

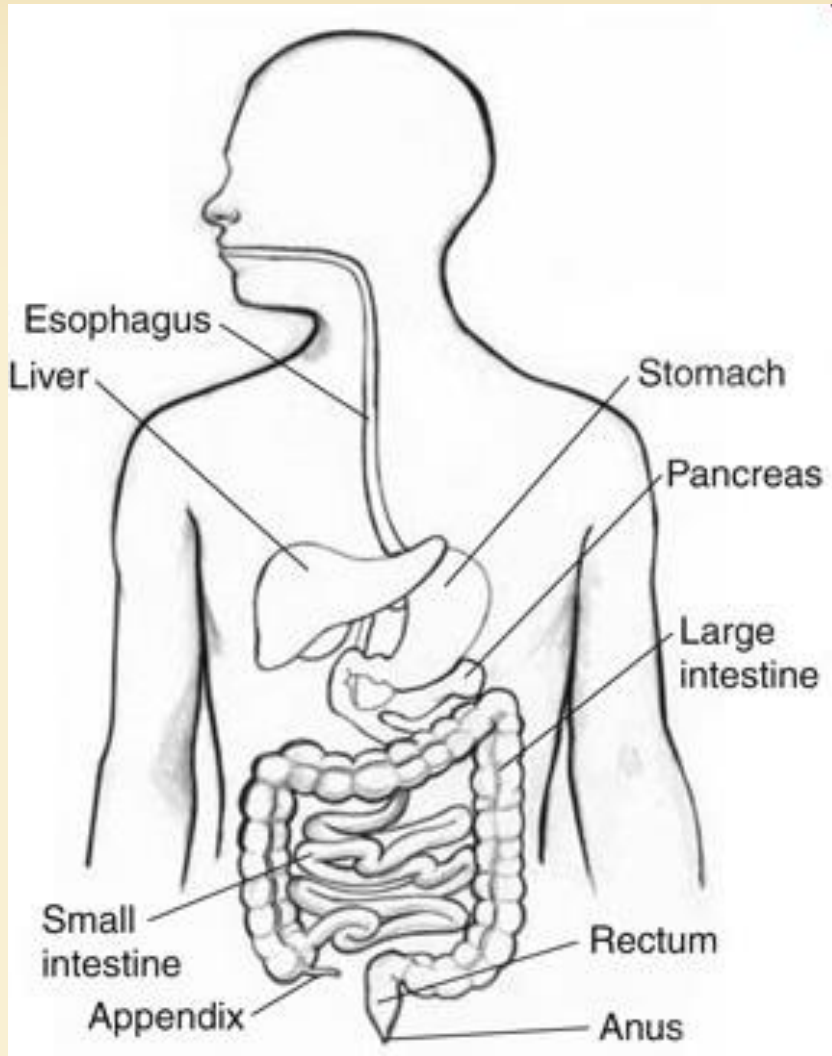
# **GASTROINTESTINAL SYSTEM**

lecture from Human Morphology

4. 11. 2021

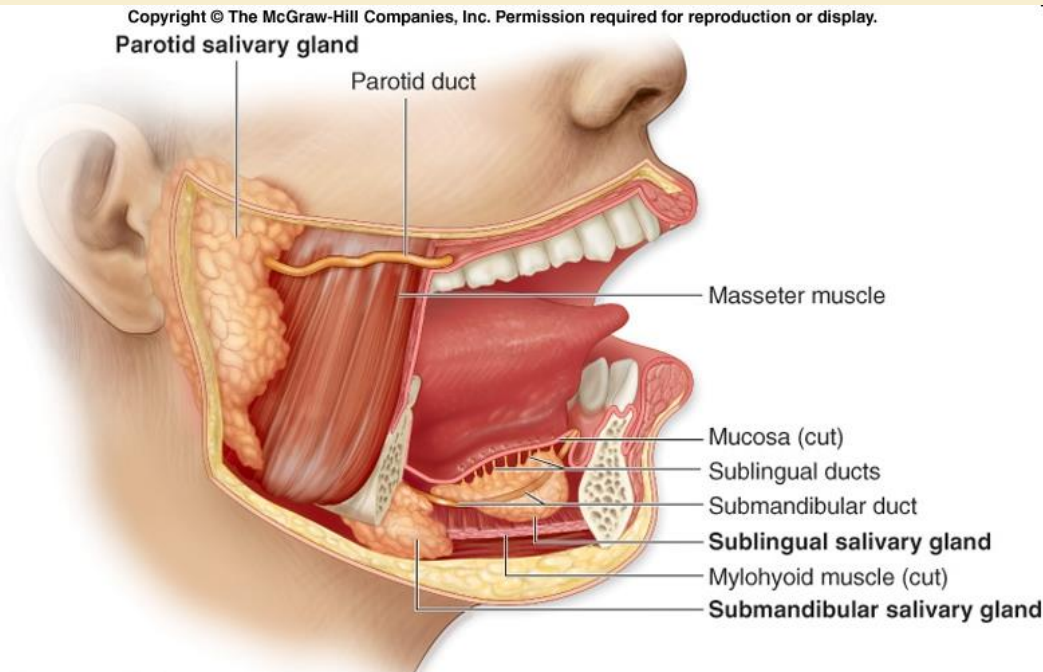
M. Chalupová

# GASTROINTESTINAL SYSTEM



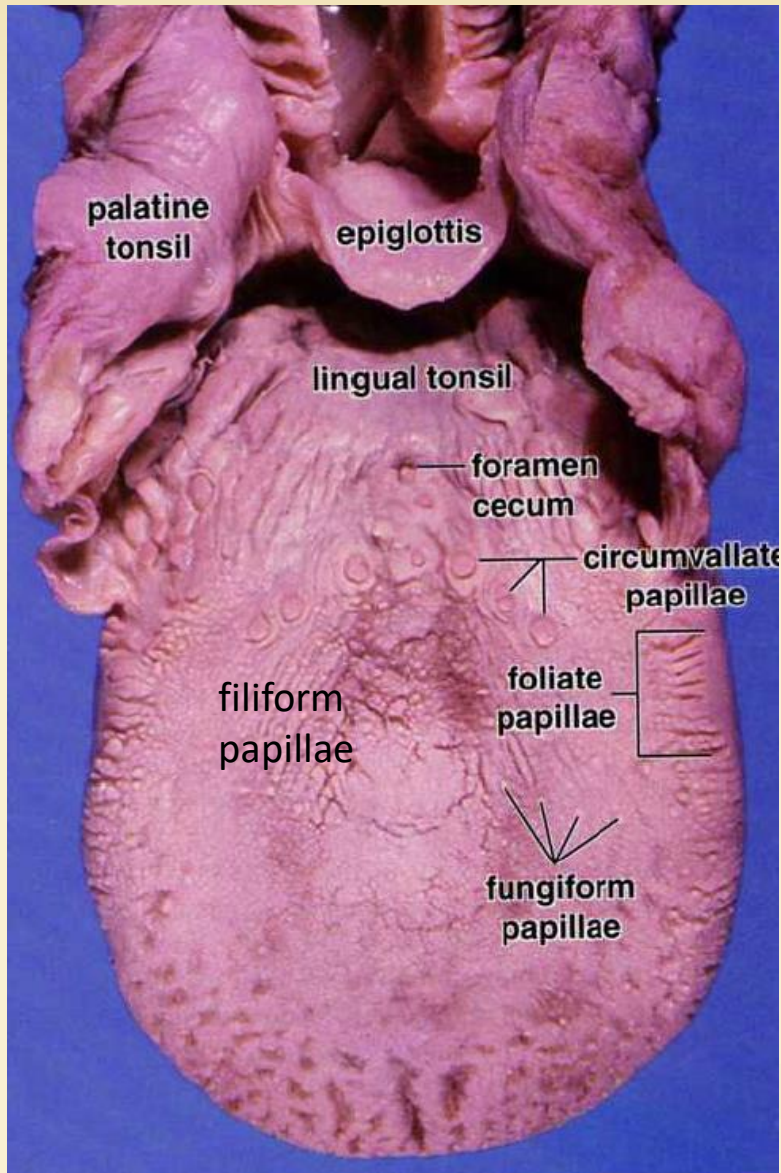
- Oral cavity and associated structures
- Pharynx
- Esophagus
- Stomach
- Small intestine
- Large intestine
  
- Liver
- Gallbladder
- Pancreas

# ORAL CAVITY



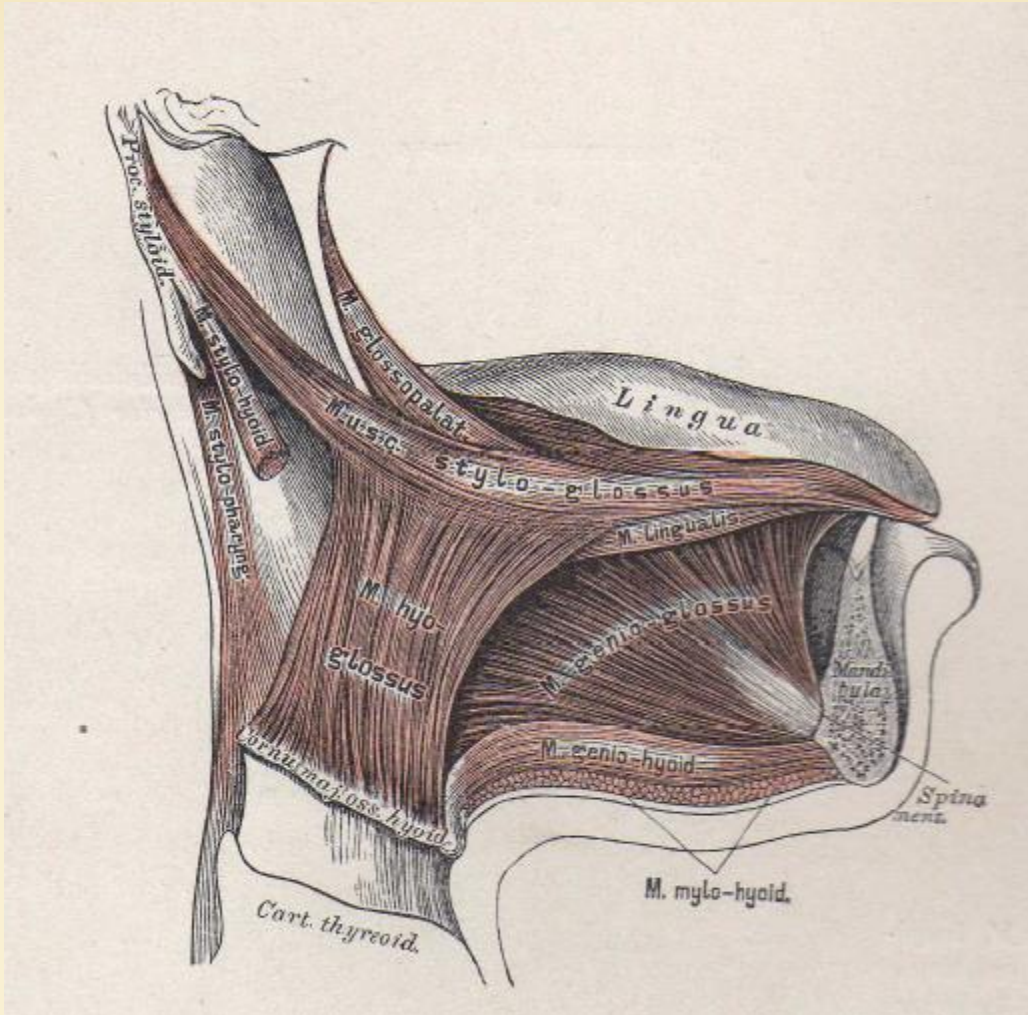
- **VESTIBULE**
  - space between the lips, cheeks, and teeth
- **ORAL CAVITY PROPER**
  - behind the teeth, bounded by the hard and soft palates superiorly, the tongue and the floor of the mouth inferiorly, and the entrance to the oropharynx posteriorly
- **TONGUE**
- **TEETH** and their supporting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

