ROOT ANATOMY

The root is the lowermost portion of the plant that normally develops below the soil surface.

Two types of roots can be distinguished on the basis of origin: tap roots and adventitious roots. Tap roots develop from the apex of the embryo that is determined to produce roots (**the radicle**) and from the pericycle of mature roots.

Adventitious roots develop from other tissues of mature roots or other parts of the plant body such as stems and leaves.

The roots of most plants are covered at the very top with a specialised tissue-the **root cap.**

It consists of parenchyma cells that contains starch and secretes mucilaginous materials to facilitate the penetration of the root through the soil.

The outer layers of the root cap are replaced by new layers from the initials as they die as a result of friction with soil particles.

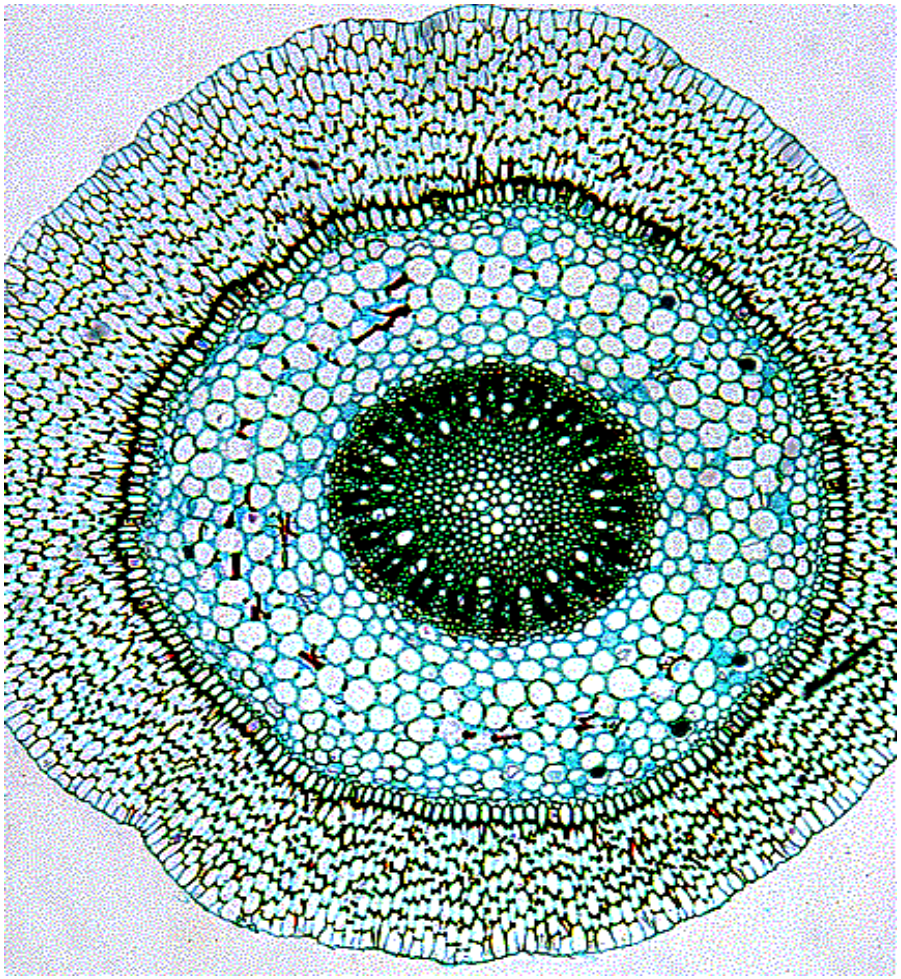
Arrangement of the primary tissues in the mature root

1- The epidermis

The epidermal cells of the root are thin walled and devoid of cuticle.

The root epidermis is usually uniseriate but in the aerial roots of some plants such as Orchidaceae, it may be multiseriate where it forms a **velamen**

Epiphytic root



The most characteristic feature of the root epidermis is the production of **root hairs** that are adapted to the uptake of water and nutrients.

They are restricted to a few centimetres from the root apex and they die on the more mature parts of the root.

In some plants all the epidermal cells have root hairs while in others only some cells, **trichoblasts**, may do so.

* **A trichoblast** is a cell on the exterior surface of a plant's root that is responsible for forming root hairs.

2- The root cortex

The root cortex of dicotyledons and gymnosperms is formed mainly of parenchyma.

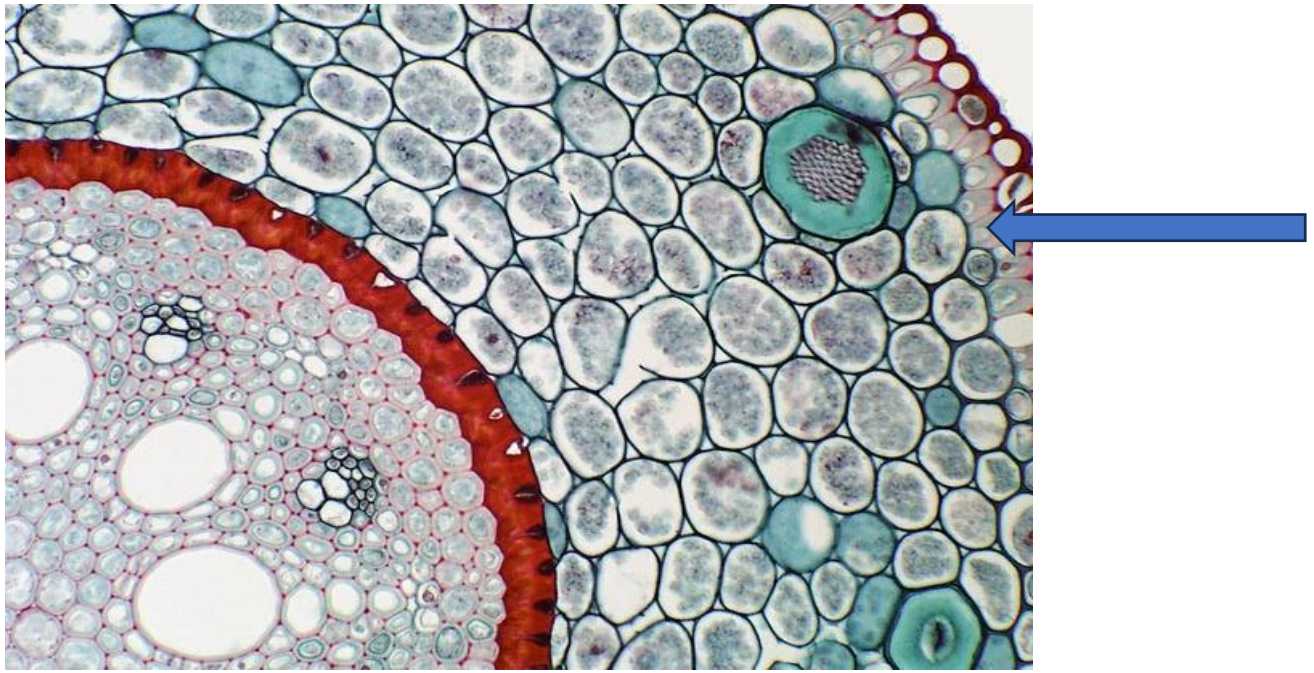
The cortical parenchyma lacks chlorophyll except in some aerial roots of epiphytes and usually contains starch.
Secretory cells can exist in the cortex.
Sclerenchyma may exist in roots of monocotyledons in addition to parenchyma.

