Plant Cells

BAG204- Crop Physiology
B.Sc. Agriculture (H)- II semester
Department of Agriculture
Invertis University

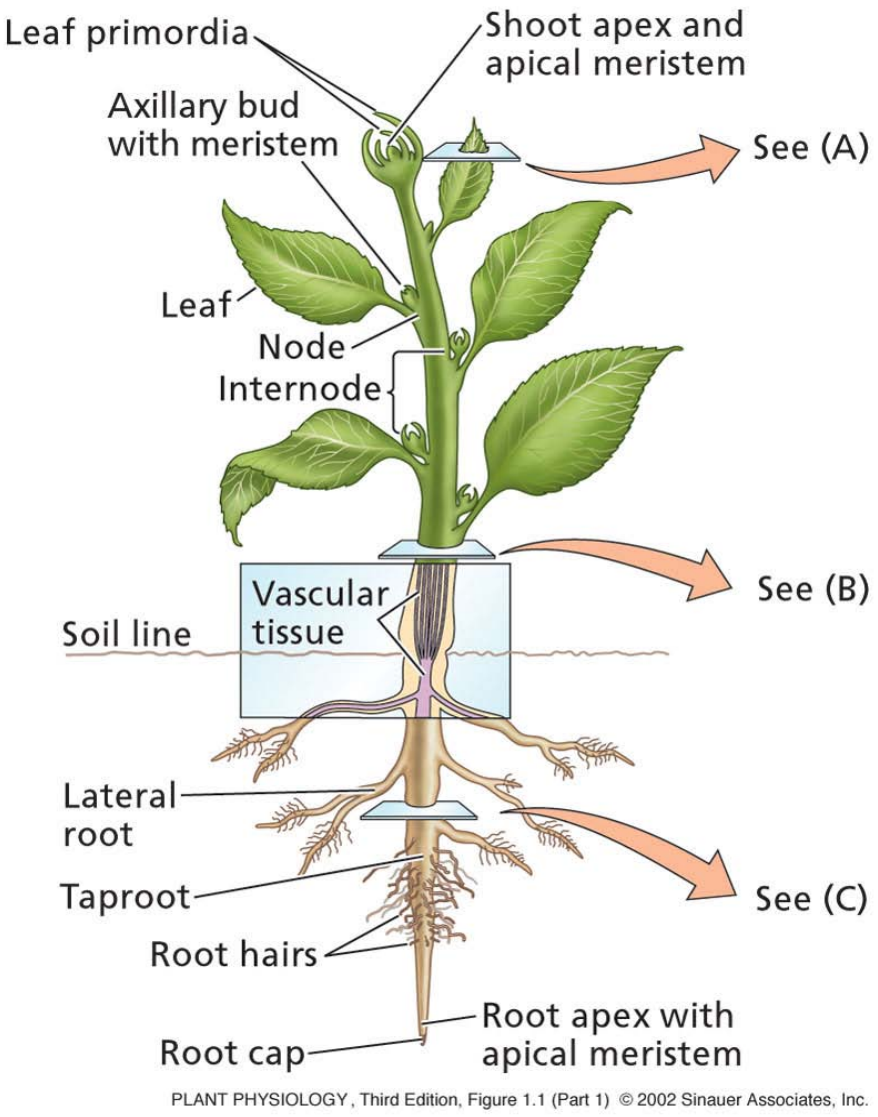
Overview of Plant Structure

- Plants are Earth's Primary Producers
  - Harvest Energy from sunlight by converting ***light*** energy into ***chemical*** energy
- They store this Chemical Energy in bonds formed when the synthesize ***Carbohydrates*** from Carbon Dioxide and Water.

- Non- motile
  - Have evolved to grow towards resources throughout their life span.

Overview of Plant Structure

- The vegetative body consists of:
- **Leaf:** ***Photosynthesis***
- **Stem:** ***Support***
- **Roots:** ***anchorage*** and absorption of ***water*** & ***minerals***.
- **Nodes:** leaf attached tc stem.
- **Internode:** Region of stem between two nodes



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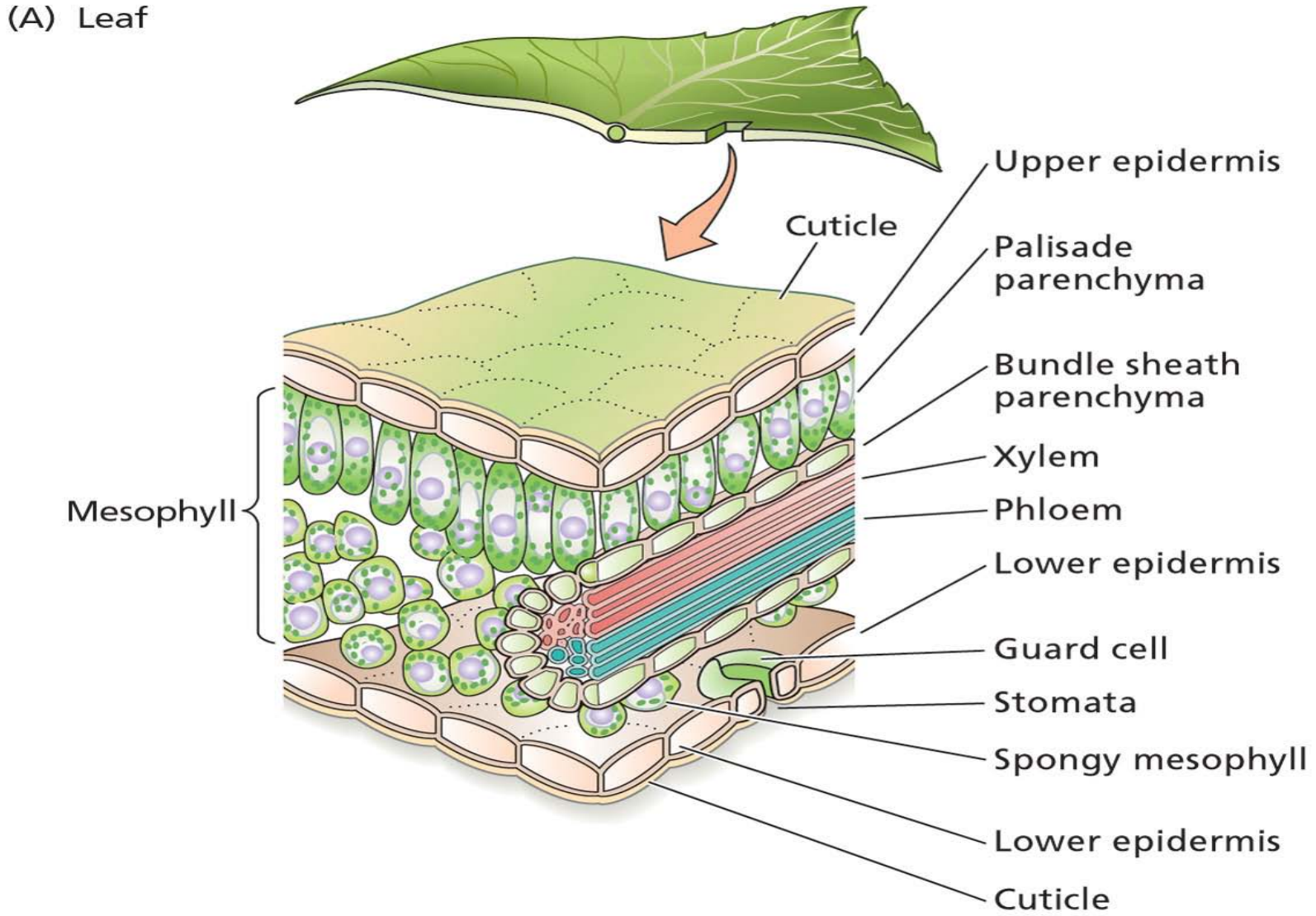
THE LEAF



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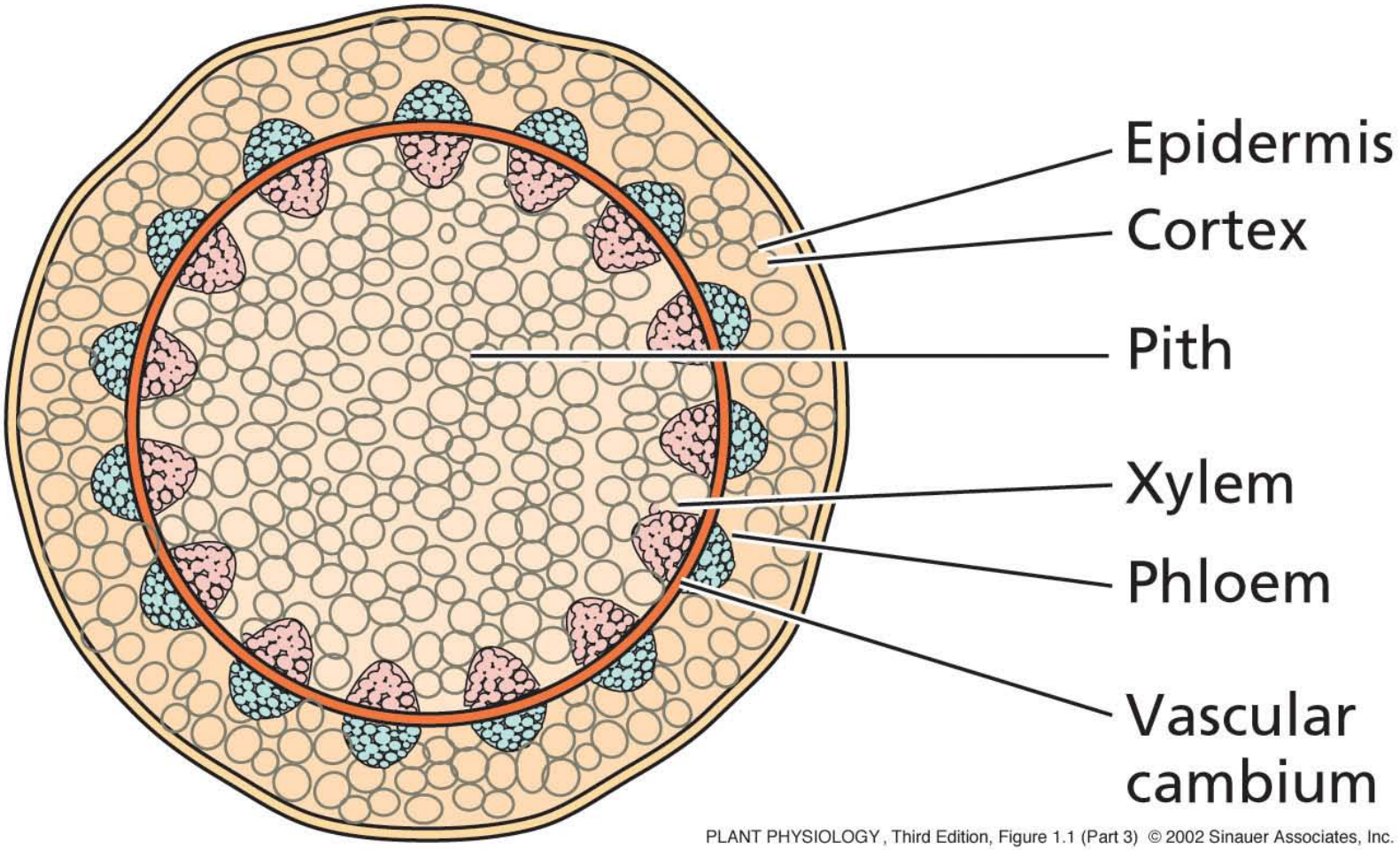
THE STEM

