

Root, Root for Life



LEVEL: Grades 2-6

SUBJECTS: Science, Language Arts

SKILLS: Analyzing, applying, collaborating, collecting data, comparing similarities and differences, concluding, cooperating, describing, developing vocabulary, discussing, drawing, evaluating, explaining, following directions, identifying, inferring, observing, predicting, recording, understanding cause and effect, writing

MATERIALS

One mature potted houseplant (with holes in bottom of pot), one empty pot with holes, small bag of potting soil, sharp knife, toothpicks, small container of salt, three bowls, teaspoon, water, paper towels (brown is best), markers, drawing materials, student journals or notebooks, masking tape, magnifying glass or hand lens, dictionaries, encyclopedias, and the Internet for reference, examples of different root systems (such as houseplant, sod/grass, carrot with top, beet with top), a variety of roots commonly eaten by people (carrots, ginger, jicama, parsnips, radishes, beets, turnips), bedding plants, small clear plastic cups, sweet potatoes, photocopies of attached **Route to Roots** station signs and **Root Drawings** sheets. **Optional:** tweezers.

VOCABULARY

active transport, erosion, fibrous roots, leaves, minerals, nutrient, root hairs, roots, soil, stem, taproots, xylem

RELATED LESSONS

Fruits and Veggies
The Plant and Me

SUPPORTING INFORMATION

Ready to unearth some facts about roots? We might find 13 million roots in 2 cubic feet of soil. End to end, they could reach from where you sit to a town hundreds of miles away. But because we do not readily see them, it's easy to overlook the value of roots. Food chains all start with plants, and roots are a

plant's critical lifeline. That's why we are here to root for roots...and root, root for life!



Roots play a vital role to help plants meet their basic needs. They anchor the plant in the soil, provide support, and absorb necessary water and nutrients from soil (or other growing medium). Many roots are further specialized to store sugars and other carbohydrates and nutrients that the plant can use to carry out other functions. (Note: Not all plants have roots [e.g., algae] nor do all plants absorb water and nutrients through their roots [e.g., bromeliads use roots only as an anchor].)

Roots and stems form a partnership, enabling most green plants to meet their basic needs for nutrients and water. Soil nutrients are first absorbed through roots. Absorption of water and minerals occurs primarily through tiny root hairs. Through a process called active transport, soil nutrients move up into other parts of plants. They are then built into the tissues of the plant as it grows and matures. Most of the water absorbed by roots is used to replace water lost from leaves as they transpire (lose water by evaporation from leaves and stems) through pores, called stomata, during the photosynthetic process.

Plants have many different root structures. As a seed germinates, the first part to emerge is the primary root. It anchors the plant and begins to absorb water and minerals so the shoot can develop. From that point on, root development depends on the type of plant. Some plants have a

BRIEF DESCRIPTION

Students discover the importance of roots to plants, soil and people during hands-on learning-station activities.

OBJECTIVES

The student will:

- identify at least three ways in which roots help plants;
- explain how roots help the soil;
- list three reasons why roots are important to people;
- compare taproots and fibrous roots;
- observe roots and write observations;
- grow plants from roots; and
- eat and evaluate roots.

ESTIMATED TEACHING TIME

Session One: 20 minutes for introduction and one-and-a-half to three hours to move through six learning stations.
Session Two: 30 minutes for conclusion.
Session Three: 30 to 60 minutes for root-tasting feast.

Stations can be done as whole-class demonstrations for grades 2-5, as stations for grades 2-6, or as two stations a day for three days. An adult or upper-grade facilitator per station may be helpful when groups from grades 2 and 3 move through the stations.

primary taproot with a few smaller, hairy branches. These long, strong roots reach deep under the soil surface, pulling up nutrients and water from far below. Dandelions are examples of plants with taproots. Many plants such as carrots, sweet potatoes, beets, radishes, and turnips have taproots that expand in size and become storage sites for sugars and starches. People often harvest and eat the taproots before the plants use their stored food to make mature plant structures such as stems, leaves, flowers and seeds.

Other kinds of plants have a fibrous-root system. You can identify these by a network of branching rootlets and root hairs appearing off primary roots. These networks can be extensive, which makes them particularly good at holding onto soil particles. Beans, tomatoes and grasses are examples of plants with fibrous-root systems.

In both taproot and fibrous-root systems, tiny root hairs are the bridges between the root and the water and dissolved nutrients in the soil. These root hairs provide a huge surface area for absorbing water and nutrients. If these root hairs are broken or damaged, a plant will have trouble meeting its needs for water and nutrients.

Root hairs are fragile, but root tips are protected by a cap of cells. Root tips have concentrations of plant growth hormones called auxins that cause these cells to divide and grow larger. Dead root cap cells are shed ahead of the root tip, making a pathway that allows the delicate root to work its way through the soil, around hard objects, and into tight places. That is how growing roots can exert enough force to crack concrete, pipes, and rocks.

Roots are valuable in many ways. Not only do they help feed the plant, hold soil in place, and prevent erosion - wearing away of soil by water, ice, or wind - but they help keep water and air clean. Eroded soil can end up as sediment that clogs streams and dirties the air. By breaking off tiny pieces of rock as they grow through cracks in rocks, roots assist the long process of soil formation. Some roots produce substances that help dissolve rocks. Living roots aerate and loosen soil which is a help to burrowing insects and animals. Dead and decomposed roots contribute to the rich humus in the soil.

