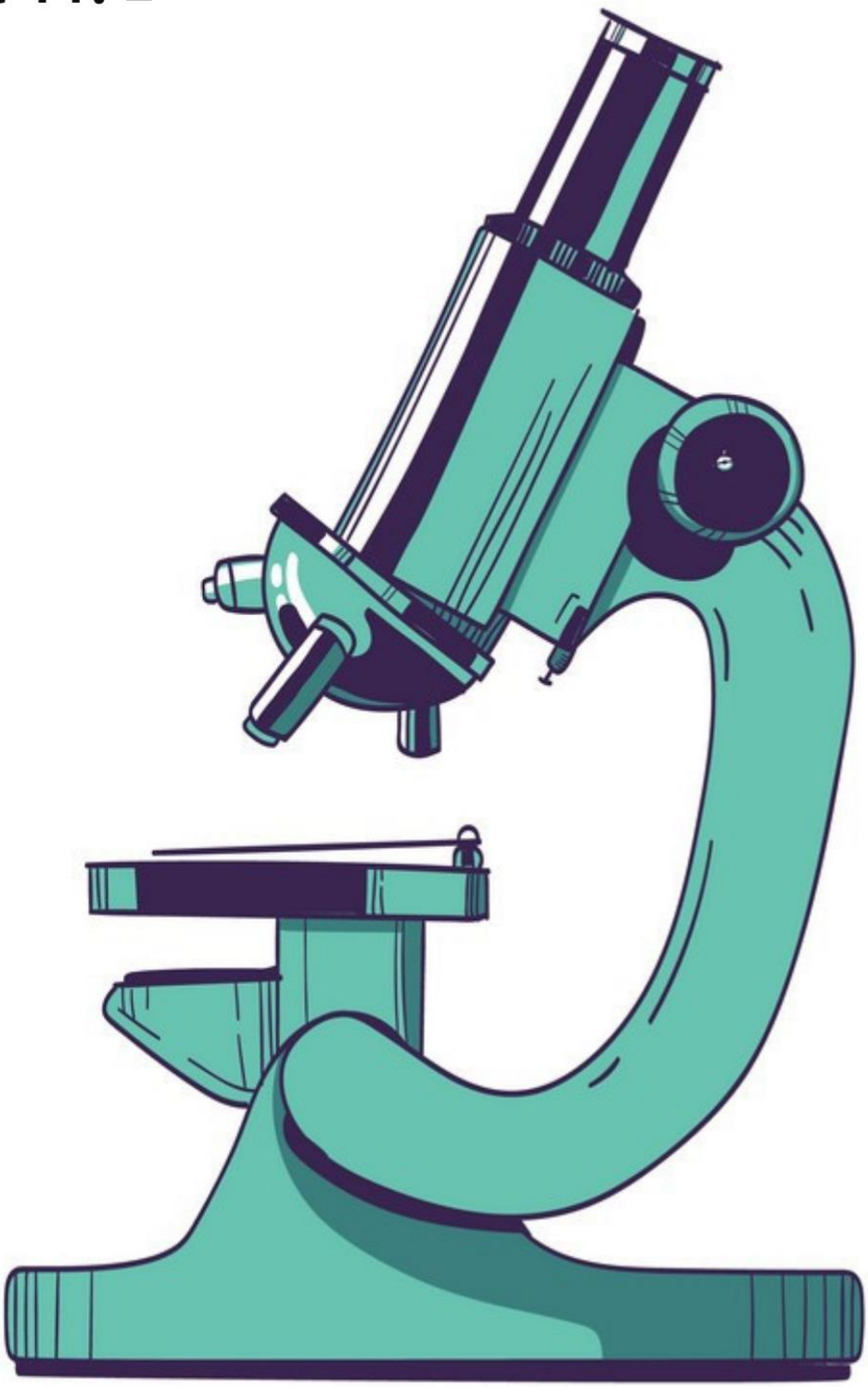
Histology

Sheet n.1



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Upper digestive tract histology

This is the first histology lecture of the GIT. Histology is very important for understanding diseases. Pathology specialty is in fact primarily dependent on histology, because if you didn't know the normal histology of the tissues you wouldn't be able to recognize and diagnose diseases.

Purple: Slides
Black: The professor's speech
Blue: Outside material for extra explanation
Red: Important subject

OBJECTIVES

At the end of this lecture, you should be able to:

- **Describe the cells of the GI tract and their function.**

  For example, if we examined the mucosa of the stomach, we'd find four types of cells present: Parietal cells that produce HCl, Chief cells that produce pepsinogen, Endocrine cells for hormones, and Mucous cells to produce mucous. Each type of cells produces a different type of secretion
  .
- **Describe the histological features of each part of the GIT and Differentiate between different parts of the GI tract.**

  If we studied the oral cavity, its epithelial cells are stratified squamous non-keratinized, and it's the same type present in pharynx and esophagus, but when we travel down to the stomach, the epithelial tissue is different, it's simple cuboidal/columnar epithelium without goblet cells, while down in small intestines it has goblet cells. As we move distally, the goblet cells and the mucosal cells increase in number -especially in the large intestine; because it needs lubrication the most-.

