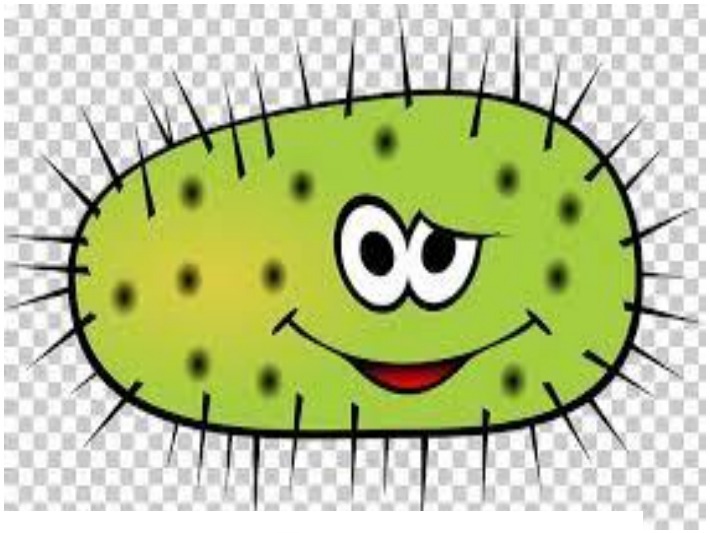
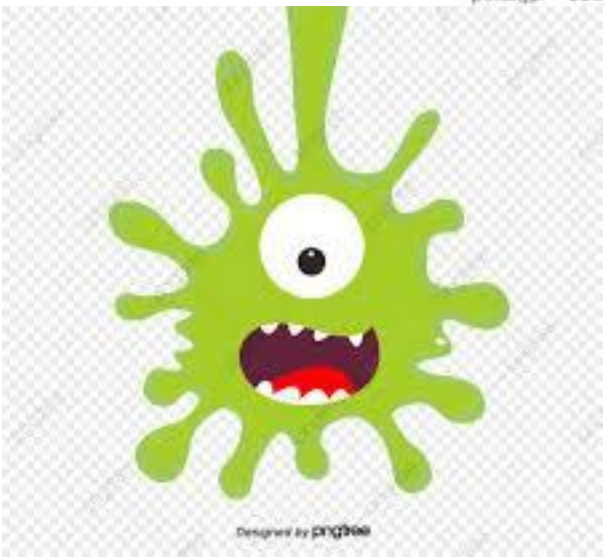
Cells surface modifications



Dr Shahab

Associate Professor

Anatomy KGMC



LATERAL SURFACE FEATURES

- Tight junctions
- Desmosomes
- Gap junctions

APICAL SURFACE FEATURES

- Microvilli
- Cilia
- Flagellum

BASAL SURFACE FEATURES

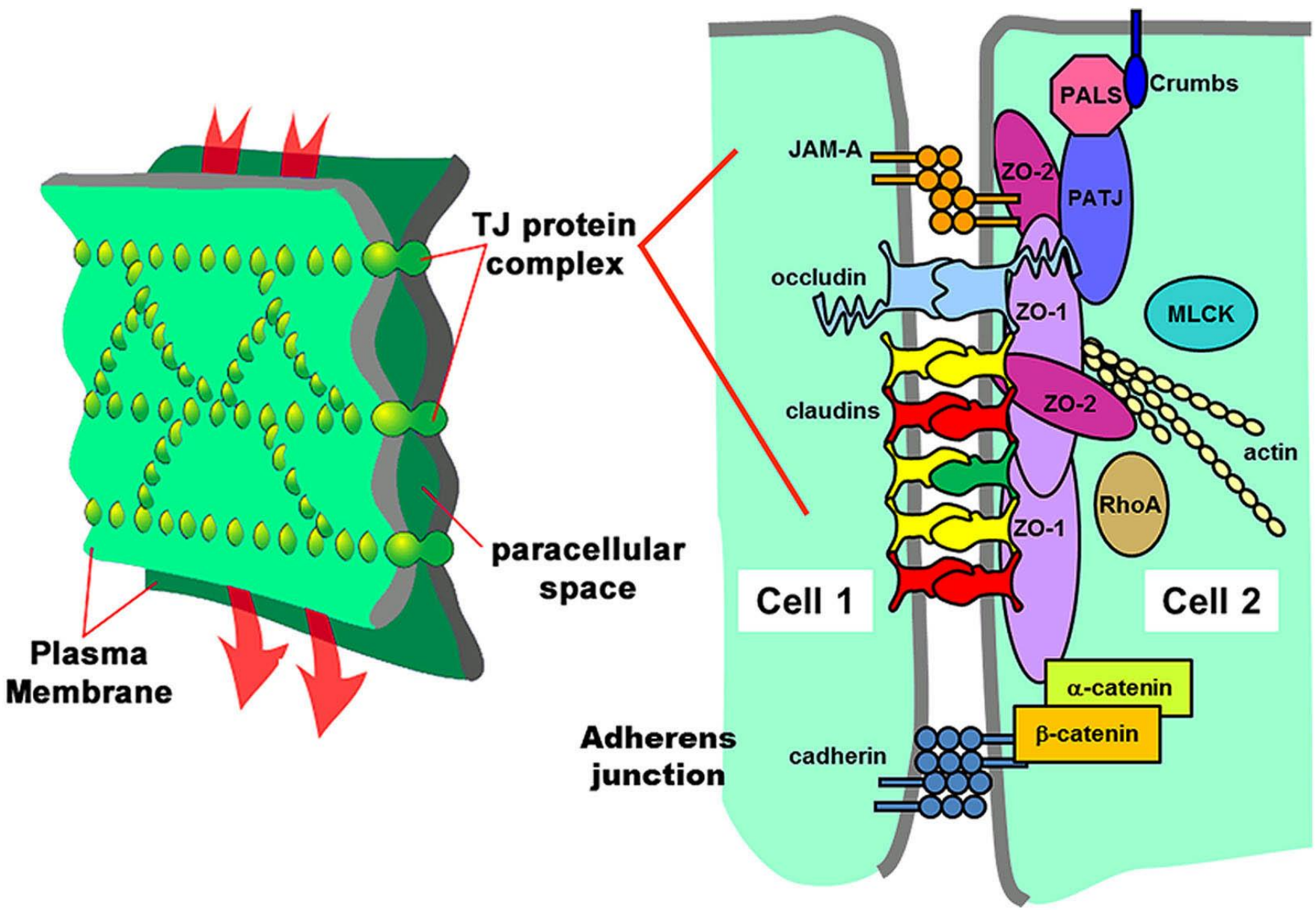
- Basement membrane
- Basal lamina

GLYCOCALYX

Rich in polysaccharides, act as receptor cite for hormones and enzymes

1. Tight Junction (Zonula occludens)

- Integral proteins of adjacent cells fuse together
- Completely encircle the cell and form an adhesion belt.
- Form an impermeable junction.
- Common near apical region
- Prevent molecules from passing between cells of epithelial tissue.


TJ protein complex
paracellular space
Plasma Membrane
JAM-A
occludin
claudins
PALS
Crumbs
ZO-2
PATJ
ZO-1
MLCK
ZO-2
actin
RhoA
ZO-1
Cell 1
Cell 2
α-catenin
β-catenin
Adherens junction
cadherin

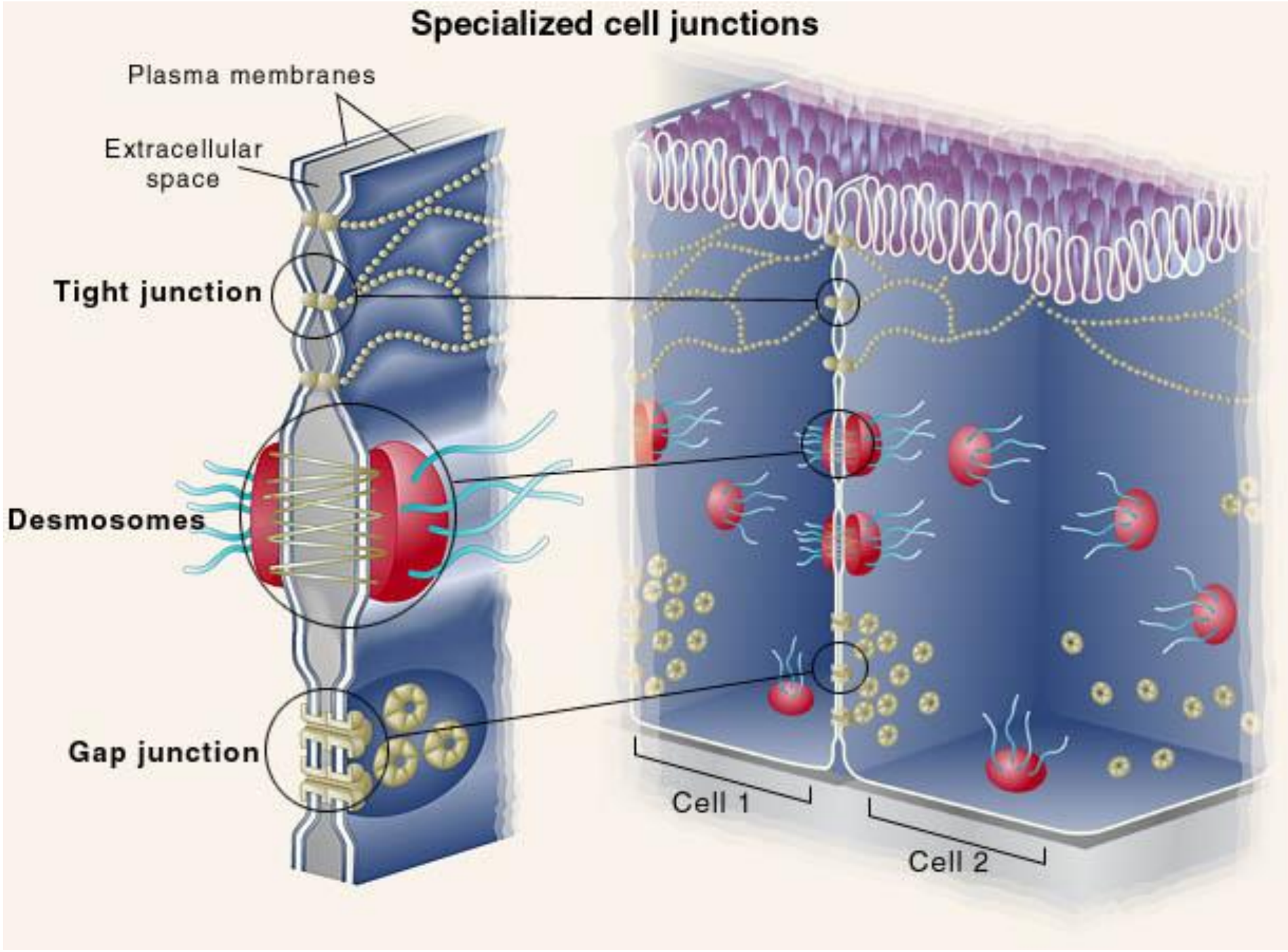
2. Desmosomes (Macula adherens)

