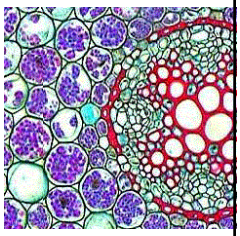
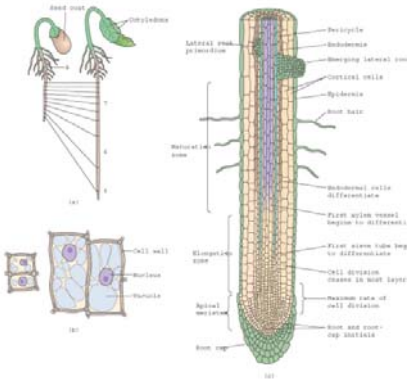
- To understand how plants behave, we need to focus on the units. What do plant cells do?
- **Outline**:
  - Cells are dynamic units of life. Cells differ in their shape and function. All cells are derived from meristems. Thus all cells share basic structural and functional traits.
  - **Structure**: What are the subcellular parts? What do they look like?
  - **Function**: What are the major roles of each organelle?
  - **Origin:** where did each come from?
  - **What are unique structures and functions?** Plastid, vacuole, cell wall, cytoskeleton, plasmadesmata

Lec. 3. Plant cells: components and functions



Cells divide, elongate & differentiate

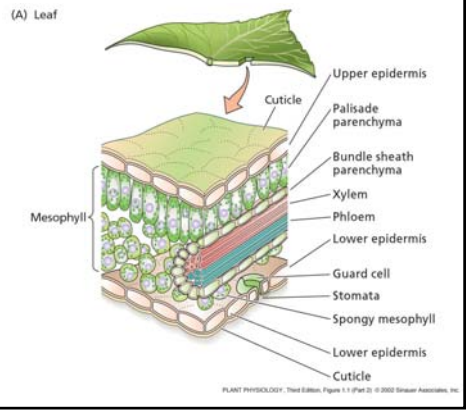


All cells are derived from meristems.

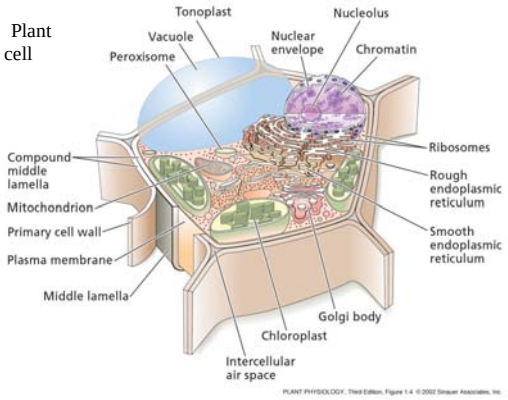
Thus all cells share basic structural and functional traits.

There is no "typical" Plant Cell.

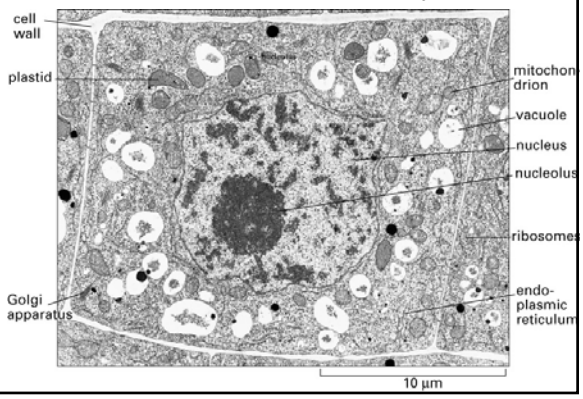
Leaf consists of many cell types



1-4. Plant leaf cell

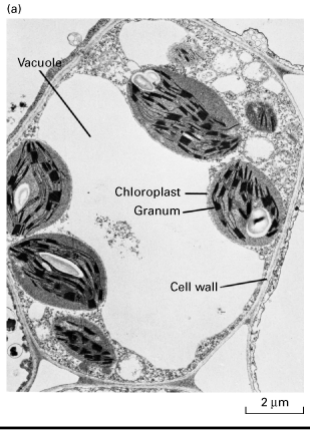


All cells originate from meristem cells.
Meristem cell: one that can divide continuously.

