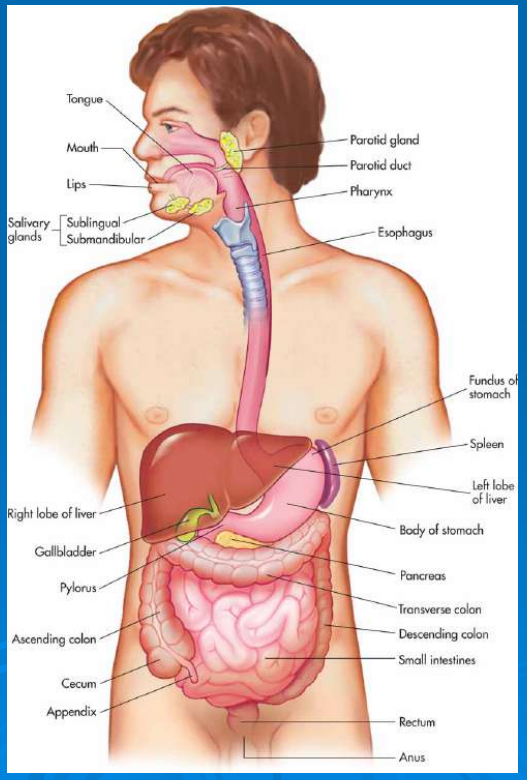
Chapter 15
The Gastrointestinal System:
Fuel for the Trip
"You are what you eat!!!"
oink----oink!!!

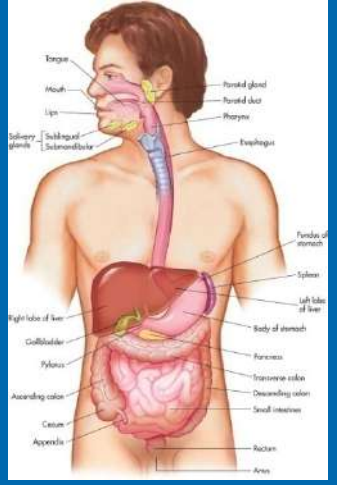


Introduction

Gastrointestinal System Functions:

- Ingest raw materials
- Physically & chemically digest raw material to usable elements.
- Absorb elements
- Eliminate what is NOT useable

System Functions



- Ingestion: food enters mouth
- Mastication: chewing
- Digestion: chemical act of breaking down food into small molecules.
- Secretion: acids, buffers, enzymes, & H2O aid in breakdown of food.
- Absorption: molecules pass through lining of digestive tract.
- Excretion or defecation: elimination of waste products.

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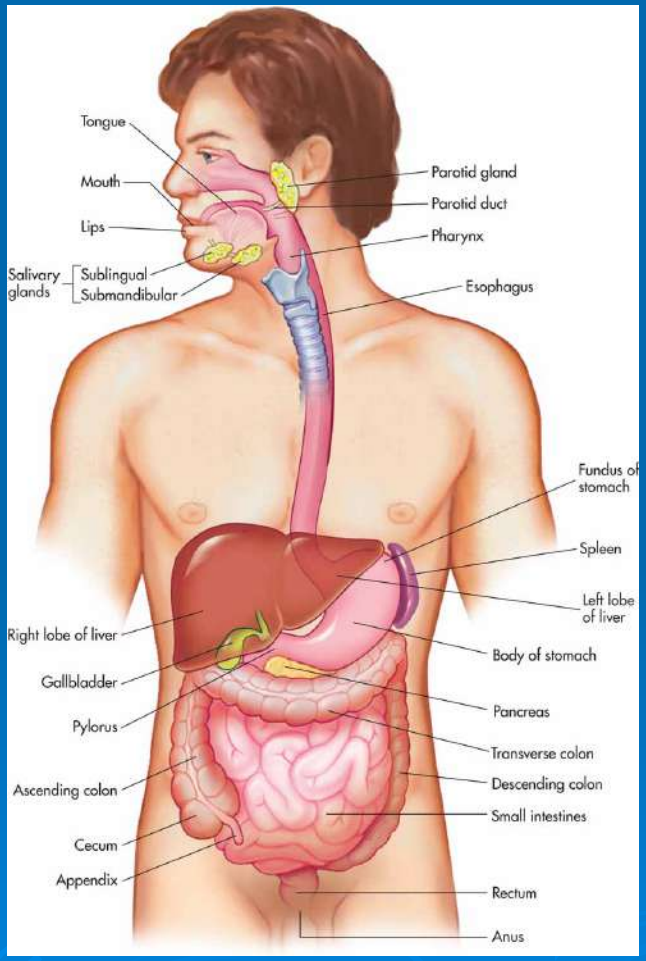
The Digestive System



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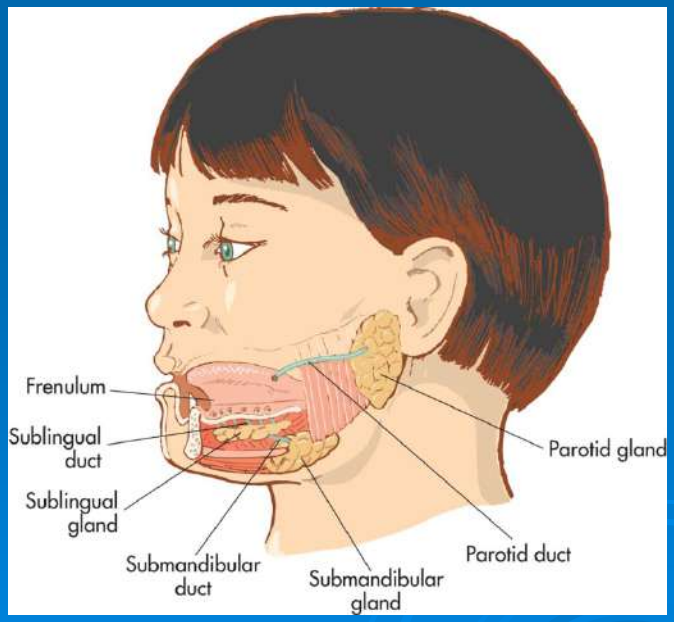
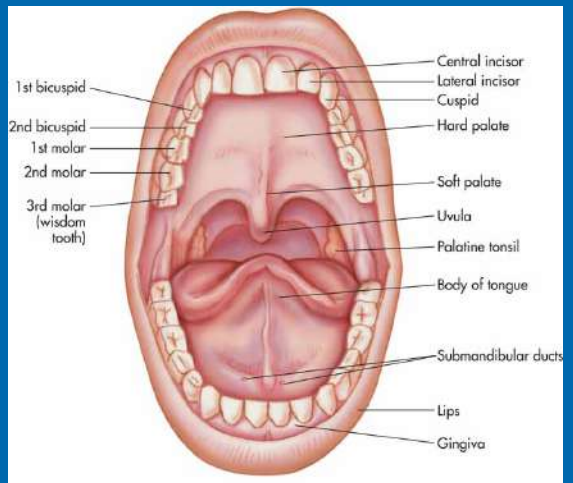
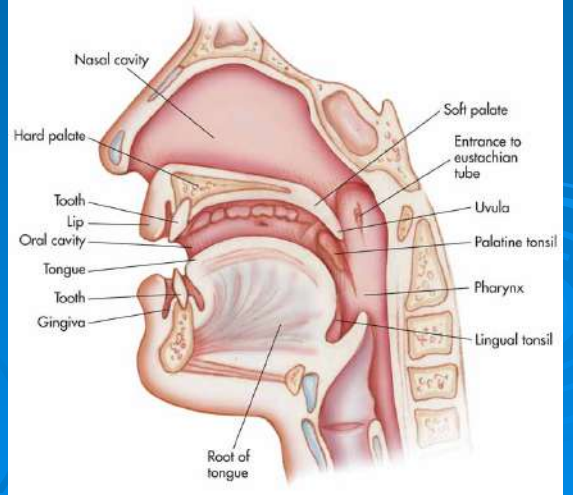
Buccal (oral) Cavity

- Lips: act as door to cavity
- Hard & Soft Palate: form roof of mouth
- Tongue: acts as floor
- Cheeks: form walls







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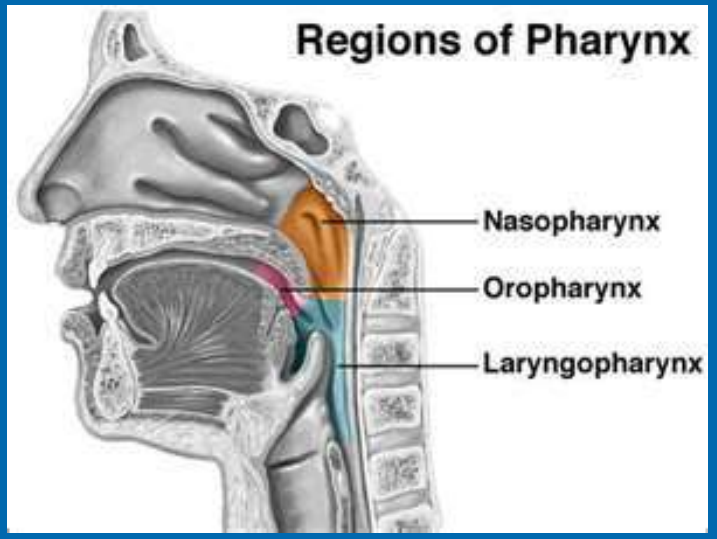
Tongue



- Muscle: provides taste stimuli to brain, determines temperature, manipulates food, & aids in swallowing.
- Saliva: added to moisten & soften food, while teeth crush food.
- Bolus: ball-like mass, pushed by tongue so it may be swallowed, passed to pharynx.
- Lingual Frenulum: membrane under tongue, keeps you from swallowing tongue & aids in speaking.

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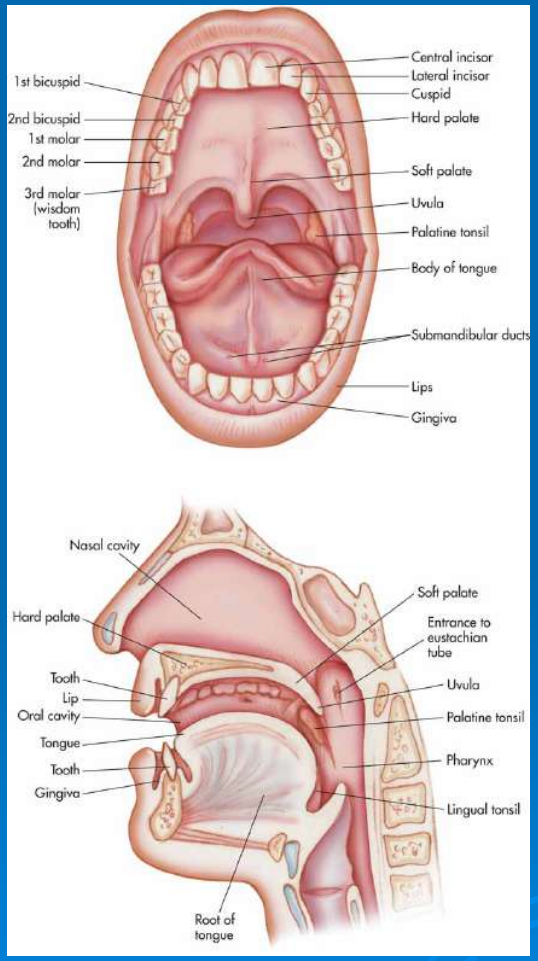
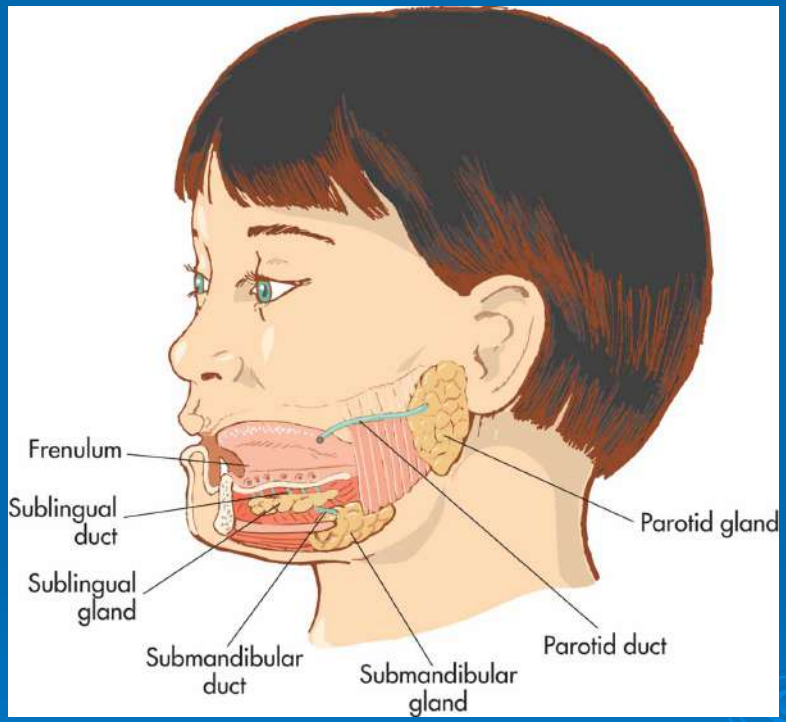
Buccal & Oral Pharynx





