

Epithelium and Glands

Color Textbook of Histology, 4th ed.

Gartner

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- <https://rps.unibo.it/rilevatori/rilevazione-start/>

Glandular Epithelia

- A **gland** is one or more cells that produce and secrete a specific product.
- The product is always a water-based fluid (aqueous) and usually contains proteins (the product is referred to as a **secretion**).

Glandular Epithelia

Glands are classified into two groups based on characteristics:

Where they release their product

- Glands can be *endocrine* (secrete internally)
- or *exocrine* (secrete externally).

Exocrine Glands

Exocrine glands secrete their products onto the skin or into body cavities. Unicellular exocrine glands do this directly by exocytosis, while multicellular glands transport their product through a duct on the epithelial surface. Products secreted by exocrine glands include sweat, oil, mucous, bile, and more.

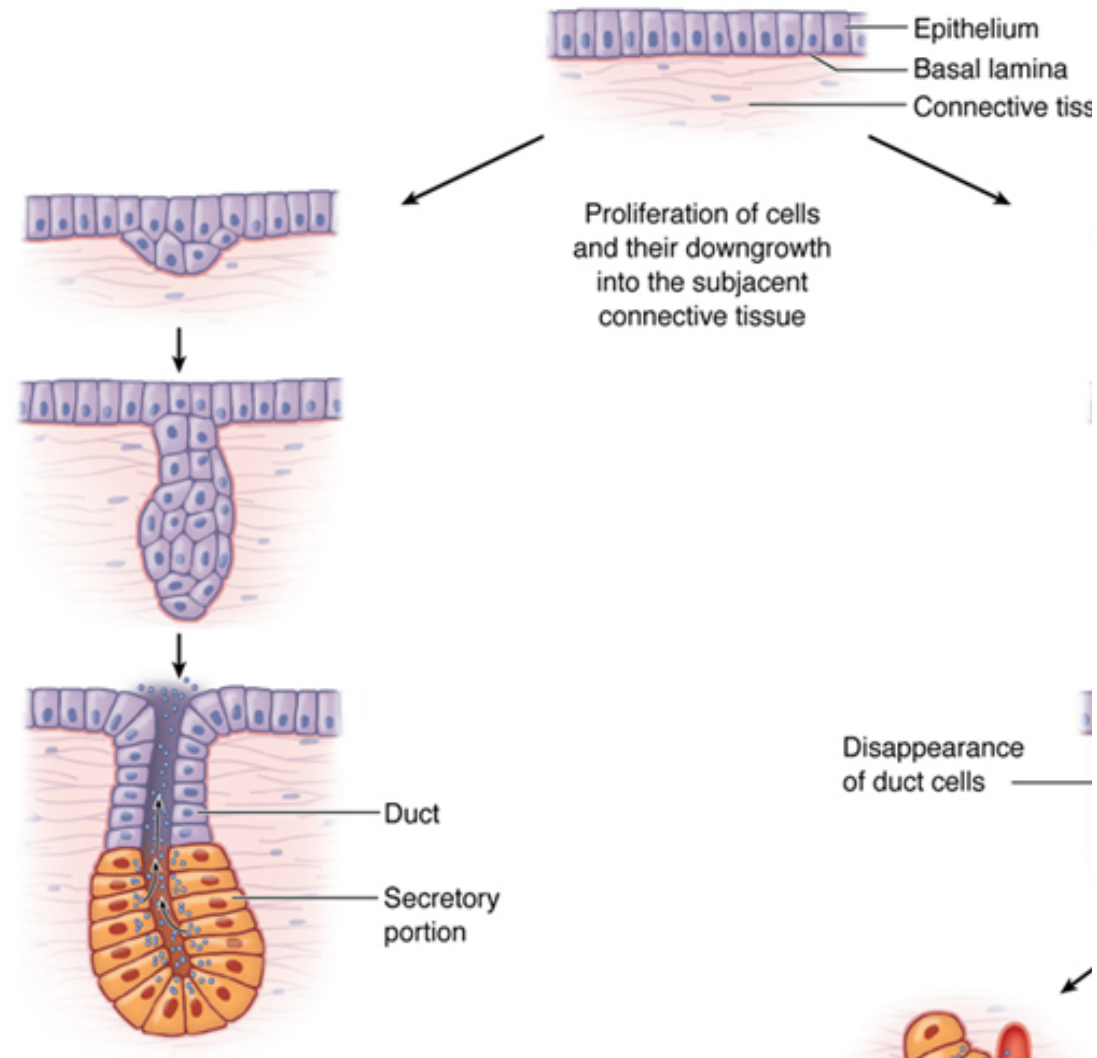
Glands classification

Glands are classified into two major groups:

Exocrine glands: **secrete their product via ducts** onto the external epithelial surface from which they originated. They require the presence of specialized cells, forming the duct to vehicle the secretion outside.

Endocrine glands: **are ductless**, having lost their connections to the originating epithelium, and thus secrete their products into the blood or lymphatic vessels for distribution.

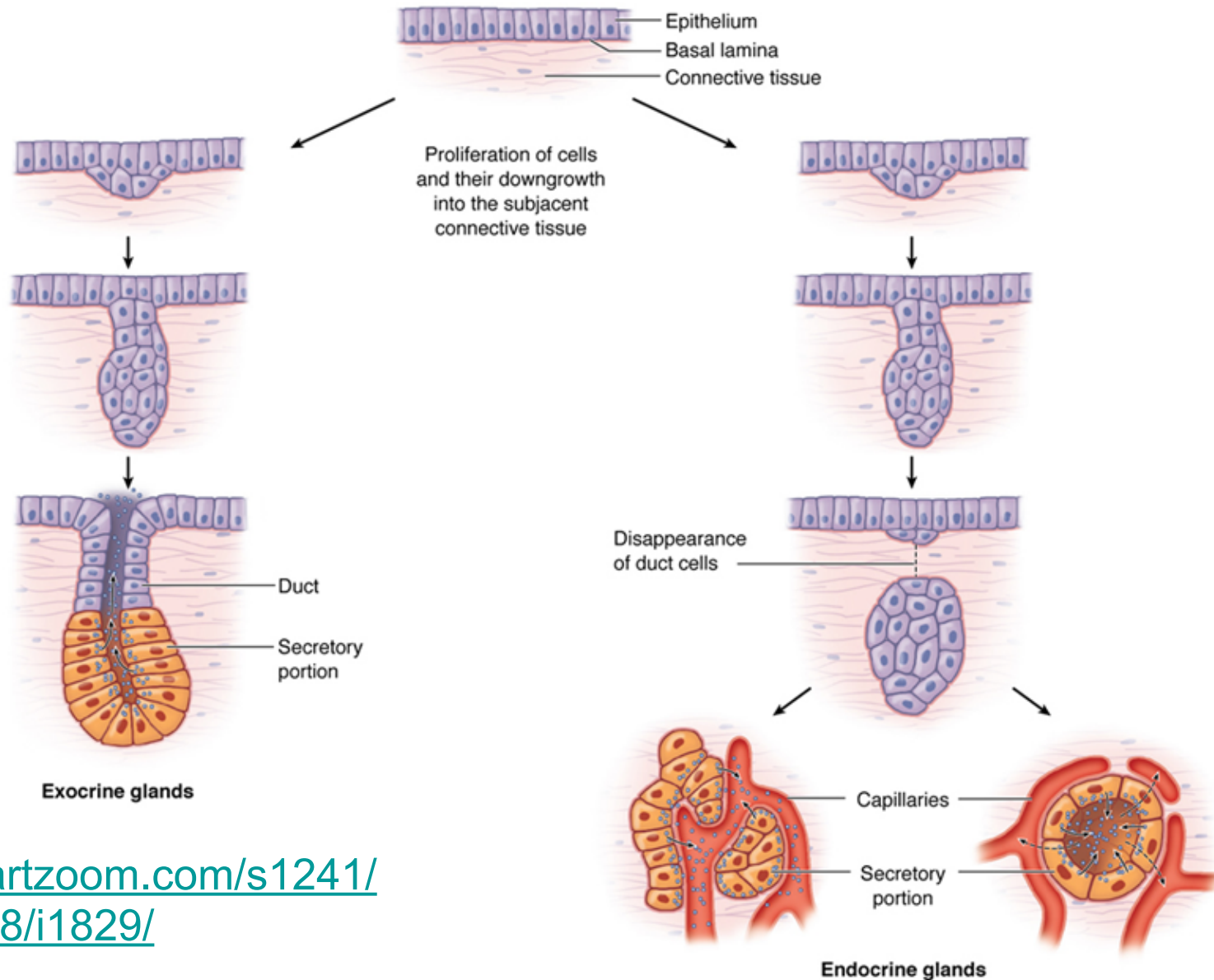
Formation of Glands from Covering Epithelium



Epithelial cells proliferate and invade the connective tissue.

Glands Genesis

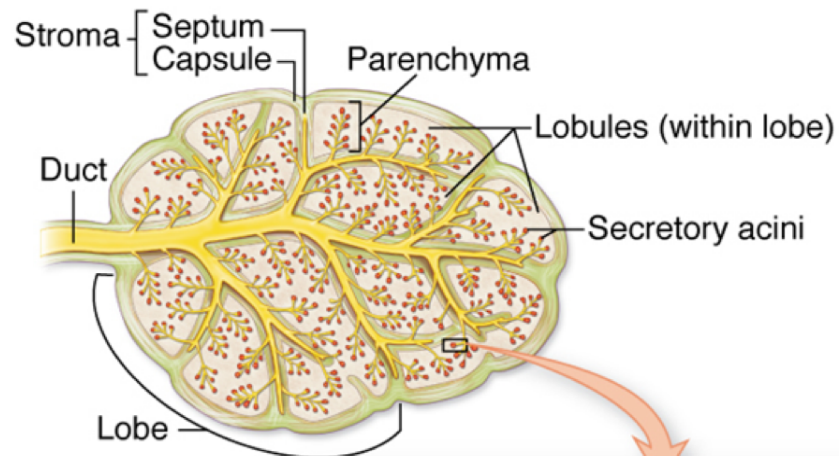
Formation of glands from covering epithelium



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Exocrine Glands

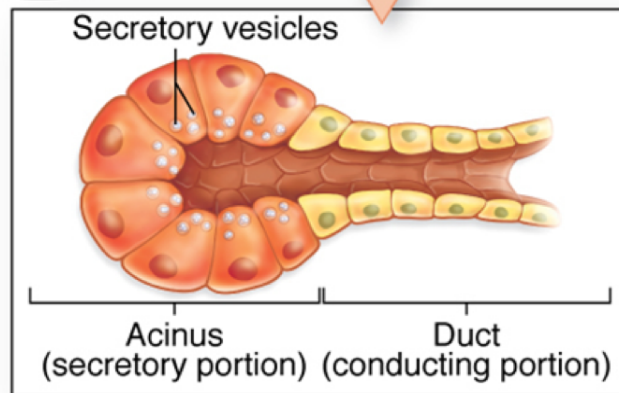
General structure of exocrine glands



Secretory portion:

- Acinar or tubular
- May be branched
- Produces secretory product

Acinus = berry



Conducting portion:

- Branched or unbranched
- Modifies secretory product by absorption
- In some glands, contributes to secretion

Large multicellular glands are surrounded by a collagenous connective tissue capsule, which sends septa-
strand of connective tissue into the gland, subdividing in lobes and lobules

Secretory granules

Glandular epithelia manufacture their products by synthesis of macromolecules that are packaged and stored in specialized vesicles called **secretory granules**.

