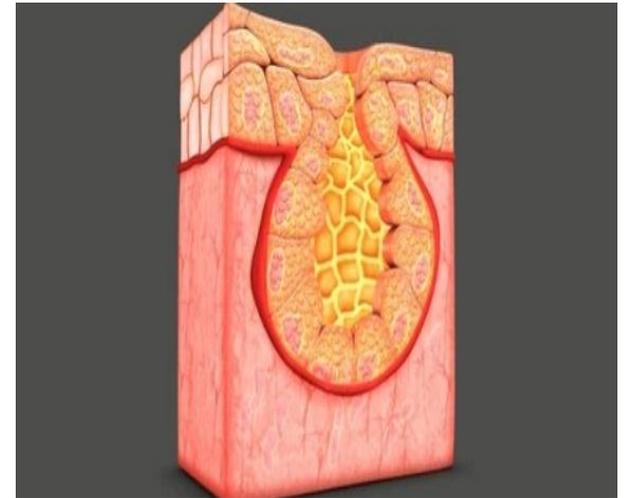
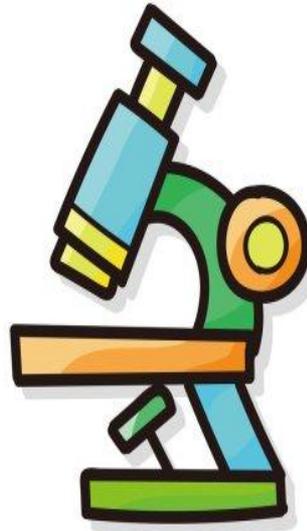
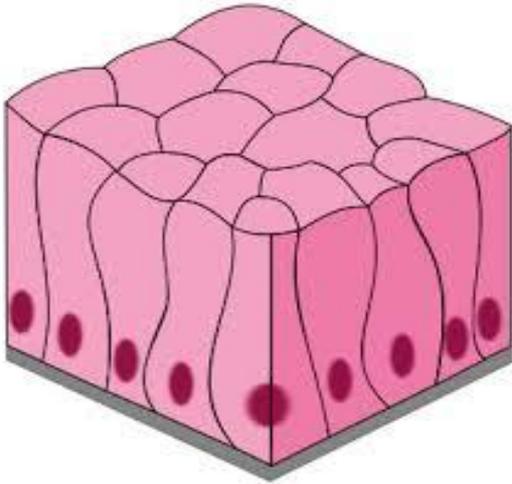


# Epithelial Tissue



By

**Dr. Heba Sharaf Eldin**

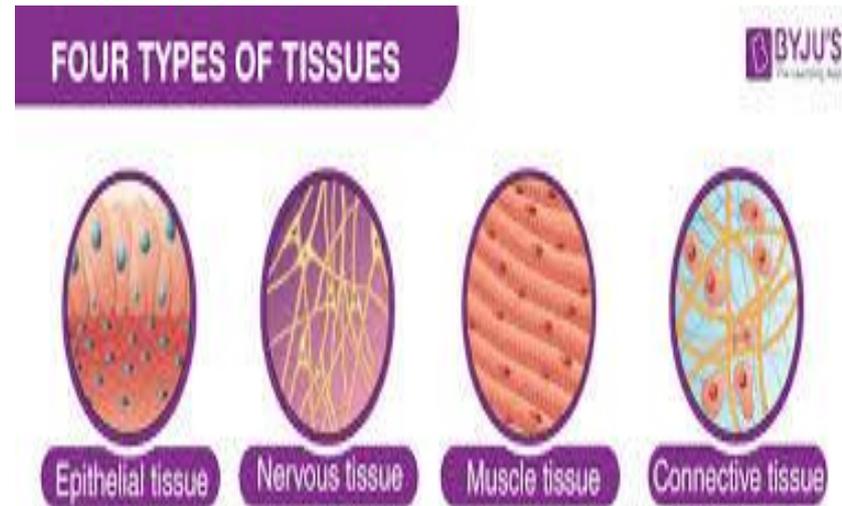
Associate Professor of Histology & Cell Biology

# LEARNING OUTCOMES

1. Identify different **types of epithelium**.
2. Describe the **structural characteristics** of the epithelial tissue
3. **Predict** the special type of epithelial cells from its components.
4. **Differentiate** between **different types** of epithelial tissue.
5. Relate the **composition** of epithelial tissue type to its specific **function**.
6. Enumerate **specializations of the cell surface**.
7. Explain the **biology** of epithelial cells.

- The human body is composed of only **4** basic types of tissue:

- Epithelial tissue.
- Connective tissue.
- Muscular tissue.
- Nervous tissue .



- The structure of a tissue is:

- Group of **cells** that are **similar** in structure and function with **extracellular matrix** in-between.

# Any Tissues

**Cells**

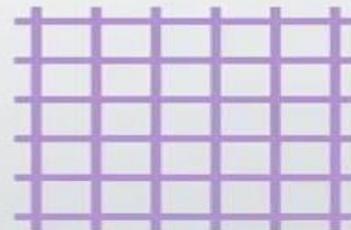
**Extracellular  
Matrix ( ECM)**

ECM consists of many kinds of  
macromolecules

**cells**

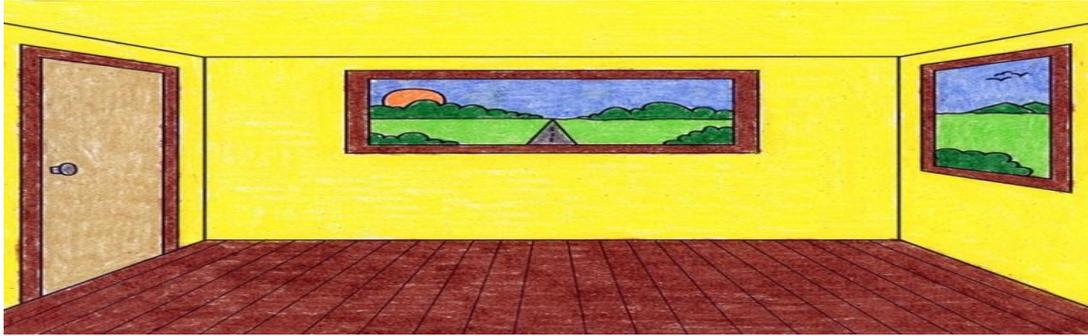


**matrix**

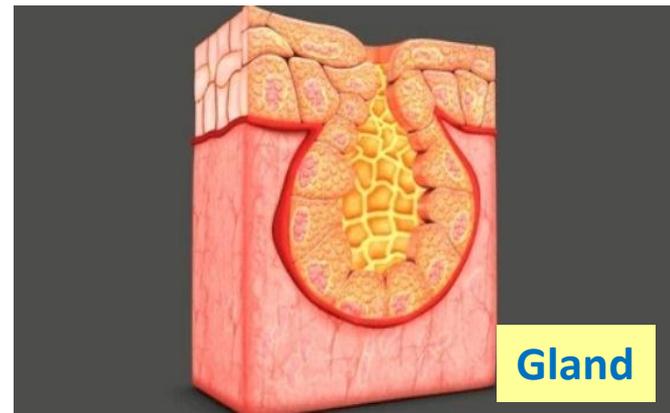
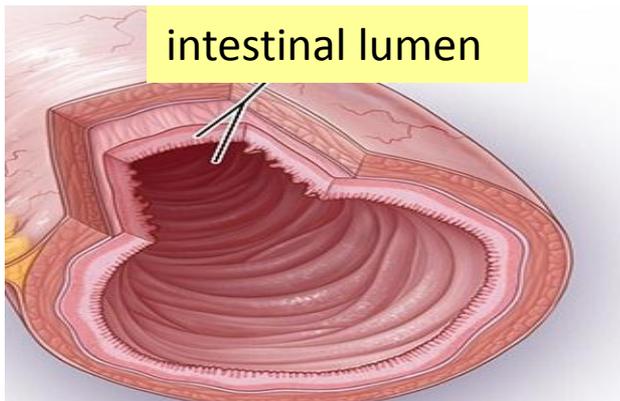


# Epithelial tissue النسيج الظلائي (Epithelium)

- Greek word (*Epi* , upon + *thele* , nipple).



- Epithelia either form cellular sheets that **line** the cavities of organs and cover the body surface **Or** form **secretory elements** known as **glands**.



# Characters of the epithelial cells

## 1-Origin:

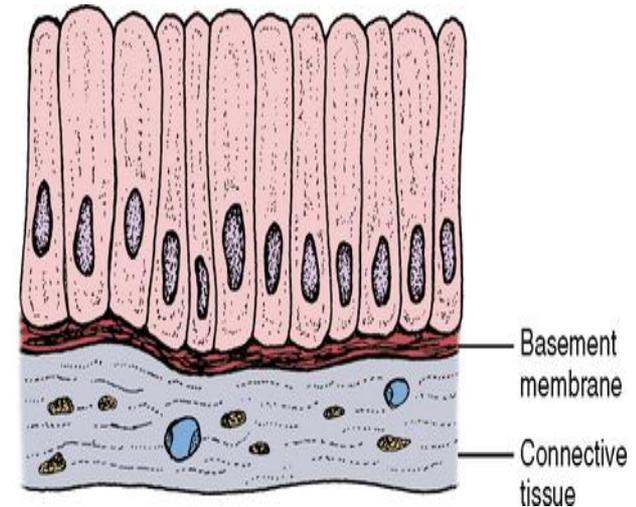
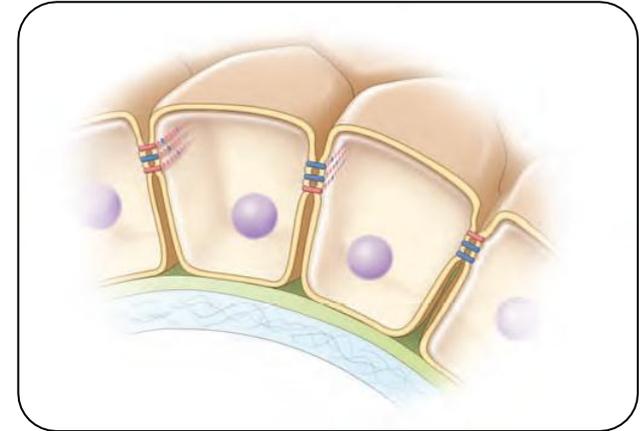
Derived from **all three embryonic** germ layers:

- **Ectoderm**: e.g: skin
- **Endoderm**: e.g: lining epithelium of the gut.
- **Mesoderm**: e.g: Endothelial lining of Blood vessels

## 2- Structure :

### The epithelial cells are:

- ❑ Closely aggregated cells with *very little* intercellular substance in-between.
- ❑ Have **strong adhesion** to one another and attached to each other by many types of **cell junction** Forming continuous **sheet**
- ❑ Resting on **basement membrane** that separated it from the underlying connective tissue.



### 3- Avascular :

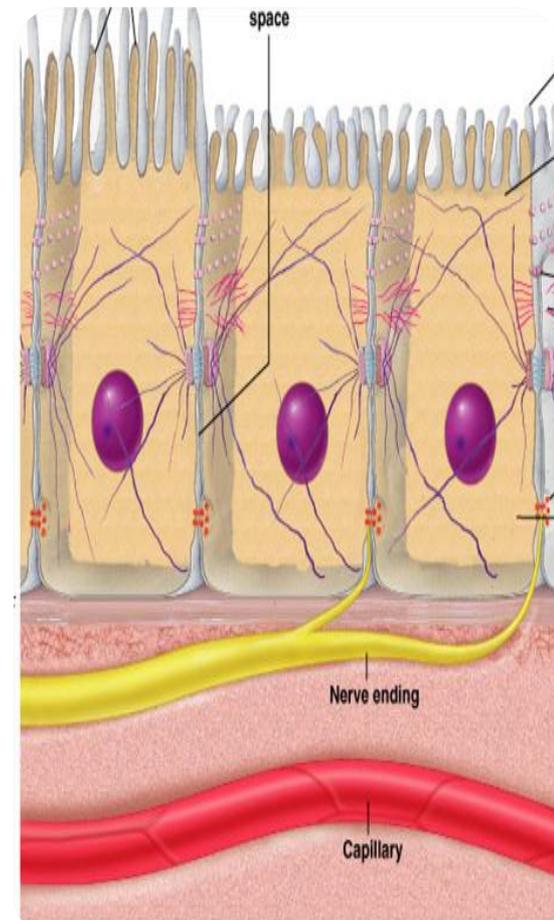
- ❑ Blood vessels **do not penetrate** the epithelial tissue, *however* its nutrition depends on the **diffusion of metabolites** from the capillaries present in the **underlying** connective tissue.

### 4- Nerve supply :

- ❑ The sensory nerve ending present in the underlying connective tissue penetrate the epithelium and provide it with proper sensation.

### 5- Renewal :

Epithelial cells are continuously renewed through rapid mitotic activity



# Functions of epithelial tissue

**1- Protection** (covering and lining of surfaces e.g. skin) from:

- Mechanical abrasion, chemical penetration.
- Bacterial invasion.
- Reduction of friction.

**2- Absorption** e.g. small intestine (of nutrients )

**3- Secretion** e.g. glands. **forming glands** whose function is **secreting** enzymes, hormones, lubricants, or other products

**4-Excretion** of waste products e.g. kidney tubules

**4- Sensation** receiving sensory signals e.g. neuroepithelium.

**5- Contractility** e.g. Myoepithelial cells.

# Classification of Epithelium

Epithelia are classified according to their structure & function into:

□ Two main groups:

(1) Covering and lining epithelium.

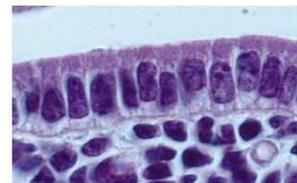
(2) Glandular epithelium.

□ Special types

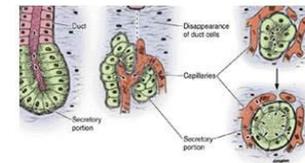
(3) Neuroepithelium.

(4) Myoepithelium.

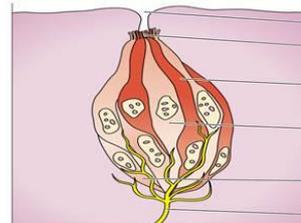
I- covering& lining.



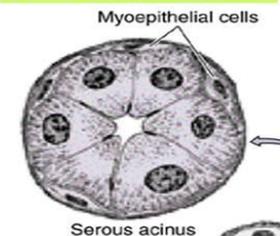
II- Glandular.



III-Neuroepithelium.



IV-Myoepithelium.



# I. Covering epithelium (Epithelial membranes)

Are classification according to the:

1-The **shape** of the **most superficial** cell layer to:

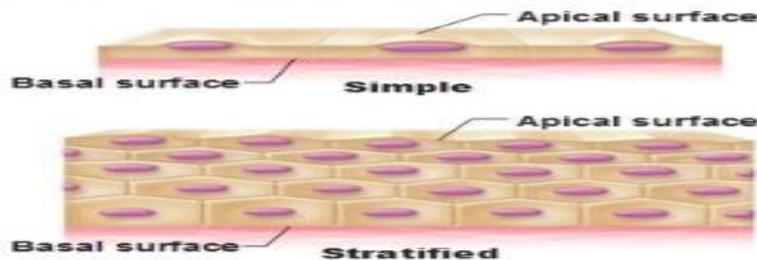
- Squamous (flat)
- Cuboidal
- Columnar

N.B: the shape of the nuclei are suitable to the shape of the cells

2-The **number** of **cell layers** composing the epithelium:

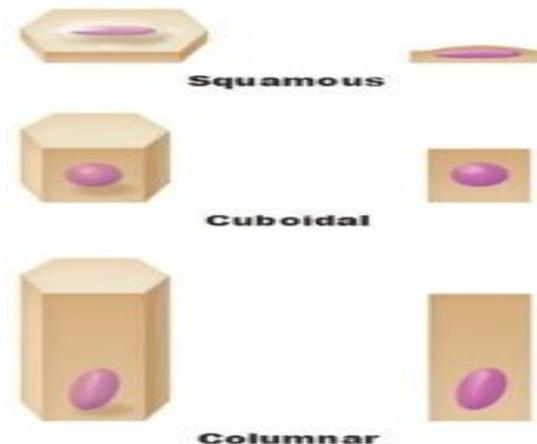
- Single layer of cells constitutes a **simple epithelium**.
- Two or more layers of cells are referred to as a **stratified epithelium**.

