

# Glandular Epithelium

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# Glands

- ▶ “Glandular epithelia are tissues formed by cells specialized to produce secretion.”
- ▶ **Secretion**: if substances produced are used elsewhere in the body, they are called secretions.
- ▶ **Excretion**: if products are discarded from the body, they are known as excretions.



# Glands

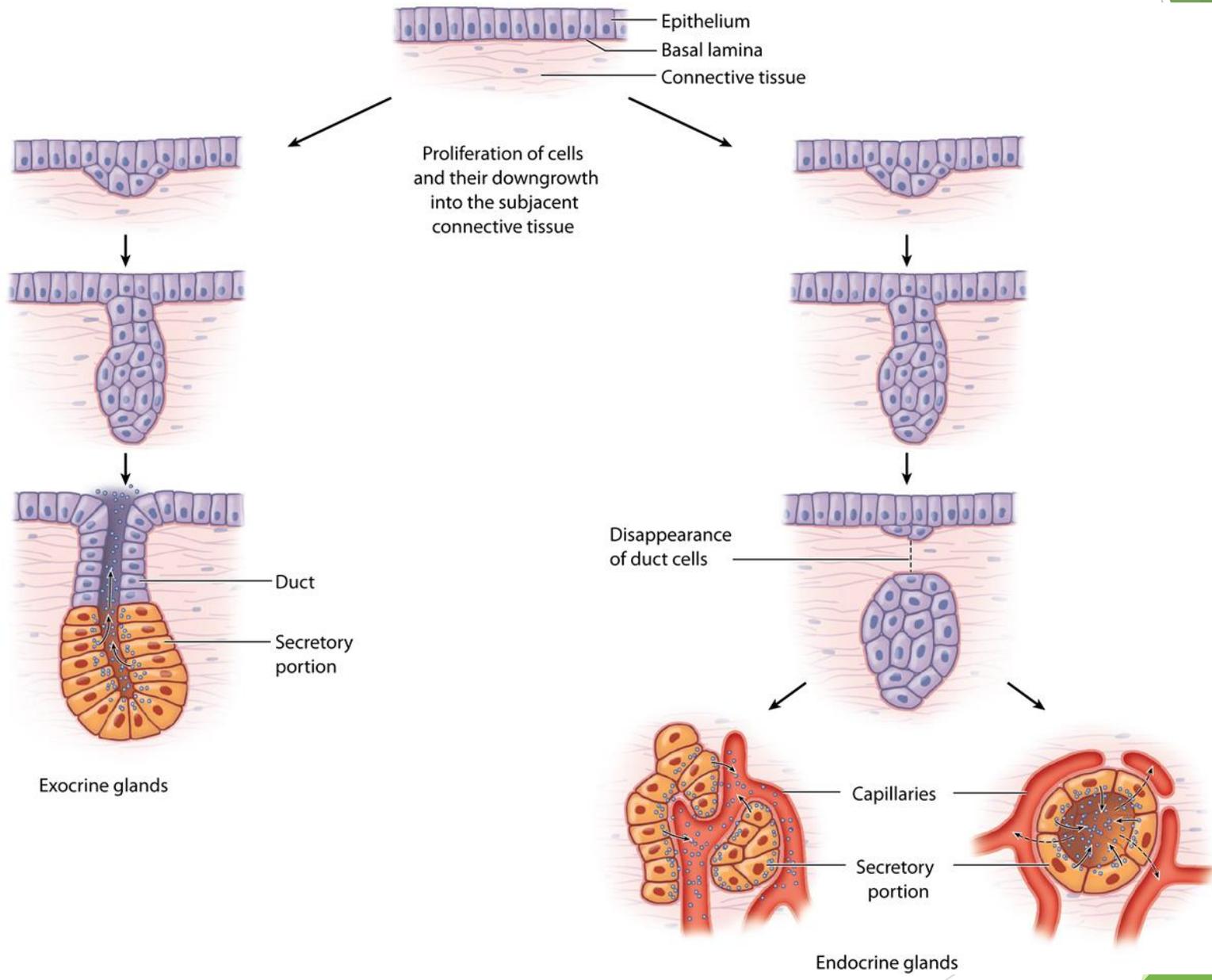
- ▶ Glandular epithelial cells may synthesize, store, and secrete proteins (e.g. pancreas), lipids (e.g. sebaceous glands), or complexes of carbohydrates and proteins (e.g. salivary glands).
- ▶ The mammary glands secrete all 3 substances.
- ▶ Some glands have low synthesizing activity (e.g. sweat glands). They secrete mostly substances transferred from the blood to the lumen of the gland.



# Development of glands:

- ▶ Glands develop as invaginations of covering epithelia. Epithelial cells proliferate and penetrate connective tissue. They may-or may not-maintain contact with the surface. When contact is maintained, **exocrine glands** are formed; without contact, **endocrine glands** are formed.





# Exocrine glands are classified according to number of cells into

## A. Unicellular glands

- e.g. Goblet cells which are present in the lining epithelia of intestine and the respiratory tract

## B. Multicellular glands

- they form most of the glands of the body
- e.g. salivary gland

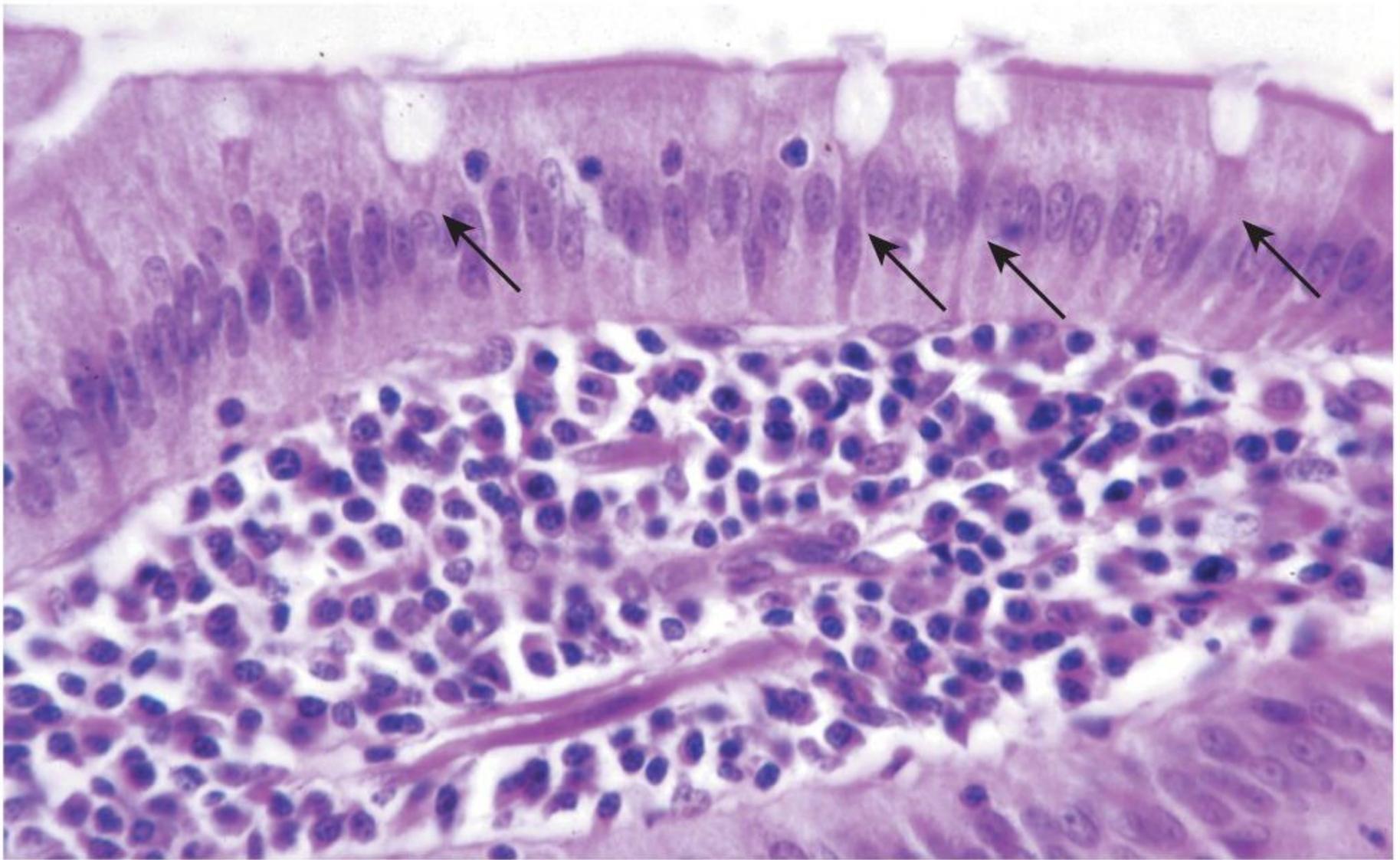


# Goblet cells

- ▶ They are scattered secretory cells, sometimes called unicellular glands.
- ▶ They are common in simple cuboidal, simple columnar, and pseudostratified epithelia.
- ▶ Goblet cells are abundant in the lining of the small intestine and respiratory tract.
- ▶ They secrete lubricating mucus that aids the function of these organs.

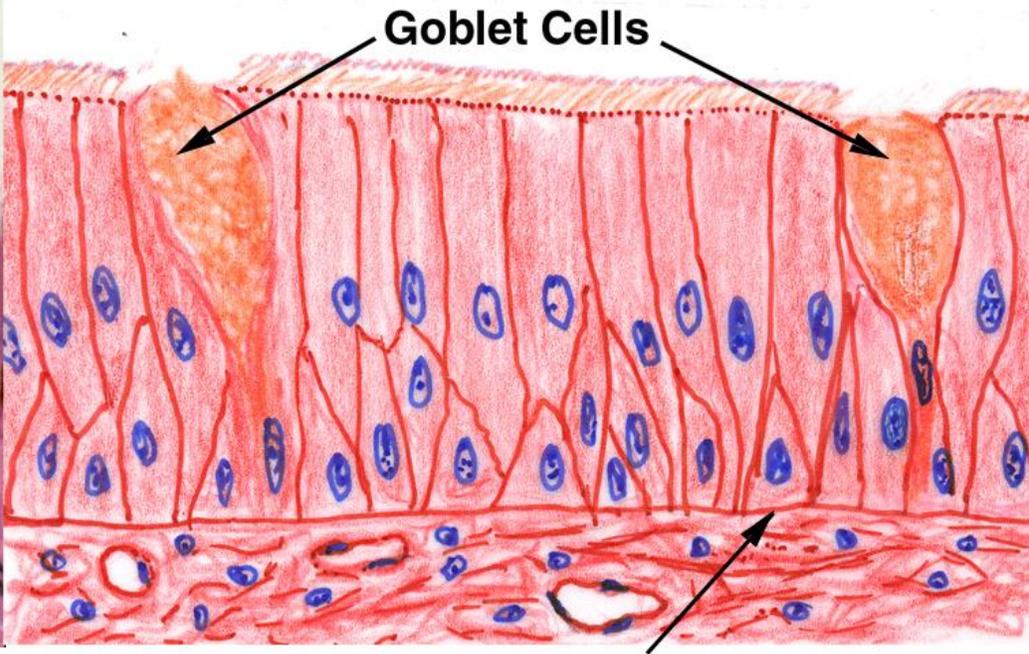
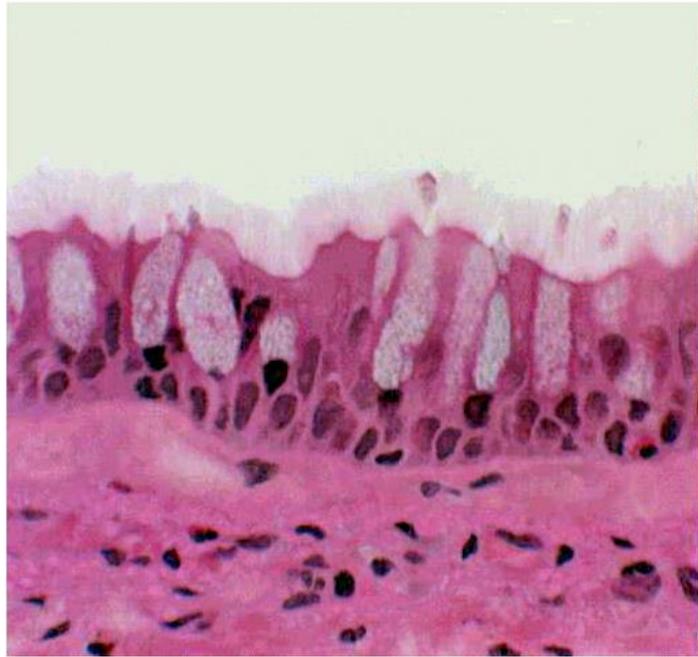






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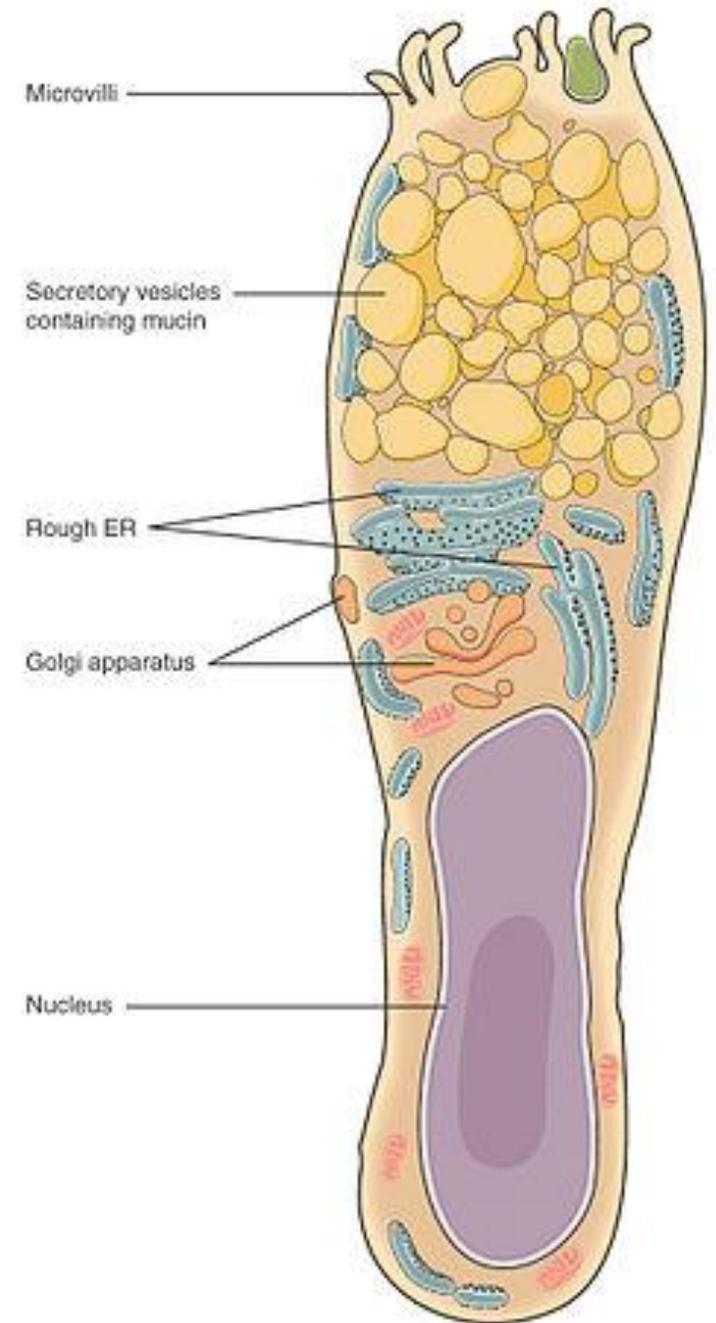


Basement Membrane

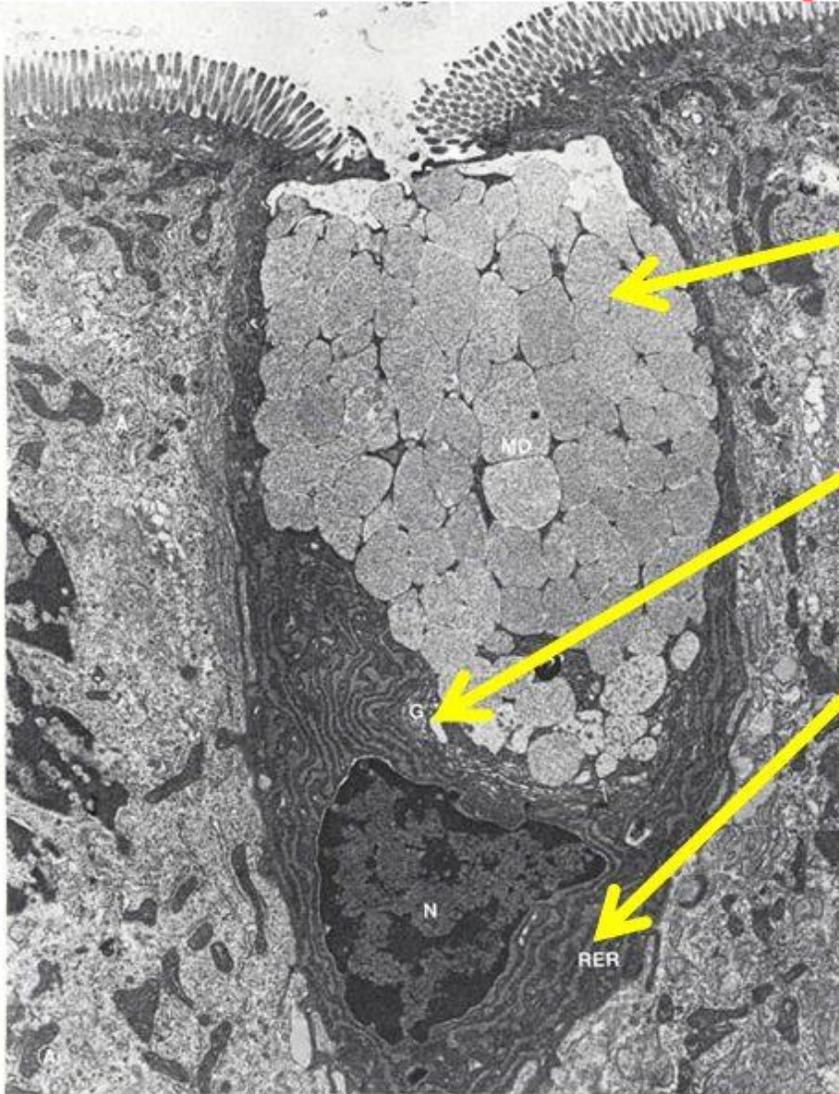


# Goblet cell

The goblet cell is **highly polarized** with the nucleus and other organelles concentrated at the base of the cell. The remainder of the cell's cytoplasm is occupied by membrane-bound secretory granules containing mucin.

