

Plant Cells & Tissues

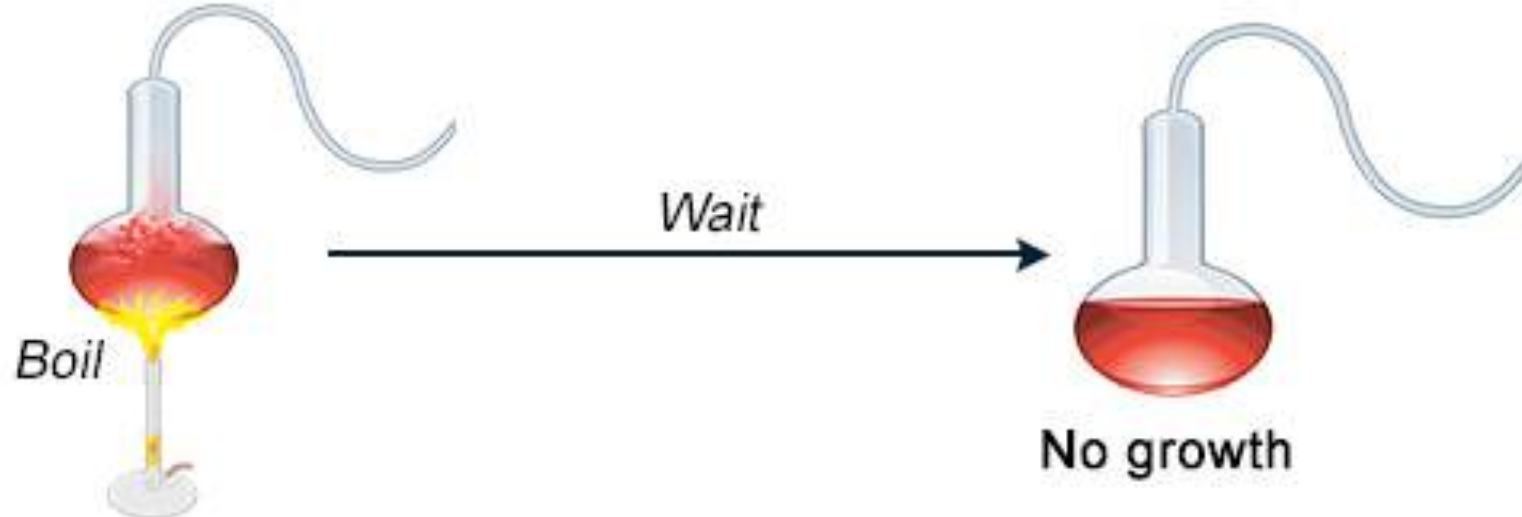


History

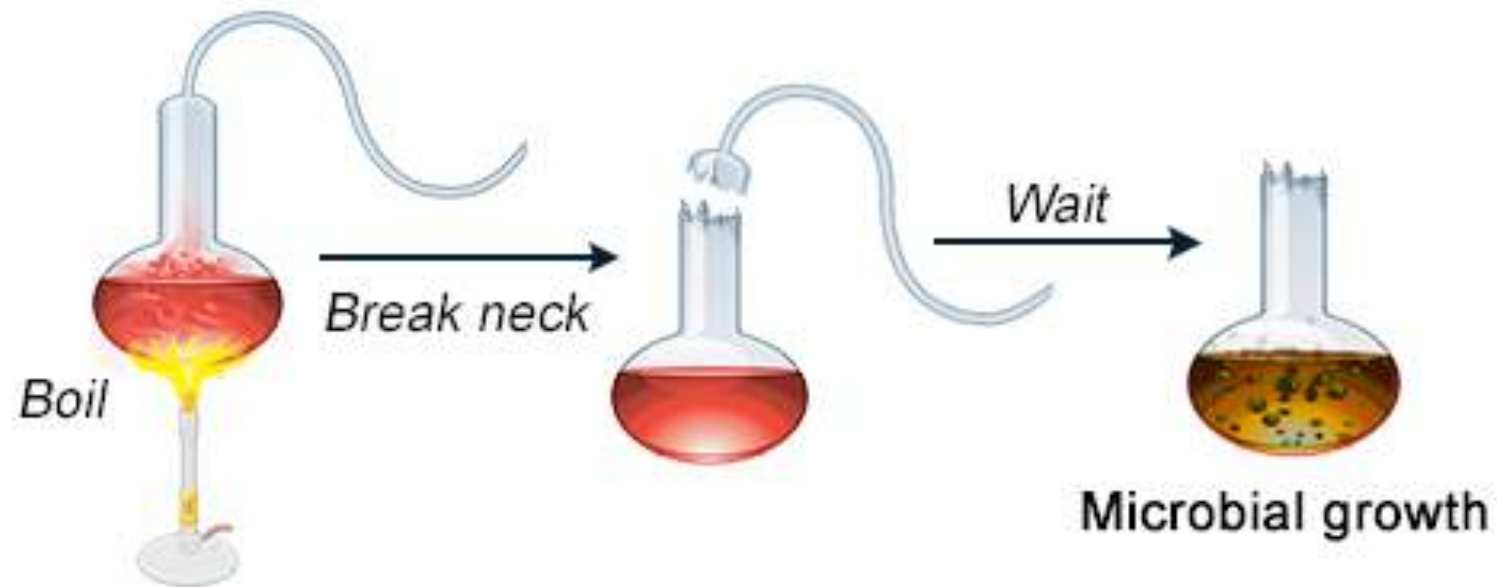
- Cells discovered in 1665 by **Robert Hooke**.
- **Cell Theory** was generally developed around 1838 by Schleiden and Schwann.
 - ❖ All living organisms are composed of cells.
 - ❖ Cells come from cells.
 - ❖ Cells are the basic unit of life.
- 1858 - Virchow argued there is no spontaneous generation of cells.
 - ❖ Pasteur and Redi experimentally disproved spontaneous generation in 1862.

Louis Pasteur's Experiment

①



②



Francisco Redi's Experiment



Flask unsealed

Flask sealed

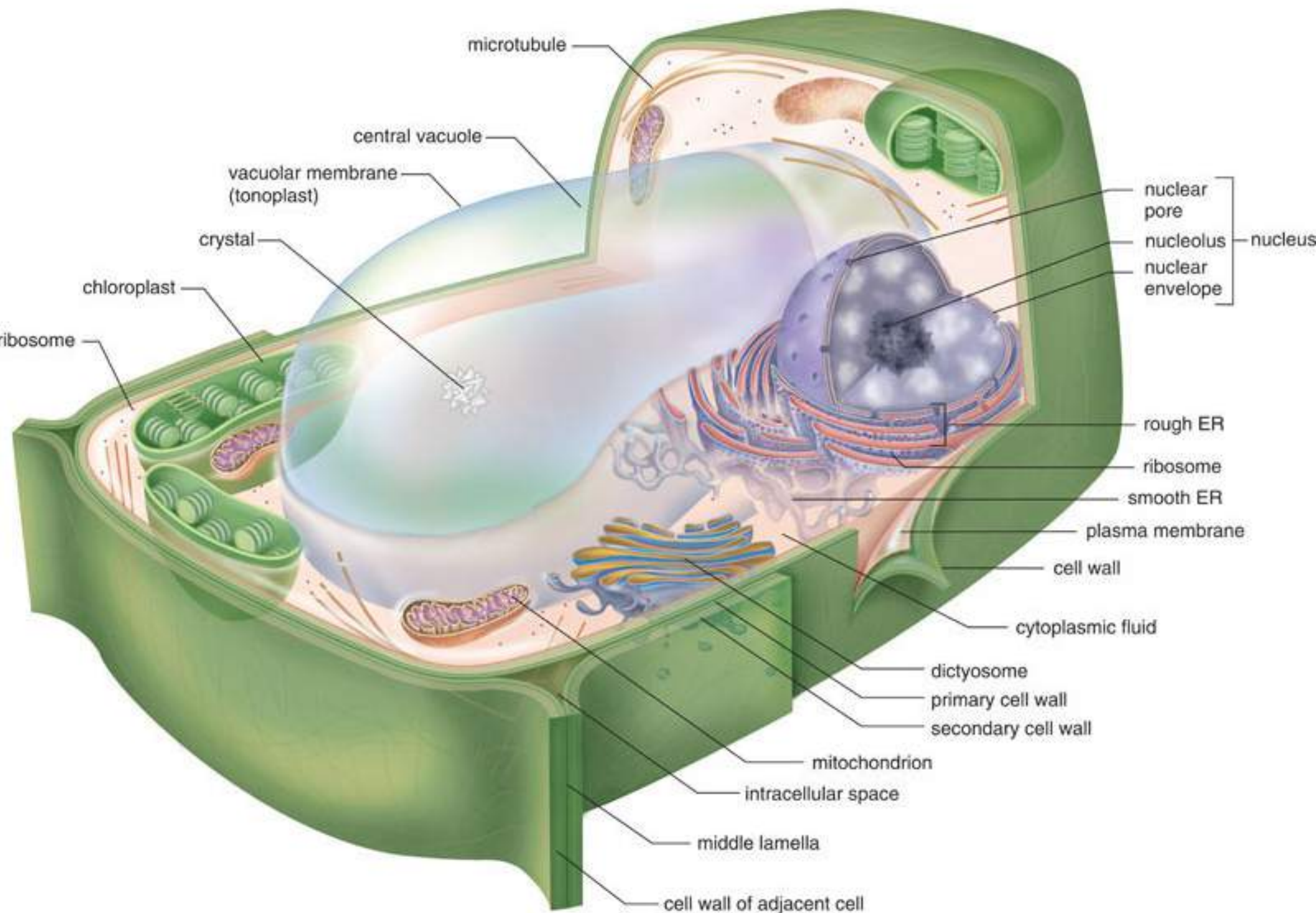
**Flask covered
with gauze**

Eukaryotic versus Prokaryotic Cells

- **Prokaryotic** - Cells lacking a nucleus, includes all bacteria.
- **Eukaryotic** - Cells containing a nucleus, includes all cells except for bacteria.
 - ❖ **Organelles** - Membrane-bound bodies found within eukaryotic cells. Think of them as “little organs”.

Cell Structure

- **Cell Wall** surrounds protoplasm (contains all living cell components). In plants the cell wall is made out of **cellulose** (complex carbohydrate).
 - ❖ Bound by a **plasma membrane**.
 - **Cytoplasm** consist of all cellular components between the plasma membrane and the nucleus.
 - **Cytosol** - Fluid within cytoplasm containing organelles.



Cell Size

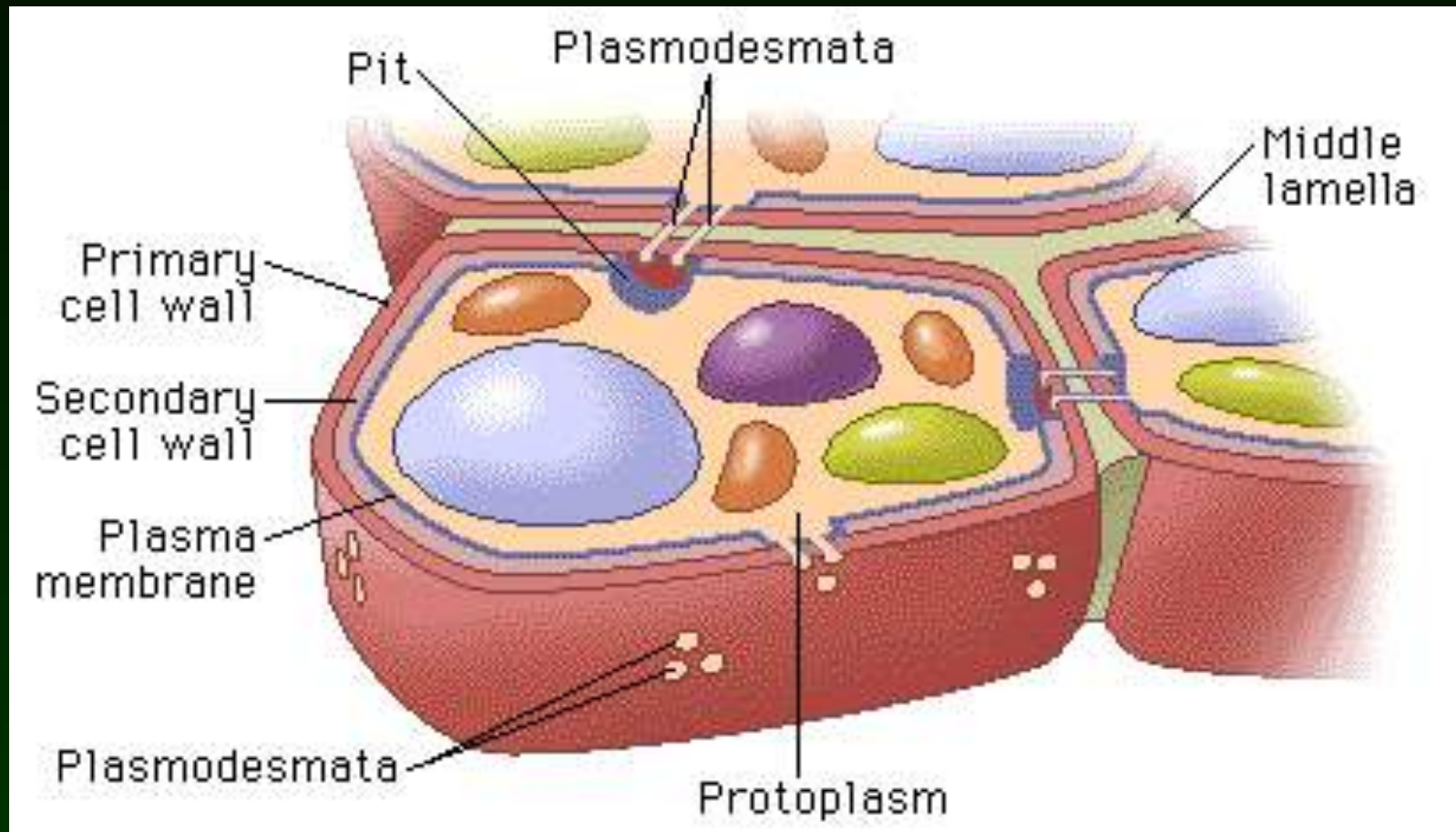
- Cells of higher plants generally vary in length between 10 and 100 micrometers.
- Increase in surface area of a spherical cell is equal to the square of its increase in diameter, but its increase in volume is equal to the cube of its increase in diameter.
 - ❖ Smaller cells have relatively large surface to volume ratios enabling faster and more efficient cellular communication.

Cell Wall

- Main structural component of cell walls is **cellulose**.
 - ❖ Also contain matrix of **hemicellulose**, **pectin**, and **glycoproteins**.
- **Middle lamella** is first produced when new cell walls are formed.
- **Secondary walls** are derived from primary walls by thickening and inclusion of lignin.

Communication Between Cells

- Fluids and dissolved substances can pass through primary walls of adjacent cells via **plasmodesmata**.

