



Epithelial Tissue



<http://fdjpkc.fudan.edu.cn/d201404/main.htm>

Prof. Hong CHEN MD, PHD

**Department of Anatomy, Histology & Embryology
Shanghai Medical College
Fudan University**

Office: Building 9 E., Rm. 304

Tel: 54237019-9304

Mobile: 18602109425

Email: hchen30@hotmail.com; hchen@graduate.hku.hk

WeChat: [chenhong990543](#)



Review - Tissues



- Made of two interacting components:

- Cells
- Extracellular matrix (ECM)

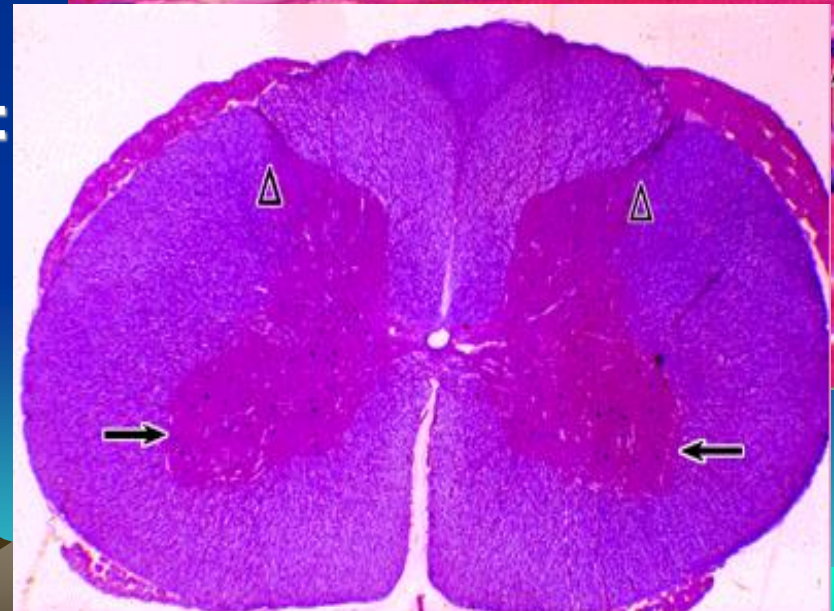
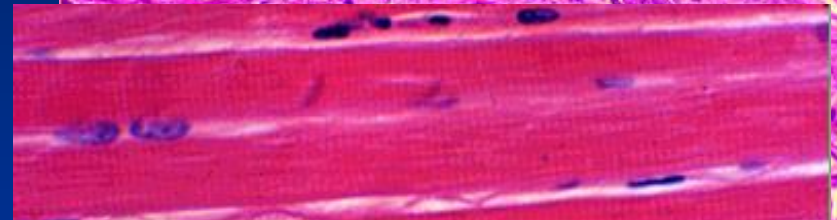
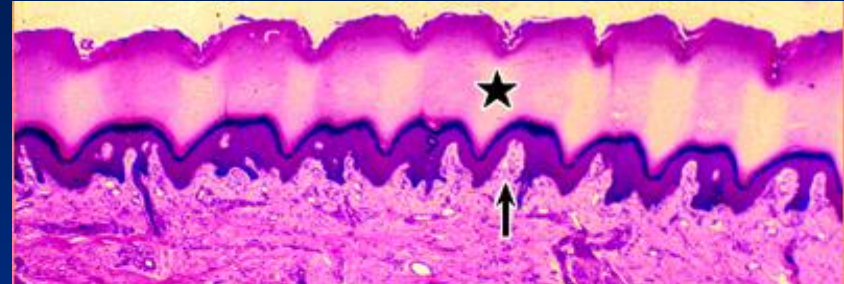
★ Continuum:

functions & reacts to stimuli and inhibitors together

- Four basic types of tissue:

★ cell-specific associations

- Epithelial Tissue
- Connective Tissue
- Muscle Tissue
- Nerve Tissue





OUTLINE



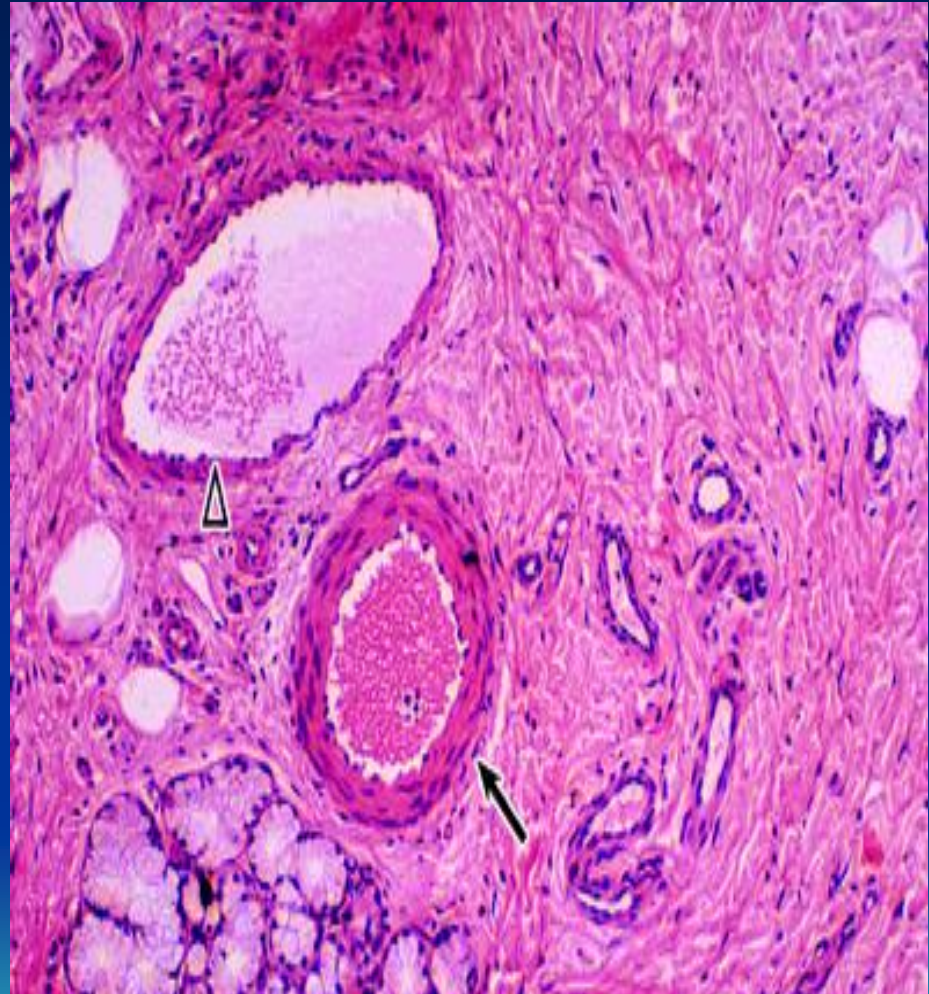
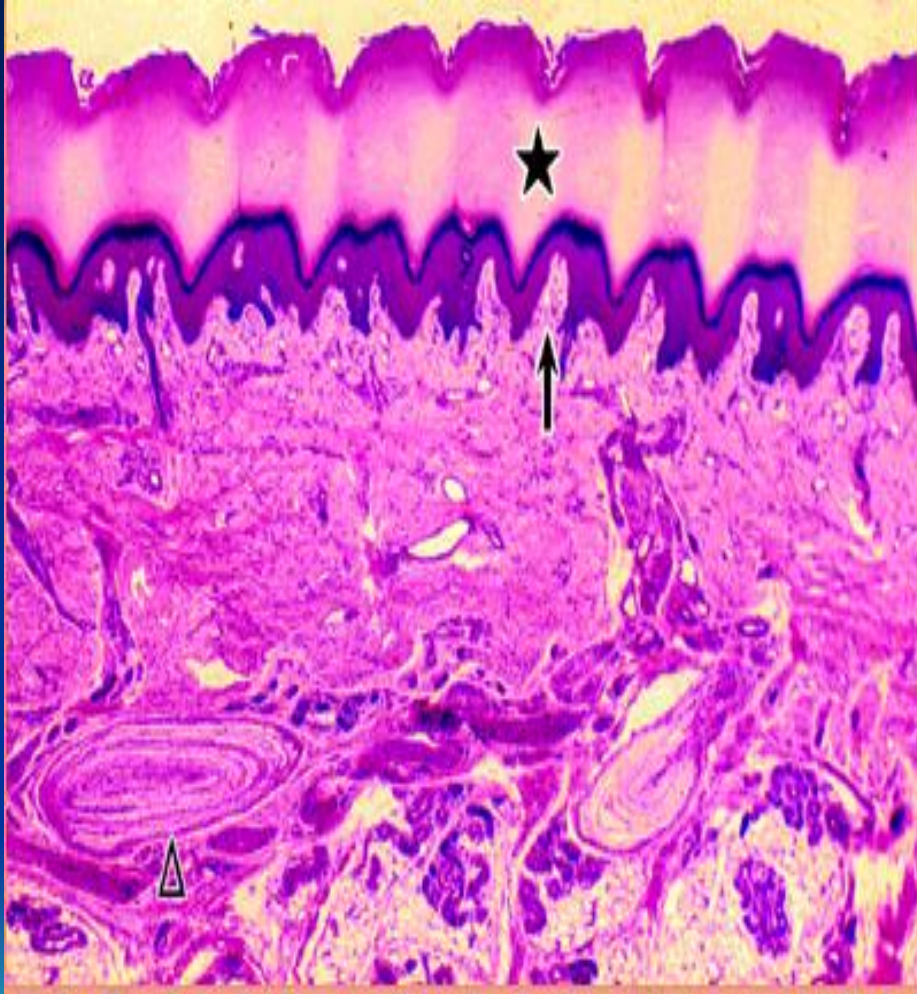
- Characteristic **features** of epithelial cells
- **Classification** of epithelia
- **Morphological types** of **covering epithelia** and associated characteristic features
- **Specializations** of epithelial cells

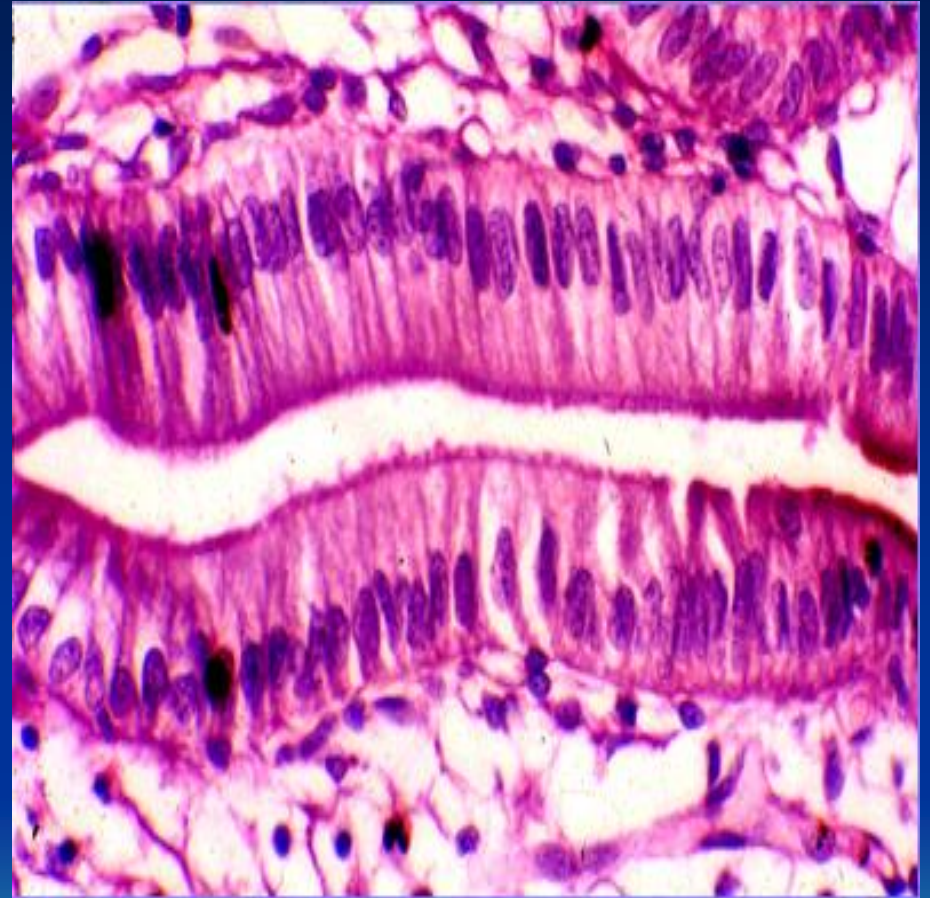
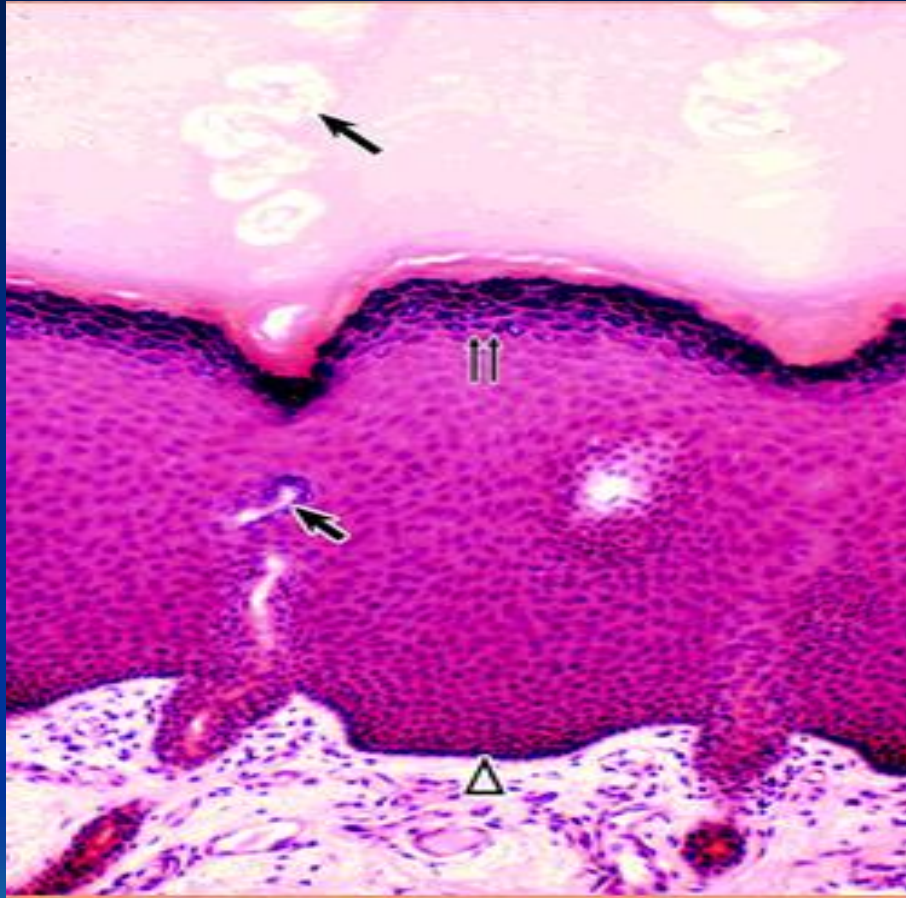
- **Glandular (Secretory) epithelia: self-study**
 - Classification
 - Types of glands



Characteristic Features

- **A sheet-like structure surrounding “free” surfaces** of body or cavity.
- **More** cells **bound tightly together** structurally and functionally with **little** ECM.
- **Polarity: Apical, Basal**
- Rest on **basement membrane** underlying connective tissue
- **No** blood vessels, **rich** nerve endings
- **Functions: protecting surfaces**, absorption or transcytosis, secretion, contractility, sensory.







Classification

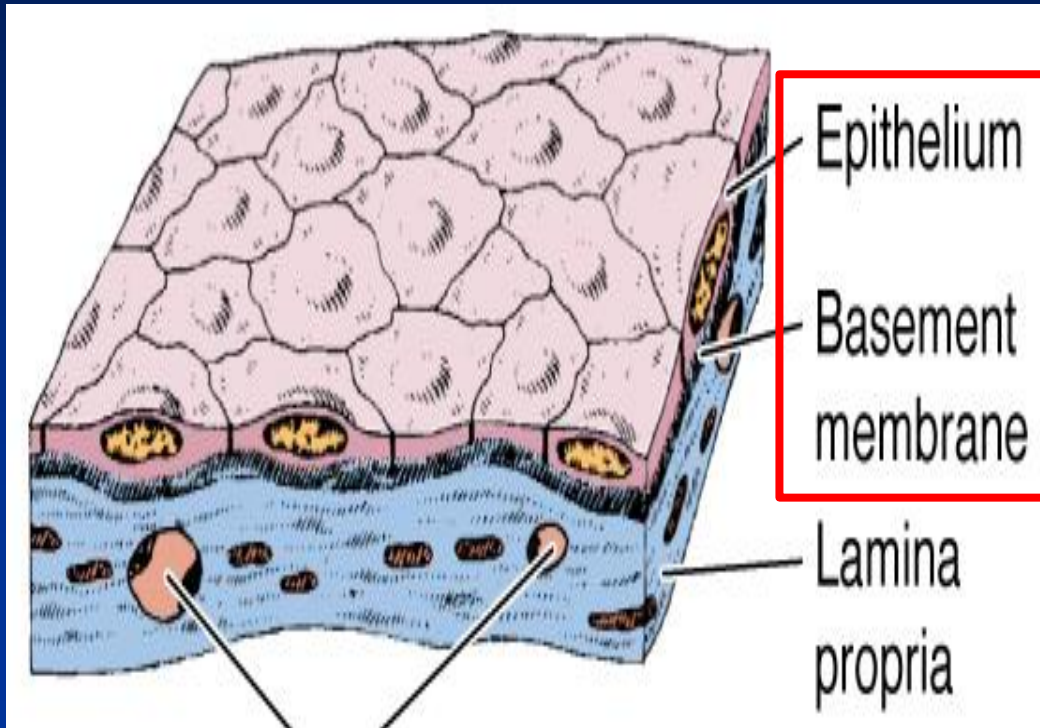
- **Covering epithelia**
 - Formed by cells **surrounding “free” surfaces** of body or cavity
 - **Continuous sheet-like structure**
 - The **interphase** between environment and tissue
- **Glandular epithelia (self-study)**
 - Formed by cells **specialized to be secretory.**



