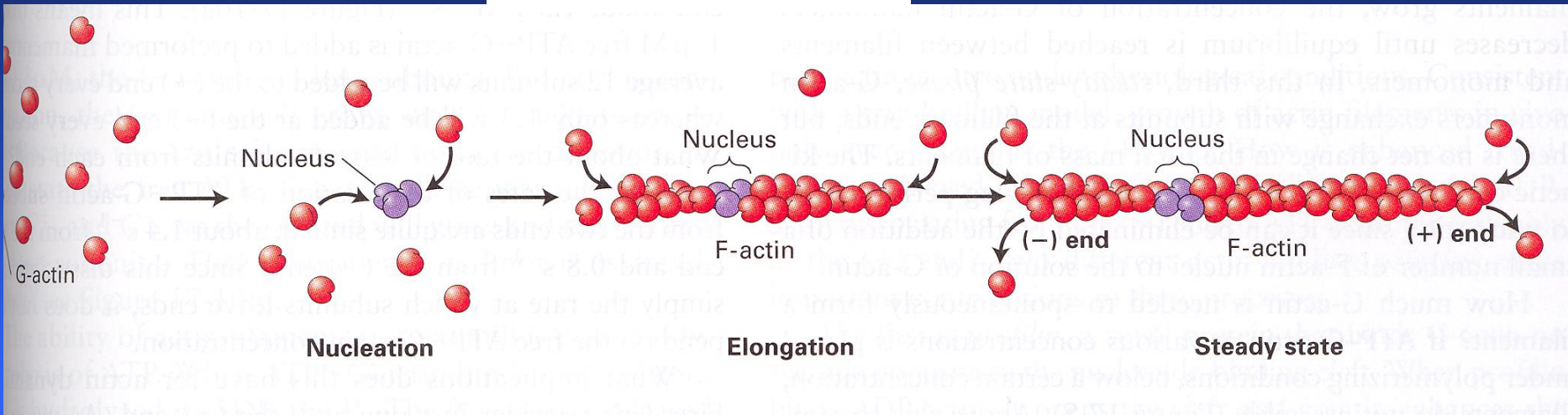
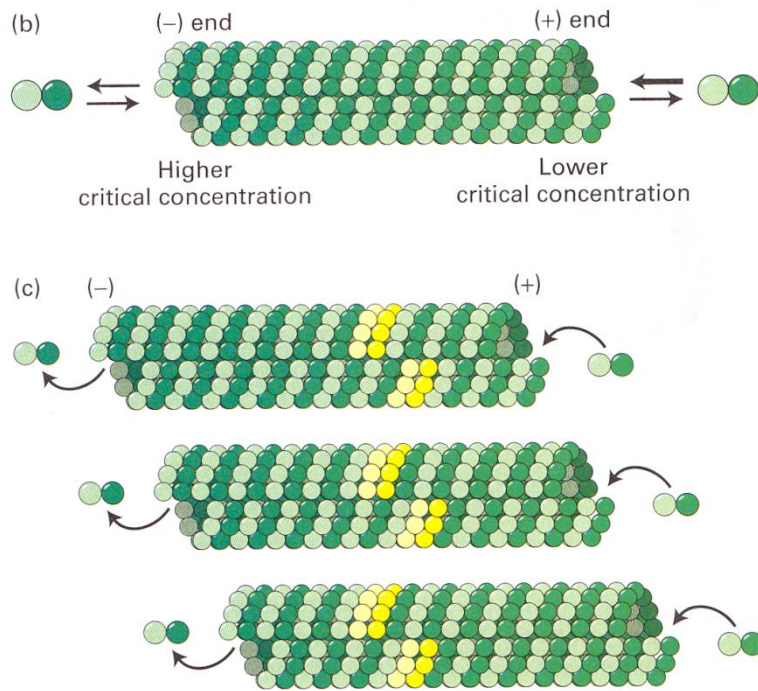


Cytoskeleton and Movement

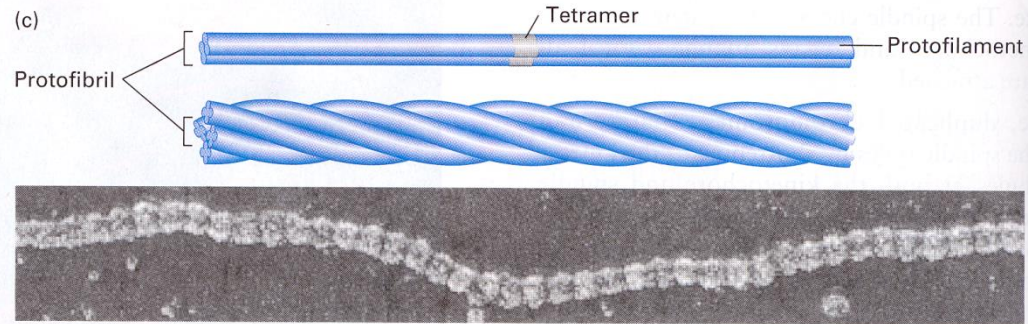
Actin microfilaments



Tubulin microtubules



Intermediate filaments



Microfilaments

Actin

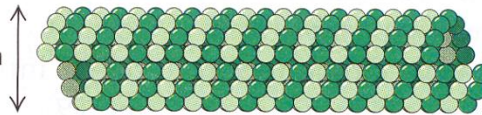
7 – 9 nm



Microtubules

$\alpha\beta$ -Tubulin dimer

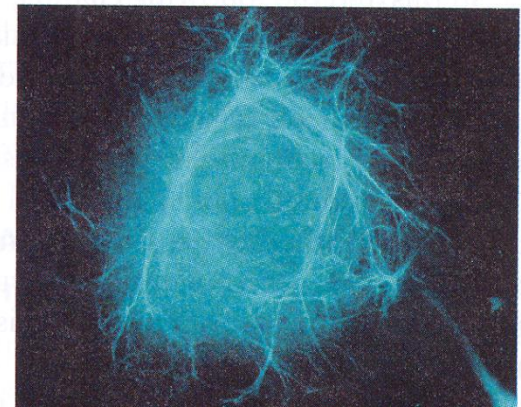
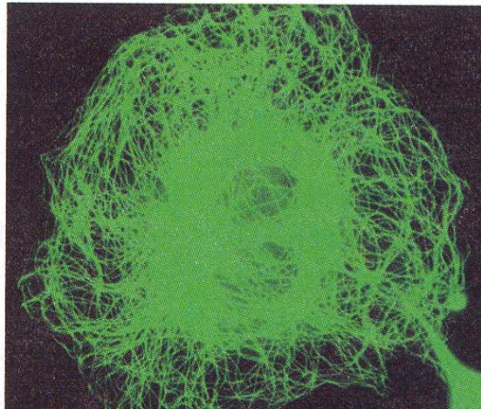
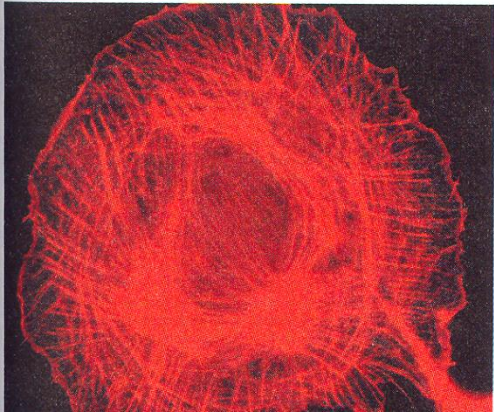
25 nm



