MUNI
PHARM

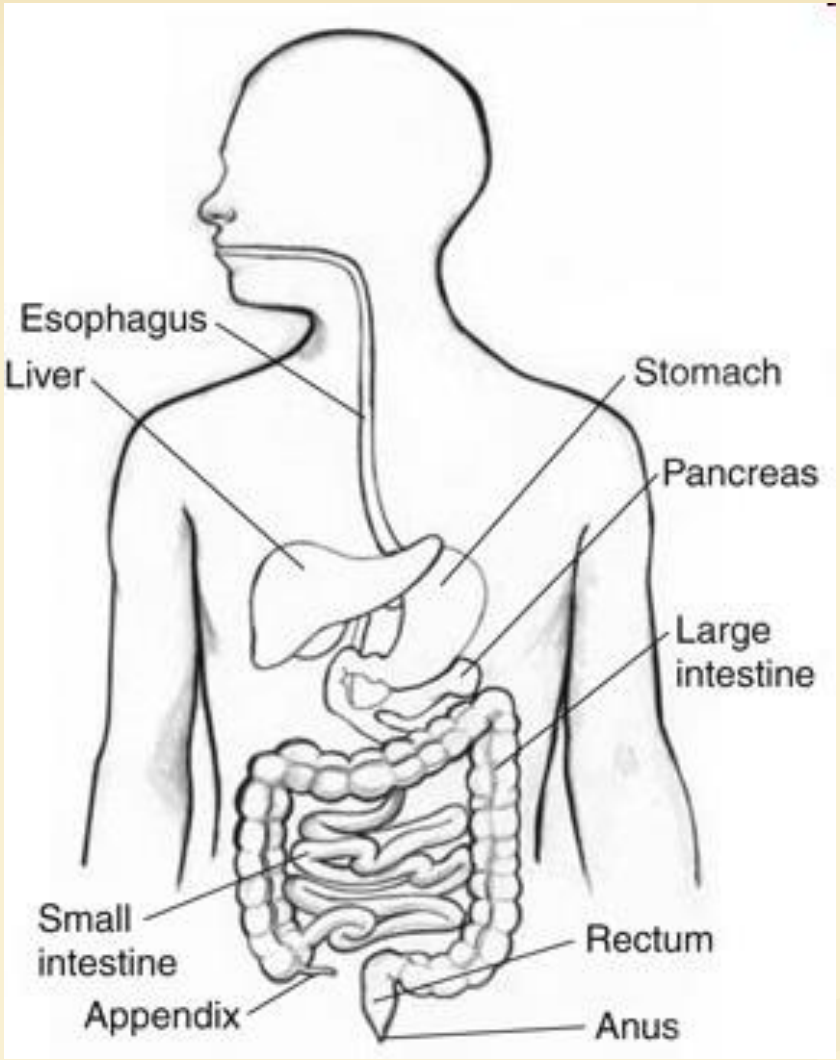
GASTROINTESTINAL SYSTEM

lecture from Human Morphology

16. 11. 2023

M. Chalupová

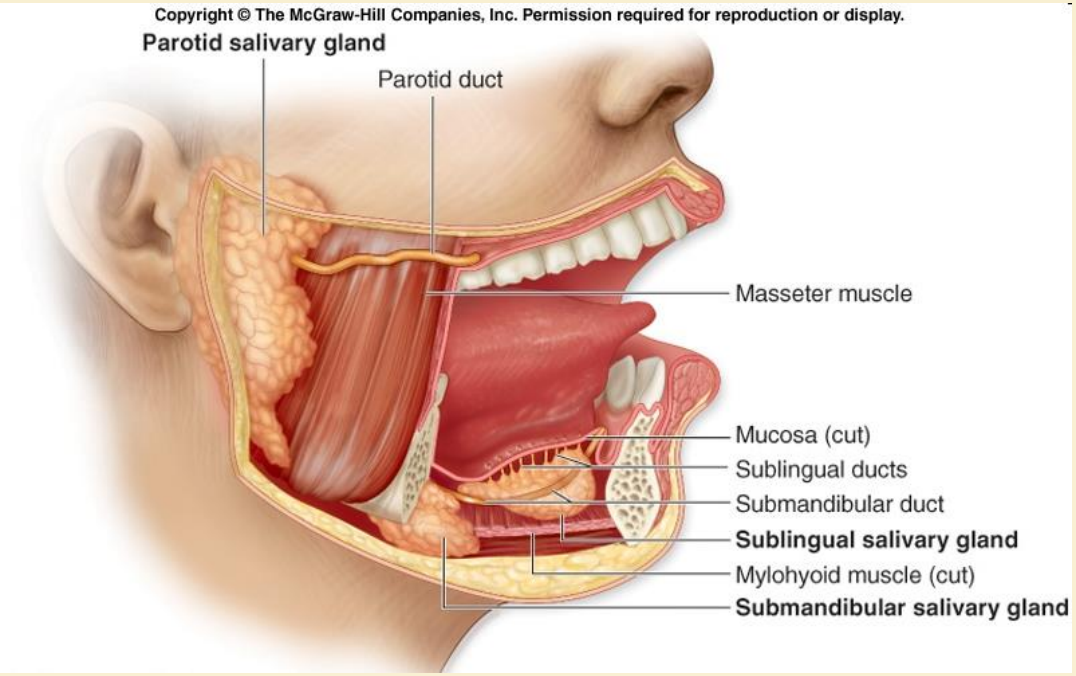
GASTROINTESTINAL SYSTEM



- Oral cavity and associated structures
- Pharynx
- Esophagus
- Stomach
- Small intestine
- Large intestine

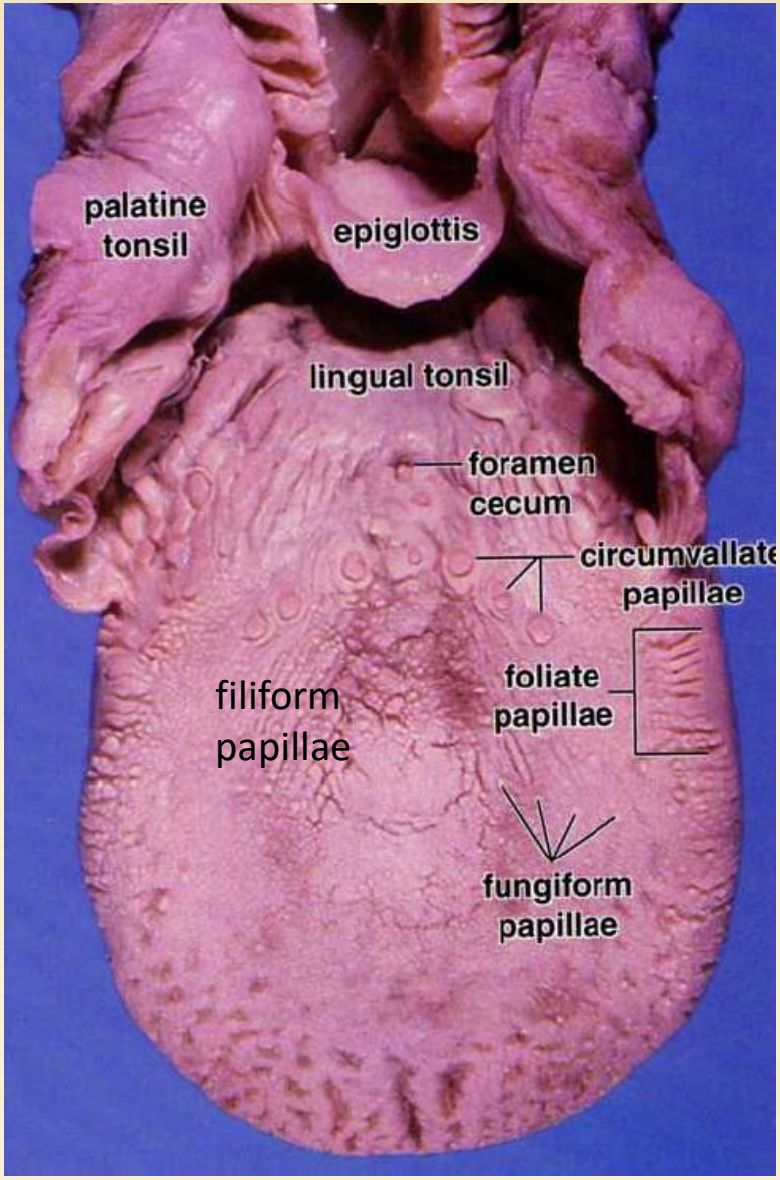
- Liver
- Gallbladder
- Pancreas

ORAL CAVITY



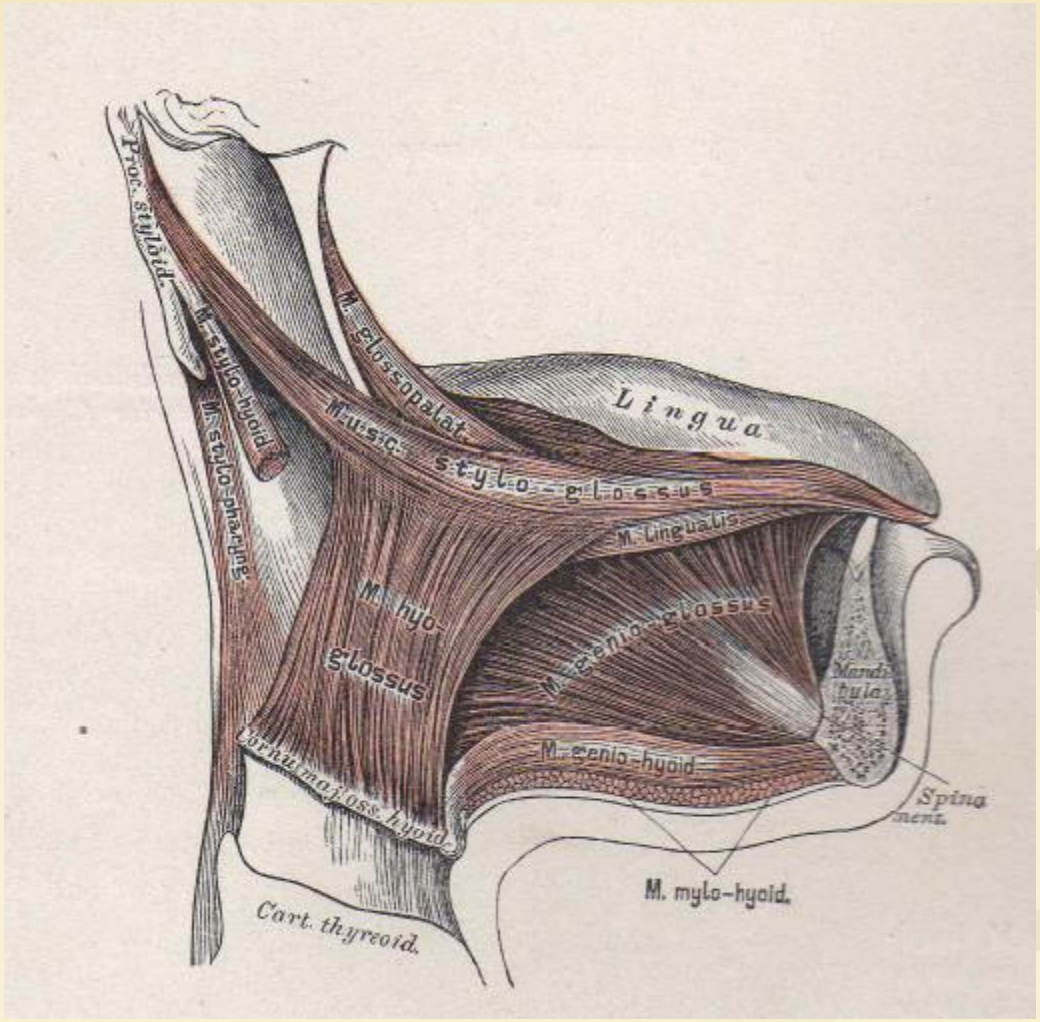
- **VESTIBULE**
  - space between the lips, cheeks, and teeth
- **ORAL CAVITY PROPER**
  - behind the teeth, bounded by the hard and soft palates superiorly, the tongue and the floor of the mouth inferiorly, and the entrance to the oropharynx posteriorly
- **TONGUE**
- **TEETH** and their supporting structures
- **MAJOR** and **MINOR SALIVARY GLANDS**
- **TONSILS**

ORAL CAVITY – Tongue



- muscular organ projecting into the oral cavity
  - **body**
  - **tip (apex)**
  - **root**
- the dorsal surface covered by ***papillae*** (mucosal elevations)
  - **filiform**
  - **fungiform**
  - **circumvallate**
  - **foliate**

