

Feb 22: 1° Tissues II: leaves part 2; roots

Partial review of last week's lecture. Note, however: 1) the new/expanded information for collenchyma and sclerenchyma, below (reviewed briefly in today's lecture), and; 2) It is highly unlikely that I will ask explicit questions about parenchyma and collenchyma, but you'll encounter these terms in texts/online so I include them in the course them for your edification.

Recall that plant structure is organized at 3 levels:



I. Organs (for now):

- 1) Leaves
- 2) Roots
- 3) Stems

II. Tissues: (only 1° tissues have been discussed so far; remember - 2° tissue is wood and bark)

- 1) epidermis (includes: trichomes, stomata, cuticle)
- 2) vascular tissue (xylem, phloem)
- 3) ground tissue

III. Cells: Three types, defined by cell wall thickness. Here is a brief overview of each, and where they are found in leaves.

1) Parenchyma – cells with thin primary walls.

- Ubiquitous, and by far, the most common cell type in plant 1° tissues
- Highly diverse in form and function (we'll study many in labs throughout the semester)
- Examples in leaves (from last lecture): palisade parenchyma, spongy parenchyma, epidermis, phloem, xylem (as we will learn, xylem can also exist as sclerenchyma cells when it develops a 2° cell wall (in wood) – we'll get to that next week when we explore 2° tissues!)

2) Collenchyma – cells with thickened primary cell walls.

- Relatively rare - a low percentage of plant calls are collenchyma.
- Used to provide structural support in leaves and herbaceous stems – mostly absent in roots!
- "Plastic": Can be deformed and maintain a new shape. Critical for leaves and the tips of herbaceous stems that must change shape as they grow
- Examples in leaves: small bundles that provide support in herbaceous leaves/stems.

3) Sclerenchyma – thick secondary cell wall (and of course, the primary cell wall remains present)

A) Conducting sclerenchyma: xylem. We will discuss in great detail in a later lab and lecture!!

B) Non-conducting sclerenchyma

1) Fibers – long and elastic

- Elastic: Can be deformed, but they return to their original shape
- Present in tissues where growth is completed, and used to maintain "final shape" of tissue/organ but provide flexible support for organs/tissues to bend in the wind etc.
- Examples in leaves: sclerophylls such as *Yucca*.

2) Sclereids – cuboidal and brittle (do not bend)

- Resist deformation – used at protective tissue to resist any deformation – like a "helmet"
- Not in leaves – examples include walnut 'shells', pits of stone fruits (cherry, peaches, etc).
- Present in fruit of pears (the "gritty" texture when one bites into a pear) and visible under microscope (we'll see these in lab when we examine fruits).

LEAVES PART 2

After a brief review of last week's lecture about plant cell types (parenchyma, collenchyma, and sclerenchyma – see the information box above), leaf adaptations, and specialized leaves, we continued our discussion of specialized leaves. We focused on cotyledons and the leaves of carnivorous plants.

Cotyledons

Cotyledons (AKA, *seed leaves*) are leaves or leaf-like structures that are part of the embryo, emerge at germination, and that store nutrients (in dicots and gymnosperms) or transfer nutrients (monocots) for the embryo (the seed contains the embryo, which is what grows into an adult plant).

Flowering plants are divided into two groups: dicots (two cotyledons emerge at germination) and monocots (a single leaf emerges at germination). Monocots and dicots have many important structural differences that we will explore throughout the semester. We started a monocot vs. dicot "scorecard" in lecture. It appears in these notes in the *ROOTS* section, below. The distinction between monocots and dicots is an important one for all fields of botany, including (but not limited to) plant identification, agriculture, horticulture, landscaping, and gardening.

Carnivorous plants

We explored the structure and function of three types of carnivorous plants (listed below). We then watched a video on the subject {*PLOP "Growing" 30:55-38:30*}

In our exploration of these three plant types, we emphasized how the leaf blade and trichomes are adapted to capture insects (or larger prey!) and thus increase a plant's survival and reproduction. You should be able to describe the form and function of the leaf blades and trichomes for each plant. I am making a conscious decision to not include many of the detailed drawings we made in lecture – this is the purpose of meeting in lecture and talking about these concepts!

- 1) Venus' Flytrap (e.g., *Dionaea muscipula*): trichomes act as triggers that causes two modified leaves to close upon each other. Recall our conversation about this, and that two forces drive the rapid closing of the leaves:
 - a) the release of solutes into the leaf blade, and subsequent osmosis that causes changes to cell turgor and size (exactly how this happens is not completely understood). These changes to cell size in turn causes initial deformation of the leaf blade.
 - b) rapid and drastic change in leaf blade shape (from convex to concave) due to the transition of the leaf blade from one mechanical stable state (convex) to the other (concave). If you missed lecture, have a classmate walk you through this.

