Denver Urban Gardens School Garden and Nutrition Curriculum

Grocery Bag Botany

Lesson

Goals

Students will learn to identify foods by their plant part.

Objectives

Students will classify various foods we eat into which part of the plant they come from.

Colorado Academic Standards

Science: Life Science

GR.2-S.2-GLE.2

Did you know?
Even though potatoes grow underground, they are not roots. They are specialized stems.

Total Time – 60 minutes

Materials

- 15-30 fruits and/or vegetables
- Enlarged photo of a plant
- Journals
- Snack (see recipe at end of lesson)

Vocabulary

roots	stems	leaves
flowers	fruits	seeds

Background for Teachers

This lesson is great to use as a precursor for individual lessons on each plant part. The follow-up lessons include: Leaves Make Food, What is a Stem, Introducing the Seed and Rooting for Roots.

Method

Introduction (10 minutes)

1. Begin the class by asking students if they ate any plants for breakfast. List the foods they mention on the board. Brainstorm with the class the six different parts of a plant that people eat: roots, stems, leaves, flowers, fruits and seeds. Tell the class that you had a delicious breakfast of plant parts, explaining that people rarely eat a whole plant. Tell the students you ate a bowl of oval, flattened seeds and dried, brown shriveled fruit with fragrant, crushed bark sprinkled on top. You drank a cup of dried leaves soaked in water with a spoonful of granulated stems and a slice of yellow fruit. Can they guess what you ate? (A bowl of oatmeal with raisins and cinnamon, and a cup of tea with a spoonful of sugar and slice of lemon.) Review the class' list and classify the foods by the part of the plant from which they came.

2. Explain to the class that they will be doing a sorting activity based on the different plant parts that people eat. As a whole group label the plant parts on the enlarged picture of a plant.

Activity (40 minutes)

1. Break the class into groups of four or five students. Hand out 5-10 items to each group.

2. As a group, have the students decide which part of the plant they are eating when they eat each item. Some items may be harder to determine than others. Make sure to have all the plant parts written up on the board (fruit, flower, stem, leaf, root and seed) to remind the class of the possible choices.

3. After the groups have made their decisions, have each group elect a spokesperson to present their findings to the larger class why they chose the plant part that they did.

4. Have each student write up a breakfast, lunch or dinner menu based on the plant parts he or she would eat, similar to the breakfast menu presented at the beginning of the activity. Students will then read their menu to their small groups and the groups will try to guess what foods the menu describes.

Conclusion (5 minutes)

Have the class discuss or write in their journals two different foods for each plant part (roots, stems, leaves, seeds, fruits and flowers).

Snack (5 minutes)

Provide a healthy snack that includes various plant parts, such as ants on a log (celery-stem, peanut butter-seeds, raisins-fruit) or Asian Broccoli Salad (end of lesson). While eating the snack reinforce the different parts of the plants that they are eating.

Assessment Tools

- Participation
- Presentation
- Journal

Modifications

- Give each group the same items and make it a contest to see which group can correctly name the plant part of each item.
- Instead of giving each group food items, have the class decide as a whole. This would mean the teacher would be in front of the class with a grocery bag and pulling out one item at a time. Make sure all students understand why each item was put into its category before moving on. Write the items on the board under each plant part as you go.

Extensions

- Have students examine packaged items and have students discuss which plant part(s) that particular packaged food item came from (i.e. catsup is made from tomatoes, a fruit).
- Give students a recipe of a familiar food item. Have students collaborate on what ingredient comes from what plant. Students will then record their thinking in their journals.

Suggested Products

- Asparagus (stem)
- Broccoli (flower, stem)
- Cabbage (leaf)
- Beans (seed)
- Corn (seed)
- Squash (fruit)
- Potatoes (underground stem)
- Onions (leaves)
- Garlic (stem)
- Raisins or grapes (fruit)
- Nuts (seed)
- Herbs (leaf, stem, seed)
- Parsnip (root)
- Carrots (root)
- Peas (seed)
- Celery (leaf-petioles)
- Ginger (underground stem)
- Cucumber (fruit)

Asian Broccoli Salad

- 4 broccoli heads (flower)
- 1 carrot (root)
- 2 oz. sunflower seeds (seed)
- 4 oz bok choy or savoy cabbage (leaf)
- 1 can mandarin oranges (fruit)
- 1 tsp sesame oil (seed)
- 2 tsp olive oil
- 1 Tbsp honey
- 1 Tbsp rice wine vinegar
- 1 Tbsp low sodium soy sauce
- 1 garlic clove (stem)
- 1 Tbsp grated ginger (stem)

Preparation (20 minutes): Cut broccoli into bite sized pieces and blanch in salted hot water and then shock in cold water. Grate carrot and julienne bok choy (or cabbage). Combine with the broccoli. Drain the liquid from oranges and then mix with the vegetables and sunflower seeds. Mince garlic clove and grate ginger. In a bowl mix sesame oil, rice wine vinegar, soy sauce, garlic and ginger. Whisk together. Combine dressing with the other ingredients, mix well and serve.

Source
Recipe courtesy of Corey Ferguson

A RESOURCE OF DENVER URBAN GARDENS
303.292.9900 | DIRT@DUG.ORG | WWW.DUG.ORG

Denver Urban Gardens School Garden and Nutrition Curriculum

Introducing the Seed

Lesson

Goals

This lesson lays the foundation for understand the connection between the seeds that we plant and the plant that grows from the seed.

Objectives

Students will to identify different parts of a plant inside of a bean seed and determine if their onion seeds are viable.

Standards

Science: Life Science

GR.2-S.2-GLE.1
GR.2-S.2-GLE.2
GR.3-S.2-GLE.1
GR.4-S.2-GLE.3
GR.5-S.2-GLE.1

Total Time – 60 minutes (plus 10 minutes a day for the following week)

Did you know?

Even if a seed is planted upside down, the seedling always grows right-way up. Plants can sense gravity.

The largest seed in the world is the double coconut (Coco de Mer). It can measure up to 50cm (1.6ft) around the middle.

Materials

- Large bean seeds soaked overnight (limas work great)
- Magnifying glasses
- Copies of "A trip inside a bean seed" (end of lesson)
- Onion seeds (enough for each student or group to have 10 seeds each)
- Paper towels
- Ziploc bags

Background for Teachers

The seed is made up of three main parts: embryo, endosperm and seed coat. The embryo is basically a miniature plant. The endosperm is the built-in food supply, which is made up of proteins, carbohydrates or fats. The testa (seed coat) is the hard out covering, which protects the seed from disease and insects. It also prevents water from entering the seed, which would initiate the germination process before the proper time.