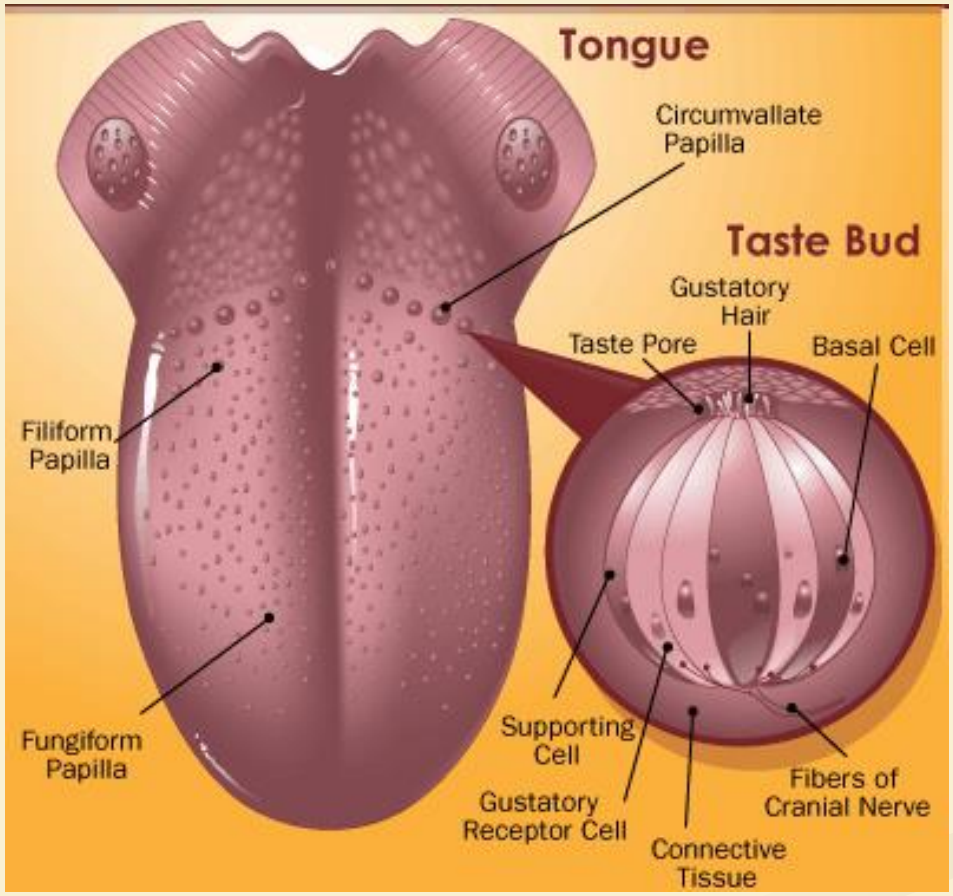
Tongue – Muscles



- ***extrinsic (extraglossal)***
  – arise from skeletal structures

- ***intrinsic (intraglossal)***
  – located only inside the tongue

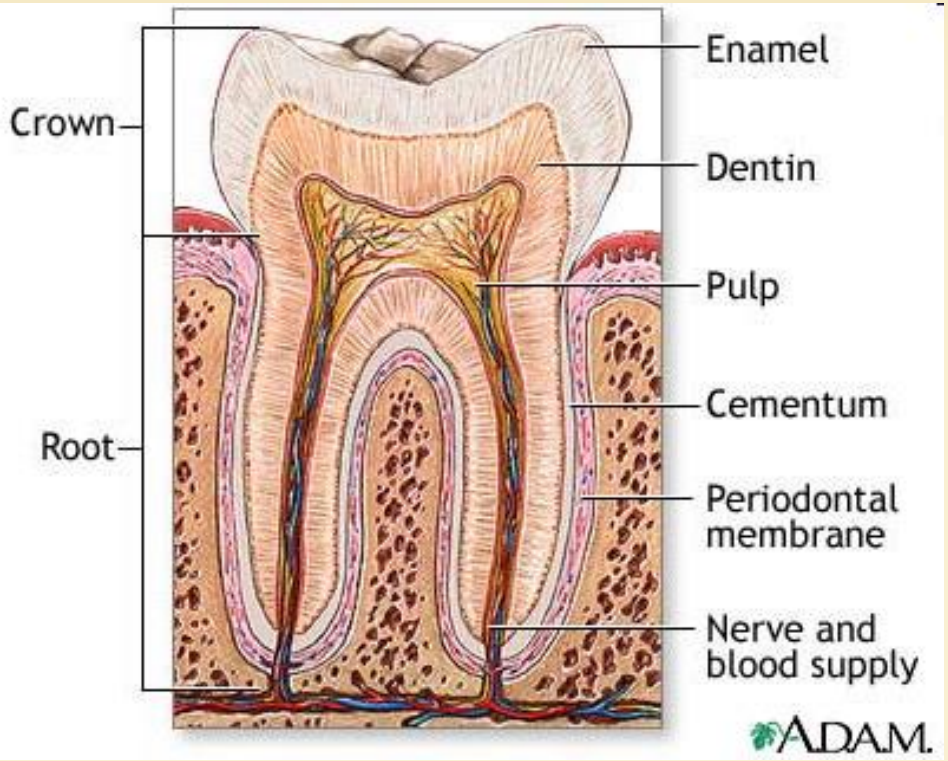
ORAL CAVITY – Tongue Taste Buds



TASTE BUDS

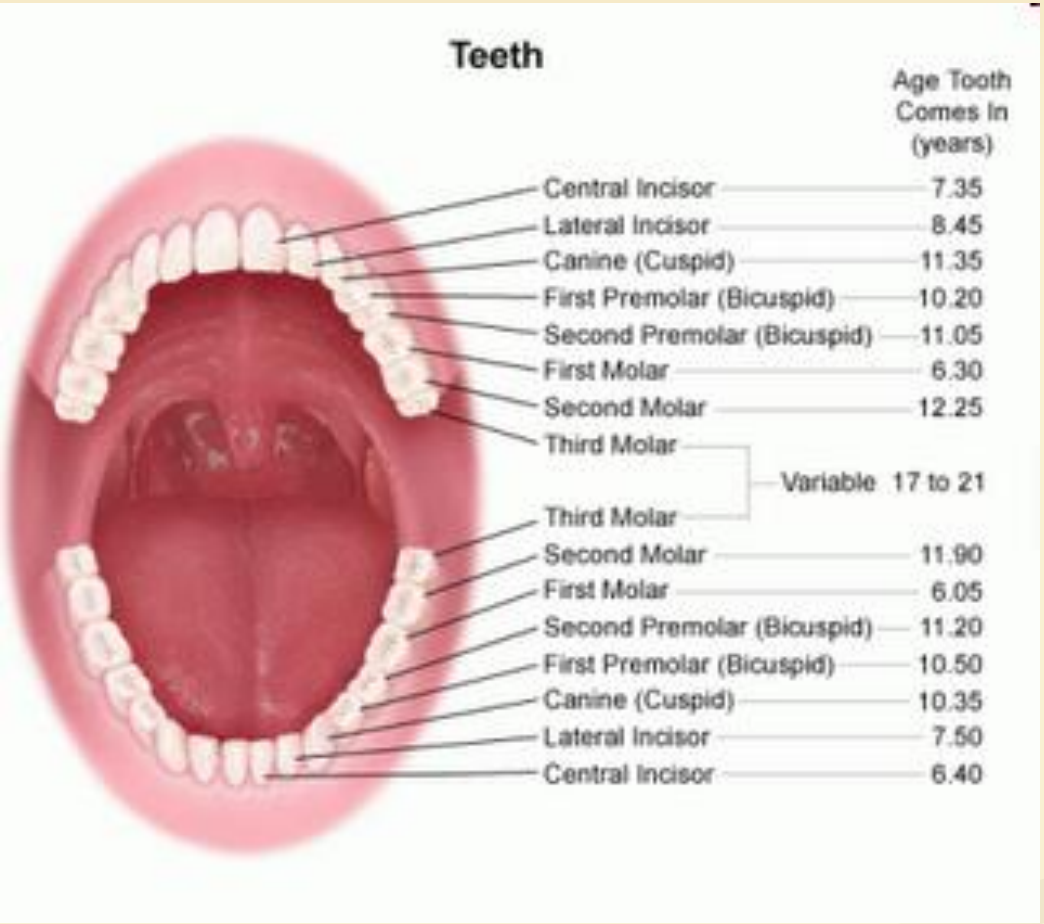
- present on fungiform, foliate, and circumvallate papillae
- three types of cells
  - **sensory cells**
  - **supporting cells**
  - **basal cells**

ORAL CAVITY – Tooth



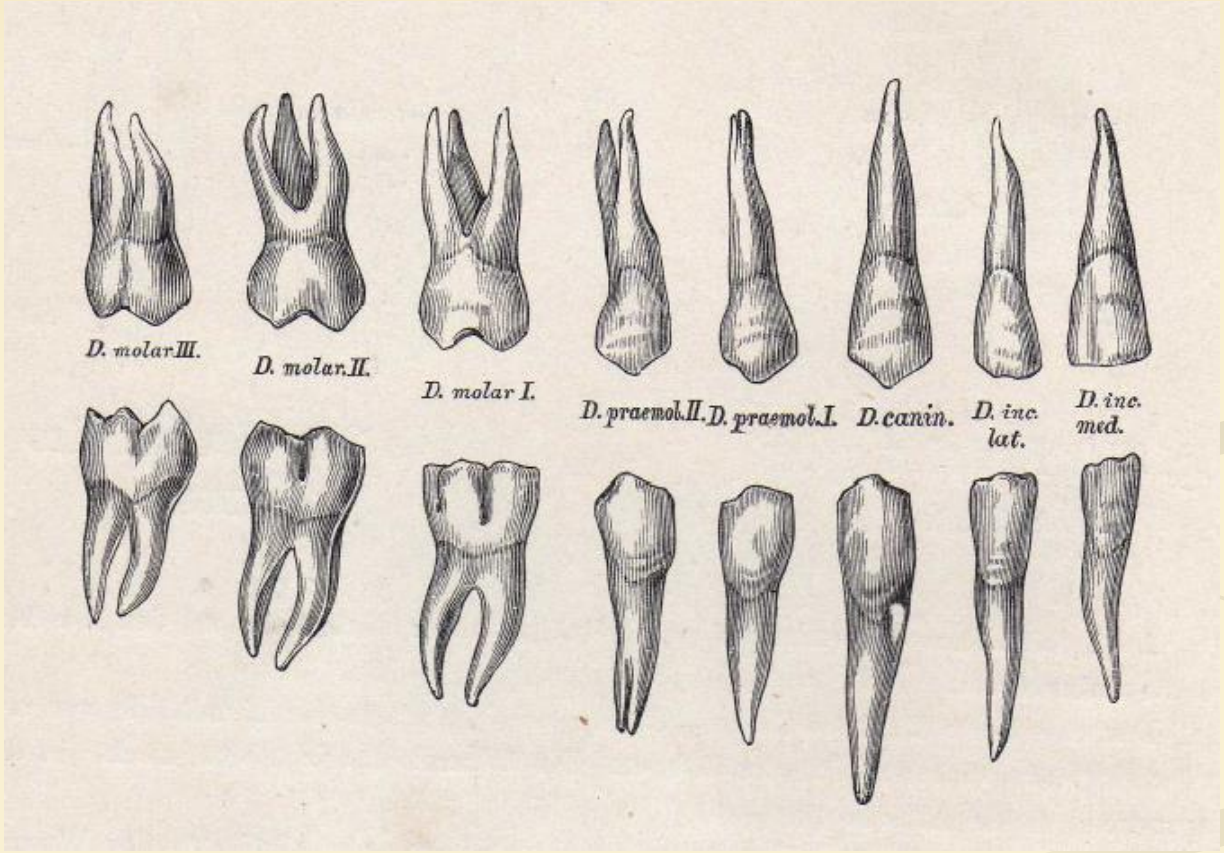
- **ENAMEL**
  - produced by ameloblasts
  - the hardest substance in the body, consists of hydroxyapatite
- **DENTIN**
  - produced by odontoblasts
  - calcified material that forms most of the tooth substance
- **CEMENTUM**
  - a thin layer of bone-like material
  - attached to alveolar bone

ORAL CAVITY – Teeth



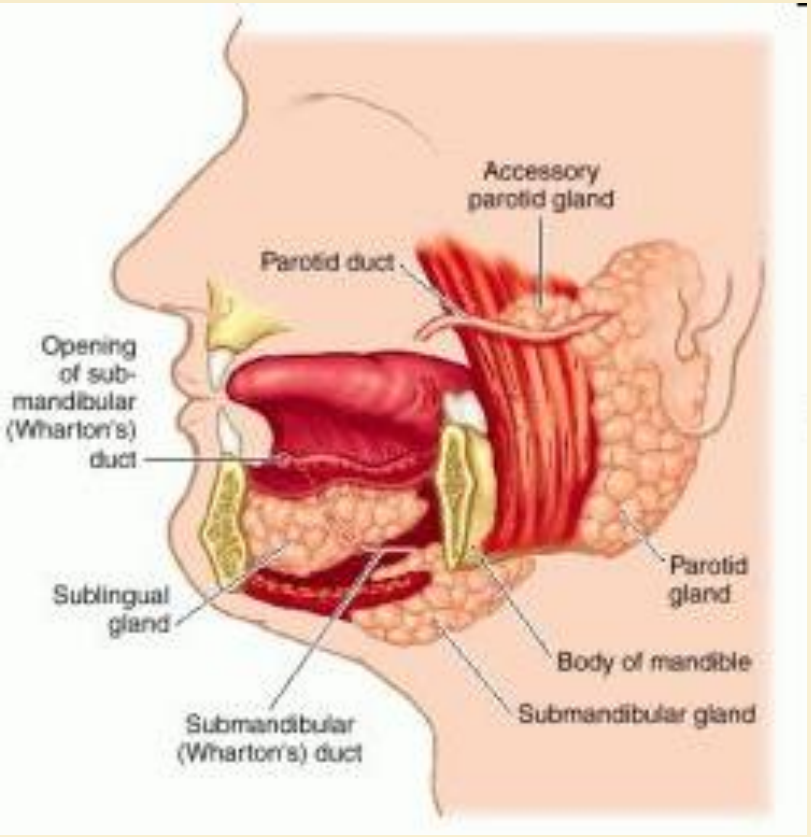
- ***major component*** of the oral cavity
- ***essential*** for the beginning of the digestive process
- embedded and attached to the ***alveolar processes of the maxilla and mandible***
- children – 20 ***DECIDUOUS*** (primary, milk) teeth
- adults – 32 ***PERMANENT*** (secondary) teeth

ORAL CAVITY – Teeth



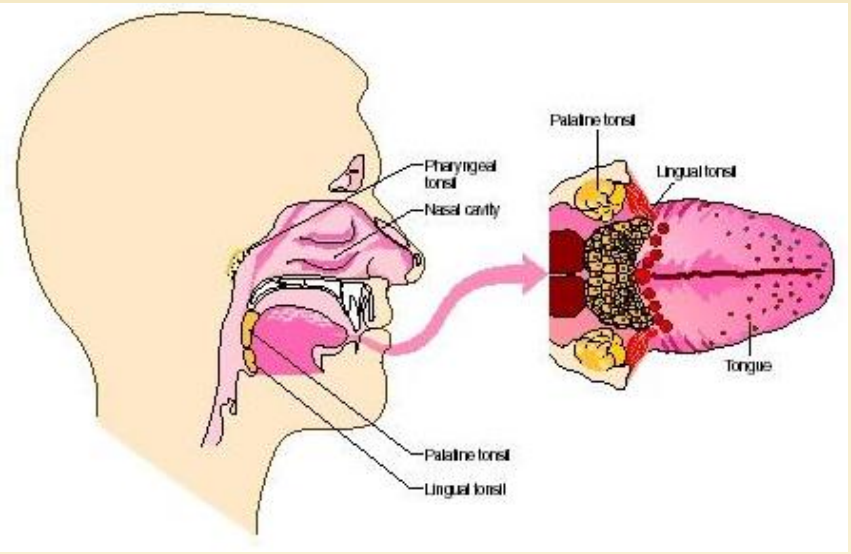
- medial **incisor**
- lateral **incisor**
- **canine**
- **premolar** teeth
- **molar** teeth

