

# Cell Wall

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- Typical component of plant cell that fixes the size and shape of the mature plant cell.
- The kind of cell wall present determines the texture of a tissue.

- **Functions**

- **Mechanical functions**

- Like a skeleton around each cell
- Determine shape and size of cell
- Determines the limits of expansion and water uptake

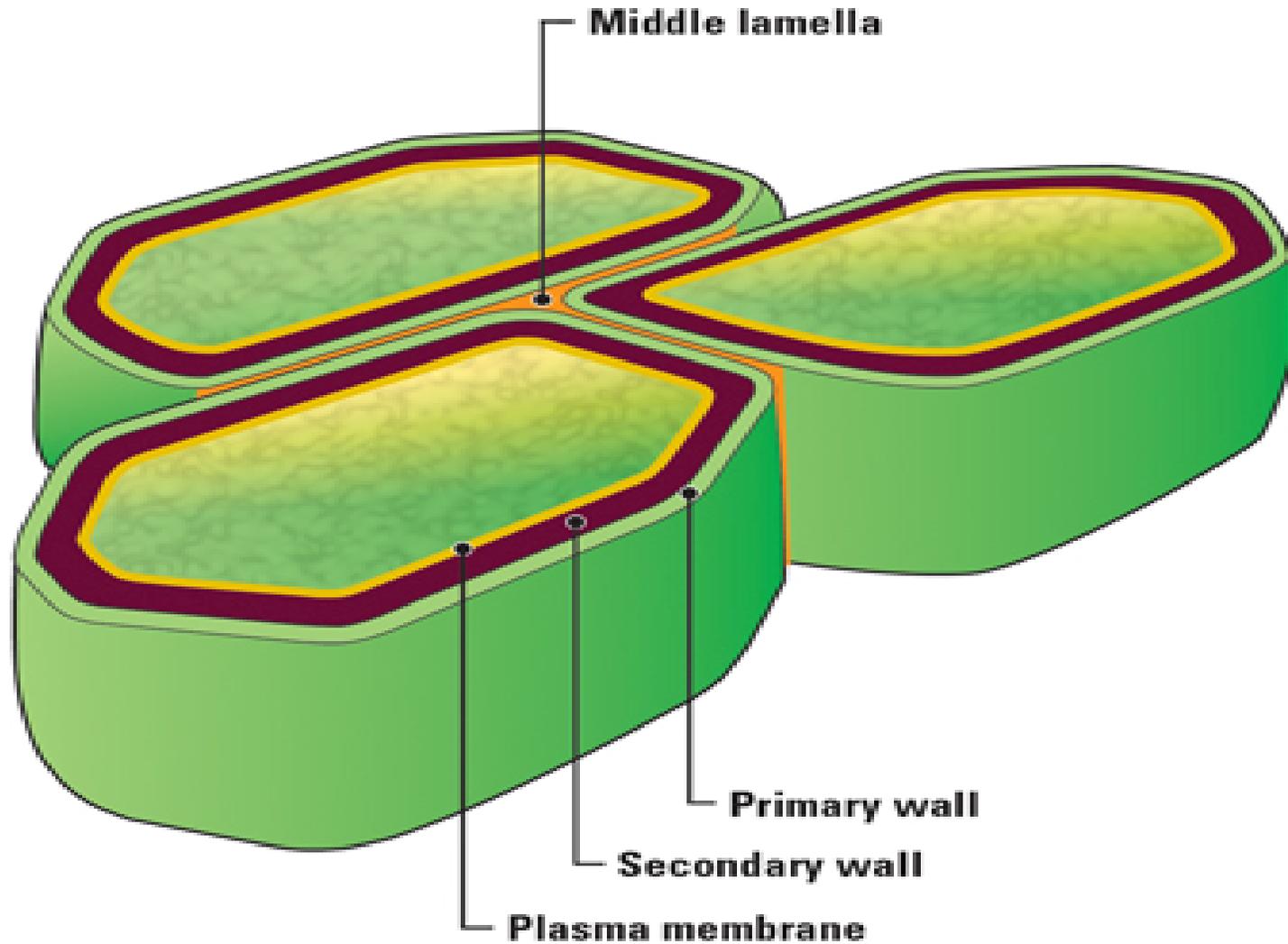
- **Metabolic Activity**

- Living part of cell
- Receives signals such as hormones.
- Wall signals transmitted through plasmalemma and into cytoplasm,  
-biochemical response

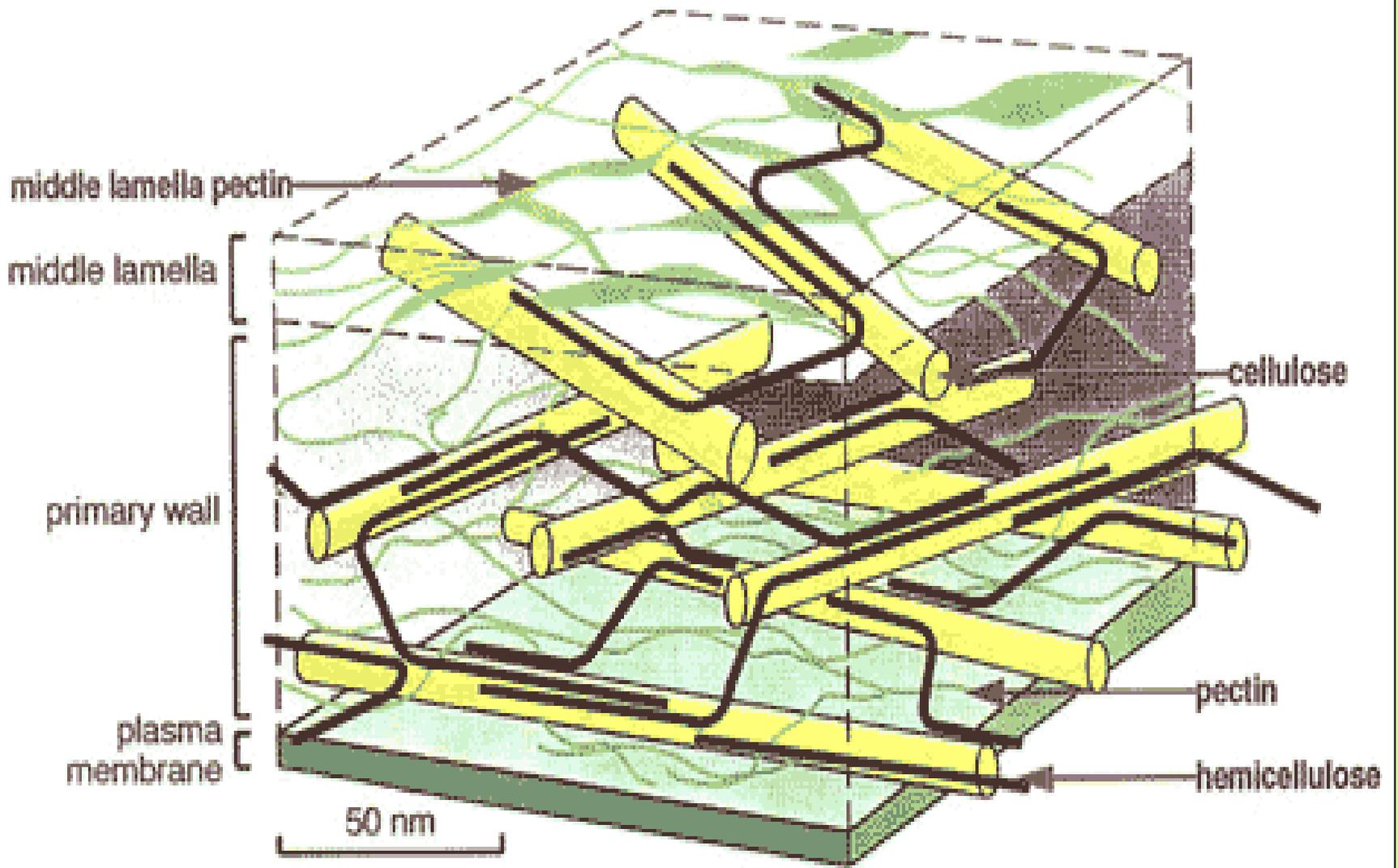
- **Nourishment – persimmon**

- **Absorption or secretion** – root hairs, rhizoids.

- The cell walls vary much in thickness in relation to age and type of cells. Young cells have thinner cell walls than the fully developed ones.
- The cell wall is complex in its structure and usually consists of three layers:
  - **Primary cell wall** ( usually consists of one layer
  - **Intercellular substance** (middle lamella) cements together primary wall of two adjacent cells.
  - **Secondary cell wall** ((made up of one- many layers , frequently three)



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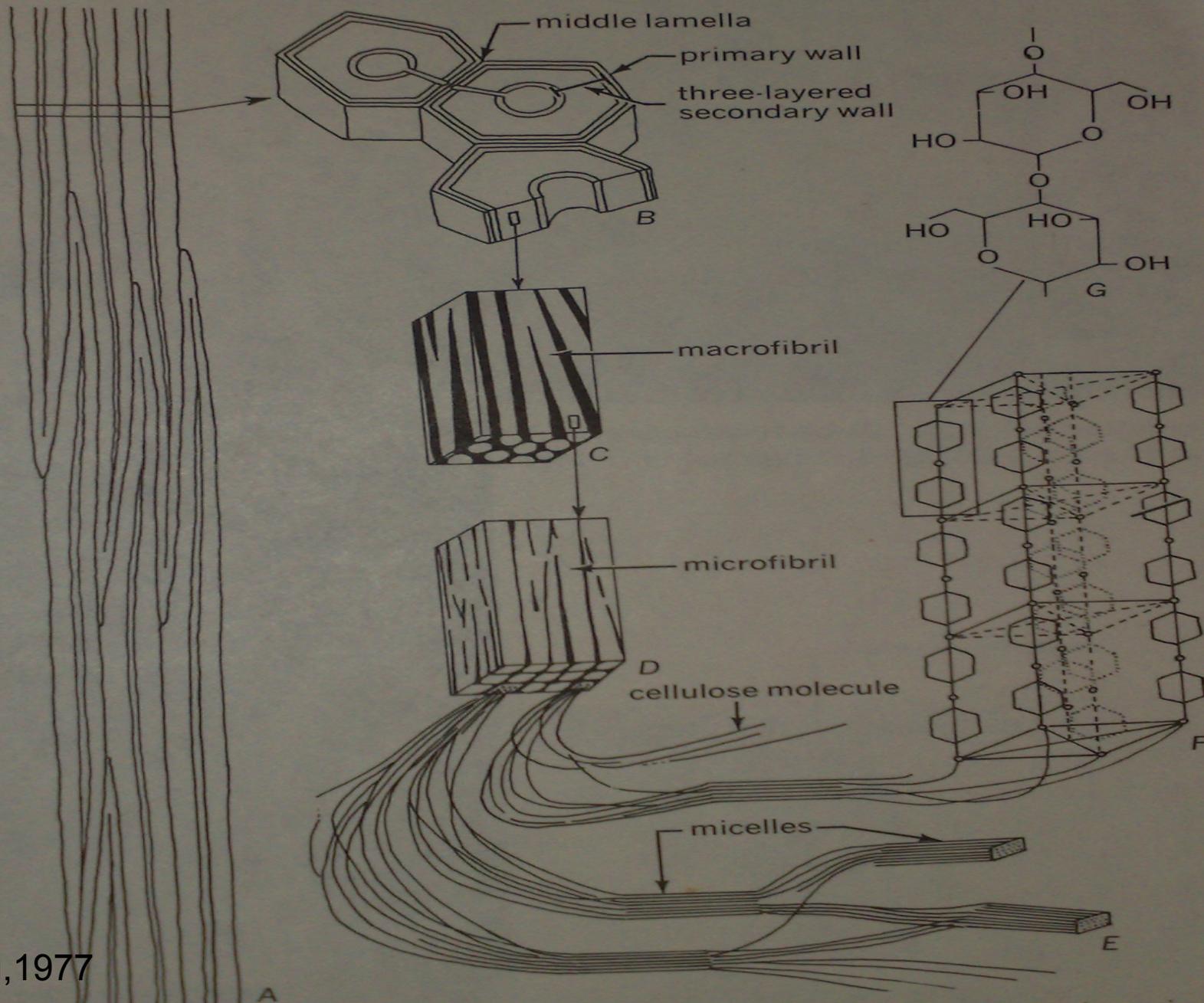


