Plant Anatomy (Lec. 4)

Internal Structure of Root

Root Structures and Their Functions:

Root Tip: the end 1 cm of a root contains young tissues that are divided into the:
root cap, quiescent centre, and the sub apical region.

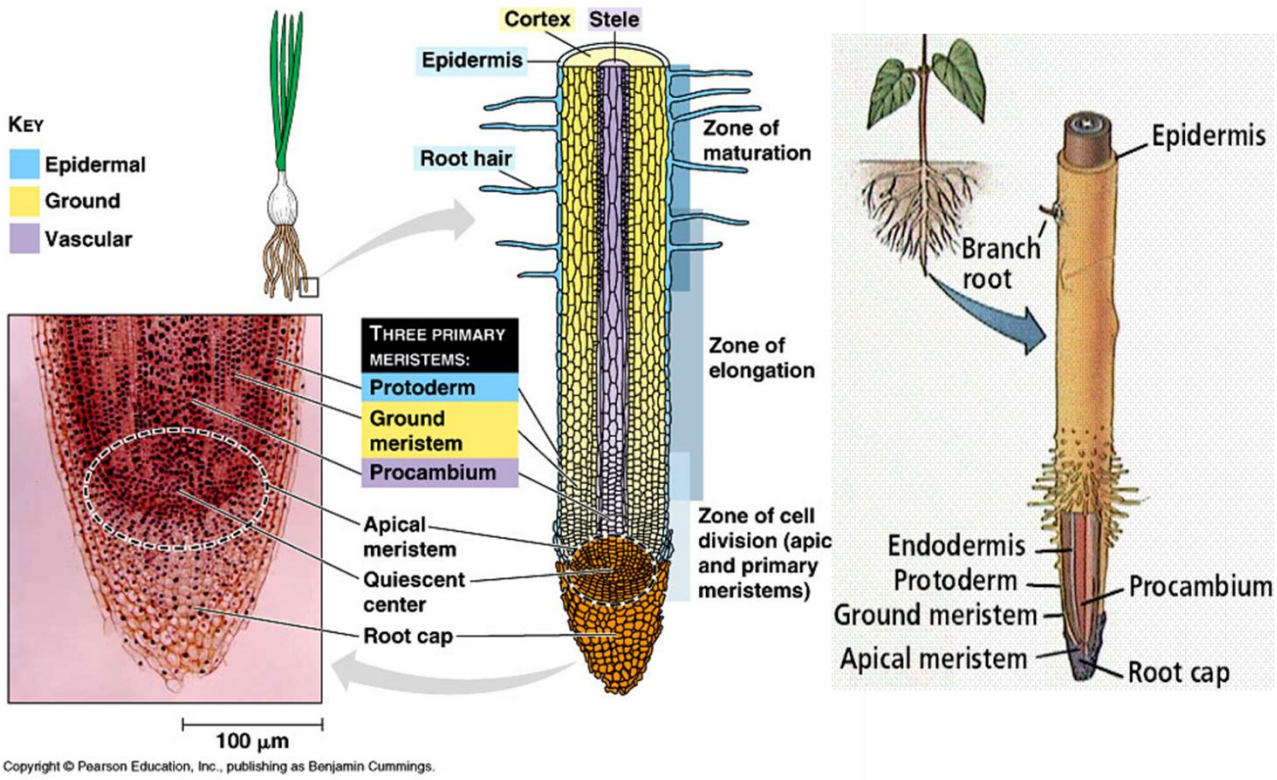
Root Cap: root tips are covered and protected by the root cap. The root cap cells are derived from the root cap meristem that pushes cells forward into the cap region. Root cap cells differentiate first into columella cells. **Columella** cells contain amylopasts that are responsible for gravity detection. These cells can also respond to light and pressure from soil particles. Once columella cells are pushed to the periphery of the root cap, they differentiate into peripheral cells. These cells secrete **mucilage**, a hydrated polysaccharide formed in the dictyosomes (Golgi) that contains sugars, organic acids, vitamins, enzymes, and amino acids. Mucilage aids in **protection** of the root by preventing desiccation. In some plants the mucilage contains **inhibitors** that prevent the growth of roots from competing plants. Mucilage also lubricates the root so that it can **easily** penetrate the soil. Mucilage also aids in water and nutrient **absorption** by increasing soil: root contact. Mucilage can act as a **chelator**, freeing up ions to be absorbed by the root. Nutrients in mucilage can aid in the establishment of **mycorrhizae** and **symbiotic** bacteria.

Quiescent Center: behind the root cap is the quiescent centre, a region of inactive cells. They function to replace the meristematic cells of the root cap meristem.
Subapical Region: this region, behind the quiescent centre is divided into three zones. Zone of Cell Division - this is the location of the apical meristem (~0.5 -1.5 mm behind the root tip). Cells derived from the apical meristem add to the primary growth of the root.
Zone of Cellular Elongation - the cells derived from the apical meristem increase in length in this region. Elongation occurs through water uptake into the vacuoles. This elongation process shoves the root tip into the soil.
Zone of Cellular Maturation - the cells begin differentiation. In this region one finds root hairs which function to increase water and nutrient absorption. In this region the xylem cells are the first of the vascular tissues to differentiate.

