Plant Tissues & Roots

Laboratory 6

Introduction

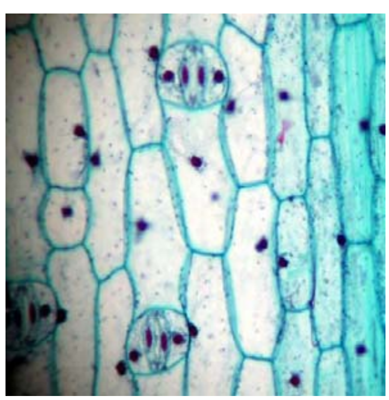
As living organisms, plants perform a variety of activities including photosynthesis, water transport, nutrient transport and storage. Therefore, to efficiently carry out each of these duties, different groups of cells have become specialized to perform a particular function. As similar cells work together to perform a specific function, they form **tissues**. A tissue system consists of one or more tissues organized into a functional unit connecting the organs of a plant. Each plant organ (roots, stems and leaves) has dermal, vascular and ground tissues. Plant tissues classified as **simple tissues** are composed of only one cell type and **complex tissues** are composed of two or more cell types.

STATION 1
Three Tissue Systems of Plants

Dermal Tissue

The **dermal tissue system**, which provides a protective covering over plant parts, is composed of two complex tissues: epidermis and periderm. The **epidermis** consists of **epidermal cells** and **guard cells** which cover herbaceous plant parts**.**. Epidermal cells are living, flattened, parenchyma cells that usually lack chloroplasts and function to protect the interior photosynthetic tissues. These cells are covered with a non-cellular, waxy cuticle that minimizes water loss from the plant. Guard cells, chloroplast-containing cells scattered throughout the epidermal layers regulate the opening and closing of the **stoma**. Periderm tissue forms the outer bark of woody plants and will be discussed later.

Observe the prepared slide of a leaf epidermis and compare with the micrograph below. Label the stoma, epidermal cells and guard cells.



Leaf Epidermis w/ Guard Cells

Vascular Tissue

Xylem and **phloem** are complex tissues designed for the transport of materials throughout the plant body. Xylem transports water and dissolved minerals from the roots throughout the plant body. As a complex tissue, it is composed of four cell types: vessel elements, tracheids, parenchyma cells and fibers. **Vessel elements**, non-living, barrel-like cells, and **tracheids**, non-living, tapered cells, are the actual water-conducting cells of xylem tissue. The parenchyma cells function in storage and the fibers function in support.

Phloem transports the carbohydrate products (sugars) of photosynthesis throughout the plant. Similar to xylem, phloem is composed of four cell types: sieve tube members, companion cells, parenchyma cells and fibers. **Sieve tube members**, considered as some of the most unique cells in nature, are long, enucleate (no nucleus), living cells responsible for the transport of food. **Companion cells**, smaller cells adjacent to sieve tube members, are living, nucleate cells that assist by loading and unloading sugars into and out of the sieve tube members. Parenchyma cells and fibers function as in the xylem, providing storage and structural support.

Ground Tissue

The ground tissue system forms the bulk of the plant body and includes **parenchyma tissue, collenchyma tissue** and **sclerenchyma tissue.** Parenchyma tissue is composed of living, metabolizing, thin-walled parenchyma cells that may function in storage, secretion or photosynthesis. Located throughout the plant body, parenchyma tissue is the most common tissue. Collenchyma tissue is composed of living, metabolizing collenchyma cells that have unevenly thickened primary cell walls. The thickened cell walls allow this tissue to offer flexible, structural support for the plant. Collenchyma tissue usually forms long strands near stem surfaces and along leaf veins. Sclerenchyma tissue is characterized by cells having both primary and secondary cell walls. The thickened secondary cell walls provide strength and mechanical support for the plant. Found throughout the plant body, sclerenchyma cells may be of two types. **Sclereids**, short, cubical cells, common in shells of nuts and in pits of stone fruits (cherries, peaches), and **fibers**, elongated, tapered cells, often occurring in clumps in stems (wood, inner bark) and some leaves.

