Biology

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❖ Glandular epithelium:

One of the specialized functions of epithelia is secretion.

Glands consist of groups of epithelial cells modified to synthesize and secrete.

Glands are classified into three major groups on the basis of the method of distribution of their secretory products:

- exocrine glands, which secrete their products to the external environment via ducts.
- endocrine glands, which secrete their products directly into the blood (ductless glands)
- mixed glands, which have both exocrine and endocrine secretion.

Exocrine glands:

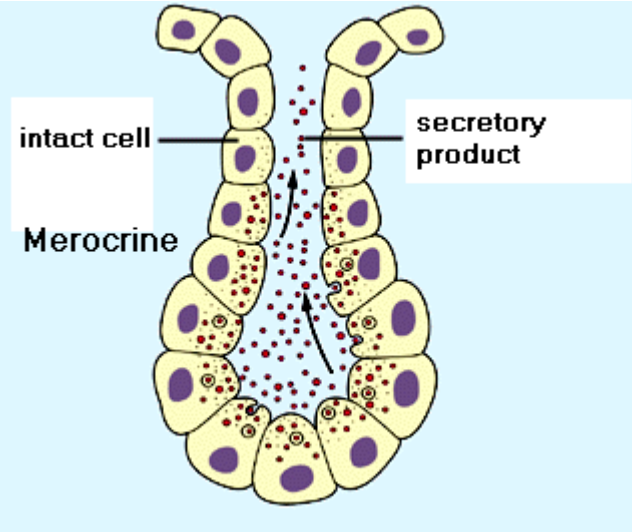
Classification of exocrine glands:

1. Exocrine Glands Classified by Mechanisms of Secretion:

Exocrine glands classified according to the mode or way in which the secretory products leave the cell into:

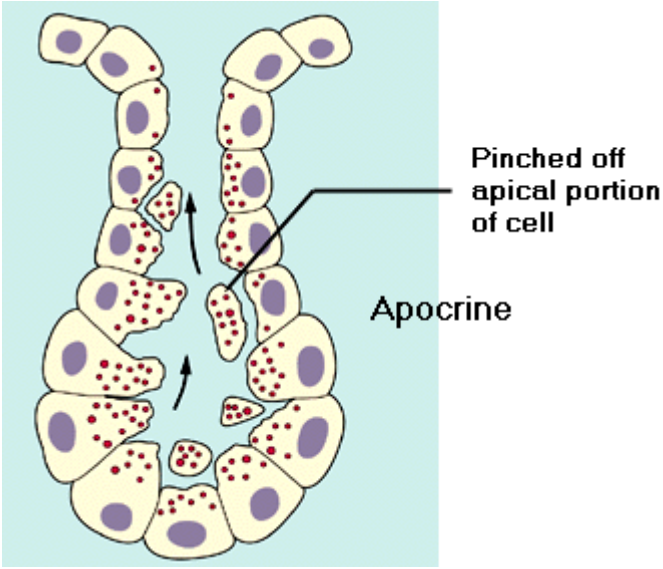
(a) Merocrine (or eccrine) secretion:

This is the most common type of exocrine secretion. Secretory granules (packaged in the Golgi bodies) migrate to the apical surface of the cell. The membranes of the secretory granules fuse with the apical membrane and the secretion is released to the external environment by exocytosis.



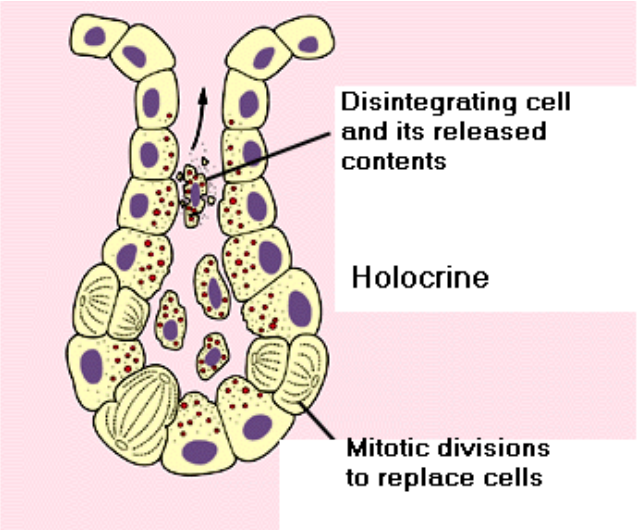
(b) Apocrine secretion:

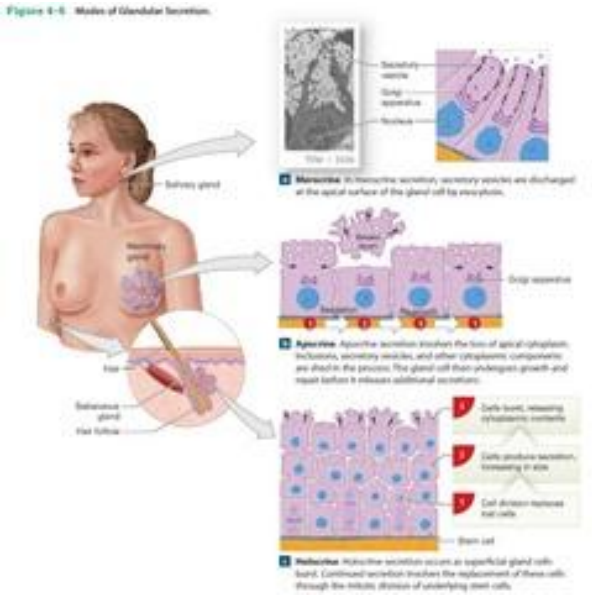
With apocrine secretion the apical portion of the cells, together with the secretory contents, are budded off and released to the lumen or external environment. Examples of such apocrine secretion are found in the apocrine sweat glands of the armpits.



(c) Holocrine secretion:

Holocrine secretion involves the secretion of whole cells and their contents. This is best seen in the sebaceous glands associated with hairs of thin skin.





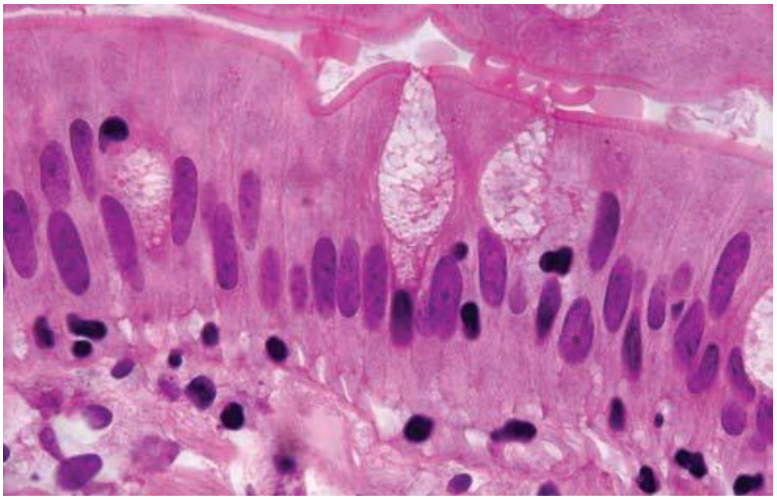
2. Exocrine Glands Classified by Morphology:

Exocrine glands are classified according to the no. of cells into two groups:

- ❖ unicellular glands
- ❖ multicellular glands.

Unicellular exocrine glands:

The main example of a unicellular exocrine gland is the goblet cell. Goblet cells are found scattered in the heterogeneous epithelium of mucous membranes, for example, in the pseudostratified epithelium of the respiratory tract or in the absorptive epithelium of the small and large intestine. These glands synthesize and secrete mucin (the precursor of mucus) to the epithelial surface. This mucoid secretion helps lubricate and maintain the moistness of the epithelium, and may also be involved in trapping dust or particulate material and in responding to infection. The nuclei of goblet cells are basally situated and usually are very flattened.



