Cell Junctions, Cell Adhesion

Are critical for every aspect of the organisation, function and dynamics of multicellular structures.

The mechanisms of cohesion govern the architecture of the body (shape, strength, arrangement of its different cell-types).

Cells may:

- cling to one another - cell-cell junctions;

- be bound together by extracellular matrix (ECM).

"Key players":

- CELLS (Cytoskeleton and specific membrane proteins)

- ECM (complex network of proteins and polysaccharide chains)

- JUNCTIONS.

Multicellular structure - ways to transmit stresses

STRENGTH

- **Extracellular matrix – network of proteins and polysaccharide chains**
- **Cytoskeletons – cell-cell adhesions**

Strategies – dependent on tissue. E.g.:

- **Connective tissue – bone/tendon (ECM, less cells)**
- **Epithelial tissues – gut/skin cells (C-skeleton - stress - interior of cells)**

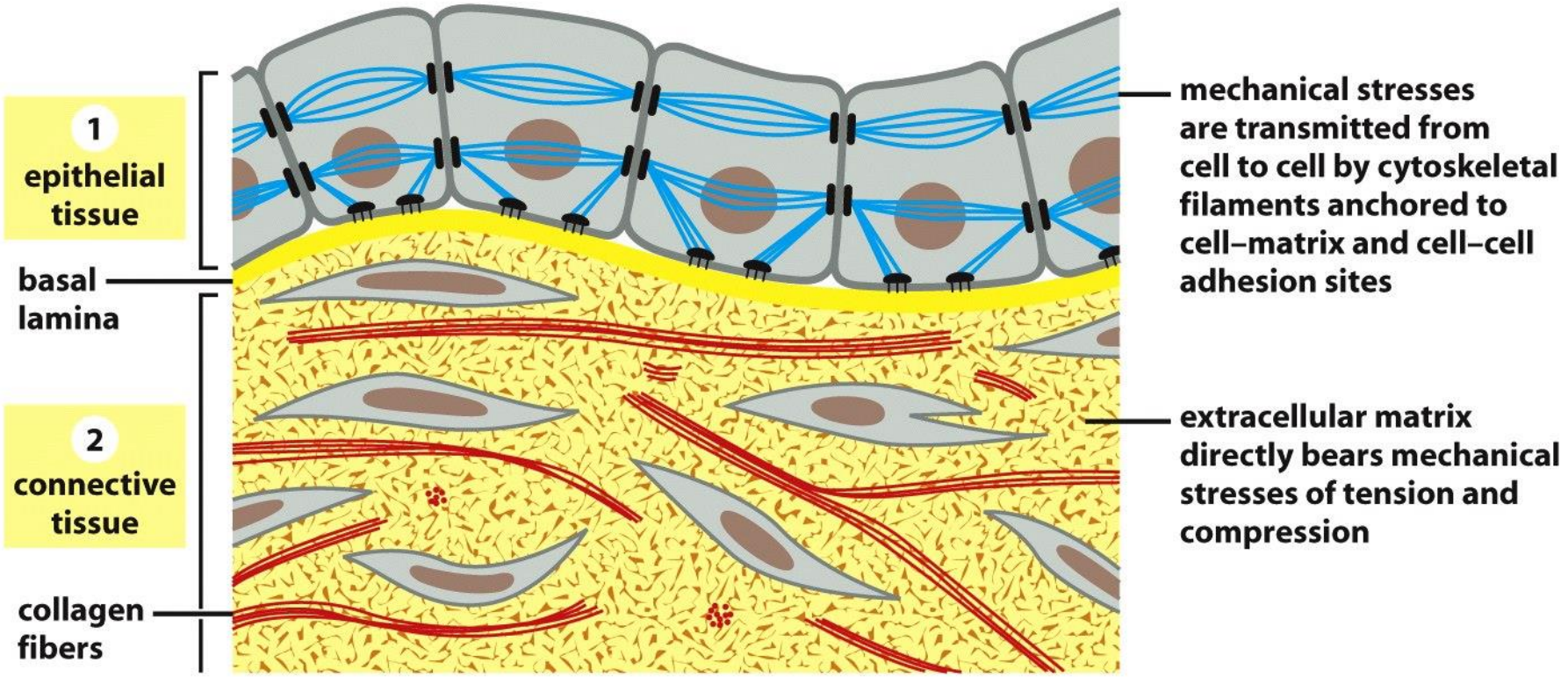


Figure 19-1 *Molecular Biology of the Cell* (© Garland Science 2008)

4 FUNCTIONAL CLASSES OF CELL JUNCTIONS

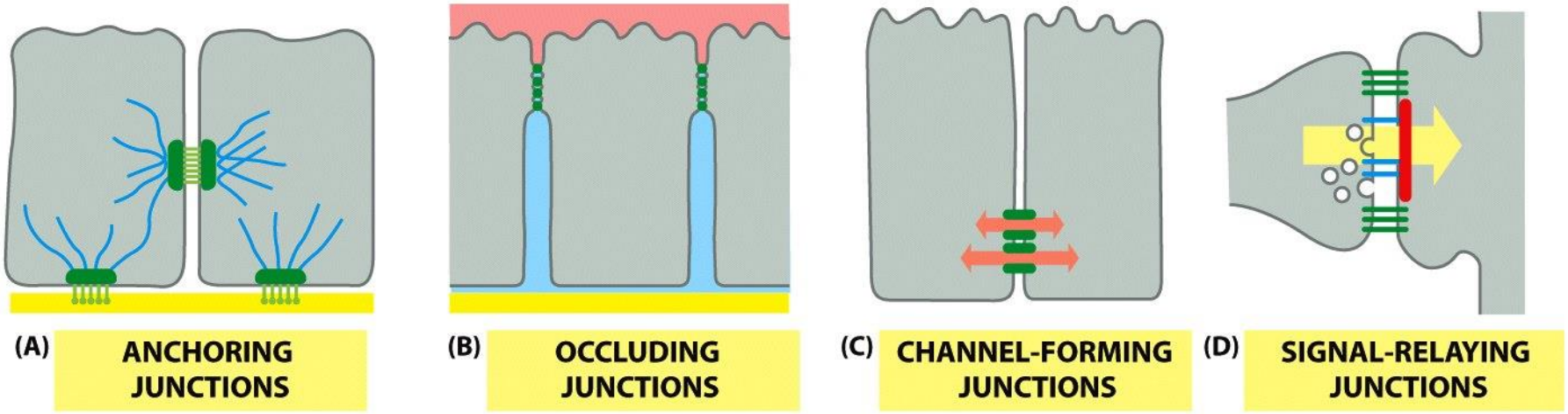
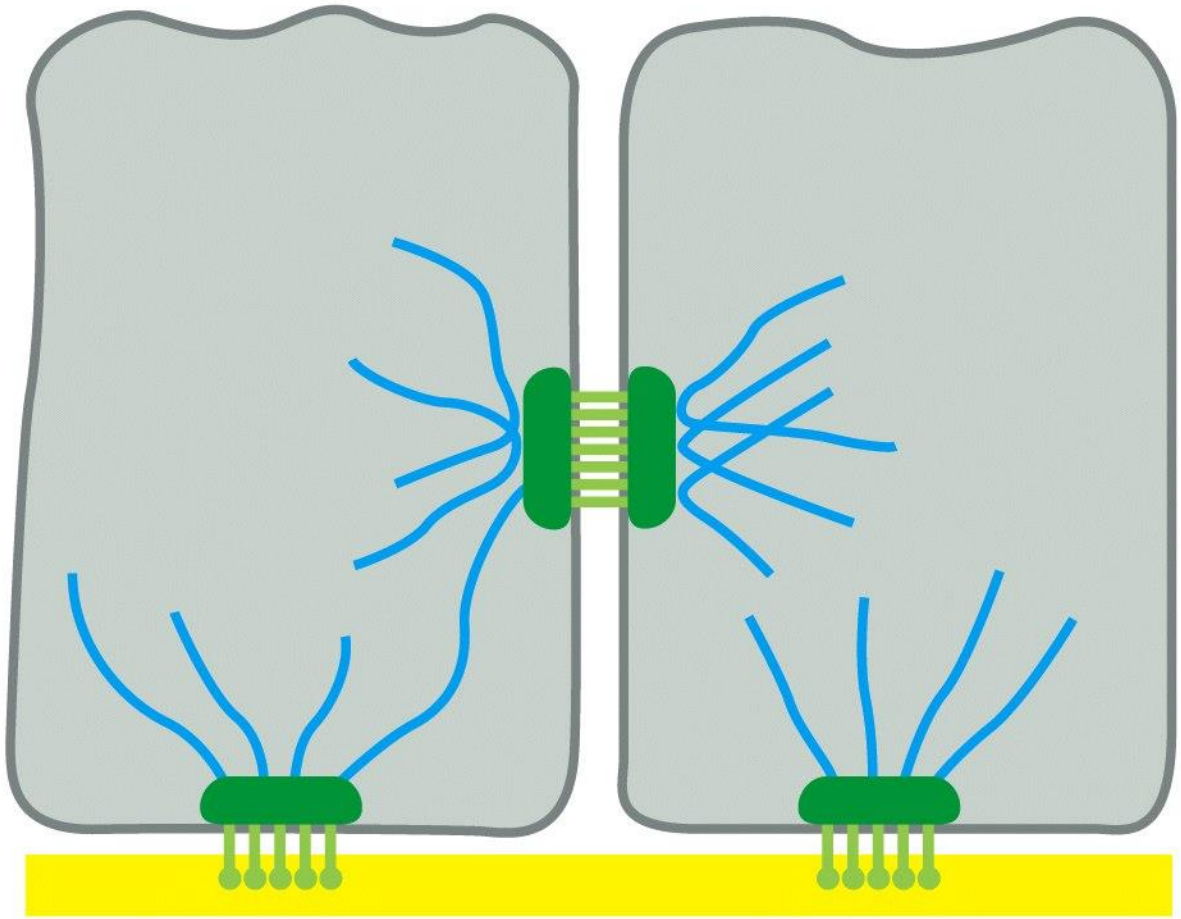
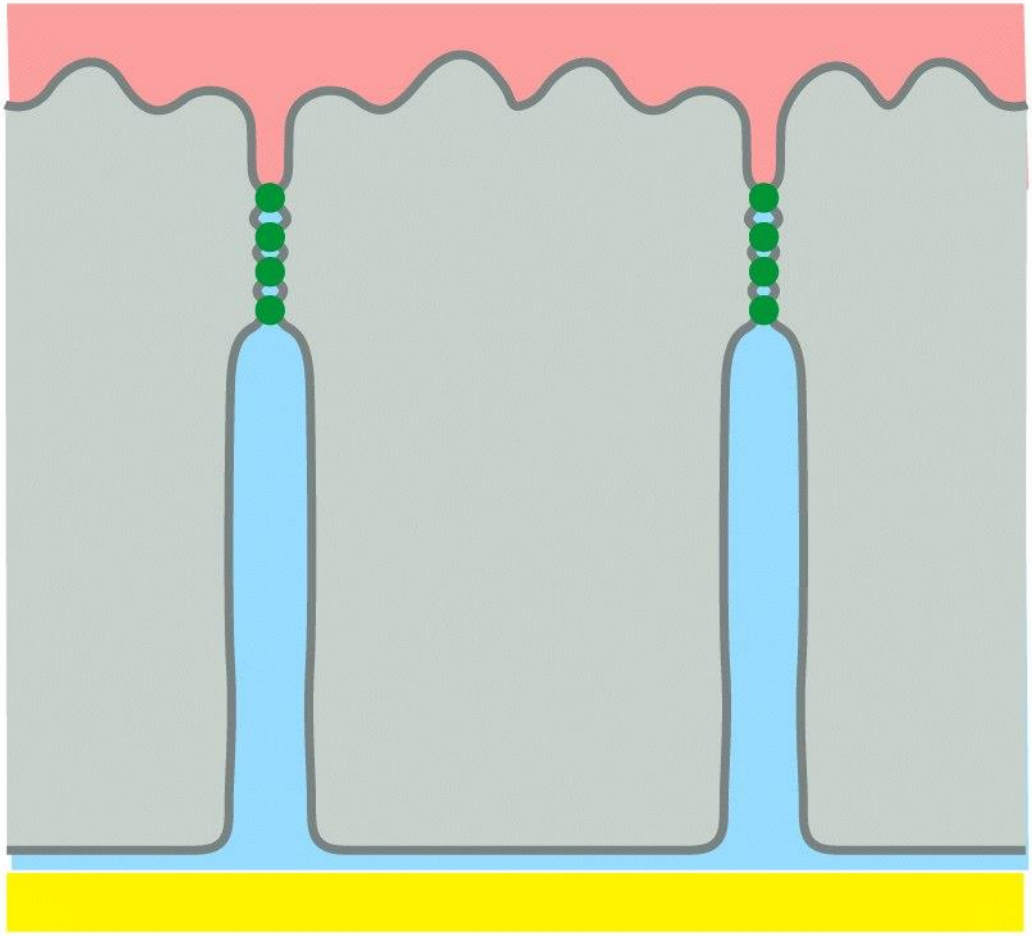


Figure 19-2 *Molecular Biology of the Cell* (© Garland Science 2008)



ANCHORING JUNCTIONS

Figure 19-2a *Molecular Biology of the Cell* (© Garland Science 2008)



OCCLUDING JUNCTIONS

Figure 19-2b *Molecular Biology of the Cell* (© Garland Science 2008)