Mature Root: the primary tissues of the root begin to form within or just behind the Zone of Cellular Maturation in the root tip. The root apical meristem gives rise to three primary meristems: protoderm, ground meristem, and procambium.

Root Hairs

Tiny one celled hair-like extensions of the epidermal cells located near the tips of roots.
Increase surface area. Absorb water & minerals.



INTERNAL STRUCTURE OF DICOTYLEDONOUS ROOT

A thin T, S. of gram "chickpea" *(Cicer arietinum)* root shows the following structure:

(1) **Epiblema**: This is also known as the piliferous layer. It is characteristically single layered, arranged closely and compactly without intercellular spaces comprising tubular living components. Cuticle and stomata are absent. Root hairs are exogenous in origin (originating externally) and formed due to distention of cell wall. The hairs help in absorption of water from the soil and increase surface area. As epidermis produces root hairs, it is also called **epiblema or rhizodermis** or **piliferous layer**. The cells that produce root hairs are comparatively **smaller** than the other cells and are called **trichoblasts**.

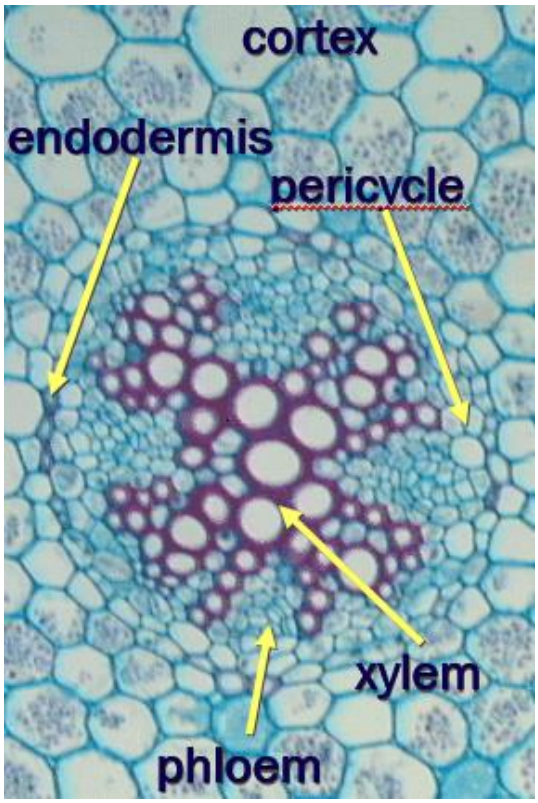
(2) **Cortex**

This consists of many layers of thin-walled parenchymatous cells with plenty of intercellular spaces. In some cases, the epiblema soon dies off; a few outer layers of the cortex become cutinized and form the exodermises. The cortical cells store starch but in the aerial roots of ***Tinospora*** it contains chloroplasts and thus become green and photosynthetic.

(3)**Endodermis**: The innermost layer of cortex is the endodermis which completely surrounds the stele. It comprises a single layer of barrel-shaped cells without intercellular-spaces. Cells

of endodermis have special thickenings called Casparian strips. Endodermal cells outside the protoxylem, do not have casparian strips such cells are called passage cells.

(4) **Pericycle**: It is made up of thick-walled parenchymatous cells. Lateral root originates from the pericycle. Thus lateral roots are endogenous in origin. The branches of stem are exogenous in origin because, they originate from the outer part of cortex.



(5) **Vascular bundles**

These are always arranged in a ring and are radial i.e.; xylem and phloem are situated at different radii. The protoxylem is always away from the centre and metaxylem towards the centre. This condition of xylem is called exarch. The number of vascular bundle in dicot is 2-6 (diarch to hexarch).

(6) Conjunctive tissue: The parenchyma lying in between xylem and phloem bundles forms the conjunctive tissue. Vascular cambium is formed from the conjunctive tissue during the secondary growth.

(7) **Pith**: occupies a small area in the centre of the root and consists of parenchymatous cells.

INTERNAL STRUCTURE OF MONOCOTYLEDONOUS ROOT

In a T, S. of the maize *(Zea mays) root* the following structures are seen:

(i) **Epiblema**: It is the outermost layer of the root with large number of unicellular hair.

(ii**) Cortex**: Below the epiblema is present multilayered parenchymatous tissue with intercellular spaces.

(iii) **Endodermis**: The innermost layer of the cortex is the endodermis. Endodermal cells are barrel-shaped, **without** casparian strips as the whole wall is thickened.

