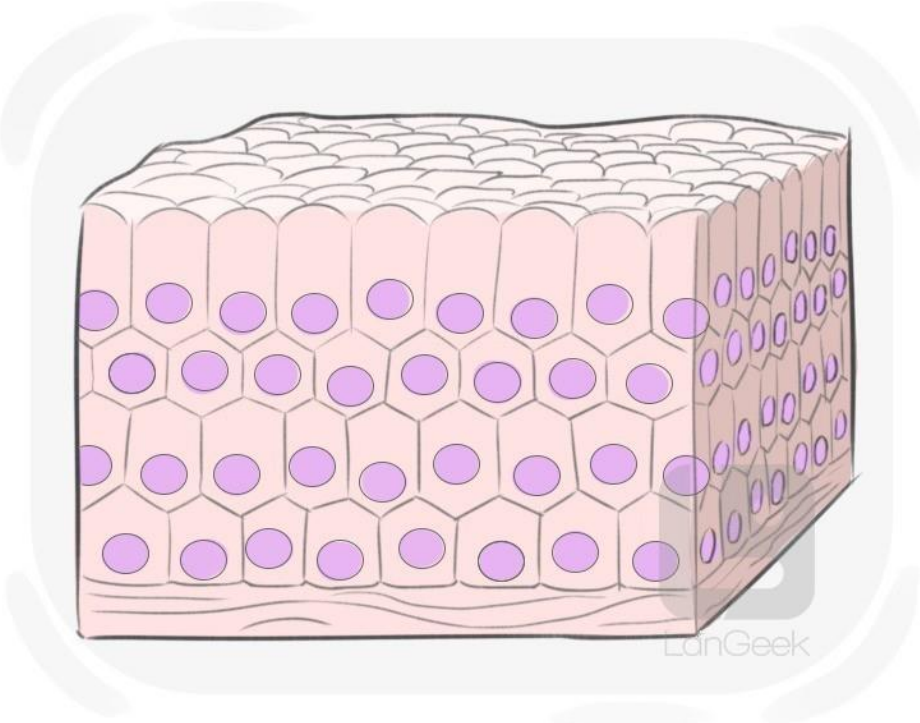
КАЗАНСКИЙ (ПРИВОЛЖСКИЙ) ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ

EPITHELIAL TISSUE

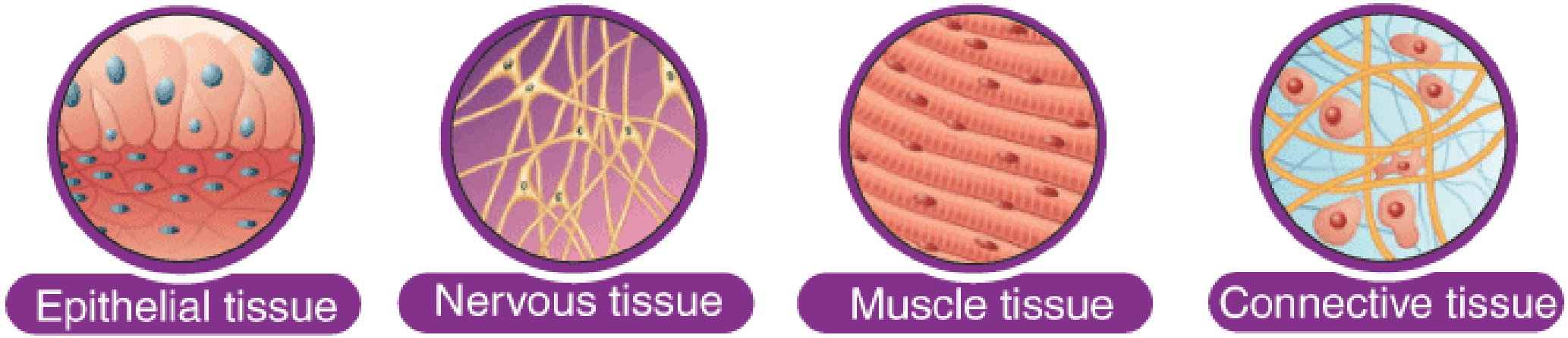
Histology is the study of tissues

Tissue is a complex of cells that have a common function

- ✓ The cells in a tissue may all be the same type, or they may be of multiple types.



The Four Primary Tissue Types:



- Each tissue type has a very specific set of functions
- Intercellular matrix fills the space between the cells

✓ **Epithelium (epithelial tissue)** covers body surfaces, lines body cavities, and forms glands.

✓ **Connective tissue** underlies or supports the other three basic tissues, both structurally and functionally.

✓ **Muscle tissue** is made up of contractile cells and is responsible for movement.

✓ **Nerve tissue** receives, transmits, and integrates information from outside and inside the body to control the activities of the body.

General features of Epithelium:

1. Can be derivate of all three germ layers

2. Cells show polarity

3. Little intercellular material

4. Cells are laying close to each other

5. Numerous intercellular junctions for attachment and anchorage

6. Rest on a basement membrane

7. Avascular

8. Line surfaces and cavities or form glands

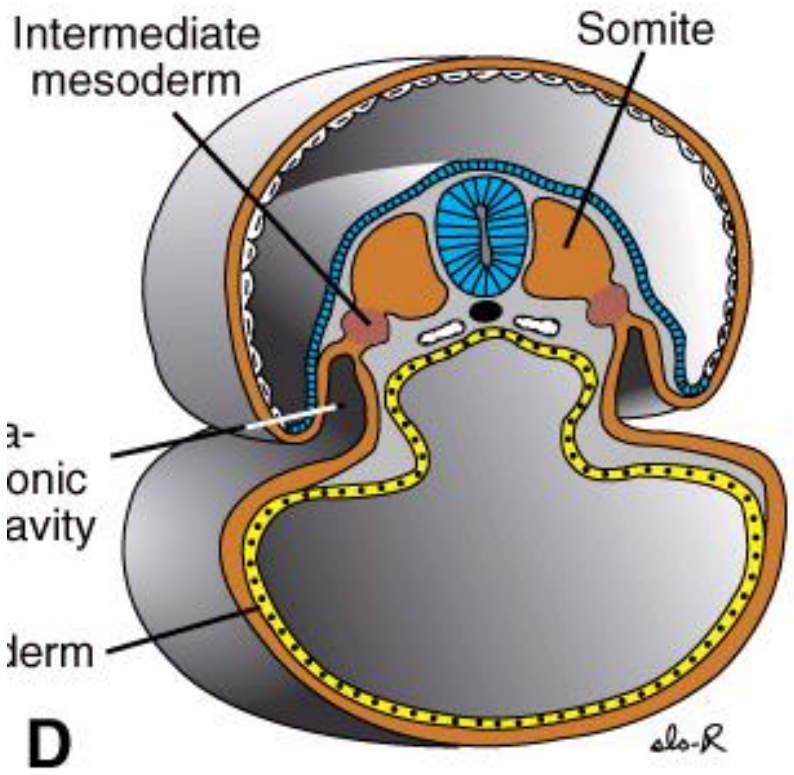
9. Mitotically active

Epithelium derivation:

Ectoderm

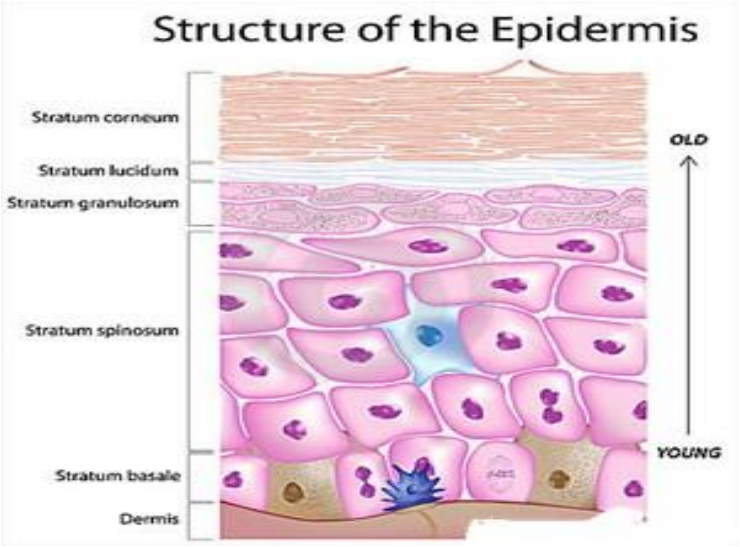
Mesoderm

Endoderm

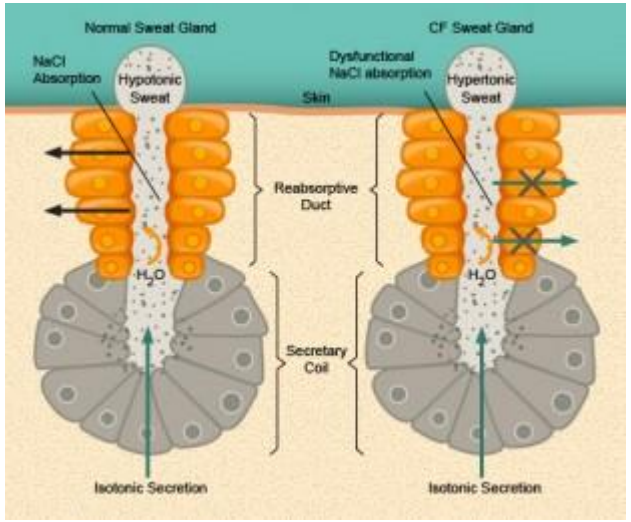


Ectoderm

- Epidermis of skin

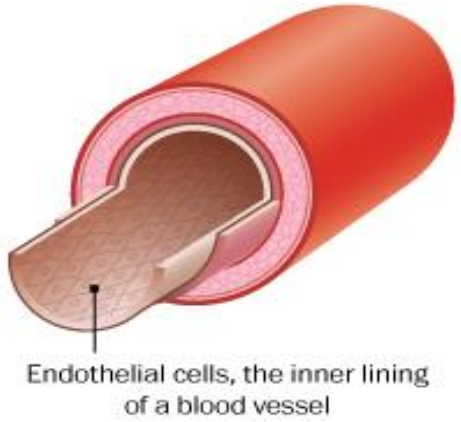


- Sweat glands and ducts



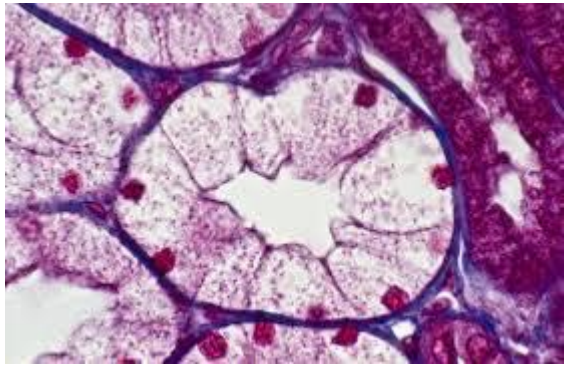
Mesoderm

- Endothelium lining of vessels



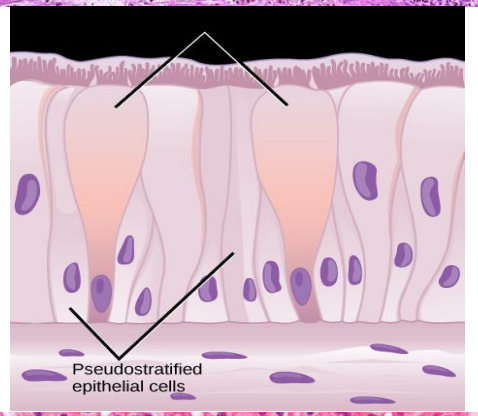
- Mesothelium lining of body cavities

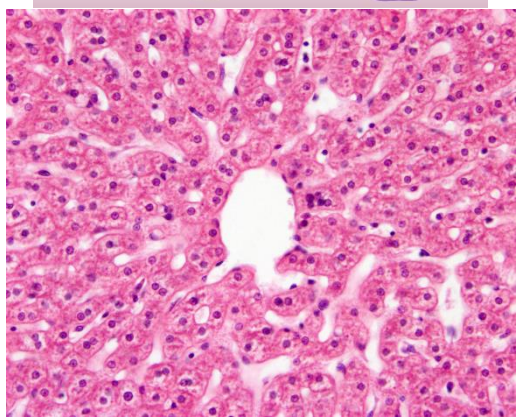
- Lining of urinary and genital organs



Endoderm

- Lining of gastrointestinal tract
- Lining of respiratory tract
- Liver, pancreas

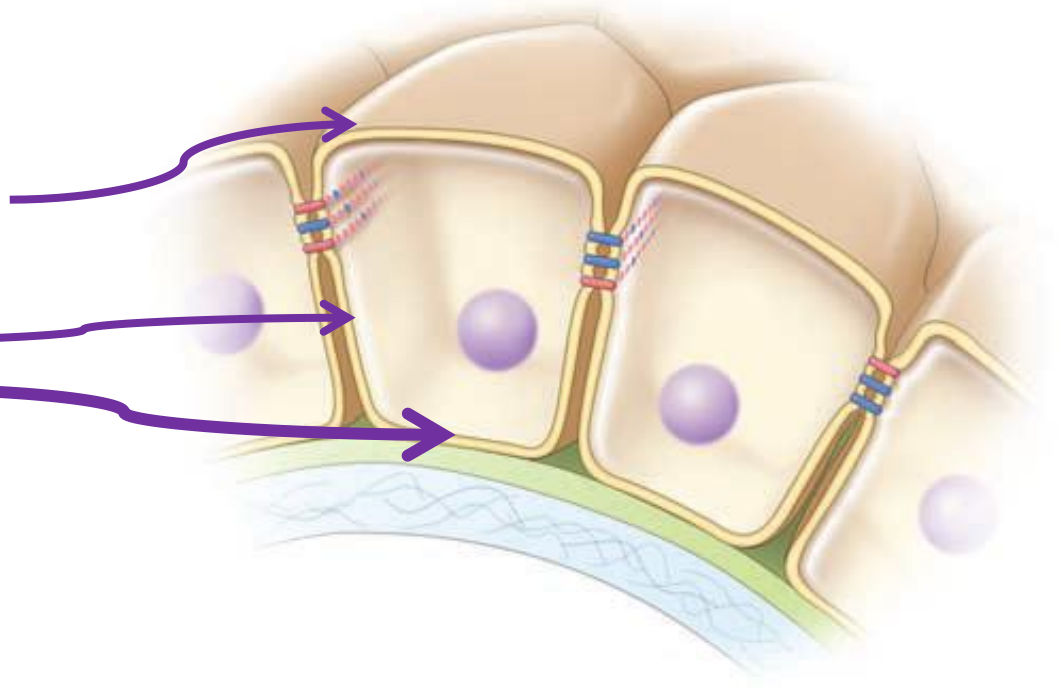




Polarity

Epithelial cells exhibit distinct **polarity.**

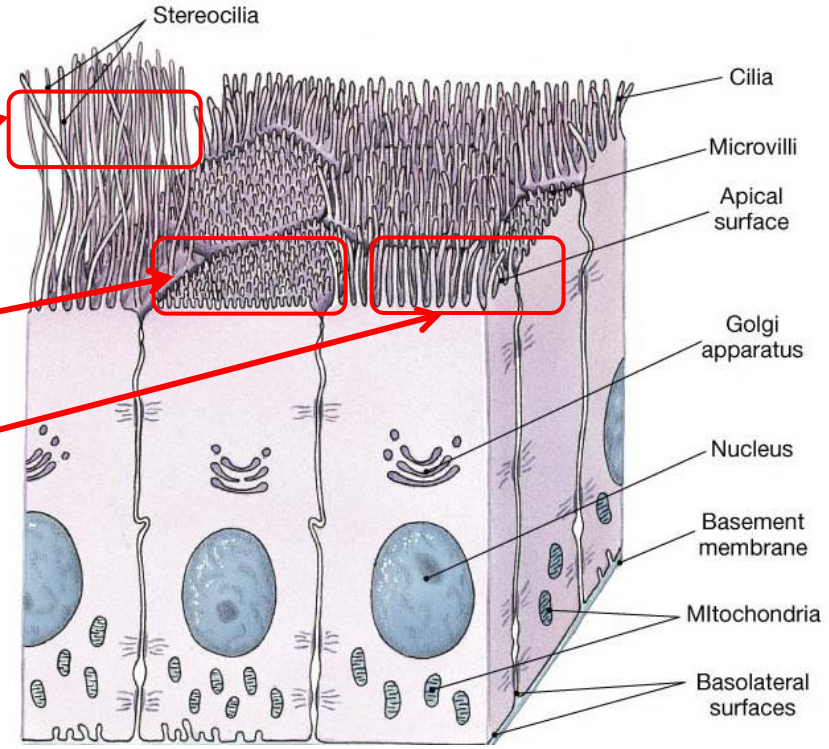
They have an apical domain,
a lateral domain,
and a basal domain.



The apical domain

- Part of the epithelial cell that looks towards the lumen or the surface

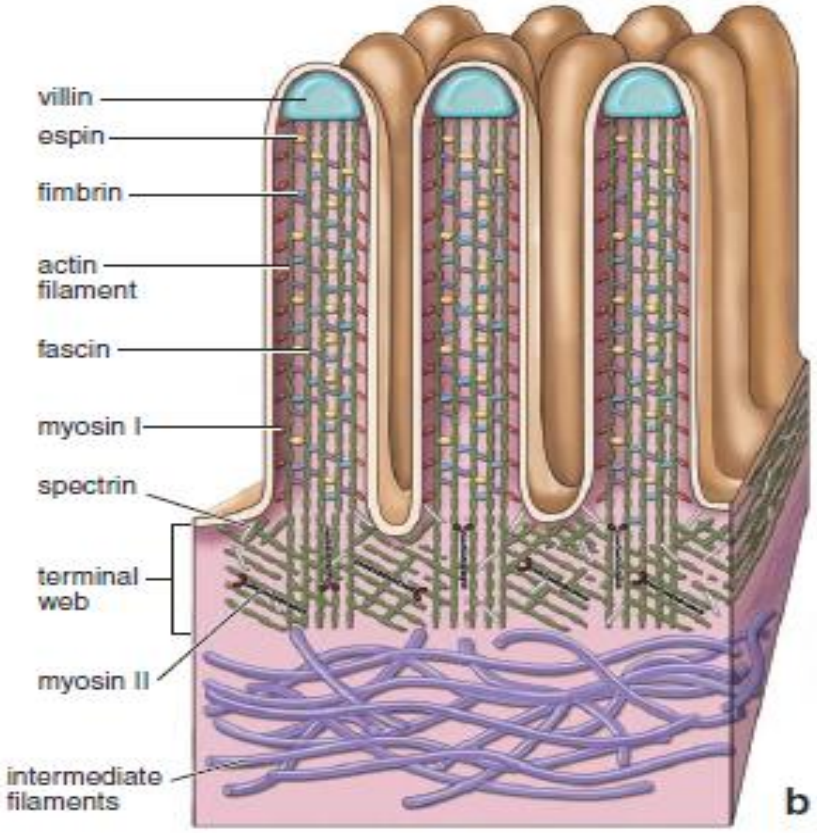
- Can have:
  - stereocilia
  - microvilli
  - cilia



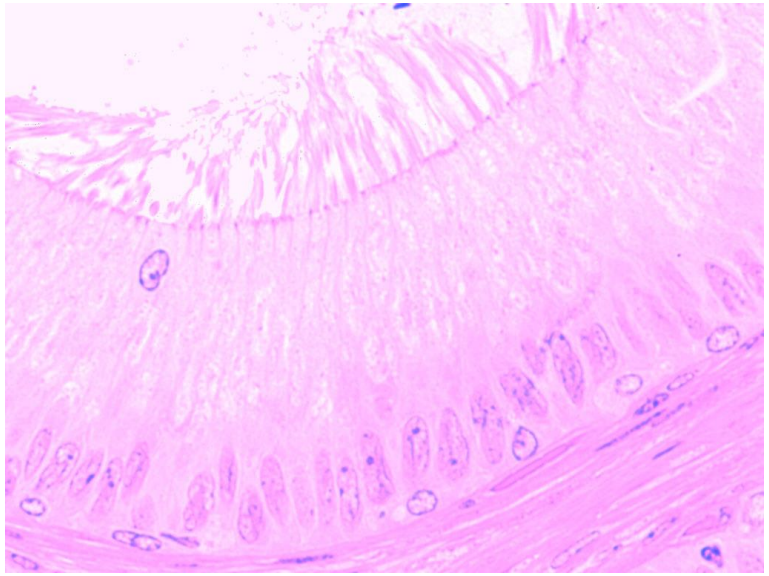
Microvilli

- **Fingerlike cytoplasmic projections on the apical surface**

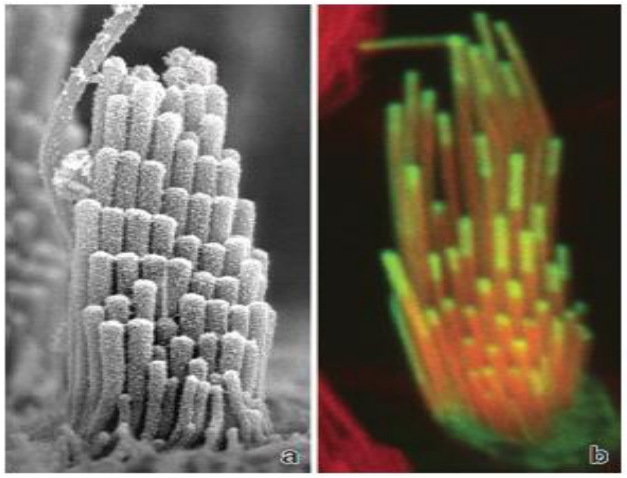
- Are usually present in large numbers on each cell and, collectively, are called **a brush border**
- Internal structure of microvilli contain a core of **actin filaments**
- Are relatively non-motile
- **Increase the surface of absorption (small intestine, proximal convoluted tubules in kidney)**