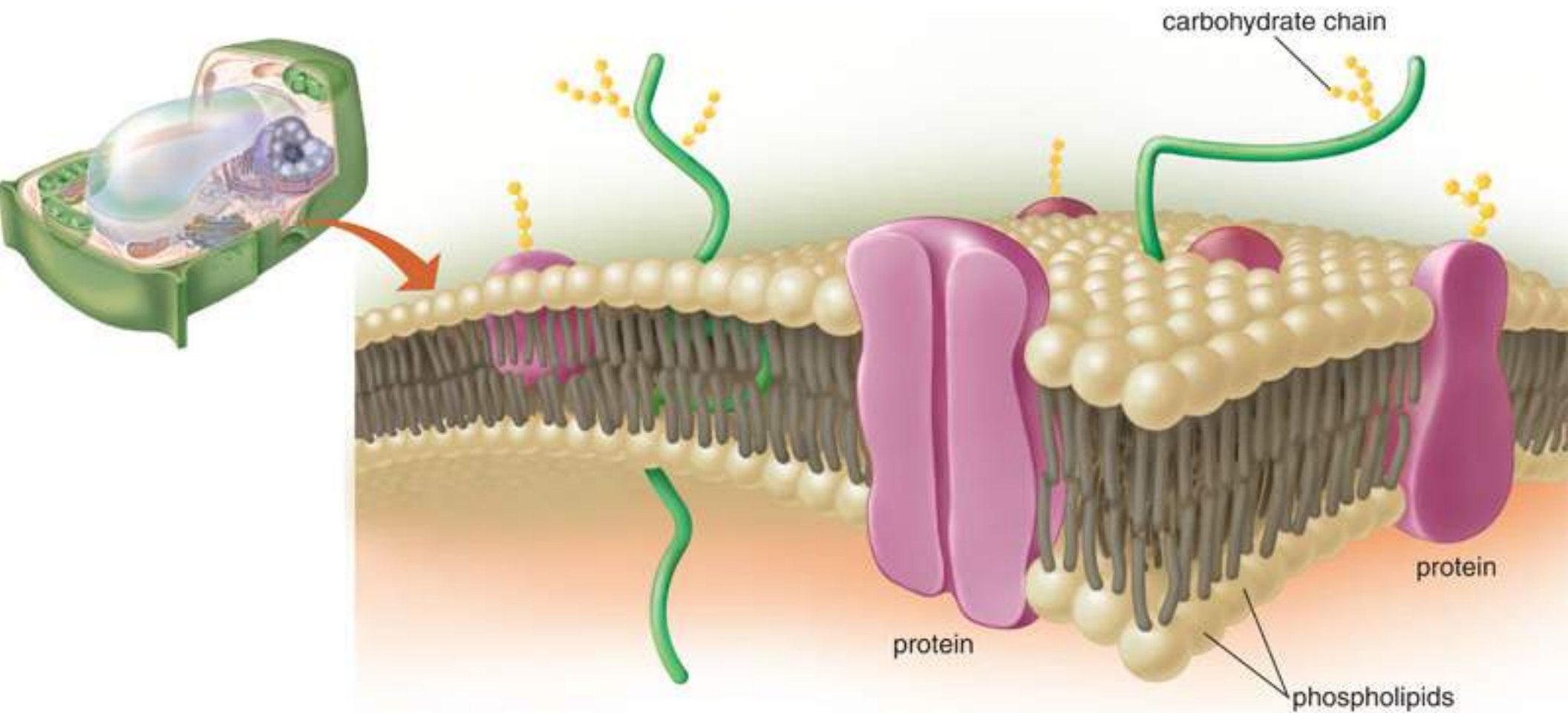


Cellular Components

- **Plasma Membrane**

- ❖ Composed of phospholipids arranged in two layers, with proteins interspersed throughout.
 - Some proteins extend across the entire width, while others are embedded to the outer surface.

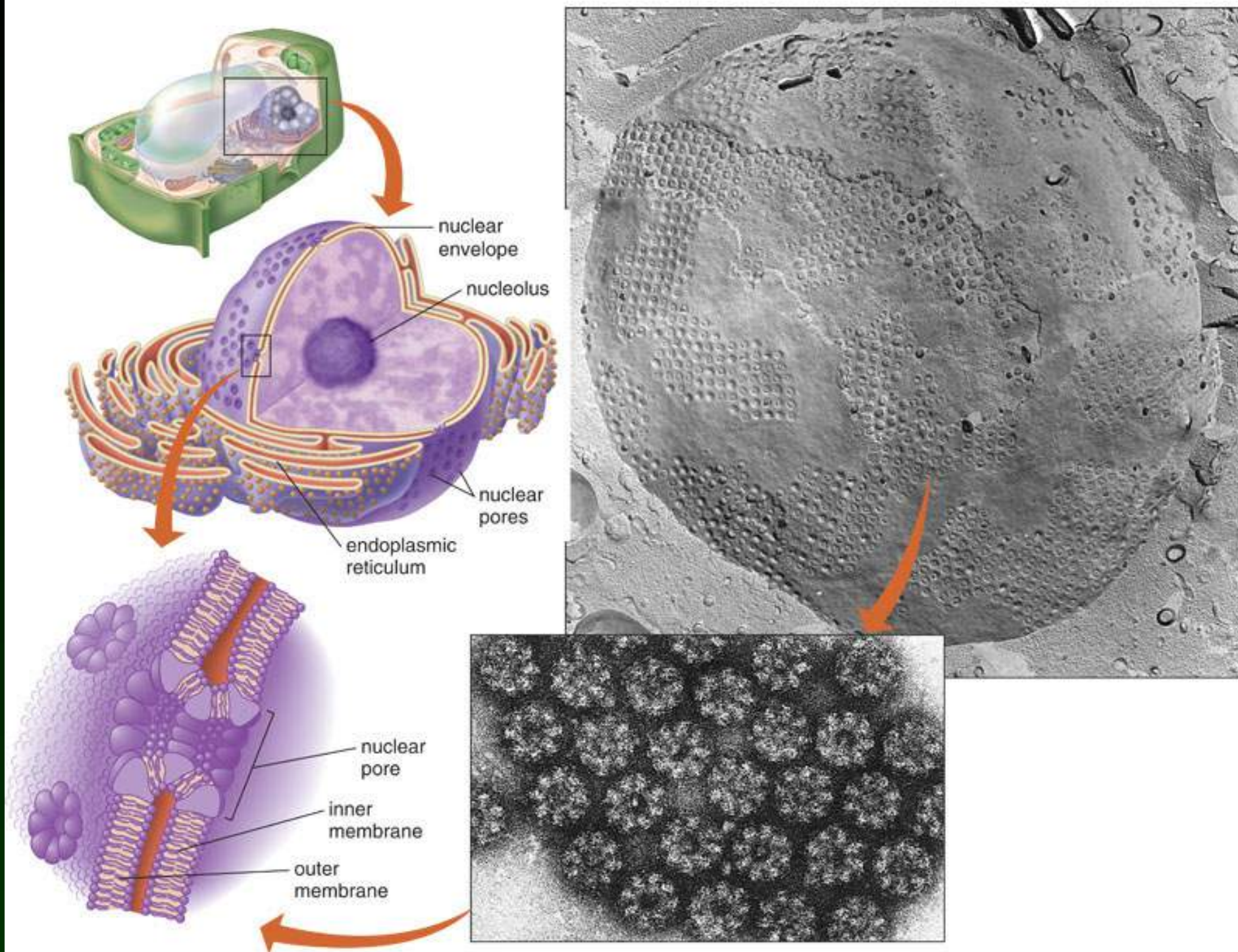
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Nucleus

- **Nucleus** is bound by two membranes, which together constitute the **nuclear envelope**.
 - ❖ Structurally complex pores occupy up to one-third of the total surface area.
- Contains fluid **nucleoplasm** packed with short fibers, and contain larger bodies.
 - ❖ **Nucleoli** composed primarily of RNA.
 - ❖ **Chromatin Strands** - Coil and become chromosomes.



Endoplasmic Reticulum

- **Endoplasmic Reticulum** facilitates cellular communication and materials channeling.
 - ❖ Enclosed space consisting of a network of flattened sacs and tubes forming channels throughout the cytoplasm.
 - **Ribosomes** may be distributed on outer surface (**Rough ER**).
 - Associated with protein synthesis.
 - **Smooth ER** is devoid of ribosomes and is associated with lipid secretion.

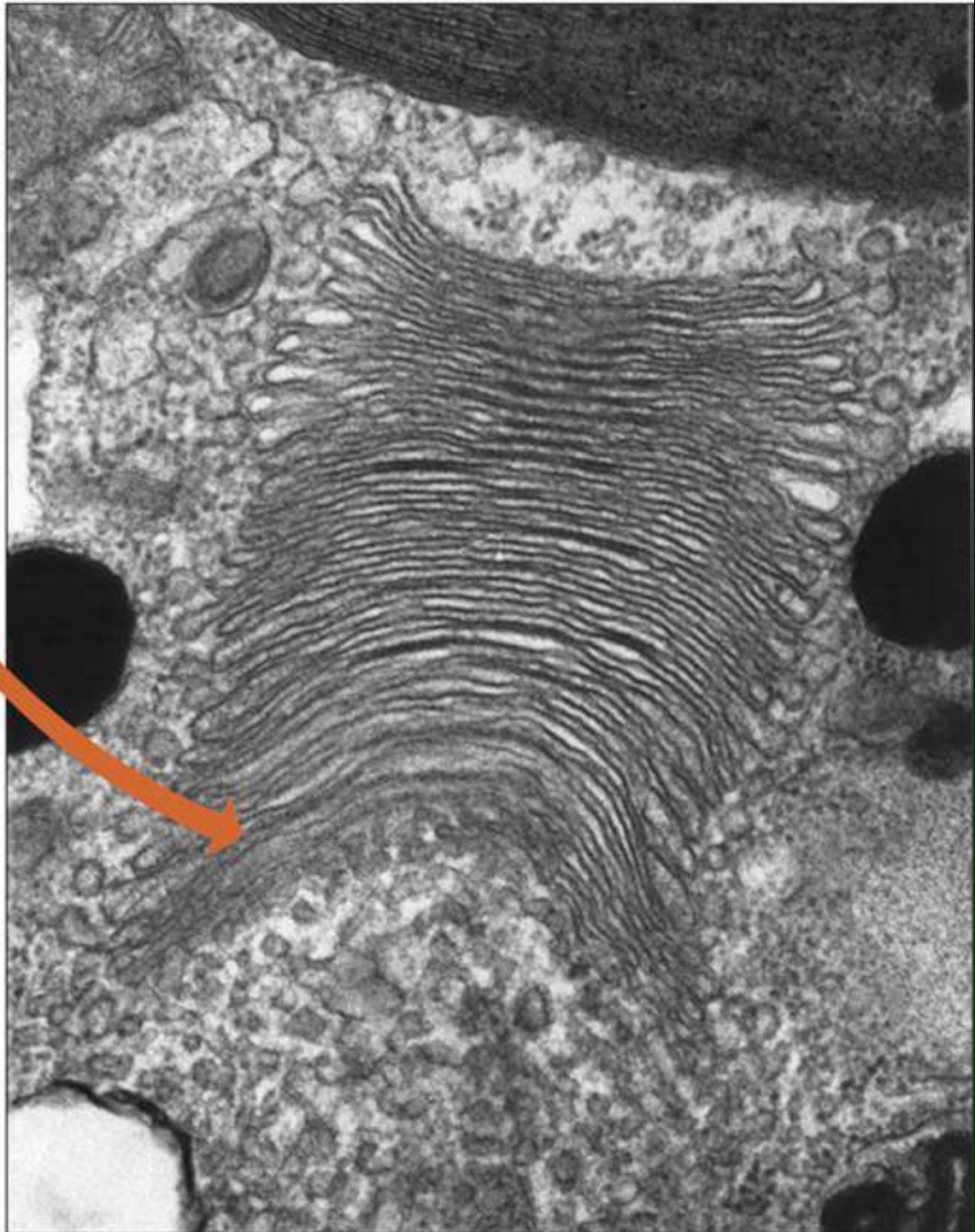


Ribosomes

- Ribosomes are composed of two subunits composed of RNA and proteins.
 - ❖ Ribosomes are made in the nucleolus and are the sites of protein synthesis.
 - Have no bounding membranes.

Dictysomes

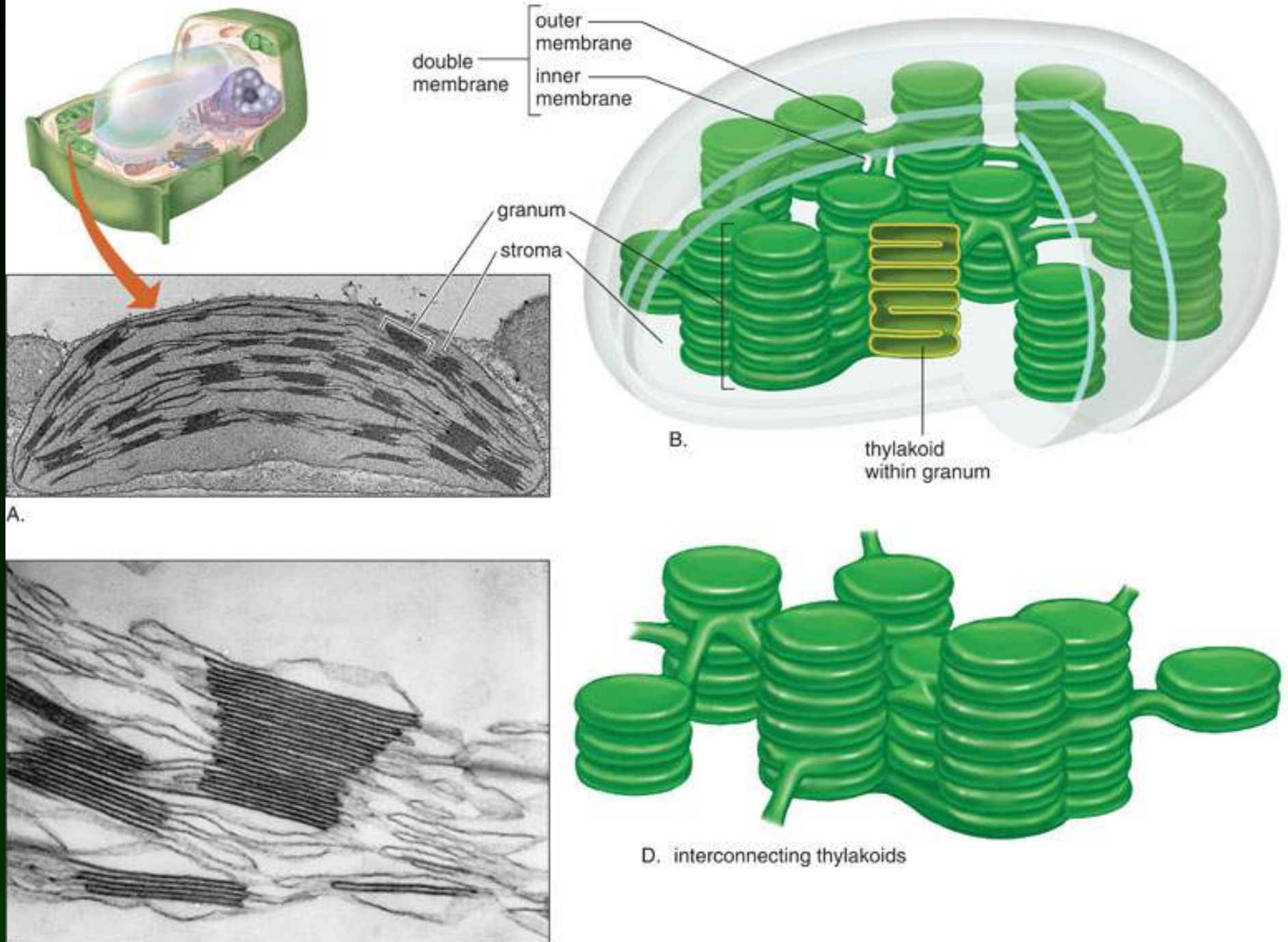
- **Dictysomes (Golgi Bodies** in animals) are often bound by branching tubules that originate from the ER.
 - ❖ Involved in the modification of carbohydrates attached to proteins synthesized and packaged in the ER.
 - Polysaccharides are assembled within dictysomes, and collect in small vesicles.
 - Migrate to plasma membrane and secrete contents to the outside.



(Electron micrograph courtesy John Z. Kiss; Inset from Sylvia S. Mader, Biology, 7th edition. © 2001 The McGraw-Hill Companies. All rights reserved.)

