

Digestive system

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Digestive system

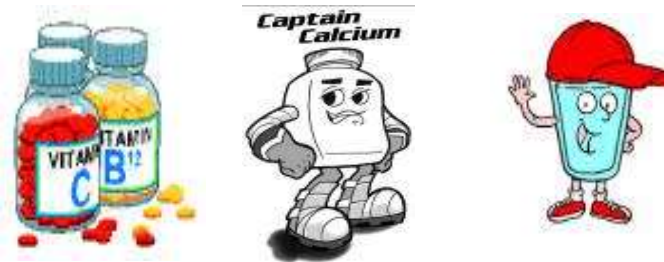
Nutrition : **Process by which organisms obtain and utilize their food.**

There are two parts to Nutrition:

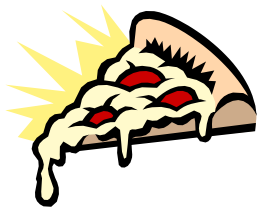
1. **Ingestion**- process of taking food into the digestive system so that it may be hydrolyzed or digested.
2. **Digestion**- the breakdown of food (either chemically or mechanically) in order to utilize nutrients.

Types of Nutrients :

Micronutrients- vitamins, minerals, & water .



Macronutrients- proteins, lipids, carbohydrates.



Digestion

- Phases Include
 1. Ingestion
 2. Movement
 3. Mechanical and Chemical Digestion
 4. Absorption
 5. Elimination
- Types:
 - Mechanical (physical):
 - Chew
 - Tear
 - Grind
 - Mash
 - Mix
 - Chemical: Enzymatic reactions to improve digestion of:
 - Carbohydrates
 - Proteins
 - Lipids

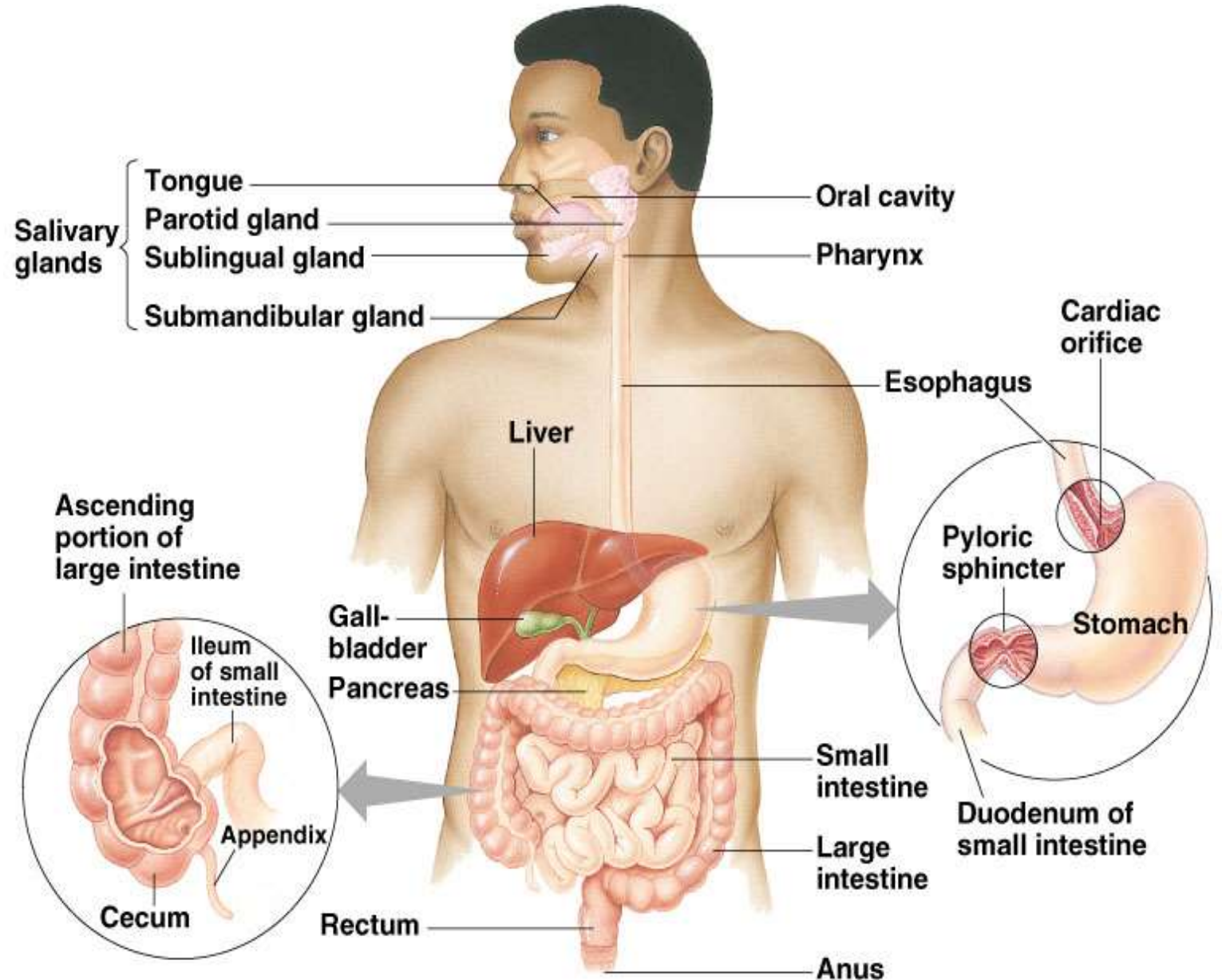
Digestive System Organization

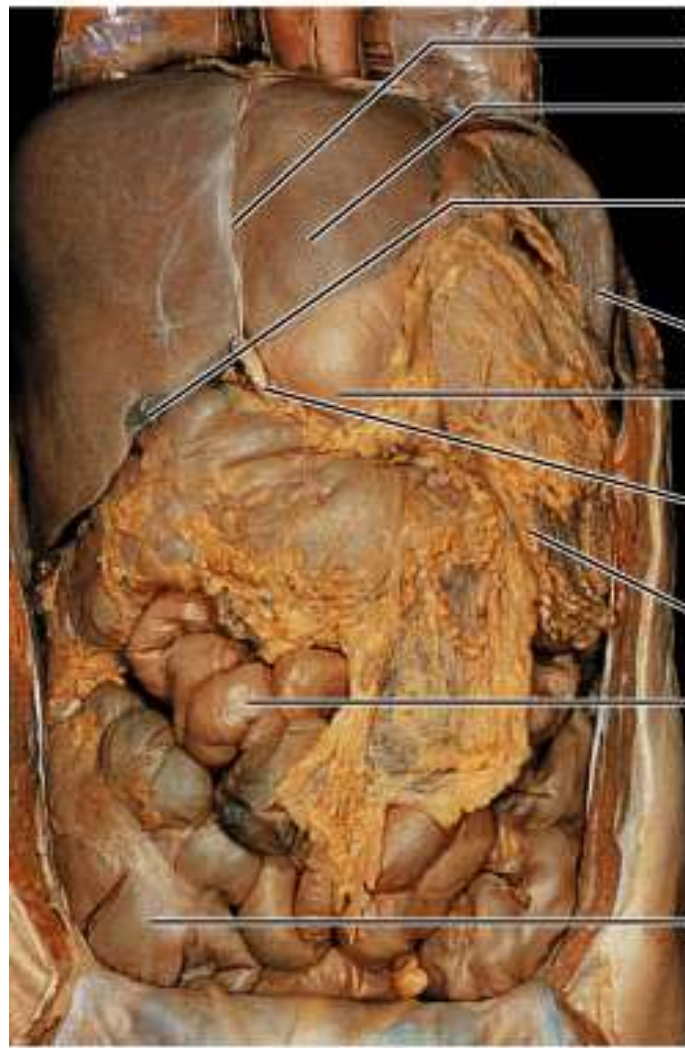
Human digestive system

- Gastrointestinal (GI) tract
 - Tube within a tube
 - Direct **link/path** between organs
 - Structures
 - Mouth
 - Pharynx
 - Esophagus
 - Stomach
 - Small intestine
 - Large Intestine
 - Rectum (Anus)
- **The accessory digestive organs**