(B) Stem



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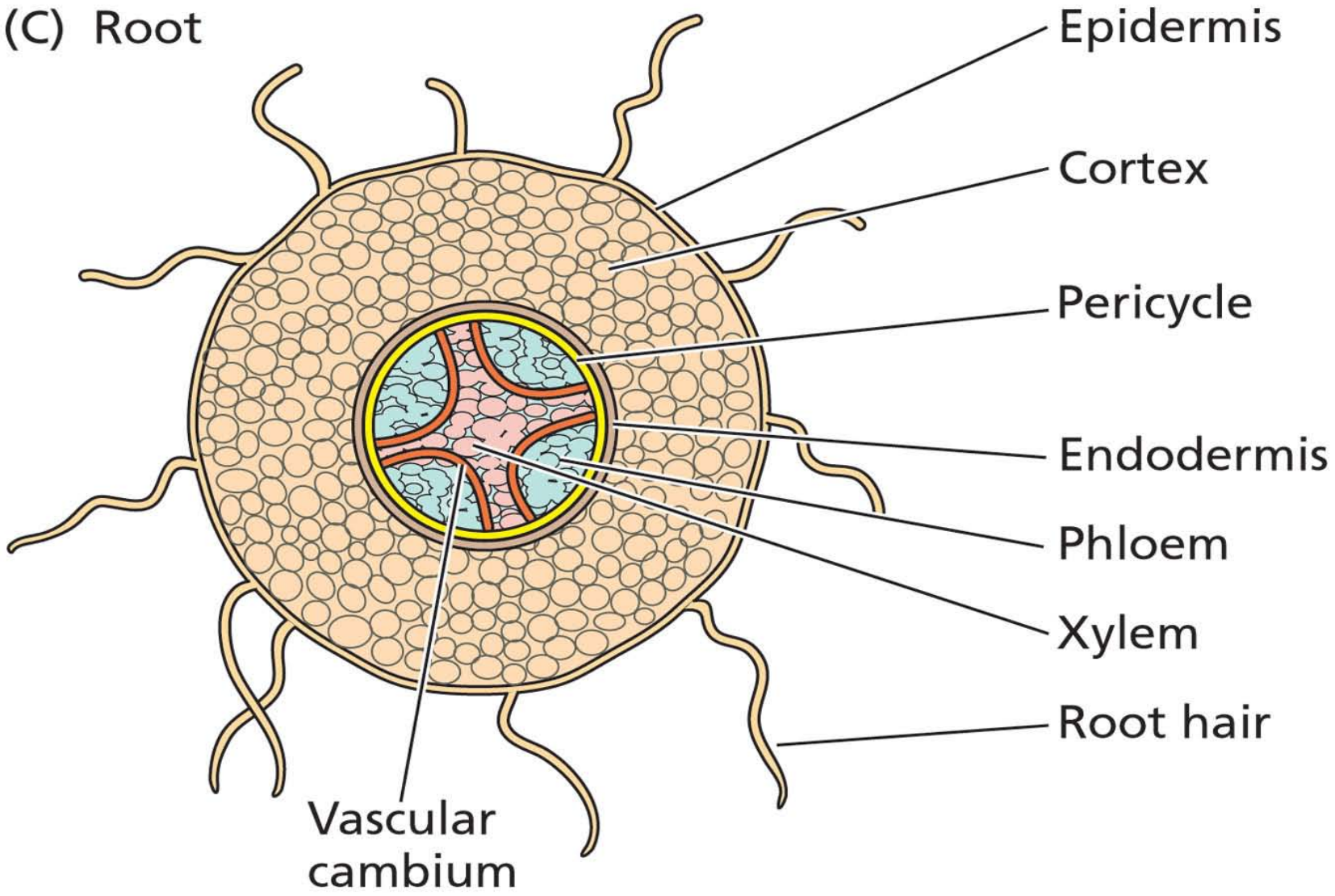
THE ROOT

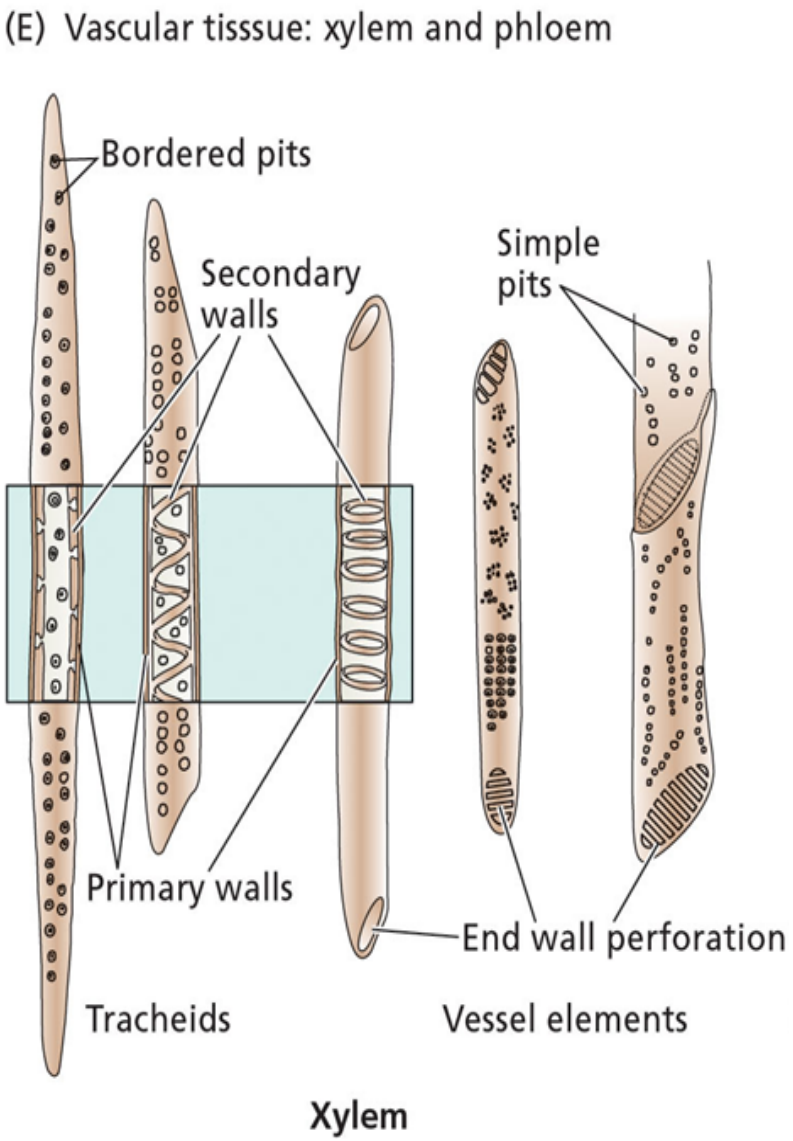


Overview of Plant Structure

- Two general types of plants:
- ***Angiosperms***:
  - More advanced type of plant
    - About 250,000 species known
    - Major innovation is the Flower
      - So these are also known as flowing plants!
- ***Gymnosperms***:
  - Less advanced than angiosperms
    - About 700 species known
    - Largest group is the conifer (cone bearer)
      - ie, pine, fir, spruce, and redwood

