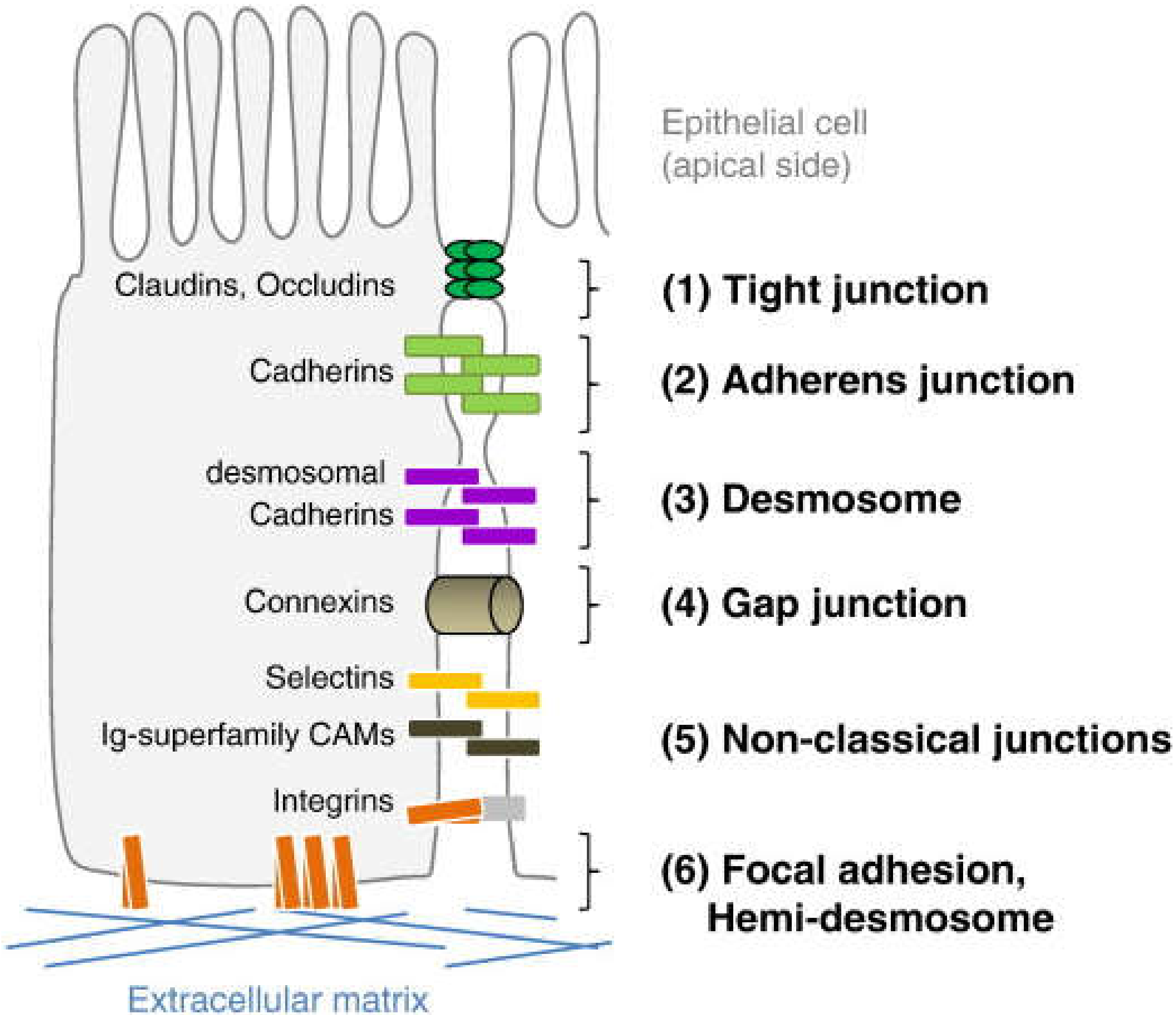
# CELL- CELL INTERACTION



**Cell adhesion molecules (CAMs) and junctional complexes are abundant in epithelial tissues.**

(1) Tight junctions build a seal between adjacent cells and are connected to actin filaments.

(2) Adherens junctions are plaques of classical cadherins linked to the actin cytoskeleton.

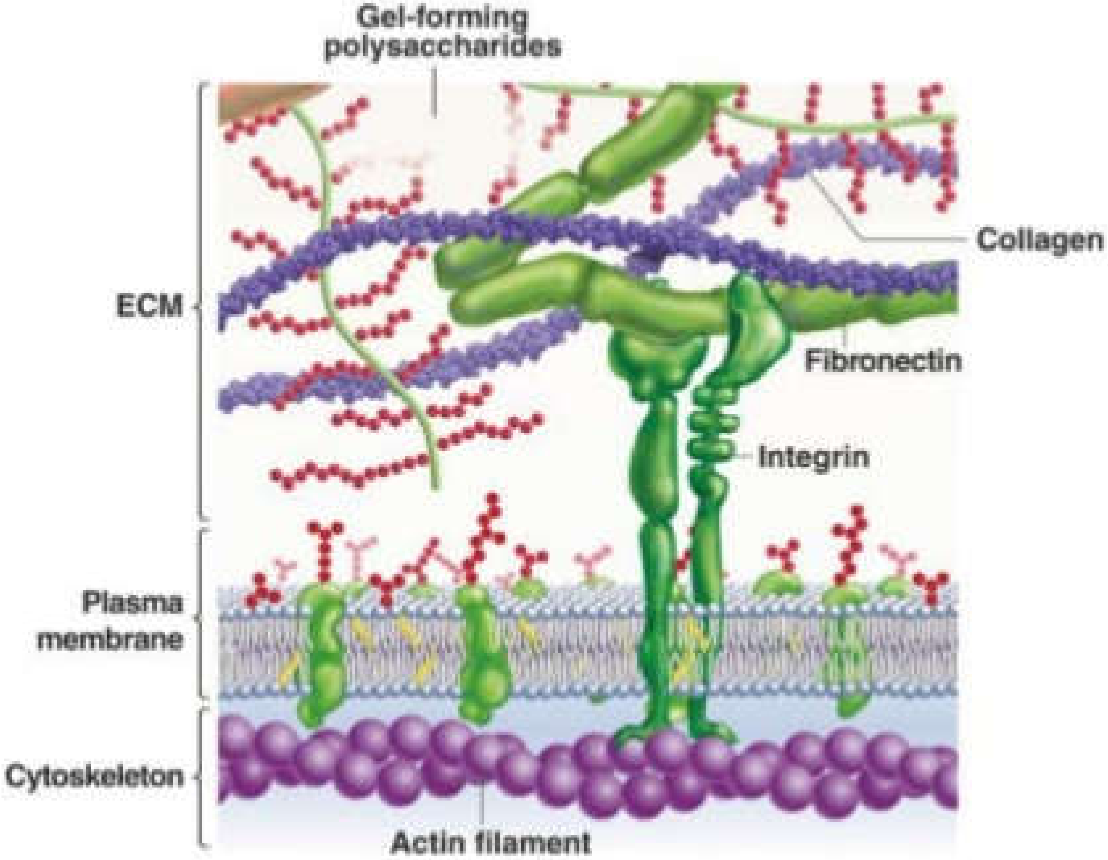
(3) Desmosomes are formed by desmosomal cadherins, linked to intermediate filaments.

(4) Gap junctions connect the cytoplasm of two adjacent cells and are linked to microfilaments.

(5) Selectins, Ig-superfamily CAMs, but also other CAMs not belonging to the classical families can promote homophilic adhesion outside of junctions. Integrins bind in a heterophilic manner.