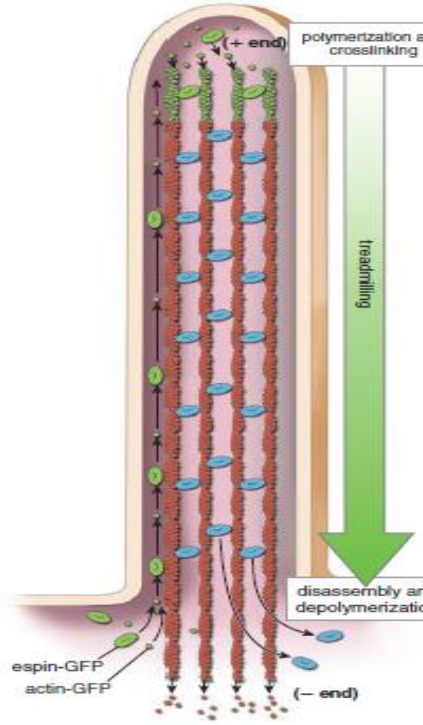


Stereocilia

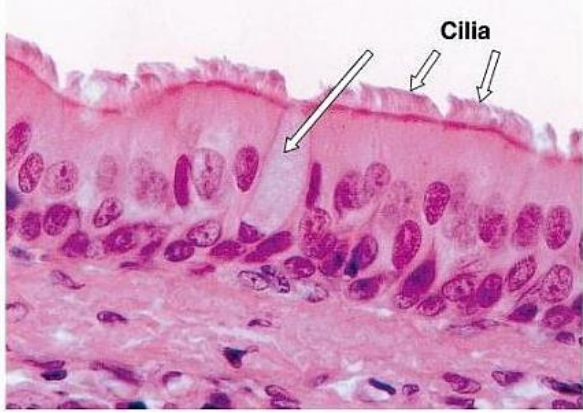


- Unusually long, immotile microvilli
- Contain a core of actin microfilaments
- In sense organs (hair cells) serve as mechanoreceptors
- In male reproductive tract (epididymis and ductus deferens) have absorptive function





Cilia



- one cell might have 250 cilia
- highly motile; beat in a wave-like motion
- capable of moving fluid and particles along the epithelial surface (bron tree, oviducts)
- present in sperm cell as flagella (forward movement)

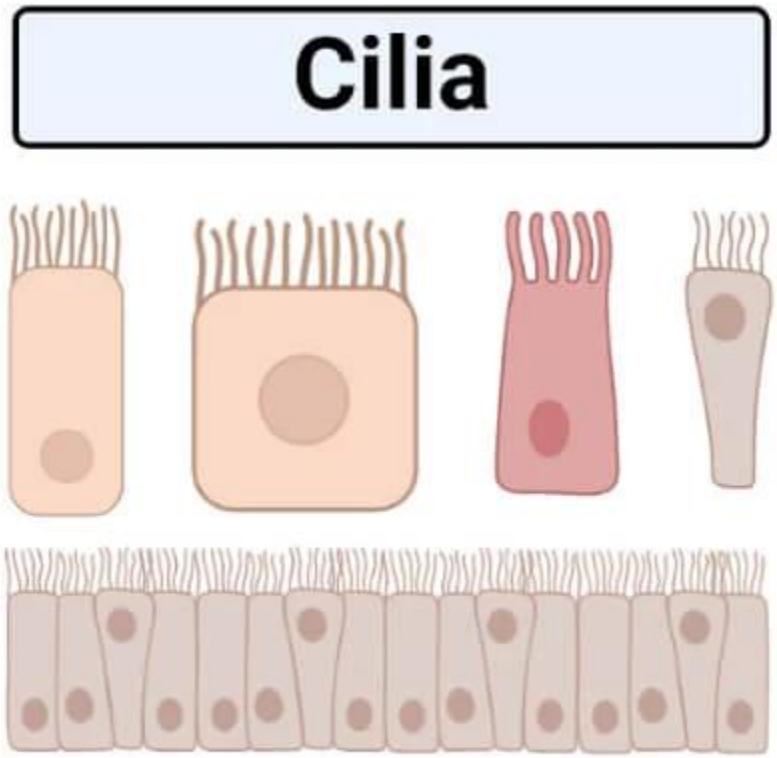
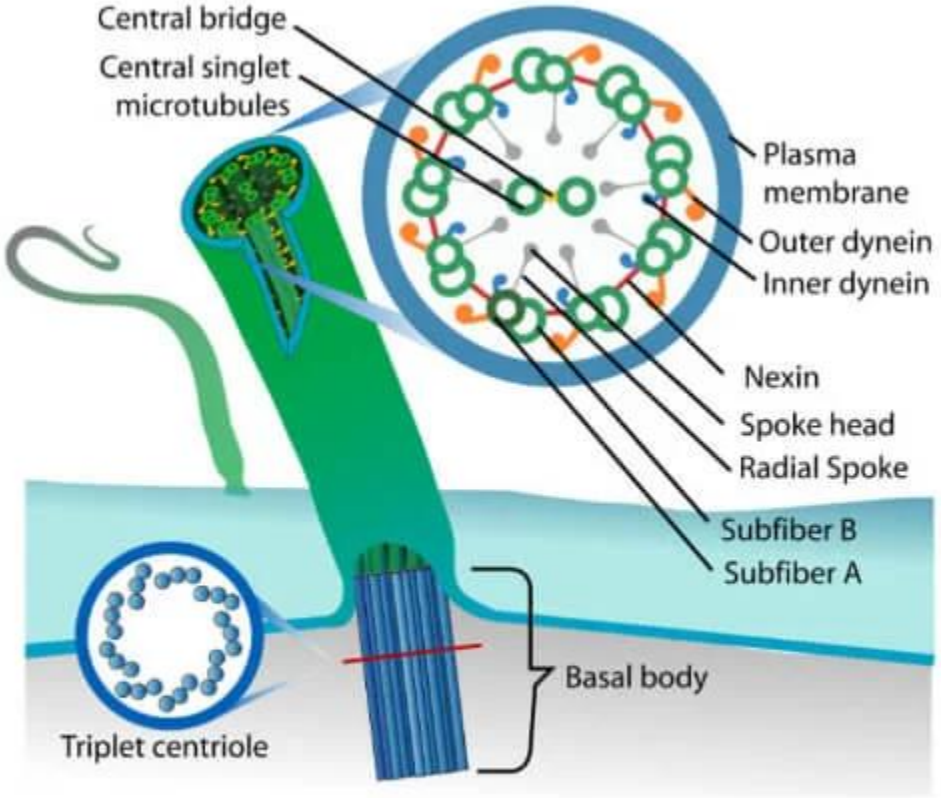


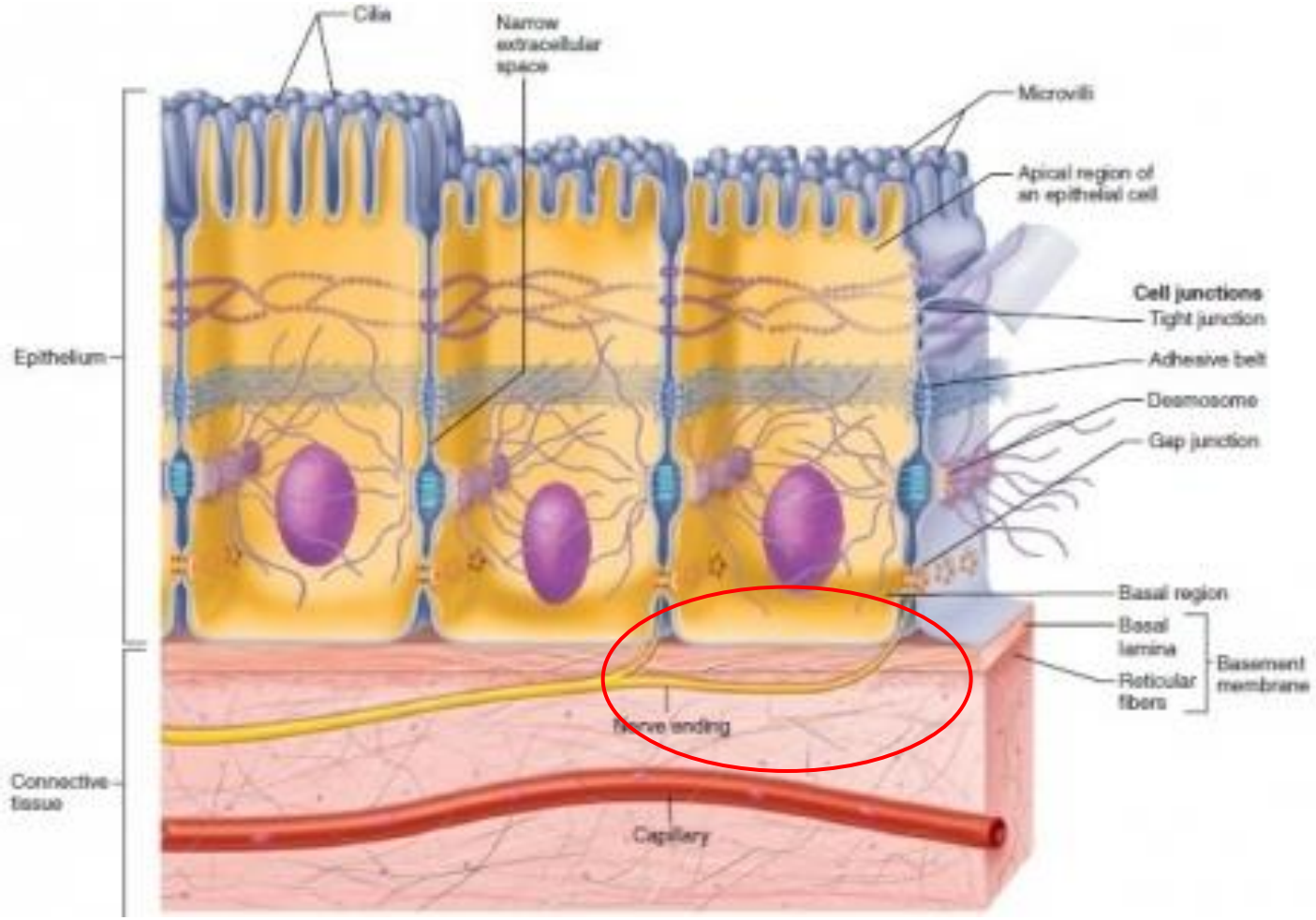
Figure: Cilia in ciliated epithelium



Core of a cilium is called the **axoneme**, in which nine pairs of microtubules surround two central, individual microtubules (9 + 2 arrangement).
The axomene originates from a **basal body** that is composed of nine triplets of microtubules.

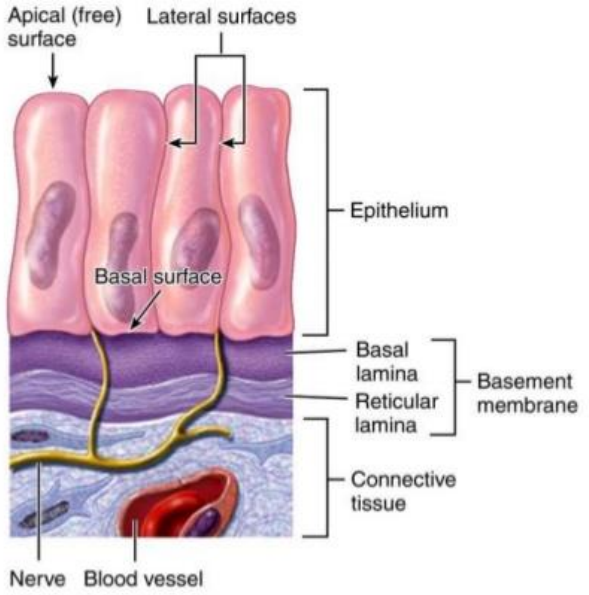
The basal domain

- A part of the cell faced towards the basement membrane



Basement membrane

- a thin, fibrous, extracellular matrix that separates the epithelial cells from underlying connective tissue



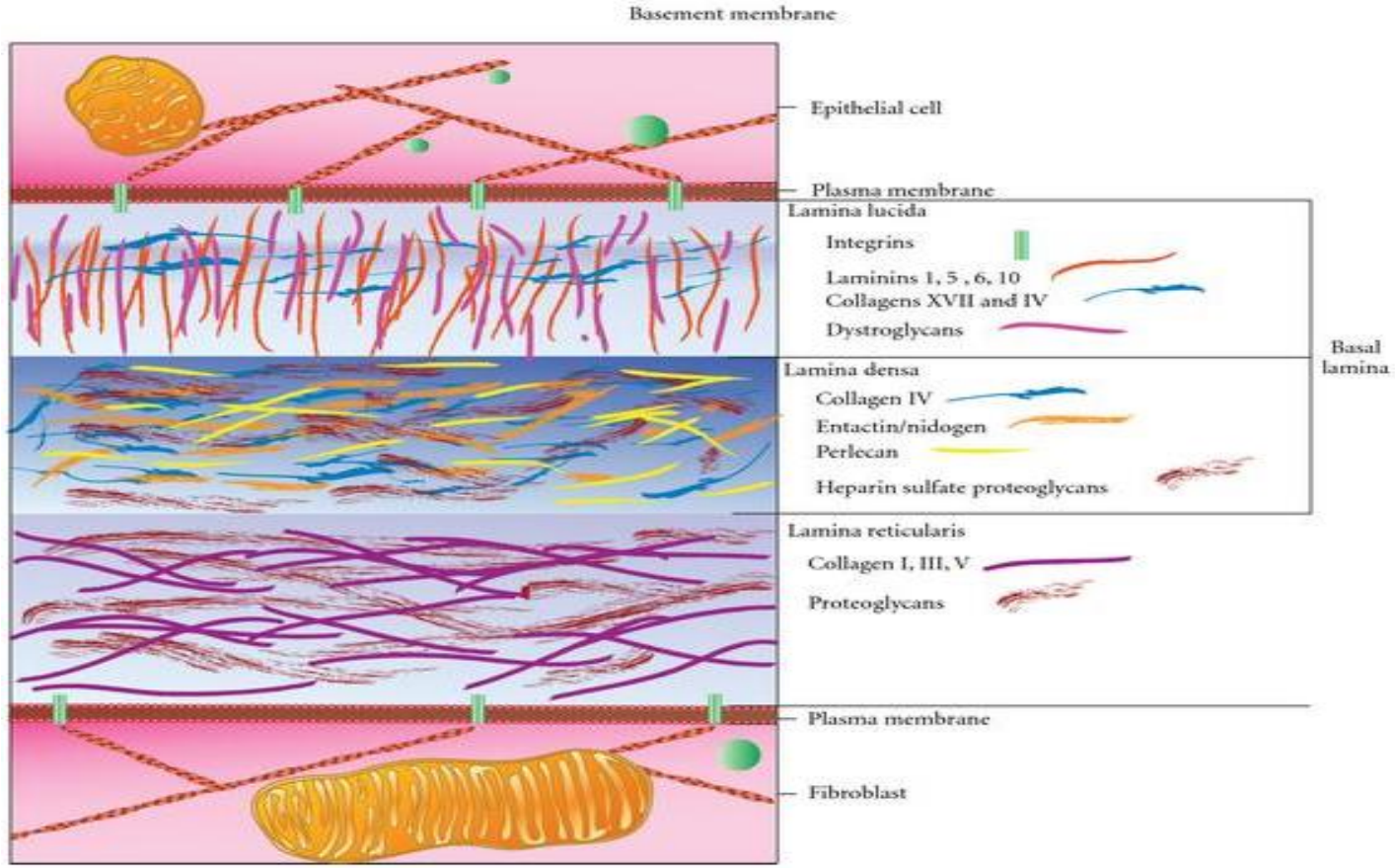
Basement membrane

Basal lamina:

- ✓ Collagen type IV
- ✓ Heparan sulfate
- ✓ Fibronectin and laminin

Reticular lamina:

- ✓ Collagen type III (reticular fibers)
- ✓ Proteoglycans



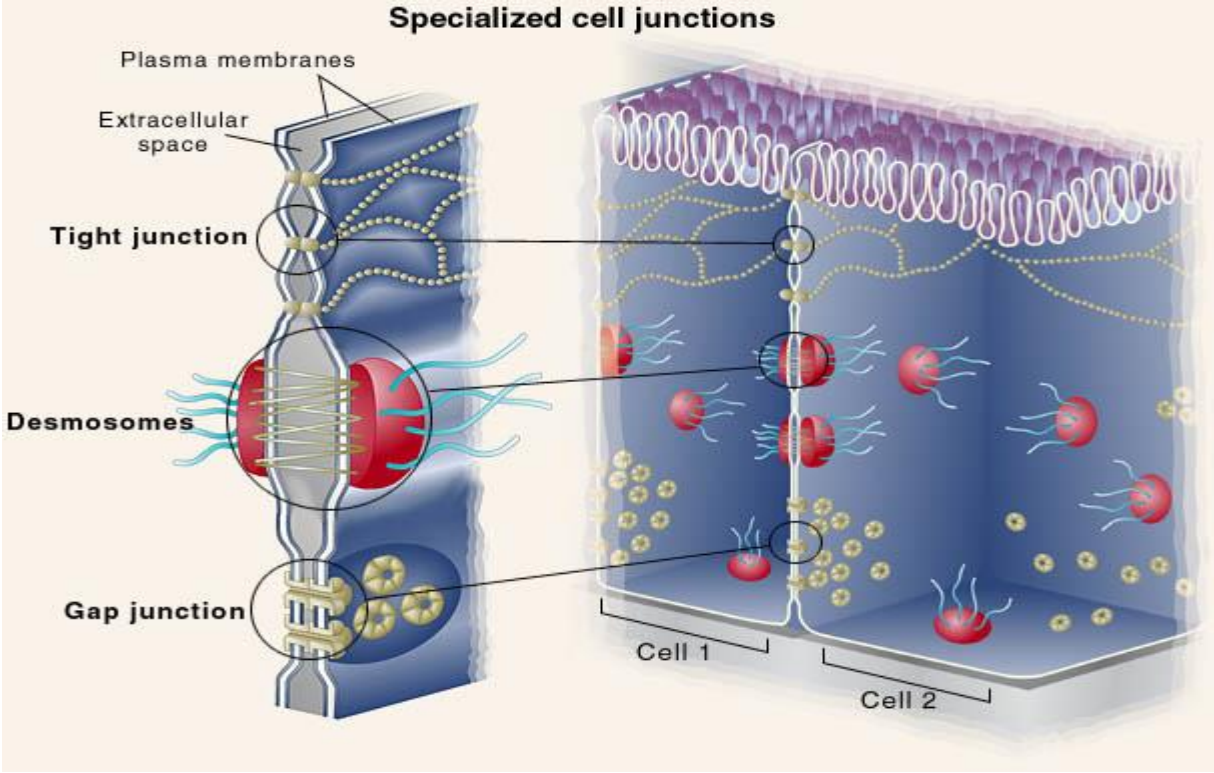
Functions of the basement membrane:

- Anchoring the epithelial cells to underlying connective tissue
- Mechanical barrier
- Accelerates the differentiation of endothelial cells
- Allow nutrients and waste to diffuse