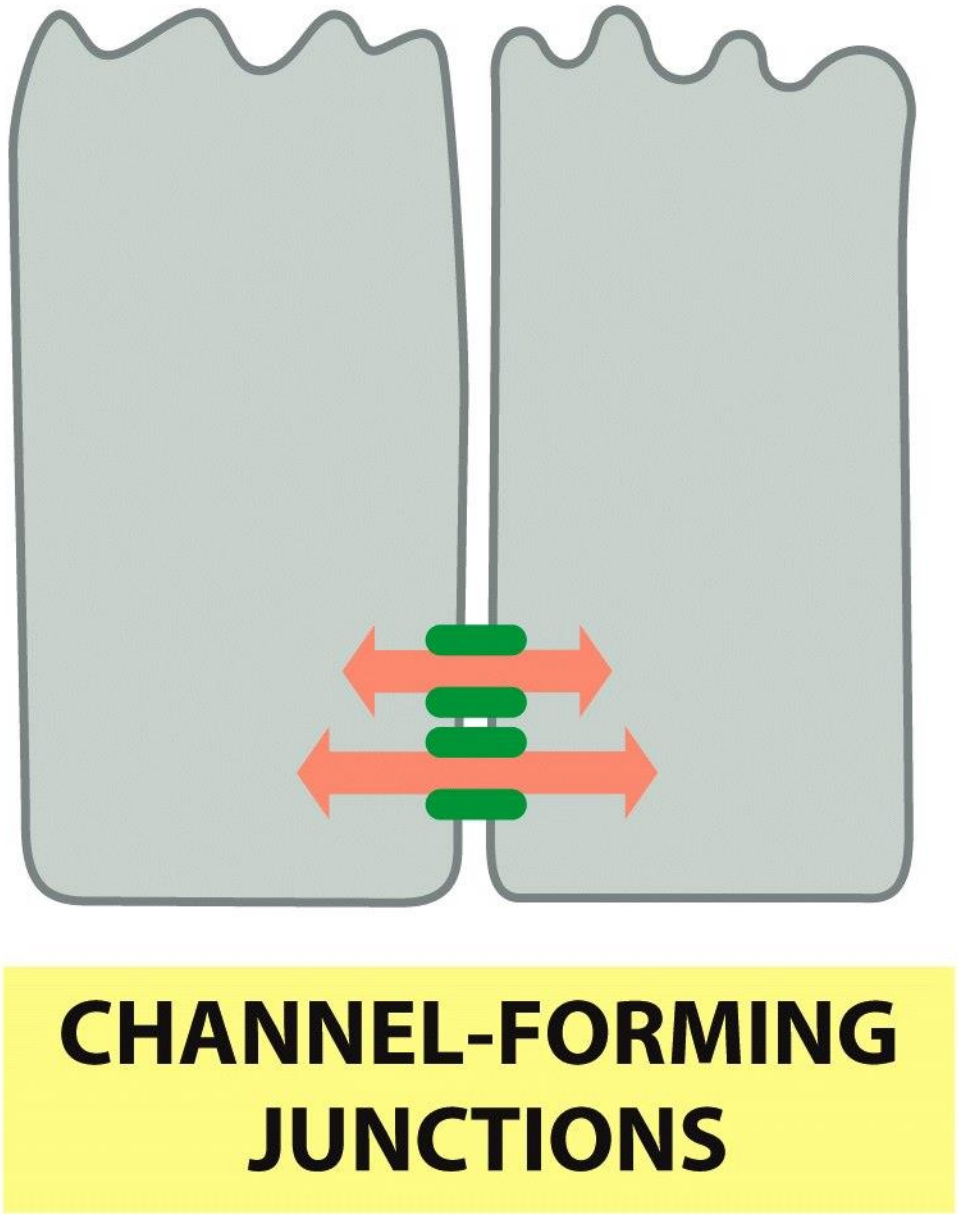
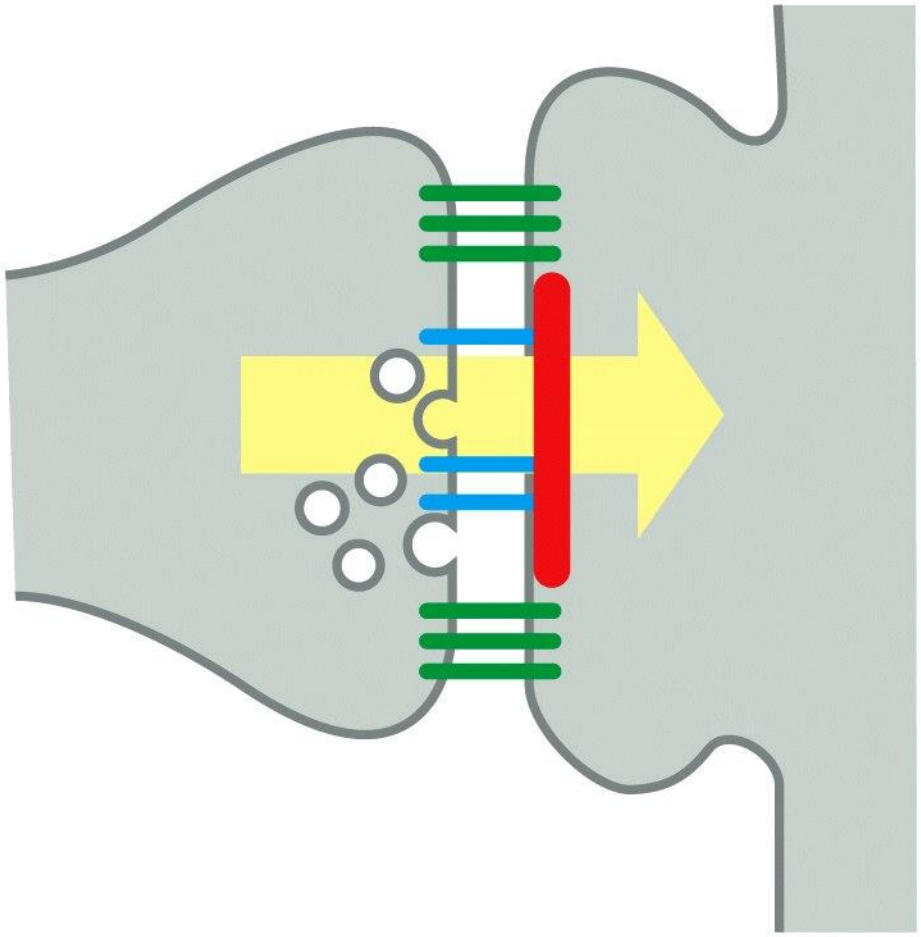


Figure 19-2c *Molecular Biology of the Cell* (© Garland Science 2008)



SIGNAL-RELAYING JUNCTIONS

Figure 19-2d *Molecular Biology of the Cell* (© Garland Science 2008)

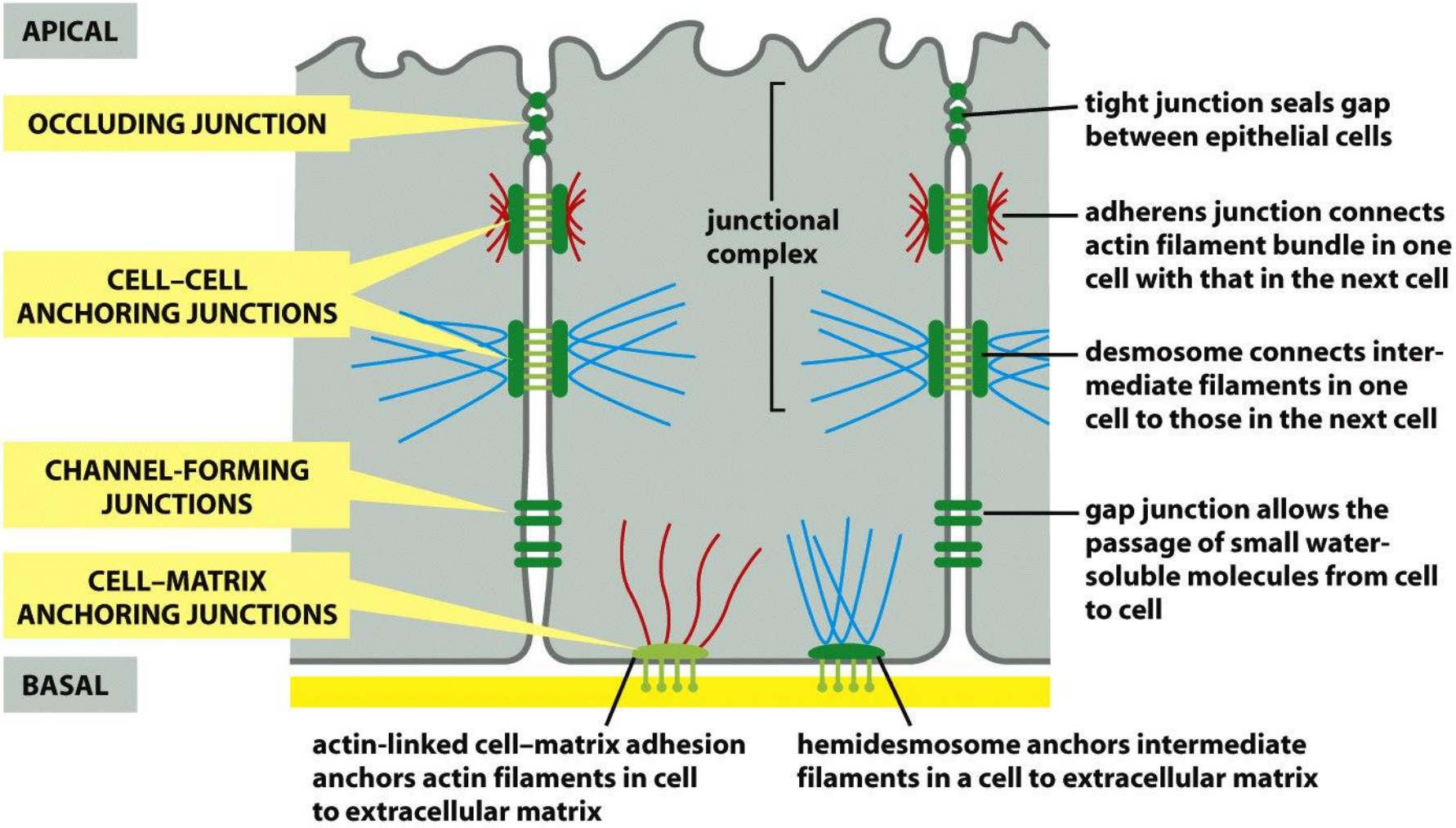
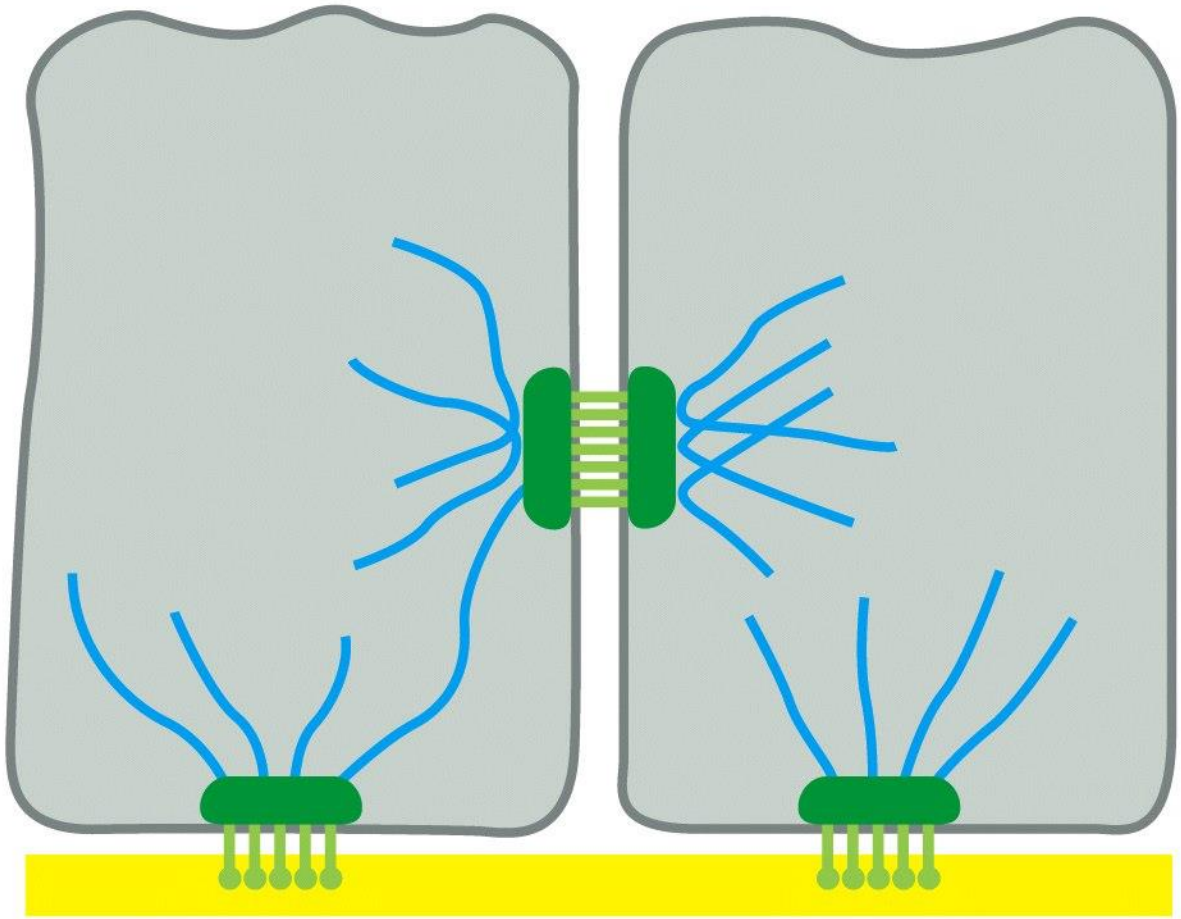


Figure 19-3 *Molecular Biology of the Cell* (© Garland Science 2008)



ANCHORING JUNCTIONS

Figure 19-2a *Molecular Biology of the Cell* (© Garland Science 2008)

Table 19–1 A Functional Classification of Cell Junctions

ANCHORING JUNCTIONS
Actin filament attachment sites
1. cell–cell junctions (adherens junctions)
2. cell–matrix junctions (actin-linked cell–matrix adhesions)
Intermediate filament attachment sites
1. cell–cell junctions (desmosomes)
2. cell–matrix junctions (hemidesmosomes)
OCCLUDING JUNCTIONS
1. tight junctions (in vertebrates)
2. septate junctions (in invertebrates)
CHANNEL-FORMING JUNCTIONS
1. gap junctions (in animals)
2. plasmodesmata (in plants)
SIGNAL-RELAYING JUNCTIONS
1. chemical synapses (in the nervous system)
2. immunological synapses (in the immune system)
3. transmembrane ligand–receptor cell–cell signaling contacts (Delta-Notch, ephrin-Eph, etc.). Anchoring, occluding, and channel-forming junctions can all have signaling functions in addition to their structural roles

Table 19-1 *Molecular Biology of the Cell* (© Garland Science 2008)