We spent considerable time discussing and elucidating this trapping mechanism. On any upcoming assessments, you should be able to label the axes of the graph we drew on the board (including a drawing of the leaf blades open (convex) and concave (closed) along the y-axis), list what happens in Phases I, II, and III of leaf closing, plot the change in leaf blade curvature as a function of time (time is the x-axis), and know how long each Phase lasts.

(Carnivorous plants, cont...)

- 2) Pitcher plants (e.g., *Darlingtonia californica*). Leaf blade is modified into a hollow tube, trichomes point downwards and make the interior of the plant “slippery” and difficult to escape. What other adaptations are present on the leaf blade and at the base of the inside of the plant? How do the plants digest animals, anyways...?
- 3) Sundews (e.g., *Drosera capensis*, *D. rotundifolia* – trichomes have glands that exude a sweet and sticky substance that attracts then traps prey. It’s all osmosis from there...as the leaf blade curls to surround the prey item.

ROOTS

The basics:

Root: organ (typically underground) that anchors the plant in place, and absorbs water and nutrients. In plants, there are two types of root systems, plants with a taproot and plants with fibrous roots:

Radicle: the embryonic root in a seed plant

Taproot: A large central root derived from the radicle, from which other roots branch off (**lateral roots**).

Fibrous roots: A mass of similar sized roots, each arising directly from the stem, none derived from radicle. Fibrous roots are found in ferns, monocots, and some dicots. All other plants have taproots (mosses have no true roots – we’ll get to them in a few weeks!).

Adventitious root: Root arising from non-root tissue (stem, leaf, node).

We’ll explore additional and interesting concepts about root structure and function in lab next week. It is possible that a portion of the material covered in lab will appear on the next Midterm, but it will not be on any in-class quizzes prior to Midterm #2.

Monocots vs. dicots:

Before we proceed with our examination of roots, we should take this opportunity to establish a few of the many differences between two large groups of plants: monocotyledons (‘monocots’) vs. dicotyledons (‘dicots’). All species of flowering plants fall into one of two groups: monocotyledons (‘monocots’) vs. dicotyledons (‘dicots’). So far this semester, we have discussed leaves and roots, so here is a list of how leaf and root structures vary in these two groups of plants (we’ll expand this list as the semester progresses):

Monocotyledons (‘monocots’, ~60,000 spp.)	Dicotyledons (‘dicots’, ~200,000 spp.)
One seed leaf (seed leaf = “cotyledon”)	Two seed leaves (seed leaf = “cotyledon”)
Leaf venation: parallel	Leaf venation: not parallel (pinnate, palmate, etc.)
Leaf shape: long and “strap-like” (e.g., corn, most orchids)	Leaf shape: variable but not long and “strap-like” (e.g., <i>Quercus</i> spp., <i>Ceanothus</i> spp., all the species we have and will press in lab)
Root system: fibrous roots (typically)	Root system: taproot with lateral roots (typically)

Specialized roots

Storage roots – store starch for future use. (Ex: carrot, radish, sweet potato).

Aerial roots – Roots above the ground, typically adventitious. Many types. Example emphasized was orchids. Most orchids are **epiphytic** because they grow on other plants (epi, “on” + phyte “plant”), the host is usually a tree. Orchid roots have a **velamen** – white sheath for sequestering H₂O and protecting roots.

Prop roots (aka stilt roots) – type of aerial root used for structural support. Grow downwards from stem tissue, when they contact ground they conduct water up into the plant. [Ex: corn (*Zea mays*), banyan (*Ficus benghalensis*)]. Common in tropical trees b/c tropical soil is often shallow.

Buttress roots – Plate-like roots that provide support. As with prop roots, common in tropical trees that grow in shallow soil. (*FYI: some classify buttress roots as types of prop roots...you need not distinguish*).

Pneumatophores – semi-hollow root projections that protrude upwards from roots and enhance access to O₂. Common in trees that grow in submerged soils where O₂ levels are low [mangroves, bald cypress swamps (*Taxodium distichum*)]. *Remind me...why do the roots require O₂?* Interestingly, recent research indicated that the “knees” (pneumatophores) of bald cypress trees do not increase O₂ delivery to roots. What then, is their purpose? That is unknown for the time-being., but alternative hypotheses focus on increasing structural stability in the muddy/swampy soils in which they are found.