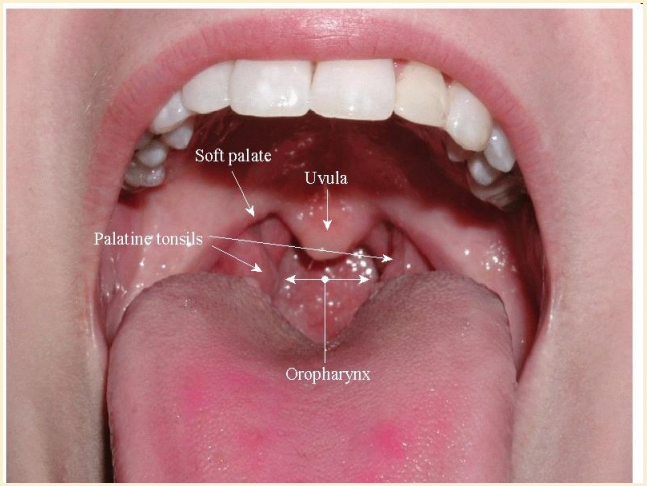
ORAL CAVITY – Salivary Glands



- **PAROTID GLAND**
  - purely serous
- **SUBMANDIBULAR GLAND**
  - mixed gland that is predominantly serous
- **SUBLINGUAL GLAND**
  - mixed gland that is mostly mucous
- **MINOR SALIVARY GLANDS** – buccal, labial, lingual, and palatine
- 99% water, electrolytes, buffers, mucin, IgA, lysozyme, **salivary amylase (ptyalin)**

ORAL CAVITY – Tonsils

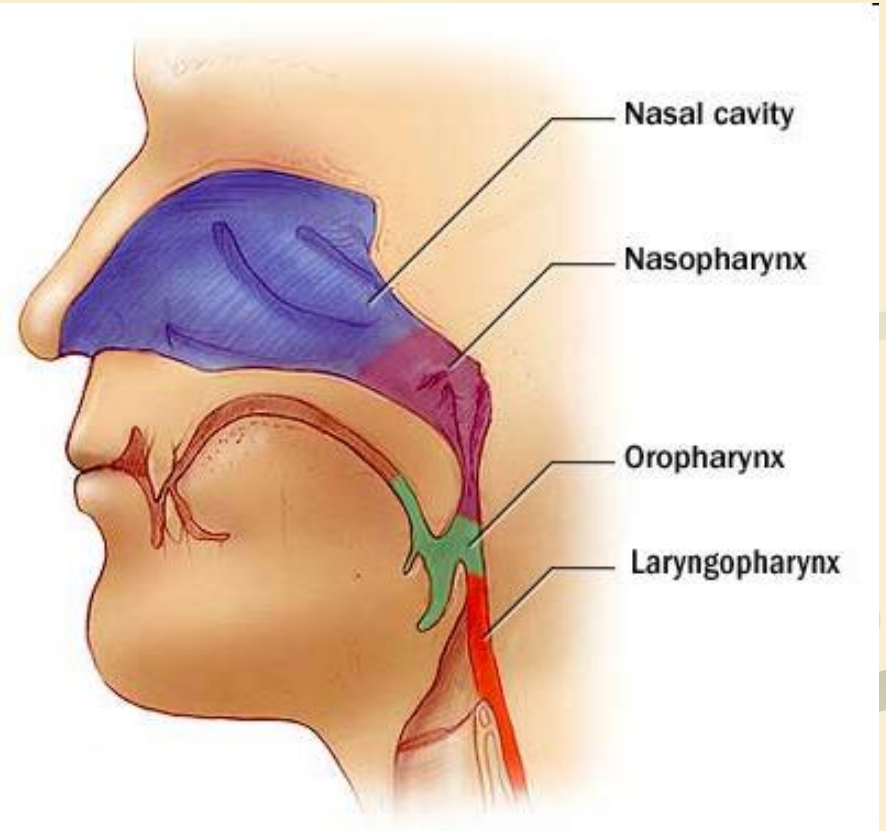




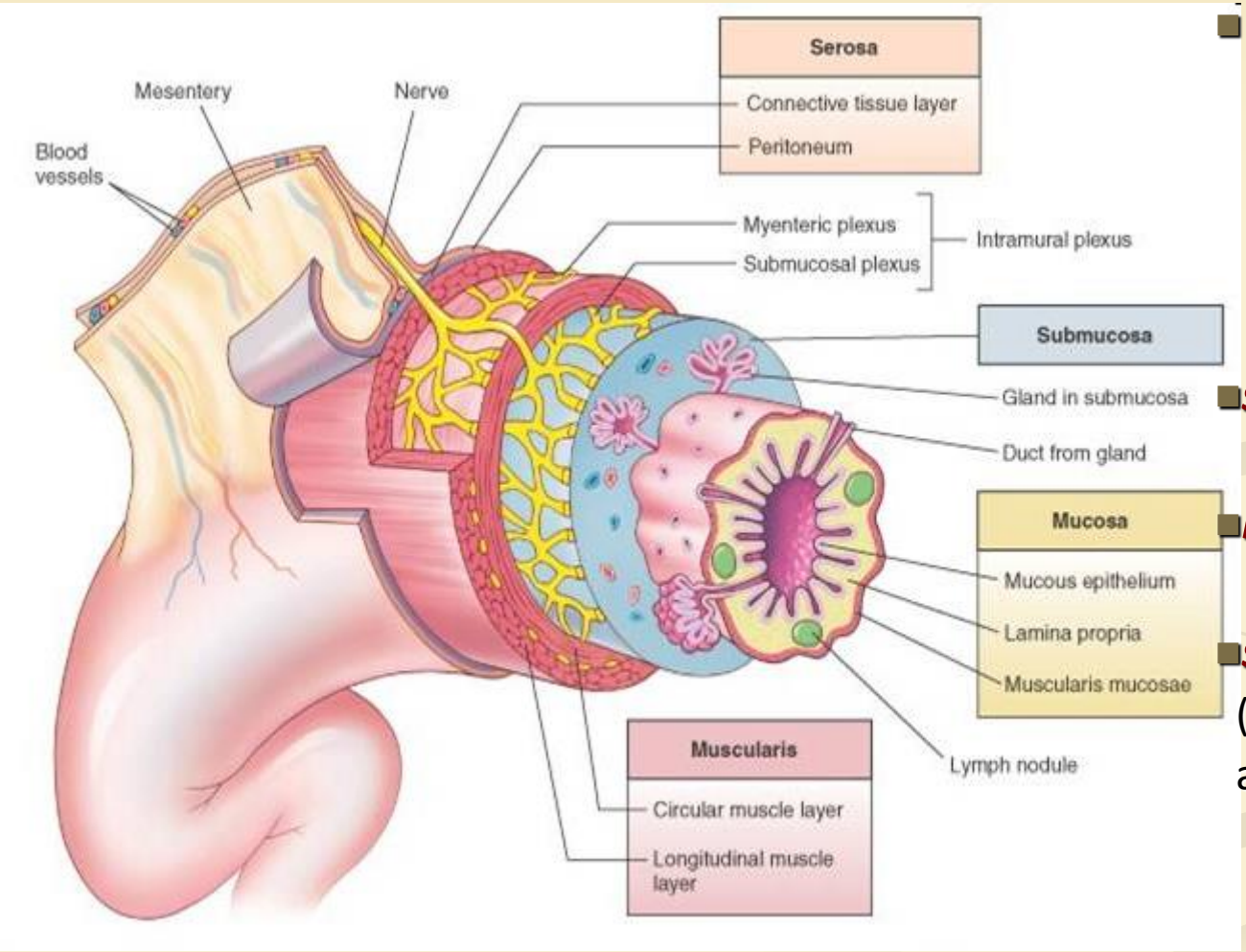
- ***aggregations of lymphatic nodules*** clustered ***around the posterior opening of the oral and nasal cavities***
- lymphatic tissue organized into a ***tonsillar ring*** (***Waldeyer´s ring***) of immunologic protection at the shared entrance to the digestive and respiratory tracts
- **PALATINE TONSILS**
- **TUBAL TONSILS**
- **PHARYNGEAL TONSIL**, or **ADENOID**
- **LINGUAL TONSIL**

PHARYNX

- muscular tube 12–15 cm long
- **nasopharynx**
- **oropharynx**
- **laryngopharynx**

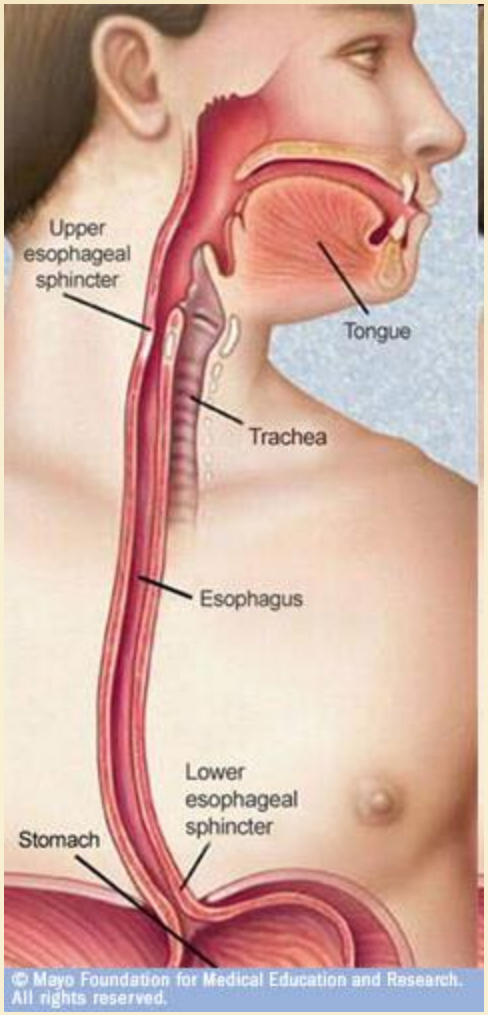


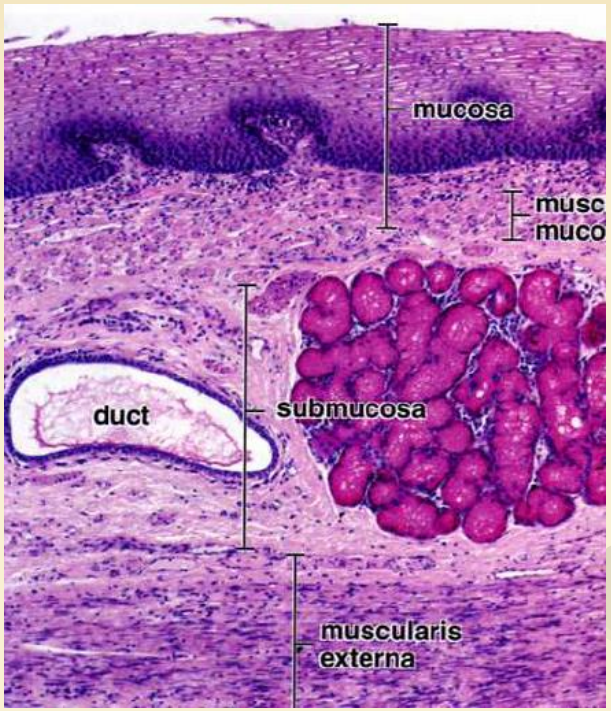
ALIMENTARY CANAL Layers



- ***mucosa*** (consisting of **epithelium**, an underlying connective tissue – **lamina propria**, and the **muscularis mucosae** composed of smooth muscle)
- ***submucosa*** (dense connective tissue)
- ***muscularis externa*** (two layers of smooth muscle)
- ***serosa /adventitia*** (connective tissue fixed to adjoining structures)

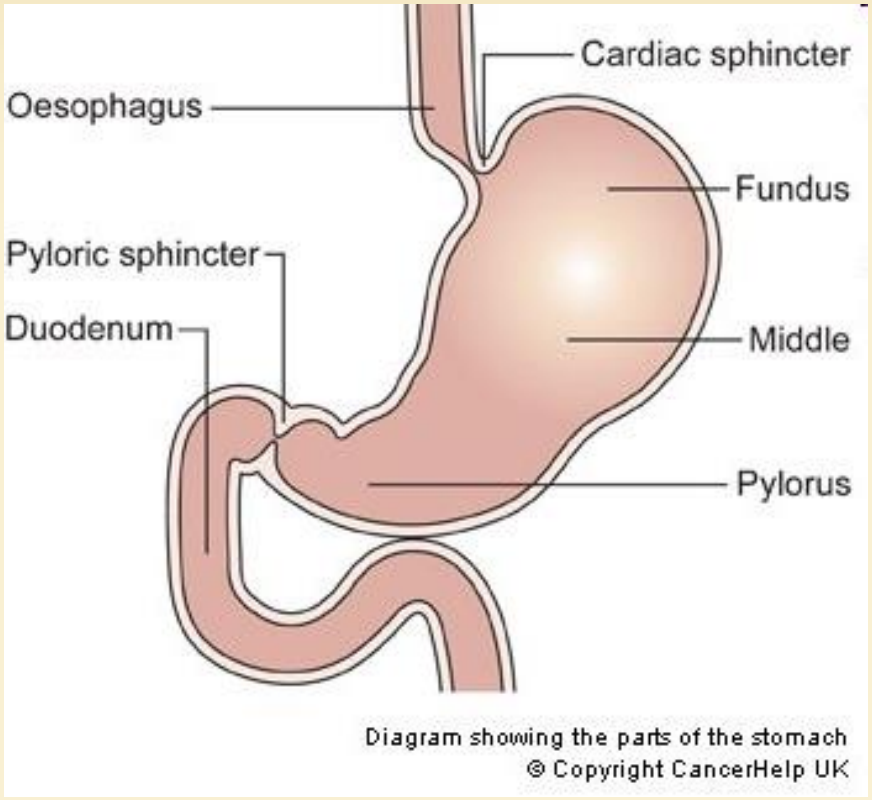
ESOPHAGUS





- muscular tube transporting the food bolus from the pharynx to the stomach
- courses through the neck and mediastinum
  - **cervical part**
  - **thoracic part**
  - **abdominal part**
- length is about 25 cm

