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Digestive System

Primary Care Paramedicine

Module: 17

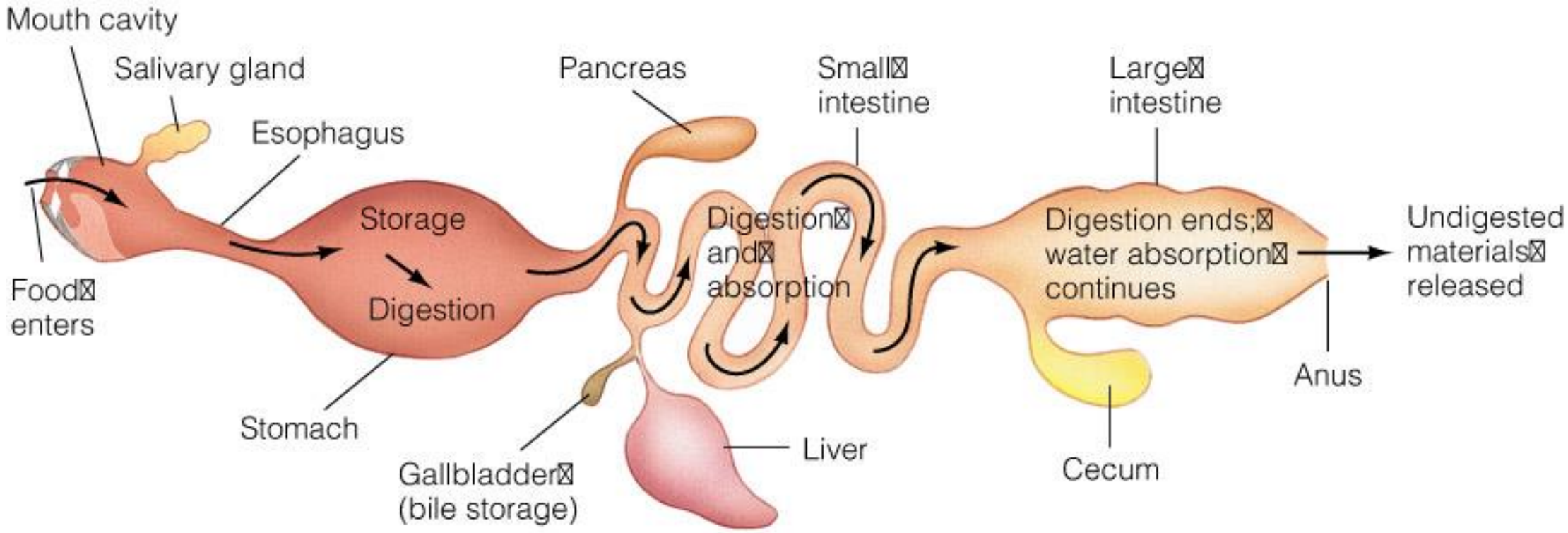
Section: 01a

The Digestive System

- The digestive system, also called the gastrointestinal system, is composed of the alimentary canal (GI tract) and the accessory organs.
  - The alimentary canal extends from the mouth to the anus through the ventral body cavity (approximately 8 m).
  - The accessory organs include the teeth, tongue, salivary glands, liver, gallbladder and pancreas.

The Alimentary Canal

- An 8-meter-long muscular tube passing through the thoracic and abdominopelvic cavities



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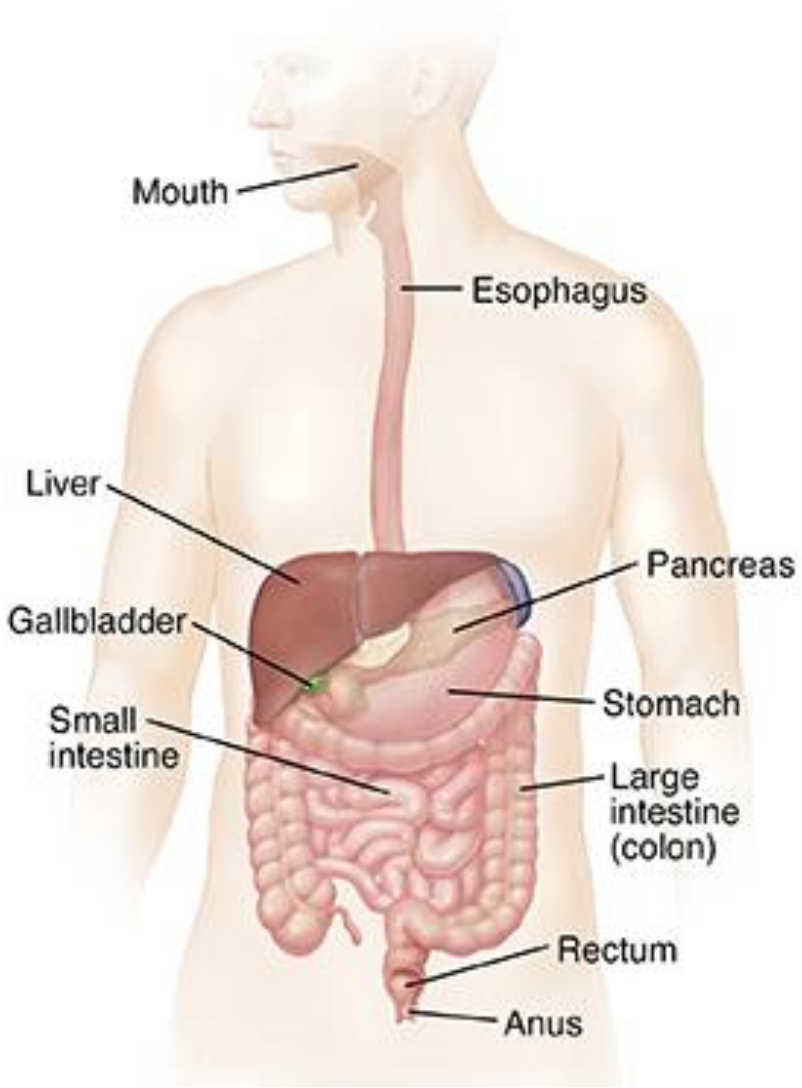
The Digestive System



GI Tract	Accessory Organs
Mouth	Salivary Glands
Oropharynx	Tongue
Esophagus	Teeth
Stomach	Liver
Small Intestine	Gallbladder
Large Intestine	Pancreas
Cecum	Vermiform Appendix
Rectum	
Anal Canal	

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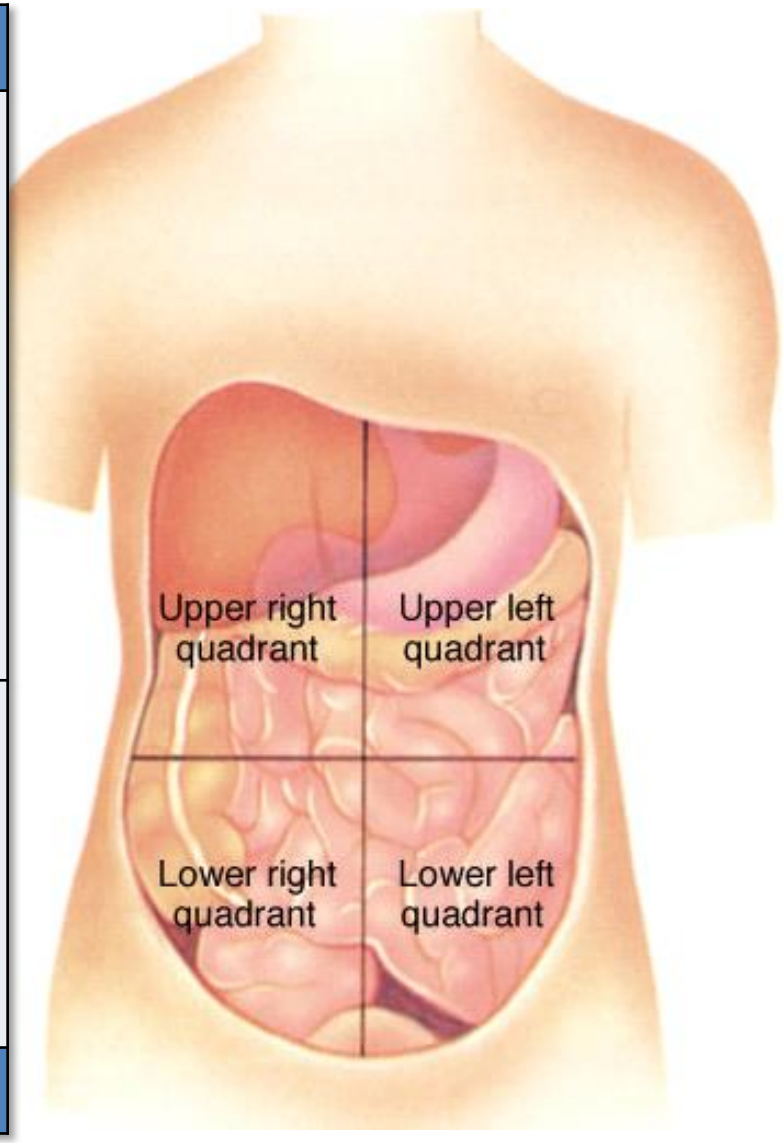
Organs

RUQ	LUQ
• Liver • Gall Bladder • Kidney • Part of the Pancreas • Large Intestine • Small Intestine	• Spleen • Stomach • Kidney • Part of the Liver • Kidney • Large Intestine • Small Intestine • Part of the Pancreas
• Appendix • Large Intestine • Rt Ureter • Small Intestine • Femoral Artery/Vein to Rt Leg	• Lt Ureter • Large Intestine • Small Intestine • Femoral Artery/Vein to Left Leg
RLQ	LLQ



