I. **Announcements** Dr. Bovee feedback due < 5 pm today. Outline + Quiz 1 update? Quiz Key posted near lab. **NB:** Group member feedback. Next T Lab *Nutritional Analyses.* Record diet ≥ 2 d to analyze w/ *DietController*!

II. **Addiction Medicine Follow-up** Opioid overdose + Narcan story/ies! Vaping linked to host of new health risks.

III. **Nutritional Physiology** Zuti & Golding, Diet vs. Exercise historical research! Estimating food & liquid quantities.

IV. **Gastrointestinal Physiology** G&H ch 63, 64, 65, 66 + LS2
   A. Digestion overview + alimentary tract fig 63-1
   B. Gut cross section, histology + plexi fig 63-2
   C. Secretions + phases tab 65-1, fig 65-7
   D. **Hydrolysis:** Central theme of digestion ch 66 p 833-42
      1. Carbohydrate fig 66-1
      2. Fat fig 66-3, fig 66-4
      3. Protein fig 66-2

Heck yeah! Nutrition Lab on Tuesday! Move more, eat smart, weigh less!
WOW!  SUPER

~ TOP 5 - 10 ~

EXCELLENT!!

~ TOP 15 ~

GREAT EFFORT

~ TOP 20 - 25 ~
Vaping Linked to Host of New Health Risks

https://www.sciencenewsforstudents.org/article/vaping-may-threaten-brain-immunity-and-more
https://www.sciencenews.org/article/vaping-linked-host-new-health-risks
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5493817/
Vaping of E-cigarettes

- Nicotine
  - Nicotine (80-70% Vaporized)
- Solvent Decomposition
  - Toxic Metals
  - Organic Compounds
- Flavoring Additives
  - Vanillin, Ethyl Maltol, Ethyl Vanillin, Menthol etc.

Oxidative Stress

- Pulmonary Diseases (i.e. COPD)
- Cardiovascular Diseases
- Neurodegenerative Disorders (i.e. Alzheimer's)
- Cancer

4 oz → 3 oz

≡ 1 c

or

≡ 1/3 c

raw → cooked

≡ 1 oz

equiv

≡ ¼ c

≡ 1.5 oz

Deck of Cards

≡

Pumpkin Show at Night

There are 100,000+ lbs of pumpkins, squash and gourds on the street display.

NB: Each group 500 kcal deficit/day, 16 weeks
Exercise is better than dieting for lowering body fat & preserving muscles!
Dietary Composition & Physical Endurance

eg, Atkins!

High-fat diet

Normal mixed diet

High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:

57 min

114 min

167 min
Tedium of Metabolic Lab & Dietary Research
Record diet for ≥ 2 d!
No need to purchase software, as we have on computers in lab!
http://www.dietcontroller.com/
**Digestion Steps**

1. Ingestion
2. Mechanical Digestion
3. Chemical Digestion
4. Peristalsis
5. Absorption
6. Storage
7. Defecation

GI-Doughnut Analogy

GI Lumen

Body

Me ?
GI Regulation

1. Local/Intrinsic
2. Nervous
3. Hormonal

rapid

Slower, but longer lasting!

autoregulation

extrinsic
Star: Myenteric motor plexus!

Star: Meissner's sensory & secretory plexus!

Localization:

- Muscularis Externa
- Epithelium
- Serosa
- Submucosa
- Lumen
- Lamina Propria
- Longitudinal Muscle
- Circular Muscle
- Glands

See: G&H 2011 fig 62-2, G&H 2016 fig 63-2

H Howard 1990
Parasympathetic Branch Activates the Gut!

NERVOUS

G&H 2011 fig 60-3 p 731
G&H 2016 fig 61-3 p 775
What about feedback for hunger-satiety?

Ghrelin (stomach fundus, pancreas, …)
Leptin (adipocytes)

Gastrin $\rightarrow$ HCl, Pepsinogen by stomach

Motilin $\rightarrow$ ↑ Motility

Secretin $\rightarrow$ HCO$_3^-$, H$_2$O by pancreas

Cholecystokinin $\rightarrow$ Gallbladder contraction + Pancreatic enzymes

↓ Motility $\leftrightarrow$ GIP

↑ Insulin

↓ Motility $\leftrightarrow$ GLP-1

↑ Insulin

↑ Cl$^-$ $\leftrightarrow$ Guanylin

↑ NaCl + H$_2$O in feces

↓ Motility $\leftrightarrow$ GIP

↑ Insulin

↑ Cl$^-$ $\leftrightarrow$ Guanylin

↑ NaCl + H$_2$O in feces

G&H 2011 tab 62-1 p 758
G&H 2016 tab 63-1 p 802
**FIGURE 15-6**

**Peristalsis in the esophagus.** As the wave of peristaltic contraction sweeps down the esophagus, it pushes the bolus ahead of it toward the stomach.

