What is plant anatomy?

- ANATOMY: study of the **structure** of organisms… looking at cells, tissues
- (Morphology: Study of form)

Always keep in mind that in plant anatomy, morphology & physiology…

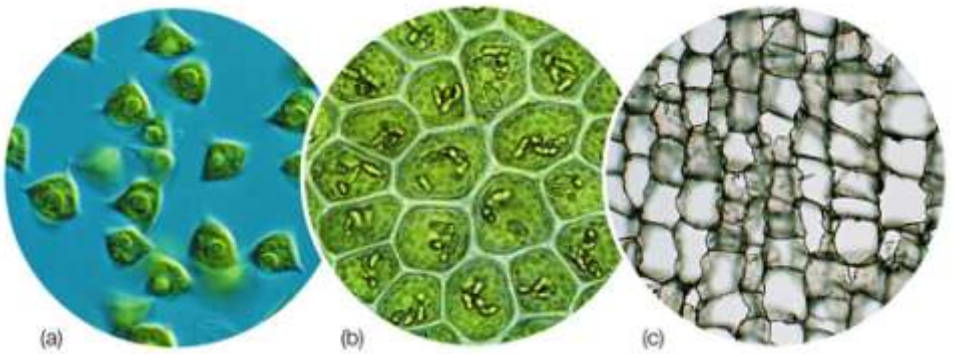
“**Structure** correlates to **function**”

- How can water move from the ground all the way to the top of a 100 m tall redwood tree?

Plant Anatomy: Cells

- Plant cells are basic building blocks
- Can specialize in form and function
- By working together, forming tissues, they can support each other and survive
- Levels of organization

atoms > molecules > cells > **tissues** > **organs** > whole plant > pop.



Plant Tissues Types

All plant organs (roots, stems, leaves) are composed of the same tissue types.

There are three types of tissue:

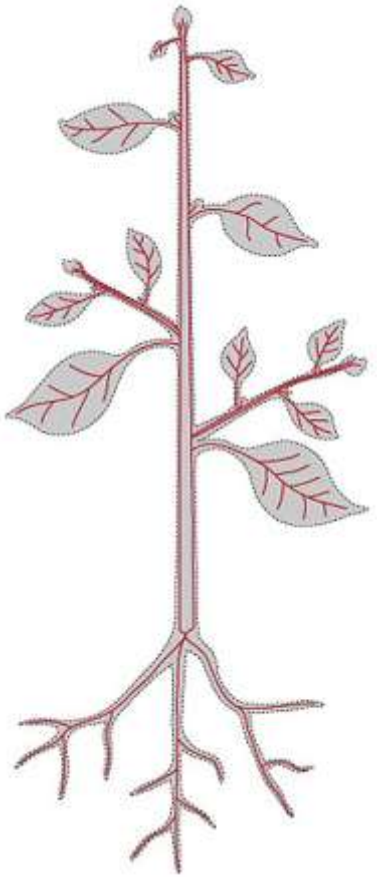
- **1. Dermal** – outermost layer
- **2. Vascular** – conducting tissue, transport
- **3. Ground** – bulk of inner layers

1. Dermal tissue

- **Epidermis** is the outermost layer of cells
- Like the “skin” of animals
- In stems and leaves,
  epidermis has **cuticle**,
  a waxy layer that prevents
  water loss.
- Some have **trichomes,** hairs.
- Root epidermis has **root hairs,** for
  water and nutrient absorption

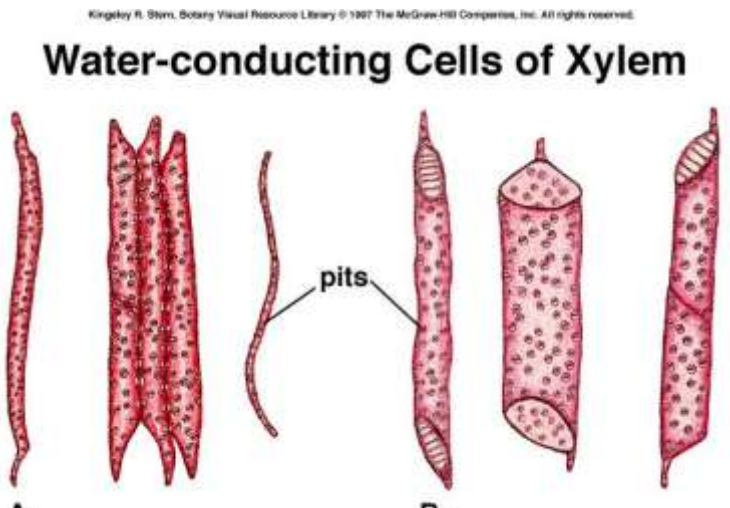
2. Vascular tissue

- Transports water and organic materials (sugars) throughout the plant
- **Xylem** – transports water and dissolved ions from the root to the stem and leaves.
- **Phloem** – carries dissolved sugars from leaves to rest of the plant



a. Xylem

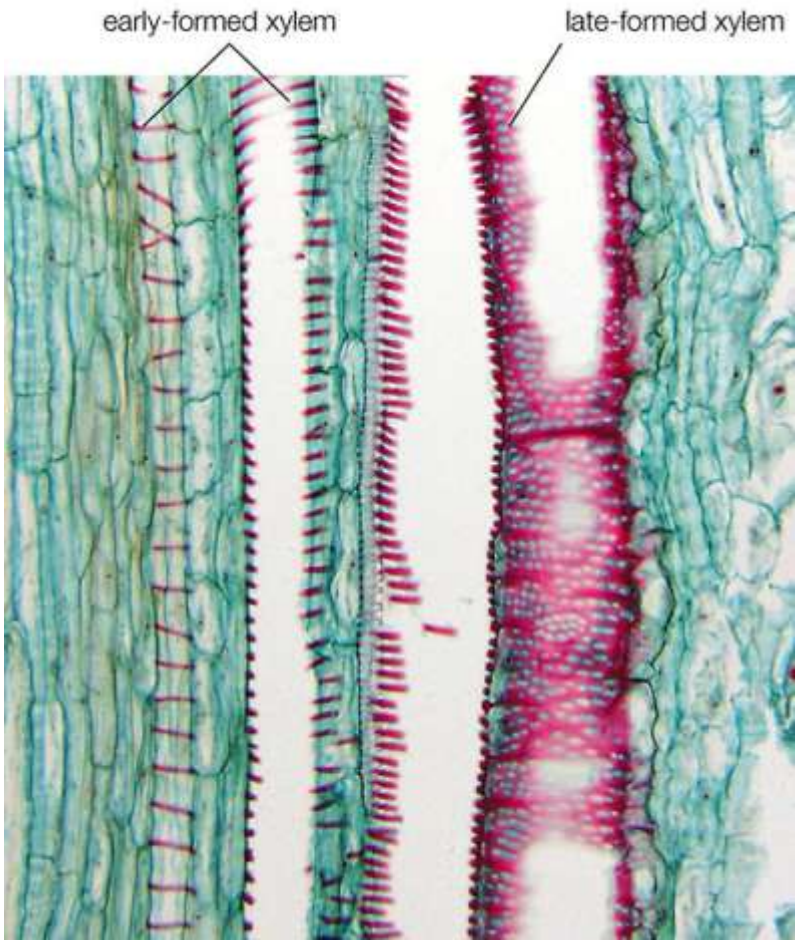
- Transports water and dissolved minerals
- **Tracheids**: long, thin tube like structures without perforations at the ends
- **Vessel elements**: short, wide tubes perforated at the ends (together form a pipe, called vessel).
- Both cells have **pits** (thin sections) on the walls



