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Glandular Epithelia

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Glandular epithelia are formed by cells specialized to secrete. The molecules to be secreted are generally stored in the cells in small membrane-bound vesicles called secretory granules. Glandular epithelial cells may synthesize, store, and secrete proteins (eg, in the pancreas), lipids (eg, adrenal, sebaceous glands),or complexes of carbohydrates and proteins (eg, salivary glands). Mammary glands secrete all three substances. The cells of some glands have low synthetic activity (eg, sweat glands) and secrete mostly water and electrolytes transferred into the gland from the blood.

The epithelia that form glands can be classified according to various criteria.

1- **Unicellular glands** consist of large isolated secretory cells , The classic unicellular gland is the goblet cell in the lining of the small intestine or respiratory tract.
2- **Multicellular glands** have clusters of cells.

The term "gland," however, is usually used to designate large aggregates of secretory epithelial cells, such as in the salivary glands and the pancreas.
Glands develop during fetal life from covering epithelia by means of cell proliferation and invasion of the subjacent connective tissue, followed by further differentiation

1- **Exocrine glands** retain their connection with the surface epithelium, the connection taking the form of tubular ducts lined with epithelial cells throughwhich the secretions pass to the surface.
2- **Endocrine glands** have lost their connection to the surface from which they originated during development. These glands are therefore ductless and their secretions are picked up and transported to their sites of action by the bloodstream rather than by a duct system.

In multicellular glands, whether exocrine or endocrine, also have connective tissue in a surrounding capsule and in septa that divide the gland into lobules. These lobules then subdivide, and in this way the connective tissue separates and binds the glandular components together Formation of glands from covering epithelia.
During fetal development epithelial cells proliferate and penetrate the underlying connective tissue. They may—or may not—maintain a connection

with the surface epithelium. When the connection is maintained, exocrine glands are formed; with the connection lost, endocrine glands are formed. Exocrine glands secrete to the body surface or gut by duct systems formed from the epithelial connection. The cells of endocrine glands, which secrete hormones can be arranged in cords or in follicles with lumens for storing the secretory product. From either the cords (left) or follicles (right) of endocrine cells, the secretory product is released outside the cells and picked up by the blood vessels for distribution throughout the body.

General structure of exocrine glands.

Exocrine glands by definition have ducts that lead to an organ or body surface. Inside the gland the duct runs through connecting septa and branches repeatedly, until its smallest branches end in the secretory portions of the gland. Exocrine glands have a secretory portion, which contains the cells specialized for secretion, and ducts, which transport the secretion out of the gland. The morphology of these components allows the glands to be classified according to the scheme and summarized as follows:

- Ducts can be simple (unbranched) or compound (with two or more branches).
- Secretory portions can be tubular (either short or long and coiled) or acinar (round or globular). Either type of secretory portion may be branched. Compound glands can have tubular, acinar, or tubuloacinar secretory portions.

Structural classes of exocrine glands.

Simple glands have unbranched ducts, although the ducts may be short or long and coiled. The secretory portions attached to these ducts may themselves be branched. The secretory portions are either tubular, if more or less cylindrical in shape, or acinar, if bulbous or saclike. If the ducts branch to serve multiple secretory units, the gland is compound. On compound glands, the secretory units may be all tubular, all acinar, or a combination of the two shapes .

Exocrine glands are also classified functionally according to the way the secretory products leave the cell

a- Merocrine secretion (sometimes called eccrine) involves typical exocytosis of proteins or glycoproteins this is the most common mode of secretion.

b- Holocrine secretion involves the cell filling with secretory product and then the whole cell being disrupted and shed. This is best seen in the sebaceous glands of skin

c- Apocrine secretion, the secretory product is typically a large lipid droplet and is discharged together with some of the apical cytoplasm and plasmalemma

Functional classification of exocrine glands.

