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Cells and Tissues Sequence
Medical Histology

Epithelium

Fall, 2008

University of Michigan
Medical School

Tissues

[Fr. Tissu, *woven* ; L. texo, *to weave*]

A tissue is an organized aggregation of cells or groups of cells that function in a coordinated manner to perform one or more specific functions.

Tissues combine to form larger functional units, called ORGANS. Thus, the tissues are the basic functional units responsible for maintaining body functions.

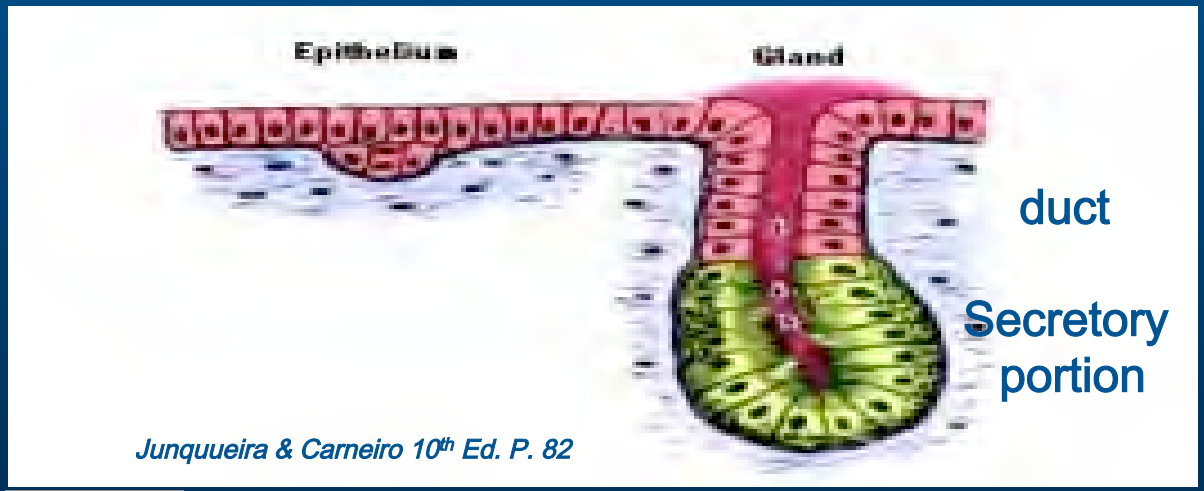
BASIC TISSUES

Epithelium
Connective tissue
Muscle
Nervous tissue
Blood

Epithelium is a cohesive sheet of cells that:

1. Covers the external surface and lines the internal surface of the body.
   - Protection (by withstanding wear and tear, from hydration and dehydration)
   - Transport (i.e. O_2 and $C0_2$)
   - Selective Absorption: (Control the movement of substances between the outside environment and the internal compartments in the body.)
   - Secretion (secretory cells)

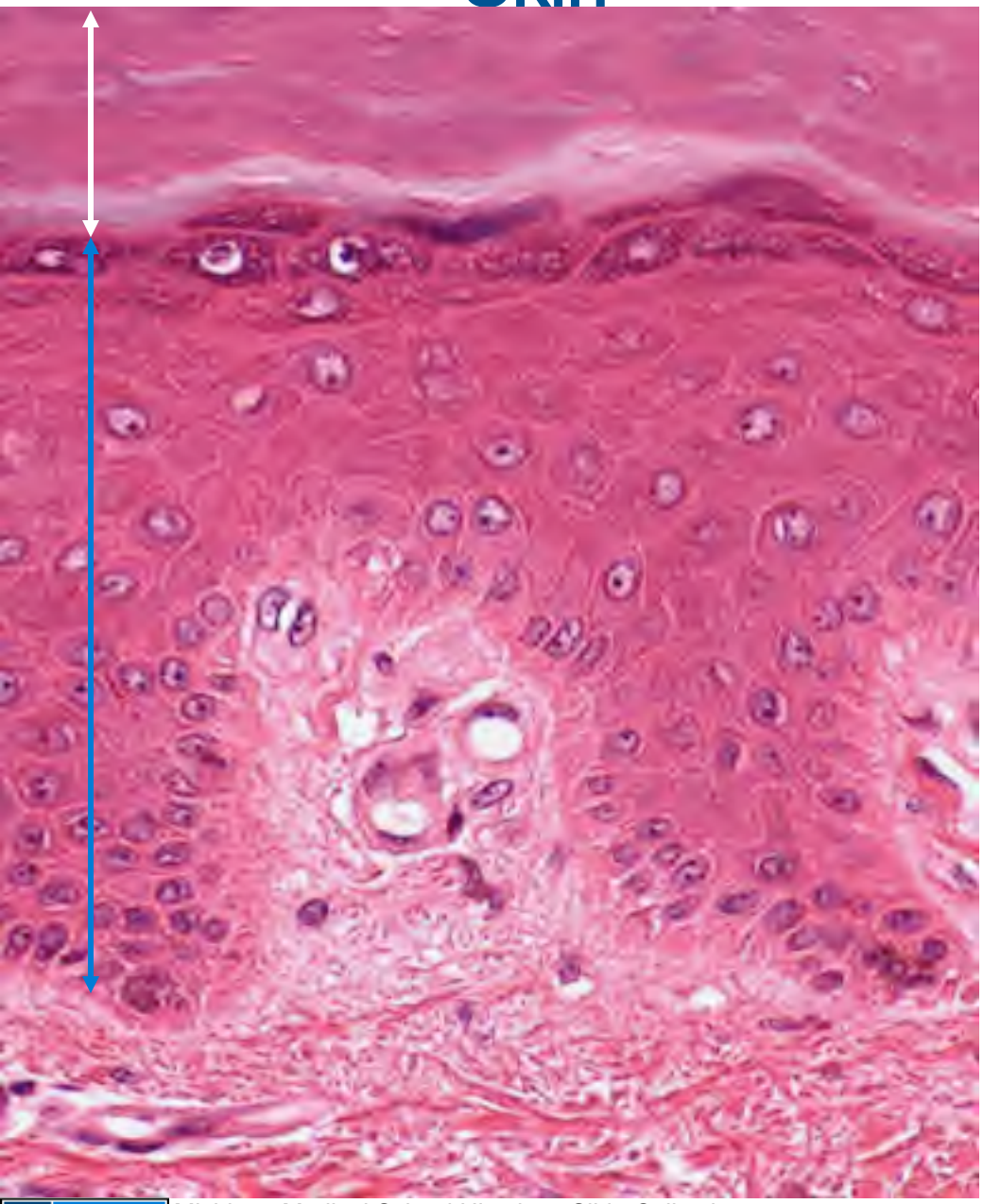
2. Forms endocrine and exocrine secretory glands.



 Junqueira and Carnein 10th Ed. P. 82

Epithelial lining cells of

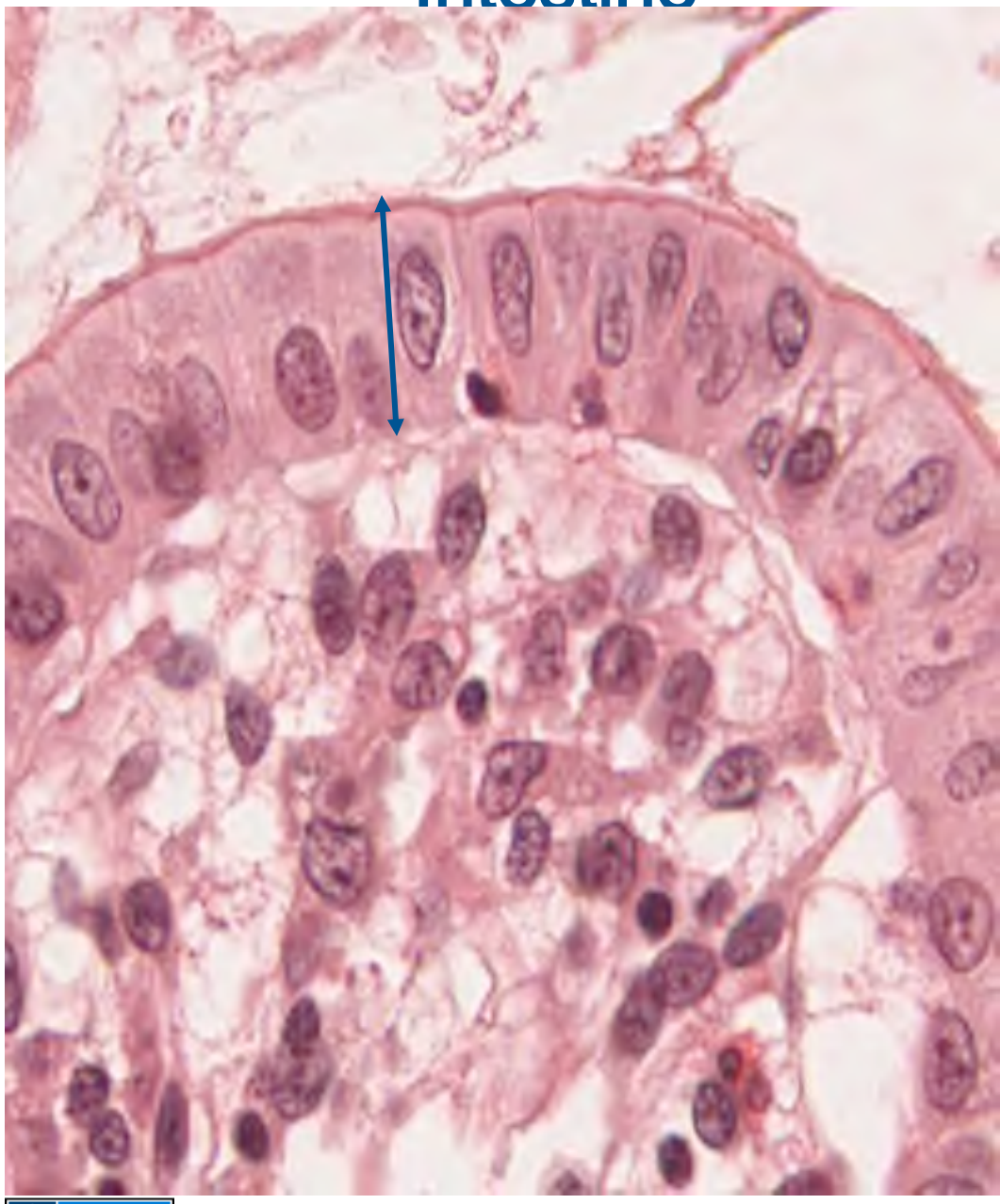
Skin



PD-INEL Michigan Medical School Histology Slide Collection

Multiple layers of flat (squamous) cells

Intestine



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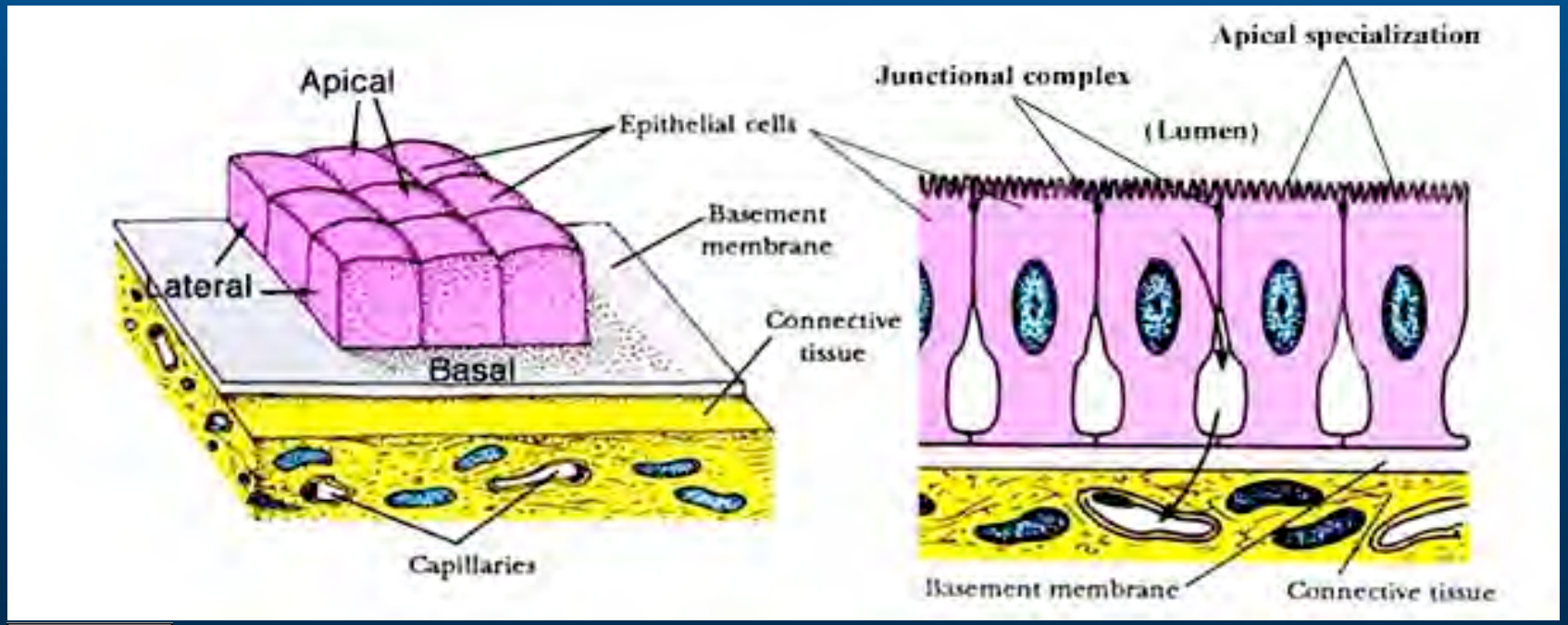
Single layer of tall (columnar) cells

Epithelial cells:

1. Form avascular sheets that differ in number of cell layers, shape of the cells and structural specializations of the free (apical) cell surface, depending on the tissue function(s).
2. Are structurally and functionally polarized: Have apical, lateral and basal domains.
3. Are held together by several specializations, known as the intercellular junctions, and bind to the underlying connective tissue via the basement membrane (LM) or basal lamina (EM).
4. Are capable of renewal and regeneration.

non-specialized epithelium - all cells

specialized epithelium - stem cells



 Ross/Romrell p. 52

Epithelial cells:

1. Form avascular sheets that differ in number of cell layers, shape of the cells and structural specializations of the free (apical) cell surface, depending on the tissue function(s).
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3. Are held together by several specializations, known as the intercellular junctions, and bind to the underlying connective tissue via the basement membrane (LM) or basal lamina (EM).
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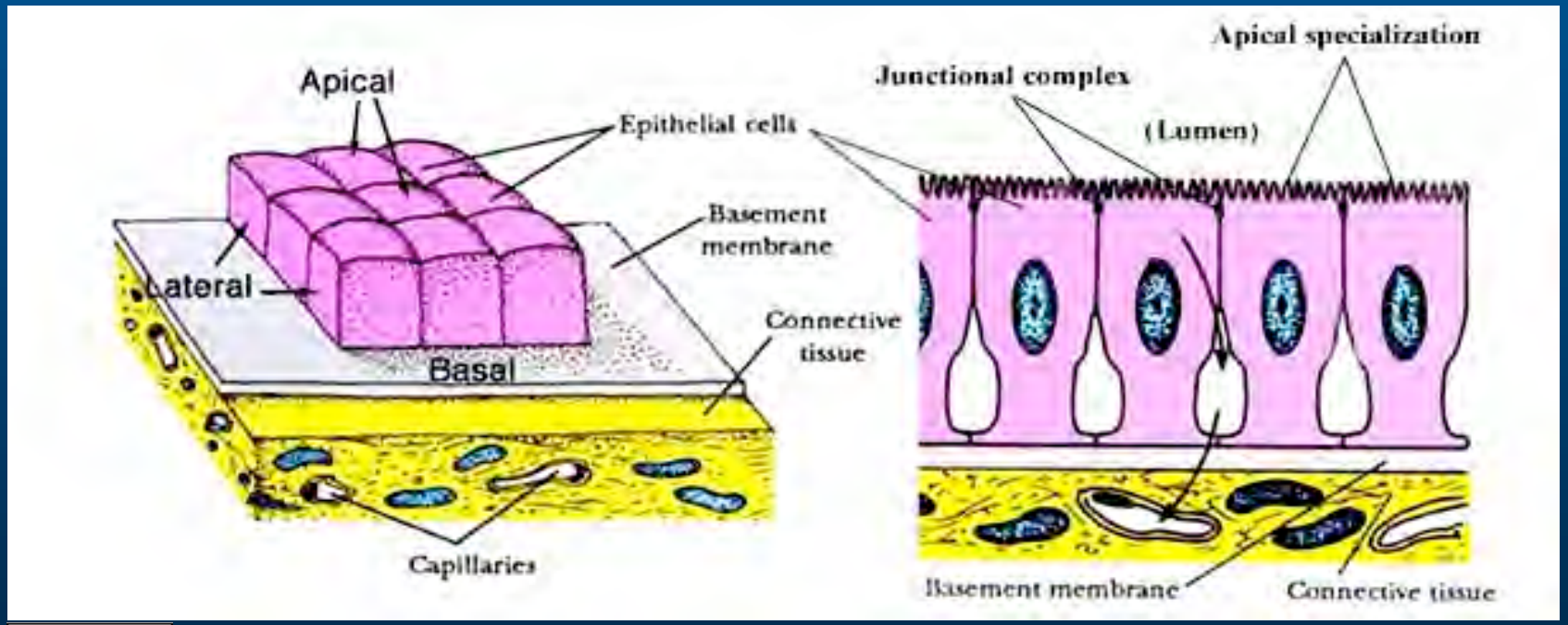
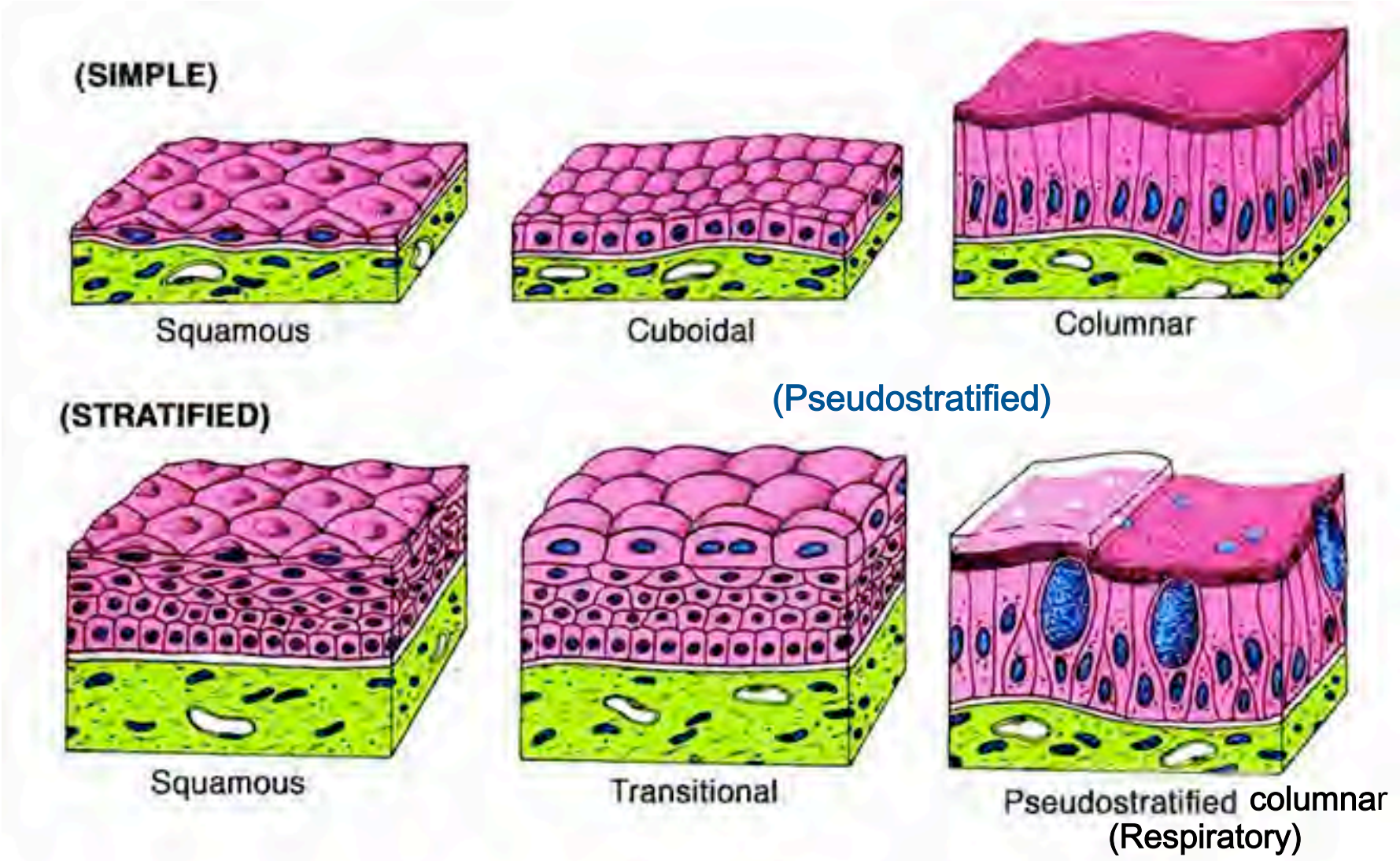