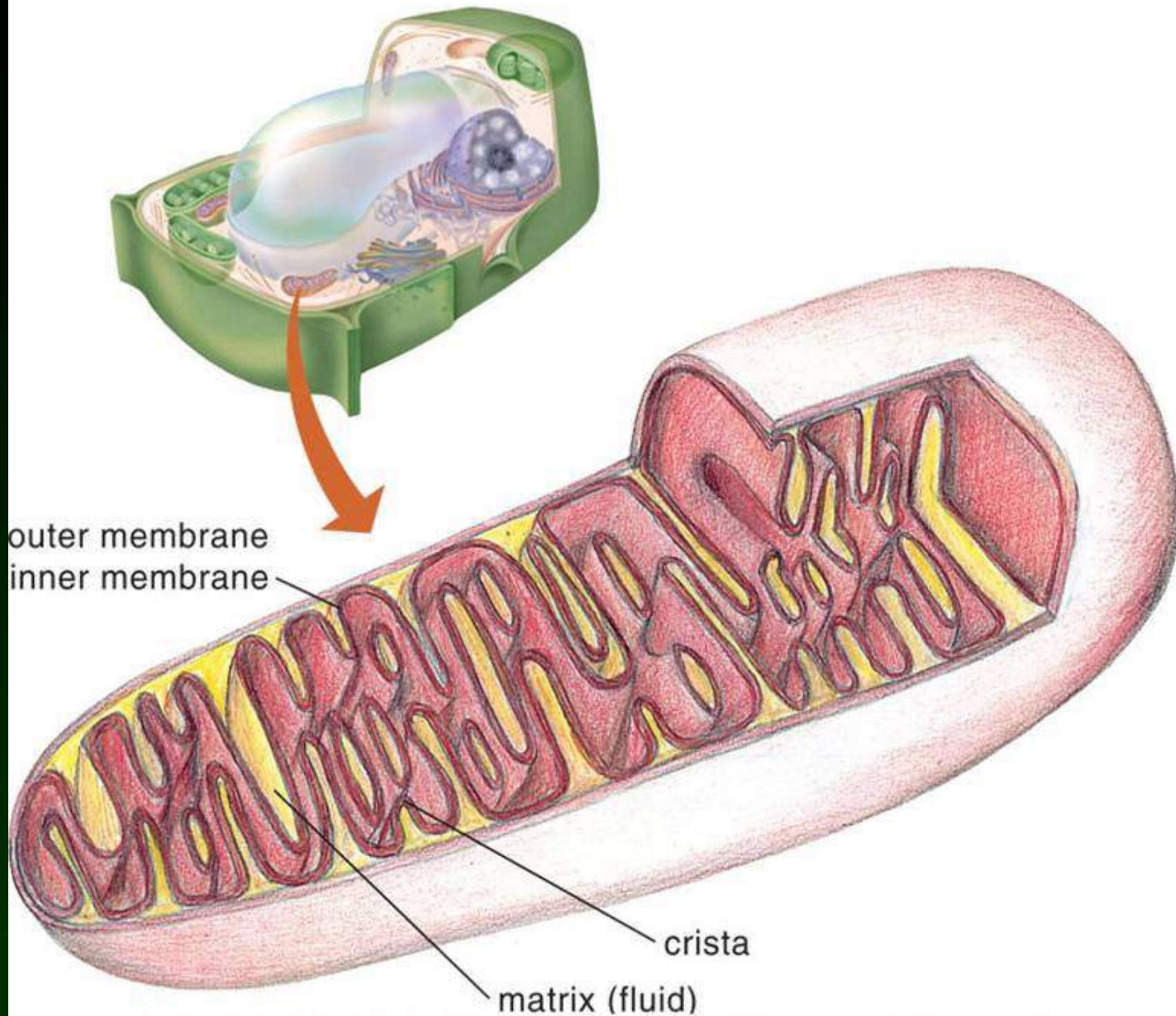
Plastids

- **Chloroplasts** are the most conspicuous plastids.
 - ❖ Each bound by double membrane.
 - Contain **stroma** - Enzyme-filled matrix.
 - Contain **grana** made up of **thylakoids**.
 - Thylakoid membranes contain **chlorophyll**.
- **Chromoplasts** and **Leucoplasts** are additional plastids found in many plants.
- Crash course - photosynthesis.



Mitochondria

- Mitochondria release energy produced from cellular respiration.
 - ❖ Inward membrane forms numerous folds (**cristae**).
 - Increase surface area available to enzymes in the matrix fluid.



Microbodies

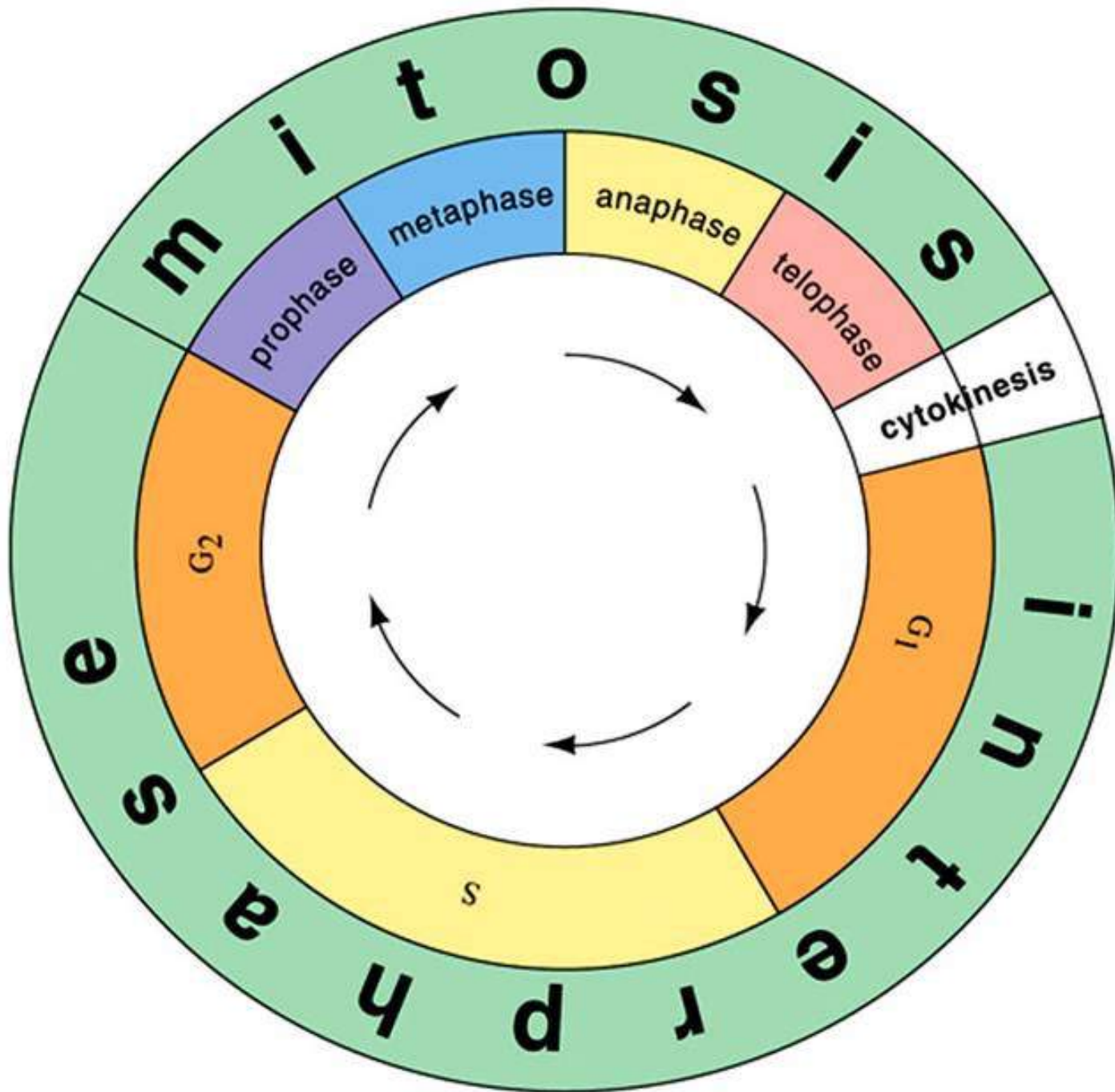
- **Microbodies** are small, spherical bodies with a single membrane, distributed throughout the cytoplasm which contain specialized enzymes.
 - ❖ **Perixosomes** - Serve in photorespiration.
 - ❖ **Glyoxisomes** - Aid in converting fat to carbohydrates.

Vacuoles

- In mature cells, 90% of volume may be taken up by **central vacuoles** bounded by vacuolar membranes (tonoplasts).
 - ❖ Filled with **cell sap** which helps maintain pressure within the cell.
 - ❖ Also frequently contains water-soluble pigments.

Cytoskeleton

- **Cytoskeleton** is an intricate network of microtubules and microfilaments.
 - ❖ Microtubules control the addition of cellulose to the cell wall.
 - ❖ Microfilaments play a major role in the contraction and movement of cells in multicellular animals.
 - Appear to play a role in cytoplasmic streaming.



Cellular Reproduction

- Cell division process referred to as **cell cycle**.
 - ❖ Divided into **interphase** and **mitosis**.
- **Interphase**
 - ❖ Period when cells are not dividing.
 - **G₁** - Cell increases in size.
 - **S** - DNA replication takes place.
 - **G₂** - Mitochondria divide, and microtubules produced.

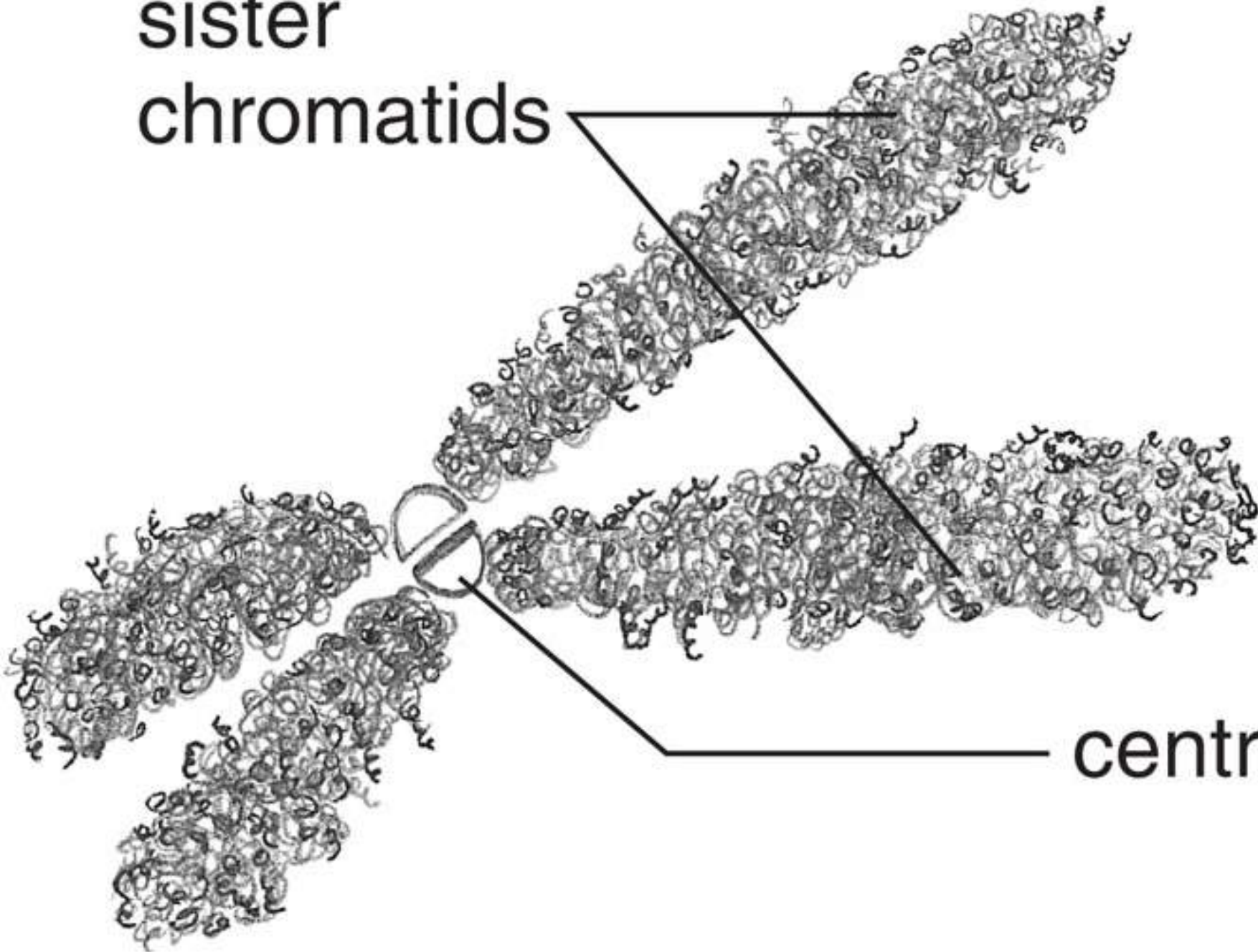
Mitosis

- Mitosis refers to the process of cellular division that produces two daughter cells with equal amounts of DNA and other substances duplicated during interphase.
 - ❖ Each daughter cell is an exact copy of the parent cell.
 - Mitosis occurs in meristems.

Prophase

- **Chromosomes condense.**
 - ❖ Strands of **chromatin** coil and tighten with centromeres holding each pair of chromatids together.
- **Nuclear envelope fragments.**
 - ❖ **Kinetochores** are located on the outer surface of each centromere.
 - Spindle fibers develop and become attached to the kinetochores.

sister
chromatids



centromere

Metaphase

- Chromosomes align at the cell's equator.
 - ❖ Spindle fibers collectively referred to as the **spindle**.
 - ❖ At the end of metaphase, the centromeres holding each sister chromatid separate lengthwise.

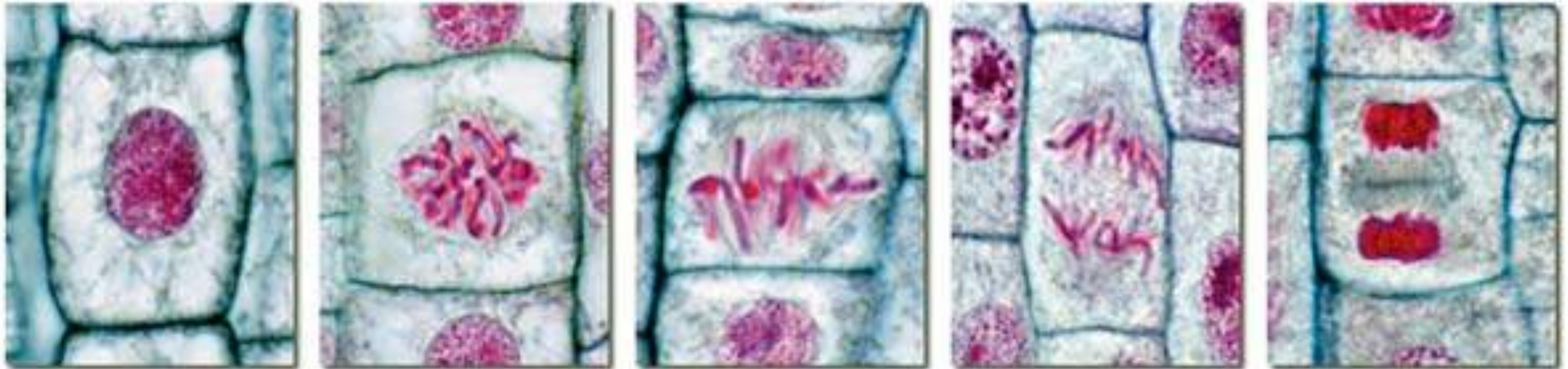
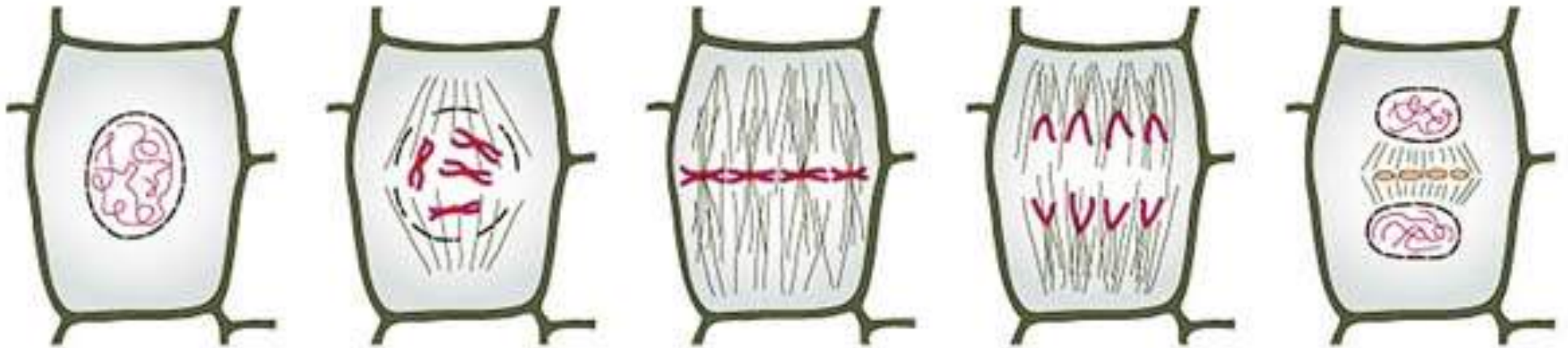
Anaphase

- Sister chromatids separate and are pulled to opposite poles.
 - ❖ Spindle fibers gradually shorten as material is continuously removed from the polar ends.