Morphological Principles of Classification of Covering Epithelia

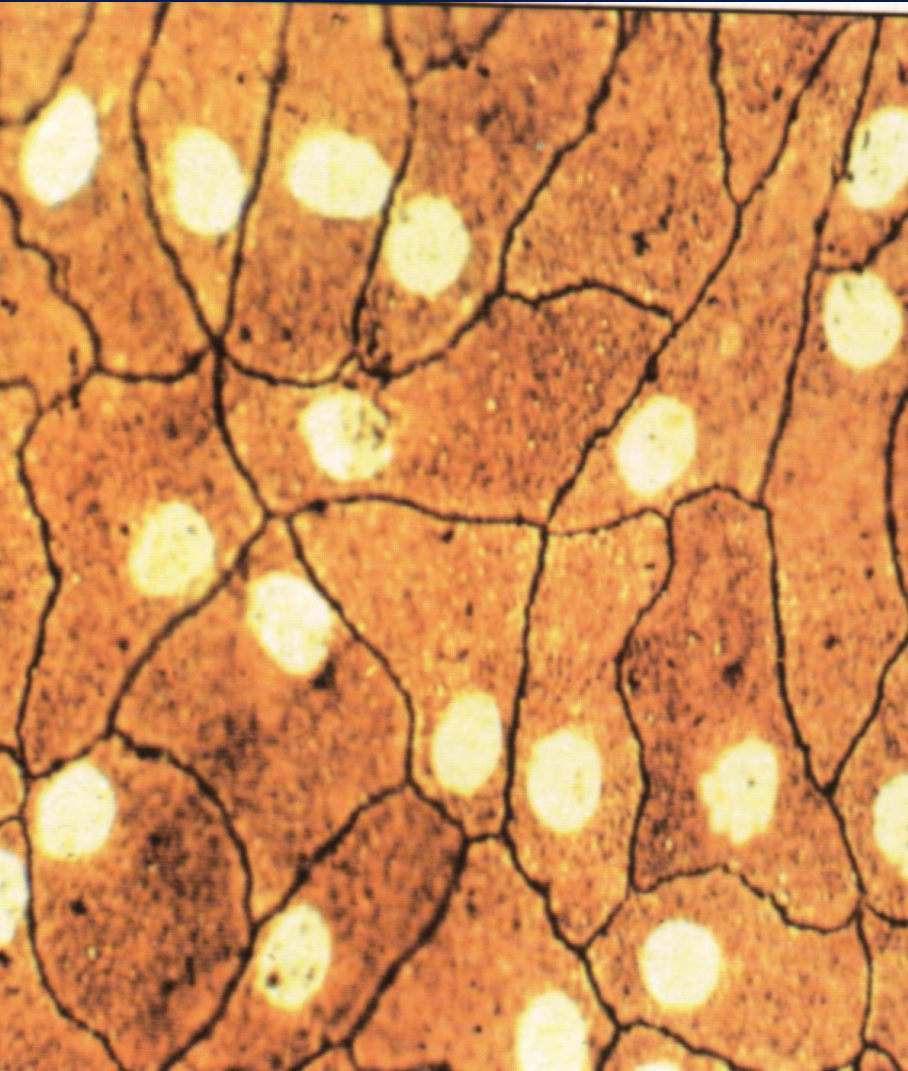
- Number of **layers** or **thickness**
 - One layer **simple**
 - More than one **stratified**
- **Shape** or **height** of cells
 - Flattened **squamous**
 - Cube **cuboidal**
 - Tall pillar shape **columnar**

Simple Squamous Epithelium

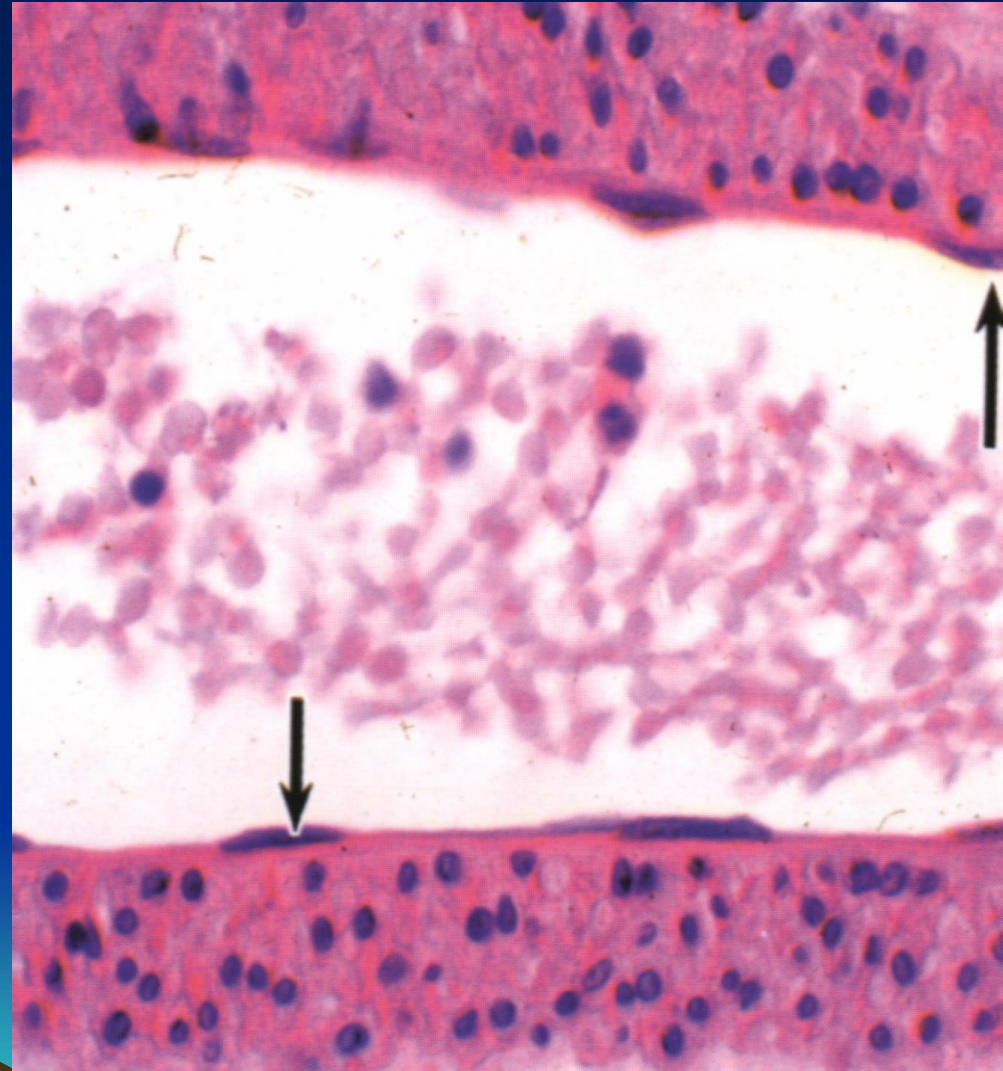


- **Single** layer of **highly flattened** cells
- **Nuclei flattened**
- **Facilitate exchange** of materials
- e. g. **lung alveoli, capillary endothelial cells, etc.**

Simple Squamous Epithelium



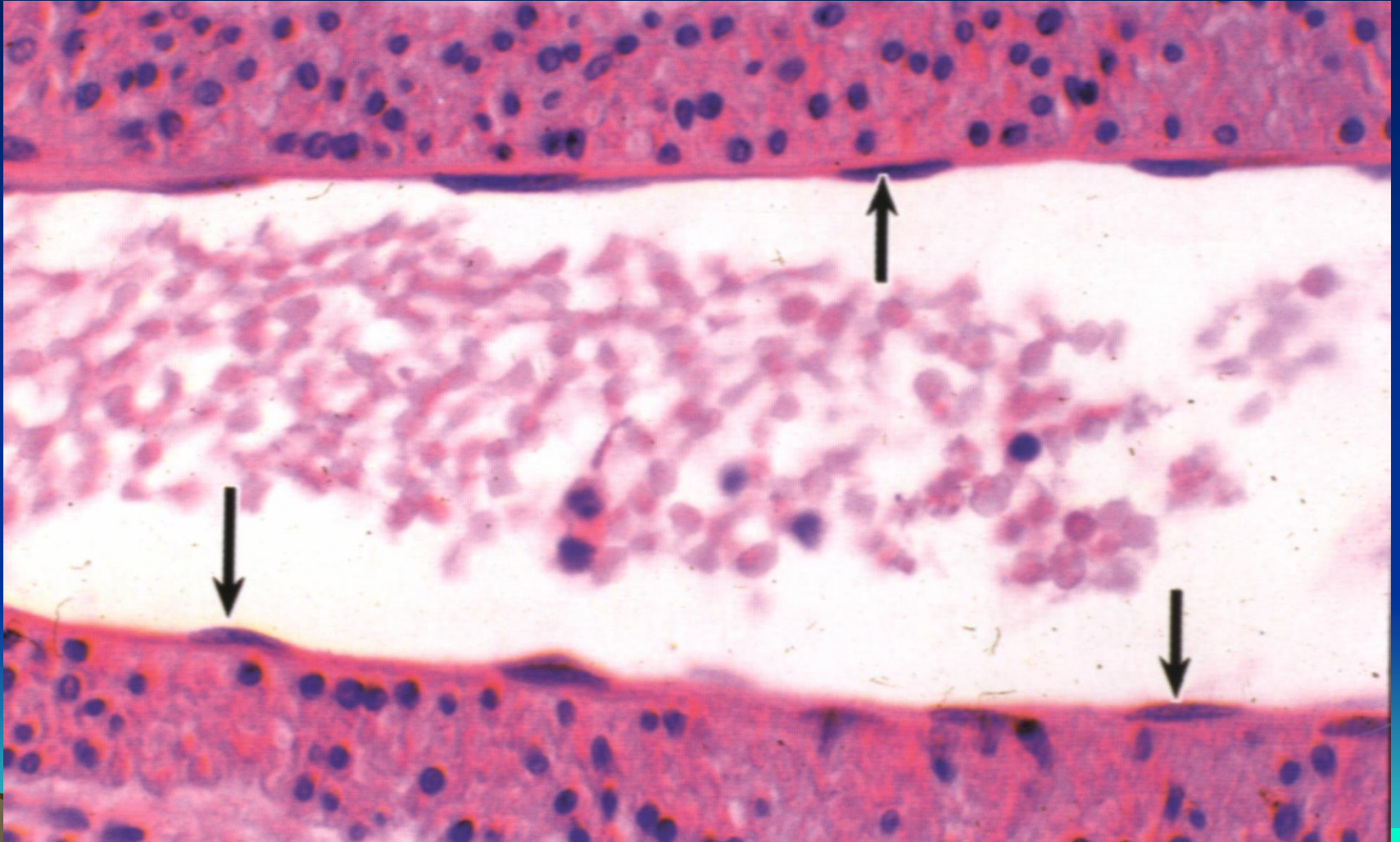
Surface



Lateral

Endothelium (↓)

Lining of **vessels** and **chambers of heart**

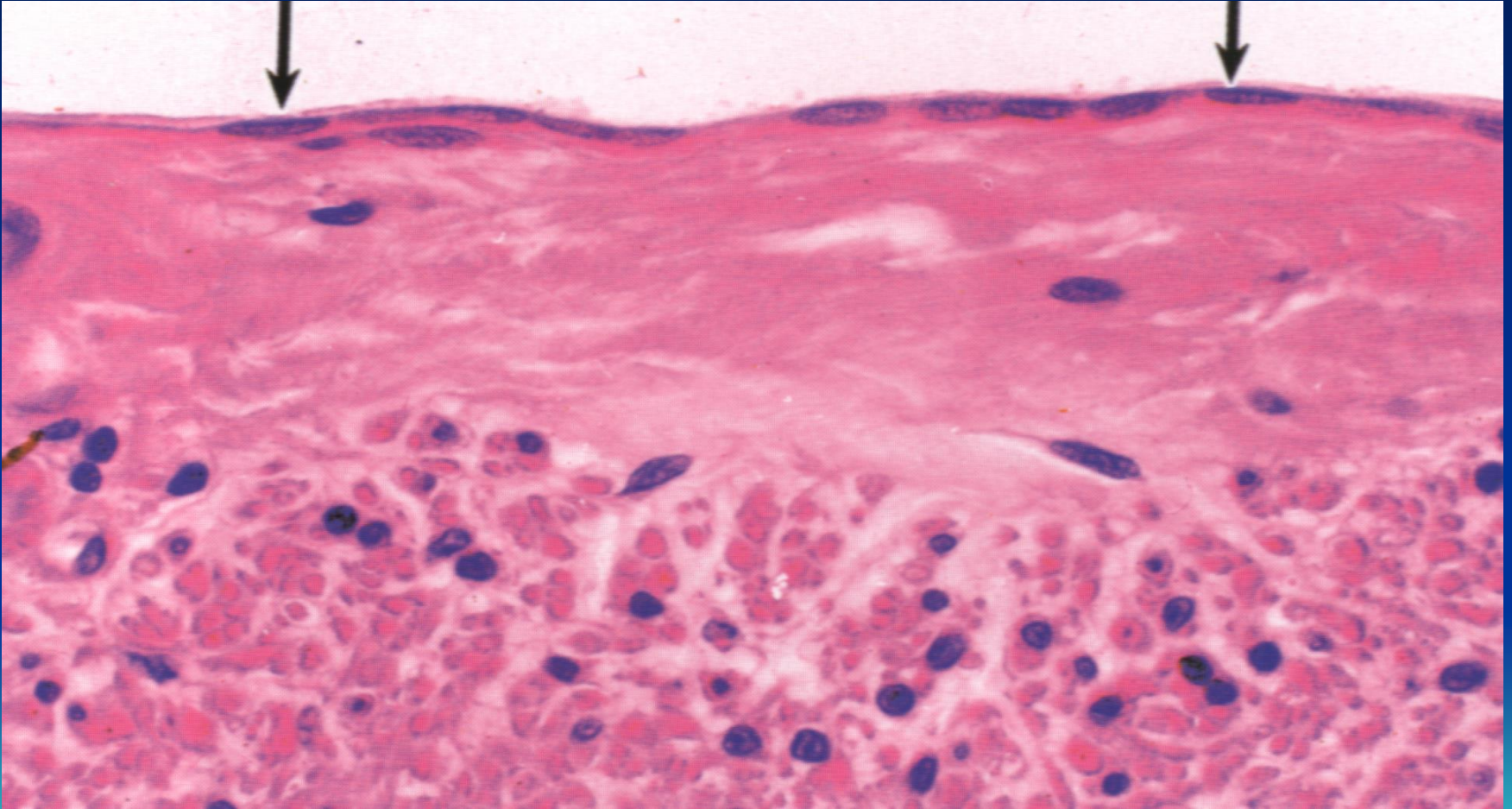




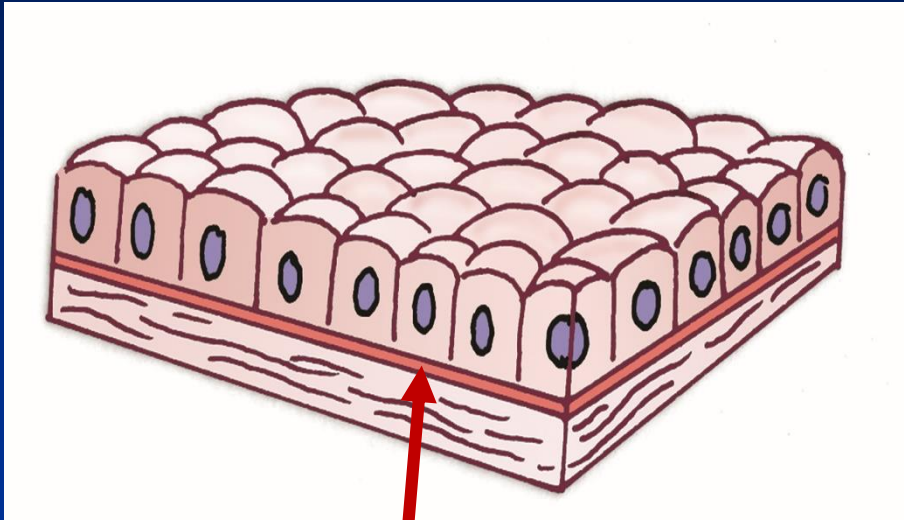
Mesothelium (↓)



Serous lining of the cavity of **pleural, peritoneum** and **pericardium**.

