

The Digestive System

- I. Interesting Factoids
 - A. You eat about 1,100 pounds of food a year.
 - B. You produce about 1.7 liters of saliva each day.
 - C. Your stomach can hold about 1.5 liters of food.
 - D. About 12 liters of food passes through your digestive system each day, but only 100mL is lost as feces.
 - E. You've got about 400 species of bacteria in your colon.
 - F. The stomach digests all of its contents in 2-6 hours.
 - G. The volume of an individual flatus is 15-35 mL.
 - H. Most people pass about 200-2,000mL of gas a day in 13-14 passages.
 - I. Farts are composed of O₂, N₂, CO₂, H₂ and CH₄ (methane)

Major Concepts Overview Grid

II. Functions

- A. **Ingestion** – taking in food
- B. **Digestion** – breaking down food
- C. **Absorption** – getting nutrients into the bloodstream
- D. **Excretion** – rid of indigestible wastes

III. Major Divisions (2)

A. Alimentary Canal (aka. Gastrointestinal Tract)

1. Long tube that runs through body
2. Digestion & Absorption of food
3. Mouth → Pharynx → Esophagus → Stomach →
Small Intestine → Large Intestine → Rectum → Anus

B. Accessory Digestive Organs

1. Aid digestion chemically and/or mechanically
2. Pancreas, Liver, Gall Bladder, Salivary Glands, Teeth

~~Assn: p452 Multiple Choice #1-3; Short Answer Essay #1-3.~~

IV. Structures of the Alimentary Canal (fig 14.3/p415)

A. Four basic tissue layers from esophagus - large intestine

1. Mucosa

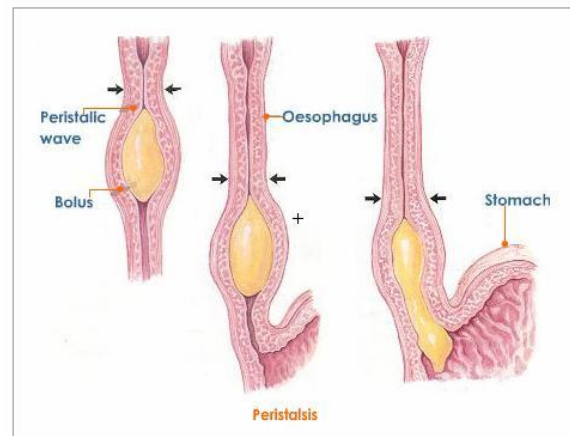
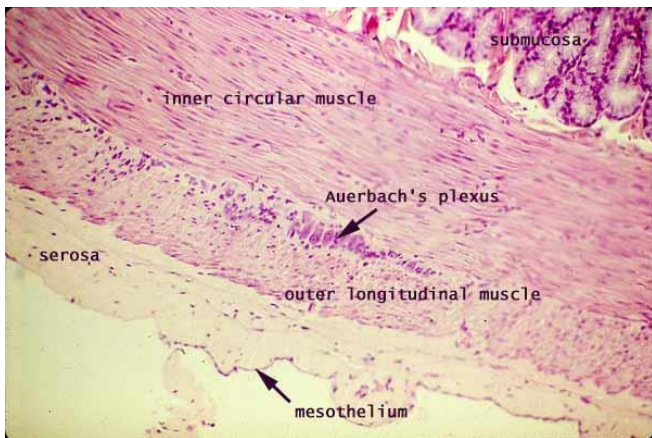
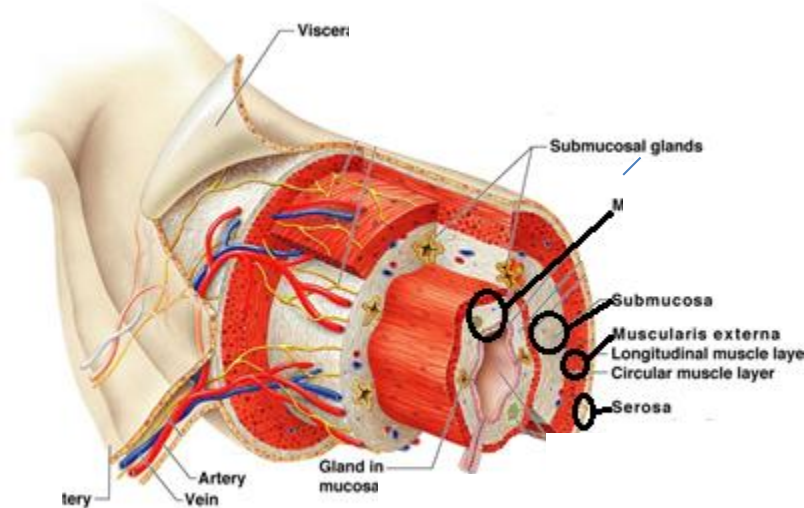
- a. Inside layer
- b. Simple columnar epithelium

2. Submucosa

- a. Beneath mucosa
- b. Soft connective tissue
- c. Blood vessels, nerve endings, lymph structures

3. Muscularis Externa

- a. Circular & longitudinal smooth muscle
- b. Peristalsis



4. Serosa

- a. Outermost layer
- b. Single layer of fluid-producing cells

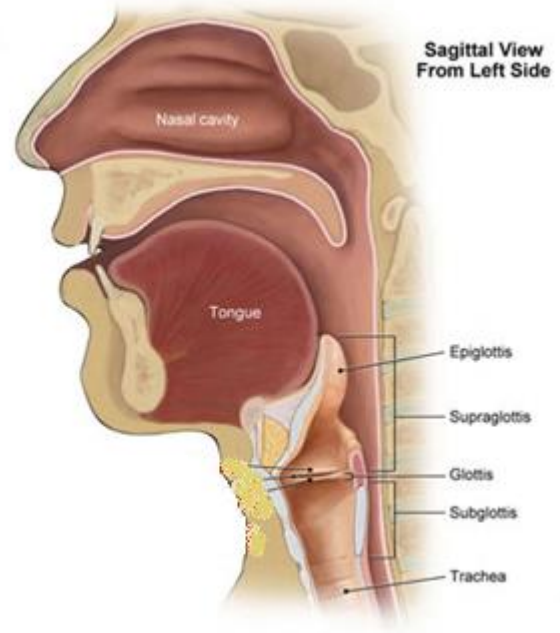
V. Quick Trip through the Alimentary Canal

A. Mouth (oral / buccal cavity)

- 1. analysis, lubrication, mechanical & chemical digestion
- 2. **amylase** – enzyme that starts to break down carbs
- 3. tongue mixes food & saliva
- 4. portion of swallowed food called a “**bolus**”

B. Pharynx

1. back of throat before splitting into esophagus & trachea
2. common passageway for food, fluid, air
3. peristalsis begins here

