Unit B: Plant Anatomy

Lesson 1: Understanding Root Anatomy

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. List the functions of roots in plants.
2. Identify the parts of a root.
3. Identify the two major types of root systems.
4. Recognize a healthy root system.
5. Recognize the economical importance of roots.

Recommended Teaching Time: 2 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

1. A PowerPoint has also been developed with use of this lesson plan
2. http://en.wikipedia.org/wiki/Root

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Projector
PowerPoint slides
Transparency Masters
Copies of student lab sheet
Small, rootbound plant(s) from your area
Pencils and paper for students
Carrots
Plant parts that we eat

Terms. The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide #2):

- Apical meristem
- Epidermis
- Fibrous root system
- Primary root
- Root cap
- Root hairs
- Secondary roots
- Taproot system

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Have a variety of plants that we eat sitting on a table. These plants will need to be a mixture of plant roots, stems, leaves, fruits, and flowers. Have the students guess which of these are roots.

**** Use this activity to lead into a discussion over importance roots.**

Summary of Content and Teaching Strategies

**** Before giving the students the information on Objective 1, ask them to recall some of the functions that roots have. Then proceed with Objective 1. If the students already know the information, continue to ask the students questions about root function as a review.**

Objective 1: List the functions of roots in plants.

(PowerPoint Slide # 3)

I. Root Function

A. A plant's health is very closely tied to its roots. When roots are weak or diseased, the whole plant has difficulties. The roots need to be constantly growing in order to stay healthy. This is one reason that a plant growing in one pot for a long time tends to become rootbound.

(PowerPoint Slide # 4)

The following are functions of the root system.

1. The roots must absorb all of the water and minerals that a plant needs to live.
2. The root must anchor the plant to the ground and support the above ground part of the plant.
3. The roots store food that has been made through photosynthesis. This food can be used later when a plant needs it to grow or survive.

*****TM: B1-1 can be used to highlight the information for the students. Have them repeat this information aloud as a class. Do this a few times until every student is participating and they are all speaking the words together.***

Objective 2: Identify the parts of a root.

(PowerPoint Slide # 5)

II. When a plant seed germinates, the first structure to emerge from the seed is a root.

A. This root becomes the ***primary root*** and on some plants the most important root in the whole root system.
B. Other roots eventually branch out from the primary root. These are called ***secondary roots***.

(PowerPoint Slide # 6)

C. At the tip of the root, there is an area where new cells develop, called the ***apical meristem***. The apical meristem is easily damaged and so it has a ***root cap*** over the top of it to protect it from damage as it grows through the large and sometimes coarse soil particles.

(PowerPoint Slide # 7)

D. The surface of the root is covered with a skin of cells called the ***epidermis***. This epidermis is where the water and minerals enter the root through osmosis and diffusion. The larger the surface area of the epidermis, the better able the plant is to bring in water and minerals. So, the epidermis cells begin to elongate and grow hairlike projections. These projections, called ***root hairs***, greatly increase the surface area of the root and allow much more water and minerals to enter the plant.

**** Use TM B1-2 to show a diagram of the root parts to the students. Have them draw these in their notebooks and label them as well. You can also show the picture on PowerPoint slide # 8. Tell the students to look over this drawing.**

If you draw this picture on the board, erase the parts that you have labeled. Have the student put their notes away. See if the students can label the parts. As a review ask why each root part is important.

Objective 3: Identify the two major types of root systems.

(PowerPoint Slide # 9)

III. Plants root systems are organized in two basic ways. The two ways have a lot to do with primary and secondary roots.
   A. A root system which is composed of one main primary root and many secondary roots branching off of the primary root is called a ***taproot system***. **(PowerPoint Slide # 10 provides pictures of taproots)**

(PowerPoint Slide # 11)

1. Advantages
   a. Penetrate deeper into the soil
   b. Obtain water from lower levels
   c. Anchor the plant
2. Disadvantages
   a. Difficult to remove/harvest plants
   b. Do not stabilize the soil well

(PowerPoint Slide # 12)

B. A system which has no dominant primary root but is made of many primary and secondary roots of similar size is called a ***fibrous root system***.

