Chapter 2

Epithelial tissue

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I General Biology of Epithelium

1.1 General structural features

- The cells are polarizable with free top surface and basal surface that rests on a basal lamina.
- Adhesion between these cells is strong because of tight juncion.
- The space between adjacent epithelial cells is very narrow and occupied by very little intercellular substance.
- There is innervation (nerve), but avascularity (no blood vessel), in epithelium.

1.2 principal functions:

- protection, covering and lining surfaces (skin);
- absorption (intestine);
- secretion (epithelial cells of gland);
- sensation (neuroepithelium);
- contractility (myoepithelial cells).

Classification of epithelia

- **Covering epithelium:**
  which cover body surface or line the inner surface of body cavities, tubes and sac.
- **Glandular epithelium:**
  which main function is secretion.

II Covering epithelium:

According to the number of cells layers and morphology of cells

- **Simple epi.: one layer of cells**
- **Stratified epi.: more than one layer**

2.1 Simple epithelium

According to cell form

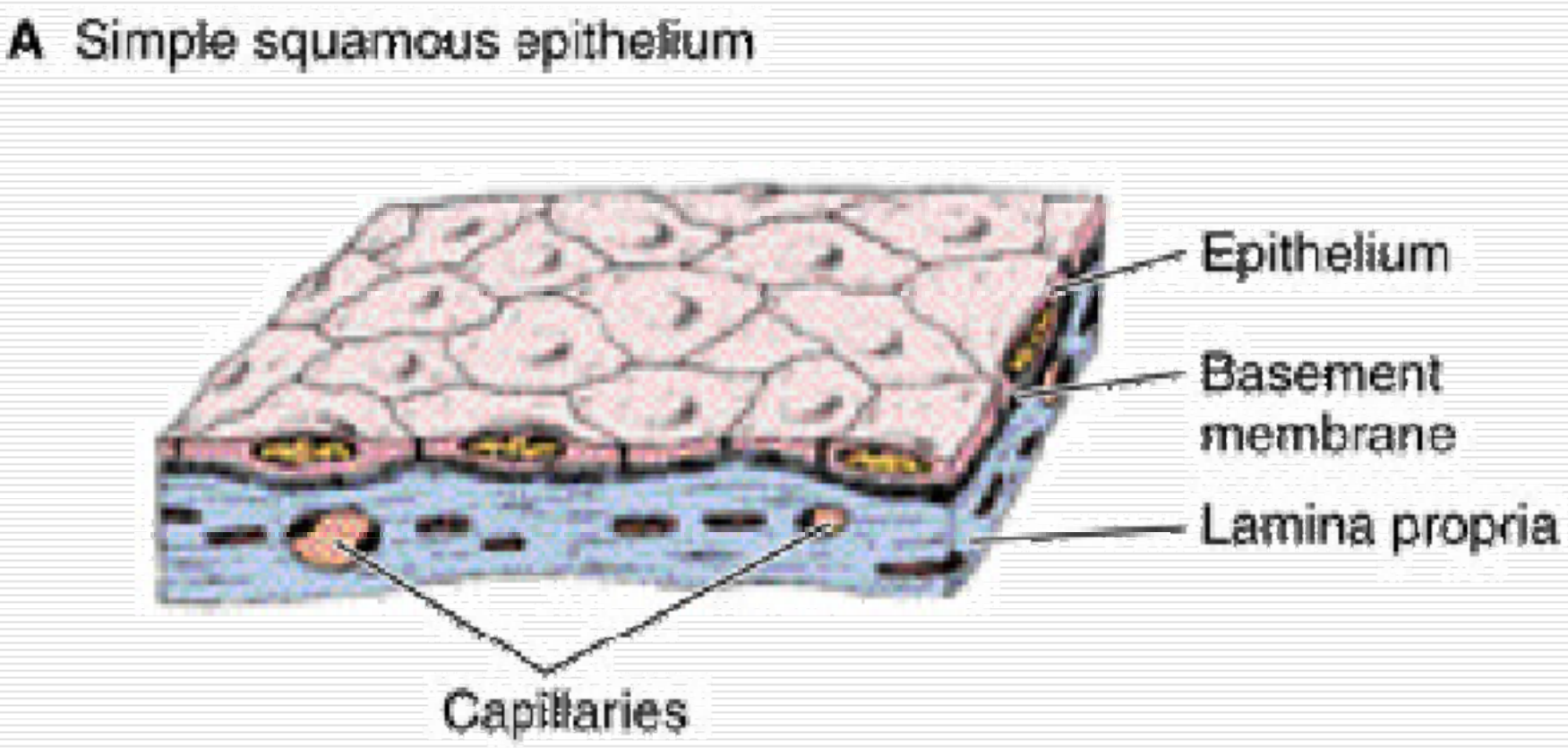
---simple squamous epi.

---simple cuboidal epi.

---simple columnar epi.

---pseudostratified ciliated columnar epi.

- one layer flattened cells with flattened ellipic nucleus
- cell borders are interdigitate. (wave-shaped).
- The middle part of the cell is slightly thicker



---Distribution:

- **endothelium:**

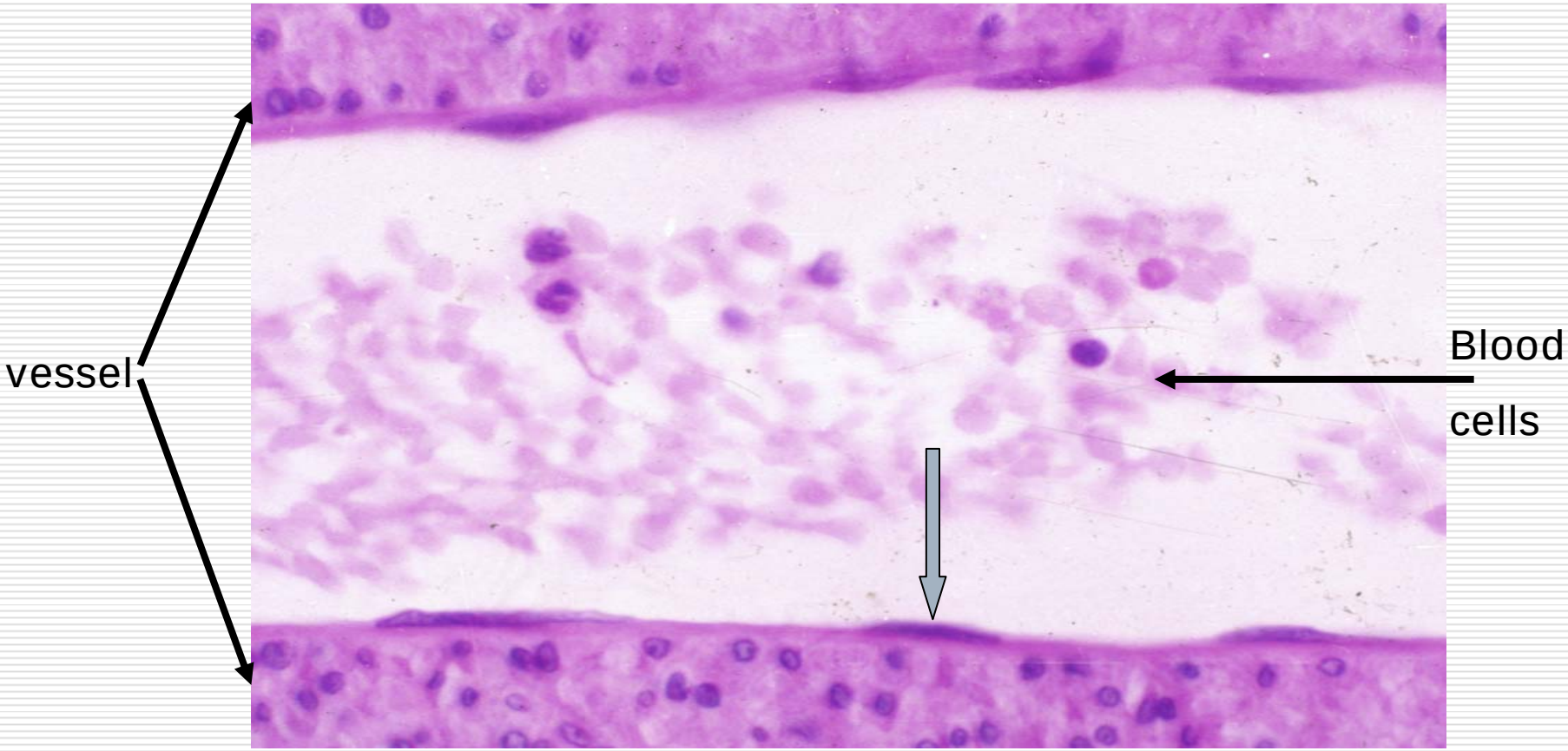
  lining the inner surface of cardiovascular and lymphatic system.

- **mesothelium:**

  lining the inner surface of body cavities.

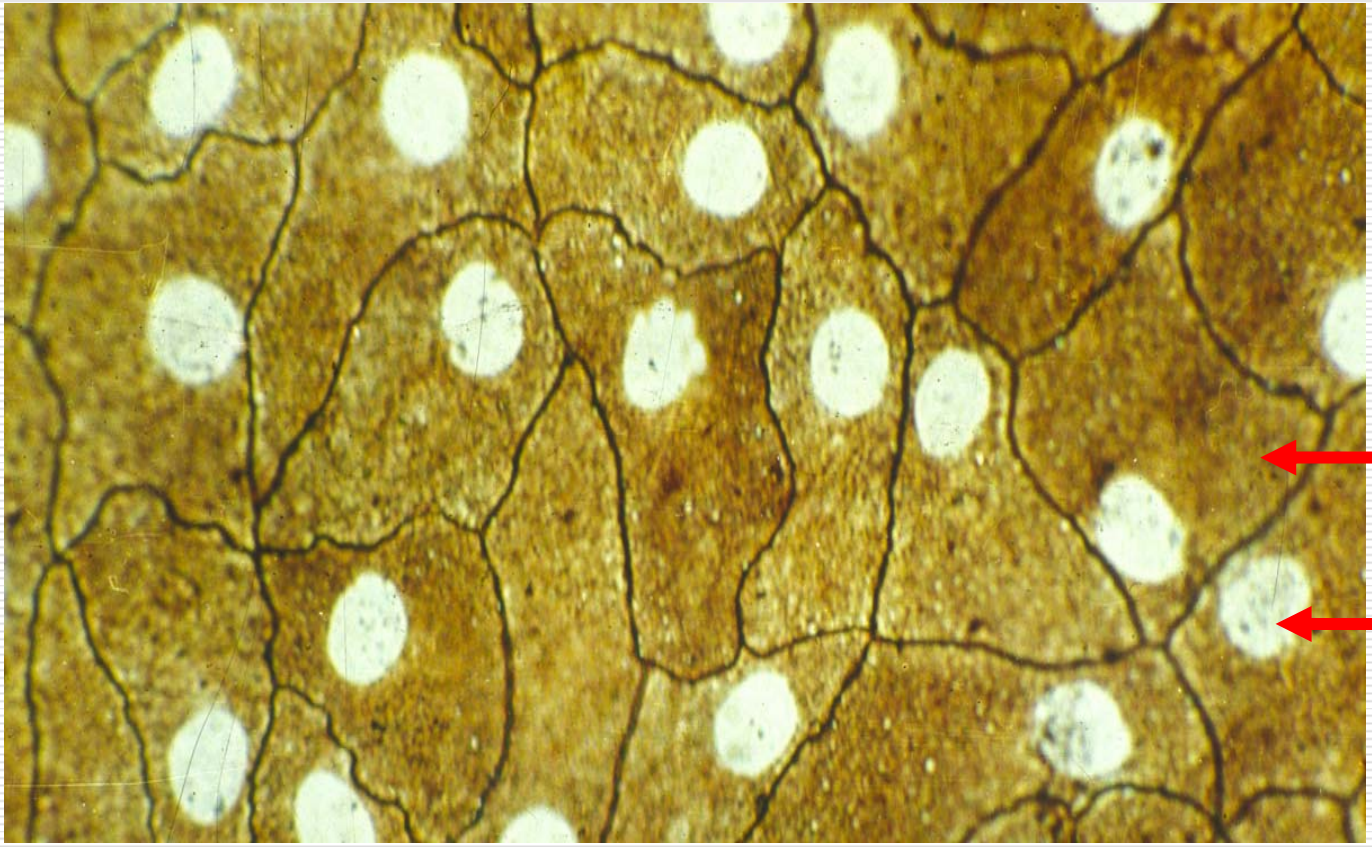
  thoracic, pericardiac and abdominal cavity

- **Other place: alveolus of lung, parietal layer of renal capsule**



Simple squamous epi. in lateral view

All blood vessels are lined with a simple squamous epithelium called endothelium (arrowheads). HE stain



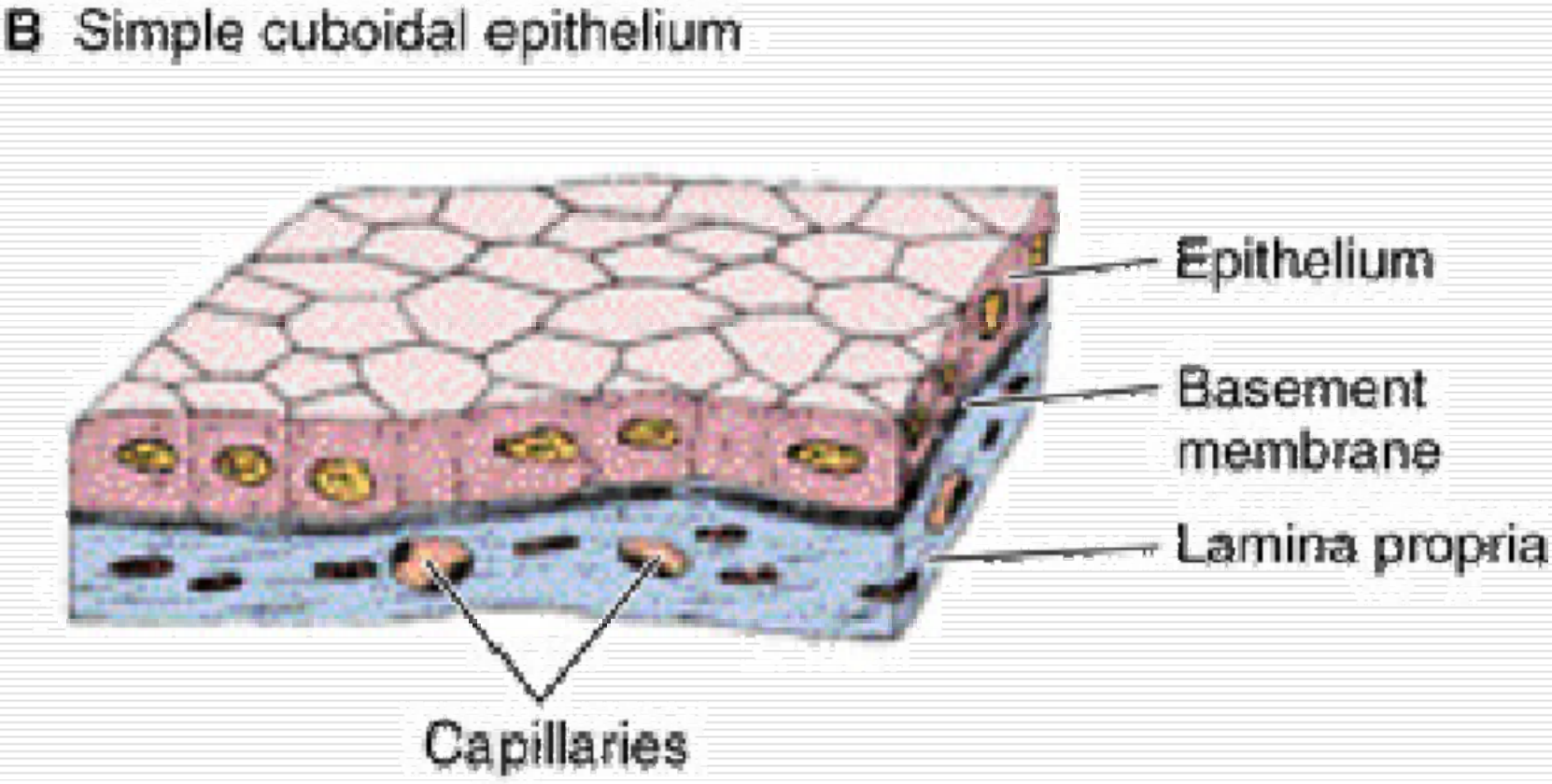
Simple squamous epi. (mesothelium) in surperfical view sliver stain

- **Function:**

a) transport materials

b) facilitate movement of viscera

- **one layer of cells, and hexagonal outline (in superficial view).**
- **Cubic with spherical centrally-located nucleus, same height and width (in lateral view)**



---**Distribution: the renal tubule**

thyroid

ducts of many glands

---Function: covering and secretion

Simple cuboidal epithelium (arrow) from follicle of thyroid. HE stain.

