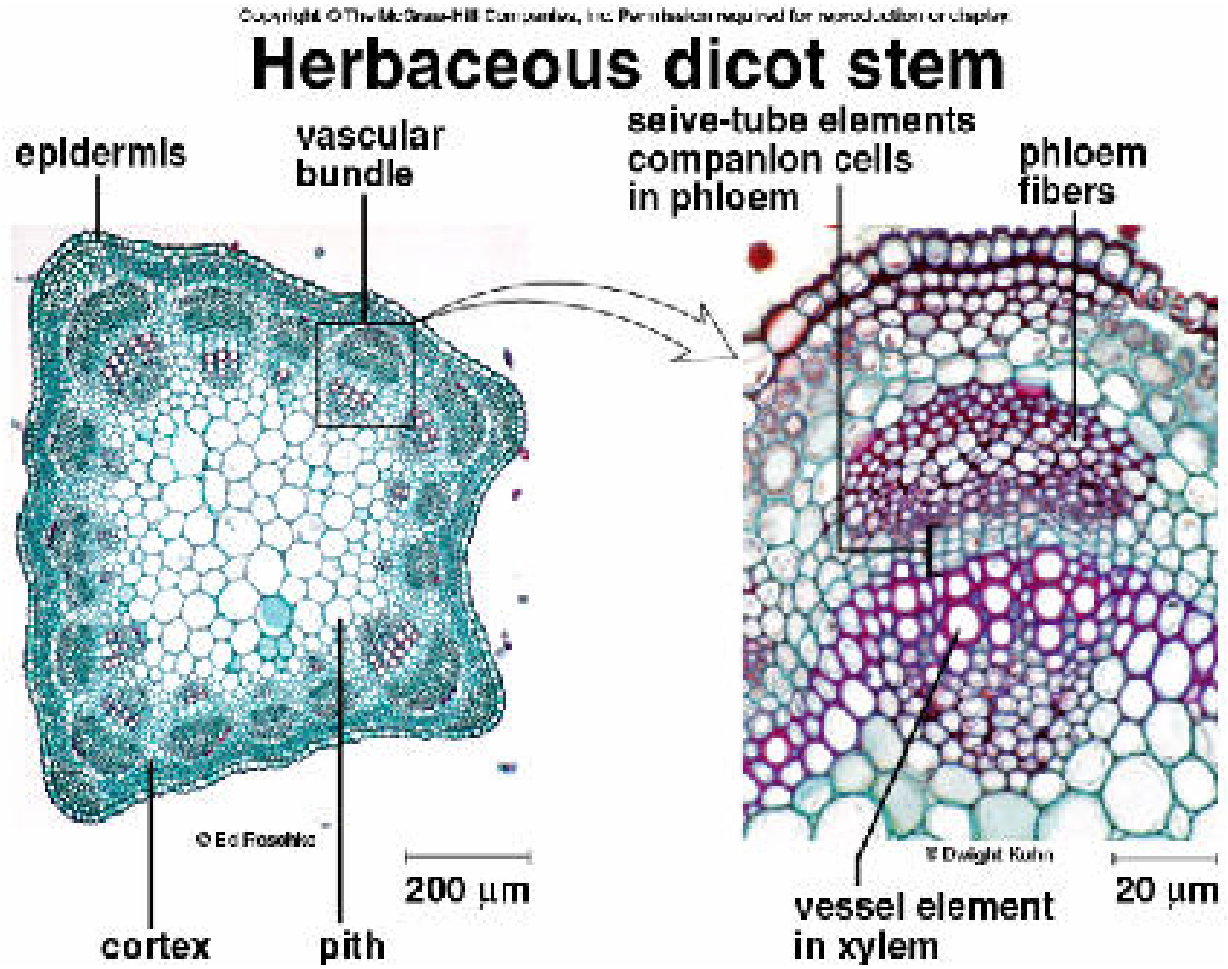
Dicot/Monocot Stem Anatomy

Dicot stems differ form the roots of the same plant in a variety of ways. The figure below illustrates a section of an herbaceous dicot stem and an enlarged section of a vascular bundle.



