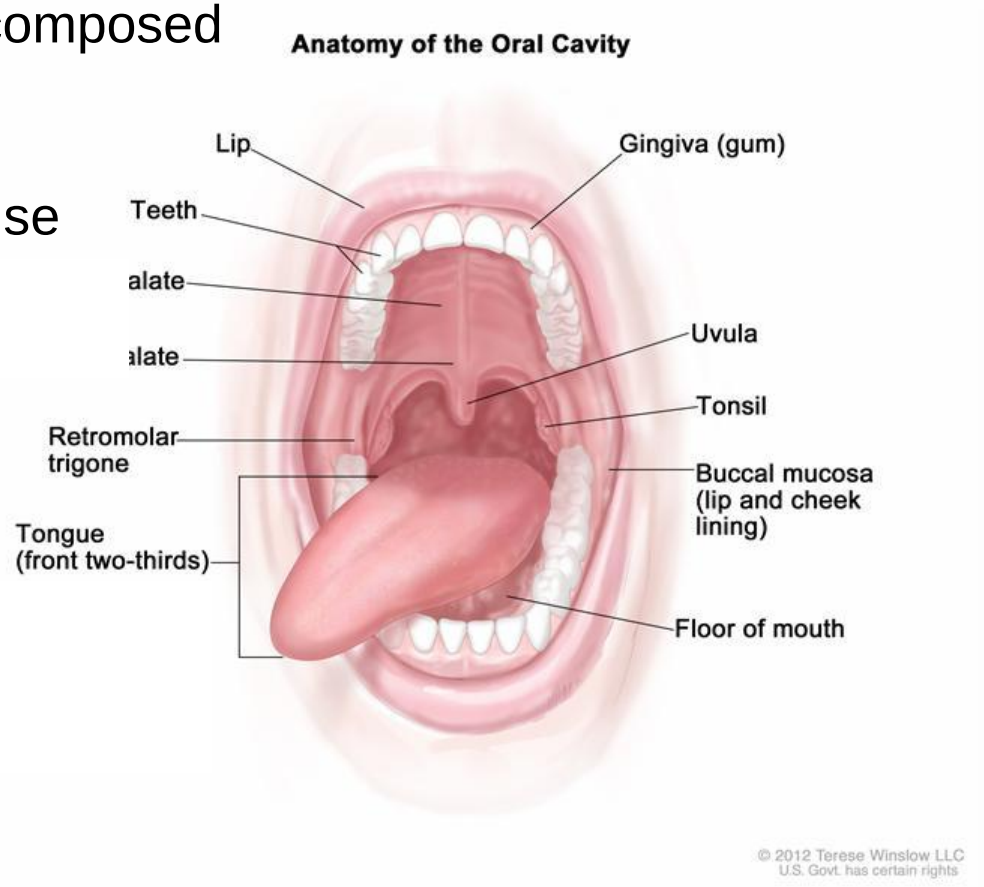
DIGESTIVE SYSTEM - oral cavity, esophagus and stomach

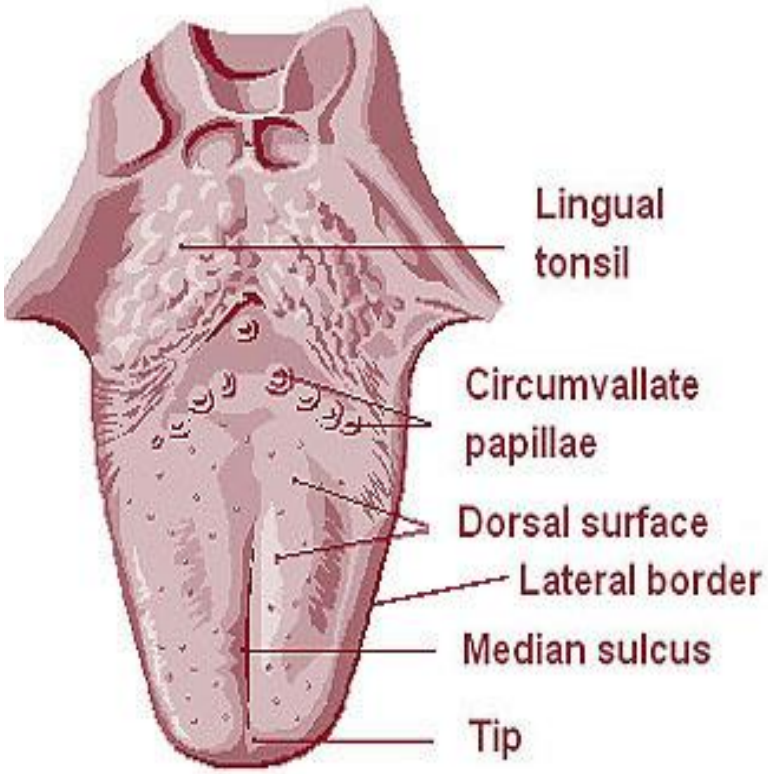
gingiva, dorsal surface of the tongue, and hard - **masticatory mucosa** composed of **parakeratinized to completely keratinized stratified squamous epithelium** with an underlying dense irregular collagenous connective tissue.



The remainder of the oral cavity - **lining mucosa,** composed of a **nonkeratinized epithelium** overlying a looser type of dense irregular collagenous connective tissue

dorsal surface of the tongue and patches of the soft palate and pharynx - **specialized mucosa** (specialized to perceive taste).

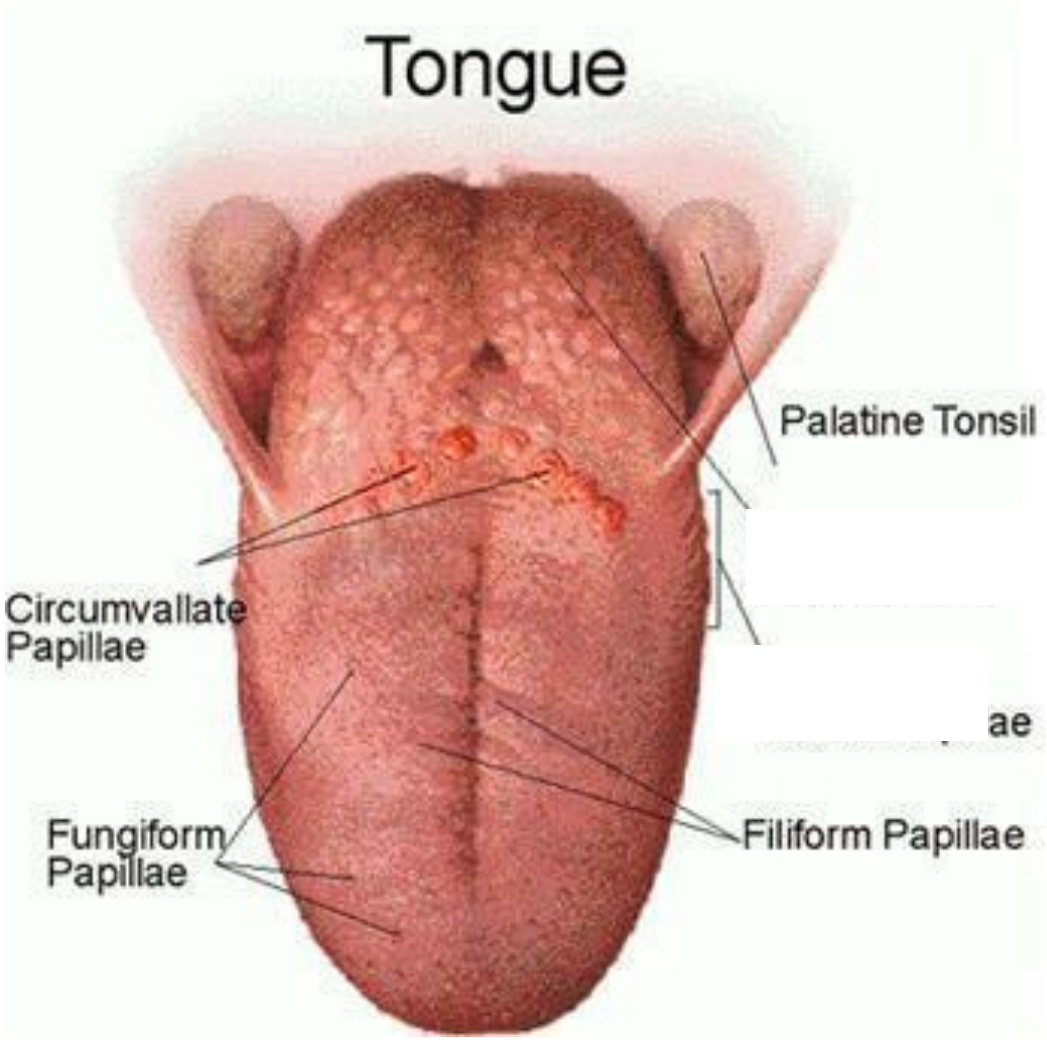
dorsal surface of a tongue - larger **anterior** and the smaller **posterior**
The two regions are separated with the **sulcus terminalis**



Lingual papillae cover the anterior two thirds of the tongue's dorsal surface (most of which project above the surface).

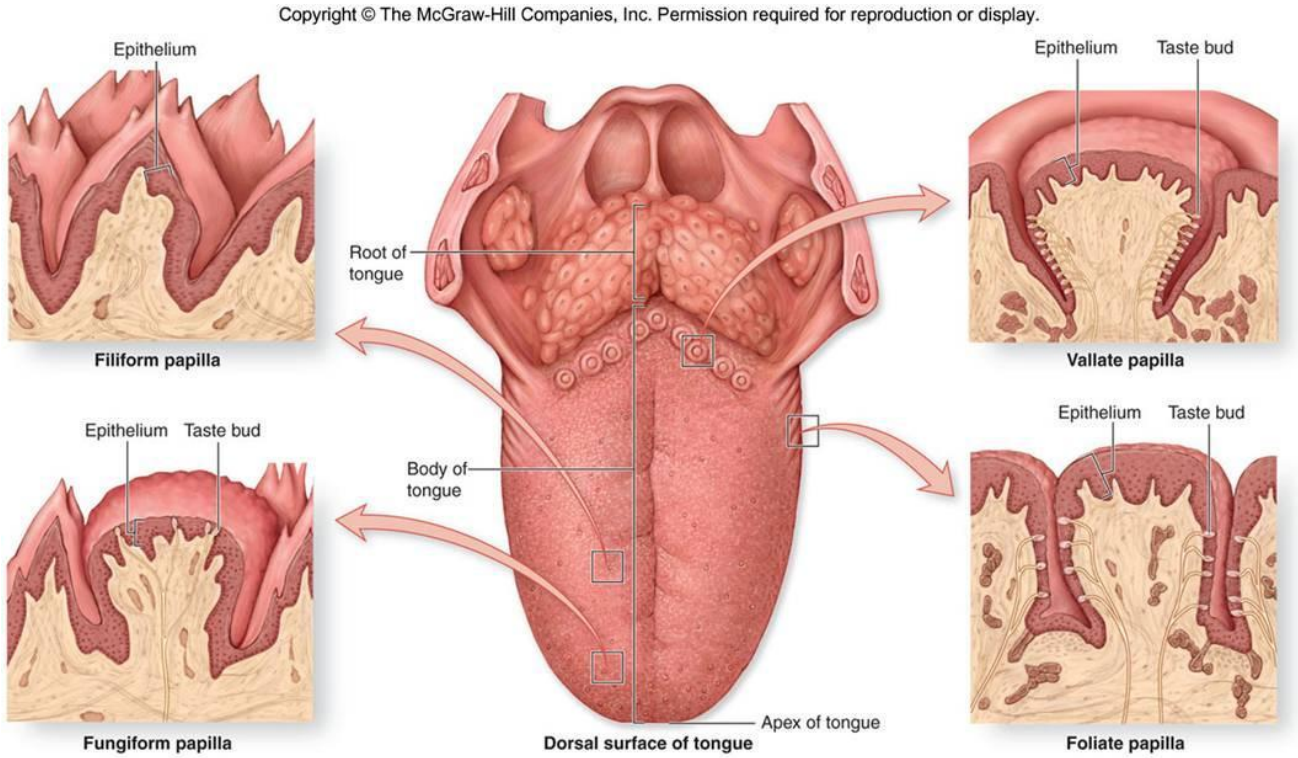
Lingual papillae – four types -

filiform
fungiform
foliate
circumvallate



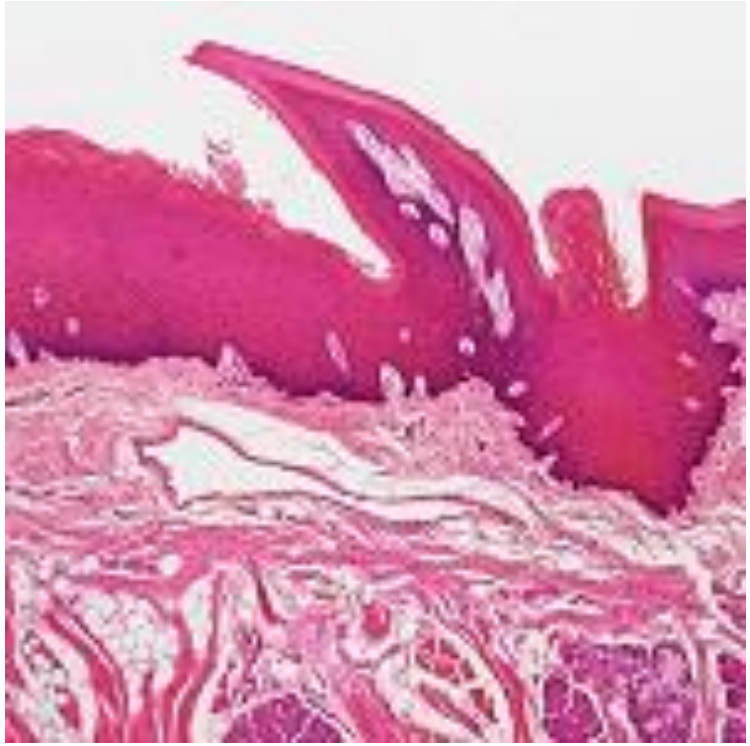
- located anterior to the **sulcus terminalis** on the dorsal and lateral aspect of the tongue

localization of papillae on the dorsal surface of the tongue

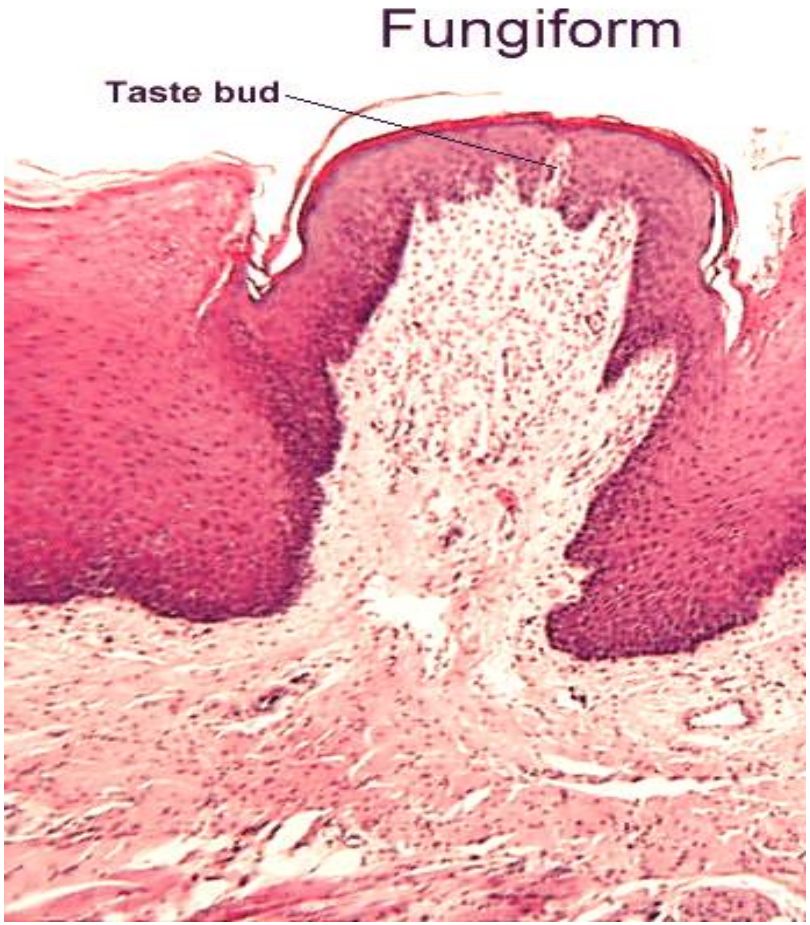


Filiform papillae cover most of the dorsum of the tongue
Fungiform papillae are scattered throughout the filiform papilla but mainly at the tip and lateral margins of the tongue
Foliate papillae are found on the lateral margins of the tongue
Circumvallate papillae are situated immediately in front of the sulcus terminalis, forming a row; the two rows meet in the midline.

Filiform papillae

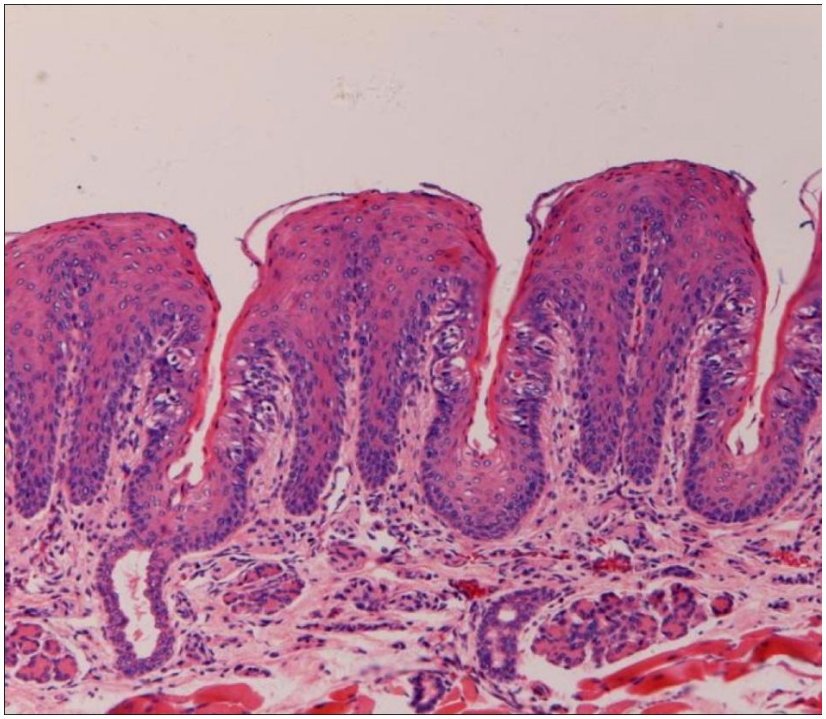


Filiform papillae are slender structures covered by **stratified squamous keratinized epithelium** and help to scrape food off a surface. **Filiform papillae do not have taste buds.**



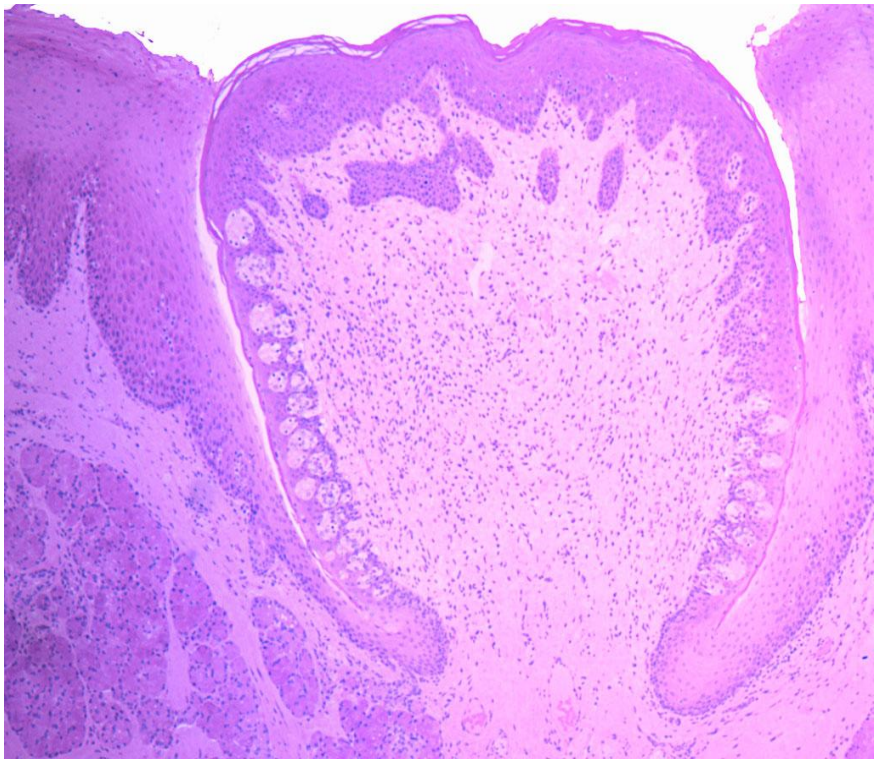
Fungiform papillae resemble a mushrooms covered with **stratified squamous nonkeratinized epithelium**.

Fungiform papillae have taste buds on the dorsal aspect of their cap.



Foliate papillae are located along the posterolateral aspect of the tongue

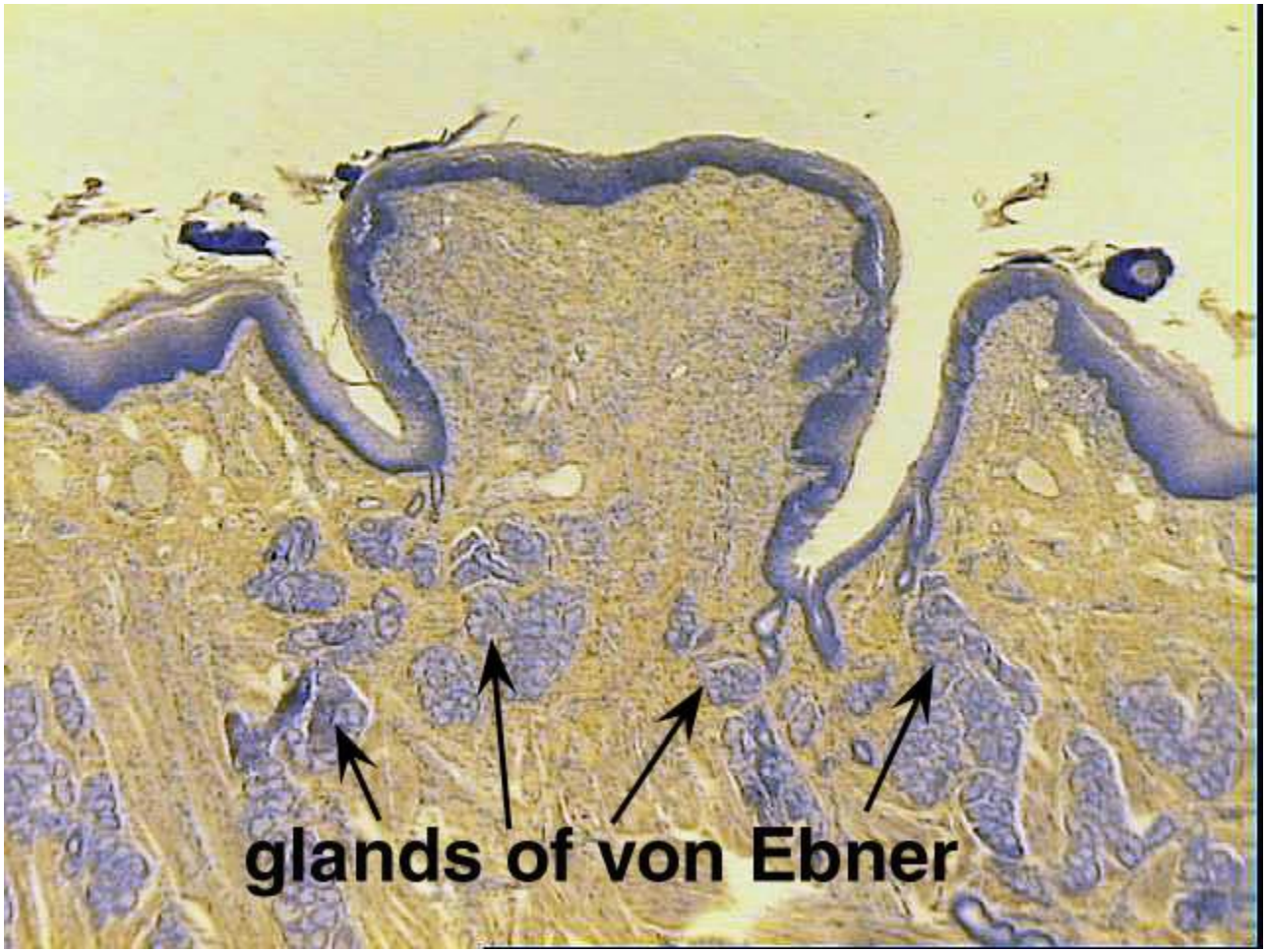
They have functional taste buds only in the neonate

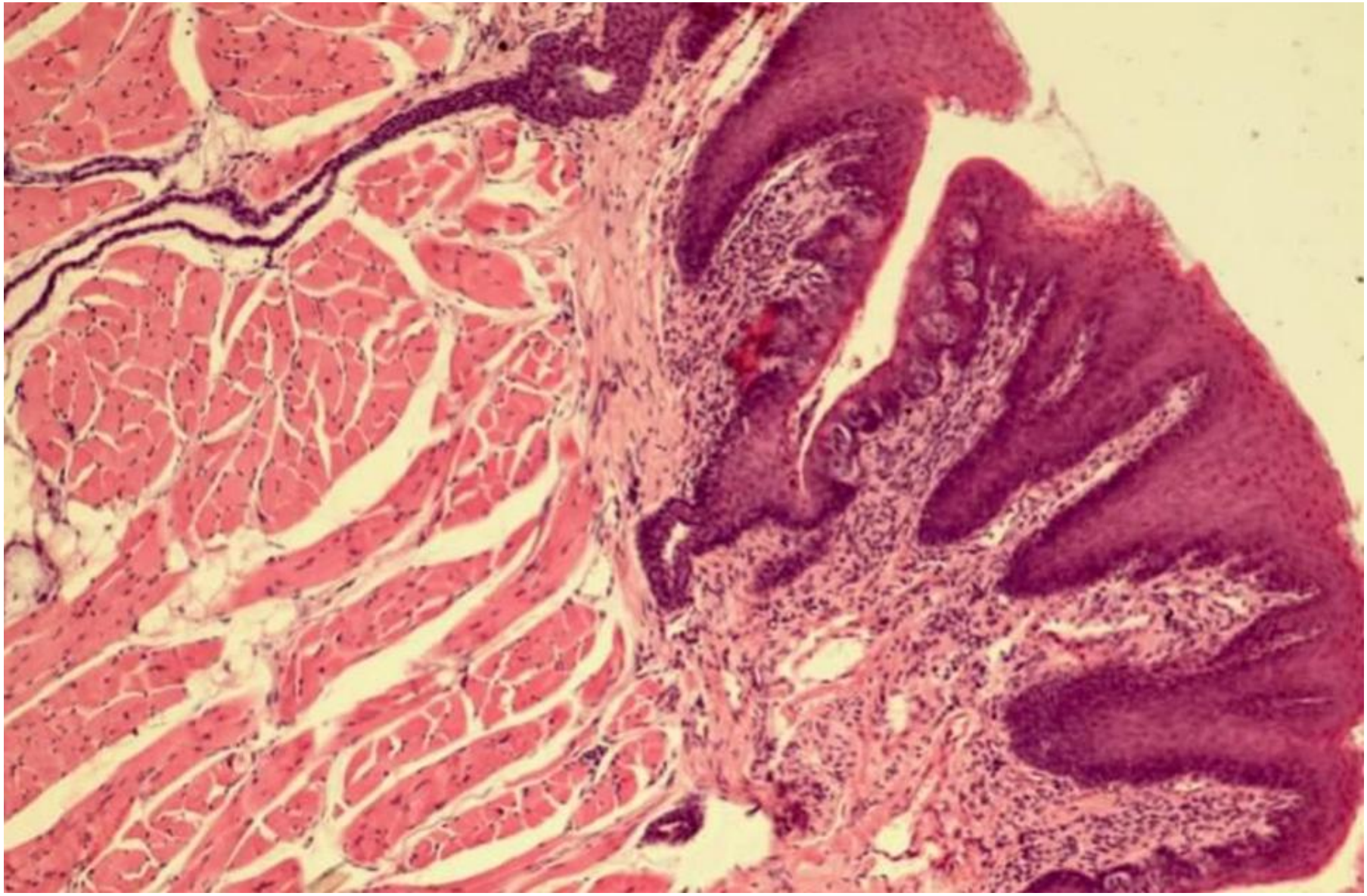


Circumvallate papillae - surrounded by groove, whose base is pierced by slender ducts of **glands of von Ebner**. The epithelial lining of the groove and the side of these papillae **have taste buds**.

