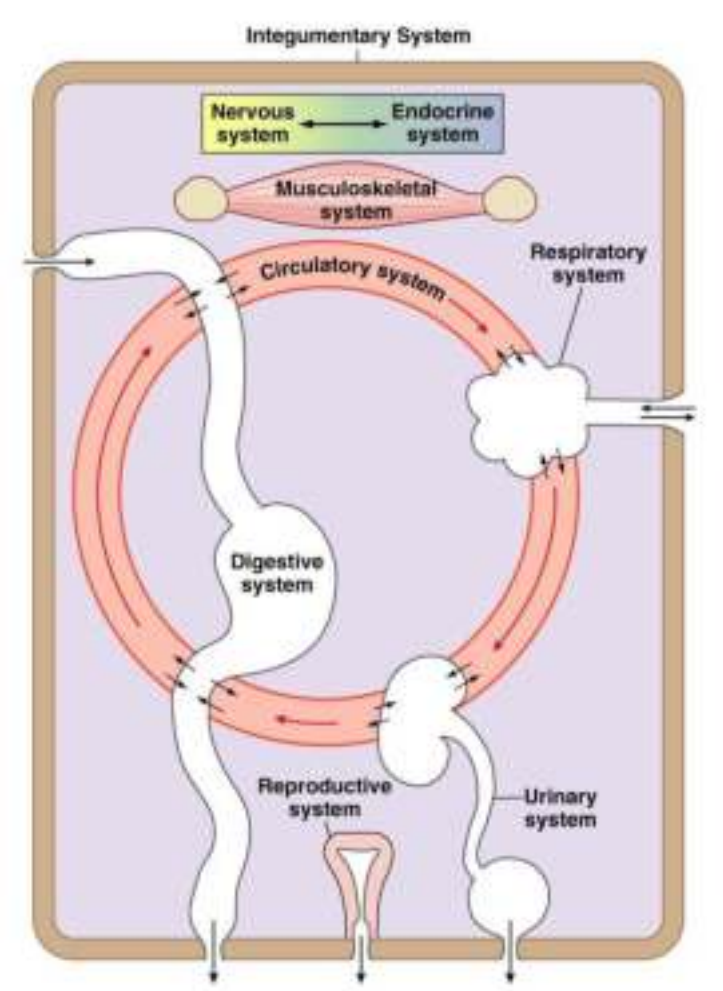
: Digestion

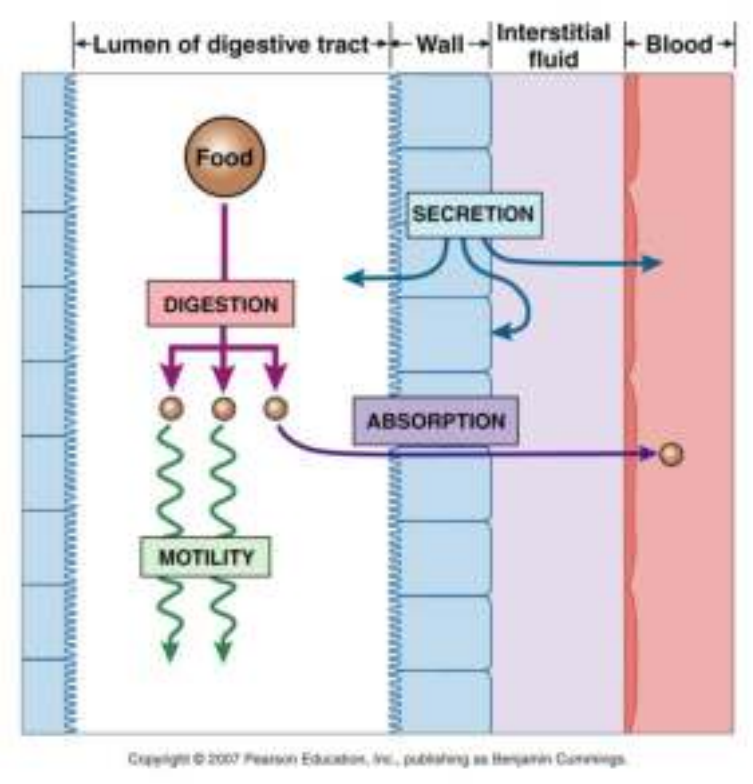
Anatomy of digestive system (review!)

