Ch 21: Digestion

Anatomy of digestive system (review!)

4 major processes of digestive system:
1. Motility
2. Secretion
3. Digestion
4. Absorption
Motility

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) $\Rightarrow$ wave of contraction
  - Like cardiac muscle, Ca$^{2+}$ can regulate contraction strength

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

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

Figure 21-5

1. Motility
2. Secretion
3. Digestion
4. Absorption
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
  - Table 21-1
Digestion Overview

- 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

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

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
~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
    - May serve as allergens (Ch 24)
    - DDAVP
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

See fig 21-19
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?

See p.700
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
  - NaHCO₃ from pancreas
  - Running Problem: Peptic Ulcer and antacids, including H₂ antagonists and proton pump inhibitors
- Pancreatic enzymes
  - Digest protein, CHO
- Bile acids
  - Emulsion of Fat
- Absorption of H₂O
Bacterial fermentation of CHO and proteins
Lactate, some vitamins are digested and/or absorbed
More H₂O absorption

Osmotic diarrhea vs. secretory diarrhea
- Osmotic-solutes prevent H₂O reabsorption
  - Lactose intolerance
- Secretory- bacterial toxins ("flush out' pathogens)
- Defecation Reflex

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

Fig 21-21
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

Clinical focus p. 707