The lateral domain

Provide cellular connections

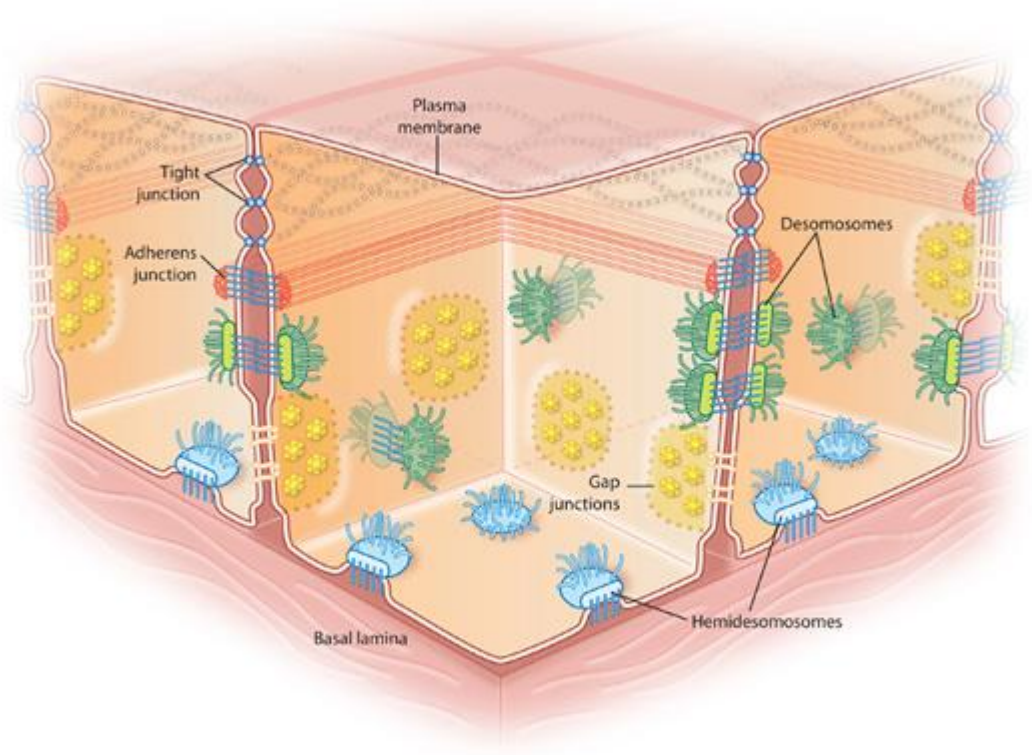
- Bind cells together
- Form permeability layer
- Intercellular communications



Cell junctions

Specialized structures of the plasma membrane that:

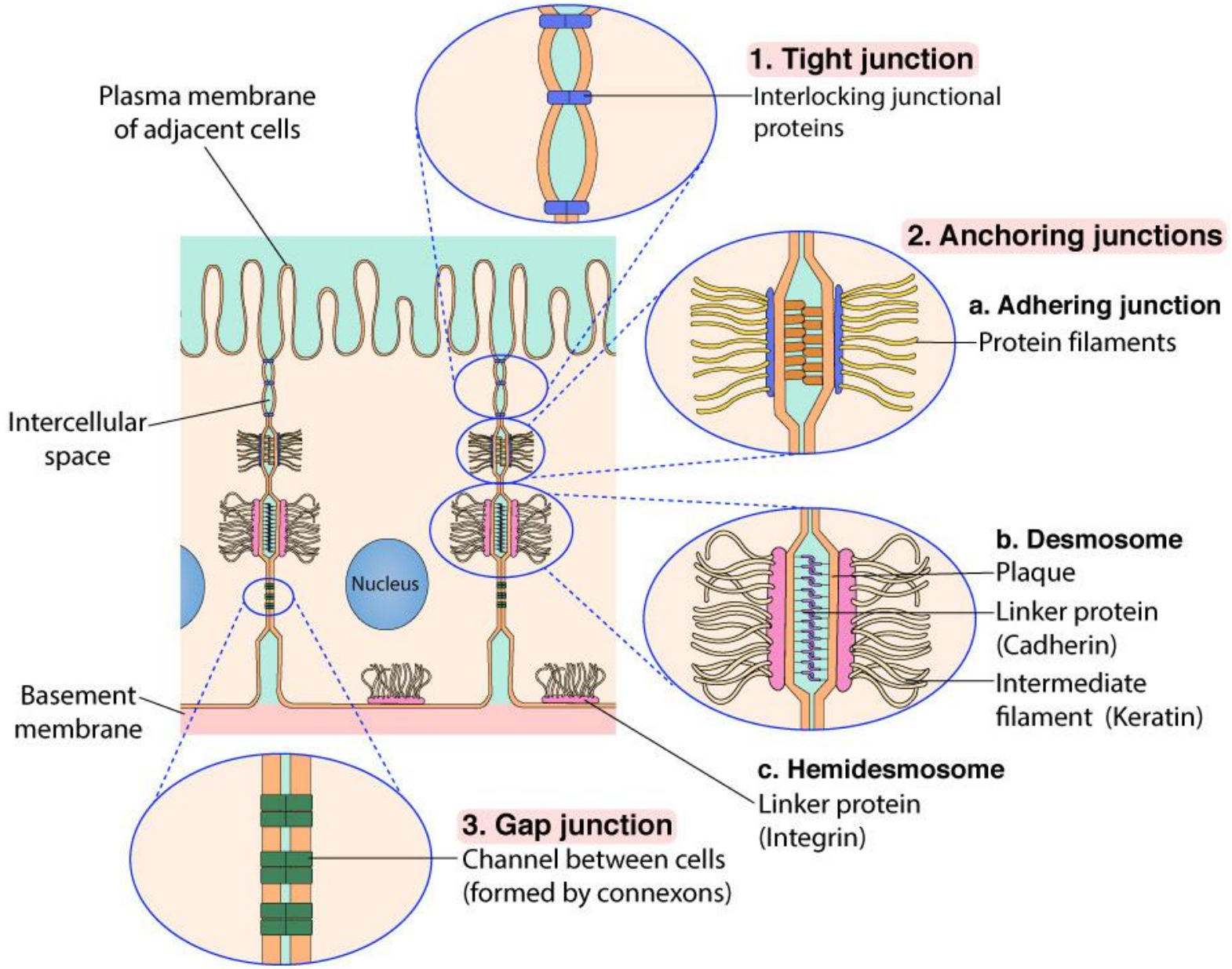
- Attach and anchor cells
- Establish apical and basolateral membrane domains by sealing adjacent plasma membranes
- Provide channels for ionic and metabol coupling



Not restricted to epithelial cells; cell junctions occur, however, in large number in epithelial tissues to resist the physical forces acting on the cells.

Types of cell junctions

- Tight Junctions (occluding junctions)
- Desmosomes (anchoring junctions)
- Gap junctions (communicating junctions)



Tight junctions (occluding junctions)

✓ Belt-like, barrier junction around apex of the cell

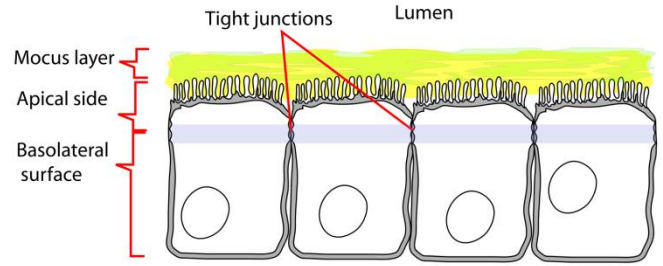
✓ Provides close apposition of adjacent plasma membranes and occludes the intercellular space

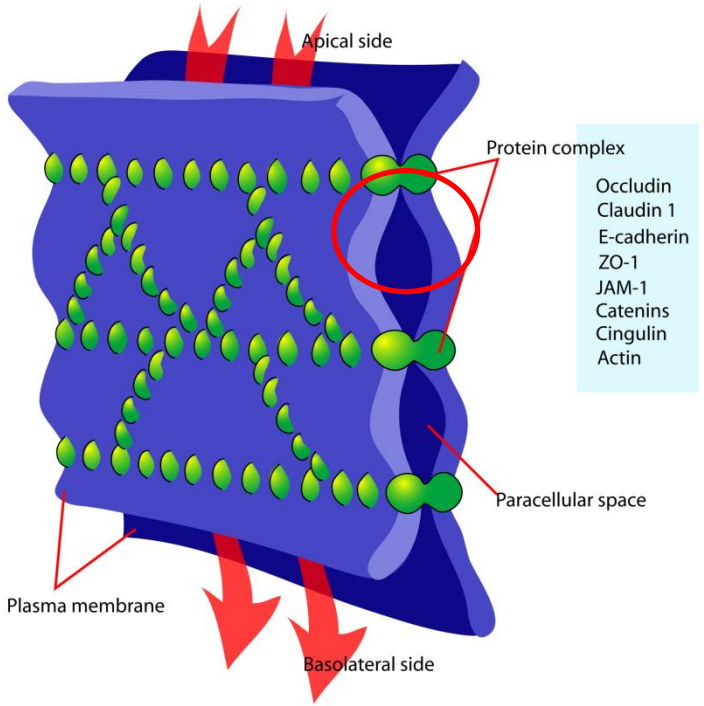
✓ 3 types of proteins:

- occludins
- claudins
- junctional adhesion molecules

✓Prevents diffusion of material between the intercellular space and the lumen of the organ

✓Functions as a permeability barrier (ex. makes us waterproof)

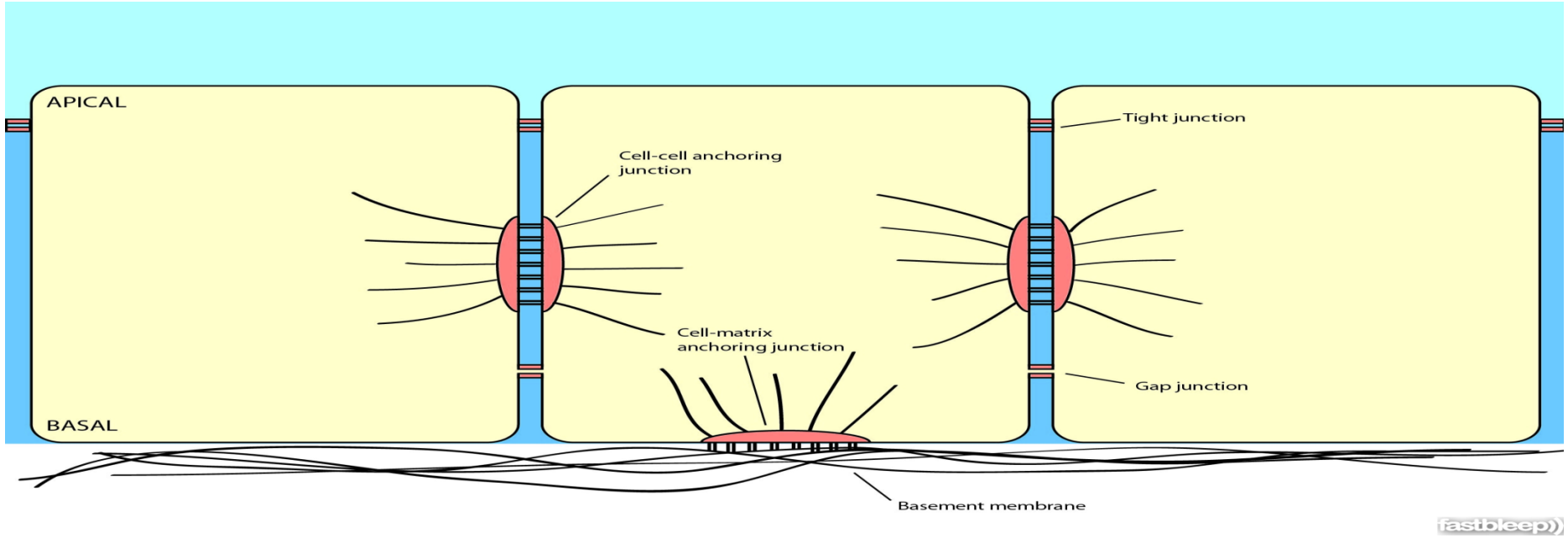




Anchoring junctions

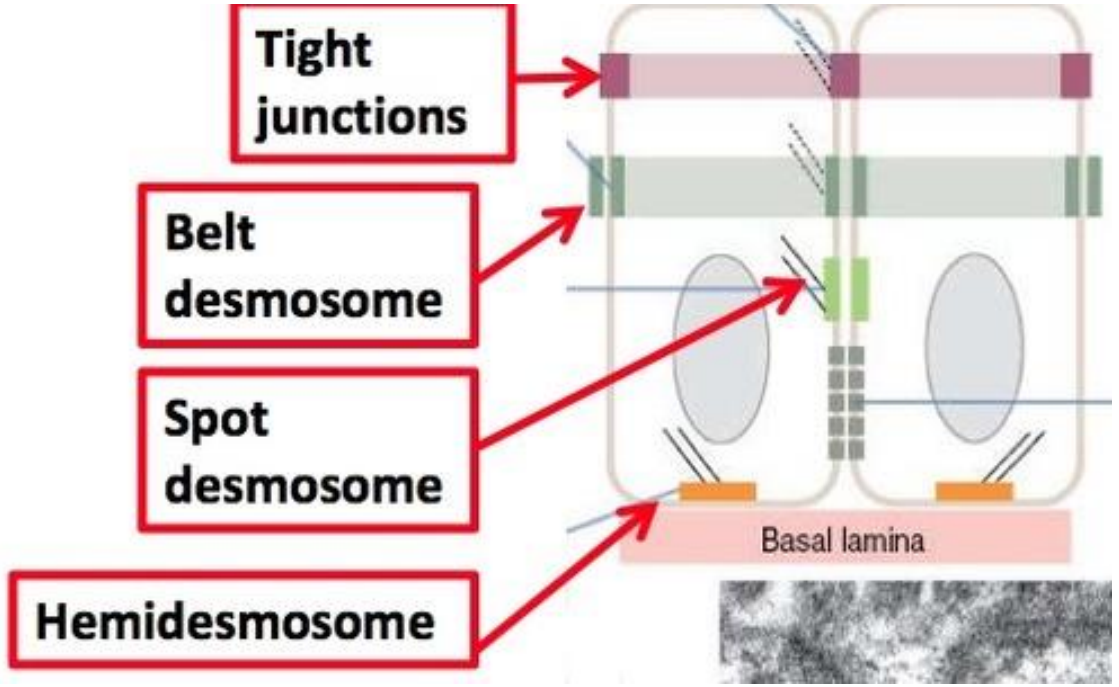
(Desmosomes, hemidesmosomes)

- ✓ Attach cells to each other or anchor them to the basal lamina; no fusion of the plasma membrane
- ✓ Attach cytoskeleton of neighboring cells or to the extracellular matrix
  - Intracellular anchor proteins
  - Transmembrane adhesion proteins
- ✓ Do not prevent the flow of substances around cells



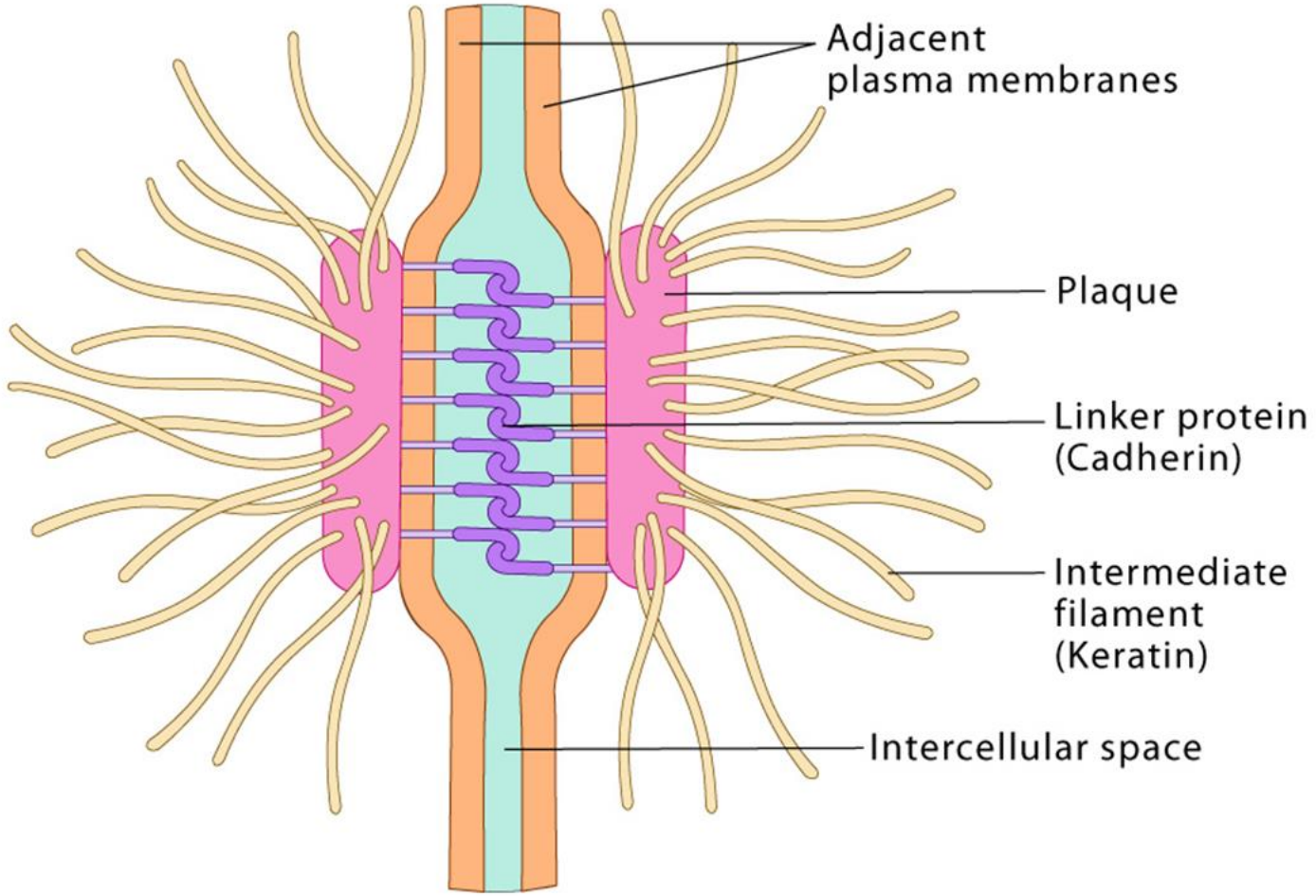
Belt desmosome (zonula adherens)

- Belt-like junction that encircles the apex of the cell like a barrel strap and is located immediately beneath the zonula occludens
- serves to attach adjacent cells together
- associated with actin filaments.

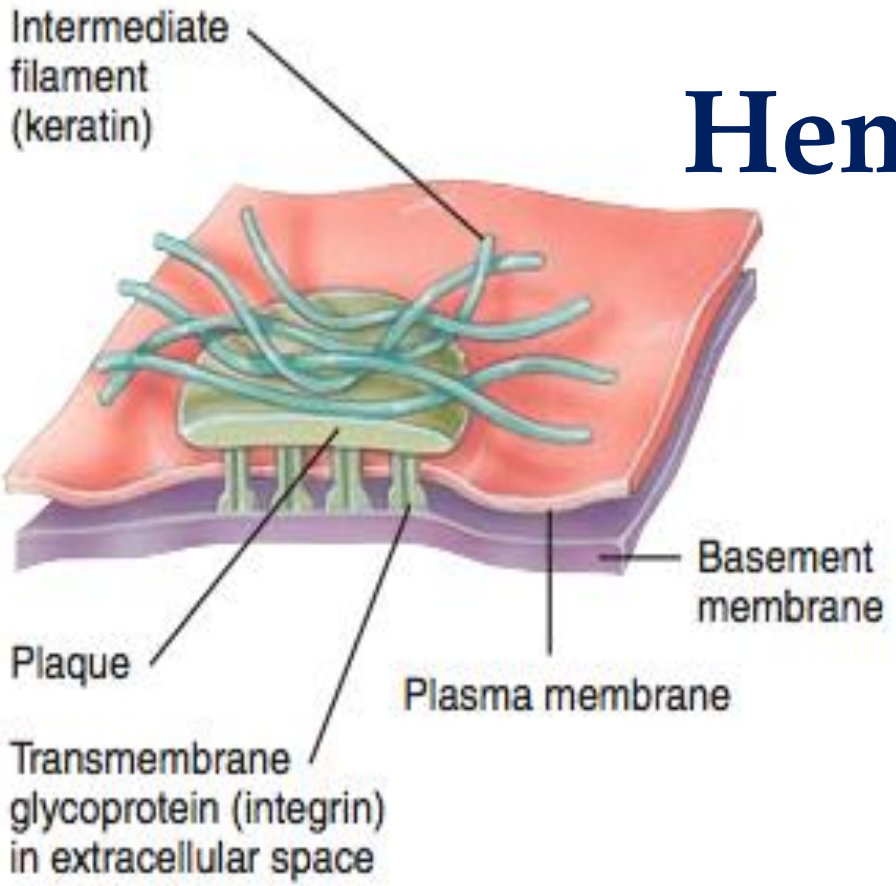


Spot desmosome (macula adherens)

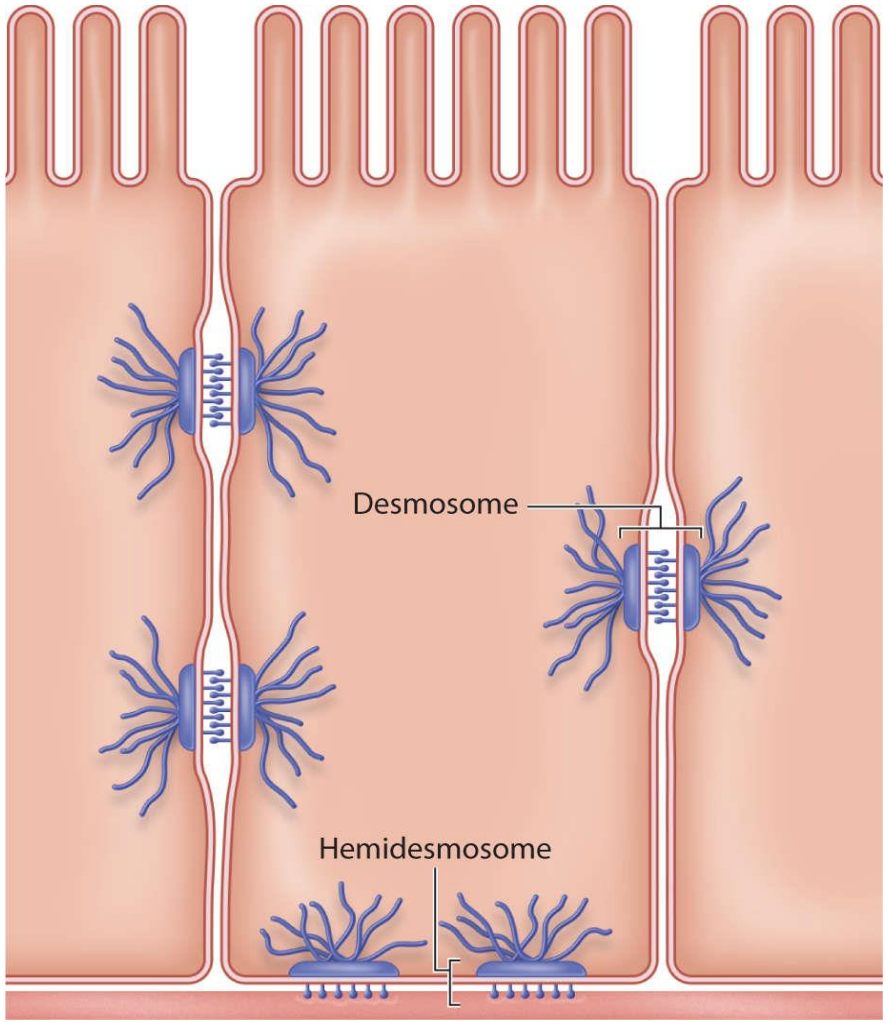
- Disk-like junctions scattered over the surface of the cell, which are paired with similar structures in adjacent cells
- Associated with **intermediate filaments** (keratin filaments in epithelial cells).