The root cortex is normally **wider than that of stem**

The exodermis

In some plants, the cell walls of the outer subepidermal layers of the cortex become suberized to form a protective layer, the **exodermis.**

The exodermal cells contain viable protoplasms even when mature.



3- The endodermis

The endodermis is a single layer of cells that separates the cortex from internal tissues.

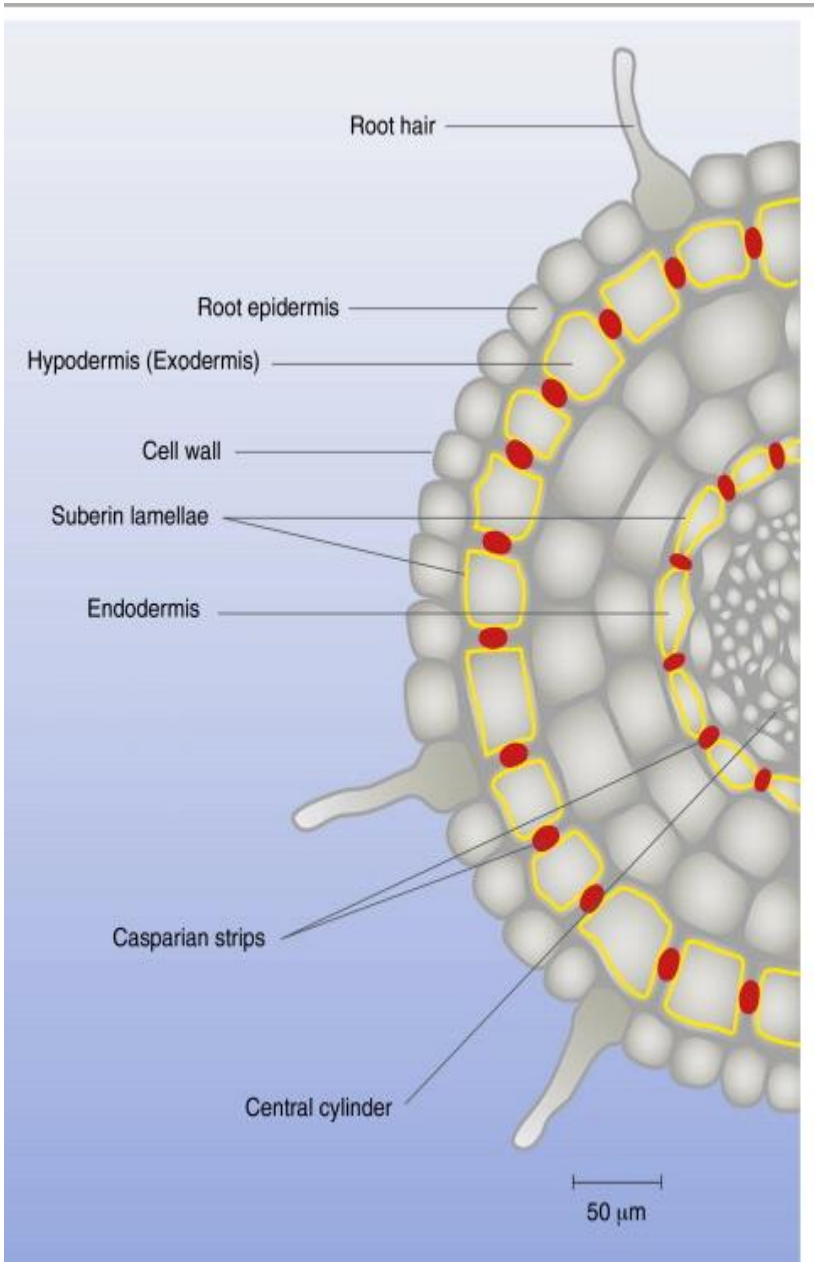
The endodermis controls the passage of water and nutrients from the cortex to the vascular cylinder.