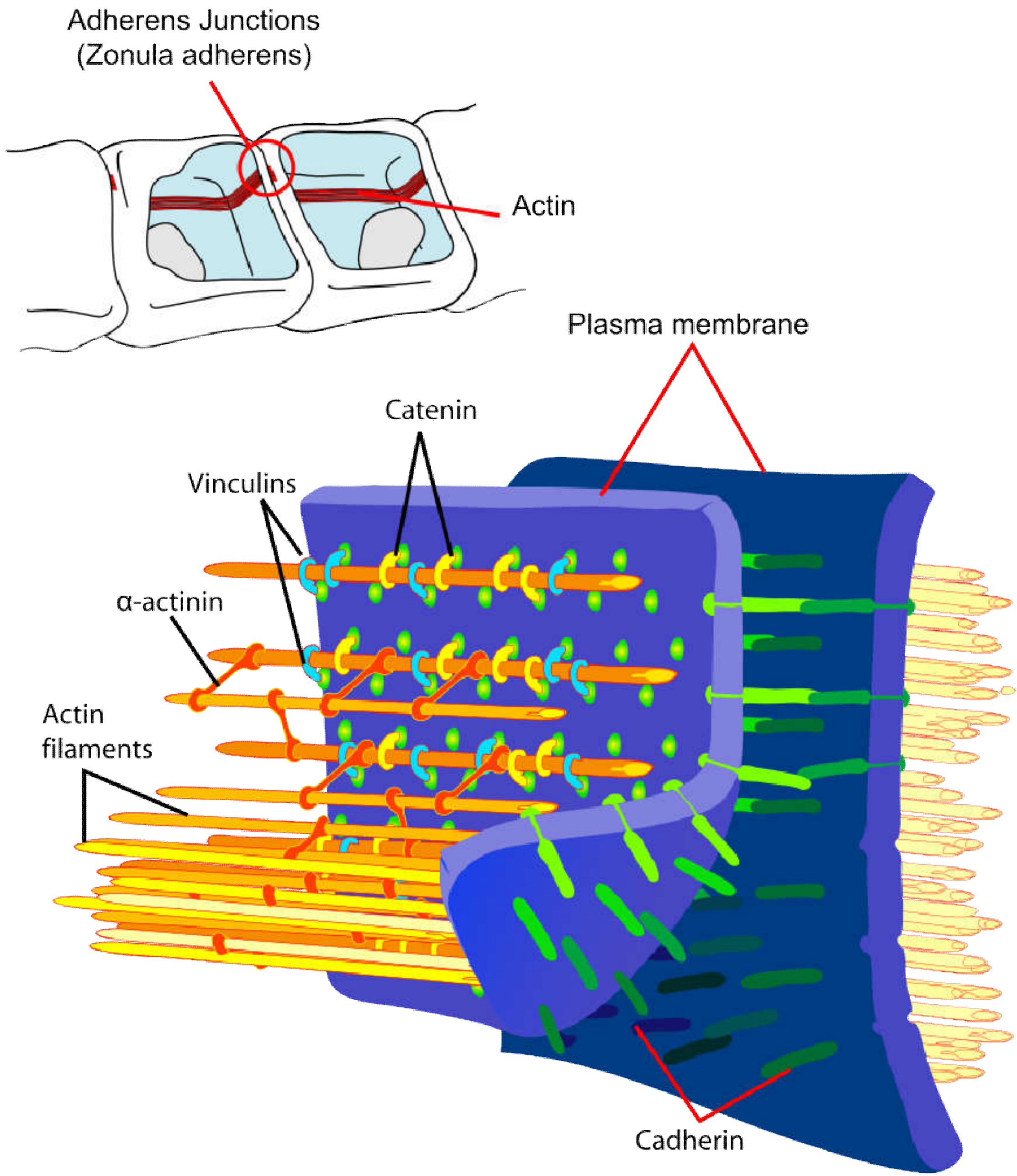
(6) Focal adhesions (linked to actin) and hemi-desmosomes (linked to intermediate filaments) are cell–matrix junctions that are formed by integrins.

# The Extracellular Matrix (ECM)




- Specifically, actin filaments are linked to transmembrane proteins called integrins, which are linked to proteins (e.g. fibronectins and laminins) which are linked to collagen proteins.

# ADHERENS JUNCTION

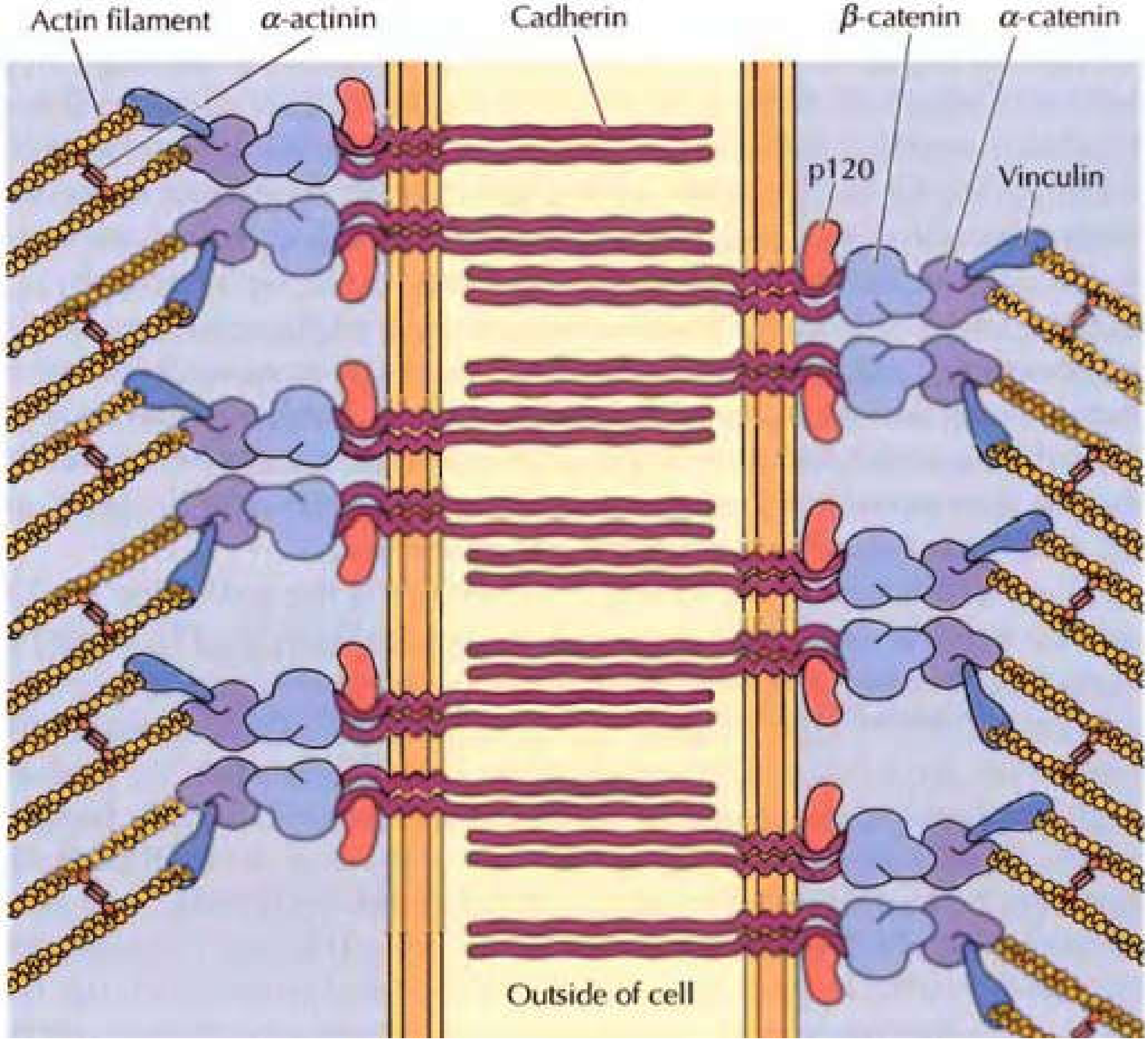


**THE JUNCTION appear as bands encircling the cell (zonula adherens) or as spots of attachment to the extracellular matrix (adhesion plaques). Adherens junctions uniquely disassemble in uterine epithelial cells to allow the blastocyst to penetrate between epithelial cells**

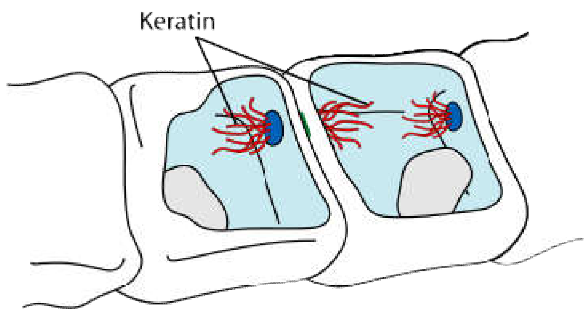
## Proteins involved in junction formation