Hemidesmosome

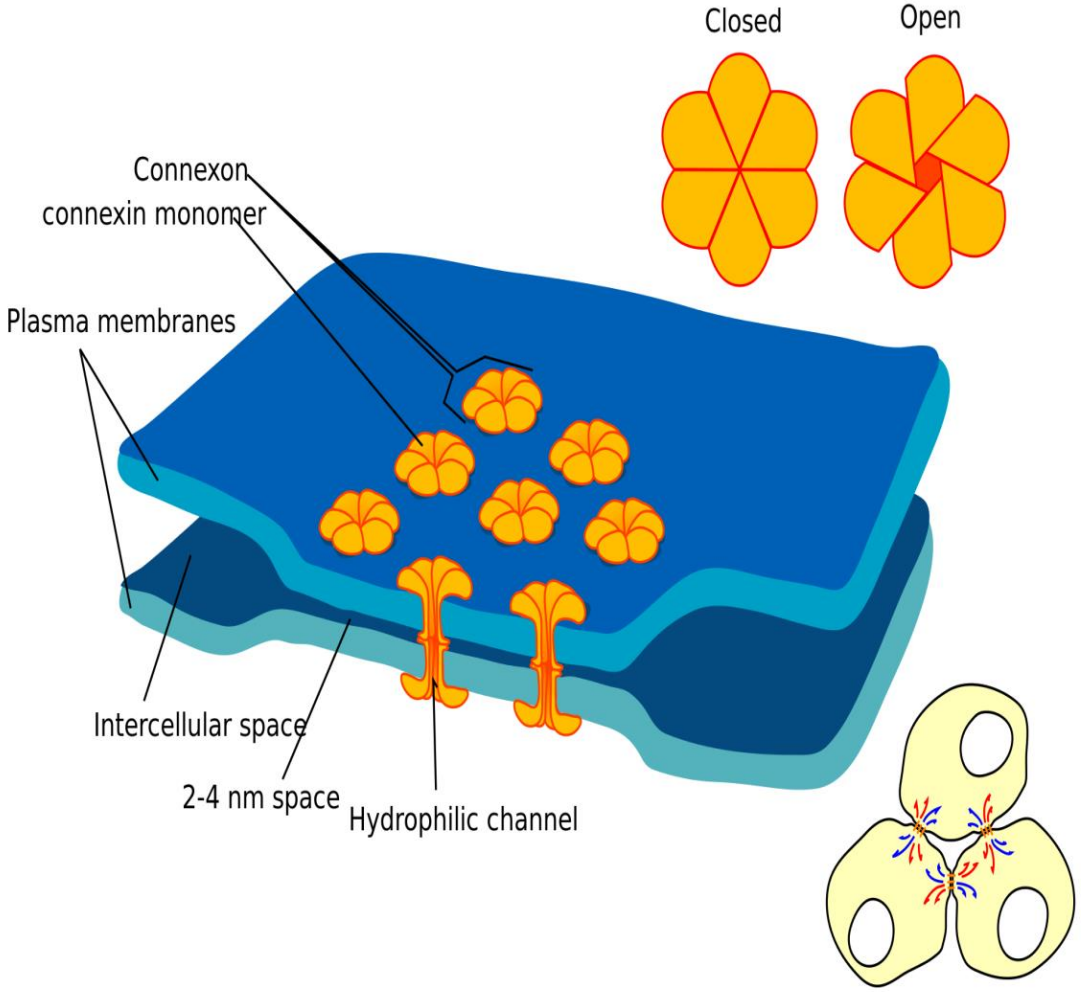


- Represents a “half desmosome”
- Anchor the basal surface of the cell to the basal lamina



Gap junction
(communicating junction or nexus)

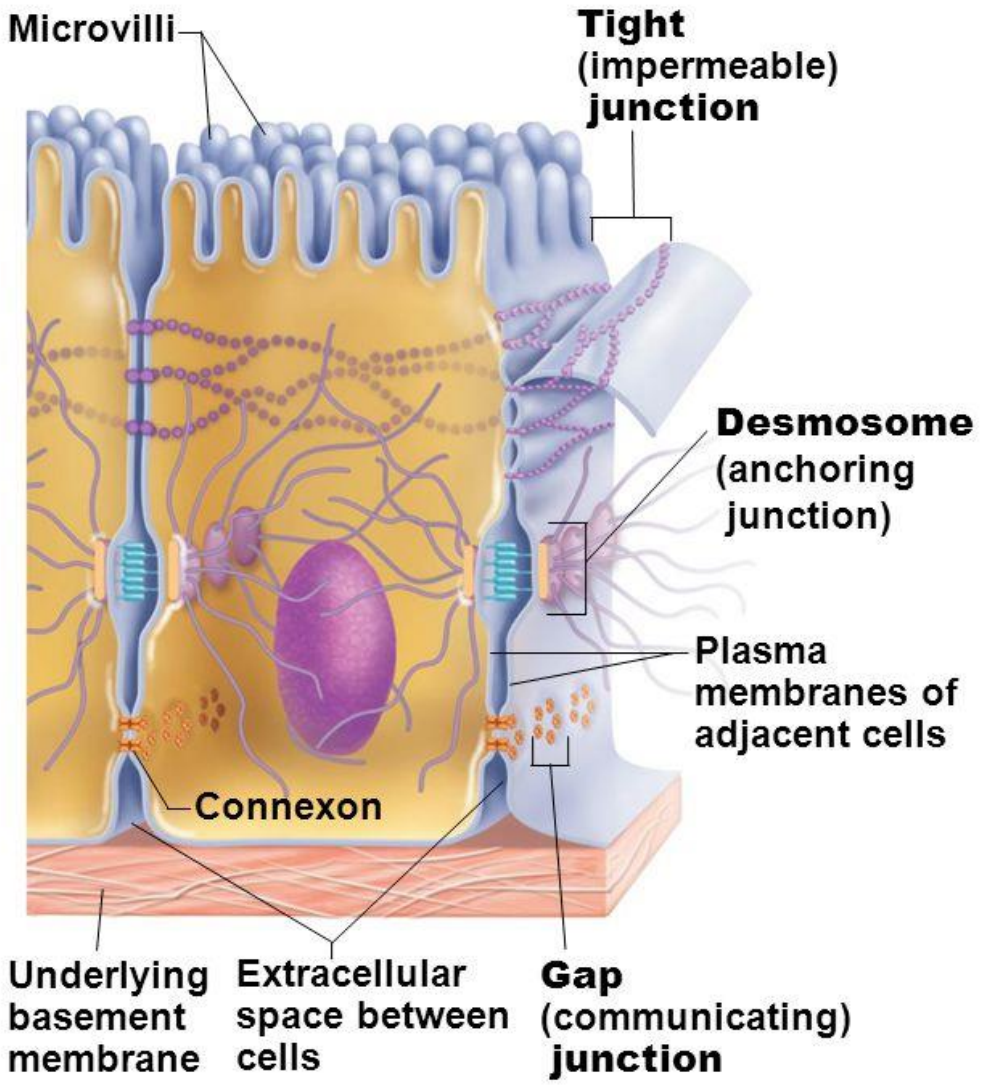
- Direct connection of the cytoplasm of two cells allows various molecules and ions to pass between cells
- Channels composed of transmembrane proteins – connexins
- **Connexon** – assembly of six connexin proteins creating a gap between plasma membranes of two cells
- Provides metabolic and electrical continuity (coupling) via the pores between cells



Junctional Complexes

- Consists of the zonula occludens, zonula adherens, and desmosomes;
- Because these structures cannot be resolved as separate structures at the light microscopic level, they appear as a single, bar-shaped, dark region at the apical corners of adjacent cells.
- The term terminal bar was used by early microscopists to define the zonula occludens and zonula adherens at the light microscopic level.

Figure 3.3 Cell junctions.



Examples:

- ✓ **Tight junctions**

 - in the intestines – helps to keep the intestinal bacteria and toxins out of the bloodstream

- ✓ **Desmosomes**

- skin – gives the ability to stretch but keeps cells together

- ✓ **Gap junctions**

 - cardiac muscle – allows to spread action potential for contraction of cardiomyocytes

Mitotic activity

- ✓Most epithelial cells have a life span less than that of the whole organism
- ✓The replacement of cells produced by mitotic activity of **adult stem cells**

- The **stratified squamous epithelium of skin** is replaced in a period of approximately 28 days.

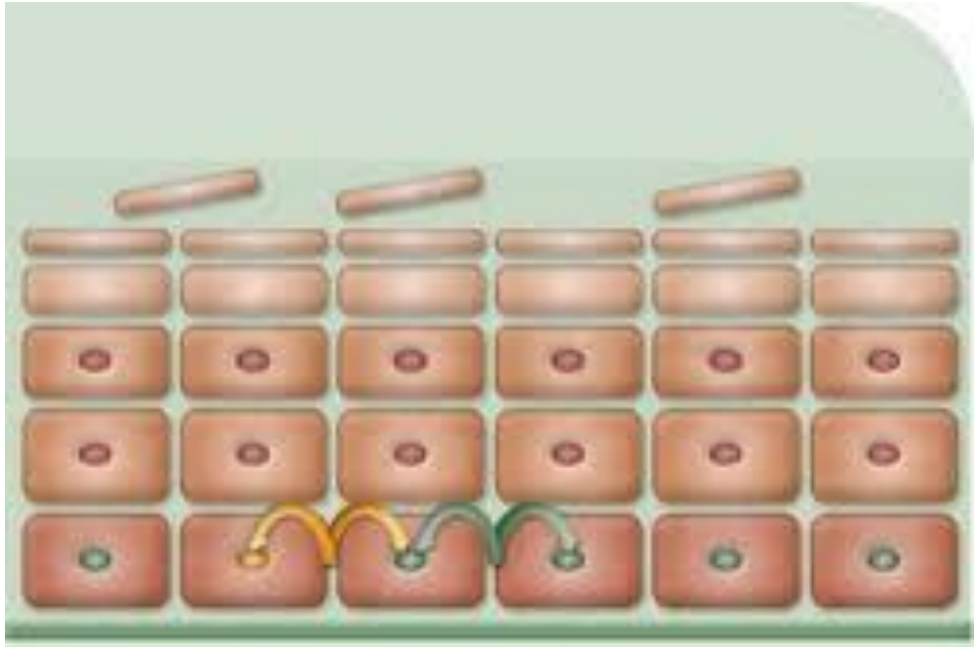


Figure 1 – Epidermal regeneration.

Functions of epithelium:

- **protection,** as in the stratified squamous epithelium of the skin (epidermis) and the transitional epithelium of the urinary bladder;

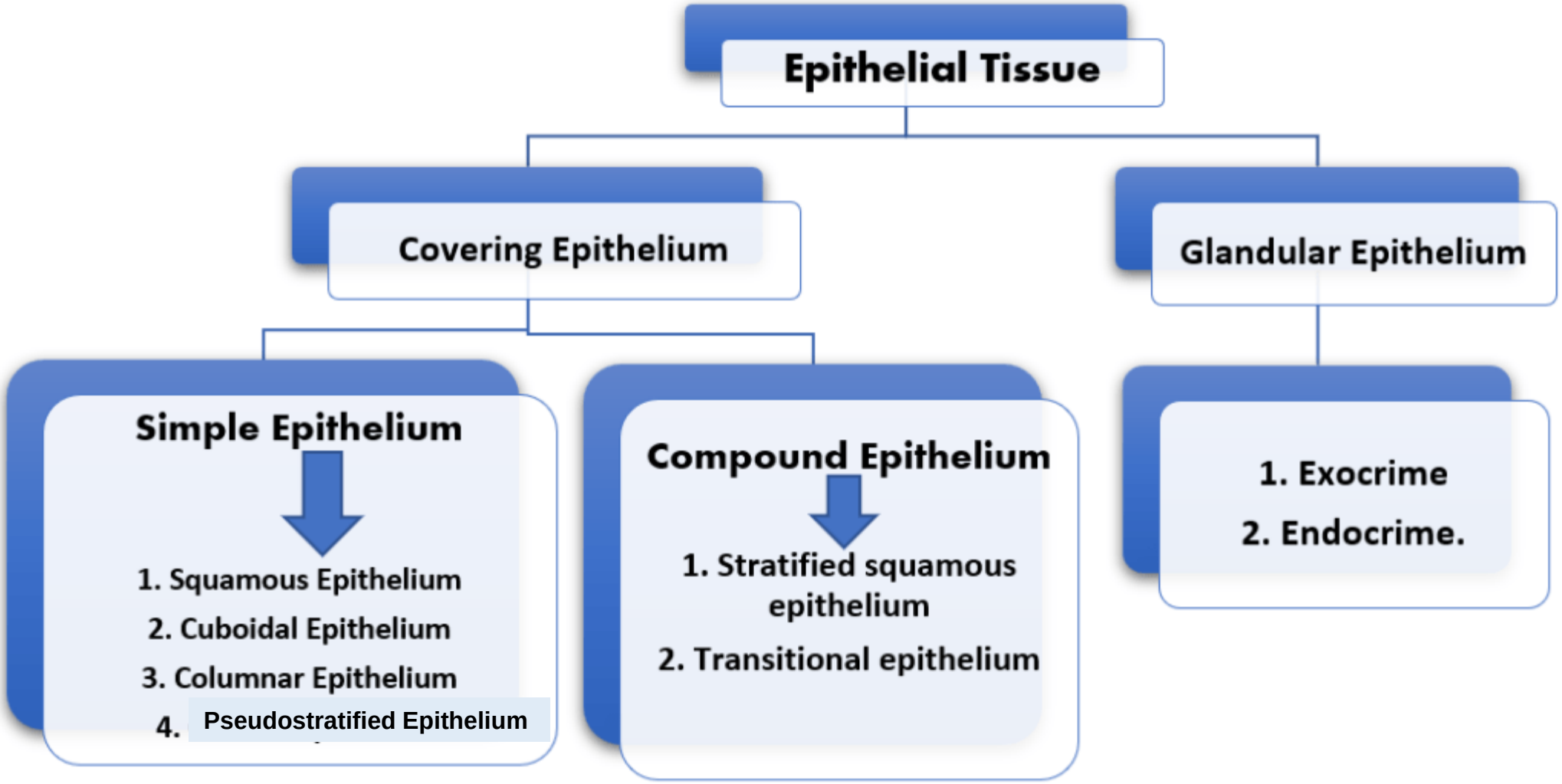
- **absorption,** as in the columnar epithelium of the intestines and proximal convoluted tubules in the kidney;

- **secretion,** as in the columnar epithelium of the stomach and the gastric glands;

- **transportation,** as in the transport of materials or cells along the surface of an epithelium by motile cilia or in the transport of materials across an epithelium to and from the connective tissue;

- ***receptor function*** to receive external stimuli, as in the taste buds of the tongue, olfactory epithelium of the nasal mucosa.

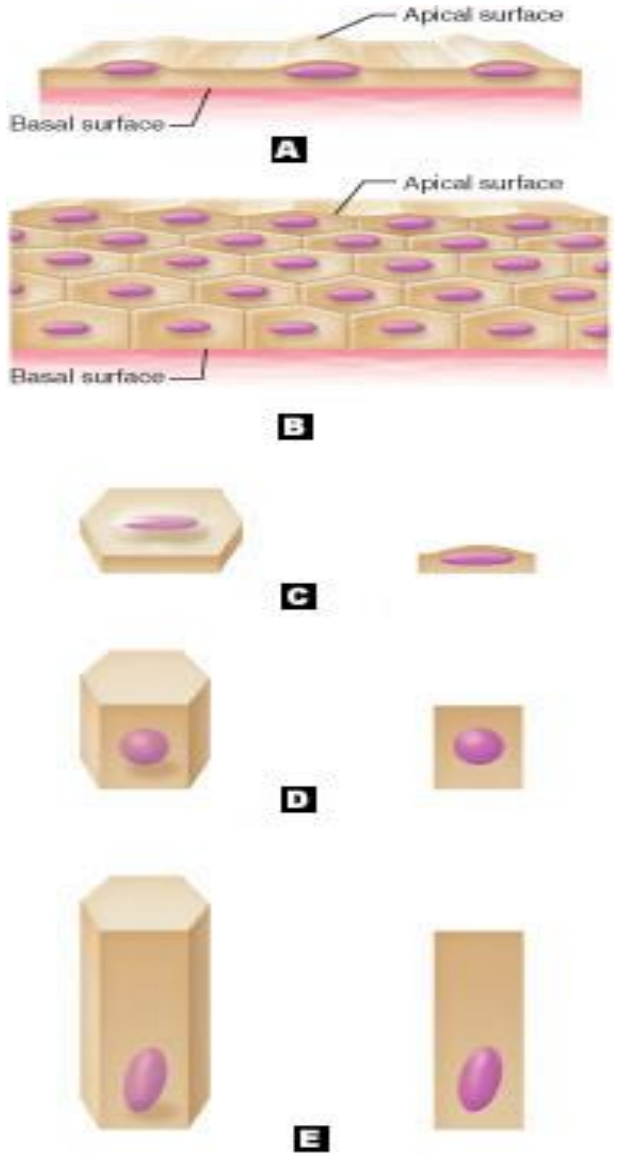
Classification of epithelium



Classification of epithelium

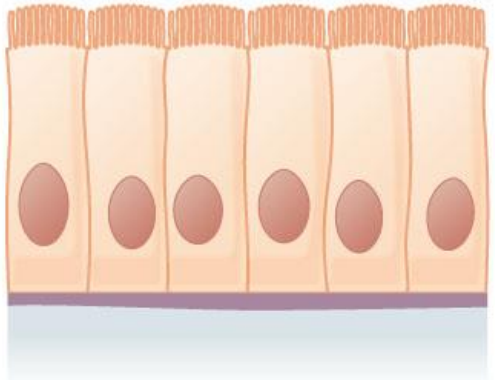
1. Number of cell layers

2. Shape of cells in the superficial layer

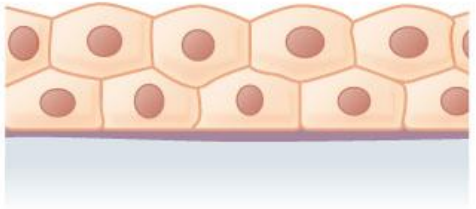


Number of cell layers

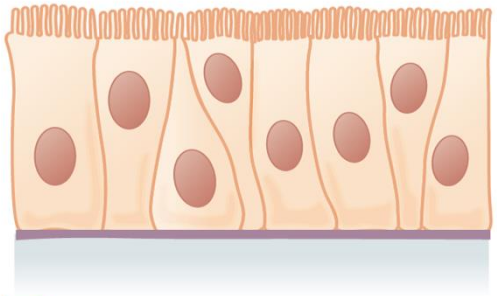
- **Simple** epithelium - single layer of cells