Intermediate filaments

Various

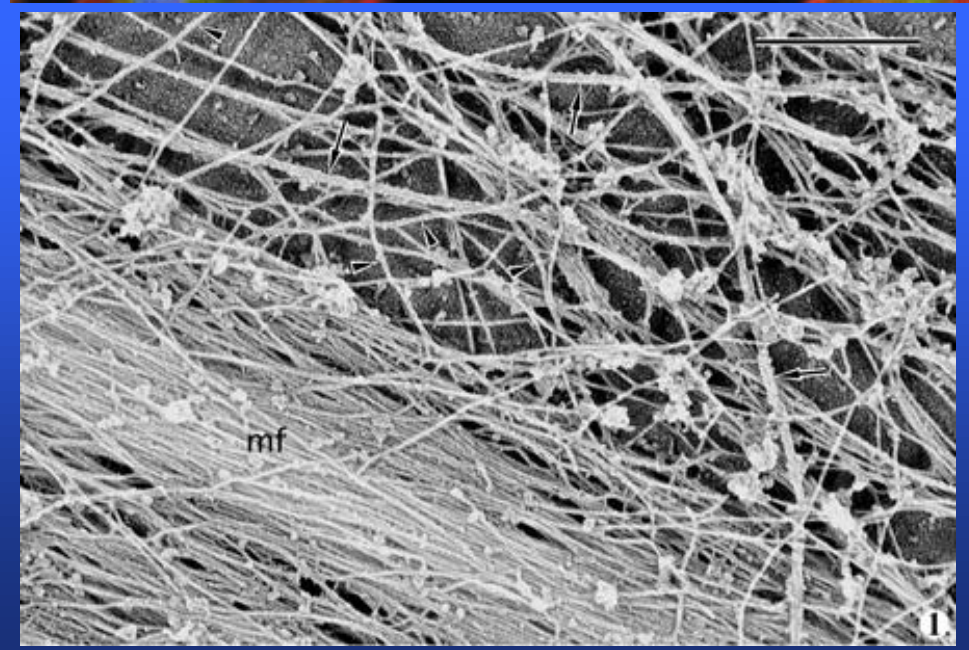
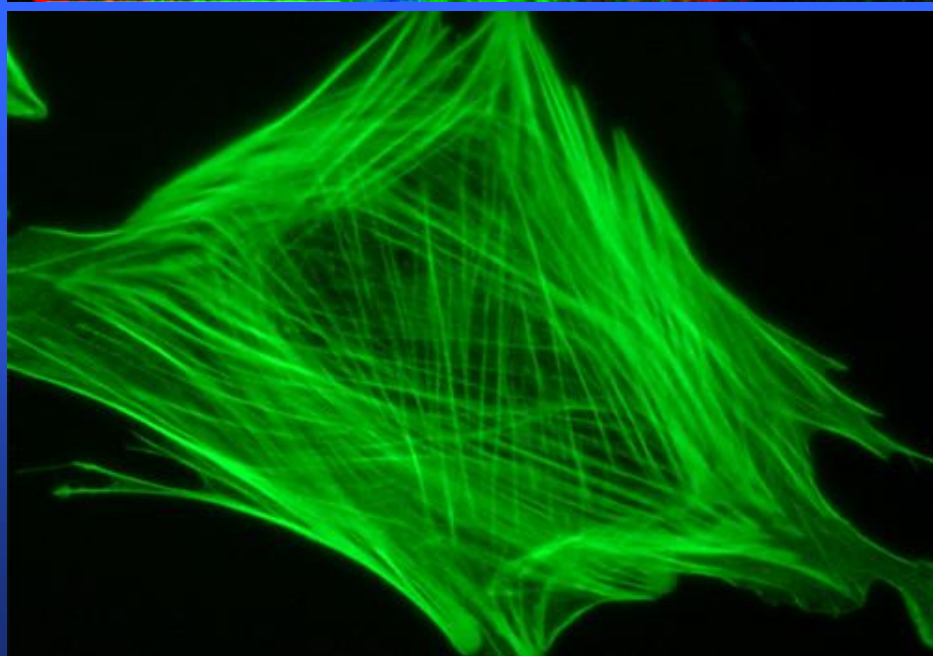
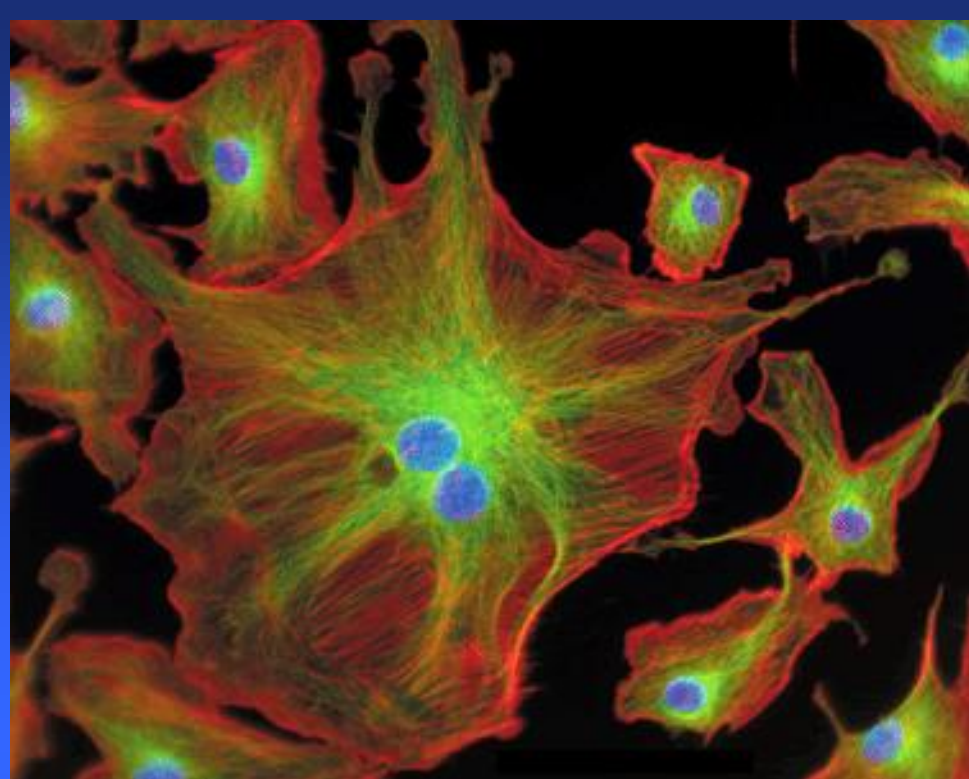
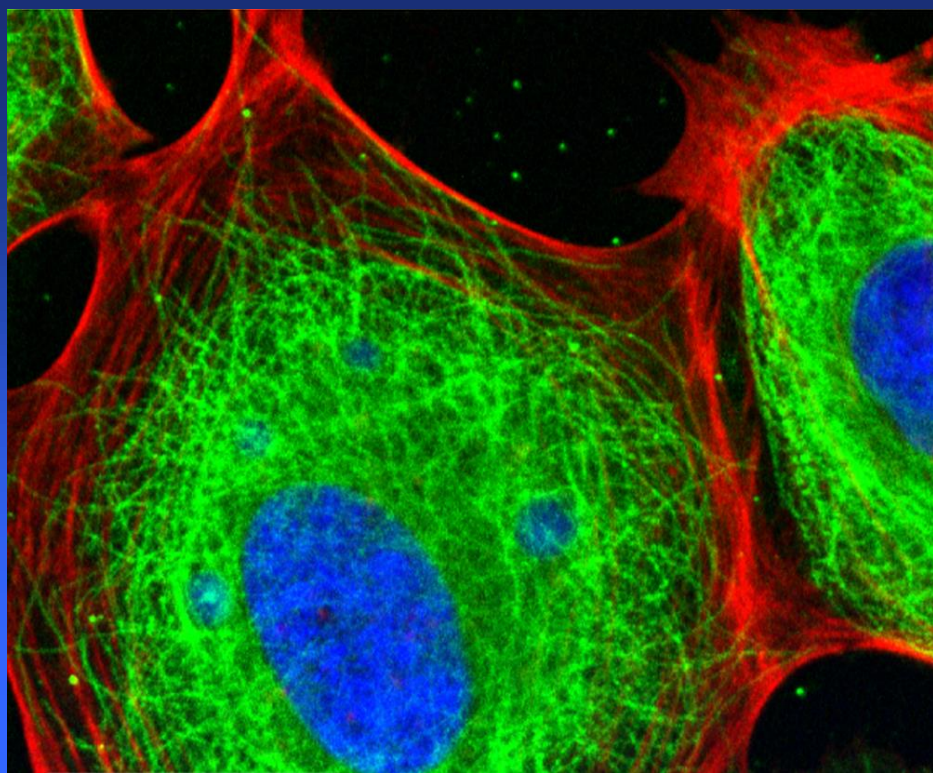
10 nm



Microfilaments – G-actin (whole filaments - F-actin), polarised (+ and - end), bind ATP/ADP, dynamic, function – contraction, cell network, roads for myosins.

Microtubules – $\alpha\beta$ -tubulin (protofilaments), polarised (+ and - end), bind GTP/GDP, dynamic, function – organisation, long-distance transport of organelles, roads for kinesins and dyneins. MT pre-prophase band, MT cortical, MT mitotic apparatus.

Intermediate filaments – biochemically heterogeneous, high tensile strength, no polarity, don't bind nucleotides, stable, in animals only, function – cell and tissue integrity, without motors.

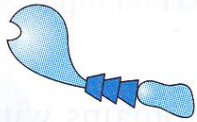


Myosins - motors maintaining endocytosis, contraction, transport of organelles (max. 7 $\mu\text{m/s}$) along actin microfilaments (consumption of ATP).