  Again, the type of epithelium differs along the GIT, small intestines have simple columnar epithelium and goblet cells, and the large intestine has numerous goblet cells, the small intestines mucosal cells have finger-like projections to increase the surface for absorption too. (Those differences are important to know in histology).

- **Appreciate the histopathology of the GI tract.**

- **Describe the histological basis of some clinical problems:** we have multiple clinical problems, such as smoking, which is an important cause of stomach diseases, because nicotine affects the mucosa and blood vessels.

OVERVIEW

- **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, gallbladder, and pancreas.**

- **Its function is to obtain the molecules necessary for the maintenance, growth, and energy needs of the body from ingested food.**

- **Large molecules such as proteins, fats, complex carbohydrates, and nucleic acids are broken down into small molecules: amino acids, fatty acids, and glucose, respectively, that are easily absorbed through the lining of the digestive tract, mostly in the small intestine.**

  After this, all absorbed material SHOULD go to the liver through the portal vein, this is why the liver is a crucial part of GIT; it works in metabolism, storage of fat and carbs, formation of hormones and enzymes, coagulative material and heparin are synthesized by the liver as well. The liver also secretes bile and bile salt through the bile duct to the second part of the duodenum, which completes the digestion of fat.

- **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.**

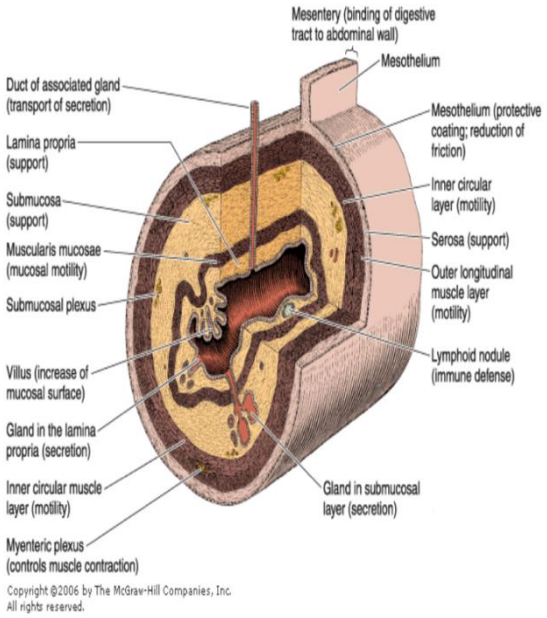
GENERAL STRUCTURE OF THE DIGESTIVE TRACT

The entire gastrointestinal tract presents certain common structural characteristics,

It is a hollow tube composed of a lumen whose diameter varies, surrounded by a wall made up of four principal layers: the mucosa, submucosa, muscularis, and serosa.

1. **The mucosa (frequently called the mucous membrane) is made up of an epithelial lining, a lamina propria of loose connective tissue rich in blood and lymph vessels, and smooth muscle cells, sometimes also containing glands and lymphoid tissue,**

   The internal mucosa (lining epithelium=mucosa) covers the whole digestive tract, and it's a different type of epithelium in each part of the tract like we mentioned earlier (oral-stomach-intestines-anal canal)



- **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. The mucosa is frequently called a mucous membrane.**

2. **The submucosa is composed of dense connective tissue with many blood and lymph vessels and a submucosal (also called Meissner's) nerve plexus.** It's different from the mucosal layer, **It may contain glands and lymphoid tissue too.**

3. The muscular layer, **consisting of a thin inner circular layer & an outer longitudinal layer of smooth muscle cells.**

4. The outer layer, **the serosa is a thin layer of loose connective tissue, rich in blood lymph vessels, and adipose tissue, and a simple squamous covering epithelium (mesothelium). In the abdominal cavity, the serosa is continuous with the mesenteries and with the peritoneum, and 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.**

The outer layer is either adventitia or serosa, if the organ is intra-abdominal, it's called serosa and it'd compose of a simple squamous type of epithelium – mesothelium. – But if the organ was outside the abdomen, it'll be covered by connective tissue and it's then called adventitia (like the esophagus). Some organs in the posterior abdominal wall are situated behind the peritoneum, these will be covered be adventitia except the anterior surface. (We took this concept with Dr Heba when we talked about serous membranes)