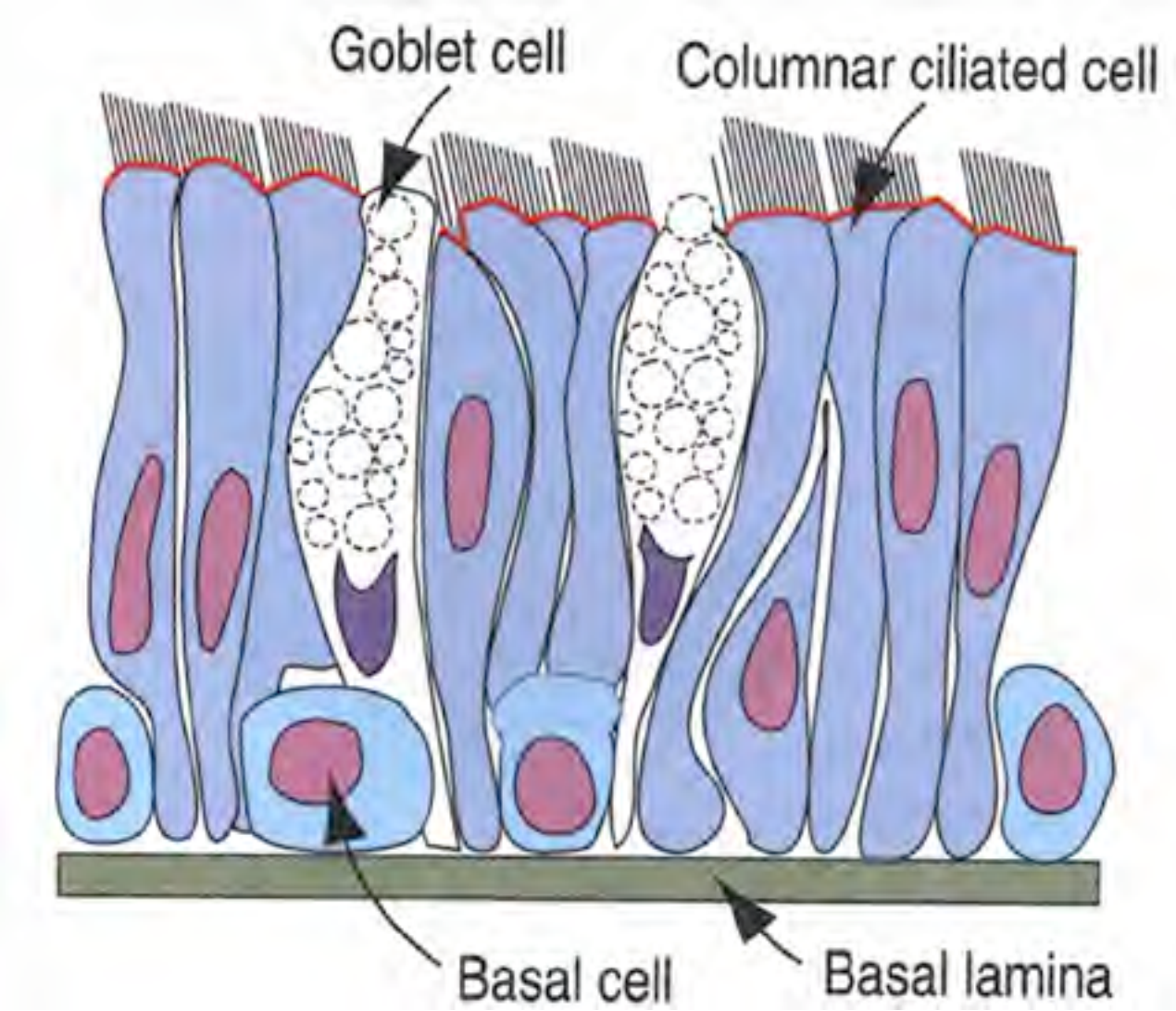
 Ross/Romrell p. 52

Classification of Epithelium

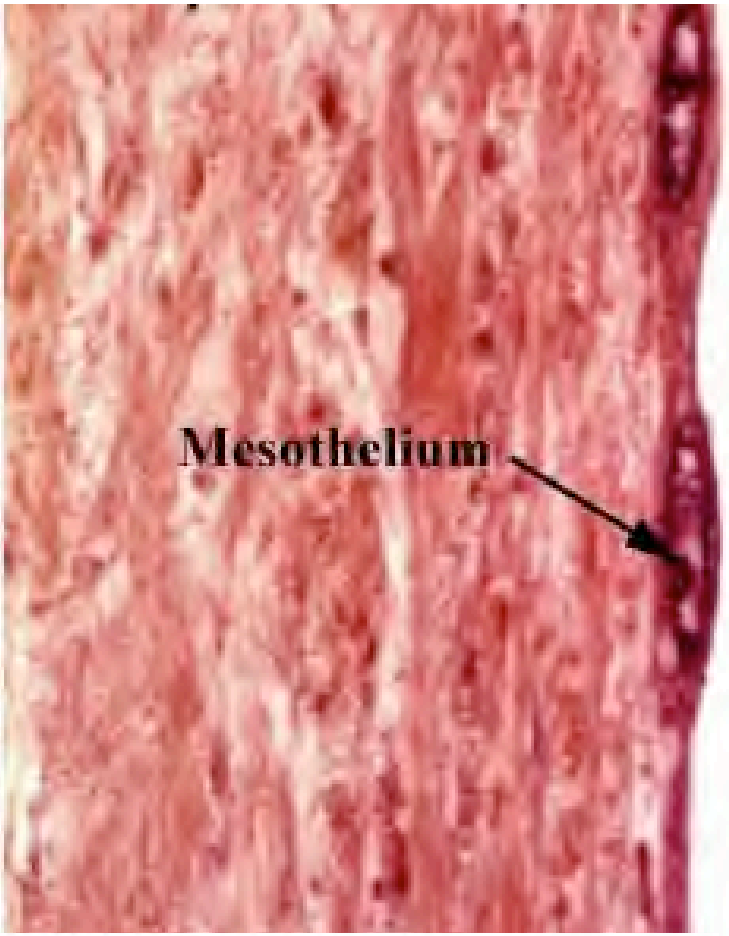


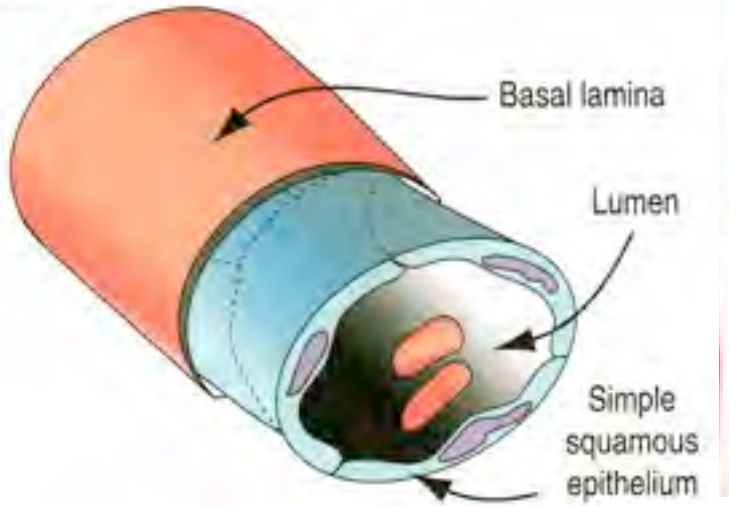
 Ross/Romrell p. 53

Pseudostratified Epithelium



Simple squamous epithelium: endothelium and mesothelium

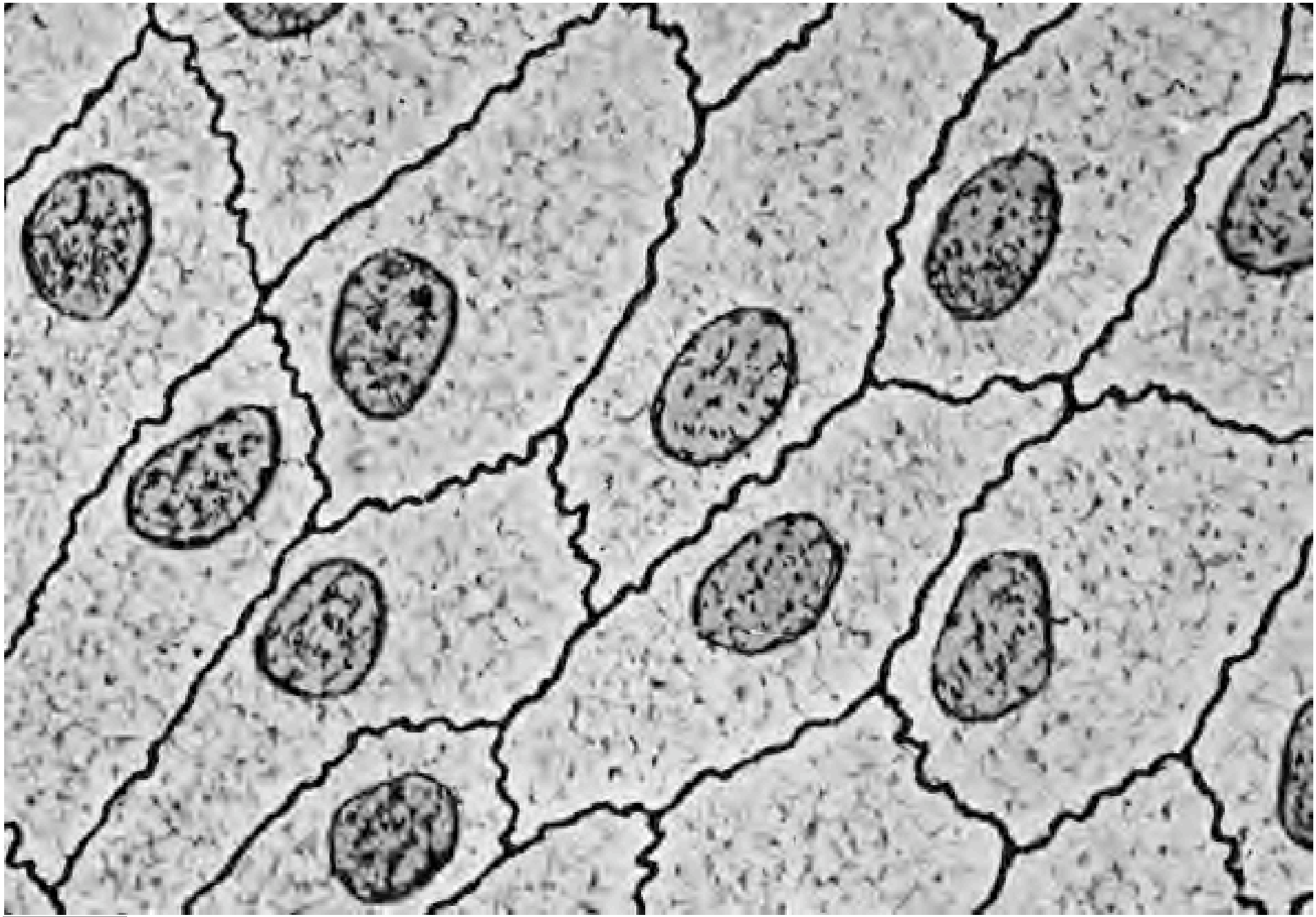




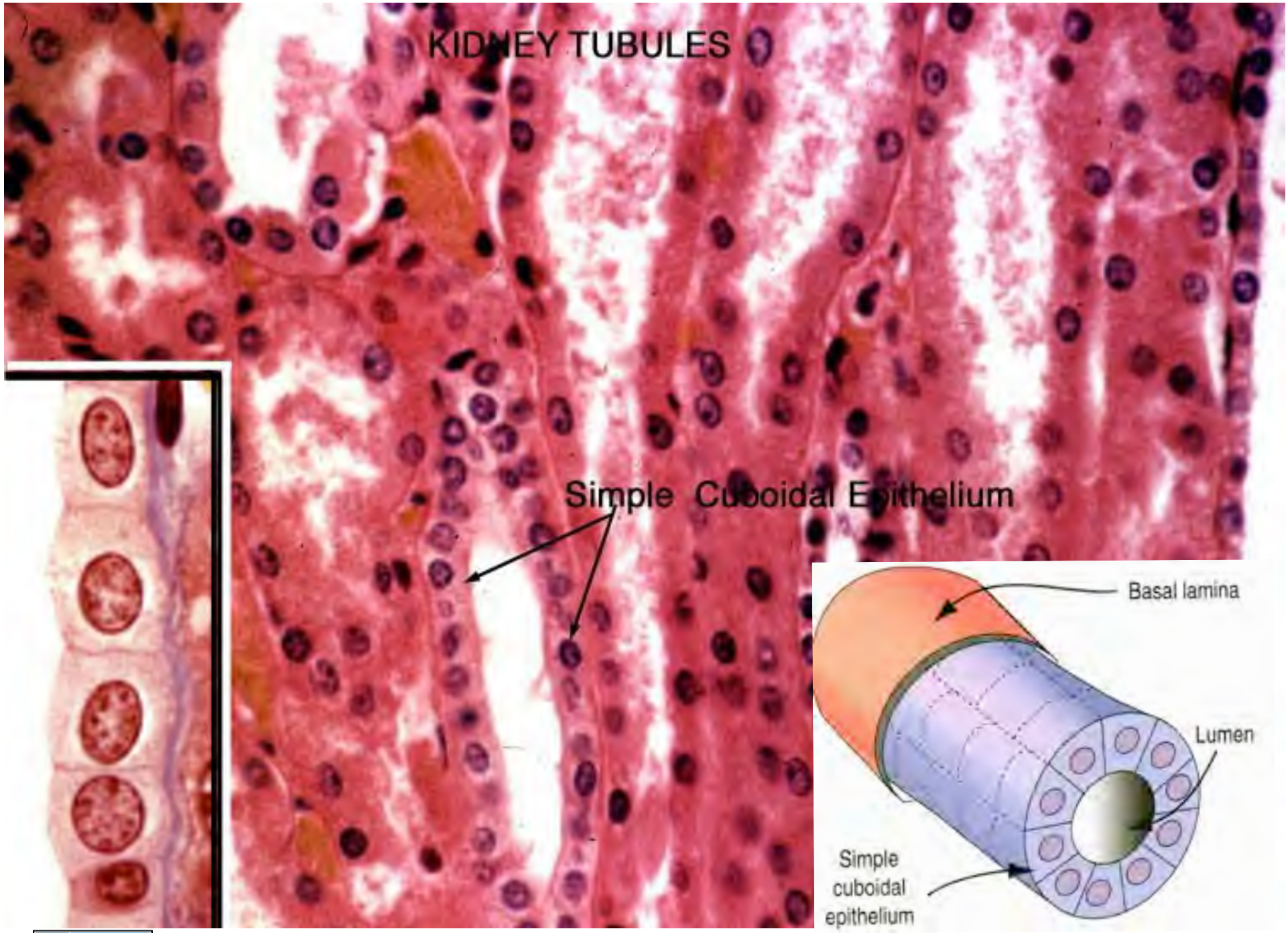
 Michigan Medical School Histology Slide School

 Kierszenbaum p.4

Endothelium/Mesothelium
(Simple Squamous Epithelium)



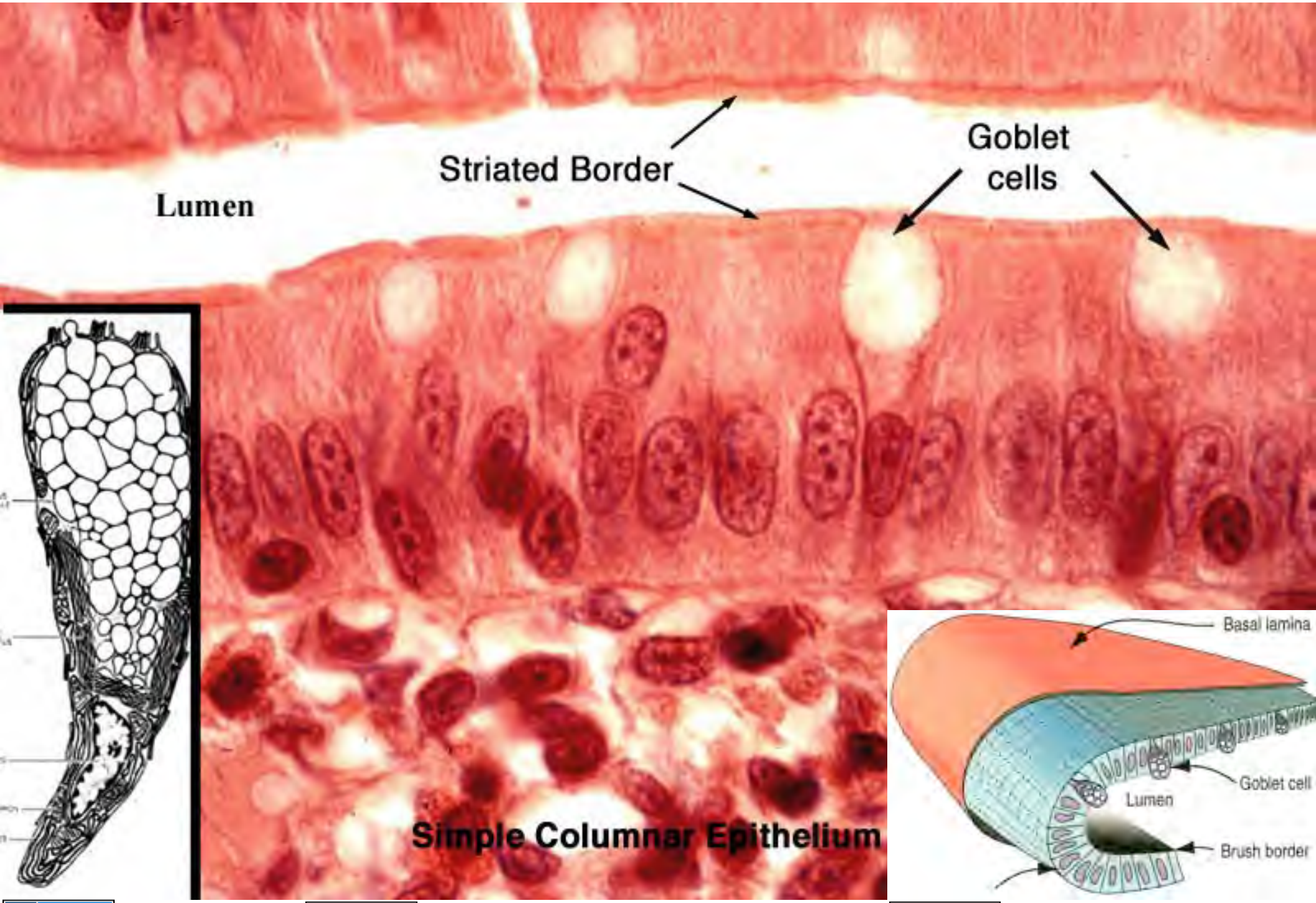
Simple Cuboidal Epithelium



PD-INEL Michigan Medical School Histology Slide School

PD-INEL Kierszenbaum p.4

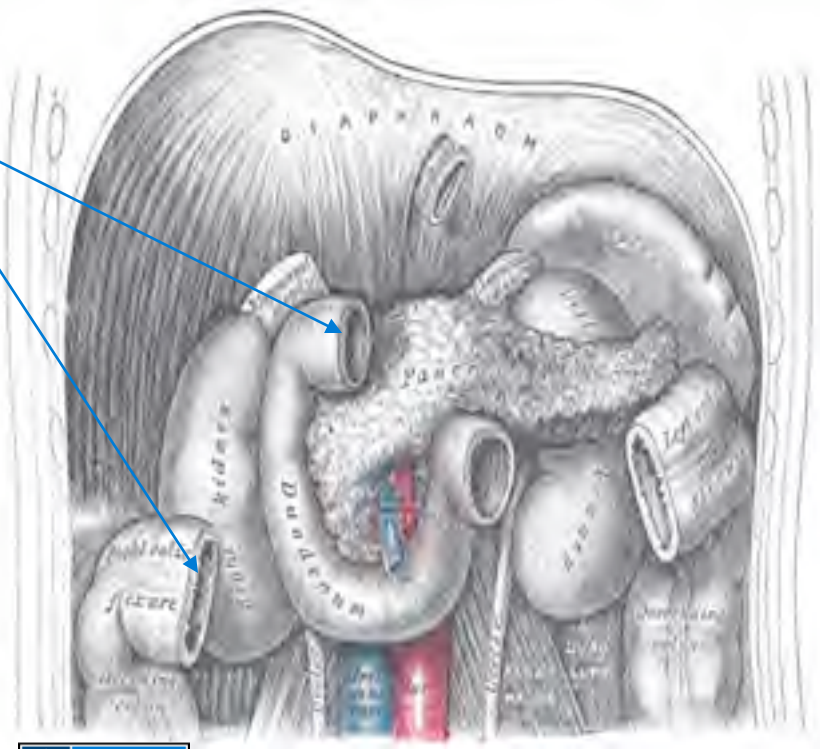
Simple Columnar Epithelium



Simple columnar epithelium
lining the gut lumen

Two layers of smooth muscle on the wall

lumen



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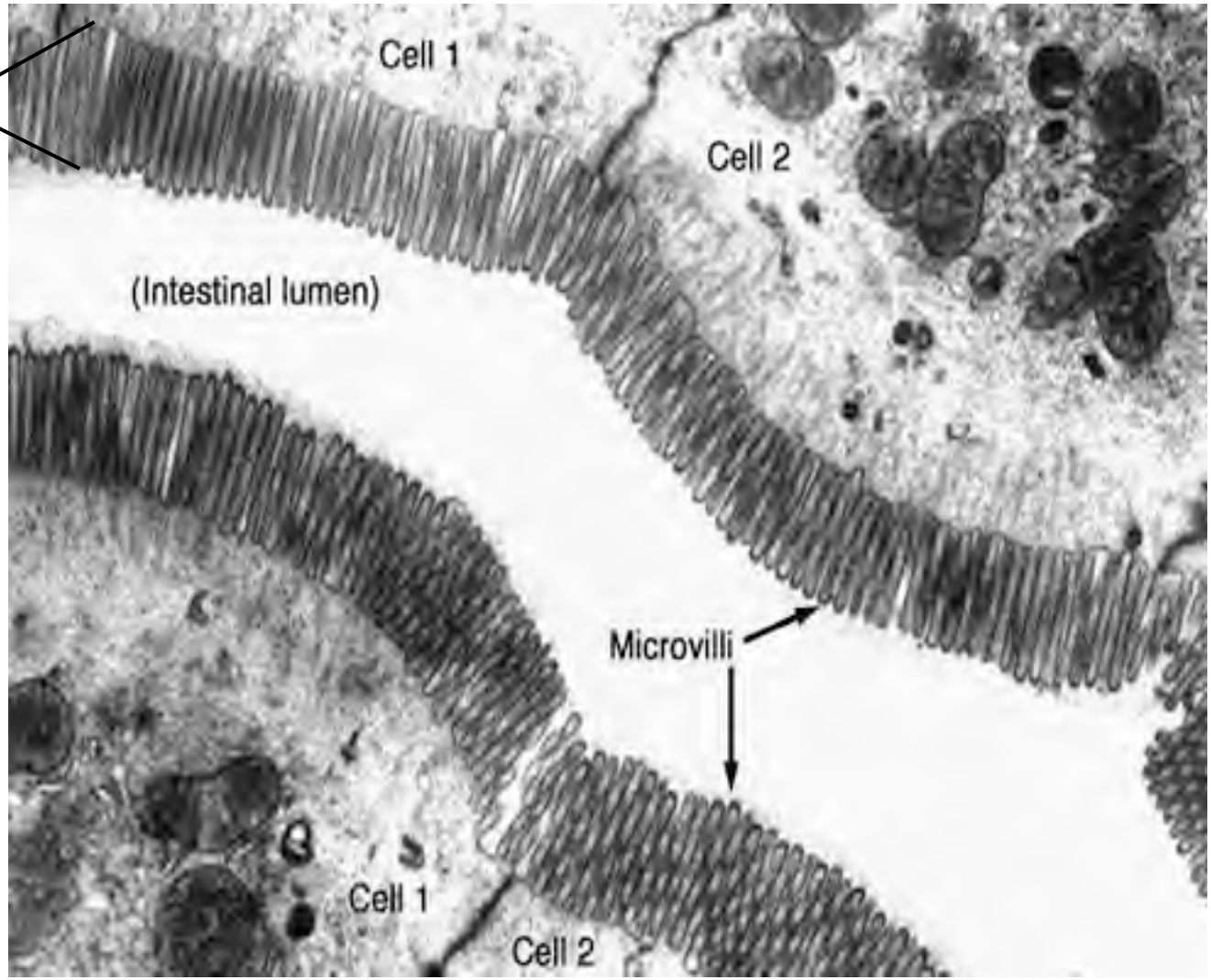
PD-EXP Gray's Anatomy, wikimedia commons