Because roots store sugars and starches for plants, many are sweet and nutritious food sources for people and other animals. This is nothing new. It might surprise your students to learn that hunting and gathering to meet needs for food, fuel, clothing and shelter has been a significant occupation of people since they have been on Earth. Throughout human history many societies have gotten all their food by gathering wild plants, hunting and fishing.

All around the world, roots are basic sources of nutrition to people and many animals; a root's nutrients are passed on to those who eat them. Sweet potatoes, carrots, beets, turnips, and radishes are actually plant food-storage roots. The roots of the tropical plant cassava give us the tapioca we use in desserts, and cassava is a food staple in many tropical countries and in South Florida. Poi is a nutritious native Hawaiian food made from the root of the taro, which is cooked and ground to a paste then fermented. Carrots, ginger, jicama, parsnips, radishes, beets, rutabaga or Swedish turnip, and turnips are great-tasting, nutritious root foods that we can all enjoy.

Yams are a staple in Africa and potatoes are familiar mainstays to most of us. But potatoes are tubers, not roots. What's the difference? The roots mentioned previously are naturally modified *root structures*, whereas bulbs and tubers are modified *stem structures*. Bulbs and tubers are sometimes mistaken for roots because they also grow underground. This lesson is a good time to get to the root of the distinctions among roots, bulbs and tubers — many of which are nutritious foods.

Roots and stems have different cell arrangements as seen under a microscope; that is how scientists determined that a potato is not a root, but actually a stem structure or tuber. Tubers are swollen, fleshy, usually oblong or rounded thickenings of underground stems, bearing tiny buds called eyes from which new plant shoots arise. Examples of tubers people eat are the potato, Jerusalem artichoke (not a true artichoke, but the tuber of a sunflower), and water chestnut. Bulbs are short, modified, underground stems. Examples of bulbs we eat are onions, scallions, leeks, garlic, kohlrabi, and shallots.

In some places, roots are important parts of celebrations or holidays. In Oaxaca (wa-HAH-kah), Mexico, it's a custom each December before Christmas for farmers to entice shoppers to buy their produce by carving radishes into figures or designs to depict a story. December 23 is called the Night of the Radishes. Also in Mexico, a unique sweet called camote, or sweet potato candy, is served on Cinco de Mayo (May 5) to celebrate Mexico's victory over the French in the Battle of Puebla. Camote is made and sold in dozens of shops throughout Puebla, as well as in our own Southwest. (See the camote recipe in Extensions and Variations 9.) And in the United States, many Thanksgiving tables offer candied sweet potatoes as a traditional favorite.

This lesson offers an opportunity to point out another important distinction: sweet potatoes and yams are as different as tomatoes and apples. Sweet potatoes (*Ipomoea batatas*) are from the morning glory family (*Convolvulaceae*). They have a moist, soft flesh and

are traditionally grown in the South. Yams are the very large (sometimes weighing as much as 100 pounds), fleshy, edible tuber of a climbing tropical plant (family *Dioscoreaceae* and genus *Dioscorea*), native to south-east Asia, Africa, India, and parts of the Caribbean. Yams are a major food crop in many tropical countries such as New Guinea and western Africa. True yams are rarely seen in American markets. In the United States, what we call yams are a northern variety of sweet potato with a rather deep orange color and moist flesh. No yams are grown in the United States because of the relatively cold climate and short growing season. The sweet potato is also unrelated to the potato. The potato belongs to the nightshade family *Solanaceae*. In addition, potatoes are tubers, but sweet potatoes are roots.

Finally, what do roots have to do with that thirst-quenching favorite called root beer? This effervescent soft drink is flavored with a syrupy mixture of sugar and the bark and roots of the sassafras tree. Next time you and your students taste root beer, you'll have a new appreciation for roots. In the meantime, watch enthusiasm take root as students learn to root, root for life!

GETTING STARTED

Consider doing this lesson in the season when carrots with green tops and sweet potatoes are abundant (spring or fall depending on where you live). Set aside a learning station area in your classroom. Stations can be modified for two to three students at a time or for whole-class demonstrations or lessons. Decide how many groups there will be depending on the independence and number of your students. For each station, gather the following materials for each group and/or demonstration. Allow yourself about one hour to set up all six stations once you have materials.