- **Stratified** epithelium - several layers of cells



- **Pseudostratified** epithelium – single layer of cells of variable size and shape, with nuclei at a different layer

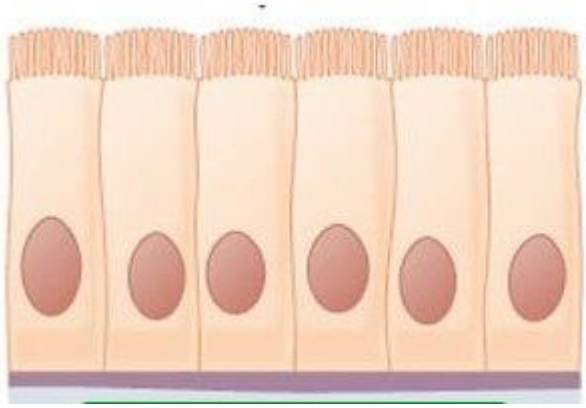


Shape of cells

- ✓ **Squamous -** the width of the cell is greater than its height;

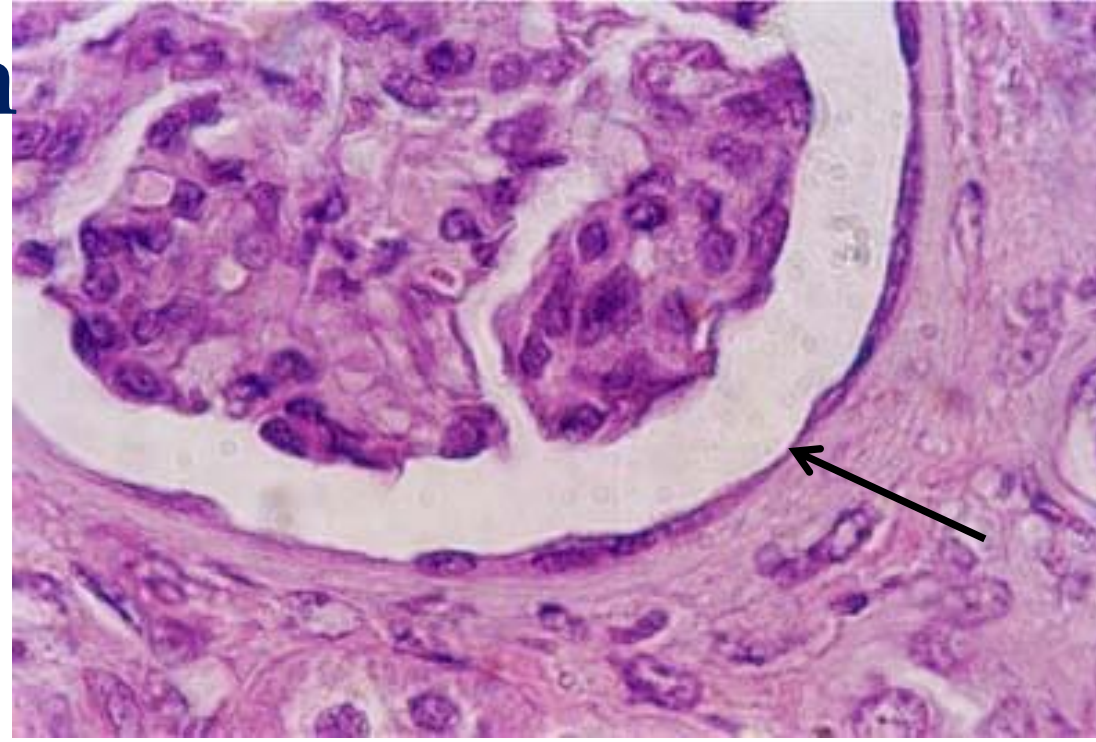
- ✓ **Cuboidal -** the width, depth, and height are approximately the same;

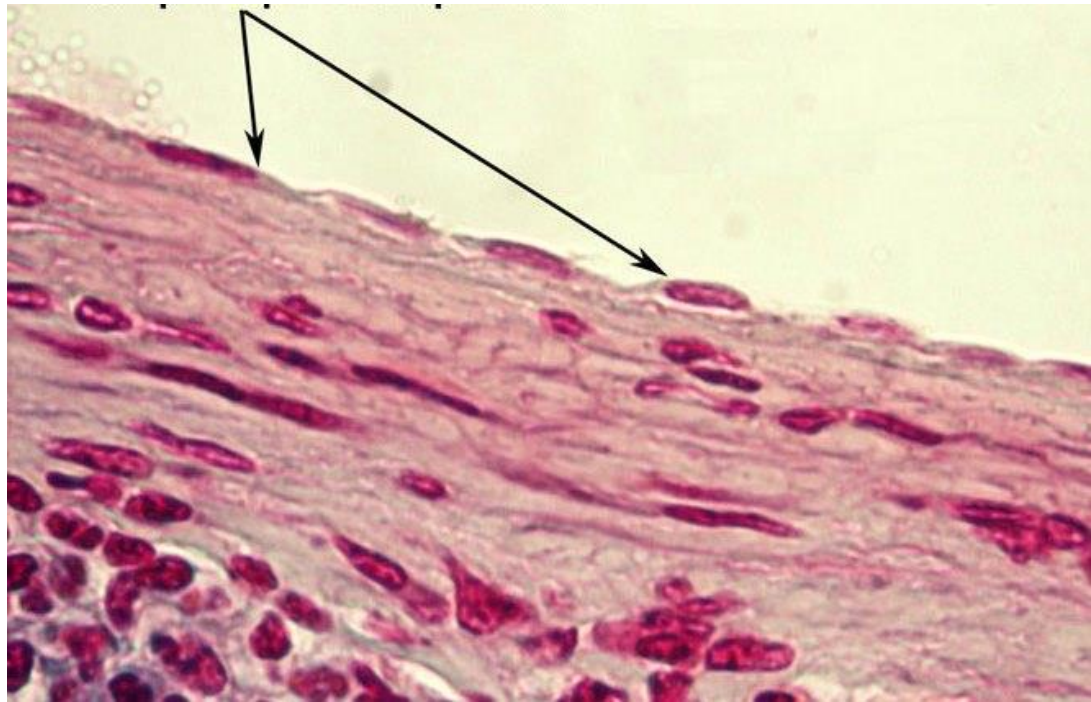
- ✓ **Columnar -** the height of the cell exceeds the width



Simple squamous epithelium

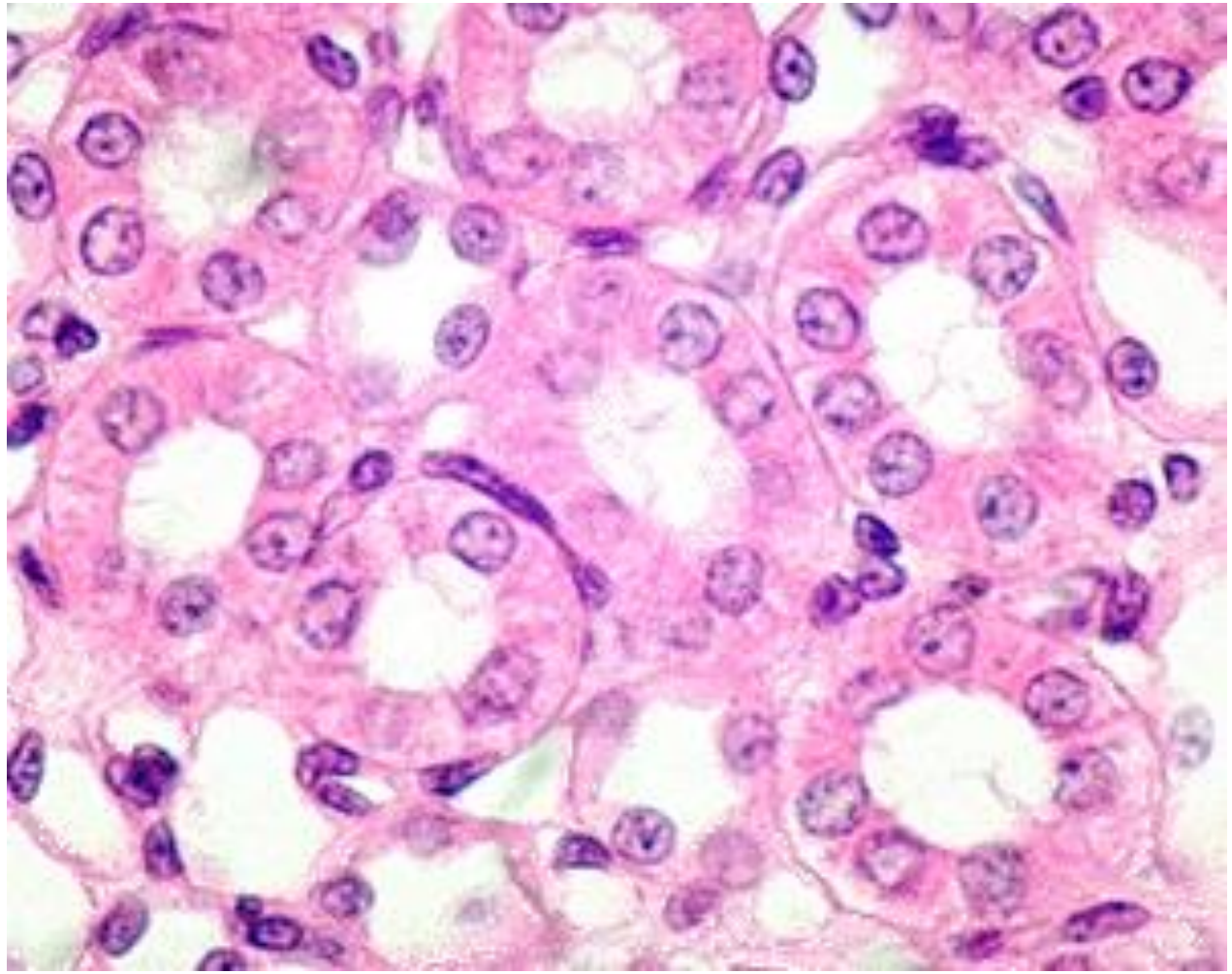
- Cells are much wider than tall
- Nucleus is highly flattened
- Allows for rapid diffusion across the epithelium
- Forms the lining of blood vessels, alveoli of the lungs, and internal body cavities





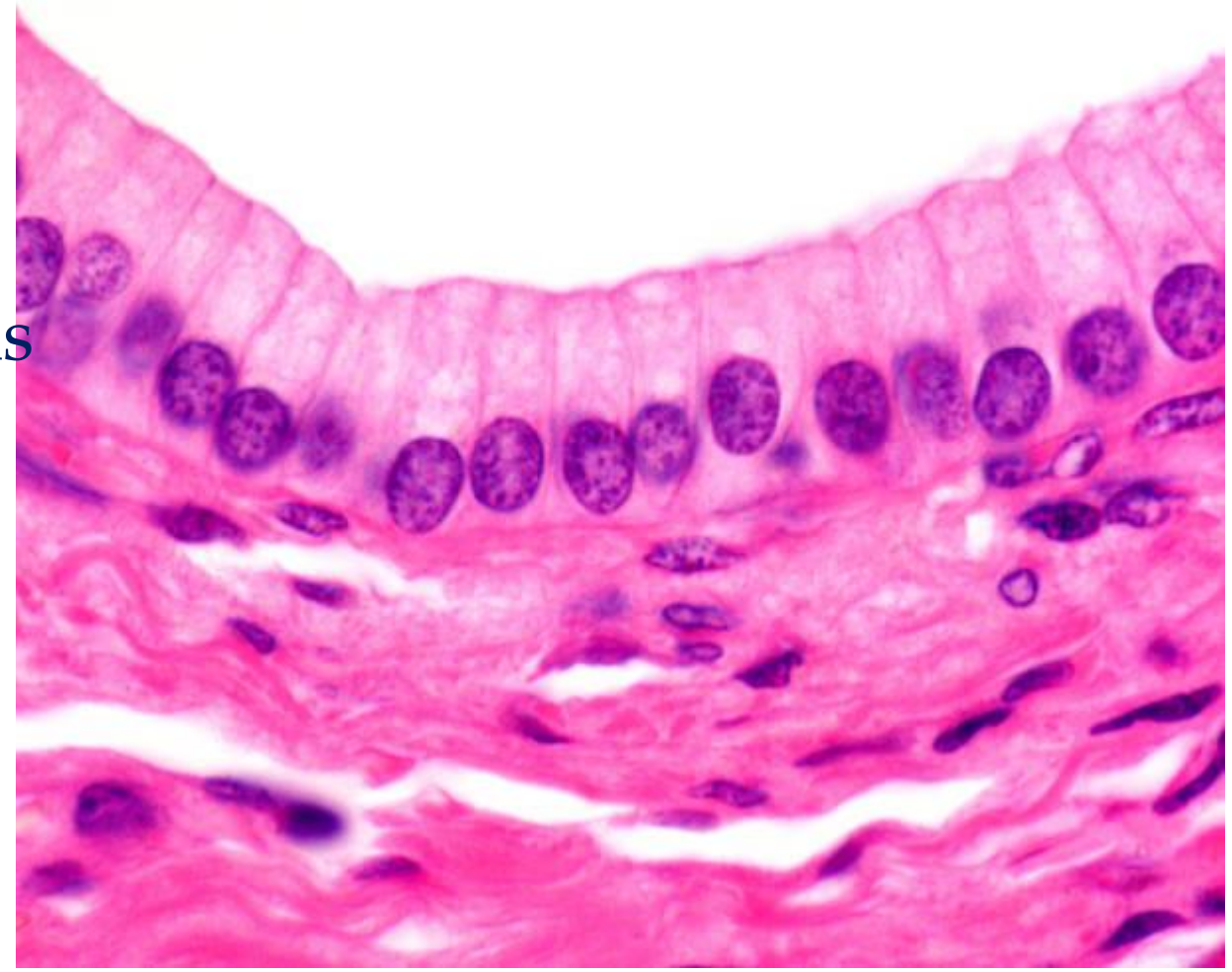
Simple cuboidal epithelium

- Cells are of equal height and width
- Nucleus is spherical
- Lines and absorbs
- Forms the walls of ducts and tubules



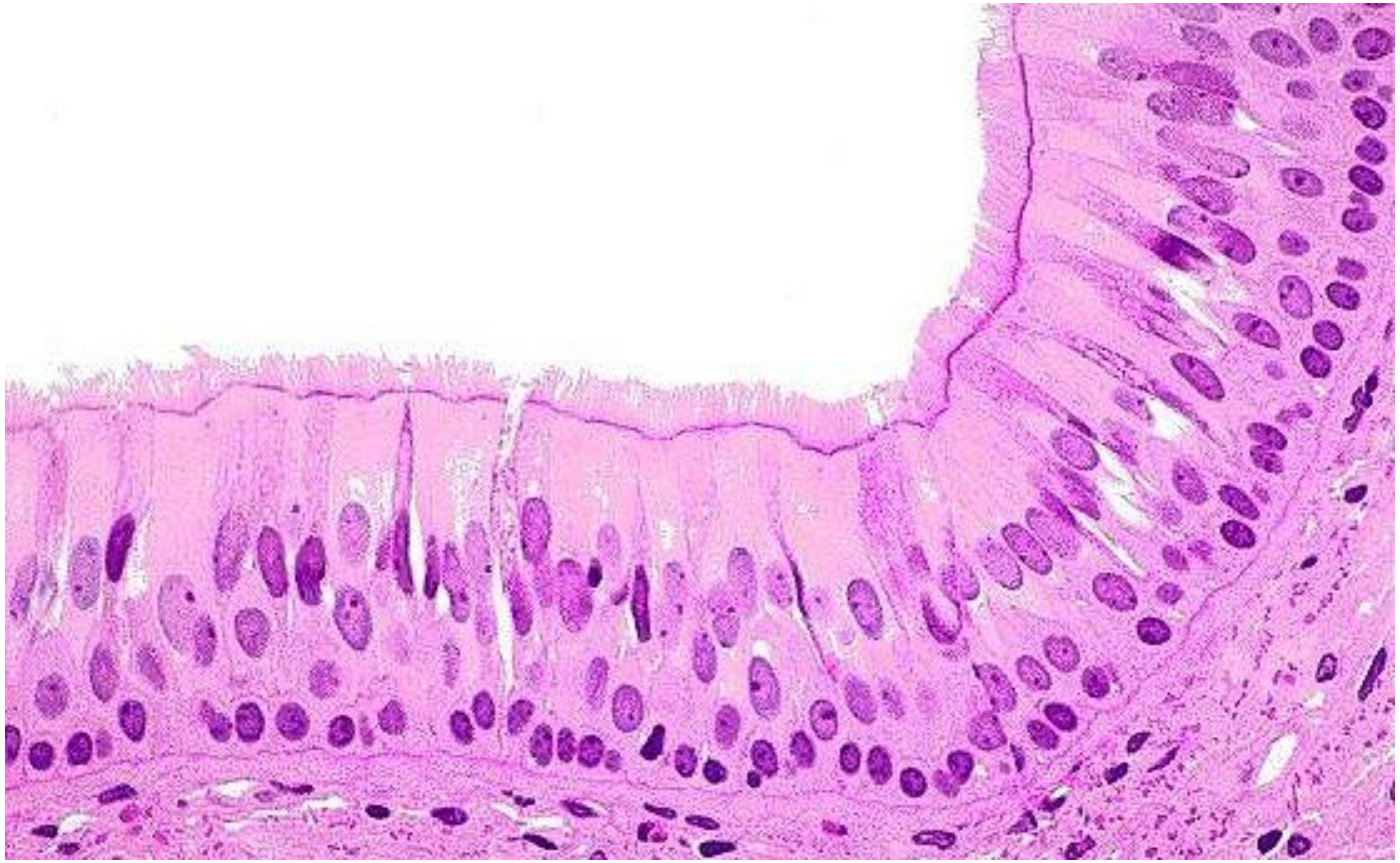
Simple columnar epithelium

- Cells are much taller than they are wide.
- Nucleus is oval shaped, generally located in the mid to lower portions of the cell.
- Lines and absorbs
- Forms the lining of the intestines and gall bladder



