Lab 4

Glandular Epithelium

What are Glandular Epithelial Cells?

Glandular epithelial cells are specialized epithelial cells that secrete bodily products, sometimes called simply glands. Glands include two types: endocrine and exocrine.

A Comparison of Endocrine and Exocrine Glands:

Endocrine Glands	**Exocrine Glands**
No duct system	Ducts to release products
Secretions directed into the extracellular fluid (basal side), move into vascular system	Secretions released to the apical cell surface, move out of ducts to outside environment

Exocrine glands are often the only glands associated with the term "glandular epithelium." These glands are classified by the following morphological characteristics.

Number of Cells

Unicellular Glands	**Multicellular Glands**
Made of only one glandular epithelium cell; called intraepithelial cells	Multiple cells make up one gland; called extraepithelial cells
Goblet cells are the only human example (Figure 1)	Many examples, including secretory sheets in the human stomach

Type of Secretion

Serous	**Mucous**	**Mixed Serous-Mucous**
Thin, watery protein-rich secretion	Viscous secretion with lubricating or protective function	Serous demilunes (cells) secrete into space between mucous cells

Where are glandular epithelial cells found? What do they do?

Glandular epithelial cells make up any glands within the body. Examples include sebaceous glands of the skin and glands in the intestinal lining (exocrine glands), and many endocrine glands releasing hormones, such as the thyroid follicle as seen below in Figure 2. The function of glandular epithelial cells is directly related to their location. Exocrine glands hold secretions for linings and coverings of the body until the secretions are needed, at

which time the cells follow the above secretion mechanisms. Endocrine glands control hormone production processes, enclosing the formed hormones until they are needed in the body.

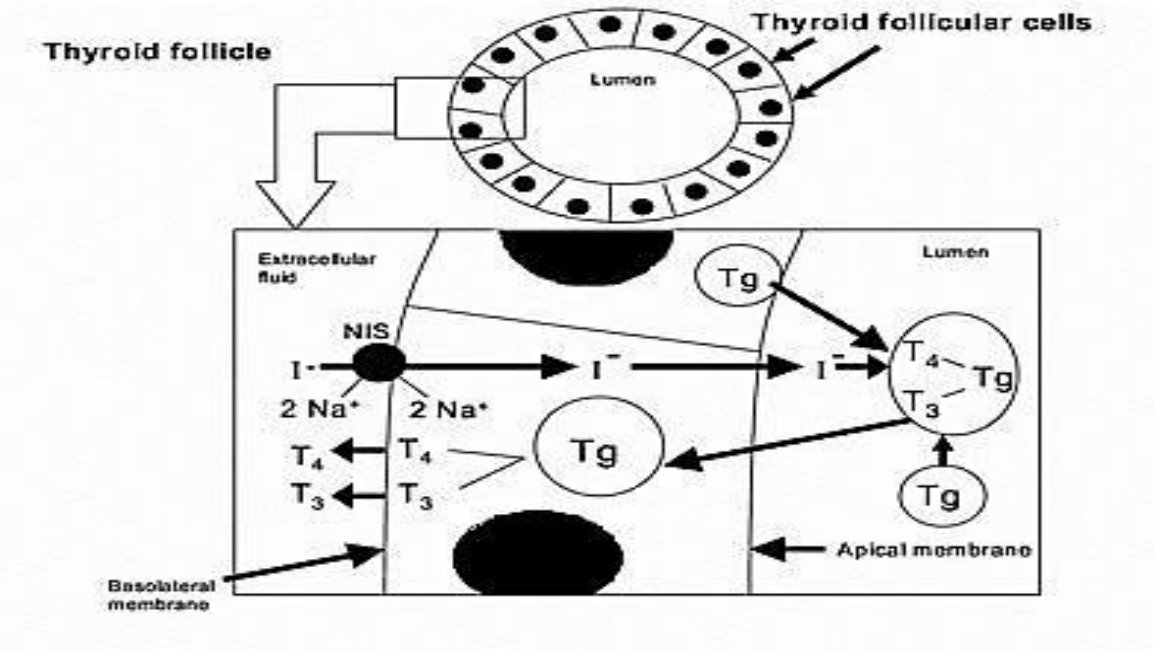


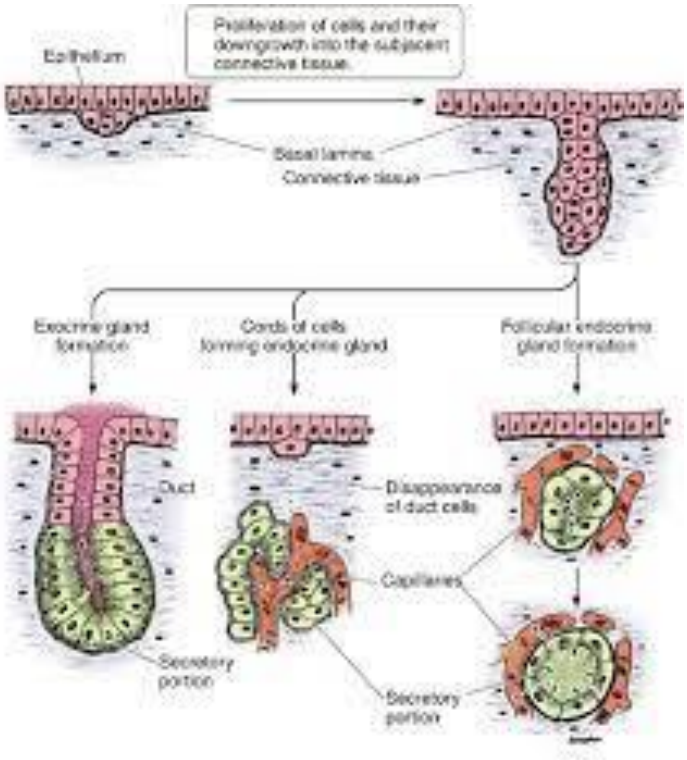
Figure 2. Representation of a thyroid follicle, which is surrounded by glandular epithelium. The follicle holds necessary components of thyoid hormones (T3 and T4) until they can be assembled and secreted from the cell as shown above.
Source: Reprinted with permission from Health Implications of Perchlorate Ingestion ©2005 by the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

GLANDS

are cells or aggregations of cells whose function is secretion.

