TOWER GARDEN BY JUICE PLUS+

PLANT LESSON

LEARNING ABOUT PARTS OF PLANTS

Grade 2 and up

Science

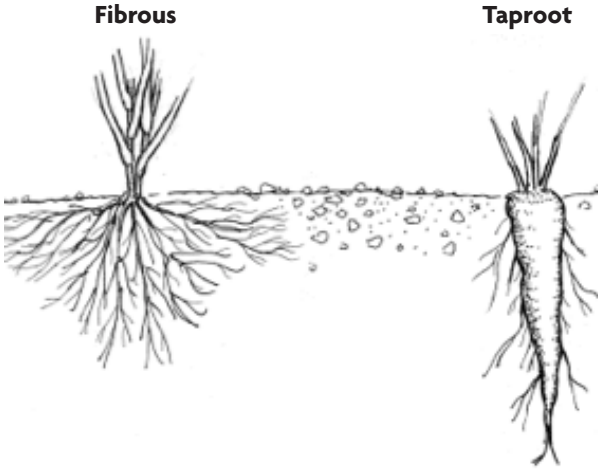
Roots

1 Purpose and Content of Lesson:

Roots will be visible in the Tower Garden® plants because they will not be hidden by soil. Growers of aeroponic plants may be amazed at the abundance of root growth in their plants. Roots are the most overlooked parts of plants, because in nature, we do not see them as we do the stems, leaves, and flowers. Roots comprise about ¼ to ⅓ the total weight of a plant and are essential to its growth and health.[1]

The functions of the roots:

- Anchor the plant in the ground
- Bring water with dissolved minerals into the plant from the ground
- Store products of photosynthesis from the leaves (sugars, starches)



Some roots are called fibrous, branch out in all directions, and are about the same length. Monocots, like grasses, corn, and lilies, have fibrous roots.

Others, called taproots, have a main downward growing root with smaller roots branching off from it. Carrots, radishes, beets, parsnips, and turnips are storage taproots since they hold sugar and starches made in the leaves. Most dicot plants have taproots.

Root hairs are extensions of the root responsible for bringing water into the plant.

2 Next Generation Science Standards (NGSS):

http://www.nextgenscience.org/search-standards

Disciplinary Core Ideas

LS1.A: Structure and Function

All organisms have external parts. Plants have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (Grades K-2)

Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (Grades 3-5)

LS1.D: Information Processing

Plants respond to some external inputs. (Grades K-2)

3 Common misconceptions about roots:

The idea that water is absorbed into the plant by the leaves is a misconception. Water being absorbed by underground roots in the soil cannot be observed; but droplets on the leaves can be observed, further supporting this misconception.

The notion that nutrients and water that come from the soil are "food" for the plant is another misconception. Fertilizer is called "plant food," and we know that plants need water to grow. Young learners may have difficulty believing, therefore, that leaves make the food for the plant.

4 Lesson Objective:

Learners will explain the function of roots, recognize two types of roots (fibrous and taproot), and describe how they grow in their science journals.

Developed by: Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

5 Lesson Procedure— THE LEARNING CYCLE: The Five Es

ENGAGE

Living things need water, and plants are living organisms. *How do they get their water?*

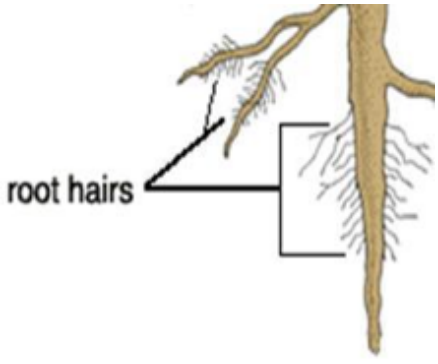
Begin with a house plant in a pot.

Ask: *If I am going to water this plant, what part do I water? Why? When it rains, how does water get into a tree?*

Identify any misconceptions about watering the leaves and explain that leaves do not bring water into the plant. Tell students that in this lesson you'll examine the part of the plant that provides water.