Supply secretions contributing to the breakdown of food

- Teeth & tongue
- Salivary glands
- Gallbladder
- Liver
- Pancreas





Falciform ligament

Liver

Gallbladder

Lesser omentum

Spleen

Stomach

Duodenum

Ligamentum teres

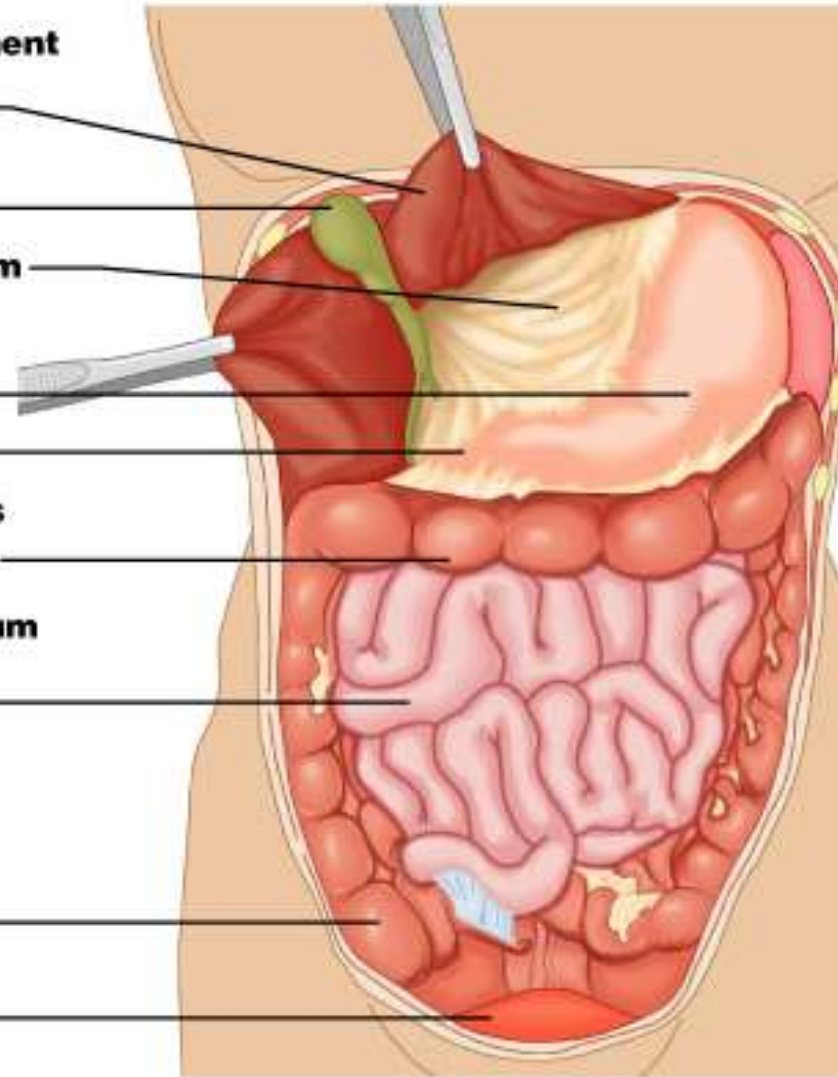
Transverse colon

Greater omentum

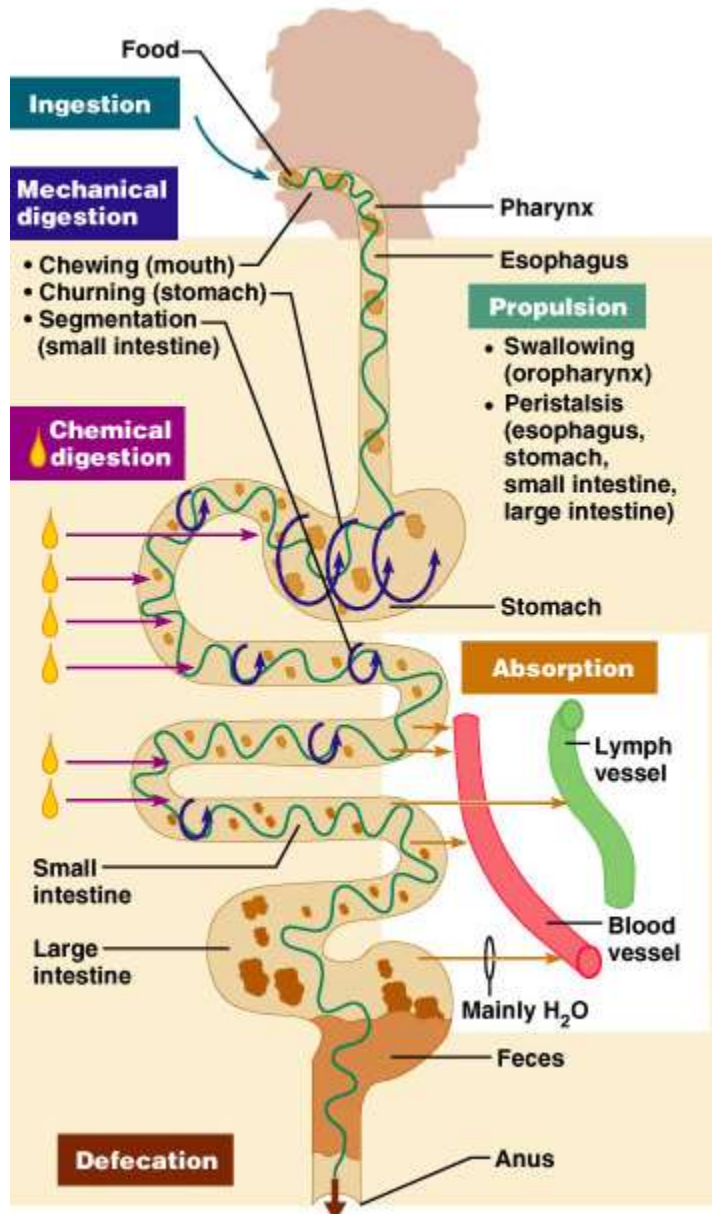
Small intestine

Cecum

Urinary bladder



The Digestive Process



- **Ingestion**
 - Taking in food through the mouth
- **Propulsion** (movement of food)
 - Swallowing
 - Peristalsis – propulsion by alternate contraction & relaxation
- **Mechanical digestion**
 - Chewing
 - Churning in stomach
 - Mixing by segmentation
- **Chemical digestion**
 - By secreted enzymes: see later
- **Absorption**
 - Transport of digested end products into blood and lymph in wall of canal
- **Defecation**
 - Elimination of indigestible substances from body as feces

Ingestion

• Mouth

• mechanical digestion : teeth : mechanically break down food into small pieces. Tongue mixes food with saliva .

- Epiglottis is a flap-like structure at the back of the throat that closes over the trachea preventing food from entering it.

• Peristalsis : involuntary muscle contractions to move food along

• chemical digestion

• Saliva

- Water: liquify food into chyme

- Amylase : enzyme digests starch

• mucin

- slippery protein (mucus)

- protects soft lining of digestive system

- lubricates food for easier swallowing

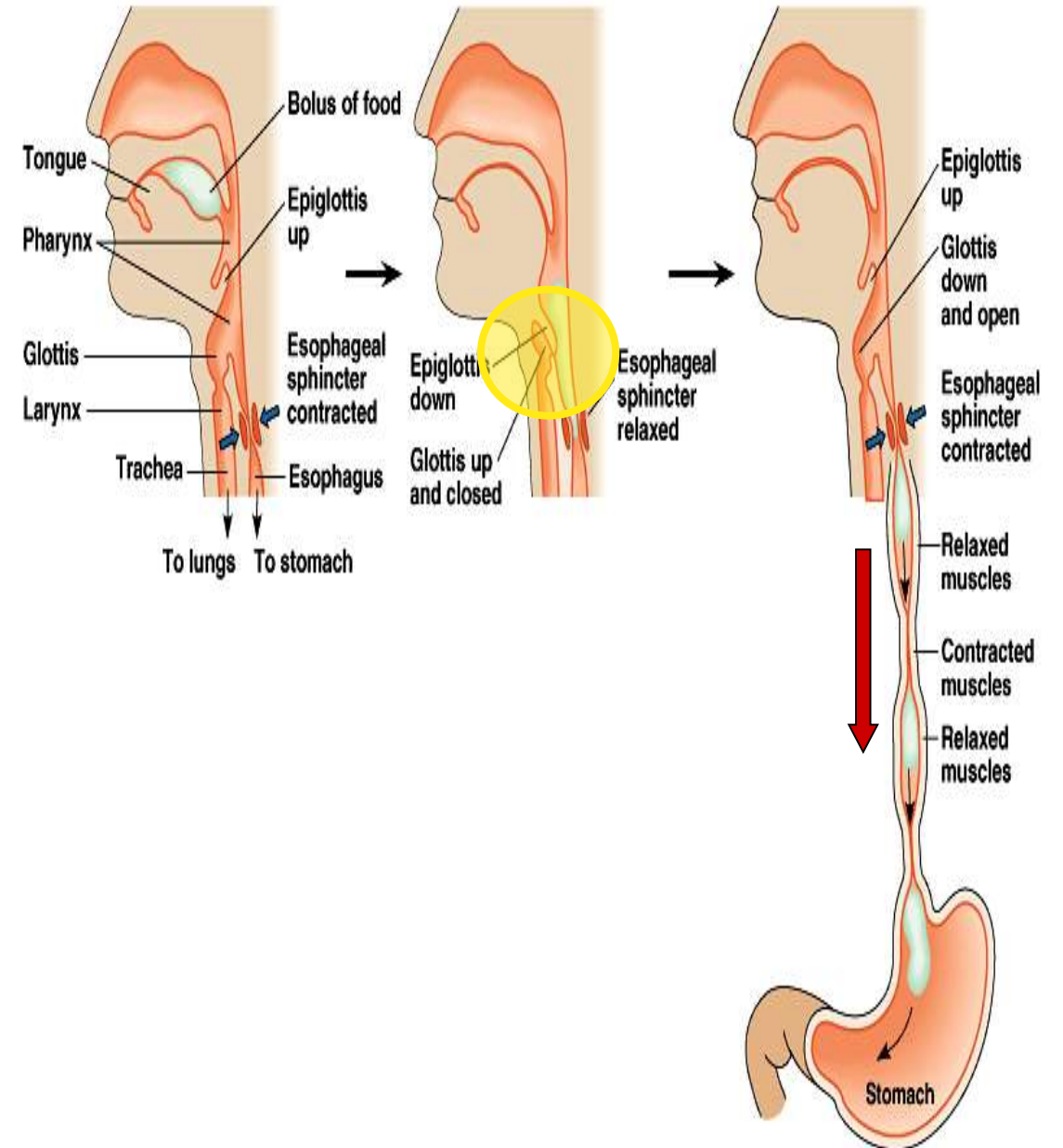
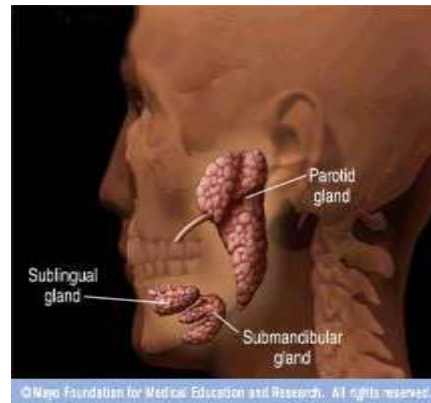
- buffers : sodium bicarbonate

