

A microscopic view of epithelial tissue, showing a layer of cells with prominent, dark purple nuclei and light purple cytoplasm. The cells are arranged in a regular, brick-like pattern, characteristic of simple cuboidal or columnar epithelium. The cell boundaries are clearly visible, forming a honeycomb-like structure.

EPITHELIAL TISSUE

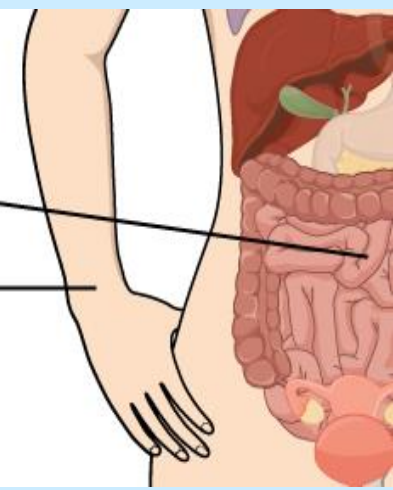
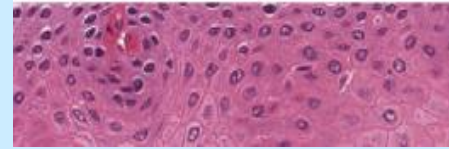
Epithelial tissue

1. Epithelia

- cover external surface of the body and line the body on its internal surface

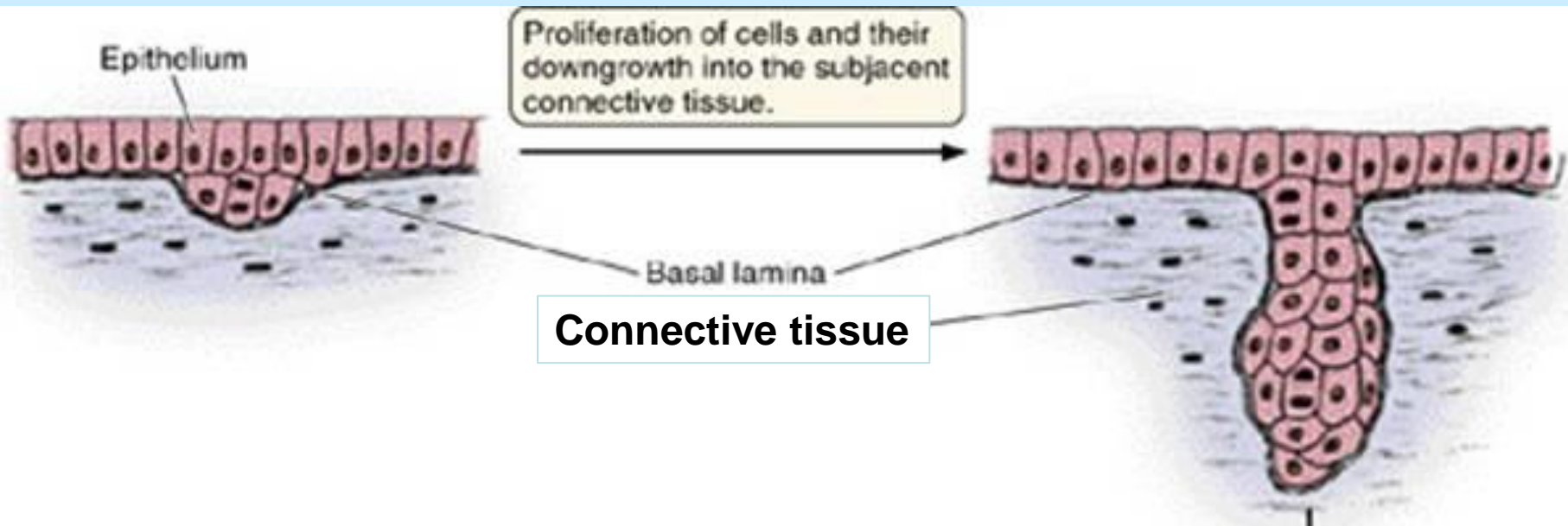
Epithelial tissue

- Lining of GI tract organs and other hollow organs
- Skin surface (epidermis)



2. Glands

- originate from invaginated epithelial cells

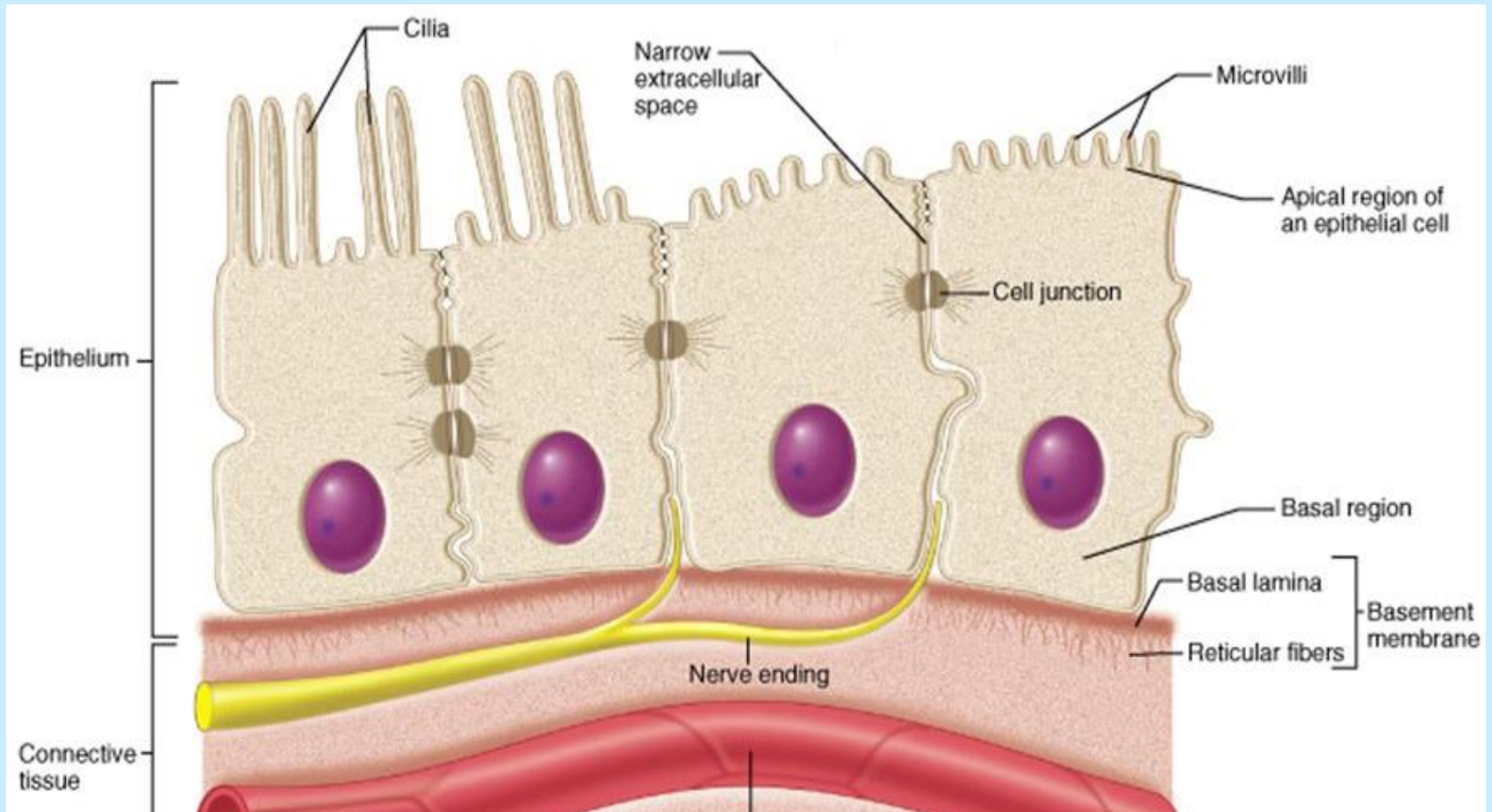


Functions of epithelial tissue

- Protection – Skin, lining of internal organs
- Absorption – intestines
- Filtration – Kidney
- Secretion – Hormones, mucus, sweat, etc.

Basic characteristic of epithelia

- cells - tightly bound by junctional complexes
- small amount of extracellular matrix
- cells - arranged in one or more layers, separated from the underlying tissue by a **basal lamina**.



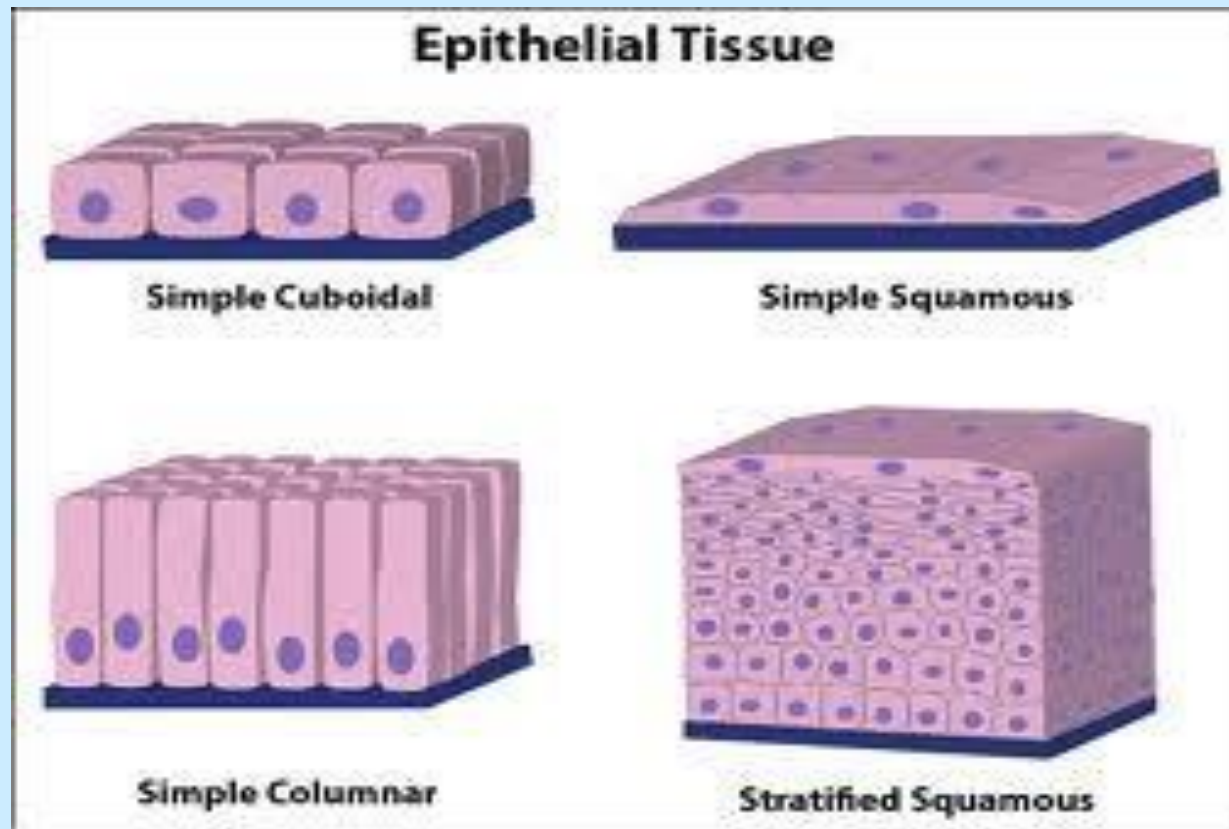
Classification of epithelia

According to;

✓ the number of cell layers between the basal lamina and the free surface - **simple epithelium, stratified epithelium**

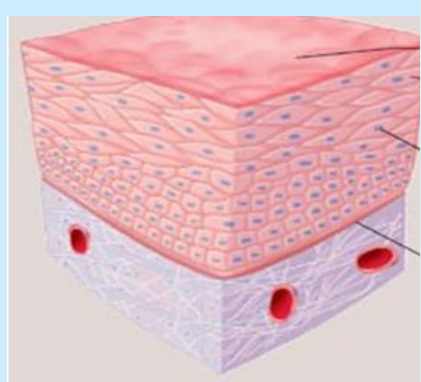
✓ the morphology (shape) of the epithelial cells

- **squamous (flat)**
- **cuboidal**
- **columnar**

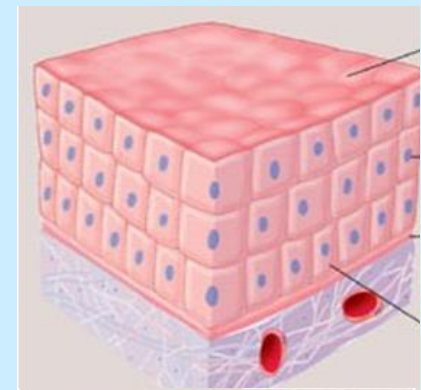


Stratified epithelia – classification

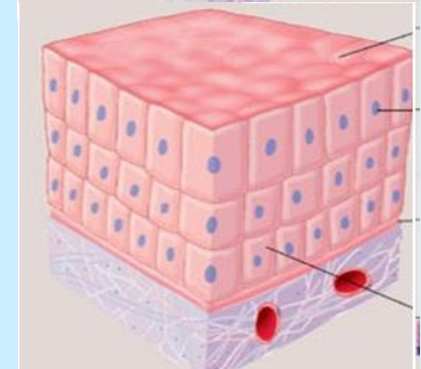
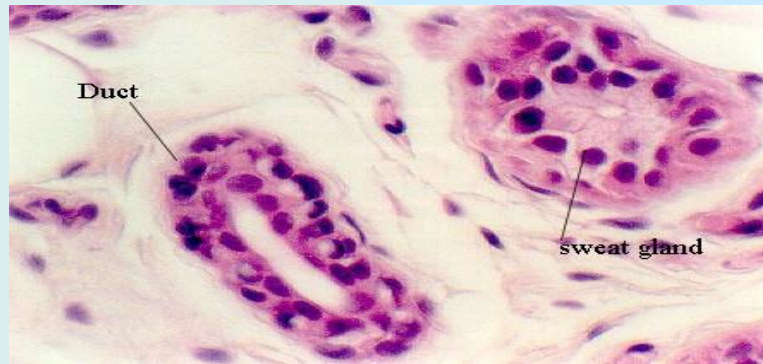
- by the morphology of the cells in superficial layer



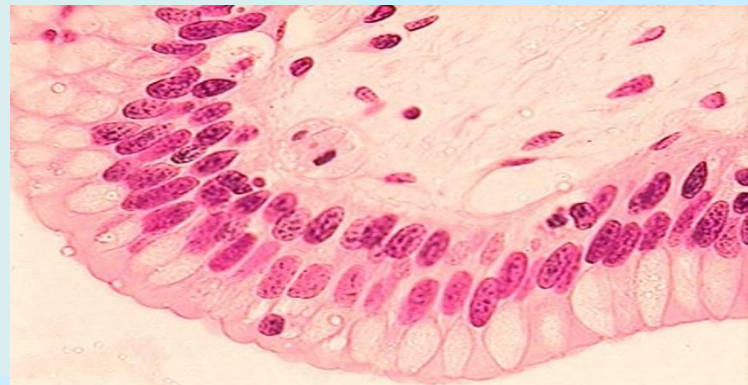
**stratified
squamous
epithelium**



**stratified
cuboidal
epithelium**

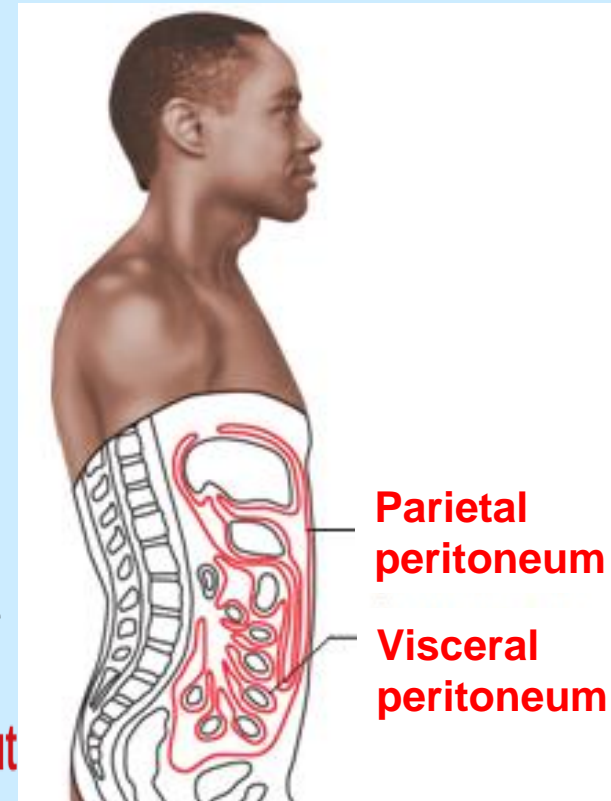
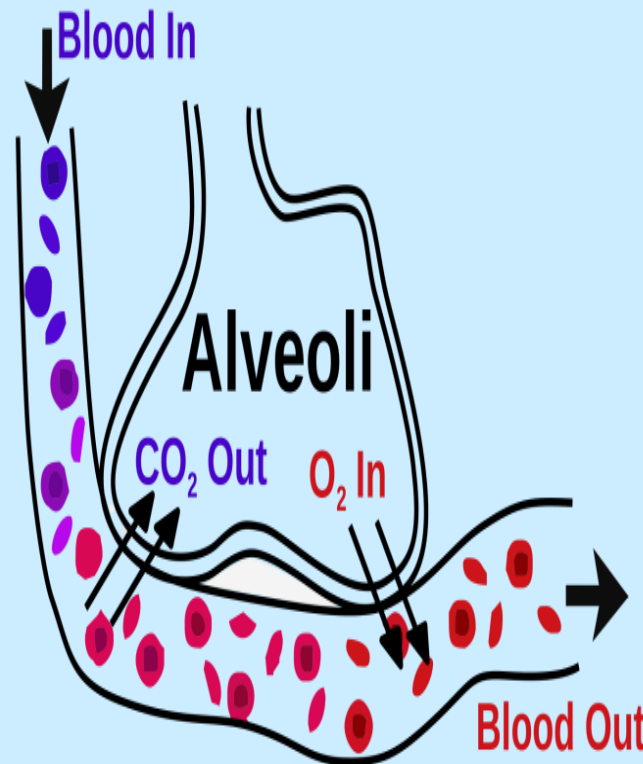
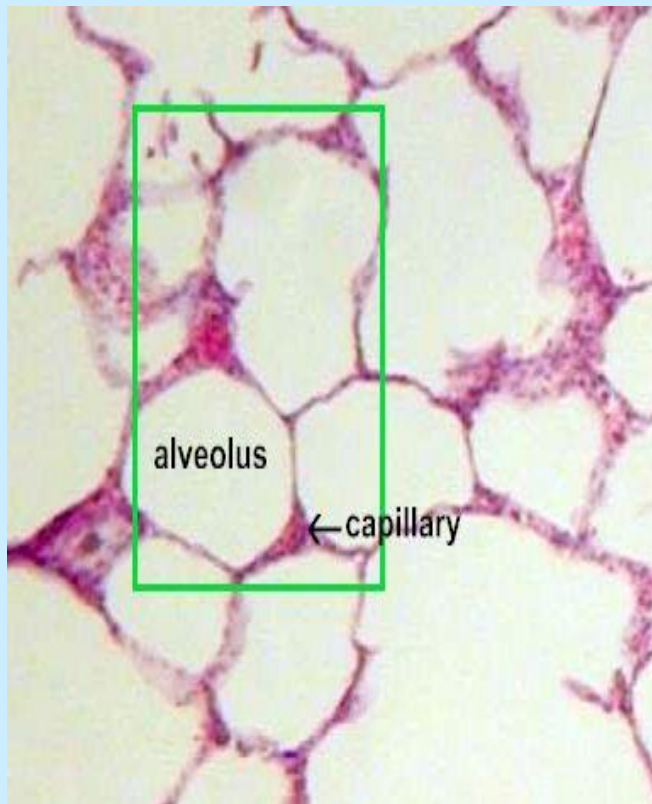