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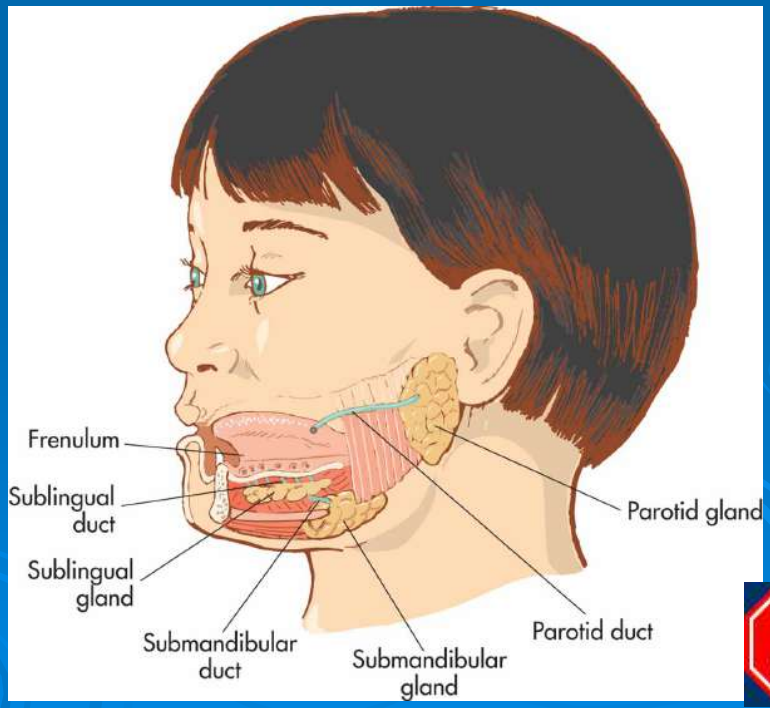
Salivary Glands

- Sublingual: found under tongue
- Submandibular: located along both sides of inner surface of mandible, or lower jaw.
- Controlled by: autonomic nervous system
- Parotid: slightly inferior & anterior to each ear. Swell with "viral Parotitis.."



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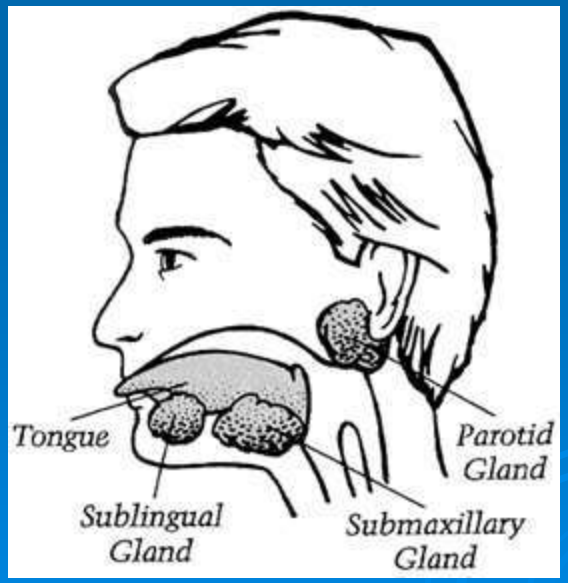
Salivary Glands con't

- Produces: 1–1.5 liters of saliva QD
- Keep mouth moist: but idea or presence of food increase production significantly.
- Contains: 99.4% water, & contains antibodies, buffers, ions, waste products, & enzymes.



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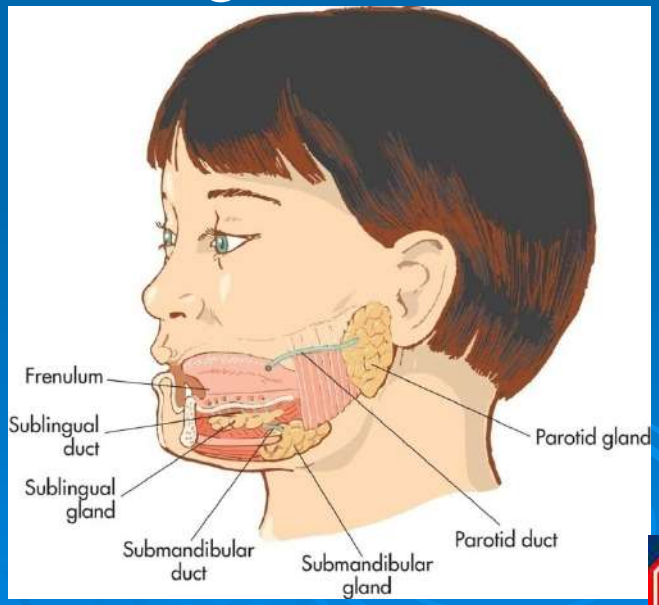
Salivary Glands con't

- Enzymes: act as organic catalysts to speed up chemical reactions.
- Salivary Amylase: speeds chemical activity of breaking down carbohydrates.
- Saliva cleans oral surfaces, reducing amount of bacteria that grows in mouth.



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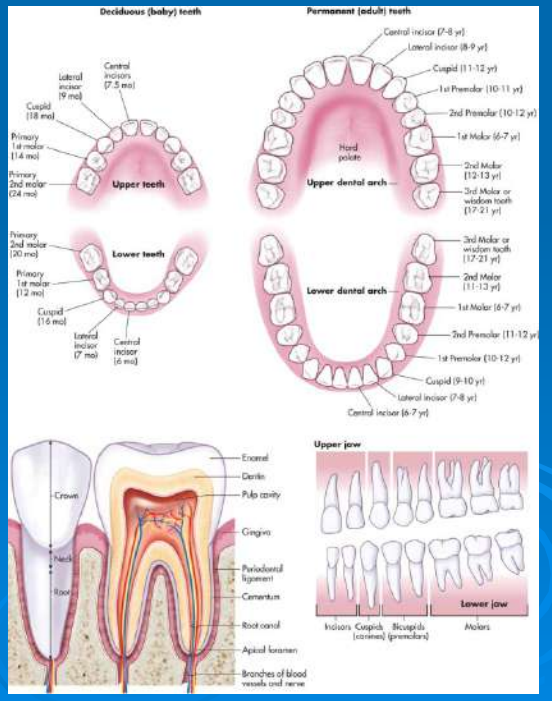
Teeth

- Deciduous: first set of teeth as a baby
- First tooth: appears @ 6 months of age; lower central incisors appear first, all 20 teeth in place by age 2½.
- Between 6 and 12 years these teeth fall out, are replaced by 32 permanent teeth.
- Wisdom teeth: appear by age 21



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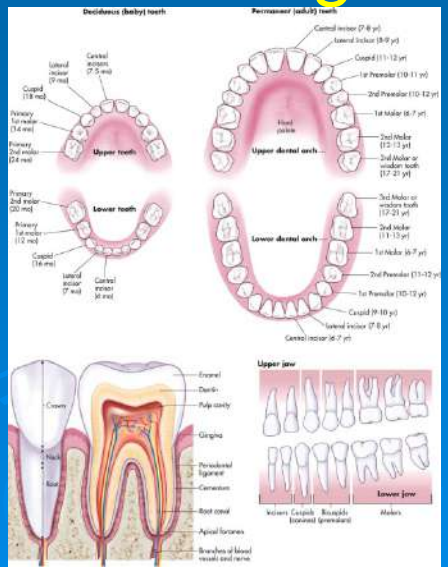
Teeth Con't

- Incisors: at front of mouth, blade shaped, used to cut food.
- Canine: for holding, tearing, or slashing food; known as eyeteeth or cuspids, located next to incisors.
- Bicuspids: or premolars: transitional teeth
- Molars: have flattened tops; both bicuspids & molars are responsible for crushing & grinding food.



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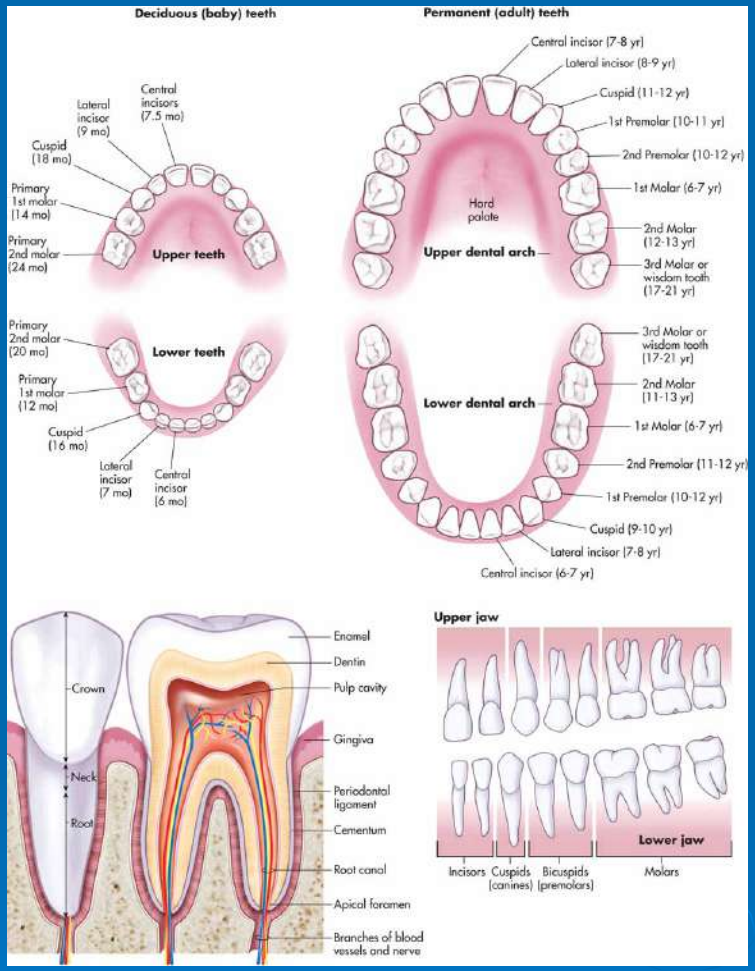
Teeth Con't

Parts of Tooth:

- Crown: covered by hard enamel.
- Neck: transitional section that leads to root.
- Root: nestled in bony socket, held in place by fibers of periodontal ligament.
- Dentin: made of mineralized bone-like substance.