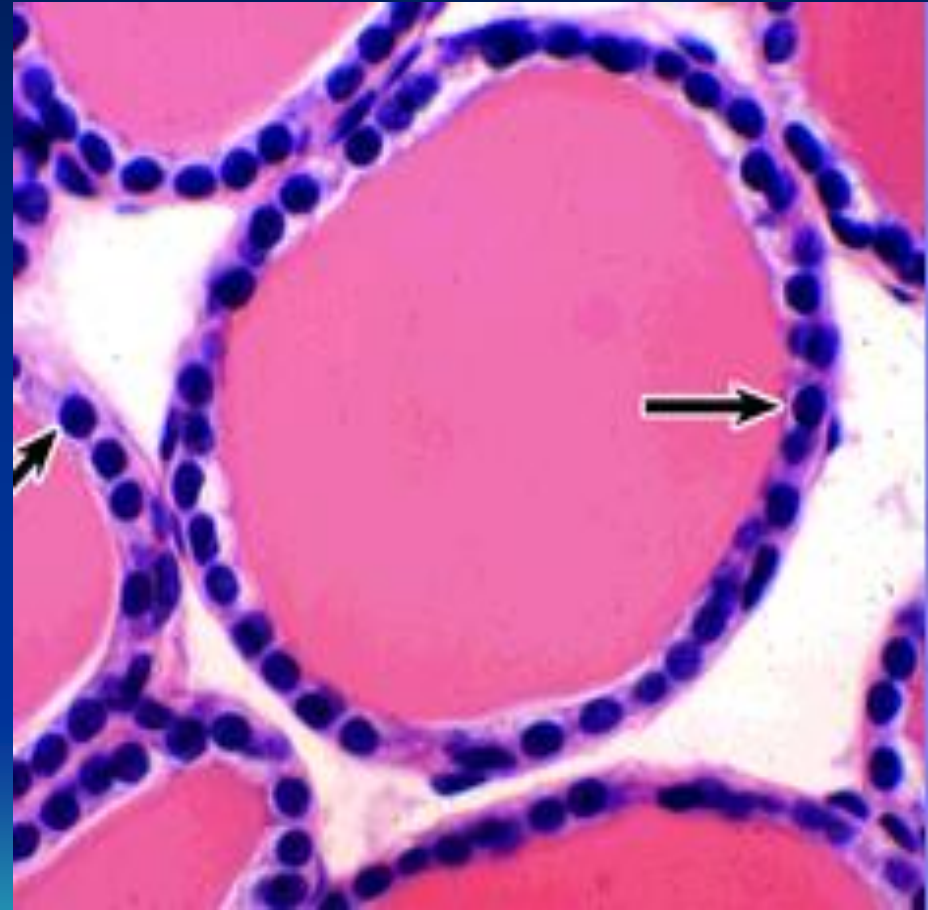


Simple Cuboidal Epithelium

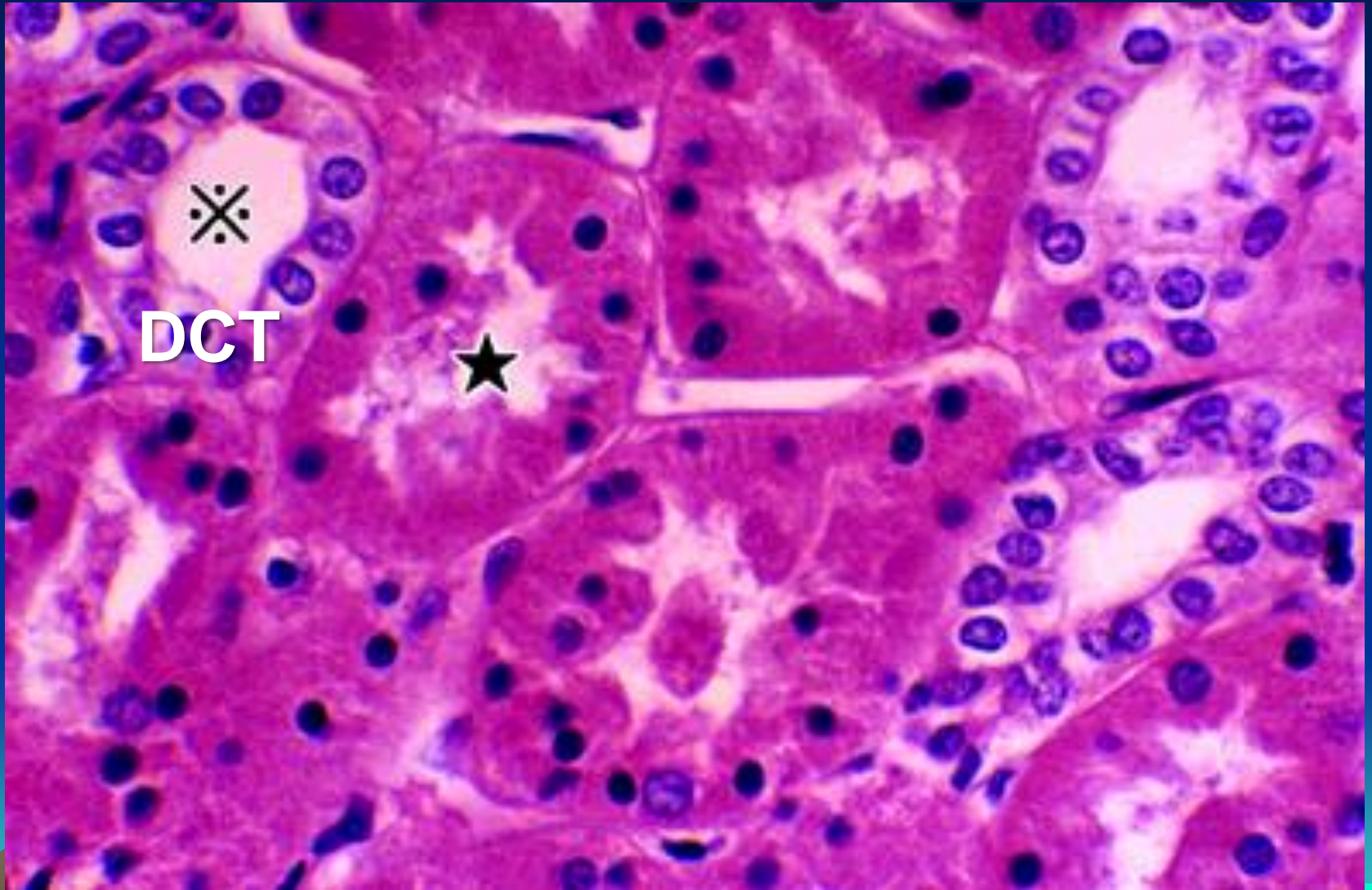


Basement membrane

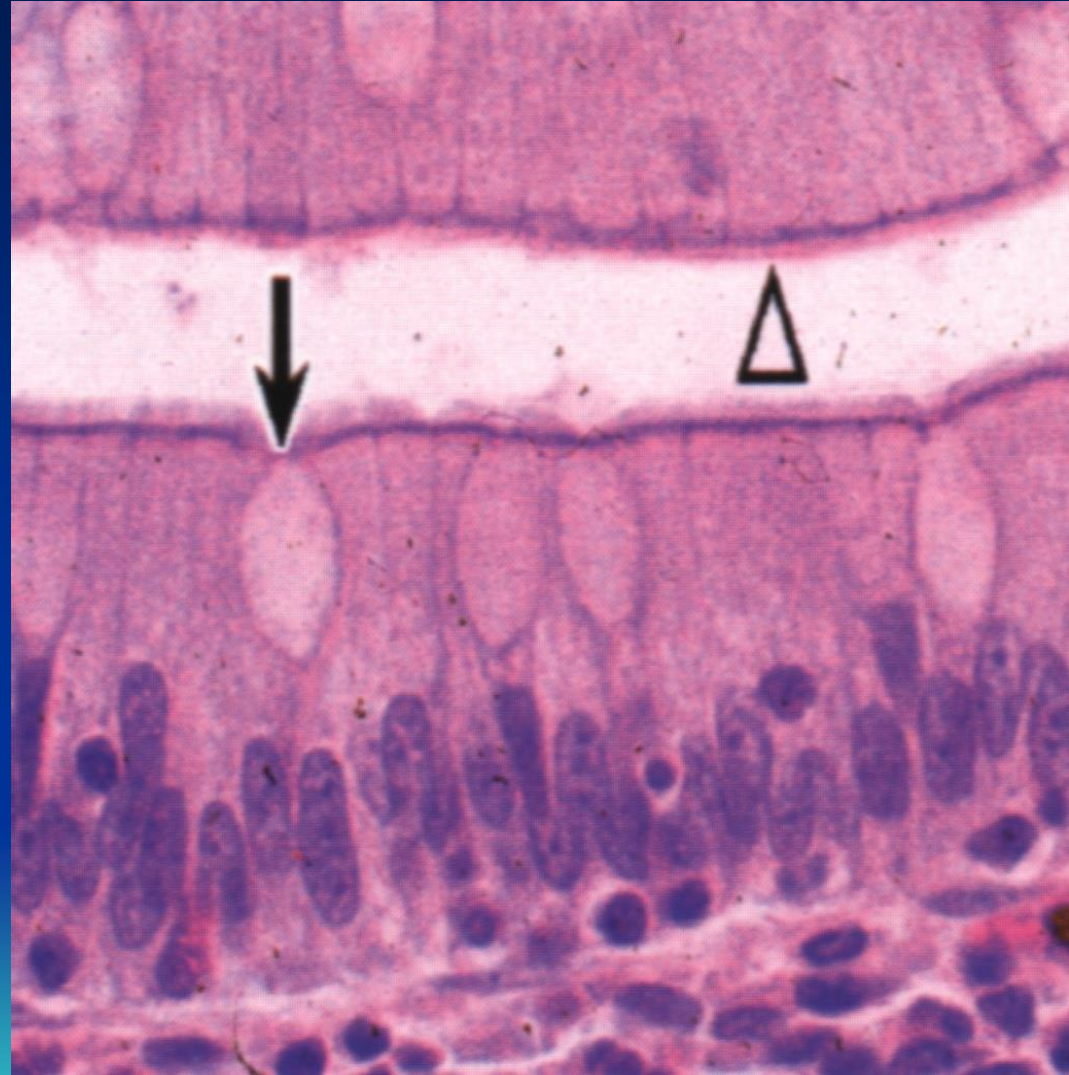
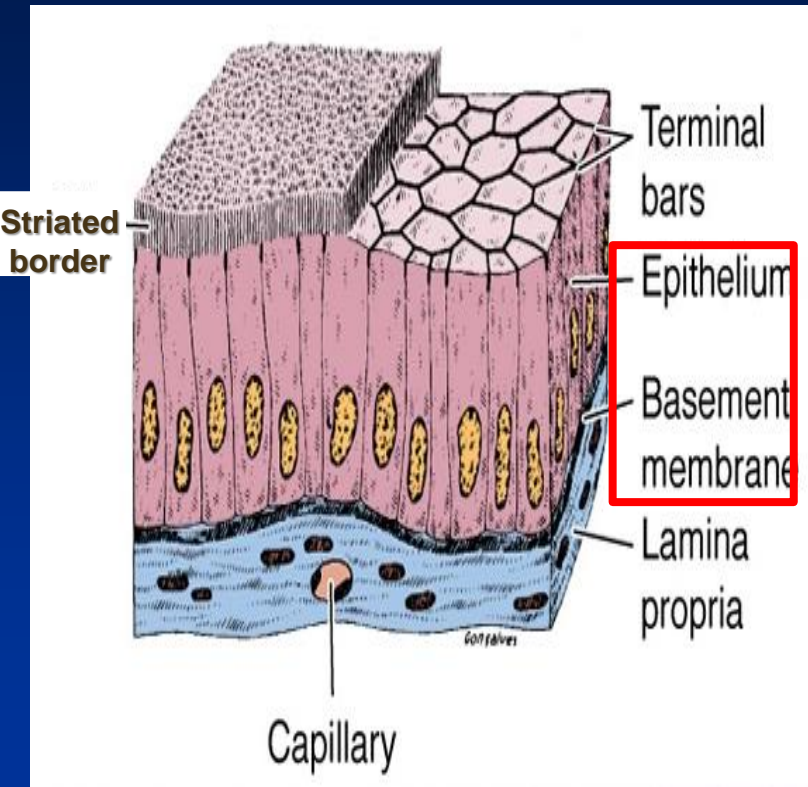
- **Cubical** in profile
- **Nuclei spherical**



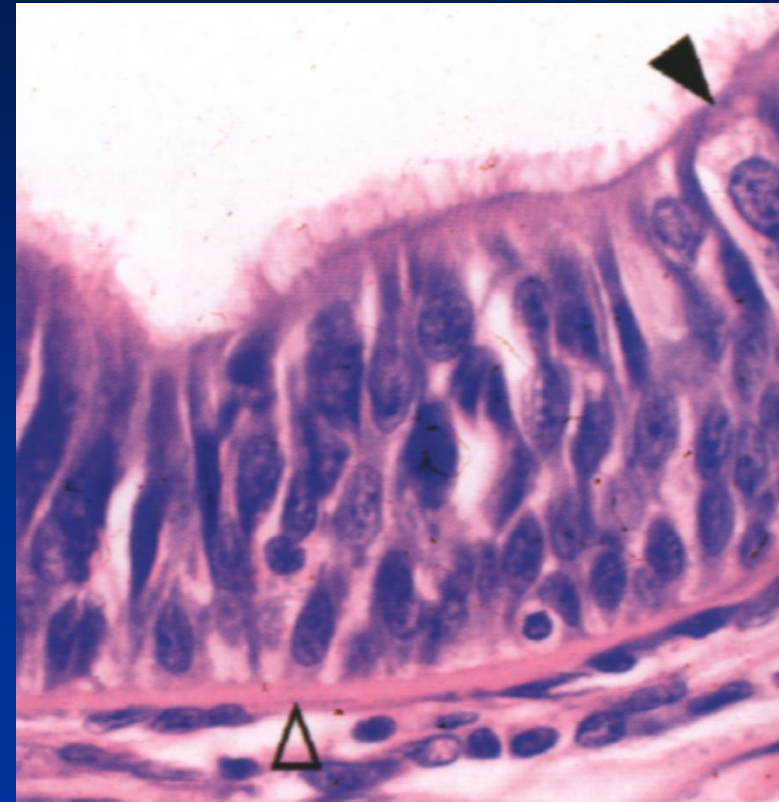
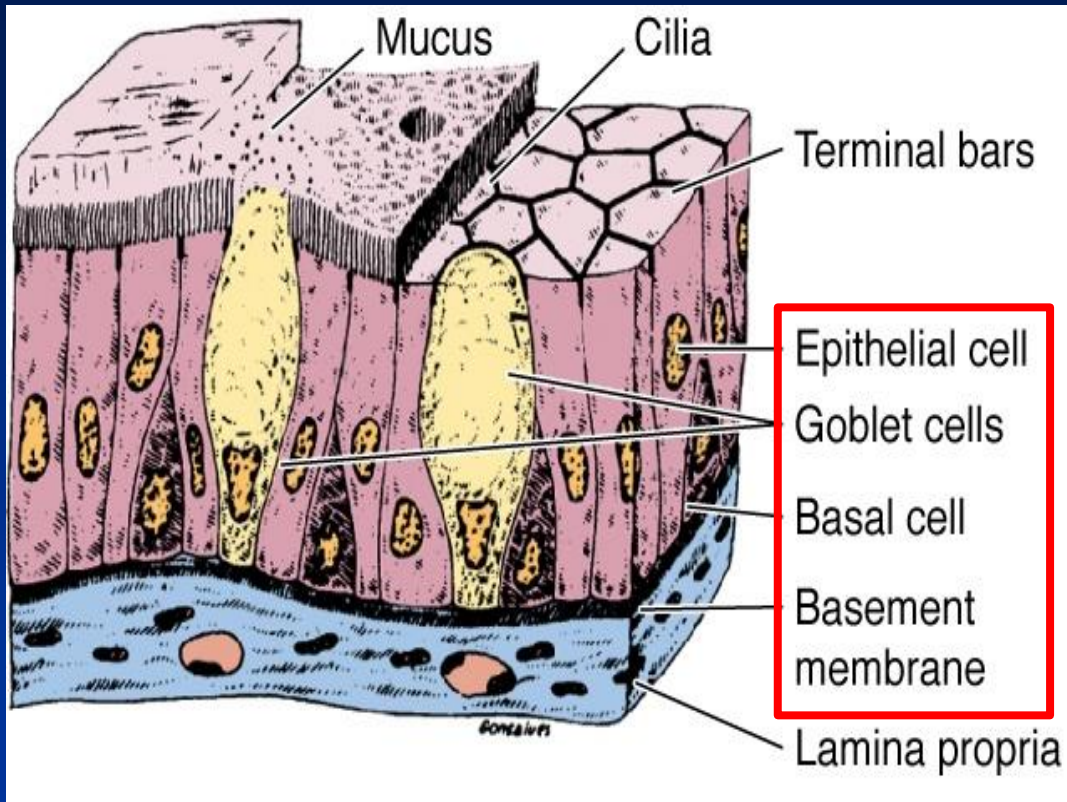
Simple Cuboidal Epithelium (※)



Simple Columnar Epithelium

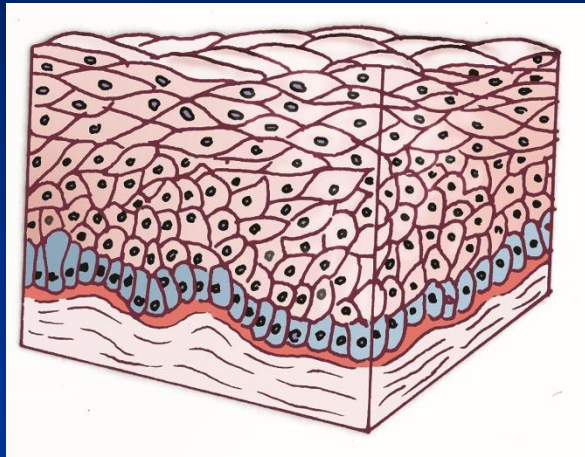


- **Single** layer of **tall pillar** shaped cells
- **Nuclei elongated**



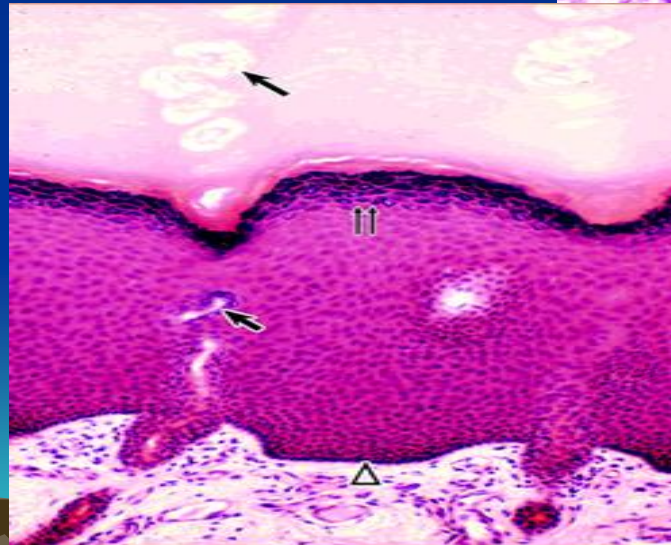
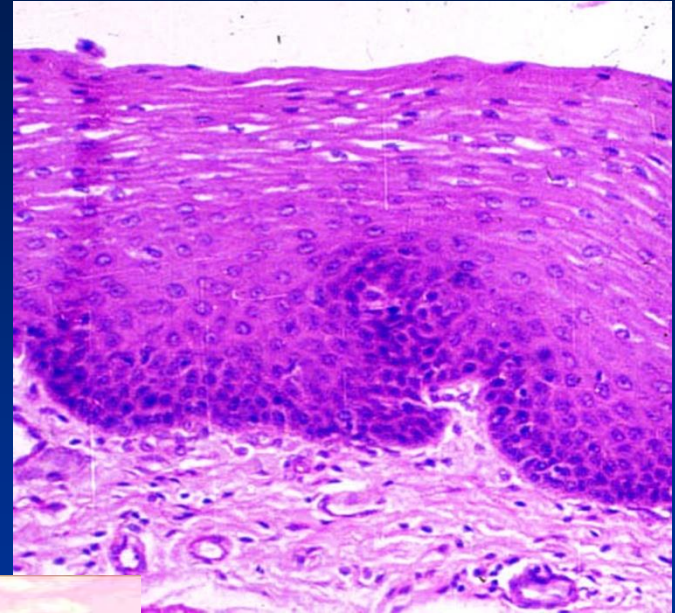
- Tall columnar cells **interspersed** with short basal cells
- **All** cells rest on basement membrane
- **Only** columnar cells & goblet cells **reach the surface**
- **Nuclei spread** over a broad band

Stratified squamous epithelium



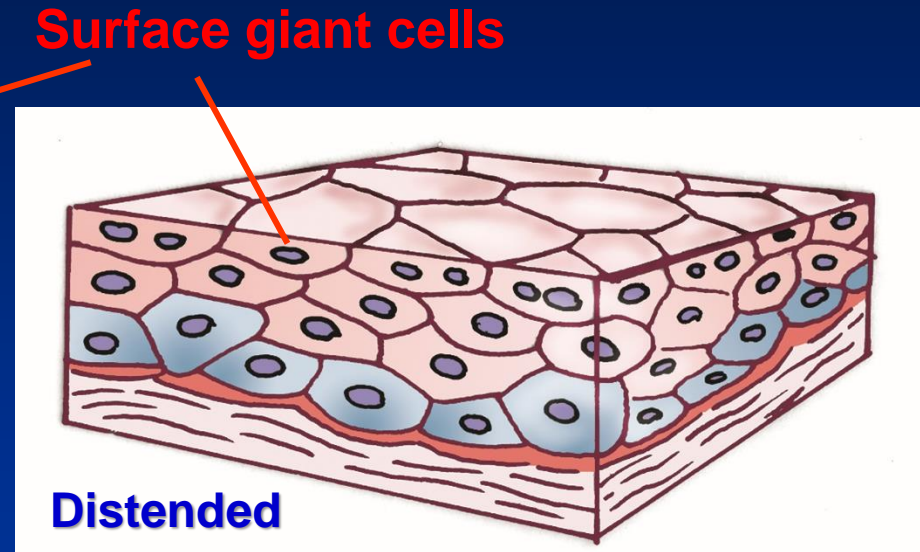
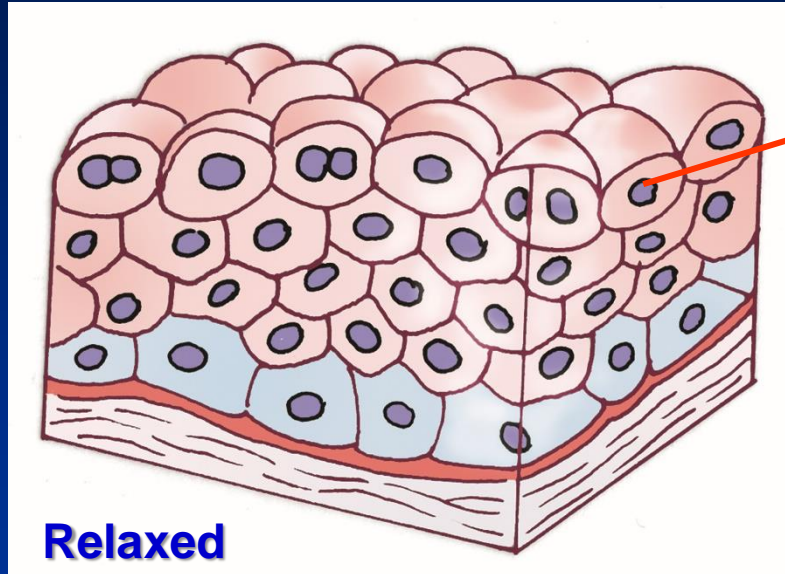
- **Multiple** layers
- **Surface cells squamous** in shape
- **Moist or dry** surface