Different cellular secretion processes are used in exocrine glands, depending on what substance is being secreted. This apical portion of the cell may subsequently break down to release its contents during passage into the duct. Apocrine secretion, along with merocrine secretion, is seen in mammary glands. Holocrine secretion in a sebaceous gland. In holocrine secretion, best seen in the sebaceous gland adjacent to hair follicles, entire cells fill with a product and are released during secretion. Undifferentiated cells deep and peripheral in the gland fill with lipid-rich granules and become metabolically inactive as they mature and move upward and toward the gland's center. When terminally differentiated, the cells separate and quickly disintegrate to form the secretion which 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.

Apocrine secretion in the mammary gland.

The secreting portions of a mammary gland demonstrate apocrine secretion and are characterized by the discharge of the secretion product with a pinched off portion of the apical cytoplasm . The released portion of cell contains lipid droplet(s). Merocrine secretion also occurs from the same and other cells of the secretory units.

Exocrine glands with merocrine secretion can be further categorized as either serous or mucous according to the nature of the proteins or glycoproteins secreted and the resulting staining properties of the secretory cells. The acinar cells of the pancreas and parotid salivary glands are examples of the serous type which secrete digestive enzymes. The basal ends of serous cells have well-developed RER and Golgi complexes and the cells are filled apically with secretory granules in different stages of maturation. Serous cells therefore stain intensely with any basophilic or acidophilic stain.

Serous cells.

Serous acinar cells of the exocrine pancreas are arranged in small acini of 5-10 cells with a very small central lumen. Each acinar cell is roughly pyramid-shaped, with its apex at the lumen.The cells' basal ends contain the large rounded nuclei. Golgi complexes, and secretory granules and the very small size of the acinus lumen are found . Secretion here is merocrine and typically the mature zymogen granules, filled with digestive enzymes, remain in the apical cell region until the cell is stimulated to secrete. Other cells secrete constitutively, with small granules undergoing exocytosis as soon as they emerge fully formed from the Golgi apparatus.

Mucous cells

such as goblet cells, while also rich in RER and Golgi complexes are filled apically with secretory granules containing strongly hydrophilic glycoproteins called mucins. When mucins are released from the cell, they become hydrated and form mucus, a viscous, elastic, protective lubricant material. Mucin-containing granules stain well with the periodic acid-Schiff (PAS) method for glycoproteins, but are not intensely acidophilic like zymogen granules of serous cells . Mucous cells of large glands are organized as secretory tubules and in mixed seromucous salivary glands crescent-shaped clumps of serous cells frequently share the ends of the tubules as serous demilunes , Mucous cells are typically larger than serous cells, with more flattened basal nuclei. The apical region and most of the other cytoplasm of each mucous cell is filled with secretory granules containing mucin like that of goblet cells. The basal region contains the RER, nucleus, and a well-developed Golgi apparatus. The RER and Golgi are very rich in enzymes called glycosyltransferases, which attach sugars to polypeptide chains to make glycoproteins. Mucus contains many glycoproteins with important water binding properties. The lumens (small arrows) of mucous tubules are larger than those of serous acini. The large arrow indicates a secretory duct. Other types of mucous cells are found in the stomach, the various salivary glands, the respiratory tract, and the genital tract. These cells show great variability in both their morphologic features and in the chemical nature of their secretions. Seromucous, compound tubuloacinar gland. The submandibular salivary glands have both mucous and serous secretory units, typically shaped as acini and tubules respectively. Clumps of serous cells at the ends of some mucous tubules appear as crescent-shaped structures called serous demilunes. At the left is seen a striated duct whose cells' basal membranes are folded into long folds with many mitochondria, an

arrangement specialized for ion transport across the epithelium. Several exocrine glands (eg, sweat, lachrymal, salivary, and mammary glands) contain stellate or spindle-shaped myoepithelial cells located between the basal lamina and the basal pole of secretory or duct cells. Long processes of these cells embrace an acinus as an octopus might embrace a rounded boulder. Along ducts they are more longitudinally arranged. Myoepithelial cells are connected to each other and to the epithelial cells by both gap junctions and desmosomes. These cells are specialized for contraction, containing myosin and a large number of actin filaments. Their major function is to contract around the secretory or conducting portion of the gland and thus help propel secretory products into the duct.