EPITHELIAL TISSUES

Tissues and Histology

- Tissues are group of cells that are similar in structure and function
- Histology is the study of tissues
- The four primary tissue types are
  - Epithelial tissue
  - Connective tissue
  - Muscle tissue
  - Nervous tissue

Embryonic Tissue

- Primary tissue types are derived from the embryonic germ layers
  - Endoderm
    - Forms the lining of the digestive tract and its derivatives
  - Mesoderm
    - Forms tissues such as muscle, bone, and blood vessels
  - Ectoderm
    - Forms the outermost layer of skin and the nervous system
- Gives rise to all tissues of the body

4 Fundamental Types of Tissues:

1.Epithelial tissue

- covers body surfaces and lines hollow organs, body cavities and ducts

Functions:

a. protection

b. absorption

c. filtration

d. secretion

2. Connective tissue

- protects and supports the body and organs
- Bone, ligaments, adipose tissue

3. Muscle Tissue

- generates physical force need to make the body structure move

4. Nervous Tissue

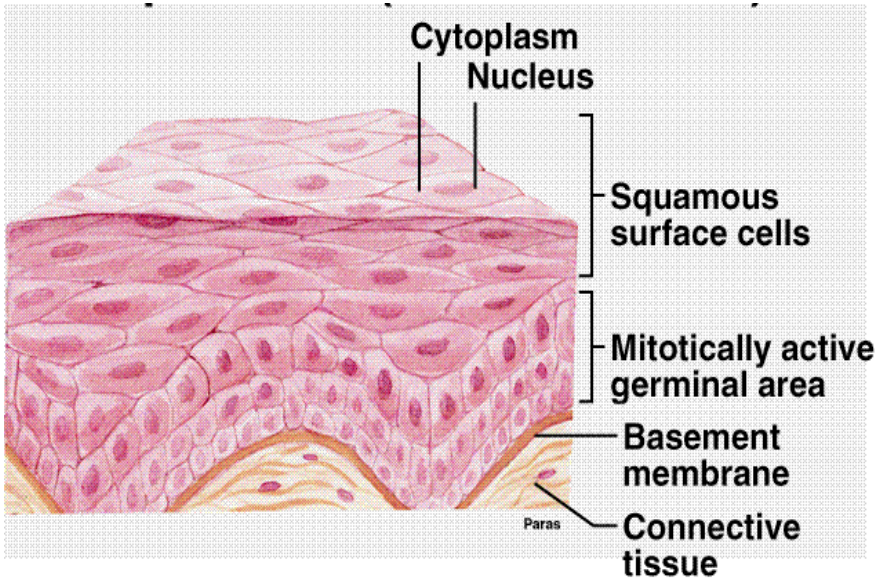
- reception of stimuli and transmit impulses that coordinate body activities

Characteristics of Epithelial Tissue:

- Cells are compactly arranged in one or more layers
- Form continuous sheet
- Single layer or Multiple layers

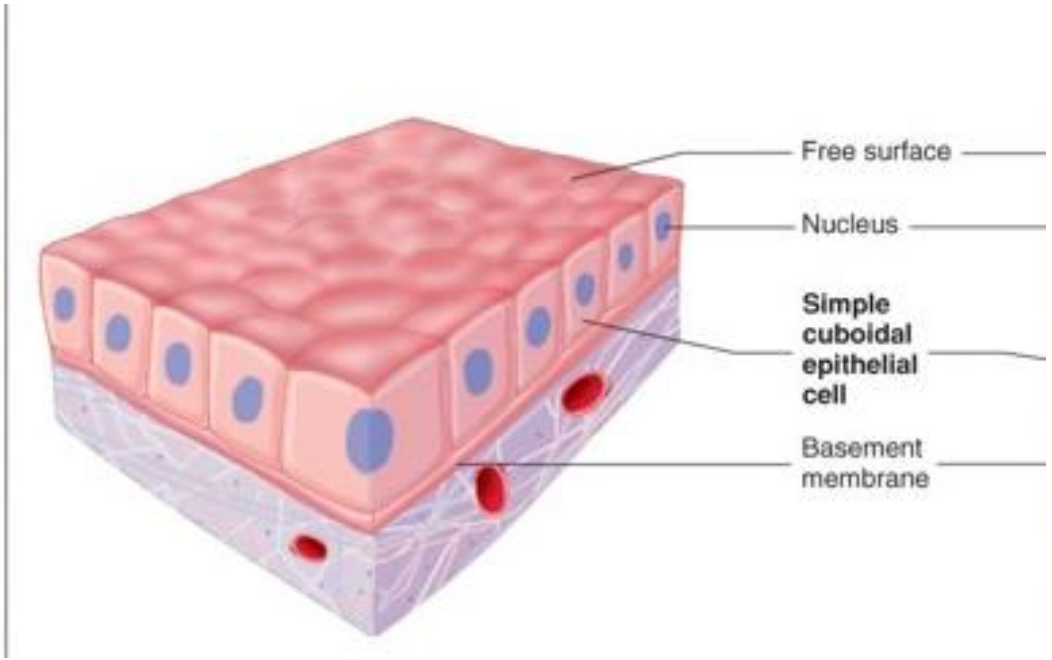
  Simple epithelium - cells are attached to the basement membrane

  Stratified epithelium – only basal cells are attached
- Basement membrane
- Avascular
- Nourished by connective tissue
- With specialized contacts/junctions



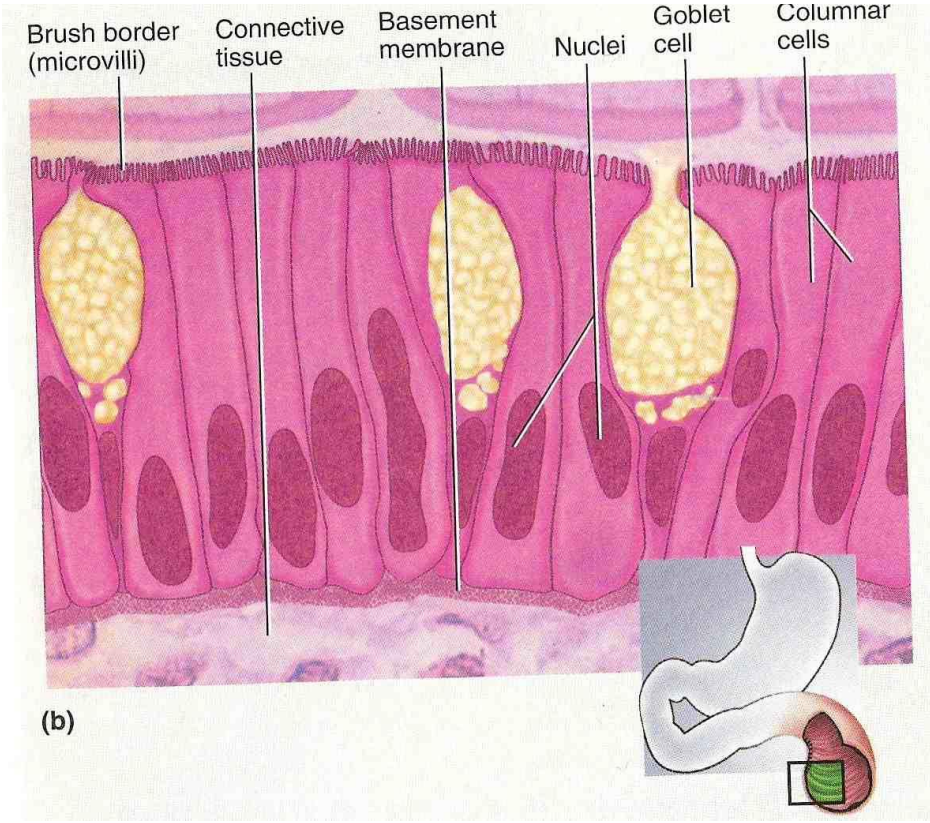
Characteristics of Epithelial Tissue

- Epithelial cells
  - Have a free, or apical, surface (not attached to other cells)
  - A lateral surface (attached to other cells)
  - A basal surface (attached to the basement membrane)



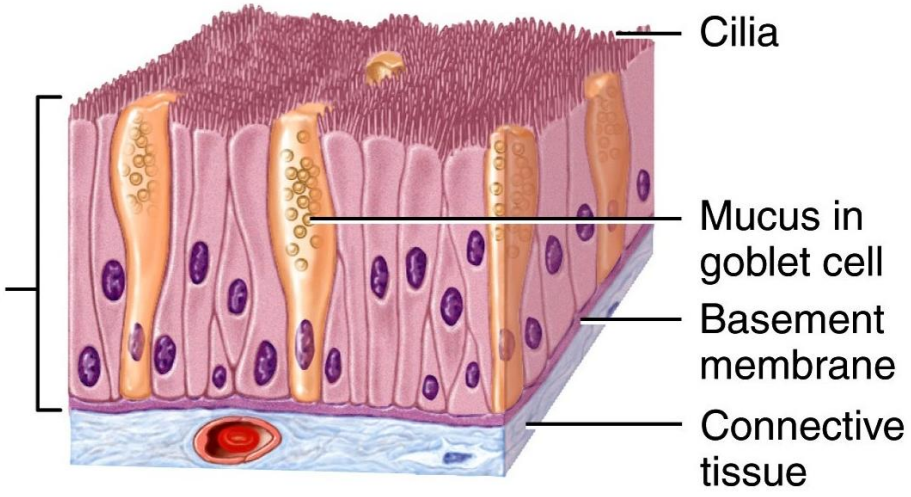
Special Features of Apical Surface of Epithelial Cells:

- **Microvilli: (eg.) in small intestine**
  - Finger-like extensions of the plasma membrane of apical epithelial cells
  - Increase surface area for absorption
  - Temporary or permanent
  - 1 µm : height
  - 0.8 µm : width

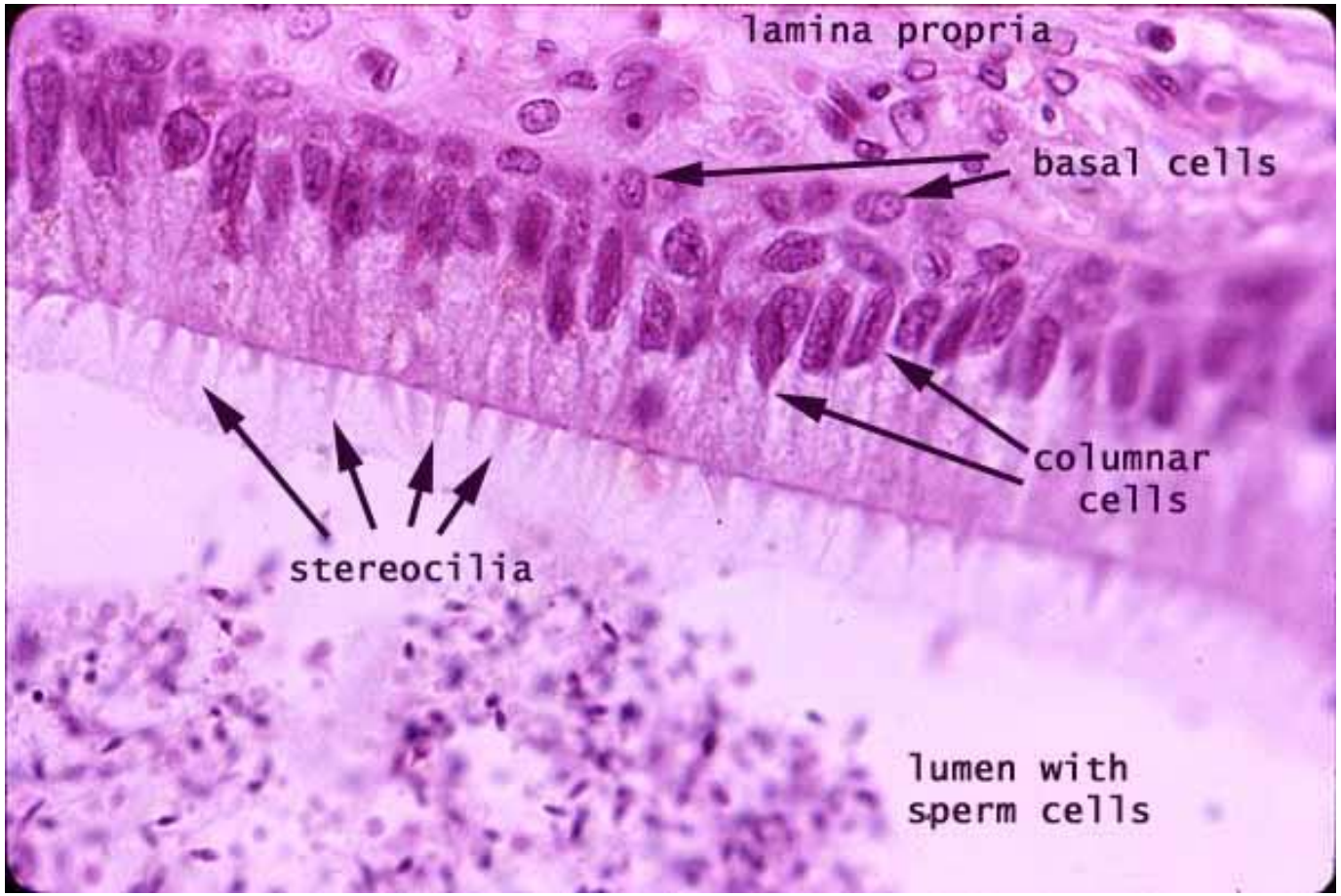


Special Features of Apical Surface of Epithelium

- **Cilia: (eg.) respiratory tubes**
  - short hair like extensions
  - move materials over the epithelial surface
  - Move mucus over epithelial surface
  - 5-10 µm : length
  - 0.2 µm : diameter



- **Stereocilia (eg.) epididymis & ductus deferens**
  - **Longer but less motile than microvilli**
  - **Branched**



CELL JUNCTIONS

- Tight junctions bind adjacent cells together and form a permeability barrier
- Desmosomes mechanically bind cells together
- Hemidesmosomes mechanically bind cells to the basement membrane
- Gap junctions allow intercellular communication

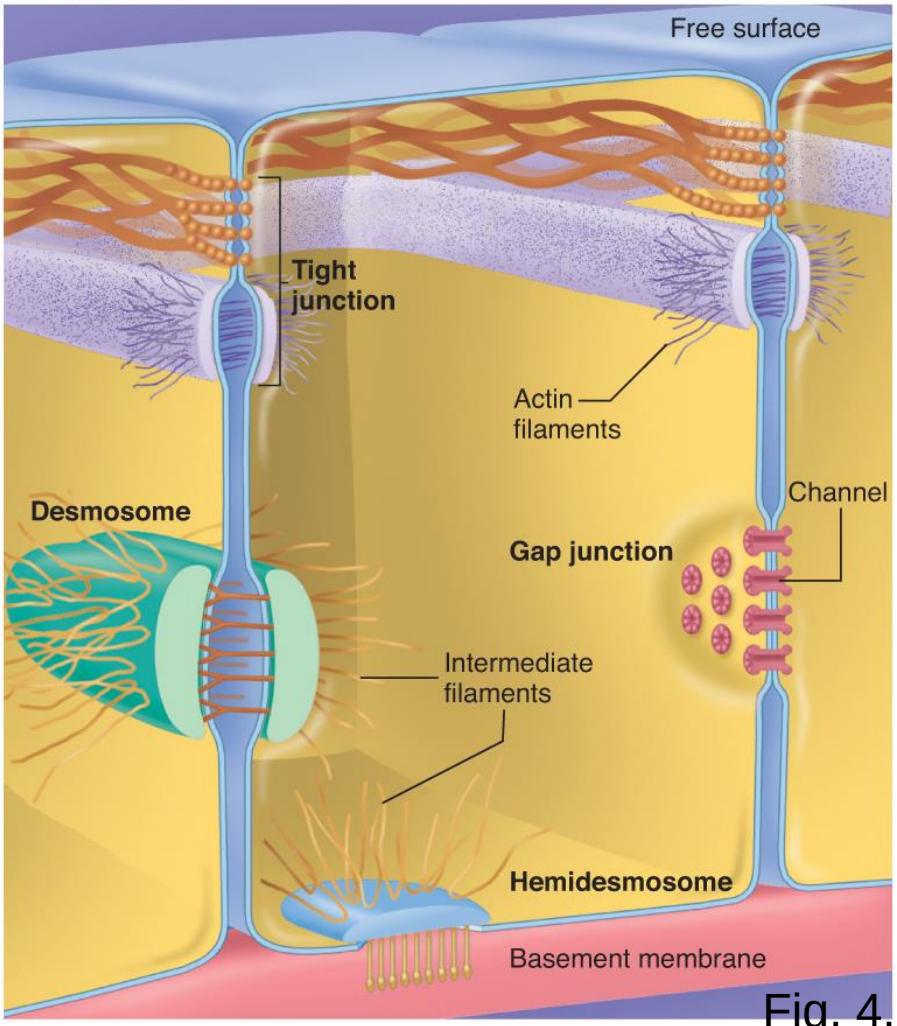
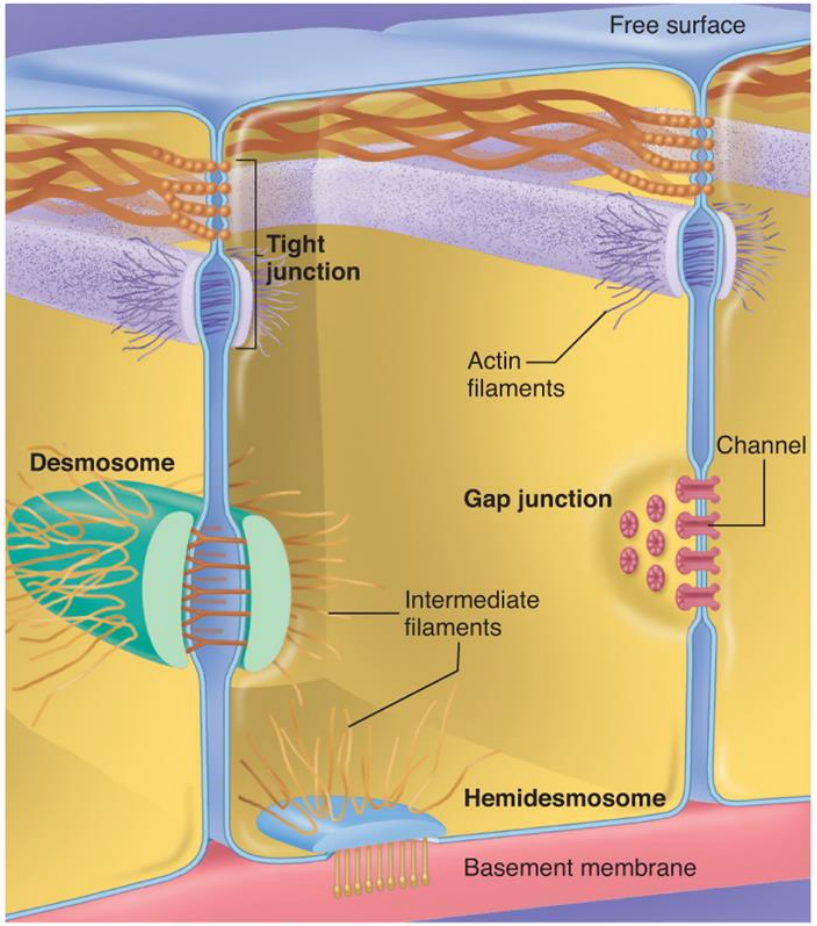


Fig. 4.2

ZONULA OCCLUDENS

- Most apical of the junctions
- Aka “tight” junction
- Belt-like structure that encircles the entire circumference
- OCCLUDIN



DESMOSOME

- Aka macula adherens
- Resembles spot-weld but does not form a belt around the cell
- Found along the lateral cell membrane
- CADHERIN
- Helps to resist shearing forces

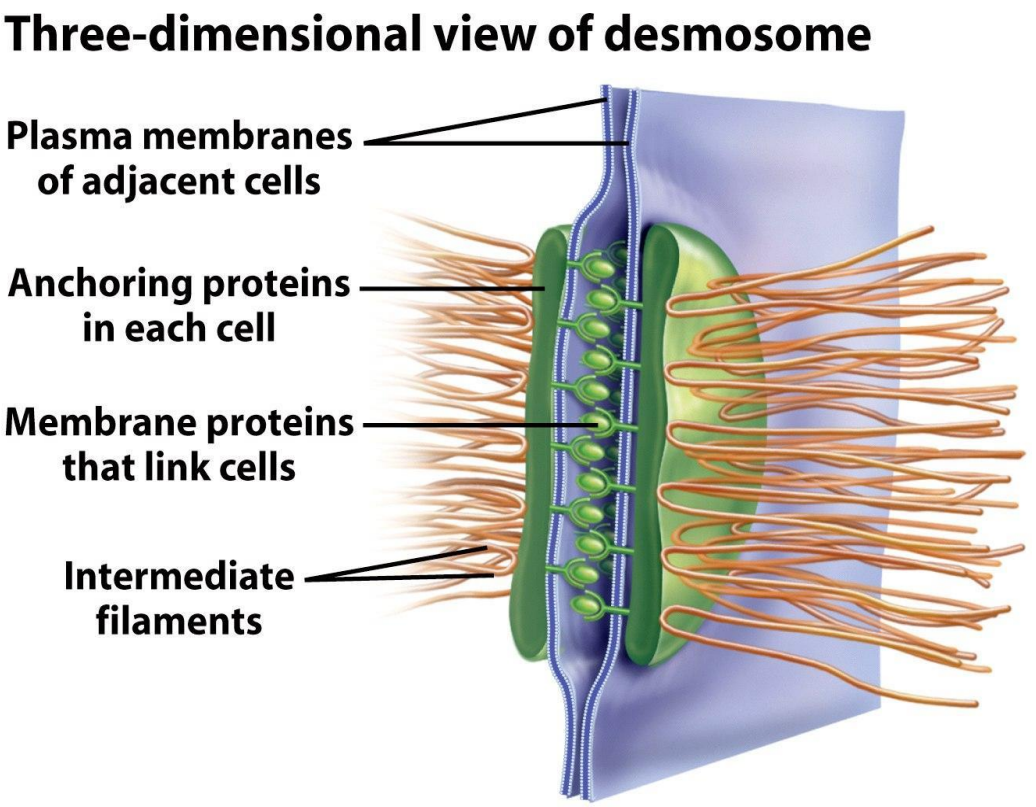
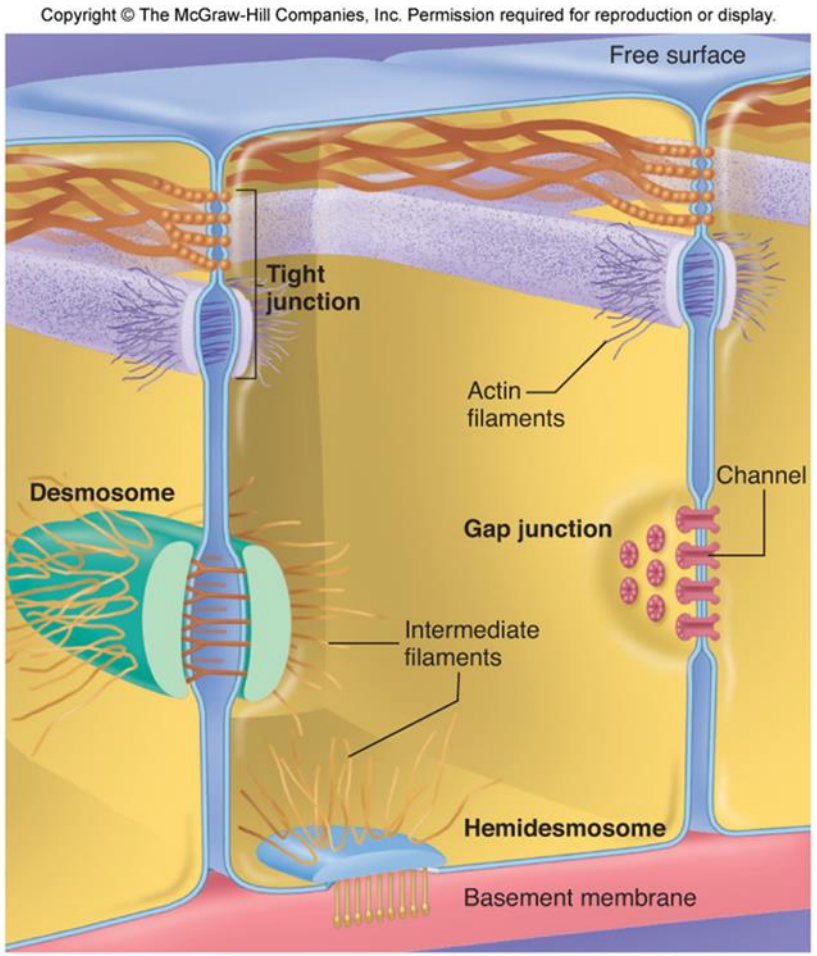