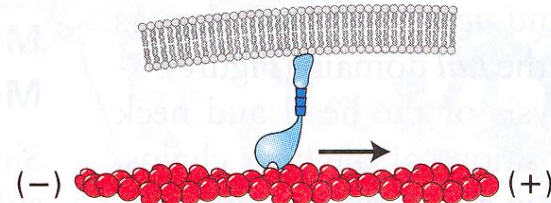
Class

Step size

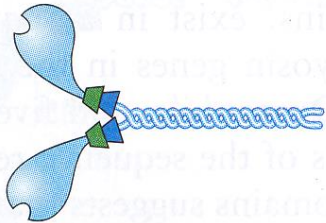
I



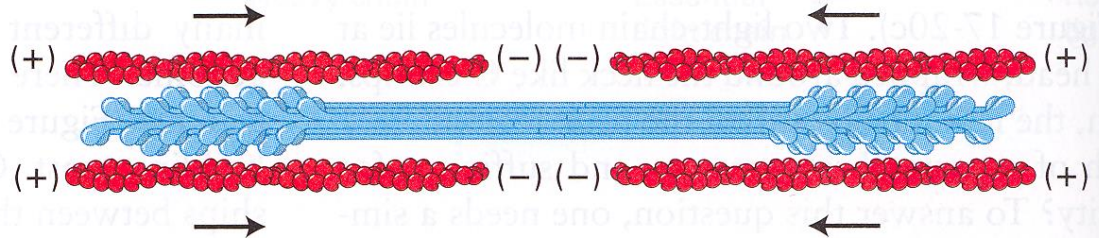
10–14 nm



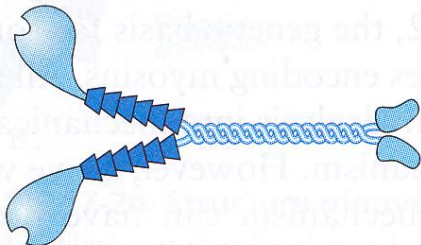
II



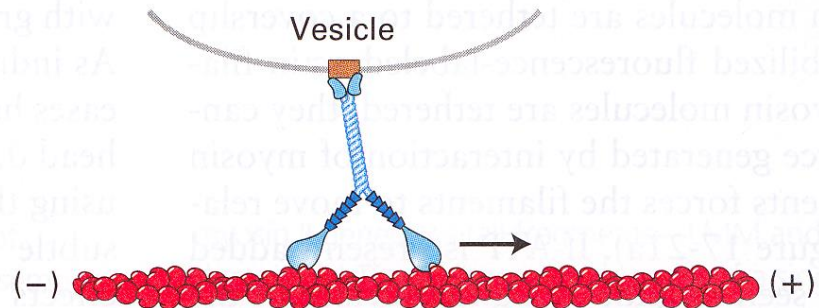
5–10 nm



V

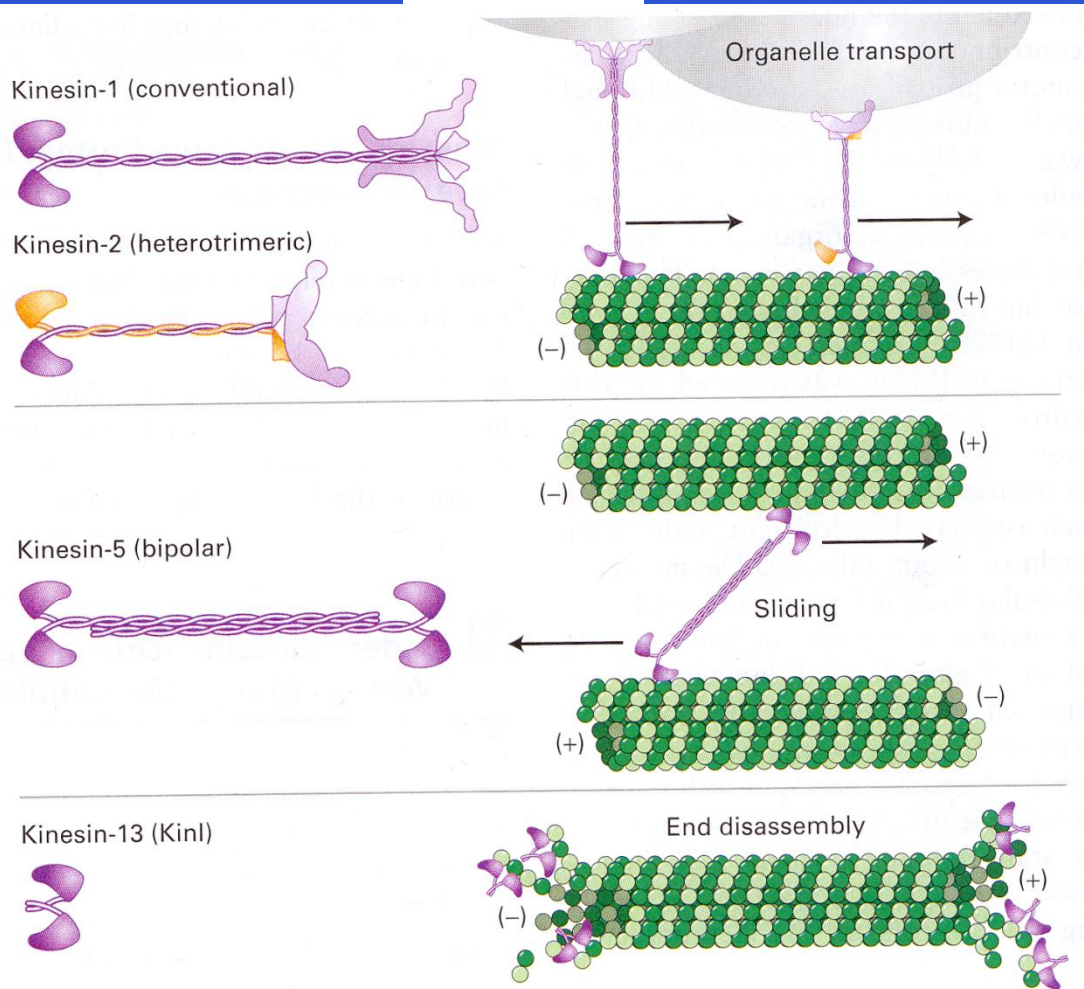


36 nm

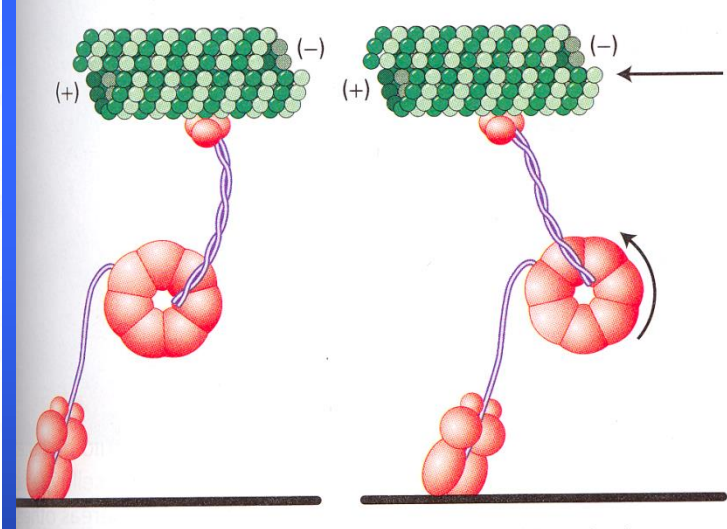


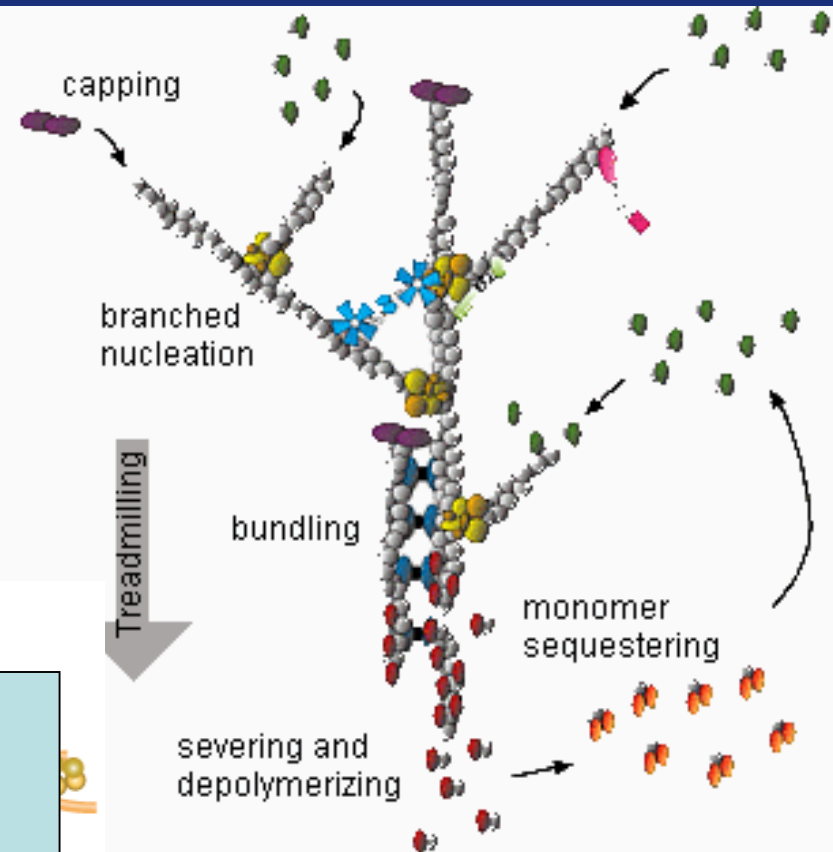
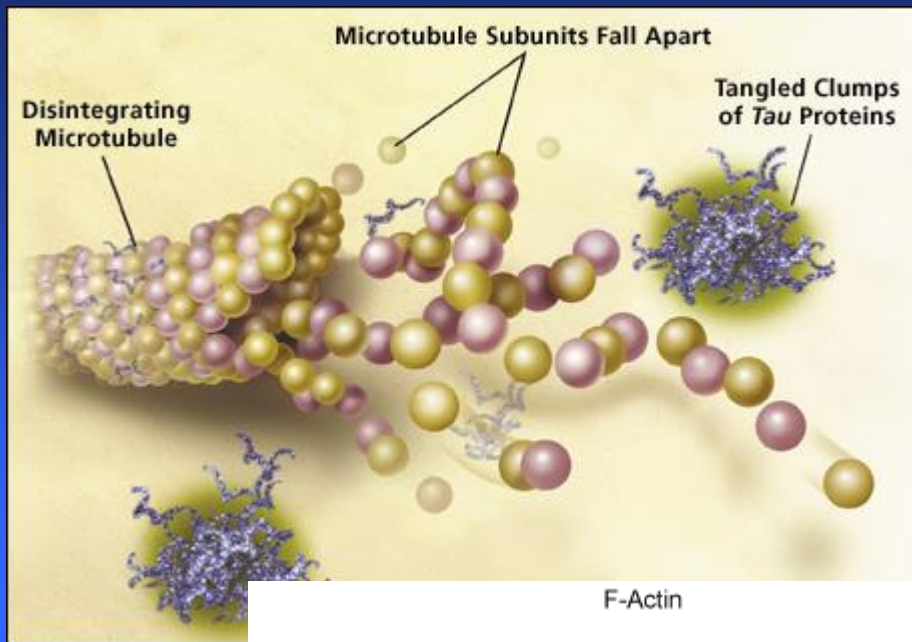
Kinesins and dyneins - motors maintaining transport (max. 3 $\mu\text{m/s}$) along tubulin microtubules, relative movement of microtubules, depolymerisation of microtubules (consumption of ATP).