4 major processes of digestive system:

1. Motility
2. Secretion
3. Digestion
4. Absorption

GI Anatomy


Integumentary System
Nervous system
Endocrine system
Musculoskeletal system
Circulatory system
Respiratory system
Digestive system
Reproductive system
Urinary system


Lumen of digestive tract
Wall
Interstitial fluid
Blood
Food
SECRETION
DIGESTION
ABSORPTION
MOTILITY
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Motility

1. Motility
2. Secretion
3. Digestion
4. Absorption

2 purposes:

- Forward movement of food
- Mechanical mixing

GI smooth muscles contract spontaneously

- Pacemaker cells, (Interstitial Cells of Cajal), connected by gap junctions, generate slow wave potentials
- APs spread throughout longitudinal muscles (gap junctions) ⇒ wave of contraction
  - Like cardiac muscle, Ca^{2+} can regulate contraction strength

Different Patterns of Contraction

Tonic Contractions

Sustained contraction, usually in the stomach

Phasic Contractions

Peristaltic contractions

- progressive waves moving along segments of longitudinal layer → forward propulsion
- circular layer contracts proximal to bolus
  - Especially esophagus

Segmental contractions

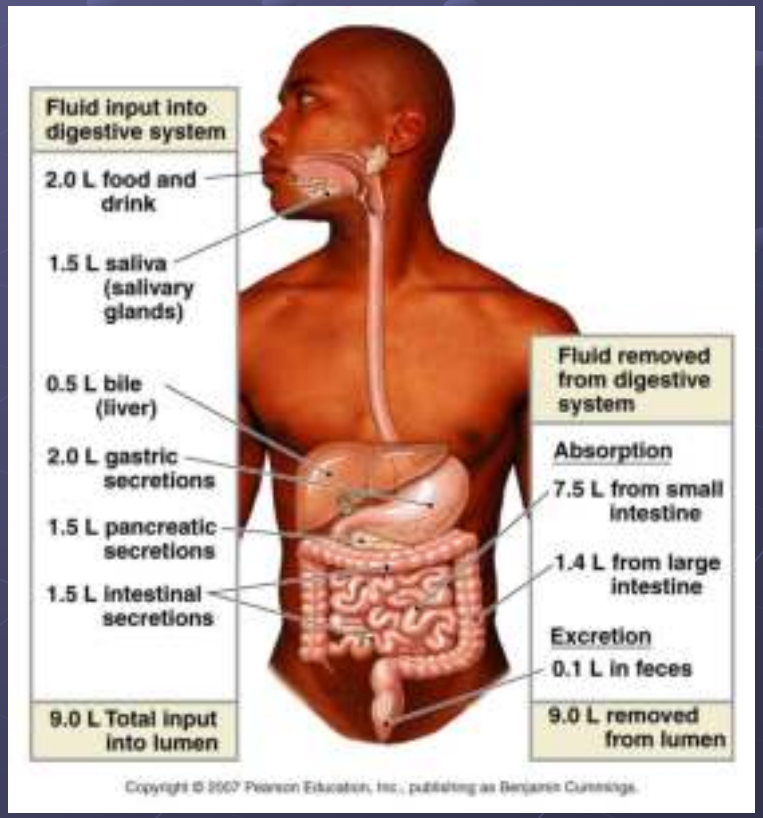
- alternate contraction & relaxation lead to mixing
- A side effect of narcotics

Secretion

1. Motility
2. Secretion
3. Digestion
4. Absorption

- 9 L of fluid pass through the GIT (only 2 L from food & drink) ⇒ Secretion and Reabsorption important
  - Ions and water; similar to renal mechanisms
    - Saliva
  - Hydrochloric Acid (Parietal Cells)
  - **Bicarbonate** (enzyme necessary ?)
  - **Enzymes** (zymogens)
  - **Mucus** (Goblet cells)
  - **Bile** (bile salts – function?)