**stratified
columnar
epithelium**

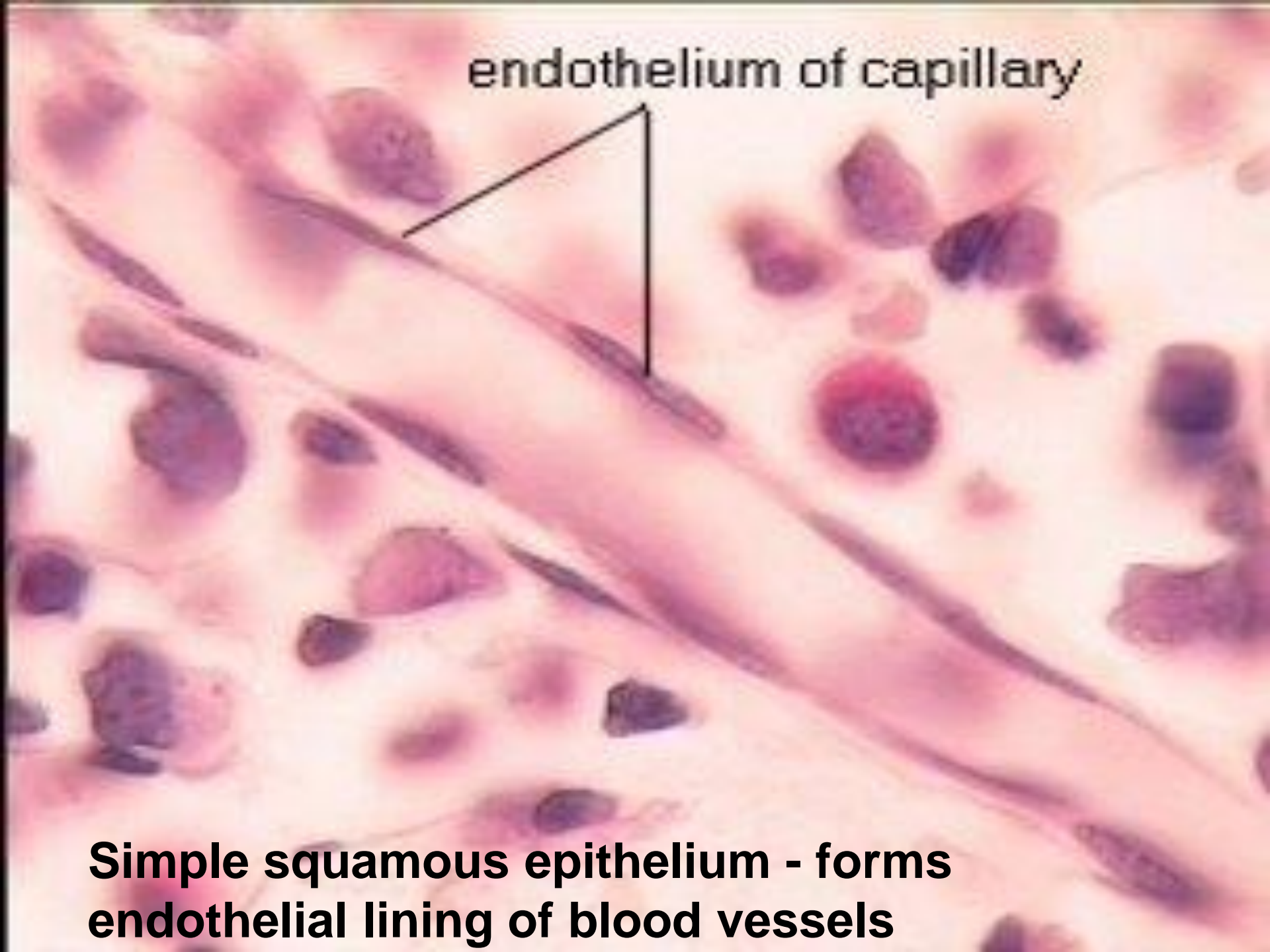


Simple squamous - a single layer of flat cells

- allows materials to diffuse through it - in the alveolar sacs in lungs (exchange of CO_2 and O_2).
- covers organs (serous membranes - **peritoneum**) in abdominal cavity



endothelium of capillary

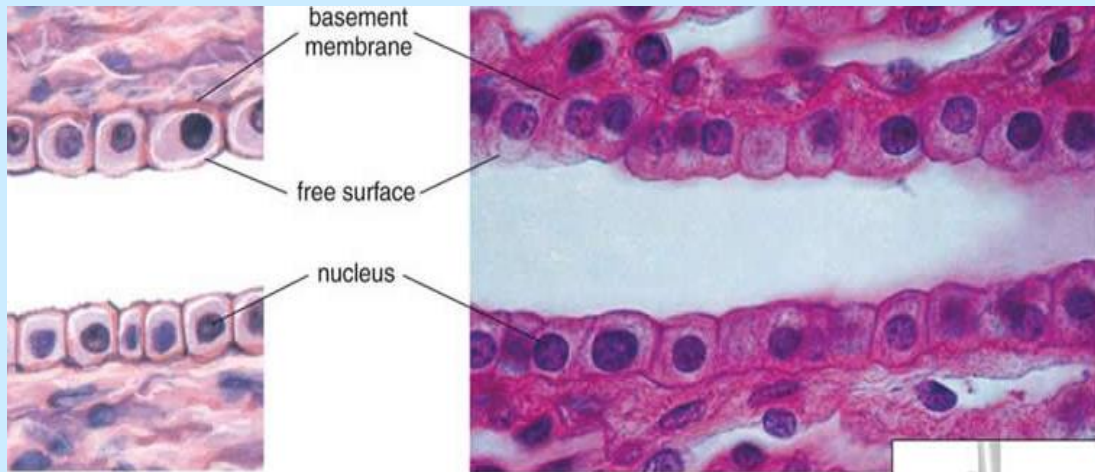


Simple squamous epithelium - forms endothelial lining of blood vessels



Simple cuboidal:

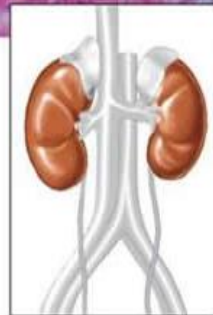
- a greater volume, more organelles.
- cells - carrier proteins - active transport and facilitated diffusion of material



Simple Cuboidal Epithelium

Location:
Lines kidney tubules; ducts of many glands; covers surface of ovaries

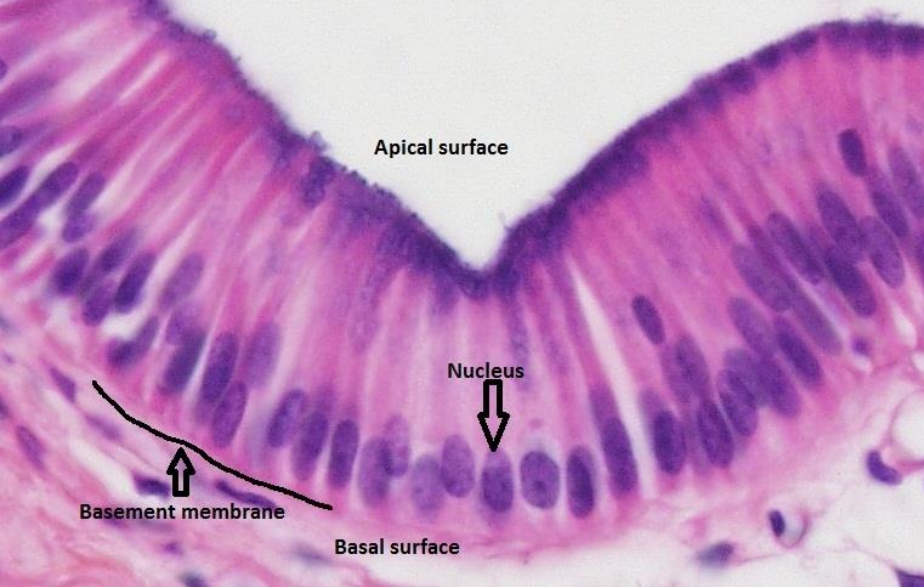
Function:
Secretion; absorption



- kidney - cells excrete waste products of metabolism and reabsorb any needed materials from urine before it's excreted.

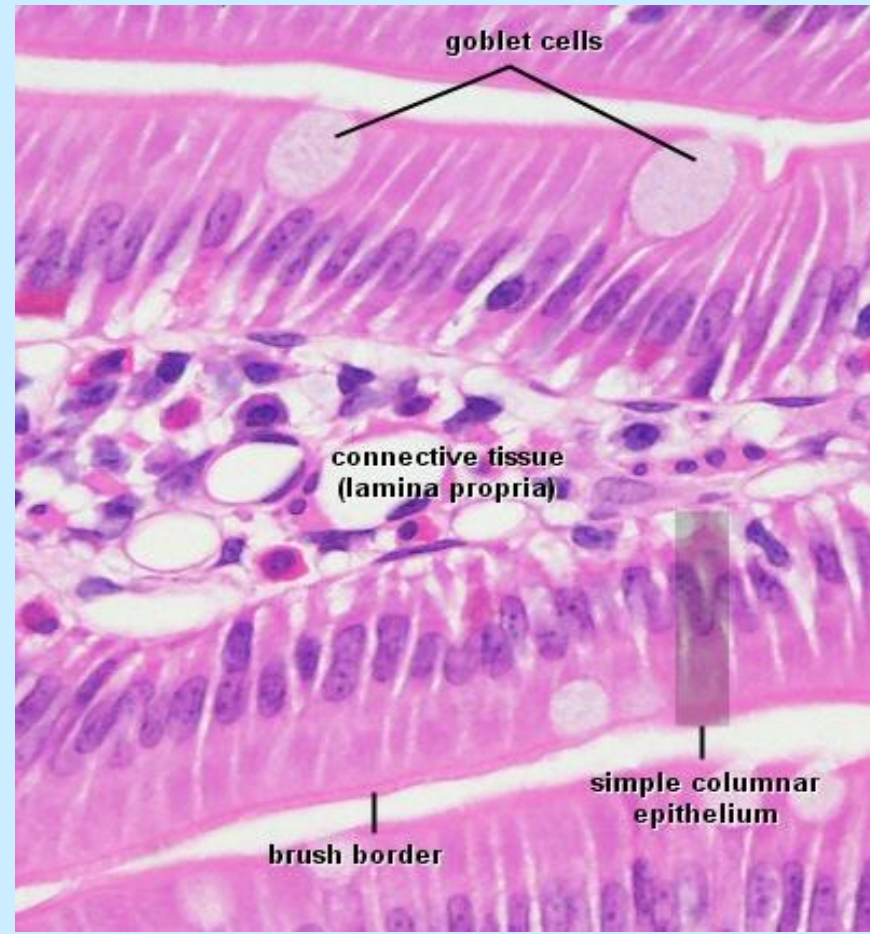
a single layer of tall, thin cells

Simple columnar epithelial cells in the digestive tract

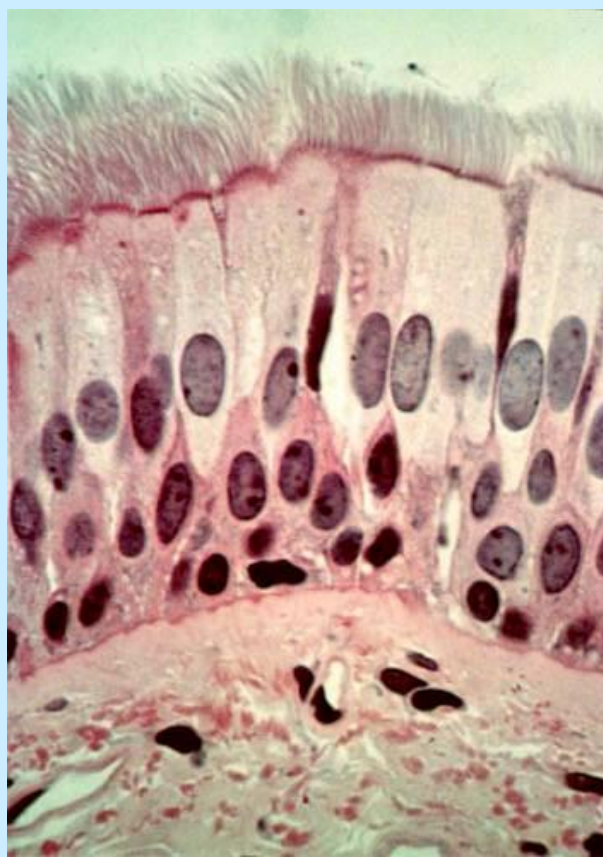


Simple columnar:

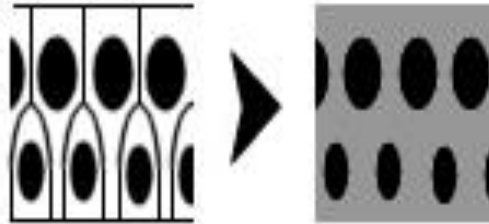
- in the **intestine** – production of digestive enzymes, **absorption of nutrients**



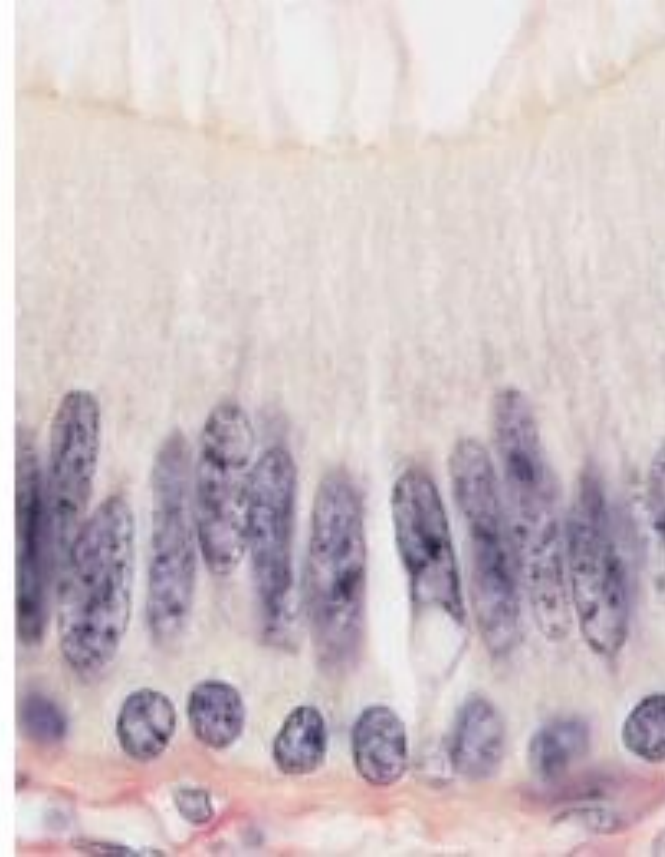
A **goblet cell** - a simple gland
- secretes gel forming **mucins** - the major components of **mucus** (covers the surface of digestive tract)



pseudostratified
epithelium

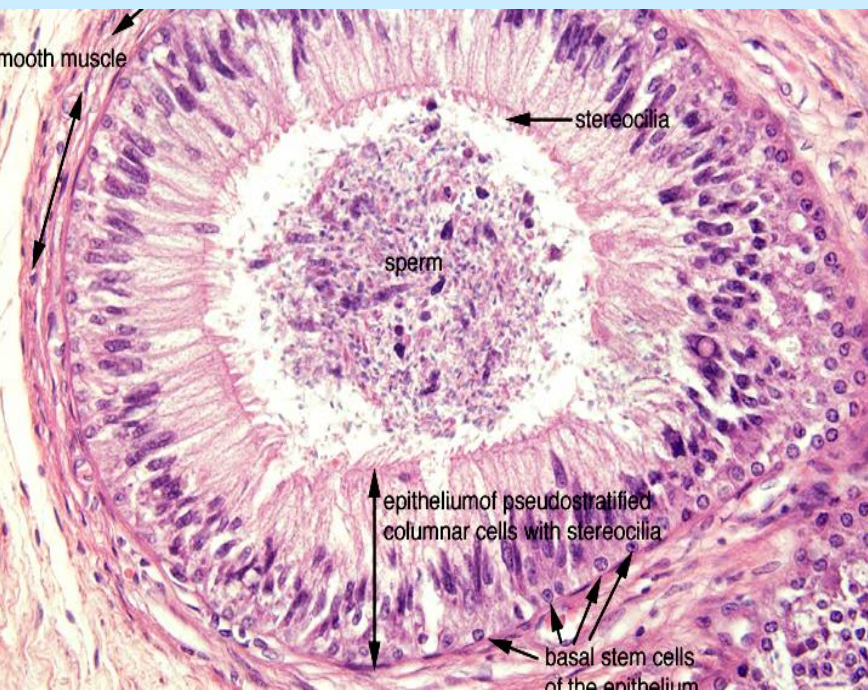


**Simple
epithelium**



Pseudostratified columnar - appears to be stratified but is simple

- one layer of cells - all cells attached to the basement membrane, but not all cells have a free surface - short cells are covered by tall cells - two, or more layers of nuclei