The secretory products are:

- **polypeptide hormone (an example EGF)**
- **Waxy substances**
- **Mucinogen (goblet cells)**
- **Milk (lipid+protein+carbohydrates): mammary glands**
- **Cytokines for cell- cell communication**

Types of stimulation

Depending on the distance that the cytokine must travel to reach its target cell, which **possesses** a receptor for the specific ligand:

- **Autocrine:** The ligand affects its own producer cell; the cell stimulates itself.
- **Paracrine:** The target cell is located in the vicinity of the signaling cells.
- **Endocrine:** The target cell is far from the signaling cells. These cytokines must be transported via **blood vessels or the lymphatic vascular system.**

Exocrine glands

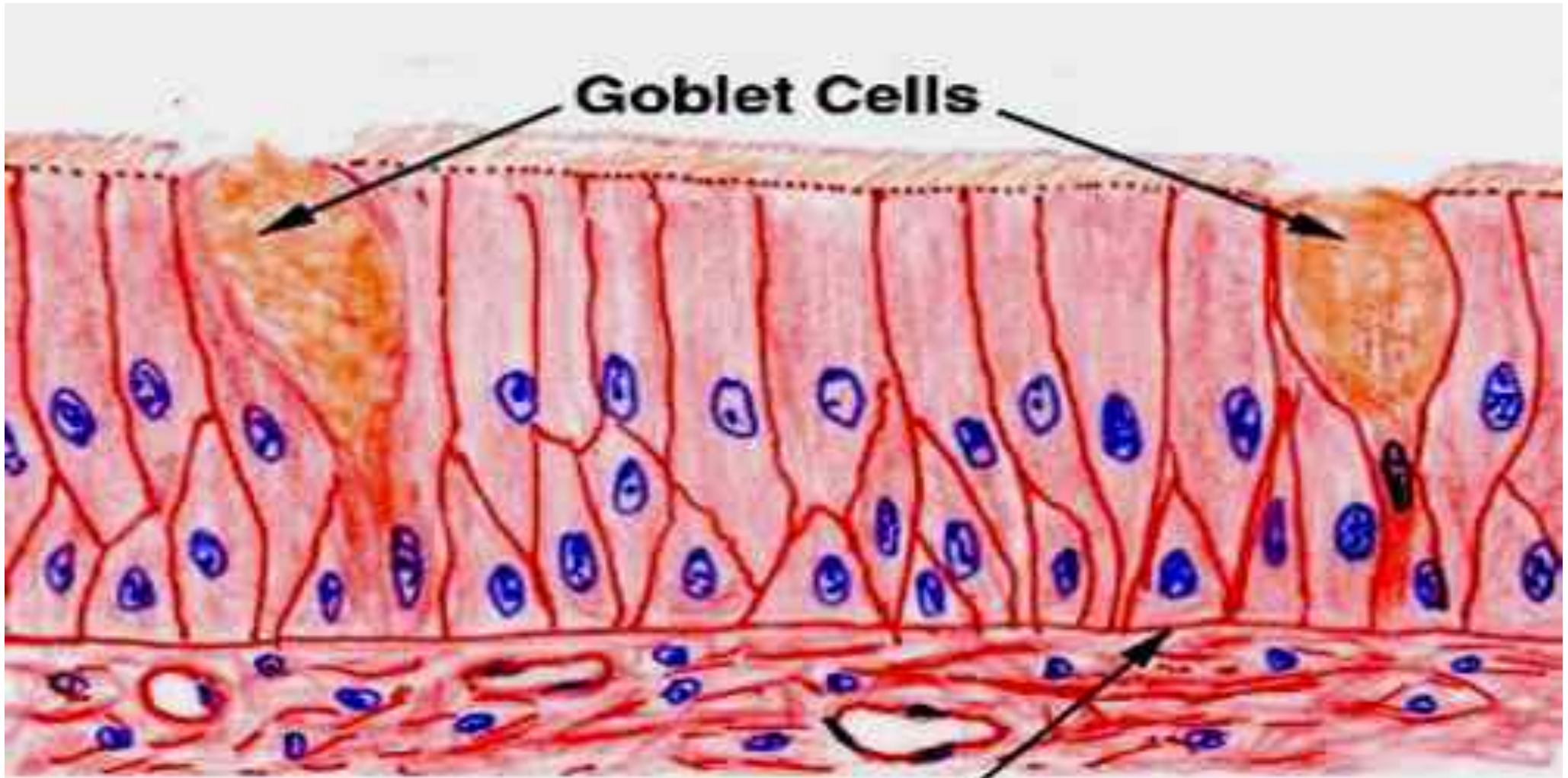
- Number of secreting cells
- Nature of secretion
- Mode of secretion

Classification

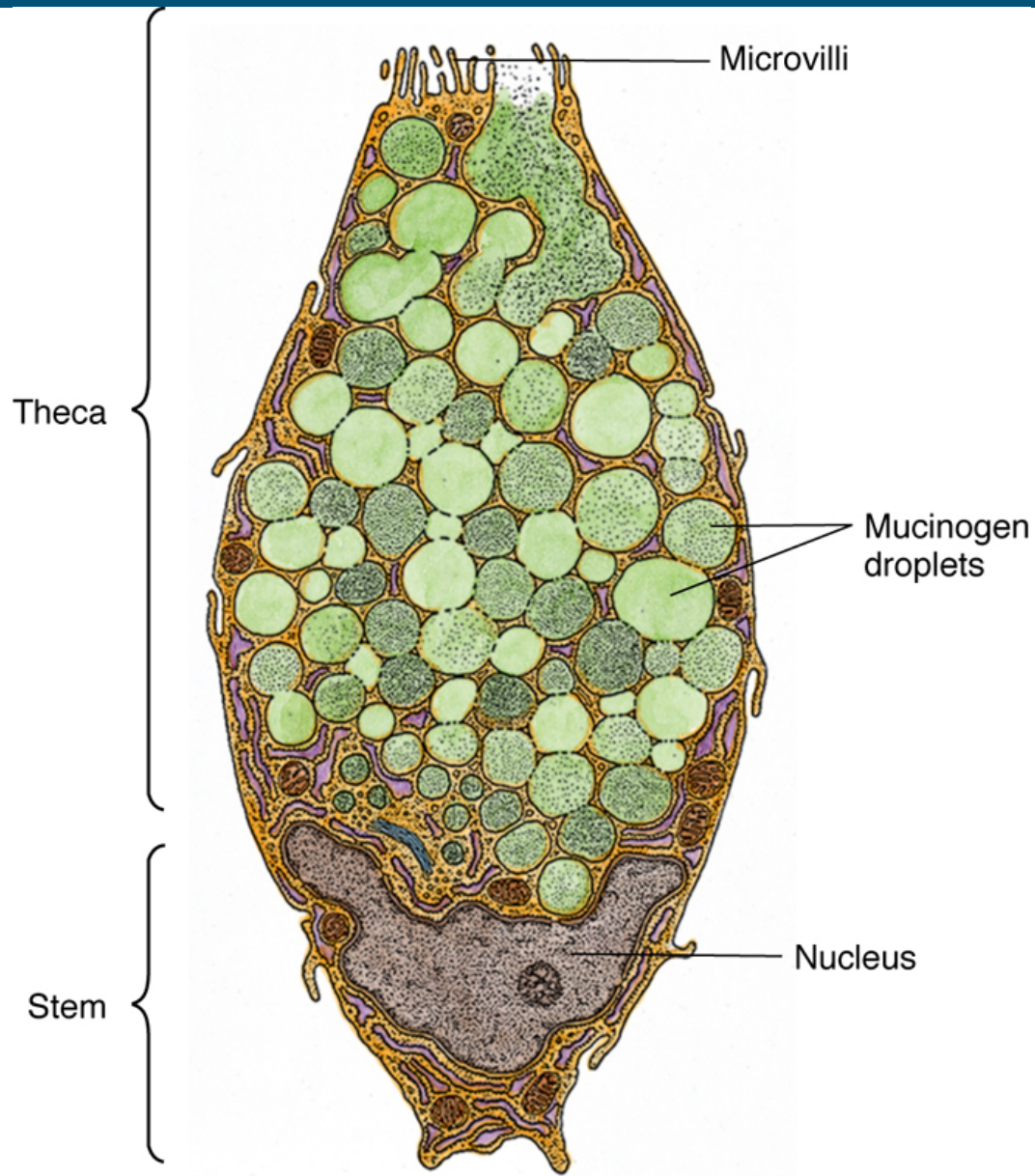
Number of Cells

Unicellular Gland
Goblet Cells of the lining small intestine
or respiratory tract

Multicellular Glands,
composed of cluster of
cells



Goblet Cell



Goblet cells derive their name from their shape.

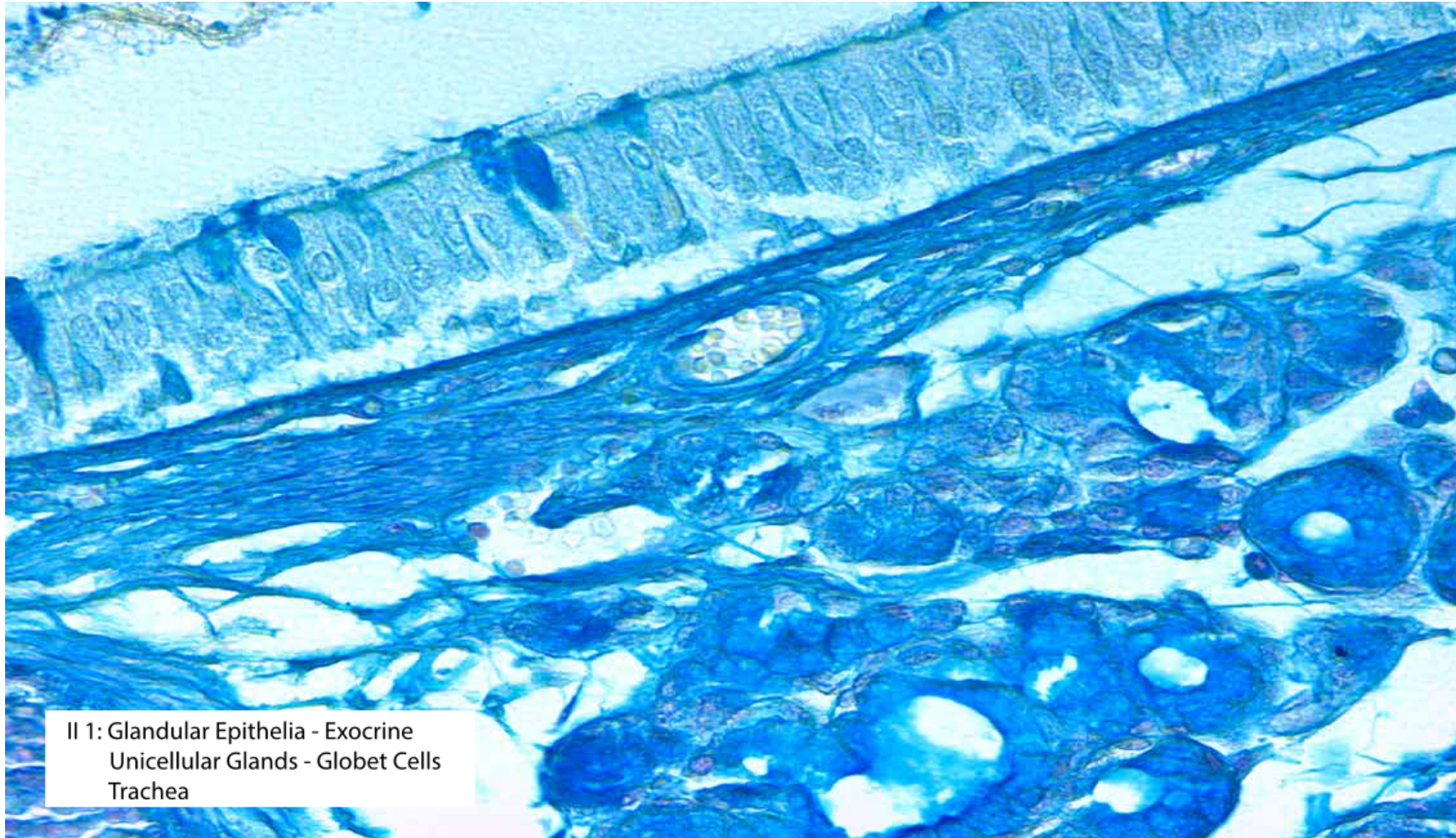
Their thin basal region sits on the basal lamina, whereas their expanded apical portion, the **theca**, faces the lumen of the digestive tube or respiratory tract.