Germination is the resumption of active embryo growth. Prior to any visual signs of growth the seed must absorb water through the testa. When the seed is ready to germinate, water is taken in through the micropyle, which is a tiny hole in the testa. In addition, the seed must be in the proper environmental conditions; that is, exposed to oxygen, favorable temperatures, and for some correct light. The radicle (embryonic root) is the first part of the seedling to emerge from the micropyle. It will develop into the primary root from which root like hairs and lateral roots will develop. The next part to emerge is the embryonic shoot (plumule), from which the first seed leaves called cotyledons develop. The embryonic stem above the point of attachment of the cotyledon(s) is the epicotyl. The embryonic stem below the point of attachment of the cotyledon(s)

is the hypocotyl. The seed leaves (cotyledons) encase the embryo and are usually different in shape from the leaves that the mature plant will produce. After cotyledons have exhausted their supply of food, the first true leaves appear and the cotyledons wither and die. Plants producing one cotyledon fall into the group of monocotyledons or monocots, which includes grasses and corn. Plants producing two seed leaves are called dicotyledons or dicots, which includes beans and squash.

Method

Introduction (10 minutes)

1. Tell the class that you can hold 250 onions in your hand. How is this possible? After letting them problem solve, show the class the onion seeds.

2. Have a discussion with the class about seeds (what are they, what do they need to grow, where do you find them, etc).

3. Review the term *germination* (when the seed begins to grow) and what is needed for germination.

Activity (35 minutes)

1. Pass out the copies of "A trip inside a bean seed" and review the various parts and their purposes.
    a. Seed Coat – Provides protection for the seeds.
    b. Embryonic Root – First part of the seed to grow and will turn into the root.
    c. Cotyledon – First set of "leaves" to emerge and provides nutrients for the tiny plant. They look unlike the rest of the leaves that will emerge.
    d. First Leaves – These are the first true leaves and emerge after the cotyledons.

2. Once the class understands the different parts of the seed, demonstrate how to dissect the bean seed. A document reader can be helpful here so the class can easily see how to dissect and the parts they are looking for.

3. To dissect the bean, carefully remove the seed coat with your fingernails. Then separate the two halves (cotyledons). Inside you should find the tiny first leaves and the embryonic root.

4. Pass out a bean seed and magnifying glass to each student or pair. Have them carefully dissect the bean and find the various parts.

5. Walk around and make sure all of the students understand the various parts of the bean seed before moving on to the second half of the activity.

6. Explain that the class will now get to germinate seeds to figure out if they are viable.

7. Pass out a moist paper towel folded into quarters and 10 onion seeds to each group. Have the students place the seeds evenly on one edge of the towel. Roll up the towel and place in a plastic bag. Label with the date and seed variety.

8. Once a day for the next week, have the class gently remove and unroll their towel. Blow on the seeds to give them some carbon dioxide. While the towel is unrolled, have the students record

the number of seeds that are germinated and note any changes in appearance.

9. Seeds are viable if 60% or more germinate within 5-7 days. Below 50% germination, seeds are considered non-viable. Have students do the math to figure out if their seeds are viable.

Snack & Conclusion (15 minutes)

1. Review with the class the different parts of the seed. Have the class choose one part and write in their journal its name and purpose.

2. Have a seed-based snack such as the Black Bean Dip below. Make sure to clearly discuss which parts of the snack are seeds (black beans, cumin, coriander and pumpkin seeds).

Assessment Tools

- Participation
- Germination observation chart
- Math calculations on germination rate

Possible Modifications and Extensions

- Consider doing only the dissection of the seed or germination test and use the other half of the class to plant seeds for the classroom grow lab.
- Make connections to what types of foods are seeds and why they are so healthy for us (high in protein, healthy fats and many nutrients).
- Compare germination rates between seeds from different years or different varieties.

Black Bean Dip and Pumpkin Seed Garnish

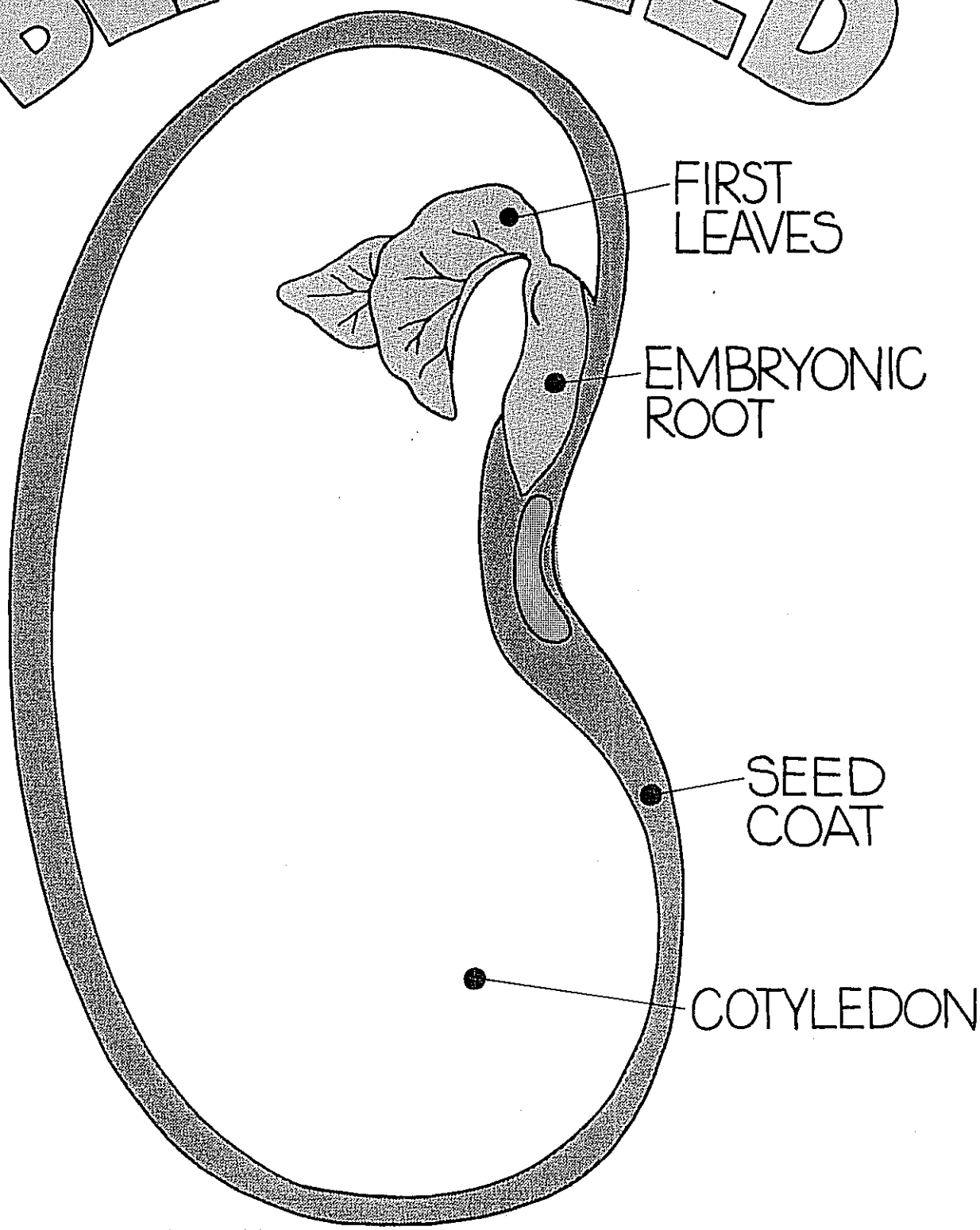
- 2 cans cooked black beans
- 1 bunch cilantro
- 1/2 red onion
- 1 jalapeno
- 1 Tbsp cumin
- 1/2 Tbsp ground coriander
- 1/2 lime, juiced
- salt and pepper to taste
- 1 cup pumpkin seeds
- 1 Tbsp honey
- 1 oz lime juice
- cayenne to taste
- tortilla chips or crackers

