Announcements
Dr. Bovee feedback due < 5 pm today. Outline + Quiz 1 update? Quiz Key posted near lab. Next T Nutritional Analyses. Record diet ≥ 1 d DLN p 4-6

Addiction Medicine Follow-up
Vaping linked to host of new health risks. ETOH dependence-endocannabinoid link?

Nutritional Physiology in the News

Metabolic Lab Research cf: Dietary Intake Estimation

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 65-1, 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
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
ETOH Dependence + Link to Endocannabinoids?

Suspect Genes?
Dopaminergic Receptor DA D2
ETOH Dehydrogenase
Aldehyde Dehydrogenase
Fatty Acid Amide Hydrolase (FAAH)
G- vs A-allele μ-Opioid Receptor (OPRM 1)
Cation Transport & Synaptic Transmission

e.g., Delete Gene for FAAH or Block FAAH Action by URB597 (KDS4103)

1. ↑ Preference for ETOH
2. ↑ Sensitivity to ETOH Sedation
3. ↑ Recovery from ETOH Motor Incoordination

Metabolizes Anandamide + Δ 9-THC
Anandamide Deficient → Anxiety

e.g., G- vs A-Allele for OPRM 1
1. ↑ Feelings of Intoxication/Sedation
2. ↑ Happiness/Euphoria
3. Naltrexone more effective in patients with G-allele?

http://www.ncbi.nlm.nih.gov/pubmed/26756798
Ask people what they ate yesterday or even today, and the odds are that they’ll underestimate the amount. This discrepancy is called the eye-mouth gap.

One study found that some obese people actually ate twice as much as they reported. Research has shown that perhaps 80% of us – even lean and athletic people – underestimate our food intake.
Adults underestimate, on average, their daily intakes by 800 calories. > 1 ½ lb per wk!!

They overestimate intakes of fruit & dairy products, but underestimate amounts of sweets, refined grains, oils, and other fats they eat.

Misreporting is seldom a deliberate deception – it’s likely an unconscious response perhaps to social & family pressure, combined with wishful thinking.

People don’t know how much food they put on their plates.
If you’re trying to lose weight or improve your diet, don’t trust your eyes.

Weigh or measure the food you eat to get a good sense of how much you’re really eating.

Lombo editorial comments:
1. Train yourself to make good guesses/estimates rather than weigh everything.
2. Train yourself…that is…Exercise! Exercise!! Exercise!!!
4 oz $\rightarrow$ 3 oz

Deck of Cards

or

1 c

raw $\rightarrow$ cooked

1/3 c

1 oz

1.5 oz

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

- **High-fat diet**
- **Normal mixed diet**
- **High-carbohydrate diet**

eg, Atkins!

~ 1/3 endurance!

Maximum endurance time:
- 57 min
- 114 min
- 167 min
Tedium of Metabolic Lab & Dietary Research
Discussion/Lab 4: Nutritional Analyses via 2 Programs

ChooseMyPlate.gov

In Lab!

https://www.supertracker.usda.gov/

http://www.dietcontroller.com/
Digestion Steps

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

GI Regulation

1. Local/Intrinsic
2. Nervous
3. Hormonal

rapid

Slower, but longer lasting!

autoregulation
extrinsic
Muscularis Externa
Glands
Serosa
Epithelium
Submucosa
Lumen
Lamina Propria
Longitudinal Muscle
Circular Muscle
Meissner’s sensory & secretory plexus!
H Howard 1990

\textbf{LOCAL}

\textbf{Myenteric motor plexus!}

\textit{cf:} G&H 2011 fig 62-2, G&H 2016 fig 63-2
Parasympathetic Branch Activates the Gut!

NERVOUS

Ciliary ganglion
Ciliary muscles of eye
Pupillary sphincter
Sphenopalatine ganglion
Lacrimal glands
Nasal glands
Submandibular ganglion
Submandibular gland
Otic ganglion
Parotid gland
Heart
Stomach
Pylorus
Colon
Small intestine
Ileocecal valve
Anal sphincter
Bladder
Detrusor
Trigone

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)

Motility  ← GIP
↓ Motility  ← GLP-1
↑ Insulin
↑ Insulin

↑ Cl-  ← Guanylin
↑ NaCl + H₂O in feces

Motilin  → ↑ Motility
Secretin  → HCO₃⁻, H₂O by pancreas

Gastrin  → HCl, Pepsinogen by stomach

Cholecystokinin  → Gallbladder contraction + Pancreatic enzymes

G&H 2011 tab 62-1 p 758
G&H 2016 tab 63-1 p 802
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.
# 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>
</tbody>
</table>
# Table 64-1 Daily Secretion of Intestinal Juices

<table>
<thead>
<tr>
<th></th>
<th>Daily Volume (ml)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saliva</td>
<td>1000</td>
<td>6.0-7.0</td>
</tr>
<tr>
<td>Gastric secretion</td>
<td>1500</td>
<td>1.0-3.5</td>
</tr>
<tr>
<td>Pancreatic secretion</td>
<td>1000</td>
<td>8.0-8.3</td>
</tr>
<tr>
<td>Bile</td>
<td>1000</td>
<td>7.8</td>
</tr>
<tr>
<td>Small intestine secretion</td>
<td>1800</td>
<td>7.5-8.0</td>
</tr>
<tr>
<td>Brunner’s gland secretion</td>
<td>200</td>
<td>8.0-8.9</td>
</tr>
<tr>
<td>Large intestinal secretion</td>
<td>200</td>
<td>7.5-8.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6700</strong></td>
<td></td>
</tr>
</tbody>
</table>
Figure 64-1 Typical function of a glandular cell for formation and secretion of enzymes and other secretory substances.

G&H 2011 fig 64-1 p 774, G&H 2016 fig 65-1 p 818
Figure 64-2  Formation and secretion of saliva by a submandibular salivary gland.
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!!

H₂O + Enzyme

Hydrolysis of Energy Nutrients

...Central-linking theme!!
Polymer to Monomer (Many to One)

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

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

Monosaccharides

Peptide (portion of protein molecule)

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
- Sucrose
  - Sucrase (intestine)

- Glucose
- Lactose
  - Lactase (intestine)
- Galactose
- 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 increases the risk of heart disease.
Fat Digestion = \(2^0\) Energy Nutrient

Fat \(\rightarrow\) (Bile + Agitation) \(\rightarrow\) Emulsified fat

Emulsified fat \(\rightarrow\) Pancreatic lipase \(\rightarrow\) 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

Autocatalysis

Pepsinogen → Pepsin

Digestion

Protein → Peptide fragments

Gastric lumen

HCl

Various amino acids

Enzymatic splitting of a chemical bond

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

Proteins $\xrightarrow{Pepsin} \left[\text{Proteoses, Peptones, Polypeptides}\right]$  
$\xleftarrow{\text{Trypsin, chymotrypsin, carboxypolypeptidase, proelastase}} \left[\text{Polypeptides, Amino acids}\right] \xrightarrow{\text{Peptidases}} \text{Amino acids}$
What is the major function of the small intestine?

Absorption!!
Brush border

Pinocytic vesicles

Endoplasmic reticulum

Mitochondria
Why is the pancreas so unique?
Enzymes specific for all 3 energy nutrients!
Poor motility causes greater absorption, and hard feces in transverse colon causes constipation.

Excess motility causes less absorption and diarrhea or loose feces.
Questions + Discussion