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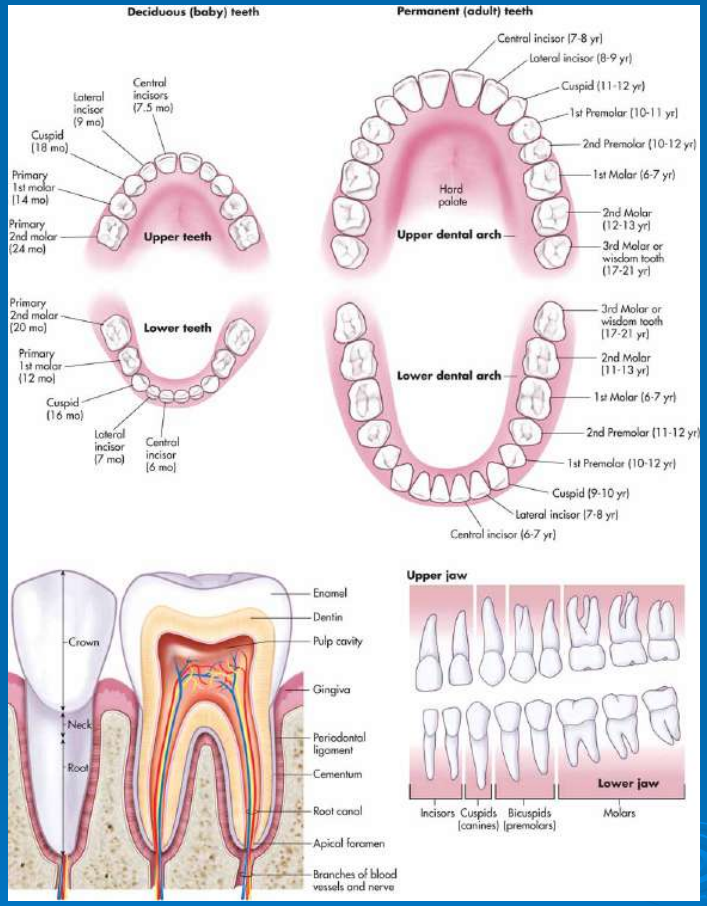
Teeth Con't

- Connective tissue: pulp, located in pulp cavity
- Pulp cavity: contains blood vessels & nerves providing nutrients & sensation; nerves & blood vessels get to pulp cavity via root canal.
- Cementum: (soft version of bone) covers dentin of root, aiding in securing periodontal ligament.



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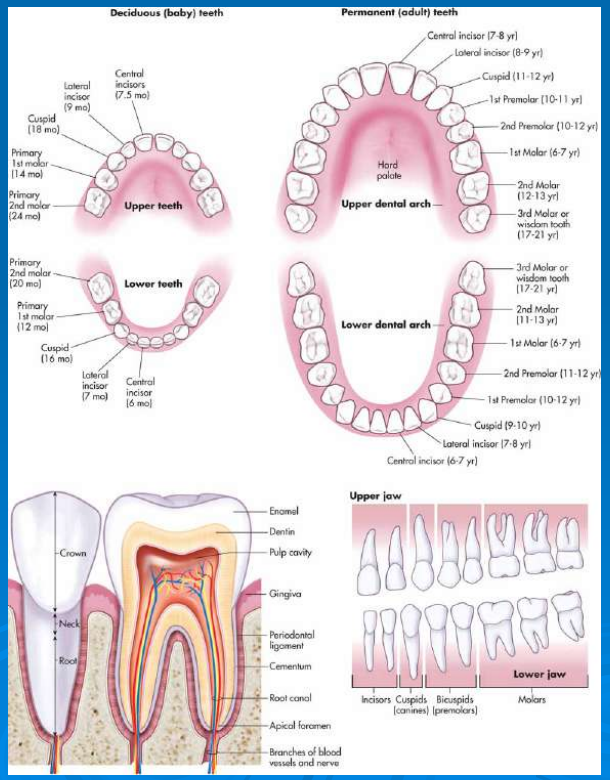
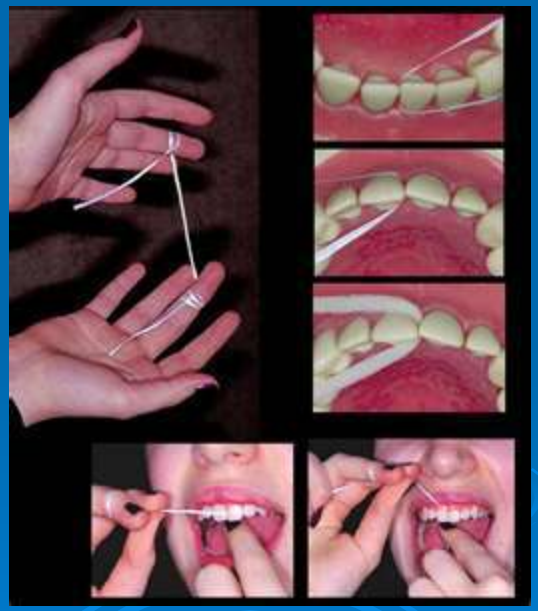
Teeth Con't

- Gingiva: gums, help hold teeth in place
- Epitheal cells form tight seal around tooth to prevent bacteria from coming into contact with tooth's cementum.





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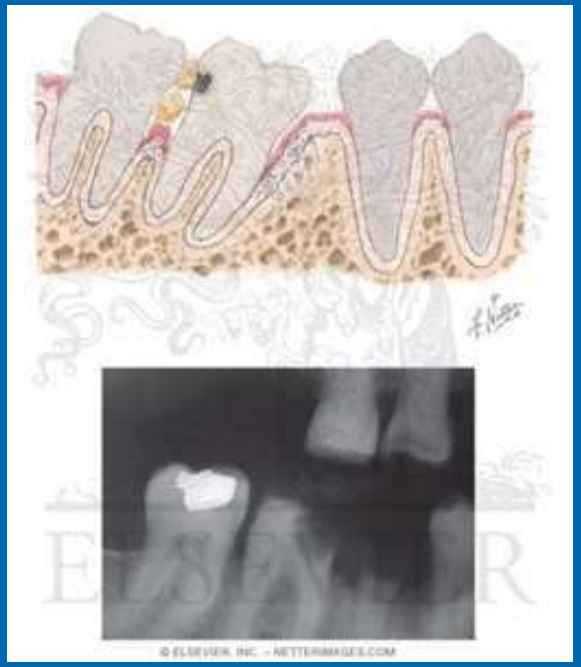
Pathology Connection:
Oral Disorders



Dental Caries (cavities)

- Form when microorganisms attack tooth enamel
- Related to dental plaque: sticks to teeth forming sticky substance.
- Forms great hideout for bacteria
- Bacteria creates acids that attack surface of teeth.

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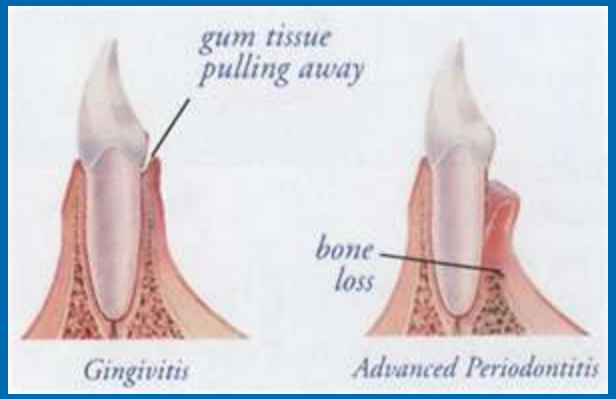
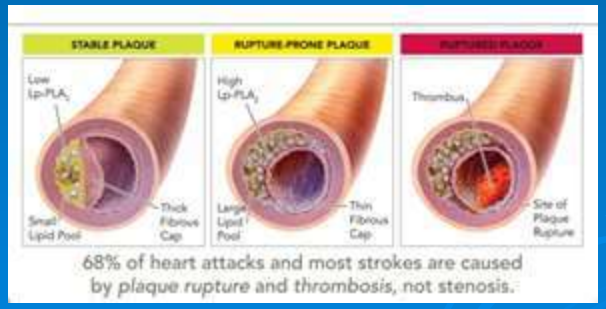
Risk Factors for Plaque Formation

- High carbohydrate diet
- Poor dental hygiene
- Lack of regular visits to dentist





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Risk Factors for Plaque Formation con't

RX:

- Clear out & fill caries
- Rx infection

Prevention:

- Proper dental care
- Fluoride in H2O & tooth paste
- Evaluate for heart disease & buccal ca

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Pathology Connection:
Periodontal Disease

- Plaque & bacteria affects gums & supportive structures of teeth.
- Can result in gingivitis, bleeding & tooth loss

End Of Slide

Pathology Connection:
Oral & Lip Cancer

Cause:

- Excessive sun exposure
- Tobacco
- ETOH

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Oral & Lip Cancer ***con't***

Leukoplakia:

- white patch of tissue in mouth
- associated with use of chewing tobacco

Pathology Connection:
Stomatitis

- Inflammation of oral mucosa
- poor fitting dentures
- Apthous stomatitis (“canker sores”)
- Cheilitis: cracking & inflammation of lips & corners of mouth; often related to infection, allergy, or nutritional deficiency.

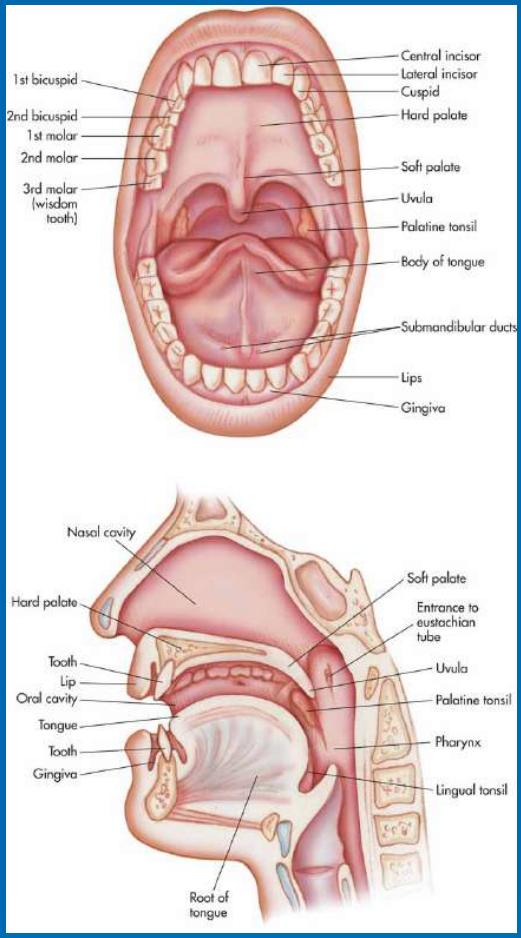
Pharynx (3 Parts)

Nasopharynx:

- primarily part of respiratory system, blocked by soft palate.

Oropharynx & laryngopharynx:

- act as passageway for food, water, & air; *epiglottis* covers trachea to prevent food from entering lungs, forcing food into opening for esophagus.



