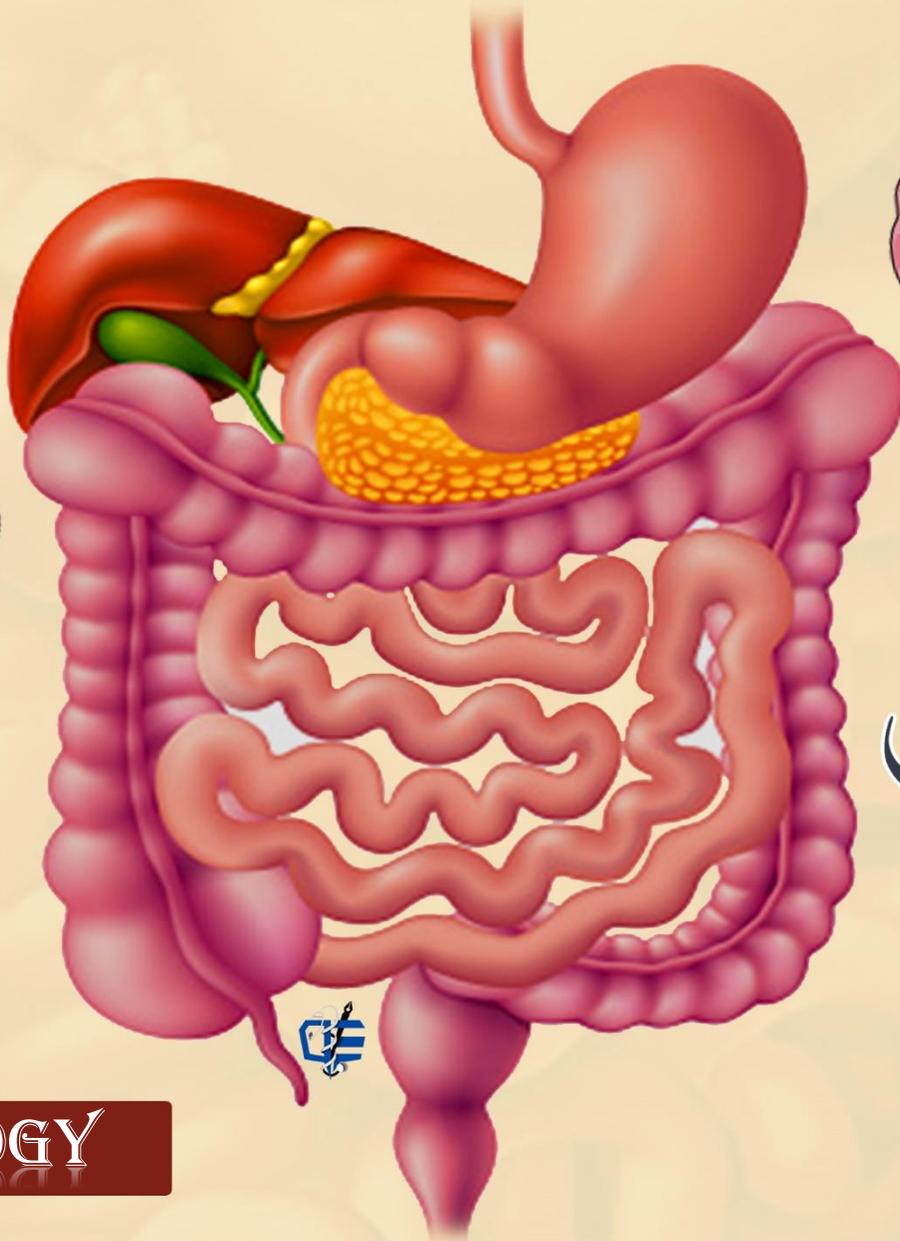


GastroIntestinal System



HISTOLOGY

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- The digestive system consists of: **the digestive tract**:oral cavity, esophagus, stomach, small and large intestines, rectum, and anus—and **its associated glands**:salivary glands, liver, and pancreas.
- The digestive system **function** is : to obtain the molecules necessary for the maintenance, growth, and energy needs of the body from ingested food.

It change large molecules into simple absorptive materials like carbohydrates to simple glucose , proteins to amine acids , fats to fatty acids so they are easily absorbed through the lining of the digestive tract, mostly in small intestine.

Water, vitamins, and minerals are also absorbed from ingested food. In addition, the inner layer of the digestive tract is a protective barrier between the content of the tract's lumen and the internal milieu of the body.