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Functions

- Digestion
- Absorption
- Metabolism

Digestion

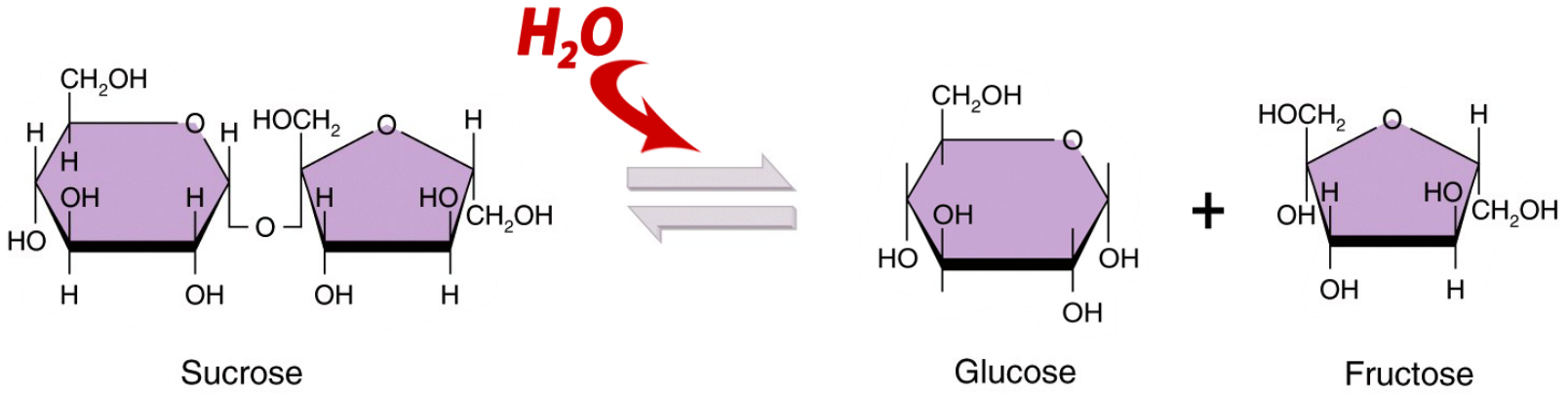
- Prepares nutrients for absorption
- Follows six steps
  - Ingestion
  - Secretion
  - Digestion
    - Mechanical digestion (mastication)
    - Chemical digestion (hydrolysis with digestive enzymes)
  - Movement (mixing and propulsion)
  - Absorption
  - Elimination

The Digestive System

- Mechanical digestion includes all movements that facilitate catabolic processes:
  - Mastication (chewing)
  - Deglutination (swallowing)
  - Mixing
    - Increase contact of food with digestive chemicals
  - Peristalsis
    - Movement of muscles within the GI tract that facilitates movement of food

The Digestive System

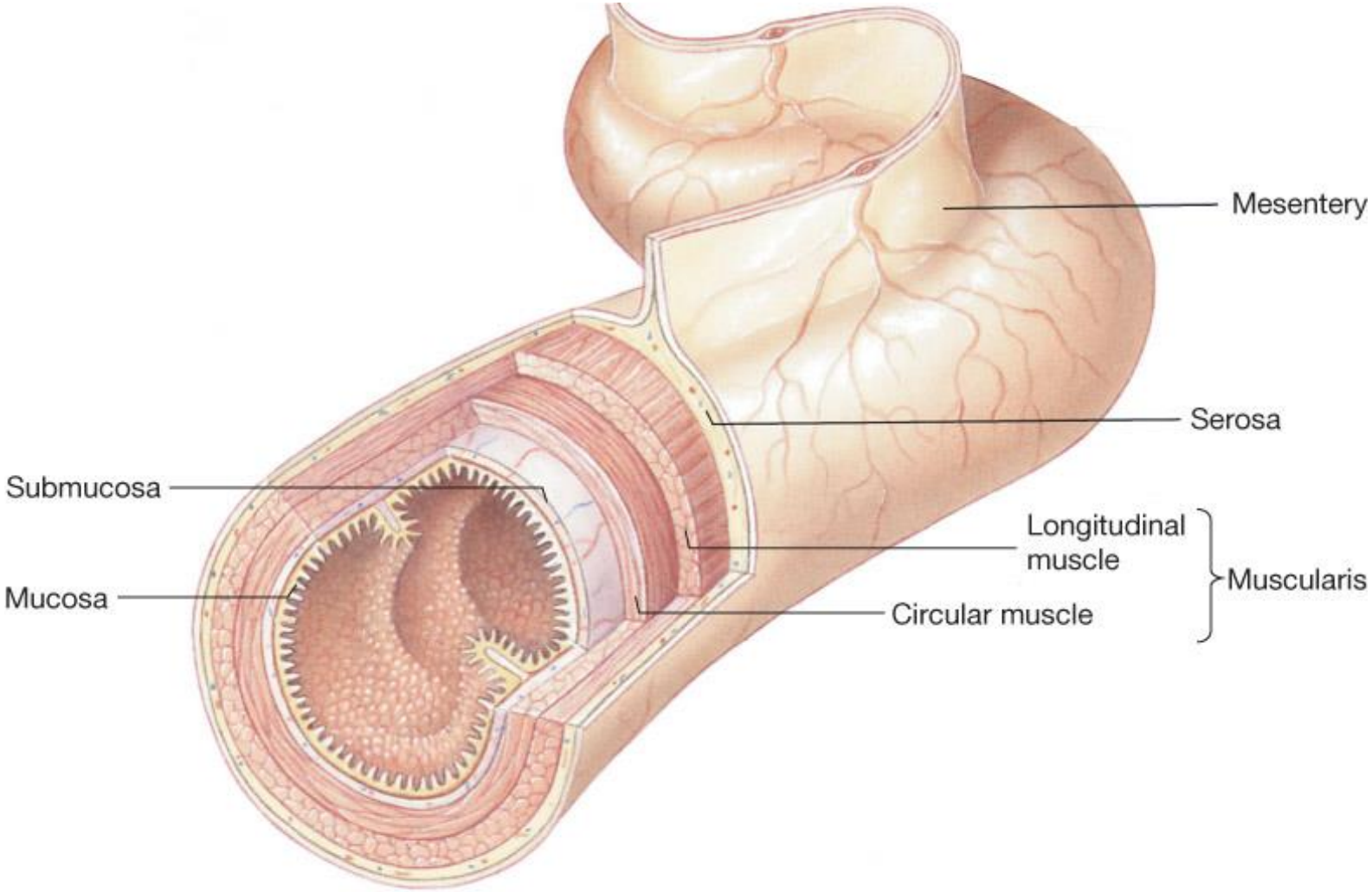
- Chemical digestion is mainly accomplished by using water to break chemical bonds (hydrolysis).
  - Fats are broken down into fatty acids and glycerol.
  - Carbohydrates are broken down from polysaccharides into monosaccharides.
  - Proteins are broken down into polypeptides and amino acids.



General Structure of the Digestive Tract

- One continuous tube (8 m long)
- The wall has four layers
  - Mucosa
  - Submucosa
  - Muscularis layer
  - Serous layer (serosa/adventitia)

General Structure of the Digestive Tract



Mucosa

- Inner most layer
- Consists of:
  - Epithelium tissue (thicker in mouth and anus)
  - Connective tissue
  - Smooth muscle
- May develop folds in areas for increased surface area
- Some cells secrete mucus, digestive enzymes and hormones
- Some glands release into the GI tract through this

Submucosa

- Thick layer of connective tissue
- Also contains:
  - Blood and lymphatic vessels
    - Blood supply for nourishment of tissues
    - Blood and lymph absorb and move nutrients out
  - Nerves and some glands
    - Parasympathetic nerves form submucosal plexus (autonomic control)

Muscularis Layer

- Consist of 2 layers of smooth muscle
- Inner circular layer
  - Circular muscle around the tube
  - When constricted diameter decreases
- Outer longitudinal layer
  - Extend along the axis of the tube
  - When constricted decrease length
- Myenteric plexus with submucosal plexus control movements

Outer layer

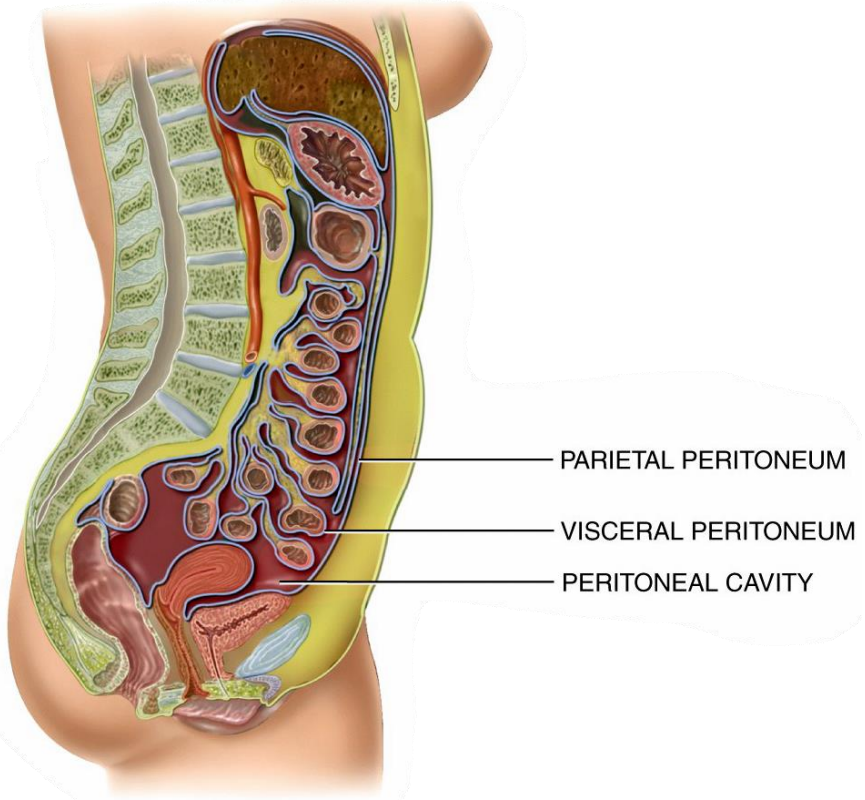
- Above diaphragm (Adventitia)
  - Connective tissue
- Below diaphragm (Serosa)
  - Has epithelium covering connective tissue
  - This forms the visceral layer of the peritoneum
  - Releases serous fluid to allow for smooth movement of organs