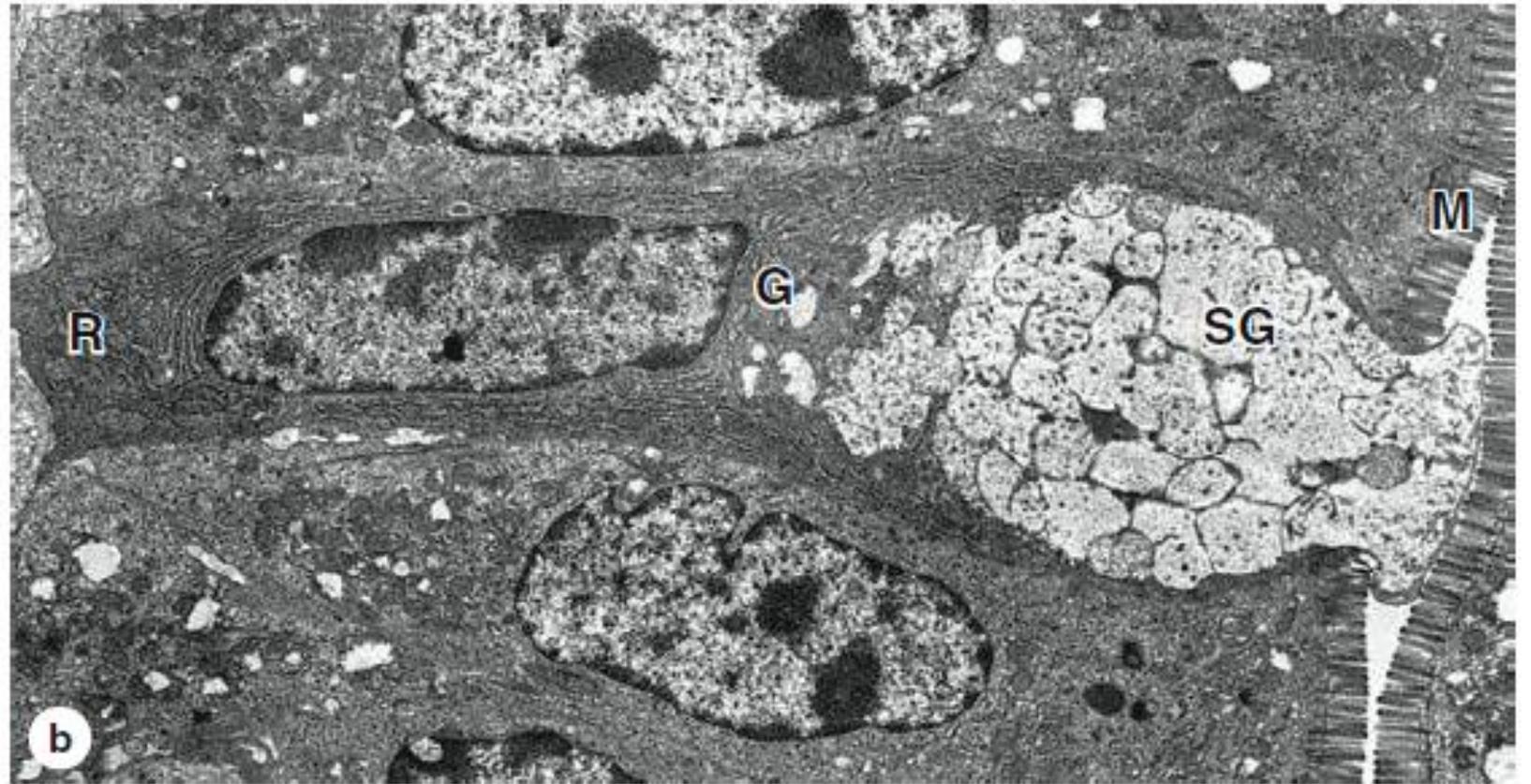
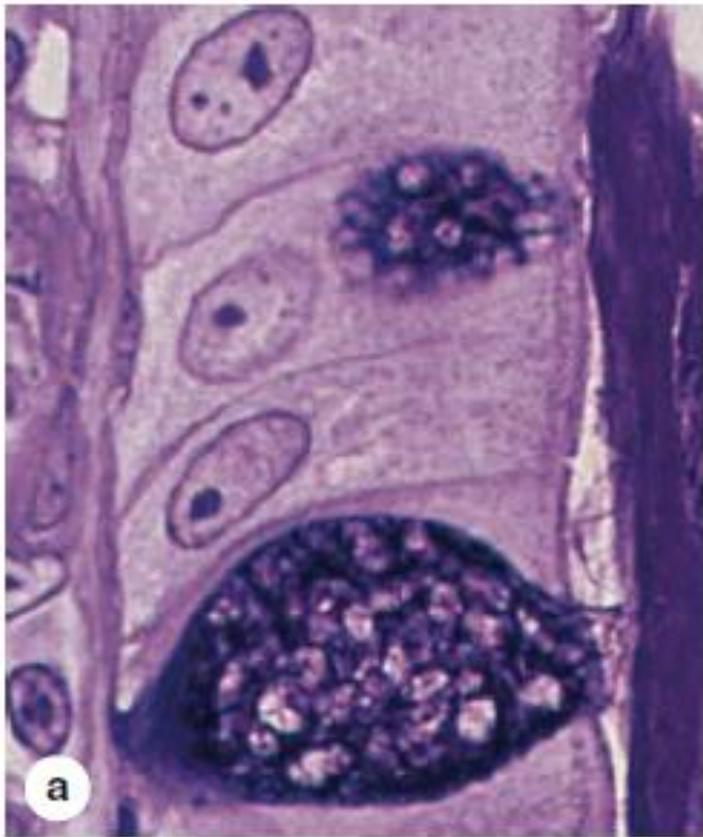


# Goblet cell (by transmission electron microscope "TEM")



- mucous
- Golgi
- rER





The simple columnar epithelium lining the small intestine shows many isolated goblet cells secreting mucus into the lumen. **(a)** With a stain for the oligosaccharide components of mucin glycoproteins, the cytoplasmic secretory granules of two goblet cells and secreted mucus are stained purple. **(b)** As shown ultrastructurally, goblet cells always have basal nuclei surrounded by RER (**R**), a large Golgi complex (**G**), and abundant apical cytoplasm filled with large secretory granules (**SG**). After exocytosis mucin components are hydrated and become mucus. A brush border of microvilli (**M**) is seen on neighboring columnar cells.



# Classification of glands

## ▶ Exocrine glands

release their products onto an epithelial surface, either directly or through a duct e.g. the salivary glands.

## ▶ Endocrine glands

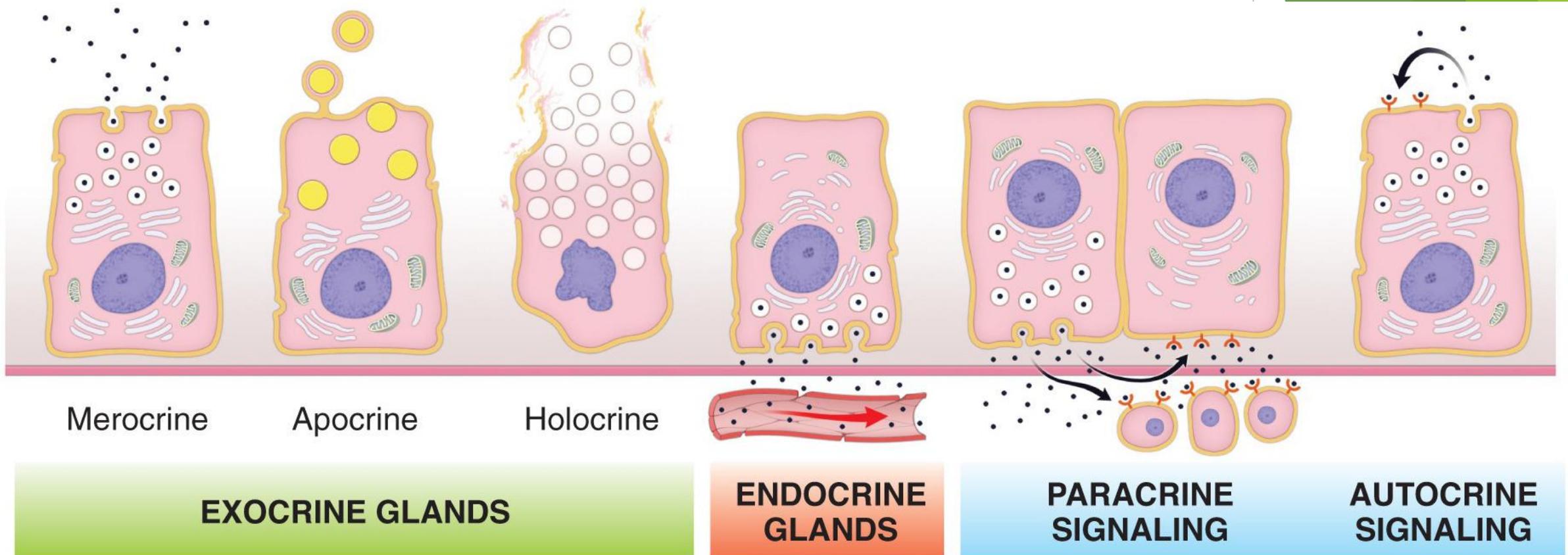
release their products into the blood stream (ductless), e.g. thyroid gland. The products of endocrine glands are called **hormones**.



# Classification of glands----cont'd

- ▶ In some epithelia, individual cells secrete substances that do not reach the bloodstream but rather affect other nearby cells. Such secretory activity is referred to as **paracrine signaling**.
- ▶ In addition, a cell may secrete molecules that bind to receptors that are present on the same cell. This type of messaging is called **autocrine signaling**. In many cases, signaling molecules initiate negative feedback pathways to modulate their own secretion.

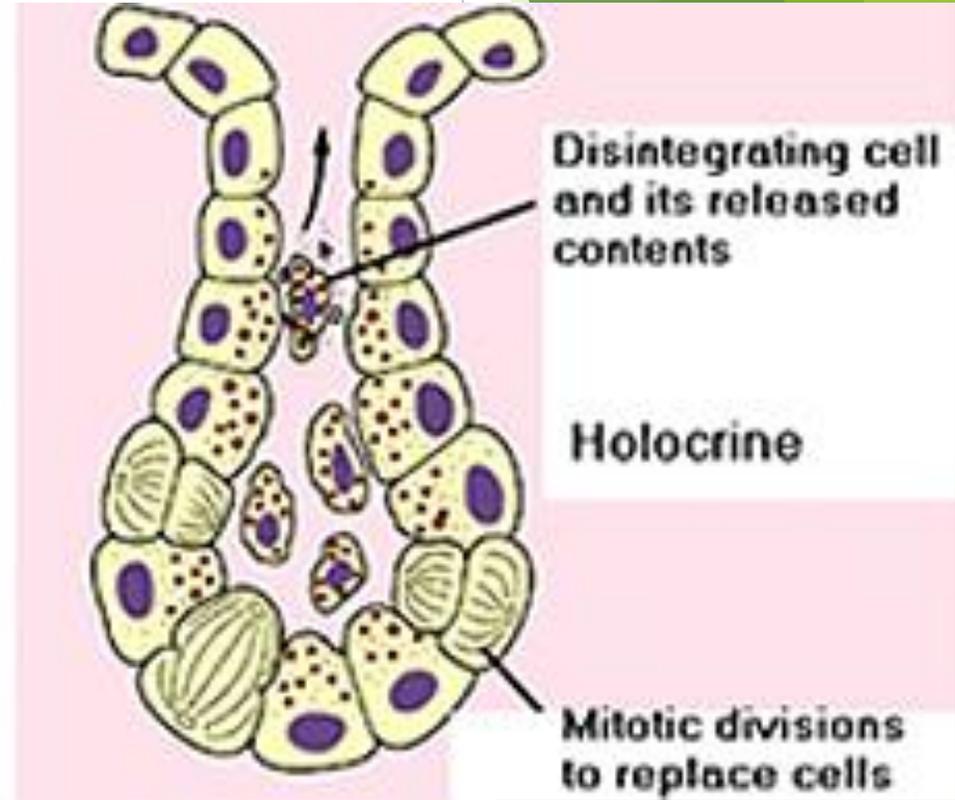
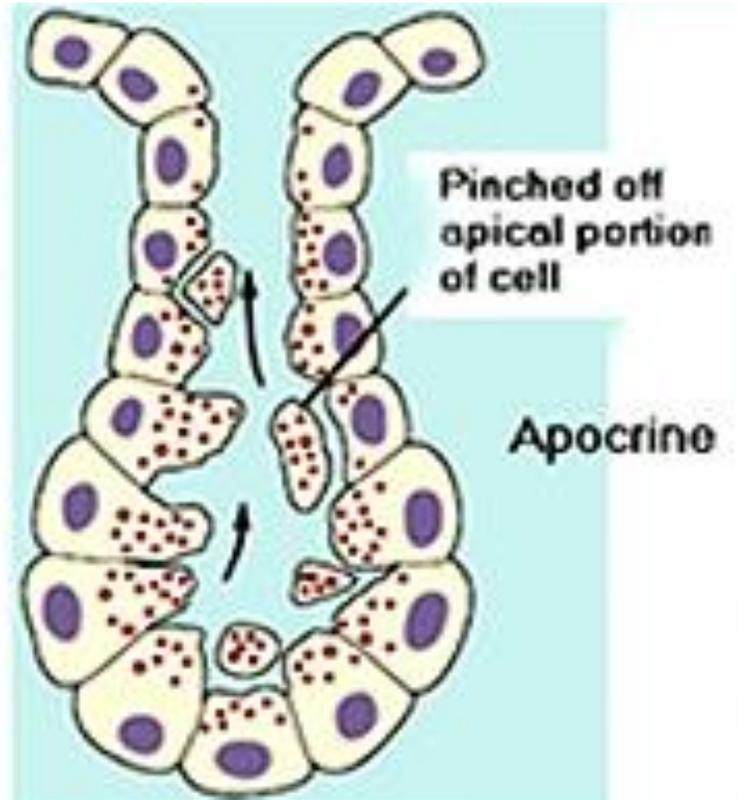
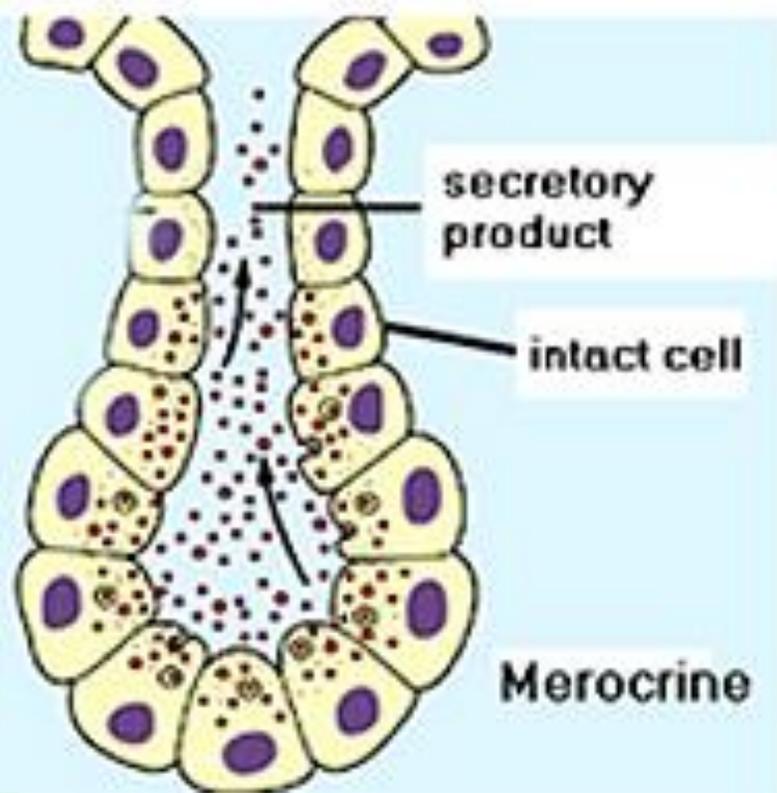