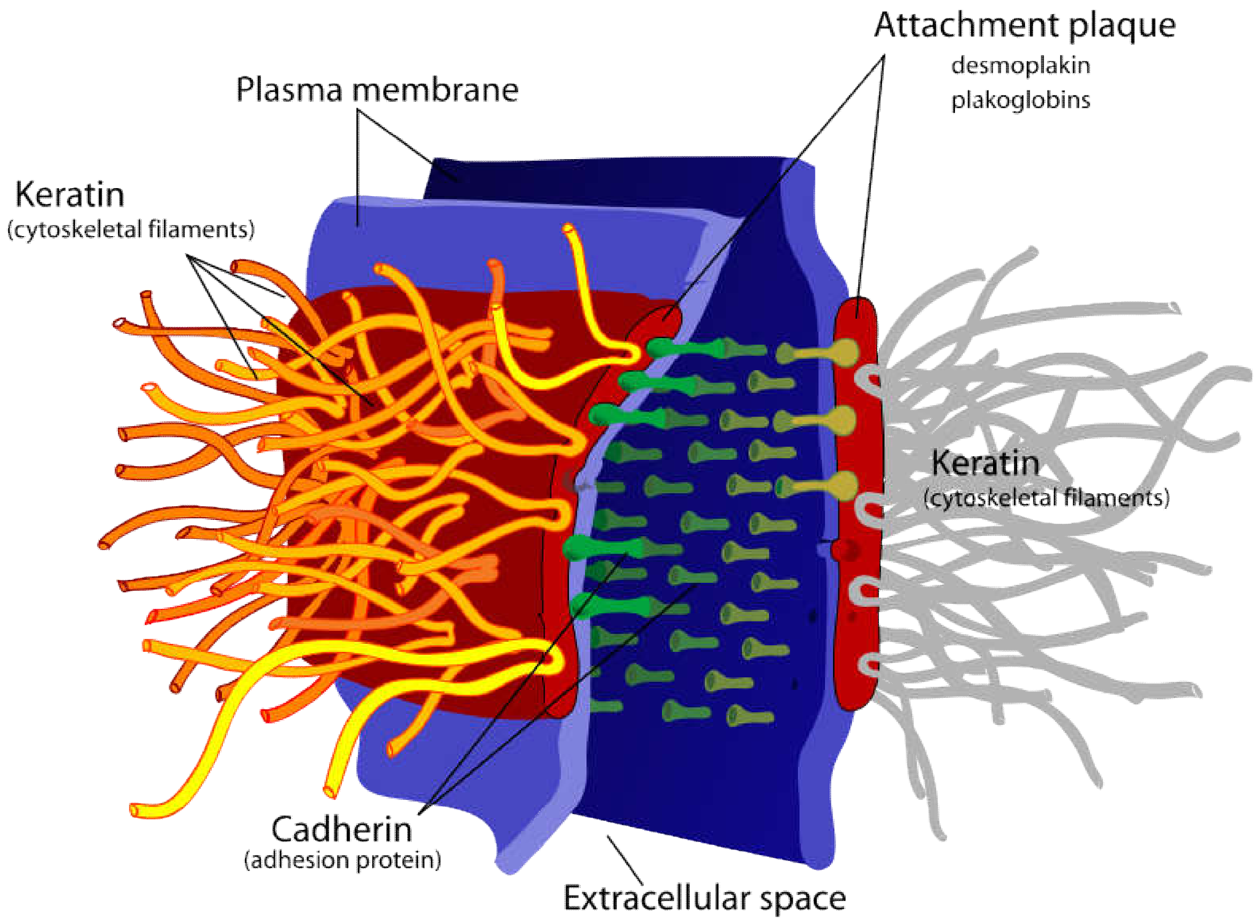
Adherens junctions are composed of the following proteins:

- Cadherins The cadherins are a family of transmembrane proteins that form homodimers in a calcium-dependent manner with other cadherin molecules on adjacent cells.
- p120 (sometimes called delta catenin) binds the juxtamembrane region of the cadherin.
- γ-catenin or gamma-catenin (plakoglobin) binds the catenin-binding region of the cadherin.
- α-catenin or alpha-catenin binds the cadherin indirectly via βcatenin or plakoglobin and links the actin cytoskeleton with cadherin

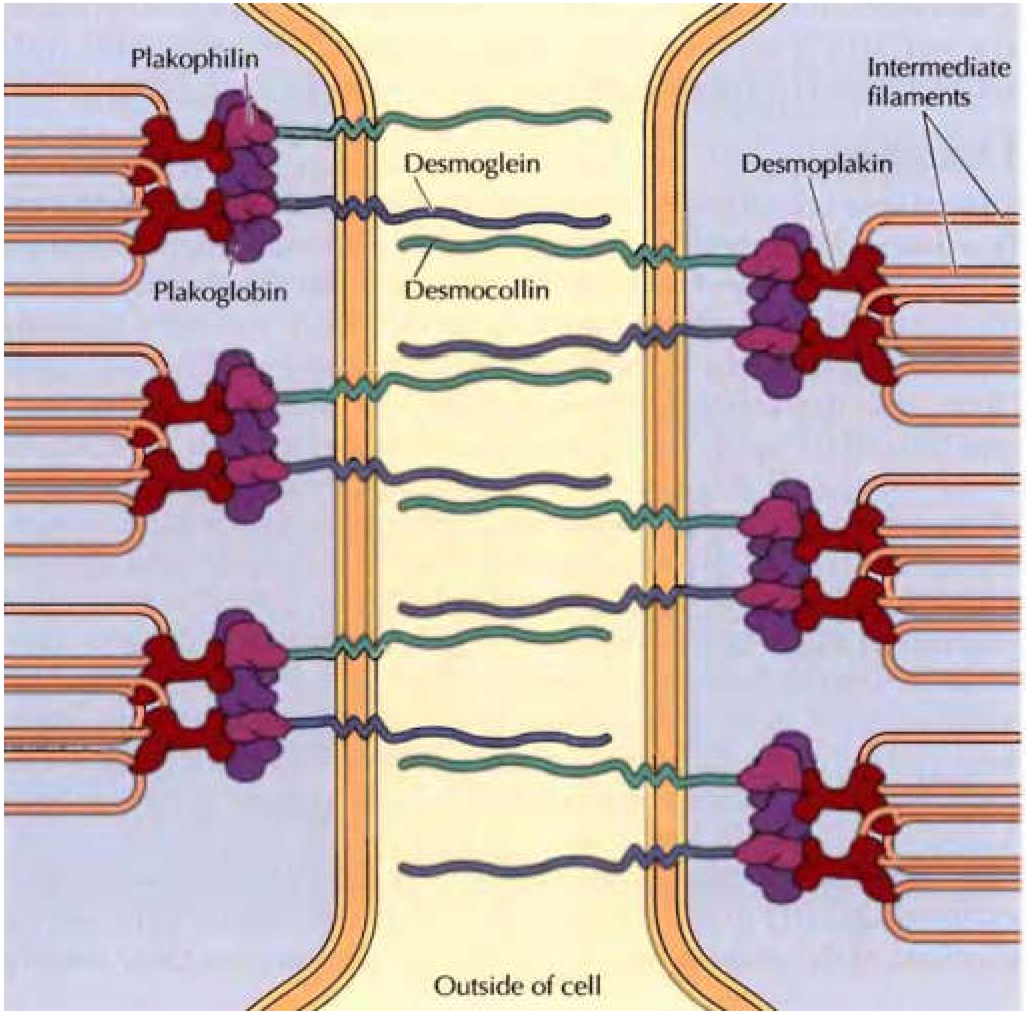

Actin filament
α-actinin
Cadherin
β-catenin
α-catenin
p120
Vinculin
Outside of cell

# DESMOSOME JUNCTION



**Desmosome** also known as a **macula adherens** is a cell structure specialized for cell-to-cell adhesion . A type of junctional complex, they are localized spot-like adhesions randomly arranged on the lateral sides of plasma membranes. Desmosomes are one of the stronger cell-to-cell adhesion types and are found in tissue that experience intense mechanical stress, such as cardiac muscle tissue, bladder tissue, gastrointestinal mucosa, and epithelia



# TIGHT JUNCTIONS

The multiprotein junctional complexes whose general function is to prevent leakage of transported solutes and water and seals the **paracellular pathway**.

Epithelia are sheets of cells that provide the interface between masses of cells and a cavity or space (a lumen).

The portion of the cell exposed to the lumen is called its **apical** surface.

The rest of the cell (i.e., its sides and base) make up the **basolateral** surface.

Tight junctions seal adjacent epithelial cells in a narrow band just beneath their apical surface. They consist of a network of **claudins** and other proteins.

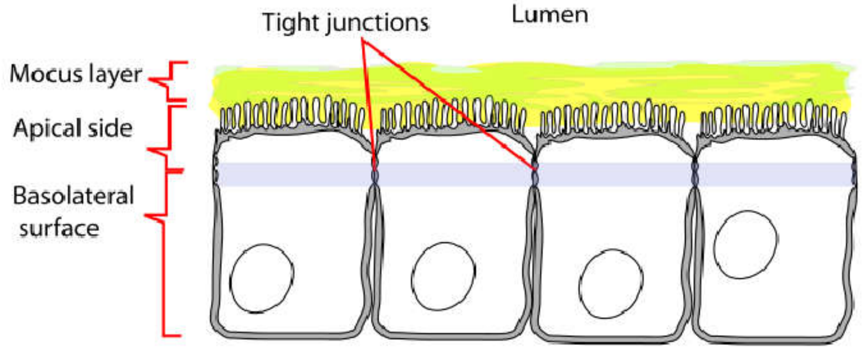
***Tight junctions perform two vital function***

•They limit the passage of molecules and ions through the space between cells. So most materials must actually enter the cells (by diffusion or active transport) in order to pass through the tissue. This pathway provides tighter control over what substances are allowed through.