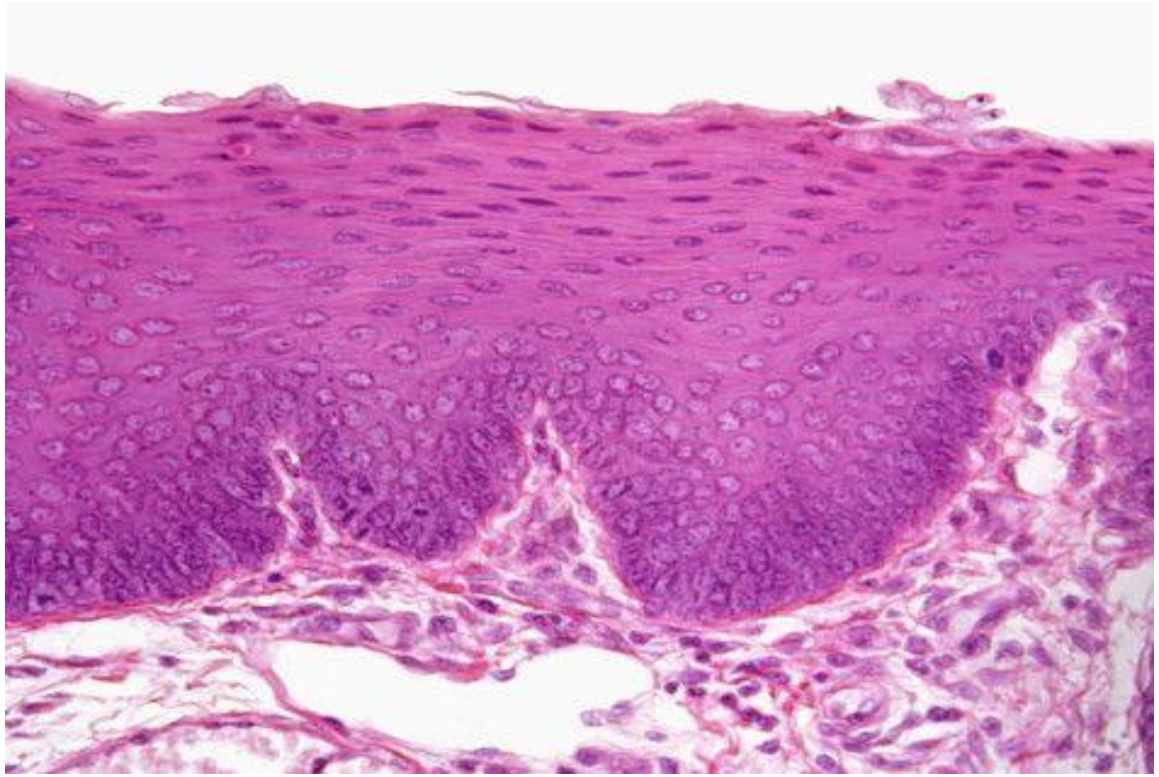
Pseudostratified columnar epithelium

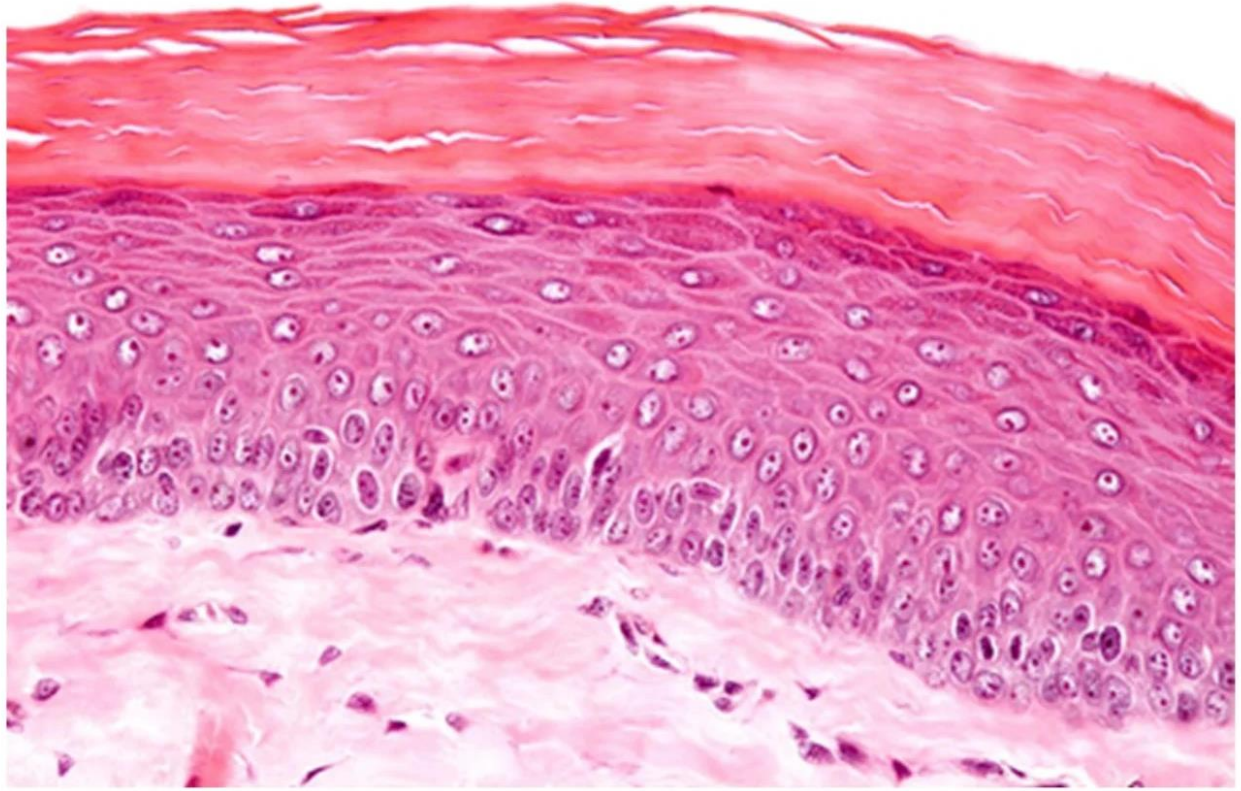
- Cells are of various heights.
- All cells rest on the basement membrane, but only the tallest cells reach the free surface.
- Variation in height of the cells and the location of nuclei give the appearance of a stratified epithelium.
- Frequently ciliated.
- Provides protection and surface transport when ciliated
- Forms the lining of much of the respiratory tract and much of the male reproductive system



Stratified squamous epithelium

Protects from physical abrasion and prevents desiccation





nonkeratinized

- Surface cells are nucleated and living.
- Lining of wet cavities, including the mouth, esophagus, rectum, and anal canal, vagina, cornea

keratinized

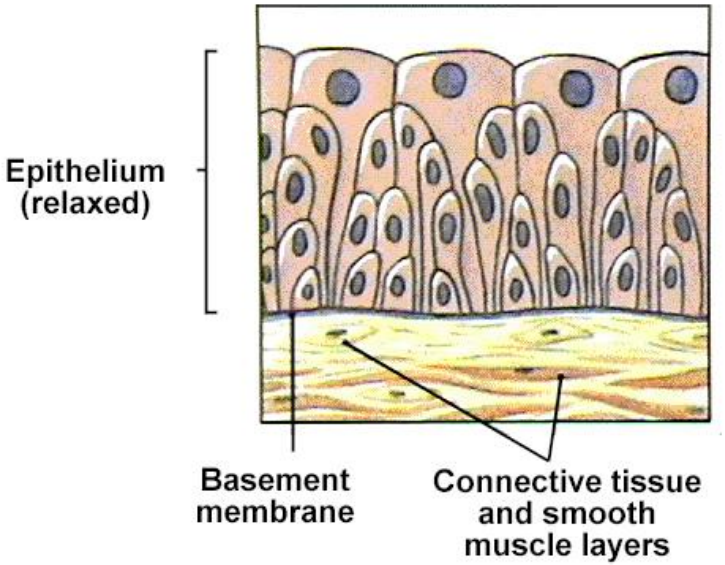
- Surface cells are nonliving
- Epidermis of the skin

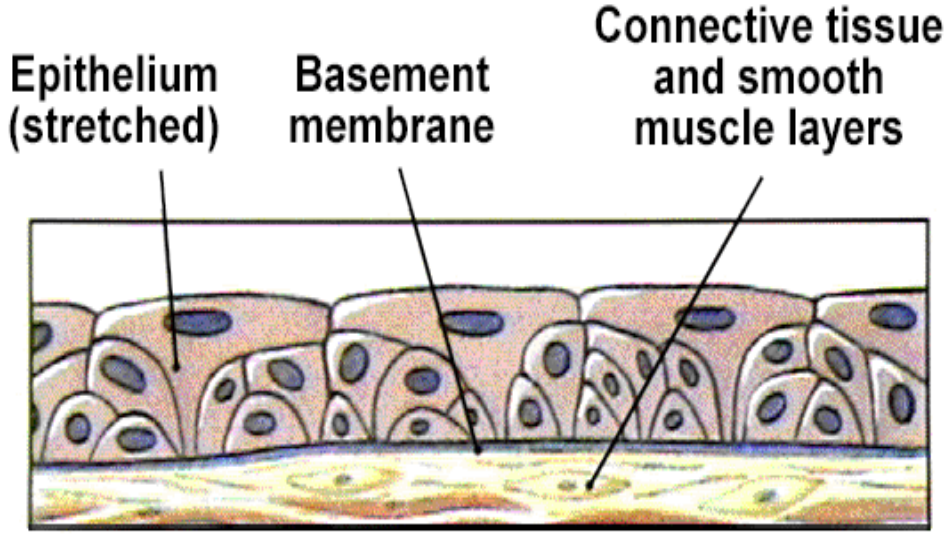
Stratified cuboidal/columnar epithelium

Lines the larger ducts of exocrine glands, conjunctiva

Transitional Epithelium

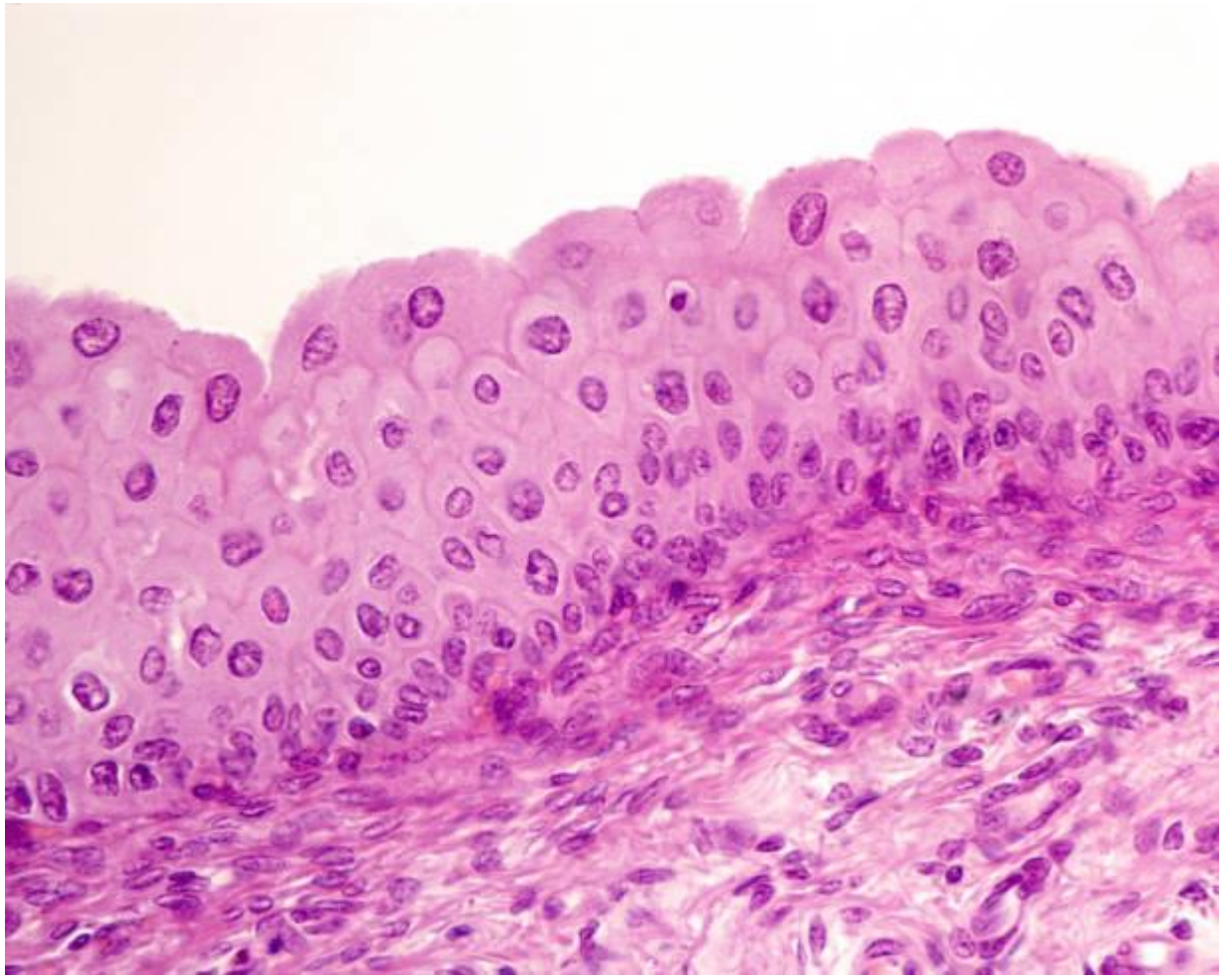
- ✓ A special type of stratified epithelium lining most of the urinary passages (ureters, bladder)
- ✓ When the organ is empty surface cells appear domelike
- ✓ When the organ s full the surface cells stretch and flatten





Transitional Epithelium

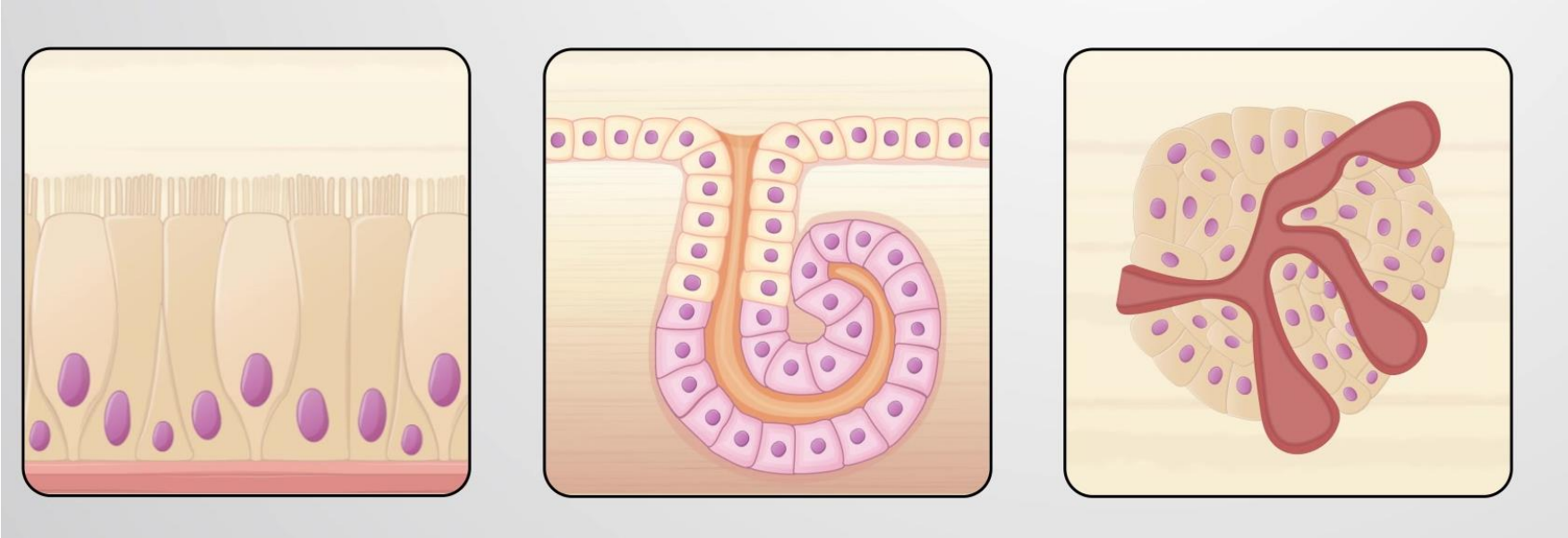
- Protective function; constructed to expand with distension of the hollow organs it lines
- Unique to the urinary system; lines the urinary bladder and ureter



Glandular epithelium

GENERAL CHARACTERISTIC:

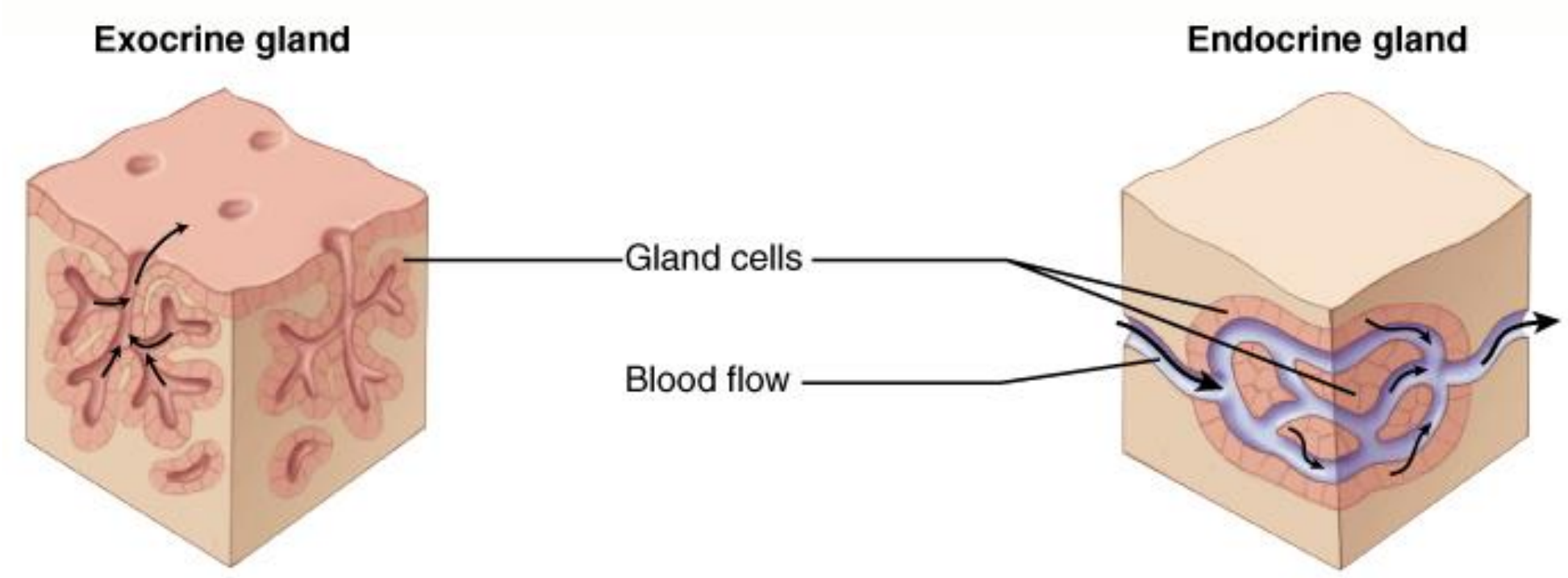
- ✓ Develop from or within a lining or covering epithelium
- ✓ Secretory cells may:
- Differentiate but remain in the lining epithelium
- Invaginate into the underlying connective tissue and remain attached to the lining epithelium
- Invaginate into the underlying connective tissue but lose their connection to the epithelium



Glandular epithelium

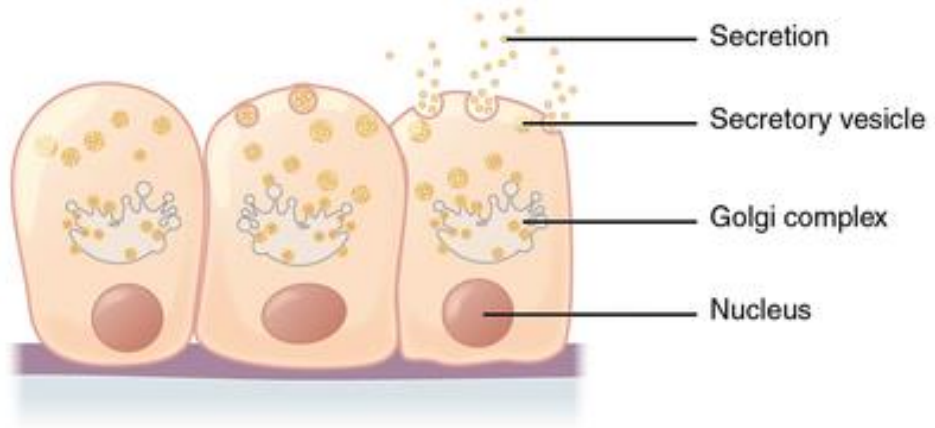
- **Exocrine glands** secrete their products **through the ducts** that are connected to a surface.

- **Endocrine glands lack a duct system.**
- Secrete their products directly into the extracellular fluid where they can affect adjacent cells **(paracrine secretion)** or enter the bloodstream to influence cells throughout the body **(endocrine secretion).**
- Secretory products are called hormones.

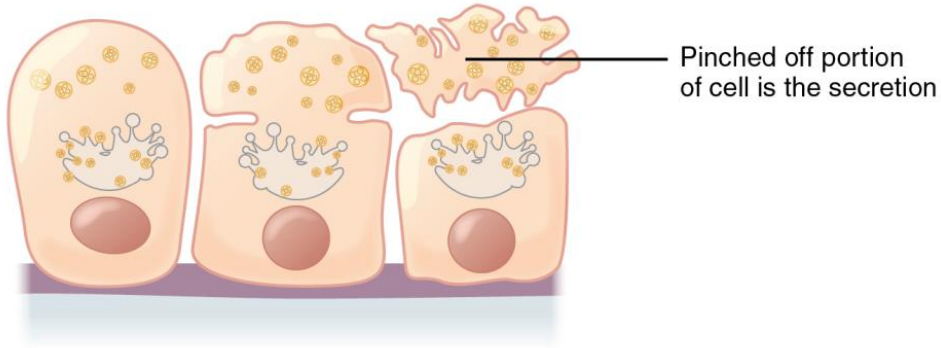


The **mechanisms of secretion**

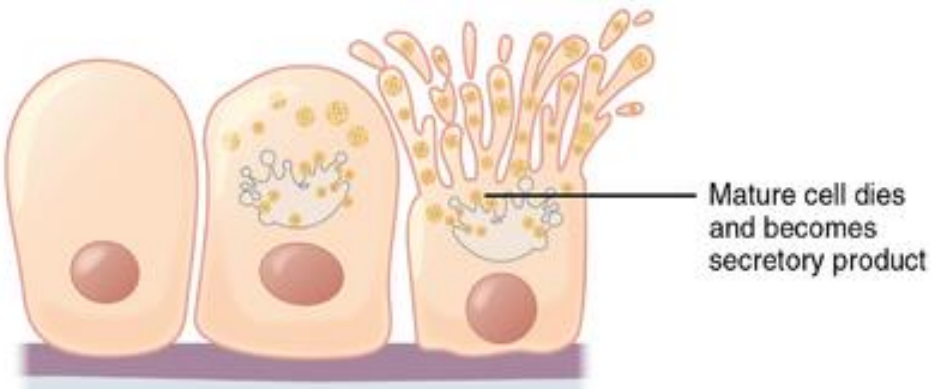
• **Merocrine secretion -** the secretory product exits cell by exocytosis, no loss of cytoplasm (pancreas).