The theca is filled with secretory droplets, **which displace the cytoplasm to the cell's periphery and the nucleus toward its base.**

The process of mucinogen release is regulated and stimulated by chemical irritation and parasympathetic innervation, resulting in exocytosis of the entire secretory contents of the cell, thus protecting the epithelial sheet.

Ultrastructure of a goblet cell illustrating the tightly packed secretory granules of the theca. (From Lentz TL: *Cell Fine Structure: An Atlas of Drawings of Whole-Cell Structure*. Philadelphia, WB Saunders, 1971.)

Unicellular glands

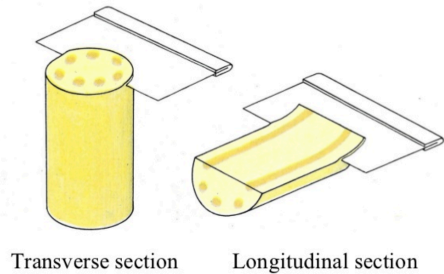


II 1: Glandular Epithelia - Exocrine
Unicellular Glands - Globet Cells
Trachea

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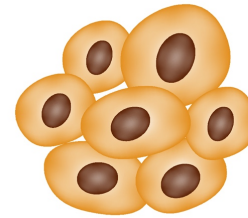
Classification by the morphology

Cutting sections



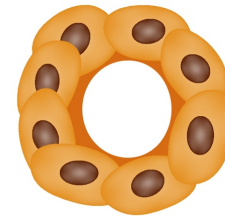
Secretory Portion

Acinar



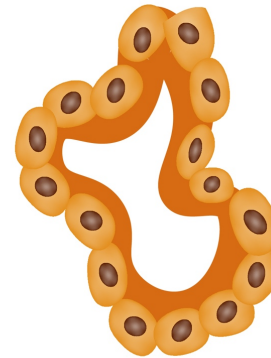
No lumen

Tubular



Regular lumen

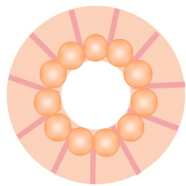
Alveolar



Wide lumen

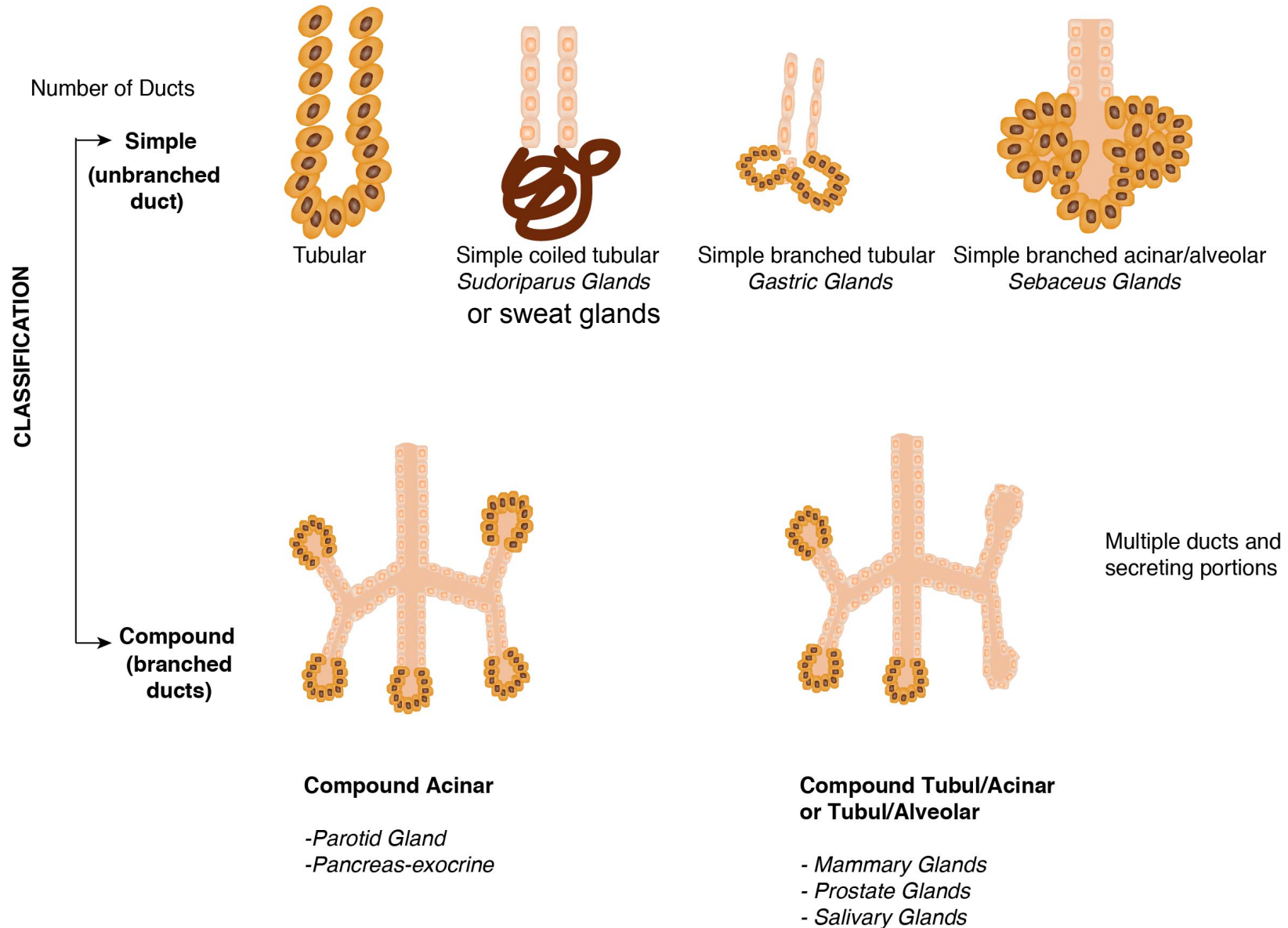
Cross or Transversal Section

Ducts morphology:

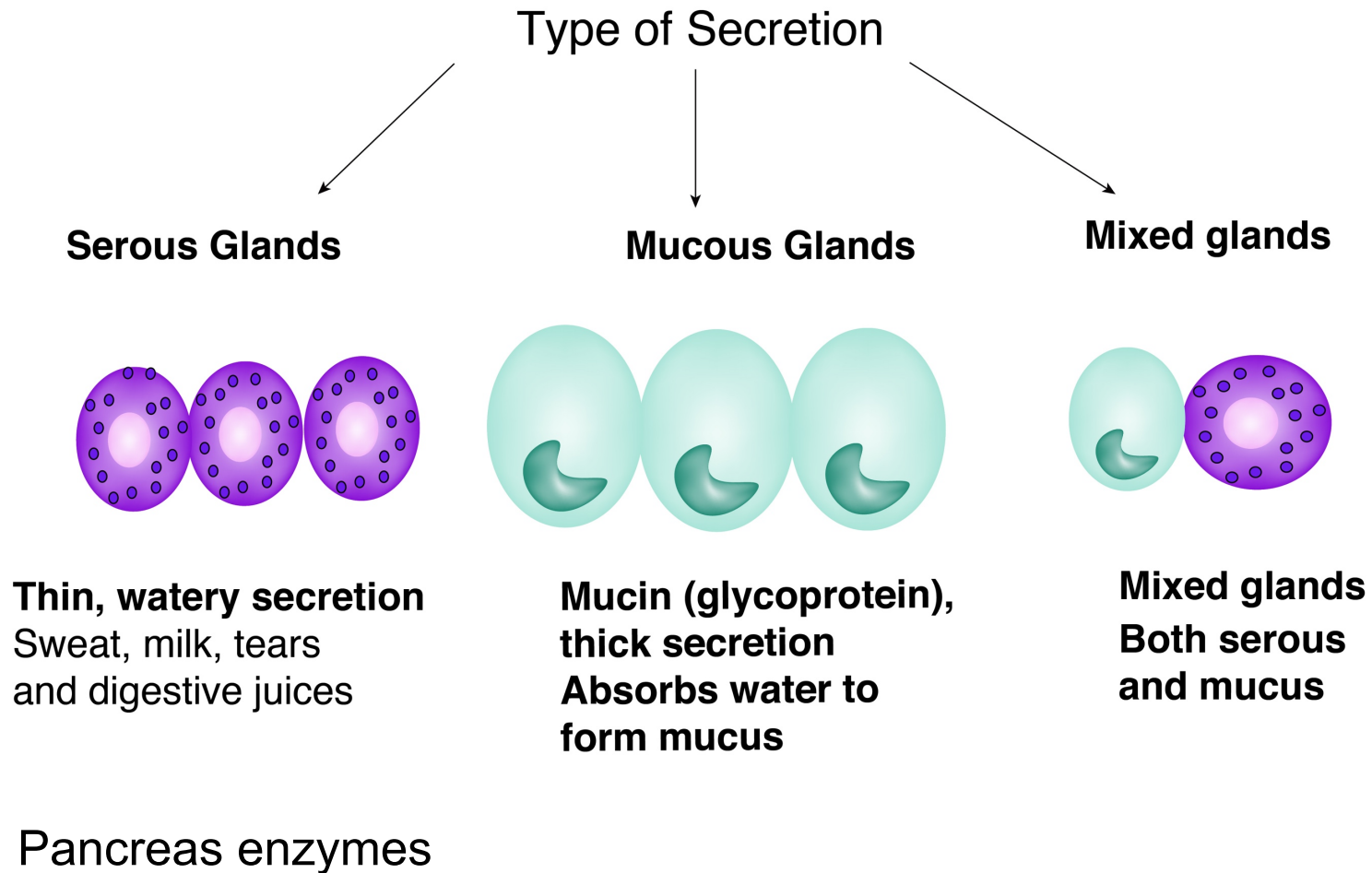


aligned nuclei
as in a pearl necklace

Exocrine Glands Classifications

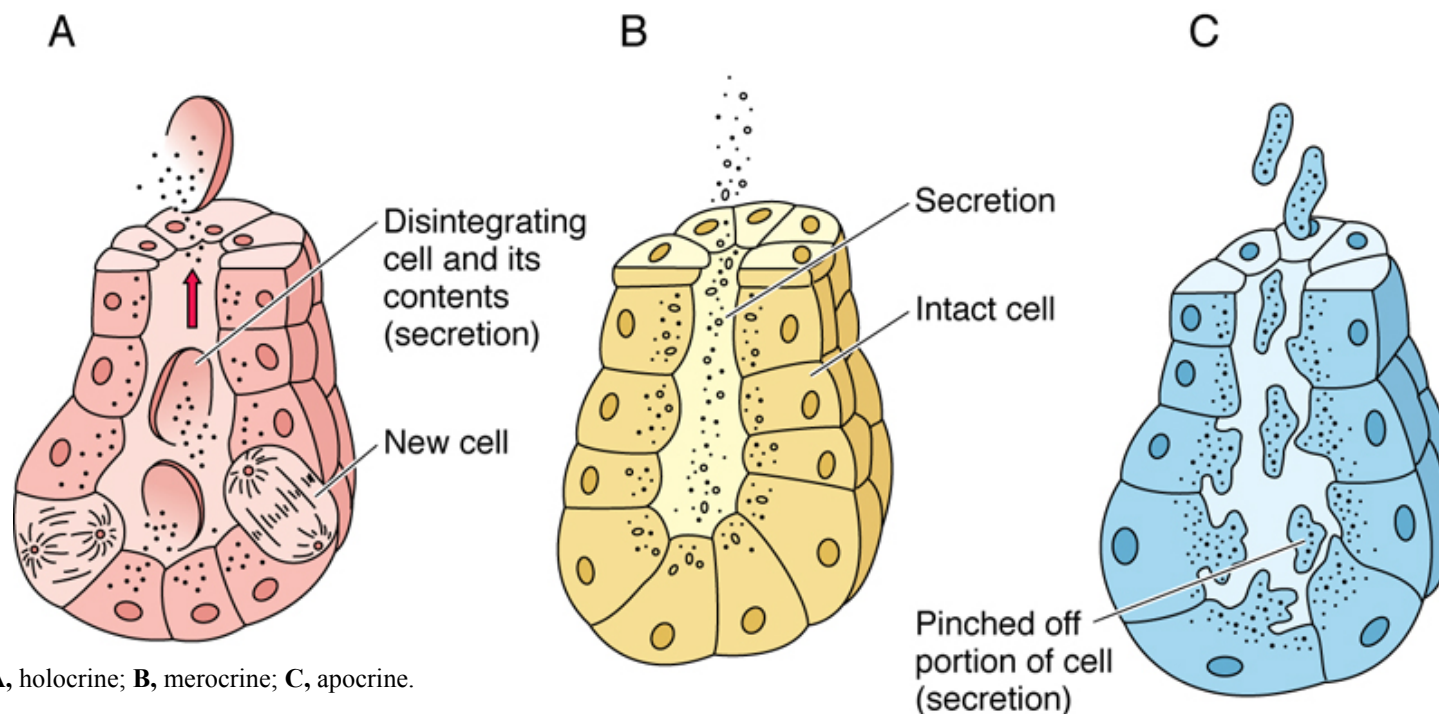


Type of secretion



Serous when they secrete a watery fluid, or mucous when the secretion is thick and rich in glycoproteins.