- Exocrine glands release the secretory product via a system of ducts that opens upon one of the surfaces of the body which are in contact with the external world (skin, gastro-intestinal tract etc.).
- Endocrine glands release their secretory product (typically hormones) into the spaces between the secretory cells (extracellular space) from which it enters the bloodstream.

Both endocrine and exocrine glands are developmentally derived from epithelia, which form a down-growth into the underlying connective tissue. The cells forming this down-growth then develop the special characteristics of the mature gland. Exocrine glands maintain the connection with the body surface whereas it is lost by endocrine glands.



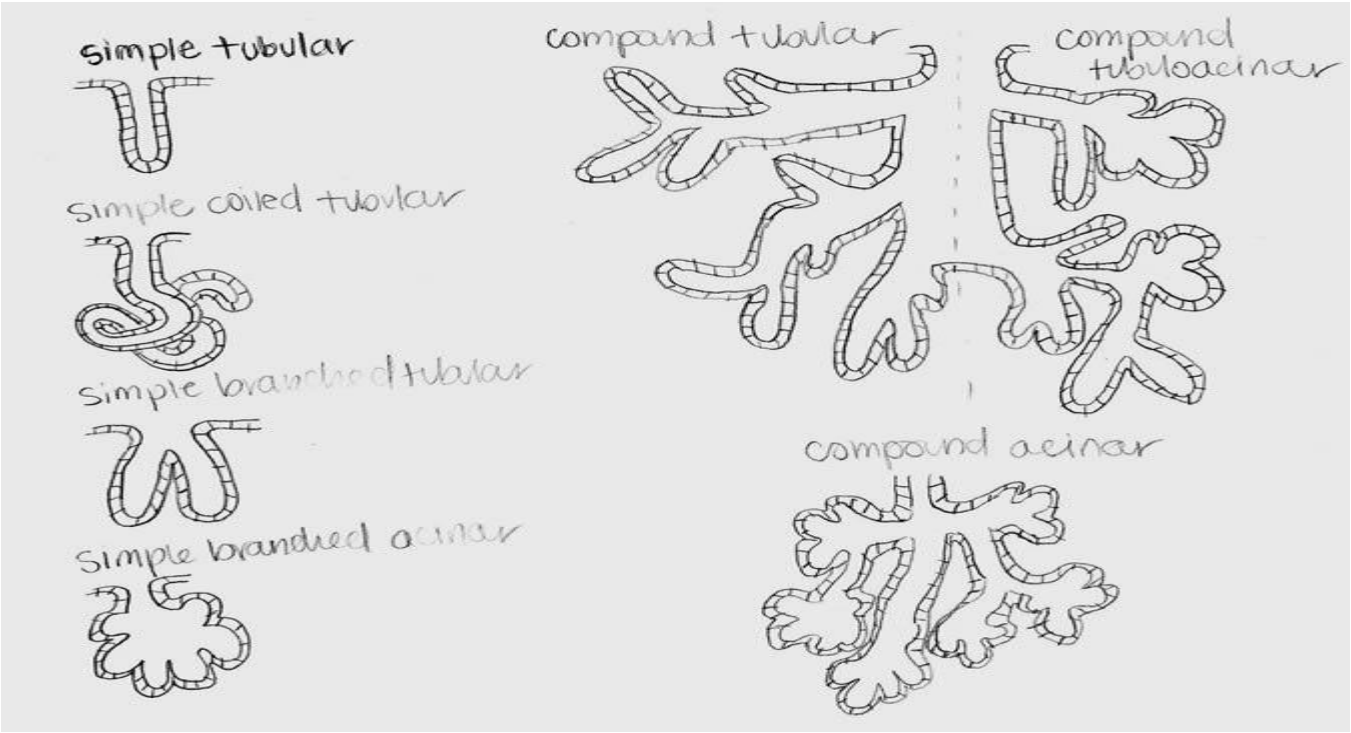


Figure 3. A hand-drawn representation of various shapes and arrangements of glands. Glandular epithelial cells are shown by rectangular shapes, which line the exterior of the glands.

Why should Glandular Epithelial Cells be studied?

Adenocarcinoma, a malignant tumor of the glandular epithelium, accounts for 40% of all lung cancer, making it the most common type. A histological example of adenocarcinoma is shown in Figure 4.