## Classifications of Epithelia



(a) Classification based on number of cell layers

Note that basal cells regenerate; as apical cells slough off, they are replaced by basal cells



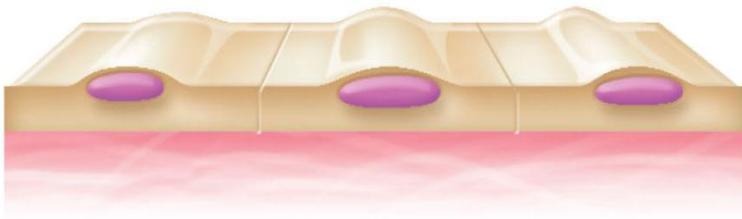
(b) Classification based on cell shape

# Covering epithelium

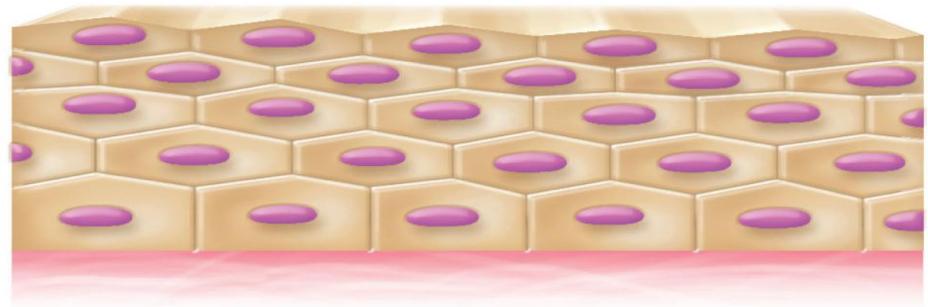
- Cover a surface  
or Line a cavity

It can be divided according to the **number** of layers into:

- A) **Simple epithelium:** contain **only one layer of cells.**
- B) **Stratified Epithelium:** contain **more than one layer of cells.**



**Simple**



**Stratified**

# Simple epithelium

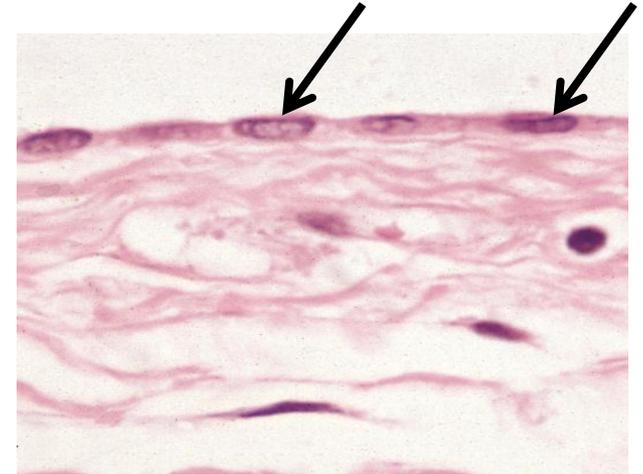
Classified according to **shape** of cells into:

- 1- Simple **squamous** epithelium
- 2- Simple **cuboidal** epithelium
- 3- Simple **columnar** epithelium
- 4- **Pseudostratified** columnar epithelium



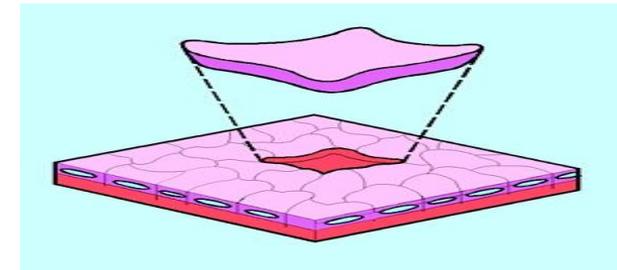
# Simple **squamous** epithelium

- ❑ **Shape of the cell:** Thin-flat, plate like
- ❑ **Shape of the nucleus:** Flat
- ❑ **function:**
  - Interchange of substances (gases or liquids)
  - Easy movement due to its smooth surface



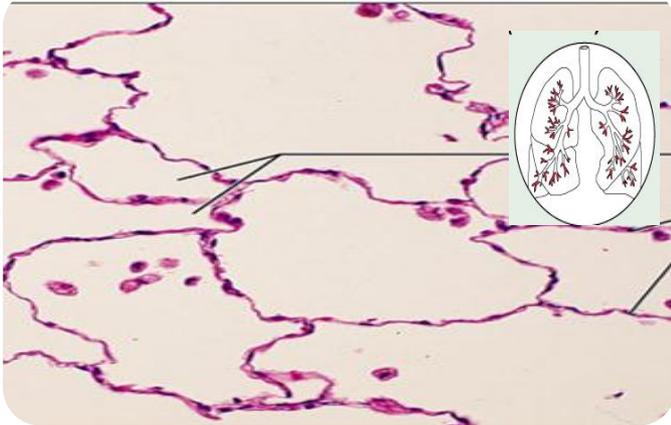
## ❑ **Sites**

- Kidneys (Bowman's capsule).
- Lungs (lining the alveoli).
- Endothelium (lining the blood and lymphatic vessels).
- Mesothelium (peritoneum, pericardium and pleura).

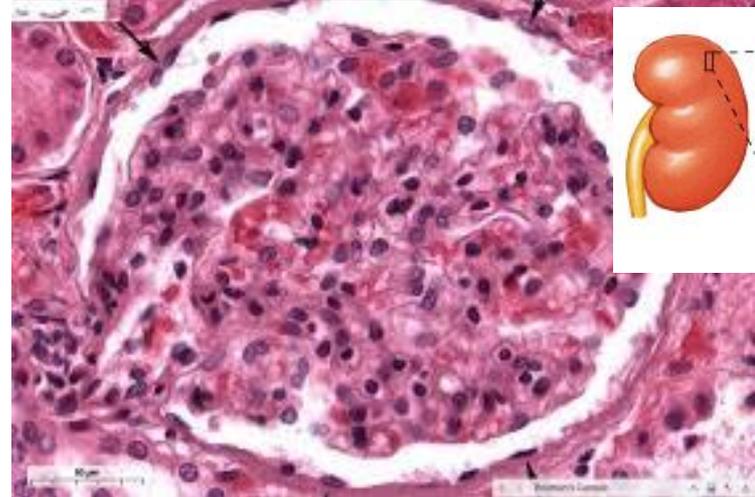


# Simple **squamous** epithelium

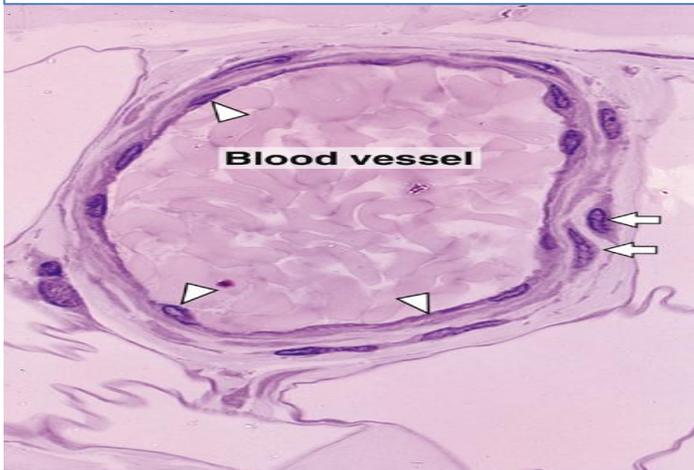
**Lungs (lining the alveoli).**  
Gas exchange



**Kidneys (Bowman's capsule).**  
Filtration of blood



**blood vessel: Endothelium lining**  
Smooth surface



**Mesothelium**  
Easy movement



# Simple **cuboidal** epithelium

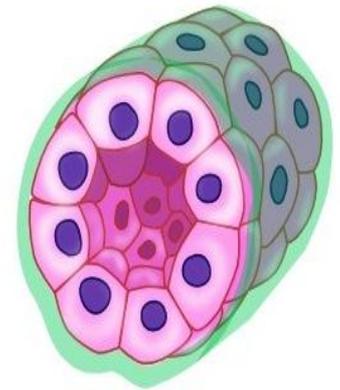
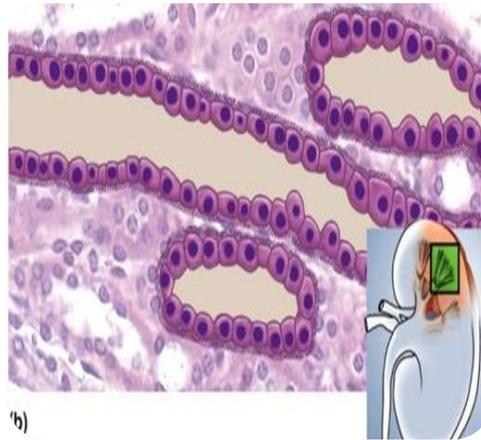
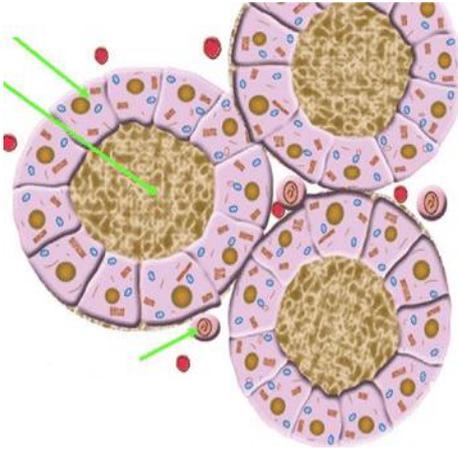
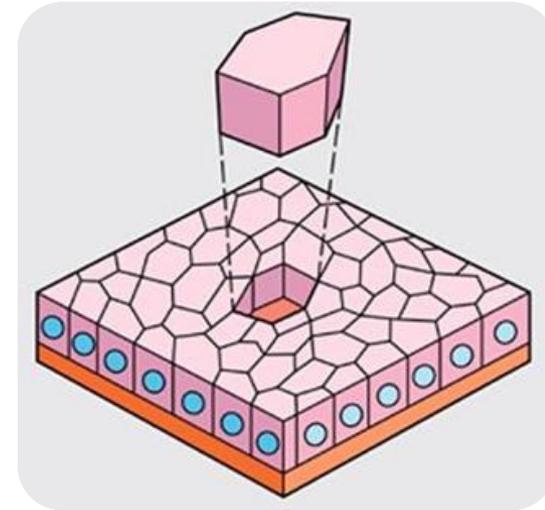
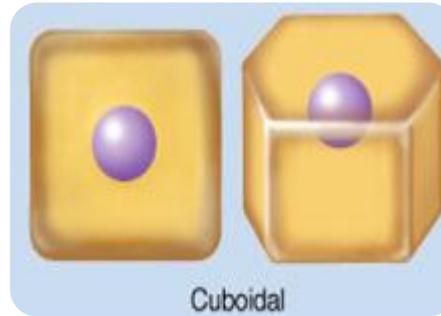
## □ *Shape of the cell:*

Cuboidal

## □ *Shape of the nucleus*

Rounded Central nucleus

## □ *Sites: lining:*



Thyroid follicles

Tubules of the kidney

Ducts of glands(**medium**)

# Simple **columnar** epithelium

## □ *Shape of the cell:*

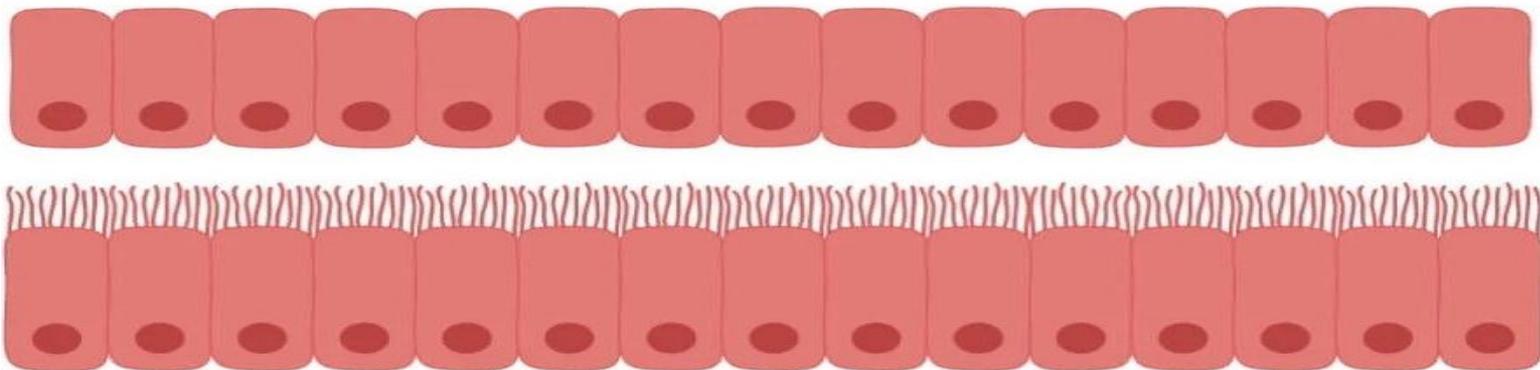
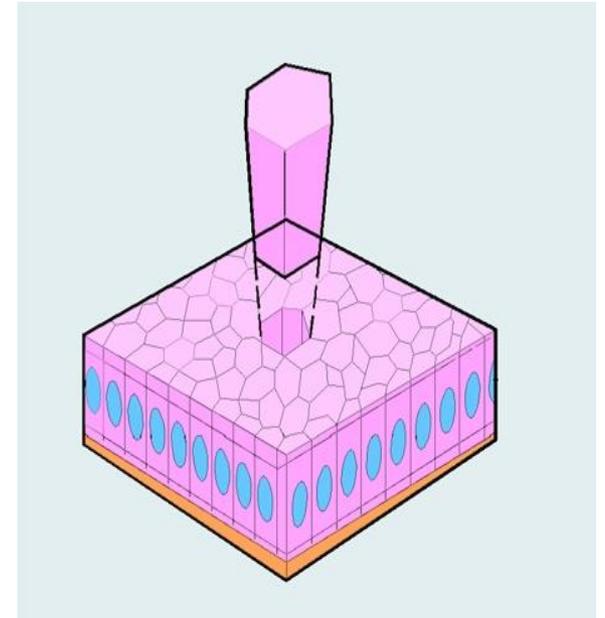
tall rectangular

## □ *Shape of the nucleus*

oval basal nuclei.

## □ *It is subdivided into:*

Non-ciliated and ciliated varieties:



# Simple **columnar** epithelium

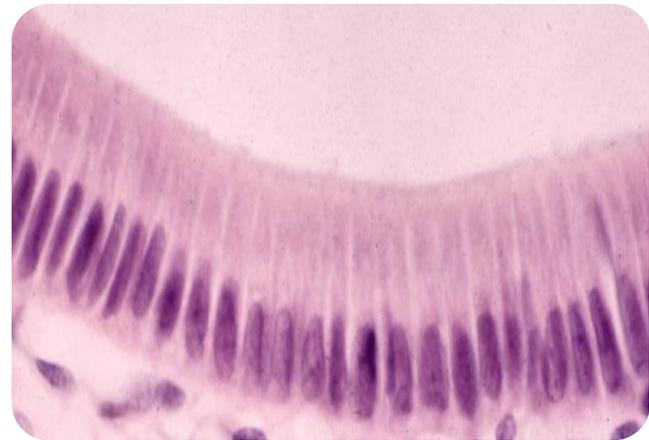
## Simple columnar **ciliated** epithelium:

- ❑ The cells have motile hair-like processes called cilia on their free surface
- ❑ **Function:** movements of particles or fluids over the surface
- ❑ **Sites**
  - Conducting bronchioles of lung
  - Together **with** non-ciliated lining the uterus and fallopian tubes



## Simple columnar **non-ciliated** epithelium:

- ❑ **Sites & functions:**
  - Gastro-intestinal tract & Gall bladder :absorption
  - Glands, line the large ducts :secretion



# Pseudostratified Columnar Epithelium

## ❑ Structure:

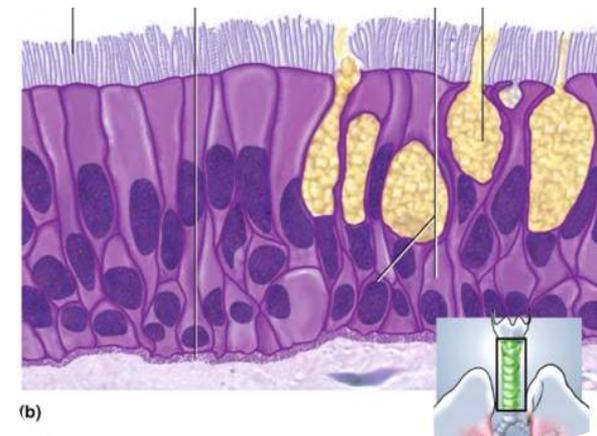
- A **single** layer of cells. It gives the appearance of being stratified

- some cells are tall
- while others are short not reach the surface.
- However ***all*** the cells are resting on the basement membrane.
- **The nuclei** lie at a various levels so give the false appearance of being stratified.

## ❑ Site:

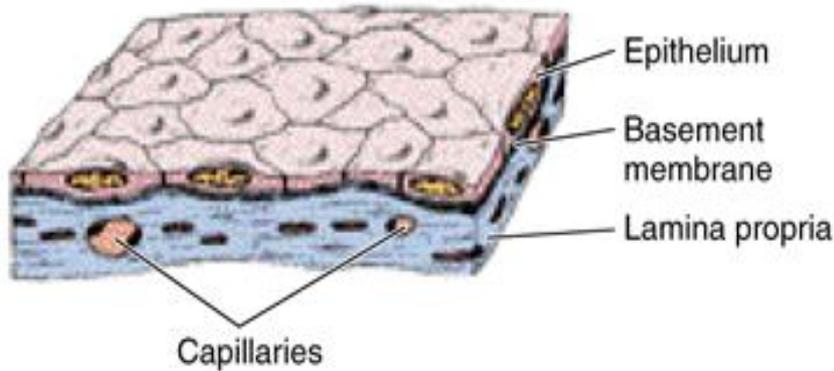
**I) The ciliated type** is present in the respiratory passage as **trachea** and is usually associated with goblet cells.