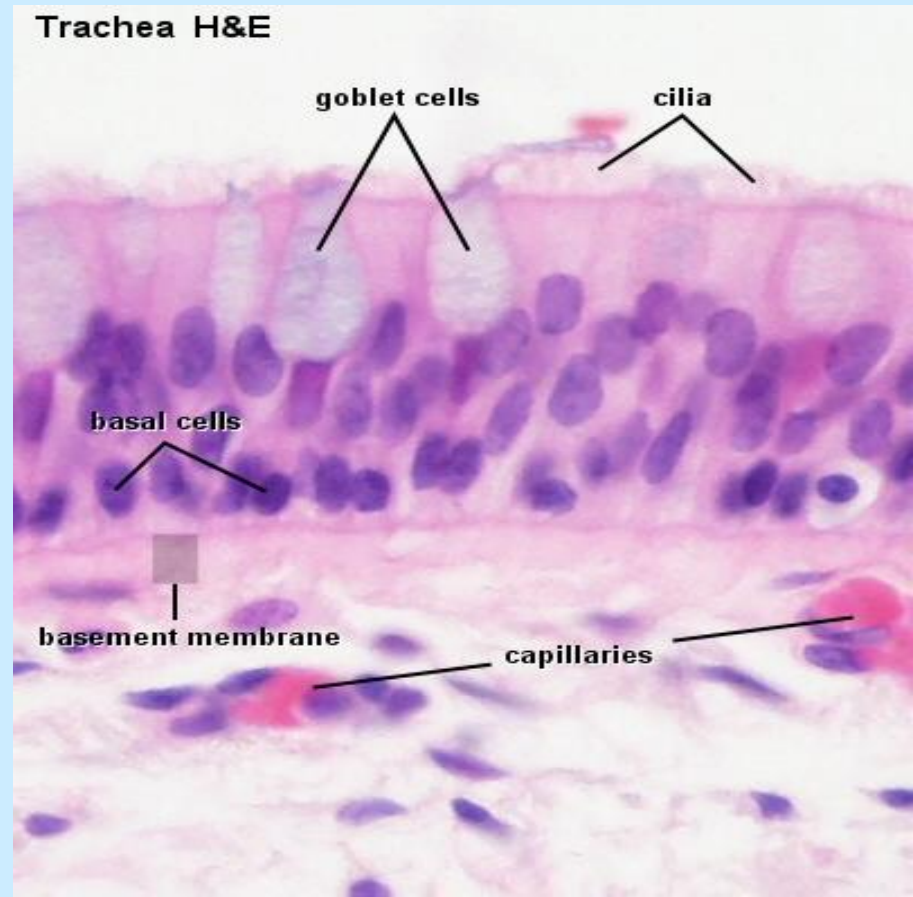


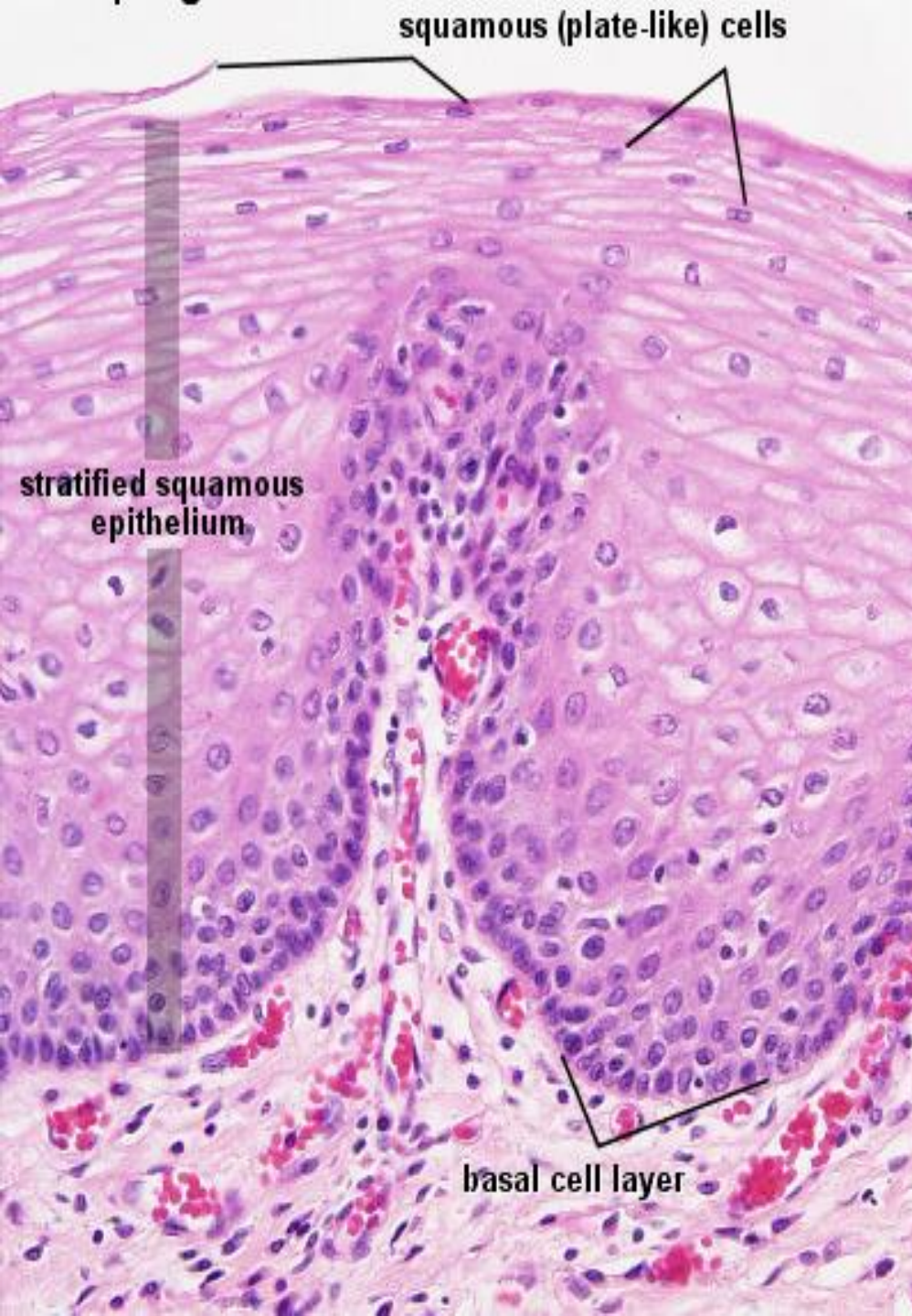
Pseudostratified columnar epithelium- a single layer of cells

- in the **male urethra** and **epididymis**

Pseudostratified ciliated columnar epithelium

- cells with **cilia** on the apical surface
- **goblet cells** - mucus
- **in respiratory tract:** trachea, primary bronchi and nasal cavity



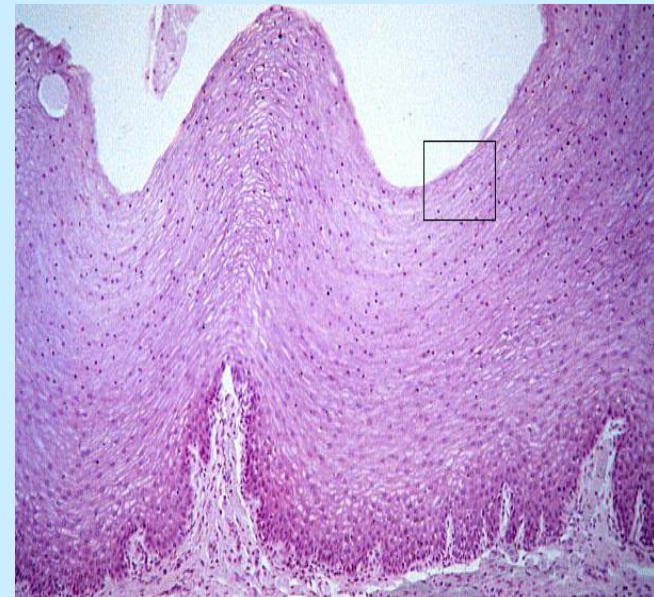


- Stratified squamous:** a multilayered epithelium
- the outer layer squamous cells
 - the deepest (basal) cells - columnar
 - columnar cells divide - replace damaged cells
 - cells renewal

Types of stratified squamous epithelium

- Nonkeratinized
- Parakeratinized
- Keratinized

cells of superficial layer nucleated - are alive



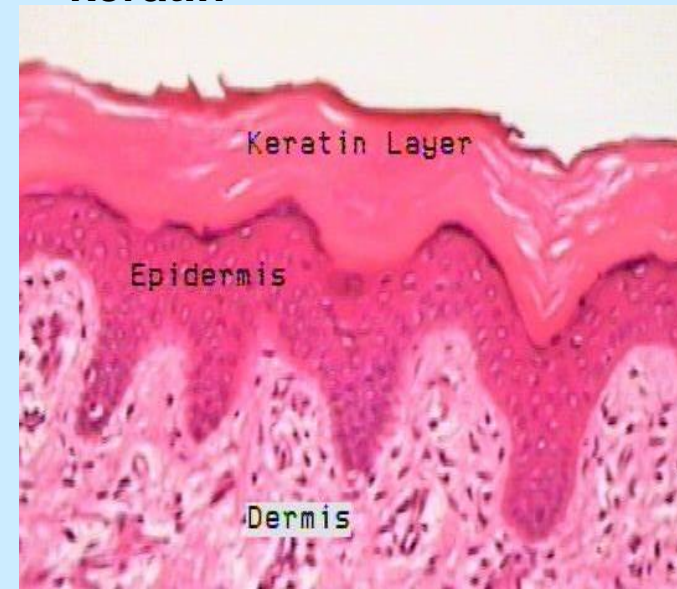
Nonkeratinized
- mouth, esophagus, vagina

cells of superficial layer have nuclei (*) but are filled with keratin



Parakeratinized
- gingiva

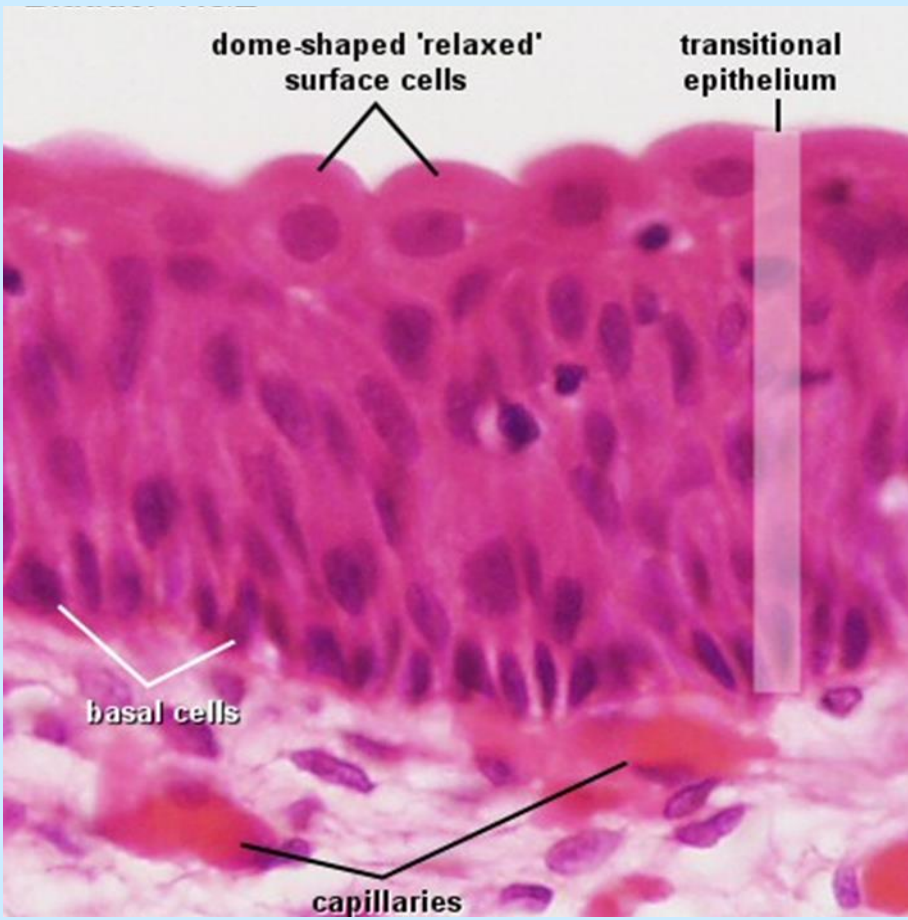
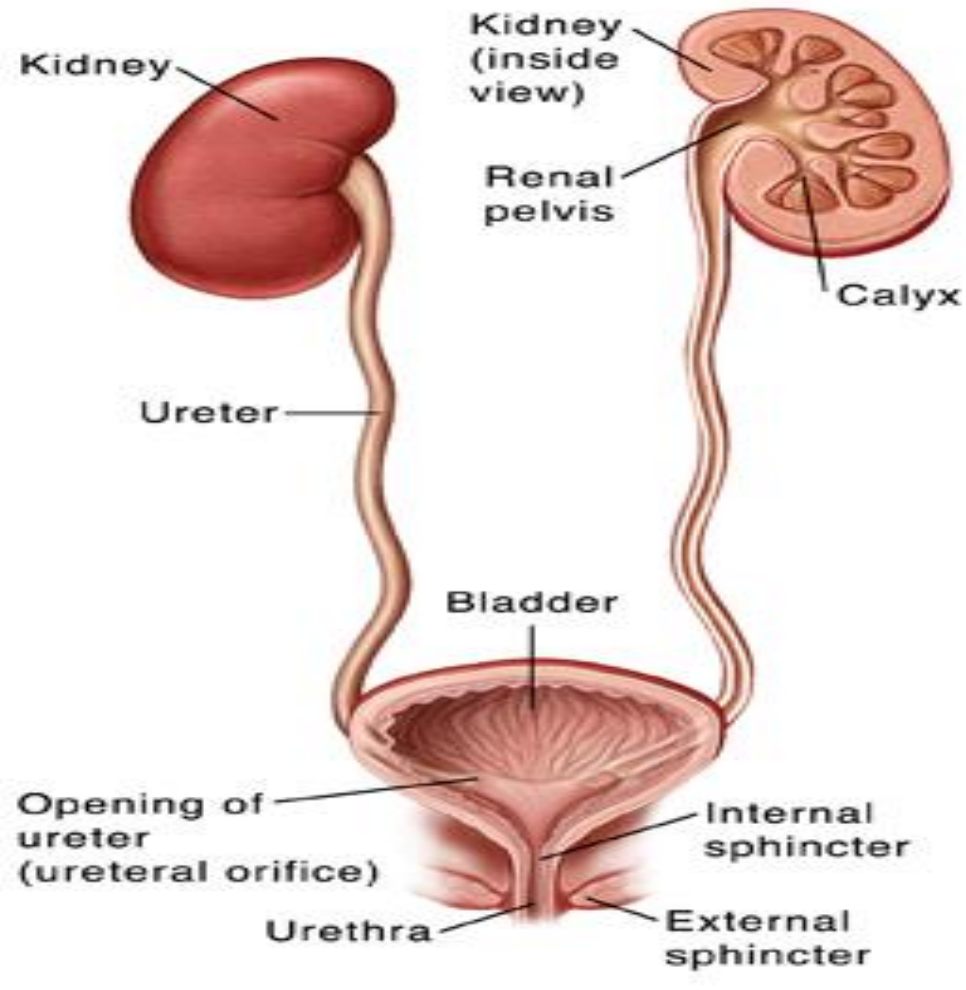
cells of superficial layers - dead - nuclei are invisible, cytoplasm - keratin



Keratinized
- epidermis of skin

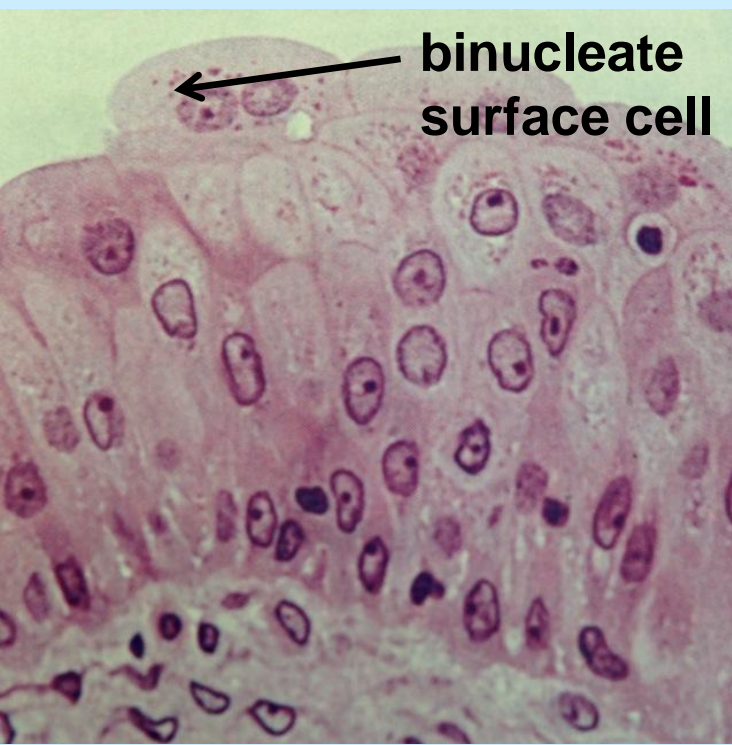
Transitional epithelium- stratified epithelium