Figure 8-10b Biological Science, 2/e

HEMIDESMOSOME

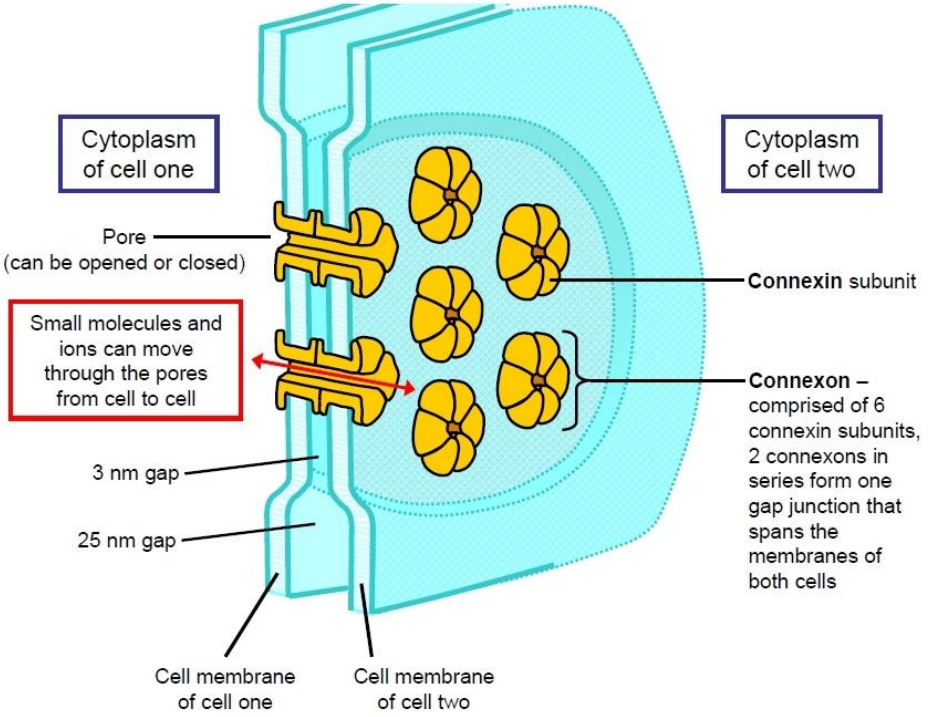
- Resembles half-desmosomes
- Bind the cell to the BL
- Contains integrins



GAP JUNCTION

- Aka: communicating junction
- Connexin:
- aqueous pores from the plasma membrane thru the intercellular space
- Connexons:

  hexameric complexes



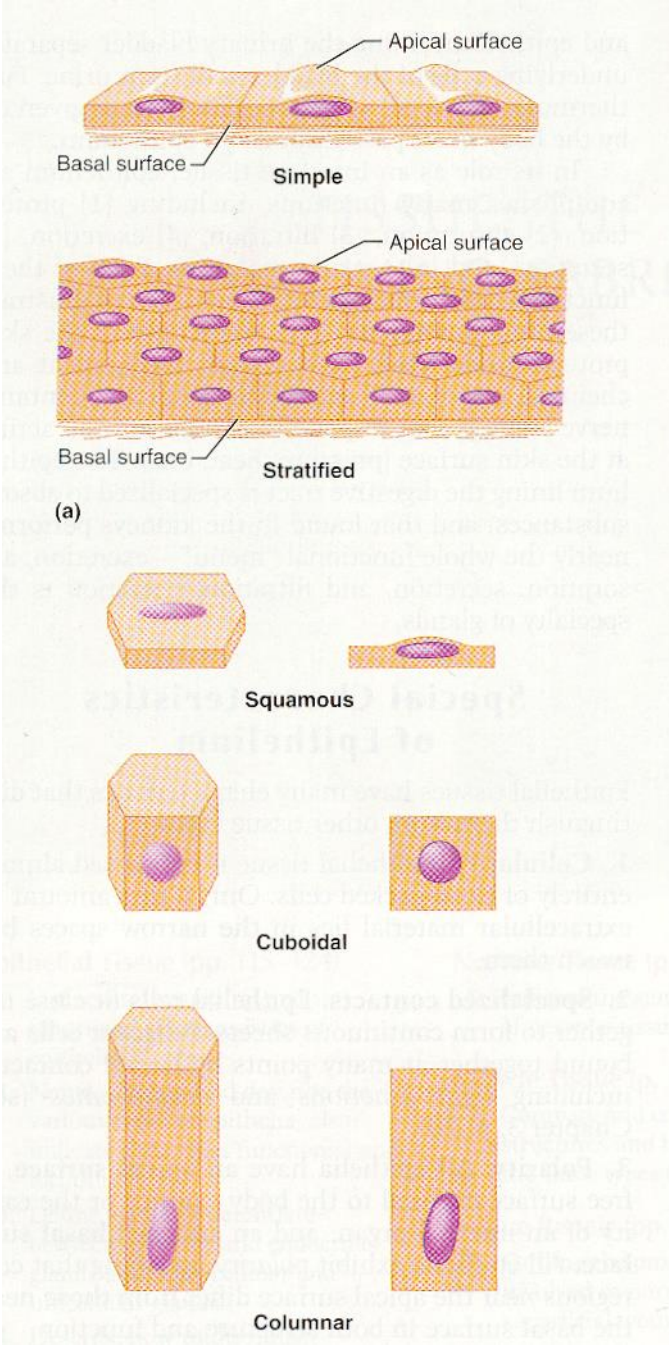
Above: gap junctions connecting the cytoplasm of two neighbouring animal cells

Functions of Epithelial Tissue

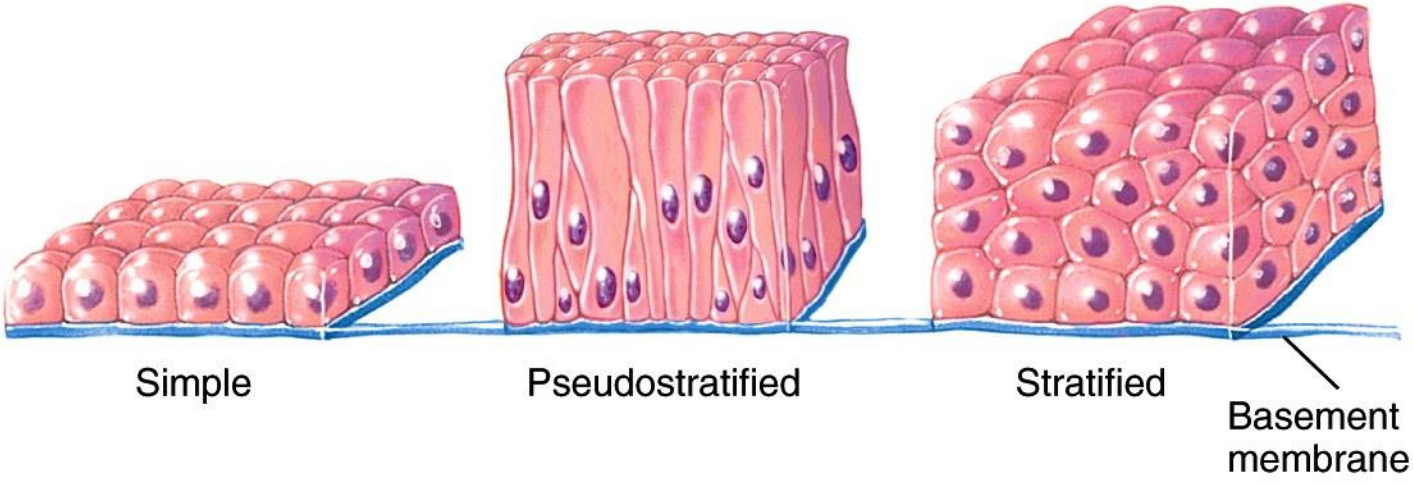
- **Protection**
  - Skin protects from sunlight & bacteria & physical damage.
- **Absorption**
  - Lining of small intestine, absorbing nutrients into blood
- **Filtration**
  - Lining of Kidney tubules filtering wastes from blood plasma
- **Secretion**
  - Different glands produce perspiration, oil, digestive enzymes and mucus

BASES OF Classification of Epithelial Tissue

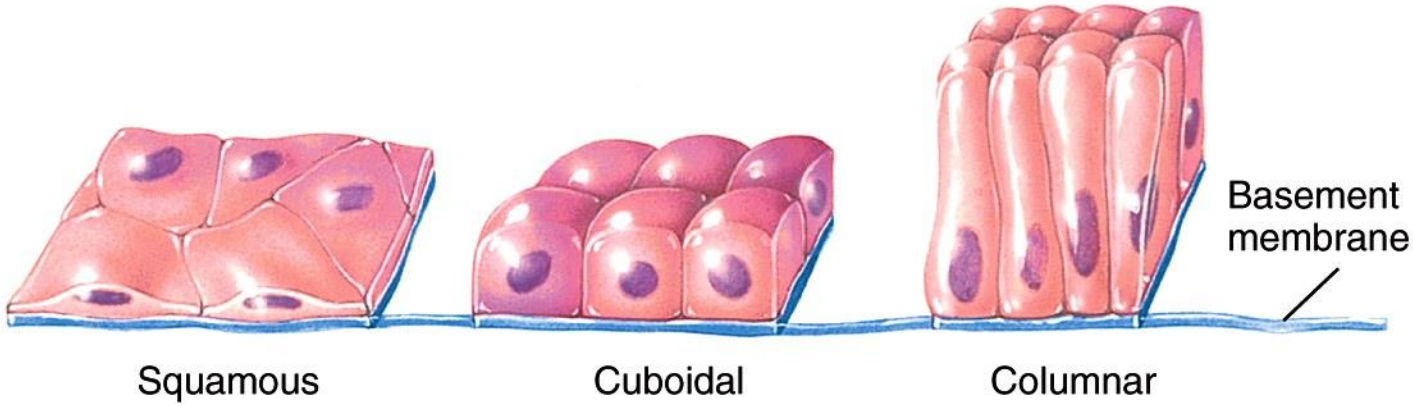
- Cell Shape
  - Squamous – flattened like fish scales
  - Cuboidal - cubes
  - Columnar - columns
- Cell Layers
  - Simple (one layer)
  - Stratified (many layers)
    - Named for the type of cell at the apical surface.

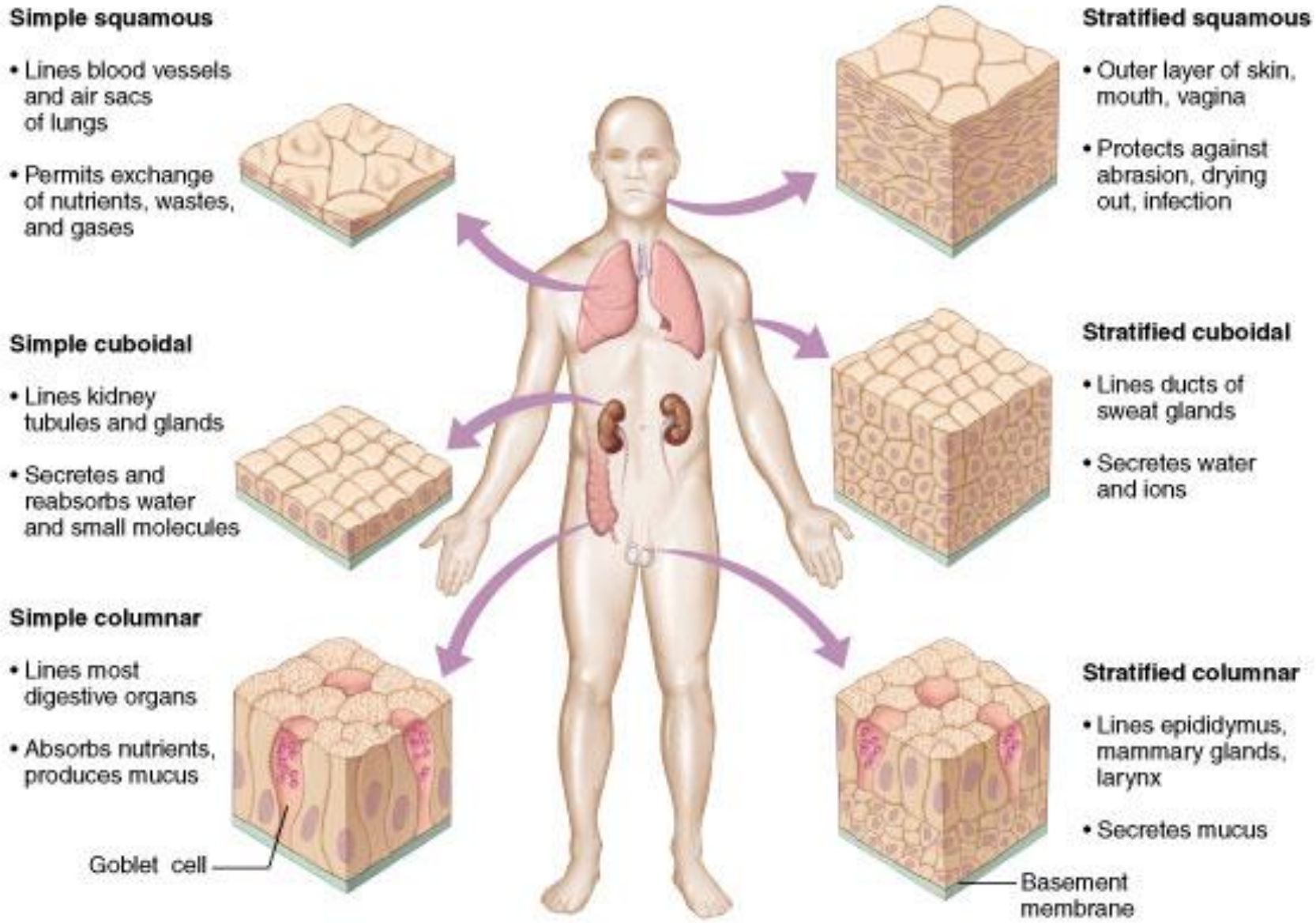


Arrangement of layers



Cell shape



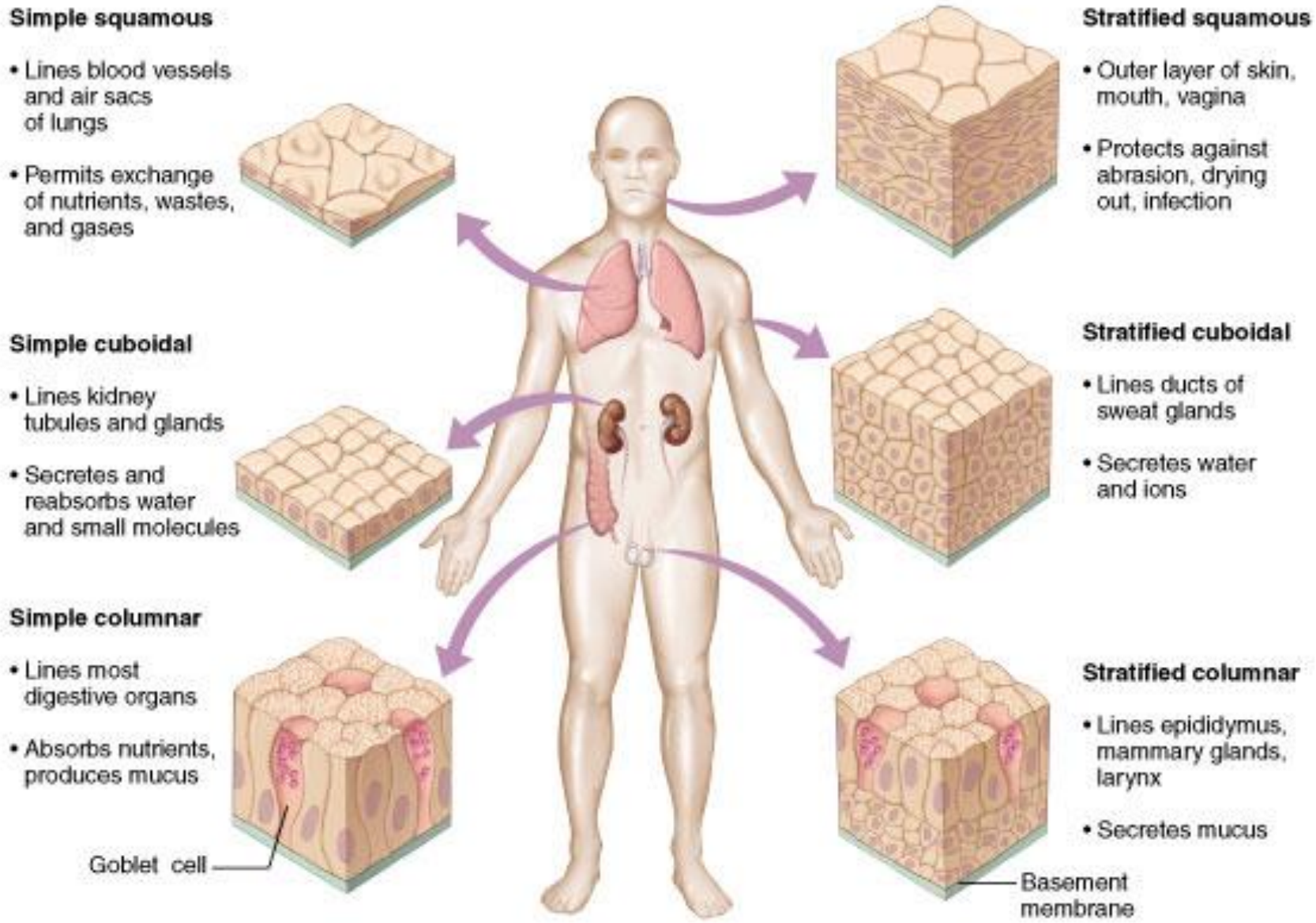


(a) Most epithelial tissues line or cover surfaces or body cavities

CLASSIFICATION

- EPITHELIAL MEMBRANE(COVERING AND LINING EPITHELIUM
- EPITHELIAL GLANDS

EPITHELIAL MEMBRANE

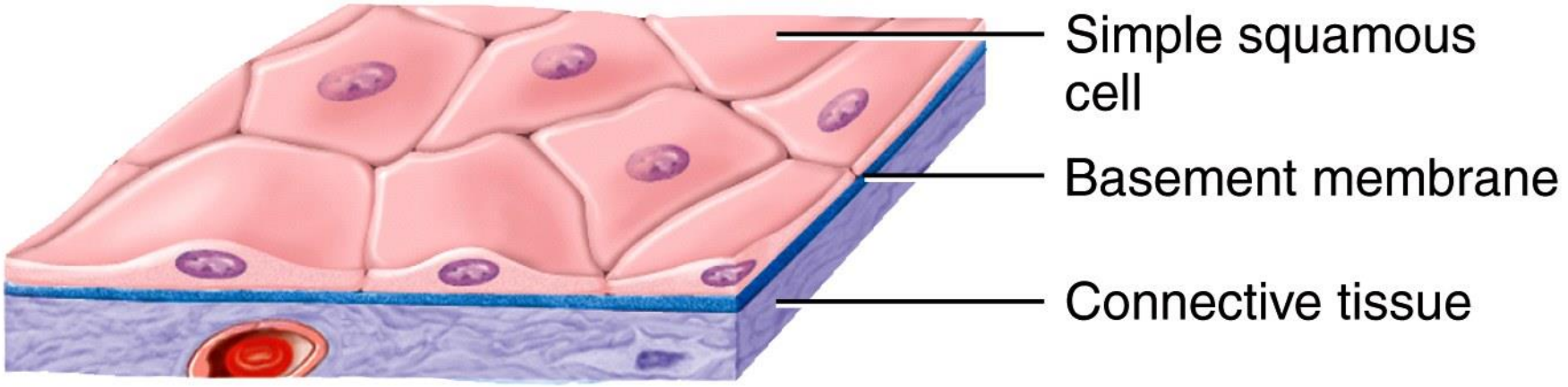


(a) Most epithelial tissues line or cover surfaces or body cavities

Simple Squamous Epithelium

- Structure
  - Single Layer of flattened cells
- Function
  - Absorption, and filtration
  - Not effective protection – single layer of cells.
- Location
  - Walls of capillaries, air sacs in lungs
  - Form serous membranes in body cavity
  - "pavement epithelium"

