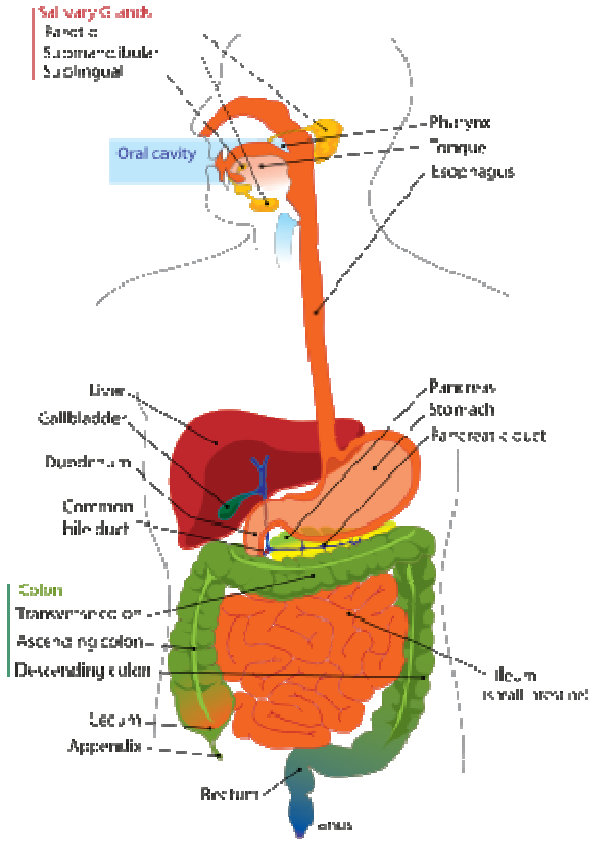
The digestive system

- **The digestive system comprises:**

I. The mouth or oral cavity (lips, cheeks, tongue, teeth and gums).

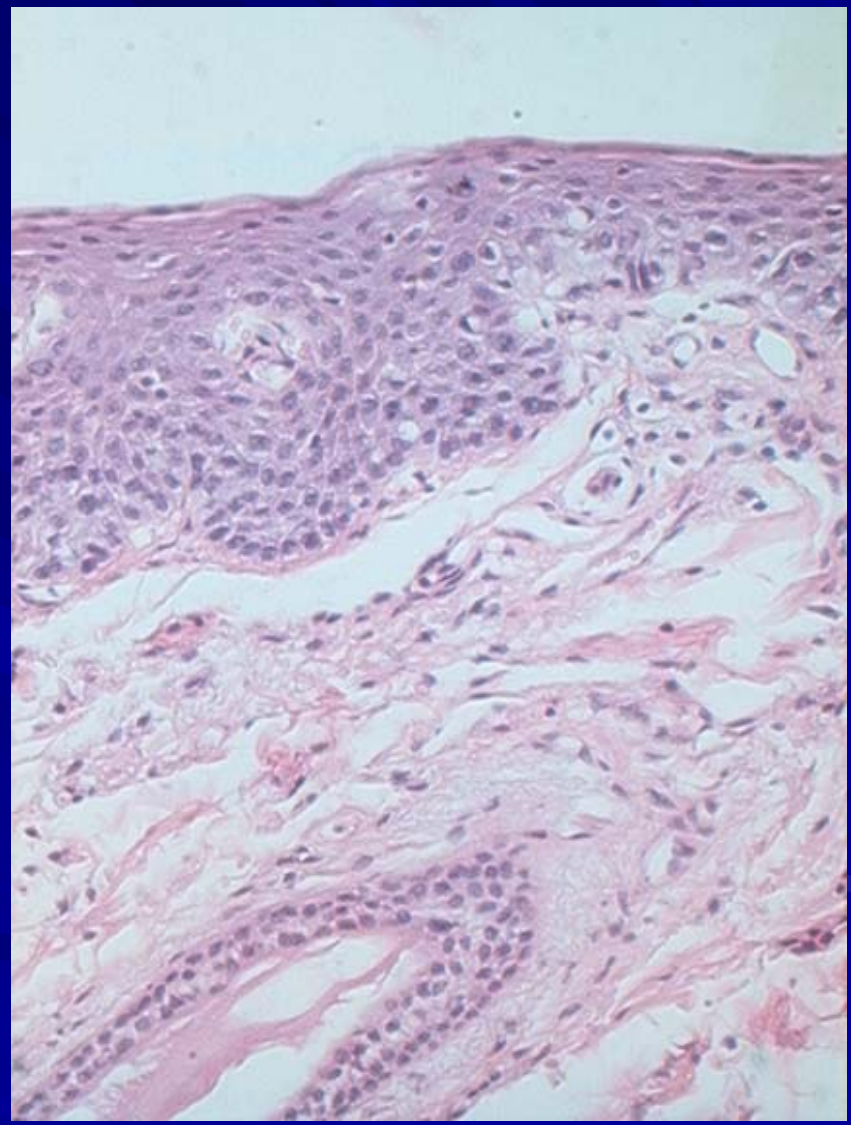
II. GIT (Gastro-intestinal tract) (pharynx, esophagus, stomach, intestine (small and large).

III. Associated glands (salivary glands, liver and pancreas).



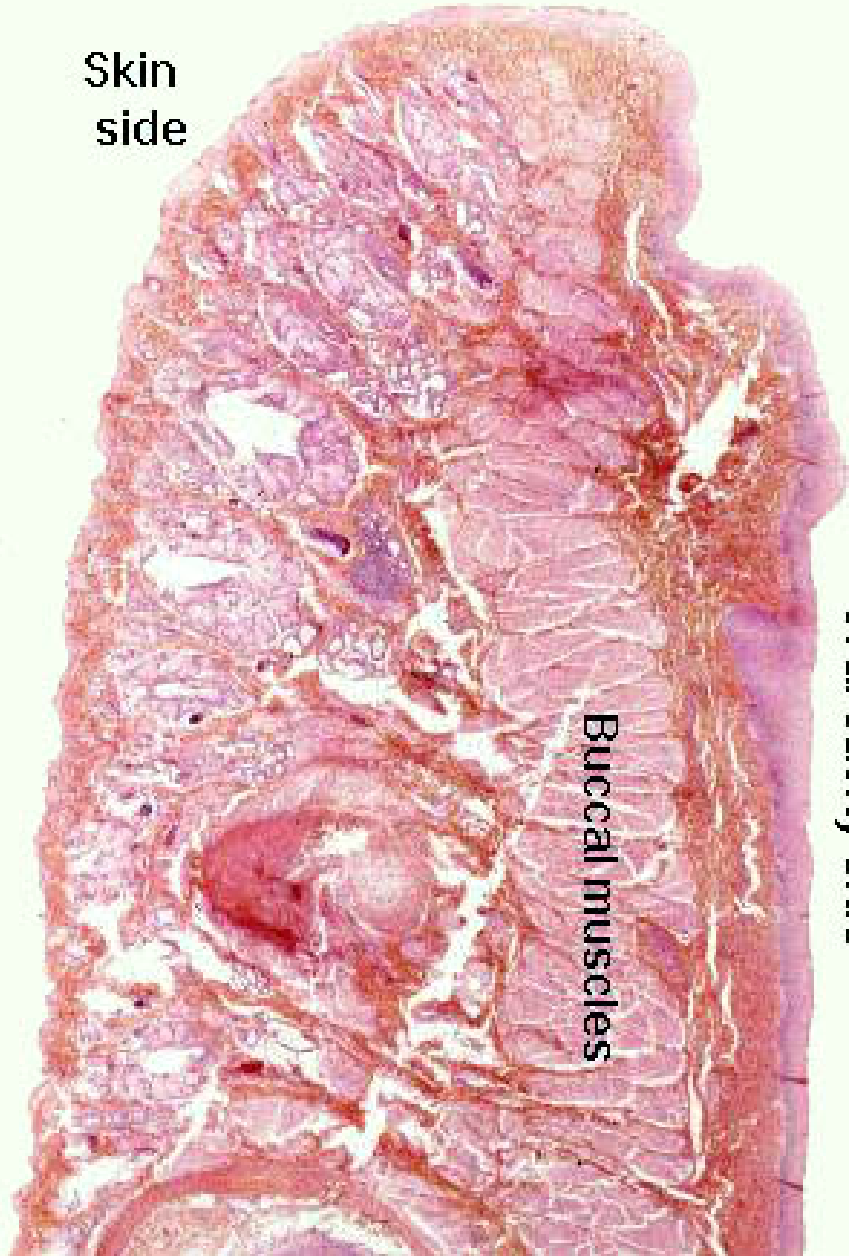
The mouth or oral cavity

- Lined with mucous membrane (MM).
- The MM is formed of epithelium and lamina propria.
- The epithelium is stratified squamous-non keratinized.
- The lamina propria is loose CT contains small salivary glands.