- Net Fluid Balance in GI system



Regulation of GIT

- ANS
  - Parasympathetic (R & R)
  - Sympathetic
- Emotional (cephalic reflexes)
  - E.g., smell of food
- ENS (Enteric Nervous System)
  - Self-contained (intrinsic)
- GI peptides can have regulatory role as hormones or paracrines
  - E.g., Gastrin, CCK

Digestion Overview

1. Motility
2. Secretion
3. Digestion
4. Absorption

- Mechanical breakdown and mixing aid enzymatic breakdown
  - Chewing
  - Tonic contractions, esp. stomach
- Enzymatic breakdown converts macromolecules into absorbable units
- Bile emulsifies fats
- Optimal pH of enzymes indicates location of activity

Absorption Overview

1. Motility
2. Secretion
3. Digestion
4. Absorption

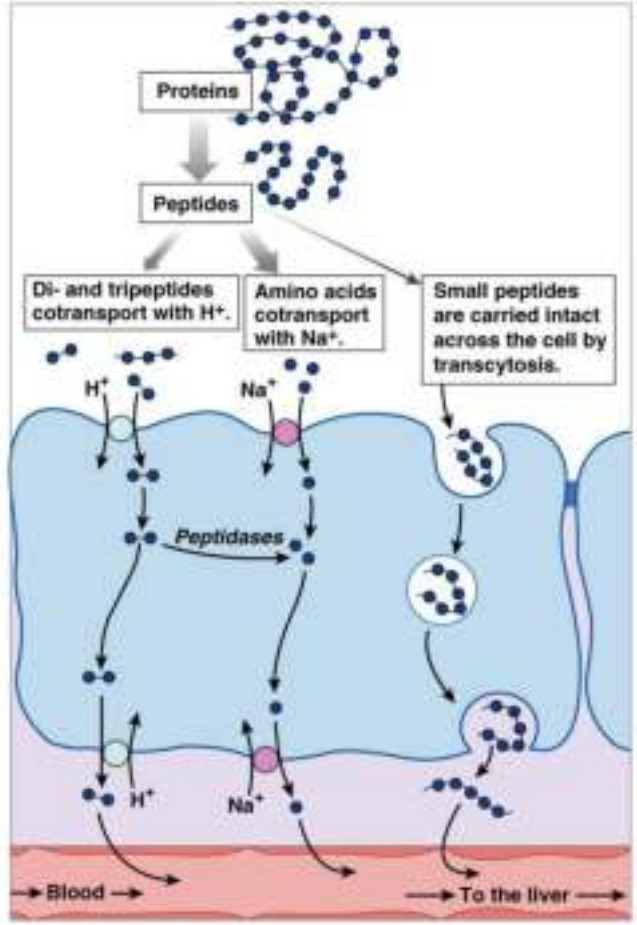
- Most nutrient absorption takes place in ?
  - Fats absorbed into lacteals
  - Everything else absorbed into portal vein
- Alcohol & aspirin across gastric epithelium
- Additional: H_2O, ions & some vitamins absorbed in _____
- Mechanisms analogous to renal absorption

CHO Digestion & Absorption

- ~50% of calories in average American diet
  - Starch (polysaccharide) and sucrose (disaccharide)
  - Cellulose (roughage) not digestible
- Enzymes: amylases, disaccharidases (maltase, sucrase, lactase)
- Absorbed only as monosaccharides (glucose, fructose)
  - Small intestine