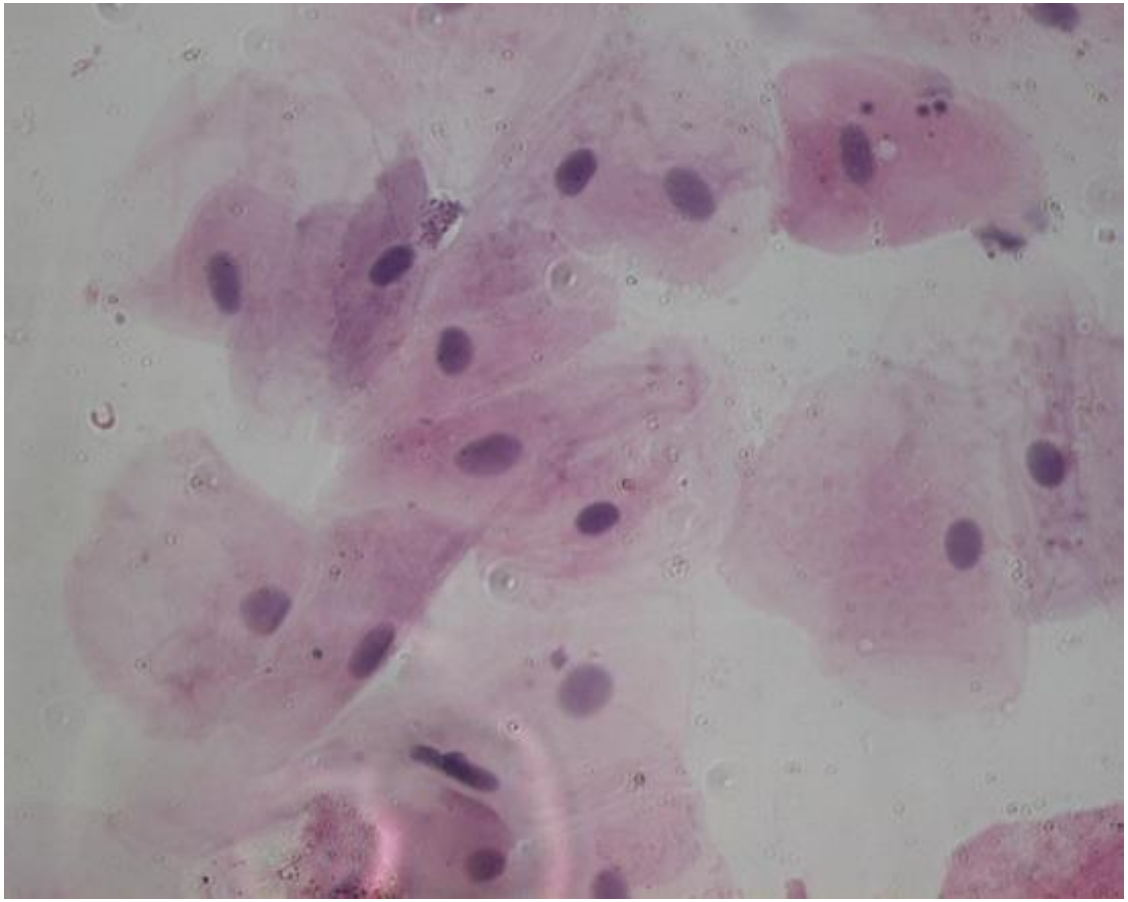
Simple Squamous Epithelium



Simple squamous epithelium

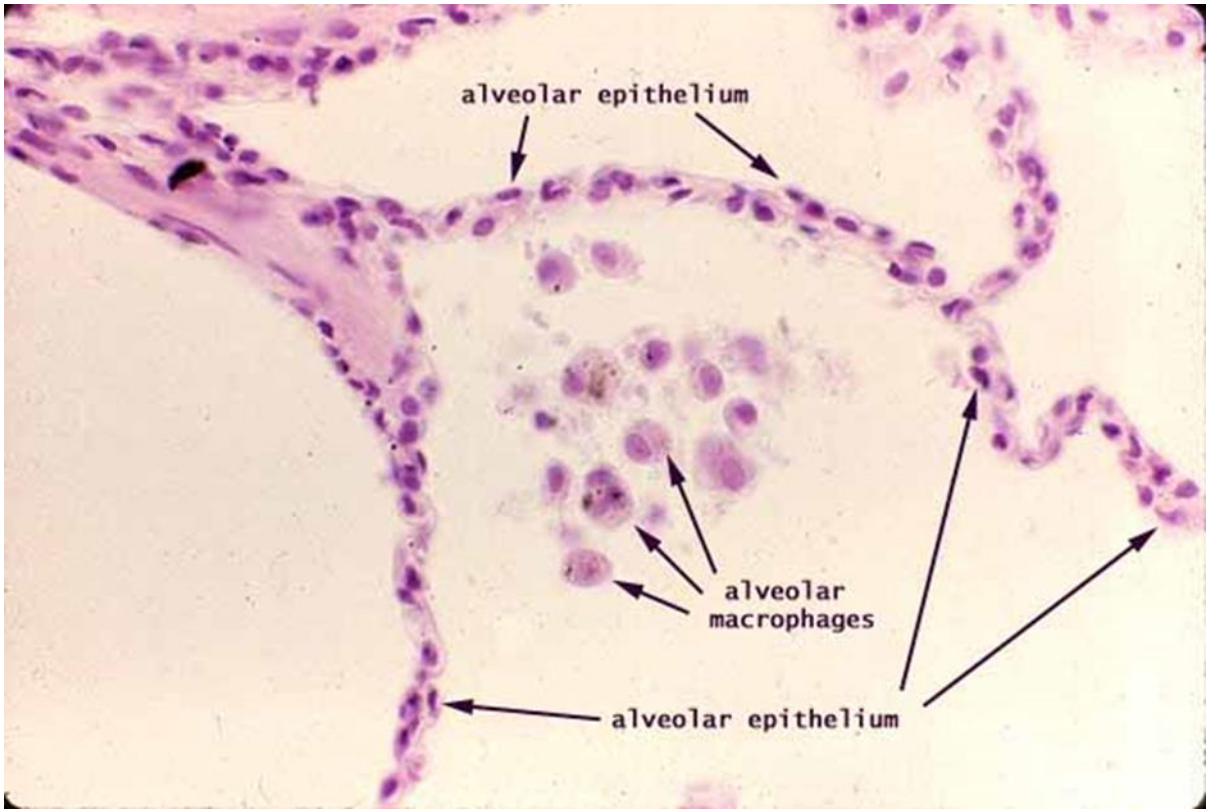
Simple Squamous Epithelium

Source: Inner cheek scrapings



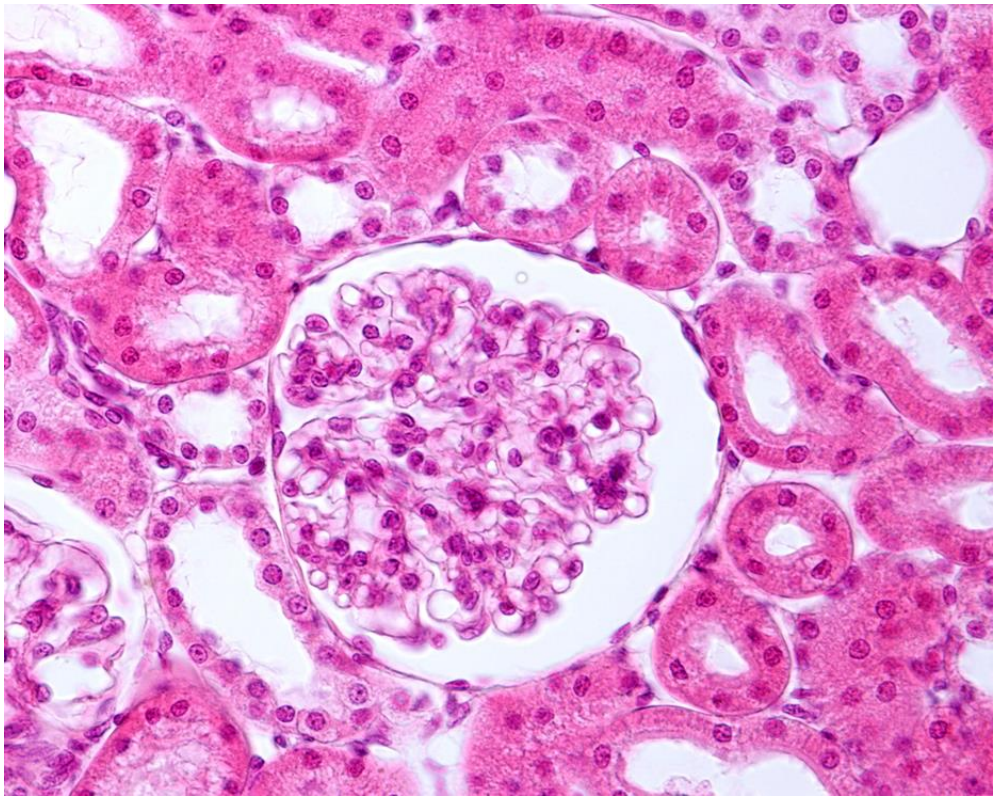
Simple Squamous Epithelium

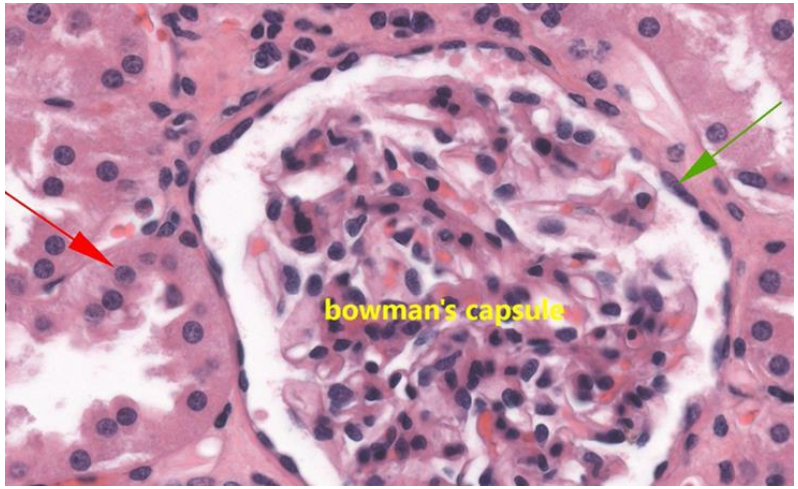
Tissue source: Alveolar wall (lungs)



Simple Squamous Epithelium

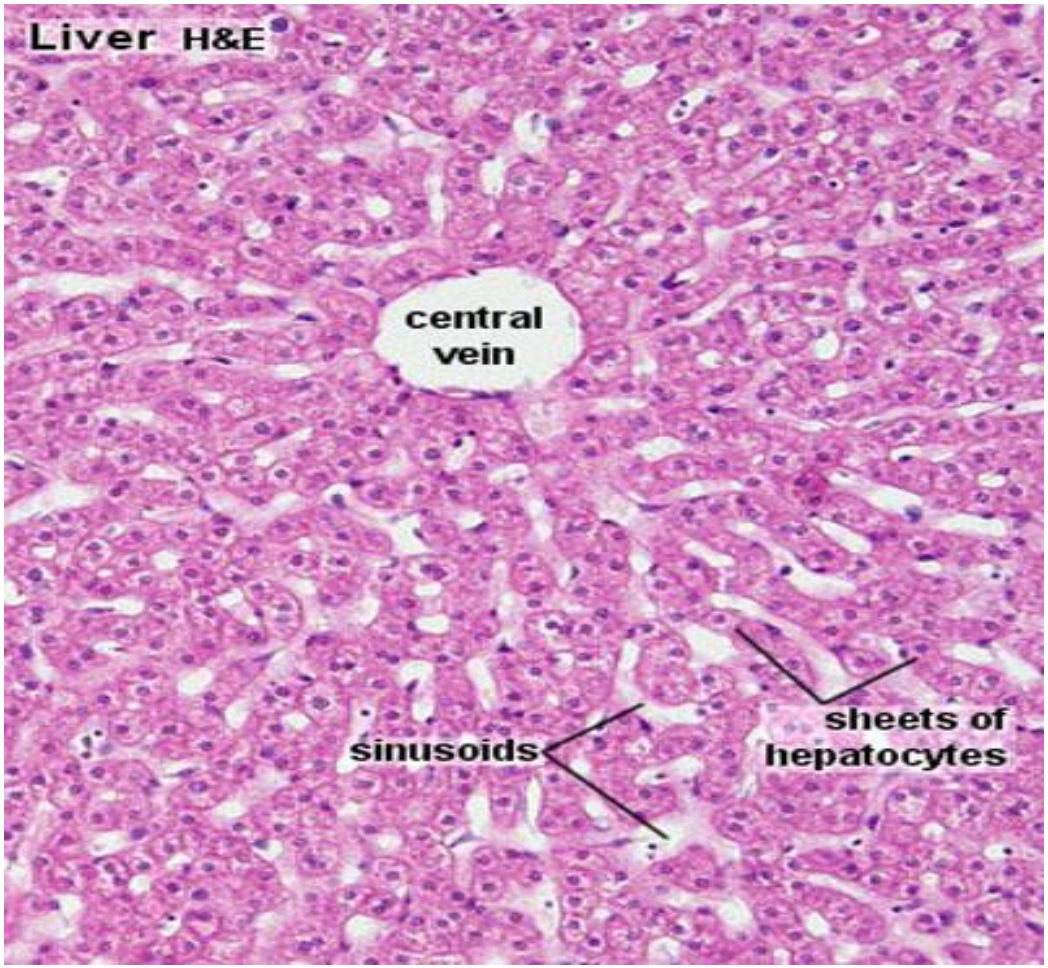
Tissue source: Bowman's capsule of kidney





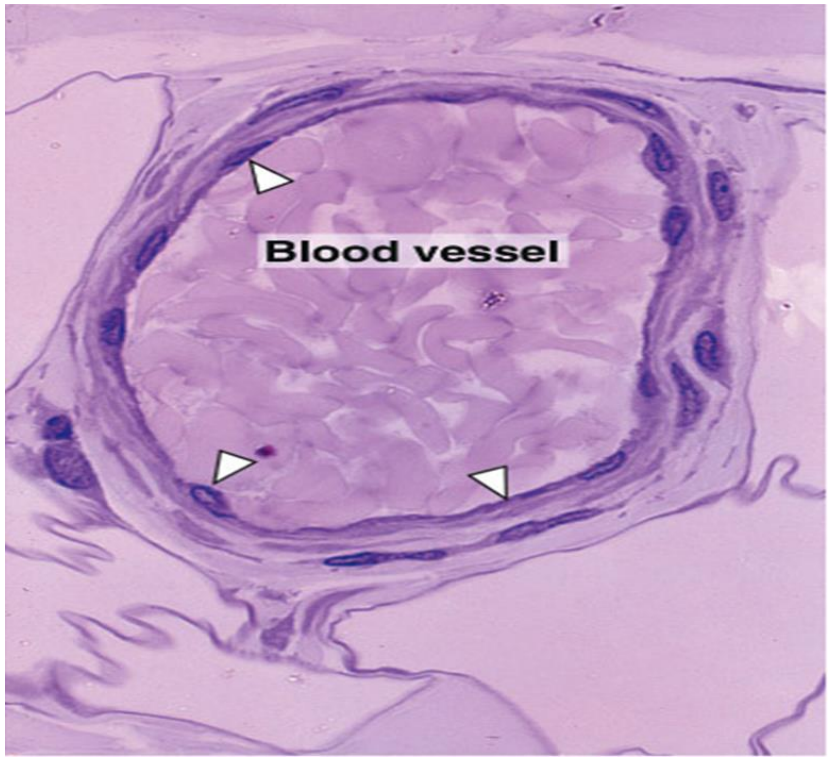
Simple Squamous Epithelium

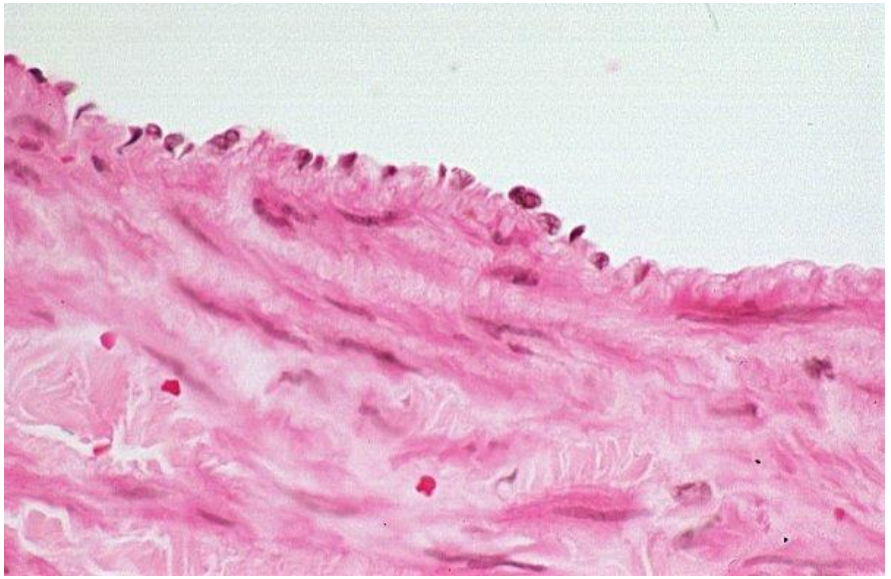
Tissue source: sinusoids of the liver



Simple Squamous Epithelium

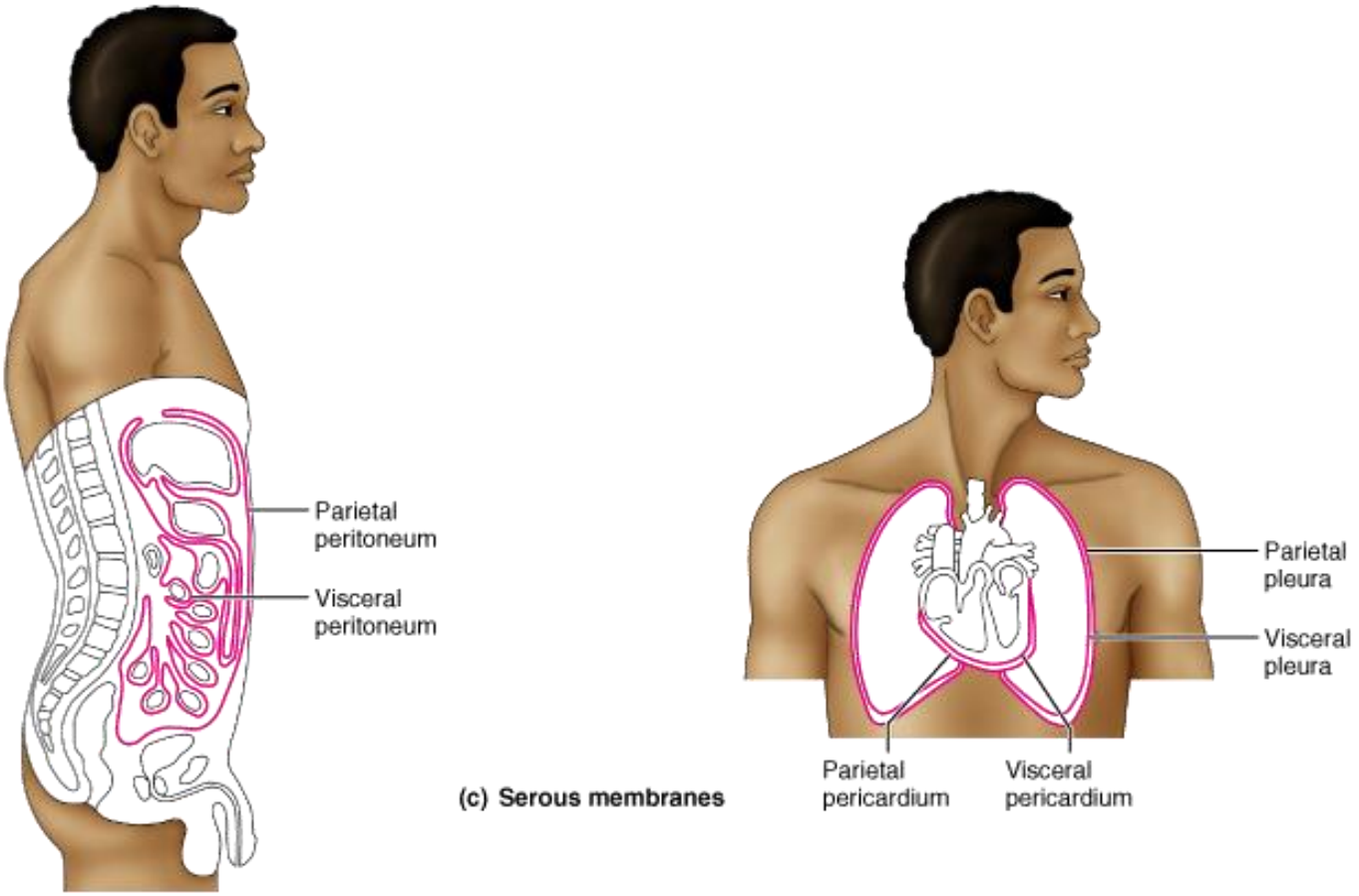
Tissue source: endothelium of blood vessels