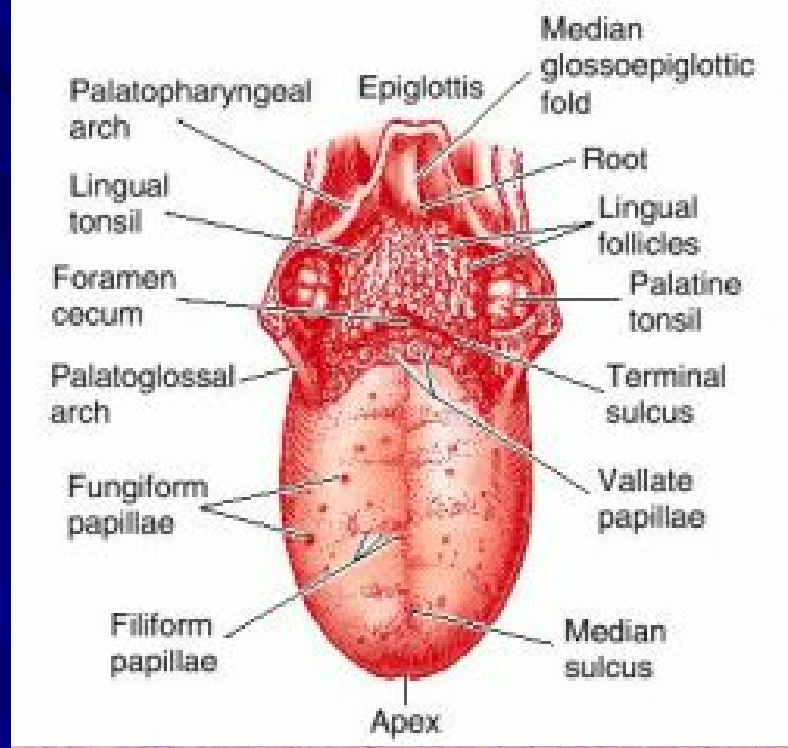
Lips

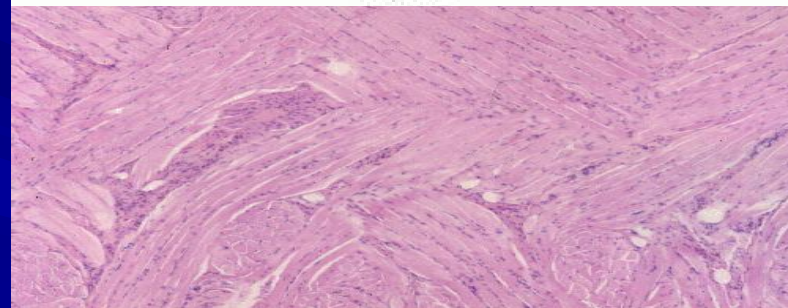
- The lips consists of striated muscle fibers (orbicularis oris), and CT.
- The outer surface (skin side) of the lips is covered by skin (composed of epidermis and dermis.
- The epidermis is stratified squamous keratinized epithelium.
- The dermis is a CT layer containing hair follicles, sebaceous and sweat glands.
- The inner surface (oral side) is lined by oral mucosa (OM).
- The OM consists of stratified squamous non-keratinized epitjelium and lamina propria containing mucous glands (labial glands).
- The free red margin of the lips is covered with modified skin (transparent, non-keratinized epidermis, with no hair follicles, sebaceous or sweet glands in the dermis) richly supplies by blood vessels and nerves rendering the lips red and very sensitive.

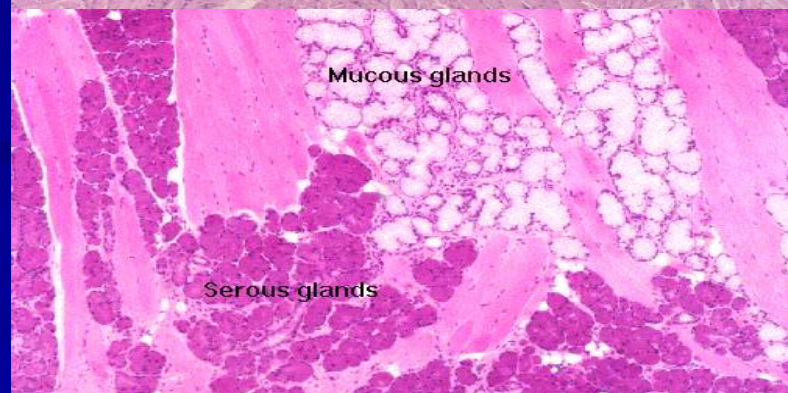


Tongue

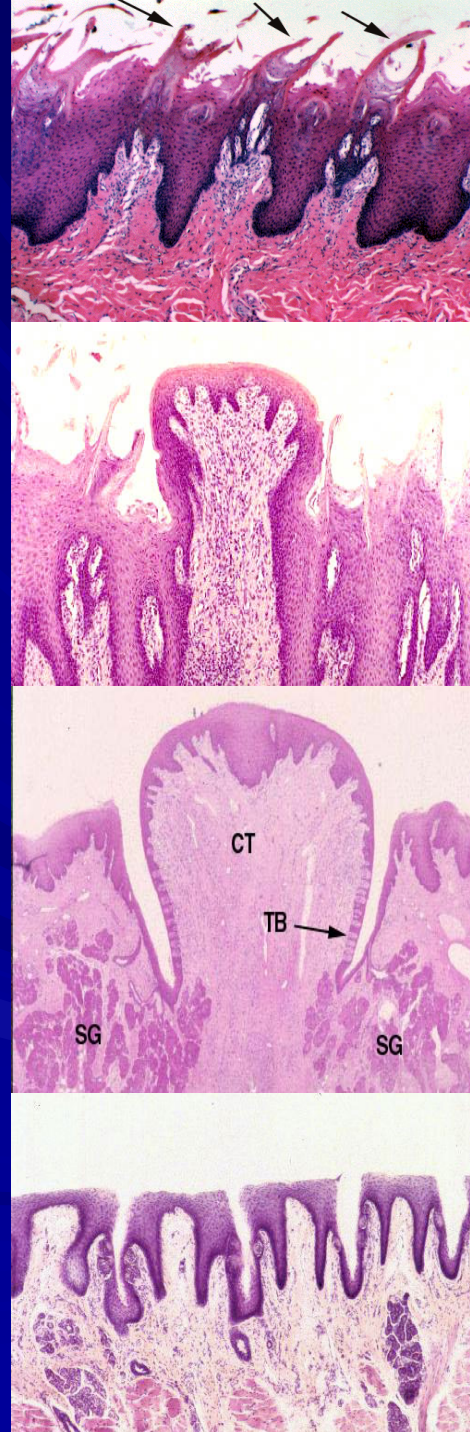
- Muscular organ covered by mucous membrane.
- The bulk of the tongue is formed of striated skeletal muscle bundles separated by CT containing blood vessels, nerves, and mucous and serous glands.
- On the dorsal surface, the anterior 2/3 of the upper surface is separated from the posterior 1/3 by a V-shaped sulcus.
- The anterior 2/3 of the tongue is rough due to the presence of lingual papillae (filiform, fungiform, circumvallate, and foliate).





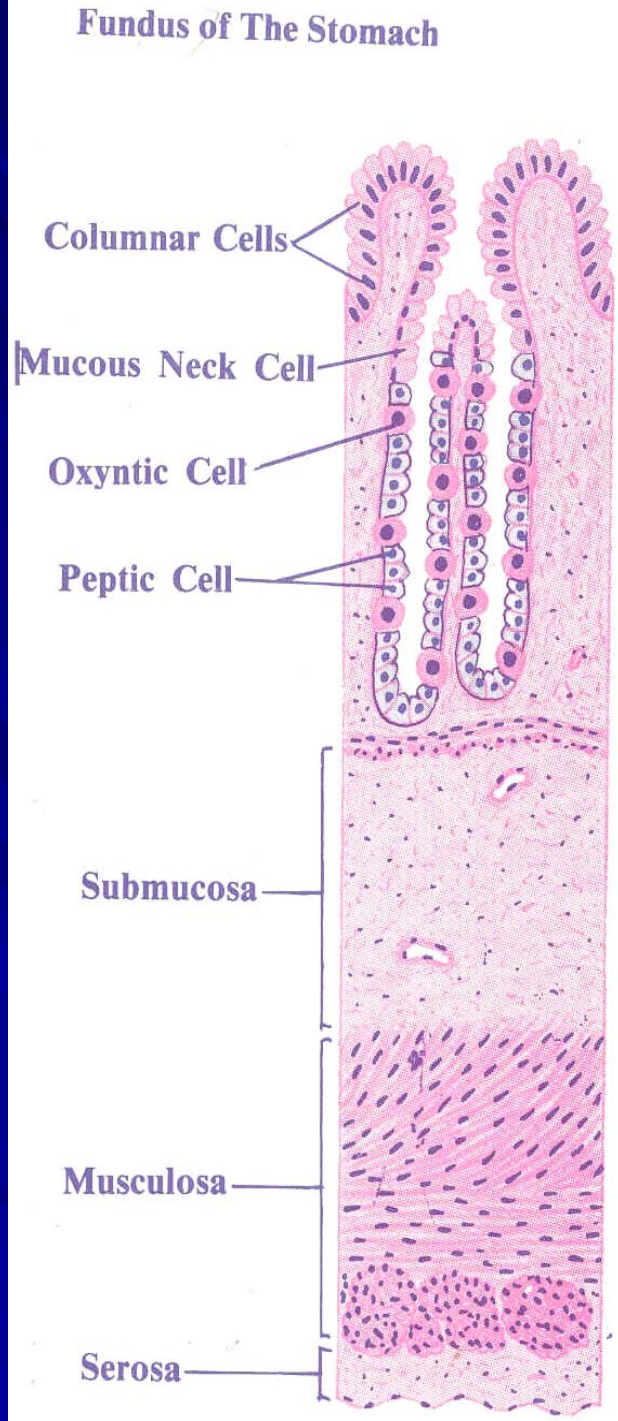


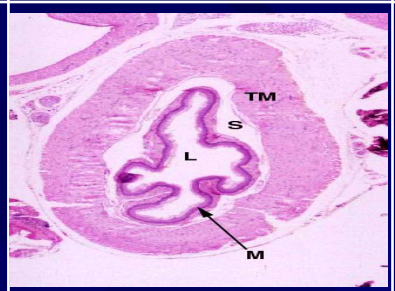
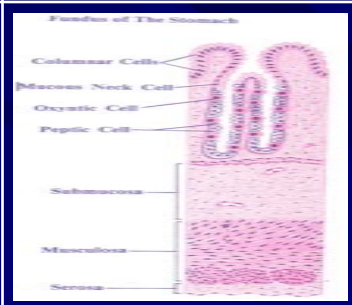
- **Lingual papillae**
- **The filiform papillae are the most numerous and thread-like in shape. They are covered with stratified squamous keratinized and have no taste buds.**
- **The fungiform papillae are fungus-like, with wide apex and narrow stalk, scattered between filiform papillae, and have taste buds on its upper surface.**
- **The circumvallate papillae are large, rounded and surrounded by a deep groove, 7-12 in numbers located along the V-shaped sulcus, numerous taste buds on the lateral surface, and serous (Von Ebner's) glands open into the groove.**
- **The foliate papillae are poorly developed in human and present in some animals (rabbits), consists of parallel ridges separated by deep furrows and they are rich in taste buds.**