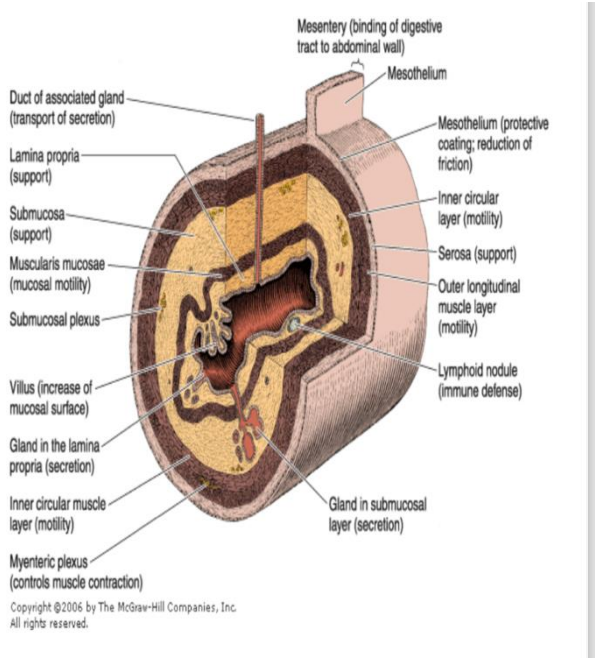
Let's dive into more details:

- The mucosal layer consists of three layers:

  1- <u>Lining Epithelium</u> -which we talked about-

  2- <u>Lamina Properia</u>, which is loose connective tissue and its importance in the GIT lies in the glands it contains that help in secretion or absorption such as: the stomach-gastric glands, small intestines-crypts of Lieberkühn, etc…

  3- <u>Muscularis Mucosa</u> (which is different than the "Muscular" layer of the GI tract). It's composed of one or three ribbons of smooth muscle; its function is to give the shape of the lumen.



- The submucosa: Dense connective tissue, has blood vessels, lymphatics, but it does NOT contain glands EXCEPT in two organs: the esophagus and the duodenum. (both have glands in submucosa & lamina propria). Brunner's glands, which are the duodenal submucosal glands, secrete an alkaline solution to neutralize the stomach's acid which has a very low pH. However, the proximal duodenum still remains as the most common site for peptic ulceration due to it facing the highest point of stomach acidity.
  The submucosa also contains a plexus of nerves called Meissner's plexus, it's parasympathetic and it innervates the glands and is important for the motility.

- **The muscular layer contains smooth muscle cells that are spirally oriented and divided into two sublayers according to the main direction the muscle cells follow, In the internal sublayer (close to the lumen), the orientation is generally circular; in the external sublayer, it is mostly longitudinal (inner circular and outer longitudinal) in between is a plexus of nerves called the myenteric (or Auerbach's) nerve plexus.**

It is a parasympathetic plexus that innervates glands and motility muscles. A preganglionic nerve that comes from the vagus nerve -which innervates the whole GIT- synapses in the ganglia of the plexus and exits as a very short post ganglionic nerve in the wall of the organ.

- The serosa & adventitia which are the outermost layer. Serosa or mesothelium if it was in the abdomen and is covered by peritoneum, the adventitia on the other hand is connective tissue covering extra-abdominal structures.

BASIC MUCOSAL FORMS IN THE GI TRACT

- **Protective: stratified squamous epithelium that is found in the oral cavity, pharynx, the esophagus and the anal canal**
- **Secretory: the mucosa consists of a long closely packed tubular glands, found in the stomach**
- **Absorptive; the mucosa is arranged in a fingerlike projections called villi with intervening short glands called crypts, that is typical for the small intestine. In the duodenum some crypts extend from the muscularis mucosa to the submucosa (Brunner's Gland)**
- **Absorptive/protective; the mucosa is arranged into closely packed tubular glands specialized for water absorption and mucus secreting goblet cells; It lines the whole large intestine**

the professor didn't say anything about this slide.

Now let's talk about the oral cavity:

The oral cavity is lined with stratified squamous epithelium, keratinized or non-keratinized, depending on the region:

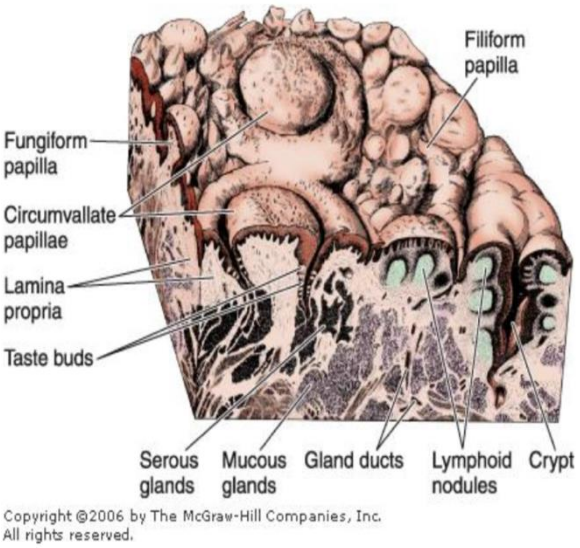
From the outside it's keratinized but the inside is non-keratinized. The gingiva or gum that has sockets for teeth is very tough, which means it's mucosa is a dense connective tissue adherent to its periosteum, while at the floor of the mouth and the soft palate it's a loose connective tissue.