For an animation of this figure, click the Gastrointestinal Motility tab in the Gastrointestinal Physiology tutorial on the CD-ROM.

Ringlike peristaltic contraction sweeping down the esophagus

---

LS2 2006; cf: G&H 2011 fig 62-5, G&H fig 2016 fig 63-5
# Gut Secretions

<table>
<thead>
<tr>
<th>Secretion</th>
<th>Release Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mucus</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>2. Enzymes</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>3. H₂O, acids, bases+</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>4. Hormones</td>
<td>into Blood</td>
</tr>
<tr>
<td></td>
<td>Daily Volume (ml)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Saliva</td>
<td>1000</td>
</tr>
<tr>
<td>Gastric secretion</td>
<td>1500</td>
</tr>
<tr>
<td>Pancreatic secretion</td>
<td>1000</td>
</tr>
<tr>
<td>Bile</td>
<td>1000</td>
</tr>
<tr>
<td>Small intestine secretion</td>
<td>1800</td>
</tr>
<tr>
<td>Brunner’s gland secretion</td>
<td>200</td>
</tr>
<tr>
<td>Large intestinal secretion</td>
<td>200</td>
</tr>
<tr>
<td>Total</td>
<td>6700</td>
</tr>
</tbody>
</table>

G&H 2011 tab 64-1 p 775, G&H 2016 tab 65-1 p 819
Figure 64-7 Phases of gastric secretion & their regulation. G&H 2011 fig 64-7 p 780, G&H 2016 fig 65-7 p 824.
Hi gang!!
You need me for digestion!!

\[ H_2O + \text{Enzyme} \]
Polymer to Monomer
(Many to One)

Carbohydrate → Glucose
Protein + Fat → Amino Acids
Amino Acids → Fatty Acids + Glycerol

...Central-linking theme, again!!
Disaccharide

Maltose + Water → Glucose + Glucose

Monosaccharides

Peptide

(portion of protein molecule)

+ Water → Amino acid + Amino acid

Fat + Water → Fatty acids + Glycerol

cf: G&H 2011 pp 789-93, G&H 2016 p 833-7
Carbohydrate Digestion = 1° Energy Nutrient

- Starches
  - Ptyalin (saliva) – 20–40%
  - Pancreatic amylase – 50–80%
- Maltose and 3 to 9 glucose polymers
  - Maltase and α-dextrinase (intestine)
- Glucose
- Lactose
  - Lactase (intestine)
- Galactose
- Sucrose
  - Sucrase (intestine)
- Fructose

G&H 2011 fig 65-1 p 790
G&H 2016 fig 66-1 p 834
Why Do Some People Have Trouble Digesting Milk?

- Ability to digest milk carbohydrates varies
  - Lactase
    - Made by small intestine
- Symptoms of intolerance
  - Gas, diarrhea, pain, nausea?
- Milk allergy?
- Nutritional consequences
- Milk tolerance and strategies
HIGH FAT FOODS

An LDL to HDL ratio greater than 5 to 1 in men or 4.5 to 1 in women

Increased risk of heart disease
Fat Digestion = $2^0$ Energy Nutrient

Fat $\xrightarrow{(Bile + Agitation)}$ Emulsified fat

Emulsified fat $\xrightarrow{Pancreatic lipase}$ Fatty acids and 2-monoglycerides

G&H 2011 fig 65-4 p 792
G&H 2016 fig 66-4 p 836
HIGH PROTEIN (FAT?) FOODS?
Where does enzymatic digestion of protein begin?
Zymogen = inactive precursor

LS2 2006
G&H 2011
fig 64-4
G&H 2016
fig 65-4
Protein Digestion = \(3^0\) Energy Nutrient

Proteins → Pepsin → Proteases, Peptones, Polypeptides

Trypsin, chymotrypsin, carboxyprleptidase, proelastase

Polypeptides + Amino acids → Peptidases → Amino acids

G&H 2011 fig 65-2 p 791
What is the major function of the small intestine?

Absorption!!
Brush border

Pinocytic vesicles

Endoplasmic reticulum

Mitochondria
A
- Central lacteal
- Blood capillaries
- Vein
- Artery

B
- Brush border
- Basement membrane
- Venules
- Arteriole
- Central lacteal
- Capillaries

G&H 2011 fig 65-6, G&H fig 66-6
Why is the pancreas so unique?
Enzymes specific for all 3 energy nutrients!

Duct cells secrete aqueous NaHCO₃ solution
Acinar cells secrete digestive enzymes

Exocrine portion of pancreas (Acinar and duct cells)

Endocrine portion of pancreas (Islets of Langerhans)

Hormones (insulin, glucagon)

Blood

The glandular portions of the pancreas are grossly exaggerated.
Poor motility causes greater absorption, and hard feces in transverse colon causes constipation.

Excess motility causes less absorption and diarrhea or loose feces.

cf: G&H 2011 fig 63-5, G&H fig 64-5
Questions + Discussion