# ORAL CAVITY – Tongue



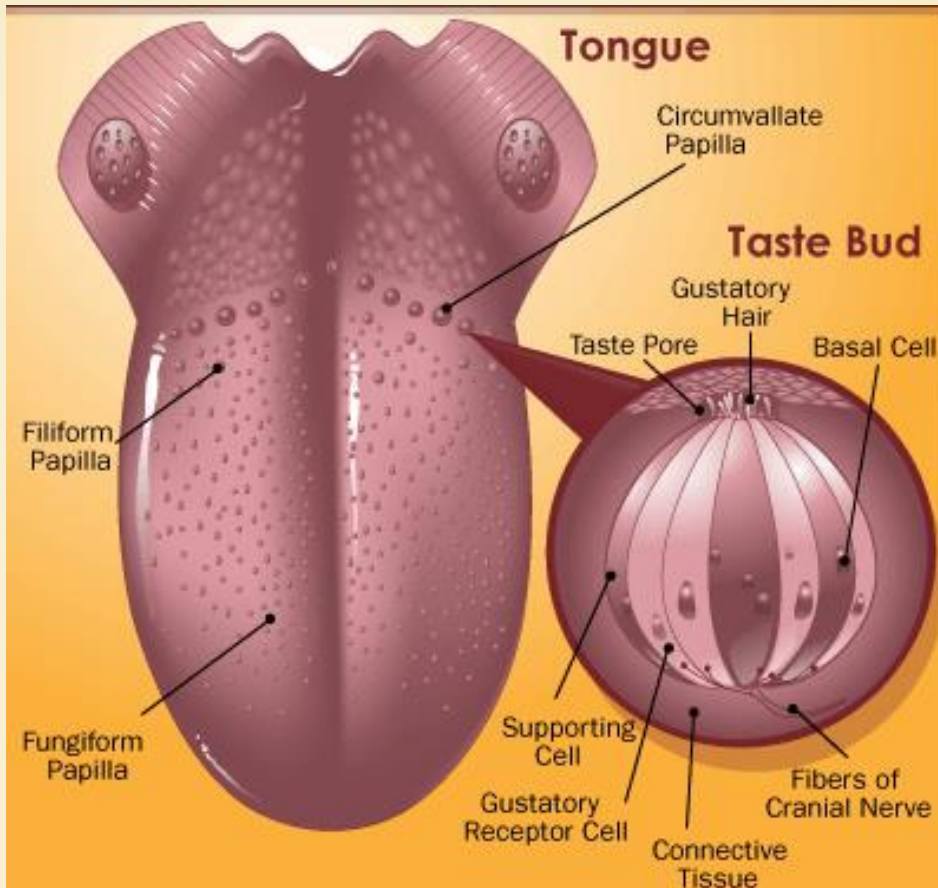
- muscular organ projecting into the oral cavity
  - **body**
  - **tip (apex)**
  - **root**
- the dorsal surface covered by **papillae** (mucosal elevations)
  - **filiform**
  - **fungiform**
  - **circumvallate**
  - **foliate**

# Tongue – Muscles



- ***extrinsic (extraglossal)***  
– arise from skeletal structures
- ***intrinsic (intraglossal)***  
– located only inside the tongue

# ORAL CAVITY – Tongue Taste Buds

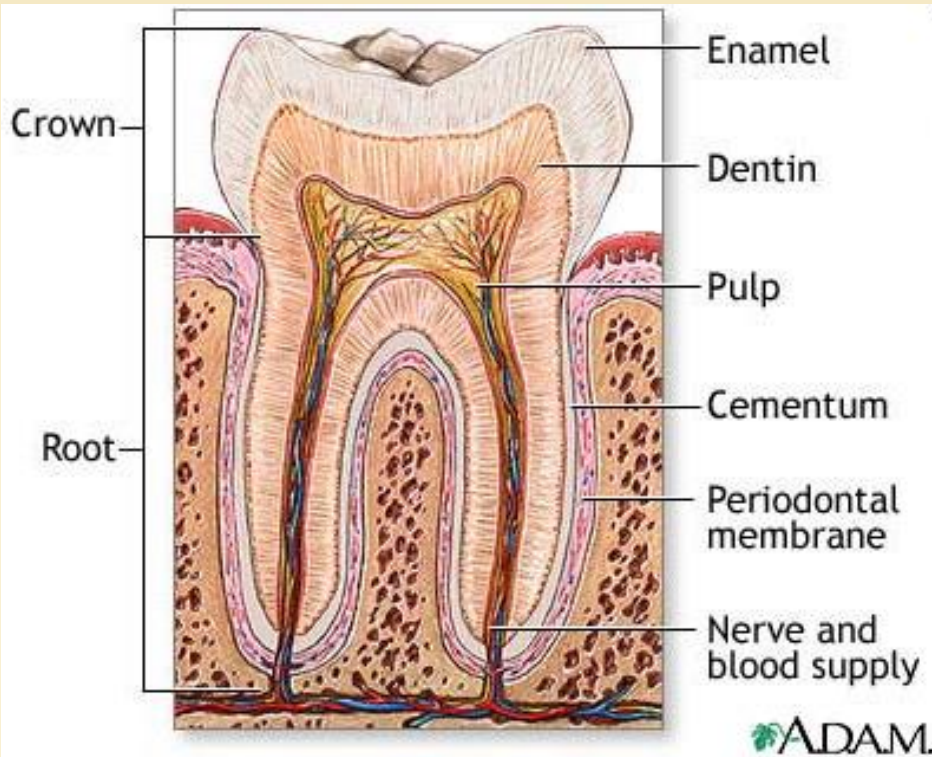


## TASTE BUDS

- 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

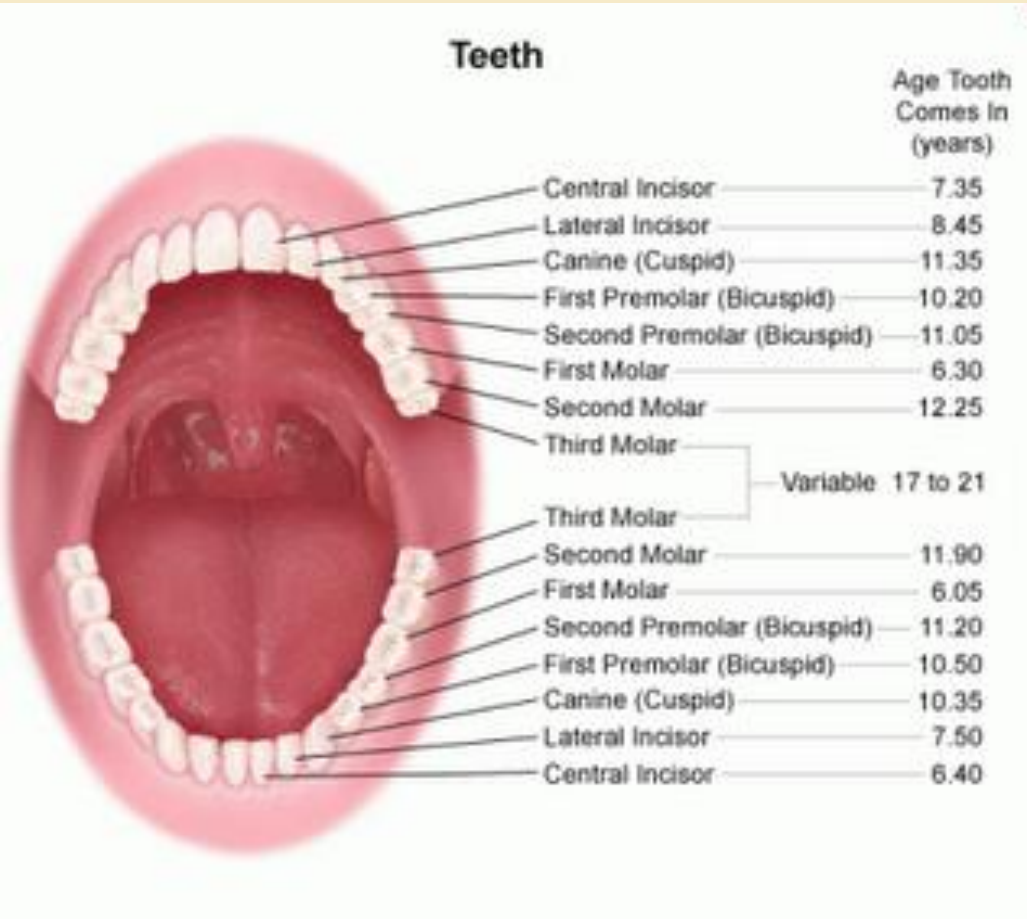
## ■ DENTIN

- produced by odontoblasts
- calcified material that forms most of the tooth substance

## ■ CEMENTUM

- a thin layer of bone-like material
- attached to alveolar bone

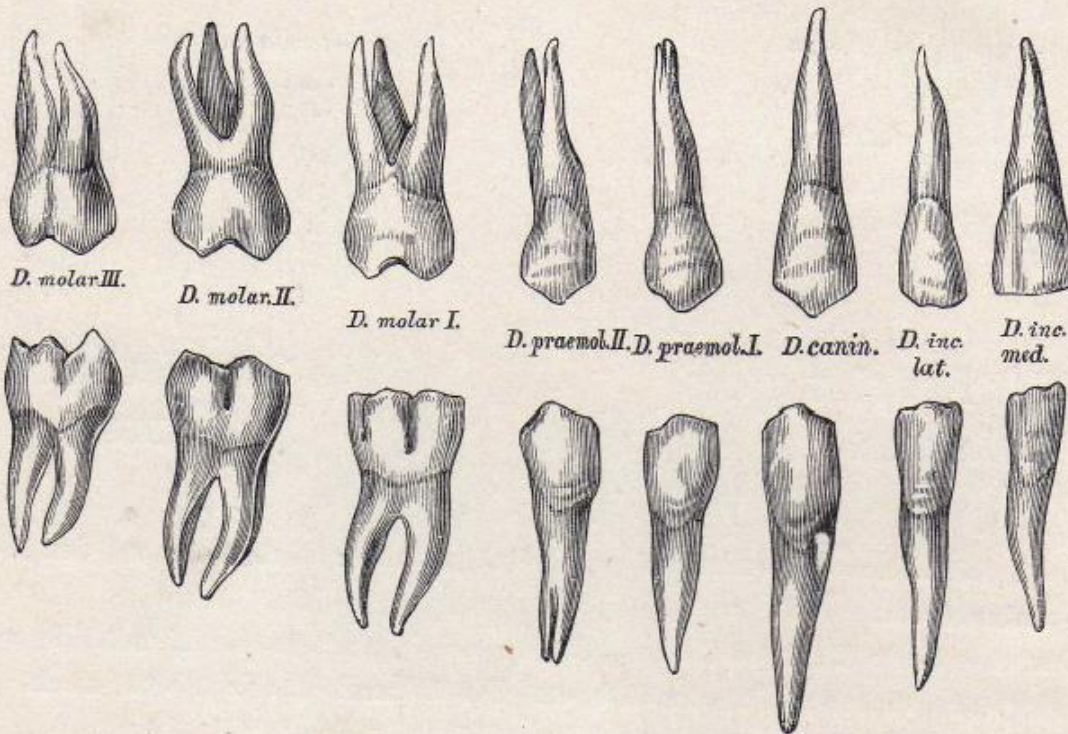
# ORAL CAVITY – Teeth



- **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

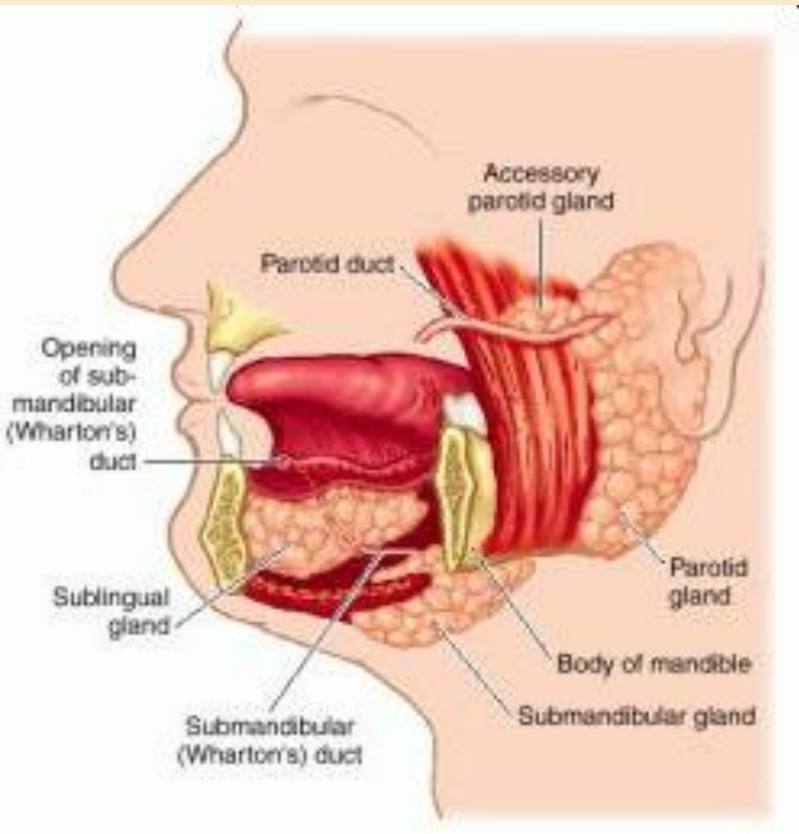


# ORAL CAVITY – Teeth



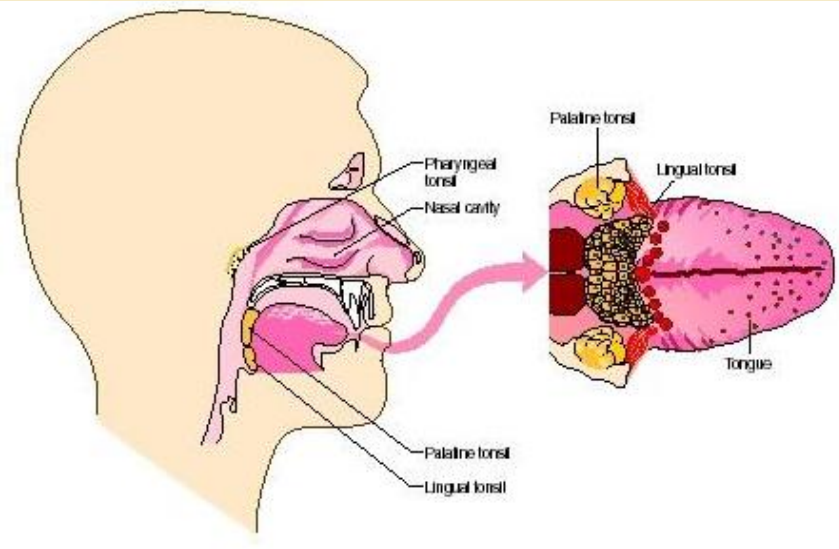
- medial **incisor**
- lateral **incisor**
- **canine**
- **premolar** teeth
- **molar** teeth

