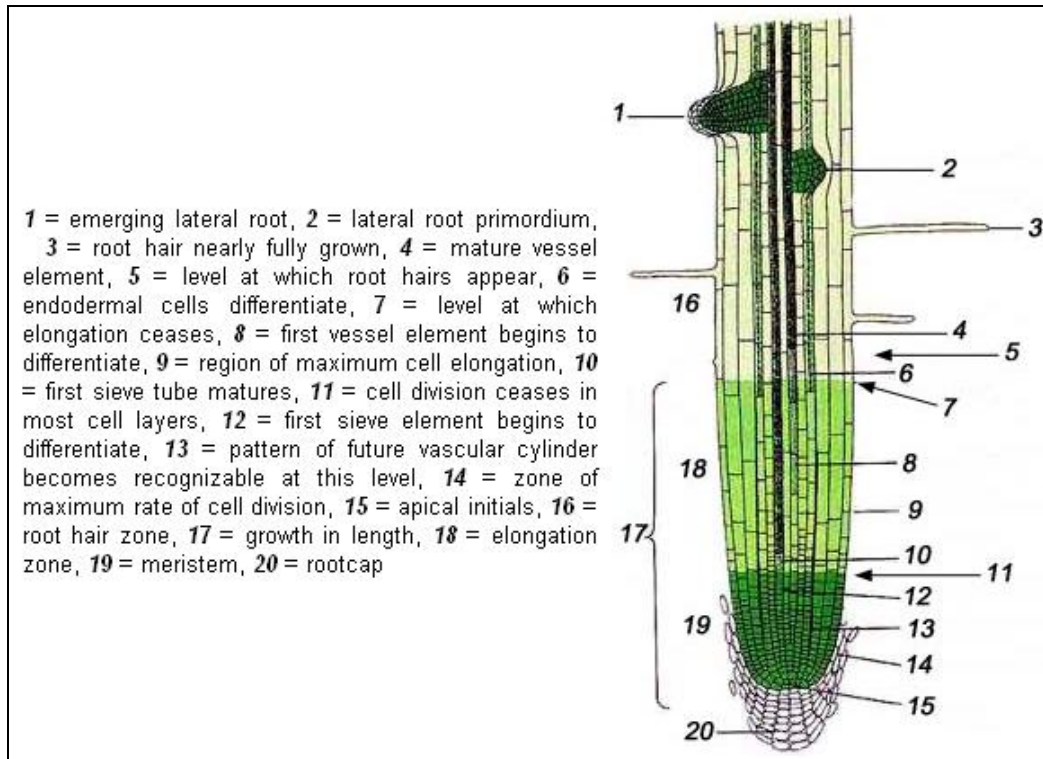


Plant Anatomy Lab 4 - Roots I

This lab and part II next week are concerned with the anatomical structure of roots. We will be considering roots from dicot (this week) and monocot (next week) flowering plants. Focus your attention on the various tissues and cell types in the root, where they are found in the root, and how these tissues develop as the root grows. Consult your text for pictures of roots or see the books in the lab. Also see your text glossary if you run across unfamiliar terms in the material below.



Roots I - Roots of the pea plant (*Pisum sativum*; a dicot)

Seeds of peas have been germinated and grown in the flat at the back of the lab. They were planted about 5 days ago. Obtain a couple of seedlings from the flat. Be sure to extract them carefully, so that the root and the root hairs or branches are not damaged. Roots do not have a waxy cuticle and will dry out rapidly, so keep them in water.

Sectioning: Using a fresh, sharp razor blade, we will be making transverse sections through the root at several points along it starting near the tip. We want to examine the root at 4 or 5 points; make sections about every centimeter or less depending on the available length of the root (if the roots are short, make sections closer together). The tissue is not very rigid, but will cut very easily. At each point, cut at least six sections. Your ability to see clearly will strong depend on how thin you manage to cut the sections. Practice on an extra seedling if you'd like.

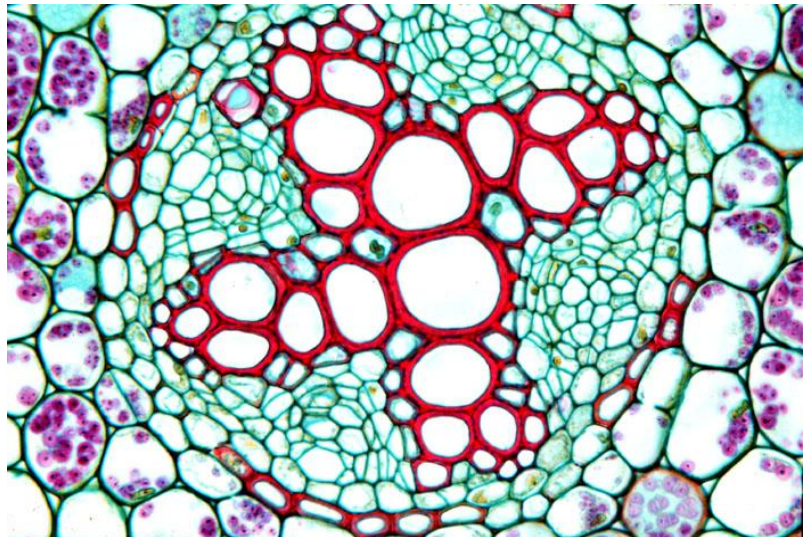
Staining: The vascular tissue will show up very well if stained with toluidine blue. Work with only one set of sections at a time. Place your sections in a milliliter or so of stain in a watch glass. Let them stain for a minute or two. Then rinse the sections by transferring them to another watch glass containing water. You can use a dissecting needle to transfer sections - picking them up with forceps will damage the cells. Mount the sections in water on a slide with a cover slip. If you have a thin section, the walls of the xylem and phloem cells will stand out dramatically (medium blue, not purple).