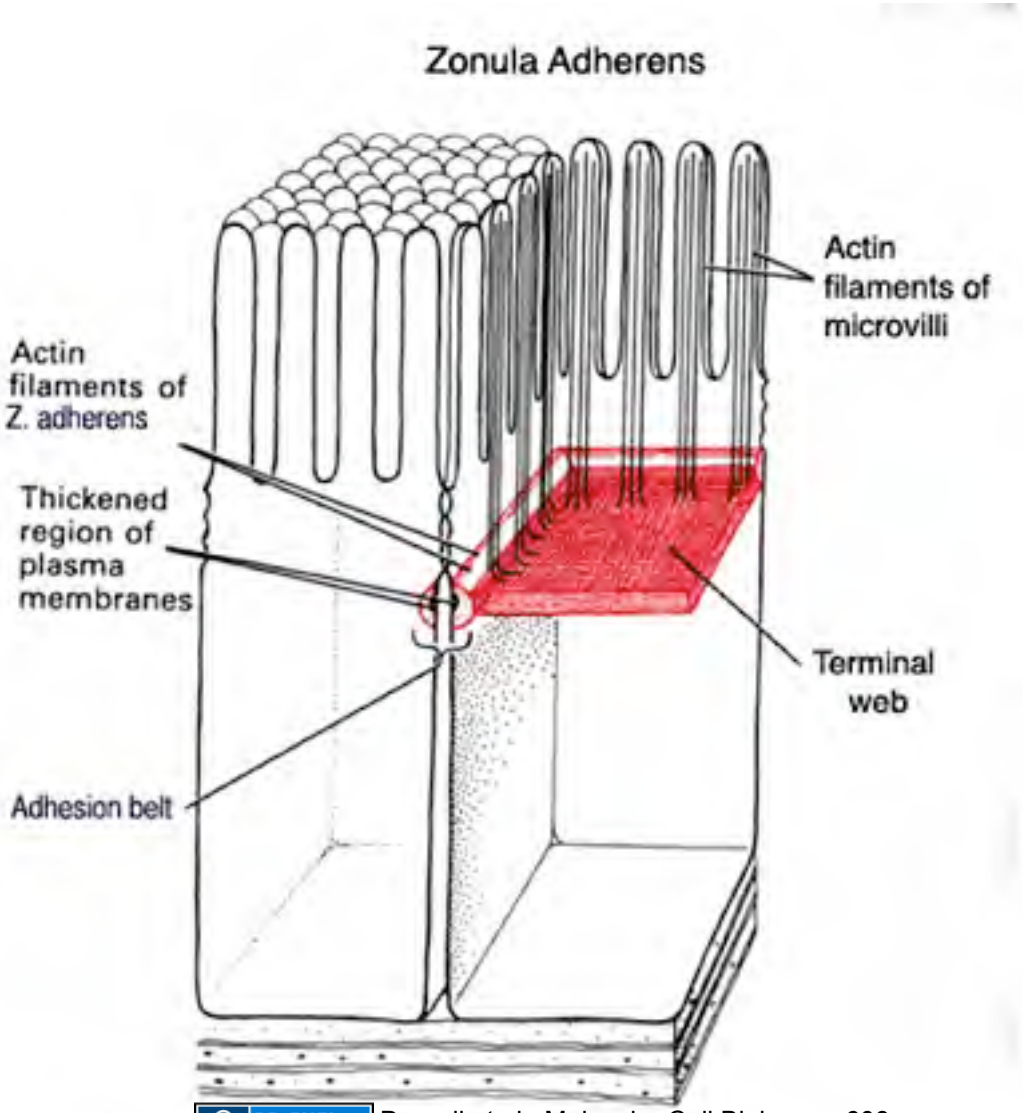
Apical Cell Surface Specializations - 1
Striated Border (Microvilli)



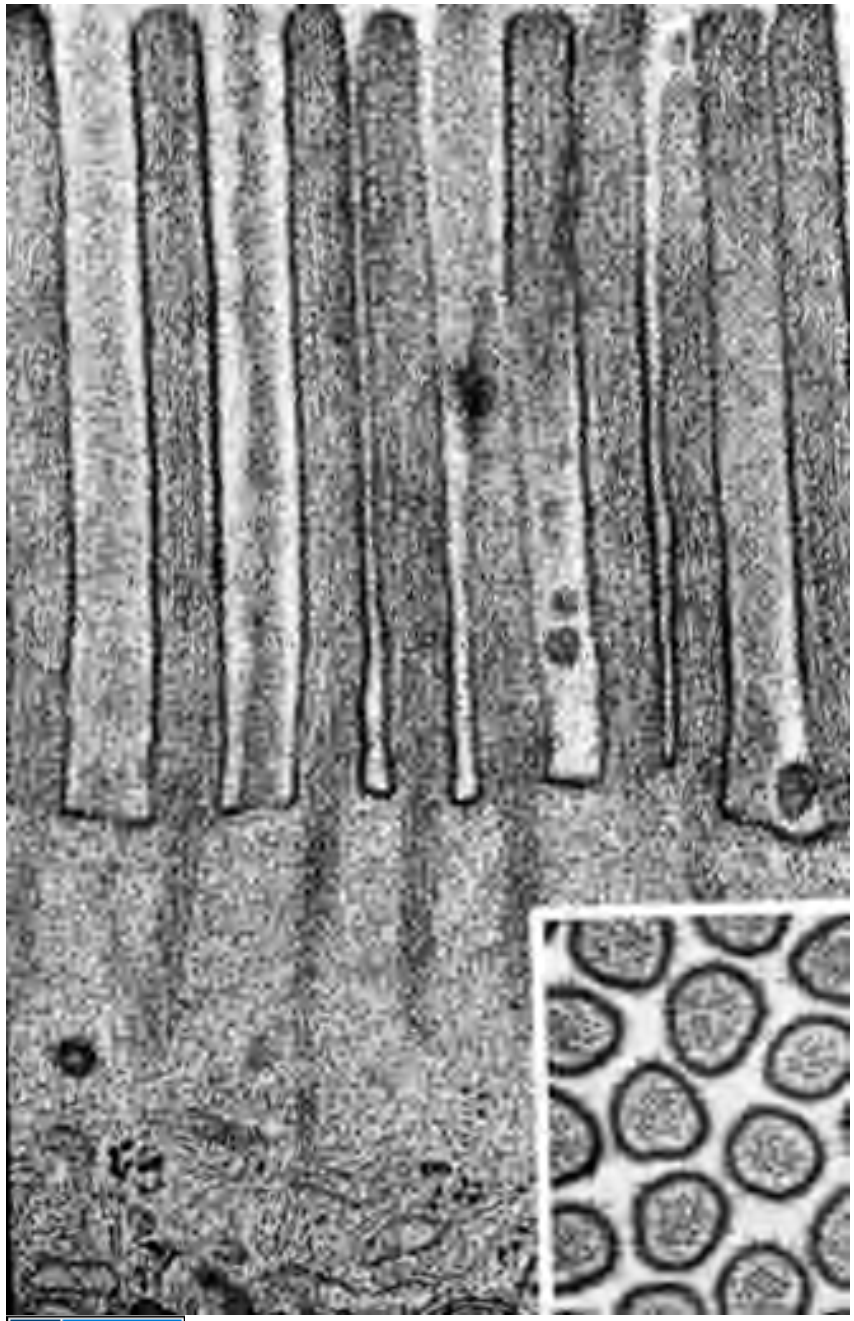
G: goblet cell

Microvilli

(Core of actin filaments)



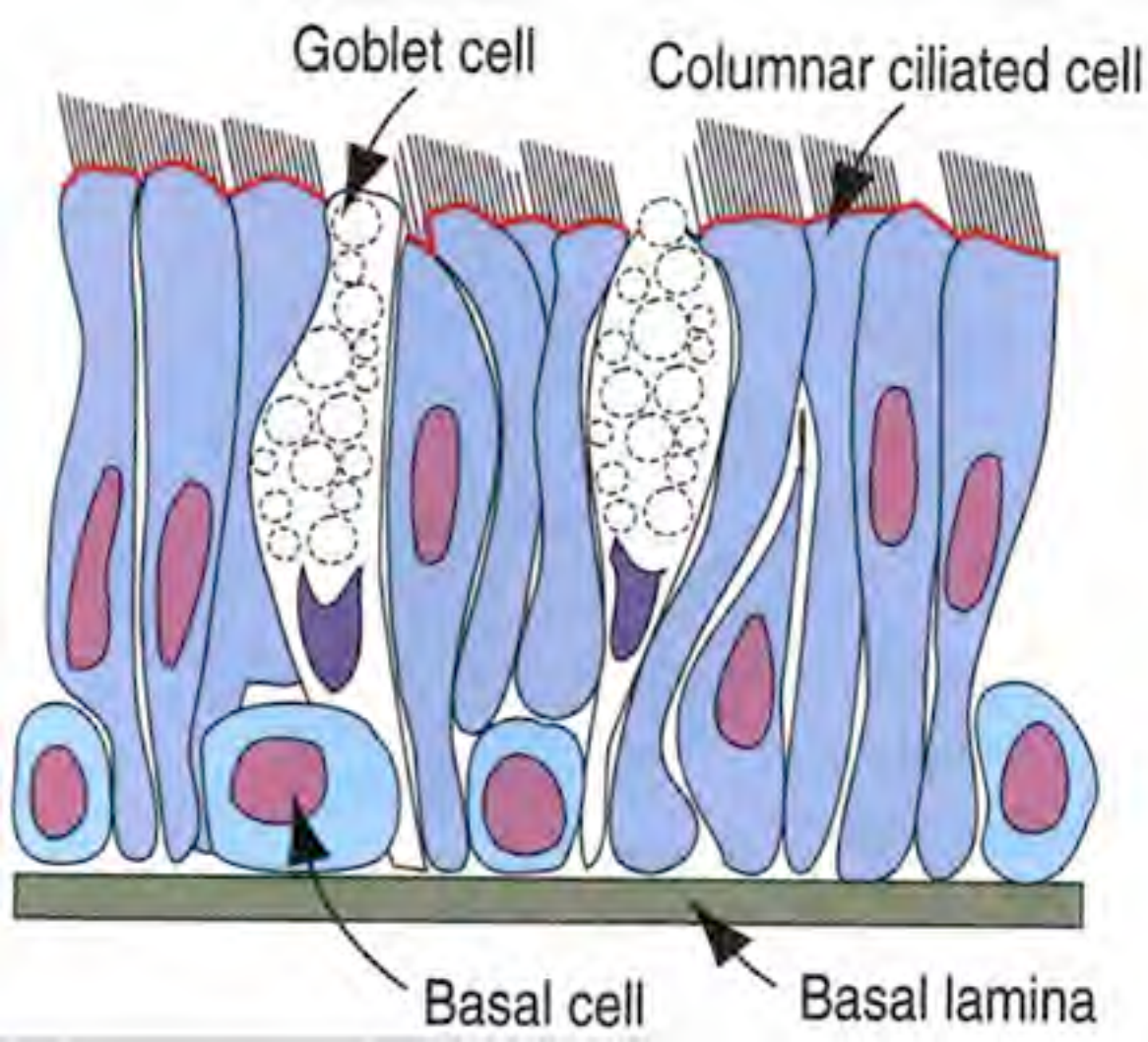
PD-INEL Darnell et al., Molecular Cell Biology p. 608



PD-INEL Source Undetermined

Apical Cell Surface Specializations – 2

Cilia on the Respiratory Epithelial Cells



PD-INEL Kierszenbaum p.6

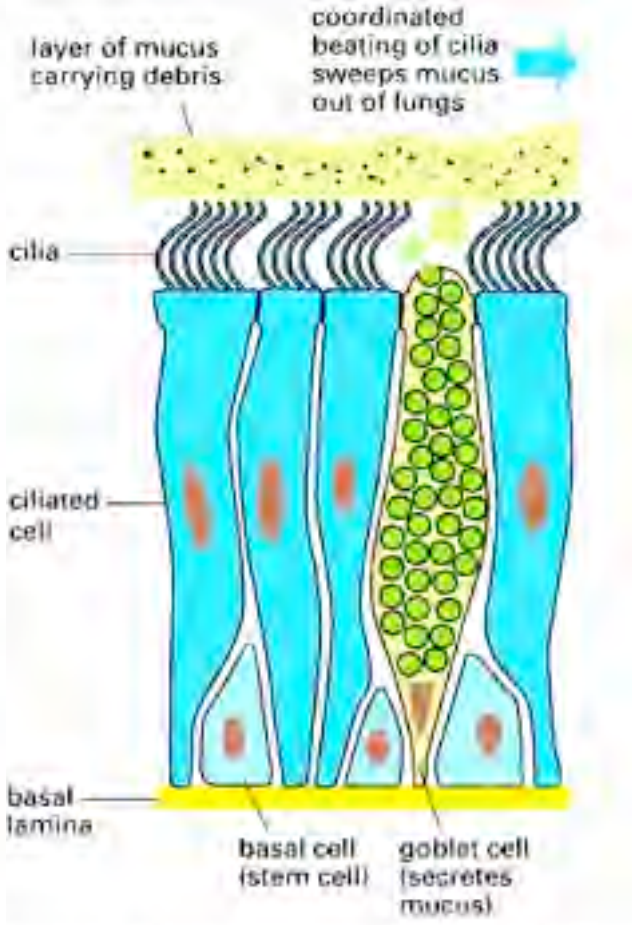
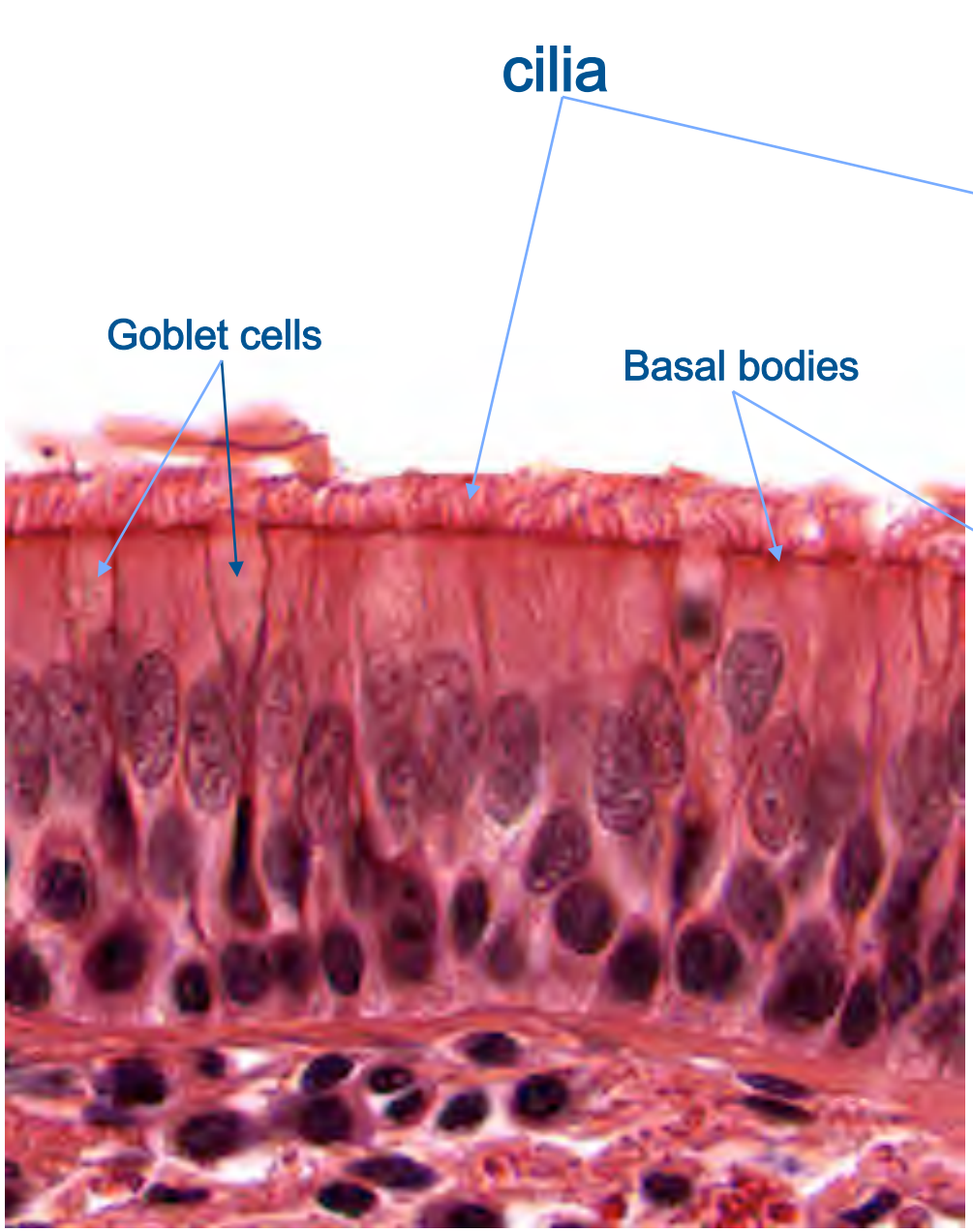


Figure 22-18. Molecular Biology of the Cell, 4th Edition.

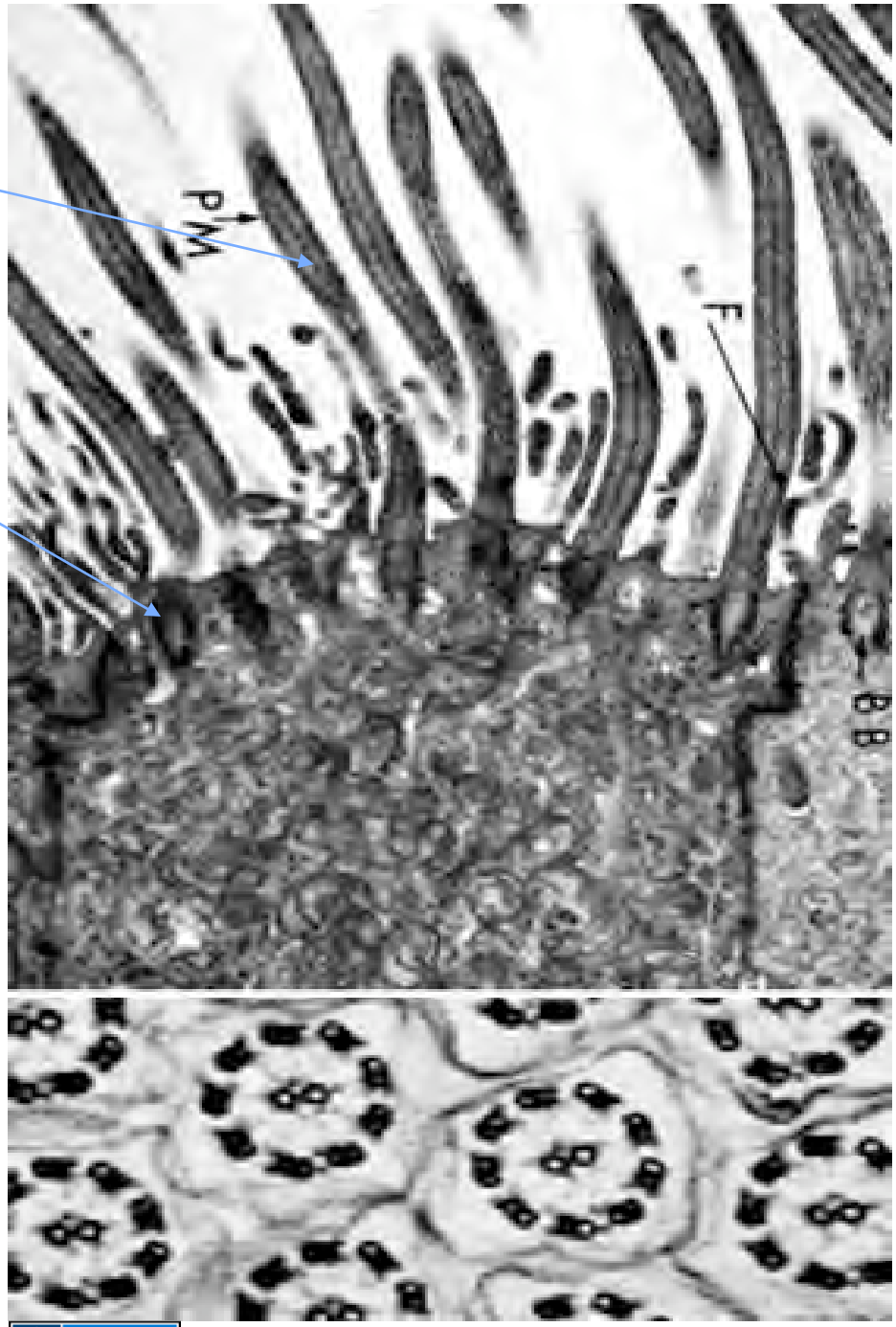
PD-INEL Verhey. Molecular Biology of the Cell, 4th Edition.