Kinesins



Dyneins



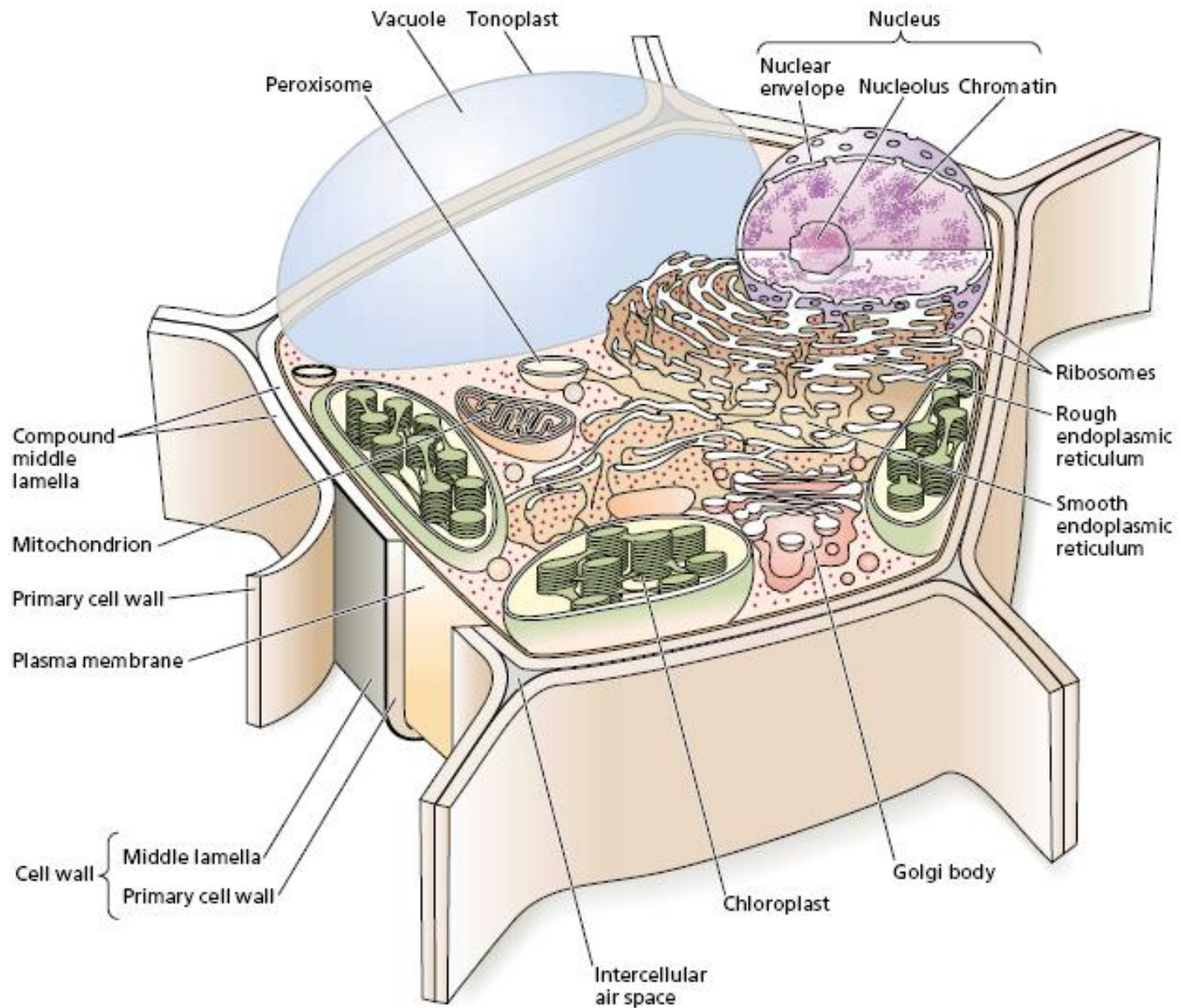


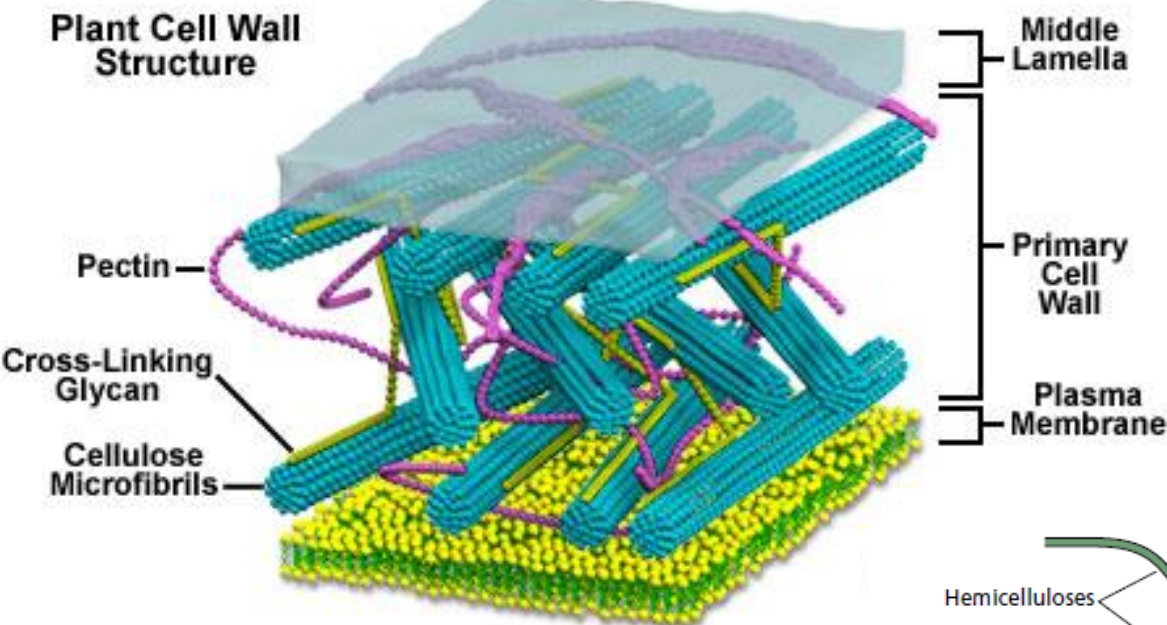
Dynamic cytoskeleton plays crucial roles in cell signalisation, vesicular transport, organelle movement and integrity, cell differentiation and movement.

Dynamic of cytoskeleton is in the cells regulated on several levels (gene transcription, posttranslation modifications of proteins, etc.)

Cell Wall

Cell Wall)





Cell wall components:

Cellulose (8 – 45 %)

Hemicelluloses

Pectins

Lignin (exodermis, endodermis, xylem, sclerenchyma)

Proteins (<12 %)

Lipids

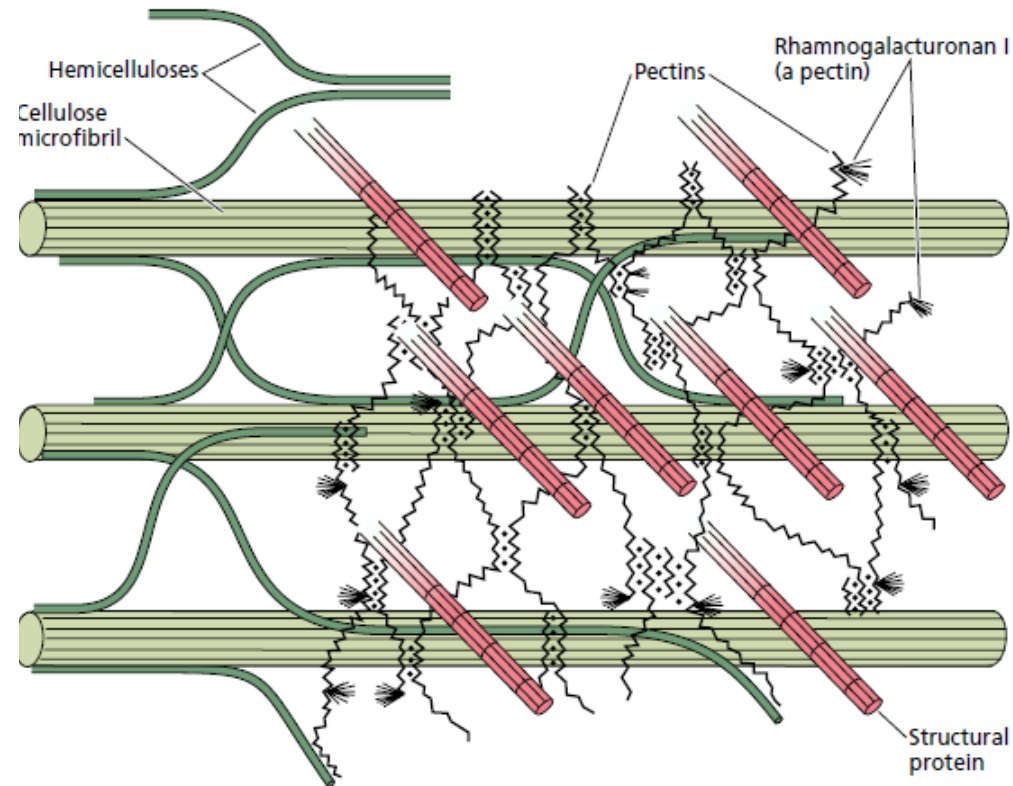
Suberin (exodermis, endodermis, cork)

Cutin (epidermis)