Preparation (10 minutes): Put cilantro (without the stems), red onion and jalapeno into a food processor. Pulse until roughly chopped. Remove and set aside. Pulse the black beans in food processor until semi-smooth. Add the cumin, coriander, lime juice and jalapeno mixture. Pulse and season to taste with salt and pepper. For the pumpkin seed garnish, whisk honey and lime juice until combined. Sprinkle with cayenne to taste and toss with the pumpkin seeds. Sprinkle the pumpkin seeds on top of the bean dip and serve with crackers or tortilla chips.

Source

Recipe courtesy of Corey Ferguson

A TRIP INSIDE A BEAN SEED



Denver Urban Gardens School Garden and Nutrition Curriculum

Leaves Make Food

Lesson

Goals

Students are introduced to the concept of plants being food producers, how leaves make food for the plant using photosynthesis and the connection to healthy eating.

Objectives

Students will begin to understand how leaves make food for the plant and why some leaves are really healthy for you. Students will investigate different varieties of leaves by touching and drawing them and then prepare a recipe using leaves we eat.

Standards

Science: Life Science

GR.2-S.2-GLE.2
GR.5-S.2-GLE.1

Total Time – 60 minutes

Did you know?

Spinach is best eaten straight from the garden. Half of the major nutrients are lost by the eighth day after harvest.

Materials

- Variety of leaf and plant samples (real are much more effective)—use cuttings from houseplants, ask a nursery for a few leaf samples and/or collect any from outside
- Magnifying glasses
- Journals

Method

Introduction (20 minutes)

1. Review with the class the different parts of a plant (roots, stems, seeds, flowers, fruit and leaves). Go over any part that you have discussed in previous lessons. Remind the class that different parts of the plant all work together to make the plant grow and be healthy, just like in a community—all the different people in a community work together to make a community healthy and happy.

2. Acting like a plant, ask the class: *How would you eat if your feet were stuck to the ground? Would you stretch your tongue and catch a passing snack? Could you capture the sun's energy and turn in into food? While we get our energy from food we eat, plants have the ability to make their own food and use if for energy. All living things run on energy they obtain from food. Green plants are food producers. Humans and other animals are food consumers.*

3. Have the class list the different functions of leaves.
    a. Manufacture food through photosynthesis
    b. Gas/air exchange (CO2 to Oxygen)
    c. Protect vegetative and floral buds
    d. Transport water
    e. Store food during germination (cotyledons)
    f. Collect water for roots (funnel shaped)

g. Provide shade for roots and stem
h. Flat to provide a lot of surface area for photosynthesis, gas exchange and water transportation

4. Explain to the class: *Plants make their own food and leaves are the food-making machines (autotrophs) during the process of photosynthesis. They are able to turn water, carbon dioxide and sunlight into a nutritious substance called glucose, which in turn provides sustenance for plants and trees. This sugar, glucose, is the source of food used by most plants and then by all other consumers (heterotrophs) like us when we eat the plants.*

   Chlorophyll is the green pigment in plants that traps the light's energy when light strikes the plant. Water molecules are taken up by the roots and transported to the leaves, split into hydrogen and oxygen, using the captured light energy.

   With photosynthesis, plants take in carbon dioxide and release oxygen. How do you think this affects humans? (Without plants there would not be enough oxygen replaced in the environment to support life. Make a connection to global warming and the importance of not cutting down all the forests.)

5. Once the class understands the basics of photosynthesis, make the connection to healthy eating. Have the class think of different leaves we eat (lettuce, spinach, kale, herbs, cabbage, etc).

6. Emphasize why leaves are healthy (they contain high levels of minerals, vitamins and phytochemicals) and how this relates to photosynthesis (leaves are nutrient rich because this is where the food is being produced). If you have covered vitamins and phytochemicals, here is a great time to make a connection. Remind the class that the healthiest leaves are the darkest ones (spinach, kale, red leaf lettuce, etc).

Activity (25 minutes)

1. Have your leaf cutting examples in a non-see through bag. Pull each sample out individually so each leaf you pull out surprises the students.

2. Identify the plants the leaves belong to. It is helpful to show and discuss why different plants have different leaves.

3. Give each student or group a leaf sample. Have them examine the leaf—looking at the veins under a magnifying glass. Have them draw the leaf and write a few sentences about why the leaf is neat or special.

Snack & Conclusion (15 minutes)

1. Have a snack that includes leaves, such as Lettuce Wraps. Discuss the different parts of the snack and which part of the plant each item is. See if the class is able to identify all the plant parts.

