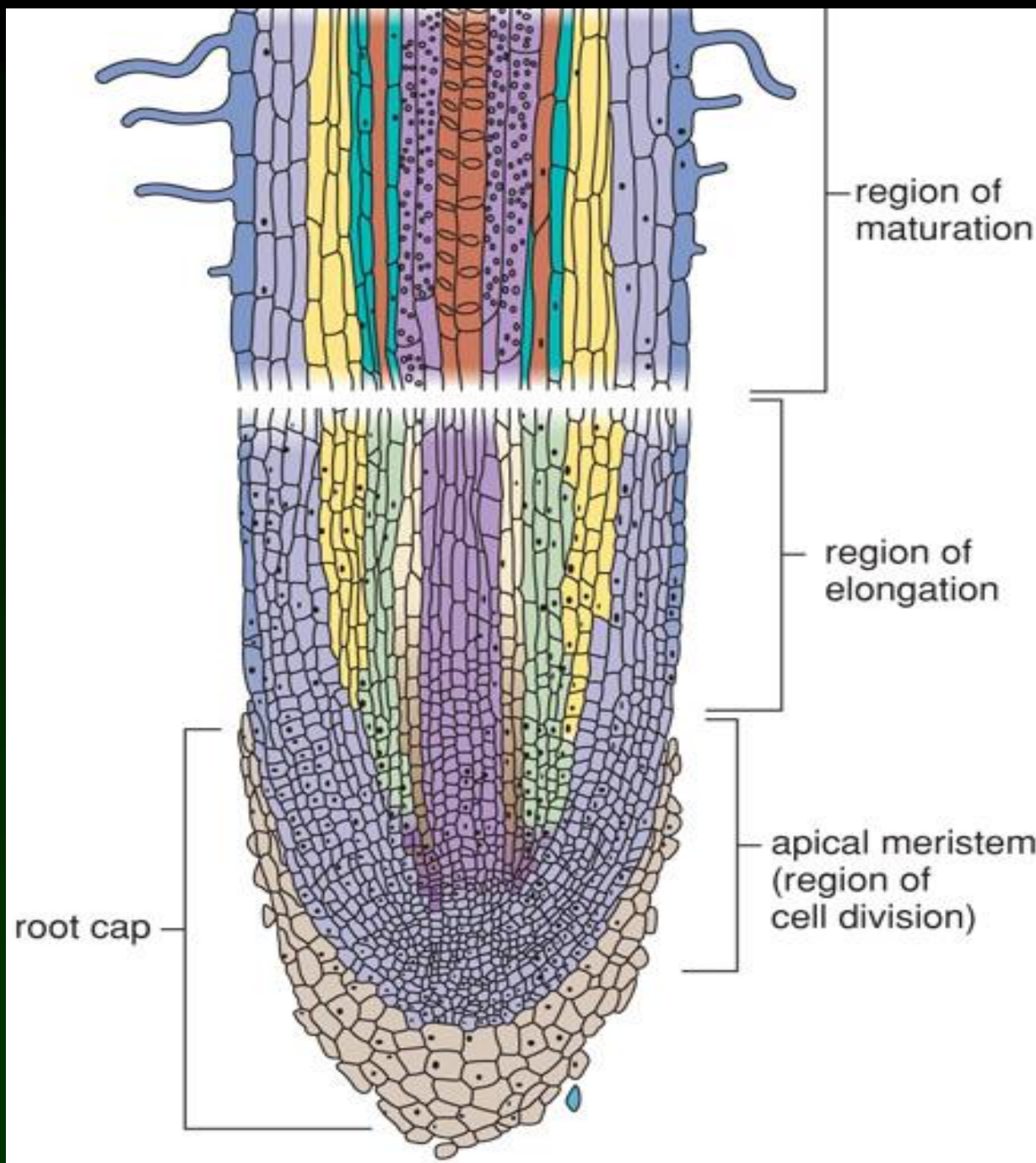


Roots & Soils&cells and tissues

DR. Haitham Kurbaj



Root Structure ...

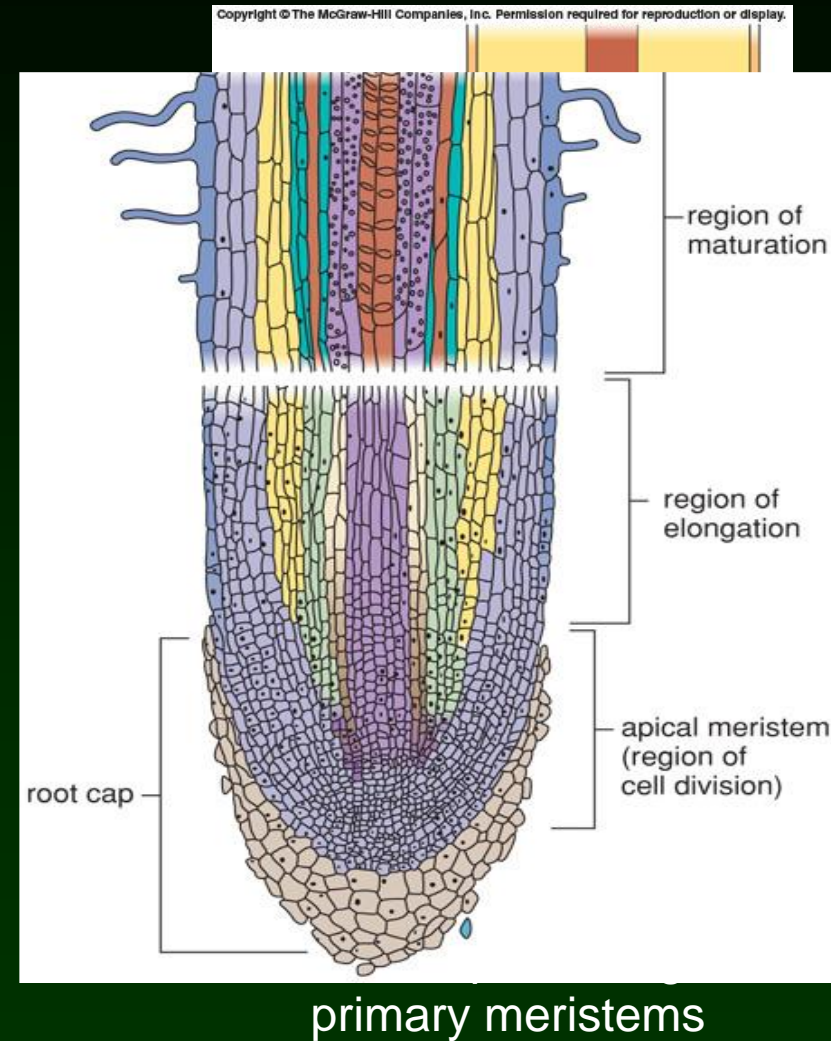
2. Region of Cell Division

3. Region of Elongation:

4. Region of Maturation

- Cells Differentiate,
Specialize, and Mature
to become different
cell types.

- HOW:



Root Structure ...

B. MATURE TISSUES produced by Region of Maturation

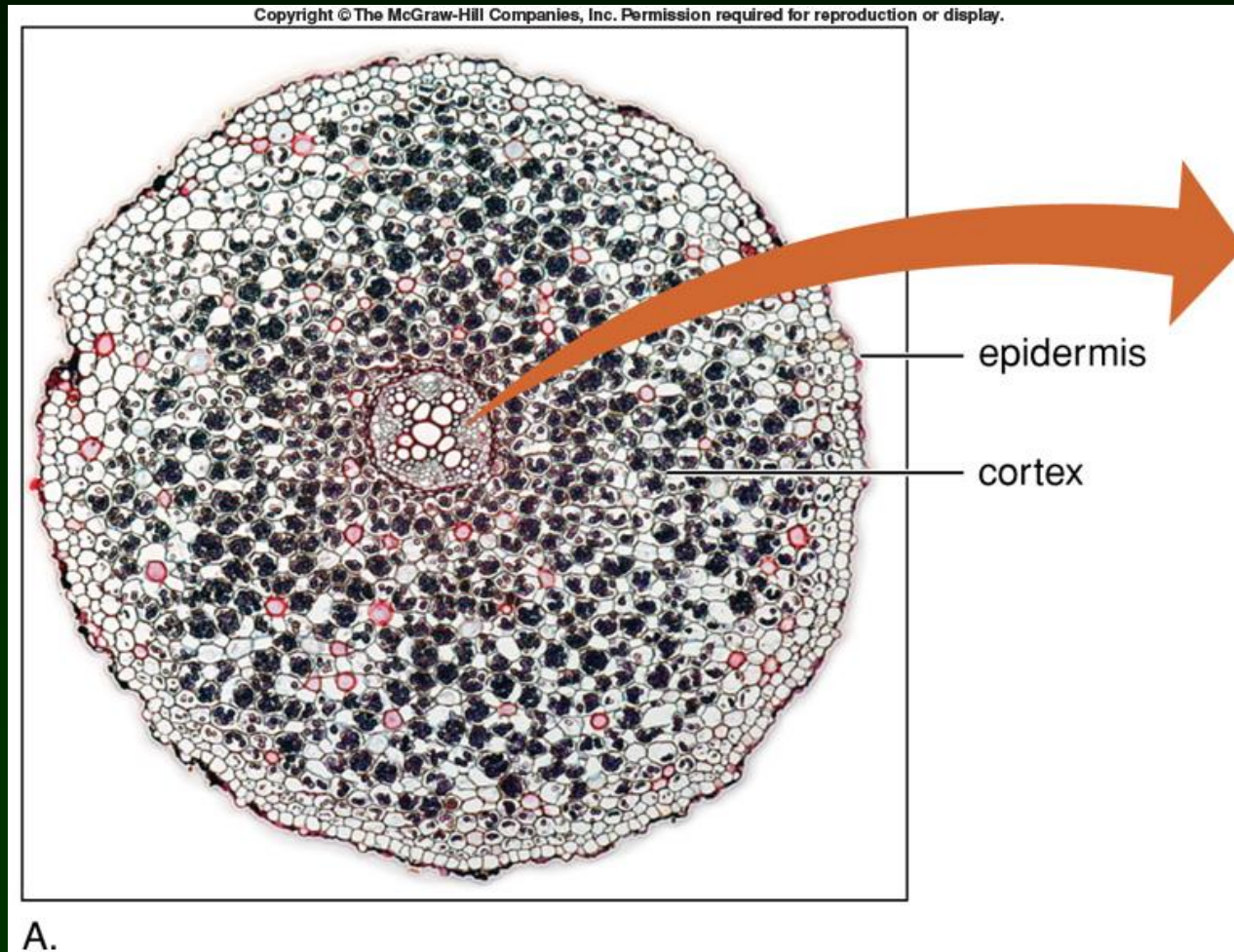
- EPIDERMIS:
 - Root hair Cells
 - Root Hairs
 - Function



