XI. Magnoliophyta: The Flowering Plants

We come in the end to the largest of all vascular plant groups, the flowering plants. There are about 250 – 350,000 of them in about 460families and 40 orders. Three features of flowering plants set them apart from all of the other vascular plants: 1) a folded and sealed leaf called the *carpel*, which encloses the ovules; 2) a highly reduced female gametophyte, of just eight nuclei in seven cells; and 3) *double fertilization*, that is the fusion of one sperm with an egg and a second sperm with a neighboring cell of the female gametophyte to yield a nutritive tissue called the endosperm.

Part 1 (to be completed today in lab, April 25, 2023)

A. Apical Meristems

Angiosperms share an unusual kind of meristem with the Gnetophyta (a group we will mention in lecture, but which won't be examined in lab). This meristem, called the tunica-corpus meristem, is well known to biology students because it figures prominently in introductory biology. However, not many divisions of vascular plants have this type of meristem.

1. Examine the prepared slides of *Coleus* apical meristems available in the lab. The tunica and corpus are visible at the very summit of the stem (the apical dome), along with the leaf primordia (mounds of tissue destined to be leaves and buds) and leaf traces developing below each one.

*S1. Sketch a *Coleus* shoot from the prepared slide. Label the terms highlighted above.

B. Angiosperm Stem Anatomy

The angiosperm stem has a variable and confusing anatomy, but a there are a few basic features that most have in common.

1. Look at prepared slides of alfalfa (genus *Medicago*, Fabaceae). Under low power, look for the ring of vascular bundles surrounding a large pith and surrounded by a narrow cortex.

2. Now look closely at the ring under medium power. What you should be able to pick out is

a group of vascular bundles disrupted by secondary tissue produced by a vascular cambium.

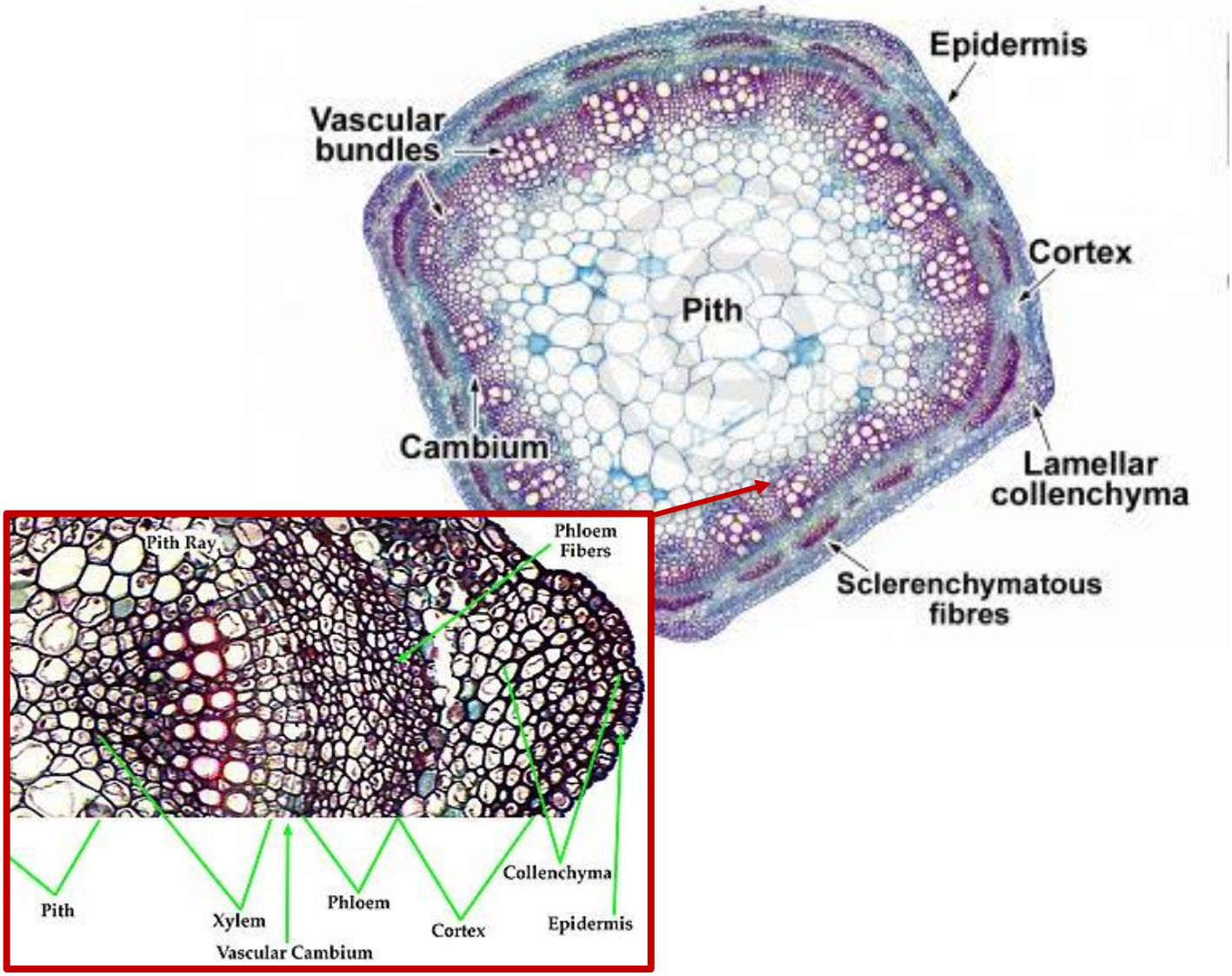
Look for the following critical features:

a. the vessel elements of the xylem, with thick, red-stained secondary walls

b. the sieve tube elements of the phloem, located to the outside of the xylem.

c. to the outside of the sieve tube elements, look for a mass of phloem fibers
These have lime-green or reddish staining walls and are irregular in shape and arrangement.

*S2. Sketch the stem transverse section and of a single vascular bundle in detail. Label the features highlighted above.



D. The Structure of Angiosperm Wood

Wood structure varies quite a bit from family to family among the angiosperms; here we examine the structure of maple (*Acer*) wood by studying prepared slides. See Fig. 2 for examples of tracheary elements of various woods.

First, identify the three kinds of sections: transverse, radial, and tangential. Remember, all cells in the transverse section are more or less round. In the radial section the tracheary elements appear long vertically and the parenchyma rays look like brick walls.

1. In transverse sections, notice that there are large vessel elements distributed randomly through the wood. The remaining cells are either very thick-walled fibers or parenchyma

2. In radial section, study the vessel elements to see how they fit together into vessels. Remember, the places where the primary wall is missing are called perforations. The fibers in this section have just a few very narrow pits. Radial rows of parenchyma cells are also visible - these are called vascular rays.

*S3. Sketch a transverse section of the maple wood in all three sections. Identify the terms highlighted above in each section.

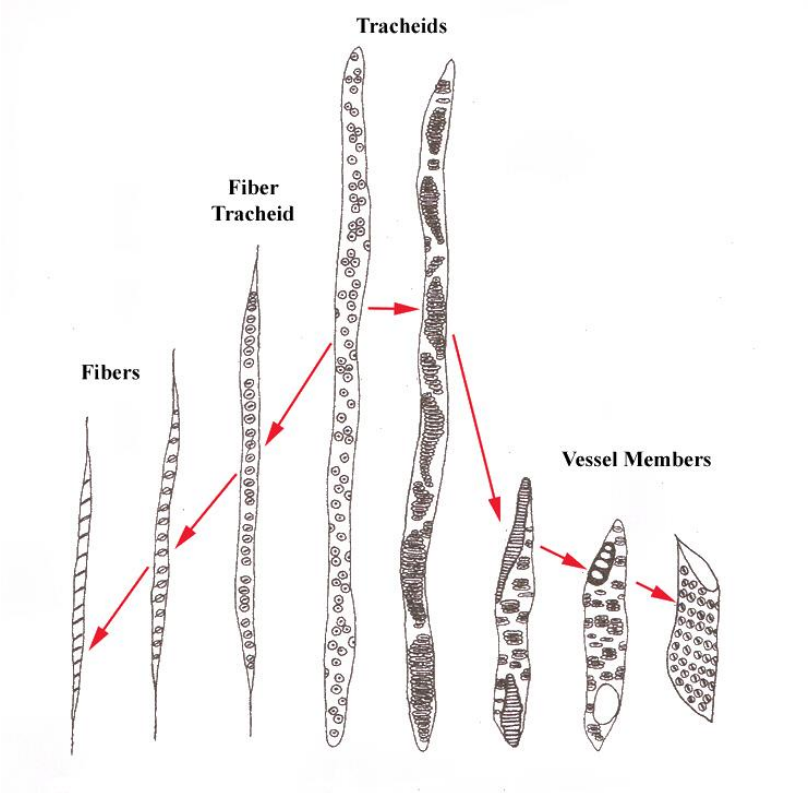


Fig. 2 Evolutionary trends of tracheary elements and fibers. Primitive long tracheids; , vessel element with scalariform perforation plate; vessel elements with simple performation plate.