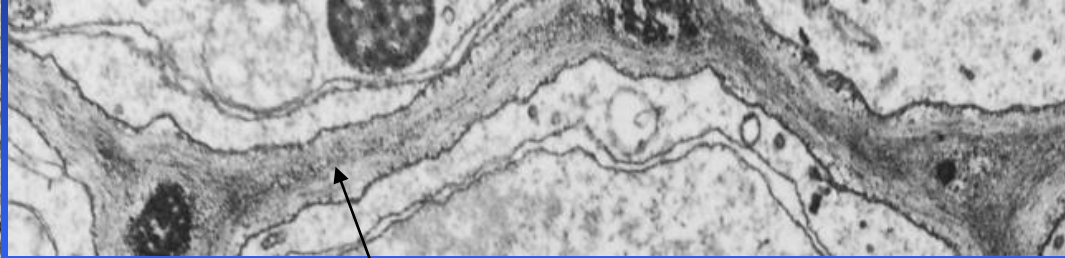
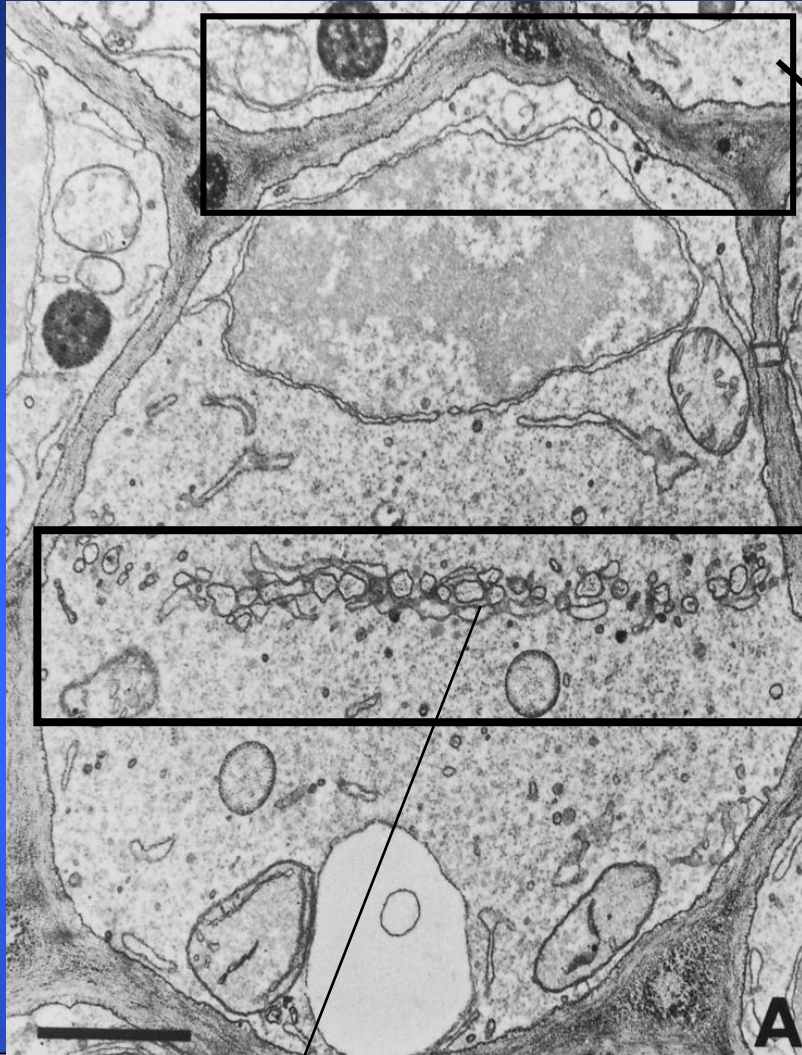
Chitin (cells of lower plants, insect and fungi)

Water

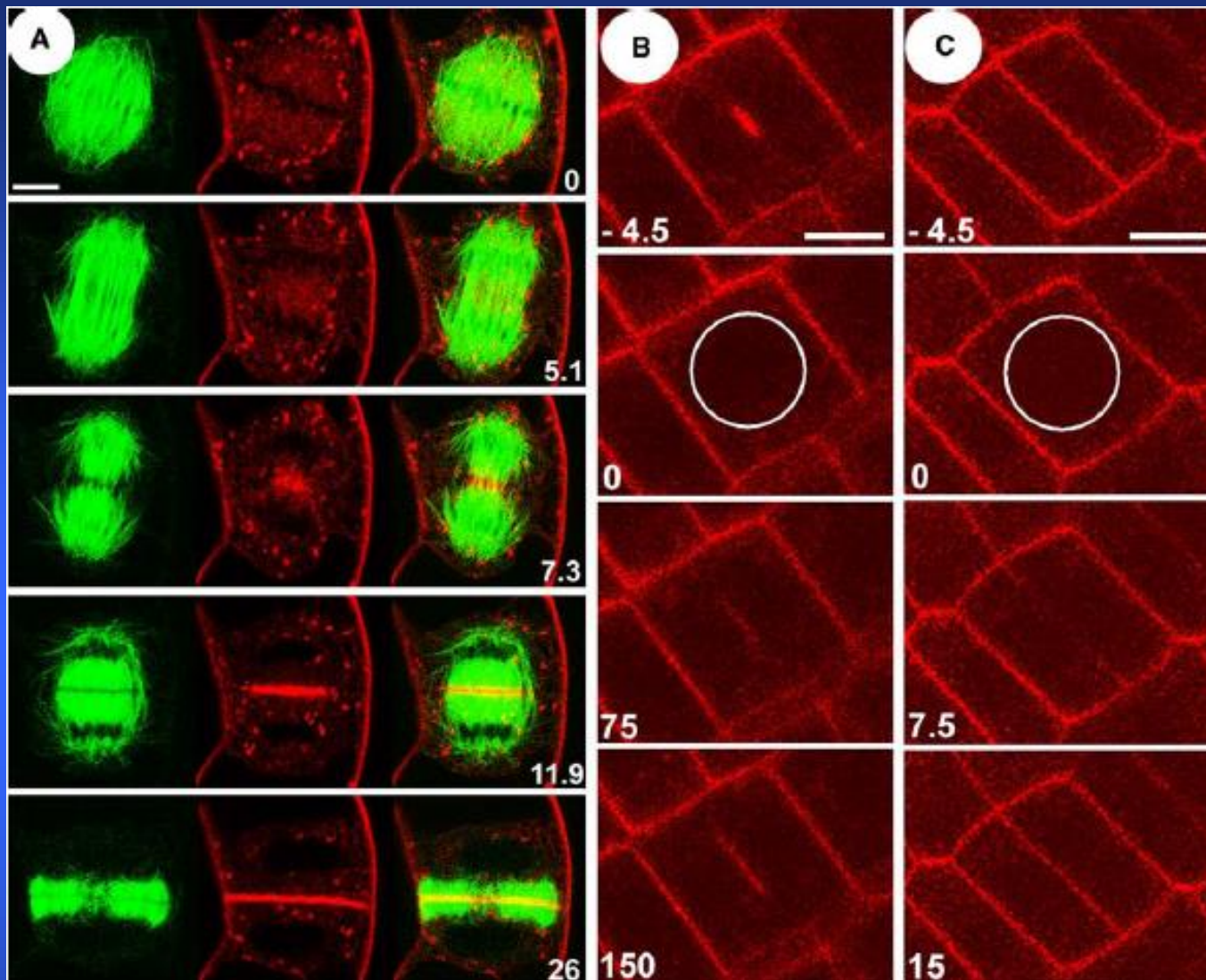
Ions



Biogenesis of Cell Wall



A new cell wall starts to form during cytokinesis. The fusion of vesicles (originated in GA and endocytosis) creates **phragmoplast** and next gradual fusion builds a **cell plate**. This provides a background for primary cell wall formation. The material of cell plate contains pectins – between the two cells (their primary cell walls) locates middle pectin lamella.



A: marker of endocytosis **FM4-64** and its gradual localisation into the cell plate (plant cell endocytosis molecules/material of apoplast, and thus of cell wall as well)

B: FRAP (**fluorescence recovery after photobleaching**) FM4-64 – cell plate formation

C: FRAP FM4-64 cell plate contacting cytoplasmic membrane

Endocytosis of Cell Surface Material Mediates Cell Plate Formation during Plant Cytokinesis

Pankaj Dhonukshe,^{1,2,*} František Baluška,^{3,4}
Markus Schlicht,³ Andrej Hlavacka,³ Jozef Samaj,^{3,5}
Jiří Friml,^{2,*} and Theodorus W.J. Gadella, Jr.^{1,*}