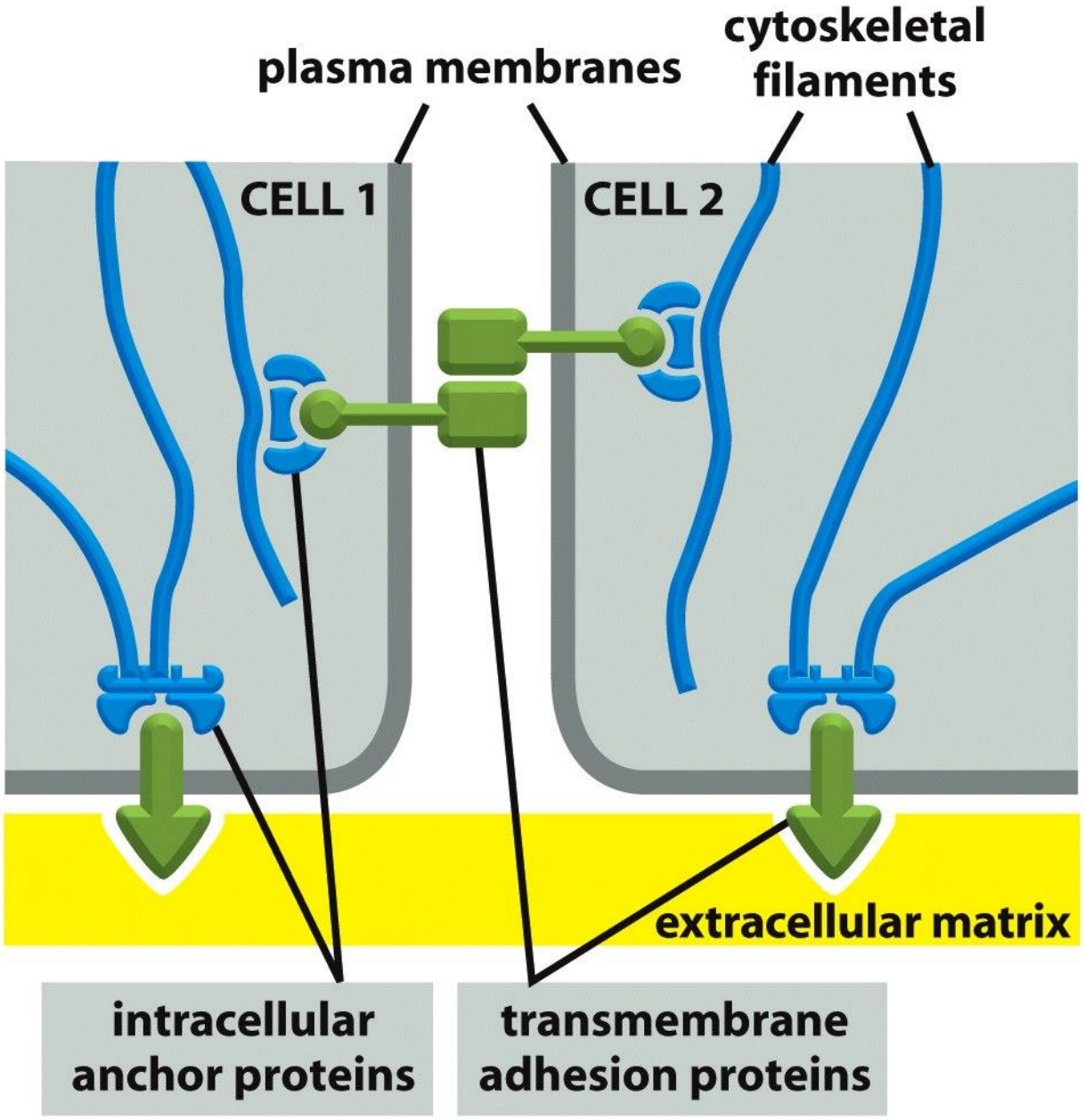


Figure 19-4 *Molecular Biology of the Cell* (© Garland Science 2008)

Table 19–2 Anchoring Junctions

JUNCTION	TRANSMEMBRANE ADHESION PROTEIN	EXTRACELLULAR LIGAND	INTRACELLULAR CYTOSKELETAL ATTACHMENT	INTRACELLULAR ANCHOR PROTEINS
Cell–Cell				
adherens junction	cadherin (classical cadherin)	cadherin in neighboring cell	actin filaments	α-catenin, β-catenin, plakoglobin (γ-catenin), p120-catenin, vinculin, α-actinin
desmosome	cadherin (desmoglein, desmocollin)	desmoglein and desmocollin in neighboring cell	intermediate filaments	plakoglobin (γ-catenin), plakophilin, desmoplakin
Cell–Matrix				
actin-linked cell–matrix adhesion	integrin	extracellular matrix proteins	actin filaments	talin, vinculin, α-actinin, filamin, paxillin, focal adhesion kinase (FAK)
hemidesmosome	integrin α6β4, type XVII collagen (BP180)	extracellular matrix proteins	intermediate filaments	plectin, dystonin (BP230)

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CaDHERINS

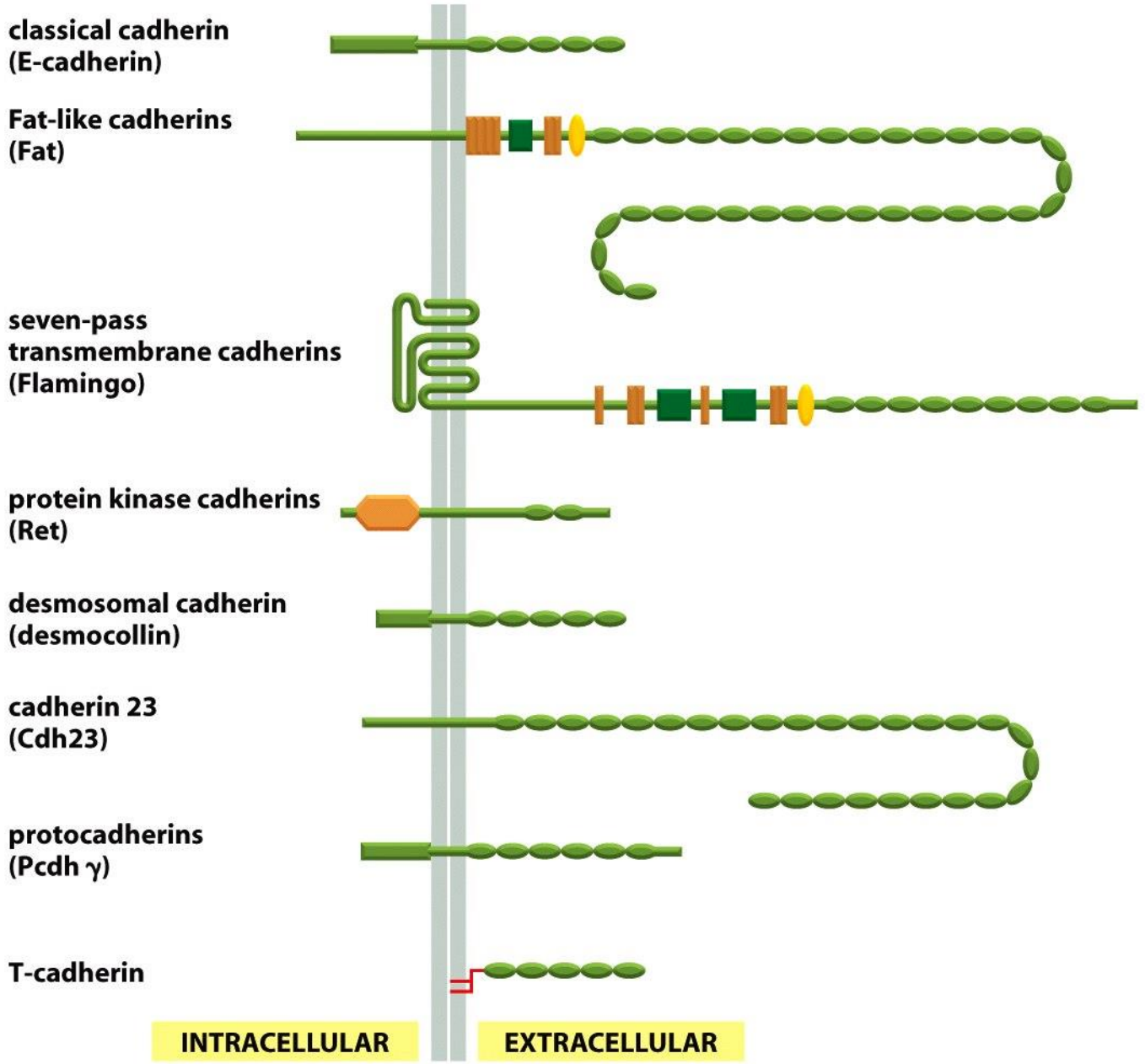


Figure 19-7 *Molecular Biology of the Cell* (© Garland Science 2008)

Table 19–3 Some Members of the Cadherin Superfamily

NAME	MAIN LOCATION	JUNCTION ASSOCIATION	PHENOTYPE WHEN INACTIVATED IN MICE
Classical cadherins			
E-cadherin	many epithelia	adherens junctions	death at blastocyst stage; embryos fail to undergo compaction
N-cadherin	neurons, heart, skeletal muscle, lens, and fibroblasts	adherens junctions and chemical synapses	embryos die from heart defects
P-cadherin	placenta, epidermis, breast epithelium	adherens junctions	abnormal mammary gland development
VE-cadherin	endothelial cells	adherens junctions	abnormal vascular development (apoptosis of endothelial cells)
Nonclassical cadherins			
Desmocollin	skin	desmosomes	blistering of skin
Desmoglein	skin	desmosomes	blistering skin disease due to loss of keratinocyte cell–cell adhesion
T-cadherin	neurons, muscle, heart	none	unknown
Cadherin 23	inner ear, other epithelia	links between stereocilia in sensory hair cells	deafness
Fat (in *Drosophila*)	epithelia and central nervous system	signal-relaying junction (planar cell polarity)	enlarged imaginal discs and tumors; disrupted planar cell polarity
Fat1 (in mammals)	various epithelia and central nervous system	slit diaphragm in kidney glomerulus and other cell junctions	loss of slit diaphragm; malformation of forebrain and eye
α, β, and γ-Protocadherins	neurons	chemical synapses and nonsynaptic membranes	neuronal degeneration
Flamingo	sensory and some other epithelia	cell–cell junctions	disrupted planar cell polarity; neural tube defects

Table 19-3 *Molecular Biology of the Cell* (© Garland Science 2008)

CaDHERINS

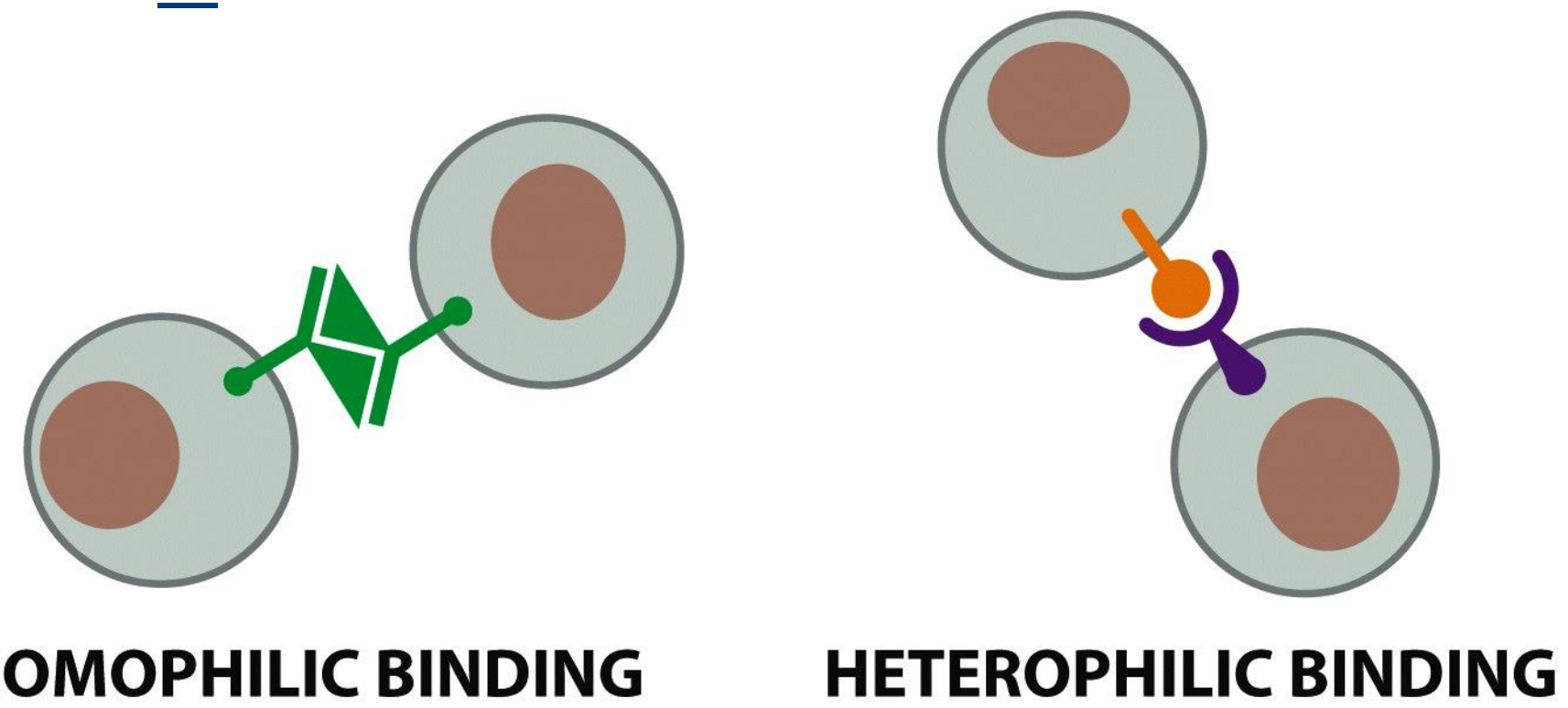


Figure 19-8 *Molecular Biology of the Cell* (© Garland Science 2008)

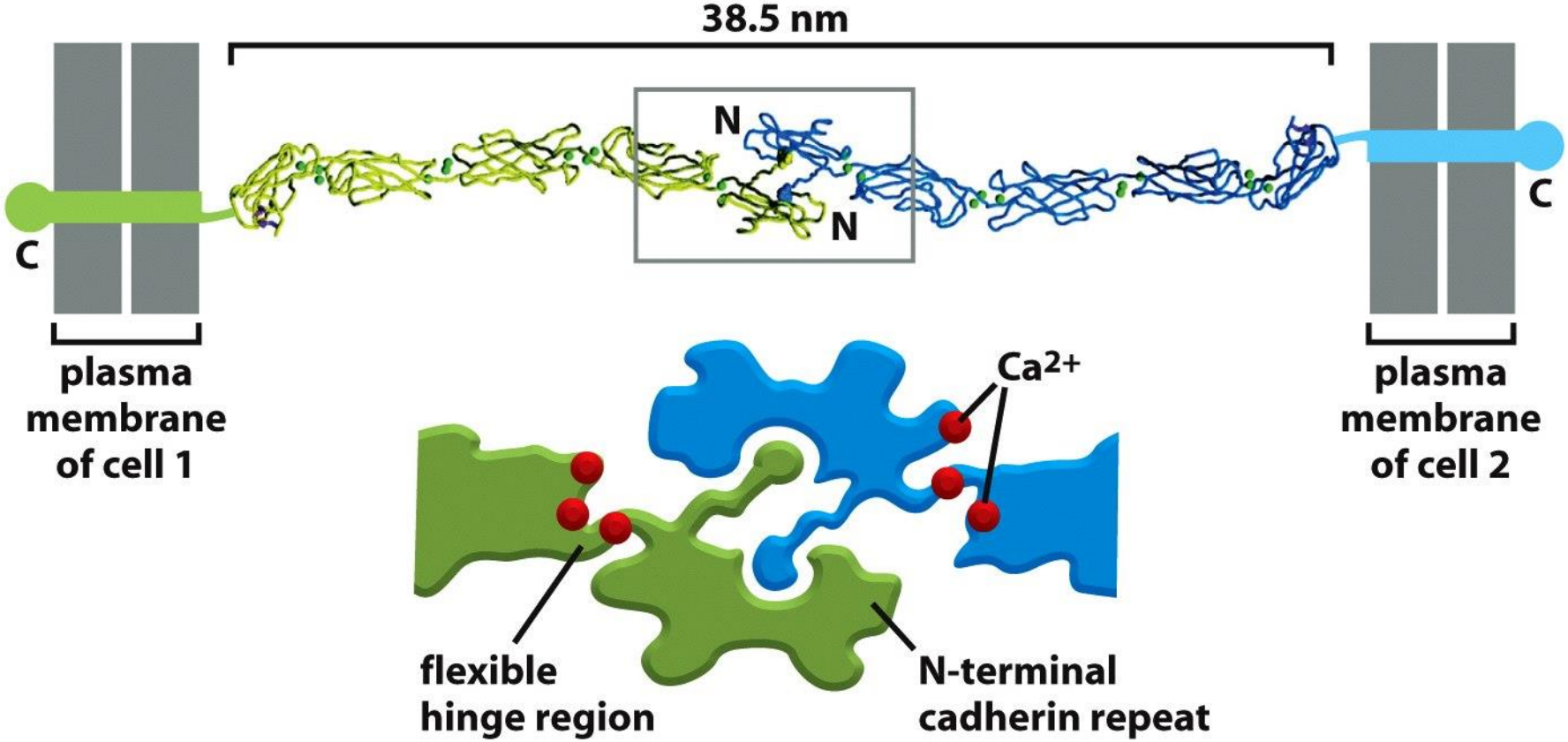


Figure 19-9a *Molecular Biology of the Cell* (© Garland Science 2008)