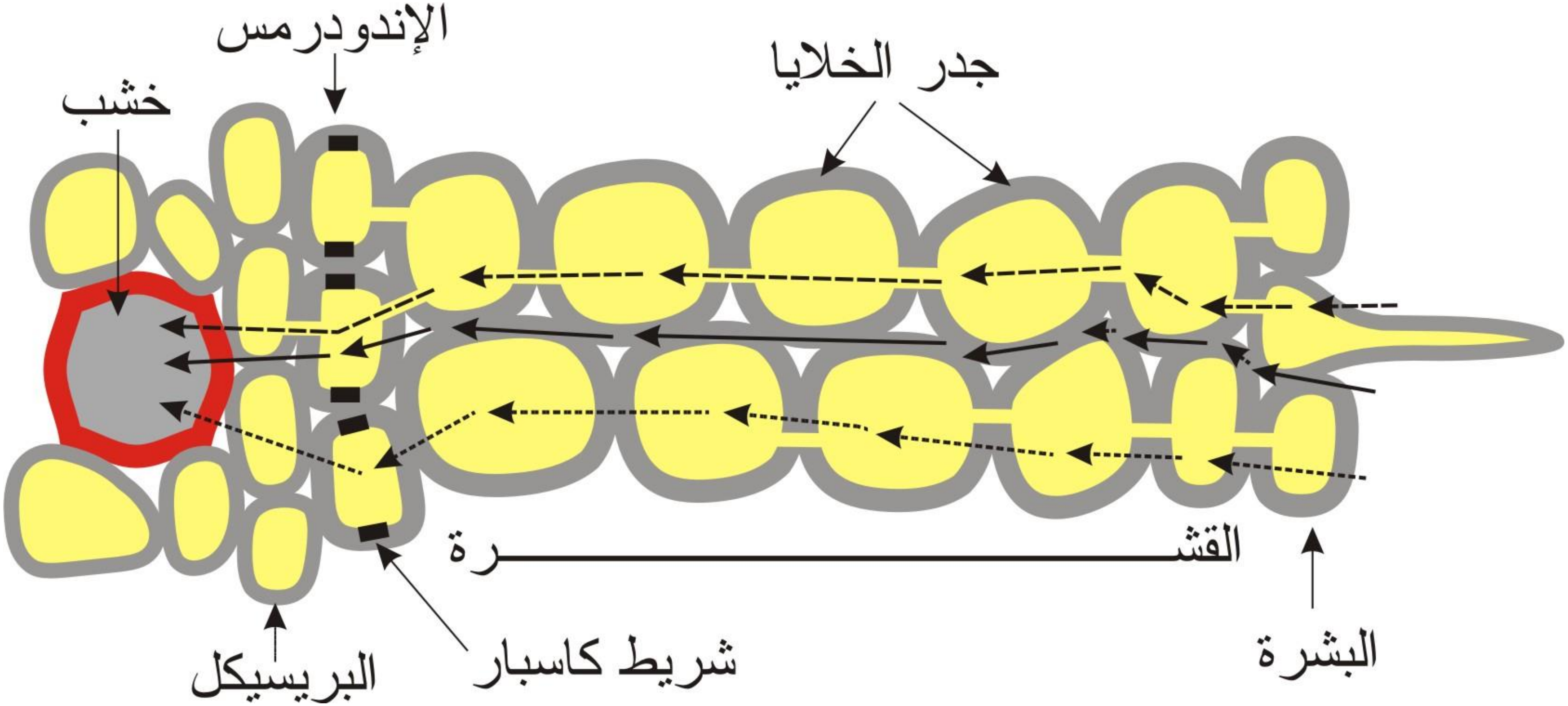
Water can pass through the cortex through the cytoplasms of the cortical cells and also by diffusion through their walls and intercellular spaces.

Suberin restricts the movement of water within and from the plant.

The suberin in the Casparian bands/strips of the endodermis and exodermis reduces the transport of water and solutes.

Loss of water from roots in dry soil is reduced by suberin in the exodermis

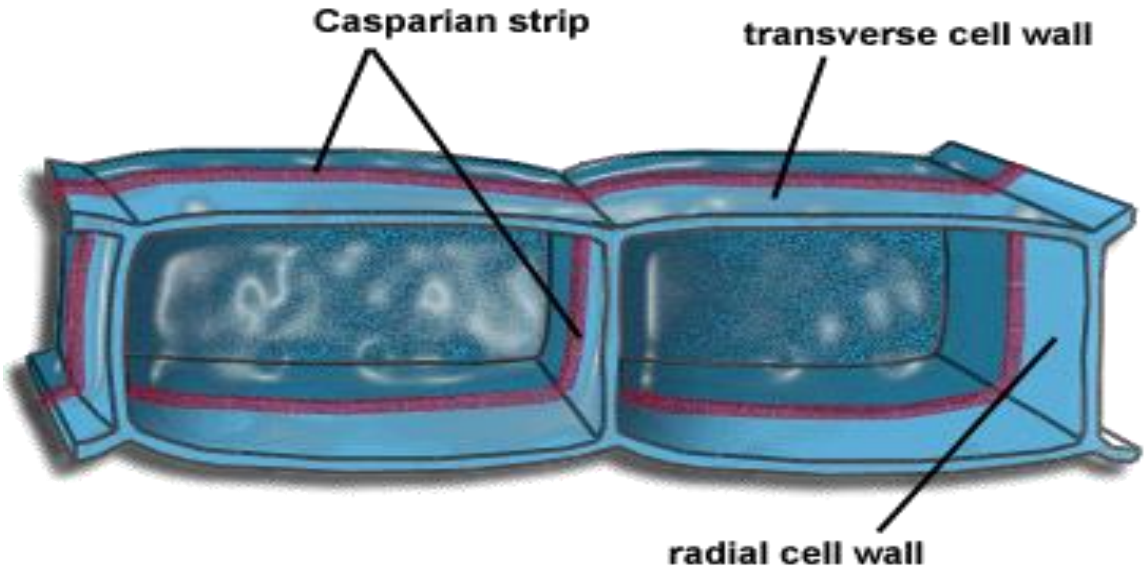




الإندودرمس
جدر الخلايا
خشب
القشـــــــــــــــــــــــــــــــرة
البريسيكل
شريط كاسبار
البشرة

The endodermal cells are compact and their walls are thickened in such a way that prevents the passage of water and nutrients except through their cytoplasms.

The endodermal cells are characterized by the development of casparian strips on their radial and cross walls but not on the tangential walls, which face the cortex and vascular cylinder.



These strips are composed of lignin and suberin.