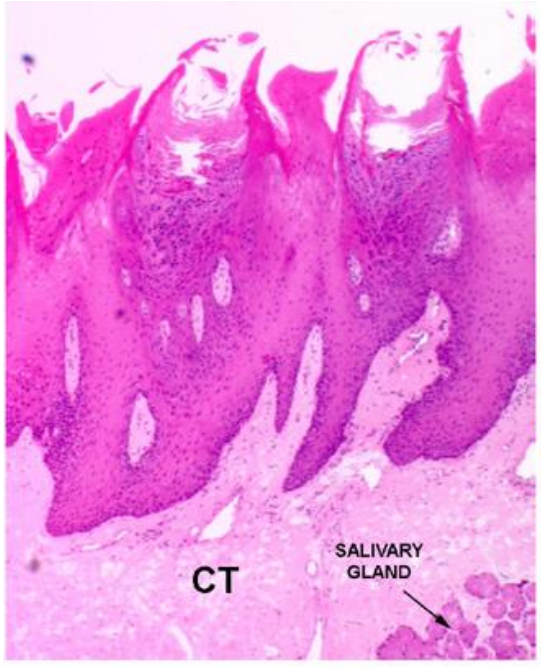
glands of von Ebner

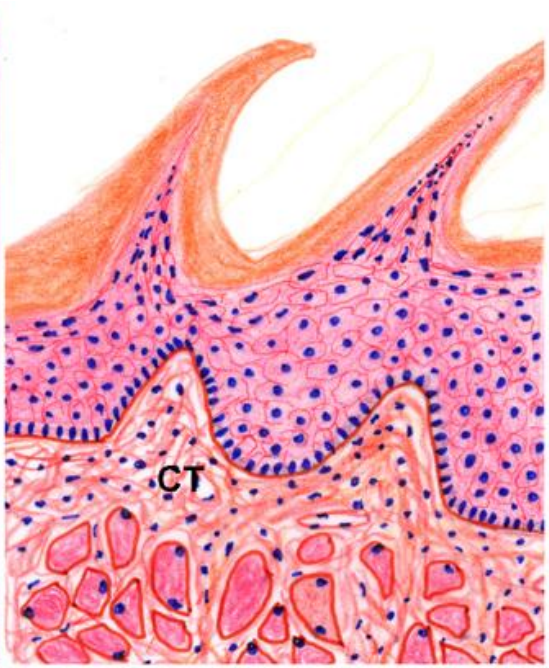
- are located around circumvallate and foliate papillae in the tongue
- empty their serous secretion into the base of the moats located around the papillae. This secretion presumably flushes material from the moat to enable the taste buds to respond rapidly to changing stimuli

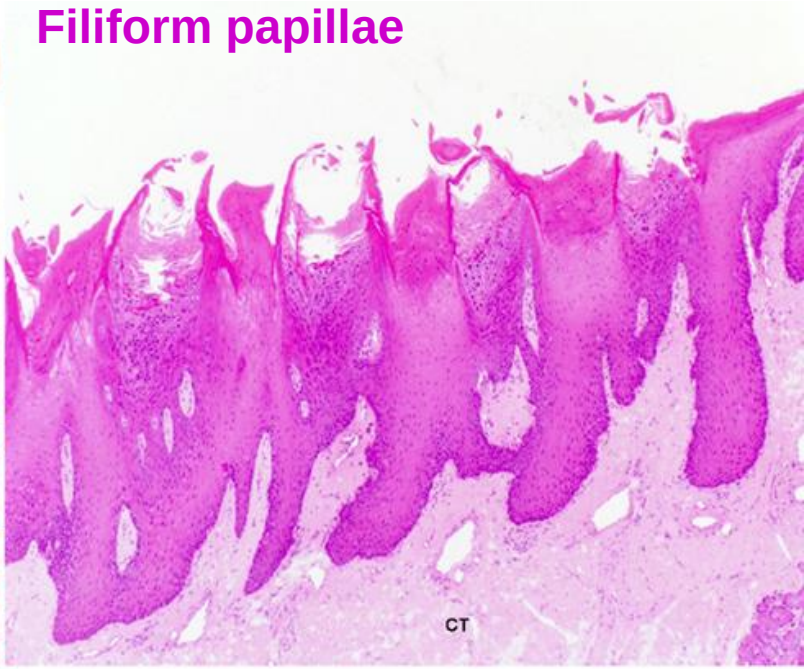




Filiform papillae

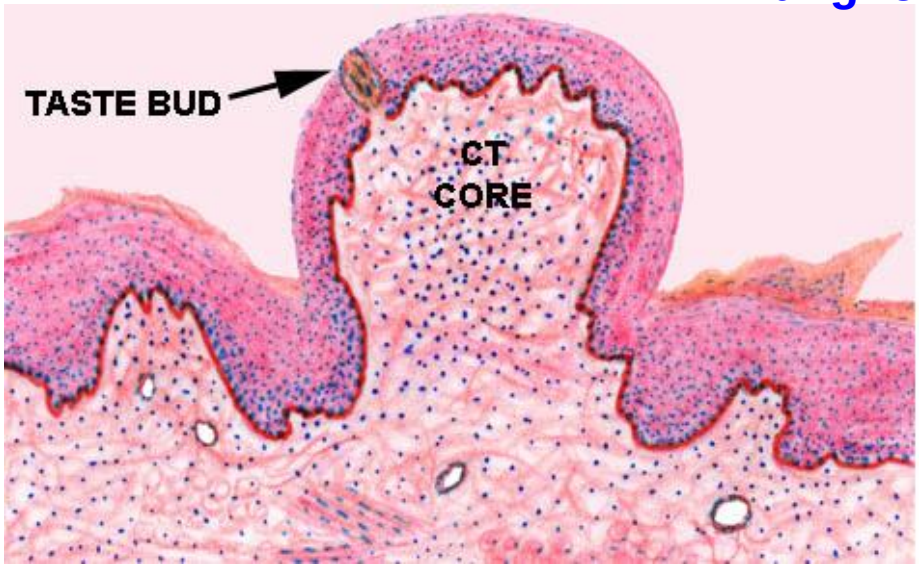


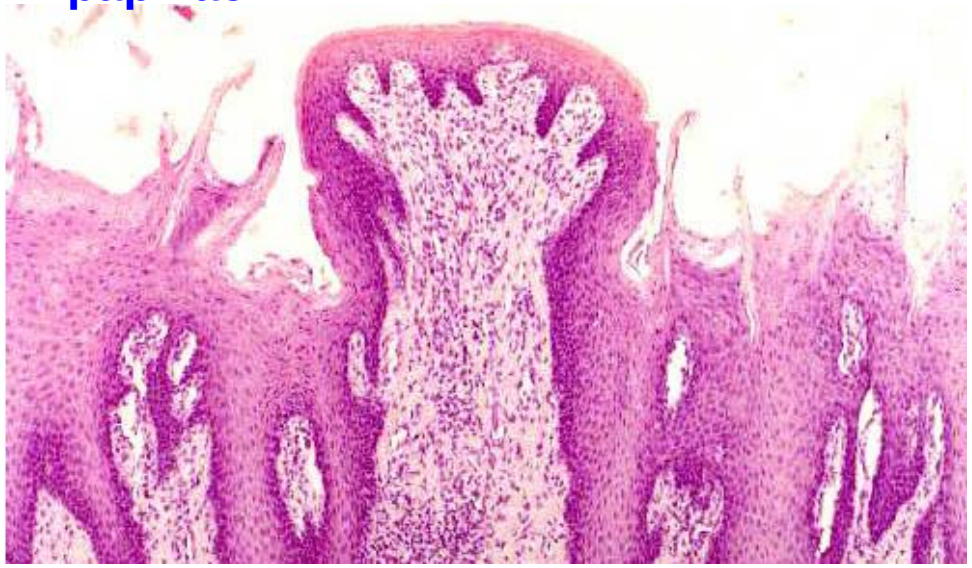




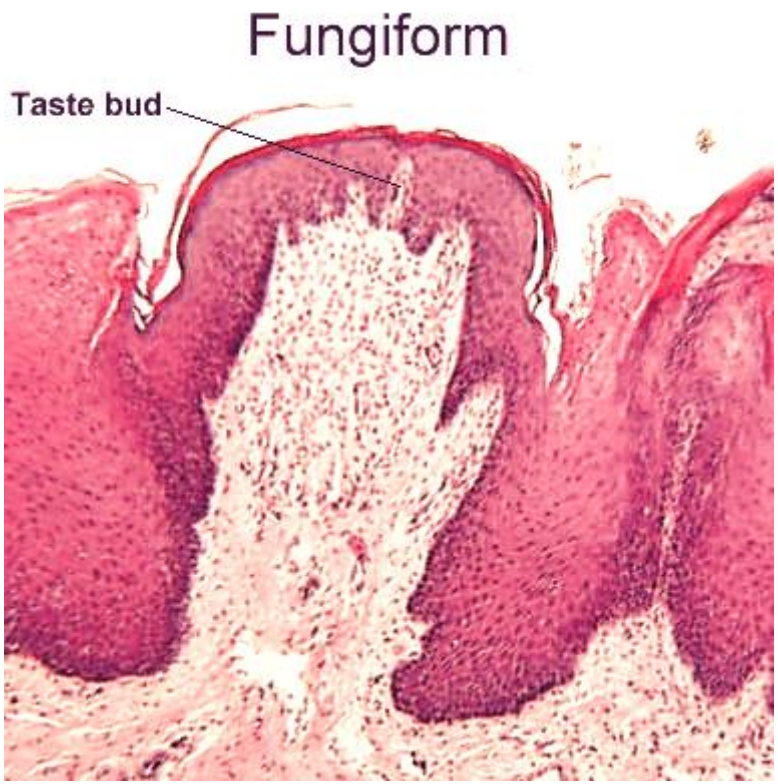
FILIFORM PAPILLAE IN SCHEMATIC VIEW (CENTER) AND AT HIGH AND LOW MAGNIFICATION. Note that the papilla is made solely of the keratinized epithelium: there is no CT core in this type.

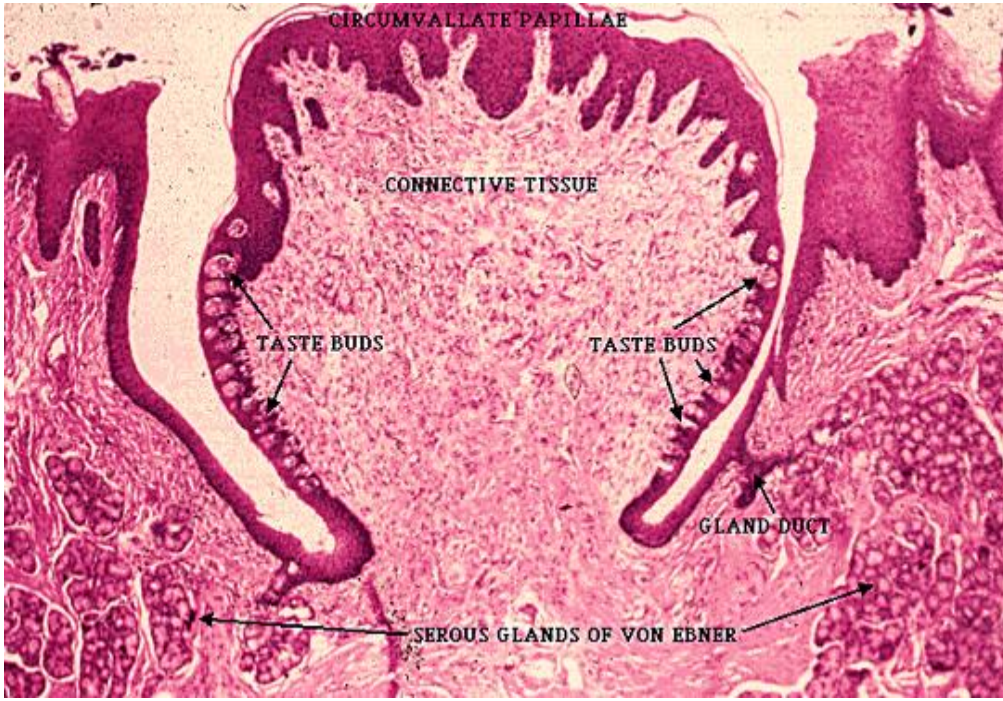
Fungiform papillae





Taste Buds - **Circumvallate papillae**
- **Fungiform papillae**
- **Foliate papillae (only in the neonate)**



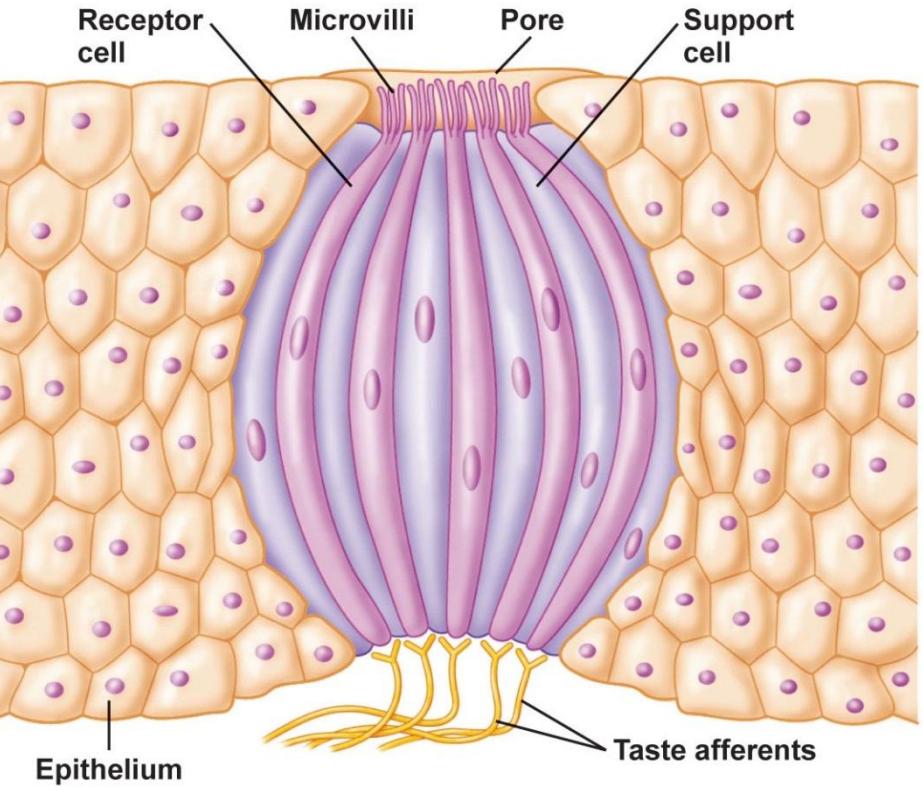


Taste buds in histological sections appear as ovoid lightly stained bodies

Taste Buds

- are involved in detecting the five (known) elements of taste perception: salty, sour, bitter, sweet, and umami

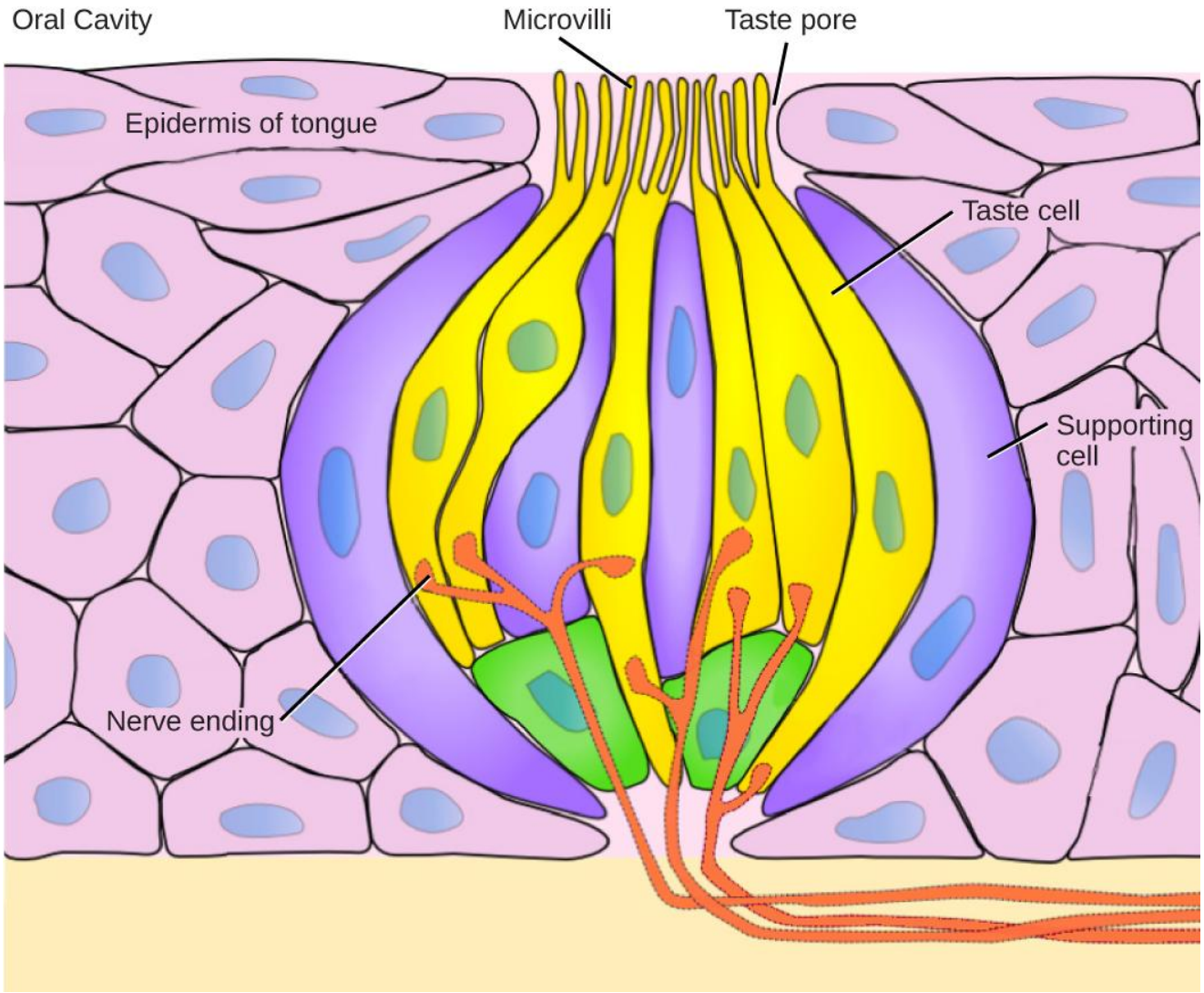
(People taste umami through receptors for glutamate, commonly found in its salt form as the food additive monosodium glutamate. For that reason, scientists consider umami to be distinct from saltiness)



Taste buds

- an oval structure, and is distinctly paler than the epithelium surrounding it.
- the narrow end of the taste bud, located at the free surface of the epithelium, projects into an opening, the **taste pore,** formed by the squamous epithelial cells that overlie the taste bud.

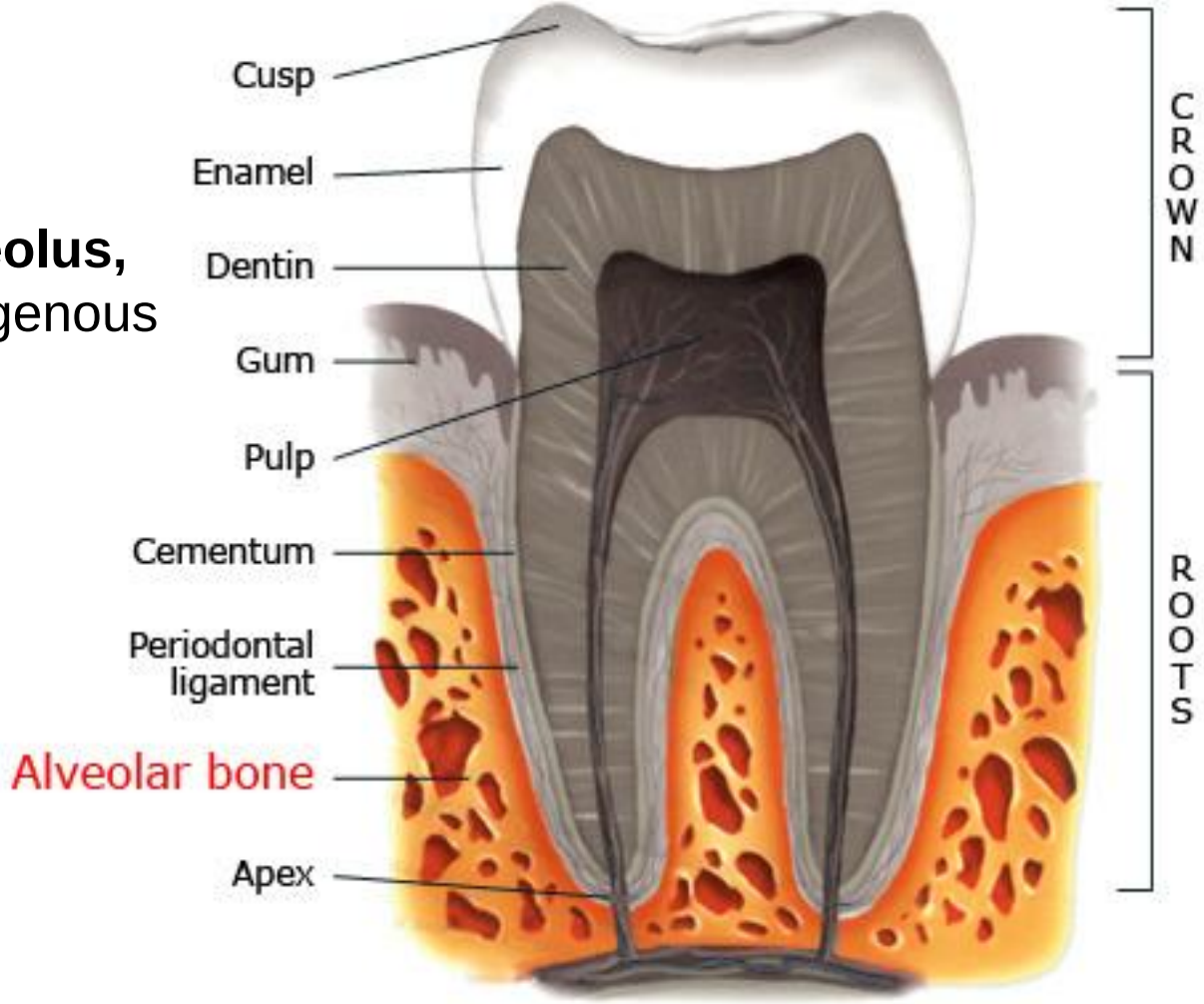
Taste Buds



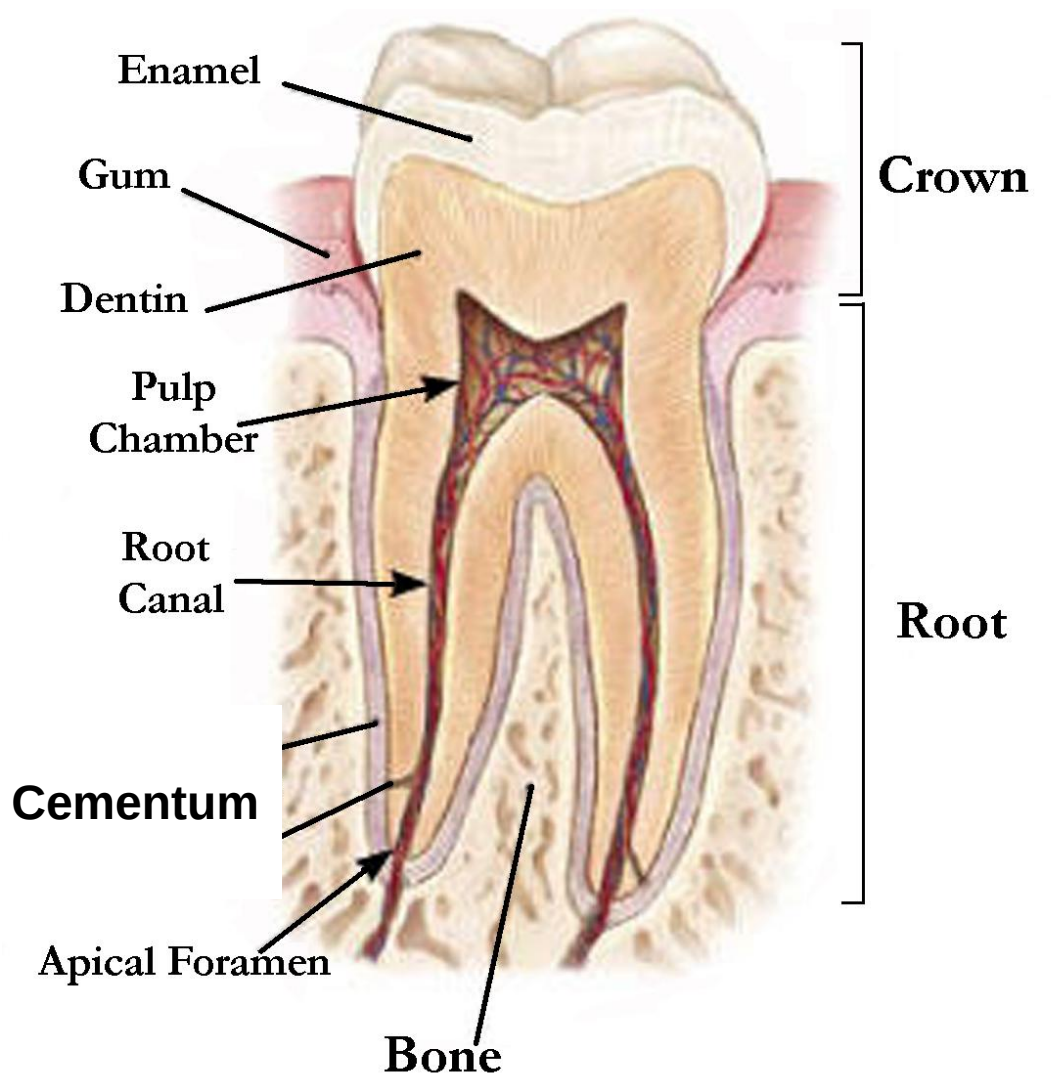
Nerve fibers enter the taste bud and form synaptic junctions with type I, type II, and type III cells, indicating that all three cell types probably function in the discernment of taste. Each of these cell types has long, slender microvilli that protrude from the taste pore.