Telophase

- Each group of daughter chromosomes become surrounded by a **nuclear envelope**.
- Daughter chromosomes become indistinguishable.
- **Nucleoli** reappear
- Spindle fibers disintegrate
- **Cell plate** forms.

Phases of Mitosis (Remember PMAT)



Tissues



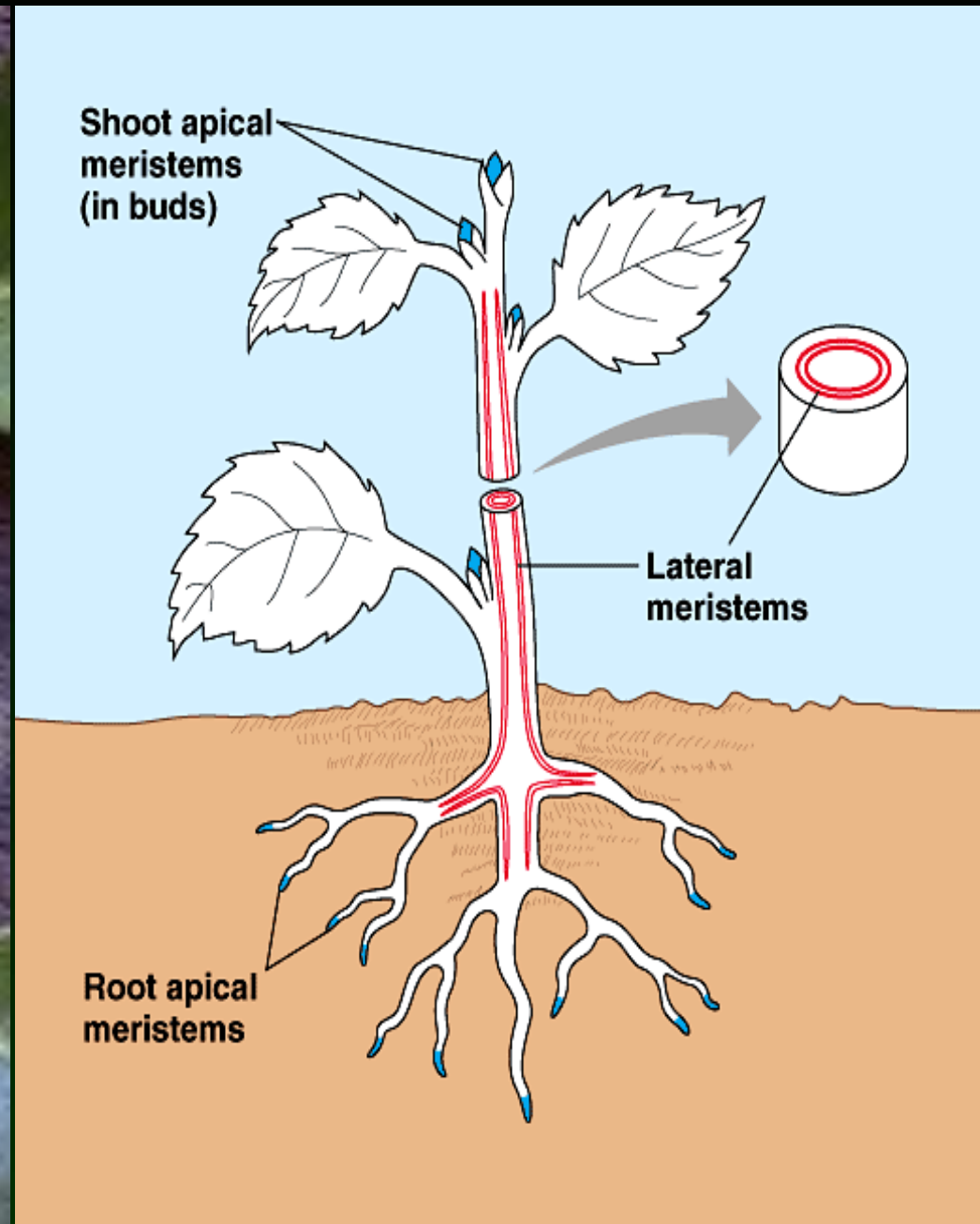
Meristematic Tissues

- **Meristems** - Permanent regions of active cell division.
 - ❖ **Apical Meristems** - Found at the tips of roots and shoots.
 - Increase in length as the apical meristems produce new cells (primary growth).
 - **Primary Meristems**
 - Protoderm
 - Ground Meristem
 - Procambium

Meristematic Tissues

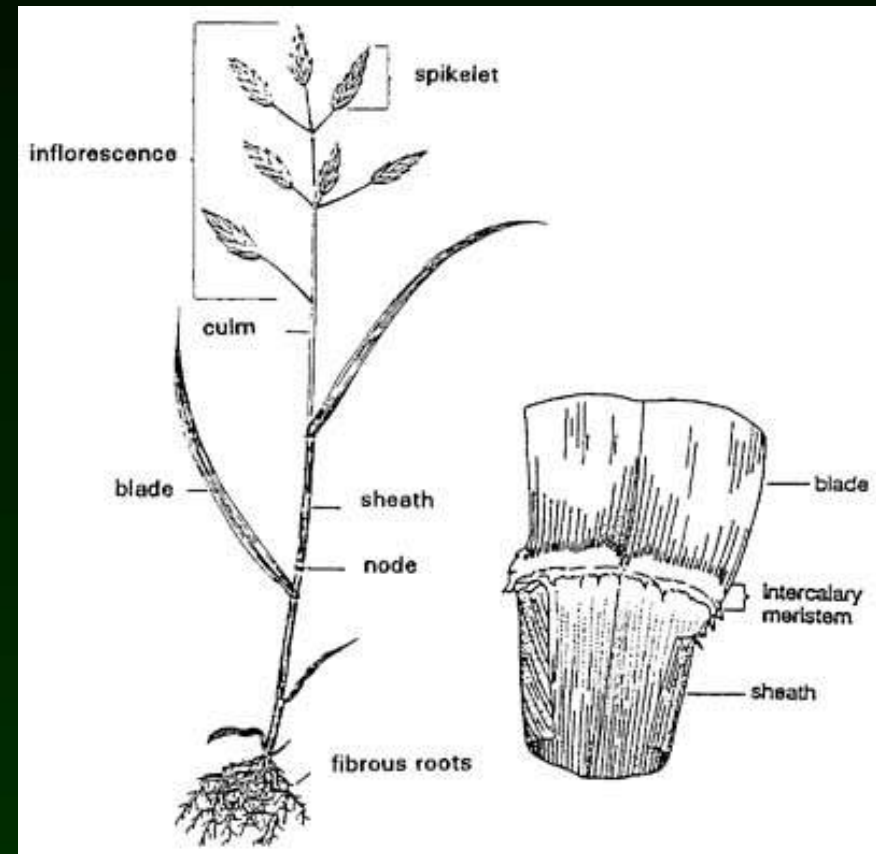
- ❖ **Lateral Meristems** - Produce tissues that increase the girth of roots and stems.
 - **Secondary Growth**
 - **Vascular Cambium** - Produces secondary tissues that function primarily in support and conduction.
 - Thin cylindrical cells.
 - **Cork Cambium** - Lies outside vascular cambium just inside the outer bark.

Meristems



Meristematic Tissues

- Grasses and related plants do not have vascular cambium or cork cambium, but do have apical meristems in the vicinity of the nodes.
 - ❖ Intercalary meristems



Tissues Produced By Meristems

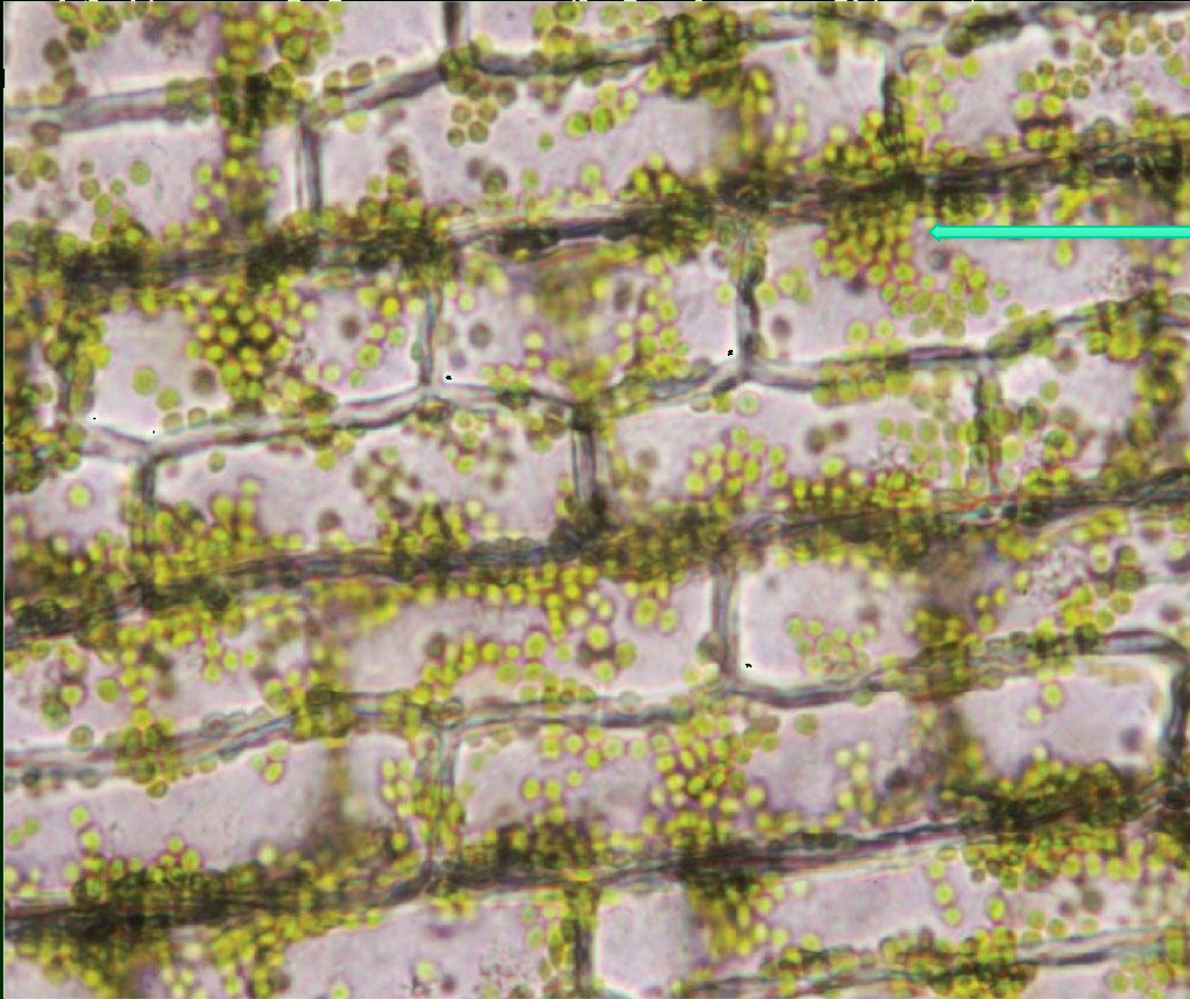
- Simple Tissues

- ❖ **Parenchyma** - Tend to have large vacuoles and many contain various secretions.

- **Aerenchyma** - Parenchyma tissue with extensive connected air spaces.

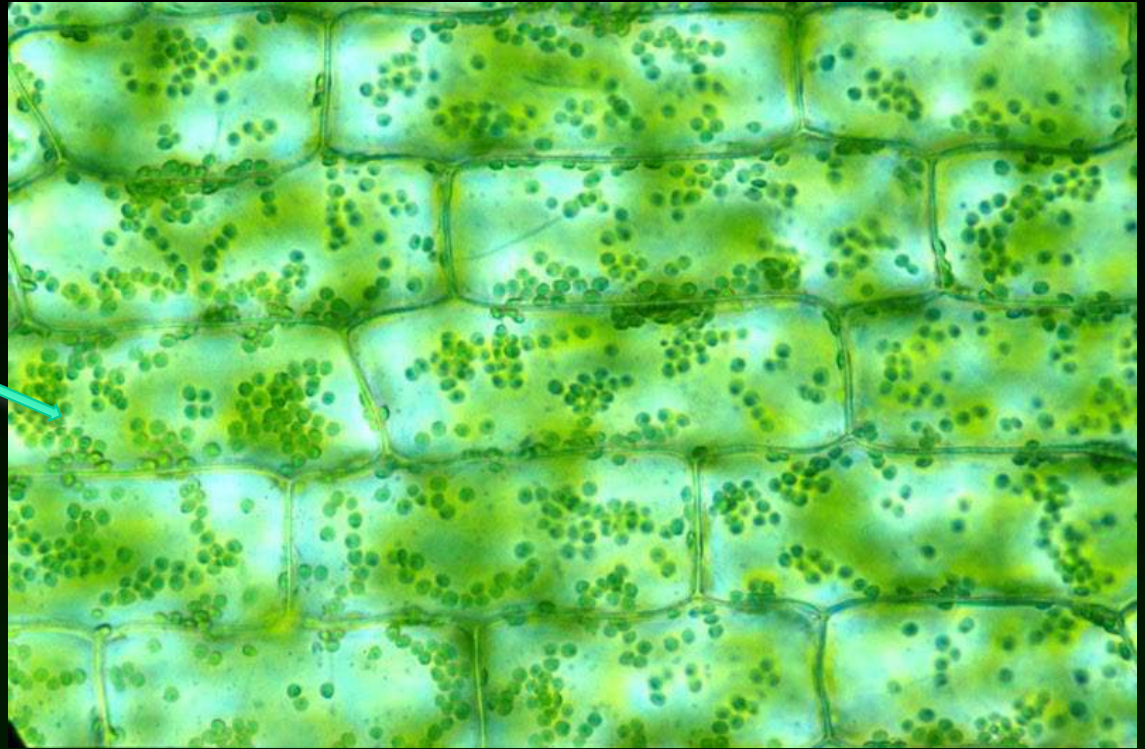
- **Chlorenchyma** - Parenchyma cells containing chloroplasts.