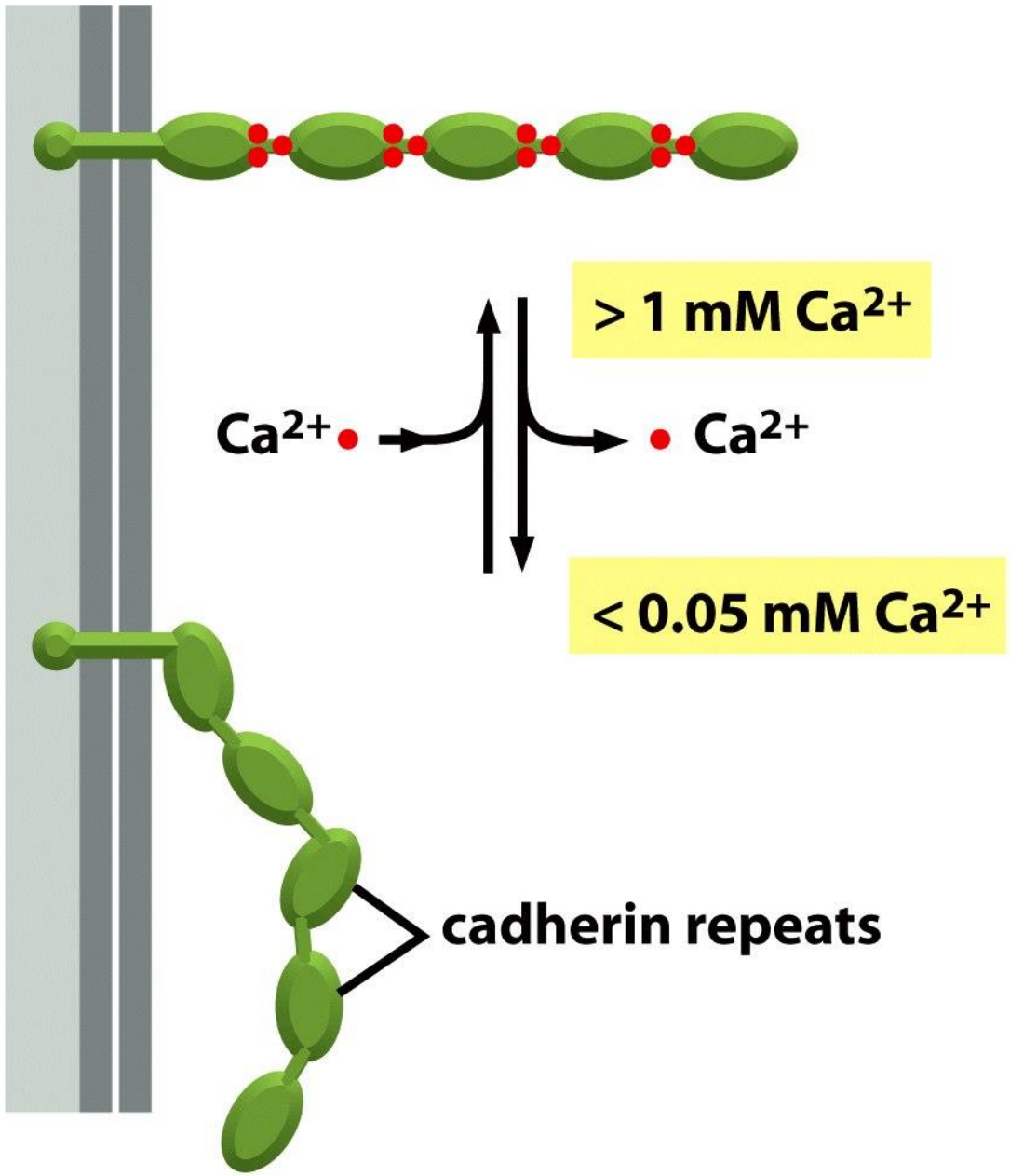
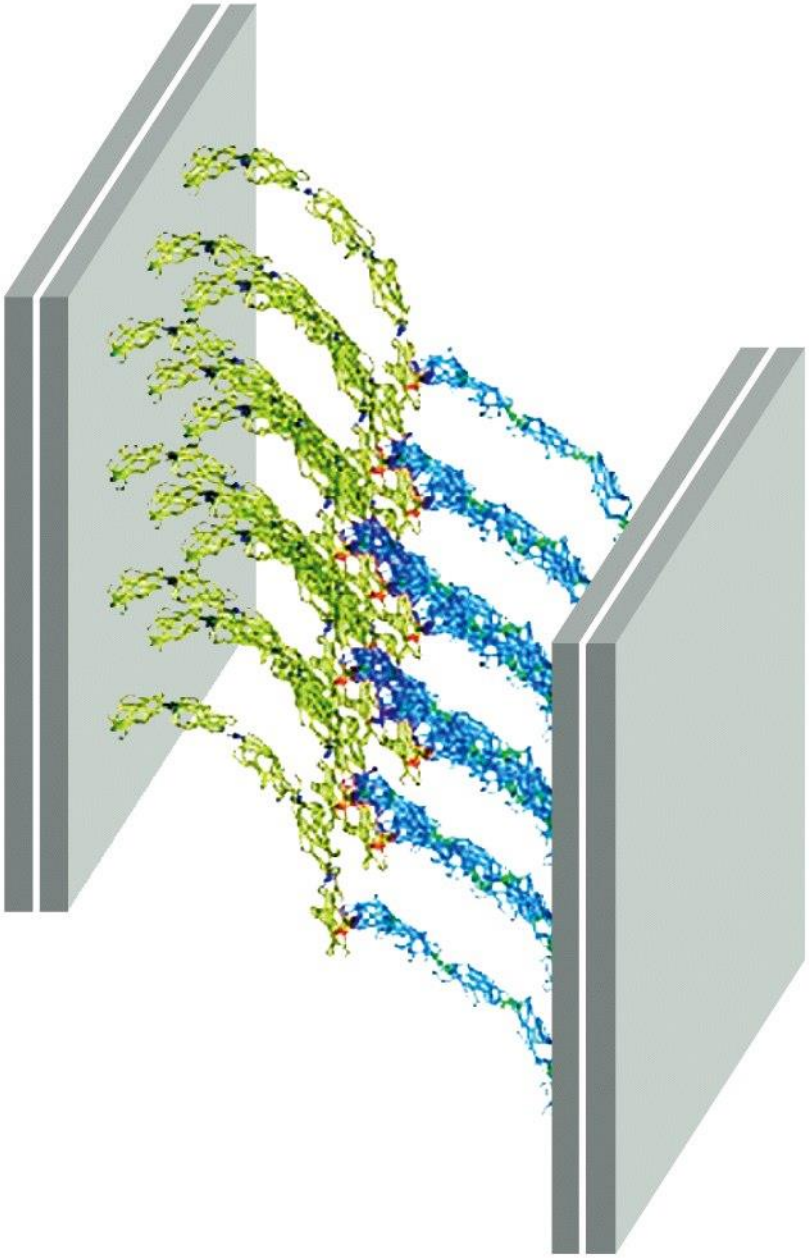


Figure 19-9b *Molecular Biology of the Cell* (© Garland Science 2008)



Velcro

Figure 19-9c *Molecular Biology of the Cell* (© Garland Science 2008)

Anchor proteins

(adherens junction)

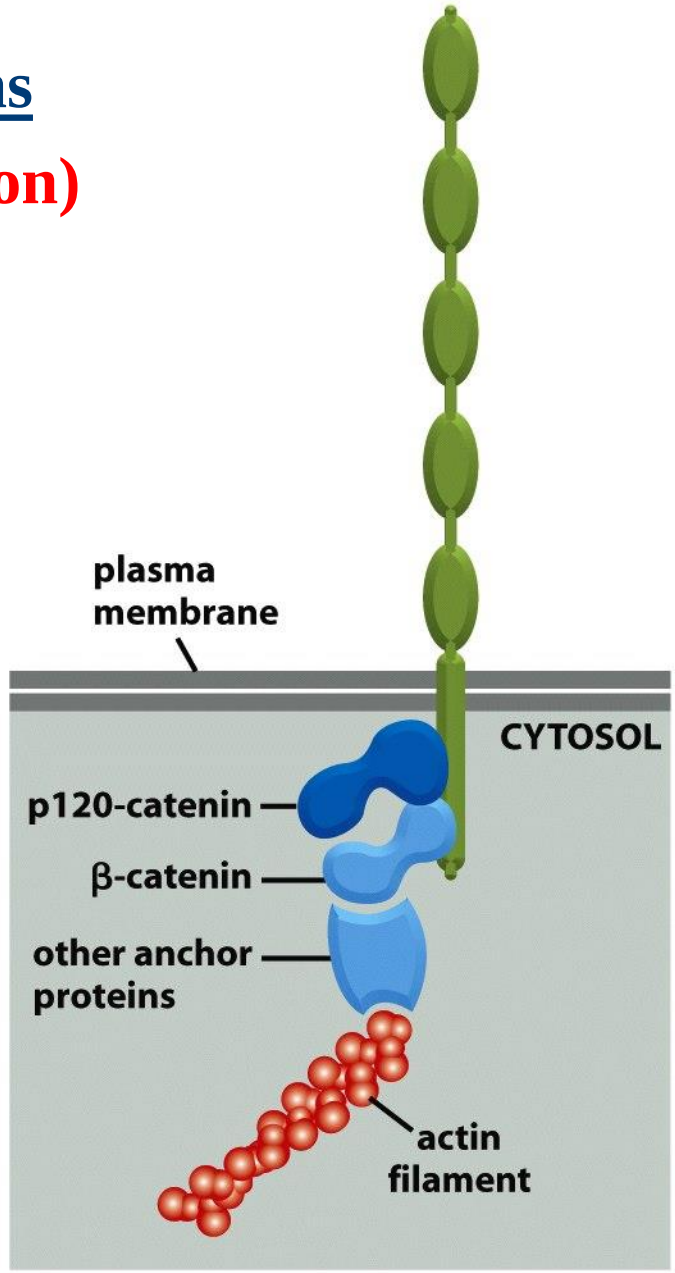


Figure 19-14 *Molecular Biology of the Cell* (© Garland Science 2008)

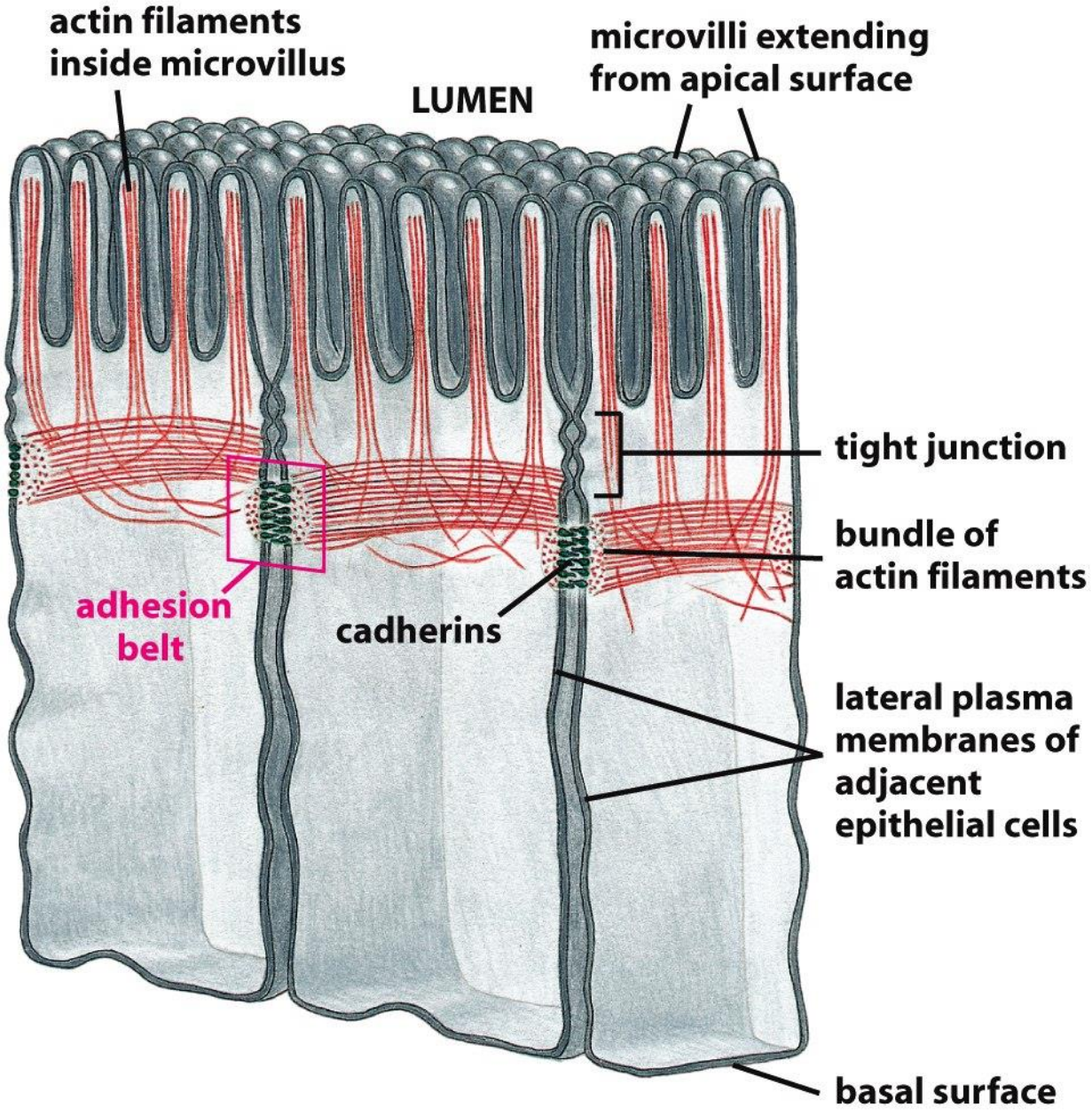


Figure 19-15 *Molecular Biology of the Cell* (© Garland Science 2008)