Tracheids Vessel elements

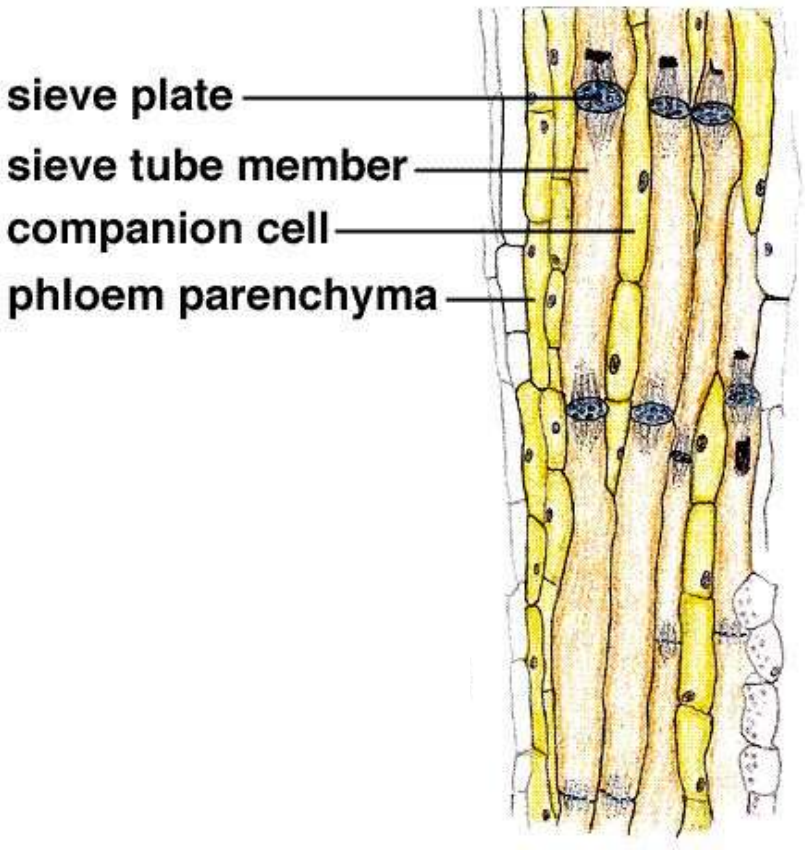
Xylem cells

- **Xylem** cells are dead!
- They are hollow cells and consist only of <u>cell wall</u>



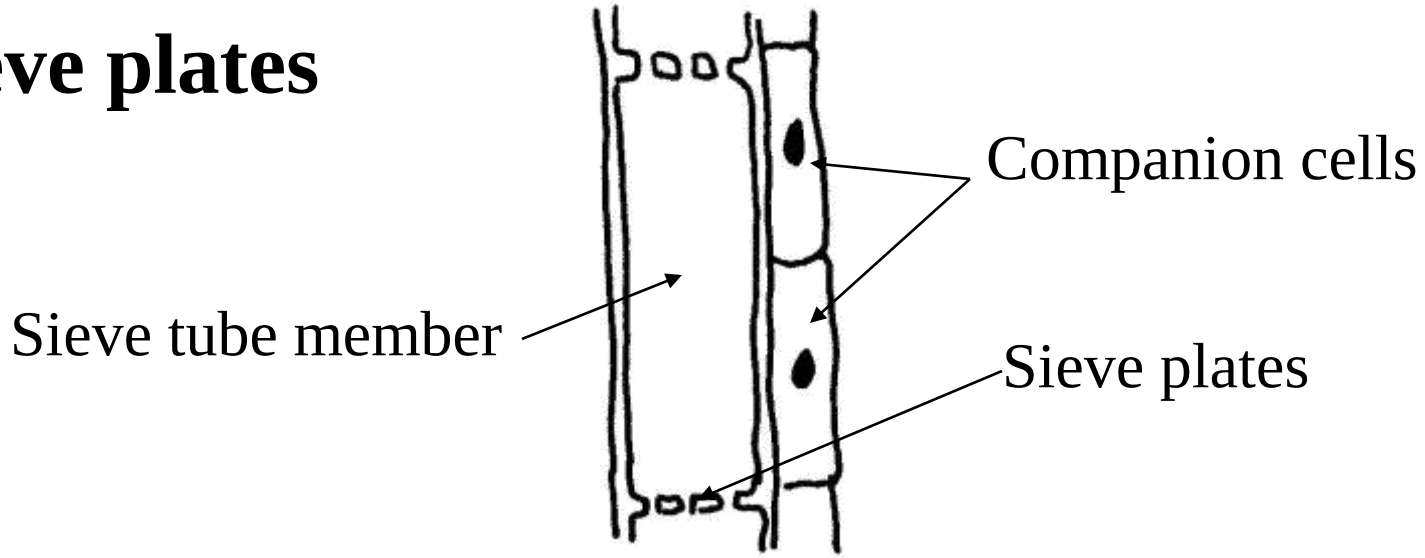
b. Phloem

- Cells that transport organic materials (sugars)
- Phloem cells are ALIVE! (unlike xylem)
- However, they lack nucleus and organelles



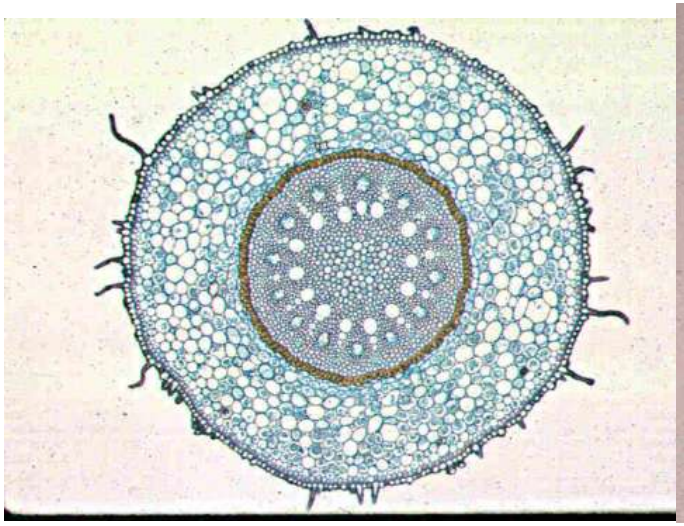
Phloem: transports sugars

- Phloem composed of cells called **sieve tube members (STM)**
- **Companion cells** join sieve tube members, are related, and help to load materials into STM
- End walls of STM have large pores called **sieve plates**