# ORAL CAVITY – Salivary Glands



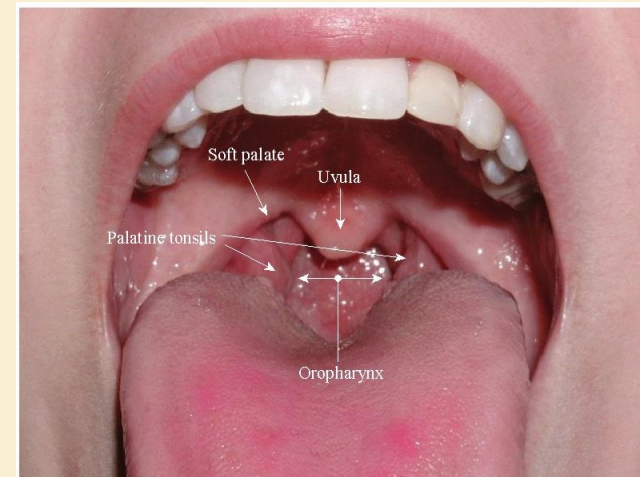
- **PAROTID GLAND**
  - purely serous
- **SUBMANDIBULAR GLAND**
  - mixed gland that is predominantly serous
- **SUBLINGUAL GLAND**
  - mixed gland that is mostly mucous
- **MINOR SALIVARY GLANDS** – buccal, labial, lingual, and palatine
- 99% water, electrolytes, buffers, mucin, IgA, lysozyme, **salivary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

# ORAL CAVITY – Tonsils



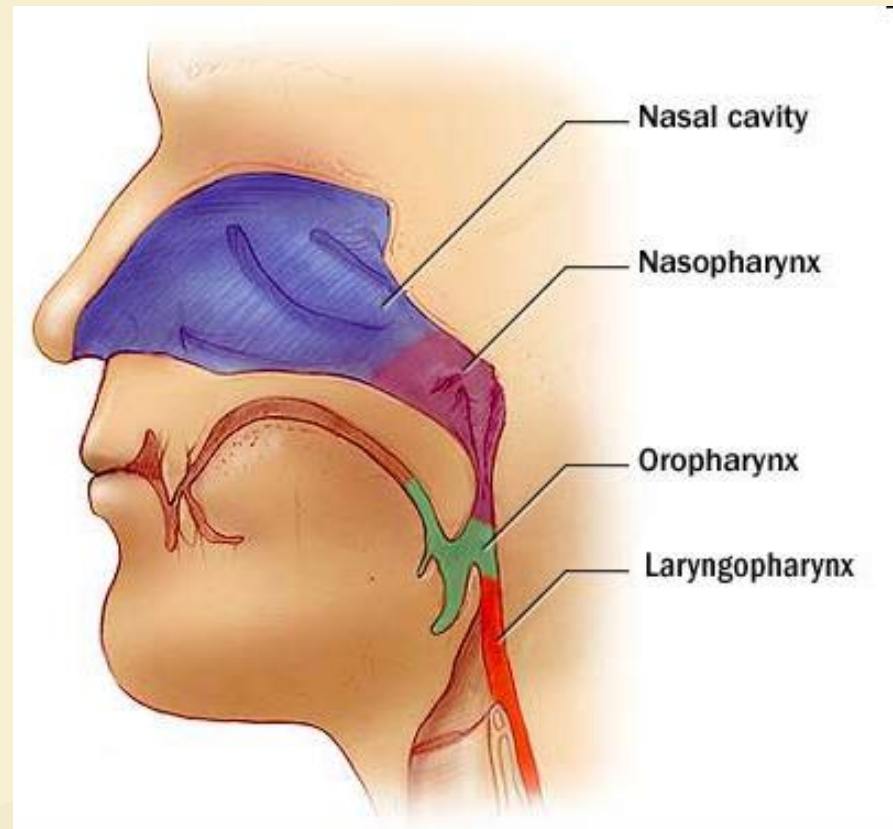
- **aggregations of lymphatic nodules** clustered **around the posterior opening of the oral and nasal cavities**
- lymphatic tissue organized into a **tonsillar ring (Waldeyer's ring)** of immunologic protection at the shared entrance to the digestive and respiratory tracts

- **PALATINE TONSILS**
- **TUBAL TONSILS**
- **PHARYNGEAL TONSIL, or ADENOID**
- **LINGUAL TONSIL**

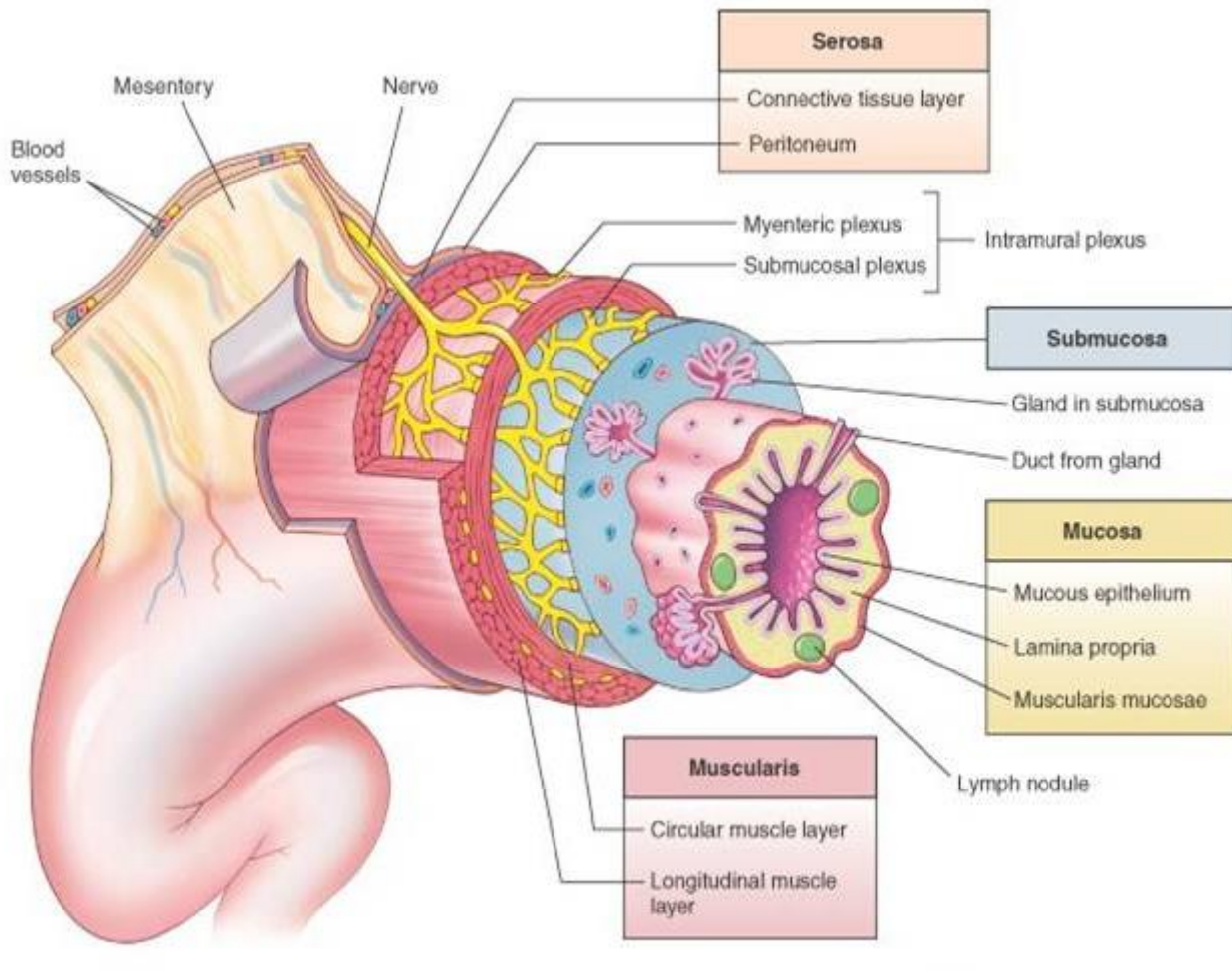


# PHARYNX

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

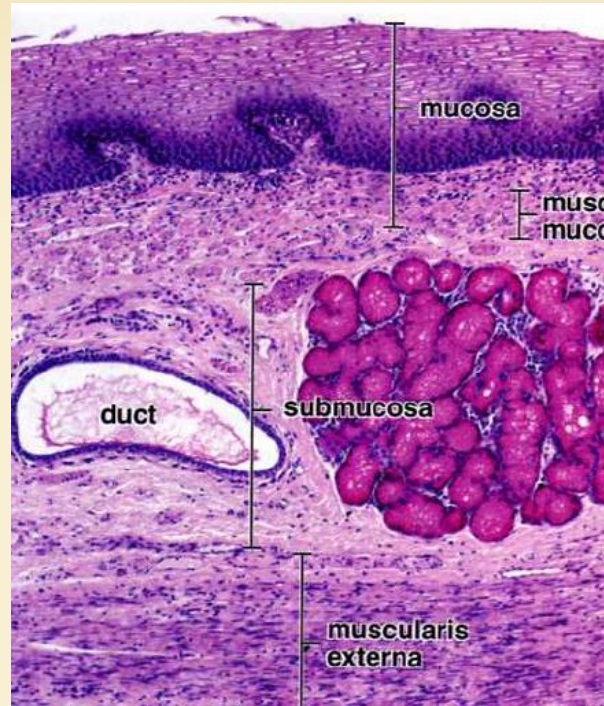
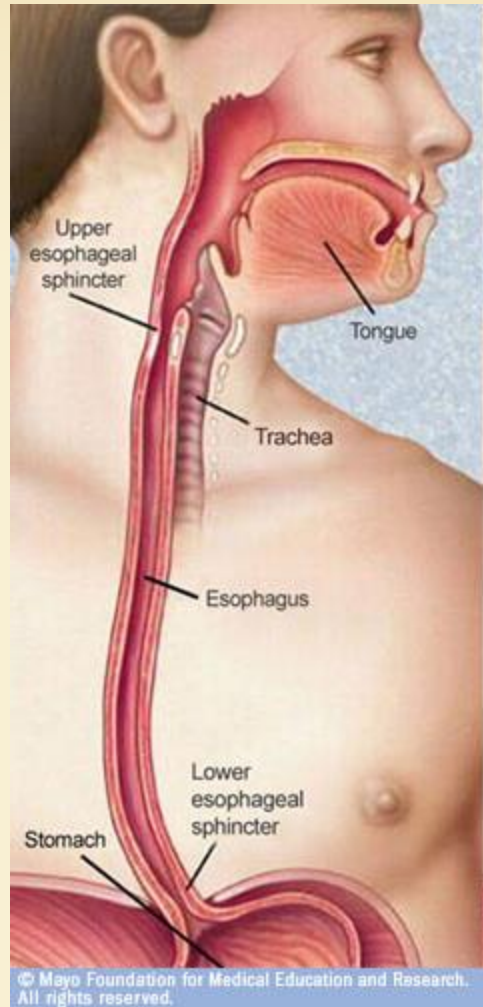