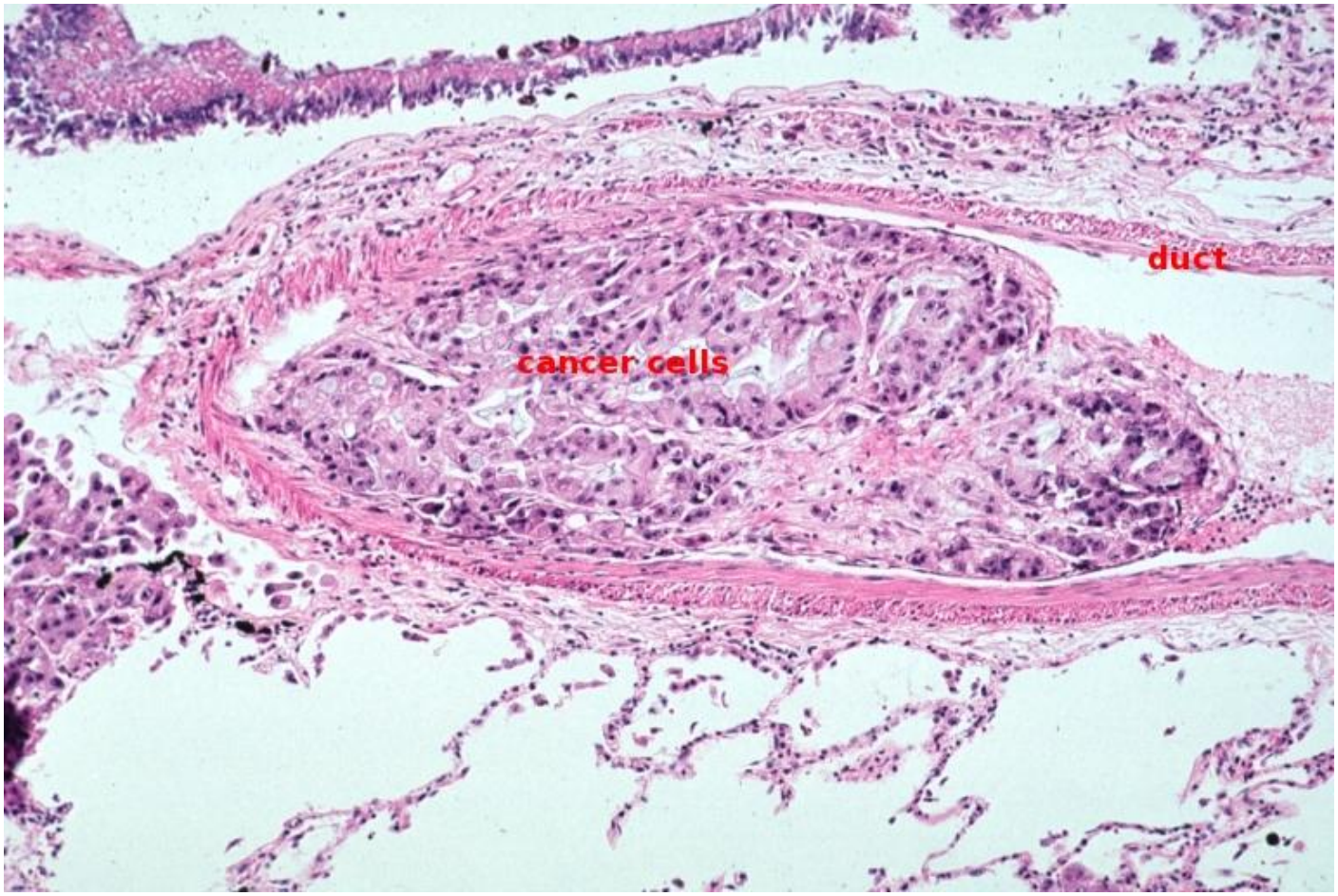


Figure 4. Adenocarcinoma of the Lung. Glandular epithelial cells create the lining of the duct, while the cancerous cells shown in the center of the duct are malignant glandular epithelial cells.
Source: http://peir2.path.uab.edu/scripts/acdis.dll?cmd=see&fp=/dbif/PEIR/00003022.tif&fmt=jpg&q=100&h=512

References:

Adenocarcinoma - definition and more from the free merriam-webster dictionary. Retrieved 9/6/2010, 2010, from http://www.merriam-webster.com/dictionary/adenocarcinoma

Classification of Exocrine Glands : Exocrine glands may be classified according to cell number, and/or the shape and branching pattern of their secretory portions and ducts.

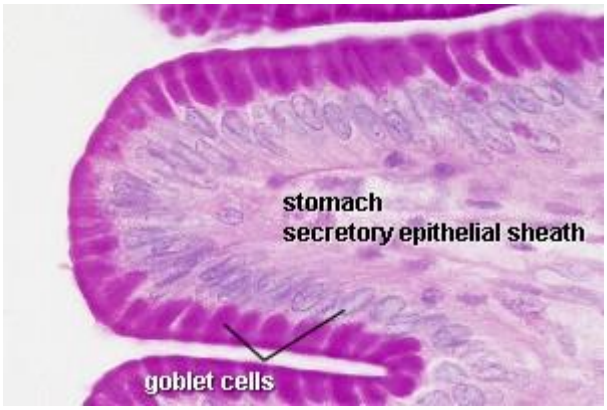
Unicellular Glands

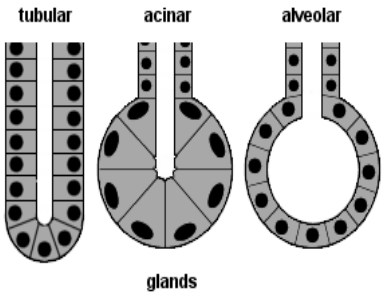
consist of a single secretory cell. In mammals the only example of unicellular exocrine glands are goblet cells, which occur in the epithelium of many mucous membranes. Goblet cells secrete the glycoprotein mucin, which by the uptake of water is converted into a slimy substance, mucus.

Multicellular glands

The simplest form of a multicellular gland is a secretory epithelial sheath - a surface epithelium consisting entirely of secretory cells (e.g. the epithelium lining the inner surface of the stomach,

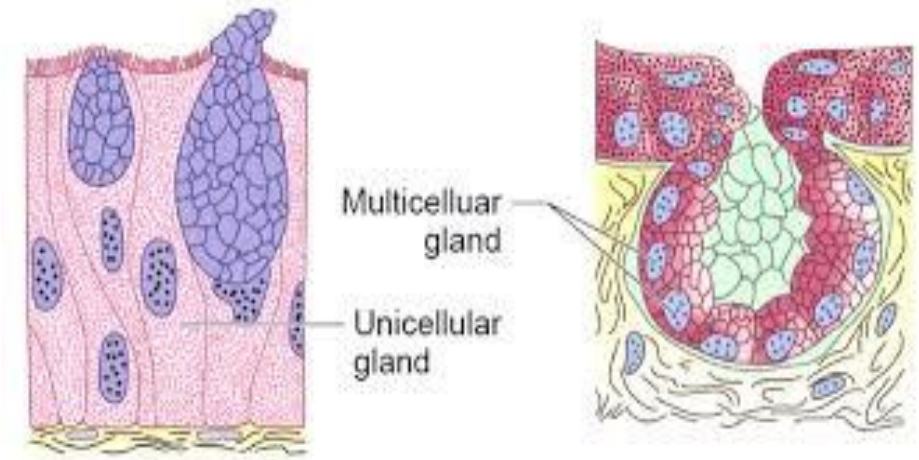
where the mucous secretion protects the stomach wall from the acidic contents of the stomach). Other multicellular glands have their secretory portion embedded in the connective tissue underlying the epithelium. The secretion is either discharged directly from the secretory portion onto the epithelium or reaches the epithelium via a duct system that consists of non-secretory cells.