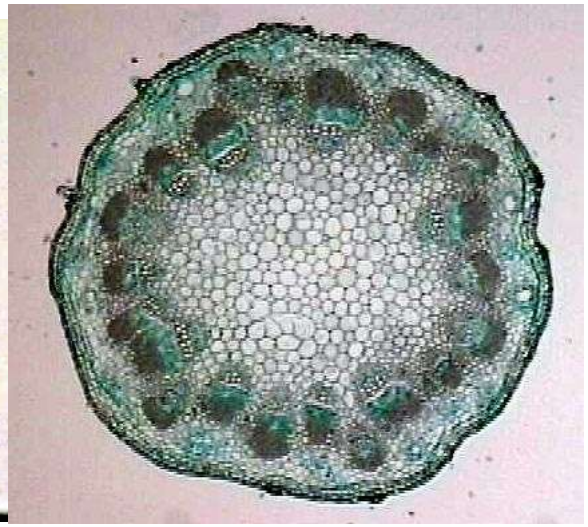


3. Ground tissue

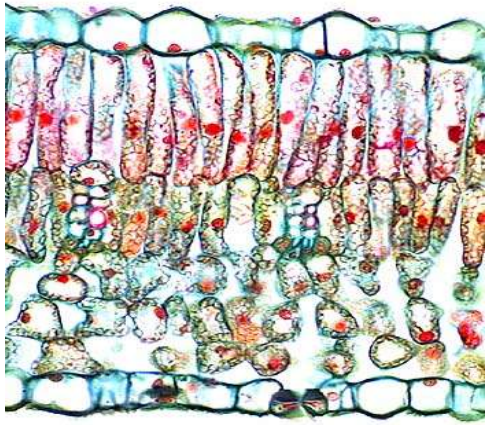
- Makes up the bulk of plant organs.
- Functions: Metabolism, storage and support.



Root



Stem

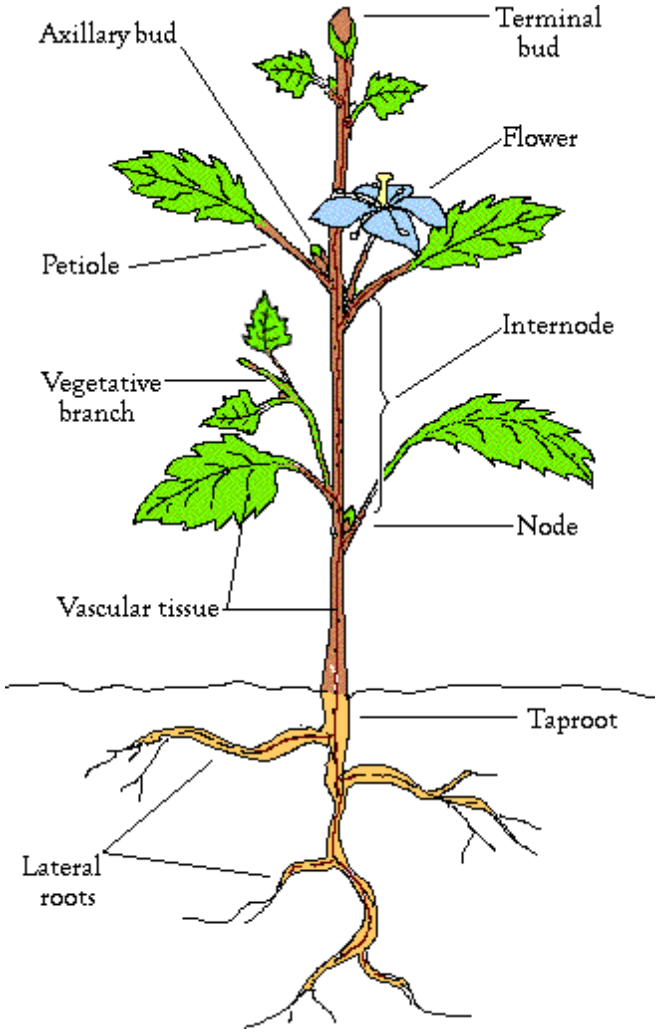


Leaf

Plant Organs

Organs: tissues that act together to serve a specific function

- Roots
  - Dermal
  - Vascular
  - Ground
- Stems
  - Dermal
  - Vascular
  - Ground
- Leaves
  - Dermal
  - Vascular
  - Ground



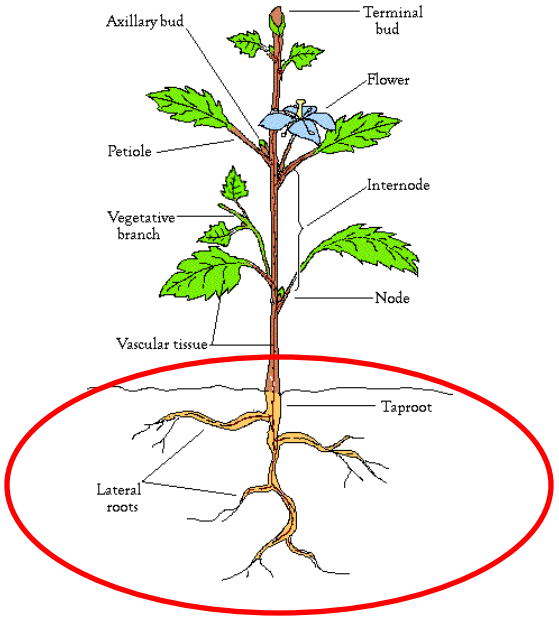
Functions of plant organs:

- ROOTS: Anchorage, water/nutrient absorption from soil, storage, water/nutrient transport

- STEMS: Support, water/nutrient transport

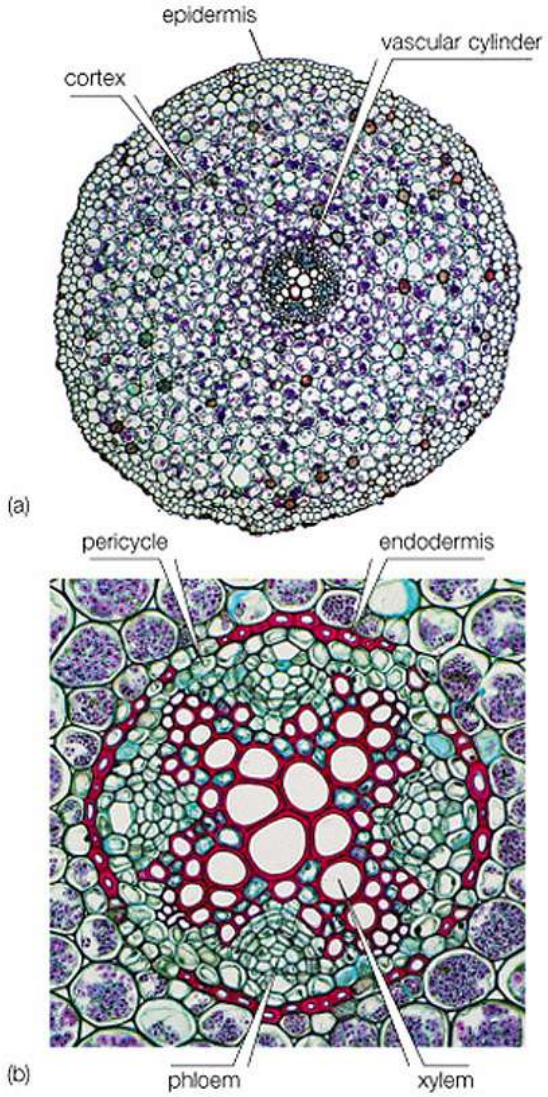
- LEAVES: Photosynthesis (food production)