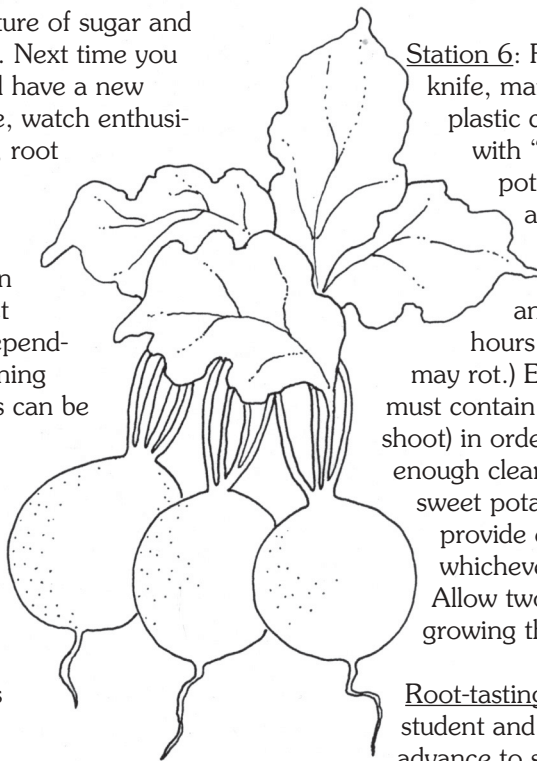
Station 1: Purchase a flat of "bedding plants," get small potted houseplants, or start your own seedlings a minimum of two weeks ahead of the lesson. (Beans, marigolds, radishes, and carrots are quick germinators, show both taproot and fibrous-root systems among them, and are fun for students to grow.)

Station 2: Bowl with one cup of water, one paper towel (brown is best), 1/2 teaspoon of salt.

Station 3: One mature potted plant (with drainage holes in bottom of pot), one pot (with holes in the bottom) of soil with no plants (soil may need to be refilled after each group), two bowls to capture the water, two cups of water (one cup for each pot), one paper towel.

Station 4: Root samples from four different plants (include at least one tap and one fibrous-root sample), one **Root Drawings** sheet per student, a magnifier or hand lens. You may use freshly pulled (or dug) weeds, root vegetables, or seedlings, and be sure the root systems are kept moist to keep them alive. Tweezers can be helpful when comparing roots.

Station 5: Several kinds of root foods for students to observe and draw (jicama, beets, carrots, radishes), drawing materials for each student. Try to locate a grocery store or farmers' market where root vegetables still have the leaves attached. Students can help by bringing items from home. If you do not use real items, provide reference books (encyclopedias, dictionaries, the Internet, science textbooks) with good illustrations of root foods from which students can make observations and drawings.



Station 6: Four to six toothpicks, sharp knife, marker, masking tape, water, plastic cups, small sweet potatoes with "eyes." Use a whole sweet potato, if you conduct this station as a whole-class demonstration. Otherwise, cut the sweet potatoes into sections and allow them to air dry for 24 hours. (Wet pieces placed in water may rot.) Each piece of sweet potato must contain at least one eye (an immature shoot) in order to sprout. You will need enough clear plastic cups, toothpicks, and sweet potato pieces with "eyes" to provide each student or every group, whichever you decide is suitable. Allow two subsequent weeks for growing the sweet potatoes.

Root-tasting Feast (Session Three): Enlist student and parent cooperation in advance to supply a sharp knife, paper plates or napkins (one per student), carrots, ginger, jicama, parsnips, radishes, beets, sweet potatoes, rutabaga (Swedish turnip), and turnips. Try to get these roots in raw form to cut up and as ingredients in various prepared dishes for tasting. A successful feast will have plenty of samples, as well as family recipes using root ingredients. Encourage a variety of forms of root food: carrot cake, carrot juice, pickled beets, radish sandwiches, ginger tea, stews, raw kohlrabi pieces to dip, and others.

Photocopy and cut apart the **Route to Roots** station signs and direction sheets, staple on individual pieces of construction paper, and post at each station. Each student needs a photocopy of the **Root Drawings**

sheet and notebook or science journal for recording results. **Optional:** You may choose to copy the questions for each station onto reproducible sheets so each student can take a copy back to his or her desk to complete.

Decide how and when you want the groups to work their way through the stations, or if you will do each station as a whole-class demonstration. If you decide to do the stations in small groups, arrange for station facilitators for younger students.

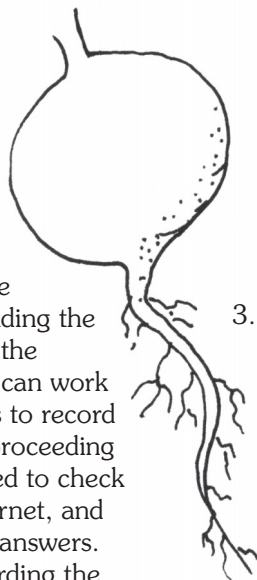
Read through the Supporting Information and **Route to Roots Station Answers** at the end of the lesson before you begin. Also make sure that facilitators are familiar with the Supporting Information, procedures, and answers for their stations, because they will be directing the younger students.

Decide on a date for the root-tasting feast so students can bring items from home. Write a letter to parents explaining the project and asking them to help students provide samples of roots and family recipes using root ingredients. You may want to include some of the examples suggested in Session Three.

PROCEDURE

SESSION ONE (When Conducting the Six Stations)

1. Introduce the lesson by announcing that students will be working in learning stations to observe plant roots and to learn how roots are important to plants, soil, animals and people. Share all of the Supporting Information or parts your students would find interesting.
2. Divide the class into groups of two or three students. Explain the procedure for working through the stations independently. If you have facilitators at each station to help, explain that the person is there to guide the students through the activity. The directions and materials will be at each station. Group members may share and change roles, but one student (or the station facilitator) is in charge of reading the station directions aloud and leading the discussion at each station. Students can work at the station area or return to seats to record answers in their notebooks before proceeding to the next station. Groups may need to check dictionaries, encyclopedias, the Internet, and science textbooks for some of their answers. Each student is responsible for recording the



answers to the questions and the observations and results in his or her notebook or science journal.

