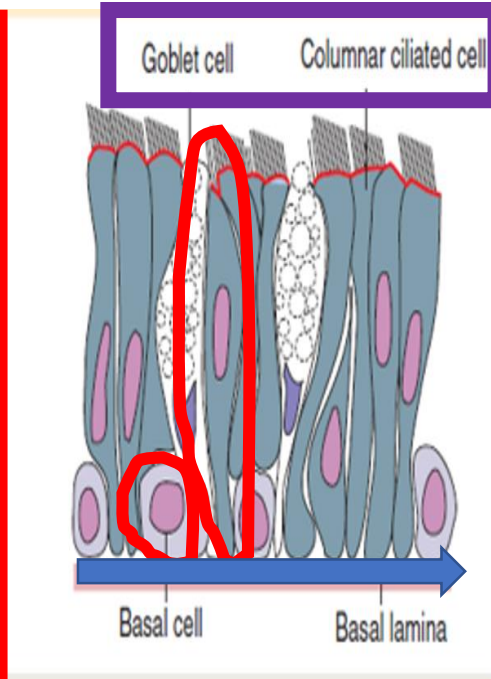
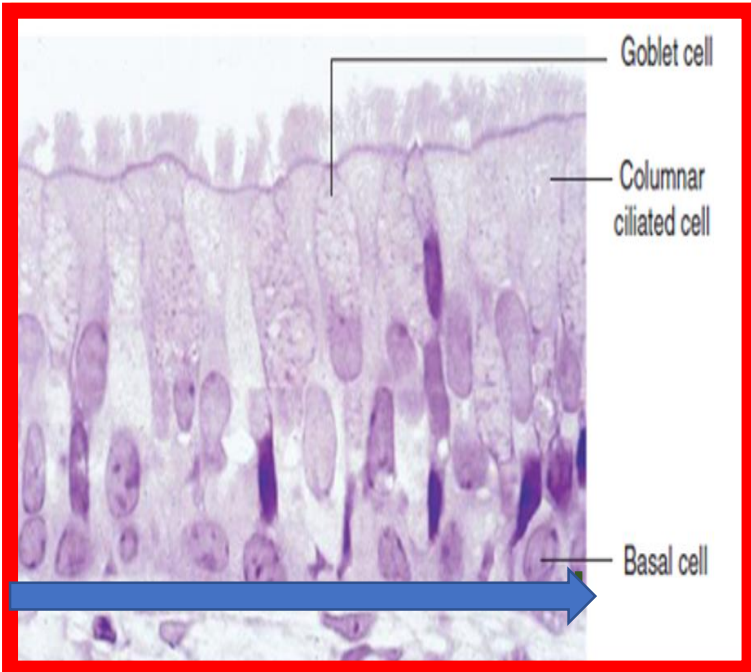


**TABLE 3-2** Epithelium

Types of Epithelia	Number of Layers	Type of Cells in the Epithelium	Apical Surface	Main Locations (Lining)	Main Functions
Simple squamous epithelium	One	Flattened, squamous epithelial cells	Smooth	Cornea, blood, and lymphatic vessels—endothelium; surface of body cavities—mesothelium (pleural, pericardial, peritoneal); alveoli in the lung	Fluid transport, lubrication, and exchange
Simple cuboidal epithelium	One	Cuboidal epithelial cells (height equal to width)	Smooth/short microvilli; long microvilli depending on location	Kidney tubules, thyroid follicles; small ducts of exocrine glands and surface of ovary	Absorption, secretion, and transportation
Simple columnar epithelium	One	Absorptive columnar cells and secretory cells, such as goblet cells	Mostly microvilli; cilia in some locations	Most of digestive tract and gallbladder; oviducts and ductuli efferentes	Secretion, absorption, protection, and transportation
Pseudostratified columnar epithelium	One	Ciliated columnar cells, goblet cells, and short basal cells not reaching lumen; all cells rest on the basement membrane	Mostly cilia; stereocilia in some locations	Most of respiratory tract; ductus deferens and epididymis	Secretion, transportation, and absorption
Stratified squamous epithelium	Several	Flattened surface cells, polygonal cells in the middle layers, and cuboidal cells in basal layer	Keratinized or nonkeratinized surface layer	Epidermis of the skin; oral cavity, epiglottis, and esophagus; vagina	Protection (barrier)
Stratified cuboidal epithelium	Two to three	Cuboidal cells	Mostly smooth	Large ducts of exocrine glands and ducts of sweat gland (not common type)	Transportation
Stratified columnar epithelium	Two to three	Low columnar surface cells and cuboidal basal cells	Smooth	Large ducts of exocrine glands; conjunctiva of the eye (not common type)	Transportation and protection
Transitional epithelium	Four to six layers (relaxed); two to three layers (distended)	Dome-shaped surface cells (relaxed), polygonal in the middle layer, cuboidal cells in the basal layer	Smooth	Urinary tract	Transportation and protection (distensible property)

# Pseudostratified columnar epithelium

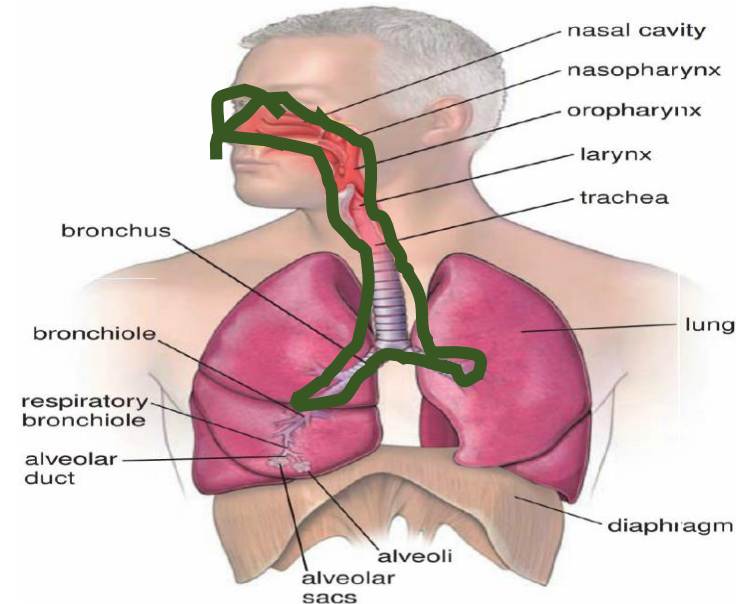
## Pseudostratified columnar ciliated with Goblet cell

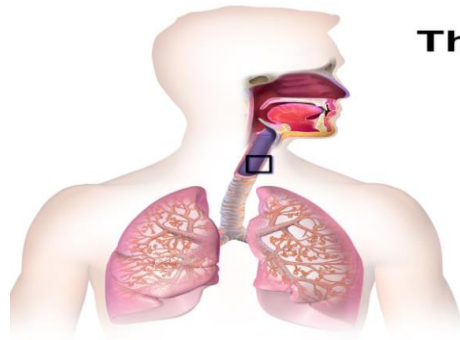


- ✓ In true sense, this is a **simple** epithelium
- ✓ **All cells** rests on the **basement membrane**
- ✓ This epithelium gives an **appearance of a multilayered**
- ✓ Due to **unequal height** and shape of cells

### Locations:

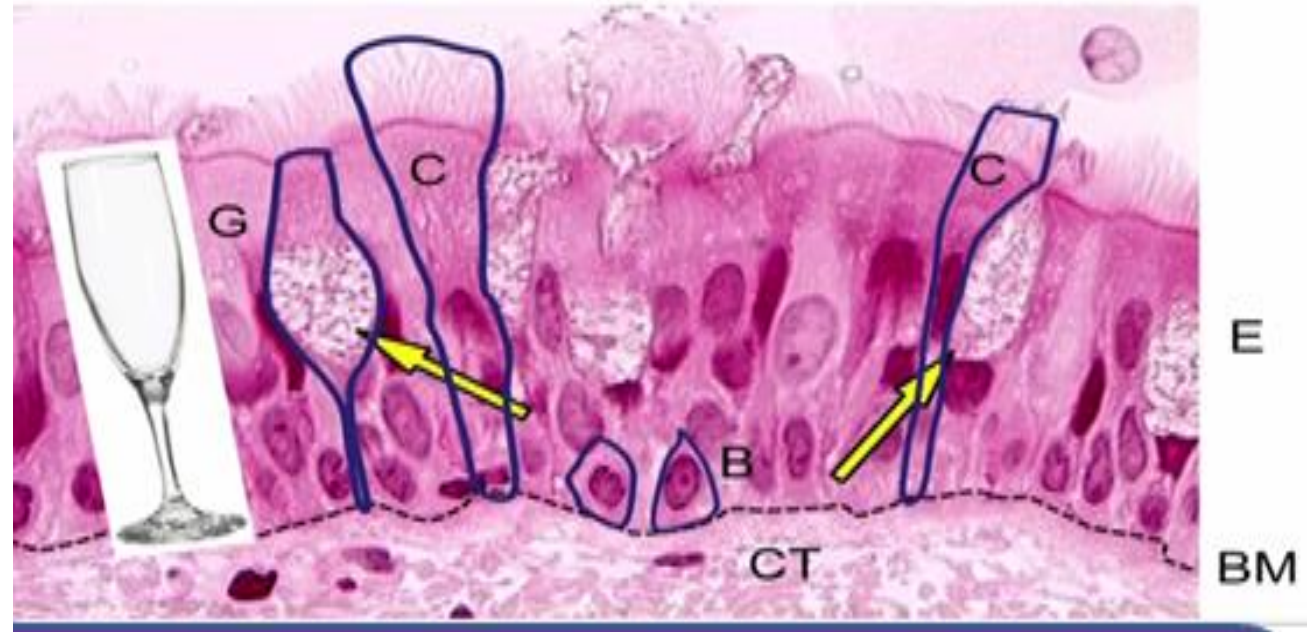
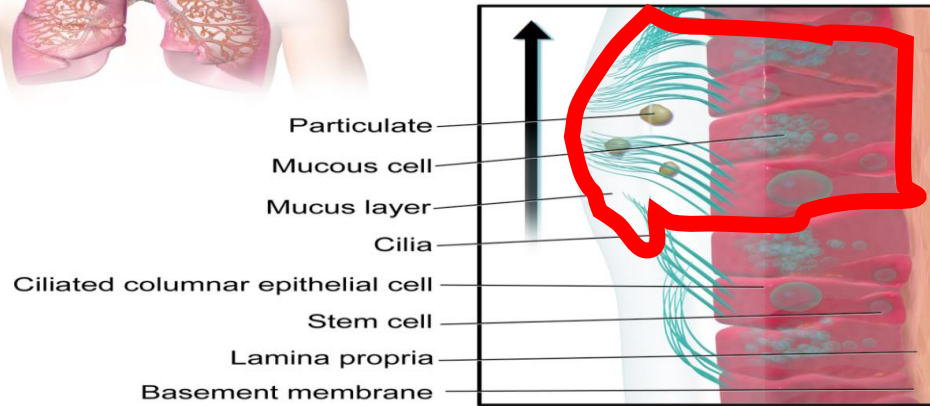
- ❖ **Nose, larynx, trachea and bronchial tree**
- ❖ **It is known as respiratory epithelium**
- ❖ **Respiratory Epithelium** has two major cell types:
  - **Columnar Ciliated cells + Goblet cells** form together **Respiratuar Mucociliary Activity.**