Simple Squamous Epithelium

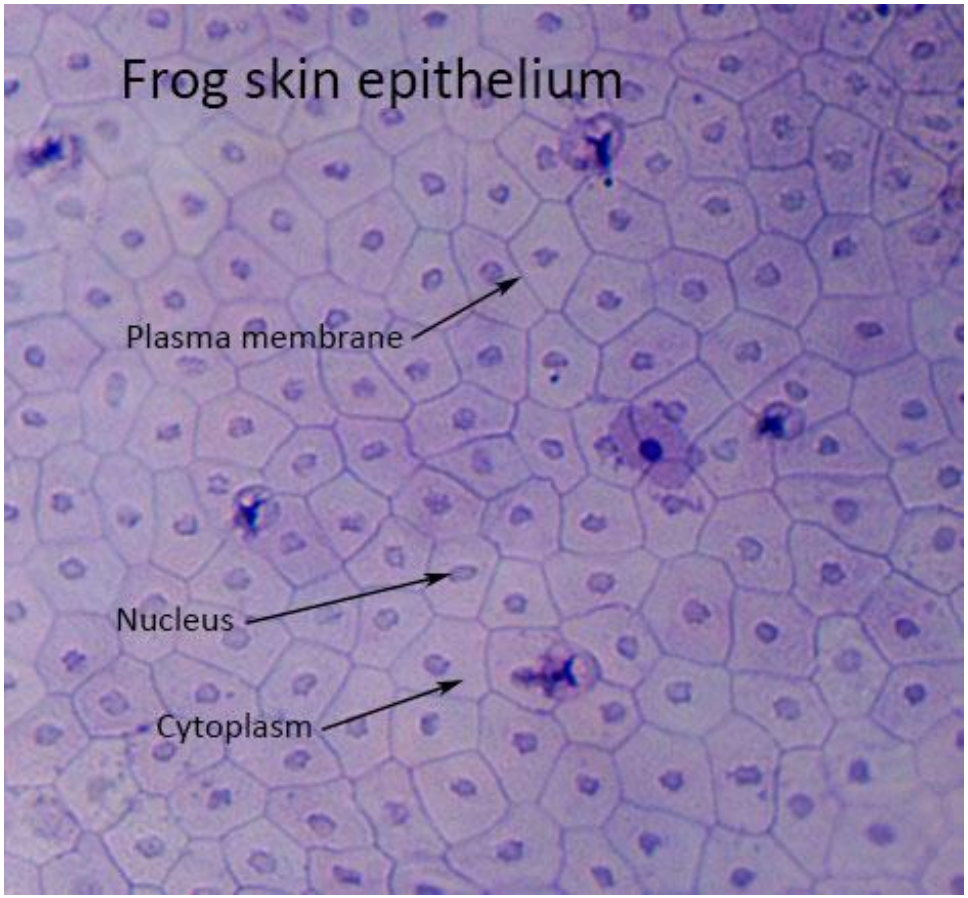
- mesothelium



(c) Serous membranes

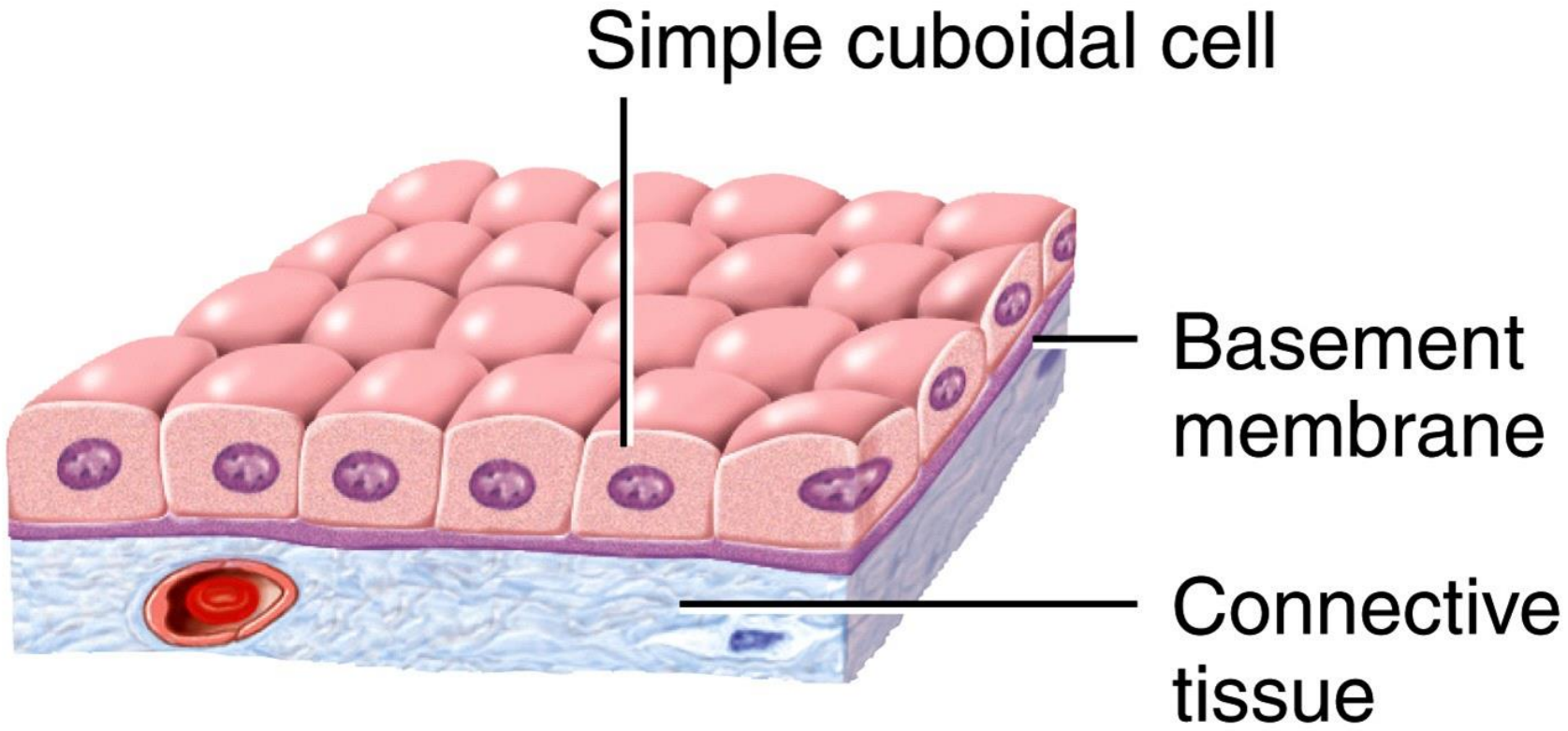
Simple Squamous Epithelium

Tissue source: frog skin



Simple Cuboidal Epithelium

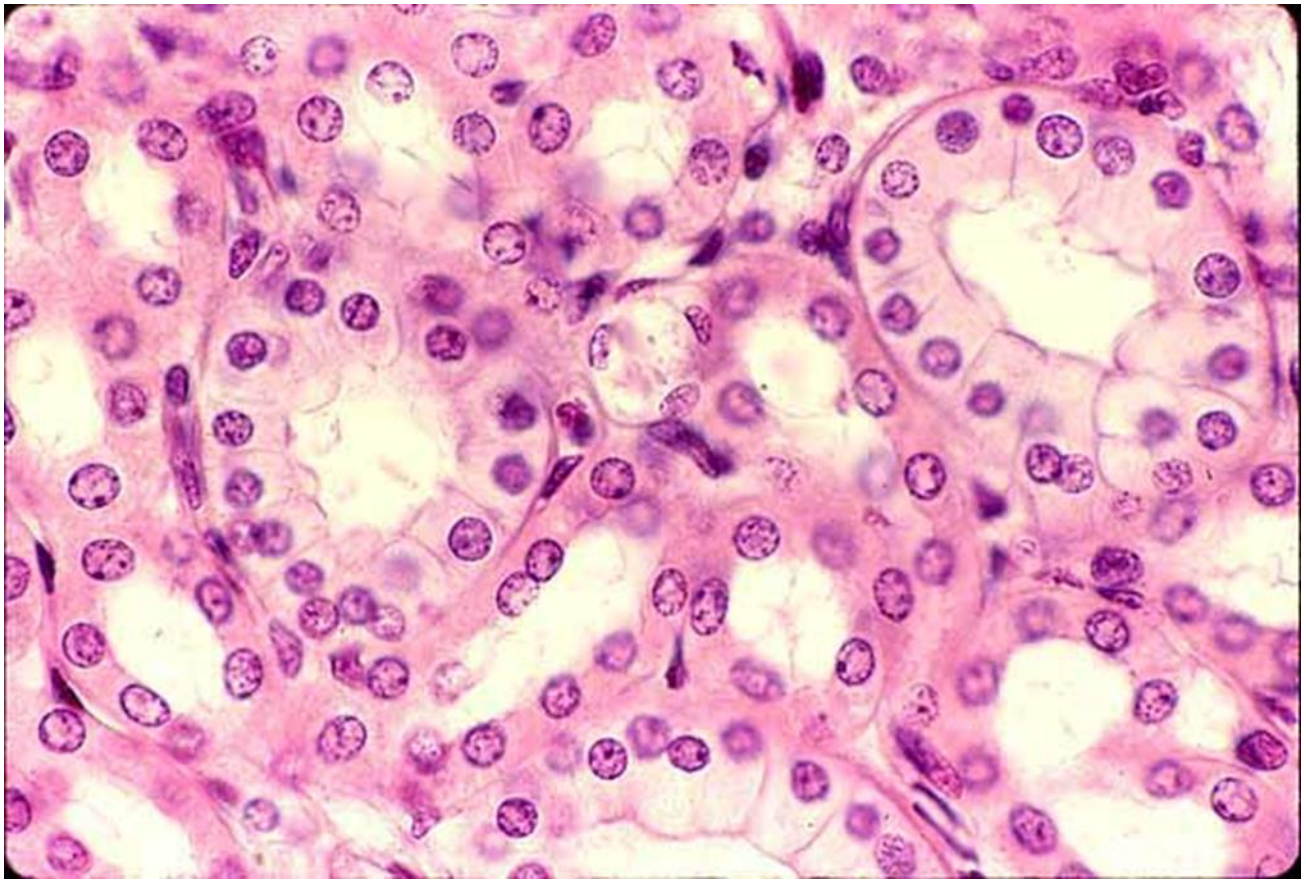
- Structure
  - Single layer of cube shaped cells
- Function
  - Secretion and transportation in glands, filtration in kidneys
- Location
  - ducts of pancreas, kidney tubules, surface of ovaries



Simple cuboidal epithelium

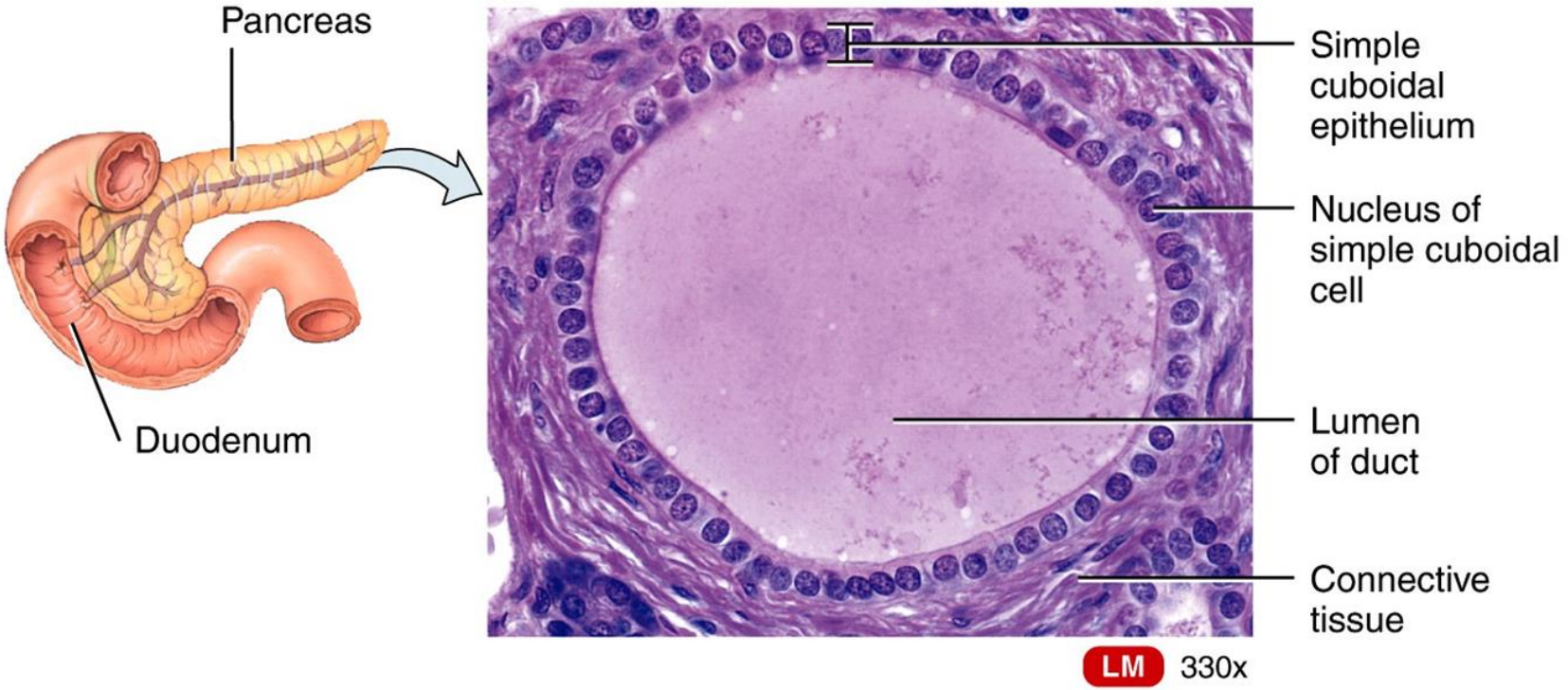
Simple Cuboidal Epithelium

Tissue source: kidney tubules



Simple Cuboidal Epithelium

Tissue source: interlobular duct of pancreas



Sectional view of simple cuboidal epithelium of intralobular duct of pancreas

Simple Columnar Epithelium

- Structure
  - Elongated layer of cells with nuclei at same level
- Function
  - Absorption, Protection & Secretion
- Special Features
  - Microvilli, bumpy extension of apical surface, increase surface area and absorption rate.
  - Goblet cells, single cell glands, produce protective mucus
  - Cilia (uterine tubes, oviduct)
- Location
  - Linings of entire digestive tract, fallopian tubes, uterus (ciliated)

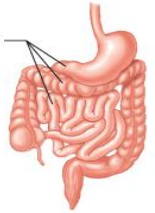
Table 4.1 Simple Epithelium—Continued

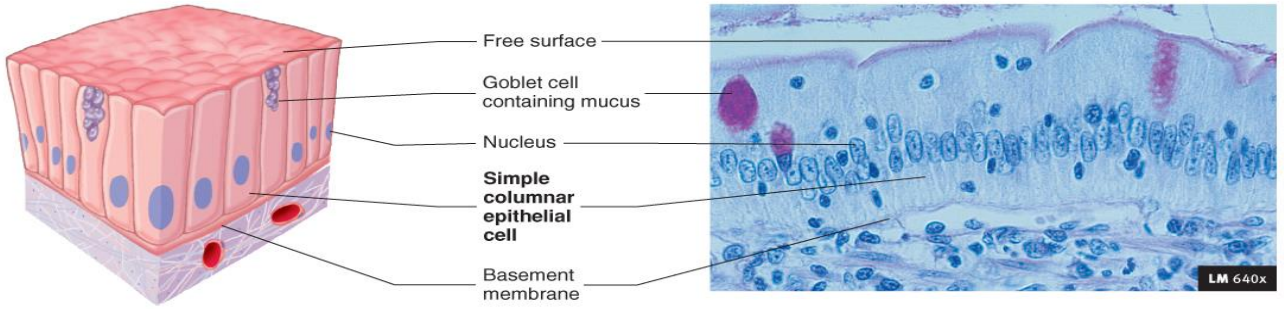
(c) Simple Columnar Epithelium

Structure:
Single layer of tall, narrow cells; some cells have cilia (bronchioles of lungs, auditory tubes, uterine tubes, and uterus) or microvilli (intestines)

Function:
Movement of particles out of the bronchioles of the lungs by ciliated cells; partially responsible for the movement of oocytes through the uterine tubes by ciliated cells; secretion by cells of the glands, the stomach, and the intestine; absorption by cells of the intestine

Location:
Glands and some ducts, bronchioles of lungs, auditory tubes, uterus, uterine tubes, stomach, intestines, gallbladder, bile ducts, ventricles of the brain



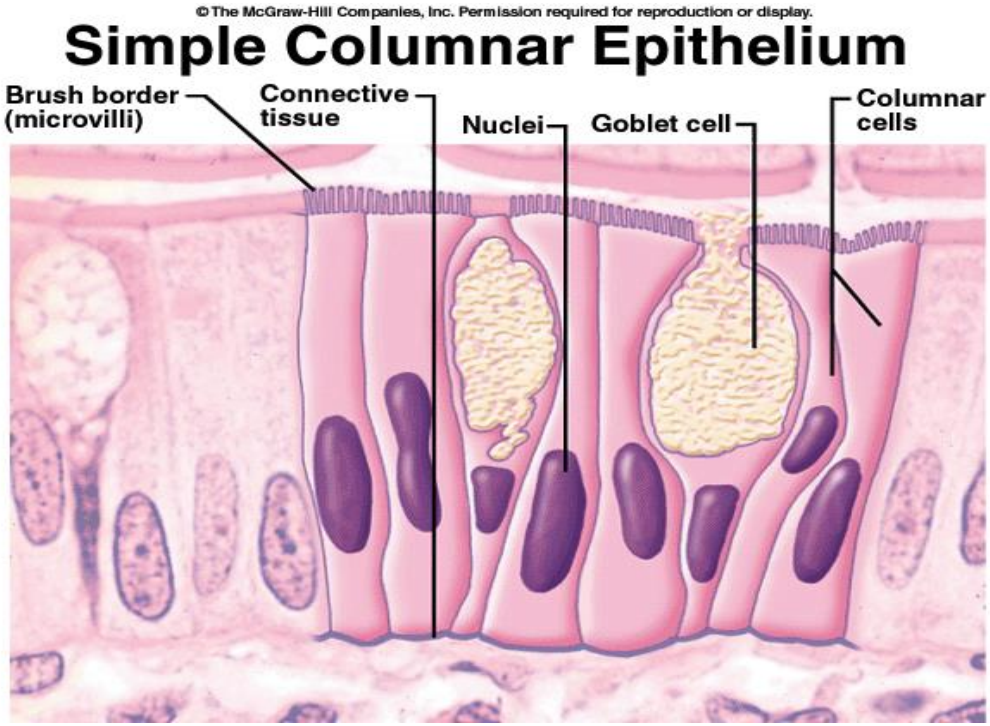


Description:

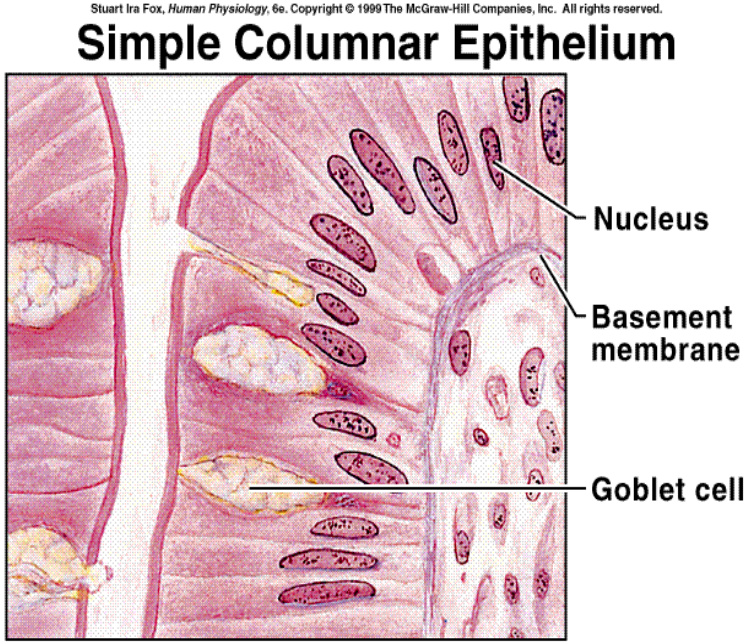
- single layer of columnar shaped cell
- Goblet cells – secrete mucus for lubrication
- nuclei near the base of the cell

Location:

- lines the entire length of digestive tract (stomach to the anus), oviduct, uterine tubes



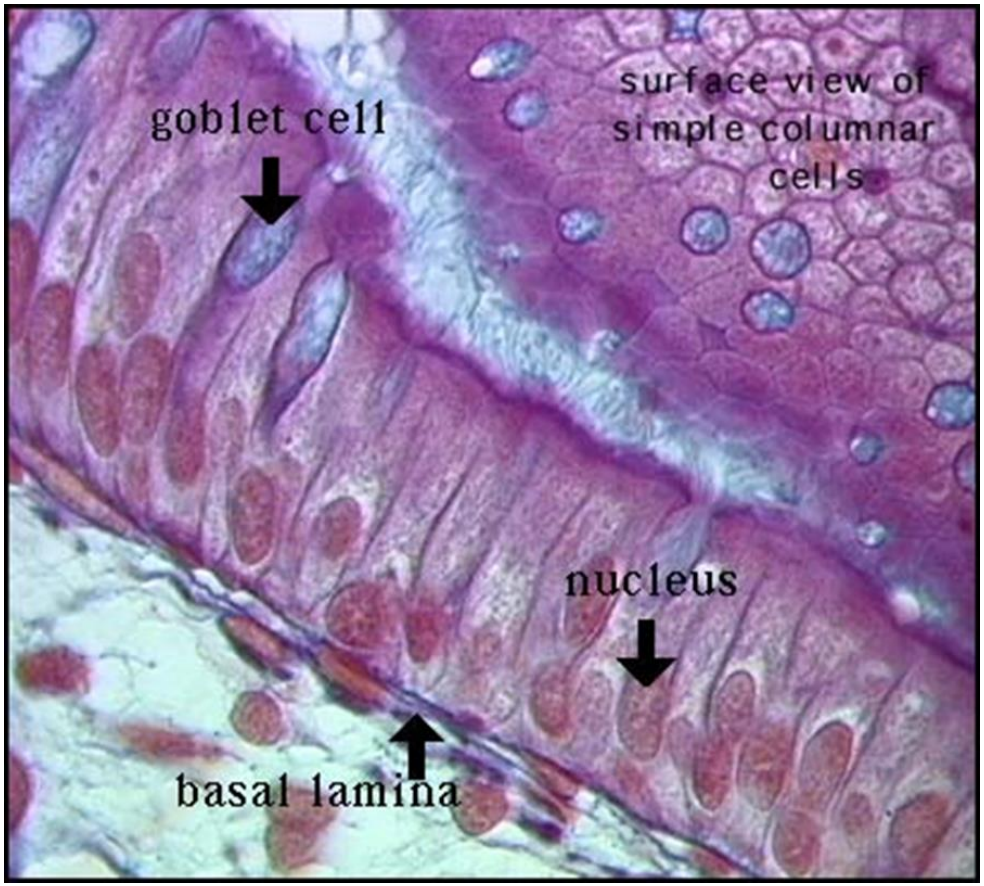
Goblet cells - epithelial cells whose sole function is to secrete mucus