- **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

The 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 tongue's dorsal surface is irregular, covered anteriorly by a great number of small eminences called papillae.**

You can clearly see the taste buds on the surface, present on the lingual papillae (projections present at the dorsum of the tongue), inside these projections are the taste buds, we have 5 types of papillae on the tongue, we'll discuss 3:

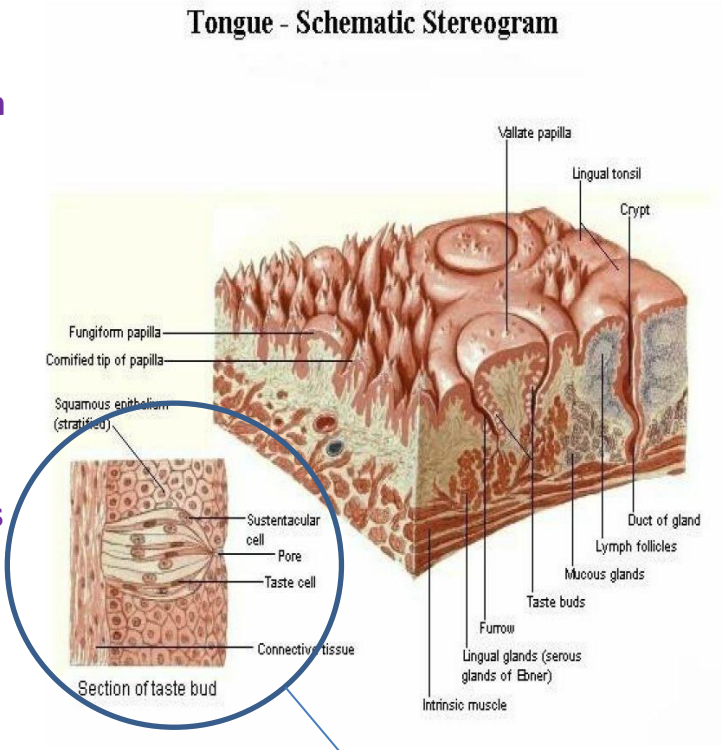
- Filiform papillae -which is the most abundant on the dorsum of the tongue at the anterior two thirds- these papillae do NOT have taste buds.

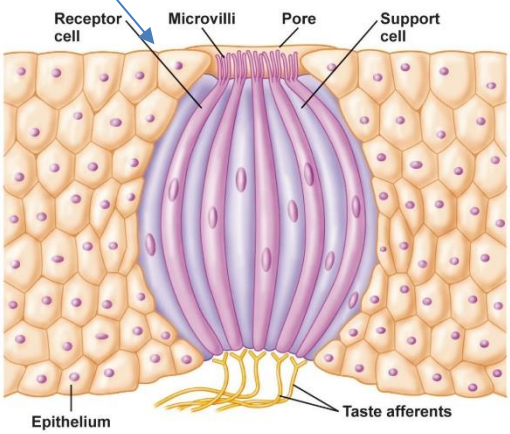
- Fungiform papillae, present on the edges and have taste buds.

- Circumvallate papillae, is in front of the sulcus terminalis (sulcus terminalis: a V-shaped groove separating the anterior two thirds of the tongue from the posterior third and containing the circumvallate papillae) in the anterior two thirds, however unlike other papillae in the anterior two thirds, it's innervated by the glossopharyngeal nerve. It varies between 12-20, they're responsible for the bitter taste.

  A common wrong practice is when you give someone pills to swallow and they put it at the back of their tongue, they're actually putting it on the bitter taste buds ☺, the anterior tip of the tongue is where you're supposed to put it -sweet taste buds, which will give you minimal bitter flavor-, and at the edges of the tongue are the sour taste buds.

TONGUE





• The posterior one-third of the dorsal surface of the tongue is separated from the anterior two-thirds by a V-shaped boundary

• Behind this boundary, the surface of the tongue shows small bulges composed mainly of two types of small lymphoid aggregations:

• small collections of lymphoid nodules

• And the lingual tonsils, where lymphoid nodules aggregate around invaginations (crypts) of the mucous membrane.

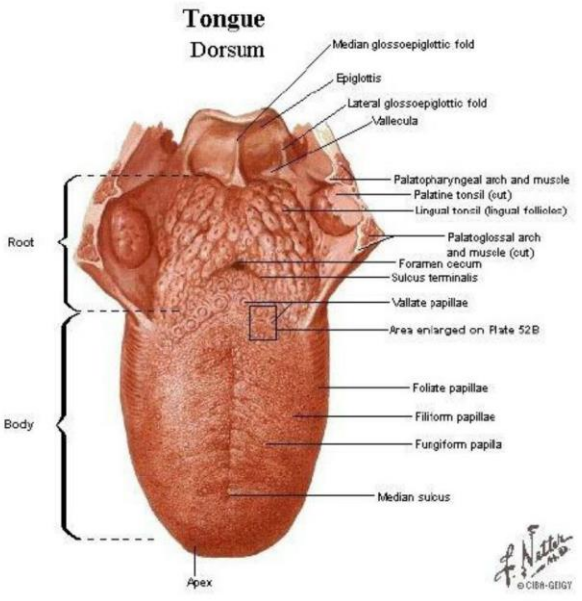
This is an example of taste bud.

