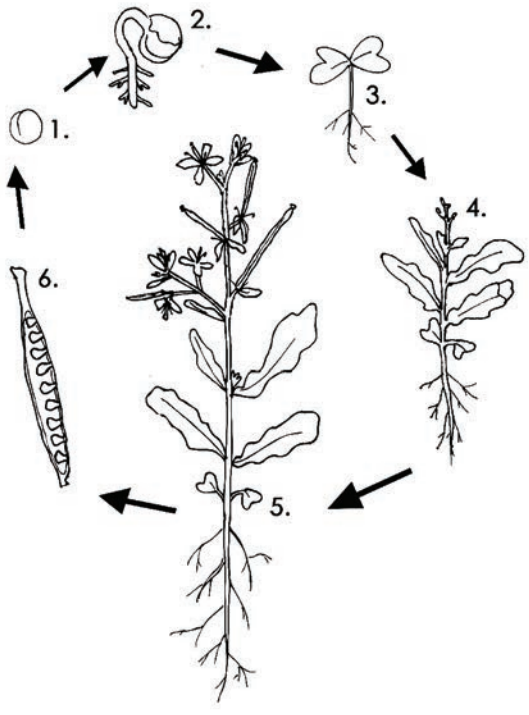
Word Box

a. Bee
b. Germination
c. Nectar
d. Seed
e. Pollination
f. Anther

28. Which of the following do plants **NOT** need in order to grow:
    a. Water
    b. Soil
    c. Light
    d. Nutrients

29. A plant that is grown in low light will produce fewer seeds.
    a. True
    b. False

30. Below is a diagram of the fast plant life cycle. Each number corresponds to a stage of growth. Write a short description of what is happening at each stage.



1. _____
_____

2. _____
_____

3. _____
_____

4. _____
_____

5. _____
_____

6. _____
_____

ANSWER KEY

Soil Solutions Cumulative Assessment

1. Why is soil important?
   a. It filters pollutants out of water
   b. It helps recycle waste
   c. It provides a space for plants to grow
   (d.) All of the above

2. Soil is made up of air, water, mineral soil particles, and decomposed organic material.
   (a.) True
   b. False

3. Which soil particle size is the smallest?
   a. Sand
   b. Silt
   (c.) Clay
   d. Humus

4. What does hand texturing tell you about the soil?
   a. The color of the soil
   (b.) How much clay, silt, and sand is in the soil
   c. The amount of water in the soil

5. Which kind of soil does water drain through quickly and is usually dry?
   (a.) Sand
   b. Silt
   c. Clay
   d. Humus

6. Which soil does water drain through the slowest?
   a. Sand
   b. Silt
   (c.) Clay
   d. Humus

7. What mostly fills the pore spaces in soil?
   (a.) Air and water
   b. Worms
   c. Insects
   d. Bacteria

8. Some plants are more adapted to grow in certain soils than others.
   (a.) True
   b. False

9. What kind of soil would you want in your garden? Why?

   Based on the soil solutions investigations, students should come to the conclusion that each soil texture has benefits and disadvantages. For example, clay can cause water to drain too slowly, but it holds many nutrients; on the other hand, sand can be too dry. A combination of clay, sand, silt, and humus would be best.

10. If you put soil and water in a jar and shake it up, what would happen?

The students should recall the soil shimmy. When water and soil is shaken together and allowed to settle, the largest soil particle, sand, will fall to the bottom, followed by silt, clay, and sometimes a layer of humus on top.

11. Write down 5 different plants we grow for food in North Carolina.

The answers may depend on the actual plants that the students grew. They could include any of the following: soybean, corn, wheat, rye, oats, peanuts, tomatoes, potatoes, sweet potatoes, watermelons, squash, beans, apples, blueberries, peaches, melons, grapes, raspberries, etc.

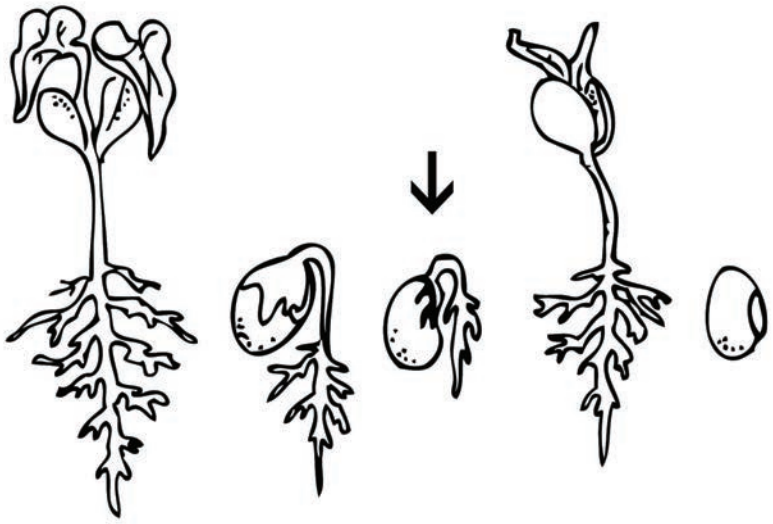
12. Describe what happened to your plants that grew in different soils?

The experiment results should vary depending on the soils used, but one might expect to see plants grown in sand to grow poorly and exhibit signs of stress like brown leaves and stunted growth. Plants grown in a soil that is well-drained and kept moist should grow well with dark green leaves and healthy development.

13. What is the most important in the process of germination?

(a.) Water
b. Air
c. Light
d. Soil

14. Below are some pictures of a seed growing. The pictures are not in order. Number the pictures in the order that shows the correct growth of the seed.