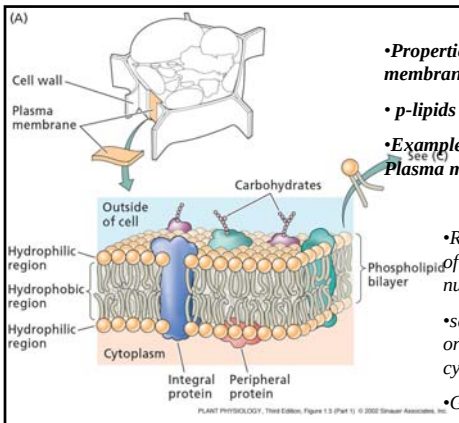


Differentiated cell –

Leaf Mesophyll cell



How do the two cells differ?



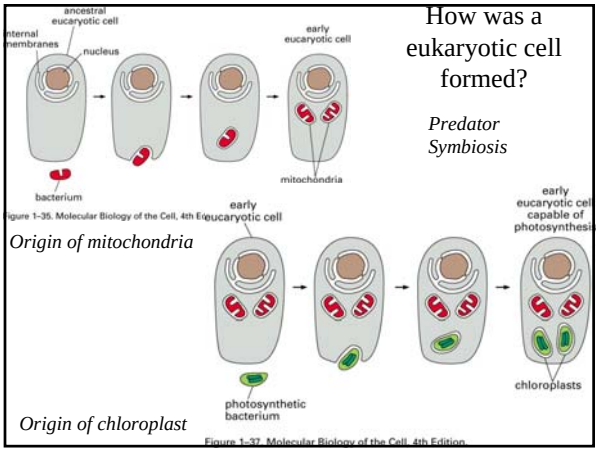
- ***Properties of membranes***
- ***p-lipids and proteins***
- ***Example- Plasma membrane***
- *Regulate passage of ions and nutrients.*
- *separate organelles from cytoplasm*
- *Generate energy.*

Organelles that contain the information of life

Double membrane organelles

- **Nucleus**
- **Mitochondria**
- **Plastid**

- **Have 2 membranes**
- **Contain DNA and RNA**
- **DNA synthesis and transcription**
- **Nuc is unique to eukaryotes**
- **Mitochondria and plastid originated from prokaryotes millions of years ago.**
- **Mitochondrion and plastid divide by fission to form new organelles.**



How was a eukaryotic cell formed?

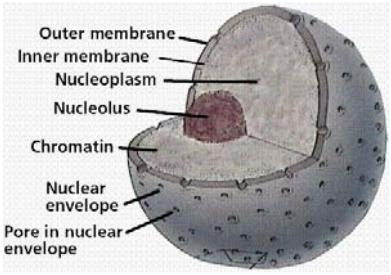
Predator
Symbiosis

Origin of mitochondria

Origin of chloroplast

Figure 1–37. Molecular Biology of the Cell, 4th Edition.

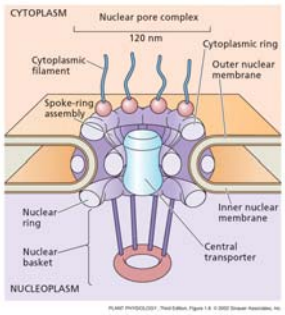
Nucleus



Function?