- the urinary tract from the renal calyces to the urethra



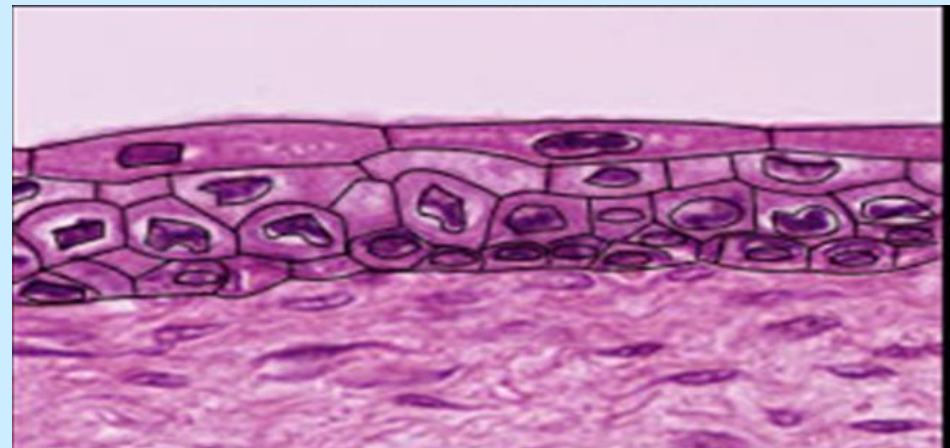
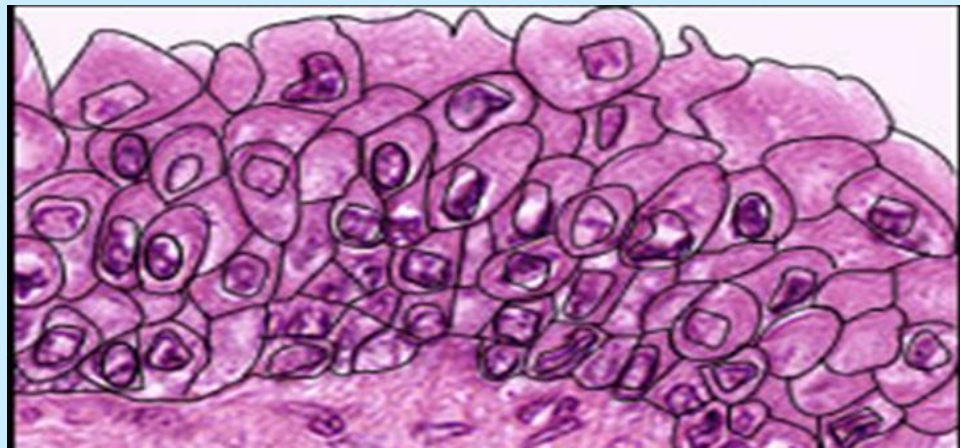
- many layers of low-columnar or cuboidal cells

-



Transitional epithelium:

- is capable of stretching and changing shape.
- when the tissue is stretched, cells are flat to cover more area, and resemble squamous cells.



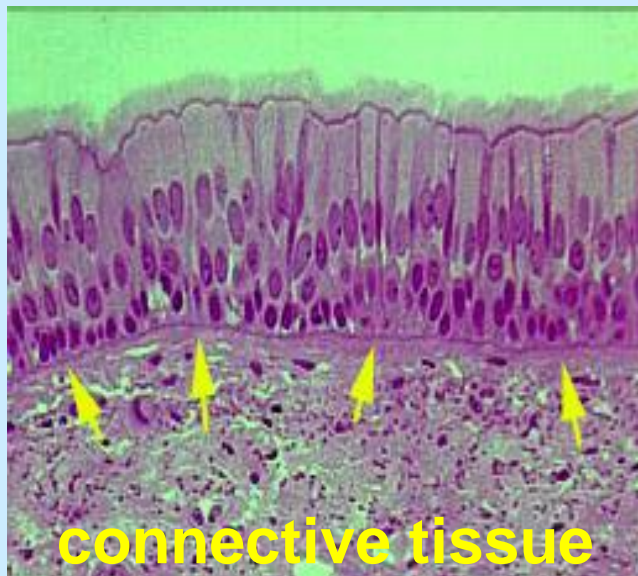
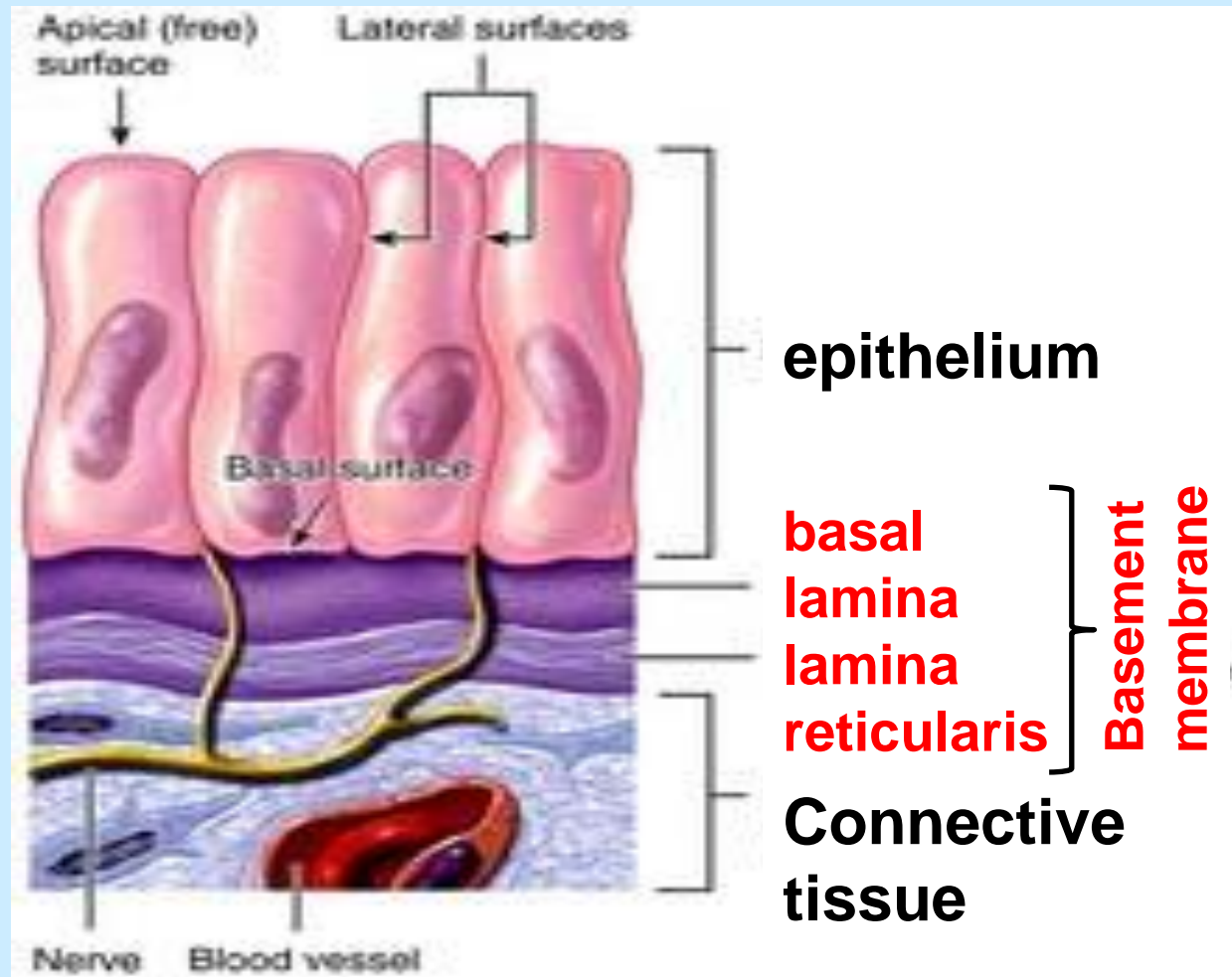
empty urinary bladder – superficial cells large and dome-shaped
bladder distended - superficial cells flattened,

Basement membrane

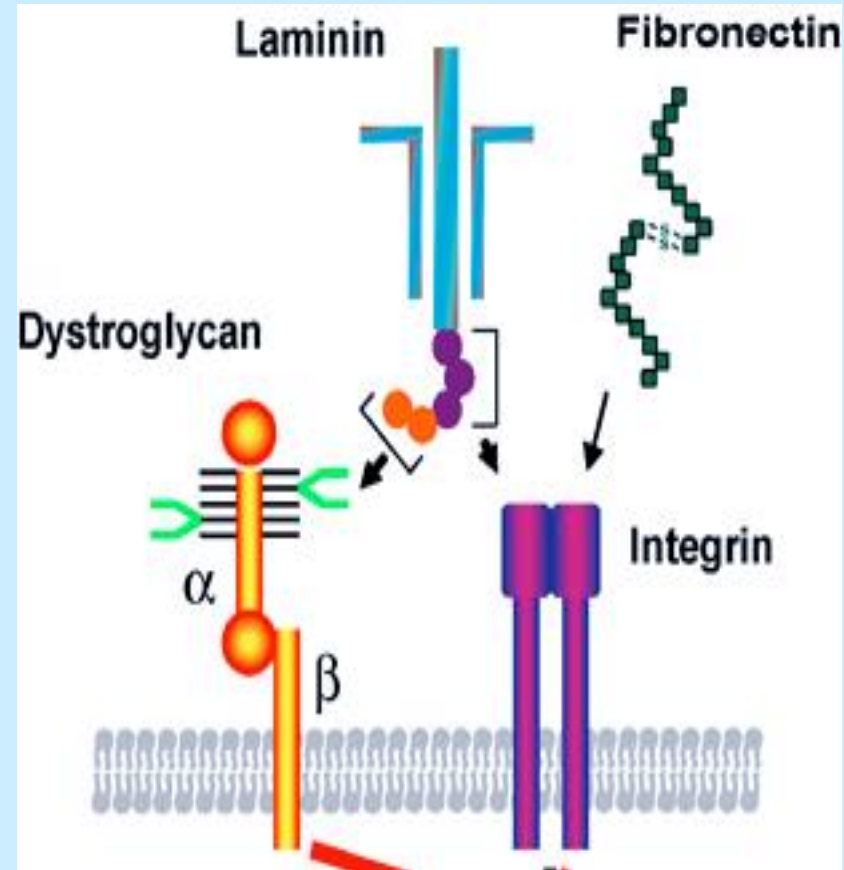
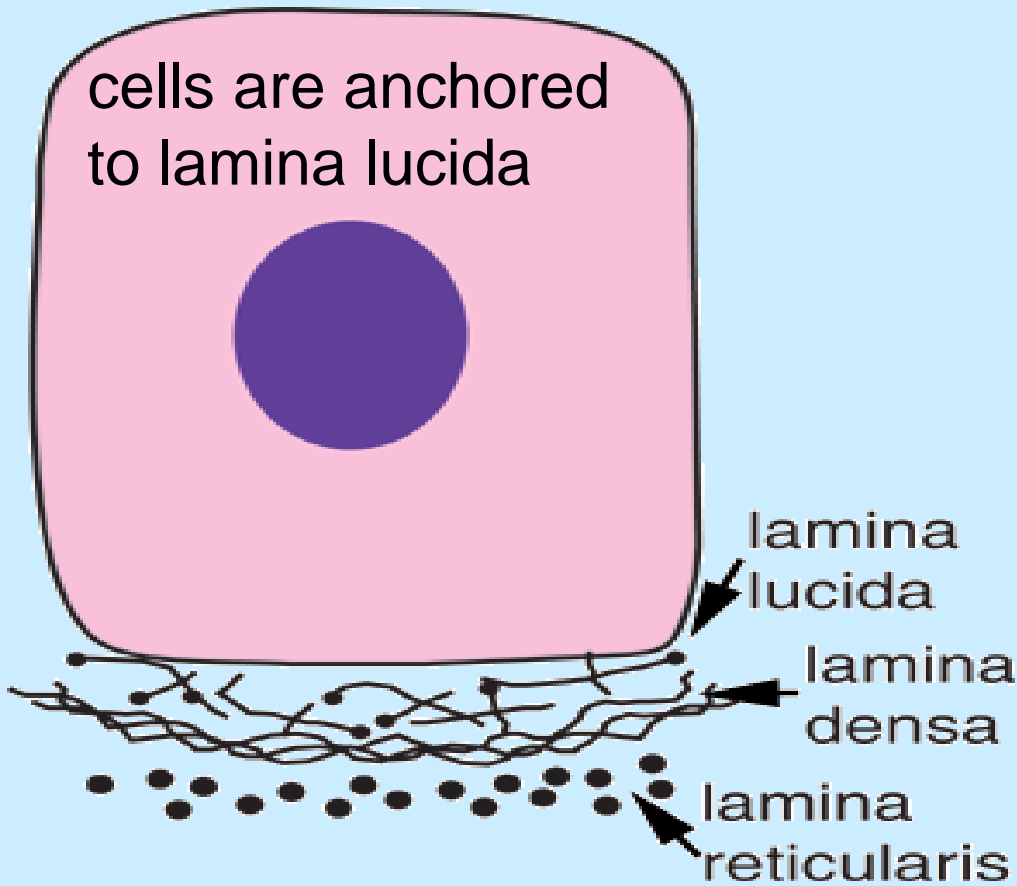
- anchors the epithelium to connective tissue

1. **basal lamina** - manufactured by epithelial cells

2. **lamina reticularis** - produced by cells of connective tissue



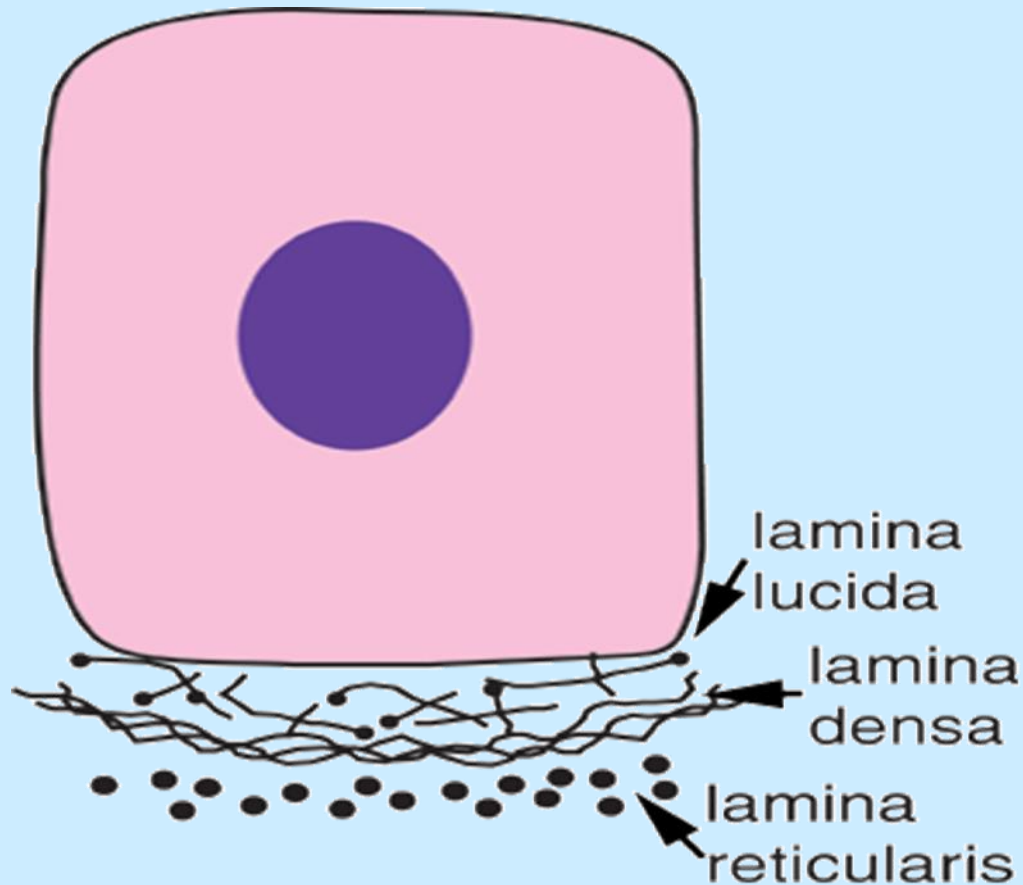
Basal lamina = lamina lucida (rara) + lamina densa



lamina lucida

- glycoproteins (**laminins**, **fibronectin**), **integrins** and **dystroglycans** (laminin receptors)