SESSION ONE (When Conducting Stations As Demonstrations or Lessons)

1. Introduce the lesson by announcing that students will watch six different demonstration stations to observe plant roots and to learn how roots are important to plants, soil, animals and people.
2. Plan one and one-half hours to go through the six stations for older students and up to three hours for younger students. Explain that the directions and materials will be at each station. You will lead the demonstration and discussion at each station; the students will then return to their seats to record answers in their notebooks or science journals before proceeding to the next station. Students may need to check dictionaries, encyclopedias, the Internet, and science textbooks for some of their answers. Each student is responsible for recording the answers to the questions and the observations and results in his or her notebook or science journal.

SESSION TWO

1. Have students sing the folk song Sandy Land from the state of Oklahoma.
2. After students have completed all the stations, lead a discussion of students' observations and results. In a visible place, list their findings and/or conclusions about the importance of roots. What did students learn about these roots? For example:
 - Roots hold plants in place.
 - Roots soak up water.
 - Roots hold soil in place.
 - The roots of different plants are different.
 - Roots are the bottom or lower part of a plant.
 - Roots usually grow under the ground.
 - New plants can grow from some roots.
 - Some roots are taproots and we eat them as food.
 - Roots grow away from light and in places where they can get water.
3. Explain that another way in which roots help plants is by storing nutrients for the plant itself, as well as for people and animals. Ask:
 - What is a nutrient? (*Something people, animals, or plants need for life and growth.*)
 - Where does the plant get nutrients? (*A plant's nutrients come from the minerals in the soil. Minerals are substances found in nature that*

are not living. Calcium, magnesium and potassium are examples.)

- What does the plant do with the nutrients? (*The plant uses nutrients to build its tissues as it grows and matures. Plants often store excess nutrients in roots or other parts.*)
- How does this help people? Animals? (*When people and animals eat plant parts, the plant's nutrients become theirs for growth and health.*)
- What roots do people eat? (*Carrot, ginger, jicama, parsnip, radish, beet, rutabaga, sweet potato, and turnip. Other edible underground plant parts that are tubers and bulbs include potato, onion, kohlrabi, garlic, and so on.*)
- What other plant parts do we eat? (*Leaves as in lettuce, spinach and cabbage; stems, as in celery and asparagus; modified stems or tubers, as in potatoes and yams; flowers, as in broccoli and cauliflower; seeds, as in sesame and sunflower; fruit, as in apples and oranges.*)

SESSION THREE

1. Have the class plan a root-tasting feast that will include an evaluation of the root foods. Plan the menu by inviting the students to volunteer to provide samples of root foods that are eaten by their families. Encourage culturally diverse dishes and a variety of forms that may use roots: carrot cake, carrot juice, carrot medallions, carrot sticks, pickled beets, hot fresh beets in butter sauce, radish sandwiches, radish blossoms, ginger tea, gingerbread, candied sweet potatoes, sweet potato pie, camote, hot mashed jicama, fresh crisp jicama sticks with lime juice, etc. Once the list is complete add root foods that the students are not familiar with: turnips, rutabagas, vegetable oysters, parsnips, etc. Decide whether guests should be invited and asked to join in the evaluation.
2. Have the class create a rubric that all students can use to evaluate the root dishes. Include the likes and dislikes of the students as well as color, taste, texture, and other generic observations. From this work develop an evaluation form for all students to use.
3. Conduct the root-tasting feast serving the root foods planned by the class and have the students complete the evaluation forms that they have designed.

EVALUATION OPTIONS

1. Evaluate students' recording of answers, observations and results in their notebooks or science journals and their **Root Drawings** sheet for understanding and completeness. Also rate their participation and capability to move through the learning stations.
2. Have students complete a landscape picture, including views above and below the ground, by drawing appropriate roots (tap or fibrous) on the plants in the picture. Have the students label both the taproots and fibrous roots in their drawing
3. Have students illustrate verbally or in a drawing how roots help plants and soil - or how the lack of roots would affect plants and soil - and are important to people.
4. Have students complete one or more phrases.
 - The most interesting thing I discovered about roots is...
 - My favorite root to eat is _____ because...
 - Two reasons roots are important to me are...
5. Have the students create a graph from their root evaluation in Session Three or write a food review from the evaluation and the root-tasting event.

EXTENSIONS AND VARIATIONS

1. Fill glass jars or clear plastic cups with potting soil or damp paper towels and plant large seeds such as beans next to the sides of the jars. Have students observe root growth and development and record notes in a science journal. Point out that this is how we propagate or grow plants using seeds. Remind students that they grew plants another way during Station Six, planting a piece of sweet potato with an "eye."
2. Investigate plant propagation using stem cuttings. Provide pots, potting soil, and houseplants such as begonias, Swedish ivy, philodendron, and zebra plant. Invite a master gardener to demonstrate and explain this and other methods of plant propagation, if you are not comfortable doing so, then have students try propagating their own plants by different methods. Students can experiment to determine the smallest piece of potato that can produce a new plant.