- Two disc-like plaques connected across intercellular space
- Plaques of adjoining cells are joined by proteins called *cadherins*
- Proteins interdigitate into extracellular space
- Intermediate filaments insert into plaques from cytoplasmic side

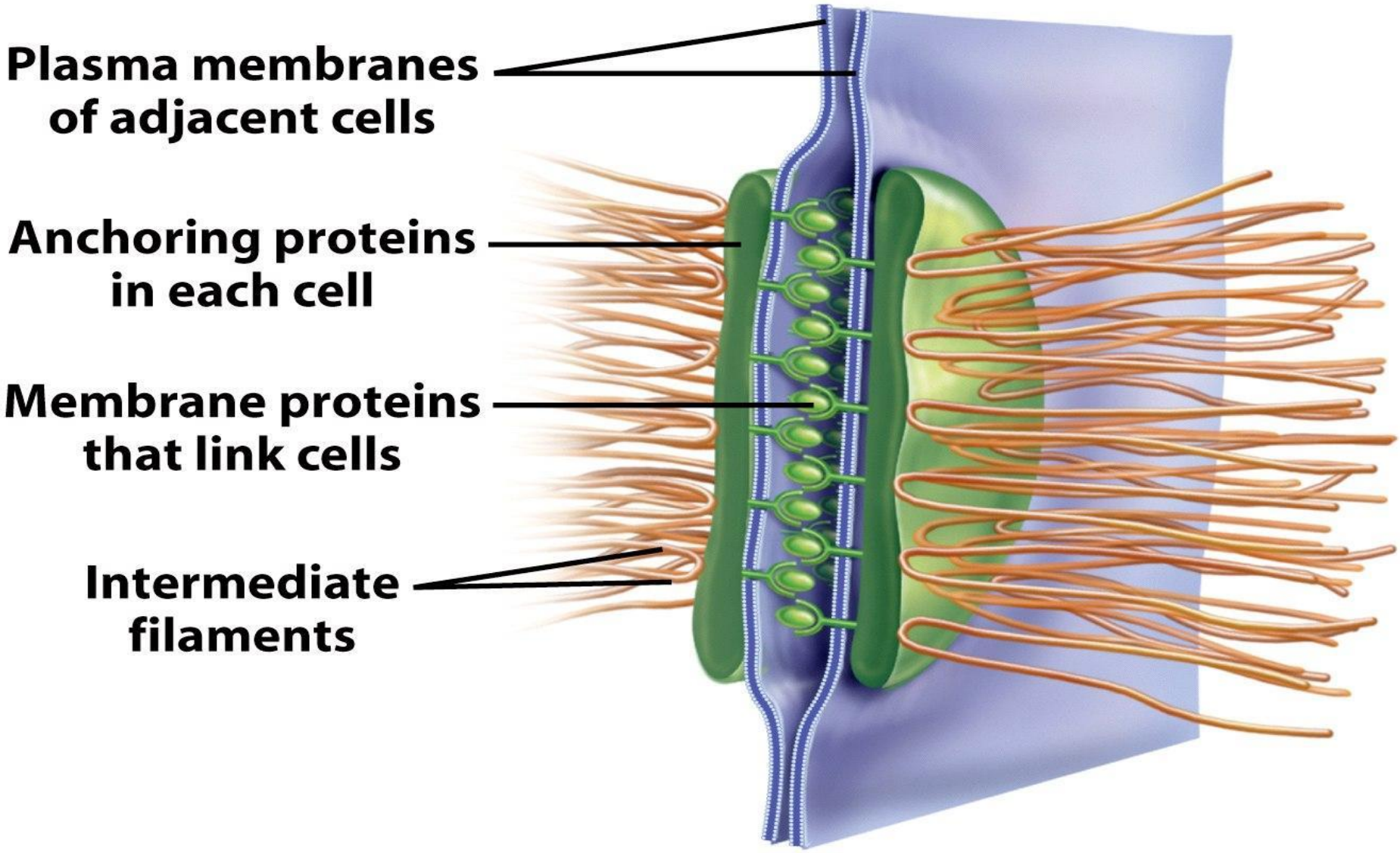
Membrane Junctions: Desmosome

Linker proteins extend from plaque like teeth of a zipper. Intermediate filaments extend across width of cell.

- Common in superficial layers of skin; skin peels after a sunburn
- Reduces chance of tearing, twisting, stretching

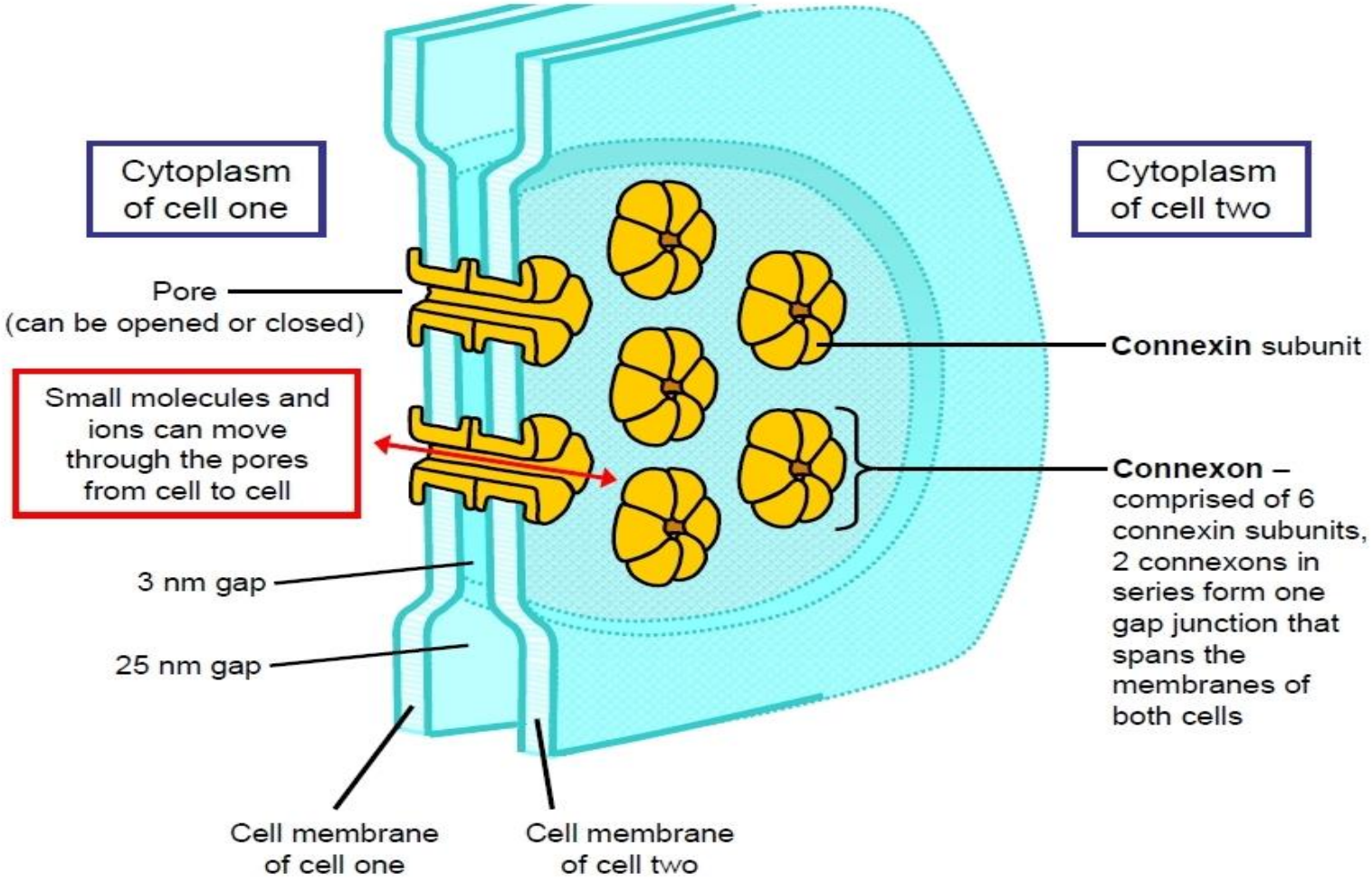

Specialized cell junctions
Plasma membranes
Extracellular space
Tight junction
Desmosomes
Gap junction
Cell 1
Cell 2

Three-dimensional view of desmosome



3. Gap Junction (Nexus)

- *Connexon* proteins are trans- membrane proteins.
- Present in electrically excitable tissues (heart, smooth muscle)



Above: gap junctions connecting the cytoplasm of two neighbouring animal cells

Gap junctions create gaps that connect animal cells.