# ALIMENTARY CANAL Layers



- **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

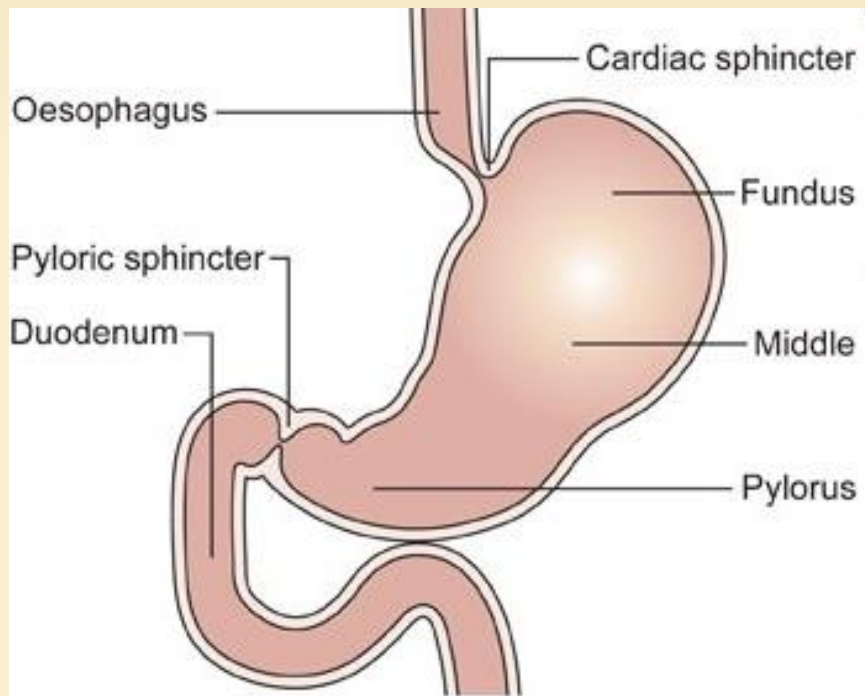
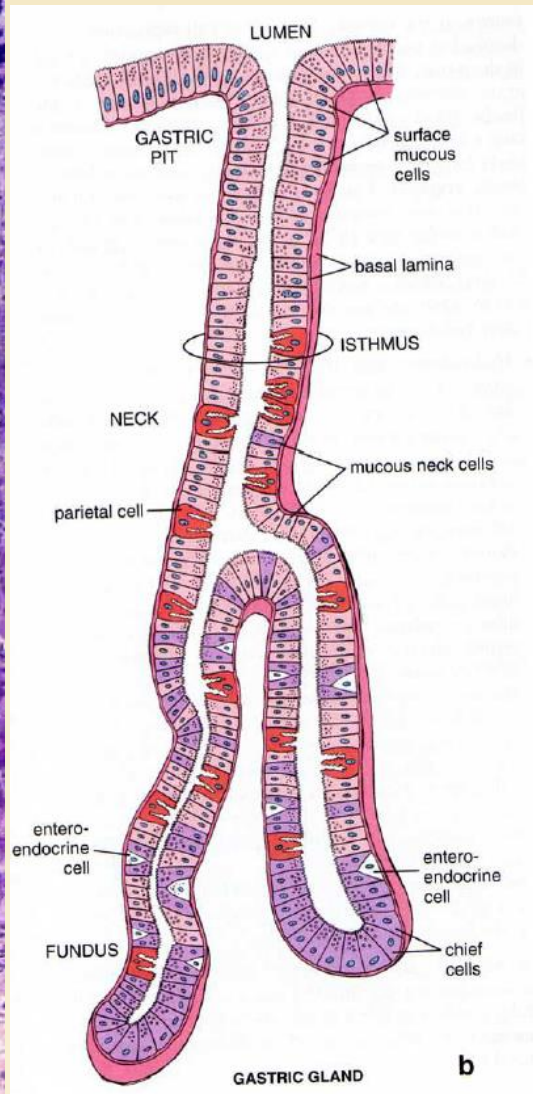
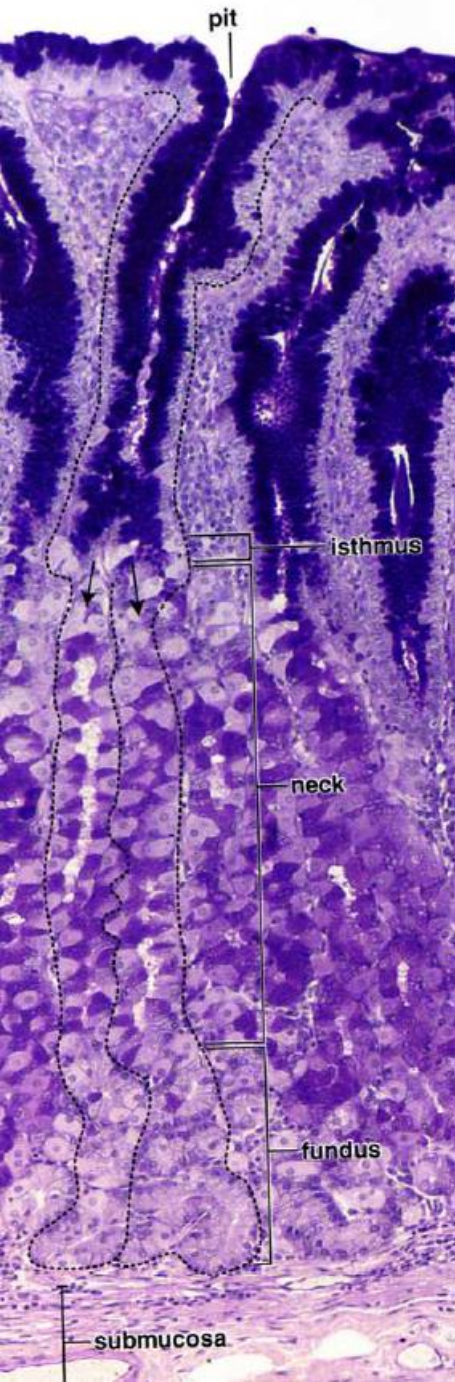


Diagram showing the parts of the stomach  
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- an ***expanded part*** of the digestive tube that lies beneath the diaphragm
- receives the ***bolus*** of macerated food from the esophagus
- mixing and partial digestion of the food by gastric secretions produces a pulpy fluid mix called ***chyme***
- **cardia**
- **fundus**
- **corpus (body)**
- **pylorus**
- longitudinal ***submucosal*** folds, ***rugae***, allow the stomach to distend when filled

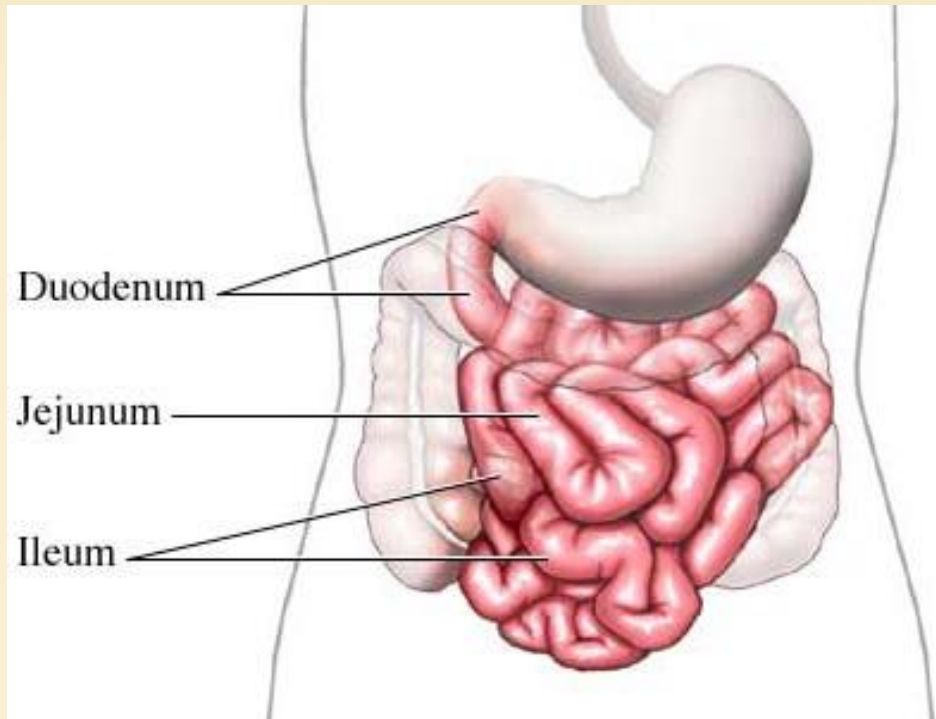
# STOMACH Glands



- ***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)



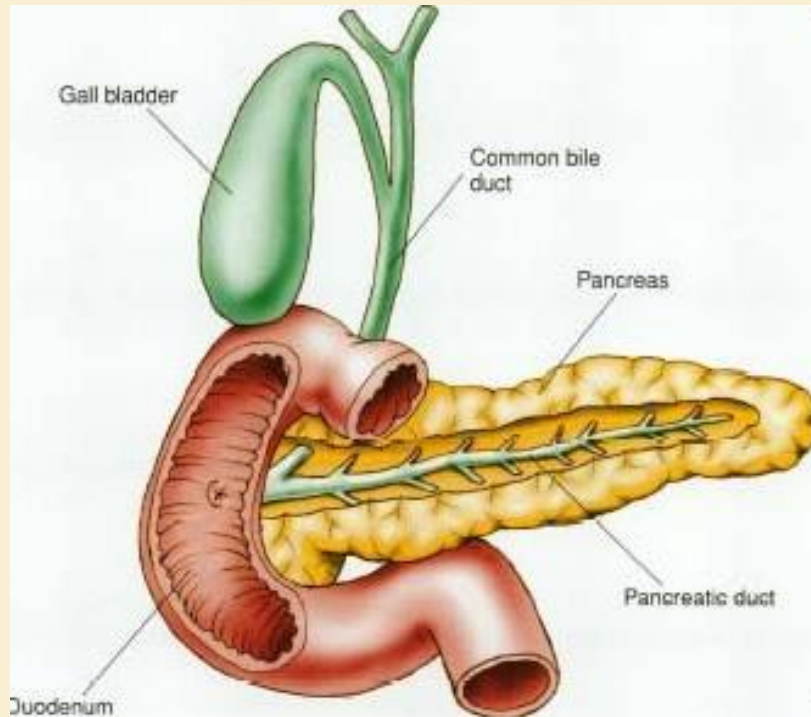
# SMALL INTESTINE



- 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

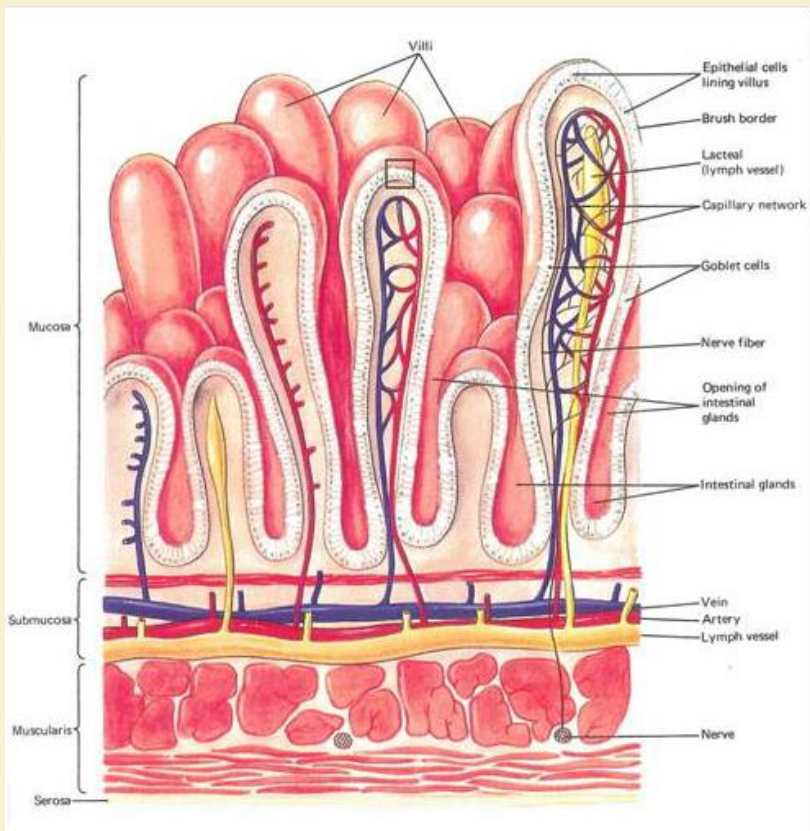
- **duodenal (Brunner's) glands**
  - produce mucous that neutralizes the acid-containing chyme received from the stomach (*pH of 8,1 to 9,3*)