Cilia

core of microtubules in 9+2 arrangement (axoneme)

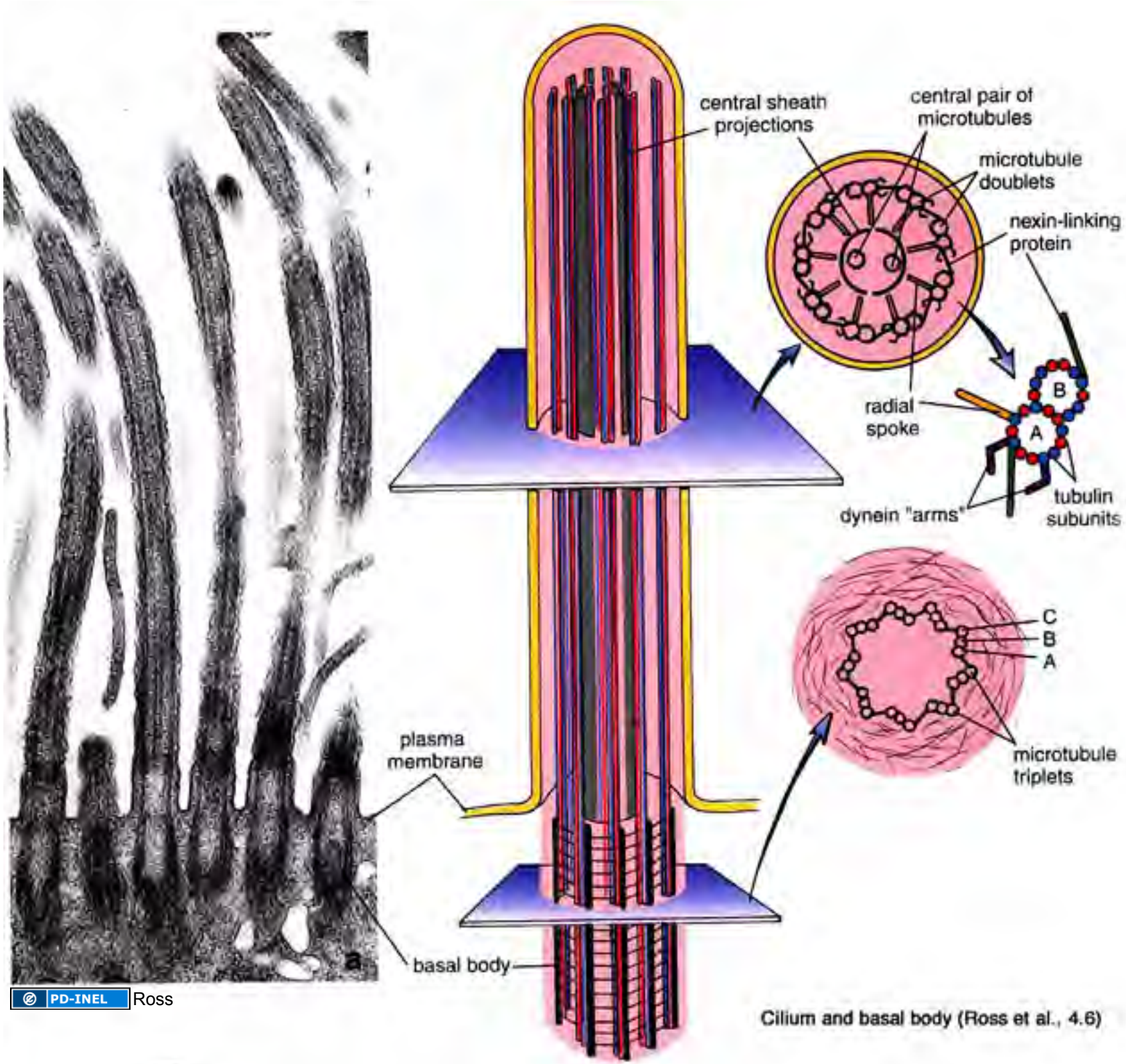


Respiratory epithelium



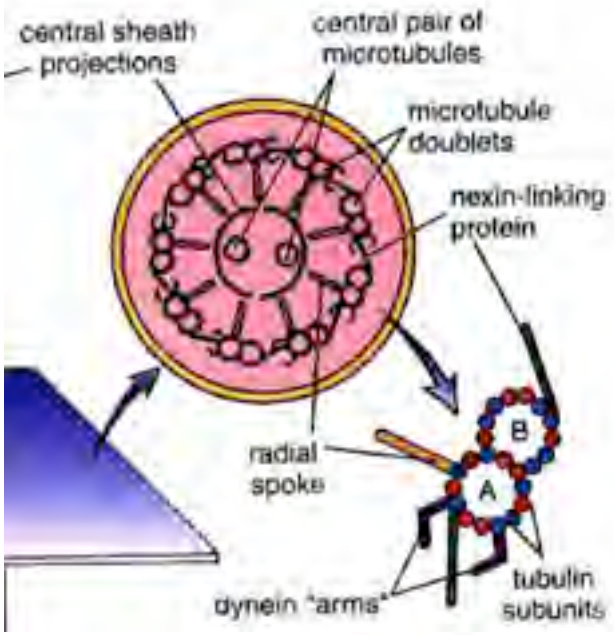
9 + 2

(Axoneme)

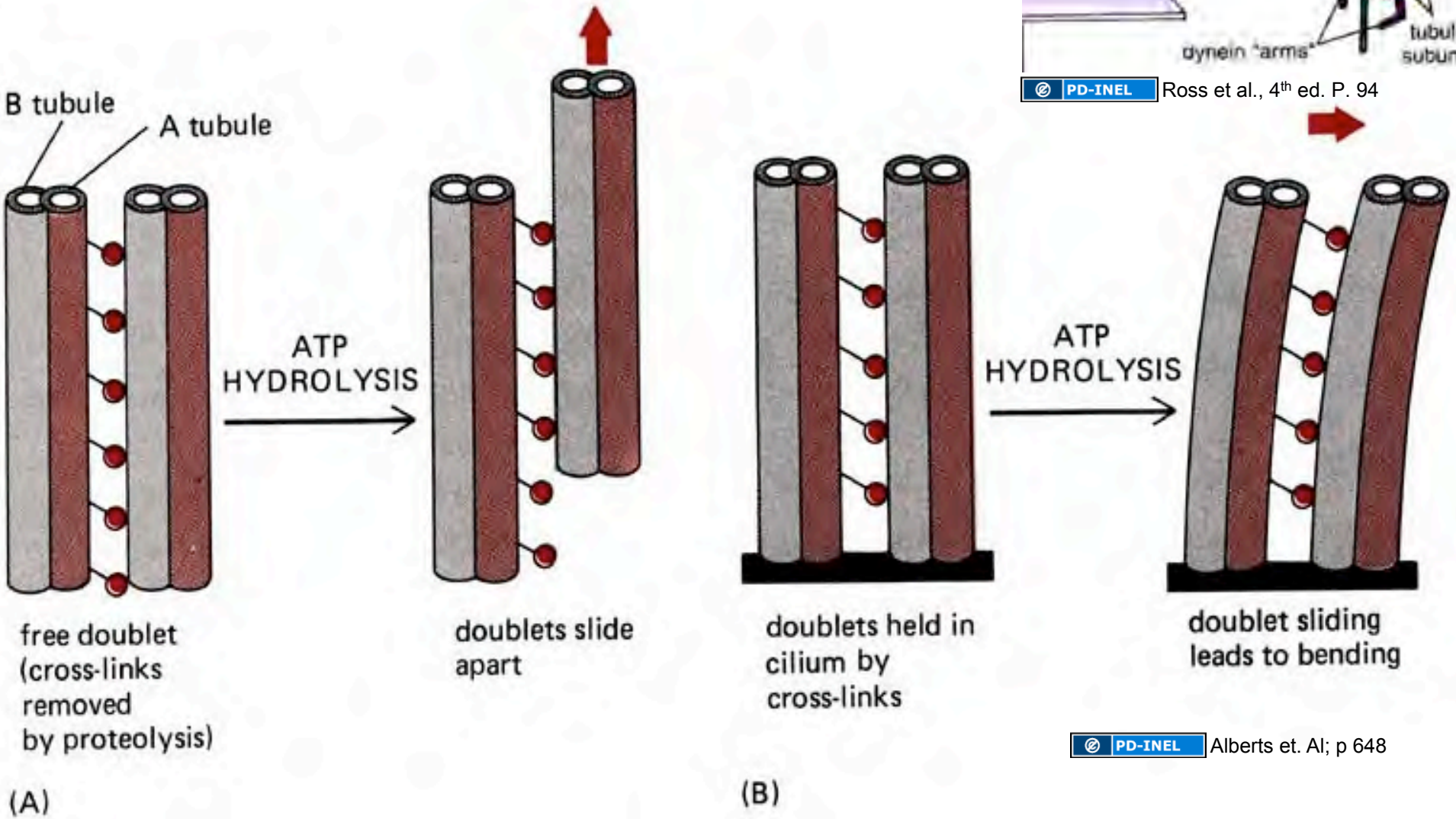


Cilium and basal body (Ross et al., 4.6)

Dynein is responsible for the sliding.