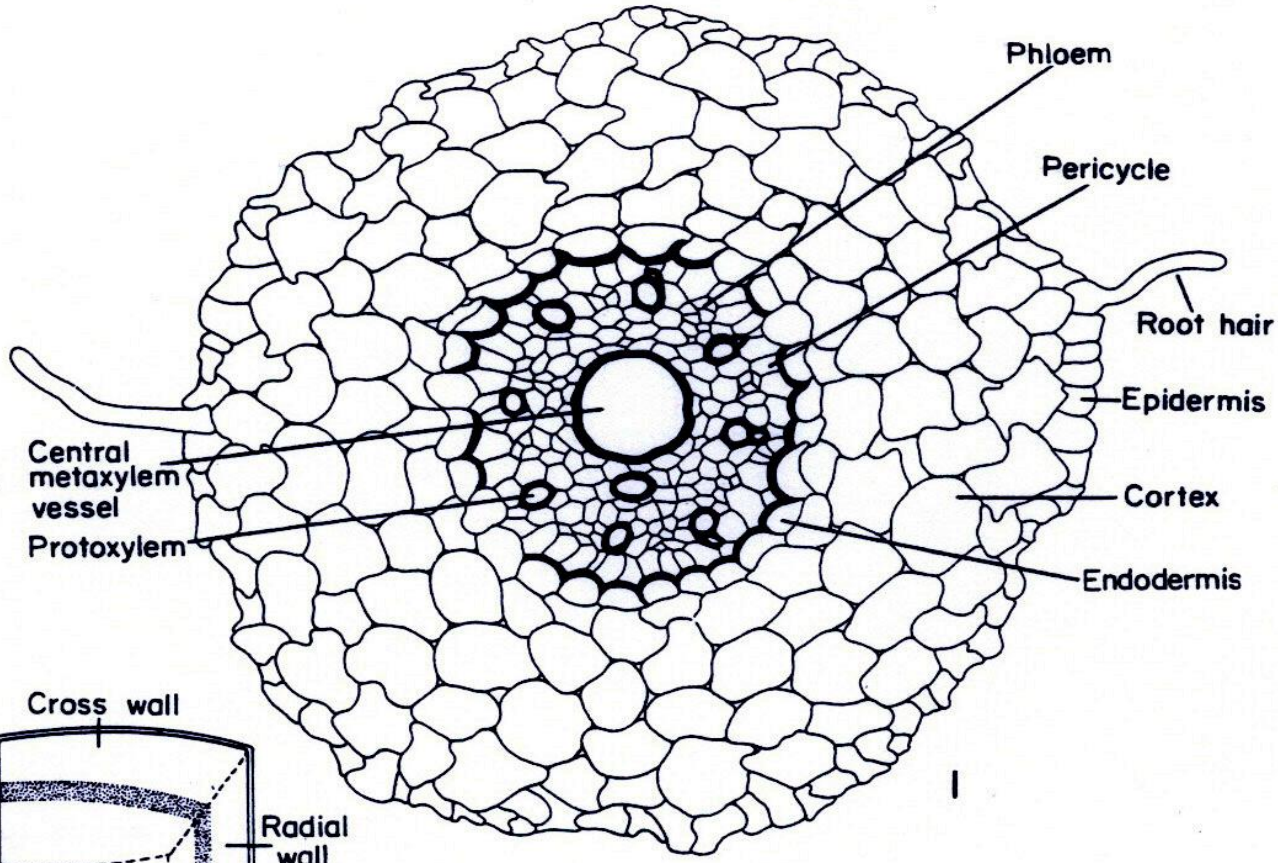
The casparian strip is the **primary stage of wall thickening** of the endodermal cells.

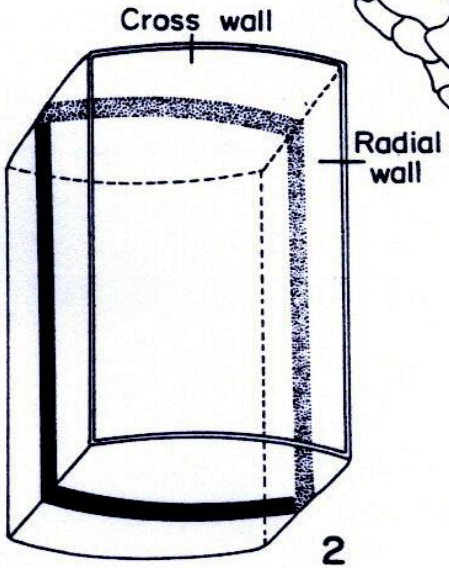
In plant with no secondary growth such as monocotyledons, an **entire suberin** lamella develops on the inner side of the endodermal cell wall including casparian strip.

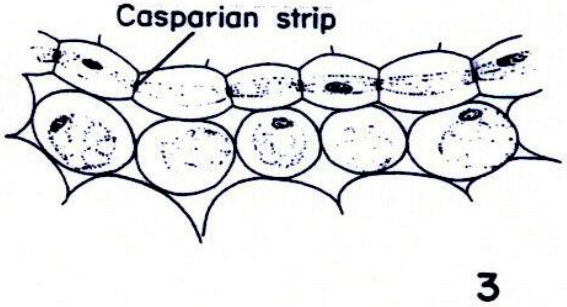
This lamella is the **second stage** of wall development.

Because of the delay in thickening of the cell walls of endodermal cells opposite to the xylem, some cells usually have casparian strips only and are termed **passage cells**.

Passage cells are thought to **facilitate the passage of water through the endodermis** as it is retarded through the other endodermal cells with thick walls.


Phloem
Pericycle
Root hair
Epidermis
Central metaxylem vessel
Protoxylem
Cortex
Endodermis
1


Cross wall
Radial wall
2


Casparian strip
3

4- The vascular cylinder

The vascular cylinder occupies the central part of the root.

It is clearly delimited from the cortex by the endodermis.

Immediately inside the endodermis is a single layer of thin walled parenchyma, **the pericycle**.

It is a meristematic tissue from which the primordia of the **lateral roots develop**.

The vascular tissues of the root, xylem and phloem, are arranged in separate **alternating strands** at the periphery of the vascular cylinder.

The root xylem is ***exarch*** *i.e.,* **protoxylem is external** to metaxylem

The number of protoxylem groups in the root i.e., whether one, two, three etc., is expressed by the terms monarch, diarch, triarch respectively.

A root with many protoxylem groups is termed **polyarch**. Polyarch arrangement is characteristic of **monocotyledons**

Roots with fewer protoxylem groups, **up to six** groups, are characteristic of **dicotyledons**

Cambium appears on the inner side of phloem and on the outer side of protoxylem. Therefore, cambium becomes an undulating cylinder between xylem and phloem.

In the center of the vascular cylinder, **pith** may exist.

It is formed of parenchyma. Its size depends on the size of the whole cylinder. Bigger vascular cylinders usually have bigger pith.