# SMALL INTESTINE Mucosa



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



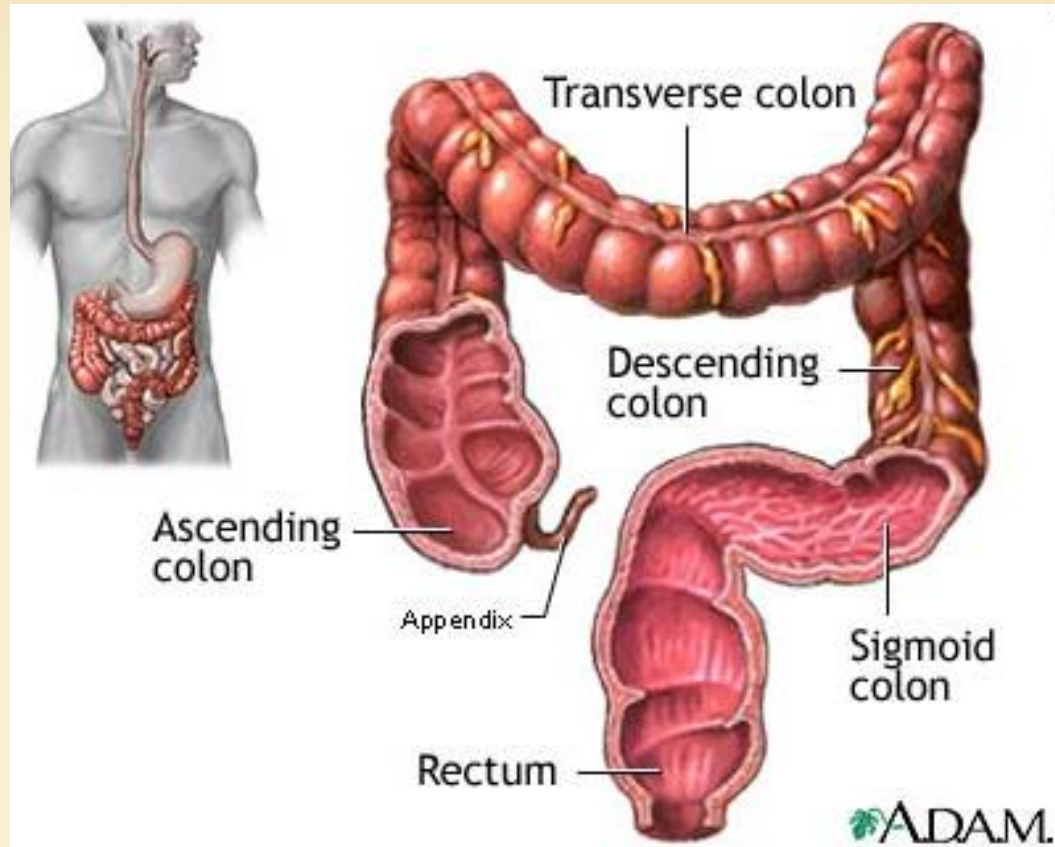
- **intestinal villi** and **microvilli** increase the absorptive surface area
- **enterocytes** (producing enzymes needed for terminal digestion and absorption)
- **goblet cells** (produce mucus)
- **enteroendocrine cells** (produce peptide hormones)

# 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**

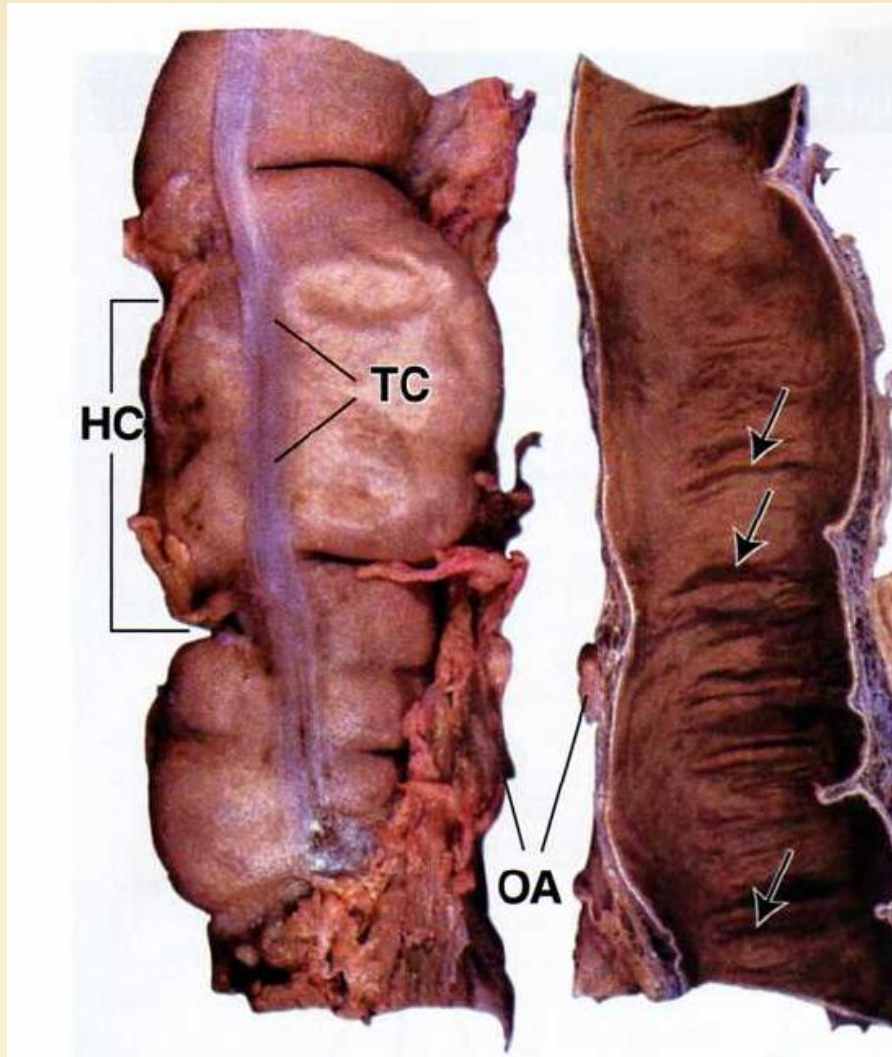
- **COLON**

- ascending
- transverse
- descending
- sigmoid

- **RECTUM**

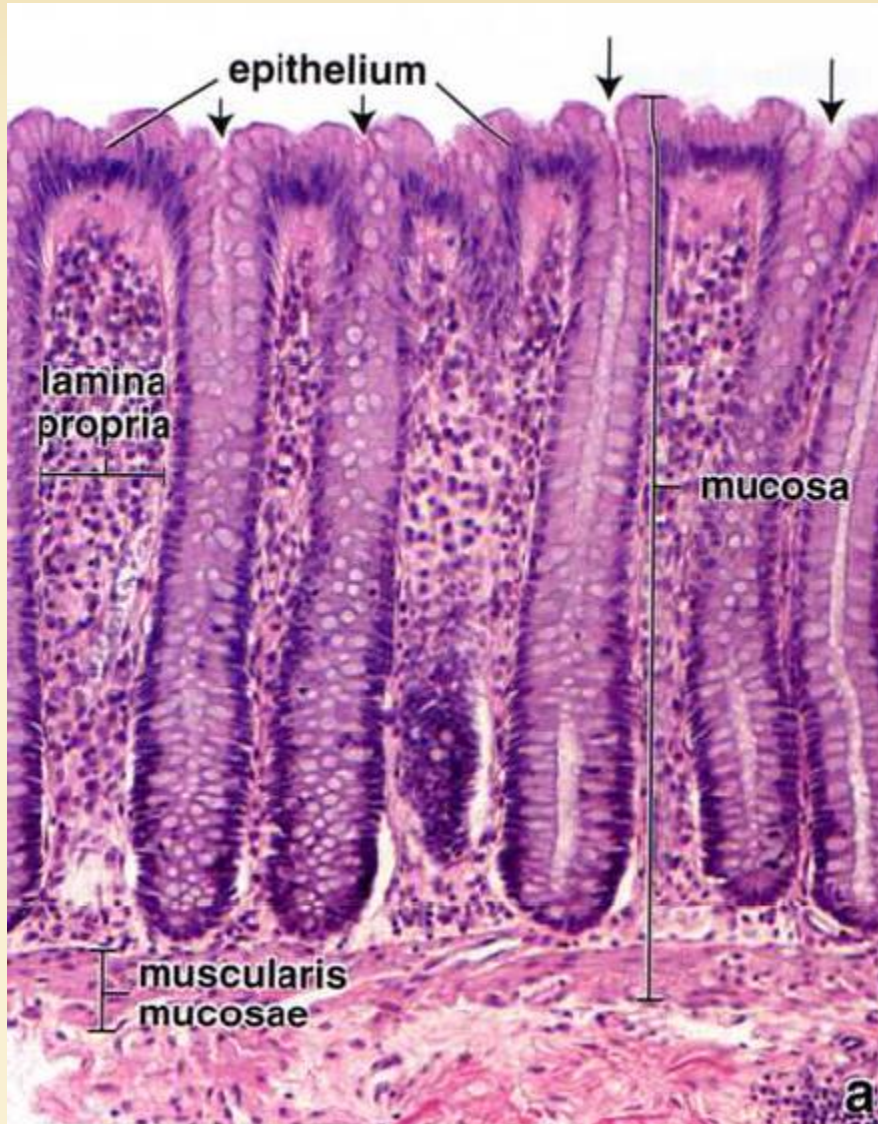
- **ANAL CANAL**

# LARGE INTESTINE



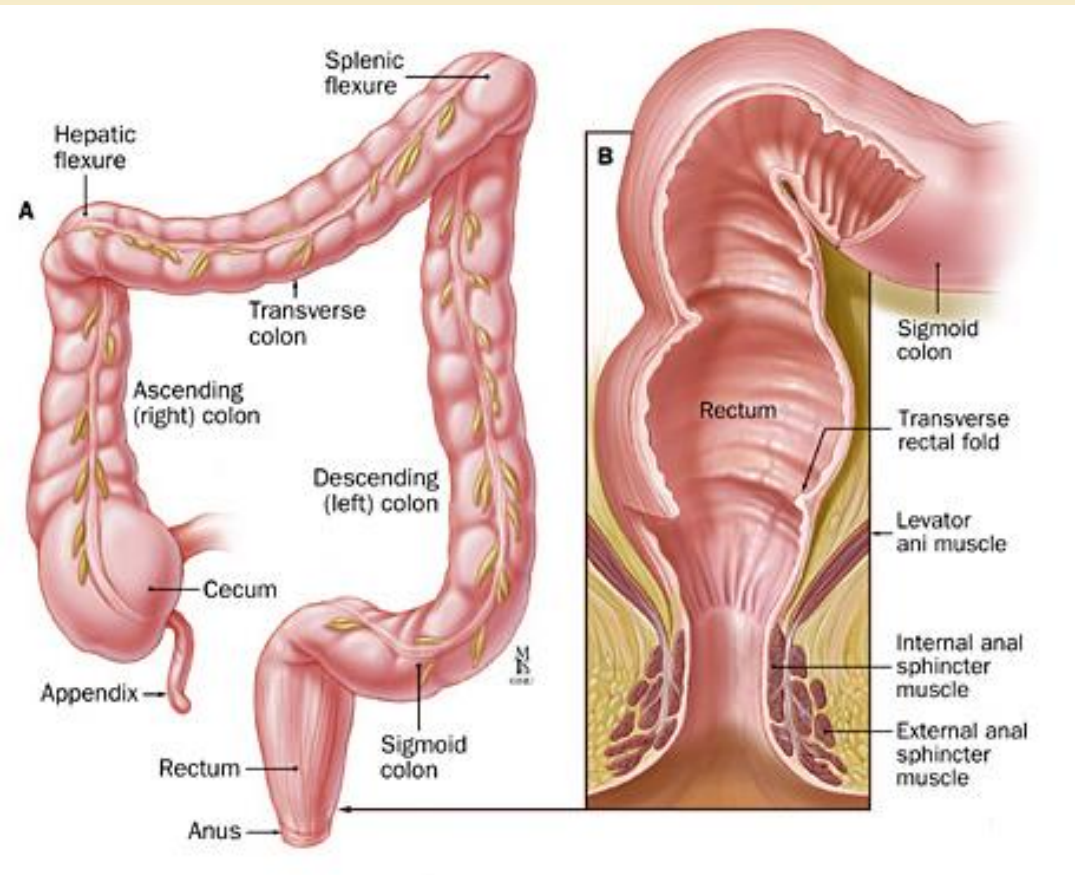
- the outer longitudinal layer of muscles exhibits three thickened, equally spaced bands – *teniae coli*
- the external surface of the cecum and colon exhibits sacculations – *haustra* – visible between teniae
- small fatty projections of the serosa – *omental appendices*

