Digestion, Absorption

How & where?
What happens to food?

• **Three** processes
  - Digestion
  - Absorption
  - Elimination

• Where do they occur?
  - GI tract
Overview of Digestion
GI tract

- **Gastrointestinal (GI) tract**: series of organs (essentially sacs) arranged in a long tube
  - Ex: stomach, small intestine
  - Organs separated by circular muscles (sphincters)
How is the GI prepared before each meal?

• Cephalic phase
  – Thinking about food

• Gastric phase
  – Mechanical manipulation of food
Cephalic (Brain) phase

- **Anticipatory phase**
  - Sensations (smell, sight, tactile), plus association of previous meals stimulate MO
  - MO sends signals along nerve fibers to stomach cells
  - Stimulate stomach cells to secrete goodies
    - Positive feedback of gastrin
Digestion begins in mouth

- Chewing - **mechanical** digestion
- Adds saliva - softens and lubricates food
- Salivary **amylase** - **Enzyme** begins **chemical** digestion of carbohydrates
Moves down esophagus

Through the esophageal sphincter
Into Stomach

Longitudinal

Circular

Diagonal

Three layers of muscle
Stomach jobs

• **Mechanical** digestion mixes food with **gastric juice** (highly acidic!)

• **Chemical** digestion of proteins and fats by gastric juices
  - Hydrochloric acid (HCl)
  - Pepsin
  - Gastric lipase

• **Protection** of cells by secreting mucus

• **Absorption**
Stomach cell anatomy

- Heavily infolded; allows stretch
- 4 types cells
  - Mucous: mucus
  - Parietal: HCl & intrinsic factor
  - Chief: pepsinogen
  - Endocrine: regulatory hormones (gastrin)
Stomach secretions

- **Pepsin**: breaks covalent bonds between protein monomers (Amino Acids).
- **HCl**: converts pepsinogen to pepsin; low pH kills microorganisms
- **Intrinsic factor**: binds to vitamin $B_{12}$ to promote absorption in SI
- **Gastrin**: hormone that regulates stomach secretions; influenced by “hunger”
- **Mucus**: lubricates and protects cells from chyme (acidic) & pepsin (protein digesting enzyme)
Gastric phase

- Most secretions
- Promoted by presence of food in stomach
  - Stretching stimulates local & CNS reflexes (receptor type?)
    - Increases HCl & pepsinogen secretion
  - Peptides stimulate additional HCl secretion
More stomach jobs

• *Mix* and churn the digesting mass into **chyme**: semi-solid product of mechanical and chemical digestion

• *Absorb* some $H_2O$, fatty acids and drugs

• *Store* food and *regulate release* to small intestine
To Small Intestine

• Longest part of GI tract
• Three sections: *duodenum, jejunum, ileum*
• Chyme enters through pyloric sphincter
• Chemical digestion continues (most takes place here) using *pancreatic enzymes* and *bile*
Clicker Q

- Why is the stomach separated on both ends by a sphincter?

1. To prevent gastric juice from leaking into and irritating the esophagus
2. To prevent food from leaving the stomach too fast.
3. To prevent gastric juice from leaking into and irritating the small intestine
4. All of the above.
Intestinal phase

- Food entering duodenum inhibits gastric secretions:
  - *Chyme* (pH < 2.0) stimulates secretion of secretin
  - *Lipids* stimulate secretion of Cholecystokinin (CCK) & GIP
  - These signals also stimulate neuronal inhibition locally & via the MO
Show “Three phases of gastric secretion” vid
Small intestine + Accessories

- Bile from the gallbladder emulsifies fat to aid digestion
- Pancreatic lipase digests fats
- Pancreatic amylase digests carbohydrates
- Proteases digest protein
- Bicarbonate secreted by the small intestine neutralizes acidic chyme coming from the stomach into the small intestine
Accessory digestive organs help

- **Liver**: produces & secretes bile, which emulsifies fats
- **Gall bladder**: stores bile
- **Pancreas**: produces & secretes proteinases, lipases, nucleases & amylase
Control of Bile secretion

- **Nervous**: direct stimulation of gall bladder
- **Hormonal**: A “full” duodenum releases:
  - **Secretin** & bile salts: stimulates release of bile (liver) & of bicarbonate (Duodenum & pancreas)
  - **CCK**: stimulates release of bile by gall bladder
Control of pancreatic secretions

• Hormonal
  - Secretin & CCK increases secretion of pancreatic enzymes

• Nervous
  - Direct parasympathetic stimulation increases enzyme secretion
The pH Scale

pH’s of common substances:

14 — Concentrated lye
13 — Oven cleaner
12 — Household ammonia
11 — Baking soda
9 — Bile
8 — Pancreatic juice
7 — Blood
6 — Water
5 — Saliva
4 — Urine
3 — Coffee
2 — Orange juice
1 — Vinegar
0 — Lemon juice
— Gastric juice
— Battery acid

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Small intestine 
*digests and absorbs*

- **Absorption**: the process of moving molecules across a cell membrane and into a cell
  - Small amount of absorption occurs in the stomach
  - Most absorption of nutrients occurs in the *small intestines*