3. Investigate bulbs and tubers, other fleshy, edible plant parts that are sometimes mistaken for roots because they also grow underground. Bulbs we eat include leeks, onions, scallions, garlic, kohlrabi, and shallots. Tubers we eat are Jerusalem artichokes (not a true artichoke, but the tuber of a sunflower), potatoes, and water chestnuts. What are some differences and similarities in shape, color and taste among roots, bulbs and tubers?
4. Have students research the minerals needed by plants, animals and people for survival.
5. Sing the praises of roots. Have students work cooperatively to write a song summarizing their learning. Start with the tune to "Row, row, row your boat," and sing the words: "Root, root, root for life. . . ." Your students will take it from there!
6. Make veggie jewelry. Have students cut carrots, parsnips, and sweet potatoes into half-inch cubes. They can string them randomly in a pleasing pattern of colors using a large needle and sturdy thread in a length they would like. Tie the ends of the thread together after stringing and hang to dry. Even adults will enjoy wearing these colorful "beads"! (Avoid beets because they stain.)
7. Keep an ongoing class chart of vegetables you grow or study including the following categories: vegetable, plant part, how it helps us, how it helps the plant, ways we eat it, and more.
8. Create root-growing gloves to show root growth, how seeds sprout and grow, how roots develop in problem soil, how water moves through different soil types, how cuttings form roots, and so on. Each student needs one clear utility glove, soil, and seeds from five different seed packets (e.g., lettuce, radish, squash, carrots, turnips). Have students use a felt pen to put their name on the top of their glove and to number the fingertips and thumb (1-5). Place soil in each of the fingertips and thumb and plant different seeds in each. Water the soil and hang gloves (open so the seeds get air) in various places (e.g., near window, dark corner, and so on). Water the soil if necessary. Once the seeds have sprouted, plant them in a cup of soil and watch the plants grow.
9. Enjoy a Mexican taste treat. Make camote! (See Supporting Information for origin.) Gather ingredients and supplies and have students wash their hands and the working surface before handling the food items. Utensils: two saucepans,

mixing spoons, measuring cups and spoons, mixing bowl, can opener, hot plate or stove, 9" x 13" pan, and blender. Ingredients: one 20-oz. can of crushed pineapple, 1-lb. can of sweet potatoes, 4 cups of granulated sugar, and 1/2 cup of powdered sugar.

- Open the can of pineapple and empty the contents into a saucepan. Cook over medium heat about 10 minutes, or until pineapple is tender.
 - Remove the pineapple from the heat and cool slightly. Pour into a blender and blend on high for a few seconds. Pour mixture into a mixing bowl.
 - Open the can of sweet potatoes and puree the contents in the blender.
 - Pour the pureed sweet potatoes into a saucepan and heat thoroughly over medium heat for about 5 minutes. Stir in the granulated sugar and simmer for 5 minutes.
 - Remove mixture from heat. Cool slightly.
 - Add the sweet potato mixture to the pineapple and stir to mix. Pour the blended mixture into a greased 9" x 13" pan and allow to set up for 34-36 hours.
 - When mixture is firm enough to unmold, divide into small portions and roll each into a finger-like shape. Refrigerate. Roll the shapes in powdered sugar before serving.
10. Make artful root prints. Use the roots, bulbs, and tubers left from stations or use a new collection. Slice some roots or carve a "stamp design" in the cut surface of a potato half. Brush root surfaces with tempera paint and apply them to construction paper with a press-and-lift motion. Repeat or overlap with various colors and roots or carvings to create pleasing designs. Let dry. Frame and display in a Root Gallery.
 11. Consider taking a class hike to determine what plant parts and species in your area you might be able to eat, if you were a hunter-gatherer, and what you might consider growing, if you were an early horticulturist. Do some research to see whether your community has a resource person to serve as a specialist for such an activity, and remind students never to eat anything unfamiliar.

ADDITIONAL RESOURCES

Banek, Yvette Santiago (illustrator). *Garden Wizardry For Kids*. Barrons Juveniles. 1995. ISBN: 0812013174.

Burge, Weldon, Heather Clemon (editor). *Grow The Best Root Crop*. Storey Communications, Inc. 1991. ISBN: 088266624X.

Carlson, Laurie. *Green Thumbs: A Kid's Activity Guide to Indoor and Outdoor Gardening*. Chicago Review Press. 1995. ISBN: 155652238X.

Elliot, Douglas. *Wild Roots: A Forager's Guide to Edible & Medicinal Roots, Tubers, Corms, & Rhizomes of North America*. Inner Traditions International, Ltd. 1995. ISBN: 0892815388.

Fowler, Allan. *Taking Root (Rookie Read About Science)*. Children's Press. 2000. ISBN: 0516270583.

Gibbons, Euell. *Stalking the Wild Asparagus*. Alan C. Hood. Reprint 1987. ISBN: 0911469036.

Growing Ideas, a Journal of Garden-Based Learning. National Gardening Association, 180 Flynn Avenue Suite 3, Burlington, VT 05401. (802) 863-1308. <http://www.garden.org>

Hughes, Meredith Sayles. *Buried Treasure: Roots & Tubers (Plants We Eat)*. Lerner Publishing Company. 1998. ISBN: 0822528304.