# 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



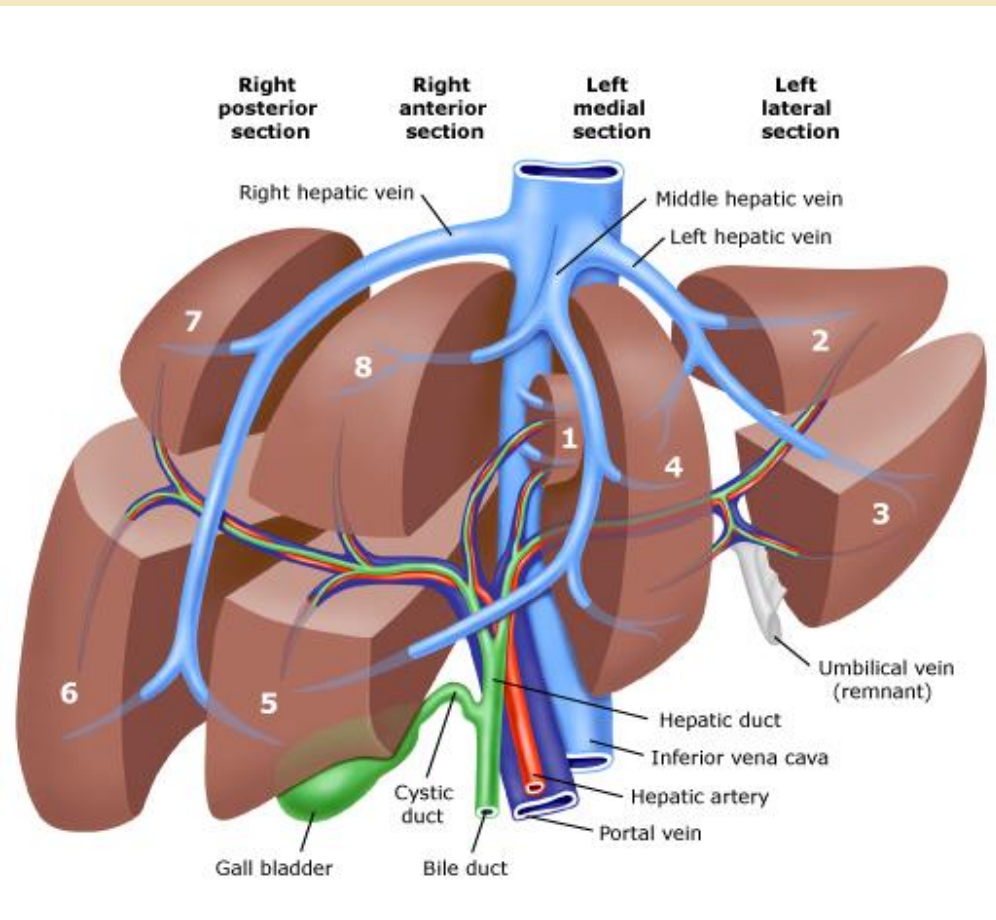
## ■ RECTUM

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

## ■ ANAL CANAL

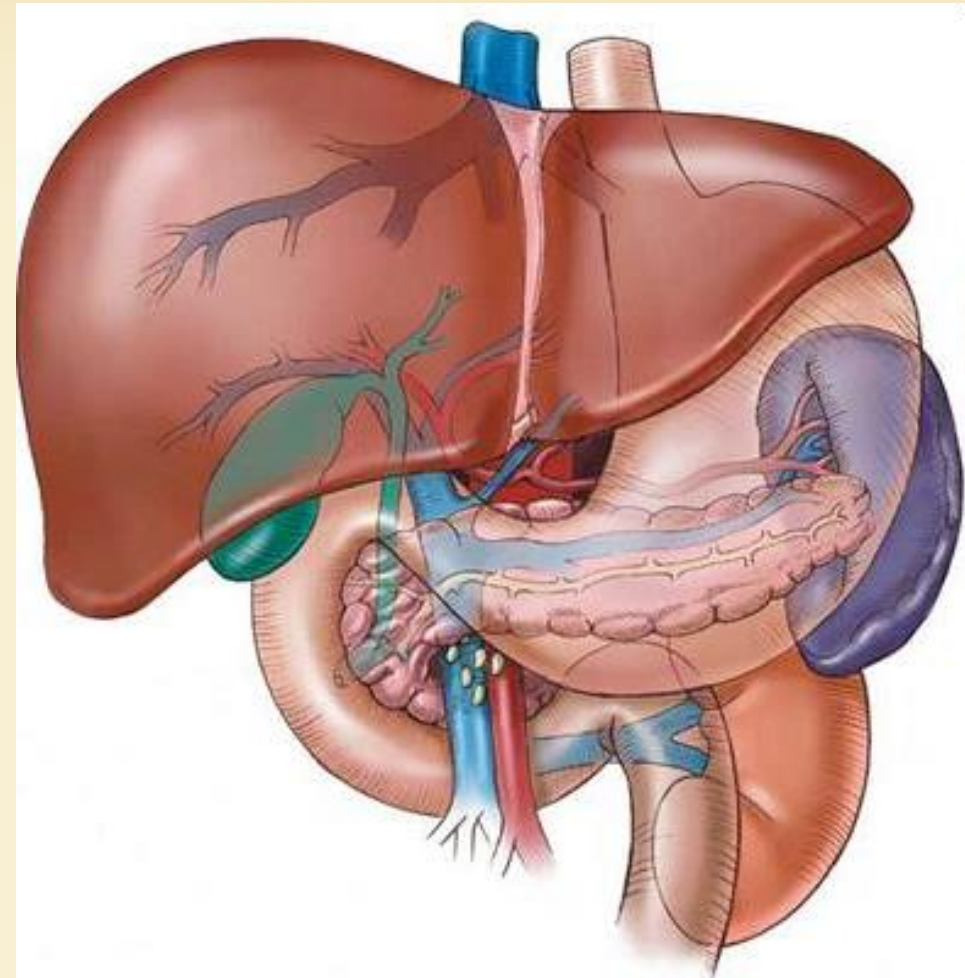


# LIVER



- 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)

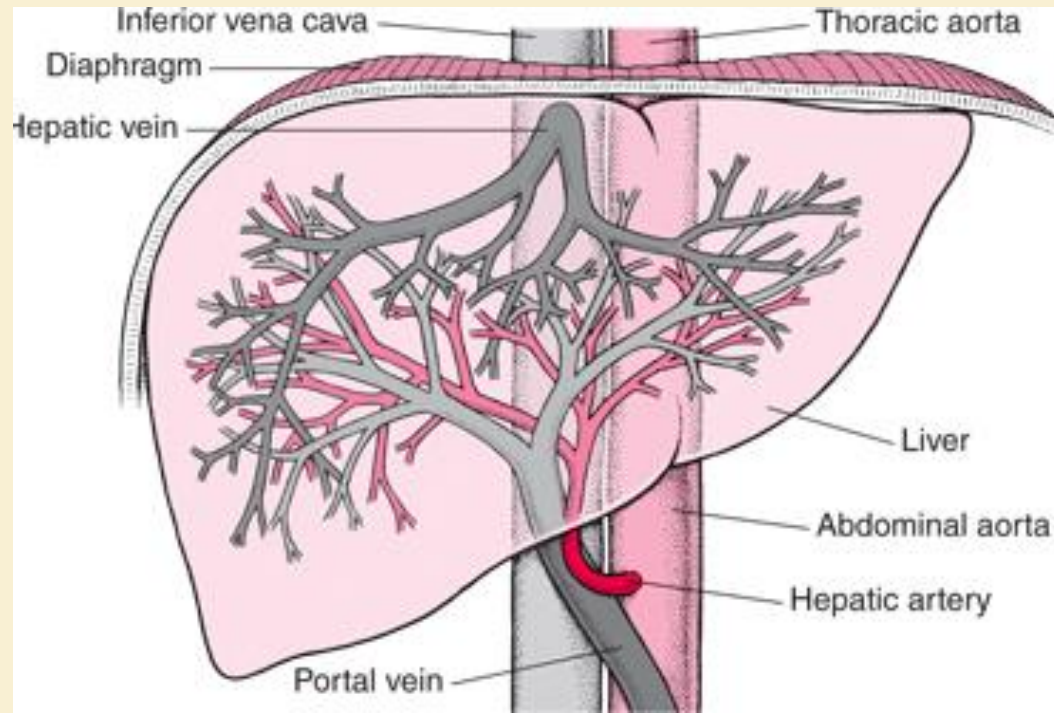
# LIVER Physiology



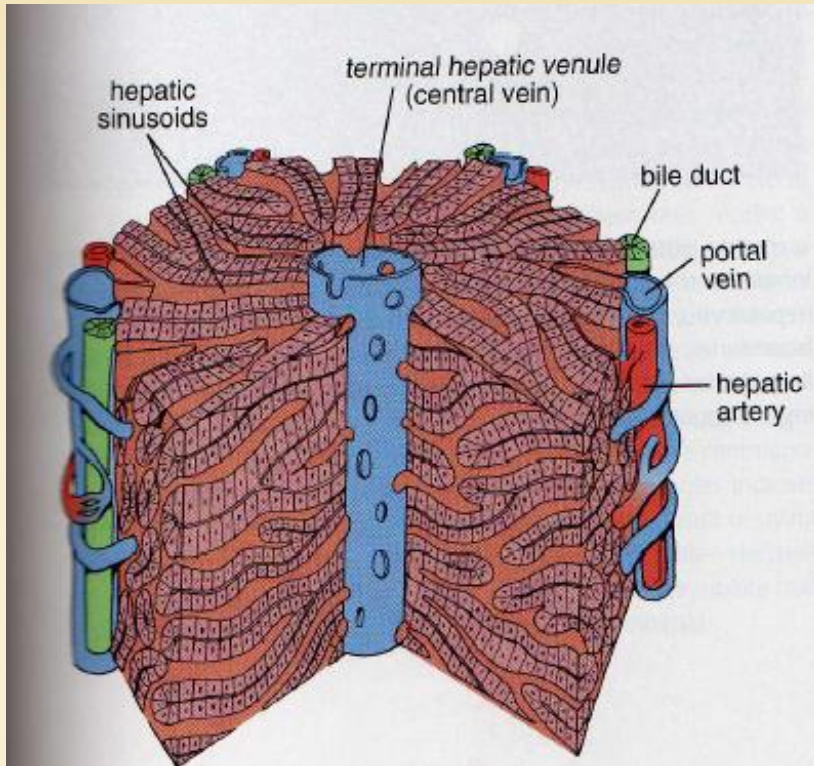
- produces most of the body's circulating **plasma proteins** (albumins, lipoproteins, glycoproteins, prothrombin and fibrinogen,  $\alpha$ - and  $\beta$ -globulins)
- stores and converts several **vitamins and iron** (vitamin A, vitamin D, vitamin K)
- degrades **drugs** and **toxins**
- is involved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

# LIVER Blood Supply

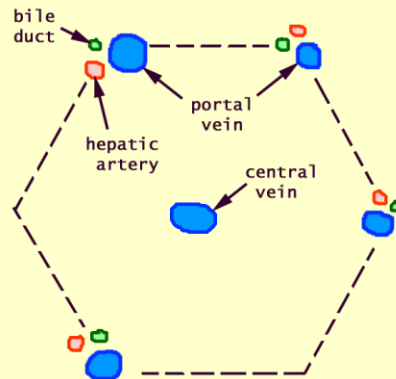
- unique blood supply
- dual blood supply consisting of a venous (portal) supply via **the hepatic portal vein** and an arterial supply via **the hepatic artery**
- both vessels enter the liver at a hilum – *porta hepatis*
- receives the blood that initially supplied the *intestines, pancreas, and spleen*