A. Examine cells of parenchyma tissue.

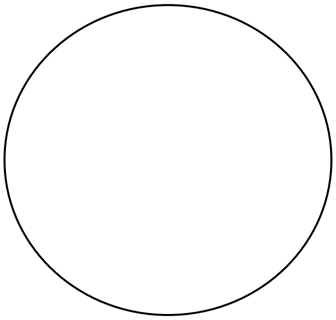
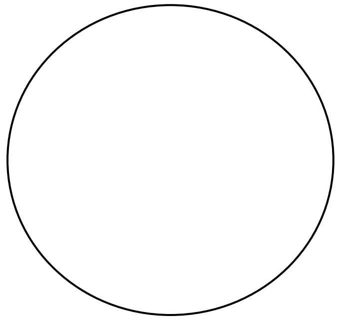
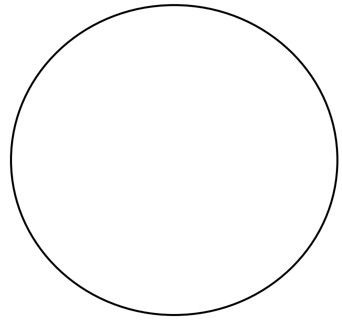
1) Remove the skin from the tomato. Using the razor blade, scrape some of the pulp and transfer to a slide.
2) Place a few drops of water on the tissue; add the coverslip.
3) Observe the tissue under the microscope and sketch a few of the cells.

B. Examine cells of collenchyma tissue.

1) Using the razor blade, cut a very thin section of a celery stalk.
2) Place the tissue on the slide with a few drops of water; add coverslip.
3) Observe the tissue under the microscope and sketch a few of the cells.

C. Examine sclereid cells of sclerenchyma tissue.

1) Remove the skin from the pear. Using a razor blade, scrape some of the pulp.
2) Place the tissue on a slide with a few drops of water; add coverslip.
3) Observe the tissue under the microscope and sketch a few of the cells.

Tomato	**Celery**	**Pear**
		
Parenchyma cells (high power)	**Collenchyma cells** (high power)	**Sclerenchyma cells** (high power)

Review Questions

1. Contrast a simple tissue with a complex tissue. Give an example of each.

2. Explain how the unevenly thickened primary cell walls of the collenchyma cells relate to the function of these cells.

3. Provide the function(s) for each of the cell/tissue types below:

   Parenchyma cells

   Sclerenchyma cells

   Xylem

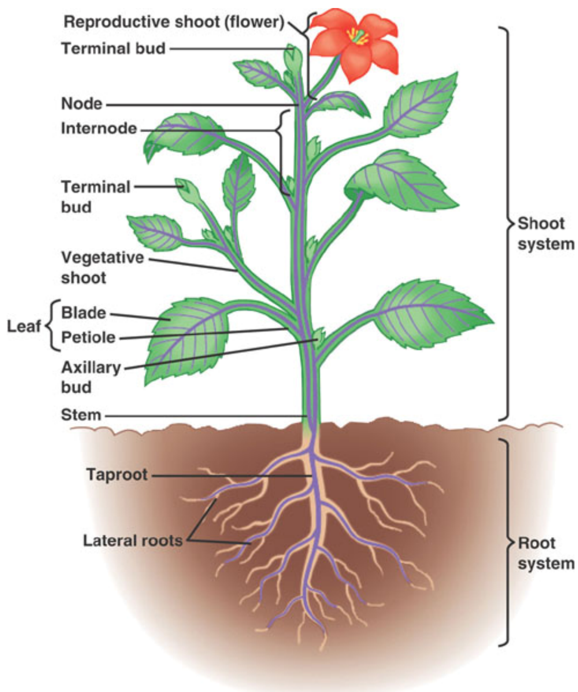
   Phloem

   Epidermis

STATION 2A
Introduction to Plant Organs
Roots & Zones of a Root Tip

Introduction to Plant Organs

The morphology of a plant reflects how these organisms must adapt to two different environments – one above-ground and the other below-ground. The evolutionary solution to this separation of resources was the development of three basic organs -- the root, the stem and the leaves. The plant body is divided into a root system and a shoot system (consisting of the stems and leaves). Each of these systems depends upon the other for accessing the resources within their respective environments.