- neutralizes acid to prevent tooth decay

- Maintain neutral pH for amylase

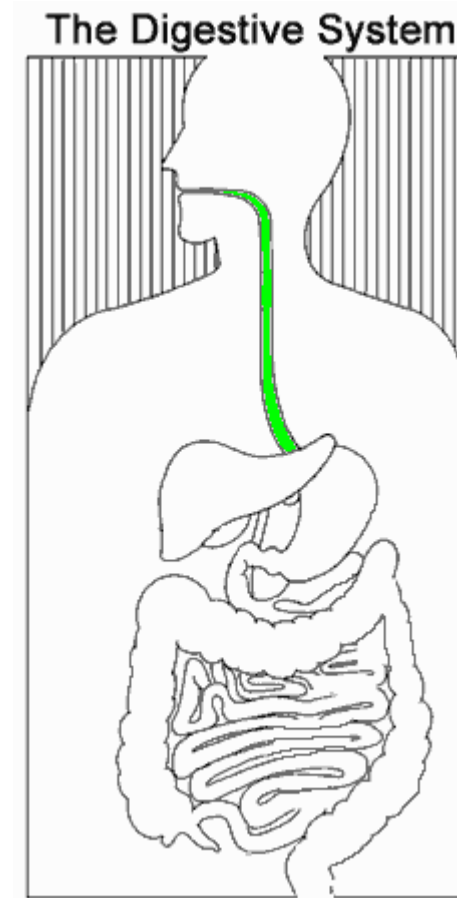
• anti-bacterial chemicals

- kill bacteria that enter mouth with food



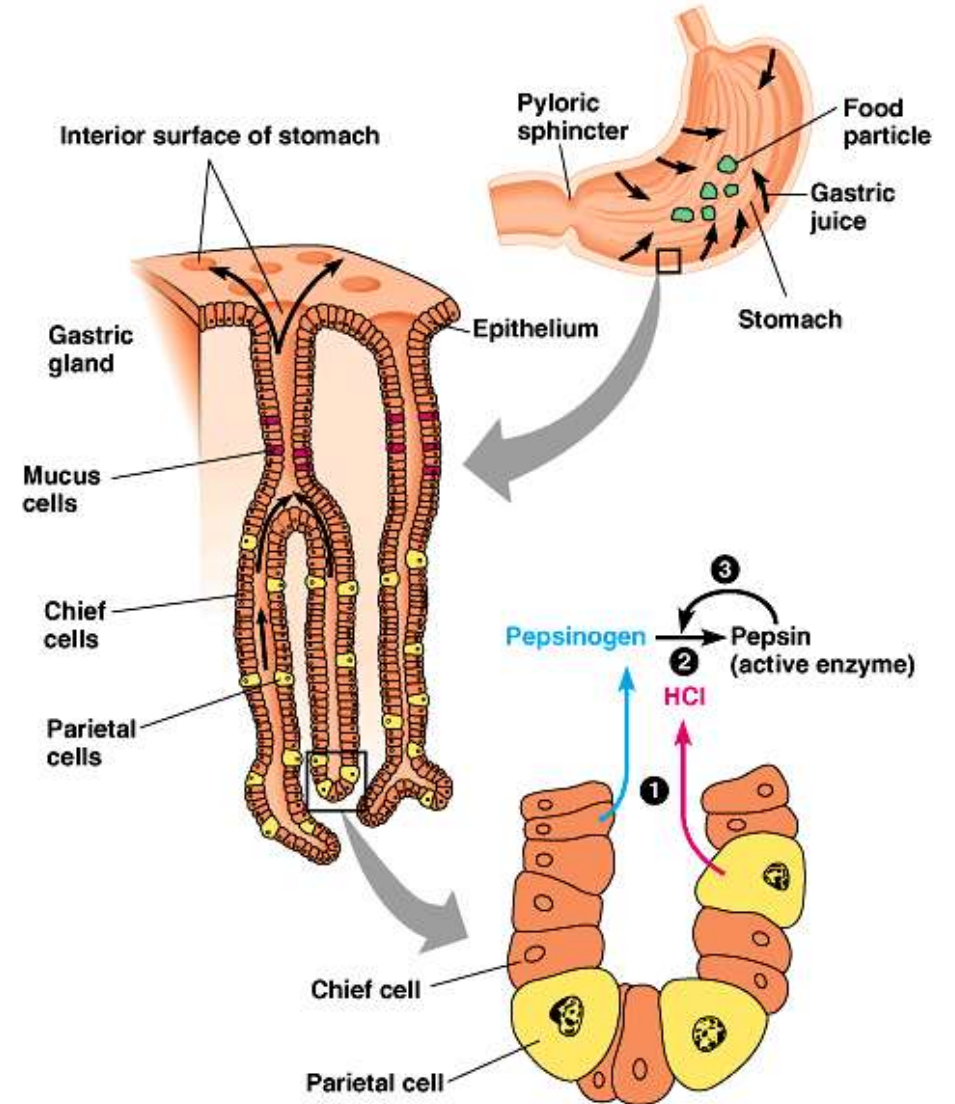
Esophagus

- Approximately 10" long
- Functions include:
 1. Secrete **mucus**
 2. Moves food from the throat to the stomach using muscle movement called **peristalsis**
- If acid from the stomach gets in here that's **heartburn**.



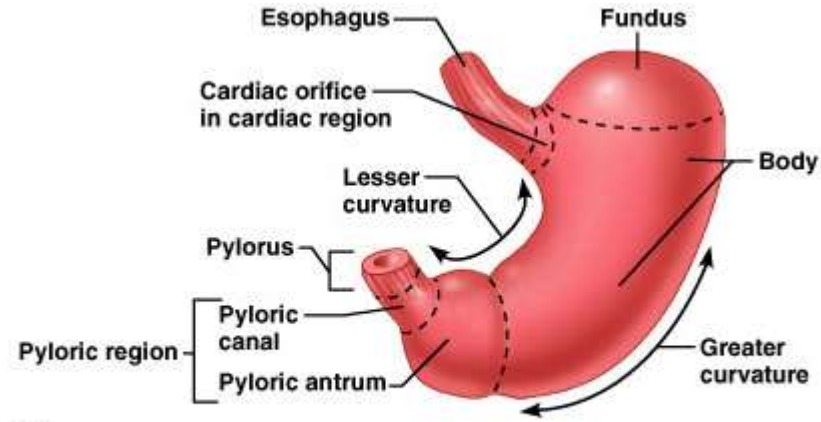
Stomach

- J-shaped muscular bag widest part of alimentary canal that stores the food 2 L, Temporary storage and mixing – 4 hours Food found in the stomach is called **chyme**. breaks it down into tiny pieces.
- Mixes food with **digestive juices** that contain enzymes to break down proteins and lipids.
- Pepsin (protein-digesting enzyme needing pH=2.5, secretion by chief cells in inactive form pepsinogen)
- parietal cells secret :HCl (hydrochloric acid): pH=1.5-2.5, helps kill bacteria. also secret interensing factor that bind with B12 to facilitate its absorption.
- Gastric juice made up water, mucus and digestive enzymes.
- Most nutrients wait until get to small intestine to be absorbed; exceptions are: Water, electrolytes, some drugs like aspirin and alcohol (absorbed through stomach).