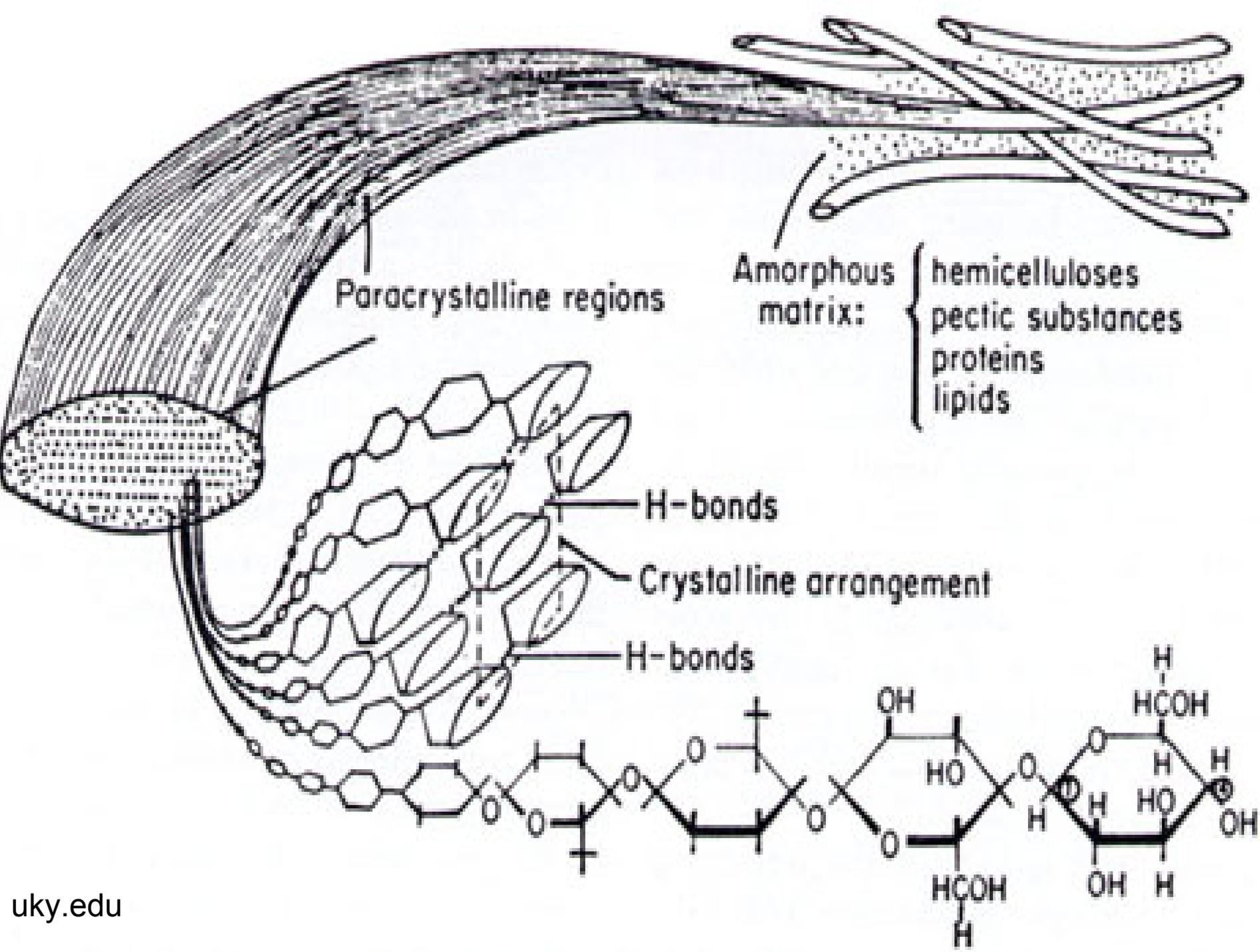
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# The Primary Cell Wall composition and texture

- Three Major Polysaccharides

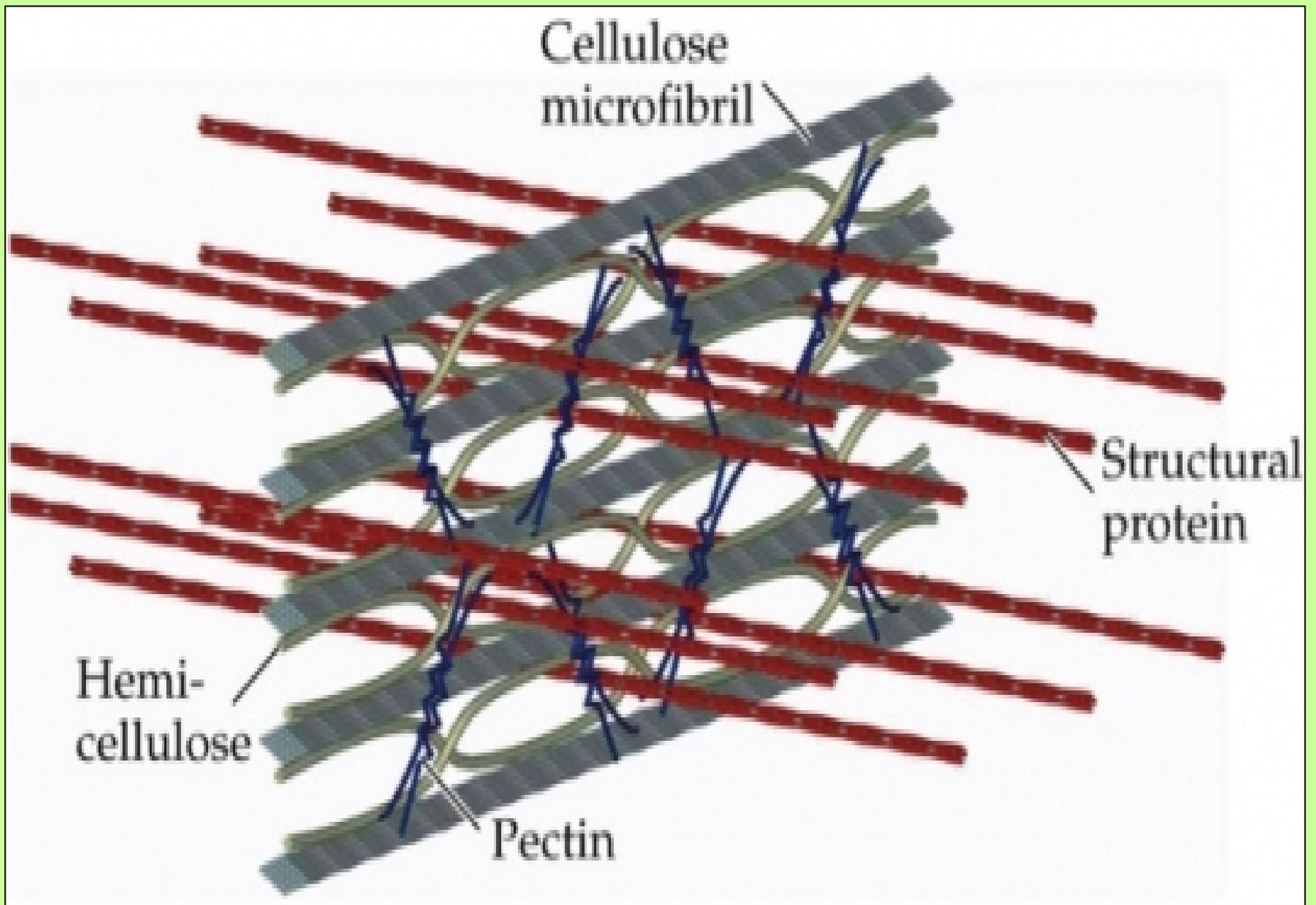
- 1) **Cellulose** = B 1-4 linkage, long unbranched linear chain of glucose, with crystalline properties because of arrangement of cellulose.
- found in a form **Microfibrils are bundles of** about 30 thread-like cellulose molecules (10-25 nm in diameter) orderly arranged in parallel arrays forming an extended three-dimensional lattice characteristic of crystals (called **micelles**).
  - **Macrofibrils** in secondary walls





## 2) Hemicellulose

- Highly branched long chains of glucose (**xyloglucans, xylans**)
- Microfibrils are coated with the fibrous hemicellulose = xyloglucan
- Hydrogen bonds with cellulose
- Xyloglucan is, in turn, chemically bonded to another hemicellulose that serves as a cross-link between pectin molecules.