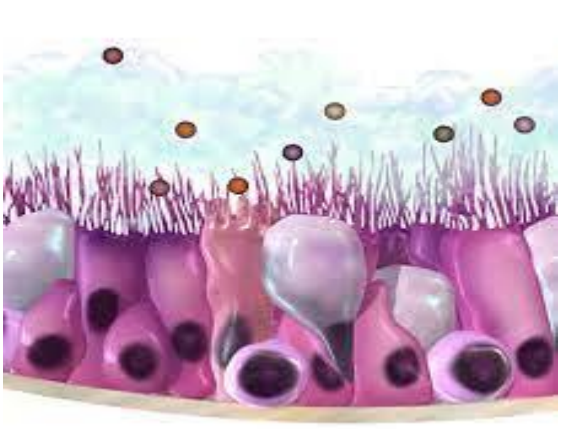


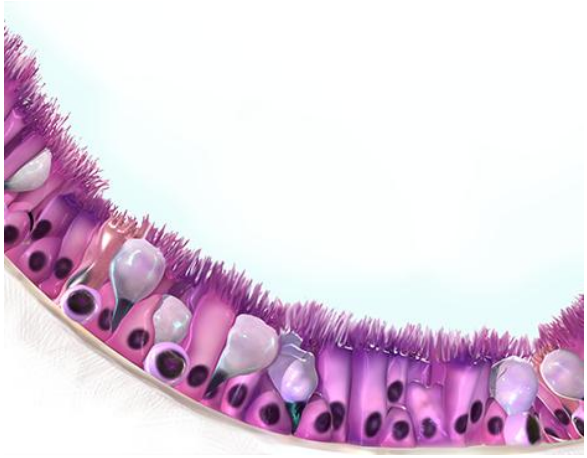


The secretory portion may have a variety of shapes. Secretory cells may form

- tubes in tubular glands,
- acini in acinar glands or
- alveoli in alveolar glands.



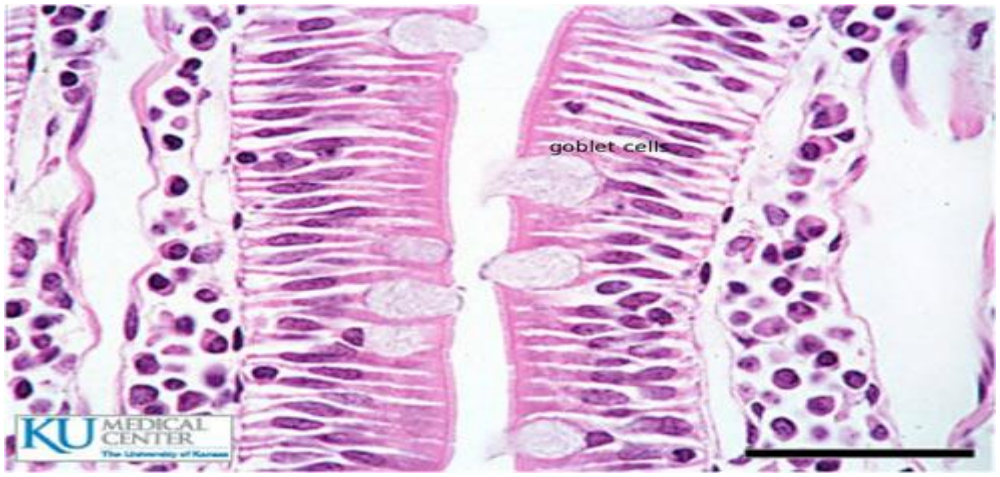




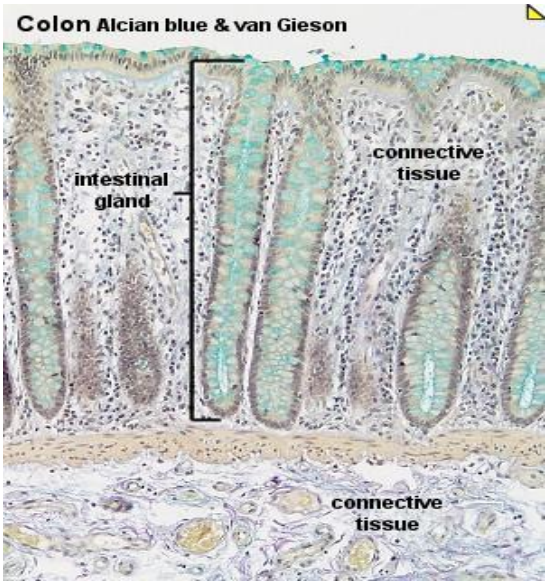
Combinations exist - the pancreas is a tubulo-acinar gland, in which each section of the secretory system has a specialized function.
The precursors of digestive enzymes are produced by the acinar cells. **Tubular cells secrete the alkaline bicarbonate solution which eventually neutralizes the acidic** contents of the stomach that are released into the duodenum.

Multicellular glands with an unbranched excretory duct are called simple. We talk about a compound gland when the excretory duct is branched. Finally, the part of the gland consisting of secretory cells is branched in a (surprise!) branched gland.

The classification scheme may appear somewhat elaborate - but there are many exocrine glands around. All of them can be identified and described by this scheme, and some ideas about their function can be derived from this description.



A goblet cell, in the villi of the intestine, secreting mucus.



Suitable Slides

unicellular exocrine glands (goblet cells): sections of intestines (duodenum, jejunum, ileum or colon) or trachea - H&E

secretory epithelial sheath: stomach - H&E

straight tubular glands: sections of stomach (principal glands) or colon (intestinal glands) - van Gieson, H&E

coiled tubular glands: sections of skin (sweat glands) - see lab section on the Integumentary System page.

Colon, human - van Gieson Straight tubular glands extend from the surface of the colon into the underlying connective tissue. Although they are present throughout the intestines they are largest in the colon and, because of the smooth inner surface of the colon, they often show in good longitudinal or transverse sections. The lumen of the glands is narrow and surrounded by secretory cells of several types, which include goblet cells. The connective tissue beneath the epithelium and surrounding the glands in the colon contains more cells than the connective tissue beneath other epithelia that were considered on this page. This is a characteristic feature of the epithelia in the digestive system.Glands cut at slightly oblique angles will connect to the lumen outside of the plane of the section. If possible, draw both longitudinally and transversely sections intestinal glands. Include part of the surrounding connective tissue and surface epithelium.