1. Control center of gene expression
2. Store and duplicate genetic material

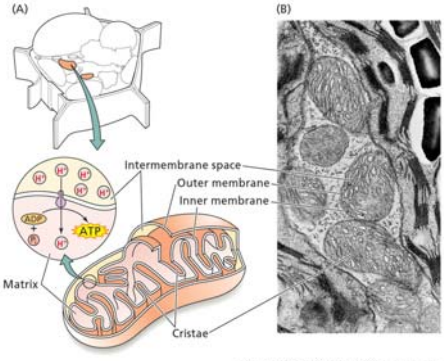
A nuclear pore



Nuclear pore allows passage of small & large molecules,

e.g. selected proteins and RNA

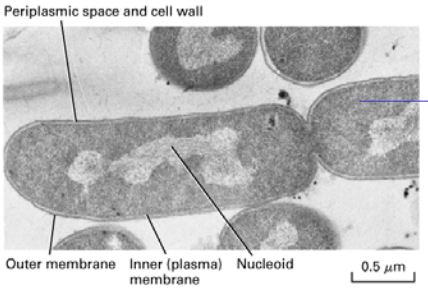
Site of ATP production. ??



Mitochondrion divide by fission

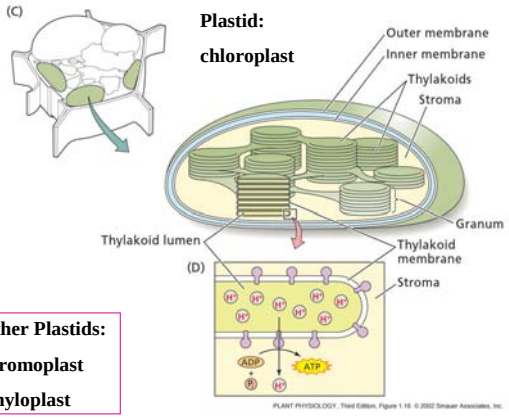
- Show pic from Karp

Fig. 1-7. E coli divide by fission



Inside: pH 7.4
100-200 mM K
< 1 μM Ca
-100 mV

Outside: pH ~5.5 (acidic)
trace ions ~ 1 mM K, Ca, Na
other ions < 1 mM



Plastid:

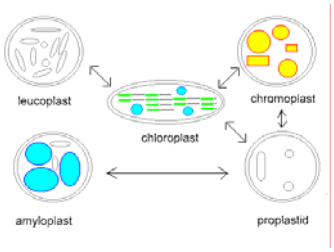
chloroplast

Other Plastids:

chromoplast

amyloplast

Plastids differentiate as cells develop



M Knee, OHIO St U.

Endomembrane system-

Synthesis and sorting of membrane and secreted proteins

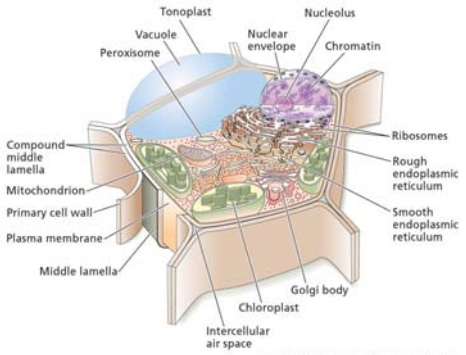
ER

Golgi

Vacuole

Secretory vesicles

Plasma membrane



Endomembrane system

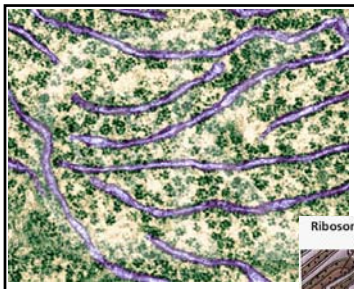
ER- source of other membranes,
-membrane proteins and
-secreted proteins are made here
-p-lipid synthesis

Golgi- proteins are modified and sorted to destination
synthesis of cell wall material in plants

Vacuole- large and multifunctional in plants

Plasma membrane

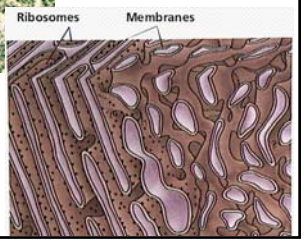
-Very dynamic- membrane trafficking



Endoplasmic reticulum:

source for other membranes

site of synthesis-
-p-lipids
-membrane proteins
-secreted proteins



EM

Smooth vs rough ?