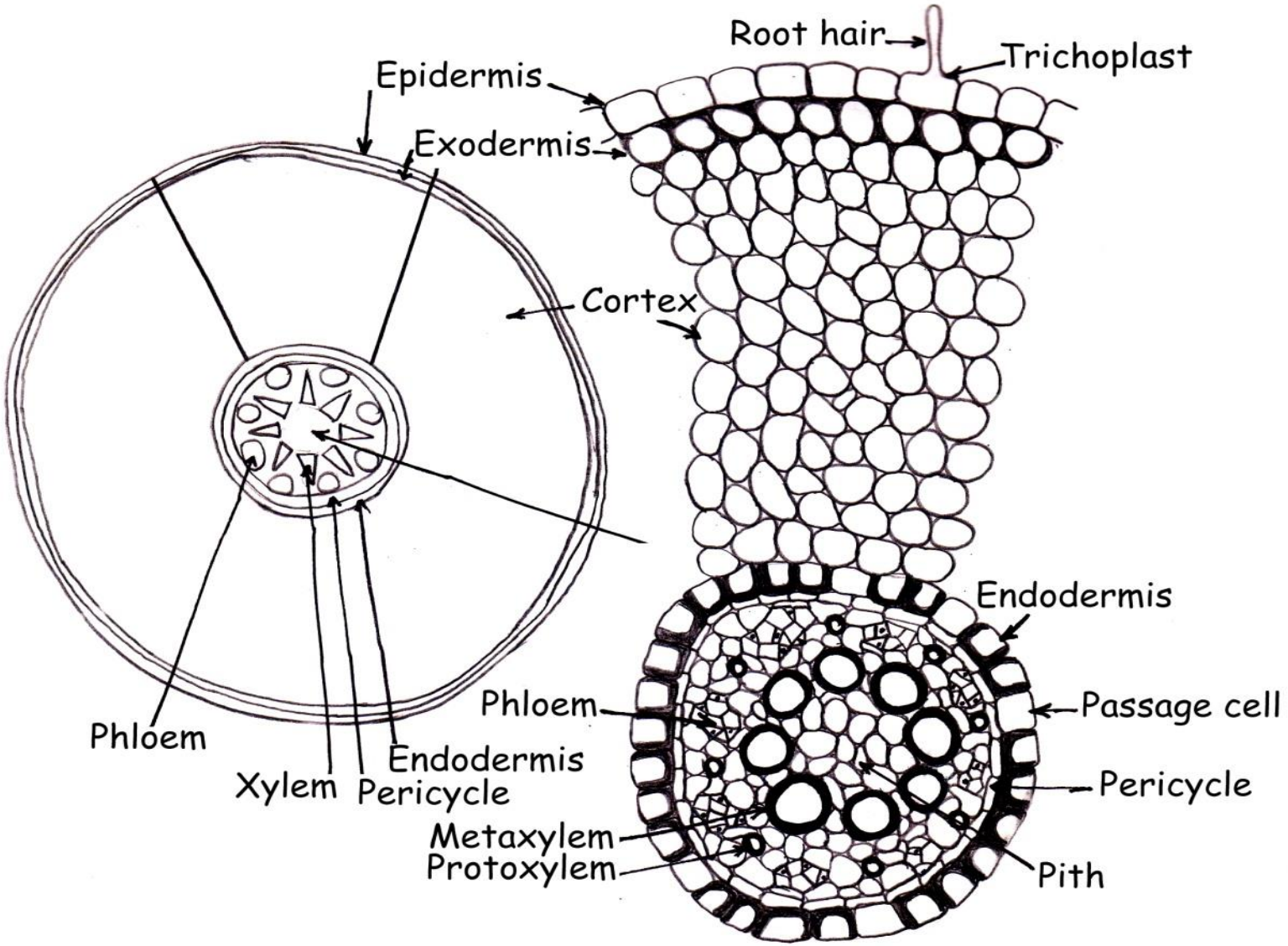


Diagram and T.S. of a young monocot root.