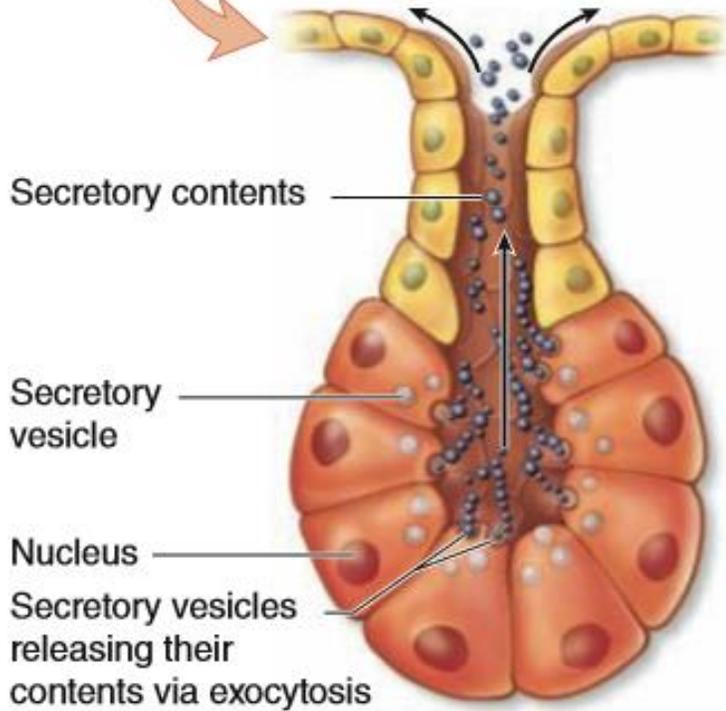
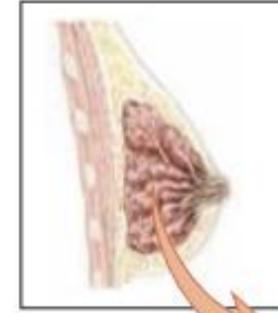
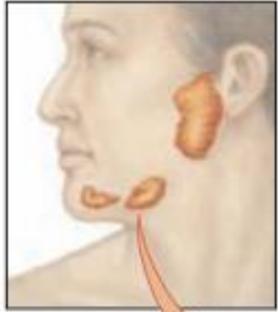


# Classification on the basis of the mode of secretion

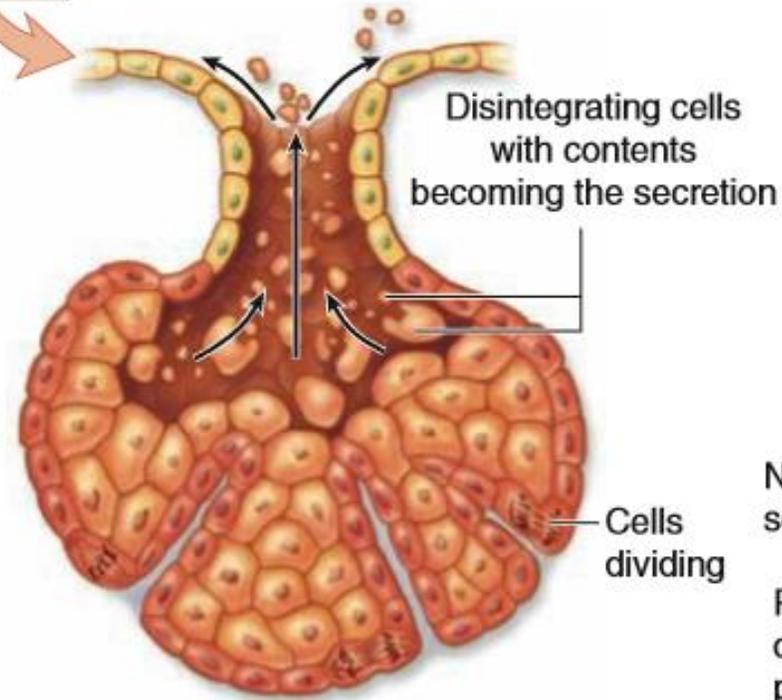
- ▶ Depending on their mode of secretion i.e; the manner in which the secretory product is elaborated, the exocrine glands are classified into the following varieties:
  1. Merocrine glands
  2. Apocrine glands
  3. Holocrine glands



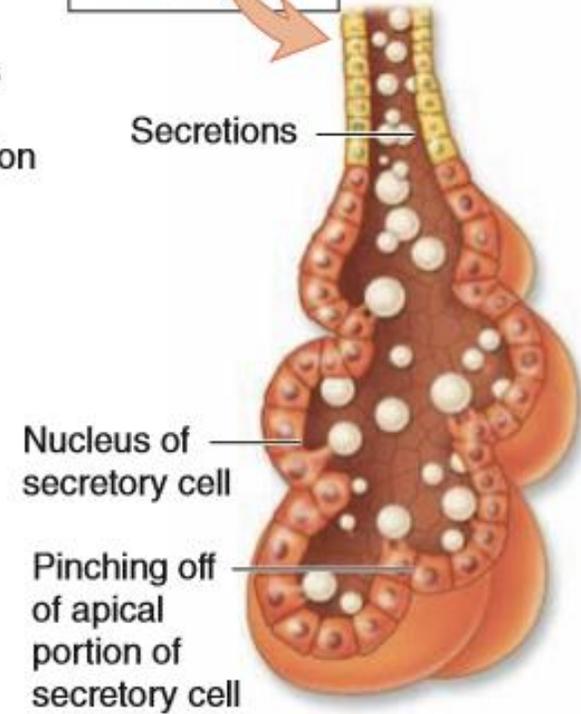




(a) Merocrine gland



(b) Holocrine gland



(c) Apocrine gland



# Merocrine secretion

- ▶ This secretory product is delivered in **membrane-bounded vesicles** to the apical surface of the cell. Here, vesicles fuse with the plasma membrane and extrude their contents by exocytosis. This is the most common mechanism of secretion and is found, for example, in pancreatic acinar cells.

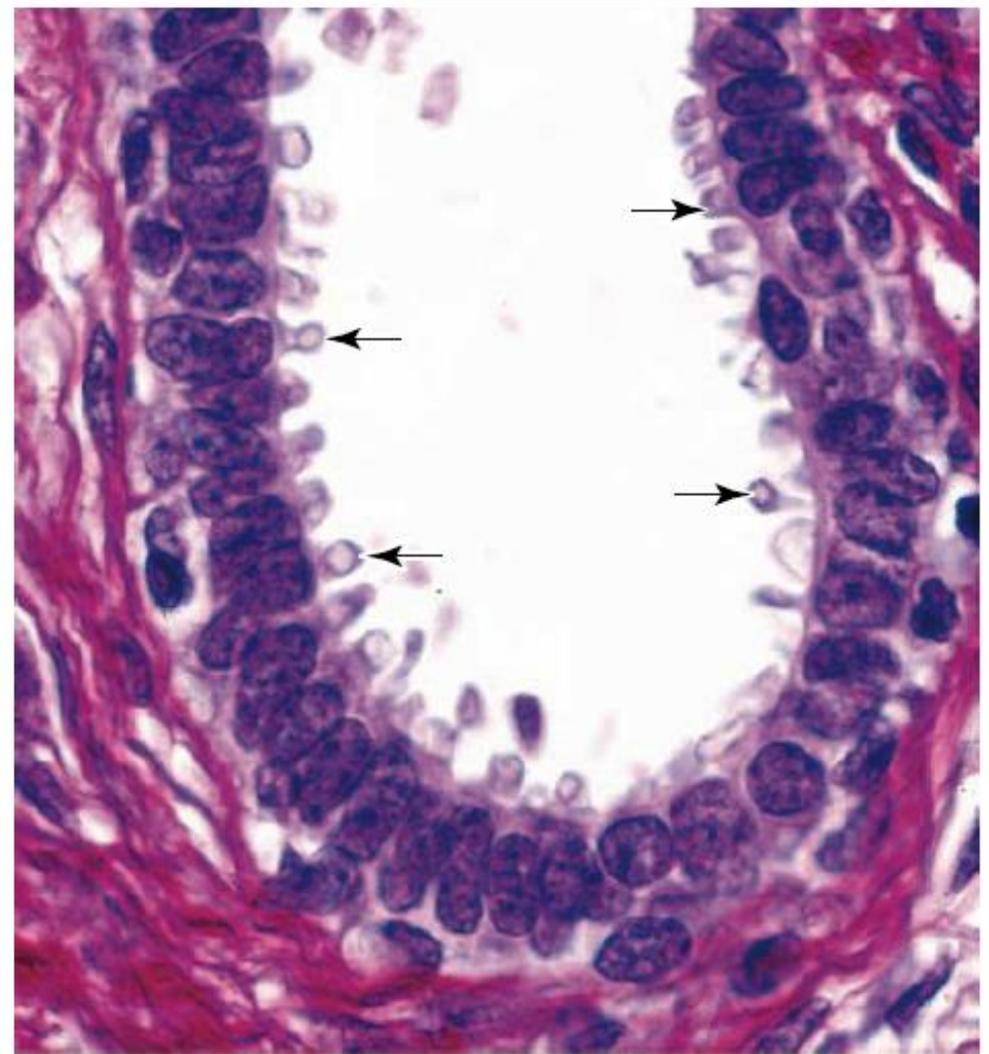


# Apocrine secretion

- ▶ The secretory product is released in the apical portion of the cell, surrounded by a thin layer of cytoplasm within an envelope of plasma membrane. This mechanism of secretion is found in the **lactating mammary gland**, where it is responsible for releasing large lipid droplets into the milk.



The secretory portions of a mammary gland demonstrate apocrine secretion, characterized by extrusion of the secretion product along with a bit of apical cytoplasm (arrows). The released portion of cell contains lipid droplet(s).



# Holocrine secretion

- ▶ The secretory product accumulates within the maturing cell, which simultaneously undergoes destruction orchestrated by **programmed cell death** pathways. Both secretory products and cell debris are discharged into the lumen of the gland. This mechanism is found in **sebaceous glands of skin**.



In holocrine secretion, best seen in the sebaceous gland adjacent to hair follicles, entire cells fill with a lipid-rich product as they differentiate. Mature (terminally differentiated) cells separate and completely disintegrate, releasing the lipid that serves to protect and lubricate adjacent skin and hair. Sebaceous glands lack myoepithelial cells; cell proliferation inside a dense, inelastic connective tissue capsule continuously forces product into the duct.



# Classification according to secretions

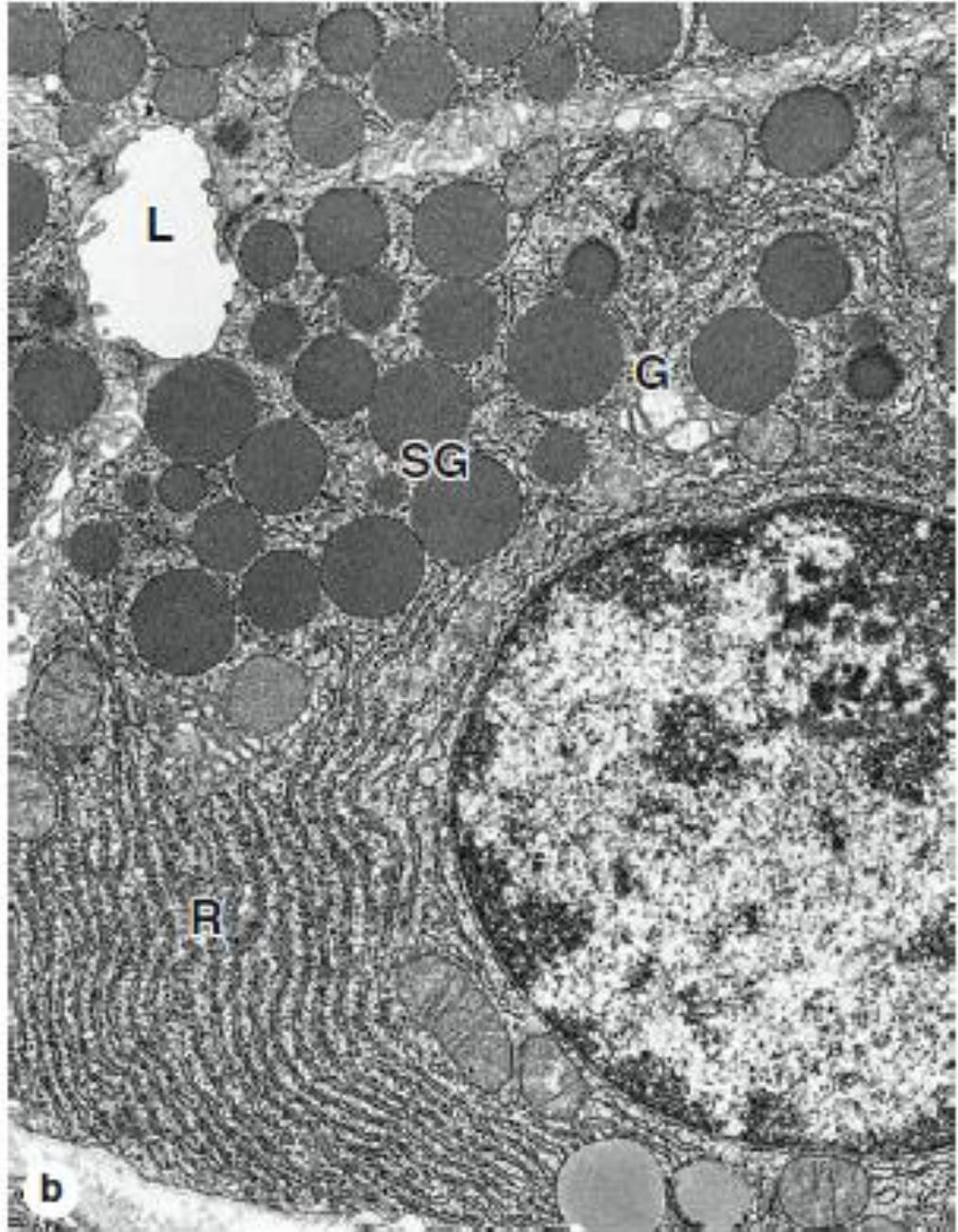
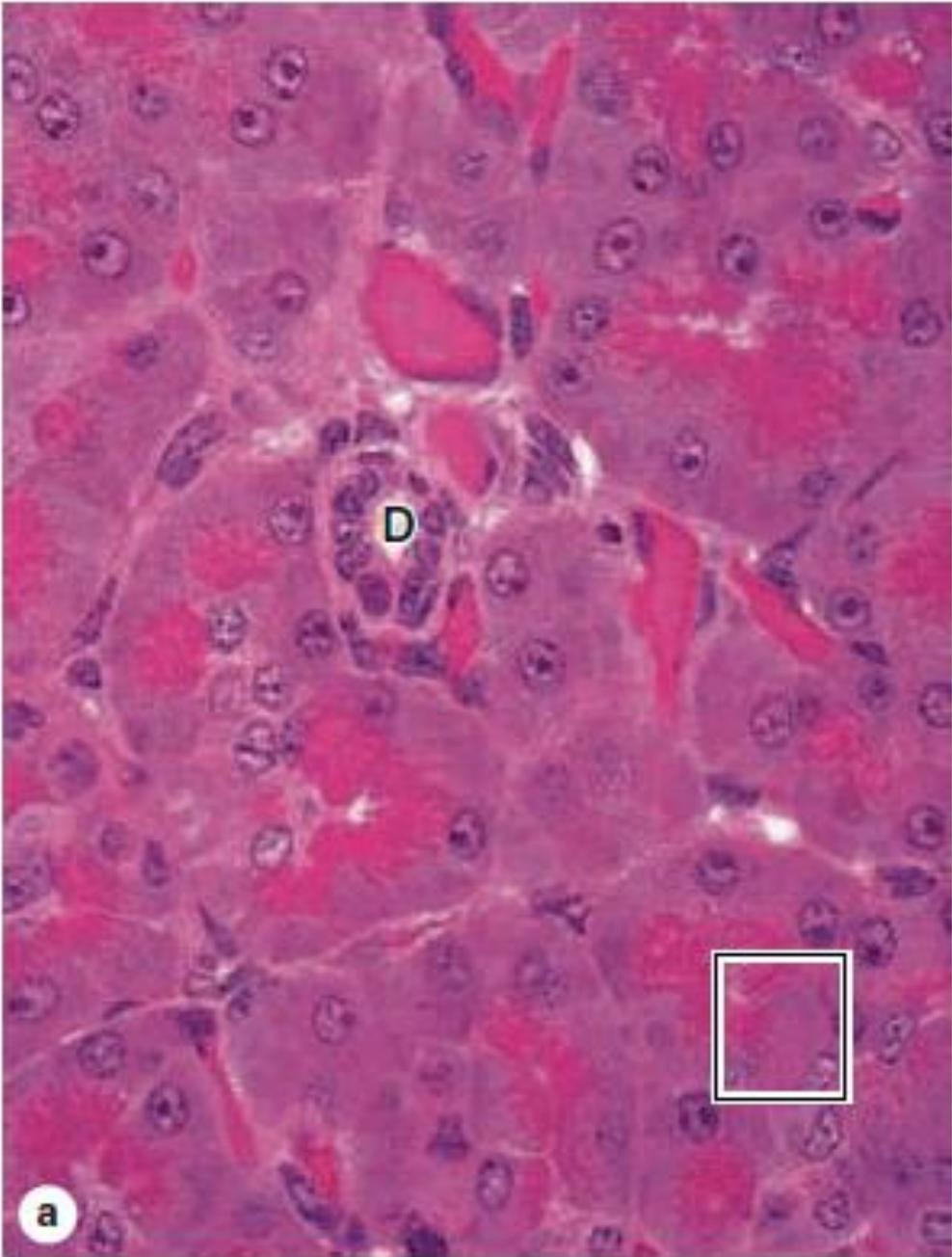
- ▶ Exocrine glands with merocrine secretion can be further categorized according to the nature of their secretory products, which give distinct staining properties to the cells
  - ▶ Serous-secreting: synthesize proteins that are mostly not glycosylated
  - ▶ Mucous-secreting: heavily glycosylated proteins called mucins
- ▶ Some salivary glands are mixed seromucous glands, having both serous acini and mucous tubules with clustered serous cells