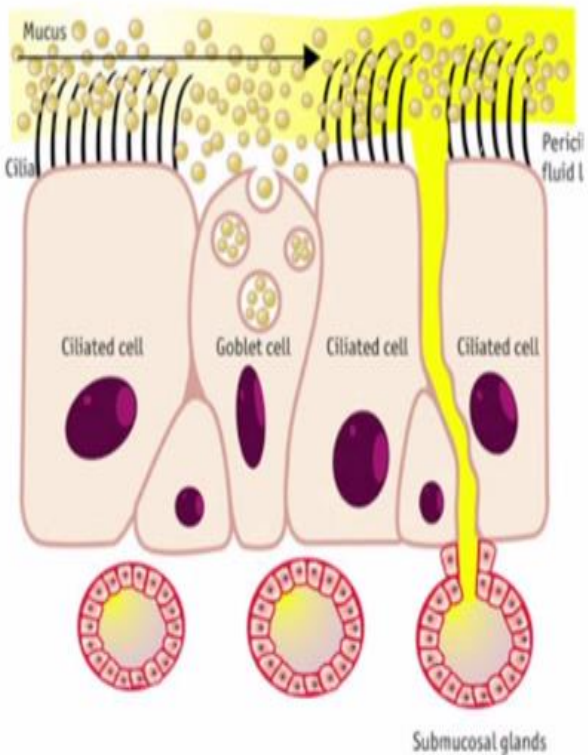
## The Respiratory Epithelium

Movement of mucus to the pharynx



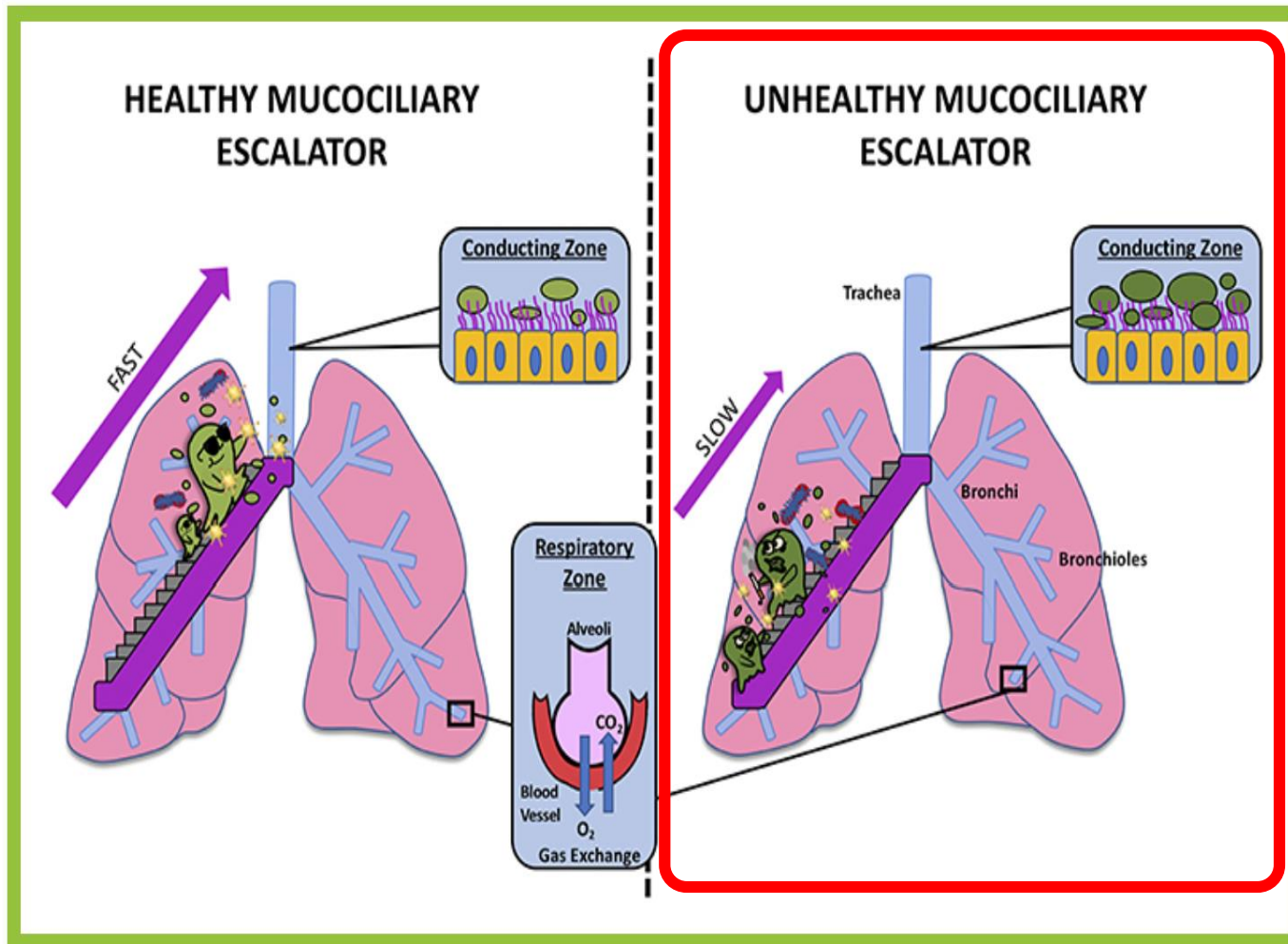
- 1. Ciliated columnar cells** are the most abundant, each with **250-300 very motile and active cilia** on its apical surface.
    - **Cilia beat at 1.000 to 1.500 cycles per minute** resulting in movement of the mucus blanket.
    - The direction of their beat is targeted towards the pharynx, either upwards from the lower respiratory tract or downwards from the nasal structures.
  - 2. Goblet Cells:** produce mucus. It contains:
    - 1. Mucin:** helps maintain epithelial moisture and traps particulate material and pathogens moving through the airway.
    - 2. Antimicrobial molecules** such as defensin, lysozyme and Ig A.
- \*\*\* Ciliated cells and Mucus,** together are responsible for very important **“Mucociliary clearance function”**.
- This function is also known as **mucociliary escalator or apparatus**.
  - The **mucociliary escalator** is our airways method of **keeping themselves swept clean of irritants and potential pathogens**.

**Mucociliary escalator:** starts in the bronchioles



<https://www.youtube.com/watch?v=c5P-c7rc4bA>

- **Mucociliary clearance (MCC), mucociliary transport, or the mucociliary escalator,** describes the **self-clearing mechanism of the airways in the respiratory system.**
- This mechanism is responsible for **movement of mucus up and out of the respiratory tract; mucus traps particles and cilia propel mucus up and out of the lungs.**
- It is the **vital and essential mechanism** for the lungs in **removing inhaled particles** including pathogens before they can reach the delicate tissue of the lungs.
- Mucociliary clearance has **a major role in pulmonary hygiene.**

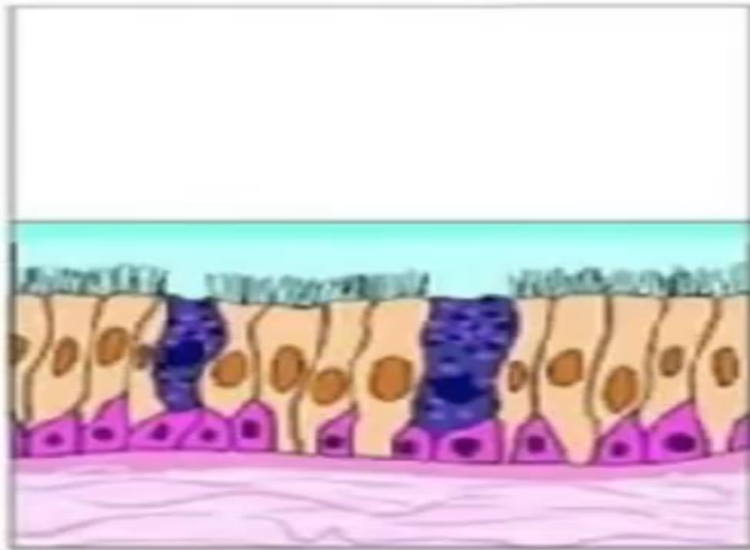


**The enemies of mucociliary activity:**

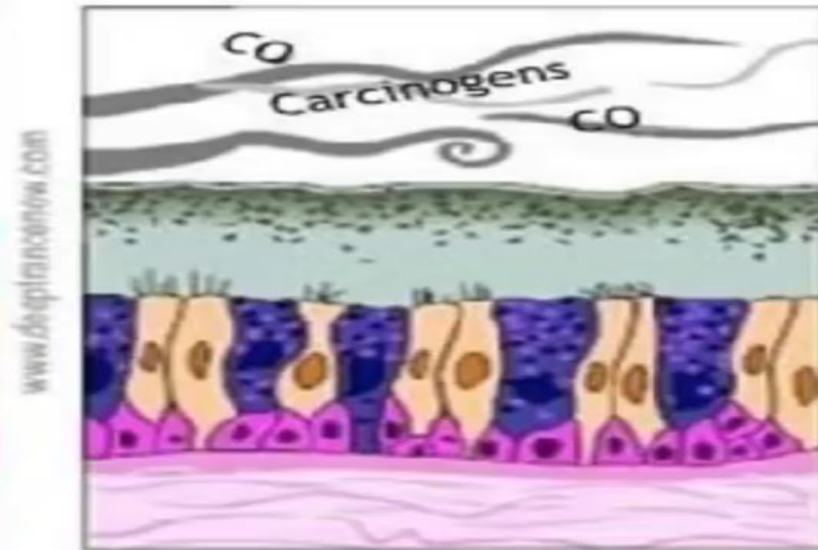
- Cigarette smoke, hypoxia, atmospheric pollutants
- Reduced clearance increases risk of infection and airway obstruction.

Figure 1 - The mucociliary escalator in a healthy person (left) and in a person with a diseased mucociliary escalator (right).

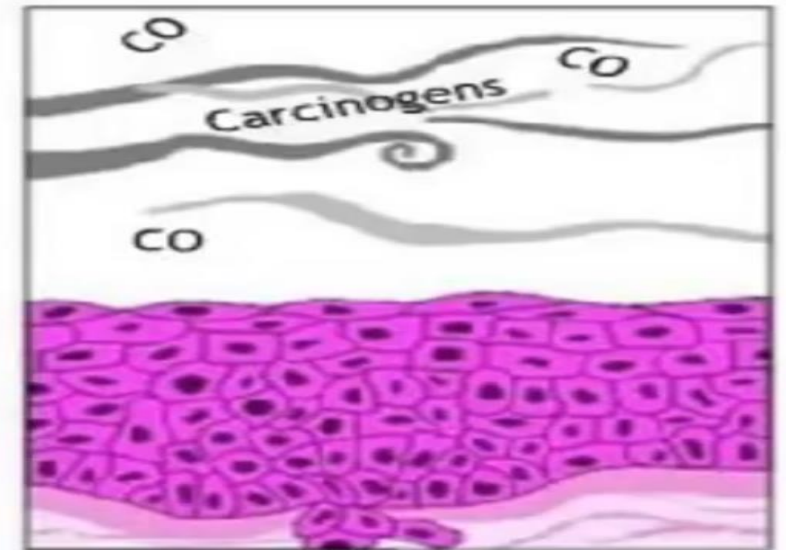
The mucociliary escalator is found in the trachea, bronchi, and bronchioles, which are part of the conducting zone. Gas exchange occurs in the alveoli in the respiratory zone (inset).



Normal Bronchial Epithelium



Smoker's Epithelium



Carcinoma

### Clinical Correlation: Squamous metaplasia, dysplasia and cancer in the Respiratory Tract

- Polluted air and cigarette lead to starting cancer process...
- The chronic presence or accumulation of toxins that occur with heavy cigarette smoking or industrial air pollution affects the respiratory epithelium beginning in the nasal cavities.
- Immobilization of the cilia causes failure to clear mucus containing filtered material and exacerbates the problem, leading eventually to the likelihood of squamous metaplasia of the epithelium.
- A change from pseudostratified ciliated columnar to stratified squamous epithelium can occur, particularly in the mucosa of bronchi.
- This can produce precancerous cell dysplasia and then cancer in this tissue.