Observations:

1) Note the root hairs at the epidermis. They are usually found at some distance from the root tip and may occur along the remainder of the root for these young seedlings. Look at them closely and see how they are epidermal cell extensions - there is no cell wall between the epidermal cell and the root hair. Think about how much these hairs must be increasing the root surface area.

2) Look for starch grains in the parenchyma cells of various tissues (remember the iodine test, if you want to make sure). Do they occur in the cortex? Make sure you know where these tissues are located.

3) Observe the vascular tissues. Most roots are either triarch or tetrarch with respect to the number of xylem poles. Which is pea? Compare the xylem with pictures in lab and note which cells are protoxylem and which are metaxylem. Is this xylem developmental pattern exarch or endarch? For sections close to the root tip, you will see only a few protoxylem and perhaps no metaxylem. Metaxylem cell numbers should increase with distance from the root tip. Which cells are wider? Which would conduct water with less resistance?

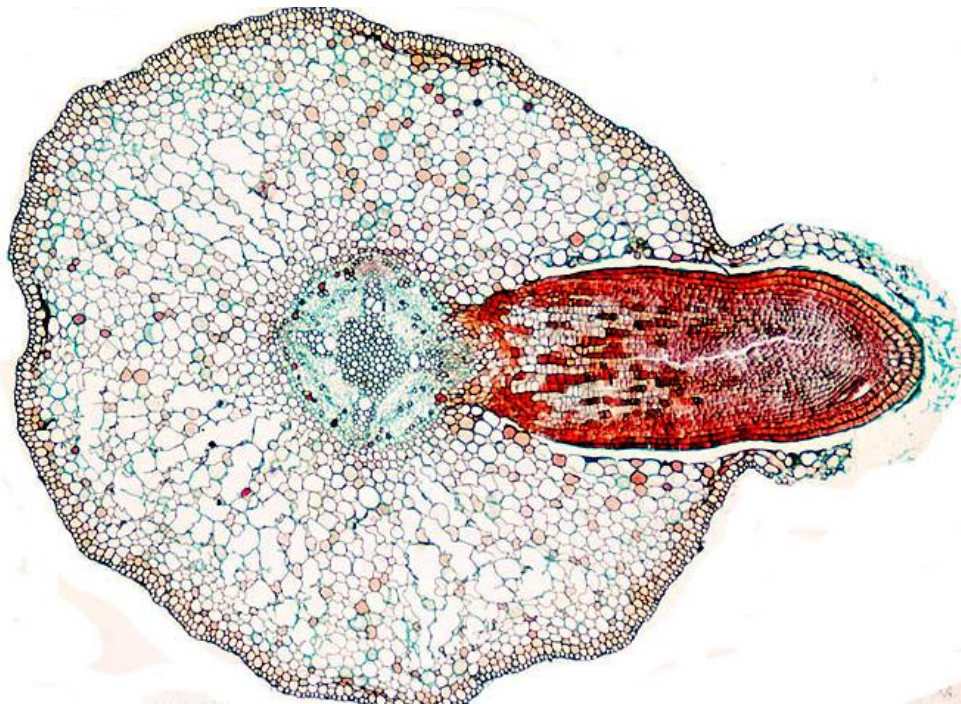


Central region of a buttercup (*Ranunculus*) root, showing the tetrarch xylem, phloem, and early endodermis development. A vascular cambium is just starting to form between the xylem and phloem. Notice the starch grains in the parenchyma cells of the cortex.

Also observe the phloem cells. Near the root tip they will be protophloem. Their numbers should increase somewhat with distance from the root tip. Where are they located with respect to the xylem poles?

4) Look for the start of endodermis (not the same as “epidermis”) development. Near the root tip, it is not clear that an endodermis is present. Among your last sections (furthest from the root tip), you should start to see elongated cells outside the phloem. Do the walls appear to be thickening, especially on the radial cell faces? Look at the pictures in the text and note how the endodermis initially has gaps near the xylem poles. When you first start seeing these endodermal cells (as you work back further from the root tip), they may be found primarily outside of the phloem.

5) Lastly, you will undoubtedly find root branches developing in some of your sections. Consider where this starts to occur in relation to the root tip. Eventually the branches become visible to the eye, but you should start to see them in sections much closer to the root tip. From what region of the root do these structures seem to arise? Typically, they arise from the pericycle, just inside the endodermis.



Extra!! You might also try to make a longitudinal section through the center of the root (a medial longitudinal section). When stained, the different wall characteristics of the protoxylem and metaxylem will become apparent. You should also have a nice view of the developmental sequence of root tissues (see figure on the first page of this handout). This orientation of sectioning is more difficult to do and you may not get a very large section (not very long in the direction of the axis of the root), but it will be worth seeing the cells from the side - for example, you will be able to see secondary wall thickenings along the side (lateral) wall of the xylem cells.