What does Golgi do?

A. **Proteins** synthesized in the ER,

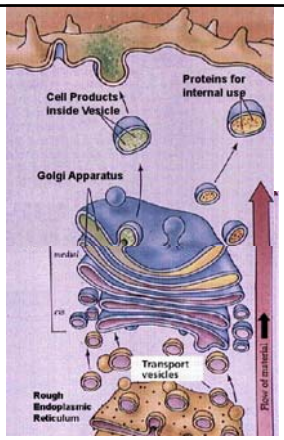
-modified and

-sorted in the Golgi,

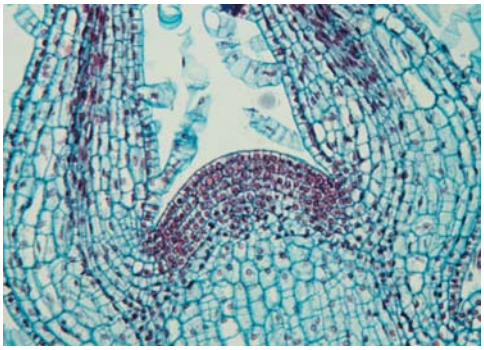
-soluble proteins are secreted at the PM or delivered to vacuole.

B. Cell wall polysaccharides are synthesized, modified in the Golgi, and delivered to the cell wall.

Proteins & wall materials are carried by vesicles.
Vesicles bud, move, fuse.
= Vesicular transport



What is a vacuole? A single membrane organelle



16-13. Shoot apical meristem cells are much smaller than other cells. Cell expansion is due to vacuole enlargement

Vacuoles- unique organelle

Small in meristem cells.

Large in mature cells, up to 90% of cell volume.

Functions: many

1. Osmotically active compartment needed for cell expansion

   Store of ions, water, many molecules

2. Storage site of secondary products.
   Storage depot- sugar (sugar cane)
3. Defense: nicotine
   Attractant: pigments in petals
4. Recycling center: enzymes

Cytoplasm

•Contains most metabolites, ions

•Enzymes for biosynthesis and for breakdown.

1. Sugar breakdown: glucose 6C --->2 (3C) sugar
2. Synthesis of sugars, amino acids, lipid precursors
3. Synthesis of proteins in cytoplasm

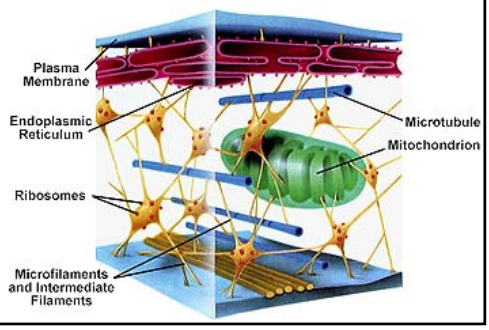
   synthesis of mitochondrial and chloroplast proteins

•An interconnected network of filamentous proteins keeps the contents in cytoplasm organized -cytoskeleton

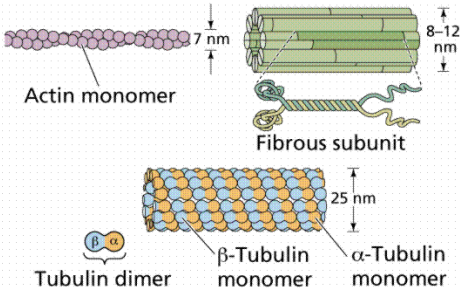
The cytoskeleton

(Farabee-5)