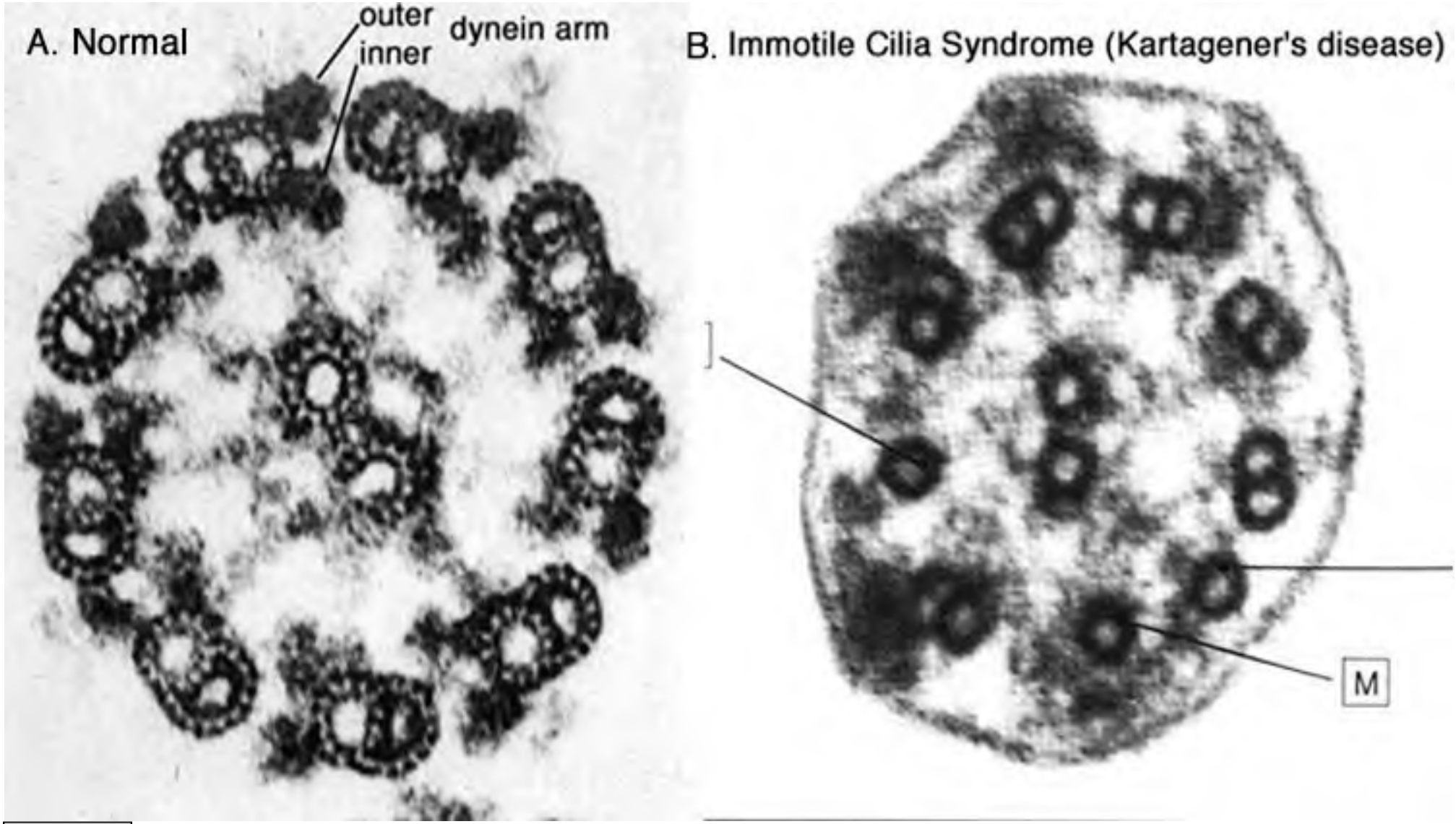


PD-INEL Ross et al., 4th ed. P. 94

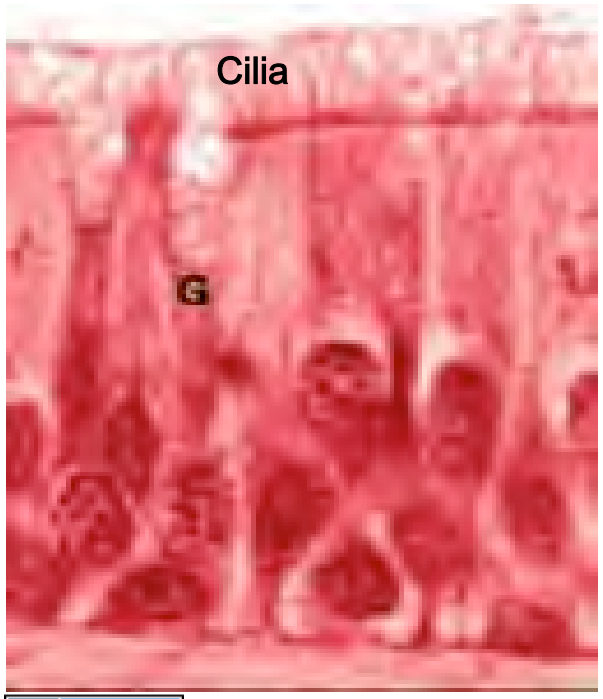


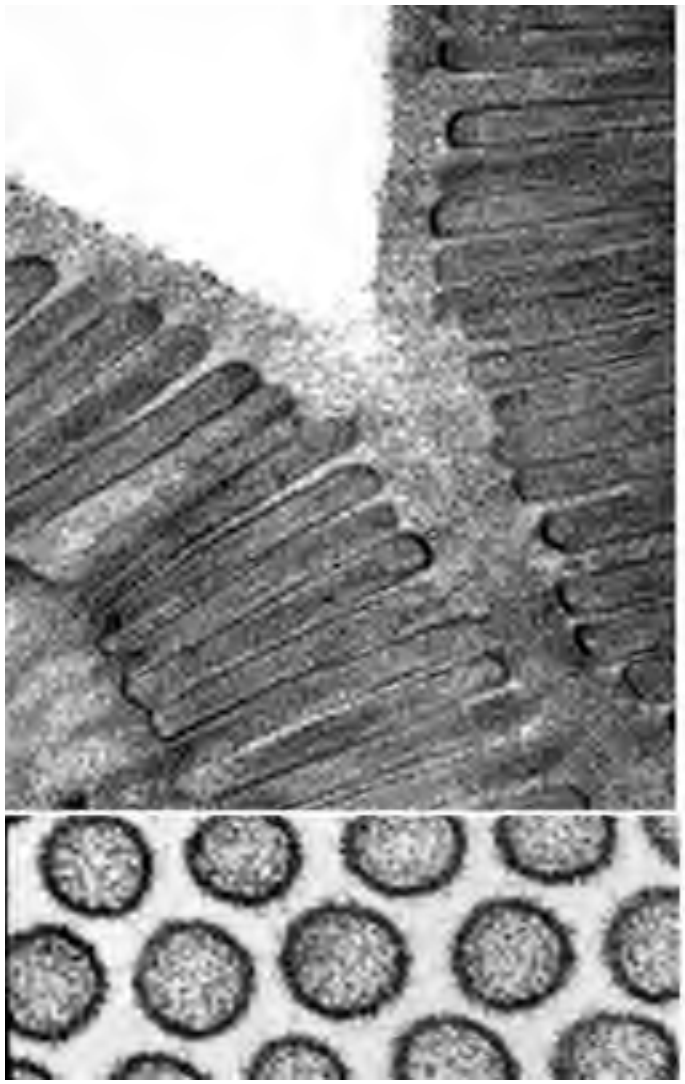
PD-INEL Alberts et. Al; p 648

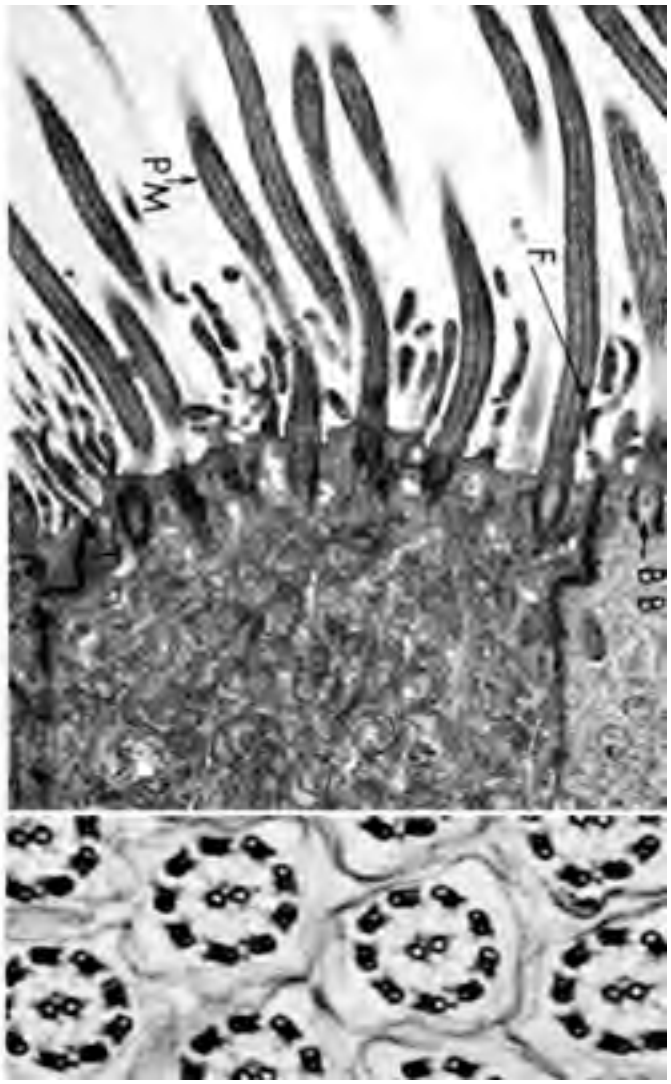
Dynein Defects in Immotile Cilia



Microvilli and cilia

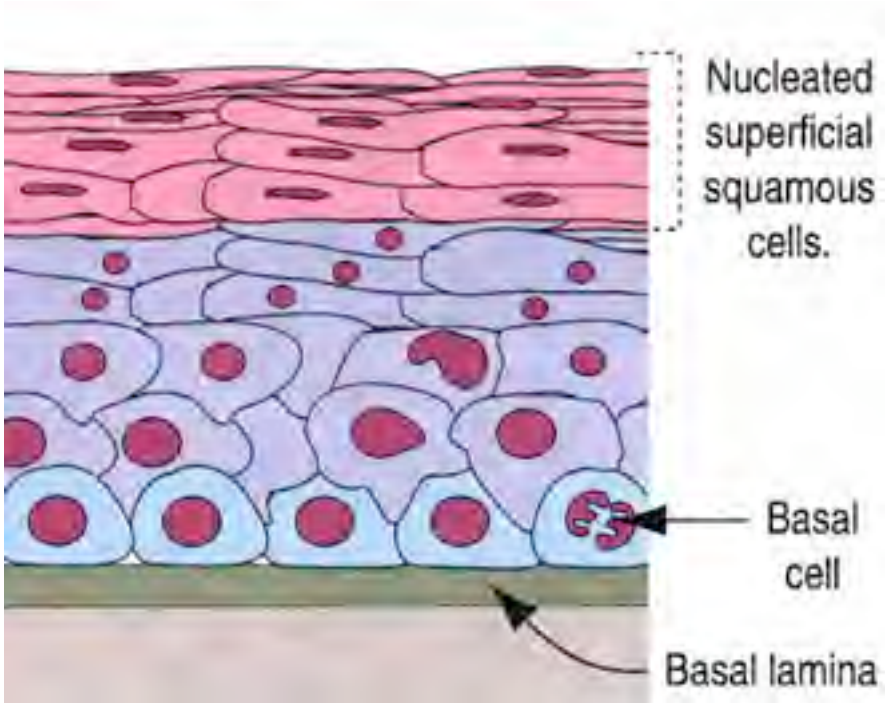






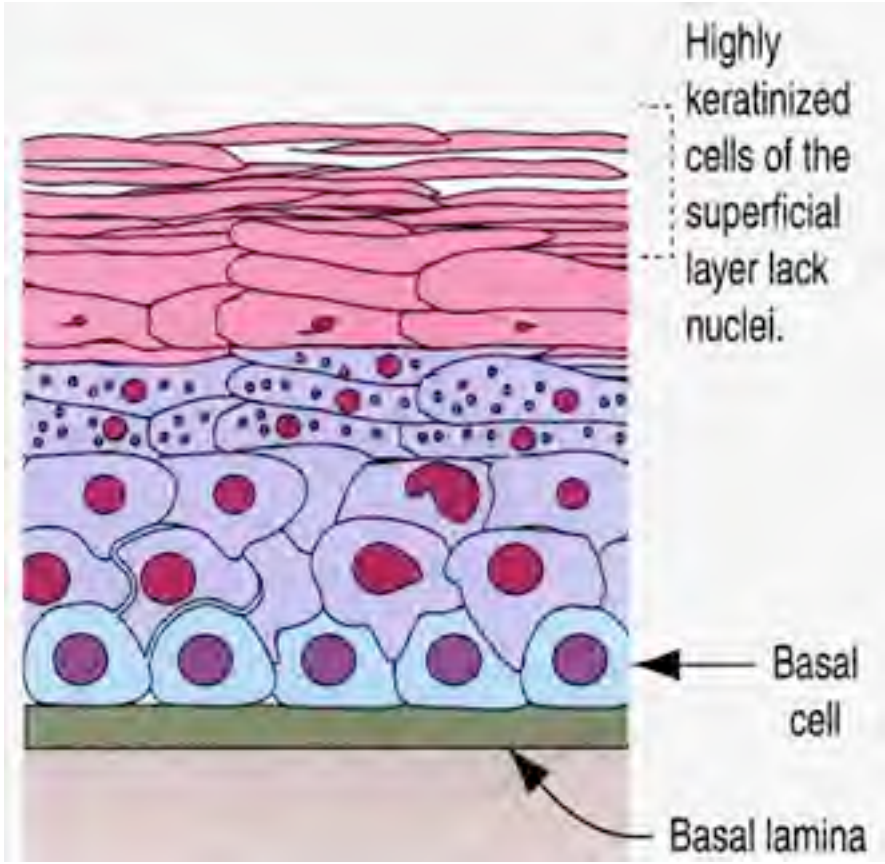
Stratified Squamous Epithelium

non-keratinized



PD-INEL Kierszenbaum pg 5

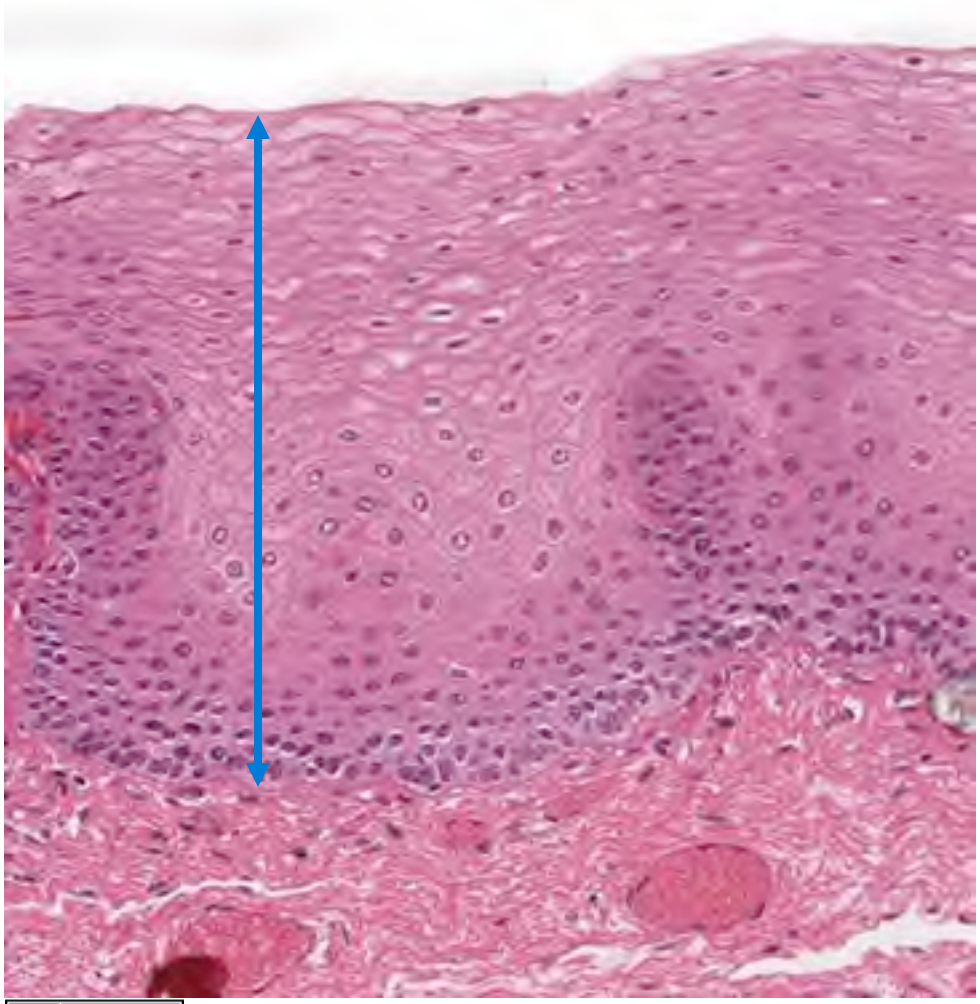
keratinized



PD-INEL Kierszenbaum pg 5

Stratified Squamous Epithelium

Non-keratinized



PD-INEL Michigan Medical School Histology Slide Collection

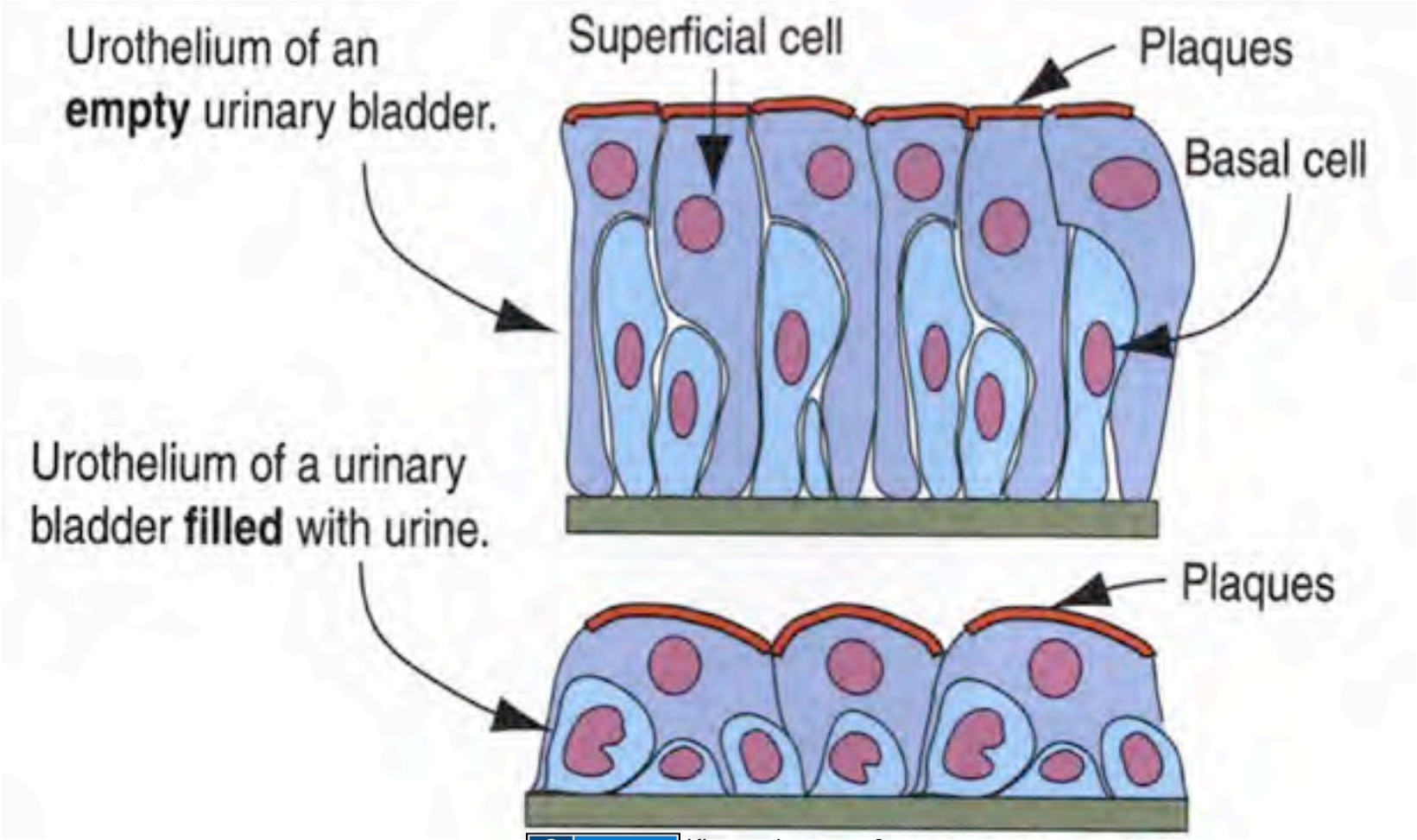
Lines esophagus, oral cavity, vagina…

Keratinized

PD-INEL Michigan Medical School Histology Slide Collection

Lines thick and thin skin

Transitional Epithelium
(urothelium)



PD-INEL Kierszenbaum pg 6

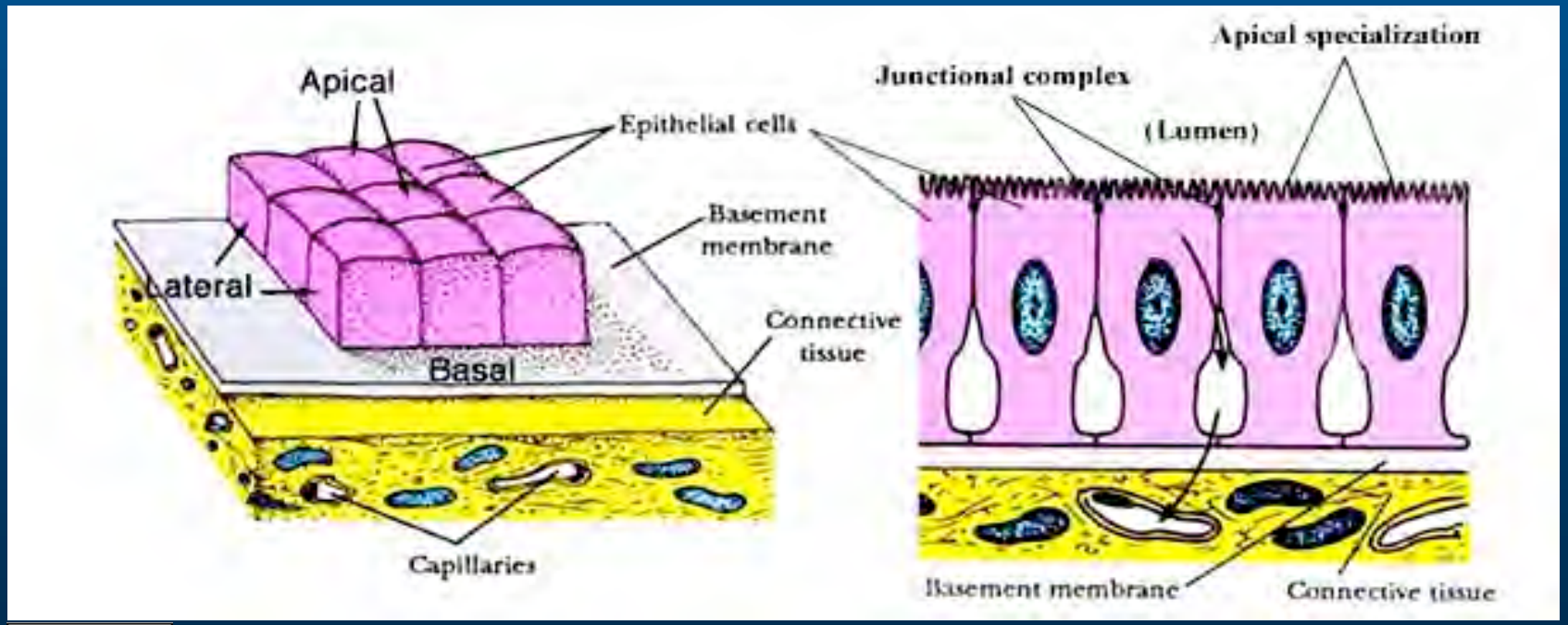
Transitional Epithelium
(urothelium)

Epithelial cells:

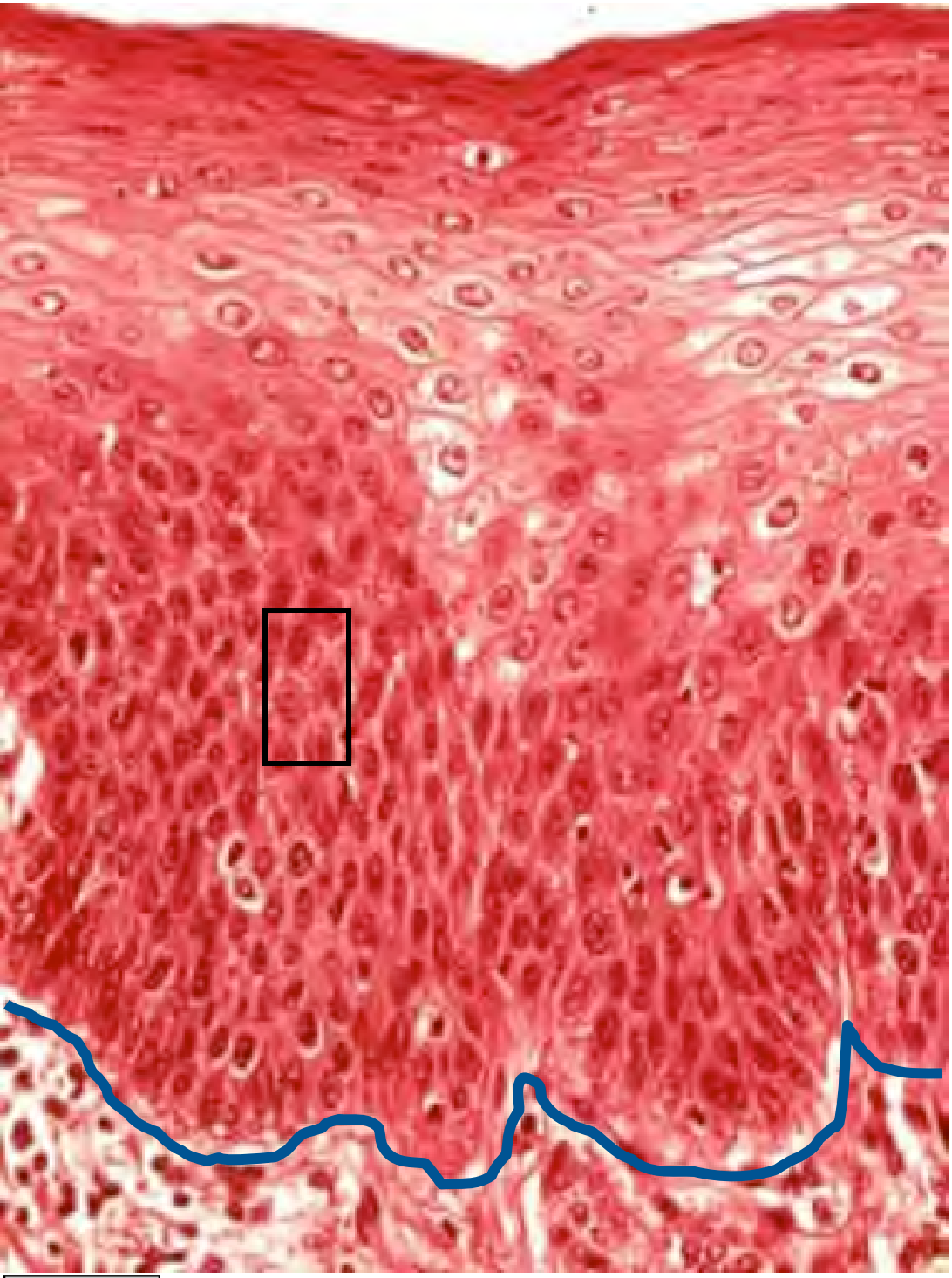
1. Form avascular sheets that differ in number of cell layers, shape of the cells and structural specializations of the free (apical) cell surface, depending on the tissue function(s).
2. Are structurally and functionally polarized: Have apical, lateral and basal domains
3. Are held together by several specializations, known as the intercellular junctions, and bind to the underlying connective tissue via the basement membrane (LM) or basal lamina (EM).
4. Are capable of renewal and regeneration.

non-specialized epithelium - all cells

specialized epithelium - stem cells



 Ross/Romrell p. 52

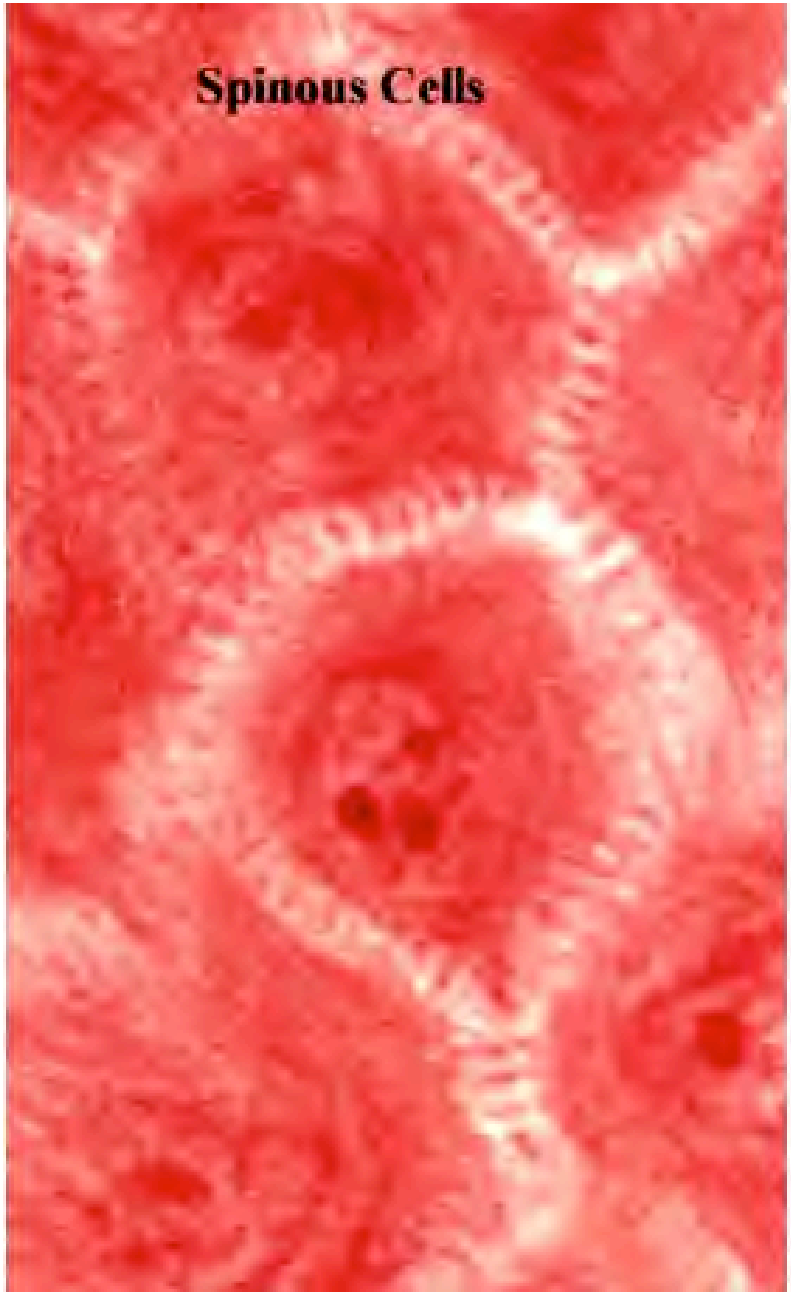


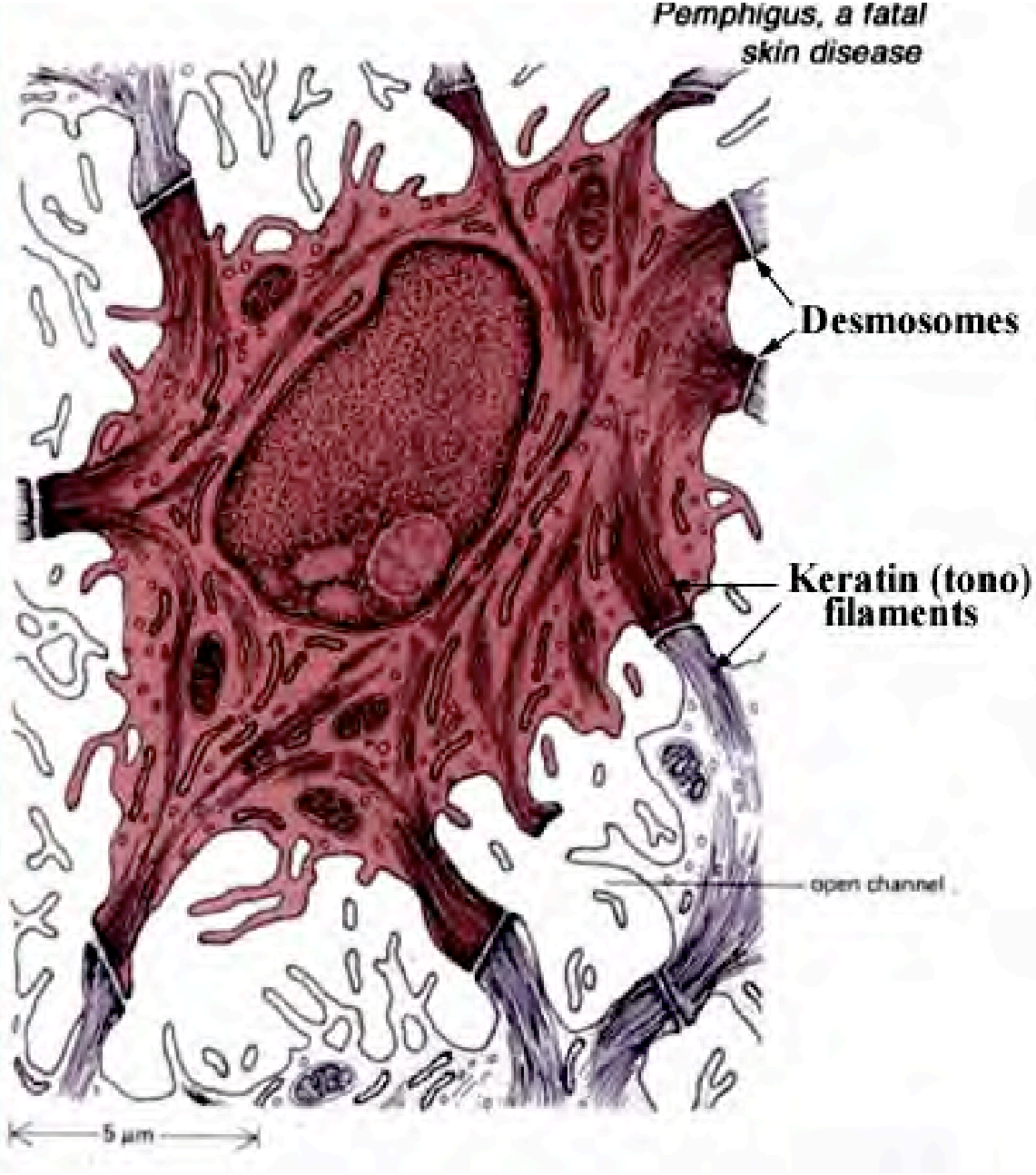
What structures hold the cells together and attaches the epithelium to the connective tissue?

Ans. Intercellular junctions

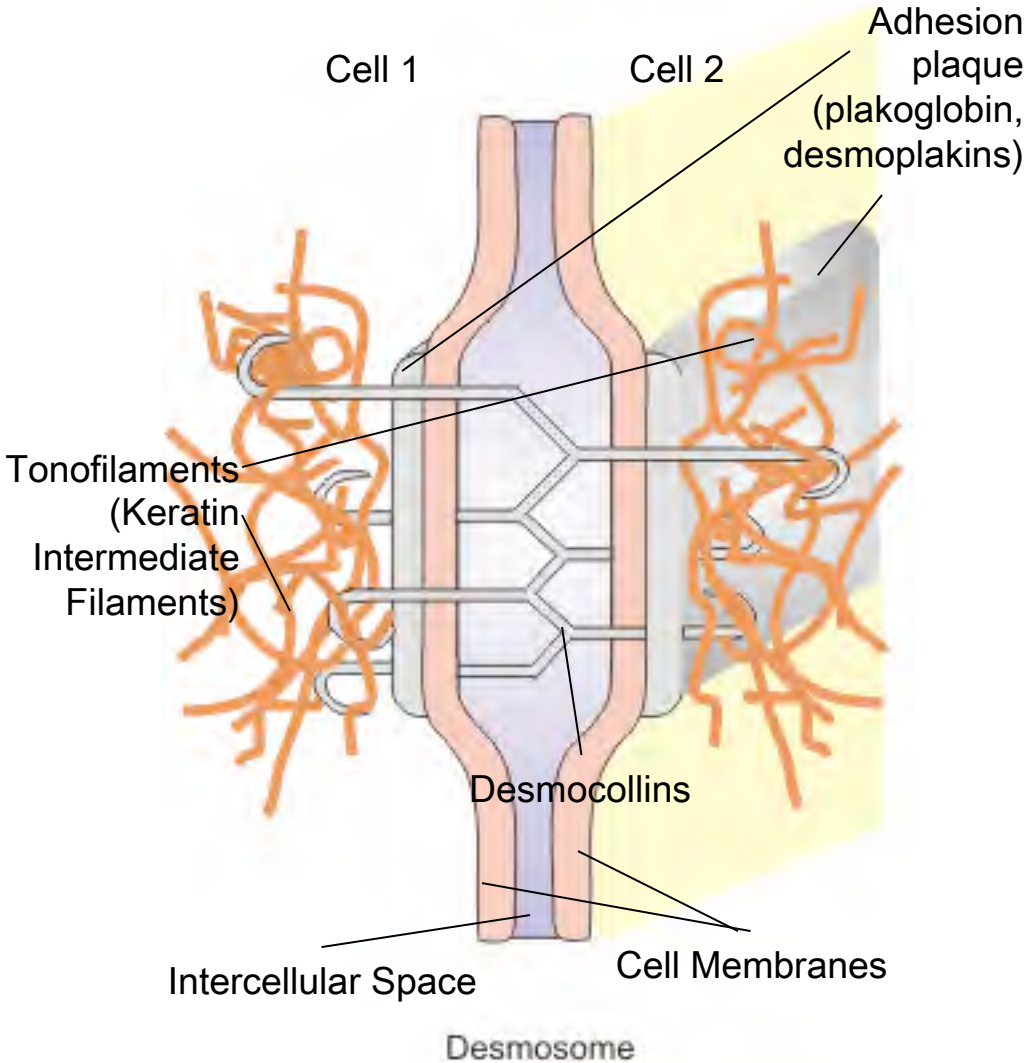
Basement membrane (basal lamina)