**Layers**

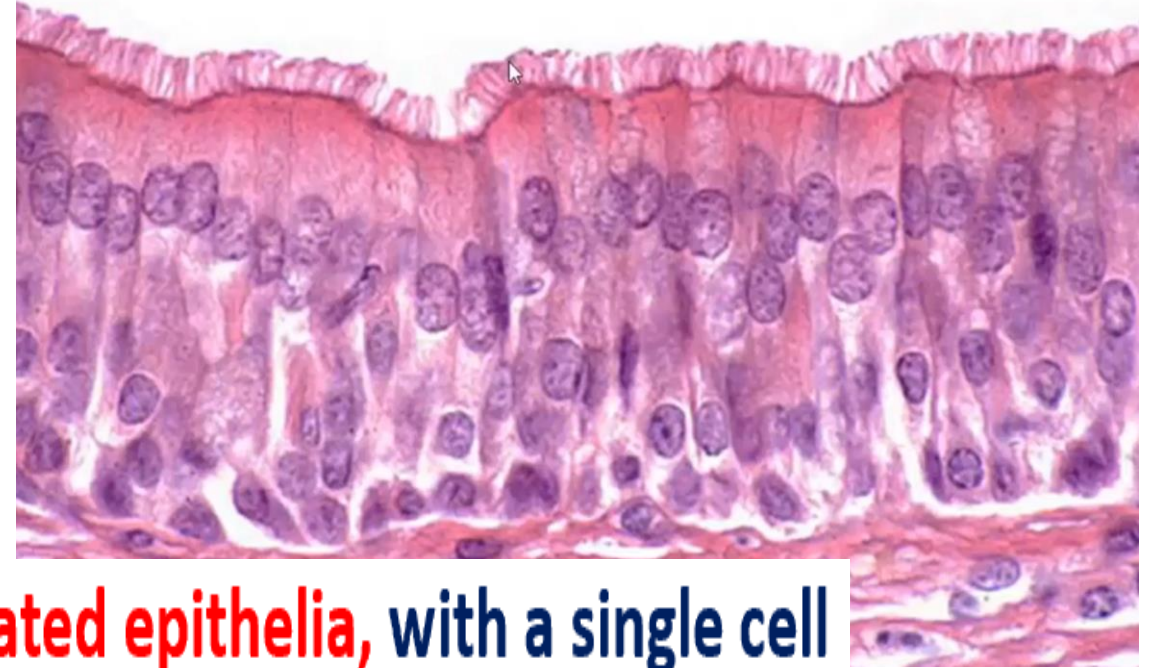
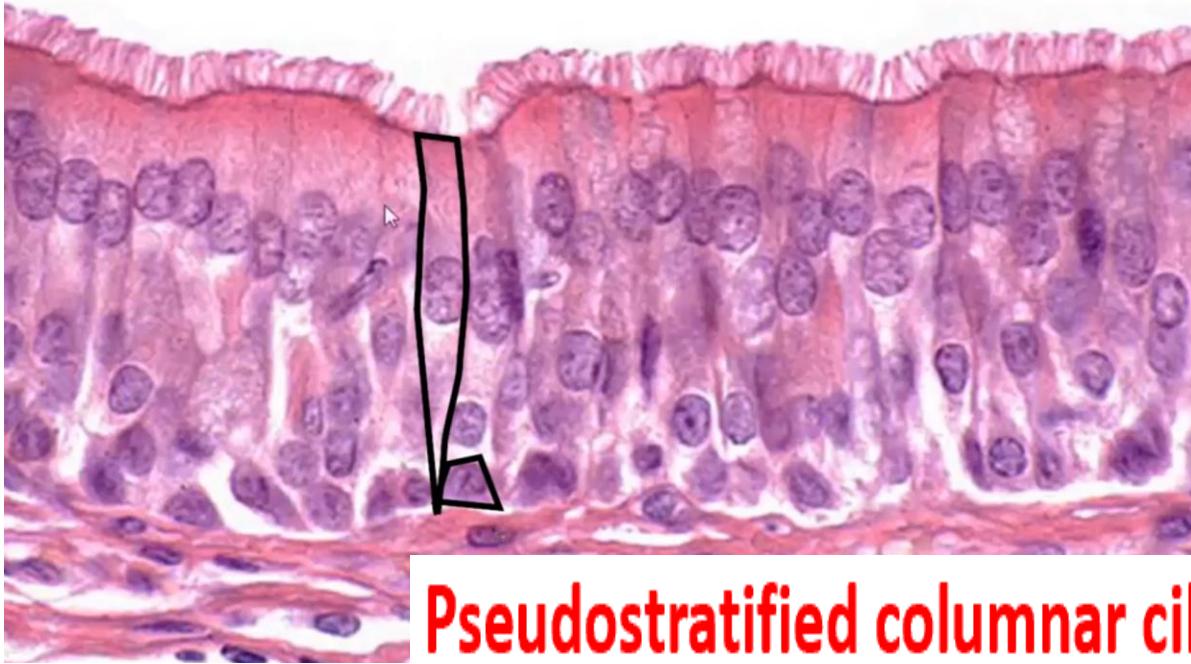
**Shape**

**Function**

**Pseudostratified**

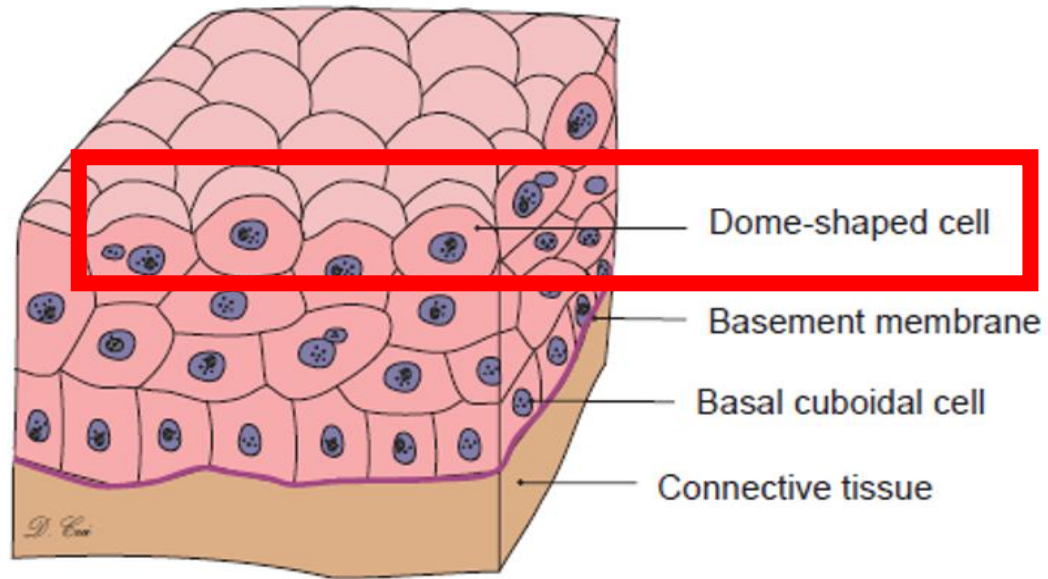
**Columnar**

**Protection**



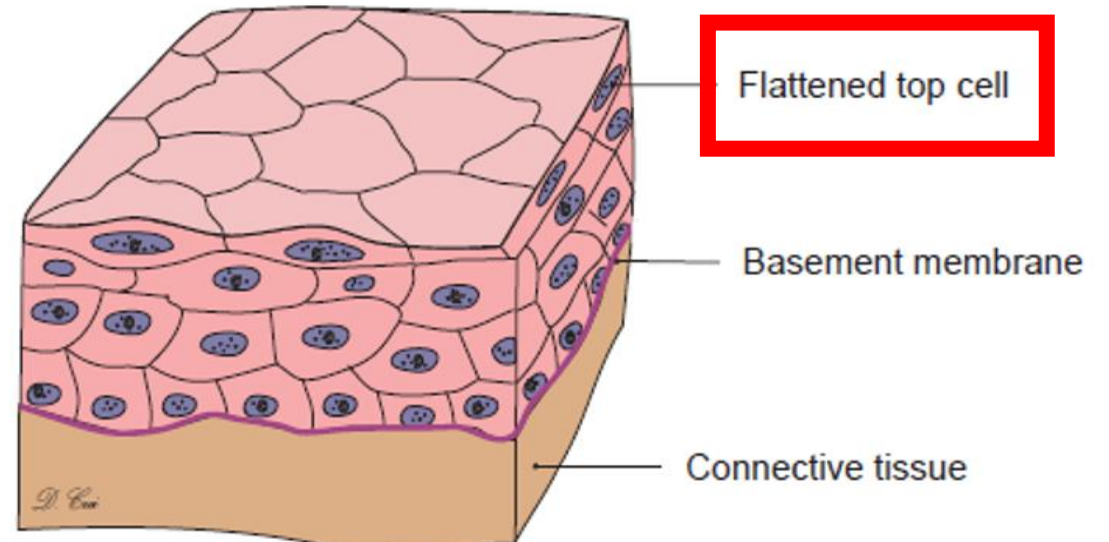
**Pseudostratified columnar ciliated epithelia, with a single cell layer on the basement membrane but containing cells of varying heights: Nasal cavity, larynx, trachea and bronchia**

## Transitional Epithelium (Urothelium)



### Transitional epithelium (relaxed urinary bladder)

- ✓ Epithelium is composed of 4-6 layers of cells
- ✓ The cells located in the **most superficial layer** are larger and exhibit a **dome shape** that bulges into the lumen (**Umbrella Cells**)

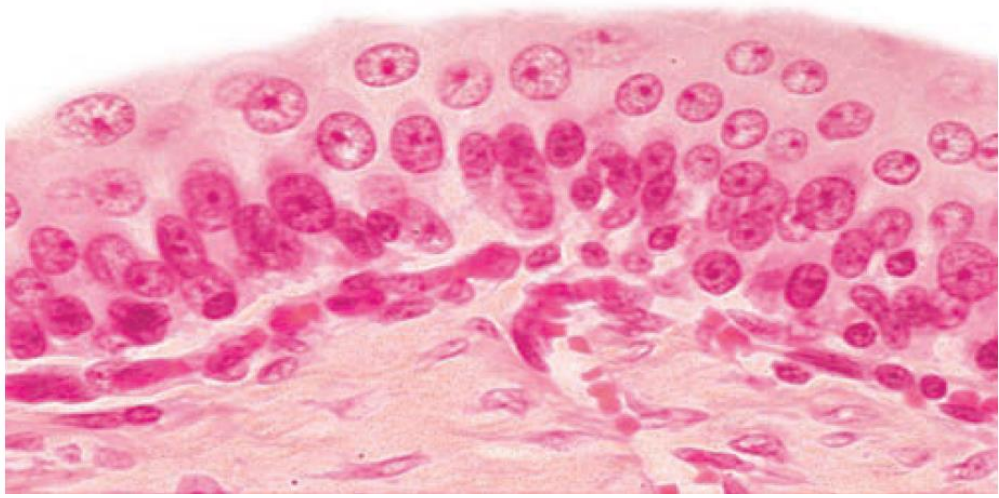
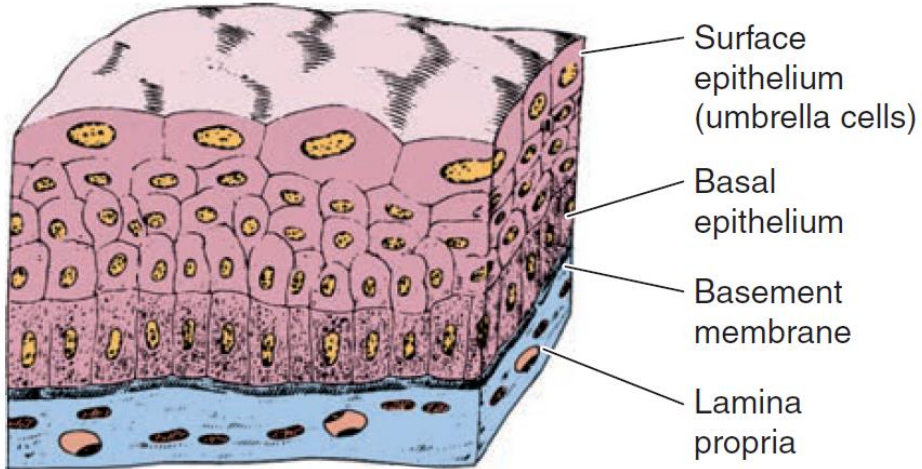


### Transitional epithelium (distended urinary bladder)

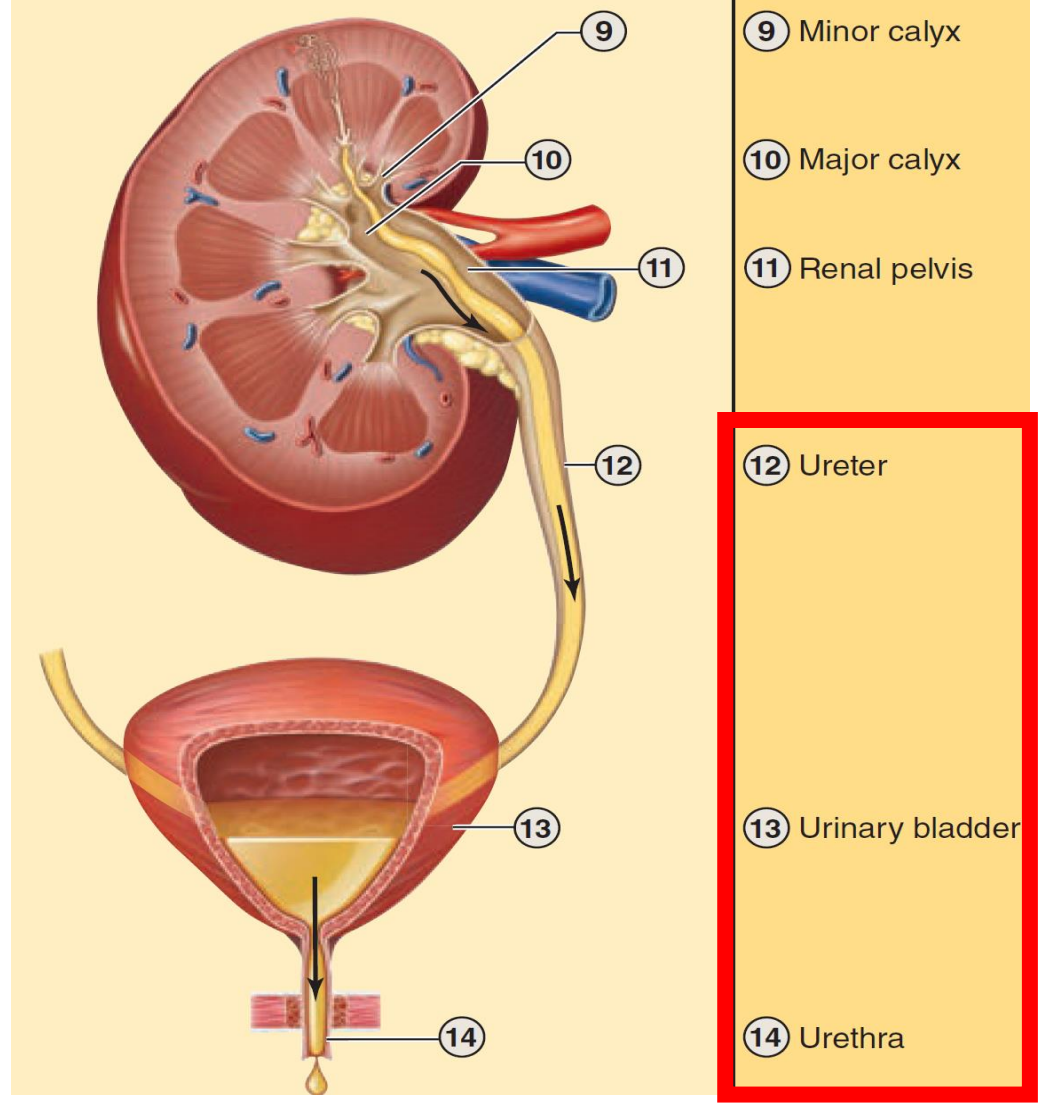
- ✓ This epithelium is specialized to **accommodate distension**.
- ✓ These cells change shape according to the degree of distention of the bladder.
- ✓ When the transitional epithelium is **stretched**, the top dome-shaped cells **become flattened cells** and the epithelium becomes thinner.