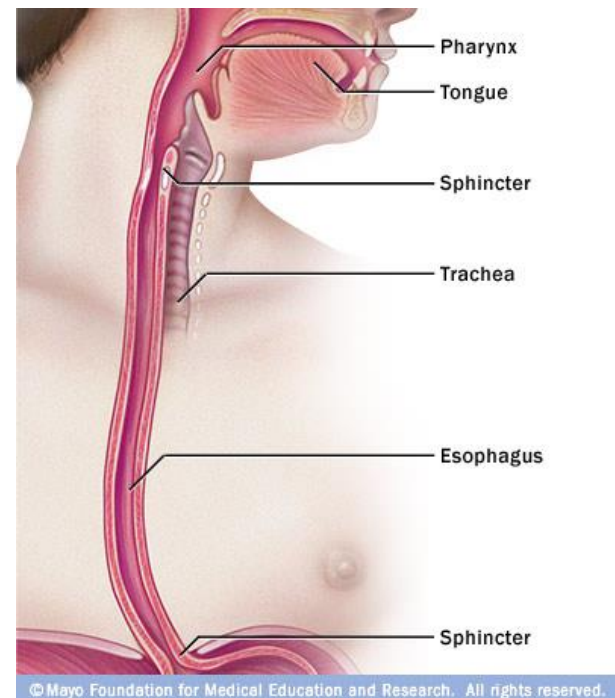


C. Glottis & Epiglottis

1. glottis – opening to larynx (windpipe)
2. epiglottis – flap of cartilage that covers glottis during swallowing to prevent choking.

D. Esophagus

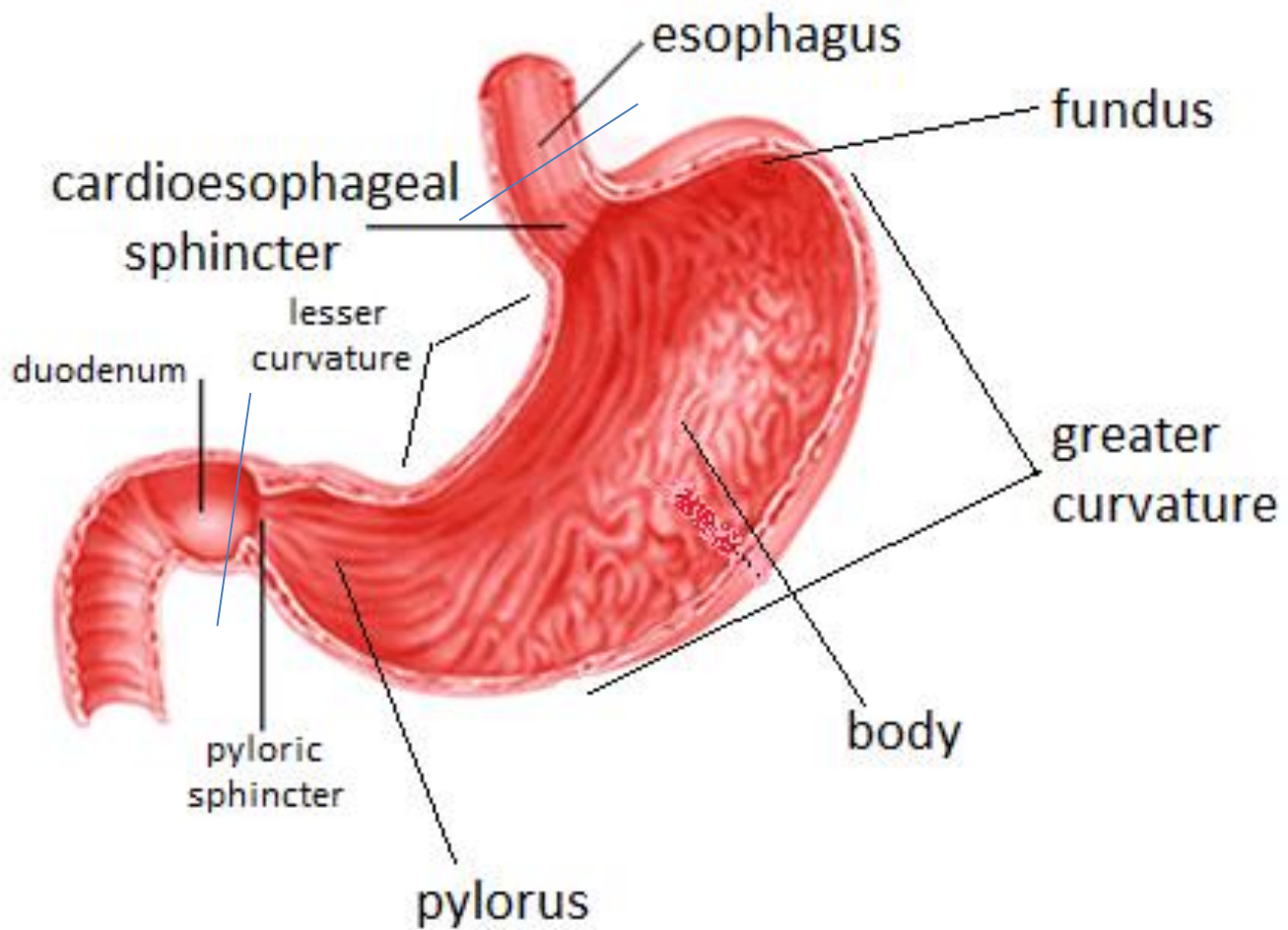
1. 10-inch stretchable tube to stomach.
2. cardiac sphincter muscle at end closes off stomach.



E. Stomach

1. Storage area for mixing and digesting food.

2. Regions of the stomach:



3. Folds in inner stomach lining called “rugae” increase the surface area for nutrient absorption.

4. Third layer of oblique muscle to mix food better.

5. "Gastric Juice"

a. 2-3L/day

b. Break food down into "chyme"

c. Mix of chemicals:

- HCl – acidic environment activates enzymes
-stomach lined with mucous for protection

**[Harvesting Power from the Gut](#)*

- Pepsin – enzyme that digests most proteins.
- Rennin – digests milk proteins.

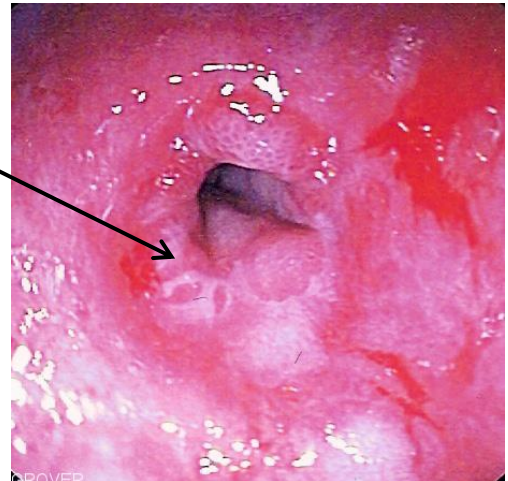
6. Gastrointestinal Reflux Disease

a. Stomach contents leak into esophagus.

b. Can cause a stricture.