Teeth

Each tooth is suspended
in its bony socket, the **alveolus,**
by a dense, irregular collagenous
connective tissue,
the **periodontal ligament.**



The portion of the tooth that is visible in the oral cavity is called the **crown,** the region within the alveolus is known as the **root.** The portion between the crown and the root is the **cervix.**

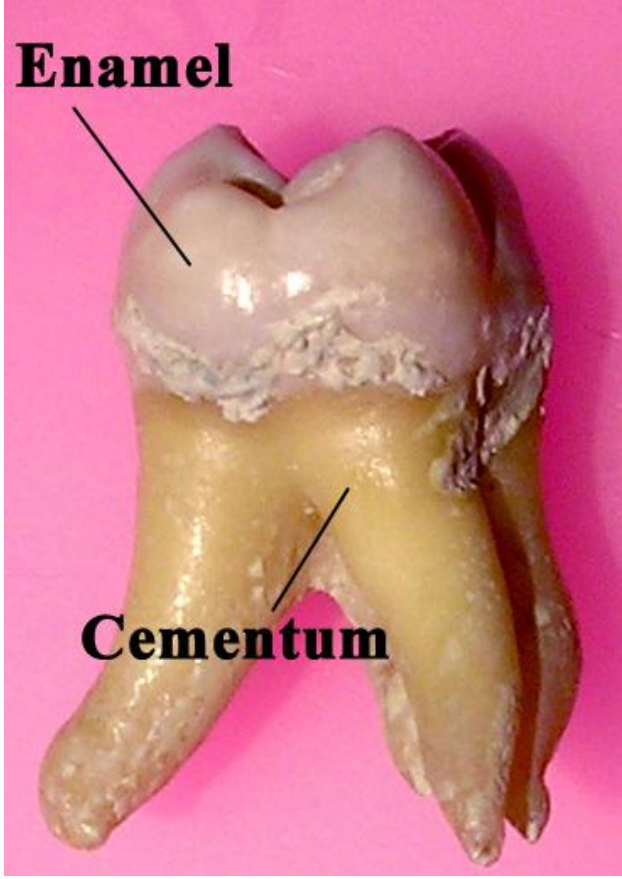


The tooth is composed of three calcified substances, which enclose a soft, gelatinous connective tissue, the **pulp,** located in a continuous space subdivided into **the pulp chamber and root canal.**

The mineralized structures of the tooth are **enamel**, **dentin,** and **cementum**. **Dentin** surrounds the pulp chamber and root canal and is covered on the crown by **enamel** and on the root by **cementum**

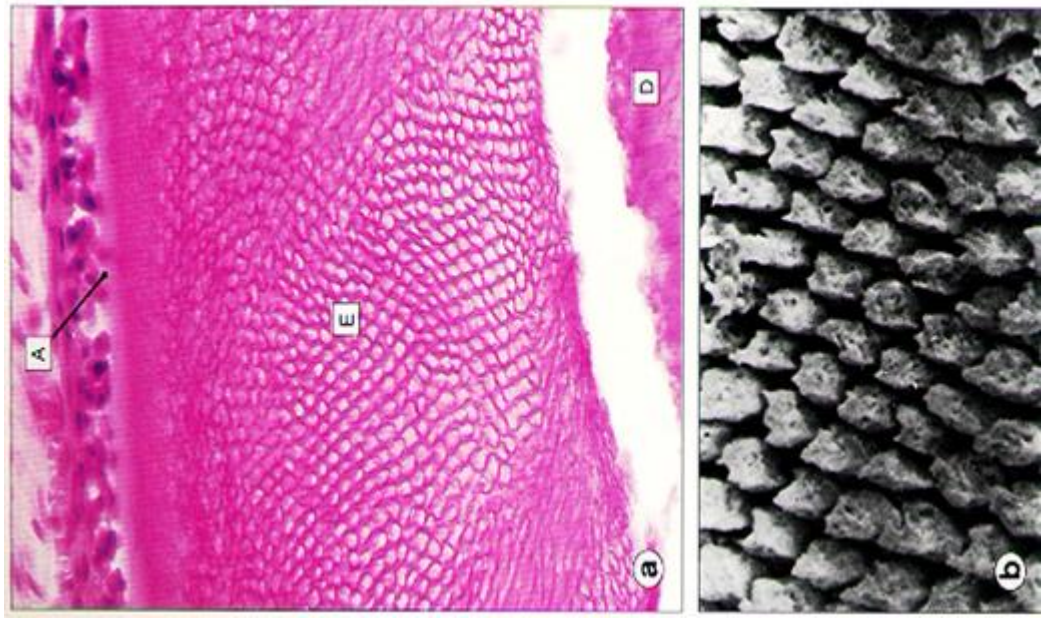
ENAMEL

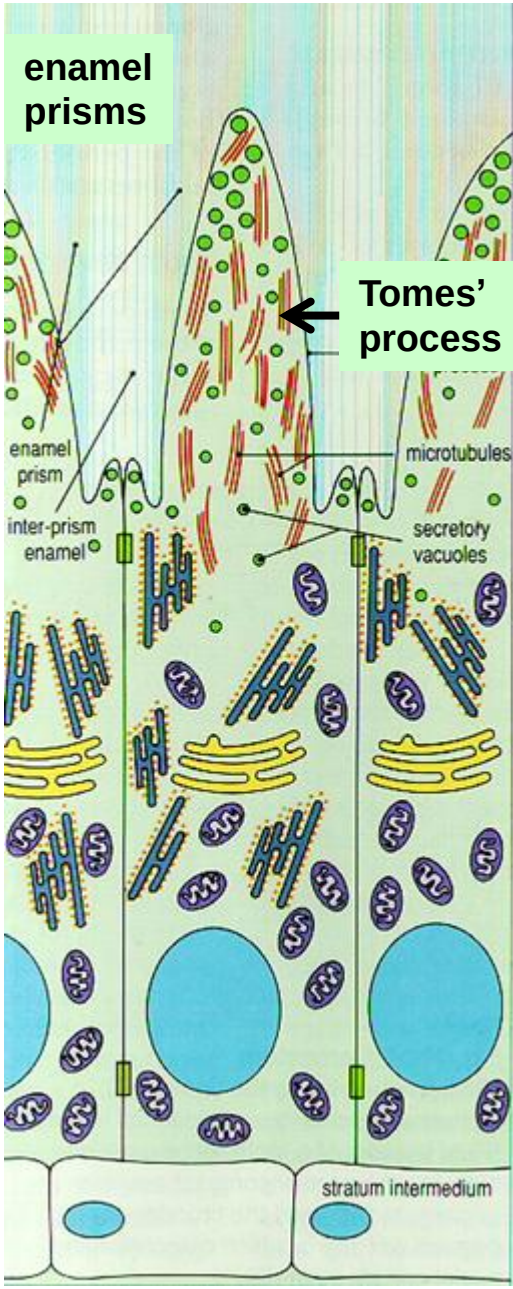
- is the hardest substance in the human body and contains the highest percentage of minerals - 96% (the primary mineral is hydroxyapatite), water and organic material (enamelins, tuftleins)
- is produced by **ameloblasts**

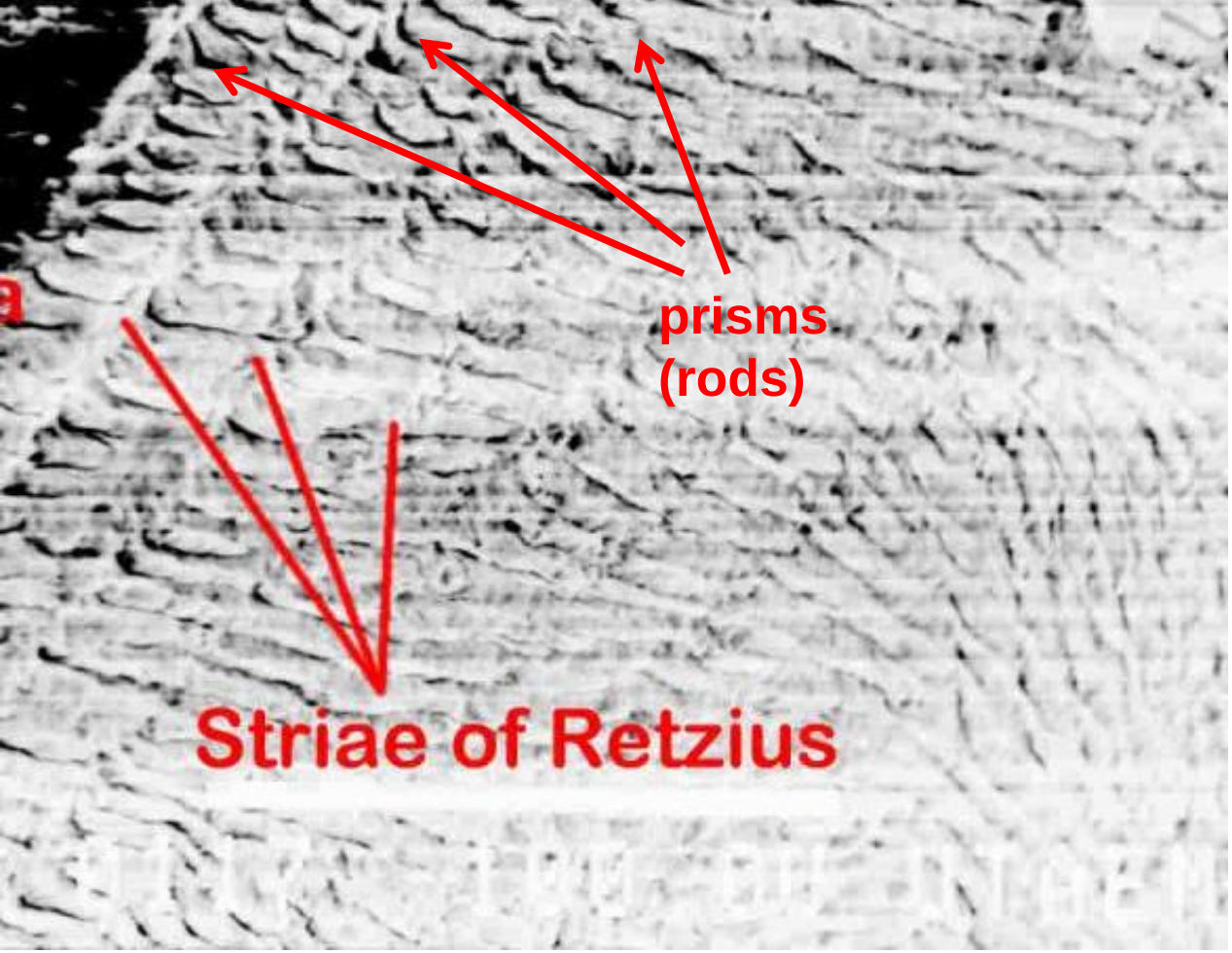


Ameloblasts

- are cells, present only during tooth development, that deposit tooth enamel
- secrete the enamel proteins **enamelin** and **amelogenin** which will later mineralize to form **enamel (enamel prisms)**
- are polarized cells columnar cell. The secretory end of the ameloblast is known as the **Tomes' process**



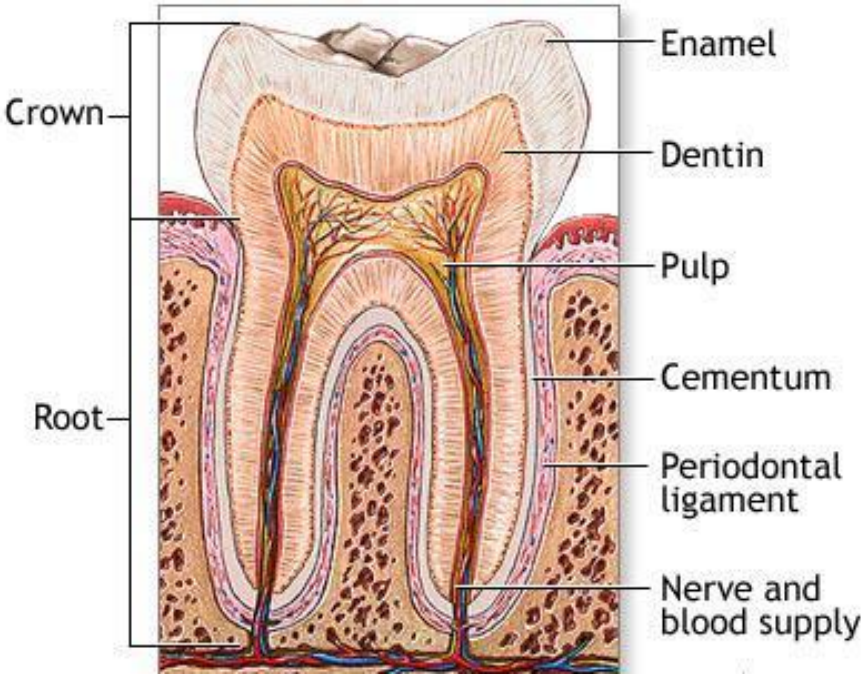


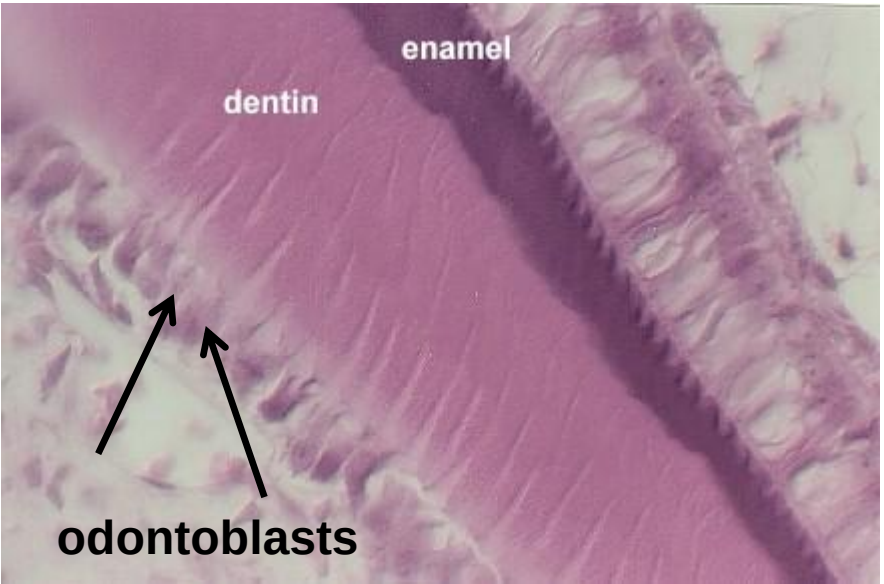


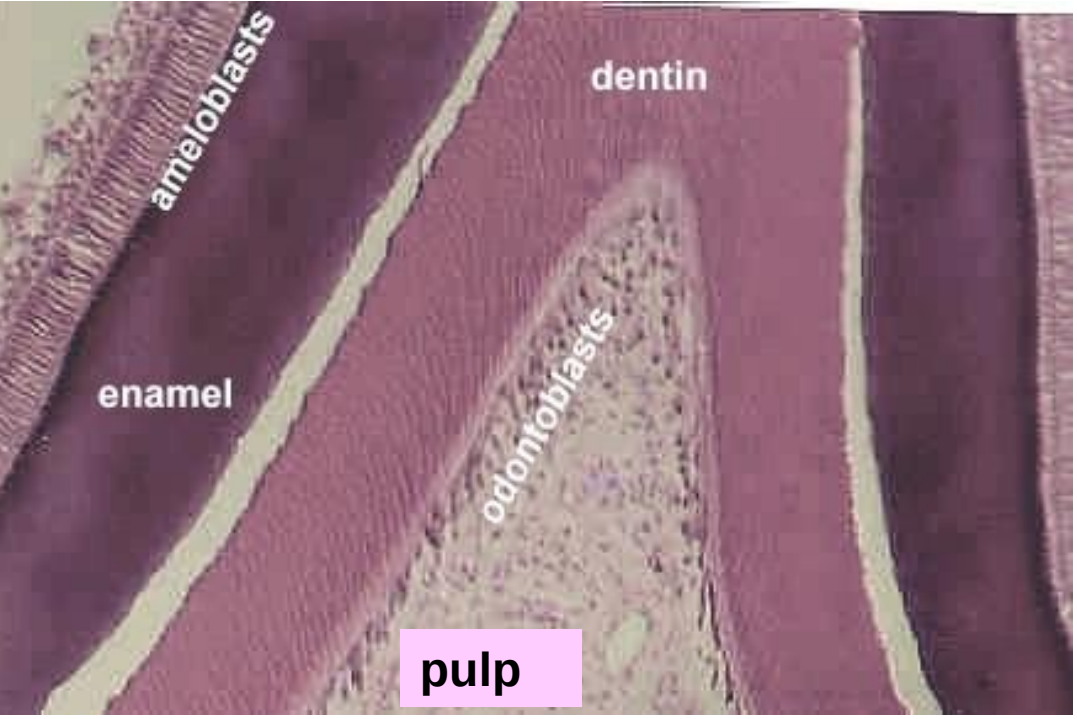
- **enamel** is produced by **ameloblasts** in form of **rod segments**
- **rod segments** adhere one to another forming **enamel rods (prism)**
- **striae of Retzius** – reflect the metabolic state of the person during the time of enamel formation

Dentin

- is usually covered by enamel on the crown and cementum on the root and surrounds the entire pulp.
- 70% of dentin consists of the mineral hydroxyapatite, 20% is organic material (mainly type I collagen and proteoglycans) and 10% is water
- is the second hardest tissue of the body
- is produced by **odontoblasts**

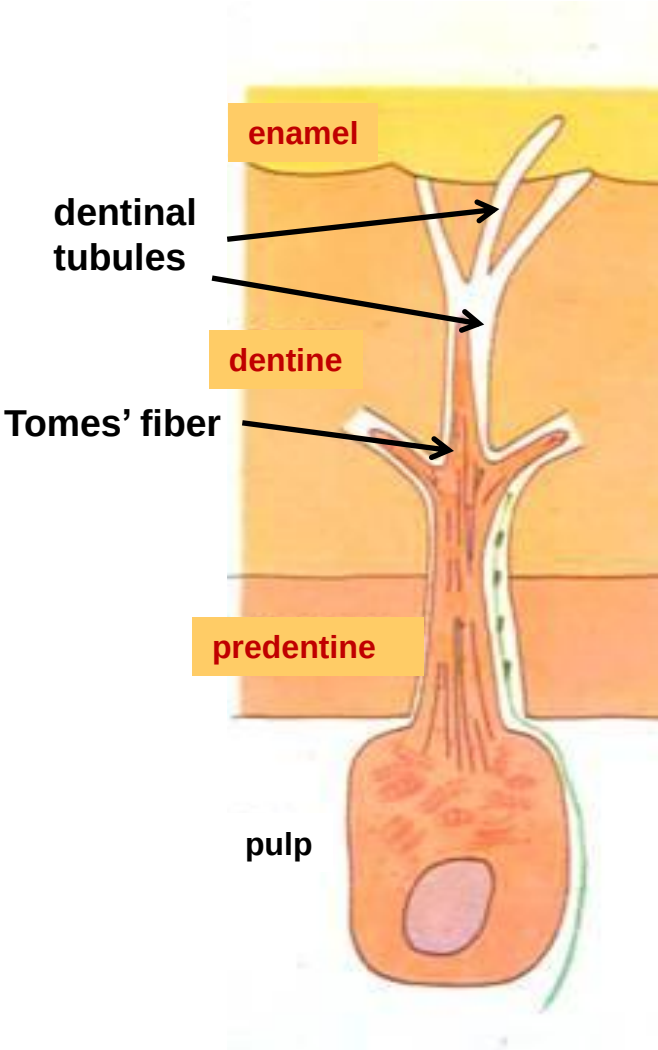






Odontoblasts

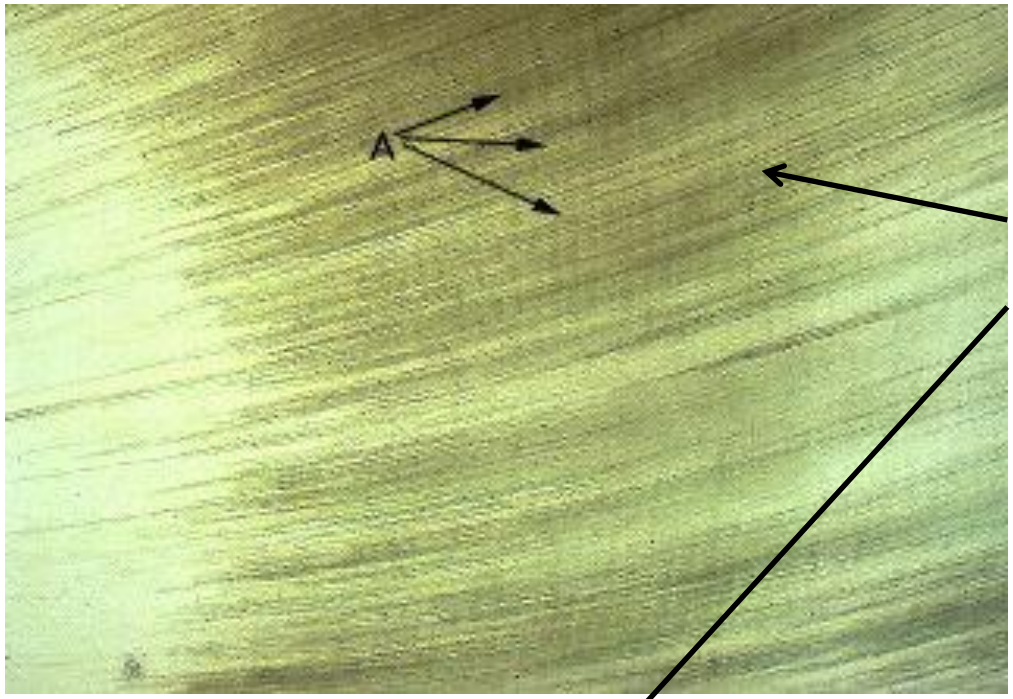
- are located at the periphery of the pulp



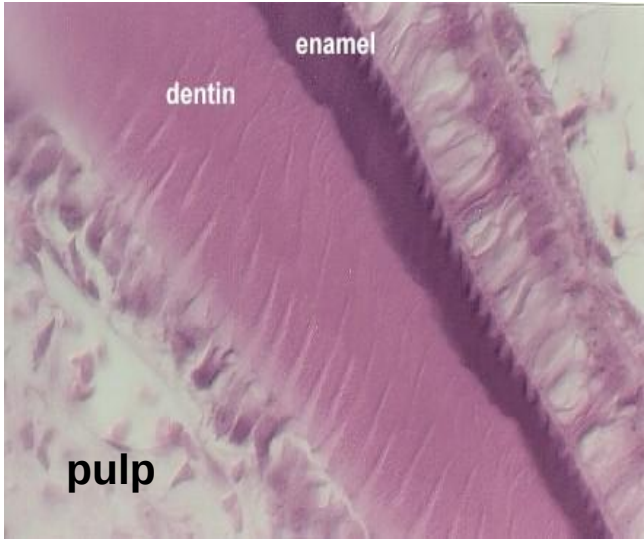
Tomes' fibers (odontoblasts processes) run in dentinal tubules, extensively branched near the junction between dentin and enamel.

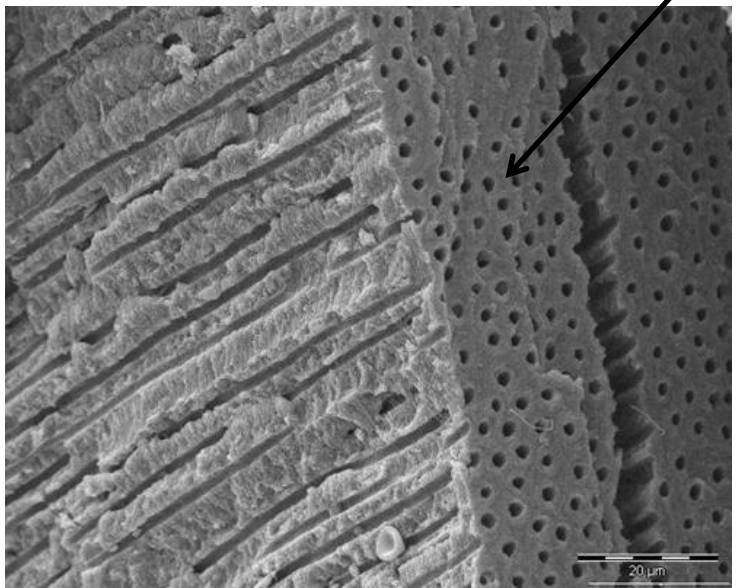
Matrix deposited by odontoblasts is at first non-mineralised (**predentine**).

dentin



dentinal tubules

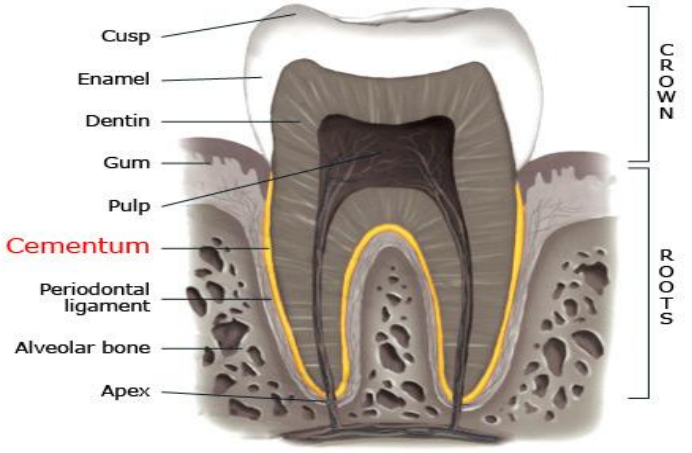




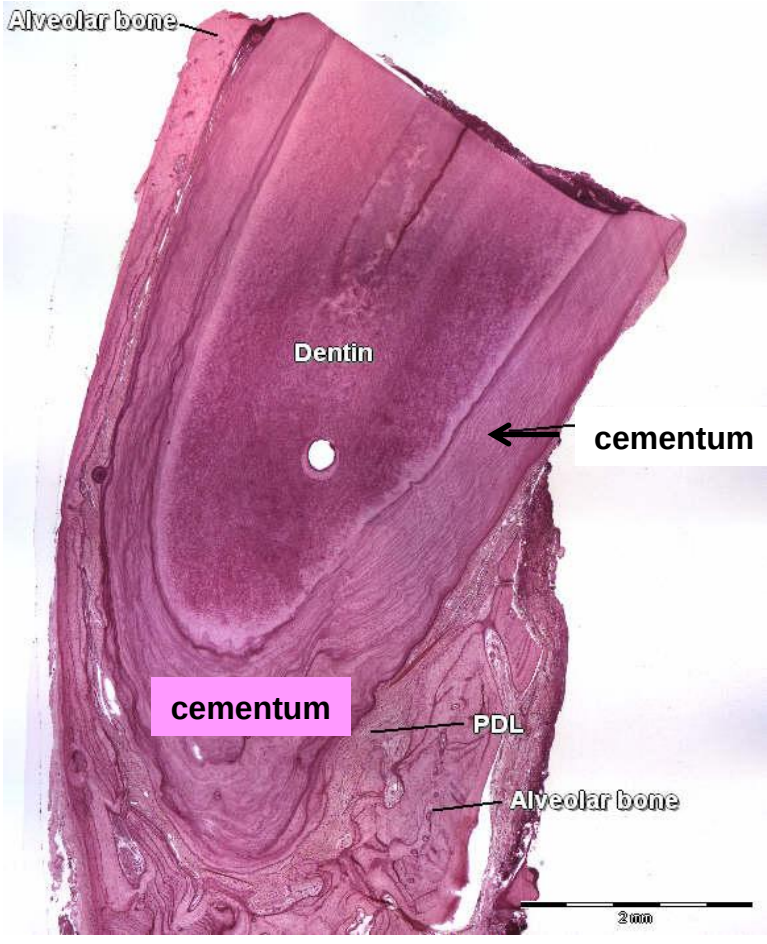
dentinal tubules

- microscopic channels which radiate outward through the dentin from the pulp to the exterior cementum (in the root) or enamel (in the crown) border
- contain odontoblastic processes and fluid

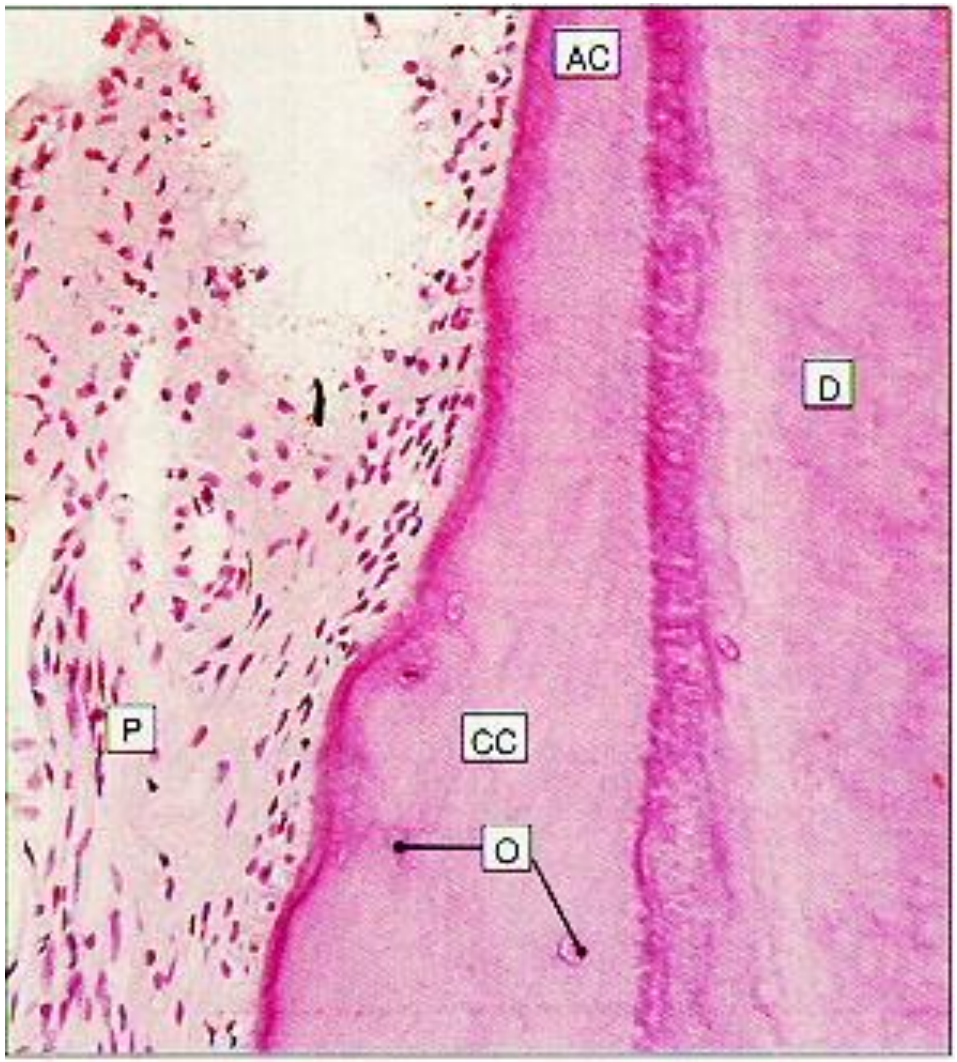
cementum



- is a specialized calcified substance covering the root of a tooth
- is slightly softer than dentin and consists of about 45% to 50% inorganic material (hydroxylapatite) and
50% to 55% organic matter (type I collagen and proteoglycans) and water.
- is secreted by cells called **cementoblasts**



Acellular and cellular cementum

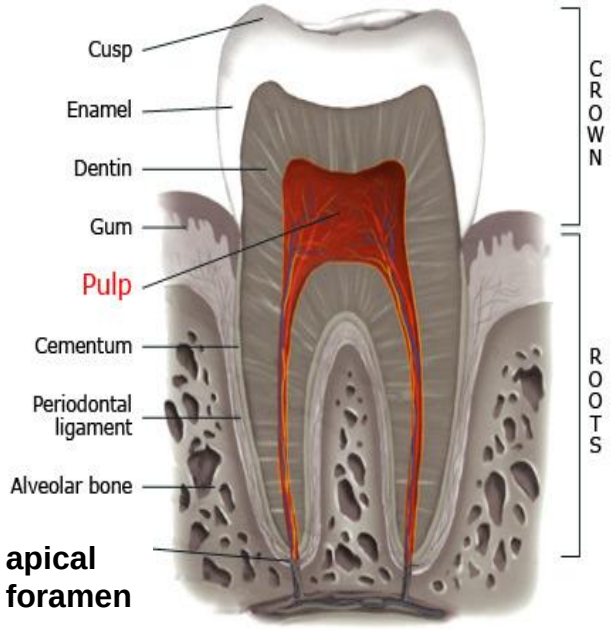


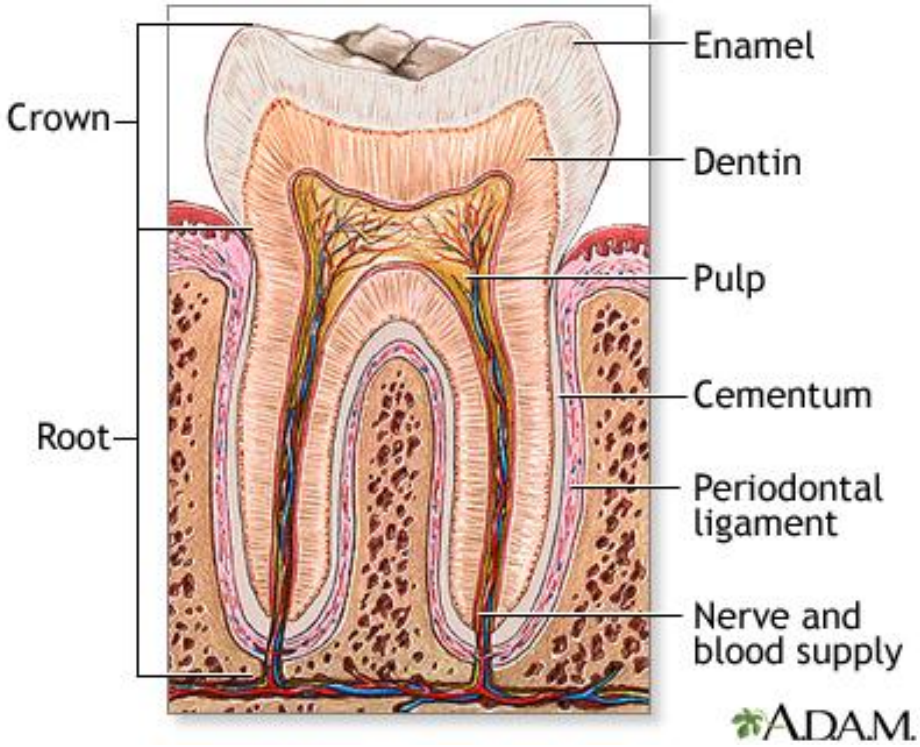
Acellular cementum is formed by calcified extracellular matrix. It is produced before eruption of tooth. It is deposited as a thin layer along the root of the tooth.