**FIGURE 4-16** Transitional epithelium or urothelium.



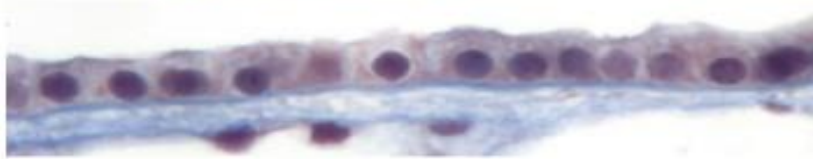
# Locations



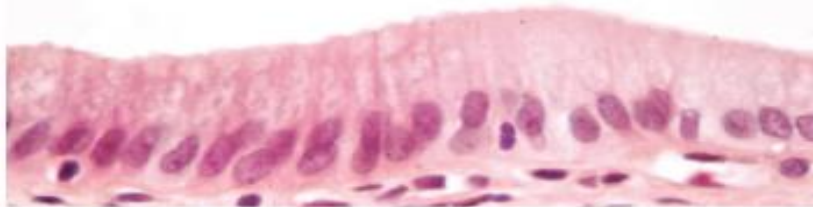
What types of epithelia are shown here?



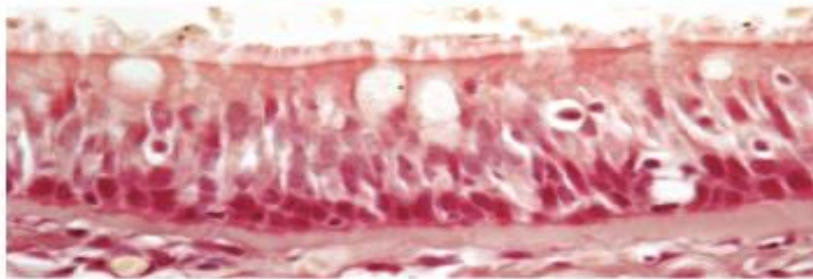
1



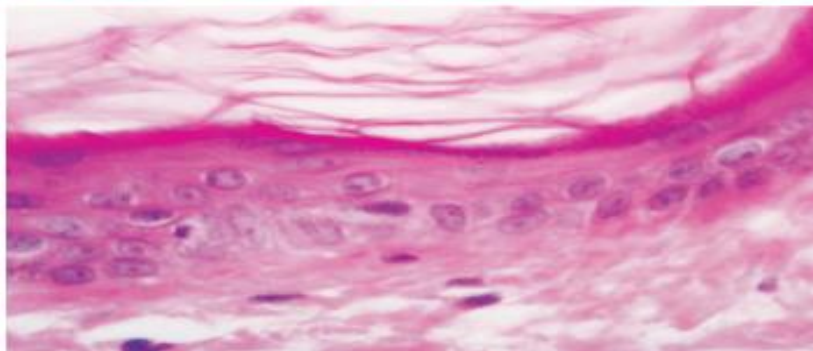
2



3



4



5

1. **Simple squamous epithelia**, with one layer of flattened cells: Endothelium, mesothelium, bowman's capsule, alveol (rapid exchange)
2. **Simple cuboidal epithelia**, with one layer of roughly cube-shaped cells: Many ducts of glands, thyroid follicles, ovary epithelium, retinal pigment epithelium, kidney tubules
3. **Simple columnar epithelia**, with one layer of tall cells: Stomach, intestines and gallbladder (non-ciliated), uterine tubes and uterus (ciliated)
4. **Pseudostratified columnar ciliated epithelia**, with a single cell layer on the basement membrane but containing cells of varying heights: Nose, Trachea and bronchia
5. **Stratified squamous keratinized epithelium**: have multiple layers, with cells becoming keratinized: Epidermis of the skin, hard palate and gingiva

# Two Types of Epithelial Tissues

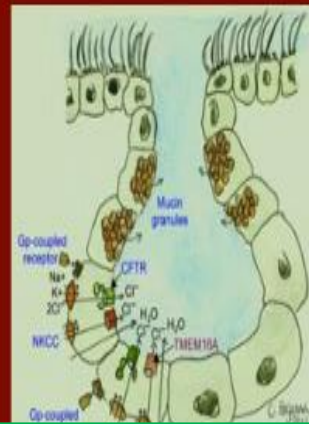
## Covering/lining Epithelium

- covers the outside surfaces of the body and lines internal organs.



## Glandular Epithelium

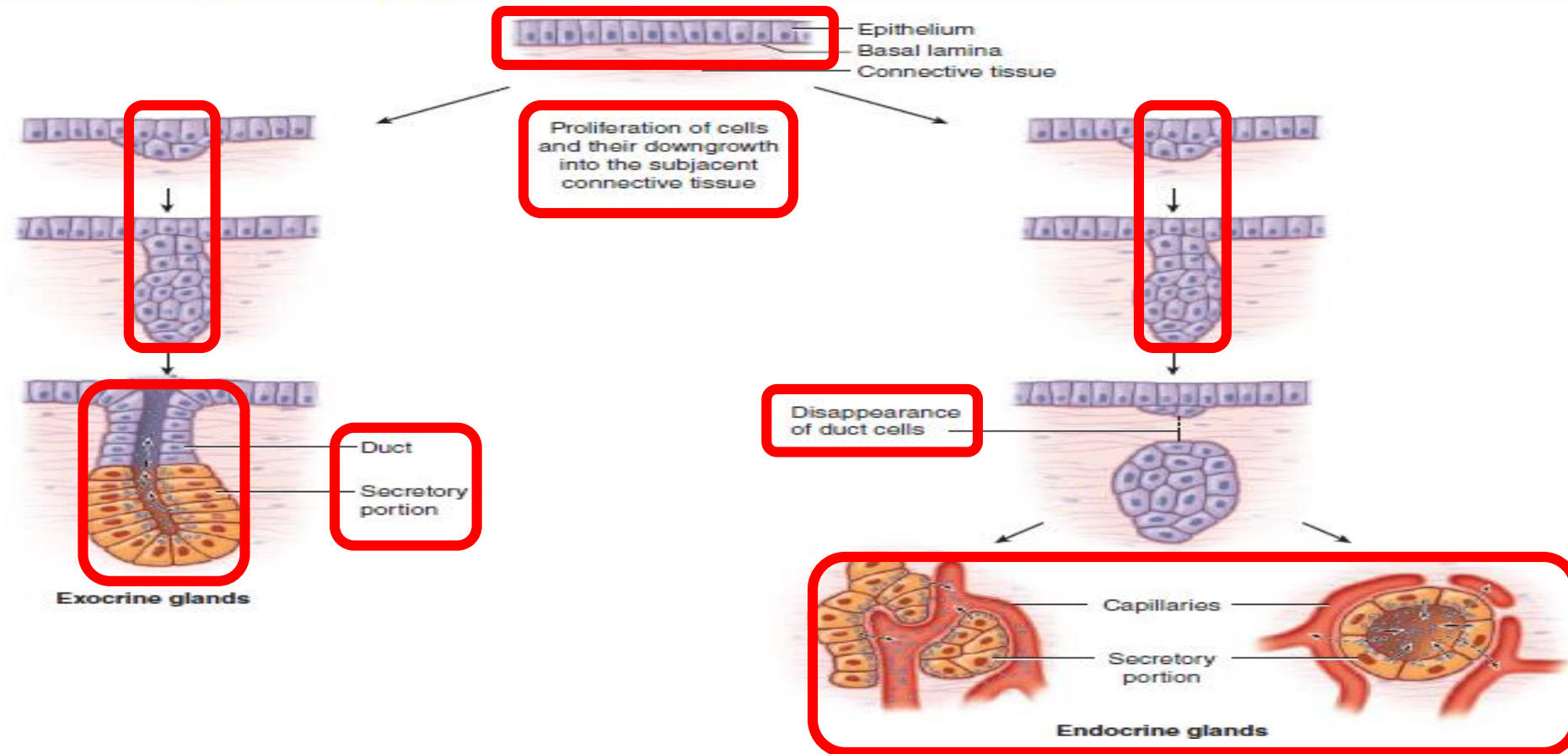
- secretes hormones or other products (mucous, milk).
  - Consists of one or many cells



## Learning Outcomes

- I) Formation of the Glands and general microscopic design
- II) How we can classify exocrine glands
- III) Unicellular intraepithelial gland: Goblet Cell
- IV) Serous, mucous and mixed-seromucous glands

FIGURE 4-19 Formation of glands from covering epithella.



### Formation of the Glandular epithelium

- ✓ During fetal life, covering epithelial cells **proliferate and downgrowth** into the **underlying connective tissue**.
- ✓ They further **differentiate** into **exocrine and endocrine glands**.
- **Exocrine glands** retain their connection with the surface epithelium with a **duct**
- **Endocrine glands** lose the connection to their original epithelium and therefore **lack ducts (ductless glands)**
- ❖ **Exocrine glands** are **salivary glands, sweat and sebaceous glands, lacrimal, goblet, stomach and intestinal glands**
- ❖ **Endocrine glands** are **thyroid, hypophysis, parathyroid and adrenal glands**

## Exocrine Glands

Maintain contact with the body surface by a duct (epithelial tube that directs secretions to the surface)

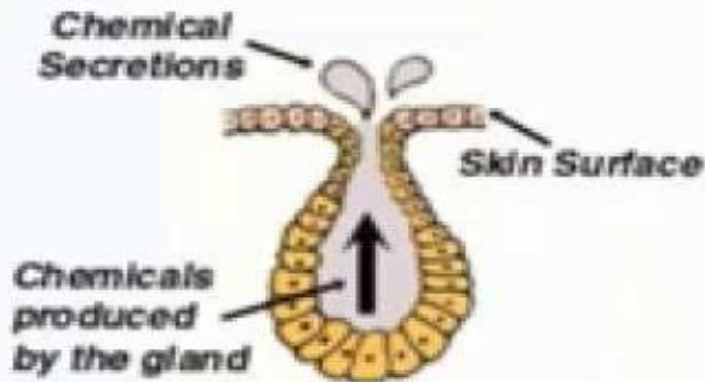
Examples: tear glands, sweat glands, and mammary glands

## Endocrine Glands

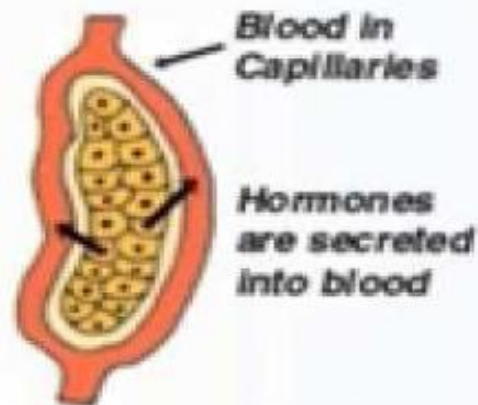
Do not have contact with the body surface or cavities which lead to the "outside"