STOMACH

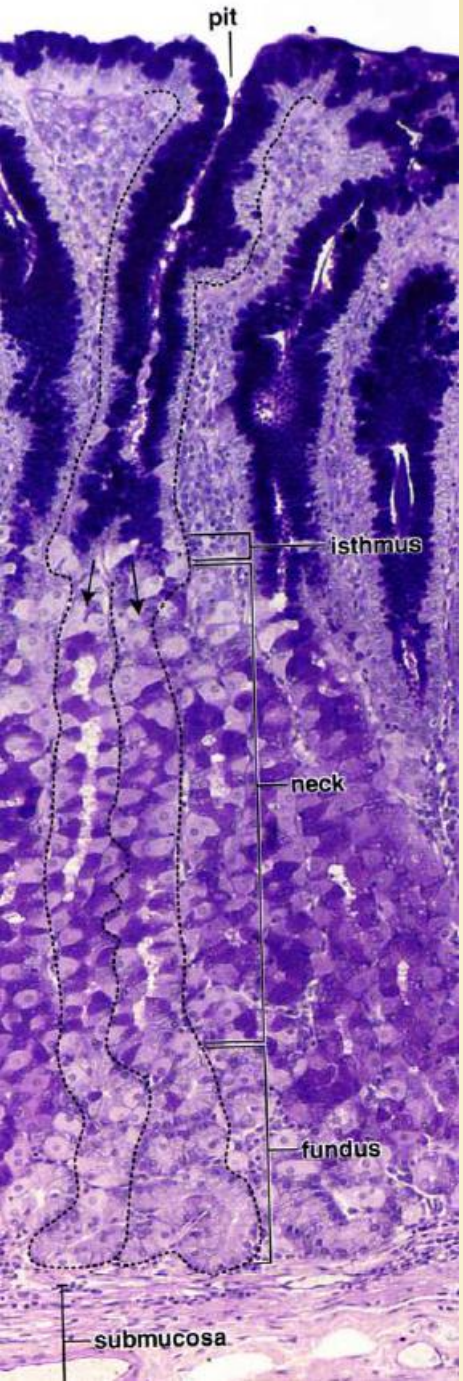


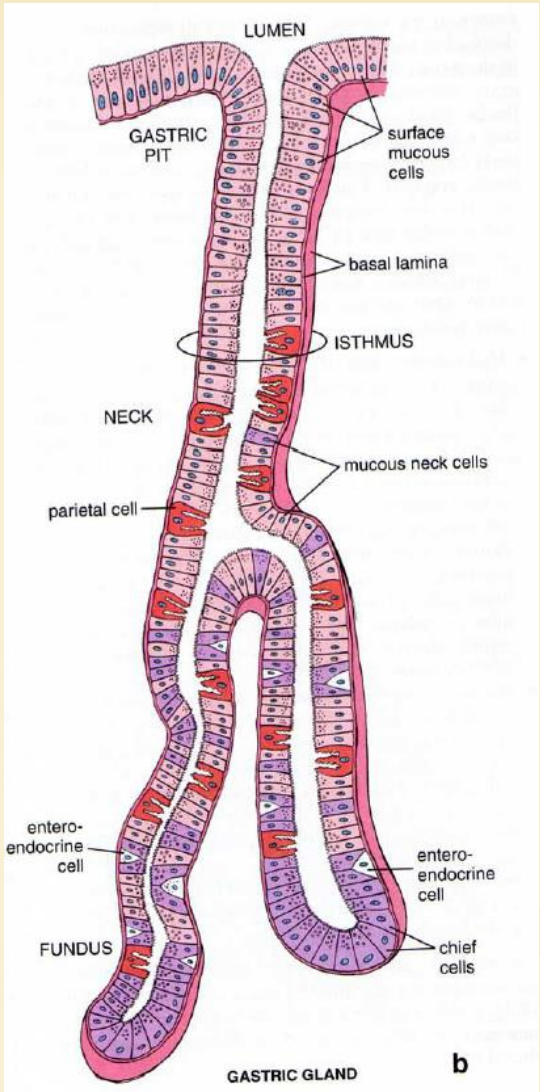
- an ***expanded part*** of the digestive tube that lies beneath the diaphragm
- receives the ***bolus*** of macerated food from the esophagus
- mixing and partial digestion of the food by gastric secretions produces a pulpy fluid mix called ***chyme***

- **cardia**
- **fundus**
- **corpus (body)**
- **pylorus**

- longitudinal ***submucosal*** folds, ***rugae***, allow the stomach to distend when filled

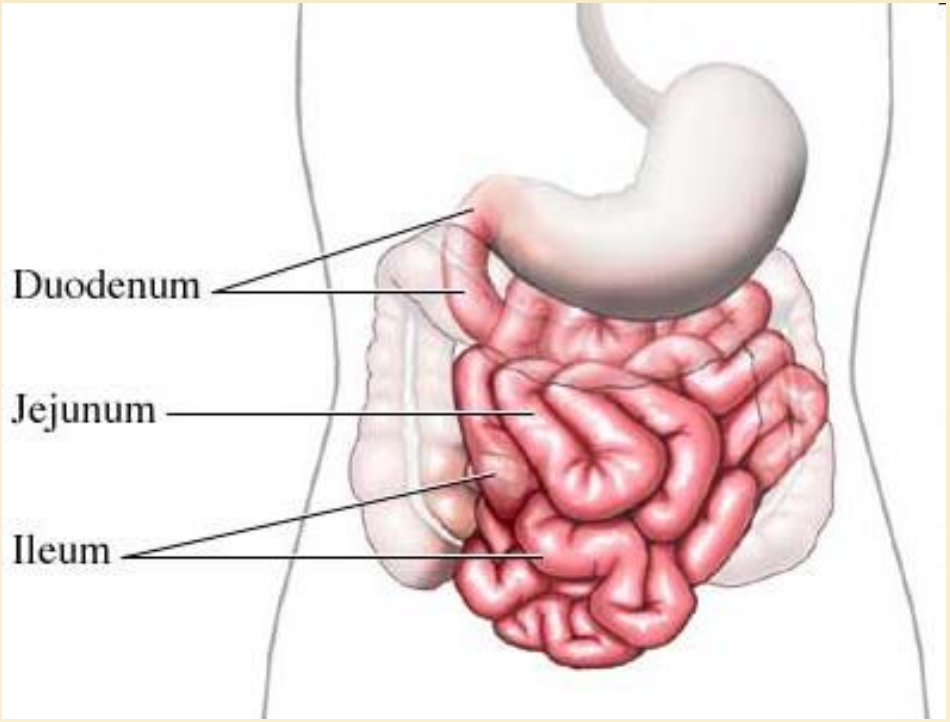
STOMACH Glands





- ***mucosa*** divided into smaller regions formed by grooves – ***gastric pits***
  - the ***gastric glands*** open into the bottom of the gastric pits
  - ***simple columnar*** epithelium
- **mucous neck cells** (secrete soluble mucus)
- **chief cells** (pepsinogen secreting cells)
- **parietal cell** (secrete HCl and intrinsic factor)
- **enteroendocrine cells** (dispersed local endocrinal function)

SMALL INTESTINE



- the ***longest*** component of the digestive tract, measuring over 6 m

- divided into three anatomic portions:

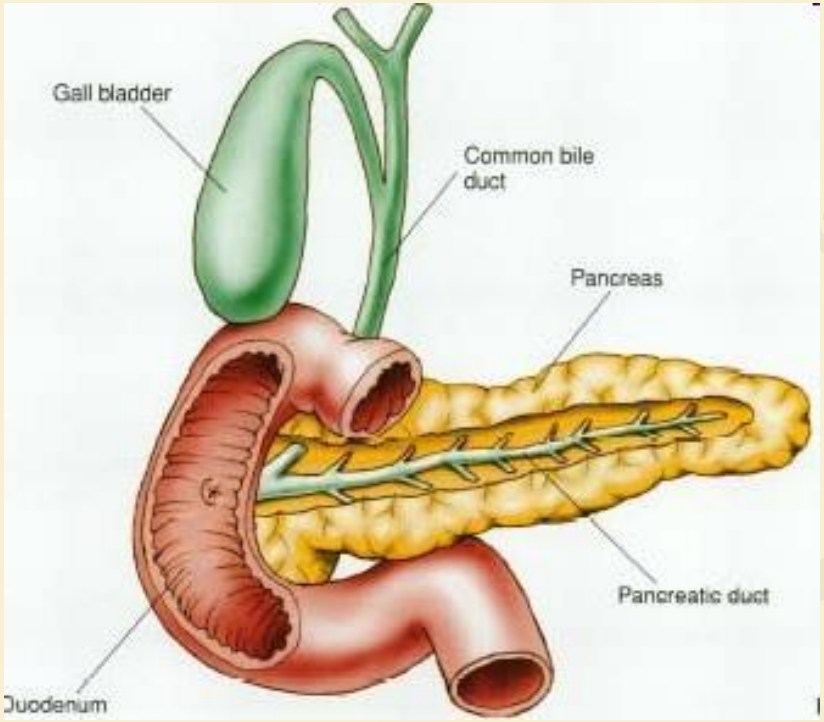
DUODENUM (~25 cm long)

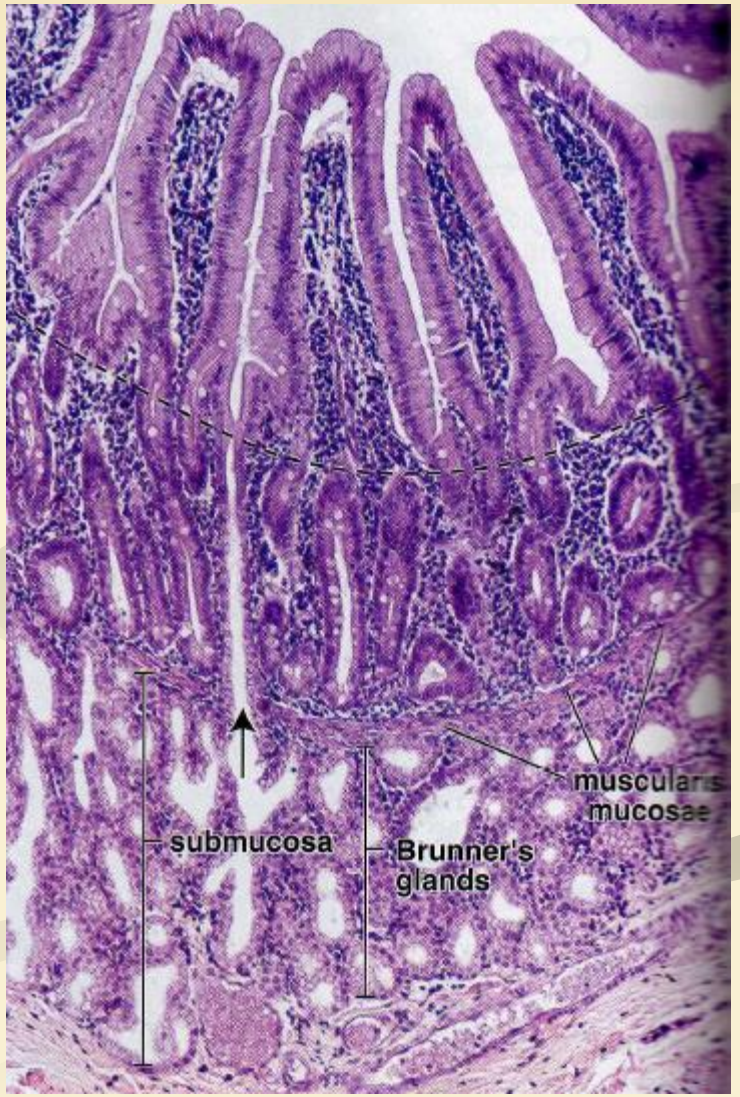
JEJUNUM (~2,5 m long)

ILEUM (~3,5 m long and ends at the ileocecal junction)

DUODENUM

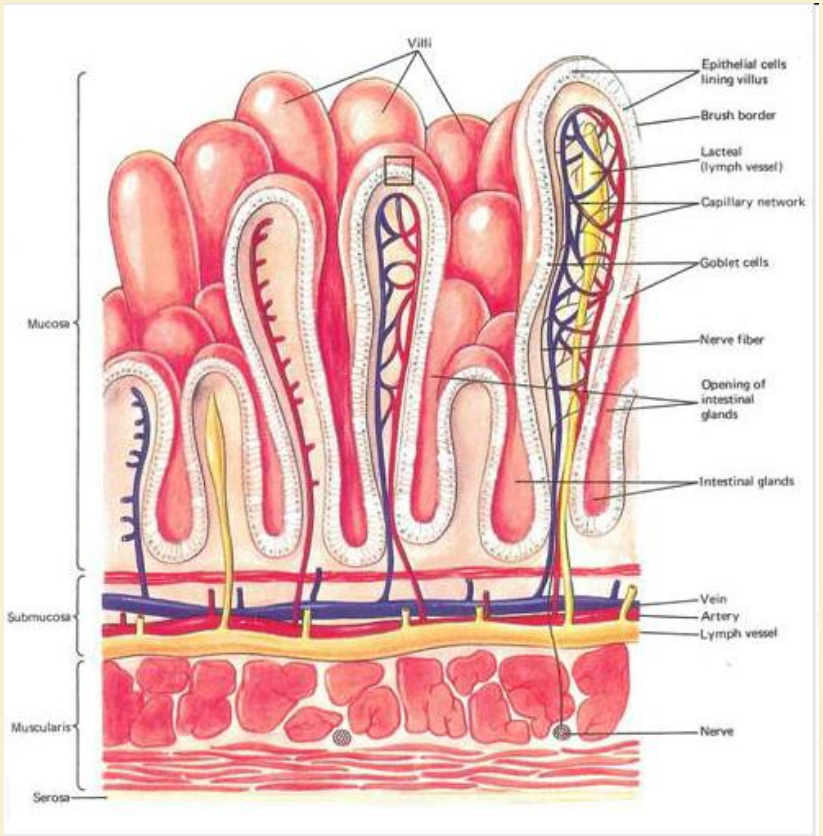
- **duodenal (Brunner´s) glands**
  - produce mucous that neutralizes the acid-containing chyme received from the stomach (*pH of 8,1 to 9,3*)





SMALL INTESTINE Mucosa

- the principal site for the ***digestion*** (enzymatic breakdown of nutrients into absorbable components) and ***absorption*** of nutrients

