Primary Structure of the Stem

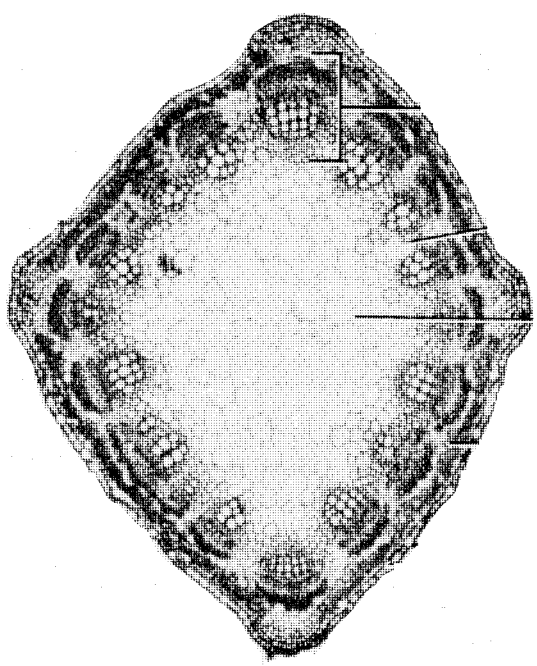
The stem has two principal functions: **support**, and **conduction** of nutrients and water. Substances manufactured in the leaves are transported through the phloem tissue of stems to regions of the plant which are growing, or to developing flowers, seeds, and fruits; or to storage regions of the plant. Much of the nutrient material is stored in parenchyma cells of roots, seeds, and fruits, but stems are also important storage organs. Water and dissolved minerals are transported from the roots to the leaves in the xylem of the stem. Leaves, the principal photosynthetic organs of the plant, are supported by the stems, which place them in positions favorable for absorption of light. Most dicots and all conifers have secondary growth, an expansion in girth as well as in length. Monocots lack true secondary growth, although some obtain large dimensions. While increase in length is accomplished by the meristems at growing tips of plants (which is primary growth), secondary growth is accomplished by a special meristem, called cambium. You will observe features of both primary and secondary growth in stems in this lab.

A Herbaceous Dicot Stem Structure

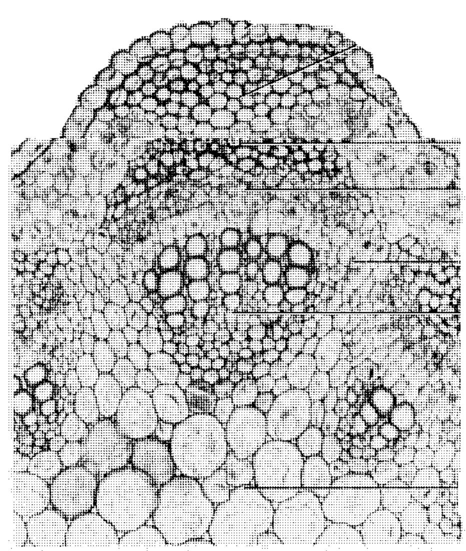
Observe the stem cross section of alfalfa or sunflower. On this slide you will be able to examine the primary plant body, although a little secondary growth may have occurred in some of the stem sections. Both alfalfa and sunflower are excellent examples of herbaceous dicotyledons with little secondary growth.

Identify the following tissues in your stem section:

- **Epidermis**
- **Cortex** region composed of collenchyma and parenchyma
- Primary **vascular bundles** with conspicuous primary **phloem** fibers and phloem to the outside of a cambium layer of cells, and **xylem** to the inside of the cambium
- **Pith**. Note the pith rays between the vascular bundles. Look for **cambium** cells moving into the pith rays in the alfalfa stem sections. This is the start of secondary growth which results in the familiar growth rings of wood.