Cellular (secondary) cementum is formed after tooth eruption in the lower part of the root. It is produced in the apex of tooth during the whole lifetime compensating for the physiological wear of the teeth. Cementocytes are similar to osteocytes but do not communicate through canaliculi.

Pulp

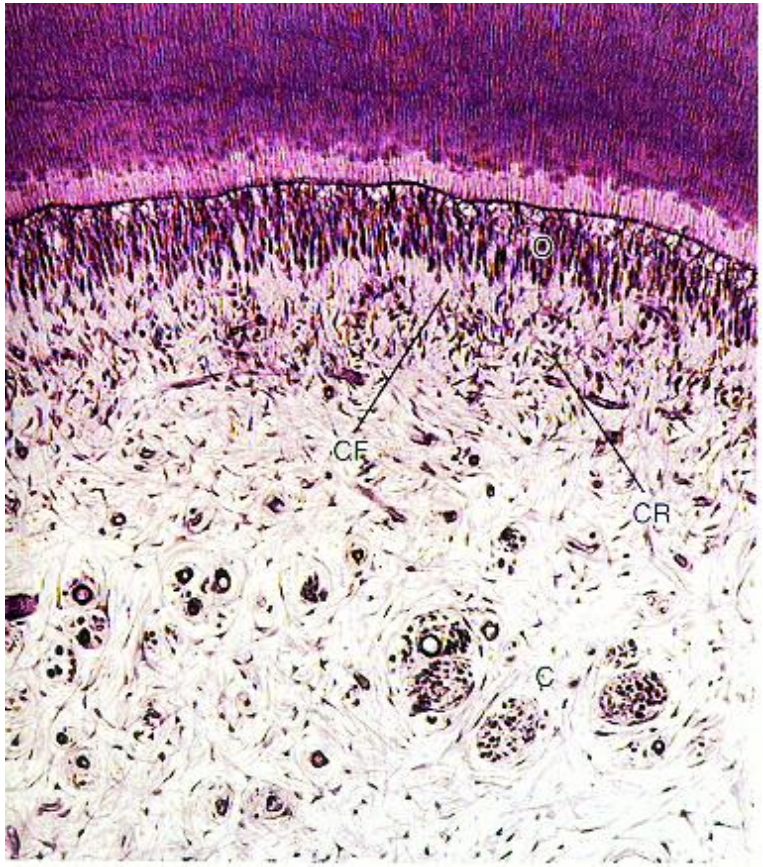
- is composed of loose, gelatinous connective tissue.
- has an extensive vascular and nerve supply

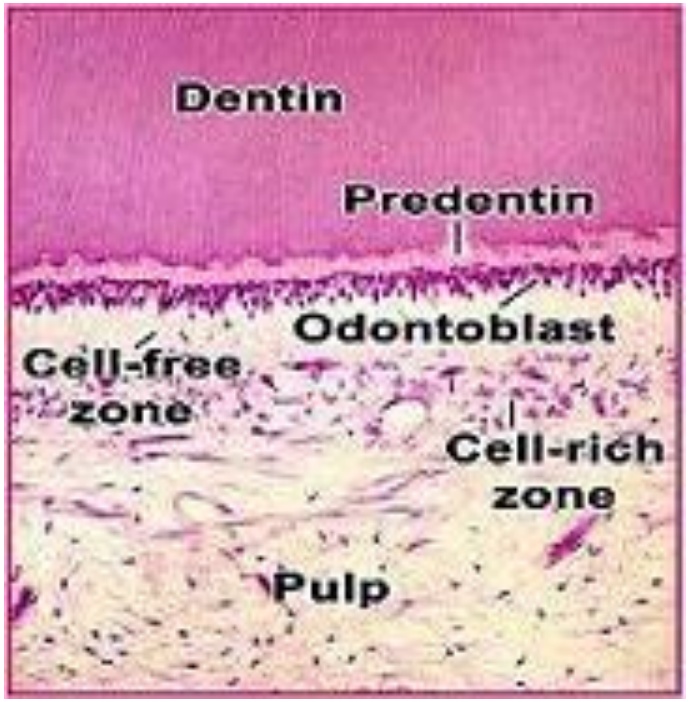




Nerves and blood vessels enter and leave the pulp through apical foramen

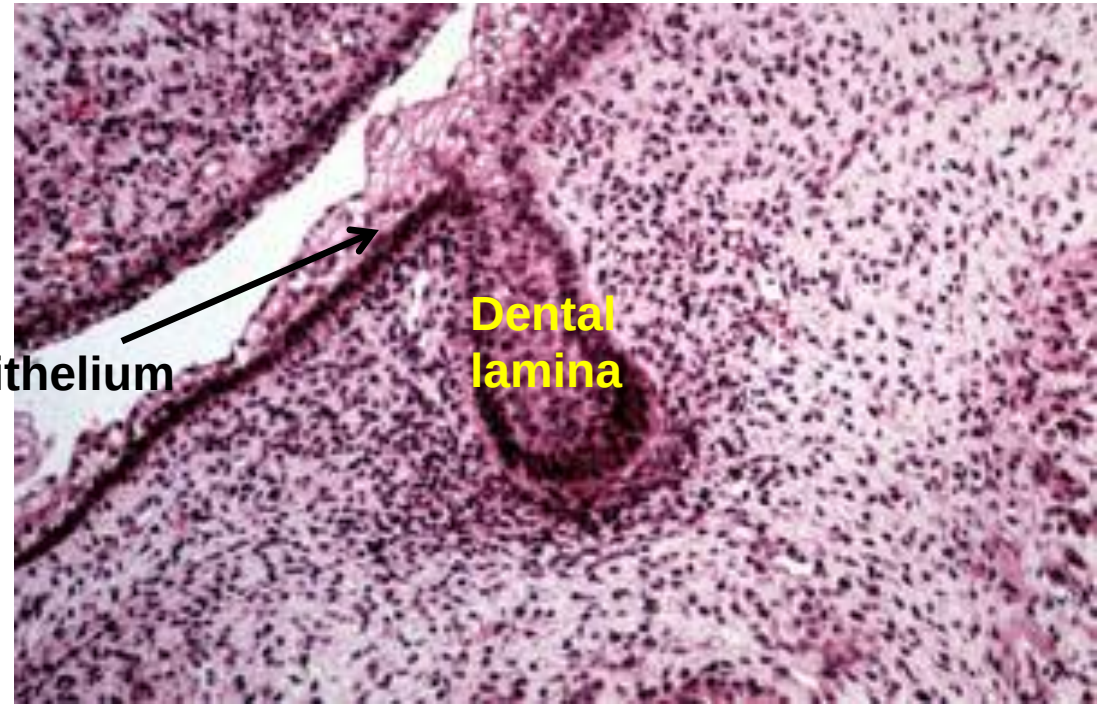
Dentin and pulp



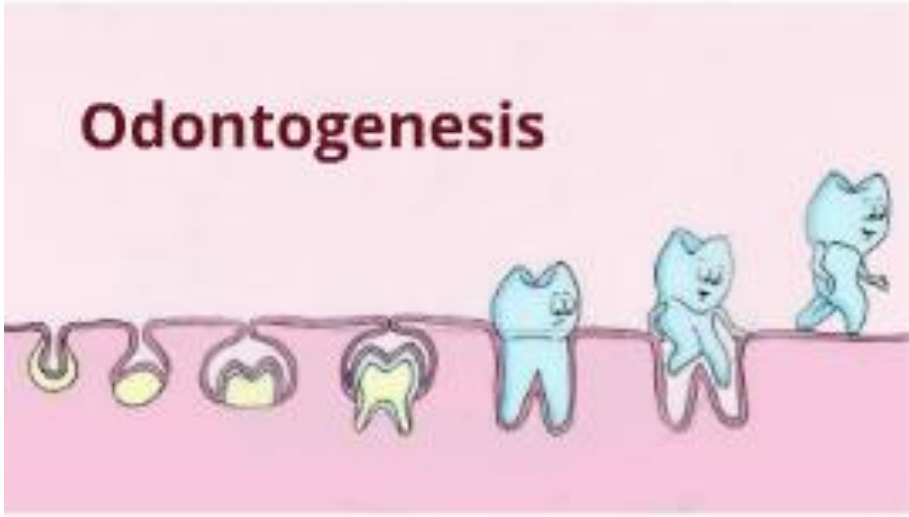


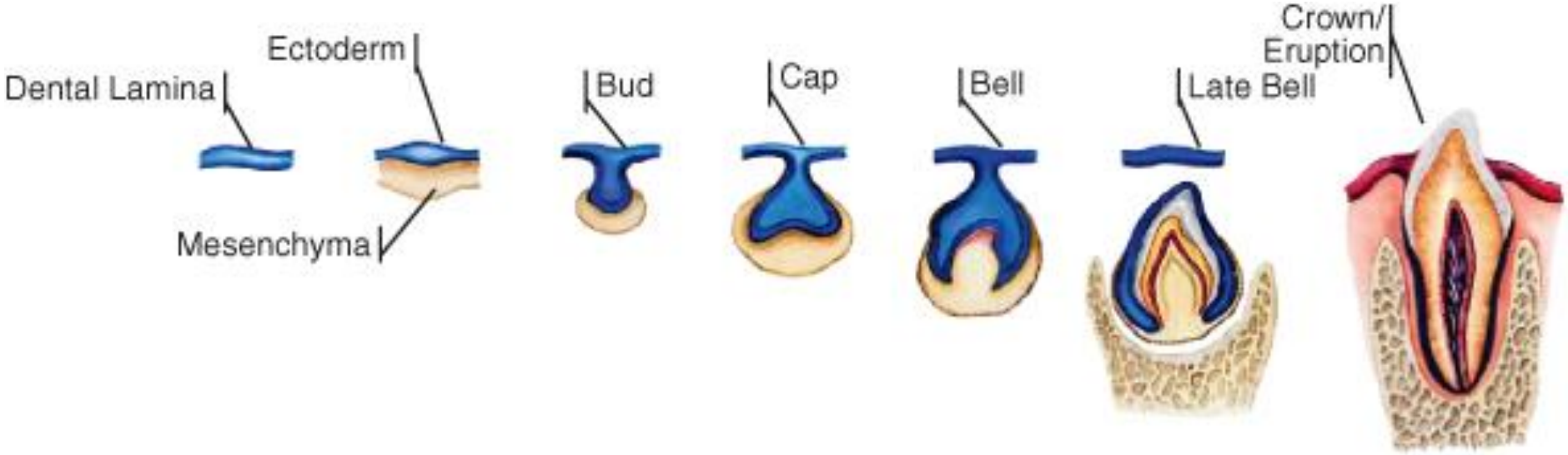
Odontogenesis - Tooth development

- is the complex process by which teeth are formed from embryonic cells, grow, and erupt into the mouth.
- begins with the appearance of the dental lamina (results of the proliferation of the oral epithelium cells)

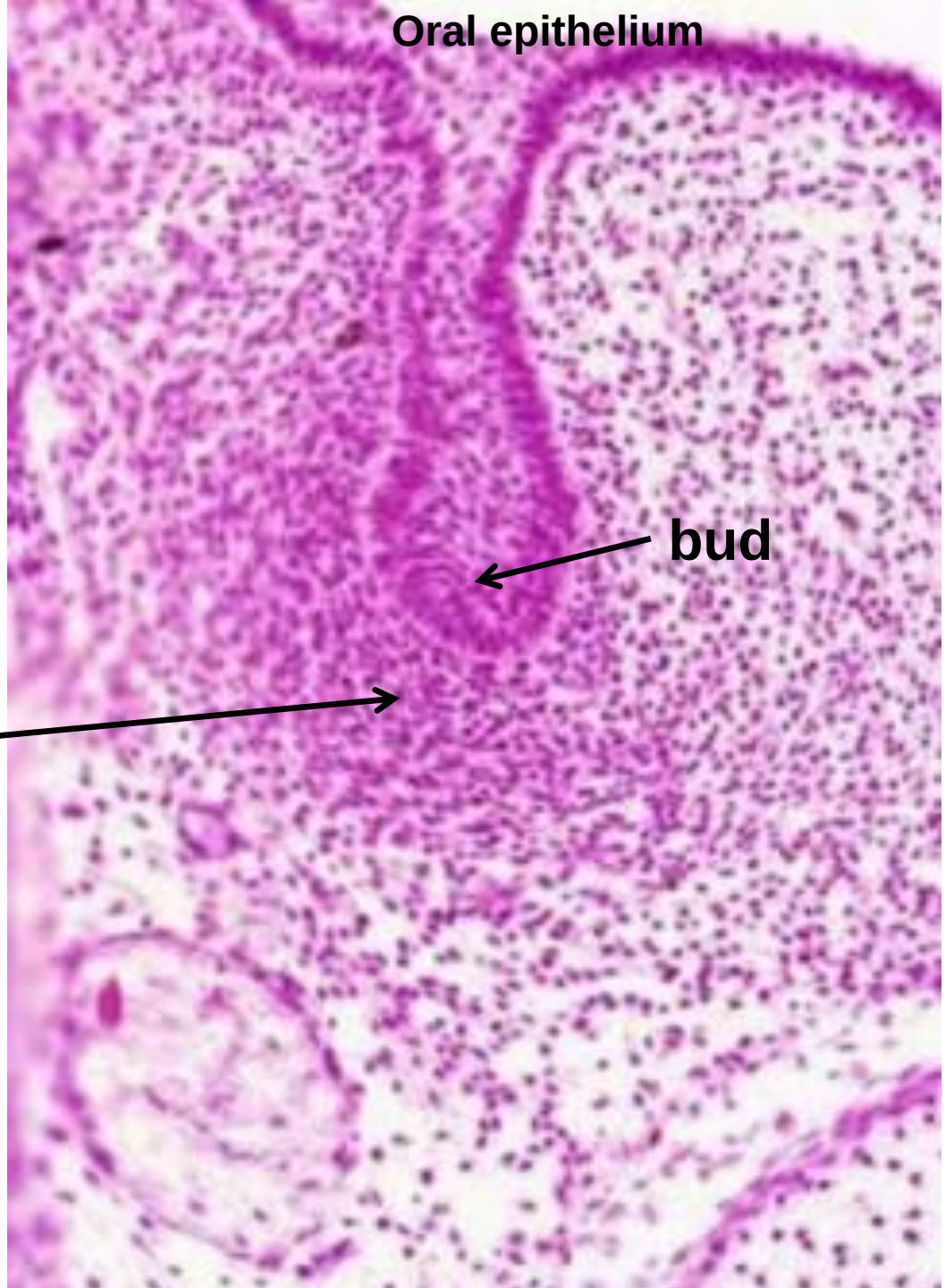


Odontogenesis - stages



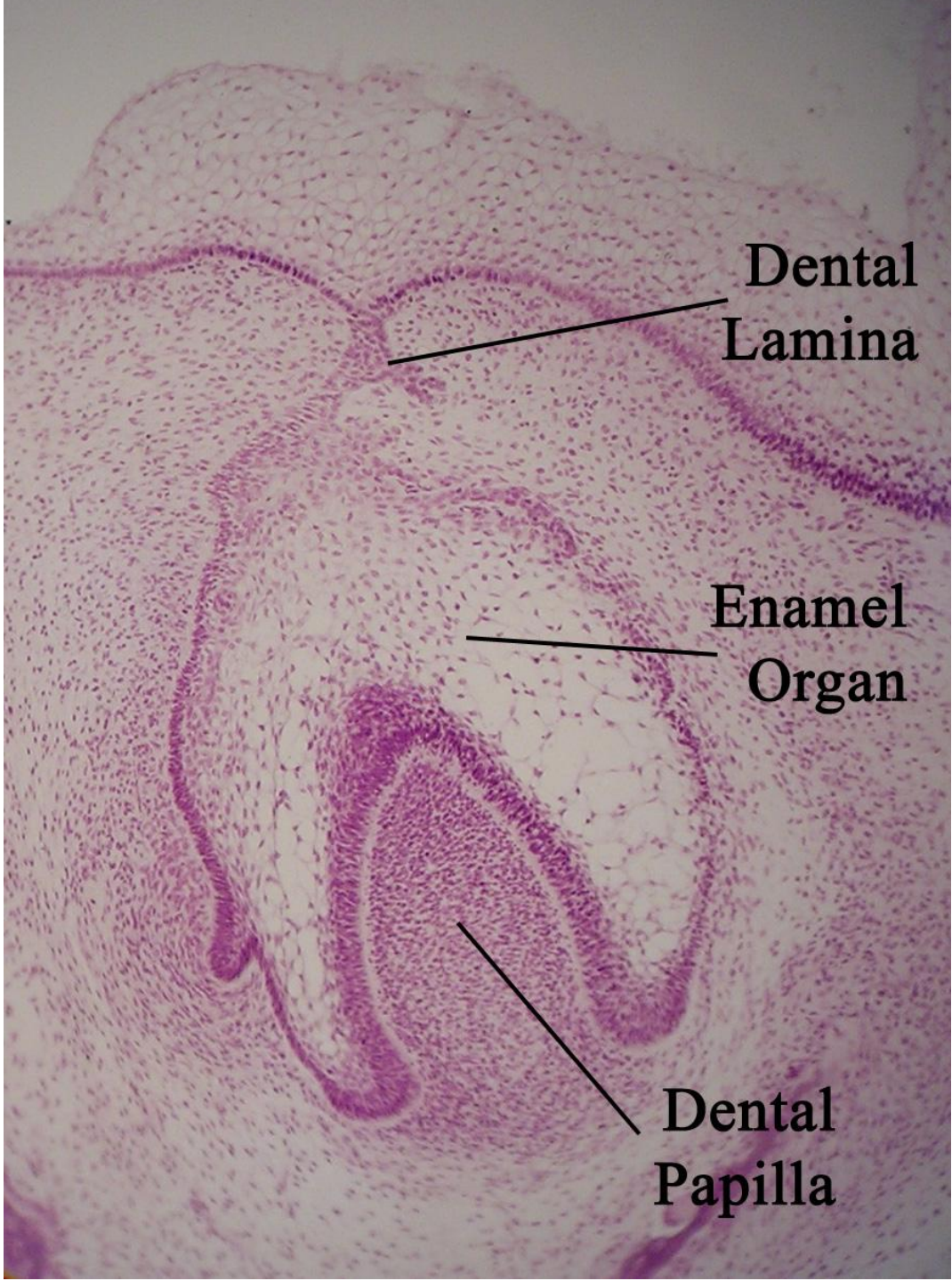


Bud stage


Oral epithelium
bud
Dental papilla
(a condensation of
ectomesenchymal cells)

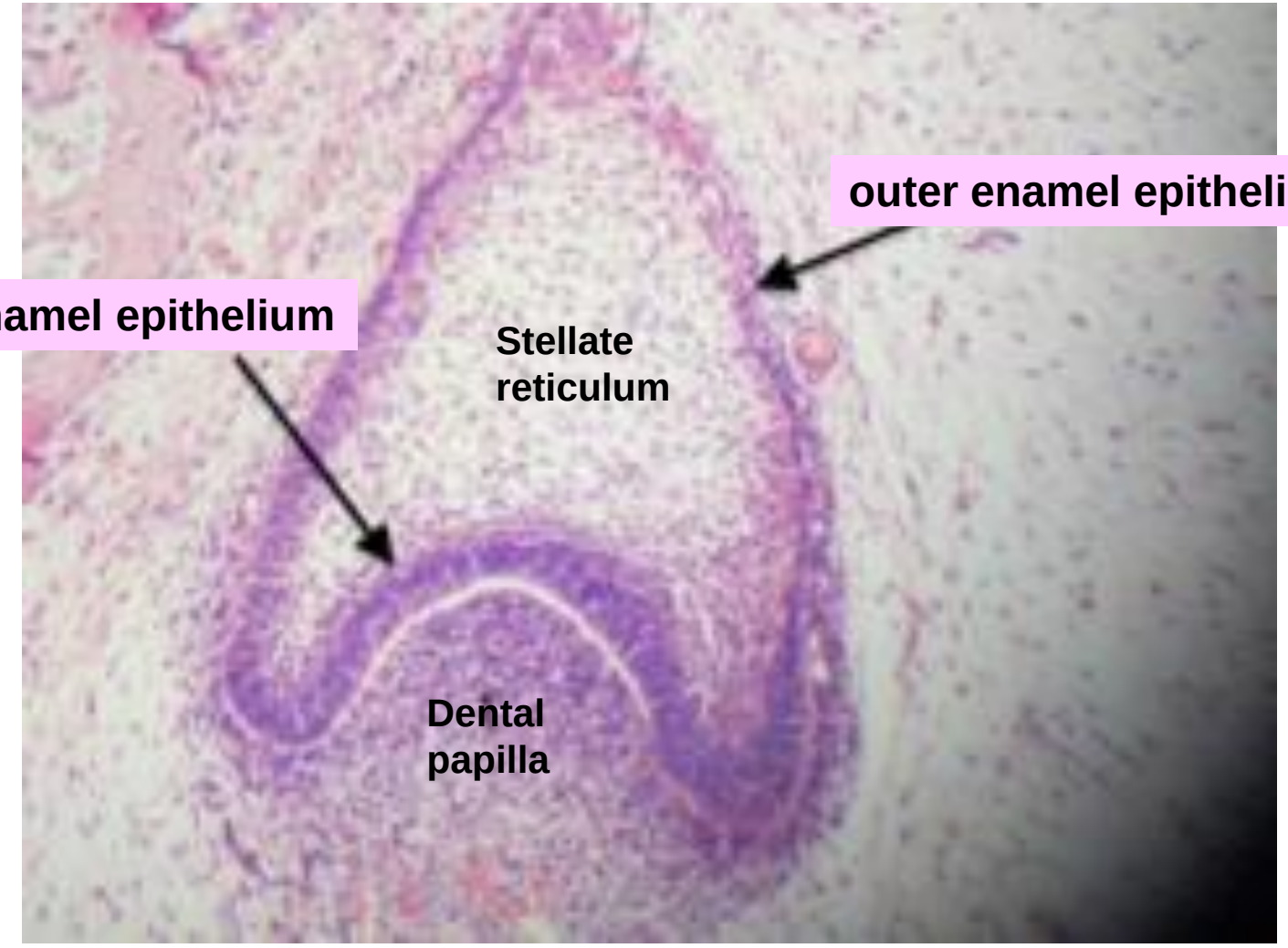
Cap stage

- is recognized by the formation of enamel organ (**eventually, the enamel organ will produce enamel, the dental papilla will produce dentin and pulp**)



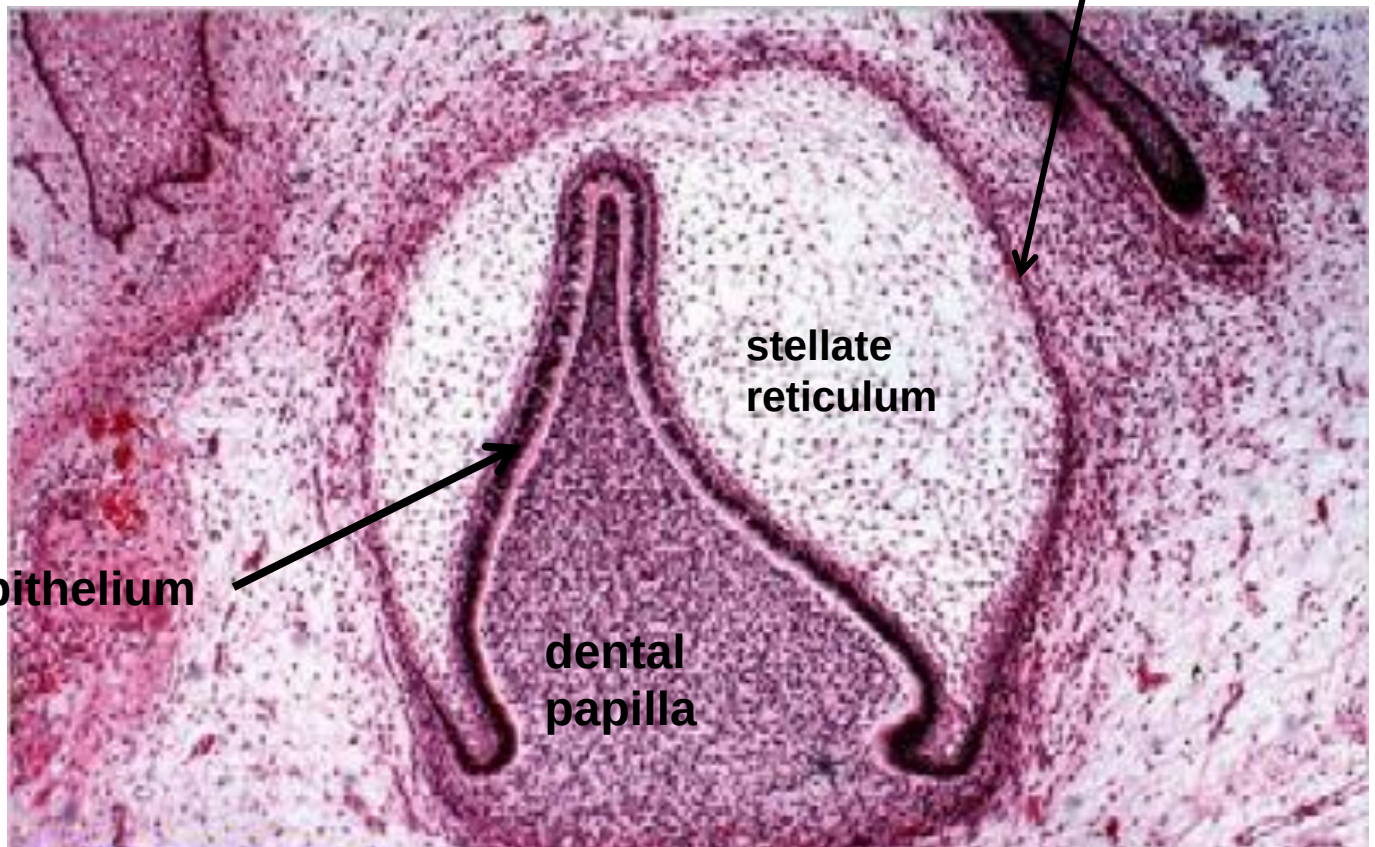
Enamel organ

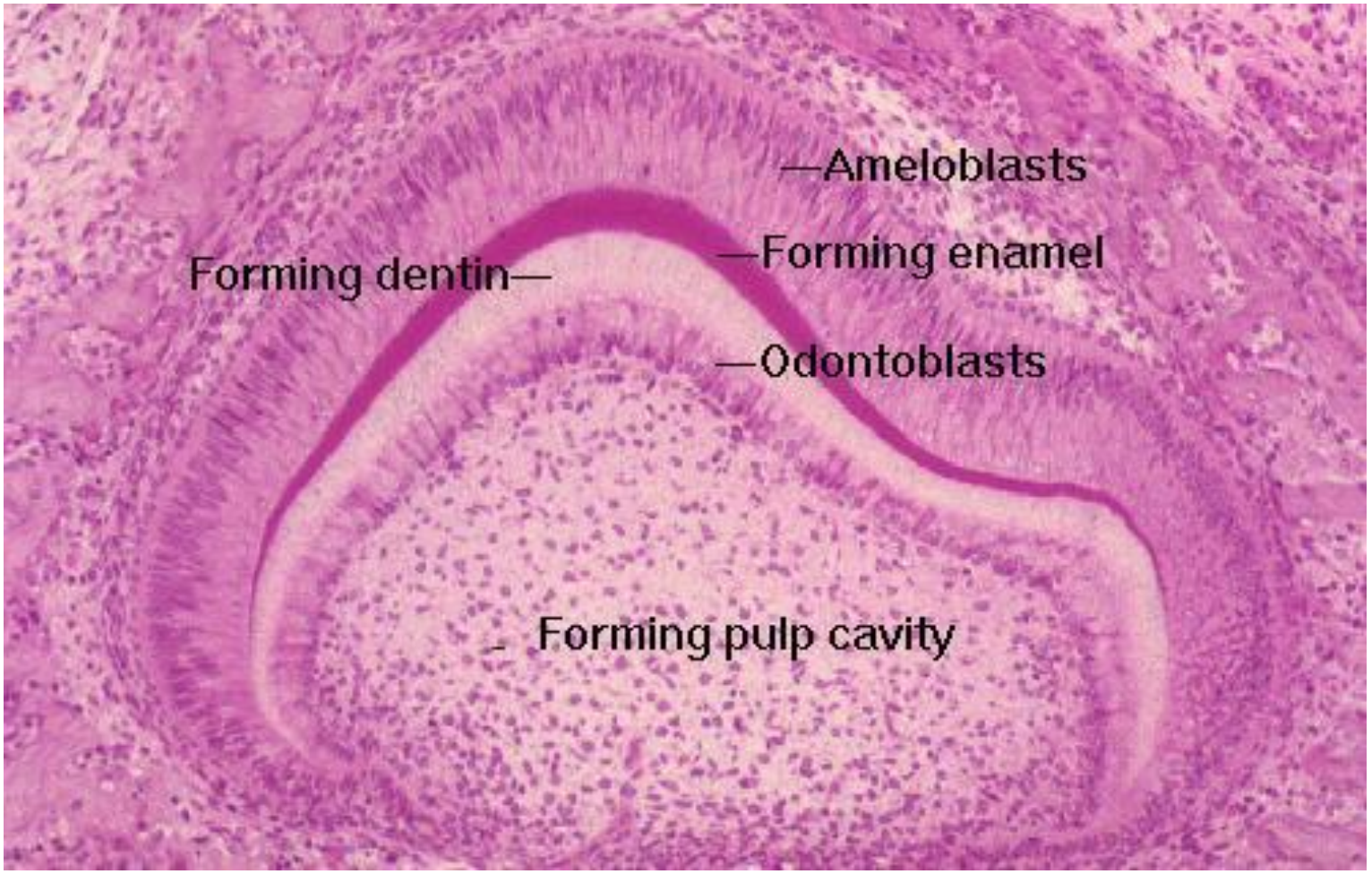
- functions in the formation of enamel, initiation of dentin formation and establishment of the shape of a tooth's crown
- 3 types of cells