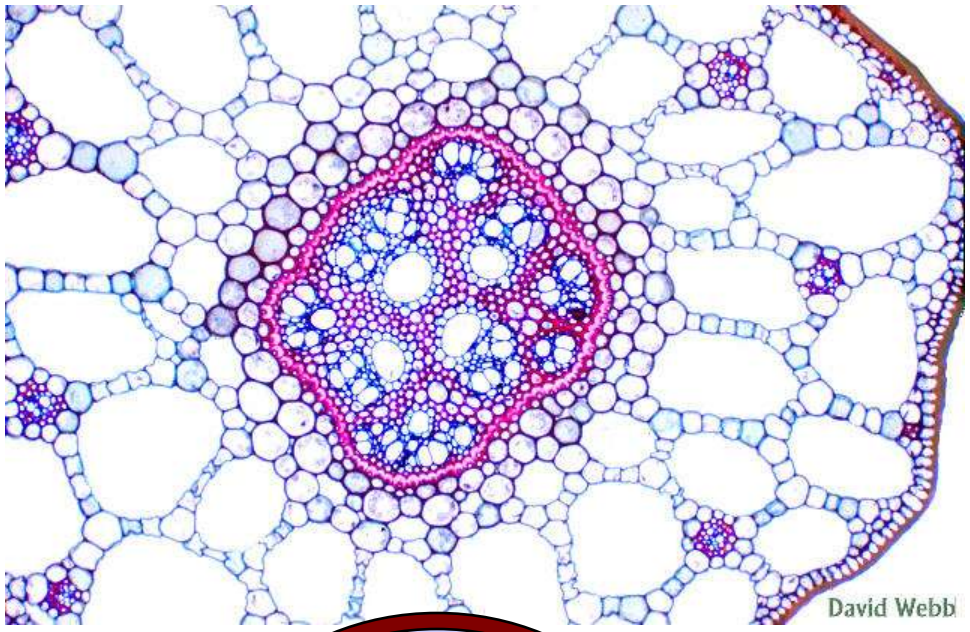
ROOTS



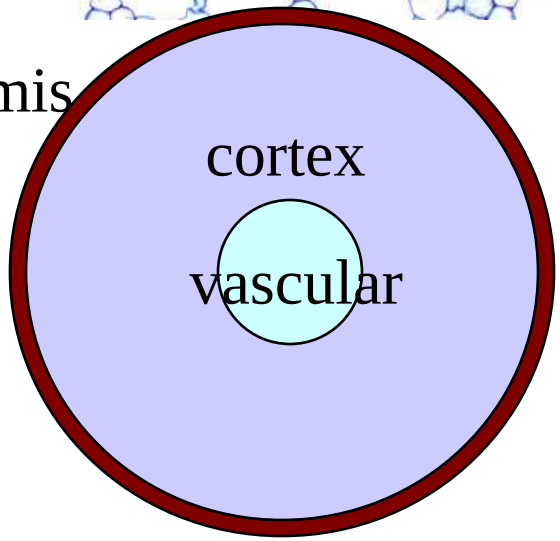
- **ROOTS** "the hidden half"
- Functions of roots:
- Ancorage
- Absorption of water & dissolved minerals
- Storage (surplus sugars, starch)
- Conduction water/nutrients

Anatomy of a root



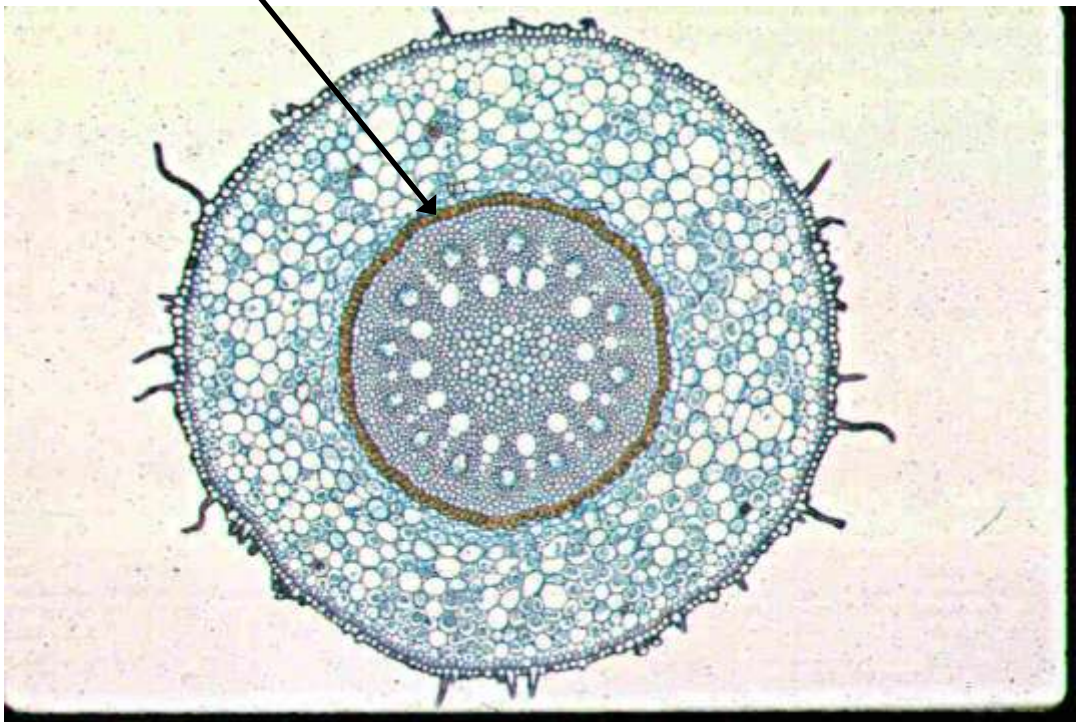


epidermis



Root Cortex: Endodermis

- **Endodermis**: the innermost layer of the cortex



6.3 THE ROOT

Root is that part of the plant axis which develops from the radicle and grows beneath the soil (exceptions : aerial roots).

Salient features in the internal structure of roots :—

(1) Epidermal cells are not cuticled and *lack* stomata, cells remain thin-walled[1] on both surfaces—hence epidermis of the root is specially called *epiblema* or *piliferous layer.*

(2) Root hairs are always *unicellular.*

(3) Distinct *endodermis* with Casparian strips is present. Pericycle is *one-cell layer* in thickness.

(4) Vascular bundles are of *radial type.*

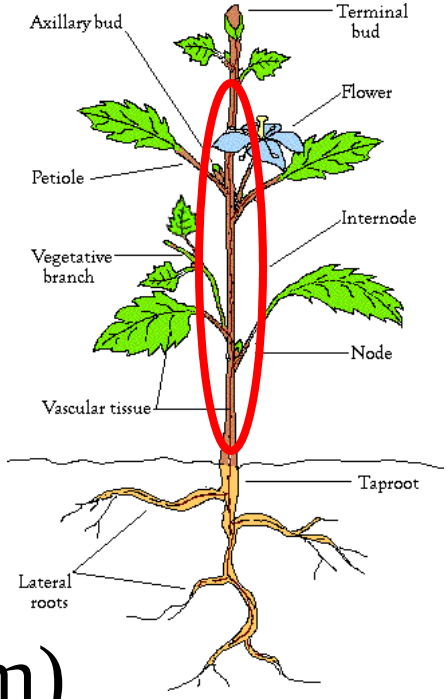
(5) Xylem always *exarch.*

(6) Branch roots always develop *endogenously* from permanent tissue in the pericycle.