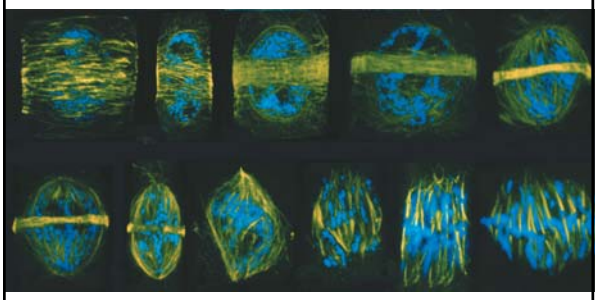
-Determines cell shape
-organizes cytoplasm
-aids in transport of vesicles & chromosome
-brings about motility



Actin and tubulin filaments of the cytoskeleton. Filaments can be assembled and disassembled.



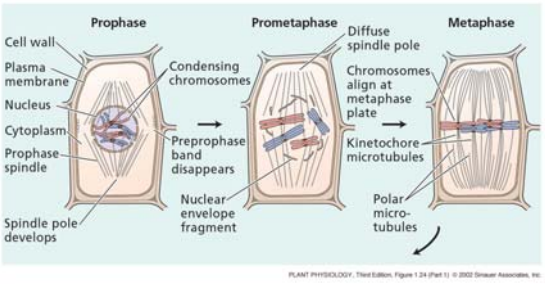
Dynamic states of Microtubules and Microfilaments before and during mitosis of plant cells

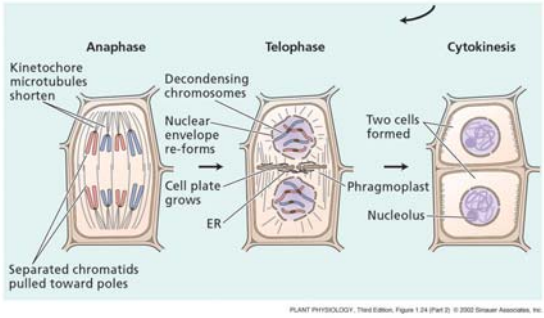


MT- yellow/green

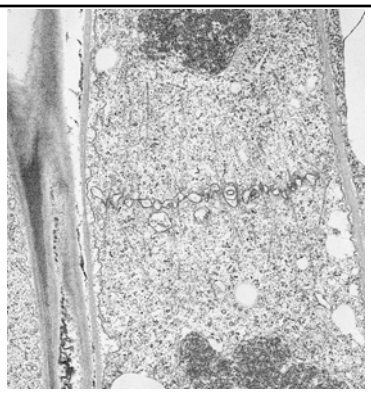
Chromosome- blue

Mitosis in Plant Cell

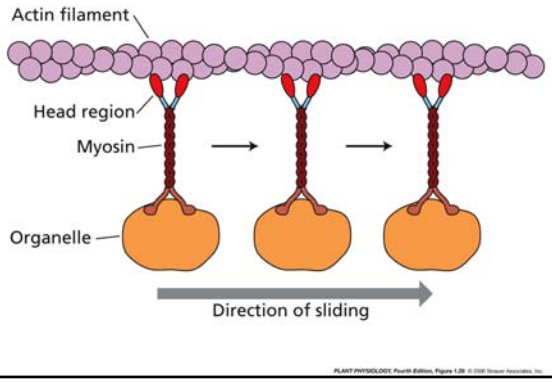




1-25



1.29 Myosin-mediated transport of organelles along actin microfilaments



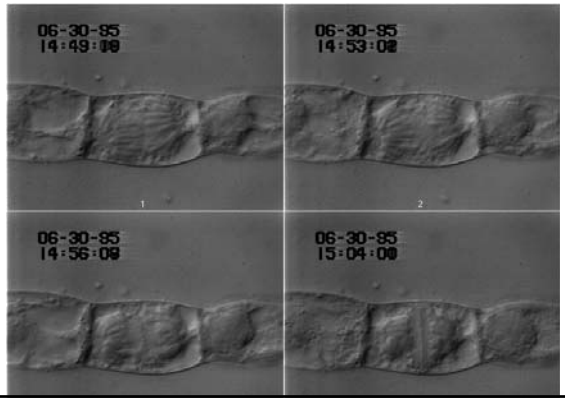
Living cells are dynamic

Cytokinesis movie (Nebenfuhr)
http://botany1.bio.utk.edu/cellbiol/iv/ck.htm

Golgi & cytoskeleton

Cytoplasmic streaming

Cell plate formation (Wolniak)