2. Have the class write in their journals two new facts they learned about leaves. Have a few students share their insights.

Assessment Tools

- Participation
- Journals

Possible Modifications and Extensions

- You could easily do this lesson in the fall and connect it to the changing of the leaves.
- Consider extending the lesson and discussing how leaves can be used for propagation.
- Have a leaf taste test with different edible leaves. You may want to try some cooked and some raw or try them both ways. Ideas include: spinach, lettuces, swiss chard, cabbages, arugula, endive, watercress, kale, mizuna and radicchio.

Vocabulary Words

- *photosynthesis* – the process that occurs inside plants, which converts light energy (sunlight), carbon dioxide, chlorophyll and water into sugar and oxygen
- *chlorophyll* – green pigment in plants that traps the light's energy
- *autotroph* – a food producer (plants)
- *heterotroph* – a food consumer (animals)

Lettuce Wraps

This is a great recipe to follow up the leaf lesson and can help reinforce other plant parts we eat. Below are two different options for fillings.

- Large lettuce leaves, washed and dried
- Toothpicks

Southwest Filling

- Black beans
- Corn, fresh or frozen kernels
- Tomatoes, chopped
- Cilantro, chopped
- Cheese, grated
- Salsa

Asian Filling

- Veggies of choice (carrots, cabbage, snow peas, etc)
- Cilantro, chopped
- Peanut sauce (store bought or mix peanut butter soy sauce, sugar and chili sauce)

Preparation (10 minutes): Mix all ingredients together in a bowl. Spoon a couple of tablespoons into each lettuce leaf. Wrap and secure with a toothpick.

A RESOURCE OF DENVER URBAN GARDENS
303.292.9900 | DIRT@DUG.ORG | WWW.DUG.ORG

Denver Urban Gardens School Garden and Nutrition Curriculum

Rooting for Roots

Lesson

Goals

Students will learn about different types of roots and the functions of roots.

Objectives

Students will be able to identify different roots that we eat and why we include them in our diet. They will also be able to identify different types of roots and explain their various functions.

Colorado Academic Standards

Science: Life Science

GR.2-S.2-GLE.2
GR.5-S.2-GLE.1

Total Time – 60 minutes and follow-up one week later

Did you know?

Aspen trees that grow near each other often share the same roots. This makes Pando, an Aspen tree grove in Utah, the world's largest organism. It includes 47,000 stems and covers 107 acres. It is thought to be 80,000 years old.

Materials

- Examples of roots (carrots, beets, radishes, daikon radishes, scallions, living lettuce, celery root, etc)
- 1 or 2 large carrots
- 5 or more clear plastic cups
- Radish and lettuce seeds
- Germination mix
- Rocks
- Water
- Journal
- Snack (see end of lesson)

Vocabulary

roots	functions	taproot
edible	fibrous	function
eroding	germination mix	hypothesis

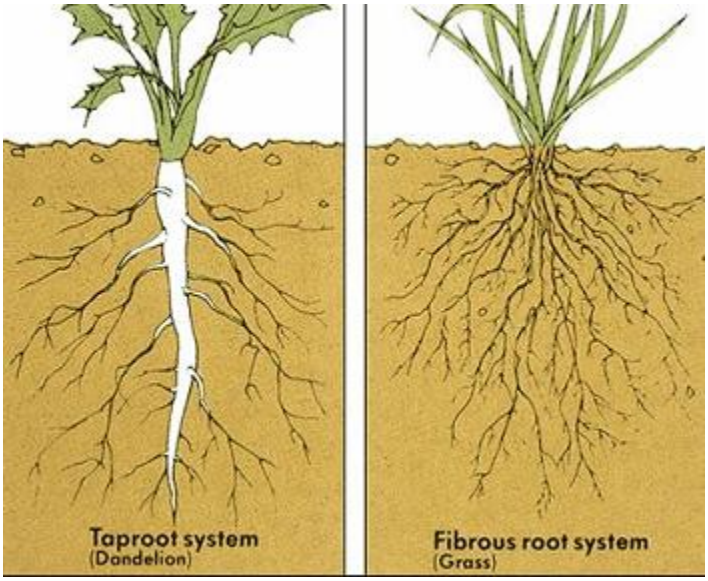
Method

Introduction (15 minutes)

1. Review with the class the different parts of a plant (roots, stems, seeds, flowers, fruit and leaves). Go over any part that you have discussed in previous lessons. Remind the class that different parts of the plant all work together to make the plant grow and be healthy, just like in a community—all the different people in a community work together to make a community healthy and happy.

2. Have the class list all that they know about roots. Then have them list roots that are commonly eaten (carrots, radishes, beets, etc).

3. Discuss with the class the different types of roots, while showing examples (these can be brought in or you can pull them up online from the websites listed at the end of the lesson).
    a. Taproots grow somewhat straight and vertically down. Plants with taproots are difficult to transplant. Edible examples include: carrots, beets and radishes. A non-edible example is a dandelion.
    b. Fibrous roots are more of a mass of small, entangled roots that grow directly from the stem. Examples include: onions, lettuce, tomatoes, grasses and corn. They often remind the class of hair.



4. Once the class understands the difference between a taproot and a fibrous root, it is time to move on to the functions of the roots.
    a. Roots anchor and provide support for the plant.
    b. Roots absorb the water and nutrients necessary for plant growth.
    c. Roots prevent soil from eroding.
    d. Roots increase organic material and help with moisture retention as they decompose (acting like a blanket).
    e. Roots store sugars and carbohydrates.

Activity (35 minutes)

1. Cut off 2" from the top of each carrot. Remove any old leaves. Place the carrot top cut side down in a plastic cup. Add water until the carrot is halfway covered. Place rocks around the carrot to hold it in place. Put the bowl in a bright place, but not too sunny or too hot. Make sure there is always water in the container.

2. Have the class predict what will happen to the carrot. Have the students write their predictions in their journals. Why do they predict that? (Soon feathery green leaves will emerge. Since the carrot is only 2", the plant will eventually die because it does not have enough food.)

3. Break the class up into four groups. Have each group fill a plastic cup with germination mix.

4. Give group one ten radish seeds to place on top of the germination mix in their plastics cups. Have group two do the same with only three radish seeds. Group three will get ten lettuce seeds and group four will get three lettuce seeds. Have each group try to place some of the seeds near the edges of the container so they can watch the roots grow.