- **Nonkeratinized**
- **Moist surface**
Esophagus
Vagina



- **Keratinized**
- **Dry surface**
Skin

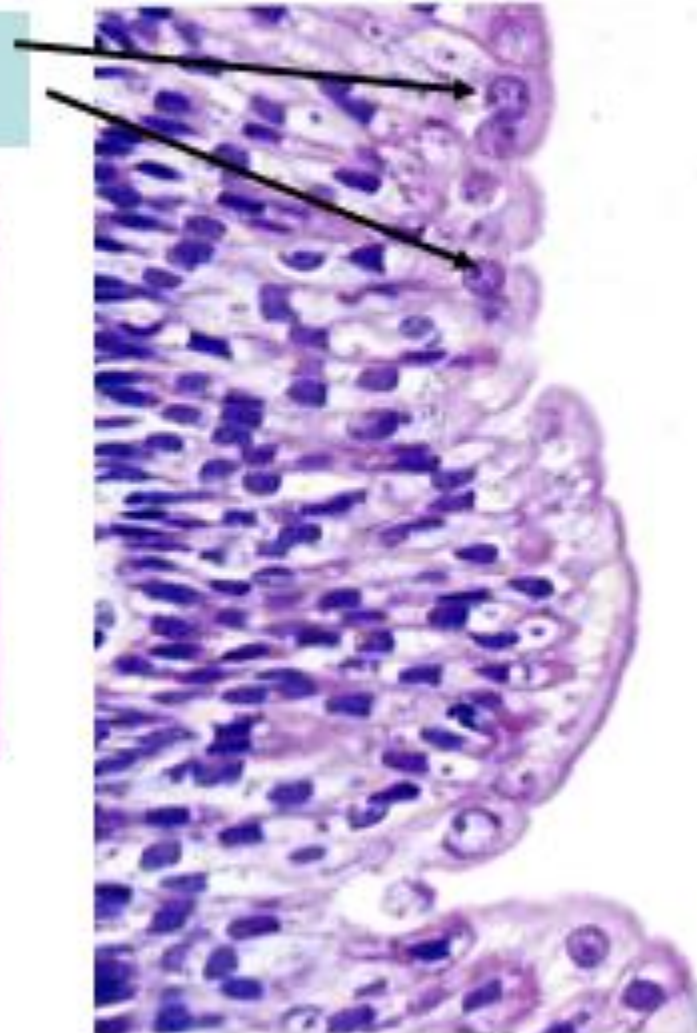
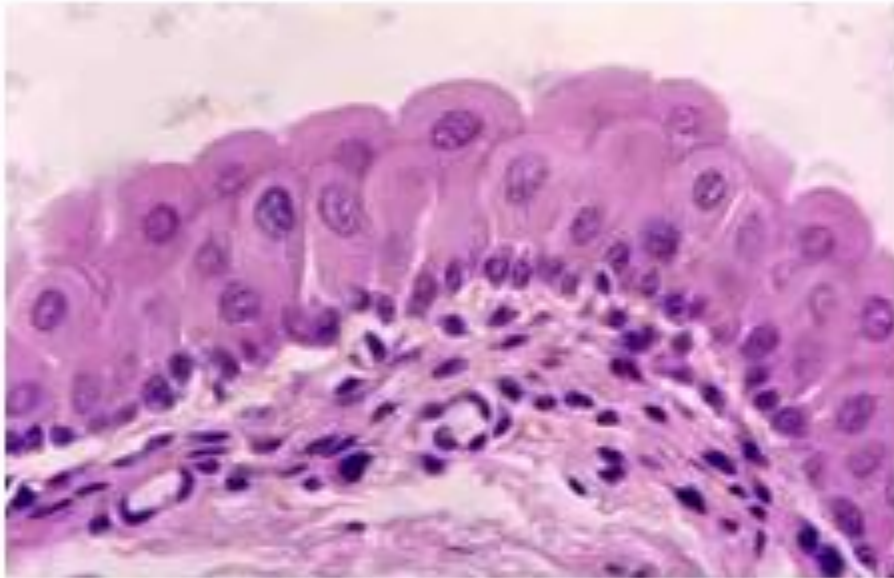
Transitional Epithelium



- **Multiple** layer
- **Variable** in thickness
- **Superficial giant cells** (facet or umbrella cells) often with **two nuclei**; **specialized** to withstand high tonicity of urine

Transitional epithelium

Large superficial (facet or umbrella) cells with two nuclei

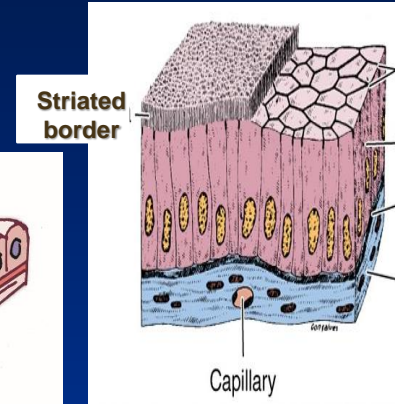
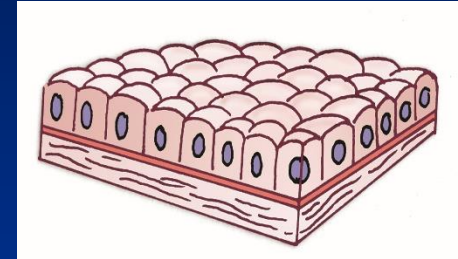
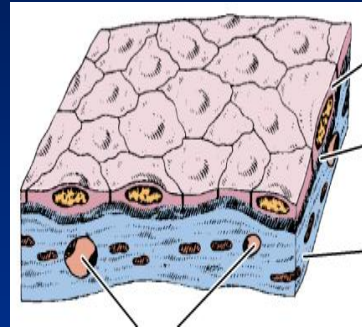


SUMMARY 1

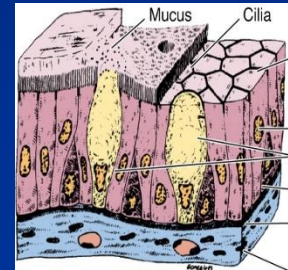
• Covering or Lining Epithelia

– Simple

- Squamous
- Cuboidal
- Columnar

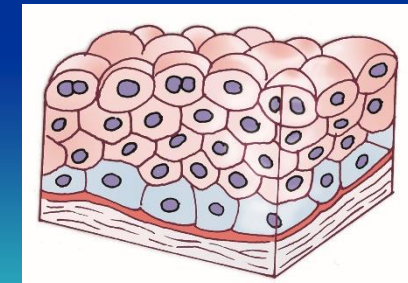
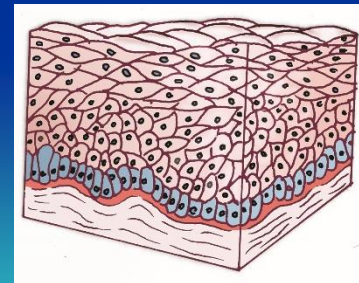


– Pseudo-stratified



– Stratified

- Squamous
 - Keratinized (dry)
 - Nonkeratinized (moist)
- Transitional





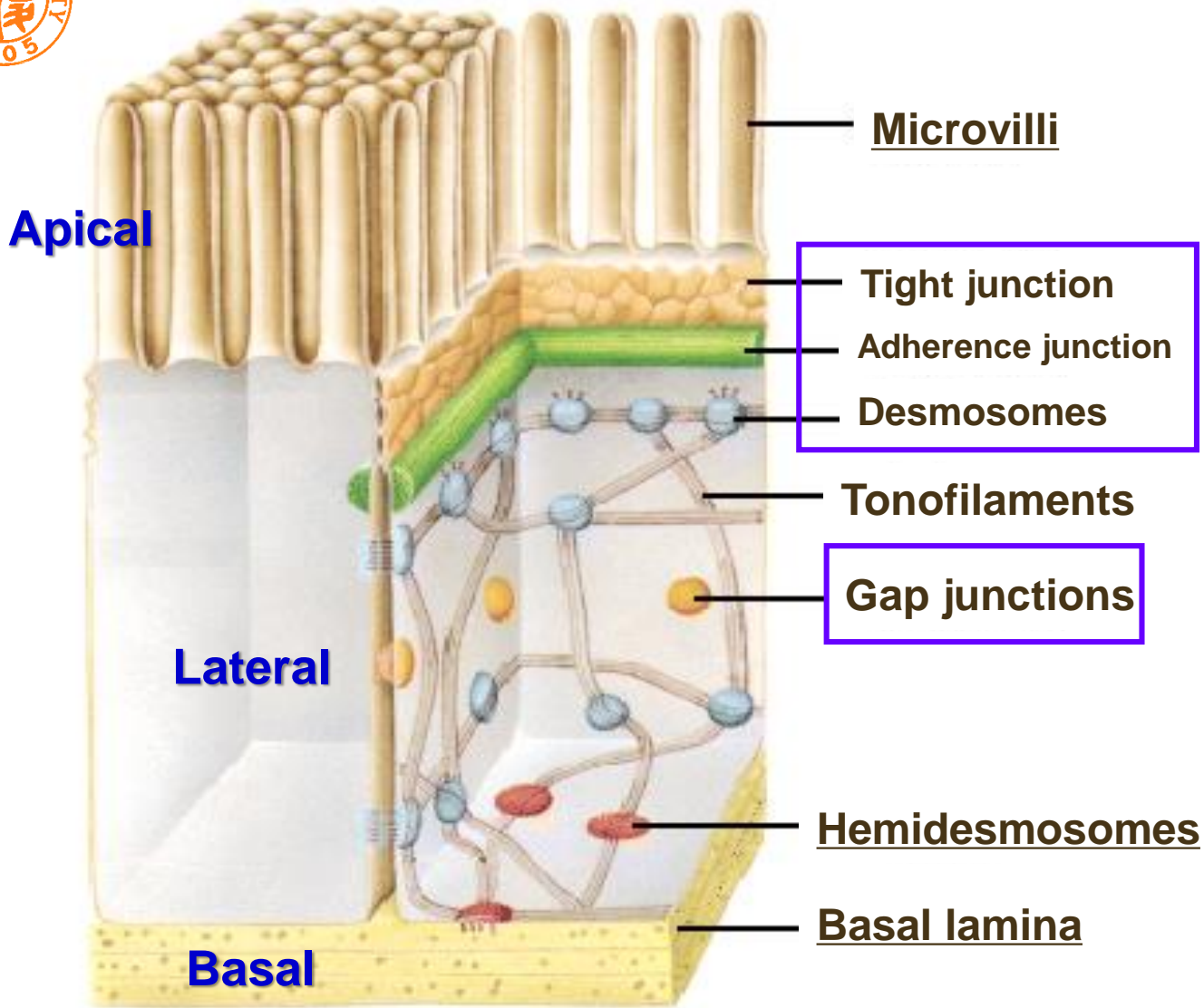
Specializations of Epithelia

- **Polarization**
- **Cell membrane**
 - **Apical membrane**
 - **Microvilli**/stereocilia
 - **Cilia**/flagellum
 - **Basal membrane**
 - **Basal infoldings**
 - **Hemidesmosomes/anchoring junction**
 - **Basement membrane/basal lamina**
- **Lateral membrane**
 - **Lateral interdigitations**
 - **Seal between adjacent cells**
 - **Tight/Occluding junction**
 - **Cell adhesion/anchoring junction**
 - **Adherence junction**
 - **Desmosomes**
 - **Cell communication**
 - **Gap junctions**



Polarization

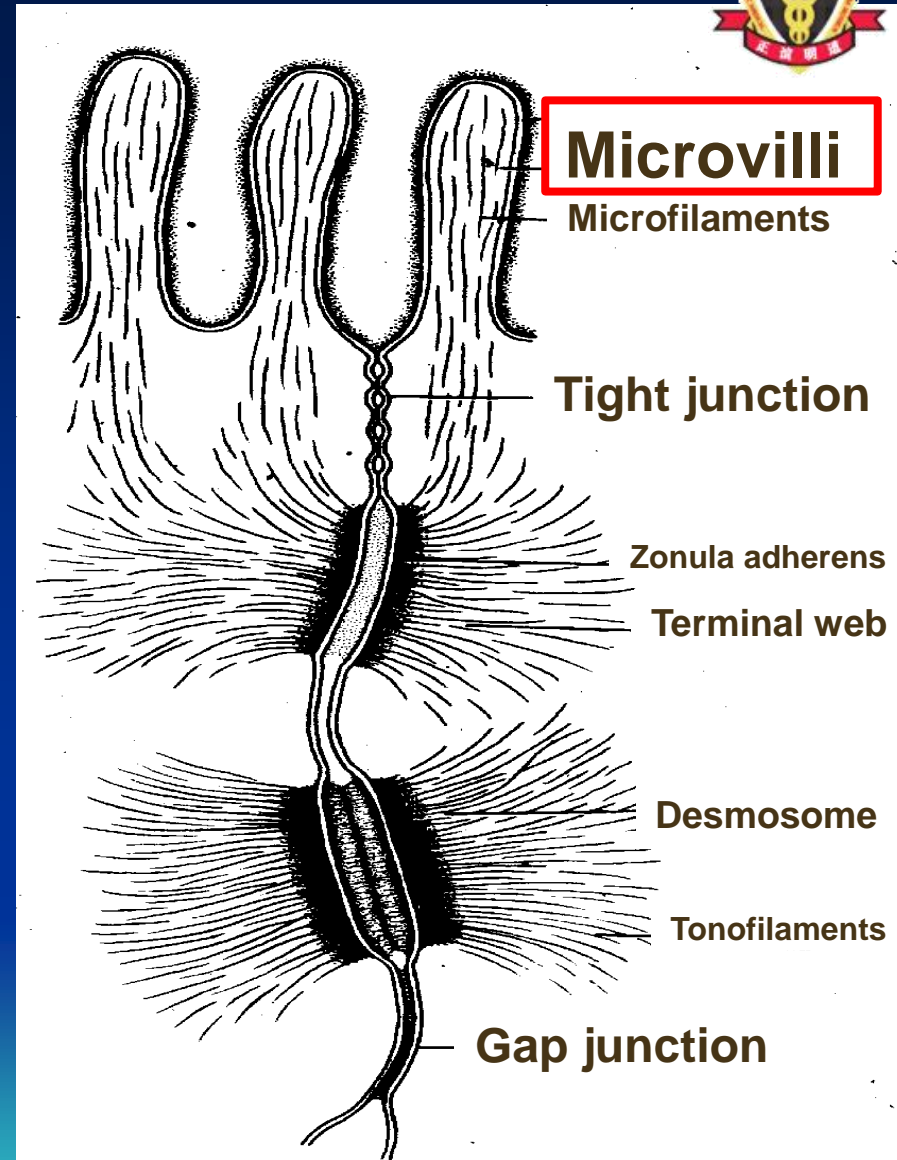
- **Cells morphologically and functionally polarized**
- A **free** surface, for **absorption and secretion**
- A **basal** surface, for **adhesion** to tissue beneath and **transport**
- **Cell organelles arranged** according to these different functions



Specializations of epithelial cells

Free Surfaces

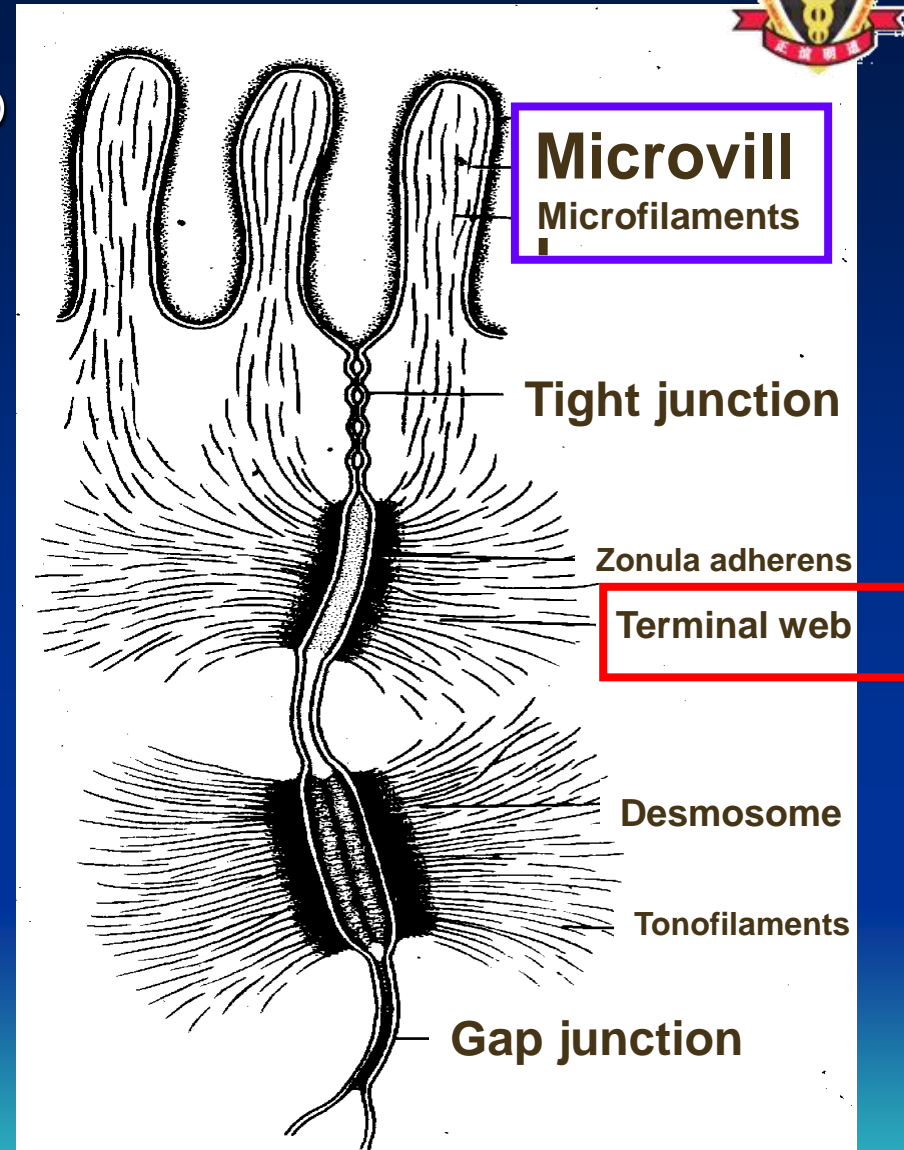
- Microvilli
- Cilia



Microvillus

(LM: Striated border、Brush border)

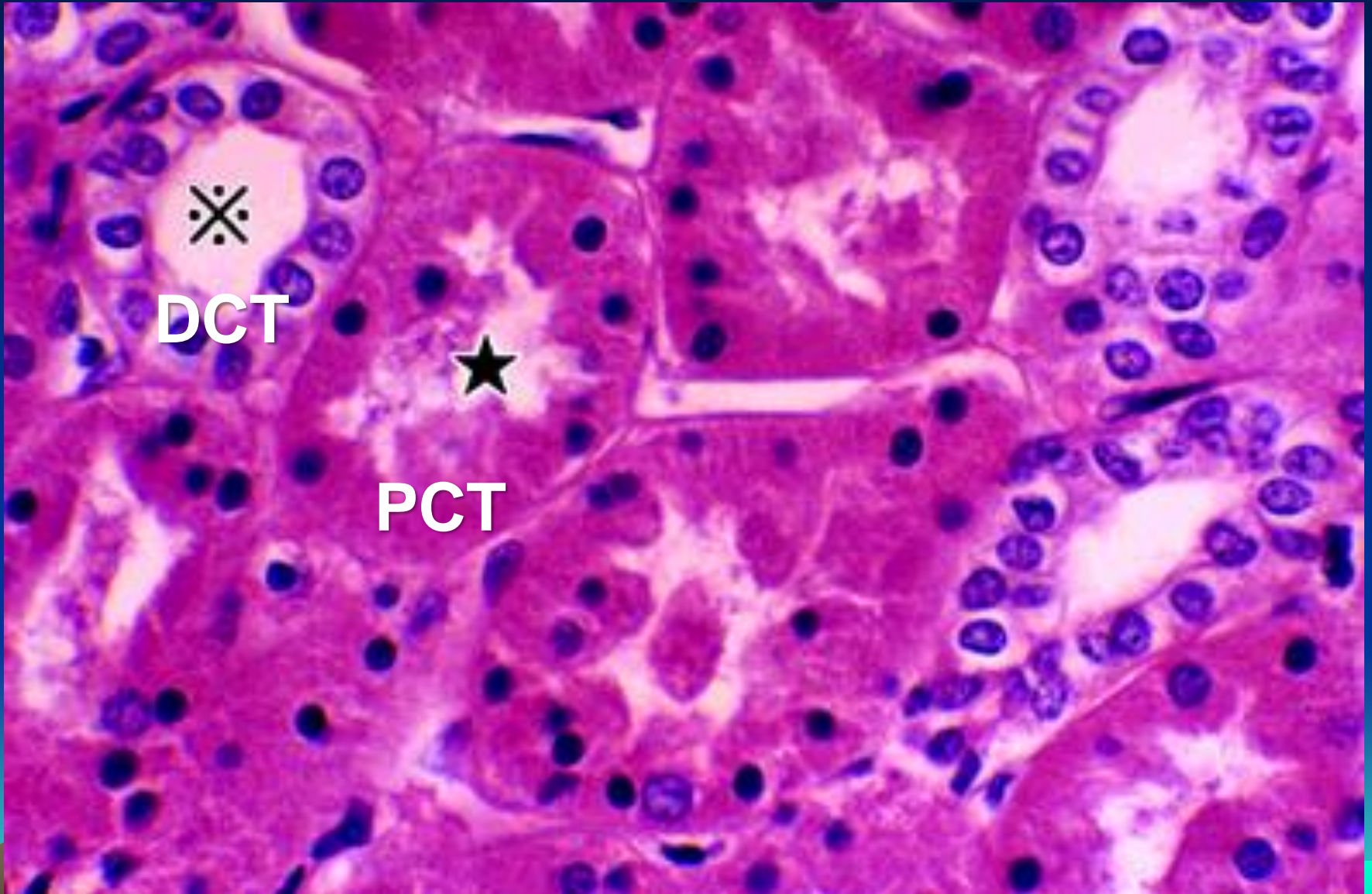
- **Fingerlike cytoplasmic projections**
 - **Increase surface area** of absorption
- **Microfilamentous core** attached to terminal web
 - **“Movement”** of microvilli to increase **efficiency**
- **Extremely long** microvilli in some cells are known as **stereocilia, i.e., epididymal duct.**