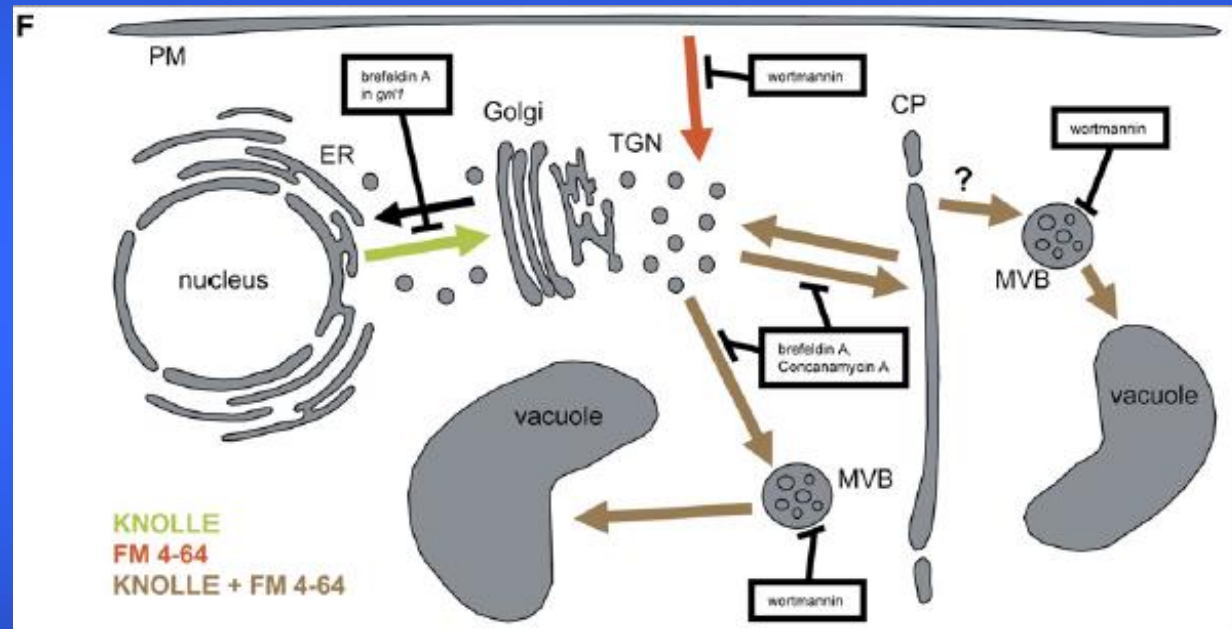
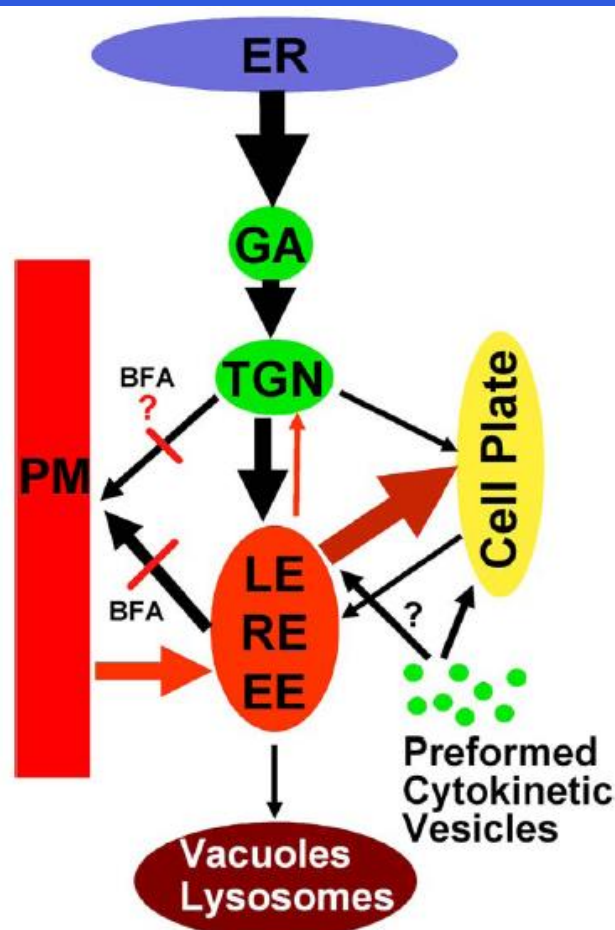
Introduction

Cytokinesis in immobile plants striking

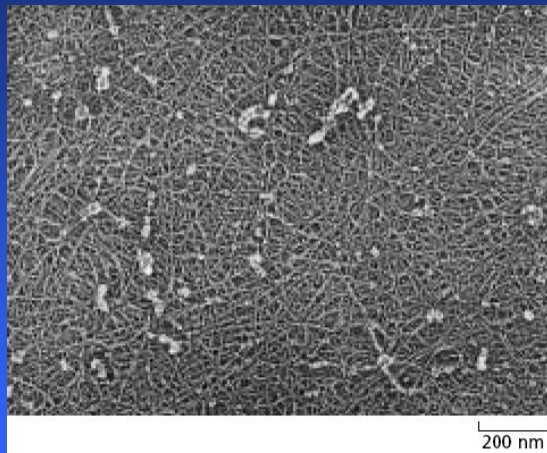
Plant Cytokinesis Requires De Novo Secretory Trafficking but Not Endocytosis

Ilka Reichardt,¹ York-Dieter Stierhof,² Ulrike Mayer,¹
Sandra Richter,¹ Heinz Schwarz,³ Karin Schumacher,⁴

Results and Discussion

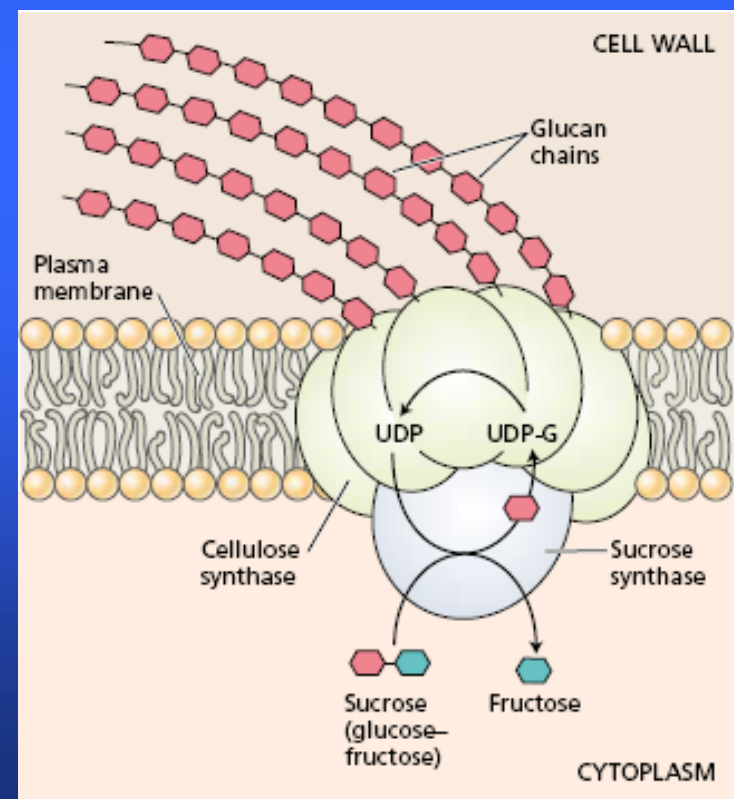


Structure and Biogenesis of Primary Cell Wall

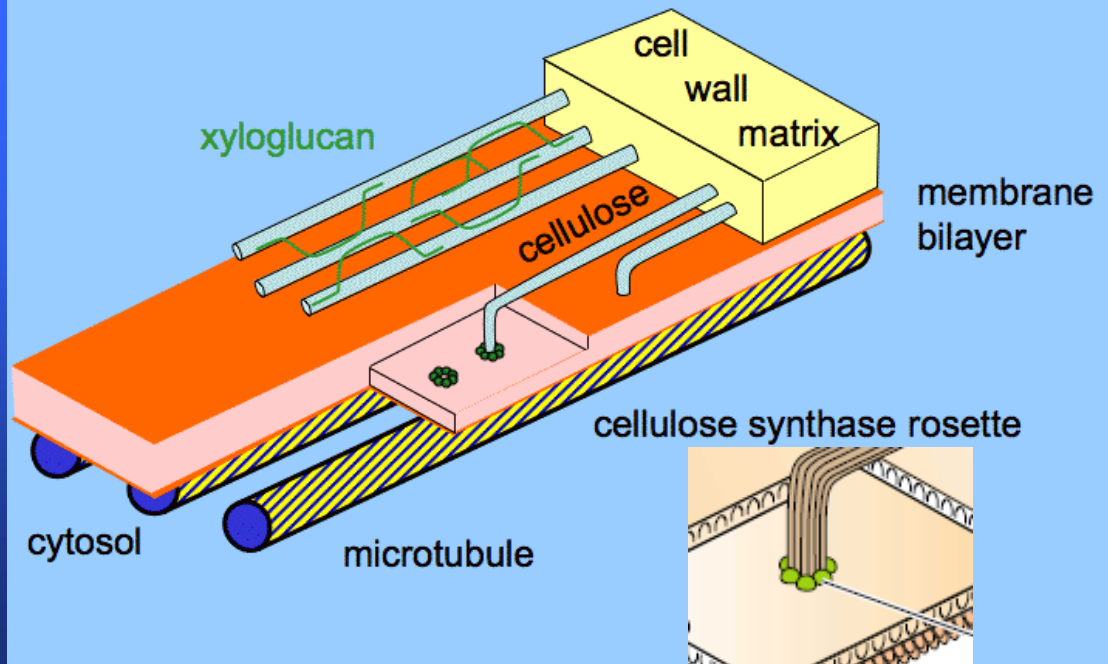


Primary cell wall consists of cellulose microfibrils and matrix (pectins, hemicelluloses...).

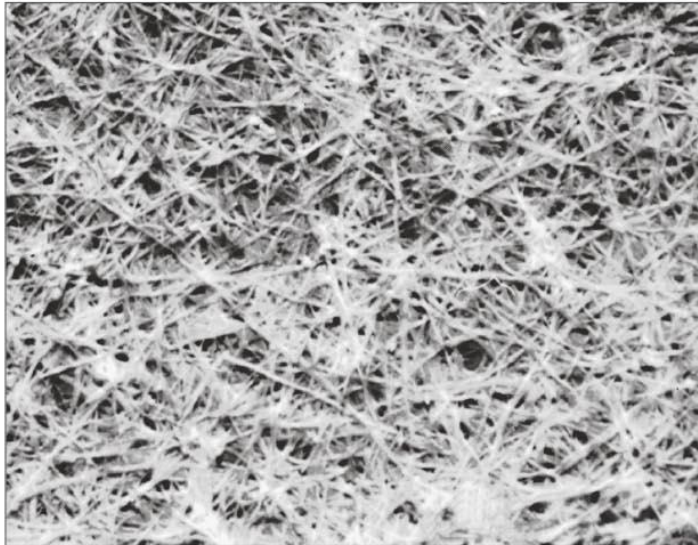
Cellulose polymers are synthesized by enzyme complex **cellulose synthase** (CS), that is emerged in plasmatic membrane. Individual complexes of CS aggregate and form **rosette terminal complex**, which produce material for cellulose microfibril formation.