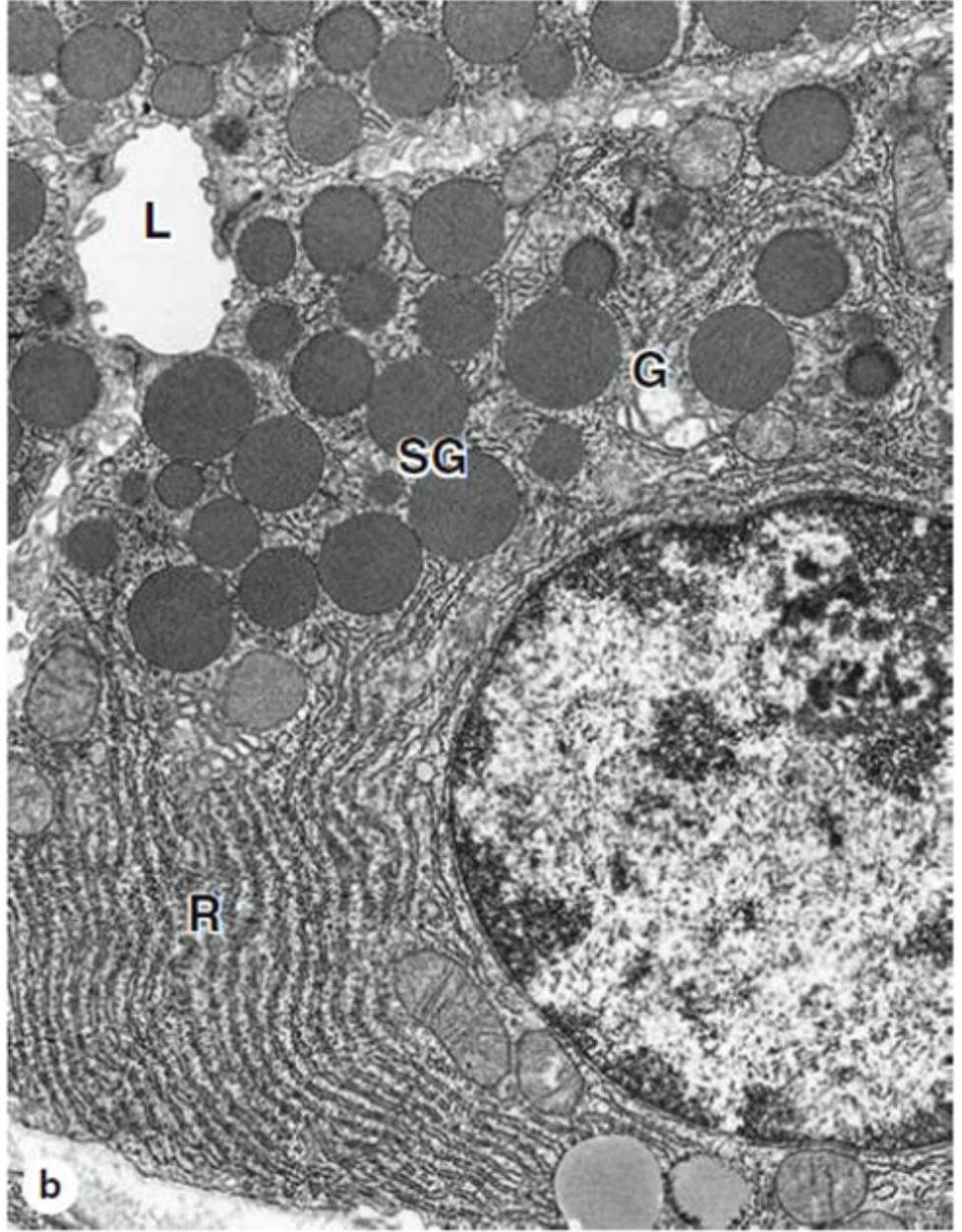


# Serous-secreting glands

- ▶ Serous cells synthesize proteins that are mostly not glycosylated, such as digestive enzymes.
- ▶ The cells have well-developed RER and Golgi complexes
- ▶ They are filled apically with secretory granules in different stages of maturation.
- ▶ Serous cells therefore stain intensely with basophilic or acidophilic stains.
- ▶ Acini of the pancreas and parotid salivary glands are composed of serous cells.



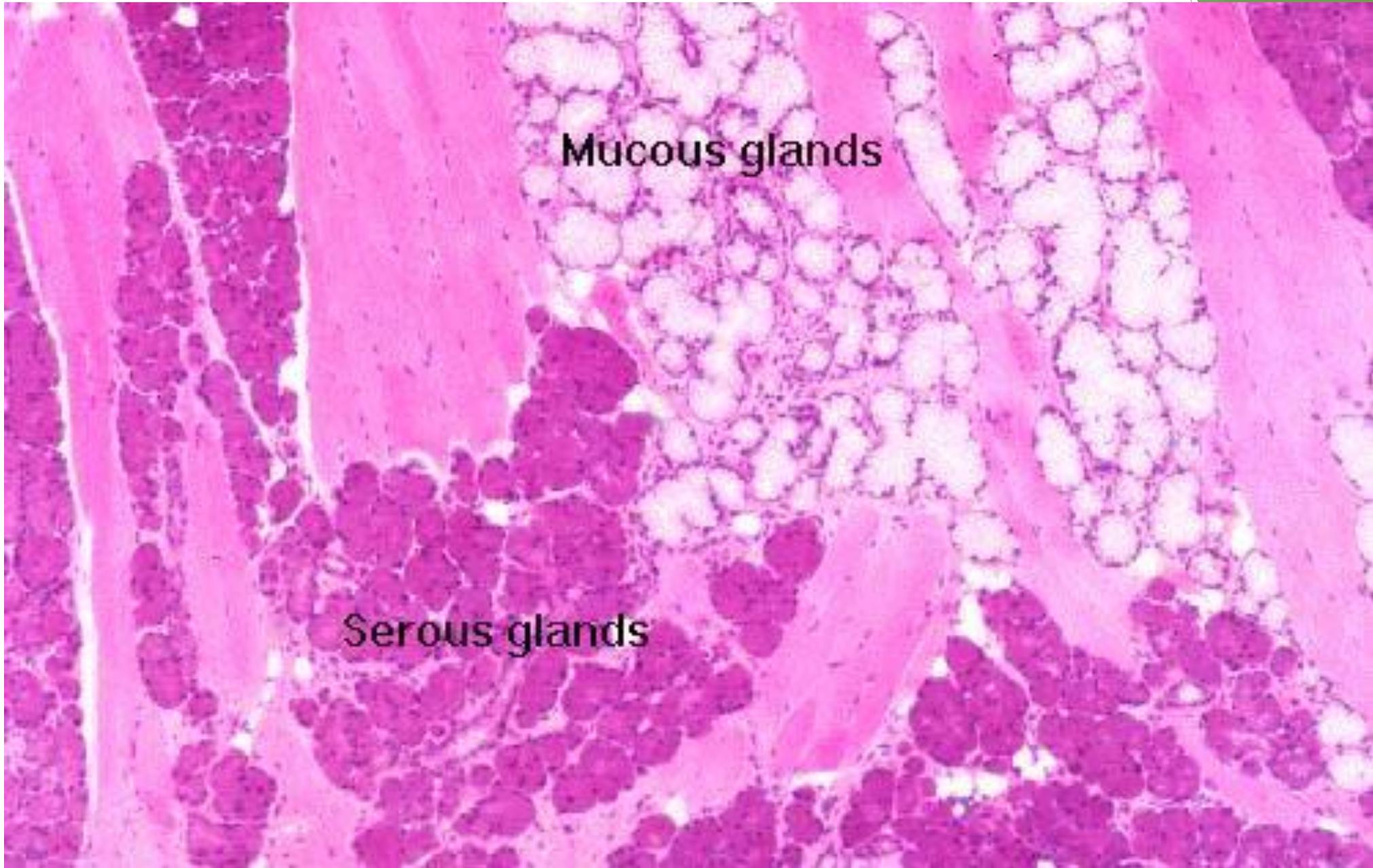




# Mucous-secreting glands

- ▶ Mucous cells, such as goblet cells, have RER and Golgi complexes.
- ▶ They are filled apically with secretory granules, that contain heavily glycosylated proteins called **mucins**.
- ▶ When mucins are released from the cell, they become hydrated and form a layer of **mucus**.
- ▶ The hydrophilic mucins are usually washed from cells during routine histological preparations, causing the secretory granules to stain poorly with eosin.
- ▶ Mucous cells can be stained by the PAS method.

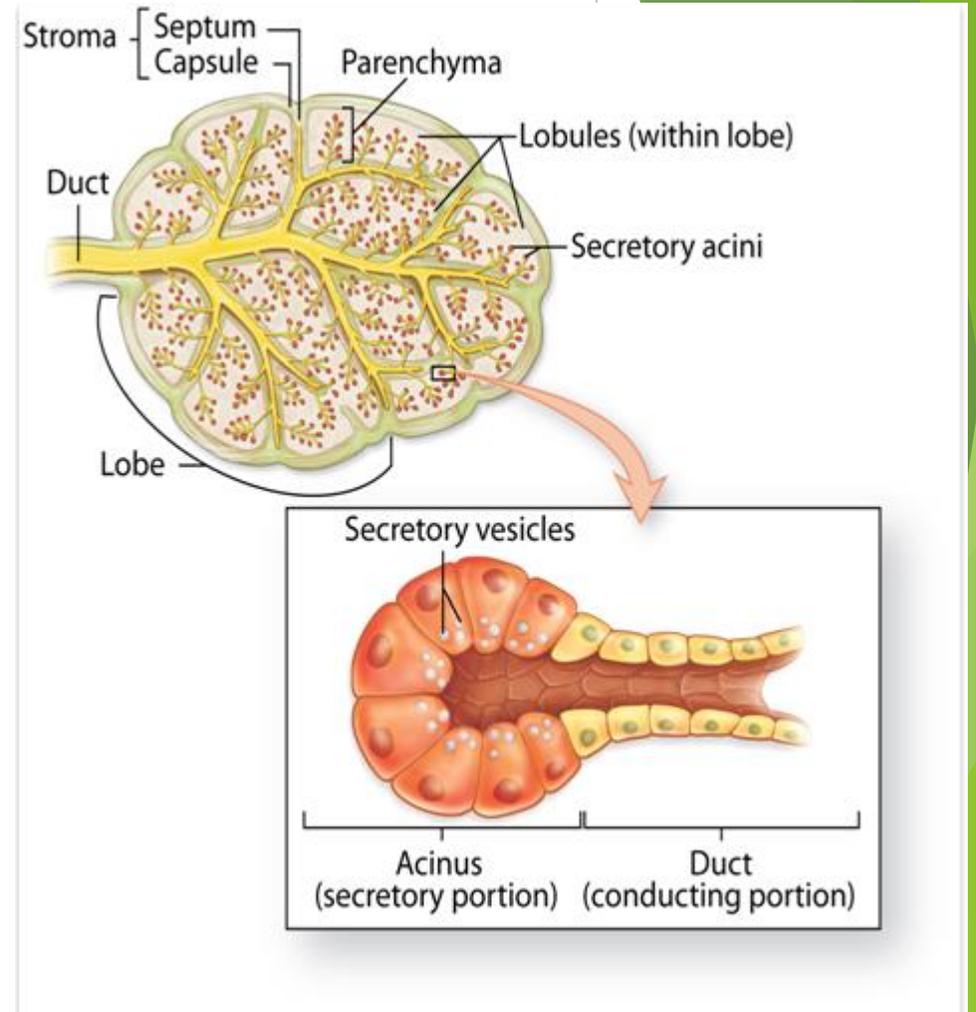




# Multicellular Glands



- ▶ Generally the larger glands have the same structural pattern.
- ▶ Epithelia of exocrine glands are organized as a continuous system of many small **secretory portions** and **ducts** that transport the secretion out of the gland. This is called the paranchyma.
- ▶ The secretory units are supported by a stroma of connective tissue.
- ▶ Externally a gland is surrounded by a dense layer of connective tissue which forms **capsule** of the gland.
- ▶ From the capsule connective tissue septa extend into the gland, thereby dividing its substance into a number of **lobes**.



# Multicellular Exocrine Glands

- Have two basic parts
  - Secretory unit
  - Epithelium-walled duct
- Classified according to structure of duct
  - Simple
  - Compound
- Categorized according to secretory unit
  - Tubular
  - Acinar (Alveolar)
  - Tubuloacinar

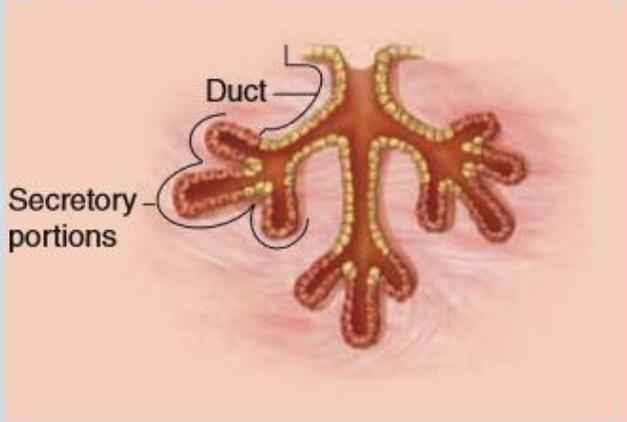
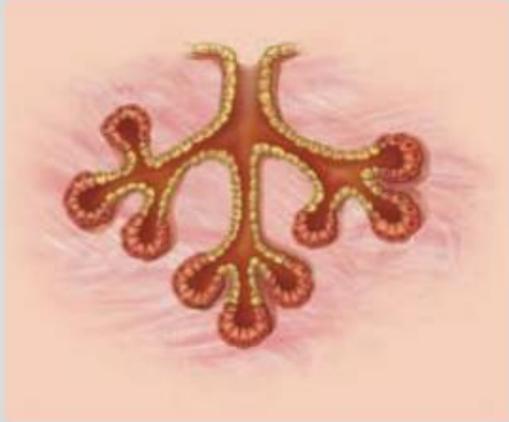
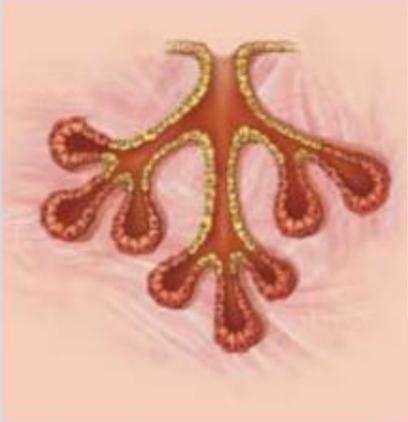


## SIMPLE Glands (Ducts Do Not Branch)

Class	Simple Tubular	Branched Tubular	Coiled Tubular	Acinar (or Alveolar)	Branched Acinar
Features	Elongated secretory portion; duct usually short or absent	Several long secretory parts joining to drain into 1 duct	Secretory portion is very long and coiled	Rounded, saclike secretory portion	Multiple saclike secretory parts entering the same duct
Examples	Mucous glands of colon; intestinal glands or crypts (of Lieberkühn)	Glands in the uterus and stomach	Sweat glands	Small mucous glands along the urethra	Sebaceous glands of the skin

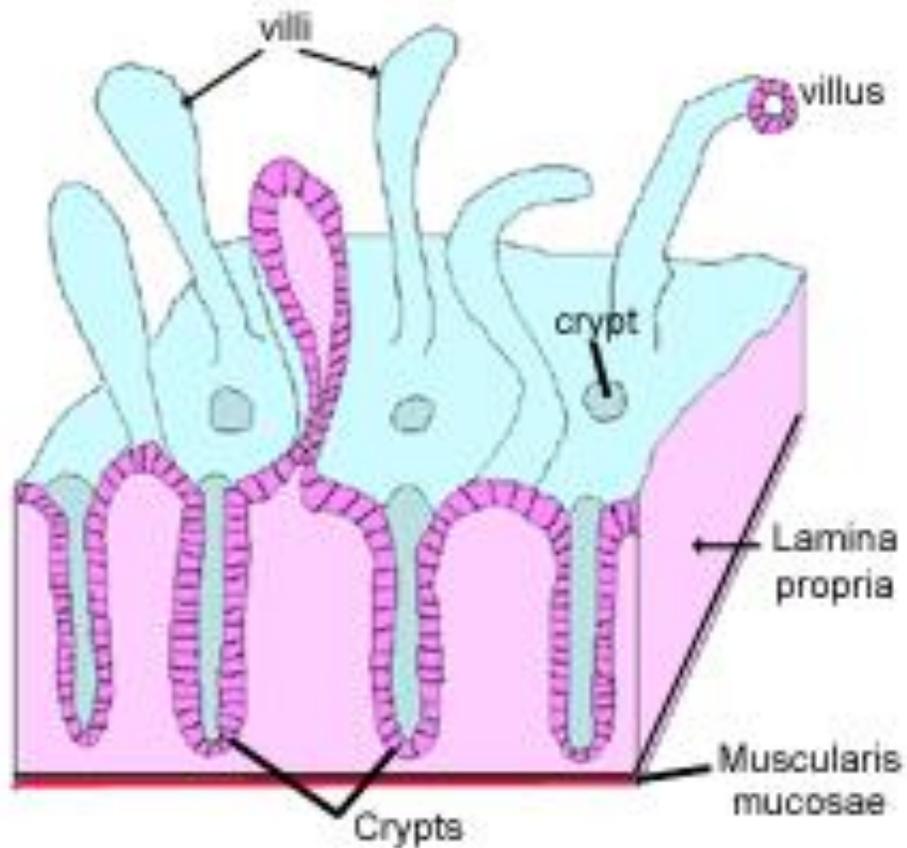


**COMPOUND Glands** (Ducts from Several Secretory Units Converge into Larger Ducts)

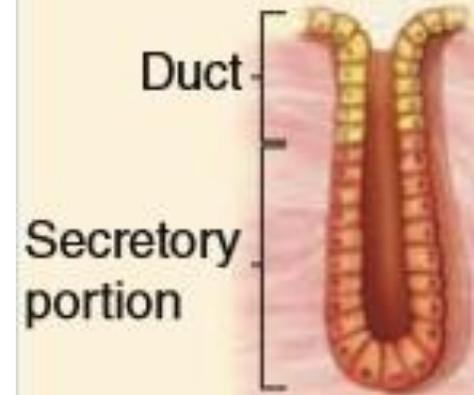
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Examples	Submucosal mucous glands (of Brunner) in the duodenum	Exocrine pancreas	Salivary glands