Microvillus - Striated border (▽)

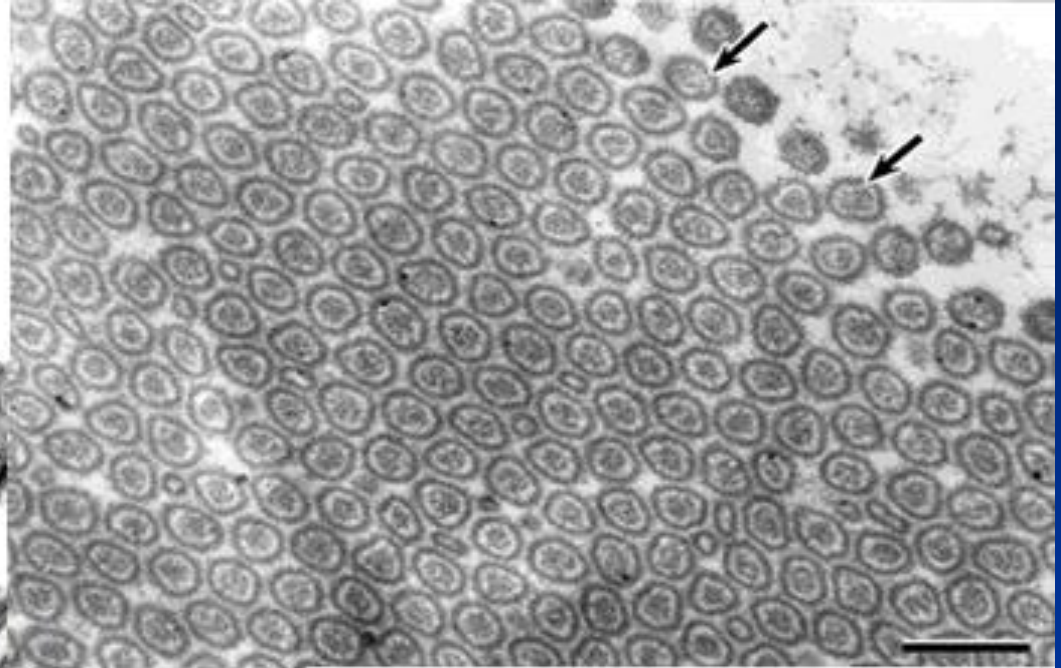
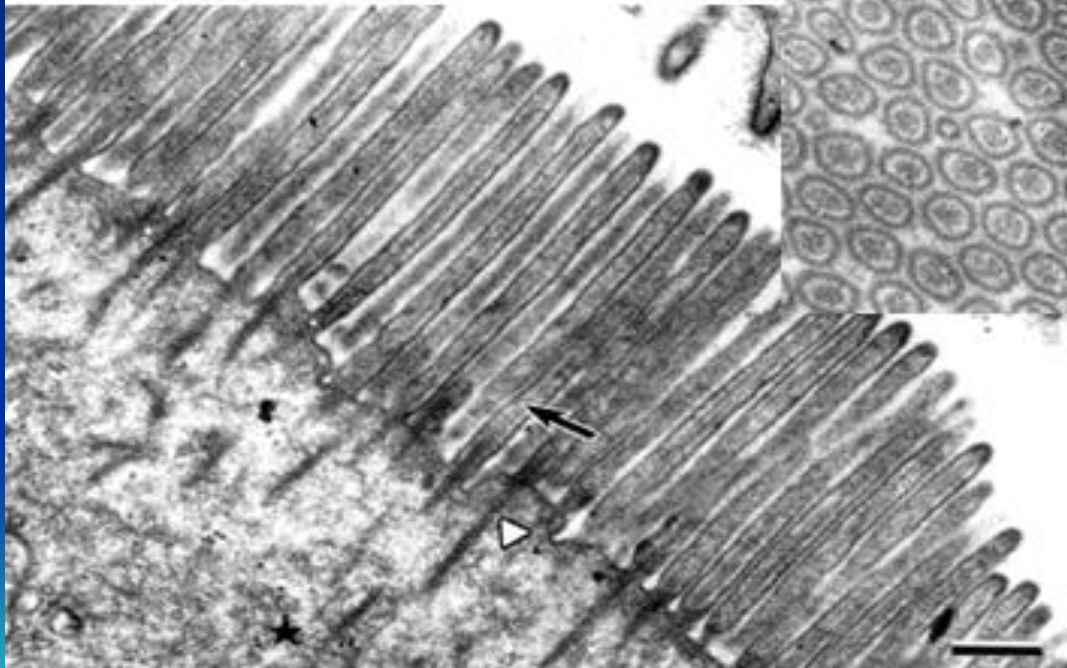


Microvillus - Brush border (★)



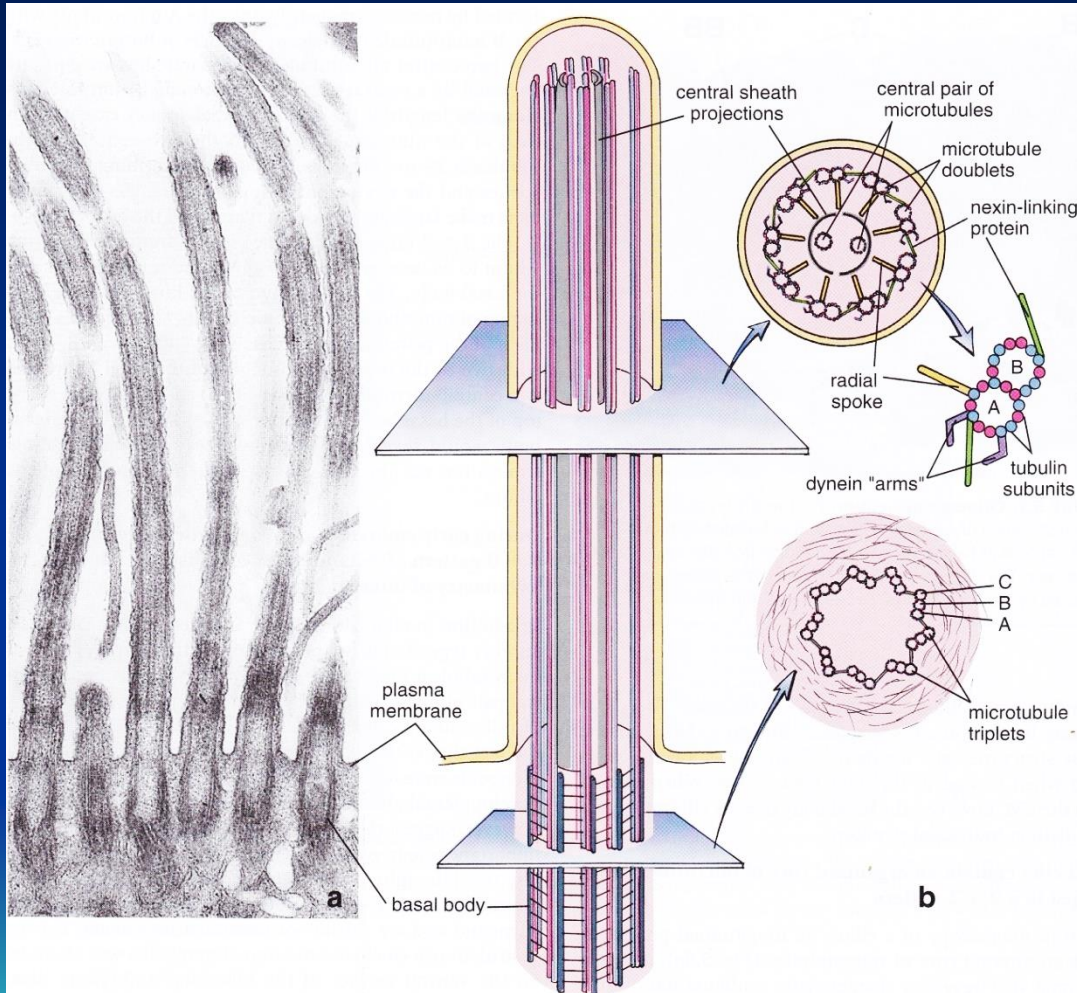
Microvillus

Longitudinal section

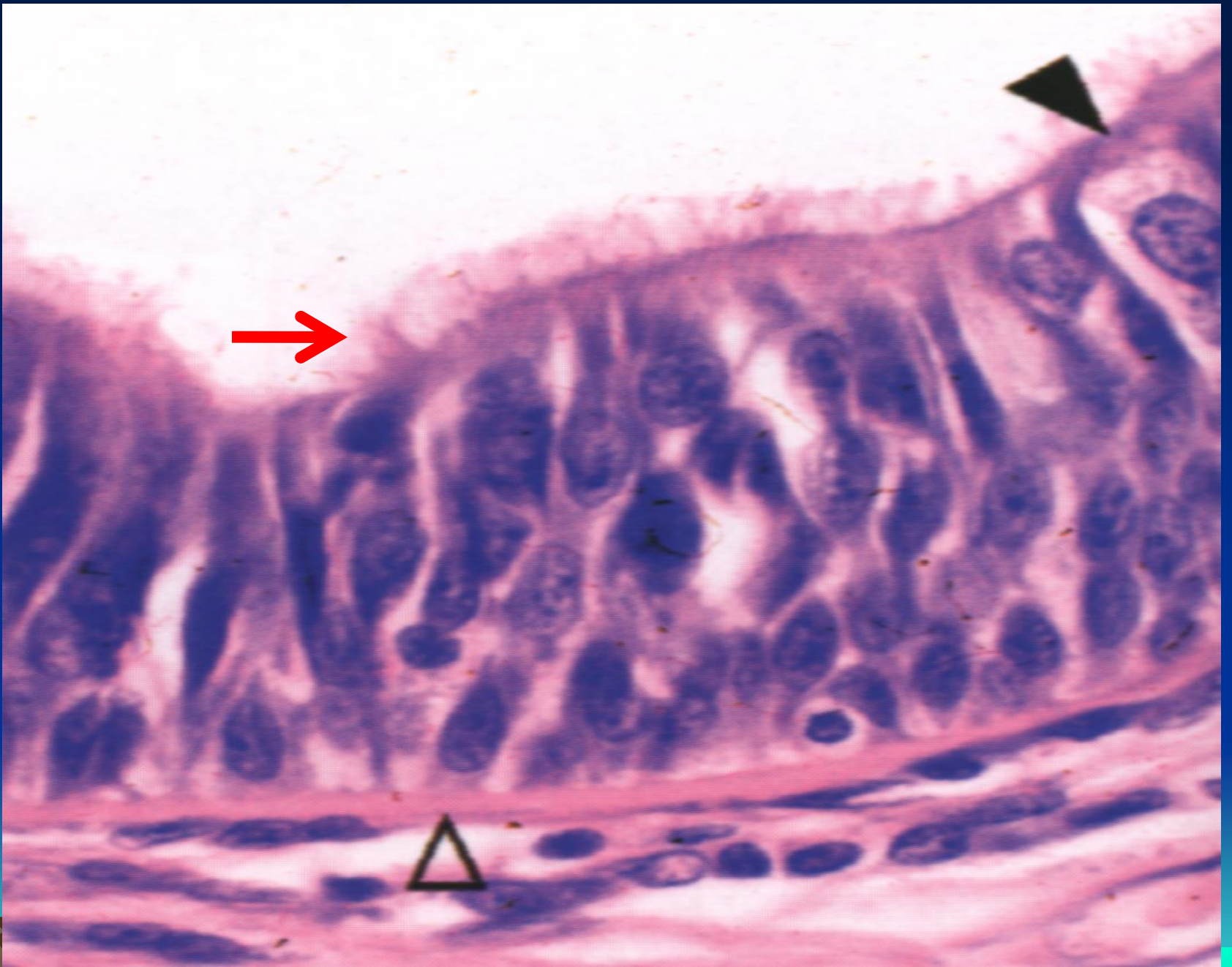


Cross section

Cilia/Flagellum



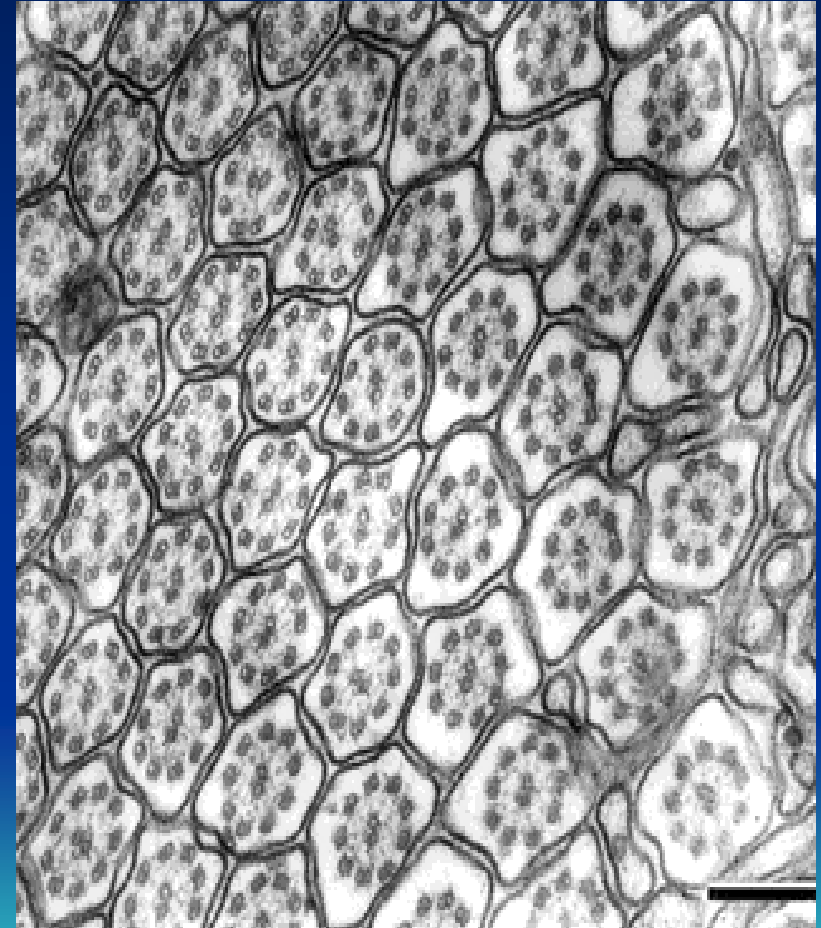
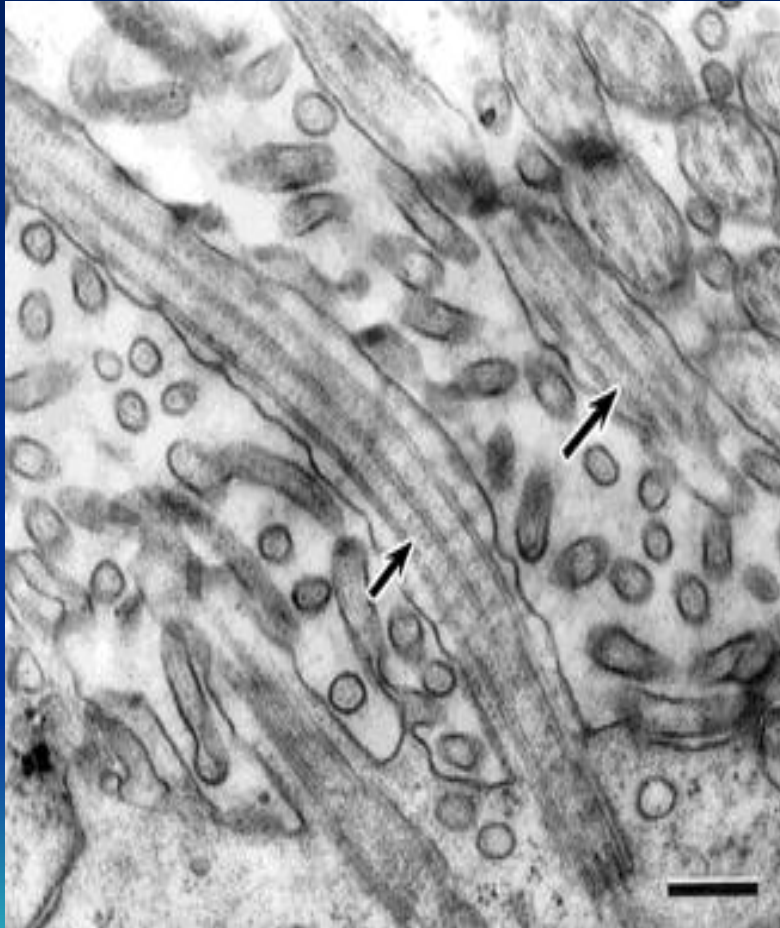
- **Much long, highly motile cytoplasmic projections**
- **Axoneme core elongated**
 - **One central pair of microtubules**
 - **9 peripheral microtubular pairs**
- **Rapid back-and-forth movements.**