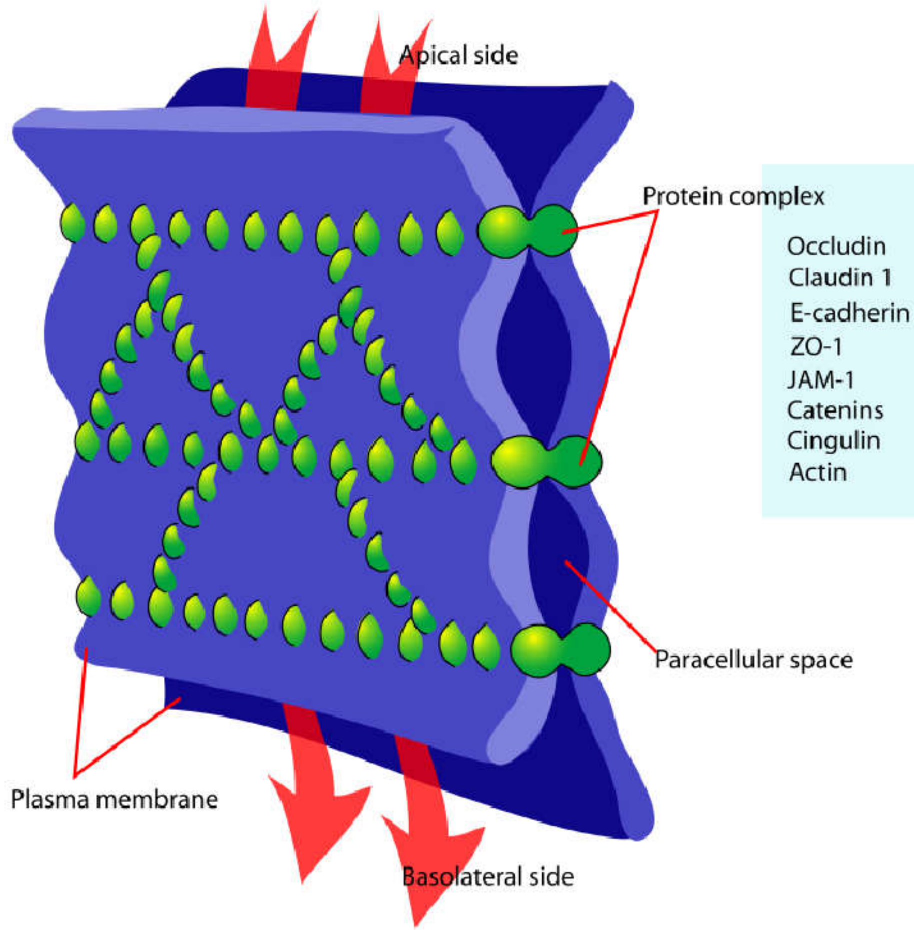
•They block the movement of integral membrane proteins (red and green ovals) between the apical and basolateral surfaces of the cell. Thus the special functions of each surface, for example

Receptor-mediated endocytosis at the apical surface

Exocytosis at the basolateral surface can be preserved.



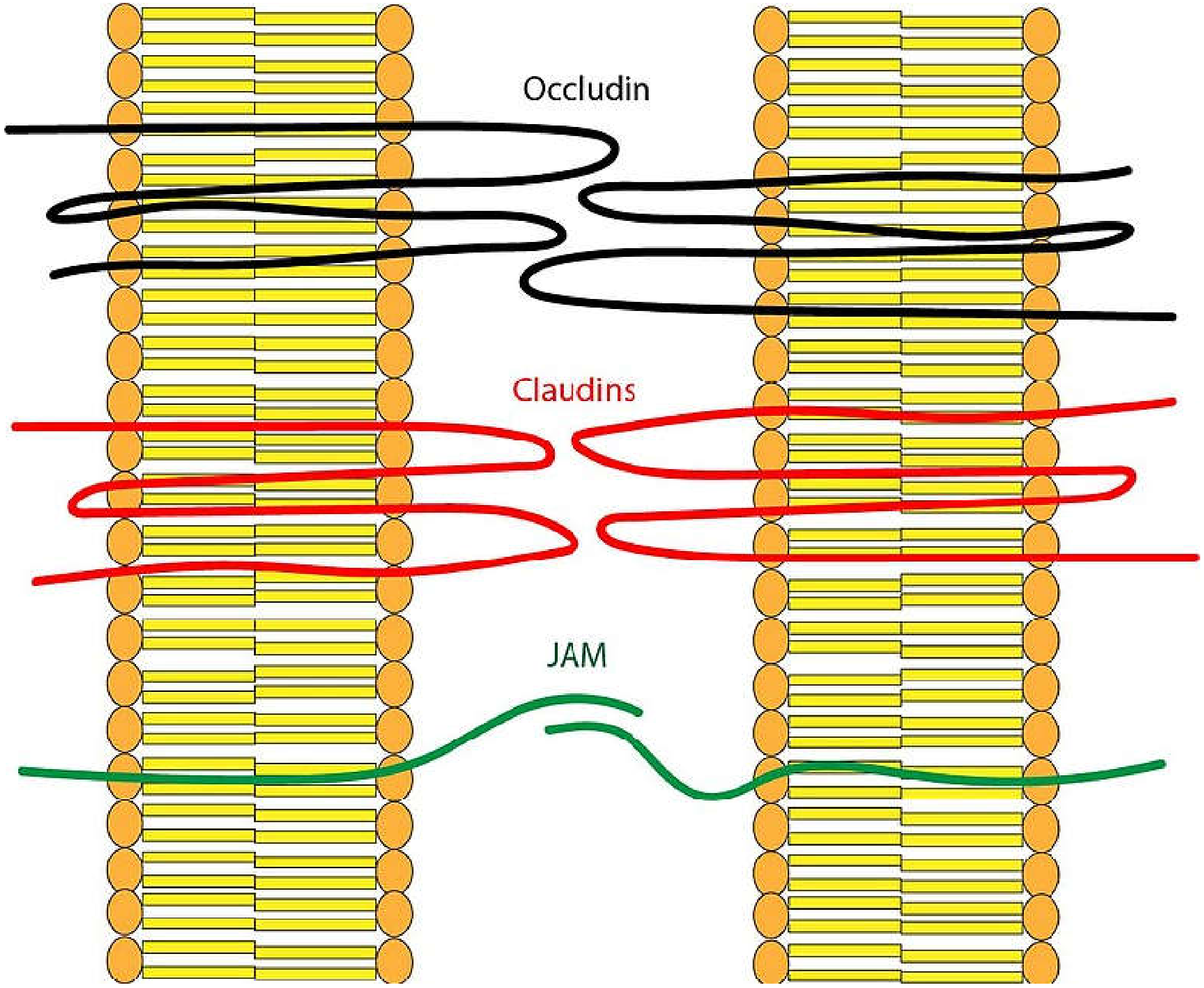
Tight junctions
Lumen
Mocus layer
Apical side
Basolateral
surface

Apical side
Protein complex
Occludin
Claudin 1
E-cadherin
ZO-1
JAM-1
Catenins
Cingulin
Actin
Paracellular space
Plasma membrane
Basolateral side

Tight junctions are composed of a **branching network of sealing strands**, each strand acting independently from the others. Therefore, the efficiency of the junction in preventing ion passage increases exponentially with the number of strands.

Each strand is formed from a row of transmembrane proteins embedded in both plasma membranes, with extracellular domains joining one another directly. There are at least **40 different proteins** composing the tight junctions



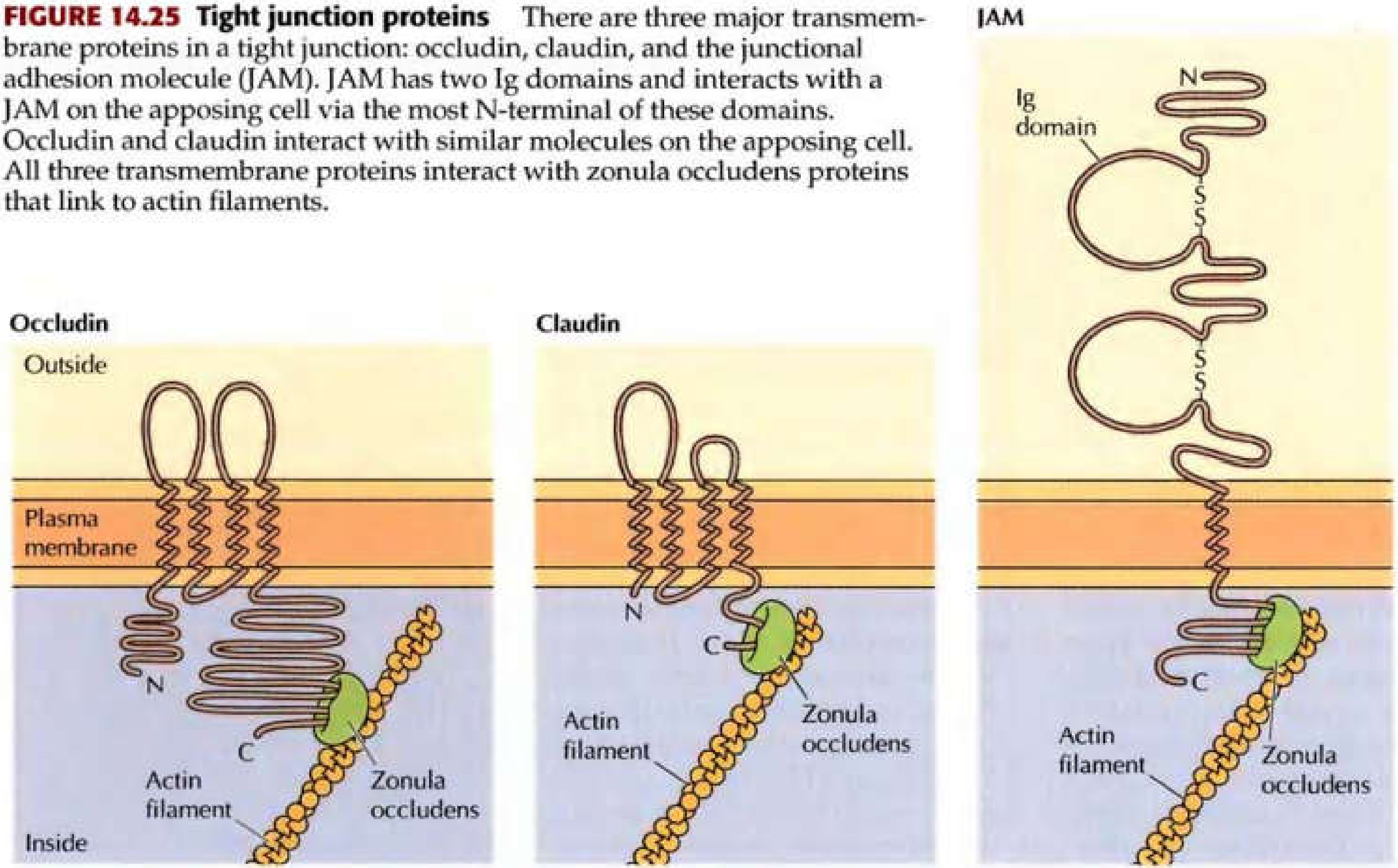
# Transmembrane proteins:

•**Occludin** was the first integral membrane protein to be identified. It has a molecular weight of ~60kDa. It consists of four transmembrane domains and both the N-terminus and the C-terminus of the protein are intracellular. It forms two extracellular loops and one intracellular loop. These loops help regulate paracellular permeability. Occludin also plays a key role in cellular structure and barrier function.