Root hair zone of radish seedling

Root Structure ...

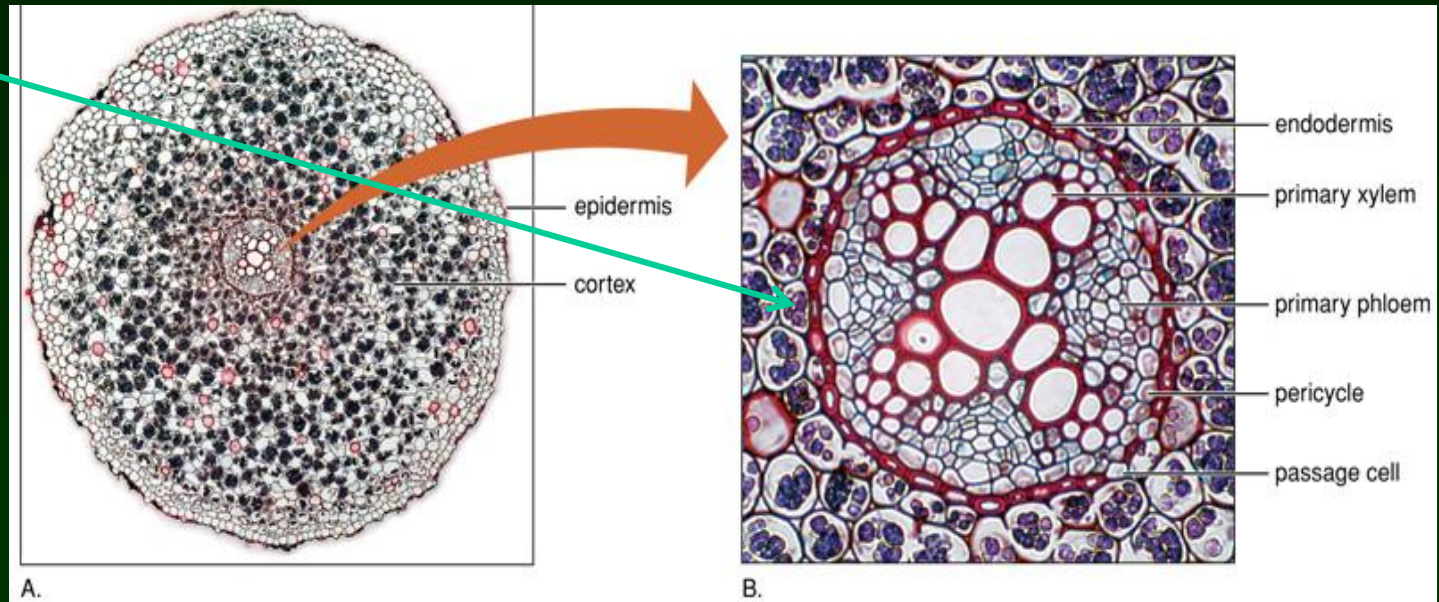
- **Cortex** - Region inside to epidermis
 - Tissue and cells:
 - Function:



Cross section of
dicot root

Root Structure ... Cortex ...

- Endodermis - Inner boundary of cortex
- =
- Casparian Strip: wax (suberin) around Endodermis
 - o Function: Substances moving in from soil with water must enter through endodermis cell membrane = control over _____

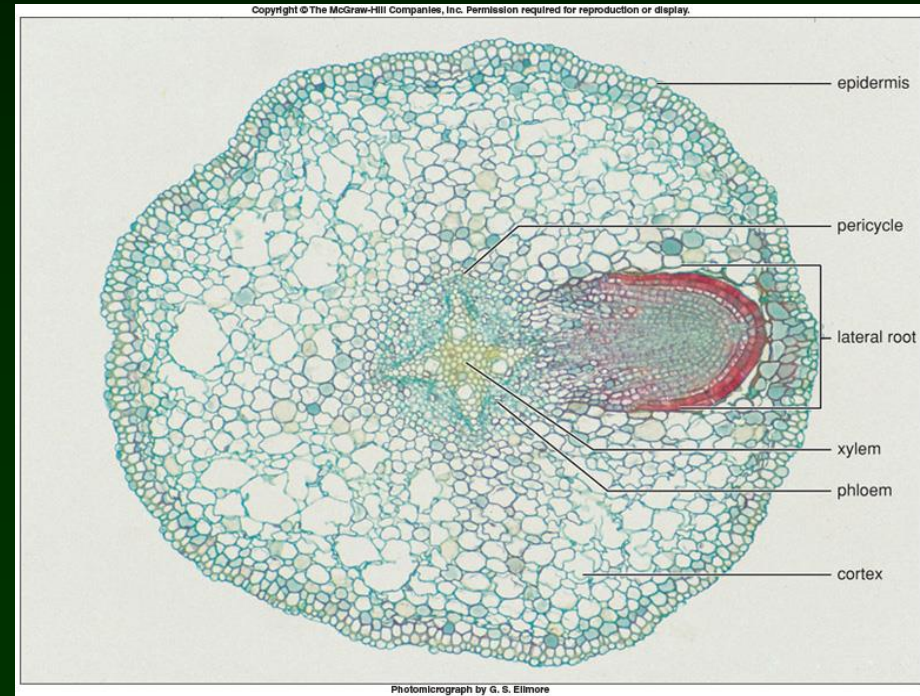
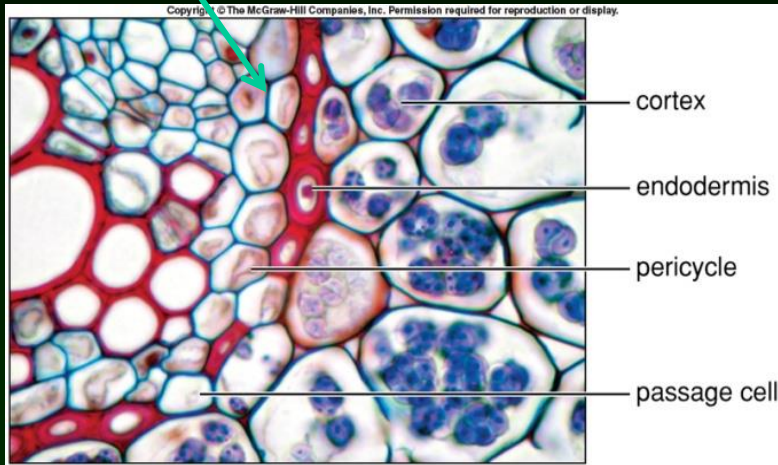


Enlargement of vascular cylinder of dicot root

Root Structure ...

- Vascular cylinder – Region
 - **Pericycle** – outermost layer/region of Cylinder
 - Function:

and dicot

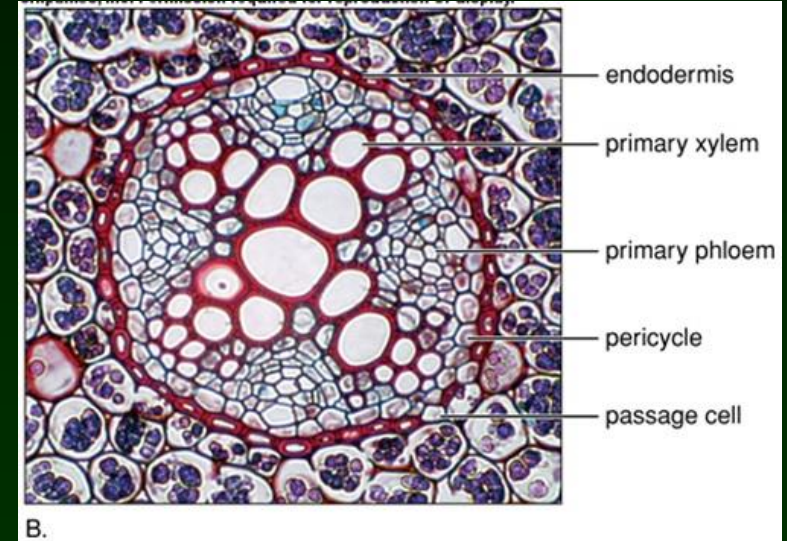
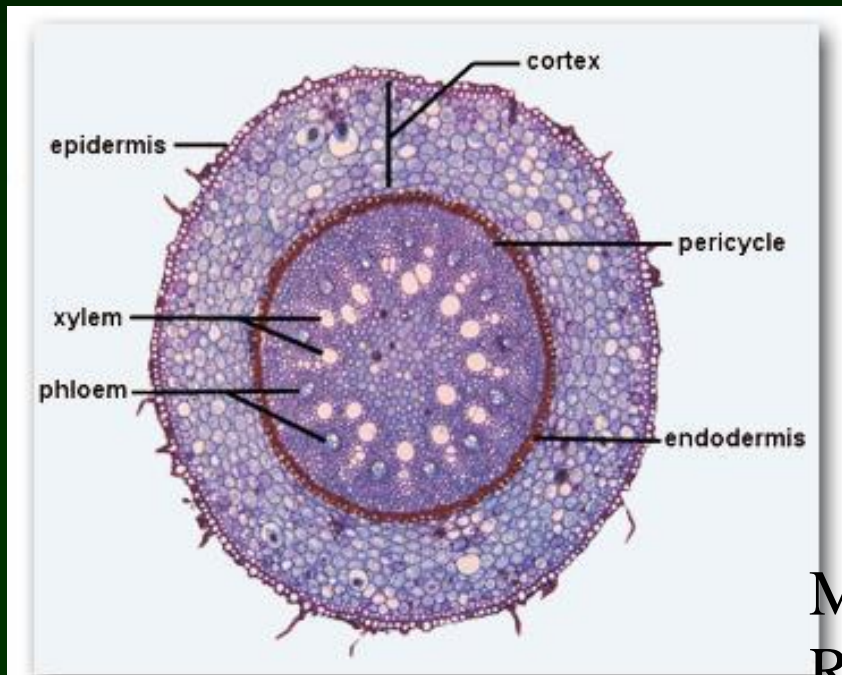


Lateral root formation

Root Structure ...

Vascular Cylinder ...

- **Xylem T.:** with Vessel Elements
- **Phloem T.** with Sieve-tube Elements and Companion Cells
- Other tissue patterns:



Vascular cylinder
of dicot root

Monocot
Root

❖ Propagative Roots

- Suckers/Adventitious buds; - Develop into aerial stems
 - Example: Fruit Trees



Specialized Roots

❖ Pneumatophores

- water plants
 - Gas exchange

Example:

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A.



B.

Lani Stemmerman

Mangrove pneumatophores

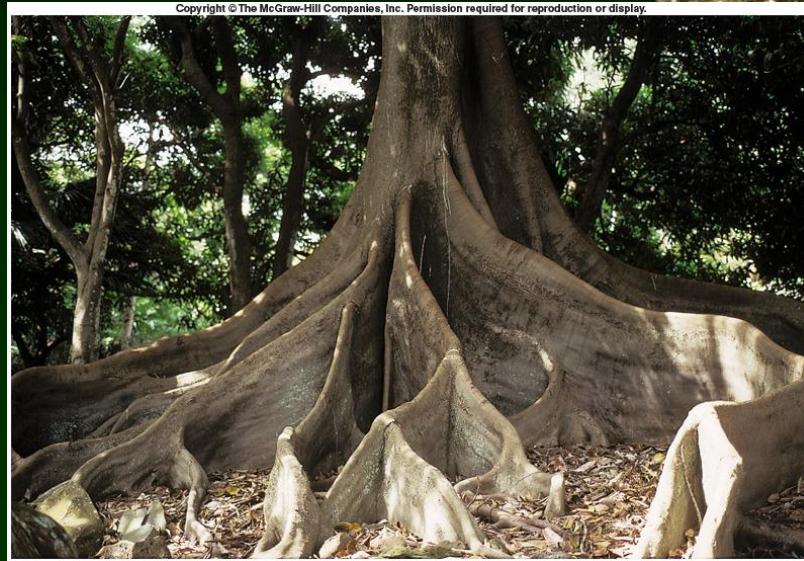
Specialized Roots

❖ Prop Roots



❖ Buttress Roots

- Function:
- Tropical Trees



Buttress roots of
tropical fig tree

Specialized Roots

❖ Contractile Roots

- Function
 - Lilly bulbs, dandelions

❖ Parasitic Roots

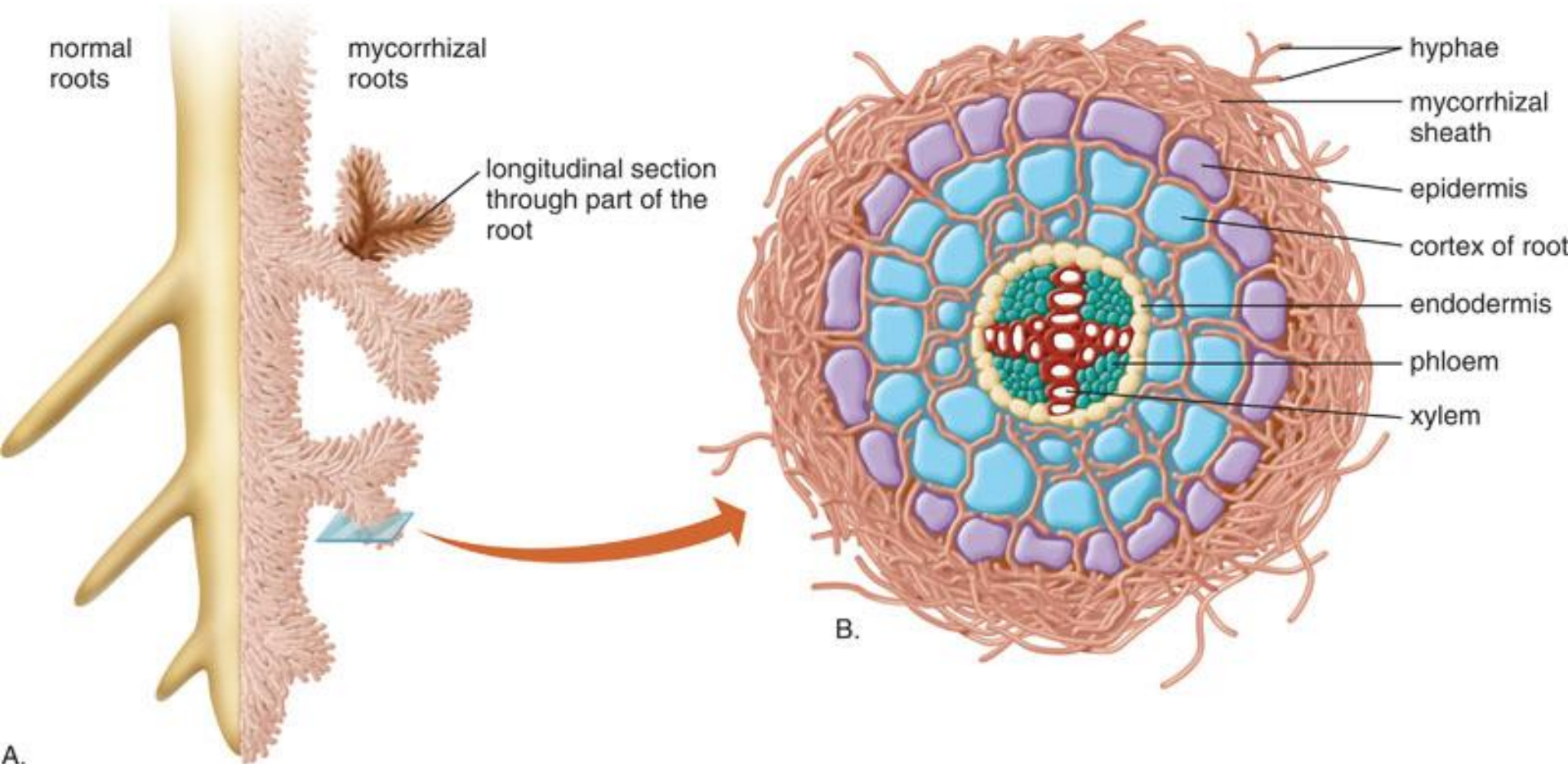


Mycorrhizae

- ❖ **Mycorrhizae** - Fungi that form a mutualistic association with plant roots
 - **Mutualistic association:** + + Both organisms benefit
 - Plant benefits: more water and nutrients, (phosphorus)
 - Fungi benefits: sugars and amino acids to fungus.