### 3) **Pectins**

- Cellulose and hemicellulose embedded in.
- Form a separate network that interdigitates with the cellulose-hemicellulose network.
- Note middle lamella (region between cells) is composed of pectin- glues cells together
- Hydrophilic = holds up to 65% **water** in primary walls
- **function in** Cell adhesion, regulate porosity

# Plant Cell Wall Structure

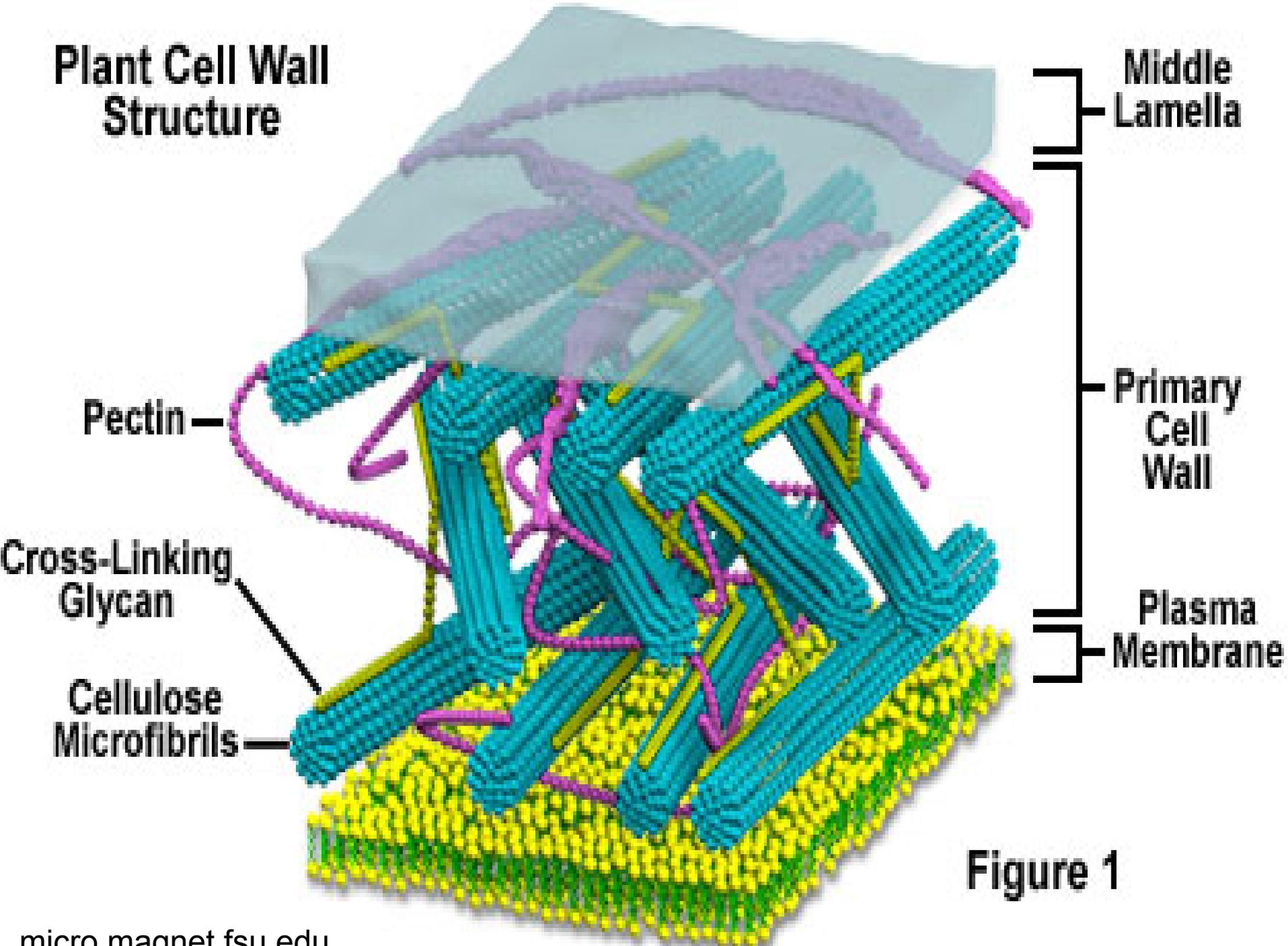


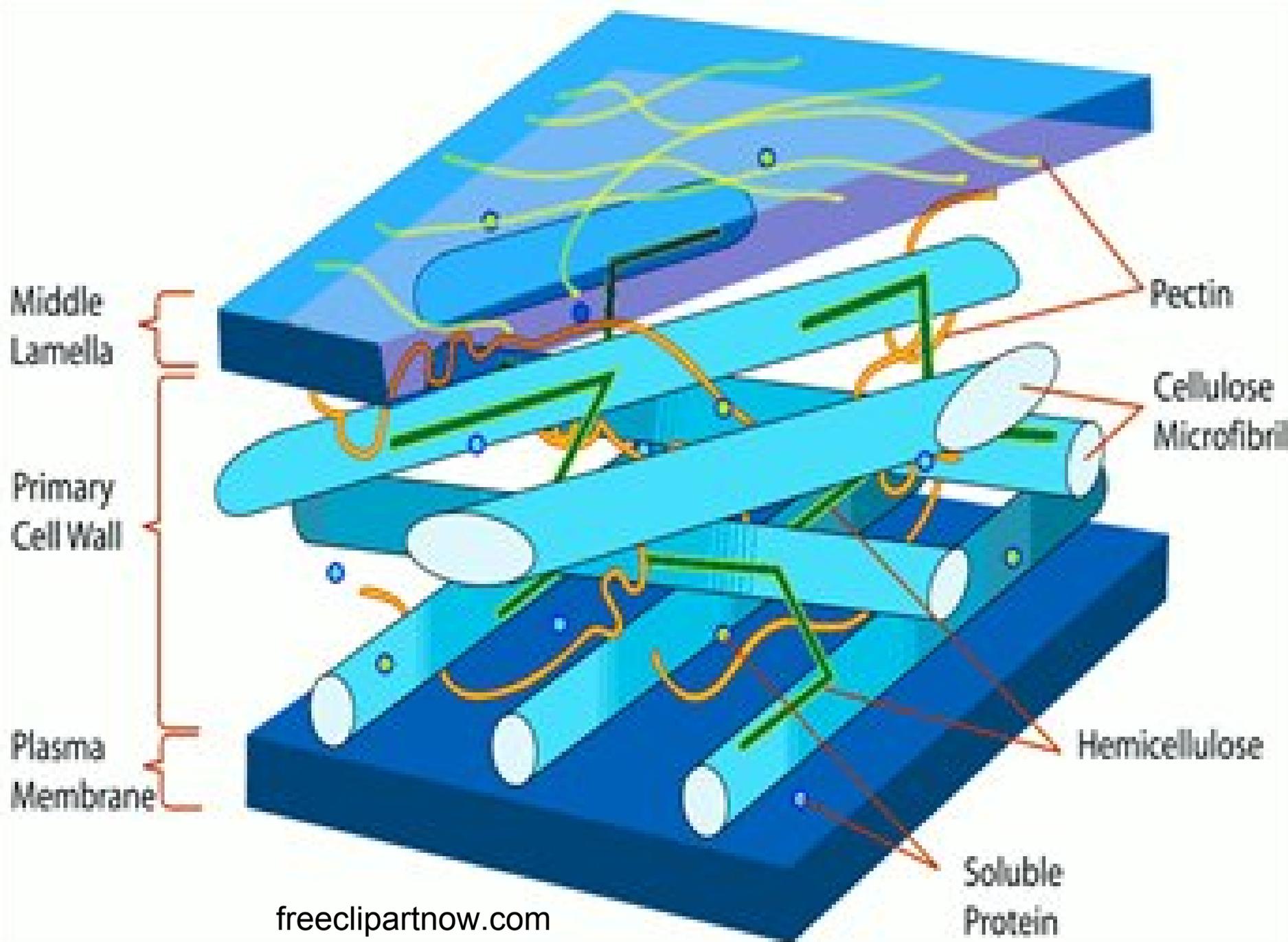
Figure 1

## Proteins:

- Structural and enzymes (10% dry weight)
- Peroxidases, cellulases, pectinases, phosphatases
- Hydroxyproline rare amino acid found in plasma membrane bounded to polysaccharides of the wall forming **glycoproteins** rich proteins