Chlorenchyma

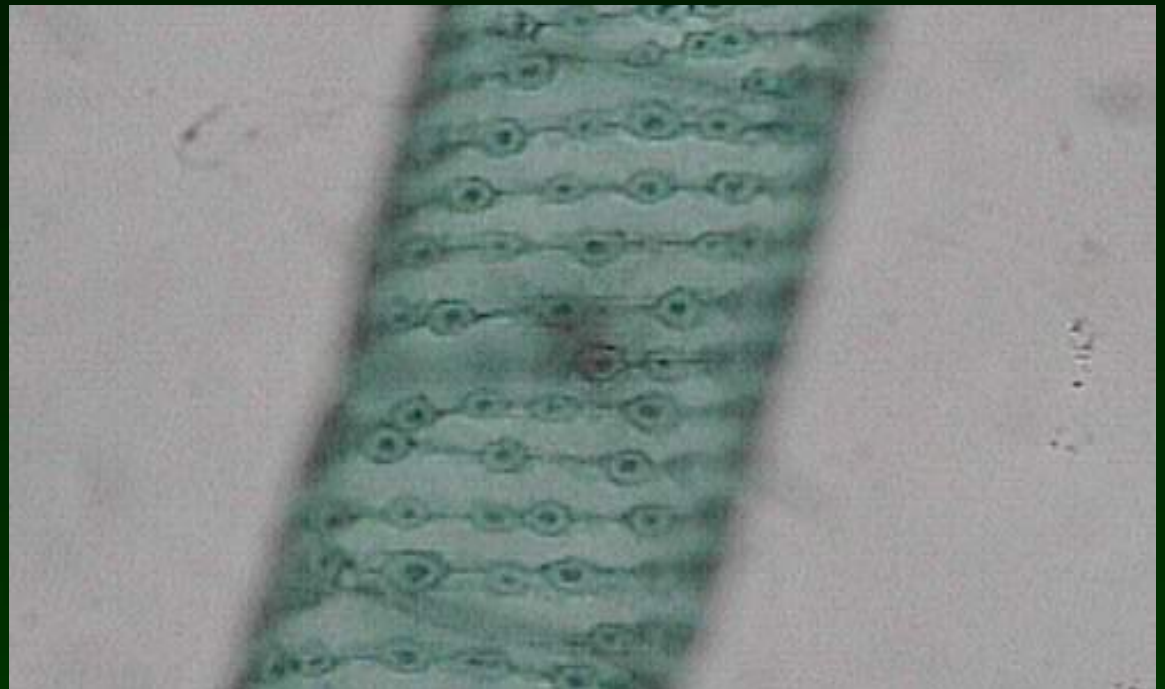


Chloroplasts

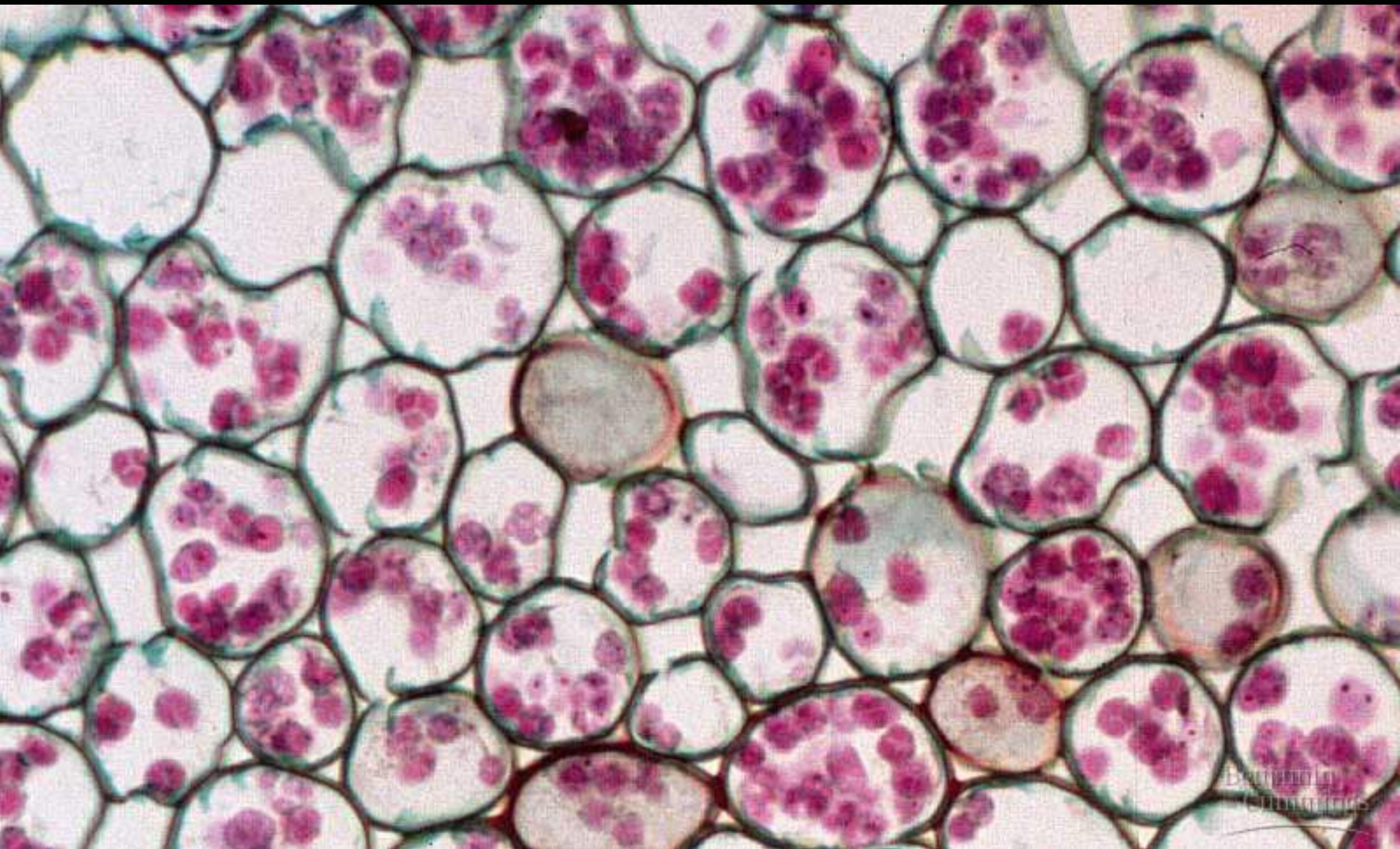
Chloroplasts



Chlorenchyma



Parenchyma



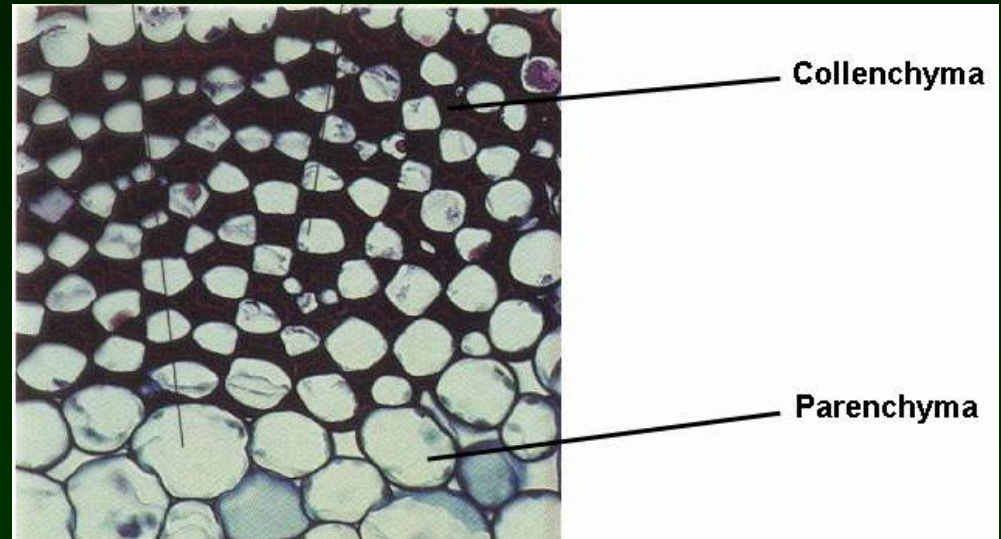
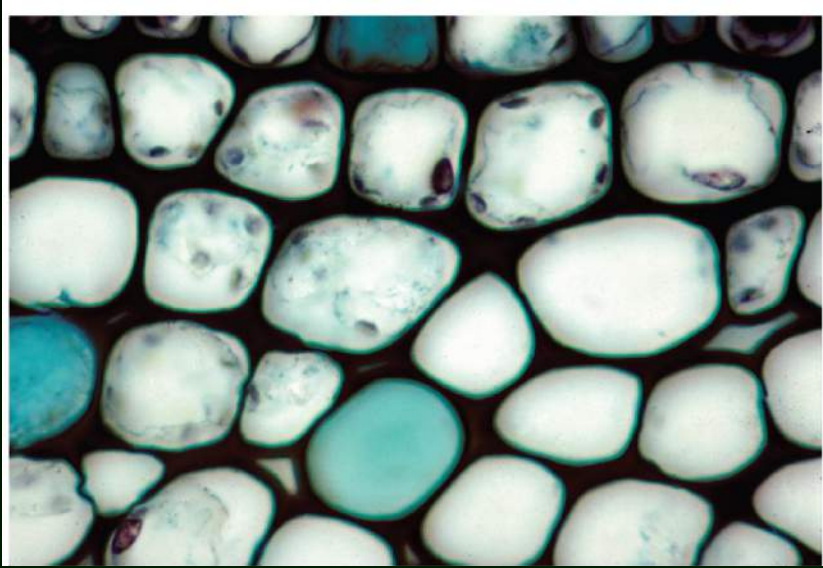
Simple Tissues

- ❖ **Collenchyma** - Contain living cytoplasm and may live an extended time.
 - Provide flexible support for organs.
- ❖ **Sclerenchyma** - Cells with thick, tough, secondary walls, normally impregnated with lignin.
 - **Sclerids** - Stone Cells
 - **Fibers** - Contain Lumen

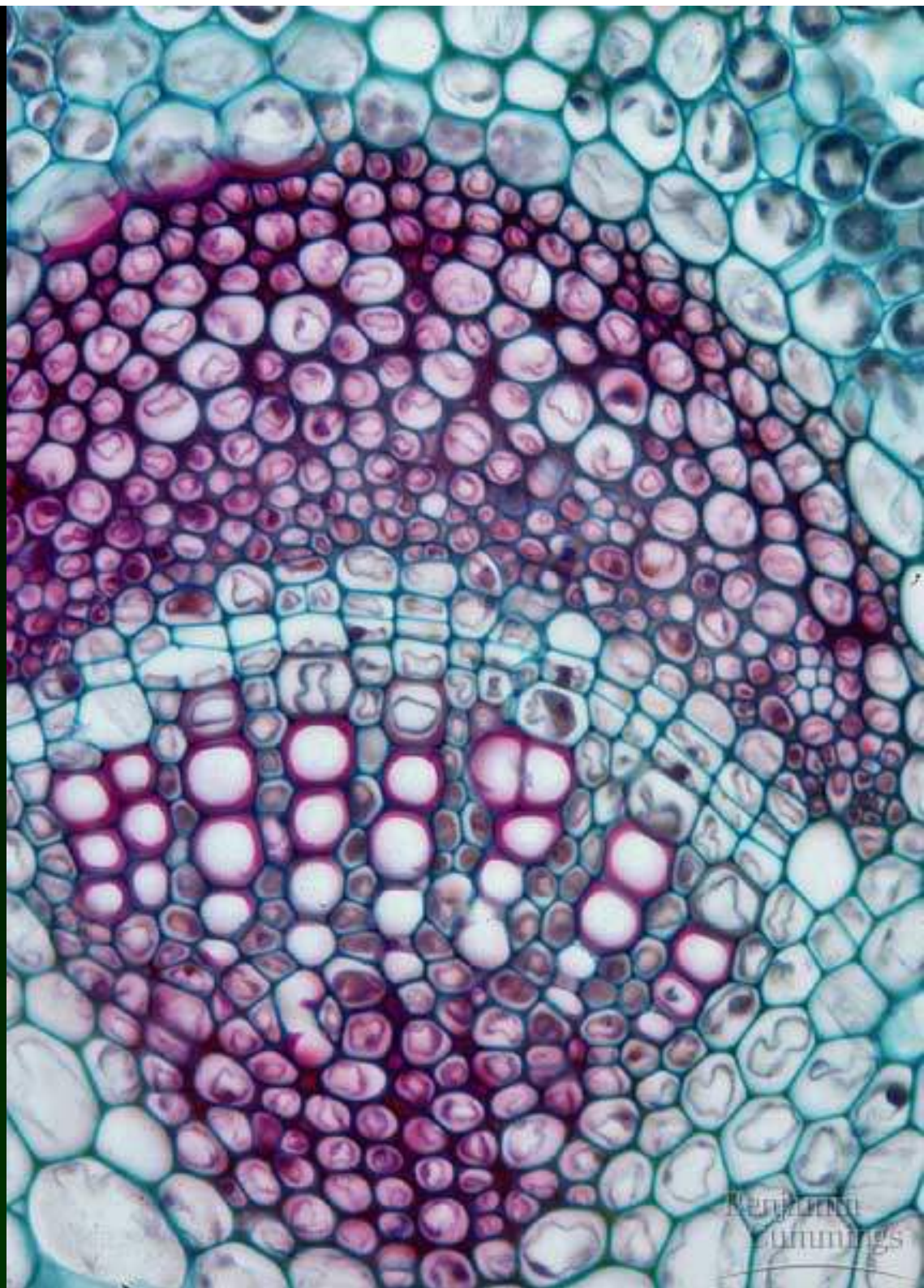
Collenchyma

Thick-walled (uneven); living

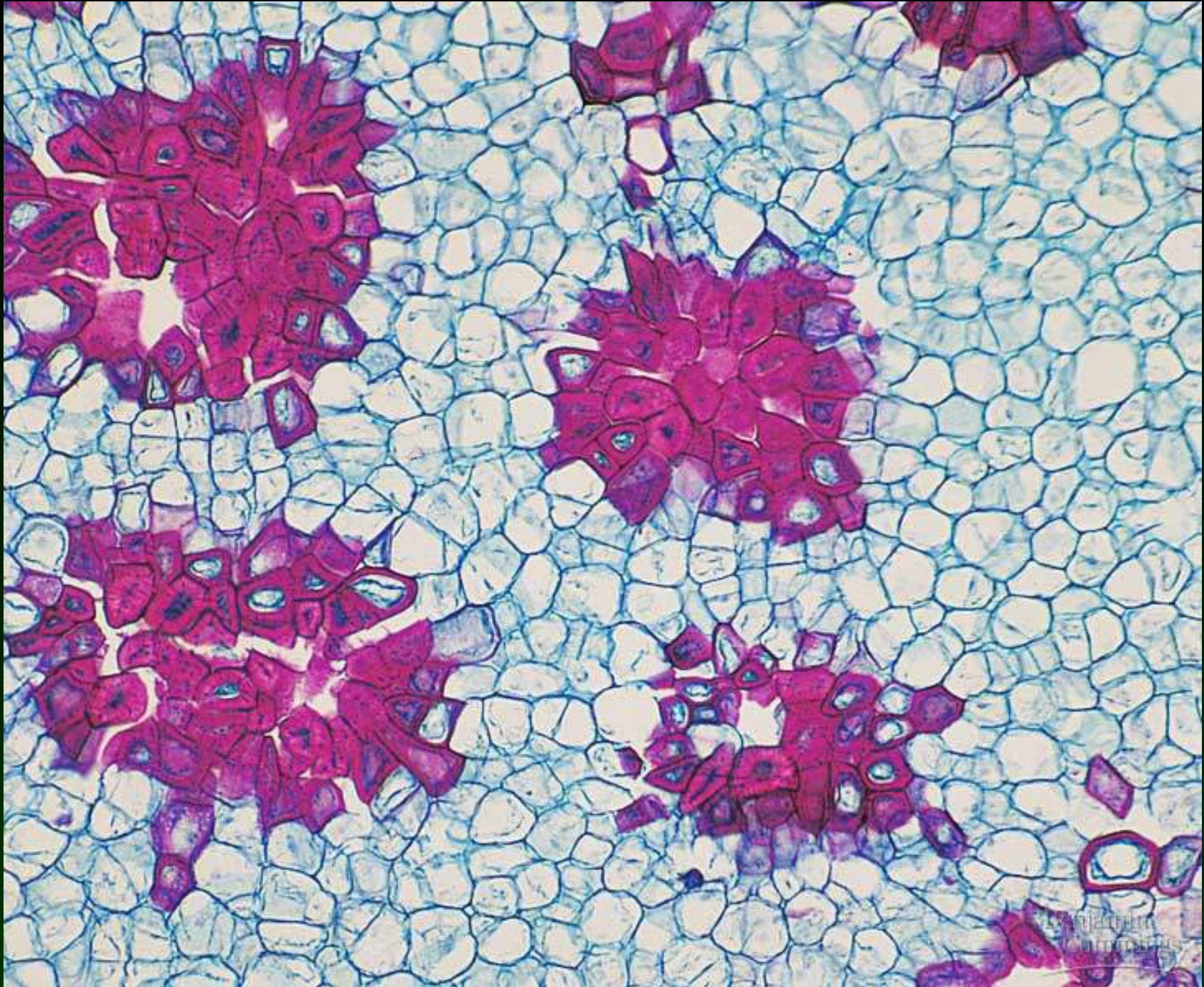
- Offers support (flexible & strong)
- Able to elongate
- Grouped in strands, lack secondary wall