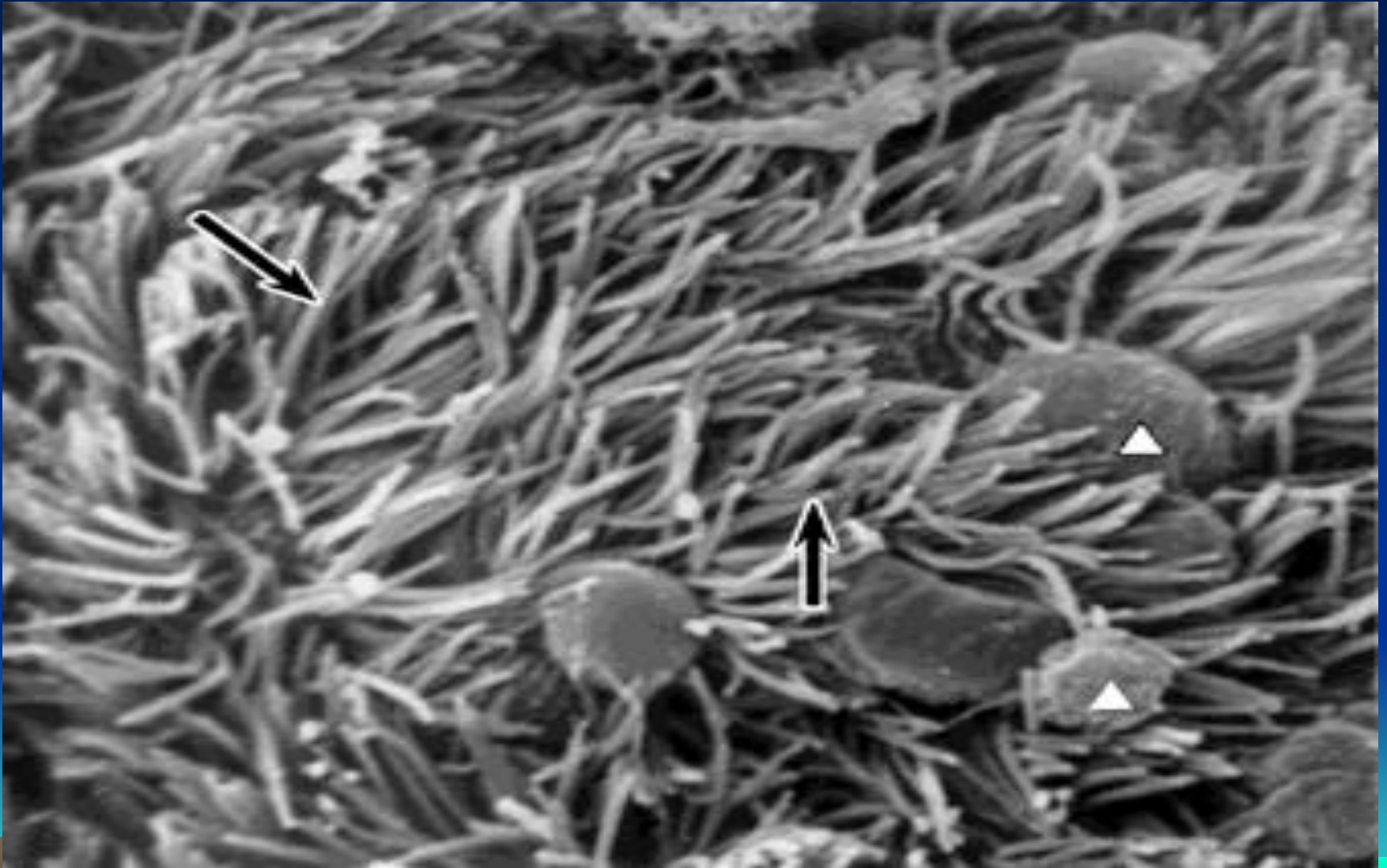
Cilia/Flagellum

Longitudinal section

Cross section



Cilia/Flagellum (↑)





Lateral membrane



- Intercellular adhesions

- **Types:**

- Seals:

- **Tight/Occluding** junctions

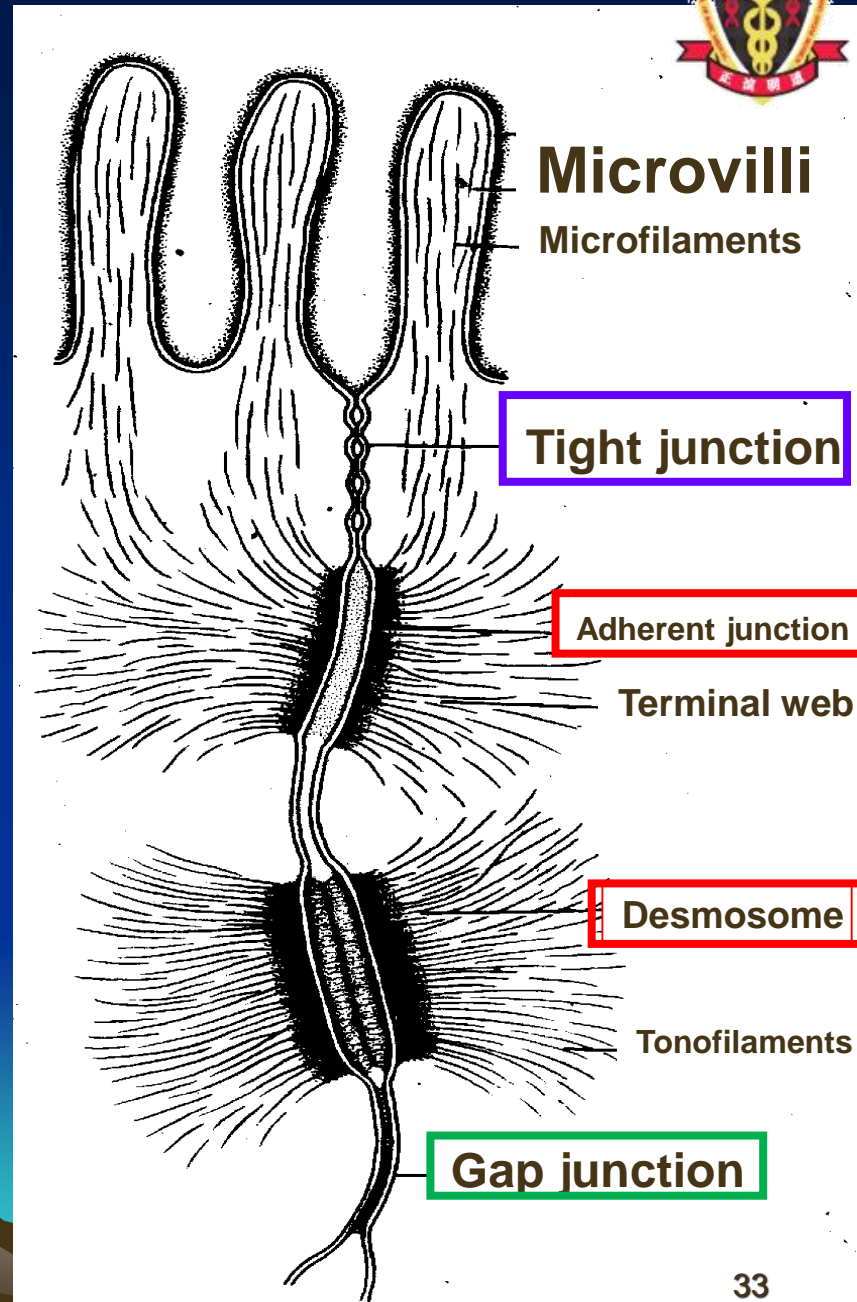
- Adhesion:

- **Adherent/Anchoring** junctions
- **Desmosomes/Anchoring** junctions

- Communication:

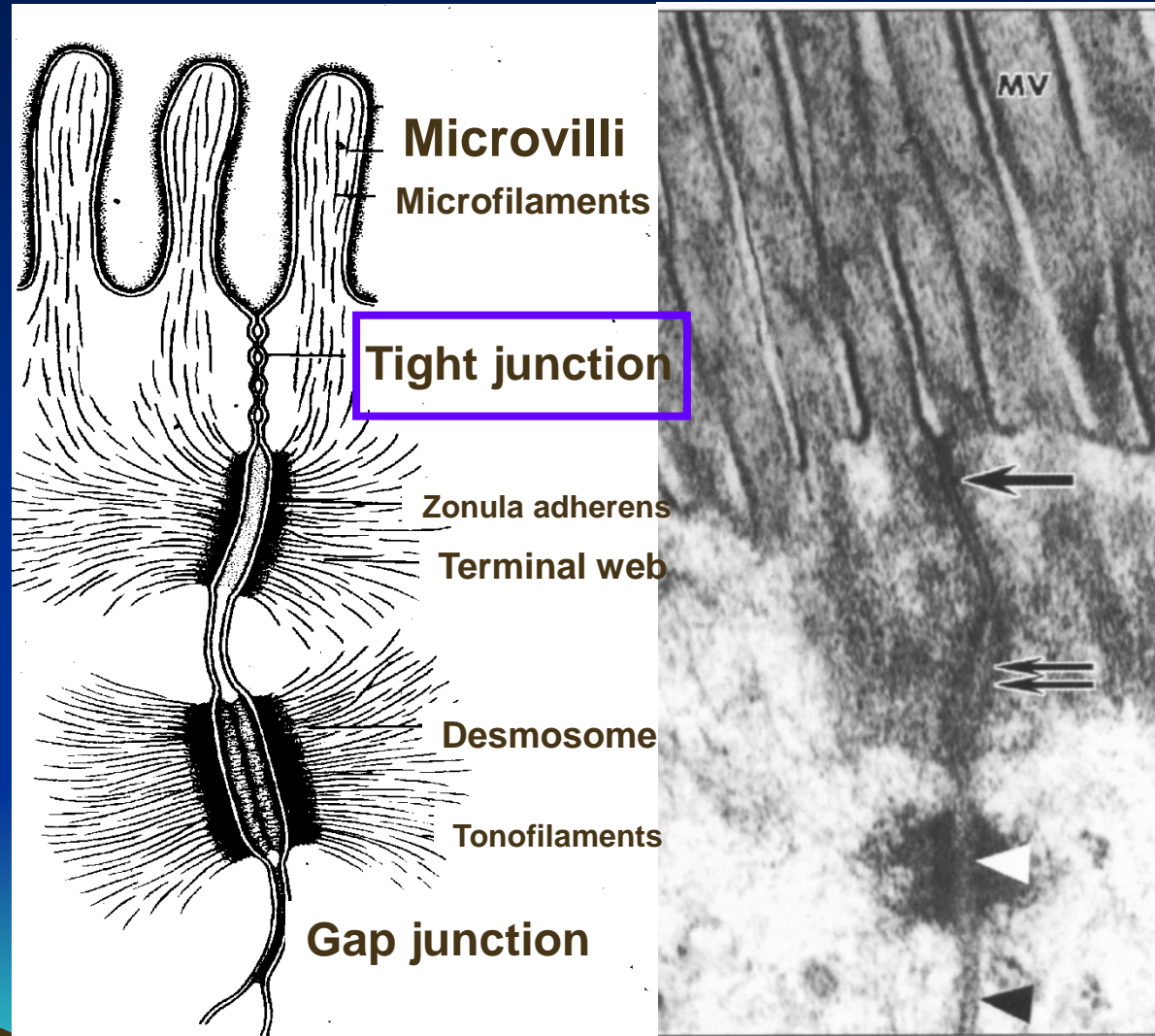
- **Gap** junctions

Junctional Complex: if more than two

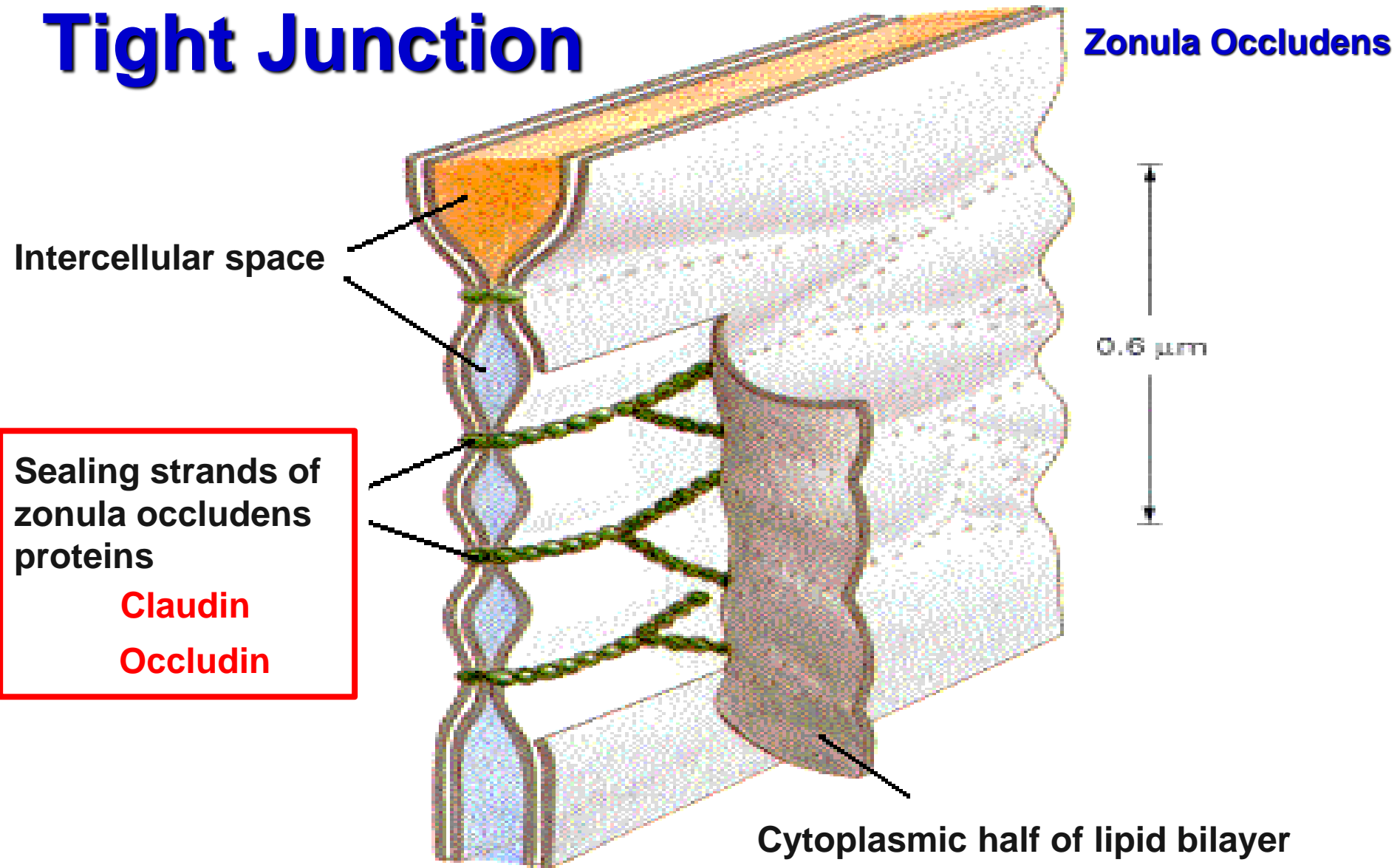


Tight Junction/Zonula Occludens (←)

- **The most apical sealing junction**
- **Zonula:** sealing bands completely
- **Occludens:** membrane fusion by trans-membrane proteins **claudin & occludin.**
- Seals to protect **the flow of materials** between cells.



Tight Junction

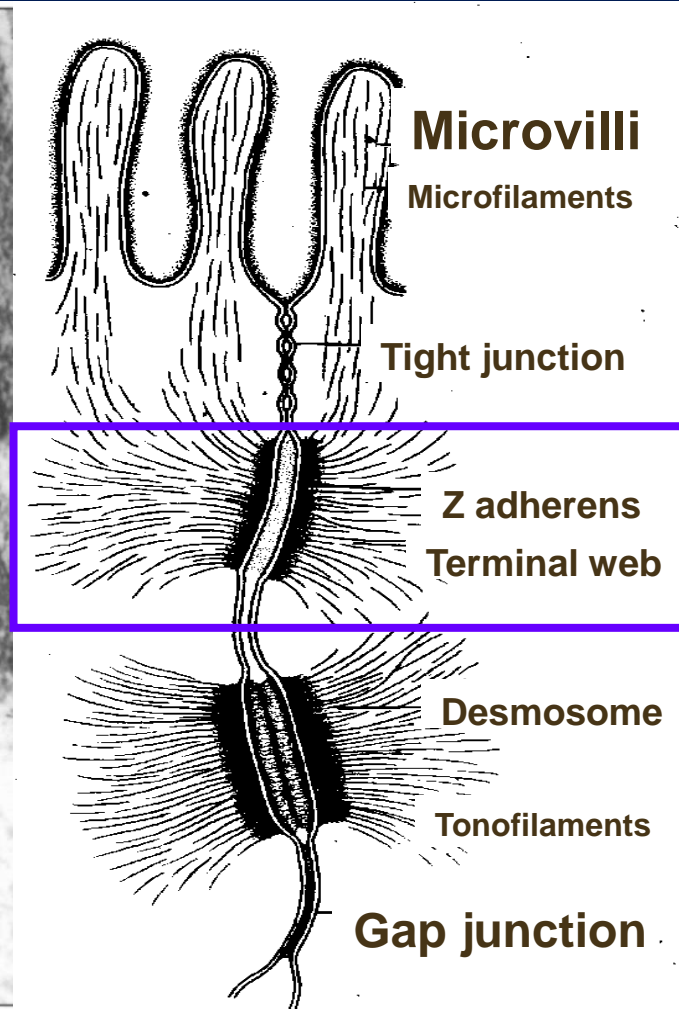
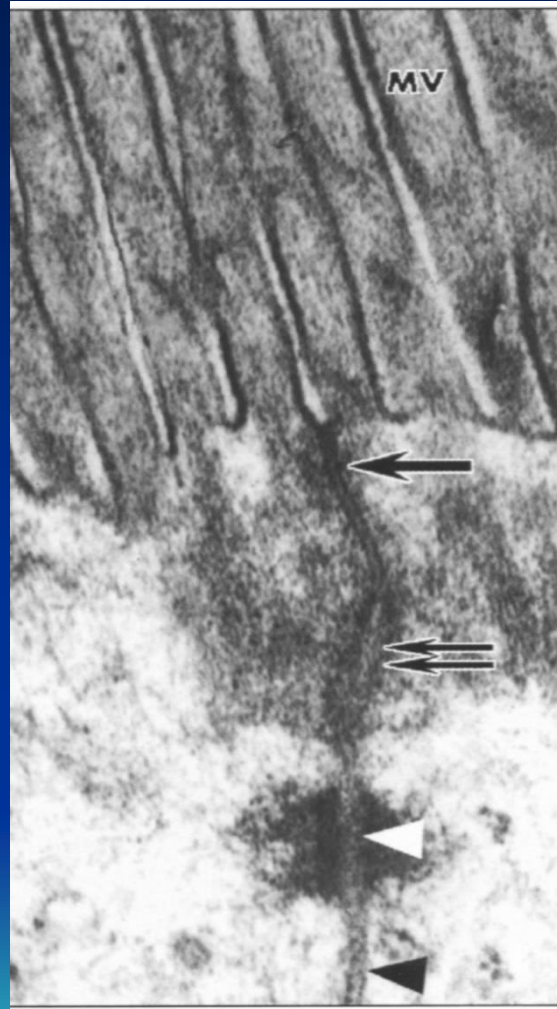


Tight Junction/Zonula Occludens (▽)