Basal lamina - lamina lucida (rara) + lamina densa

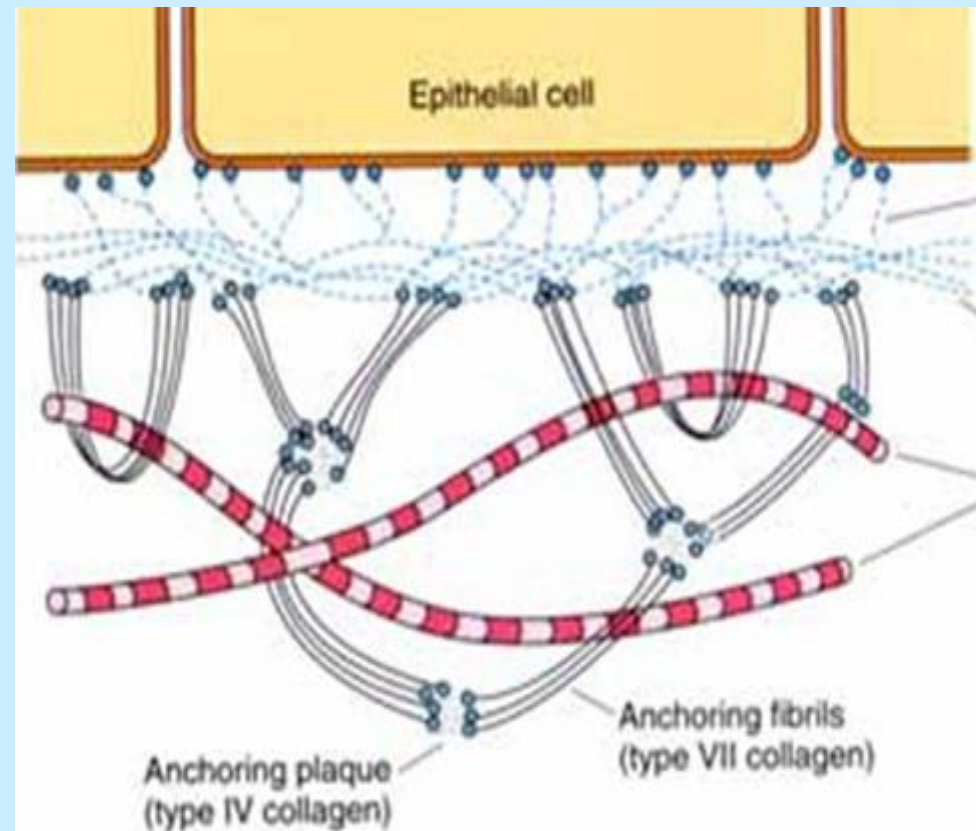
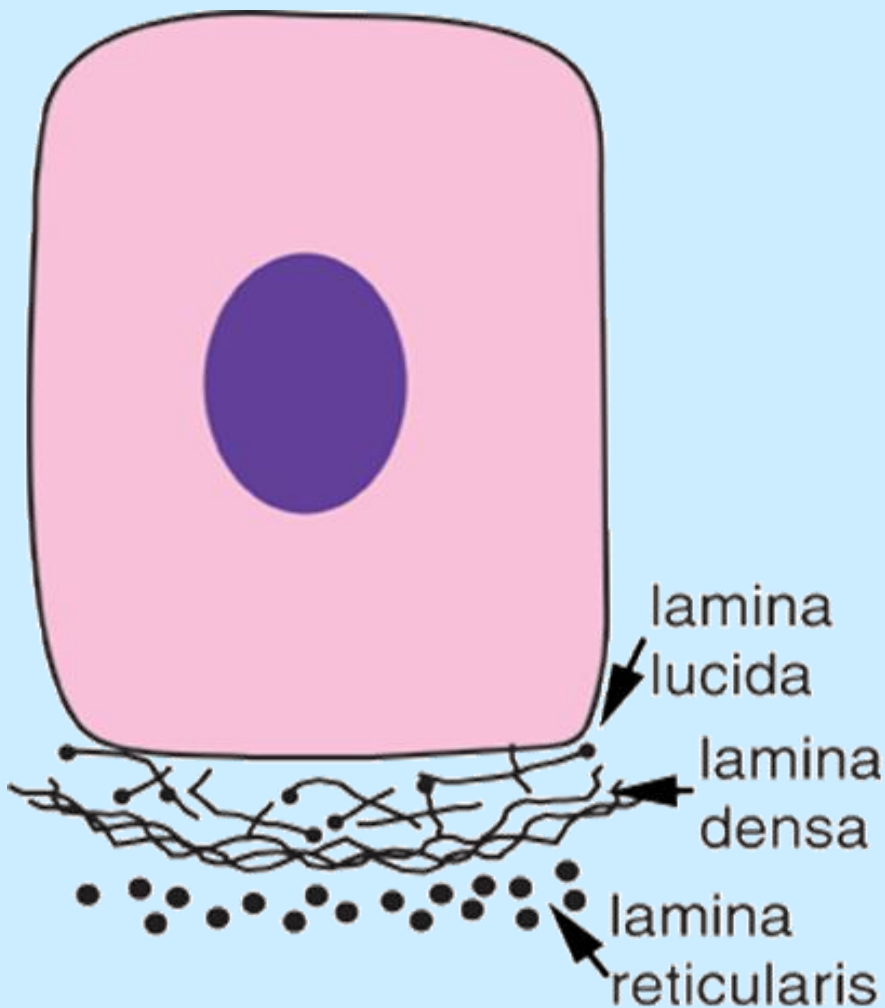


lamina densa

- a meshwork of **type IV collagen**, proteoglycans (perlecan, heparan sulfate)

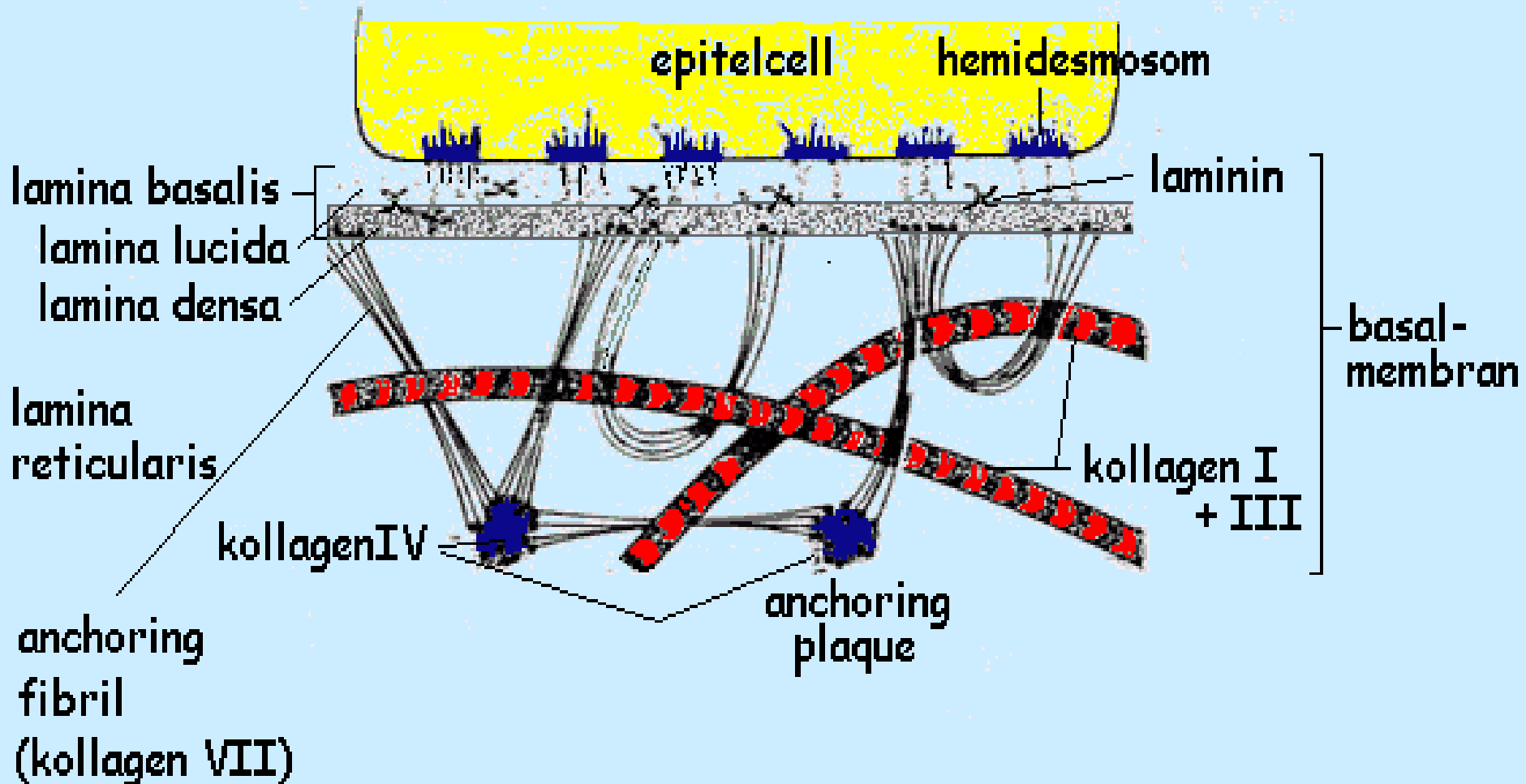
- Laminins from lamina lucida - bind to collagen IV of lamina densa

Basal lamina (lamina lucida (rara) + lamina densa) is attach to the lamina reticularis by collagen type VII fibers - anchoring fibers



Lamina reticularis

- manufactured by fibroblasts (cells of connective tissue), **type I, III and VII collagen**
- affixes the **basal lamina to the connective tissue**



Polarity of the cell

- epithelial cells - different functions - different modifications - different functional domain

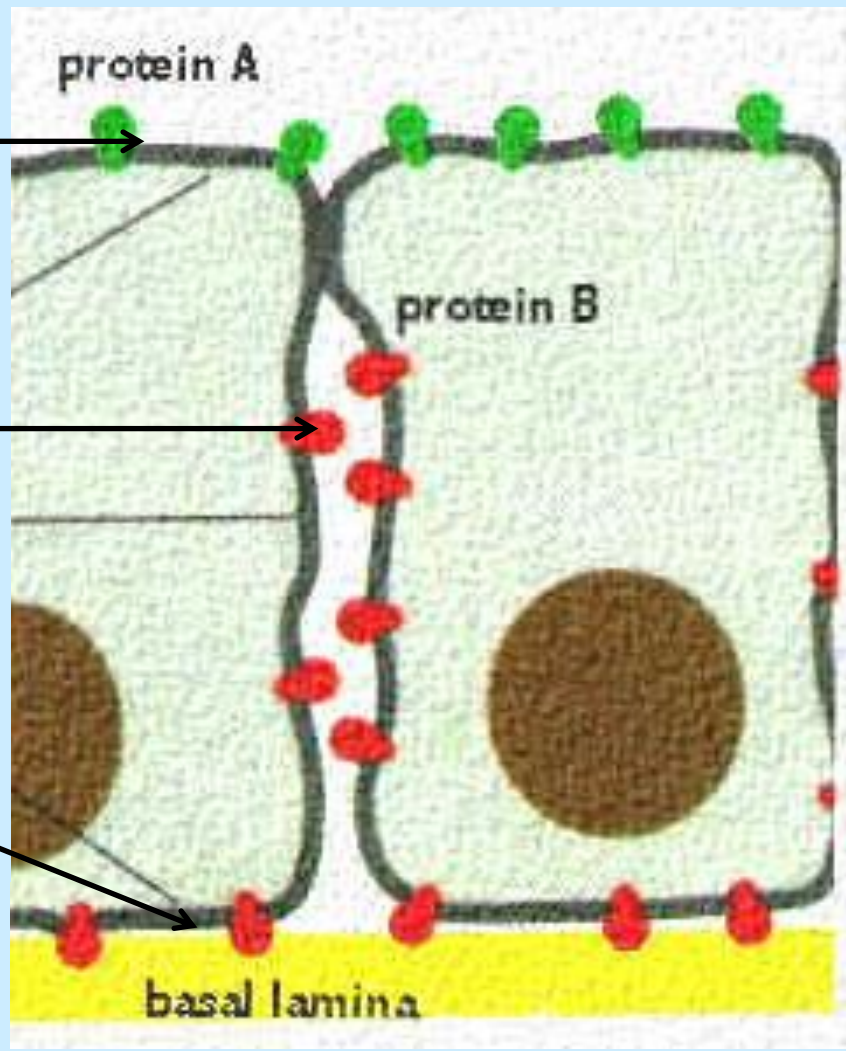
apical domain

- faces a lumen
- **microvilli or cilia**

lateral domain

- basolateral domain
- **junctional complexes**

basal domain

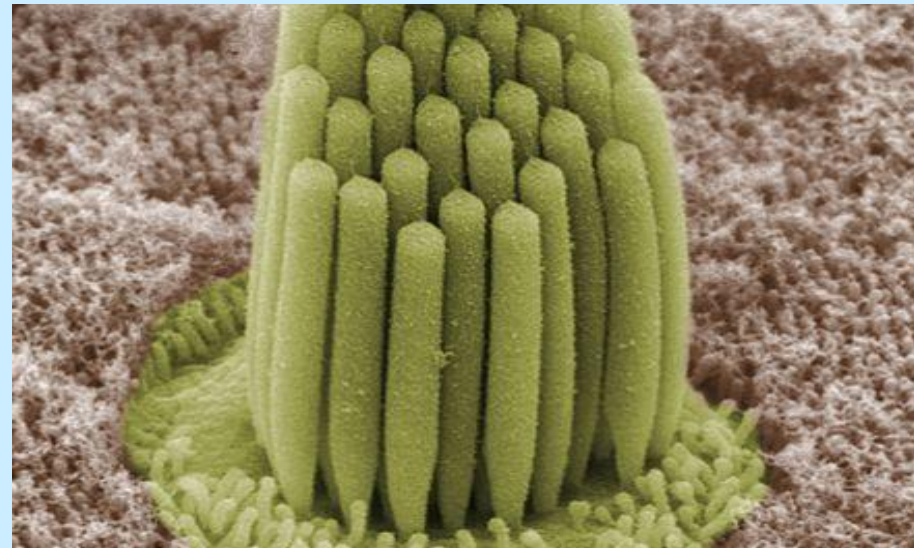


- **apical surface - absorption and secretion** - finger-shaped extensions - increase the surface area of epithelial cells
- **microvilli** (small intestine) - shorter than stereocilia
- **stereocilia** (epididymis)
- stereocilia and microvilli are **immovable**

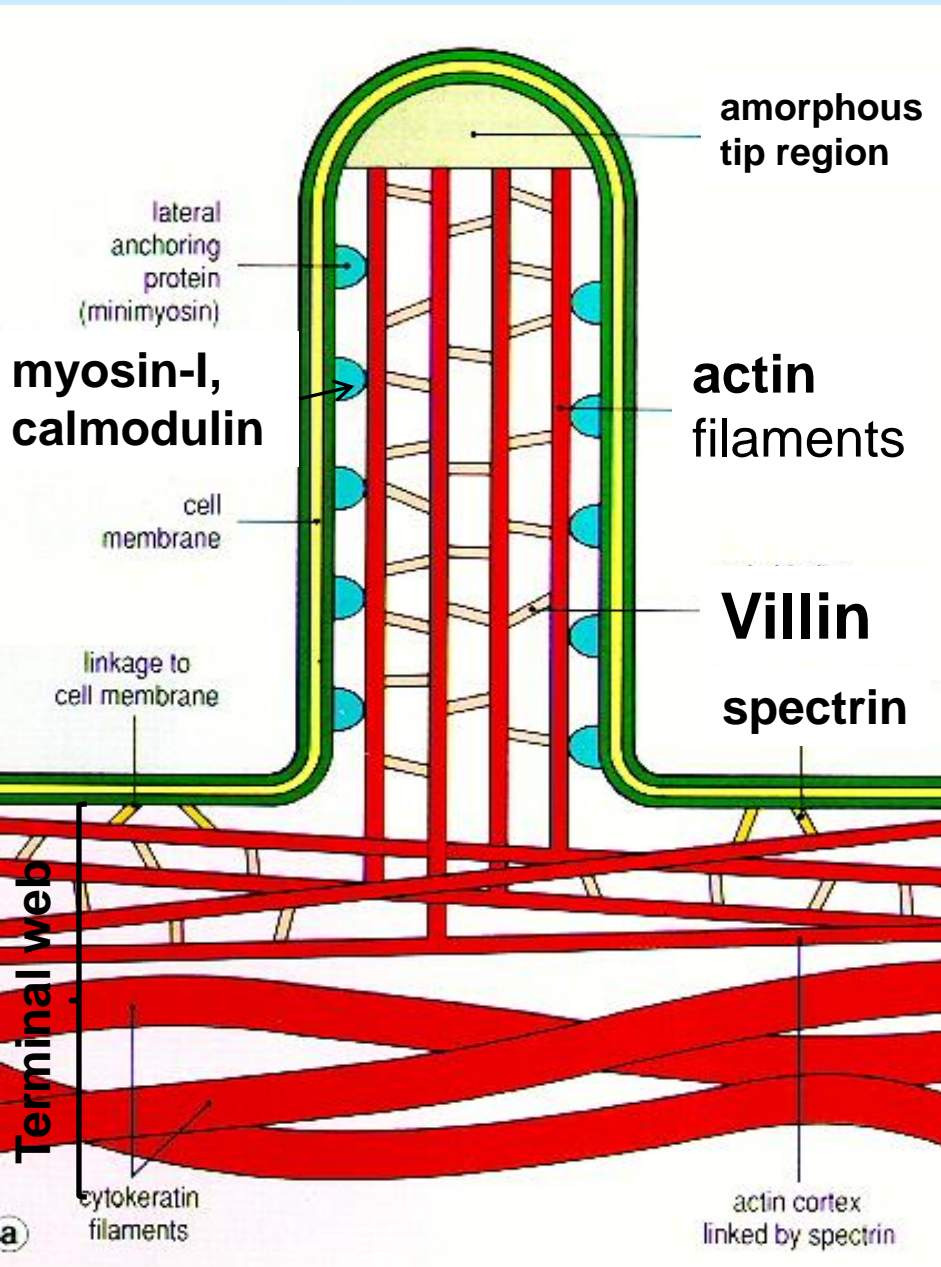
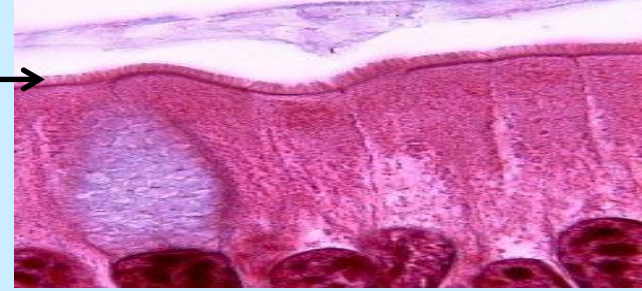
microvilli