Cellulose synthesis is aligned with microtubules



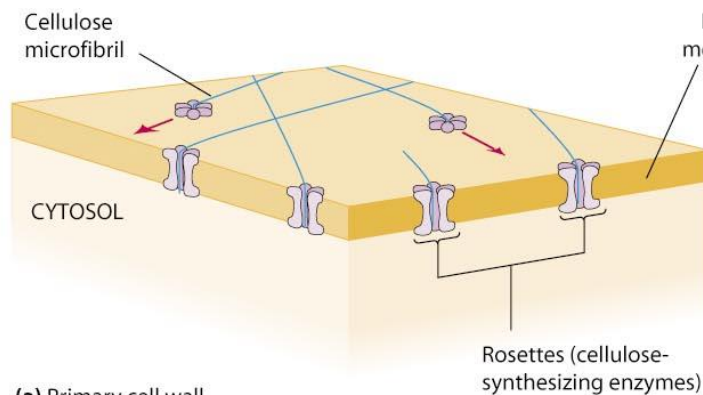
Arrangement and dynamics of rosette terminal complexes determine arrangement of cellulose microfibrils in cell walls (a role of cytoskeleton)



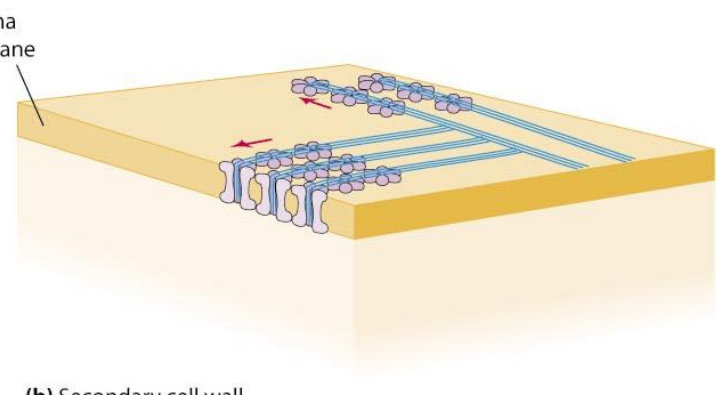
Anisotropic orientation CM 1 μm



Isotropic orientation CM 1 μm

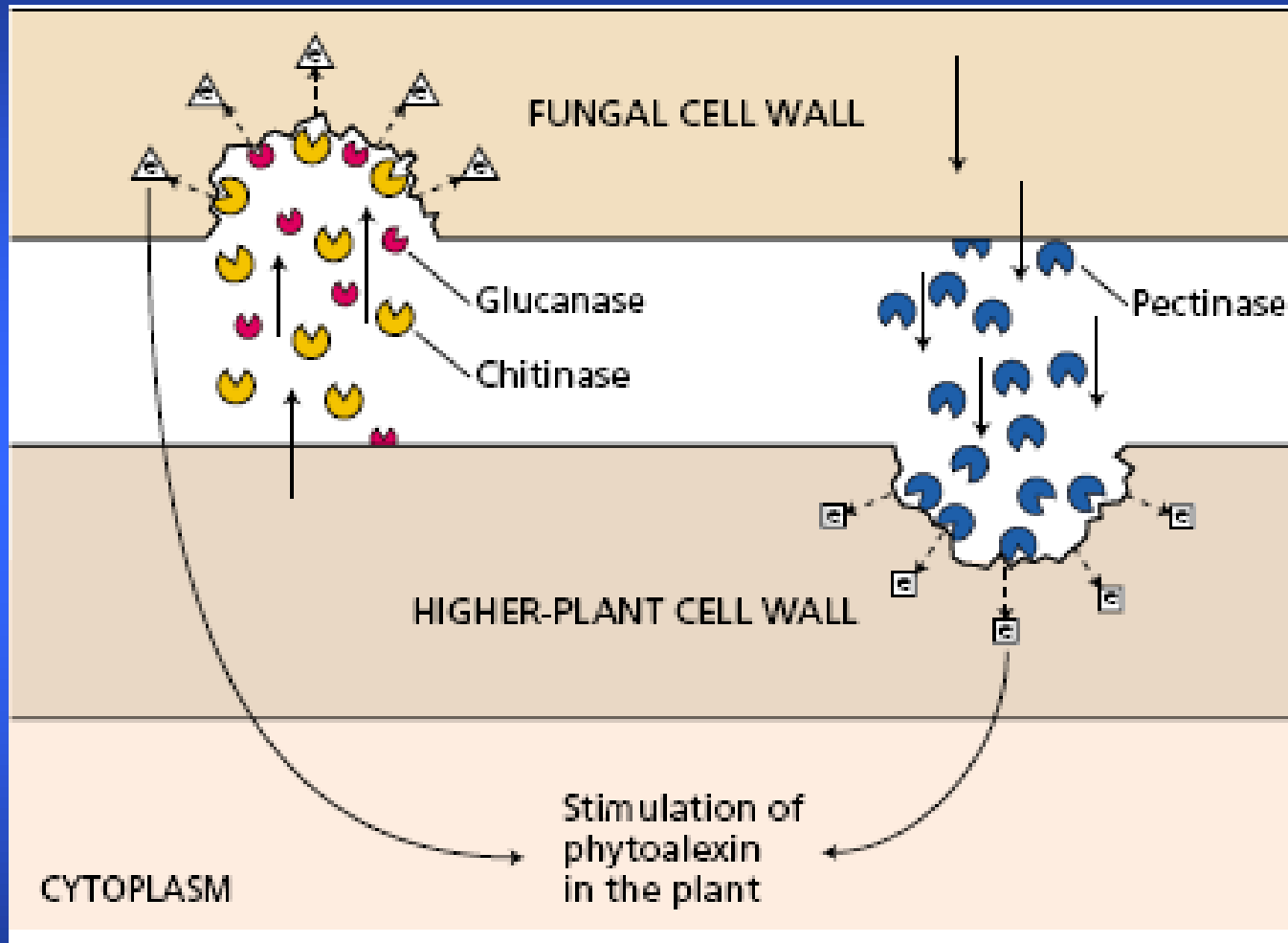


(a) Primary cell wall

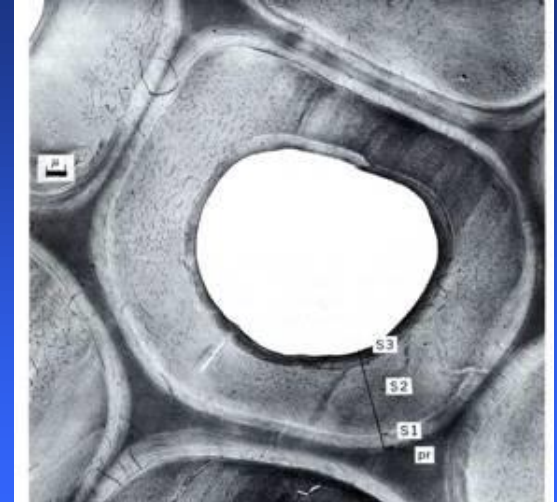
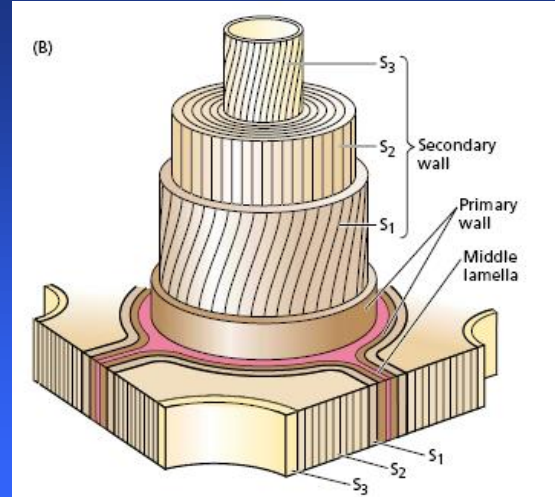
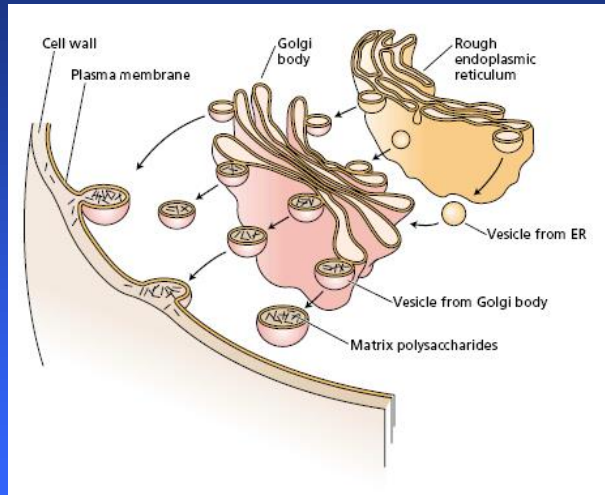