قطاع عرضى فى جذر من ذوات الفلقة الواحدة

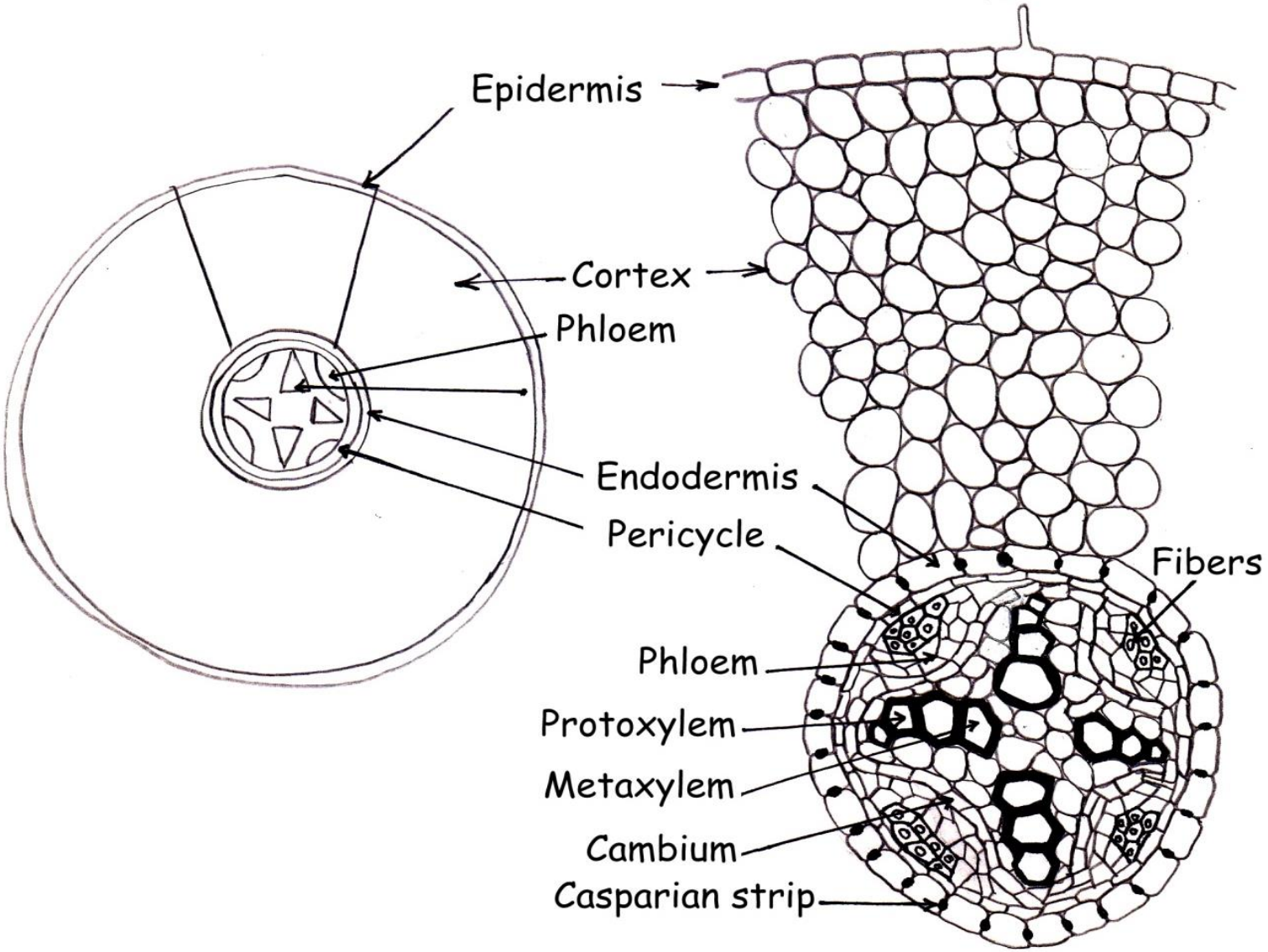
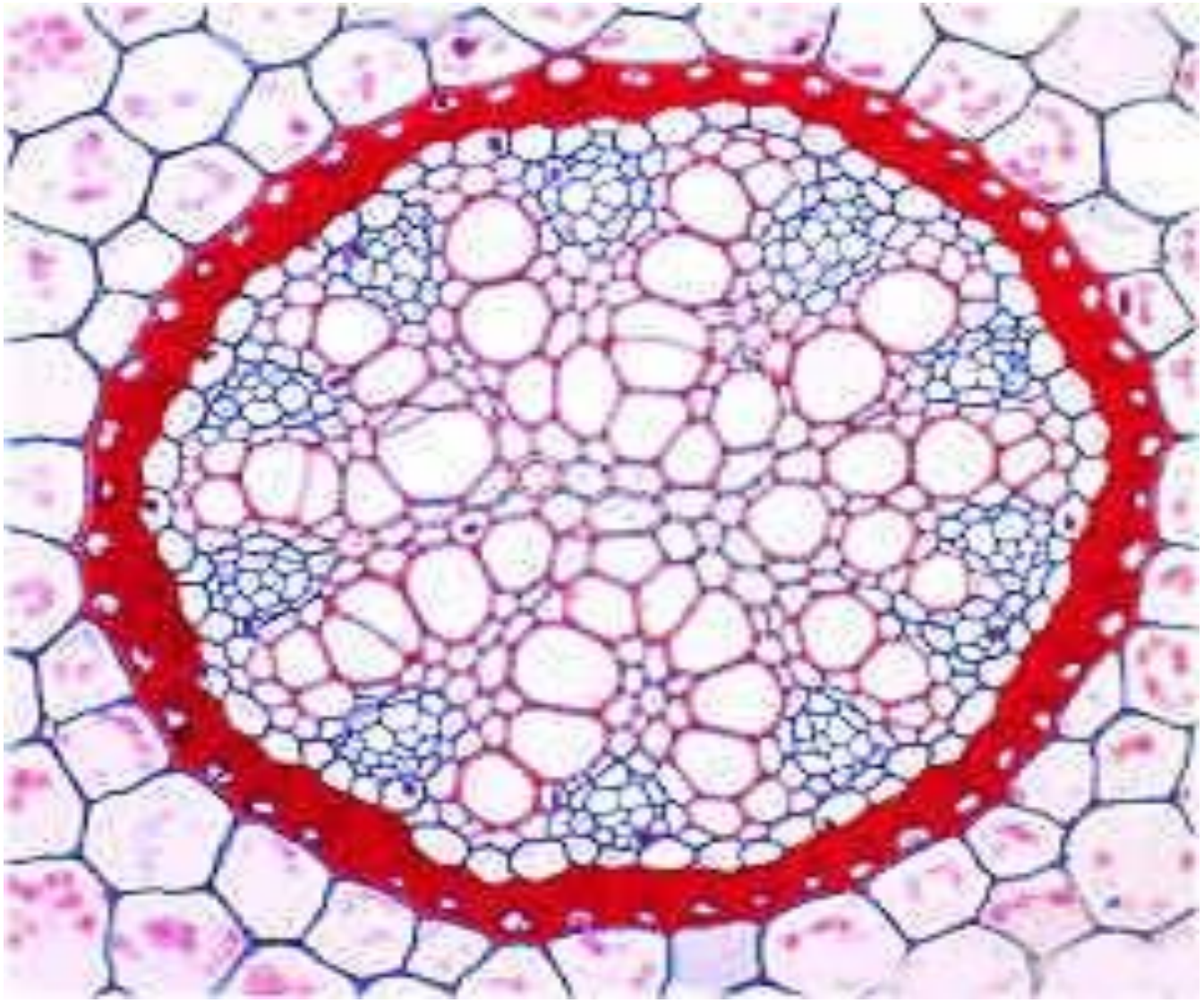
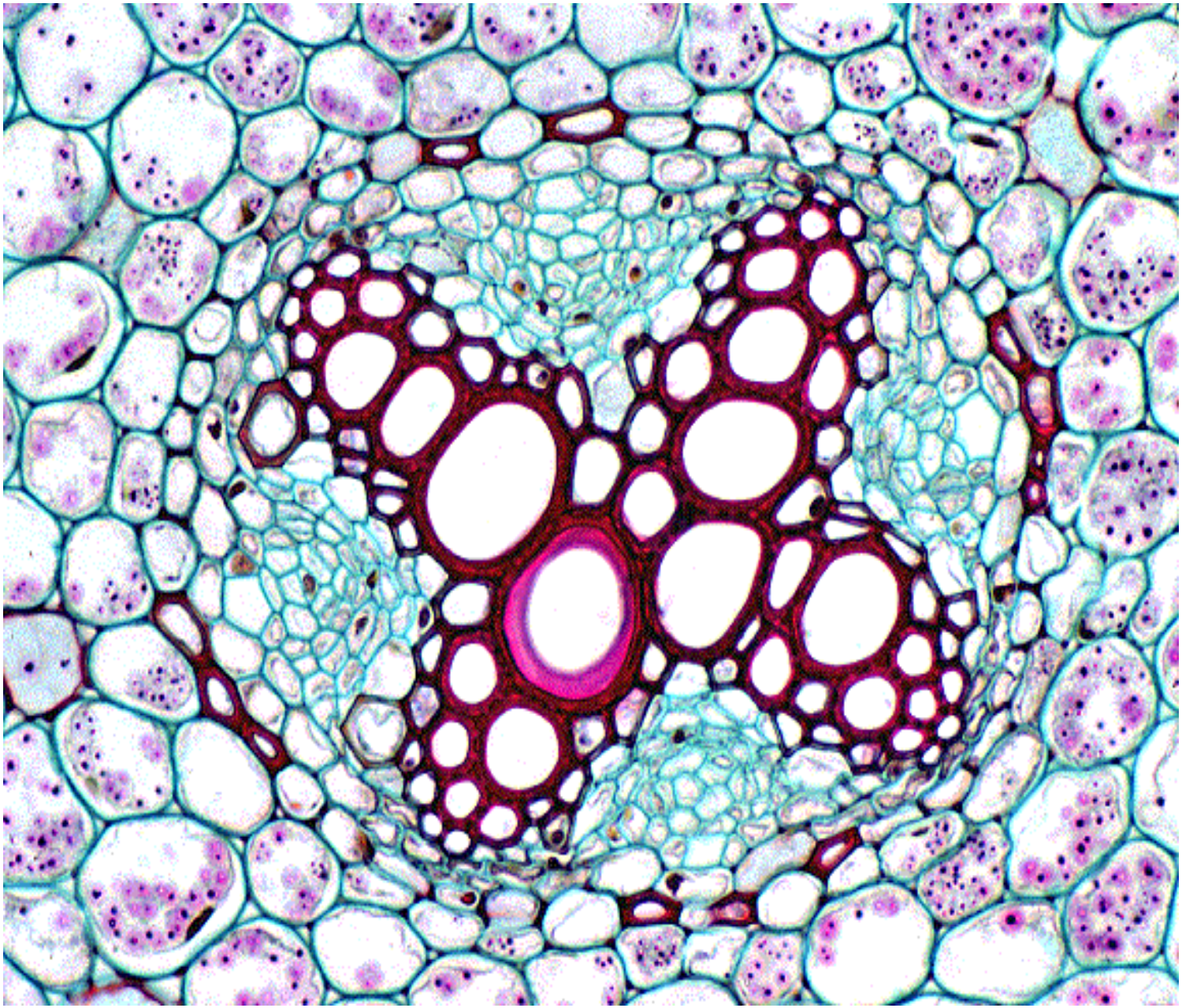
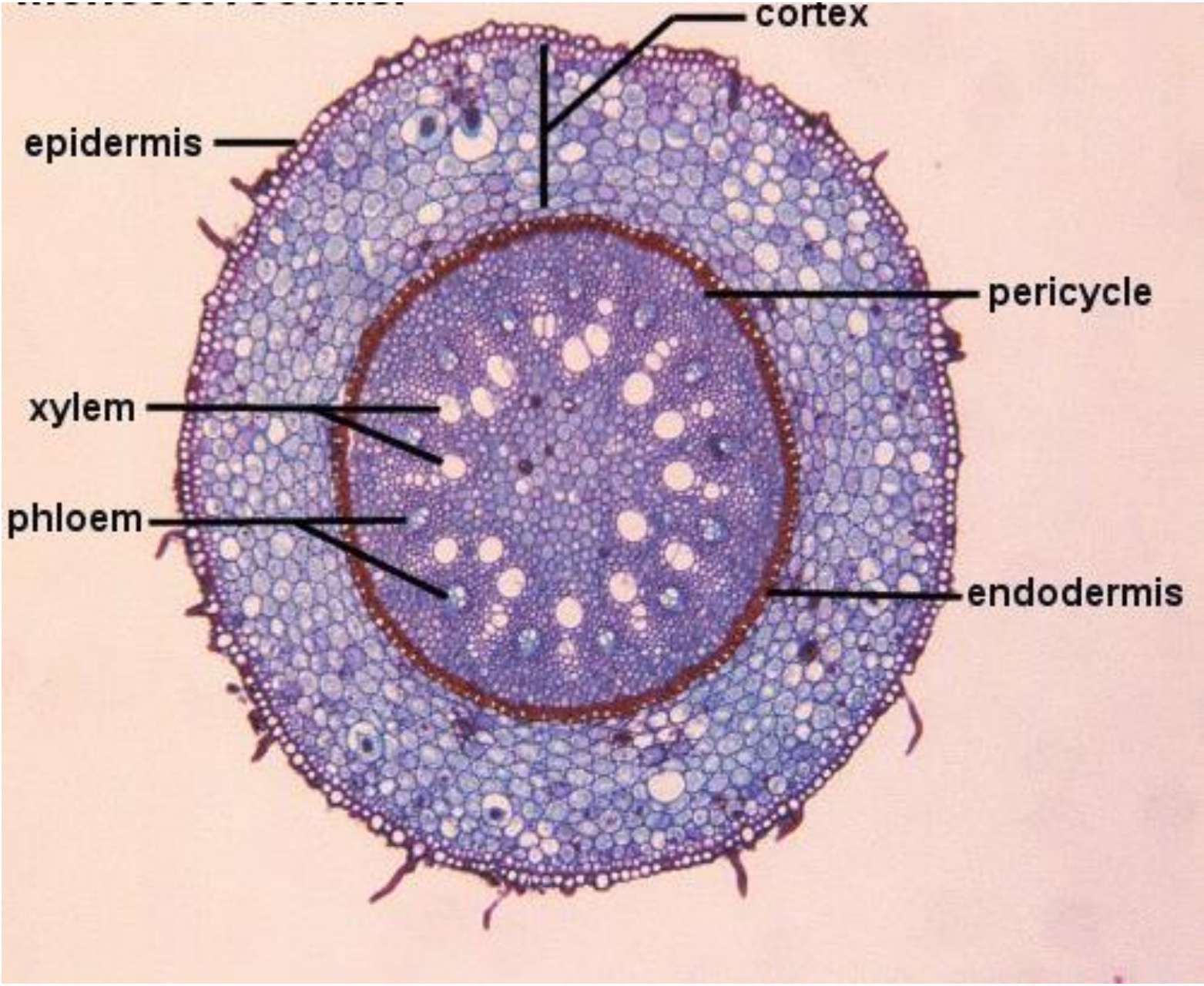