The internal structure of a few dicotyledonous and monocotyledonous roots are described as follows :

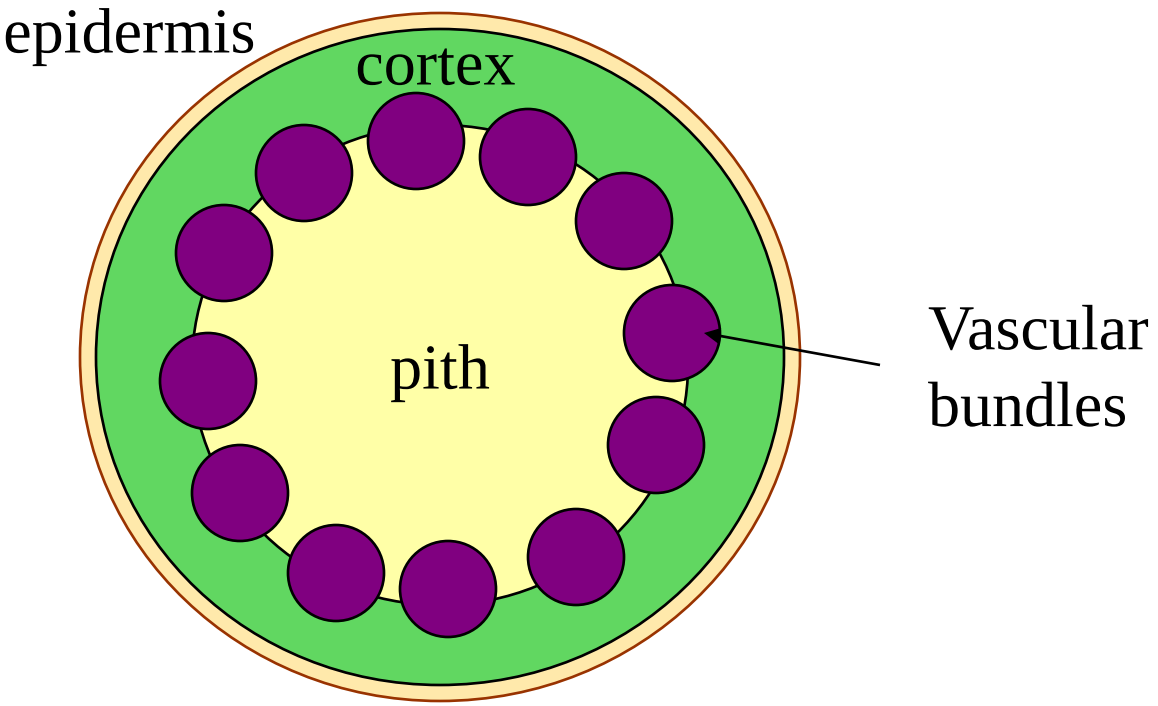
STEMS

- Above-ground organs (usually)
- Support leaves and fruits
- Conduct water and sugars throughout plant (xylem and phloem)



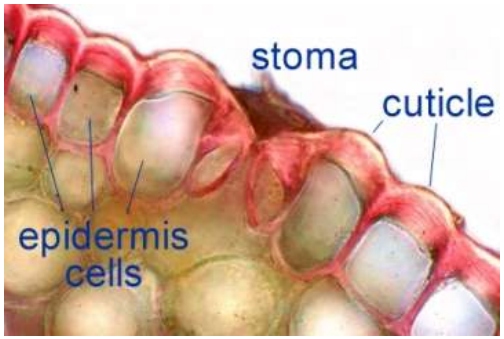
Stem anatomy

- Dermal, ground and vascular tissues…



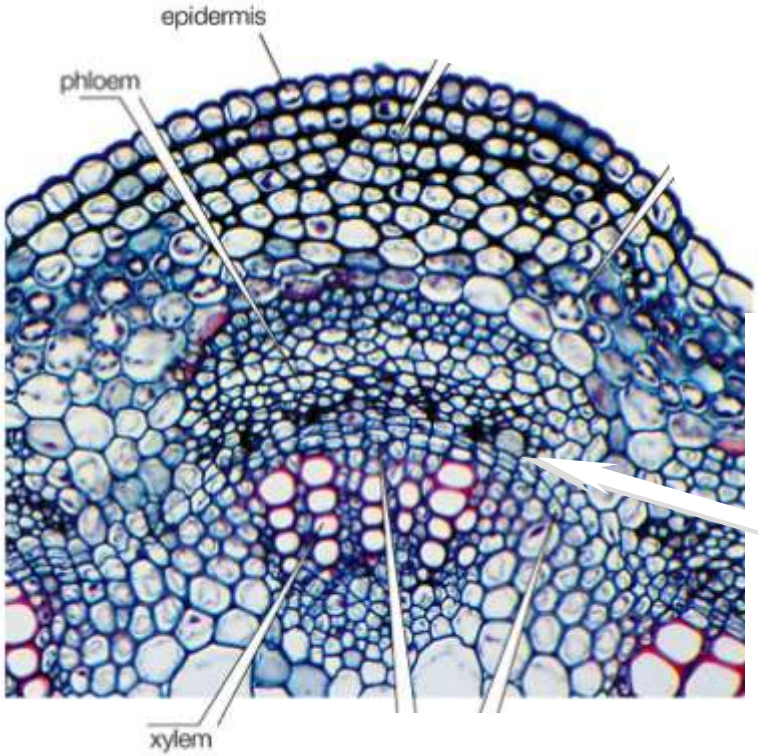
Tissues of stems

- **Epidermis** (Dermal tissue type)
- Provides protection
- Has **cuticle** (wax) prevents water loss
- Trichomes (hairs) for protection, to release scents, oils, etc.