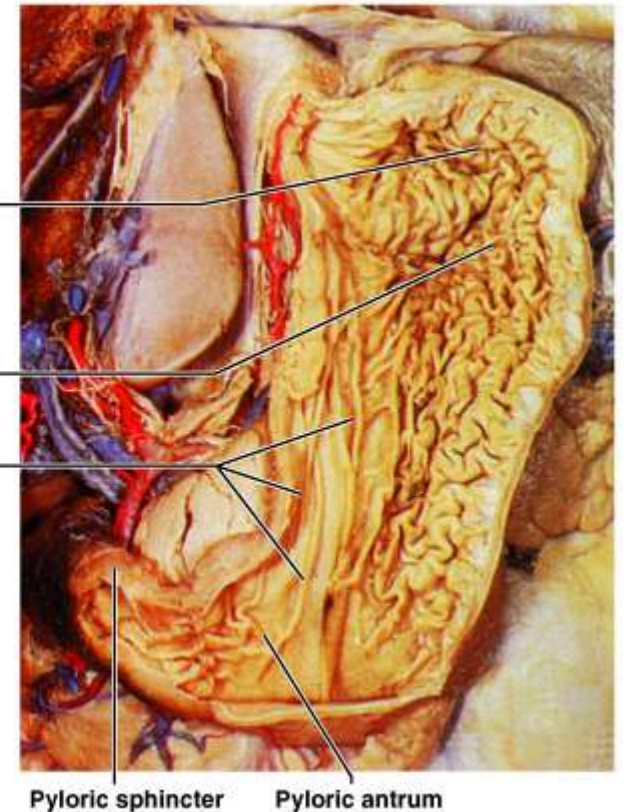
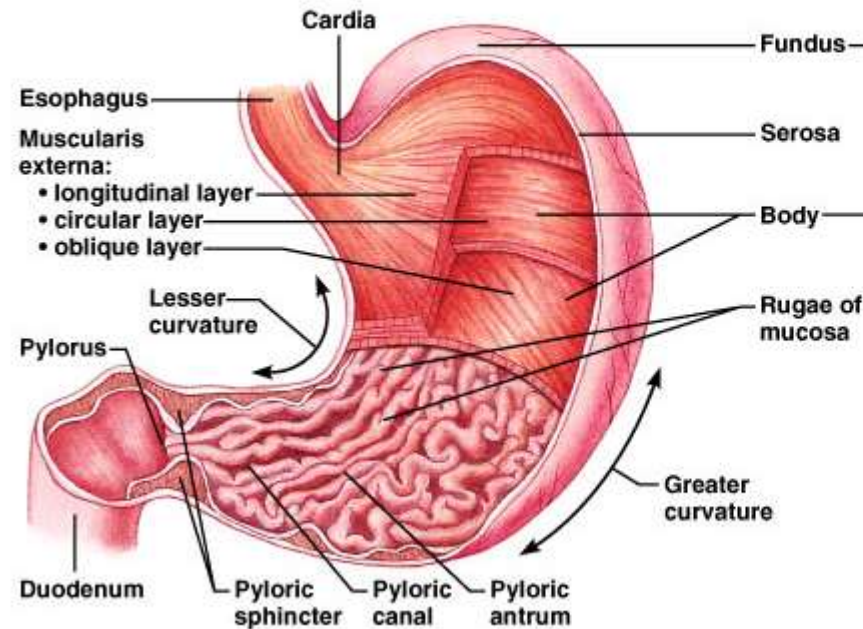


Stomach Regions

- Cardiac region
- Fundus (dome shaped)
- Body
 - Greater curvature
 - Lesser curvature
- Pyloric region
 - Antrum
 - Canal
 - Sphincter



(a)

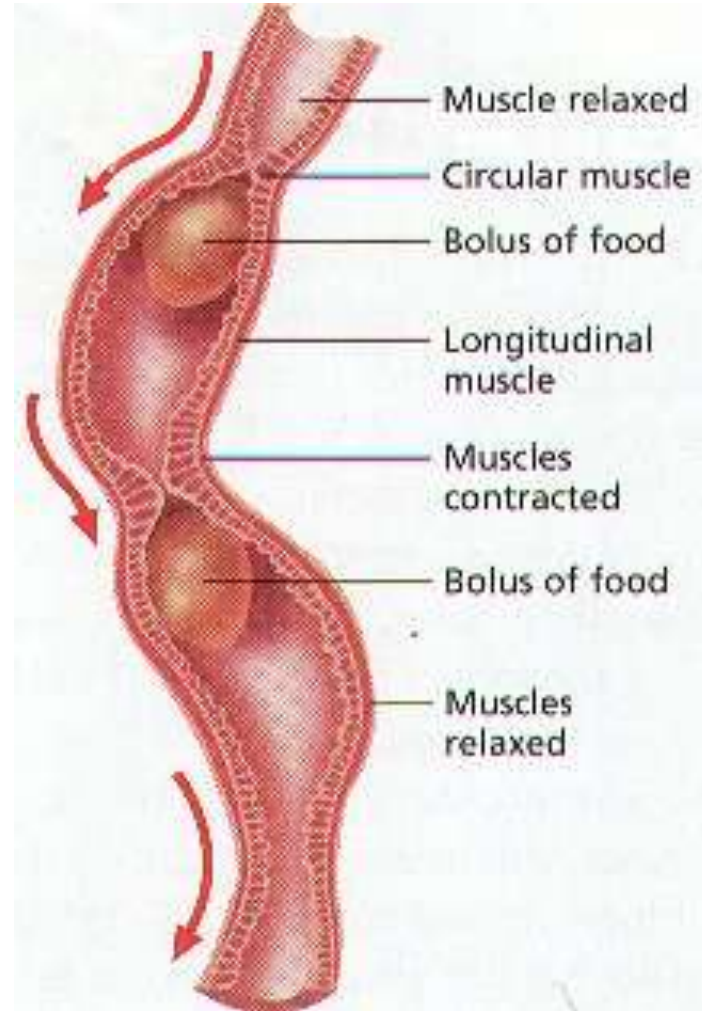


**But the stomach is made out of protein!
What stops the stomach from digesting itself?**

**mucus secreted by stomach cells
protects stomach lining**

movement

- Peristalsis: series of involuntary wave-like muscle contractions which move food along the digestive tract.
- Segmentation: reflexes cause a forward and backward movement with single segmentation of the G tract, mixing food with digestive juice and bring it with intestinal mucosa to facilitate absorption.
- Observed in esophagus, stomach and small intestine.



Regulation of motility

Gastric motility : Chyme is ejected every 20 seconds into duodenum that controlled hormonal and nervous mechanisms:

Hormonal mechanism: fat in duodenum stimulate release of gastric inhibitory peptide (GIP) which decrease peristalsis of gastric muscle and slow passage of chyme into duodenum.

Nervous mechanism : receptors in the duodenal mucosa are sensitive to presence of acid and distention, impulses over sensory and motor fibers in the vagus nerve cause a reflex inhibition of gastric , interogastric reflex.

Small intestine:

Peristalsis moving the chyme through duodenum, jujnum and illum after mixing with enzymes that take 5 hours , this regulated by reflexes and cholecystokinin hormone.

digestion

Chemical digestion: change in chemical composition of food resulted of hydrolysis.

Digestive enzymes: extracellular catalysts. Specific in their action. Function at specific pH.

Catalyze reaction in both direction. Continuously synthesized. Inactive proenzymes.

Protein digestion:

Protease hydrolysis of protein into amino acids (pepsin in GJ, trypsin in PJ, peptidases in Intestinal brush border.

Carbohydrate digestion:

Polysaccharides are hydrolyzed by amylase to disaccharides, sucrase, lactase, maltase (cell membrane of villi).

lipid digestion:

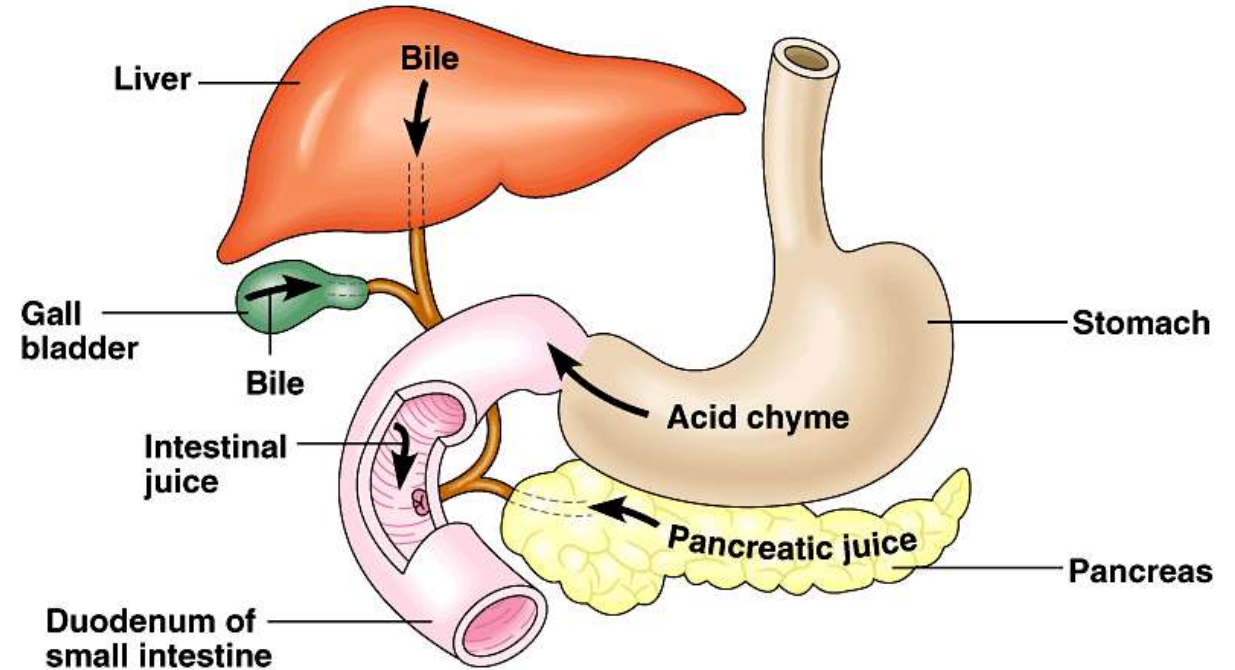
Fat insoluble in water so emulsified by bile in SI before digestion.