Glands – Modes of secretion



Modes of secretion: **A**, holocrine; **B**, merocrine; **C**, apocrine.

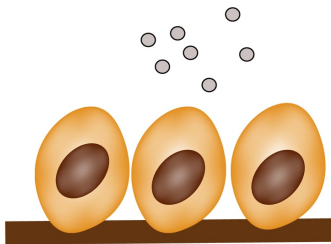
Cells of exocrine glands exhibit three different mechanisms for releasing their secretory products: (1) merocrine, (2) apocrine, and (3) holocrine.

- The release of the secretory product of **merocrine glands** (e.g., parotid gland) occurs via exocytosis; as a result, neither cell membrane nor cytoplasm becomes a part of the secretion.
- In **apocrine glands** (e.g., lactating mammary gland), a small portion of the apical cytoplasm is released along with the secretory product.
- In **holocrine glands** (e.g., sebaceous gland), as a secretory cell matures, it dies and becomes the secretory product.

Modes of secretion

METHODS OF SECRETION

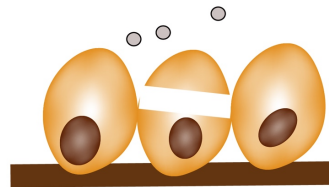
MEROCRINE



Use exocytosis to release substances

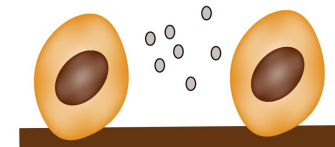
Parotid glands

APOCRINE



The apical part of the secretory cells is released along with the secreted (mammary glands)

HOLOCRINE



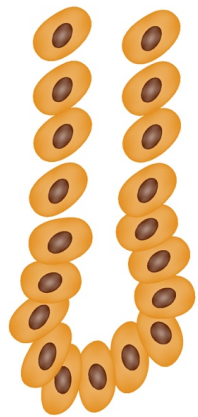
Secretory cells disintegrate
-deliver their accumulated product
-some cells fragments
(sebaceous glands)

Simple Tubular

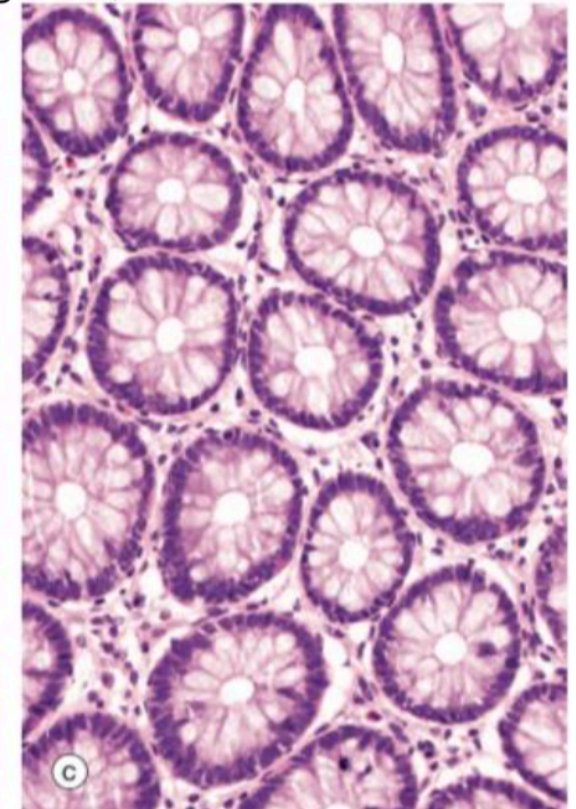
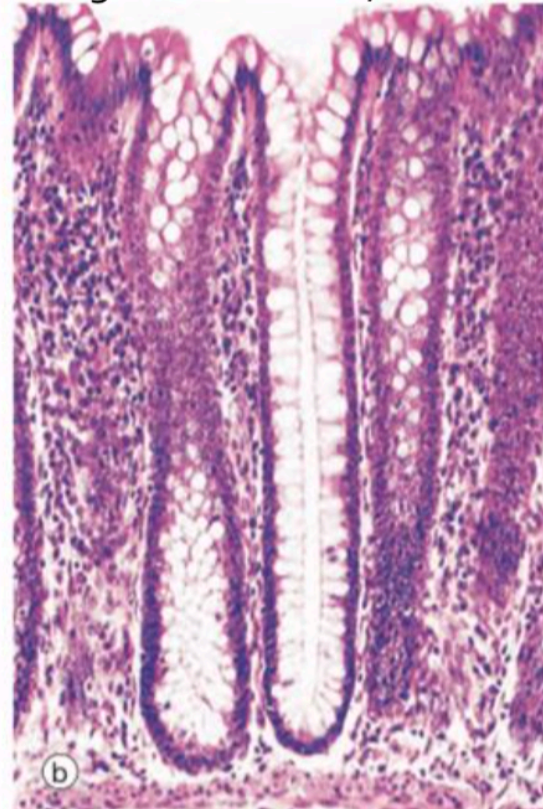
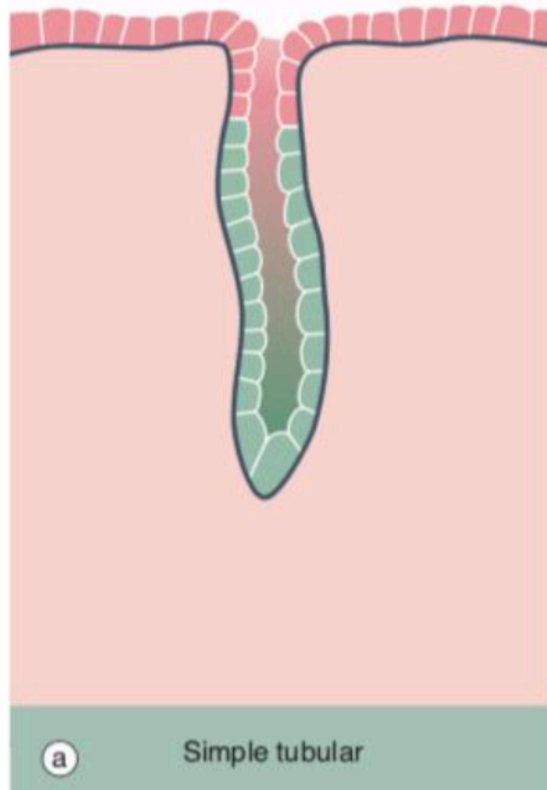
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_elongated secretory portion
_duct usually short or absent

(ex. mucous glands of colon, intestinal glands)



Tubular



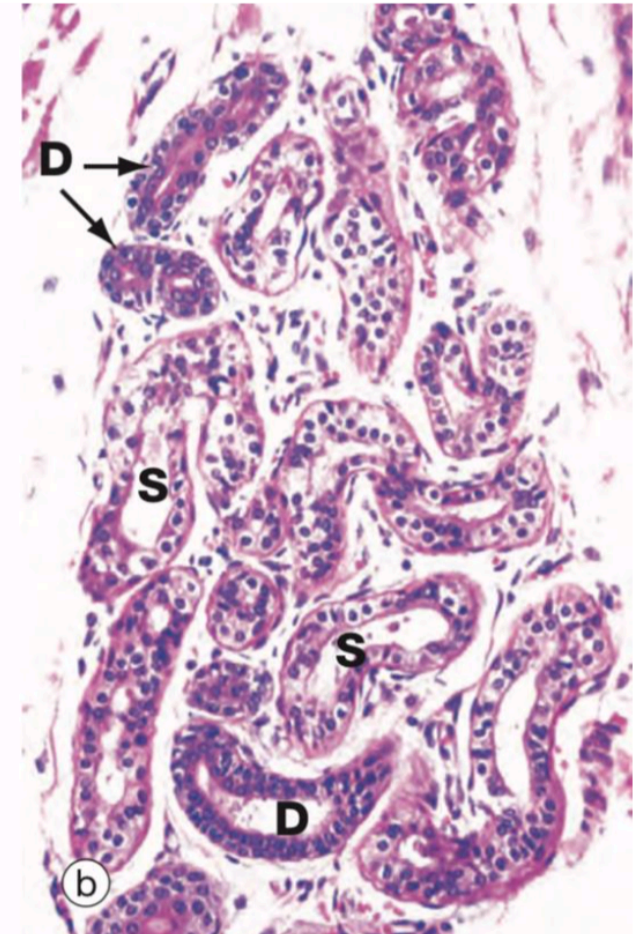
Simple Coiled Tubular



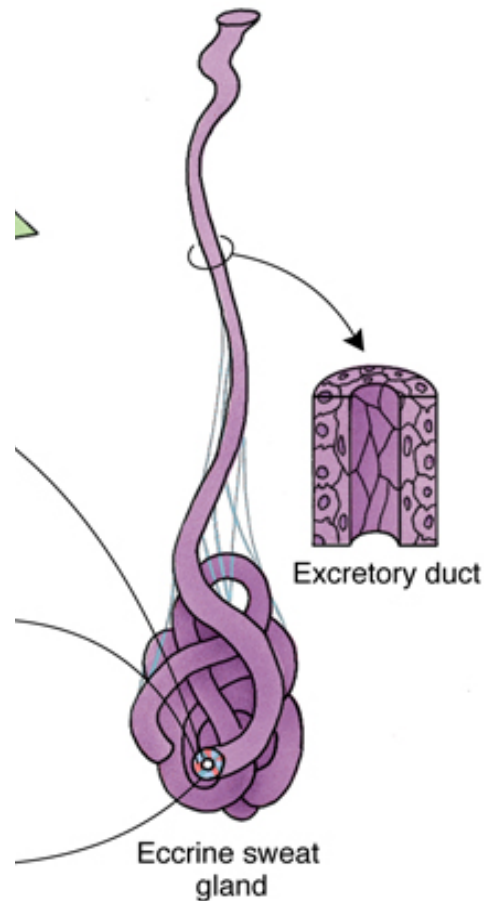
Simple coiled tubular
Sudoriparus Glands

the gland is
coiled without
losing its tubular
form

_secretory portion is very long and coiled
(ex. sweat glands)



Simple Coiled Gland: Sweat Glands (merocrine secretion)



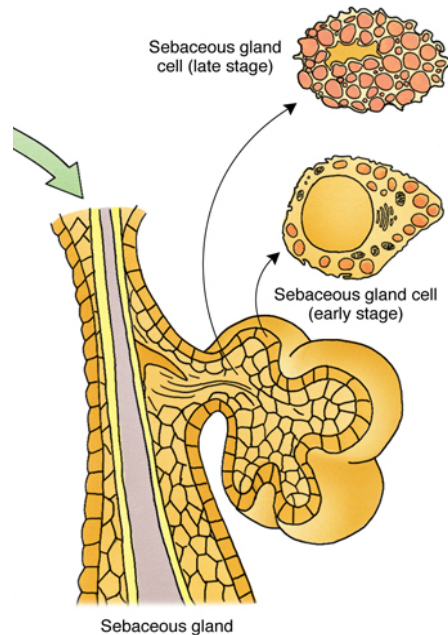
The sweat **glands** are **simple coiled tubular glands** (composed of simple cuboidal epithelium) located deep in the dermis.