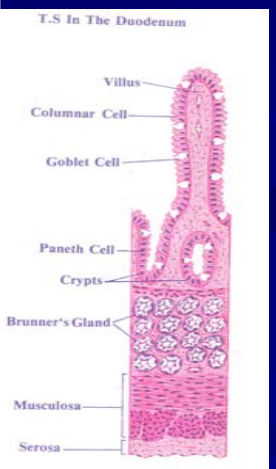


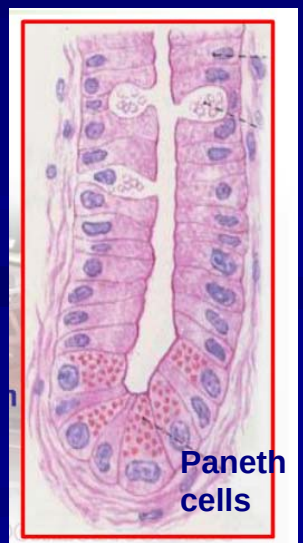
Gastro-Intestinal Tract (GIT)

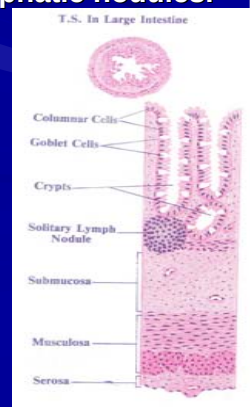
- The wall of GIT is formed of 4 main layers: mucosa, submucosa, musculosa, and serosa.
- The mucosa comprises epithelium, lamina propria, and muscularis mucosa.
- The epithelium differs according to the function of the part it lines: protective (esophagus), secretory (stomach) and absorptive (intestine).
- The lamina propria is formed of loose CT containing blood vessels, lymph nodules and glands.
- The muscularis mucosa, inner circular and outer longitudinal smooth muscle fibers.
- The submucosa is a loose CT contains elastic fibers, blood and lymph vessels, Meissner's plexus of nerves and in some parts mucous glands (as in oesophagus, duodenum) or lymphoid tissue (as in ileum).
- The musculosa consists of inner circular and outer longitudinal layers with Auerbach's plexus.
- The serosa (adventitia) loose CT rich in blood vessels and adipose tissue with an outer mesothelial covering (serosa, intraabdominal) or without mesothelium (adventitia)



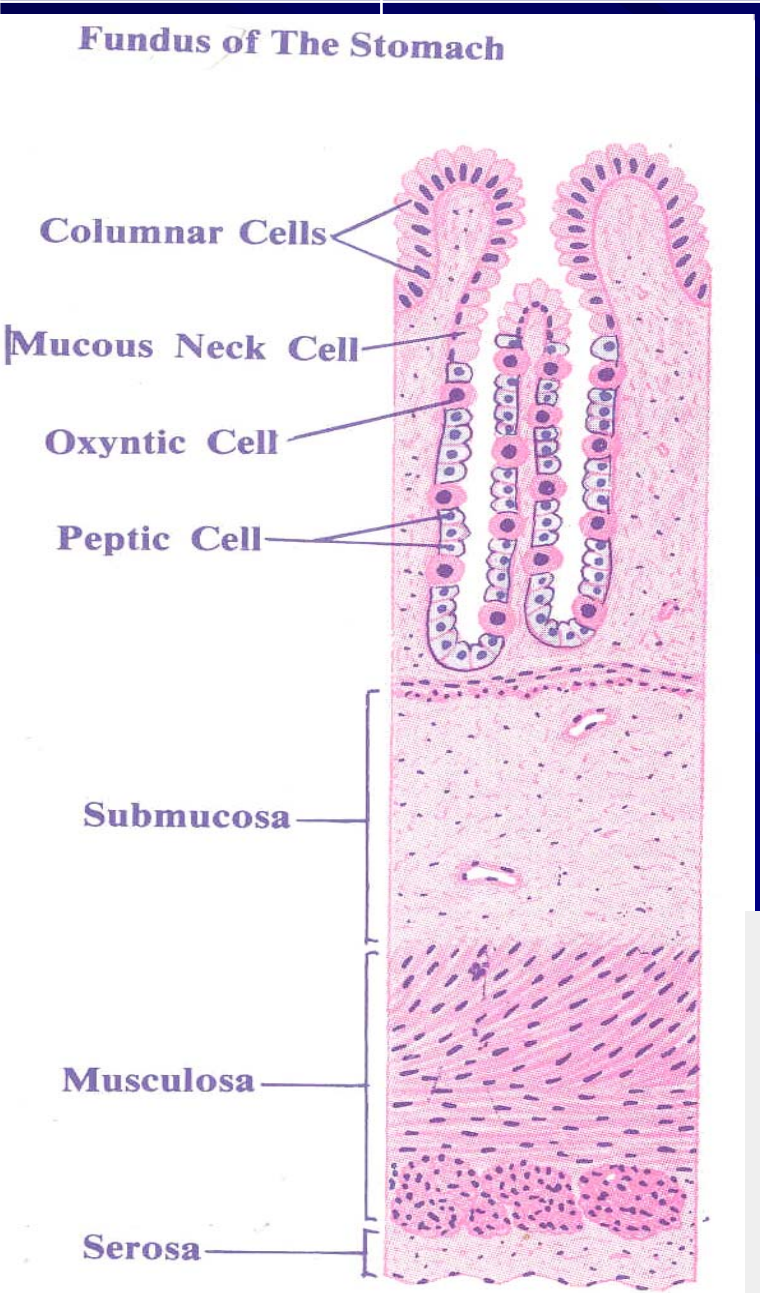
Aspect	Esophagus	Stomach	S. Intestine	L. Intestine
Mucosa	 Folded	 Folded With gastric pits, foveoli or rouge	The small intestine is subdivided into 3 main regions: duodenum, jejunum, and ileum. The mucosa is arranged into villi. The villi are epithelial finger-like projections.	The large intestine is subdivided into 3 main regions: cecum, appendix, colon, and rectum. The mucosa is smooth without villi. Only crypts are present.
Epithelium	Stratified squamous non keratinized (protective).	Simple columnar secretory.	Simple columnar absorptive with brush border and goblet cells.	Simple columnar absorptive with brush border and abundant goblet cells.
Lamina propria	Loose CT contains simple tubular glands at the lower part near the stomach (esophageal cardiac glands)	Contains gastric glands of 3 types: cardiac, fundic, and pyloric. They are simple branched tubular gland. They extend from the gastric pits to muscularis mucosa. Each gland is formed of neck, body and fundus. The glands are lined with mucous neck cells, parietal cells, zymogenic (chief) cells and entero-endocrine cells. The Zymogenic cells has basal basophilic cytoplasm and apical acidiphilia. They secrete enzymes (pepsinogen, renin).	Loose CT containing intestinal mucosal glands (intestinal crypts). The crypts of Liebekuhn is lined by simple columnar with brush border, goblet cells, endocrine cells, stem cells, and Paneth cells (present at the base of the crypts, and secrete digestive enzymes and lysozyme.	The crypts (glands) are lined by simple columnar cells, large number of goblet cells, entero-endocrine cells (few), and undifferentiated stem cells. The lamina propria is rich in lymphocytes and lymphatic nodules.







Aspect	Esophagus	Stomach	S. Intestine	L. Intestine



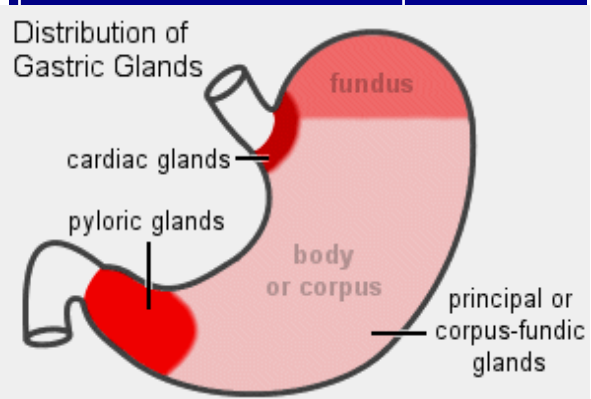
The parietal cells have acidophilic cytoplasm, secrete HCl & interinsic factor for absorption of vitamin B12.