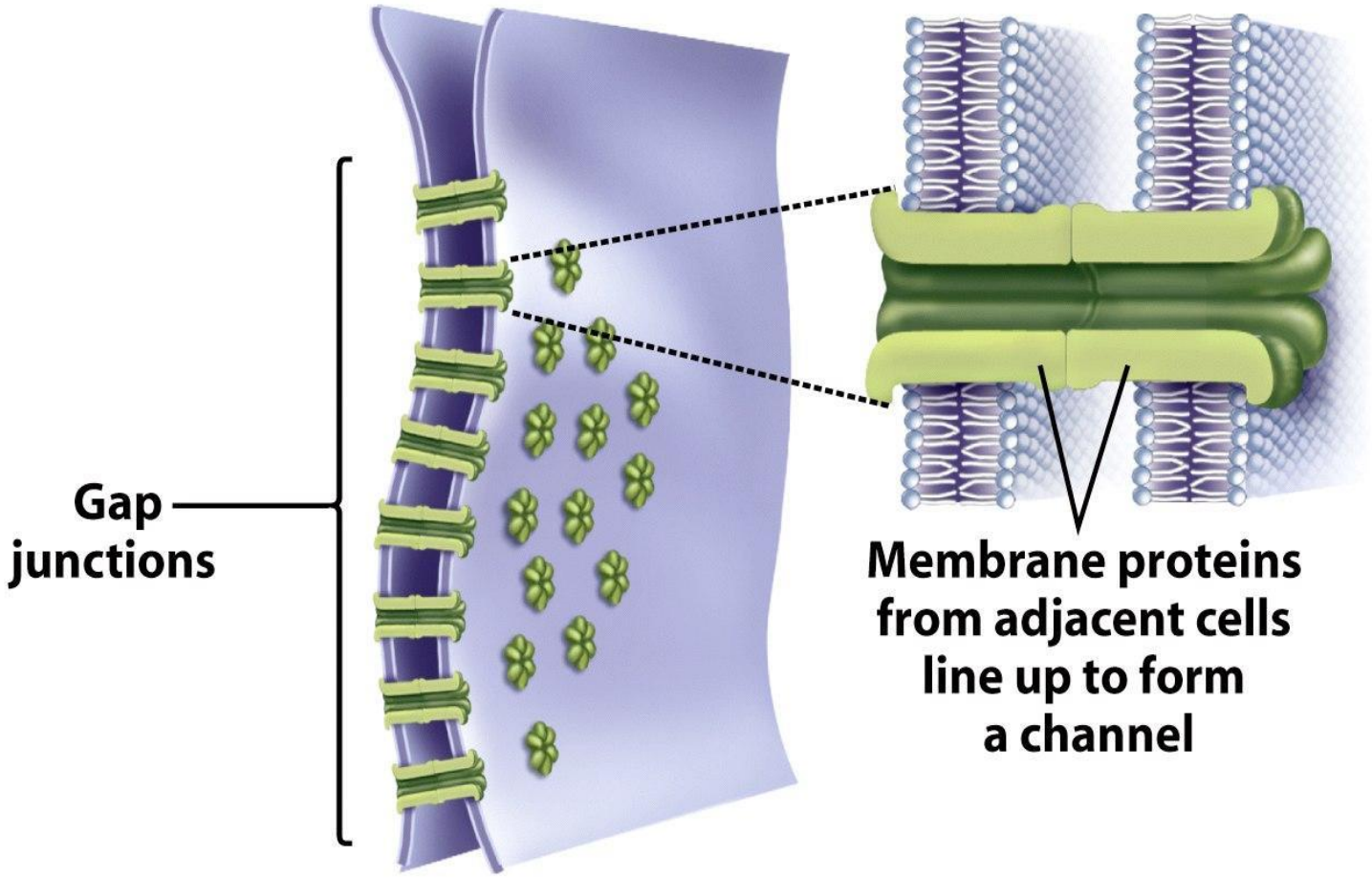


Figure 8-13b part 2 Biological Science, 2/e

Intercellular Junctions

Tight junctions

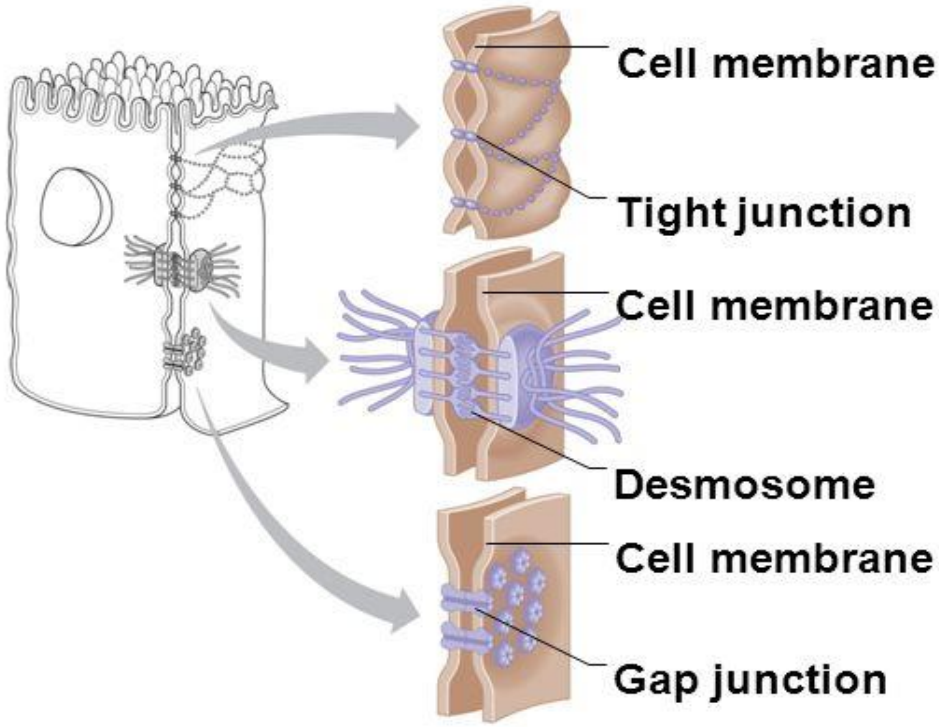
- Close space between cells
- Located among cells that form linings

Desmosomes

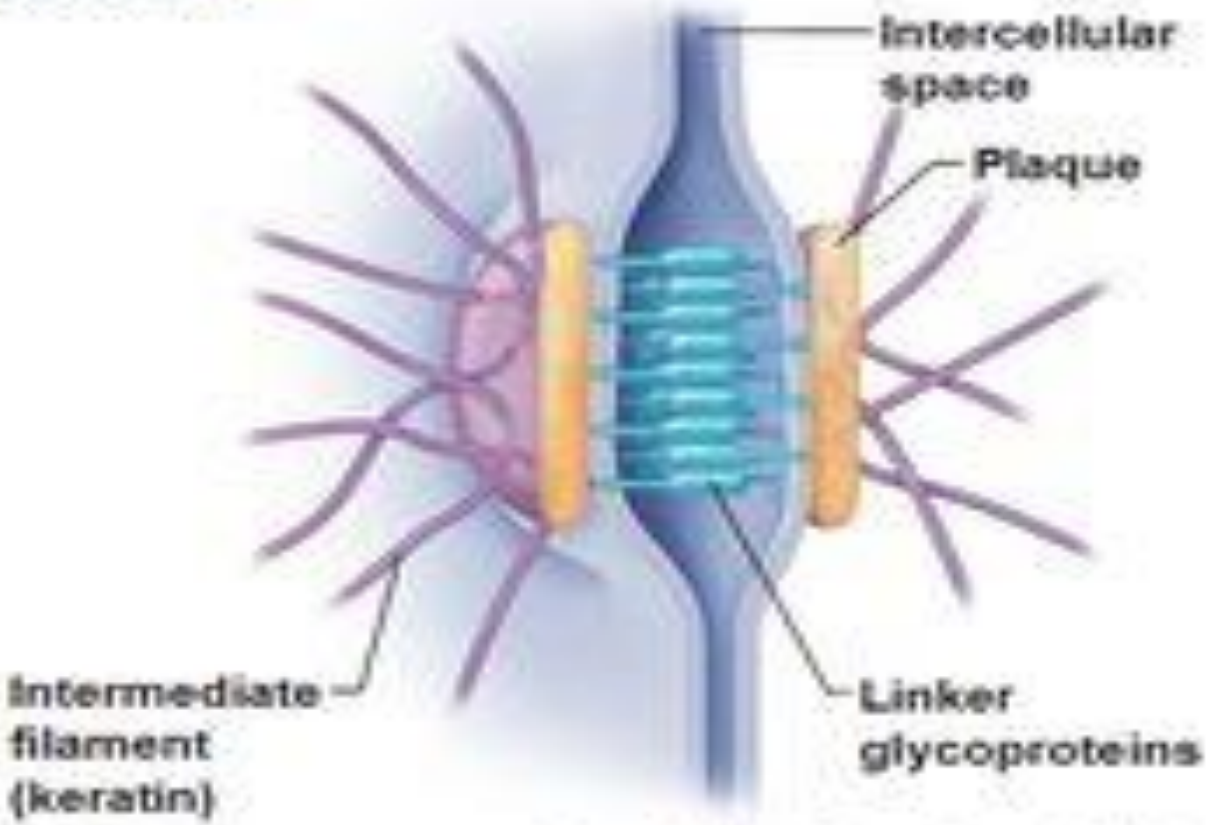
- Form anchors between cells
- Located among outer skin cells