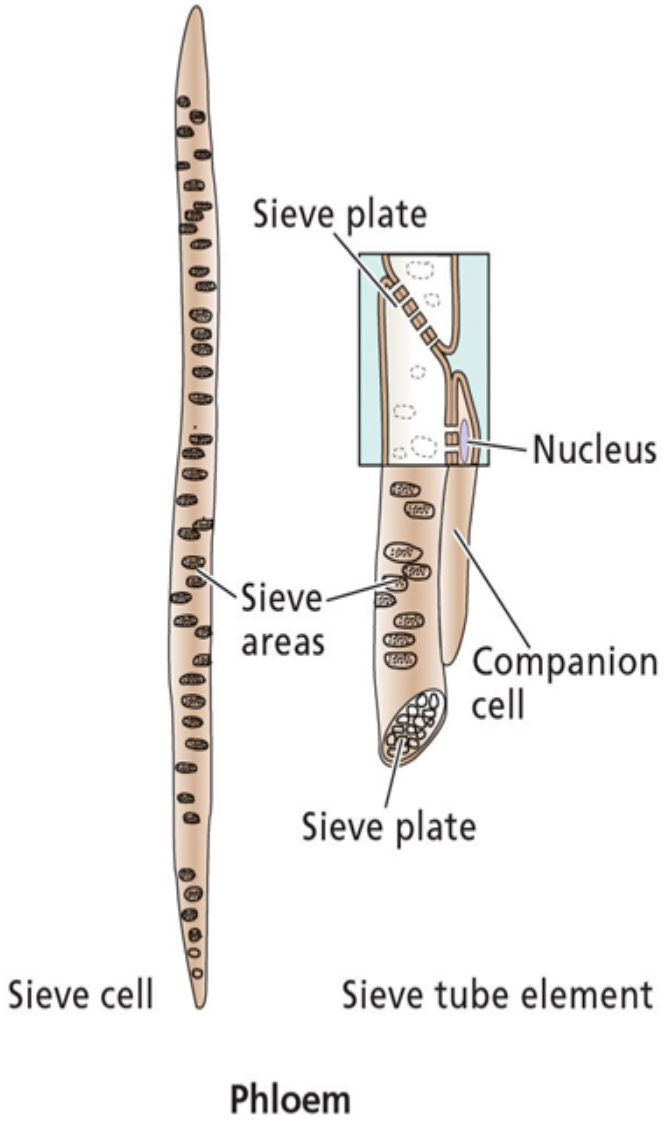
Overview of Plant Structure

- ***Xylem:***
  - Main water-conducting tissue of vascular plants.
  - arise from individual cylindrical cells oriented end to end.
  - At maturity the end walls of these cells dissolve away and the cytoplasmic contents die.
  - ***The result is the xylem vessel, a continuous nonliving duct***.
  - carry water and some dissolved solutes, such as inorganic ions, up the plant

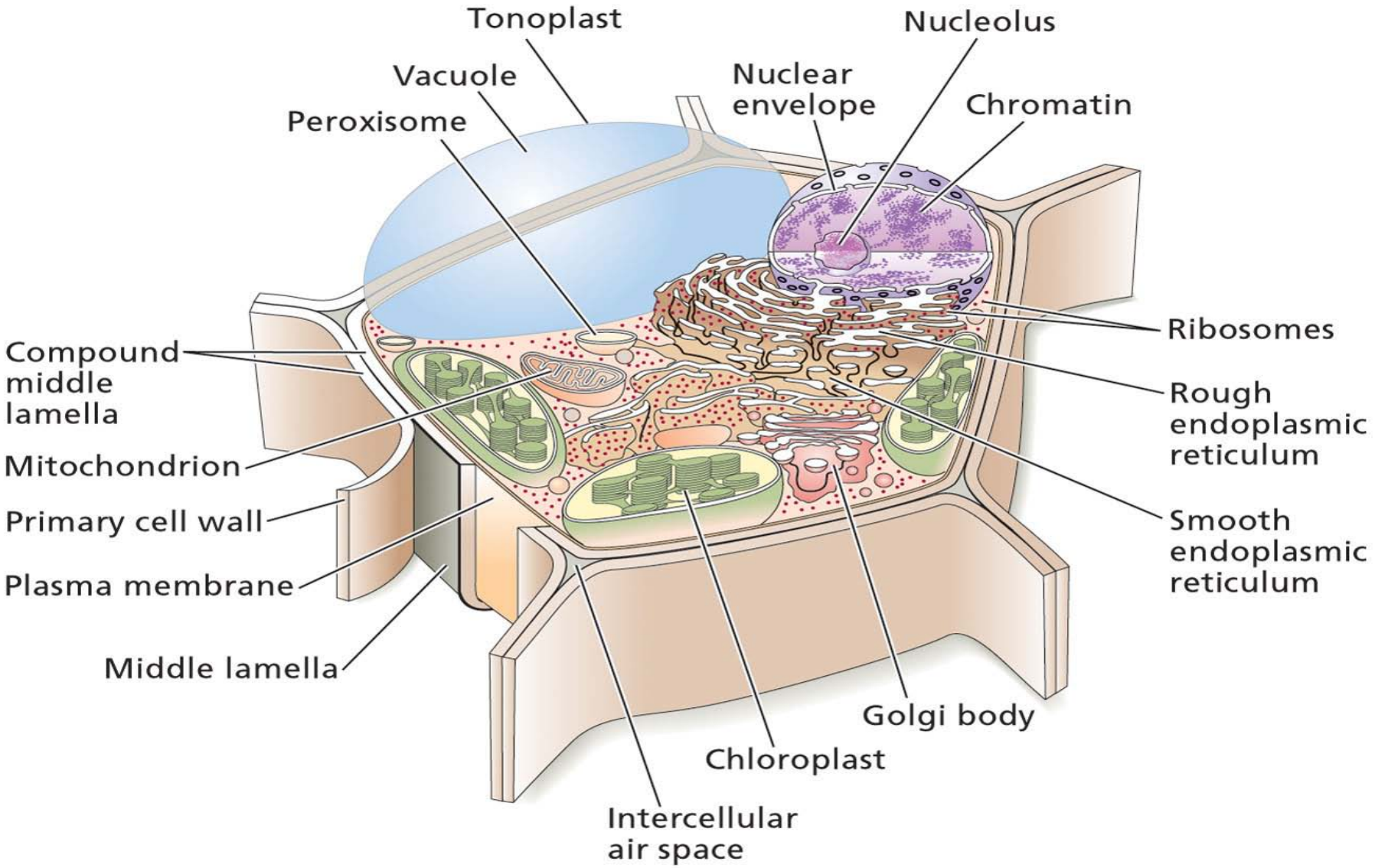


Overview of Plant Structure

- ***Phloem:***
  - The main components of phloem are
    - ***sieve elements***
    - ***companion cells***.
  - Sieve elements have no nucleus and only a sparse collection of other organelles . ***Companion cell provides energy***
  - so-named because end walls are perforated - allows cytoplasmic connections between vertically-stacked cells .
  - conducts sugars and amino acids - from the leaves, to the rest of the plant



The Plant Cell



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The Plant Cell

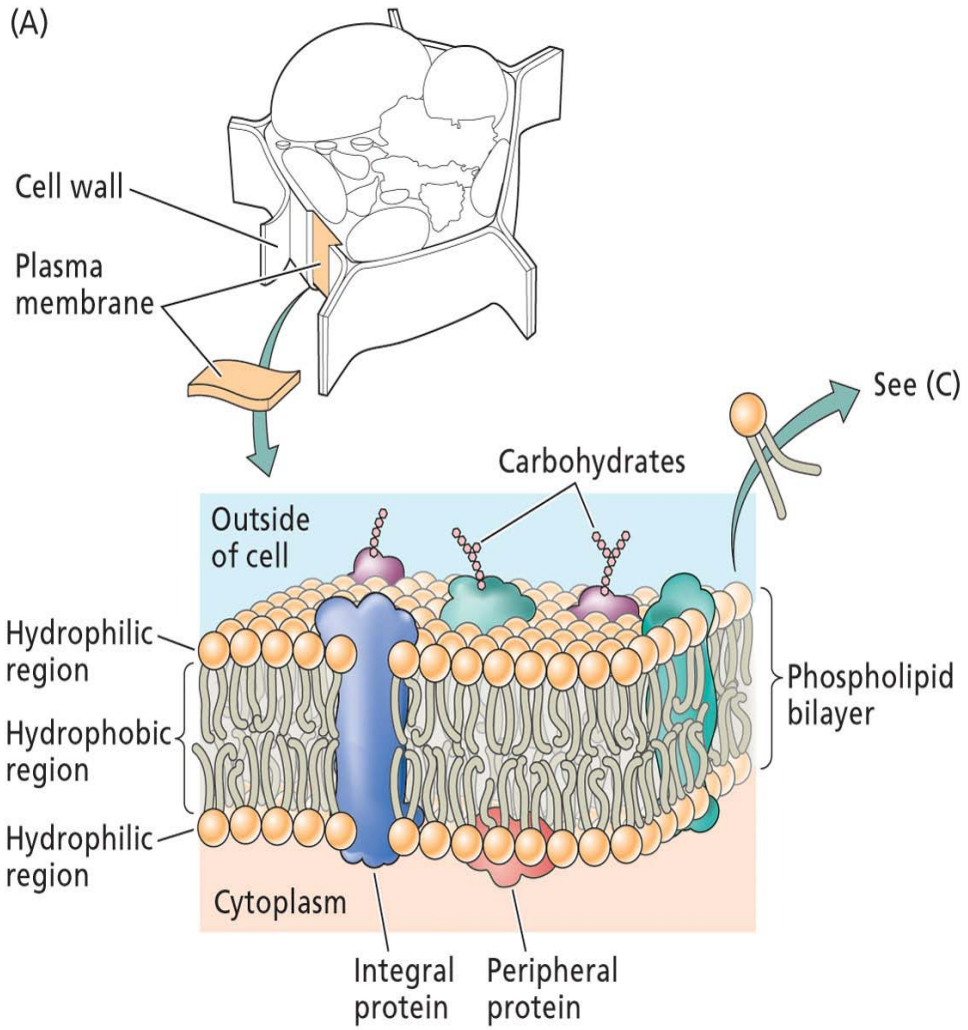
- All plant cells have the same basic eukaryotic organization
  - ***However***, at maturity when they become specialized, plant cells may differ greatly from one another in their structures and functions
    - ***Even those physically next to each other.***
    - ***Even the nucleus can be lost in some plant cells***

- Contains many organelles with specific functions

- Enclosed by a membrane which defines their boundaries
- ***Don't Forget the Cell Wall!!!!!!!!!!***