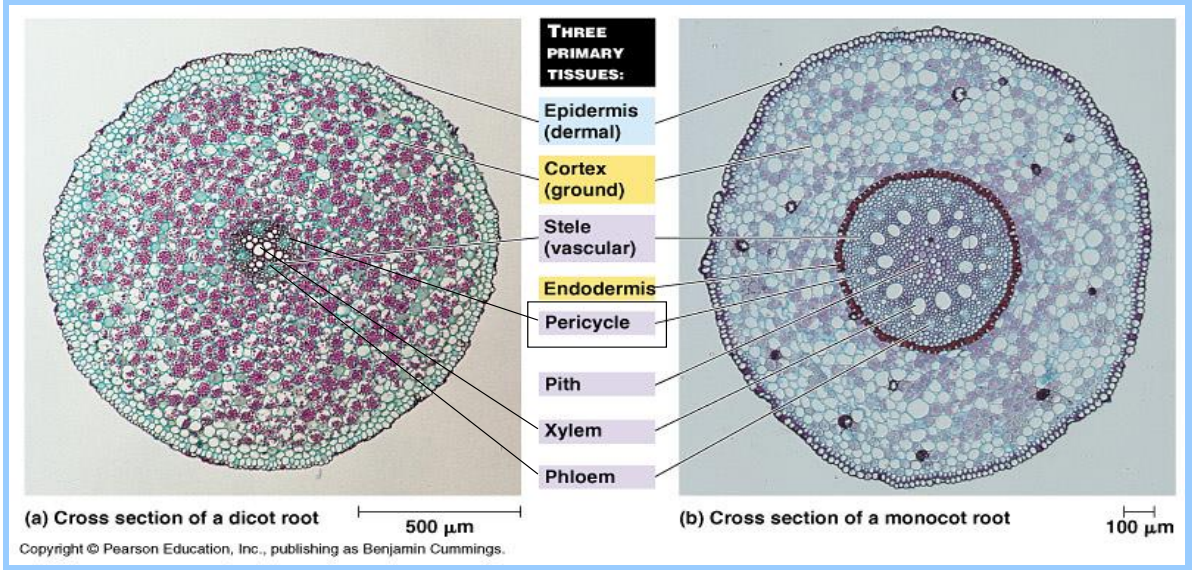
(iv) **Pericycle**: It is uniseriate and is made up of Prosenchyma.

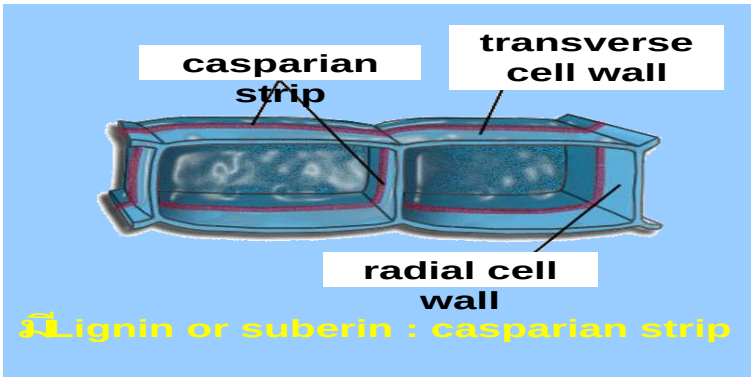
(i) Vascular bundle: Vascular bundles are polyarch, radial and exarch. Phloem parenchyma absent.

(ii) **Conjunctive tissue**: It is made up of parenchymatous cells in between the xylem and phloem.

(iii) **Pith**: Large, made up of loosely arranged parenchymatous cells with abundant starch grains.

Organization of primary tissues in young roots. Note the difference between the monocot and the dicot in the arrangement of the xylem & phloem in the stele.





Casparian Strip
Function: forces fluids from outside through plasma membrane = selective absorption

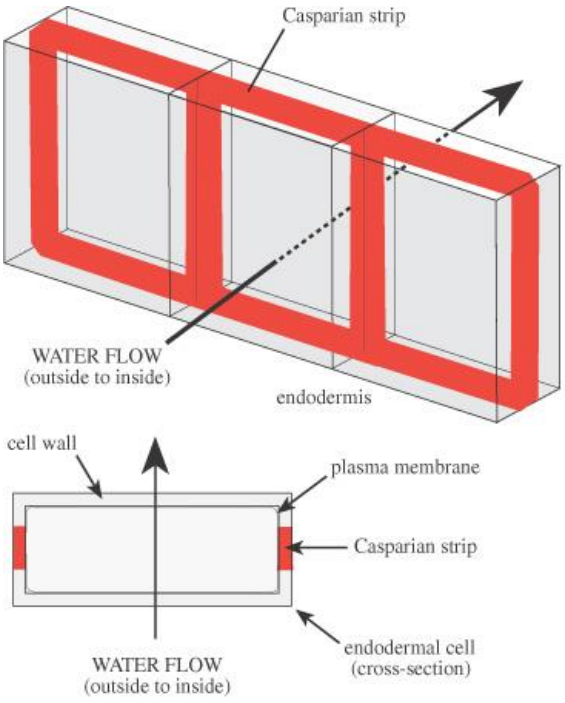


Figure 10.13 The Casparian strip, a specialized feature of cells of the endodermis.