1-5. Taiz. What is the **Plant cell wall**?

pectin

Functions:

Cell shape

Support

Protection

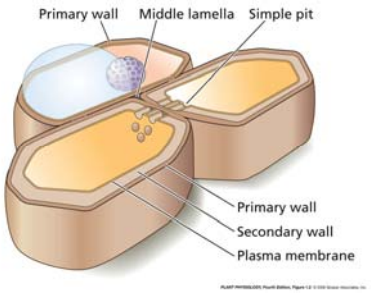
Conductance

Cell adherence

Molecules can penetrate

Water & ions flow

Gas can diffuse



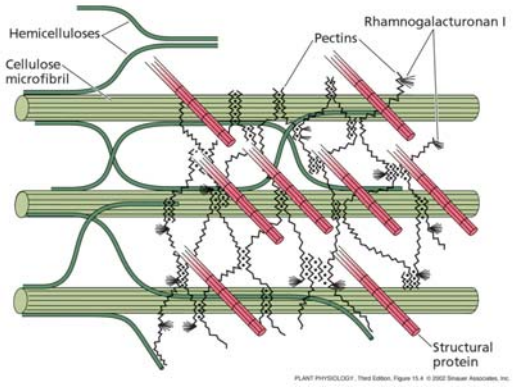
Chemical components that make up the cell wall.

Taiz: Table 15-1

Wall: main components	Primary	Secondary
Polysaccharides	90%	65-85%
Cellulose	30	50-80
Hemicellulose	30	5-30
Pectin	30	---
Proteins	10%	---
Lignin		15-35

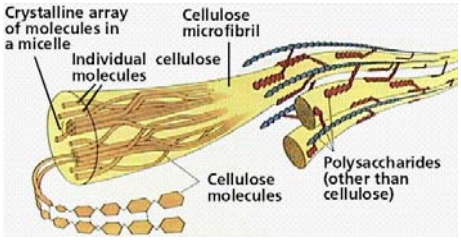
Cellulose : most abundant organic C compound in nature

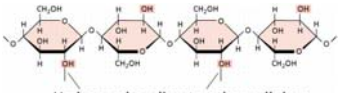
15-4. Model of cell wall



Cellulose is a linear polymer of glucose units.

Cellulose microfibril is a bundle of cellulose polymers.

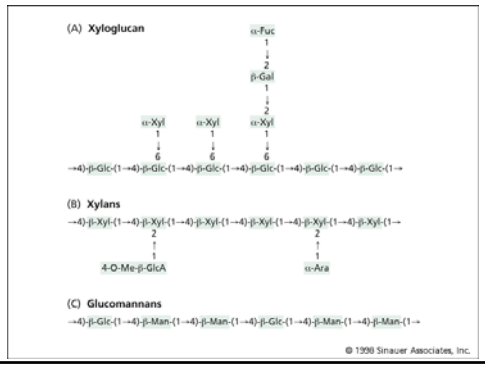


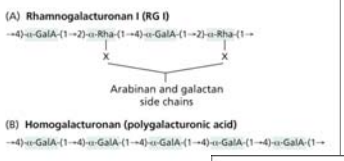


Cell Wall Model

= Taiz 15-4 & 15-6

15-10. Hemicellulose: is branched and made of a complex mixture of sugars.
E.g. Backbone is glucose. Branches are 5C sugars.