There is a pore for secretion and material entry.

There are cells for protection called sustentacular cells and they are considered as supportive cells.

In the middle there are bipolar cells (taste cells) or receptor cells, they are responsible for transmit taste sensation → that's why they have nerve fibers at their end.

PAPILLAE



• Papillae are elevations of the oral epithelium and lamina propria that assume various forms and functions. There are four types

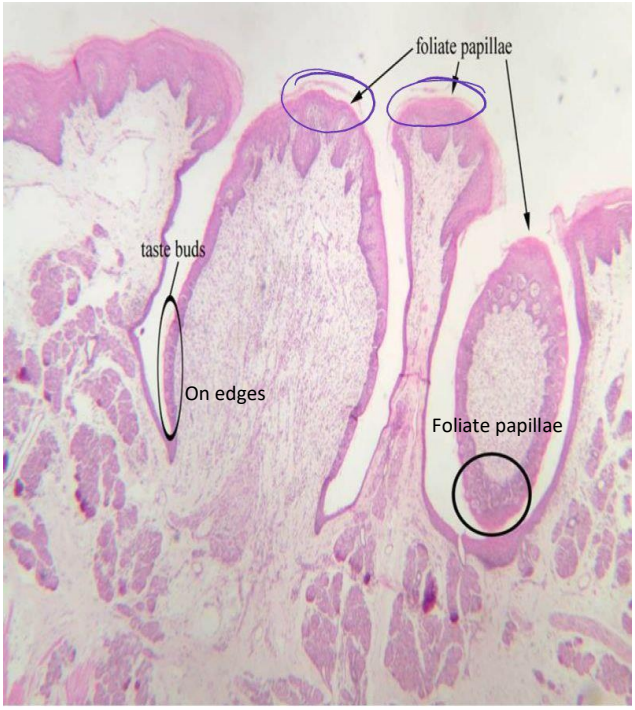
• Filiform Papillae

• Filiform papillae have an elongated conical shape; they are quite numerous and are present over the entire surface of the tongue

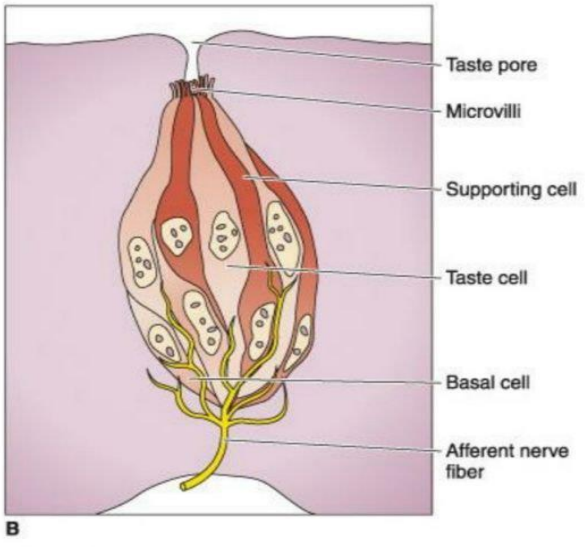
• Their epithelium, which does not contain taste buds, is keratinized.

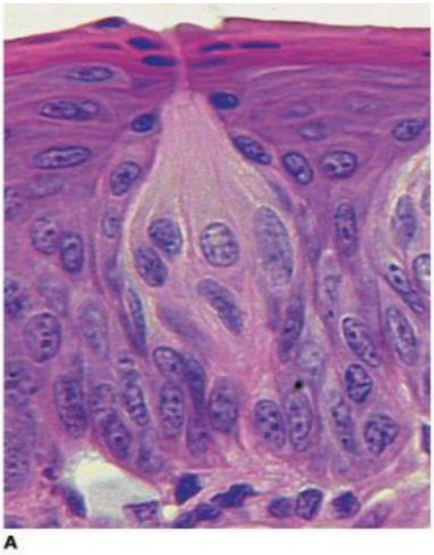
• Fungiform Papillae

- **Fungiform papillae resemble mushrooms in that they have a narrow stalk and a smooth-surfaced, dilated upper part**
- **These papillae, which contain scattered taste buds on their upper surfaces, are irregularly interspersed among the filiform papillae.**
- **Foliate Papillae**
- **Foliate papillae are poorly developed in humans**
- **They consist of two or more parallel ridges and furrows on the dorsolateral surface of the tongue and contain many taste buds.**