5. Lightly sprinkle germination mix over the seeds. Label each cup.

6. Water the seeds and place in a warm sunny location.

7. Have the class write in their journals what they will predict will happen in each cup and why. (Within a week the seeds will germinate and begin to grow. Initially the cups with ten seeds will look wonderful, but over time these cups will fail because they do not have enough room for the roots to develop. The radishes will develop taproots and the lettuce will develop fibrous roots.)

8. Follow-up: Continue to fill carrot container with water and keep seeds moist. Check on them regularly. A week or so later, have the class check their predictions and see if they were right.

Conclusion (5 minutes)
Have the class write in their journals one cool new fact they learned about roots today and their favorite root and why.

Snack (5 minutes)
Hand out the Root Vegetable Salad with Parsnip Puree and discuss the different roots the class is eating.

Assessment Tools

- Journals
- Participation

Modifications

- Check out the following websites and share the images with the class.
    - Information about Pando, the world's largest organism:

http://watchingtheworldwakeup.blogspot.com/2008/08/unbearable-lightness-of-aspen-part-1.html

    - Images of the largest and heaviest carrots:

http://www.carrotmuseum.co.uk/record.html

- Have the students illustrate in their journal one example of a tap root plant and one example of a fibrous root plant

Extensions

- Have the students hypothesize why certain plants have taproots while others have fibrous roots in journal.

Root Vegetable Salad with Parsnip Puree

- 2 carrots
- 2 parsnips
- 2 turnips
- 1 bunch of radishes
- 1 jicama
- 6 oz arugula
- 1 oz lemon juice
- 3 oz olive oil
- 2 garlic cloves
- 1 or 2 oz milk or water
- salt and pepper to taste

Preparation (1 hour): Chop parsnips. Rub parsnips and garlic cloves with a little olive oil. Wrap in aluminum foil. Place in 400 degree oven for 45 minutes or until cooked through. Place parsnips and garlic in blender and puree with milk (or water) until smooth. Season with salt and pepper and set aside. Make a simple vinaigrette by whisking the olive oil and lemon juice together. Season with salt and pepper. Grate the carrots and thinly slice the radishes and turnips. Peel and julienne the jicama. Combine carrots, radishes, turnips and jicama with arugula. Toss the ingredients with vinaigrette. Serve on top of a the parsnip puree.

Source
Recipe courtesy of Corey Ferguson

A RESOURCE OF DENVER URBAN GARDENS
303.292.9900 | DIRT@DUG.ORG | WWW.DUG.ORG

Denver Urban Gardens School Garden and Nutrition Curriculum

Spring Planting

Lesson

Goals

Students learn about early spring crops and how to transplant seedlings.

Objectives

Students will plant spring crops and transplant seedlings from flats to the garden.

Standards

Science: Life Science

GR.2-S.2-GLE.1
GR.4-S.2-GLE.3

Total Time – 60 minutes

Did you know?

A study done by the Centers for Disease Control and Prevention found that increased amounts of physical fitness translated into higher academic achievement. And working in the garden increases physical activity. So gardening makes you smarter!

Materials

- Soil preparation tools (e.g. spading forks, rakes)
- Measurement tools (rulers, yardsticks or tape measures)
- Sticks (to mark mound locations)
- Trowels
- Spring seeds (peas, spinach, lettuce, beets, radishes, Swiss chard)
- Seedlings ready to be transplanted
- Garden snack
- Journals

Vocabulary

cool season crops/plants seedling

Background for Teachers

The purpose of transplanting is to give the plants more space so they can become productive. It is important to handle the roots as little as possible when transplanting seedlings. Teach students to hold plants at the base of the stem. For younger students, you may want to dig the holes where the plant is to be planted. Use the "Vegetable Planting Guide" (end of lesson) to determine spacing needs. The "Companion Planting Guide" (end of lesson) will assist you in intercropping plants that are beneficial to each other. Seedlings need to be transplanted when they are overcrowded in the flat, have their first true leaves or both. Note: The first leaves to emerge are called cotyledons and are not true leaves. Plants that can handle light frost can be planted as early as April and up to the end of May. Earlier is better for longer living cool season crops.

This lesson is a great follow up to the "Dig In!" lesson:
http://dug.org/storage/school-garden-curriculum/Dig_In.pdf.

Method

Introduction (15 minutes)

1. Discuss with the class: *Now that our garden soil is turned and has been fed with our compost it is ready to start growing cool season plants. Does anyone know what cool season crops are?* (Plants that can handle light frost and cooler soil temperatures, such as peas, lettuce, spinach, root crops, etc.) *We are also ready to give our seedlings a new home. The seedling is like a baby. How do we handle it carefully?* (Squeeze it gently out of the flat; don't touch the roots.) *Visualize the plants when they will be big. What kind of space will our plants need? When the plants are put back in the ground, how will we get the soil to stick to the roots*? (Press the plant firmly into the soil and water it well.)

Activity (35 minutes)

1. Mark the spaces in the bed where transplants and seeds will be planted.

FOR TRANSPLANTS:

2. Have students dig a hole two times the size of the root ball for each plant.

3. Demonstrate how to remove the seedling from the flat, shading the roots from the sun to prevent the roots drying out and handling from the base of the stem gently.

4. Demonstrate how to separate the plants carefully. Think them apart, trying not to break too many roots and keeping as much soil around them as possible.

5. Hand each student a seedling, making sure to hold it by the base of the stem.

6. Help students plant each seedling gently by holding it at the stem, having the roots fall straight down, gently covering the roots with dirt up to the first set of leaves, and pressing the soil firmly around the plant.

7. Water the plants and label them.

FOR SEEDS:

8. Have students dig a row as deep as the seeds need to be planted (see seed packet for instructions).

9. Pour a small handful of seeds into the students' hands, helping them space them appropriately (see seed package), explaining to them the need to place one seed gently in the hole at a time and not to hurry.

10. Have the students gently push the removed soil from the row back onto the seeds, like sealing an envelope. Do not pack the soil down, but simply cover the seeds.

11. Water the seeds and label the row.

TRANSPLANTING SEEDLINGS INTO POTS:

12. Seedlings may be transplanted into slightly larger single pots (4") for a plant sale or for students to take home. To transplant into pots, place potting soil in the bottom of pot just enough for

seedling top to be slightly lower than pot top. Add potting soil on top of seedling and lightly packing it in.