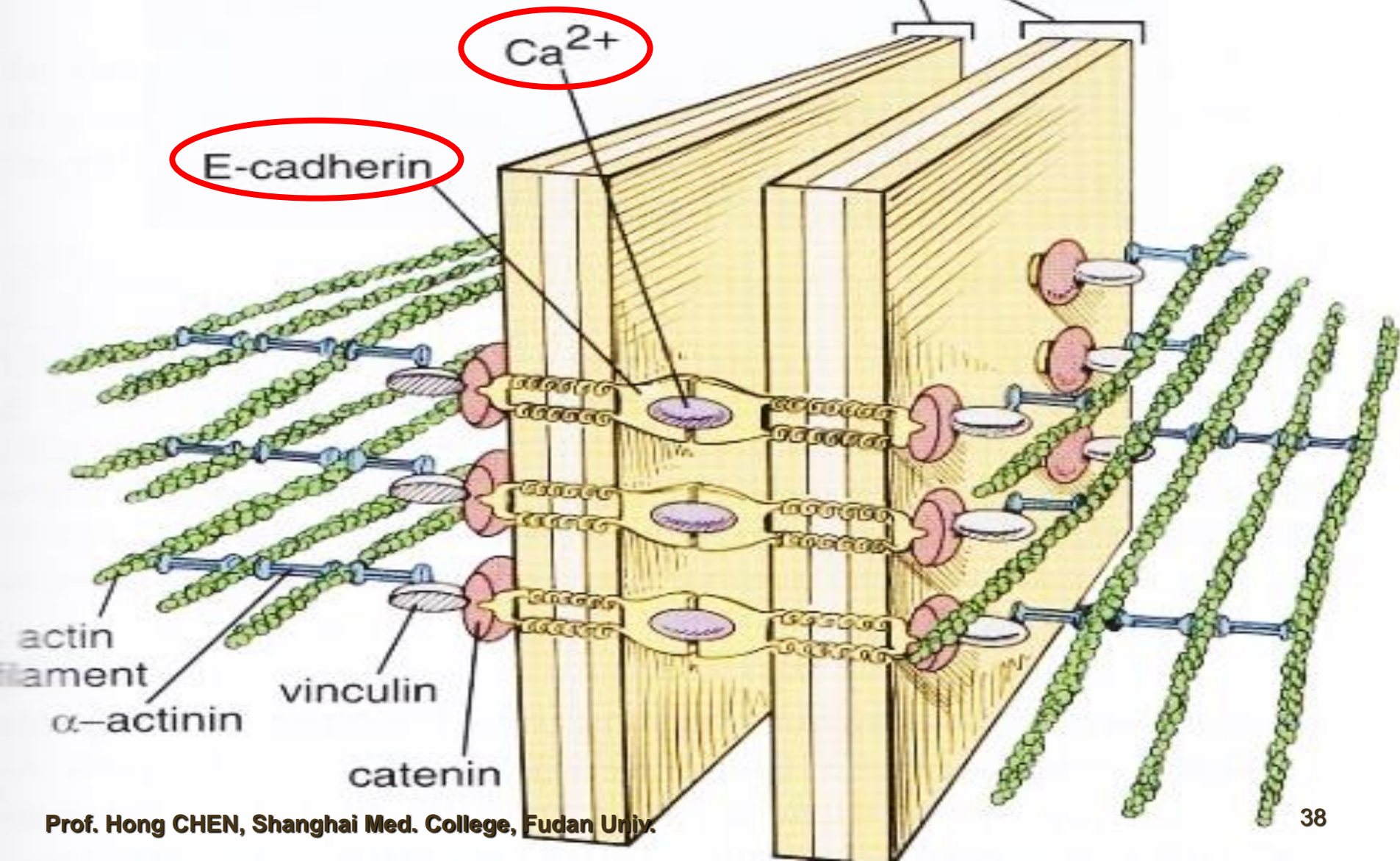
Freeze etching method

- **Just below** the zonula occludens
- **Encircling** the cells as **continuous band**
- **Terminal web:** more **actin filaments**
- **Firm** adhesion mediated by **cadherins & Ca²⁺**



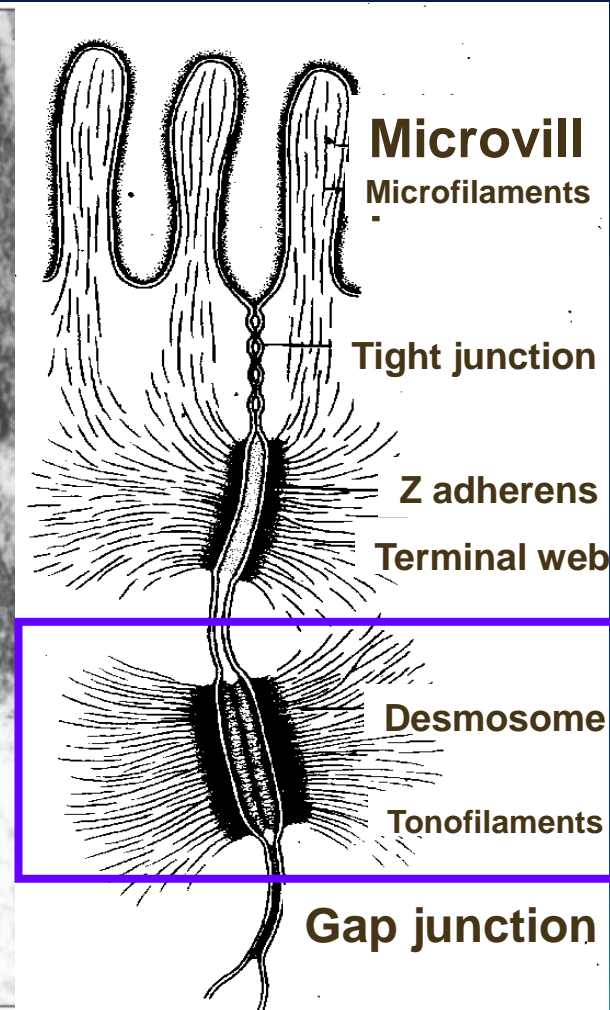
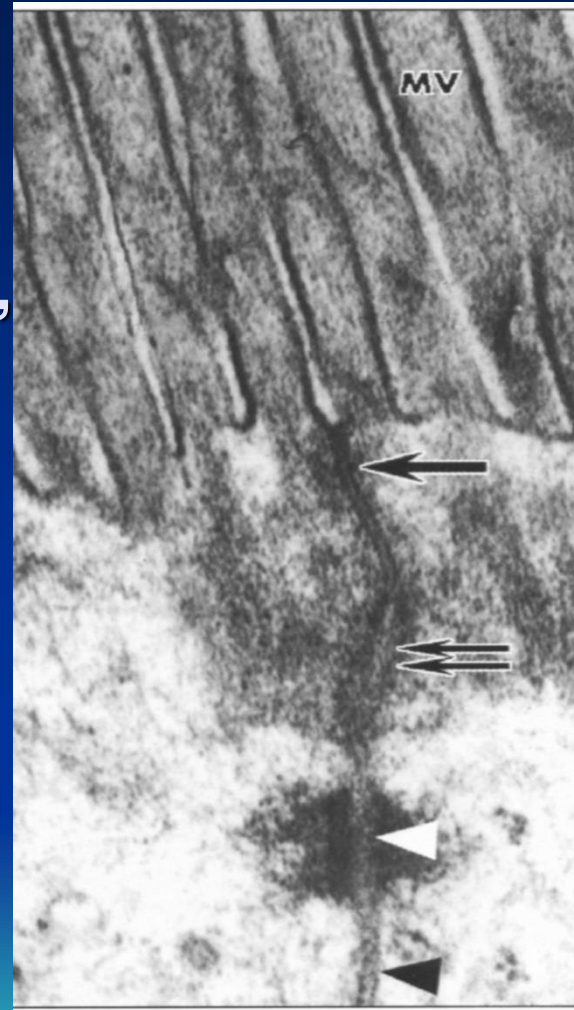
Adherent Junction / Anchoring Junctions

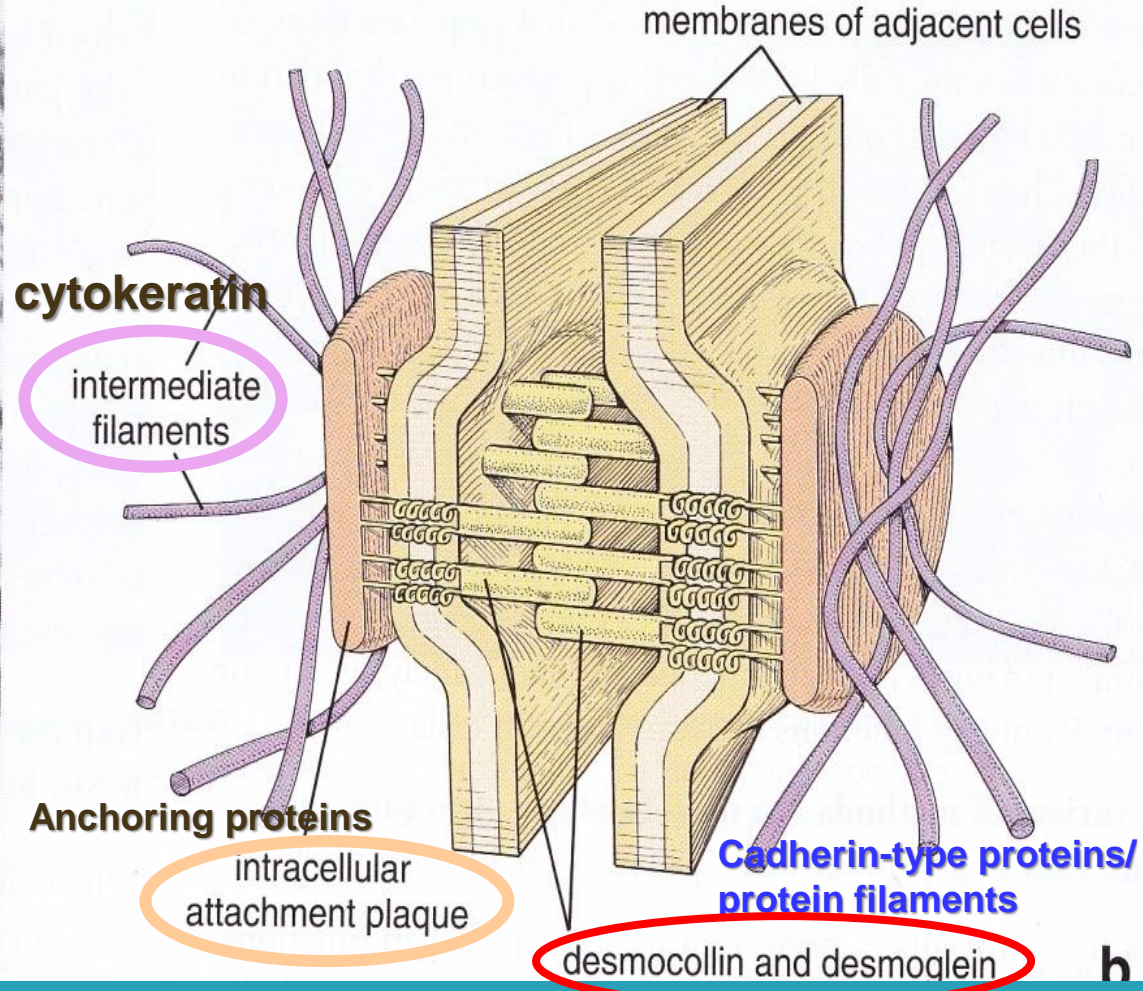
membranes of adjacent cells



Desmosome (Δ)/Anchoring Junctions

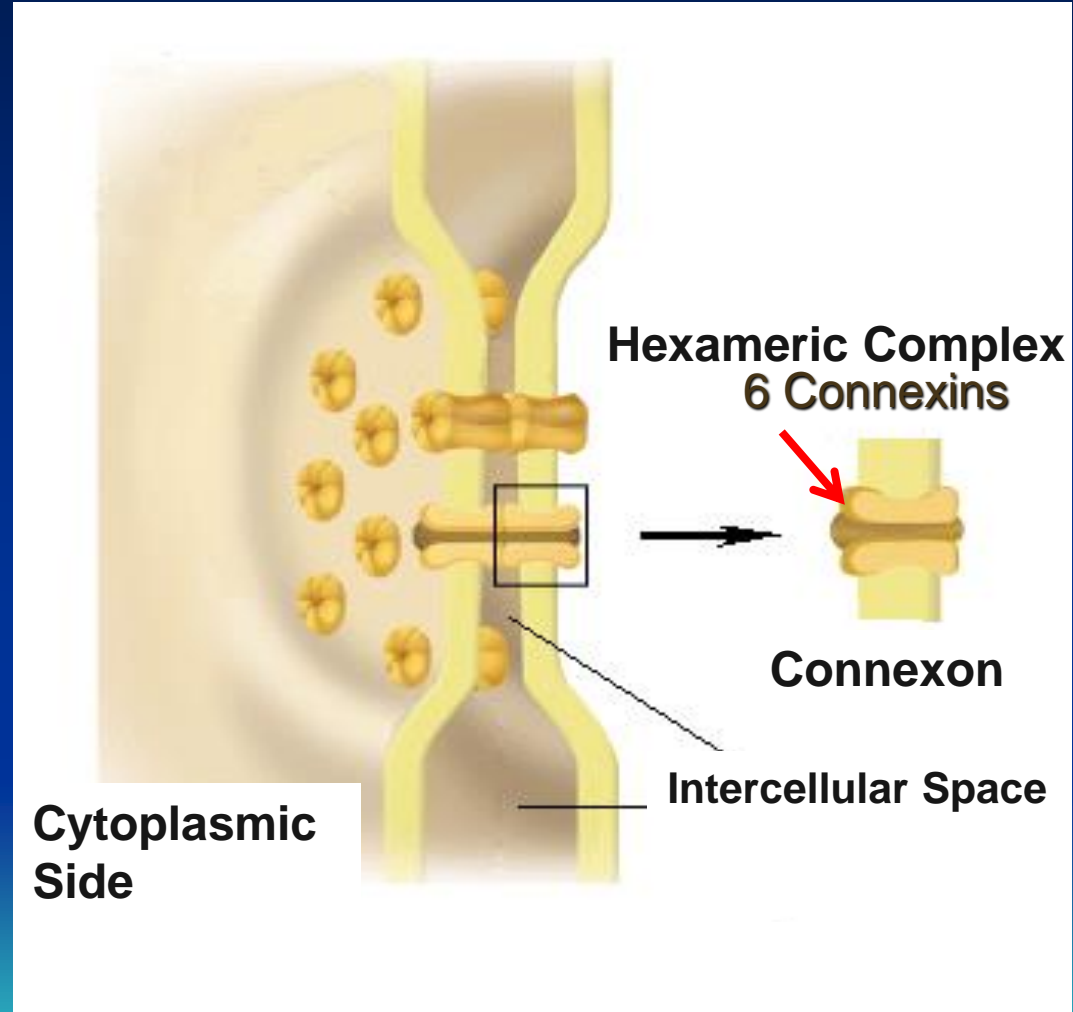
- **Specialized junction**
- A single **spot-weld**, no belt formed around the cell
- **Firm** adhesion mediated by **cadherin family proteins** (desmogleins, desmocolin)





Gap Junctions

- Present **almost everywhere**
- **Circular patches** formed by aggregated **trans-membrane protein complex (connexons)**
- Each connexon is made of **6 connexins**.
- **Communications**



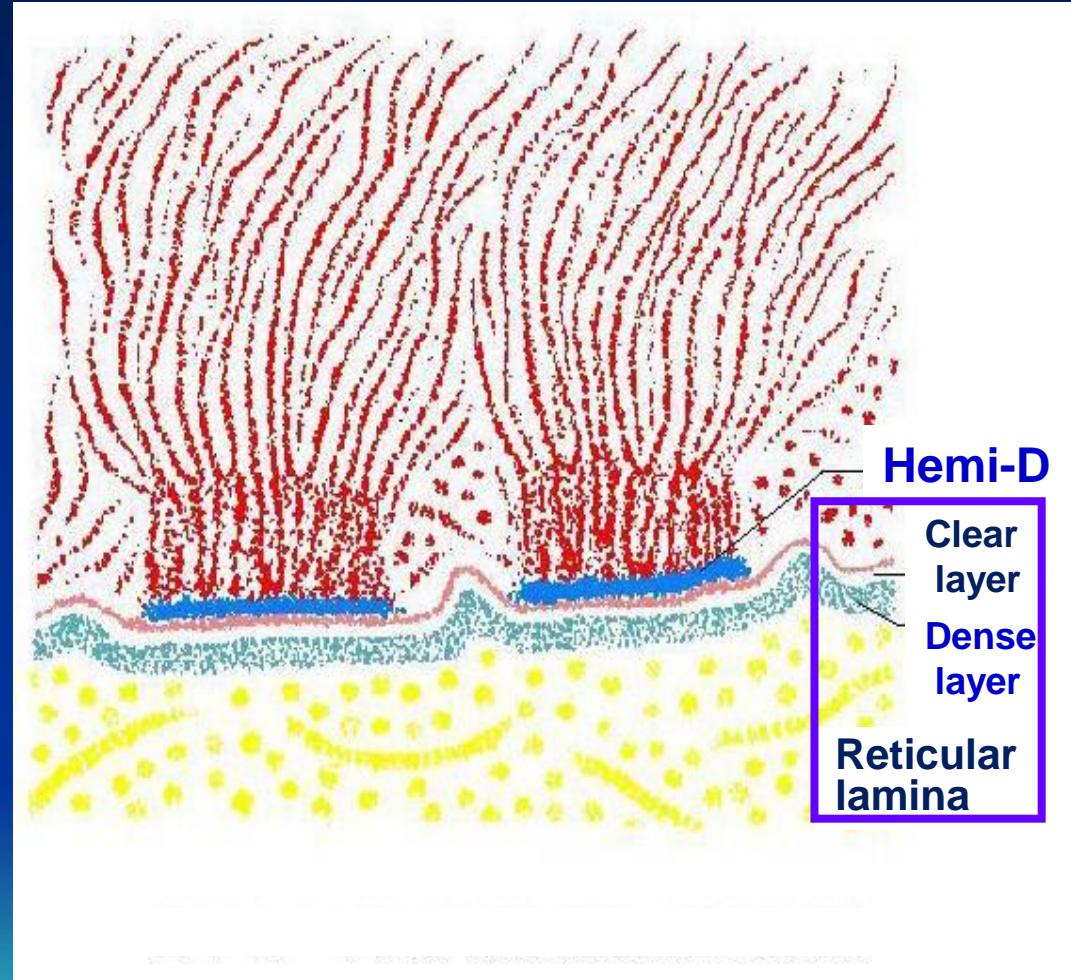


Basal Surfaces

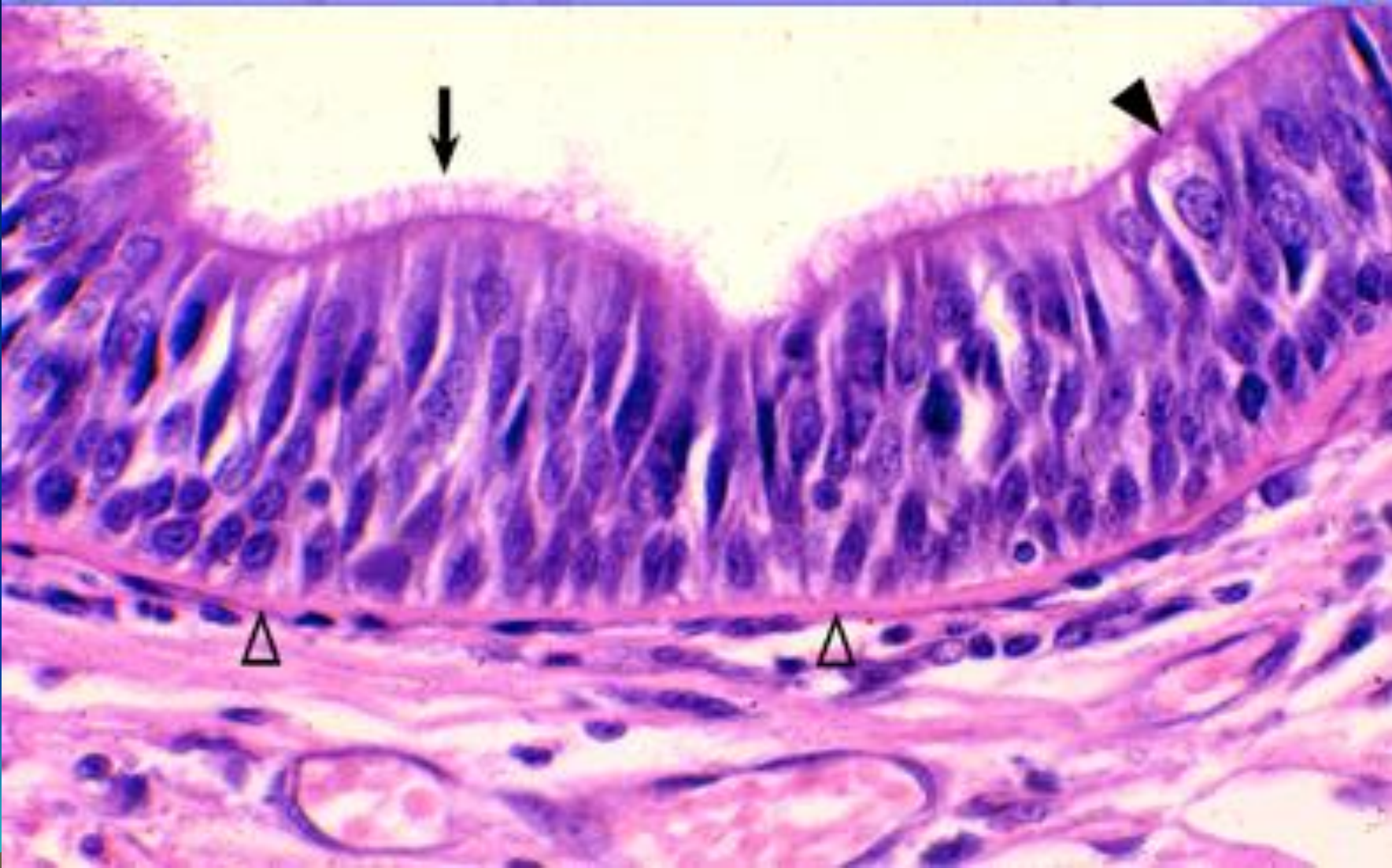
- **Basement Membrane**
- **Plasma Membrane Infolding**
- **Hemidesmosome**