Exercise: Draw a compound branched tubulo-acinar gland. Indicate in your drawing which parts are secretory and which parts are non-secretory.

Mechanism of Secretion

Merocrine	Apocrine	Holocrine
Expelled by exocytosis	Uses membrane vesicles	Entire secretory cell lost, as plasma membrane breaks to release product
Only secretory product is lost	Secretory product and some membrane lost	Sebaceous glands use this method

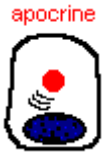
Shape and Arrangement

Shapes include tubular, coiled tubular, acinar or alveolar, or a combination of these. The arrangement could be simple, branched, or compound (Figure 3).

Secretory Mechanisms

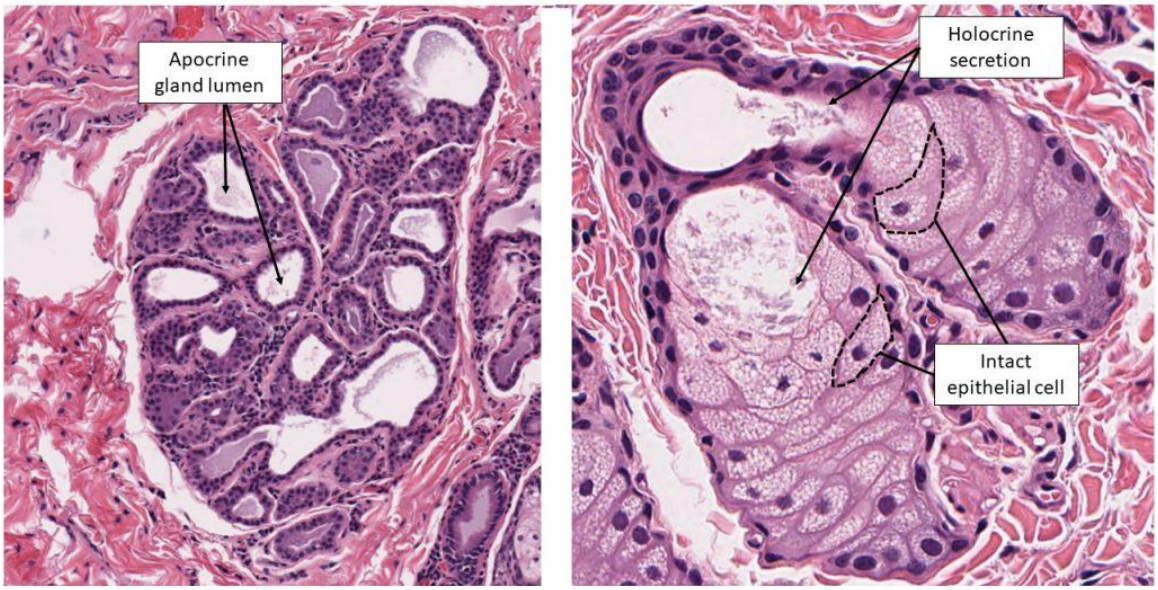
The secretory cells can release their secretory products by one of three mechanisms.

1. Merocrine secretion corresponds to the process of exocytosis. Vesicles open onto the surface of the cell, and the secretory product is discharged from the cell without any further loss of cell substance.



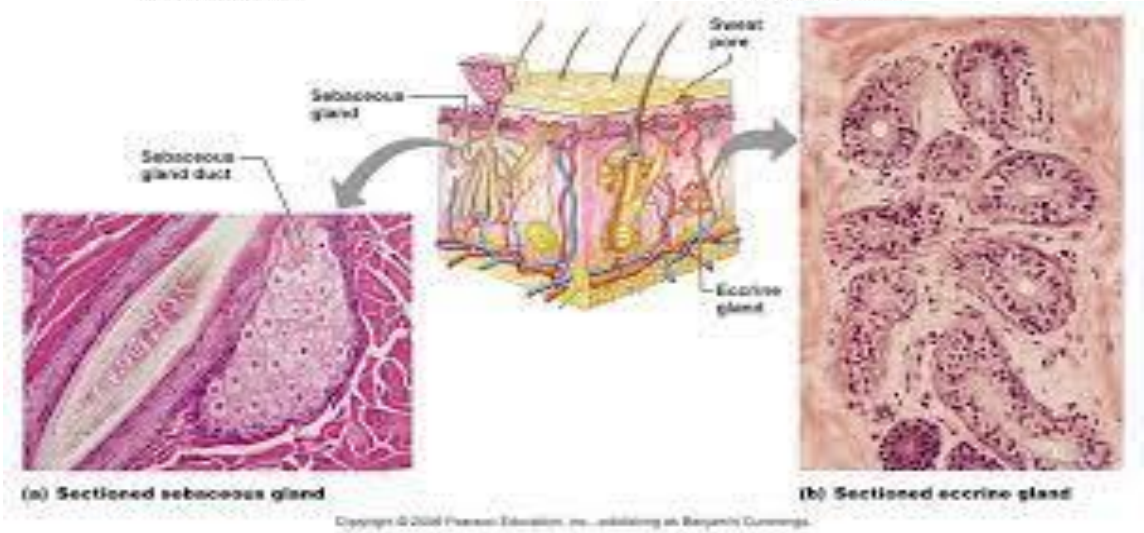
2. Apocrine secretion designates a mechanism in which part of the apical cytoplasm of the cells is lost together with the secretory product. The continuity of the plasma membrane is restored by the fusion of the broken edges of the membrane, and the cell is able to accumulate the secretory product anew. This mechanism is used by apocrine sweat glands, the mammary glands and the prostate.

3. Holocrine secretion designates the breakdown and discharge of the entire secretory cell. It is only seen in the sebaceous glands of the skin.