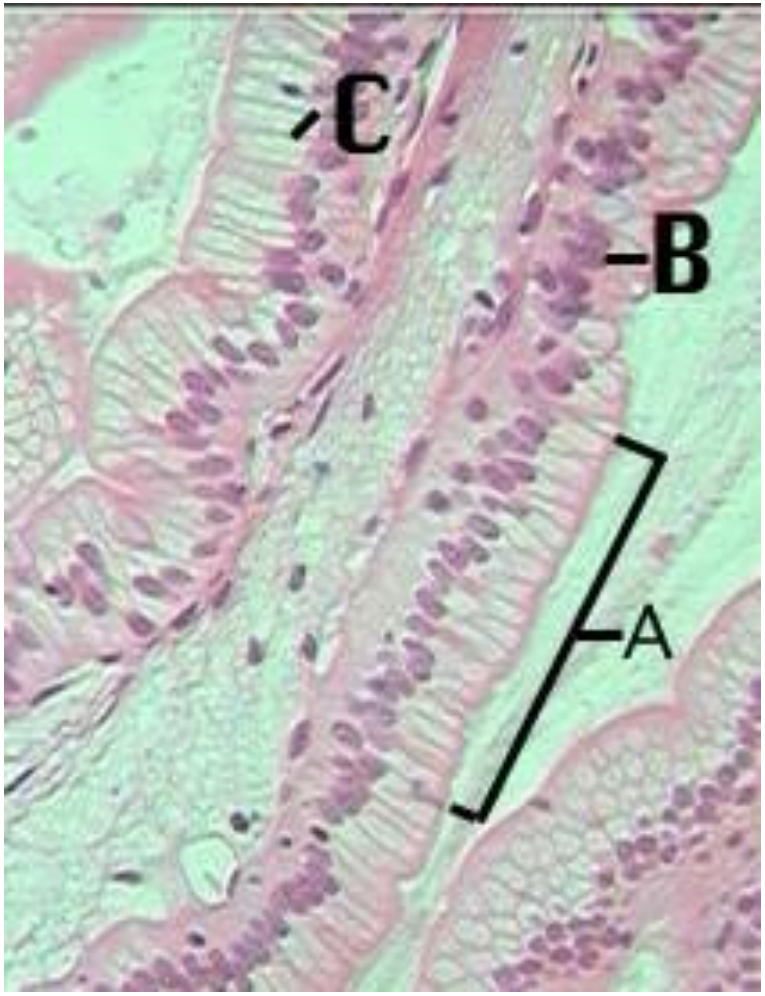
Simple Columnar Epithelium

Tissue source: ileum of small intestine

- Goblet cell
- microvilli



Simple Columnar Epithelium

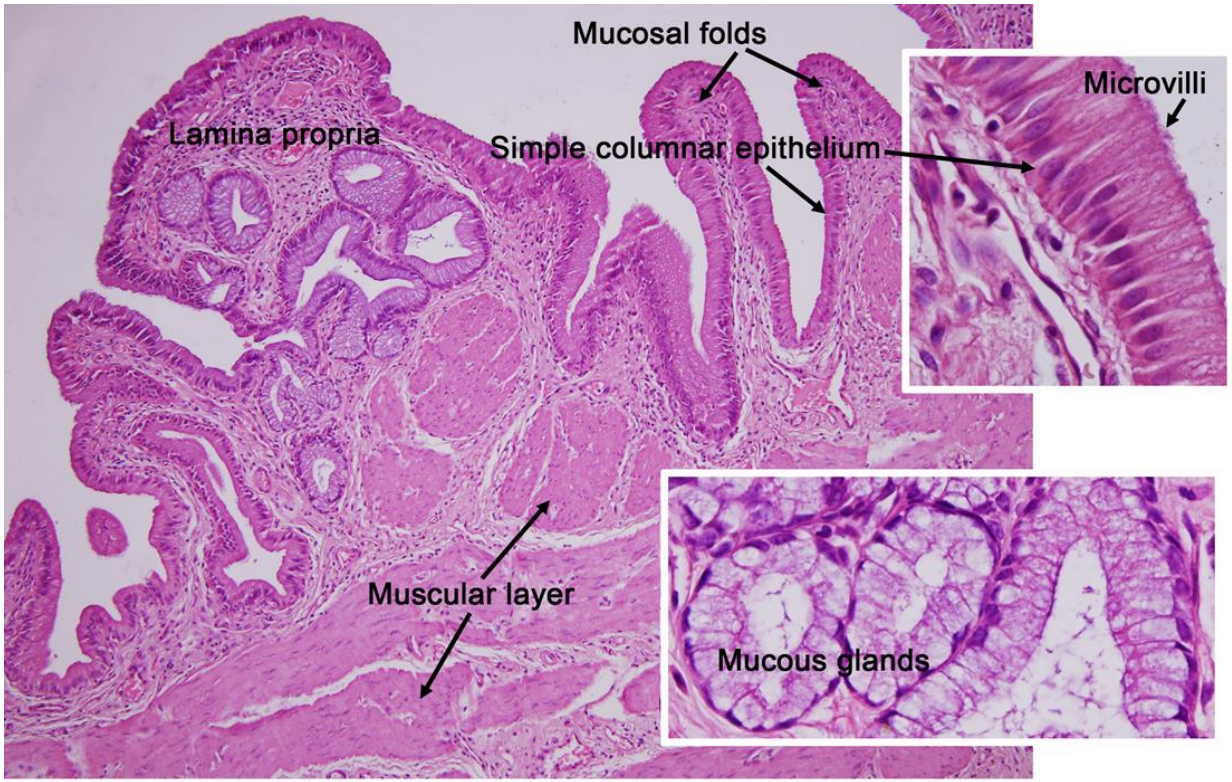


cross section of small intestine

- Cells (**A)** are not as wide as they are tall
- **nuclei (B)** located at the base of the cells.
- cell membranes **(C)** are very thin but easily identified.

Simple Columnar Epithelium

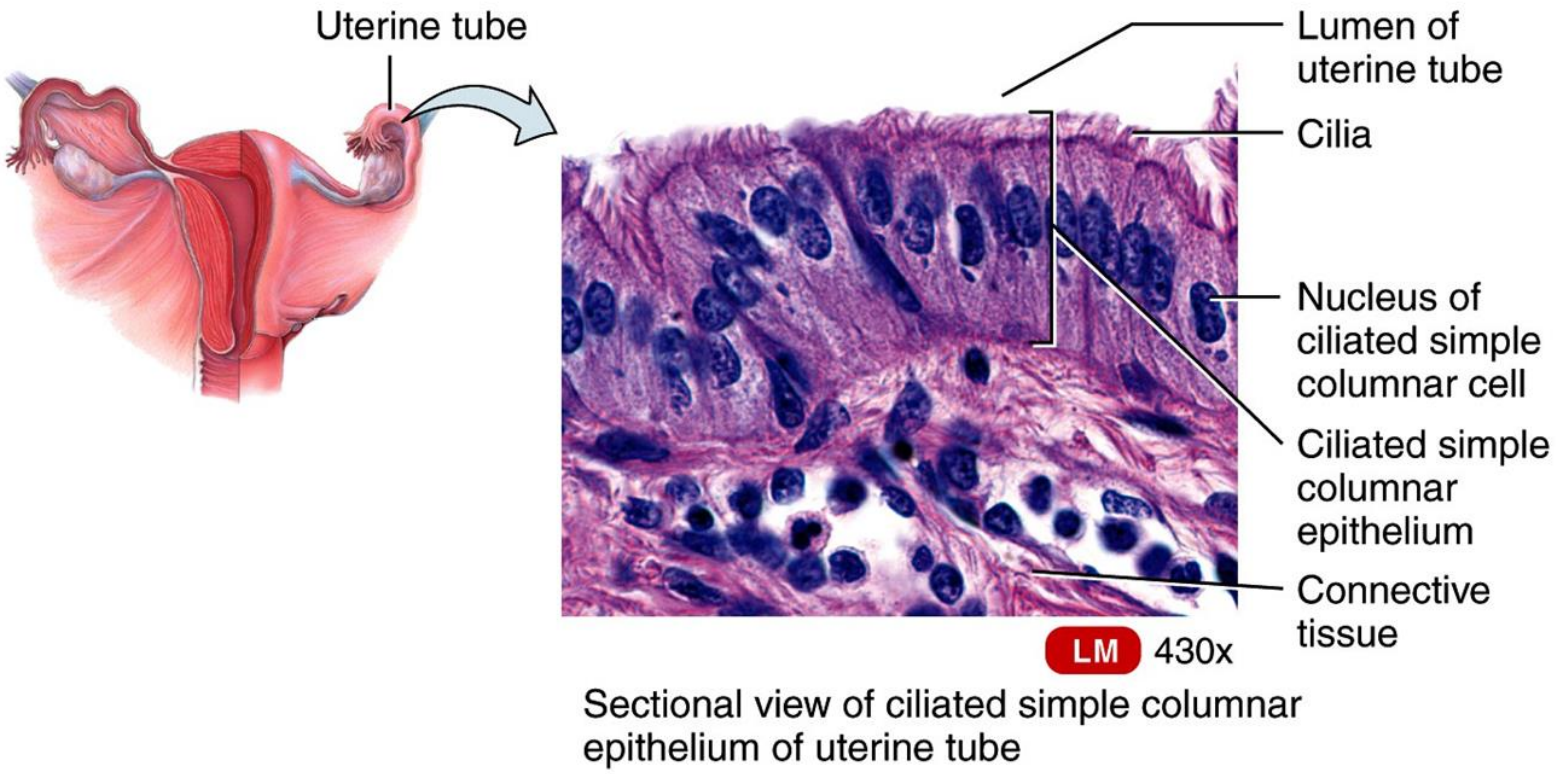
Tissue source: gallbladder



Gallbladder - Vesica Fellea, Stain: HE

Simple Columnar Epithelium

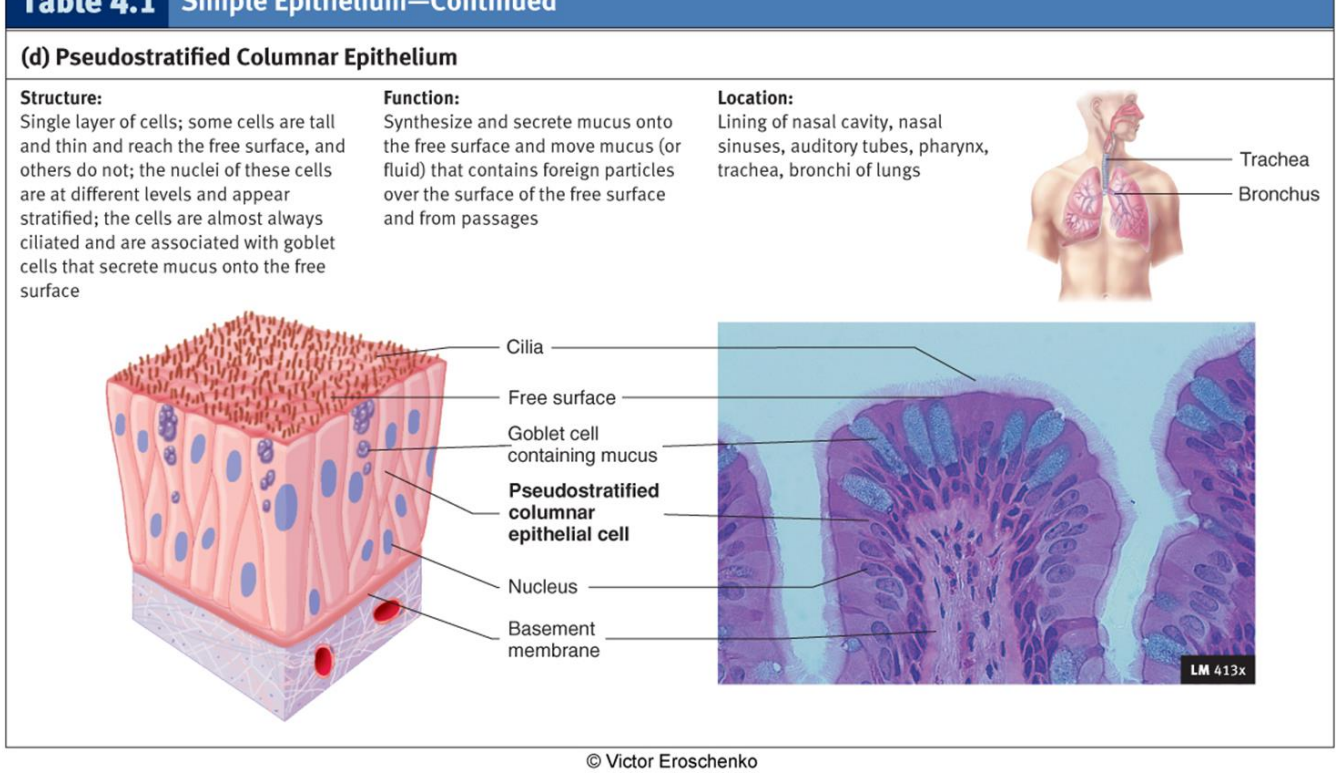
Tissue source: uterine tube, oviduct (with cilia)



Sectional view of ciliated simple columnar epithelium of uterine tube

Pseudostratified Epithelium

- Structure
  - with nuclei at different levels
  - All cells reach basement membrane
- Function
  - Absorption and Secretion
  - Goblet cells produce mucus
  - Cilia (larger than microvilli) sweep mucus
- Location
  - Respiratory Linings & Reproductive tract



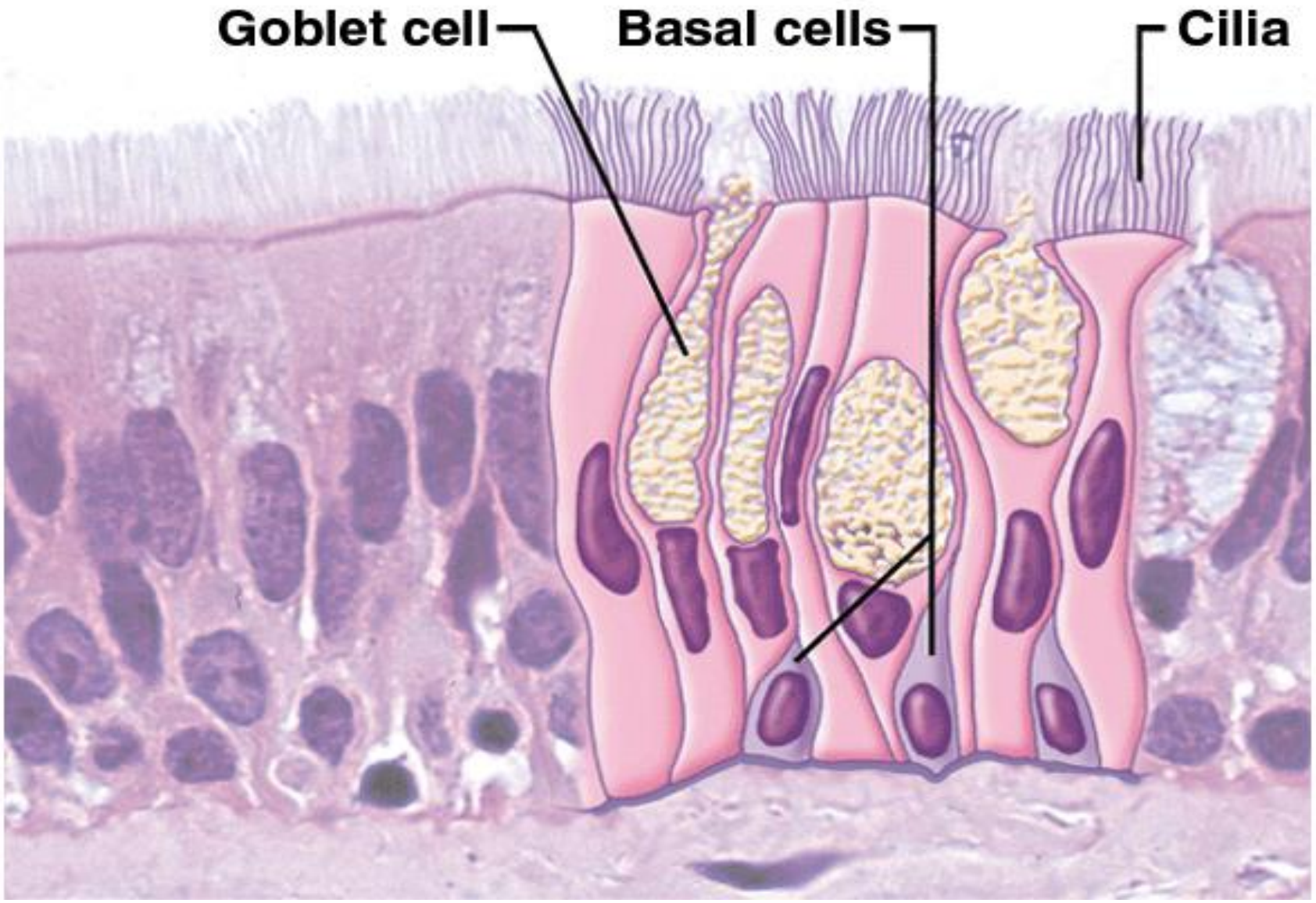
Description:

- not a true stratified tissue
- some cells are shorter, nuclei of the cells are at different levels
- all the cells attached to the basement membrane
- Cilia- propel debris and dust laden mucus

Location:

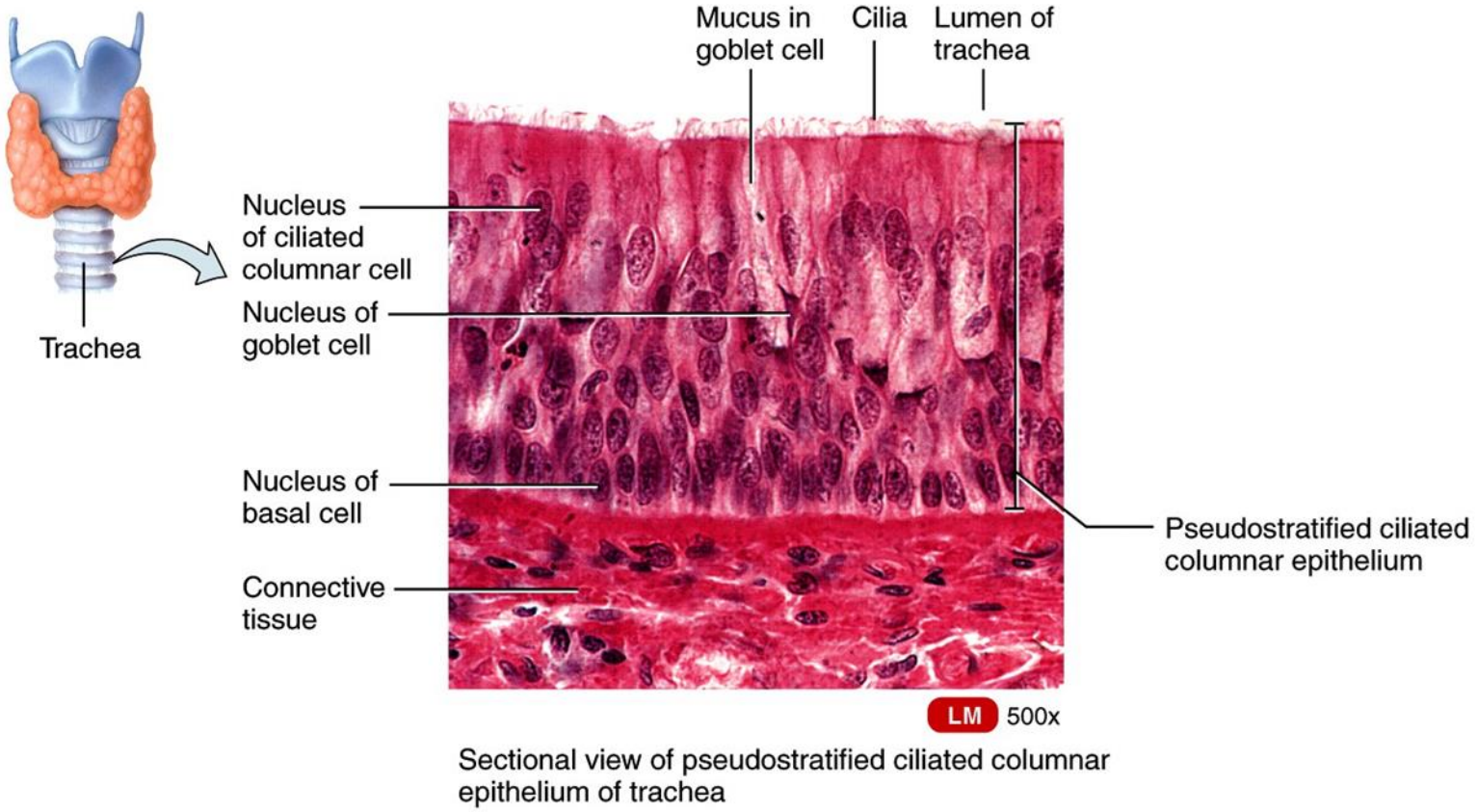
- Lining of respiratory tract "respiratory epithelium"

Pseudostratified Epithelium



Pseudostratified Columnar Ciliated Epithelium

Tissue source: Trachea



Sectional view of pseudostratified ciliated columnar epithelium of trachea

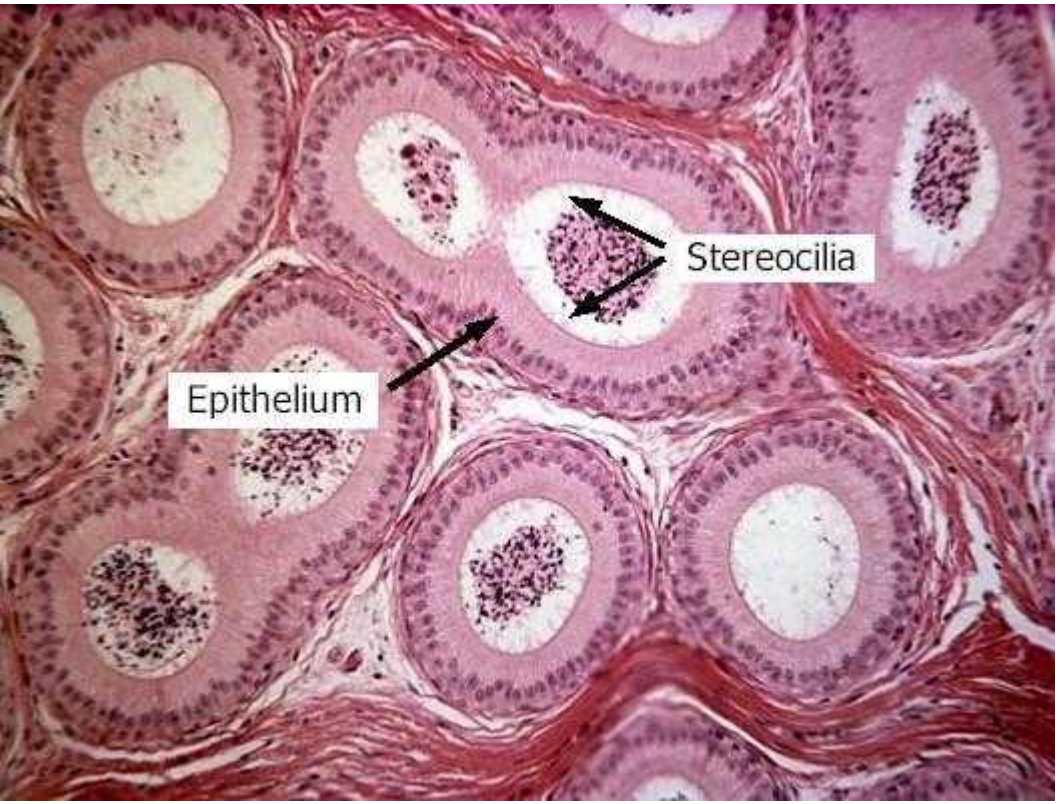
Pseudostratified Columnar Ciliated Epithelium