Function :-wall expansion

- Involved in growth and development



# Lipids

- **Cutin**

- Found in cuticle and walls of epidermal cells

- **Suberin**

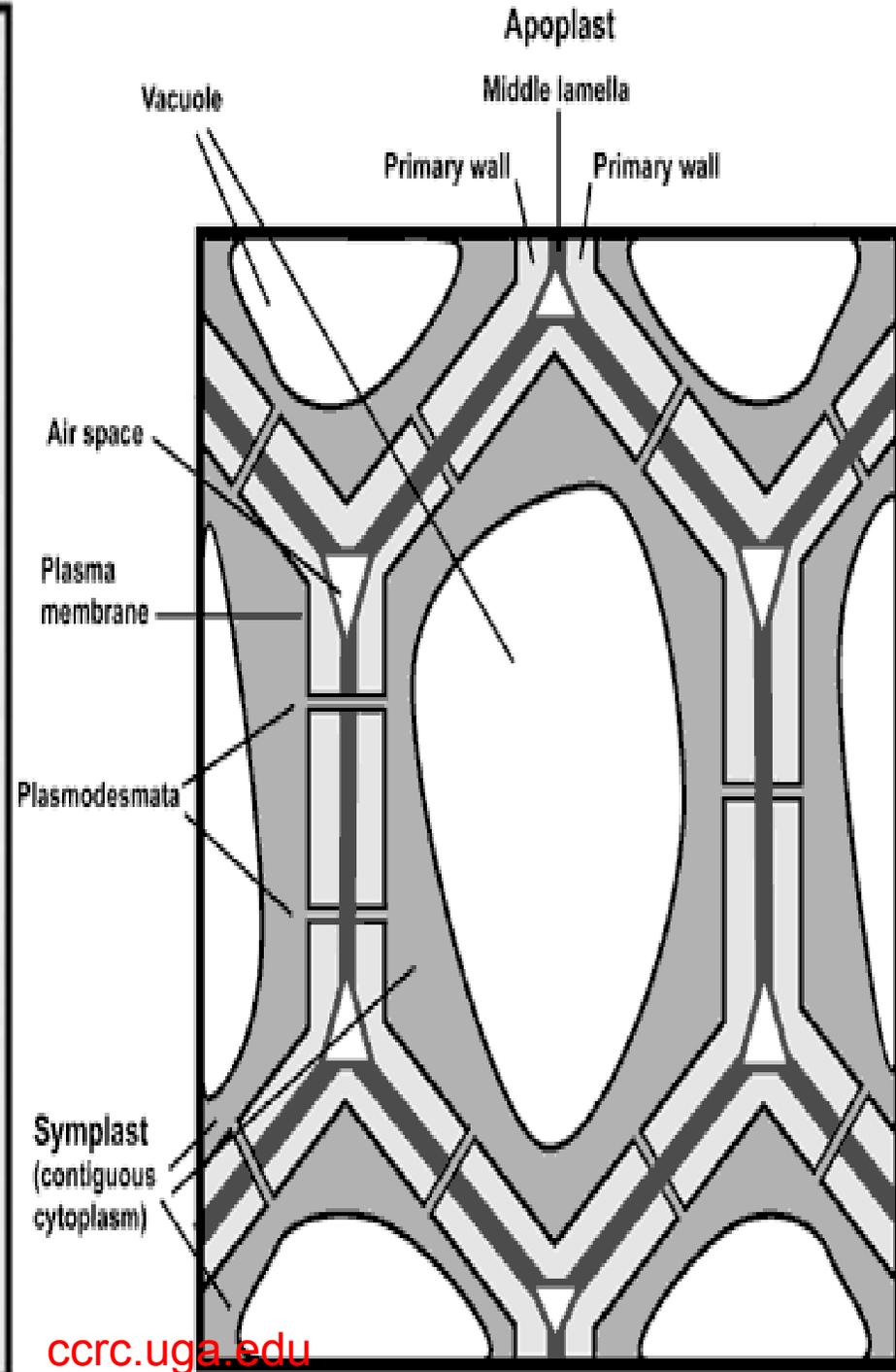
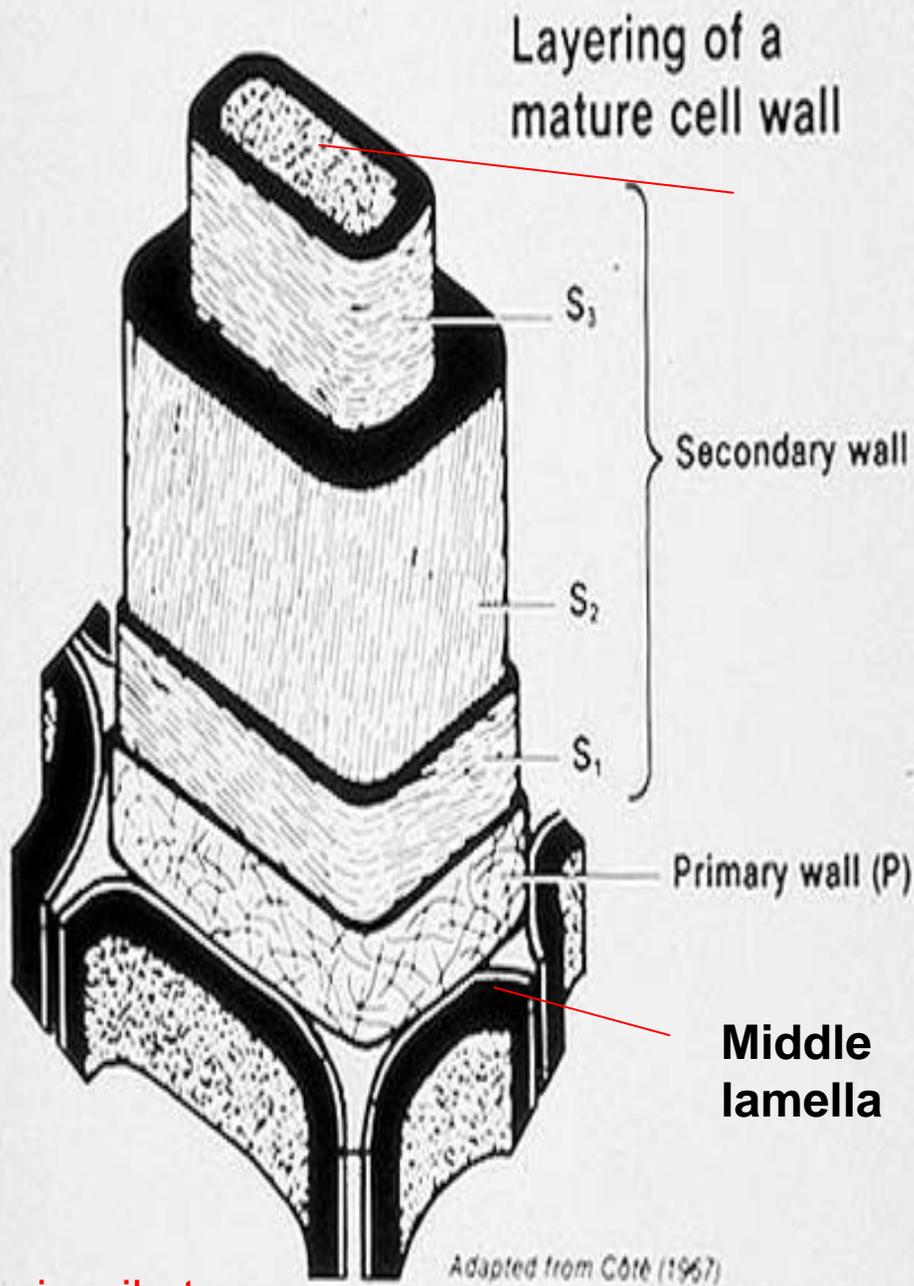
- Important for waterproofing cork cells (periderm)

- Also found in Casparian strips of endodermis

- **Waxes**

- **Cell wall layers:**

Each protoplasm form its wall from outside inward. So the oldest layer of a wall is the outermost position, the most recent one is the innermost position next to protoplasm



## The middle lamella:

- middle lamella) cements together primary wall of two adjacent cells.
- Mainly pectic in nature but often becomes lignified in older cells (lignin :complex chemical compound, polymer, gives rigidity )

- **The primary cell wall.**

- Thinner than secondary

- Cellulosic microfibrils randomly arranged.

- Found in parenchyma cells in mesophyll of leaf, storage parenchyma of roots and tubers.

- the primary may become thick as in collenchyma cells in stems , leaves and endosperms of some seeds

- thickening because of increase in amount of cellulose and noncellulosic components and water

- **Secondary cell wall:**

- Frequently made of three layers

S1

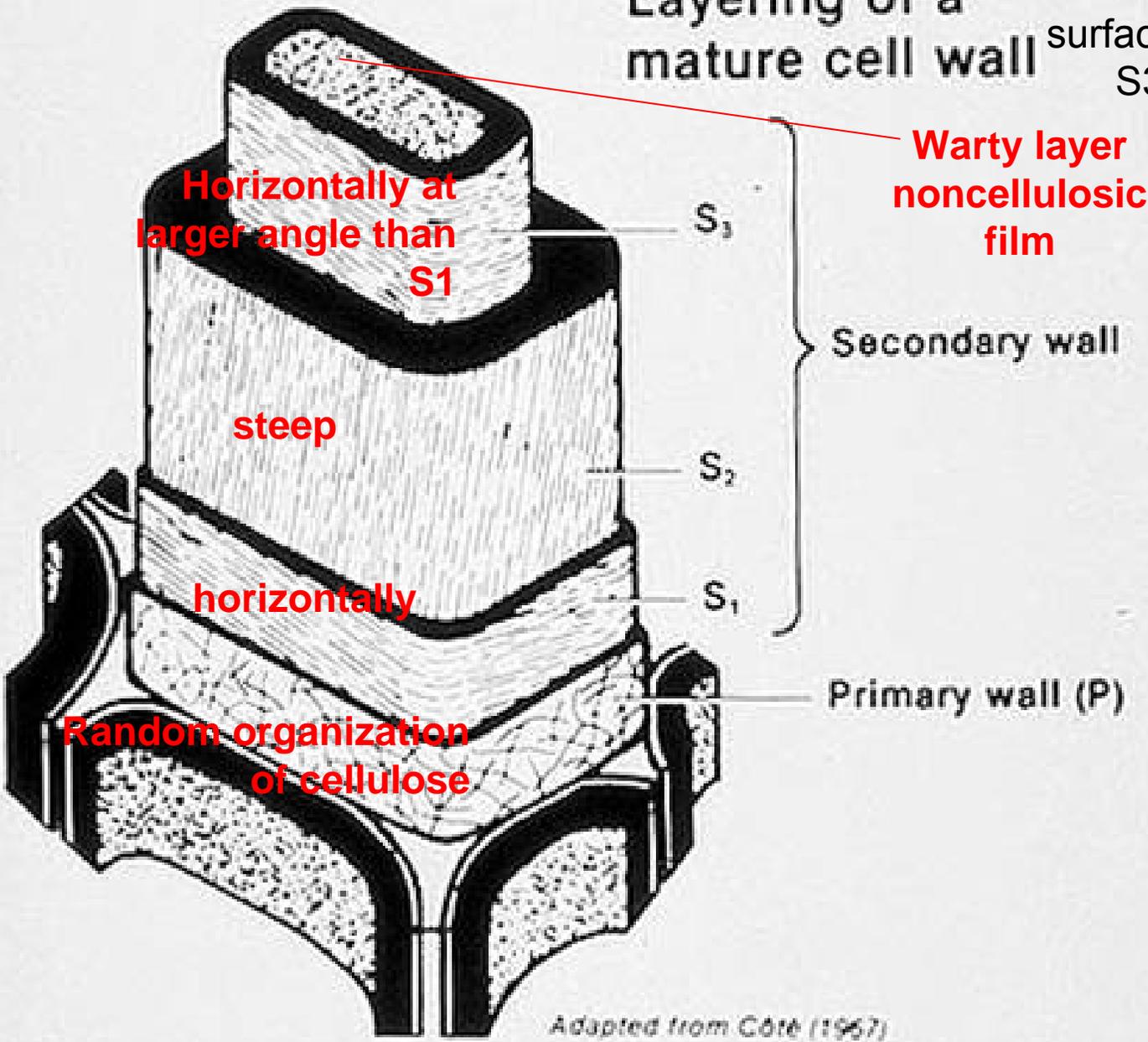
S2: the thickest and

S3: may be very thin or lacking, some times called tertiary wall

- Because the **different orientations of cellulose microfibrils in the three layers** which are **helically oriented but with different slopes**
- impregnated with lignin, which replaces pectin
  - Lignin is Polyphenol that strengthens the wall, makes it waterproof and resistant to decay and animals attack by herbivores,
  - primary walls rarely have lignin