Introduction to Roots

Roots are plant structures that typically grow underground and function to anchor the plant, store food, and absorb water and dissolved minerals from the soil. Roots also help to prevent soil erosion.

The first root that develops from the seed's embryo is termed the **primary root**. Additional roots that branch from the primary root are termed **secondary roots** or **lateral roots**. In addition, roots that develop from leaves or stems are termed **adventitious**.

Root Tip

As a young root grows, four areas are evident within the root tip. The **zone of cell division (an apical meristem)** is an area at the end of the root tip where cells are actively dividing. This area is covered by a protective layer of parenchyma cells called the **root cap**. The **region of elongation** is an area where cells increase in volume, lengthening the root. Immediately above the region of elongation is the **region of differentiation**, an area where cells mature into tissues and root hairs develop. **Root hairs** are extensions of epidermal cells designed to increase water absorption.

Observe model of young root tip. Identify root cap, zone of cell division, zone of elongation, zone of maturation, root hairs.

Zones of a Root Tip

Review Questions

1. What is the primary function of the shoot system?

2. What is the primary function of the root system?

3. Name the region that protects the zone of cell division (meristem).

4. What type of cell division occurs in the meristem – mitotic or meiotic?

5. What is the function of the root hairs?

STATION 2B
Root Tissues
Monocot vs. Eudicot Roots

Root Tissues

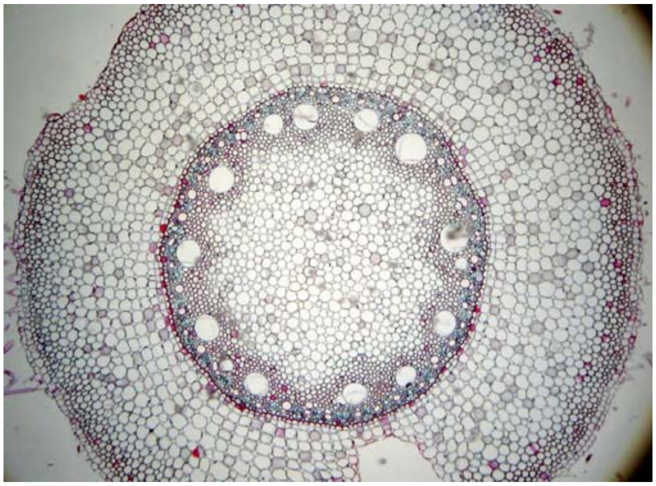
Primary roots possess epidermal, ground, and vascular tissues. The **epidermis** surrounds the **cortex**, an area of loosely spaced parenchyma cells adapted for starch storage. Interior to the cortex is a single layer of tightly packed cells called the **endodermis**. The endodermis forms a boundary between the cortex and the central core of the root known as the **stele**, or vascular cylinder. Endodermal cells produce a waxy layer called the Casparian strip that helps regulate movement of substances into and out of the stele. Just inside the endodermis is the **pericycle,** a layer of cells where secondary roots arise.

Monocot Roots

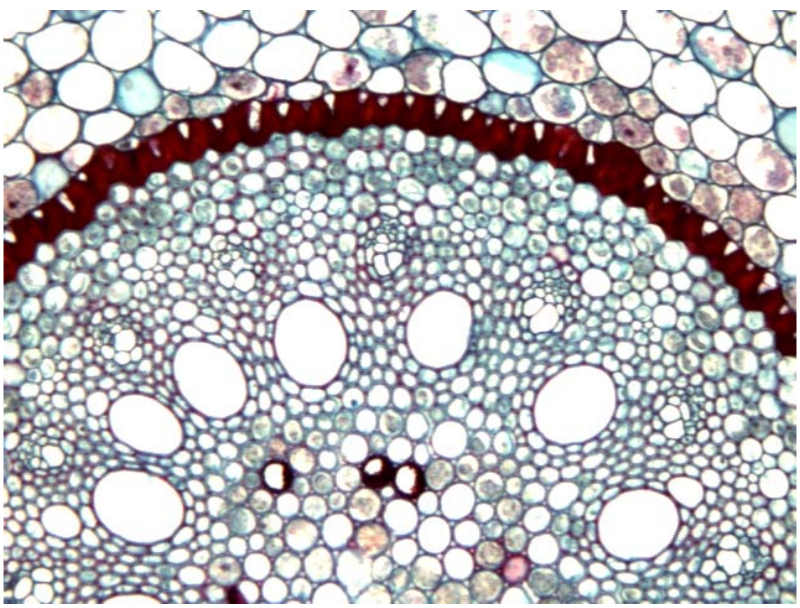
Monocot and dicot roots differ in tissue arrangement within the stele. In monocots, a **pith** is typically found in the center of the root. The pith, a collection of food-storing parenchyma cells, is surrounded by a ring of alternating bundles of **xylem** and **phloem**.