Macula adherens (desmosomes) and Intermediate Filaments

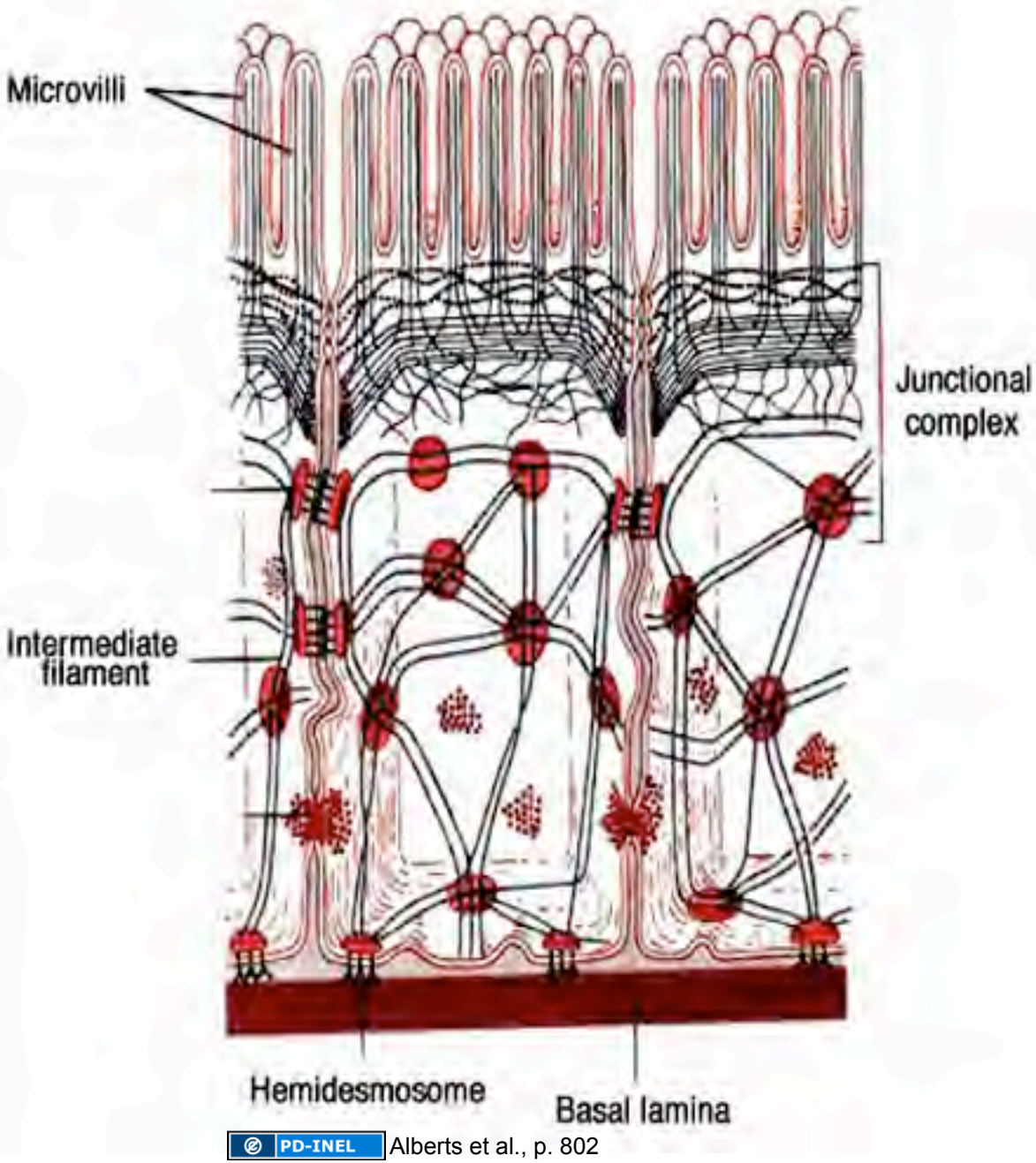




Macula Adherens (desmosome)



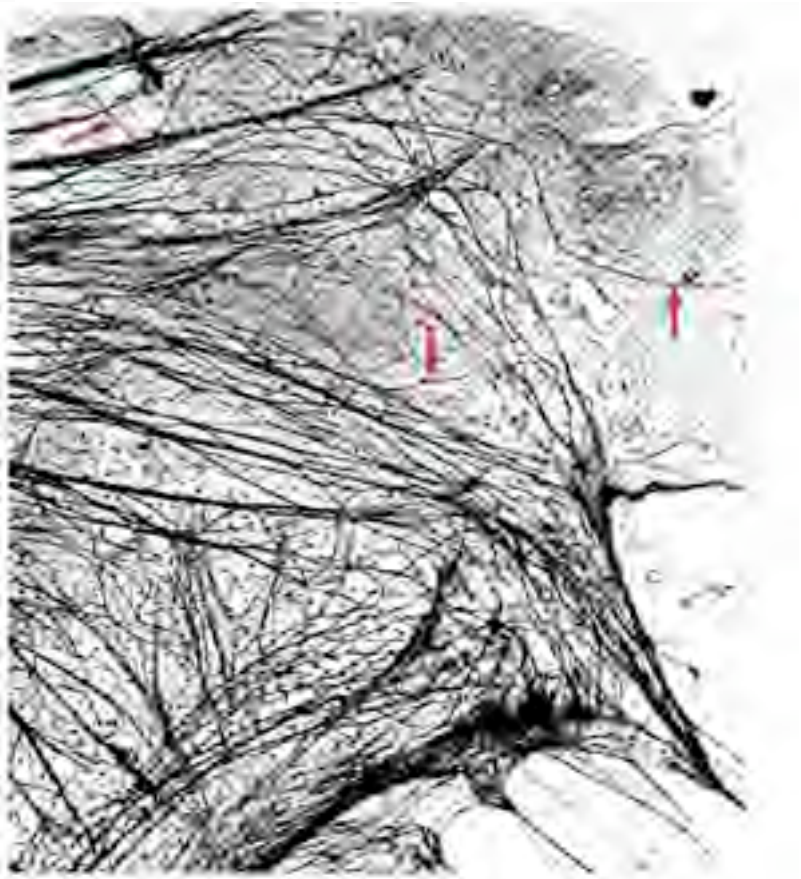
Desmosomes and Intermediate Filaments



PD-INEL Alberts et al., p. 802

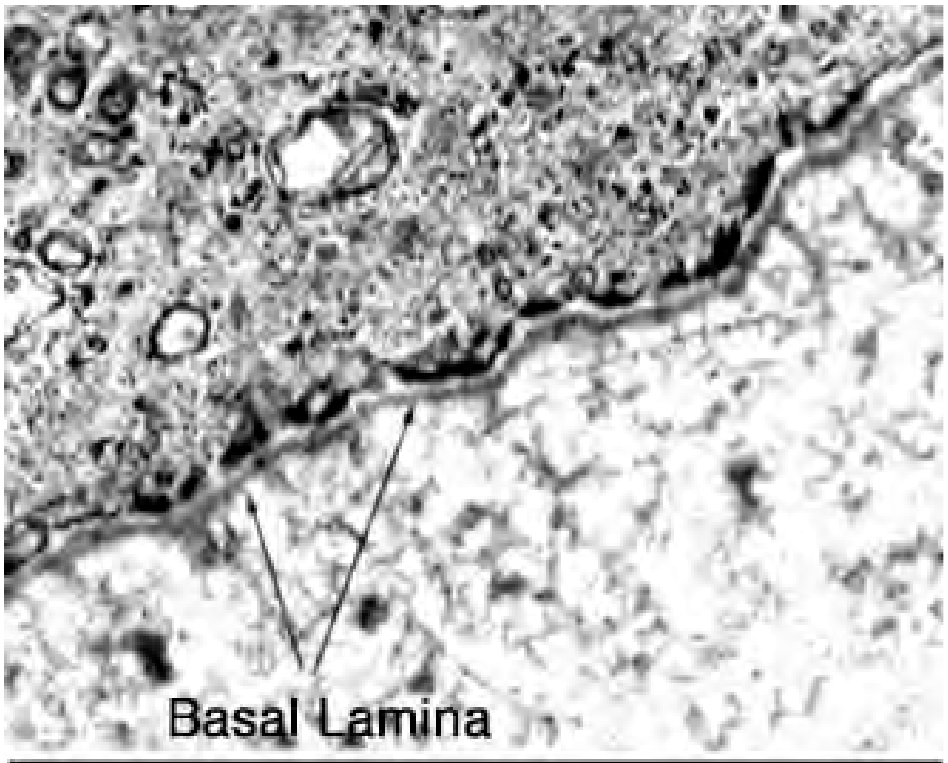
Desmosomes serve as:

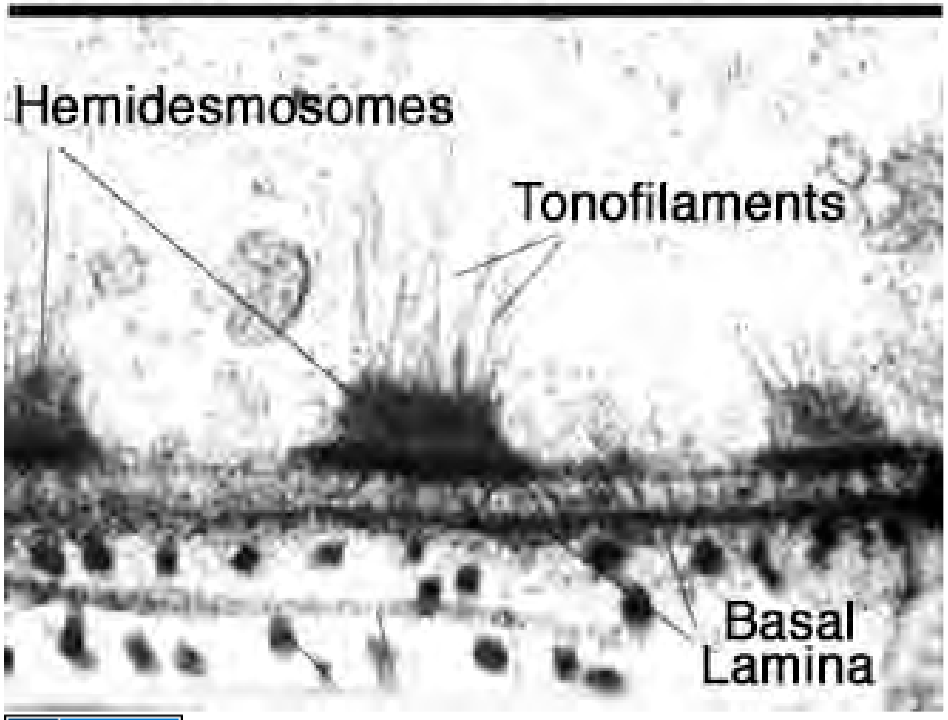
1. Spot attachment sites for adjacent cell membranes.
2. Anchoring sites for intermediate filaments.



PD-INEL Verhey. Molecular Biology of the Cell, Garland Science 2008

Hemidesmosomes function to anchor epithelial cells to the connective tissue via basement membrane (basal lamina).



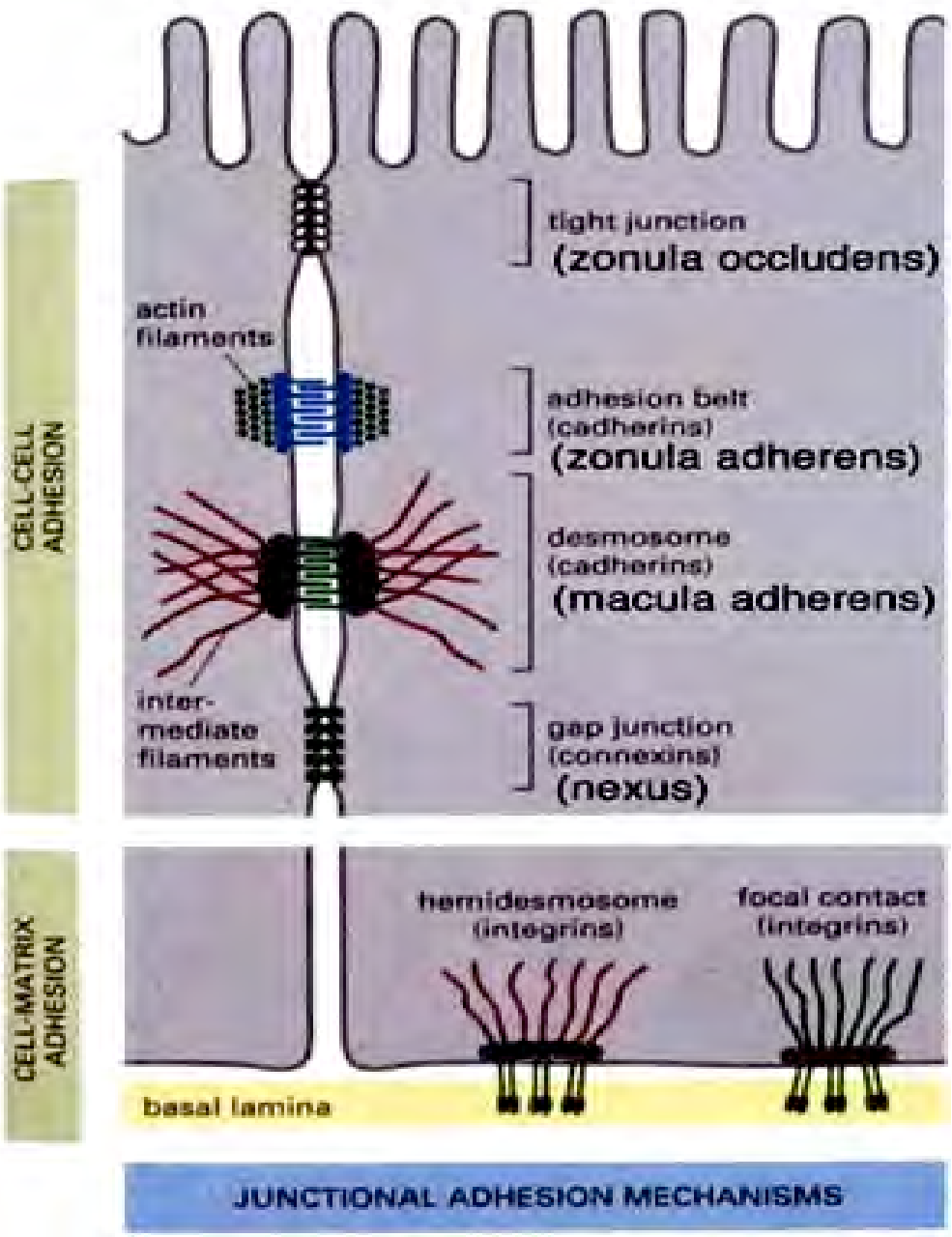


Loss of desmosome functions cause Blistering Skin Disorders

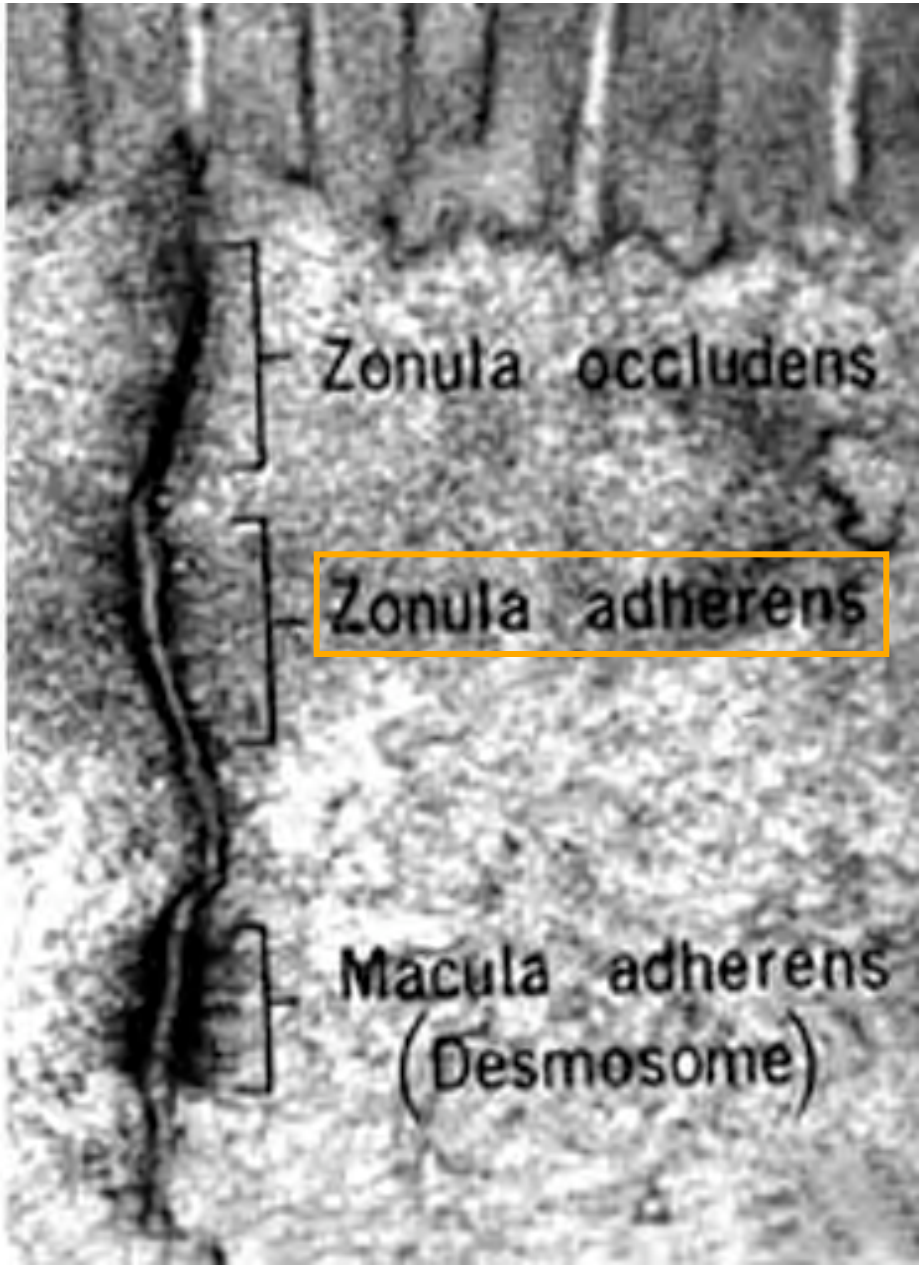
Pemphigus: *Separation of epidermal cells from each other (acantholysis) caused by loss of desmosome functions.*

Bullous pemphigoid: *Separation of epidermis from the dermis due to blistering in the basement membrane caused by loss of anchoring filaments and hemidesmosomes.*

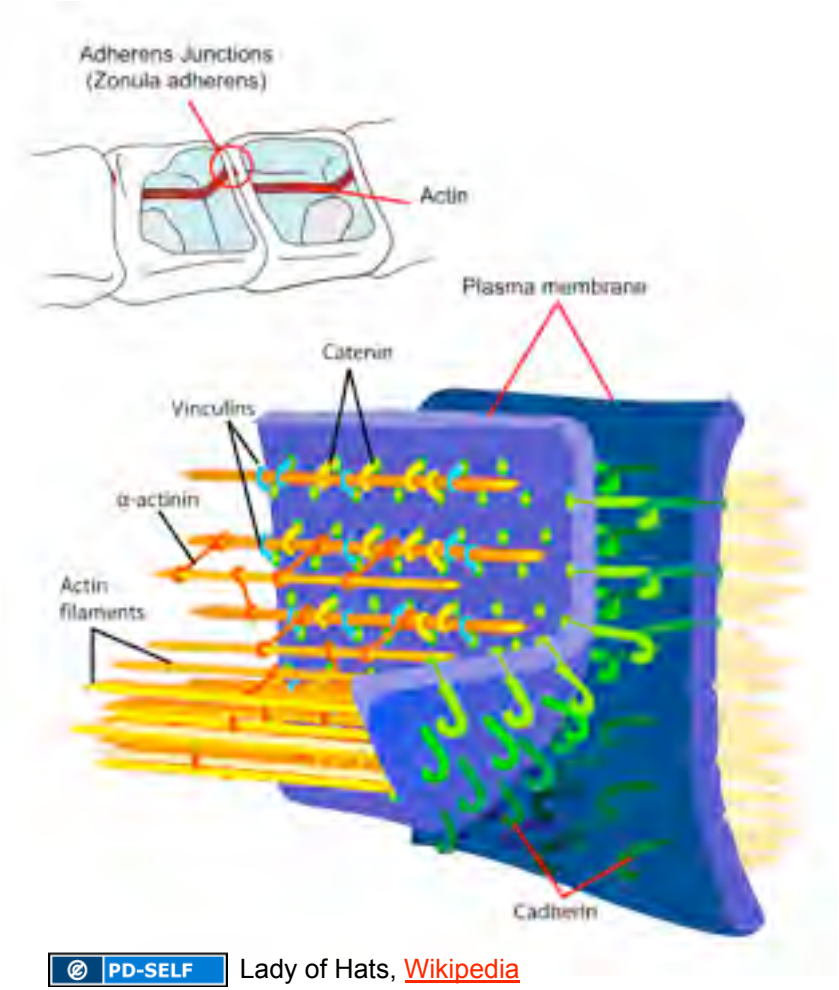
Intercellular Junctions



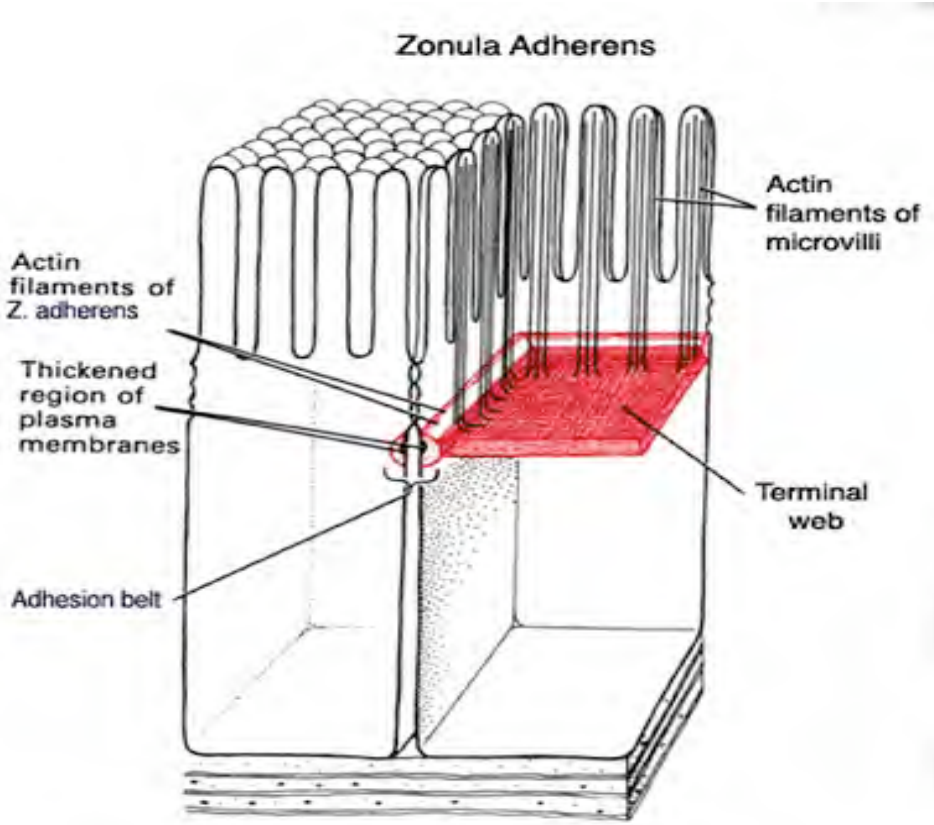
Junctional Complex



Zonula adherens (intermediate junction)