Modifications

- Same four tissue present throughout tract
- Are modified based on location
  - Esophagus
    - Stratified squamous provide protection from abrasion
  - Remainder
    - Simple columnar epithelial cells designed for absorption and secretion

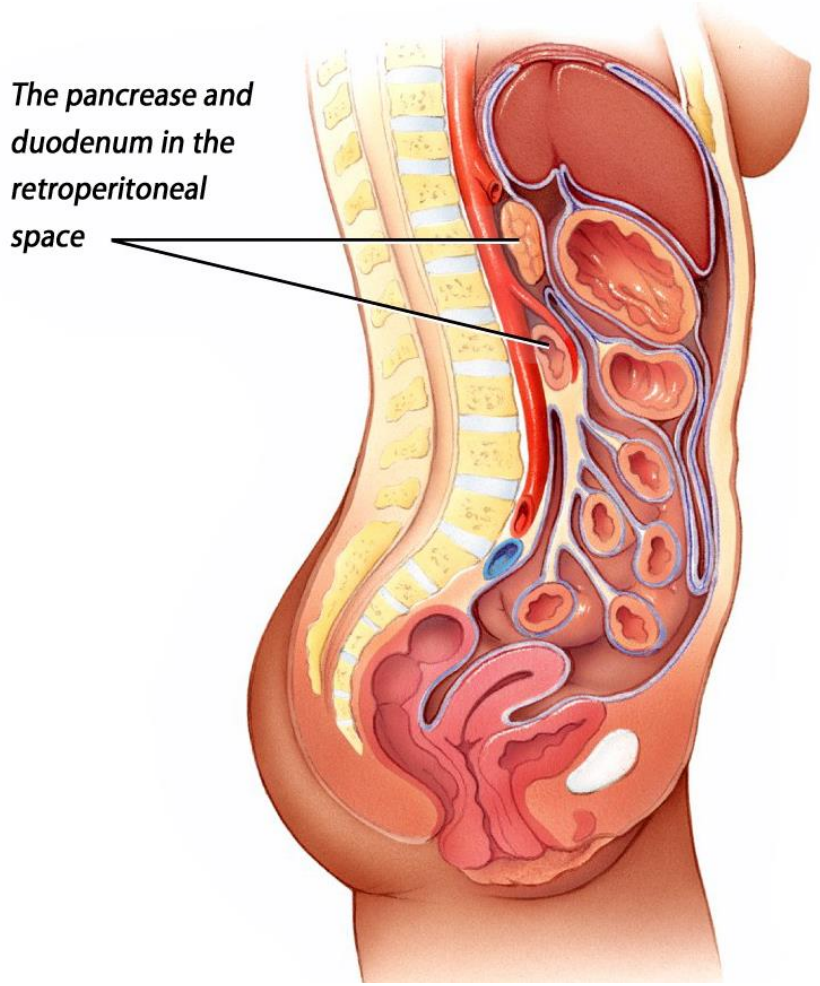
Anatomy Overview

- The peritoneum is the body's largest serous membrane, and it wraps around most abdominopelvic organs.
  - The visceral peritoneum forms the "serosa" of the alimentary canal and covers other intra-abdominal organs.
  - Continues around the abdominal wall as the parietal peritoneum.



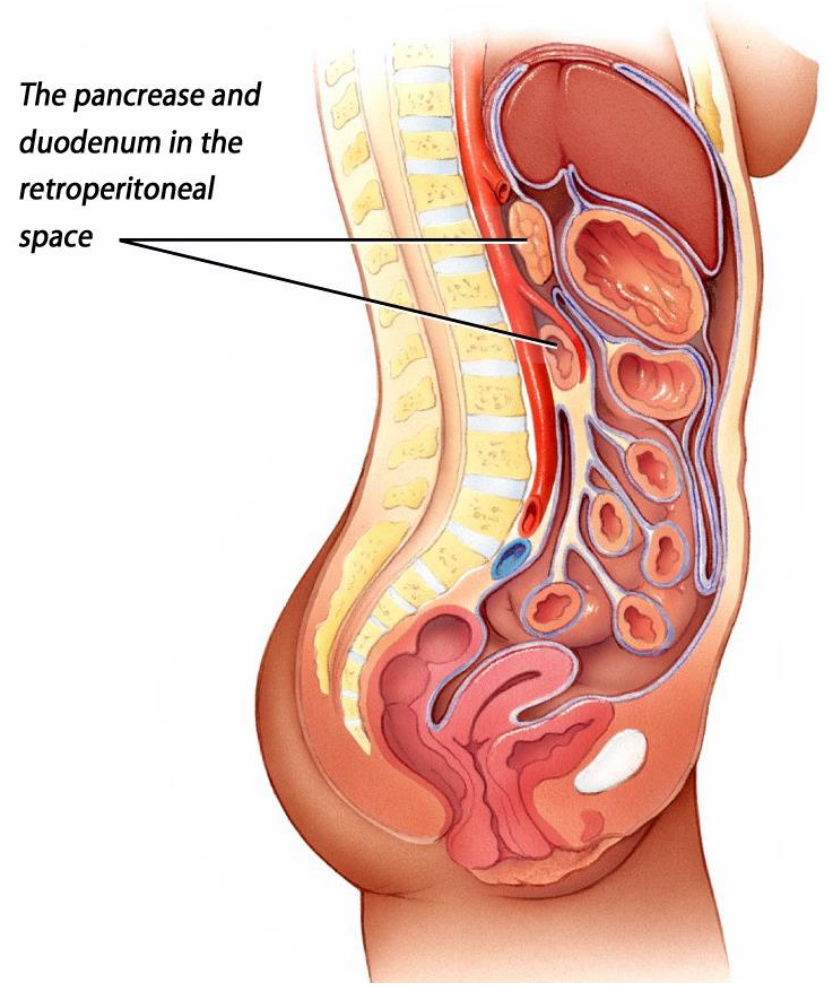
Anatomy Overview

- Some abdominopelvic organs are covered by visceral peritoneum only on their anterior surfaces. The portion of the organ that lies behind the peritoneum is said to be “retroperitoneal”.

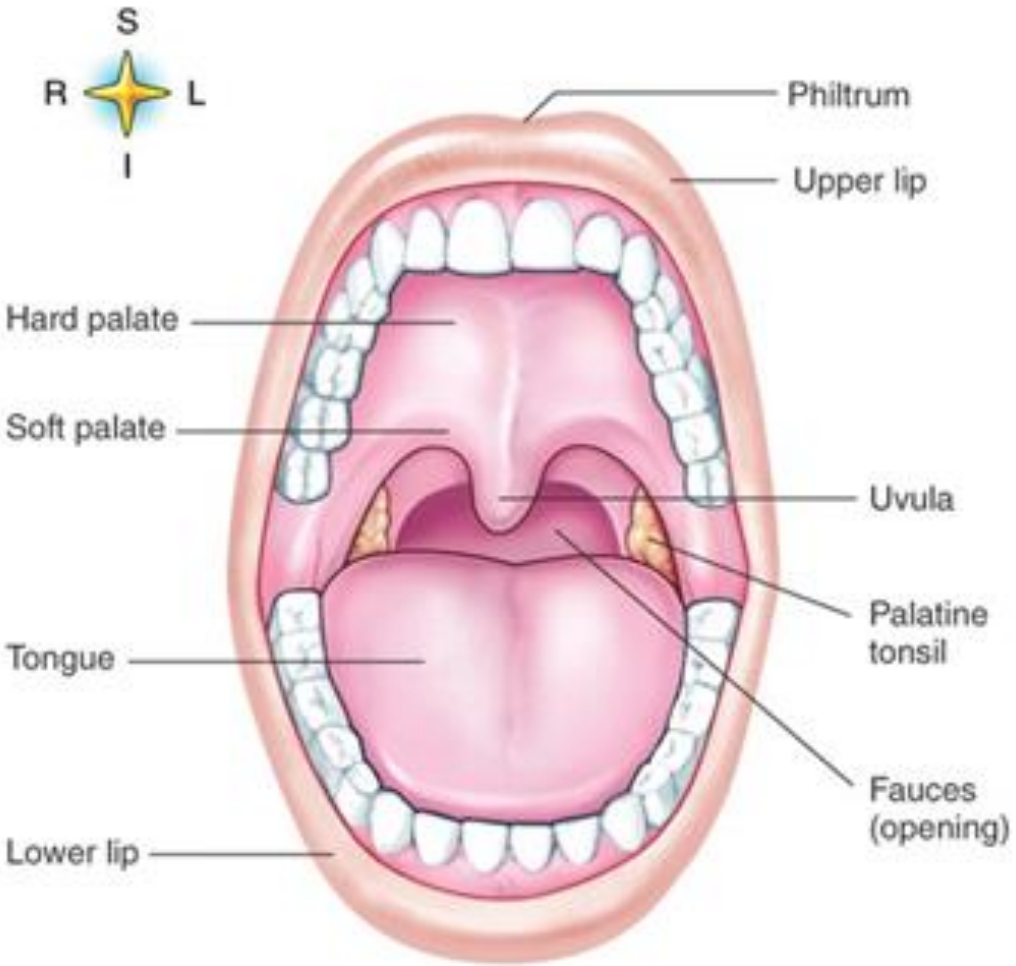


Anatomy Overview

- Organs in the retroperitoneal space include (ADUCKPIE):
  - **A**orta
  - **D**uodenum
  - **U**reters
  - **C**olon
  - **K**idneys
  - **P**ancreas
  - **I**nferior vena cava
  - **E**sophagus