Gap junctions

- Tubular channels between cells
- Located in cardiac muscle cells

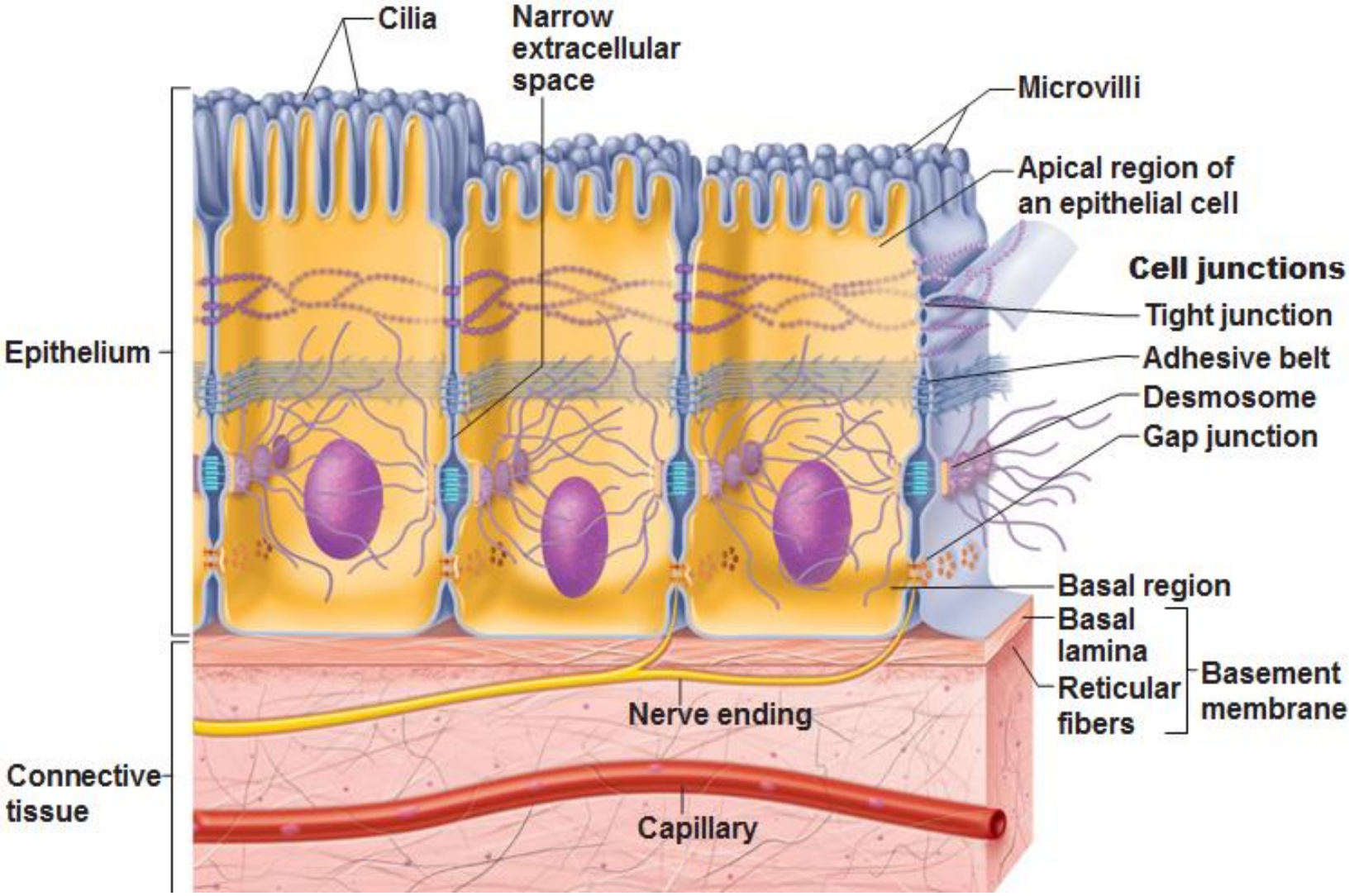


Desmosome

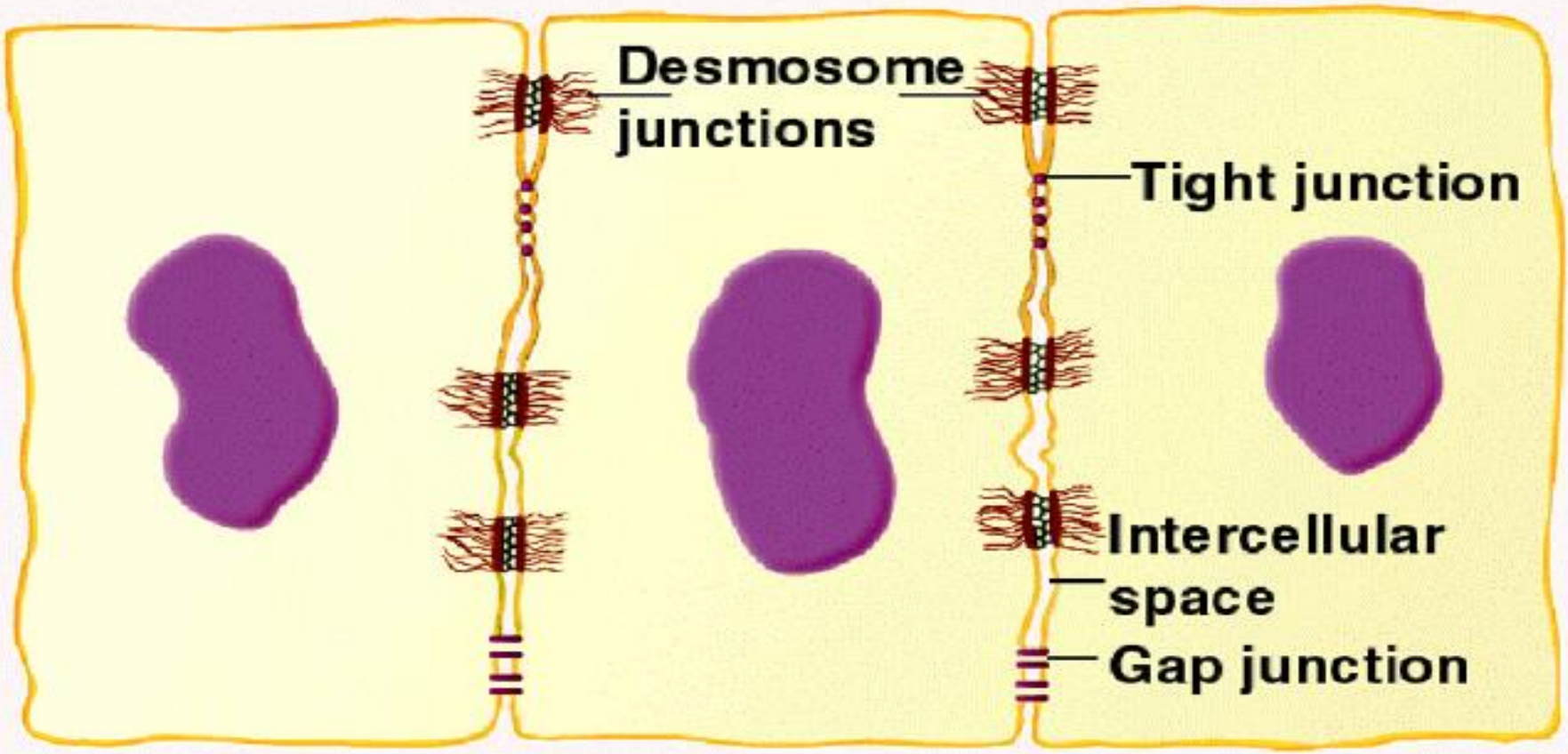


(b) **Desmosomes:** Anchoring junctions bind adjacent cells together and help form an internal tension-reducing network of fibers.

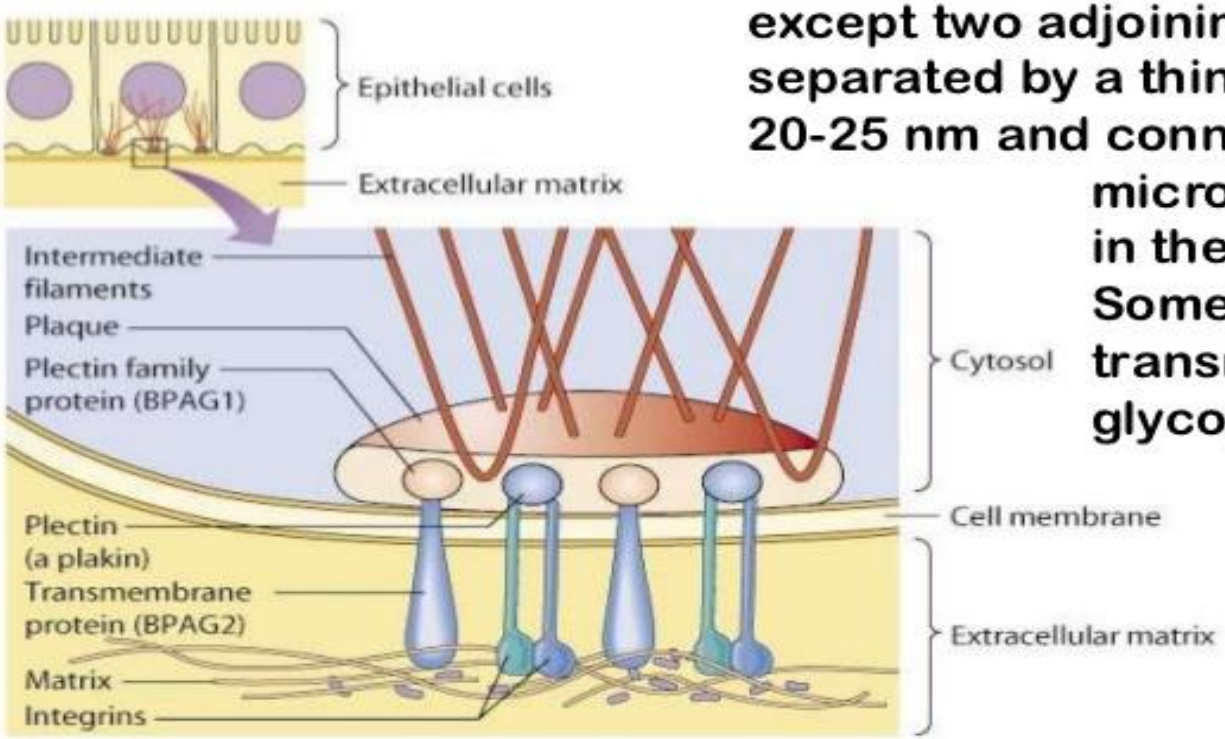
Special Characteristics of Epithelia-Cell Junctions



Animal Cell Junctions (1)



HEMIDESMOSOMES connect a cell, through a plaque, to the basal lamina (ECM) by integrins. As in desmosomes, hemidesmosomes interact with tonofilament intermediate filaments. Adherens junctions resemble desmosomes except two adjoining cells are separated by a thin space of 20-25 nm and connect to actin microfilaments in the cytoplasm. Some of the transmembrane glycoproteins are cadherins.



(c) Hemidesmosome

Desmosomes and hemidesmosomes

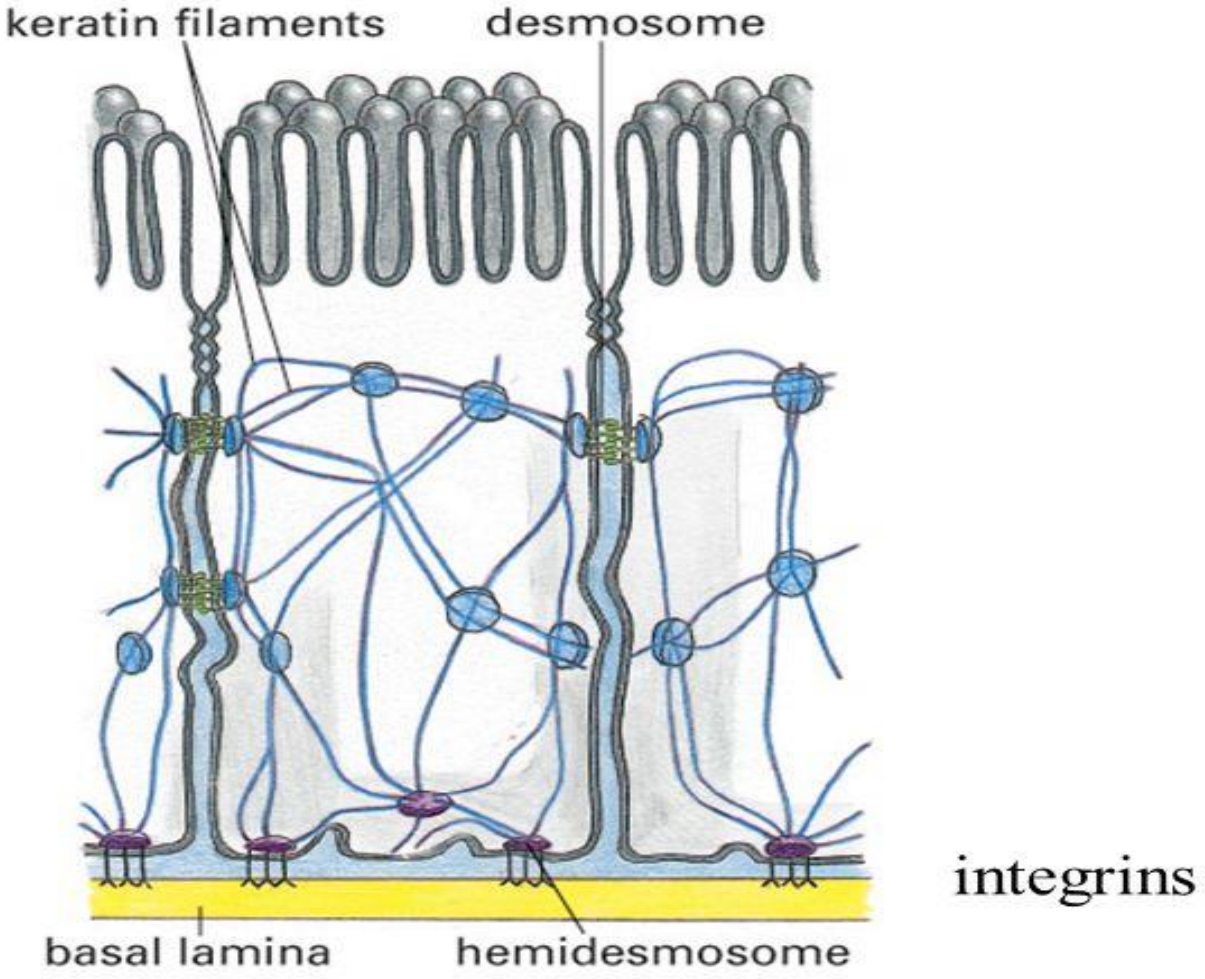


Figure 19–13. Molecular Biology of the Cell, 4th Edition.