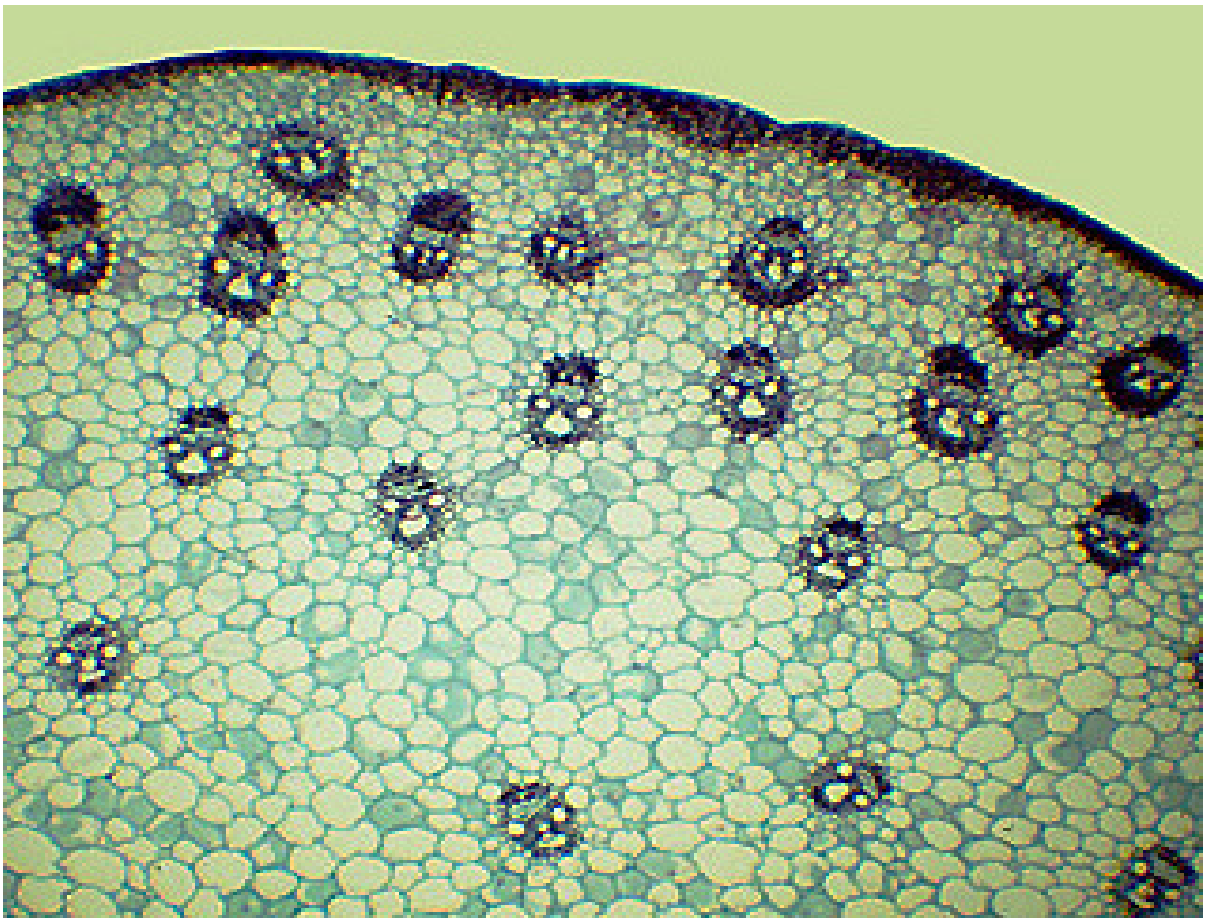
Several things will be readily apparent. The center of the stem is composed of pith while that of the root is primary xylem. The primary xylem and phloem is contained in discrete vascular bundles That form a ring around the pith rather than being radially arranged as in the root. The vascular cambium is termed a **fascicular cambium** because it is contained within a fascicle or bundle. Like that of the root it is only one cell layer thick and has its origin from the procambium. In the above right diagram it is the single row of thin walled cells immediately below the reference line for the sieve tube elements (*note that the bracket is incorrectly placed to include all the thin walled cells above the xylem vessel elements and tracheids*). If one follows the cells of the cambium out of the bundle to left and right, one can see that a row of such cells extend from one bundle to the next. These cells can be recognized as cambial cells because