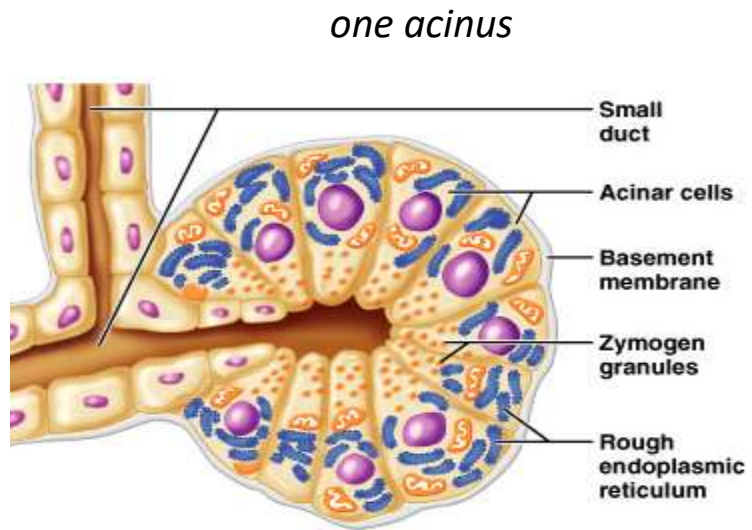
Lecitin and bile salt form micelles around fat droplets to water soluble to break down.

Pancreatic lipase is the main fat digestive enzymes.

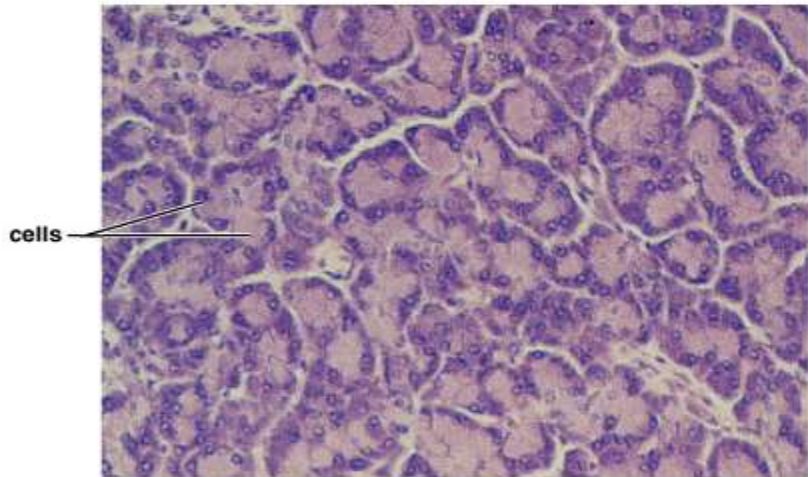
Pancreas

- An organ which secretes both digestive enzymes (exocrine) and hormones (endocrine).
- ** Pancreatic juice made of water and inactive proenzymes, digests all major nutrient types (trypsinogen).
- Trypsinogen activated by enterokinase () to trypsin that activated chymotrypsin (protein), lipase (fat), nuclease (DNA,RNA) and amylase (starch).
- Buffers :Neutralizes acid from stomach
- Nearly all digestion occurs in the small intestine & all digestion is completed in the SI.





(a)



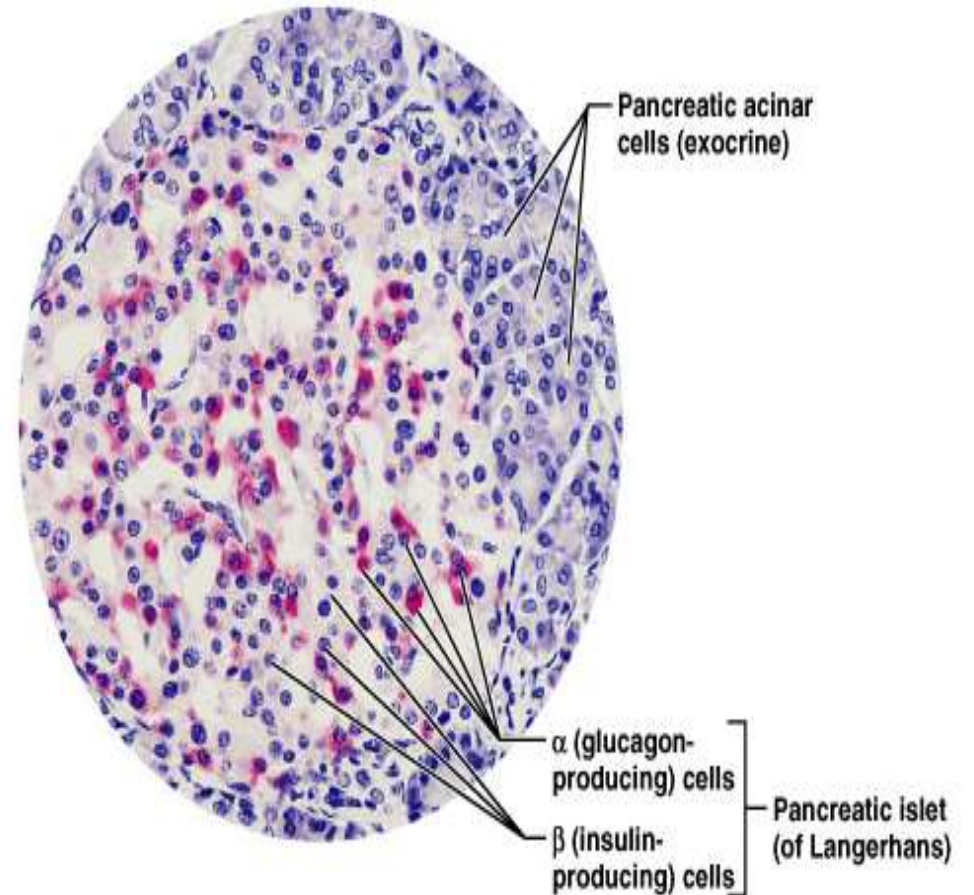
(b)

Pancreatic *exocrine* function

- Compound ***acinar*** (sac-like) glands opening into large ducts (therefore exocrine)
- ***Acinar*** cells make 22 kinds of enzymes
 - Stored in zymogen granules
 - Grape-like arrangement
- Enzymes to duodenum, where activated

Pancreatic *endocrine* function (hormones released into blood)

- ***Islets of Langerhans*** (AKA “islet cells”) are the hormone secreting cells
- ***Insulin*** (from beta cells)
 - Lowers blood glucose (sugar)
- ***Glucagon*** (from from alpha cells)
 - Raises blood glucose (sugar)

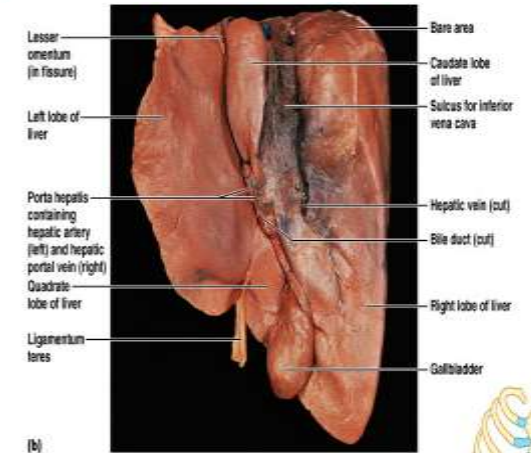
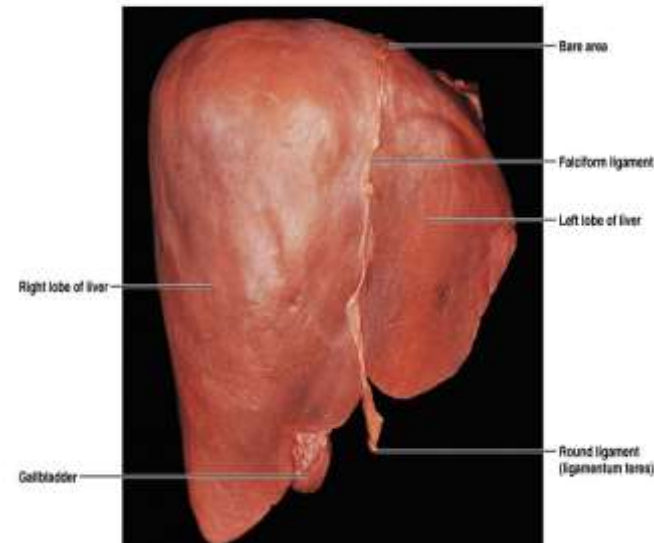
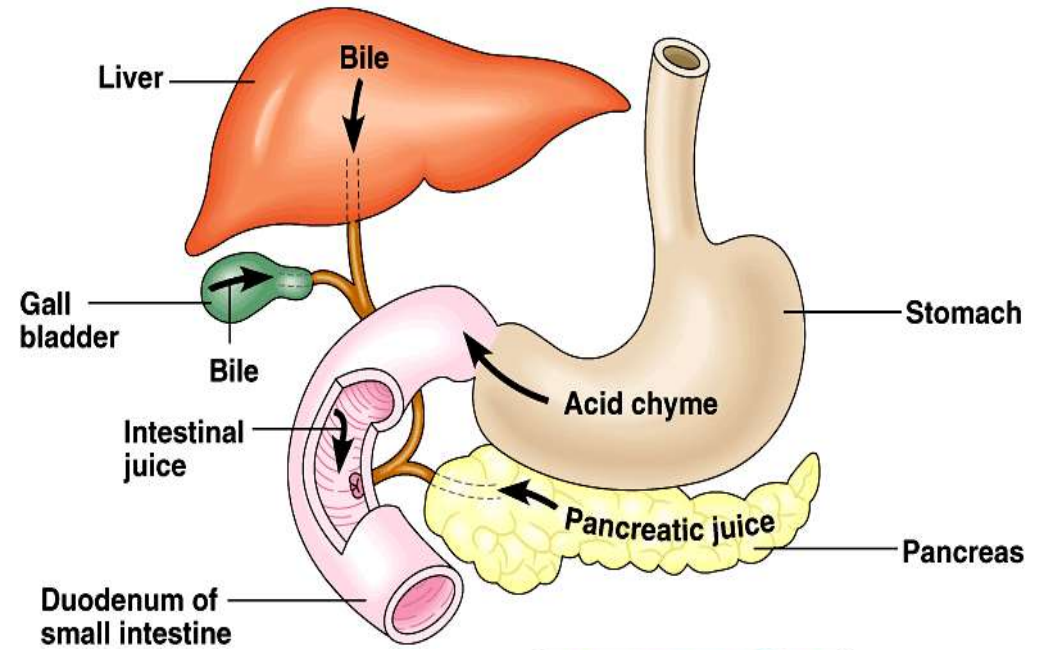