Desmosome

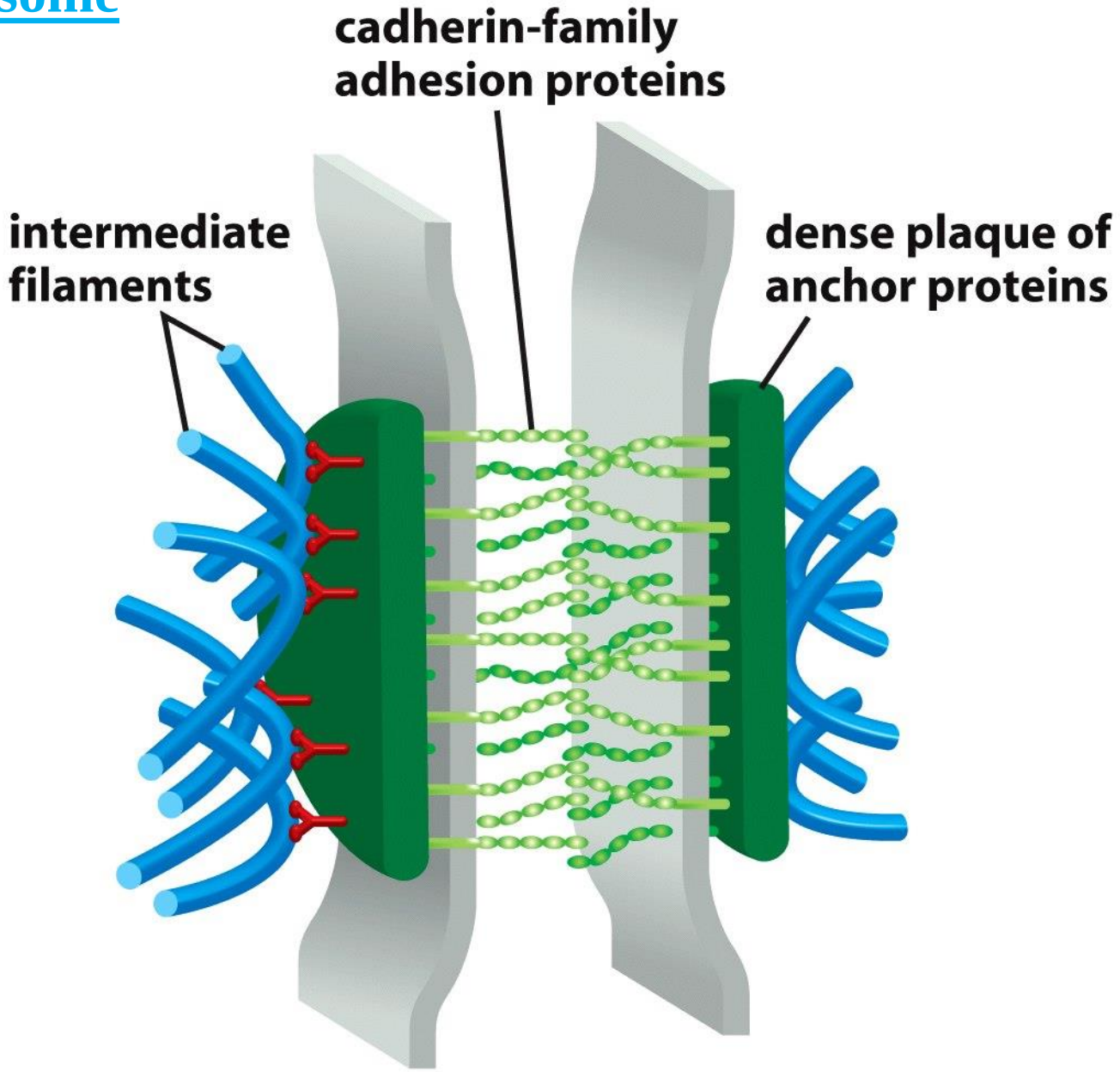


Figure 19-17a *Molecular Biology of the Cell* (© Garland Science 2008)

Anchor proteins

(desmosome)

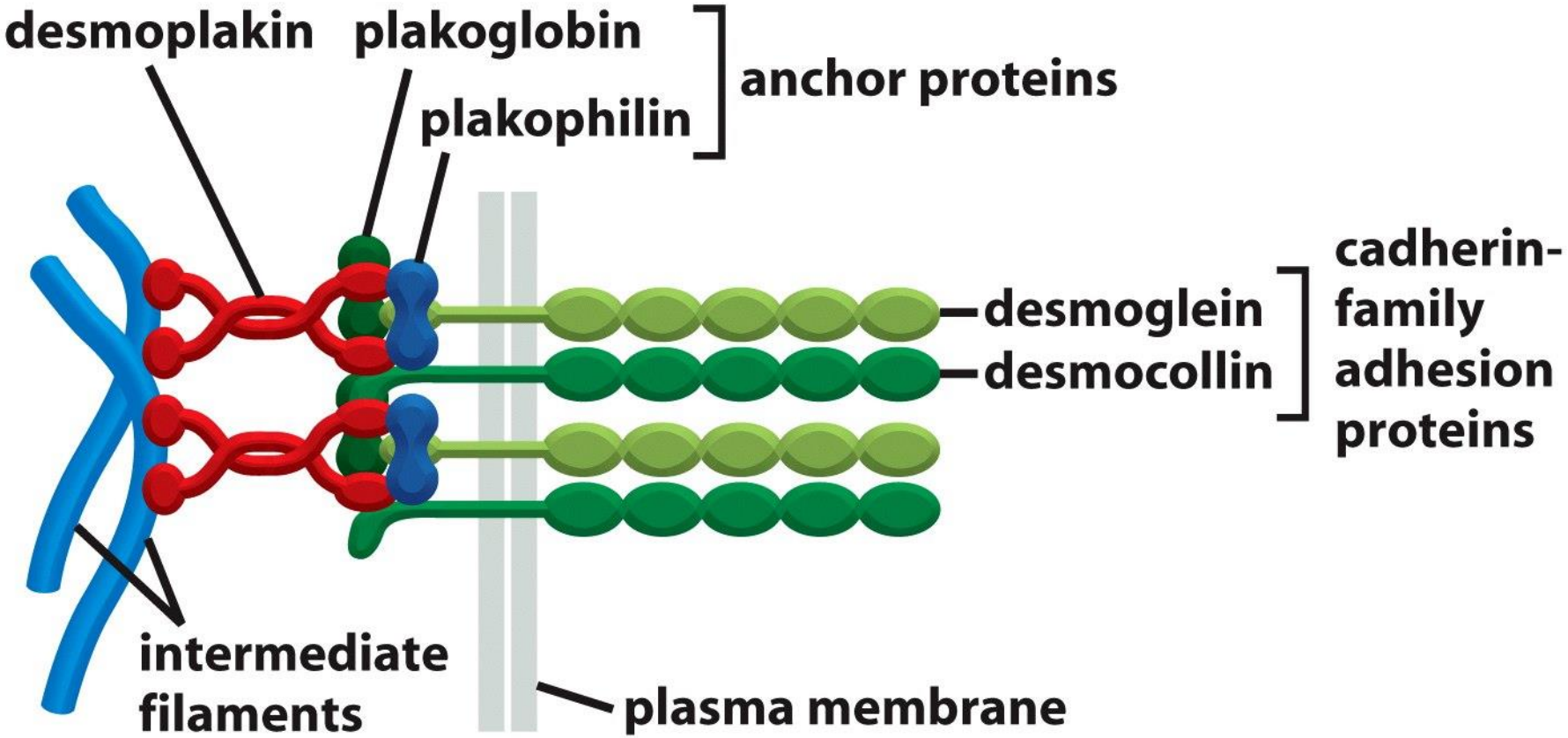


Figure 19-17b *Molecular Biology of the Cell* (© Garland Science 2008)

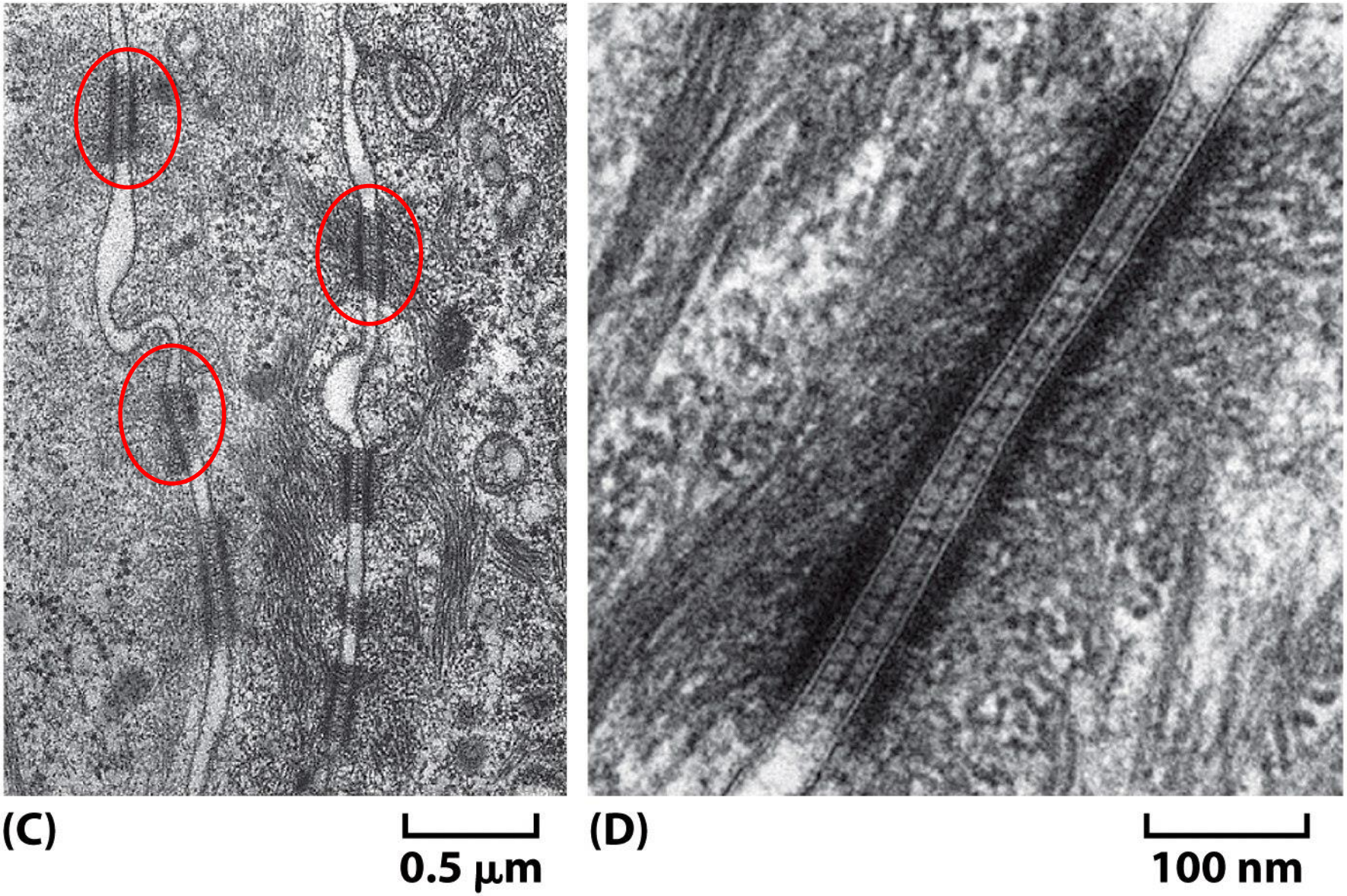


Figure 19-17c, d *Molecular Biology of the Cell* (© Garland Science 2008)

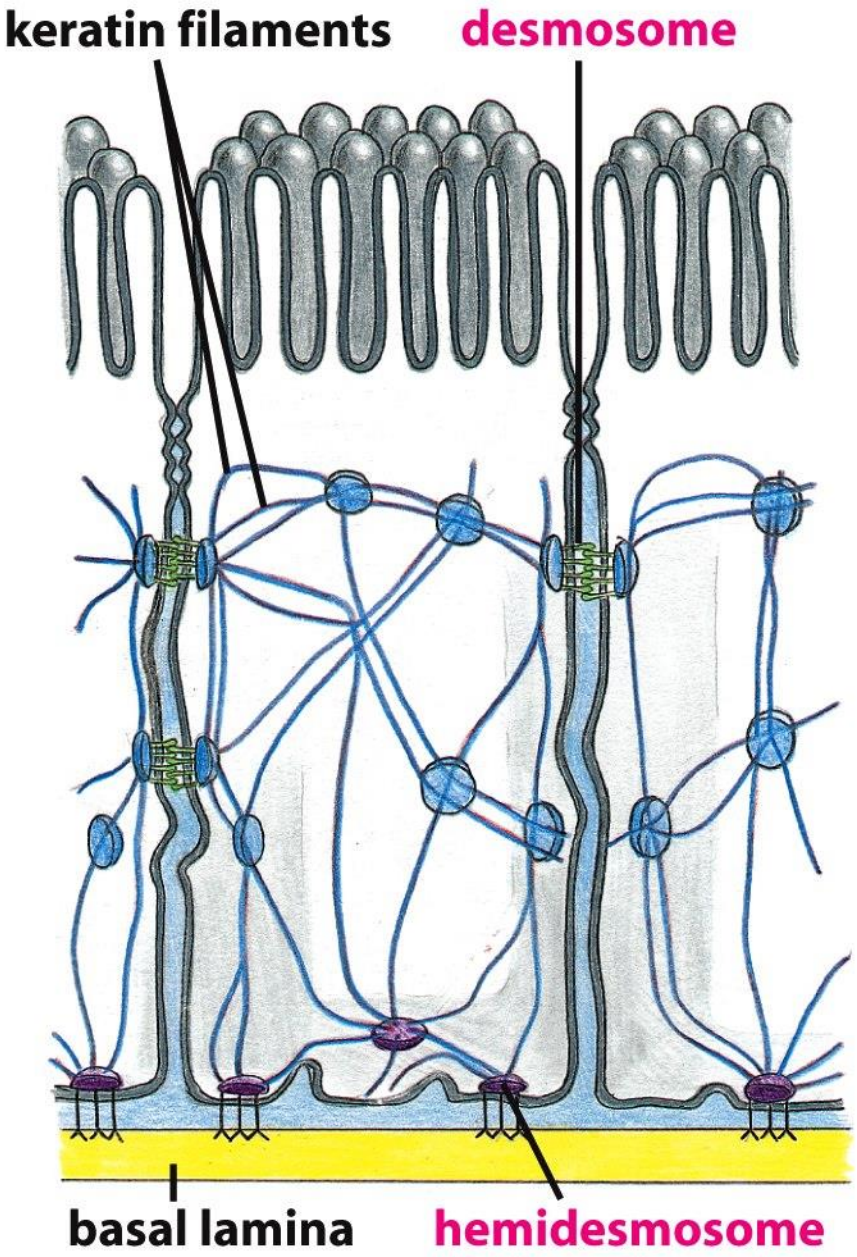


Figure 19-18 *Molecular Biology of the Cell* (© Garland Science 2008)