HEMIDESMOSOMES

Figure 10.17 part 1
Biology: How Life Works

Hemidesmosome:
Anchors epithelial cells to basal lamina
Integrins are the cell adhesion molecules

Hemidesmosome

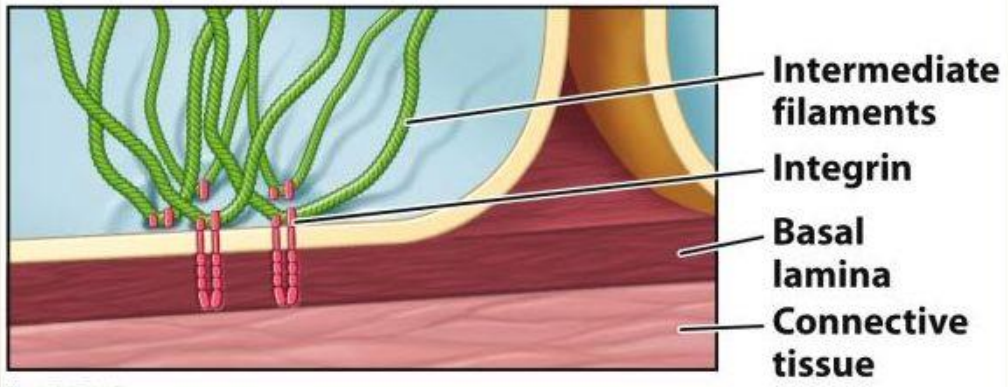
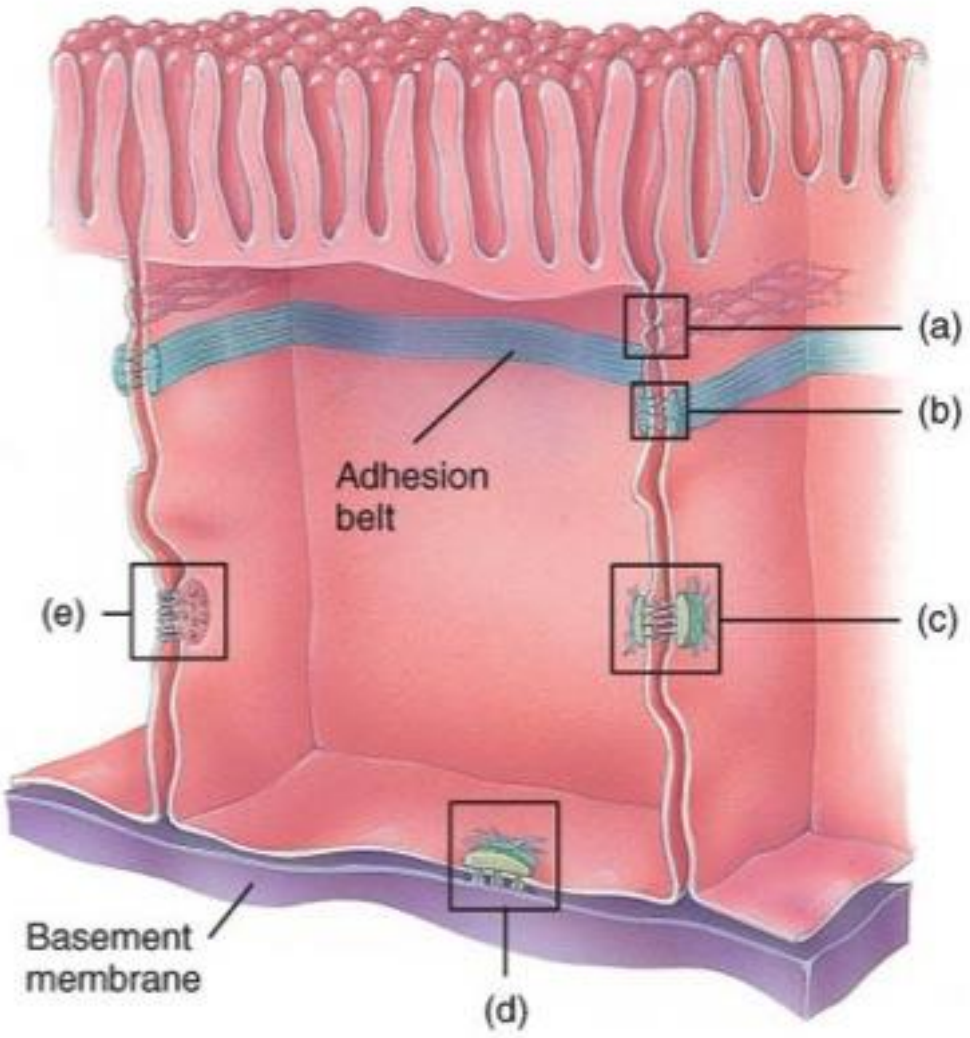


Figure 10.17 part 5
Biology: How Life Works

Cell Junctions

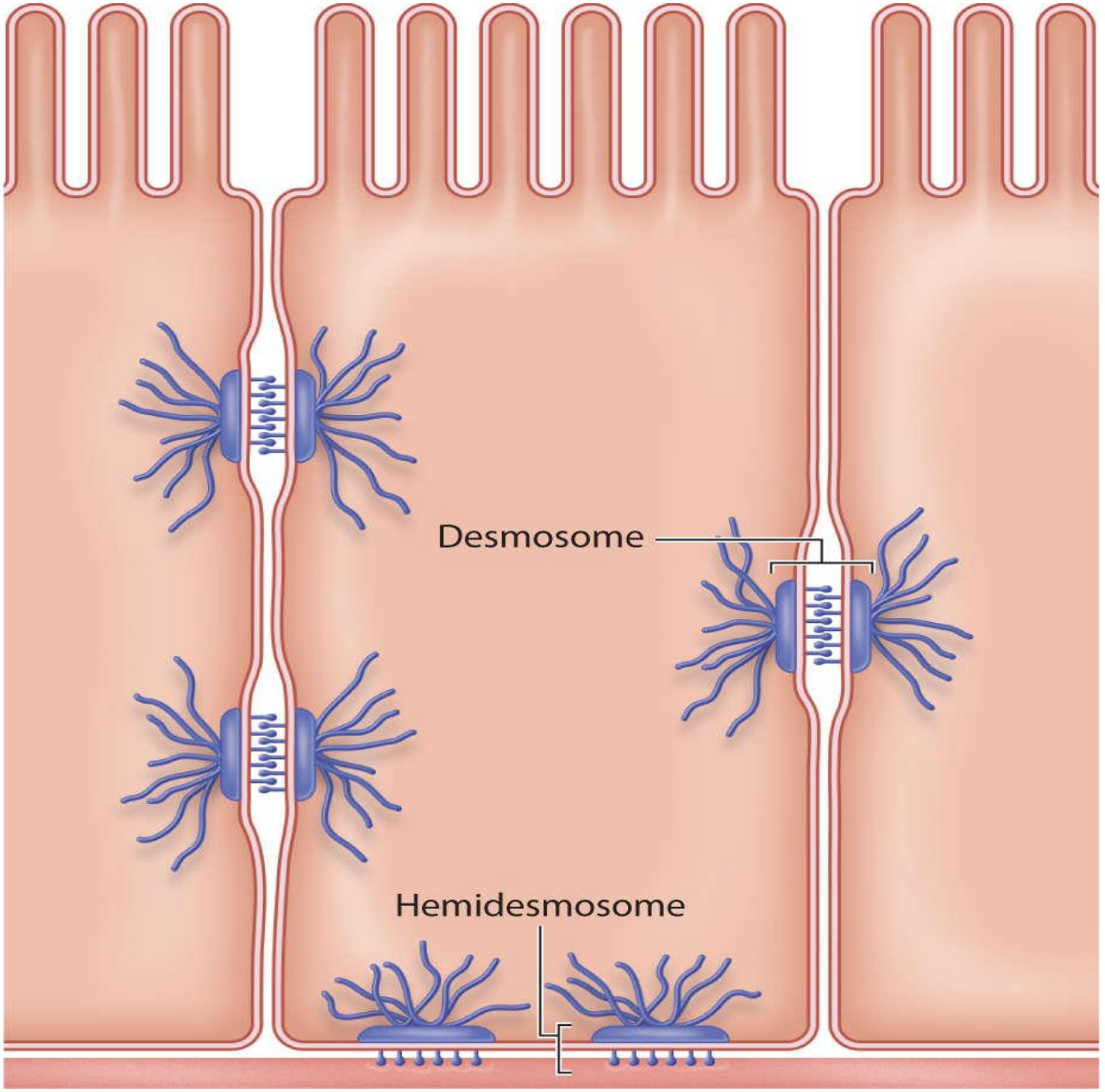


- A. Tight junctions
- B. Adherens junctions
- C. Desmosomes
- D. Hemidesmosomes
- E. Gap junctions