Mycorrhizae

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Root Nodules

❖ Bacteria and Plants:

- Nitrogen-fixing Bacteria: convert N_2 into nitrates for roots.
- **Root nodules** contain large numbers of nitrogen-fixing bacteria.
- Legume Family (Fabaceae)

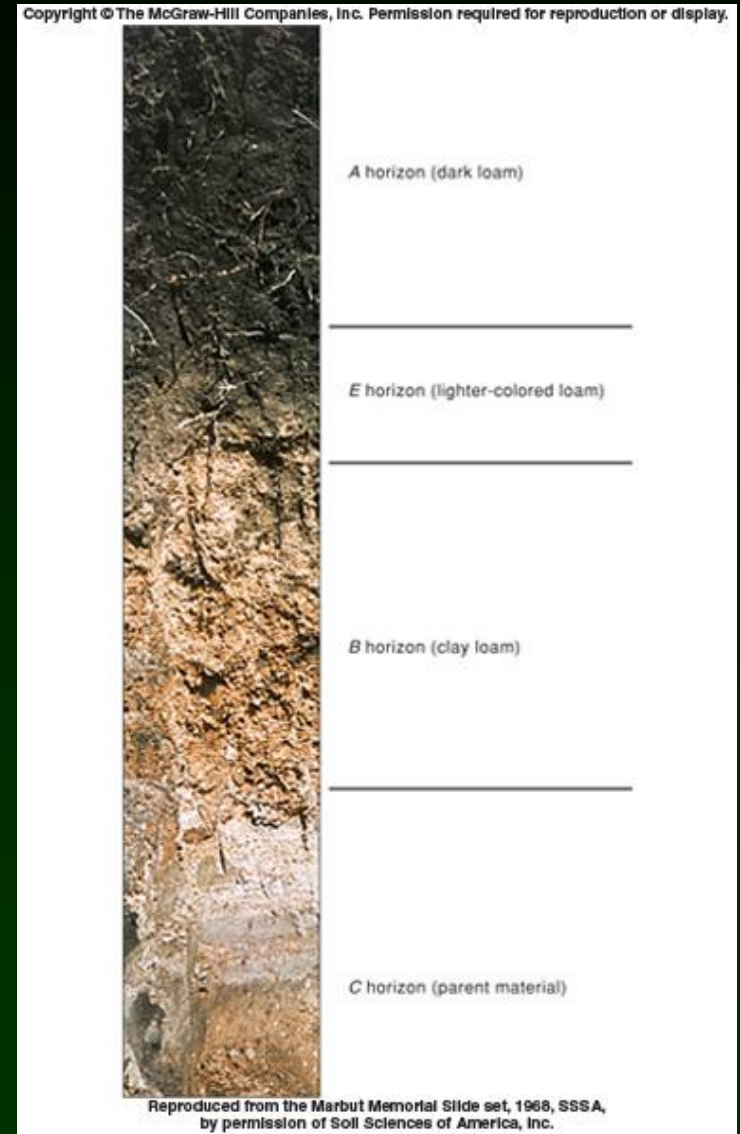


Root nodules on roots

Soils

❖ Soil Layers = horizons:

- Topsoil
 - A horizon - Dark loam, more organic material
 - E horizon - Light loam
- B Horizon - Subsoil
 - More clay, lighter in color
- C Horizon - Parent material



Soil profile

Soils

Parent Material

❖ Parent material - Rock

- Rock types:
 - Igneous – Volcanic
 - Sedimentary - Deposited by glaciers, water or wind
 - Metamorphic – Pressure or Heat Changes igneous or sedimentary

Soils Climate

❖ Climate Affects

- Deserts – Low weathering by rain → soils poorly developed
- Moderate rainfall Areas → Well-developed soils
- High rainfall Areas → minerals leached out

Soils

Living Organisms and Organic Composition

- **Bacteria and fungi:** decompose organic material to inorganic chemicals
- **Animals:** activities and wastes.
- **Humus** - Partially decomposed organic matter, dark
- **Roots and living organisms:**
 - produce carbon dioxide + H₂O → weak acids
 - increases rock dissolution into minerals.

Soils

Soil Texture and Mineral Composition

❖ Soil Texture – particle sizes

- **Sand** – Visible particles
 - Drain too quickly
- **Silt** - Particles small; need microscope
- **Clay** - seen with e- microscope
 - Clay particles = **Micelles**
 - charged and attract +ions = Mg^{++} and K^+

Soils

- ❖ **Best soils: 40% silt, 40% sand and 20% clay**
- ❖ **Soil Structure** - Arrangement of soil particles into aggregates
 - pore spaces occupying 40-60% of soil .

Soils

Water in the Soil

- ❖ **Hygroscopic Water** - Physically bound to soil
→ unavailable
- ❖ **Gravitational Water** - Drains out of pores
- ❖ **Capillary Water** - held against gravity in pores
 - Plants mostly dependent upon
 - Affected by organic matter and underground water

Soils

Soil pH

❖ **Alkalinity: some minerals less available**

- copper, iron and manganese
- Solution: adding sulfur
 - → sulfuric acid by bacteria, or by
 - add nitrogen fertilizers

❖ **Acidity inhibits nitrogen-fixing bacteria.**

- Solution: **liming** = add calcium or magnesium



Plant Tissues

**Meristems, Simple Tissues, &
Complex Tissues**

Meristematic tissues – localized regions of cell division

❖ Apical Meristems

- Primary or Transitional Meristem → Primary growth
 - Protoderm → gives rise to epidermis
 - Ground meristem → gives rise to ground tissue
 - Procambium → gives rise to 1° vascular tissue