The coiled **duct** traverses the dermis and epidermis to open on the surface of the skin at a **sweat pore**.

Secretion of sweat gland is under the hormonal control and receives innervation by fibers of post-ganglion sympathetic nervous system.

In woman sweat glands undergo cyclical changes that seem to be related to the menstrual cycle, so both secretory cells and lumina enlarge during the premenstrual period and diminish during menstruation.

Simple Branched Acinar Glands: Sebaceous Gland



sebaceous gland and their constituent cells.

Holocrine secretion,

Sebaceous glands are appendages of hair follicles.

The ducts of the sebaceous glands open into the follicular canal, where they discharge their waxy secretory product to coat the hair and, eventually, the skin surface.

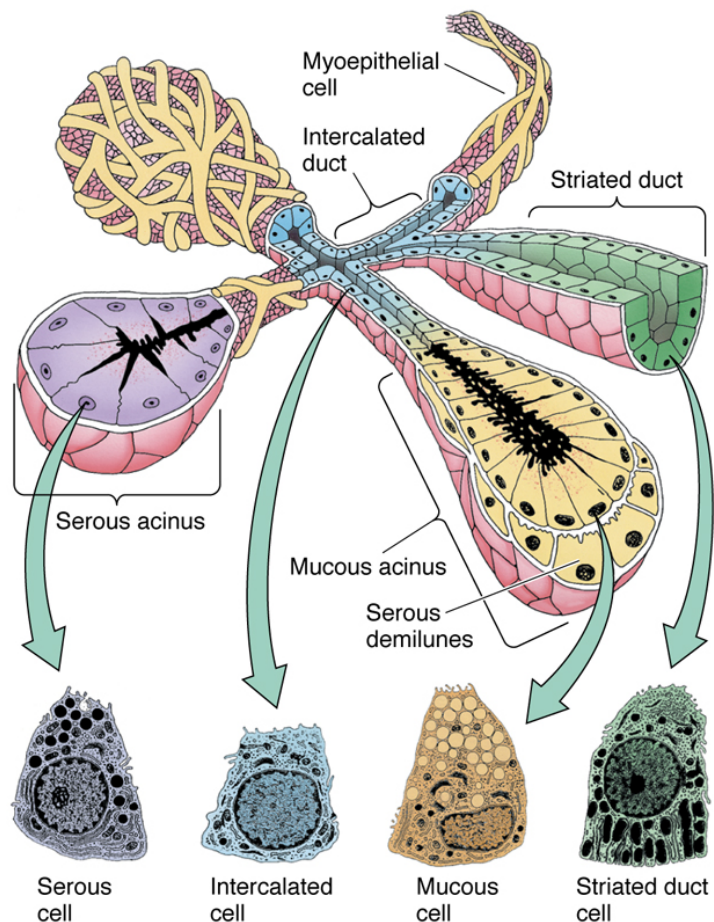
The secretory product is called sebum and it functions to facilitate the maintenance of proper skin texture and hair flexibility. It is also antimicrobial and prevent watery fluids from entering or leaving the skin.

Sebaceous Glands are under the influence of sex hormones and increase their activity after puberty.

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Compound Tubulo/acinar (Salivary Glands)

Polyhedral shape of the cells



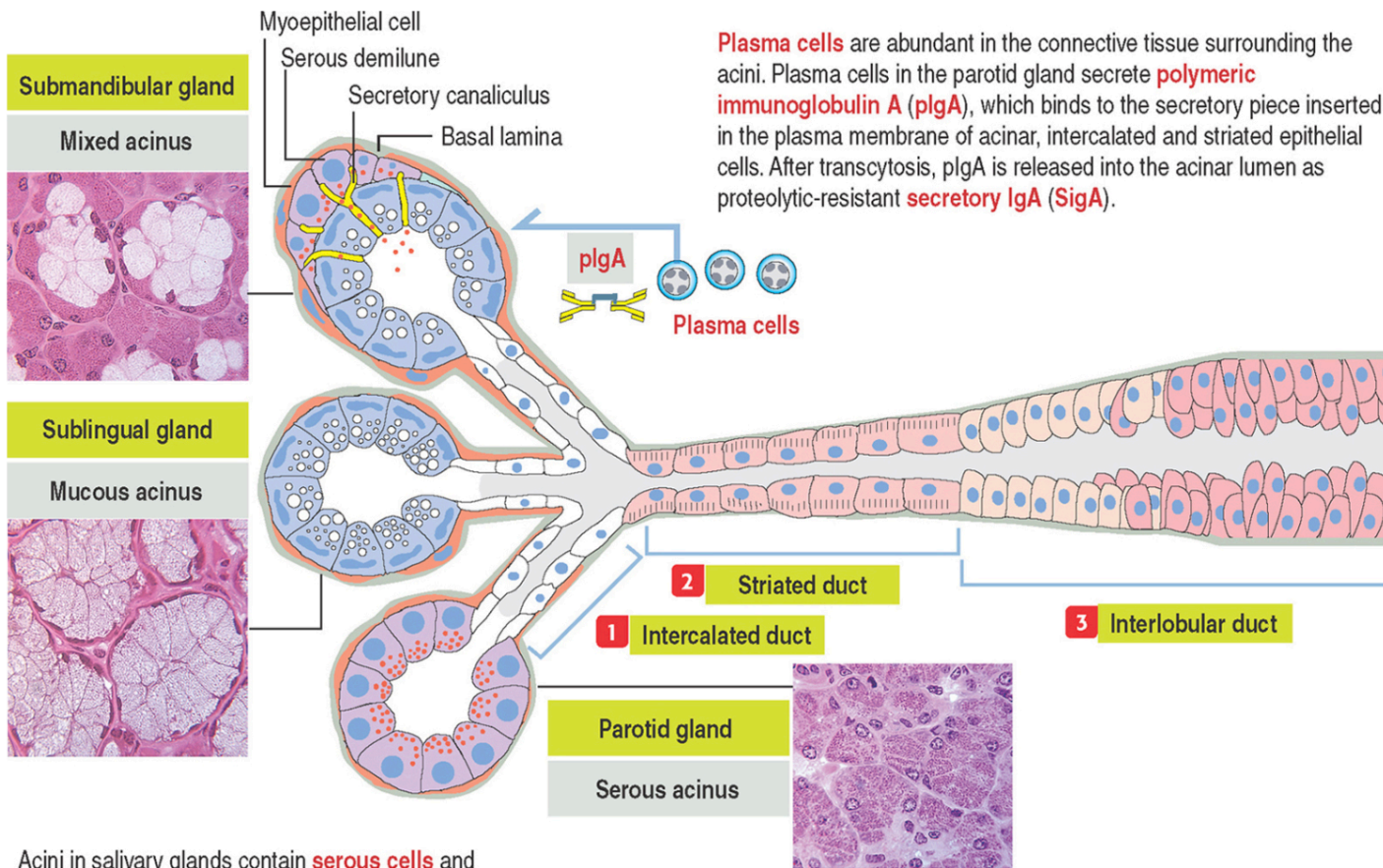
Extramural glands of the digestive system include the **salivary glands**, **pancreas**, and **liver**. The secretory products of these glands assist in the digestive process and are delivered to the lumen of the alimentary tract by a system of ducts.

By producing **saliva**, the **salivary glands** facilitate the process of tasting food, initiate its digestion, and permit its swallowing.

These glands also protect the body by secreting the antibacterial agents lysozyme and lactoferrin as well as the secretory immunoglobulin IgA.

Salivary gland acini, ducts, and cell types.

Salivary Glands: compound Tubul/acinar



Acini in salivary glands contain **serous cells** and

The **major salivary glands** are:

- Parotids-largest
- Submandibular-mixed gland
- Sublingual glands.

The secretory portions of salivary glands are composed of serous and/or mucous secretory cells arranged in **acini** or **tubules** that are surrounded by **myoepithelial cells**, whereas their **ducts** are highly branched and range from very small **intercalated ducts** to very large **principal (terminal) ducts**.

Salivary gland acini, ducts, and cell types.

Exocrine glands, compound tubulo/acinar

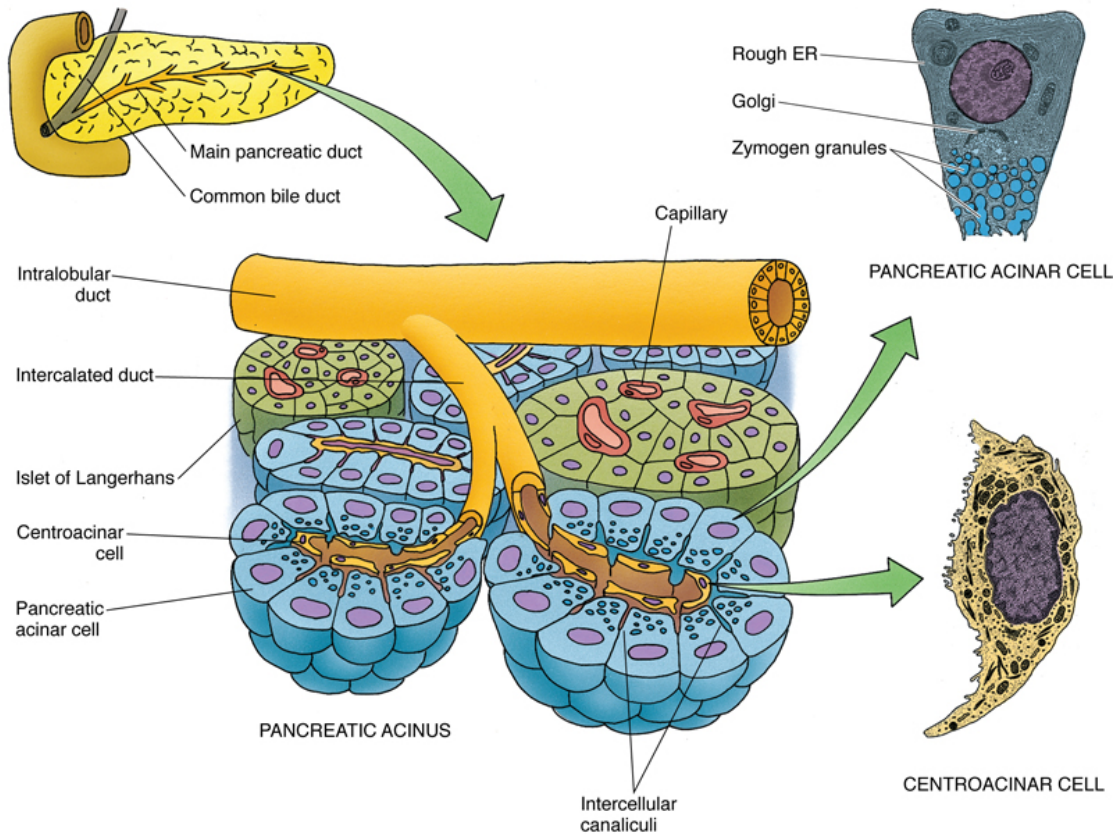
The **sublingual gland** are the smallest of the salivary glands, 2-3 g weight.

Sublingual Glands - are mixed (65% mucous and 35% serous)

It is composed mostly of mucous **tubular secretory units**, sometimes capped with serous cells, known as demilunes, and produces a **mixed saliva** but mostly mucous saliva.