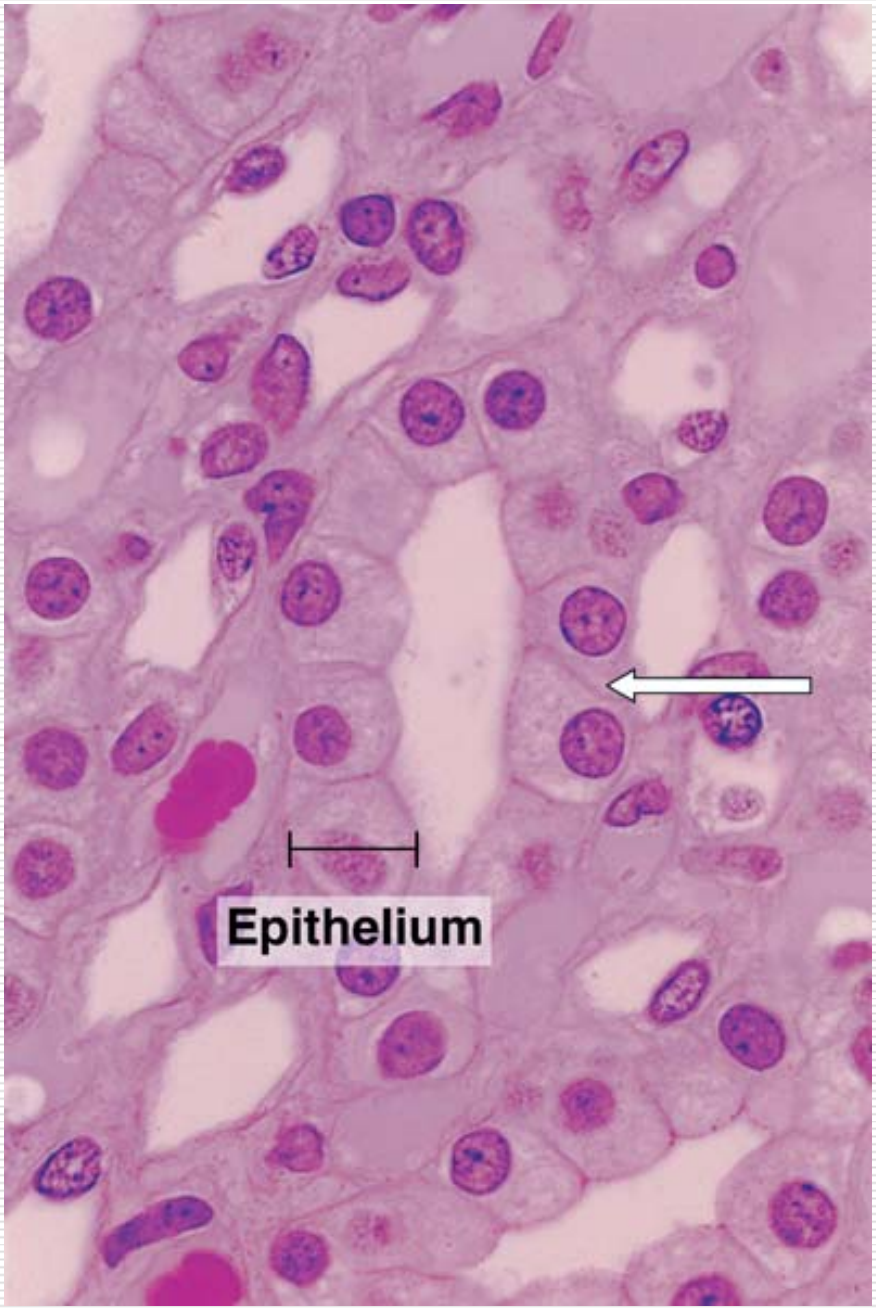
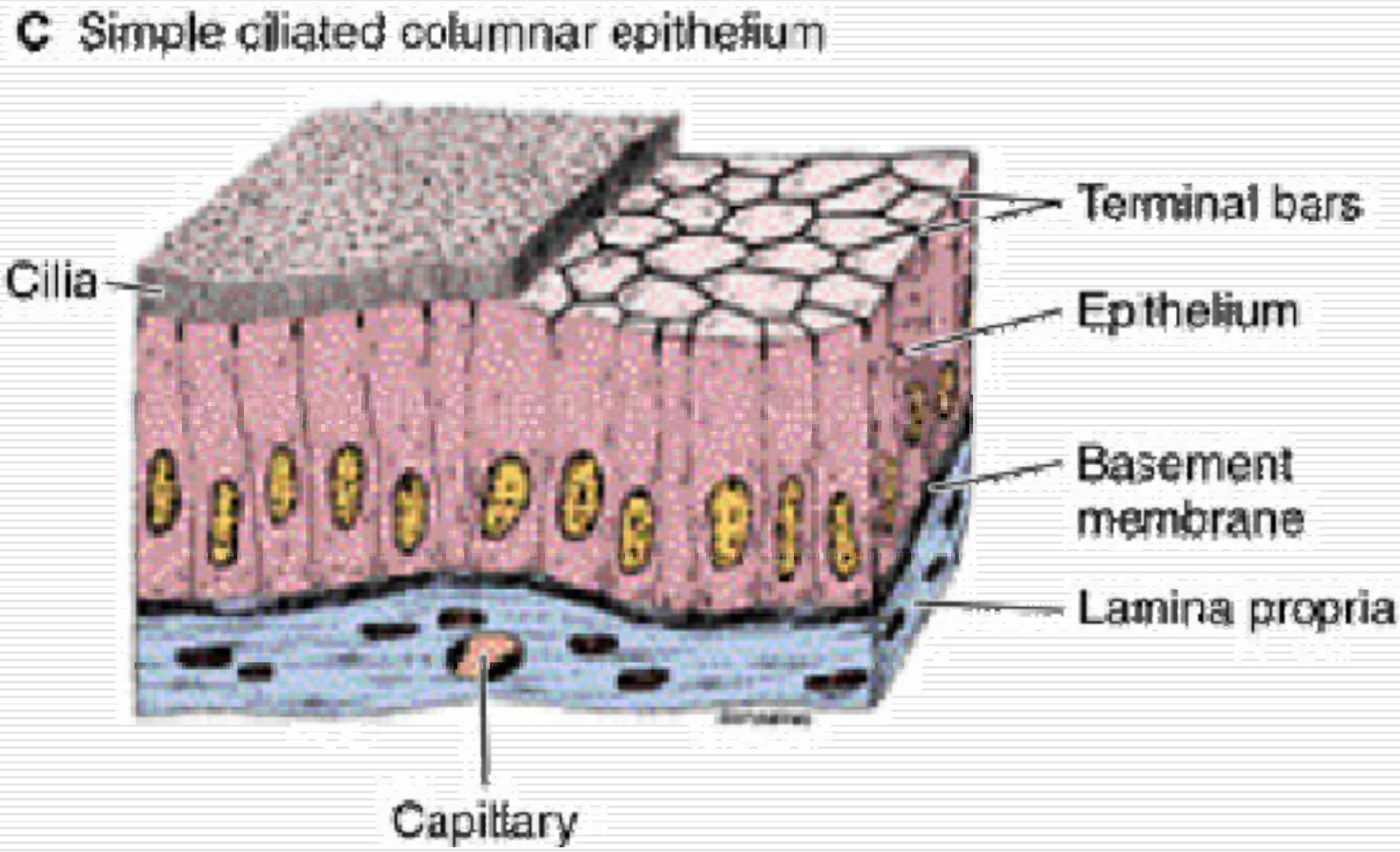


Figure 4-5.

Simple cuboidal epithelium (arrow) from kidney collecting tubules.

PT stain.

- **one layer cells with hexagonal outline in surface view.**
- **long columnar cell with elliptical nucleus in lateral view**



---distribution: gastrointestinal tract

bladder

uterus

---function: secretion and absorption

Figure 4-6. Simple columnar epithelium

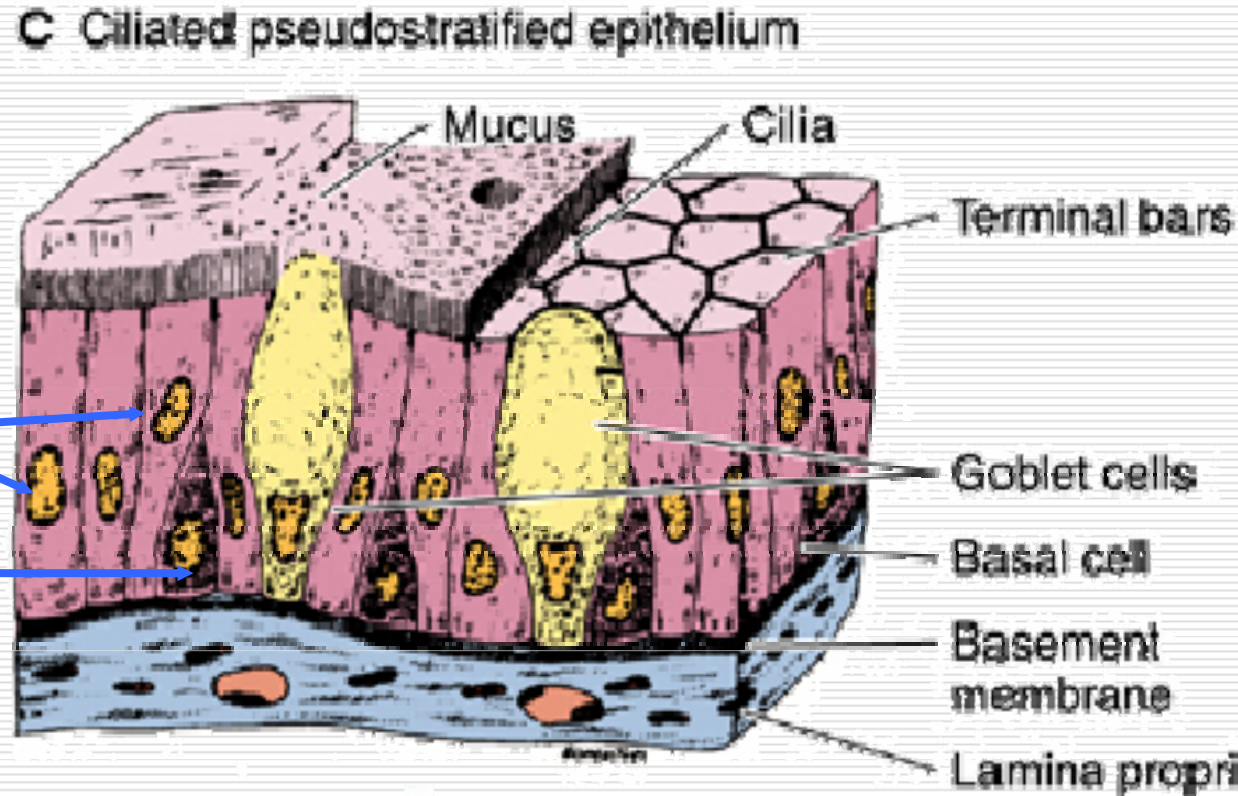
The round nuclei within the epithelial layer belong to lymphocytes (arrows). H&E stain

columnar cell: ciliated;

basal cell:pyramid-shaped

goblet cell: secreting mucinogen

fusiform cell



fusiform cell / columnar cell

basal cell

---Distribution:

inner surface of large duct of respiratory

trachea

bronchi

nasal cavity

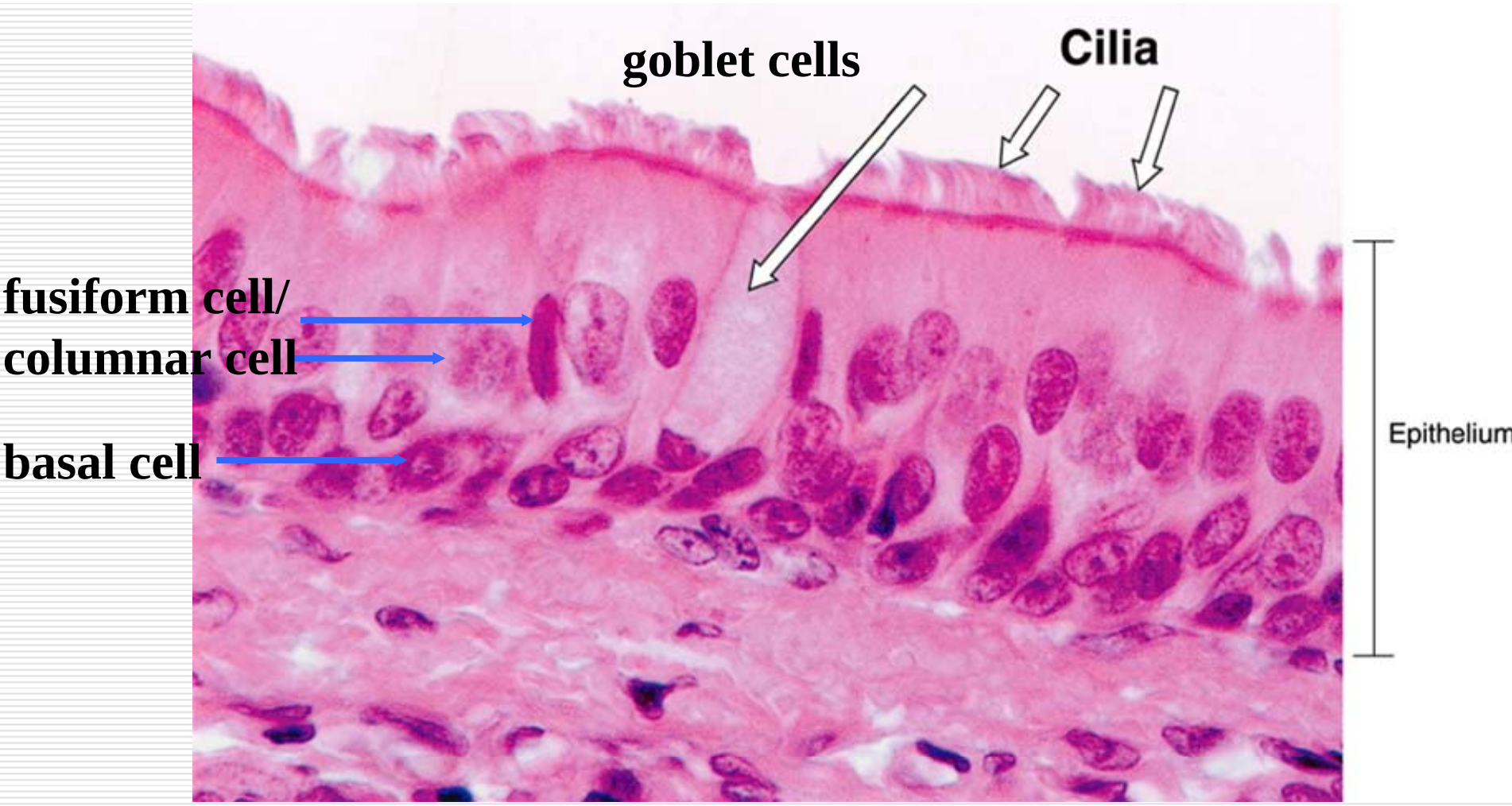


Figure 4-9. Pseudostratified ciliated columnar epithelium of trachea HE stain

2.2 Stratified epithelium

according to the cell form of its superficial layer.