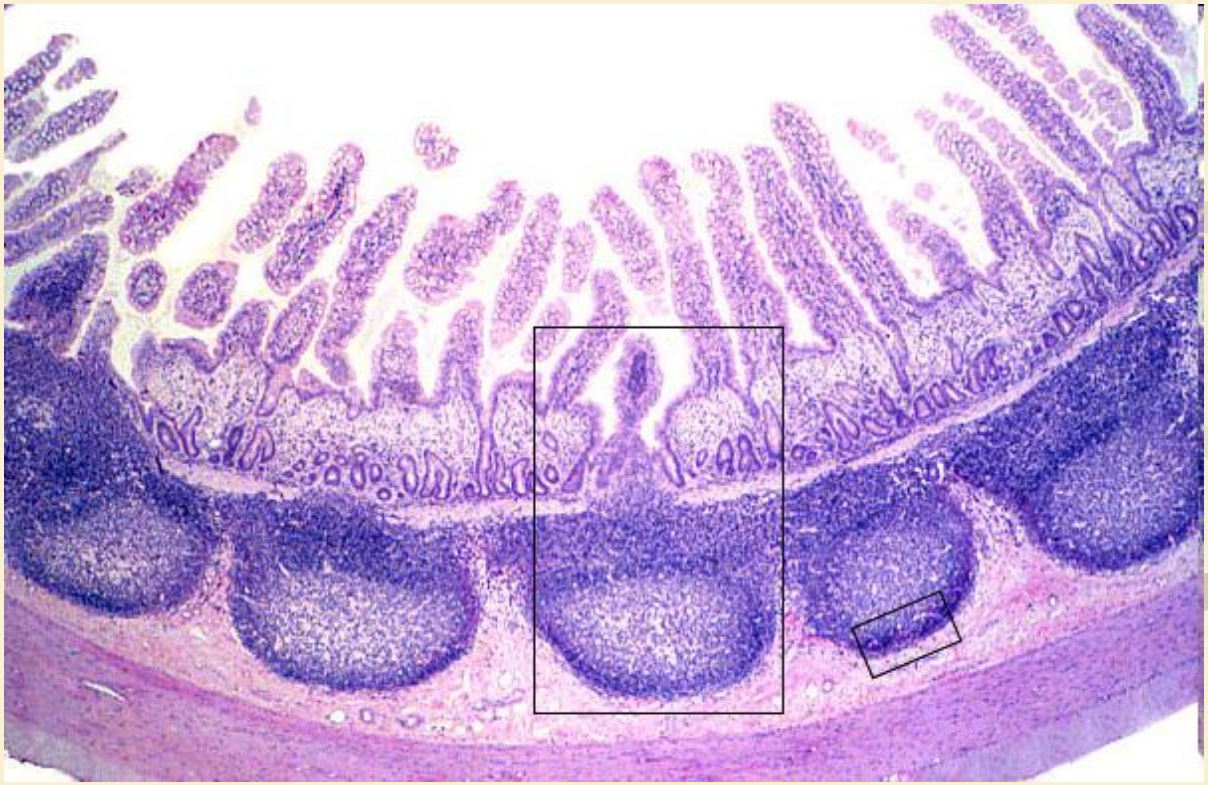


- ***intestinal villi*** and ***microvilli*** increase the absorptive surface area

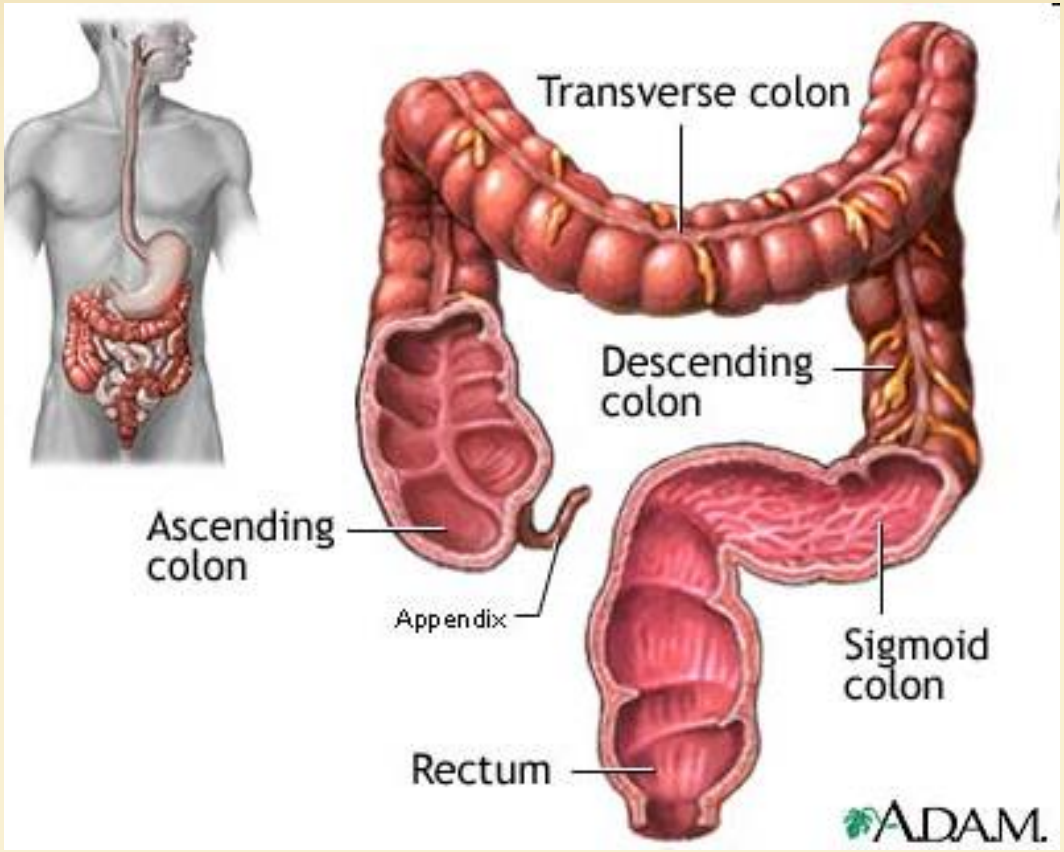
- **enterocytes** (producing enzymes needed for terminal digestion and absorption)
- **goblet cells** (produce mucus)
- **enteroendocrine cells** (produce peptide hormones)

SMALL INTESTINE GALT

- **GALT (gut-associated lymphatic tissue)**
- prominent in the lamina propria of small intestine
- nodes fuse to form large accumulations of LT called ***Peyer´s patches***

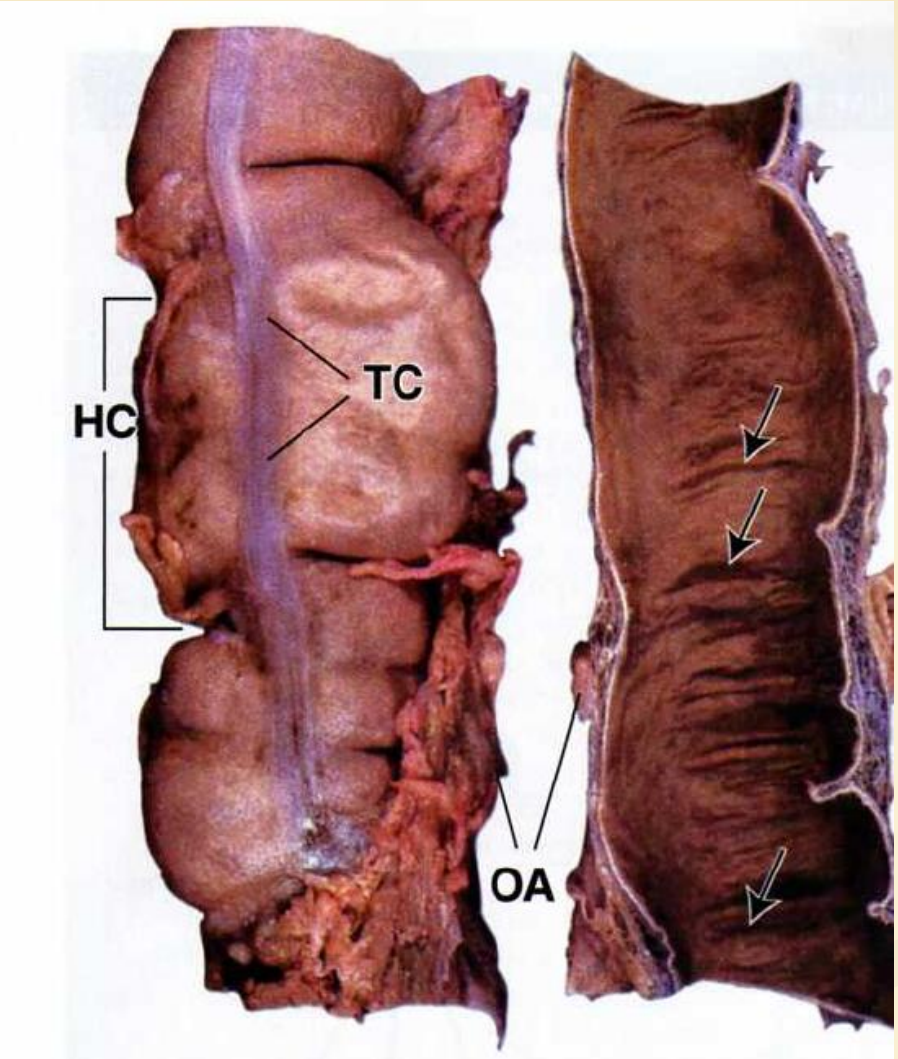


LARGE INTESTINE



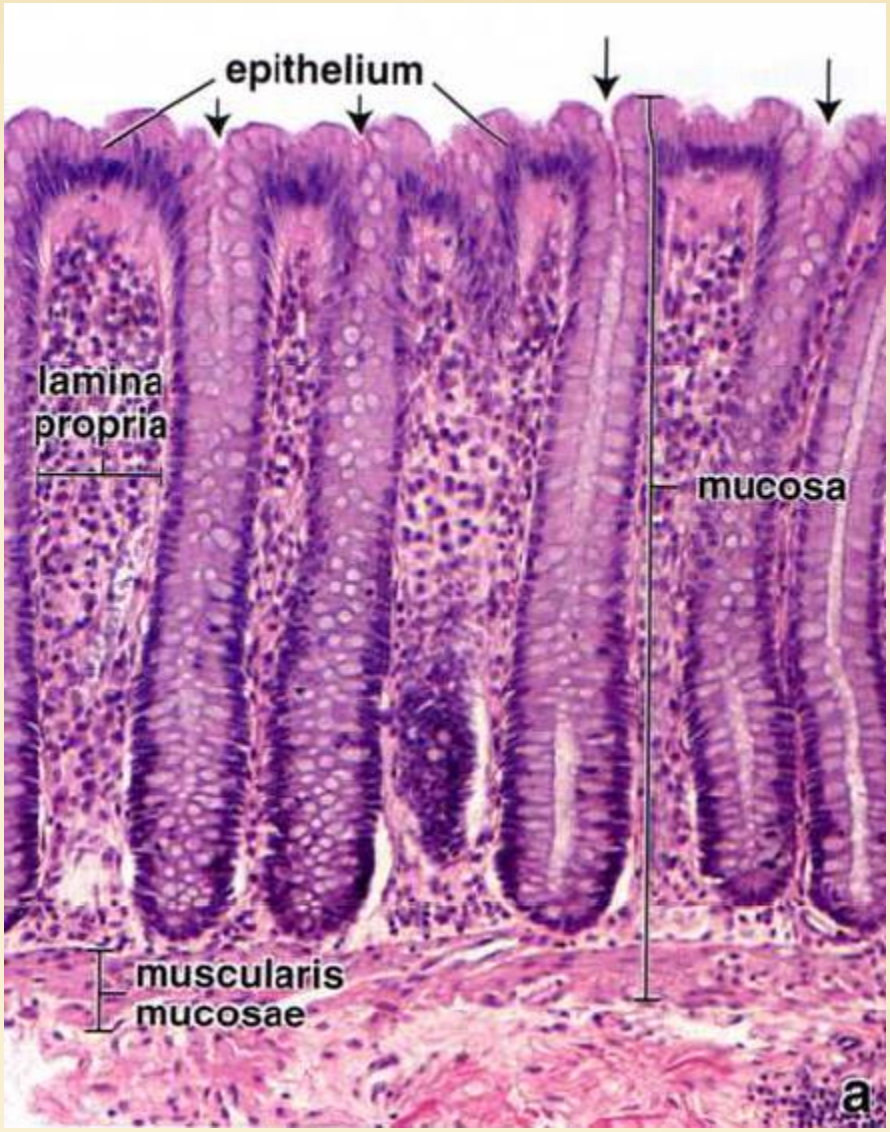
- **CECUM (CAECUM)** with **VERMIFORM APPENDIX**
- **COLON**
  - ascending
  - transverse
  - descending
  - sigmoid
- **RECTUM**
- **ANAL CANAL**

LARGE INTESTINE



- the outer longitudinal layer of muscles exhibits three thickened, equally spaced bands – ***teniae coli***
- the external surface of the cecum and colon exhibits sacculations – ***haustra*** – visible between teniae
- small fatty projections of the serosa – ***omental appendices***

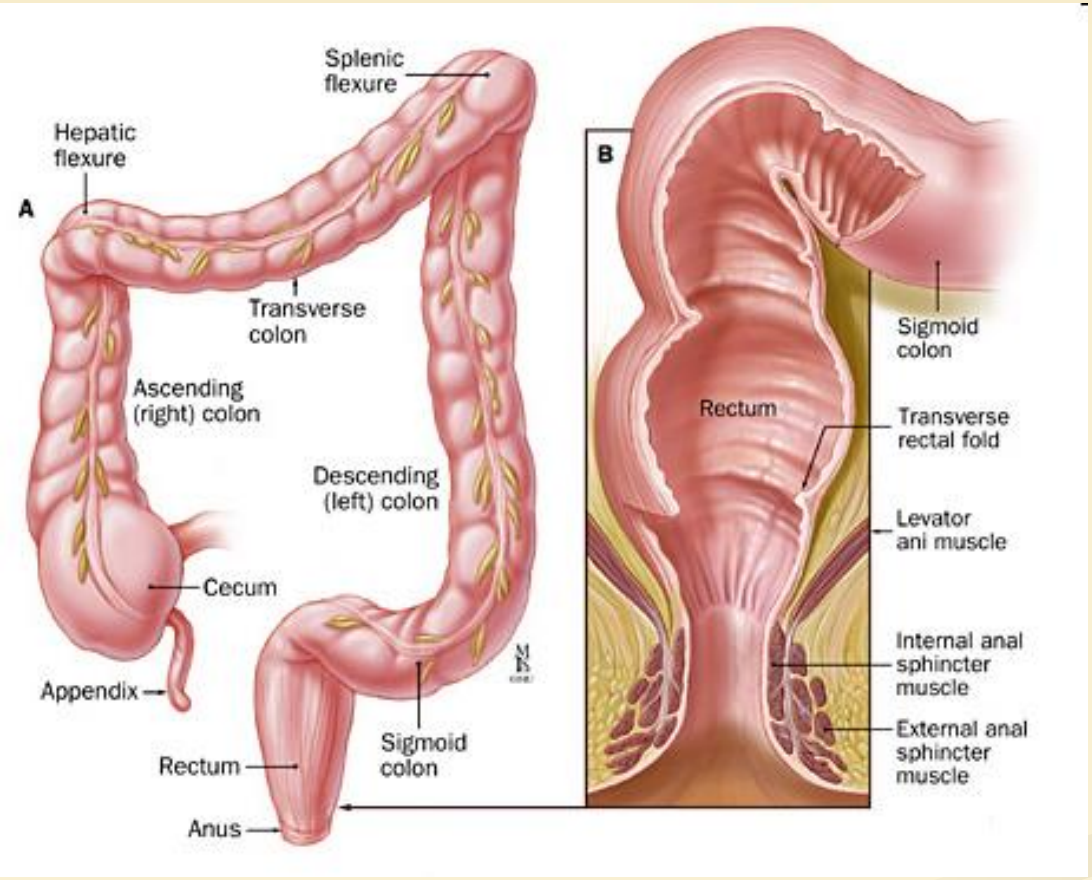
LARGE INTESTINE Mucosa



- the principal functions – ***reabsorption of electrolytes and water*** and ***elimination*** of undigested food and waste