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Compound Acinar Gland with serous secretion (**Exocrine Pancreas**)



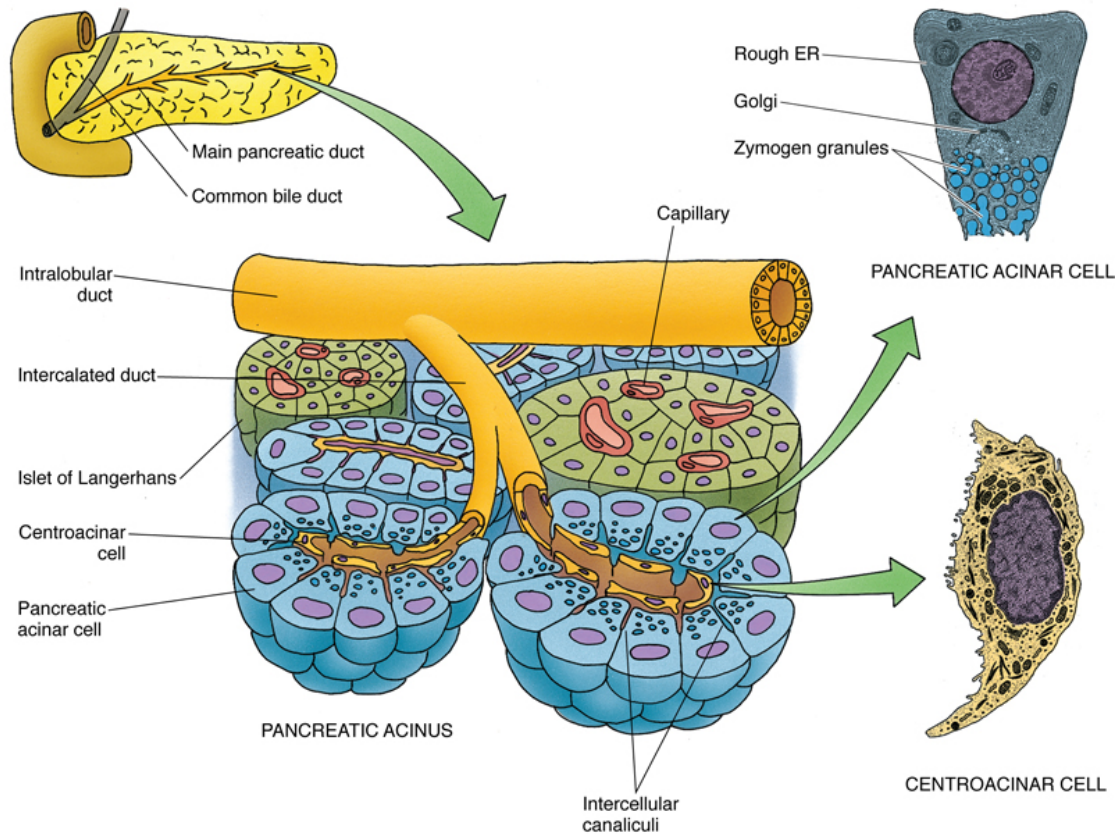
The **exocrine pancreas** is composed of acini whose lumen is occupied by **centroacinar cells**, the beginning of the **duct system** of the pancreas. The acinar cells manufacture, store, and release digestive enzymes:

- pancreatic amylase, pancreatic lipase, ribonuclease, deoxyribonuclease, and proenzymes chymotrypsinogen, procarboxypeptidase, and elastase.

They also manufacture **trypsin inhibitor**, which protects the cell from intracellular activation of trypsin.

The pancreas with secretory acini, their cell types, and the endocrine islets of Langerhans.

Exocrine Pancreas-compound acinar gland with serous secretion

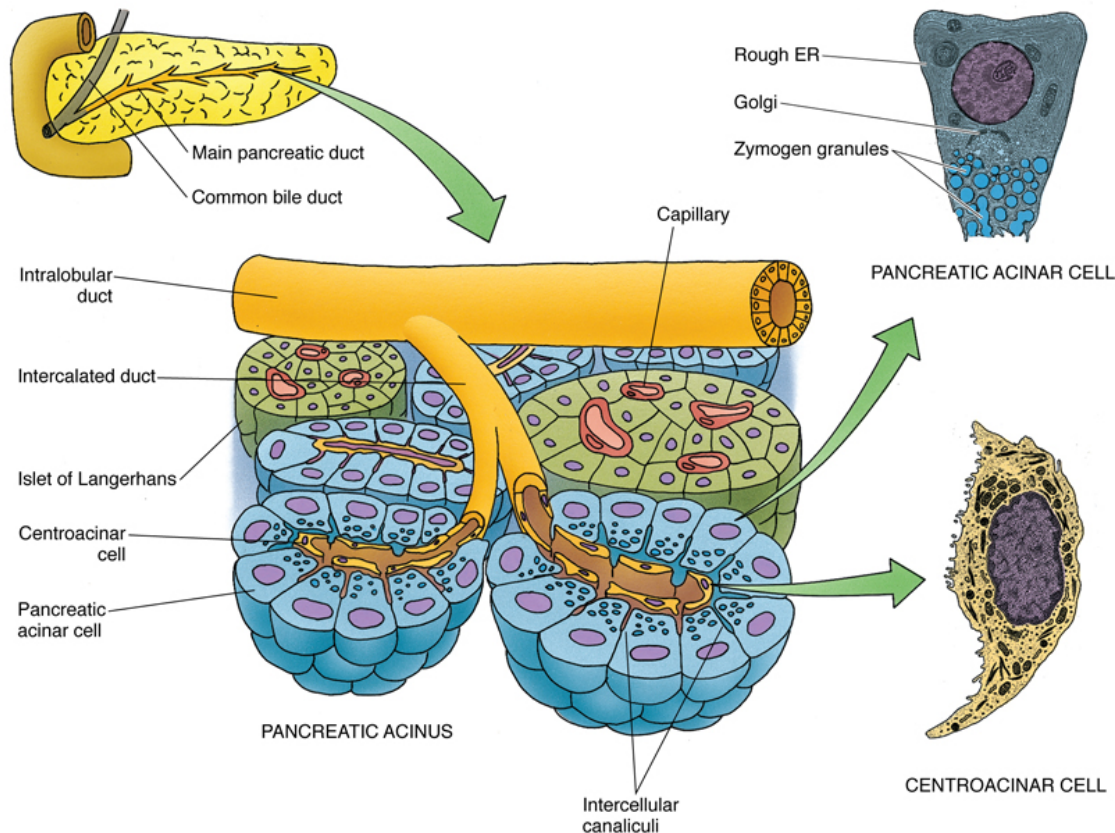


The **centroacinar cells** manufacture a bicarbonate-rich buffer, whose release is affected by the hormone **secretin**, produced by DNES (diffuse neuroendocrine cells) of the small intestine and possibly in concert with **acetylcholine**.

Thus, the enzyme-rich and enzyme-poor secretions are regulated separately, and the two secretions may be released at different times or concomitantly.

The pancreas with secretory acini, their cell types, and the endocrine islets of Langerhans.

Exocrine Pancreas-compound acinar gland with serous secretion



The duct system of pancreas begins with the center of the acinus, with low cuboidal centroacinar cells.

Both have the receptor for secretin released by small intestine (DNES - diffuse neuroendocrine cells) and acetylcholine released by parasympathetic fibers.

Intercalated ducts join each other to form intralobular ducts, converging into interlobular ducts

The pancreas with secretory acini, their cell types, and the endocrine islets of Langerhans.

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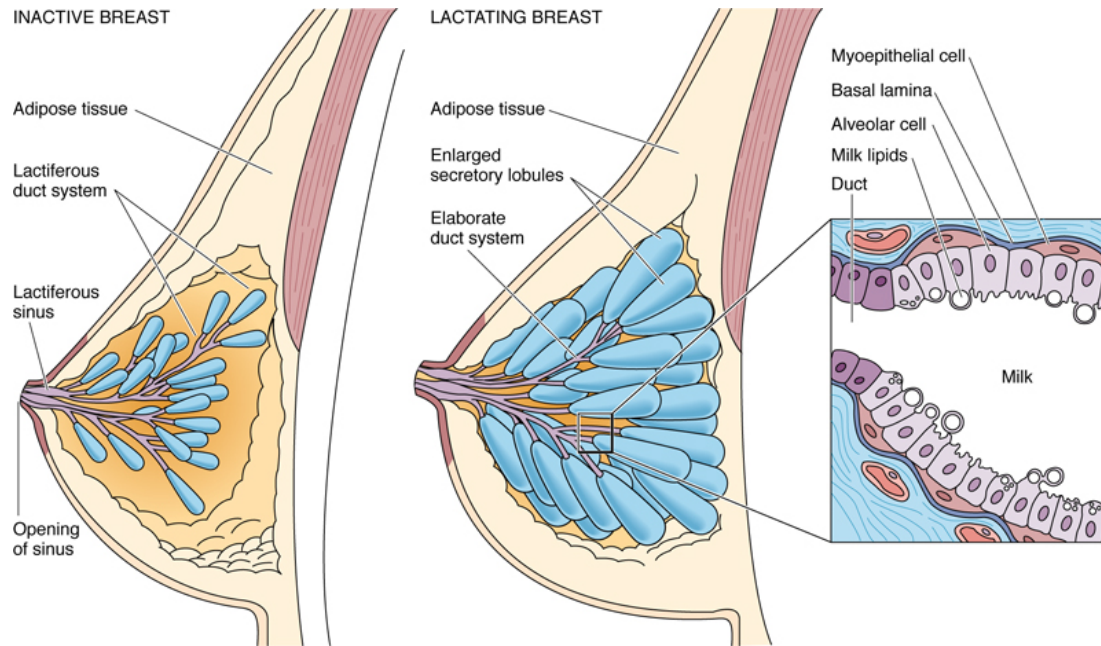
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Histophysiology of the exocrine pancreas

The acinar cells produce, store and release a large number of enzymes, and also produce trypsin inhibitor, that protect the cells from intracellular activation of trypsin.

- Pancreatic amylase: breaks down starches, carbohydrates and glycogen
- Pancreatic Lipase breaks down fats
- Pancreatic cholesterol esterase breaks down cholesterol esters into fatty acids
- Dnase and Rnase break down DNA and RNA molecules
- Elastase breaks down elastic fibers
- Trypsin and Chemotrypsin break down proteins into short peptides

Compound tubulo/alveolar gland with apocrine secretion (Mammary Gland)



Comparison of the glandular differences between an inactive and a lactating breast. *Inset* shows a longitudinal section of a gland and duct of the active mammary gland.

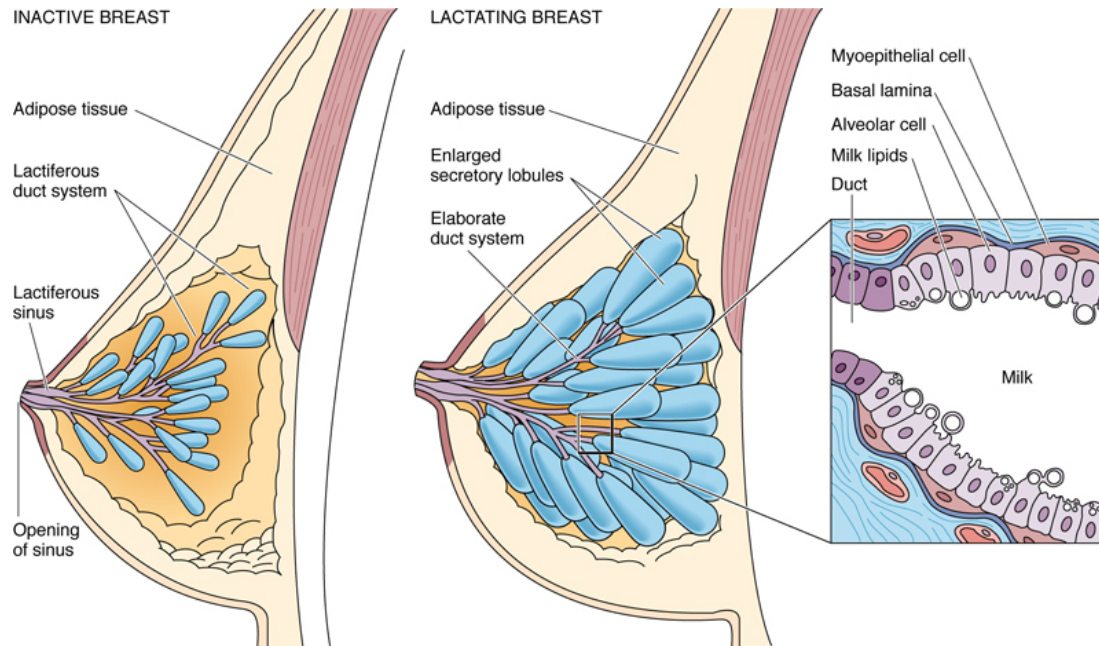
Mammary glands secrete milk, a fluid containing proteins, lipids, and lactose as well as lymphocytes and monocytes, antibodies, minerals, and fat-soluble vitamins.