# Layering of a mature cell wall

The inner surface of S3



Horizontally at larger angle than S1

steep

horizontally

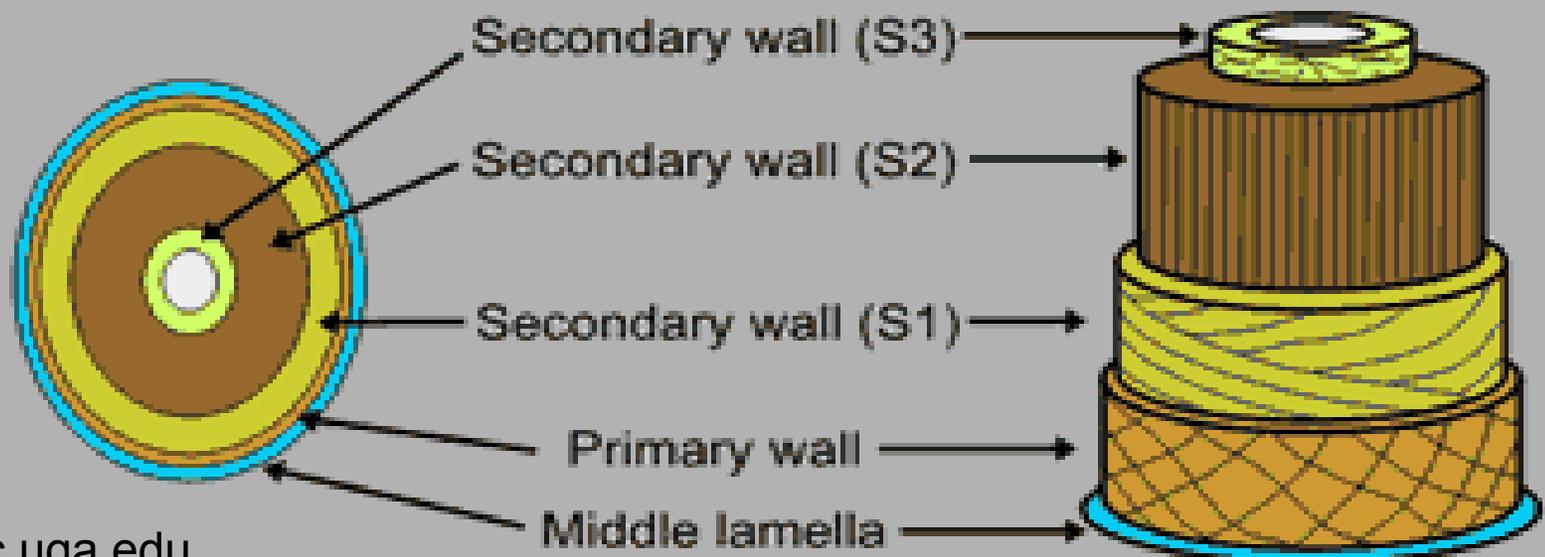
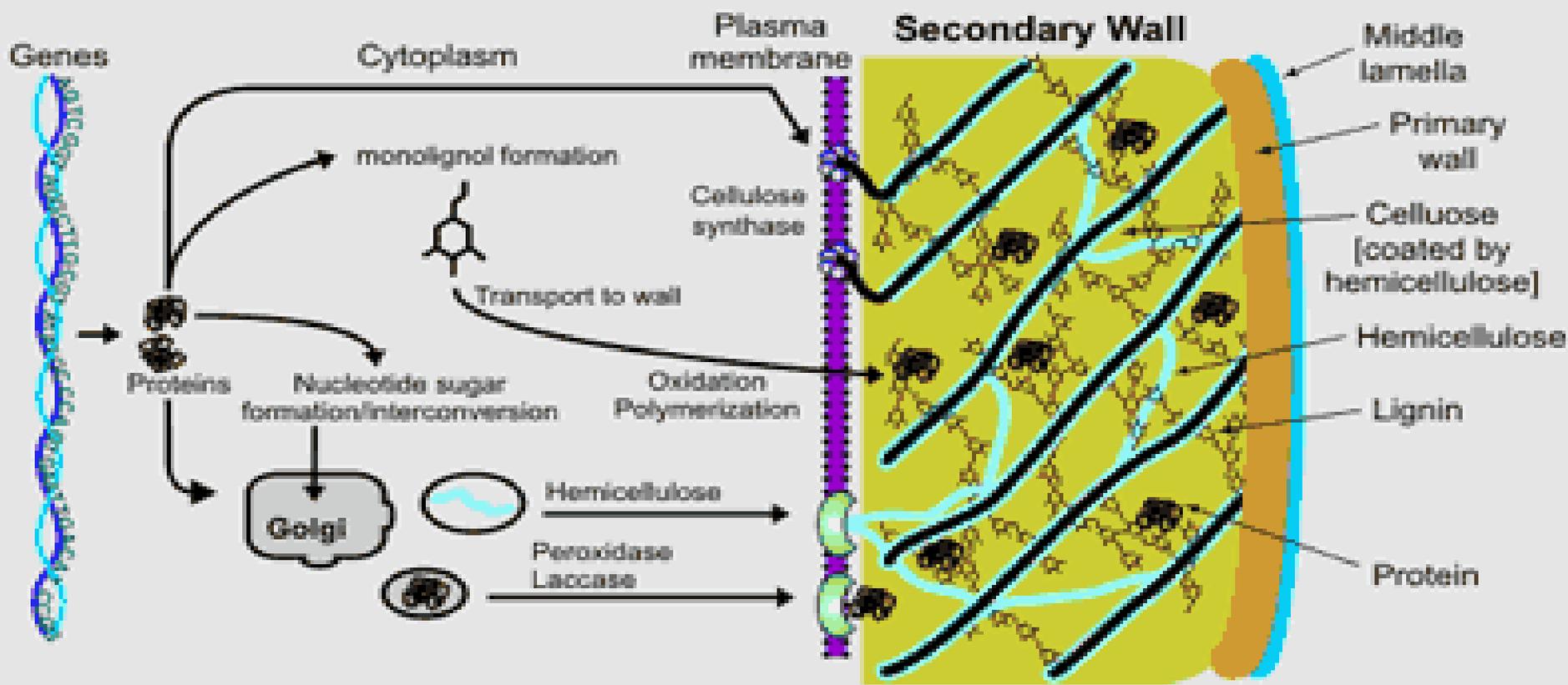
Random organization of cellulose

Warty layer noncellulosic film

Secondary wall

Primary wall (P)

Adapted from Côté (1967)



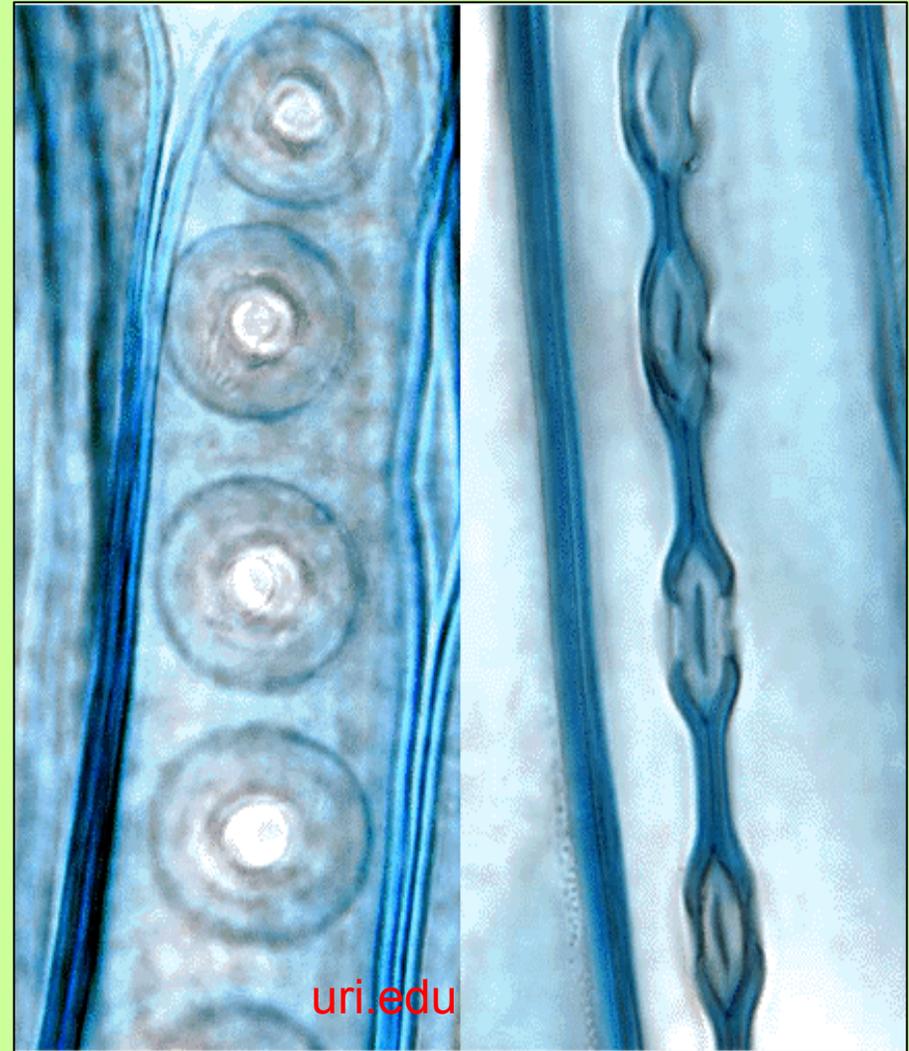
## Intercellular spaces:

- Characteristic of mature tissues, may be found in meristematic tissues (intensive respiration)
- May function as containers for secreted materials
- Are of two types:
  - 1- **Schizogenous**: the most common type develops by separating (using enzymes to remove pectin) the primary wall through the middle lamella, starts in the corner and spreads to other parts.
  - 2- **Lysigenous**: results from a breakdown of entire cells. Occurs in some roots

- **Pits:**

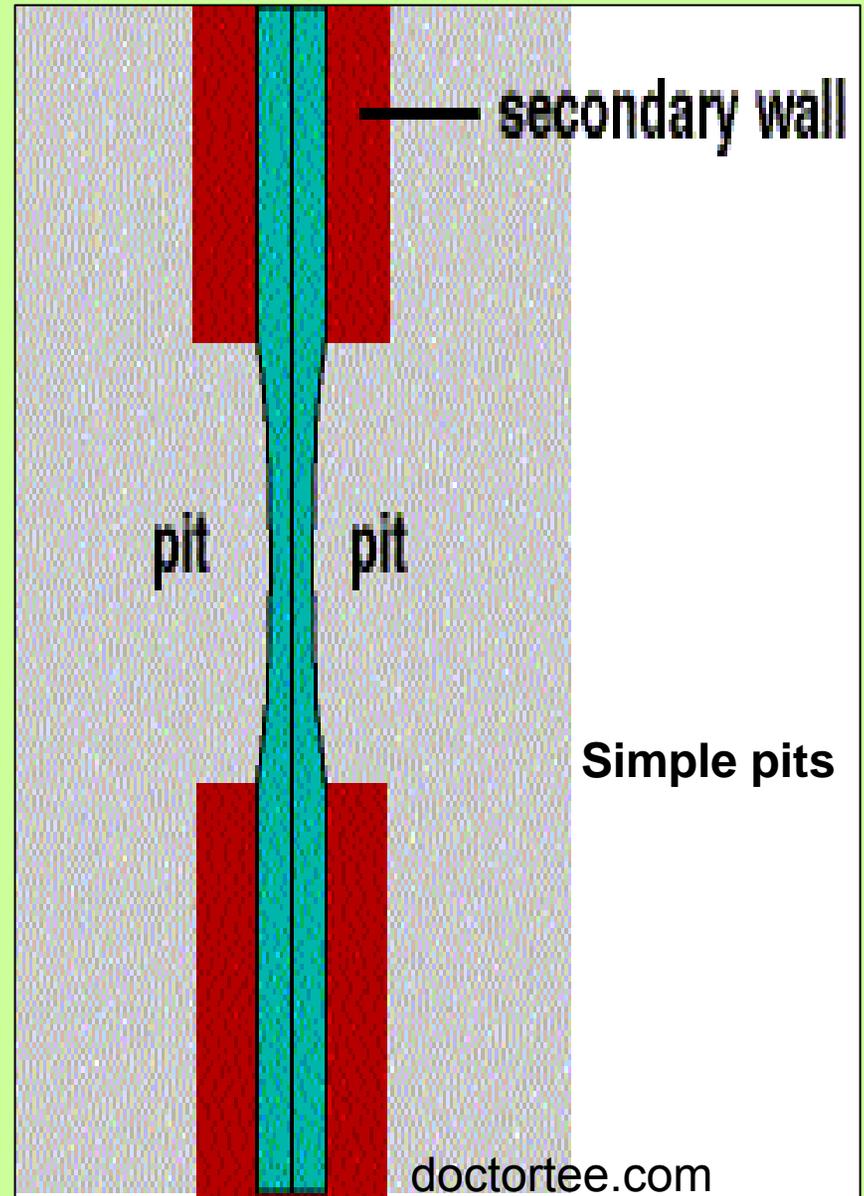
Depression  
occurs in  
secondary cell  
wall