**II) The non ciliated type** is found in the **large ducts** of the glands.

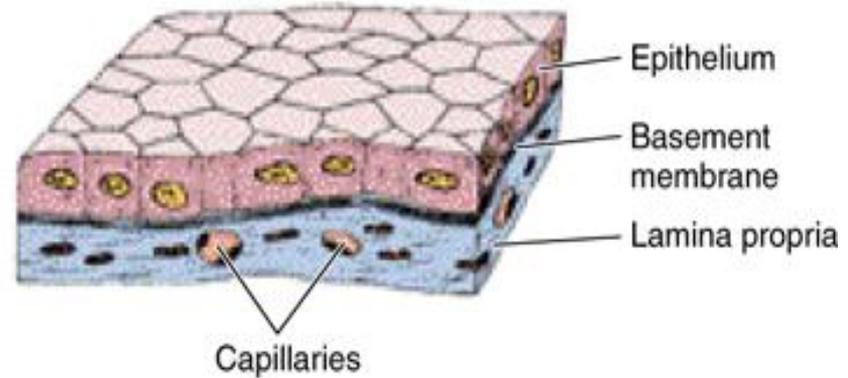


# Simple epithelium classified according to shape of cells.

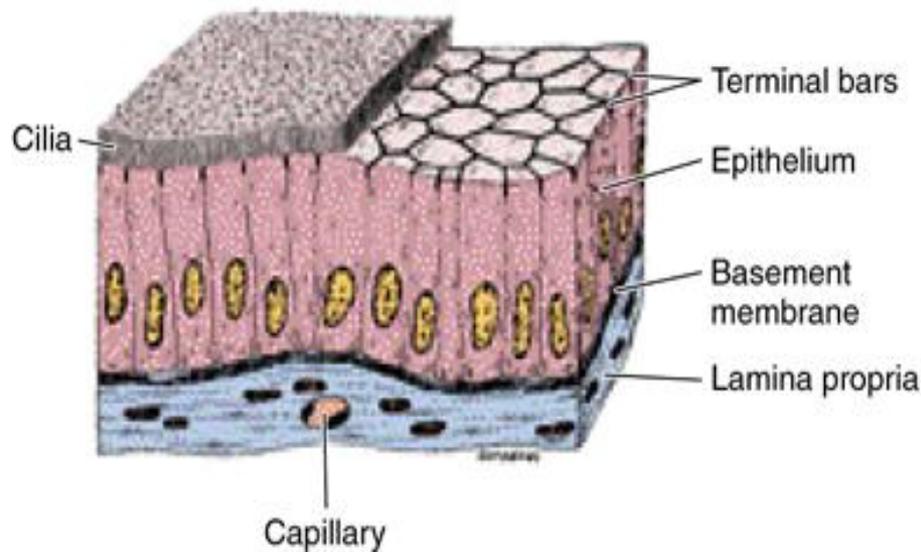
A Simple squamous epithelium



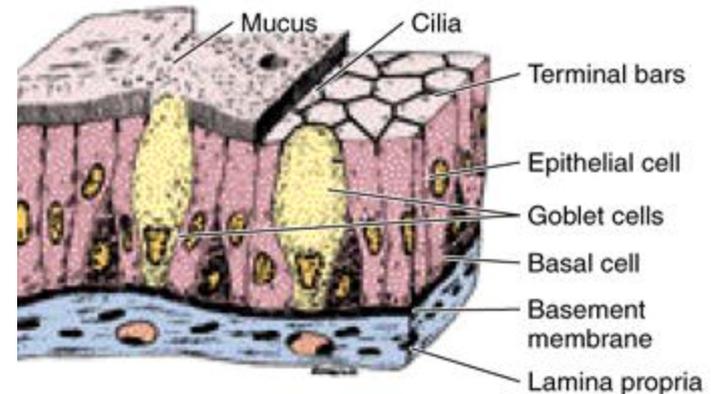
B Simple cuboidal epithelium



C Simple ciliated columnar epithelium



: Ciliated pseudostratified epithelium



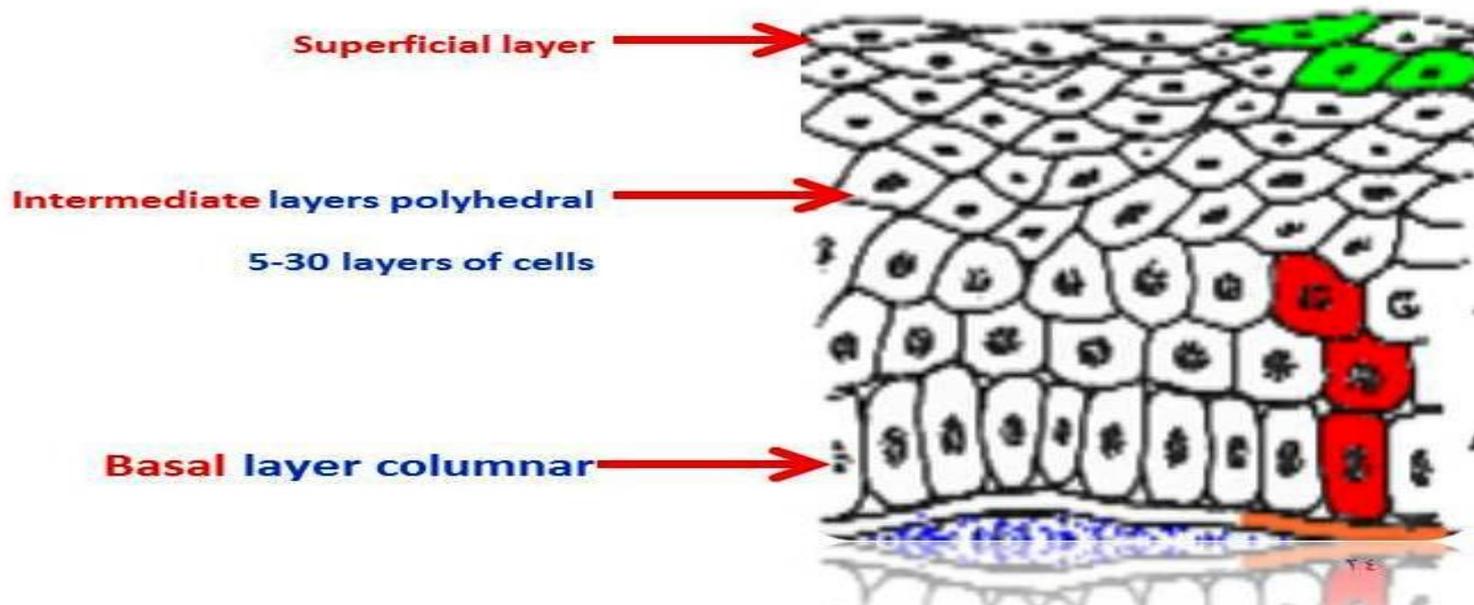
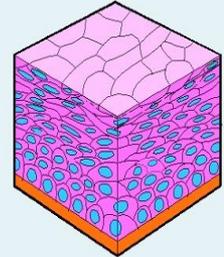
# Stratified Epithelium

It is formed of **many** layers of cells

-**the basal layer** is columnar in shape

-**the intermediate layers** are polyhedral cells

-**the superficial layer**: the shape of the cells depends on the type of the epithelium.



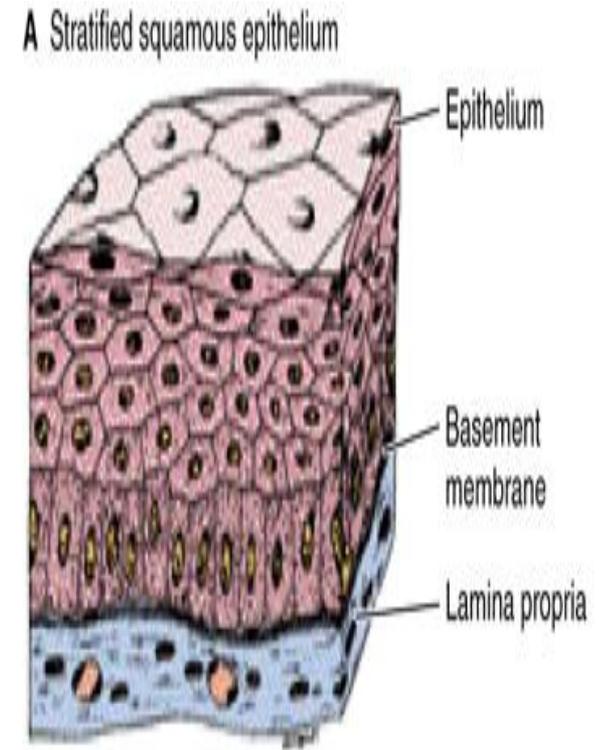
# Classification of Stratified Epithelium

According to shape of superficial cells into:

- 1- Stratified **squamous** epithelium
- 2- Stratified **cuboidal** epithelium
- 3- Stratified **columnar** epithelium
4. **Transitional** epithelium

# Stratified **squamous** epithelium

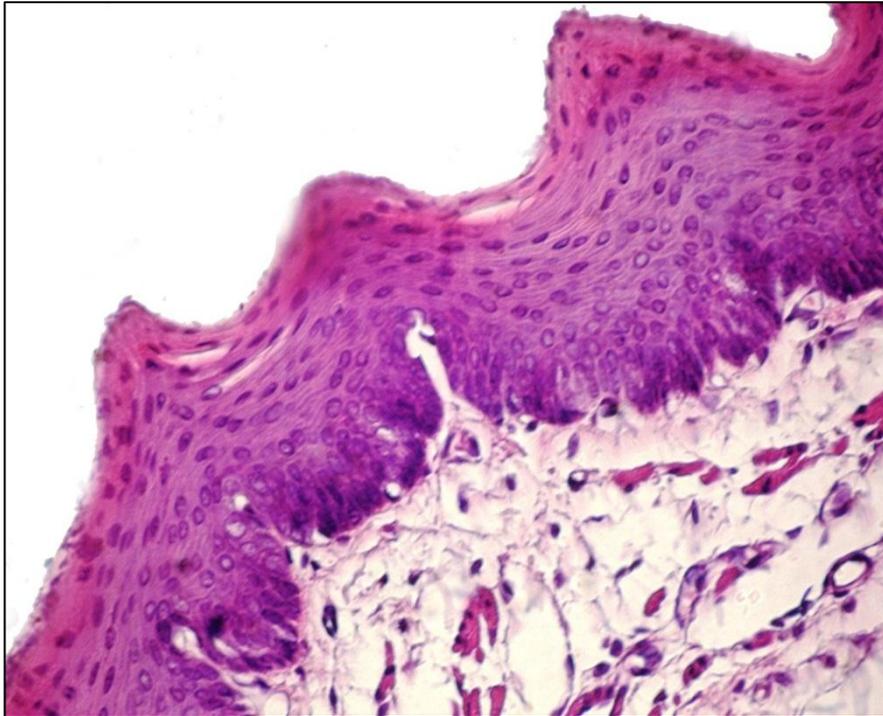
- The superficial layer is **squamous**.
- **Types: keratinized or Non keratinized**
- **Stratified Squamous **keratinized** epithelium**
  - This type is covered with **non living layer** of keratin.
  - Covers dry surfaces to protect them from **water loss**.
  - sites:**
    - **Epidermis of skin**
    - **All the opening on the surface of the skin** ( lips, nose, ears and anus)
- **Stratified squamous **non keratinized** epithelium**
  - The Superficial cells are flattened **living cells**.
  - Lines wet surfaces for protection.
  - Present in the **oral cavity** and **esophagus**



# Stratified squamous epithelium

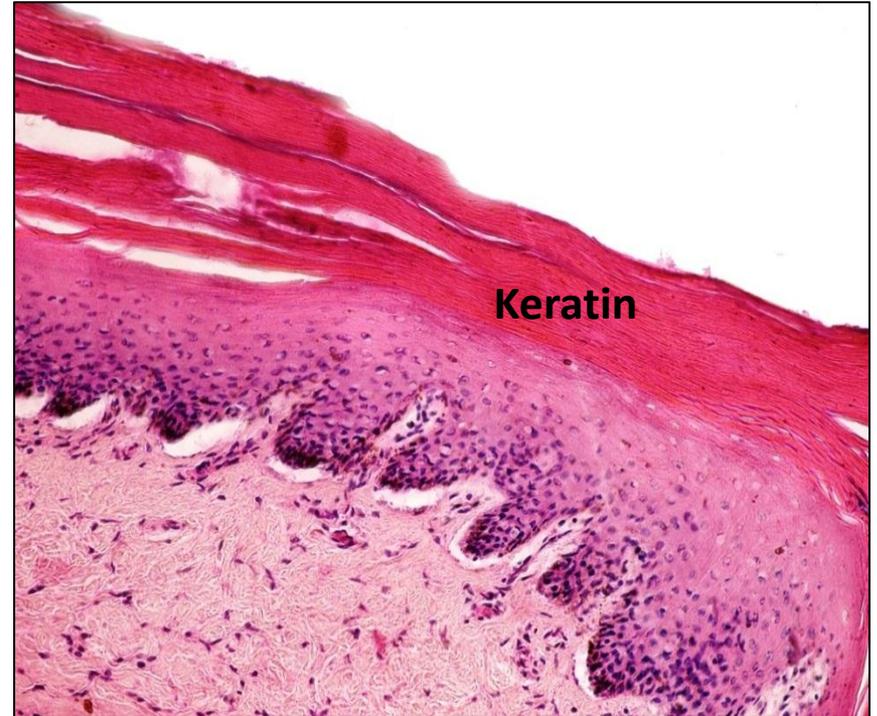
*Non keratinized*

Esophagus



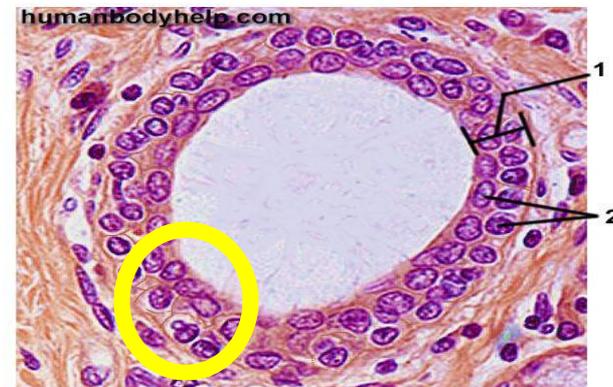
*keratinized*

Skin



# Stratified **cuboidal** epithelium

- Superficial cells **cuboidal**.
- Arranged mainly in two layers.
- **Site:** Lining ducts of sweat glands.
- **Function:** secretion



# Stratified **columnar** epithelium

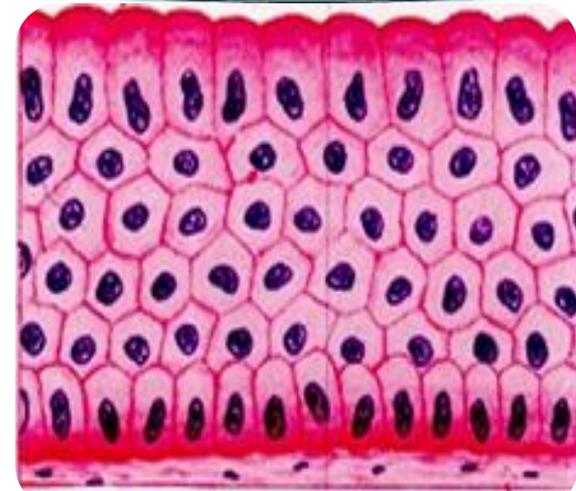
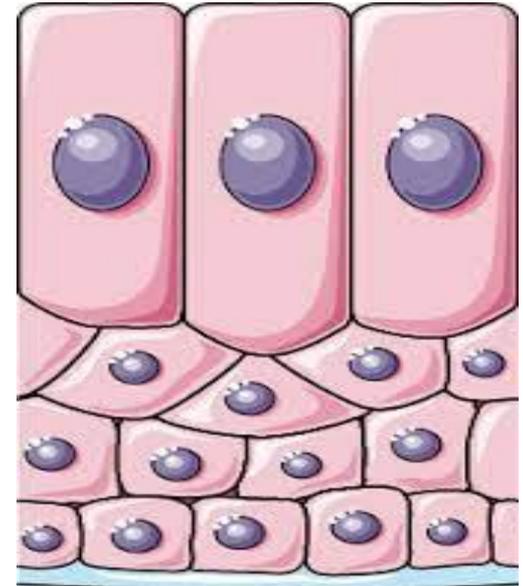
- Superficial cells **columnar**.
- Ciliated and non ciliated.