Project the following image:

http://www.lizzieharper.co.uk/news/article/40/Botanical_Illustration_-_Glorious_grasses_-_June14th_2013



Talk about the parts of the plant — roots, stem, and leaves and how water gets into the plant through roots via root hairs and travels up the stem to the leaves where the plant's food is made. The xylem and phloem vessels that bring fluids through the root systems are also found in stems. Do not yet talk about the two different types of roots since that is the purpose of the following investigation.

EXPLORE

Key questions for Seed Dissection lab:

1. **What do roots look like?**
2. **What is their function?**

Root investigation:

Have trays prepared for students to observe in groups with five or less assorted plants having a variety of taproots (dicots) and fibrous roots (monocots). Find plants in season in your yard or at the garden center.

Say to the students:

Different types of roots will be explored today. On your observation tray are several types of plants with visible root systems. Examine each, and with your group members, divide the roots into two categories by some property or characteristic other than the fact that some are edible. Be ready to explain by which property you divided your roots. Also make at least five observations of your roots in your science journal and draw each type. Fill in the chart in the Appendices on page four using names of the plants supplied by the teacher.

EXPLAIN

Have each group share some of their observations and their characteristics for dividing their roots into two groups. Help them see (if they didn't already) how the **taproots** (radish, dandelion, carrot) have a main root with smaller roots branching off. Help them also see that the **fibrous** roots do not have one main root but branch out all over equally.

Discuss how the roots have small hairs that absorb water from the soil and bring it into the root, then it continues to the stem through xylem tubes. Give out hand lenses to see if root hairs are visible, although they are invisible to the naked eye. Also mention that familiar edible roots have more stored sugars and starches (carrot, turnip, beet, radish, yam, horseradish, parsnip, ginger, jicama, rutabaga, Jerusalem artichokes) than other taproots. They are called **storage taproots**.

Critical thinking questions for groups to discuss then share with the class:

1. **Do you think desert plants (experiencing low rainfall) have deep or shallow roots? Explain.**

If you have cactus plants available, show the students the roots. They are typically shallow to get surface water when it rains. Deep roots would not yield water far into the dry ground unless there was an underground spring or aquafer.

2. **Do you think root vegetables are suitable for growth in a Tower Garden? Explain.**

Storage roots pick up more nutrients from the soil around them and stored sugars and starches from the leaves. Hydroponically grown carrots and other storage roots can get heavy, so they need a growing medium to support them, like vermic-

ulite (a moisture retaining mineral product). A little bit of vermiculite is used to plant seeds in wool cubes in the Tower Garden. Carrots, for example, also take a long time to grow — about three months, while other hydroponically grown plants can grow and be harvested more quickly.

3. **Why do you think some plants (like the ones we call "weeds") sometimes grow back after we pull them out of the ground?**

Plants can grow back after you pull up the top growth. Those with long taproots, like dandelion (a foot or more in length), or those roots that spread by sending out rhizomes are especially prone to grow new shoots.

4. **How might the function of roots in the Tower Garden be different from roots growing through soil? How might their function be the same?**

In the Tower Garden, roots begin in wool cubes, and then extensive root development appears in the interior of the tower and roots hang down, but they do not anchor the plant in the same way as soil. The plants are not subject to effects of strong winds, foot traffic, lawnmowers, or competition for resources. Roots still bring nutrient-rich water into the plant, but the root tip does not have to push through hard ground to grow.

EXPAND

Show upper-grade students a cross section slice of a carrot that was soaking in red food dye and water.[3] This way they can see the red portions as xylem; then they will also see the distinctions between phloem and the cortex. They can draw and label in their science notebooks. Show also select images and videos under "Resources."