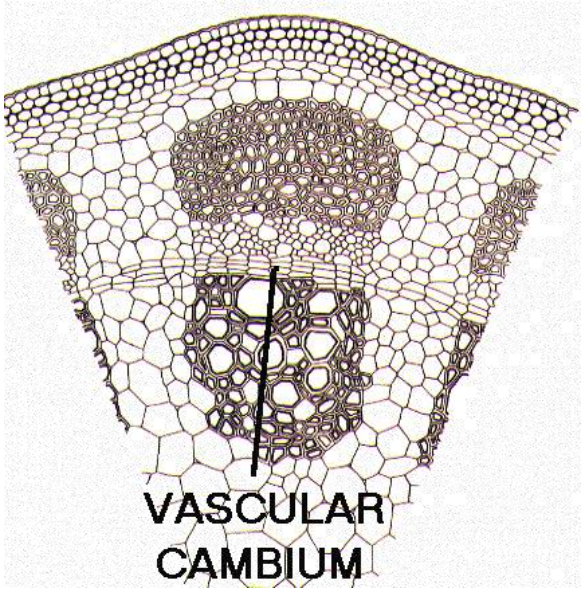
Stem Vascular tissue

- **Vascular bundles** – composed of both xylem and phloem
- **Xylem**
  - Conducts water
  - Support
- **Phloem**
  - Conducts food
  - Support



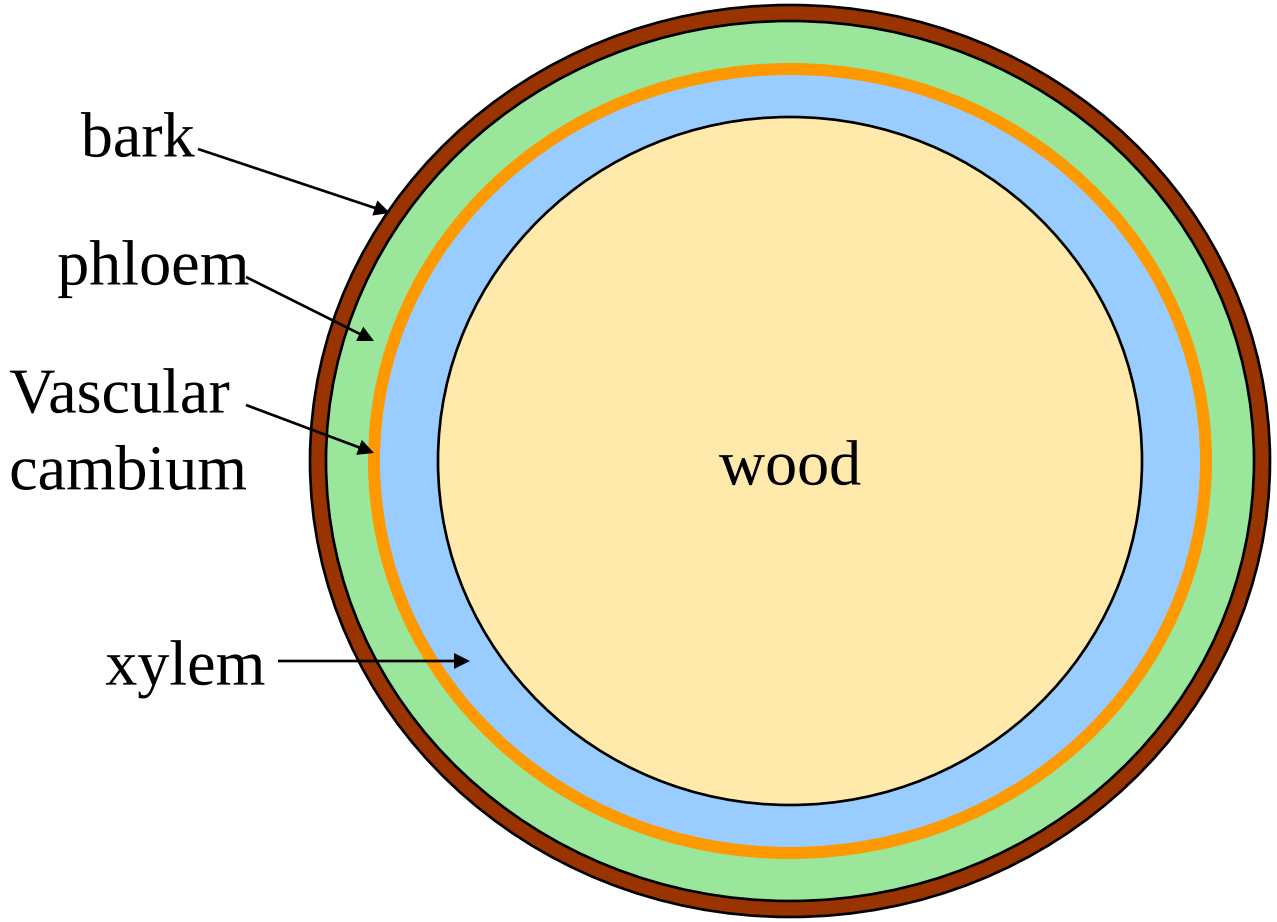
Vascular cambium

- Occurs in woody stems
- **<u>Vascular cambium</u>** located in the middle of the vascular bundle, between xylem and phloem



Vascular tissue: Trees

- Vascular tissue is located on the outer layers of the tree.



The salient features in the internal structures are :—

(1) Epidermal cells are *cuticled* (exceptions : stems of aquatic plants).

(2) Stem hairs are *multicellular*.

(5) Vascular bundles are *collateral*, *bicollateral* or *centric*.

(6) Xylem *endarch*.

(7) Branches develop *exogenously* from the superficial tissue of the extrastelar zone.