E. The Angiosperm Strobilus

The most familiar feature of angiosperms is the flower. Everybody thinks of flowers as showy structures that attract bees and hummingbirds, but in fact they are extremely diverse in form and function. Many, such as the flowers of grasses and birch trees, are not showy at all. Morphologists agree that, in terms of homology, flowers are strobili, but there are two major schools of thought as to the exact homology of the flower:

1. The flower is a *simple* strobilus made up of leaf homologs. The lower leaves of the strobilus (the sepals and petals) are without sporangia; the upper leaves bear microsporangia (stamens), and above these, integumented megasporangia (ovules) in folded leaves called *carpels*.

2. The flower is a *compound* strobilus. There are leaves below, but the stamens are branch systems, not leaves: microsporangia are borne directly on the ends of stems. The megasporangia are interpreted in the same way as in theory 1.

We will not be able to see enough kinds of angiosperm flowers to understand and make a choice between these two opinions, but at least you can have the two ideas in mind as you look

1. Begin by reviewing basic flower structure with a dissection of *Tradescantia*. Pick a flower or group of flowers from the plant in lab and use a probe to dissect one under the dissecting microscope.

You should see:

a. Most prominent: a whorl of bright purple **petals** that function in the attraction of pollinators.

b. Lowermost: a whorl of small, green **sepals** that functioned in protecting the buds (look for the sepals on the buds of *Tradescantia* flowers on the plant). These sepals also function to support the open petals. Petals and sepals together are called the **perianth**.

c. Just inside the petals: a whorl of six **stamens**. In the flowering plants stamens are made up of two parts, a stalk (called the **filament**) and a synangium (called the **anther**), usually of four connate sporangia. The filaments of *Tradescantia* have long, delicate hairs - you can see cytoplasmic streaming in these hairs if you mount one of your filaments on a slide and look at it under the microscope. Be sure to check to see that your *Tradescantia* stamens have four sporangia per synangium.

d. In the center of the flower is the **pistil**. Three distinct regions of the pistil can be recognized: the broadest part (at the base) is the **ovary**, which is where the ovules are located. Above the ovary is the slender **style**, and at the tip of the style is the stigma. In *Tradescantia* the **stigma** has a beaded appearance under the dissecting 'scope.

2. Perianth Transformations
Now for contrast, examine a flower of *Lamium* (Lamiaceae). Look for two kinds of fusion: connation (fusion of like parts) and adnation (fusion of unlike parts). Describe the symmetry of the flower.

*S4. Sketch a flower of *Tradescantia* and *Lamium* in detail. Label the terms highlighted above in each.

Part 2 to be completed… in the field, May 2, 2023!

In part 2, we continue the introduction to flowering plants that we began last week. It's designed to be completed during the trip to Niquette Bay State Park.

Instructions for S5 & S6: Find, dissect, and draw a monocot flower and a eudicot flower.

Monocots usually have parallel leaf venation, and their flowers have parts in threes or multiples of three (e.g. 3 petals, 3 sepals, 6 stamens). Additionally, they often have a perianth of tepals, in which the petals and sepals are indistinguishable except on the basis of their position.

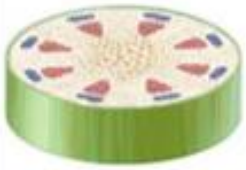
In contrast, eudicot leaves have anastomosing (reticulate) venation, and their flowers have parts in fours, fives, or multiples of these numbers (e.g. 5 petals, 5 sepals, 10 stamens). See the figure on the last page.

For each flower:

1. Start by drawing the flower overall. Experiment with what perspective yields the most interesting and informative view of the floral morphology. Include at least a portion of each whorl (calyx, corolla, androecium, and gynoecium) as it is visible in the intact flower. Label each whorl.

2. Describe the flower. Does it have radial or bilateral symmetry? How many parts make up each whorl? Is there adnation (fusion of unlike parts) or connation (fusion of like parts) or both?

3. Dissect the flower. Using a sharp knife or a razor blade, make a longitudinal section down through the pistil. Draw the flower in this view, paying particular attention to the pistil; label the ovary, ovules, receptacle, style, and stigma. Also distinguish the different parts of the stamens; label a filament and anther within an individual stamen. Likewise, label an individual petal and sepal (or tepal, if that is how your flower is constructed).

	Seed	Root	Stem	Leaf	Flower
Monocots	 One cotyledon in seed	 Root xylem and phloem in a ring	 Vascular bundles scattered in stem	 Leaf veins form a parallel pattern	 Flower parts in threes and multiples of three
Eudicots	 wo cotyledons in seed	 Root phloem between arms of xylem	 Vascular bundles in a distinct ring	 Leaf veins form a net pattern	 Flower parts in fours or fives and their multiples