(opening in  
secondary cell  
wall)



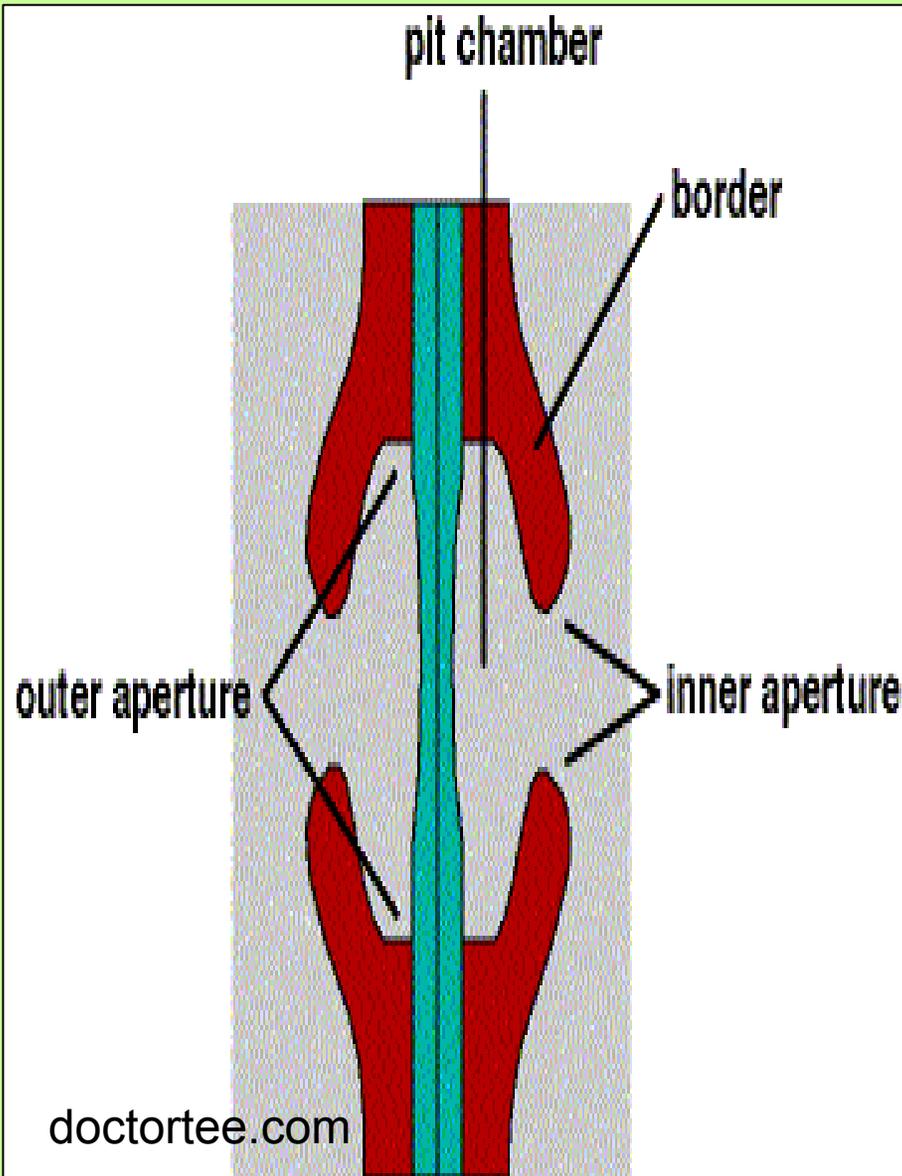
- **Types of pits**
- **Simple pits**

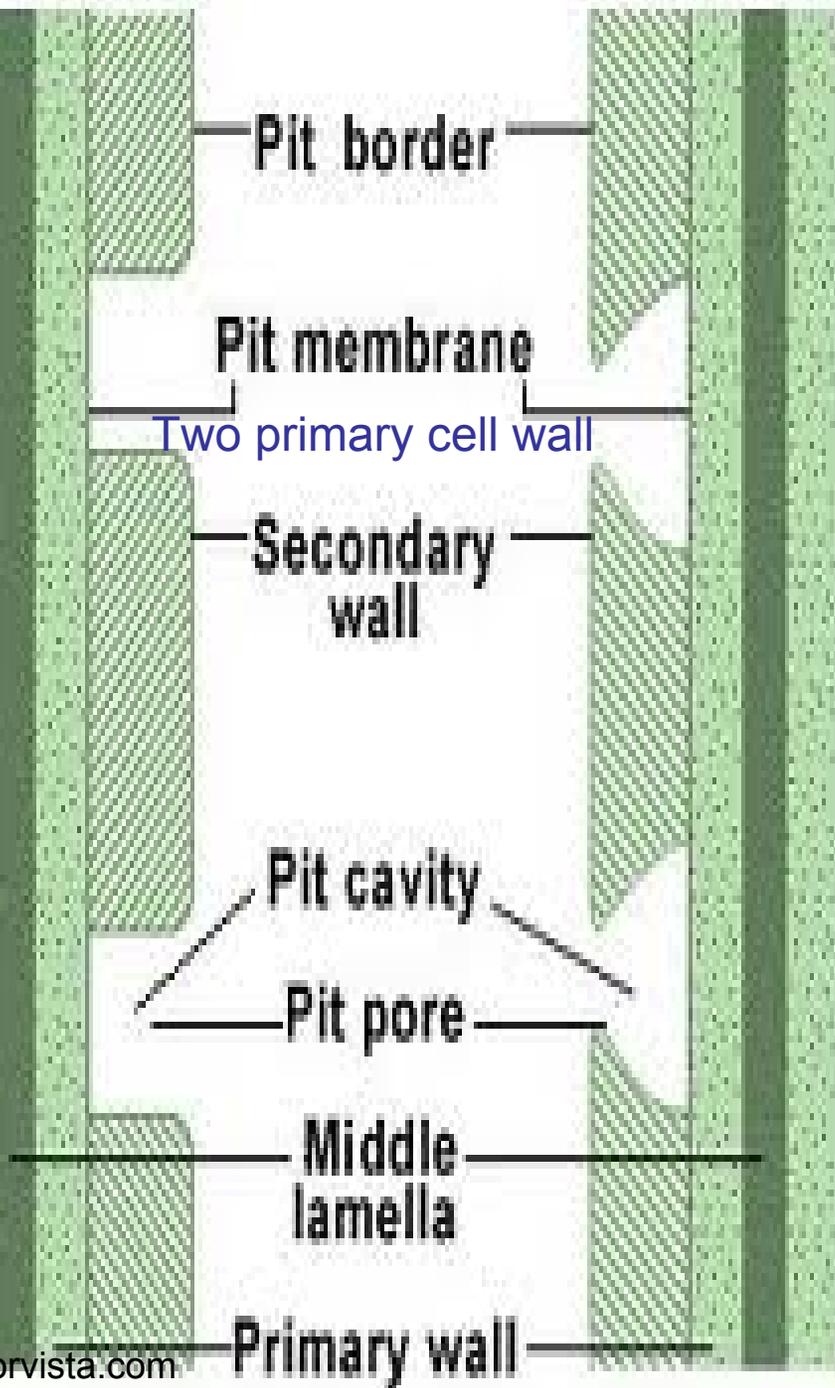
pit cavity remains of same diameter



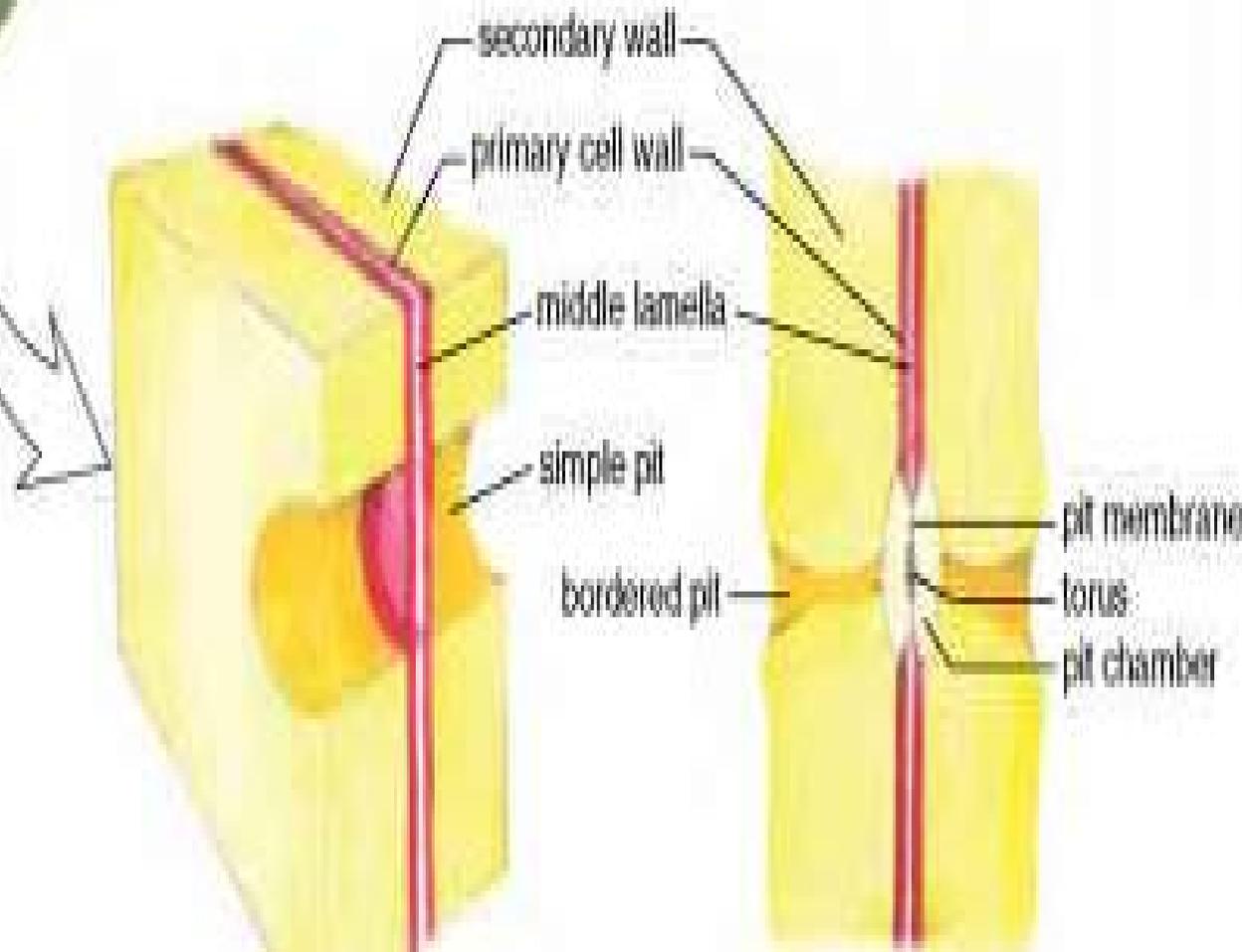
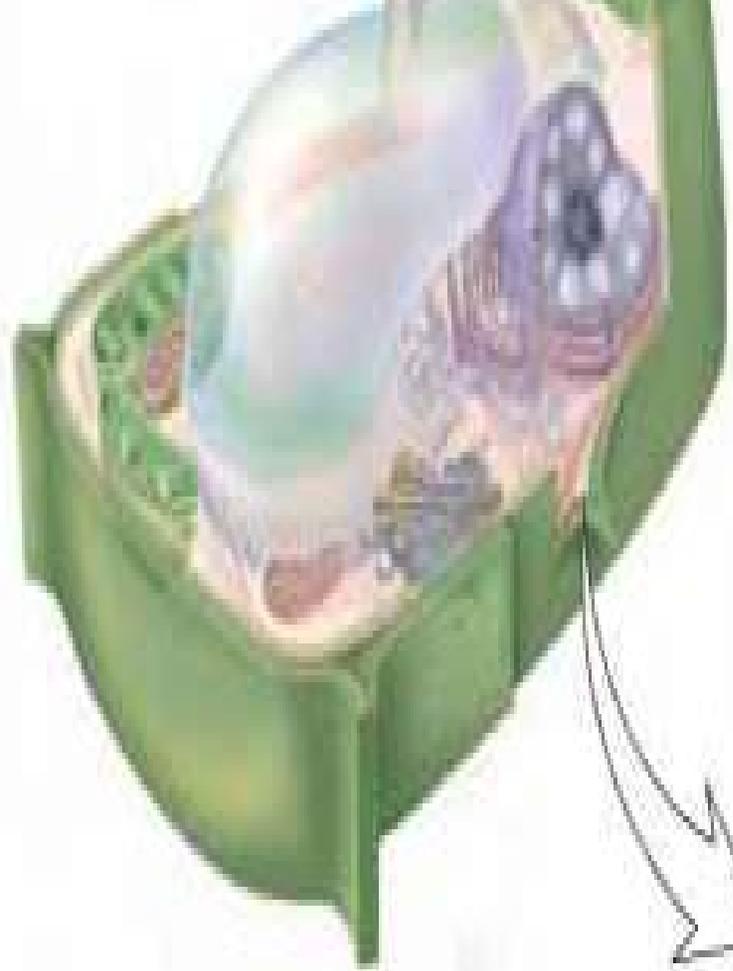
- **Bordered pit  
(bordered pit pair)**