(PowerPoint Slide # 13)

1. Advantages
    a. Shallower, thus respond more quickly to fertilization/irrigation
    b. Stabilize the soil better
2. Disadvantages
    c. Less drought resistant
    d. Tend to get exposed during cultivation

****Plants with both types of root systems can be shown to the students. You can bring in pictures of different plant roots. Have the students see if they can name the plant you are showing. Also have them classify the type of root system it has.**

Objective 4: Recognize a healthy root system.

(PowerPoint Slide # 14 and #15)

IV. Healthy root appearance and maintenance

A. A healthy root system is white or nearly white in color and smells fresh. If roots are black, brown, or dark orange and smell rotten or sour, the root system is having some problems. Although a plant growing outside has a majority of roots in only the top two feet of soil, a plant in a pot should have its roots evenly dispersed throughout the soil in the pot.

(PowerPoint Slide # 16)

B. Watering a plant properly is one of the most important ways to keep the root system healthy. Proper watering for most plants involves growing the plants in pots with proper drainage holes in the bottom of the pot. The pot is soaked with water until it is dripping out of the drainage holes. This encourages roots to grow through the entire pot. The plant's soil is usually allowed to dry slightly before watering again. If plants have adequate drainage, over-watering of plants is not a matter of *how much* water, but of *how often* watering occurs.

****To help the class understand the characteristics of a healthy root, you could do a demonstration. Get two plants of the same species. One will be over watered and the other will be watered correctly. Each class period, look at the roots. Have the students write down their observations in their notebooks. (Make sure to plant the plant specimen back when you are finished with the observations.) After a few days when you get the desired**

results, lead the class into discussion. Have them expand on the things that can be done to keep a root system healthy.

Objective 4: Recognize the economical importance of roots.

(PowerPoint Slide # 17)

V. Roots impact society in many different ways

A. The term root crops refers to any edible underground plant structure, but many root crops are actually stems, such as potato tubers.

B. Edible roots include cassava, sweet potato, beet, carrot, rutabaga, turnip, parsnip, radish, yam and horseradish. Spices obtained from roots include sassafras, angelica, sarsaparilla and licorice.

(PowerPoint Slide # 18)

1. Sugar beet is an important source of sugar. The fish poison and insecticide rotenone is obtained from roots of Lonchocarpus spp.
2. Important medicines from roots are ginseng, aconite, ipecac, gentian and reserpine.

(PowerPoint Slide # 19)

3. Several legumes that have nitrogen-fixing root nodules are used as green manure crops, which provide nitrogen fertilizer for other crops when plowed under.
4. Specialized bald cypress roots, termed knees, are sold as souvenirs, lamp bases and carved into folk art. Some people have used the flexible roots of white spruce for basketry.

(PowerPoint Slide # 20)

C. Vegetative propagation of plants via cuttings depends on adventitious root formation. Hundreds of millions of plants are propagated via cuttings annually including chrysanthemum, poinsettia, carnation, ornamental shrubs and many houseplants.

****Have students write down what they have eaten in the past two days. When they are complete have them label which foods were roots. Have the students share their answers.**

Review/Summary: Students will complete a lab to review the lesson. The teacher will need to break the students into groups. The number of people in each group will depend on how many plant specimens are available. Each student will go to their assigned plant. They will need to complete the lab using LS: B1-1. When they are finished, they can consult with their group members and compare their answers. If they disagree on their answers, they need to work as a group to come up with a common answer.

When all groups are finished, the oldest person in each group will share their answers to the entire class. When each group has presented, ask if there are any questions. Re-teach any information that the students are having trouble with.

There are also some review questions that can be used on PowerPoint slide #21 and #20

Application: Use LS: B1-1 to help students apply their knowledge of the objectives.

Evaluation: Evaluation should be based on student comprehension of the learning objectives. This can be determined using the attached sample written test.

Answers to Sample Test:

Part One: Matching

1. b
2. d
3. c
4. a

Part Two: Completion

primary root
taproot system
fibrous root system
secondary root

Part Three: Short Answer

1. a) Roots should be white.
   b) Roots should smell fresh.
   c) Roots should be evenly dispersed throughout soil.

2. a) Storage of food
   b) Absorption of water and minerals
   c) Anchorage and/or support of the plant

Sample Test Name_____

Test

Unit B Lesson 1: Understanding Root Anatomy

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. apical meristem
b. epidermis
c. root cap
d. root hair

_____ 1. Cells that make up the skin of the root.
_____ 2. These increase the surface area of the root.
_____ 3. This protects the tip of the root.
_____ 4. This is where new cells divide in the root.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. The first root to come out of a seed is called the _____.
2. A root system which has one large primary root and many secondary roots branching from that root is called a _____.
3. A root system in which all of the roots are about the same size is called a _____.
4. The root which branches off of a primary root is called a _____.