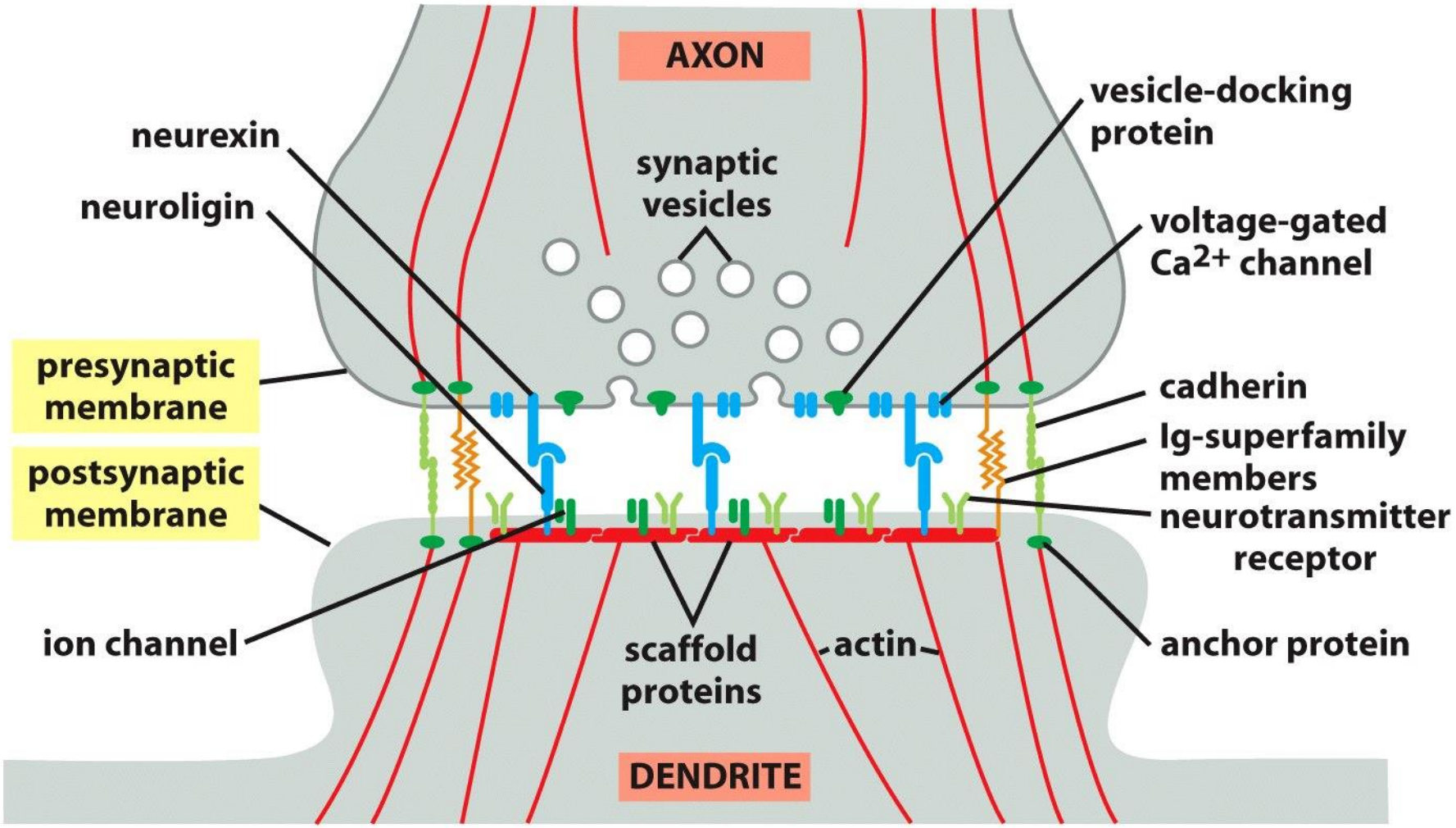
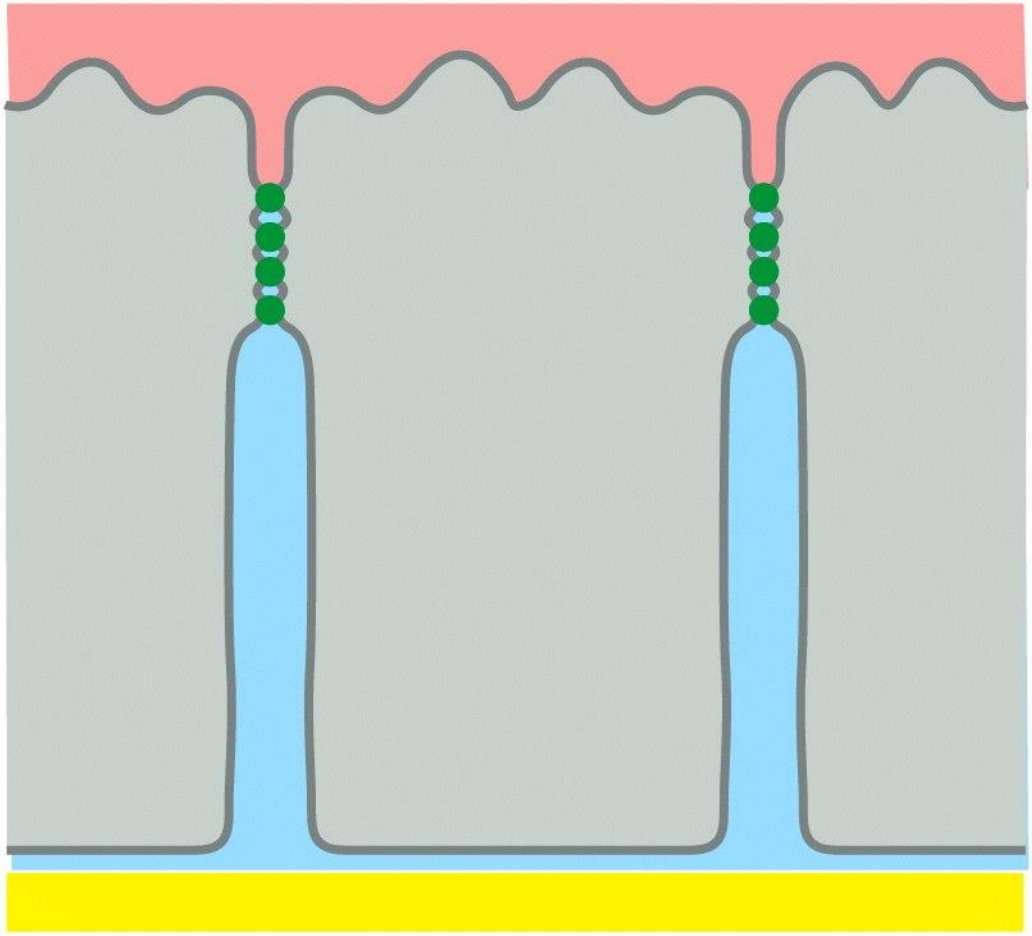


Figure 19-22c *Molecular Biology of the Cell* (© Garland Science 2008)



OCCLUDING JUNCTIONS

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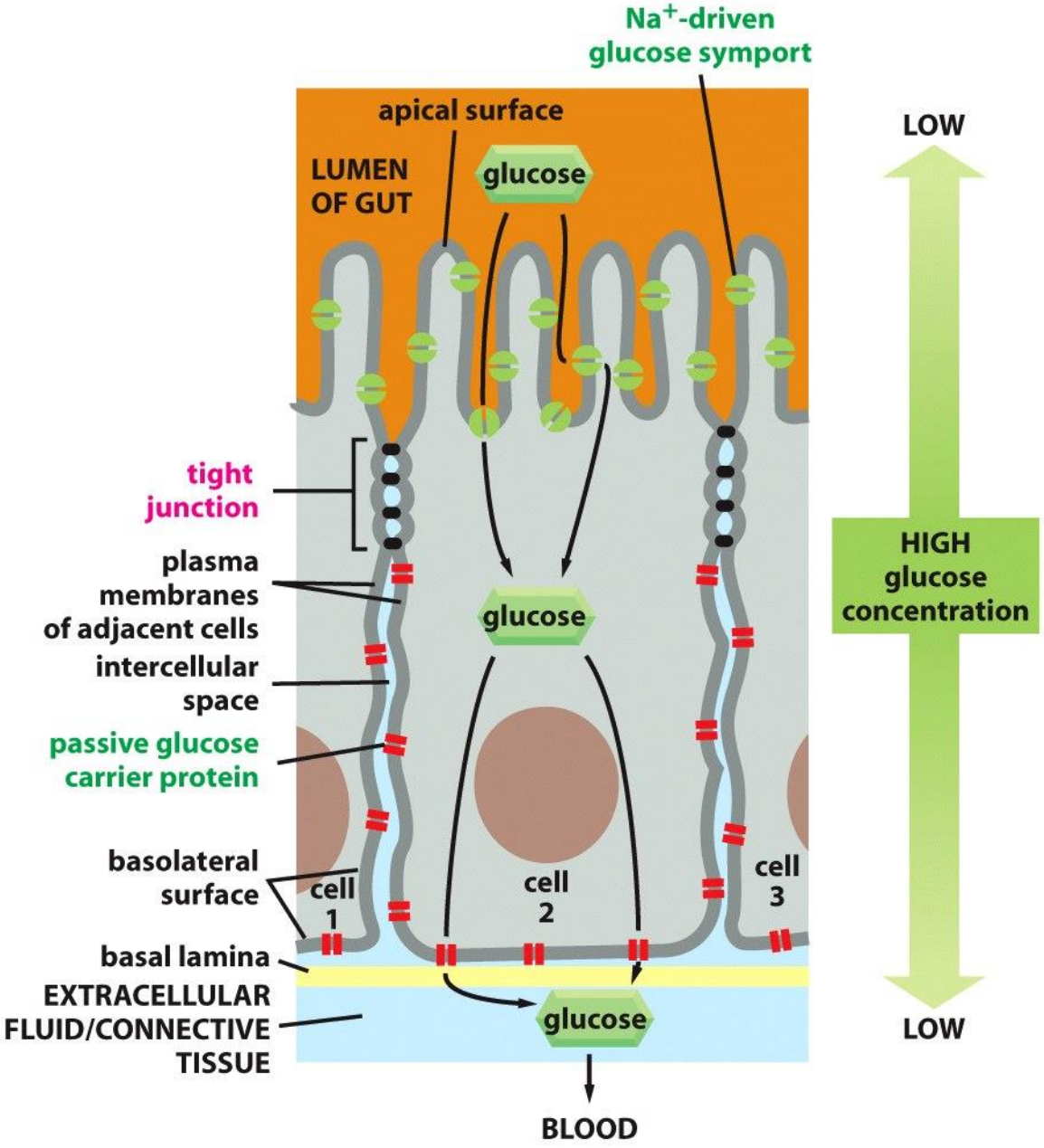

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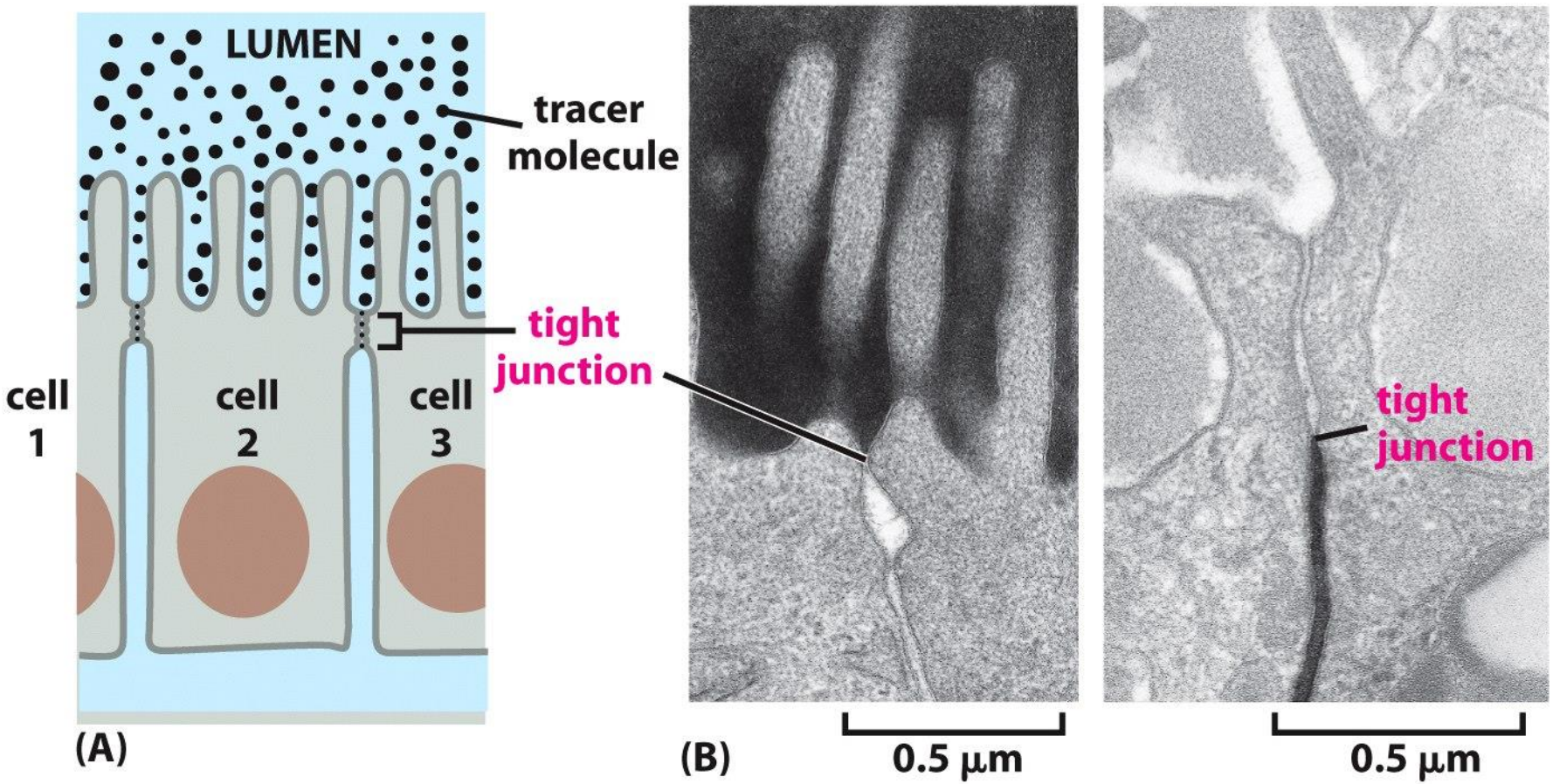
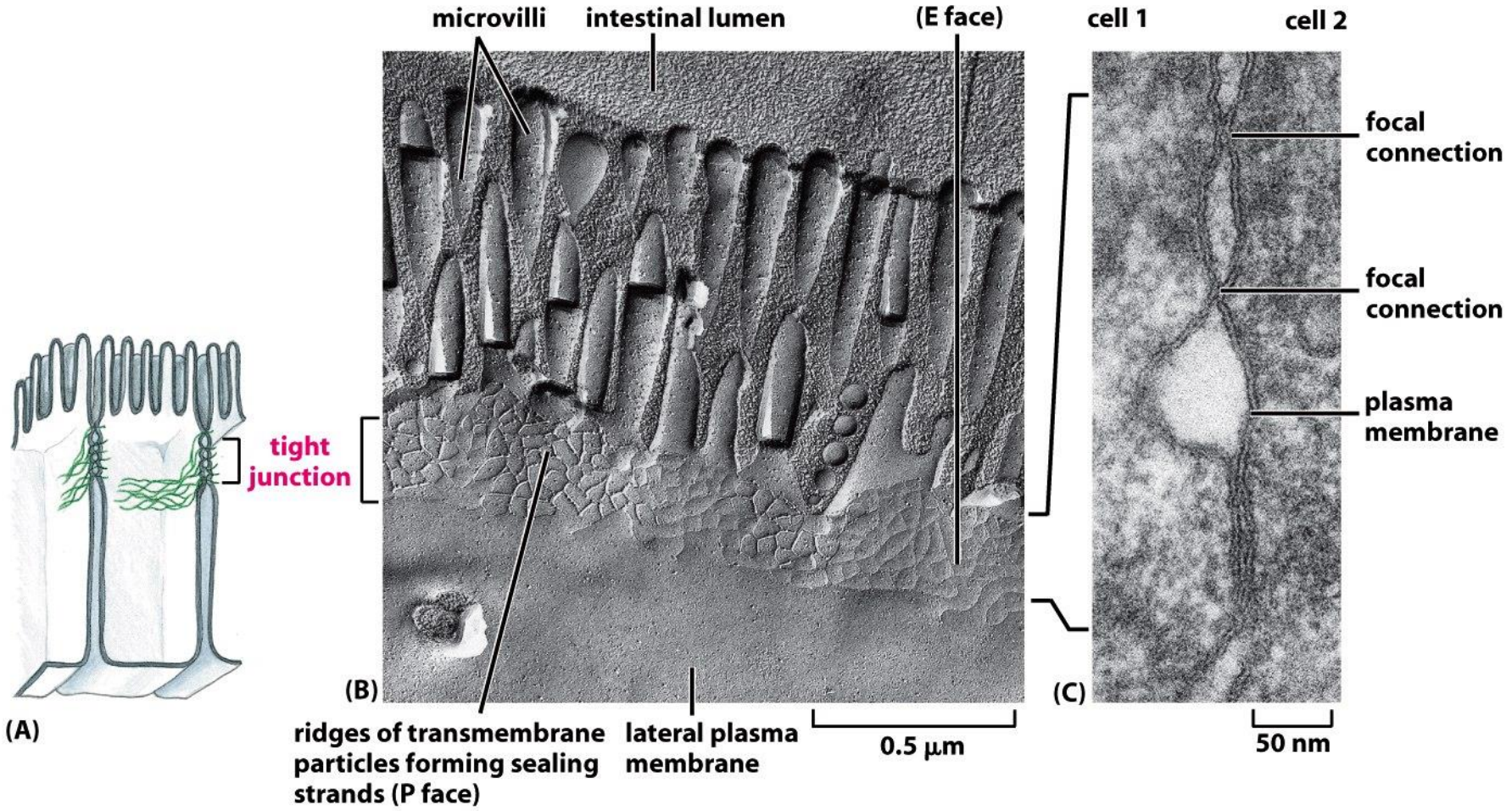