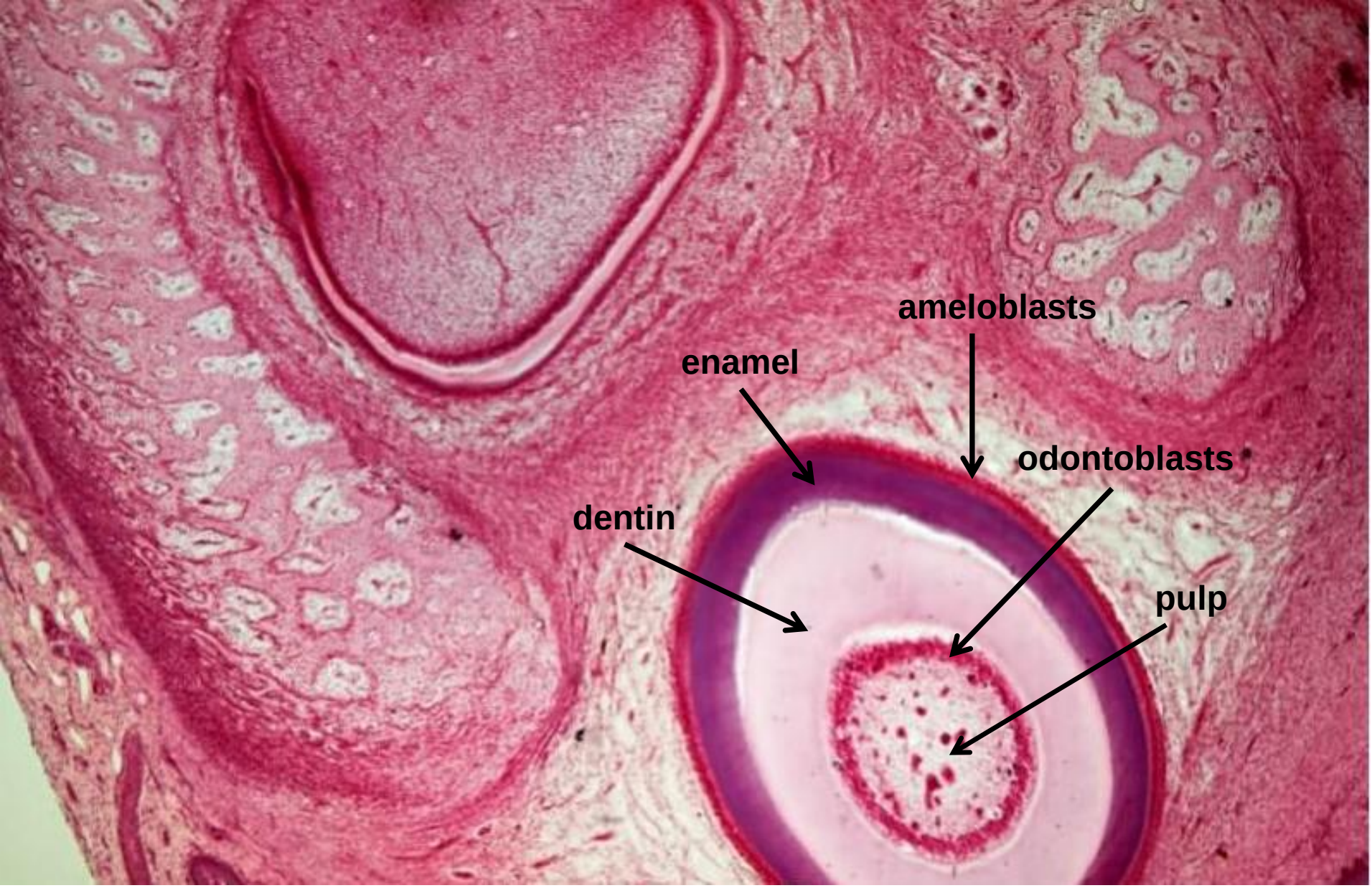
Bell stage

The cells between the **inner enamel epithelium** and the **stellate reticulum** form a layer known as the **stratum intermedium (**support the activity of the inner enamel epithelium)





inner enamel epithelium – ameloblasts - enamel
outer cells of the dental papilla – odontoblasts- dentin



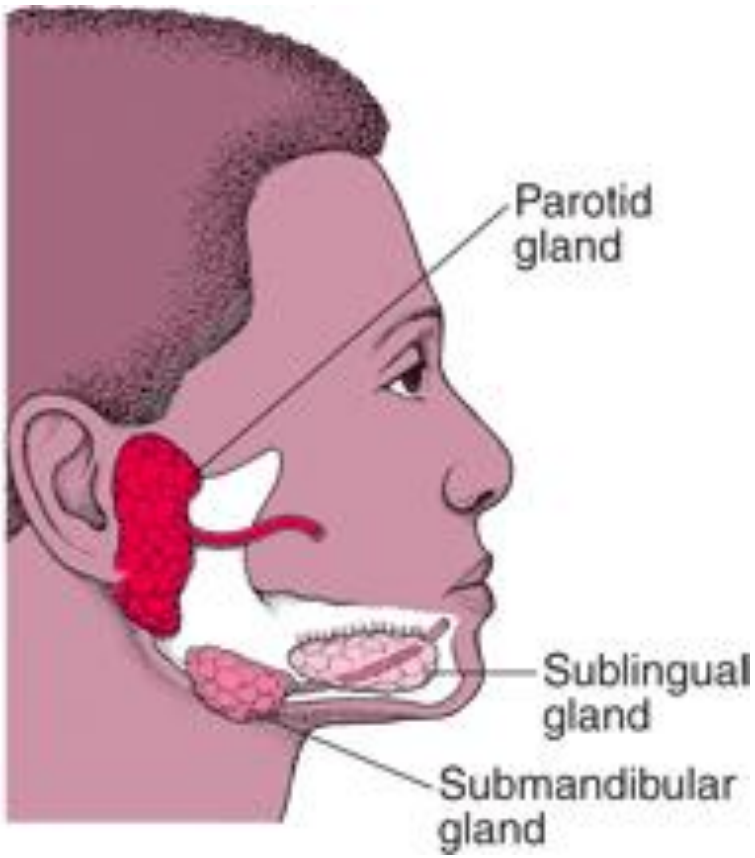
Tooth development

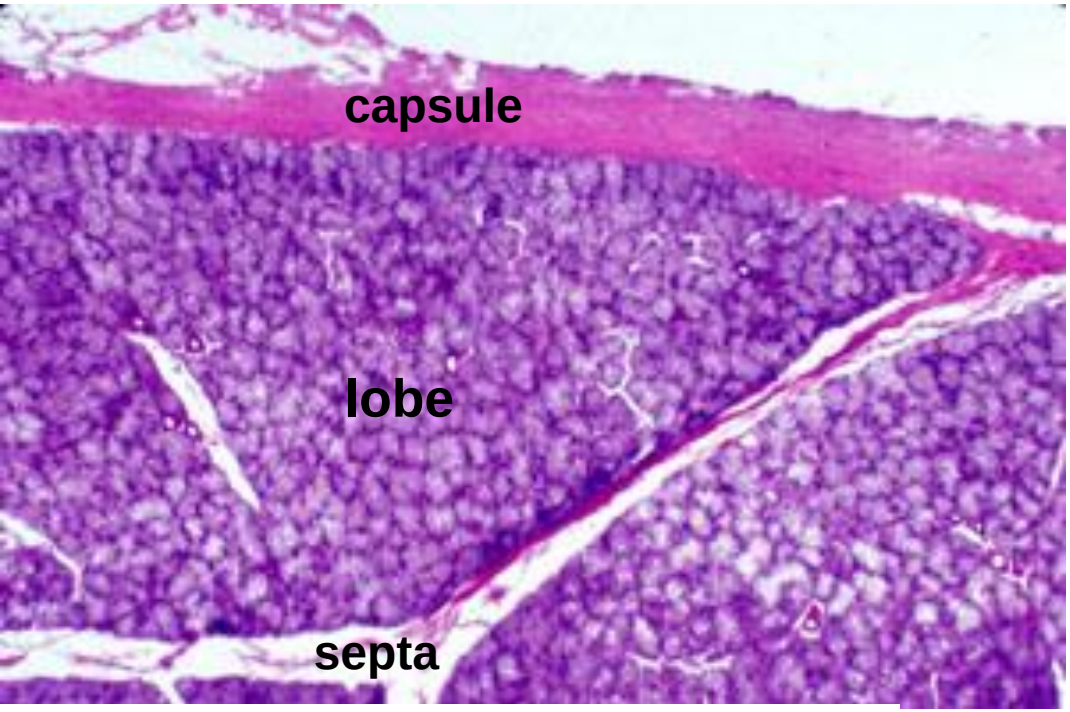
Salivary Glands

- are exocrine glands, glands with ducts, that produce **saliva**
- **saliva** facilitates the process of tasting food, initiates of digestion and permits of deglutition (swallowing). Saliva protects the body by secreting the antibacterial agents (lysozyme, lactoferrin and **IgA**)

The major salivary glands

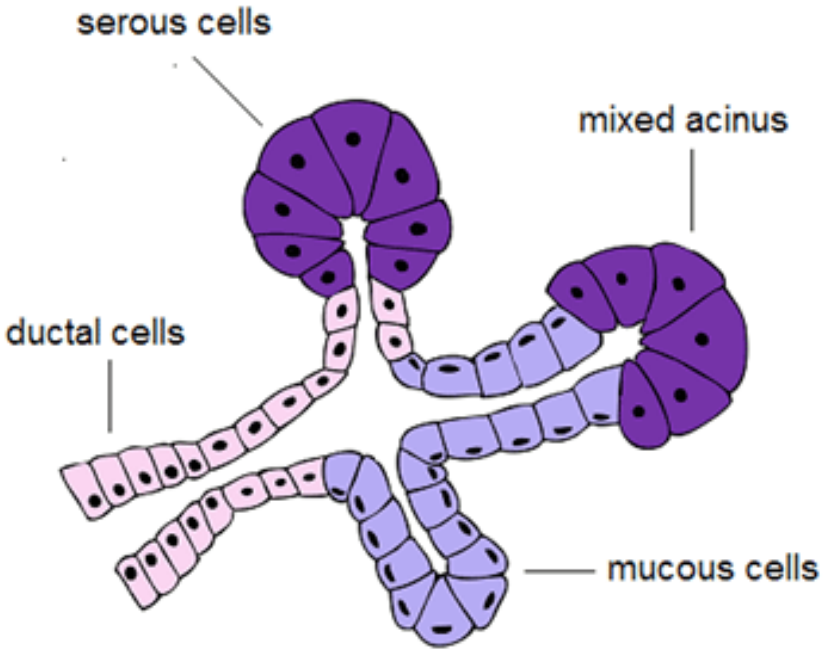
- **Parotid gland**
- **Sublingual gland**
- **Submandibular gland**





Major salivary glands

- are surrounded by the connective tissue capsule
- septa subdivide the glands into lobes and lobules



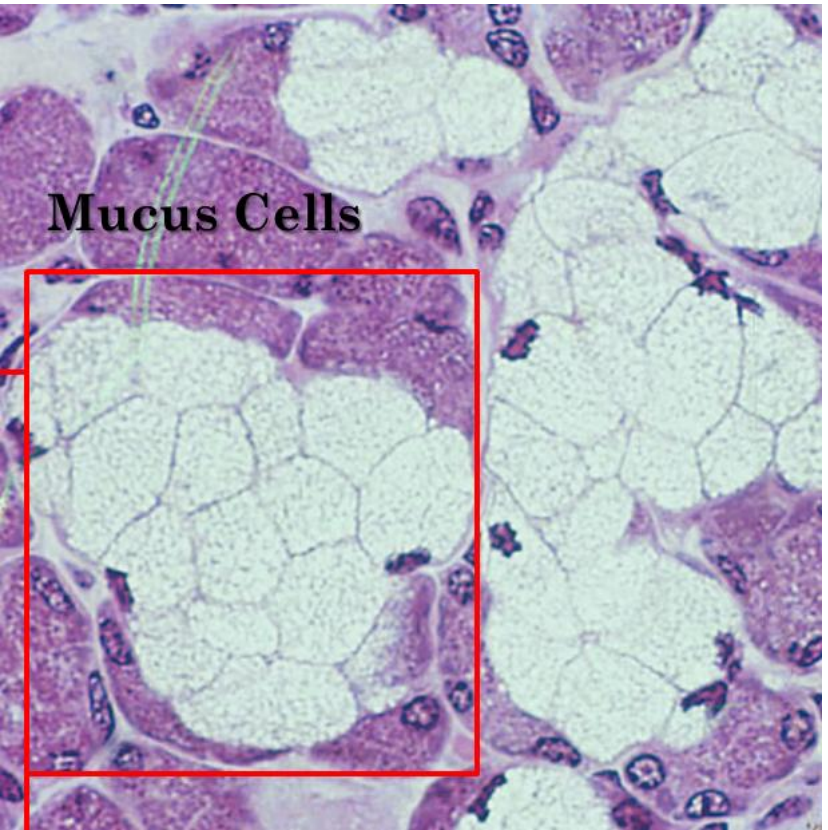
Major salivary glands are tubuloalveolar glands

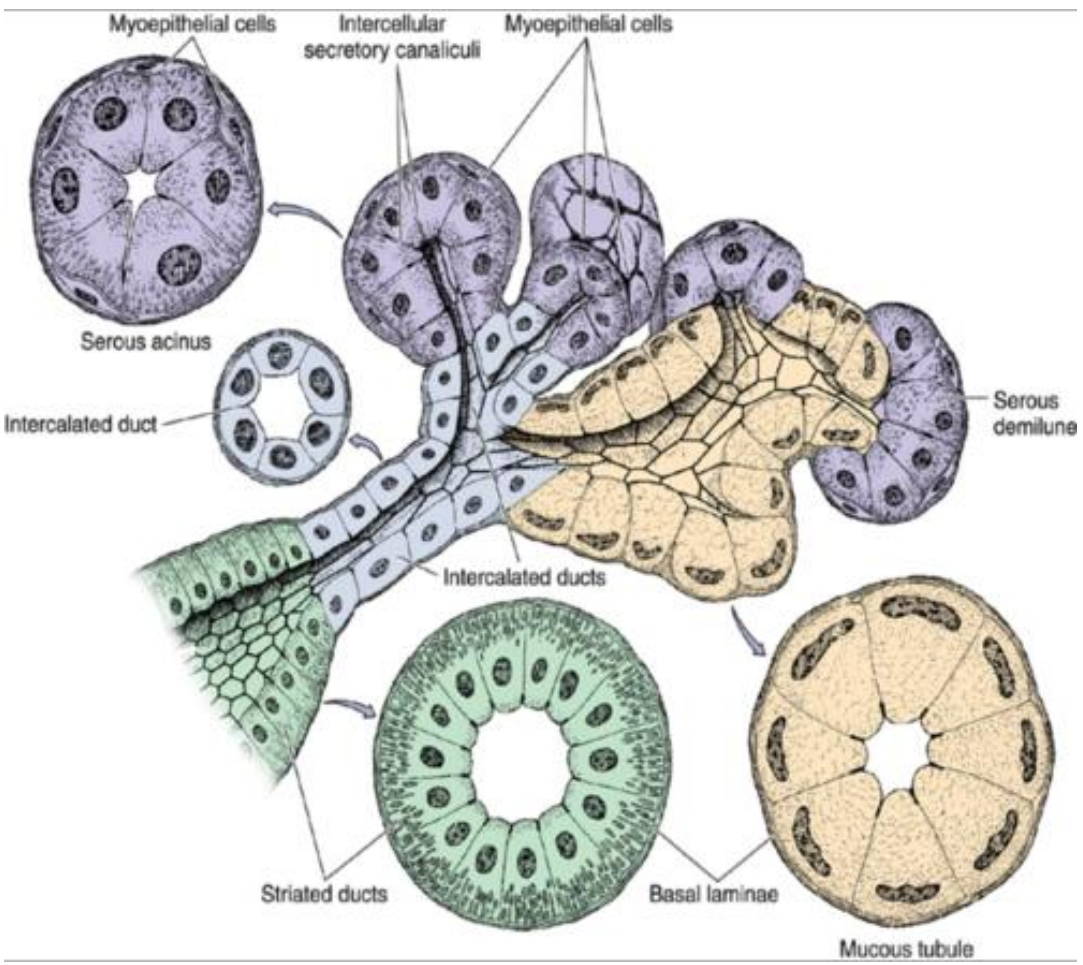
Each of major salivary gland has a **secretory** and **duct** portion

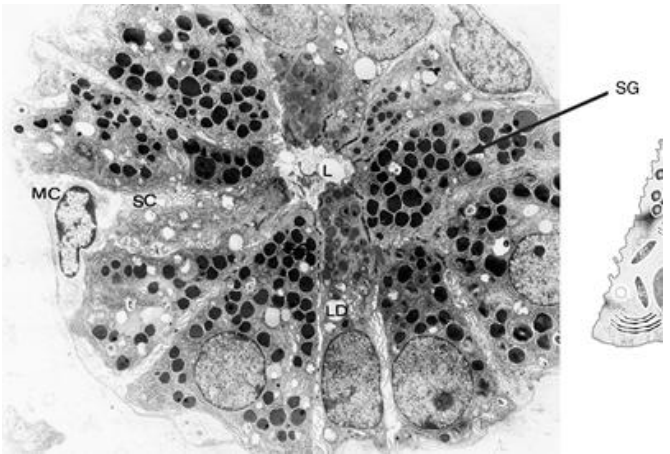
The **secretory** portions of salivary glands are composed of **serous** and/or **mucous** secretory cells arranged in **acini** (alveoli) or **tubules**

Mucous cells

- nuclei are basaly located and flattened
- apical region of the cell is occupied by abundant secretory granules

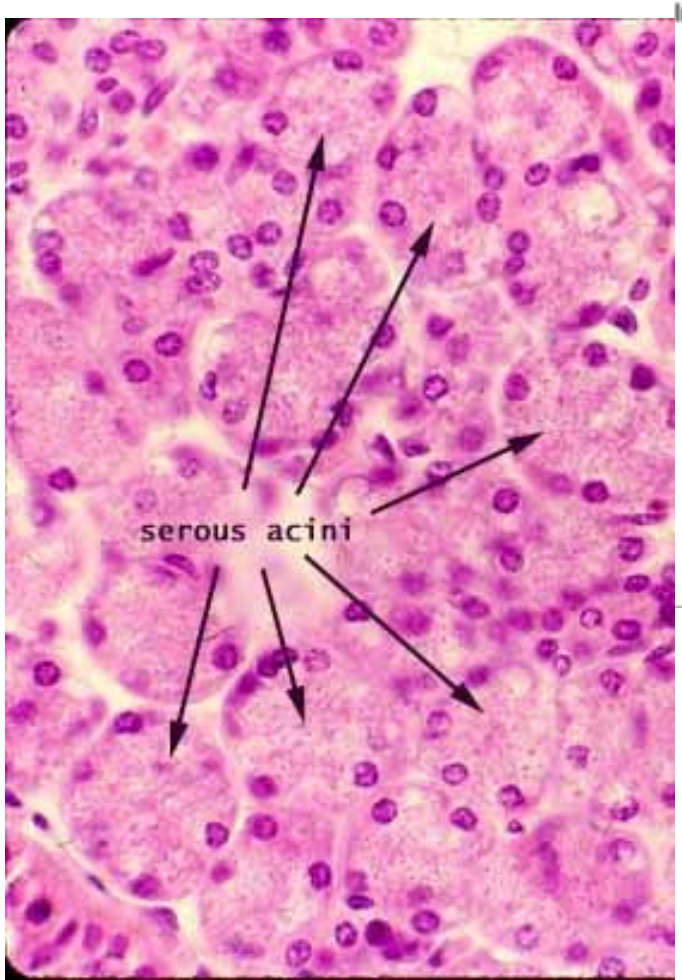


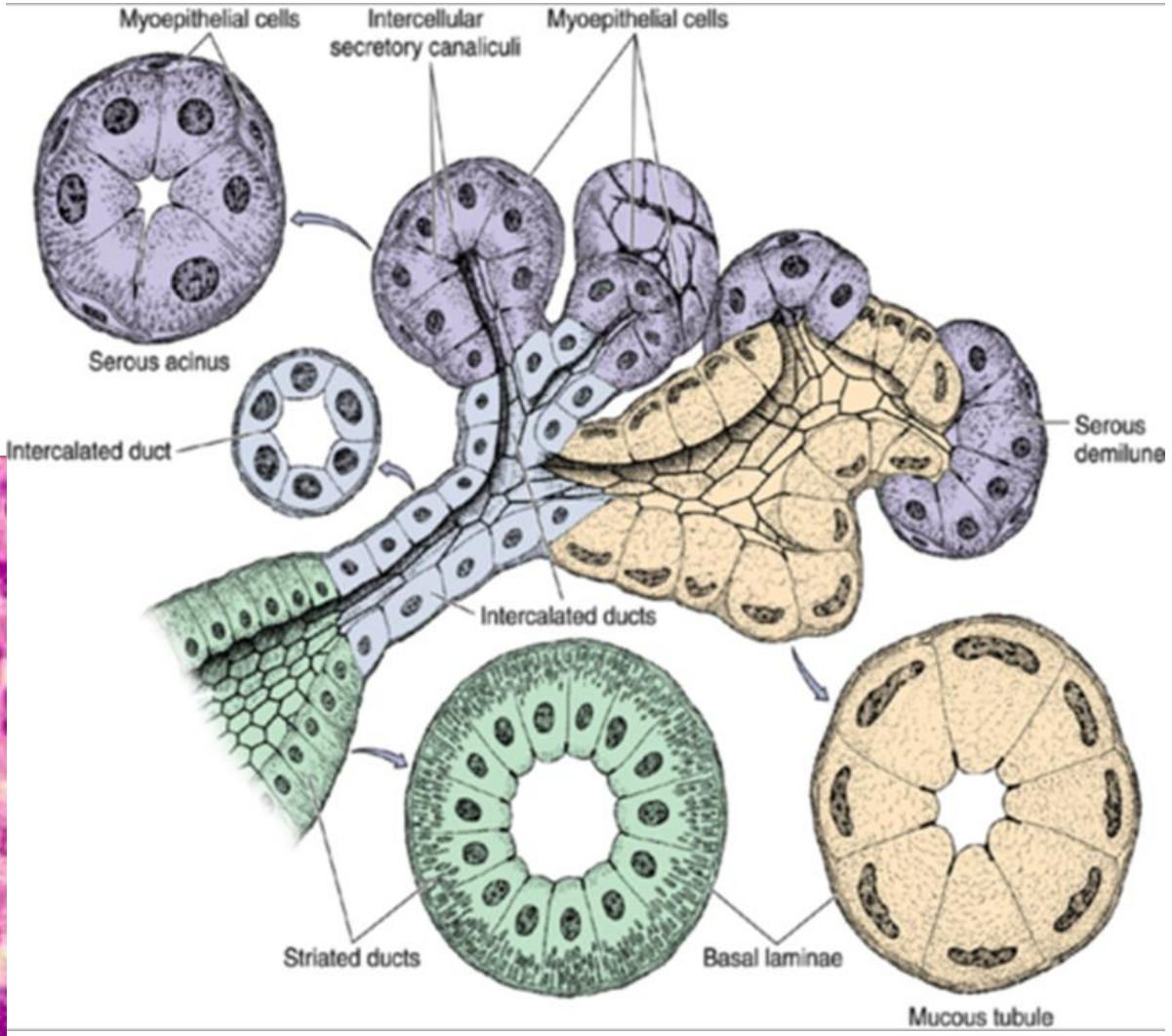




Serous cells

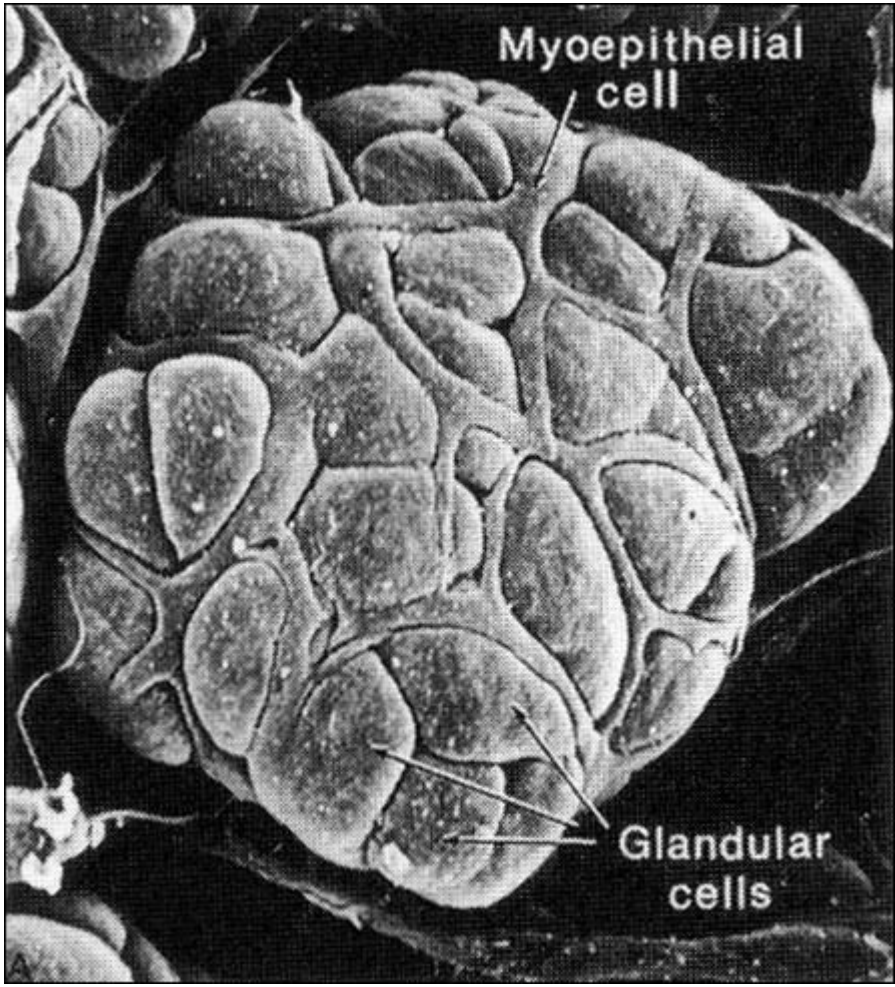
- have single, round, basally (centrally) located nuclei

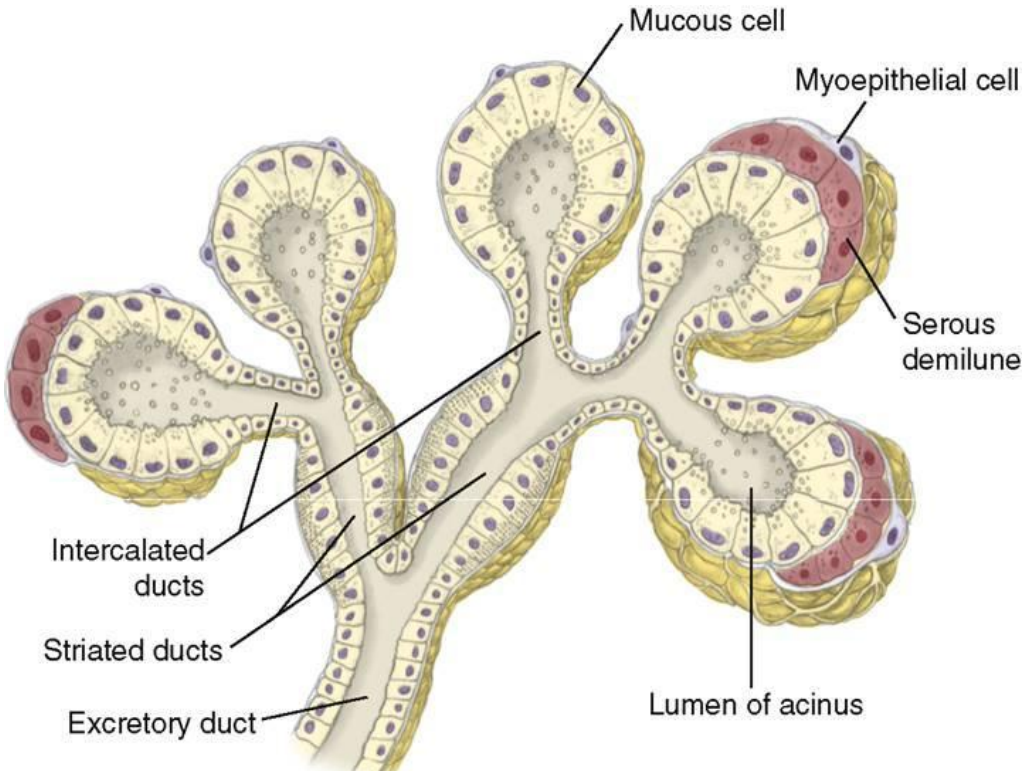




Myoepithelial cells (basket cells)