- **The digestive tract** is a hollow tube composed of a lumen whose diameter varies, surrounded by a wall made up of four principal layers:

1.mucosa

2.submucosa

3.muscularis

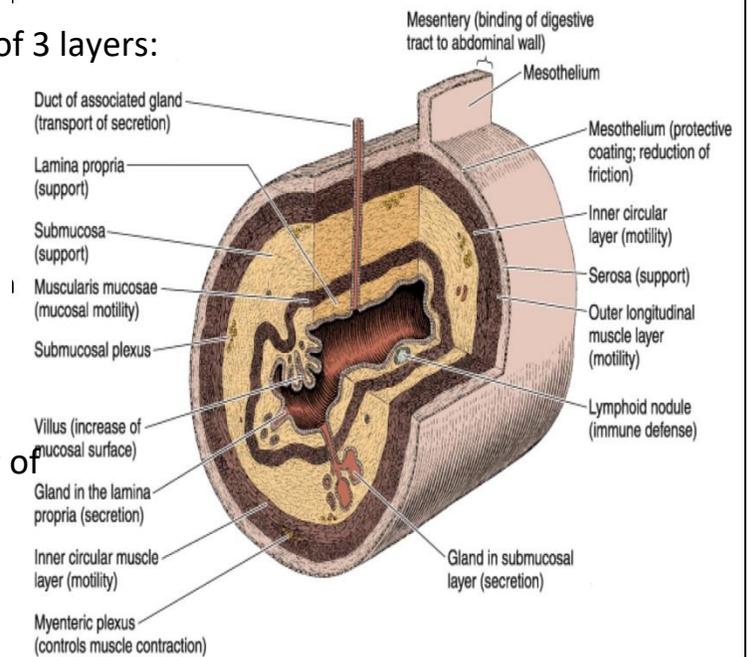
4.serosa

1. Mucosa(mucous membrane): consists of 3 layers:

A .lining epithelial.

B .lamina propria: a loose connective tissue rich in blood and lymph vessels and smooth muscle cells, and sometimes containing glands and lymphoid tissue.

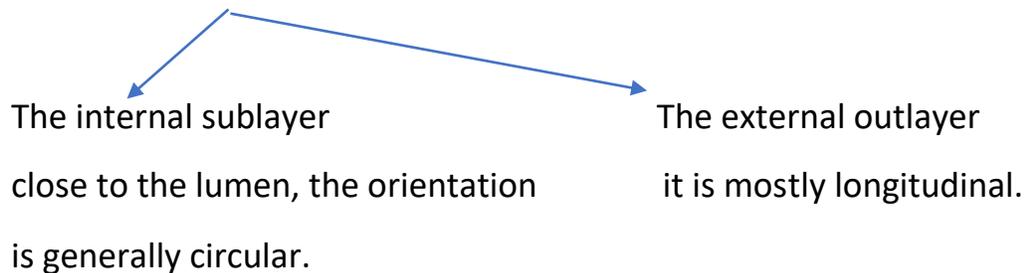
C .muscularis mucosae: usually consisting of a thin inner circular layer and an outer longitudinal layer of smooth muscle cells separating the mucosa from the submucosa.



2. submucosa: is composed of dense connective tissue with many blood and lymph vessels and a submucosal (also called **Meissner's**) nerve plexus.

It may also contain glands (like esophagus and duodenum) and lymphoid tissues.

3. muscularis: contains smooth muscle cells that are spirally oriented and divided into two sublayers according to the main direction the muscle cells follow.



(there is blood and lymph vessels in the connective tissue between the muscle sublayers.)

The muscularis also contains **the myenteric (or Auerbach's) nerve plexus**, which lies between the two muscle sublayers, its PARASYMPATHETIC, it comes from the VAGUS NERVE and called secret motor because it is responsible for the motility of the GI tract and secretion of the glands.

4. The serosa: is a thin layer of loose connective tissue, rich in blood and lymph vessels and adipose tissue, and a simple squamous covering epithelium (mesothelium)

In the abdominal cavity, the serosa is continuous with the mesenteries (a double fold of peritoneum that attaches the intestine to the posterior abdominal wall) and with the peritoneum. However, in places where the digestive organ is bound to other organs or structures the serosa is replaced by a thick adventitia, consisting of connective tissue containing vessels and nerves, without the mesothelium, example: the oral cavity, thoracic esophagus, ascending colon, descending colon and rectum.