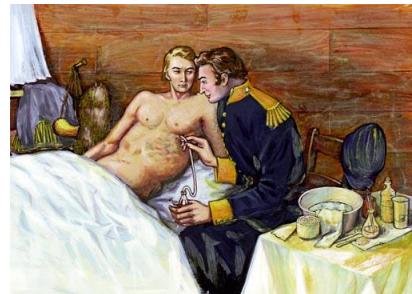
c. Treat with proton-pump
Inhibitor (PPI) drugs.

EX) Prilosec

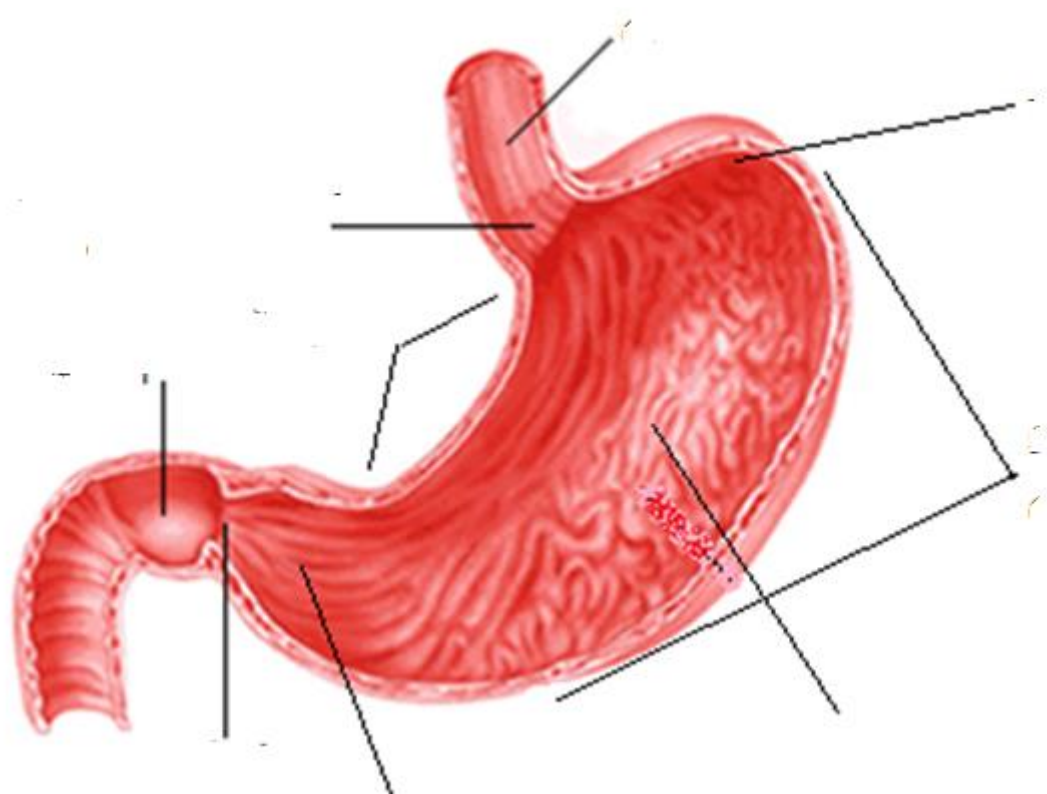


7. Ulcers

*Alexis St. Martin's famous
[gastric fistula](#)



*[Stomach Submarine](#)



7. Vomiting

a. Your body's way of getting rid of something it doesn't like!

b. From sickness or self-induced

- From sickness:

- 1) Nausea Phase – that queasy feeling

- 2) Retching Phase – abdominal muscles and diaphragm contract a few times.

- increased salivation to protect tooth enamel.

- 3) Expulsive Phase – deep breath, then epiglottis closes.

- abs contract violently

- decreased abdominal pressure and released endorphins lead to feeling of relief.

- Self-Induced (gag reflex)

- Sensory nerves in back of throat (pharynx) send message to brain stem.

- Message sent back to start at step #3.

8. Hunger & Satiation

a. Hunger – the trigger to eat:

Decreased blood sugar levels



Increased production of certain hormones

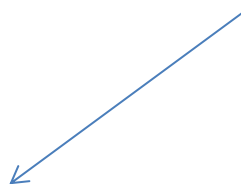
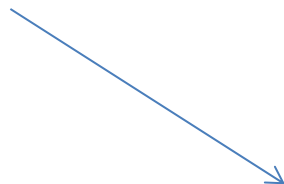


Hormones cause stomach to contract
("hunger pangs")

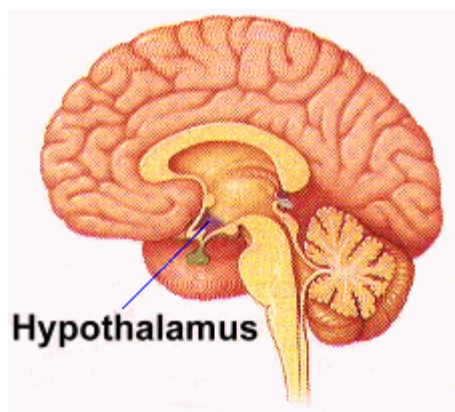
b. Satiation – the trigger to stop eating:

Stretch receptors
In stomach

blood chemistry
(sugar, insulin, fats)