•**Claudins** were discovered after occludin and are a family of 24 different mammalian proteins.They have a molecular weight of ~20kDa. They have a structure similar to that of occludin in that they have four transmembrane domains and similar loop structure. They are understood to be the backbone of tight junctions and play a significant role in the tight junction's ability to seal the paracellular space. Different claudins are found in different locations throughout the human body.

•**Junction Adhesion Molecules (JAM**) are part of the immunoglobulin superfamily. They have a molecular weight of ~40kDa. Their structure differs from that of the other integral membrane proteins in that they only have one transmembrane protein instead of four. It helps to regulate the paracellular pathway function of tight junctions and is also involved in helping to maintain cell polarity.

**FIGURE 14.25 Tight junction proteins** There are three major transmembrane proteins in a tight junction: occludin, claudin, and the junctional adhesion molecule (JAM). JAM has two Ig domains and interacts with a JAM on the apposing cell via the most N-terminal of these domains. Occludin and claudin interact with similar molecules on the apposing cell. All three transmembrane proteins interact with zonula occludens proteins that link to actin filaments.



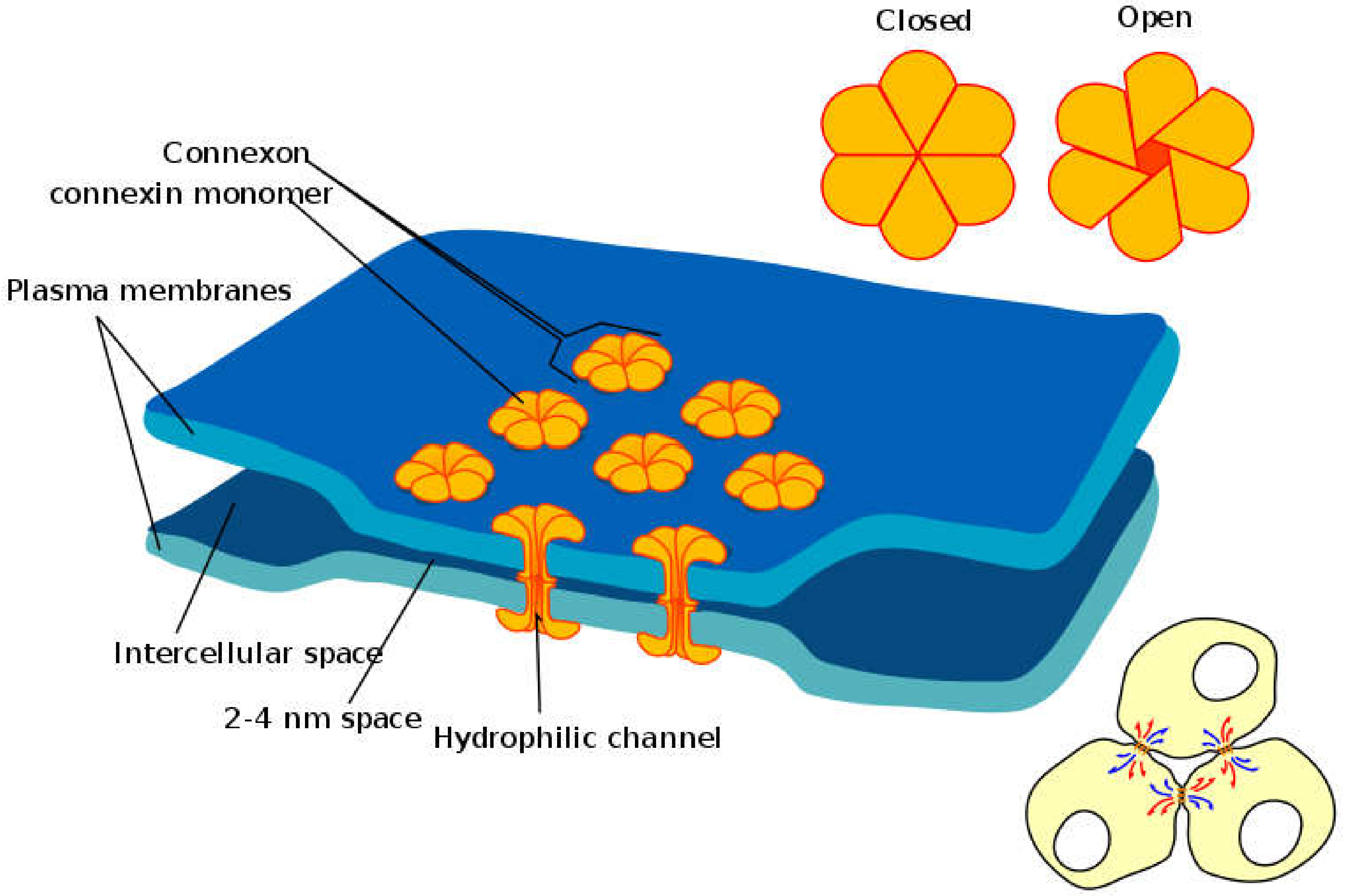
# Gap Junctions

Gap junctions are intercellular channels some 1.5–2 nm in diameter. These permit the free passage between the cells of ions and small molecules (up to a molecular weight of about 1000 daltons).

They are cylinders constructed from 12 copies of transmembrane proteins called **connexins--**6 copies in one cell juxtaposed with 6 in the connecting cell. Because ions can flow through them, gap junctions permit changes in membrane potential to pass from cell to cell.

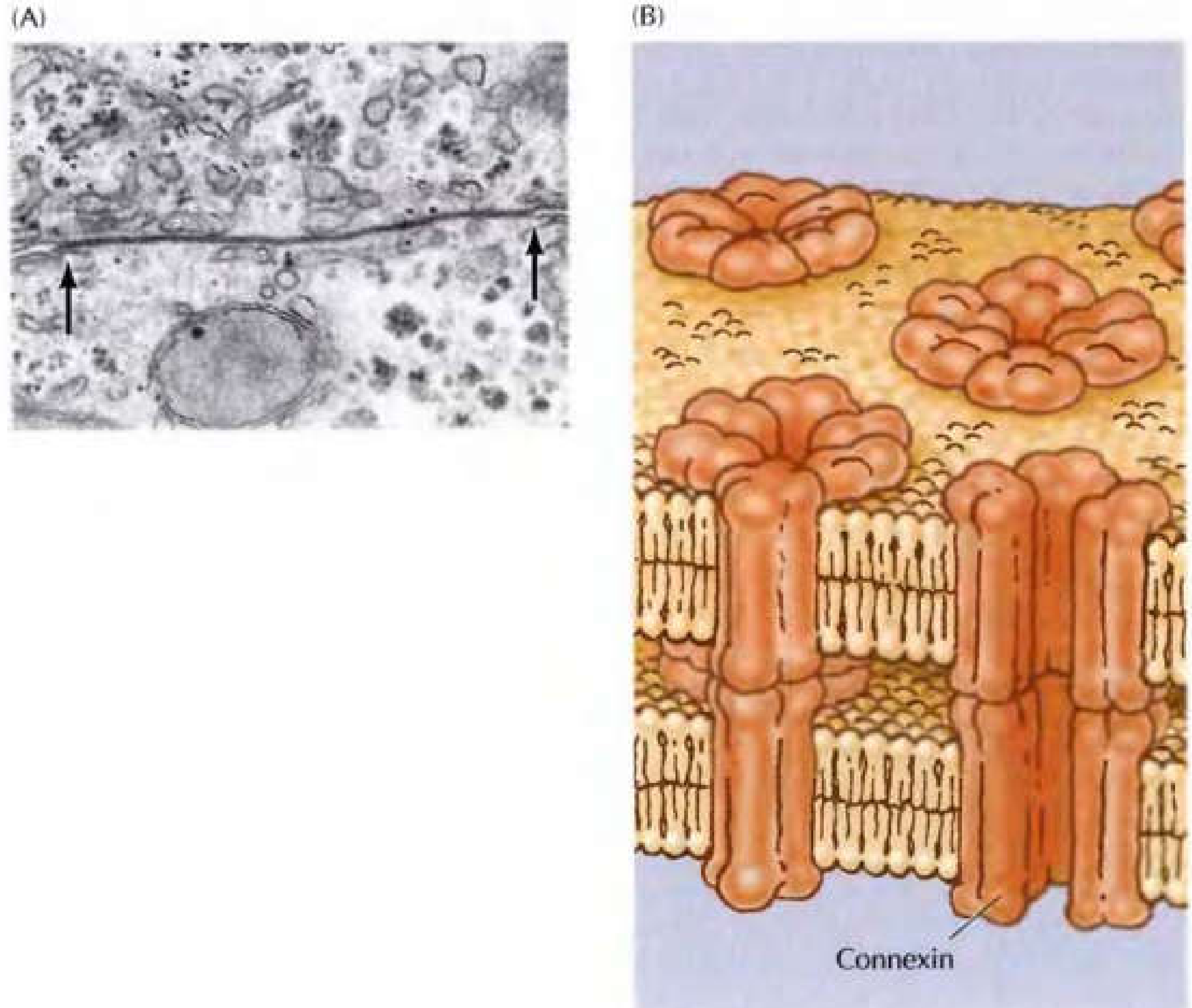
**Examples:** The action potential in heart (cardiac) muscle flows from cell to cell through the heart providing the rhythmic contraction of the heartbeat.
At some so-called electrical synapses in the brain, gap junctions permit the arrival of an action potential at the synaptic terminals to be transmitted across to the postsynaptic cell without the delay needed for release of a neurotransmitter.