The glands within the breasts are **compound tubule/alveolar glands**, consisting of 15 to 20 lobes radiating out from the nipple.

Each lobe is drained by its own **lactiferous duct** where each duct is dilated to form a **lactiferous sinus** for milk storage and then narrows before reaching the nipple.

Resting or nonsecreting mammary glands of nonpregnant women have the same basic architecture as the lactating (active) mammary gland, except that they are smaller and without developed alveoli, which occur only during pregnancy.

Mammary Gland: Compound Tubulo/Alveolar Gland with apocrine secretion



Comparison of the glandular differences between an inactive and a lactating breast. *Inset* shows a longitudinal section of a gland and duct of the active mammary gland.

Mammary glands are activated by elevated surges of **estrogen** and **progesterone** during pregnancy to become lactating glands, to provide milk for the newborn. At this time, the terminal portions of the ducts branch and grow and the alveoli develop and mature.

As pregnancy progresses, the breasts enlarge as a result of hypertrophy of the glandular parenchyma filled with **colostrum**, a protein-rich fluid, in preparation for the newborn.

Within a few days after birth, when estrogen and progesterone secretions stops, **prolactin**, secreted by acidophils of the anterior pituitary gland, activates the secretion of milk, which replaces the colostrum.

Compound tubulo/Alveolar Gland with apocrine secretion: Mammary Gland

The secretions of the alveolar cells are of two kinds: lipids and proteins.

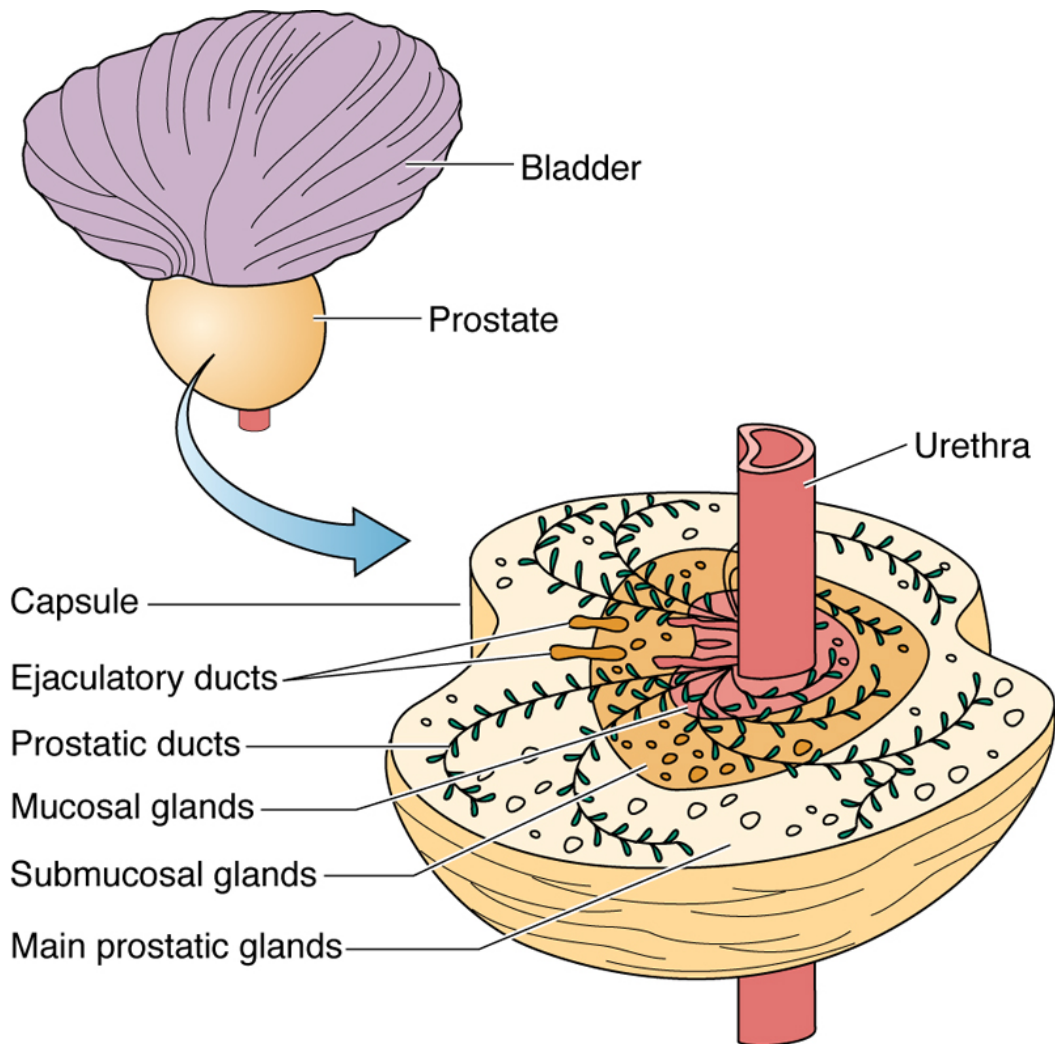
Lipids are stored as droplets within the cytoplasm. They are released from the secretory cells, by the **apocrine** mode of exocytosis.

Proteins synthesized within these secretory cells are liberated from the cells by the **merocrine** mode of exocytosis.

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Compound Tubuloalveolar (Prostate)



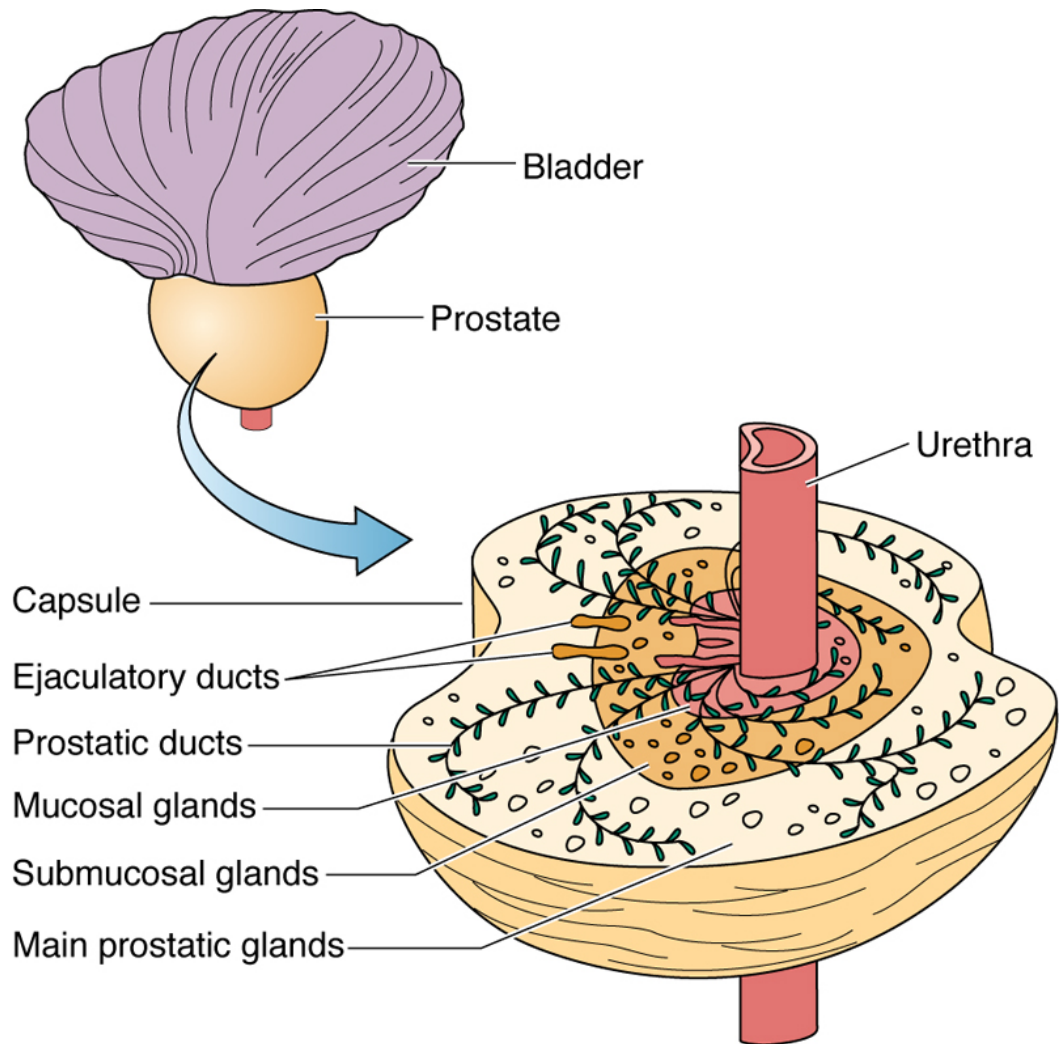
Human prostate gland.

The **prostate gland**, the largest of the accessory glands, is pierced by the urethra and the ejaculatory ducts.

The **capsule** of the gland is composed of a richly vascularized, dense irregular collagenous connective tissue interspersed with **smooth muscle cells**.

The prostate gland, a conglomeration of 30 to 50 individual **compound tubuloalveolar glands**, is arranged in three discrete, concentric layers mucosal, submucosal, and main.

Compound Tubuloalveolar (Prostate)



The lumina of the tubuloalveolar glands frequently display **prostatic concretions (corpora amylacea)**, composed of calcified glycoproteins, whose numbers increase with a person's age.

The **prostatic secretion** constitutes a part of semen.