Esophagus

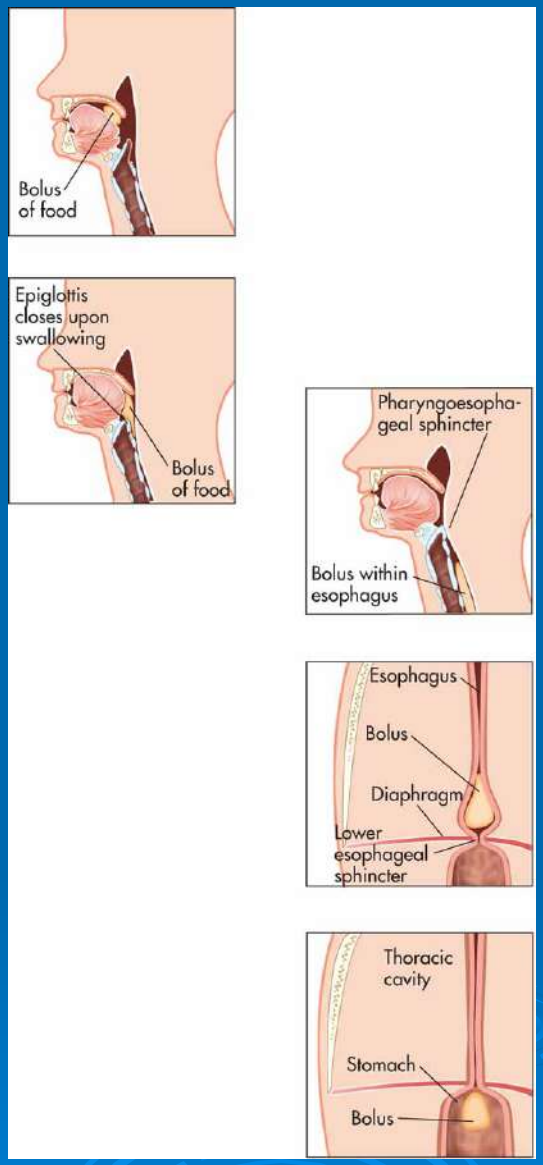
- 10 inches long, is connected to stomach
- from pharynx, through thoracic cavity, through diaphragm, connecting to stomach in peritoneal cavity.
- normally collapsed tube until “bolus” of food swallowed.
- Peristalsis: pushes food down esophagus

Esophagus con't

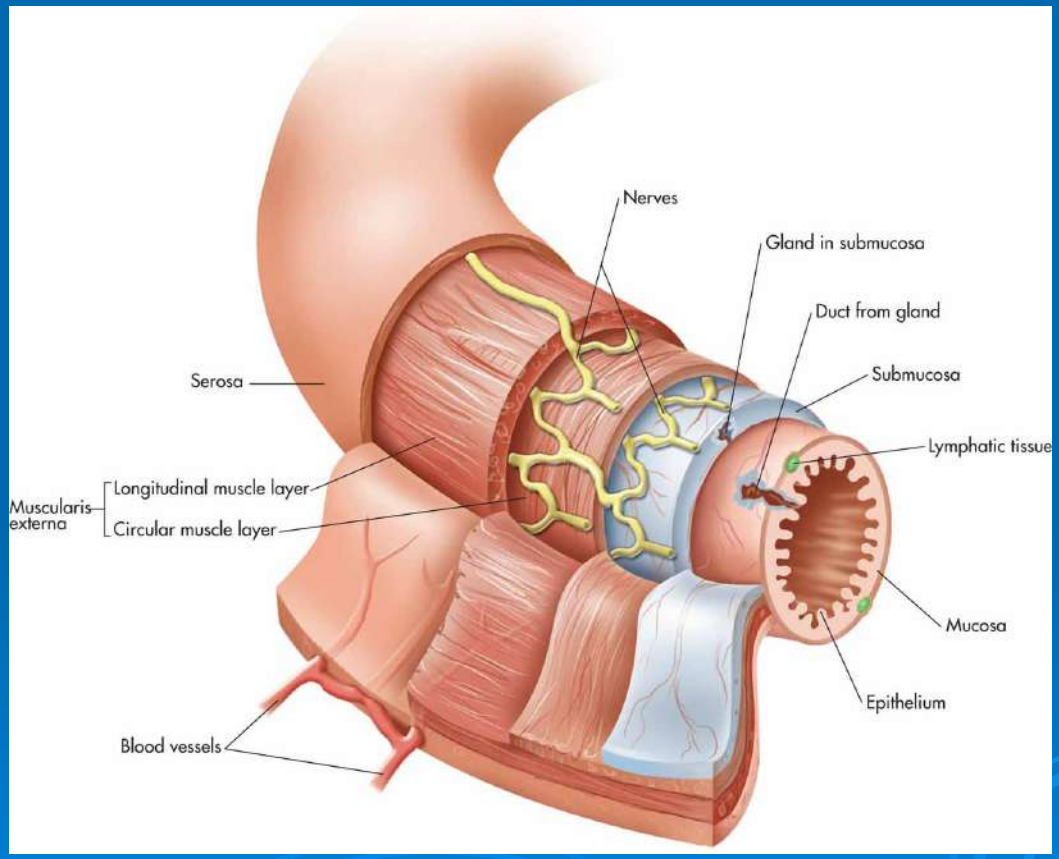
- lined with stratified squamous epithelium that secrete mucus to make walls slippery; cells make lining.
- resistant to abrasion, temperature extremes, & irritation.
- Pharyngoesophageal sphincter: relaxes to open esophagus so food can enter.

Esophagus con't

- Lower Esophageal Sphincter: opening door to stomach & closing to prevent acidic gastric juices from splashing into esophagus causing heartburn.
- process of swallowing: food 9 seconds; fluid take only seconds to reach stomach.

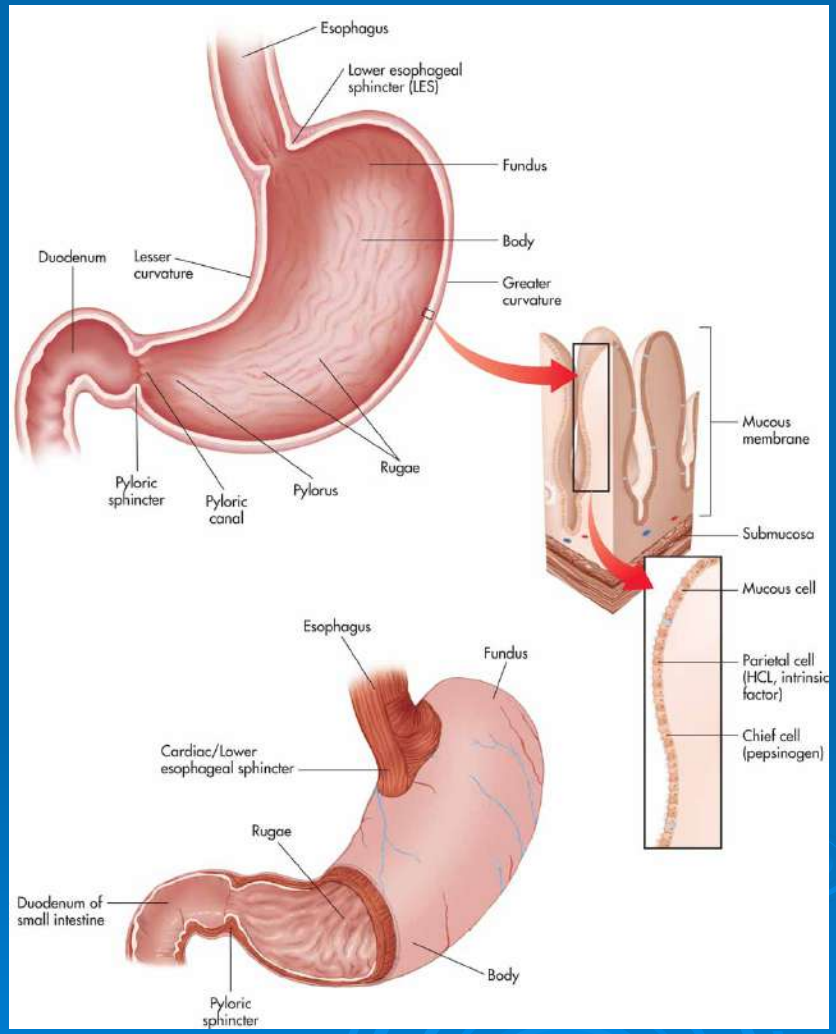


Walls of the Alimentary Canal



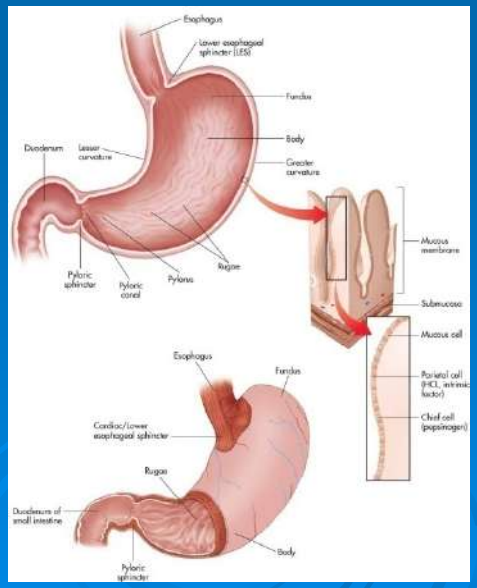
Stomach

- Located: ULQ under diaphragm, posterior to Liver.
- 10 inches long with diameter dependent on how much just eaten.
- 4 liters when filled
- Rugae: folds, help stomach expand and contract.



4 Function of Stomach

- Holding area for received food
- Chemical digestion: gastric acids & enzymes mix with food.
- Regulates rate of Chyme movement into small intestines.
- Absorbs small amounts of H2O & ETOH



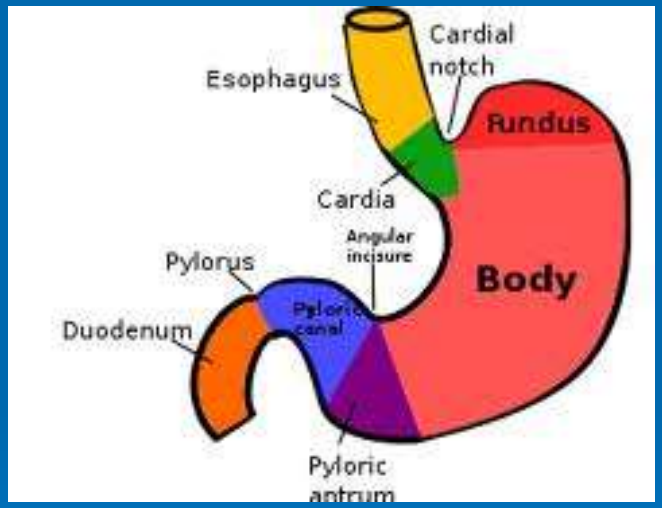
How Fast Stomach Empties

- 4 hours to empty following meal
- Liquids & carbohydrates pass quickly
- Proteins take longer
- Fats take longest 4-6 hours

4 Regions of Stomach

- Cardiac Region: surrounding lower esophageal sphincter.
- Fundus: laterally & slightly superior to cardiac region. Temporarily holds food as it enters stomach.
- Body: Mid-portion
- Pylorus:

1. terminal end of stomach
2. most of work performed
3. where food passes through pyloric sphincter into small intestine.



Chemical Digestion

Gastric Juice:

- 1500 mls produced QD
- hydrochloric acid (HCl)
- pepsinogen
- mucus

Pepsinogen, HCL & Pepsin Enzymes

- chief digestive enzyme
- secreted by chief cells
- HCL secreted by parietal cells combining to produce pepsin.
- Pepsin breaks down protein
- HCl breaks down connective tissue

Stomach & Enzymes con't

- HCL: pH of 1.5–2.0, effective at killing pathogens.
- Mucous cells: generate thick layer of mucus shielding stomach from effects of stomach acids.
- Stomach secretes intrinsic factor, allowing vitamin B_{12} to be absorbed.
- Enzyme activity controlled by parasympathetic nervous system (vagus nerve)
- Vagus increases motility & secretory rates of gastric glands.