Fiber Cells

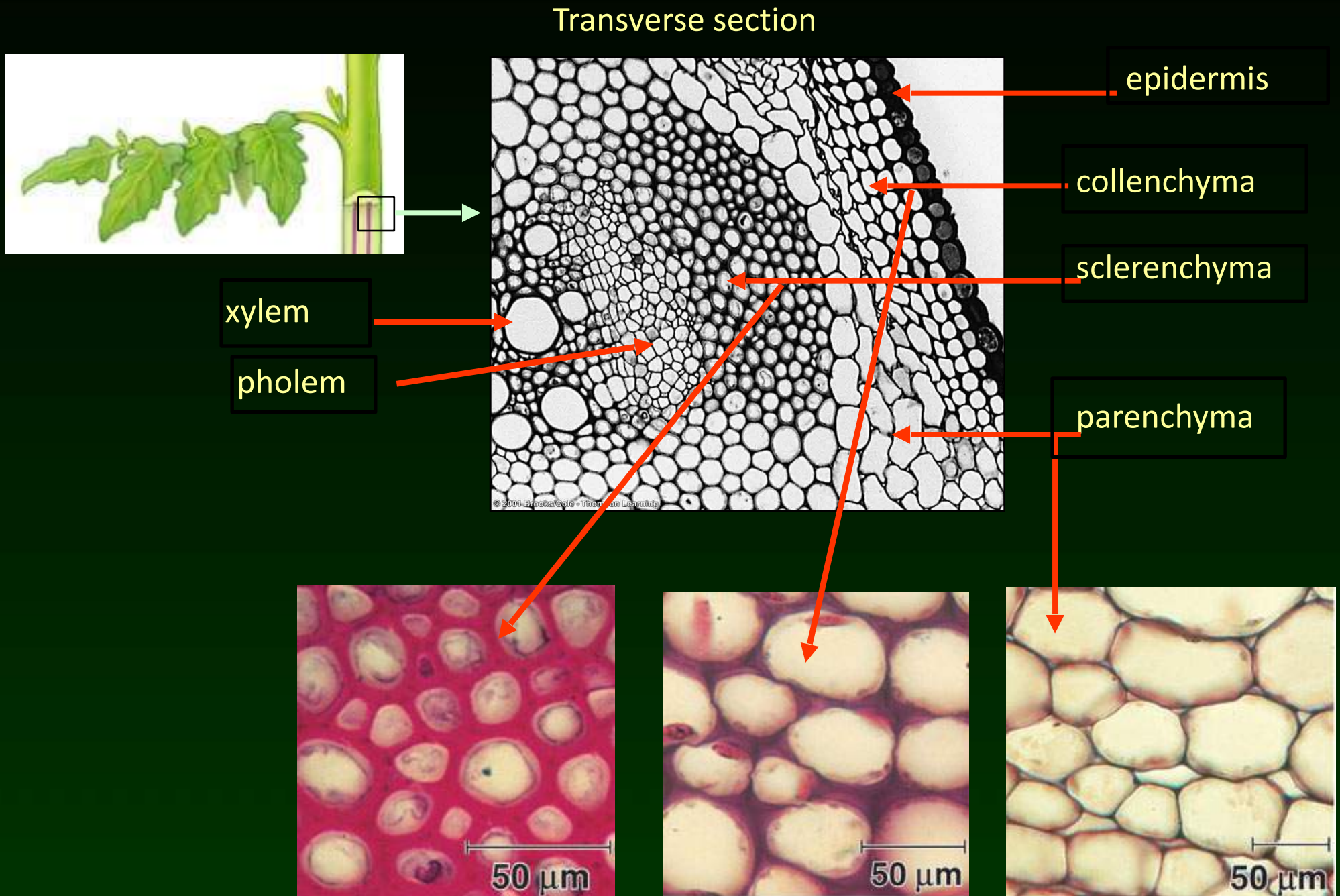


Sclereids



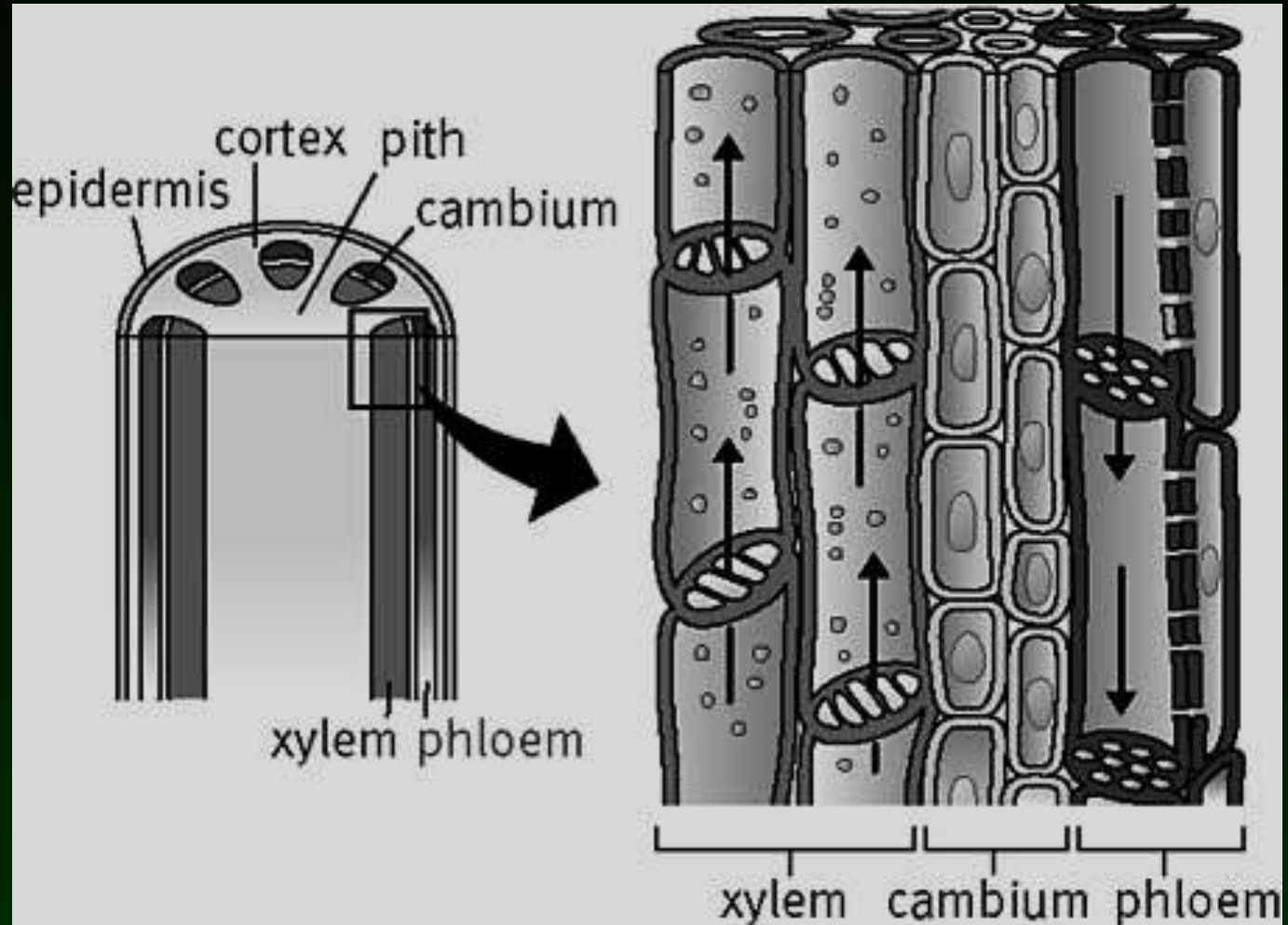
Simple tissues of parenchyma, collenchyma and sclerenchyma

Important structural tissues of many angiosperms



Plant Tissues - Vascular

Vascular tissues made up of multiple cell types:



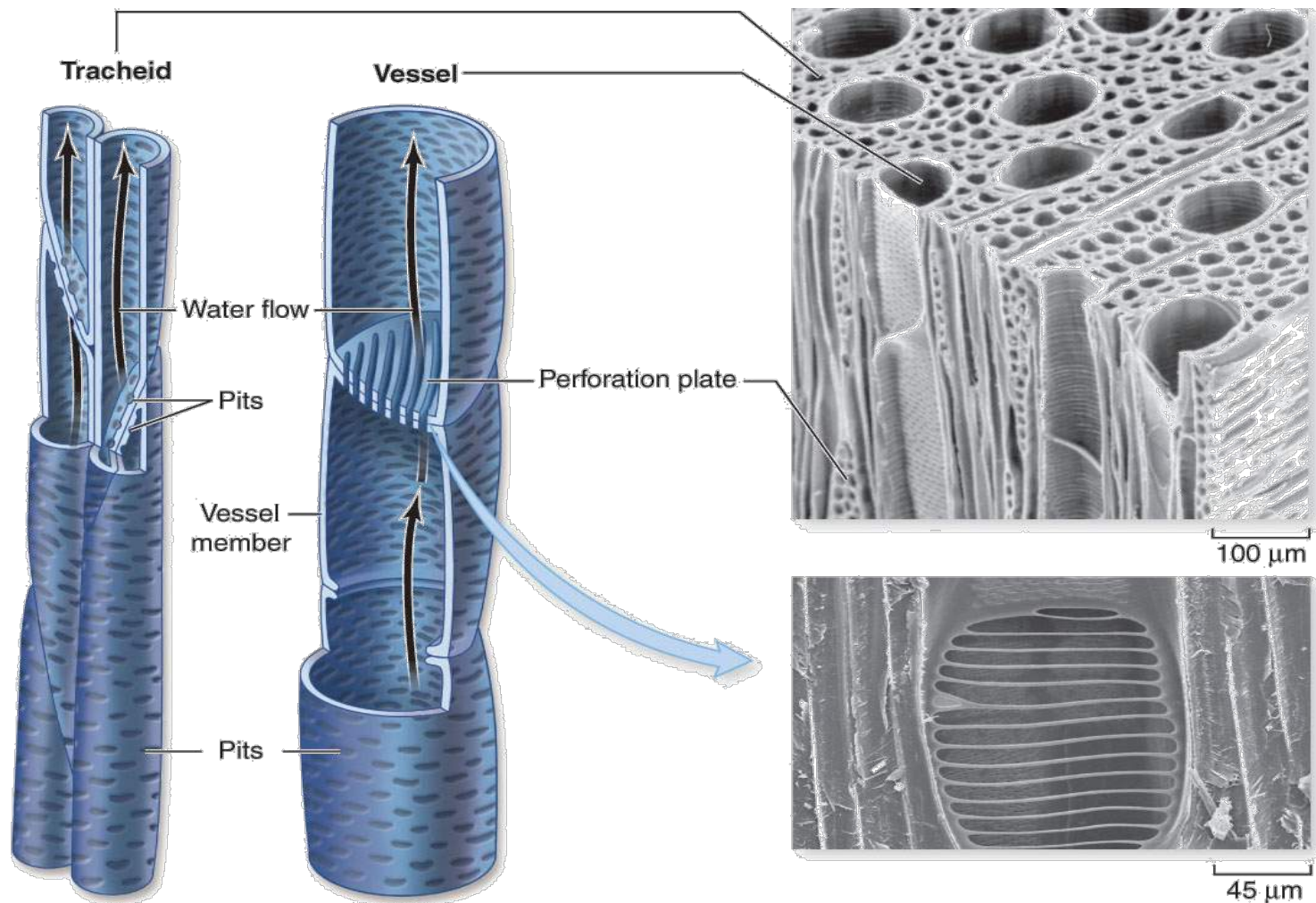
Xylem – water and nutrients

Phloem – dissolved sugars and metabolites

Plant Tissues - Vascular

1) Xylem (dead at maturity): water and minerals roots to shoots

- A) **Tracheids: Narrow, tube-like cells, pits for water movement.**
- B) **Vessel Elements: Wide, tube-like cells**
- C) **Fibers (rays) – Lateral movement**



Plant Tissues - Vascular

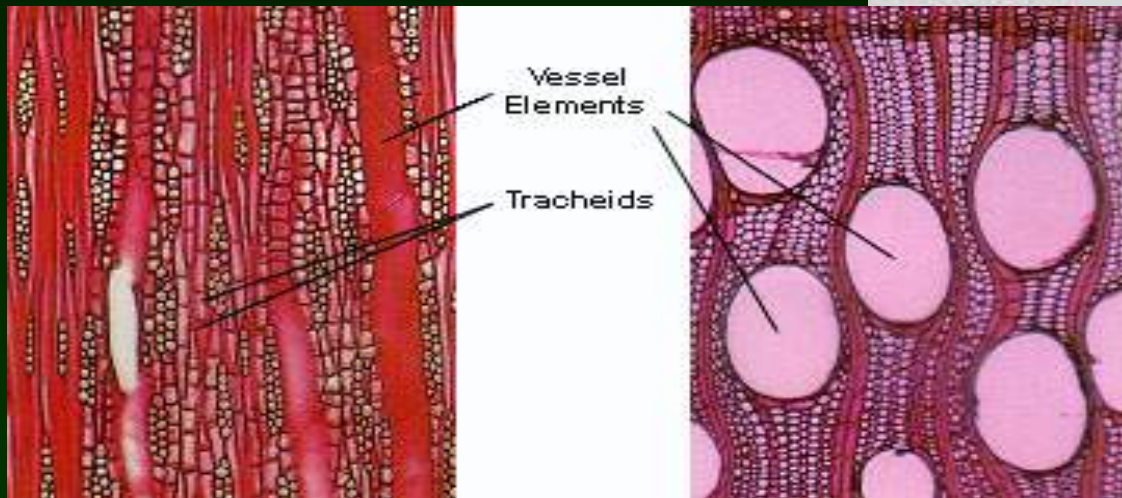
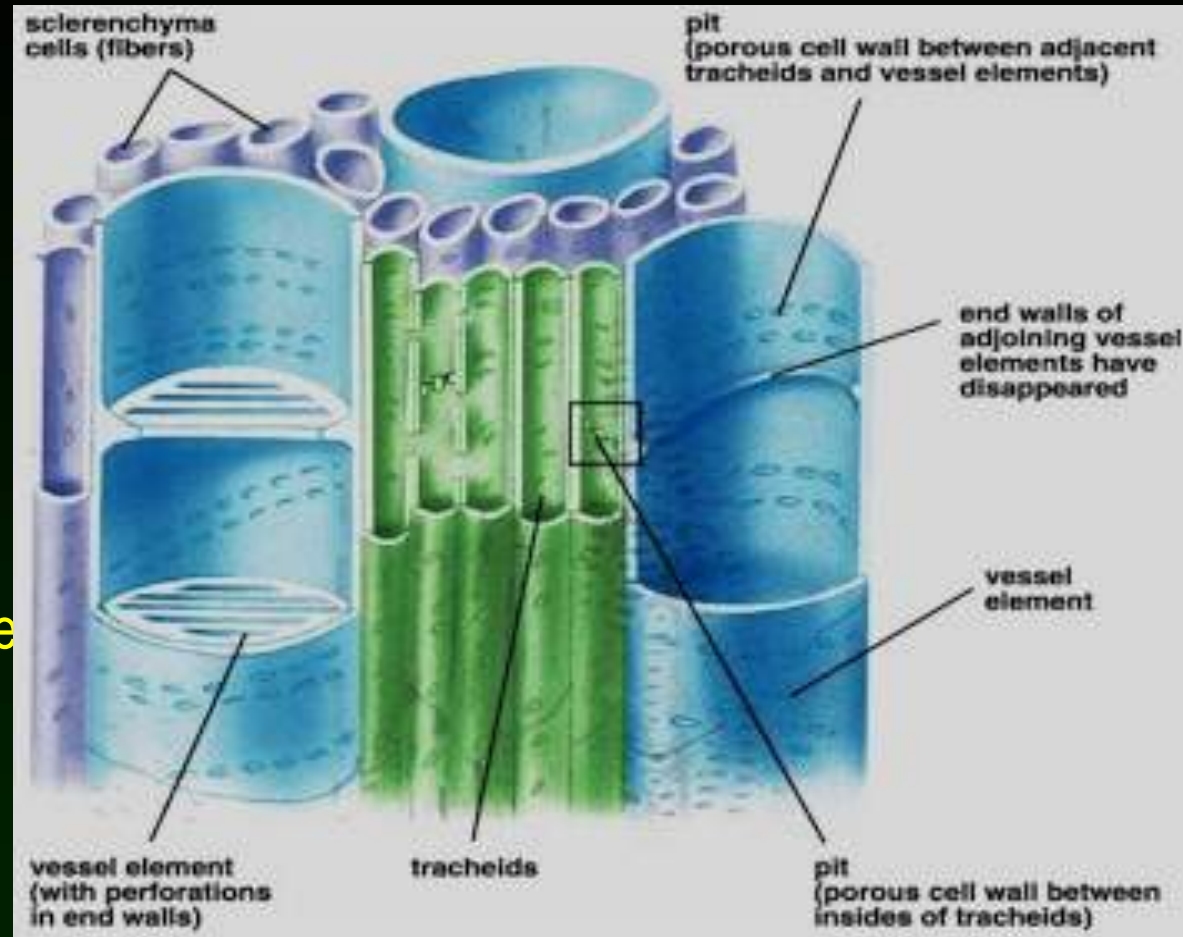
1) Xylem:

Tracheids:

- Most vascular plants
- Long, thin, tapered ends, lignified secondary walls
- Water moves cell to cell through pits

Vessel elements:

- Wider and shorter
- Perforation plates ends of vessel elements
- water flows freely through perforation plates

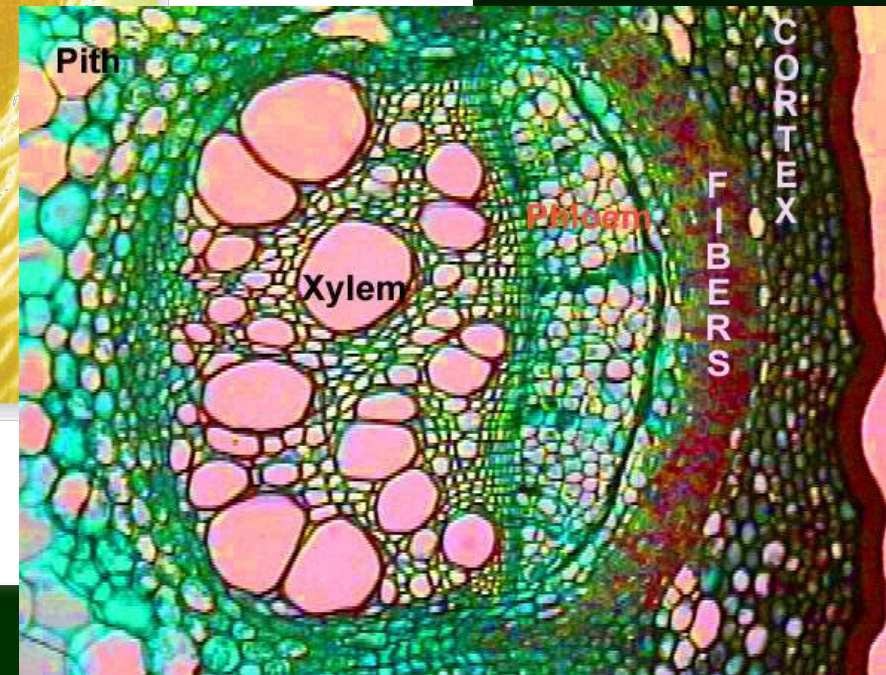
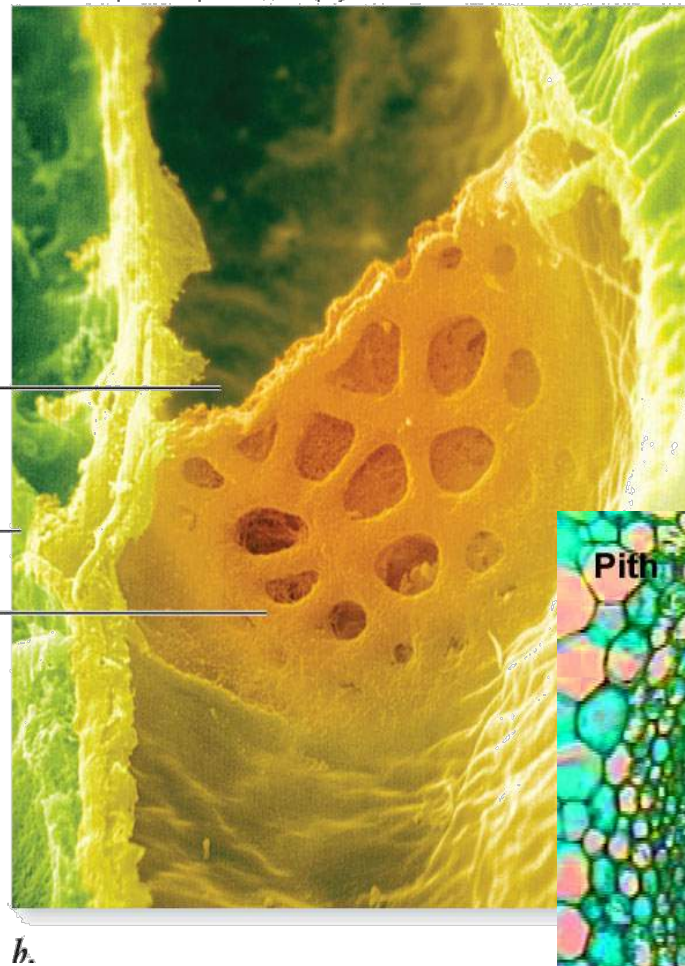
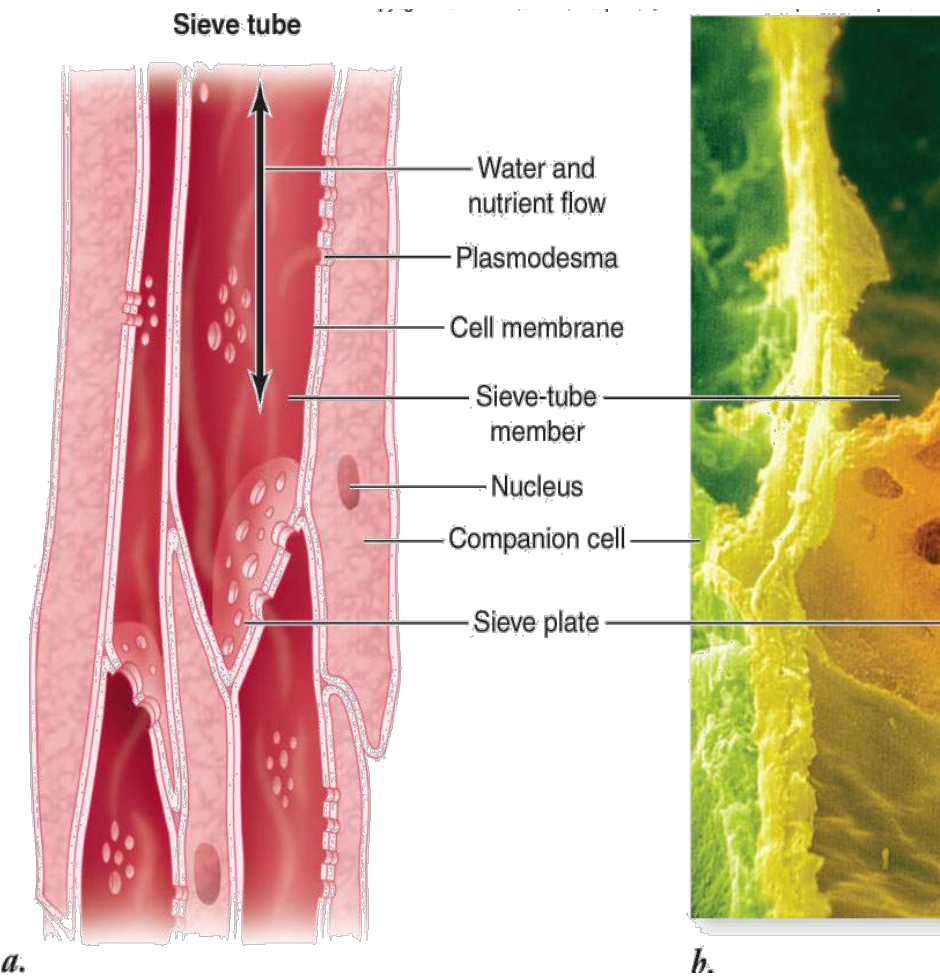


Plant Tissues - Vascular

2) Phloem (living at maturity) cells:

A) **Sieve Tubes: Wide, tube-like cells**

B) **Companion Cells: support and regulate sieve tubes**



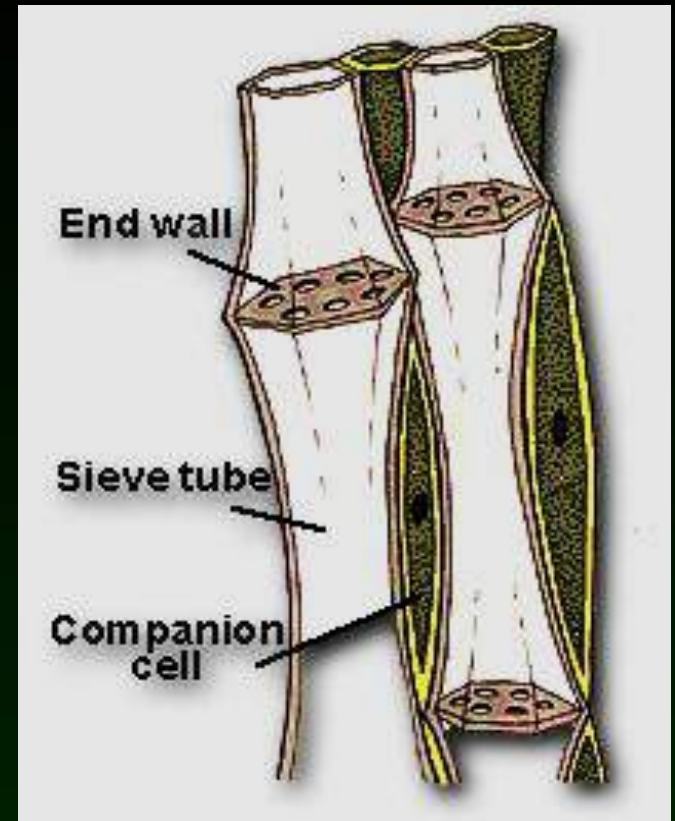
Plant Tissues - Vascular

2) Phloem (living at maturity)

- Moves water, sugar, amino acids & hormones

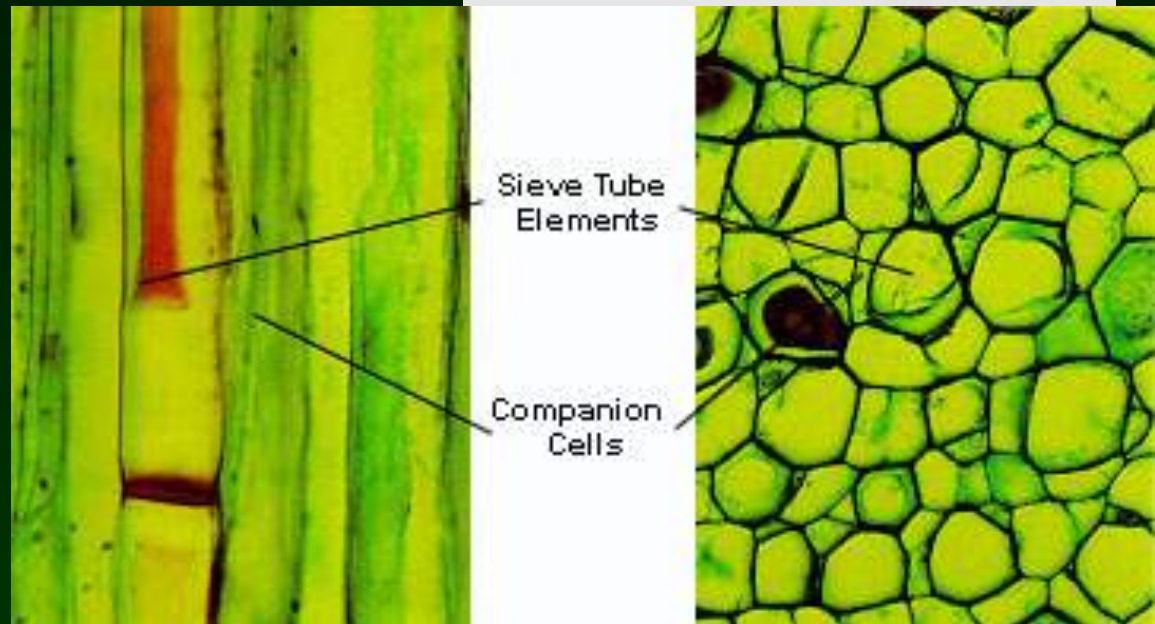
Sieve tube elements/members

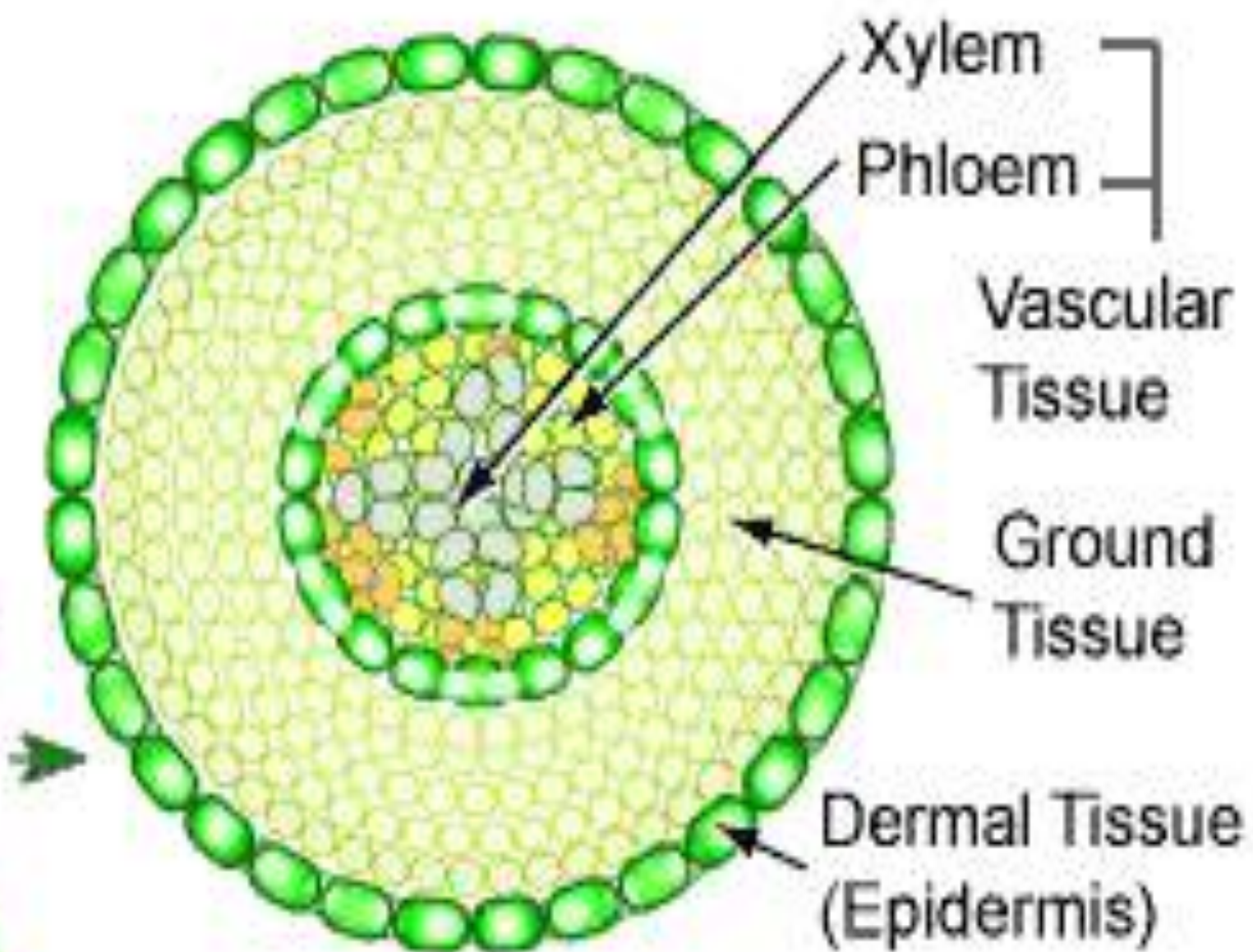
- Living parenchyma
- Long narrow cells stack end to end
- Pores in end walls (sieve plates)
- Lack most cellular structures including:
- Distinct vacuole, Some cytoskeletal elements, Nucleus, Ribosomes



Companion Cells:

- Adjacent to every sieve tube element
- Non-conducting.
- Regulate both cells
- Connected by numerous plasmodesmata