**Gap junctions are analogous to the Plasmodesmata that join plant cells.**

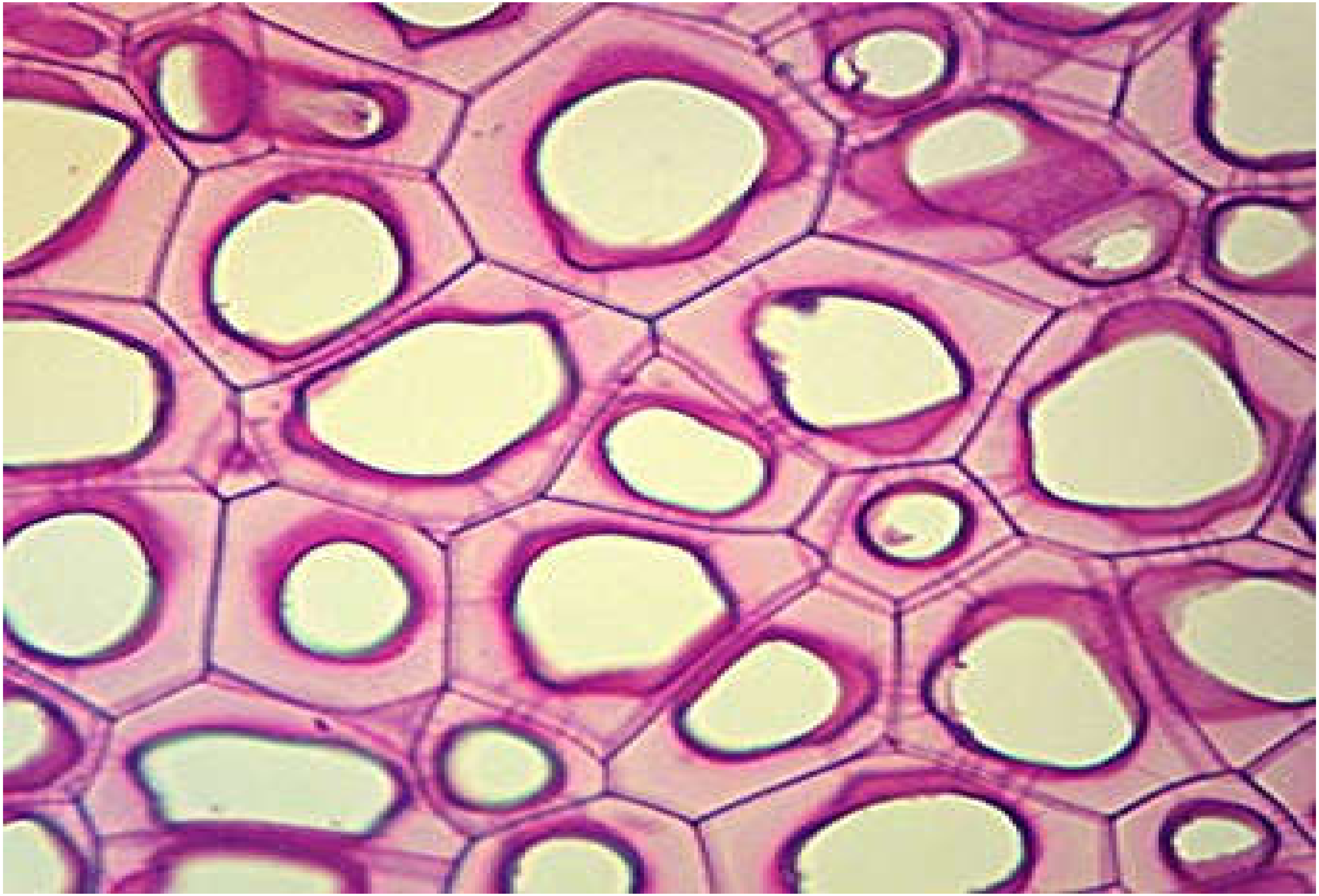


Closed
Open
Connexon
connexin monomer
Plasma membranes
Intercellular space
2-4 nm space
Hydrophilic channel

**FIGURE 14.26 Gap junctions** (A) Electron micrograph of a gap junction (arrows) between two liver cells. (B) Gap junctions consist of assemblies of six connexins, which form open channels through the plasma membranes of adjacent cells. (A, Don Fawcett and R. Wood/Photo Researchers, Inc.)



# Plasmodesmata

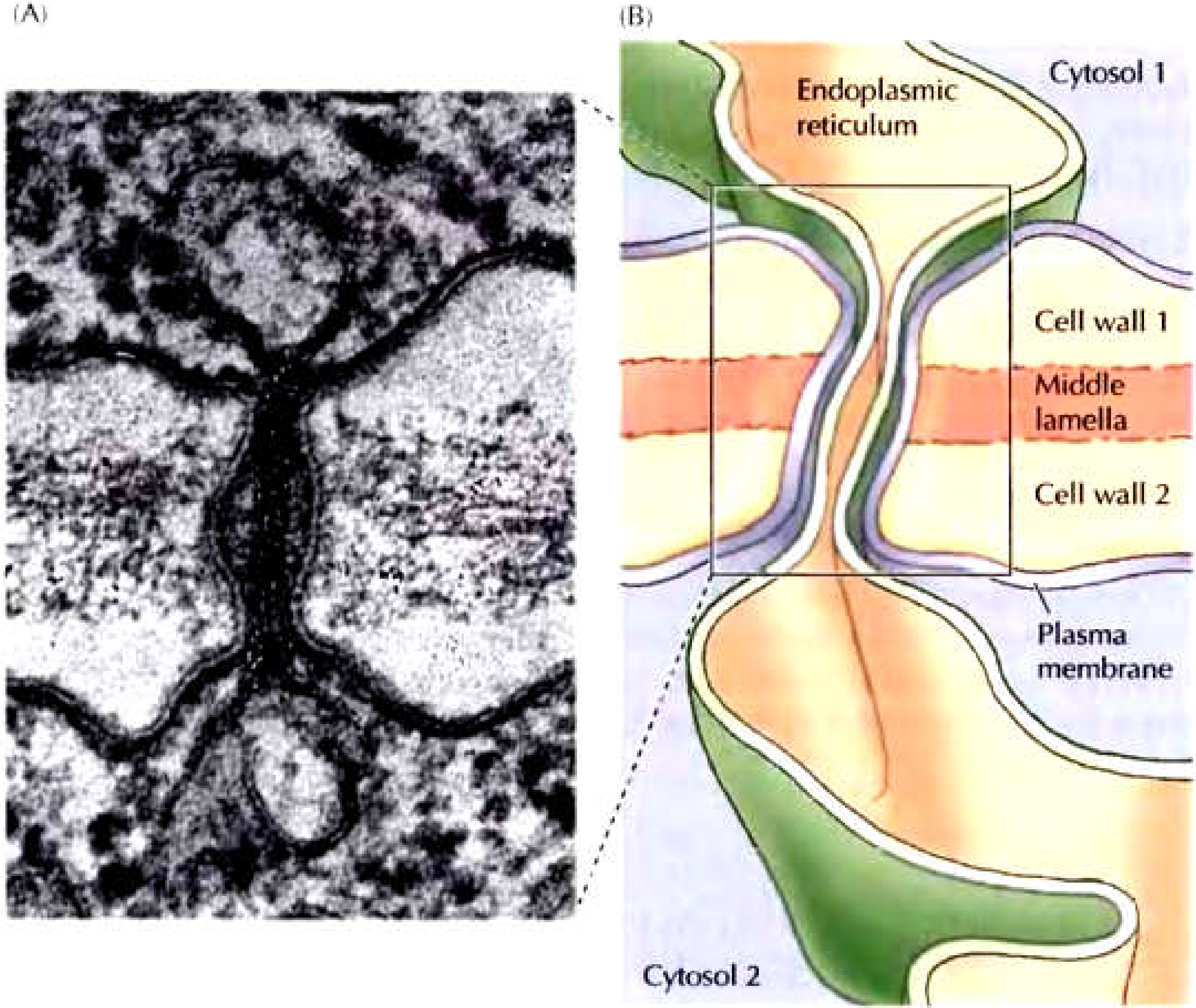


**Plasmodesmata** (singular: **plasmodesma**) are microscopic channels which traverse the cell walls of plant cells and some algal cells, enabling transport and communication between them. Plasmodesmata evolved independently in several lineages.