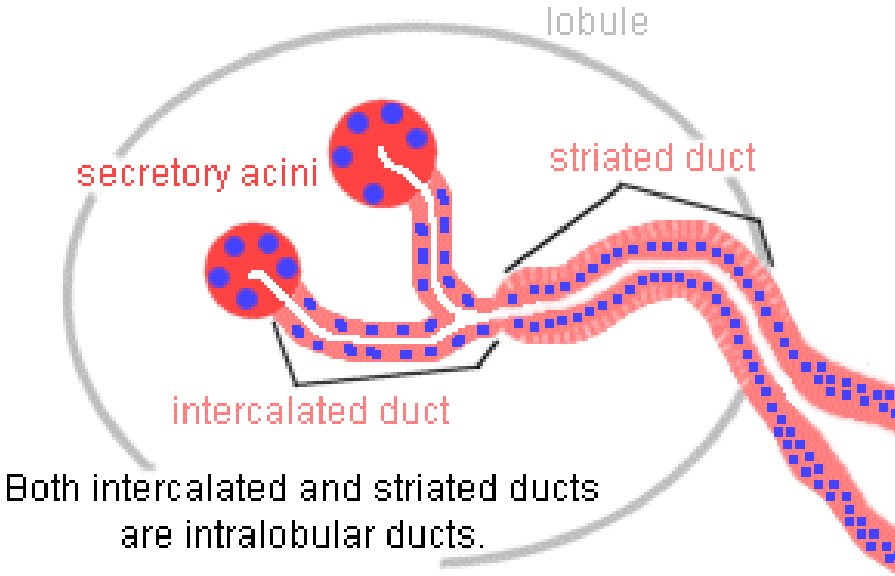
- have long processes (rich in actin and myosin) that envelope the acinus
- contraction of processes facilitate releasing of the secretory product from the acinus into the duct of the gland

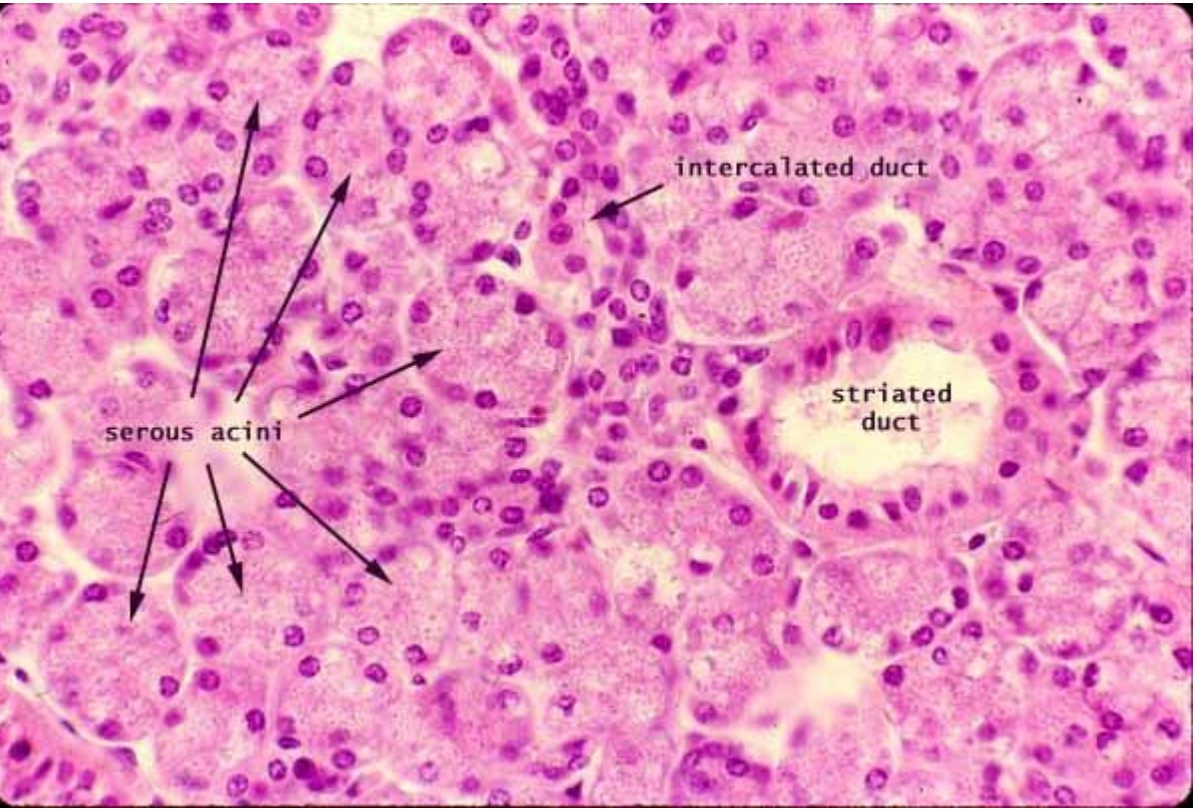




Ducts of salivary glands

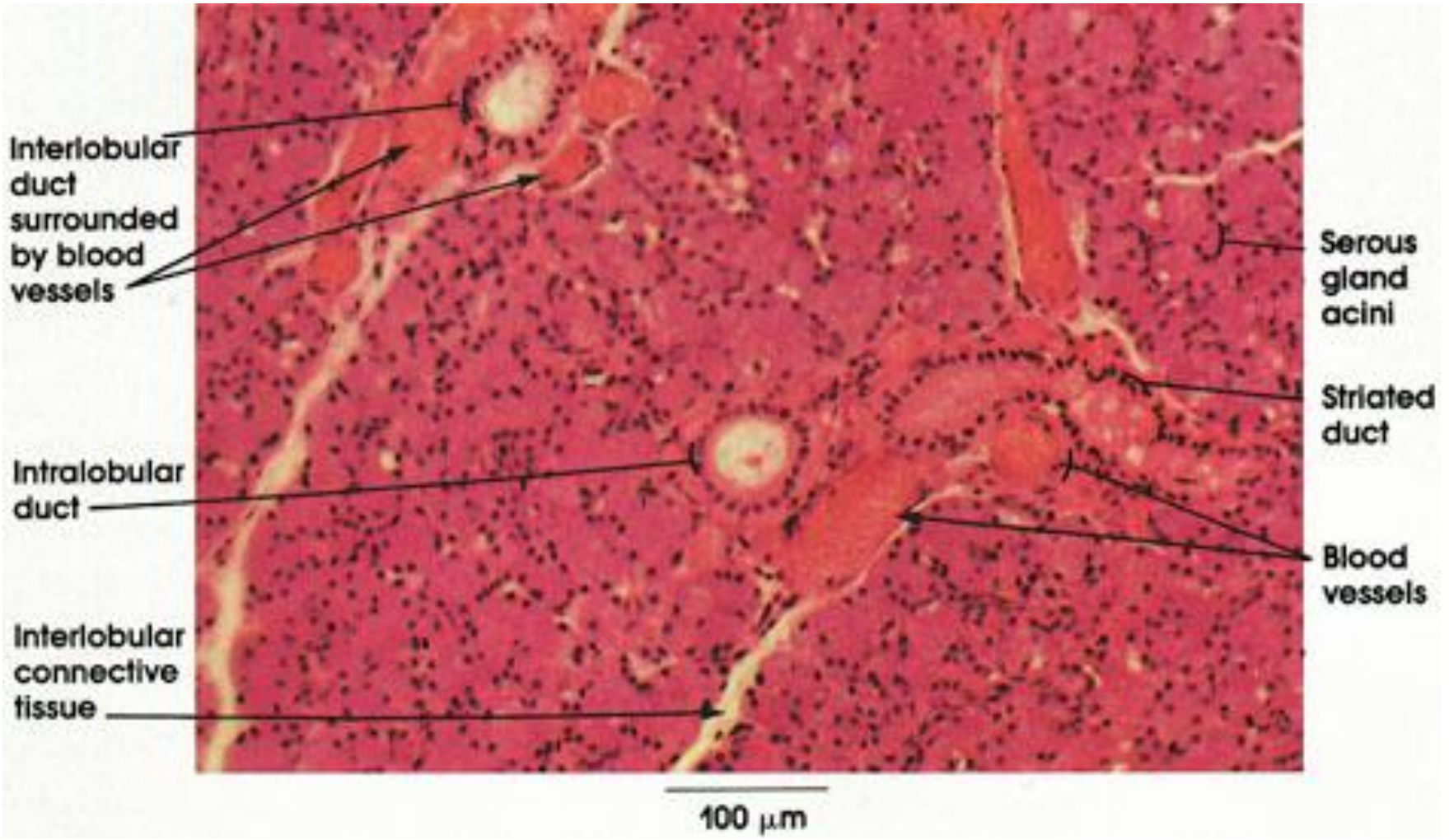
- are highly branched
- the smallest branches – **intercalated ducts** (are attached to the acini) –composed of simple cuboidal epithelium – contain myoepithelial cells
- **intercalated ducts** merge with each other to form **striated ducts**





striated duct

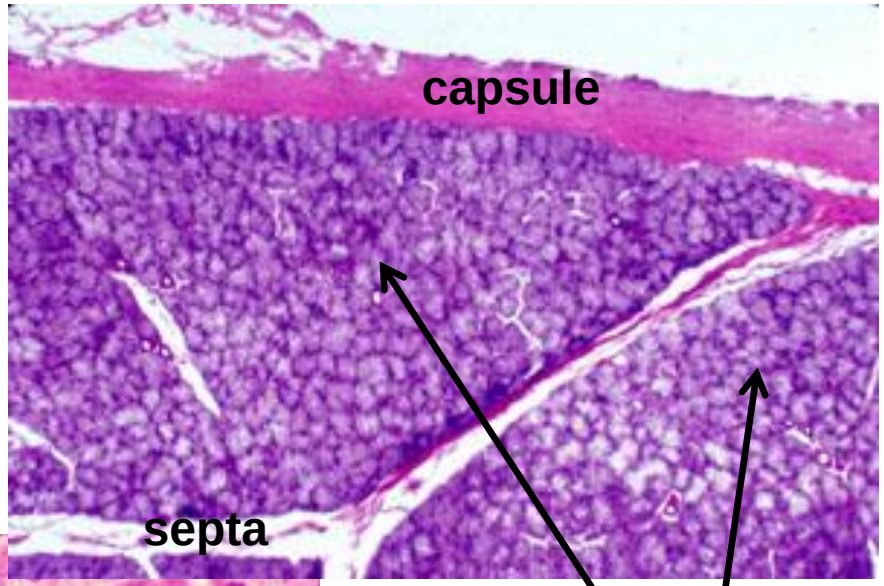
- characteristic striations in the basal portions of the cells which are due to the alignment of mitochondria between deep infoldings of the basal cell membrane

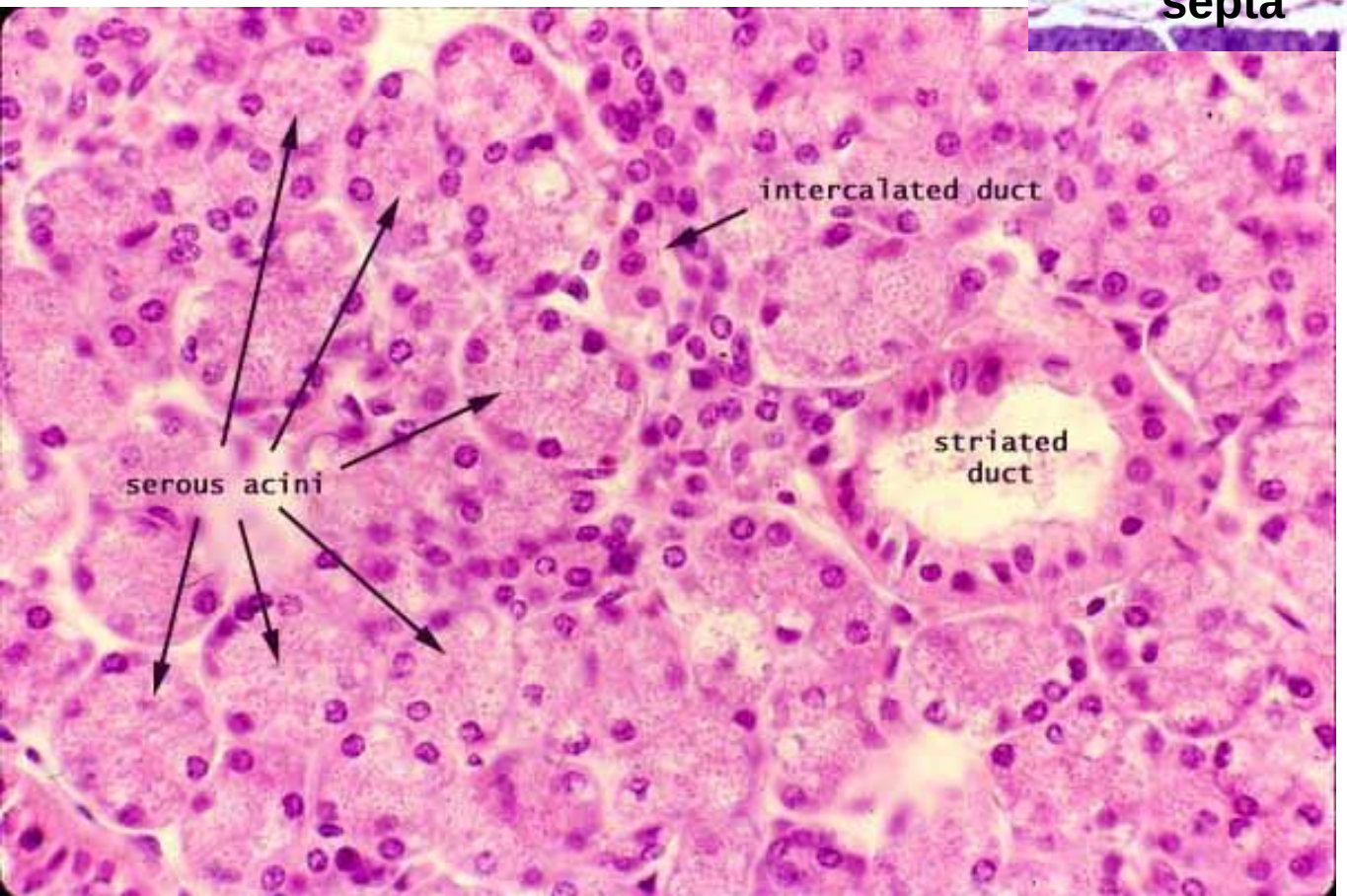


Striated duct join with each other to form **intralobular ducts**
Intralobular ducts increase the caliber and form **interlobular ducts**
Terminal (principal) duct delivers the saliva into the oral cavity

Parotid gland

- the largest of the salivary gland,
- produces only about 30% of the saliva
- surrounded by capsule (which form numerous septa that dvide the gland into lobes)
- **mainly serous salivary gland**



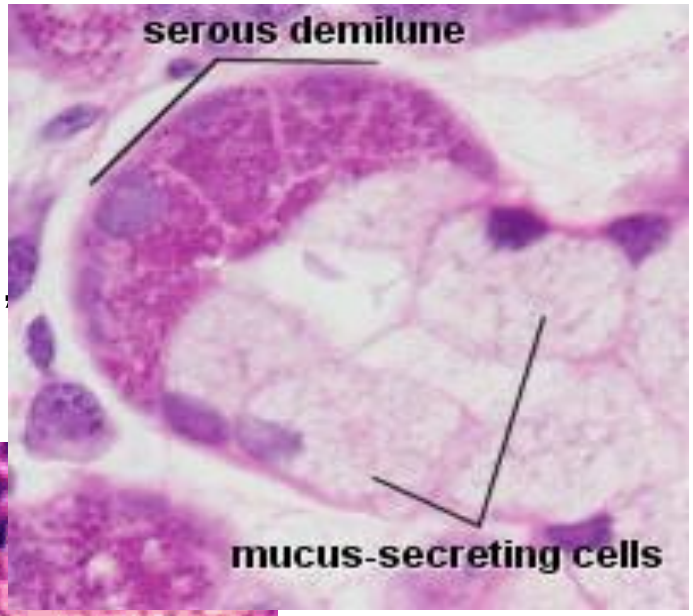


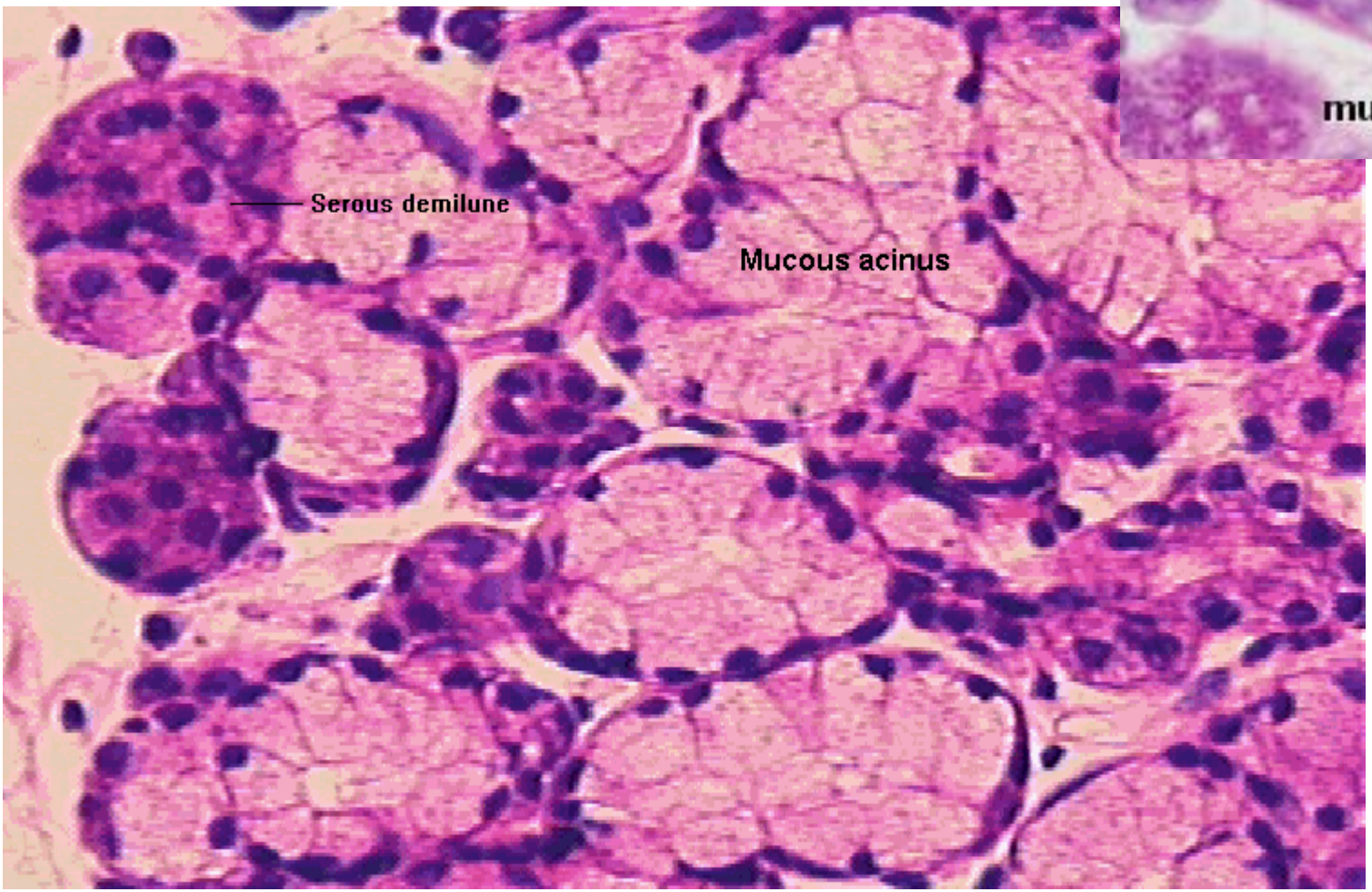
Sublingual gland

- the smallest of the major salivary gland
- is composed mostly of mucous acini

with **serous demilunes** (small claster of serous cells),

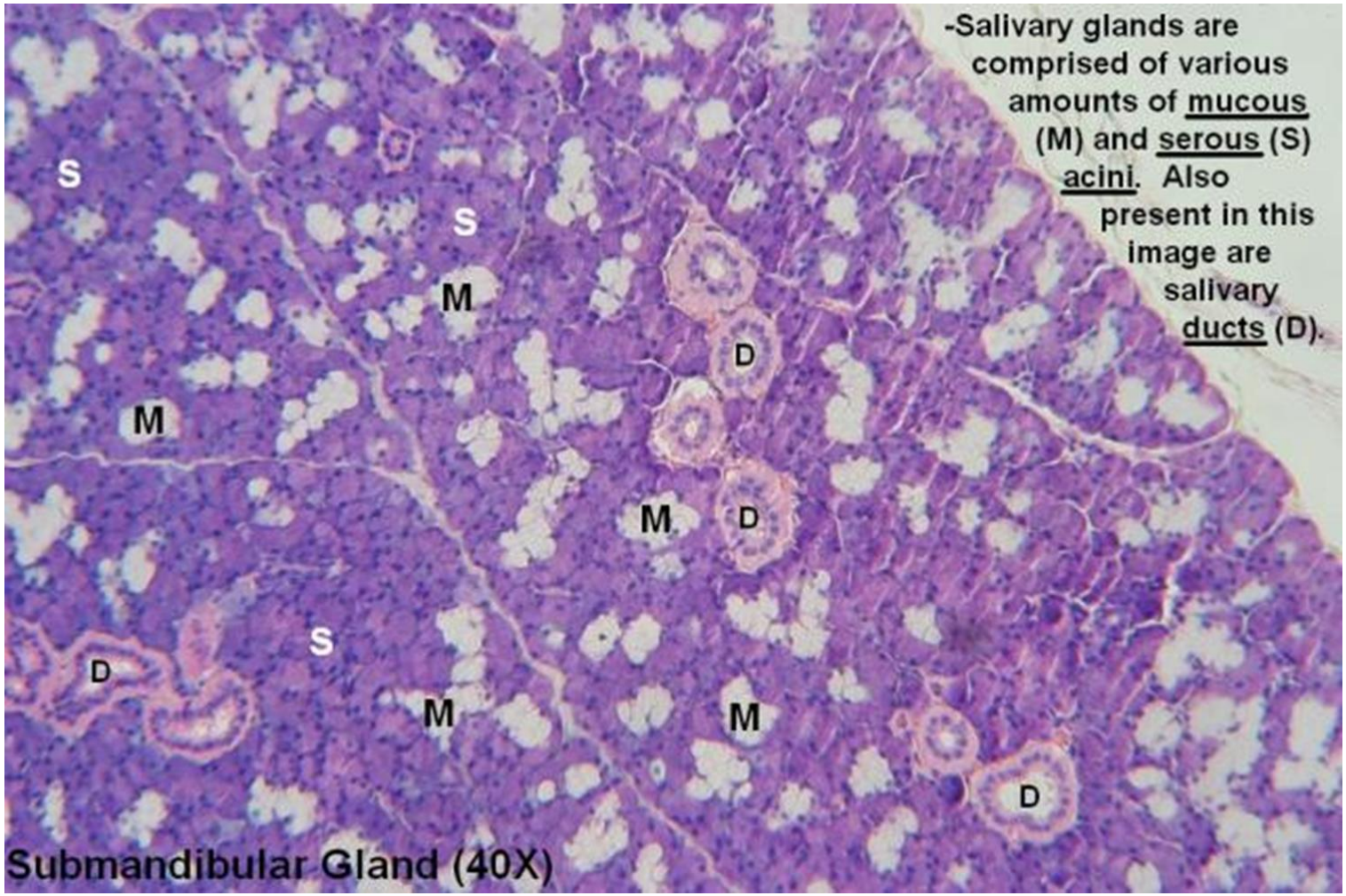
- produces a **mixed (**but mostly mucous) **saliva**.



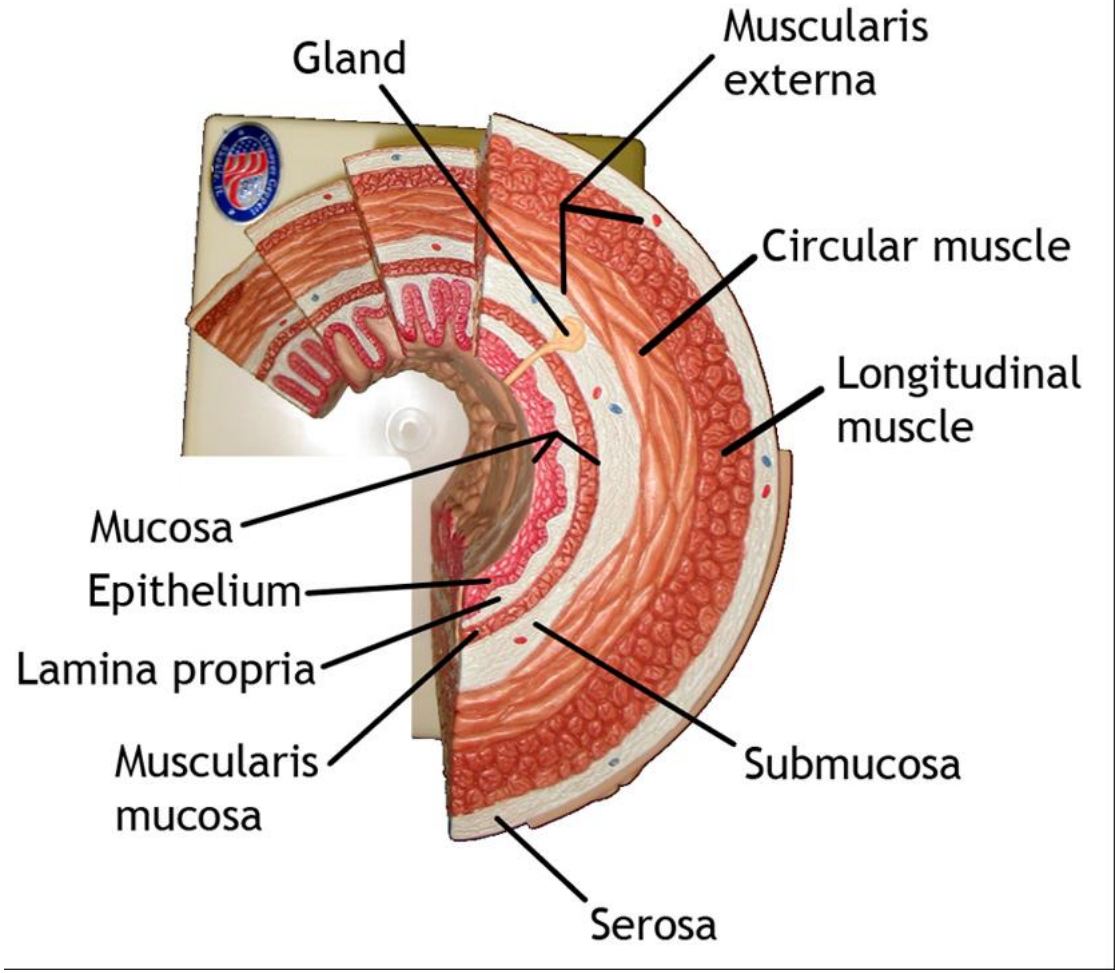


Submandibular gland

- produces 60% of the total salivary output
- is composed of either serous or mucous cells but 90% of the acini produce **serous saliva**