Johnson, Sue, Cheryl Evans. *Starting Gardening*. 1996. Usborne Publishing Ltd. ISBN: 0746023839.

Kite, Patricia. *Gardening Wizardry for Kids*. Barron's Juveniles. 1995. ISBN: 0812083628.

Linse, Barbara, Richard Judo. *Fiesta! Mexico and Central America: A Global Awareness Program for Children in Grades 2-5*. Fearon Teacher Aids. 1993. ISBN: 0822442329.

Lovejoy, Sharon. *Roots, Shoots, Buckets & Boots: Gardening Together With Children*. Workman Publishing Company. 1999. ISBN: 0761110569.

Mays, Kathleen, Sandra Gottfried. *Roots: A Vegetarian Bounty*. Woodbridge Press. 1995. ISBN: 0880072067.

Morris, Karyn. *The Kids Can Press Jumbo Book of Gardening*. Kids Can Press. 2000. ISBN: 1550746901.

Pranis, Eve, Joy Cohen. *Grow Lab: Activities for Growing Minds*. National Gardening Association, 180 Flynn Avenue Suite 3, Burlington, VT 05401. (802) 863-1308. <http://www.garden.org>. 1997. ISBN: 091587332X.

Raferty, Kevin, Kim Gilbert Rafferty. *Kid's Gardening: A Kid's Guide to Messing Around in the Dirt*. Klutz Press. 1989. ISBN: 0932592252.

Richardson, Beth. *Gardening With Children*. Taunton Press. 1998. ISBN: 1561581925.

Rosen, Michael, Diane D'Andrade (editor). *Down To Earth: Garden Secrets! Garden Stories! Garden Projects You Can Do!* Harcourt Brace. 1998. ISBN: 0152013415.

Saunders-Smith, Gail. *Carrots (Plants Growing and Changing)*. Pebble Books. 1997. ISBN: 1560654880.

Schwartz, David. *Plant Stems and Roots*. Gareth Stevens Audio. 1999. ISBN: 0836825810.

Suzuki, David. *Looking At Plants*. John Wiley & Sons. 1992. ISBN: 0471547484.

Turner, Carol. *Seed Sowing and Saving*. Storey Books. 1997. ISBN: 1580170021 (hardcover).

Turner, Carol. *Seed Sowing and Saving*. Storey Books. 1998. ISBN: 1580170013 (paperback).

Weaver, William Woys. *100 Vegetables and Where They Came From*. 2000. ISBN: 1565122380.

MUSIC

State of Oklahoma. *Sandy Land*. Folk song.

EDUCATOR'S NOTES

ROUTE TO ROOTS

Station signs and directions: Remind students they are each responsible for recording their answers, observations, and results in their notebook or science journal and on the **Root Drawings** sheet.



Station 1: What keeps me in place?

Materials: 1 moist, potted seedling

Procedure: Gently dump out or cut away the pot to remove the seedling intact. Carefully loosen the soil around the roots and brush it away to reveal the roots. Point out the plant parts you see.

Questions

1. What plant parts do you see that you can name?
2. Describe the roots. Where do they grow? How do the roots help hold such a plant in place?
3. Why is this important?
4. In which direction do roots grow with regard to light and water?
5. Describe and draw the roots and soil.



Station 2: Where do the water and minerals go?

Materials: Bowl with 1 cup of water
Paper towel (brown is best)
1/2 teaspoon of salt

Procedure A: Stir 1/2 teaspoon of salt into the water until you cannot see it. Have one student put his or her finger into the water, taste it, and describe the taste to others. Save the bowl of water and salt for Procedure B.

Questions

1. What has happened to the salt?
2. What does the water taste like?

Procedure B: Roll and twist the paper towel like a root. Dip the tip in the bowl of water. Describe what happens. (When finished, clean the bowl for the next group.)

Questions

1. If roots absorb water like a paper towel, where does the water go?
2. Can the salt in the water be absorbed through plant roots? If so, how?
3. Why is it important that roots can absorb water and other things?



Station 3: Can I really hold you?

Materials: 1 mature potted plant (with holes in bottom of pot)
1 pot (with holes in the bottom) of soil with no plants (Soil may need to be refilled after each group.)
2 bowls
2 cups of water (one cup for each pot)
1 paper towel

Procedure: Set the pots in the bowls. Write a guess or prediction of what will happen to the water as it is poured into each pot. Then pour the cup of water into each pot. Let the water drain into the bowls for two minutes.

Describe and compare the amount and color of the water and the contents in the water in each bowl. When finished, drain the water in each bowl through a paper towel. Describe what and how much is left on each paper towel. Clean the bowl for the next group.

Questions

1. How do the results for both pots compare with your guess or prediction?
2. What conclusion can you make about roots holding soil in place?
3. Why is this important?
4. Erosion is the wearing away and loss of soil by wind or water. How do plant roots help prevent soil erosion?



Station 4: Are we all alike?

Materials: 1 **Root Drawings** sheet per student
Root samples from four plants (include at least one taproot and one fibrous-root sample)
Magnifying glass or hand lens

Procedure: On your **Root Drawings** sheet, draw what each plant's roots look like. Use a magnifying glass or hand lens to see details and draw what you see in the circles.

Questions: The questions are on your **Root Drawings** sheet.



Station 5: Which part is which?