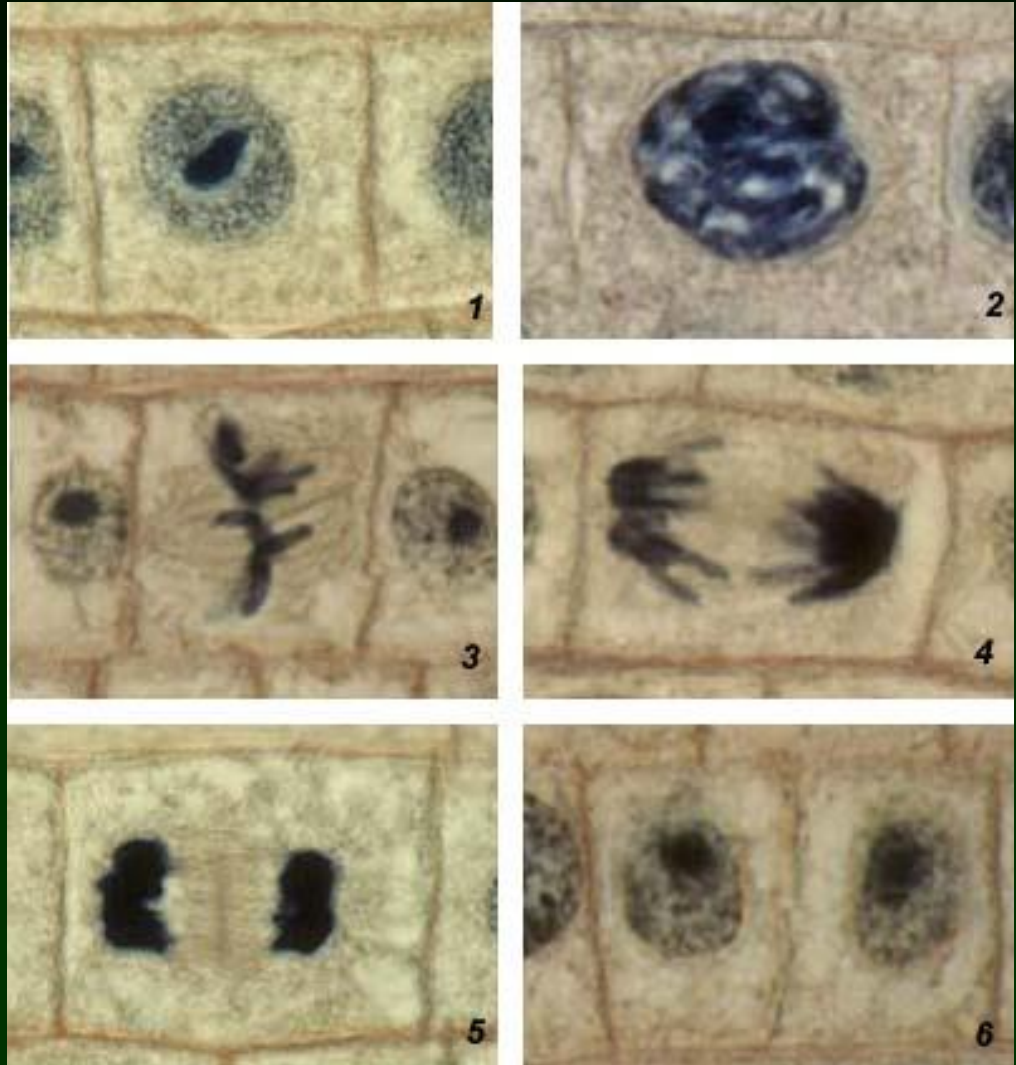
❖ Lateral Meristems

- Vascular cambium → 2° vascular tissue
- Cork cambium or phellogen → periderm

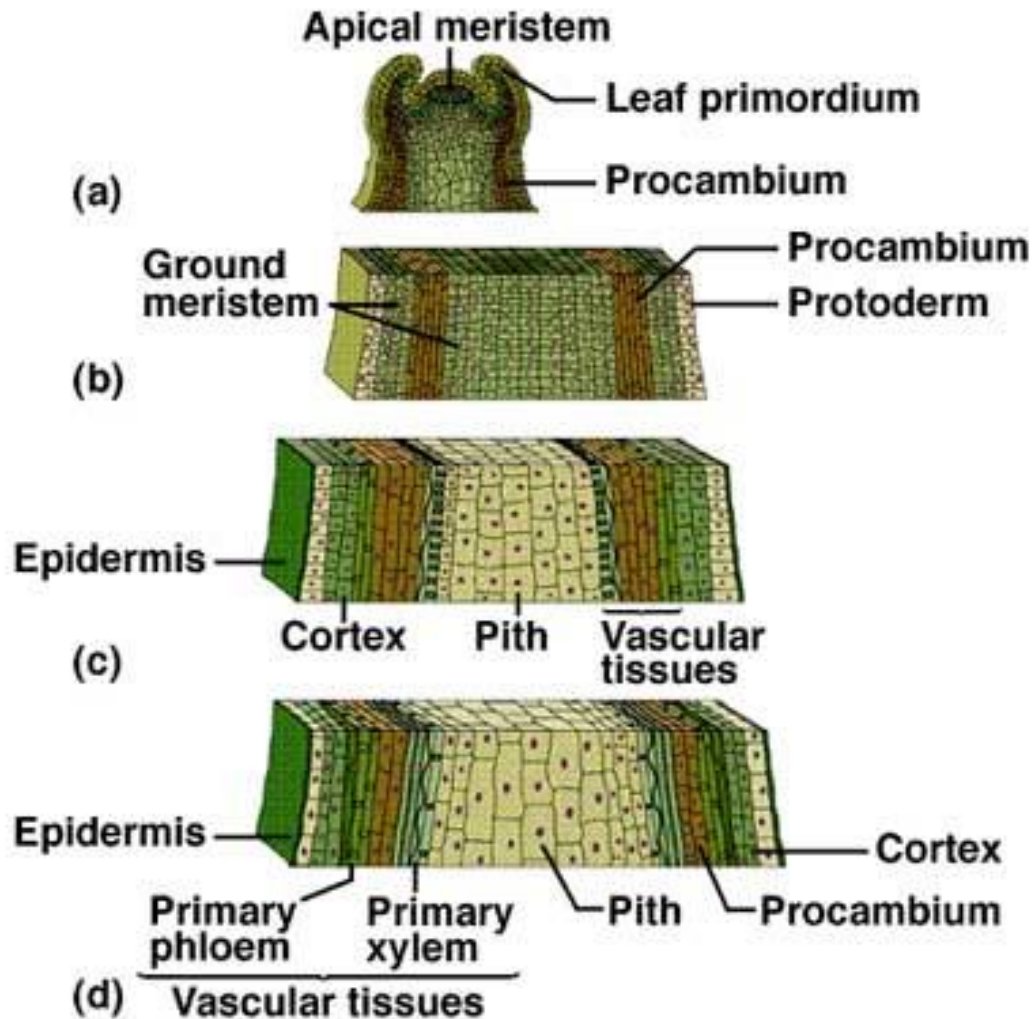
❖ Intercalary Meristems (found in the nodes of grasses)

CELL DIVISION: MITOSIS (nuclear division) + Cytokinesis (cytoplasmic division)

1. Interphase
2. Prophase
3. Metaphase
4. Anaphase
5. Telophase
6. Cytokinesis

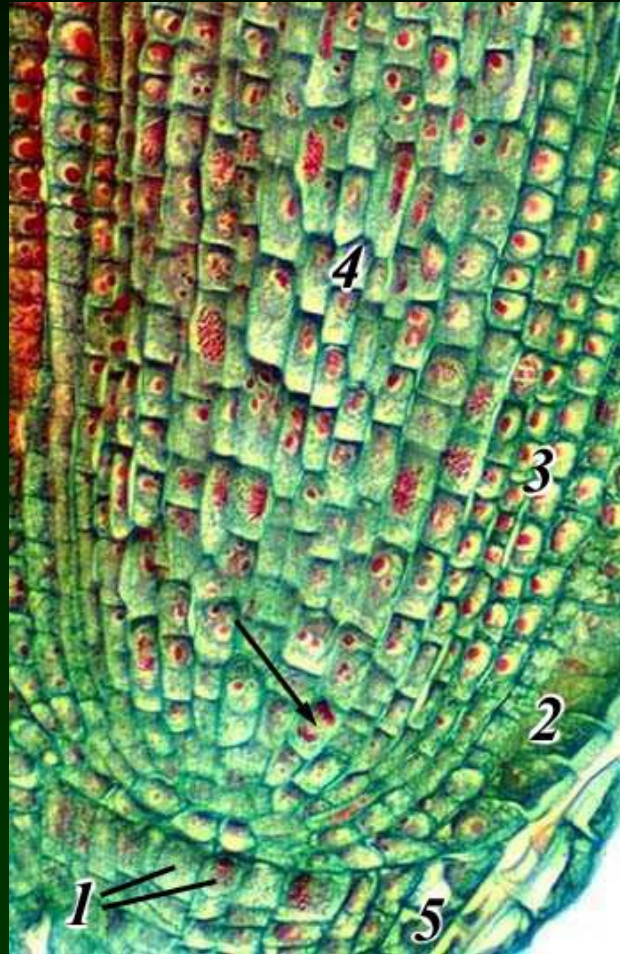


Shoot Apical Meristem

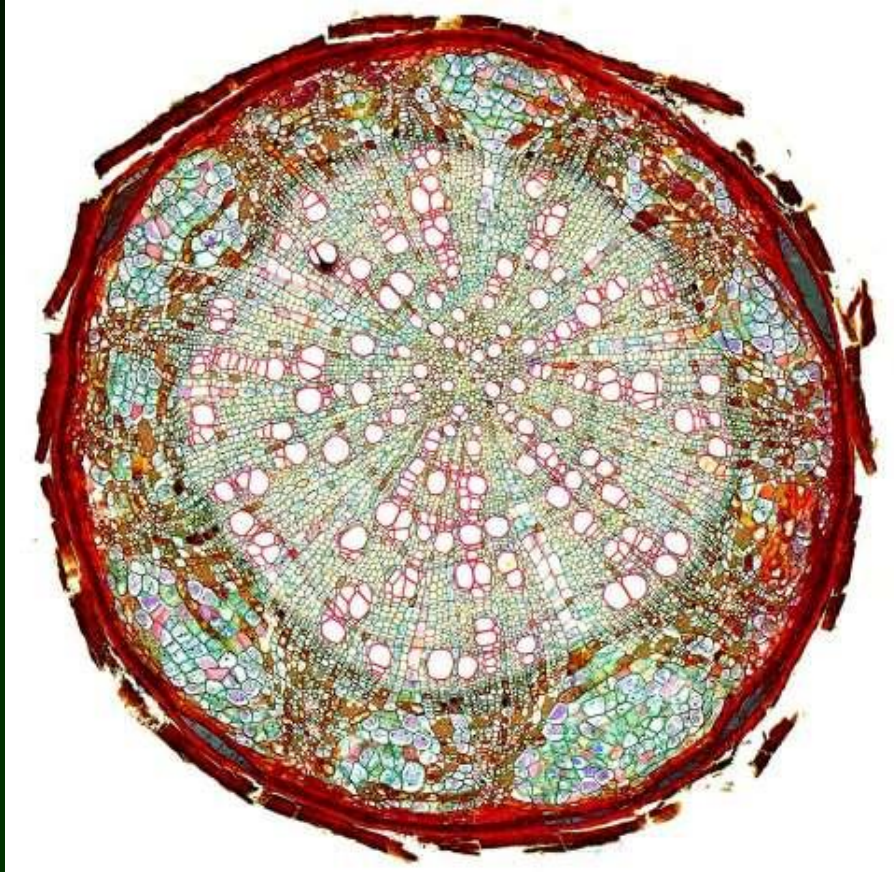


Root Apical Meristem

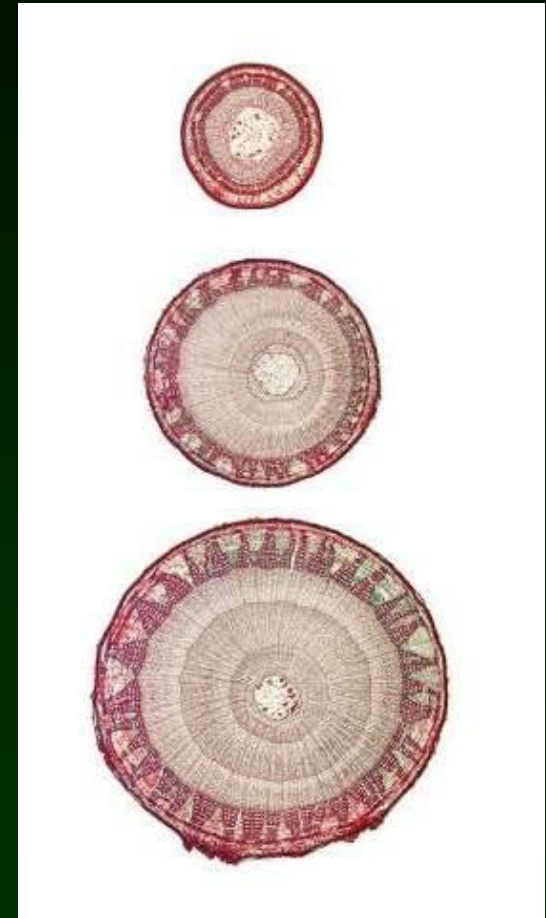
1. Root cap initials
2. Protoderm
3. Ground meristem
4. Procambium
5. Root cap