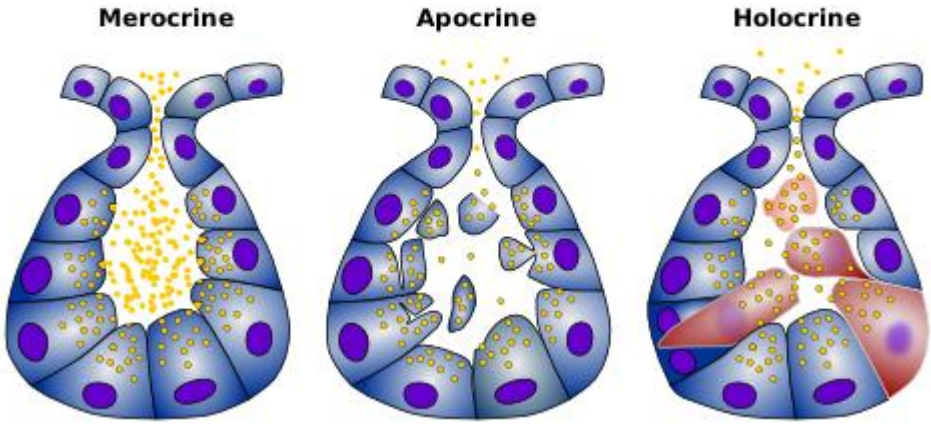


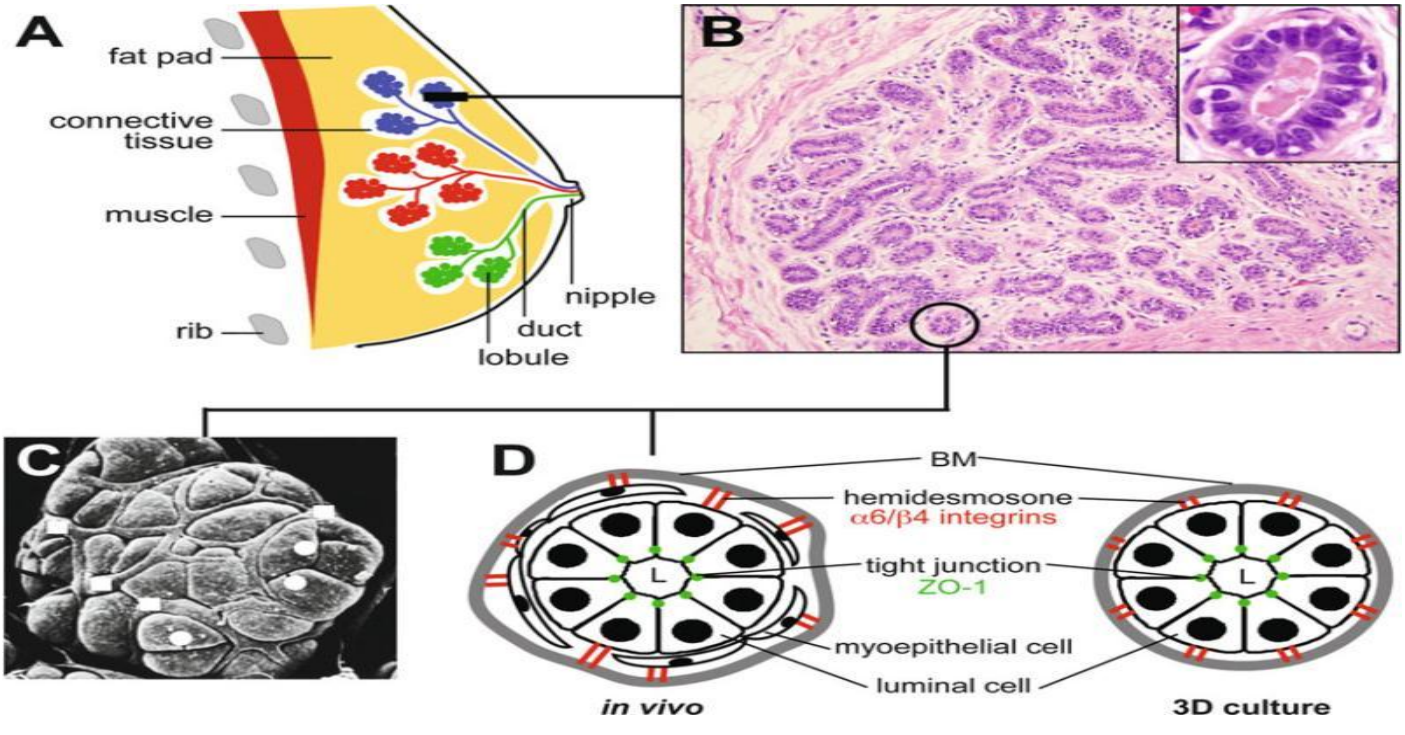
Apocrine gland
Apocrine secretion

Sebaceous gland
Holocrine secretion

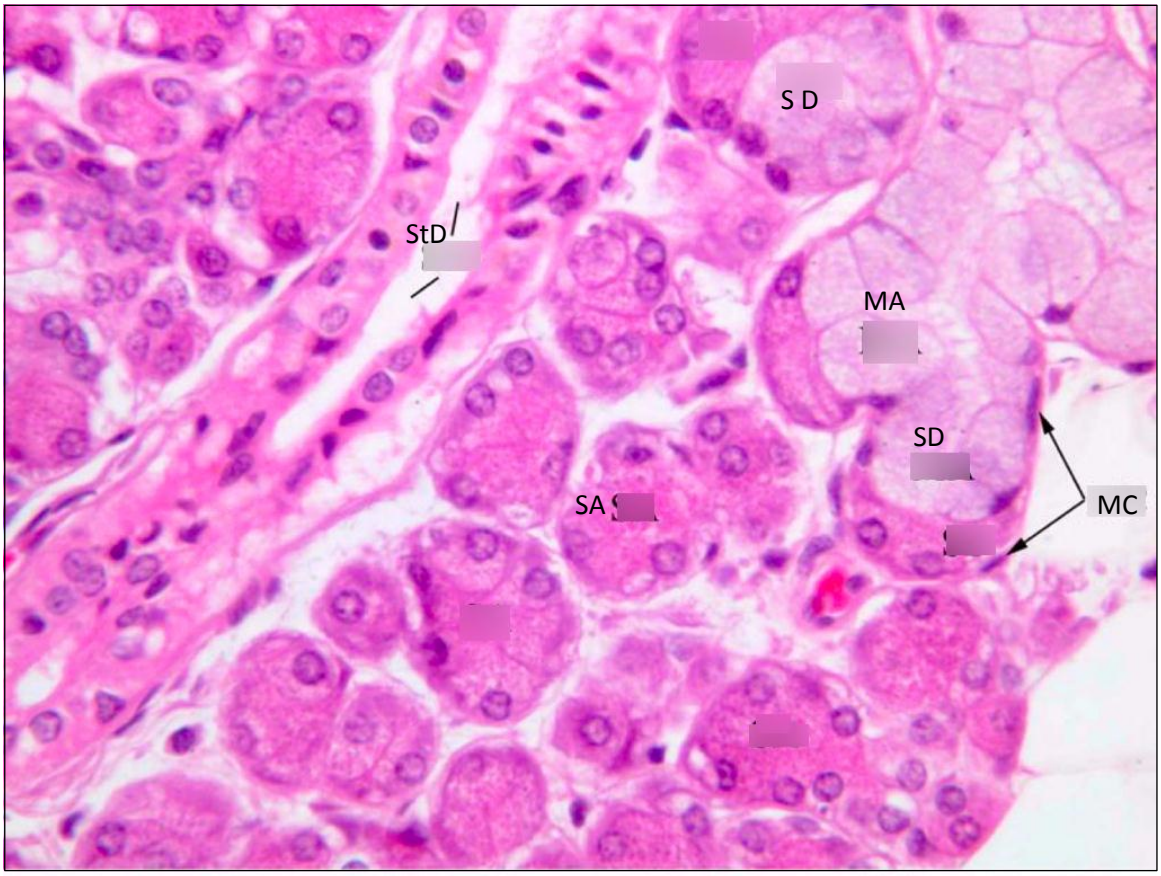



Merocrine
Apocrine
Holocrine

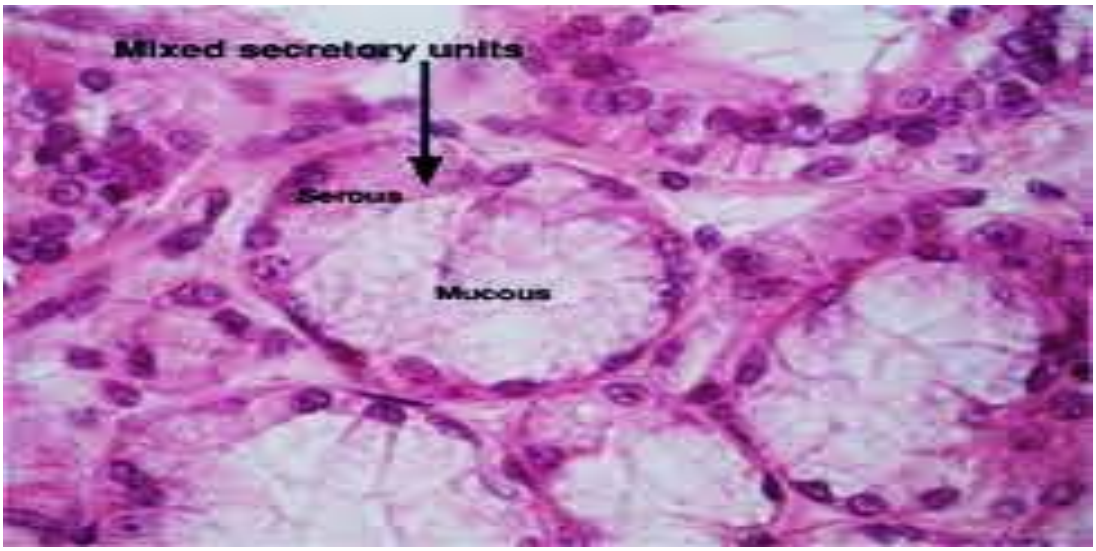

Merocrine
Apocrine
Holocrine


A
fat pad
connective tissue
muscle
rib
nipple
duct
lobule
B
C
D
BM
hemidesmosone
α6/β4 integrins
tight junction
ZO-1
myoepithelial cell
luminal cell
L
L
in vivo
3D culture

There are two additional mechanisms by which secretory cells can release their products. Lipid soluble substances may diffuse out of the secretory cell (e.g. steroid hormone producing endocrine cells). Transporters (membrane proteins) may actively move the secretory product across the plasma membrane (e.g. the acid producing parietal cells of the gastric glands). These secretory mechanisms may not involve any light microscopically visible specialisations of the cell.



SA - serous acini MA - mucous acini SD - serous demilune
StD - striated duct MC - myoepithelial cells



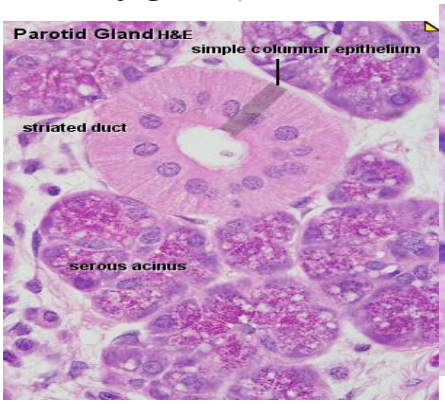