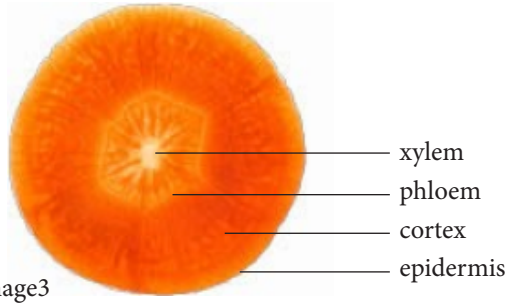


image3

EVALUATE

Students write the answer to the following questions in their science notebooks:

1. **How would the growth of a plant be affected if its roots were cut off? Suggest at least two ways.**

2. **Watering a plant means to water the soil around the plant. Why is that so?**

A summative assessment is included at the end of the lesson on STEMS.

6 Web Resources

[1]Plant Structures: Roots **http://www.ext.colostate.edu/mg/gardennotes/132.html**

[2]Roots as anchors with images: NGA's Learning Garden **http://assoc.garden.org/courseweb/course1/week1/page8.htm**

[3]Carrot experiments to show function, structure of taproots: World Carrot Museum **http://www.carrotmuseum.co.uk/experiment.html**

[4]Video of radish roots sprouting: Newton's Apple What Plants Need… **http://www.newtonsapple.org.uk/plants-what-they-need-to-live-and-grow/**

[5]Flowering Plants: Roots **http://leavingbio.net/flowering%20plants.htm**

Content — Great Plant Escape: **http://extension.illinois.edu/gpe/case1/c1facts2a.html**

Background for Teacher: Botany **http://ag.arizona.edu/pubs/garden/mg/botany/roots.html#roots**

Materials for Investigation:

- Have enough plants with exposed taproots and fibrous roots for students to observe in groups and classify.
- Carrots with leaves and smaller roots attached
- Carrots that have been soaked in dye and sliced
- Other storage taproot vegetables (radishes, turnips, beets)
- Other plants with taproots intact that are not foods (any dicot plant)
- Plants with fibrous roots (lilies, grasses, palms or any monocot plant)
- Computer and projection to show videos and images

7 Additional Applications:

Ask students to share their thoughts in groups on the following questions. After discussion, they can do research to see if their hypotheses are correct and then share findings the following day.

1. **What plant part is a sweet potato?_____ a white potato?_____ garlic? _____**

   (Sweet potato is a storage root, white potato is a modified stem, and garlic is a root)

2. **How do earthworms help plant roots grow?**

   (They move through dirt, loosening soil, and deposit waste that is rich in nutrients)

3. **How do ants help roots?** (They dig tunnels and loosen soil to make space for growth)