---stratified squamous epithelium

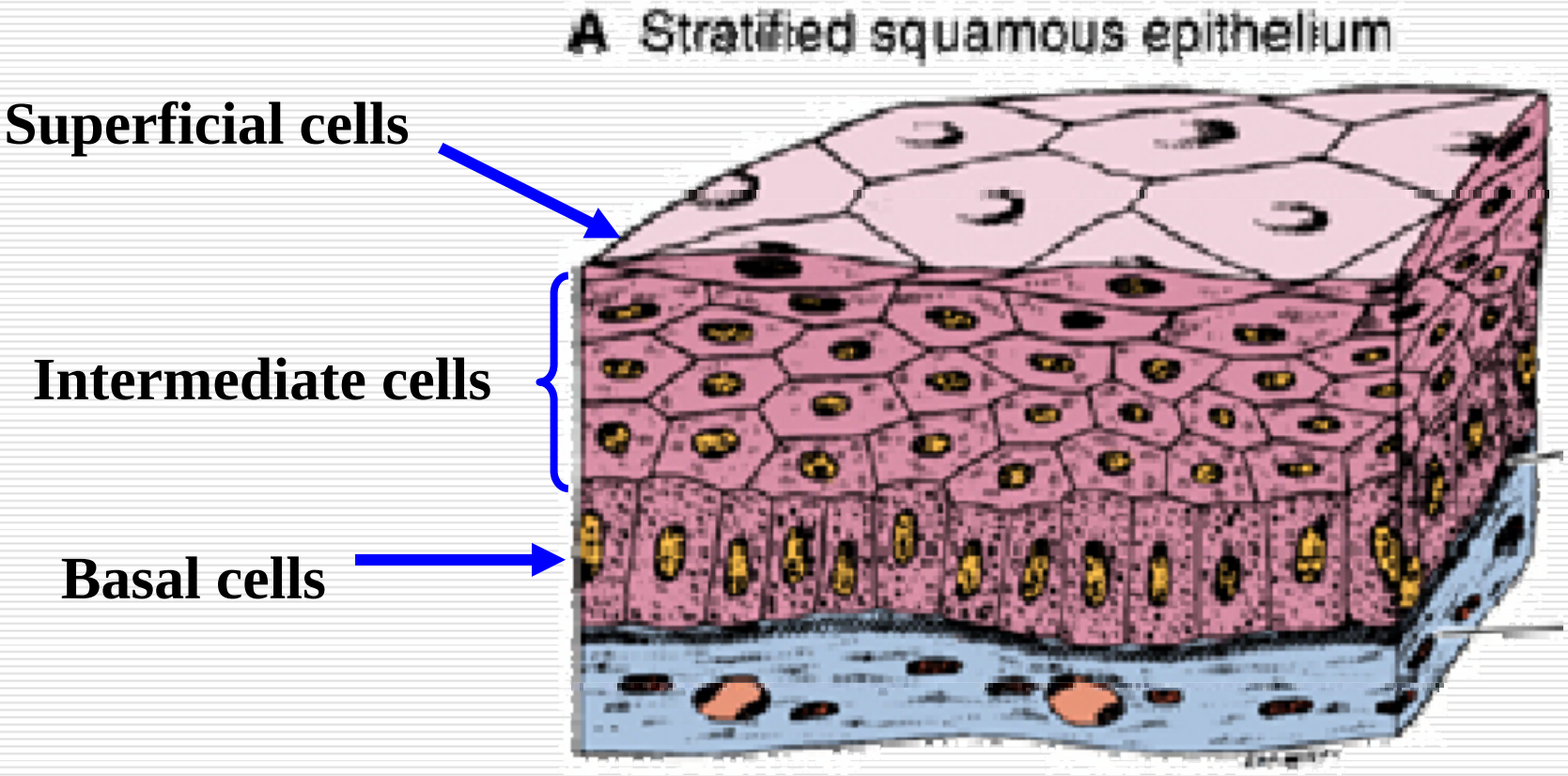
---nonkeratinized

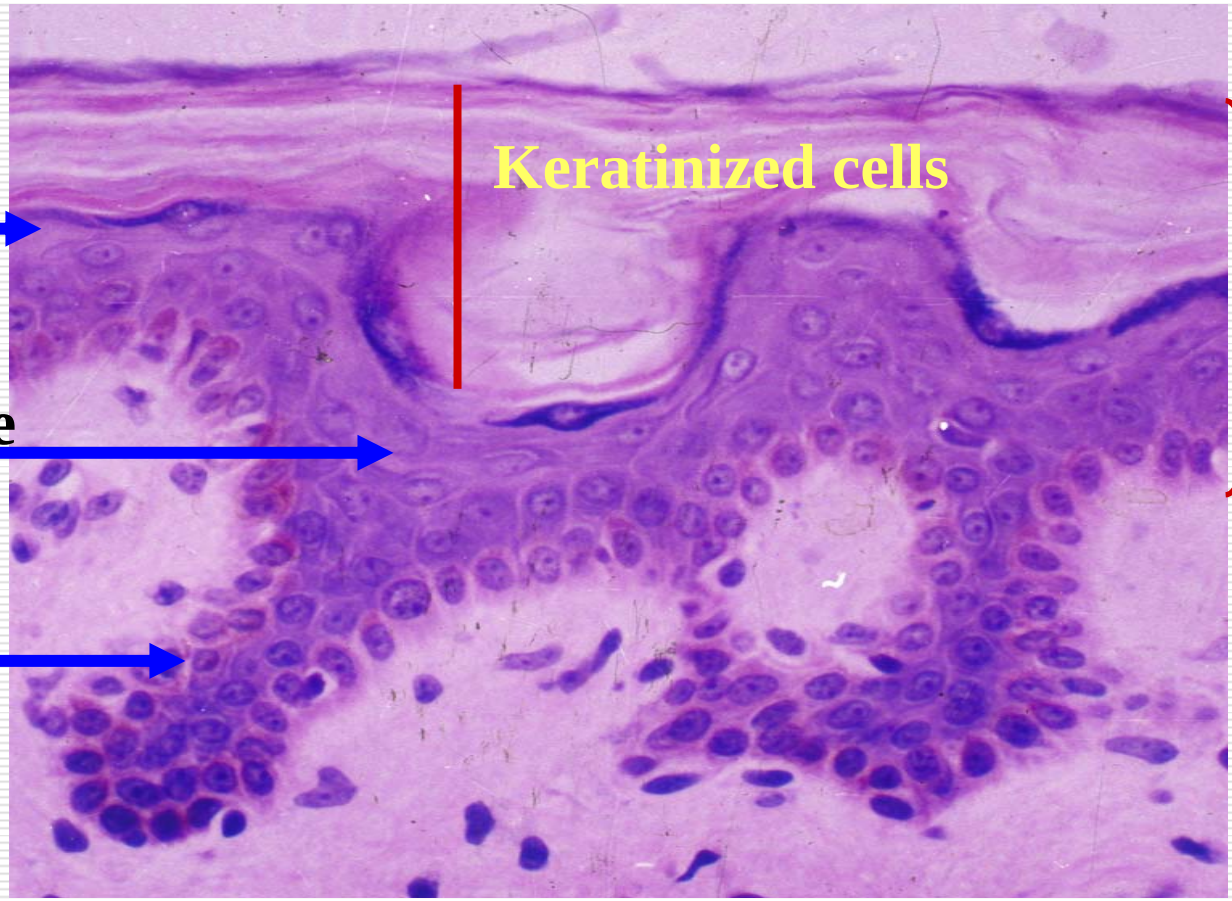
---keratinized

---stratified columnar epithelium

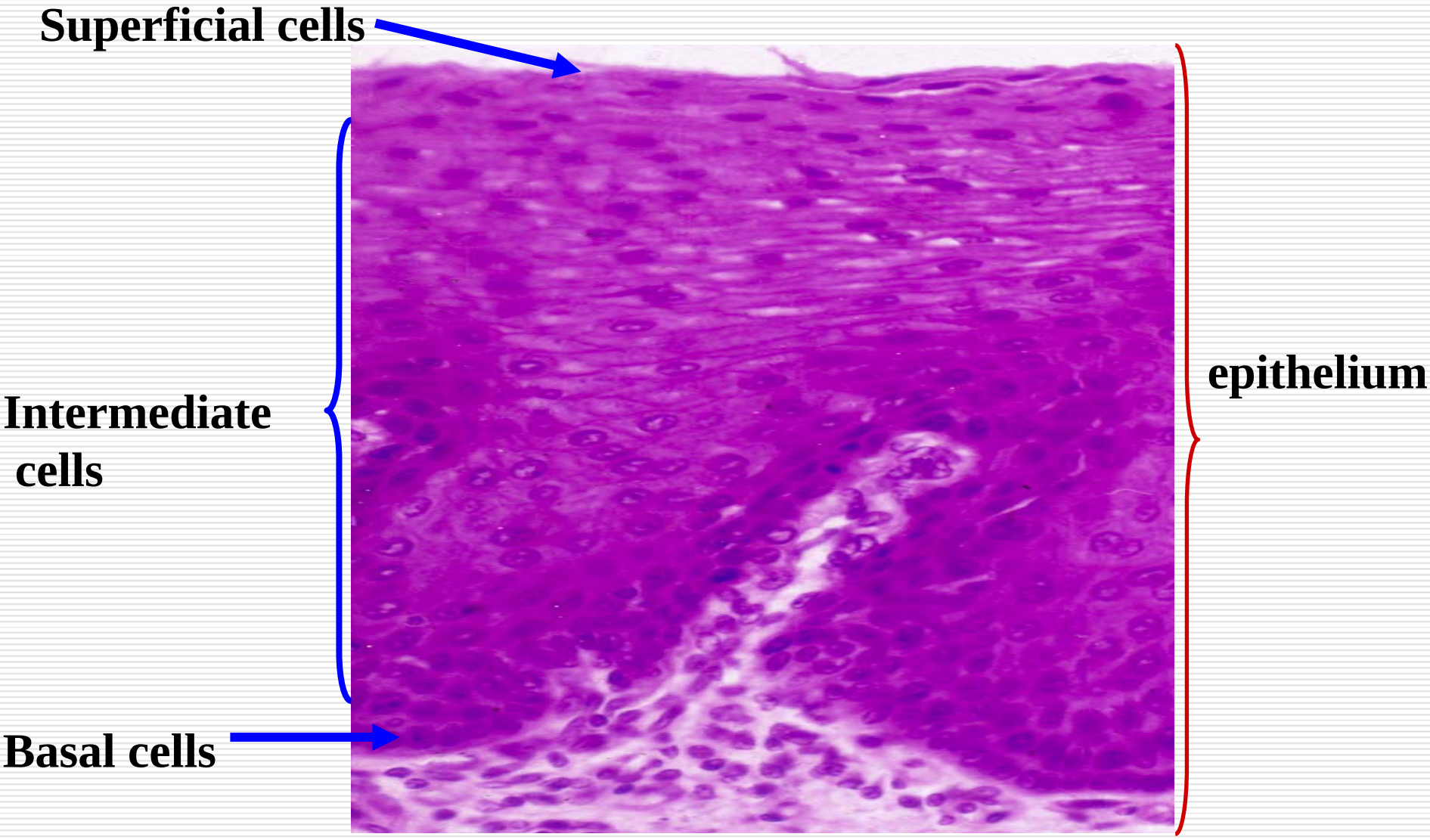
---transitional epithelium

- Basal cells: one layer of cuboidal or columnar cells
- Intermediate cells: several layers of irregular in shape gradually
- Superficial cells: thin and squamous





Stratified squamous keratinized epithelium from skin
HE stain



Stratified squamous nonkeratinized epithelium from esophagus
HE stain

---distribution:

- **non-keratinized:**

  mouth, oesophagus, and vagina

- **keratinized:**

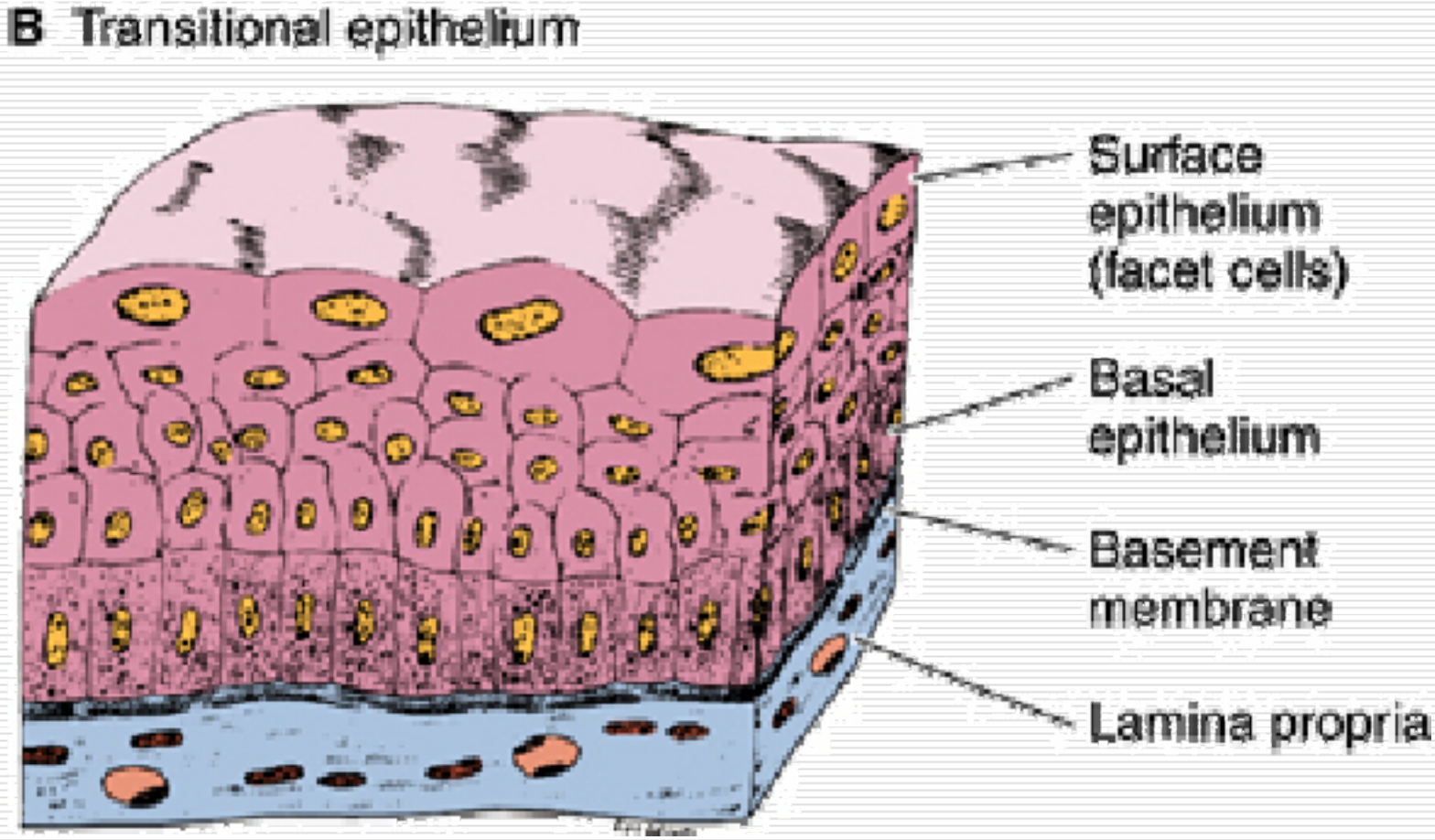
  skin

---function:

- **Protection barrier**

- **rare**
- **large ducts of salivary glands**
- **two layers of columnar epithelial cells.**

- the contracted bladder: six to seven layers cells
- the distended bladder: two to three layers cells
- surface cells are very large and cuboidal in shape



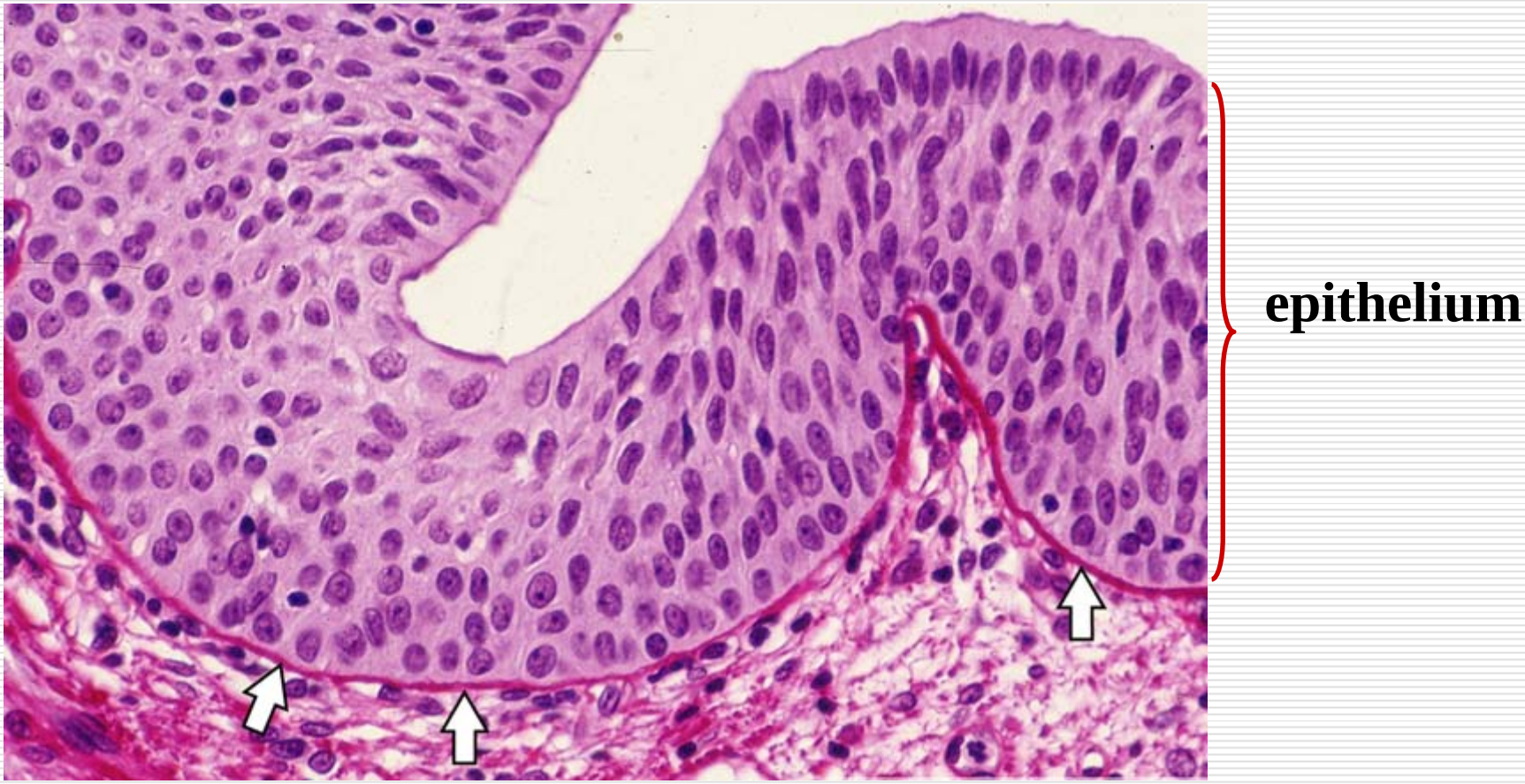


Figure 4-8. transitional epithelium of the contracted bladder basement membrane (arrows). PSH stain

---Distribution:

- **bladder**

---Function:

- **stretch**

III Epithelial specializations

- **Specializations of free surface**

  ---Microvilli （microvillus） ---Cilia (cilium)

- **Specializations of the lateral surface**

  ---Tight junction ---Intermediate junction

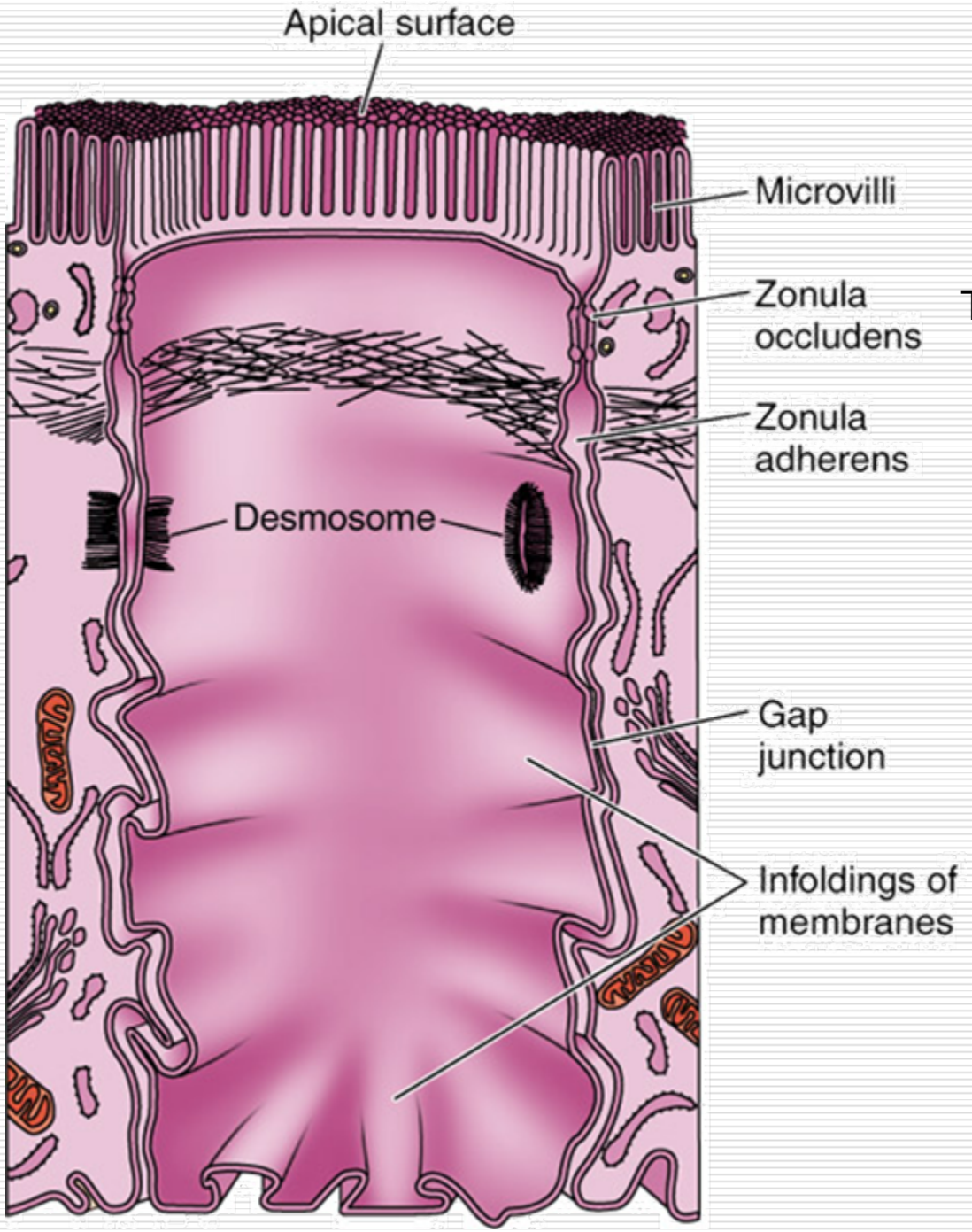
  ---Desmosome ---Gap junction

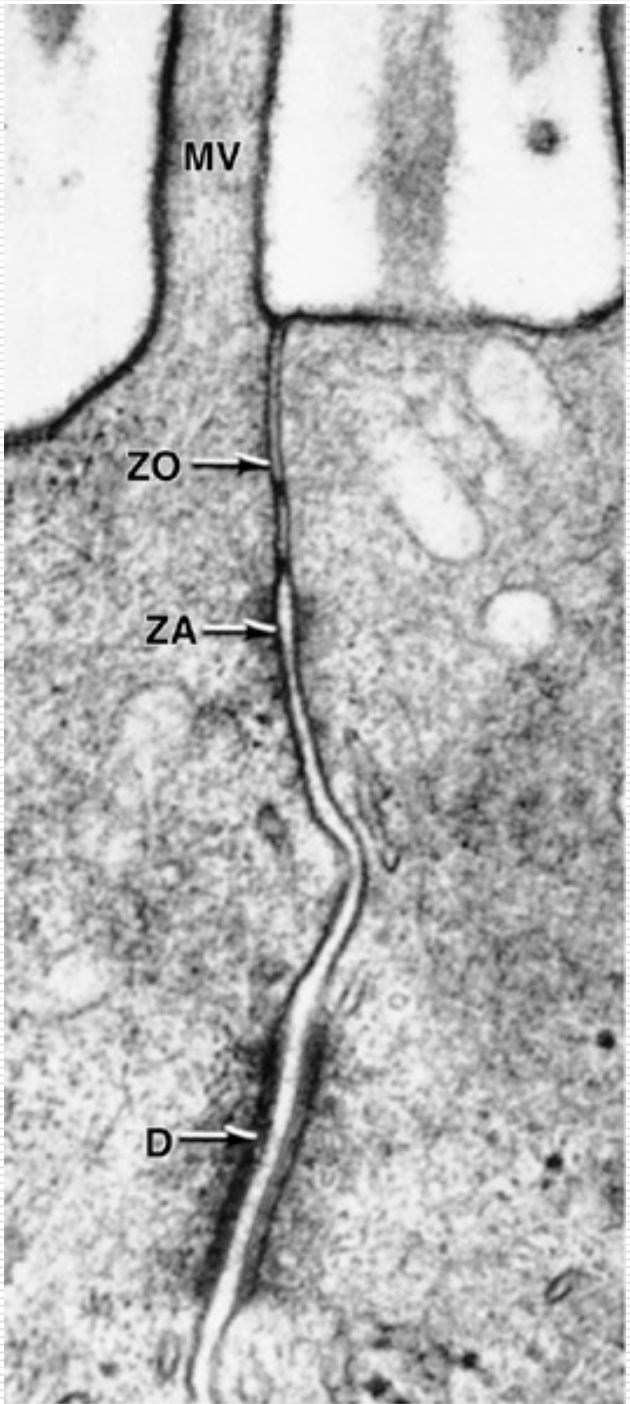
- **Specializations of the basal surface**