stereocilia



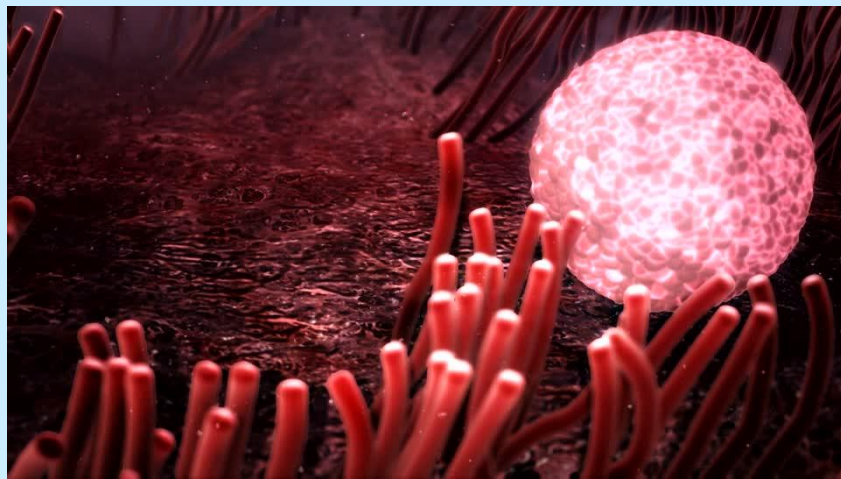
Microvilli – striated (brush) border →



Microvillus

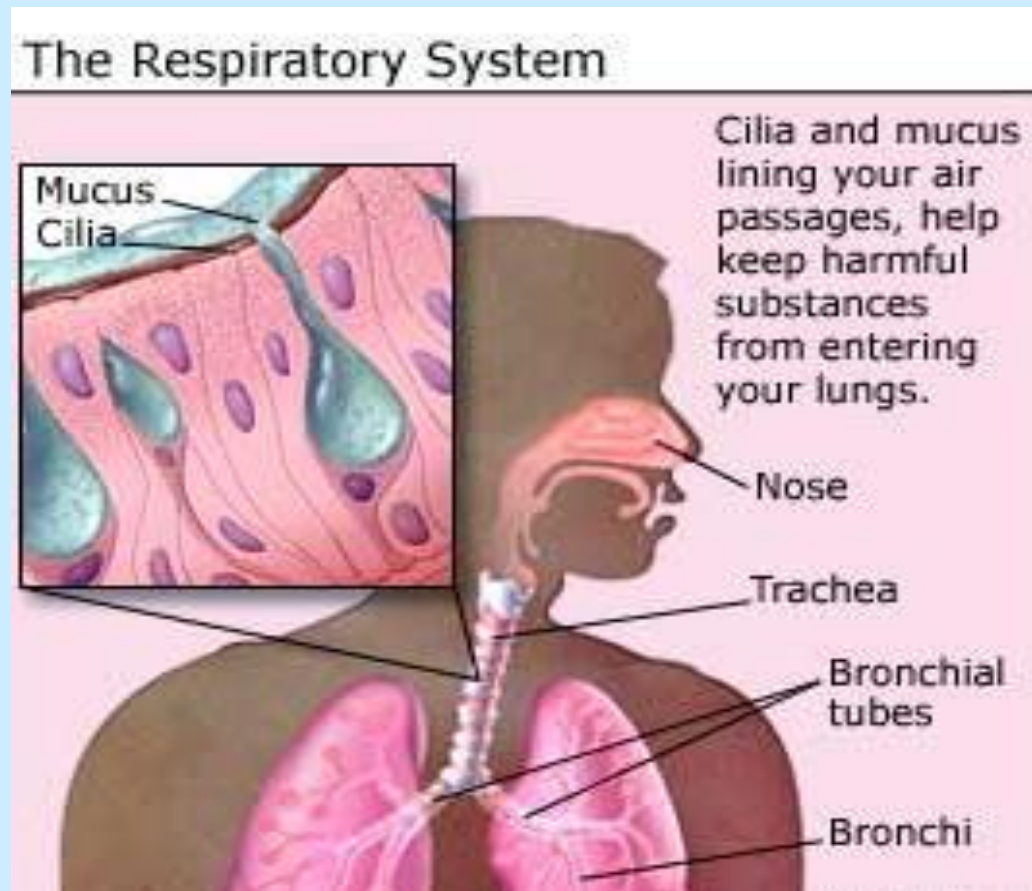
- a core - **actin** filaments - cross-linked by **villin**
- actin filaments - attached to the terminal web (complex of actin, spectrin and intermediate filaments)
- **myosin** and **calmodulin** connect the actin filaments to the plasma membrane

Cilia – Long, motile structures (respiratory tract, in the oviduct)
- a rhythmic waving or beating motion

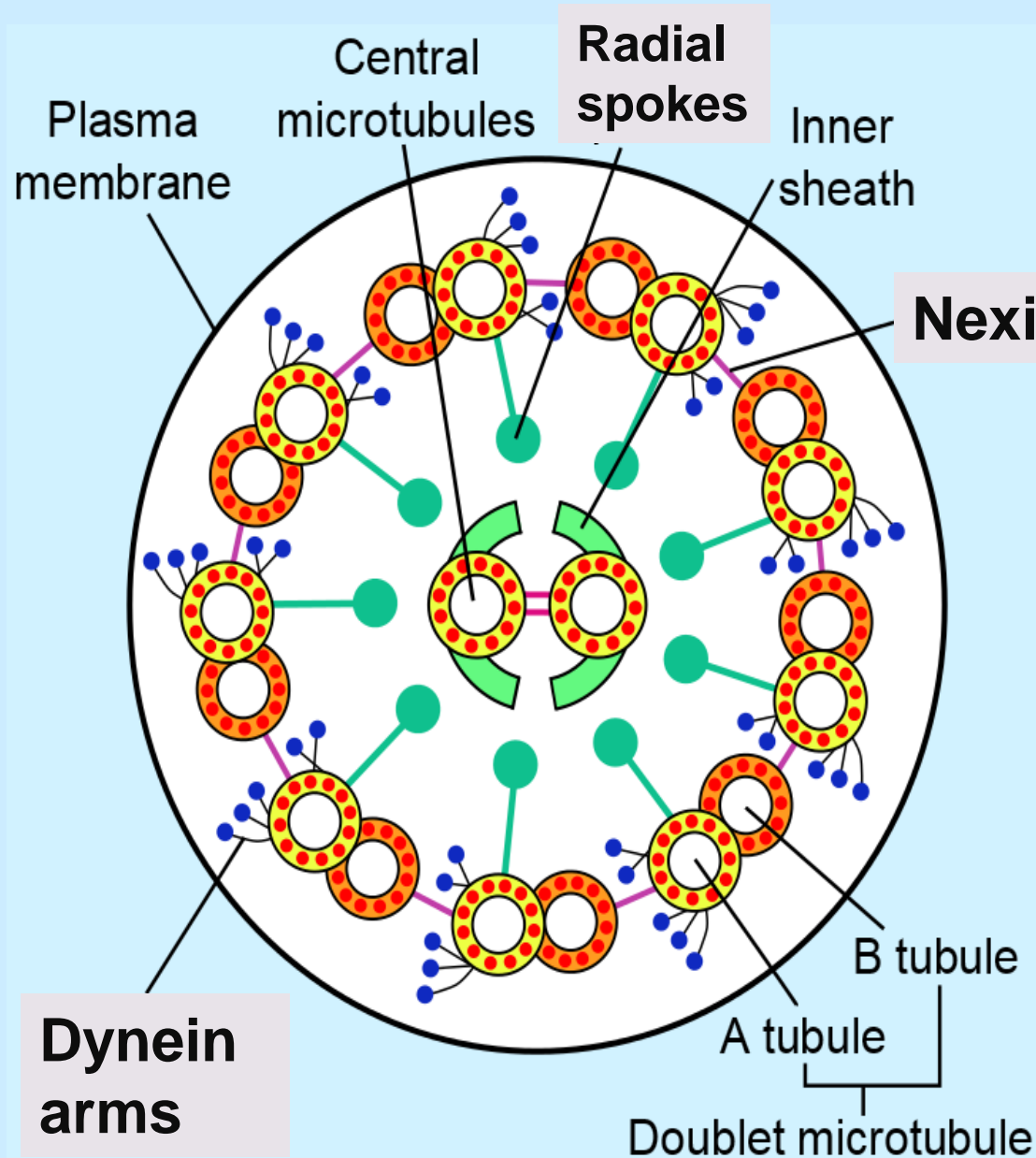


The egg travels along the oviduct

- work to keep the airways clear of mucus and dirt,



Proteins associated with the axoneme

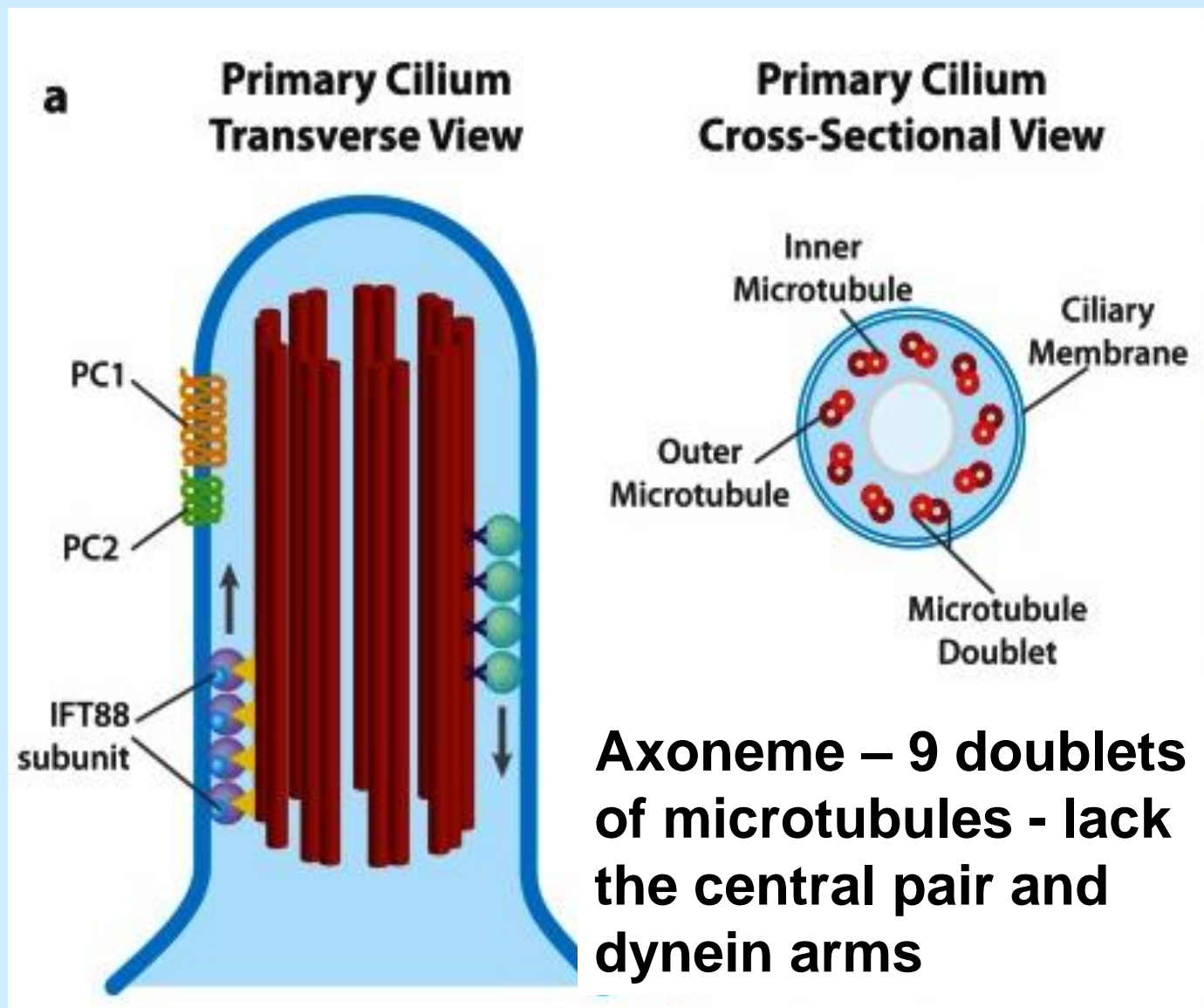


Nexin - connects neighboring doublets

Dynein - ATP-ase activity - energy for movement

Radial spokes - T-shaped structures - different proteins - interact with both the central pair microtubules and the dynein arms

Primary cilia - short, immotile cilia, on almost every cell, one per cell

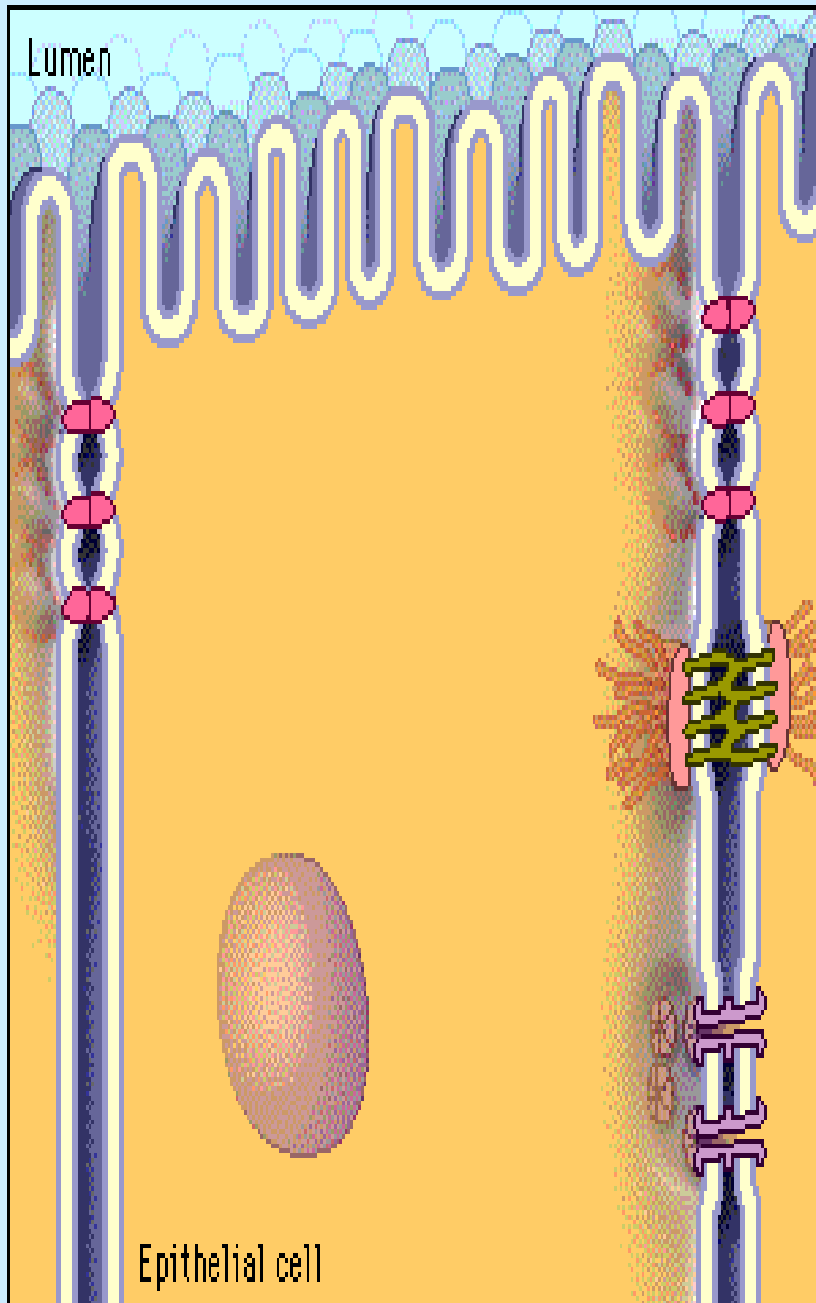


Axoneme – 9 doublets of microtubules - lack the central pair and dynein arms

Functions:

- sensory organelles - respond to mechanical and chemical stimuli

Intercellular junctions (lateral domain)



Occluding junctions

- seal cells together - **zonulae occludentes**)

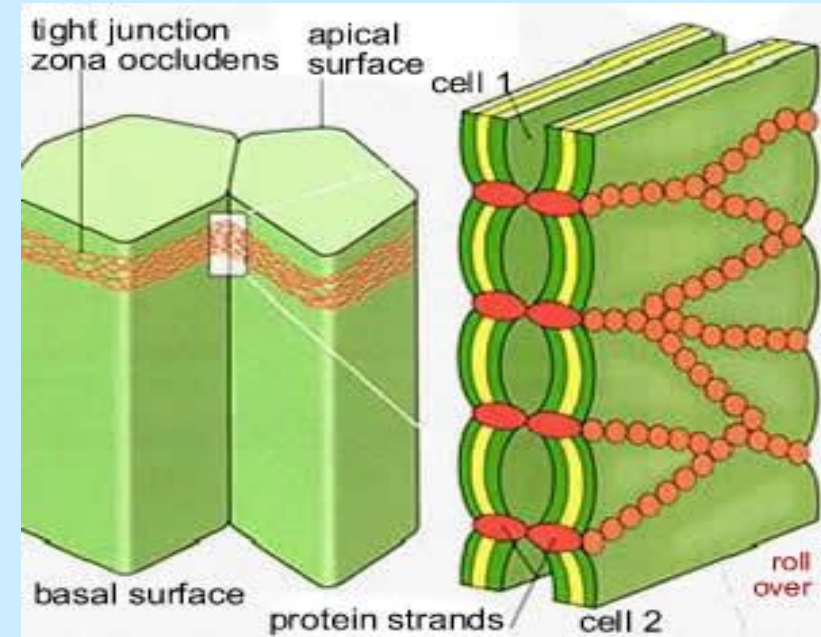
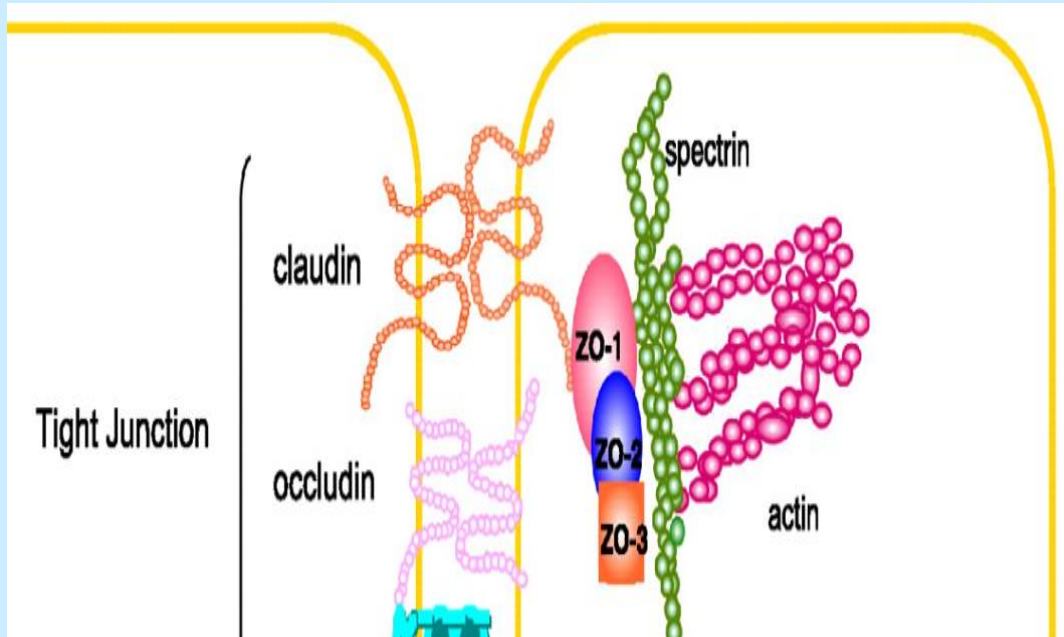
Anchoring junctions