- **Basic mucosal forms in the GI tract:**

1.Protective: stratified squamous epithelium they have the ability to undergo mitosis and regeneration to replace the damaged cells ,it is found in the oral cavity, pharynx, the esophagus and the anal canal.

2.secretory: the mucosa consists of a long closely packed tubular glands, found in the stomach.

3.absorptive: the mucosa is arranged in a fingerlike projections called vili with intervening short glands called crypts, that is typical for the small intestine it increases the area in it .

In the duodenum some crypts extend from the muscularis mucosa to the submucosa (Brunners Gland:its main function is to neutralize the acidity of the secretion of the stomach).

4.Absorptive/protective ; the mucosa is arranged into closely packed tubular glands specialised for water absorption and mucus secreting goblet cells

It lines the whole large intestine.

- **The oral cavity:**The oral cavity is lined with stratified squamous epithelium, keratinized or nonkeratinized, depending on the region.
 - The keratin layer protects the oral mucosa from damage during masticatory function and is present mostly in the gingiva (gum) and hard palate
 - The lamina propria in these regions has several papillae and rests directly on bony tissue.
 - Nonkeratinized squamous epithelium covers the soft palate, lips, cheeks, and the floor of the mouth.
 - The lamina propria has papillae, similar to those in the dermis of the skin, and is continuous with a submucosa containing diffuse small salivary glands.
 - In the lips, a transition from the oral nonkeratinized epithelium to the keratinized epithelium of the skin can be observed.

- The soft palate has a core of skeletal muscle, numerous mucous glands, and lymphoid nodules in its submucosa.

- **Tongue:** is a mass of striated muscle covered by a mucous membrane whose structure varies according to the region.

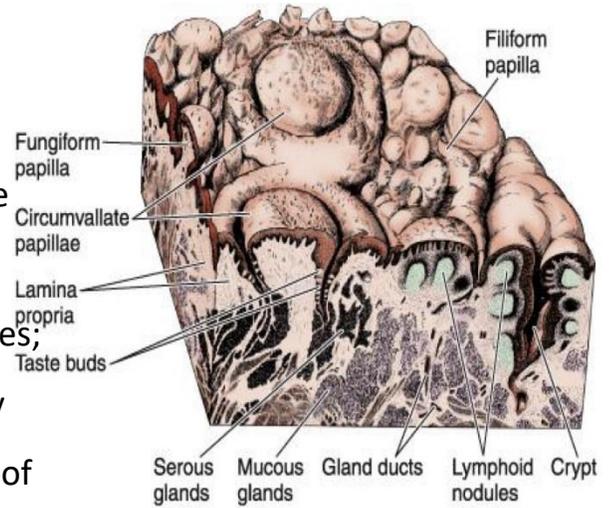
The muscle fibers cross one another in three planes; they are grouped in bundles, usually separated by connective tissue, because the connective tissue of the lamina propria penetrates the spaces between

the muscular bundles, the mucous membrane is strongly adherent to the muscle, The mucous membrane is smooth on the lower (ventral) surface of the tongue.

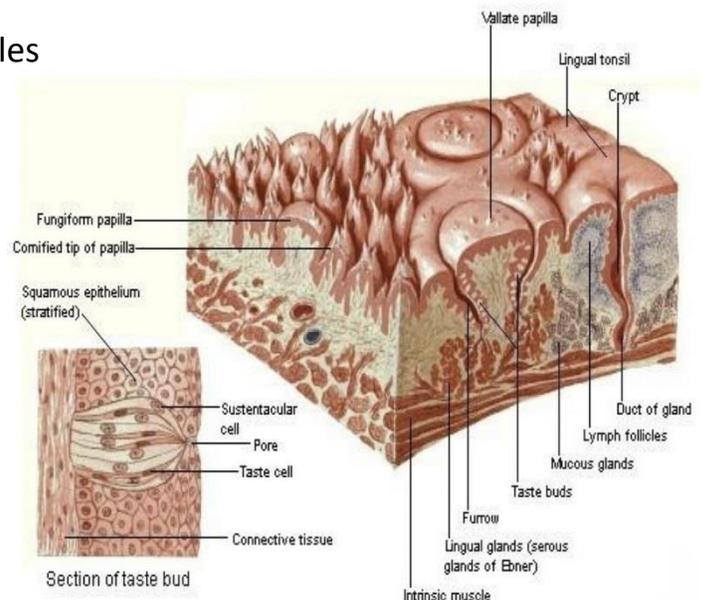
-The Lower surface of the tongue (mucosa, nonkeratinized) and the upper dorsum (parakeratinized: partially keratinized epithelium), The tongue's dorsal surface is irregular, covered anteriorly by a great number of small eminences called papillae. **The posterior one-third of the dorsal surface of the tongue is separated from the anterior two-thirds by a V-shaped boundary (sulcus terminalis).**