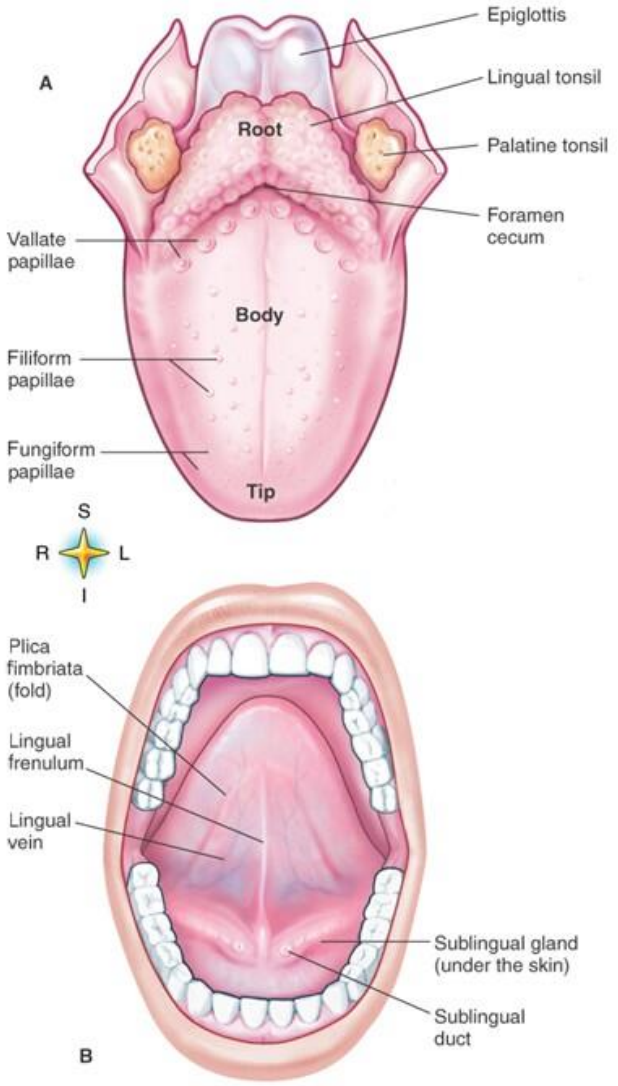


Components



- Mouth (Oral cavity)
  - Lips and cheeks
    - Hold food in place for mastication
    - Form speech
  - Palate
    - Soft palate and uvula move upward during swallowing to keep food from entering the nasal cavity

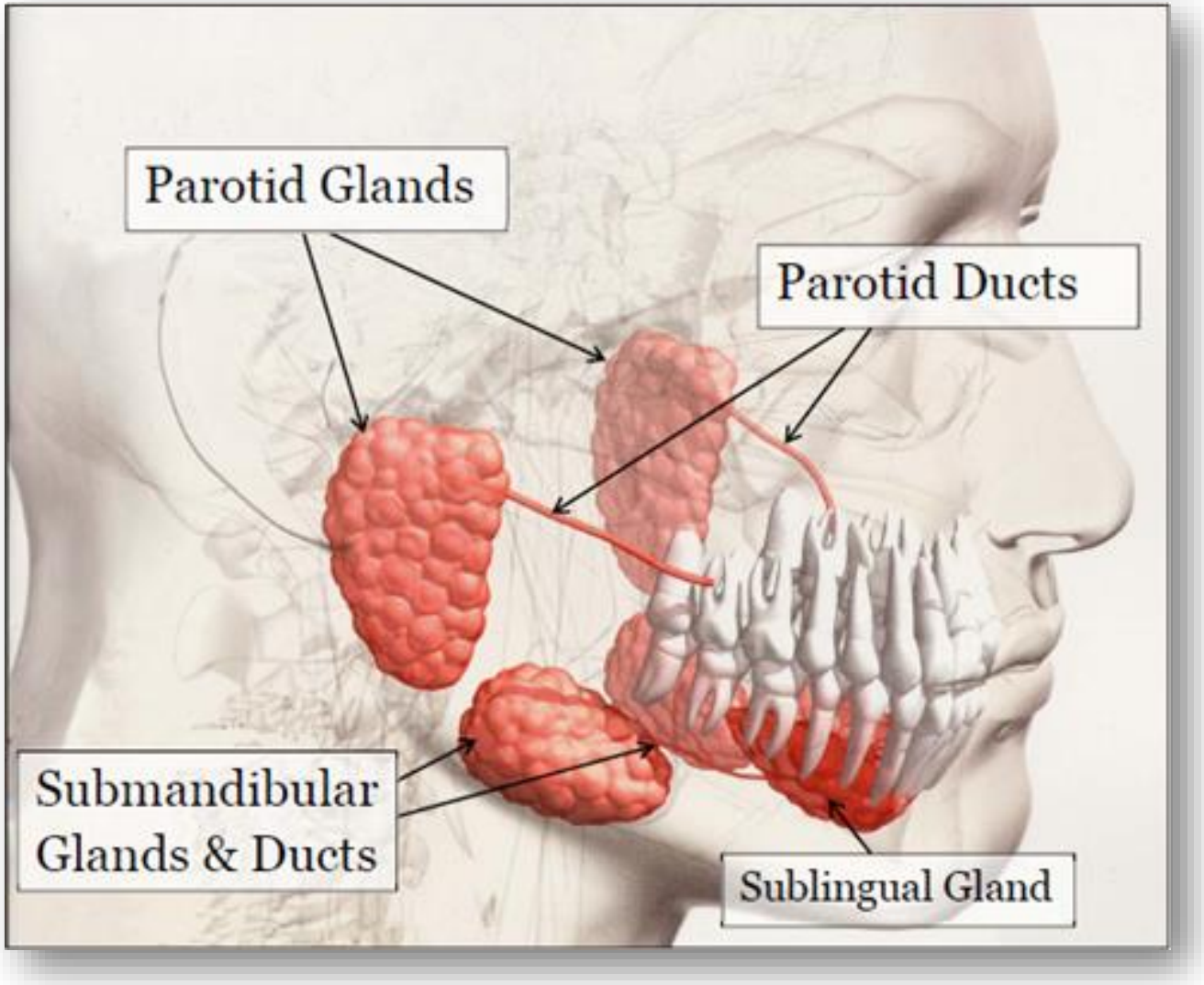
Components



- Mouth (Oral cavity)
  - Tongue
    - Made mostly of skeletal muscle connected by the frenulum (connects base of tongue to floor)
    - Intrinsic muscles
      - Control food during mastication
    - Extrinsic muscles
      - Form food into bolus
      - Aid in deglutition (swallowing) and speech
    - Contain taste buds in papillae
    - Mucous membrane very vascular