## **a) Stratified columnar **non ciliated**.**

- **Sites:** Large ducts of glands- *Fornix of conjunctiva*

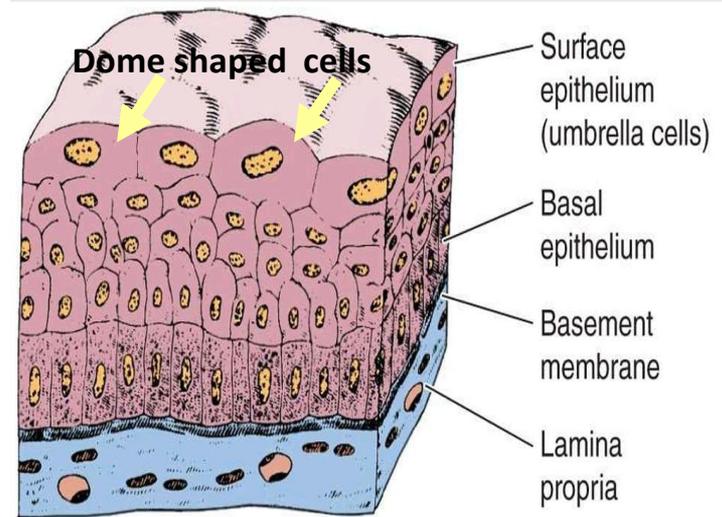
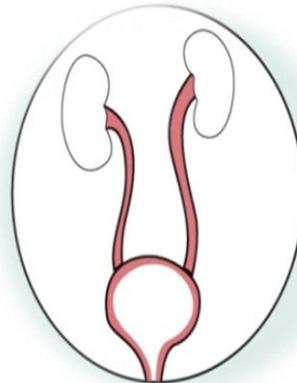
## **b- Stratified columnar **ciliated**.**

- **Sites:** Fetal esophagus



# Transitional epithelium

- **Site:** lines **the urinary tract** (kidney-ureter-urinary bladder-proximal part of urethra).
- **Structure:**
  - The most superficial cells are **large dome shaped**.
  - These cells covered by **thick cuticular border** that prevents the escape of urine between the underling cells during distension and protects them from the injurious substances present in the urine.

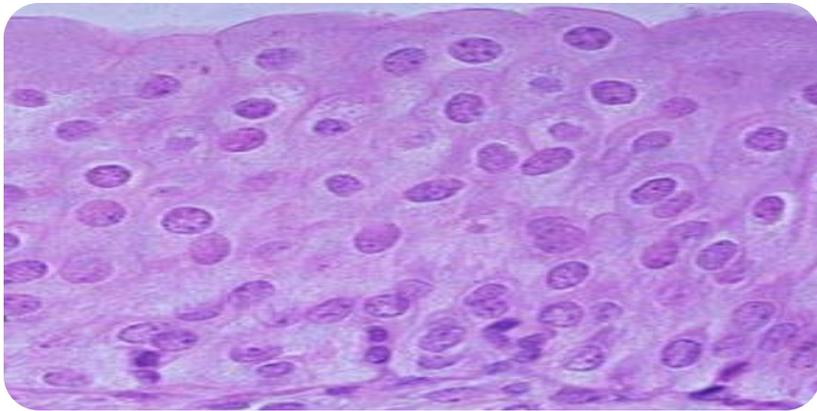


➤ It is called transitional because the number of layers changed depending on whether the organ is **contracted or distended**.

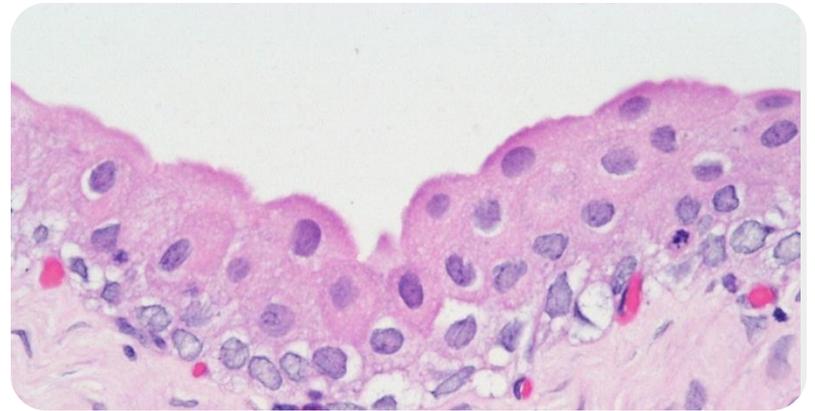
• e.g: **Urinary Bladder** when:

-**Contracted:** (empty): transitional epithelium is formed of several layers (**6-8 layers**).

-**Full with urine:** the epithelium is formed of **two or three layers** and appears as *stratified squamous epithelium non keratinized epithelium*.



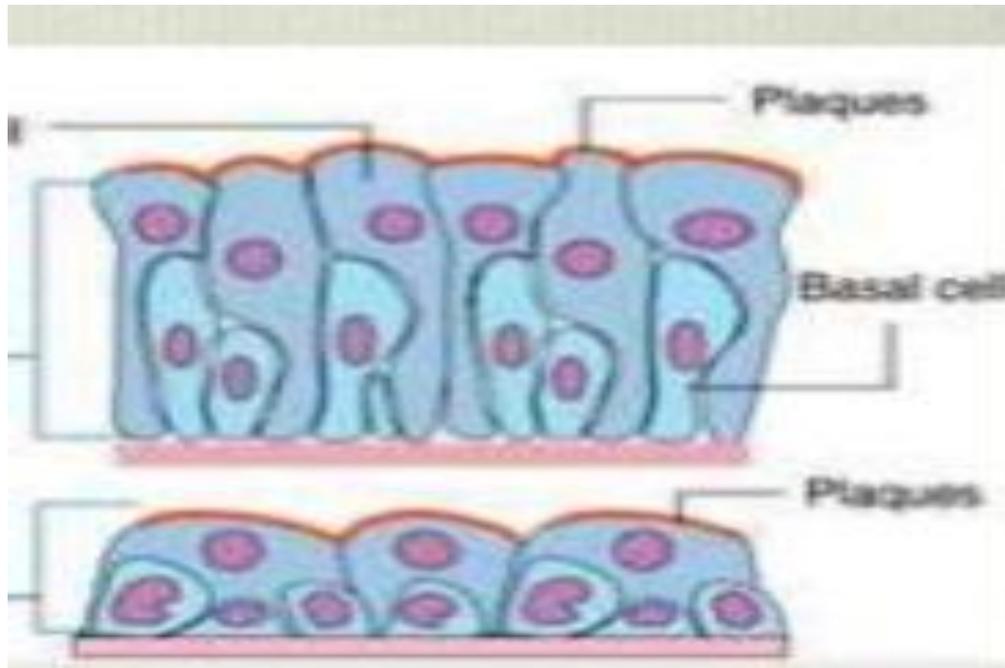
**Empty bladder**



**Full bladder**

# Causes of changes occur in transitional epithelium

- Thin **corrugated** basement membrane.
- Abundant **mucous-like** intercellular substance allowing the cells to glide over.



Type	Surface Cell Shape	Examples (Some)
<b>Simple</b>		
Simple squamous	Flattened	Lining blood and lymphatic vessel walls (endothelium), pleural and abdominal cavities (mesothelium)
Simple cuboidal	Cuboidal	Lining ducts of most glands
Simple columnar	Columnar	Lining much of digestive tract, gall bladder
Pseudostratified	All cell rest on basal lamina with only some reaching the surface. Cells that reach the surface are columnar.	Lining of nasal cavity, trachea, bronchi, epididymis
<b>Stratified</b>		
Stratified squamous (nonkeratinized)	Flattened (with nuclei)	Lining mouth, esophagus, vagina
Stratified squamous (keratinized)	Flattened (without nuclei)	Epidermis of the skin
Stratified cuboidal	Cuboidal	Lining ducts of sweat glands
Stratified columnar	Columnar	Conjunctiva of eye, lining some large excretory ducts
Transitional	Large dome-shaped cells when bladder is empty, flattened when bladder is distended	Lining renal calyces, renal pelvis, ureter, urinary bladder, proximal portion of urethra

# II. Glandular epithelium

## Definition:

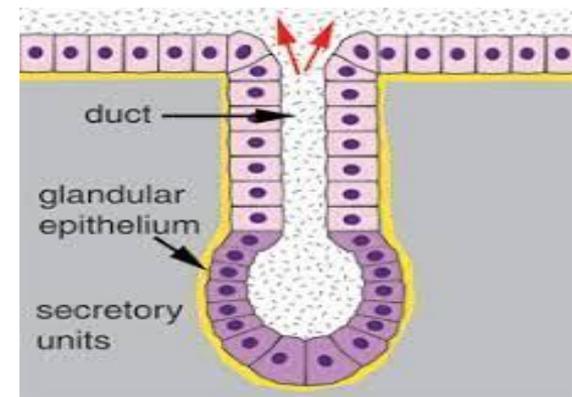
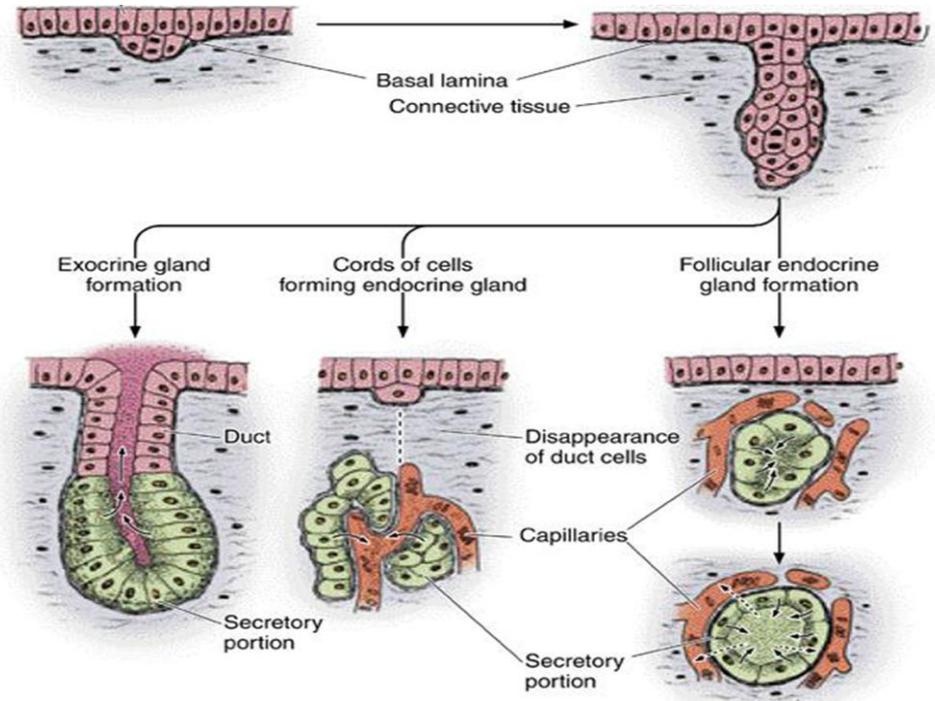
It is a special type of epithelium.

## Function:

epithelial cells specialized to produce

**secretion.** Origin:

- All glands develop embryonically from **surface epithelium.**
- The surface cells differentiate & proliferate & penetrate the underling C.T.



## Glandular epithelium is classified according to:

I- Presence or absence of *Ducts*.

II- Number of *Cells*.

III-*Branching* of the *duct* system.

IV-Shape of the *Secretory* part.

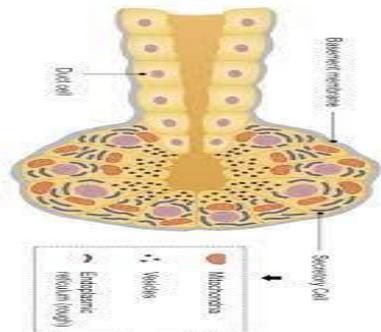
V- Mode (*Way*) of *Secretion*.

VI-Type (*Nature*) of *Secretion*.

# I. Presence or absence of ducts

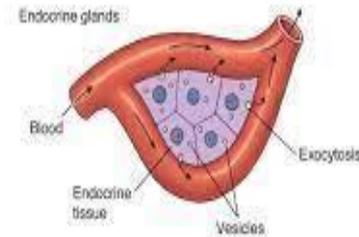
## 1- Ducts **present**: Exocrine glands.

- They retain their connection with the surface epithelium
- **Have ducts** to carry their secretion outside
- Examples: Salivary glands and sweat glands



## 2- Ducts **absent**: Endocrine glands.

- connection with the surface was obliterated-
- They secrete hormones directly **in the blood**
- Example: Thyroid gland



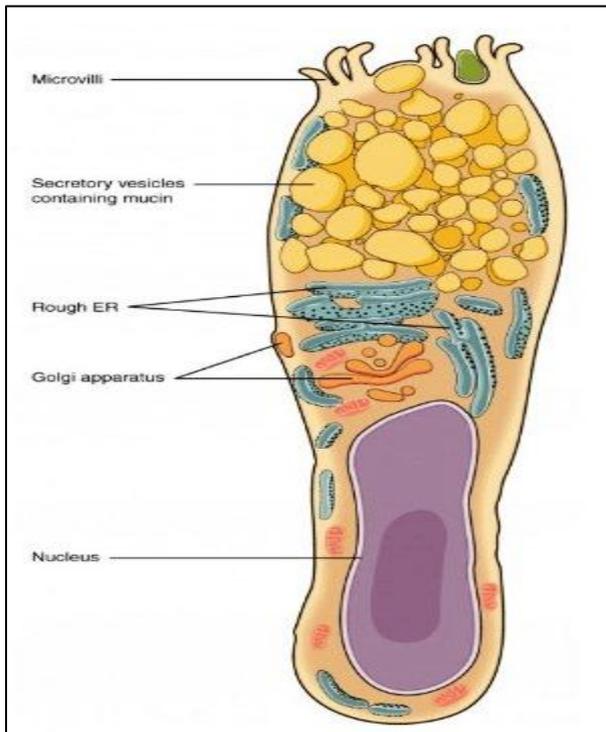
## 3- Mixed glands:

- Have **both** exocrine and endocrine functions
- Example: pancreas.

## II. Number of cells

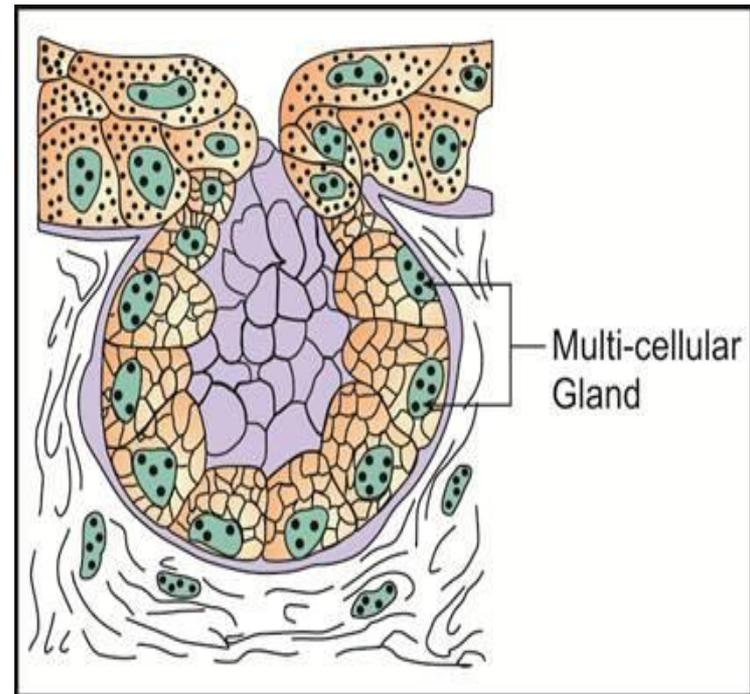
1- **Unicellular** (goblet cells)

-**one** cell is responsible for secretion



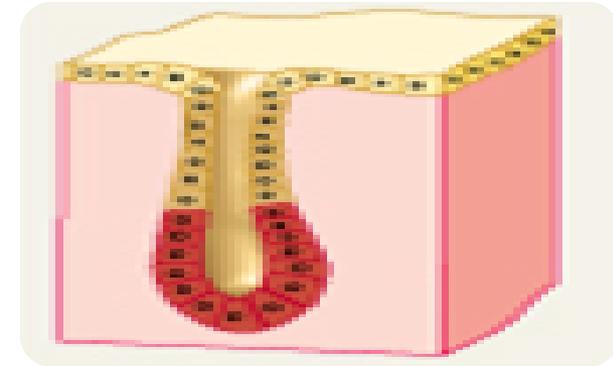
2- **Multicellular**

(salivary glands): **many** cells form a secretory unit

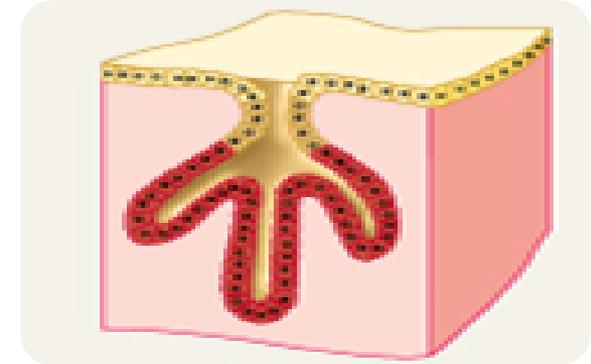


# *III-Branching of the duct system*

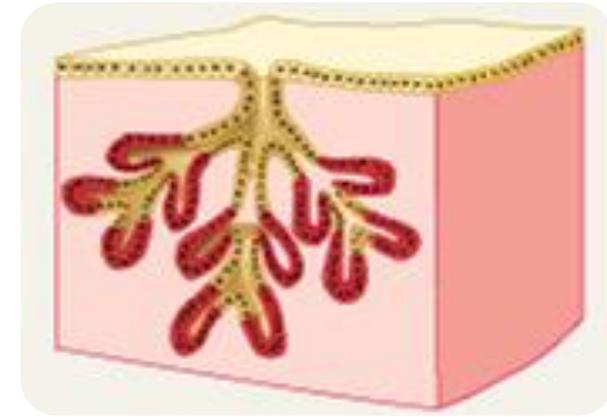
1- Simple glands have only **one** unbranched duct and **one** secretory unit.