- Behind this boundary, the surface of the tongue shows small bulges composed mainly of two types of small lymphoid aggregations: **Tongue - Schematic Stereogram**

- small collections of lymphoid nodules
- the lingual tonsils, where lymphoid nodules aggregate around invaginations (crypts) of the mucous membrane.



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Now in **the anterior two thirds** we have papillae: Papillae are elevations of the oral epithelium and lamina propria that assume various forms and functions.

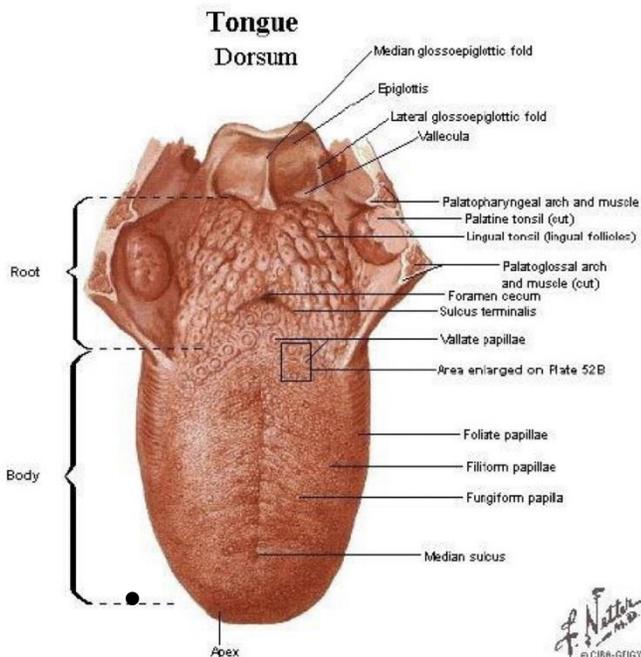
There are four types:

1-Filiform papillae have an elongated conical shape, they are quite numerous and are present over the entire surface of the tongue. Their epithelium, which does not contain taste buds, is keratinized.

2- Fungiform papillae resemble mushrooms; they have a narrow stalk and a smoothsurfaced, dilated upper part, these papillae, which contain scattered taste buds on their upper surfaces, are irregularly interspersed among the filiform papillae.

3- Foliate Papillae: poorly developed in humans, consist of two or more parallel ridges and furrows on the dorsolateral surface of the tongue and contain many taste buds.

4- Circumvallate papillae: (surrounded by circular groove, they are where we find taste buds at medial side of papilla) Circumvallate is circular, but you can see two clefts/ grooves/sulcuses in some sections, they have taste buds at both sides of papilla.



- **Taste buds:**

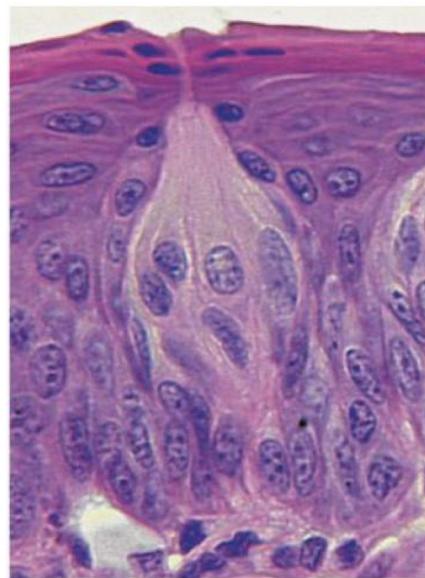
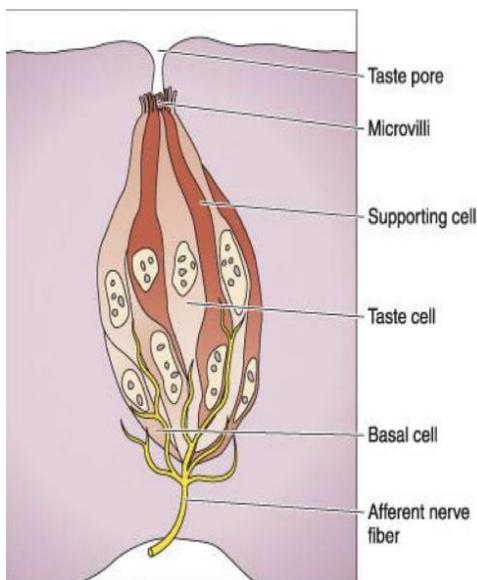
a . microvilli: in the upper part the dissolving material comes here and change from taste to impulses through the bipolar cells.