- mechanically attach cells - **zonulae adherentes, desmosomes**

Communicating junctions

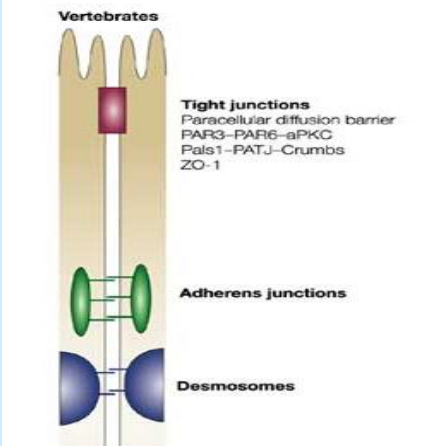
- mediate the passage of molecules - **gap junctions**

Zonulae Occludentes or Tight junctions (Occluding junction) - the most apically located junction - seal cells together

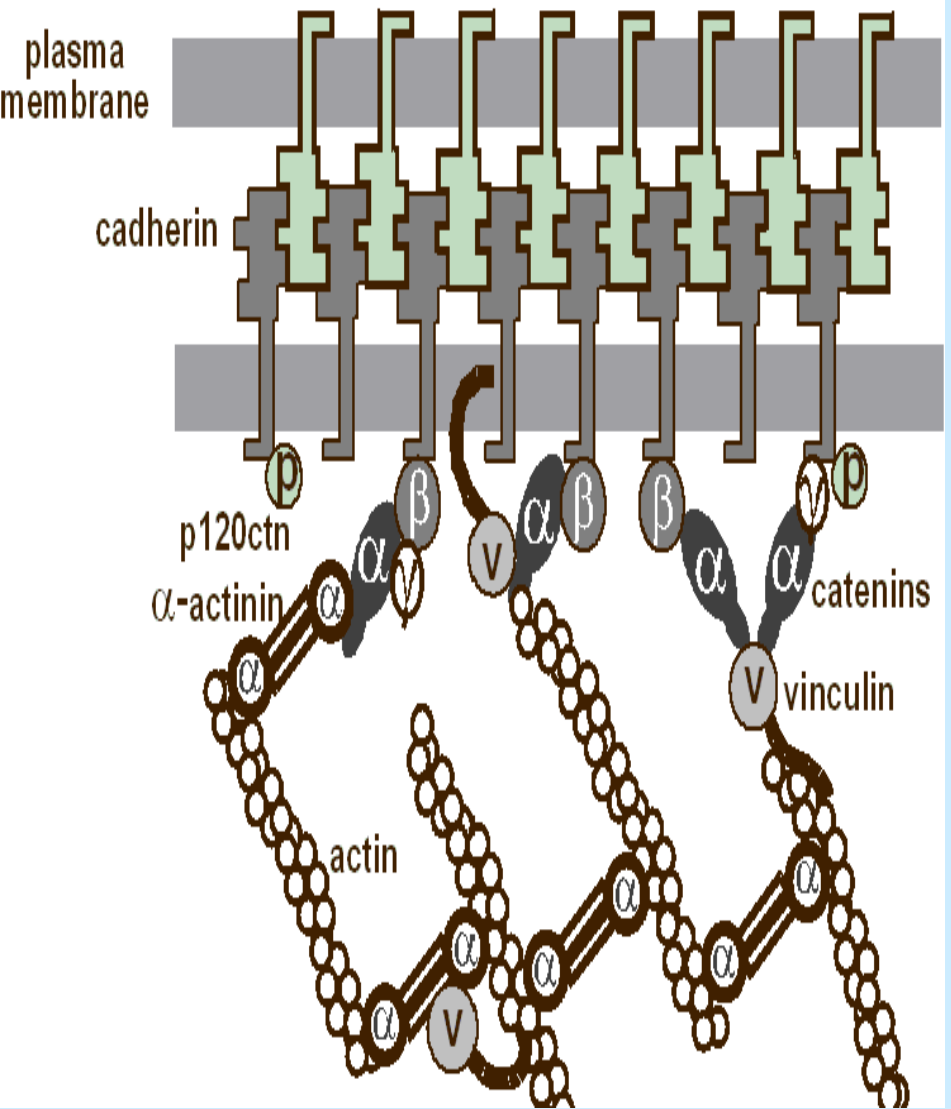


- transmembrane proteins – **claudins** and **occludins**
- prevent the movement of membrane proteins from the apical domain to the basolateral domain
- prohibit molecules from passing between cells

Zonulae Adherentes (anchoring junction)



ZONULA ADHERENS

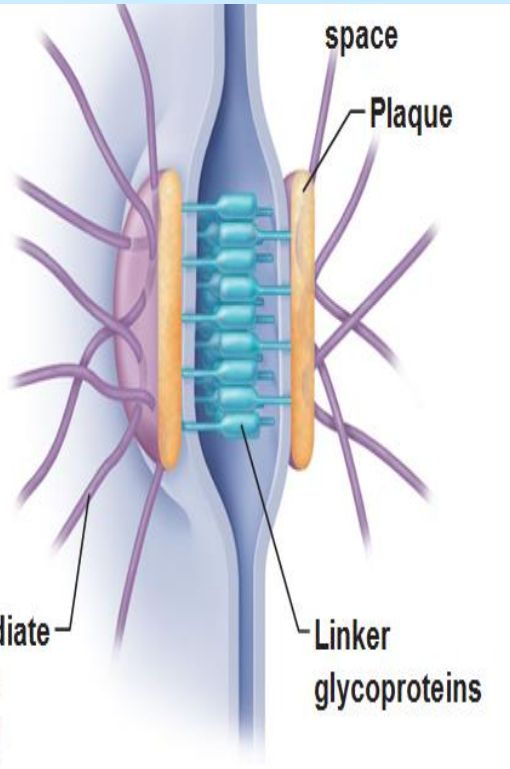
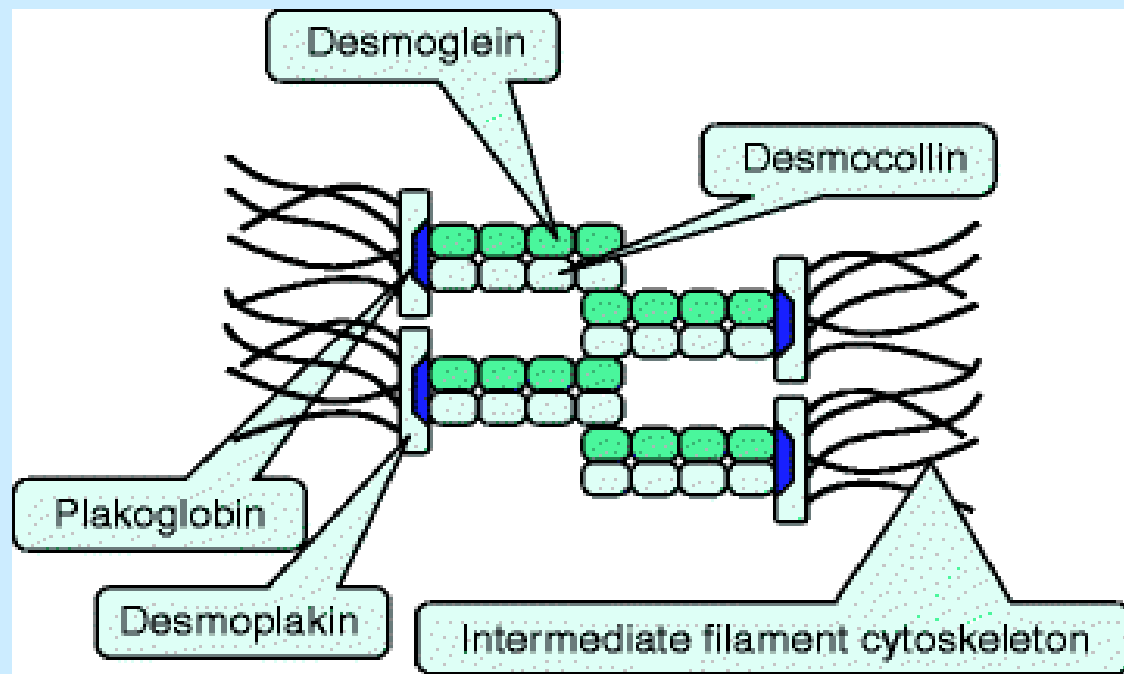


- **cadherins** (Ca²⁺ dependent proteins of the cell membrane) - bind to **actin** filaments
- Actin filaments are attached to each other and to the cell membrane by **catenin, vinculin and alpha actinins**

DESMOSOMES

(anchoring junction)

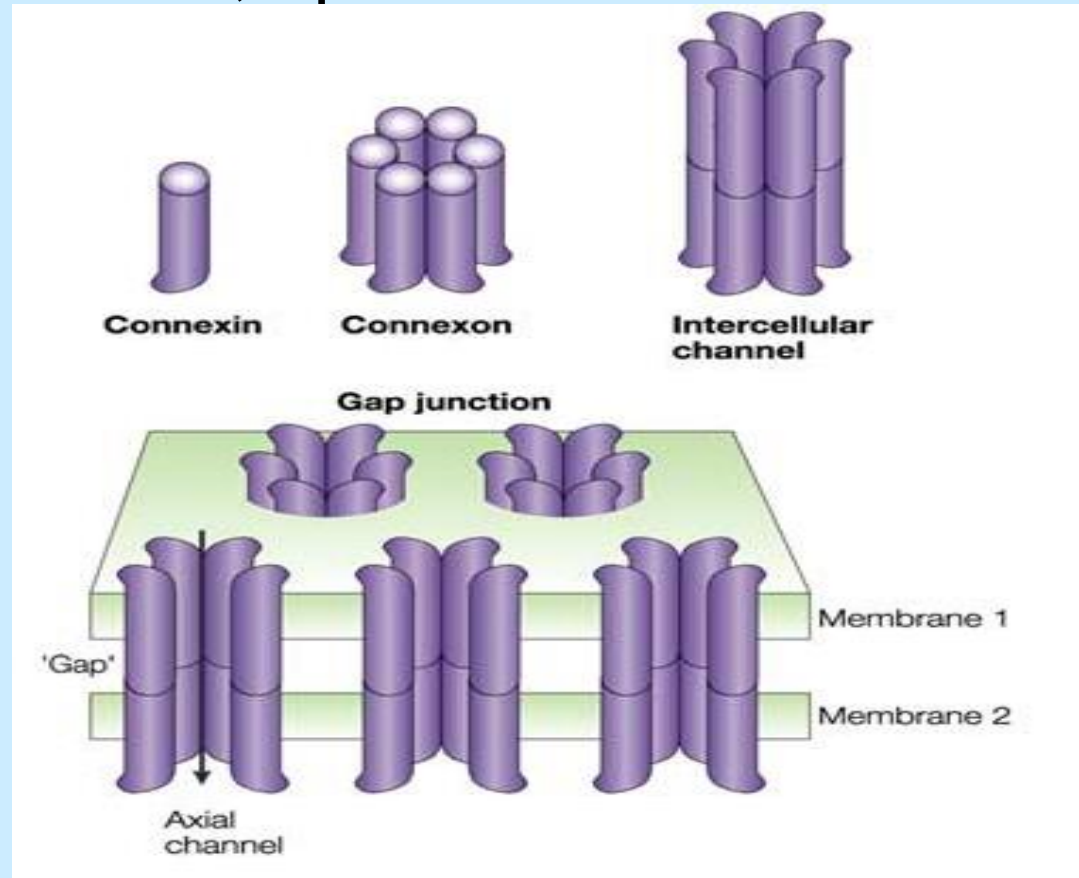
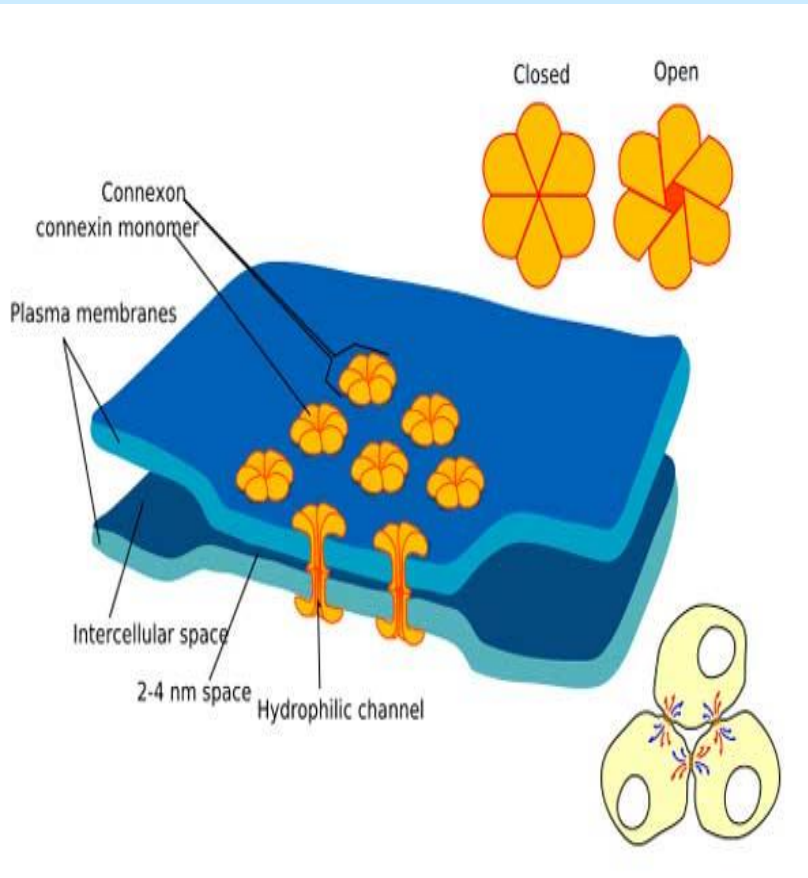
- randomly distributed along lateral cell membranes (numerous in **epidermis**)



- two **plaques** – in membranes of adjacent cells
- plaque - **desmoplakin** and **plakoglobin** - bound intermediate filaments to plaques
- **desmoglein** and **desmocollin (catherins)** - bridge the space between adjacent cells

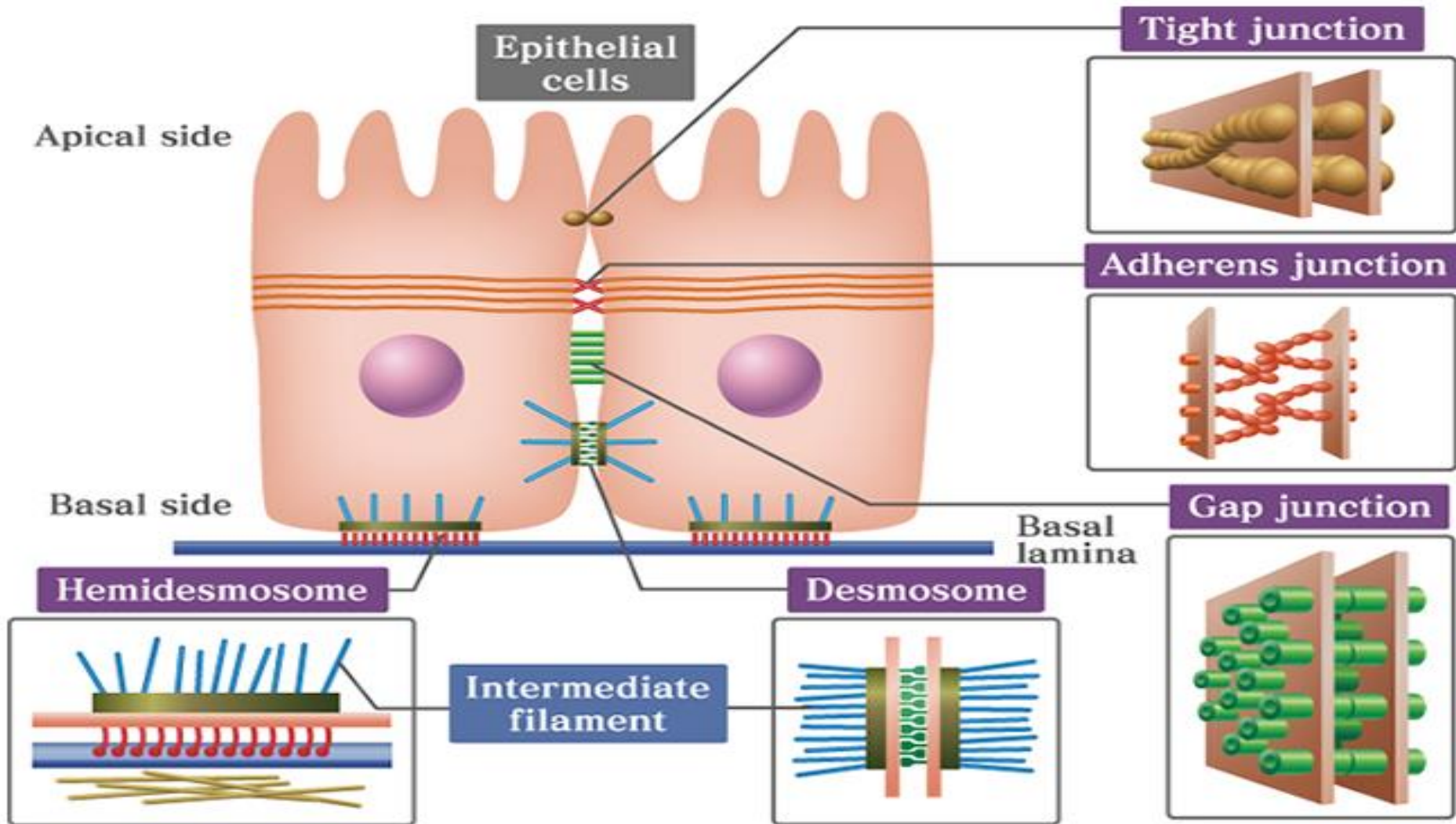
Gap junctions (communicating junction)

- intercellular channels (electrical synapses) - channel - 2 connexons. Each **connexon** - 6 proteins - **connexins**.
- Transport of ions and small molecules, up to 1500 daltons.



