Dicot/Monocot Root Anatomy

The figure shown below is a cross section of the herbaceous dicot root *Ranunculus*. The vascular tissue is in the very center of the root. The ground tissue surrounding the vascular cylinder is the **cortex**. An epidermis surrounds the entire root. The central region of vascular tissue is termed the **vascular cylinder**.

Note that the innermost layer of the cortex is stained red. This layer is the **endodermis**. The endodermis was derived from the ground meristem and is properly part of the cortex. All the tissues inside the endodermis were derived from procambium. **Xylem** fills the very middle of the vascular cylinder and its boundary is marked by ridges and valleys. The valleys are filled with phloem, and there are as many strands of phloem as there are ridges of the xylem. Note that each **phloem** strand has one enormous sieve tube member. Outside of this cylinder of xylem and phloem, located immediately below the endodermis, is a region of cells called the **pericycle**. These cells give rise to lateral roots and are also important in secondary growth.

**Label the tissue layers in the following figure of the cross section of a mature *Ranunculus* root below.**
Cross Section of an Immature *Ranunculus* Root. Fill in the labels with the name of the appropriate tissue or structure.

A = ________

B = ________

C = ________

D = ________

E = ________

F = ________

The figure shown below is that of the monocot *Zea mays* (corn). Note the differences between this and the dicot root shown above.
Note the sclerenchymized endodermis and epidermis. In some monocot roots, the hypodermis (exodermis) is also heavily sclerenchymized. There are numerous xylem points rather than the 3-5 (occasionally up to 7) generally found in the dicot root. The pericycle is multiseriate (multilayered) in comparison to the uniseriate (1 layer; occasionally 2) layer found in the dicot root and the vascular or stellar cambium is lacking, thus no secondary xylem and phloem will be produced. In addition, note that rather than having primary xylem occupying the center of the root as in the dicot, we find pith in the monocot root.

The root of the monocot *Smilax* shows the same generally anatomy but with some differences. Note the figure shown below and find the layers identical to those of the corn root.

![Monocot Root](image)

Note that the central pith is sclerenchyma rather than parenchyma tissue as seen in the corn root. In addition, we can clearly see the sclerenchymized endodermis that because of its sclerenchymization is sometimes called an exodermis.
If we take a closer look at the vascular cylinder we get a better impression of the arrangement of primary xylem and phloem in the monocot root. Again, note that there is no evidence of a vascular cambium. (See figure shown below)

Woody dicot root

The roots of woody dicots do undergo secondary growth. As is shown in the following diagram, the cambial zone in the woody dicot root is quite similar to that of the stem of that same plant.
However, there are distinctions between root and stem of a woody dicot. Both a pericycle and endodermis is typically present in the young woody dicot, although both may be lost during secondary growth as a consequence of the enlargement in diameter of the root. The stellar cambium (vascular cambium) has its origin in part from the procambium and in the young woody dicot appears little different from the incomplete cambium present in an herbaceous dicot root. However, as the woody dicot root develops, cells of the pericycle opposite the xylem points become meristematic ultimately forming a single, continuous, concentric layer of meristematic cells. Thus, the root vascular cambium is similar to the stem vascular cambium in that it is in part a **residual meristem** (develops from cells that had never lost their meristematic ability (the procambium) and in part a **resumptive meristem** (develops from cells that had lost their meristematic ability and later regained it (the pericycle). While the stem also is a resumptive meristem in part, those cells are pith ray cells opposite the cambium within the vascular bundle. (A pericycle is extremely rare in stems and the endodermis is not commonly found there).

Another difference between root and stem of the woody dicot is in the wood. The root generally shows much less distinction between spring and summer wood, thus the annual rings or growth rings are much less distinct then they are in the stem of that same plant.

Many people do not realize that woody plant roots produce cork just as found on the stem. The cork (outer bark) of roots is commonly not nearly as thick as that of the stem and the cork cells typically have a thinner layer of suberin.