B . taste pore: for the passage of the material.

C . supporting cells(sustentacular cells):present on the two sides of the bipolar

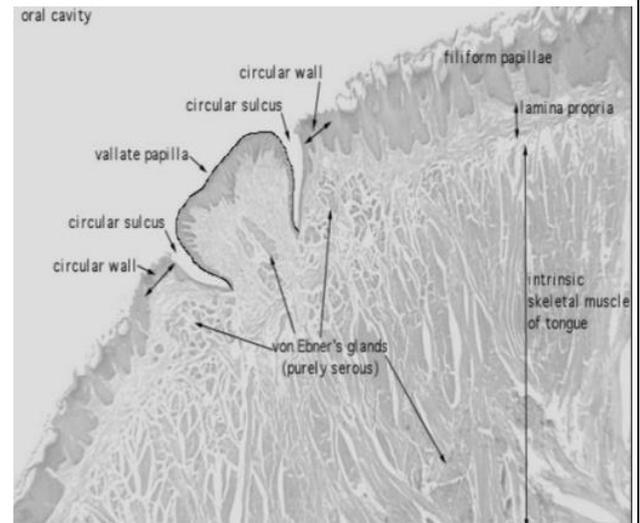
D . basal cells: responsible for mitosis and replacement of the cells.

E . afferent nerve fiber: it moves the impulses to the brain to the centers of smell.



Circumvallate Papillae:

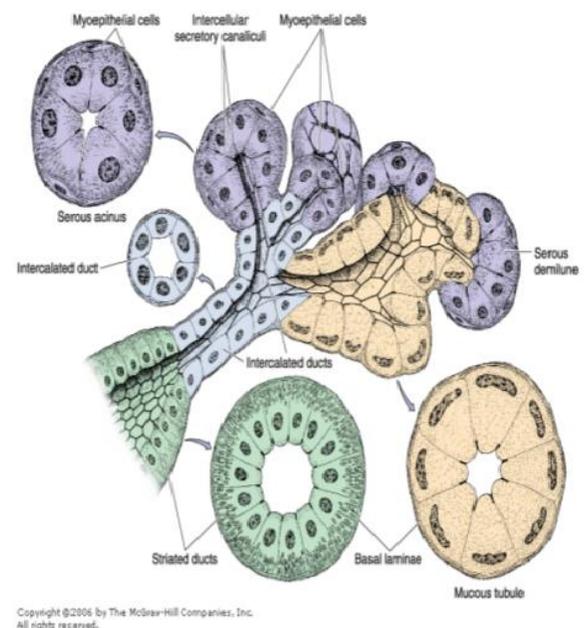
- Circumvallate papillae are 7–12 extremely large circular papillae whose flattened surfaces extend above the other papillae.
- They are distributed in the V region in the posterior portion of the tongue.
- Numerous serous (von Ebner's) glands drain their contents into the deep groove that encircles the periphery of each papilla.
- This moatlike arrangement provides a continuous flow of fluid over the great number of taste buds present along the sides of these papillae.
- The glands also secrete a lipase that probably prevents the formation of a hydrophobic layer over the taste buds that would hinder their function.
- This flow of secretions is important in removing food particles from the vicinity of the taste buds so that they can receive and process new gustatory stimuli.
- Along with this local role, lingual lipase is active in the stomach and can digest up to 30% of dietary triglycerides.
- Other small mucous salivary glands dispersed throughout the lining of the oral cavity act in the same way as the serous glands associated with this type of papilla to prepare the taste buds in other parts of the oral cavity, such as the anterior portion of the tongue, to respond to taste stimuli, so these mucous gland help in dissolving materials.



Salivary Glands:

- Saliva is a complex fluid that has digestive, lubricating, and protective functions.
- In addition to the small salivary glands scattered throughout the oral cavity, there are three pairs of **large salivary glands**: the **parotid**, **submandibular** (submaxillary), and **sublingual glands**.