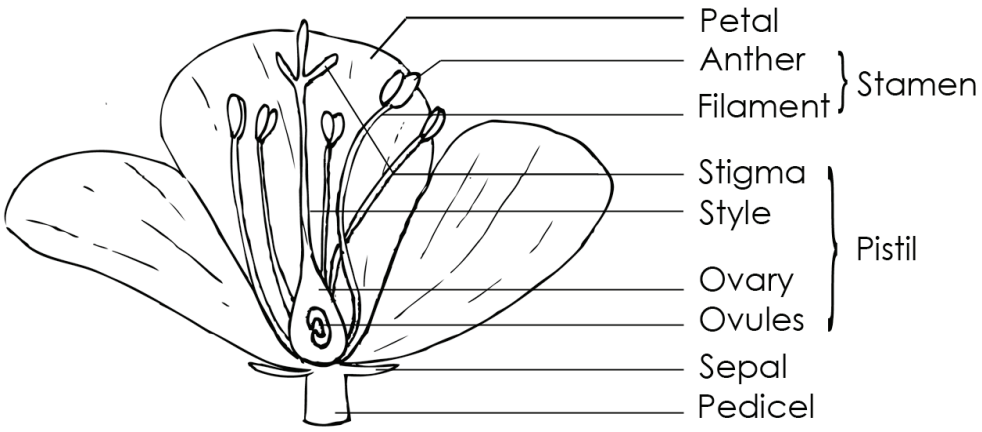


5 *3* *2* *4* *1*

15. Look at picture with the arrow above it. Describe what is happening at that stage of the life cycle.

The seed is just beginning the process of germination. The radicle or root is starting to emerge. It must have been given the proper environmental conditions, including warm temperatures and water to imbibe.

16. Look at the flower in front of you. Draw a picture of the flower and label any parts you can identify.



17. You would like to grow a corn plant in your garden. Describe what you would have to know in order for it to grow well.

Based on prior experiences in growing plants, students might suggest they need to know what type of soil is available, how many nutrients are in the soil, what the pH is, how much light is present, what the temperature is, how much water is available to the plants and given those conditions, what corn needs in order to grow well.

18. Circle the materials you would put in your compost pile

(Dead leaves)	(Hair)	(Newspaper)
Eggshells	Fish scraps	Coffee grounds
Dryer lint	Weeds	Cheese
Ashes	Banana peels	Diseased plants

19. Composted materials can be put back into the garden to give plants the nutrients they need to grow.
(a.) True
b. False

20. Microorganisms are responsible for the rise in temperature in a compost pile as ingredients begin to decompose.
(a.) True
b. False

21. List 3 ways you could tell if a plant was growing well.

There are a number of different ways to measure plant growth. Some of the ways could include: number of leaves, plant height, leaf color, disease incidence, pest problems, number of flowers, number of seeds germinated.

Vocabulary Matching

DIRECTIONS: Choose the word from the Word Box that matches each definition. Write the letter on the line.

22. _b_ The process of a seed starting to sprout and grow.

23. _e_ The process of pollen moving from the stamen to the pistil.

24. _a_ A common pollinator of flowers

25. _d_ This plant part develops after the flower has been pollinated

26. _c_ Many flowers offer this sweet reward to pollinators

27. _f_ This flower part produces pollen

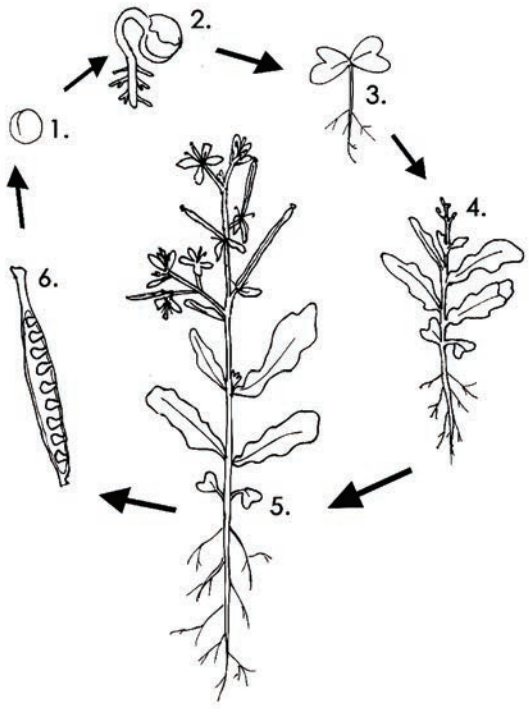
Word Box

a. Bee
b. Germination
c. Nectar
d. Seed
e. Pollination
f. Anther

28. Which of the following do plants NOT need in order to grow:
    a. Water
    (b.) Soil
    c. Light
    d. Nutrients

29. A plant that is grown in low light will produce fewer seeds.
    (a.) True
    b. False

30. Below is a diagram of the fast plant life cycle. Each number corresponds to a stage of growth. Write a short description of what is happening at each stage.



1. *Seed: the seed needs warm temperatures, oxygen, and water to start the process of germination.*

2. *Germinating Seed: the seed has begun to take in water (imbibe) and sprout a root.*

3. *Seedling: the cotyledons (seed leaves) have unfolded and the plant can begin to make food (photosynthesize) with light. It needs water, light, and carbon dioxide to grow.*

4. *Larger seedling, vegetative growth: the plant begins to grow taller and bigger by taking in more light and making more food. The roots are taking in water and nutrients to help it grow.*

5. *The plant is beginning to flower. Only Bees will need to pollinate the flowers in order for seeds to develop.*

6. *Fruit: the flowers were pollinated and fertilized allowing for fruit development. The seeds are found inside the fruit and will be the start of more plants.*