Histological Structure of Large Exocrine Glands

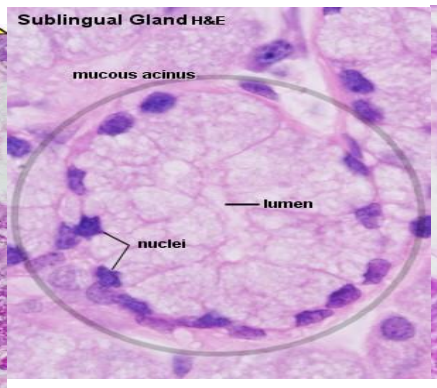
The relationship between the secretory tissue (parenchyma) of glands and the supporting connective tissue is similar in most larger glands. Externally the entire gland is surrounded by a layer of dense connective tissue, the capsule. Connective tissue sheets (septae) extend from the capsule into the secretory tissue and subdivide the gland into a number of lobes. Thinner connective tissue septae subdivide the lobes into a number of lobules. Reticular connective tissue (hardly visible in H&E stained sections) surrounds and supports the secretory units of the glands (alveoli, acini etc.) and the initial parts of the excretory ducts if present.
Blood and lymph vessels as well as nerves penetrate the capsule and form a delicate network between the secretory units and the initial parts of the duct system.
The main excretory duct conveys the secretory product to one of the external surfaces of the body. Other parts of the duct system are named according to their relation to the lobes and lobules of the gland.