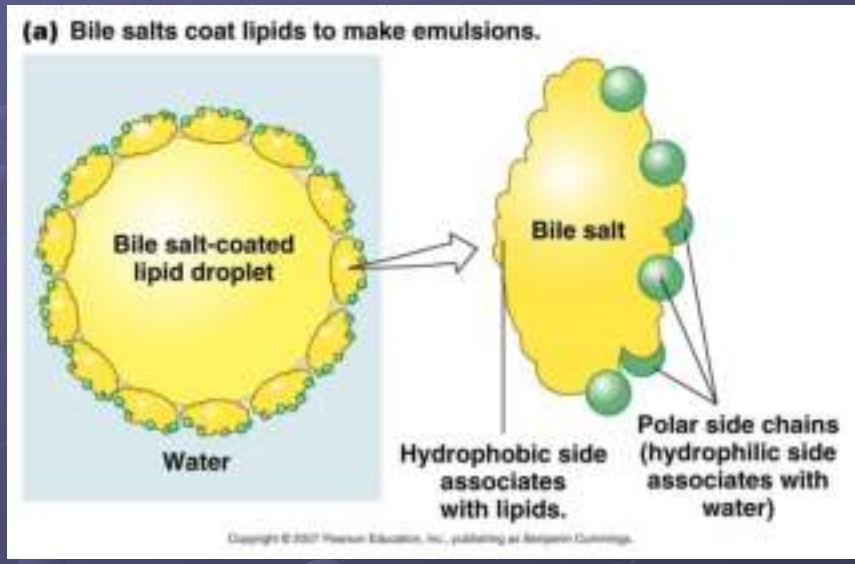
Protein Digestion and Absorption

- Variable digestibility
- 30-60% of protein not from diet
- First digestion in Stomach by HCl
- Proteases secreted as proenzymes
  - Pepsin(-ogen), trypsin, etc.
- Absorption of single a.a. and di- and tripeptides
  - Specific receptors required for larger chains



Lipid (fat) Digestion

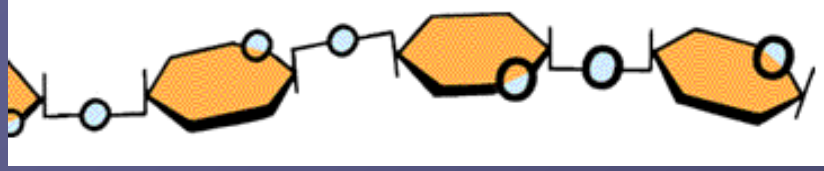
- Mostly triglycerides in diet
  - Cholesterol, Fat-soluble vitamins, others.
- Combination with bile salts creates an emulsion
  - Colipase and lipase allow formation of small micelles
- Absorption of fat via diffusion across apical CM
- Chylomicrons in the cell are absorbed into lacteals



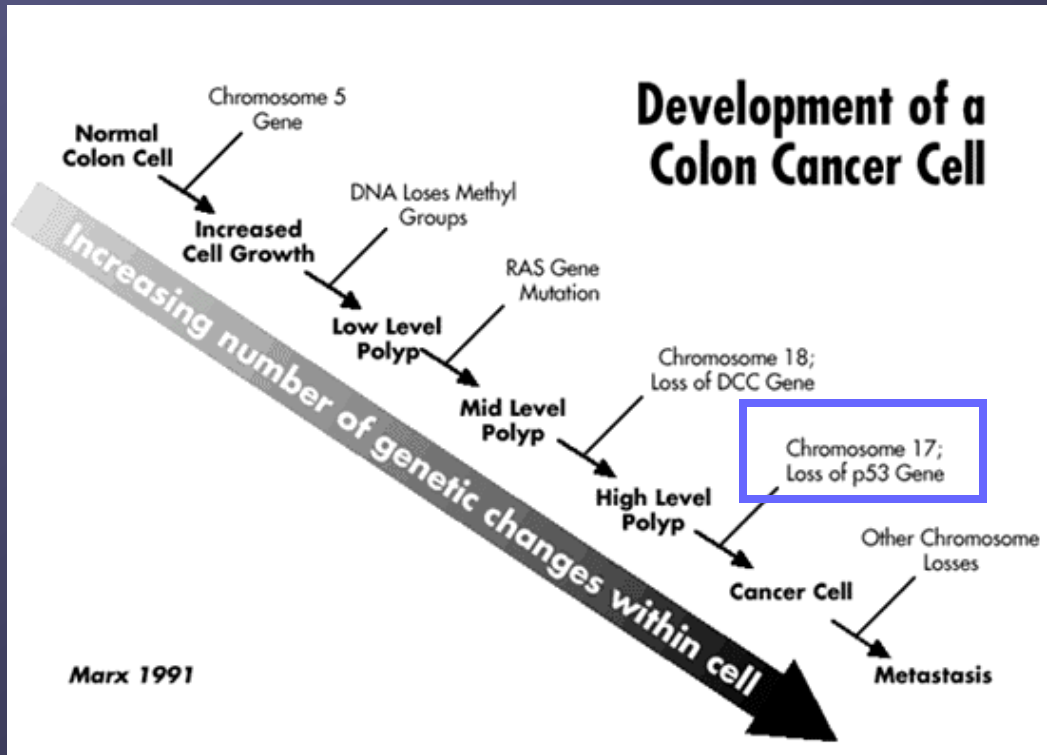
Other Stuff

- Water soluble vitamins—mediated transport
- Fat soluble vits. via absorption
- Water,Ions and Minerals
  - Various locations and methods, e.g, diffusion, carrier proteins
- Nucleic Acids

Colon Cancer



- 2nd largest cause of cancer deaths
- Cellulose (indigestible) = fiber, roughage
- Significance of “roughage” in diet??