Dicot Stem Cross Section



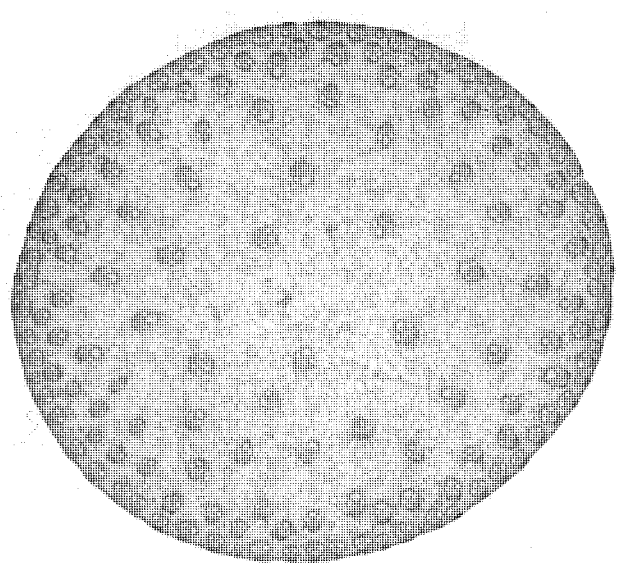
Dicot Stem Vascular Bundle

B. Monocot Stem Structure

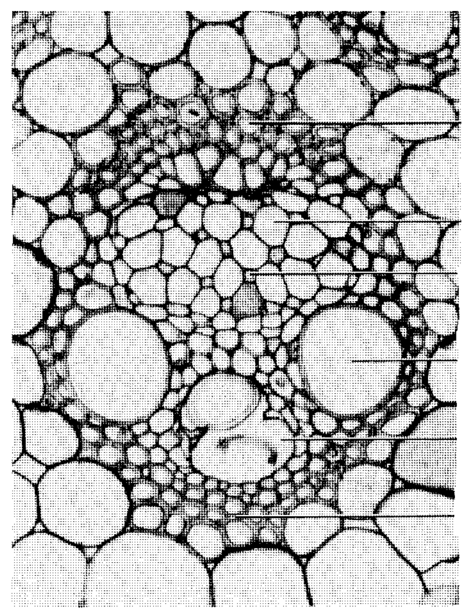
The corn (*Zea mays*) stem is an example of a stem whose vascular bundles are distributed throughout the ground tissue. The vascular bundles in corn are **closed**, that is, no cambium is produced for secondary growth. (Bundles in which cambium is formed are said to be **open**.)

Obtain a prepared slide containing a cross section of a corn stem. Examine the section under the microscope's scanning objective. Compare the distribution of the vascular bundles in the corn stem with that in the alfalfa stem. Switch to the high power objective and study an individual **vascular bundle,** which resembles a face with eyes and nose. Each vascular bundle, which is surrounded by a **bundle sheath** composed of thick-walled sclerenchyma cells, consists of phloem toward the outside and xylem toward the inside. The **phloem** consists of sieve-tubes and small, dense companion cells. The **xylem** consists of vessels with thick walls and much smaller parenchyma cells. Most of the vessels are intact, but some vessels have been stretched or destroyed during maturation of the stem. This destruction of vessels often results in the formation of a large air space (the "nose" of the "face").

The ground tissue of the corn stem cannot be distinguished as cortex and pith, since the vascular bundles are scattered throughout.



Monocot Stem Cross Section



Monocot Stem Vascular Bundle

Wood Structures and Secondary Growth

Woody plants - trees and shrubs - live for several or many years. Each year, new primary growth is resumed, and the plant increases in length at its growing tips. In addition, growth also increases the girth of the plant. This increase in girth is called **secondary growth** and results from activity of **cambium.** There are two types of cambium, **vascular cambium** and **cork cambium**. The vascular cambium produces the secondary vascular tissues - secondary xylem and secondary phloem. Cork cambium produces cork, a secondary surface tissue. Secondary growth structures are found in two regions: the bark, which consists of cork and phloem; and the wood, which consists of xylem. The vascular cambium separates the bark from the wood.

A. External Features of Twigs

Observe a twig provided. Note the terminal bud, protected by bud scales. Lateral buds will be located at nodes. Note the leaf scars beneath the lateral buds. Within the leaf scar you will see tiny vascular bundle scars.

Note assorted raised areas on the twig surface. These are **lenticels**, needed for gas exchange. Lenticels are a distinctive feature on some species of shrubs and trees.

The patterns of leaf scars, bud scale scars and lenticels can be used to identify different trees and shrubs. Bud scale scars can also be used to age twigs.