Figure 19-24 *Molecular Biology of the Cell* (© Garland Science 2008)



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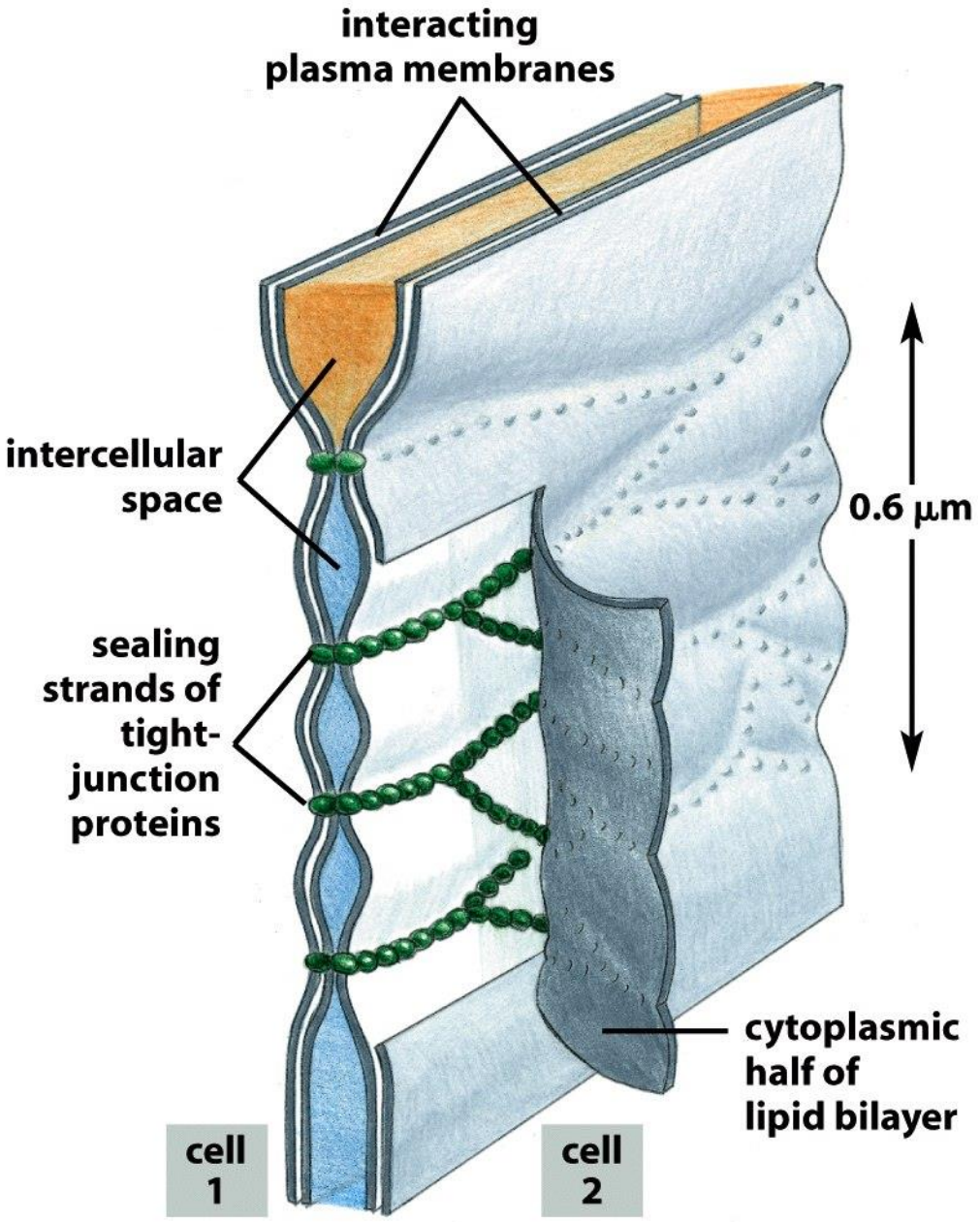

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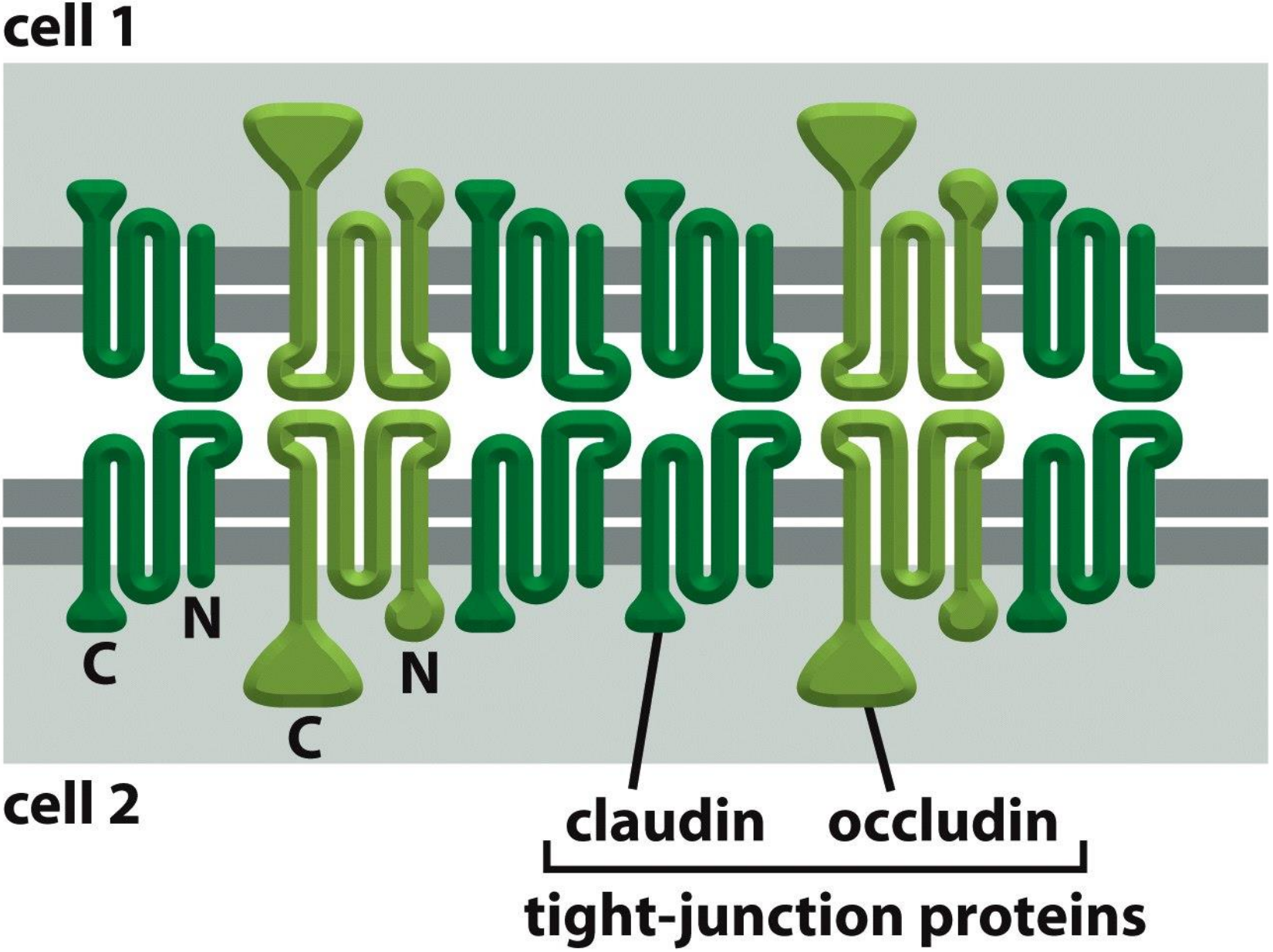

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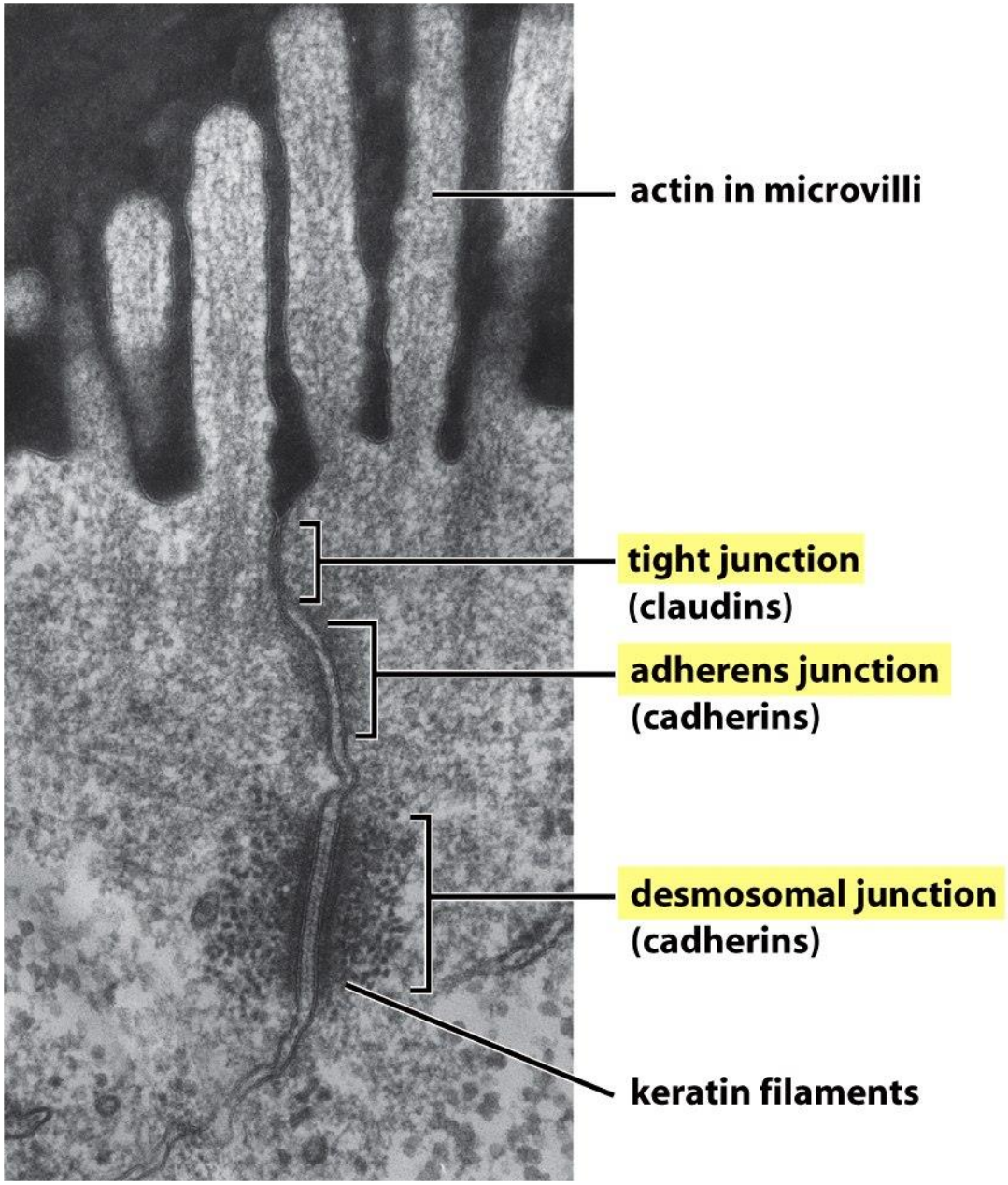