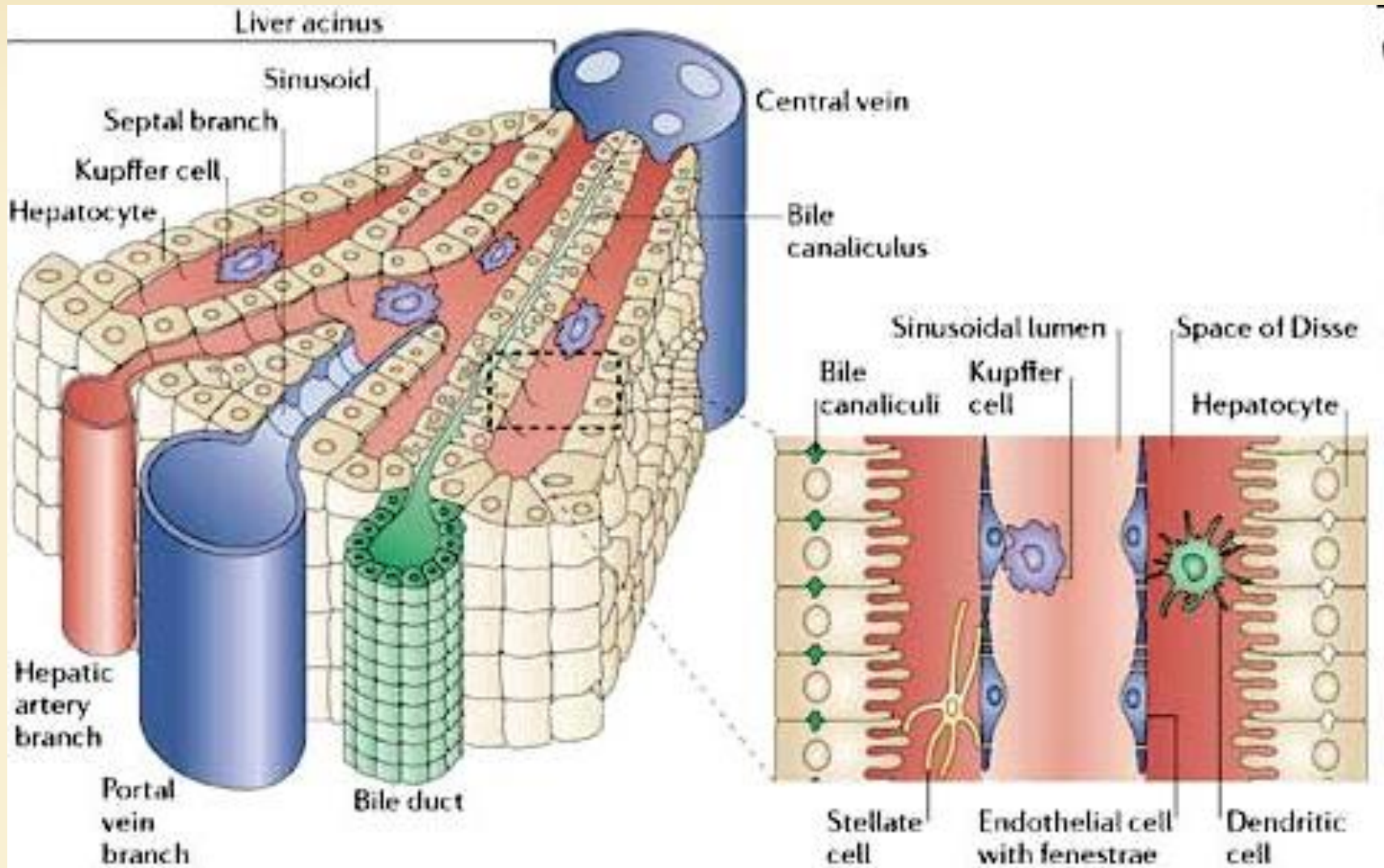
# LIVER Histology



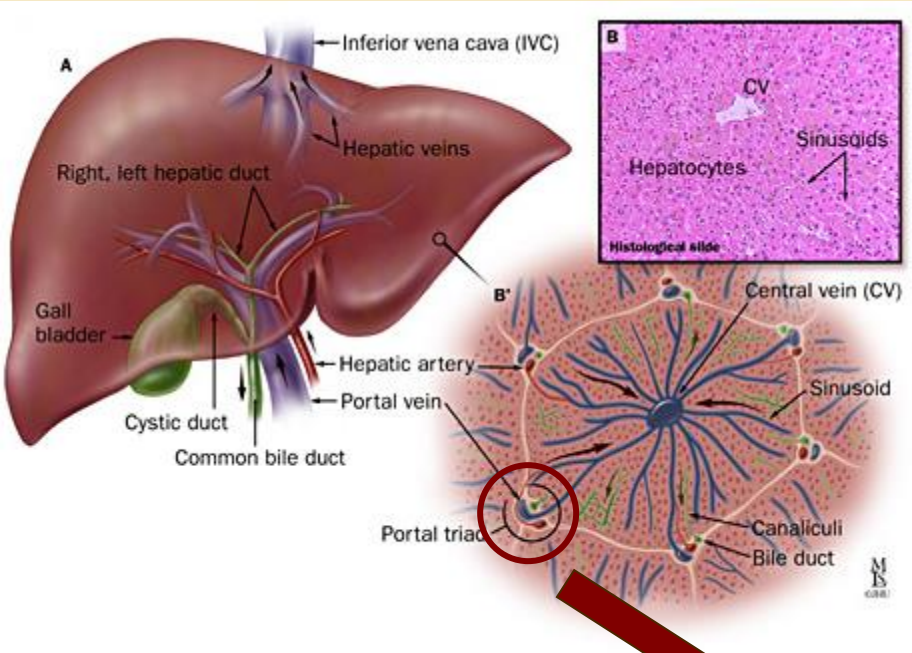
- the **hepatic lobule** is a hexagonal mass of tissue
- consists of *stacks of anastomosing plates of hepatocytes*, one cell thick
- separated by the anastomosing system of **sinusoids** that perfuse the cells
- sinusoids drain into the **central vein** which drains into the hepatic vein which empties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