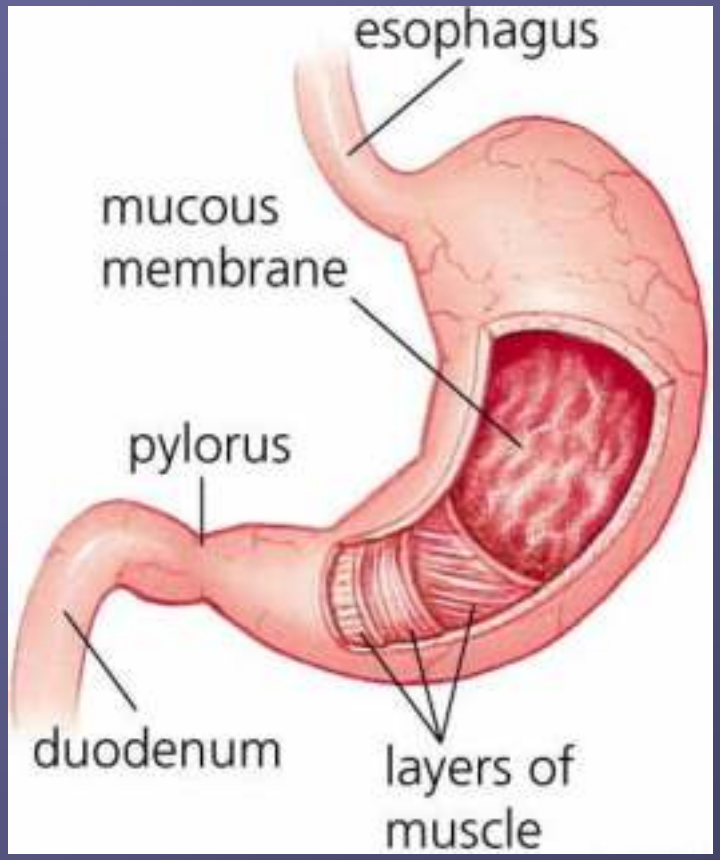
Phases of Digestion/Absorption

1. Cephalic
2. Gastric
3. Intestinal
4. Defecation

1. Cephalic
2. Gastric
3. Intestinal
4. Defecation

- Anticipation
  - Salivation
- Mastication
  - Mechanical digestion
- Deglutition
  - Peristalsis in esophagus

Reflux Esophagitis = Heartburn = GERD



Lower esophageal sphincter dysfunction

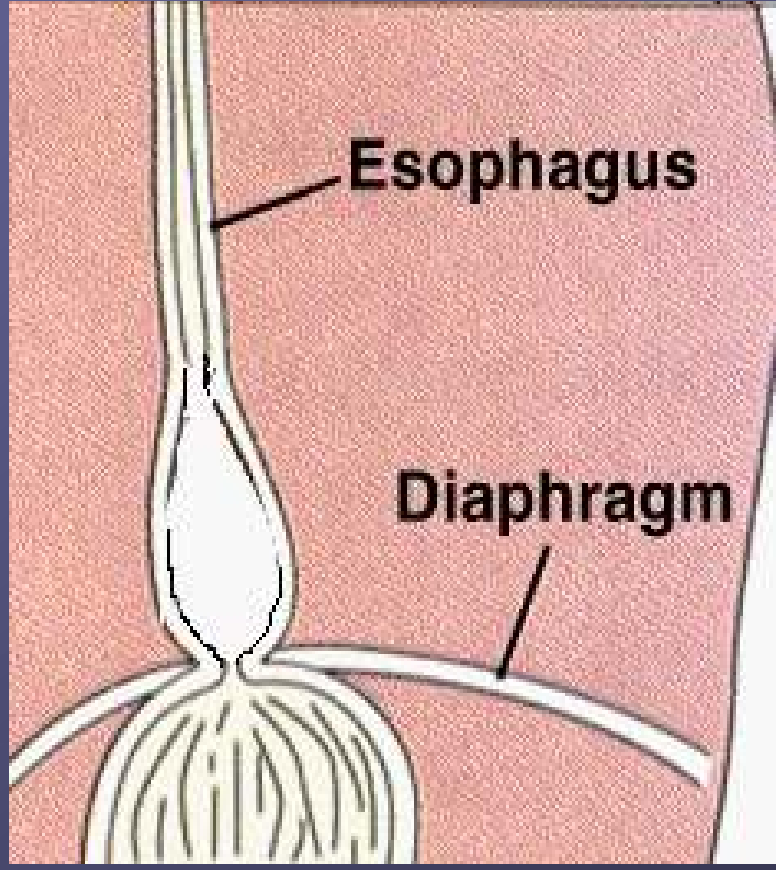
Why reflux against gravity?