Hypothalamus

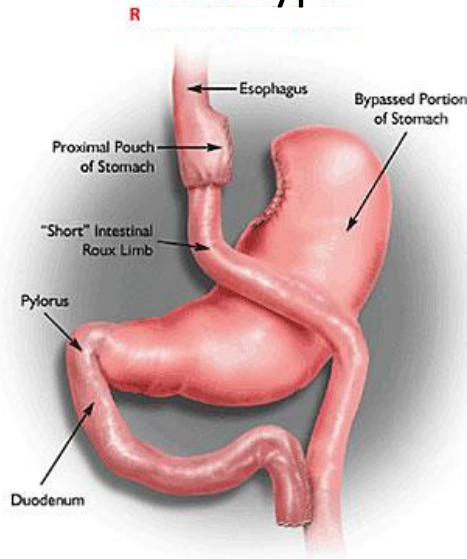


10. Bariatric Surgeries

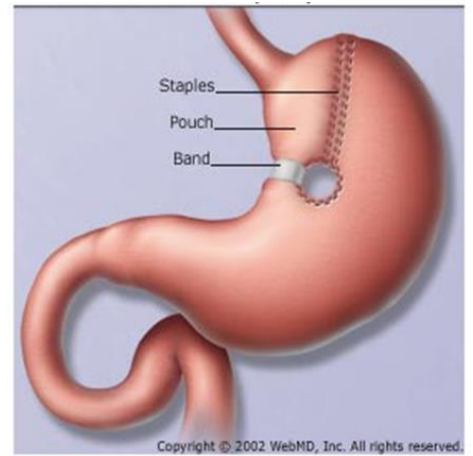
Gastric Band



Gastric Bypass



Stapling



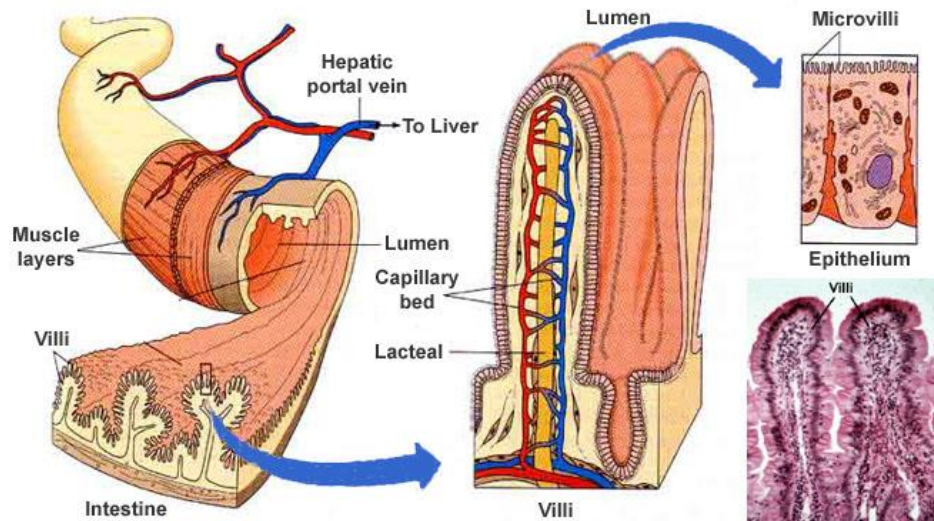
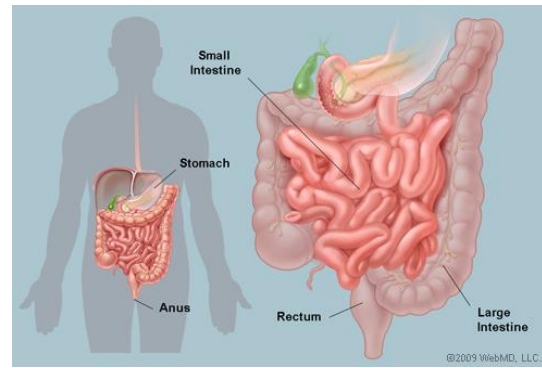
E. Small Intestine

1. 22-23 feet long / 1 inch diameter

2. Final digestion

3. Most of the nutrient absorption

*villi (tiny fingerlike projections) increase the surface area to absorb more nutrients.



(Really BAD diet idea!)

4. Three subdivisions of the small intestine:

a. Duodenum

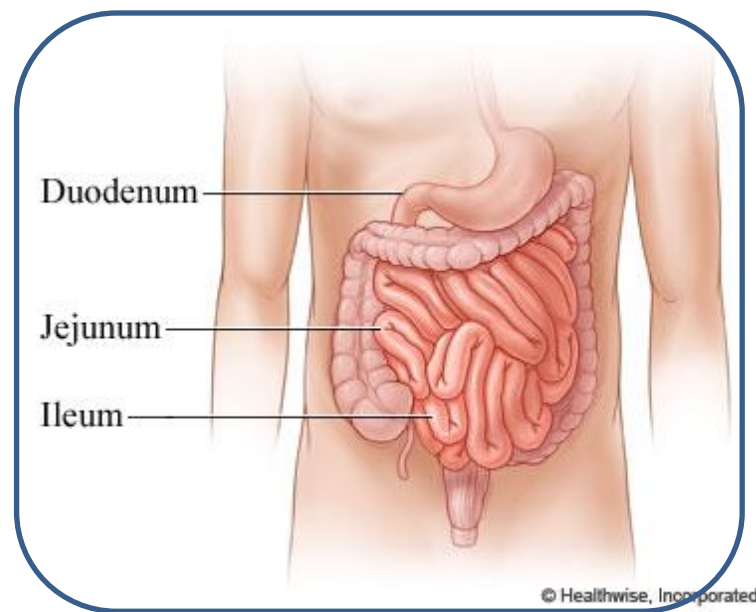
- Neutralizes stomach acid
- Receives enzymes from gall bladder and pancreas
- Coats chyme bolus with mucous

b. Jejunum

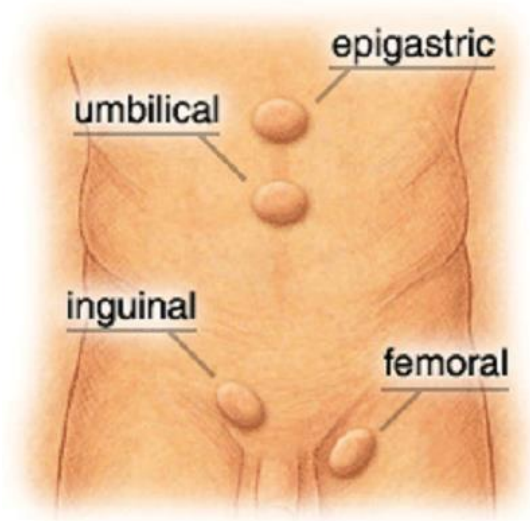
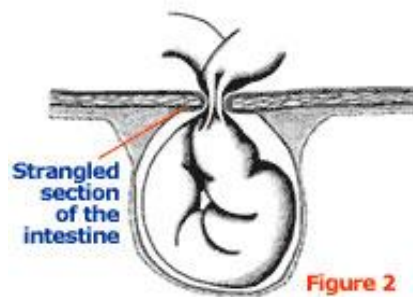
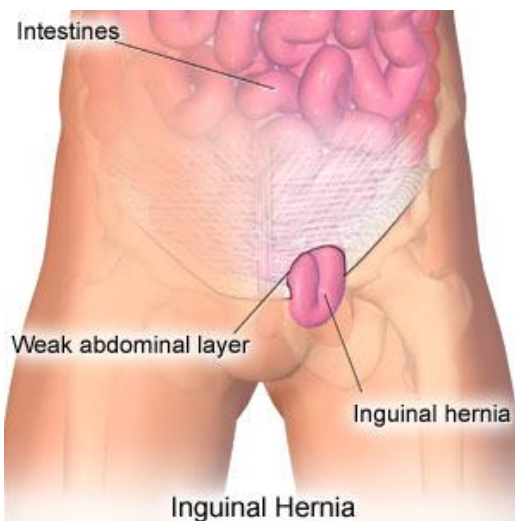
- specific nutrient absorption
- Coated with villi