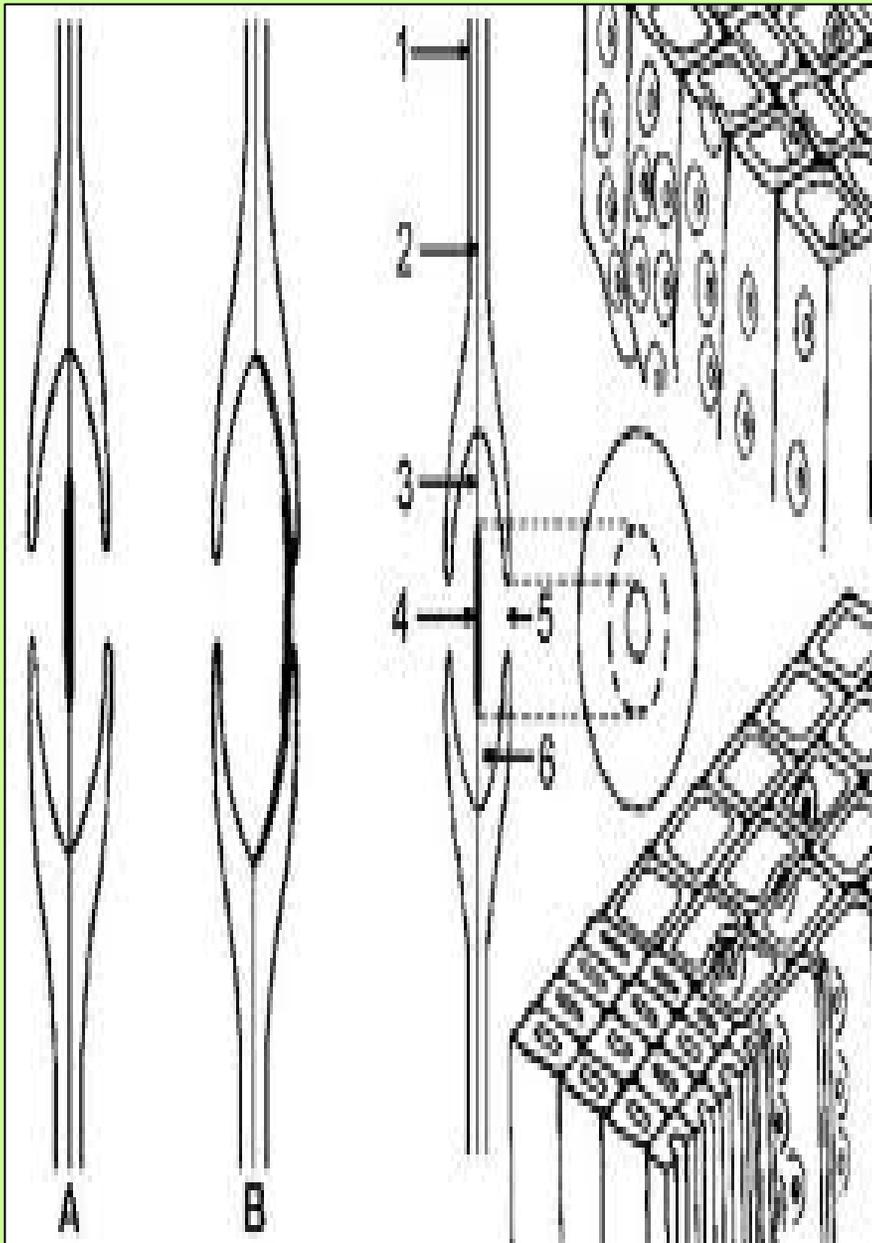
More complex,  
secondary wall  
arches over forming  
a *pit chamber*. In  
face view, this area  
appears as a *border*  
around the inner  
aperture.



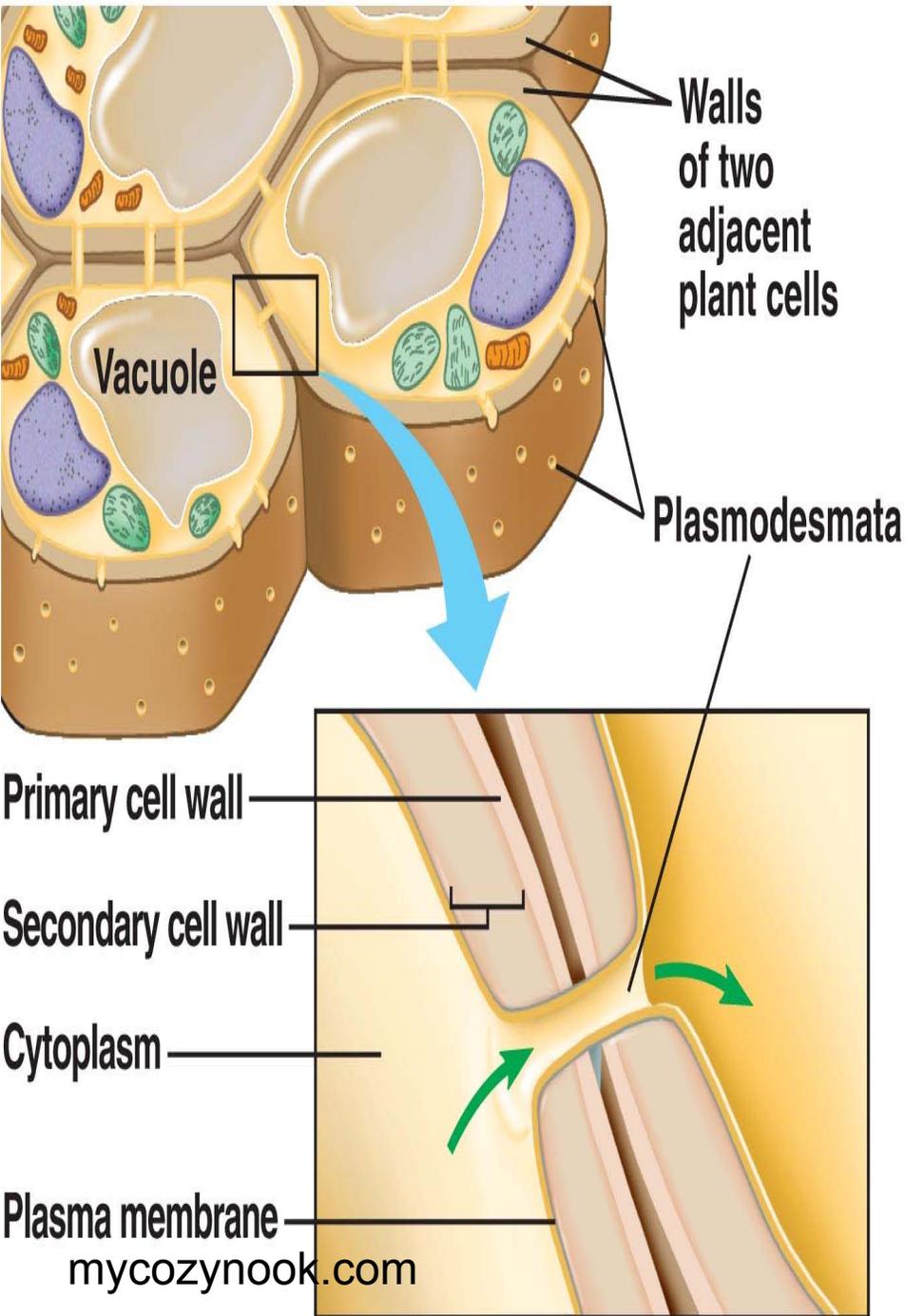


- **Pit pairs:** pits of two adjacent cells oppose one another.
- Pits results during formation of secondary cell wall due differential deposition of the wall material.