Lateral Meristems – secondary growth in woody plants



Basswood – root in cross section

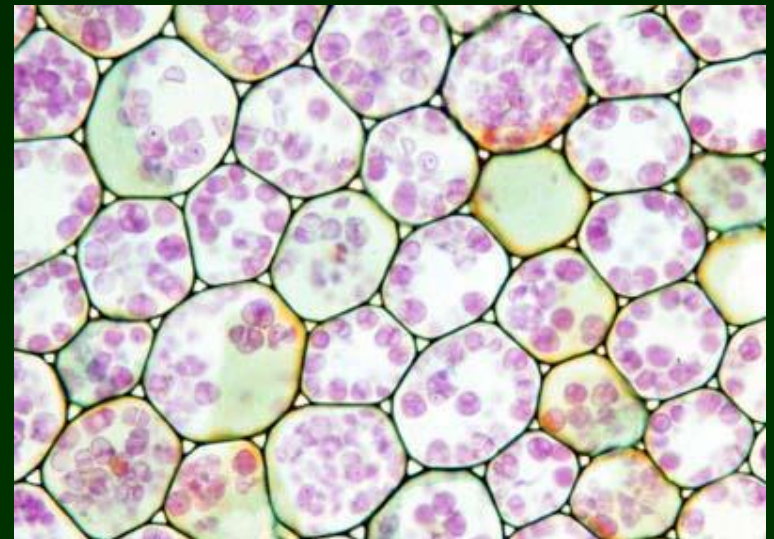
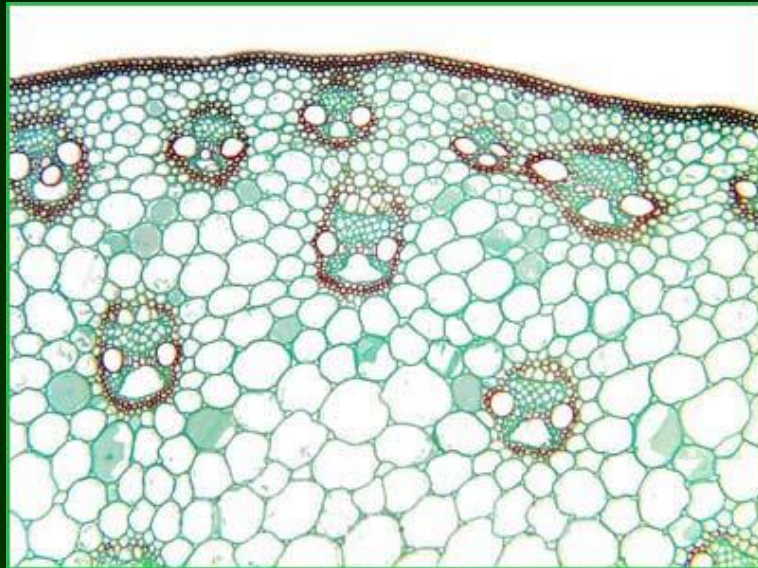
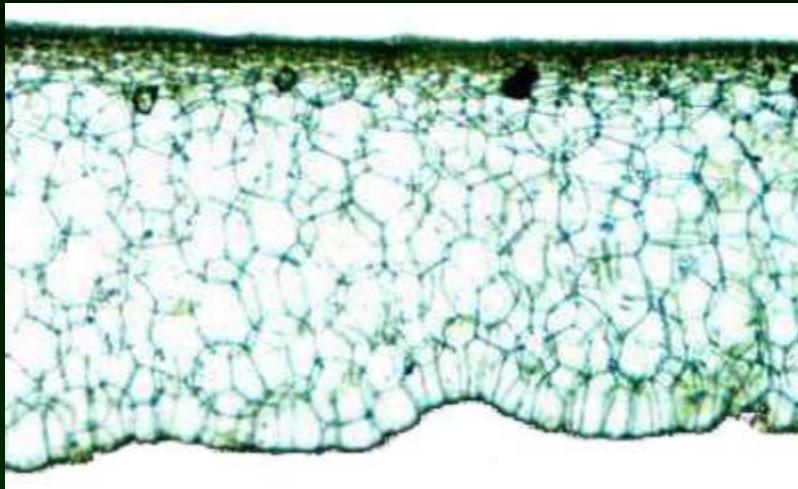


Basswood – stem in cross section; 1, 2, 3 year old stems

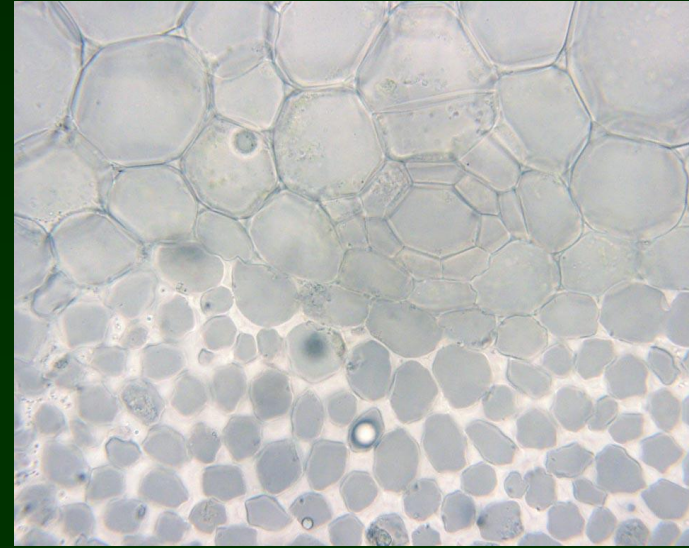
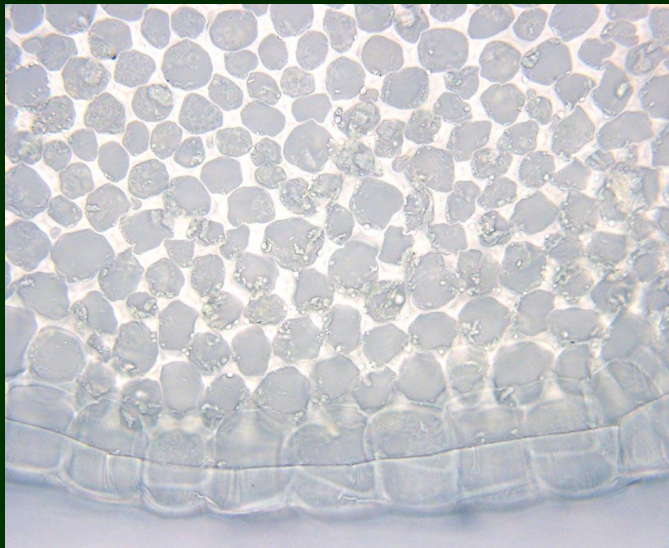
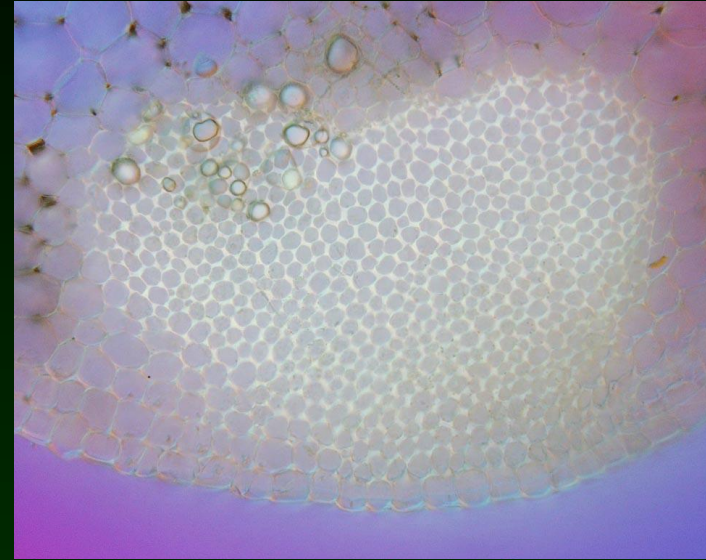
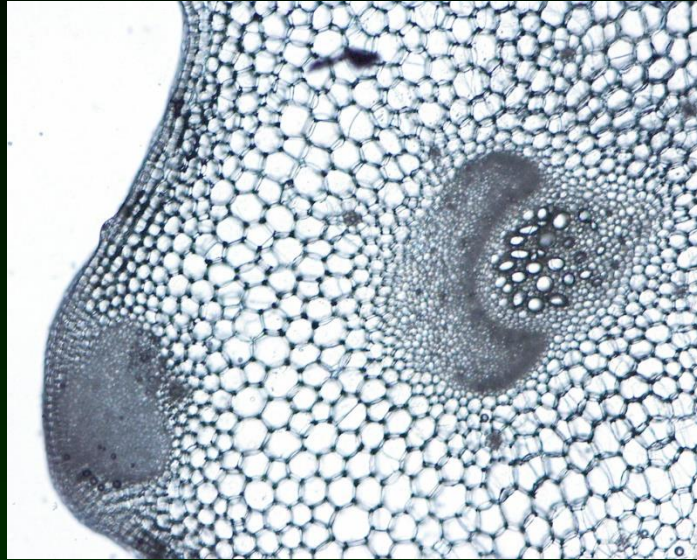
Simple Tissues – consisting of one cell type

- ❖ Parenchyma
- ❖ Collenchyma Sclerenchyma –
- ❖ **Sclerids or stone cells –**
- ❖ Epidermis – alive at maturity
 - Trichomes – “pubescence” or hairs on epidermis
 - Root Hairs – tubular extensions of epidermal cells

Parenchyma – thin walled & alive at maturity; often multifaceted.