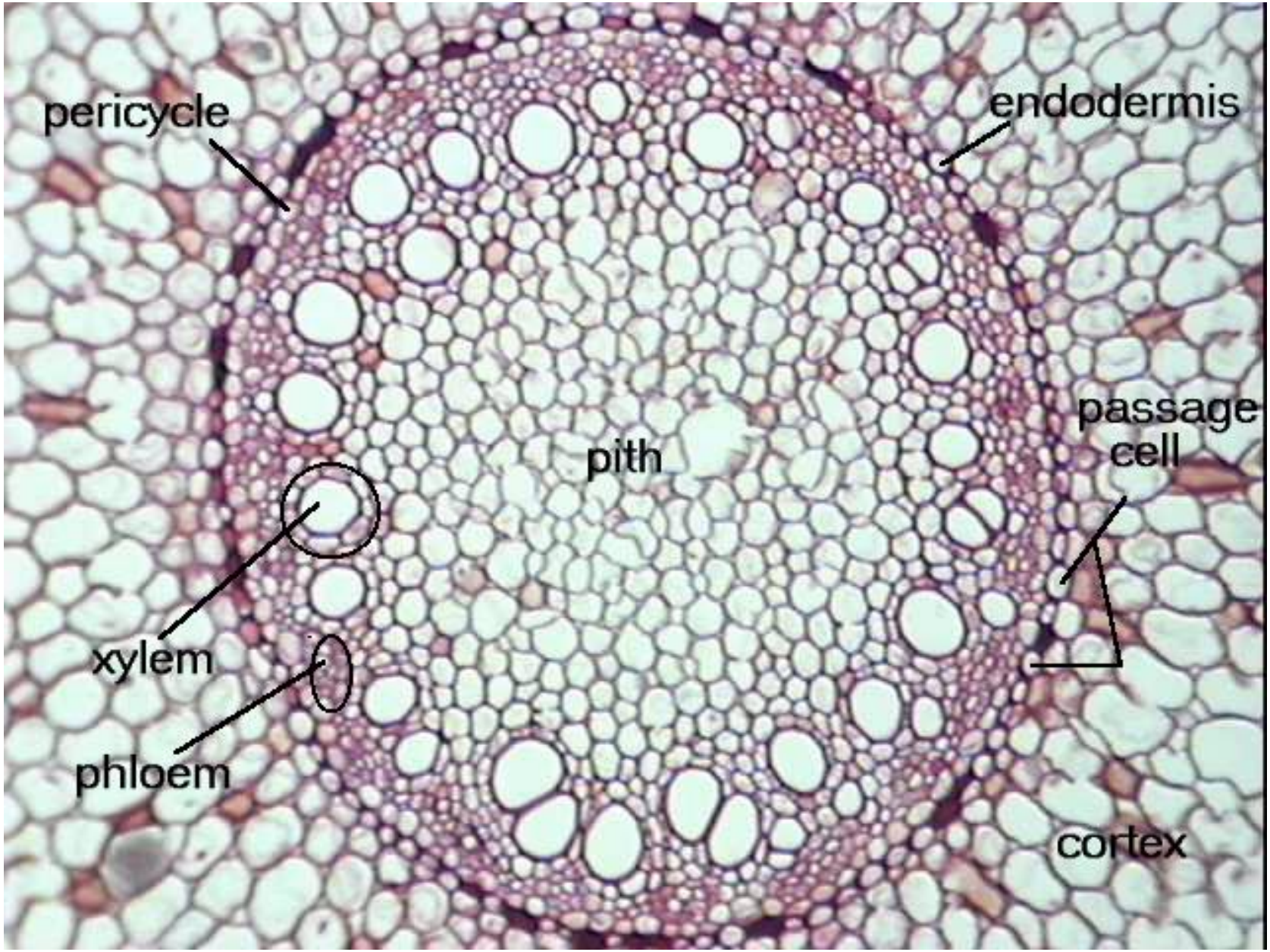
Diagram and T.S. of a young dicot root.