The secretory contents of goblet cells are stained weakly acidophilic (pink staining after H&E) and are stained intensely by the PAS technique owing to their proteoglycan (polysaccharide) content.

Multicellular exocrine glands:

Multicellular exocrine glands develop by proliferation and invagination of epithelial cells into the underlying connective tissue. The initial portions develop into the secretory duct, whereas the terminal portions develop into the secretory units. In cases where the gland develops from simple epithelium, the duct and secretory units are also single-layered (e.g. the

exocrine glands of the small and large intestine). In cases where the gland develops from stratified epithelium, the duct and secretory units usually have more than one layer of cells.

The cells of the secretory ducts are typically less poorly differentiated than the cells of the secretory units. All the epithelial cells of both the ducts and secretory units show marked polarity.

Multicellular exocrine glands are classified according to the organization of their duct components into simple or compound glands.

- Simple exocrine glands have unbranched secretory ducts.
- Compound exocrine glands have branched secretory ducts. The branching is often complex and similar to that of branches of a tree.

Multicellular exocrine glands are classified according to the organization of their secretory components into straight, branched and coiled:

- Straight exocrine glands when the terminal portion of the secretory unit is straight.
- Branched exocrine glands when the terminal portion of the secretory unit bifurcate into 2 or more branches.
- Coiled exocrine glands when the terminal portion of the secretory unit is coiled.

Multicellular exocrine glands are classified according to the shape of secretory units in both simple and compound glands into:

- tubular
- alveolar (acinar)
- tubule-acinar(alveolar)

1. simple tubular glands:

a. simple straight tubular glands: there is no secretory duct or a very short one and the terminal portion is straight tubule that opens directly onto the epithelial surface (e.g. the intestinal glands (crypts of Lieberkuhn)).

b. simple branched tubular glands: the tubules of the terminal portion bifurcate into 2 or more branches, an execretory duct may be absent as in the glands of stomach and uterus or there may be a short excretory duct as in some of the glands of the oral cavity.

c. simple coiled tubular glands: the terminal portion is a long coiled tubule connected to the surface by an unbranched excretory duct (e.g. sweat gland).

2. simple acinar glands (simple alveolar)

The terminal portion is expanded to form a spherical or elongated sac.

a. simple straight acinar glands: there is one acinous associated with one excretory duct, this type is present in the small mucous glands along the urethra.

b. simple branched acinar glands: the acinus is subdivided by partition into several smaller compartments (e.g. the sebaceous glands of the skin).

2. compound multicellular exocrine glands:

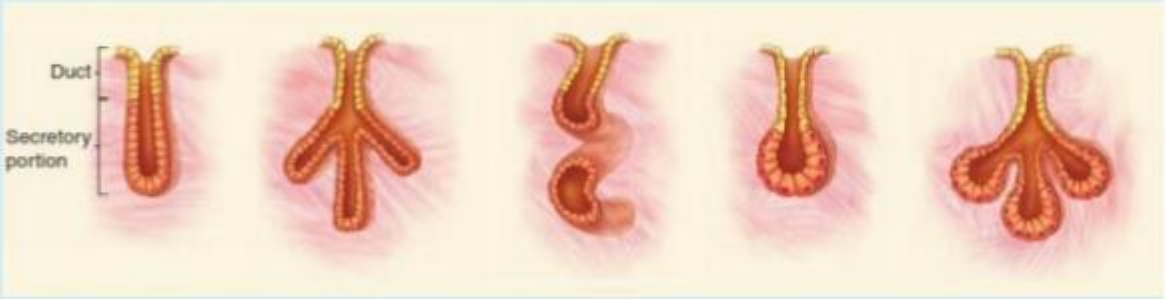
The duct of the compound multicellular exocrine gland is branched repeatedly. It is classified according to the shape of terminal portions of secretory part into:

a. compound tubular glands: the terminal portions of the smallest lobules are more or less coiled tubules, usually branching (e.g. submucosal mucous glands (of Brunner) in the dudenum).

b. compound acinar or alveolar glands: the terminal portions appear in the form of spherical shaped units (e.g. the mammary gland).

c. compound tubuloacinar (tubuloalveolar): the secretory parts are tubular and alveolar (e.g. the salivary glands).