# Simple tubular



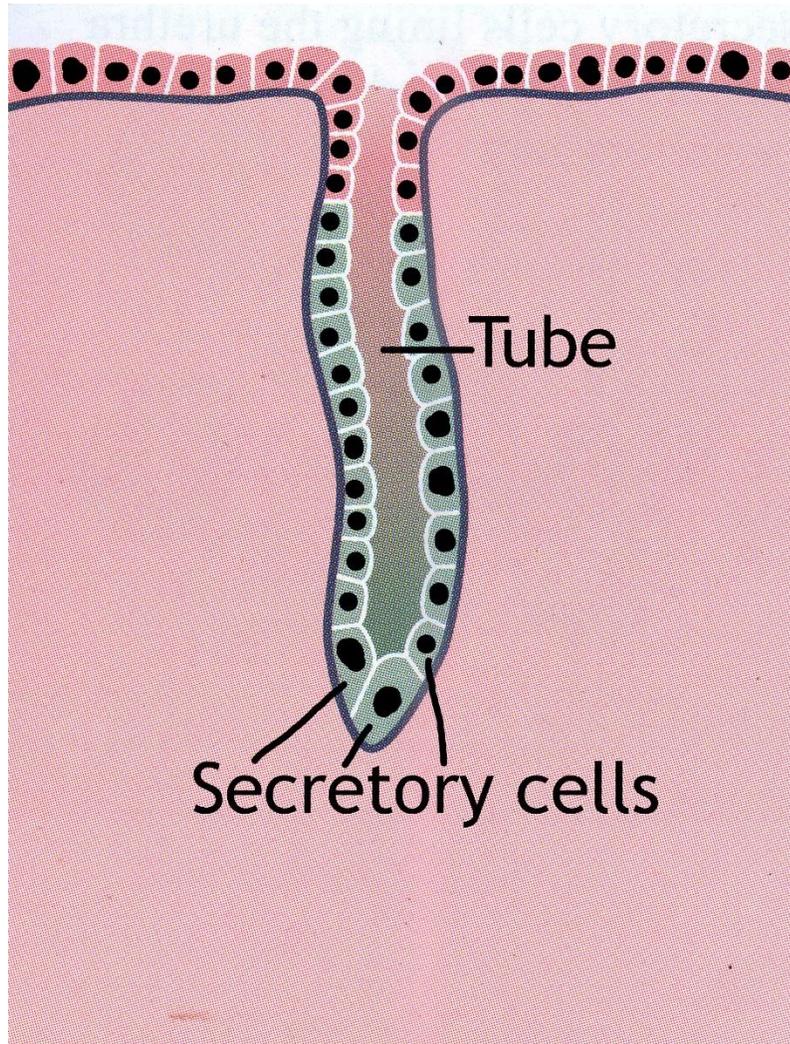
## Simple Tubular



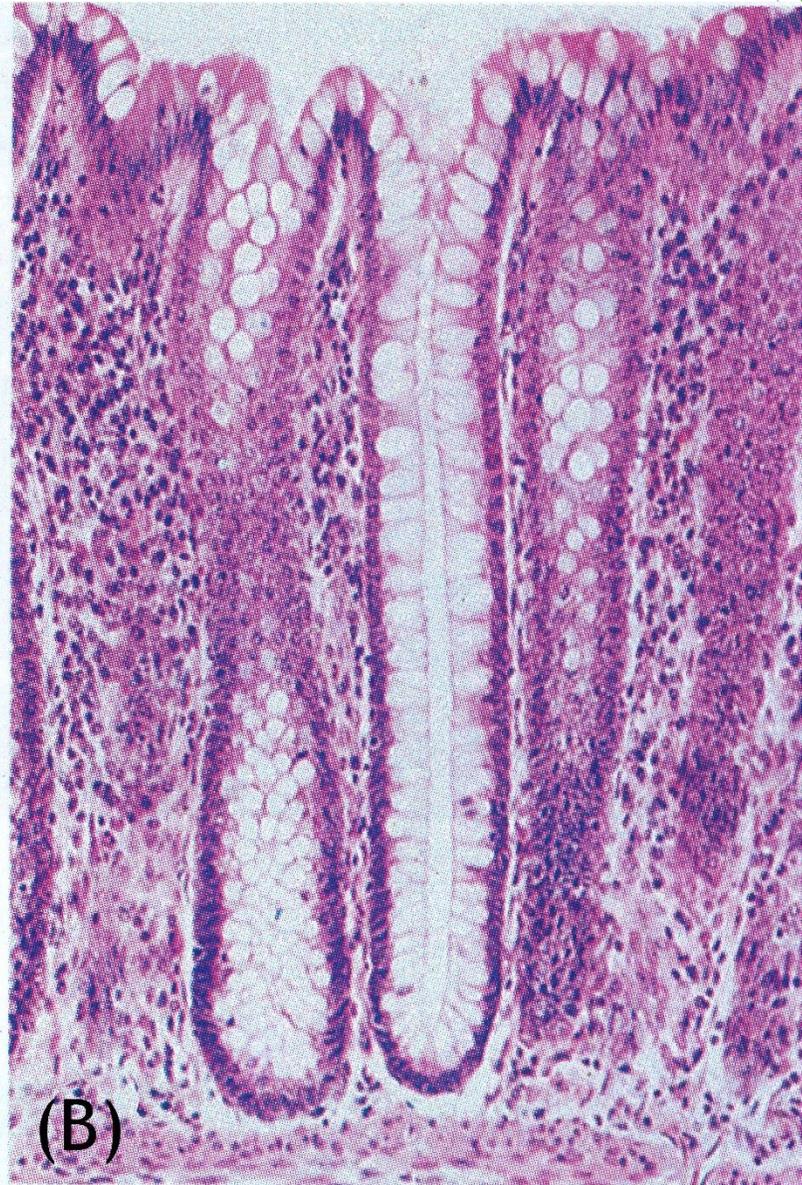
Elongated secretory portion; duct usually short or absent

Mucous glands of colon; intestinal glands or crypts (of Lieberkühn)





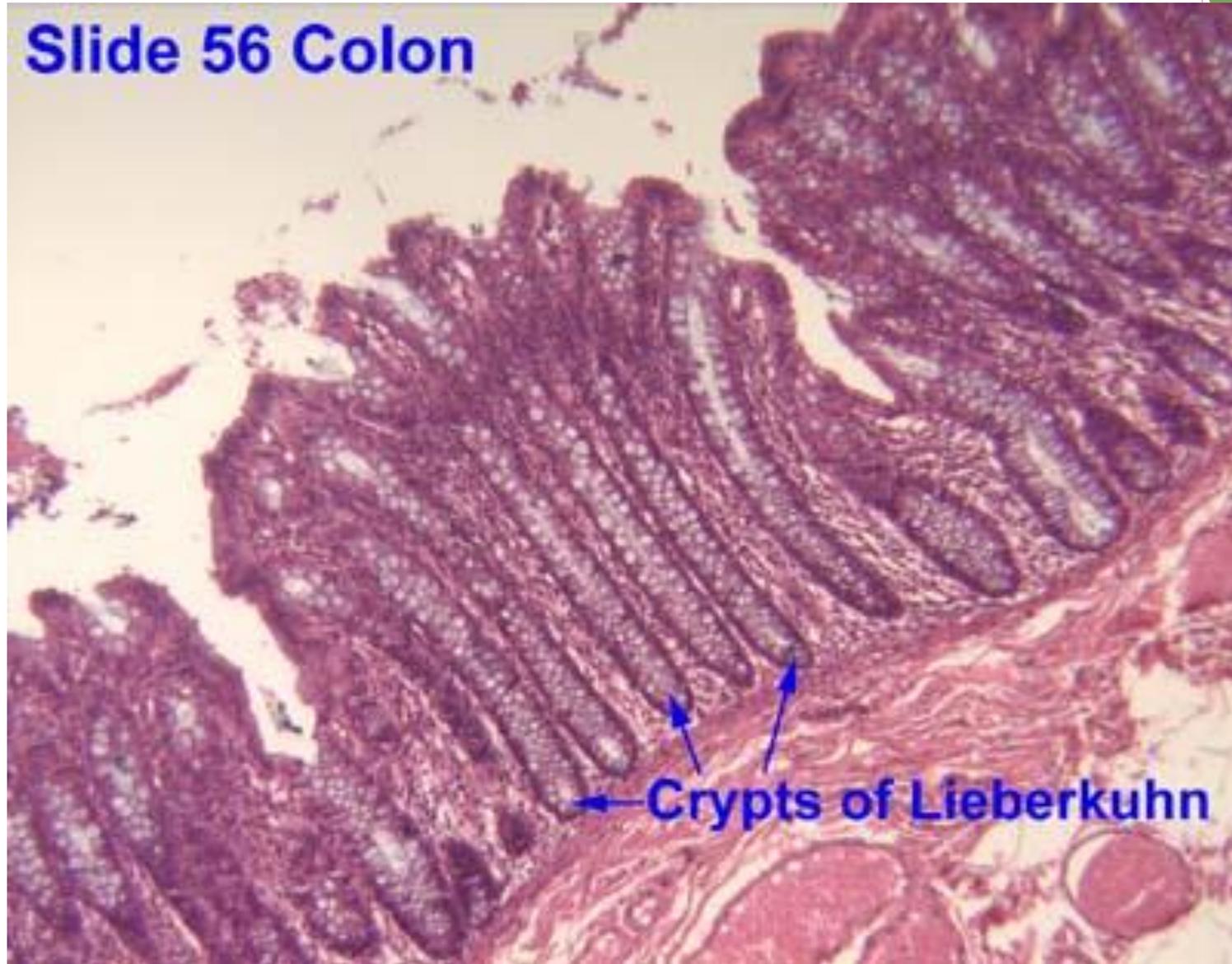
(A) Simple tubular gland



(B)