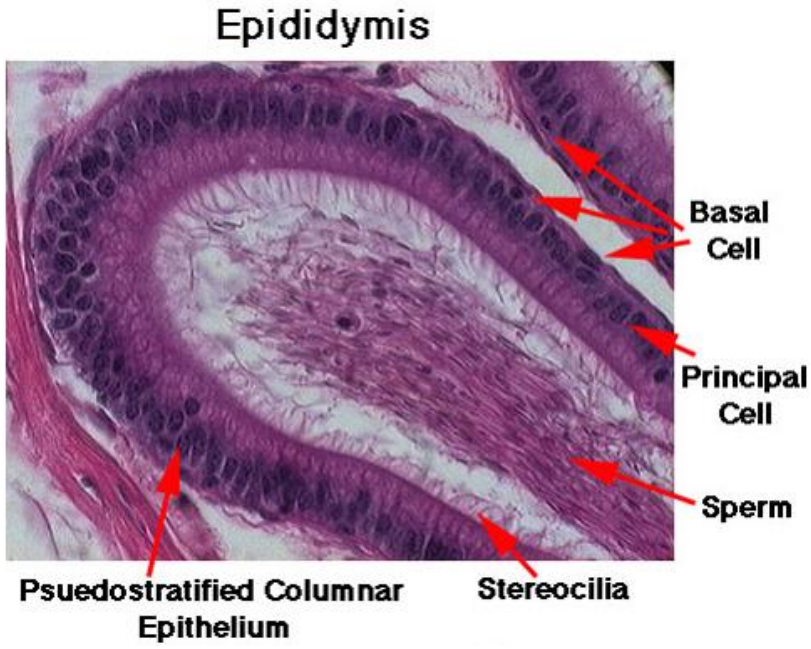
Tissue source: trachea

- **columnar cells** all begin at the basement membrane; only a few reach the surface.
- **nuclei** appear at various levels giving the tissue a stratified appearance.
- **cilia** (yellow arrow)

Pseudostratified Columnar Epithelium (with stereocilia)

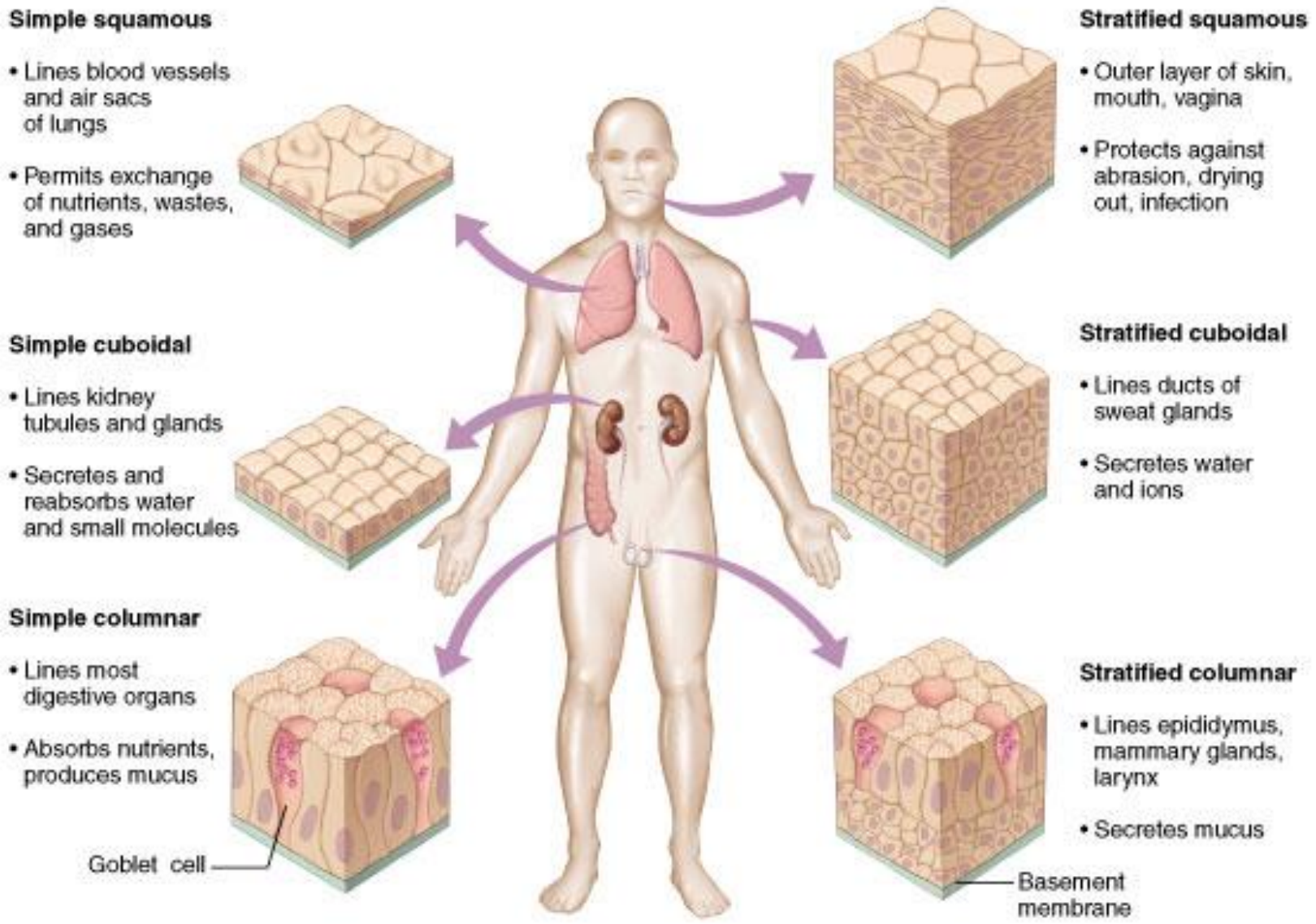
Tissue source: epididymis





STRATIFIED EPITHELIUM

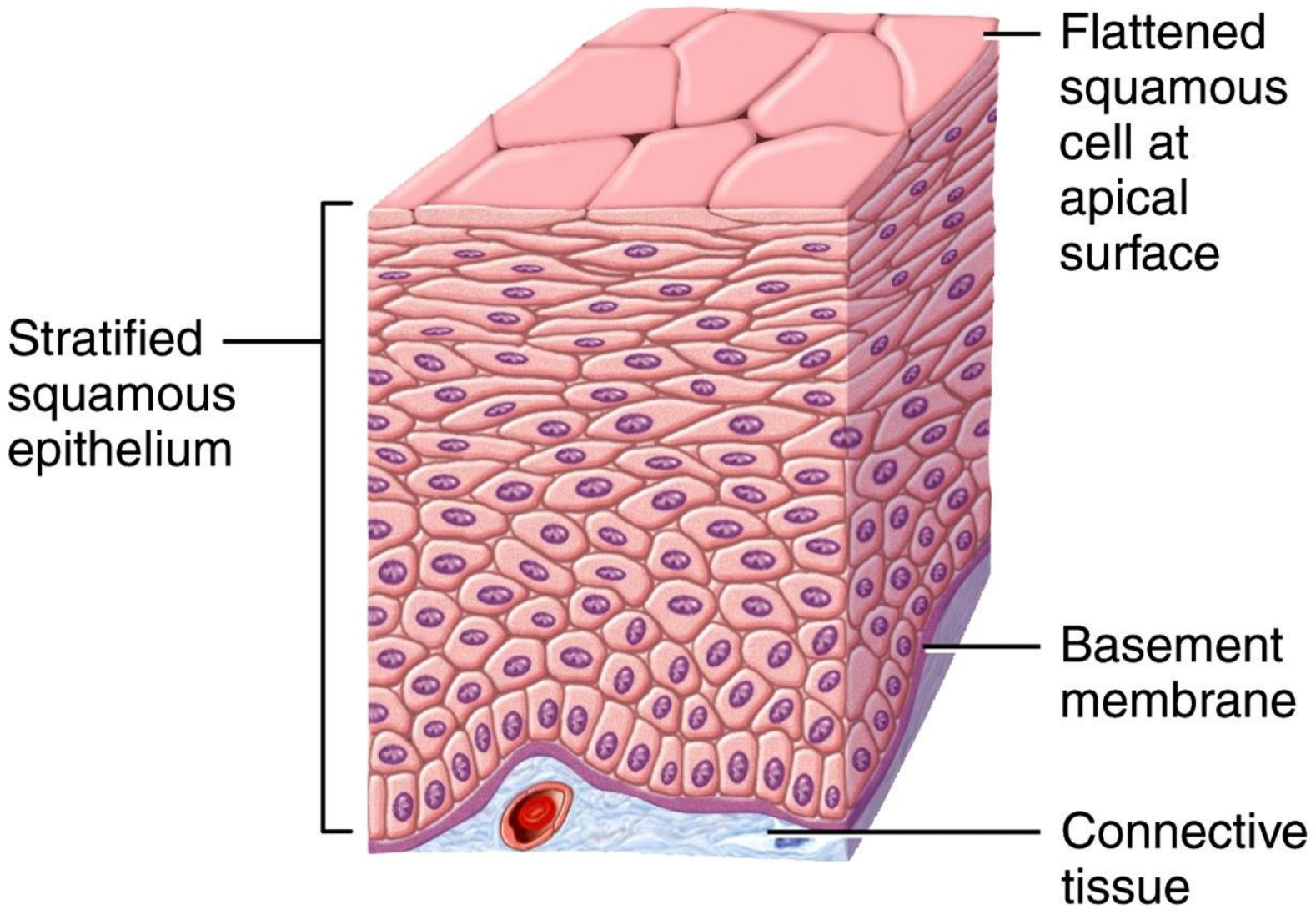
- two or more layers of cells
- more durable and gives better protection to underlying tissues
- name of specific kind of stratified epithelium depends on the shape of the cells in the apical layer



(a) Most epithelial tissues line or cover surfaces or body cavities

Stratified Squamous Epithelium

- Structure
  - Many layers, stronger than simple
- Function
  - Protection (Stratified Squamous Epithelium keratinized)
  - Keratin (protein) is accumulated in older cells near the surface – waterproofs and toughens skin.
- Location
  - Skin (keratinized)
  - esophagus, vagina (non-keratinized)



Stratified squamous epithelium

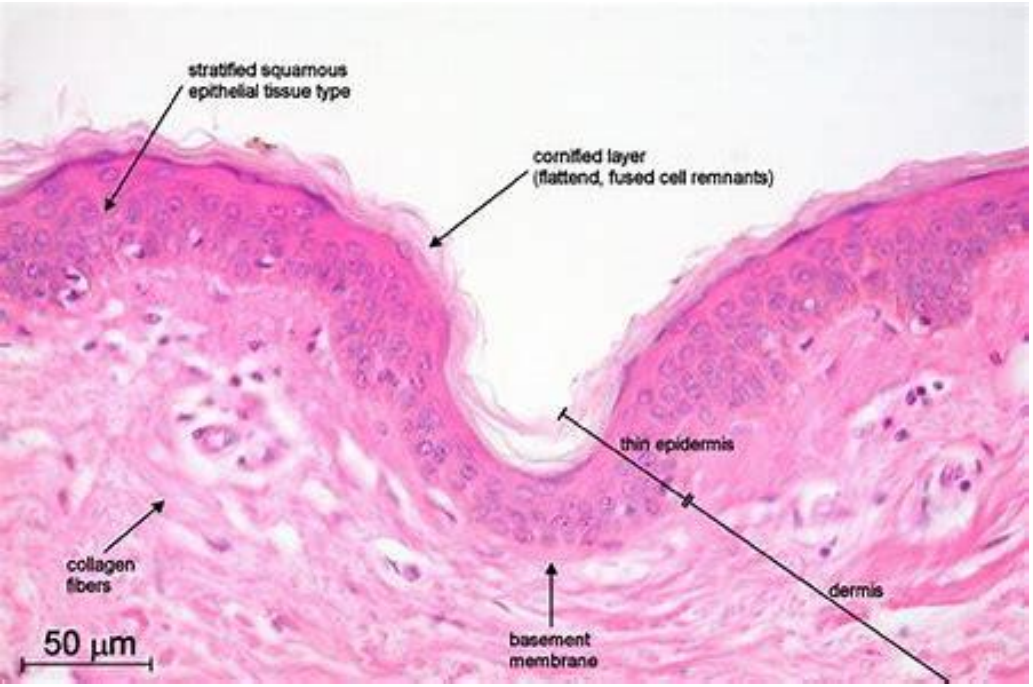
Stratified squamous epithelium (keratinized)

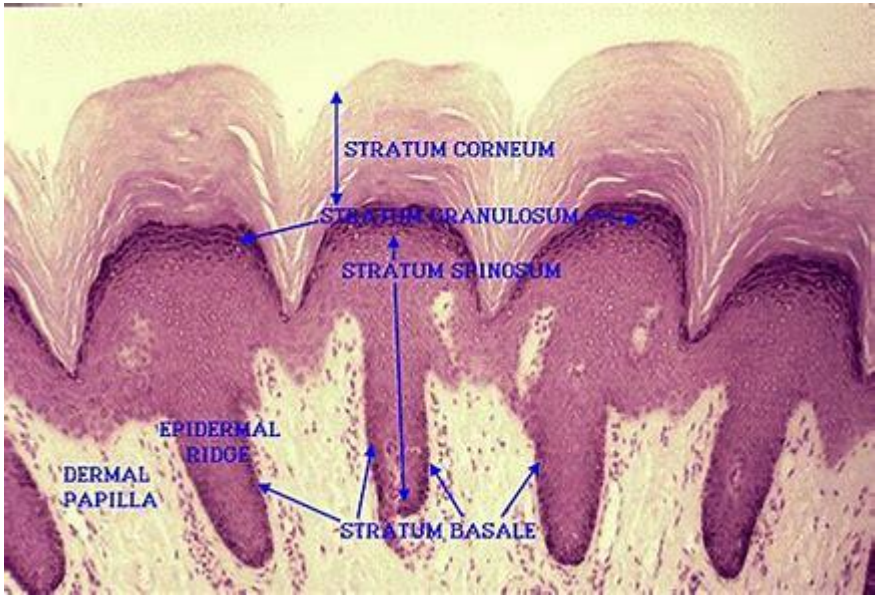
Tissue source: Human skin

Top layer: dead flattened cells

Middle layer: polyhedral cells

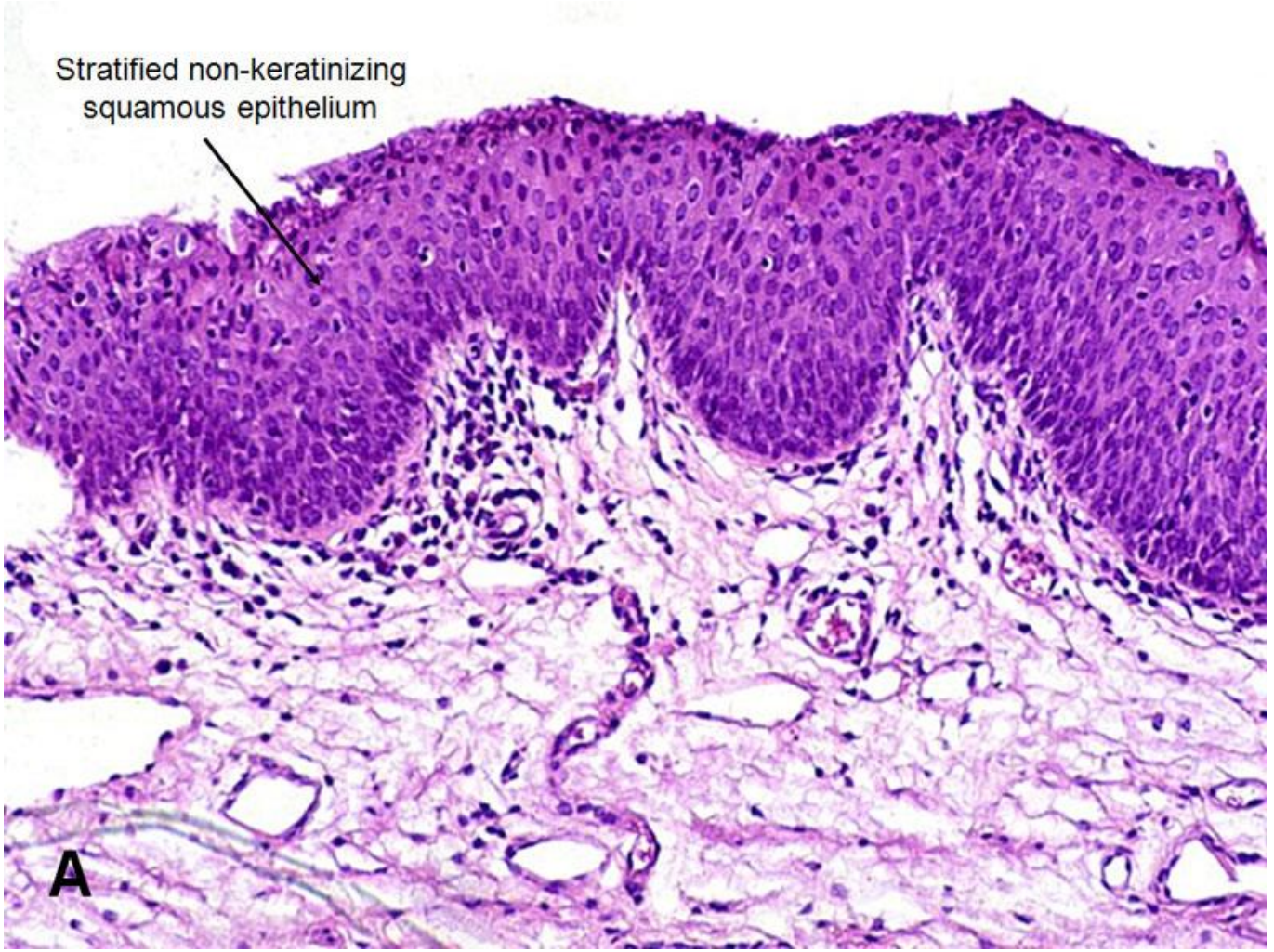
Basal layer: cuboidal or columnar cells





Stratified Squamous epithelium (non-keratinized)

Tissue source: esophagus

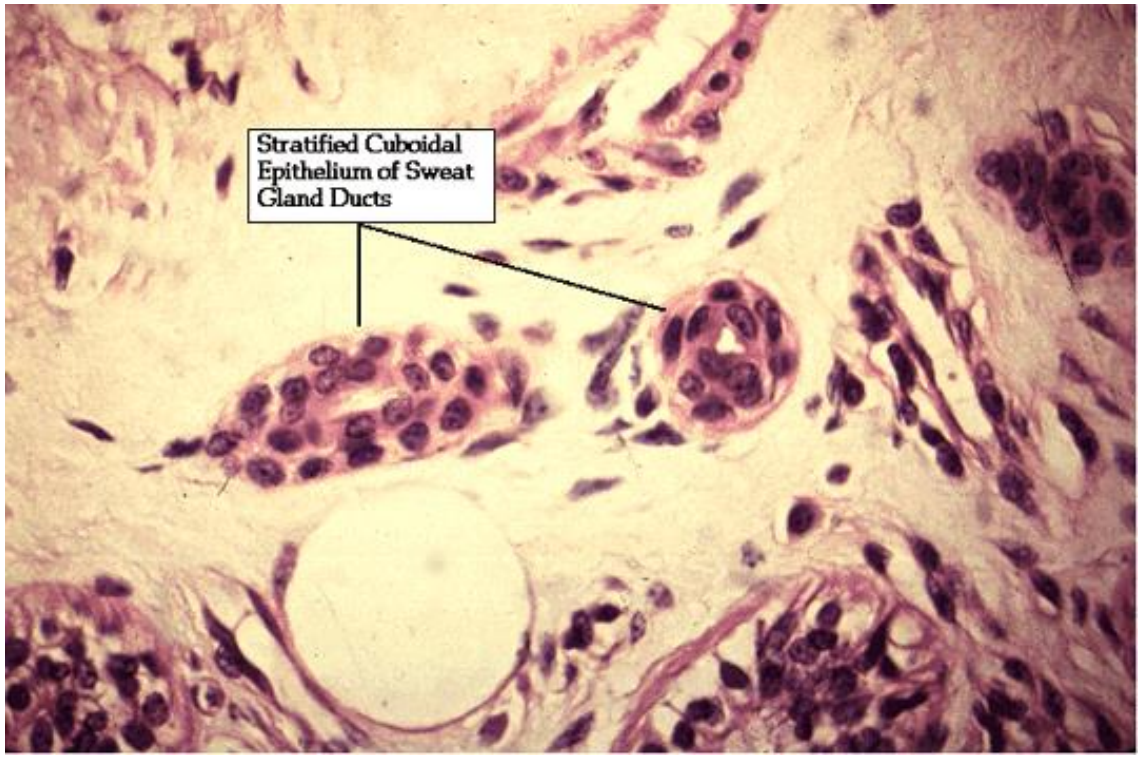


Stratified Cuboidal Epithelium

- Structure
  - Many layers, stronger of cube shape cells
- Function
  - Secretion
  - Absorption
  - Protection
- Location
  - Ducts of sweat glands
  - Ducts of salivary glands

Stratified Cuboidal Epithelium

- Tissue source: interlobular ducts of submandibular gland
- 2- 3 layers of cuboidal cells



Stratified Cuboidal Epithelium

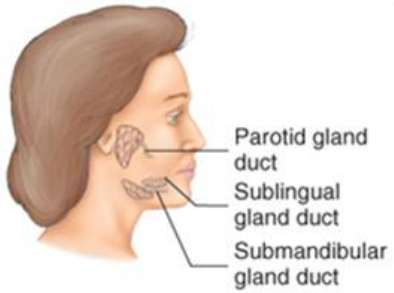
Table 4.2 Stratified Epithelium

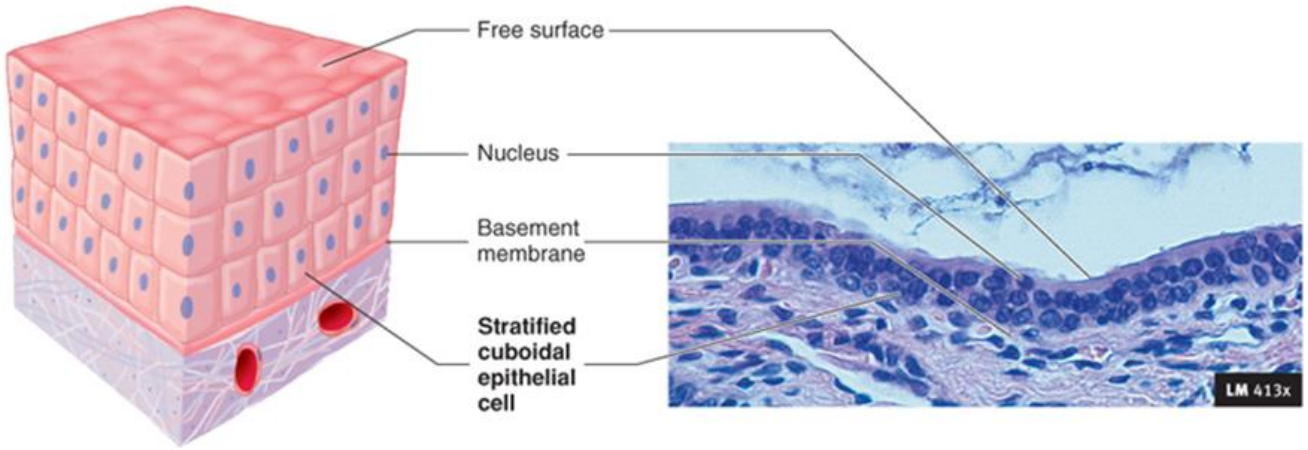
(b) Stratified Cuboidal Epithelium

Structure:
Multiple layers of somewhat cube-shaped cells

Function:
Secretion, absorption, protection against infection

Location:
Sweat gland ducts, ovarian follicles, salivary gland ducts





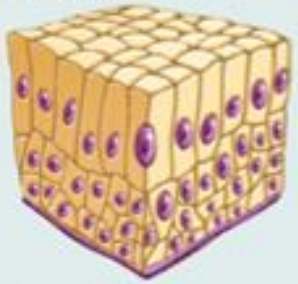
Stratified Columnar Epithelium

- Structure
  - Many layers, cells at the apical layer are columnar in shape
  - Basal cells are cuboidal in shape
- Function
  - Secretion
  - Protection
- Location
  - Epiglottis - anal mucous membrane
  - Conjuctiva of the eye - part of male urethra

Stratified Columnar Epithelium

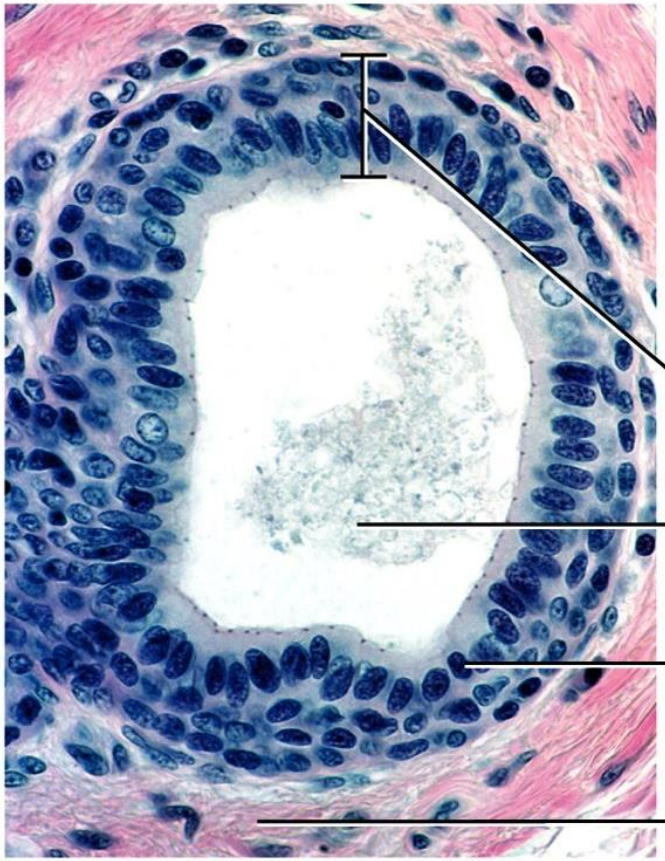
(g) Stratified columnar epithelium

Description: Several cell layers; basal cells usually cuboidal; superficial cells elongated and columnar.