Liver

- Function:

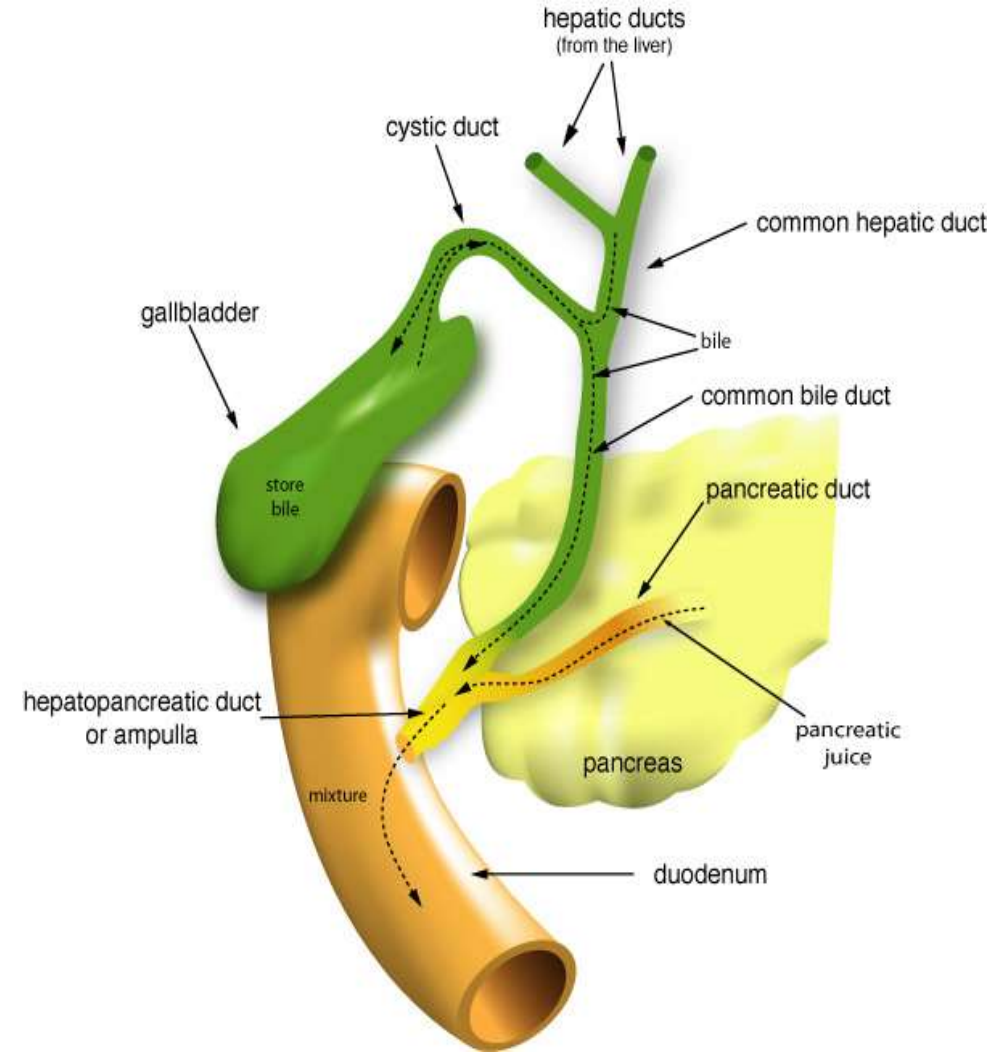
- produces bile
- bile stored in gallbladder until needed
- breaks up fats
- Picks up glucose from blood
- Stores glucose as glycogen
- Processes fats and amino acids
- Stores some vitamins
- Detoxifies poisons and drugs
- Makes the blood proteins

bile contains colors from old red blood cells collected in liver = iron in RBC rusts & makes feces brown



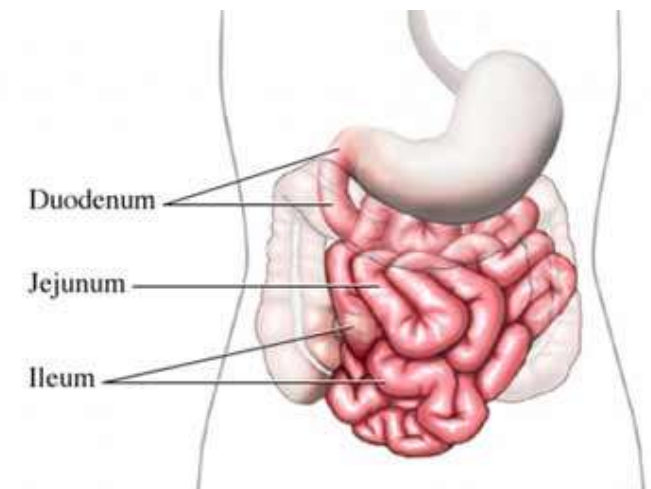
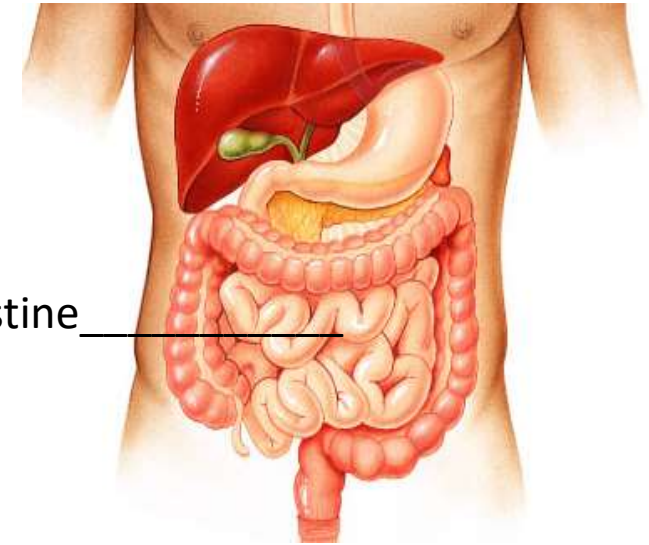
Gall bladder

- Pouch structure located near the liver which concentrates and stores bile.
- **Bile duct** – a long tube that carries BILE. The top half of the common bile duct is associated with the liver, while the bottom half of the common bile duct is associated with the pancreas, through which it passes on its way to the intestine. Bile emulsifies lipids (physically breaks apart FATS).
- Bile is a bitter, greenish-yellow alkaline fluid, stored in the gallbladder between meals and upon eating is discharged into the duodenum where it aids the process of digestion.
- Bile secretion stimulated by cholecystikinase.
- Bile contain cholesterol, bile pigments and detoxification products for removal by feces.