• **Apocrine secretion** - the secretory product collects in cell apex, entire cell apex is shed (mammary gland).



• **Holocrine secretion - t**he secretory product accumulates within the maturing cell, cell dyes, both secretory products and cell debris are discharged into the duct. (sebaceous glands of skin).



Type of secretory product (exocrine glands):

- ✓ **Mucous** – thick, viscous secretion rich in glycoproteins (sublingual gland)
  - Secretory cells are usually organized into tubules with wide lumens
  - Nucleus is flattened and located in the base of the cell.

- ✓ **Serous** – thin, watery secretion containing proteins (parotid gland)
  - Secretory cells are usually organized into a flask-shaped structure with a
  - narrow lumen, called an acinus.
  - Cytoplasm contains secretory granules.
  - Nucleus is round and centrally located in the cell.

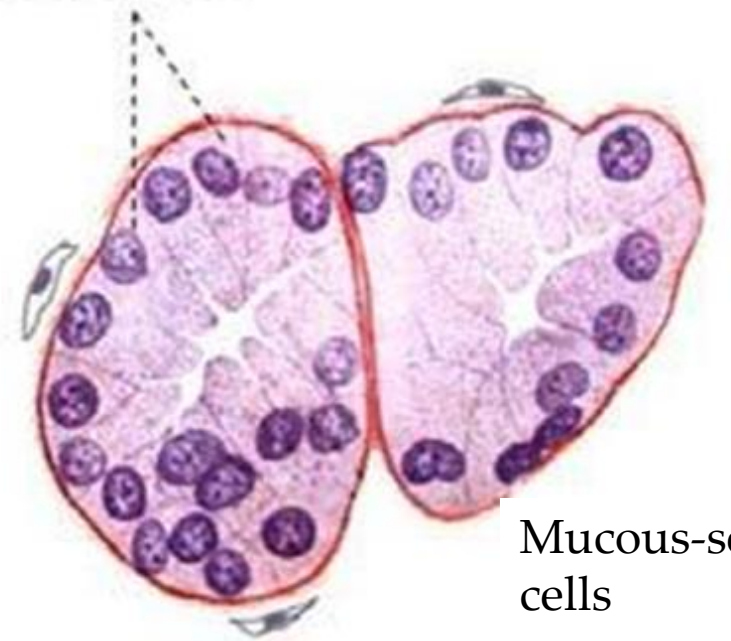
- ✓ **Special**

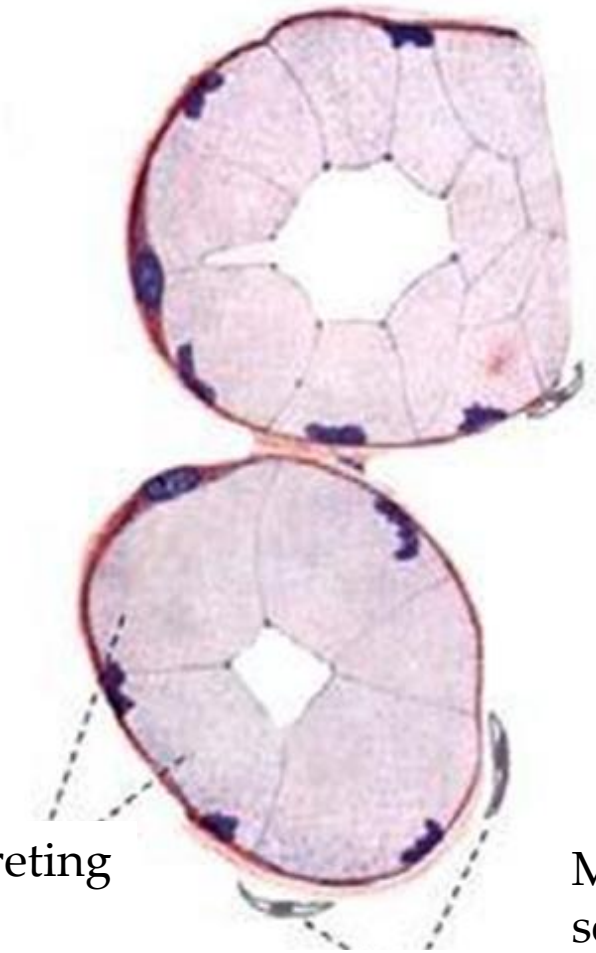
Type of secretory product (exocrine glands):

✓**Special:**

- **Lipid:** Oily secretion (sebum) from sebaceous glands and lipid portion of milk from the mammary gland.
- **Sweat:** Hypotonic, serous secretion that is low in protein content.
- **Cerumen:** A waxy material formed by the combination of the secretory products of sebaceous and ceruminous glands with desquamated epidermal cells in the auditory canal

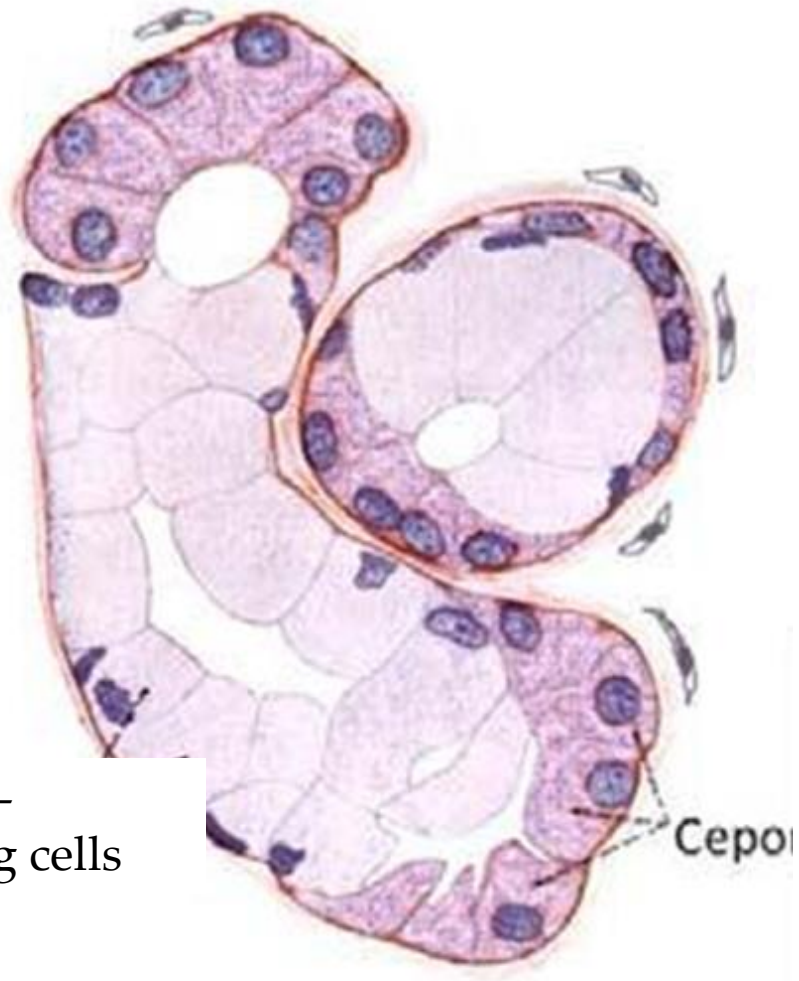
Serous-secreting cells



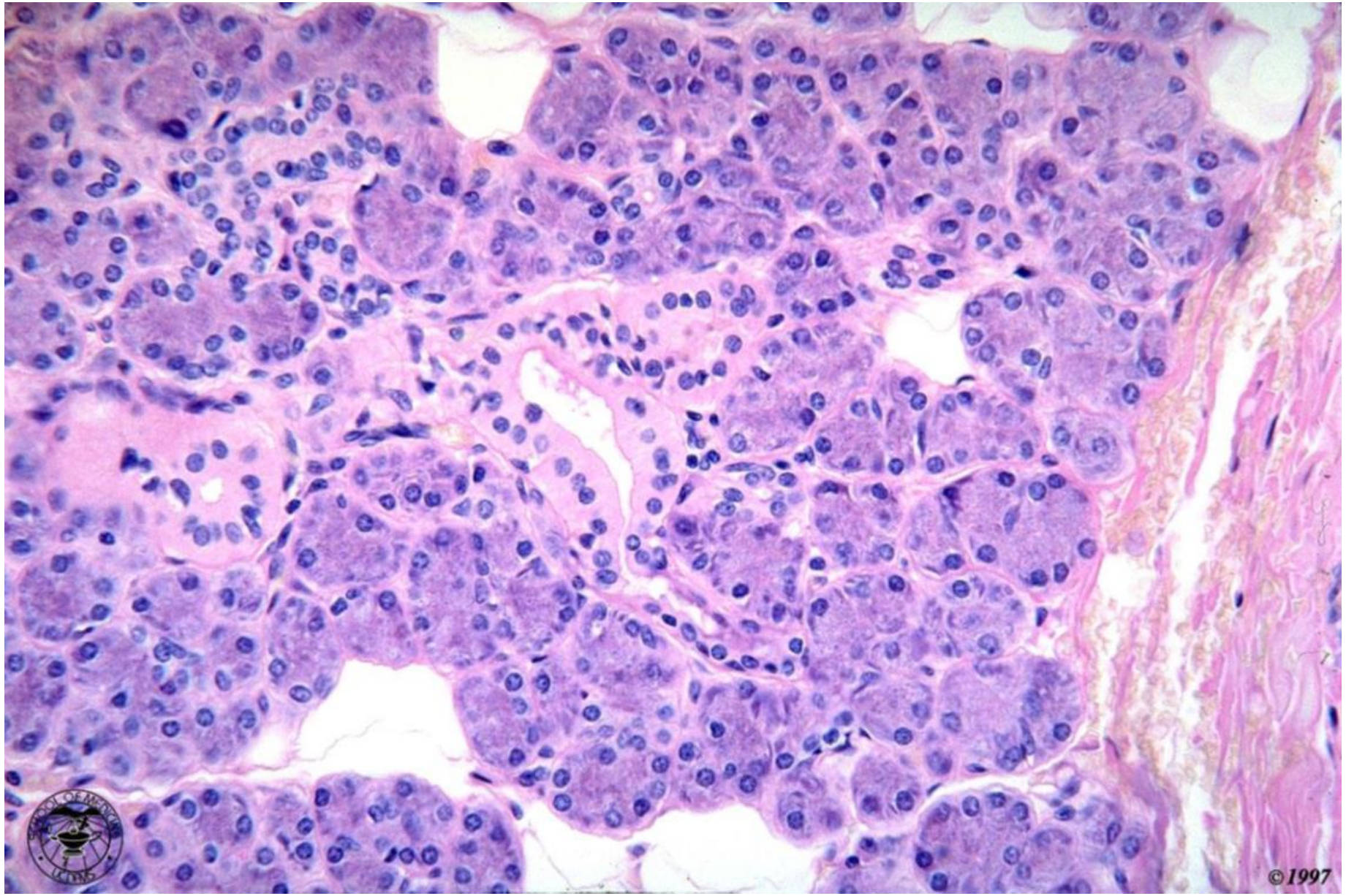


Mucous-secreting cells

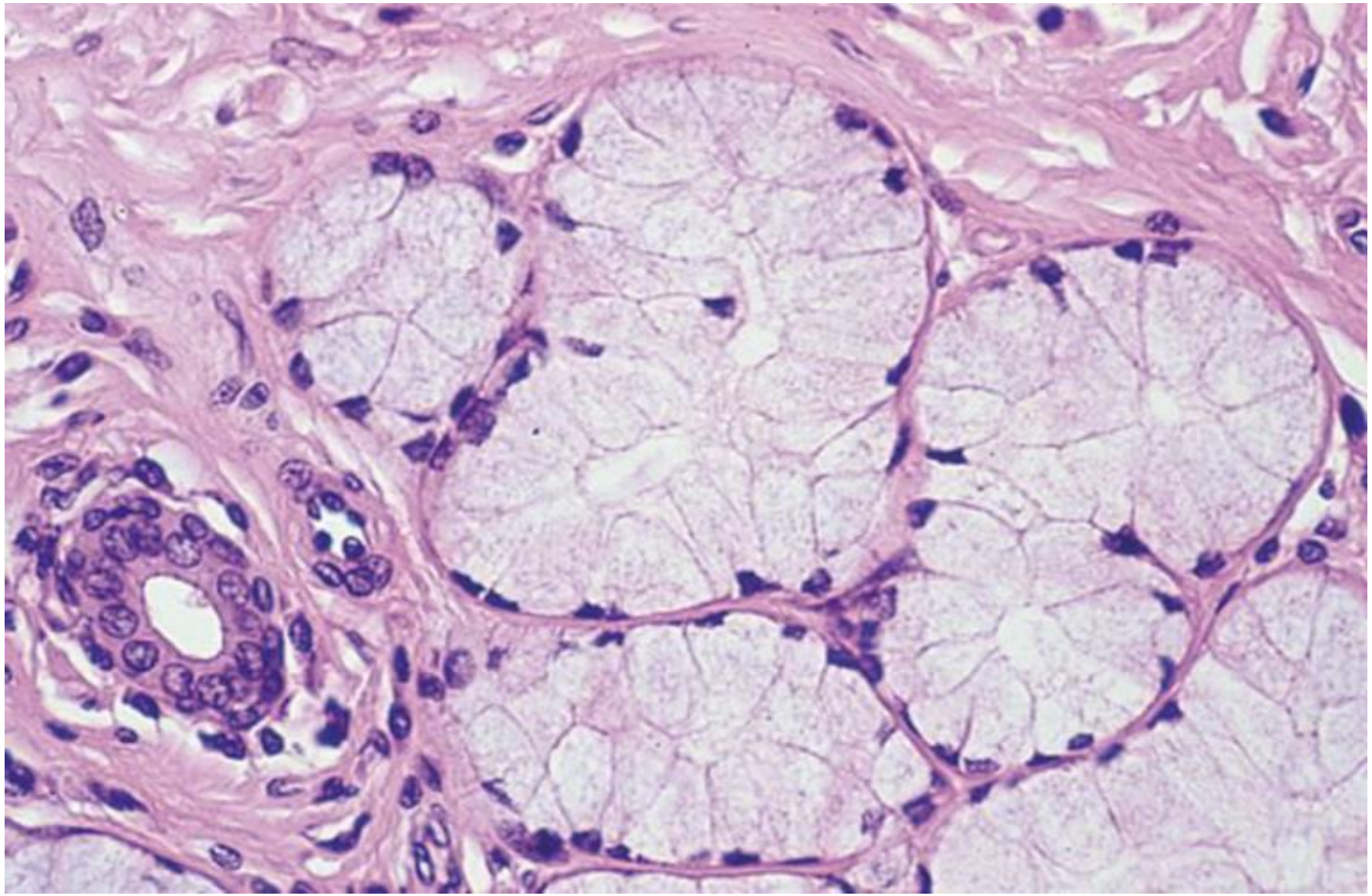
Mucous-secreting cells



Parotid gland



Sublingual gland

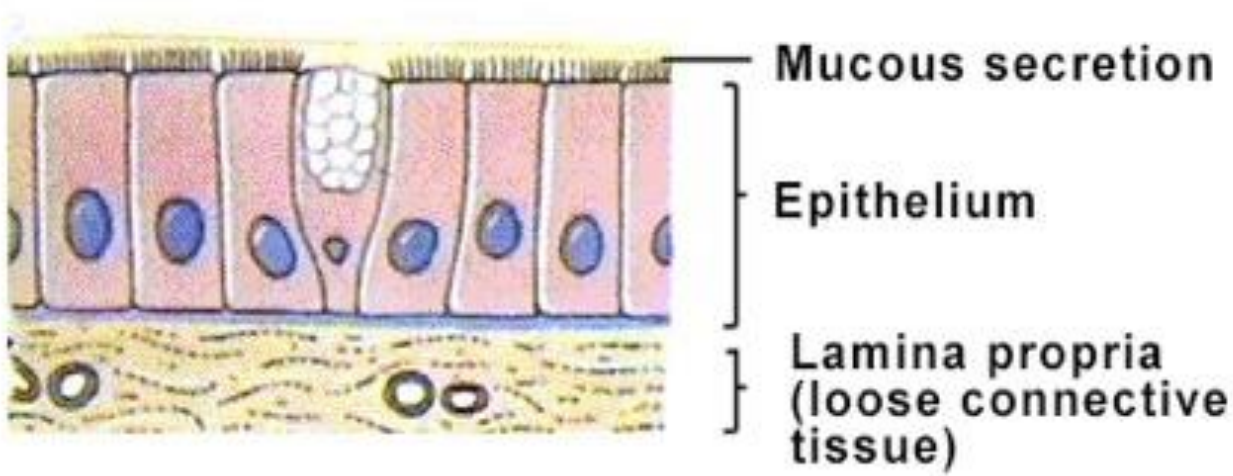


Type of secretory product (endocrine glands):

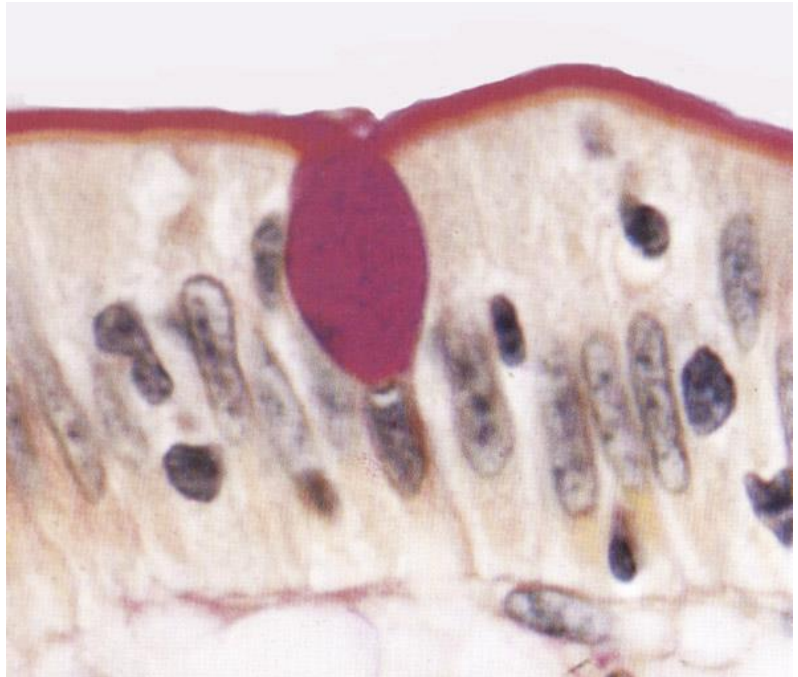
- Derivatized amino acids (thyroxine and epinephrine)
- Peptides and proteins (insulin and oxytocin)
- Steroids (testosterone and cortisol)

CLASSIFICATION OF EXOCRINE GLANDS: unicellular or multicellular

Unicellular glands are the simplest in structure: individual cells located within an epithelium