Part Three: Short Answer

Instructions. Provide information to answer the following questions.

1. Name three characteristics of a healthy root system.
   a.
   b.
   c.

2. Name three functions of roots.
   a.
   b.
   c.

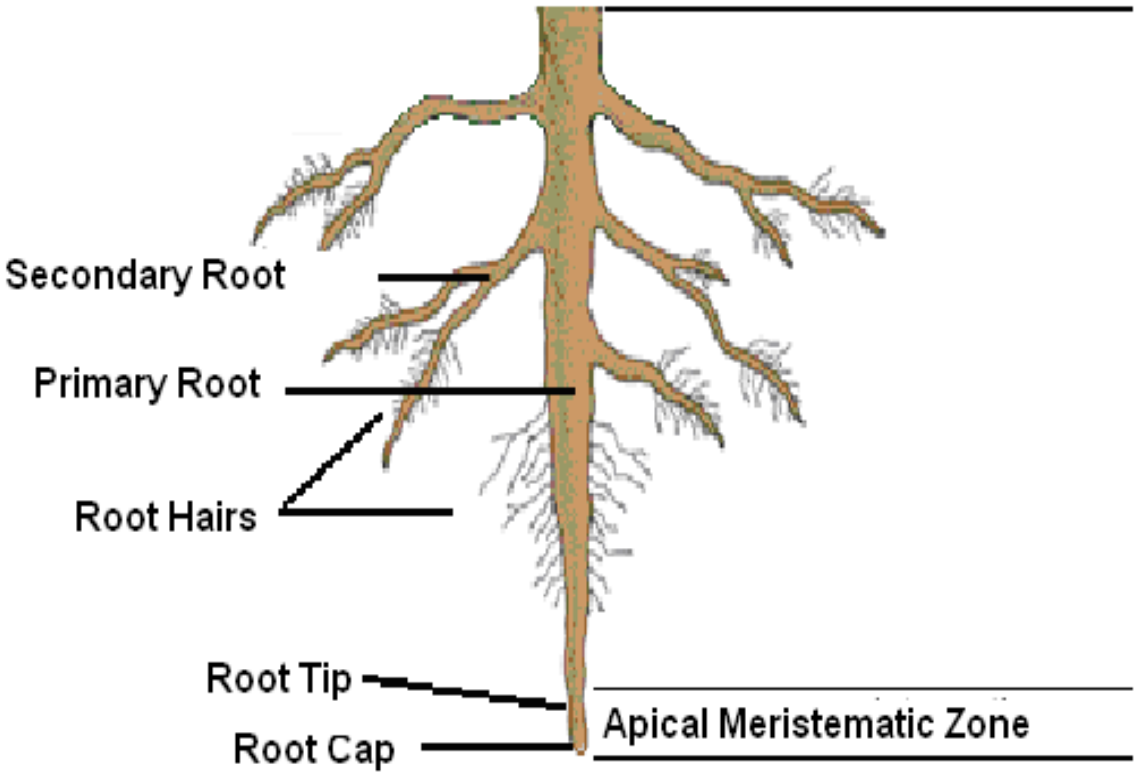
TM: B1-1

FUNCTION OF ROOTS

- **Absorption of Water and Minerals**
- **Anchor plant to the ground**
- **Storage of food**

TM: B1-2

Root Structure



LS: B1-1 Name_____

Lab Sheet

Materials needed:
A whole unwashed carrot
A whole washed carrot
A whole unpeeled carrot
A vertical section of a carrot
A horizontal section of a carrot
Other plant roots

Procedure:

1. On the next paper in the allotted space, observe each of these and record observations in detail.

2. Then, choose one of the other roots displayed in the classroom and fill in the diagram below that compare/contrast the characteristics of carrots and the other root. You will see two joining circles. On the left side you will record any observations that you notice about the carrot that your other plant does not have. In the middle (where the two circles meet) you will record any similarities of the two roots. On the right side you will record any observations that your plant root possesses that the carrot does not.

3. Draw both sets of roots and identify all the parts.

4. Answer the following question when all other steps are complete.

   What have students learned from dissecting a carrot?