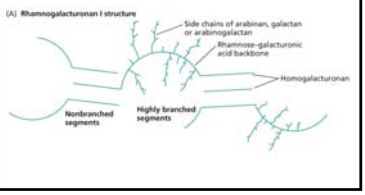




15-11 , 15-12

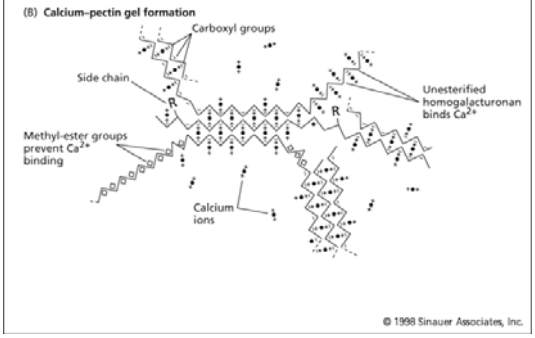
Pectin is a mixture of polymers. E.g. Galacturonic acid

Branched or linear

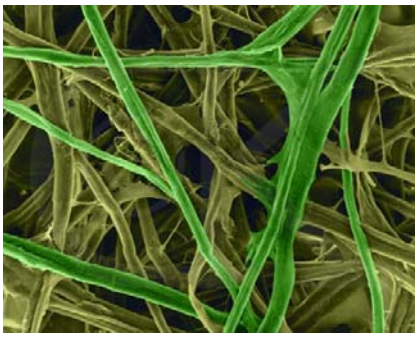


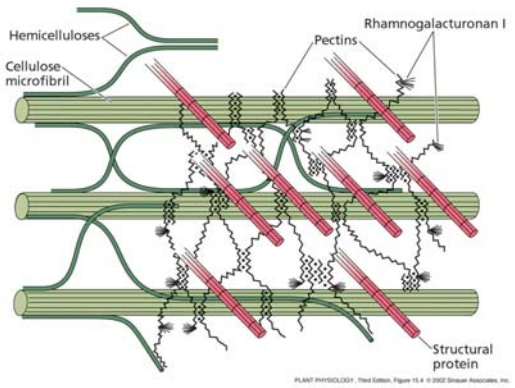
15-12. Ca ions bridge carboxyl groups of GalA in pectin.

Thus pectins act as a glue.



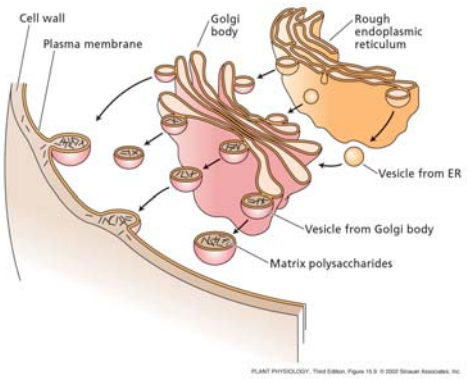
Cellulose microfibrils-SEM

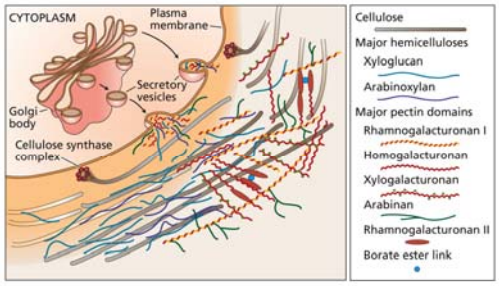




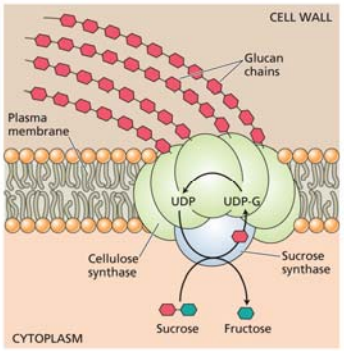
How is the primary wall formed?