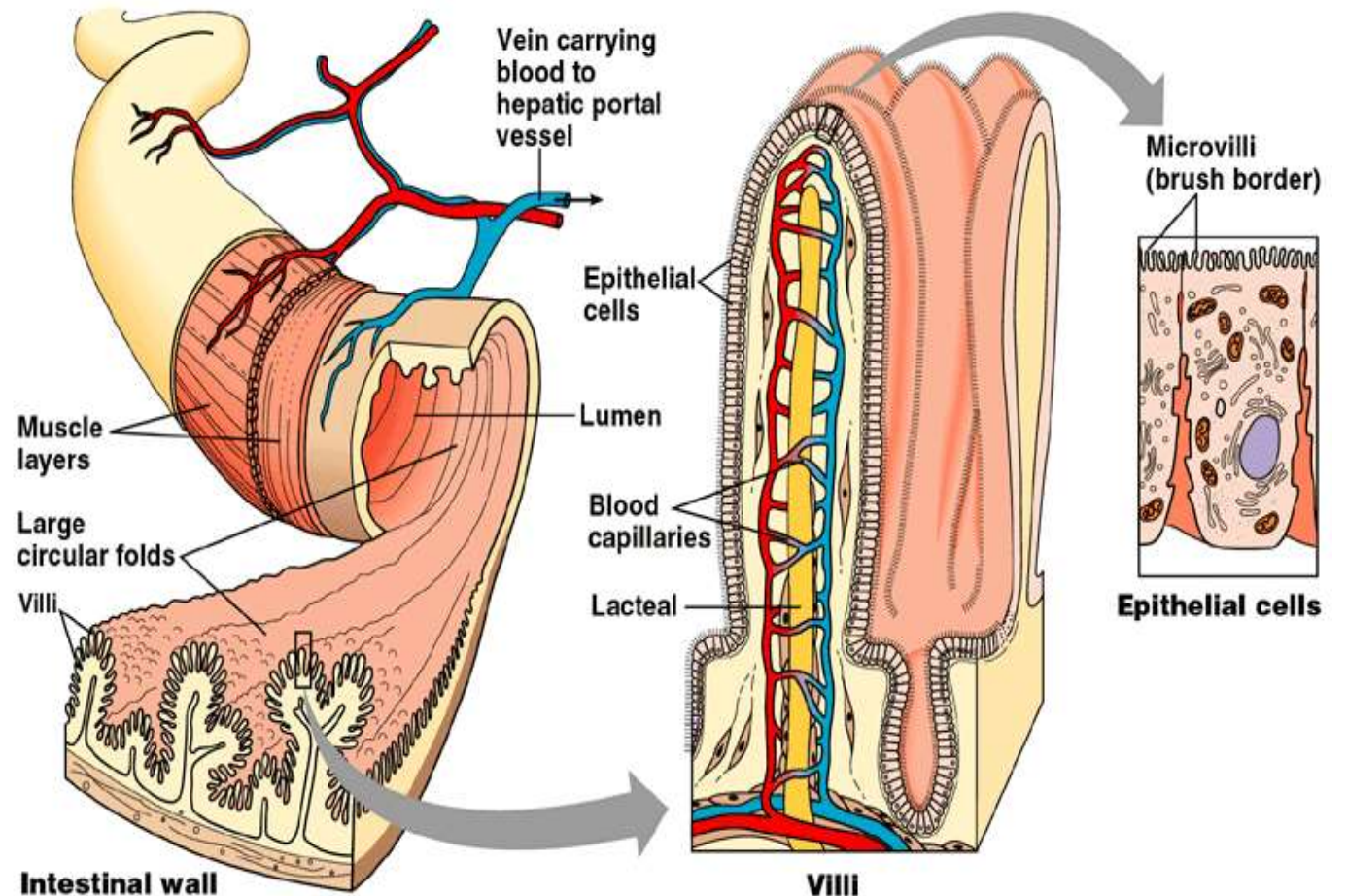
Small intestine

- Longest part of alimentary canal (2.7-5 m)
- Structure: 3 sections
 - duodenum = most digestion
 - jejunum = absorption of nutrients & water
 - ileum = absorption of nutrients & water.
 - small intestine has huge surface area = 300m² (~size of tennis court) .
- Function : chemical digestion
 - major organ of digestion & absorption
 - Most **chemical digestion** takes place here.
 - Most enzymatic digestion occurs here , Most enzymes secreted by *pancreas*, not small intestine.
 - IJ: basic, mucus solution that lubricate materials in it.
 - absorption through lining: Almost all absorption of nutrients
- Simple **sugars** and **proteins** are absorbed into the inner lining.
- **Fatty acids** and **glycerol** go to lymphatic system.
- Lined with villi, which increase surface area for absorption, one cell thick.



Duodenum

- 1st section of small intestines
 - acid food from stomach
 - mixes with digestive juices from:
- Almost 90% of our daily fluid intake is absorbed in the small intestine.
- Absorption through villi & microvilli
 - finger-like projections
 - increase surface area for absorption thus providing better absorption of materials.
 - 80% ingested water
 - Vitamins
 - Minerals
 - Carbohydrates
 - Proteins
 - Lipids

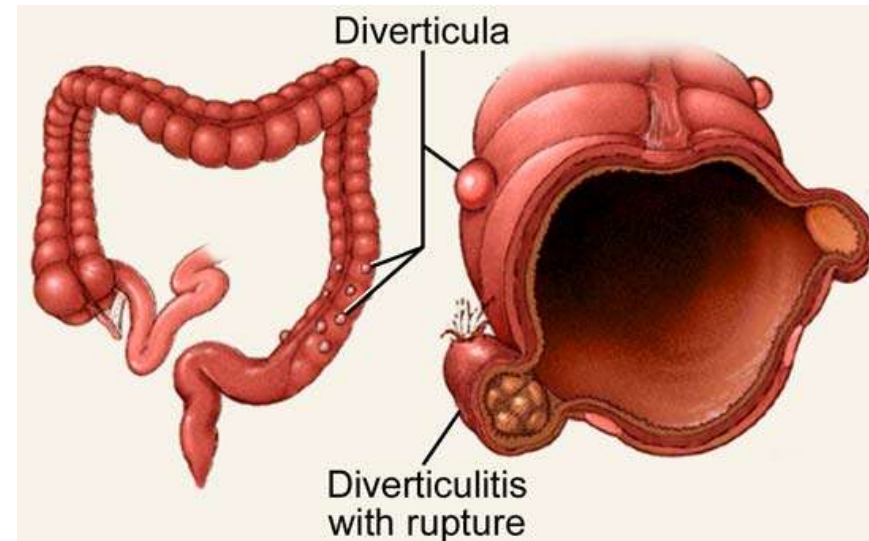


Absorption

- Water by is absorbed by osmosis >
- Na is pumped out of the cell creating a concentration gradient allowing Na to move out the GI lumen . Glucose is too large and hydrophilic to move easily through the membrane so must transported via Na cotransport.
- Amino acid move similarly to glucose.
- After absorption , the nutrients move Through hepatic portal system to liver which store excess nutrients and the rest leave via hepatic vein into circulation.
- Fat : included triglycerides, phospholipids ,steroid , fat soluble vitamin; bile salts and lecithin surround fatty acids to form micelles that approach the brush border , simple lipid molecules pass through the membrane that inside the cell form chylomicrons absorbed by lacteals and move through lymphatic system that allow it to enter the blood stream.

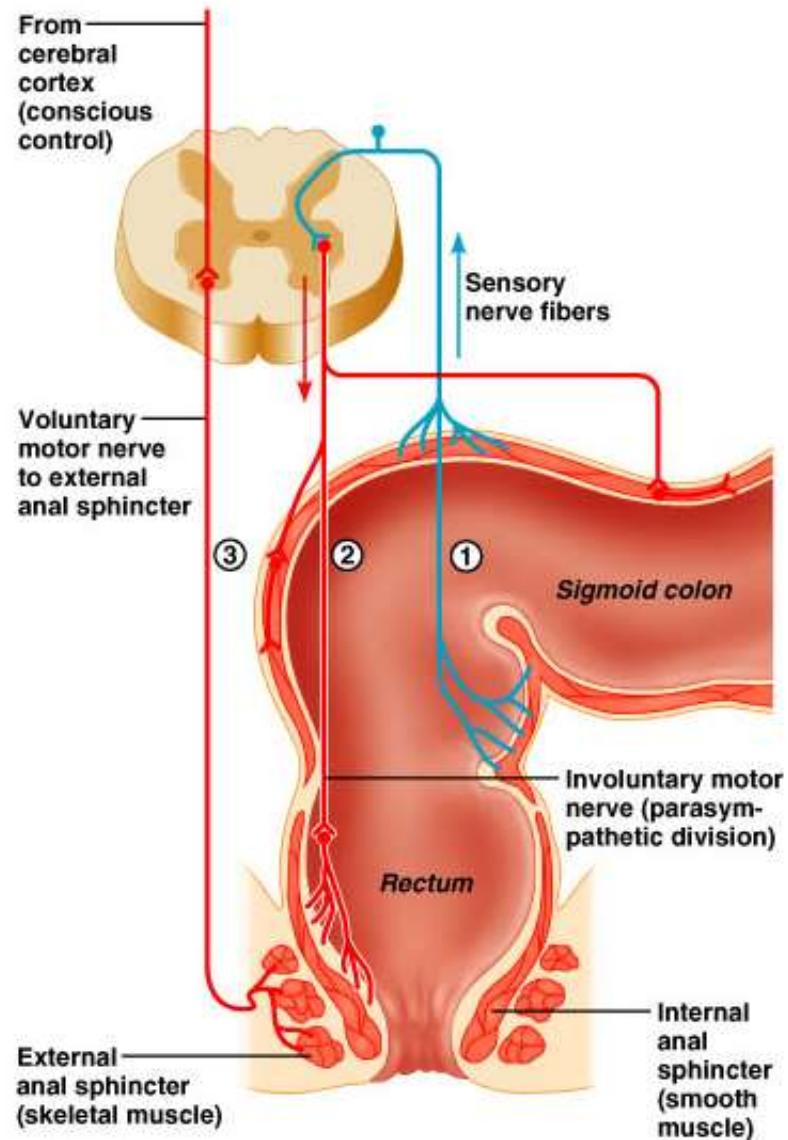
Large intestines (colon)