**Have no ducts**

**Secrete hormones directly into the blood**

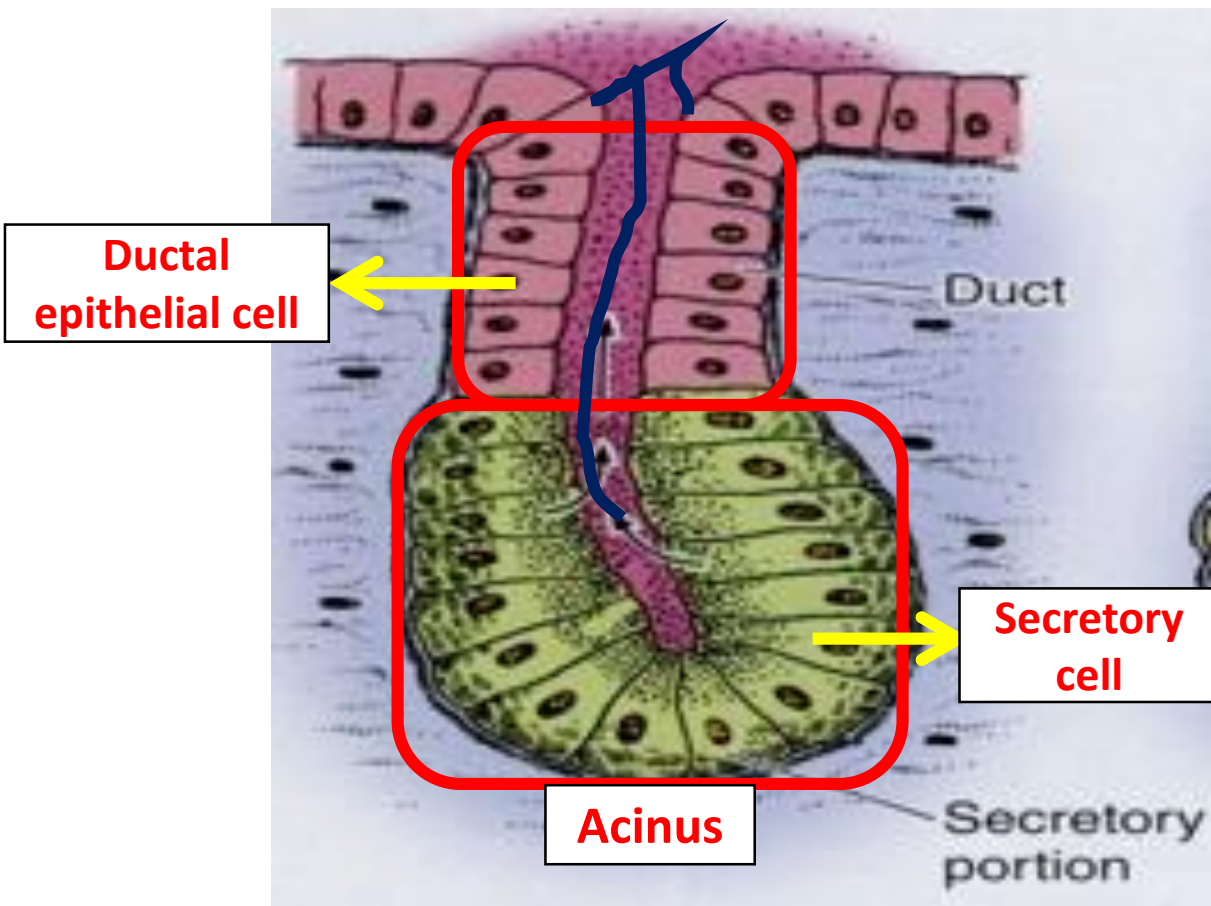


*Exocrine Gland*



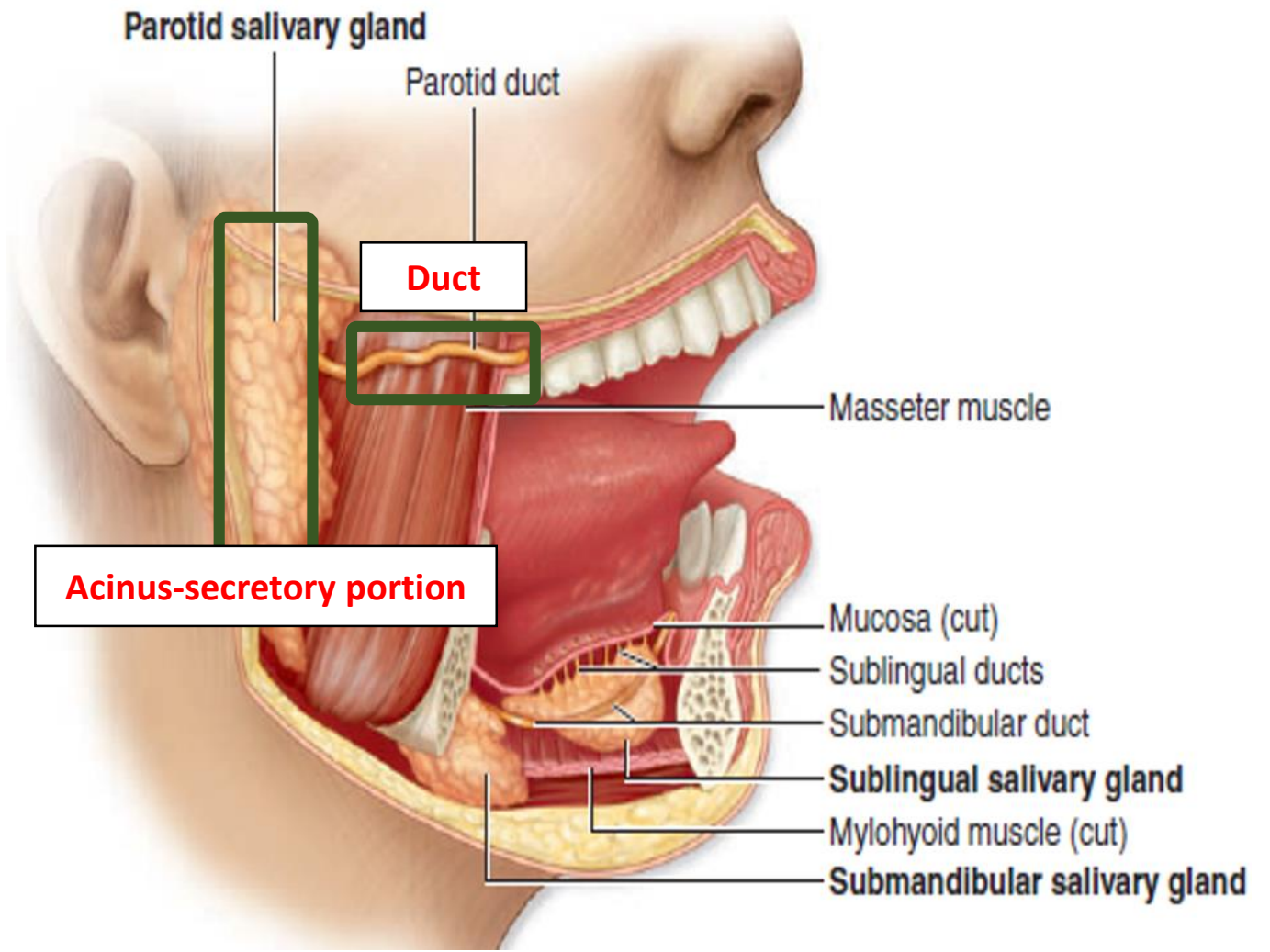
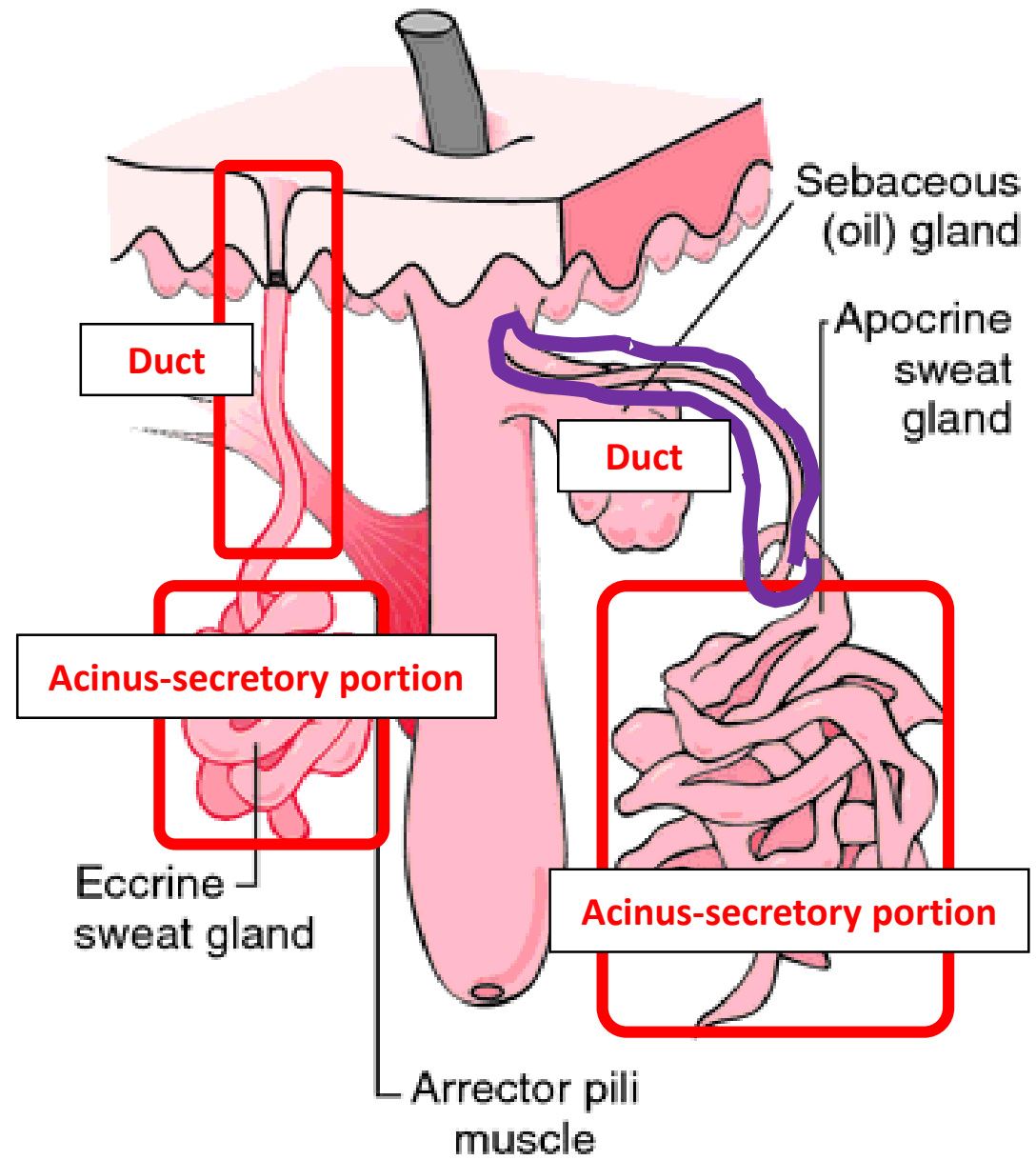
*Endocrine Gland*

Liver, gonads, and the pancreas have endocrine and exocrine functions



- ✓ Exocrine gland consists of secretory portion and duct
- ✓ Secretory portion is also called Acinus and is made up many secretory cells
- ✓ These secretory cells produce and secrete special secretory molecules (Saliva, tears, mucus, oil, sweat)
- ✓ Ducts are composed of ductal epithelial cells
- ✓ Exocrine glands secrete their products onto a surface or a lumen through epithelial ducts

**FIGURE 16-1** Major salivary glands.



**How can we classify exocrine glands?**



**Exocrine glands can be classified into several categories:**

**I) Depending on Number of Cells:**

- Unicellular and multicellular glands
- **Goblet cell** is known as **unicellular intraepithelial gland**
- All other exocrine glands are **multicellular glands**

**II) Depending on what type of secretion is produced:**

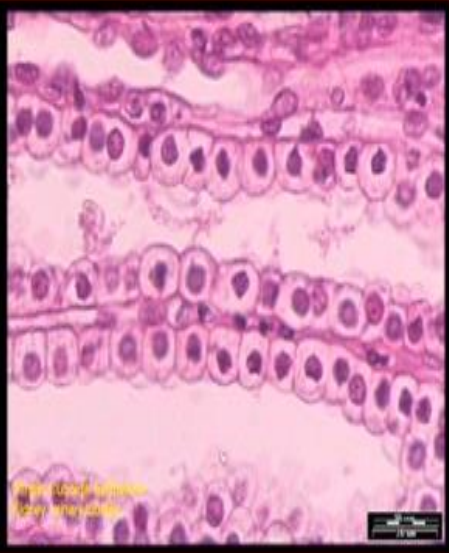
- Serous glands, mucous glands, mixed glands (seromucous)



# Two Types of Epithelial Tissues

## Covering/lining Epithelium

- covers the outside surfaces of the body and lines internal organs.