The Plasma Membrane

- Composed of a phospholipid bilayer and proteins.
- The phospholipid sets up the bilayer structure
- Phospholipids have hydrophilic heads and fatty acid tails.
- The plasma membrane is fluid--that is proteins move in a fluid lipid background



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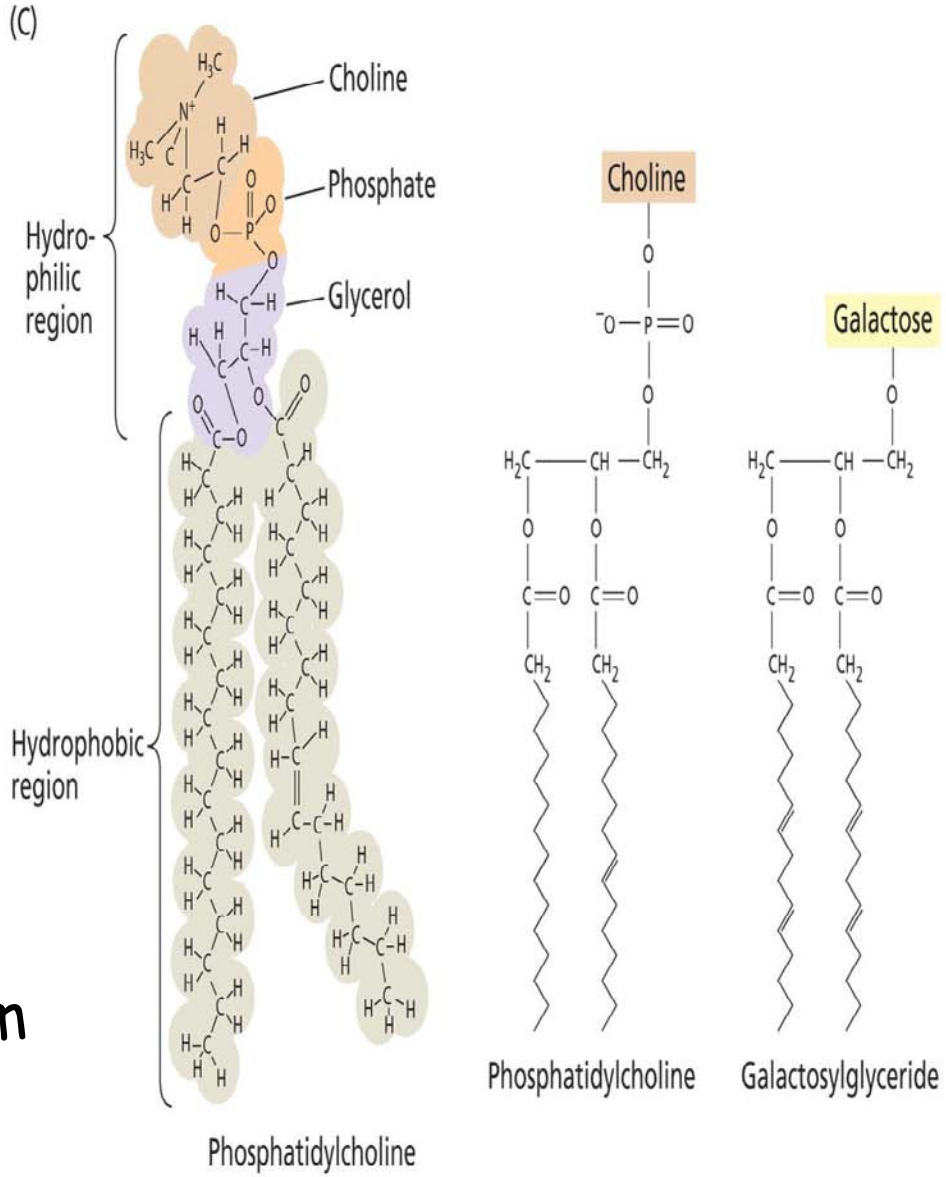
The Plasma Membrane

- ***Phospholipids***:
- Two fatty acids covalently linked to a ***glycerol***, which is linked to a ***phosphate***.
- All attached to a "head group", such as ***choline***, an amino acid.
- Head group POLAR – so ***hydrophilic*** (loves water)
- Tail is non-polar - ***hydrophobic***
- The tail varies in length from 14 to 28 carbons.

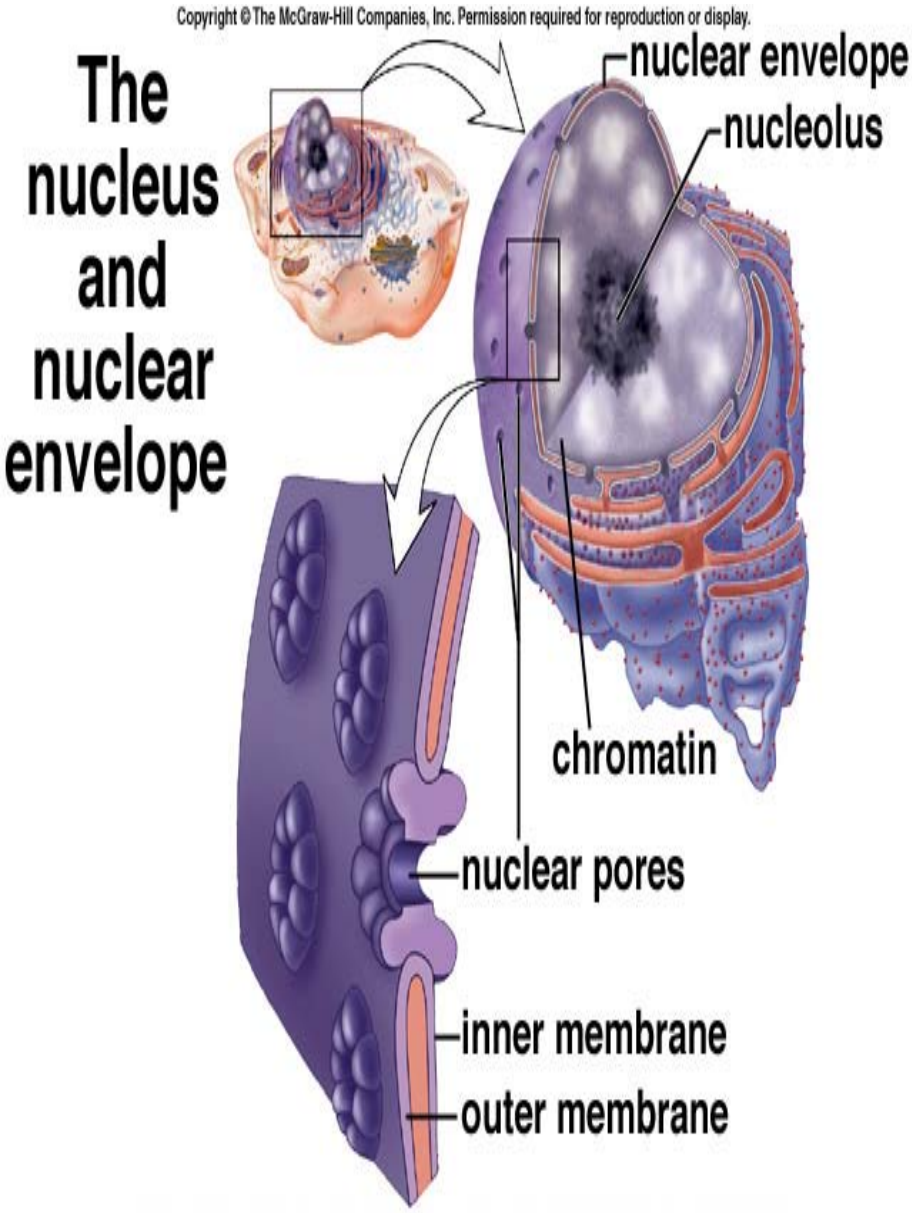


The Plasma Membrane

- ***Proteins***:
- ***Integral proteins***:
  - Embedded in lipid bylayer – serve as "ion pumps"
  - They pump ions across the membrane against their concentration gradient
- ***Peripheral proteins***:
  - Bound to membrane surface by ionic bonds.
  - Interact with components of the cytoskeleton
- ***Anchored proteins***:
  - Bound to surface via lipid molecules

The nucleus

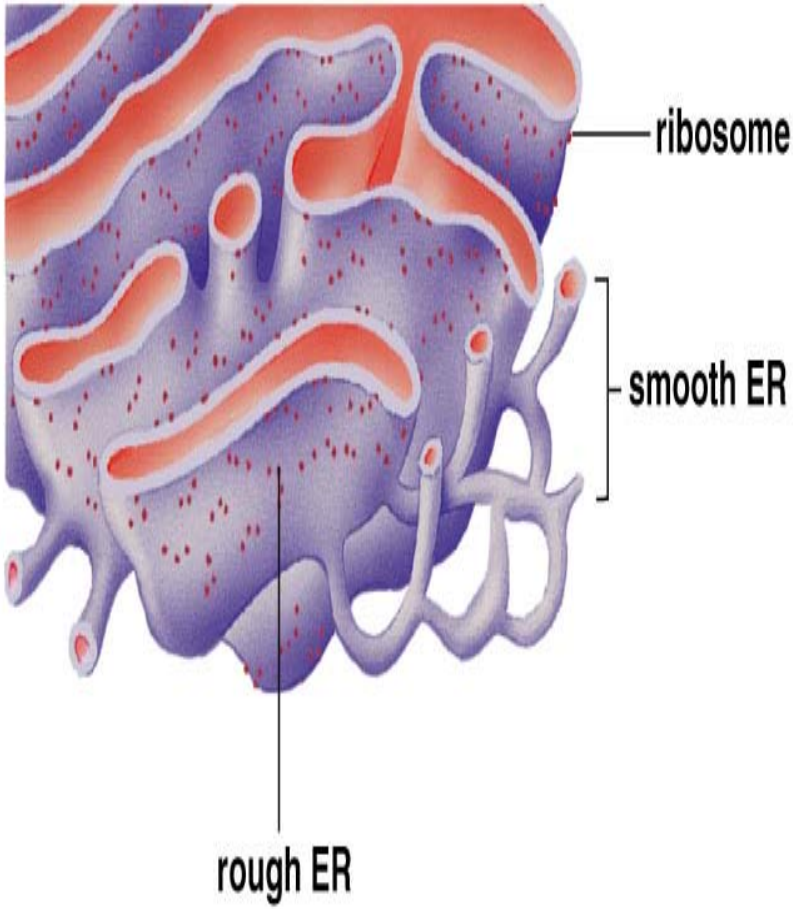
- Contains ***almost all*** of the genetic material
- What it contains is called the ***nuclear genome*** – this varies greatly between plant species.
- Surrounded by ***nuclear envelope-*** double membrane - ***same as the plasma membrane***.
- The ***nuclear pores*** allow for the passage of macromolecules and ribosomal subunits in and out of the nucleus.