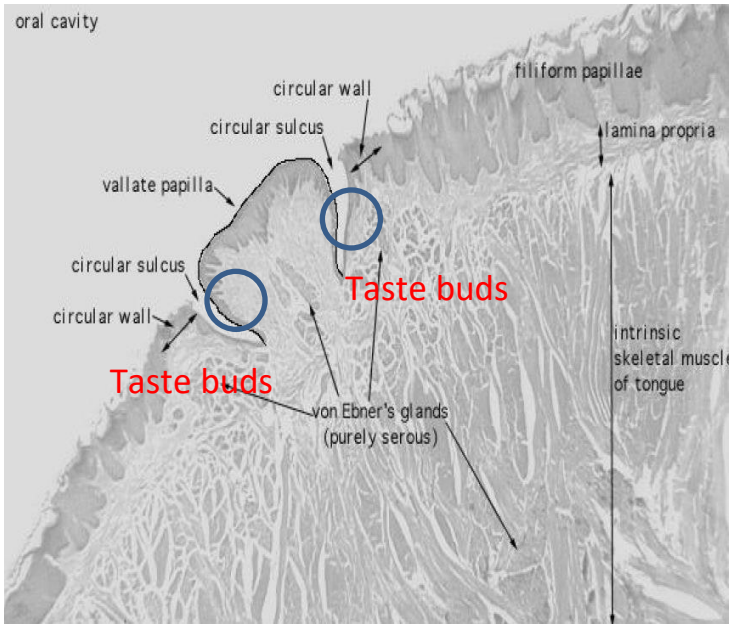
Taste buds





1-As we said **pore** for secretion entry. 2- **Microvilli** 3- **Supporting** (sustentacular) **cells** 4- **Taste cells**→bipolar (because they contain upper and lower pore), responsible for turning taste into impulses and transmit them through Afferent nerve fiber (Chorda tympani of the facial nerve) to the center of taste in the brain and gives us the different taste sensations.
5- **Basal cell** for mitosis and regeneration.

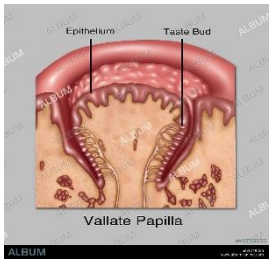
CIRCUMVALLATE PAPILLAE



• Circumvallate papillae are 7–12 extremely large circular papillae whose flattened surfaces extend above the other papillae

It has 2 grooves on sides (it is actually circle that is surrounded by a circular groove, but it is look like that because of the section) see the little picture under there.

• They are distributed in the V region in the posterior portion of the tongue



Taste buds:
1- they lie on the lateral surface of the Circumvallate Papillae.
2- they lie on the medial side of the cleft.

• Numerous serous (von Ebner's) glands drain their contents into the deep groove that encircles the periphery of each papilla.

There are glands under the cleft called **von Ebner's glands** that secrete seromucous (watery and viscous) secretion that helps in dissolving materials and maintaining taste sensitivity.

Von Ebner's glands play a role in maintaining taste sensitivity primarily by secreting a seromucous fluid that cleanses the area surrounding the taste buds.

• This moat like 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.

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.

• A capsule of connective tissue, rich in collagen fibers, surrounds the large salivary glands.

• The parenchyma of the glands consists of secretory end pieces and a branching duct system arranged in lobules (each one contains a duct), **separated by septa of connective tissue originating from the capsule** converting glands into lobes (bigger one) and lobule (smaller one) **(and this is the function of connective tissue capsule)**

We said that parotid gland is covered by 2 capsules, outer one from deep investing fascia of the neck and the inner is the connective tissue.

Clinically if there is an infection in parotid gland like mumps (أبو دغيم) it will cause severe pain, because of the presence of two capsules, they **prevent enlargement of the gland.**

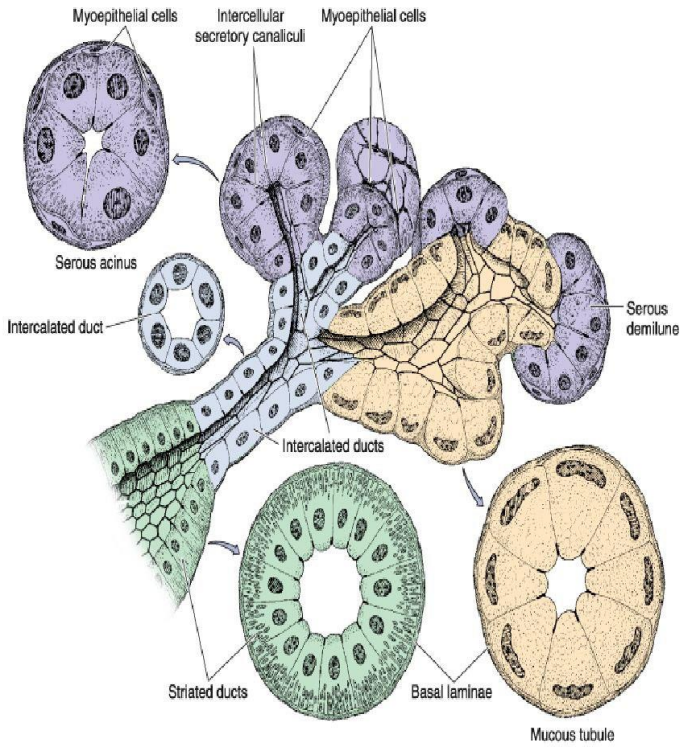
• The secretory end pieces present two types of secretory cells serous and mucous

• as well as the non-secretory myoepithelial cells

• This secretory portion is followed by a duct system whose components modify and conduct the saliva to the oral cavity.