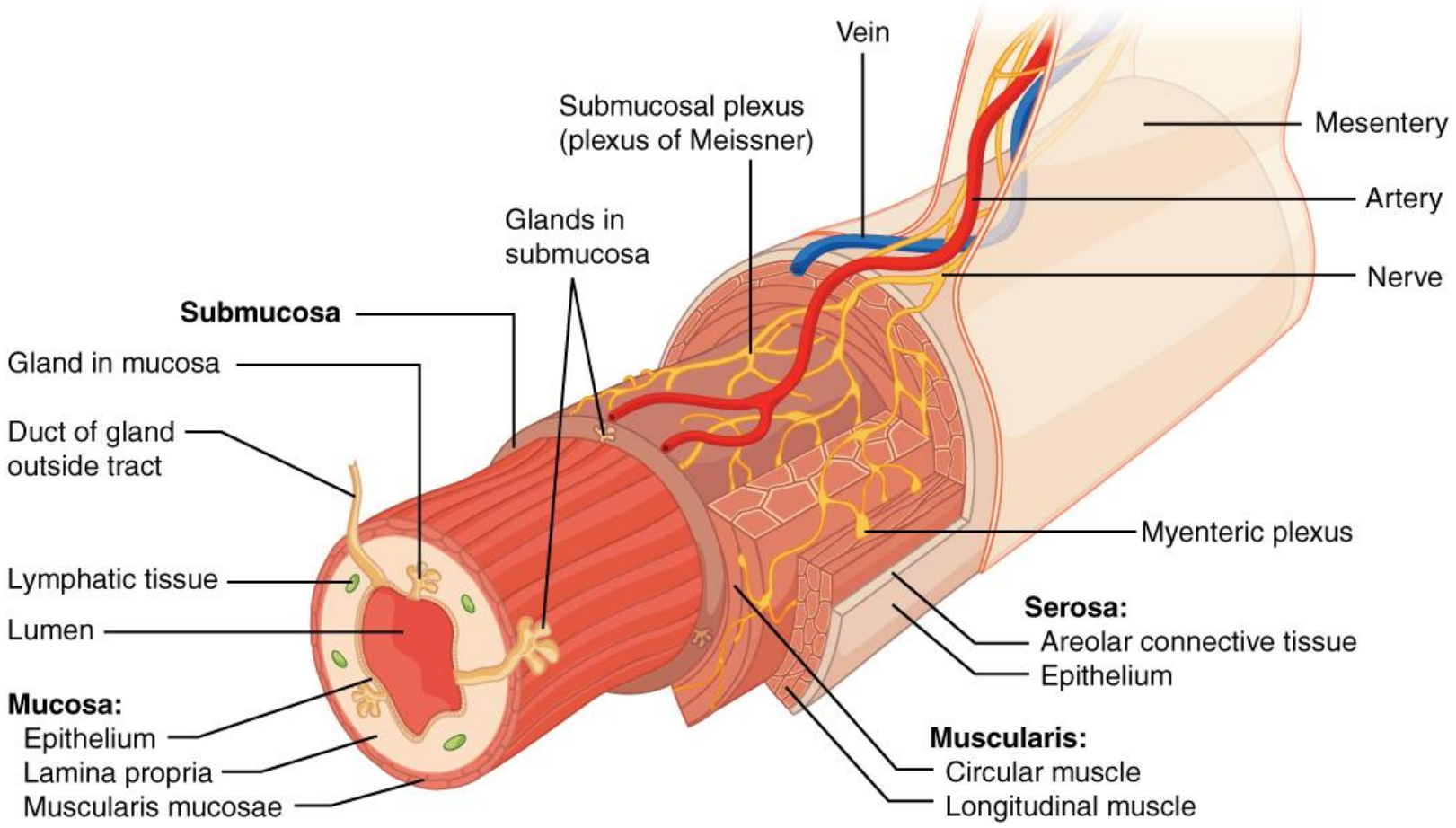


The wall of alimentary canal



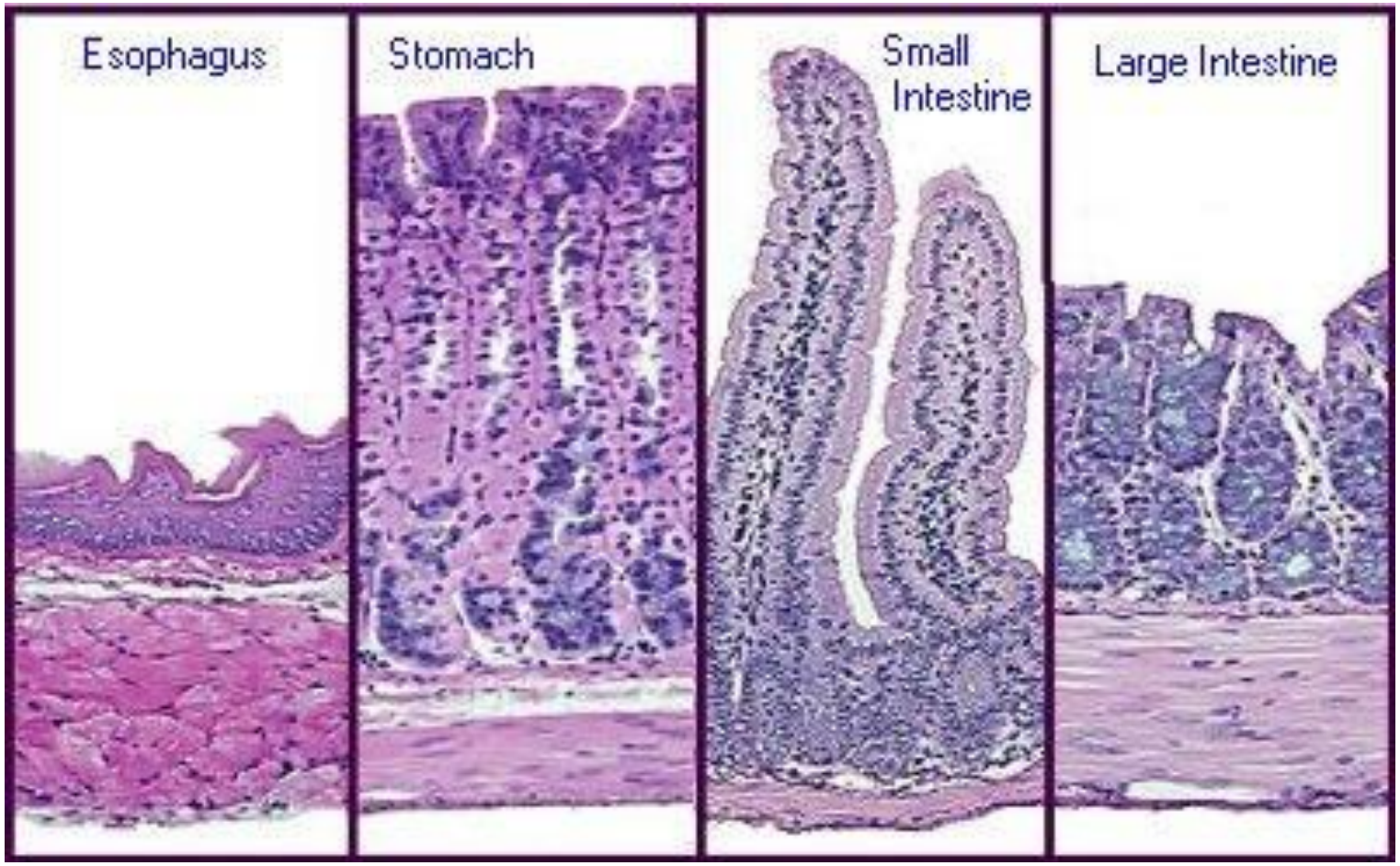
- is composed of four broad layers:
- **the mucosa,**
- **submucosa,**
- **muscularis externa, and**
- **serosa (or adventitia).**

The wall of alimentary canal



Mucosa - epithelium, lamina propria (glands), and muscularis mucosae
Submucosa - connective tissue layer (has no glands **except in the esophagus and duodenum)**
Muscularis externa - responsible for **peristaltic activity,** which moves the contents of the lumen along the tract.

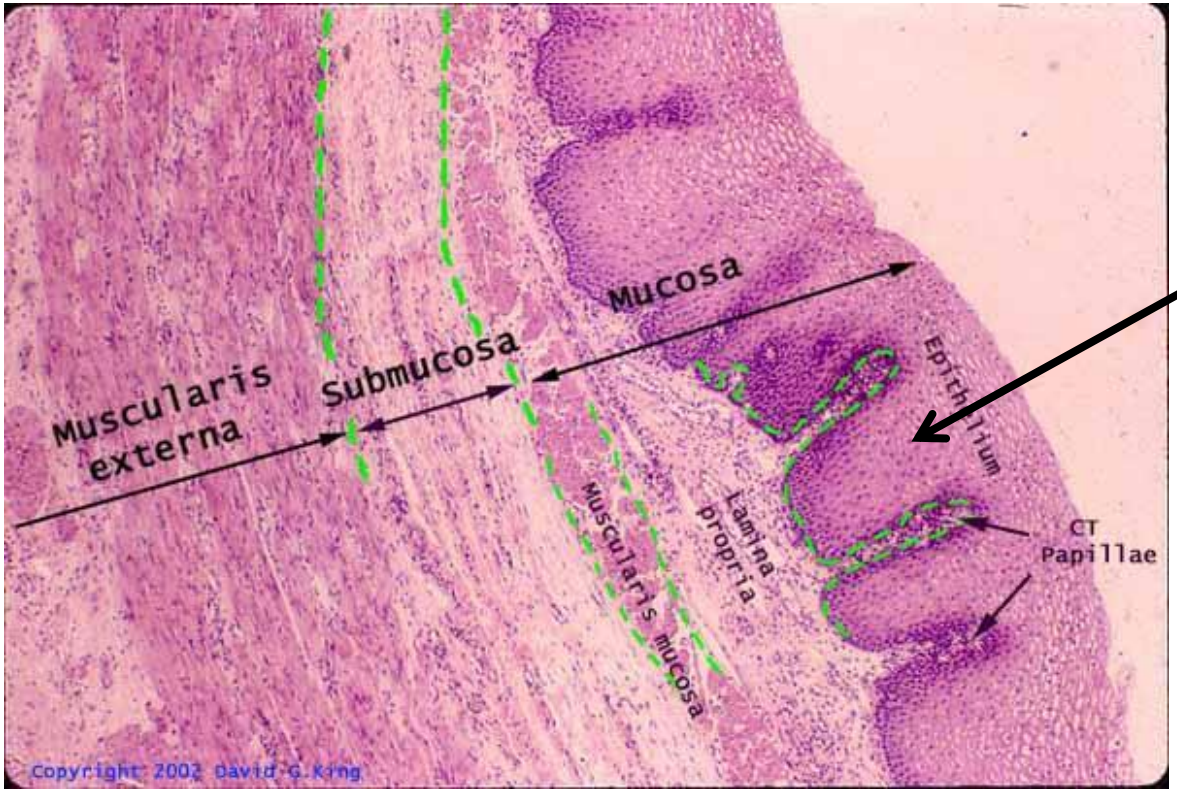
The wall of alimentary canal



- layers are similar throughout the length of the digestive tract but display regional modifications and specializations

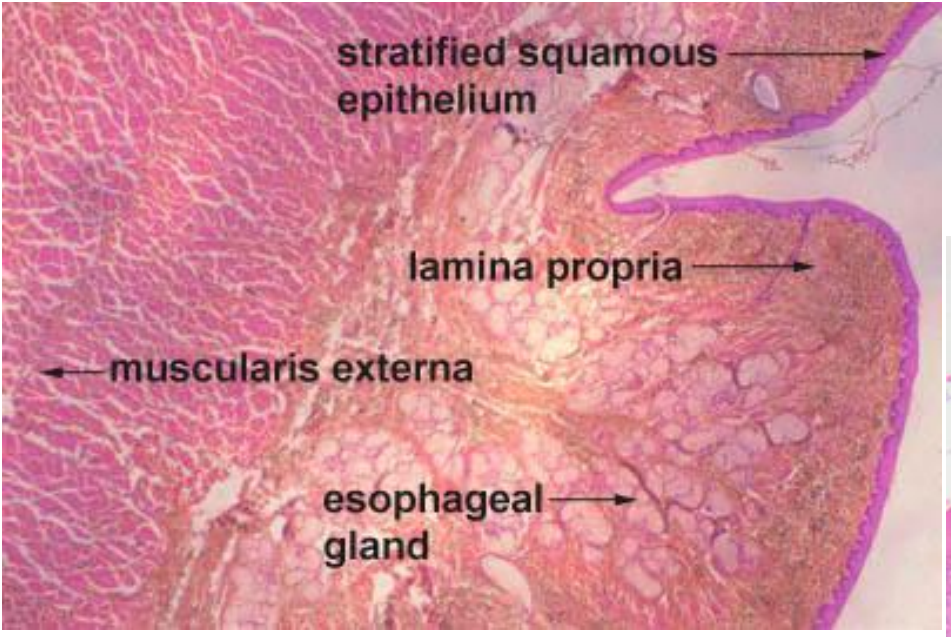
Esophagus

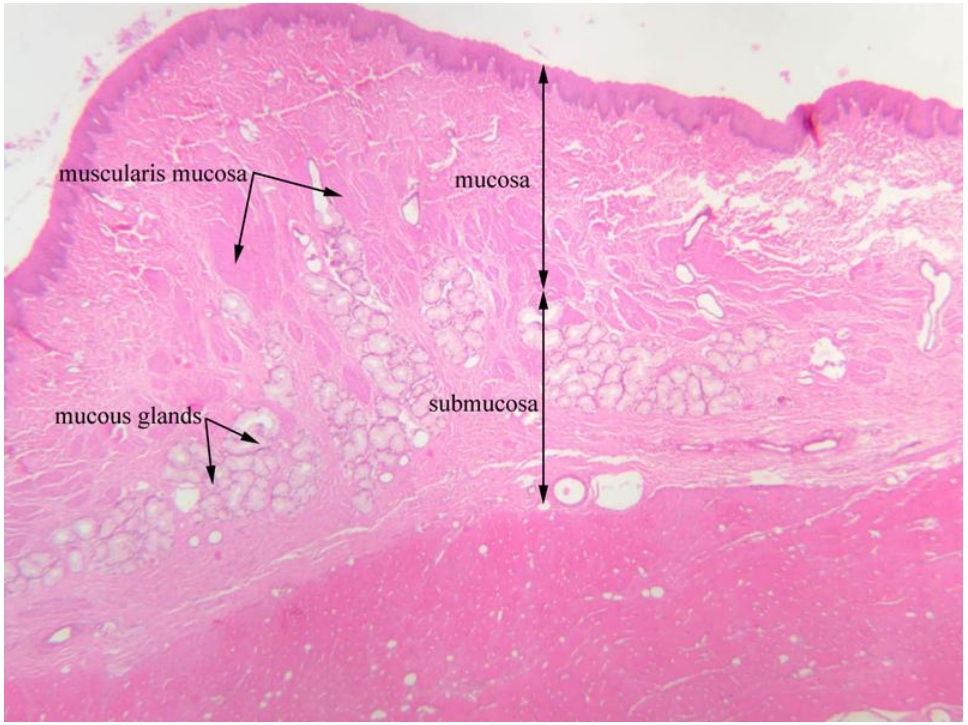
- conveys the masticated food (bolus) from oral cavity to the stomach



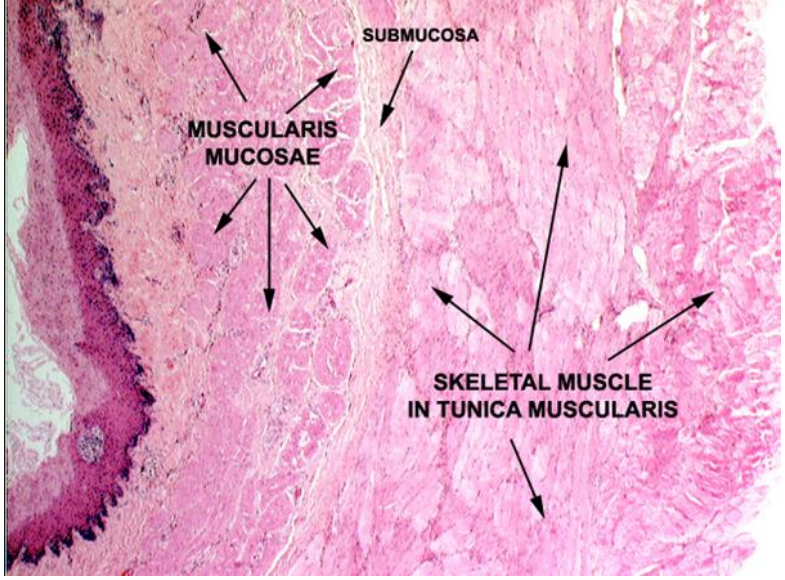
Stratified squamous nonkeratinized epithelium

Mucosa (Stratified squamous nonkeratinized epithelium, lamina propria and muscularis mucosae)
Submucosa
Muscularis
Part of the esophagus present in the peritoneal cavity is covered by **serosa**, the rest by **adventitia**.

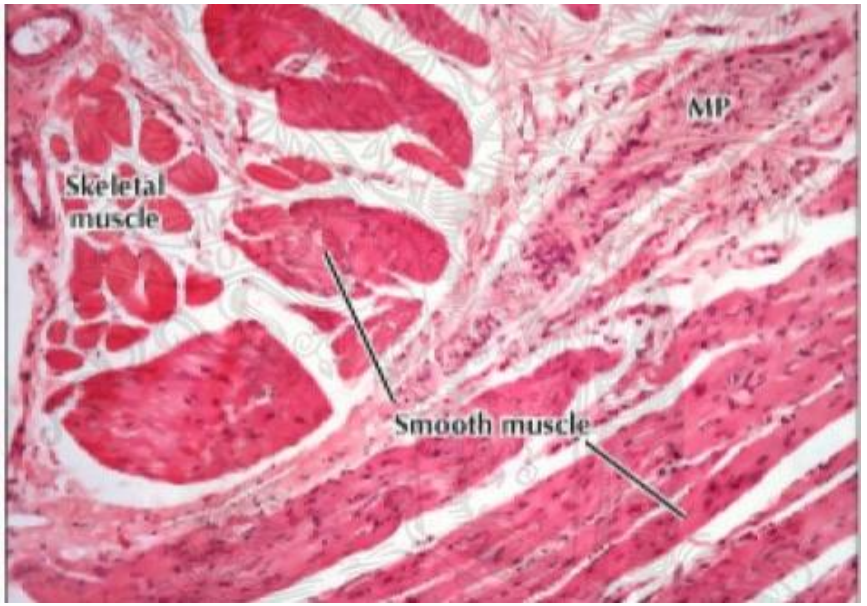


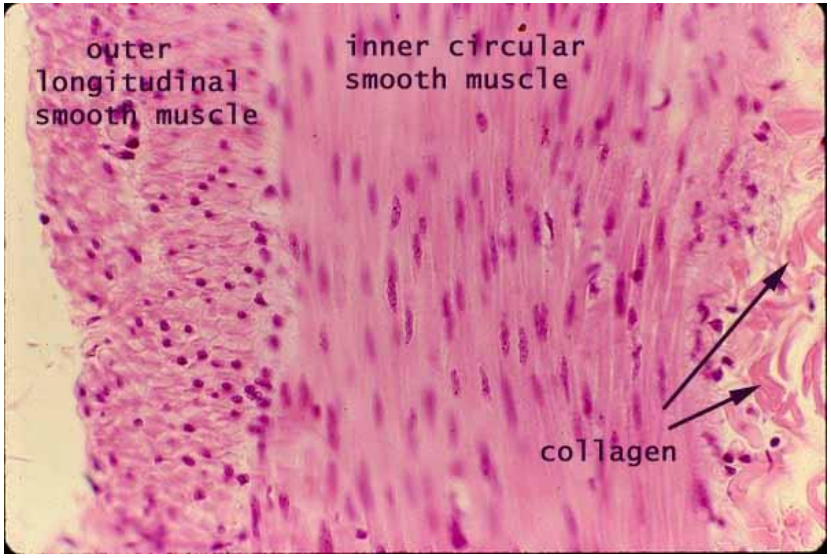


Lamina propria – only in two regions of esophagus: near the pharynx and stomach --esophageal **cardiac glands** secrete mucus.
Submucosa - esophageal **glands proper** contains mucus and serous cells (only esophagus and duodenum contain glands located in submucosa).

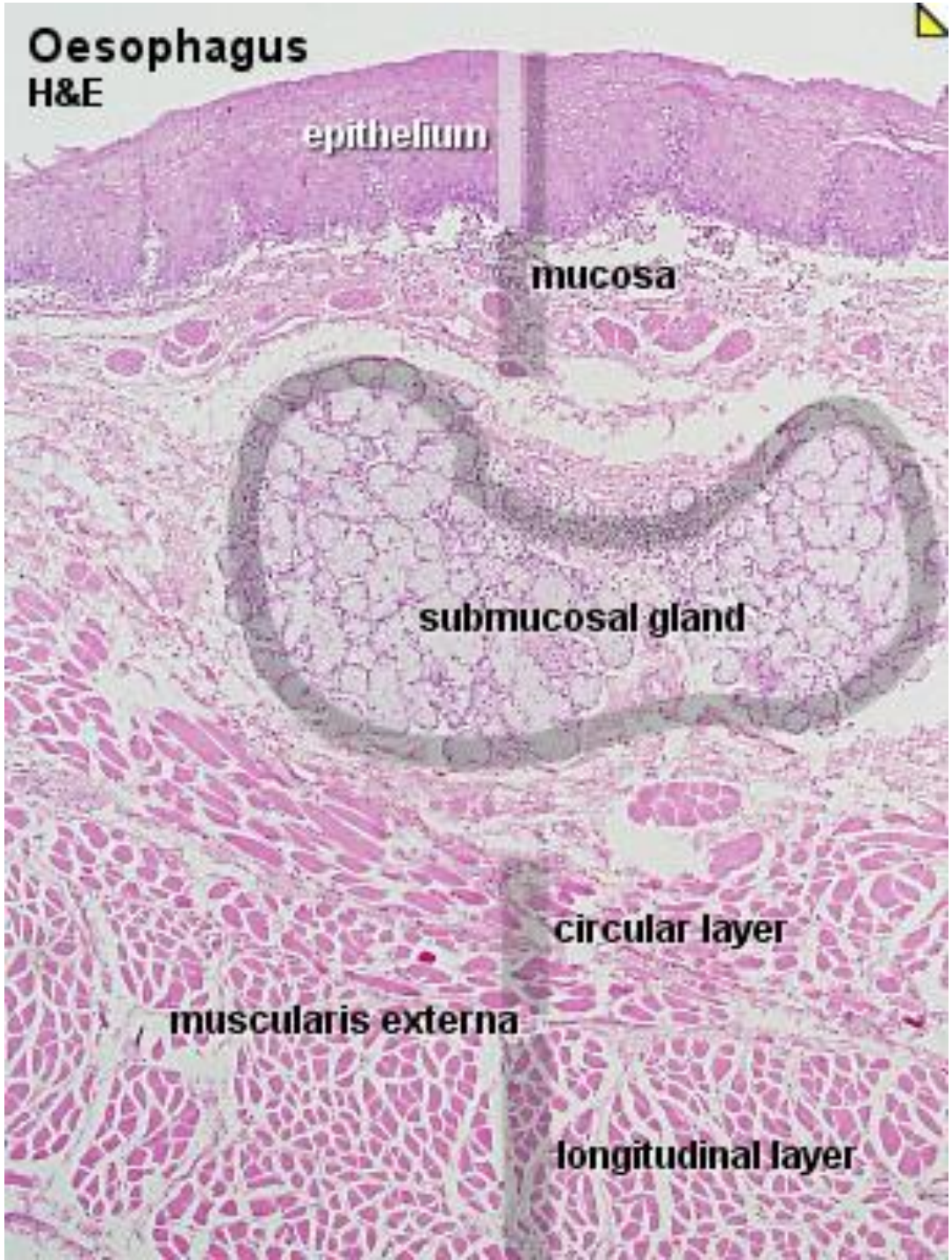


The muscularis externa of the esophagus

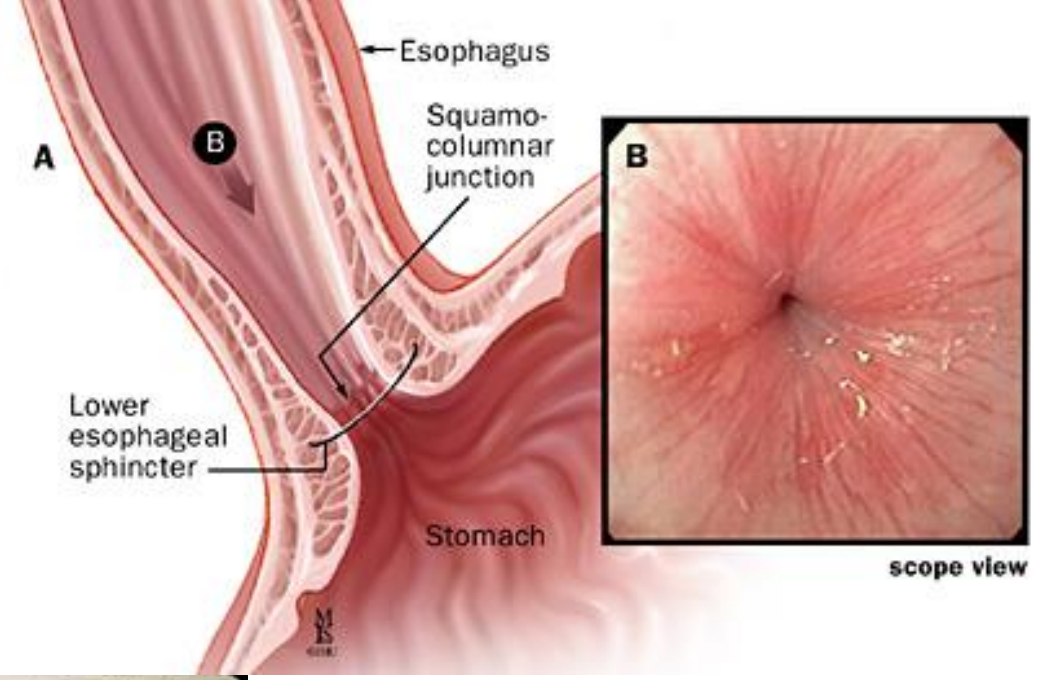




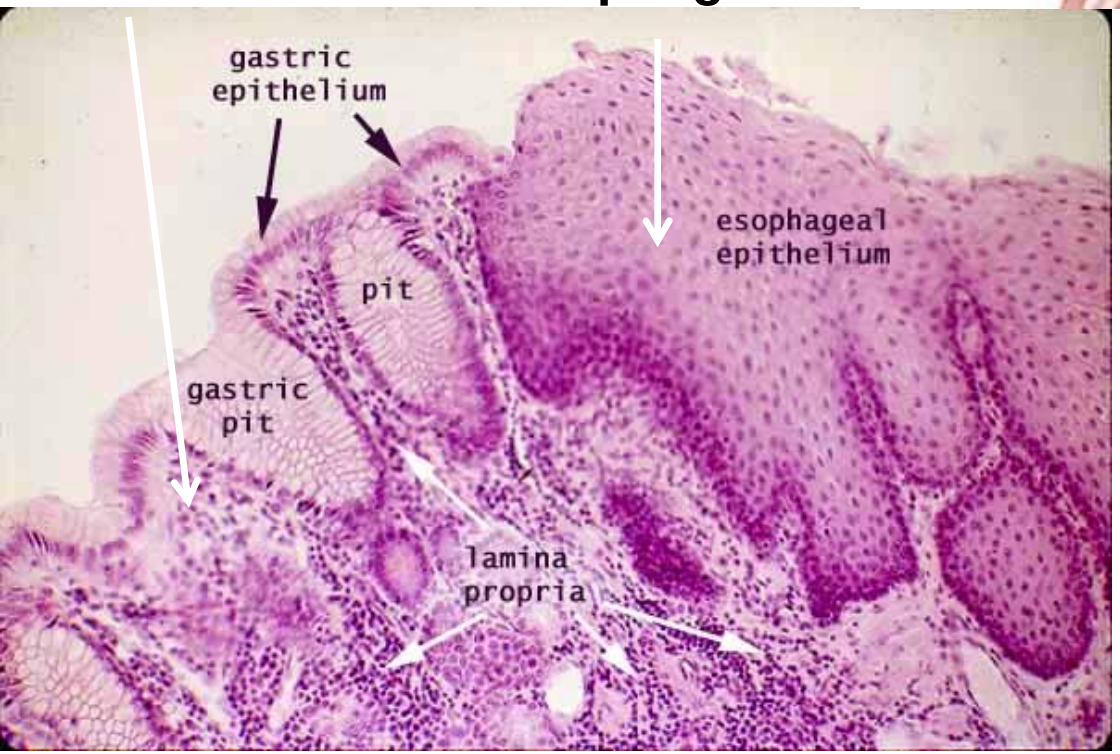
The muscularis externa of the upper third of the esophagus is composed of *skeletal* muscle the middle third has both skeletal and smooth muscle, the lowest third has only smooth muscle (arranged in two layers: inner circular and outer longitudinal)

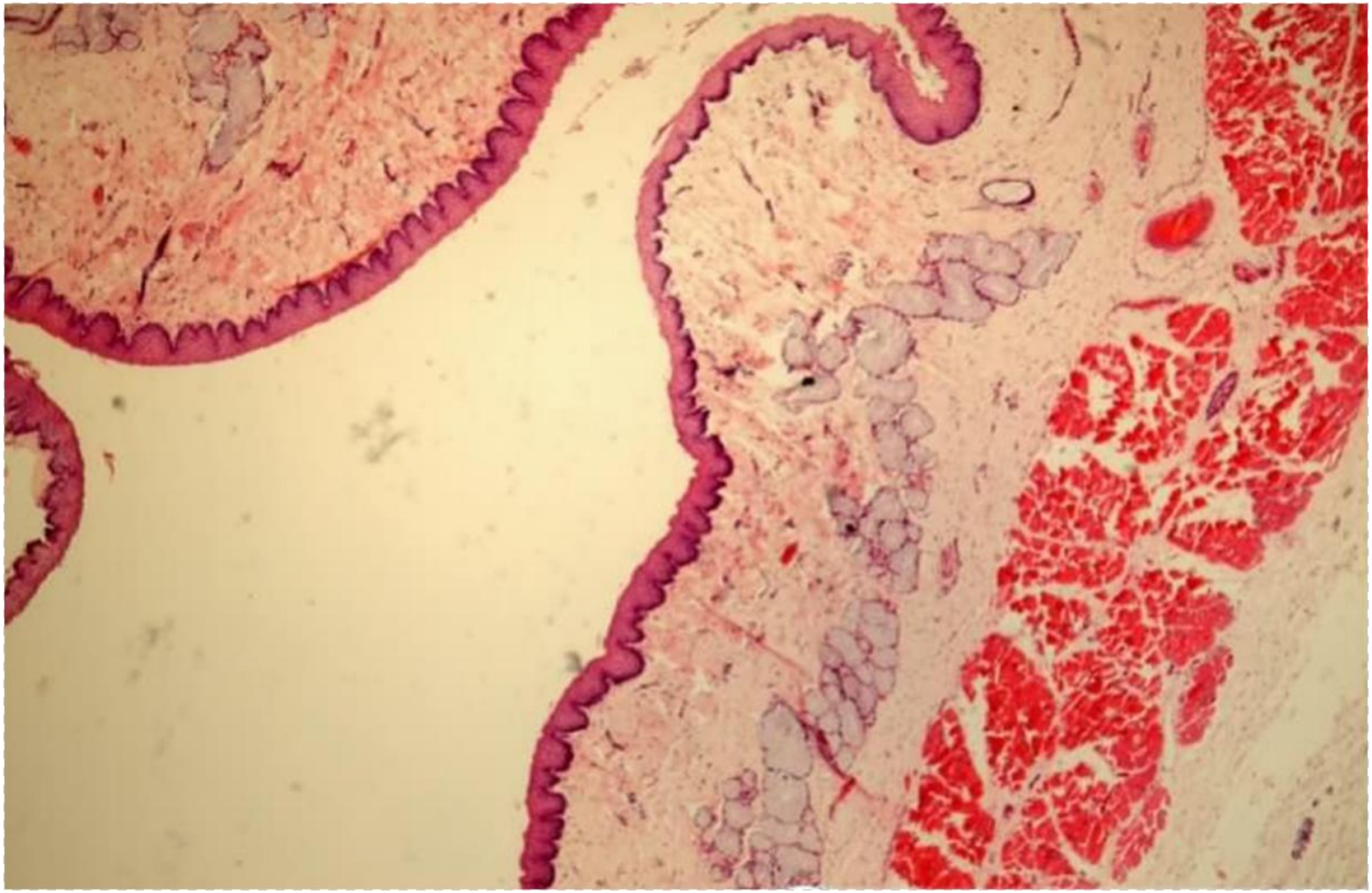

Oesophagus
H&E
epithelium
mucosa
submucosal gland
circular layer
muscularis externa
longitudinal layer