## Slide 56 Colon



**Colon H&E**



**lamina propria**

**crypt of  
Lieberkühn**

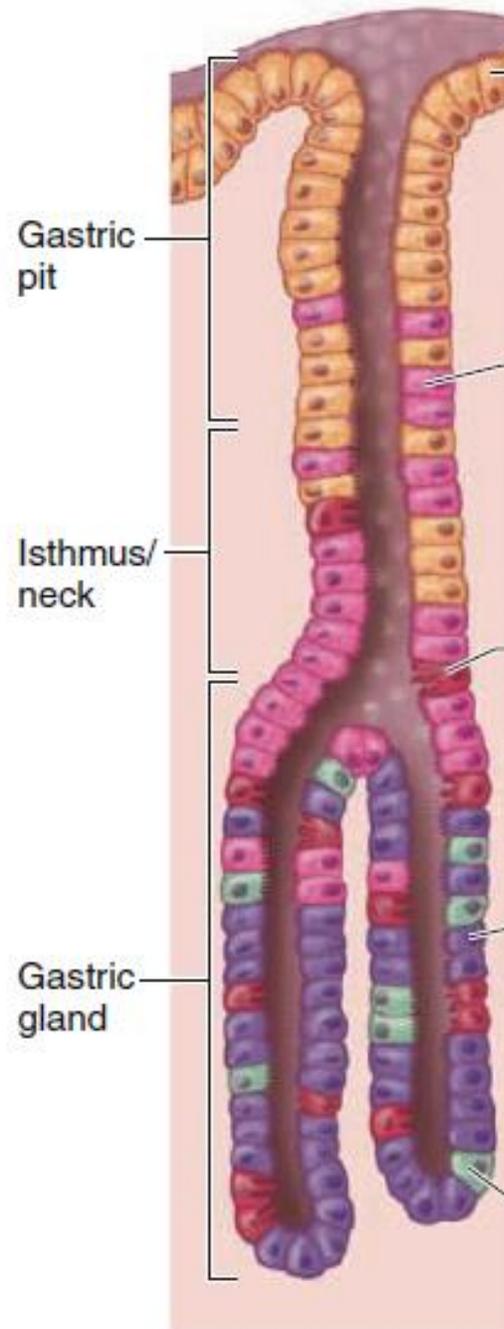
**muscularis mucosae**

**vein**

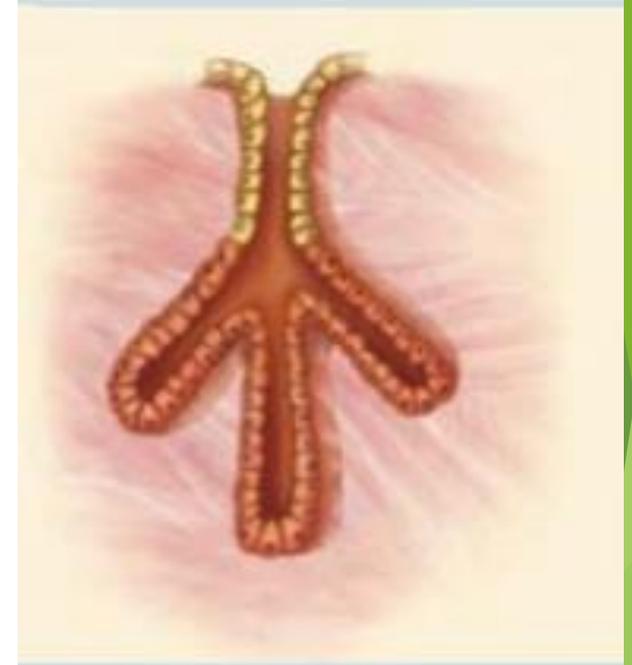
**submucosa**



# Branched tubular



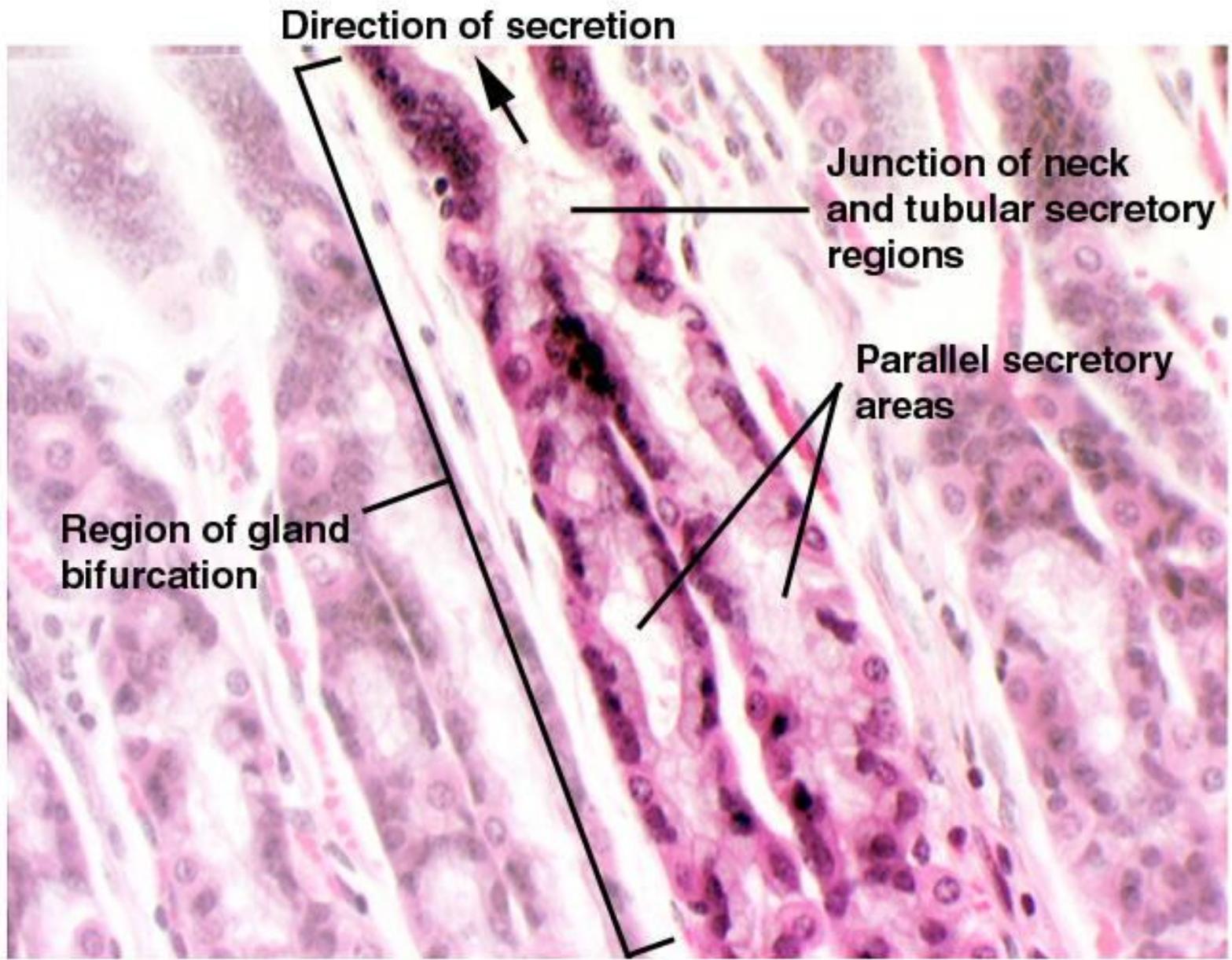
## Branched Tubular



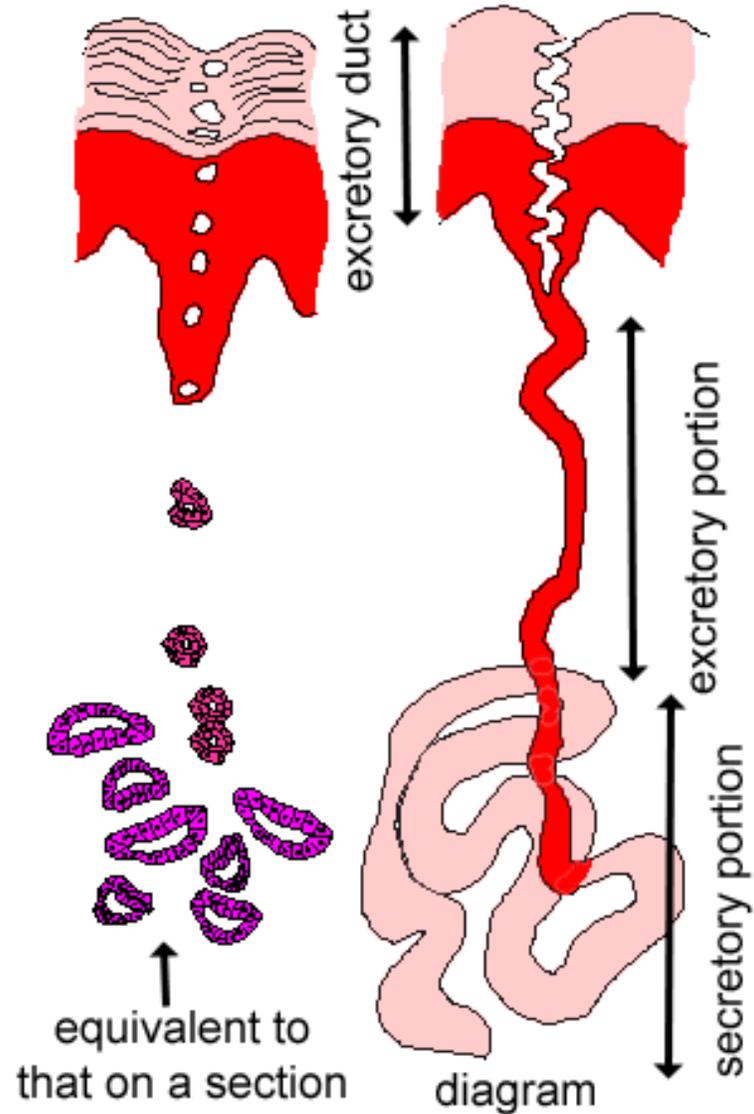
Several long secretory parts joining to drain into 1 duct

Glands in the uterus and stomach





# Coiled Tubular



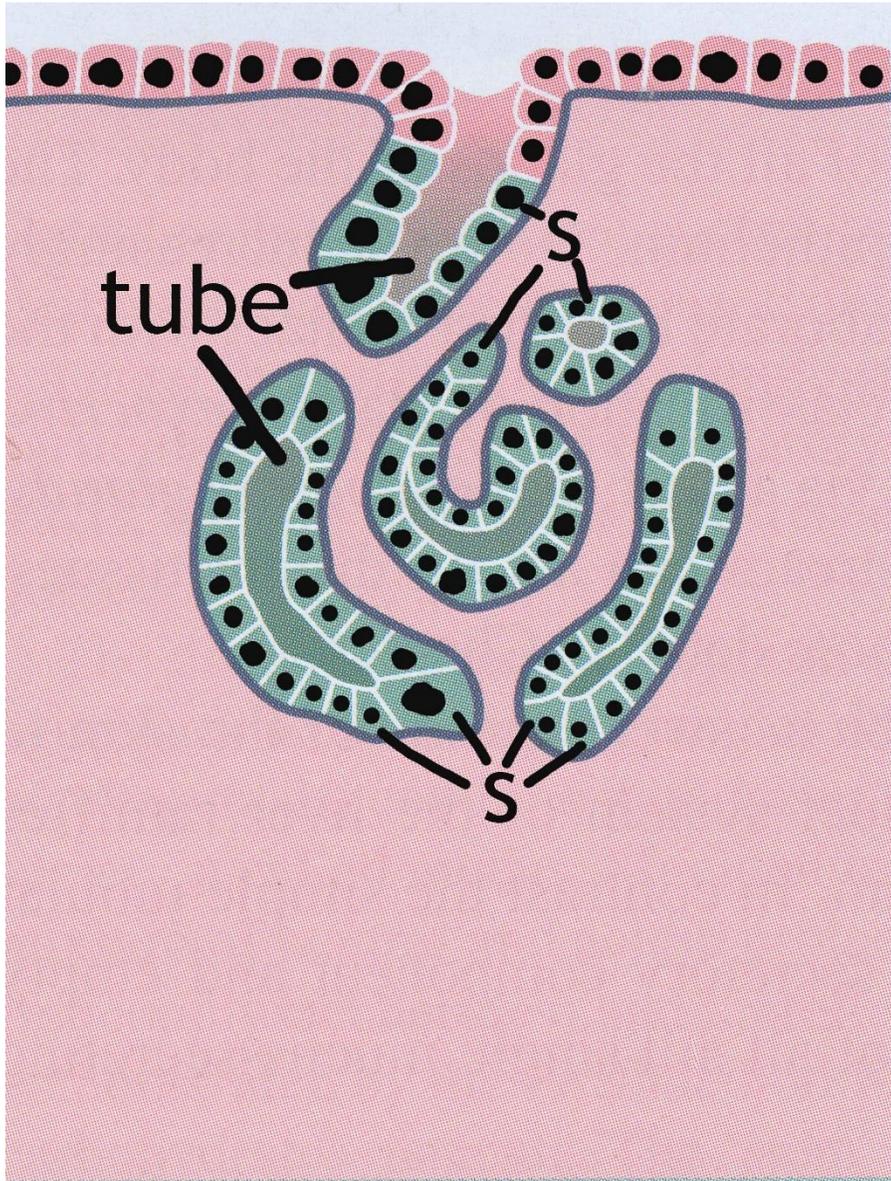
## Coiled Tubular



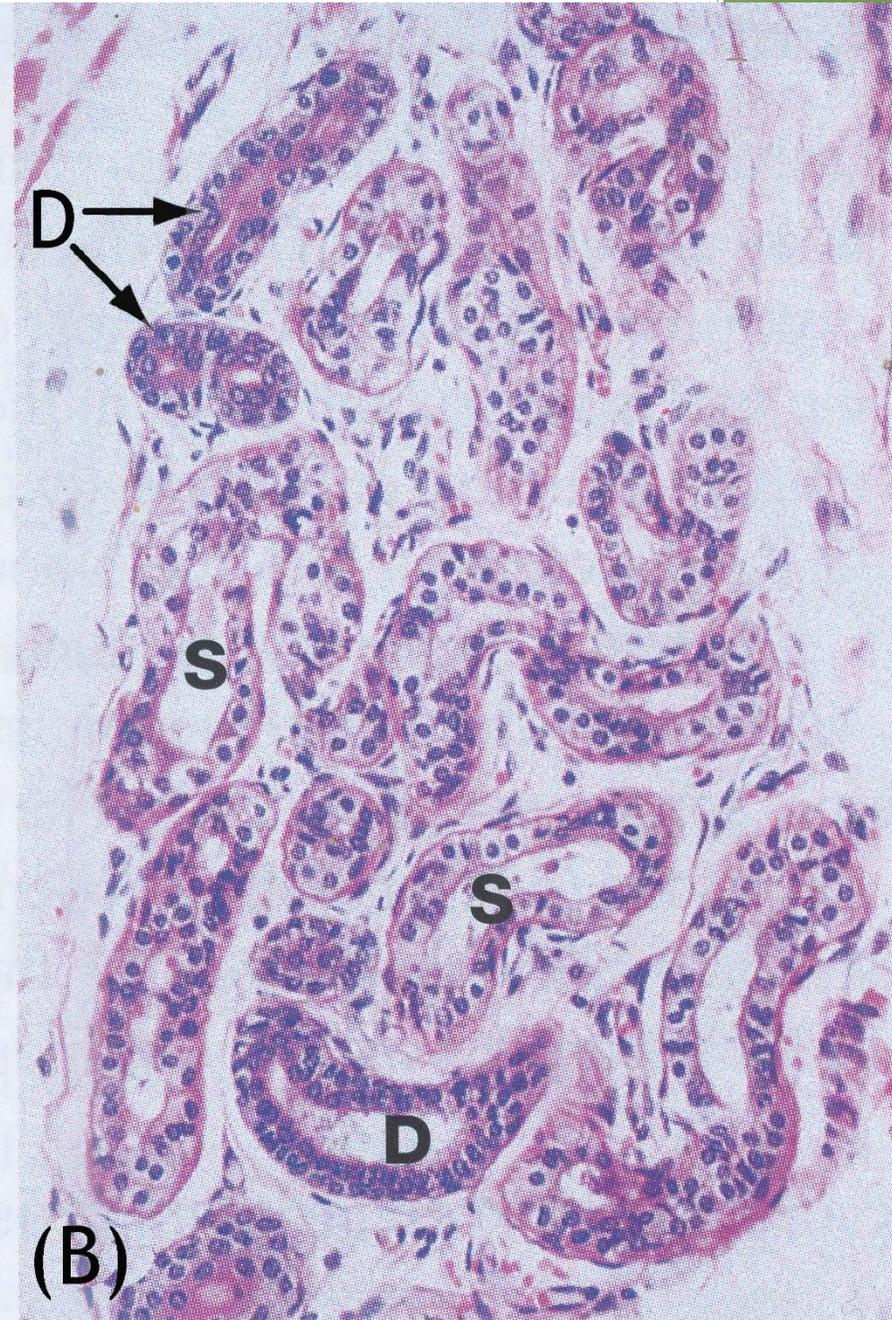
Secretory portion  
is very long and  
coiled

Sweat glands





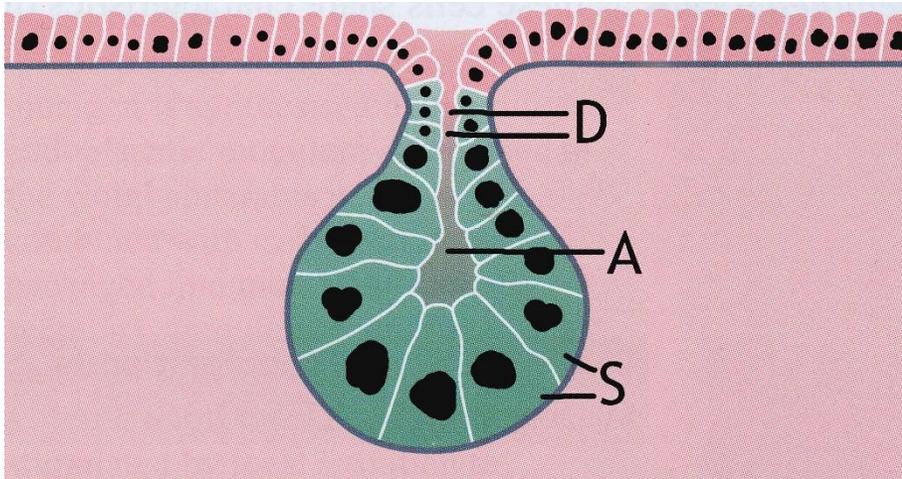
(A) Simple coil gland



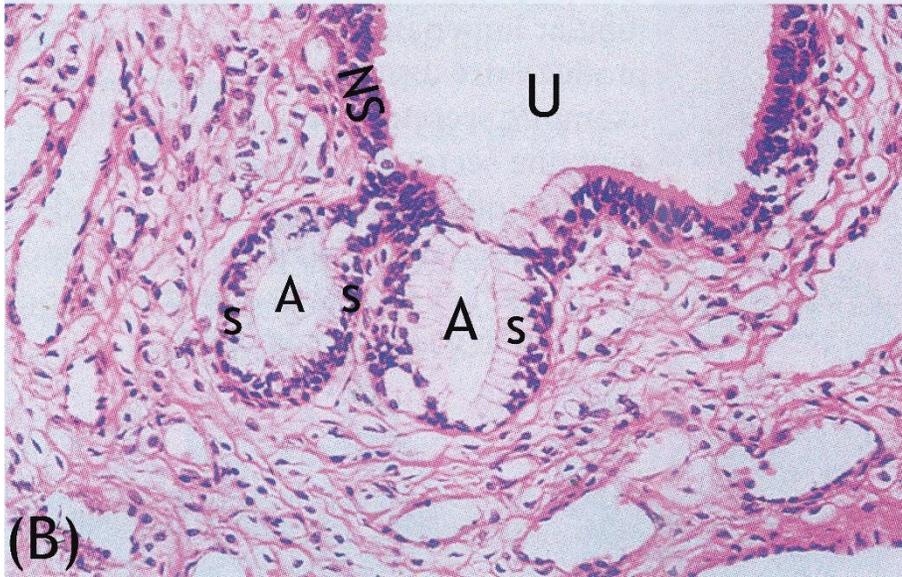
(B)



# Simple acinar (alveolar)



(A) Simple acinar gland



(B)