c. Ileum

- Final absorption



5. Common Disorders: Hernia



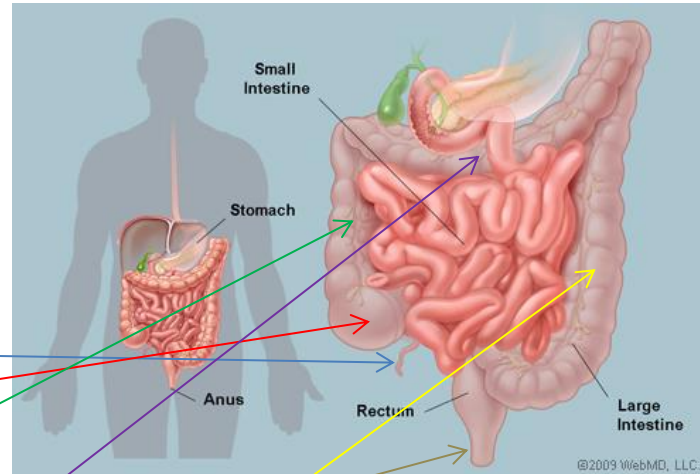
G.Large Intestine

1. 5 feet long / 3 inches diameter

2. Dries out indigestible wastes








3. Five subdivisions:

- a. Appendix
- b. Caecum
- c. Colon (ascending, transverse, descending)
- d. Rectum
- e. Anal canal
 - Involuntary internal sphincter (smooth muscle)
 - Voluntary external sphincter (skeletal muscle)



4. Common Disorders: Diarrhea, Constipation, Appendicitis

Here it is: The BRISTOL STOOL CHART!!!

Bristol Stool Chart		
Type 1		Separate hard lumps, like nuts (hard to pass)
Type 2		Sausage-shaped but lumpy
Type 3		Like a sausage but with cracks on its surface
Type 4		Like a sausage or snake, smooth and soft
Type 5		Soft blobs with clear-cut edges (passed easily)
Type 6		Fluffy pieces with ragged edges, a mushy stool
Type 7		Watery, no solid pieces. Entirely Liquid

World's Largest [COPROLITE!!!](#)

SPECIAL TREAT

Beaker #1: 60mL glue + 60mL rinse water...and mix.
Beaker #2: 60mL water + 1g borax in flask...and mix.
Pour beaker #2 into beaker #1... mix, knead and ENJOY!!!

VI. Accessory Organs

A. Teeth

1. Mechanical digestion

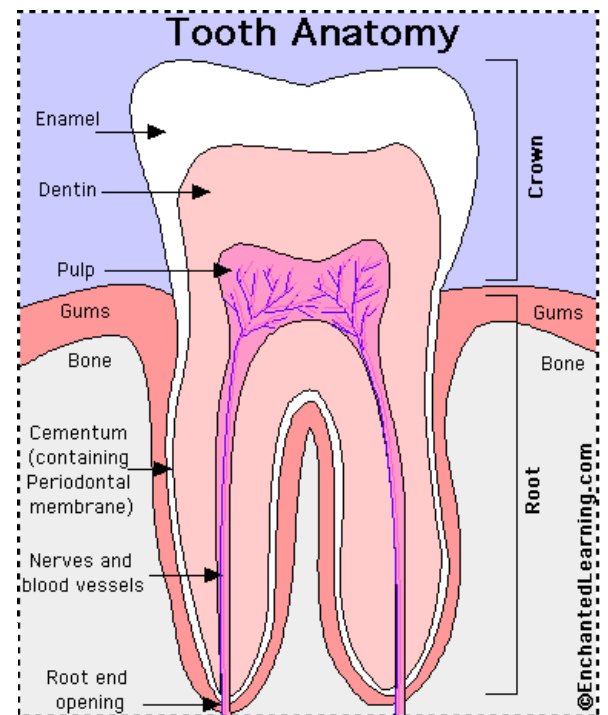
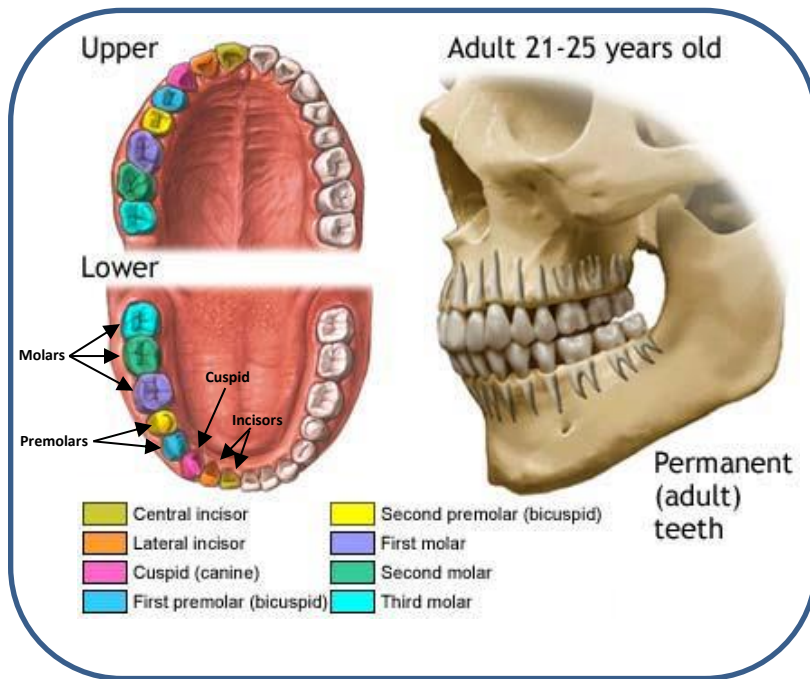
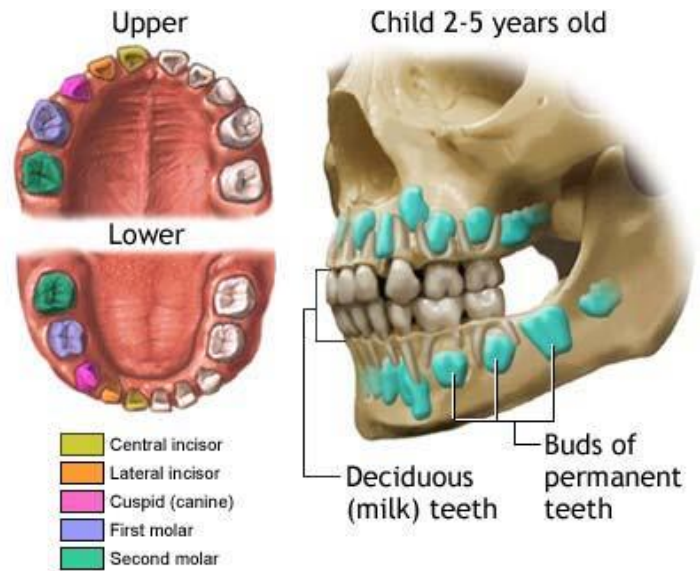
2. Two sets in lifetime