- **Primary pits:**  
Depression formed in primary cell wall

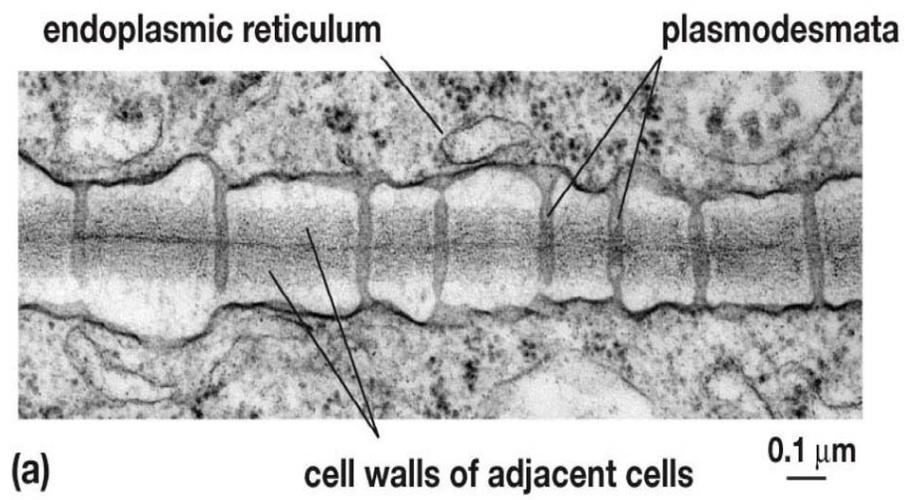


- **Plasmodesmata (plasmodesma):**

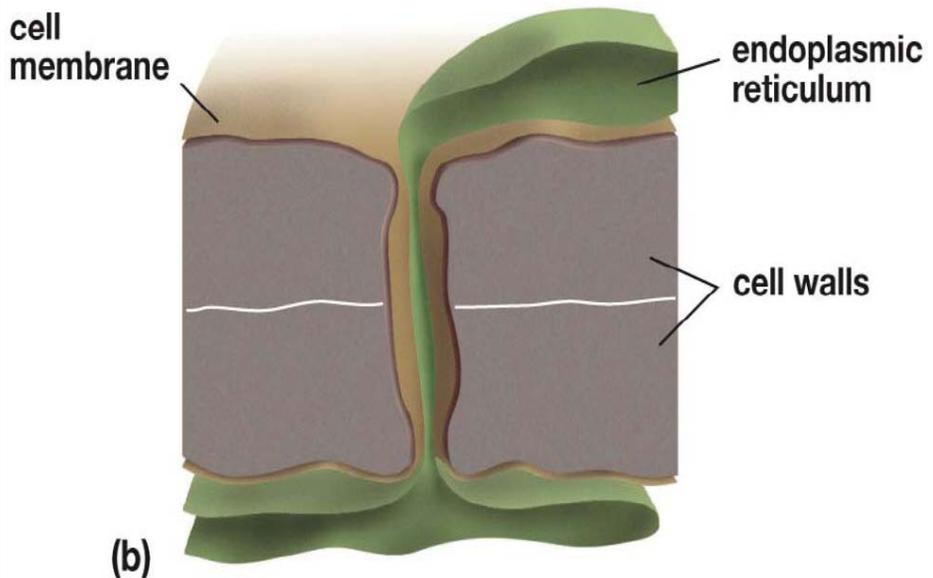
- Basically holes in the middle lamella and primary wall lined with plasma membrane
- Cannels in the cell wall lined with plasma membrane
- provides connection between adjacent cells
- May occur in pits
- May be branched

- **Growth of cell wall**
- Laid down during cytokinesis when cell plate is formed.
- **Phragmoplast** – an assemblage of microtubules extending between two daughter nuclei (spindle microtubules)
  - guide Golgi vesicles to cell plate where they fuse
  - Begins in middle and works outwardly
- Vesicles fuse releasing pectins (middle lamella and forming plasmalemma in both cells)

- **plasmodesmata** formed when fusion of vesicles into cell plate leaving gaps, gaps may trapped ER tubules
- Golgi vesicles add pectin and hemicellulose



(a)



(b)

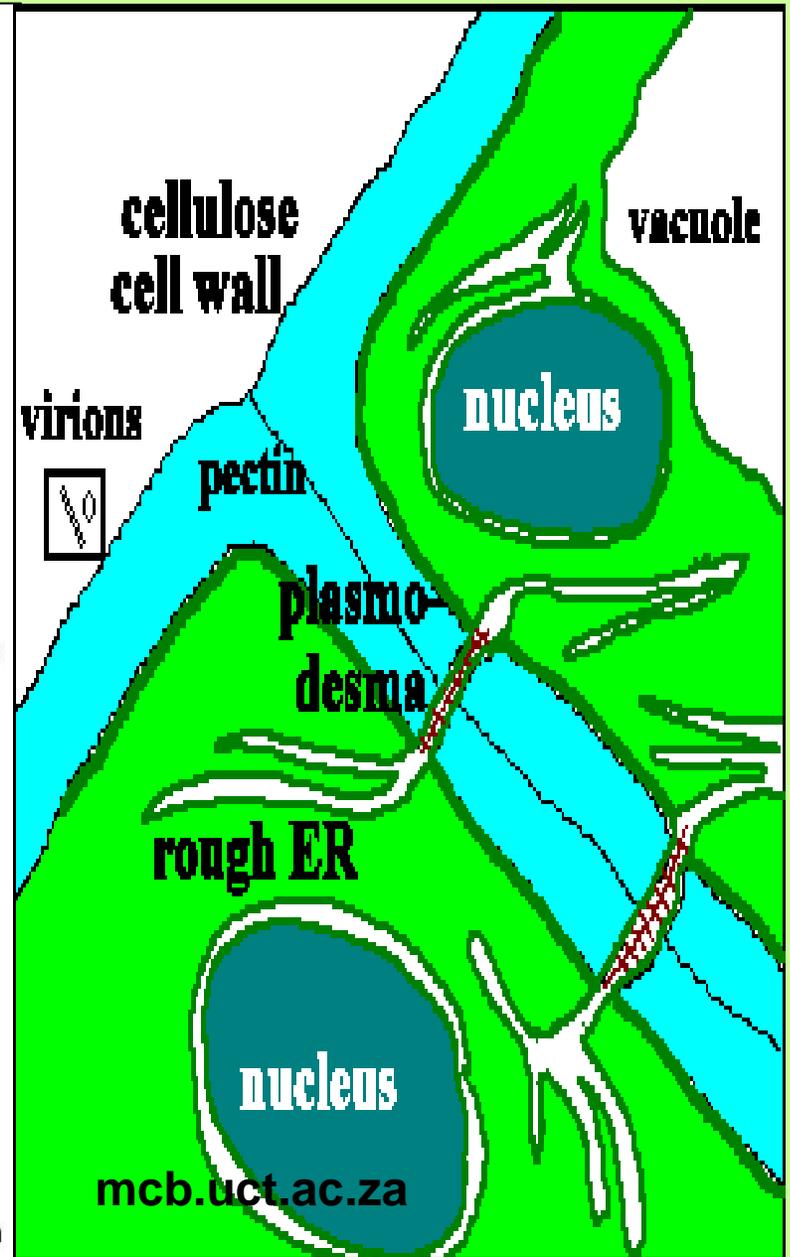
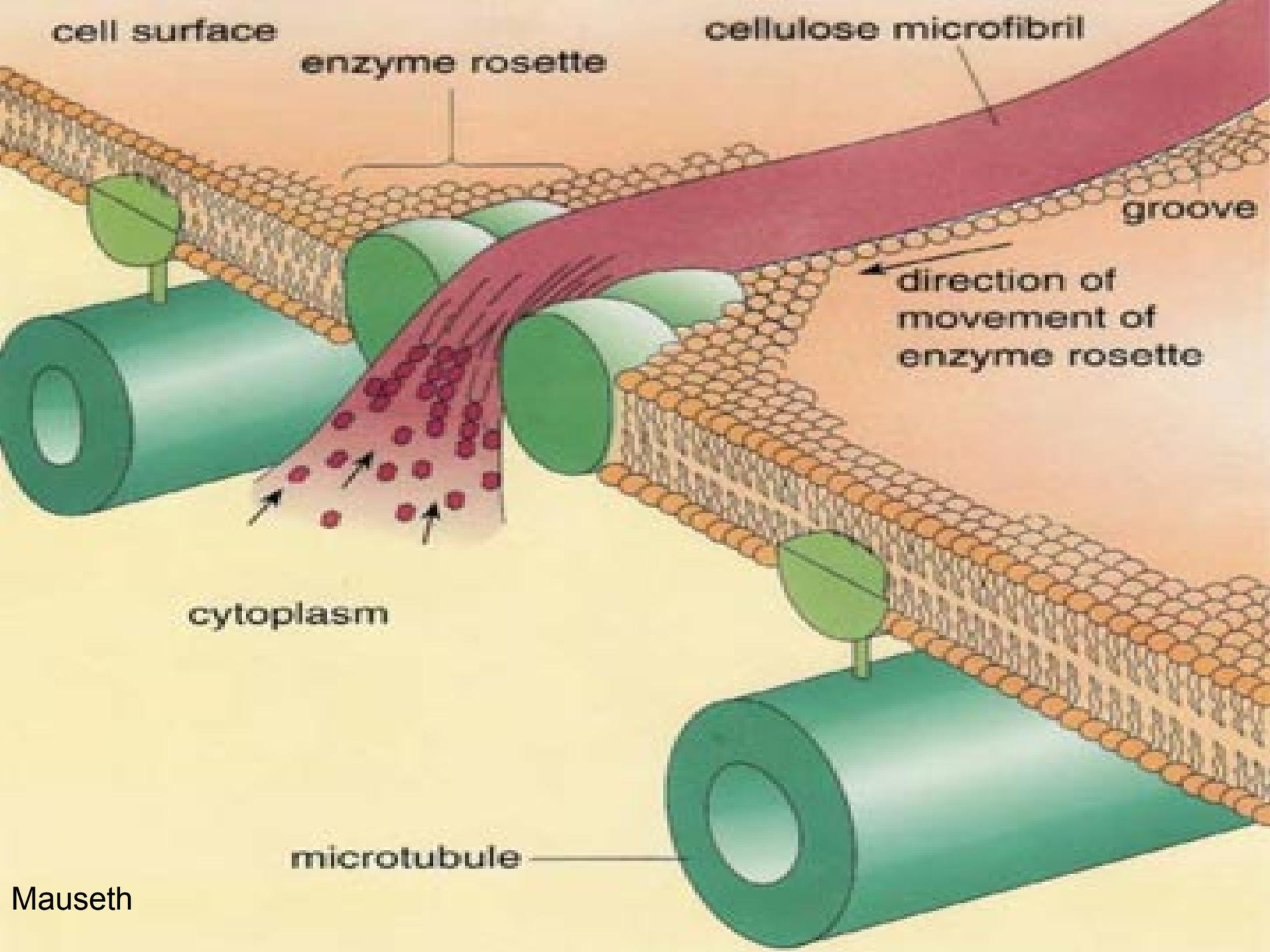


Figure 4.26 Plant Biology, 2/e

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- Walls grow from the outside in.
- New wall materials are deposited immediately outside membrane.
- Microfibrils are synthesized by **rosettes**: cellulose synthase which reside on a cell's membrane
- As cellulose fibrils are synthesized and grow extracellularly they push up against neighboring cells. Since the neighboring cell can not move easily the rosette complex is instead pushed around the cell through the fluid phospholipid membrane.



- Growth in thickness of walls is evident in secondary wall as well as primary walls.
- Occurs by deposition of wall material layer after layer, it occurs from outside to inside.