Gastric Glands & Their Functions

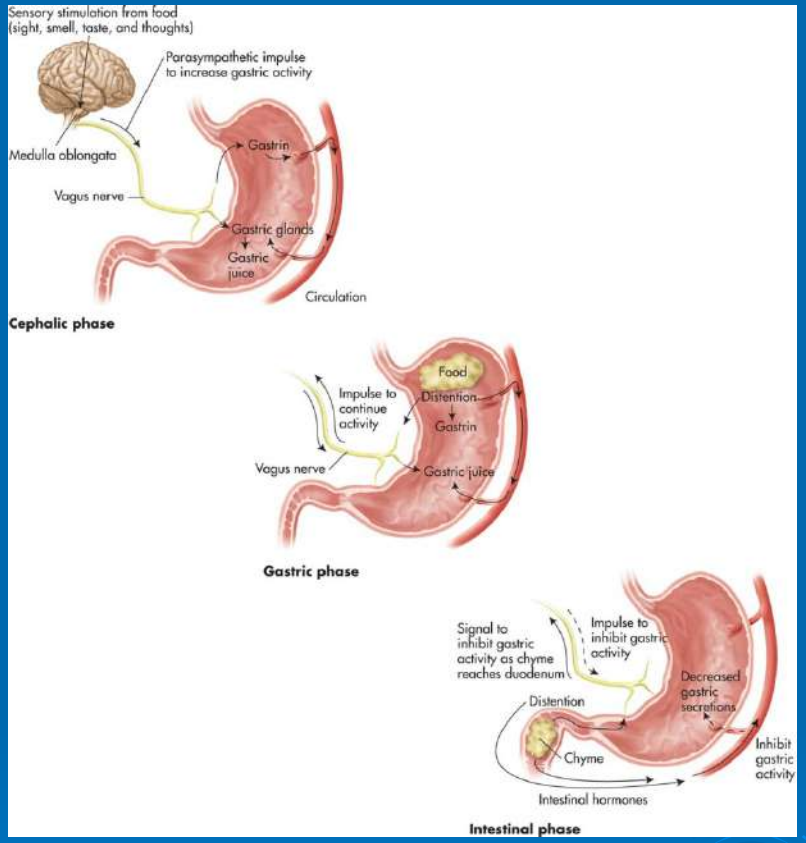
TABLE 15–1: Gastric Glands and Their Functions

DIGESTIVE CELLS	SECRETION TYPE	FUNCTION
Chief cells	Pepsinogen	Begins digestion of protein
Parietal cells	HCl	Kills pathogens, activates pepsinogen, breaks down connective tissue in meat
Mucous cells	Alkaline mucus	Protects stomach lining
Endocrine cells	The hormone gastrin	Stimulates gastric gland secretion

3 Phases of Gastric Juice Production

I. Cephalic Phase:

- sensory stimulation (sight or smell of food)
- stimulates parasympathetic nerves via medulla oblongata
- Gastrin released
- stimulating gastric gland activity in stomach



3 Phases of Gastric Juice Production con't

II. Gastric Phase:

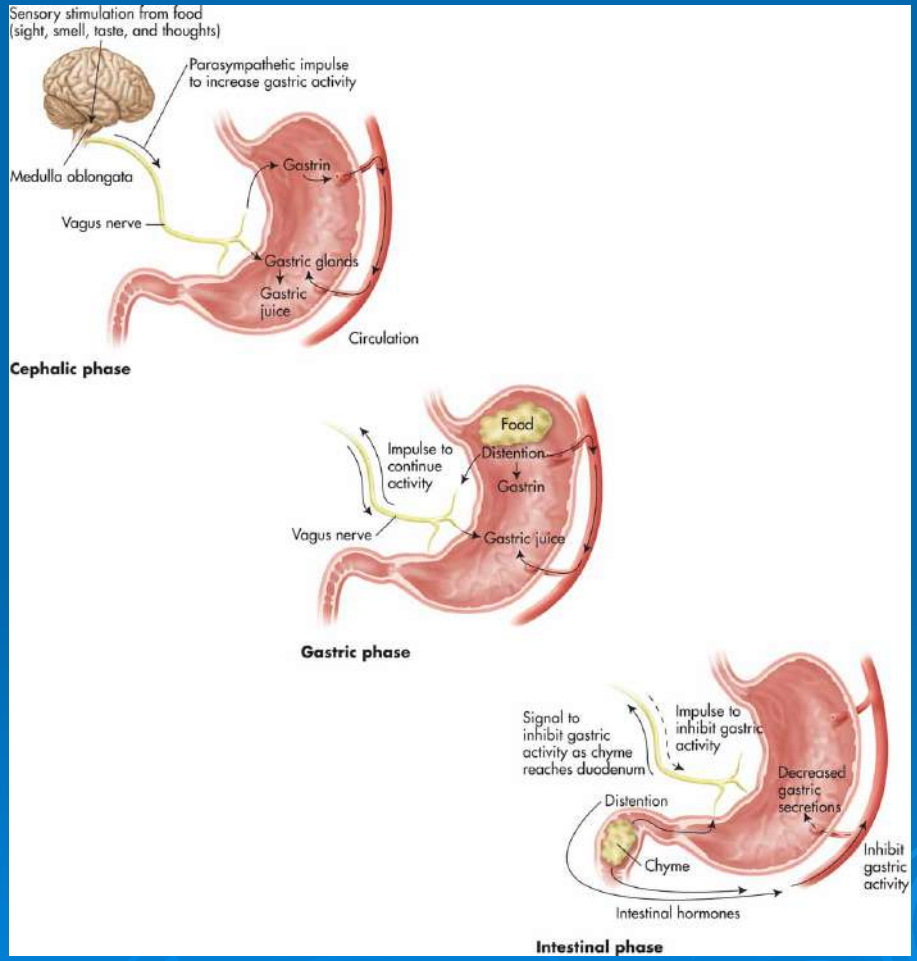
- 2/3 of gastric juices secreted as food enters stomach & distends walls.
- signaling stomach to secrete more gastric fluid

3 Phases of Gastric Juice Production con't

III. Intestinal Phase:

- food enters duodenum, distending & sensing acidity.
- intestinal hormones released
- slowing gastric gland secretions
- lasts until bolus leaves duodenum

3 Phases of Gastric Juice Production con't



Rate of Movement of Chyme

If too slow:

- rate of nutrient digestion & absorption decreased
- may allow acidity of chyme to cause erosions of stomach lining (ulcers).

If too quick:

- food particles may not be sufficiently mixed with gastric juices.
- insufficient digestion; chyme not given time to neutralize can cause erosion of intestinal lining (ulcers).

Pathology Connection:
Stomach Acid Disorders

- Gastroesophageal Reflux Disease (GERD)
  - Condition where acidic stomach contents "squirt" back into esophagus
  - Since esophagus does not have protective mucus, can cause inflammation and ulceration of esophageal tissue
  - Scar tissue can eventually form, causing narrowing of esophagus
  - If left untreated, constant inflammation can lead to esophageal cancer

GERD cont.

s/s epigastric pain and burning, can be worse when lying down
d/x symptoms, upper GI
R/x

- Antacids: treat burning sensation by decreasing acid
- Acid reducing meds
- Lifestyle changes: may help prevent GERD

Limiting fats, alcohol, caffeine and chocolate in diet
Avoiding smoking
Avoiding lying down in 4 hours after eating
Sleeping with head of bed elevated
If obese, weight loss

Peptic Ulcers

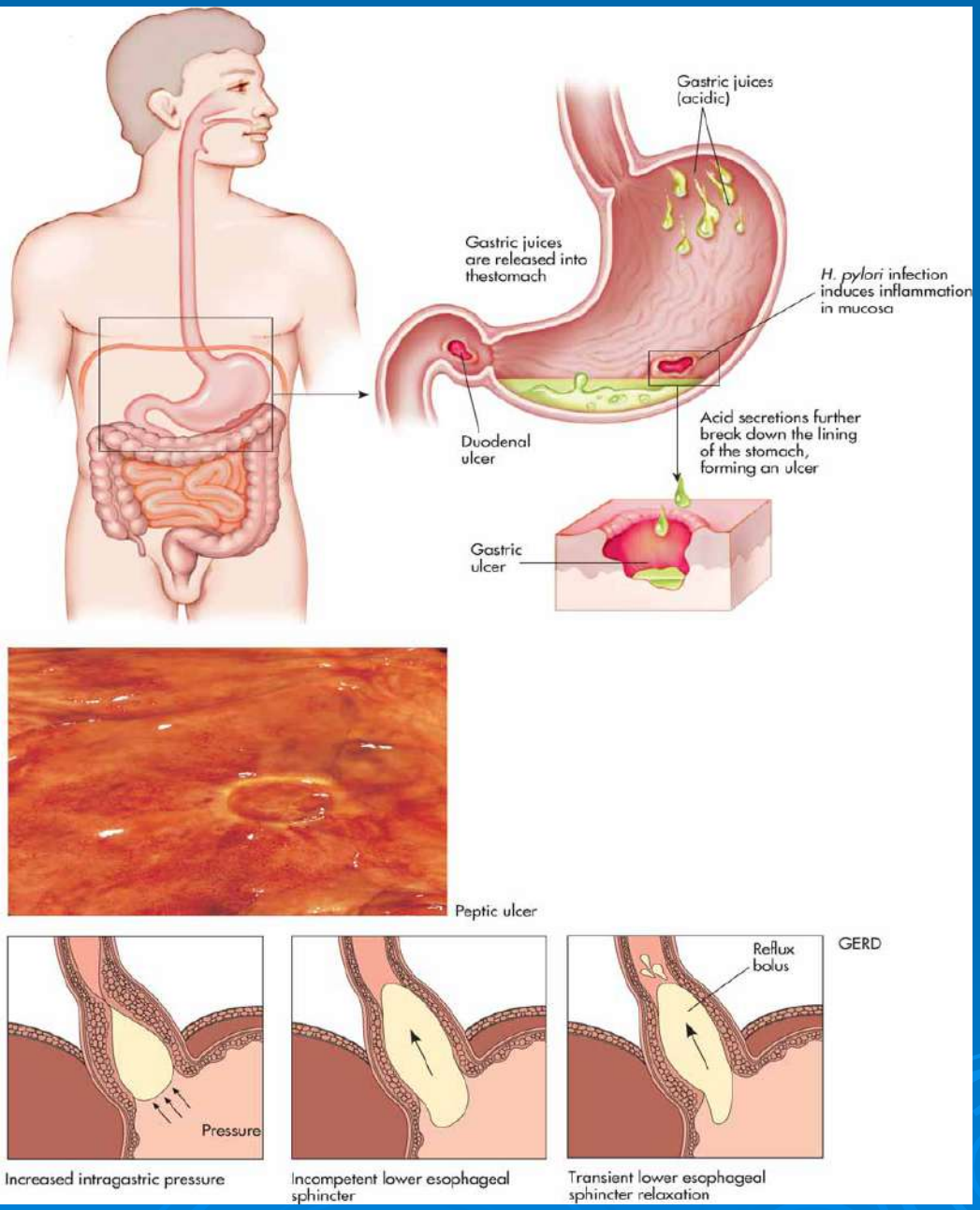
Etiology: Breakdown of mucosal membrane in esophagus, stomach, or small intestine; develop most commonly in duodenum

Factors that increase risk:

- Helicobacter pylori (H. pylori) infection in stomach:
- Smoking
- Heavy/chronic alcohol consumption
- Use of NSAID medications (including aspirin and others)
- Caffeine consumption

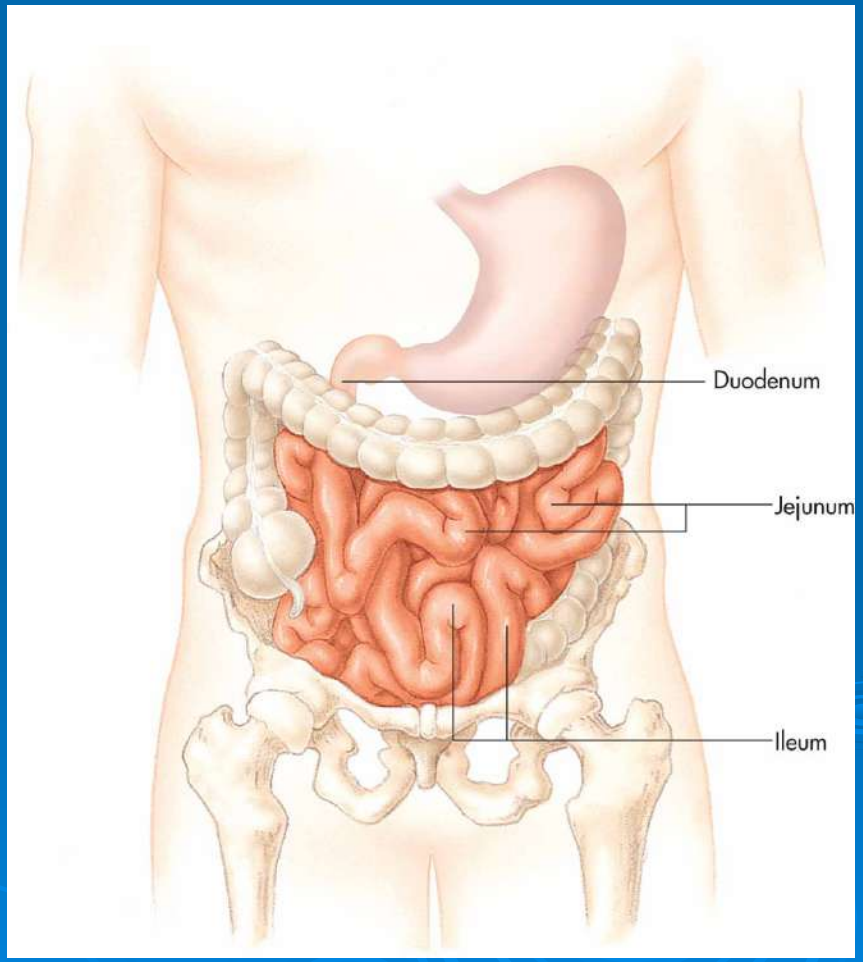
Peptic Ulcer cont.

Use of corticosteroid medications
Stress


Gastric juices (acidic)
Gastric juices are released into thestomach
H. pylori infection induces inflammation in mucosa
Duodenal ulcer
Acid secretions further break down the lining of the stomach, forming an ulcer
Gastric ulcer
Peptic ulcer
GERD
Reflux bolus
Pressure
Increased intragastric pressure
Incompetent lower esophageal sphincter
Transient lower esophageal sphincter relaxation

Small Intestine

major organ of digestion, is where most of food digested
average length of 6–20 feet and diameter ranging from 2.5-4 cm
Walls secrete digestive enzymes and hormones to stimulate pancreas

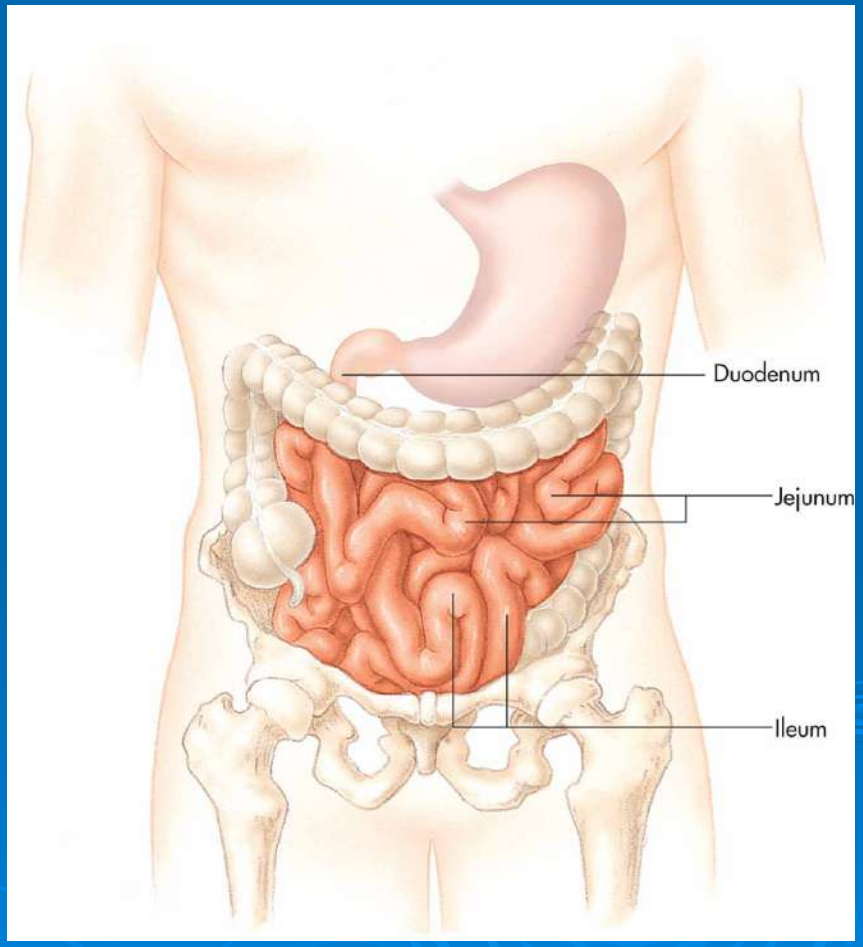


Small Intestine cont.

80% of absorption of usable nutrients occurs in sm. Intestine
Remaining 20% absorbed in stomach
Any residue not utilized in small intestine sent to large intestine for removal from body

Sections of sm. intestine

Three regions
Duodenum: approximately 25 cm long (10 inches)
Jejunum: middle section, approximately 2.5 m long
Ileum: terminal end, 2 meters long, attaches to large intestine at ileocecal valve



Sm. Intestine cont.

Pyloric valve allows small portions of chyme to enter duodenum
Pancreas and gallbladder add secretions: bile from gallbladder, pancreatic juice with enzymes from pancreas
Bile emulsifies fat, making fat disperse in water
Pancreatic juice contains sodium bicarbonate which neutralizes acidic chyme

TABLE 15–2: Hormones in the Digestive Process

HORMONE	SECRETING ORGAN	ACTION
Gastrin	Stomach	Stimulates release of gastric juice
Secretin	Duodenum	Stimulates release of bicarbonate and water from pancreas and bile from liver; slows stomach activity
Cholecystokinin (CCK)	Duodenum	Stimulates digestive enzyme release from pancreas and bile release from gallbladder; slows stomach activity

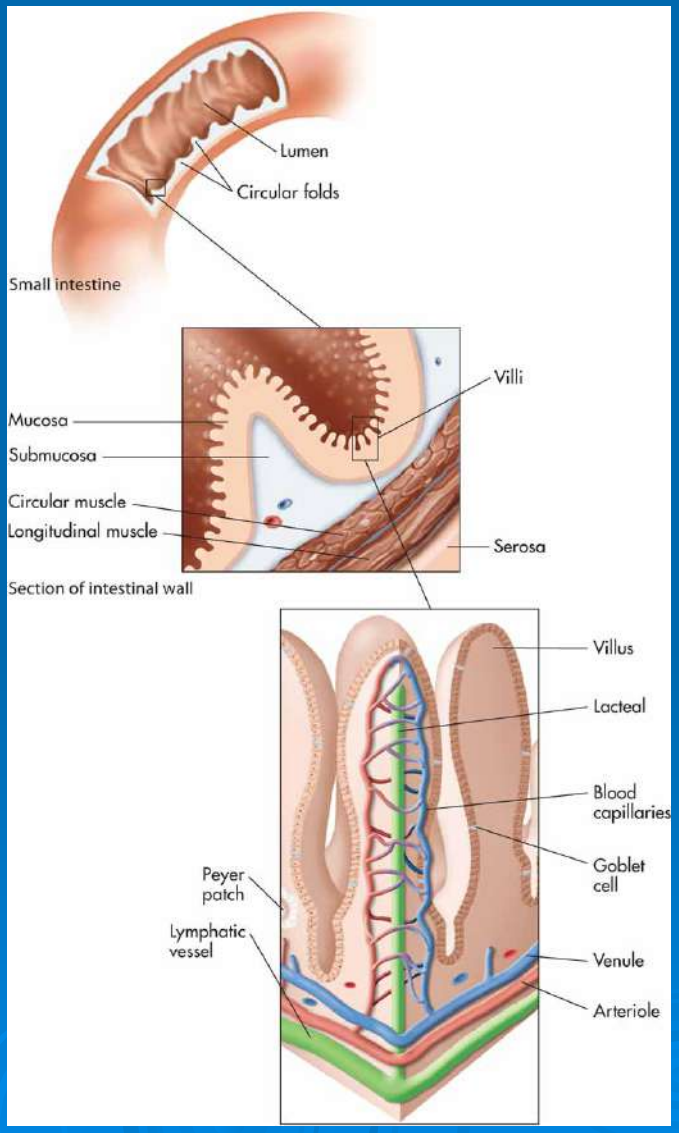
Sm. Intestine Cont.

Wall has circular folds called plicae circulares and finger-like protrusions into lumen called villi

- Villi also have microscopic extensions known as microvilli

Purpose: to provide increase in surface area of small intestine (almost to size of tennis court) increasing efficiency of absorption of nutrients