2- Simple branched glands have **one** duct and **branched secretory units**.

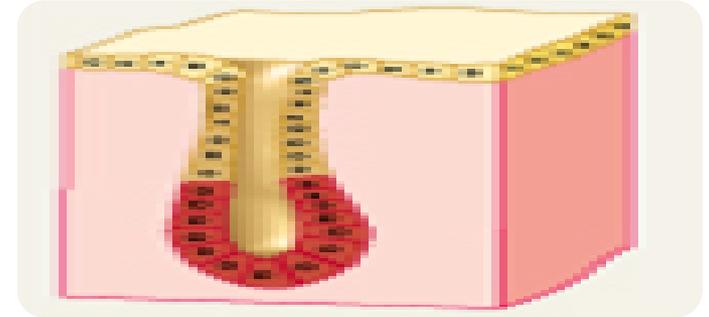


3- Compound glands have **branched ducts** and branched *secretory* units.

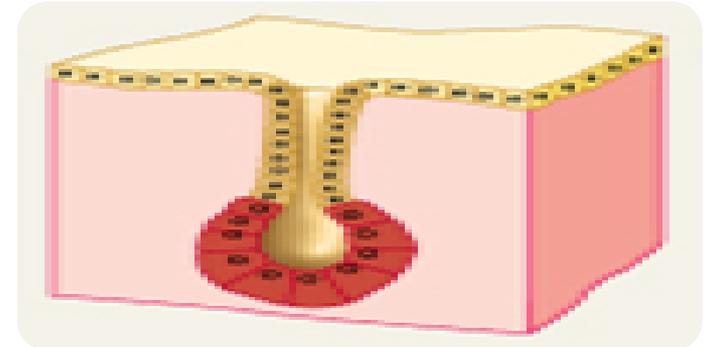


## ***IV. The shape of secretory portion***

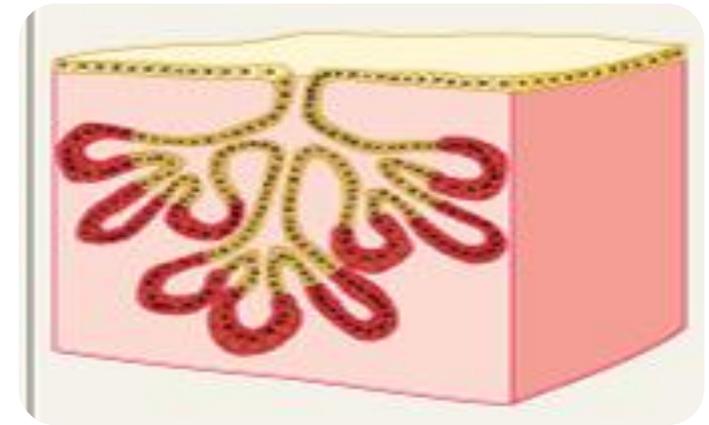
**1- Tubular** :secretory units are tubular in shape.



**2- Alveolar (acinar):**  
secretory units are pear shaped.



**3- Tubuloalveolar:**  
have both acinar and tubular secretory units.



# V. The mode of secretion

## Merocrine glands

-the secretory products leave the cell by **exocytosis**  
-with **no loss** of the cell material.

-Example: Salivary glands.

## Apocrine glands

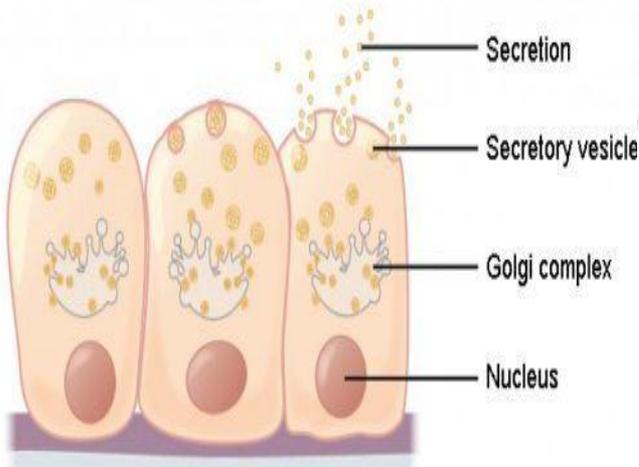
-In which the **apical parts** of the cells of the gland **are lost** and come out with the secretion.

-Example: Mammary glands.

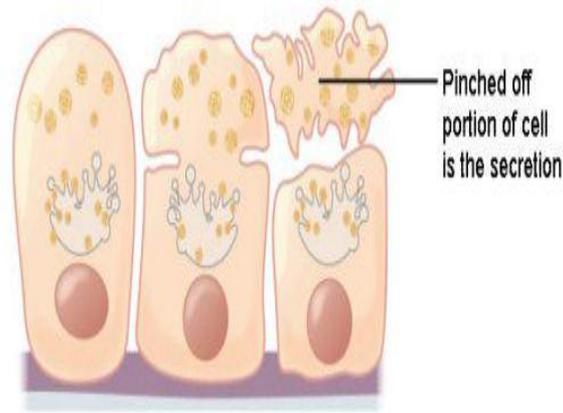
## Holocrine glands

-In which **the whole** secretory cells are **destroyed** and come out with the secretion.

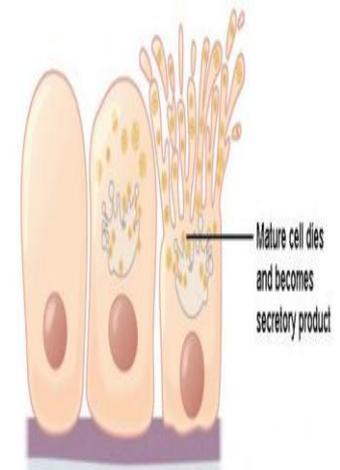
- Example: Sebaceous glands.



(a) Merocrine secretion

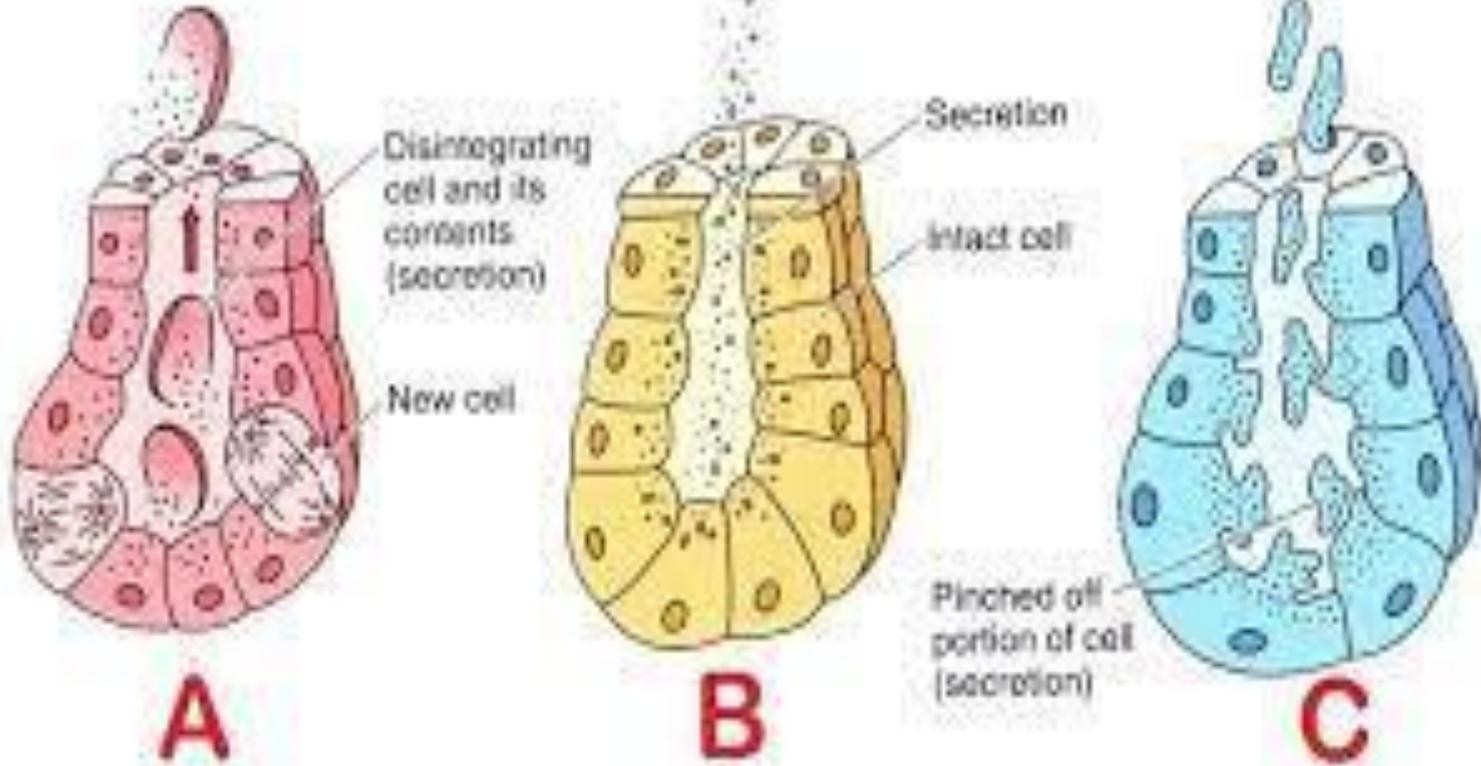


(b) Apocrine secretion



(c) Holocrine secretion

# Mode of secretion

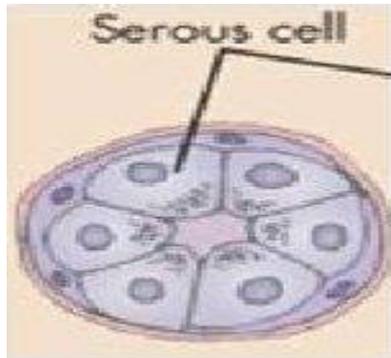


**Holocrine      Merocrine      Apocrine**

# VI. The type of secretion

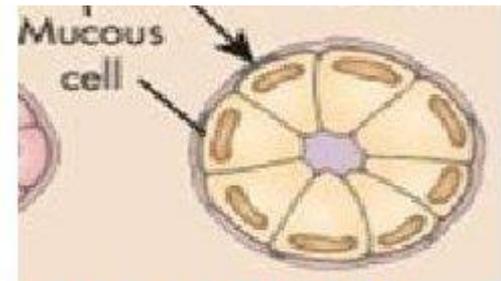
## a) Serous glands

- as **parotid gland**.
- The secretion is **watery fluid**.



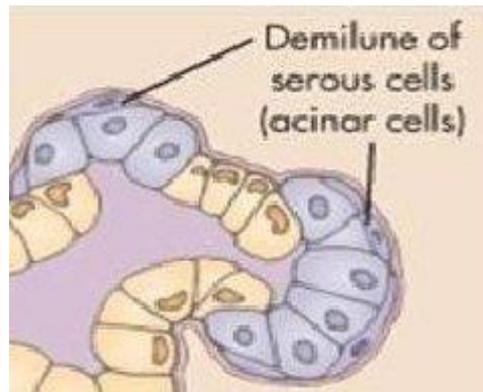
## b) Mucous glands

- as **sublingual salivary glands**
- The secretion is **viscid mucus** secretion

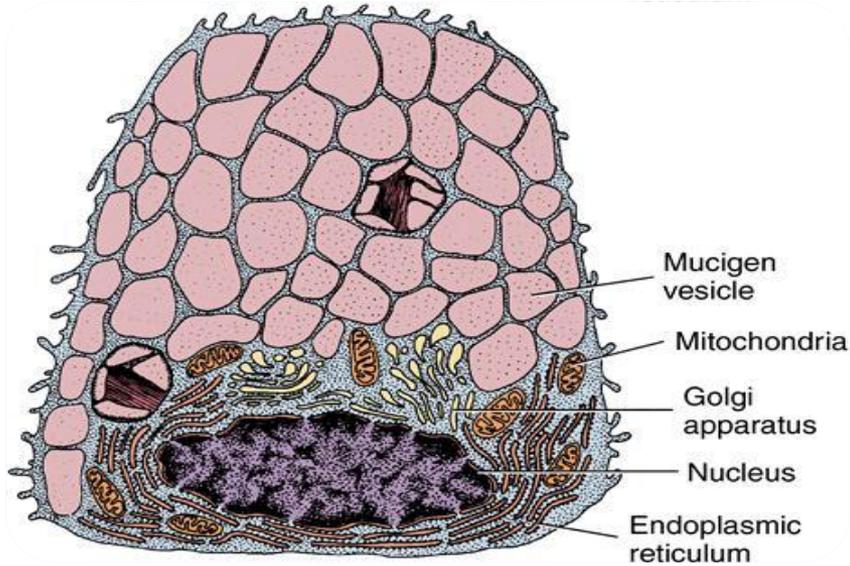


## c) Mixed glands

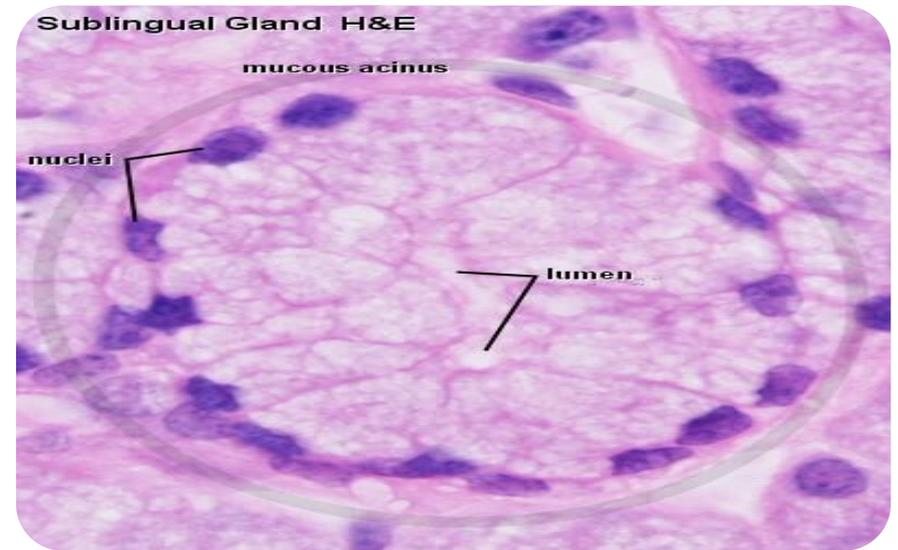
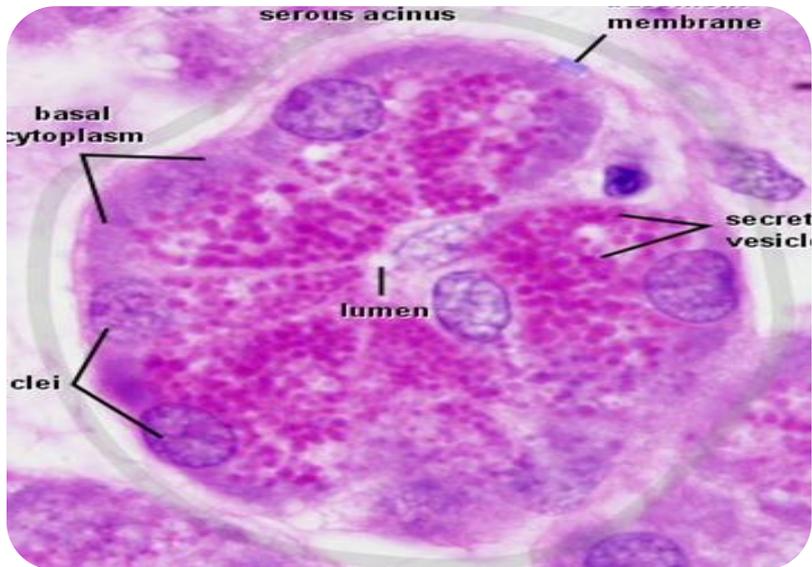
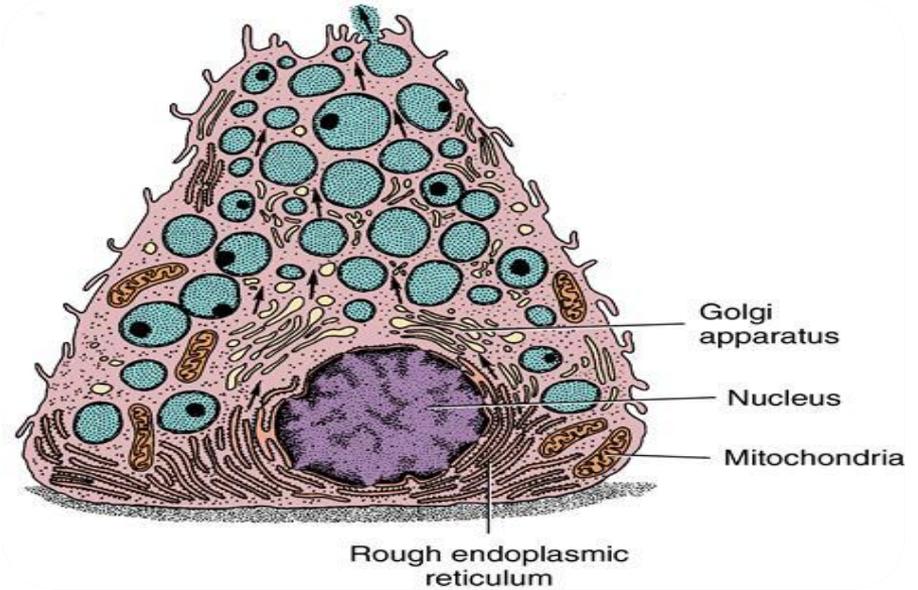
- (seromucus) as **submandibular glands**.