Conclusion (10 minutes)

Discuss or write in journals: *Why is it necessary to transplant seedlings? How did you determine how much space to leave between plants? How will you care for your transplants and seeds?*

Assessment Tools

- Participation
- Journals

Modifications

- Have students write in their journals or discuss why we transplant our seedlings.

Extensions

- Have the class come up with a plan for a plant sale, including which plants to sell, prices and an advertising plan.

Source

Jaffe, Roberta, and Gary Appel. *The Growing Classroom: Garden-based Science*. South Burlington, VT: National Gardening Association, 2007.

A RESOURCE OF DENVER URBAN GARDENS
303.292.9900 | DIRT@DUG.ORG | WWW.DUG.ORG

Vegetable Planting Guide

Vegetable	Warm Weather	Cool Weather	Sow Indoors	Sow Direct	Spring Planting		Fall Planting**
					Start Seeds*	Set Out *	
Bush Beans	•			•	3-4 before	1-2 after	12 before
Pole Beans	•			•	3-4 before	1-2 after	12 before
Beets	•			•		2-4 before	8-10 before
Broccoli		•	•		5-8 before	5-8 before	14-17 before
Brussel Sprouts		•	•		5-8 before	4-6 before	17 before
Cabbage		•	•		4-6 before	5 before	13-14 before
Carrots	•	•		•		2-4 before	13 before
Cauliflower		•	•		5-8 before	1-2 before	14 before
Celery	•		•		8-10 before	2-3 before	19 before
Chard	•	•		•		2-4 before	6 before
Corn	•			•	3-4 before	1-2 after	6 before
Cucumber	•			•	2-3 before	1-2 after	11 ½ before
Eggplant	•		•		6-8 before	2-3 after	14 before
Garlic		•		•		6 before	Sept. w/mulch
Kale		•	•			5 bef, 2 aft	6-8 before
Kohlrabi		•	•			5 bef, 2 aft	10 before
Leeks		•	•		8-10 before	5 before	
Lettuce	•	•	•			2-4 b, 2 aft	6-8 before
Onion		•	•			3 bef, 2 aft	8 after spring
Parsley	•	•	•	•	4-6 before	1-2 after	
Peas		•		•		4-6 b, 2-3 a	12 before
Peppers	•		•			1-3 after	
Potatoes	•			•		4-6 before	
Pumpkin	•			•		after frost	
Radish	•	•		•		4-6 before	7 before
Spinach	•	•		•		3-6 before	6-8 before
Squash, Summer	•			•		1-4 after	10 before
Squash, Winter	•		•			2 after	13 before
Tomatoes	•		•			2-4 after	

* Weeks before or after last frost ** Weeks before first frost

Vegetable	Days to Emerge	Days to Harvest	Spacing of Plants (inches)	Depth to Plant Seeds (inches)	Soil Temp. for Germination	Best Air Temp. for Growing
Bush Beans	4-10	50-60	6	1	60-85	60-80
Pole Beans	4-10	60-70	6-8	1	60-85	60-80
Beets	7-10	50-80	2-4	½	60-75	50-75
Broccoli	5-10	80-100	15-18	¼	50-65	60-75
Brussel Sprouts	8-10	100-110	18	¼	65-75	55-70
Cabbage	4-10	80-100	18	¼	50-75	50-75
Carrots	10-17	50-75	2	¼	55-75	45-75
Cauliflower	5-10	60-80	15-18	¼	50-75	60-72
Celery	7-12	90-120	6	¼	50-75	60-75
Chard	7-14	45-55	8	1	40-70	45-70
Corn	3-10	90-110	12-15	1	55-85	50-95
Cucumber	3-8	60	12-24	1	65-85	60-80
Eggplant	5-13	90	18	½	65-85	65-85
Garlic		180-200	4-6	½		
Kale		100-120	15	½	40-70	40-70
Kohlrabi	5-10	50-70	6-9	¼	50-75	40-75
Leeks	7-14	130-160	4-6	½	below 70	60
Lettuce	2-10	60-80	10-12	¼	45-70	55-70
Onion	4-12	85-200	4	¼	50-80	60-85
Parsley	11-27	70-90	4	¼		
Peas	6-15	60-80	4	1	40-75	55-75
Peppers	8-20	80-100	10-12	12	65-85	65-85
Potatoes	10-15	140-160	10-12	6	60-65	60-80
Pumpkin	7-10	110-130	36	1	65-85	50-90
Radish	3-10	25-40	1	¼	40-85	45-75
Spinach	6-14	50-55	4-8	¼	60-70	40-75
Squash, Summer	3-12	50-60	15-24	1	65-85	60-85
Squash, Winter	4-10	80-120	24-36	½ - 1	65-85	60-85
Tomatoes	6-14	80-100	18-24	¼ - ½	65-85	65-85

Vegetable Planting Guide

Additional Comments

Bush Beans: Sensitive to transplanting; pinch extra plants, don't pull them. Pick every 3-7 days.

Pole Beans: Sensitive to transplanting; pinch extra plants, don't pull them. Pick every 3-7 days.

Beets: Thin when young and cook tops as greens.

Broccoli: Keep cool to get stocky plants, but don't go below 40° F. Transplant into beds up to first true leaves. Harvest main head when buds begin to loosen. Side heads will form after first head is cut.

Brussel Sprouts: Keep cool to get stocky plants, but don't get below 40° F. Harvest sprouts when they are 1 ½" wide. Pick lower ones first.

Cabbage: Harvest when head is formed. Keep cool to get stocky but don't go below 40° F.

Carrots: Thin early; harvest any size.

Cauliflower: Tie outer leaves around head to protect from sun. Likes between 57°- 68° F.

Celery: Must go below 60° F at night for seeds to germinate. Requires a lot of nutrients and water.

Chard: Cut leaves close to ground when 8-10" high. Harvest outer leaves first.

Corn: Sensitive to transplanting, pinch extra plants. Plant in blocks, harvest when kernels are milky.

Cucumber: Somewhat sensitive to transplanting; pinch extra plants. Mound soil into hills; plant 3 seeds per hill.

Eggplant: Grows well in hot weather.

Garlic: Harvest when tops start to die.

Kale: Keep cool to get stocky plants, but not below 40° F. Cut outer leaves closer to stem when 10" or longer.

Kohlrabi: Keep cool to get stocky plants, but not below 40° F. Harvest when bulb is 3" in diameter.