Pectins and hemicellulose are synthesized in the Golgi, and transported to the PM, and secreted to form the cell wall

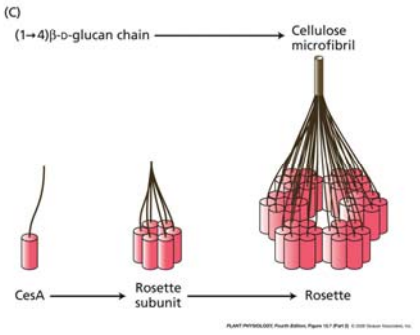




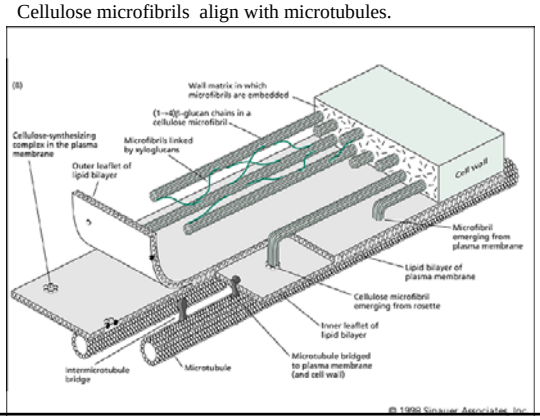
Cellulose is made at the PM



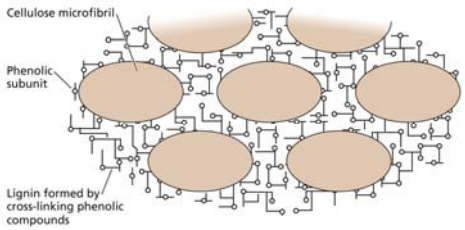
Each Cellulase synthase complex makes a microfibril.
Each rosette subunit has 6 Ces, the complex has 36 Ces.



Taiz 15-7. Cellulose is synthesized at the plasma membrane.
Cellulose microfibrils align with microtubules.



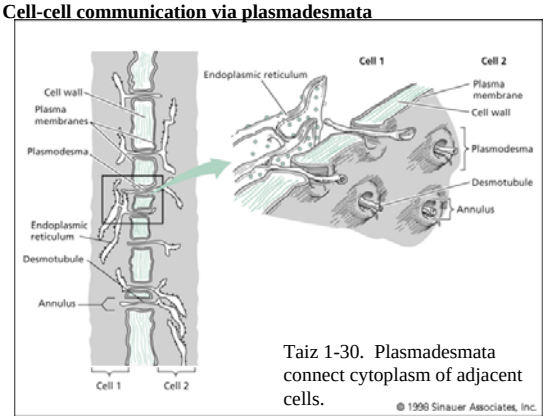
Taiz 15-17. Phenolic subunits fill in spaces and are cross-linked



Lignin: 2nd most abundant organic cpd in nature

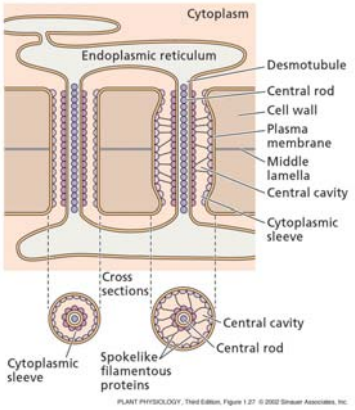
Hinders degradation of cell walls.

Cell-cell communication via plasmadesmata



Taiz 1-30. Plasmadesmata connect cytoplasm of adjacent cells.

1-27



Review

1. Novel organelles/part in plant cells ?

Name 3

2. Where can you find dividing cells in a seedling?
3. Walls of cells in elongation zone have primary or secondary cell wall?
4. Name 3 polysaccharides that form the primary wall?
5. Where is pectin formed? How does it reach the wall?
6. Location? a. DNA is transcribed to RNA
   b. Protein synthesis- glycolytic enzyme,