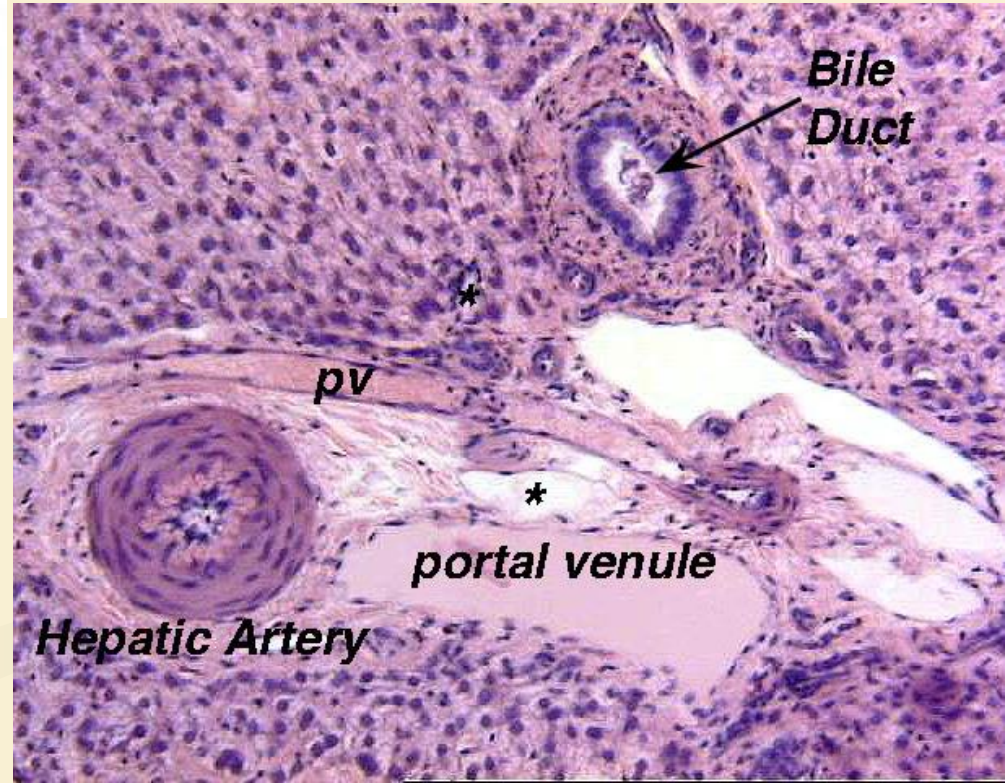
# LIVER Histology



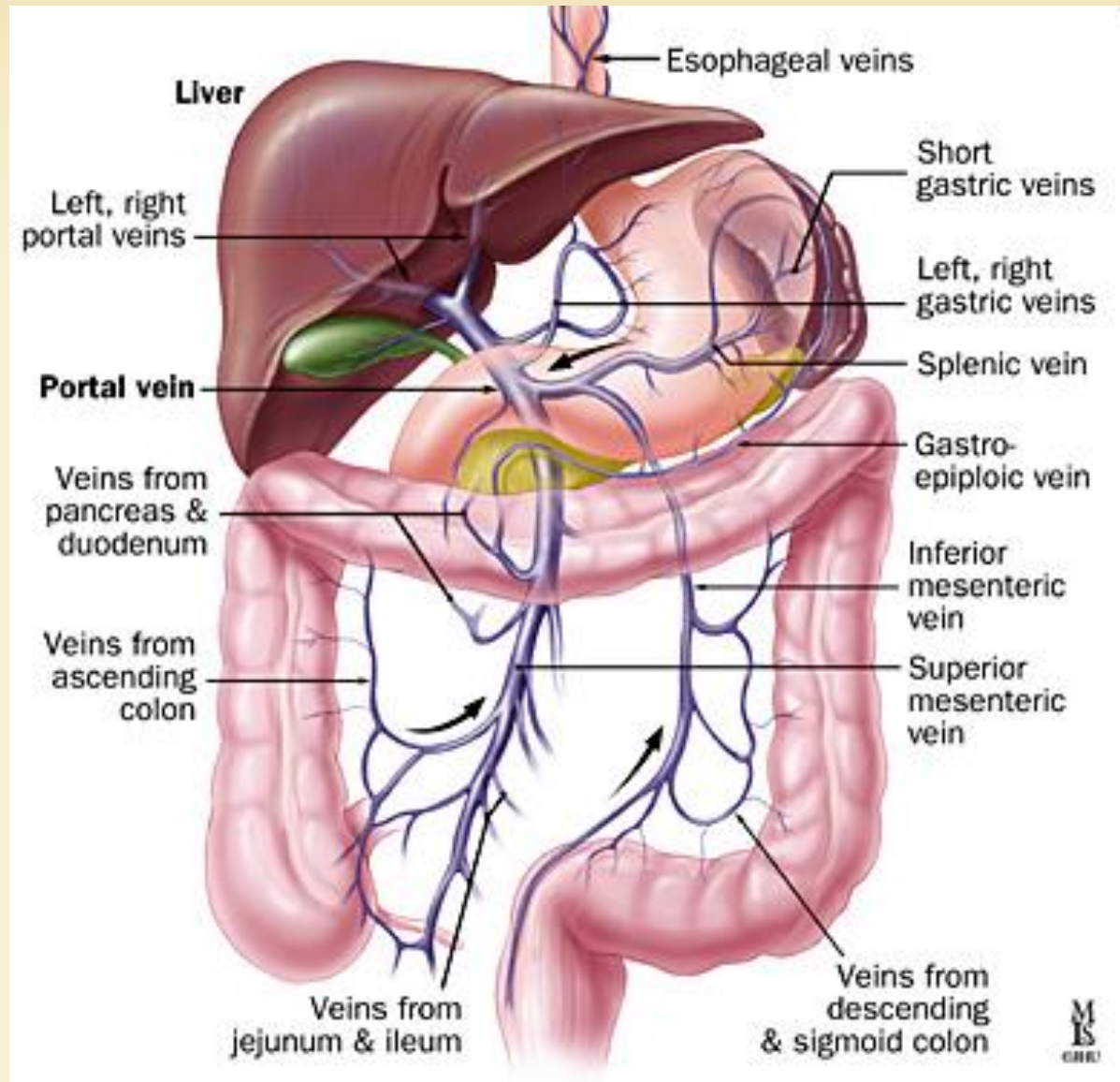
# LIVER Portal Triad



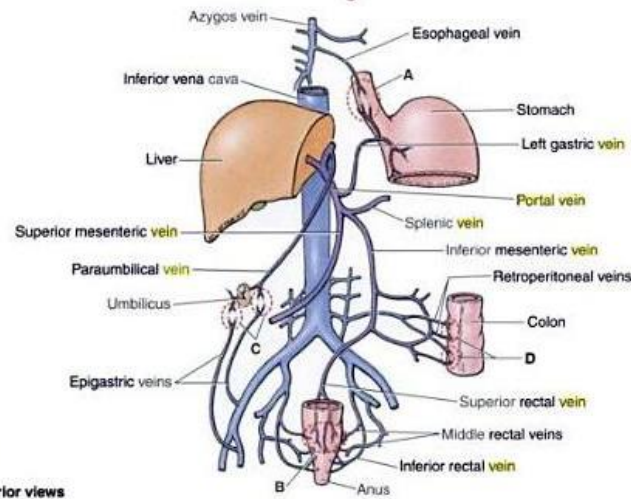
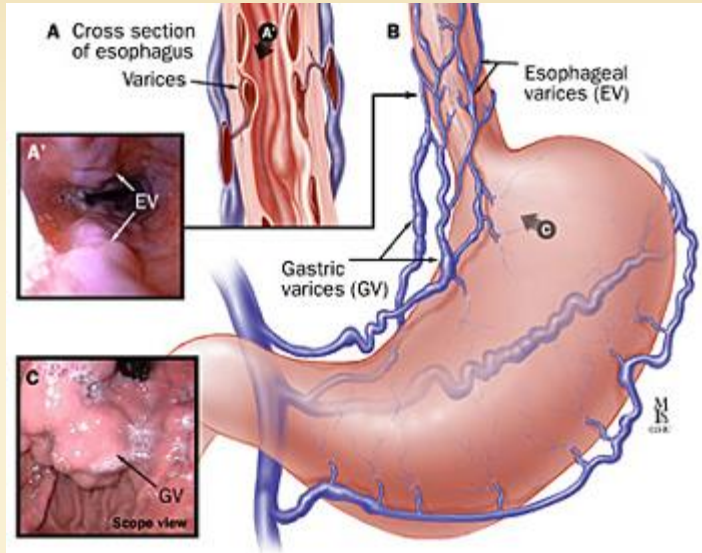
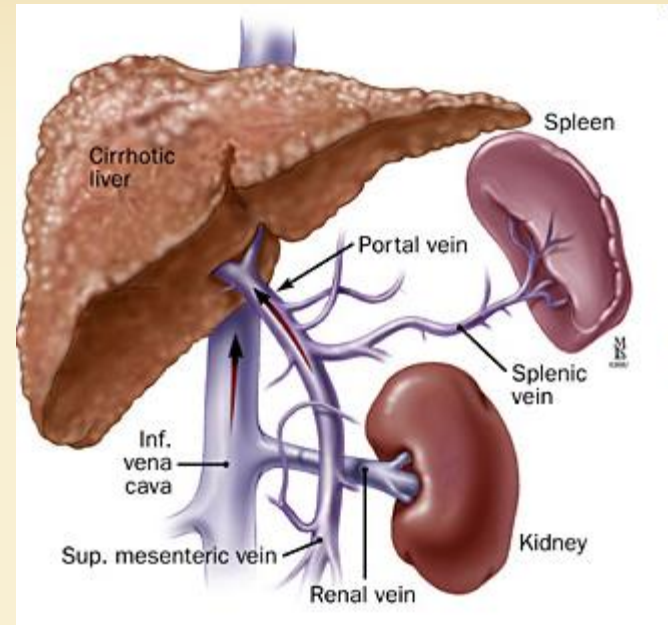
- hepatic artery
- hepatic portal vein
- bile duct



# 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.

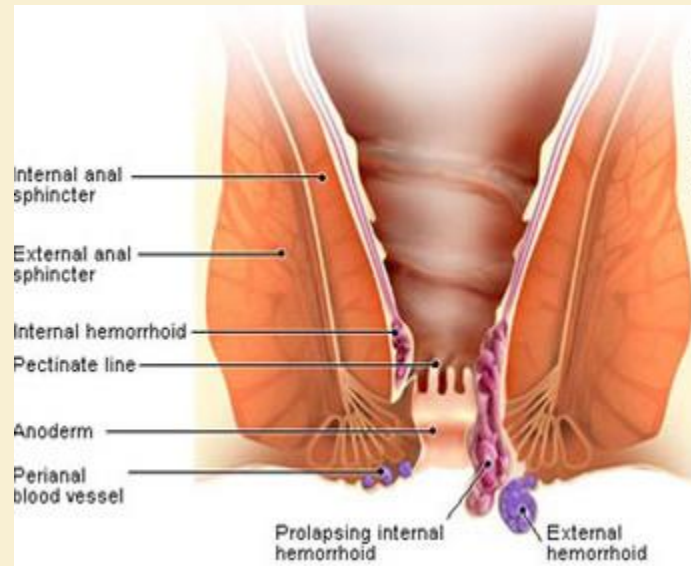


# Portocaval Anastomoses

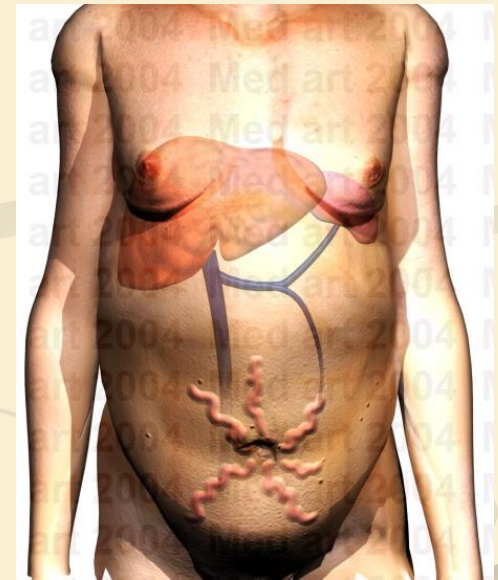
esophageal varices



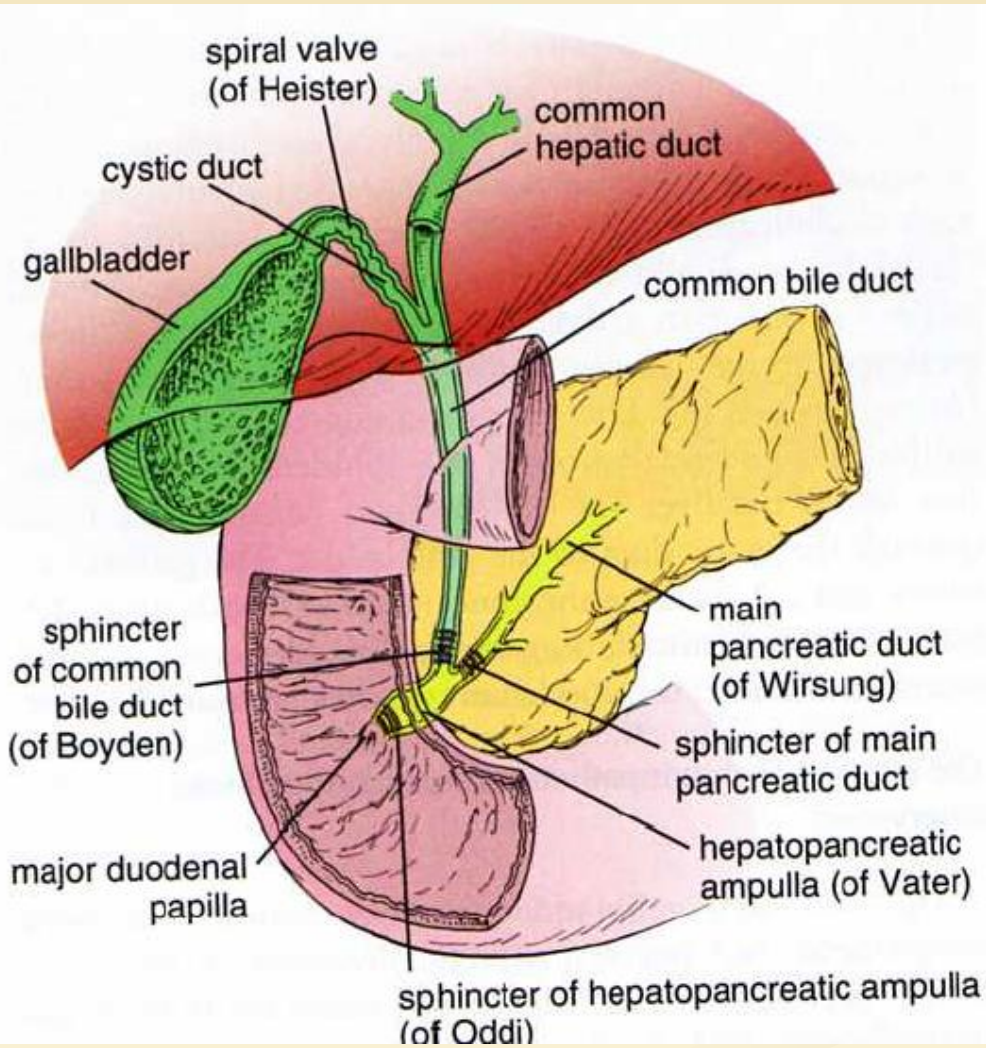
hemorrhoids



caput Medusae

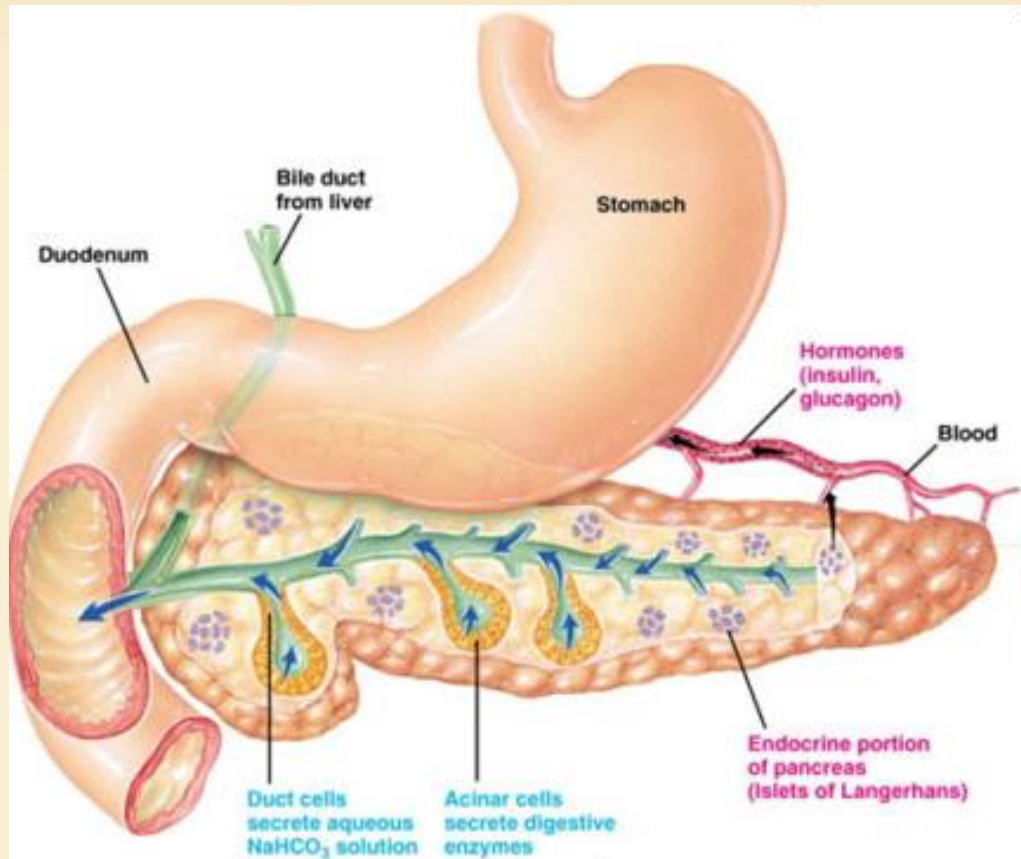


# GALLBLADDER



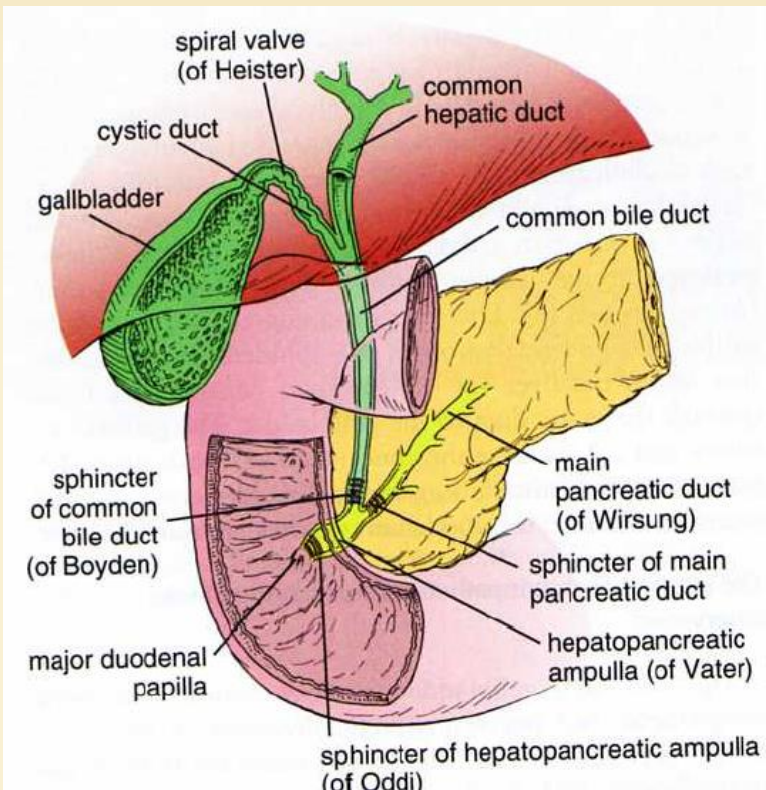
- pear-shaped, distensible sac with a volume of about 50 ml
- **neck**
- **body**
- **fundus**
- concentrates and stores **bile**
- secretion of bile is **stimulated by the presence of fat** in the duodenum
- bile contains water, ions, bilirubin, bile salts
- important emulsifier

# 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**
- 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**