Leeks: Keep cool to get stocky plants, but not below 40° F. Plant out when 4" high.

Lettuce: Keep cool to get stocky plants, but not below 40° F. Hard lettuce likes repotting. Plant successively every two weeks. Will go to seed in high temperatures. Harvest outer leaves of leaf lettuce vs. head.

Onion: Harvest when tips start to die back.

Parsley: Soak seeds overnight to speed germination. Cut outer leaves near stem.

Peas: Sensitive to transplanting, pinch extra plants, don't pull them. Harvest frequently.

Peppers: Sensitive to cold, harden off gradually. Green peppers turn red when ripe.

Potatoes: Very tender; cannot tolerate frost. Dig up with digging fork after tops have flowered.

Pumpkin: Sensitive to transplanting; pinch, don't pull plants. Plant in hills, 3-4 plants per hill, 6-8 ft. apart.

Radish: Plant every 10 days. Will get woody when over mature.

Spinach: Keep cool for stocky plants. Plant every 2 weeks. Will go to seed in hot weather.

Squash, Summer: Sensitive to transplanting; pinch extra plants, don't pull them. Harvest frequently.

Squash, Winter: Sensitive to transplanting; pinch extra plants, don't pull. Can store through the winter.

Tomatoes: Prefers warm days and cool nights.

Sources

Adapted from *Organic Gardening and Farming*, February 1972, pp. 32-33, 54, and *The Encyclopedia of Organic Gardening*, Rodale Press, Inc., 1978, pp. 233-235.

Companion Planting Guide

Vegetable	Plant with	Do not plant with
Beans	Potatoes, carrots, cucumbers, cauliflower, cabbage, summer savory, most other vegetables and herbs	Onions, garlic, gladiolus
Beans, Bush	Potatoes, cucumbers, corn, celery, summer savory, sunflowers, strawberries	Onions
Beans, Pole	Corn, summer savory	Onions, beets, kohlrabi, sunflower
Beets	Onions, kohlrabi	Pole beans
Cabbage Family (cabbage, cauliflower, kale, kohlrabi, broccoli)	Aromatic plants, potatoes, celery, dill, chamomile, sage, peppermint, rosemary, beets, onions, thyme, lavender	Strawberries, tomatoes, pole beans
Carrots	Peas, leaf lettuce, chives, onions, leek, rosemary, sage, tomatoes	Dill
Celery	Leek, tomatoes, bush beans, cucumbers, pumpkin, squash	
Corn	Potatoes, peas, beans, cucumbers, squash, pumpkin	
Cucumbers	Beans, corn, peas, radishes, sunflowers	Potatoes, aromatic herbs
Eggplant	Beans	
Leek	Onions, celery, carrots	
Lettuce	Carrots and radishes (lettuce, carrots, and radishes make strong team grown together), strawberries, cucumbers	
Onion/Garlic	Beets, strawberries, tomato, lettuce, summer savory, chamomile, beans (protects against ants)	Peas
Parsley	Tomatoes, asparagus	
Peas	Carrots, turnips, radishes, cucumbers, corn, beans, most vegetables, herbs (adds Nitrogen to soil)	Onions, garlic, gladiolus, potatoes
Potato	Beans, corn, cabbage, horseradish (should be planted at corners of patch), marigold, eggplant (as a lure for Colorado potato beetle)	Pumpkins, squash, cucumber, sunflower, tomato, raspberries
Pumpkin	Corn	Potatoes
Radish	Peas, nasturtium, lettuce, cucumbers	
Soybeans	Grows with anything; helps everything	
Spinach	Strawberries	
Squash	Nasturtium, corn	
Sunflower	Cucumbers	Potatoes
Strawberry	Bush Beans	
Tomatoes	Chives, onion, parsley, asparagus, marigold, nasturtiums, carrots, limas	Kohlrabi, potatoes, fennel, cabbage
Turnip	Peas	

Herbs	Companions and Effects
Basil	Companion to tomatoes; improves growth and flavor; repels mosquitoes and flies; dislikes rue intensely.
Beebalm	Companion to tomatoes; improves growth and flavor.
Borage	Companion to tomatoes, squash, and strawberries; deters tomato worm; improves flavor and growth.
Caraway	Plant here and there; loosens soil.
Catnip	Plant in borders; deters flea beetle.
Chamomile	Companion to cabbages and onions; improves growth and flavor.
Chervil	Radishes; improves growth and flavor.
Chives	Companion to carrots; improves growth and flavor; plant around base of fruit trees to discourage insects climbing trunks.
Dill	Dislikes carrots; improves growth and health of cabbage.
Fennel	Plant away from garden; most plants dislike it.
Garlic	Plant near roses and raspberries; deters Japanese beetle; improves growth and health; plant liberally throughout garden to deter pests.
Horseradish	Plant at corners of potato patch to deter potato bugs.
Hyssop	Companion to cabbage and grapes; deters cabbage moth; keep away from radishes.
Lamb's Quarters	This edible weed should be allowed to grow in moderate amounts in the garden, especially in the corn.
Lemon Balm	Sprinkle throughout garden.
Marigolds	The workhorse of the pest deterrents; plant throughout garden especially with tomatoes; discourages Mexican bean beetles, nematodes, and other insects.
Mint	Companion to cabbage and tomatoes; improves health and flavor; deters white cabbage moth.
Marjoram	Plant here and there in garden; improves flavor.
Nasturtium	Companion to tomatoes and cucumbers.
Petunia	Protects beans; beneficial throughout garden.
Purslane	This edible weed makes good ground cover in the corn.
Pigweed	One of the best weeds for pumping nutrients from the subsoil, it is especially beneficial to potatoes, onions, and corn; keep weeds thinned.
Rosemary	Companion to cabbage, bean, carrots, and sage; deters cabbage moth, bean beetles, and carrot fly.
Rue	Keep it far away from sweet basil; plant near roses and raspberries; deters Japanese beetle.
Sage	Plant with rosemary, cabbage, carrots, beans, and peas; keep away from cucumbers; deters cabbage moth and carrot fly.
Summer Savory	Plant with beans and onions, improves growth and flavor; deters bean beetles.
Tansy	Plant under fruit trees; companion to roses and raspberries; deters flying insects, Japanese beetles, stipend cucumber beetles, squash bugs, and ants.
Tarragon	Good throughout the garden.
Thyme	Plant here and there in the garden; it deters cabbage worm.
Yarrow	Plant along borders and near aromatic herbs; enhances essential oil production.