  ---Basal lamina and Basement membrane

  ---Hemidesmosome

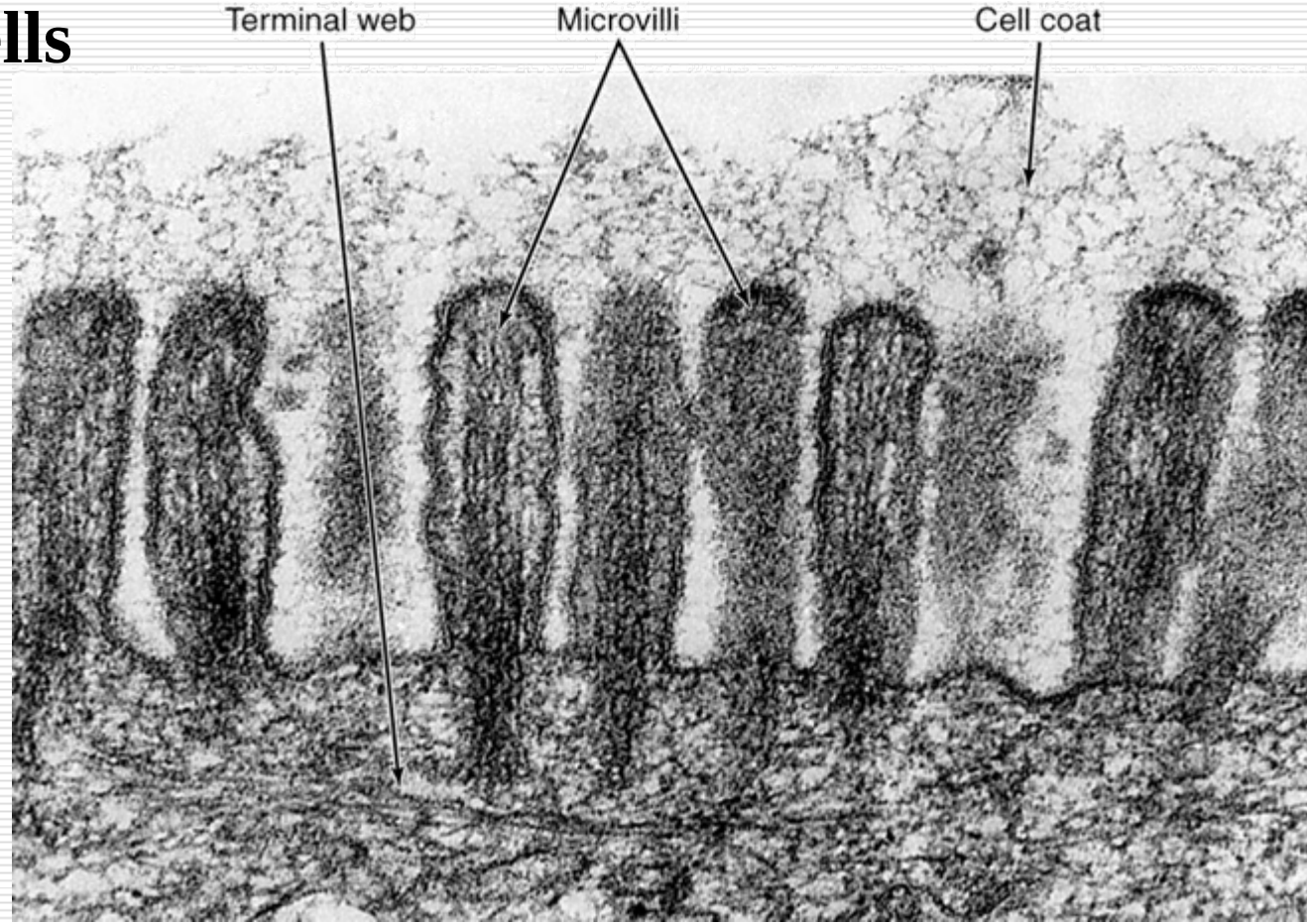
  ---Basal infolding

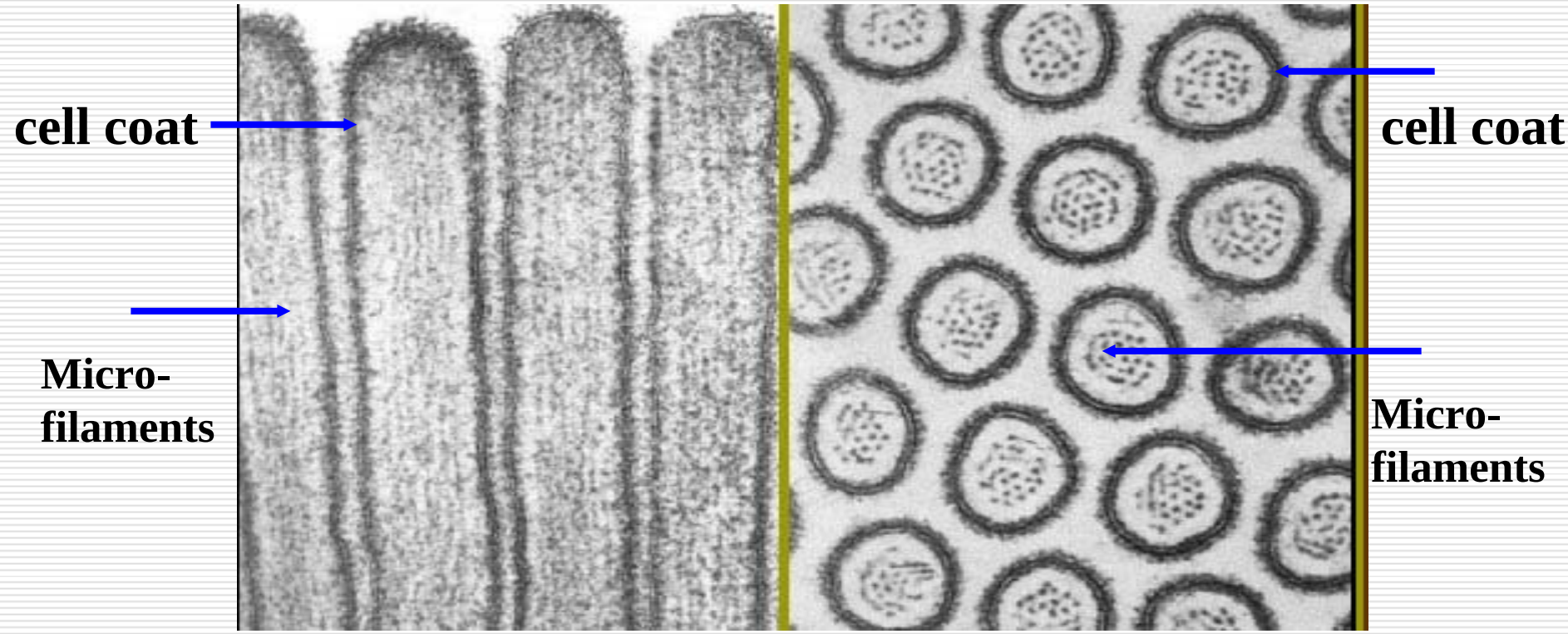

Apical surface
Microvilli
Zonula occludens
Tight junction
Zonula adherens
Intermediate junction
Desmosome
Gap junction
Infoldings of membranes



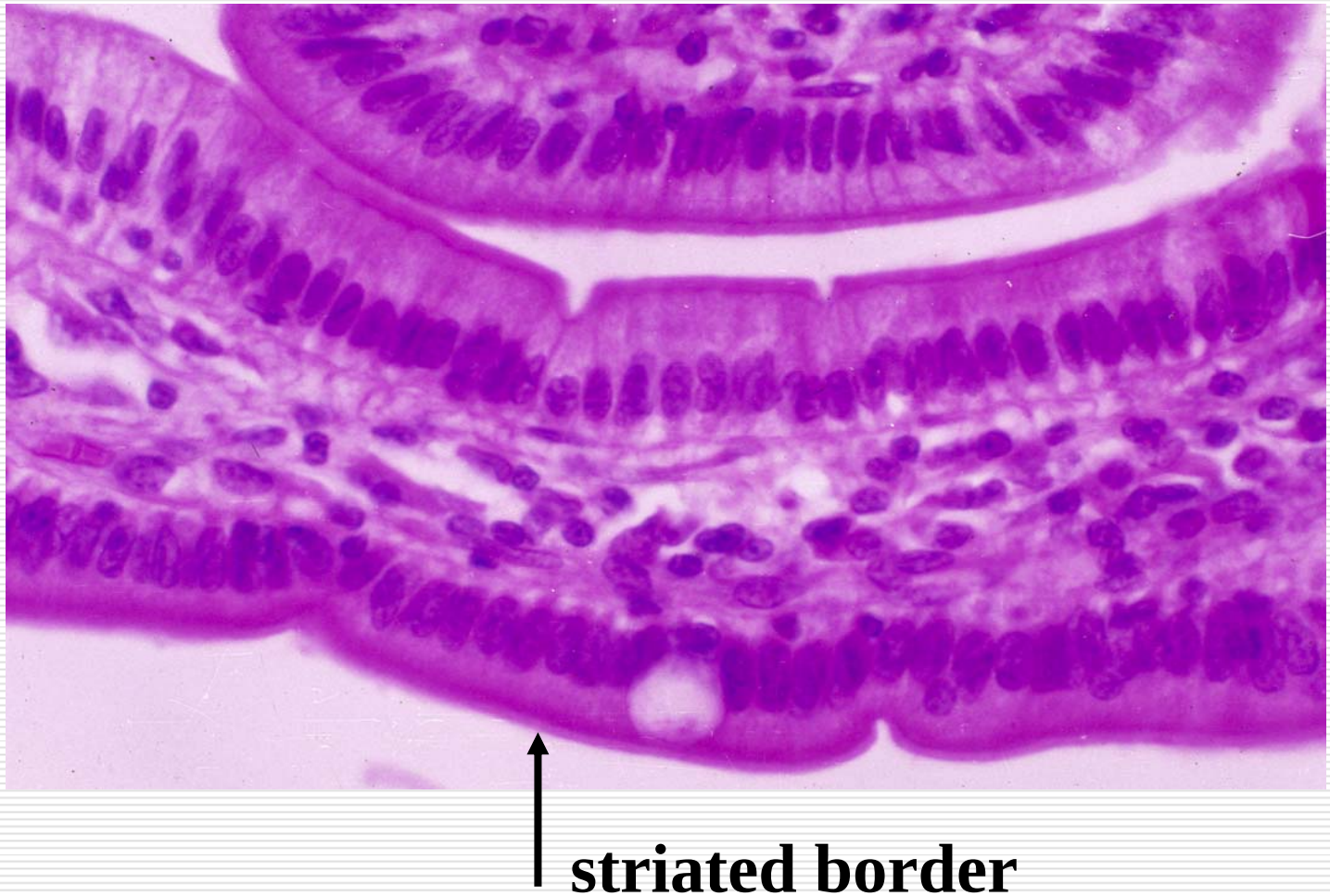
Electron micrograph of a section of epithelial cells in the large intestine showing a junctional complex with its zonula occludens (ZO), zonula adherens (ZA), and desmosome (D). Also shown is a microvillus (MV). x80,000.

- a multitude of delicate finger-like projections
- Surface： cell coat
- Interior core： vertical microfilaments fixed on terminal web
- terminal web: transverse-arranged filament at the apical side of cells





Microvilli （microvillus）　TEM



Thick, pink line along the free surface of the absorptive cells of small intestine HE stain

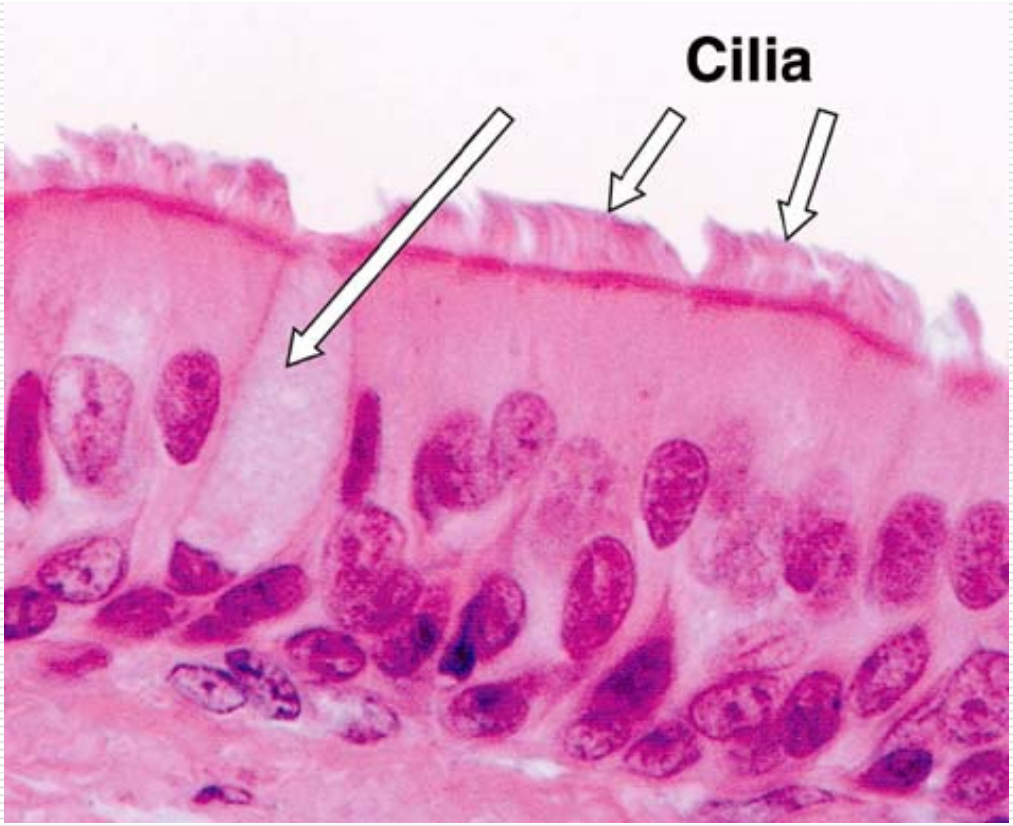
---Distribution:

- **absorptive epithelial cells**

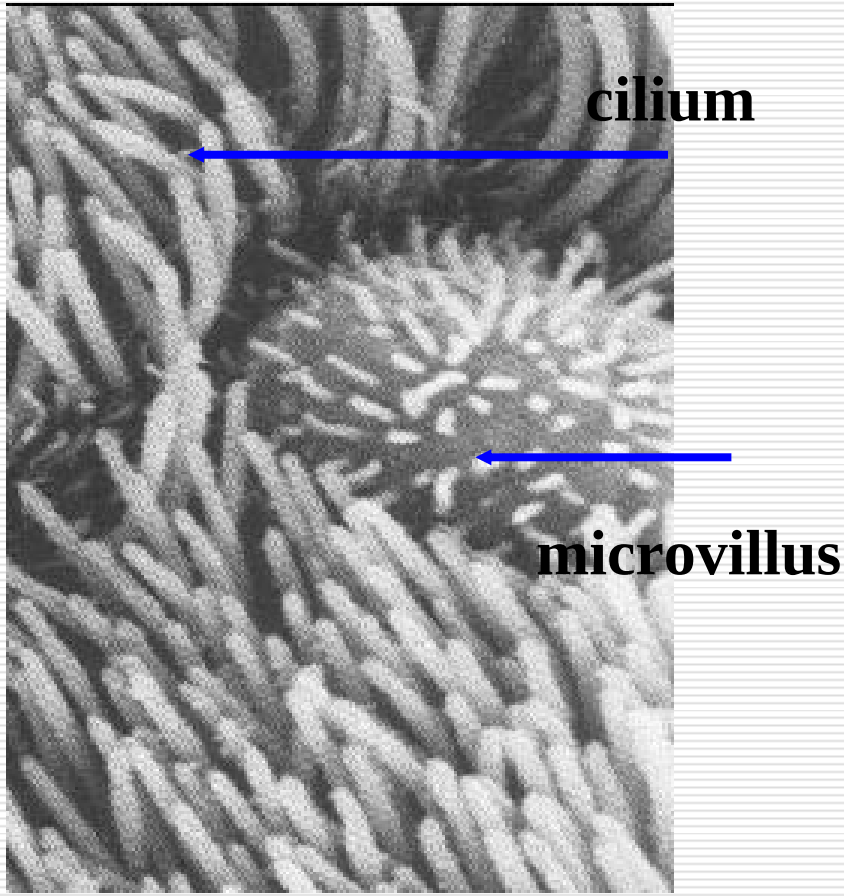
---Function:

- **increase the surface area of the cell**
- **enhancing the efficiency of absorption**

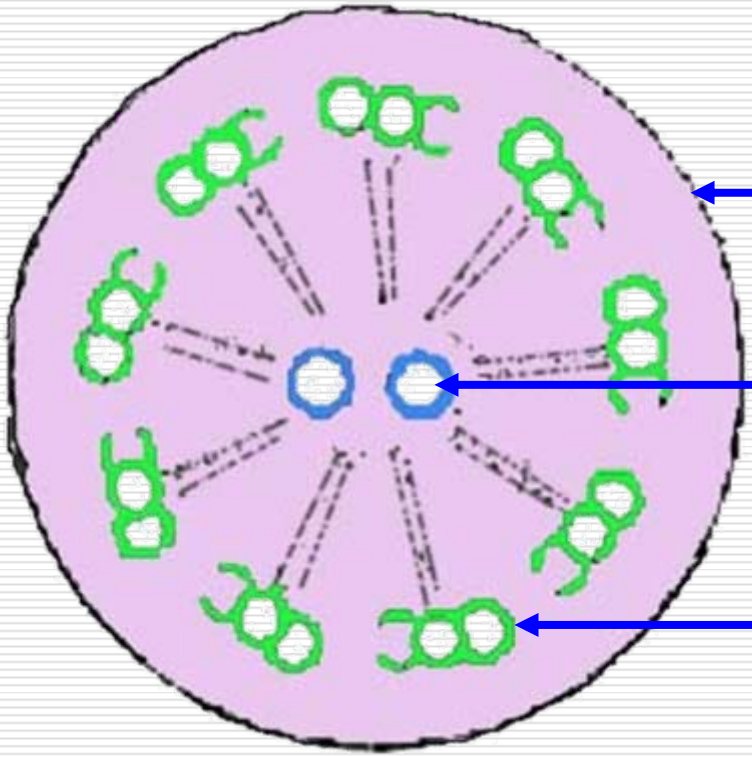
numerous elongated, motile structure on the surface of epithelial cells