Villi

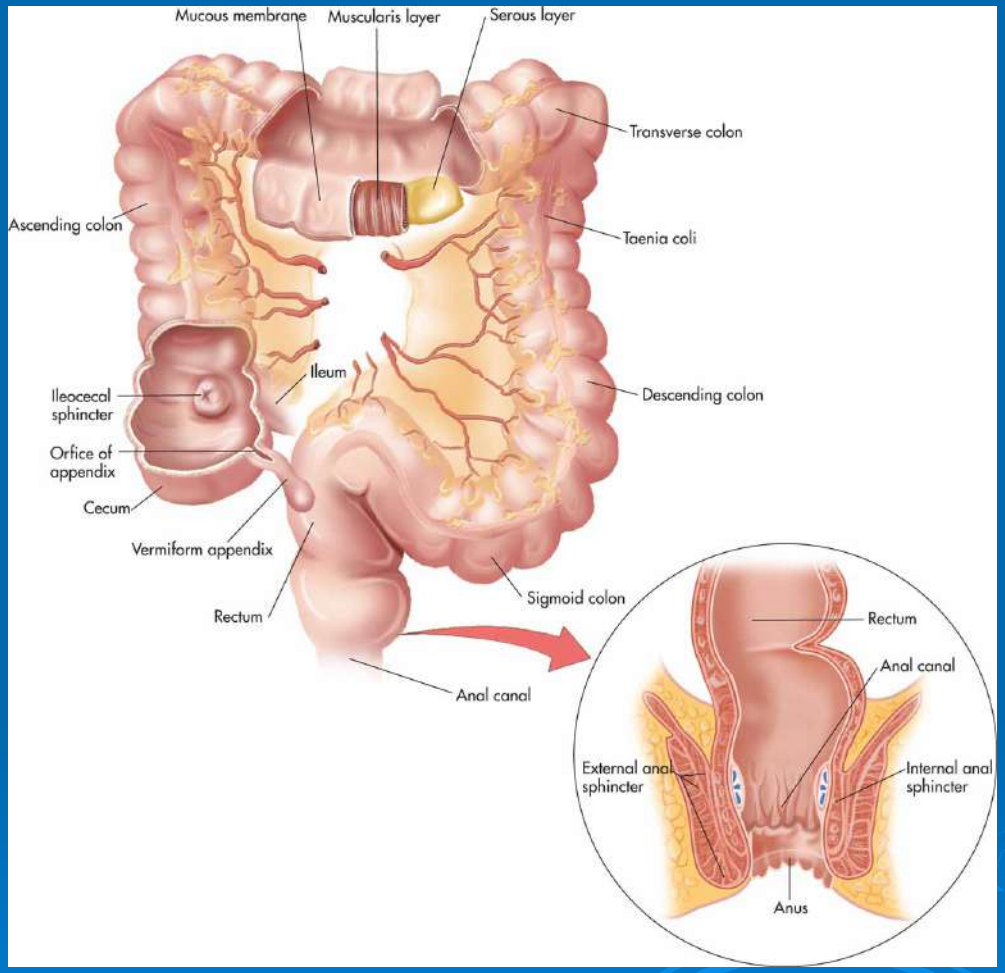

Lumen
Circular folds
Small intestine
Villi
Mucosa
Submucosa
Circular muscle
Longitudinal muscle
Serosa
Section of intestinal wall
Villus
Lacteal
Blood capillaries
Goblet cell
Peyer patch
Lymphatic vessel
Venule
Arteriole

Large Intestine

Beginning at junction of small intestine, ileocecal orifice, and extending to anus

Borders small intestine

No villi in large intestine so little nutrient absorption occurs here



Functions of Large Intestine

- Water absorption
- Absorption of vitamins produced by normal bacteria in large intestine
- Packaging/compacting waste products for elimination from body

Lg. Intestine cont.

5 feet long and 2.5 inches in diameter

3 main regions: cecum, colon, and rectum

cecum, receives any undigested food and water from ileum

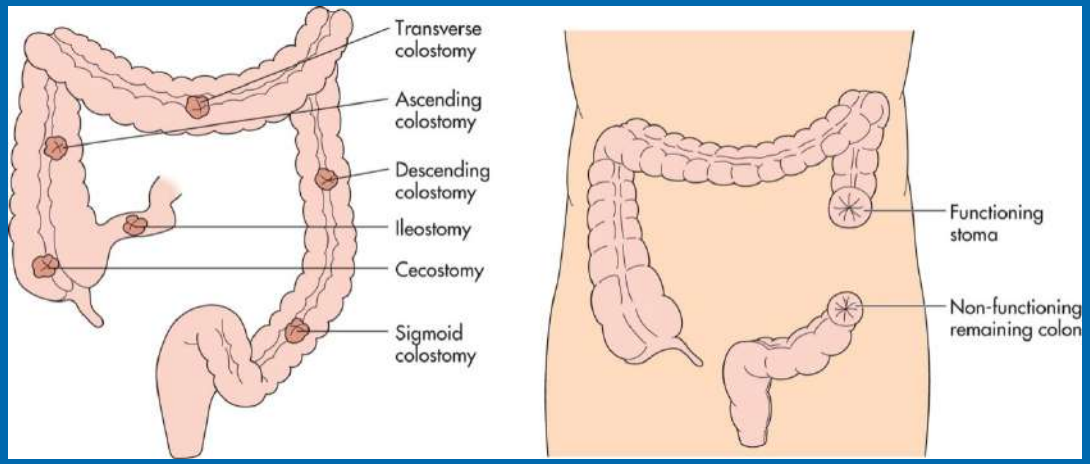
Large Intestine

*Four sections of colon: ascending, transverse, descending, and sigmoid

*Ascending colon travels up right side

*Transverse colon travels across abdomen just below liver and stomach

*Descending colon travels to left side

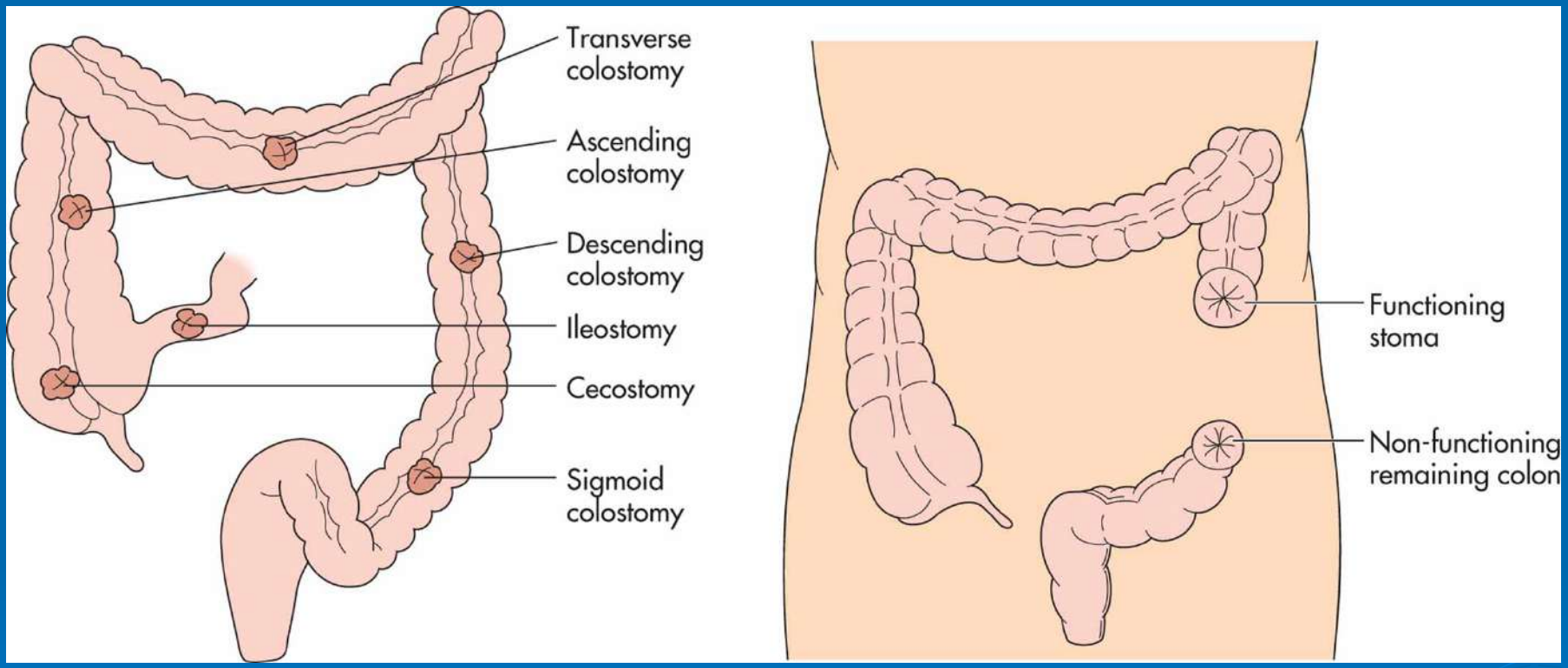


Lg. Intestine cont.

Sigmoid colon extends to rectum

Rectum opens to anal canal that leads to anus

Anal sphincter opens and closes to allow passage of solid waste (feces)


Transverse colostomy
Ascending colostomy
Descending colostomy
Ileostomy
Cecostomy
Sigmoid colostomy
Functioning stoma
Non-functioning remaining colon

Role of Intestinal Bacteria

- Help break down indigestible materials
- Produce B complex vitamins and most of vitamin K needed for proper blood clotting

Pathology: Lg. Intestine

Hemorrhoids

Etiology: varicose veins in rectum
S/S: pain, itching/burning sensation, bleeding
Dx: proctoscopy, stool sample examination
Tx: dietary changes (more fiber/water), stool softeners, medication to relieve discomfort

Colorectal Cancer

Risk factors include:

- Genetic predisposition
- Diet rich in animal fat
- Diet lacking appropriate amounts of fiber and calcium
- Tobacco usage and excessive alcohol consumption
- Higher than normal levels of “bad” cholesterol in serum
- Sedentary lifestyle

Colorectal Cancer cont.

S/S: rectal bleeding, possible abd. pain

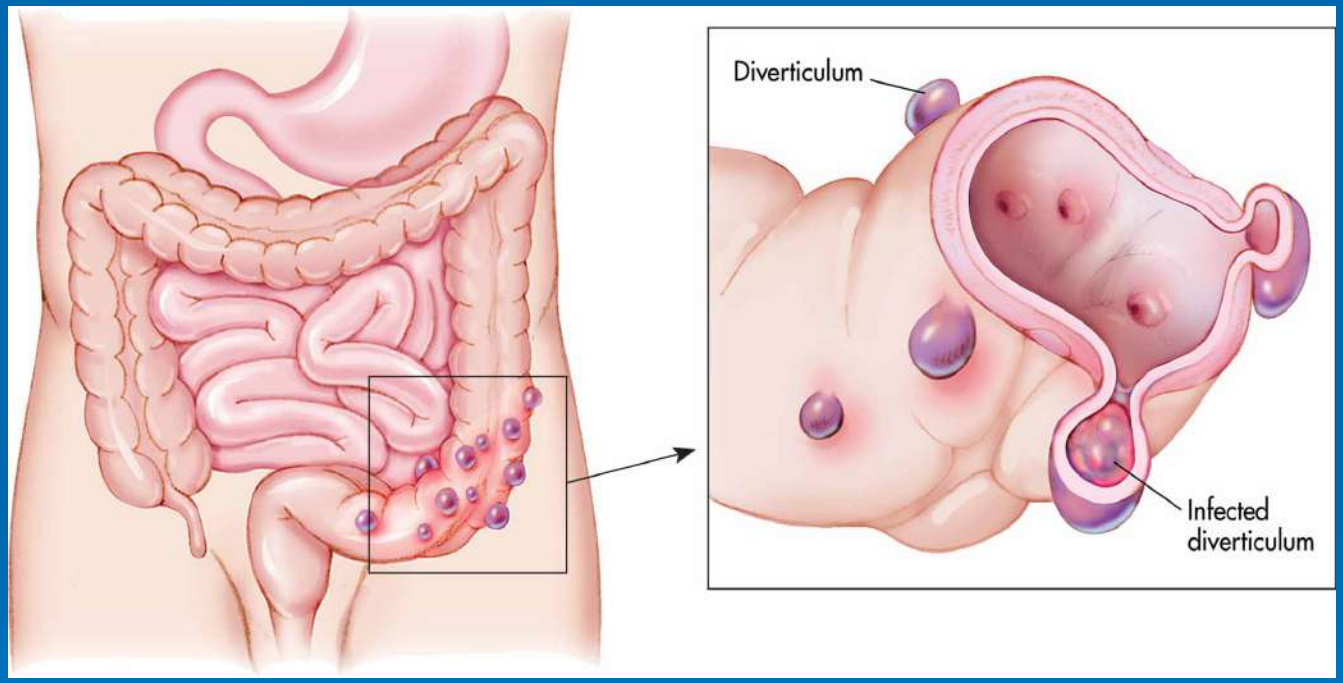
Dx: colonoscopy

Tx: surgical removal of tumor, chemo, radiation possible.