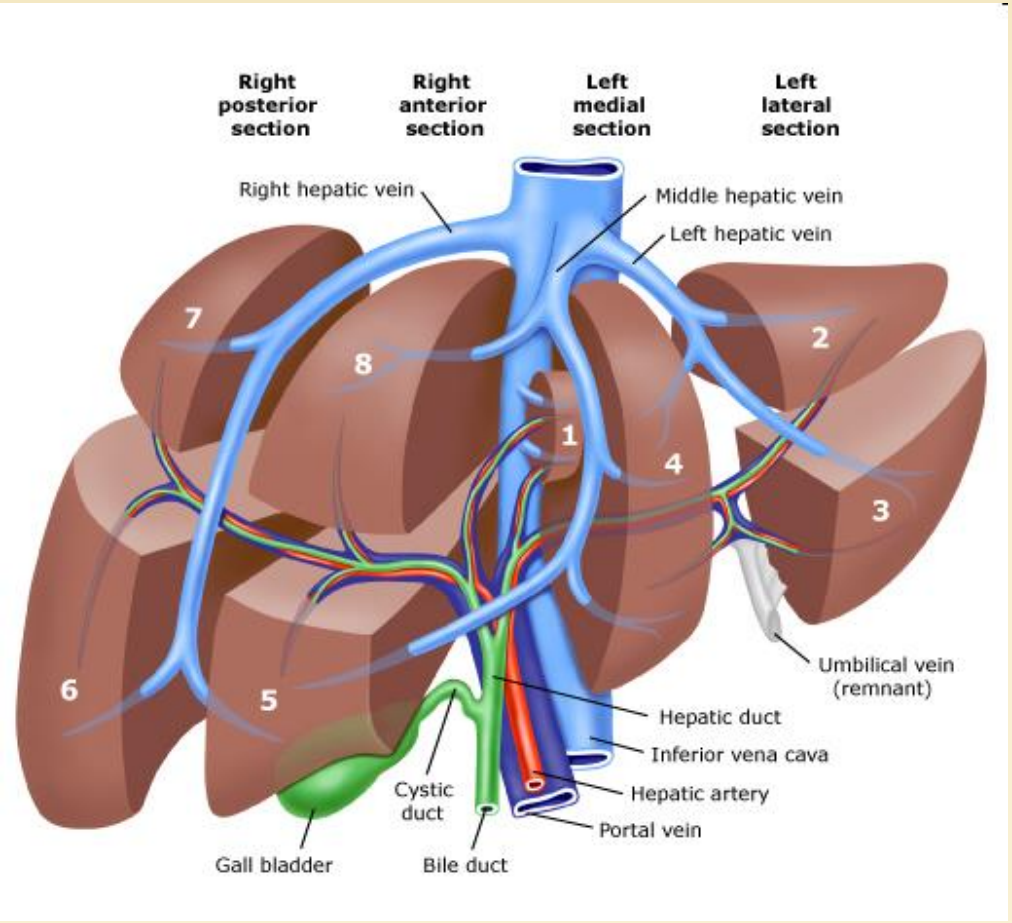
- mucosal epithelium contains the ***same cell types as the small intestine***

LARGE INTESTINE Rectum and Anal Canal



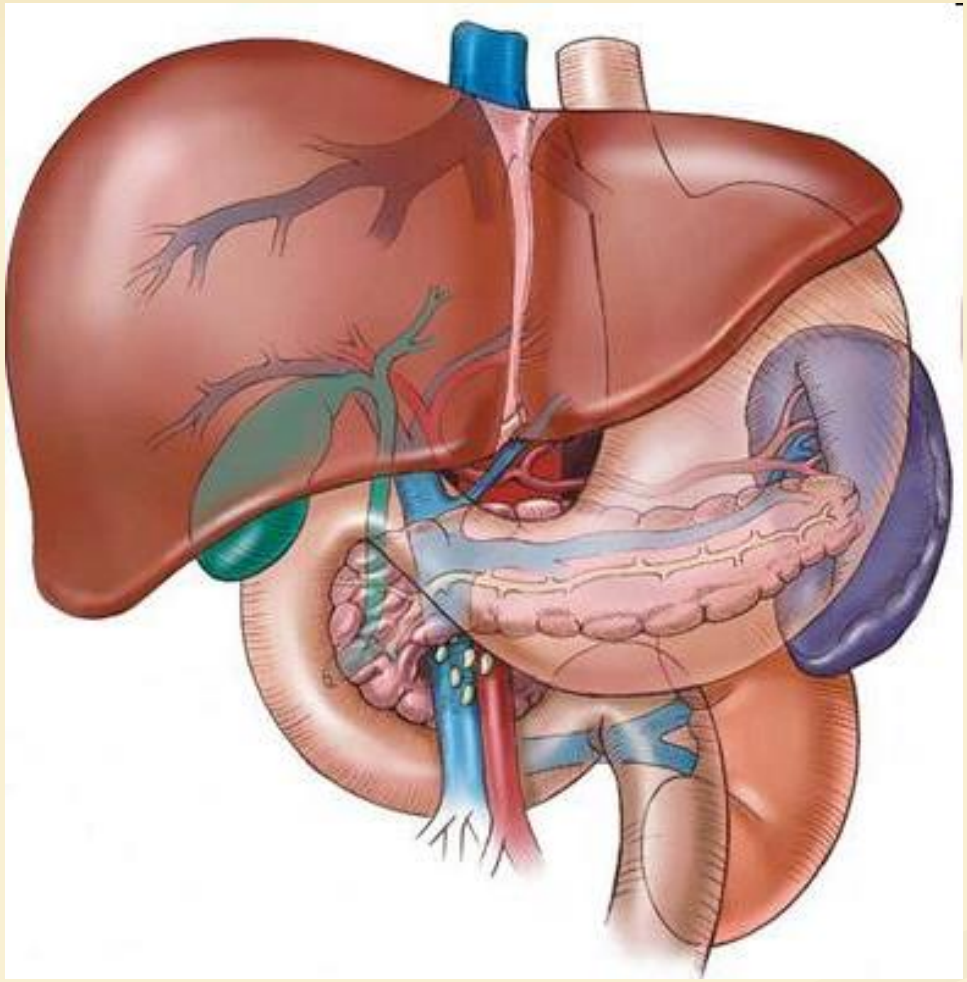
- **RECTUM**
  - dilated distal portion of the alimentary canal
  - presence of folds called **transverse rectal folds**
- **ANAL CANAL**

LIVER



- the ***largest mass of glandular tissue*** in the body weighing approximately 1500g
- located in the ***upper right*** and partially in the upper left ***quadrants*** of the abdominal cavity
- ***enclosed in a capsule*** of ***fibrous*** tissue
- anatomically divided by deep grooves into ***two large lobes*** (the right and left lobes) and ***two smaller lobes*** (the quadrate and caudate lobes)

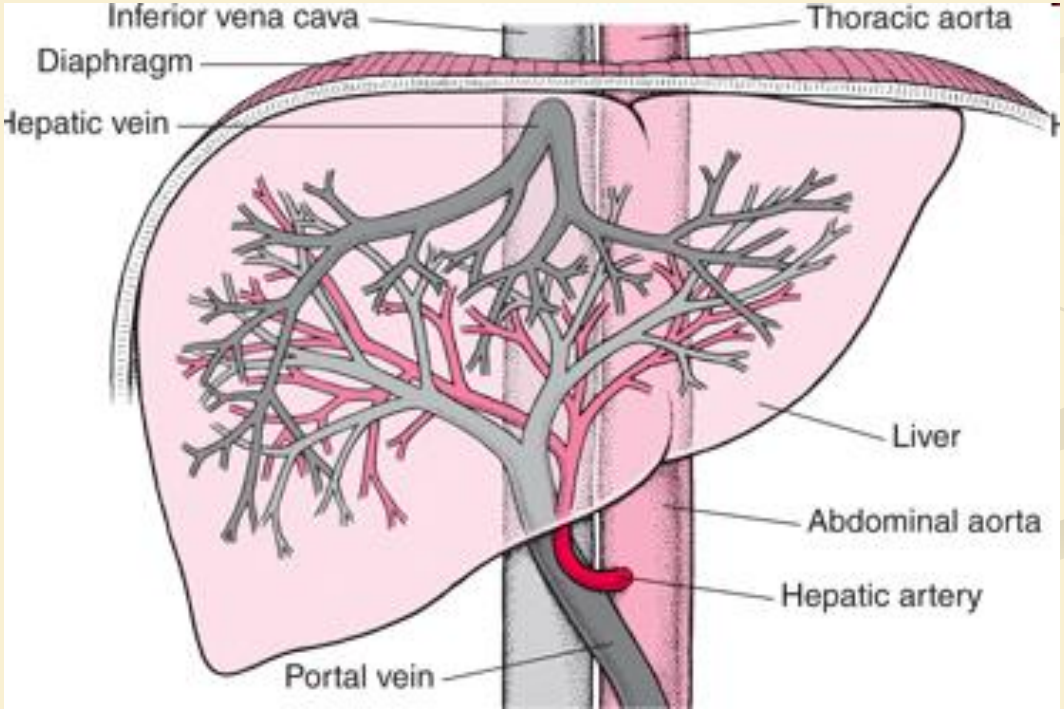
LIVER Physiology



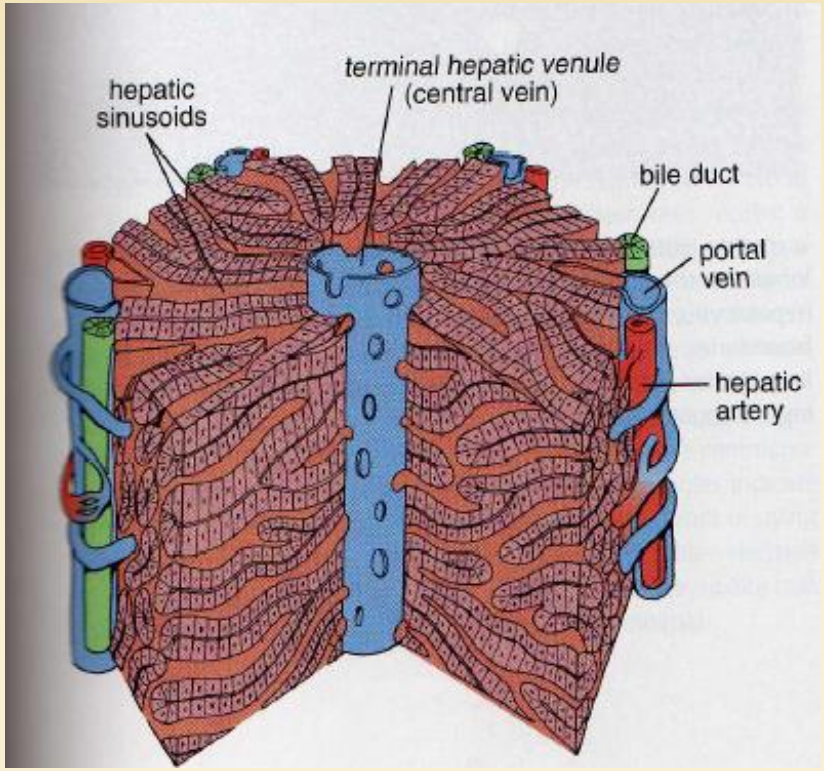
- produces most of the body´s circulating ***plasma proteins*** (albumins, lipoproteins, glycoproteins, prothrombin and fibrinogen, α- and β-globulins)
- stores and converts several ***vitamins and iron*** (vitamin A, vitamin D, vitamin K)
- degrades ***drugs*** and ***toxins***
- is involved in many other important ***metabolic pathways***
- ***bile production***

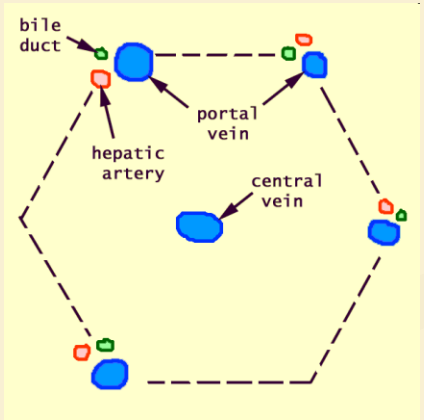
LIVER Blood Supply

- unique blood supply
- dual blood supply consisting of a venous (portal) supply via **the portal vein** and an arterial supply via **the hepatic artery**
- both vessels enter the liver at a hilum – ***porta hepatis***
- receives the blood that initially supplied the ***intestines, pancreas,*** and ***spleen***