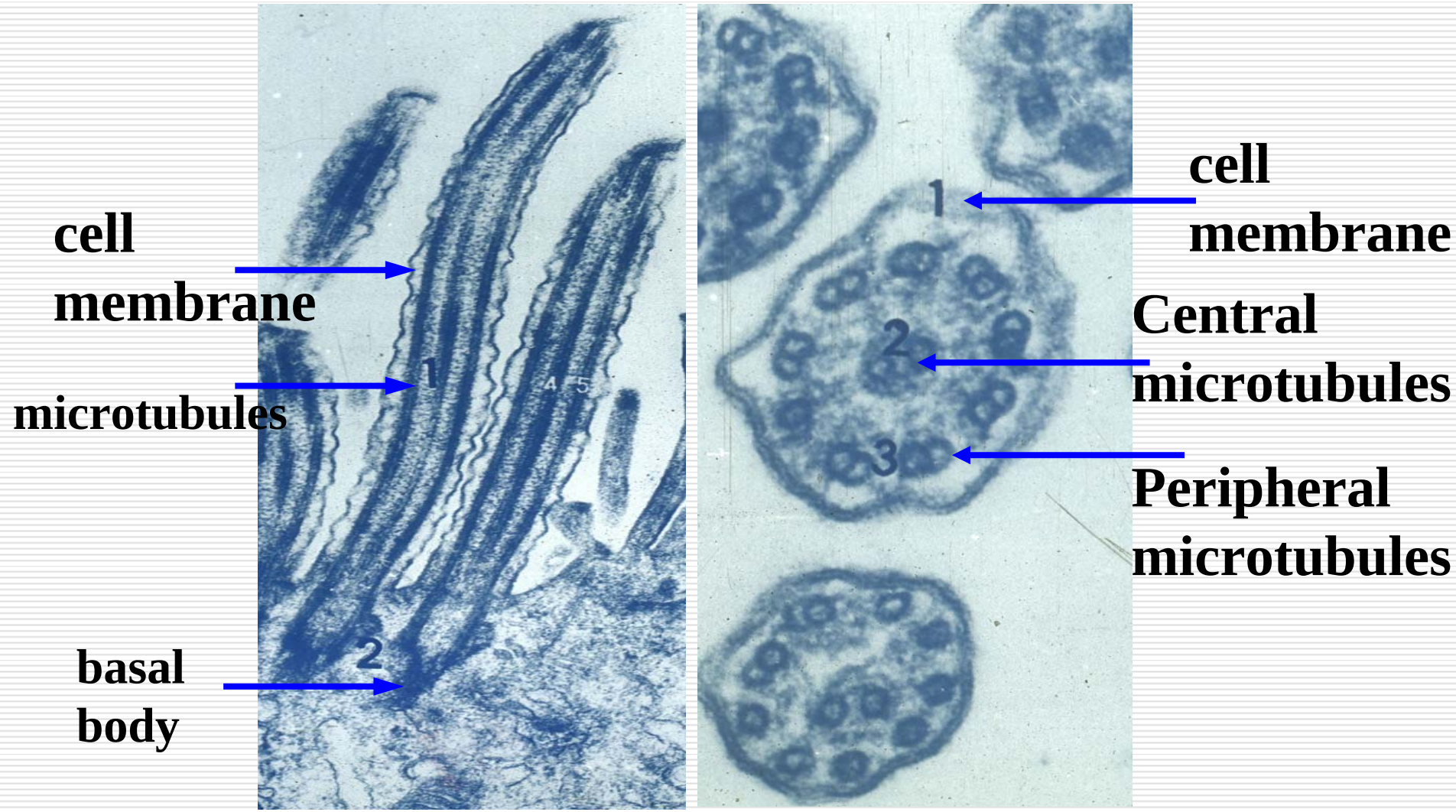
HE



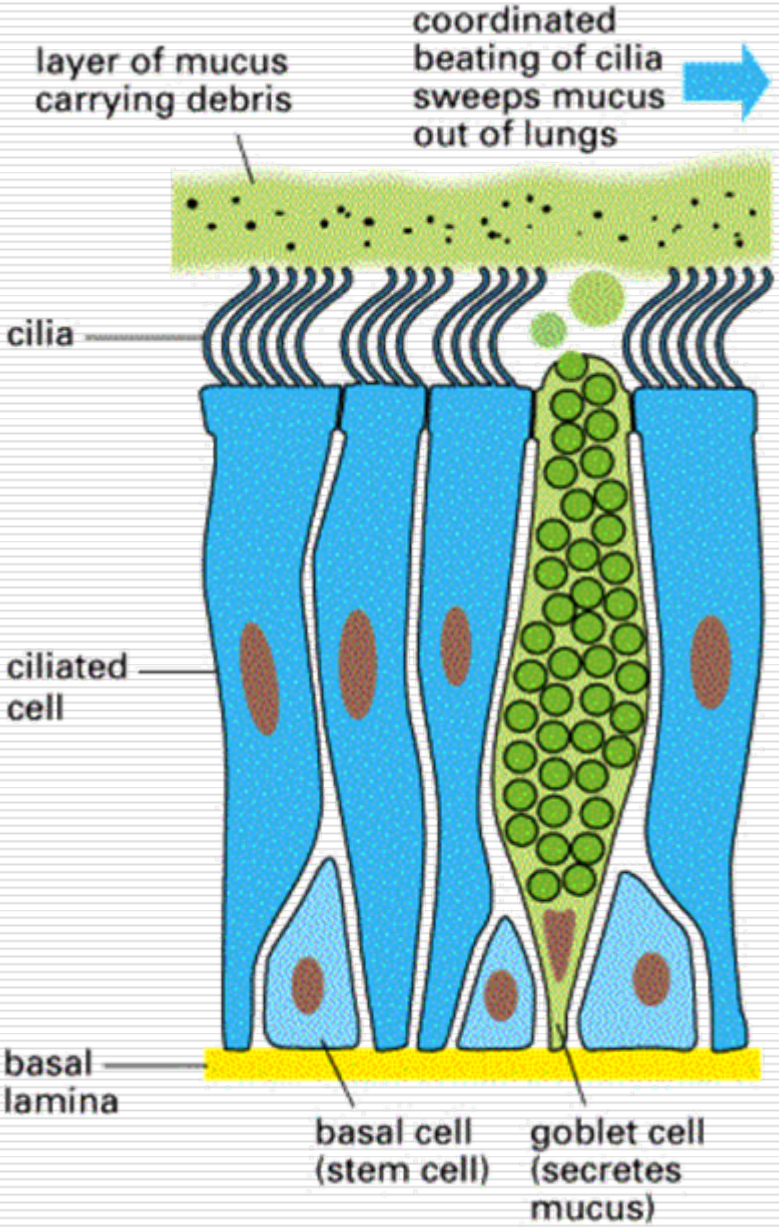
TEM



- surface: cell membrane
- core: microtubules, 9x2+2



The cilia are inserted into the basal bodies . TEM



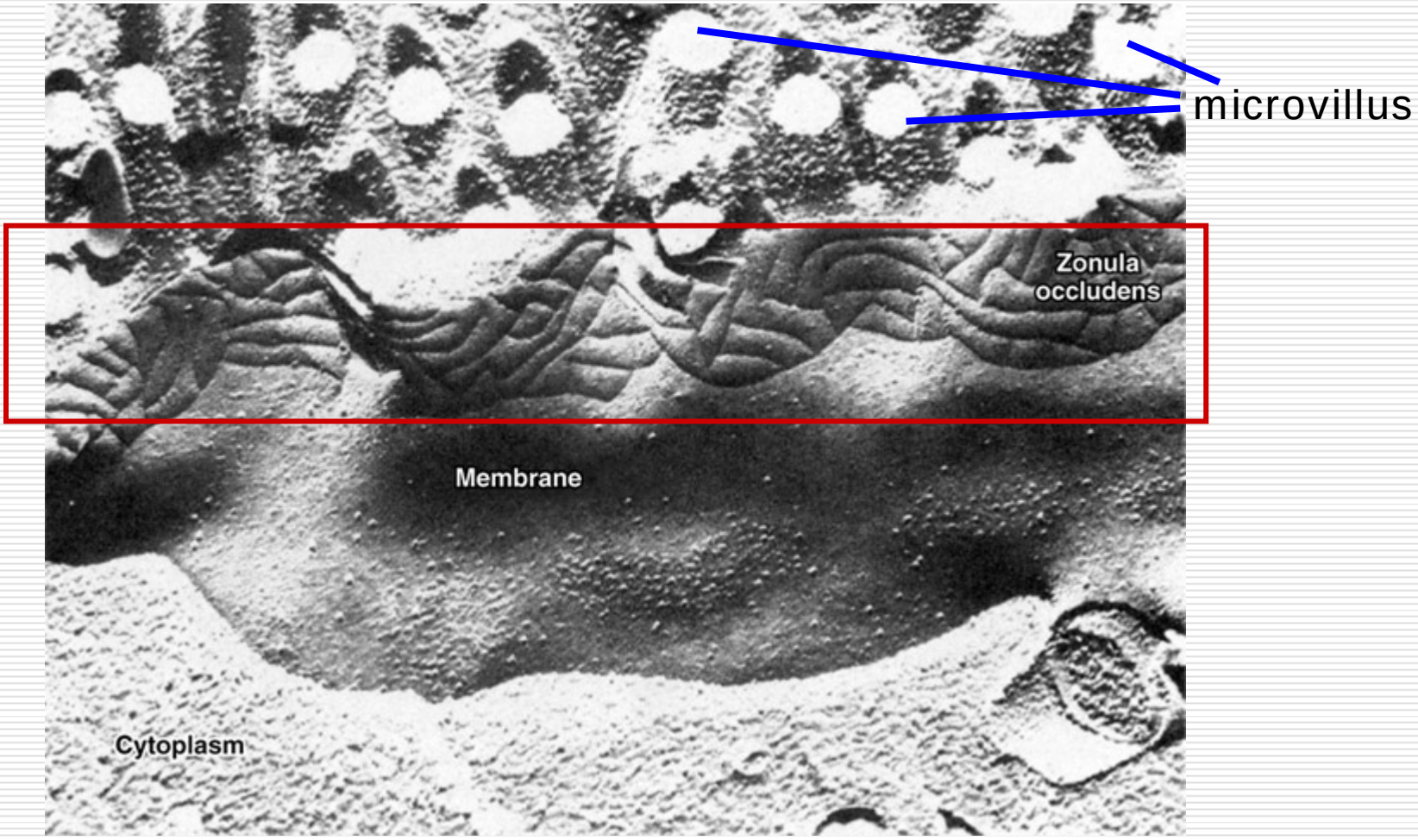
---Distribution:

- **epithelial cells of respiratory tract**

---Function:

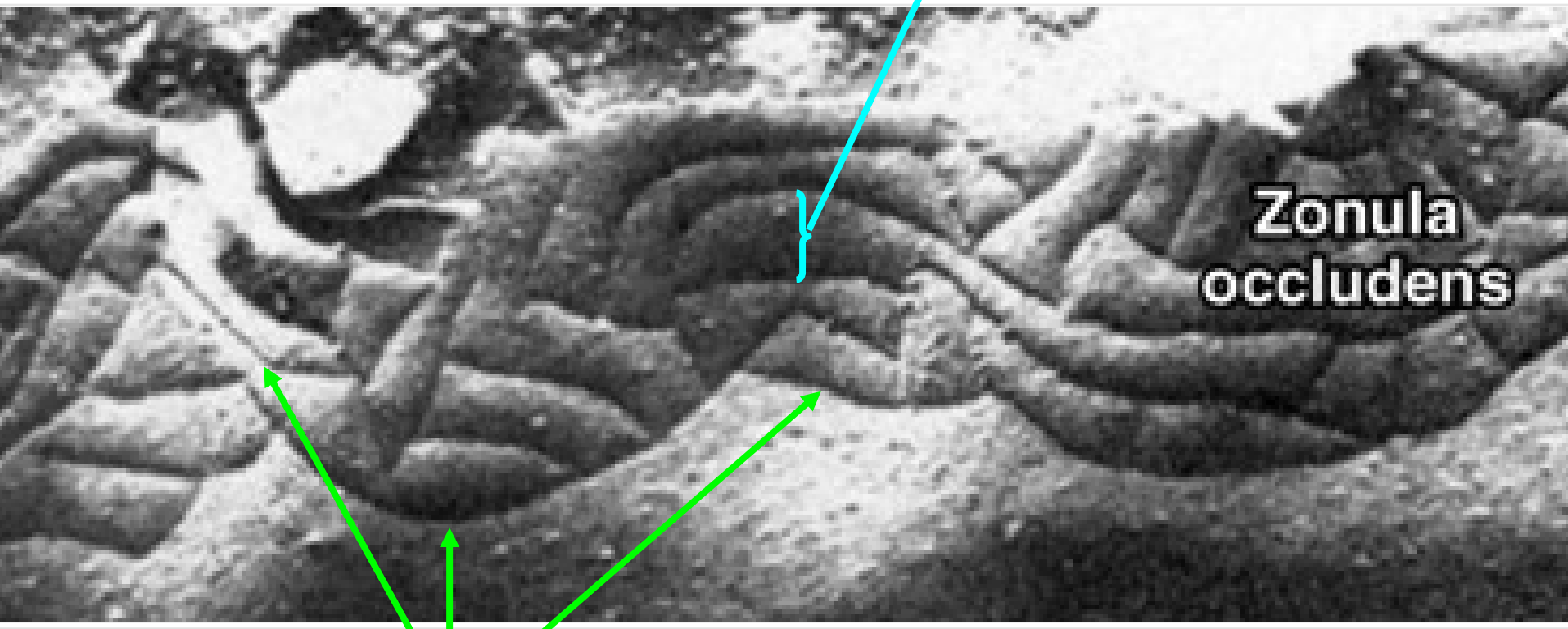
- **rapid back-and-forth movement**
- **permit a current of fluid or particulate matter to be propelled in one direction**

- belt-shaped
- surrounds the apex of epithelial cells
- a network of ridges
- membranes of 2 adjoining cell fuse into one
- Between the ridges, there are narrow gap.



Electron micrograph of a small-intestine epithelial cell after cryofracture. The grooves lie in the lipid (middle) layer of each plasmalemma.

narrow groove between two ridges



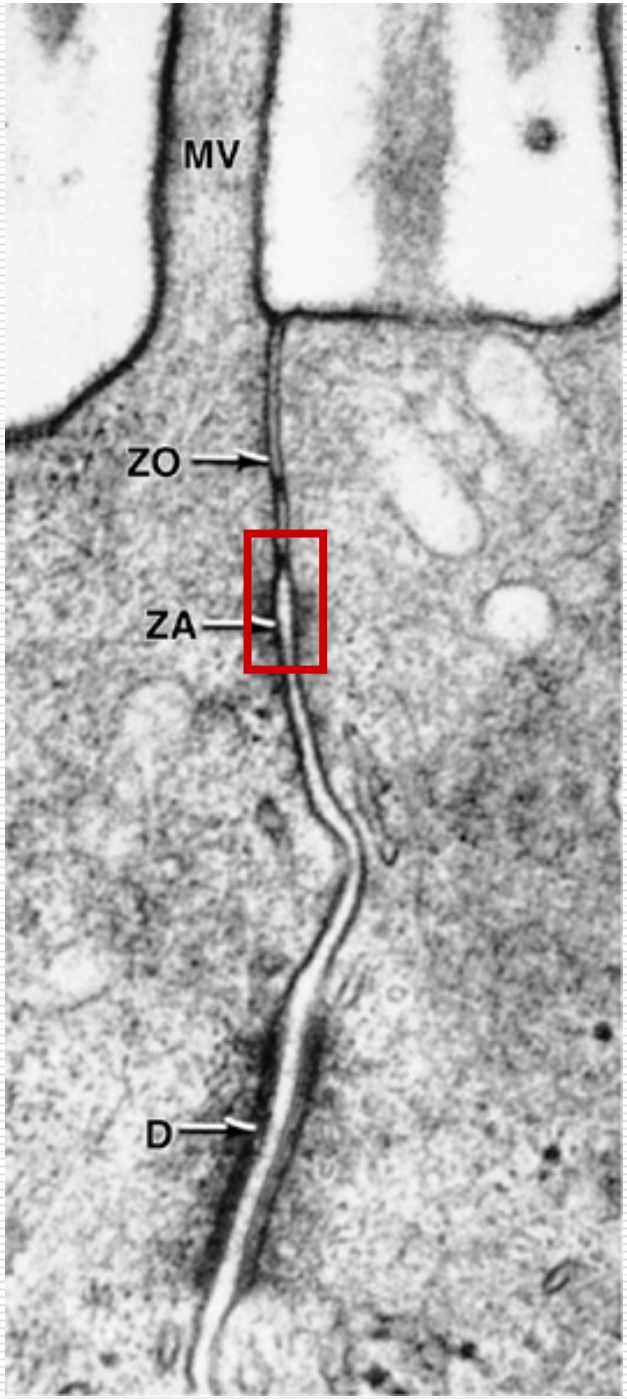
a network of ridges (thin, black line)

Tight junction EM

---Function:

- **seal the space between cells**
- **form a barrier to prevents the free passage of substances**

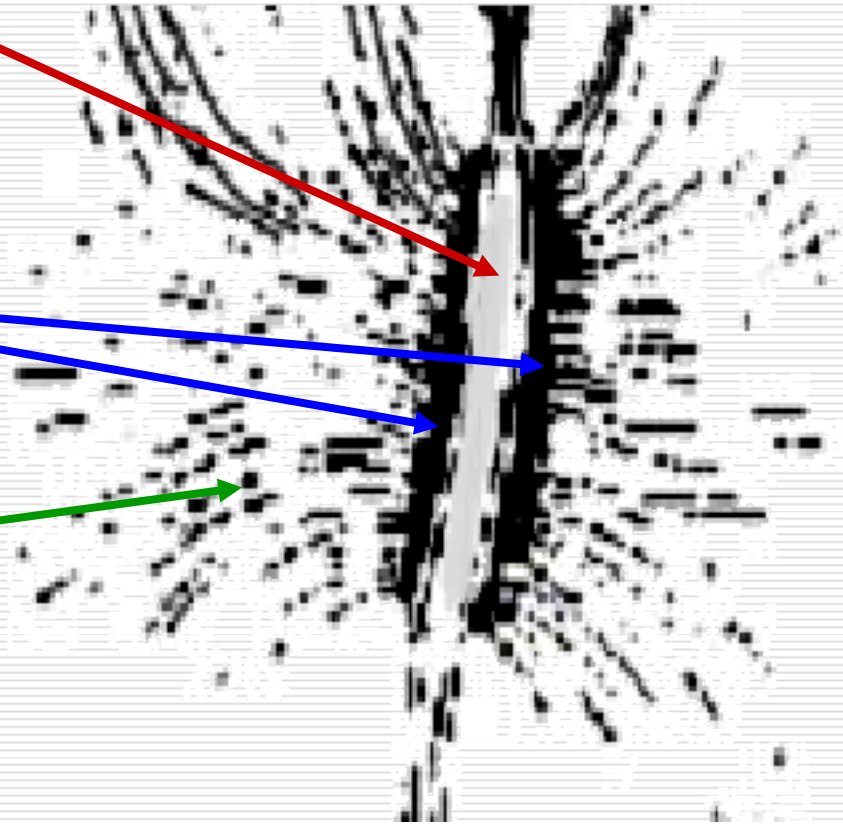
- below tight junction
- belt-shaped
- surrounds the apex of epithelial cells