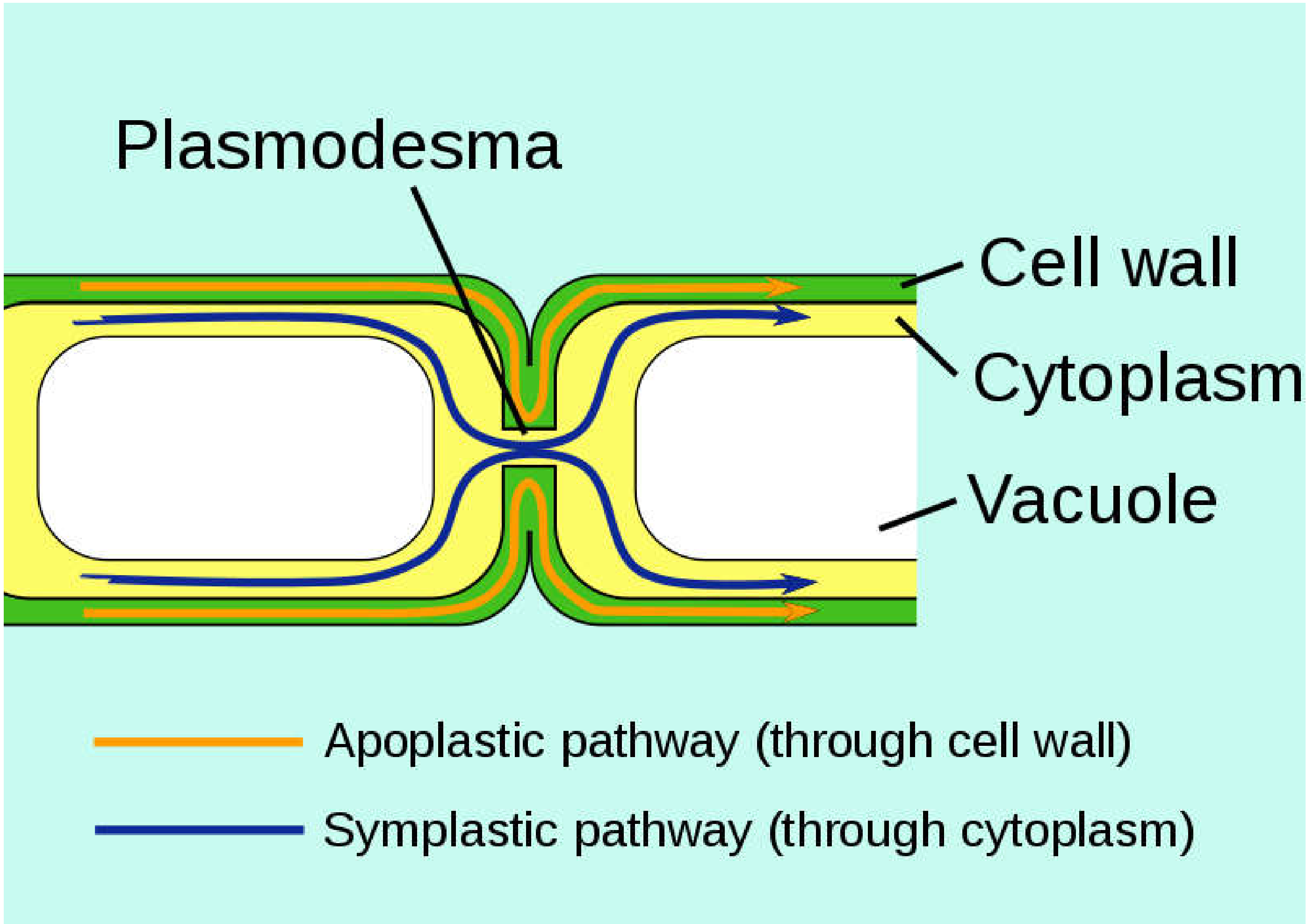
## Formation:

Primary plasmodesmata are formed when fractions of the endoplasmic reticulum [ER] are trapped across the middle lamella as new cell wall are synthesized between two newly divided plant cells. **An extension of the smooth ER passes through the pore, leaving a ring of surrounding cytoplasm through which ions and small particles were transport.** The size of molecules that can pass through plasmodesmata is determined by the size exclusion limit. transport proteins (including transcription factors), short interfering RNA, messenger RNA, viroids, and viral genomes from cell to cell.

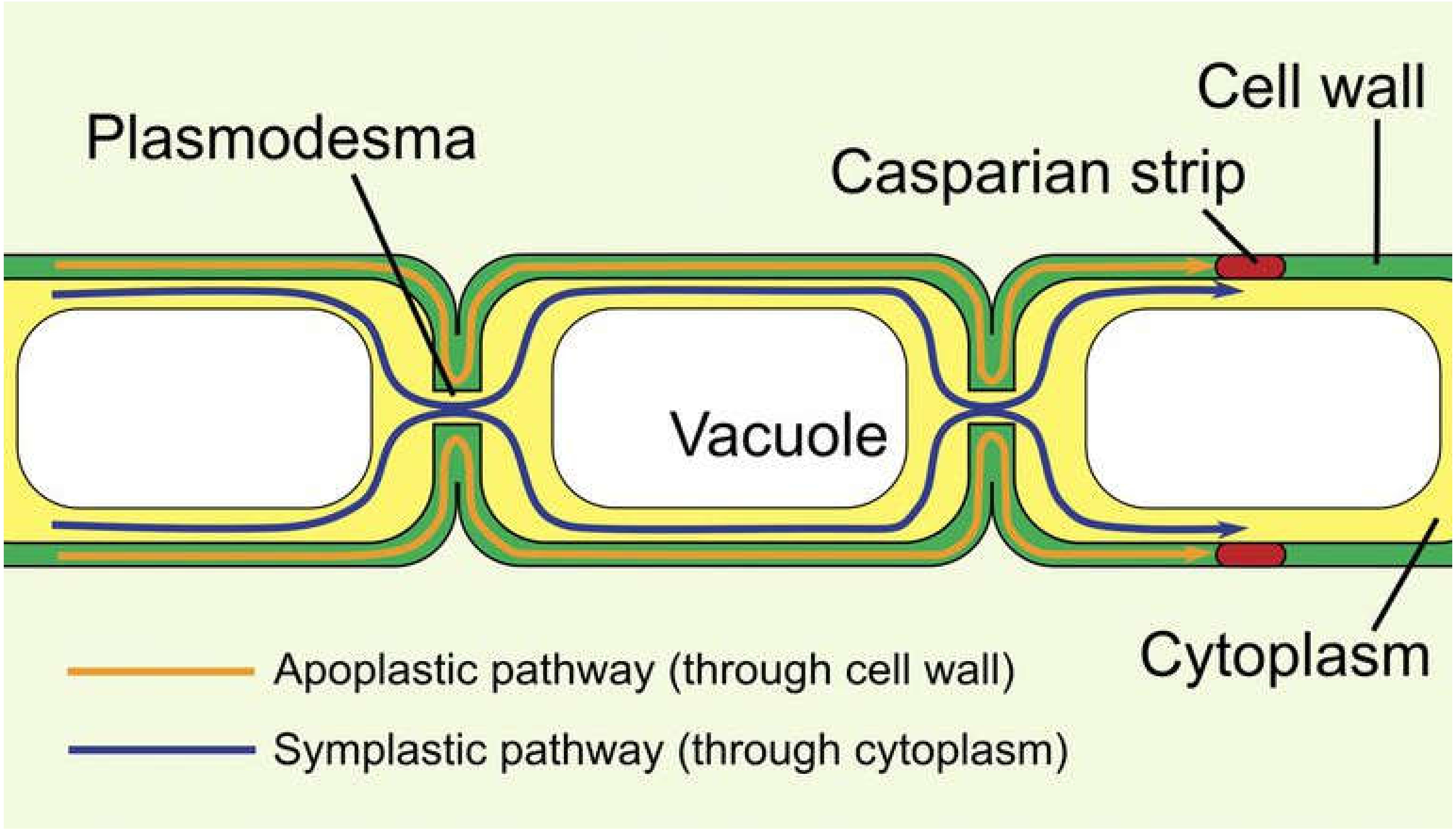
These eventually become the cytoplasmic connections between cells. At the formation site, the wall is not thickened further, and depressions or thin areas known as pits are formed in the walls. Pits normally pair up between adjacent cells. Plasmodesmata can also be inserted into existing cell walls between non-dividing cells (secondary plasmodesmata).