Record observations here:

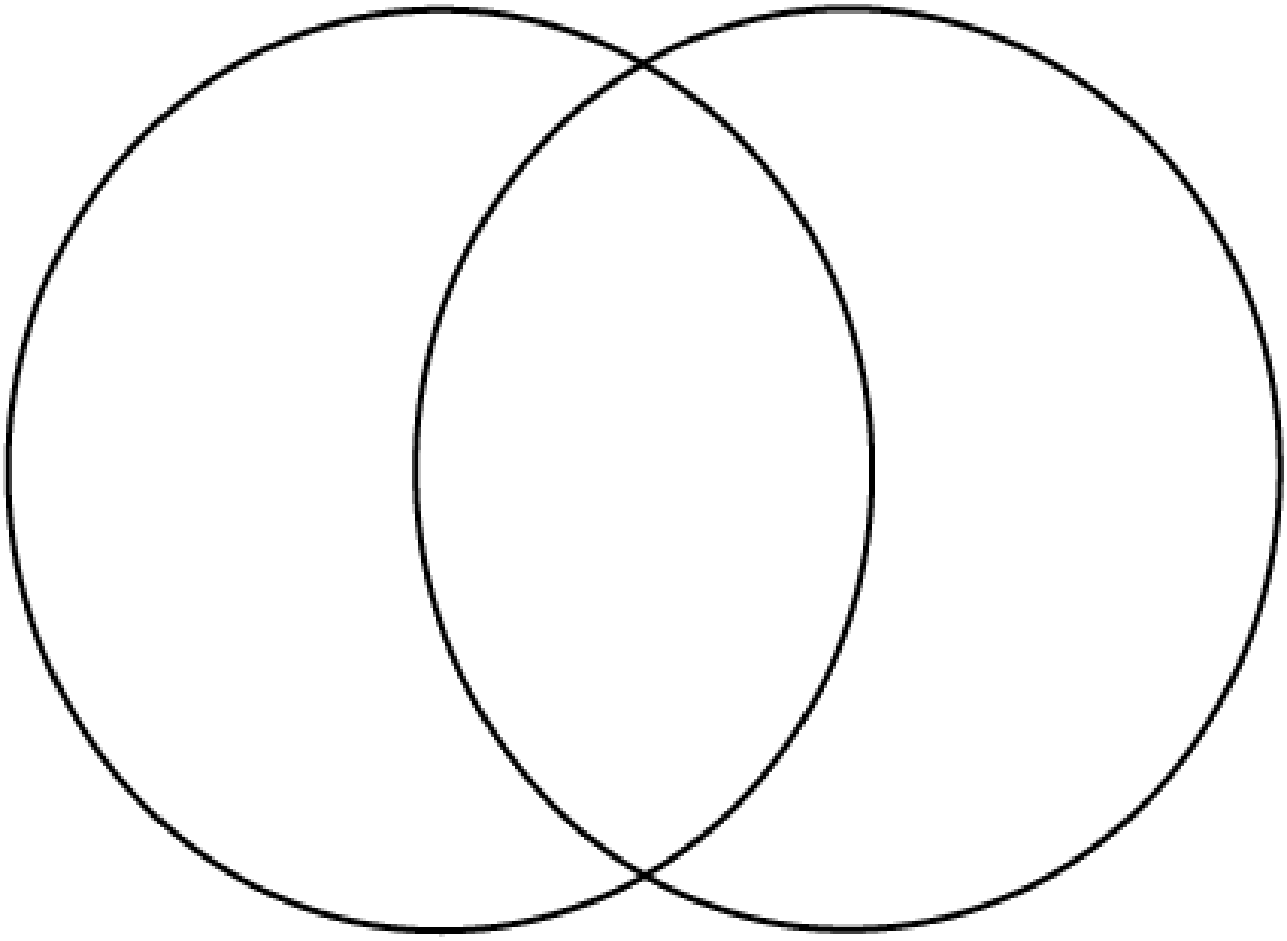
- A whole unwashed carrot:

- A whole washed carrot:

- A whole unpeeled carrot:

- A vertical section of a carrot:

- A horizontal section of a carrot:



Differences in the carrots root Similarities of both roots Differences in the other root

Draw carrot and label parts:

Draw that other plant that you chose and label parts. Place the name of the plant chosen on the line below.

_____