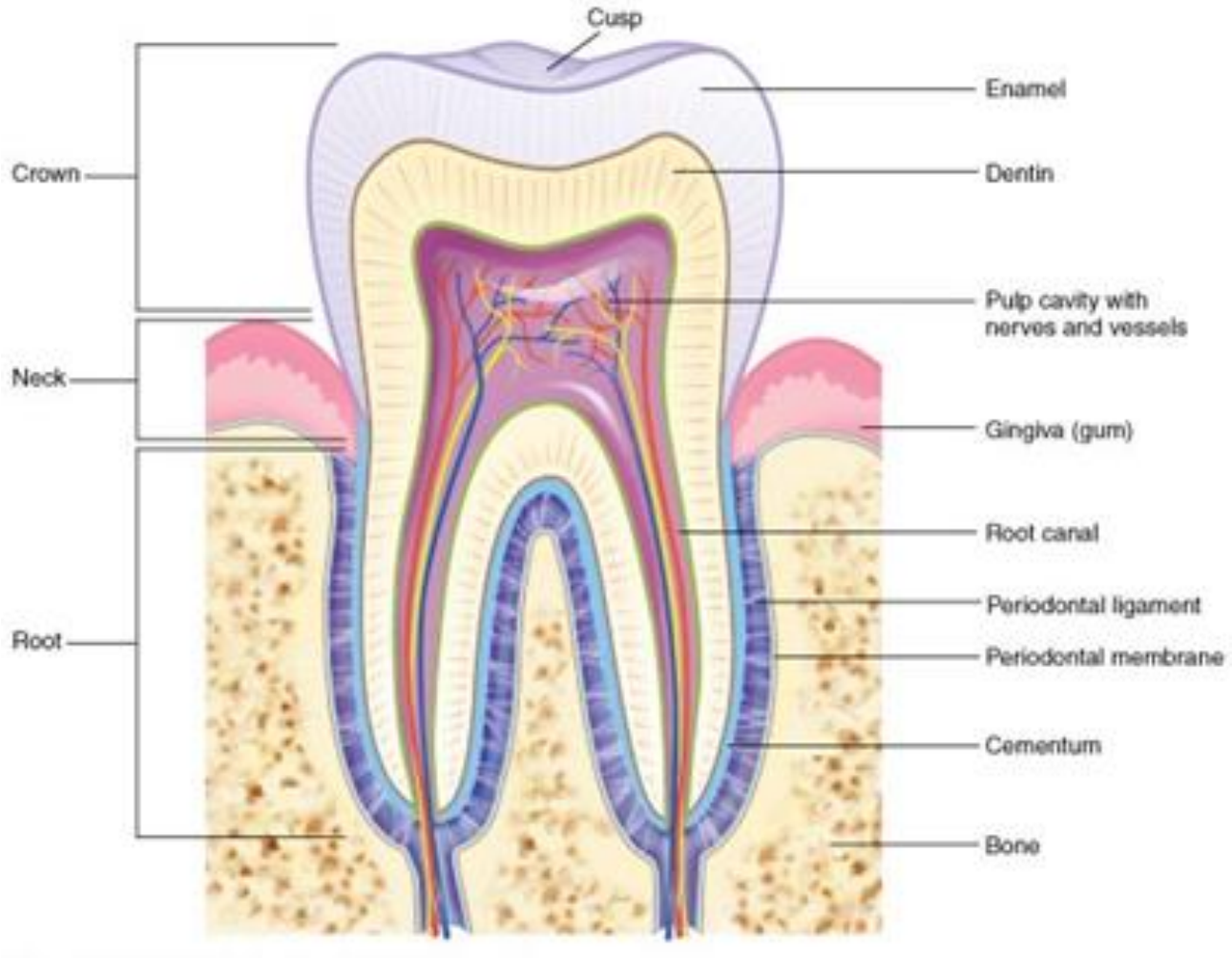
Components

- Salivary Glands
  - Produce saliva
  - 1 L/day

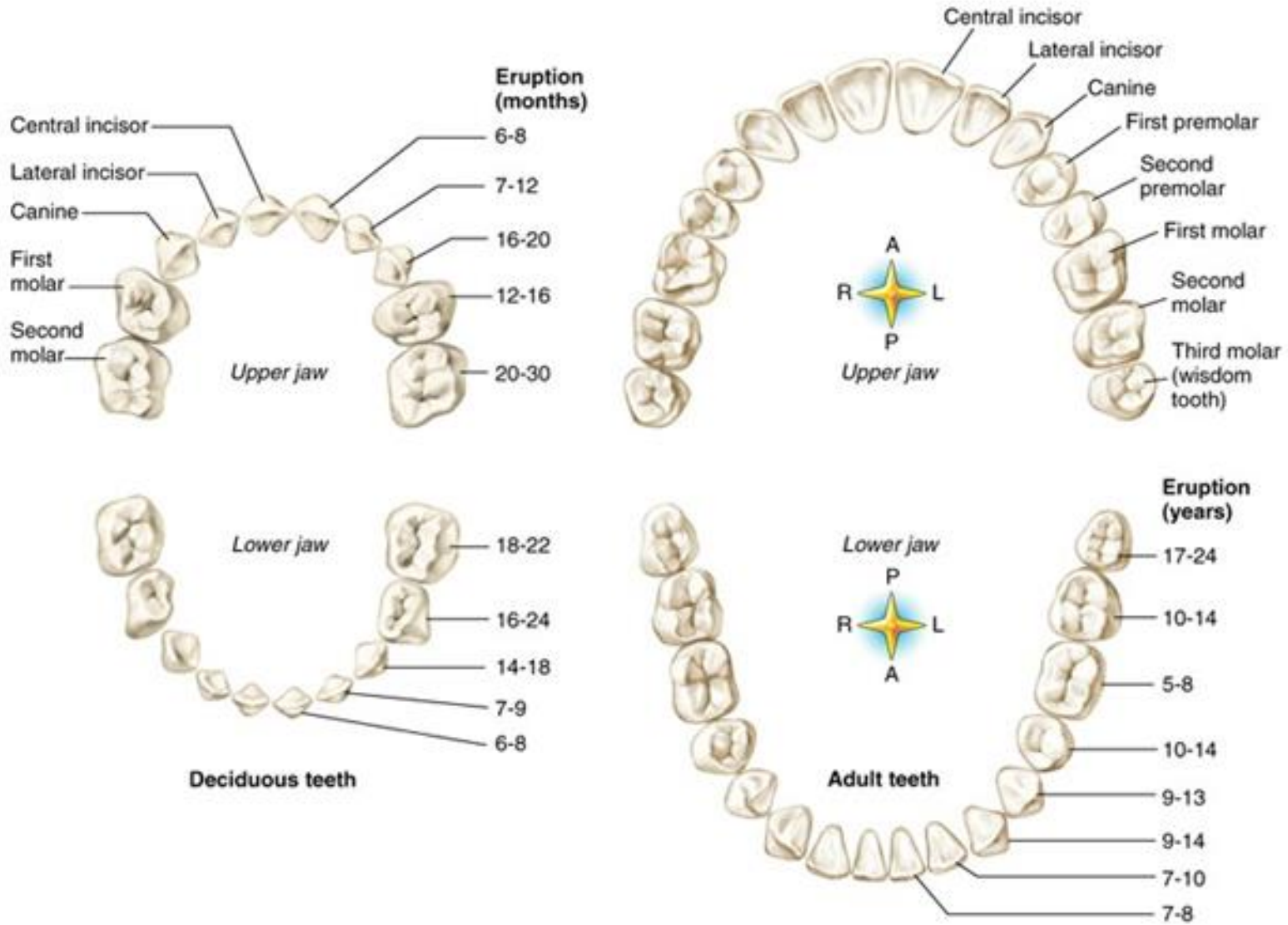


Components

- Teeth
  - Organs of mastication
  - Deciduous teeth
    - Baby teeth
  - Permanent teeth
    - 32



Teeth

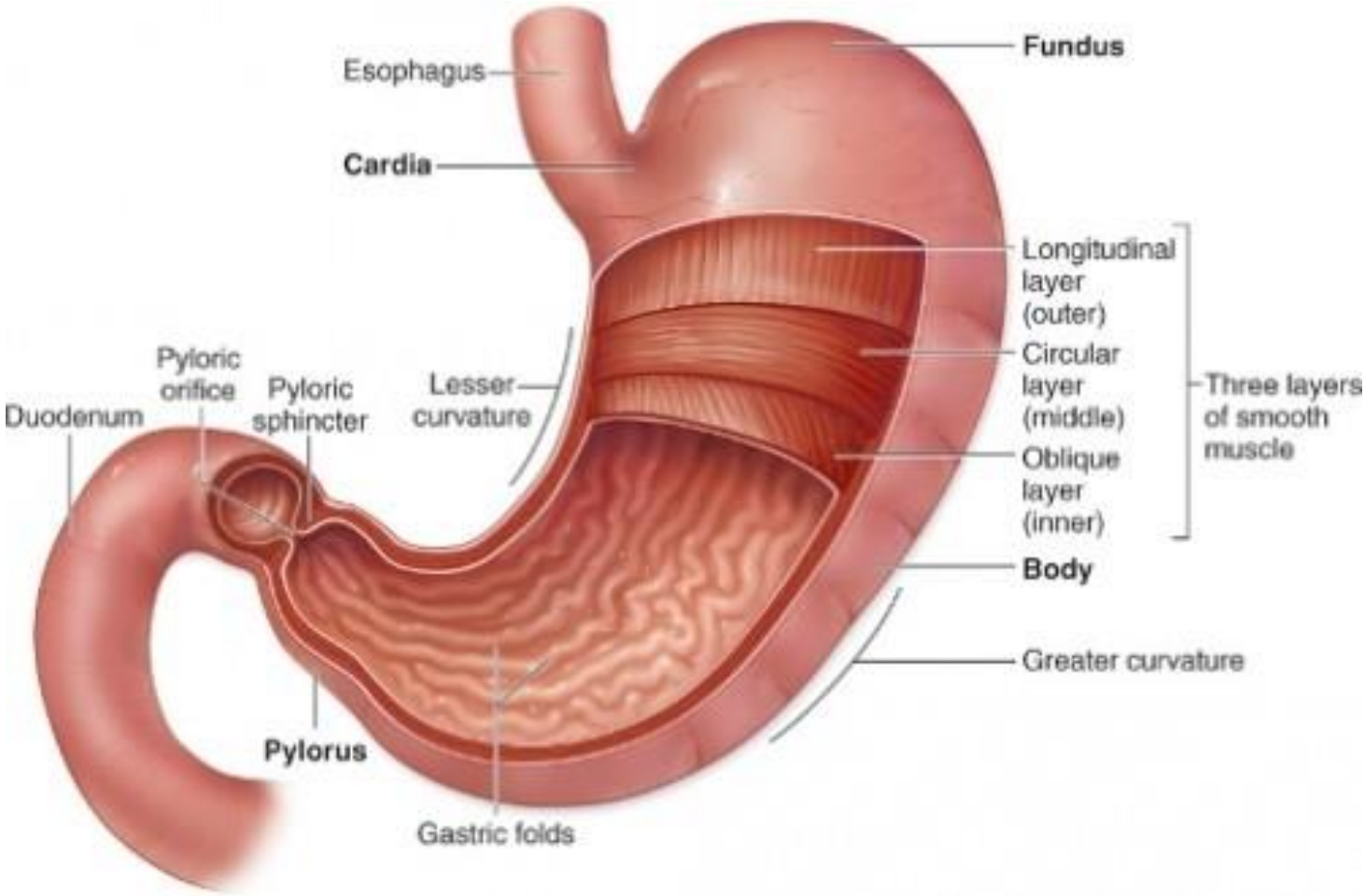

Eruption (months)
Central incisor
Lateral incisor
Canine
First molar
Second molar
6-8
7-12
16-20
12-16
20-30
Upper jaw
Lower jaw
18-22
16-24
14-18
7-9
6-8
Deciduous teeth
Central incisor
Lateral incisor
Canine
First premolar
Second premolar
First molar
Second molar
Third molar (wisdom tooth)
A
R
L
P
Upper jaw
Lower jaw
P
R
L
A
Eruption (years)
17-24
10-14
5-8
10-14
9-13
9-14
7-10
7-8
Adult teeth