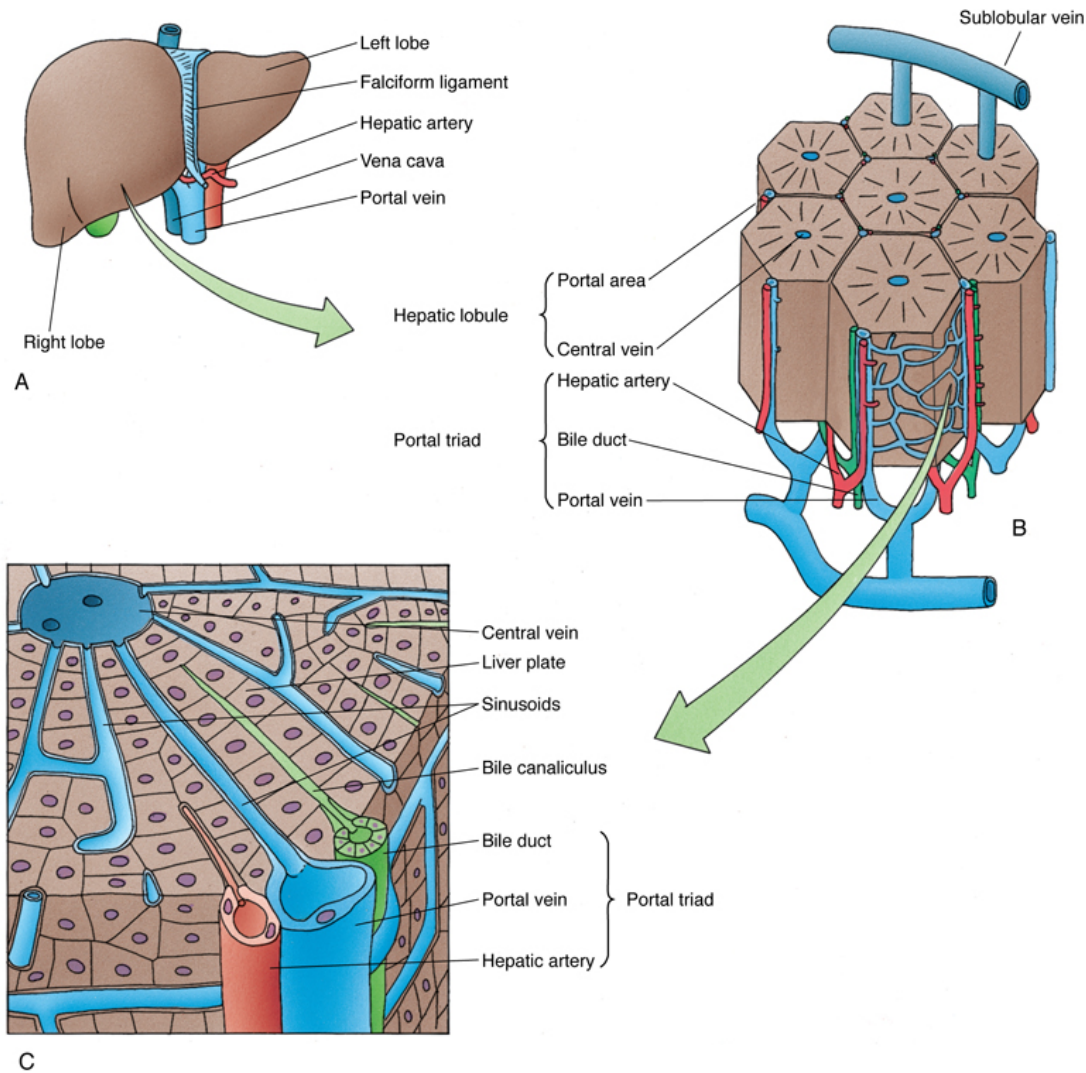
It is a serous, white fluid rich in lipids, proteolytic enzymes, acid phosphatase, fibrinolysin, and citric acid.

The formation, synthesis, and release of the prostatic secretions are regulated by **dihydrotestosterone**, the active form of testosterone.

<http://www.histologyguide.com/slideview/MH-183-prostate/19-slide-1.html?x=22367&y=21515&z=9.3>

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Liver



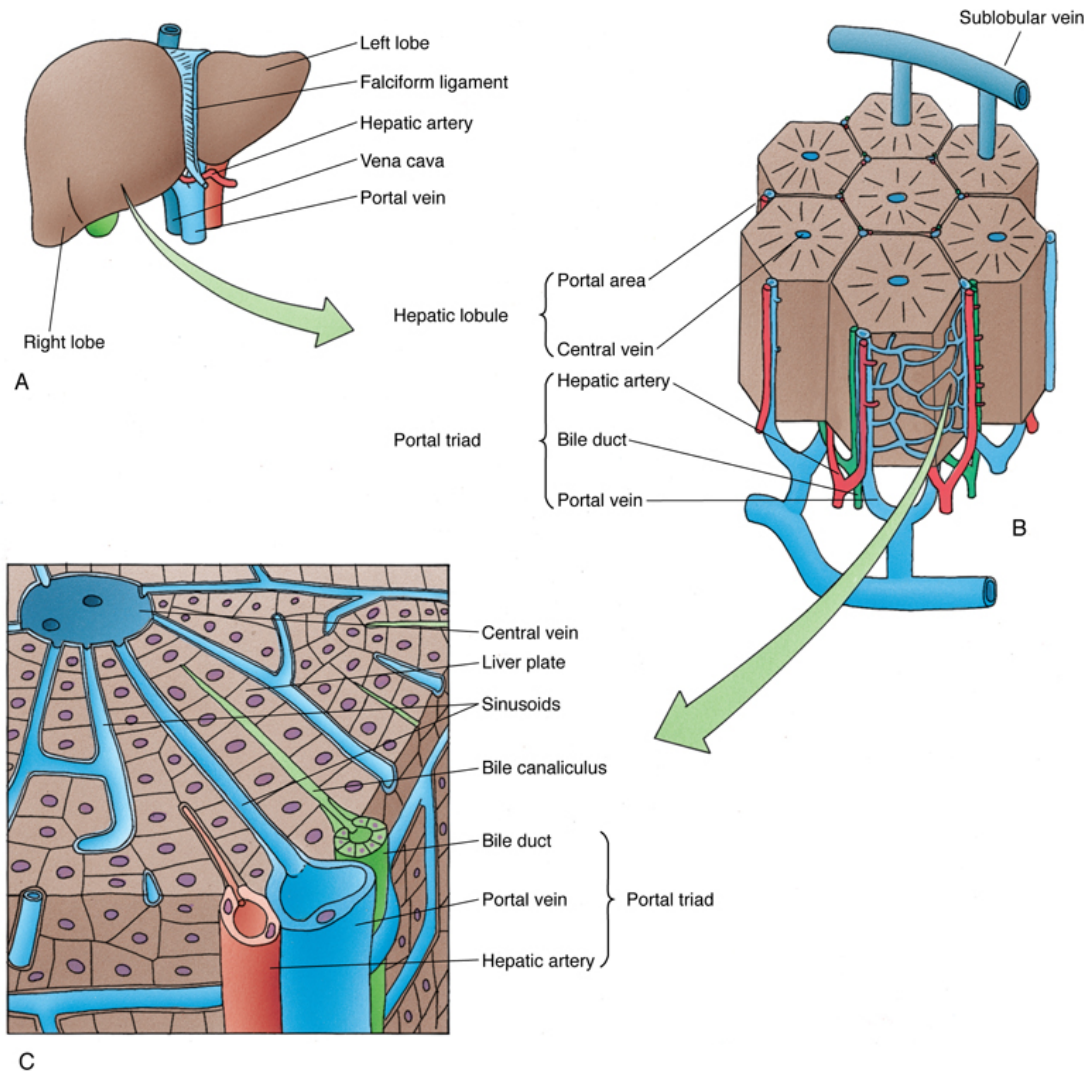
The **liver**, similar to the pancreas, has both endocrine and exocrine functions, although, the same cell, the **hepatocyte**, is responsible for the formation of its exocrine secretion, **bile**, and its endocrine products. Hepatocytes also detoxify toxins and excrete them in bile.

The liver's connective tissue capsule, **Glisson's capsule**, is loosely attached except at the porta hepatis, where it enters the liver, forming the TRIAD:

- 1 portal vein
- 1 hepatic artery
- 1 bile duct

Liver. **A**, Gross anatomy of the liver. **B**, Liver lobules displaying the portal areas and the central vein. **C**, Portion of the liver lobule displaying the portal area, liver plates, sinusoids, and bile canaliculi.

Liver



Liver. **A**, Gross anatomy of the liver. **B**, Liver lobules displaying the portal areas and the central vein. **C**, Portion of the liver lobule displaying the portal area, liver plates, sinusoids, and bile canaliculi.

The liver has a dual blood supply, receiving oxygenated blood from the **hepatic arteries** (25%) and nutrient-rich blood via the **portal vein** (75%).

Bile leaves the liver at the porta hepatis, by way of the hepatic ducts, to be delivered to the gallbladder for concentration and storage.

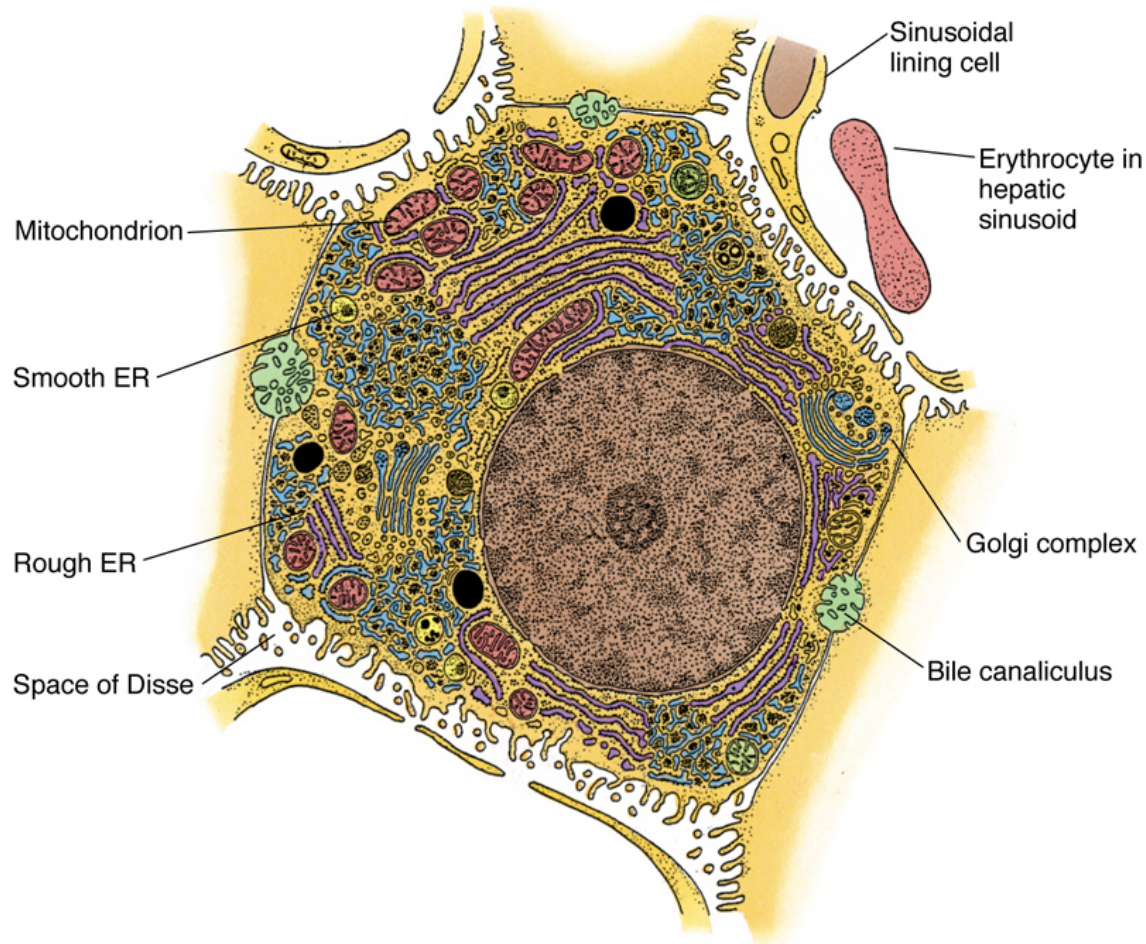
Hepatocytes form hexagon-shaped **classical lobules**

The region where three lobules join each other houses the hepatic artery, the large portal vein, and bile ducts (known as a **portal triad**).

Each lobule has a single **central vein** which receives blood from every sinusoids of that lobule

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Hepatocyte



The plasma membranes of **hepatocytes** are said to have two domains, lateral and sinusoidal.

The **lateral domains** form elaborate, intercellular spaces, 1 to 2 μm in diameter, **bile canaliculi**, that conduct bile between hepatocytes to the periphery of the classical lobules.

The **sinusoidal domains** of hepatocyte plasma membranes also have microvilli, which project into the space of Disse.

Hepatocytes have an abundance of free ribosomes, RER, and Golgi apparatus.

Each cell contains as many as 2000 mitochondria.

Hepatocytes contain varying amounts of inclusions in the form of **lipid droplets** and **glycogen**.

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Test

<http://www.histologyguide.com/slideview/MHS-261-common-bile-duct/02-quiz-1.html?x=0&y=0&z=-1&page=1#>

<http://www.histologyguide.com/slideview/MHS-268-pancreas/01-quiz-1.html?x=30839&y=22468&z=100.0&page=2#>

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<http://www.histologyguide.com/slideview/MH-017-stratified-epithelia/02-quiz-1.html?x=17062&y=20672&z=31.4&page=1>

<http://www.histologyguide.com/slideview/MH-018-transitional-epithelia/02-quiz-1.html?x=17455&y=4228&z=50.0&page=1>