## Acinar (or Alveolar)

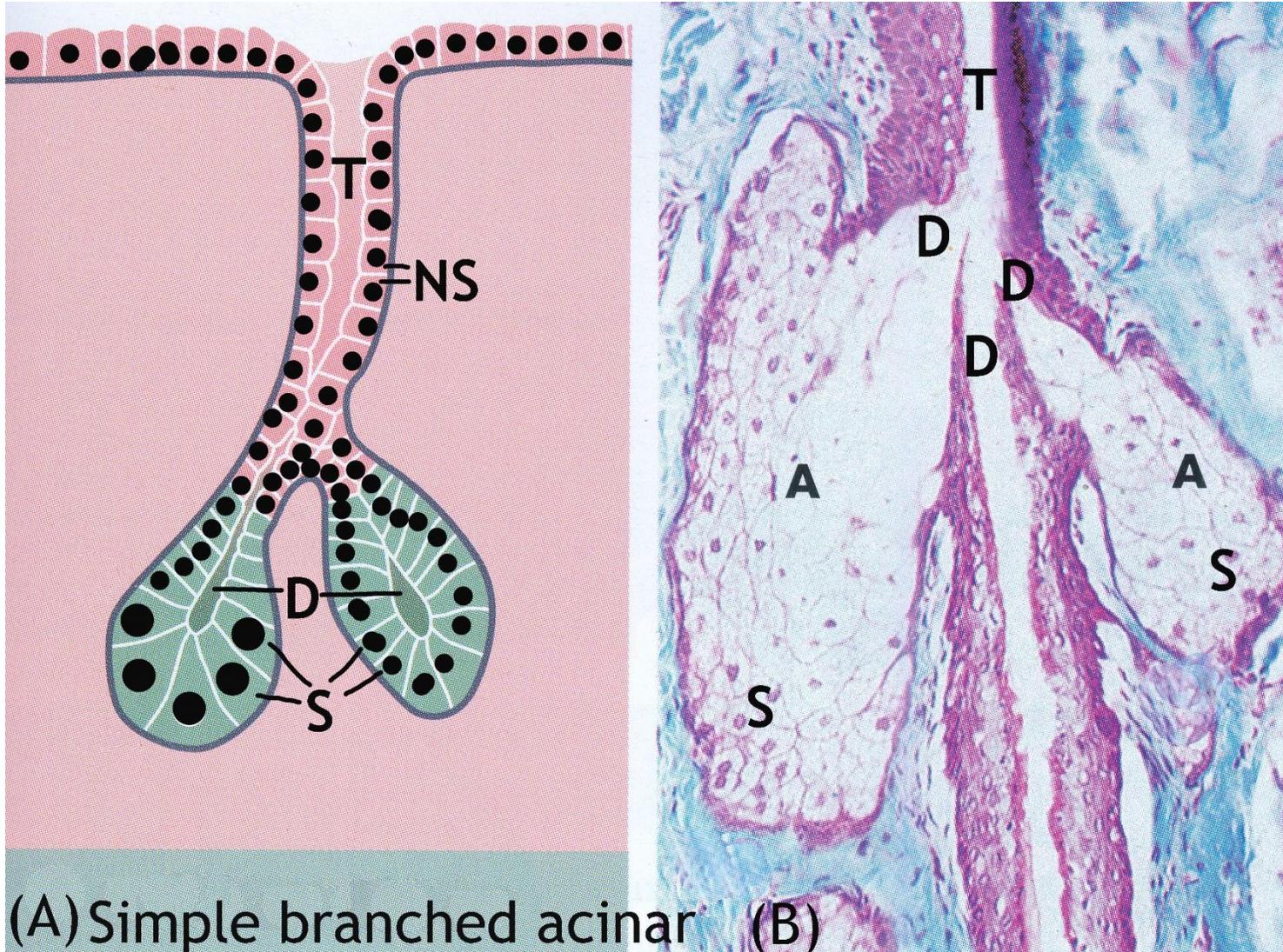


Rounded, saclike secretory portion

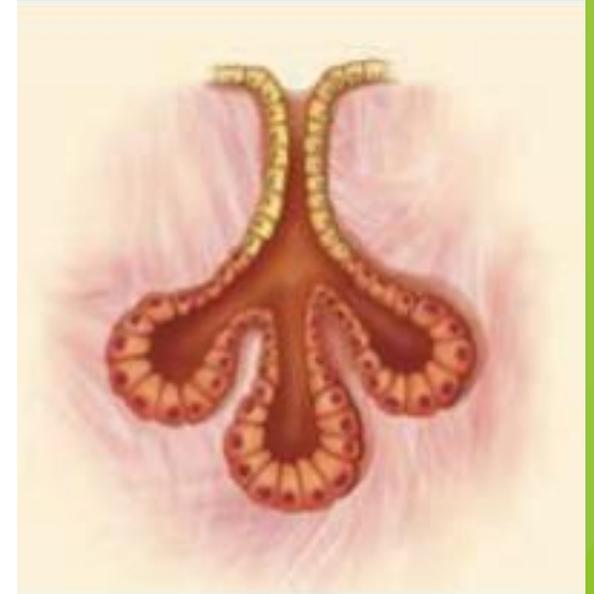
Small mucous glands along the urethra



# Branched acinar



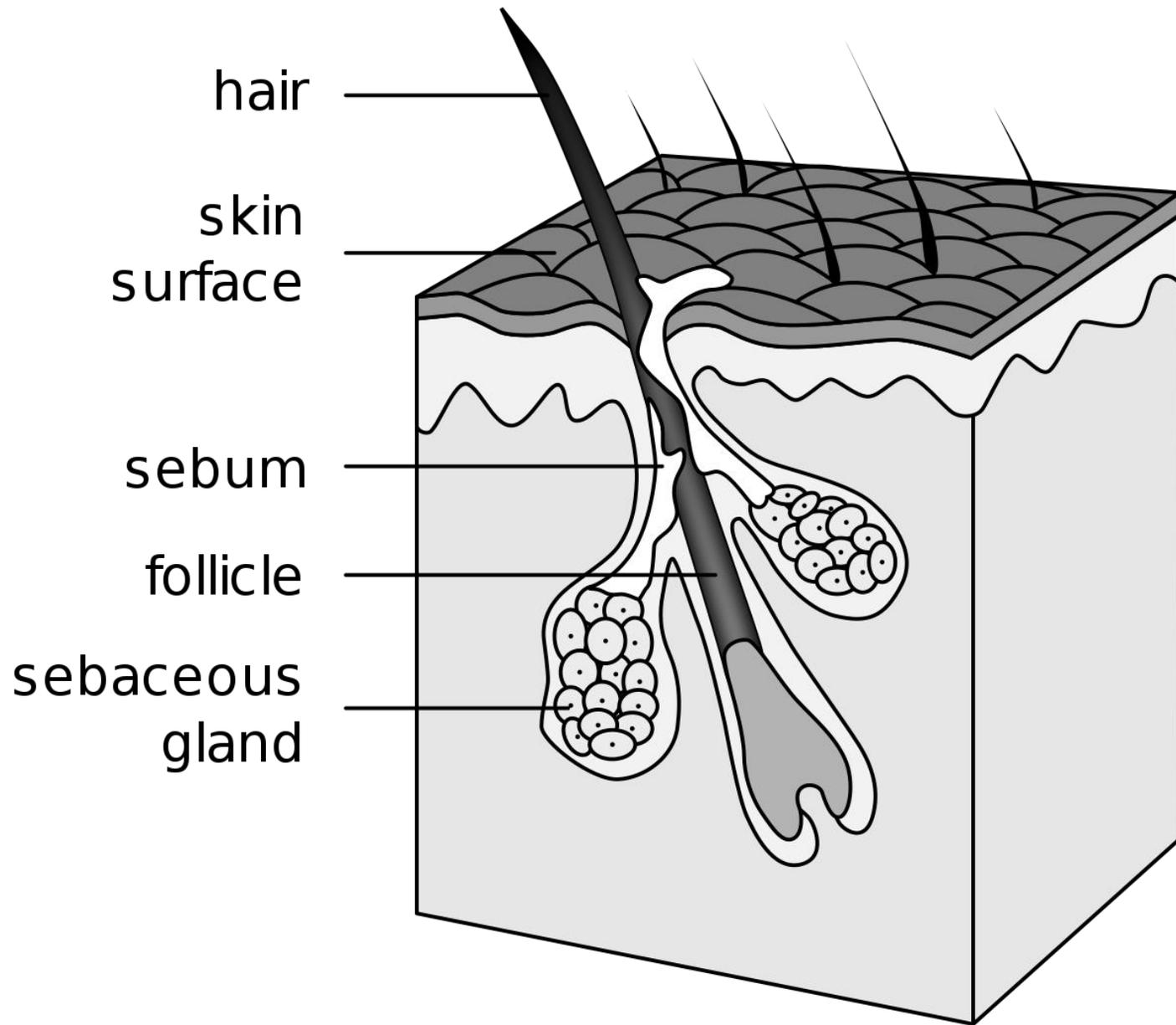
## Branched Acinar



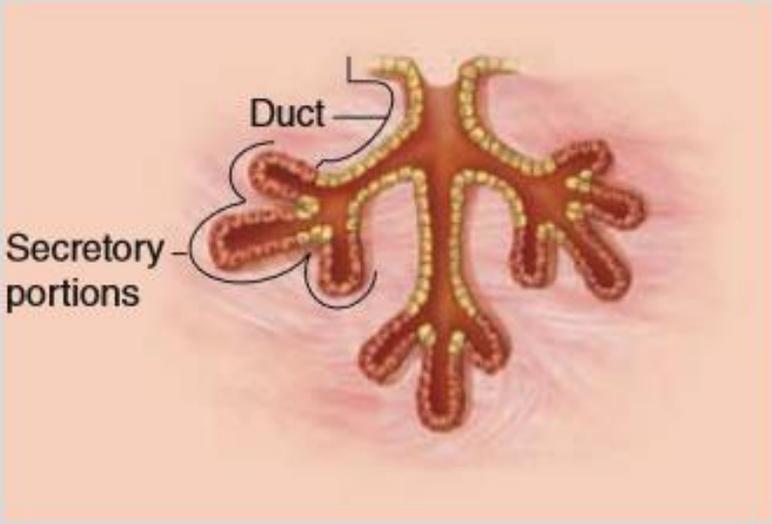
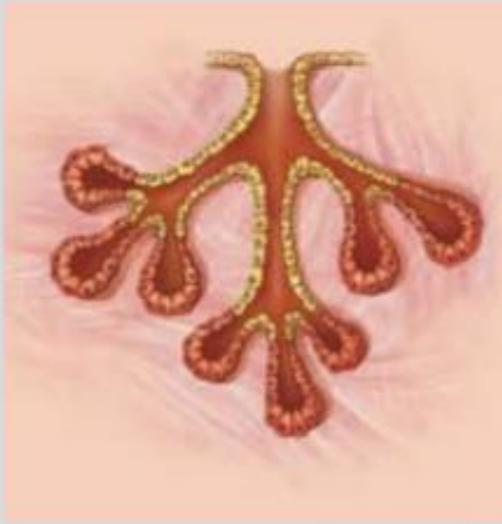
Multiple saclike secretory parts entering the same duct

Sebaceous glands of the skin



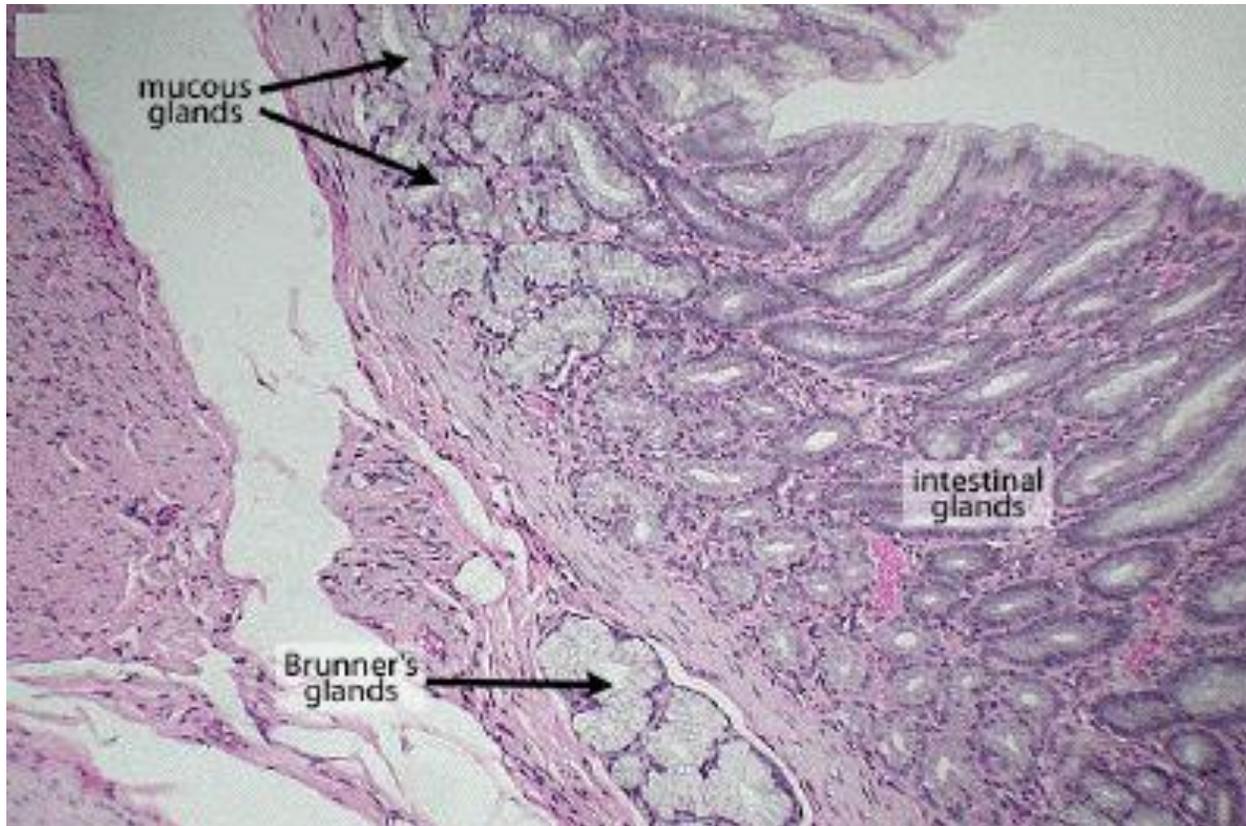


## COMPOUND Glands (Ducts from Several Secretory Units Converge into Larger Ducts)

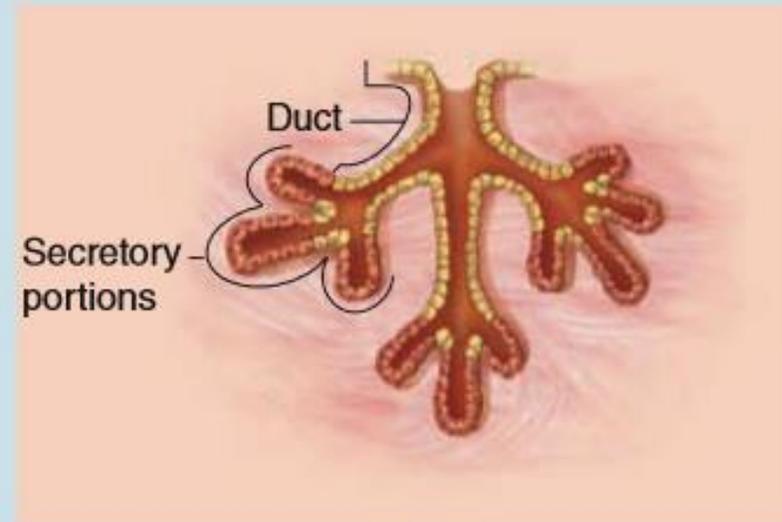
Class	Tubular	Acinar (Alveolar)	Tubuloacinar
			
Features	Several <i>elongated</i> coiled secretory units and their ducts converge to form larger ducts	Several <i>saclike</i> secretory units with small ducts converge at a larger duct	Ducts of both tubular and acinar secretory units converge at larger ducts
Examples	Submucosal mucous glands (of Brunner) in the duodenum	Exocrine pancreas	Salivary glands