8

Appendices:
Graphic handout on roots

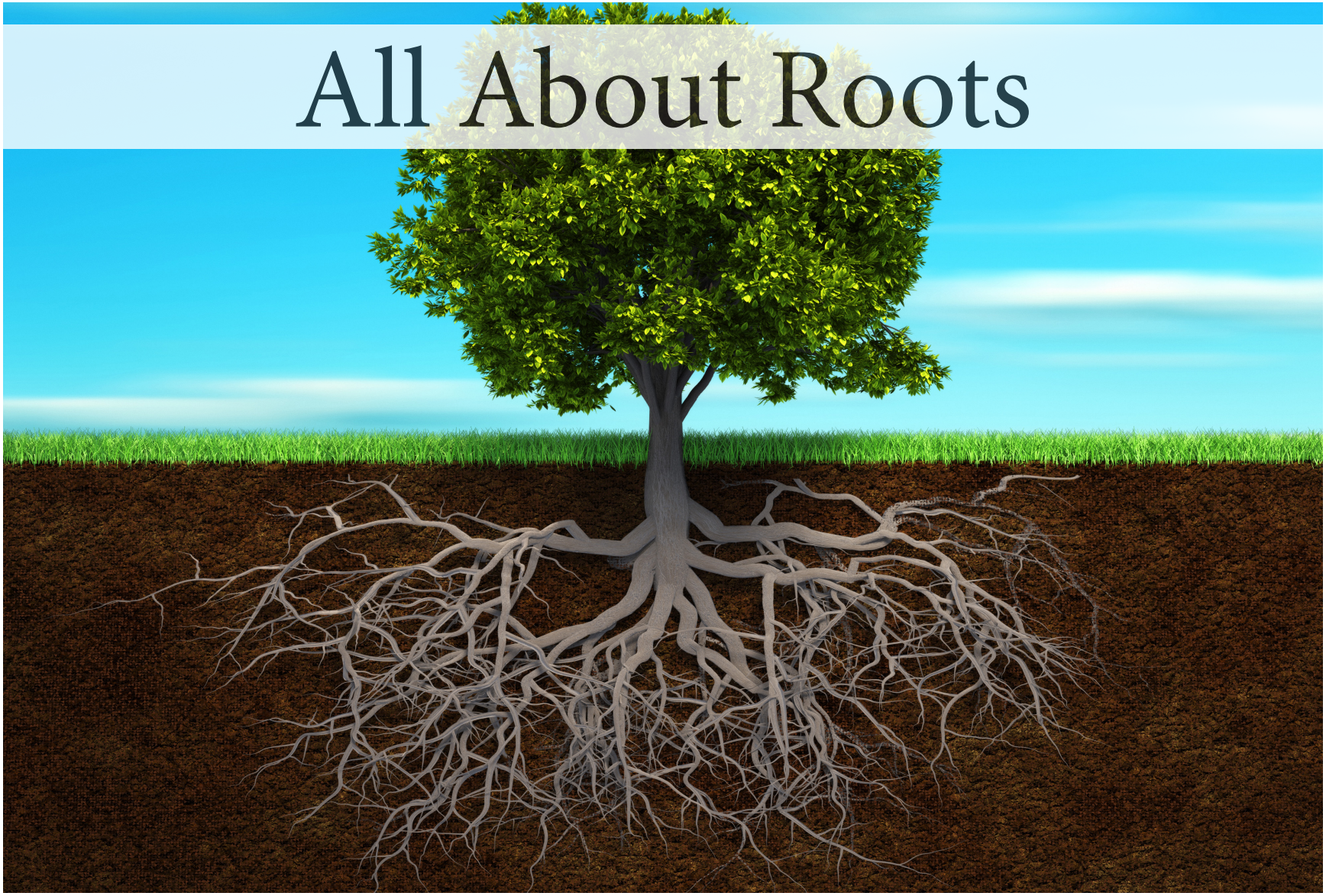
Date:_____

Name:_____

Type of Plant	Observations (write characteristics)	Plant diagram (draw)
grass		
radish		
dandelion		
lily		
carrot		

Task: *By what property or properties did your group divide your roots into two groups?*

All About Roots



DEVELOPED BY:

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Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

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The Roots of a Plant

1. What are the roots of a plant?
2. What do the roots do for the plant?

We don't often see the plant's roots, but they are very important.

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The Function of Roots

Roots are organs of a plant that **anchor the plant** in the ground.

1. Why is that job important?
2. What do you notice about these roots?

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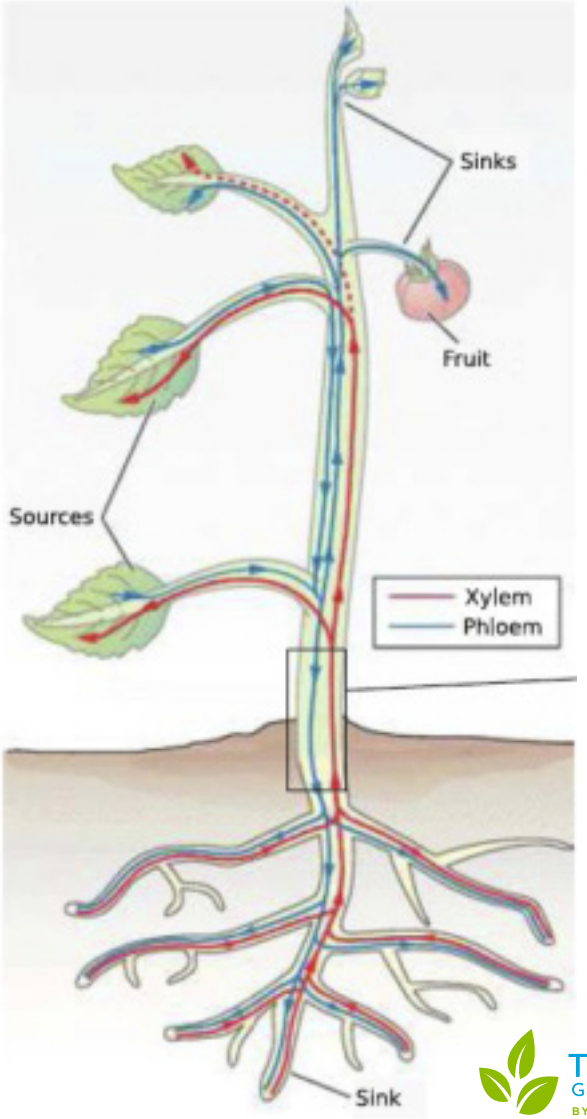
The Function of Roots