they are 1) thin walled, and 2) form a radial tier of flattened cells which in this stem is only two cells high. These meristematic cells have their origin from cells of the pith ray extending from the pith to the cortex between the bundles. As these cells had lost their meristematic ability and then regained it, similar to the root the stem vascular cambium is formed in part from a residual meristem and in part from a resumptive meristem. These comprise the **interfascicular cambium.**

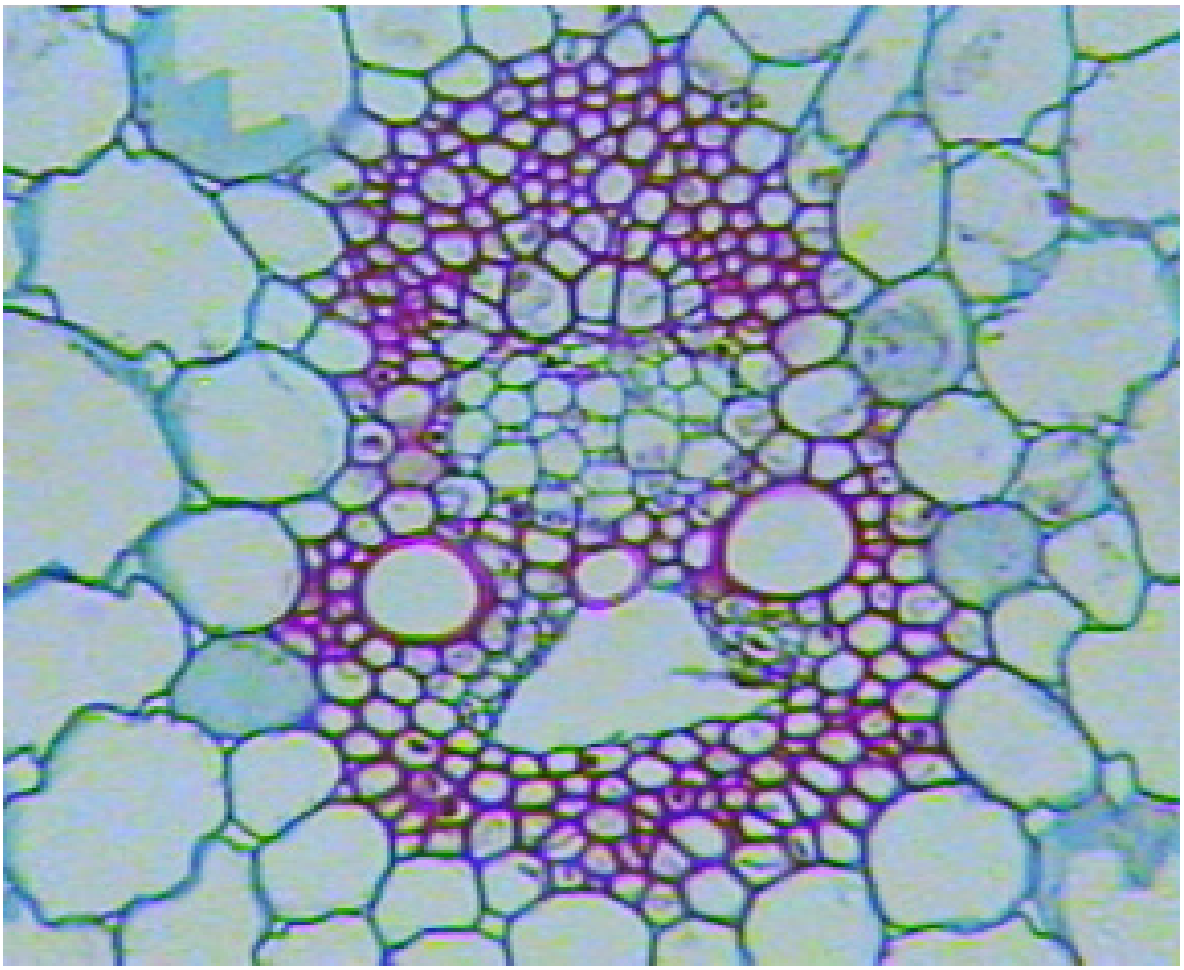
Another difference that can be found in the vascular tissue of the stem is that the xylem point in each bundle is to the inside of the bundle thus the primary xylem of the stem differentiates from the inside toward the outside forming an **endarch** pattern of maturation. In roots the protoxylem point are next to the pericycle and maturation proceeds from the outside toward the middle (an **exarch** pattern of maturation).