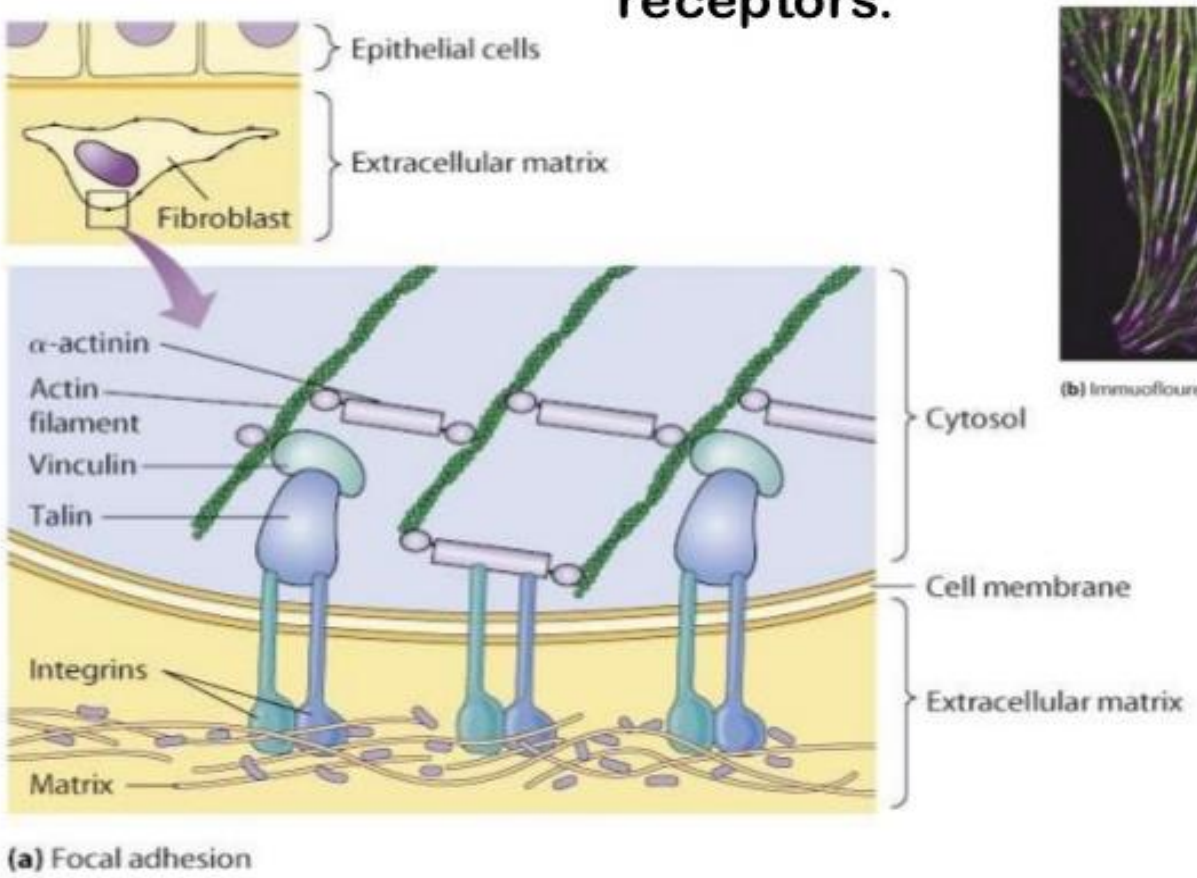
Hemidesmosomes link the cell to the basal lamina and, through additional extracellular molecules, to the rest of the extracellular matrix.

Significance: Several types of epidermolysis bullosa, a blistering skin disorder, have been shown to be caused by mutations of the genes for various desmosomal, hemidesmosomal, and intermediate filament proteins. In addition, some forms of the disease are caused by mutations of the genes for extracellular matrix proteins involved in cell-matrix adhesion. Pemphigus vulgaris and pemphigus foliaceus, blistering diseases of the oral mucosa and skin, respectively, are caused by autoantibodies to desmoglein-3 and desmoglein-I, the cadherin in desmosomes.

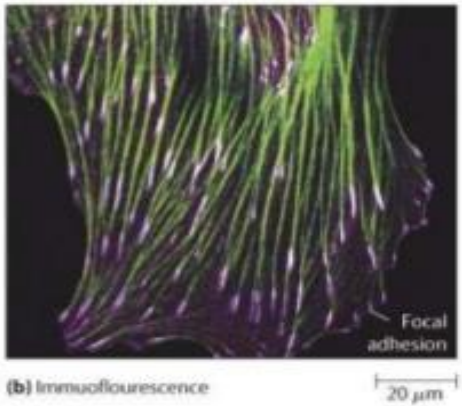

(a)
(b)
(c)


Desmosome
Hemidesmosome

Adherens junctions called FOCAL ADHESION can join a cell to the ECM, primarily through fibronectin receptors.

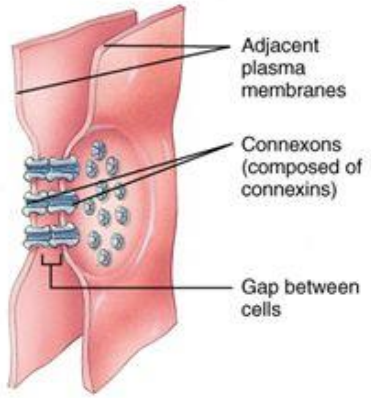


(a) Focal adhesion

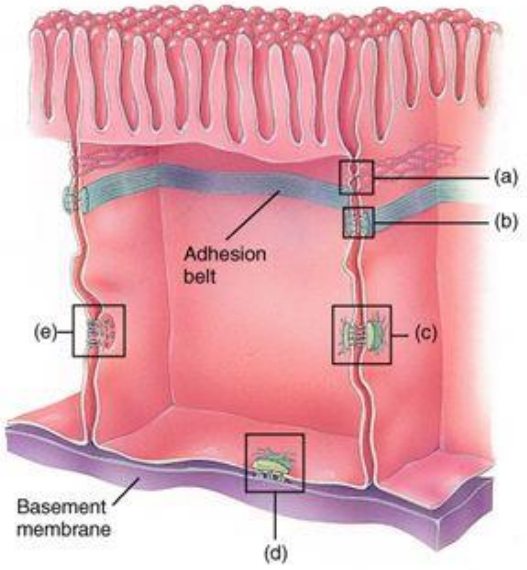


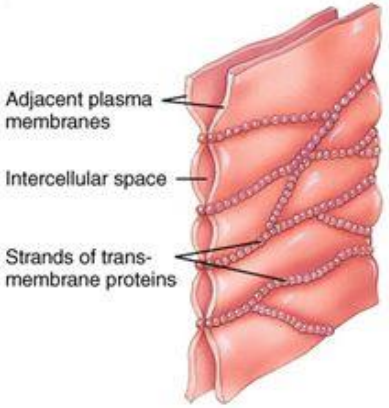
(b) Immunoflourescence

Cell Junctions

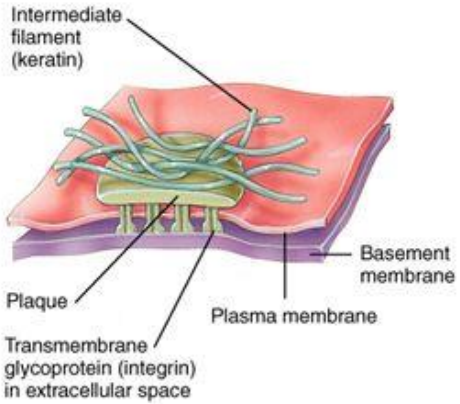


Gap Junction

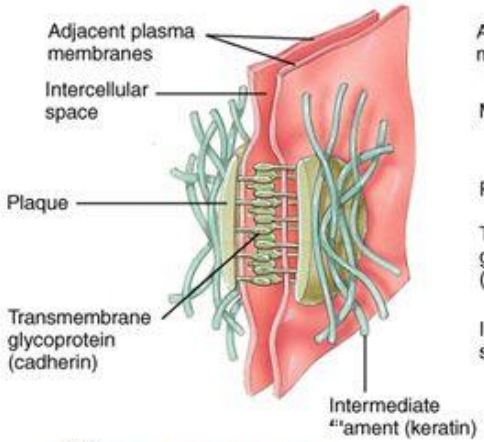




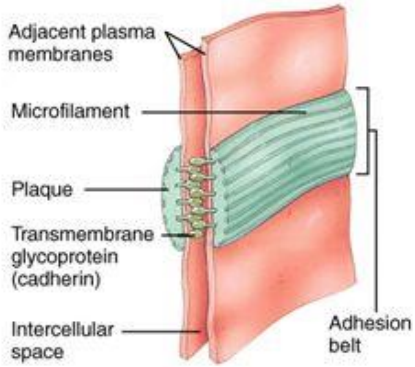
Tight Junction



Hemidesmosome

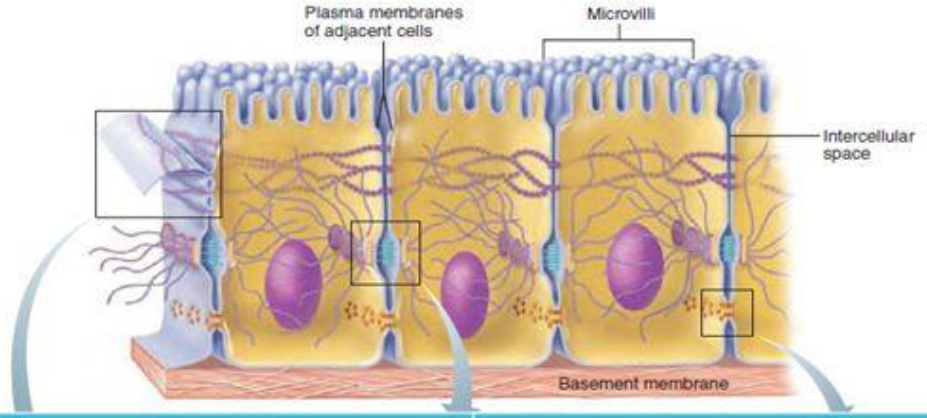


Desmosome



Adherens

Cell Junctions



Tight Junctions	Desmosomes	Gap Junctions
Impermeable junctions	**Anchoring junctions** bind to adjacent cells like Velcro	Allow for **intercellular communication**
Prevent molecules from passing through intercellular space	Form internal tension-reducing network of fibers; plaques on surface of membrane attach to protein filaments	Allow ions and small molecules to pass through channels formed by **connexon** protein cylinders
Example:	**Example:**	**Example:**
Lining of the digestive tract	Found in tissues subject to stress like skin; heart muscle	Found in electrically excitable tissue (heart; smooth muscle) to synchronize