Components

- Pharynx
  - Food moves through oral fauces into pharynx
  - Peristaltic movement pushes food into esophagus
- Esophagus
  - A collapsible muscular tube (25 cm long)
  - Passes through diaphragm at the esophageal hiatus
  - Upper esophageal sphincter (UES)
    - Helps prevent air from entering
  - Lower esophageal sphincter (LES) or Cardiac sphincter
    - Located near esophageal hiatus
    - Controls opening to the stomach

Components

- Stomach
  - Regions
    - Fundus
      - Most superior portion
      - Forms small storage area
    - Body
      - Main portion
    - Pyloric
      - Forms pyloric sphincter



Components

- Stomach
  - Muscular layer has 3 layers (compared to 2 elsewhere)
  - When stomach is empty it shows longitudinal folds called rugae
    - Formed from the mucosa and submucosa and allow for expansion
  - Marked by Gastric pits
  - Gastric glands found below pits
    - Gastric secretions contain digestive enzymes and HCl

Components

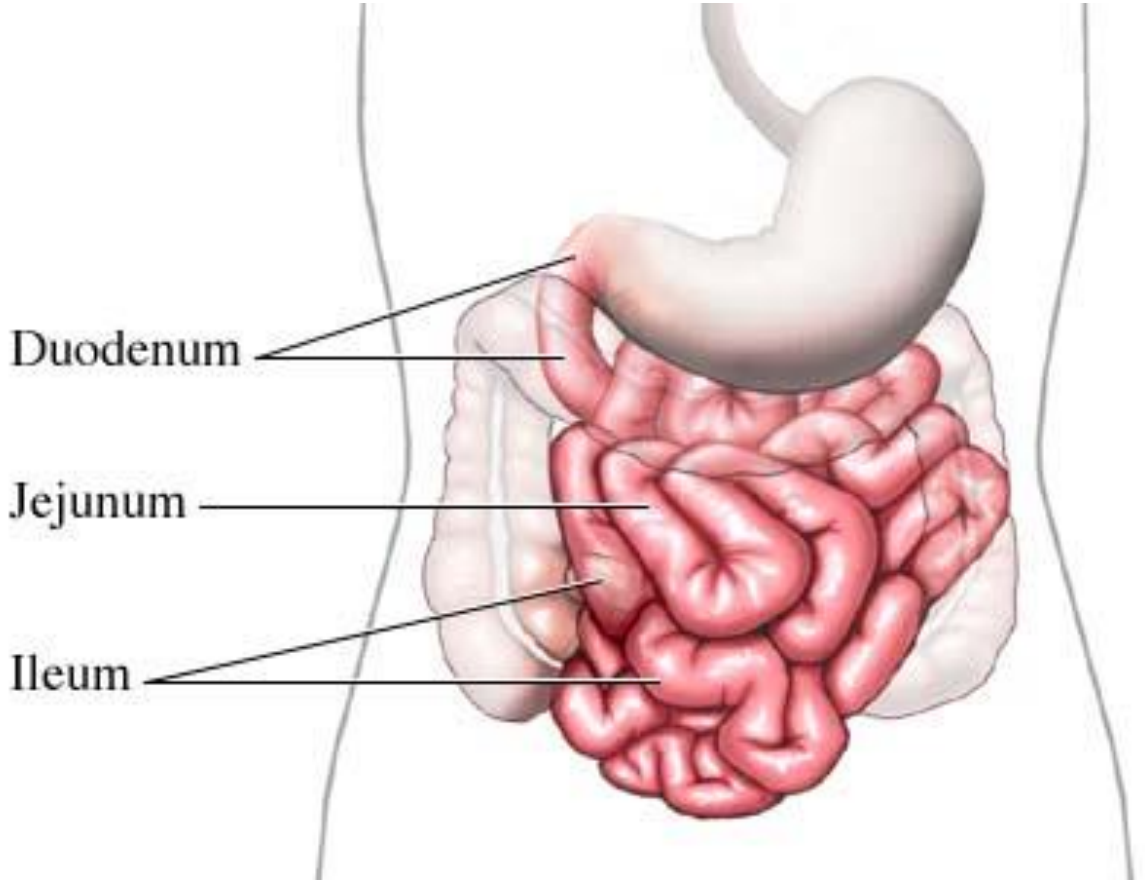
- Gastric Secretions
  - Exocrine Gland
    - Mucus
      - Thick — Forms coating on stomach
      - Thin — Mixes with food to aid in chemical rx
    - Chief Cells
      - Secrete enzymes of gastric juice (Pepsinogen)
      - Inactive form of pepsin (breakdown most proteins), activate by HCl
    - Parietal Cells
      - HCl
        - » Kills bacteria and give acidic environment for enzymes
      - Intrinsic Factor
        - » Aids in B12 absorption

Components

- Gastric Secretions
  - Endocrine Glands
    - Ghrelin
      - Stimulates hypothalamus to increase appetite
    - Gastrin
      - Regulates gastric activity
- Constant churning breaks down bolus and mixes it with gastric juice
- Produces a semifluid mixture called chyme

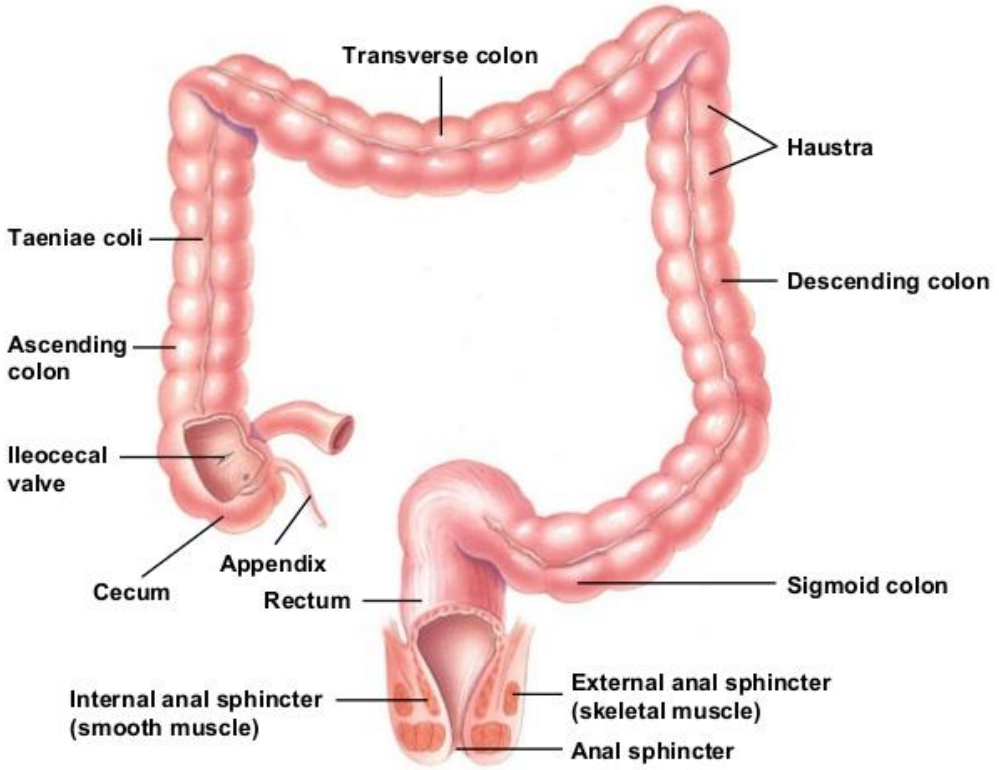
Components

- Small Intestine
  - 2.5 cm in diameter, 6 m long
  - Finishes digestion
  - Absorbs nutrients
  - Liver, gallbladder and pancreas secrete their byproducts here
  - Divided into:
    - Duodenum
    - Jejunum
    - Ileum



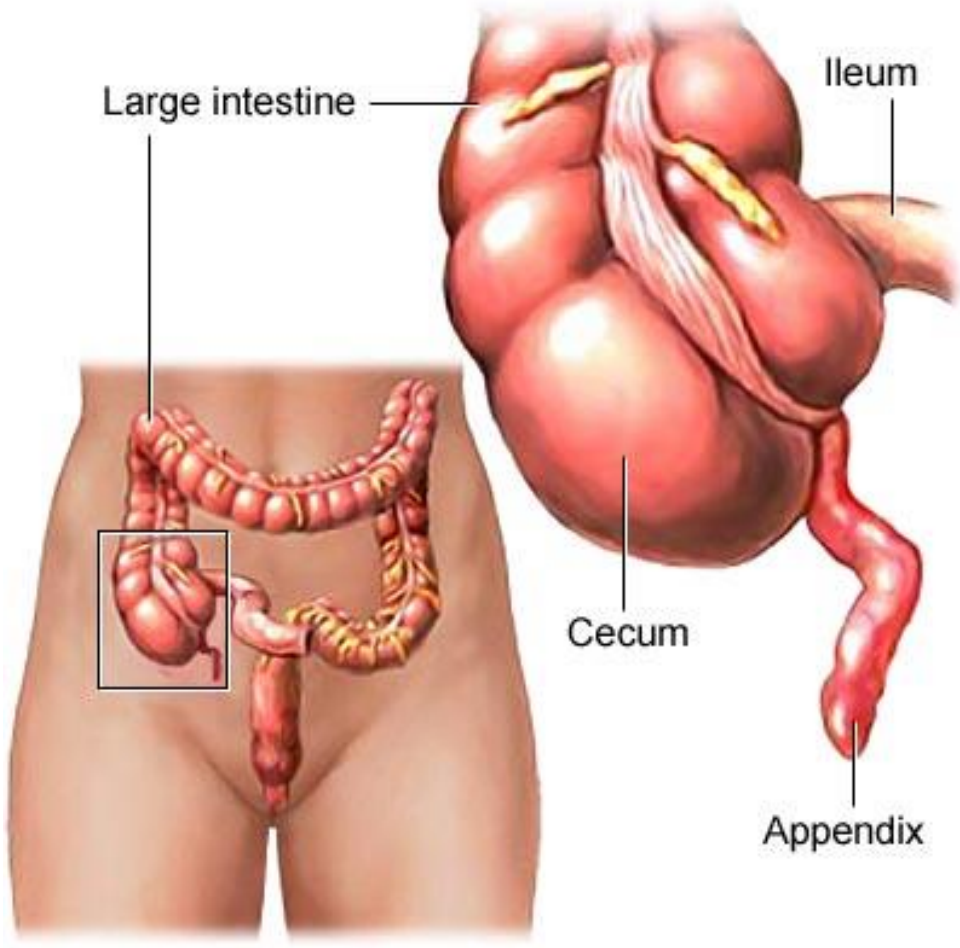
Components

- Large Intestine
  - 1.5 m long
  - Begins at the ileocecal junction
  - Divided into
    - Cecum
      - First portion, appendix attached here
    - Colon
      - Ascending, transverse and descending, and Sigmoid (S-shaped section)
    - Rectum
    - Anal canal
      - 2-3 cm long and has internal/external sphincters