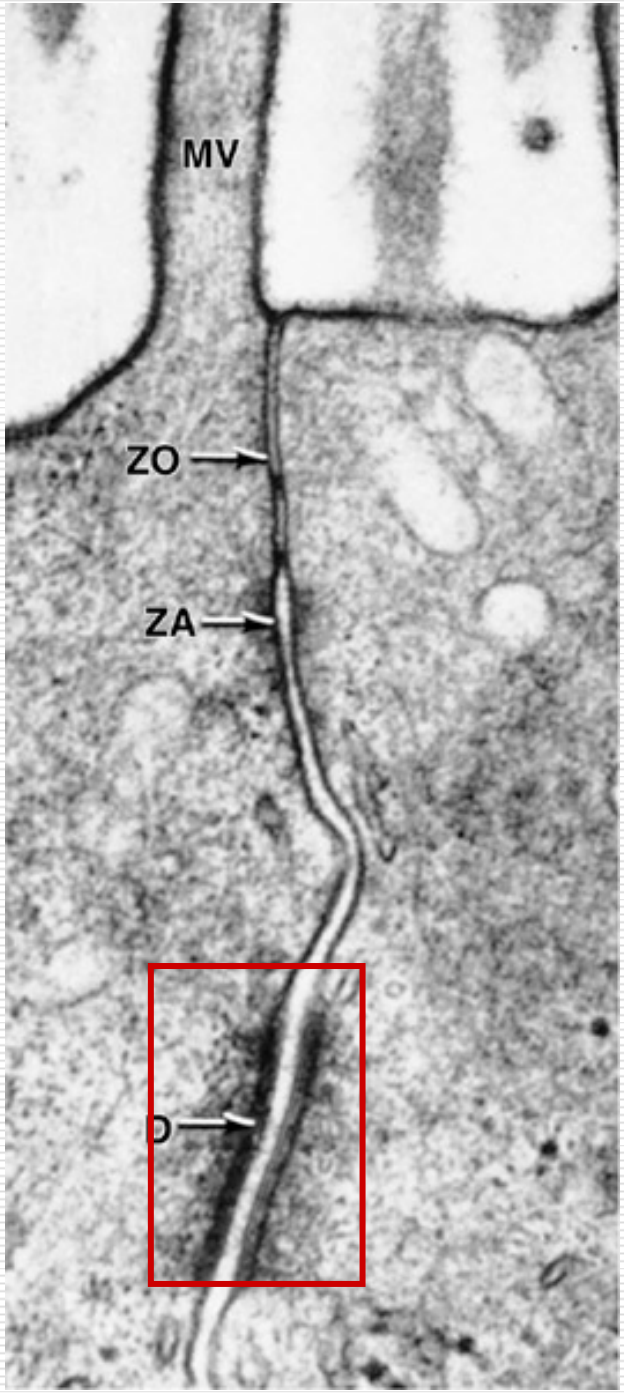
- **an amorphous electron-dense material within the gap between 2 adjacent cells**
- **An electron-dense plaque on the cytoplasmic face of the membrane.**
- **terminal web insert into the dense plaques**

-----Function :

- hold adjacent cells firmly together



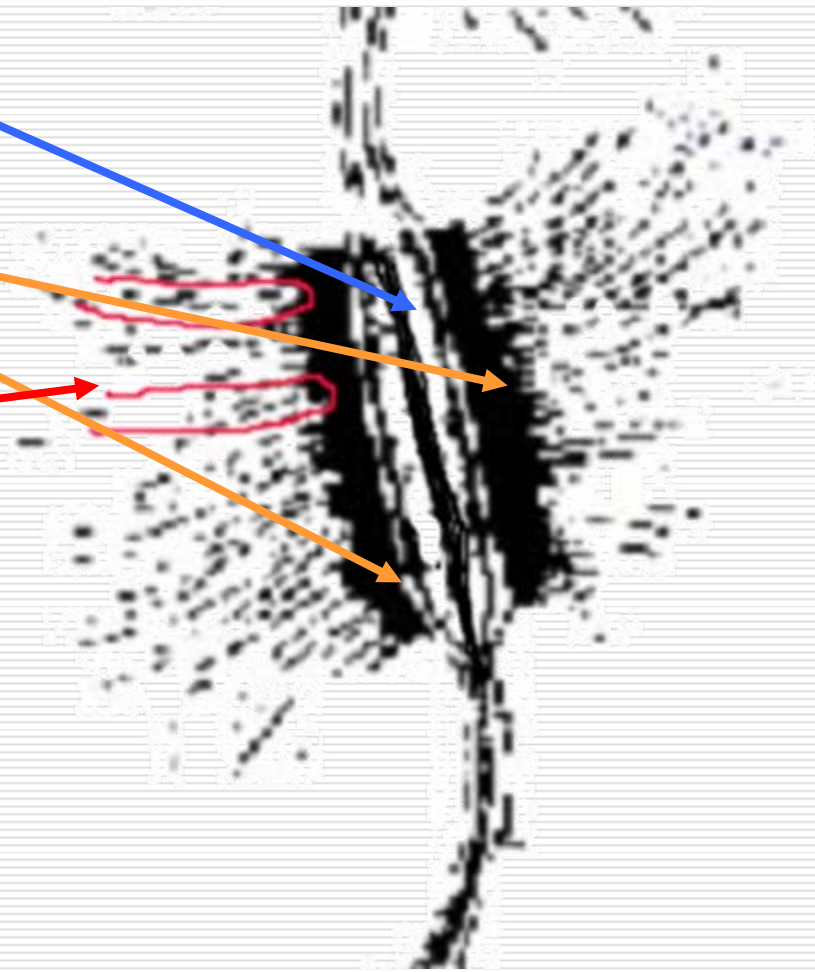
- plate or spot-shaped
- below the intermediate junction



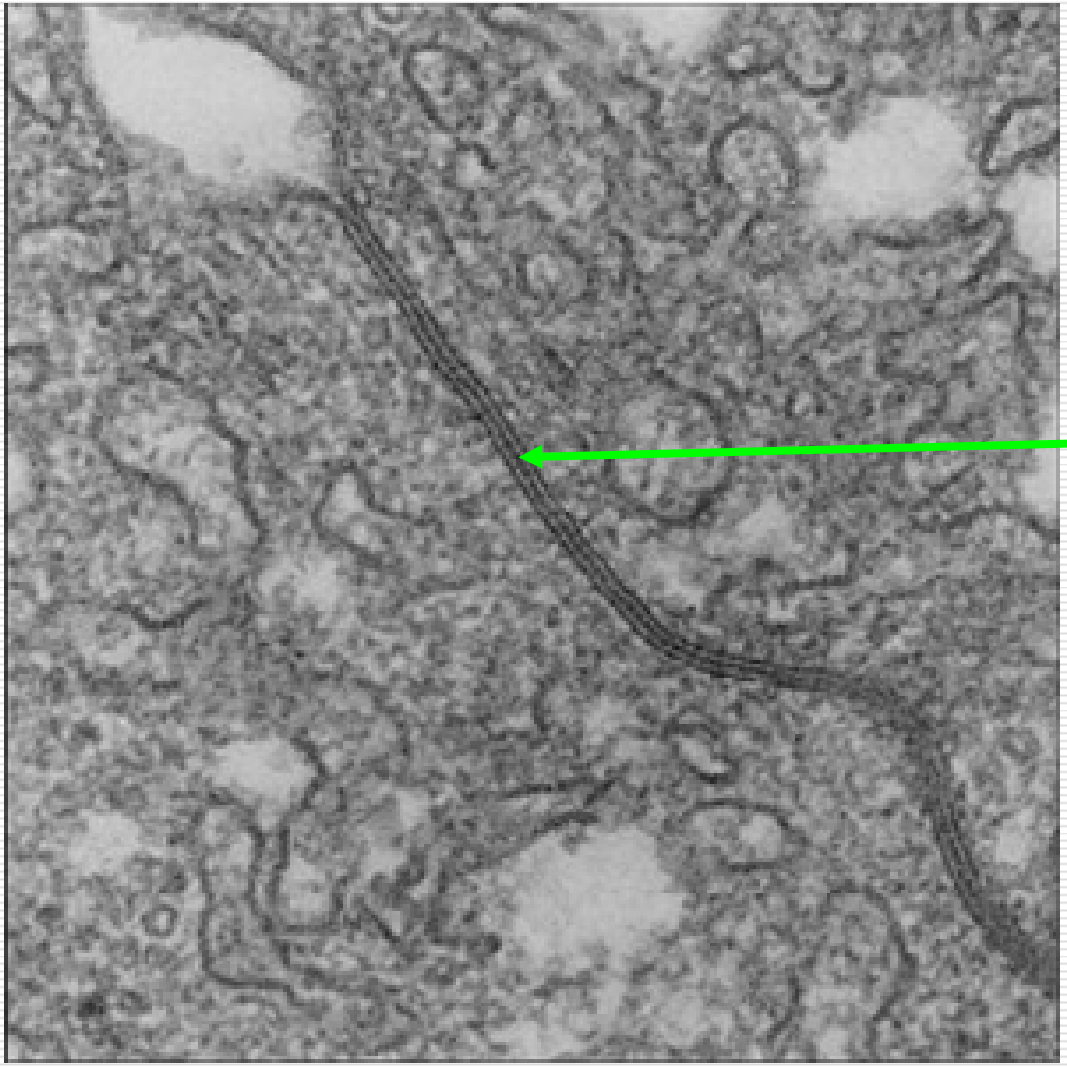
- electron-dense central stratum
- attachment plaque: on the cytoplasmic faces of the membranes.
- Keratin filament inserte into the attachment plaques and make hairpin turns

---Function:

- the strongest junction

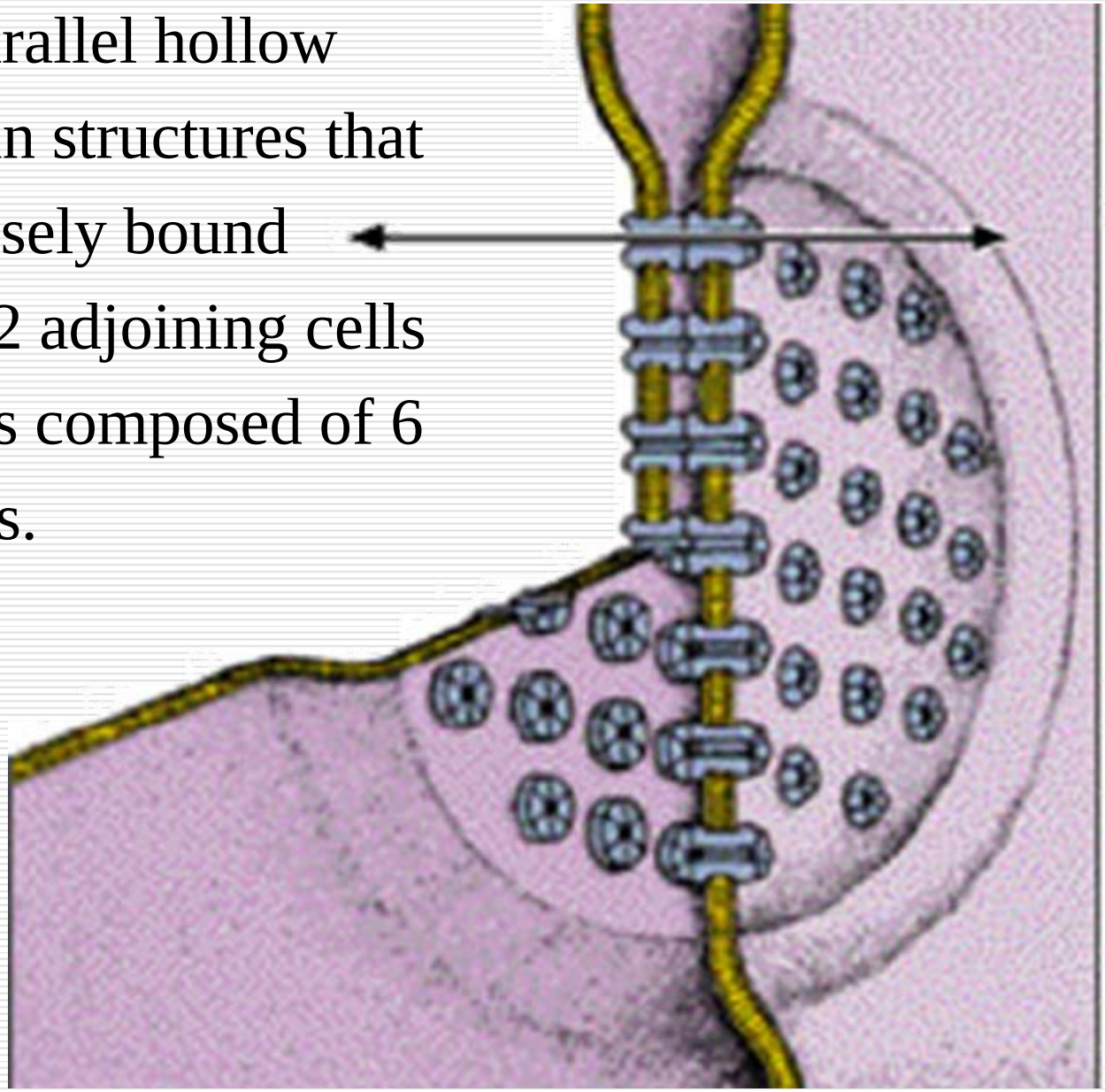


- locate at the deep part of the lateral cell surface.
- The intercellular space is very narrow



• an array of parallel hollow tube-like protein structures that traverse the closely bound membranes of 2 adjoining cells

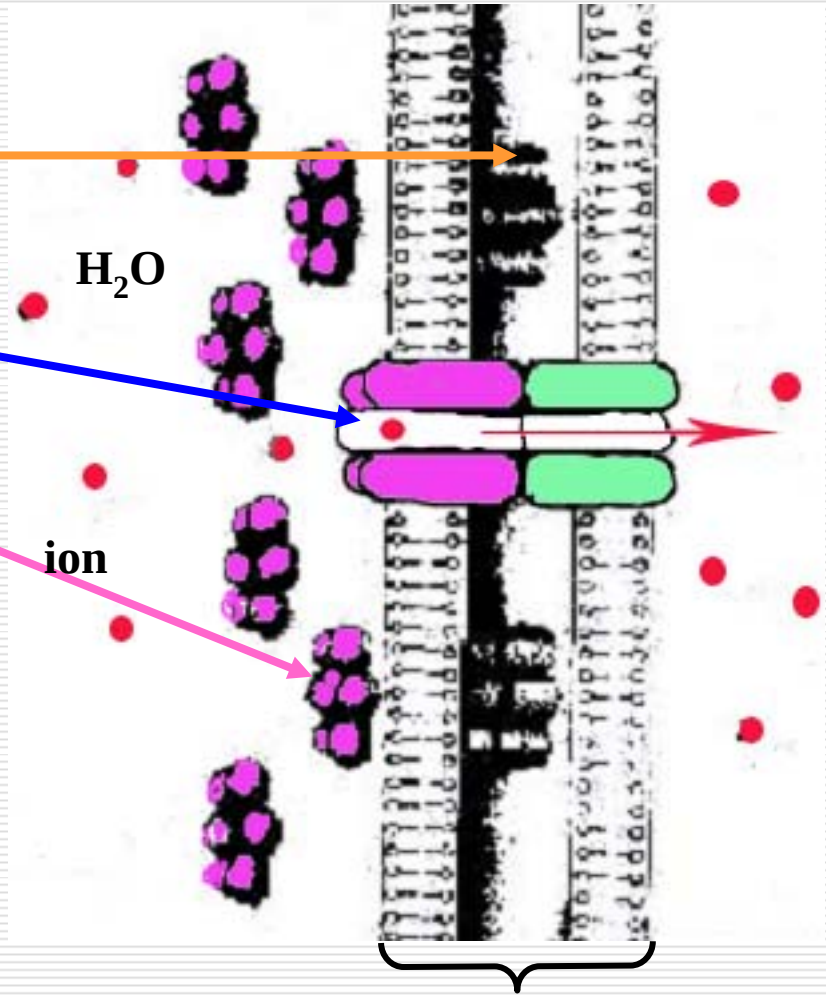
• Each “tube” is composed of 6 protein subunits.



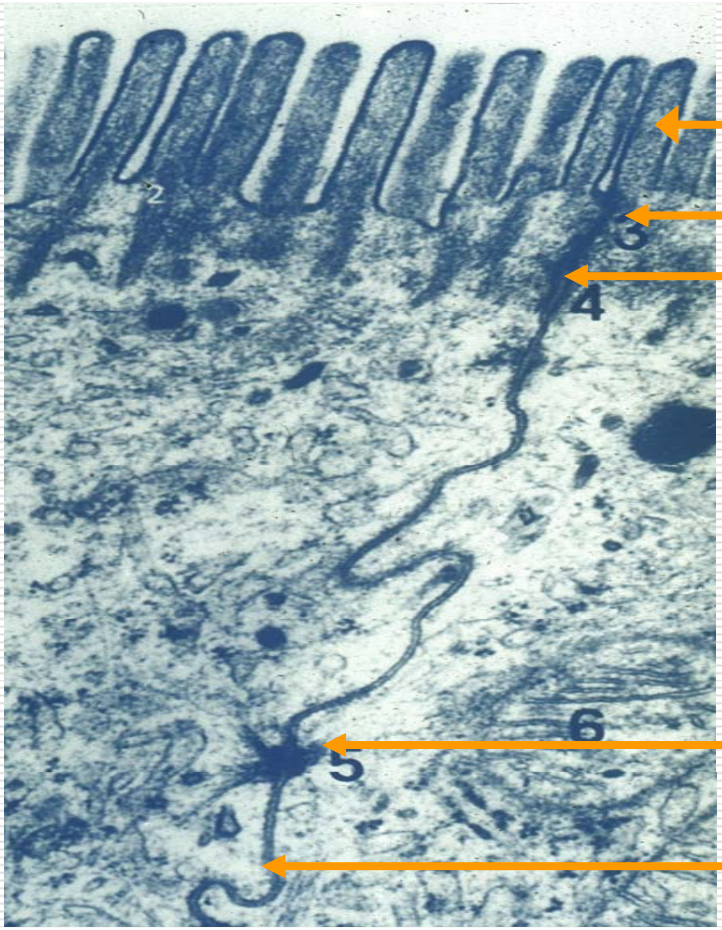
- intercellular space
- A connexon
- 6 connexins

---Function:

- the “tube” limits the size of the molecules that can pass through it.