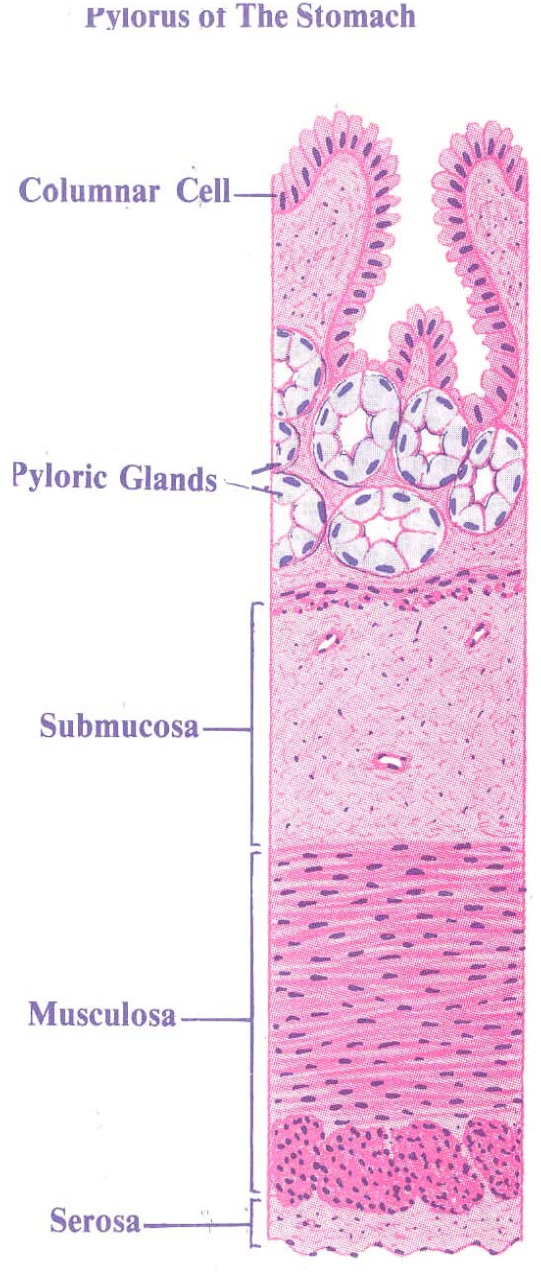
The mucous neck cells secrete mucous. They have pale vacuolated cytoplasm and flattened nuclei.

The entero-endocrine cells are amall, pyramidal, secrete some intestinal hormones.

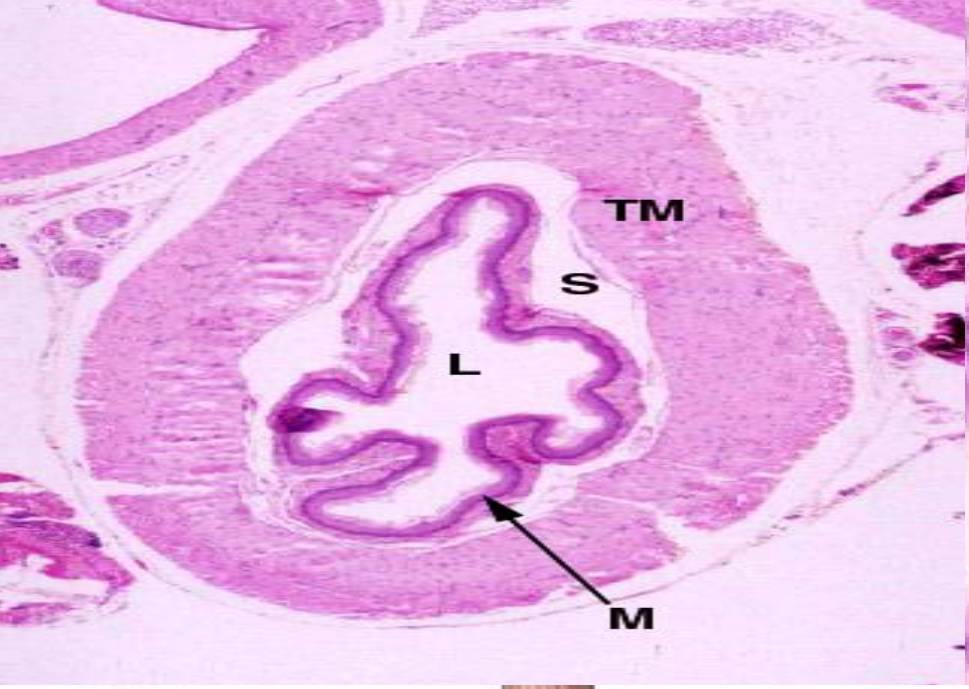
The fundic glands in the fundus and body of the stomach contain all the types of cells.

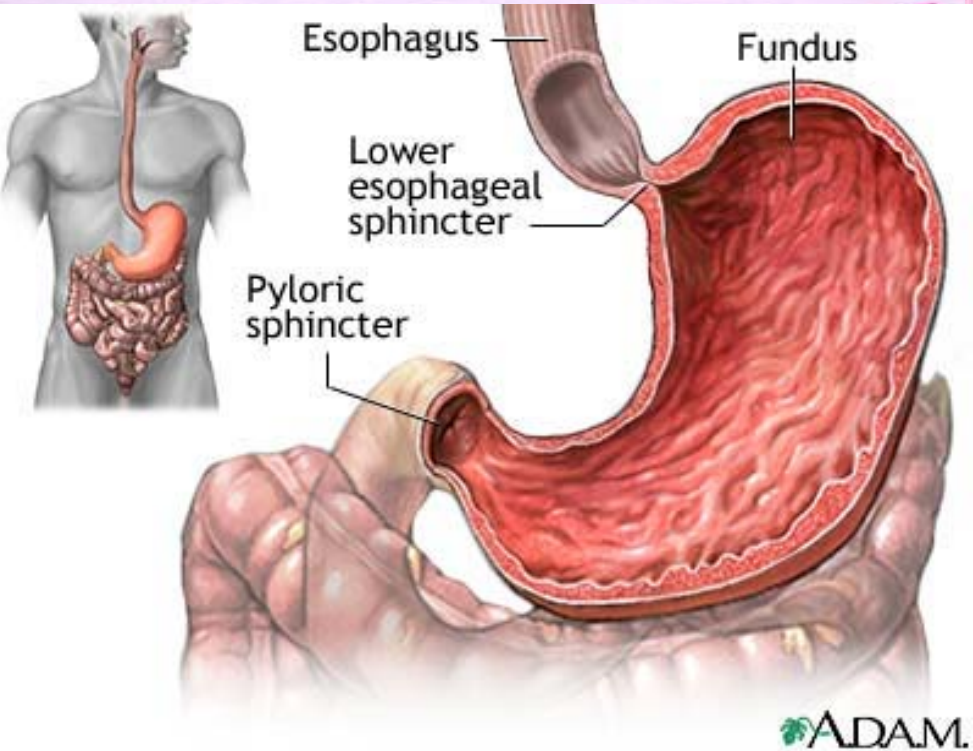
The glands in the cardiac and pyloric regions have deeper pits and more branched. Lined with mucous secreting cells.