Simple (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

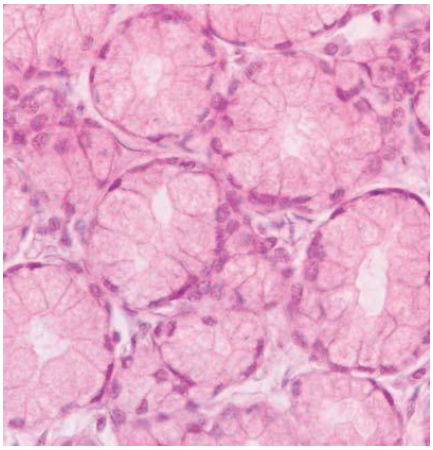
Compound (Ducts from Several Secretory Units Converge into Larger Ducts)

Class	Tubular	Acinar (Alveolar)	Tubuloacinar
			
Features	Several *elongated*, coiled secretory units and their ducts converge to form larger ducts	Several *saclike* 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 Mammary gland	Salivary glands

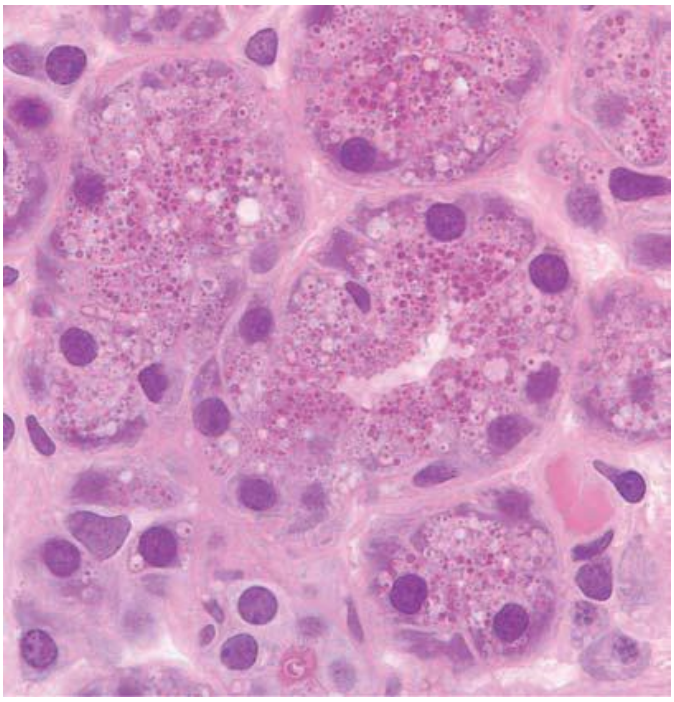
3. Exocrine Glands Classified by Product:

The secretory cells (of secretory units) of exocrine glands are classified into two histological categories based on their secretory product characteristics:

1. Mucous cells: These are rounded acidophilic or empty cells (typically with basal flattened nuclei), that are rich in glycoproteins and produce a mucoid secretion.