Materials: Drawing materials for each person

Examples of root foods, including the entire plant if possible; or reference books (encyclopedias, dictionaries, the Internet, science textbooks) in which you have noted good photos of such plants

Procedure: Choose one of the roots people eat as food. Draw and color its complete plant including root, stem, leaves, flowers, seeds, and any other distinguishing parts. Label each part. Use an encyclopedia, dictionary, the Internet, or science book as a reference to learn what the plant parts look like.

Questions

1. Why is each part of the plant important?
2. What are at least five ways in which roots are valuable to people, animals and the environment?



Station 6: How can I make a new me?

Materials: Small piece of sweet potato with an “eye” (whole sweet potato if done as whole-class demonstration)

4-6 toothpicks per sweet potato, marker, masking tape

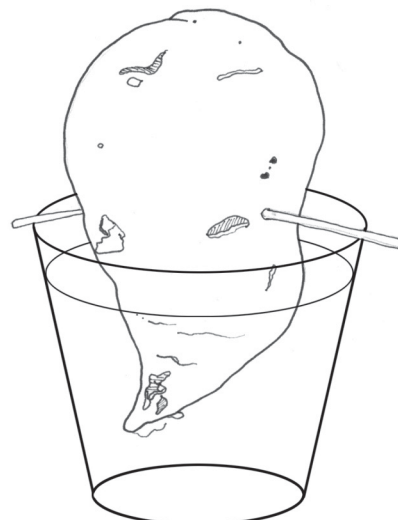
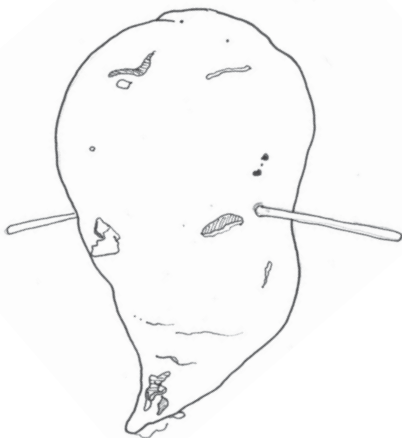
Clear plastic cup

Water

Procedure: Push toothpicks into the sweet potato as shown in the drawing below and add water to the cup to set up your investigation. Label your group’s cup (or your own cup, if everyone grows their own) with a marker and piece of tape. Place in a sunny spot or on a windowsill and write observations about it (growth rate, height, color, size, and number of leaves) during the next two to three weeks.

Questions

1. What do you think will happen?
2. Describe what you see happening during the next two weeks by drawing what you see and writing about it.
3. How might some roots grow into new plants?



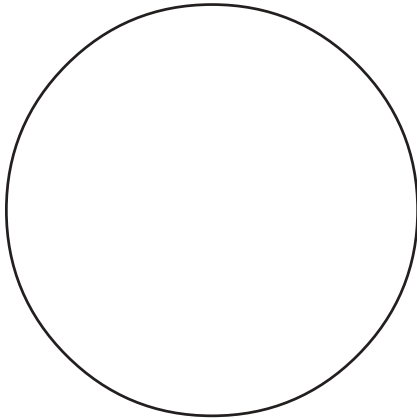
ROOT DRAWINGS

Name: _____

Some plants have one main, long root called a taproot. Taproots have many smaller roots, which are called root hairs. Some plants have many roots all about the same size. These branching root systems are called fibrous roots. Taproots and fibrous roots can store food. The more food stored, the fatter the root.

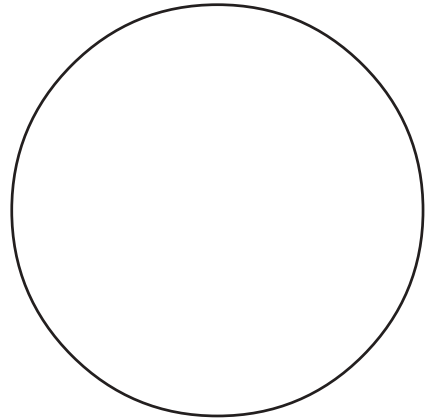
Directions: Draw the roots of each of the plants you examine with a magnifying glass or hand lens. Label each plant's roots as "tap" or "fibrous."

Plant 1 has _____ root(s)



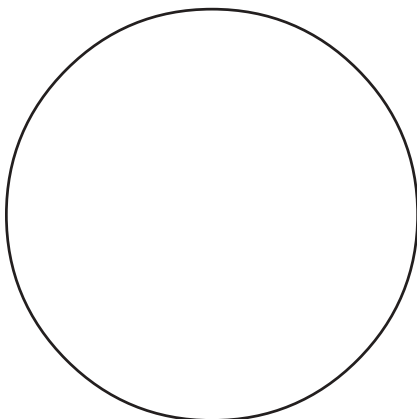
Magnified View

Plant 2 has _____ root(s)



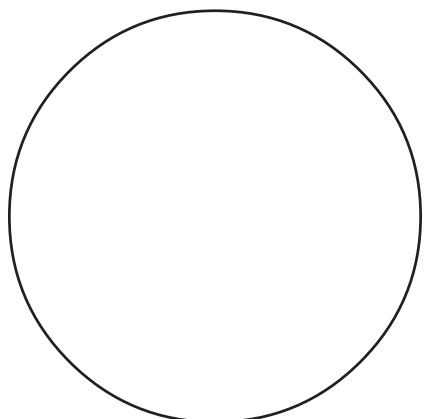
Magnified View

Plant 3 has _____ root(s)



Magnified View

Plant 4 has _____ root(s)



Magnified View

Questions: (Answer on the back if necessary.)