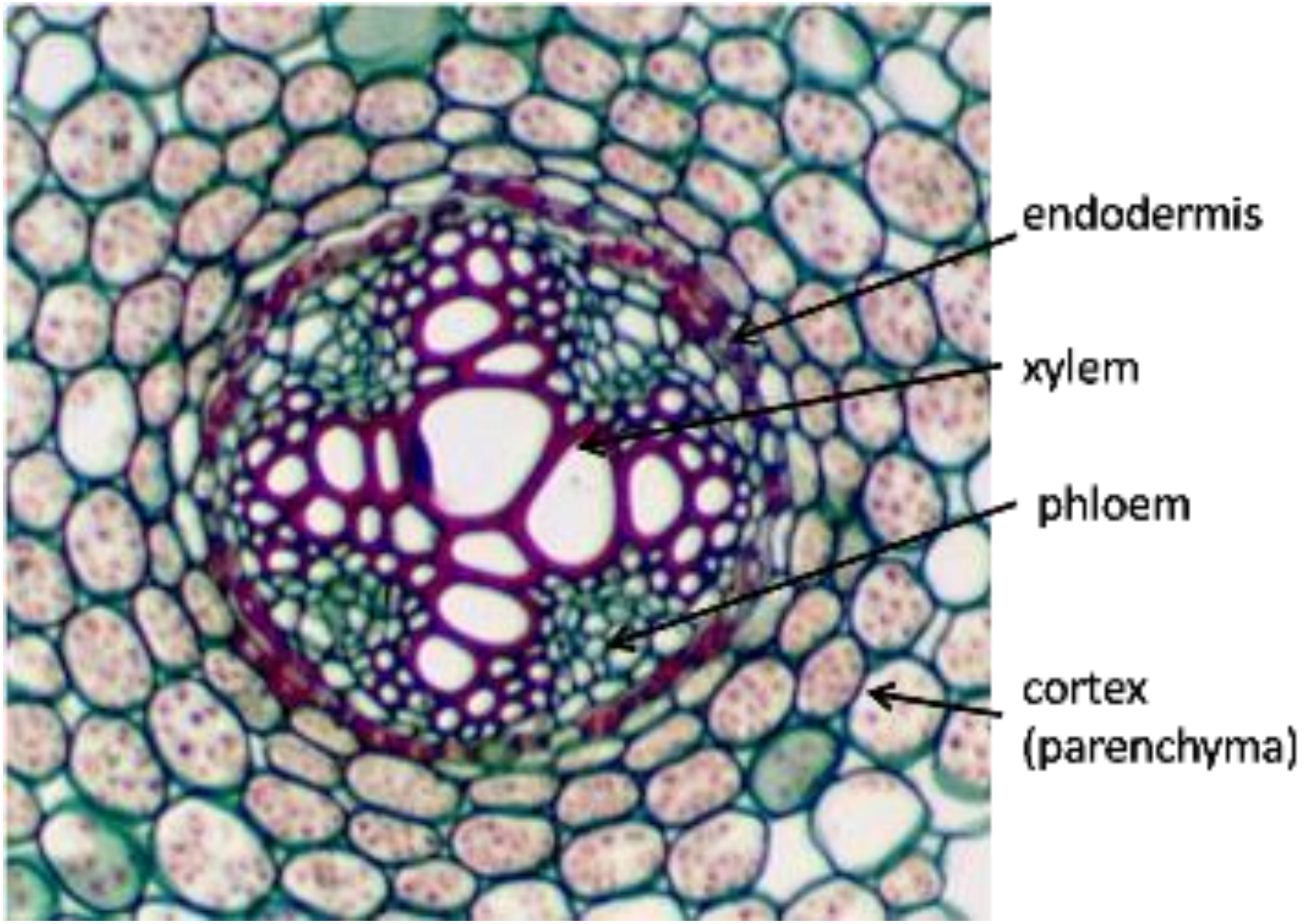
قطاع عرضى فى جذر من ذوات الفلقتين






cortex
epidermis
pericycle
xylem
phloem
endodermis


pericycle
endodermis
passage cell
pith
xylem
phloem
cortex


endodermis
xylem
phloem
cortex
(parenchyma)