The Endoplasmic reticulum

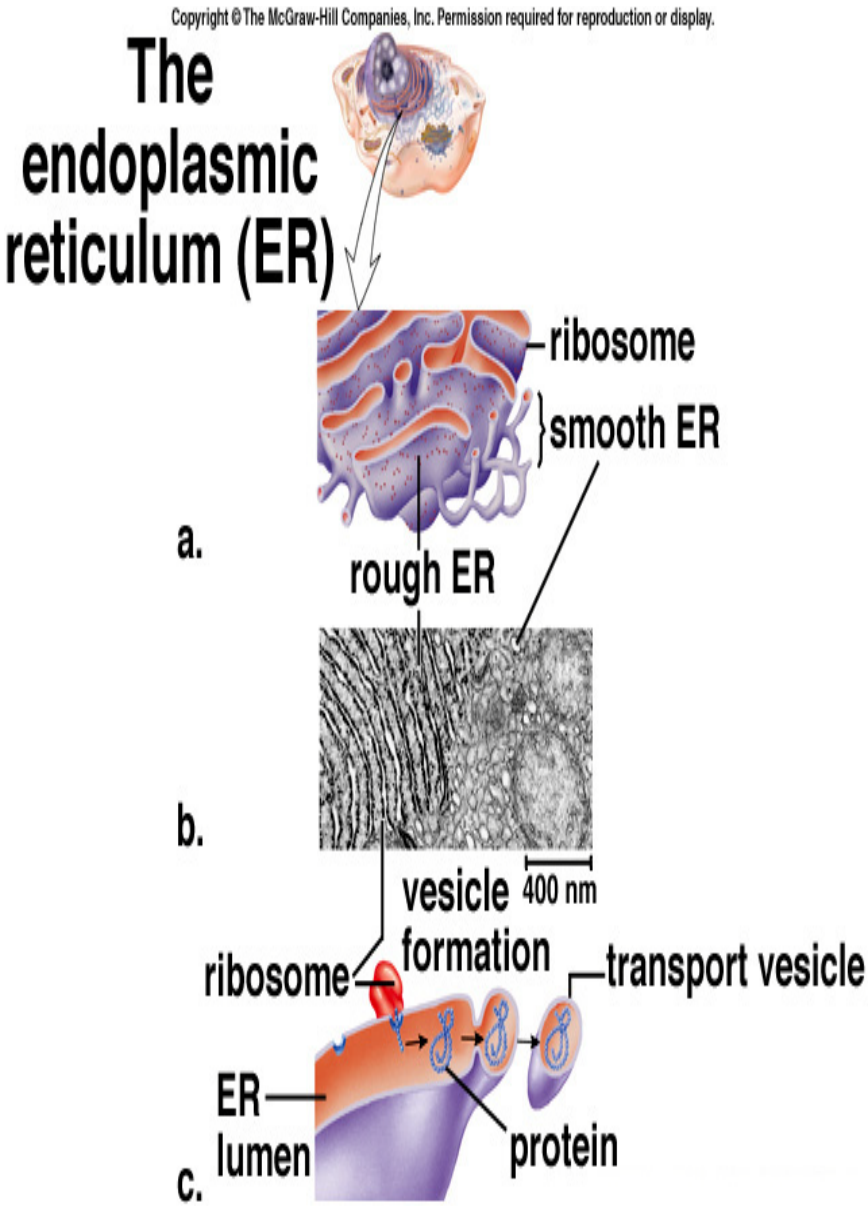
- Connected to the nuclear envelope
- 3D-network of continuous tubules that course through the cytoplasm.

- ***Rough ER***: Synthesize, process, and sort proteins targeted to membranes, vacuoles, or the secretory pathway.
- ***Smooth ER:*** Synthesize lipids and oils.
- Also:
  - Acts as an anchor points for actin filaments
  - Controls cytosolic concentrations of calcium ions



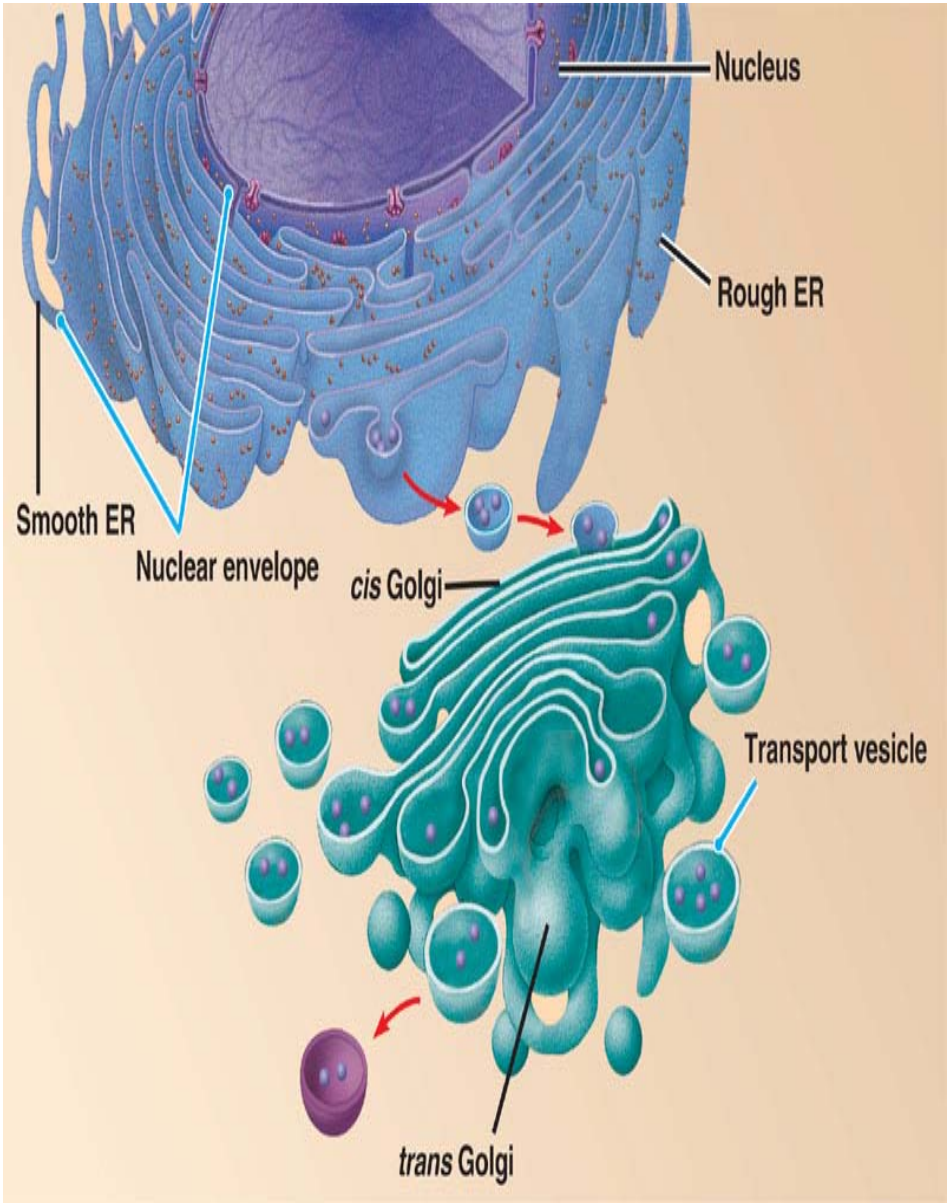
The Endoplasmic reticulum

- Proteins are made in the Rough ER lumen by an attached ribosome.
- Protein detaches from the ribosome
- The ER folds in on itself to form a ***transport vesicle***
- This transport vesicle "buds off" and moves to the cytoplasm
- Either:
  - Fuses with plasma membrane
  - Fuses with ***Golgi Apparatus***



The Golgi Network

- Proteins or lipids made in the ER contained in transport vesicles fuse with the Golgi.
- The Golgi modifies proteins and lipids from the ER, sorts them and packages them into ***transport vesicles***.
- This transport vesicle "buds off" and moves to the cytoplasm.
- Fuse with plasma membrane.
-



The Golgi Network

Site of synthesis for:

- Cellulose
- Callose

Site of synthesis for:

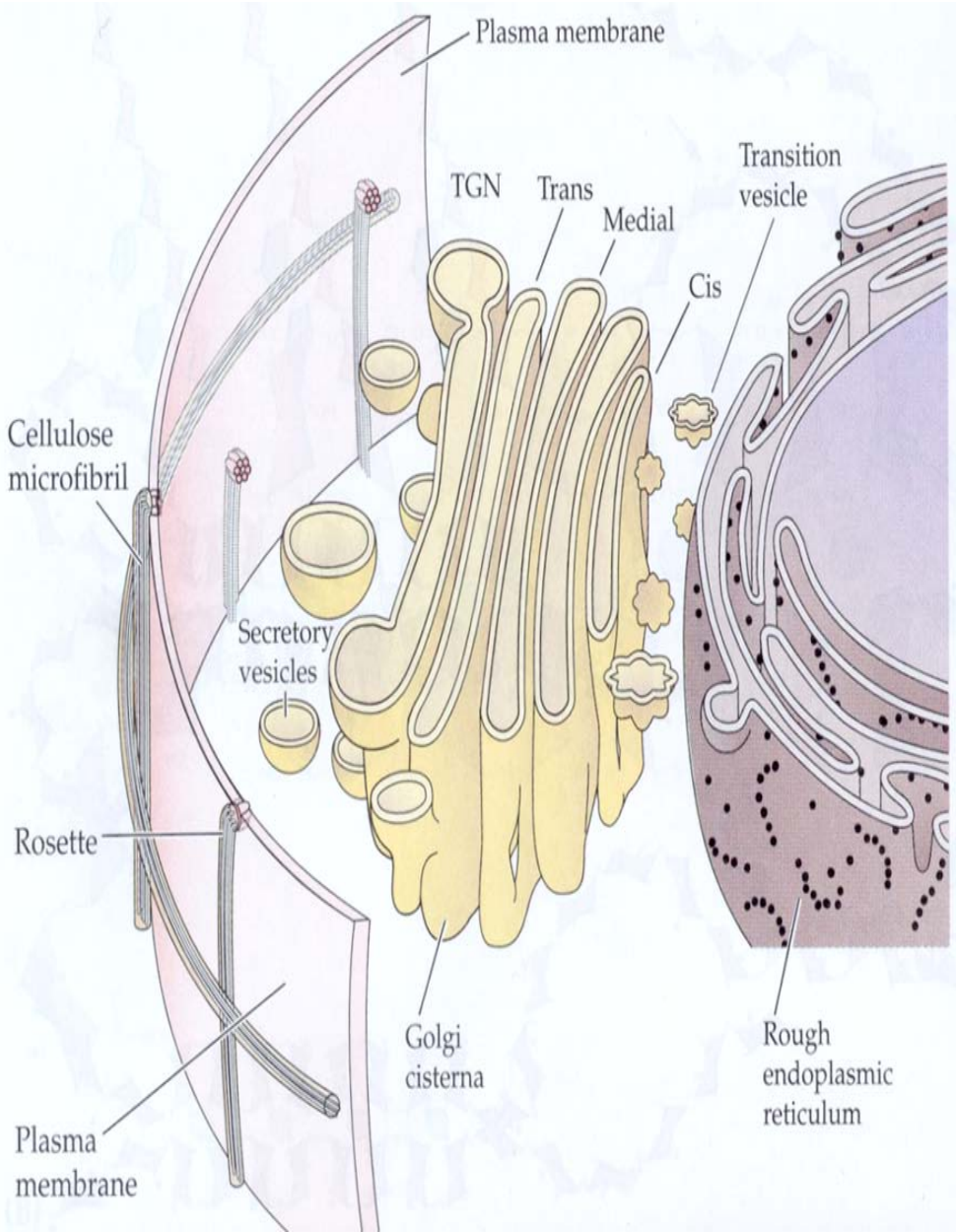
- Pectins
  - HGA
  - RG I
  - RG II
- Cross-linking glycans
  - Xyloglucan
  - Glucuronoarabinoxylan
  - β-Glucan
  - Galactomannan

Site of glycosylation of:

- HRGPs
- AGPs
- Modified glycoproteins

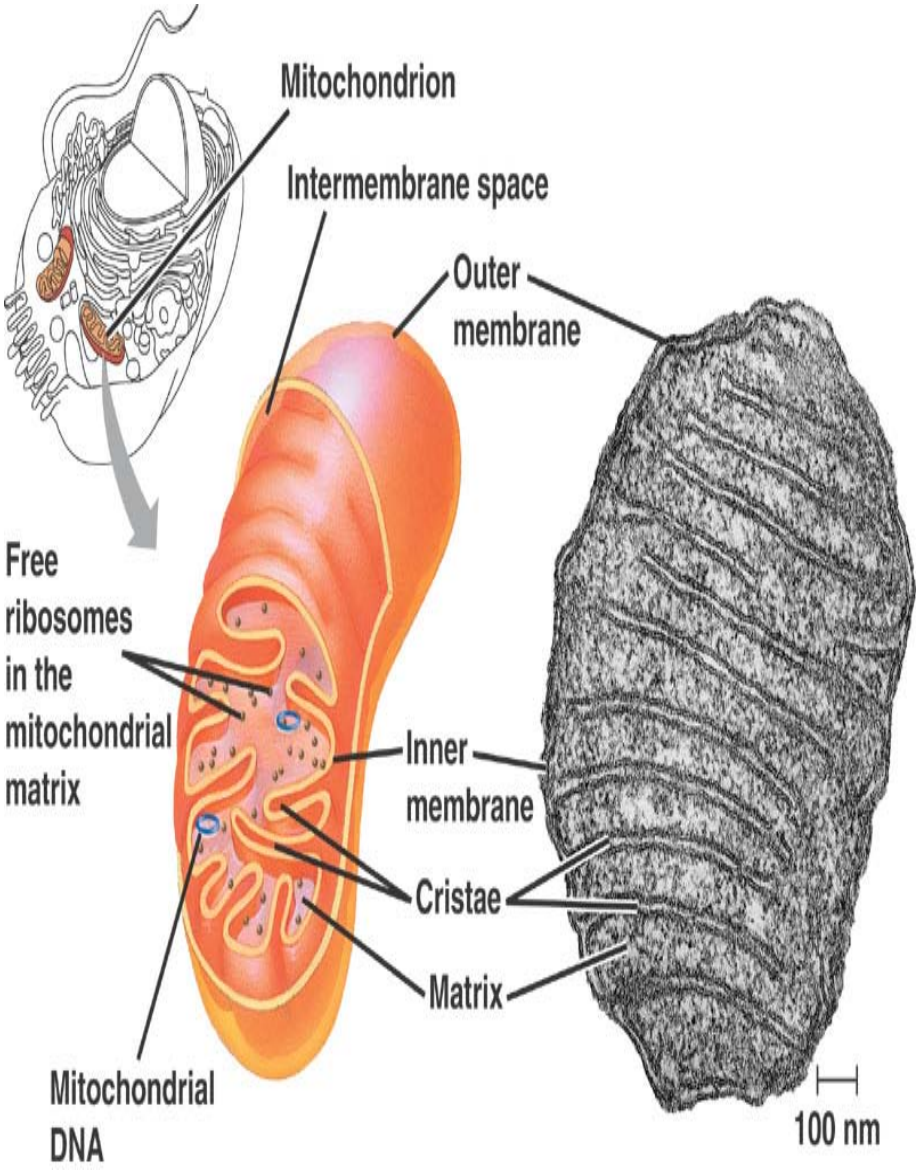
Site of synthesis for:

- Cell wall proteins
  - HRGPs
  - PRPs
  - GRPs
  - AGPs
- Enzymes
  - Hydrolases
  - Esterases
  - Peroxidases
  - Polysaccharide synthase



The Mitochondria

- Contain their own DNA and protein-synthesizing machinery
  - Ribosomes, transfer RNAs, nucleotides.
  - Thought to have evolved from ***endosymbiotic bacteria***.
  - Divide by fusion
  - The DNA is in the form of circular chromosomes, like bacteria
  - DNA replication is independent from DNA replication in the nucleus



The Mitochondria

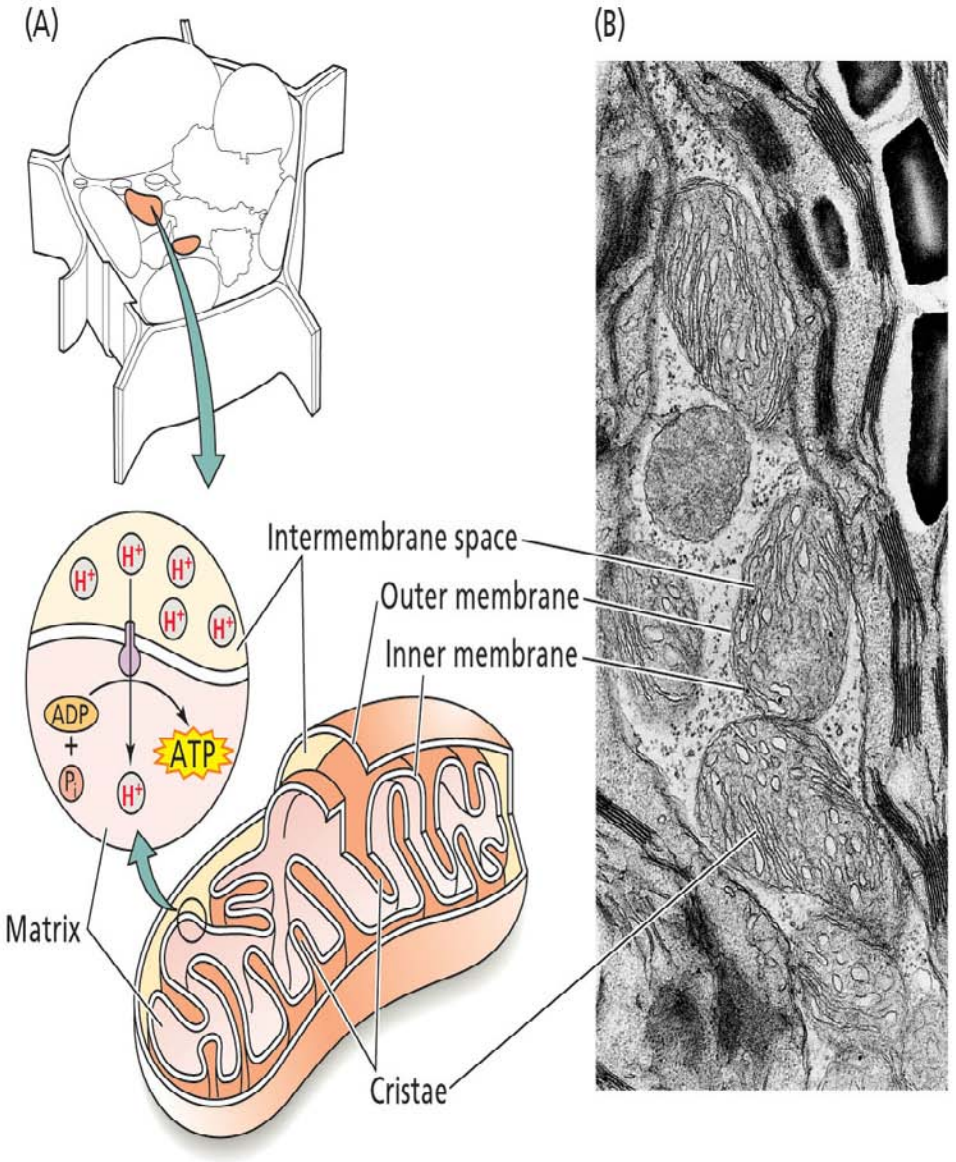
Site of Cellular Respiration

- This process requires oxygen.
- Composed of three stages:

  - ***Glycolysis***--glucose splitting, occurs in the cell. Glucose is converted to Pyruvate.

  - ***Krebs cycle-***--Electrons are removed--carriers are charged and CO2 is produced. This occurs in the mitochondrion.

  - ***Electron transport-***--electrons are transferred to oxygen. This produces H2O and ATP. Occurs in the mito.



The Chloroplast

- Contain their own DNA and protein-synthesizing machinery
  - Ribosomes, transfer RNAs, nucleotides.
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  - Divide by fusion
  - The DNA is in the form of circular chromosomes, like bacteria
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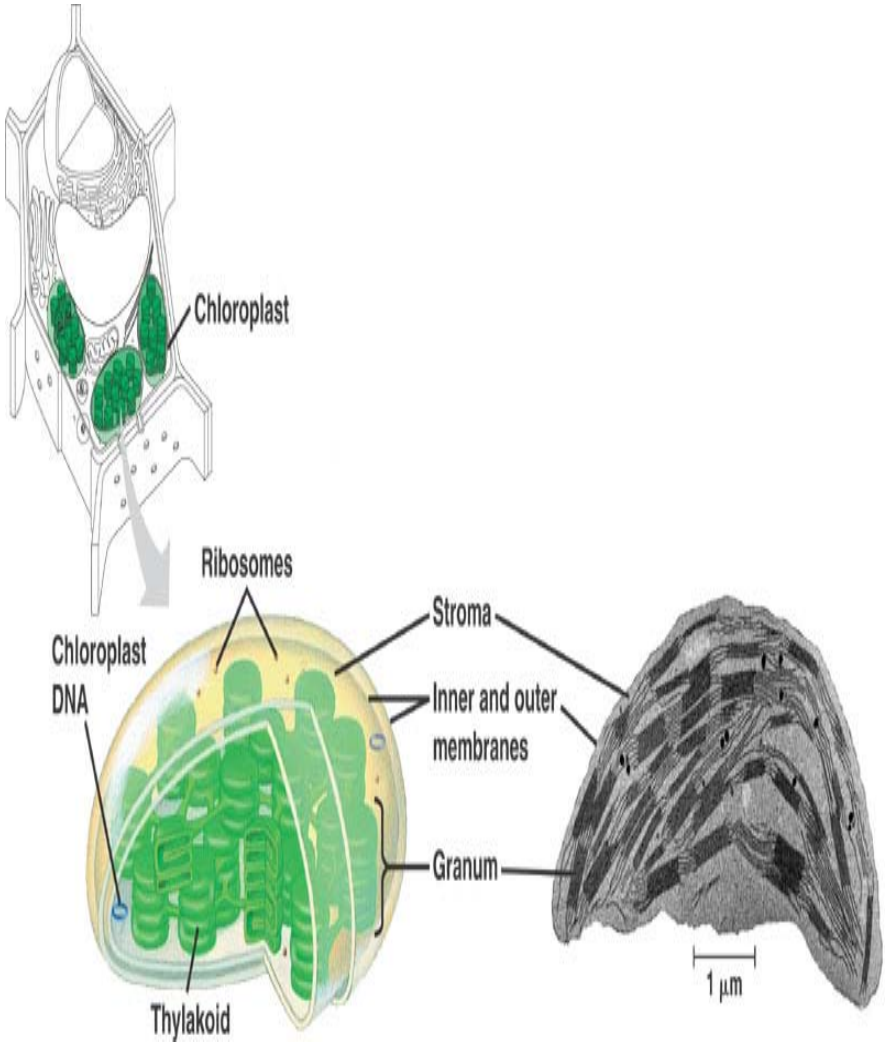
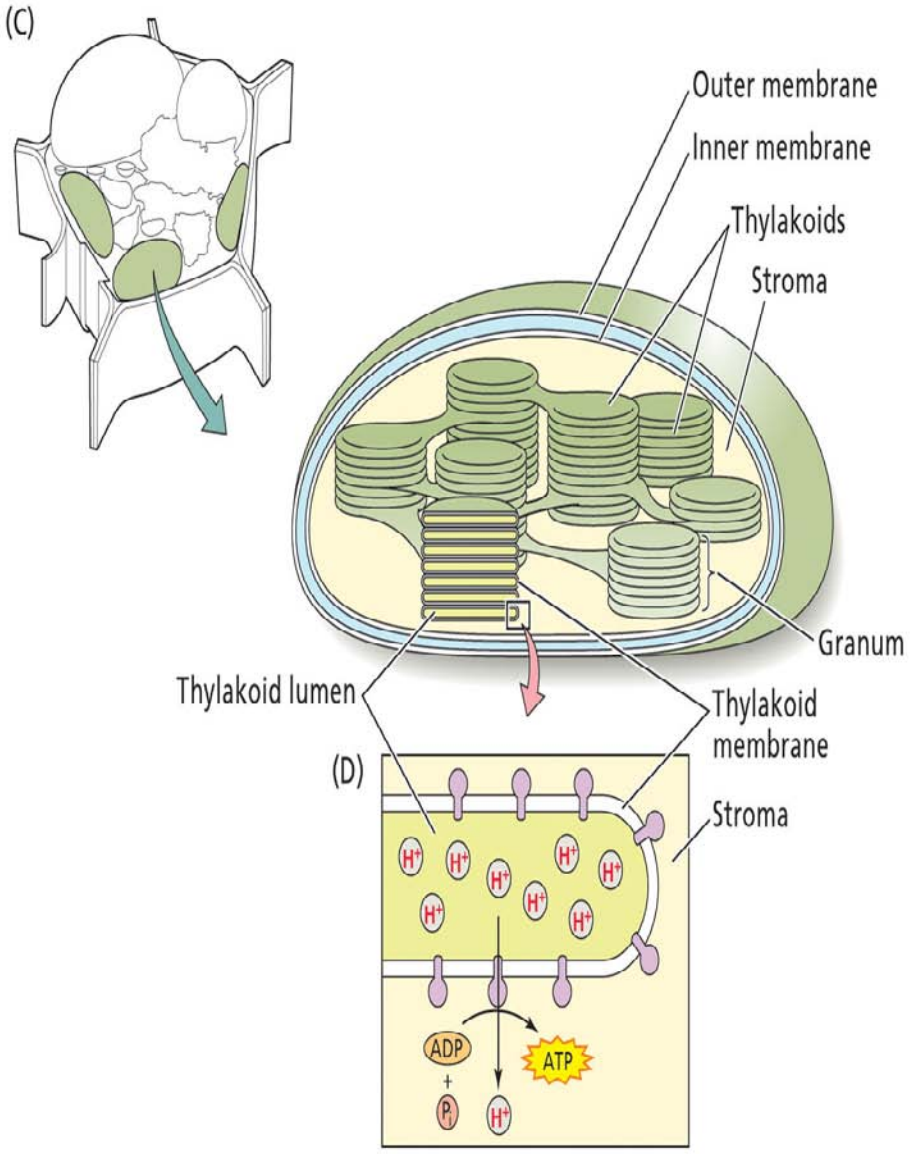


The Chloroplast

- Membranes contain chlophyll and it's associated proteins
  - ***Site of photosynthesis***
- Have inner & outer membranes
- 3rd membrane system
  - ***Thylakoids***
- Stack of Thylakoids = ***Granum***
- Surrounded by ***Stroma***
  - Works like mitochondria
- During photosynthesis, ATP from stroma provide the energy for the production of sugar molecules