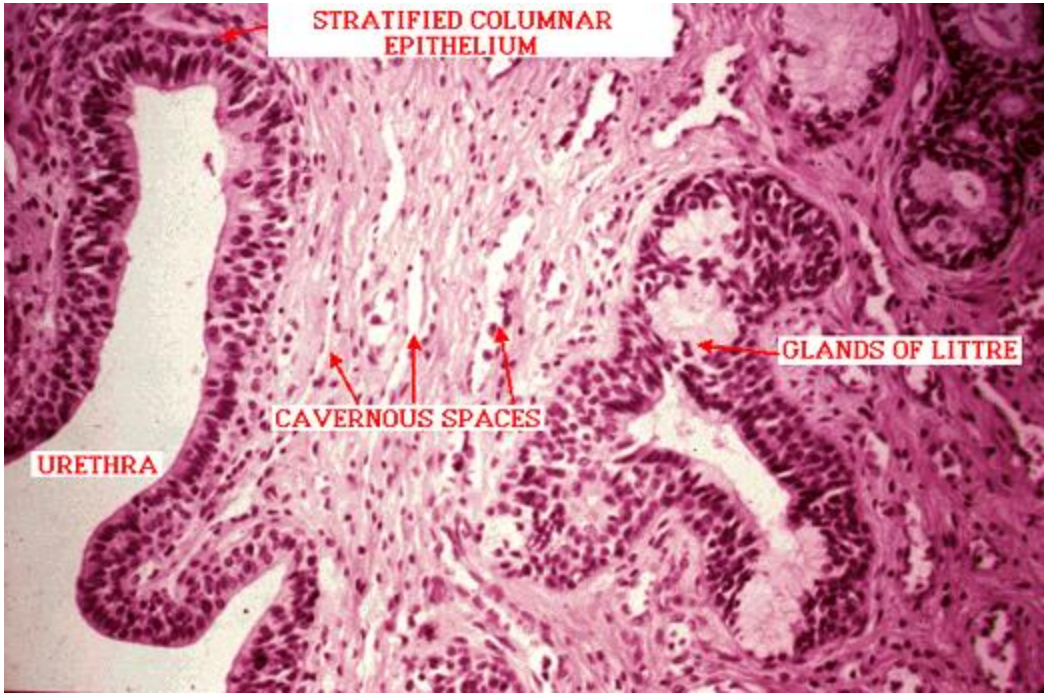
Function: Protection; secretion.

Location: Rare in the body; small amounts in male urethra and in large ducts of some glands.



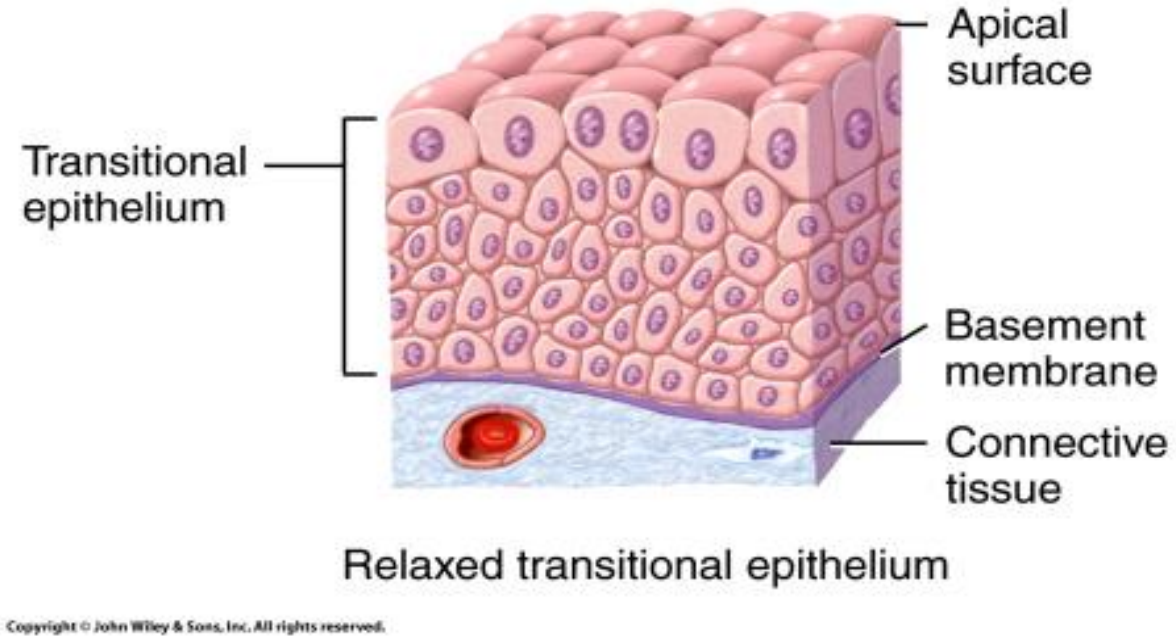
Stratified Columnar Epithelium

- Tissue source: male urethra
- Top layer: columnar cells
- Basal layer: cuboidal cell



Transitional Epithelium

- Structure
  - Many layers
  - Very specialized – cells at base are cuboidal or columnar; at surface are umbrella shaped.
  - Change between stratified & simple as tissue is stretched out.
- Function
  - Allows stretching (change size)
- Location
  - Urinary bladder, ureters & urethra
  - "Urothelium"



Description:

- basal cells are cuboidal or columnar or polyhedral in shape

- appearrance is variable/change in shape (transitional)

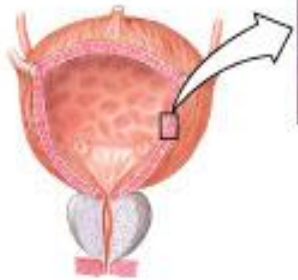
unstretched – cells are balloon,umbrella shaped or dome shaped

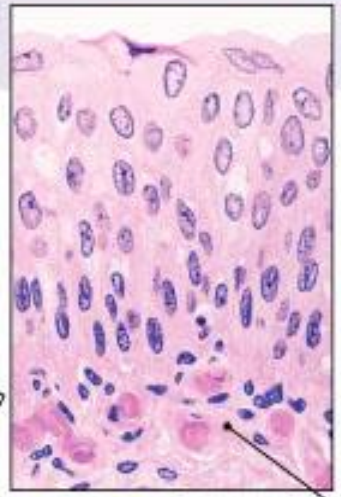
stretched/distended – cells change to squamous shape

TRANSITIONAL EPITHELIUM

LOCATIONS: Urinary bladder; renal pelvis; ureters

FUNCTIONS: Permits expansion and recoil after stretching





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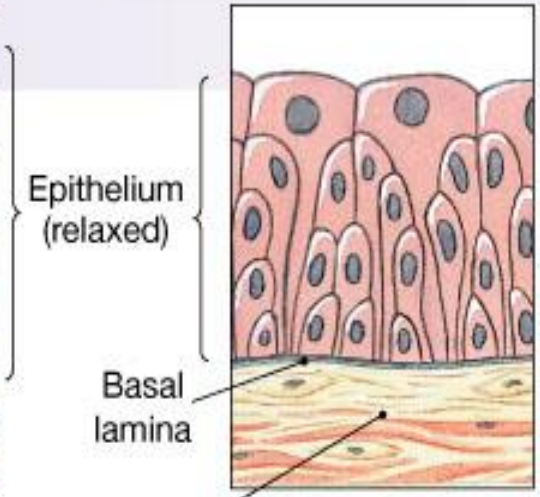
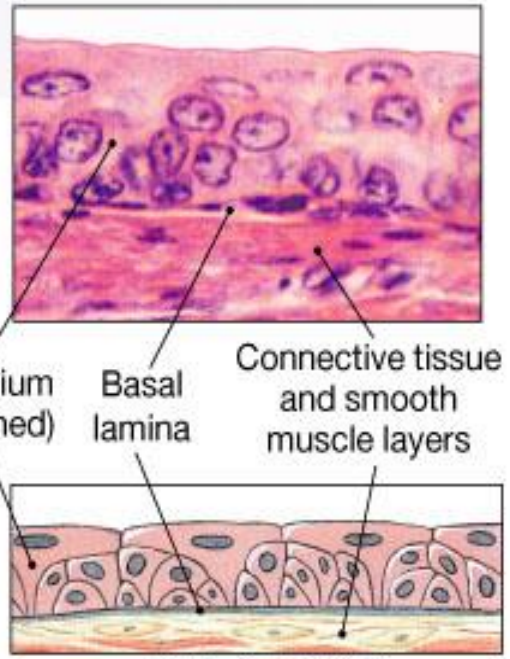


EMPTY BLADDER



FULL BLADDER

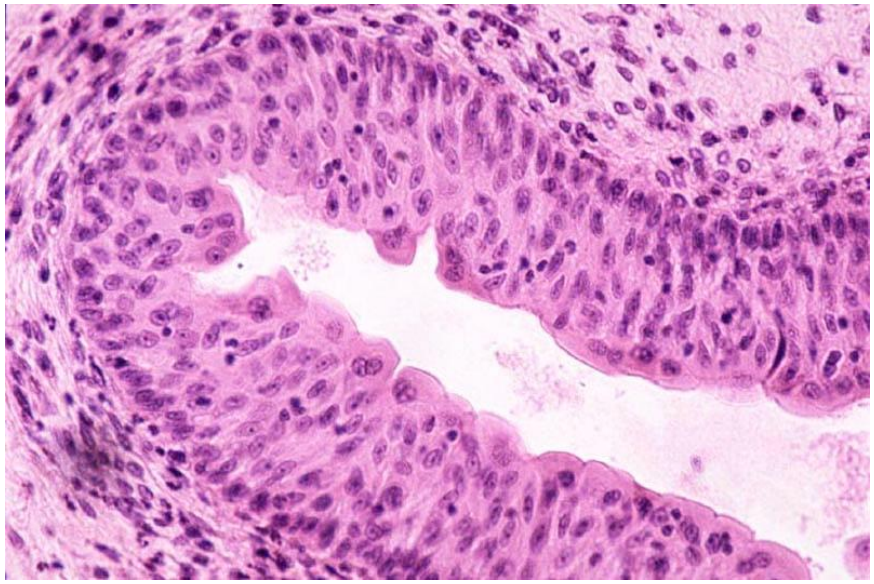
(c) Urinary bladder

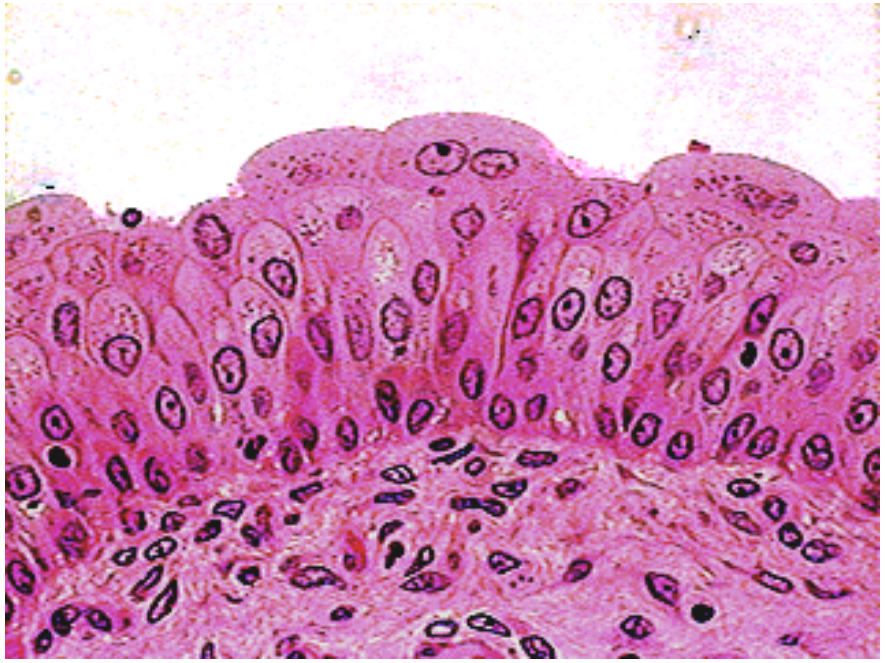
Transitional Epithelium

Tissue source: urinary bladder

Top layer: balloon shaped cells

Basal layer: columnar or polyhedral cells





Glands

- One or more cells that make and secrete a product.
- Secretion = protein in aqueous solution: hormones, acids, oils.
- Endocrine glands
  - No duct, release secretion into blood vessels
  - Often hormones
  - Thyroid, adrenal and pituitary glands
- Exocrine glands
  - Contain ducts, empty onto epithelial surface
  - Sweat, Oil glands, Salivary glands, Mammary glands.

Glandular Epithelium:

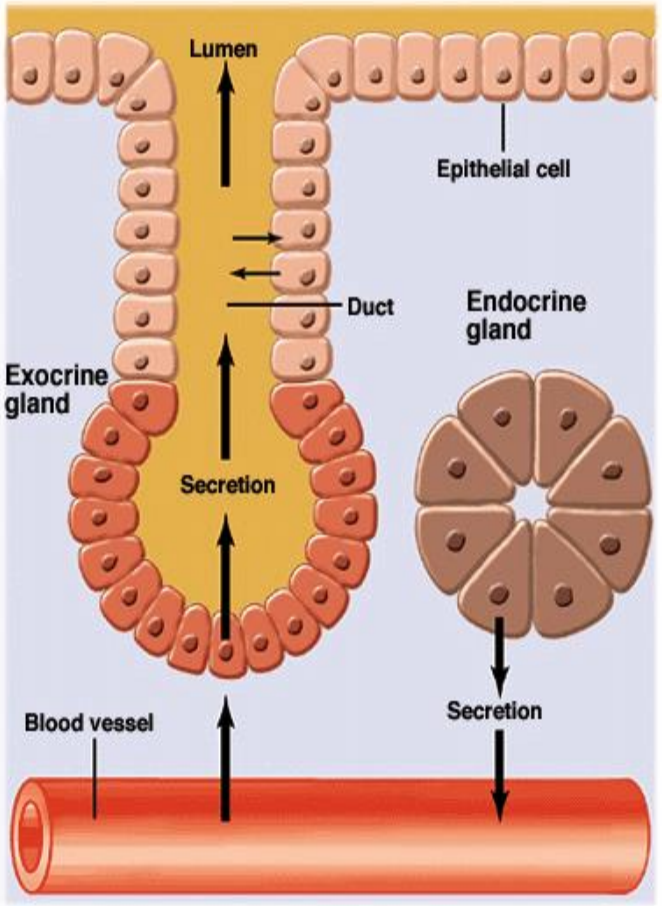
- consists single or group of cells that secrete substances
  a. into a surface (covering and lining epithelium)
  b. into the blood

Classified as:

A. Exocrine gland

- secretions flow by way of tube-like duct and empty into the surface of a covering or lining epithelium
- exocrine secretions reach the skin surface or the lumen of a hollow organ

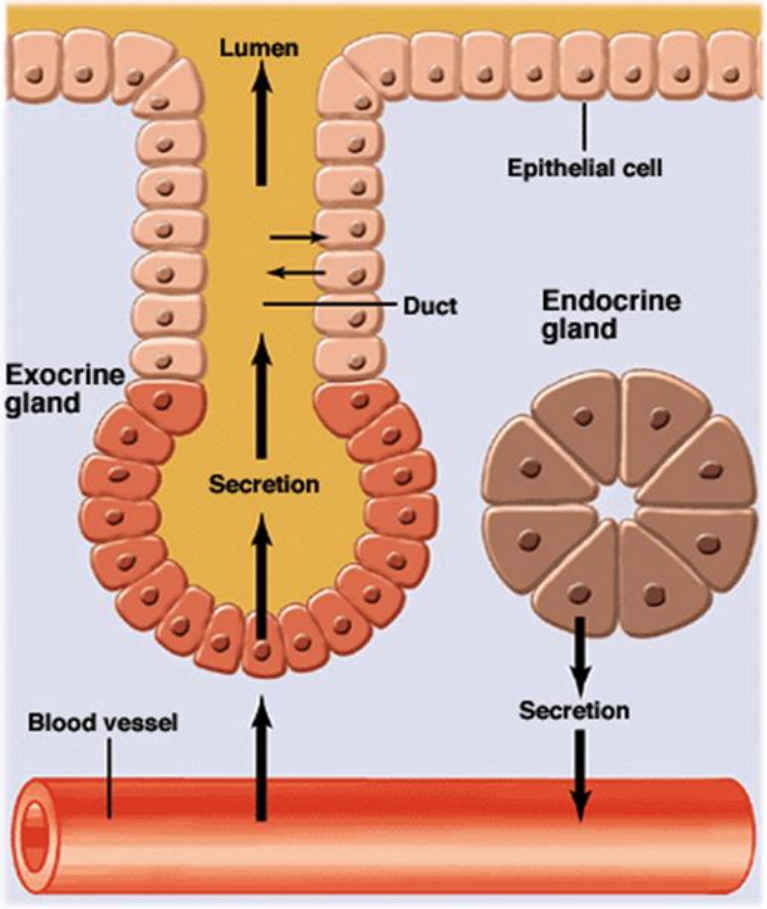
ex. Sudoriferous gland
mammary gland
sebaceous glands



B. Endocrine gland

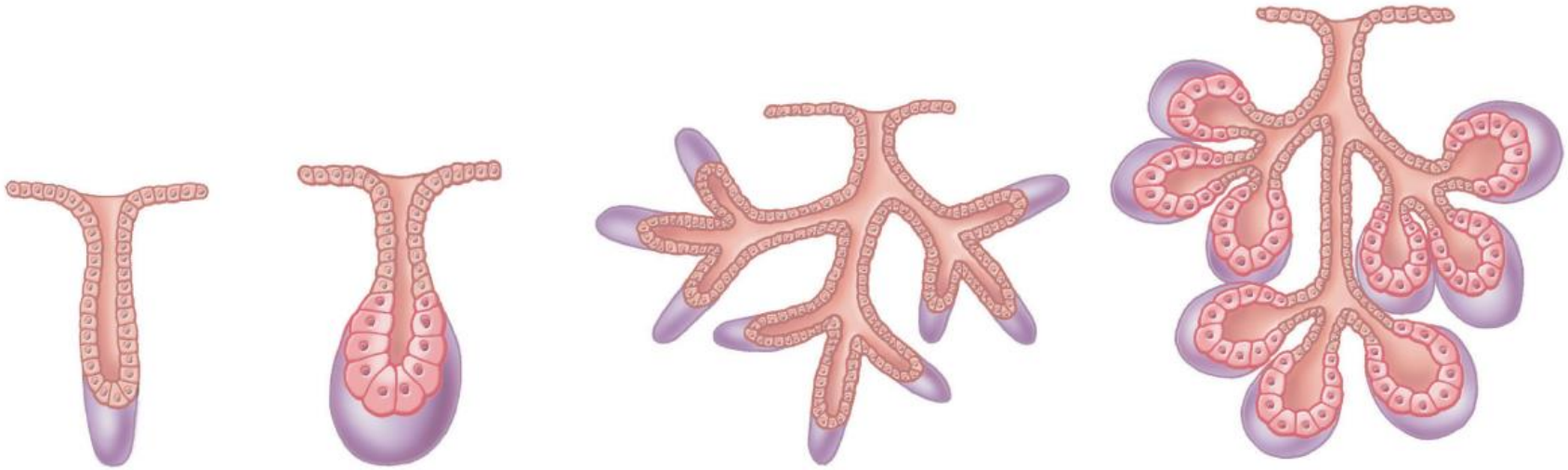
- secretes their products into the bloodstream
- ductless gland
- hormones

ex. thyroid, pituitary



Types of Exocrine Glands

- Structure of Exocrine Glands
  - Simple: have one duct
  - Compound: have ducts that branch repeatedly