In addition to anchoring the plant,

roots bring water with dissolved minerals from the ground into the plant.



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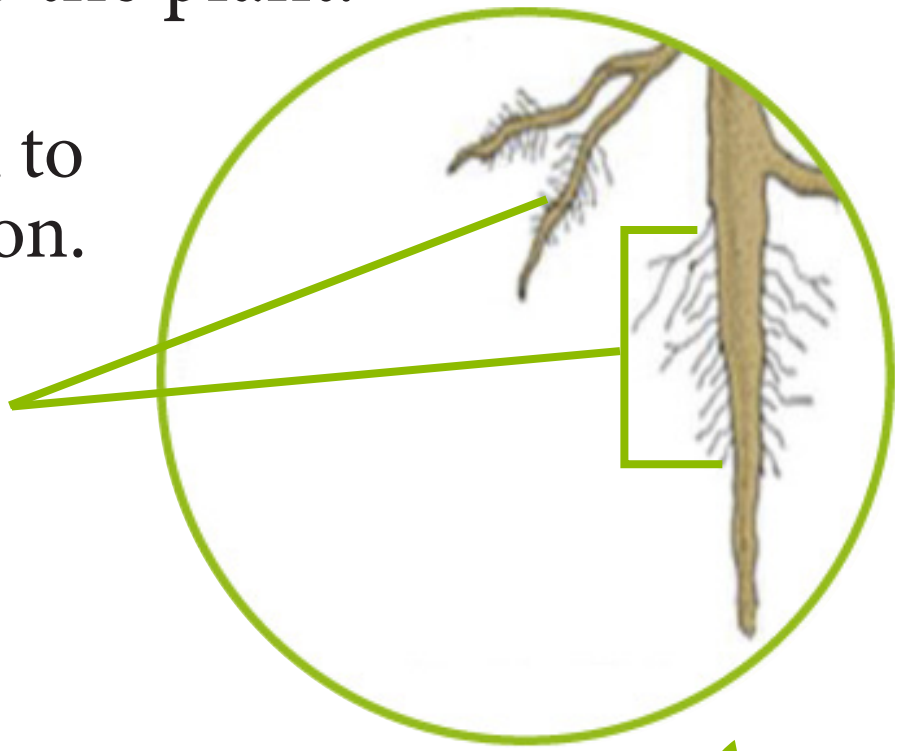
The Function of Roots

Root hairs are extensions of the root responsible for bringing water into the plant.

Root hairs are too small to see without magnification.



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The Function of Roots

In addition to **anchoring the plant** and **bringing water into the plant**, roots also:

Store sugars and starches—products of photosynthesis from the leaves.

Some roots are called **storage roots**.

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The Function of Roots

Let's Review:

What do roots do for a plant?

1. _____ the plant.

2. Bring _____ with dissolved minerals from the _____ into the plant.

3. Store _____ and _____ made in the leaves through photosynthesis.

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The Function of Roots

Were you correct?

What do roots do for a plant?

1. **Anchor** the plant.
2. Bring **water** with dissolved minerals from the **ground** into the plant.
3. Store **sugars** and **carbohydrates** made in the leaves through photosynthesis.