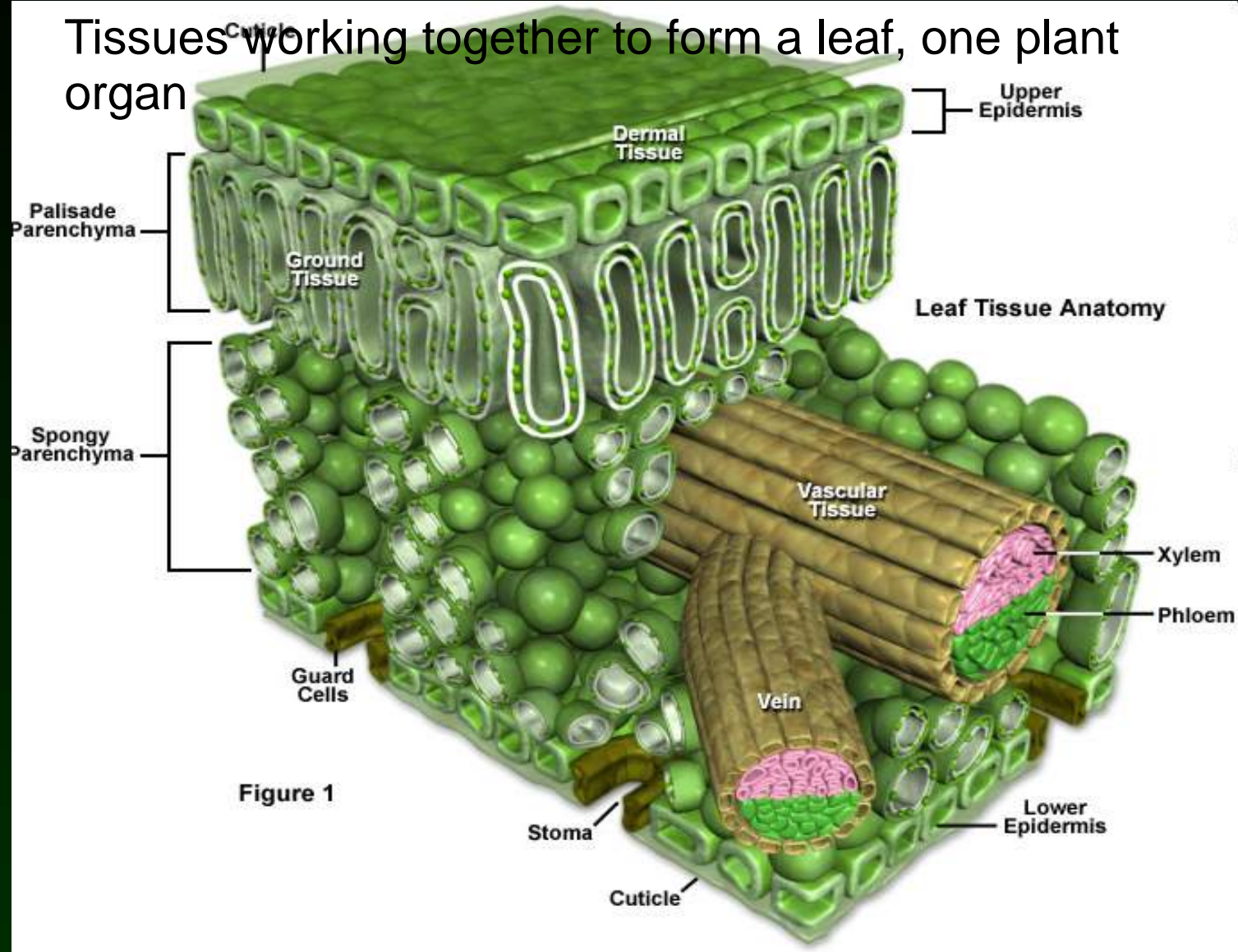


Complex Tissues

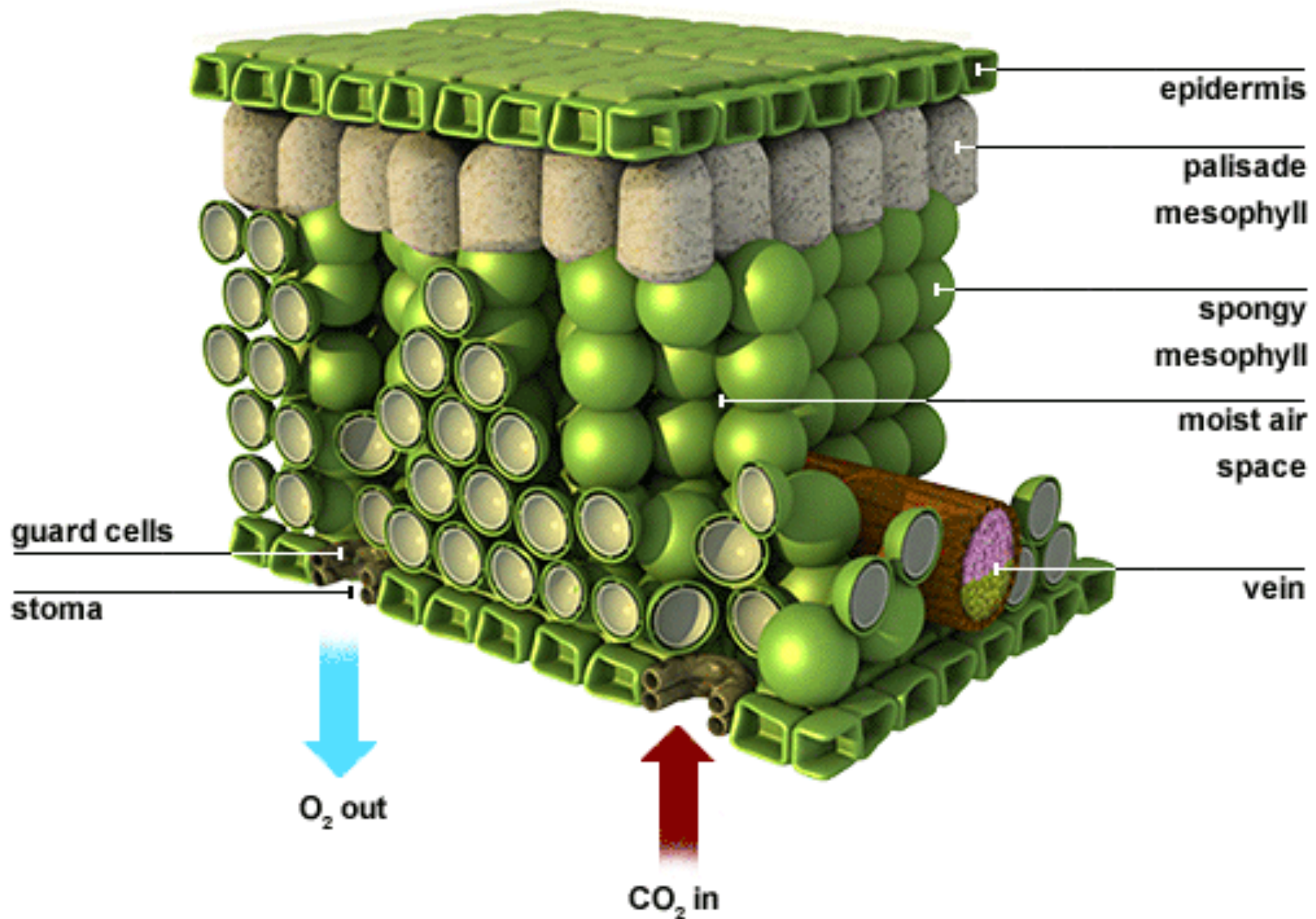
- ❖ **Epidermis** - Outermost layer of cells.
 - One cell thick
 - Most secrete fatty substance, **cutin**, on the surface of the outer walls.
 - Forms **cuticle**.
 - Root epidermal cells produce **root hairs**.
 - Leaves have **stomata** bordered by pairs of **guard cells**.

Plant Organs

Tissues working together to form a leaf, one plant organ

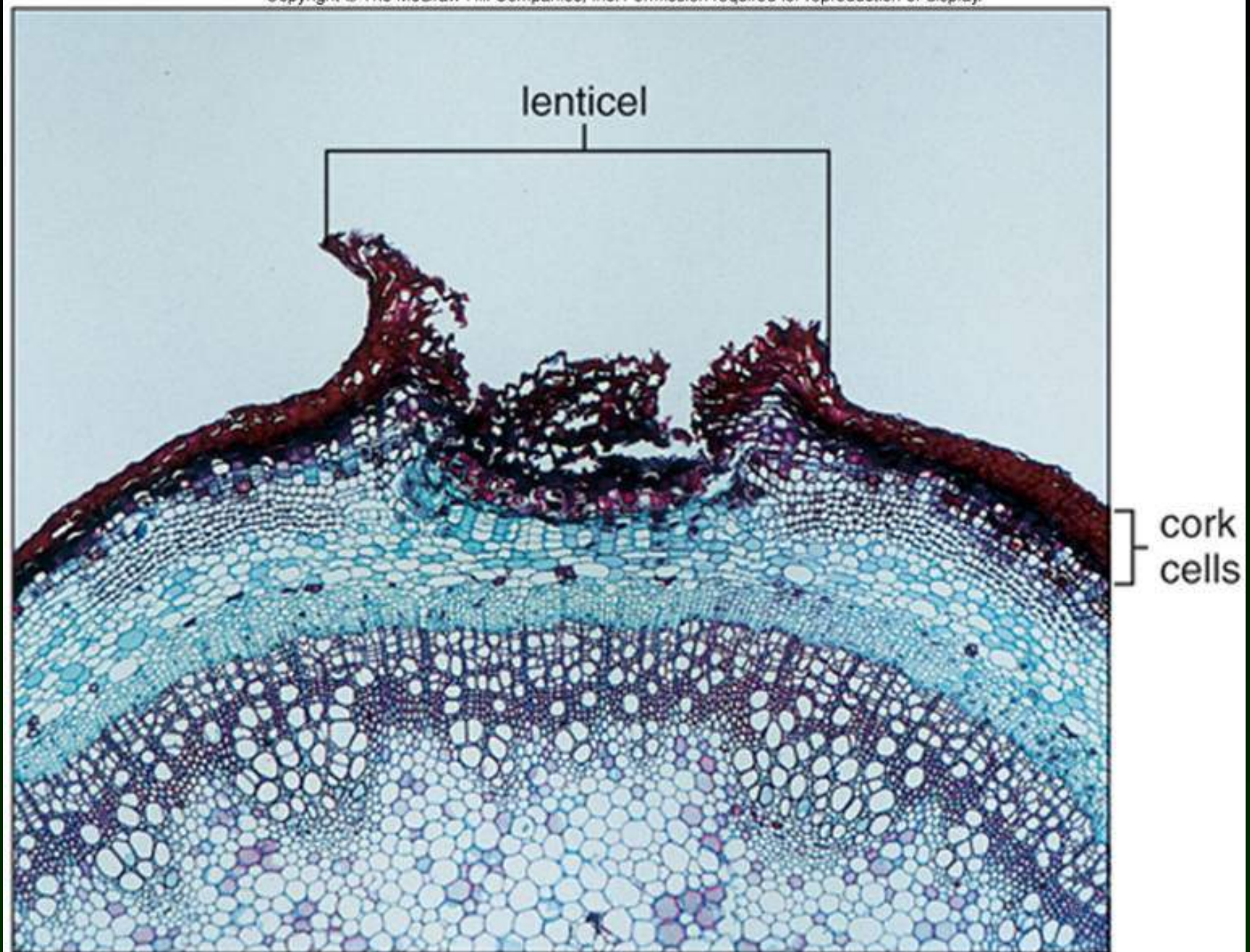


A 3D look at a leaf organ



Complex Tissues

- ❖ **Periderm** - Constitutes outer bark.
 - Primarily composed of **cork** cells.
 - Cytoplasm of corks cells secretes **suberin** into the walls.
 - Some parts of cork cambium form loosely arranged pockets of parenchyma cells that protrude through the surface of the periderm.
 - **Lenticels** - allows for gas exchange

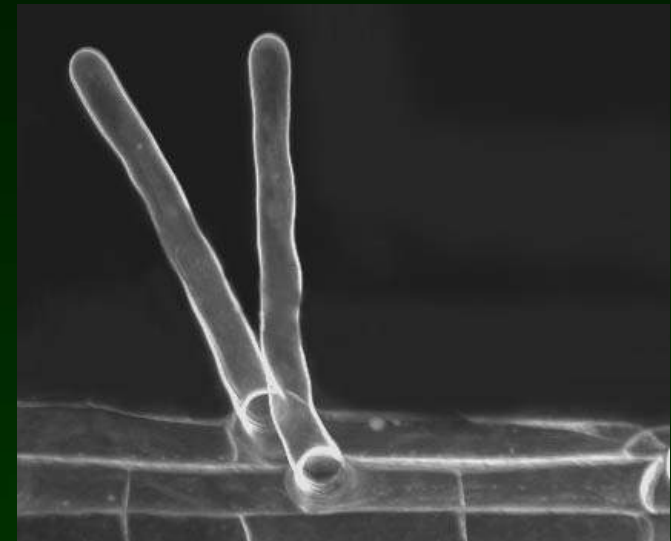
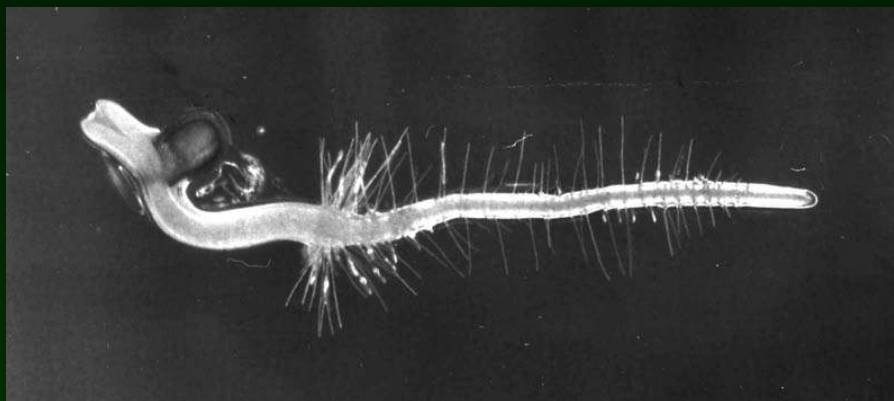
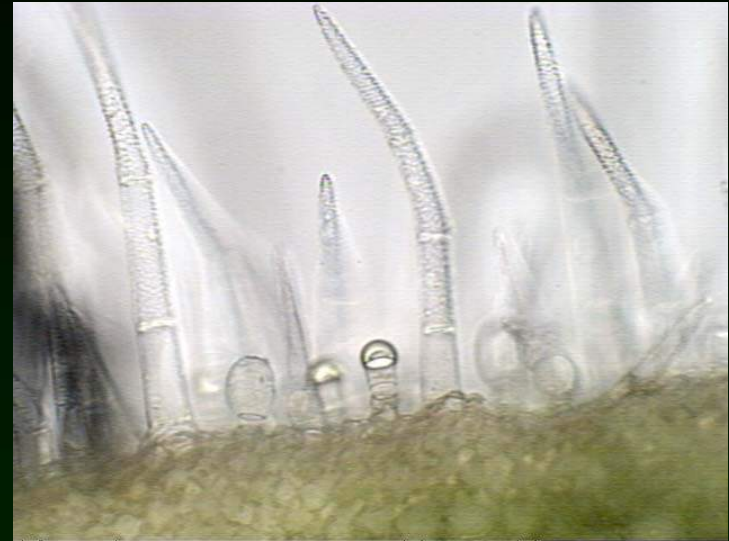


Complex Tissues

❖ Secretory Cells and Tissue

- Secretory cells may function individually or as part of a secretory tissue.
 - Flower nectar
 - Citrus oils
 - Glandular hair mucilage
 - Latex

Epidermis — stoma, trichomes, & root hairs



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

Plant Lifecycle:

Germination → flowering → seed production → death

- **Annual-** in a single year or less.
 - ❖ Many wildflowers and important food crops, such as cereals and legumes, are annuals.
- **Biennial-** spans two years.
 - ❖ Often, there is an intervening cold period between the vegetative growth season and the flowering season.
- **Perennials-** Plants that live many years,
 - Includes trees, shrubs, and some grasses.
 - ❖ These often die not from old age, but from an infection or some environmental trauma.