- Junctional complex is formed by 2 or more than 2 upper specialized types of attachment at least.



microvillius

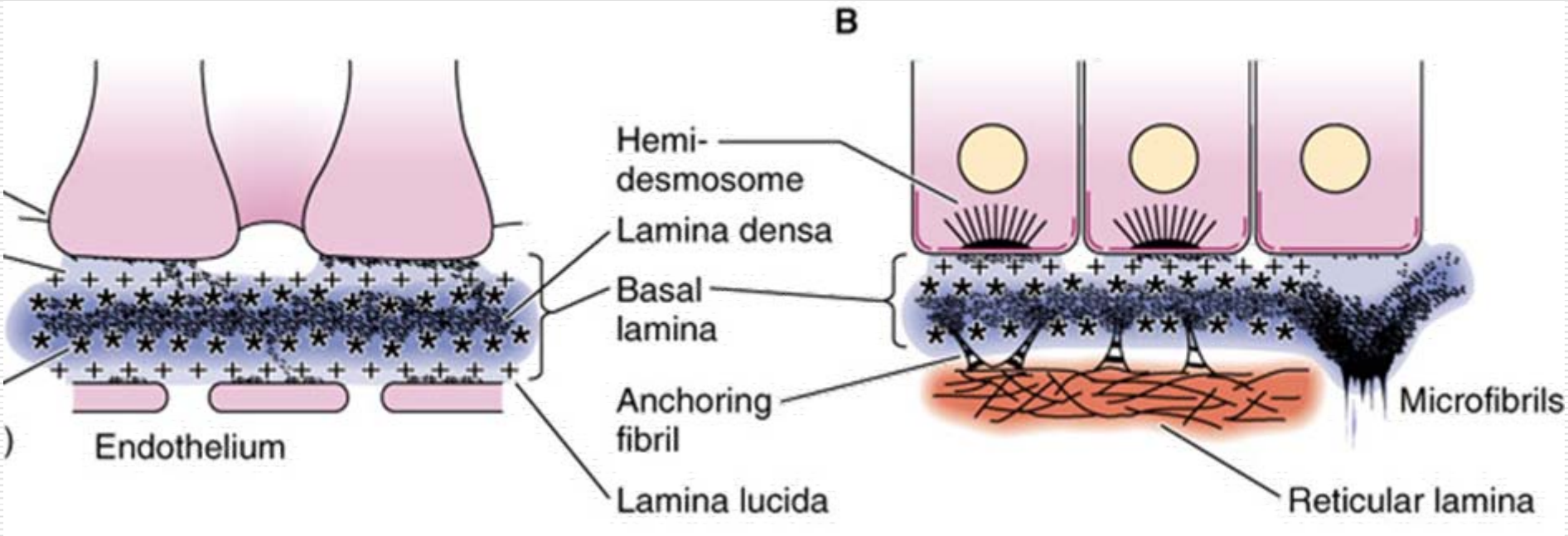
Tight junction

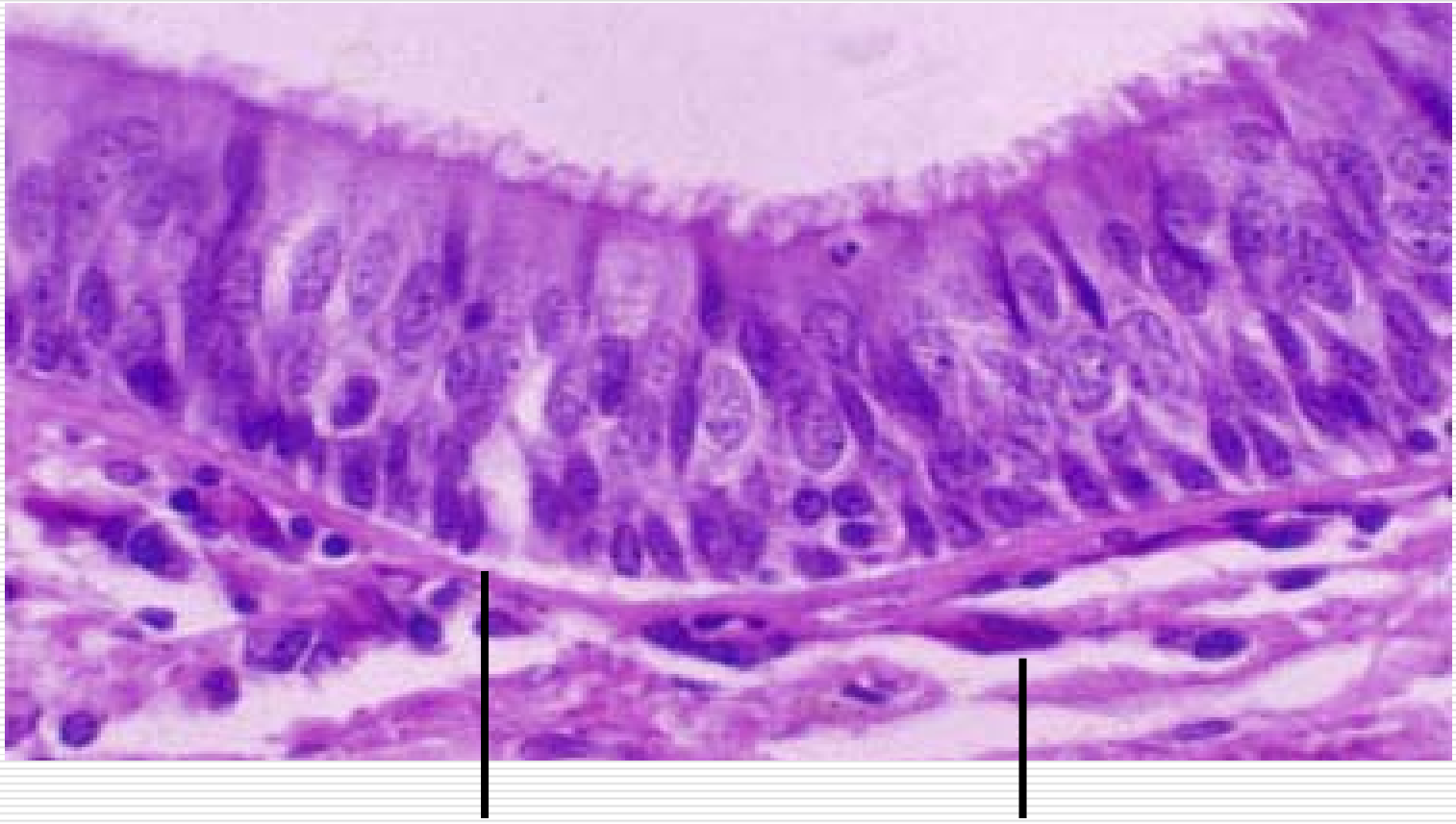
Intermediate junction

desmosome

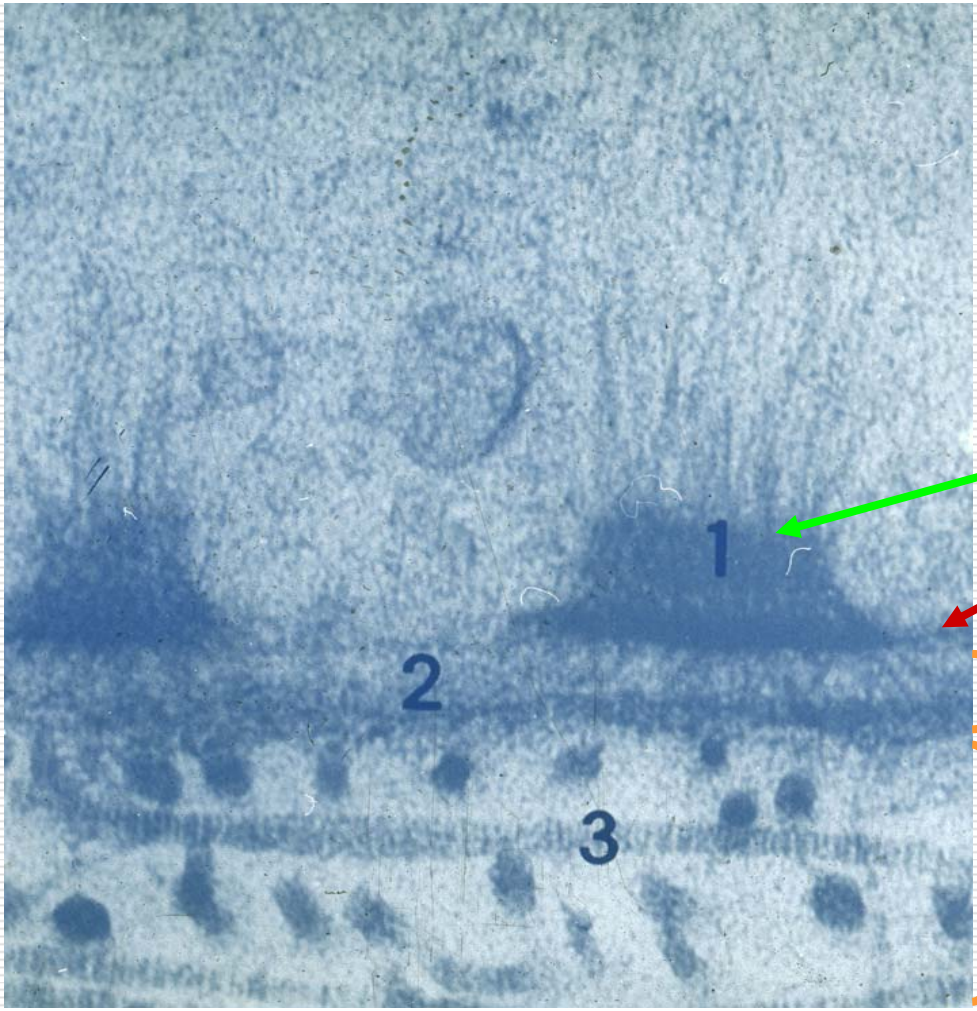
Gap junction

- basal lamina : lamina densa and laminae lucidae ; produced by epithelial cells.
- reticular lamina : produced by fibroblasts
- basement membrane： fusion of 2 basal laminae or a basal lamina and a reticular lamina.
- function: support for epithelia； semi-permeable membrane





Pseudostratified ciliated columnar epithelium from trachea
HE stain, cross section, high mag



Hemidesmosome

Cell membrane

Basal lamina

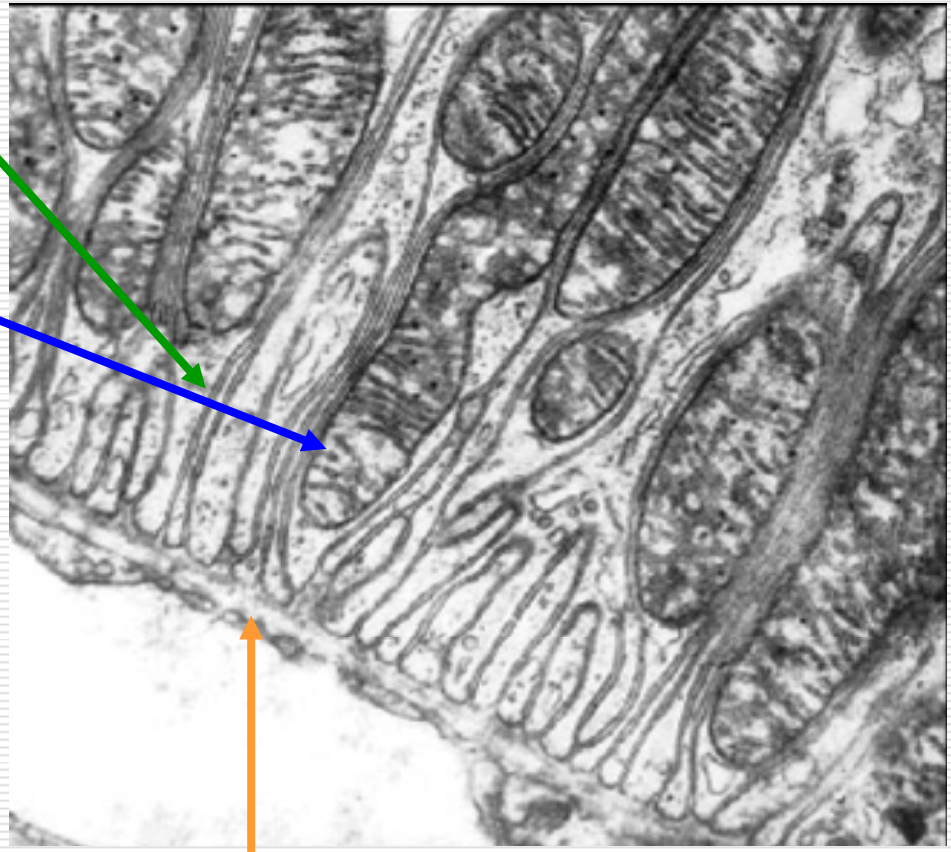
Reticular lamina

Basement membrane

- **numerous infoldings at the basal surface**
- **Many mitochondria lie in the infoldings.**

---Function:

- **increase the basal surface area**
- **facilitate the passage of water and ions**



Basement membrane

4 Glandular epithelium and glands

- **The glandular epithelia are specialized for secretion.**
- **The glands are organs composed mainly of glandular epithelia.**

- **Types of glandular epithelial cells**

----Serous cells

----Mucous cells

----Steroid-secreting cells

- **Gland**

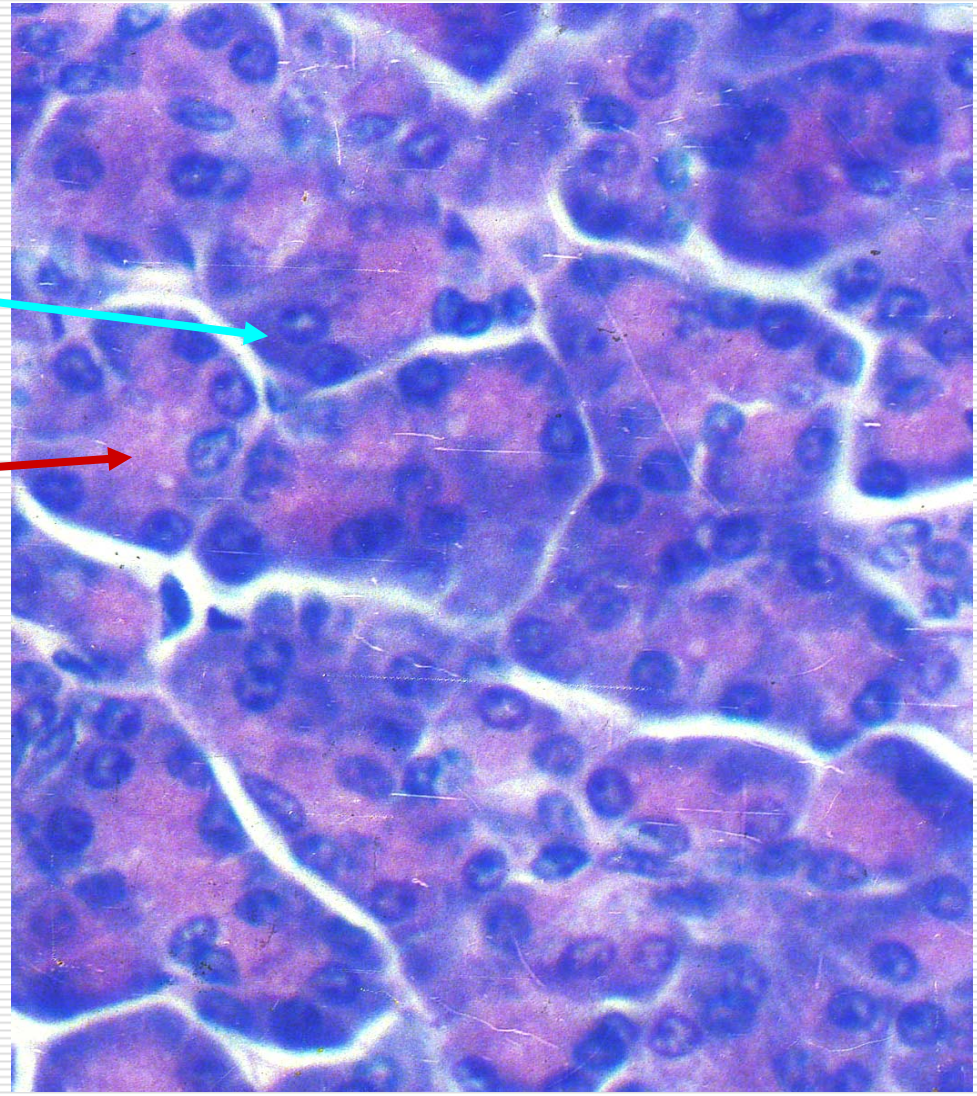
----Exocrine gland

----Endocrine gland

- **cone-shaped**
- the basal cytoplasm basophilic
- the apical granules acidophilic.

---Function:

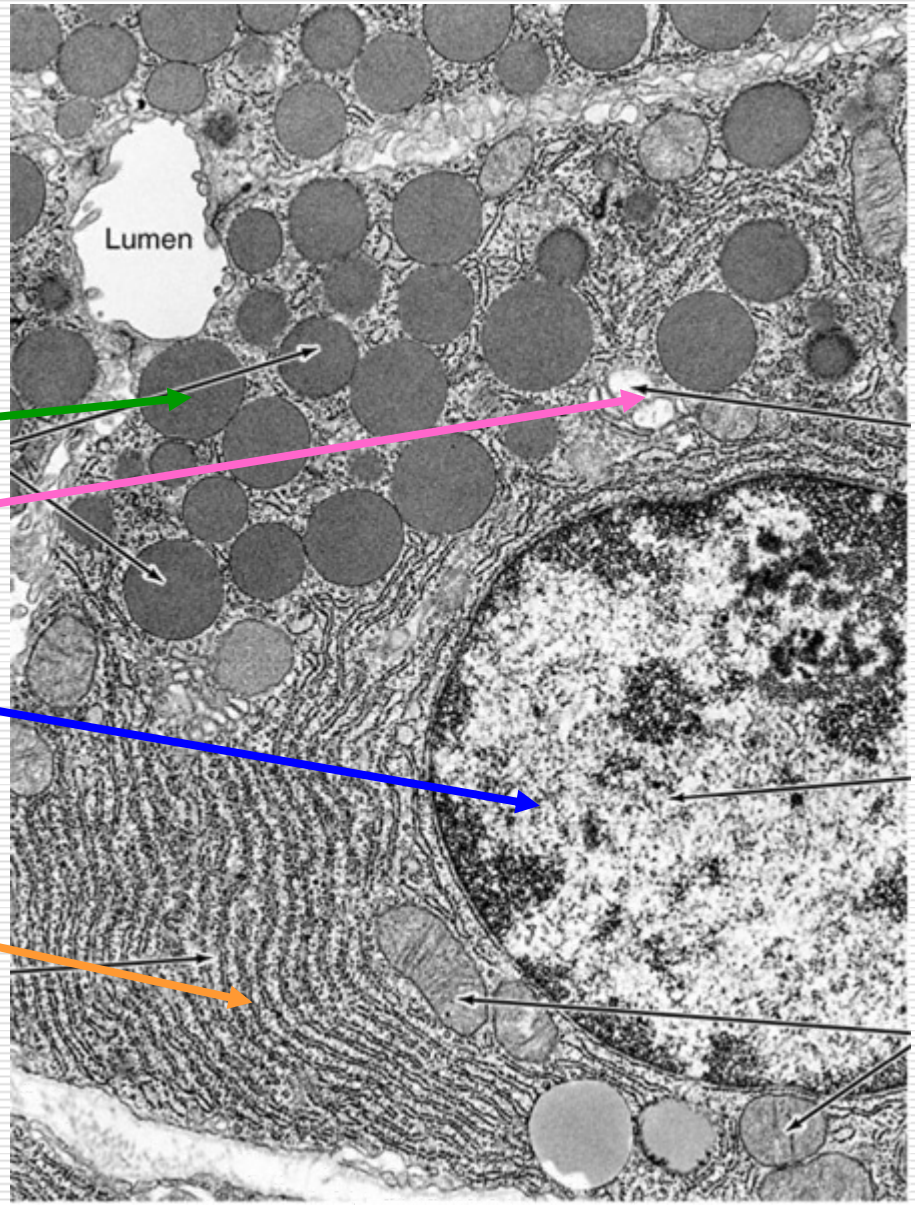
- produce a serous secretion.