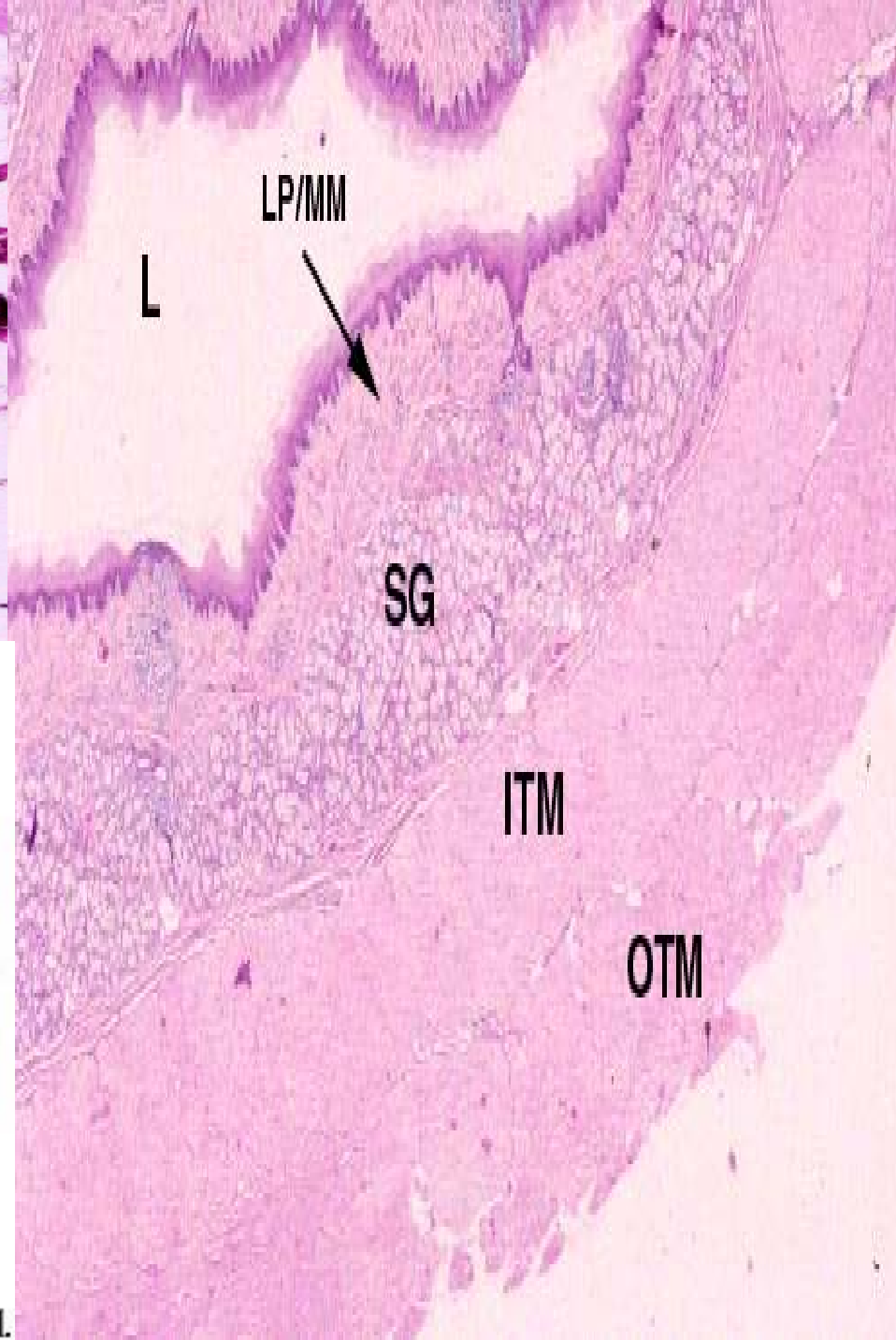




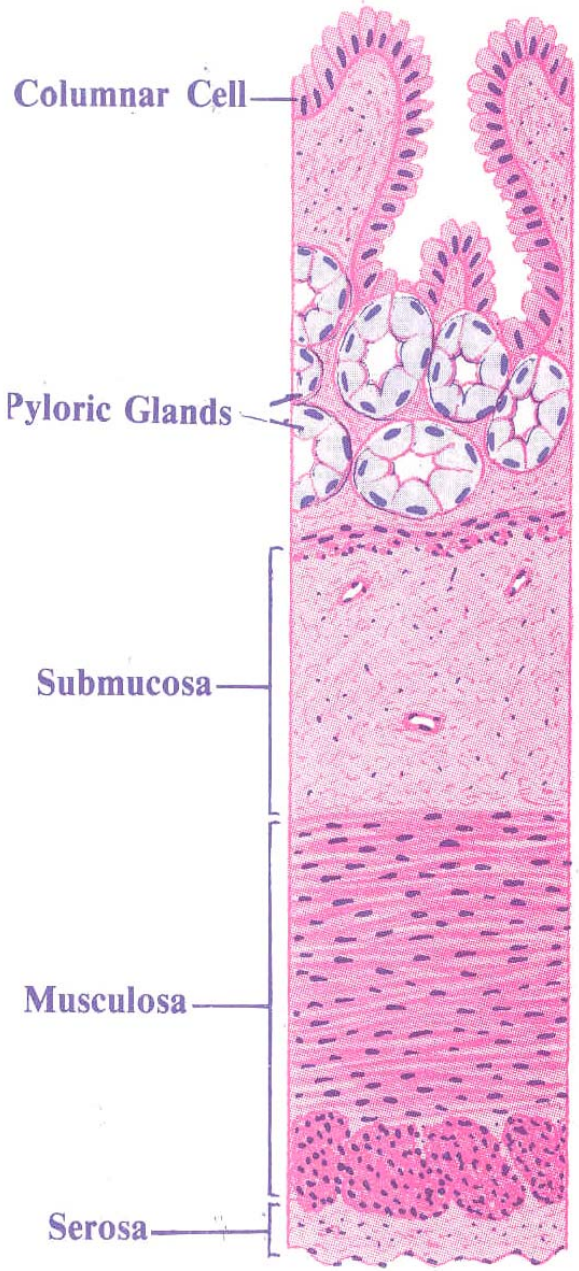
Aspect	Esophagus	Stomach	S. Intestine	L. Intestine
Muscularis mucosa	Inner circular and outer longitudinal smooth muscle layers.	Inner circular and outer longitudinal smooth muscle layers.	Inner circular and outer longitudinal smooth muscle fibers.	Inner circular and outer longitudinal smooth muscle fibers.
Submucosa	Loose CT containing mucous-secreting esophageal glands.	Loose CT rich in blood vessels, nerves, mast cells and lymphatics.	Loose CT rich in blood vessels, nerves, lymphatics, Brunner's glands in the duodenum that secrete mucous. In ileum it contains large lymphoid follicles (Peyer's patches). The jejunum has no Brunner's glands or Payer's patches.	Loose CT with glands in some parts of the colon.
Musculosa	Inner circular and outer longitudinal layers of striated muscle (upper 1/3), mixture of striated and smooth muscle (middle third), smooth muscle (lower 1/3)	Smooth muscle fibers; in the fundus consists of inner oblique, middle circular and outer longitudinal layers. In the pylorus, the muscles are arranged into 2 layers; thick inner circular forming pyloric sphincter and an outer longitudinal layer.	Inner circular and outer longitudinal smooth muscle fibers.	It is formed of continuous inner circular, while the outer longitudinal layer is collected into 3 bands called taenia coli.
Adventitia or serosa	Loose CT. The intraabdominal lower part of esophagous has a serosa.	Loose CT covered by a serous membrane (peritoneum)	Loose CT covered by mesothelium.	The serous membrane enclose adipose tissue in sac-like structure called appendices epiploicae.

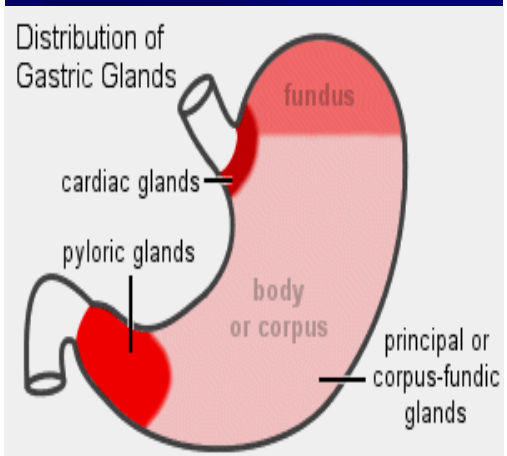

TM
S
L
M


Esophagus
Fundus
Lower esophageal sphincter
Pyloric sphincter
A.D.A.M.