Examine the monocot root model. Be able to identify epidermis, root hairs, root cap, cortex, endodermis, pericycle, xylem, phloem, pith.

View the prepared slide of a monocot root and compare with the model. Label the micrographs below: epidermis, cortex, stele, endodermis, pericycle, xylem, phloem, pith



Monocot root cross section 40x

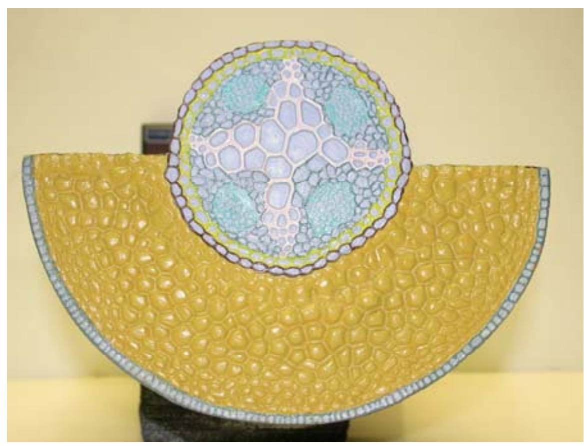


Monocot root stele cross section 100x

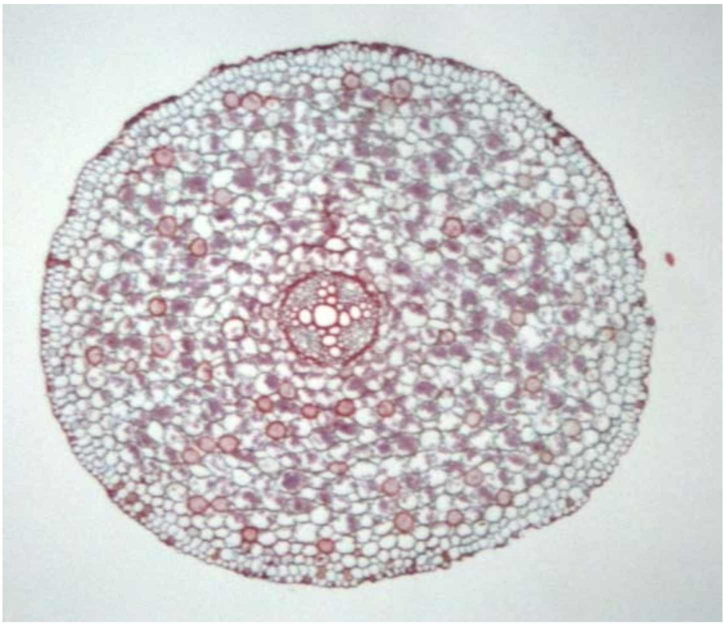
Eudicot Roots

In eudicot roots, the center of the stele is usually composed of a collection of **xylem** cells rather than a pith. The xylem is usually arranged in the shape of a cross or star, with bundles of **phloem** in between the arms of xylem tissue.

