Announcements Outline & Quiz 1 update? Quiz Key will be posted in the glass box near 112 HUE. MU Quiz? Next T 
Nutritional Analyses; Record your diet ≥ 1 d on DLN p 4-8.

Addiction Medicine Follow-up CB1 & CB2 receptors & immunity? ETOH dependence-endocannabinoids? Anxiety?


Metabolic Lab Research cf: Dietary Intake Estimation

Gastrointestinal Physiology G&H ch 62, 63, 64, 65 + LS2
A. Digestion overview + alimentary tract fig 62-1 p 753-4
B. Gut cross section, histology + plexi fig 62-2 pp 754-9
C. Secretions+phases tab 64-1, fig 64-1,64-2,64-7 pp 775-87
D. Hydrolysis: Central theme of digestion ch 65 p 789-93
   1. Carbohydrate fig 65-1 p 790
   2. Fat fig 65-3 p 791, fig 65-4 p 792
   3. Protein fig 65-2 p 791
WOW! SUPER 😊
~ TOP 5-10

EXCELLENT!!
~ TOP 15

GREAT EFFORT
~ TOP 20-25
**Endocannabinoid Receptors**

CB-1
- Brain Structures
- Controlling Energy Intake
  (e.g., Hypothalamic Hunger-Satiety Center)

CB-2
- Leukocytes/WBCs
- Immune & Inflammatory Reactions
  (e.g., Lymphocytes & Macrophages)

Endocannabinoid hyperactivity

Metabolic & Eating Disorders
1. Abdominal Obesity
2. Dyslipidemia
3. Hyperglycemia

http://www.jimmunol.org/content/165/1/373.full?ijkey=YriEsKcvAs2z
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

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

Metabolizes Anandamide + Δ9-THC
Anandamide Deficient → Anxiety

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?

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 – under-estimate 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.
The Eye-Mouth Gap Bottom Line

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

equiv $\equiv$ 1 c

raw $\rightarrow$ cooked

equiv $\equiv$ 1/3 c

equiv $\equiv$ 1 oz

equiv $\equiv$ 1/4 c

equiv $\equiv$ 1.5 oz

NB: Each group 500 kcal deficit/day, 16 weeks
Compared to dieting, exercise is superior in inducing % body fat reduction & preserving lean body mass!
Dietary Composition & Physical Endurance

- eg, Atkins!

- High-fat diet: ~1/3 endurance!
- Normal mixed diet
- High-carbohydrate diet

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

ChooseMyPlate.gov

Diet Analysis+

- The Most Extensive Database Ever provides over 20,000 easy-to-find foods, including most common foods, popular brands, regional favorites, international foods, and vegetarian options.
- "How Big Is a Serving?" Tips, based on the MyPyramid recommendations, are linked on the screen where students need help.
- Trans fats include the most up-to-date information available, and are displayed in all reports.
- MyPyramid values include the latest USDA updates, and show actual intake in all categories, including Discretionary calories.
- The 3-Day Average Wizard lets you print the most common assignment in one step.
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
   - rapid
3. Hormonal
   - Slower, but longer lasting!

autoregulation → extrinsic
Muscularis Externa
Glands
Epithelium
Submucosa
Lumen
Lamina Propria
Serosa

Myenteric motor plexus!
Meissner’s sensory & secretory plexus!

cf: G&H fig 62-2
H Howard 1990
Parasympathetic Branch Activates the Gut!

- Ciliary ganglion
- Ciliary muscles of eye
- Pupillary sphincter
- Sphenopalatine ganglion
- Lacrimal glands
- Nasal glands
- Submandibular ganglion
- Submandibular gland
- Otic ganglion
- Parotid gland

NERVOUS

Heart

Stomach

Pylorus

Colon

Small intestine

Ileocecal valve

Anal sphincter

Bladder

Detrusor

Trigone

G&H 2011 fig 60-3 p 731
Cholecystokinin → Gallbladder contraction + Pancreatic enzymes

↓ Motility

↑ Insulin

Motility ← GIP

↓ Motility

↑ Insulin

Motilin → ↑ Motility

Secretin → HCO₃⁻, H₂O

by pancreas

↑ Cl⁻ ← Guanylin

↑ NaCl + H₂O in feces

Gastrin → HCl, Pepsinogen

by stomach

↓ Motility

GIP

↑ Insulin

GLP-1

↑ Insulin

↑ Cl⁻

↑ NaCl + H₂O in feces

What about feedback for hunger-satiety?

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

Suspense – until next time!
**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.
# 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>Secretion Type</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>Total</td>
<td>6700</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.
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 p 780.
Hi gang!!
You need me for digestion!!

H₂O + Enzyme

Hydrolysis of Energy Nutrients

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

Carbohydrate

Protein + Fat

Fat

Protein

Glucose

Amino Acids

Fatty Acids + Glycerol

…Central-linking theme, again!!
Carbohydrate Digestion = $1^0$ Energy Nutrient
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
LIPID MEMBRANE MAINTENANCE
FLAVOR AROMA SATIETY
LIPID INSULATION PADDING
LIPID CARRIERS
FAT SOLUBLE VITAMIN
Fat Digestion = $2^0$ Energy Nutrient

\[
\text{Fat} \xrightarrow{(\text{Bile + Agitation})} \text{Emulsified fat} \\
\text{Emulsified fat} \xrightarrow{\text{Pancreatic lipase}} \text{Fatty acids and 2-monoglycerides}
\]
HIGH PROTEIN (FAT?) FOODS?
Where does enzymatic digestion of protein begin?
Zymogen = inactive precursor
Protein Digestion = $3^0$ Energy Nutrient

Proteins $\xrightarrow{Pepsin} \begin{bmatrix} \text{Proteoses} \\ \text{Peptones} \\ \text{Polypeptides} \end{bmatrix}$

$\begin{bmatrix} \text{Trypsin, chymotrypsin, carboxypolypeptidase,} \\ \text{proelastase} \end{bmatrix}$

$\begin{bmatrix} \text{Polypeptides} \\ + \\ \text{Amino acids} \end{bmatrix} \xrightarrow{\text{Peptidases}} \text{Amino acids}$

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
Why is the pancreas so unique?
Enzymes specific for all 3 energy nutrients!

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.
Questions
Discussion?