B. Internal Structure of a Woody Stem

Examine a prepared slide of *Tilia.* Look for the annual rings of xylem. How old is your section? The primary pith will be compressed in the center of the section. Locate the vascular cambium. Note how fibers and phloem alternate in the inner bark. In young sections, the cork and phloem are distinct from each other. As stems age, and bark is sloughed off, phloem and cork become intermixed. In between patches of phloem are triangular groups of parenchyma cells. They are dilated phloem rays. Rays are also present in the xylem. What is the function of rays?

C. Wood Features

Before leaving your observations of plant structures you might be interested in looking at some features of wood and the cellular origin of these patterns.

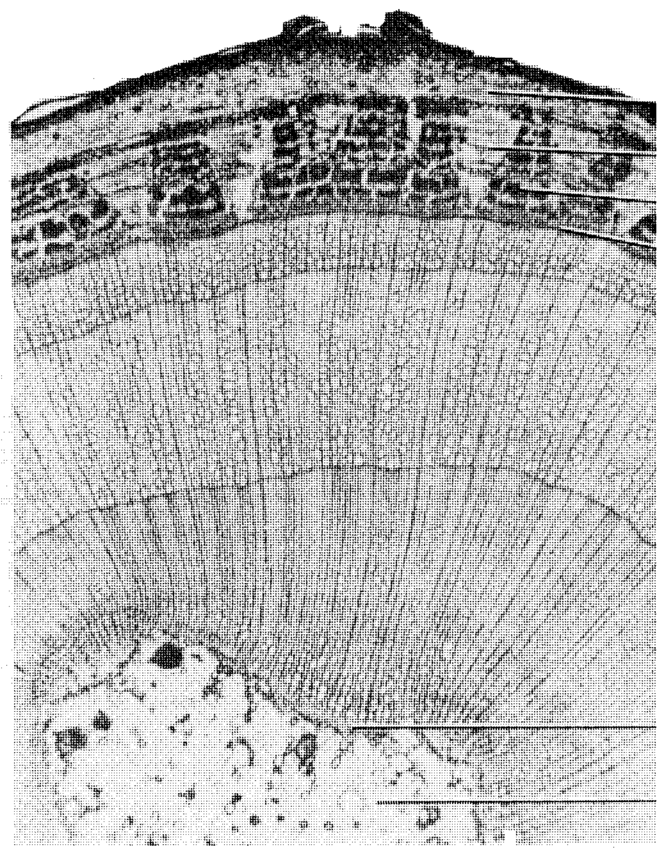
1. Superficial Features of Wood

Examine a wood block provided that has been cut to reveal **transverse, radial,** and **tangential surfaces**. Radial and tangential sections are **longitudinal sections**, that is, sections cut parallel to the long axis of the stem. These two sections differ from one another with regard to the orientation of rays. Radial sections are cut more or less parallel to the rays; tangential sections are cut at right angles to the rays. Find the **rays**, which can be seen with the unaided eye, and identify the three types of sections in the wood block.

Identify the annual rings in transverse and radial sections. Such features add variety to the appearance of wood in furniture. The difference in growth rate in spring and summer forms the characteristic rings of wood. Some tropical woods lack distinctive growth rings. Why might this be?

Examine blocks of a conifer wood, such as pine or Douglas fir, and note the absence of vessels in the wood. (Why?) Identify growth rings and early and late wood within each of the rings. The porelike structures in the late wood are **resin ducts**. The rays in the conifer block are often too narrow to be seen.

Examine the wood furniture and woodwork in the laboratory and identify the orientation of the rays and the growth rings. Note that much furniture makes use of veneers - wood strips that have been "peeled" rather than sectioned, so that wood patterns are repeated many times.



Young Woody Stem Cross Section

2. Microscope Examination of Wood Sections

a. *Taxodium* wood (xrt)

Obtain a prepared slide of *Taxodium* wood containing transverse, radial, and tangential sections (xrt). Examine the slide with low power and identify all three sections. Compare these with similar surfaces of the wood blocks available. *Taxodium* is a conifer. Its wood contains only tracheids, no vessels. Observe the scattered resin ducts, prominent in the transverse section.

b. Angiosperm wood (xrt)

Now observe an Angiosperm "xrt" section such as *Quercus*, *Acer* or *Tilia* and compare the angiosperm wood, with its many vessels and fibers with the conifer wood. Angiosperms do not have resin canals.