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Root Systems

Two kinds of root systems:

1. **Fibrous roots** branch out in all directions and are about the same length.

   Grasses, corn and lilies have **fibrous roots**

2. **Taproots** have a main downward growing root with small roots branching off of it.

   Carrots, radishes, beets, potatoes and turnips are **storage taproots** since they hold sugar and starches made in the leaves.

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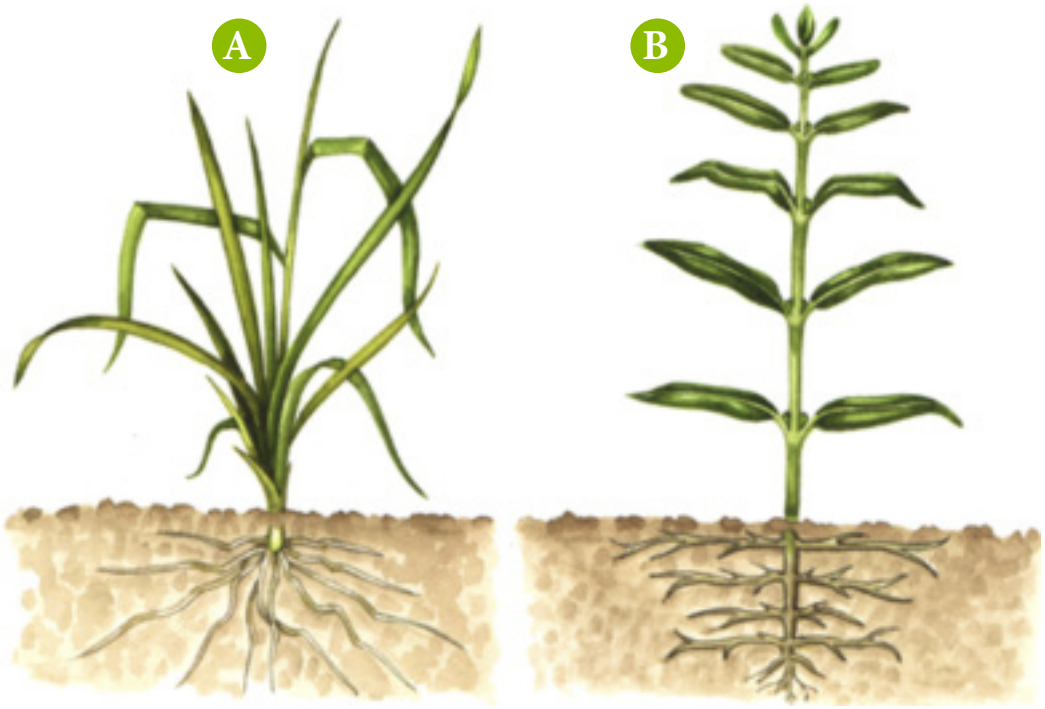
Root Systems

1. Which root system is **fibrous**?
2. Which root system is a **taproot** system?
3. Explain.



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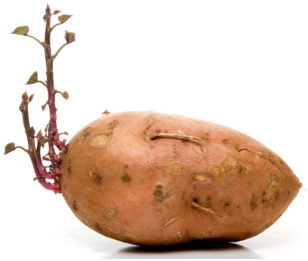
Questions About Roots

1. What plant part is a sweet potato?



A white potato?

Garlic?

2. How do earthworms help plant roots grow?

3. How do ants help plant roots grow?

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Questions About Roots

1. Do you think desert plants (experiencing low rainfall) have deep or shallow roots? Explain.
2. Do you think root vegetables (such as potatoes) are suitable for growth in a Tower Garden? Explain.
3. Why do you think some plants (like the ones we call "weeds") grow back after we pull them out of the ground?
4. How might the function of roots in a Tower Garden be different from roots growing in soil? How might their function be the same?

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Roots Assessment

Write your answers to the questions below.

1. How would the growth of a plant be affected if its roots were cut off? Suggest at least two ways.

2. Why does “watering a plant” mean to water the soil around the plant?

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