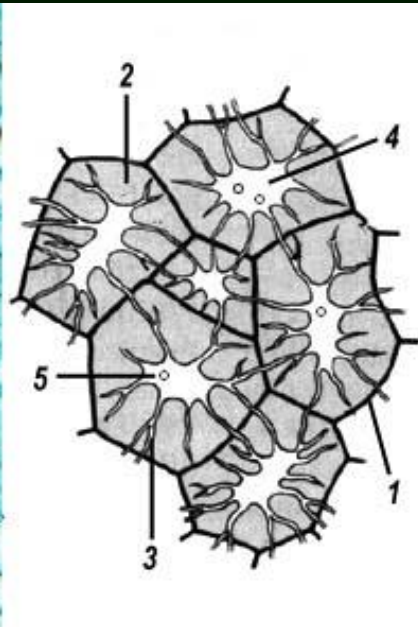


Collenchyma – thick walled & alive at maturity

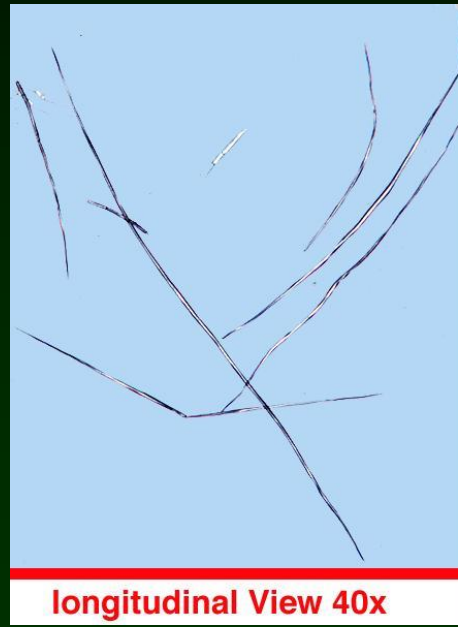


Sclerenchyma – thick walled and dead at maturity

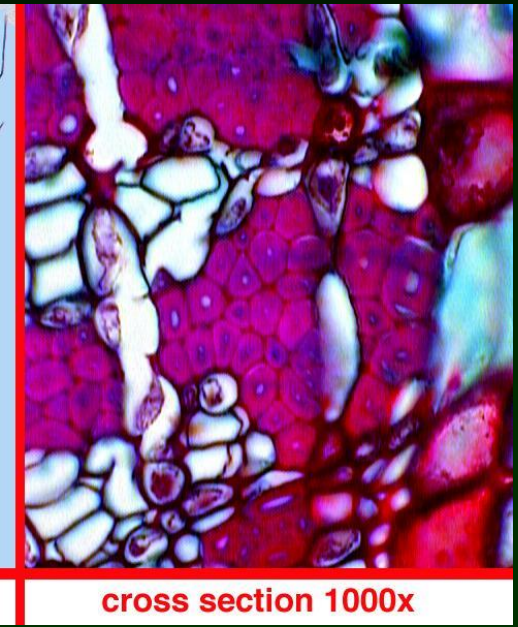
SCLERIDS



FIBERS

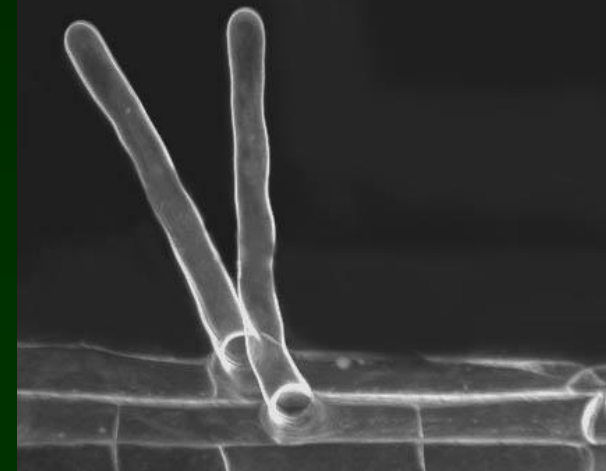
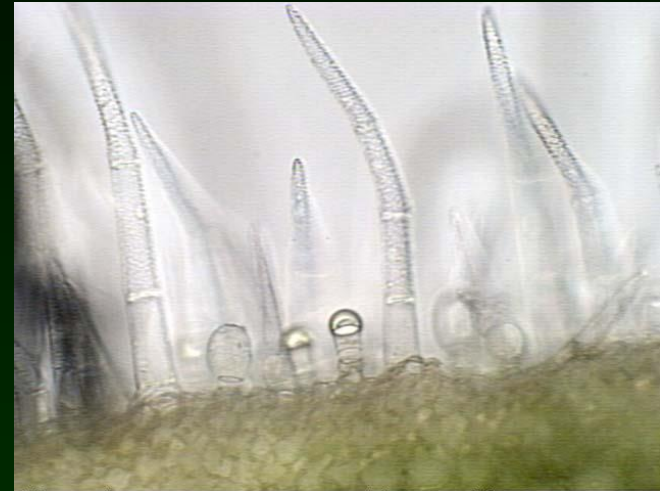


longitudinal View 40x



cross section 1000x

Epidermis – stoma, trichomes, & root hairs



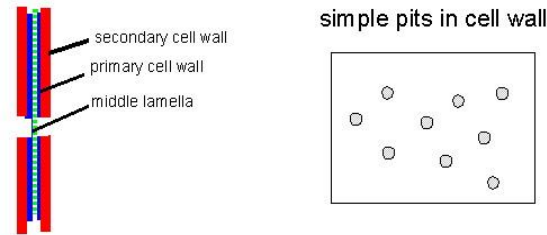
<http://www.ucd.ie/botany/Steer/hair/root hairs.html>

Complex Tissue

- ❖ **Xylem** – water conducting tissue; *parenchyma, fibers, vessels and/or tracheids, and ray cells.*
- ❖ **Phloem food conducting tissue**; *sieve-tube members (no nucleus at maturity, cytoplasm present), companion cells, fibers, parenchyma, and ray cells. In flowering plants, sieve-tube members and companion cells arise from the same mother cell.*
- ❖ **Periderm** – protective covering; *composed of cork and parenchyma.*
- ❖ **Secretory structures** – responsible for making latex, resins, nectar and other substances produced and stored in channels inside the plant body.

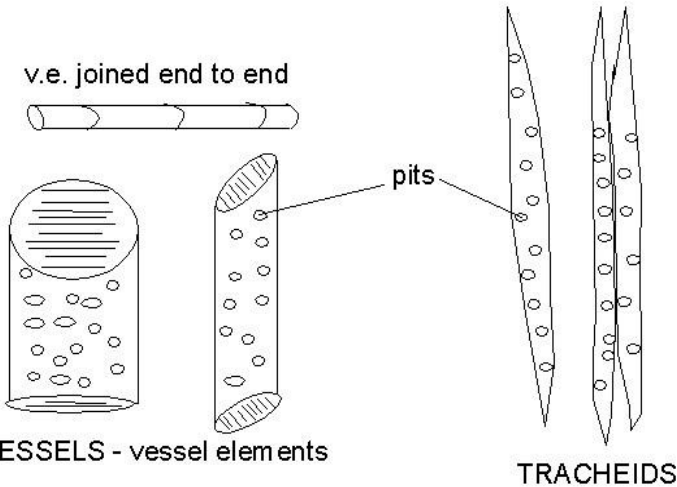
Xylem – water conducting tissue; parenchyma, fibers, vessels and/or tracheids, and ray cells.

SIMPLE PITS (middle lamella + thin primary cell wall)