Components

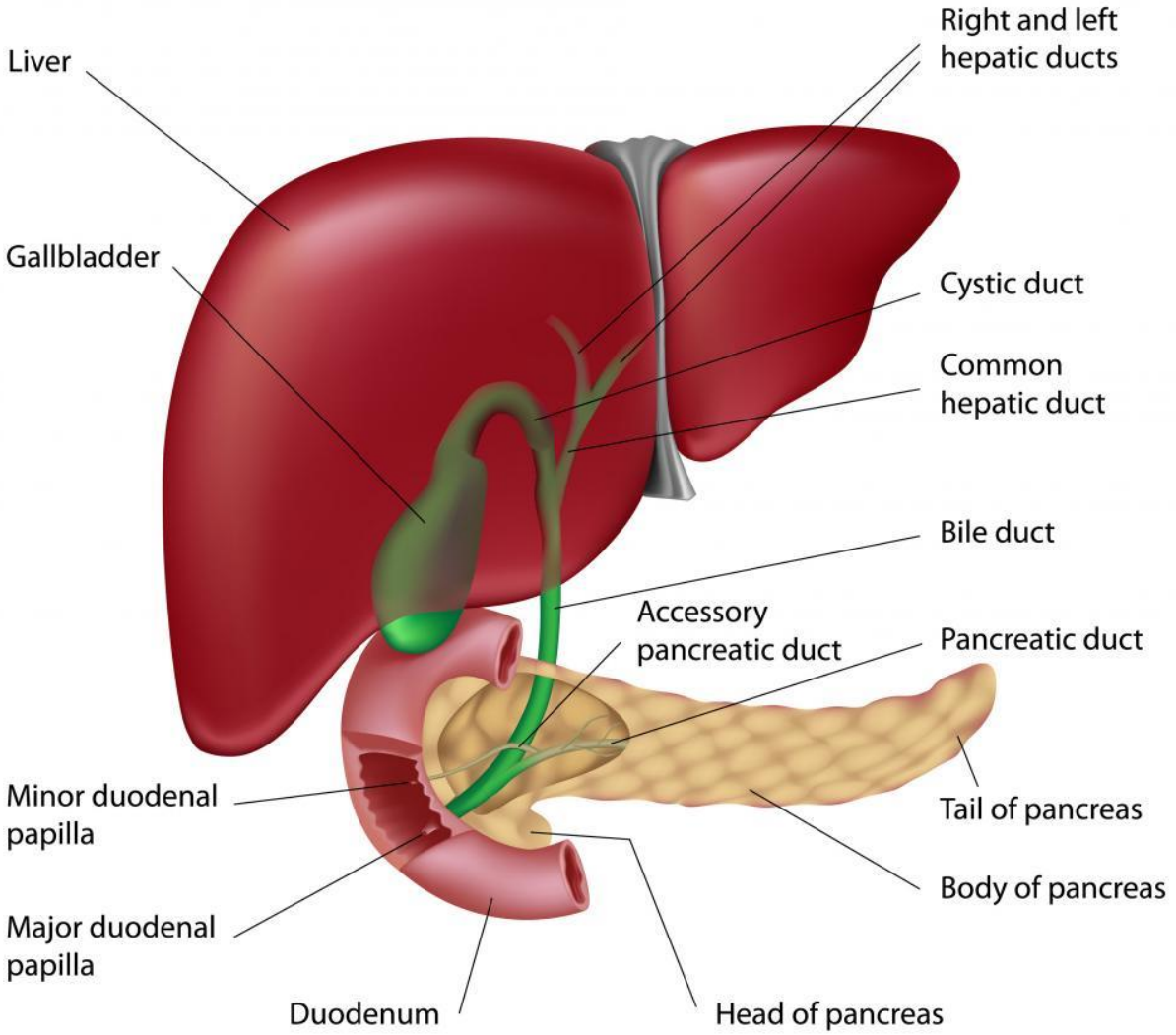
- Vermiform Appendix
  - Small worm-like tube
  - Thought to produce intestinal flora to help prevent disease



Components

- Peritoneum
  - Serous membrane lining the walls of abdominal cavity (parietal) and covering organs (visceral)
  - Forms extensions that bind organs together
    - Mesentery (fan like)
      - Posterior wall to enclose jejunum and ileum
    - Mesocolon
      - Transverse colon to posterior wall
    - Lesser Omentum
      - Liver to lesser curvature of the stomach and duodenum
    - Greater Omentum (Lace apron)
      - Greater curvature of stomach and duodenum to transverse colon
      - Fatty deposits give lace appearance
    - Falciform Ligament
      - Liver to abdominal wall

Liver



- Largest gland
- Divided into 2 lobes
  - Right Lobe
    - Right lobe proper
    - Caudate lobe
    - Quadrate lobe
  - Left Lobe

Liver

- Hepatic lobules are the functional units
  - Consists of hepatocytes
  - Radiate like spokes from the central vein
  - Tiny tubules enter the lobules (Portal Triad)
    - Hepatic artery
      - Oxygenates hepatic cells
    - Portal vein
      - For inspection by hepatic cells
    - Hepatic duct
      - Excretion of bile to gallbladder

Liver

- Sinusoids (extensions of portal triad)
  - Venous channels that separate the hepatocytes
  - They carry blood from periphery to central vein
  - Phagocytic cells (Kupffer cells) remove bacteria, foreign particles and dead RBC's from blood
- Toxics can be absorbed by hepatic cells for detoxification
- Nutrients can also be absorbed for metabolism or storage
- Central veins merge to form large vessels until they form the hepatic veins