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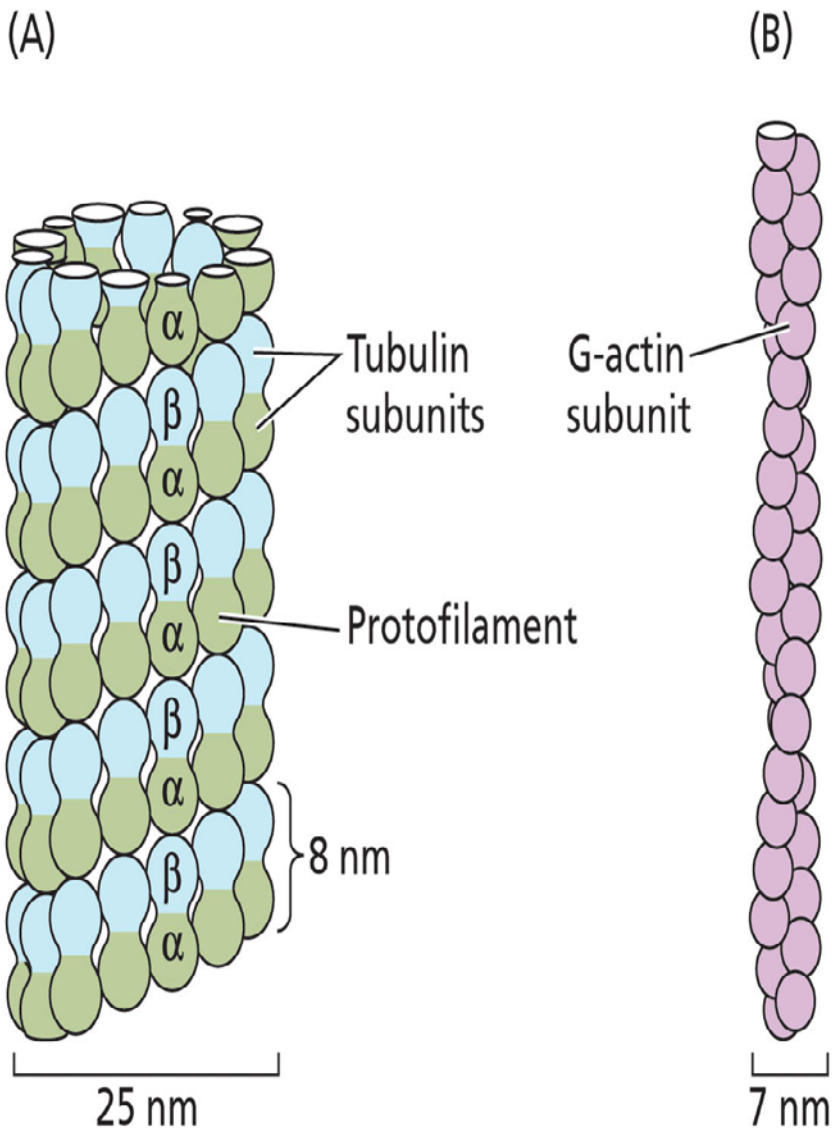
The Vacuole

- Can be 80 – 90% of the plant cell
- Contained within a vacuolar membrane (***Tonoplast***)
- Contains:
  - Water, inorganic ions, organic acids, sugars, enzymes, and secondary metabolites.
- Required for plant cell enlargement
- The turgor pressure generated by vacuoles provides the structural rigidity needed to keep herbaceous plants upright.

The cytoskeleton

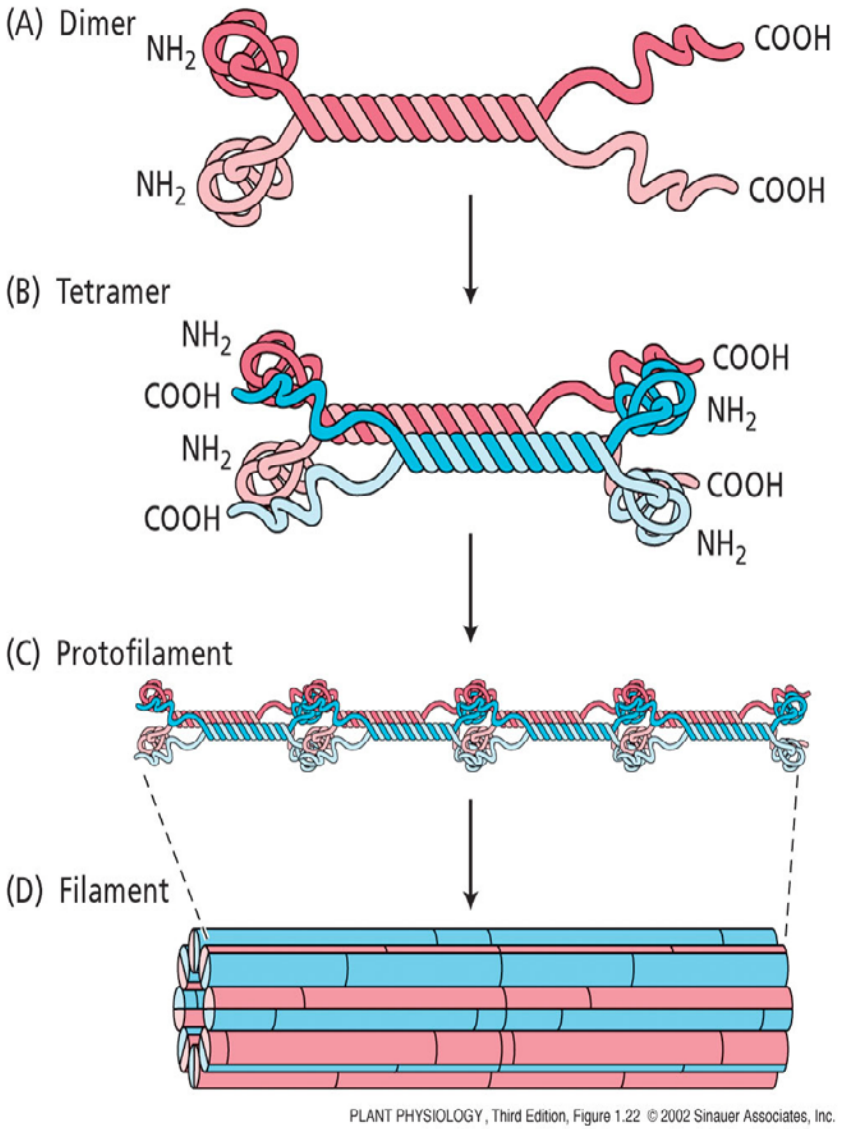
- ***Three main components:***
- ***Microtubules***: are α and β proteins that create scaffolding in a cell. MTs are formed from the protein tubulin. ***13 rows of tubulin =1 microtubule***

- ***Microfilaments***: solid (7 nm) made from ***G-actin*** protein. Consists of 2 chains of actin subunits that intertwine in a helical fashion



The cytoskeleton

- ***Intermediate filaments***: a diverse group of helically wound linear proteins.
- Dimers line up parallel to each other
- These form anti-parallel Tetramers
- These join together to form a filament



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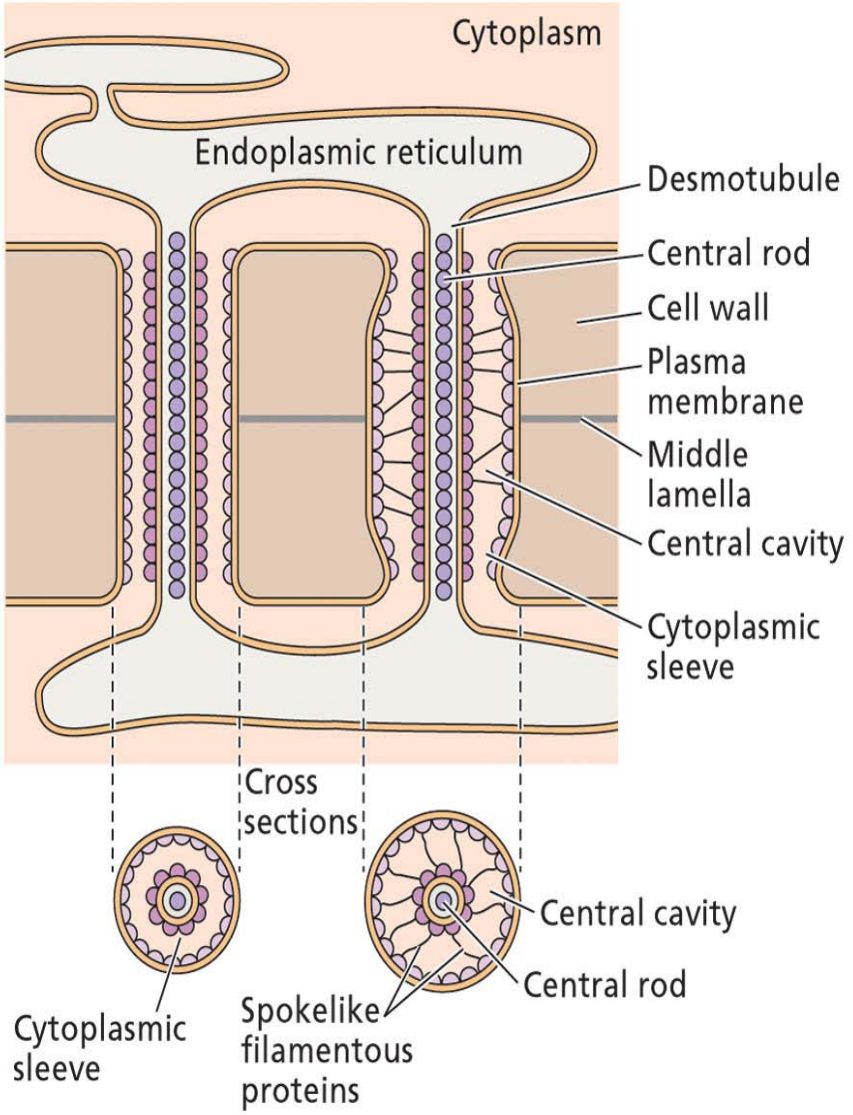
The cytoskeleton

- All these elements can assemble and disassemble

- Involved in plant cell division
  - During mitosis
    - ***Process of division that produces two daughter cells with identical chromosomal content of parent cell***

Plamodesmarta

- Each contains a tube called a ***Desmotubule***, which is part of the ER.
- This is what connects adjacent cell and allow chemical communication and transport of material throughout the whole plant.
- The restriction acts to control the size of the molecules which pass through.



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The Plant Cell wall

- Cell walls are held together by the ***middle Lamella***.
- Made up of:
- Cellulose
- Xyloglucan
- Pectin
- Proteins
- Ca ions
- Lignin
- other ions
- Water