## Glandular Epithelium

- secretes hormones or other products (mucous, milk).
  - Consists of one or many cells



## Learning Outcomes

- I) Formation of the Glands and general microscopic design
- II) How we can classify exocrine glands
- III) Unicellular intraepithelial gland: Goblet Cell
- IV) Serous, mucous and mixed-seromucous glands

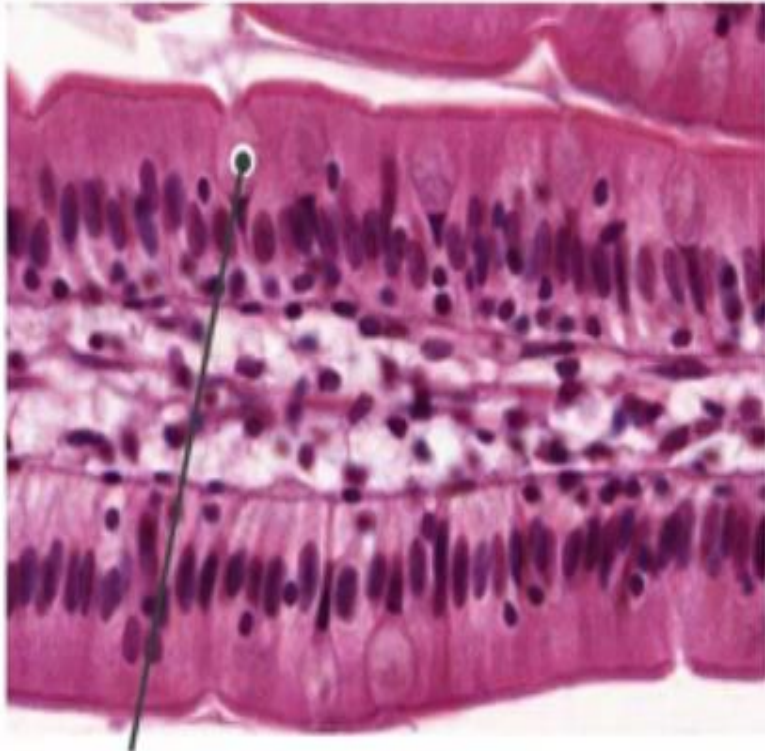
## Exocrine glands

### Classification

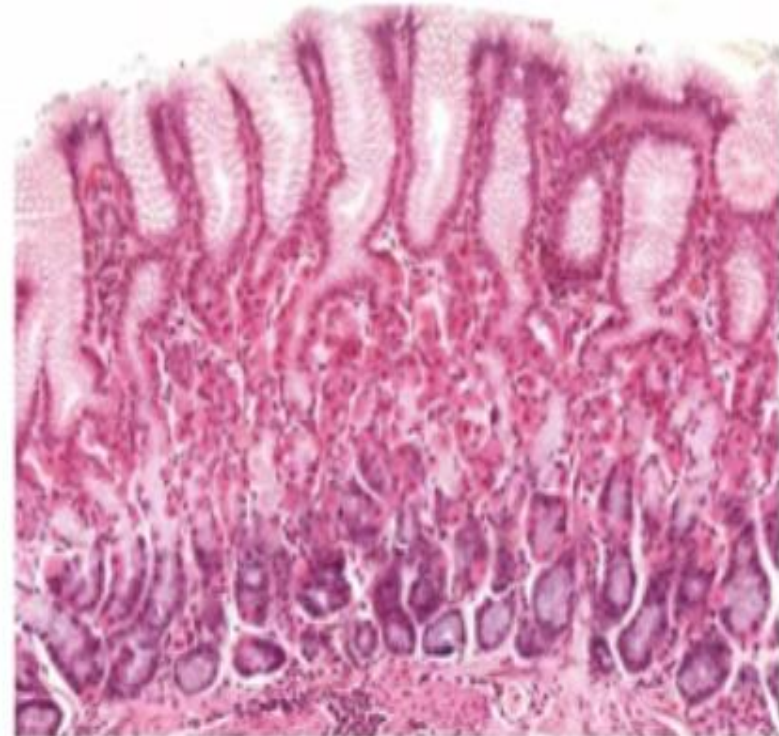
**Unicellular:** (e.g., goblet cell) have only one secretory cell type

**Multicellular:**\* (e.g., stomach mucosa) may have more than one secretory cell type

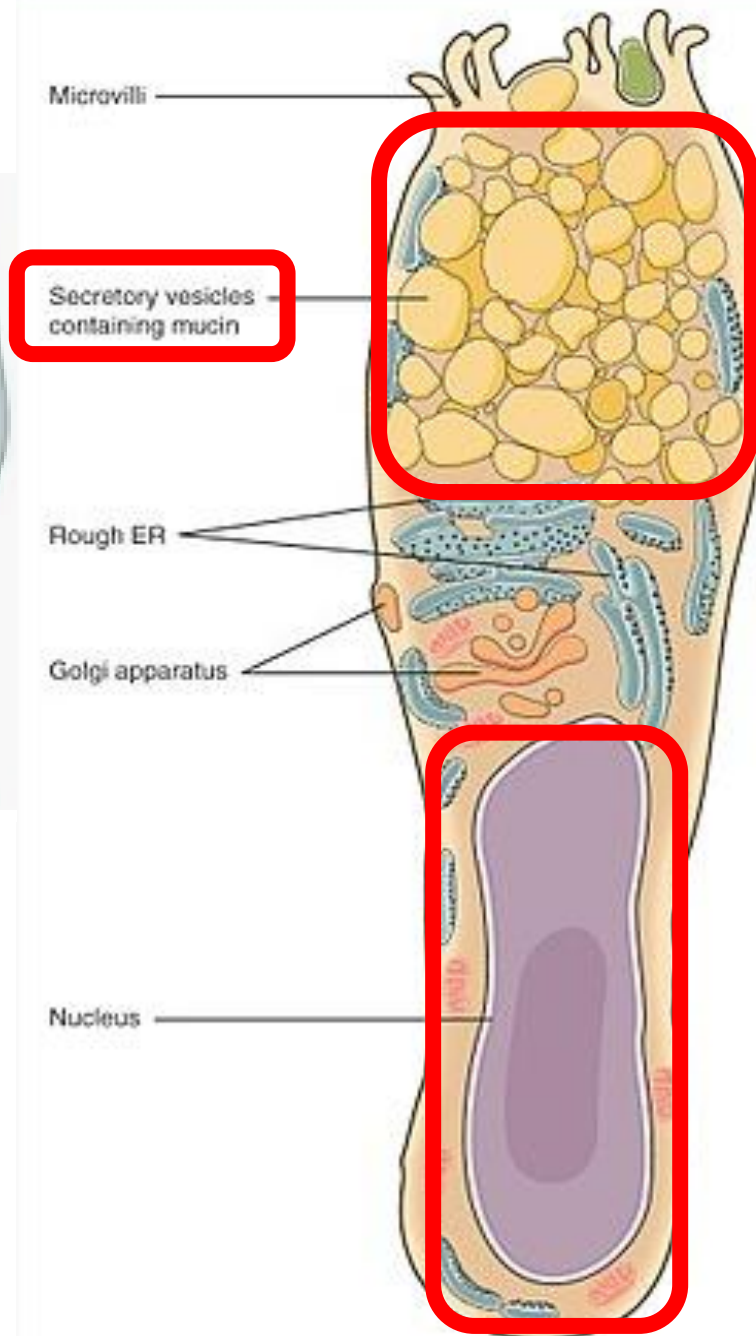
\*have more complex arrangements



Goblet cell



## Goblet cell



What does “**Goblet**” mean and its function??

- The term *goblet* refers to the cell's **goblet-like shape**.
- The **apical portion** is shaped **like a bowl**, as it is distended by **abundant mucus granules**;
- its **basal portion** lacks these granules and is shaped **like a stem (nucleus is here)**.

**Goblet Cells** produce mucus. It contains:

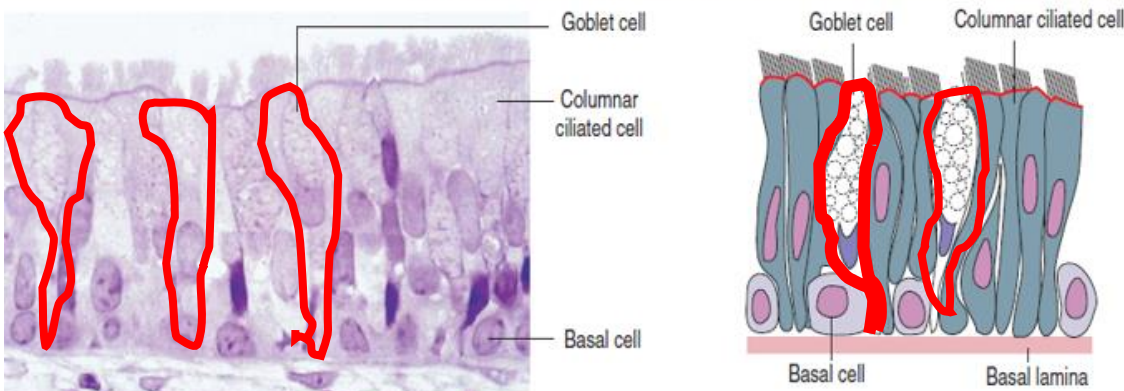
**1. Mucin:** helps maintain epithelial moisture and traps particulate material and pathogens moving through the airway.

**2. Antimicrobial molecules** such as defensin, lysozyme and Ig A.

**\*\*\* Ciliated cells and Mucus**, together are responsible for very important “**Mucociliary clearance function**”.

# Goblet cells are commonly inserted into an epithelium among the other epithelial cells

Figure 1-4. Pseudostratified epithelia



## Pseudostratified columnar ciliated epithelium (trachea)

This epithelium consists of three major cell types: (1) **Columnar cells** with **cilia** on their apical domain. (2) **Basal cells** anchored

to the basal lamina. (3) **Goblet cells**, mucus-secreting epithelial cells. Columnar ciliated and goblet cells attach to the basal lamina and reach the lumen. Basal cells do not reach the lumen.

- Goblet cells are found among **pseudostratified columnar ciliated epithelial cells** in the respiratory tract.
- They produce and secrete **MUCUS**.
- **Ciliated cells and Mucus**, together are responsible for very important **“Mucociliary clearance function”**.

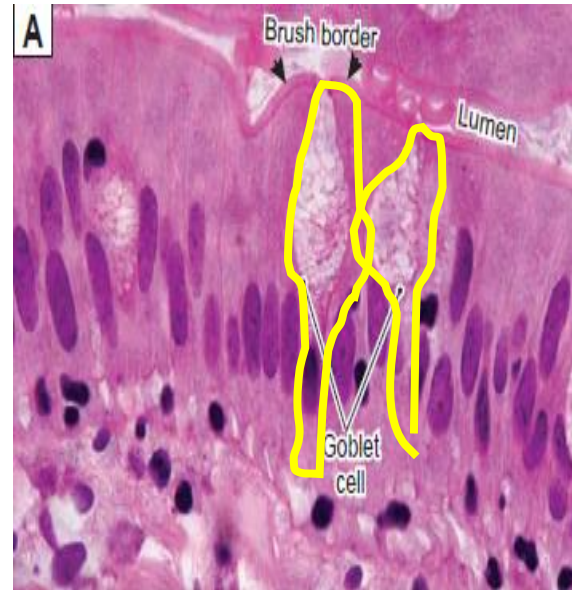


Figure 3-20A. Unicellular gland, small intestine. H&E, ×962

Unicellular glands are composed of only a single cell. The secretory products are released directly onto the surface of an epithelium. Goblet cells are an example of this type of gland. Microvilli with glycocalyx coating form a brush border (*arrows*). Note that goblet cells themselves do not have microvilli on their apical surfaces (see Fig. 3-20B).

- Goblet cells are also found among **intestinal simple columnar epithelial cells**.
- **Protection and lubrication** of epithelial surfaces of the digestive tracts (small and large intestine) **by producing mucus**.

# Two Types of Epithelial Tissues

## Covering/lining Epithelium

- covers the outside surfaces of the body and lines internal organs.