# Mucous cell



# Serous cell

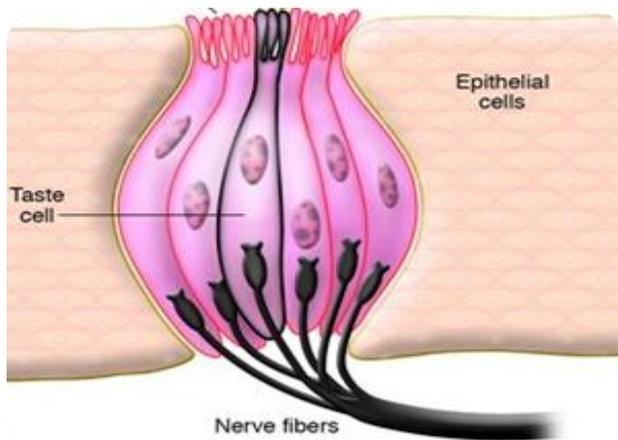


	<b>Serous cell</b>	<b>Mucous cell</b>
<b>Site</b>	Parotid - Pancreas	Goblet cell
<b>Secretion</b>	Serous	Mucous
<b>Nature</b>	Watery	Viscid
<b>Content</b>	Protein	Glycoprotein
<b>Nucleus</b>	Central rounded	Basal flat
<b>Cytoplasm by Hx &amp; E</b>	<b>Apical Acidophilia</b> (secretory granules) & <b>Basal Basophilia</b> (RER)	Pale vacuolated (secretion dissolved)

# Special types of epithelium

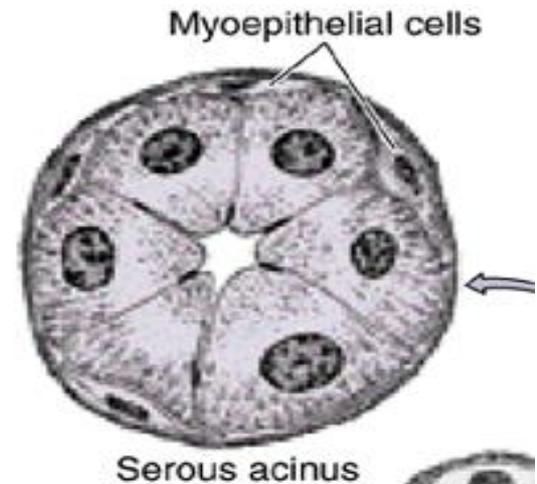
## Neuroepithelium

- ❑ Retina of the **eye**.
- ❑ Organ of Corti in the **ear**.
- ❑ Olfactory epithelium of the **nose**
- ❑ Taste buds of the **tongue**.



## Myoepithelium

- Mammary glands



# III. Neuroepithelium

- Epithelial cells with **special sensory functions**.
- **Structure:** it is composed of **3** types of cells:

## 1-Hair cells (sensory cells)

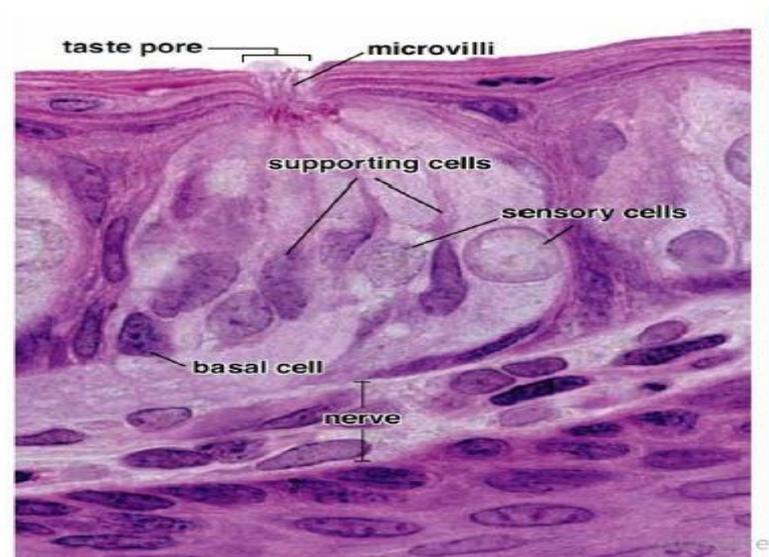
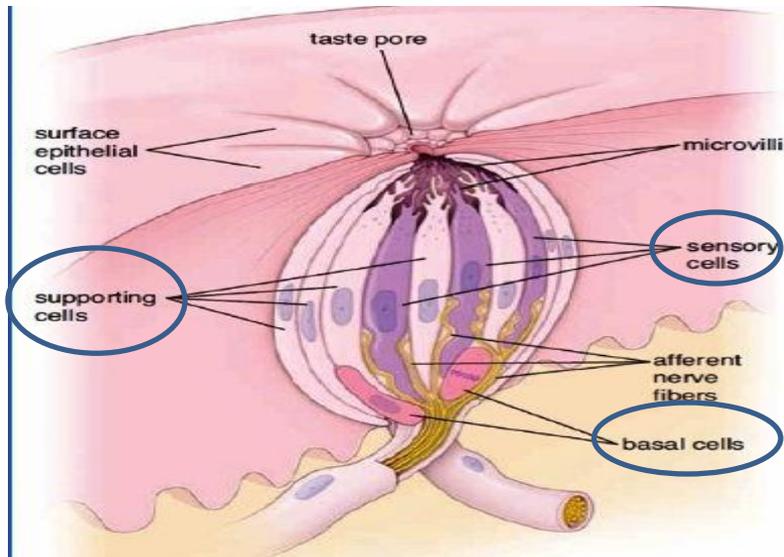
- receive sensation.
- Surround by nerve ending at their bases.
- have Apical microvilli.

## 2-Supporting cells

Give support to hair cells

## 3- Basal cells

Act as a *stem cells* for regeneration



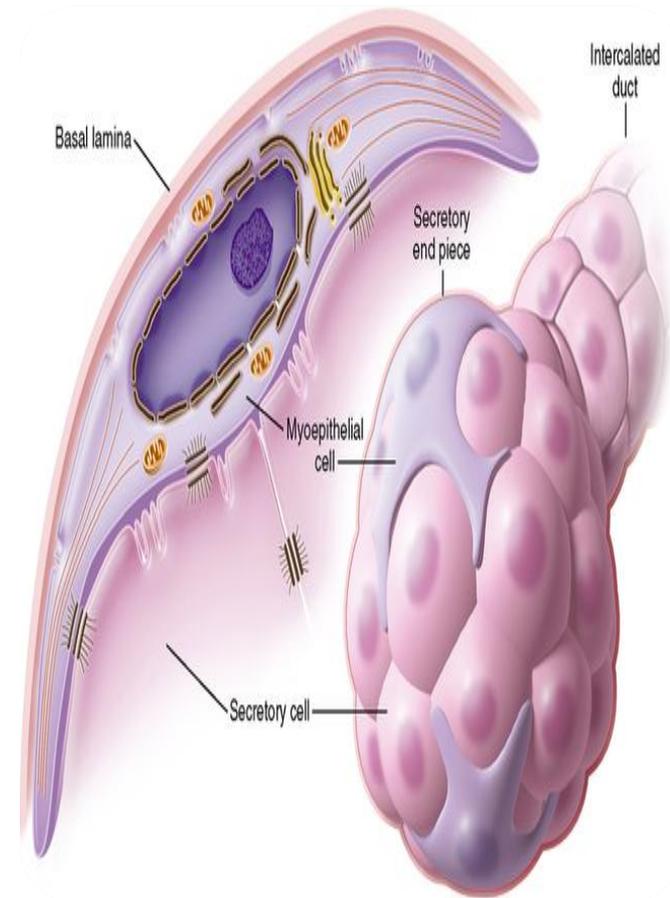
# IV. Myoepithelium

Epithelial cells specialized for **contraction**.

- They are **Stellate or Spindle** shaped.
- Present **around** gland acini and ducts
- Present between **basal lamina** and **secretory cells**.
- Contain **actin and myosin filaments**.

➤ **- Sites:**

-Lining the acini of **mammary, Sweat & Lacrimal glands**.



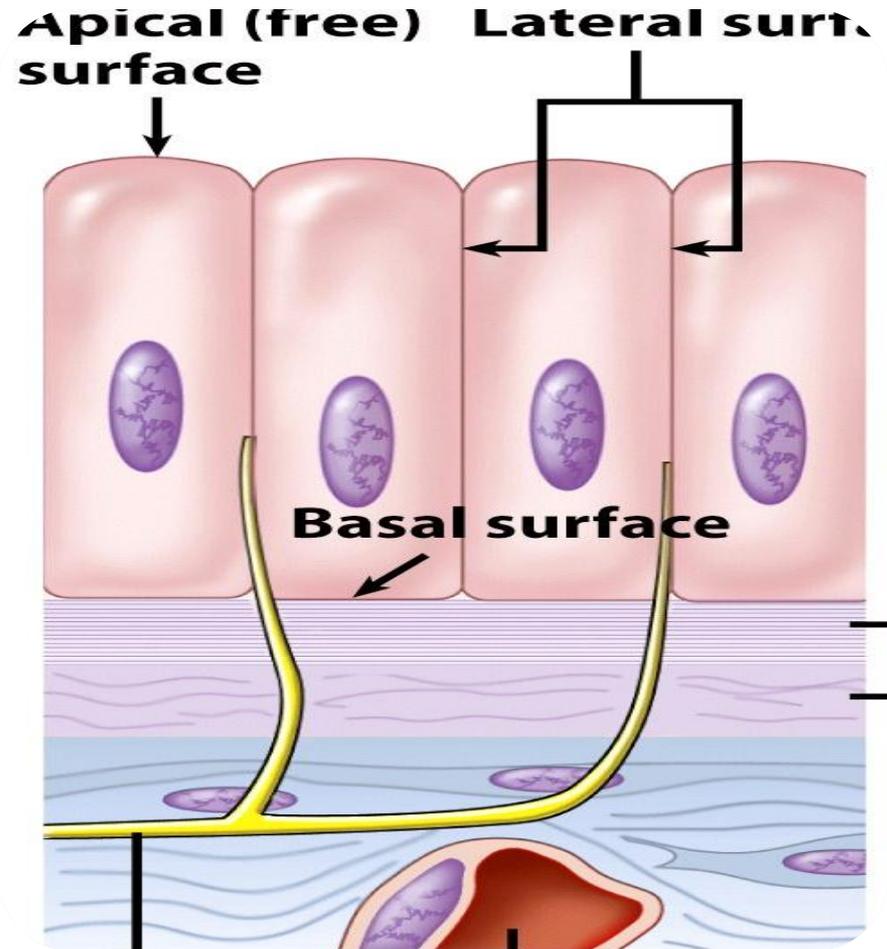
# *cell polarity*

Epithelial cells have **different poles**, each one has **specific biochemical** and **structural specializations** to perform specific function

A- Apical pole

B- Basal pole

C- Lateral surfaces.



# Specializations Of The Cell Surface

**A- Apical specializations**

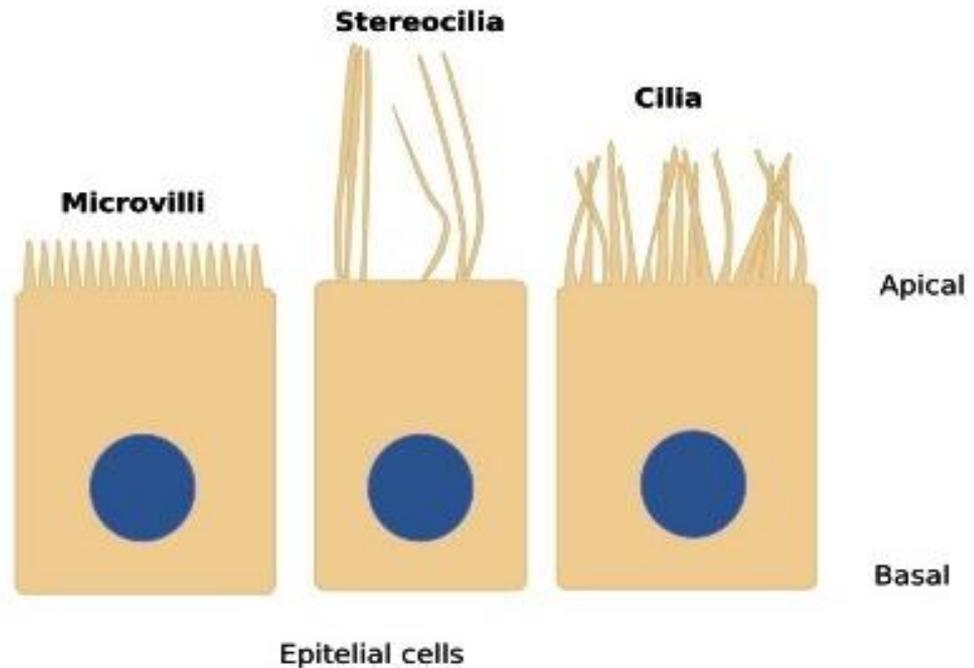
**B- Basal specializations**

**C- Lateral specializations**

<b>A- Apical specializations</b>	<b>B- Lateral specializations</b>	<b>C- Basal specializations</b>
1) Microvilli	1) Impermeable junctions	1) Hemidesmosome
2) Stereocilia	2) Adhering junctions	2) Basement membrane & basal lamina
3) Cilia	3) Communicating junction	3) Basal Infoldings
4) Flagella	4) Lateral interdigitations	

# A- Apical specializations

1. Microvilli
2. Stereocilia
3. Cilia
4. Flagella



# I-Microvilli

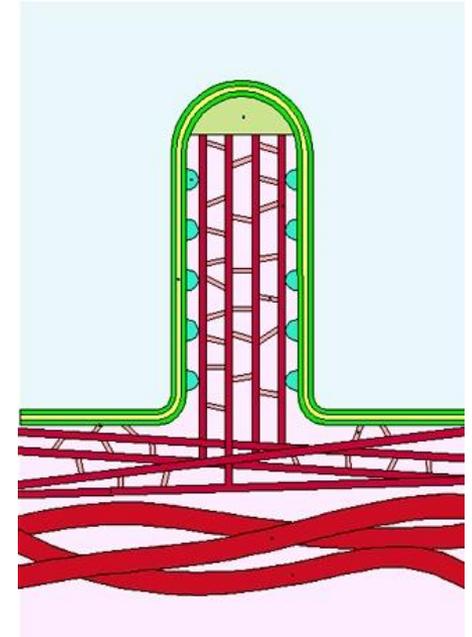
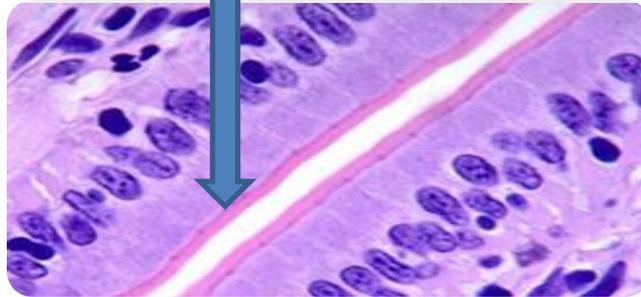
## ❑ Structure:

### E/M:

- **finger-like** extensions of the apical part of cytoplasm
- has a **core of actin** microfilaments.