a. Deciduous

- 6 mo – 12 yrs old
- 20 total
- Last 6-12 years

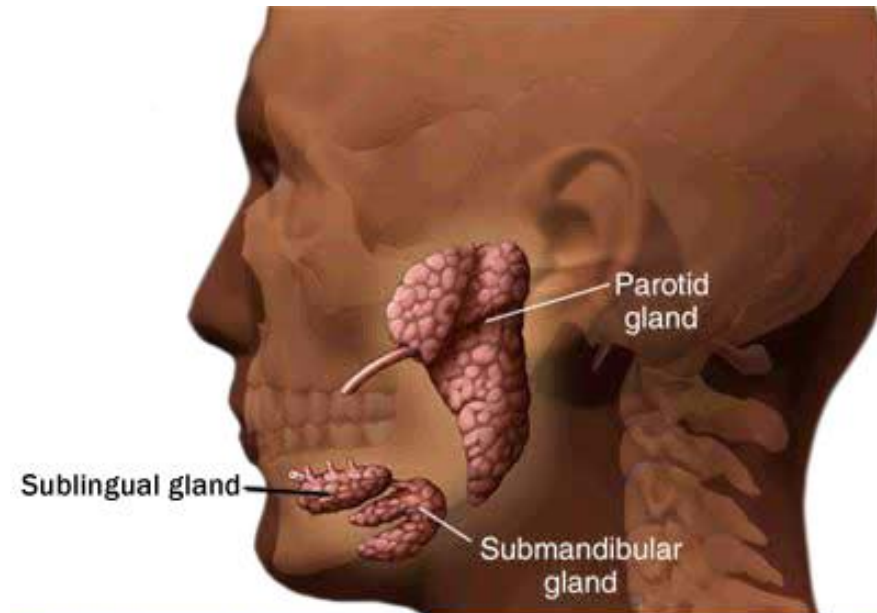
b. Permanent

- 32 total



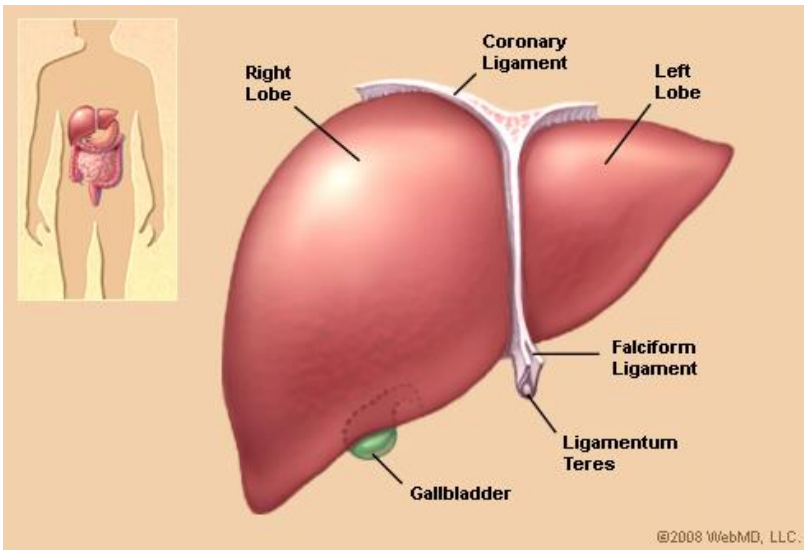
B. Salivary Glands

1. Saliva sticks chewed food into a bolus
 2. Amylase (enzyme) starts to digest carbohydrates
 3. Three sets of glands:
 - a. Parotid – side of face anterior to ears
 - b. Submandibular
 - c. Sublingual
- } *empty saliva into floor of mouth*