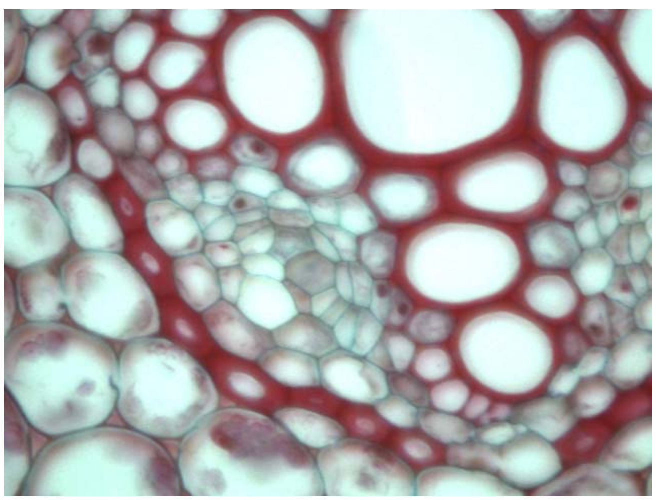
Examine the eudicot root slide with the eudicot root model. Be able to identify epidermis, cortex, root cap, root hairs, stele, endodermis, pericycle, xylem, phloem, pith



View the prepared slide of a eudicot root and compare with the model. Label the micrographs below: epidermis, cortex, stele, endodermis, pericycle, xylem, phloem, pith



Eudicot root cross section 40x



Eudicot root stele cross section 400x

Review Questions:

1. Explain how the center of a monocot root differs from that of a eudicot root.

2. What is the function of the cortex? What type of cells form the cortex?

3. Why is the endodermis important?

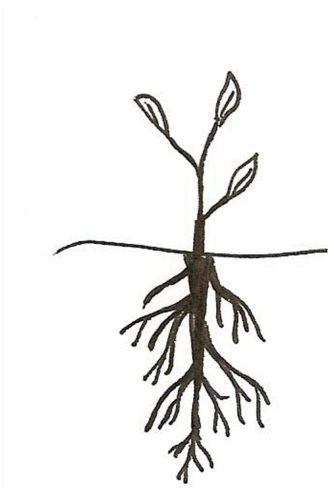
4. What is a casparian strip?

STATION 3
Root Systems & Root Modifications

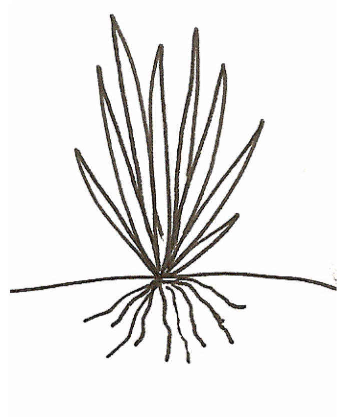
Root Systems

Plant root systems are described as taproot or fibrous. A **taproot system** has a large, central primary root with multiple smaller roots developing from it. Such taproot systems, typical of gymnosperms and eudicots, generally penetrate deeper into the soil than fibrous root systems. In monocots, the primary root dies and adventitious roots arise from the stem to form the **fibrous root system**. Unlike taproot systems, no one root is more prominent than the others in the fibrous root system.

Observe root specimens. Identify the examples of taproot and fibrous root systems.



Taproot System
(Eudicots)



Fibrous Root System
(Monocots)

Root Modifications

Many plants have modified roots that perform additional functions for the plant. While many root modifications do arise from root tissue, others are adventitious.

Observe the root modifications available. Note the function of each.

Prop roots

Prop roots are aerial, adventitious roots that develop from the stem and will eventually penetrate the soil to offer additional support to tall plants. Prop roots are common in corn and maize.

Storage roots

Some taproots are enlarged to store additional water and nutrients. Examples include sweet potatoes and carrots.

Pneumatophores

Mangroves and bald cypress trees have modified roots called pneumatophores that rise above the water line. These roots enable the plants to obtain oxygen in waterlogged soil.

Review Questions:

1. Consider the structure of tap roots vs. fibrous roots. Which root system is more likely to enable a plant to withstand drought conditions when surface moisture is not readily available? Why?

2. Why are fibrous roots considered adventitious roots?

3. Would a plant that has floral parts in three’s (e.g. 6 petals, 6 stamen) have tap roots or fibrous roots?