One can also note that the cortex, which is usually relatively thick in the root, is a relatively thin layer in the stem.

The monocot stem differs from a dicot stem and differs from the monocot root. The stem of *Zea mays* is shown below.



Note that unlike the dicot stem, the vascular bundles are not arranged in a ring but are scattered. Some botanists object to using the term “scattered” to describe this arrangement as they see an orderly pattern in the arrangement. In addition, there is no clear demarcation between the pith and the cortex thus most botanist simple refer to this as ground tissue or ground paraenchyma. A closer look at the bundles clearly indicates that similar to the monocot root, a



vascular cambium is lacking. Perhaps the most striking characteristic of the bundle is the hole found in the xylem region. The types of cells comprising the phloem is clearly noted in this bundle with the larger thin walled cells being the sieve tube cells and the smaller rectangular thin walled cells being the companion cells.

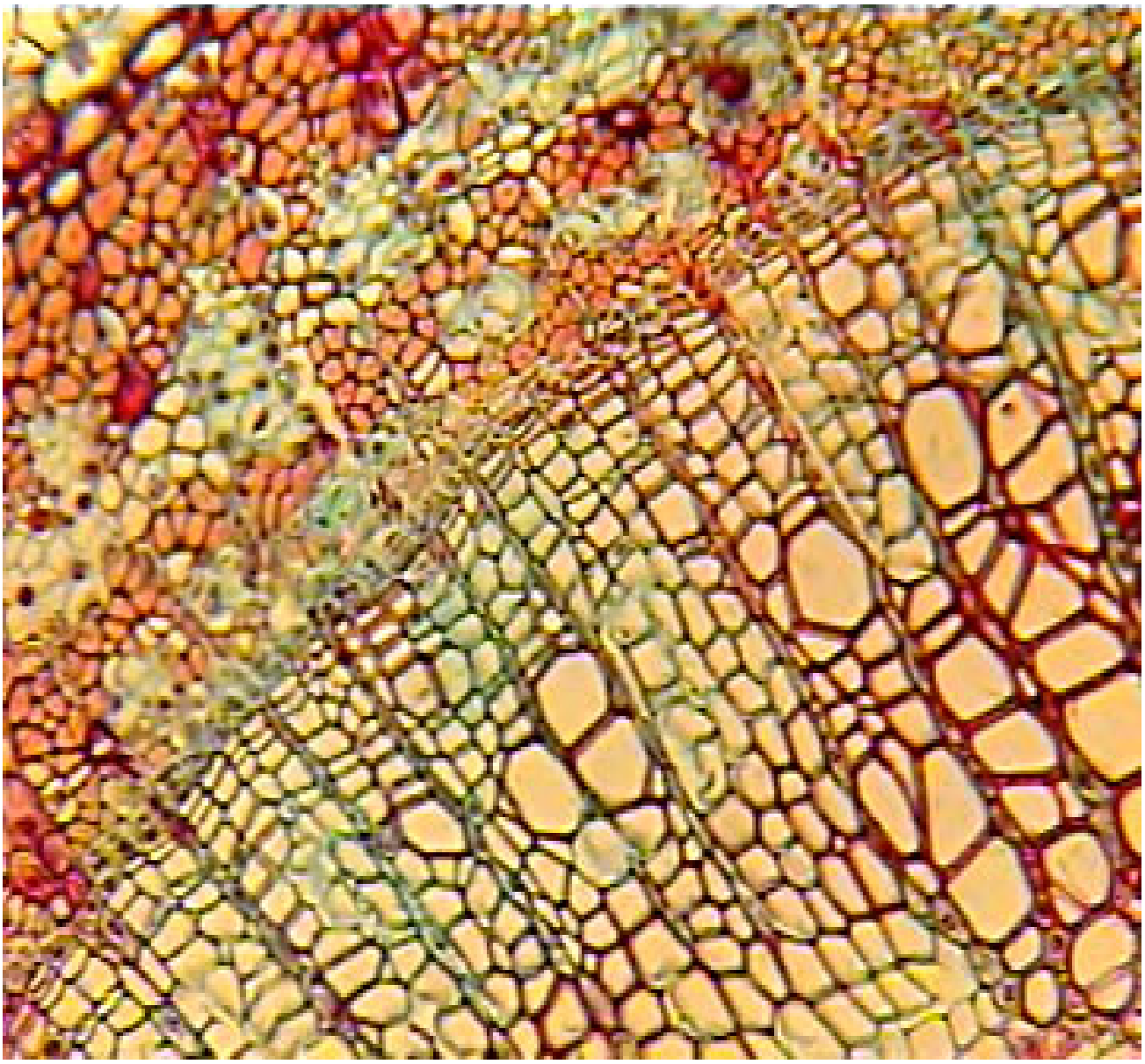
Woody Dicot Stem

The stem of a woody dicot has the same arrangement of primary tissue as the herbaceous dicot. The principle difference is that the vascular cambium becomes active producing secondary phloem towards the outside of the stem

and secondary xylem toward the inside. For every cambial derivative that differentiates, there will be approximately 10 times as many becoming secondary xylem as will differentiate as secondary phloem. The figure below

is a low power view of a woody dicot stem cross section. The generally regions of the stem can be noted; the innermost pith surrounded by primary xylem which in turn is surrounded by the secondary xylem (the **wood**). The vascular cambium is a single concentric layer of cells within a zone of thin walled cells called the cambial zone. To the outside of the cambium lies the secondary phloem. In a stem only one year old as this one is, primary phloem is probably still present, although in will be obliterated during further secondary growth as will the pericycle (if present) and the cortex. A second cambium will generally be produced to the outside of the vascular cambium, the cork cambium. The cork cambium will generally produce just a few or no layers of cells to the inside (the phelloderm), but unlike the vascular cambium will produce most of its derivatives to the outside forming the cork. These three tissues, cork, cork cambium and phelloderm comprise the **periderm**. The tissue lying between the vascular cambium and the cork cambium is termed the **inner bark** while that lying outside the cork cambium, only cork in the older stem, is the **outer bark**.