## Glandular Epithelium

- secretes hormones or other products (mucous, milk).
  - Consists of one or many cells



## Learning Outcomes

I) Formation of the Glands and general microscopic design

II) How we can classify exocrine glands

III) Unicellular intraepithelial gland: Goblet Cell

IV) Serous, mucous and mixed-seromucous glands

## II) Depending on **what type of secretion is produced:**

- **Serous glands, mucous glands, mixed glands (seromucous)**

**Serous glands** produce and secrete **protein rich enzymes** and **watery secretions**.

### **Serous Glands-Cells:**

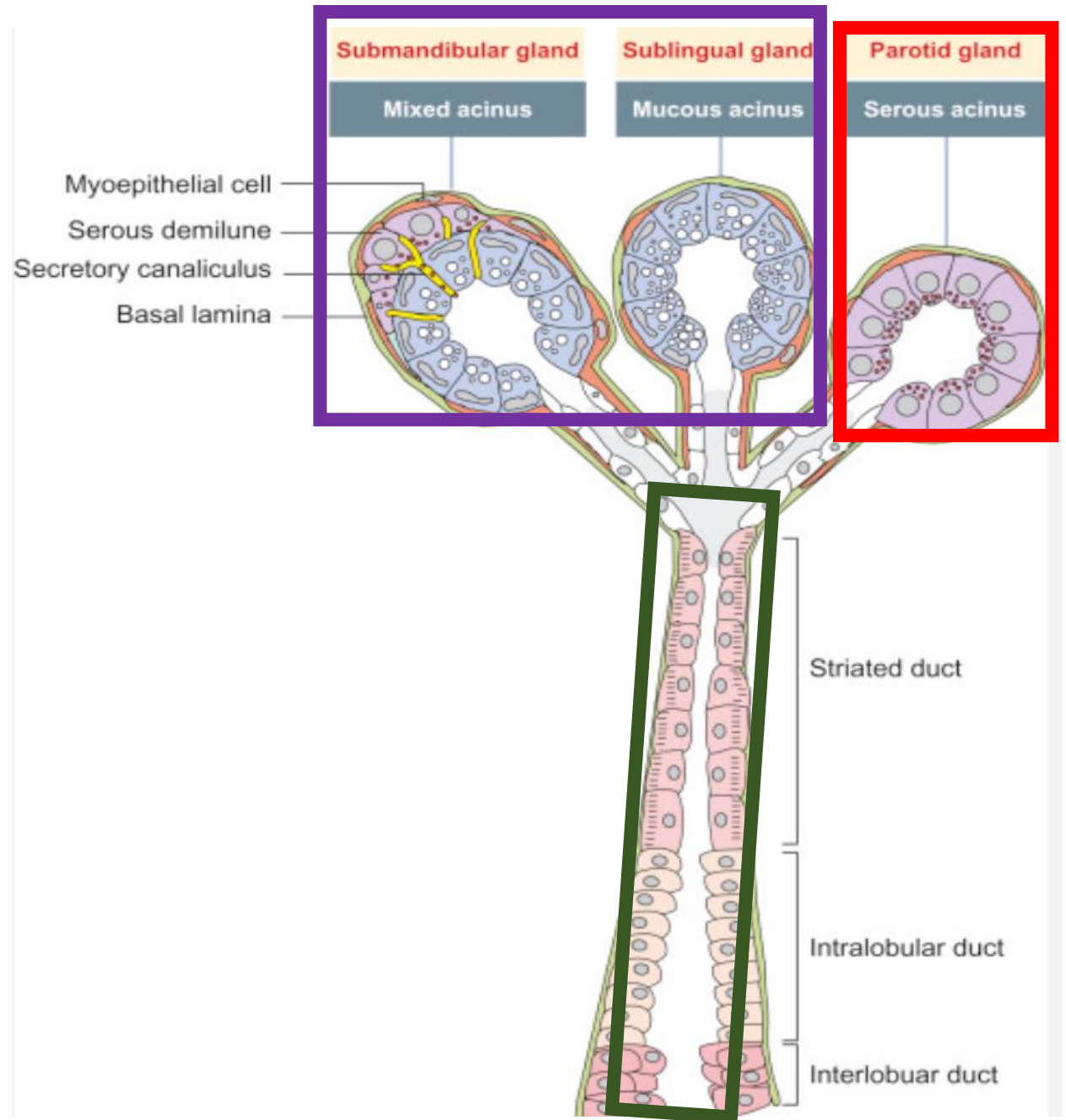
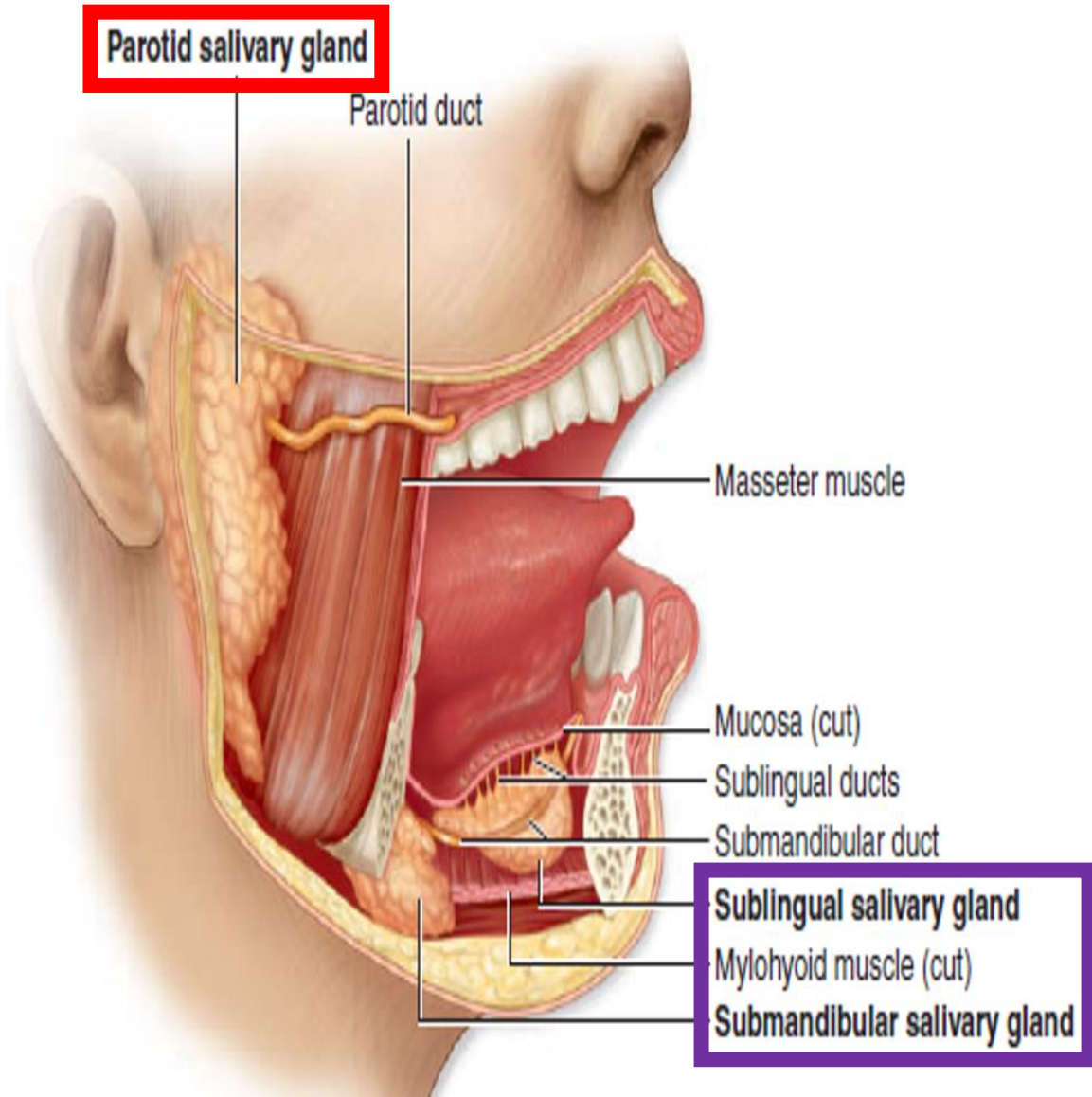
- ✓ Parotid gland (purely serous)
- ✓ Exocrine pancreas (purely serous)
- ✓ Bowman's Gland (Olfactory mucosa- purely serous)
- ✓ Lacrimal Gland (purely serous)
- ✓ Submandibular and sublingual salivary glands (mixed glands- seromucous)

**Mucous glands** produce and secrete **carbohydrate-rich, viscous** and **slimy secretion**.

### **Mucous Glands-Cells:**

- ✓ Goblet cells (purely mucous)
- ✓ Brunner's glands of duodenum (first part of the small intestine – purely mucous)
- ✓ Surface cells of the stomach (purely mucous)
- ✓ Submandibular and sublingual salivary glands (mixed glands- seromucous)

**FIGURE 16-1** Major salivary glands.



## Major and Minor Salivary Glands:

- About **95%** percent of saliva is produced by three bilateral pairs of **major salivary glands**:

- **Parotid** (purely serous gland)
- **Submandibular** (mixed, mainly serous gland)
- **Sublingual** (mixed, mainly mucous gland)

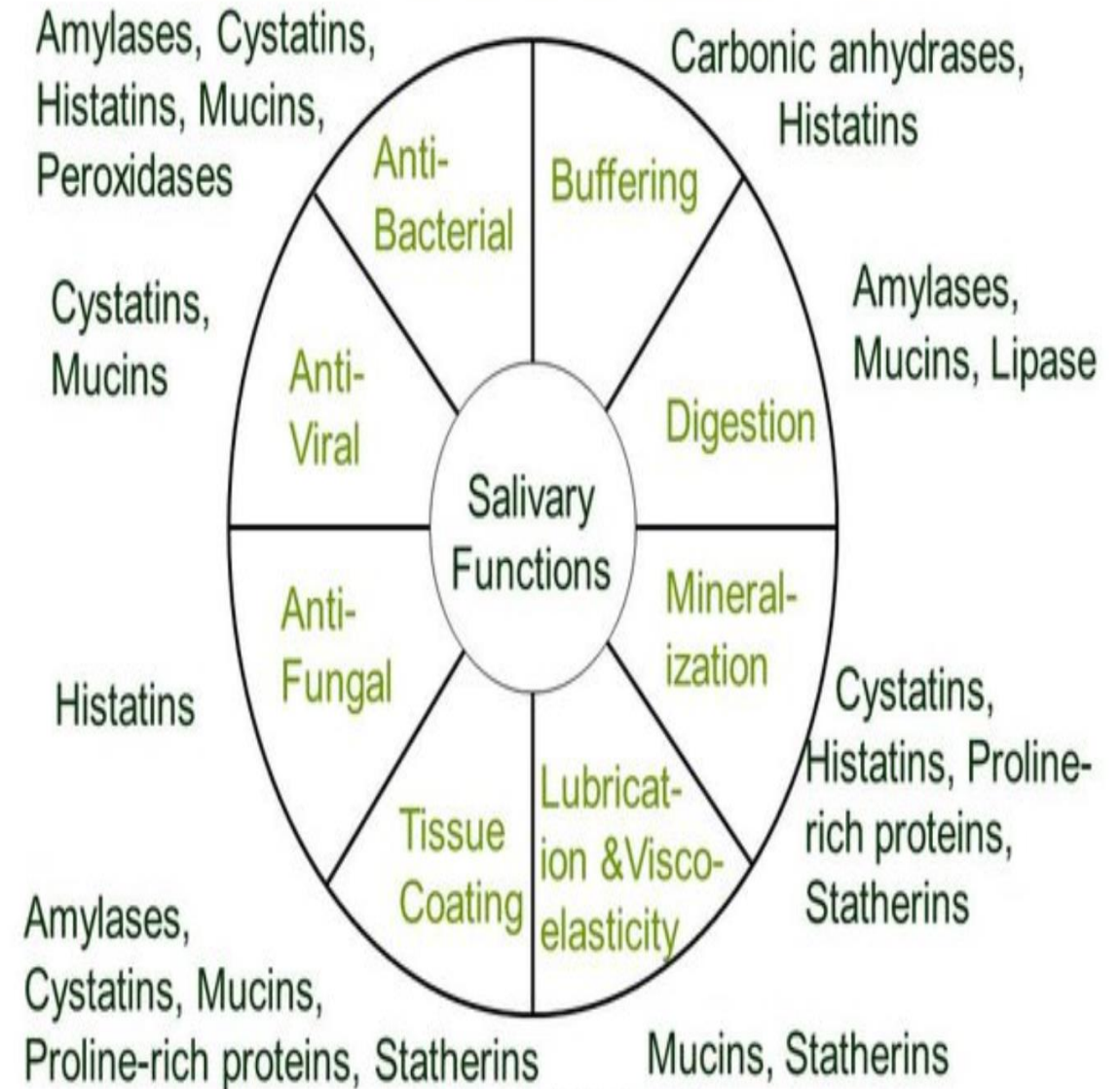
- We have also about **600-1000 minor salivary glands**, very small glands in **labial, buccal, lingual and palatine**.