### L/M:

- The microvillus is covered with a filamentous coat called **glycocalyx (Brush border)**

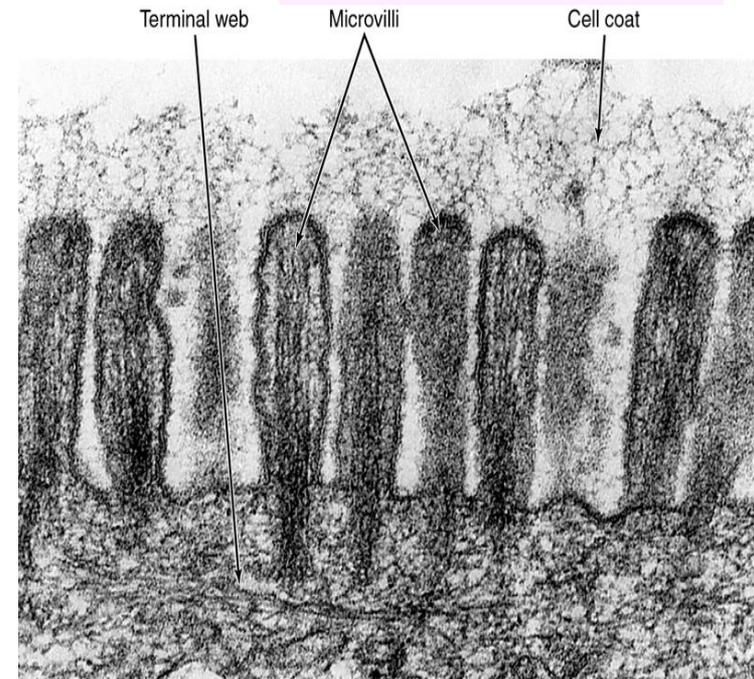


## ❑ Function:

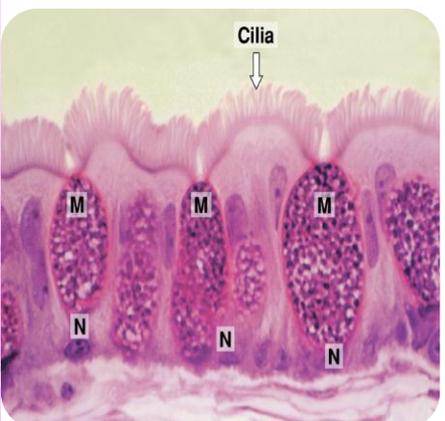
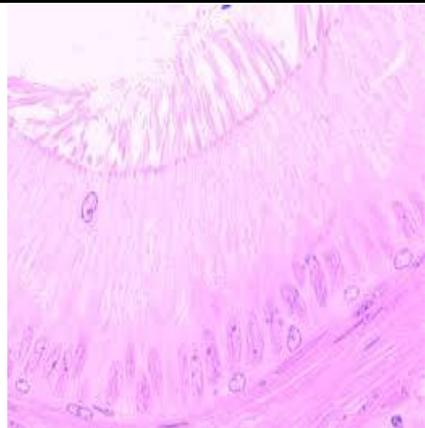
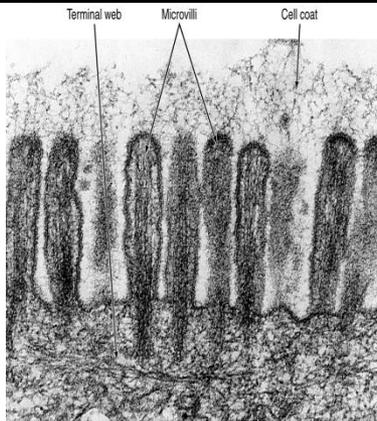
They increase the surface area for absorption.

## ❑ Sites: Absorptive epithelial cells lining the:

- Small intestine
- Cells of proximal renal tubule.



Apical Specializations	Microvilli	Stereocilia	Cilia	Flagella
Site	Small intestine	Epididymis	Trachea	Sperm
Shape	finger-like	long branched non-motile microvilli.	hair-like	single long cilia
Length	Short	Long	Long	Longest
Number	Many Brush border	Many	Many	Single
Structure	Actin Filaments	Filaments	Microtubules	Microtubules
Motility	Non	Non	Motile	Motile
Function	Increase surface area for absorption.	Increase surface area	Movement	Movement



# B- Lateral specializations

These are **membrane-associated structures** that help in cohesion and communication between cells

(**Intercellular junctions**)

-present in a definite order from apex to base

According to the function, junctions between cells can be classified into:

1- **Impermeable junctions**: link cells to form impermeable barrier

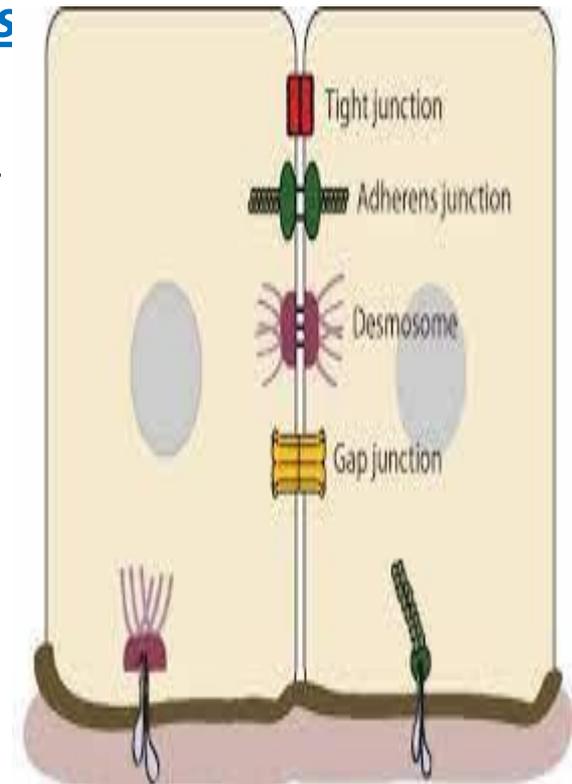
- Zonulae occludens (tight junction)

2- **Adhering junctions**: provide stability to the cells.

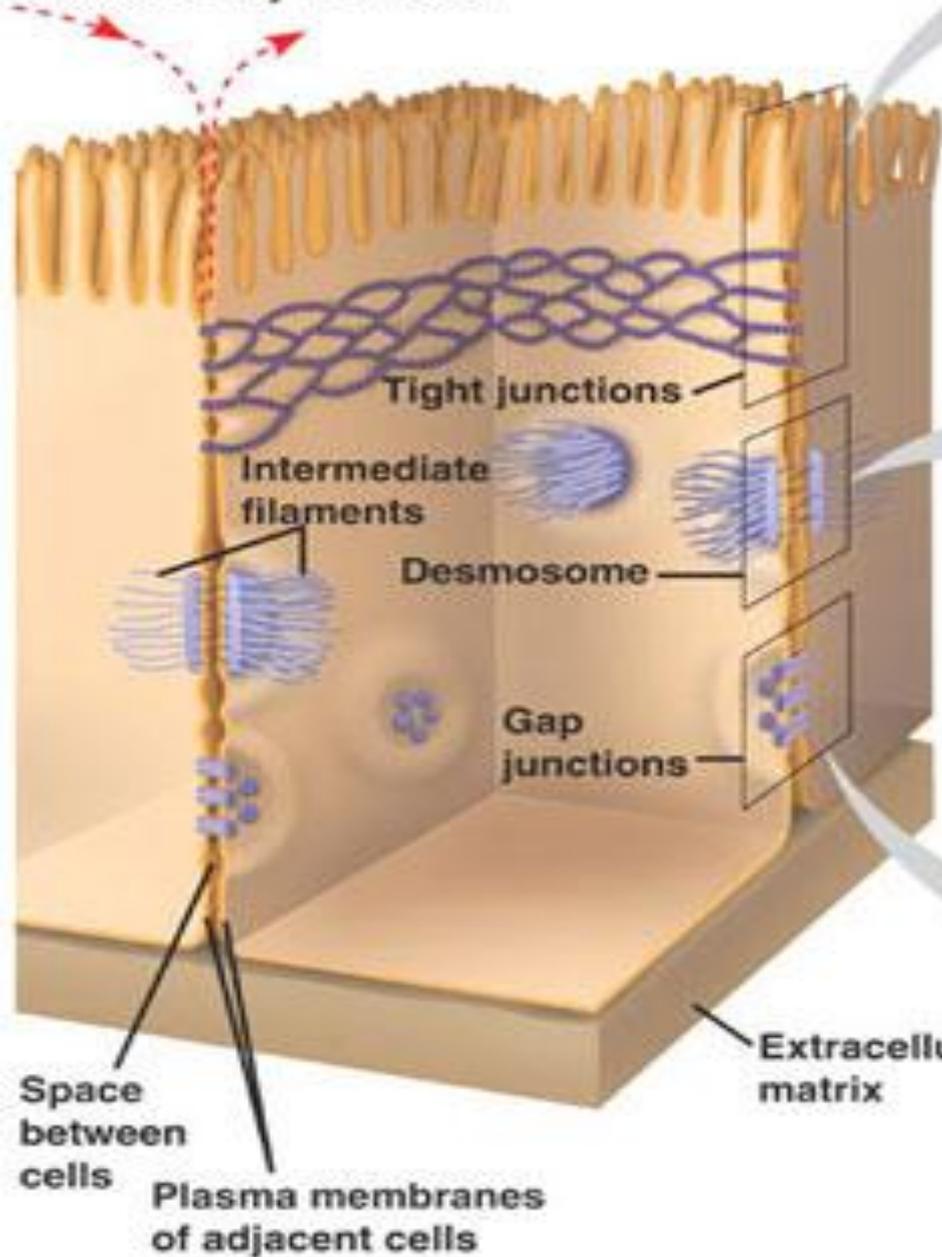
- Zonulae adherens
- Desmosomes
- Hemidesmosomes

3- **Communicating junctions**: Permit movement of molecules between the cells.

- Gap junctions:



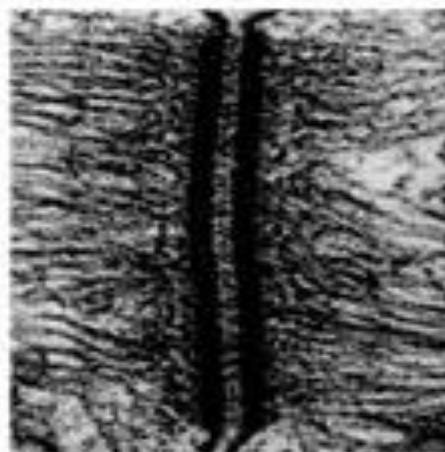
Tight junctions prevent fluid from moving across a layer of cells



Tight junction



0.5 μm



1 μm

Gap junction



0.1 μm

# C- Basal specializations

- **Basal lamina:** present between epithelial cells and C.T.
- **Visible:** only with E/M.
- **Basement membrane**

*formed of:*

- Two basal laminae
- Visible with L/M (PAS-positive).
- **Hemidesmosome**
- **Basal infoldings**

# Biology of Epithelial cells

As cells **differentiate**, they **acquire** morphologic and physiologic characteristics related to their functions.

## These are the basic epithelial cell types:

1. **Ion-transporting cells**
2. **Protein synthesizing cells**
3. **Mucus-secreting cells**
4. **Steroid secreting cells**
5. **Diffuse neuroendocrine system (DNES)**

# Ions transporting cells

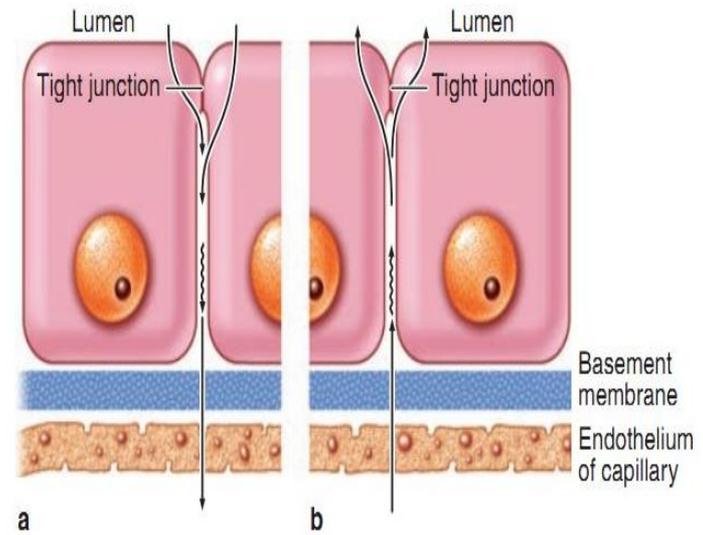
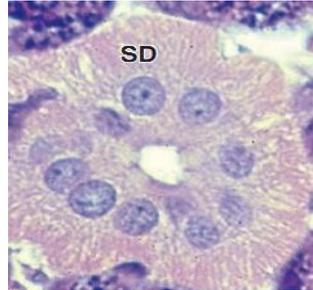
## Definition

-Epithelial cells able to transport certain ions against a concentration gradient (active transport) using ATP.

Transfer across the epithelium from the apex to the base by what is known as transcellular transport

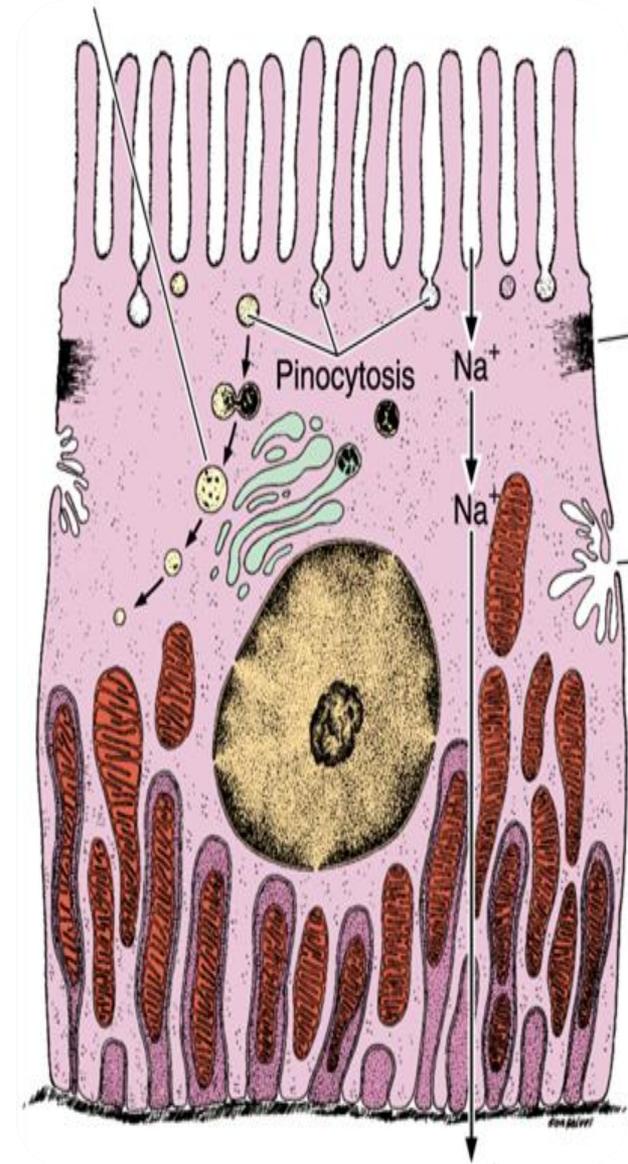
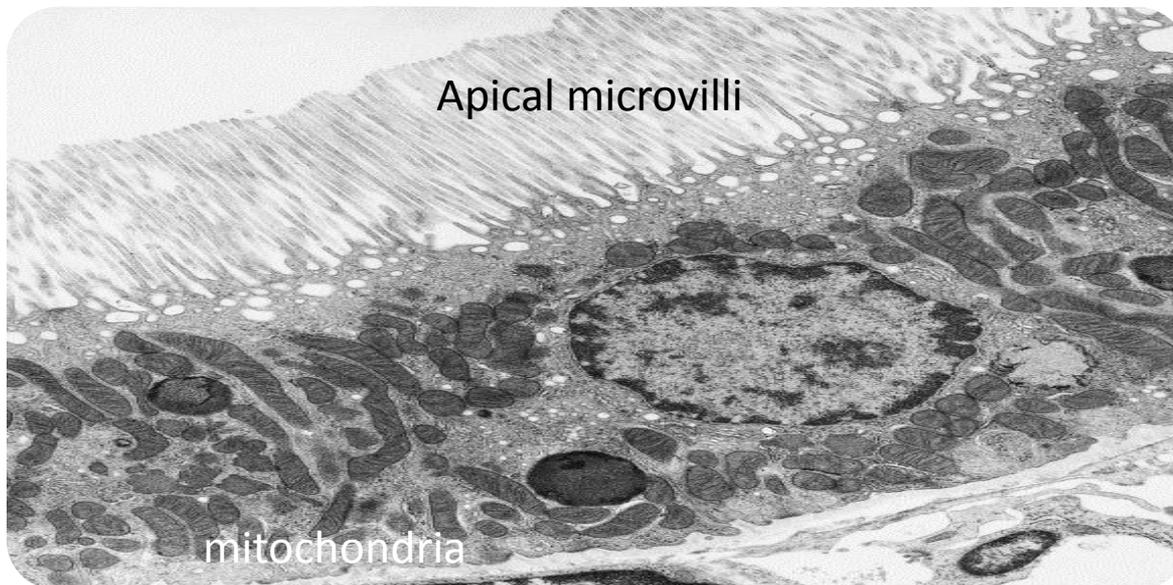
## Site(absorption sites):

- proximal and distal renal tubules
- striated ducts of salivary glands
- intestine
- gall bladder



## - *E/M*:

- **Apical** microvilli :increase surface area exposed for ions transport.
- **Apical** tight junctions: They are **impermeable** to ions, water and larger molecules, to **prevent back diffusion** of materials.
- **Basal** surfaces of these cells **have many long invaginations** with vertically oriented mitochondria (supply energy for **active transport**)
- **Lateral** membranes, there are **interdigitations** between the adjacent cells.