- Every gland is composed of **acini**(plural), **An acinus(single), a group of cells surrounded by a basement membrane and containing a lumen, allows secretion to accumulate within the lumen. From there, the secretions gather in the ducts (lobules) before being transported to the main duct** (parotid duct, submandibular duct…) this is in general, it might be unclear for now but keep reading then back to this and u will understand (:

The lobule is a structural unit of the gland that contains clusters of secretory acini (the cells responsible for producing saliva) along with associated ducts.



- As we said there are 3 types of glandular secretions (serous,mucous, mixed) so what is the difference between serous and mucous??

• 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.

• They exhibit characteristics of polarized protein-secreting cells.

• 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.

- Serous cells cuboidal in shape, nucleus is **central and rounded**, narrow lumen and ill-defined boundaries.
- Between the base of the cell and basement membrane there are cells called **myoepithelial cells (basket cells)** that **Squeeze the cells to secrete the secretion**.
- The type of cytoplasm inside the cells is serous granules→ serous secretion.

• 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.

- Flatten cells, basal nucleus, large lumen, and well-defined boundaries.
- In cytoplasm there is mucous secretion.

Now all the secretion (serous and mucous) Gather together in duct called intercalated duct. (small duct, cuboidal cells, and narrow lumen)

Then there is a bigger duct called **striated duct**. (large number of cells, taller cells, and large lumen(wide)

Striated because the base has striation made by **large number of mitochondria**.

So, the secretions go from acini to a larger duct within the lobule called **striated duct**.

After passing throw the lobule the secretion become between the lobes.

Lobes: Lobes are larger structural divisions within a gland that consist of clusters of lobules. They represent a higher level of organization compared to lobules. Lobes may contain multiple lobules and are often separated by connective tissue partitions.
Between the lobes the cell **become stratified instead of simple** (stratified cuboidal or stratified columnar).

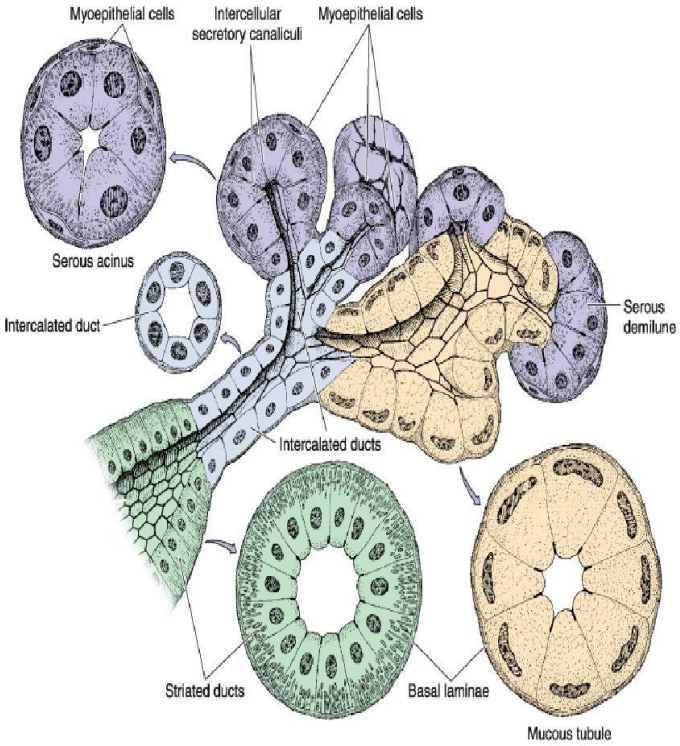
But in **large ducts (main ducts)** like parotid ducts the cells are **stratified squamous non keratinized.** The parotid gland opens in the upper second molar tooth.

MYOEPITHELIAL CELLS

Myo means it contain fibers that form contraction→ squeezing→increase secretion.

- **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 enfolded 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 septa 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 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

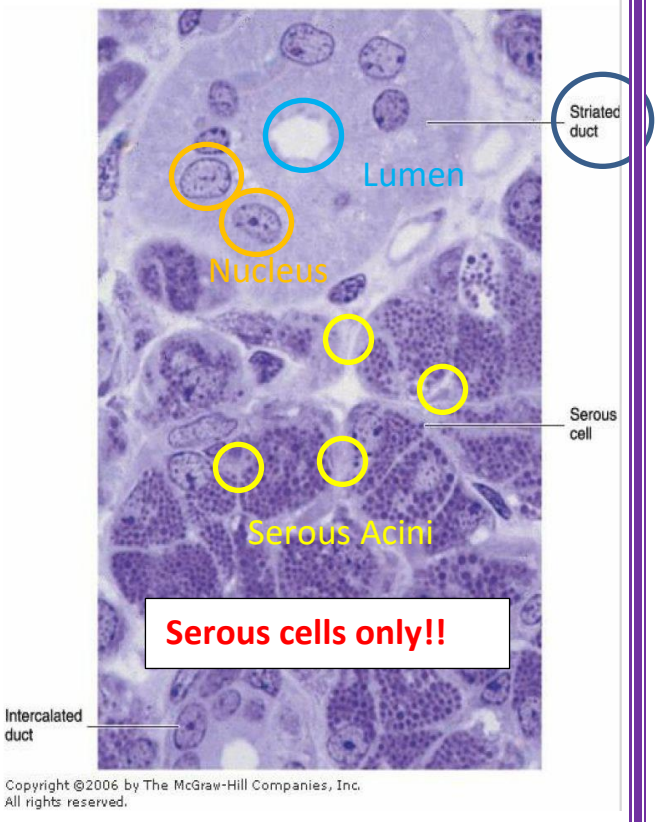
• Containing secretory granules that are rich in proteins and have a high amylase activity