PD-SELF Lady of Hats, Wikipedia



PD-INEL Darnell, et. al., p.608

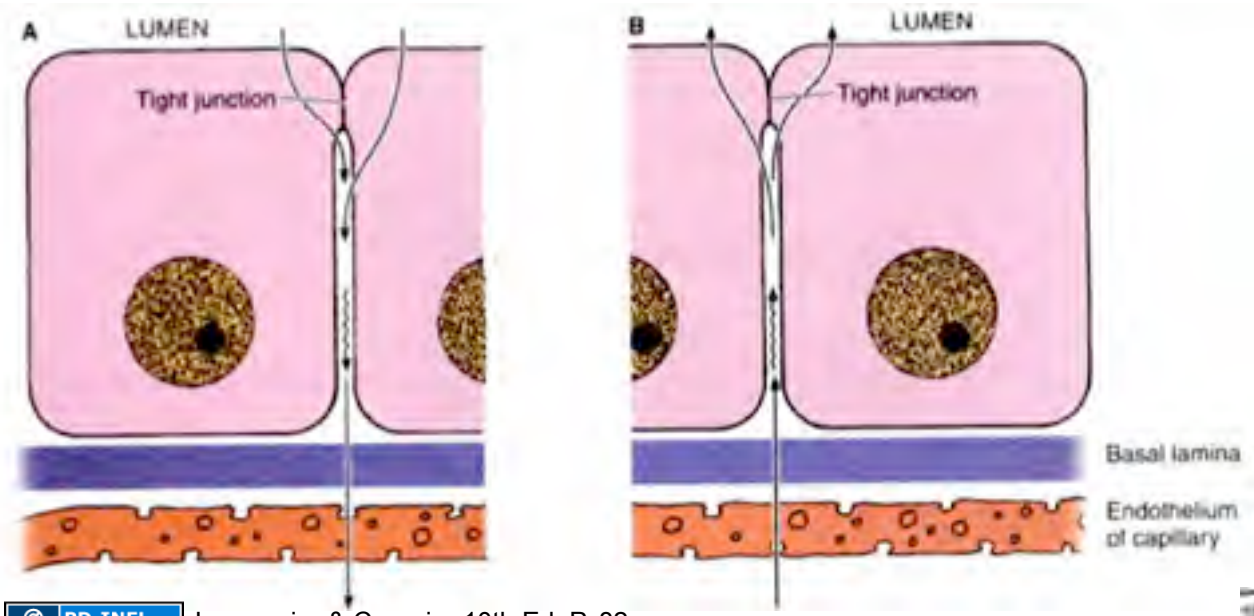
Zonula adherens

- Intermediate junction
- Adhering junction
- Cadherins
- Linked to actin filaments
- Adhesion belt

Macula adherens

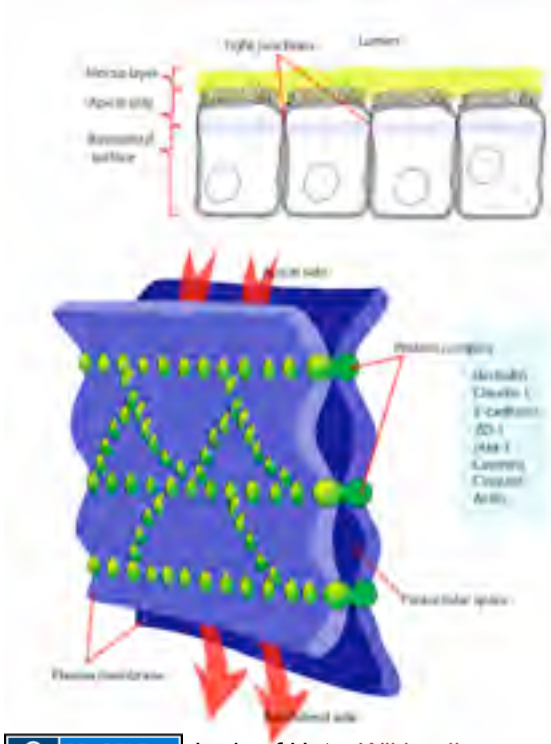
- Desmosome
- Adhering junction
- Cadherins
- Linked to intermediate filaments
- Spot adhering junction

Zonula Occludens (Tight Junction)



PD-INEL Junquueira & Carneiro 10th Ed. P. 82

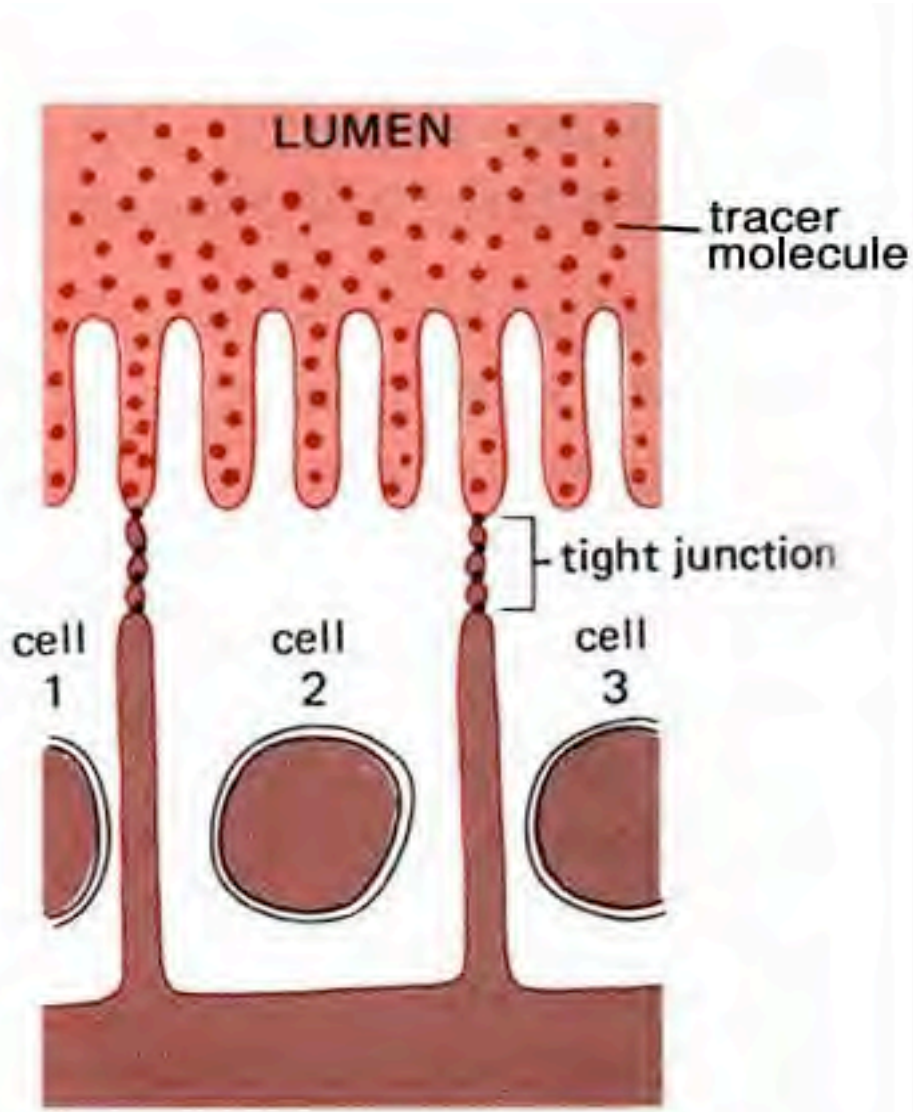
serves as a *Selective Permeability Barrier*

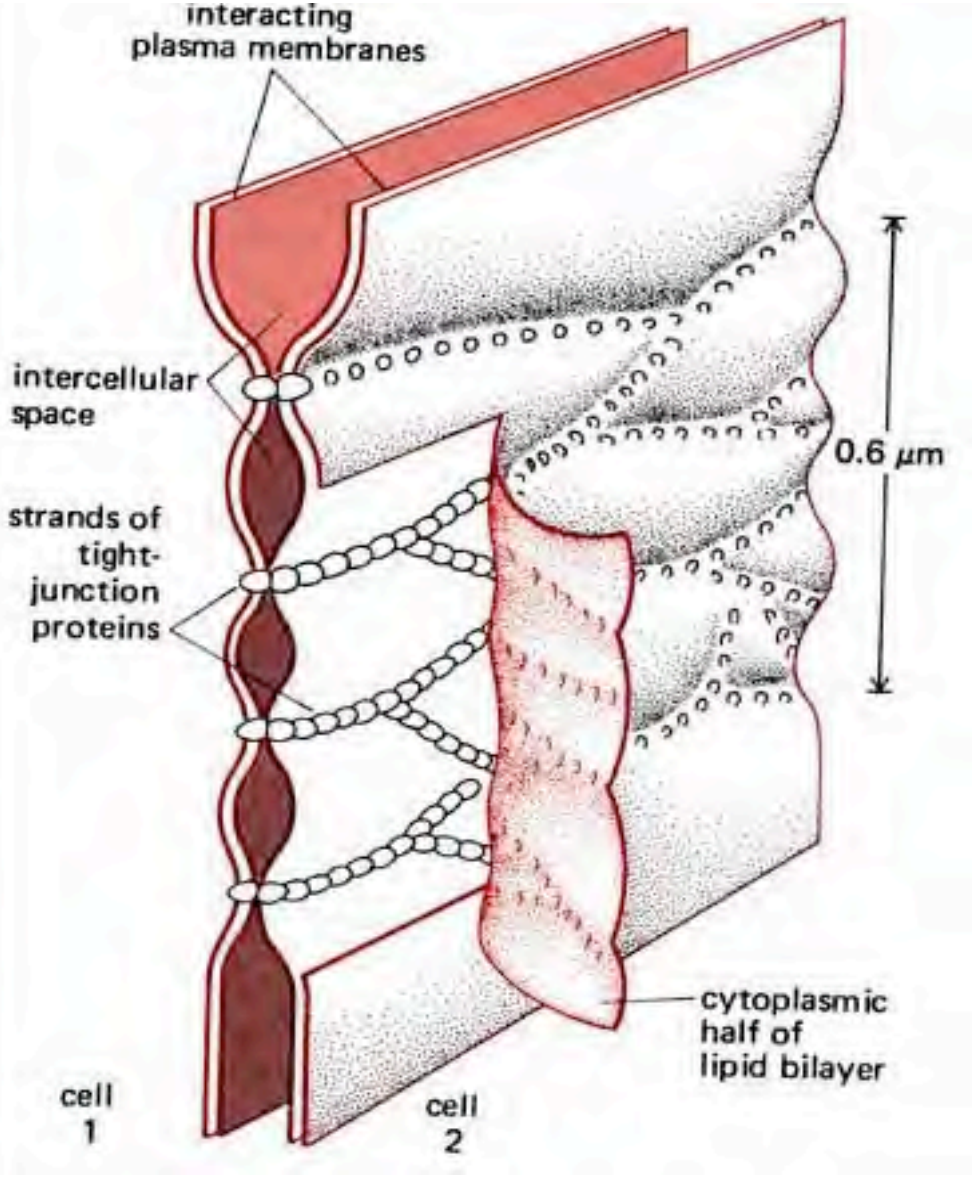


PD-SELF Lady of Hats, Wikipedia

PD-INEL Source Undetermined

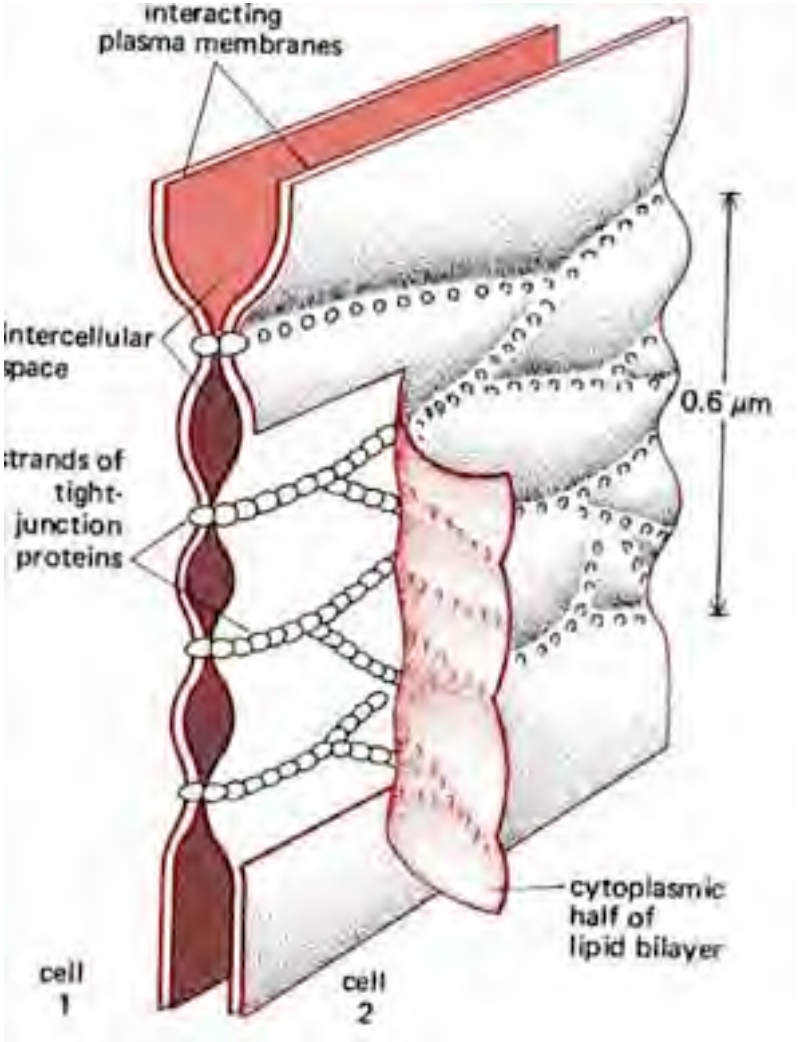
Zonula occludens (tight junction)





 Alberts et. Al, p. 794-5

Freeze-fracture preparation



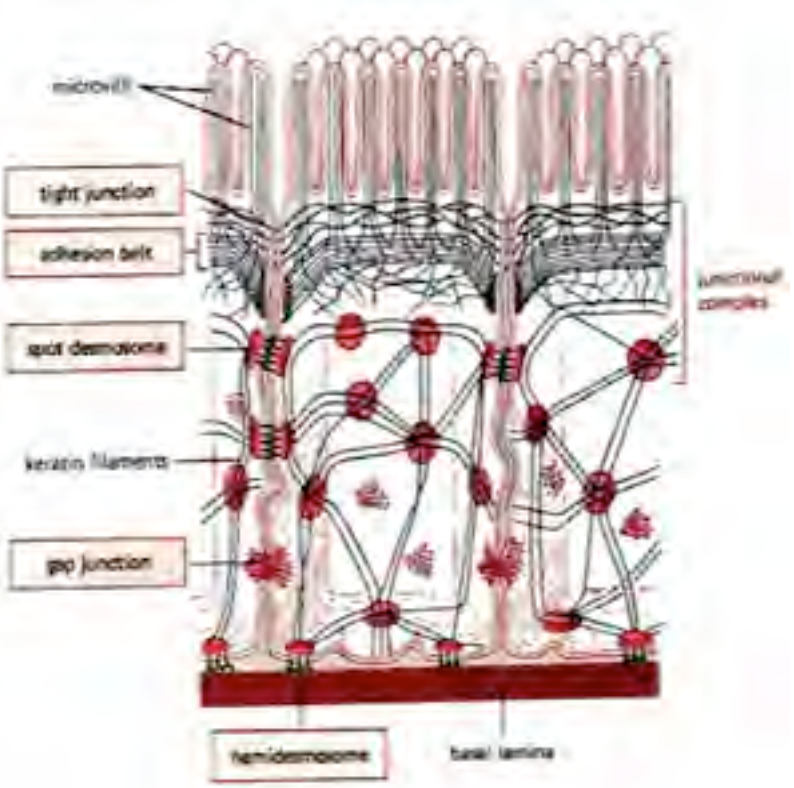
PD-INEL Alberts et al., p. 795

PD-INEL Bloom and Fawcett p. 67

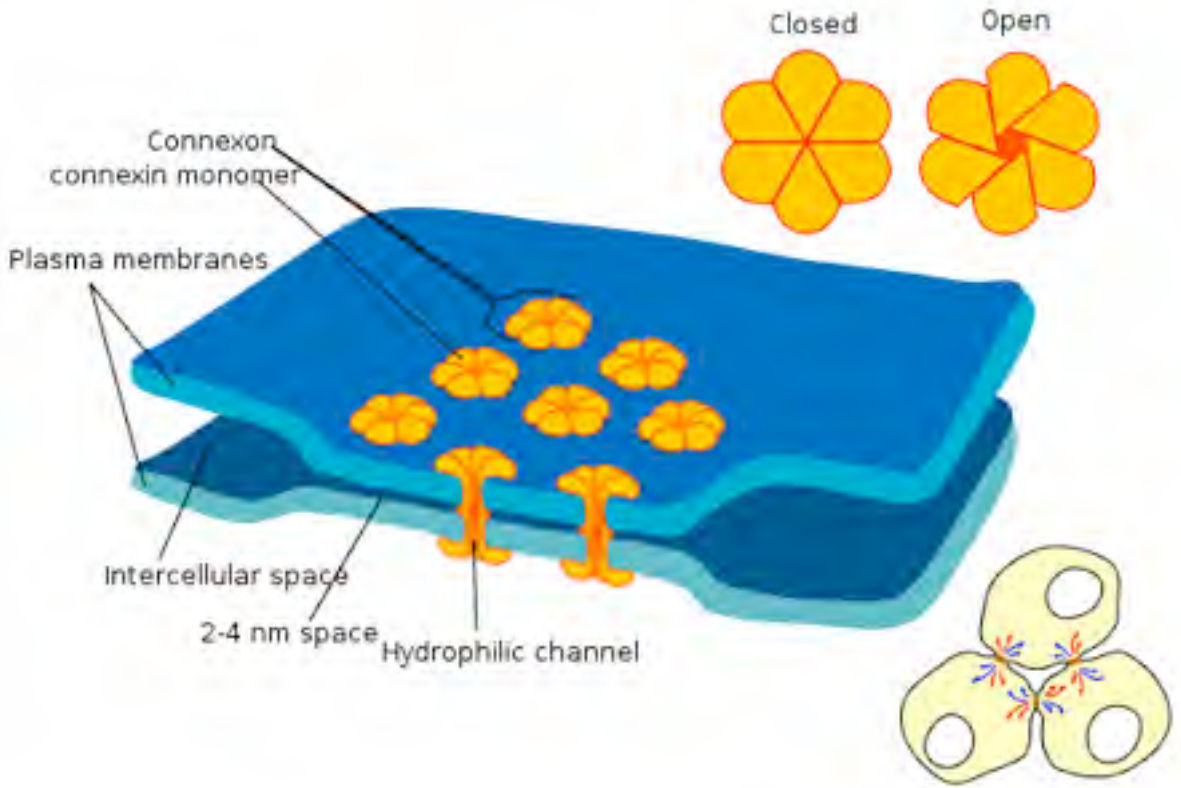
Nexus (gap Junction)

- communicating junction

Six *Connexin* subunits assemble to form a *Connexon*.