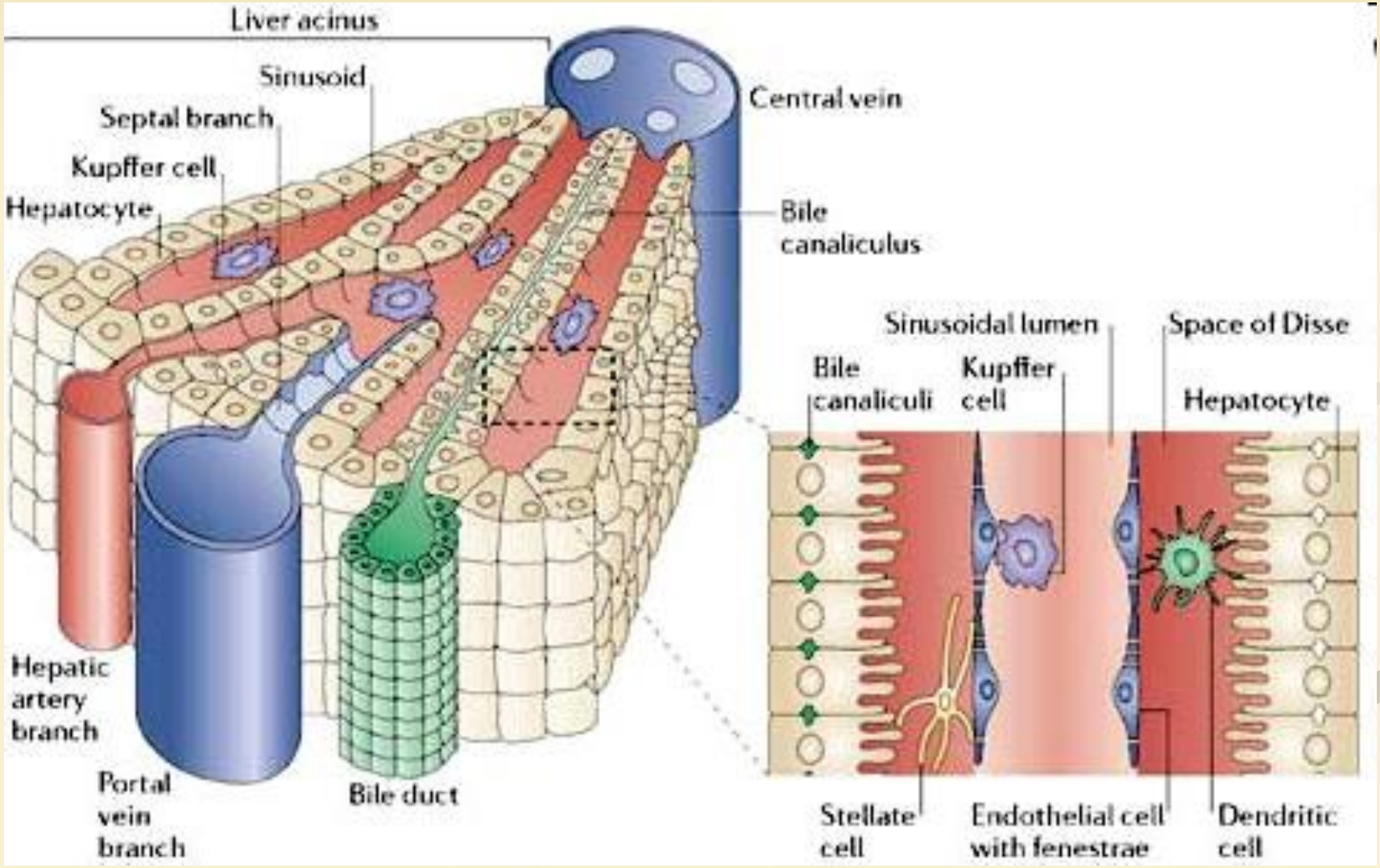
LIVER Histology



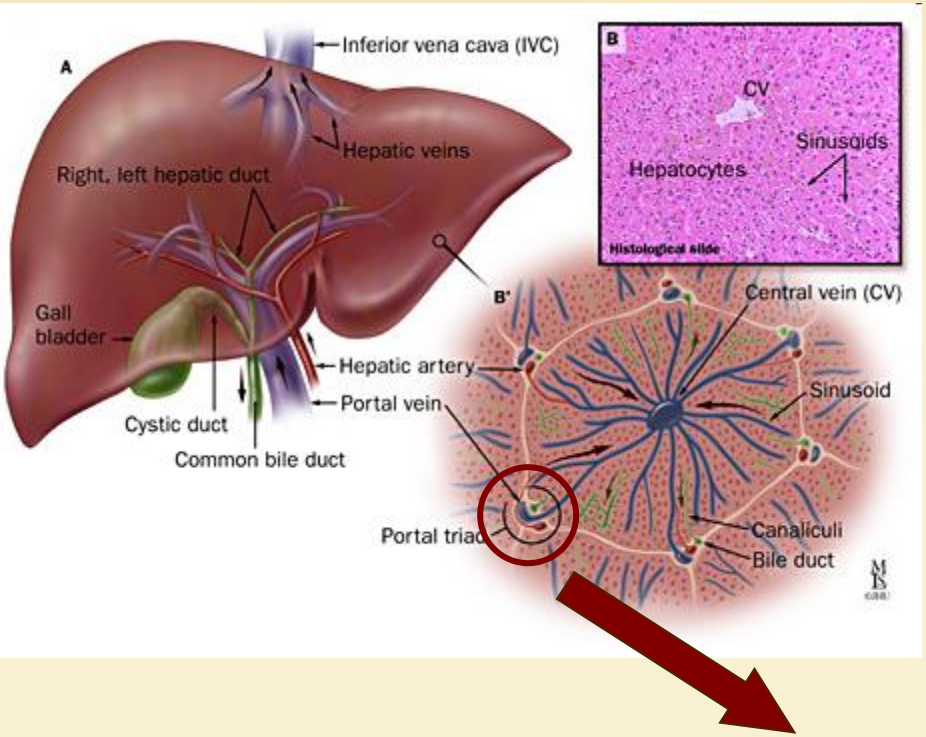


- the **hepatic lobule** is a hexagonal mass of tissue
- consists of ***stacks of anastomosing plates of* hepatocytes**, one cell thick
- separated by the anastomosing system of **sinusoids** that perfuse the cells
- sinusoids drain into the **central vein** which drains into the hepatic vein which empties into the inferior vena cava

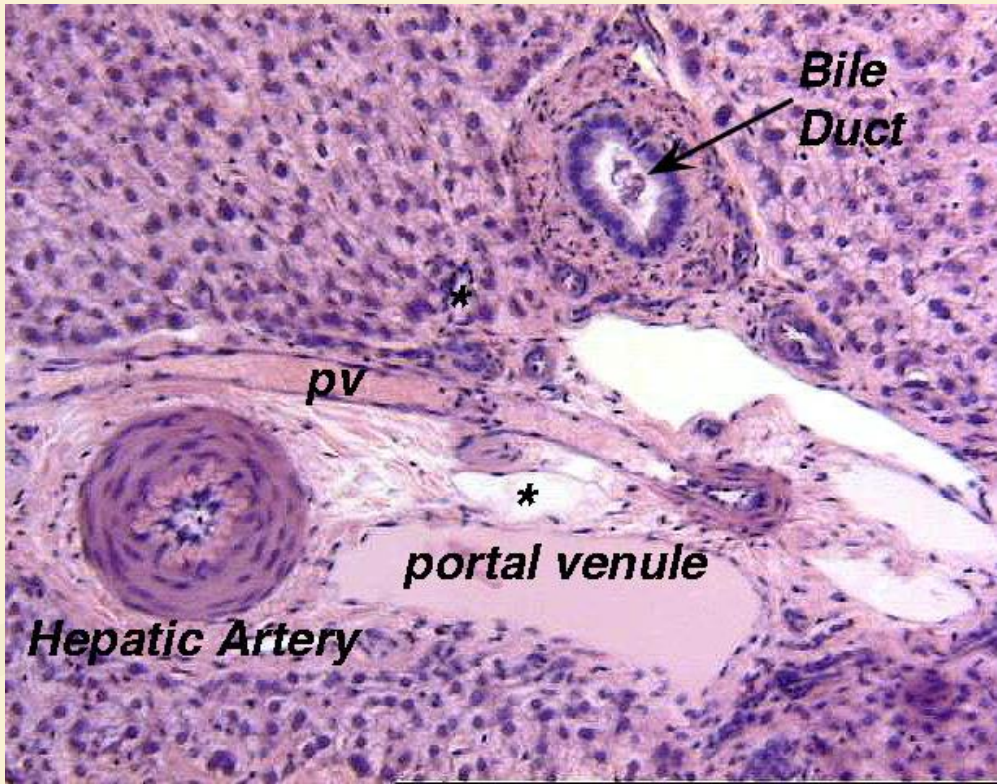
LIVER Histology



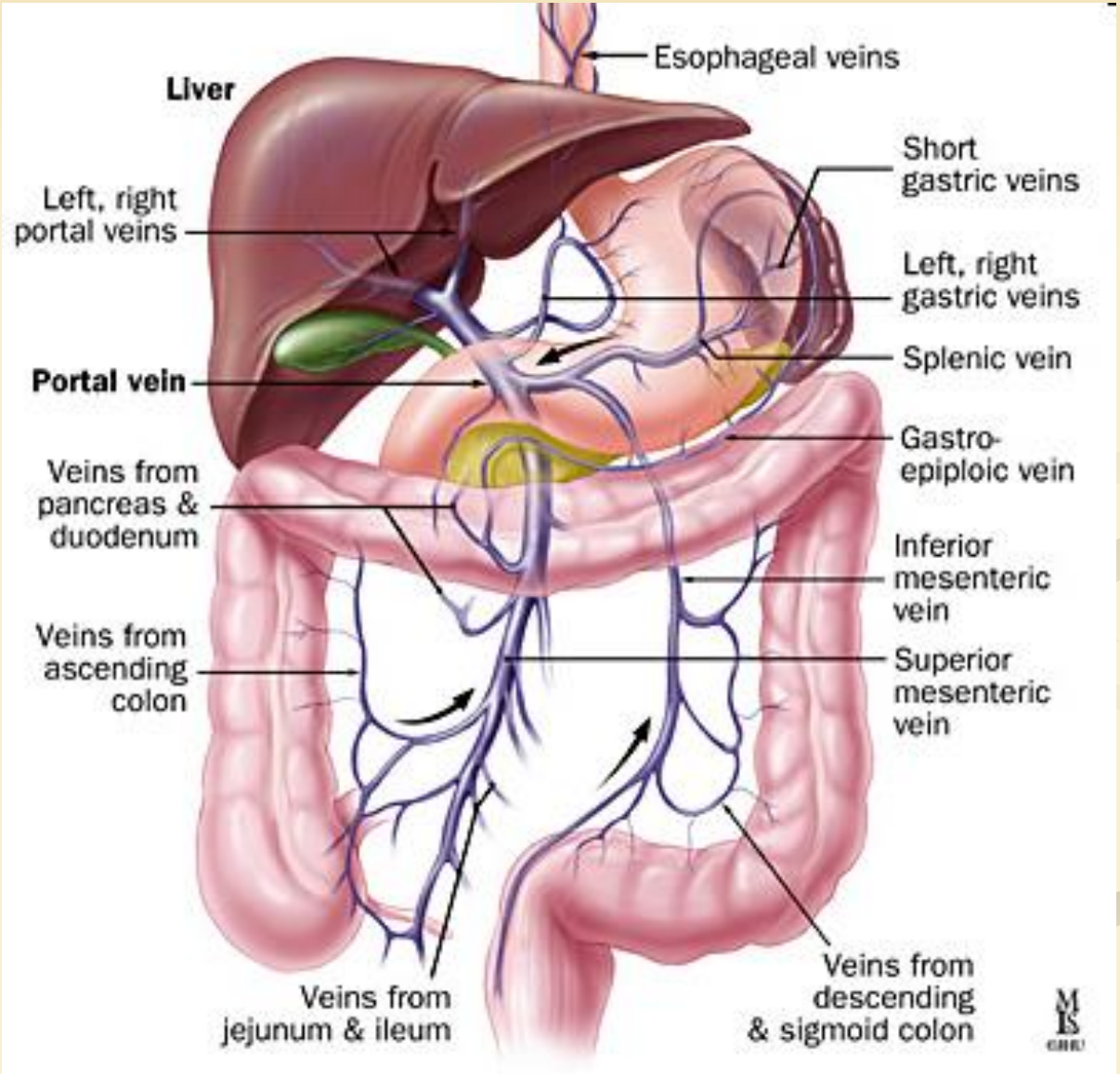
LIVER Portal Triad



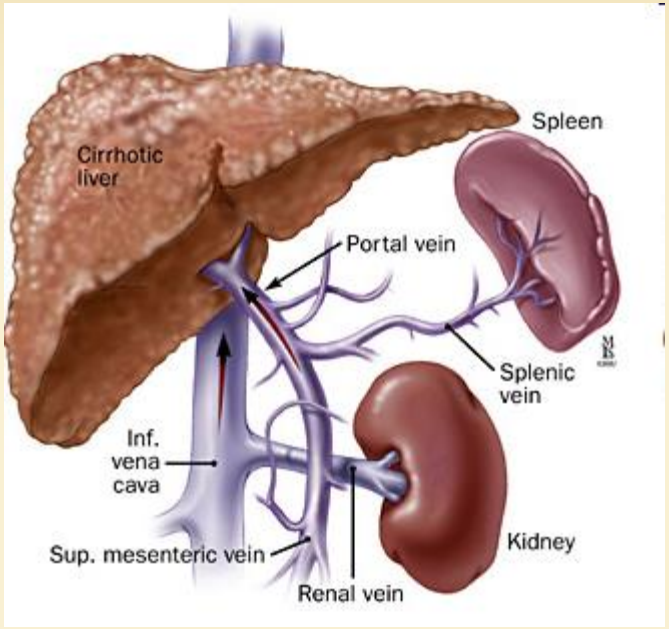
- hepatic artery
- hepatic portal vein
- bile duct