Basement Membrane

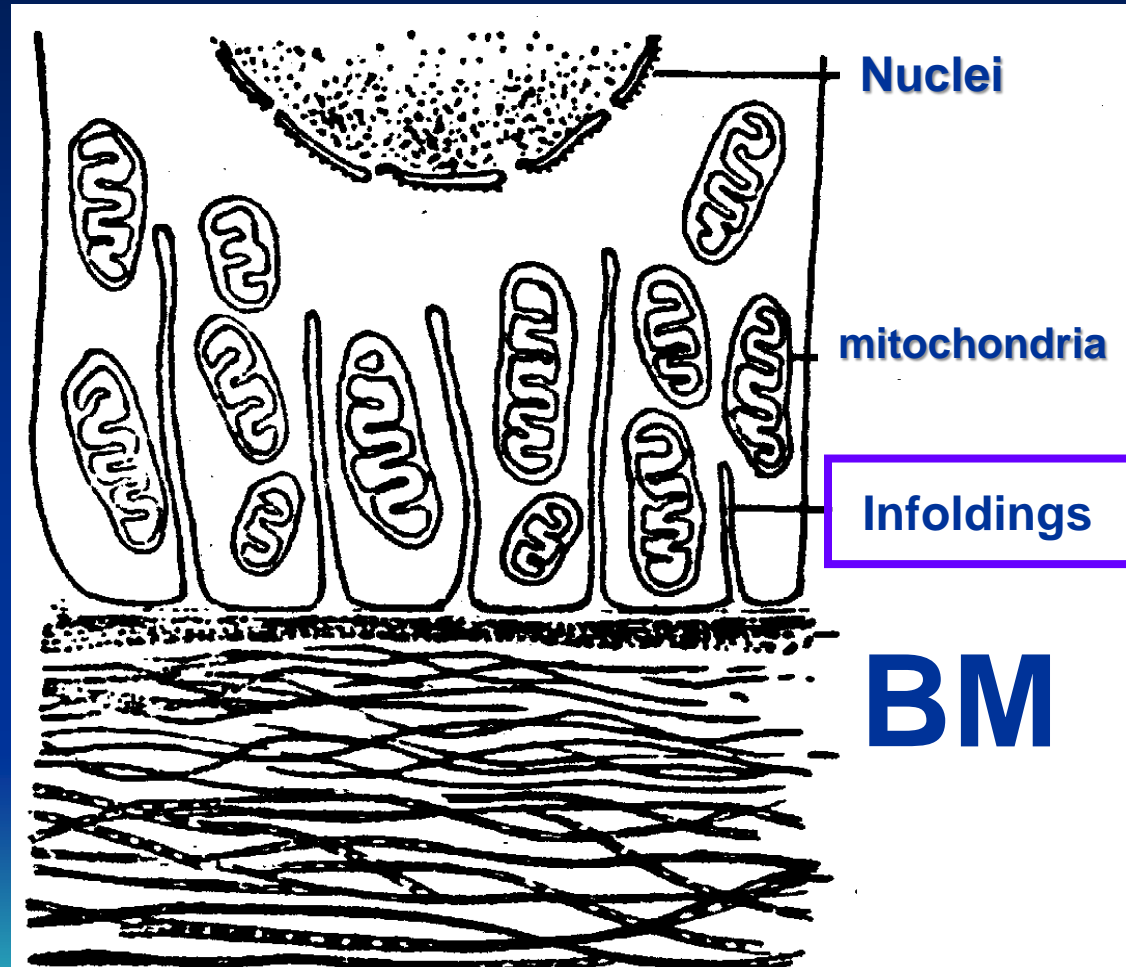
- Lies **at the interface** of epithelium and connective tissue
- EM:
 - **Clear layer**: lamina lucida
 - **Dense layer**: lamina densa, **fine fibrils**
 - **Reticular lamina**
- Collagen, glycoprotein
- Felt-like sheet, related to **movement & differentiation of epithelium**



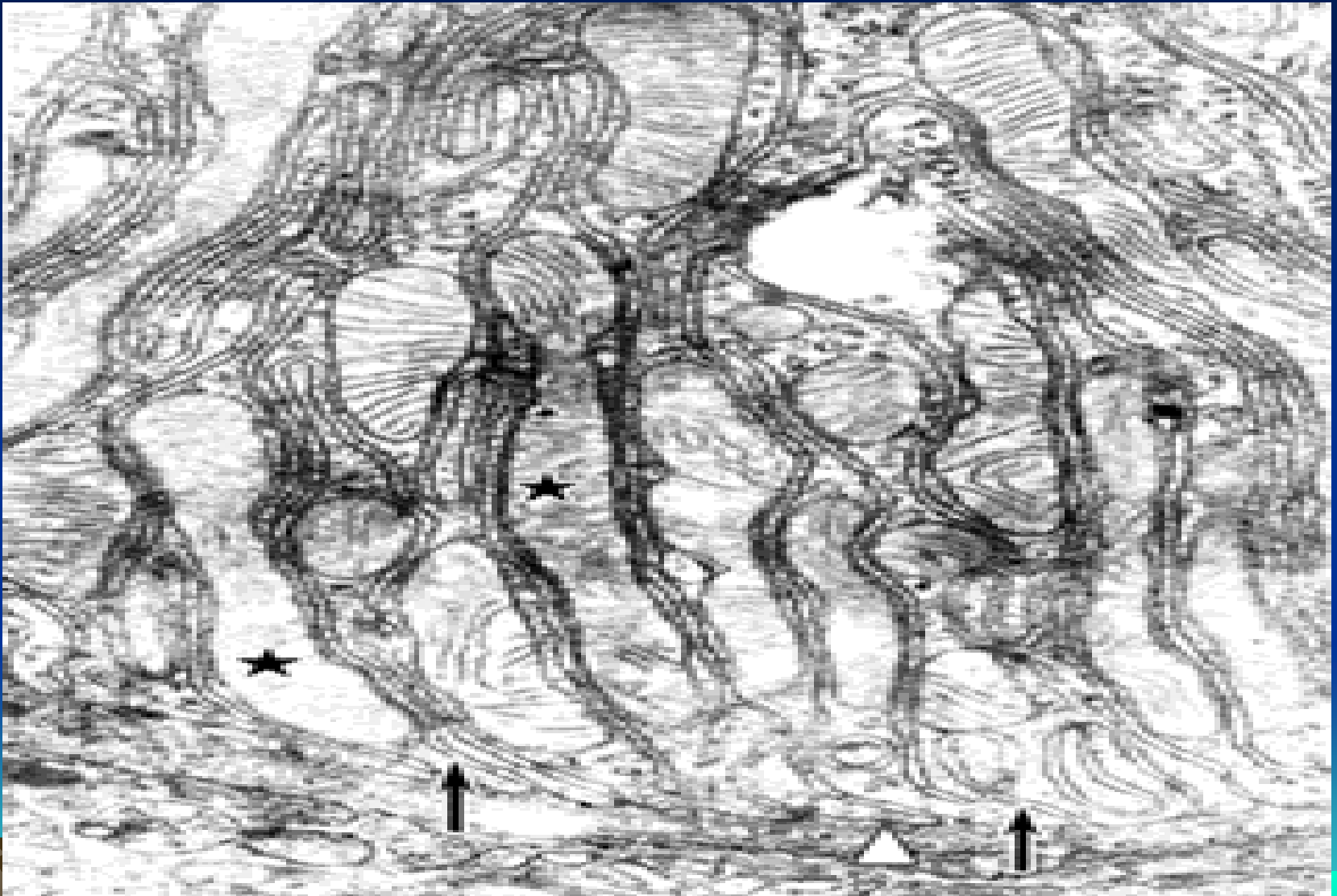
Basement Membrane (Δ) – H&E staining



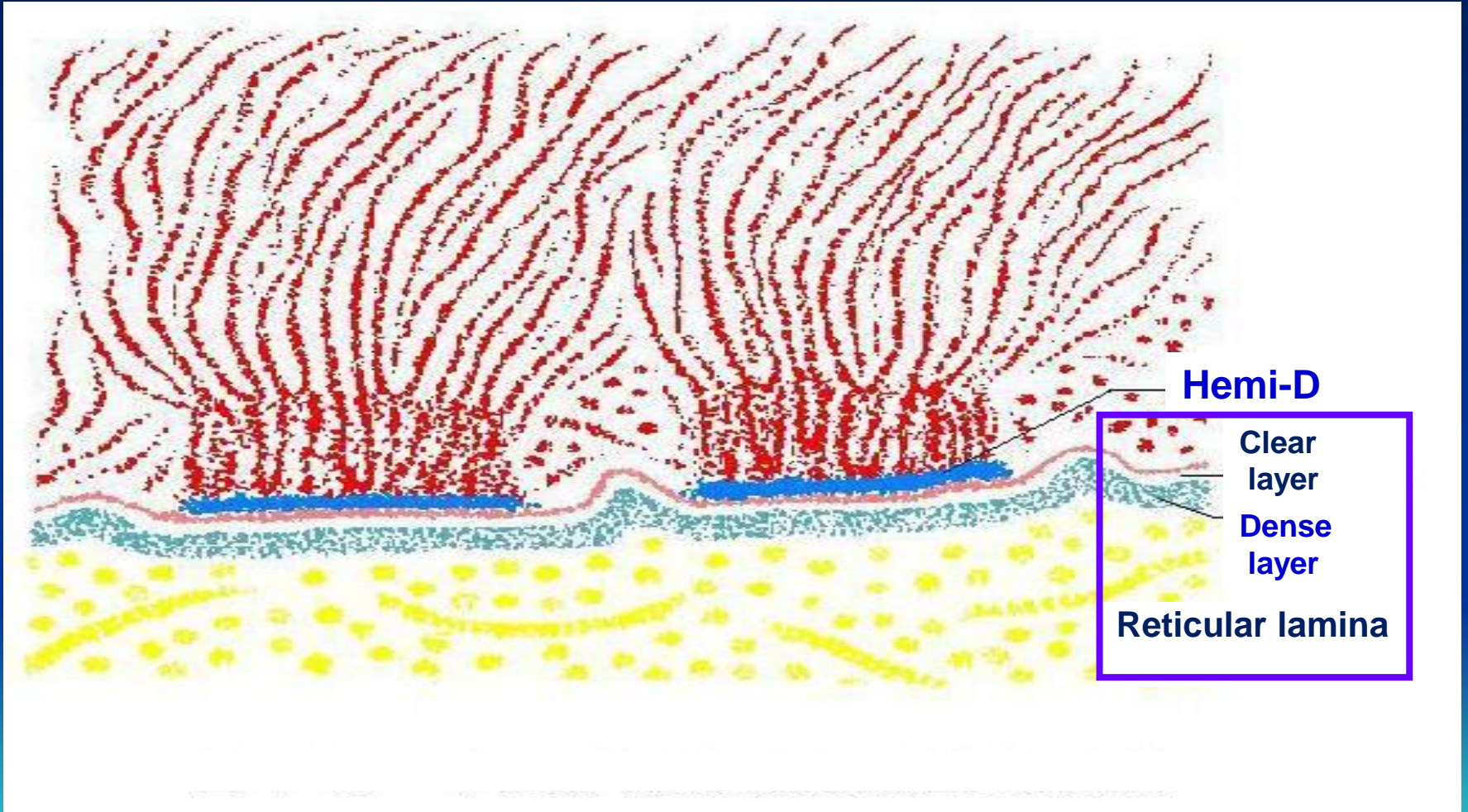
- **Infoldings** of basal membrane
- More **longitudinal mitochondria**
- **Active transport water & electrolytes** across basal membrane



Plasma Membrane Infoldings



Hemi-desmosome & Basement Membrane





SUMMARY 2



- **Specializations of Covering or Lining Epithelia**
 - **Apical**
 - **Microvilli / Stereocilia:** microfilaments core
 - **Cilia:** microtubules core
 - **Basal**
 - **Basal laminae:** collagen, glycoprotein
 - **Plasma membrane infolding**
 - **Hemidesmosome:** integrins
 - **Lateral**
 - **Tight / occluding junctions:** **sealing by** claudin & occludin
 - **Adhesive / anchoring junctions:** **adhesion by** cadherins
 - **Gap junctions:** **communication by** connexins



SUMMARY

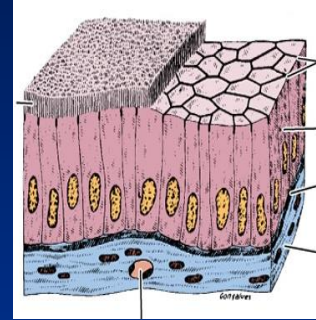
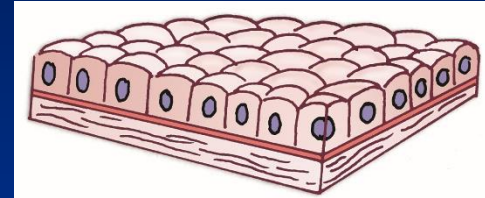
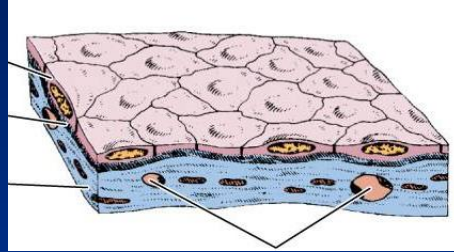
Characteristic Features

- **A sheetlike** structure surrounding “**free**” surfaces of body or cavity.
- **More** cells **tightly bound together** structurally and functionally with **little** ECM.
- **Polarity: Apical, Basal**
- **No** blood vessels, **rich** nerve endings
- **Functions: protecting surfaces, absorption or transcytosis, secretion, contractility, sensory.**

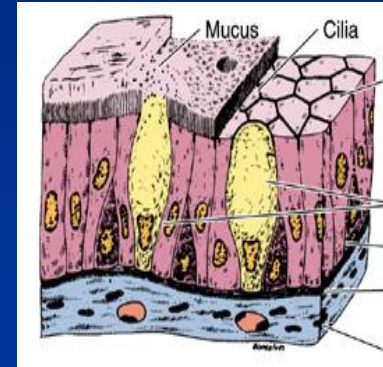
- **Covering or Lining Epithelia**

- **Simple**

- Squamous
- Cuboidal
- Columnar

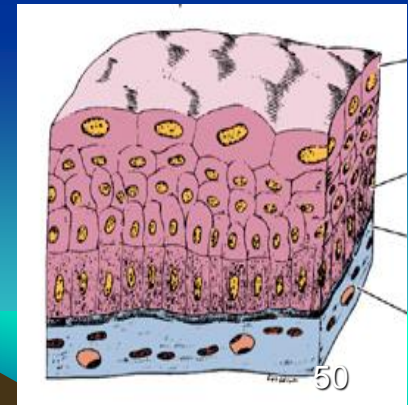
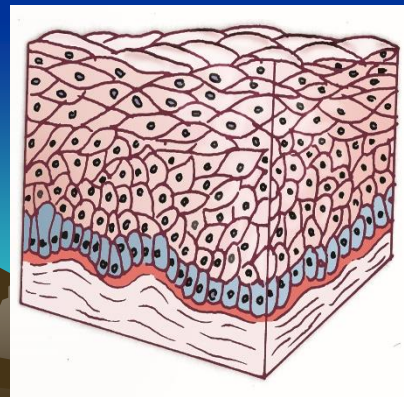


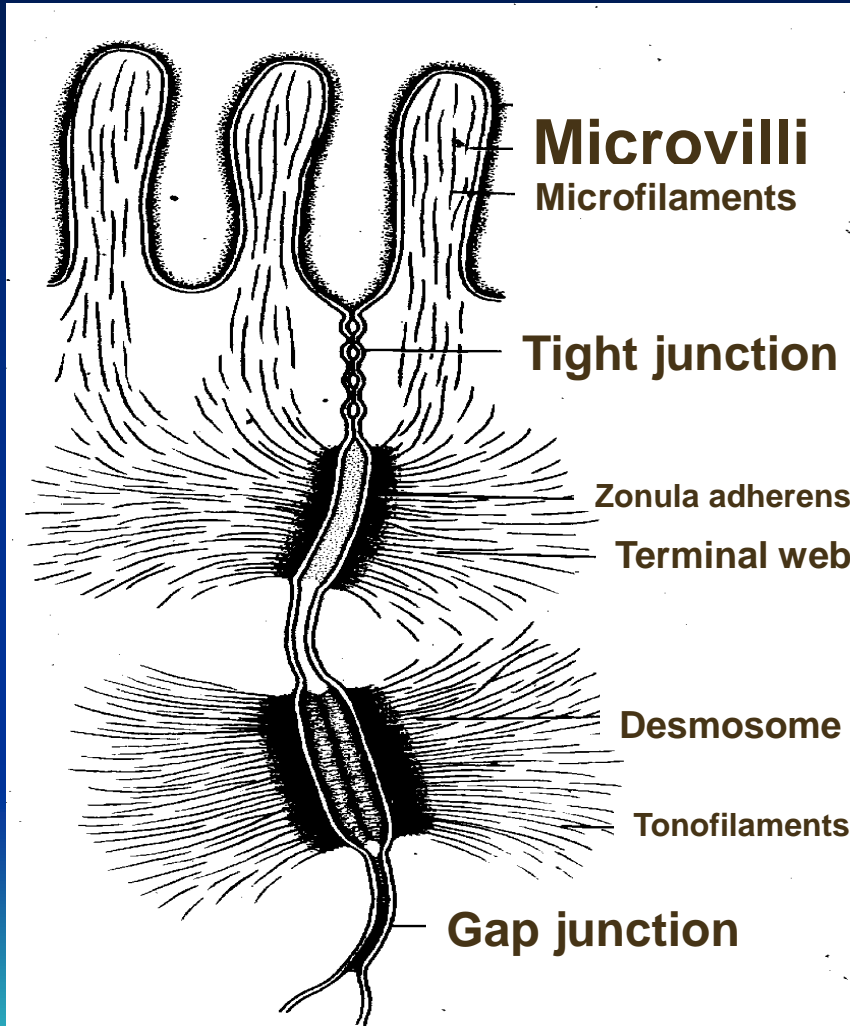
- **Pseudostratified**



- **Stratified**

- Squamous
 - Keratinized (dry)
 - Nonkeratinized (moist)
- Columnar
- Transitional





- **Apical**
 - Microvilli /Stereocilia: **microfilaments core**
 - Cilia: **microtubules core**
- **Basal**
 - Basal laminae
 - Plasma membrane infolding
 - hemidesmosome
- **Lateral**
 - Tight /occluding junctions: **sealing**
 - Adherent / anchoring junctions: **adhesion**
 - Gap junctions: **communication**



Review Questions

1. What are the **common features** of epithelia tissue?
2. How to **classify the various types** of epithelia?
3. Why is it called **endothelia** or **mesothelia**?
4. How many **specializations** have you learned? What are the **features in structure and function**?

THE END