- Daily 1–1.50 L saliva

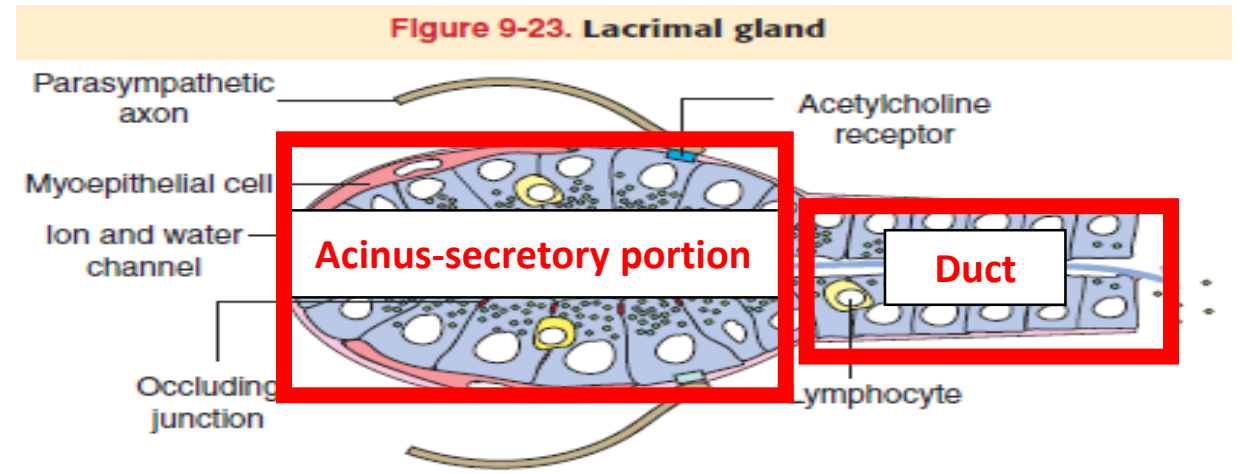
## Functions:

- Keeping the mucous membrane moist
- Lubrication of food
- Prevention of tooth decay
- Digestion starts

## Multifunctionality







Secretory proteins in tears
<b>Lactoferrin:</b> Bacteriostatic agent. It sequesters iron necessary for bacteria metabolism.
<b>Lysozyme:</b> Bacteriolytic agent. It destroys bacteria.
<b>Secretory Immunoglobulin A:</b> Defensive agent. It neutralizes infectious agents.
<b>Tear-specific prealbumin:</b> Unknown function.

- The lacrimal gland is a purely serous gland and produces a fluid, tears.
- The anterior surface of the cornea and sclera is always kept wet with a film of tears.
- A thousand times more effective than the strongest antibiotics we use daily.

**Tear Film:**

- Mucous layer
- Watery layer
- Oily layer

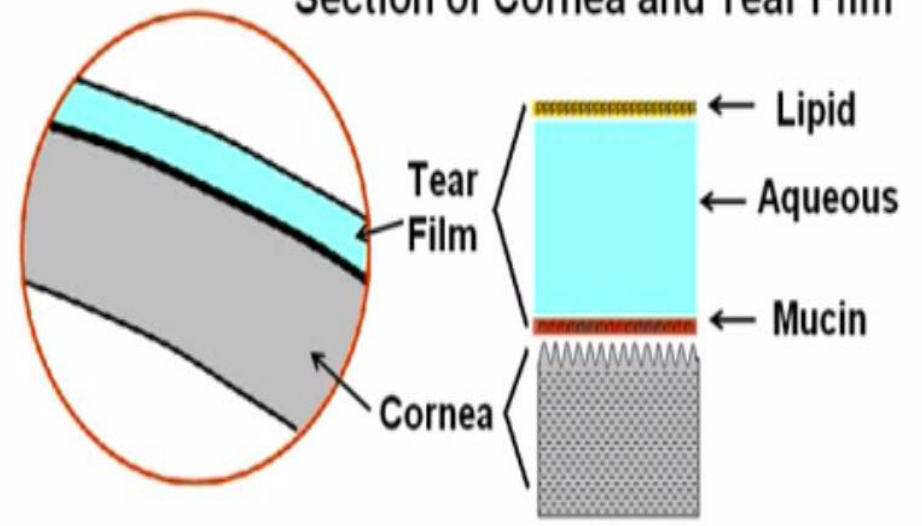


Cornea

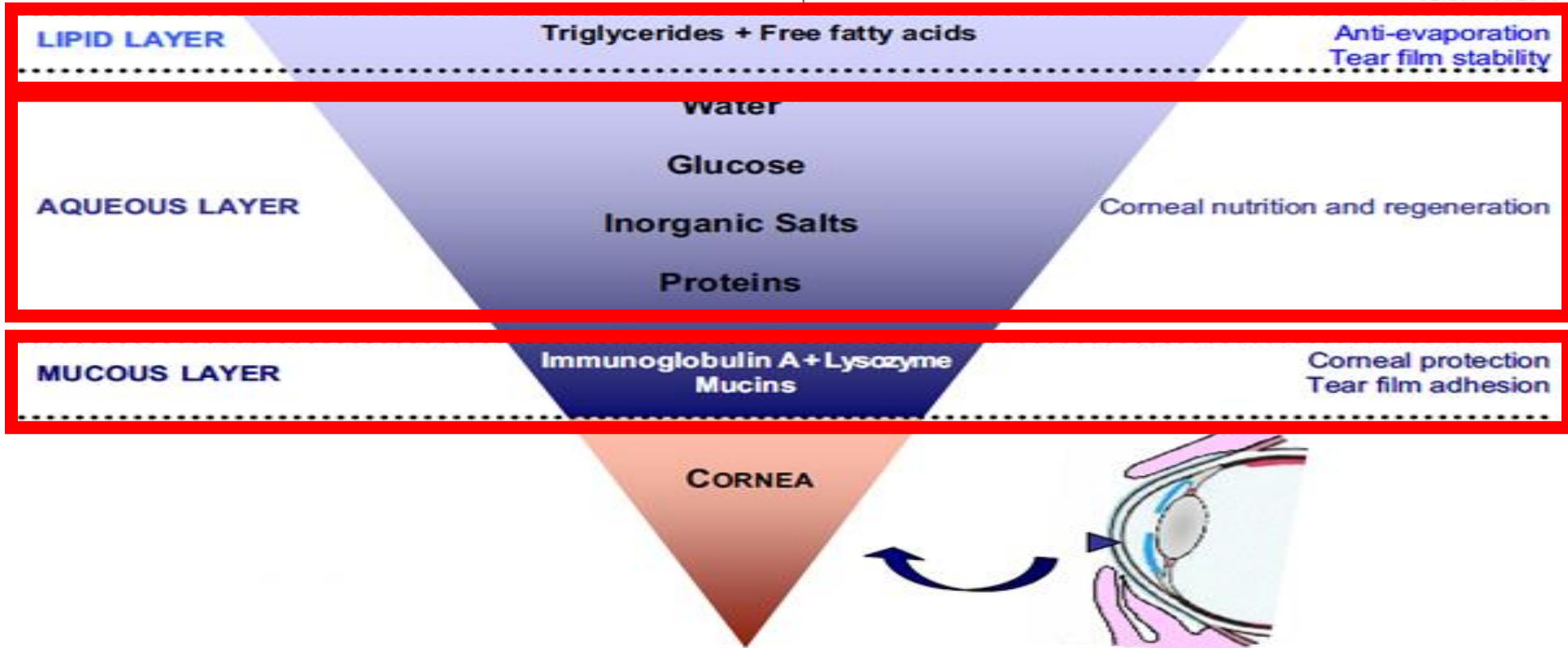
Conjunctiva

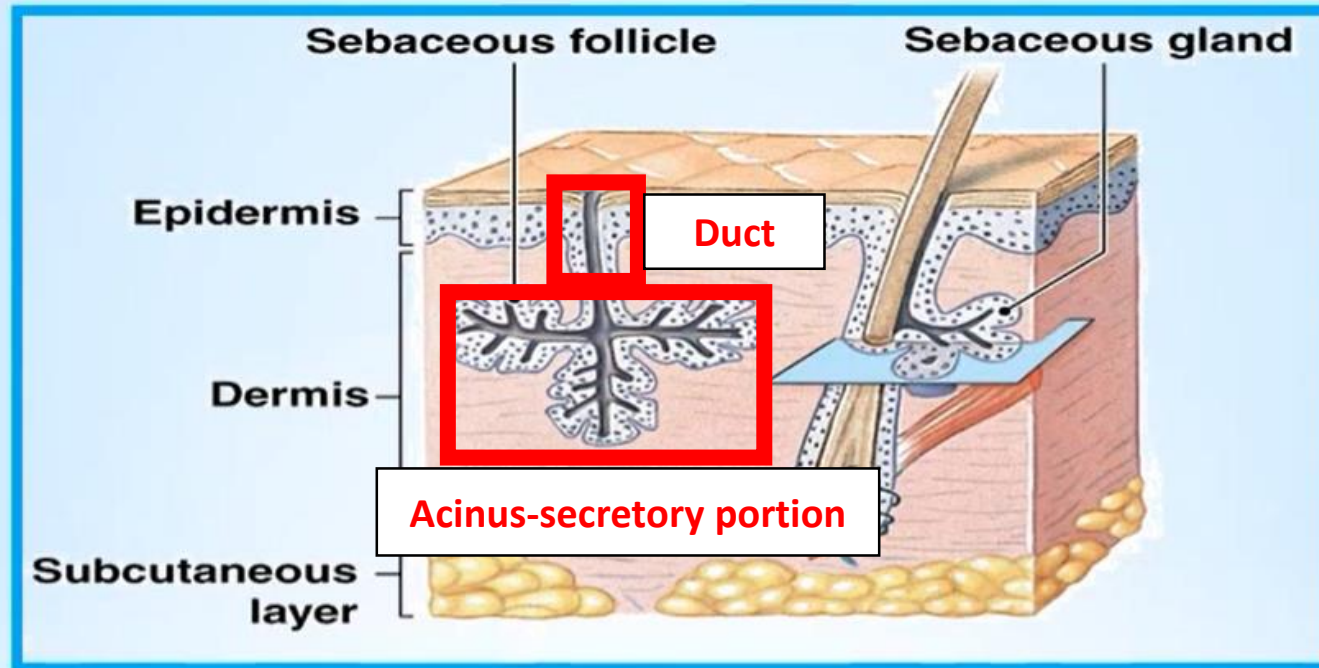
virtualmedicalcentre.com

**Section of Cornea and Tear Film**



© CBlackwell 2010





❑ **Sebaceous glands:** glands produce sebum which is an oily and waxy substance coats moisturize and protects skin. Sebaceous glands cover, a large portion of body but they are most abundant on the Scalp of face. Sebaceous glands open into hair follicles. These glands are more present in the palm of hands and the soles of feet.

# Sebaceous Glands (oil glands)

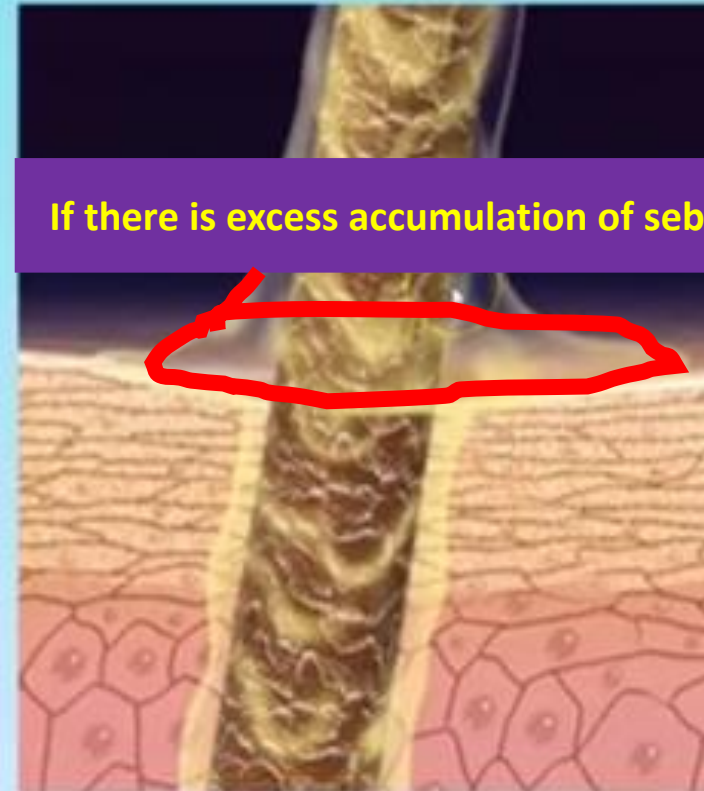
- Functions of **sebum**
  - Softens and lubricates hair and skin
  - Skin waterproofing
  - Collects dirt

**Sebum:** primarily composed of **triglycerides, wax esters, squalene and free fatty acids.**

Sebum releasing to the surface of the skin



If there is excess accumulation of sebum here, What happens?



## FOLDER 15.4 Functional Considerations: The Role of Sebum

The role of **sebum** is not clearly defined. Various investigators have ascribed bacteriostatic, emollient, barrier, and pheromone functions to sebum. Sebum does appear to play a critical role in the development of **acne**. The amount of sebum secreted increases significantly at puberty in both males and females. Triglycerides contained in sebum are broken down to fatty acids

by bacteria on the skin surface, and the free fatty acids liberated may be an irritant in the formation of **acne lesions**. On histologic examination, acne is characterized by retention of the sebum in the isthmus of the hair follicle, with variable lymphocytic infiltration. In severe cases, dermal abscesses may form in association with inflamed hair follicles.



### Formation of Skin Pimples and Acnes