# Protein synthesizing cells

Sites: p<sub>arotid</sub> - p<sub>ancreas</sub>

acinar cells

LM

- Cells: pyramidal.
- Nucleus: **central** rounded.
- Apical Acidophilia (secretory granules).
- Basal Basophilia (RER).

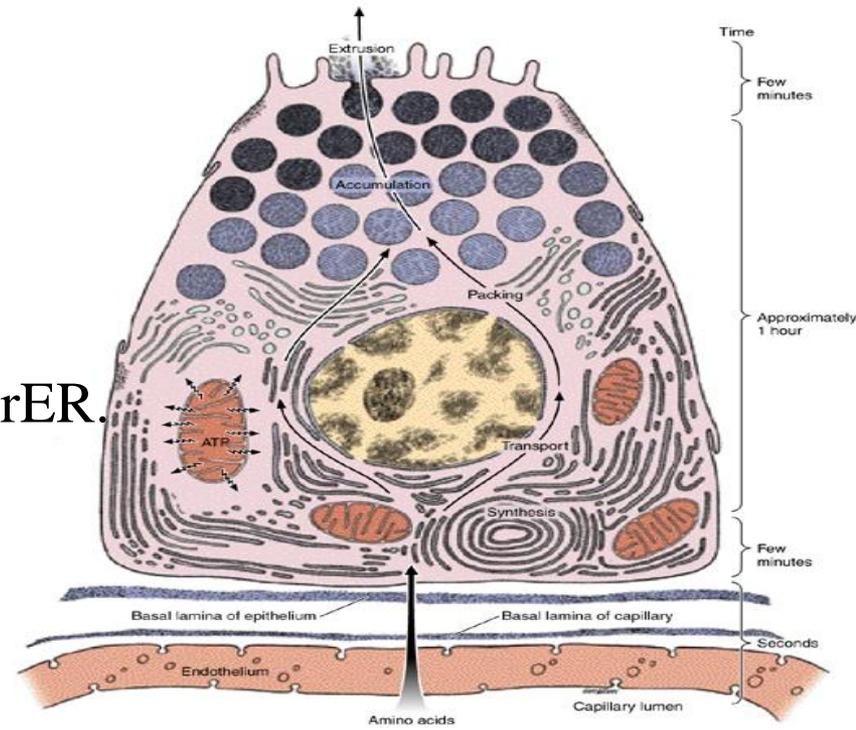
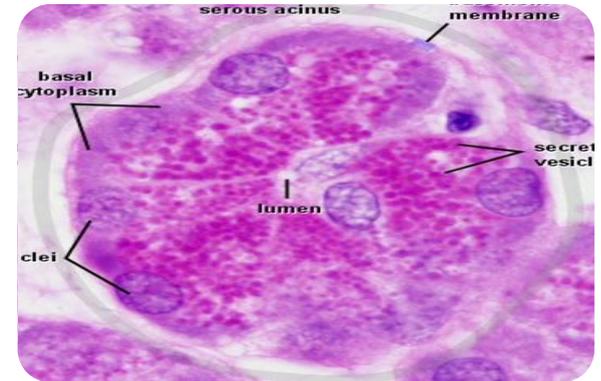
E/M

*In the basal region:*

- Infranuclear parallel arrays of rER
- Abundant ribosomes.
- Mitochondria are interspersed among rER.

*In the apical region:*

- Golgi complex supranuclear
- Secretory granules



# Mucus-secreting cells

## Sites:

- stomach
- salivary glands
- respiratory tract
- genital tract



-vary in the chemistry of their mucus secretions

-have different morphologic characteristics.

**Example:** Goblet cell

# Goblet cell

**L/M:**

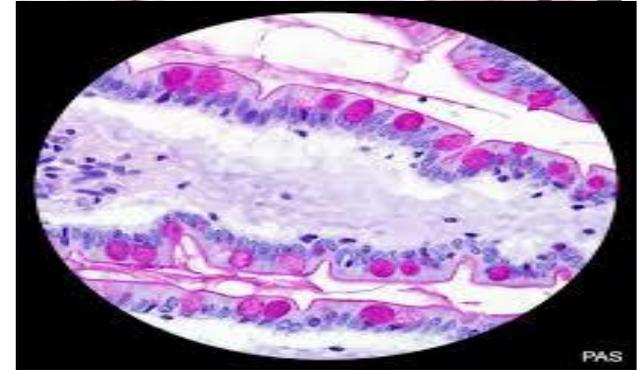
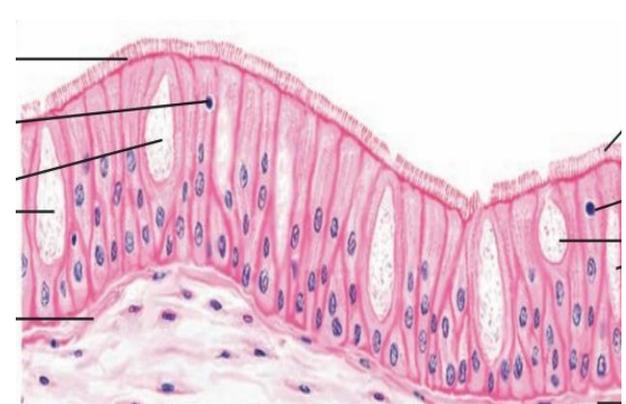
-**Apical part:** wide, contains pale, secretory granules (numerous, large and lightly stained).

-**Basal part:** narrow, contains nucleus

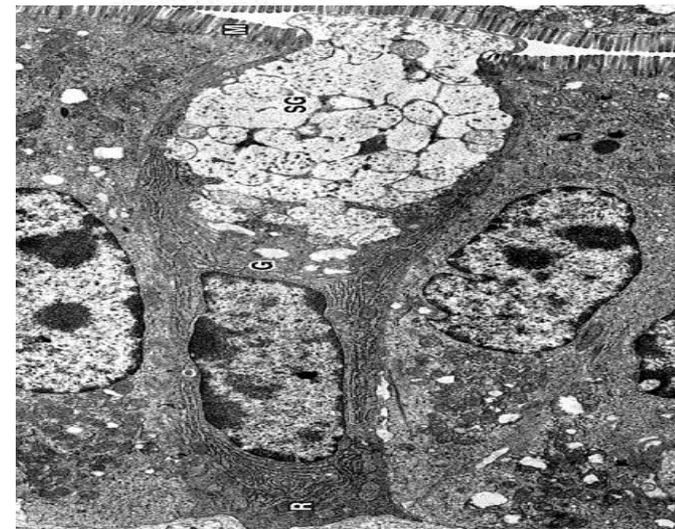
By **Periodic acid schiff (PAS)**: a **Special stain to see mucin**: appears magenta red

**E/M:**

- ❑ **Wide apical part** with multiple large pale stained secretory granules
- ❑ Supranuclear Golgi
- ❑ **Narrow Basal part** contains nucleus & RER.



A section of colon showing PAS-positive staining mucins



# Steroid secreting cells

They are **endocrine cells** that synthesize and secrete **steroids** with hormonal activity.

**Sites:** testes, ovaries and adrenal glands.

**L/M:** -cells are polyhedral in shape

-with **acidophilic** cytoplasm

-**central** nucleus.

-Rich in **lipid** droplets

**E/M:**

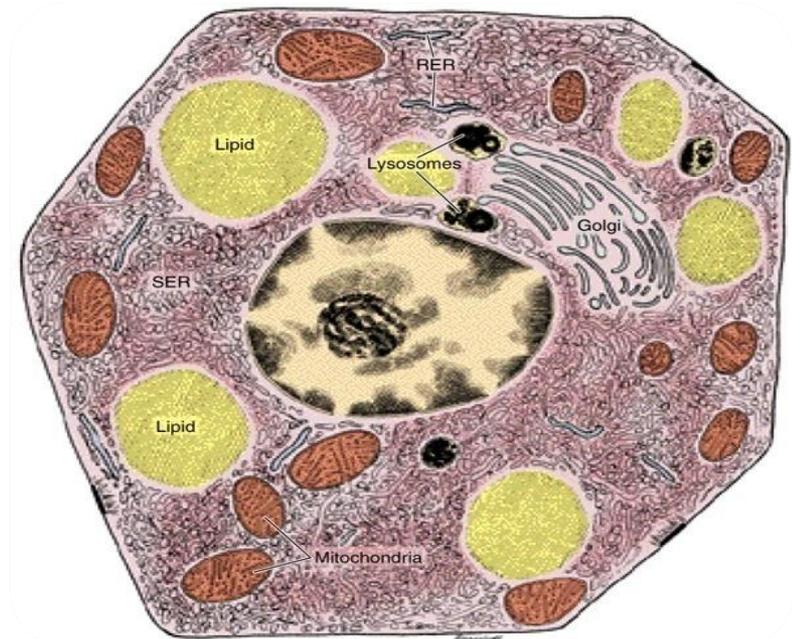
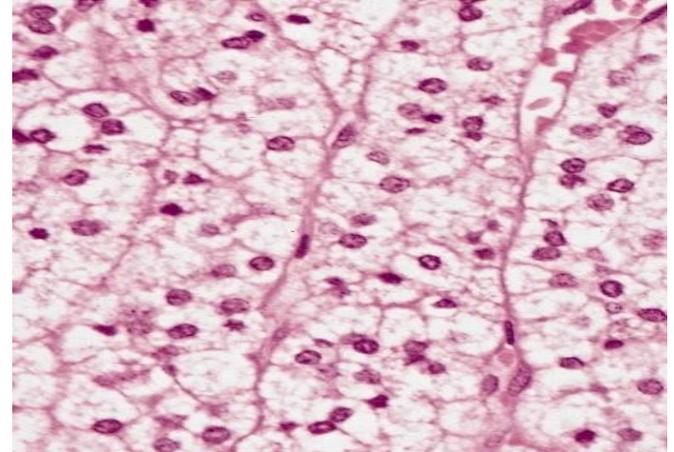
**Microvilli** on the surfaces facing blood capillaries

Rich in **SER**.

Rich in **lipid droplets**

mitochondria with **tubular cristae**

Golgi apparatus, lysosomes, and few RER



# Diffuse Neuroendocrine System (DNES)

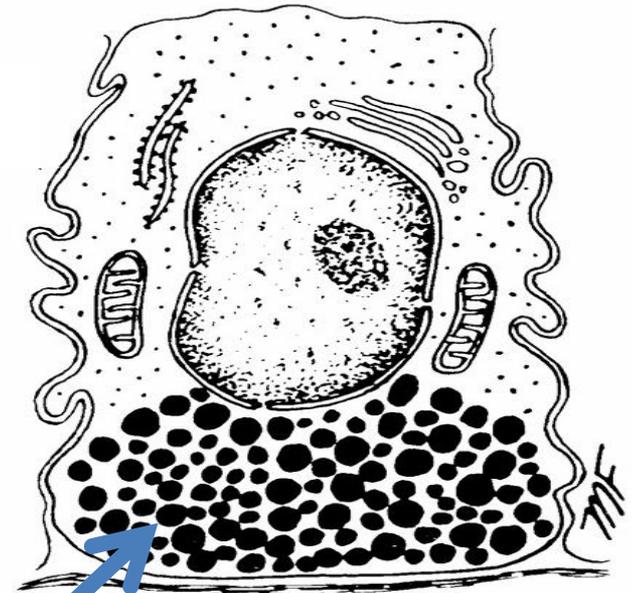
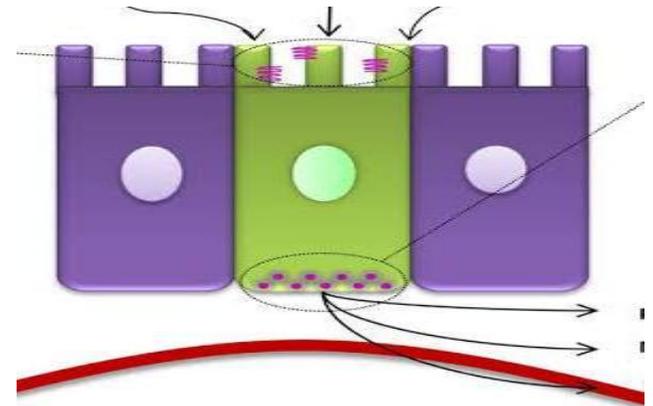
- ❑ Small granules-containing cells
- ❑ Exist **individually** or in small groups.
- ❑ **Endocrine cells** present among non-endocrine
- ❑ Cells synthesize & release **hormones** or **amine with hormonal activity**
- ❑ These hormones control many body functions

## ❑ **E/M**

- ❑ -Few RER.
- ❑ -Supra-nuclear Golgi.
- ❑ -**Basal secretory granules.**

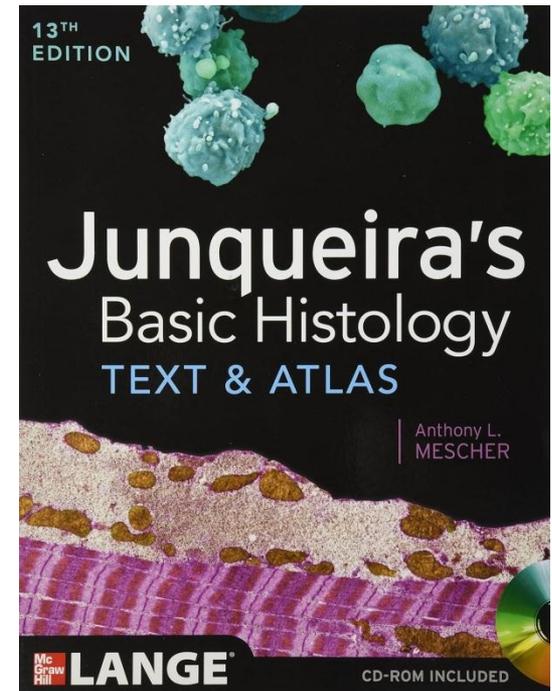
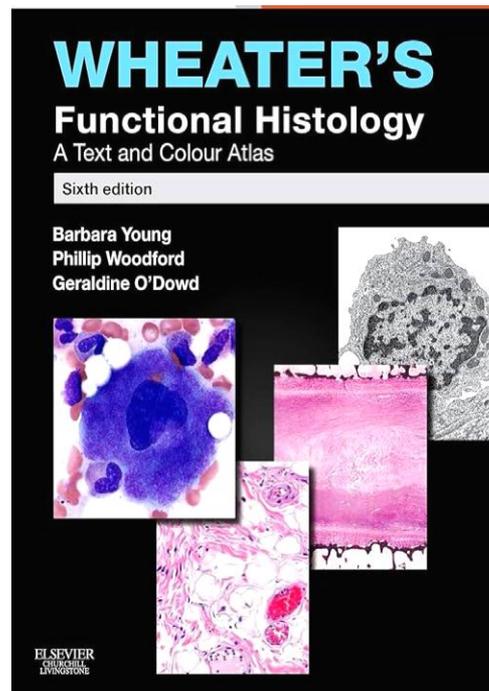
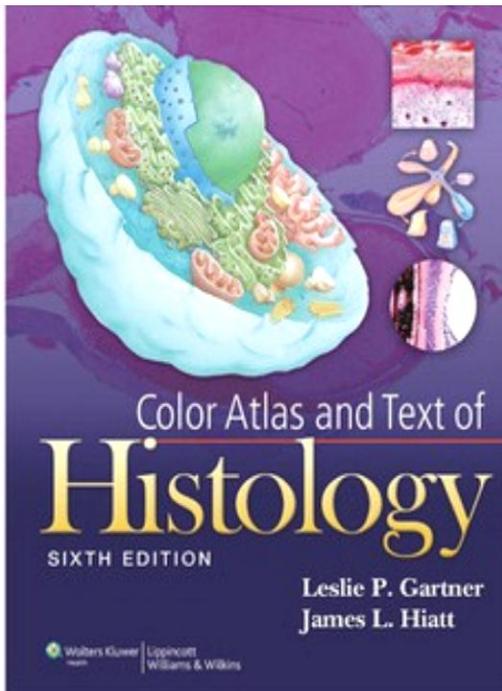
## ❑ **Sites (spread throughout the body)**

- Digestive system.
- Respiratory mucosa.



Basal secretory granules

# References



*Thank you*