Diverticulitis

- Etiology: infection and inflammation of diverticulum (sac in intestinal tract)
- S/S: bleeding, abd. pain, fever, hyperactive bowel sounds
- Dx: patient hx and exam, blood work, colonoscopy, endoscopy
- Tx: high fiber diets, stool softeners, antibiotics, surgical intervention

Diverticulitis

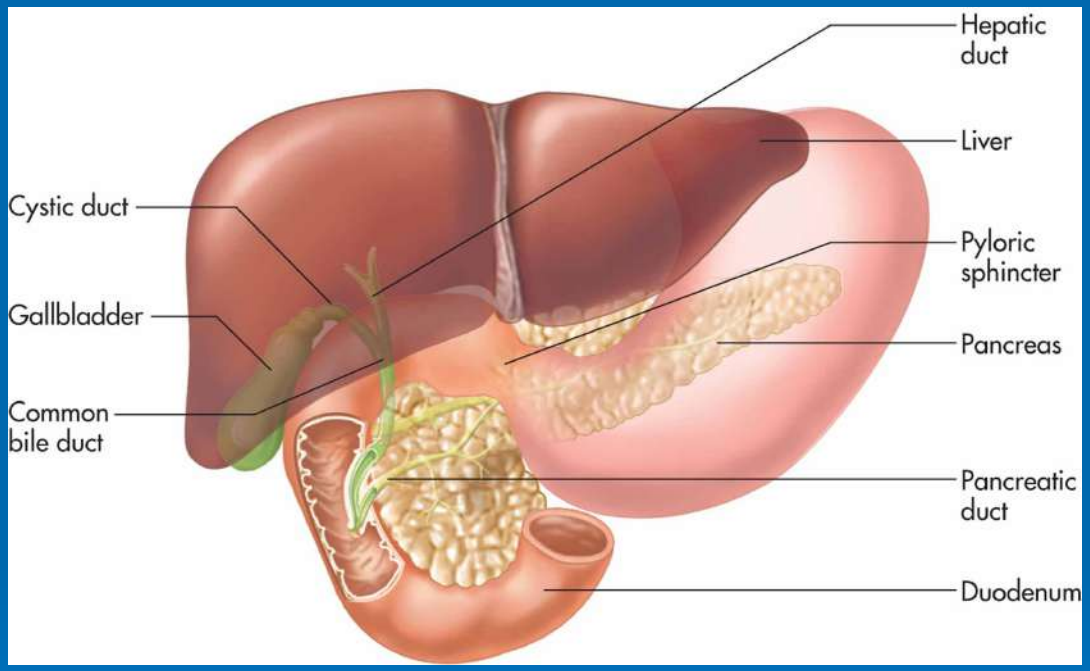


Accessory Organs

-Liver

-Gall Bladder

-Pancreas



Liver

Weighs 1.5 kg, is largest glandular organ in body
Divided into large right lobe and smaller left lobe; right lobe has two smaller inferior lobe
Receives about 1½ quarts of blood every minute from hepatic portal vein and hepatic artery

Functions of the Liver

- Detoxifies body of harmful substances such as certain drugs and alcohols
- Creates body heat
- Destroys old blood cells
- Eliminates the pigment bilirubin in bile which gives feces its distinctive color
- Forms blood plasma proteins, such as albumin and globulin

Functions of the Liver cont.

- Produces clotting factors fibrinogen and prothrombin

Creates anticoagulant heparin

Manufactures bile

- Stores and modifies fats for more efficient usage by body's cells
- Synthesizes urea, a by-product of protein metabolism

Functions of the Liver cont.

Stores glucose, as glycogen; when blood sugar level falls below normal, liver reconverts glycogen to glucose and releases it into the blood

Stores ions, vitamins A, B_{12}, D, E, and K

Makes cholesterol

Gall Bladder

Sac-shaped organ, 3–4 inches long, located under liver's right lobe
Stores bile and absorbs much of its water content, making it 6–10 times more concentrated; if over-concentrated, bile salts may solidify, forming gall stones
Fatty foods in duodenum cause release of CCK which causes bile to release into the duodenum via common bile duct

Pathology Connection: Cholelithiasis and Cholecystitis

- Etiology: inflammation of gallbladder; presence of stones or calculi in gallbladder or common bile duct
- Incidence increases with age, common in men, women following multiple pregnancies, obese patients, diabetics, and patients who have had rapid weight loss

Cholelithiasis cont.

S/S:

Asymptomatic/mild discomfort to extreme pain often preceded with ingestion of fatty or greasy foods

pain usually steady lasting from 15–30 minutes or up to several hours with spontaneous resolution

nausea/vomiting, bloating, flatulence, abdominal tenderness

Possible low grade fever

Cholelithiasis cont.

- Dx: exam/pt hx, ultrasound, blood work with rise in leukocyte count during acute cholecystitis (although other values usually within normal range)
- Tx: changes in diet, observation, surgical removal if deemed severe enough

Cirrhosis

Etiology: enlargement of liver (hepatomegaly) with normal tissue being replaced with fibrous tissue
S/S: decrease in its function, nausea/vomiting, weakness, jaundice, swollen ankles (edema), loss of weight, loss of body hair, massive hematemesis, coma, death
Dx: patient exam and history, blood results
Tx: cessation of causative agent

Hepatitis

- Etiology: inflammatory condition, most common chronic liver disease; five types: (A,B,C,D,E) each with differing routes of infection, severity and complications have been identified
- S/S: hepatic cell destruction, hepatomegaly, fever, weakness, nausea, anorexia, arthralgia, jaundice, skin eruptions, dark urine
- Dx: patient history, physical exam, blood testing/screening
- Tx: antiviral drugs

Jaundice

Pancreas

Endocrine gland that has role in digestion
6–9 inches long, located posterior to stomach, and extends laterally from duodenum to spleen
Secretes buffers and digestive enzymes through pancreatic duct to duodenum
Buffers neutralize acidity of chyme to protect the intestinal walls

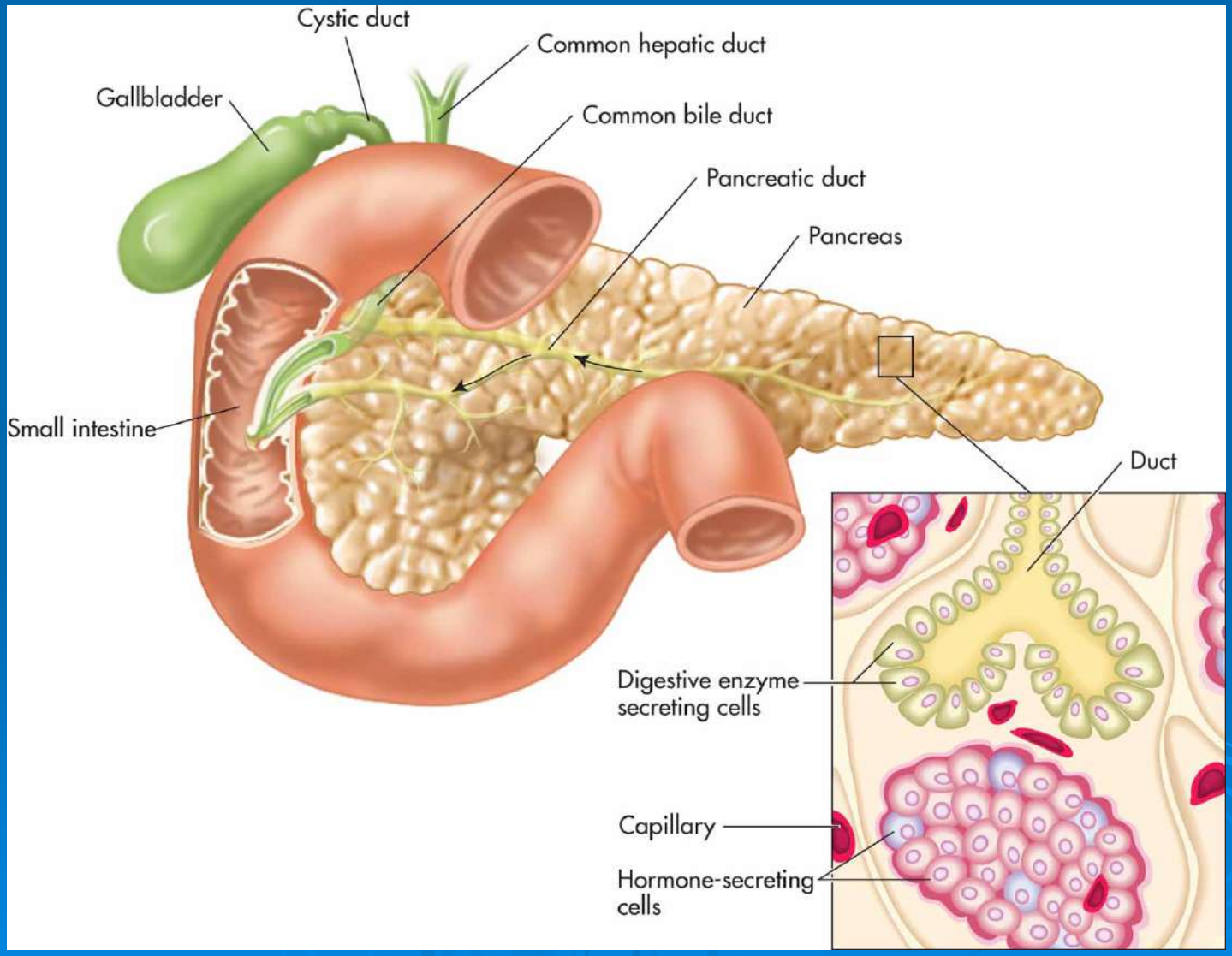
Pancreatic Enzymes

Hormones from the duodenum activate enzyme secretion

Enzymes:

- Carbohydrase: works on sugars and starches
- Lipase: works on lipids
- Proteinase: breaks down proteins
- Nuclease: breaks down nucleic acids

Pancreas


Cystic duct
Common hepatic duct
Gallbladder
Common bile duct
Pancreatic duct
Pancreas
Small intestine
Duct
Digestive enzyme secreting cells
Capillary
Hormone-secreting cells

Pancreatitis

Etiology: Inflammation of pancreas

Possible causes

Blockage of bile duct (causing pancreatic enzymes to back up into pancreas)

Excessive alcohol consumption

Irritation

Pancreatitis cont.

S/S: severe abd. Pain, N/V
Dx: physical exam and hx, enzyme levels elevated
Tx: depends on severity of symptoms
NPO
Total Parental Nutrition
Pain management

Pathology Connection: Crohn's Disease

- Etiology: form of chronic inflammatory bowel disease affecting ileum and/or colon
- S/S: pain, cramps, diarrhea, bloating, weight loss
- Dx: physical exam and history, radiologic studies
- Tx: anti-inflammatory meds such as prednisone, surgical intervention if severe

Gastritis

- Etiology: acute or chronic inflammation of stomach; due to infection, spicy foods, excess acid production, stress, alcohol, aspirin consumption, heavy smoking
- S/S: pain, tenderness, nausea, and vomiting
- Dx: patient history, imaging studies, endoscopy, gastric biopsy
- Tx: antacids, antibiotics (if bacterial infection)

Intussusception

- Etiology: result of intestine slipping or telescoping into another section of intestine just below it often in ileocecal region; common in children
- S/S: pain
- Dx: radiographic studies
- Tx: surgery

Peritonitis

- Etiology: infectious and/or inflammatory process of peritoneum; may be due to leakage of contents from gallbladder, appendix, duodenal ulcer, penetrating injuries or result of cancerous tumor
- S/S: pain, fever, malaise, shock, abscesses
- Dx: patient history, physical examination, blood work
- Tx: correction of cause, surgical intervention, antibiotics