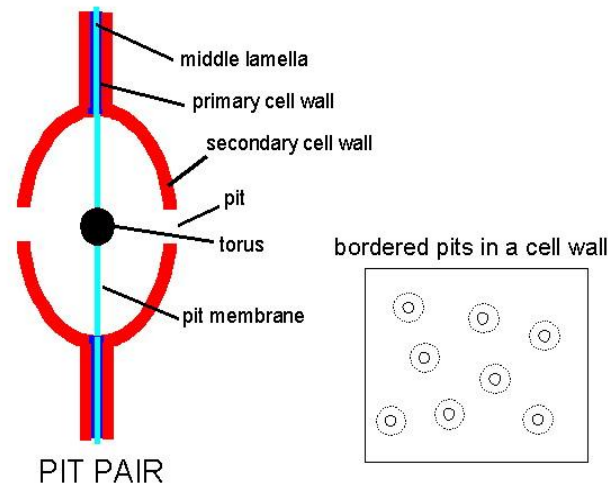
COMPONENTS OF XYLEM

v.e. joined end to end

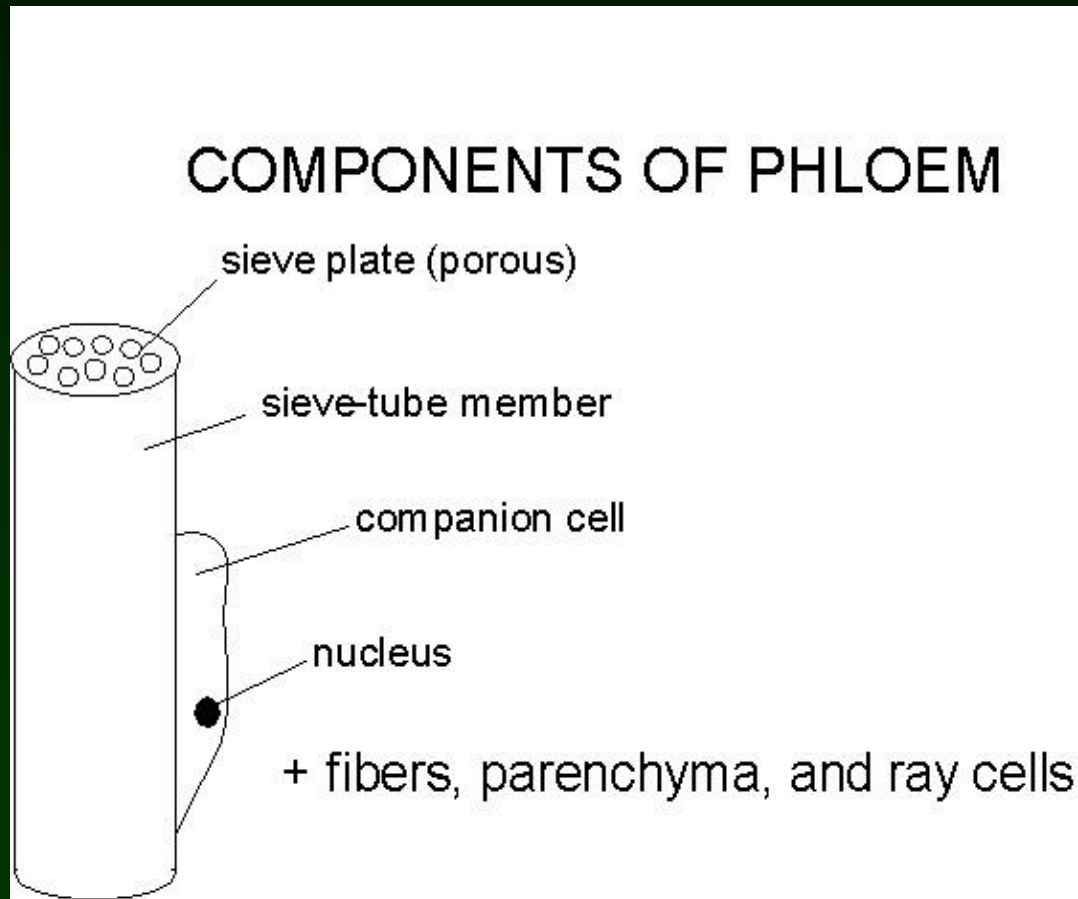


+ fibers, parenchyma, and ray cells

BORDERED PITS

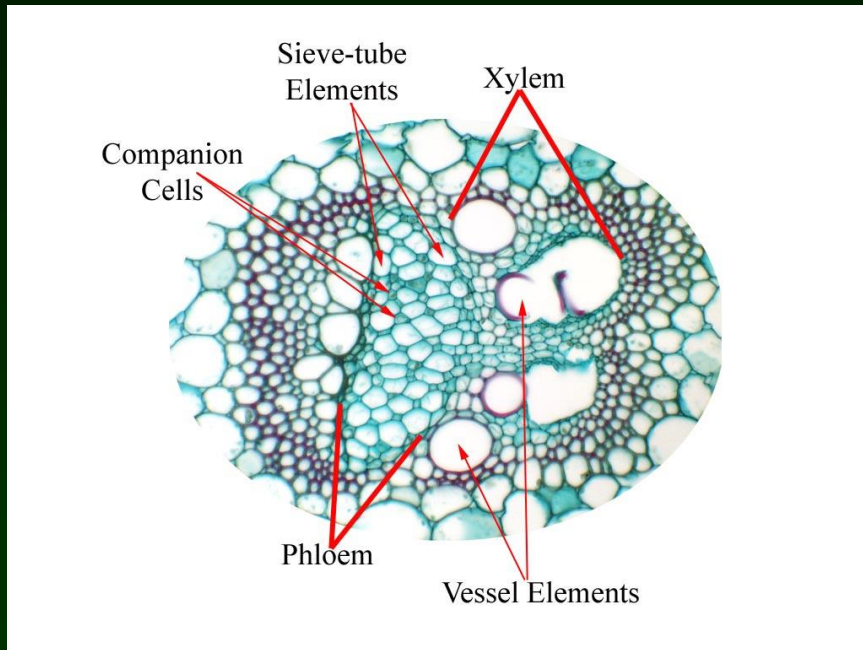


Phloem food conducting tissue; sieve-tube members (no nucleus at maturity, cytoplasm present), companion cells, fibers, *parenchyma*, and ray cells. In flowering plants, sieve-tube

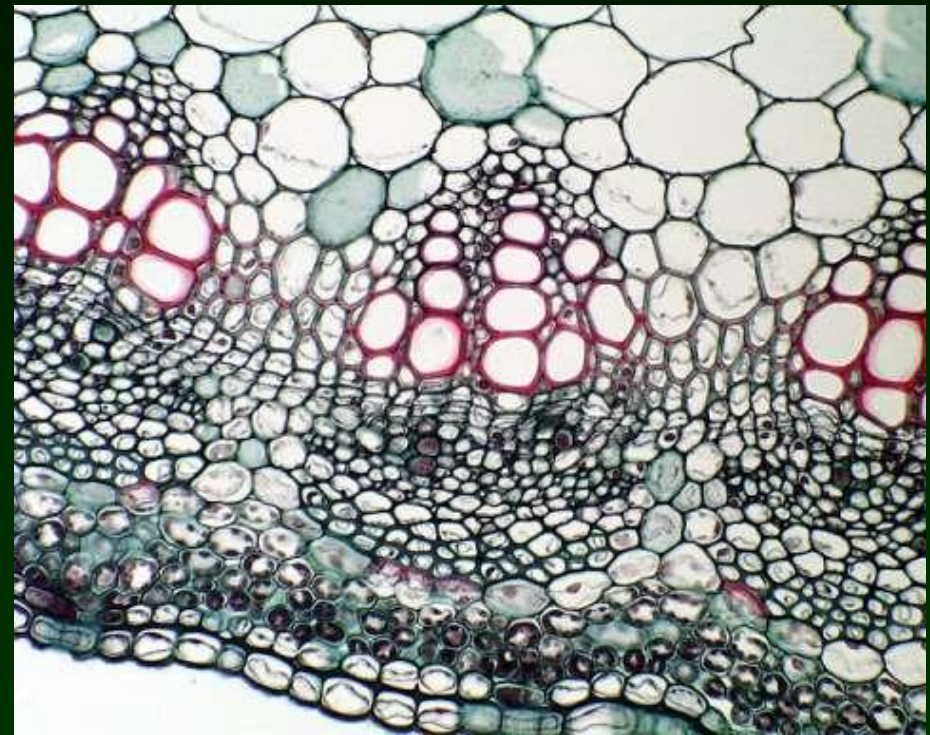


Vascular Bundles with xylem & phloem

Maize or Corn – vein in cross section

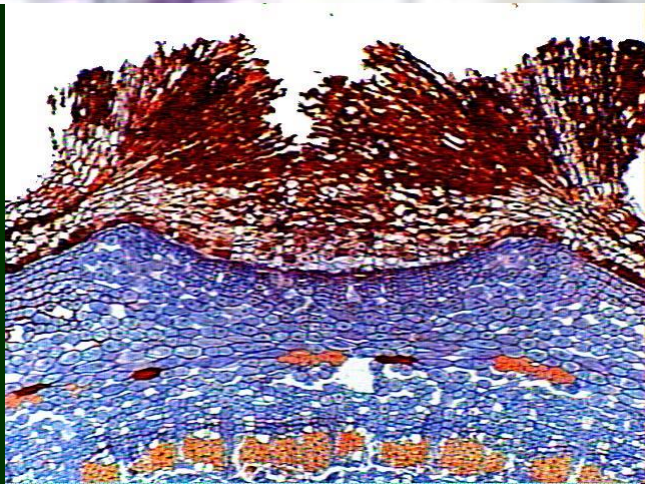


Alfalfa – vein in cross section



Periderm – cork & parenchyma

protective covering; composed of cork and *parenchyma*.



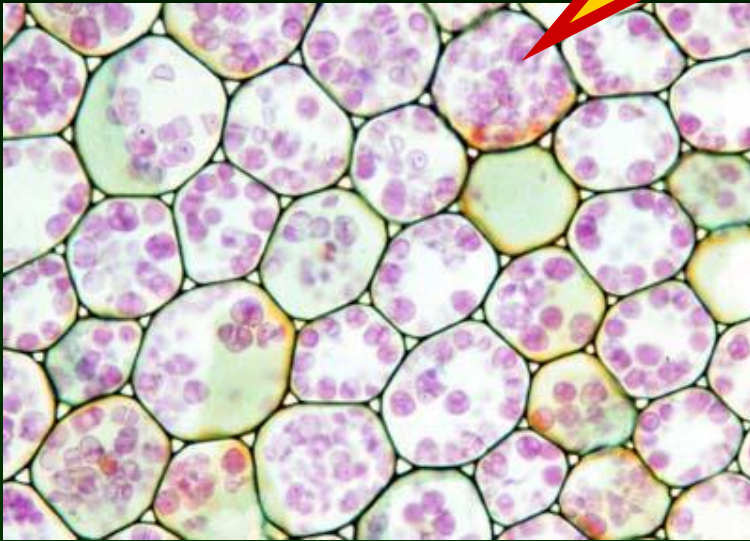
*Aesculus
hippocastanum*

TWIG WITH LENTICELS

Secretory Structures

- ❖ **nectar (flowers) from nectaries**
- ❖ **oils (peanuts, oranges, citrus) from accumulation of glands and elaioplasts.**
- ❖ **resins (conifers) from resin canals**
- ❖ **laticifers (e.g., latex - milkweed, rubber plants, opium poppy)**
- ❖ **hydathodes (openings for secretion of water)**
- ❖ **digestive glands of carnivorous plants (enzymes)**

**Bloody well ask
some questions, already!**



THANK YOU FOR YOUR ATTENTION