C. Liver

1. Largest gland in body
2. Makes *bile* – yellow/green fluid that emulsifies fats.

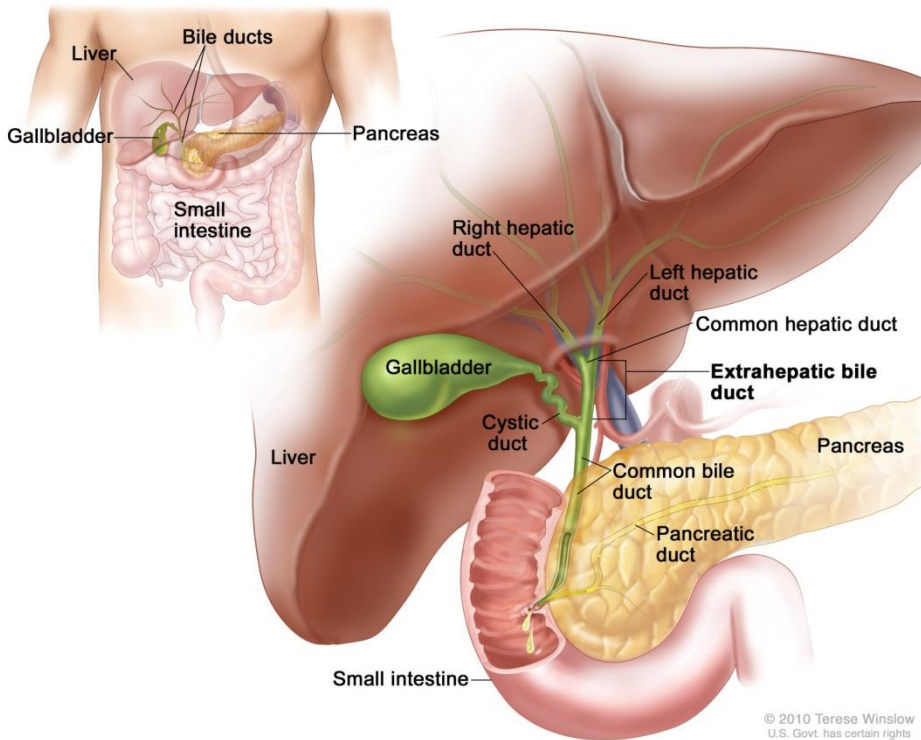


Just breaks fats down,
does not digest them

3. Common Disorders: Jaundice, Hepatitis

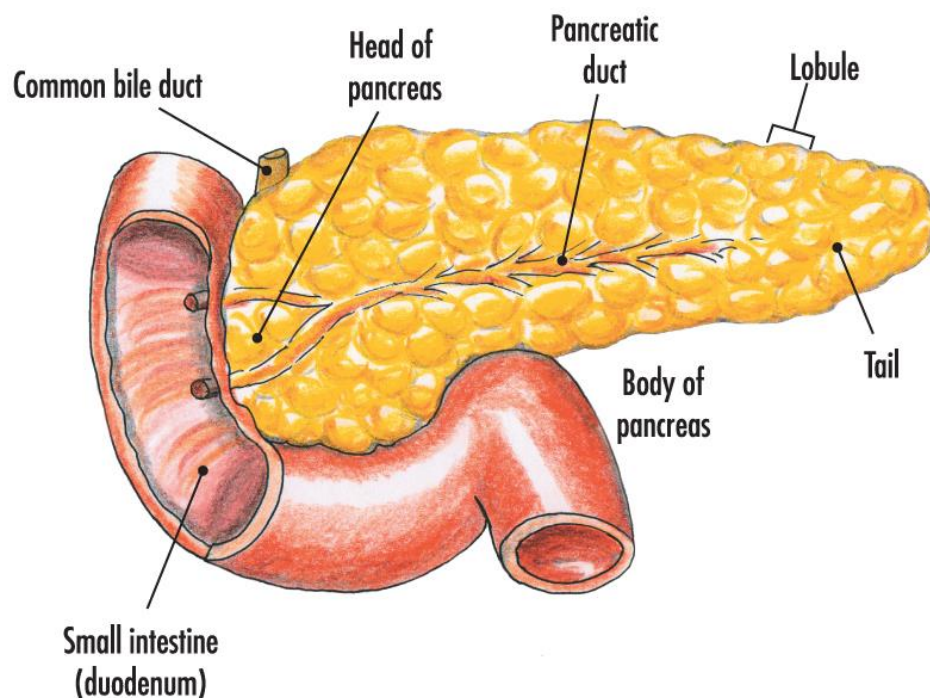
D. Gall Bladder

1. Small sac under liver
2. Stores liver's bile when not needed
3. If stored too long, bile may crystallize to form "stones"



E. Pancreas

1. Gland that produces hormones such as *insulin*.
2. Also produces enzymes called *pancreatic juice* that:
 - a. Empty into duodenum on small intestine
 - b. Digests almost anything, especially fats (*Lipase*)
 - c. Has basic pH to neutralize stomach acids
3. Common Disorders: Diabetes, Pancreatitis



VII. Nutrition

A. Nutrient – substance in food used for growth, maintenance, repair of body.

B. Six types of nutrients:

1. Carbohydrates

- almost all from plants
- sugars for quick energy
- $C_6H_{12}O_6$

2. Lipids

- “fats”; saturated (animal products) & unsaturated (plant products)
- Cholesterol

3. Proteins

- supply amino acids for body growth and maintenance
- animal products are best source; some plant products have some protein
- longer-lasting energy source

4. Vitamins

- organic nutrients needed in small amounts as coenzymes (catalysts for reactions in body)

5. Minerals

- inorganic materials
- 7 of them: Ca, P, K, S, Na, Cl, Mg

6. Water

- 60% of the volume of food
- only survive 3 days without it

VIII. Metabolism

- A. The total of all the chemical reactions happening in your body.
- B. Most of these reactions use energy.
- C. Basal Metabolic Rate (BMR)
 1. the minimum number of calories needed to keep a resting individual alive for 24 hours.
 2. things that can change your BMR:
 - age (lowers as you get older)
 - height (tall people have higher BMR)
 - pregnancy (higher BMR)
 - stress (raises BMR)
 - temperature (hot & cold raise BMR)
 - starvation (lowers BMR)
 - body fitness (lean muscle raises BMR, fat tissue lowers BMR)
- D. Formulas for calculating BMR:

Males= $66+(13.7(\text{weight}/2.2))+(5(\text{height in inches}*2.54))-(6.8*\text{age})$

Females= $655+(9.6(\text{weight}/2.2))+(1.7(\text{height in inches}*2.54))-(4.7*\text{age})$

Example: Joe weighs 150 pounds, is 5'6" tall, and is 21 years old.

$$\text{BMR} = 66 + (13.7(150\text{pounds}/2.2)) + (5(66\text{inches} * 2.54)) - (6.8 * 21\text{years})$$

$$= 66 + (13.7(68.18)) + (5(167.64)) - (142.8)$$

$$= 66 + 934.066 + 838.2 - 142.8$$

$$= 1695.5 \text{ calories per day}$$

BMI Calculator: <http://apps.nccd.cdc.gov/dnpabmi/>

IX. Starvation

A. The Process of Starvation = Resource Re-Allocation

1. First three days: Energy resources maintained by...
 - glycogen stored in liver converts to glucose (hours)
 - fats decompose into fatty acids for energy
2. Day 4 – next few weeks: Autophagy & Catabolysis
 - liver starts turning proteins into ketones for energy
 - skeletal muscle is main source of these proteins
3. 8-12 weeks:
 - proteins essential for cellular functions are used for energy
 - death usually occurs from disease (weakened immune system) or cardiac failure.