- Function: re-absorb water
- use ~9 liters of water every day in digestive juices
- > 90% of water reabsorbed
- Solid materials pass through the large intestine. These are undigestible solids (fibers).
- Vitamins K and B are reabsorbed with the water.
- Last section of colon (large intestines)
- eliminate feces
- undigested materials
- extracellular waste
- mainly cellulose from plants
- roughage or fiber
- masses of bacteria
- not enough water absorbed
- diarrhea
- too much water absorbed
- constipation



- Living in the large intestine is a community of helpful bacteria
- Escherichia coli (E. coli)
- produce vitamins
- vitamin K; B vitamins
- generate gases
- by-product of bacterial metabolism
- methane, hydrogen sulfide



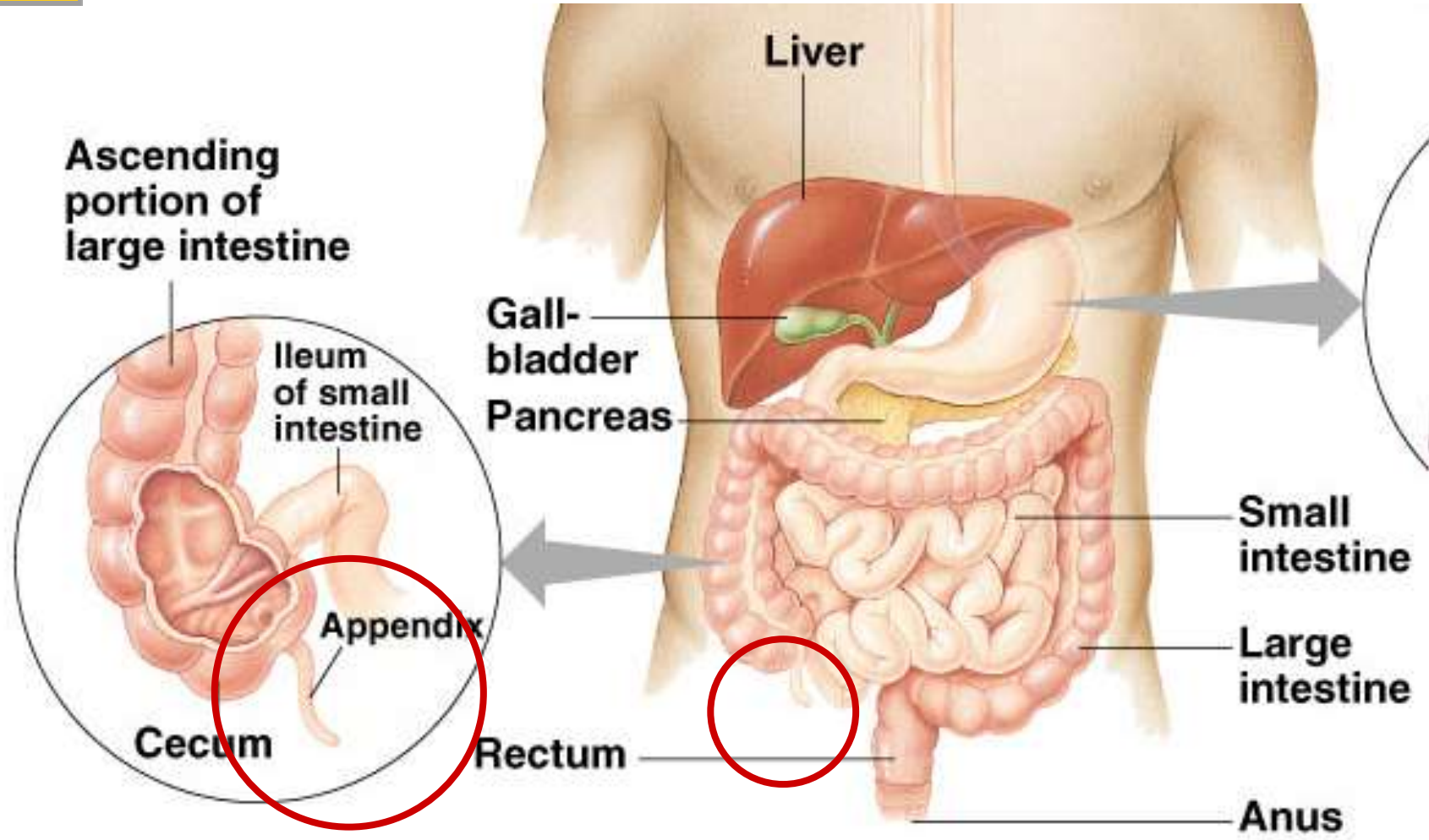


Defecation

1. Triggered by stretching of wall, mediated by spinal cord parasympathetic reflex
2. Stimulates contraction of smooth muscle in wall and relaxation of internal anal sphincter
3. If convenient to defecate voluntary motor neurons stimulate relaxation of external anal sphincter (aided by diaphragm and abdominal wall muscles -called Valsalva maneuver)

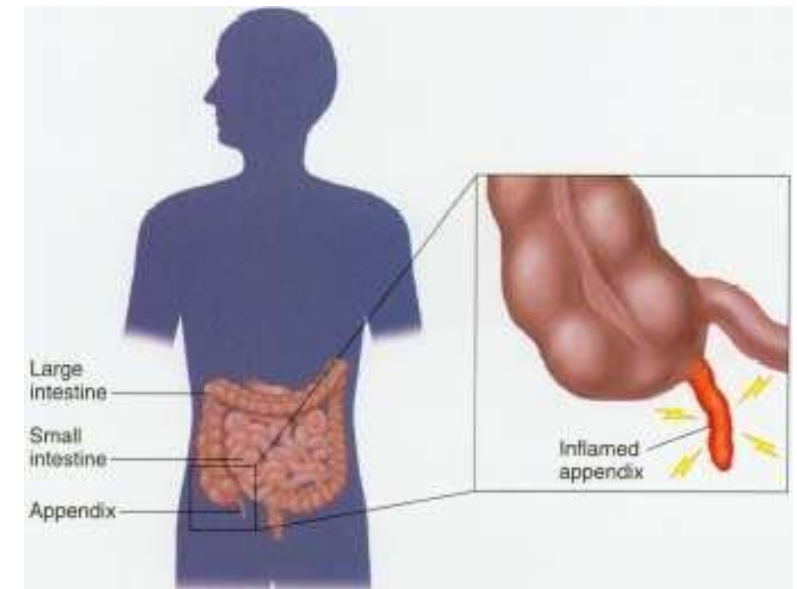
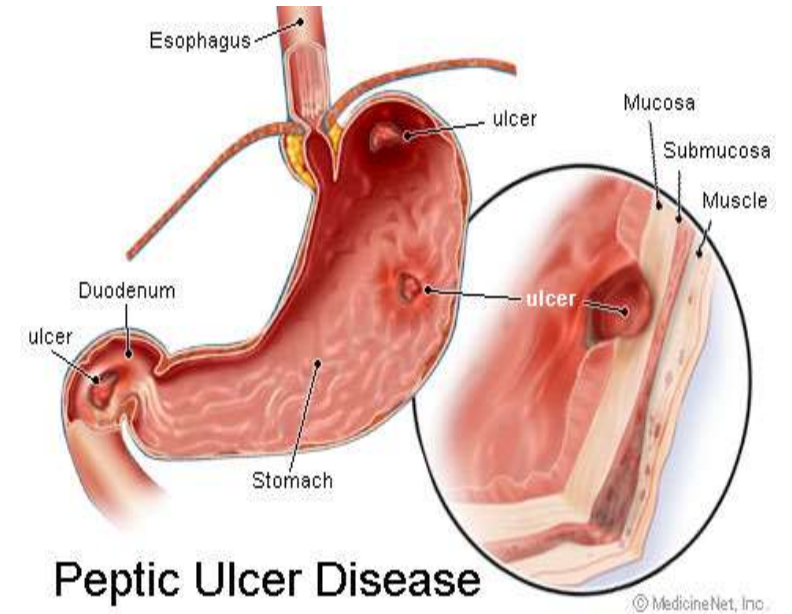
Appendix

Vestigial organ



Digestive Homeostasis Disorders

- **ULCERS** – erosion of the surface of the alimentary canal generally associated with some kind of irritant.
- **CONSTIPATION** – a condition in which the large intestine is emptied with difficulty. Too much water is reabsorbed and the solid waste hardens.
- **DIARRHEA** – a gastrointestinal disturbance characterized by decreased water absorption and increased peristaltic activity of the large intestine. This results in increased, multiple, watery feces. This condition may result in severe dehydration, especially in infants.
- **APPENDICITIS** – an inflammation of the appendix due to infection, Common treatment is removal of the appendix via surgery



Digestive Homeostasis Disorders

- GALLSTONES – an accumulation of hardened cholesterol and/or calcium deposits in the gallbladder, surgically removed.
- ANOREXIA NERVOSA - a psychological condition where an individual thinks they appear overweight and refuses to eat. Weighs 85% or less than what is developmentally expected for age and height, Young girls do not begin to menstruate at the appropriate age.
- HEART BURN – ACID from the stomach backs up into the esophagus.