• 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

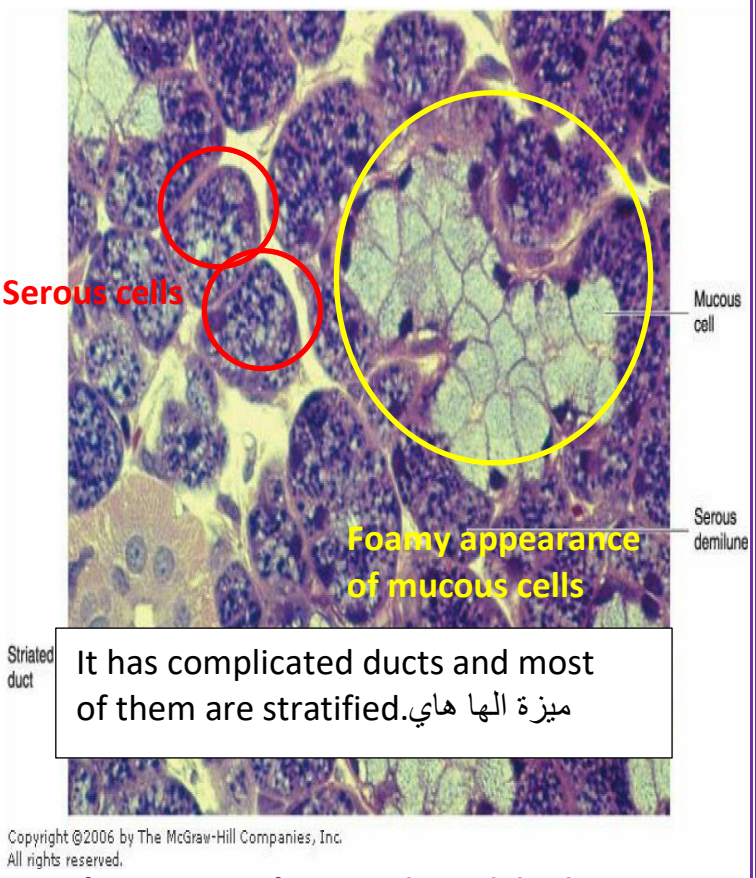


• The plasma cells secrete IgA, which forms a complex with a secretory component synthesized by the serous acinar, intercalated duct, and striated duct cells

• 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

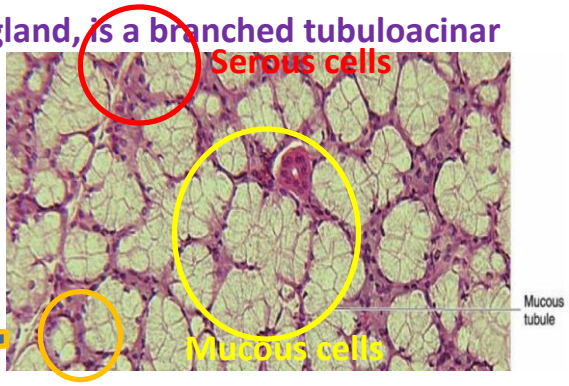
- The submandibular gland is a branched tubuloacinar gland.
- its secretory portion contains both mucous and serous cells
- The serous cells are the main component of this gland and are easily distinguished from mucous cells by their rounded nuclei and basophilic cytoplasm
- In humans, 90% of the end pieces of the submandibular gland are serous acinar, whereas 10% consist of mucous tubules with serous demilunes
- Serous cells are responsible for the weak amylolytic activity present in this gland and its saliva



- 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
- 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.



If the serous cells above the mucous cells we call it **serous demilunes.**

Like this "cap of serous over mucous" called **serous demilunes.**

I can only see this (**serous demilunes**) in sublingual and submandibular glands **(not in parotid)**

MINOR SALIVARY 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) are the only exception**
- **Lymphocyte aggregates are commonly observed within minor salivary glands, associated with IgA secretion.**

تم بحمد الله تعالى

V2 : page 12 (ill-defined instead of undefined)
Page 11 (Lobes instead of loops)

V3: page 4:we add the paragraph that starts with yellow, and we delete the last sentence of point 3 in the same page (separating the mucosa from the submucosa.)