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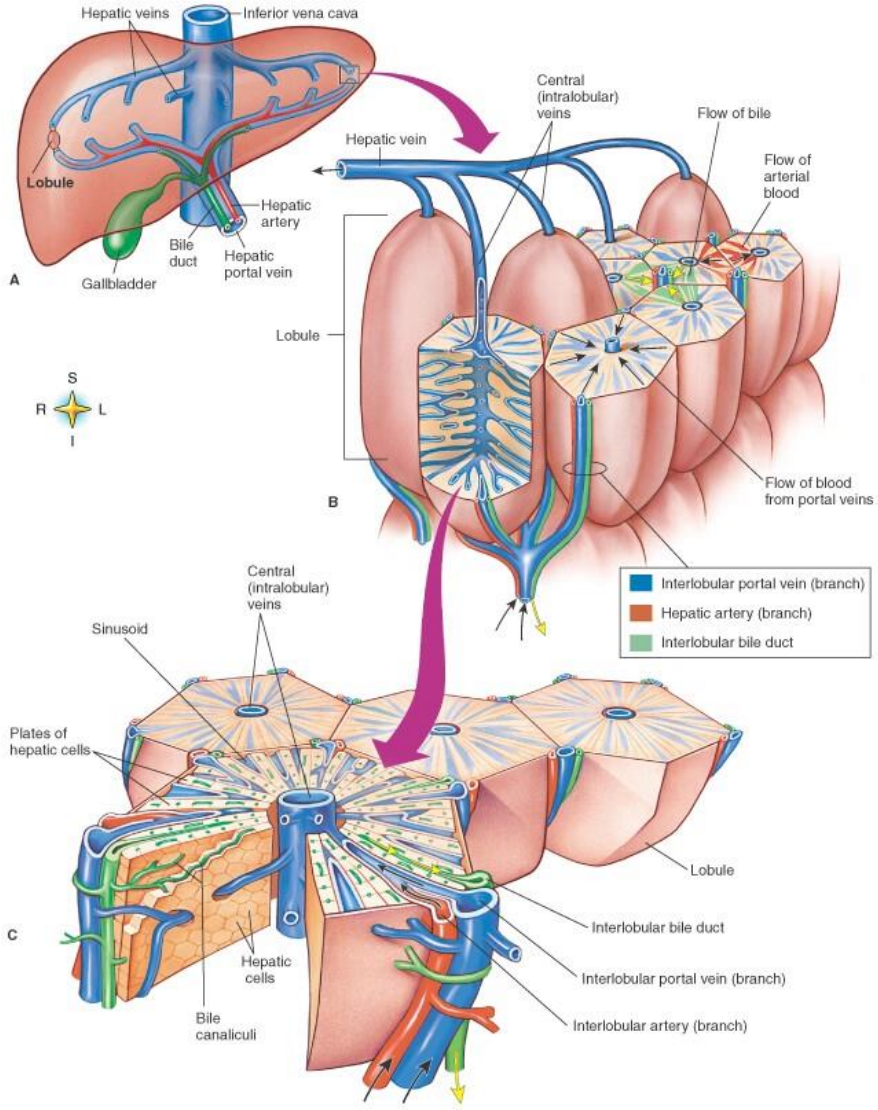
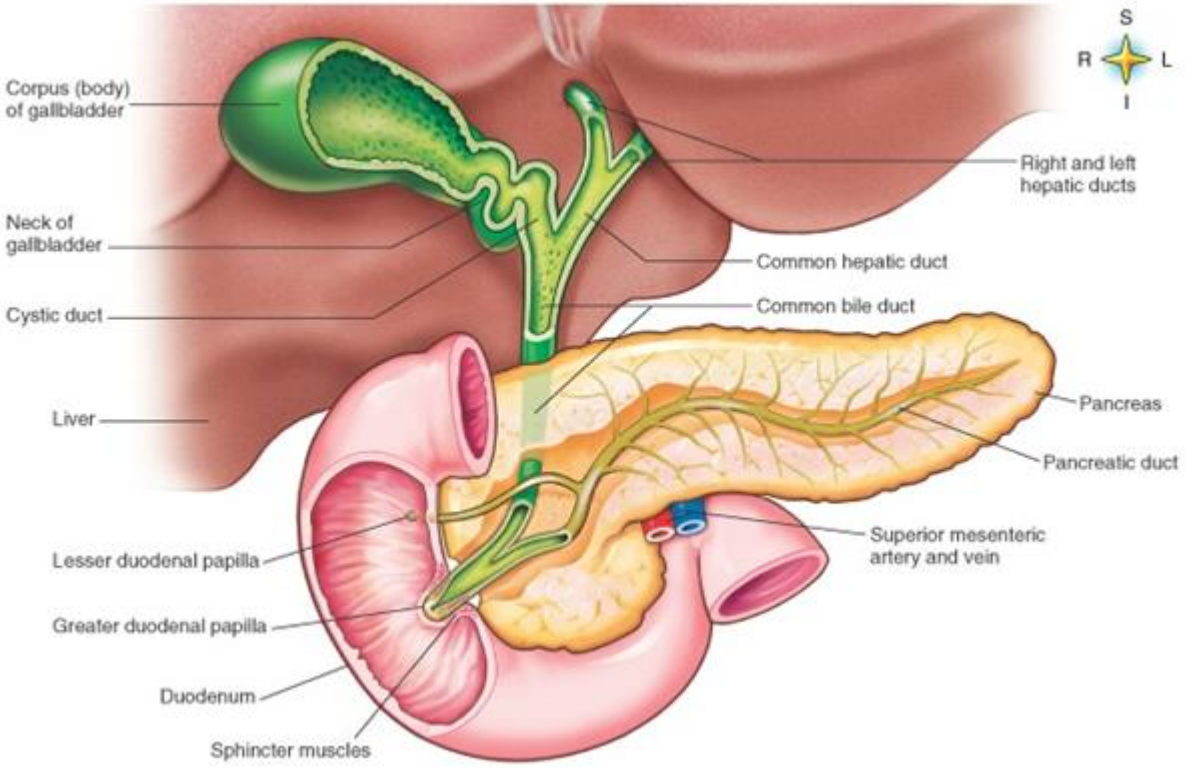
Liver



Liver



- Bile is produced in the hepatocytes and carried to the periphery by the bile canaliculi
- These merge to form the R and L hepatic ducts
- These merge to form the hepatic duct
- Hepatic duct merges with the cystic duct of the gallbladder to form the common bile duct
- This attaches to the duodenum

Functions of the Liver

- Bile
  - Yellow-green fluid
  - Approx 1 L is produced by hepatocytes daily
  - Slightly alkalitic
  - Main components
    - Bile salts (Derivatives of cholesterol)
    - Bile pigment (bilirubin) – heme portion of RBC's broken down in the spleen
    - Cholesterol
    - Water
  - Bile salts act as emulsifying agents in the break down of large fat globules to ease in absorption

Functions of the Liver

- Secretion
  - Produces and secretes bile
  - Are mostly reabsorbed and recycled
- Synthesis of plasma proteins
  - Albumin, fibrinogen, globulins (Not Ig)
- Hematopoiesis
- Storage
  - Glucose (in the form of glycogen, iron, vitamins)

Functions of the Liver

- Detoxification
  - Changes composition of toxic compounds (ammonia) make it less harmful
  - Changes configuration of certain drugs (penicillin) and excretes them into bile
- Excretion
  - Hormones, drugs, cholesterol and bile pigments excreted into bile

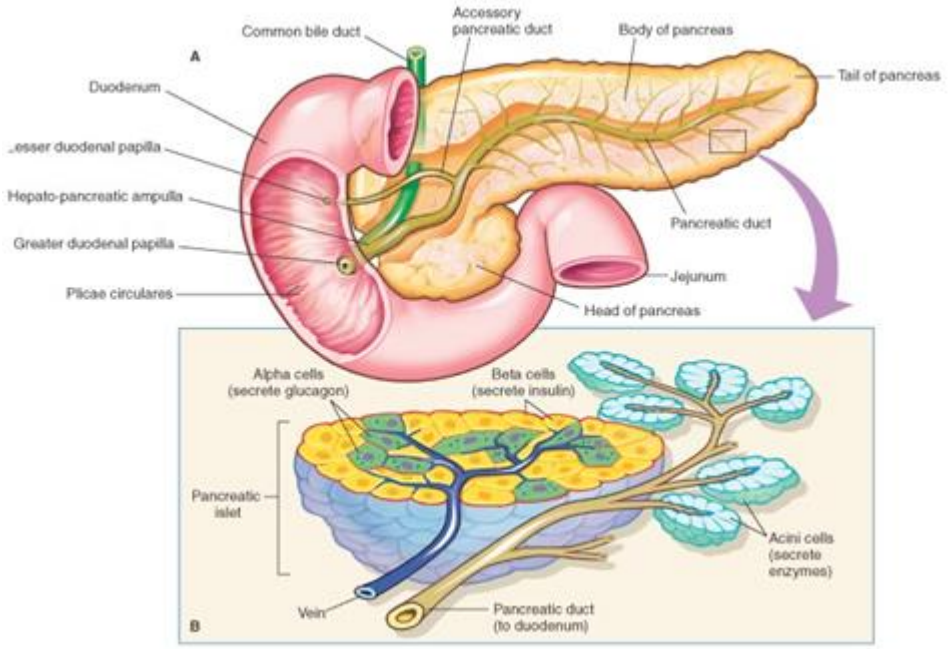
Functions of the Liver

- Carbohydrate metabolism
  - Removes excess glucose and stores it
  - Breaks down glycogen when glucose is low
  - Breaks down carbohydrates into glucose
- Lipid metabolism
  - Breaks down fatty acids during synthesis of cholesterol and phospholipids
  - Converts non-carbohydrates into glucose
- Protein metabolism
  - Can convert certain amino acids into different amino acids
- Filtering

Gallbladder

- Pear shaped sac attached to the liver by the cystic duct (which attaches to the hepatic duct)
- Stores and concentrates bile for excretion
- During digestion gallbladder will contract to move bile to the duodenum
- Sphincter of Oddi (where the common bile duct and pancreatic duct meet) at the duodenum controls release of bile
  - If sm intestine is empty, sphincter is closed
  - If sm intestine is full, sphincter opens
- Blockages to the Sphincter will cause the bile to be absorbed into the blood causing jaundice

Pancreas



- Flat, long organ
- Head is surrounded by duodenum, tail is near spleen
- Has endocrine and exocrine properties
- Islets of Langerhans
  - A cells (Glucagon)
  - B cells (Insulin)
- Digestive enzymes (from acinar) released into pancreatic duct

Summary of Organs

TABLE 24.7

Summary of Organs of the Digestive System and Their Functions

ORGAN	FUNCTION(S)
Tongue	Maneuvers food for mastication, shapes food into a bolus, maneuvers food for deglutition, detects sensations for taste, and initiates digestion of triglycerides.
Salivary glands	Saliva produced by these glands softens, moistens, and dissolves foods; cleanses mouth and teeth; initiates the digestion of starch.
Teeth	Cut, tear, and pulverize food to reduce solids to smaller particles for swallowing.
Pancreas	Pancreatic juice buffers acidic gastric juice in chyme, stops the action of pepsin from the stomach, creates the proper pH for digestion in the small intestine, and participates in the digestion of carbohydrates, proteins, triglycerides, and nucleic acids.
Liver	Produces bile, which is required for the emulsification and absorption of lipids in the small intestine.
Gallbladder	Stores and concentrates bile and releases it into the small intestine.
Mouth	See the functions of the tongue, salivary glands, and teeth, all of which are in the mouth. Additionally, the lips and cheeks keep food between the teeth during mastication, and buccal glands lining the mouth produce saliva.
Pharynx	Receives a bolus from the oral cavity and passes it into the esophagus.
Esophagus	Receives a bolus from the pharynx and moves it into the stomach; this requires relaxation of the upper esophageal sphincter and secretion of mucus.
Stomach	Mixing waves combine saliva, food, and gastric juice, which activates pepsin, initiates protein digestion, kills microbes in food, helps absorb vitamin B_{12}, contracts the lower esophageal sphincter, increases stomach motility, relaxes the pyloric sphincter, and moves chyme into the small intestine.
Small intestine	Segmentation mixes chyme with digestive juices; peristalsis propels chyme toward the ileocecal sphincter; digestive secretions from the small intestine, pancreas, and liver complete the digestion of carbohydrates, proteins, lipids, and nucleic acids; circular folds, villi, and microvilli help absorb about 90 percent of digested nutrients.
Large intestine	Haustral churning, peristalsis, and mass peristalsis drive the colonic contents into the rectum; bacteria produce some B vitamins and vitamin K; absorption of some water, ions, and vitamins occurs; defecation.