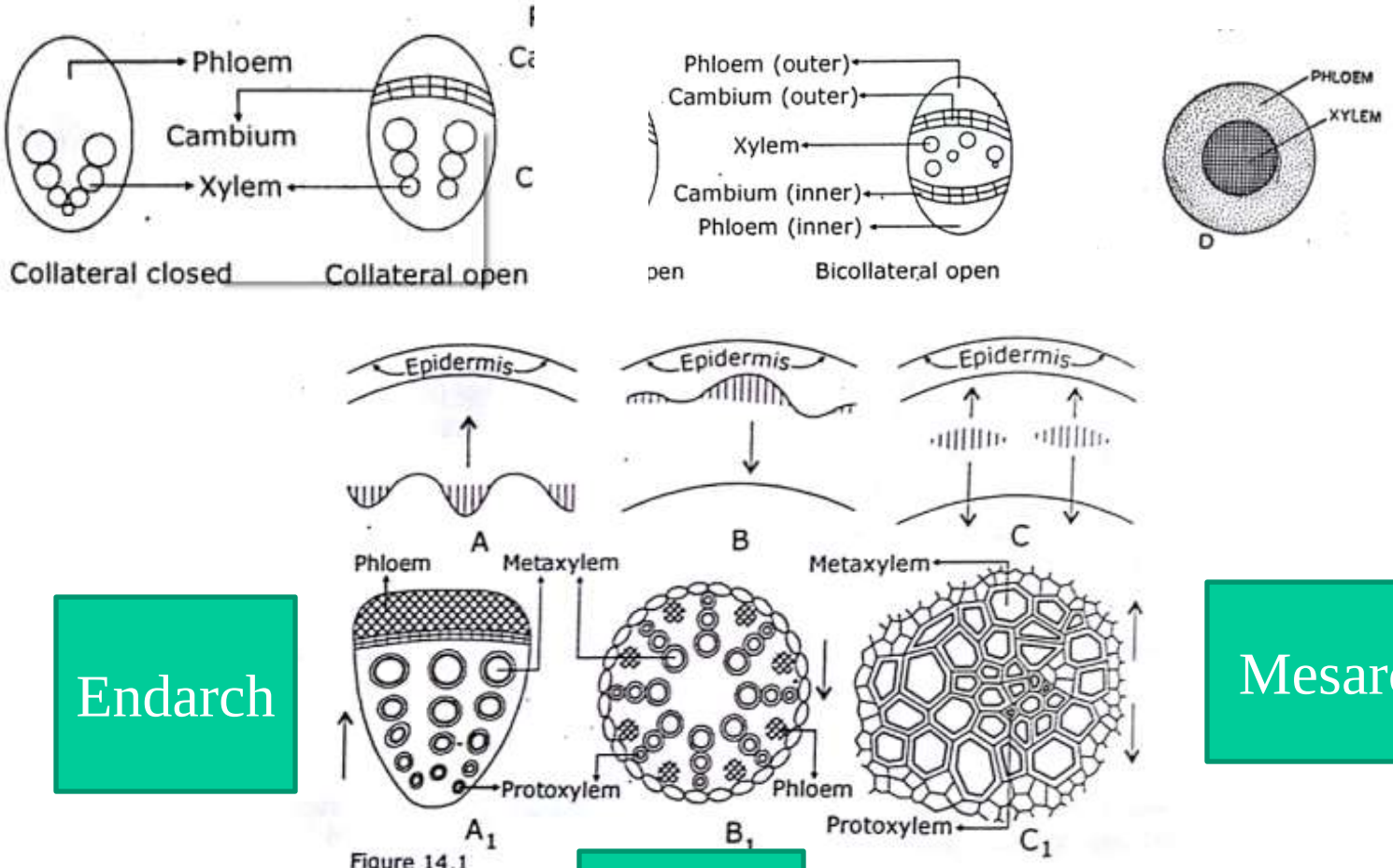


Figure 14.1

Diagrams showing or of primary vascular tissues in transverse views. A. ith endarch xylem. B. & B_1. Centripetal with exarc th centrifugal and centripetal with mesarch xylem.

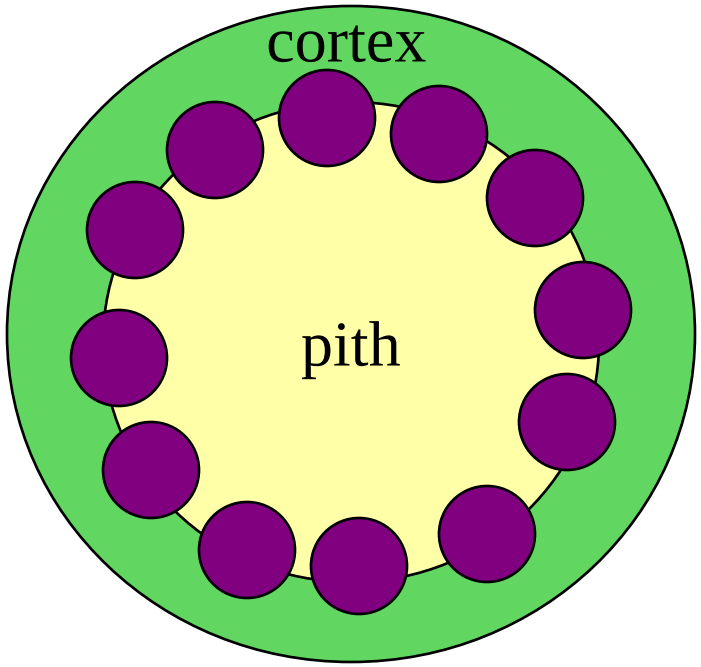
Endarch

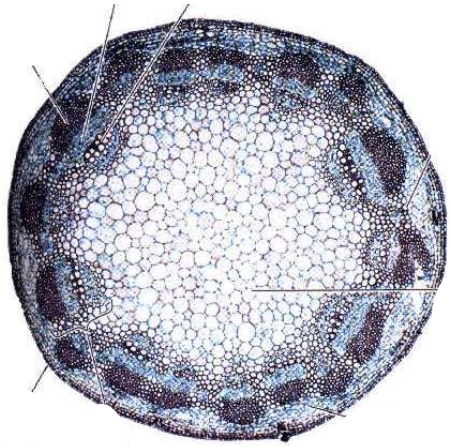
Exarch

Mesarch

Ground tissue: Cortex & pith

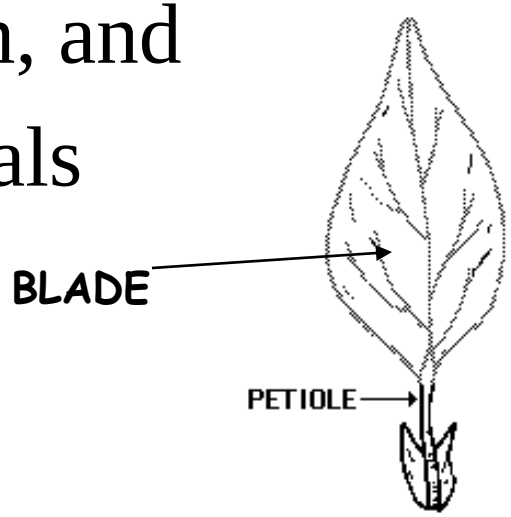
- Stores food (e.g. potato)
- Site of Photosynthesis (when green)
- Support cells





LEAVES:

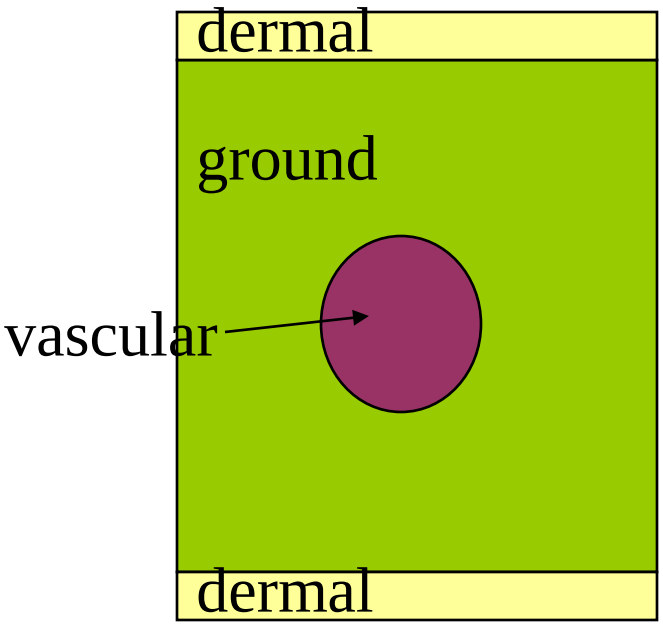
- ‘Photosynthetic factories’ of the plant…
- Function: Photosynthesis – food production for the whole plant
- **Blade**: Flat expanded area
- **Petiole**: stalk that connects leaf blade to stem, and transports materials

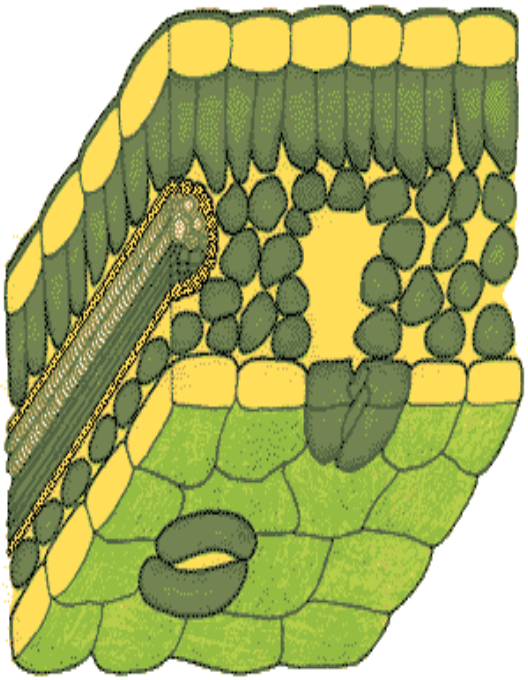


Leaf Anatomy

- Leaf anatomy is correlated to photosynthesis:

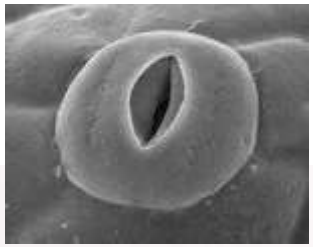
  Carbon dioxide + Water → sugars + oxygen

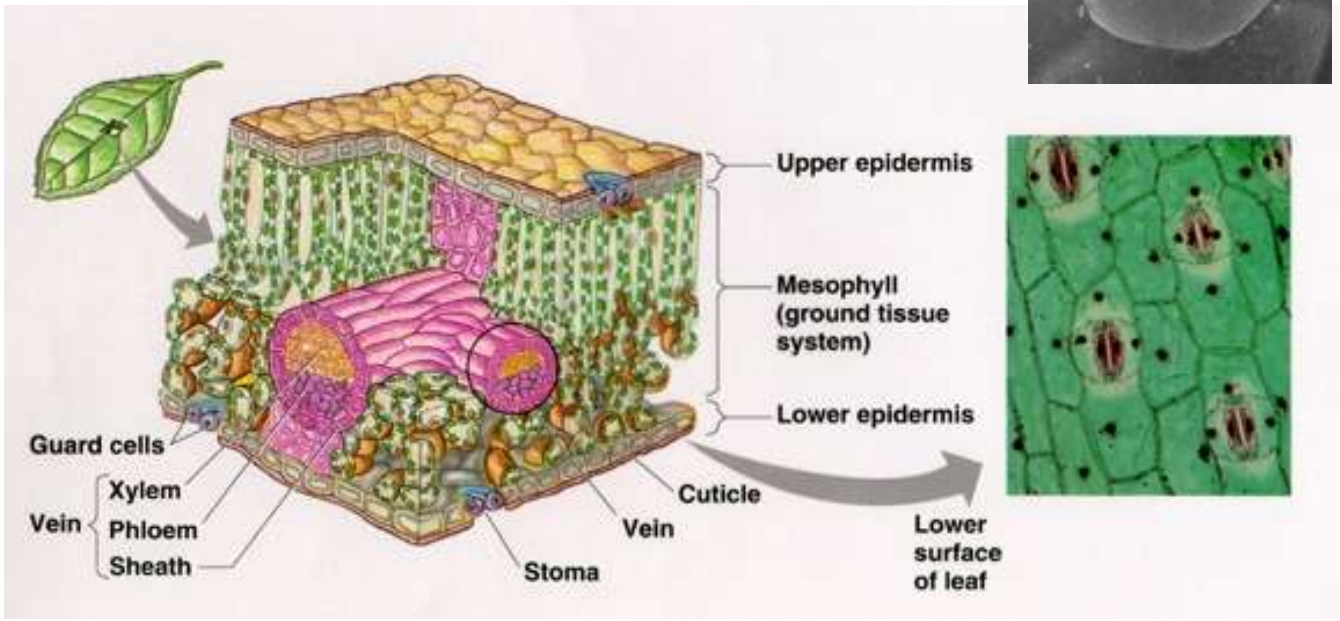




Leaf epidermis

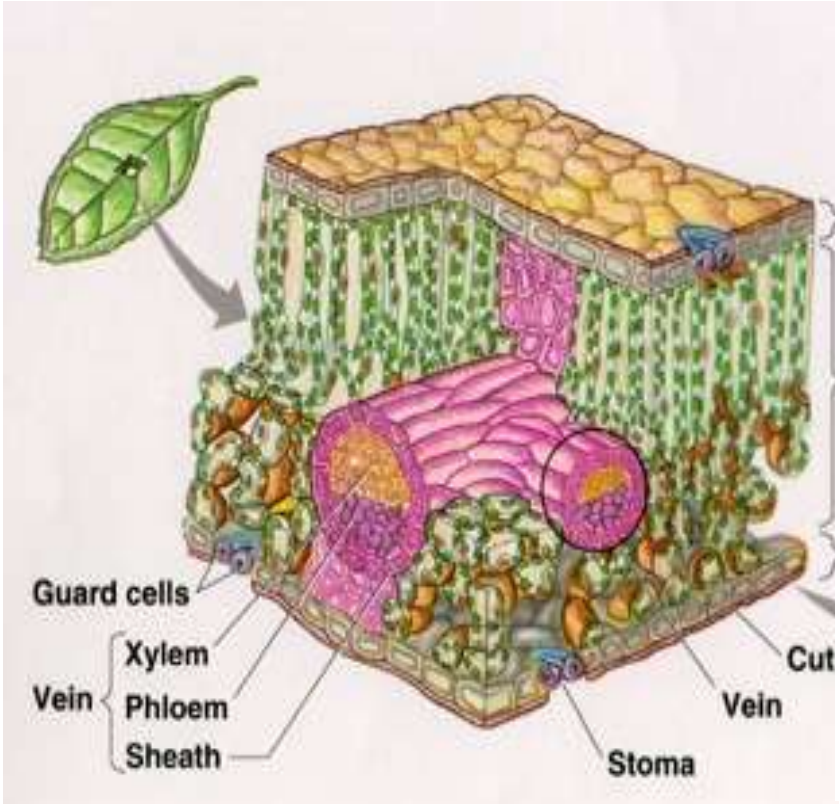
- Is transparent – so that sun light can go through.
- Waxy cuticle protects against drying out
- Lower epidermis: **stomata** with **guard cells** – for gas exchange (CO_2, H_2O in; O_2 out)





Leaf vascular tissue

- **VEINS** → vascular tissue of leaves.
  - Veins are composed of **xylem** (water transport) **phloem** (food transport) and **bundle sheaths**, cells surrounding the xylem/phloem for strength & support



Salient features in the internal structure of leaf blades :—

(*a*) There are *two* epidermis i.e. upper and lower, both are cuticled and stomata either may occur on both the epidermal layers or on lower epidermis only.

(*b*) Ground tissue is differentiated as *mesophyll tissue* which is either homogeneous or heterogeneous (i.e. differentiated into *palisade* and *spongy* parenchyma cells).

(*c*) Vascular bundles are *closed collateral*; xylem *mesarch* (protoxylem lies in the centre due to early maturation and surrounded by lately developed metaxylem). Arrangement of

Leaf Mesophyll

- Middle of the leaf (meso-phyll)
- Composed of photosynthetic ground cells:
- **Palisade** parenchyma
  (long columns below epidermis;
  have lots chloroplasts for
  photosynthesis)

Spongy parenchyma
(spherical cells)
with **air spaces** around,
(for gas exchange)

References:

- Plant anatomy by Pijush Roy
- Studies in Botany Vol-I
- Plant anatomy by Fahn
- Images taken from various sources.