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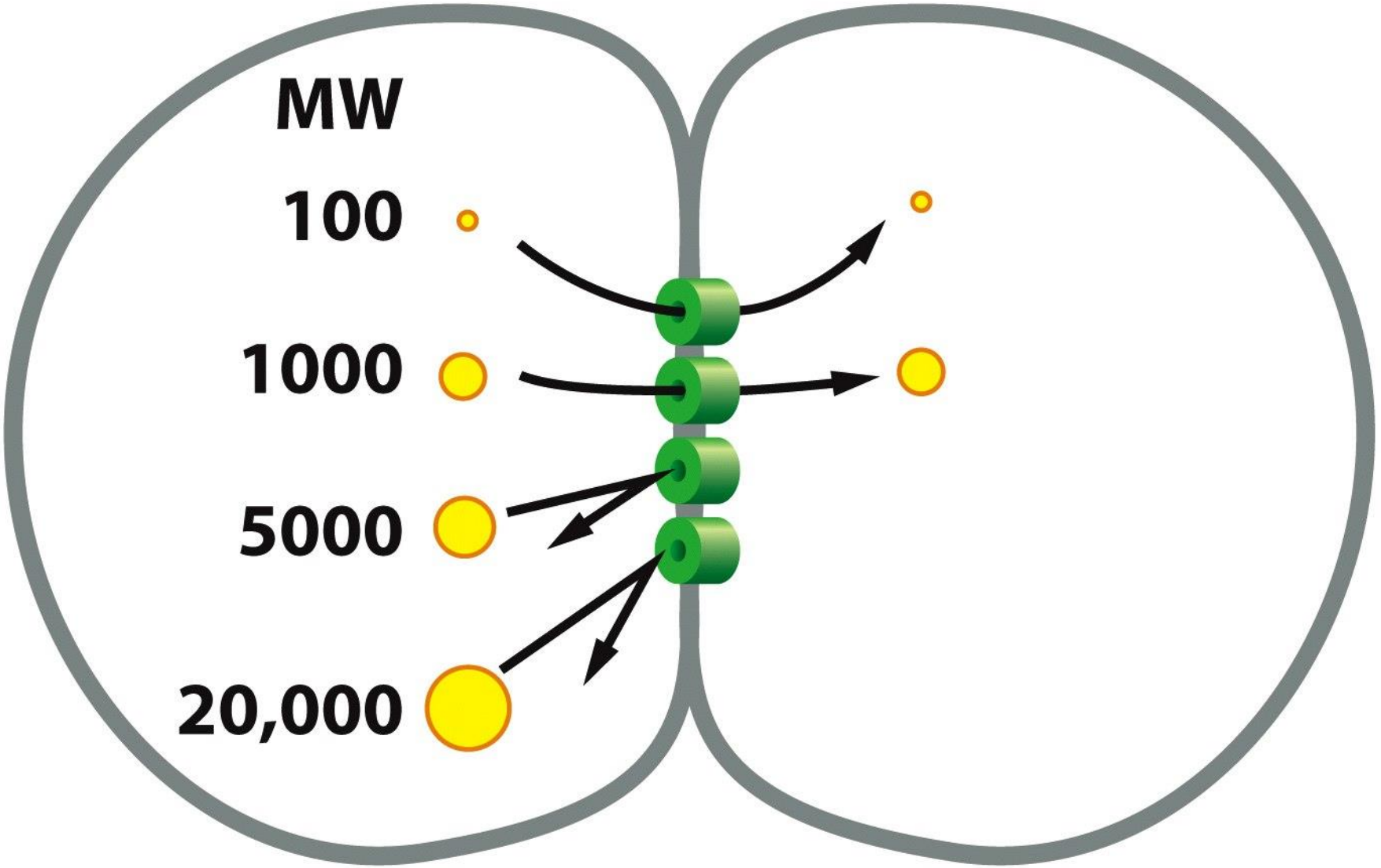

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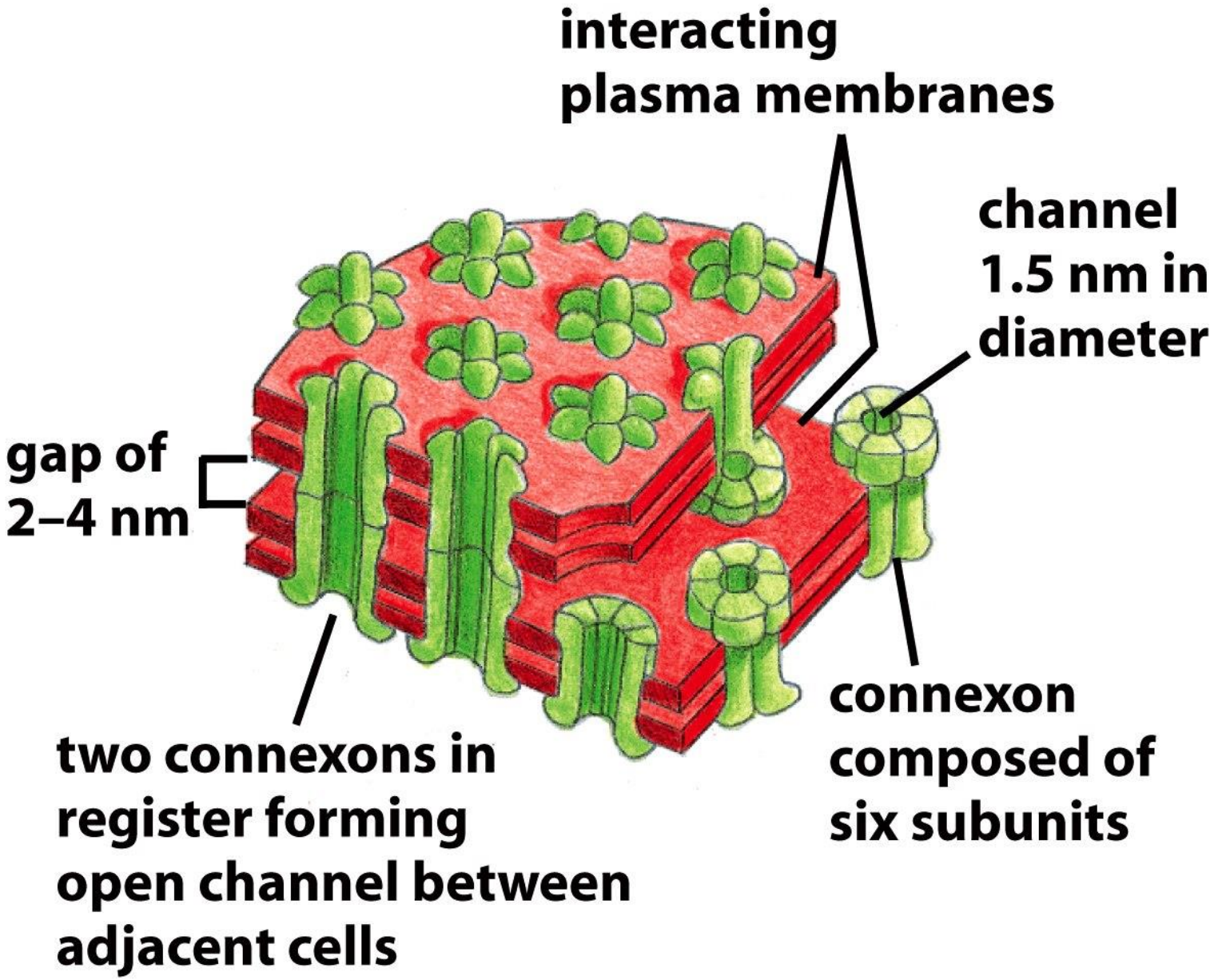

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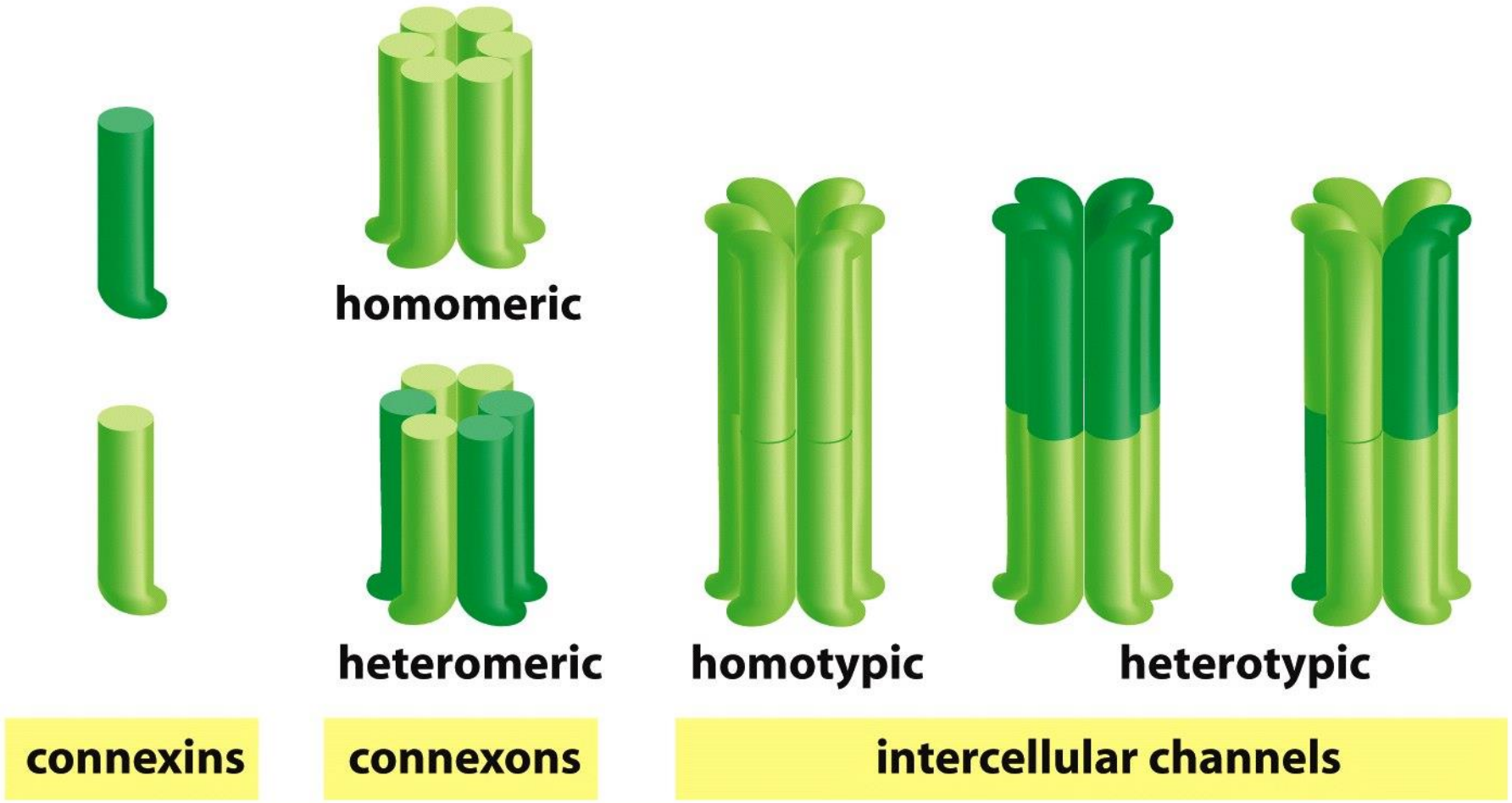

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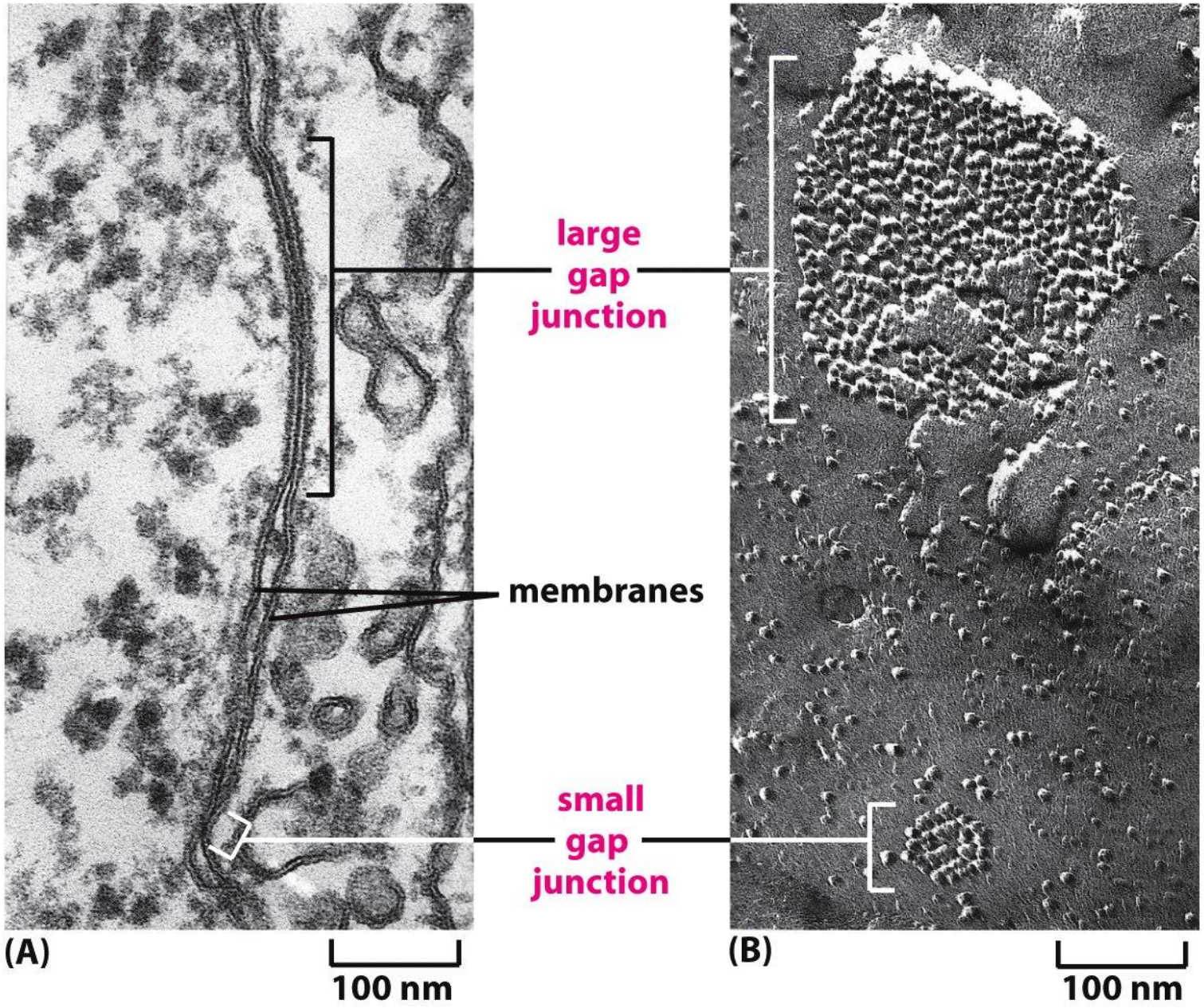

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