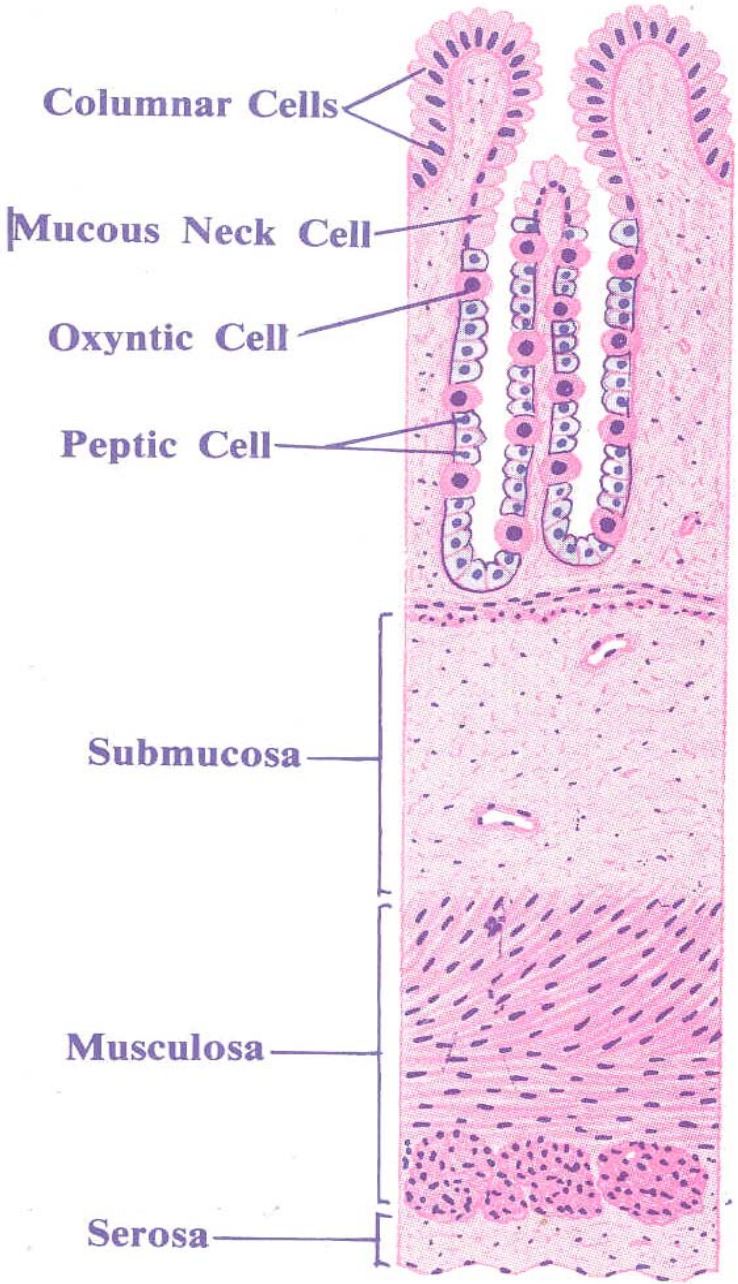

LP/MM
L
SG
ITM
OTM

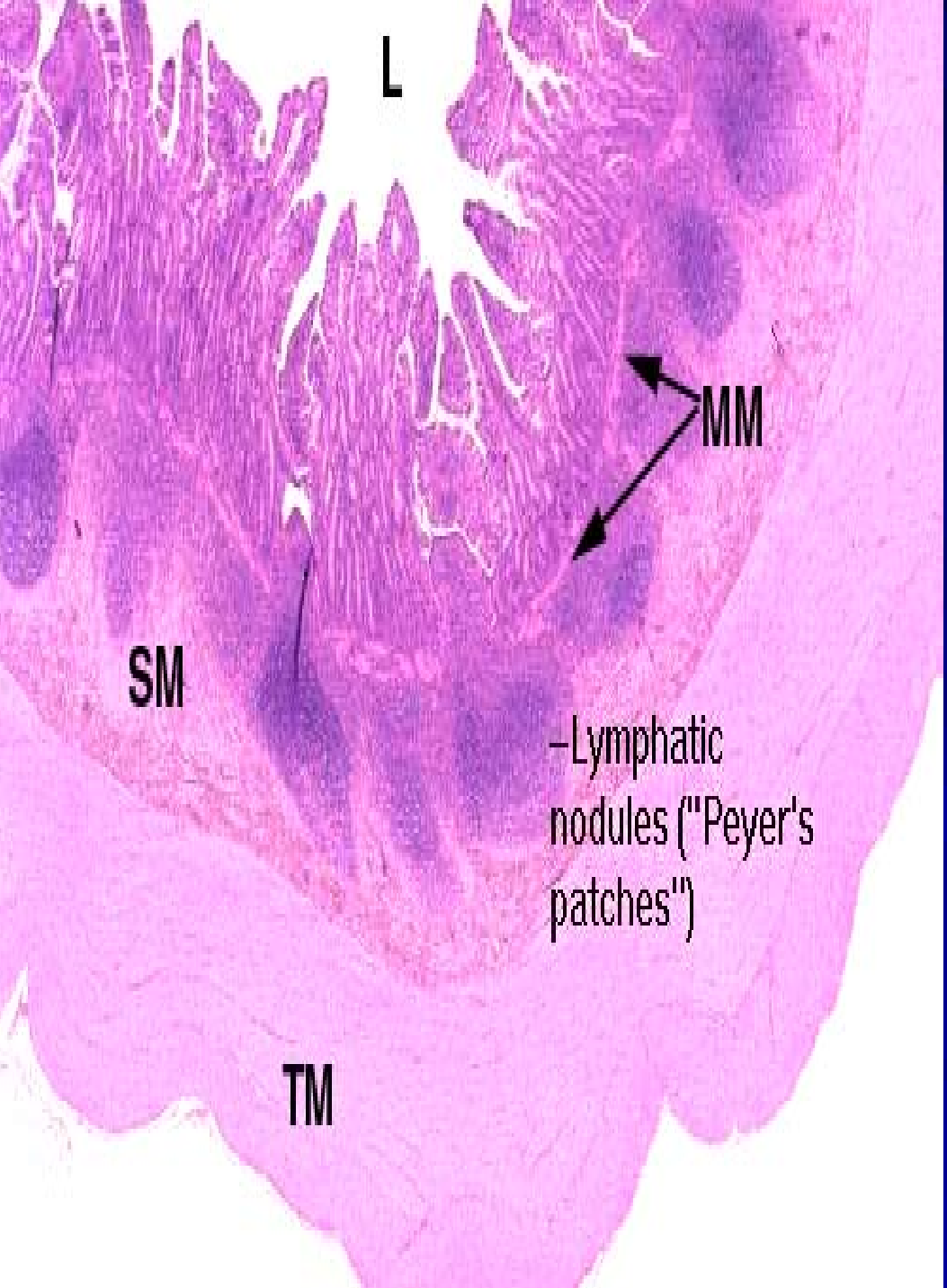
Pylorus of The Stomach



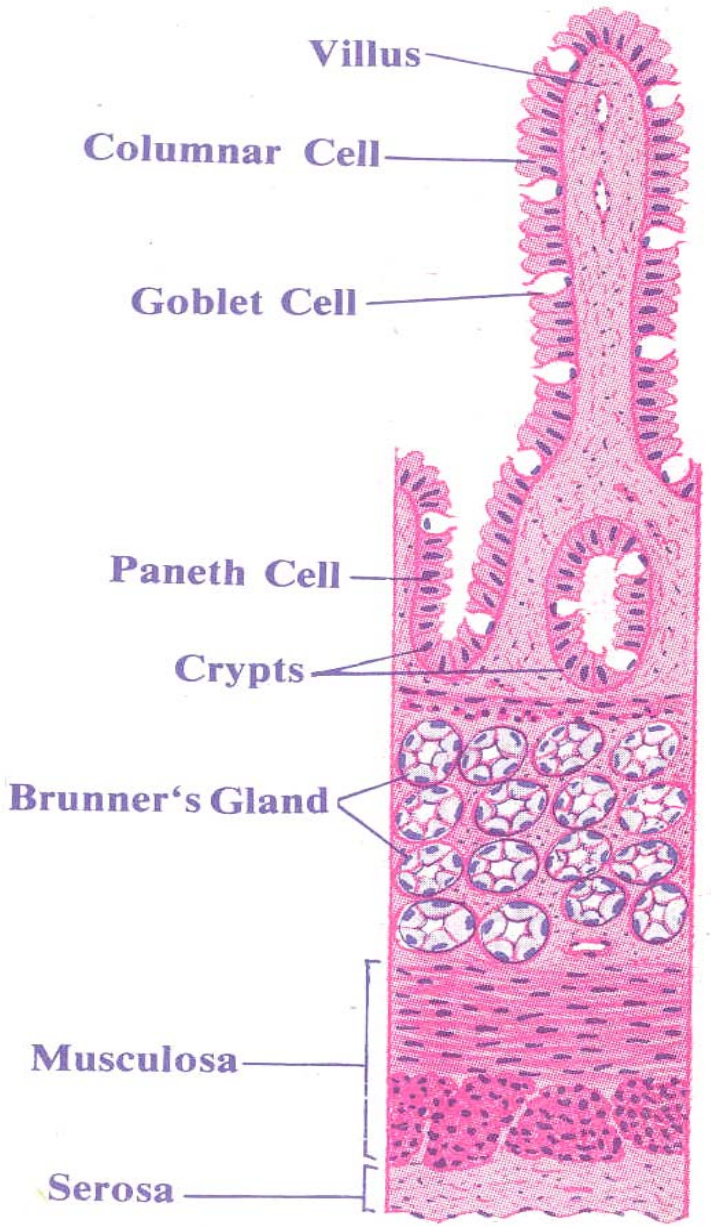


Fundus of The Stomach

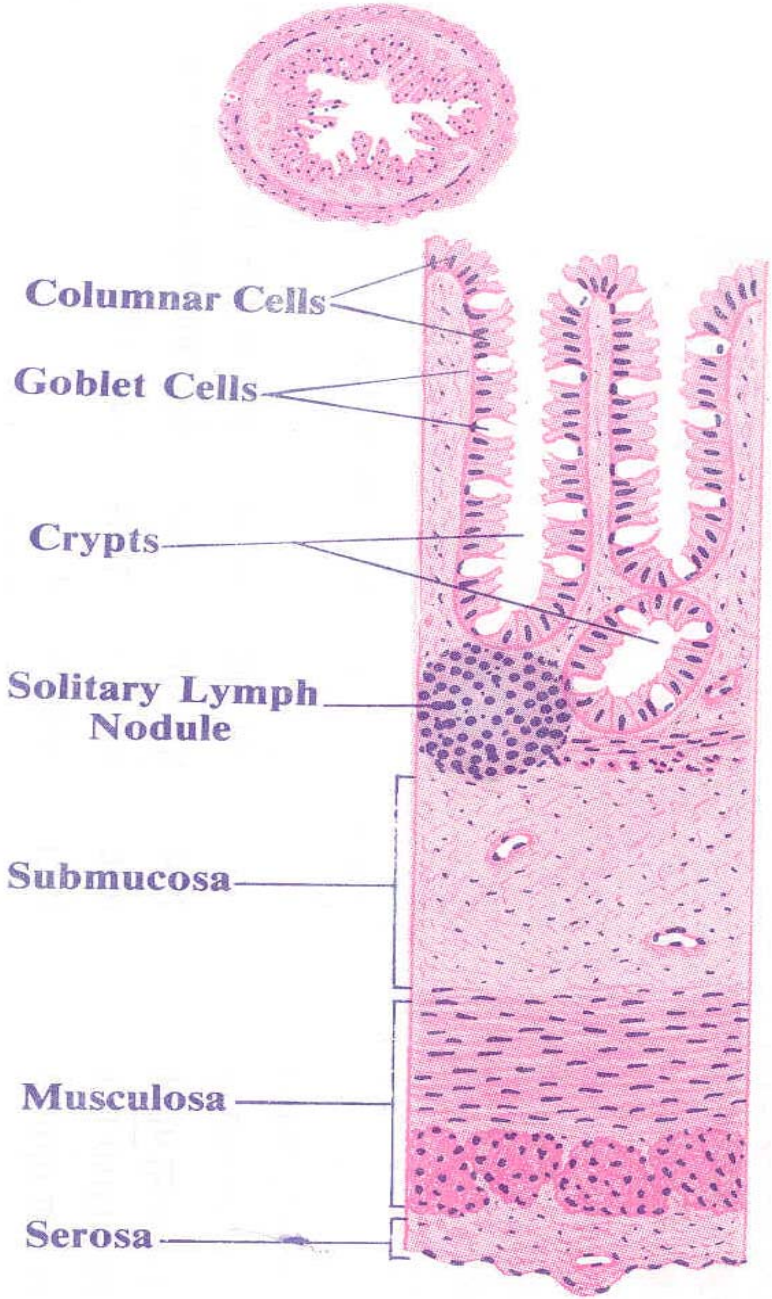




T.S In The Duodenum

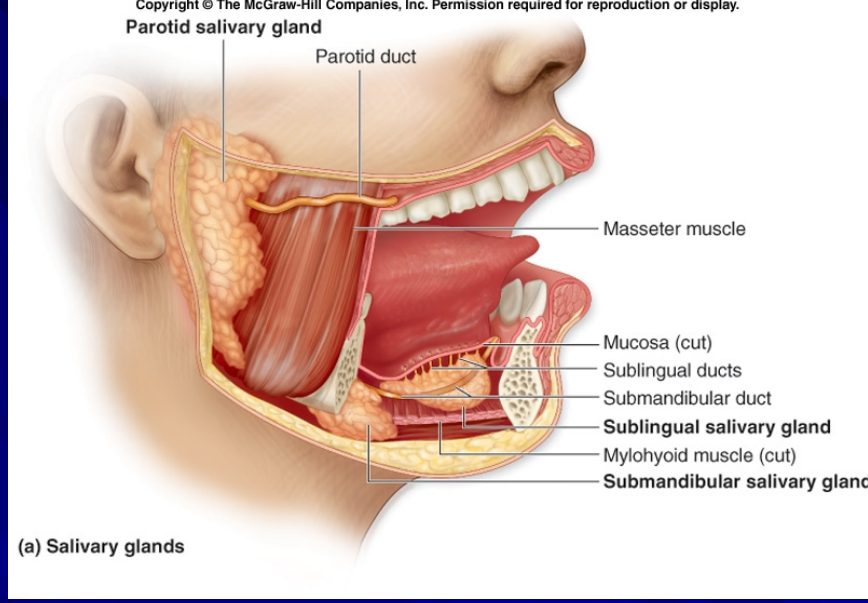


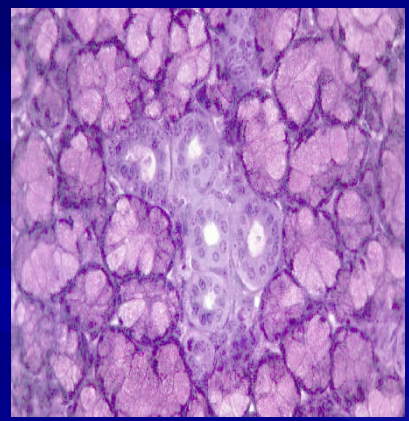
T.S. In Large Intestine

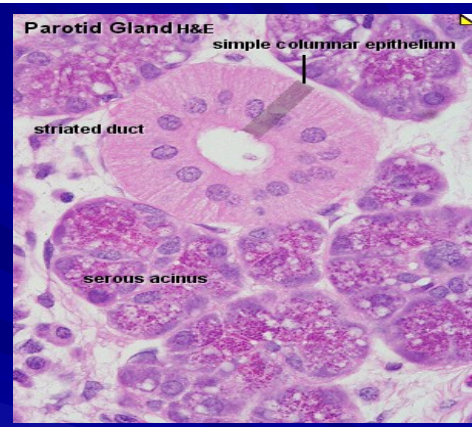


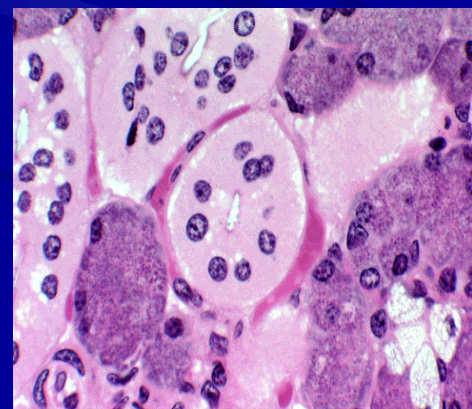
Salivary glands

1. Accessory SG are simple tubulo-alveolar small glands present in the oral cavity. Major SG are paired compound tubulo-alveolar exocrine glands (parotid, submandibular, sublingual).
2. The SG consists of stroma and parenchyma.
3. The stoma is formed of CT capsule rich in collagen, CT septa containing blood vessels, nerves and ducts and dividing the gland into lobule, and reticular stroma.
4. The parenchyma is formed of secretory part (acinus) and duct.
5. The acinus may be serous, mucous or mixed.
6. The ducts are classified into intralobular and extralobular.
7. The intralobular ducts include intercalated duct (lined with simple cuboidal epithelium), and striated duct (lined by simple columnar and has basal striation).
8. The extralobular ducts include interlobular and main duct (lined with simple or stratified columnar).
9. The parotid is serous, the SM mixed mainly serous, and the SL is mixed mainly mucous.