Oesophagogastric junction



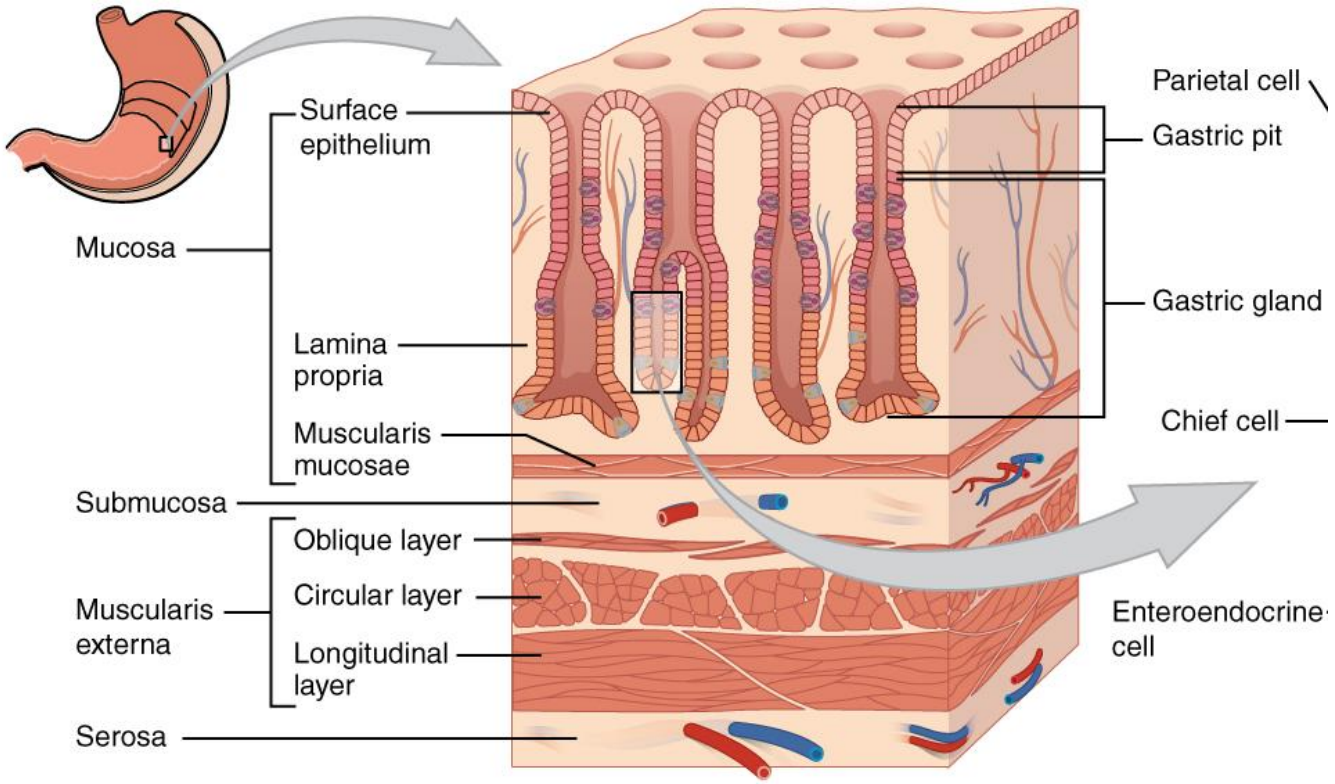
stomach **esophagus**





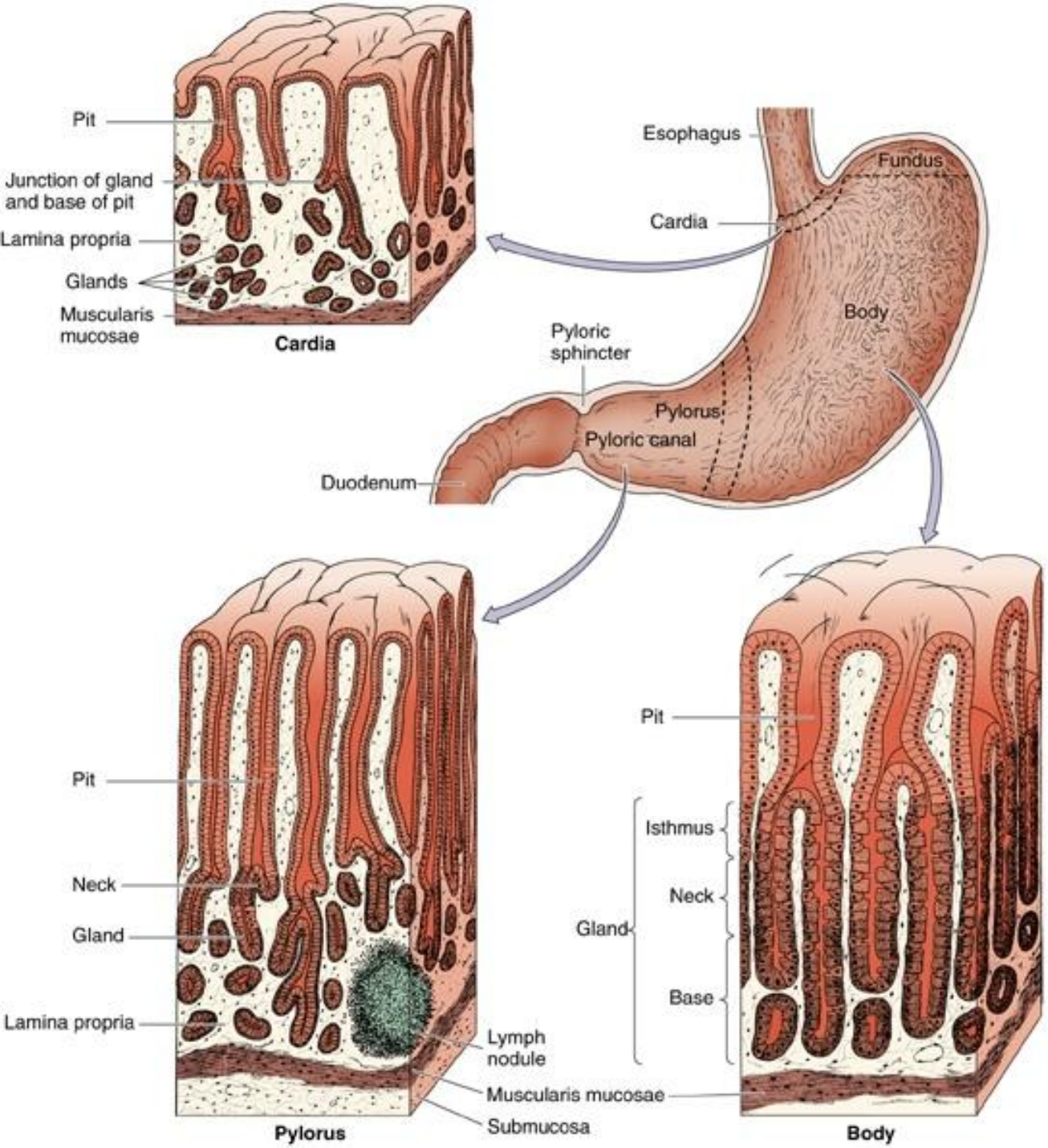
STOMACH - The most dilated region of the alimentary canal

Formation and processing of the ingested food into an acidic fluid – **chyme**.



Mucosa – epithelial lining invaginates into mucosa forming gastric pits. Lamina propria houses gastric glands.

Muscularis externa - composed of three layers of smooth muscle cells: innermost – oblique, middle circular and outer longitudinal



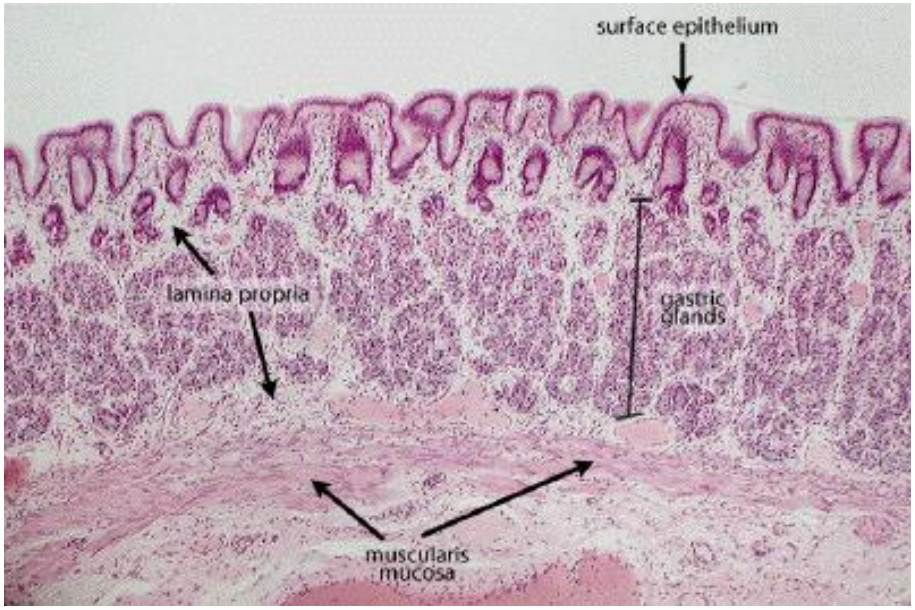
Regions of the stomach and the histological structure of mucosa

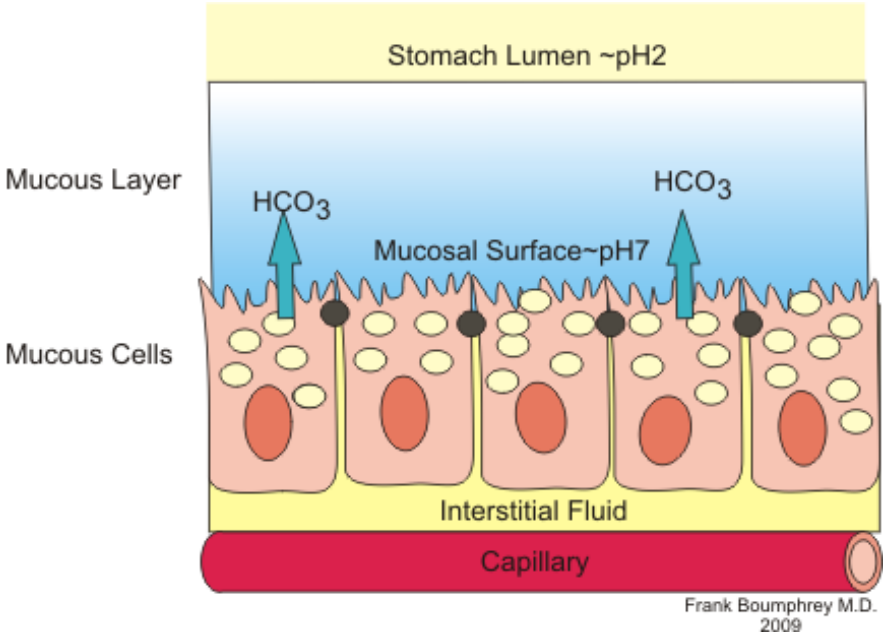
CARDIAC GLANDS contain mostly surface-lining cells which produce a thick, visible mucus, some mucous neck cells which produce soluble mucus, regenerative cells, DNES cells and a few parietal cells (no chief cells).

PYLORIC GLANDS contain the same cell types as the cardiac glands but predominant are the mucous neck cells, which beside mucus, produce – lysozyme – bactericidal enzyme.

STOMACH - MUCOSA

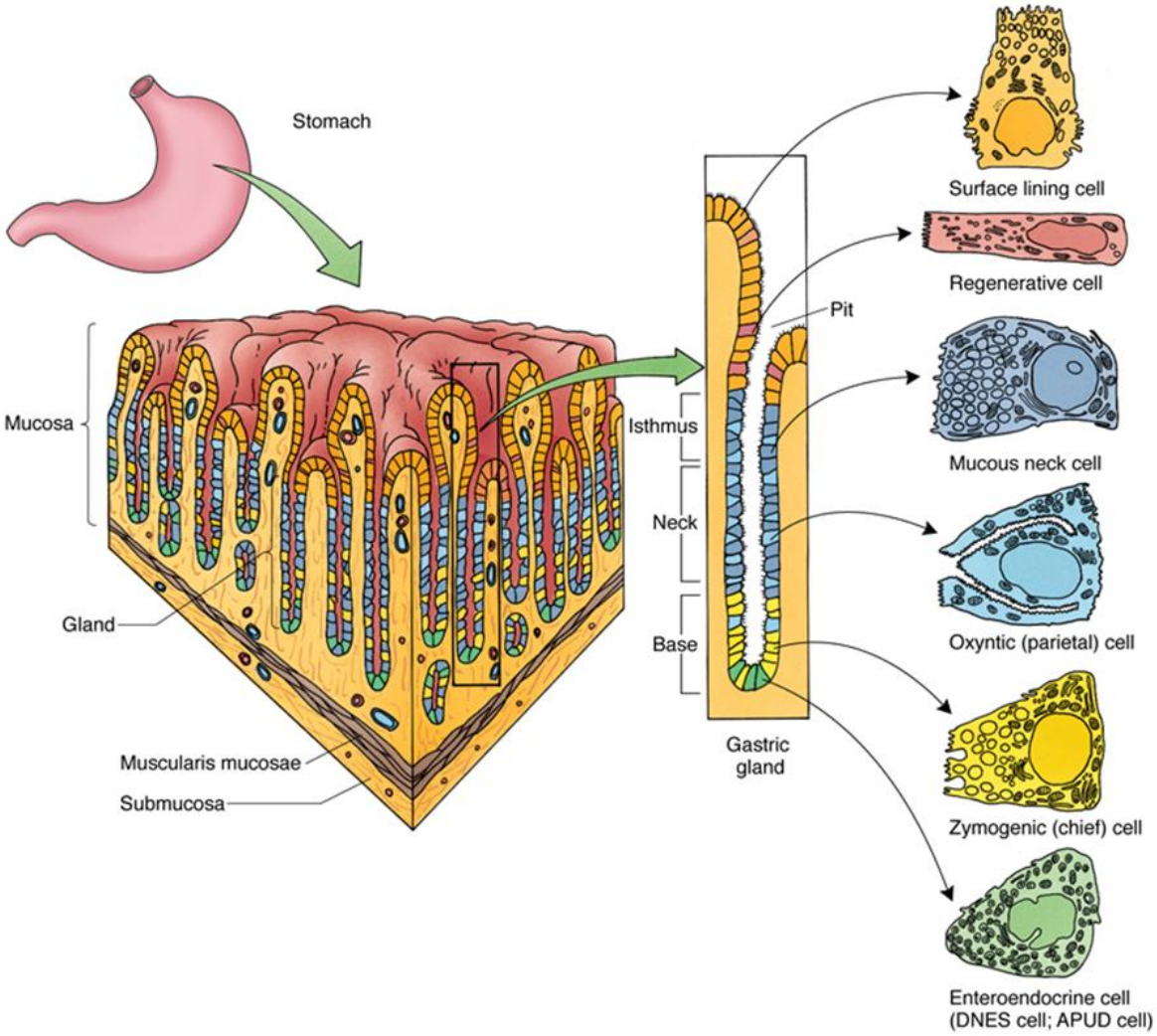
- liquefies the food, continuing its digestion via the production of **hydrochloric acid** and the enzymes **pepsin, rennin,** and **gastric lipase** and via production of paracrine hormones.





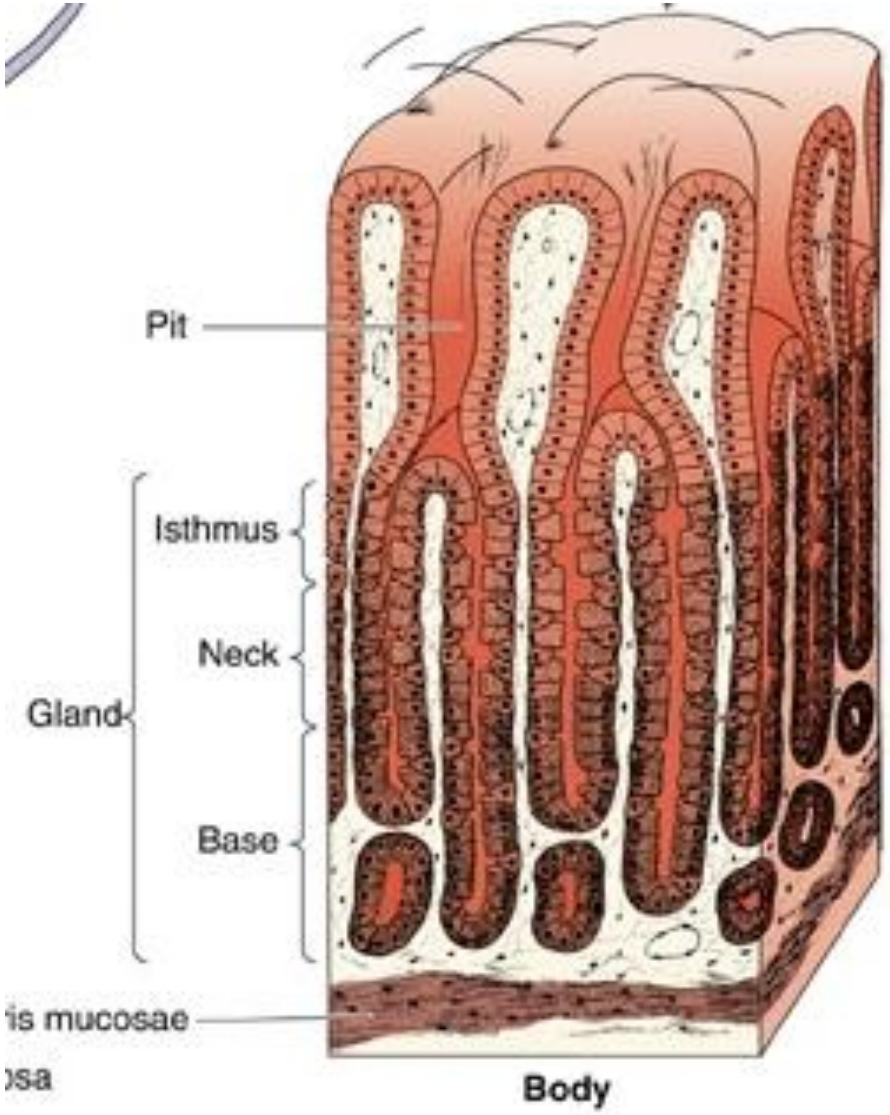
- simple columnar epithelium composed of **surface-lining cells** producing a thick mucus layer - **visible mucus**. This gel –like substance containing trapped bicarbonate ions adheres to the epithelium - protects it from autodigestion and maintains neutral pH.

STOMACH - MUCOSA



Lamina propria - gastric glands - **fundic glands** with simple columnar epithelium consisting of six cell types: surface lining cells, **parietal** cells, **regenerative**(stem) cells, **mucous neck** cells, **chief** cells, and **diffuse neuroendocrine system** (DNES) **cells**

STOMACH



FUNDUS AND BODY

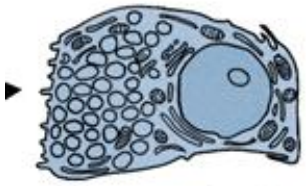
Gastric (fundic) glands contain:

Isthmus - surface lining cells and few DNES cells

Neck - mucous neck cells, stem cells, **parietal cells** and few DNES cells

Base - chief cells, occasionally parietal and few DNES cells.

DNES cells are dispersed in these three regions

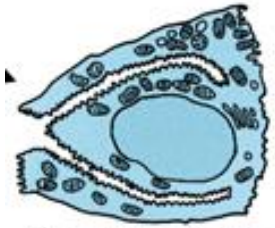


Mucous neck cell

Produce soluble mucus mixed with and lubricates the chyme, reducing friction as it moves along the digestive tract.

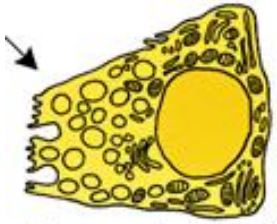
Regenerative cell

Proliferate to replace all of the specialized cells of stomach epithelium every 5-7 days.



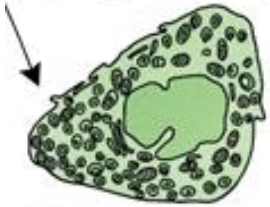
Oxyntic (parietal) cell

Manufacture hydrochloric acid and gastric intrinsic factor



Zymogenic (chief) cell

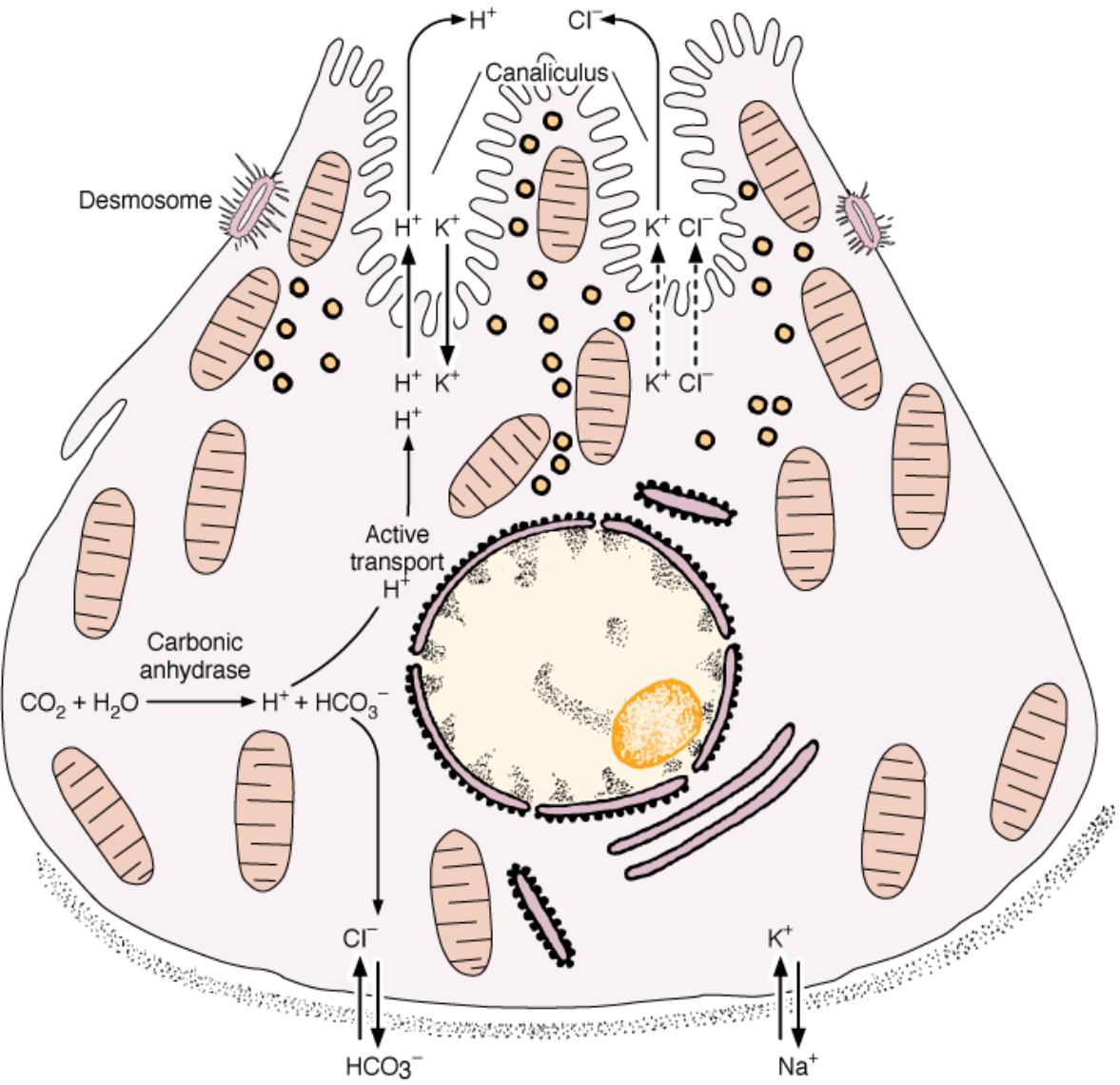
Manufacture the enzymes: pepsinogen, rennin and gastric lipase.



Enteroendocrine cell
(DNES cell; APUD cell)

Manufacture endocrine, paracrine and neurocrine hormones (e. g. gastrin - G, histamine –ECL cells)

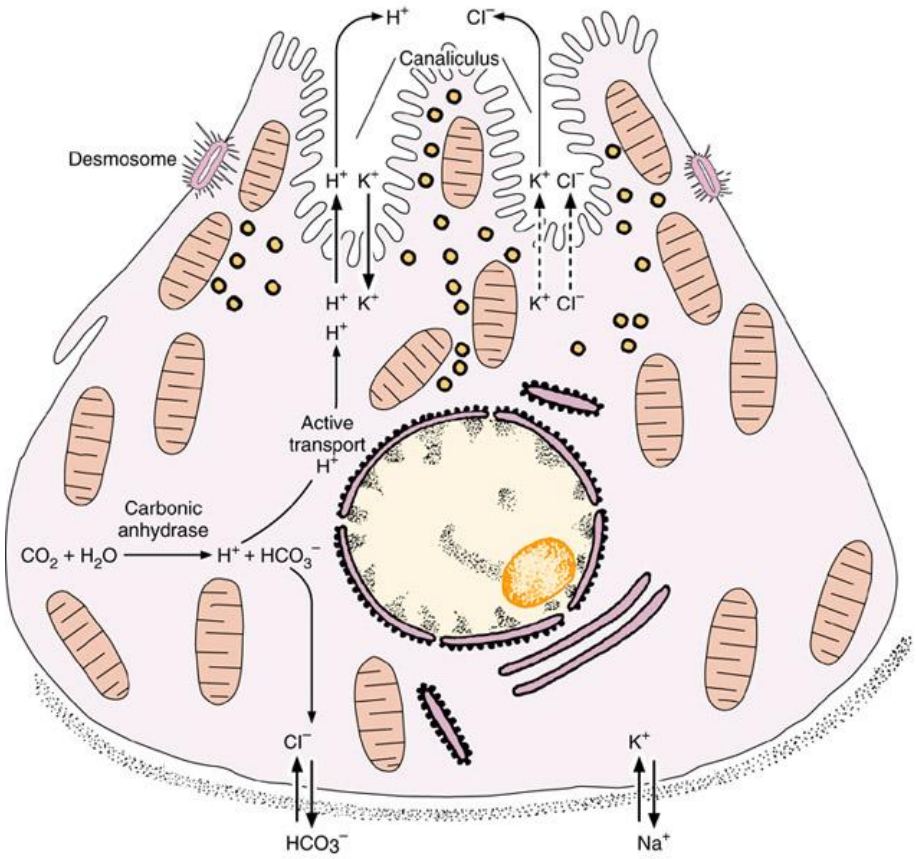
Parietal (oxyntic) cell contain:



- **canaliculi** from which the HCl is secreted by active transport (H^+ and Cl^- ions) into the stomach.
- **carbonic anhydrase** – catalyses formation of carbonic acid (H_2CO_3) from carbon dioxide and water. Carbonic acid dissociates into H^+ ions and bicarbonate ions (HCO_3^-).

- enzyme **hydrogen potassium ATPase (H^+/K^+ ATPase**) - transports the H^+ against a concentration gradient

Parietal (oxyntic) cell



Manufacture **hydrochloric acid (**breaks down food material and activates pepsinogen) and **gastric intrinsic factor (**necessary for vitamin B_{12} absorption in the ileum).

1. Carbonic anhydrase –catalyses formation of H^+ ions and bicarbonate ions.
2. H^+,K^+-ATPase – H^+ are pumped out of the cell, K^+ in.
3. The bicarbonate ions are exchanged for a chloride ions (Cl^-) and bicarbonate diffuse into the venous blood.
4. Cl^- ions are transported out of the cell by ion channels and the formation of HCl occurs.

Production of HCl is regulated by gastrin, histamine (increase) and gastric inhibitory peptide, somatostatin - inhibition.

STOMACH – FUNDIC GLANDS