Epithelial Surface Features

- Apical surface features

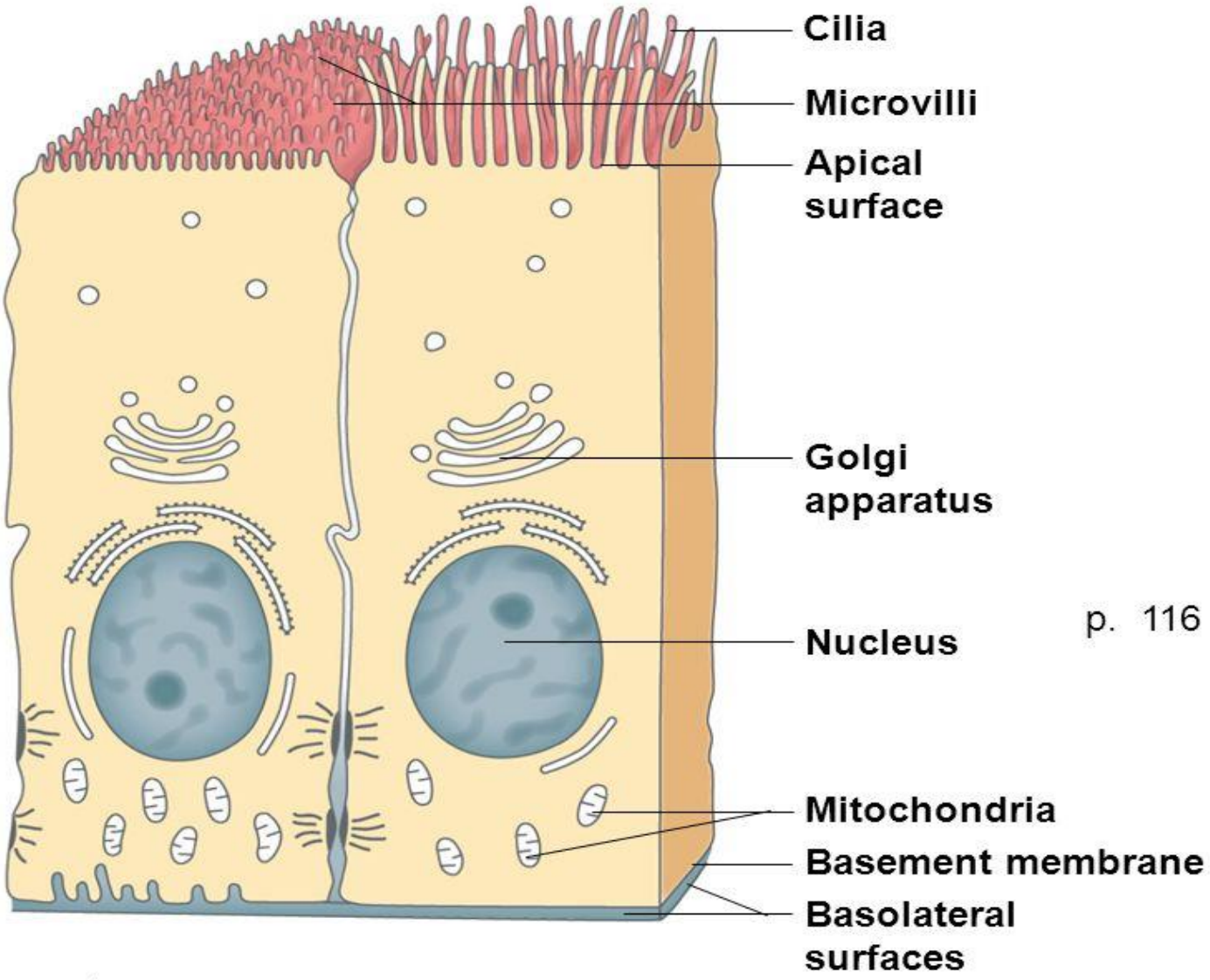
Microvilli – finger-like extensions of plasma membrane

- Abundant in epithelia of small intestine and kidney
- Maximize surface area across which small molecules enter or leave ,helps in absorption and secretion.

Cilia – whip-like, highly motile extensions of apical surface membranes

- Movement of cilia – in coordinated waves.
- Move substances over the surface of cells.

Figure 4-1 The Polarity of Epithelial Cells



p. 116

- They are both microscopic, hair-like structures that are found lining cells in your body, but that's where their similarities end.
- **Microvilli**, plural of microvillus, comes from the Greek word *mikros*, meaning ''small,'' and the Latin term *villus*, meaning ''hair.'' They are folds of the cell membrane that extend outward from the surface of certain cells. Microvilli are found in areas of the body which are specialized for absorption, such as the digestive tract or kidneys.
- They function by increasing the surface area of the cell membrane, thus allowing for more materials to be absorbed into the cell at a quicker rate. Unlike cilia, microvilli do not move.

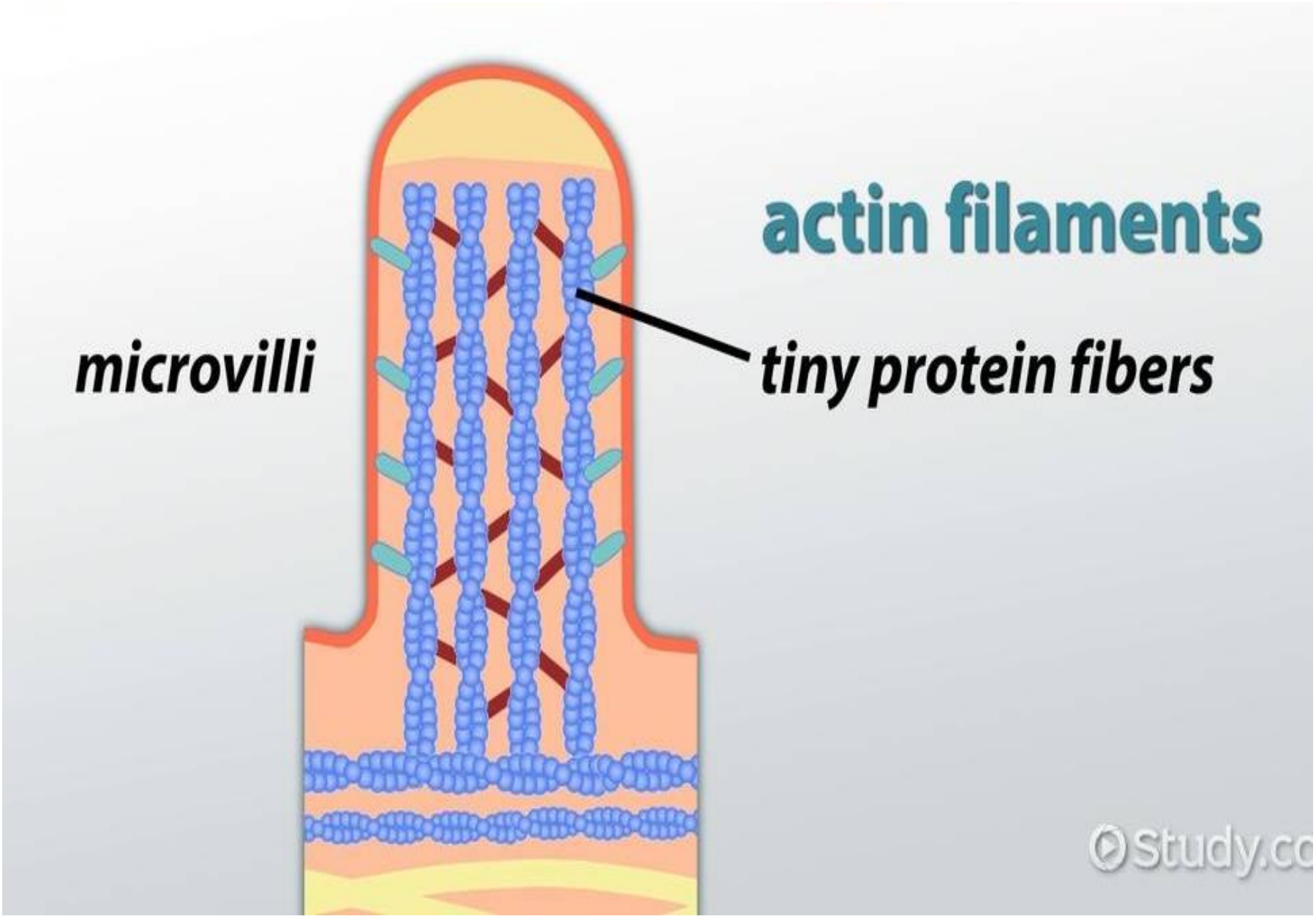
Cilia, plural for cilium, is the Latin word for ''eyelashes.'' They also resemble tiny hairs on the surface of certain cells. Many cilia move in a rhythmic, sweeping motion and serve to move particles or cells in your body.

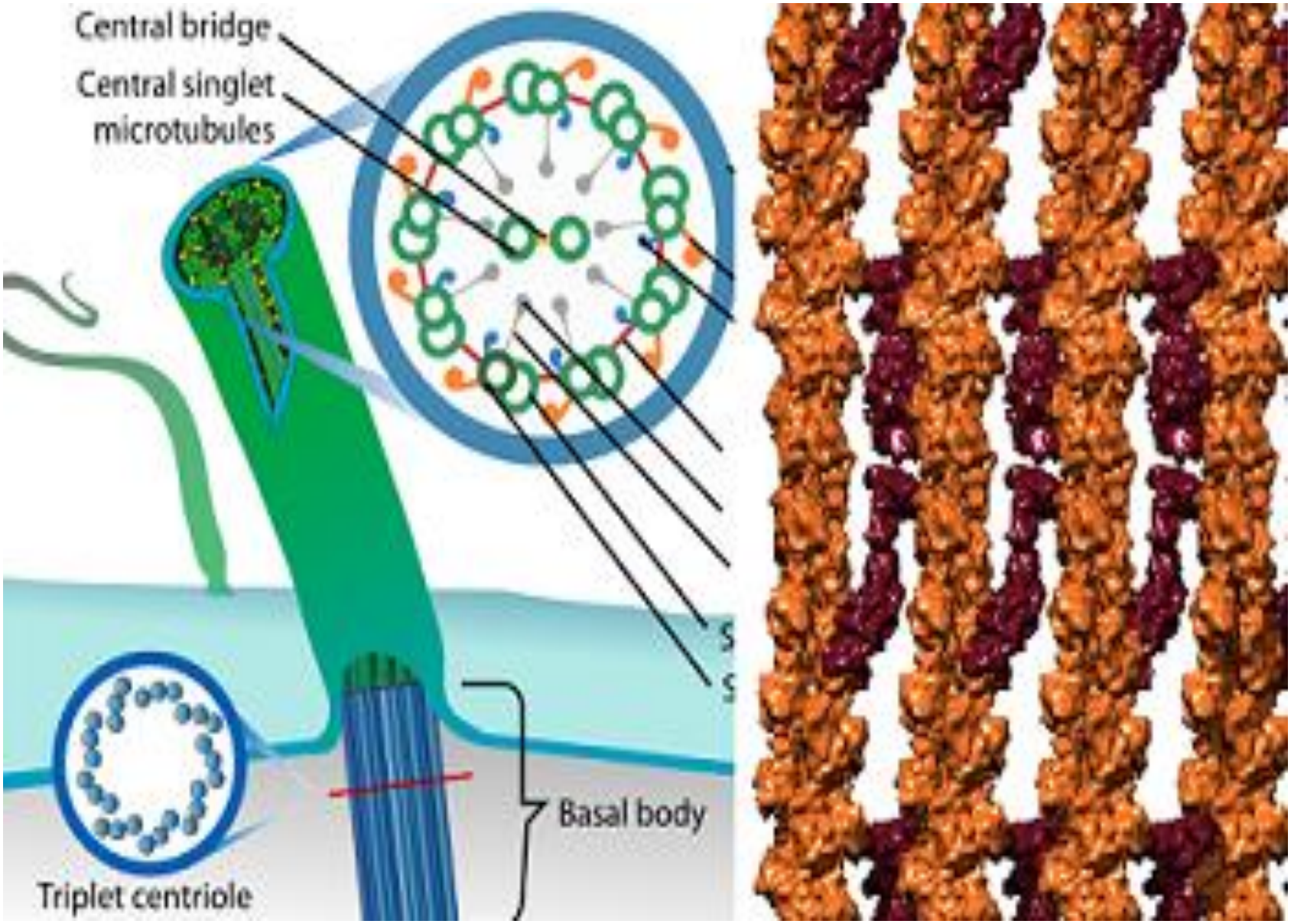
For example, the cilia lining your respiratory tract brush your airways free of mucus, dust, and dirt, helping you to breathe easier.