(A)
(B)
Cytosol 1
Endoplasmic reticulum
Cell wall 1
Middle lamella
Cell wall 2
Plasma membrane
Cytosol 2

**Neighbouring plant cells are therefore separated by a pair of cell walls and the intervening middle lamella, forming an extracellular domain known as the apoplast. Although cell walls are permeable to small soluble proteins and other solutes, plasmodesmata enable direct, regulated, symplastic transport of substances between cells.**



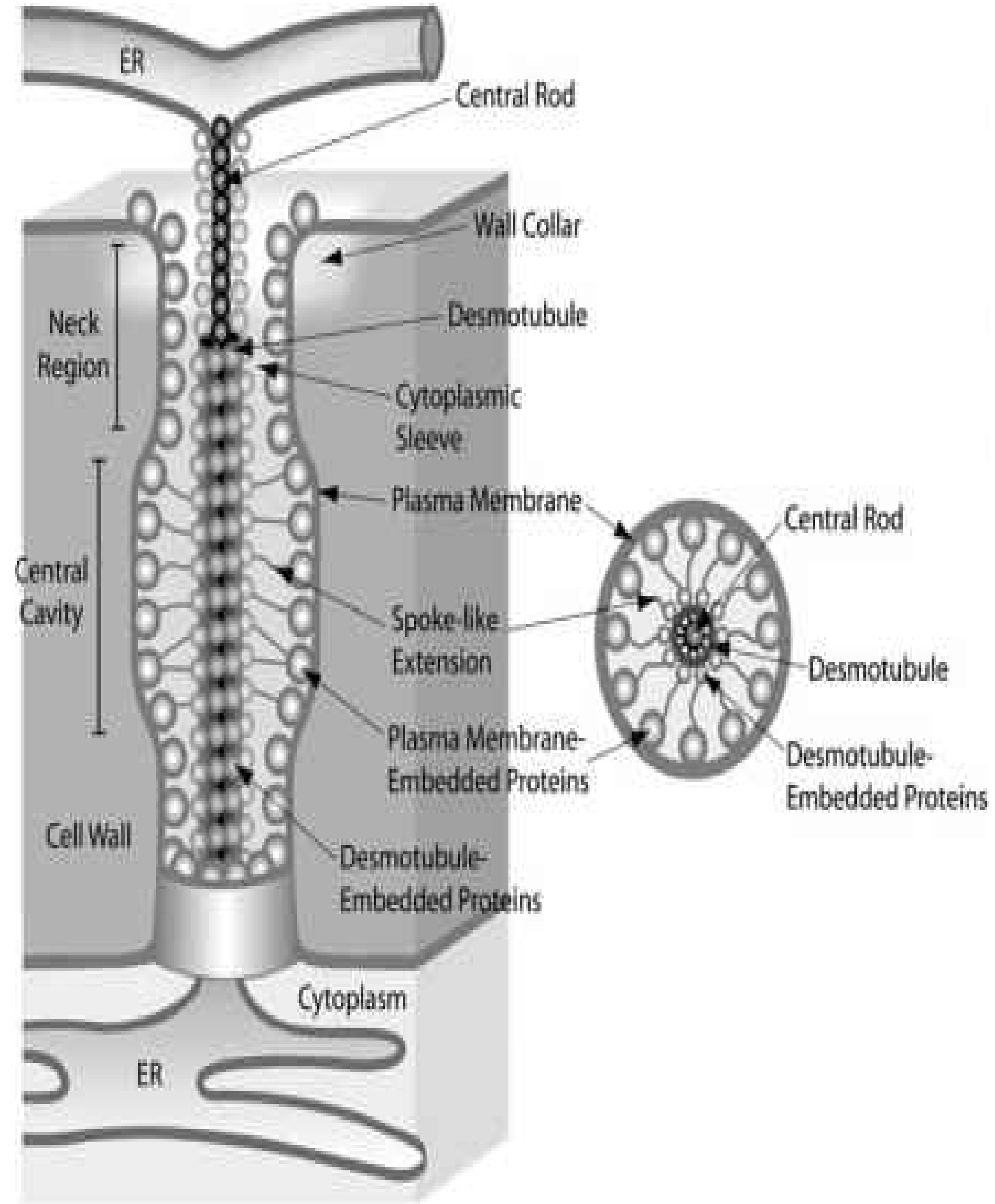
**Casparian strip_** is a band of cell wall material deposited in the radial and transverse walls of the endodermis, and is chemically different from the rest of the cell wall - the cell wall being made of lignin and without suberin - whereas the **Casparian strip** is made of suberin and sometimes lignin. It helps in controlled water transport through apoplastic bariier.

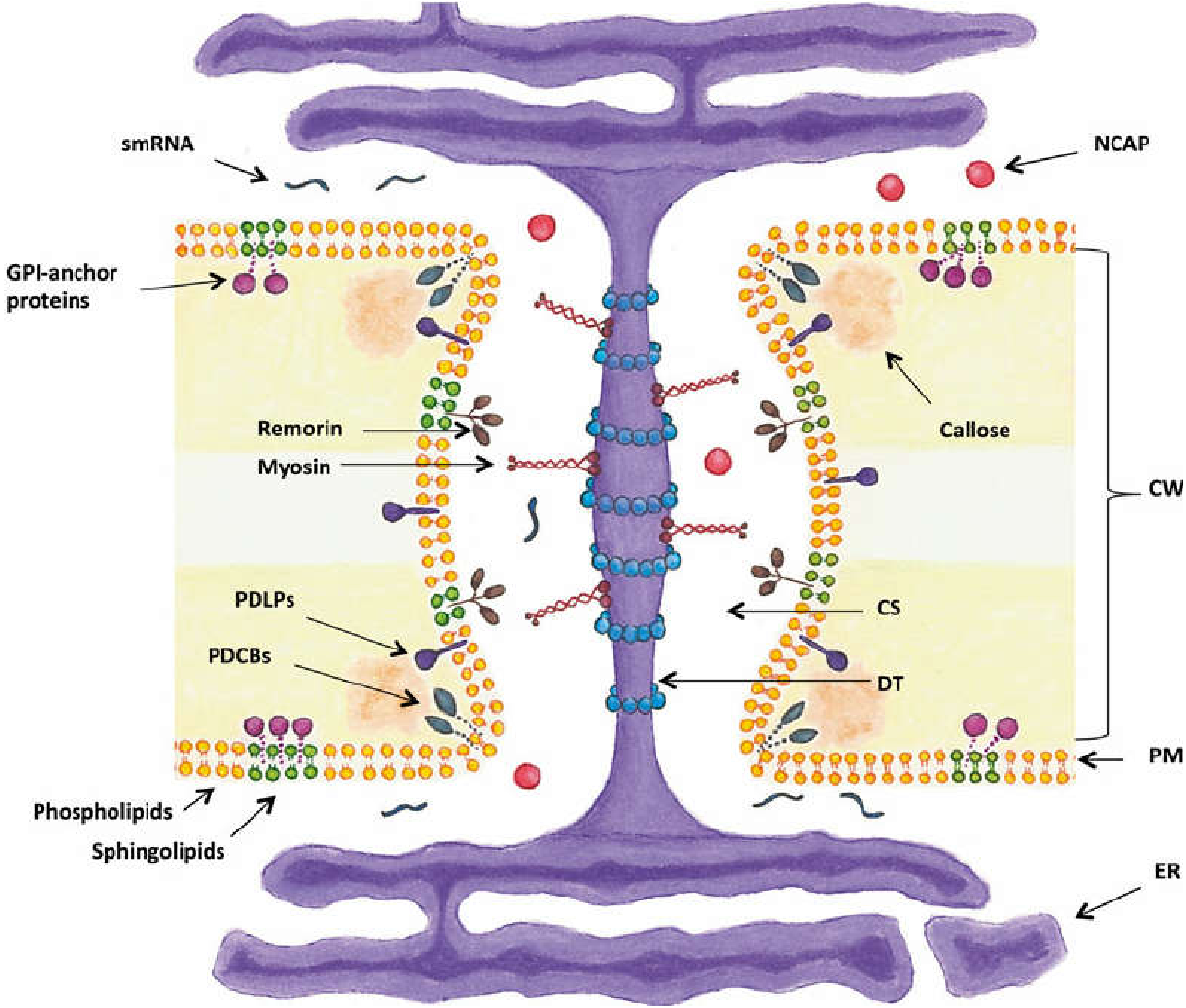


# Desmotubule

The **desmotubule** is a tube of appressed (flattened) endoplasmic reticulum that runs between two adjacent cells. Some molecules are known to be transported through this channel, but it is not thought to be the main route for plasmodesmatal transport.

Around the desmotubule and the plasma membrane areas of an electron dense material have been seen, often **joined together by spoke-like structures that seem to split the plasmodesma into smaller channels.** These structures may be composed of **myosin and actin**, which are part of the cell's cytoskeleton. If this is the case these proteins could be used in the selective transport of large molecules between the two cells.




smRNA
NCAP
GPI-anchor
proteins
Callose
Remorin
Myosin
CW
PDLPs
CS
PDCBs
DT
PM
Phospholipids
Sphingolipids
ER

# Plasmodesmata Intercellular Junction