Basal surface specializations

- **Hemidesmosomes** - attach the basal cell membrane to the basal lamina



Hemidesmosomes - resemble half desmosomes

- attach the basal cell membrane to the underlying basal lamina

cytosol

keratin filaments

Cytokeratin - intermediate filaments anchored to desmoplakin plaque

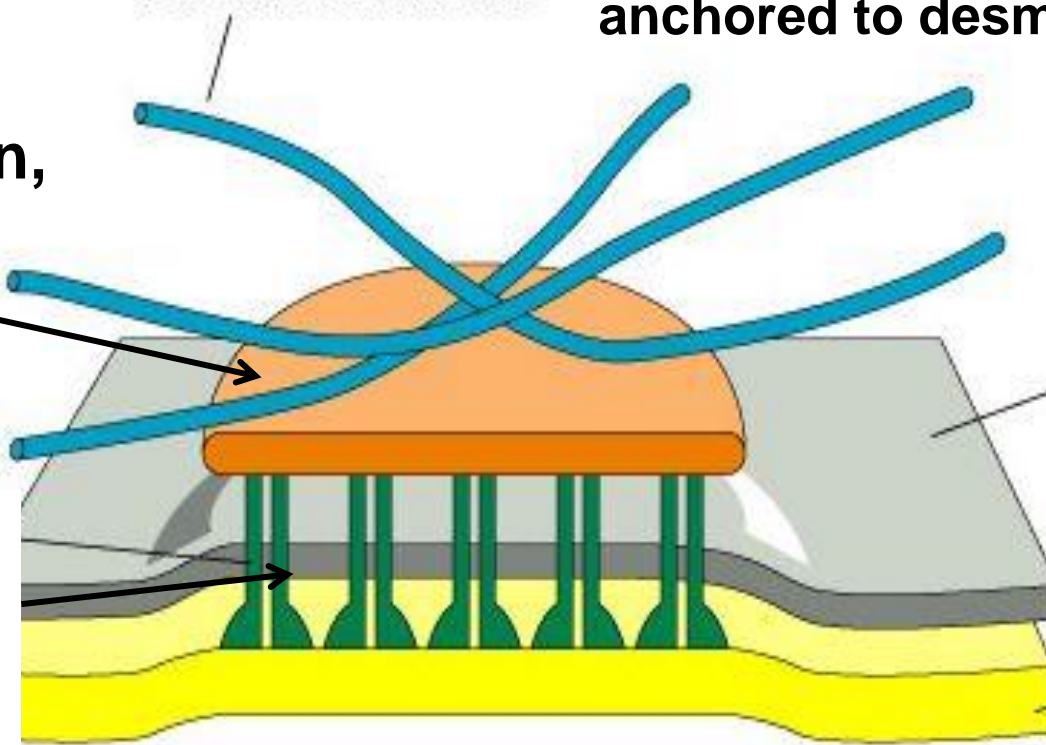
plaque with desmoplakin, plectin

basal plasma membrane of epithelial cell

anchoring proteins are attached to the plaque and the basal lamina

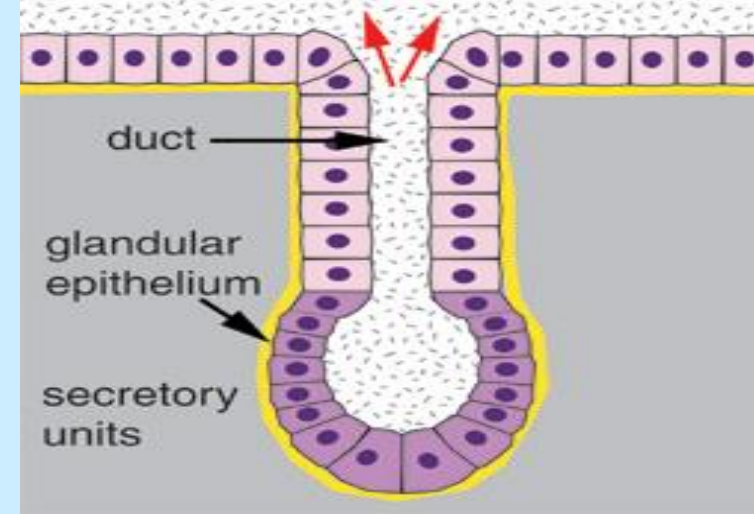
basal lamina

extracellular matrix



GLANDS

- from invaginated epithelial cells
- function - secretion.

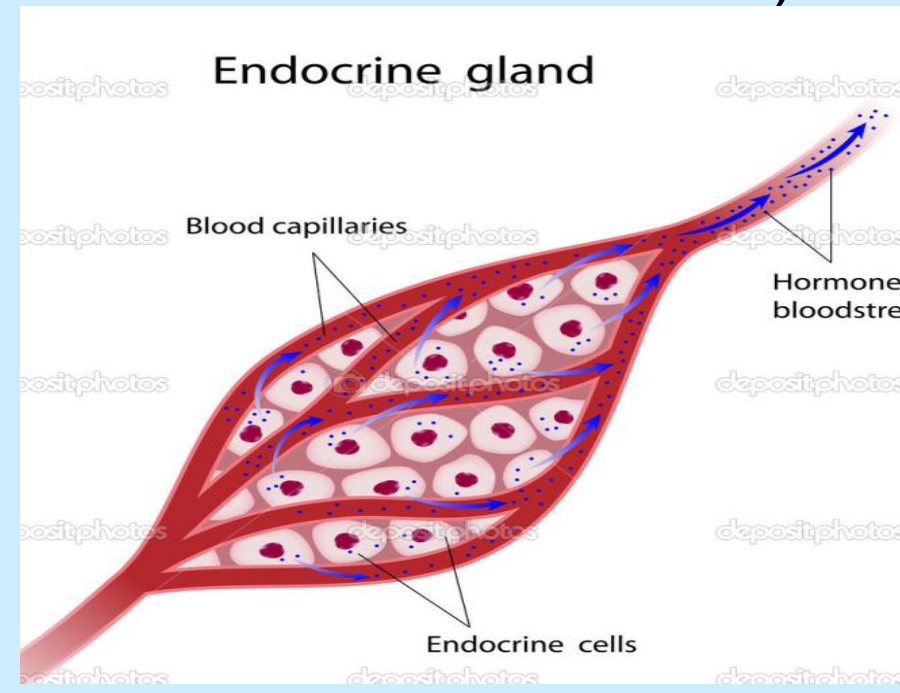


Exocrine glands

- release the secretory product via ducts that open at the surfaces of the body (skin, gastrointestinal tract etc.)

Endocrine glands

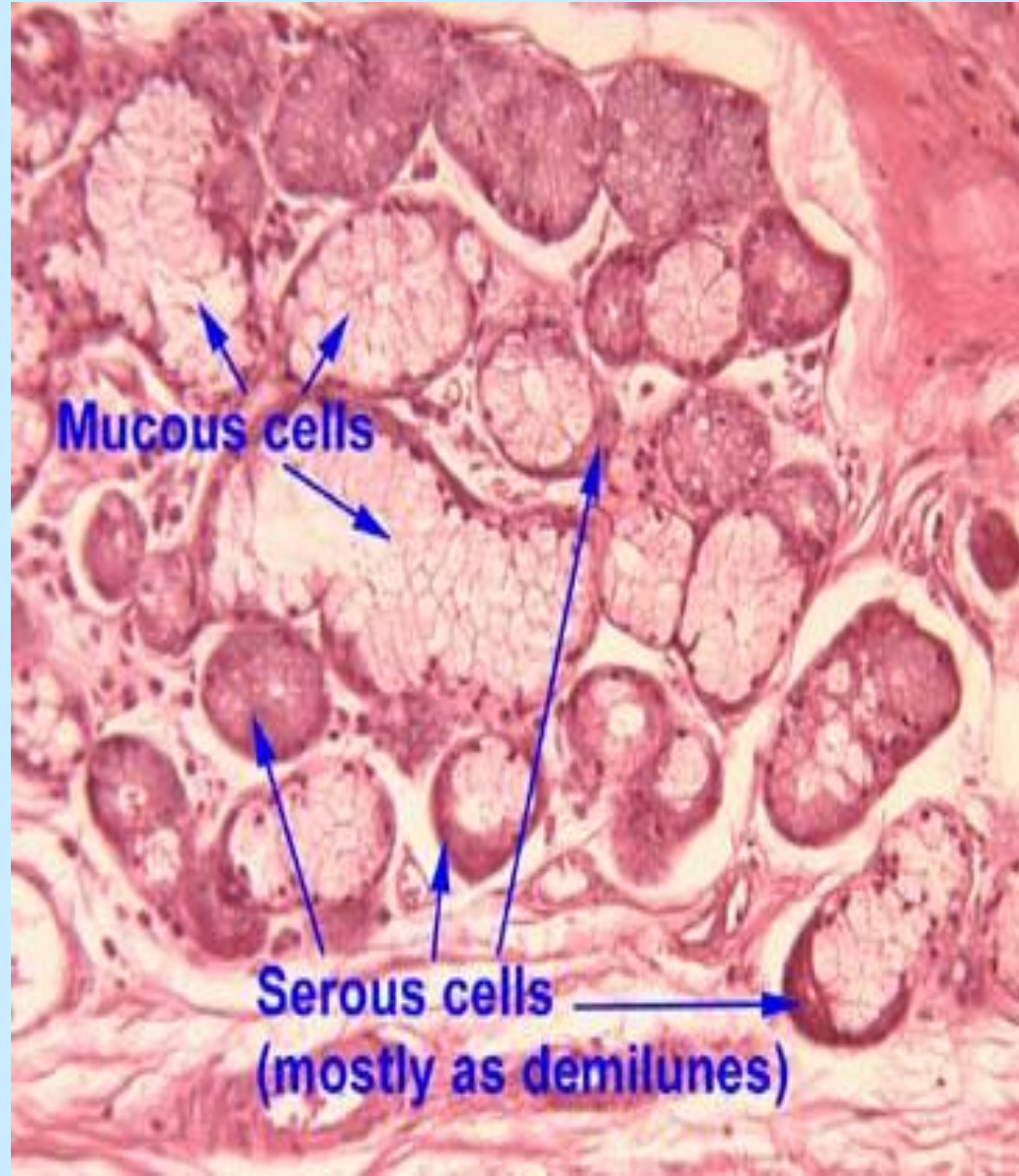
- release secretory product (hormone) into the blood.



Classification of exocrine glands

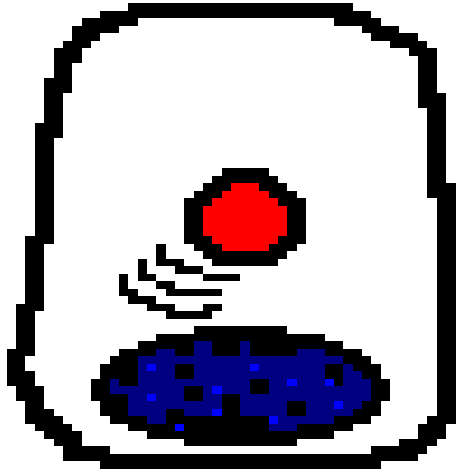
According to:

- **nature of secretion**
 - mucous glands
 - serous glands
 - mixed glands
- **mode of secretion**
 - merocrine glands
 - apocrine glands
 - holocrine glands
- **number of cells**
 - unicellular
 - multicellular

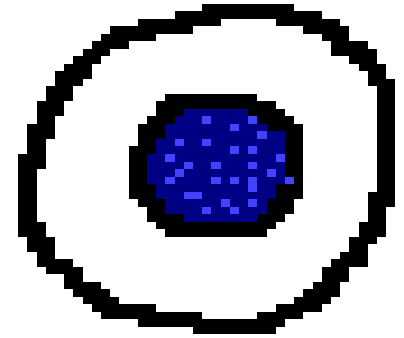
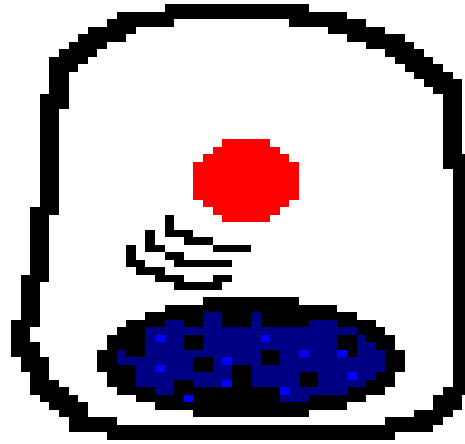


Mechanisms of secretion of exocrine glands

merocrine



apocrine



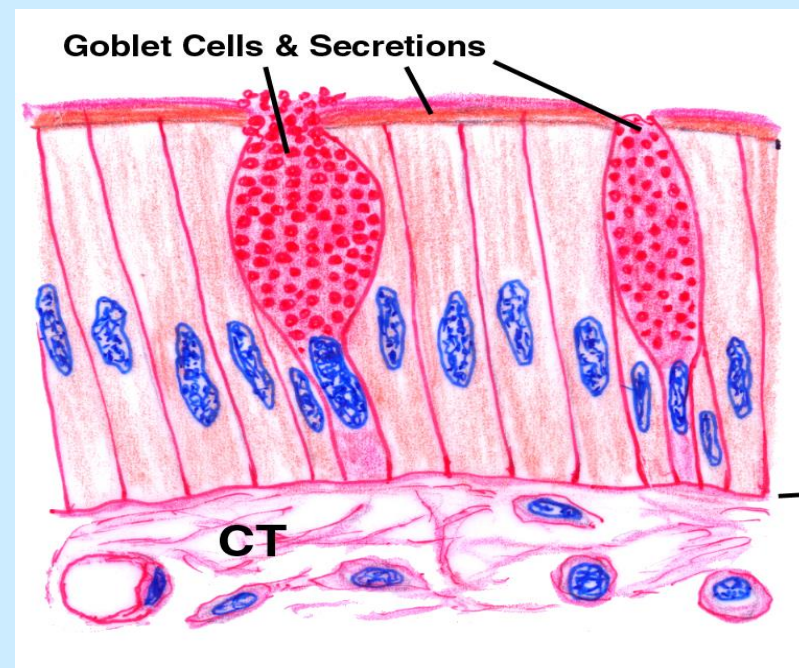
Merocrine gland – secretion is released via exocytosis, the cell is not damaged - **sweat gland**

Apocrine gland – a small portion of the apical cytoplasm is released with the secretory product - **mammary gland**

Holocrine gland – secretory cell dies and becomes the secretory product - **sebaceous glands**

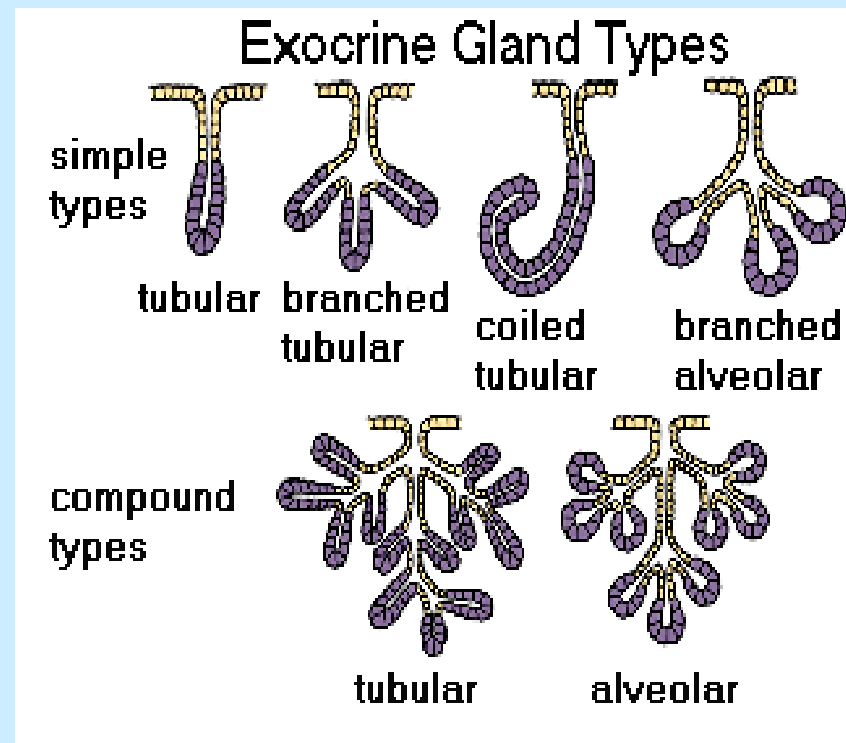
Unicellular glands

- the simplest form of exocrine glands - a single secretory cell
- **goblet cells** - in the epithelium of **simple columnar epithelium, pseudostratified epithelium.**



Multicellular exocrine glands

- secretory portion embedded in the connective tissue
- the secretory portions - different shapes - tubes, acini or alveoli



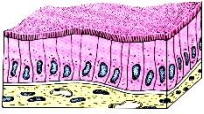
Pemphigus (*Pemphigus vulgaris*) – an autoimmune disease - affect the skin and mucous membranes.

- autoantibodies against desmoglein destroy desmosomes.
- cells become separated from each other - **acantholysis**

If not treated, **pemphigus** can be fatal from an infection. The most common treatment is the administration of oral steroids, especially prednisone, often in high doses



Seminar: Structure and function of epithelial tissue.
Practical class: Epithelial tissue, glands.



simple columnar
epithelium

- simple squamous epithelium - cornea (slide # 3),
- simple columnar epithelium - jejunum (slide # 51a),
- simple cuboidal epithelium - thyroid gland (slide # 8),
- stratified squamous epithelium – cornea (slide # 3),
- pseudostratified columnar epithelium - trachea (slide # 60),
- stratified cuboidal epithelium (transitional) - urinary bladder (slide # 67),