Sources

Adapted from *Organic Gardening and Farming*, February 1972, pp. 32-33, 54, and *The Encyclopedia of Organic Gardening,* Rodale Press, Inc., 1978, pp. 233-235.

Denver Urban Gardens School Garden and Nutrition Curriculum

What a Stem

Lesson

Goals

Students learn how materials are transported through plants by examining how stems and other objects conduct water.

Objectives

Students will consider and explore the forms and functions of stems by observing and comparing the transport action of plant stems and other objects.

Standards

Science: Life Science

GR.2-S.2-GLE.2

GR.5-S.2-GLE.1

Did you know?

Potatoes and gingerroot are actually stems and not roots.

Total Time – 45 minutes (15 minutes day one, 30 minutes day two)

Materials

- Pictures of plants and trees
- Assorted materials that might transport water (e.g. celery, carnations, wooden dowel, plastic straws, carrots, paper towel strips)
- Glass jars
- Food coloring
- Hand lenses

Method

Introduction (Day one, 15 minutes)

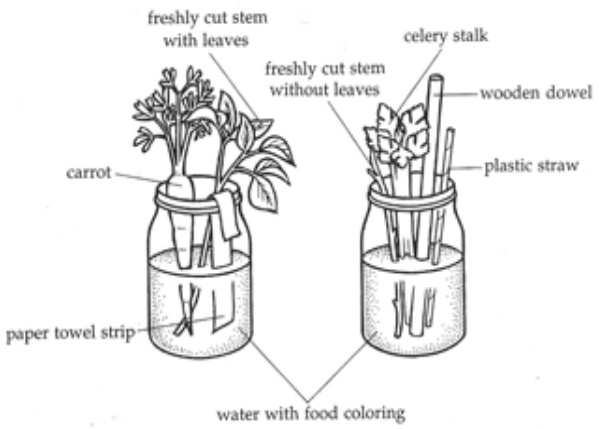
1. Show your students different plants or pictures of plants, including trees, and then point out the stem in each image. Explain to your students that just as each of their body parts have particular jobs to do, each part of the plant has special jobs to do too.

2. Have the students generate a list of the possible jobs of stems. List them on the board.
    a. Transports water, nutrients and the produces of photosynthesis
    b. Supports leaves, flowers and fruit
    c. Stores water (such as for a cactus)
    d. Can be used as a method of asexual reproduction in many plants

3. If students' ideas did not include the job that stems transport water, ask: *If you water the roots of a wilting plant, what happens to the plant? How do you think the water starts in the roots and ends up in the leaves?* Tell the students: *Although plant stems have several different jobs, during this activity we are going to focus mainly on the water-carrying job.*

4. Have the class answer the following question: *What will happen if we leave a plant stem and other objects in colored water overnight?* Have the class record their predictions.

5. Set up the following and let sit undisturbed for 24 hours.



Activity (Day two, 15 minutes)

1. Pull the items out of the colored water. Wash or blot off excess colored water from the objects.

2. Give each student (or group) an object and a hand lens to observe how the colored water traveled through the object. Have the students compare the heights the colored water reached.

3. Have the class answer: *How does what happened compare with your predictions?*

4. Have the students record their results by using colored pencils or crayons to illustrate the height the colored water traveled in each object. Ask: *What direction does the water seem to travel in the stems?*

Snack & Conclusion (Day two, 10-15 minutes)

1. Prepare a stem–based snack, which may include: celery, asparagus, broccoli or rhubarb. An easy stem recipe is included at the end of the lesson.

2. Journal or discuss one or more of the following questions:
   - Why do you think the wooden dowel carried the colored water as it did? (Hint: Where does wood come from?)
   - Why do you think the colored water did not rise in the plastic straw? What do you have to do to get your drink to rise in a plastic straw?
   - In plants, where do you think the materials inside the stem are going? From where do you think the materials in the stem are coming?
   - What do you think would happen to a plant if its stem were broken? How could you set up a test to find out?
   - How does the water you drink reach the rest of your body?
   - Do you eat stems? If so, which ones? How else do people use stems?

Assessment Tools

- Participation
- Critical thinking
- Journals

Possible Modifications and Extensions

- Turn this into a one-day lesson by presoaking all of the objects. Make sure to have samples of the objects before they were soaked.
- Compare the rate the colored water travels up the stems in light and dark conditions.
- Make tie-dyed flowers. Take a white carnation or rose and carefully slice the bottom of the stem lengthwise into multiple sections (2-4). Leave 3-5" of stem attached near the flower head. Put each section in a jar with different colored water. Let sit for two days. Have students predict what the flower will look like.
- Have a stem scavenger hung outside. Search for stems with different characteristics such as rough, thorny, flexible, green, large, etc.
- Grow some underground stems such as tubers (white potatoes), corms (crocus), bulbs (tulips, daffodils) or rhizomes (iris, ginger).
    - Plant some gingerroot in a 4" pot. Place a 1" piece of ginger ¾" below the surface of the potting mix. Keep moist and wait patiently for the grass like shoots to develop. Rub the leaves to find out if they have the same aroma as ginger.
    - Three different ways to plant a potato:
        - Fill a container halfway with soil. Lay the potatoes on the soil and cover them with 1" of soil. Water until slightly damp and place in a sunny warm place. In a week or so you should see leaves. After several weeks you may see some purple flowers too. If your container is large enough, you may also get little potatoes underground. When you dig up little potatoes make sure to show how they are extensions of the stems.
        - Put a potato in a clean jar so only the bottom stays wet. You may need to use toothpicks to hold it up. Eventually roots will sprout out of the bottom and stems and leaves will grow out of the top. Change the water once a week. If the plant does not start growing in two weeks the potato may have been treated so it will not sprout. Start over.
        - Use potatoes that have little white sprouts on them. Cut them into pieces so that there are three sprouts on each piece. Let them dry overnight. Fill an empty clean ½ gallon milk container with soil. Place this container in an old pie pan so the water does not leak all over. Plant the potato pieces under about 3" of soil. Put the cut side down and the sprouts up. Water until damp. This is how farmers plant their potatoes.

Sources

Lesson adapted from: *Plants Alive! Transport and Support* & *Gardening Wizardry for Kids*

A RESOURCE OF DENVER URBAN GARDENS
303.292.9900 | DIRT@DUG.ORG | WWW.DUG.ORG