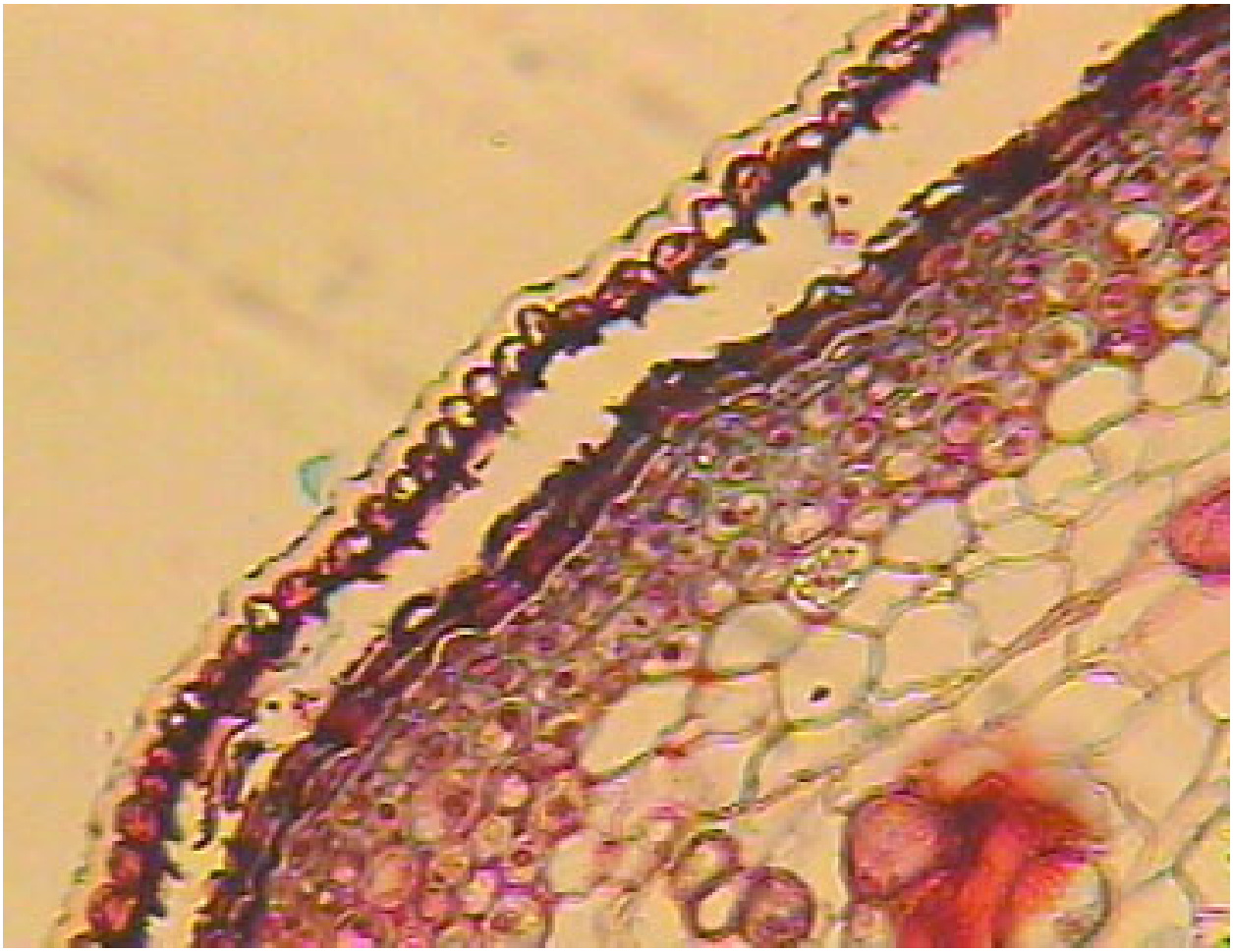
The hypodermis and epidermis will be sloughed off as a consequence of secondary growth and would not be present on an older stem. If one examines the cambial zone more carefully, as can be done with the following figure, one



can clearly see the cambial zone, characterized by the typical thin walled, narrow, rectangular cells arranged in tiers. The secondary phloem would lie to the outside of this zone, the secondary xylem (wood) would lie to the inside. The very thick walled red staining cells in the phloem are phloem fibers. Fibers are also present in the secondary xylem but in cross section would be difficult for the novice to differentiate from one of the transport cells, the tracheid. The larger more rounded cells in the secondary xylem are vessels. The thin walled cells forming radial rows of narrow rectangular cells that extend through the

secondary xylem are called xylem ray cells. These will typically extend through the secondary phloem as well where they are called phloem ray cells.

The characteristics of the zone in which a cork cambium becomes active may be seen below. This is a young stem and cortex is still present to the inside of



the single row of cork cambium. The reddish-brown stained cells to the outside are cork. One can tell this is a young stem because the epidermis is just in the process of being sloughed off.