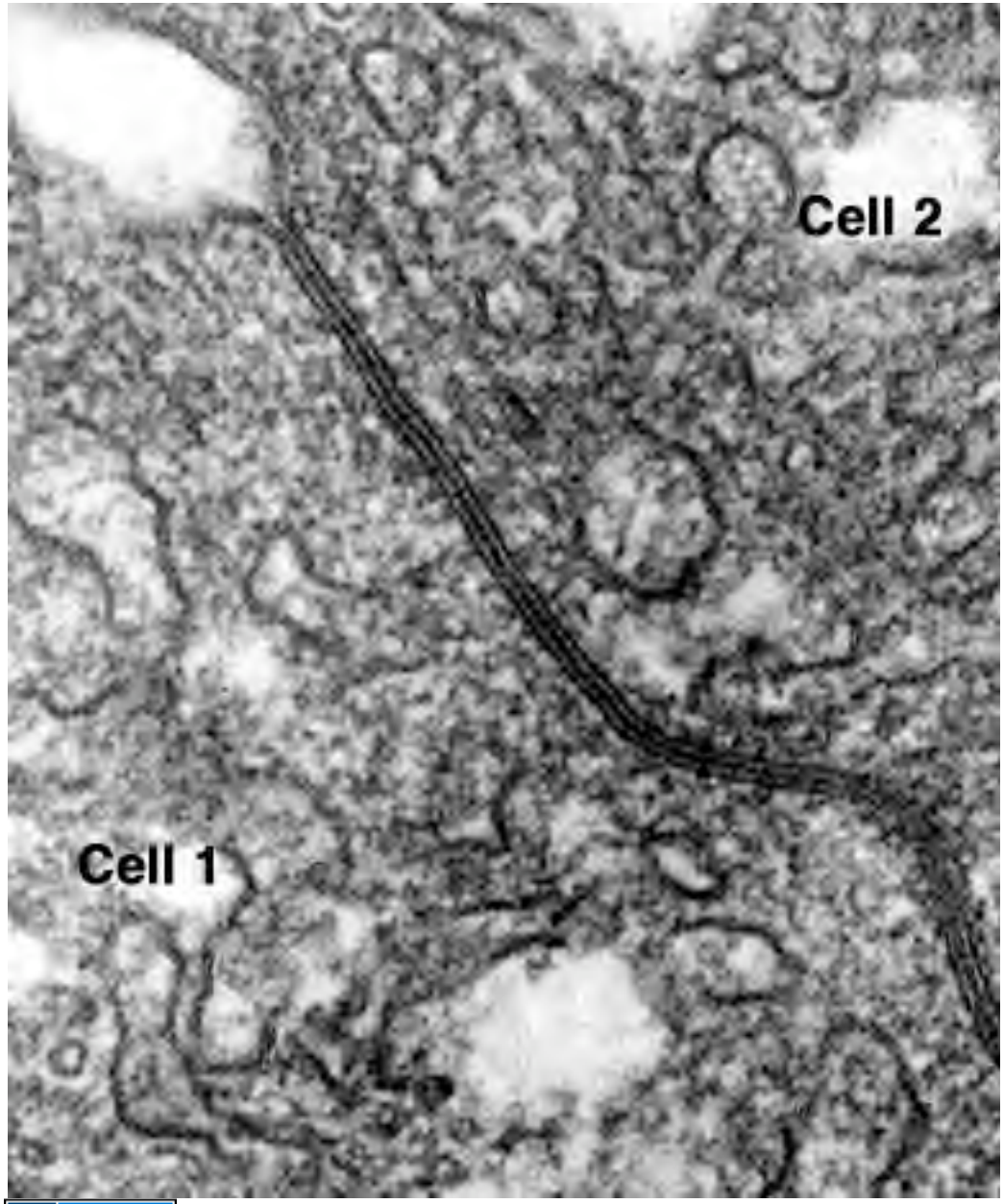


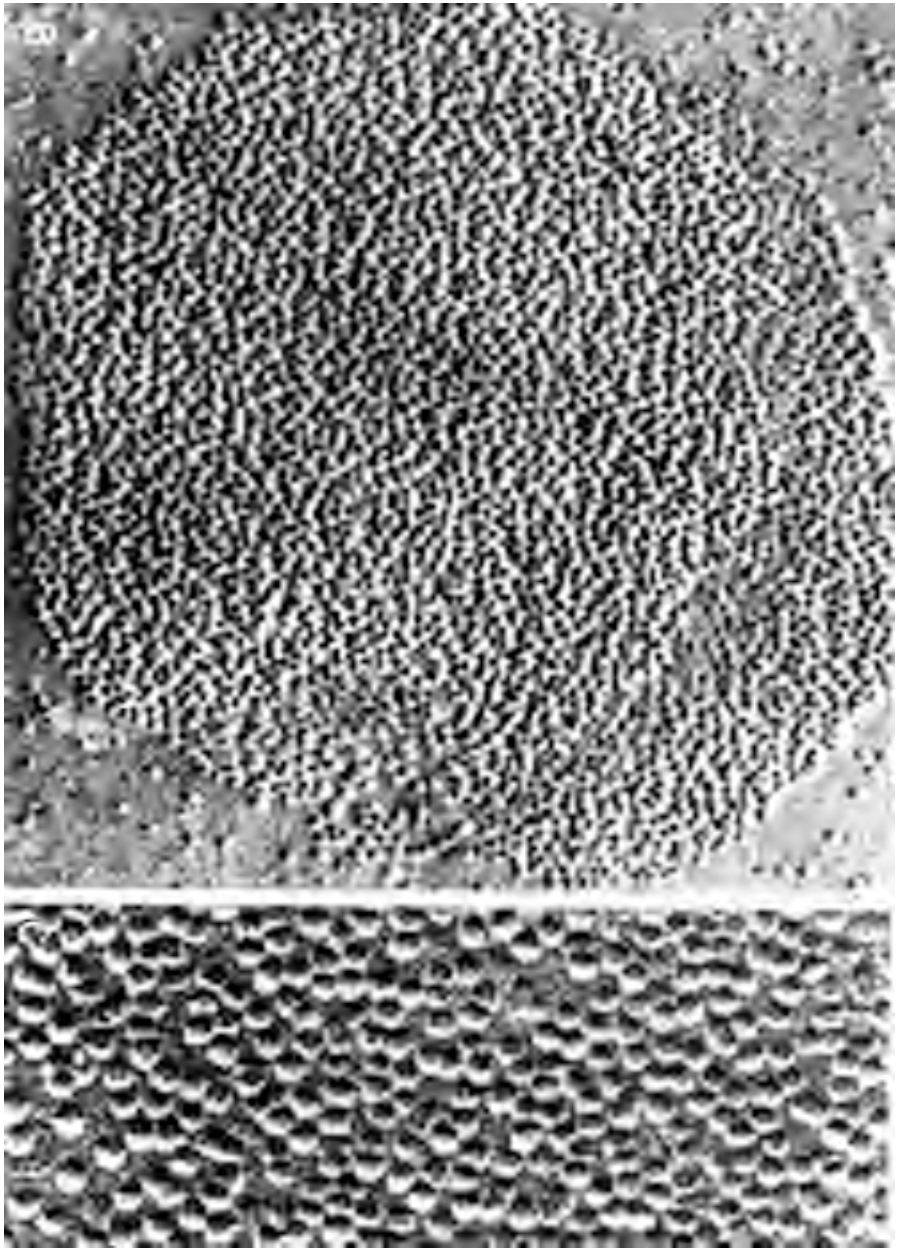
PD-INEL Alberts et al., p. 802



PD-SELF Lady of Hats, Wikipedia

Gap Junction



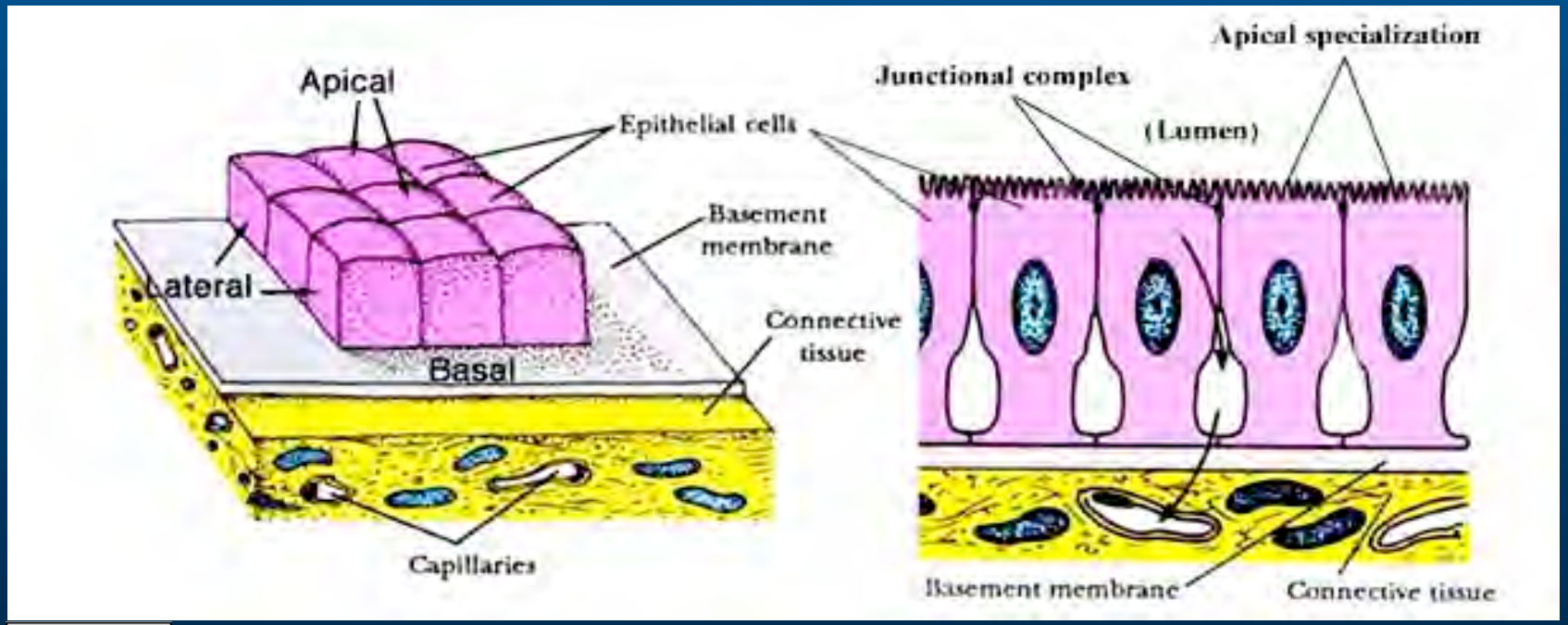


Epithelial cells:

1. Are structurally and functionally polarized: Have apical, lateral and basal domains
2. Form avascular sheets that differ in number of cell layers, shape of the cells and structural specializations of the free (apical) cell surface, depending on the tissue function(s).
3. Are held together by several specializations, known as the intercellular junctions, and bind to the underlying connective tissue via the basement membrane (LM) or basal lamina (EM).
4. Are capable of renewal and regeneration.

non-specialized epithelium - all cells

specialized epithelium - stem cells



 Ross/Romrell p.52

Epithelium

Types - simple & stratified (pseudostratified)

Apical cell surface specializations

- Microvilli - actin filaments
- Cilia - microtubules (dyneins)

Intercellular junctions

- Zonula occludens (tight junction) - ridges and grooves, seal intercellular spaces - Selective permeability barrier
- Zonula adherens - actin filaments - cell to cell adhesion
- Macula adherens (desmosome) - intermediate filaments - attachment plaque (spot)
- Hemidesmosome - attaches epithelium to basal lamina
- Nexus (gap junction) - connexons - cell to cell communication

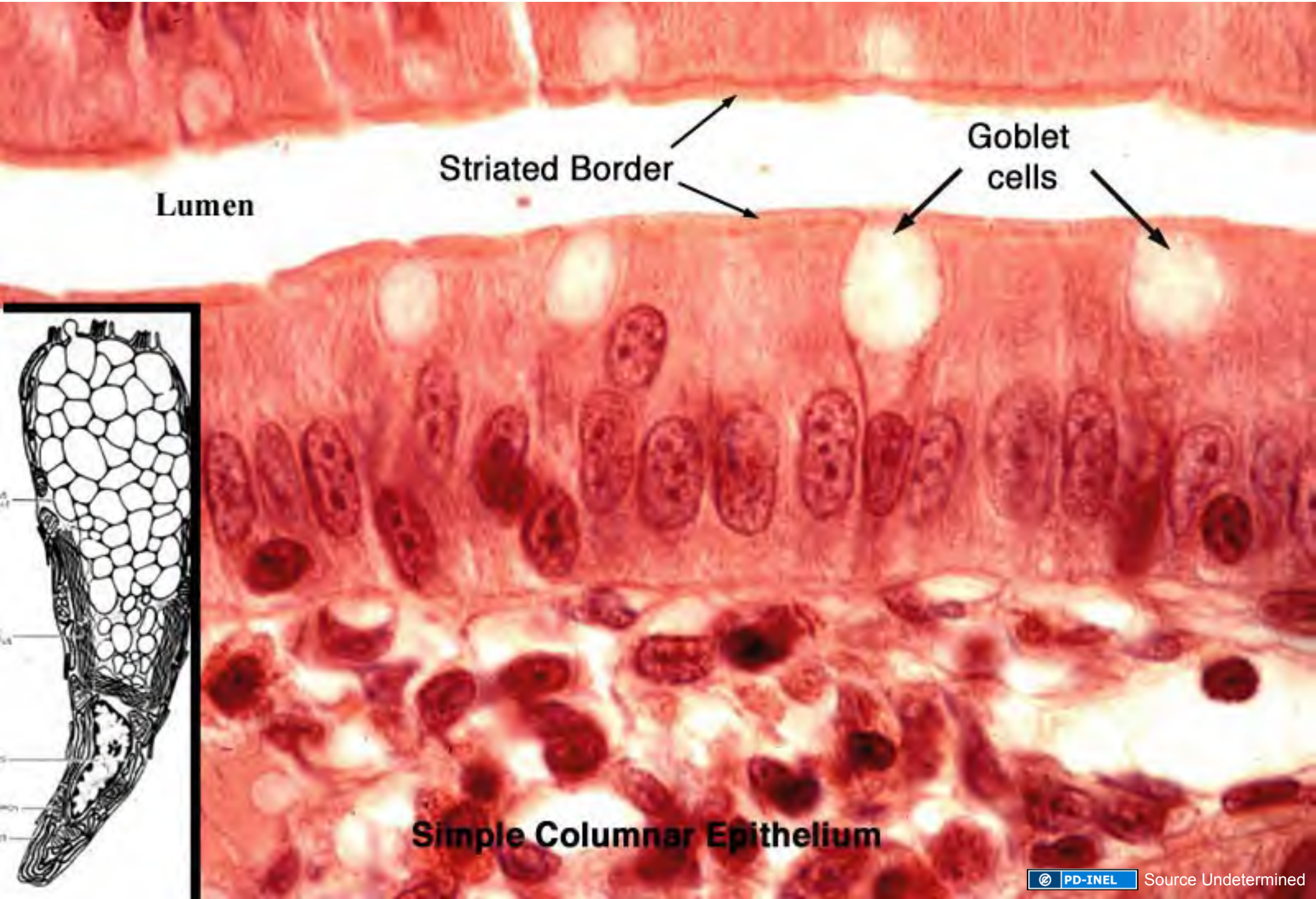
Epithelial cells form Secretory Glands

Glands: Groupings of cells specialized for secretion

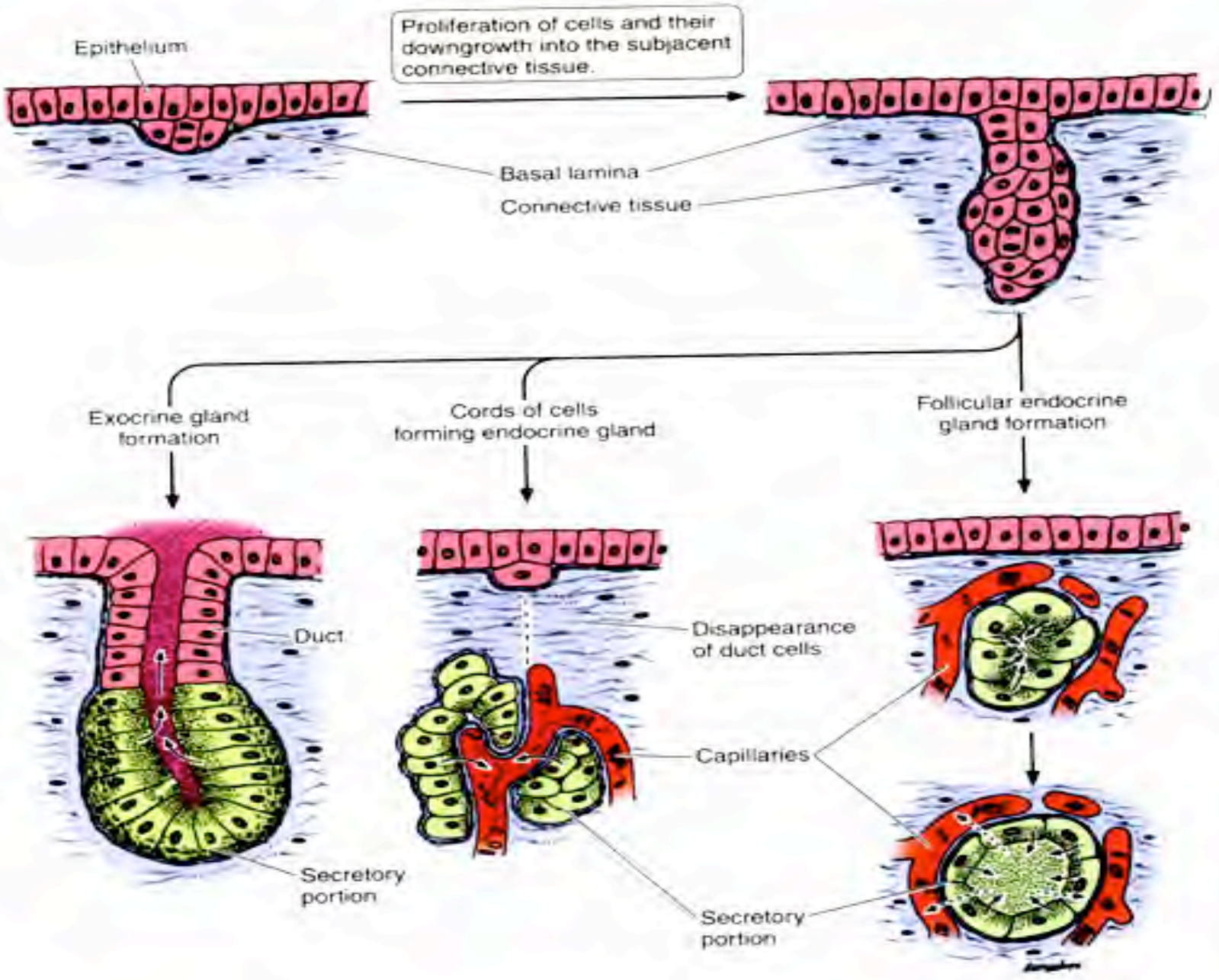
Secretion *is the process by which small molecules are taken up and transformed, by intracellular biosynthesis, into a more complex product that is then actively released from the cell*.

Exocrine (ducts) and endocrine (ductless) glands

Secretory Epithelial cells



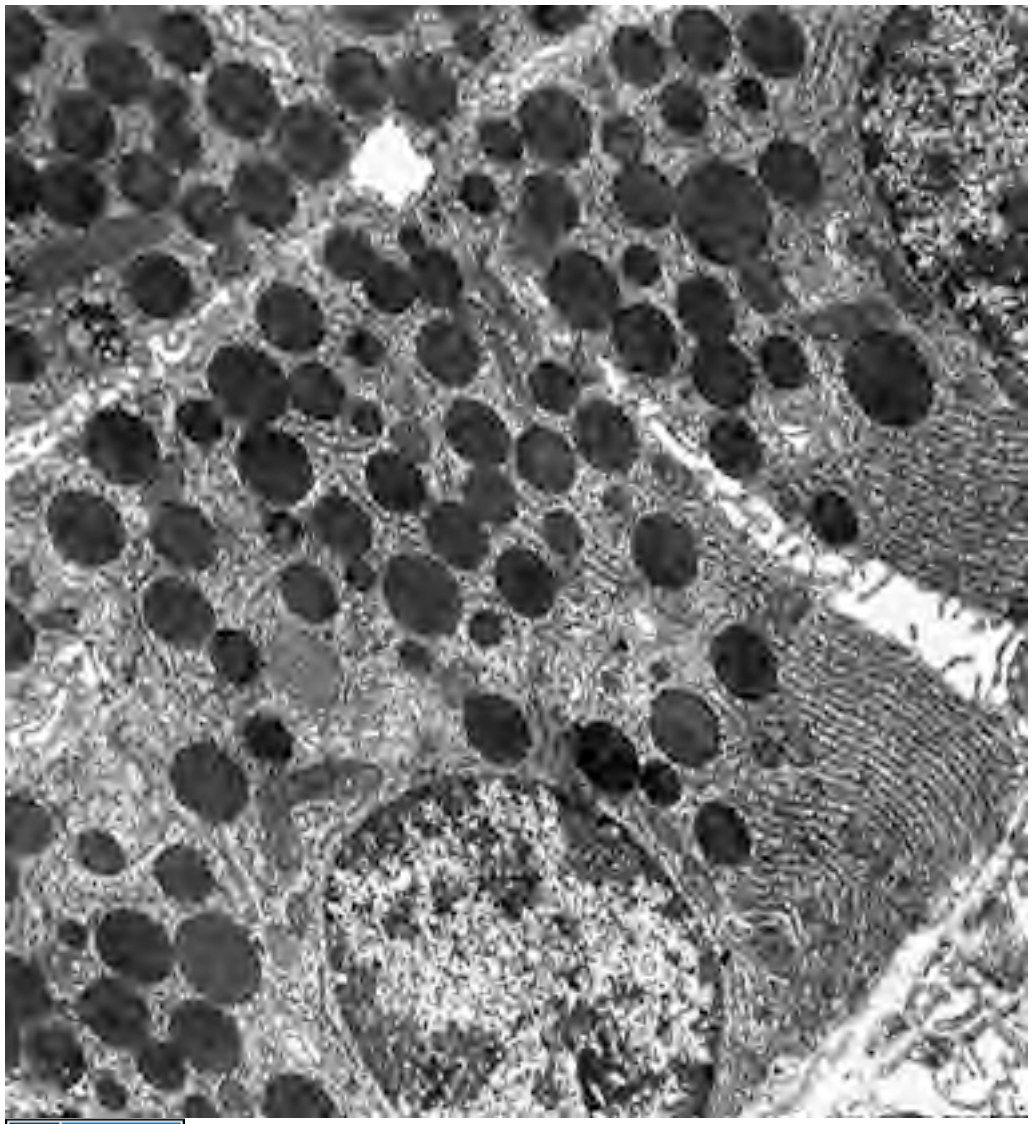
Development of Endocrine and Exocrine Glands



 Junquiera and Carnein, 10th Ed. P. 82

Secretory Units and Glandular Cells

Image of secretory units and glandular cells removed



Two Secretory Pathways

Regulated Secretion: Secretory granules accumulate in cells and the granule content is released by exocytosis upon stimulation.

Constitutive Secretion: The secretory product is not concentrated into granules but is released continuously in small vesicles.

Learning Objectives

After today's session, the students are expected to:

1. Be able to classify epithelia and identify each type.
2. Recognize four types of intercellular junctions and hemidesmosomes at the electron microscope level and know their functions.
3. Identify the apical specializations and know their functions.
4. Be able to correlate different types of epithelia to their functions and know where in the body each type occurs.
5. Know how specialized and non-specialized epithelial cells are renewed.
6. Know how exocrine and endocrine glands form and be able to recognize secretory cells.

Additional Source Information

for more information see: http://open.umich.edu/wiki/CitationPolicy

Slide 6: Junqueira and Carnein 10th Ed., pg 82

Slide 7: Michigan Medical School Histology Slide Collection

Slide 8: Ross/Romrell p.52

Slide 9: Ross/Romrell p.52

Slide 10: Ross/Romrell p.53

Slide 11: Kierszenbaum p.6

Slide 12: Michigan Medical School Histology Slide Collection; Kierszenbaum p.4

Slide 13: Source Undetermined

Slide 14: Michigan Medical School Histology Slide Collection; Kierszenbaum p.4

Slide 15: Source Undetermined; Michigan Medical School Histology Slide Collection; Kierszenbaum p.4

Slide 16: Michigan Medical School Histology Slide Collection; Gray's Anatomy, Wikimedia Commons, http://commons.wikimedia.org/wiki/File:Gray1056.png

Slide 17: Source Undetermined; Source Undetermined

Slide 18: Darnell et al., Molecular Cell Biology p. 608; Source Undetermined

Slide 19: Kierszenbaum p.6; K. Verhey

Slide 20: Michigan Medical School Histology Slide Collection; Source Undetermined

Slide 21: Ross

Slide 22: Ross et al., 4th ed. P. 94; Ross; Alberts et al., pg 648

Slide 23: Source Undetermined

Slide 24: Source Undetermined; Source Undetermined

Slide 25: Kierszenbaum; Kierszenbaum

Slide 26: Michigan Medical School Histology Slide Collection

Slide 27: Kierszenbaum, pg 6

Slide 28: Source Undetermined

Slide 29: Ross/Romrell p.52

Slide 30: Source Undetermined

Slide 31: Source Undetermined

Slide 32: Source Undetermined; CC BY Boumphreyfr, http://commons.wikimedia.org/wiki/File:Cell_junctions.png, CC:BY-SA 3.0, http://creativecommons.org/licenses/by-sa/3.0/

Slide 33: Verhey. Molecular Biology of the Cell, Garland Science 2008; Alberts et al., p. 802

Slide 34: Michigan Medical School Histology Slide Collection; Source Undetermined

Slide 35: Source Undetermined

Slide 36: Source Undetermined

Slide 37: Lady of Hats, Wikipedia, http://commons.wikimedia.org/wiki/File:Adherens_Junctions_structural_proteins.svg; Darnell, et. al., p.608

Slide 39: Lady of Hats, Wikipedia, http://commons.wikimedia.org/wiki/File:Cellular_tight_junction_en.svg; Source Undetermined; Junquueira & Carneiro 10th Ed. P. 82

Slide 40:Alberts et. Al, p. 794-5;

Slide 41: Alberts et al., p. 795; Bloom and Fawcett p. 67

Slide 42: Alberts et al., p. 802;
Lady of Hats, Wikipedia, http://commons.wikimedia.org/wiki/File:Gap_cell_junction_en.svg

Slide 43: Source Undetermined; Source Undetermined

Slide 44: Ross/Romrell p.52

Slide 47: Source Undetermined

Slide 48: Junquiera and Carnein, 10th Ed. P. 82

Slide 49: Sun-Kee Kim

Slide 50: Sun-Kee Kim