GERD, cont'd

1. **Intrapleural pressure ↓ during inspiration**

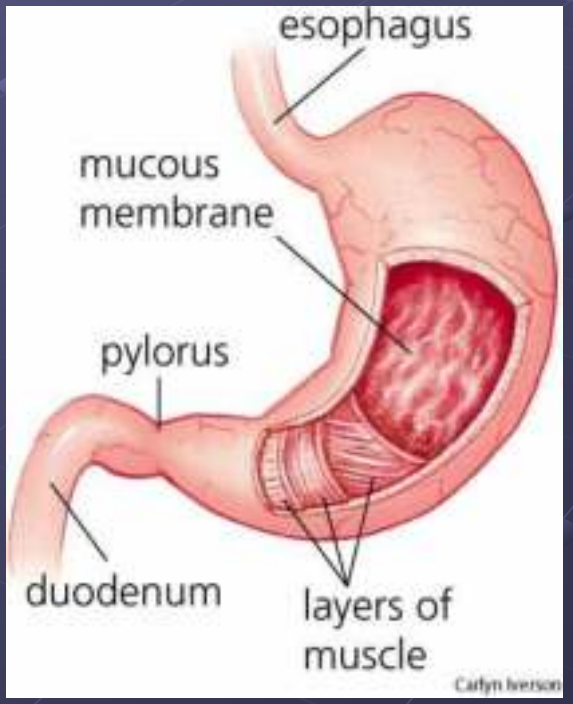
⇒ **Wall of esophagus expands**

⇒ **Subatmospheric pressure in esophageal lumen sucks acidic stomach contents into esophagus**



1. Cephalic
2. Gastric
3. Intestinal
4. Defecation

- Storage
  - Relaxation or contraction as needed.
- Digestion
  - HCl (Parietal cells)
  - Pepsin (Chief cells)
  - Mechanical
- Immune Protection
  - Ingested pathogens
  - Respiratory mucus



1. Cephalic
2. Gastric
3. Intestinal – Chyme (ingesta) enters small intestine
4. Defecation

- Neutralization of HCl
  - $NaHCO_3$ from pancreas
  - Running Problem: Peptic Ulcer and antacids, including H_2 antagonists and proton pump inhibitors
- Pancreatic enzymes
  - Digest protein, CHO
- Bile acids
  - Emulsion of Fat
- Absorption of H_2O

1. Cephalic
2. Gastric
3. Intestinal
4. Defecation

- **Bacterial fermentation of CHO and proteins**
- **Lactate, some vitamins are digested and/or absorbed**
- **More H_2O absorption**
- **Osmotic diarrhea vs. secretory diarrhea**
  - Osmotic-solutes prevent H_2O reabsorption
    - Lactose intolerance
  - Secretory- bacterial toxins ("flush out' pathogens)
  - Defecation Reflex

Lactose Intolerance

- Lactose = glucose + galactose
- Lactase only found in juvenile mammals
- Adaptive (dominant) mutation in populations with dairy-based cultures
- Lactose intolerance in
  - 95% of Native Americans,
  - 90% of Asian Americans
  - 70% of African Americans
  - 50% of Mexican Americans