Experimental Anatomy of Plant Development

Laboratory 8 - Vacular Tissues, Xylem/Phloem

Vascular tissue conducts substances throughout the plant, and consists primarily of xylem and phloem. In stems and roots there is a stele of cauline (= stem) vascular tissue, and leaf traces. There also may be branch and bud traces at levels where these organs are produced. The stele of the root usually consists of a central rod of xylem surrounded by phloem. In stems the stele has a far more variable structure than in roots. In leaves the vascular tissue consists of one or more bundles that are often referred to as veins or traces.

The principal function of the xylem is conduction of water and dissolved mineral salts. Xylem may also function in support of the plant. The conducting cells are dead, and the walls are heavily impregnated with lignin. Phloem is a tissue that functions to conduct organic molecules. It is typically found outside of the primary xylem in plants that have collateral bundles. In roots and in the stems of many pteridophytes, there is a thin layer of tissue outside of the phloem called the pericycle and immediately outside of the pericycle is a single layer of cells, the endodermis. The endodermis usually has characteristic thickenings on some of the walls. The stele is everything within the endodermis. The bundles of some leaves that are modified for xerophytic conditions are surrounded by an endodermis. In the petiole of the leaf the ground tissue may be referred to either as mesophyll or cortex.

Stem stele:

Examine a transverse section through a dicot (Medicago) stem. Identify the epidermis, cortex, pith, and vascular bundles. Within a vascular bundle, identify the phloem, phloem fibers, primary xylem, and procambium. Note that the procambium forms a complete ring throughout the stem. Procambium within a vascular bundle separates the primary xylem and phloem, and is therefore called intrafascicular ("within a fasicle) procambium, whereas procambium between bundles is called interfascicular ("between fasicles") procambium. The regions between the vascular bundles, composed of parenchyma and interfascicular procambium are called pith rays. Did the Zea (monocot) stem possess residual procambium?

1. Xylem: The function of xylem is the conduction of water and minerals (absorbed by the roots) throughout the plant body. Xylem is composed of both sclerenchyma (i.e. fibers) and parenchyma, as well as cells unique to xylem, tracheids and vessel members. Because both tracheids and vessel members are dead at maturity and possess secondary cell walls, they are considered by many botanists to be highly specialized types of sclerenchyma. The various categories of tracheary elements are:

   A. **Tracheids** are usually elongated cells, and are characterized by their possession of bordered pits. Refer to your text for a detailed illustration of a bordered pit and an explanation of its function. Bordered pits are areas where secondary cell wall is
interrupted and the primary cell wall is thinned, facilitating the passage of water. The union of bordered pits from two adjacent tracheids is called a pit pair.

Observe a prepared slide of macerated Pinus wood and identify tracheids and their bordered pits. Now observe a prepared slide of a transverse view of Pinus wood on demonstration. Identify two adjacent tracheids and their pit pair. Diagram a tracheid and include bordered pits. Is a bordered pit a hole completely through both cell walls?

B. Vessel Members (or vessel elements, as they are sometimes termed) are invariably the largest cells in a flowering plant. VM's form tubes that run throughout the plant. VM's are characterized by their generally short length and open end wall, called a perforation plate, where the next VM will occur.

Identify a VM (from an entire vessel) and it's perforation plates in a prepared slide of a longitudinal view of a Cucurbita stem. Identify a VM in transverse section (you will not see the perforation plates in this view). Diagram a VM, including the simple pits on the side walls and the perforation plates. Is a perforation plate a hole completely through both cell walls?

2. Phloem: The function of phloem is the conduction of photosynthates and metabolites throughout the plant body. Phloem is composed of parenchyma, sclerenchyma (i.e. fibers), and specialized cells called sieve tube elements and companion cells (both of which are living at maturity). Use your text for reference while looking at phloem.

A. Sieve Tube Elements (SE) are specialized for the conduction of photosynthates and metabolites. They are characteristically narrow, elongate cells with flat, perforated, end walls (called sieve plates). When SE's are injured, a proteinaceous plug is formed around the sieve plate (called a sieve plug or slime plug) which impedes movement of pathogens (bacteria or virus).

Identify SE's in transverse and longitudinal sections of Cucurbita stem.

B. Companion Cells: Companion cells are very narrow cells that control protein synthesis for SE's (which lack nuclei). Each SE has a single companion cell.

Identify a companion cell adjacent to a SE in both transverse and longitudinal sections of a Cucurbita stem. Diagram a SE and it's companion cell in transverse and longitudinal views.

Identify the fibers that cap the phloem in both transverse and longitudinal sections of a Cucurbita stem.

Repeat your observations of SEs and companion cells using a prepared slide of a Zea (corn) root. Note that Zea is a monocot. Monocot roots can be distinguished from dicot roots by their possession of a pith and lack of a residual procambium.
3. Primary Growth and Development of the Stem:

Examine a longitudinal section through a *Coleus* stem tip. Identify the apical meristem, leaf primordia (developing leaf), bud primordia (developing axillary buds), nodes, and internodes, to review your knowledge of this region of dicot stems. Identify the phytomerles. How many are present in the slide? Now identify provascular tissue at the apex, procambium, protophloem, protoxylem, metaxylem (if present) and megaphloem (if present). Make a drawing of the stem apical region that shows the distribution of the provascular tissue, procambium, proto- and metaphloem, proto- and metaxylem.

Examine a transverse section through a monocot (*Zea*) stem. Identify the epidermis and vascular bundles. Note that the vascular bundles do not form a single, discrete ring. Identify the bundle sheaths, composed of fibers, that surround each vascular bundle. Now identify the sieve tube members and companion cells of the primary phloem, and the vessel members of the proto- and metaxylem (primary xylem).

4. Check your knowledge:

   Look at the Arabisopsis mutant *ifl1*. What does this mutation effect?

   Look at the pictures provided. Is the tissue stained in red primary or secondary vascular tissue? Identify the vascular cambium, phloem and xylem.

LABORATORY – Checklist

By the end of the lab, your notebook should contain drawings of the following

[ ] Tracheid of *Pinus*.

[ ] Vessel member of *Cucurbita*.

[ ] Longitudinal section of *Coleus* and/or *Zea* stem showing distribution of provascular tissue, procambium, protophloem & protoxylem.