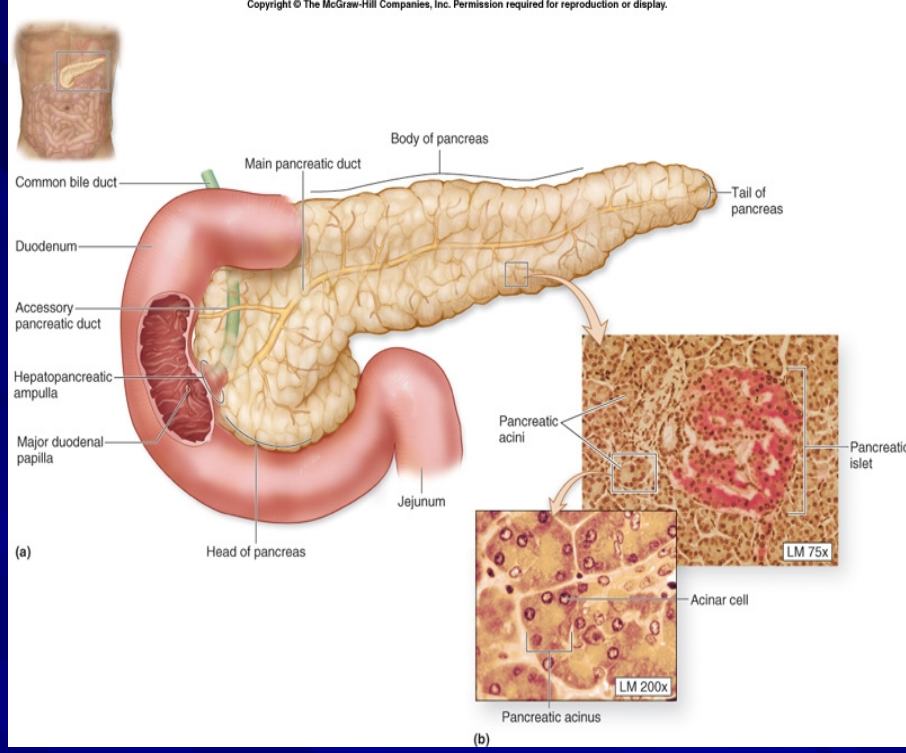


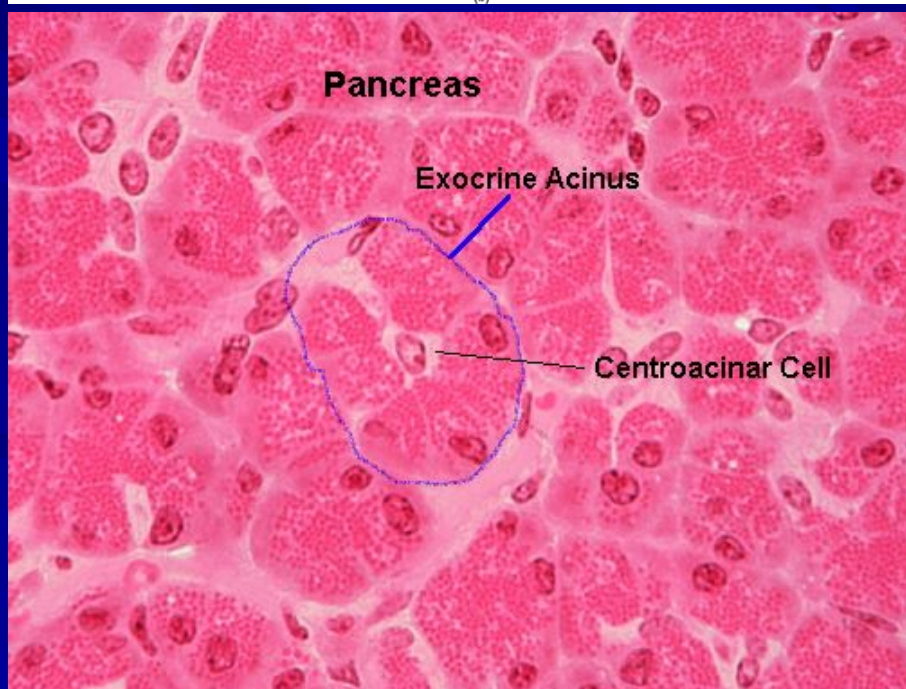




Pancreas

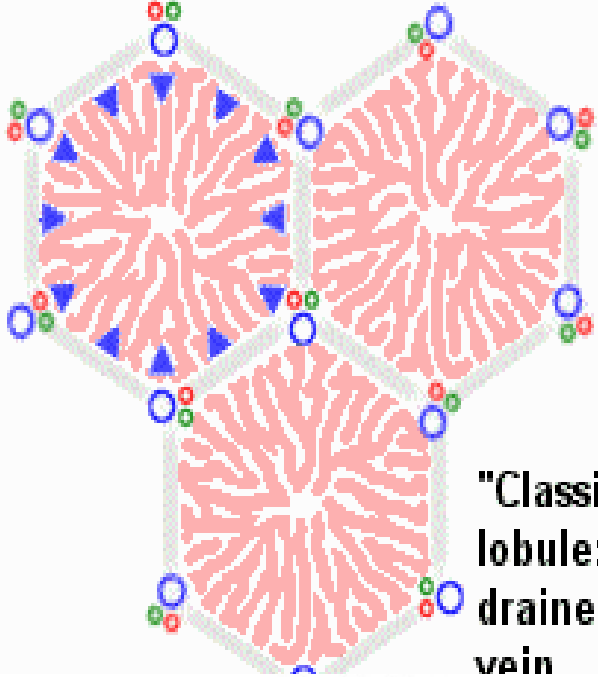
1. The pancreas is a mixed exocrine and endocrine gland, formed of head, body and tail.
2. The exocrine portion is similar to parotid gland except:
3. The islets of Langerhans are absent, the striated duct is absent, the CT capsule is thin, the serous cells show prominent basal basophilia (rER) and prominent acidophilia (zymogenic granules). The pancreas secrete digestive enzymes (trypsin, chymotrypsin, lipase and amylase).
4. The endocrine pancreas are more numerous in the tail, in H&E section as pale spherical groups of cells between the deeply stained serous acini.
5. Each islet is formed of 4 main cells types separated by fenestrated capillaries.
6. A cells 20% large cells and secrete glucagon (increase blood glucose level).
7. B cells 60-80% small cells and secrete insulin (decrease blood glucose level).
8. D cells small and secrete somatostatin (inhibit the release of growth hormone).
9. F Cells are small and secrete pancreatic polypeptide.

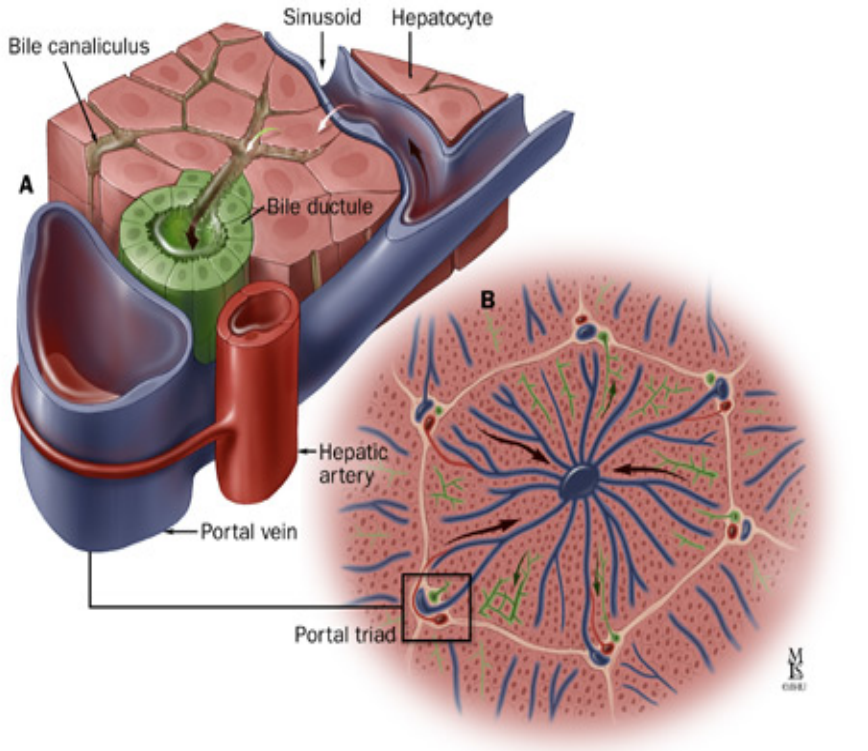




Liver

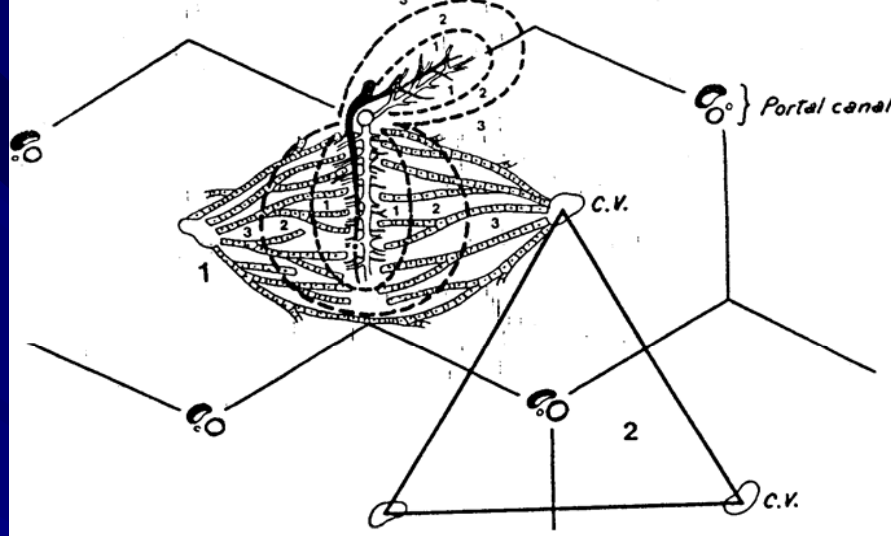
1. The liver is composed of stroma and parenchyma.
2. The stroma include CT capsule covered with peritoneum, CT septa in between the lobe and lobules (the septa are scanty in man so the lobulation is indistinct), and reticular network.
3. The parenchyma is formed of hepatocytes, polyhedral have one or two nuclei, rich in mitochondria (1000-2000), sER, rER, Lipids, glycogen, therefore appear acidophilic.
4. The hepatocytes are arranged in cords or plates of one or two cell thick.
5. Bile canaliculi are enclosed between the cells.
6. Blood sinusoids are present between the cords or plates, they are irregularly dilated blood capillaries composed of discontinuous layer of endothelial cells associated with macrophages (Von Kupffer cells) separated from the liver cells by space of Disse, which contain microvilli of hepatocytes and reticular fibers.

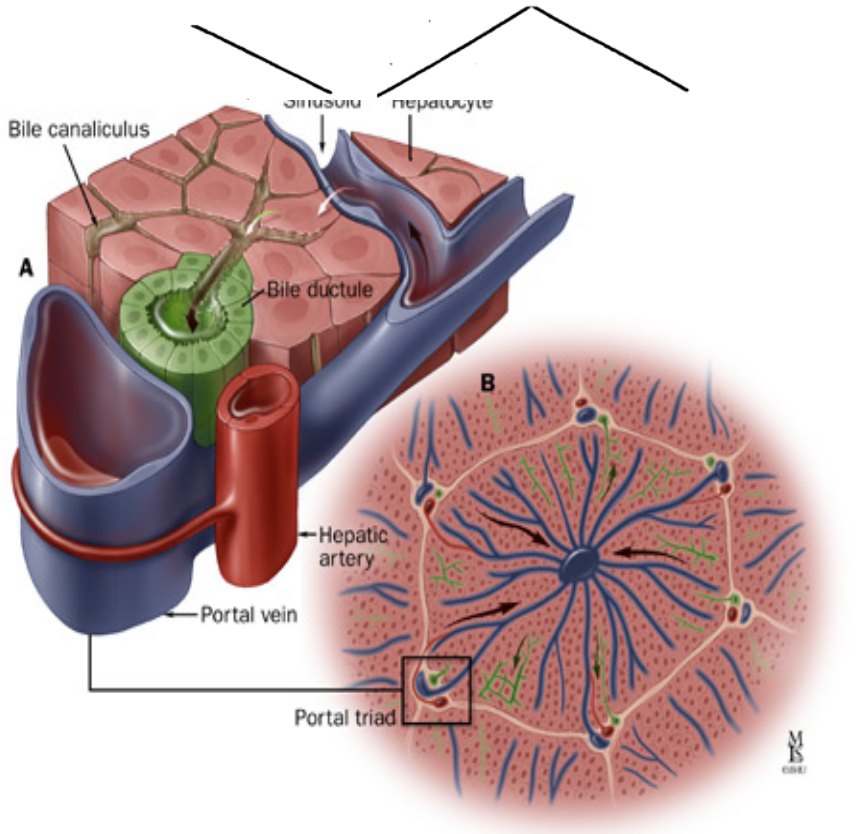




Lobulation of the Liver

- Classic hepatic lobule, portal lobule and liver acinus.
- The hepatic lobule is a polygonal mass of liver cells which drain into a central vein running along its longitudinal axis.
- Lobulation of the liver is not distinct in human due to lack of CT septa.
- The cords of liver cells are directed from the periphery of hepatic lobule to its central vein.
- At the corners of each hepatic lobule there are portal areas or space which are formed of CT containing 4 structures (branch of portal vein, branch of hepatic artery, bile duct, and lymph vessel).
- The portal lobule is a mass of liver cells that drain bile into one bile duct.
- Its formed of parts of 3 adjacent hepatic lobules having portal area or space in the center, and it is triangular in shape.





Lobulation of the Liver

- The **liver acinus** is a mass of liver cells that are supplied by the same terminal branch of portal vein and hepatic artery.
- The liver cells of an acinus are present in adjacent areas of 2 hepatic lobules.
- It is diamond in shape with each end converging on a central vein.
- The liver cells in the acinus are divided into 3 zones:
- Zone I the cells are located closest to the blood vessels with best blood supply.
- Zone II contains the cells of the middle part of the acinus, which have the best next blood supply.
- Zone III contains the cells towards the central the central vein with the poorest blood supply.
- The zonation explains the difference in the damage of liver cells in different metabolic processes and pathologic conditions.