- In humans, the minor salivary glands secrete 10% of the total volume of saliva, but they account for approximately 70% of the mucus secreted.
- These large salivary glands surrounded by capsule of connective tissue, rich in collagen fibers, and some of these glands like the **parotid gland** surrounded by **2 capsule** (outer and inner one) which is connective tissue spread inside the gland to divide the gland into **lobes and lobules**.
- The parenchyma of the glands (inside the gland) consists of **secretory end pieces** and a **branching duct system** arranged in lobules, separated by septae of connective tissue originating from the capsule, (between the lobes there are interlobar ducts, inside the lobes the interlobular ducts separated the lobules by connective tissue)
- The secretory end pieces present two types of secretory cells—**serous** and **mucous**.
- As well as the **nonsecretory, myoepithelial** cells (myo= muscles, so these cells help in the secretion contract for propel of secretion)
- This secretory portion is followed by a duct system whose components modify and conduct the saliva to the oral cavity.
- **Serous cells** are usually **pyramidal** in shape, with a broad base **resting on the basal lamina** and a narrow apical surface with short, **irregular microvilli facing the lumen**.
- This section appear **serous acinus** (group of serous cell), there are myoepithelial cells above the basement membrane surrounding the acinus.(the purple one).
- (the green one) >>mucous acinus it has basement membrane, lumen and each cell has nucleus and apex open into the lumen.
- The difference between serous and mucous acinus that the first one it is cuboidal, has central rounded nucleus, the base is basophilic and has a lot of RER, the lumen is narrow and its secrete protein and enzyme (serous secretion), **ON THE OTHER HAND** the mucous acinus its nuclei basal and



flattened, lumen is large, boundaries is distinct between cell of acini, it secrete mucous(which has a foamy appearance).

- The mucus is dissolved by the preparation of the slides that's why we Can't see it in the histological sections.
- They exhibit characteristics of **polarized protein-secreting cells**(on the apex).
- Adjacent secretory cells are joined together by **junctional complexes** and usually form a spherical mass of cells called **acinus** with a small lumen in the center.
- **This structure can be thought of as a grape attached to its stem; the stem corresponds to the duct system.**
- The lumen of acinus cells open into **intercalated ducts** (the blue one) which is formed by simple cuboidal epithelial cells and the number of this cells 5-6 cells, these intercalated ducts open into larger ducts called striated ducts (both are present inside the lobule), these ducts are called this because they have striations at their base above the basement membrane and it is composed of more than 10 columnar cells or long cuboidal cells.
- **Mucous cells** are usually cuboidal to columnar in shape; their nuclei are oval and pressed toward the bases of the cells.
- They exhibit the characteristics of mucus-secreting cells containing glycoproteins important for the moistening and lubricating functions of the saliva.
- **Most of these glycoproteins are called mucins and contain 70â€“80% carbohydrate moieties in their structure.**
- Mucous cells are most often organized as tubules, **consisting of cylindrical arrays of secretory cells surrounding a lumen.**

Myoepithelial cells:

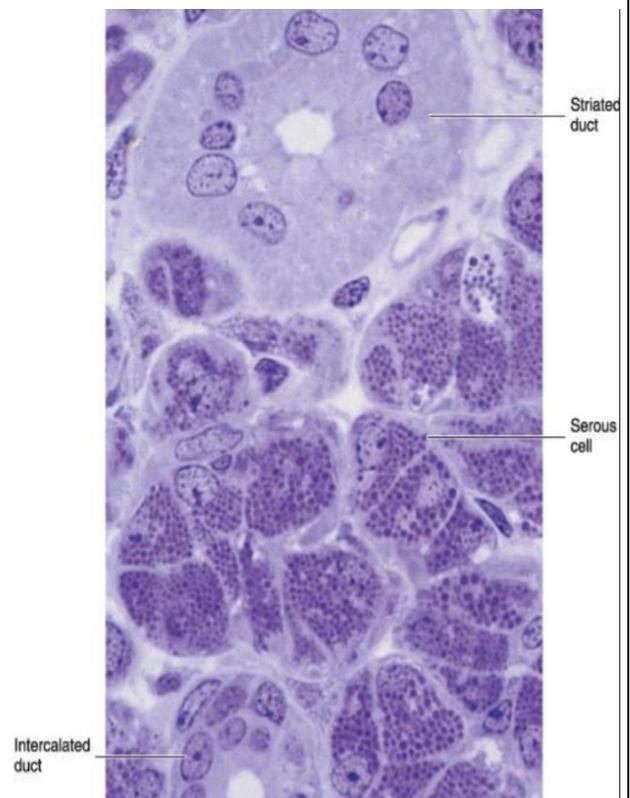
- Are found between the **basal lamina and the basal plasma membrane** of the cells.
- Forming secretory end pieces and intercalated ducts (to a lesser extent), which form the initial portion of the duct system.