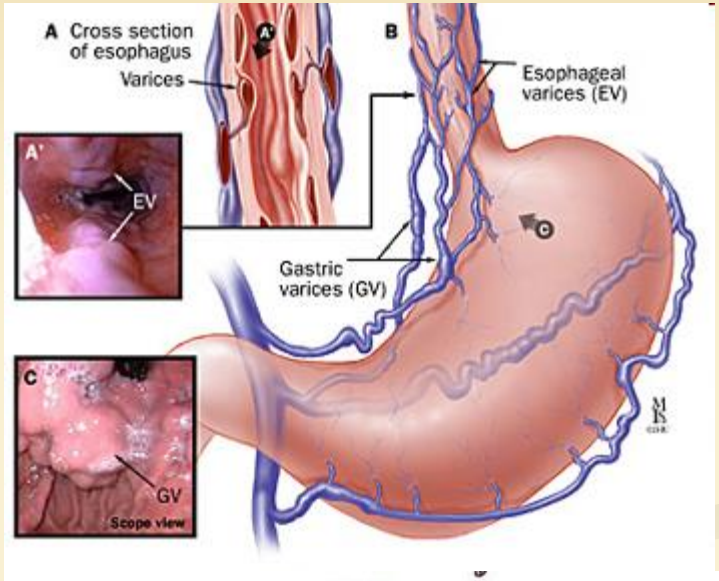


Portal Circulation



Portocaval Anastomoses





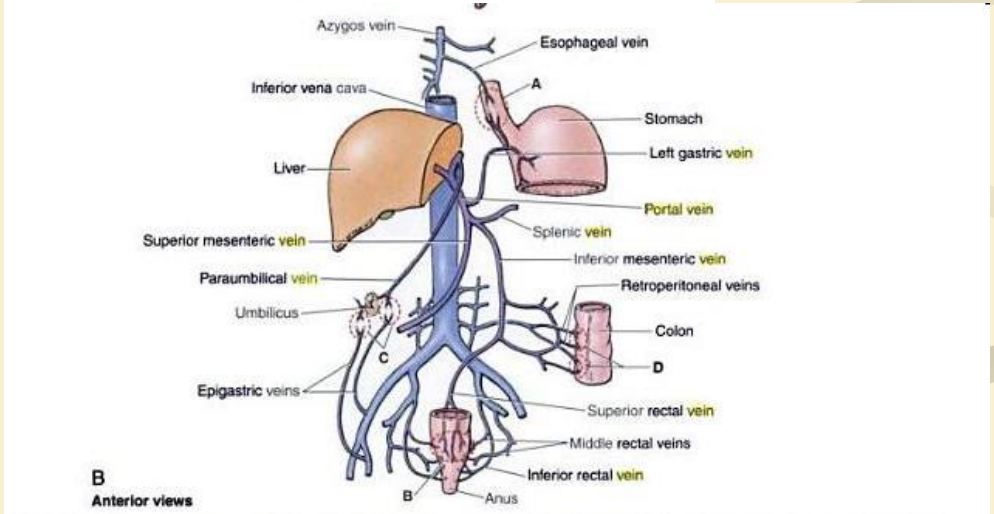
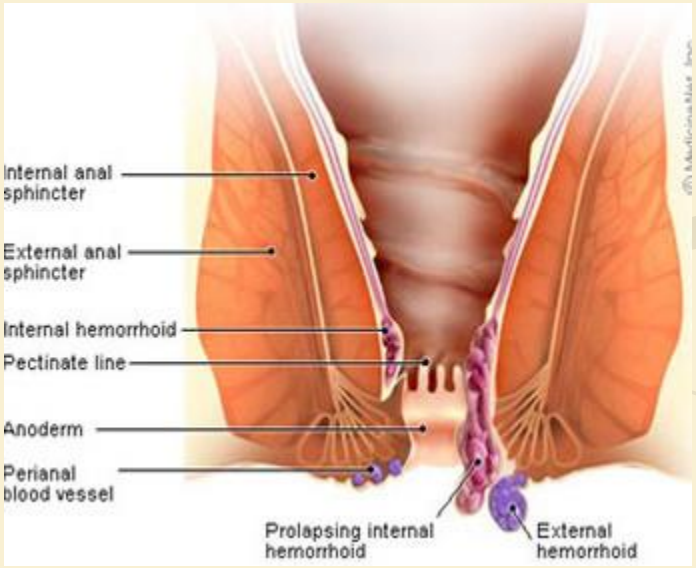


Figure 2.30. Portal venous system. A. The venous system is demonstrated. **B.** Portal–systemic anastomoses provide collateral circulation in cases of obstruction in the liver or portal vein. *Darker blue,* portal tributaries; *lighter blue,* systemic tributaries; *A,* anastomoses between esophageal veins; *B,* anastomoses between rectal veins; *C,* anastomoses between the paraumbilical veins (portal) and small epigastric veins of the anterior abdominal wall; *D,* anastomoses between the twigs of colic veins (portal) and the retroperitoneal veins.

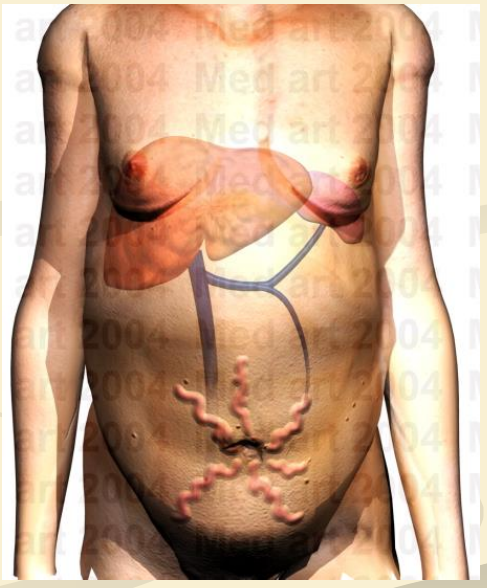
Portocaval Anastomoses

esophageal varices

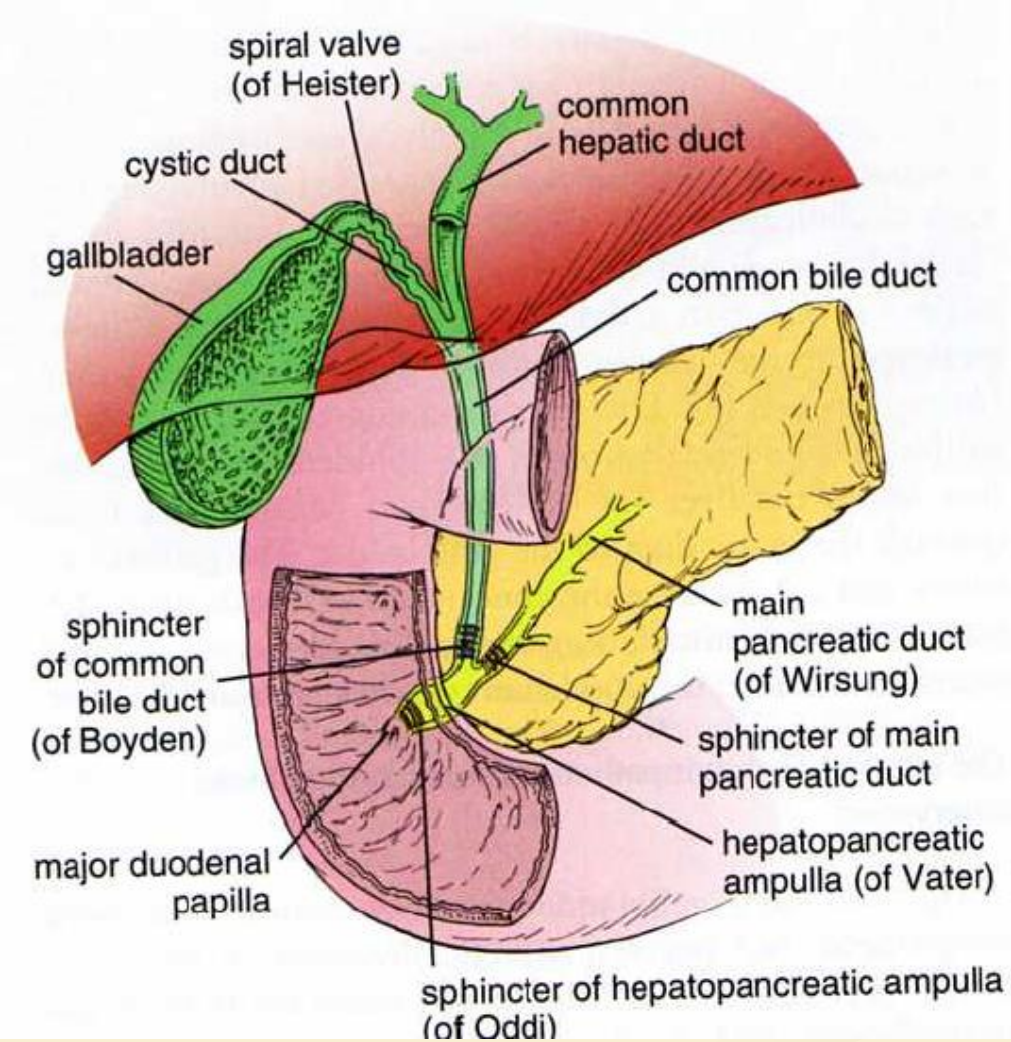
hemorrhoids



caput Medusae



GALLBLADDER

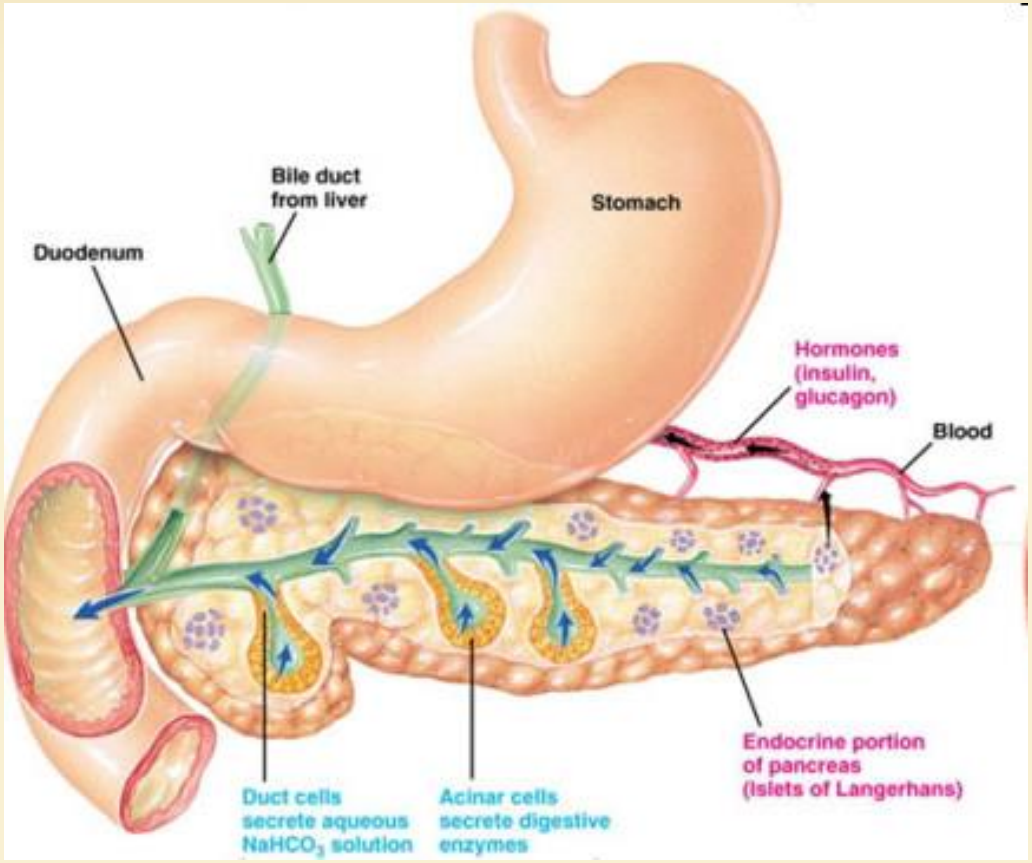


- pear-shaped, distensible sac with a volume of about 50 ml

- **neck**
- **body**
- **fundus**

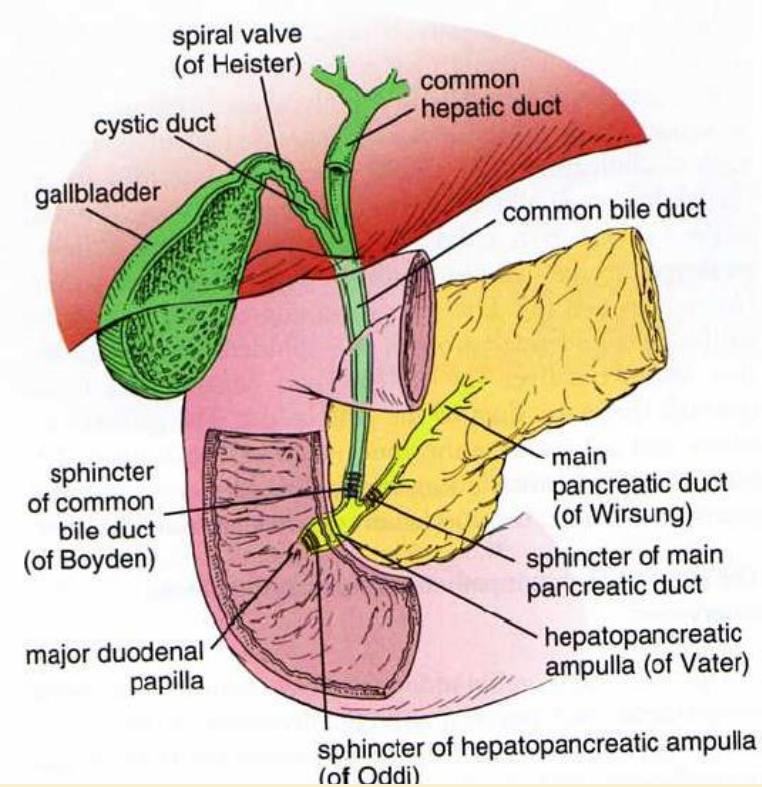
- concentrates and stores ***bile***
- secretion of bile is ***stimulated by the presence of fat*** in the duodenum
- bile contains water, ions, bilirubin, bile salts
- important emulsifier

PANCREAS



- **head** – expanded portion that lies in the C-shaped curve of the duodenum
- **body** – centrally located crosses the midline of the human body
- **tail** – extends toward the hilum of the spleen

PANCREAS – Exocrine Gland



- a ***serous*** gland producing **the digestive enzyme precursors**
  - **pancreatic amylase**
  - **pancreatic lipase**
  - **proteases (trypsin, chymotrypsin)**
- enzymes leave the gland via the **pancreatic duct** that joins with the common bile duct to drain into the duodenum at the **hepatopancreatic ampulla (of Vater)**
- controlled by **hepatopancreatic sphincter (of Oddi)** surrounding the ampulla, regulates the flow of bile and pancreatic juice into the duodenum and also prevents reflux of intestinal contents into the pancreatic duct

PANCREAS – Endocrine Gland

- a diffuse organ that secretes hormones that ***regulate blood glucose levels***
- **the islets of Langerhans** scattered throughout the organ in cell groups of varying size

- **alpha cells** producing **glucagon**
- **beta cells** producing **insulin**
- delta cells producing somatostatin