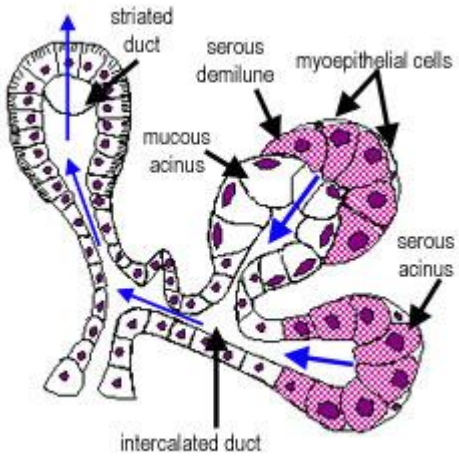
2. Serous cells: These are basophilic cells that are pyramidal. The serous cells synthesize and secrete polypeptides or proteins. Their nuclei are fairly oval or rounded centrally located, and the secretory granules may be visible in the apical portion of the cells. The basal region of the cells have accumulations of rough endoplasmic reticulum (RER) that provide the basophil staining.



The secretory units of some exocrine glands are entirely serous in nature (e.g. pancreas, parotid gland), whereas other glands may be mixed with both mucous and serous cells (e.g. submaxillary gland, glands of the fundus of the stomach).

The process of synthesis, storage and secretion in serous cells illustrates the structural and functional polarity of the cells. The RER in the basal region synthesizes the polypeptide or protein molecules, which are transported to the Golgi bodies and packaged into membrane-bound granules. These granules accumulate in the apical region of the cells and as a result of the necessary secretory signals are discharged at the apical surface to the external environment by exocytosis.

Several types of multicellular exocrine glands (of ectodermal origin) have an additional cell type known as the myoepithelial cells. These are contractile cells surrounding the secretory units, and when they receive a signal to contract, result in secretory discharge from the secretory cells. Examples of glands with myoepithelial cells include the salivary glands and the mammary glands.



3. Mixed: These glands have both serous and mucous cells.

The mucous cells ends are capped by serous cells that secrete between the mucous cells' intercellular space. These serous caps on mucous cells are called serous demilunes.

Approximately 10% of submandibular glands contain serous demilunes, but these glands are predominantly serous acini, which constitute 90% of the gland.

Endocrine glands:

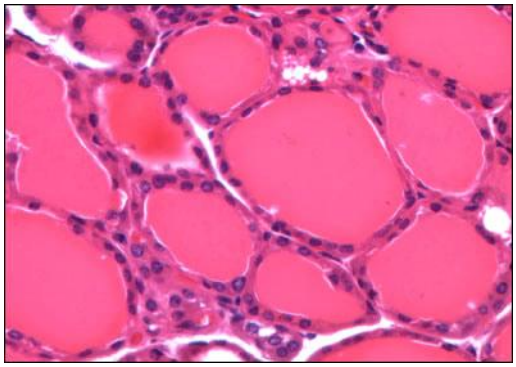
Endocrine glands develop initially in the embryo like the multicellular exocrine glands, however their ducts degenerate and disappear (ductless glands) and the glands secrete directly into the blood capillaries in the surrounding connective tissue. Endocrine secretions are known as hormones and the endocrine glands form part of a major regulatory system, known as the endocrine system. Endocrine glands, are very variable in histological appearance and owing to their great structural diversity are hard to classify according to morphology, though the secretory cells may be classified into two major groups:

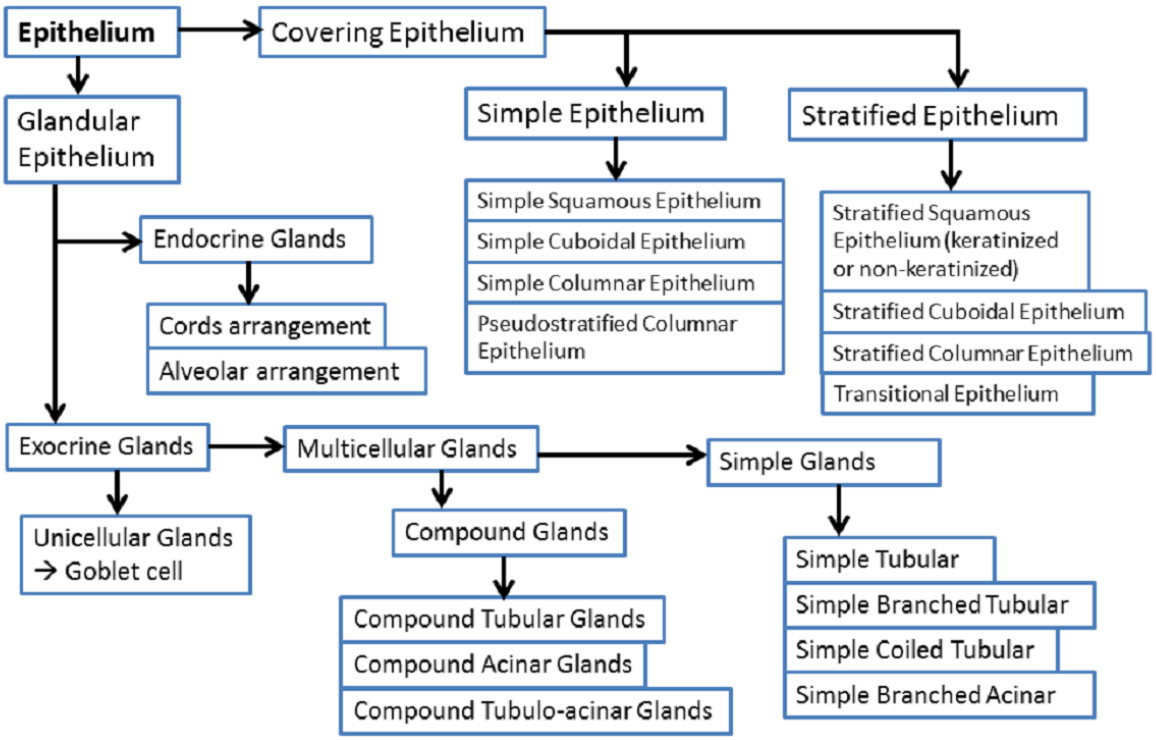
- polypeptide (or protein)-secreting cells

- steroid-secreting cells.

The endocrine polypeptide (or protein)-secreting cells are typically characterized by well-developed RER (rough endoplasmic reticulum), Golgi bodies and membrane-bound secretory granules. These endocrine cells may be isolated or in small groups (the diffuse endocrine system) and include many of the endocrine cells of the intestine.

The endocrine steroid-secreting cells (e.g. in the testis, ovary, suprarenal cortex) are characterized by well-developed SER (smooth endoplasmic reticulum) and abundant lipid droplets.





Epithelial cell renewal:

Most epithelial cells have a finite life span less than that of the whole organism.

Surface epithelia and epithelia of many simple glands belong to the category of **continuously renewing cell populations**.

The rate of cell turnover (i.e., the replacement rate) is characteristic of a specific epithelium. For example, the cells lining the small intestine are renewed every 4 to 6 days in humans.

Similarly, the stratified squamous epithelium of skin is replaced in most sites during a period of approximately 28 days. Cells in the basal layer of the epidermis, appropriately named the stratum basale (germinativum), undergo mitosis to provide for cell renewal. As these cells differentiate, they are pushed toward the surface by new cells in the basal layer. Ultimately, the cells become keratinized and slough off. In both of the above examples, a steady state is maintained within the epithelium, with new cells normally replacing exfoliated cells at the same rate.

In other epithelia, particularly in more complex glands, individual cells may live for a long time, and cell division is rare after the mature state is reached. These epithelial cells are characteristic of **stable cell populations** in which relatively little mitotic activity occurs such as in the liver. **However, loss of significant amounts of liver tissue through physical trauma or acute toxic destruction is accommodated by active proliferation of undamaged liver cells. The liver tissue is essentially restored by the stimulated mitotic activity of healthy liver tissue.**

Most of the cancers of the body are the result of uncontrolled proliferation of epithelial cells.