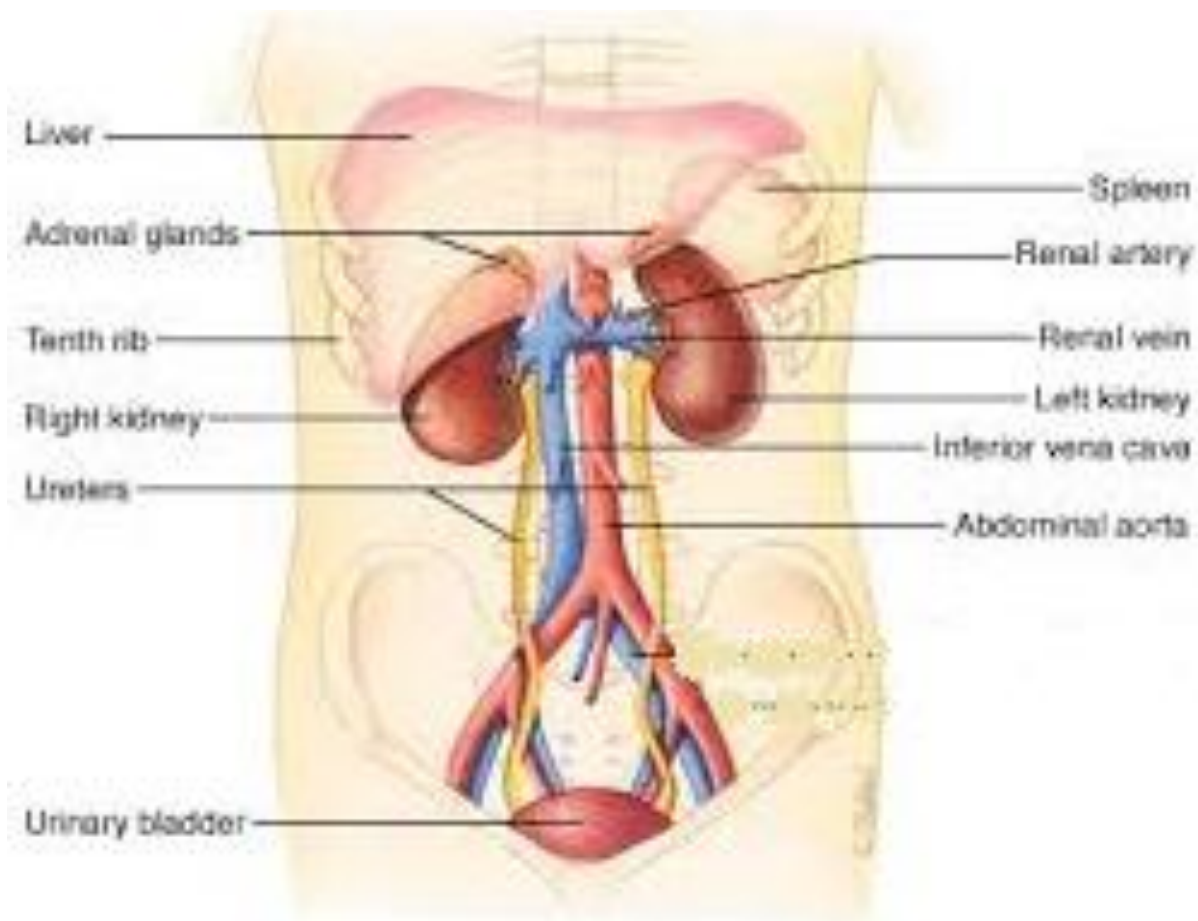
B. Effects of Starvation

1. Short-Term:
 - difficulty concentrating & making decisions
 - fatigue & irritability
 - constipation
 - dry skin & brittle hair
 - irregular heart beat
 - anemia
 - bone demineralization
 - “Starvation Mode” = calorie hoarding = weight gain
 - Losing muscle = lower metabolism = weight gain
2. Long-Term (beginning at ~20% body weight loss):
 - Cardiovascular Disease: weak heart; irregular beat
 - Kidney damage as they are trying to process the extra protein being broken down for energy
 - Brain can only run on glucose (not amino acids, ketones or fatty acids) so lack of these could result in permanent brain dysfunction or coma
 - Death occurs at a loss of ~40% body weight

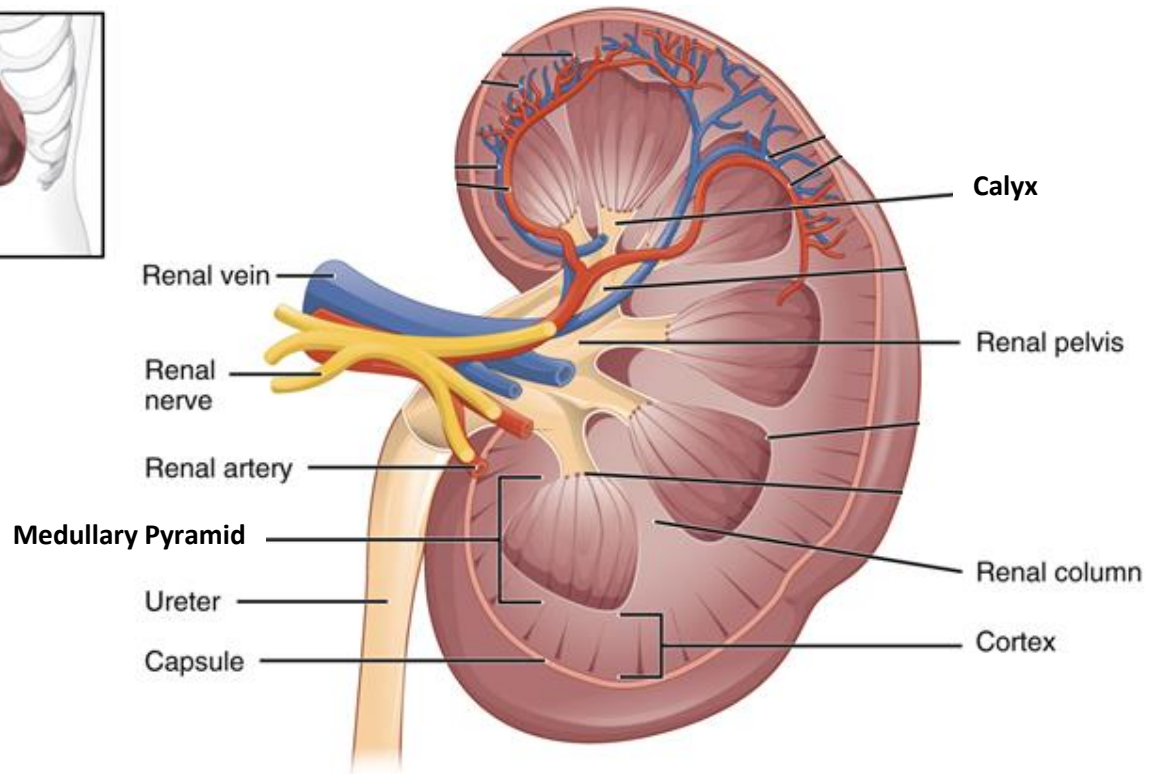
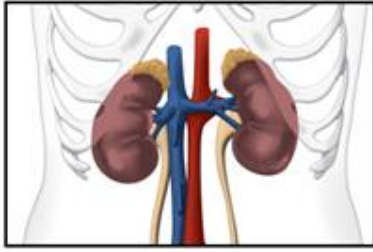
The Excretory System

Function	Structures	Role in Homeostasis
Removal of nitrogenous wastes and other toxins from the blood. Returning the proper amounts of water and other substances to the blood.	<ul style="list-style-type: none">• Kidneys• Ureters• Urinary Bladder	Regulation of the blood's volume and chemical make-up.

Structures of the Excretory System



Kidney Structure



Urine Formation

1. Filtration – water, salts, glucose, urea (nitrogen compounds) and some drugs are filtered from the blood into the kidneys.
-- blood cells and proteins are too large to be filtered out.
2. Reabsorption – water and glucose is reabsorbed back from the kidneys into the bloodstream.
3. Secretion – hydrogen and potassium ions are re-filtered back into the kidneys to adjust blood pH.



Disorders of the Excretory System

Disorder	Cause	Treatment
Urinary Tract Infection (UTI)	Bacteria invade the ureters and bladder	Antibiotics
Renal Failure	The kidneys stop working	Dialysis 3-4 times per week to remove and filter blood
Kidney Stones	Dehydration and build-up of minerals filtered from blood	Pain medication, shock wave therapy, surgery