Exocrine portion (acinus) of pancreas HE stain

Serous cell :

- **secretory granules**
- **Gilgi complex**
- **round nucleus**
- **rough endoplasmic reticulum**

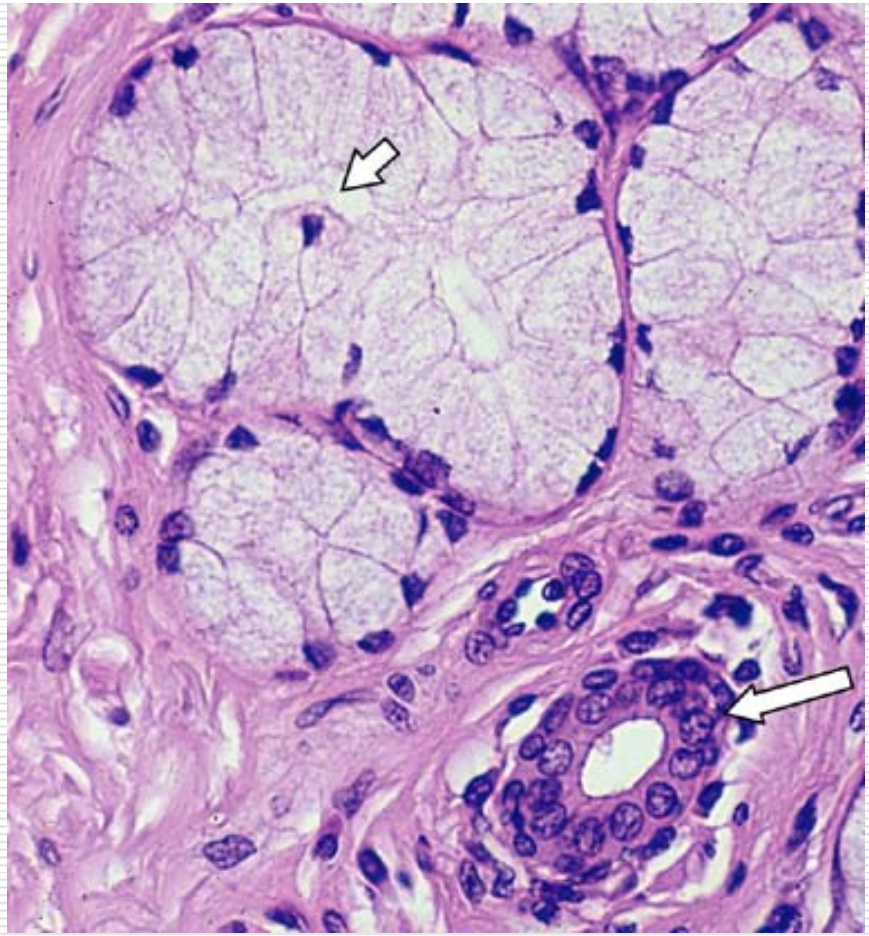


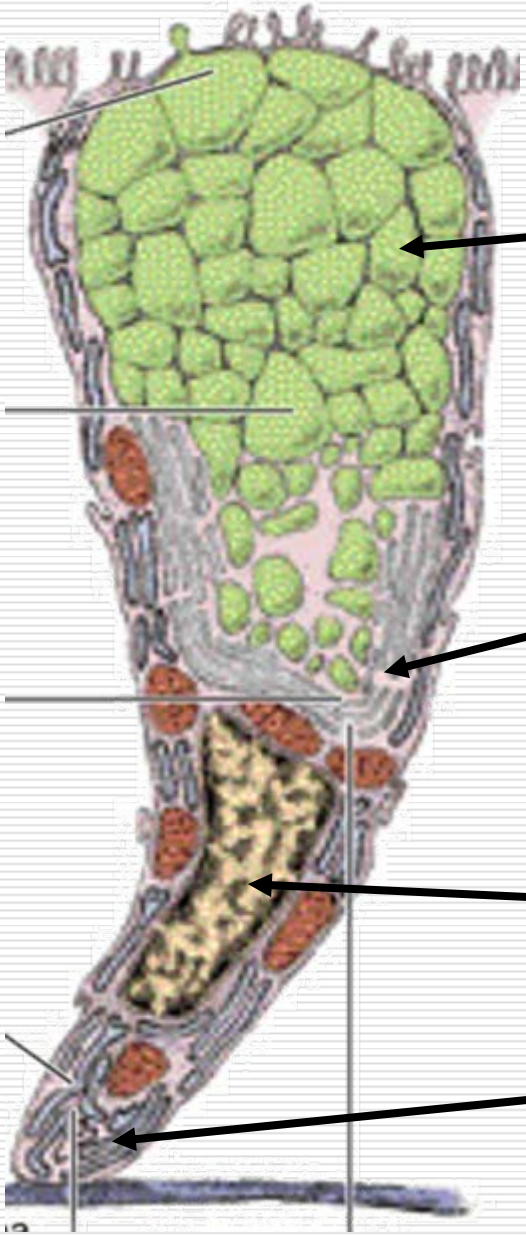
Mucous cell:

- cone-shaped
- large, secretory granules
- a flattened nucleus
- basal cytoplasm is slightly basophilic
- apical cytoplasm is clear.

---Function:

- secrete mucus.



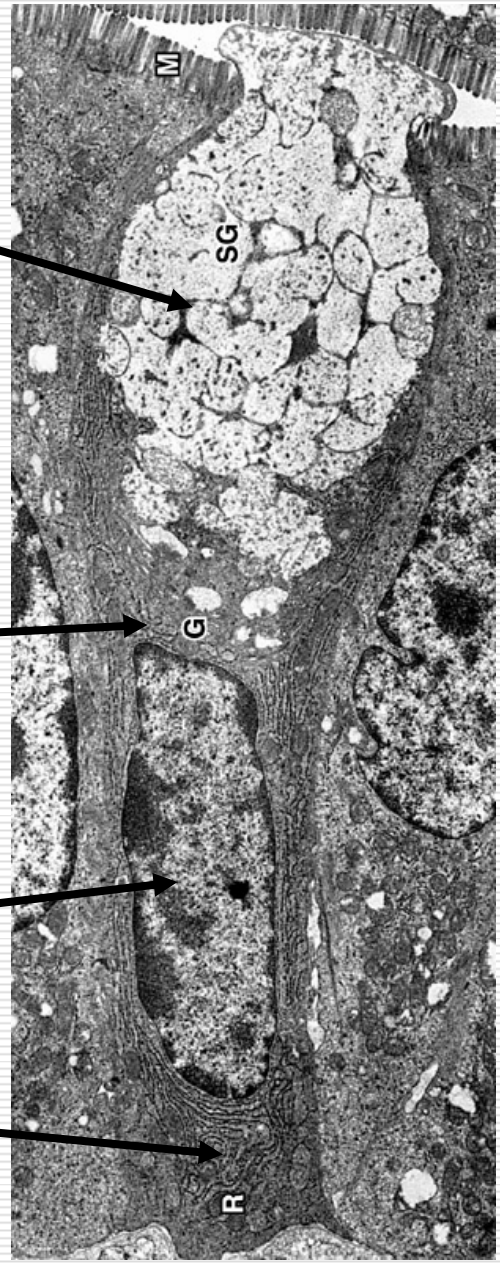


secretory granules

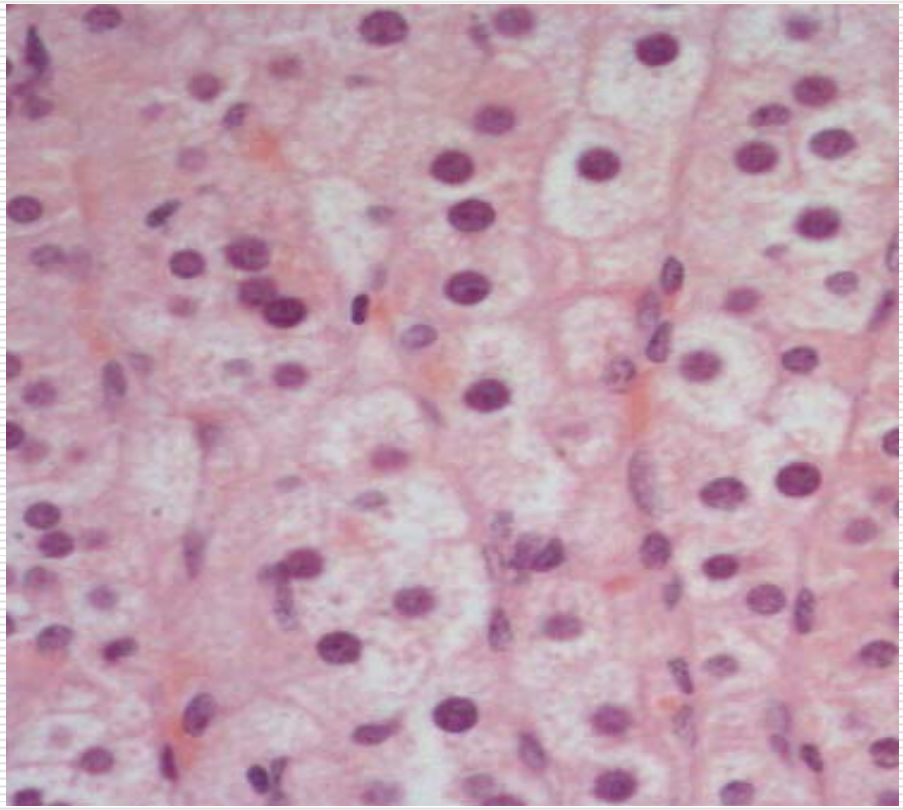
Golgi complex

flattened nucleus

Rough endoplasmic reticulum



- synthesizing and secreting steroids with hormonal activity
- polyhedral or rounded
- acidopohilic
- a central nucleus

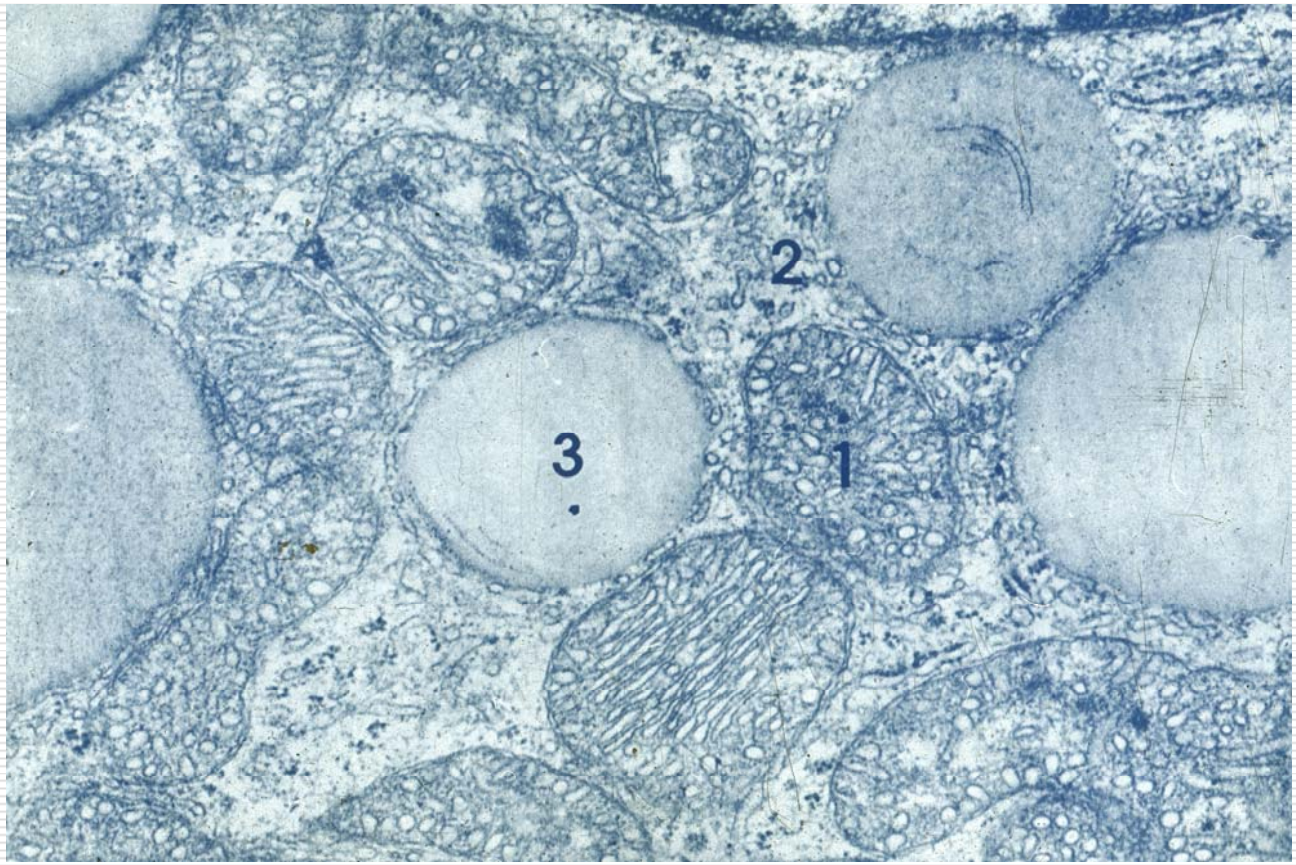


Zona fasiculata of the adrenal cortex HE stain

rich in lipid droplets

smooth endoplasmic reticulum: anastomosing tubules

mitochondria : spherical or elongated , tubular cristae



Steroid-secreting cells: 1 MT, 2 SER, 3 lipid droplets

- **The secretory portion (acinus)**

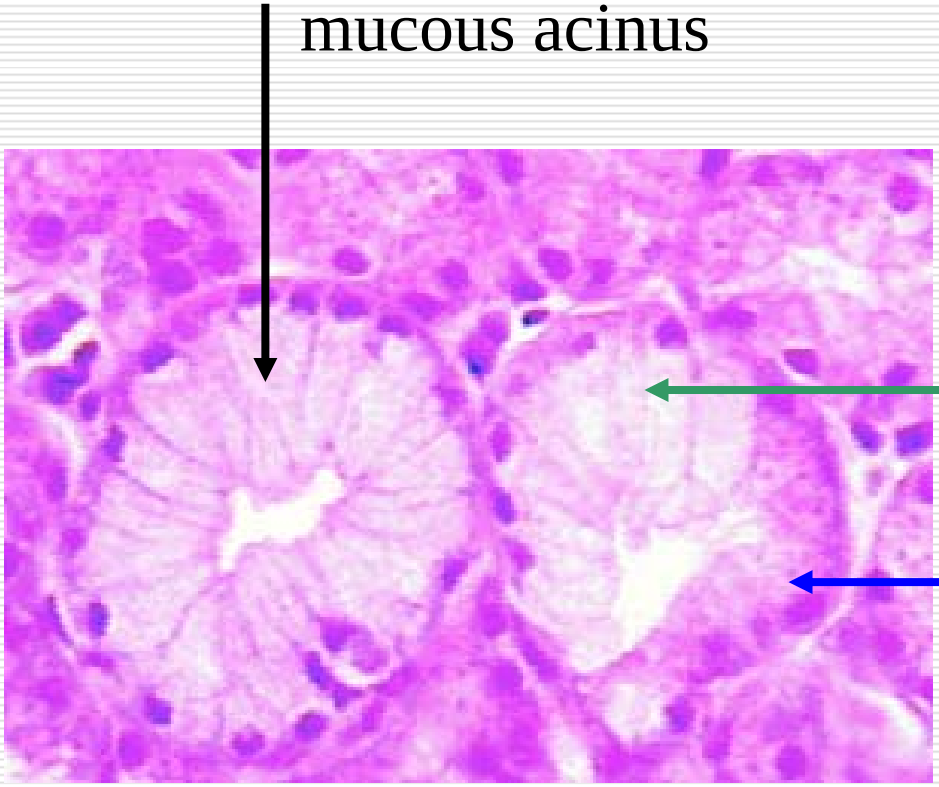
  serous acinus : serous cell

  mucous acinus: mucous cell

  mixed acinus: both of them
- **tubular ducts**

Mixed acinus :

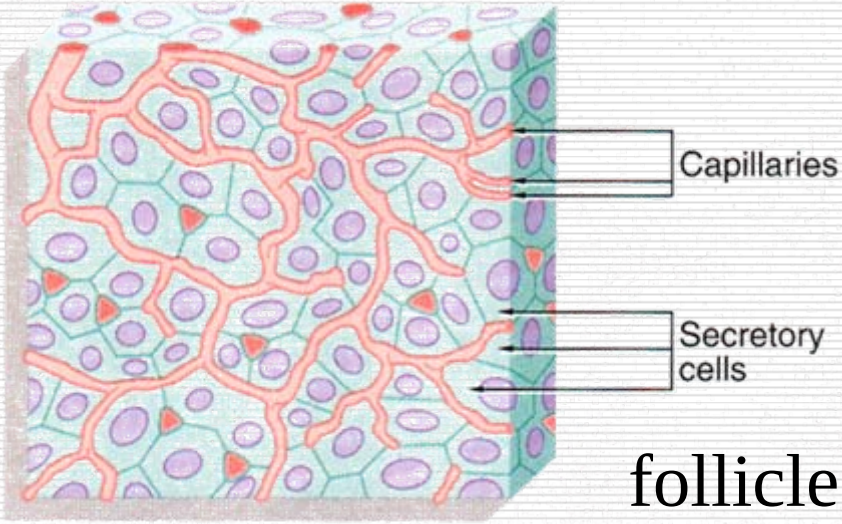
- **two types of secretory cells.**

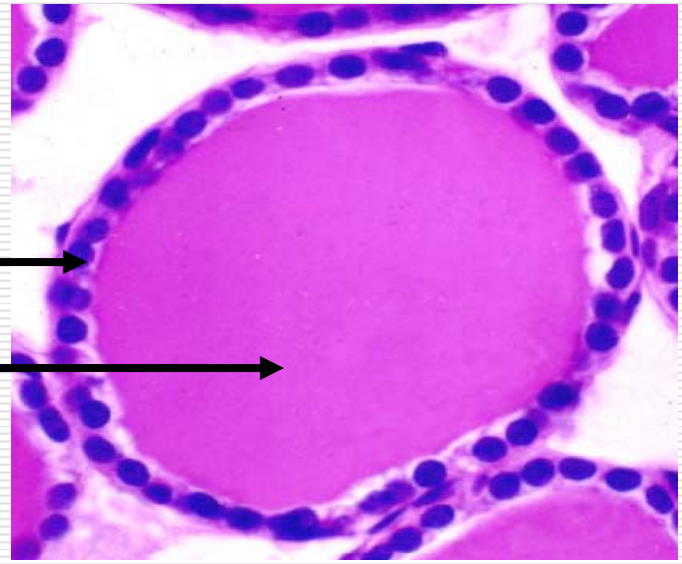


- ductless , release the secretion directly into blood steam.
- Two types

---anastomosing cords interspersed between blood sinuses.

---a vesicle or follicle with noncellular material





5 Sensory epithelium and Myoepithelium

- Neuroepithelial cells : sensory functions
- Myoepithelial : contraction; to propel secretory products of exocrine glands toward the exterior

Summary

Master:

- The types of the covering epithelium and their distributions.
- The structures and functions of all epithelial specializations
- The definition of junctional complex

Understand:

- The characters of three glandular cell, serous cell, mucous cell and steroid-secreting cells, and three types of exocrine gland.