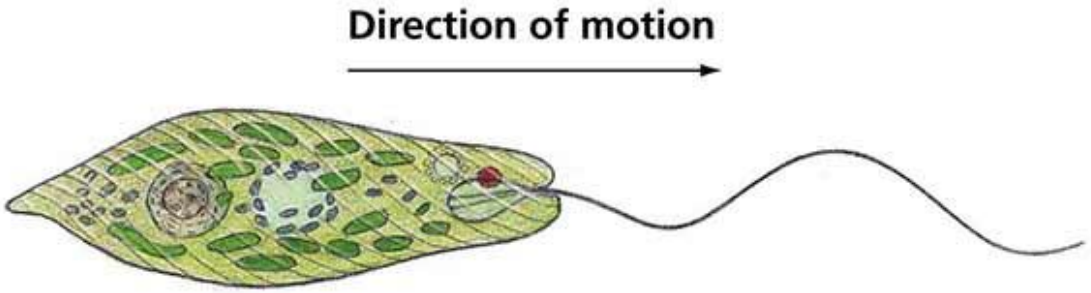
Comparing Structures

- Both microvilli and cilia consist of protein fibers that extend outward from the cell and provide shape for the structures.
- These protein fibers are covered by extensions of the cell membrane that serve to protect them. However, the type and arrangement of the protein fibers differ between cilia and microvilli.
- Cilia are composed of larger, hollow tubes called **microtubules**. The microtubules are arranged in a circle and are anchored to the cell by a structure at the base of the cilium referred to as a **basal body**.

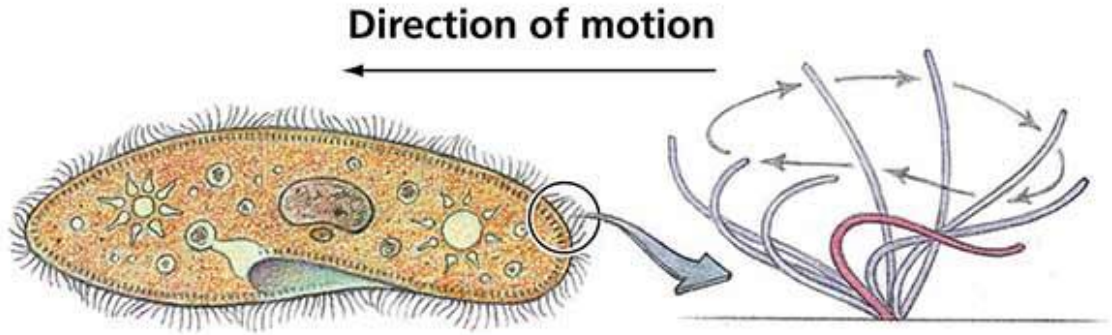
- Microvilli contain tiny fibers called **actin filaments** that extend parallel to each other down the length of the microvillus. The filaments are attached to each other and to the cell membrane by bundles of protein that run perpendicularly across the actin filaments.
- Let's more properly visualize this. Take a look at the image. On the left, you can see that the cilia have microtubules anchored to the basal body. On the right, you can see the microvilli run parallel to each other and are connected by villin.


actin filaments
microvilli
tiny protein fibers
Study.co


Central bridge
Central singlet microtubules
Basal body
Triplet centriole



(a) Flagella



(b) Cilia

Microvilli, cilia, flagella

Microvilli= surface extensions that increase surface area

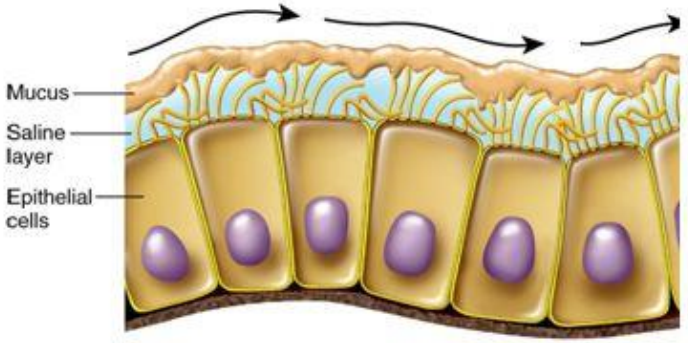
- Specialized for absorption (15-40x in intestinal tract, kidneys); sensory (taste buds, inner ear)
- Brush border= dense 'fringe' (mucus membrane)

Cilia= hairlike projections, nonmotile (more common) & motile (respiratory tract & uterine tubes)

- Beat in waves to sweep mucus, oocyte, embryo
- Beat w/in saline @ cell surface (w/ mucus floating on top)

Flagella= whiplike structure much longer than cilia

- tail of sperm



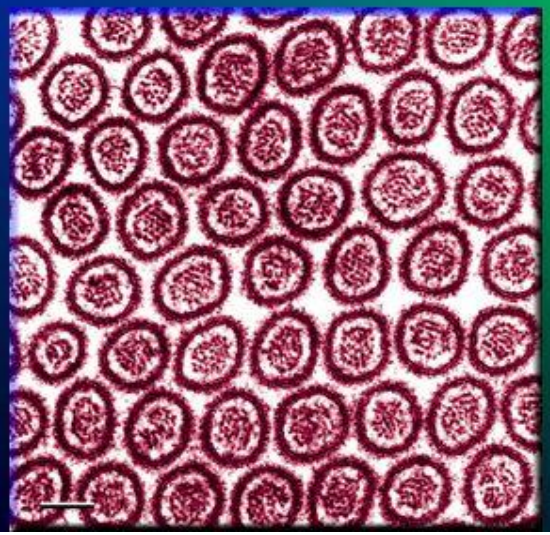
Difference between microvilli & cilia

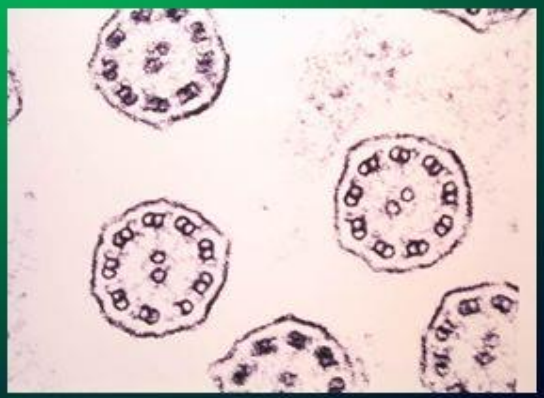
	Microvilli	Cilia
appearance	Small and short	Big and long
observation	EM	LM/EM
Surface	Cell-membrane	Cell-membrane
Axes	Cytoplasm	Cytoplasm
Composition	Microfilament	Microtubule
Basal portion	Terminal web	Basal body
Function	Increase surface area	Movement

Microvilli contd

- When in cross section do not confuse with cilia – cilia have TUBES inside them in the special arrangement, while microvilli have roughly 50 actin filaments in a bundle

microvilli





cilia

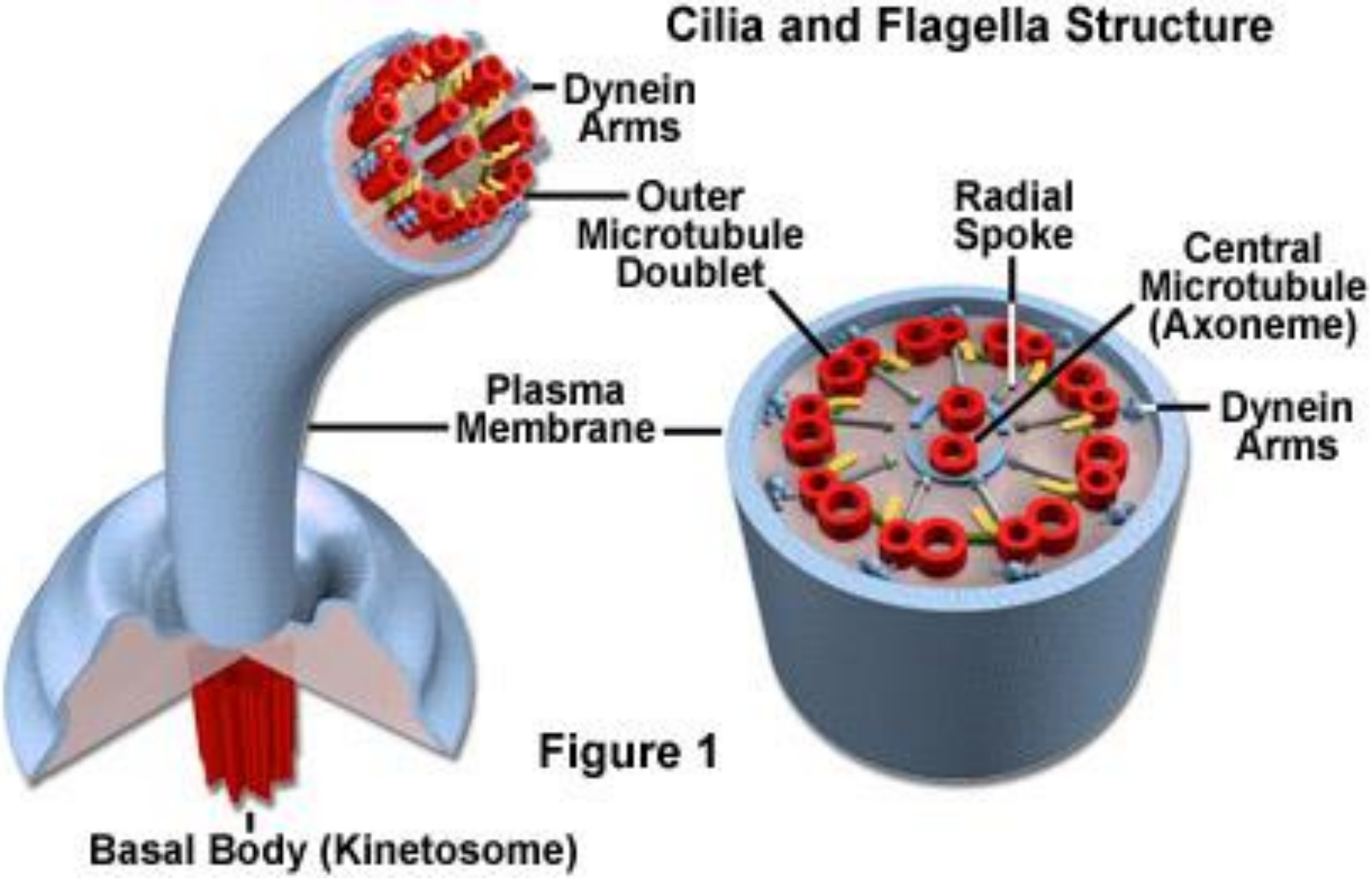

Cilia and Flagella Structure
Dynein Arms
Outer Microtubule Doublet
Radial Spoke
Central Microtubule (Axoneme)
Plasma Membrane
Dynein Arms
Basal Body (Kinetosome)

Figure 1

Thank you