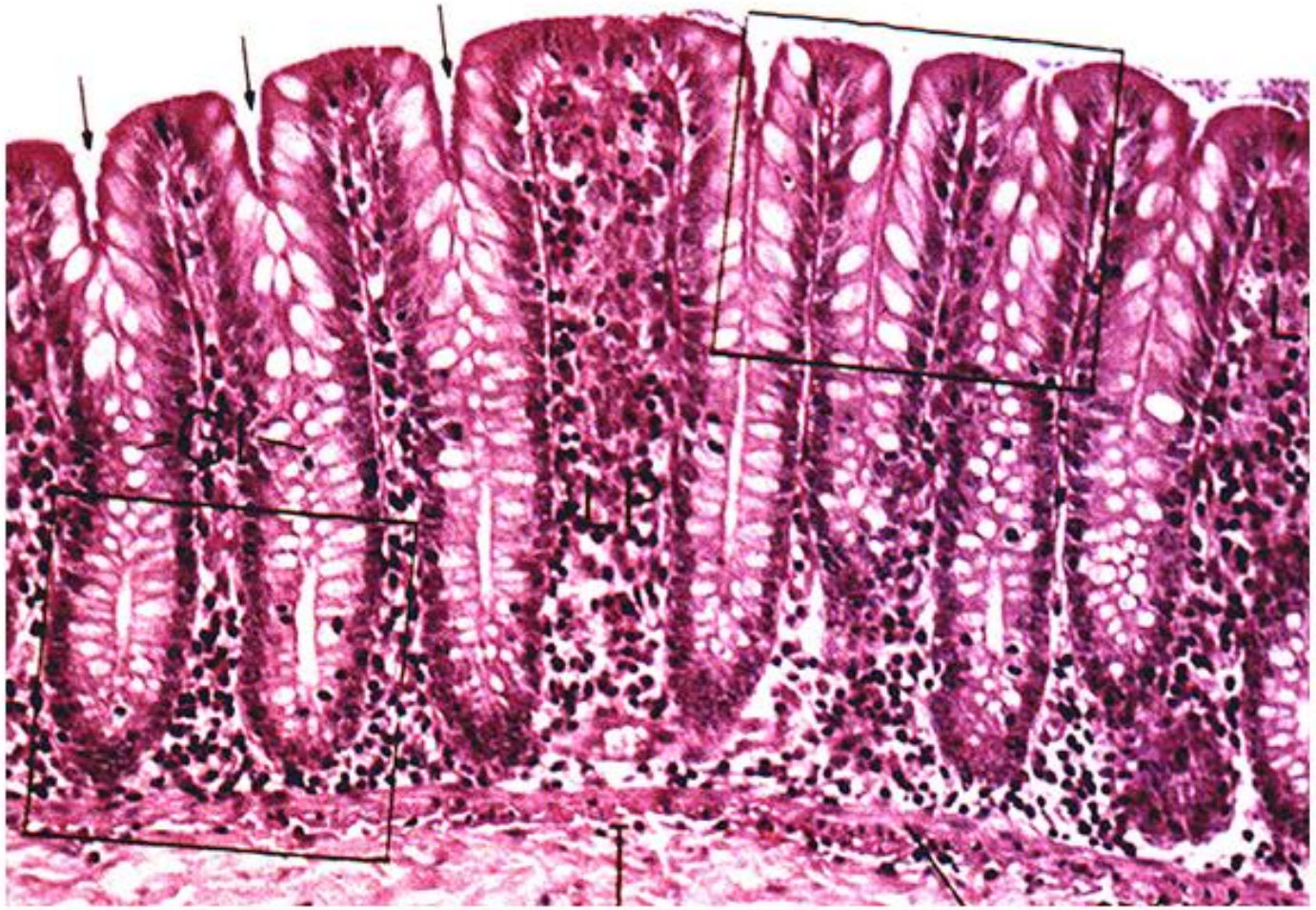


A typical example is the **goblet cell, a mucus-secreting** cell positioned among other columnar cells



Unicellular glands

Light Microscopy



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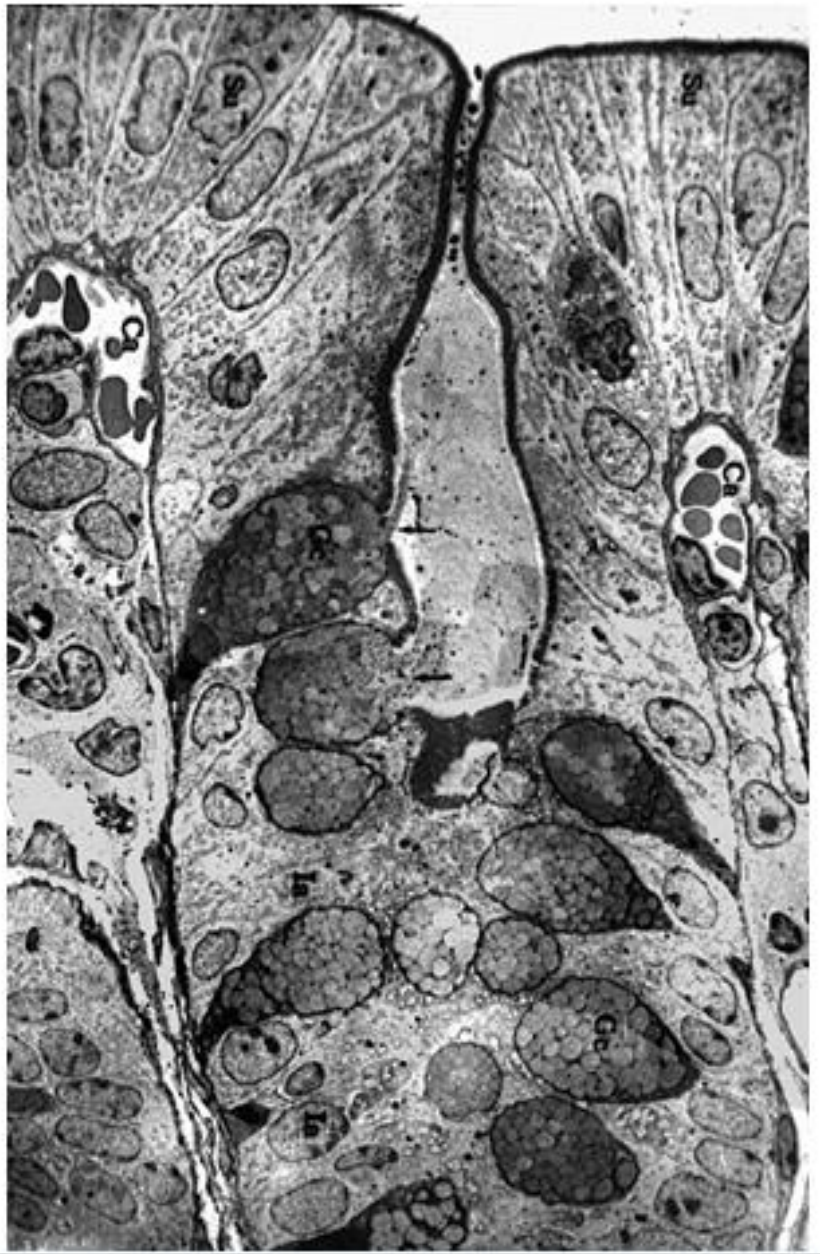


Multicellular glands are composed of more than one cell.

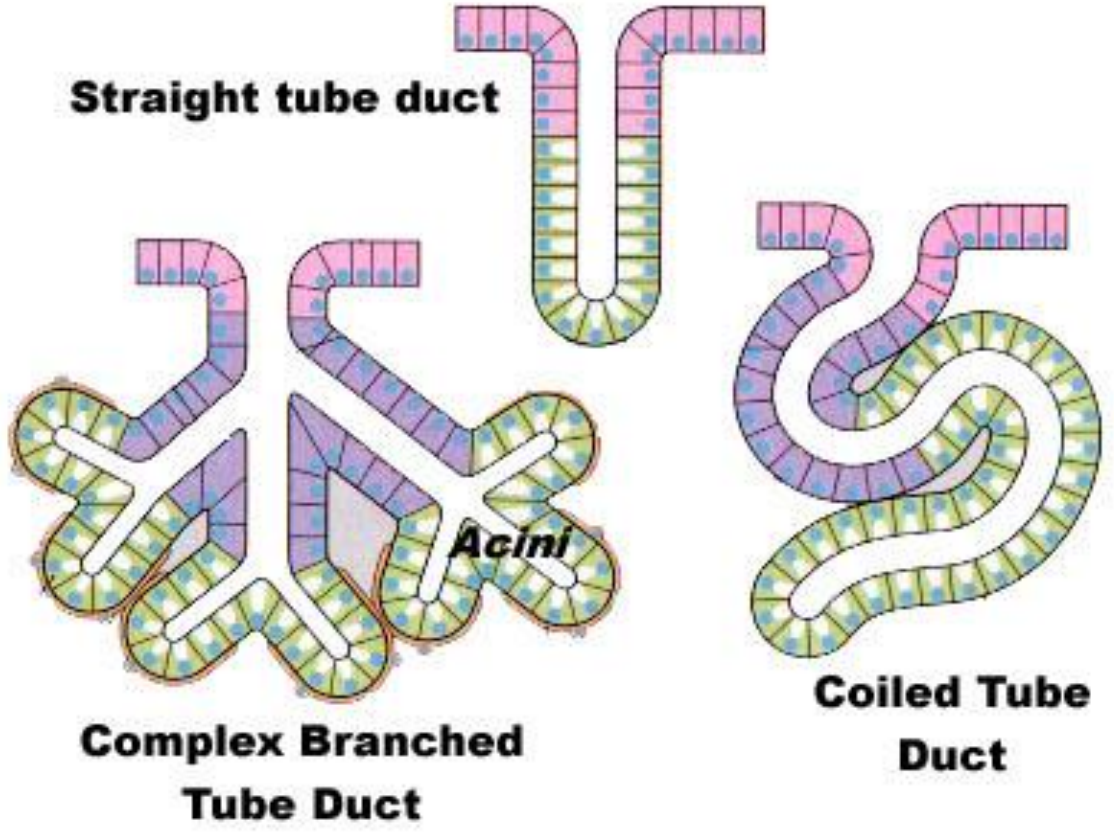
Can be classified according to the arrangement of the secretory cells (parenchyma) and the branching of the duct elements.

Ducts:

- ✓ if the duct is unbranched, the gland is called **simple;**
- ✓ if the duct is branched, it is called **compound.**

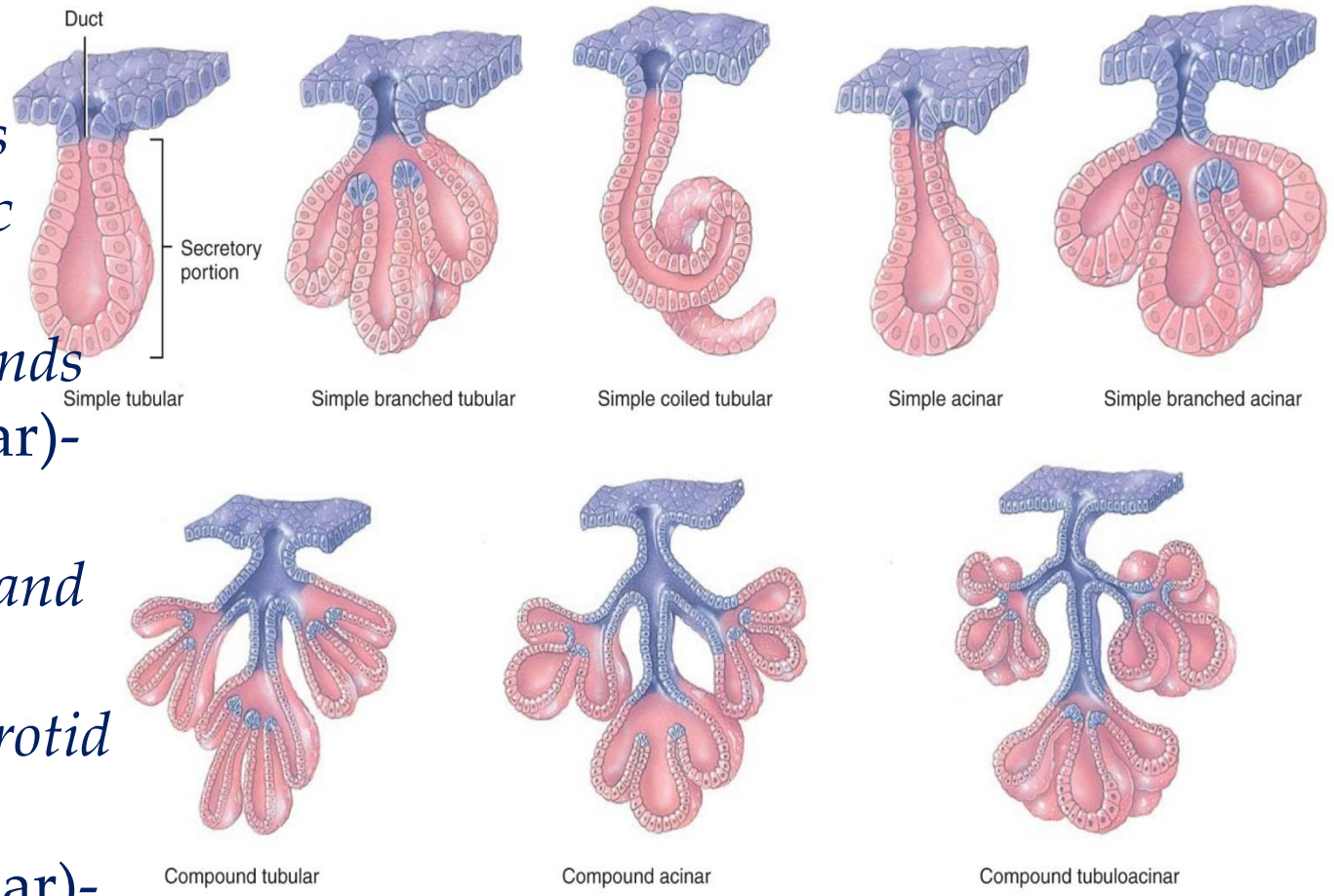
Secretary portion:

- ✓ if the secretory portion is shaped like a tube, the gland is **tubular;**
- ✓ if it is shaped like a flask, the gland is **alveolar or acinar;**
- ✓ if the tube ends in a saclike dilation, the gland is **tubuloalveolar.**



Multicellular glands

- Simple tubular – *intestinal glands*
- Simple, branched tubular- *fundic glands of stomach*
- Simple, coiled tubular- *sweat glands*
- Simple, branched acinar (alveolar)- *sebaceous glands*
- Compound tubular- *Brunners gland of the duodenum*
- Compound acinar (alveolar)- *parotid salivary gland*
- Compound tubuloacinar (alveolar)- *submaxillary salivary gland*



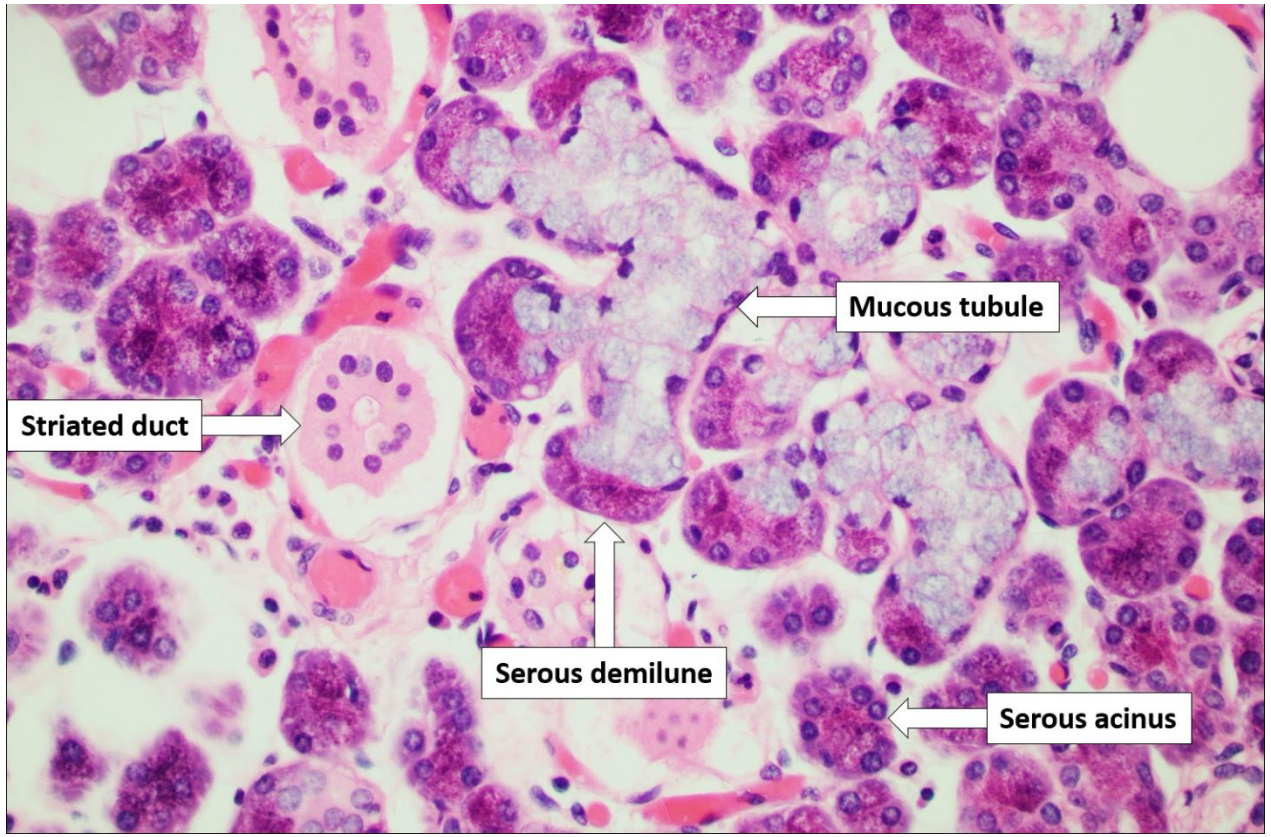
SPECIAL FEATURES OF SOME EXOCRINE GLANDS

Serous demilunes - Consist of a “cap” of serous cells around the end of a mucous tubule; appear half-moon shaped in section

Myoepithelial cells –

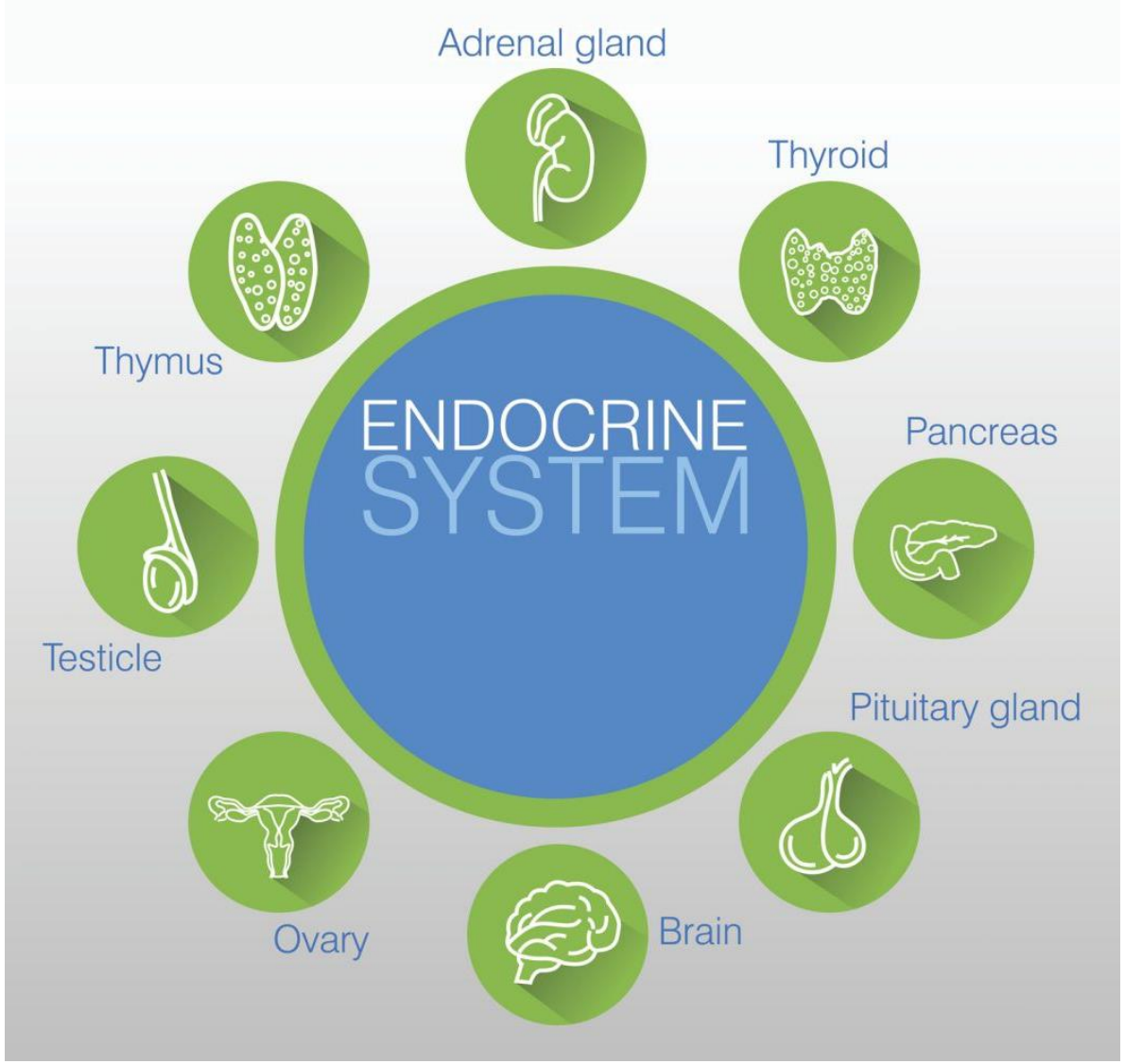
- Resemble smooth muscle cells in structure but are of epithelial origin;
- prominent in sweat and mammary glands,
- surround secretory units, lying inside the basement membrane,
- aid in the expulsion

of secretory products from the gland.



ENDOCRINE GLANDS

- ✓ **No ducts**
- ✓ **Occurrence:**
- Unicellular (enteroendocrine cells of the digestive tract)
- Small clusters of cells (islet of Langerhans in pancreas)
- Organs (thyroid gland, adrenal gland)
- ✓ **Highly vascular with fenestrated capillaries**
- ✓ **Secrete hormones**
- ✓ **Secrete by the merocrine or diffusion methods only**



Enjoy your classes!