1. How are the roots of these plants alike?
2. Why might they be alike?
3. How are the roots different?
4. Why might they differ?
5. Which type of root would you eat and why?

ROUTE TO ROOTS STATION ANSWERS

Station 1

1. What plant parts do you see that you can name? (*stems, roots, flowers, leaves*)
2. Describe the roots. Where do they grow? How do the roots help hold such a plant in place? (*Roots of most plants grow in the ground. They help hold plants in place by forming a network that clings to the soil. The root itself grips the soil and the root hairs grow in the spaces between the particles of soil. When the plant is pulled, the root hairs get “stuck” in these spaces, making it harder to pull up the plant.*)
3. Why is this important? (Accept reasonable answers, but guide students to see that roots help hold soil in place against the forces of wind, water, and ice that might move it away.)
4. In which direction do roots grow with regard to light and water? (*Roots grow away from light and into places where water is available, usually downward. The force of gravity is the signal roots use to orient downward.*)

Station 2

Procedure A

1. What has happened to the salt? (*The salt is dissolved in the water.*)
2. What does the water taste like? (*It tastes salty.*)

Procedure B

1. If roots absorb water like a paper towel, where does the water go? (*Water moves up the root into the stems and leaves of the plant.*)
2. Can the salt in the water be absorbed through plant roots? If so, how? (*Yes, as the salt is dissolved. It is similar to how plants get dissolved minerals from soil and water through their roots.*)
3. Why is it important that roots can absorb water and other things? (*Roots provide the rest of the plant with water and water-dissolved minerals that plants need for nourishment and growth.*)

Station 3

1. How do the results for both pots compare with your prediction? (Accept reasonable answers.)
2. What conclusion can you make about roots holding soil in place? (*There will usually be less water in the bowl under the potted plant and the water will be clearer. This shows how plant roots help hold soil in place.*)
3. Why is this important? (Accept reasonable answers.)
4. Erosion is the wearing away and loss of soil by wind or water. How do plant roots help prevent soil erosion? (*Plants help prevent soil erosion by holding soil in place against the forces of wind, water, and ice.*)

ROUTE TO ROOTS STATION ANSWERS (page 2)

Station 4

Answers for questions 1, 3, and 4 on the **Root Drawings** sheet will vary according to the kinds of roots used as samples.

1. How are the roots of these plants alike?
2. Why might they be alike? *(Accept logical answers for the similarities in roots. Some likenesses include functions: they are all roots which move water and nutrients to the plant and they anchor plants, hold soil, and store nutrients. Students also will comment on appearance.)*
3. How are the roots different? *(Accept reasonable answers.)*
4. Why might they differ? *(Accept logical answers for the differences in roots. There are many reasons why roots are not all the same. Larger, heavier plants need larger root systems. Plants in dryer climates may need very deep roots or very spread-out roots to reach the moisture they need. Some roots need plenty of room to grow. Others are crowded for space and fill every little crack they can find.)*
5. Which type of root would you eat and why? *(There are no right or wrong answers; taproots, however, store the most food.)*

Station 5

1. Why is each part of the plant important? *(Roots hold the plant in the soil so wind and water can't carry it away, and they absorb water and nutrients from the soil. Stems support the leaves and flowers of the plant and carry water and nutrients from the roots to other parts of the plant. Leaves gather sunlight and make food for the rest of the plant through photosynthesis. Flowers contain pollen and attract pollinators, which is important in fertilization and the production of seeds or fruit. Seeds will grow new plants, since they contain a plant embryo and the food it needs to get started.)*
2. What are at least five ways in which roots are valuable to people, animals and the environment? *(Answers will vary, but might include:*
 - *People eat roots and the plants that grow from roots.*
 - *Animals eat roots.*
 - *Roots help prevent soil erosion.*
 - *Roots hold plants in place.*
 - *Roots can be used to grow new plants.*
 - *Old roots decay, returning nutrients to the soil to nurture other plants.)*

Station 6

1. What do you think will happen?
2. Describe what you see happening during the next two weeks by drawing what you see and writing about it.
3. How might some roots grow into new plants? *(When students closely examine the sweet potato — a root — they will see small indentations or “eyes.” These are actually the beginnings of tiny buds which under the right conditions will produce sprouts that grow into plants. Sweet potatoes will first grow roots and then leaves in a few weeks to become a new plant. When a piece of sweet potato with an eye [farmers call these “seed potatoes”] is planted, the starch in this seed potato “feeds” the plant until its leaves are mature enough to photosynthesize and produce its own nutrients. If you dig up your young sweet potato plants in two or three weeks, you’ll find stems and leaves emerging from the sweet potato sprouts and thread-like roots growing from their base.)*

*I know of no pursuit in which more real and
important services can be rendered to any country
than by improving its agriculture...*

George Washington (1732-1799),
July 20, 1794