- Myoepithelial cells surrounding each **secretory portion**, usually two to three cells per secretory unit, are well developed and branched (and are sometimes called **basket cells**).
- Whereas those associated with **intercalated ducts** are spindle shaped and lie parallel to the length of the duct.
- These cells show several characteristics that resemble smooth muscle cells, including contractility. However, they also establish intercellular junctions among themselves and with secretory cells, such as desmosomes.
- Although the contraction of myoepithelial cells accelerates the secretion of saliva, their main function seems to be the prevention of end piece distention during secretion due to the increase in intraluminal pressure.
- In the **duct system**, secretory end pieces empty into the **intercalated ducts**, lined by cuboidal epithelial cells.
- These cells have the ability to divide and differentiate into secretory or ductal cells.
- Several of these short intercalated ducts join to form **striated ducts**.
- Characterized by **radial striations** that extend **from the bases** of the cells to the level of the central nuclei.
- Intercalated and striated ducts are also called intralobular ducts because of their location within the lobule.
- When viewed in the electron microscope, the **striations are seen to consist of infoldings of the basal plasma membrane with numerous elongated mitochondria** that are aligned parallel to the infolded membranes; this structure is characteristic of ion-transporting cells.
- The striated ducts of each lobule converge and drain into ducts located in the connective tissue septae separating the lobules, where they become **interlobular, or excretory, ducts**.
- They are initially lined with pseudostratified or stratified cuboidal epithelium, but more distal parts of the excretory ducts are lined with stratified columnar epithelium containing a few mucus-secreting cells.
- The parotid duct has **squamous non keratinized epithelium**.
- The main duct of each major salivary gland ultimately empties into the oral cavity and is lined with **nonkeratinized-stratified squamous epithelium**.
- Vessels and nerves enter the large salivary glands at the hilum and gradually branch into the lobules.

- A rich vascular and nerve plexus surrounds the secretory and ductal components of each lobule.
- The capillaries surrounding the secretory end pieces are very important for the secretion of saliva, stimulated by the autonomic nervous system.
- Parasympathetic stimulation, usually through the smell or taste of food, promotes vasodilation and a copious watery secretion content. Sympathetic stimulation produces small amounts of viscous saliva, rich in organic material.

Parotid Gland:

- The parotid gland is a **branched acinar gland**; its secretory portion is composed exclusively of serous cells.
- containing secretory granules that are **rich in proteins** and **have a high amylase activity**
- This activity is responsible for most of the hydrolysis of ingested carbohydrates.
- **The digestion begins in the mouth and continues for a short time in the stomach, before the gastric juice acidifies the food and thus decreases amylase activity considerably.**
- Intercalated and striated ducts are easily observed **within the lobules**, due to their length.
- As in other large salivary glands, the connective tissue contains many **plasma cells and lymphocytes**.
- The plasma cells secrete IgA, which forms a complex with a **secretory component** synthesized by the serous acinar, intercalated duct, and striated duct cells.



- The **IgA-rich** secretory complex released into the **saliva** is **resistant to enzymatic digestion and constitutes an immunological defense mechanism against pathogens in the oral cavity.**

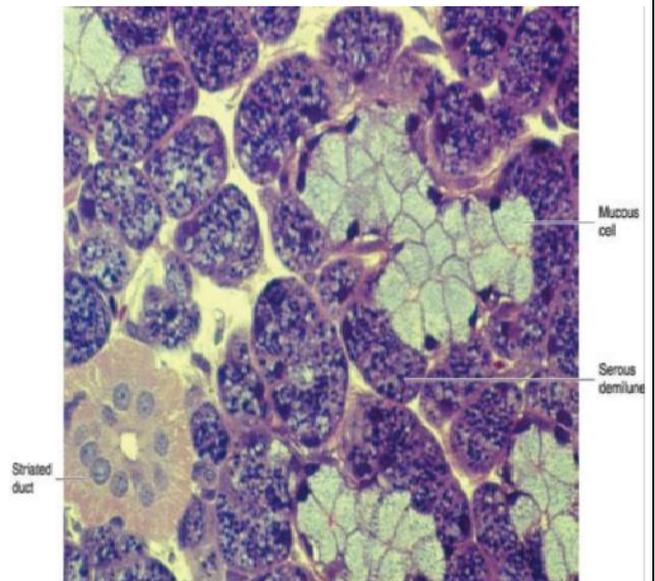
Submandibular (Submaxillary) Gland:

- It's called complicated duct gland because it has a lot of ducts inside the gland
- The submandibular gland is a branched **tubuloacinar gland**.
- Its secretory portion contains both **mucous** and **serous cells**.

- The serous cells are the main component of this gland and are easily distinguished from mucous cells by their rounded nuclei and basophilic cytoplasm.

- In humans, 90% of the end pieces of the submandibular gland are serous acinar, whereas 10% consist of mucous tubules with **serous demilunes**(serous acini overlying the mucous acini).

- **Serous cells are responsible for the weak amylolytic activity present in this gland and its saliva.**



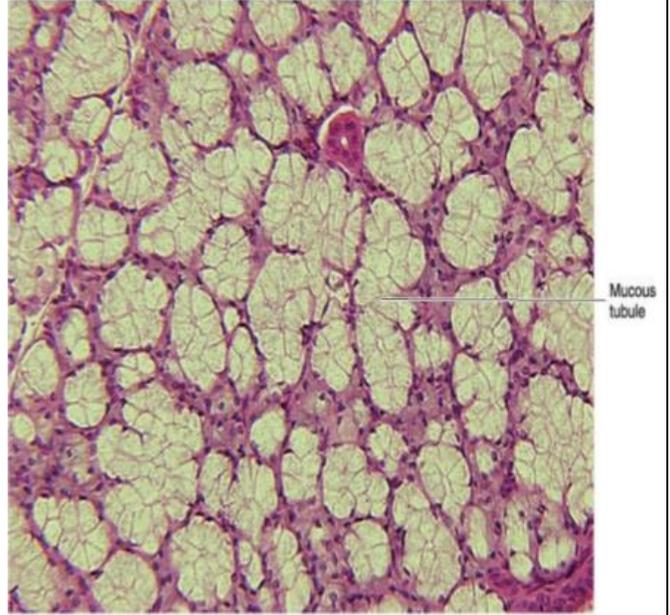
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- The cells that form the demilunes in the submandibular gland secrete the enzyme **lysozyme**, whose main activity is **to hydrolyze the walls of certain bacteria** (bacterial killing).
- Some acinar and intercalated duct cells in large salivary glands also secrete **lactoferrin**, which **binds iron**, a nutrient necessary for bacterial growth.
- **Striated ducts are easily observed in the human submandibular gland, but intercalated ducts are very short.**

Sublingual Gland:

- The sublingual gland, like the submandibular gland, is a branched tubuloacinar gland formed of **serous and mucous cells**.

- Mucous cells predominate in this gland; serous cells are present almost exclusively on demilunes of mucous tubules.
- As in the submandibular gland, cells that form the demilunes in this gland secrete lysozyme.
- Intralobular ducts are not as well developed as in other major salivary glands.



Minor Salivary Glands:

- Small gland, numerous present in the lips (labial glands) and in the palate (palatine glands) and in the tongue (lingual glands).
- These nonencapsulated glands are distributed throughout the oral mucosa and submucosa.
- Saliva is produced by **small groups of secretory units** and is conducted to the **oral cavity** by short ducts, with little modification of its content.
- Although variations exist, minor salivary glands are usually mucous.
- The small serous glands present in the posterior region of the tongue (von **Ebner's glands**; which open into the bottom of circum valit papillae) are the only exception.
- Lymphocyte aggregates are commonly observed within **minor salivary glands**, associated with **IgA secretion**.

THE END...

"لا تدري، علَّ لحظتك الآن هي التي أردت يوماً وتمَّيت، أعلم أنَّ الطريقَ صعب، لكنَّك صاحبُ قلبٍ لا يهزُّه عصفُ ريحٍ عاتية، أمنتَ بأنَّ الله قادر، وارتويتَ بأنَّه اللطيفُ بك، بقيَ عليك دورك، لا تكسرِ قلبك بضعفِ إرادتك، فمؤمنًا والنَّرمُ تُغرك"