# Compound tubular



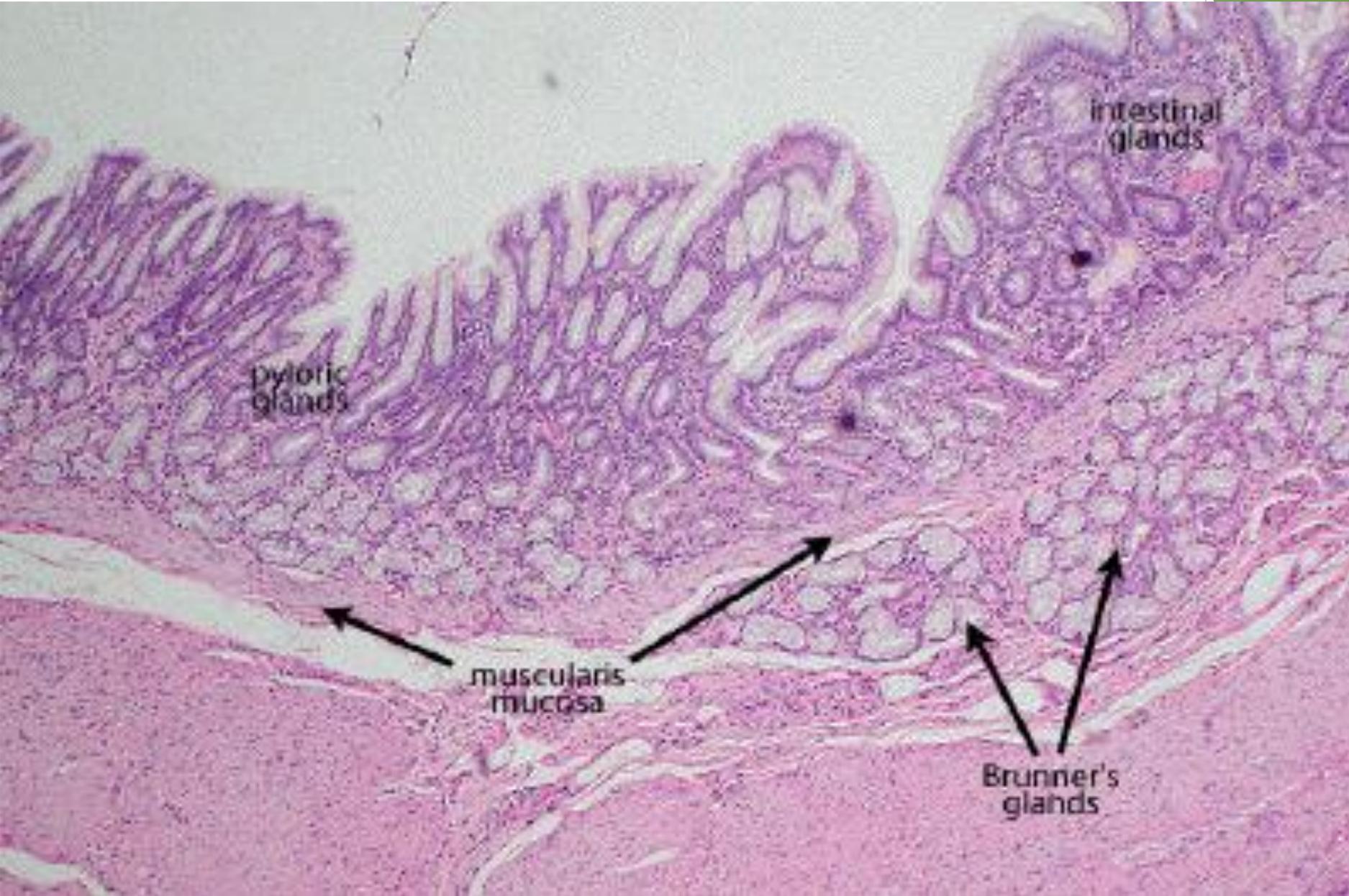
## Tubular



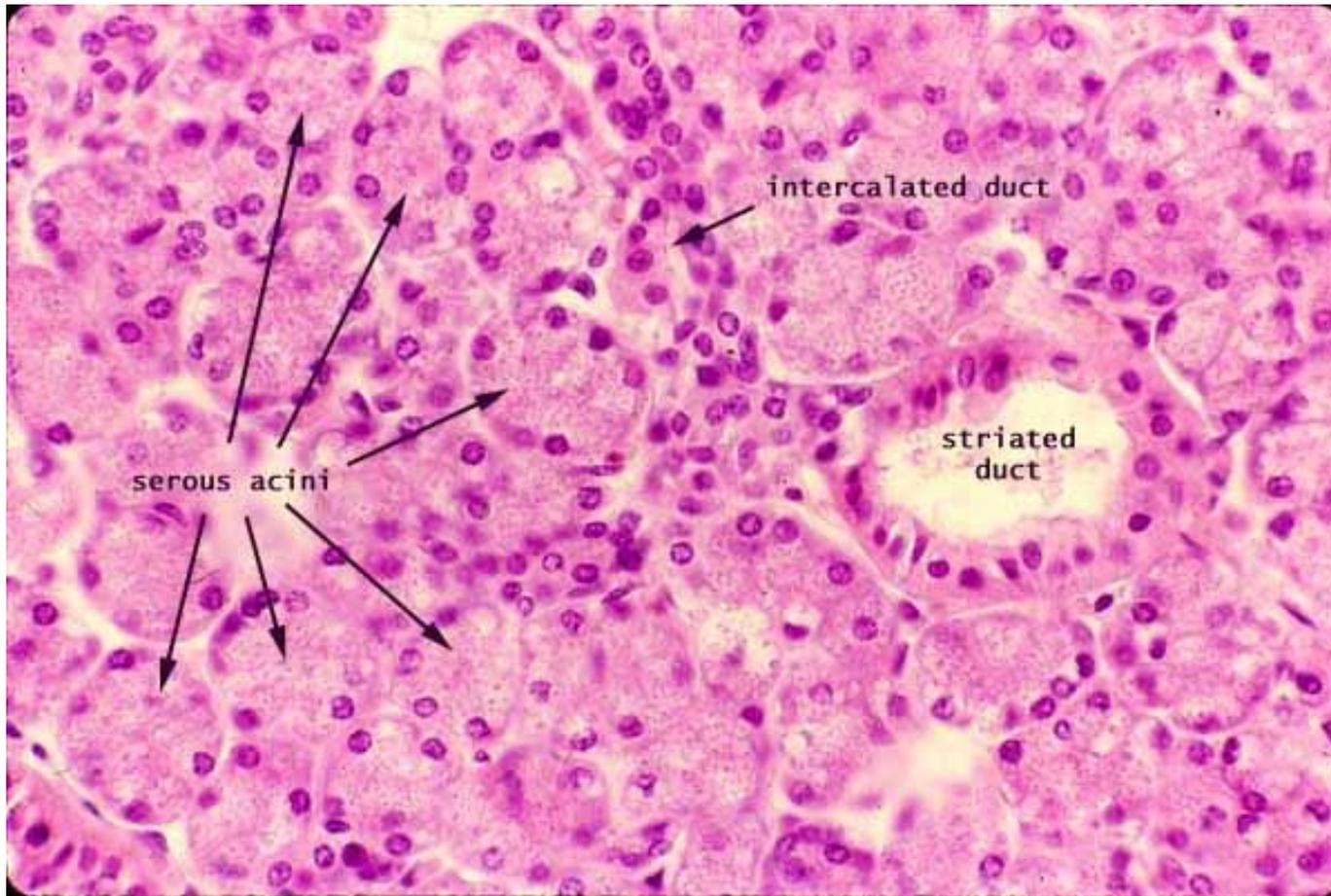
Several *elongated* coiled secretory units and their ducts converge to form larger ducts

Submucosal mucous glands (of Brunner) in the duodenum





# Compound acinar (alveolar)



Acinar (Alveolar)

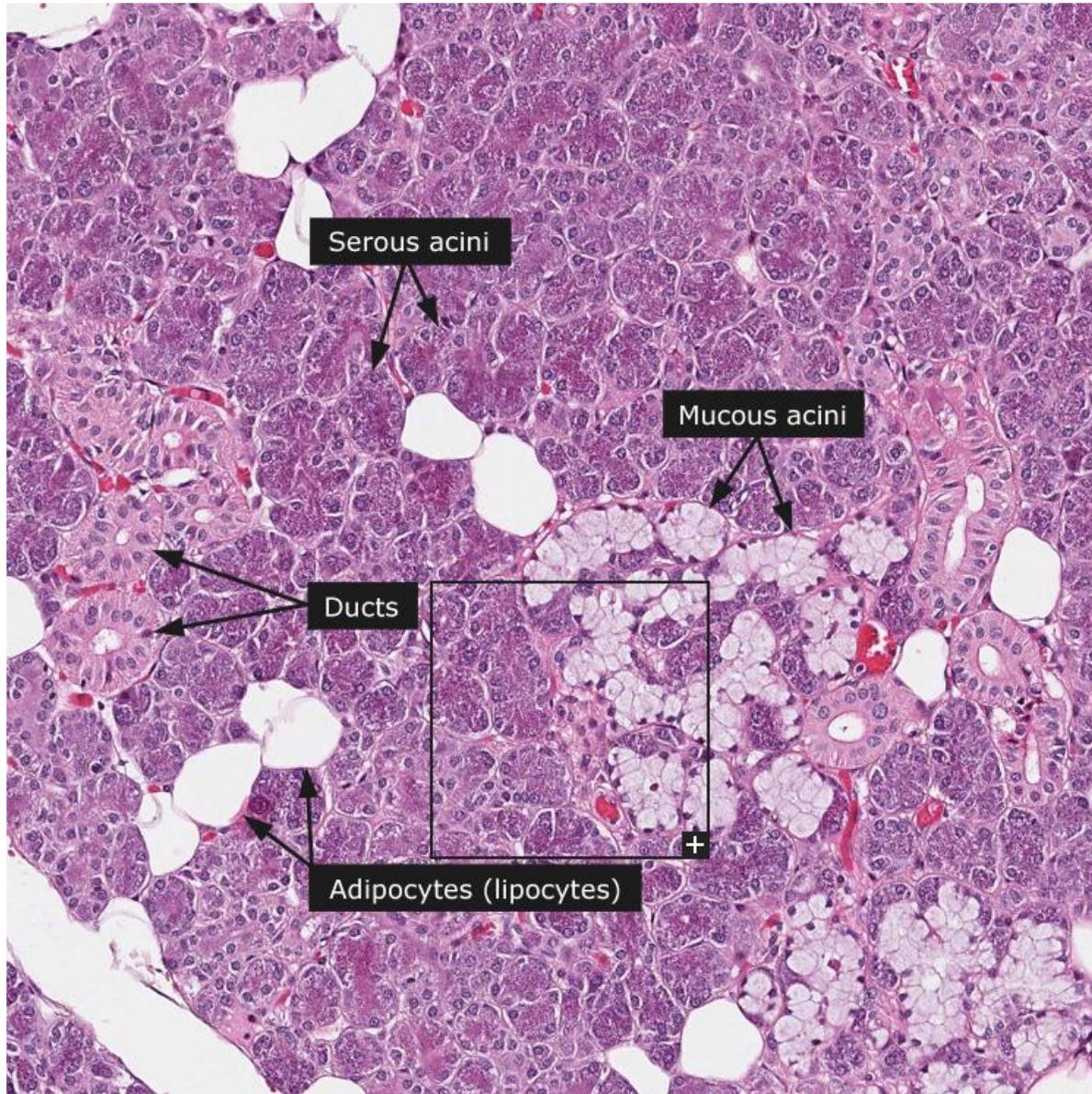


Several *saclike* secretory units with small ducts converge at a larger duct

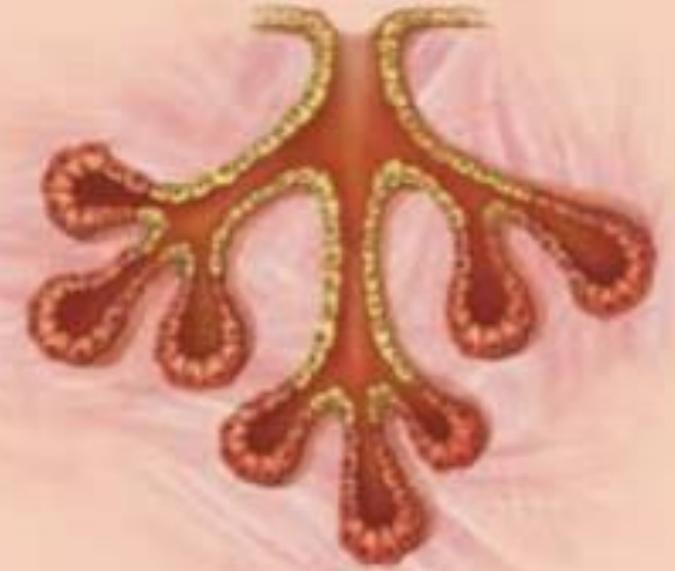
Exocrine pancreas



# Compound tubuloacinar



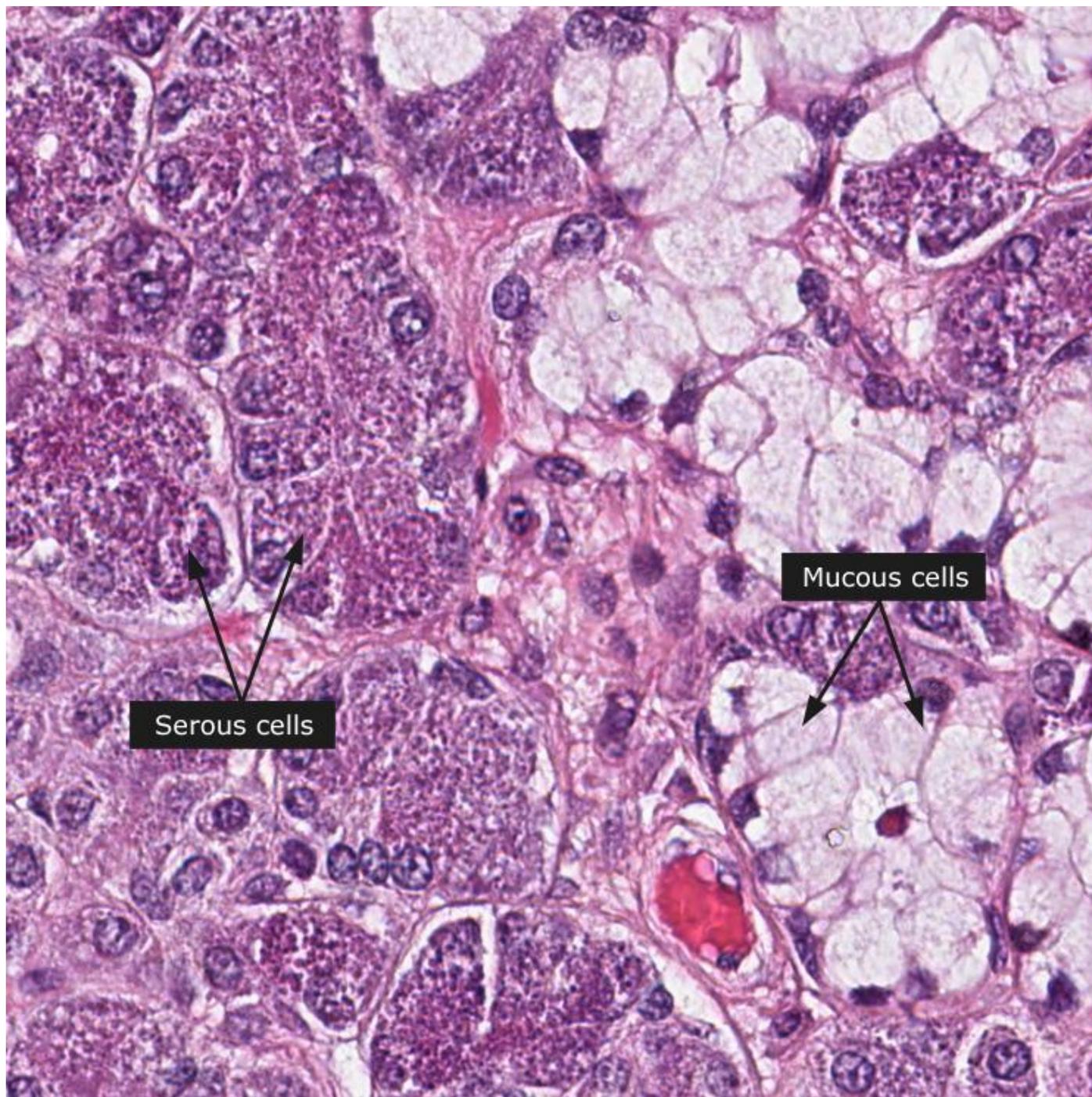
## Tubuloacinar



Ducts of both tubular and acinar secretory units converge at larger ducts

Salivary glands



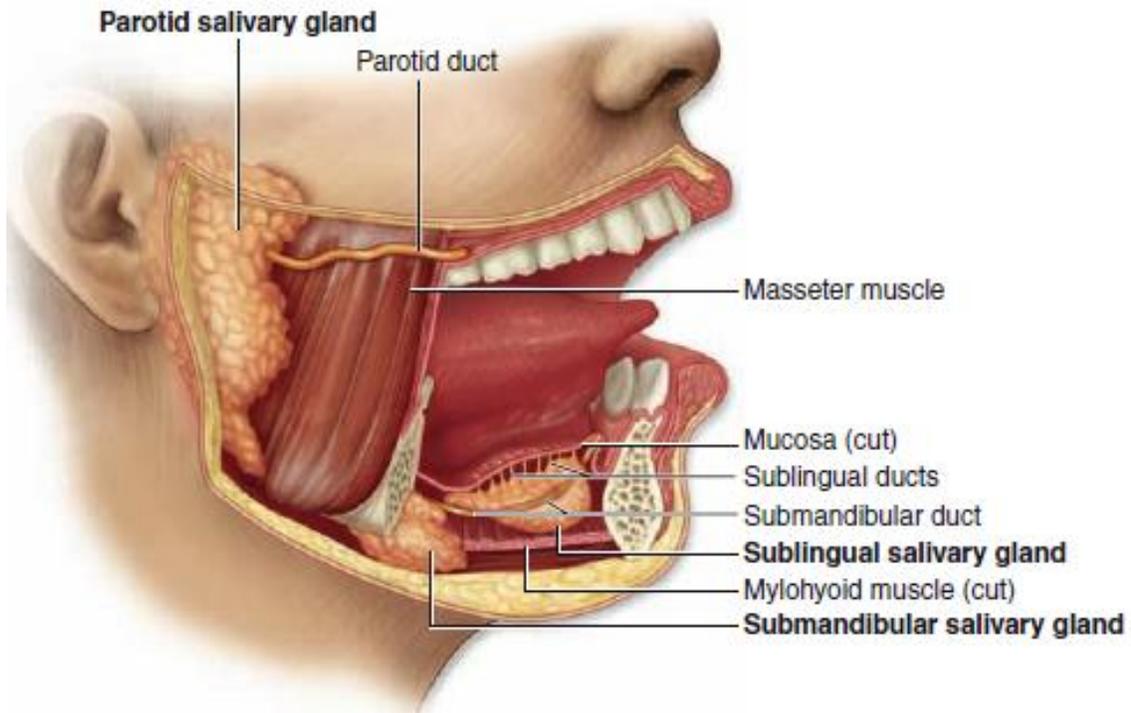


Serous cells

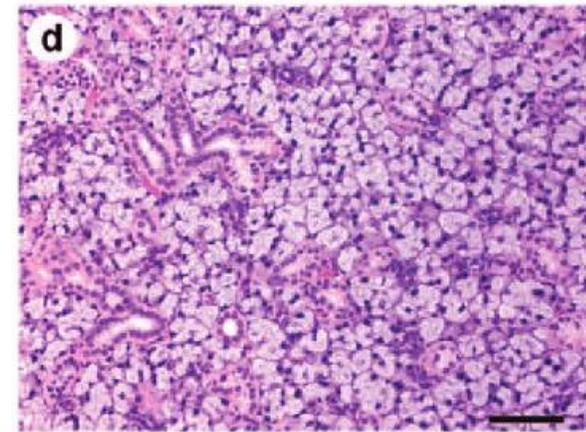
Mucous cells



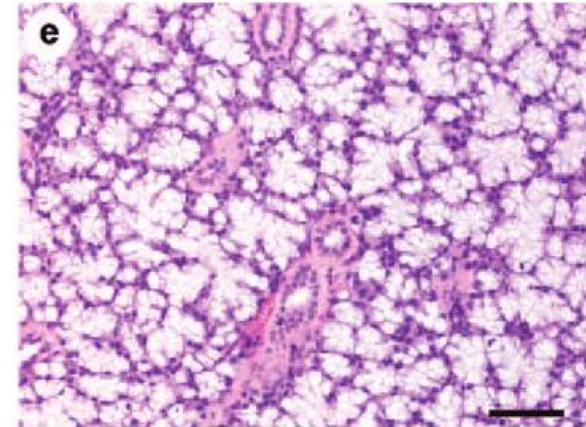
# Comparison between salivary glands



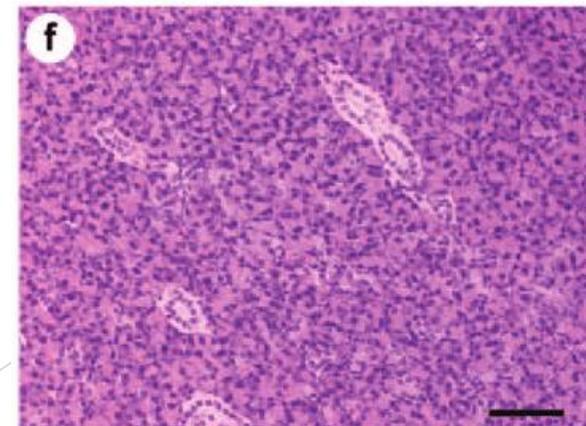
Sub-  
mandibular



Sublingual



Parotid



# Myoepithelial Cells

- ▶ Located between the secretory cells and the basement membrane
- ▶ These cells are rich in actin and myosin
- ▶ When myoepithelial cells contract, they help to extrude the glands' contents
- ▶ Each myoepithelial cell has long cytoplasmic processes which wrap around a secretory unit