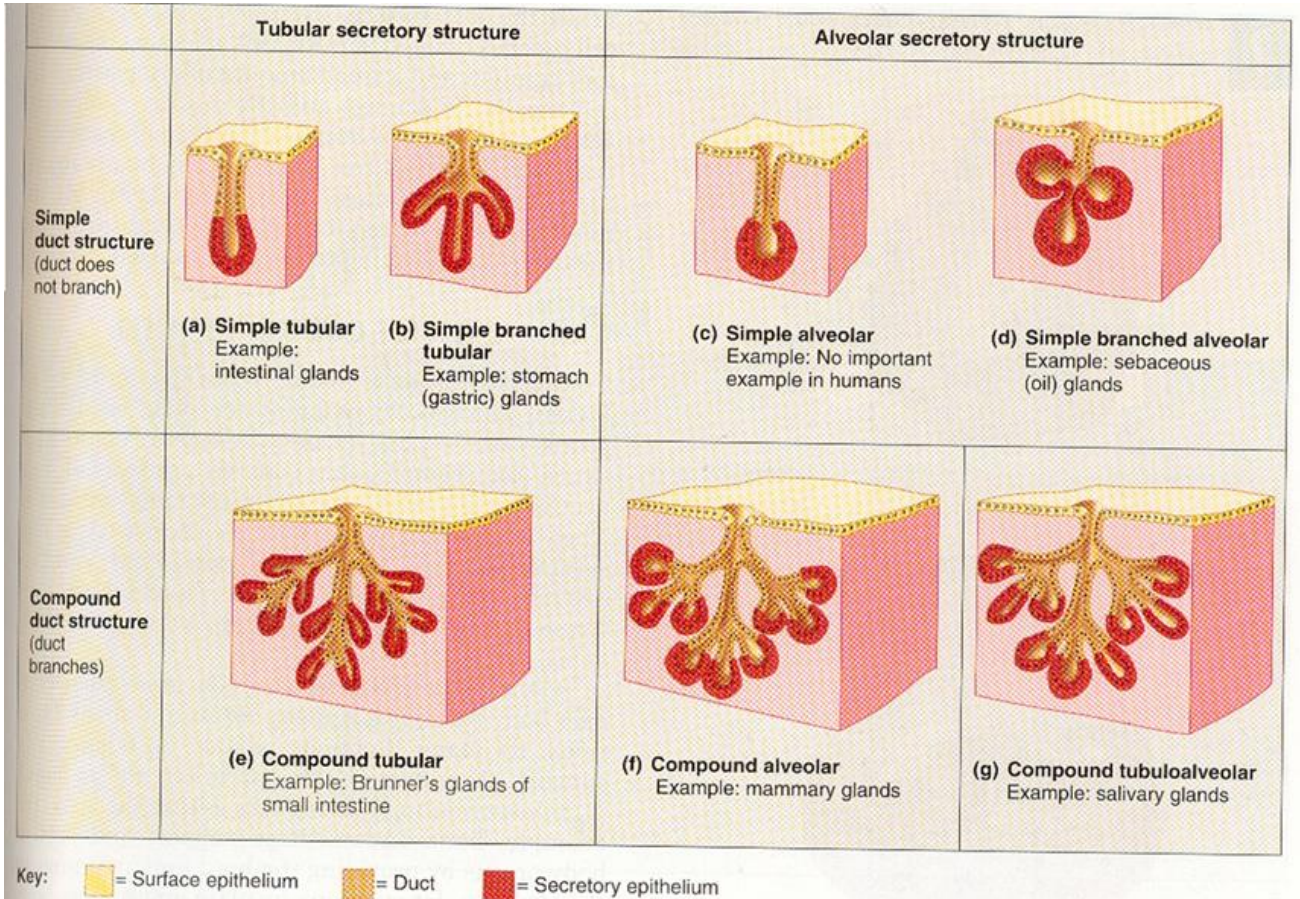
(a) Simple straight tubular (glands in stomach and colon)

(b) Simple acinar or alveolar (sebaceous glands of skin)

(c) Compound tubular (mucous glands of duodenum)

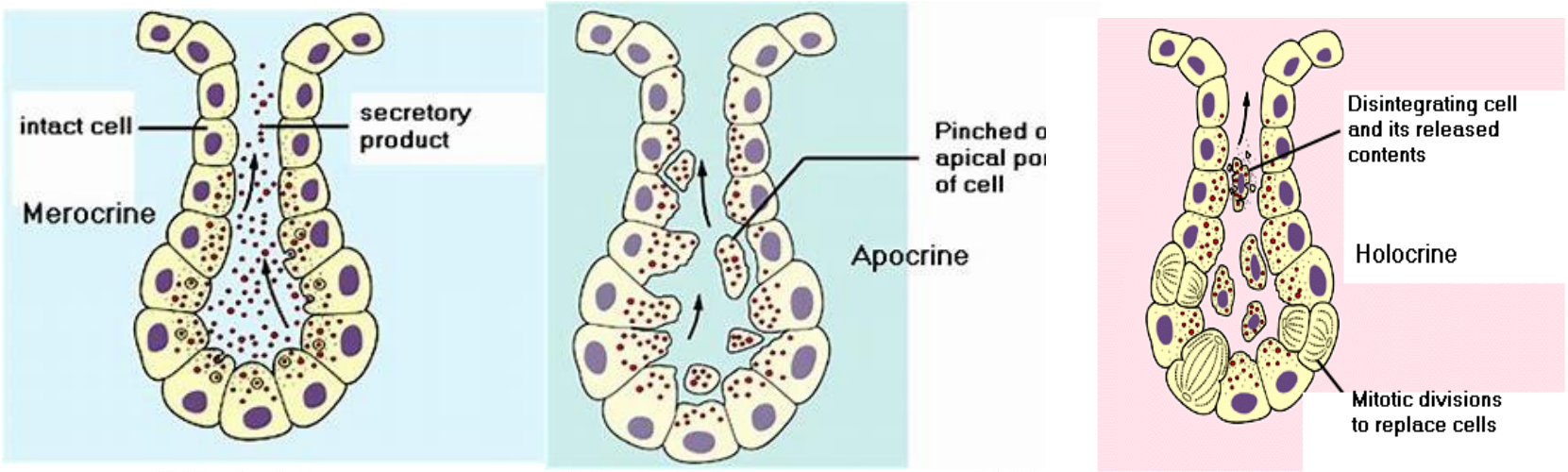
(d) Compound acinar or alveolar (mammary glands)

- Shape of duct end/secretory portion:
  - Tubular – shaped like a tube
  - Alveolar – shaped like flasks or sacs
  - Tubuloalveolar – has both tubes and sacs in gland



Epithelial Tissue Glands

- Exocrine Glands and Secretion Types
  - Merocrine – no loss of cellular material (Ex. sweat glands)
  - Apocrine – part of the cell pinches off (Ex. mammary glands)
  - Holocrine – entire cell is shed (Ex. sebaceous glands)



(a) **Merocrine gland** Cells of the gland produce secretions by active transport or produce vesicles that contain secretory products, and the vesicles empty their contents into the duct through exocytosis.

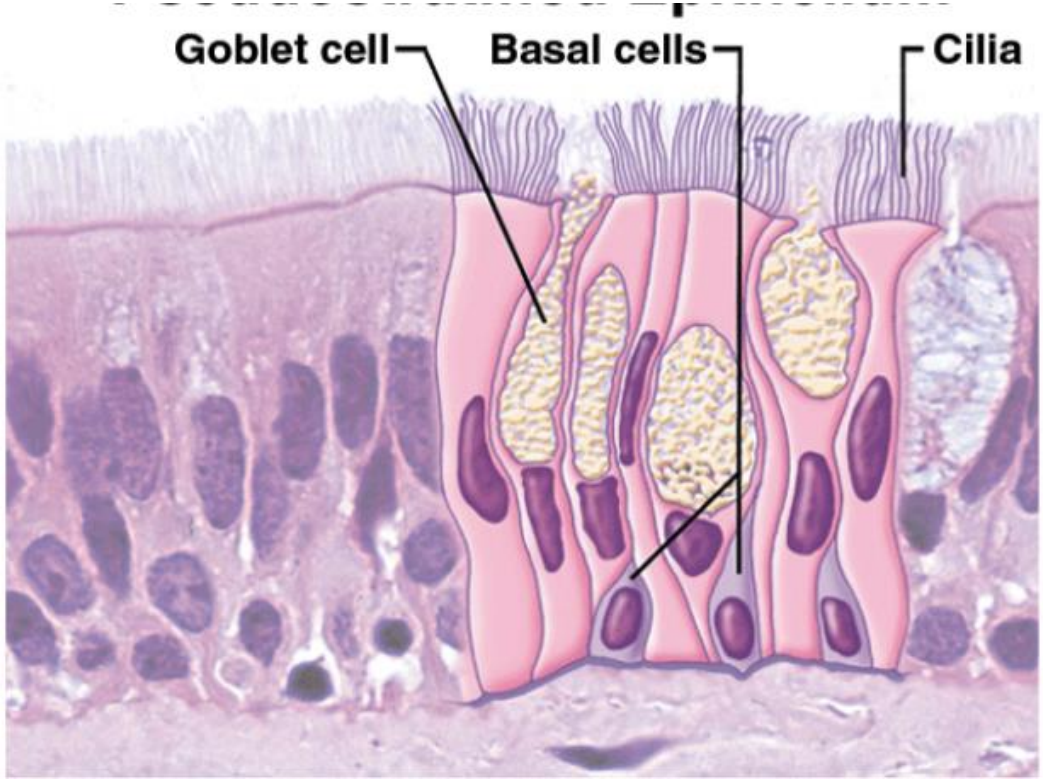
(b) **Apocrine gland** Secretory products are stored in the cell near the lumen of the duct. A portion of the cell near the lumen containing secretory products is pinched off the cell and joins secretions produced by a merocine process.

(c) **Holocrine gland** Secretory products are stored in the cells of the gland. Entire cells are shed by the gland and become part of the secretion. The lost cells are replaced by other cells deeper in the gland.

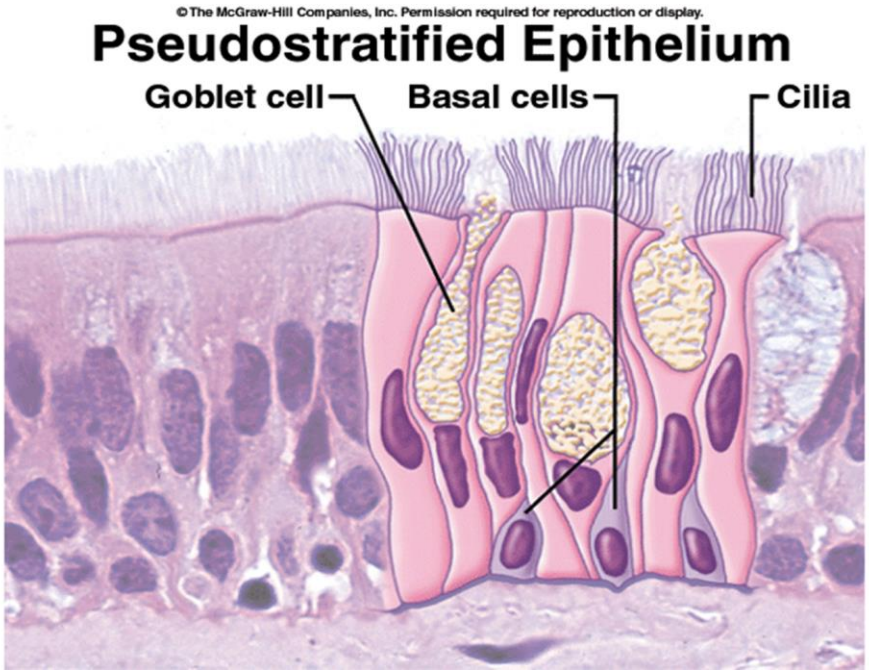
Fig. 4.4

Exocrine Gland

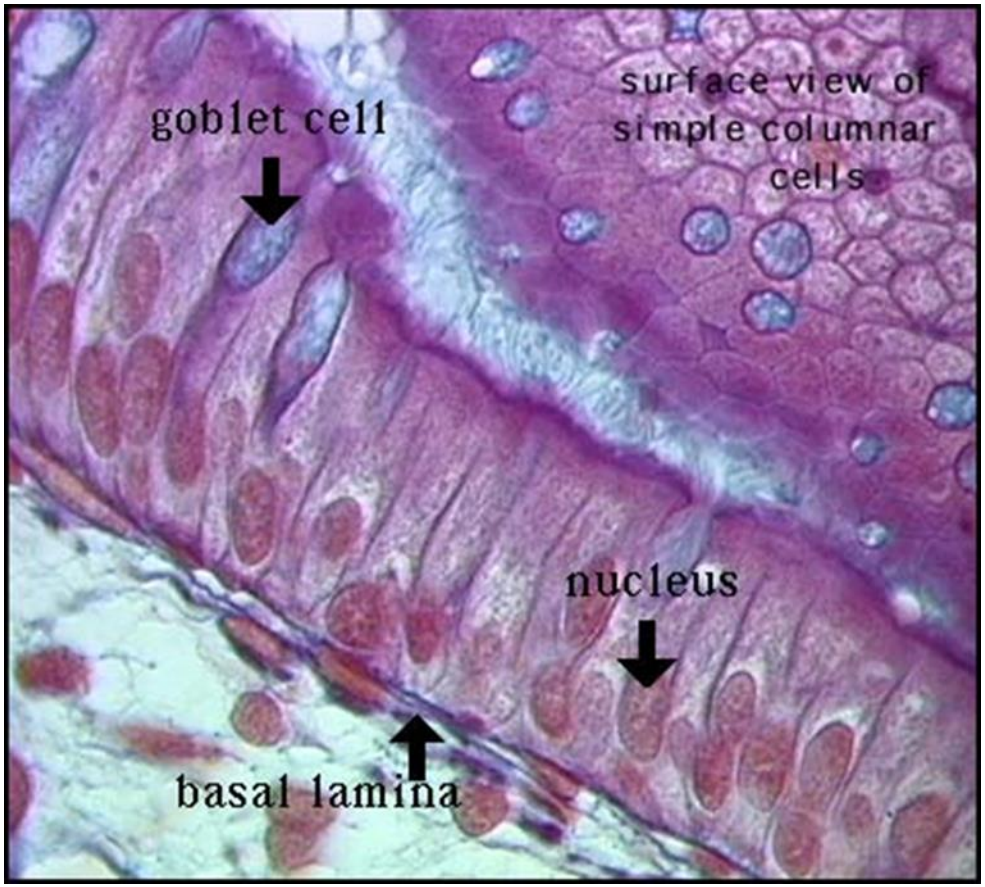
- Goblet cells
- single cell gland
- produce protective mucus

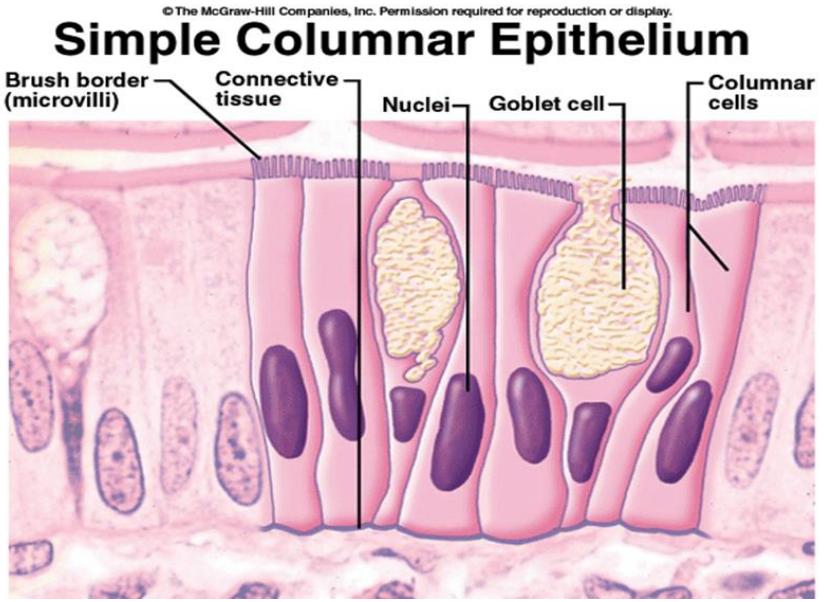


Exocrine Glands (Goblet cells)



Exocrine Glands (Goblet cells)





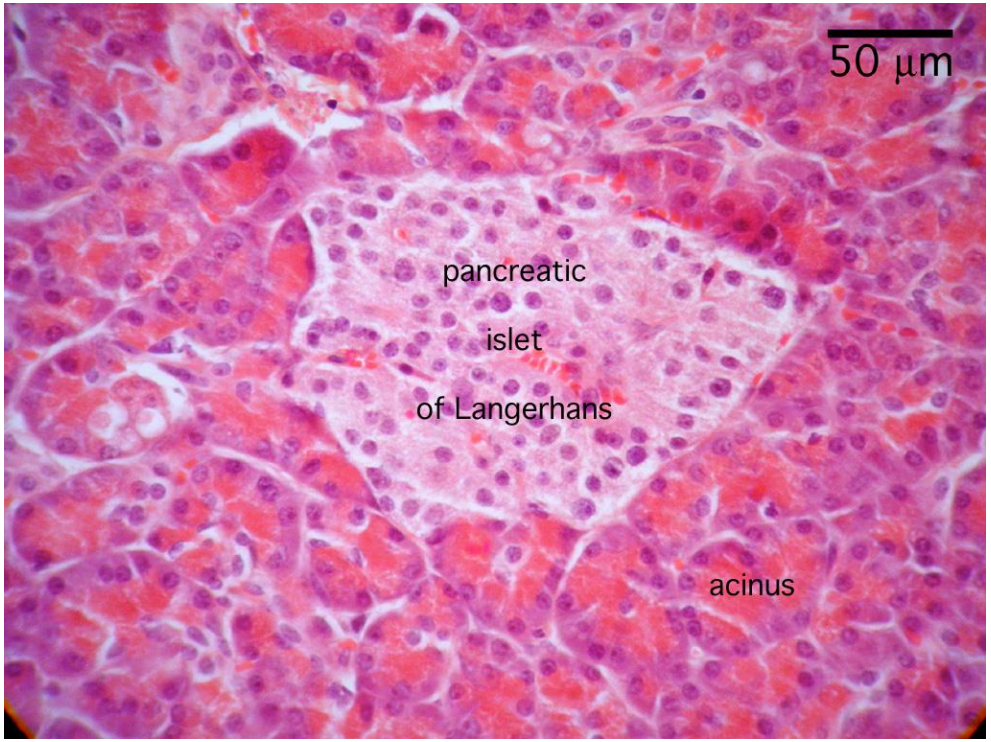
Endocrine Gland

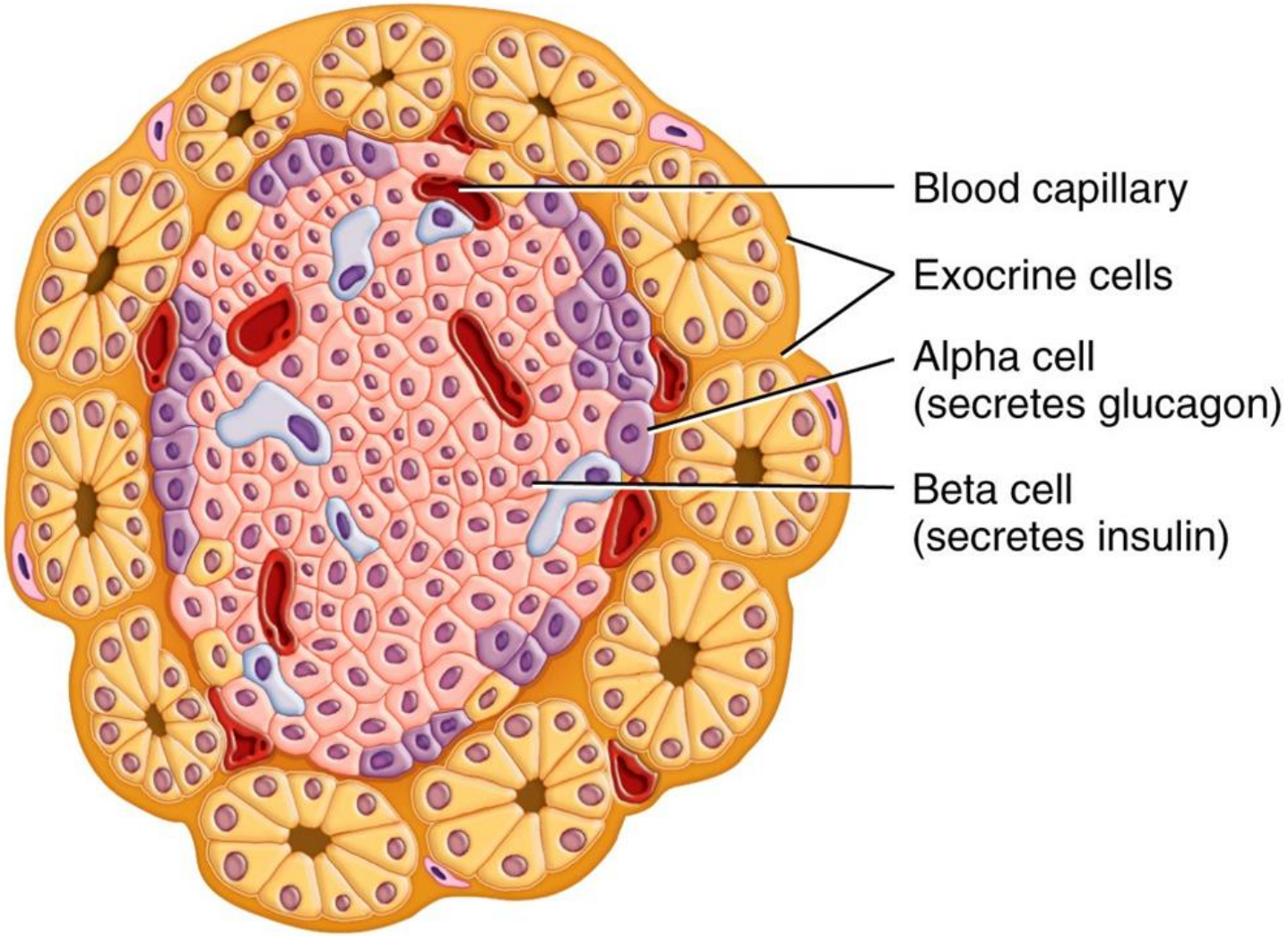
Tissue source: pancreas (islets of Langerhans)

- Cell Types

Alpha cells- glucagon

Beta cells - insulin





Pancreatic islet and surrounding acini

Exocrine Gland

Tissue source: (pancreatic acini cells)