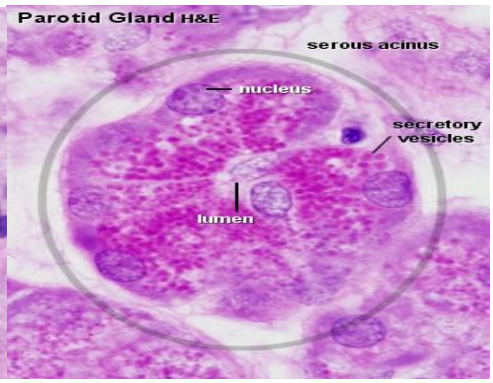
- Lobar ducts are are large branches of the main duct which extend to the lobes of the gland. They may be called
- Interlobar ducts if they are found in the connective tissue surrounding the lobes. Interlobar ducts branch and give rise to
- Interlobular ducts, which are found in the connective tissue surrounding the individual lobules of the gland. Branches of the interlobular ducts enter the lobules and are now called
- Intralobular ducts. The terminal branches of the duct system, which connect intralobular ducts with the secretory units of the gland, are called
- Intercalated ducts.

The appearance of the different portions of the duct system is quite variable from gland to gland and may allow the identification of the gland. Quite often, the appearance of parts of the duct system also permits some deductions about their functions.

Note that lobes and lobules are defined by their relationship to each other. Many small lobules may form one large lobe. Neither size nor the spatial relationship between different parts of the tissue can be unequivocally determined in a single, two-dimensional section of the tissue. Lobes and interlobar ducts may therefore be difficult to distinguish from lobules and interlobular ducts.
Suitable Slides alveolar gland: lactating mammary gland - see lab section on the Female Reproductive System page.
serous and mucous acinar glands: sections of parotid gland, sublingual gland or tongue (lingual salivary glands) - H&E







Parotid Gland, human - H&E

Find an area of secretory tissue at low magnification, and scan over this area at high magnification. Within the lobules and between the acini of the parotid you can find two types of ducts. Since they are both located within the lobules they are both intralobular ducts. Striated ducts are lined by a simple tall columnar epithelium. Intercalated ducts are lined by a simple cuboidal epithelium and connect individual acini to the striated ducts. Try to capture the features of the acini, intercalated and striated ducts in one compound

drawing which shows how they connect to each other. Label your drawing. Parotid Gland, human and Sublingual Gland, human - H&EMany secretory cells and the secretory structures formed by them belong to one of two morphologically distinct forms: they can be serous or mucous. Serous secretions have a low viscosity, i.e. they are rather "watery". Mucous secretions have a high viscosity, i.e. they are rather "slimy". The apical cytoplasm of the cells forming serous acini is usually well-stained. Secretory vesicles are visible in the apical cytoplasm in well-preserve tissue. The nuclei are round or slightly ovoid and located in the basal cytoplasm of the cells. The bluish color of the basal cytoplasm reflects the presence of large amounts of rough endoplasmic reticulum. The contents of the secretory vesicles in the apical cytoplasm of cells forming mucous acini are only weakly stained. These empty-looking vesicles give the apical cytoplasm of mucus-producing cells a distinct "foamy" or "frothy" appearance. The nuclei of mucous cells appear darker and smaller than the nuclei of serous cells. They also seem to be "pressed" against the basal limit of the cells and may look flattened with an angular ("edgy") outline. Glands containing mucous acini (e.g. the sublingual glands) are called mucous glands. Glands containing serous acini (e.g. the parotid glands) are called serous glands. If both types of acini are present the gland is muco-serous. Identify and draw serous and mucous acini at high magnification. Label your drawing. Make sure that the features which characterize serous and mucous acini are visible in your drawing - if necessary use a little artistic freedom.

Types of glands

- **Exocrine glands:**
  - Synthesize and secrete their products onto a surface:
    - Directly:
      Unicellular glands
    - Via a tube (duct):
      Multicellular glands
  - **Examples:**
    - Sweat glands
    - Sebaceous glands
    - Salivary glands
    - Mucous glands in the intestinal and respiratory tracts
    - **Pancreas** (**digestive enzymes**)

- **Unicellular** (**mucous cells and goblet cells**):
  - Secrete by exocytosis
  - Present in the intestinal and respiratory tracts
- **Multicellular**:
  - Secreted by ducts
  - Composed of 2 basic parts:
    - Epithelium-derived duct
    - Secretory unit (acinus)
  - Connective tissue surrounds the acinus and supplies it with blood and nerve fibers.

- **Endocrine glands:**
  - Ductless
  - Synthesize and secrete their products into the extracellular space
  - Secretory products reach target cells via the blood.
  - Examples:
    - Pancreas (insulin, glucagon)
    - Thyroid
    - Adrenal glands
    - Ovaries
    - Testes
    - Pituitary gland
  - Hormones produced in epithelial cells are released into the interstitial fluid
- **Paracrine glands:** Secretions affect adjacent epithelial cells.

Exocrine Glands

Structural classification

- **Simple glands:** unbranched ducts
- **Compound glands:** branched ducts
- Based on the secretory unit shape:
  - Alveolar (secretory cells forming small sacs)
  - Tubular (secretory cells forming tubes)
  - Tubuloalveolar (a mix of alveolar and tubular)

Ways of secretion

- **Merocrine**
- **secretion:**
  - Most glands are merocrine.

- Secretory cells are not altered by the process of secretion.
- Cells produce and store the products at the apex of the cell → stimulation → granules move to the apical surface and release products by exocytosis
- Examples: pancreas, salivary and sweat glands

- **Apocrine**
  secretion: Secretion product is stored at the apical surface → component of apical surface breaks off → secretion product + part of the cytoplasm released
  - The release of lipid droplets by mammary glands is an example of apocrine secretion
  - Secretions of the mammary glands are merocrine when Proteins are released in milk.
- **Holocrine**
  secretion:
  - Cells synthesize the product and accumulate it in the cytoplasm → undergoes apoptosis → cell is lost in the luminal space
  - Example: sebaceous glands of the skin