(b) Secondary cell wall

Pectinases and cellulases hydrolyse primary cell wall



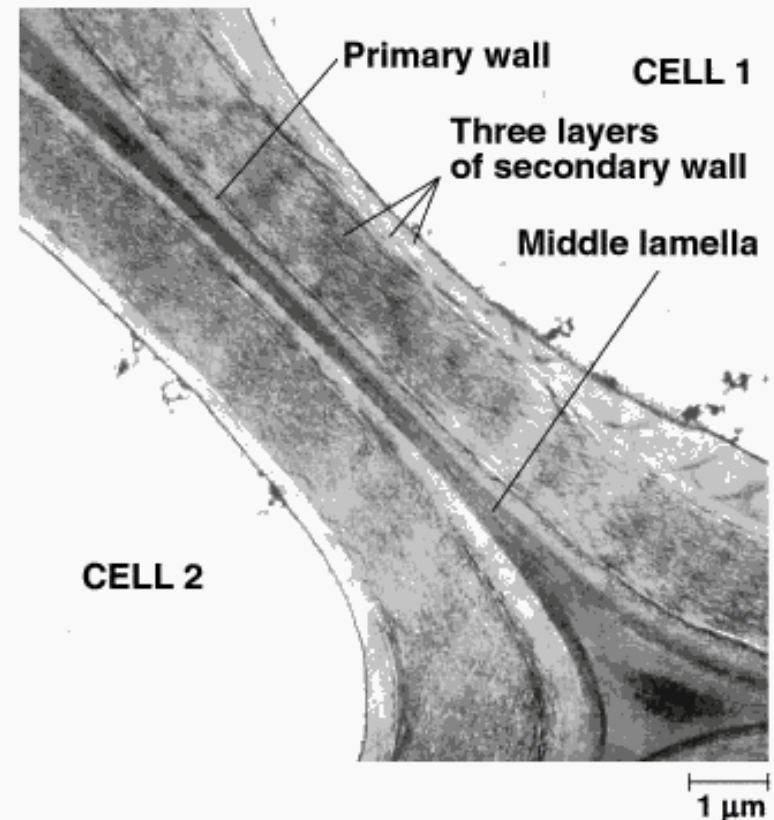
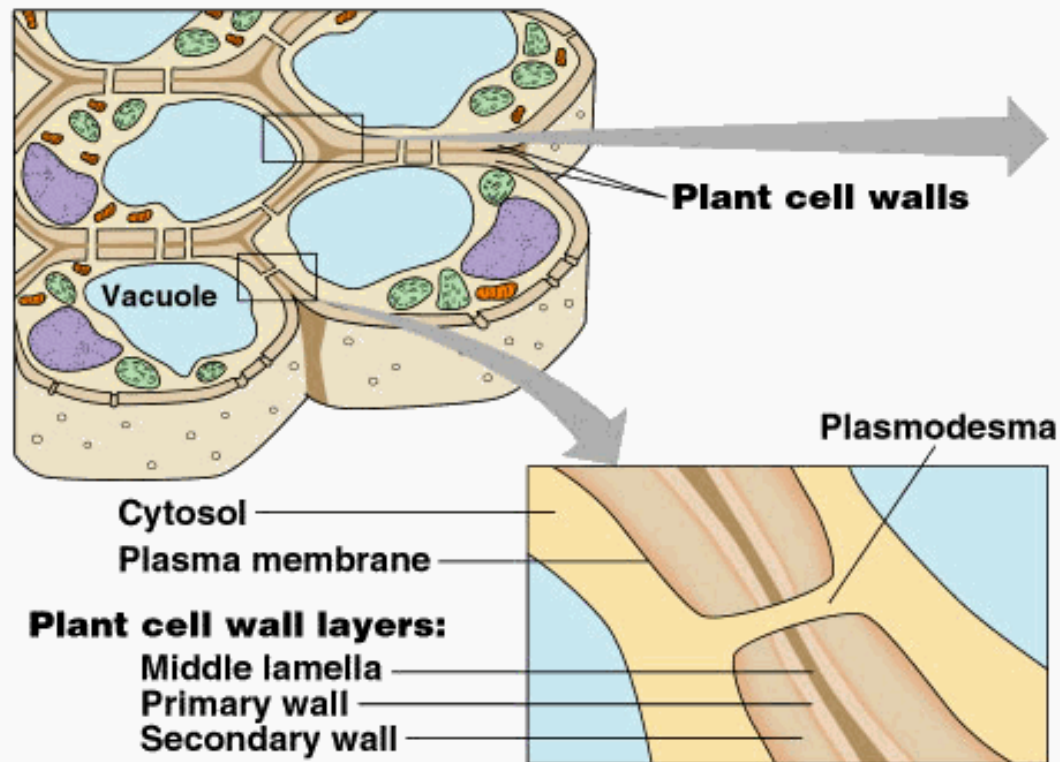
Cell Wall Thickening – Formation of Secondary Cell Wall



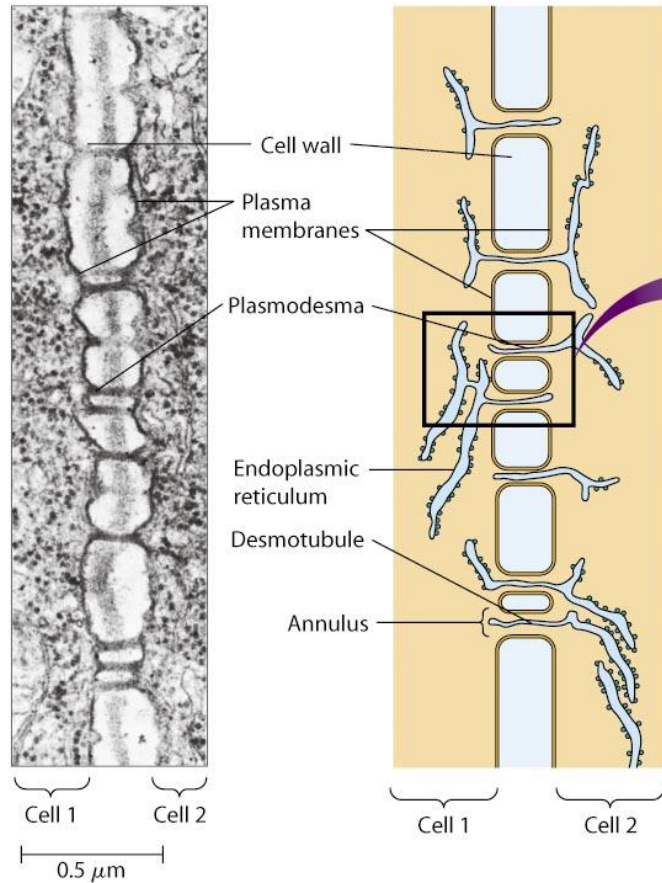
Primary cell wall grows – expands. Newly synthesised cellulose microfibrils bind with matrix molecules (that material can be transported via vesicle trafficking).

The cell growth closely relates to cell wall growth. Two main types are known: tip growth and diffusion growth via a process of **intussusception**.

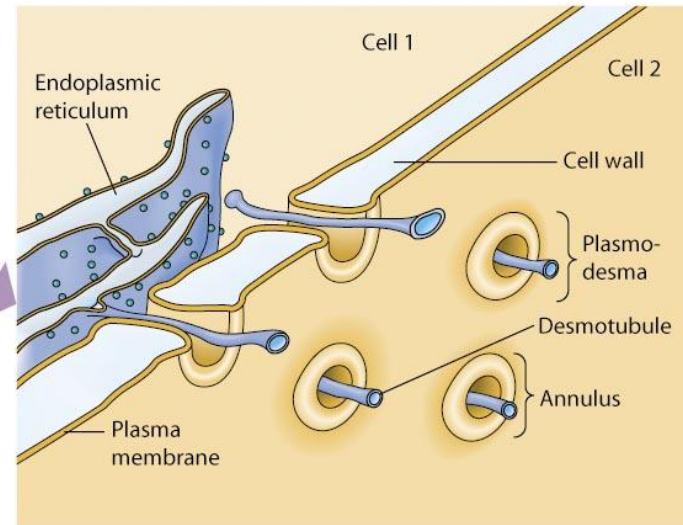
After finished expansion growth of a cell, the wall may start to thicken via a process of **apposition** – secondary cell wall is formed (mostly lignified). That can occur unevenly – typical for vascular cells.



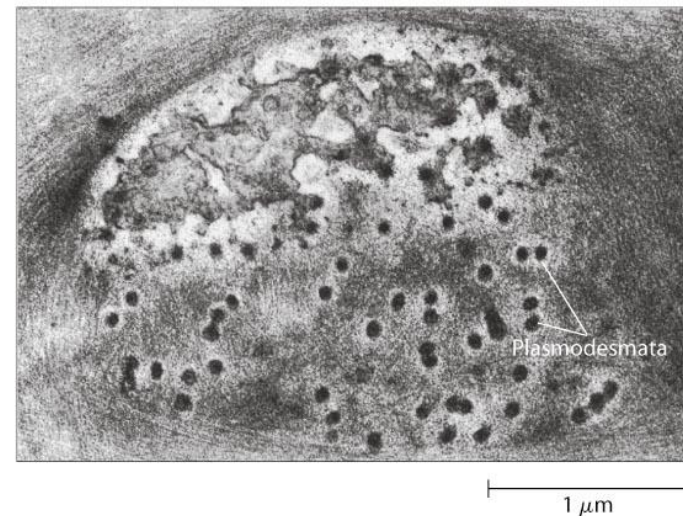
Plasmodesma (Plasmodesmata)



(a) Electron micrograph and diagram of plasmodesmata in longitudinal section



(b) Diagram of plasmodesmata



(c) Electron micrograph of plasmodesmata in cross section