BI 121 Lecture 6

I. **Announcements** Data + Flashdrive for today’s lab! Q?

If you want notebook to study for Exam I on Oct 25th, turn in prior lecture next Tuesday, Oct 18th. Sample Exam Q.

II. **Nutritional Physiology in the News** Pondering Paleo Nutrition Action Health Letter, Marlene Zuk, U Minnesota + Shake the salt habit! UC Berkeley Newsletter. → Drink Your Calories? PEBB Identifying Nutrition Quackery, Kleiner & Monaco

III. **Nutrition Connections** DC Mod 2, Sizer & Whitney (S&W) Sci Lib

A. Diet & endurance? What’s the best path to losing weight?
B. Low-carbohydrate dieting? What about fasting?
C. Balanced approach, Dr. Sacks AHA NPAM Council

IV. **Gastrointestinal Physiology** DC Module 3 pp 17-23, LS ch 15+

B. How is the gut controlled?
C. Organ-by-organ review A&P LS tab 15-1 pp 440-1 +...
D. Zymogen? = Inactive precursor LS fig 15-9 p 452...
G. Large intestine? LS fig 15-24 pp 472-4
Lab 3: Nutritional Analyses via 2 Programs

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

In Lab Today!
Sample 1. What is human physiology? (+2) How does it differ from human anatomy? (+2)

Sample 2. Give 2 examples of when positive feedback may occur normally in the human body. (+4)

Sample 3. Cells are progressively organized into
  a. organs, systems, tissues, then the whole body
  b. tissues, organs, systems, then the whole body
  c. systems, tissues, organs, then the whole body
  d. None of the above are correct.
Pondering Paleo?

Evolutionary Biologist
Behavioral Ecologist
U Minnesota

http://www.nutritionaction.com/daily/how-to-diet/pondering-paleo/
More Reasons to Shake the Salt Habit

① blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+!
② Ca²⁺ excretion ↑ bone loss, risk of osteoporosis & fractures.
③ May directly impair kidney function & ↑ risk of kidney stones.
④ GI cancer risk, inflammation?

UCB Wellness Letter Jun 2011 p 5
Macronutrients & Micronutrients
Essential for Life

**Macronutrients**

- **H₂O/Water**
- **1° Carbohydrates**
- **2° Fats/Triglycerides/Lipids**
- **3° Proteins**

**Sample Food Sources**

- **Water, other drinks, fruits & vegetables**
- **Grains, vegetables, fruits, dairy products**
- **Meats, full-fat dairy products, oils**
- **Meats, legumes, dairy vegetables**

**Micronutrients**

- **Vitamins (A, D, E, K; C + B)**
- **Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺, Fe²⁺, Zn²⁺, …)**

**NB: Need only minute quantities!**

- **Vegetables, vegetable oils, fruits, citrus, grains, dairy**
- **Fruits, vegetables, grains, nuts, dairy, meats, processed foods**

**Energy nutrients = yield ATP**
US Modifications to 1992 Food Pyramid 2005

Fats, oils, and sweets
Use sparingly

Milk, yogurt, and cheese group
2-3 servings

Vegetable group
3-5 servings

Meat, poultry, fish, dry beans, eggs, and nuts group
2-3 servings

Fruit group
2-4 servings

Bread, rice, pasta group
6-11 servings

KEY
- Fat (naturally occurring and added)
- Sugars (added)

“good” fats!
saturated & trans fats!
3 or more!
5 or more!
e.g. fish, nuts
4 or more!
1/2 whole grain

Regular Physical Activity: Exercise! Exercise!!
Dietary Guidelines for Americans 2005
Food Guidance System

1. ↑ emphasis on ↓ kcal + ↑ exercise.
2. 9-A-Day! 4 fruit + 5 vegetable servings.
3. > 3 of 6 whole grains → ½ whole grains!
4. 3 servings of dairy, eg 3 c fat-free milk.
5. ↓ saturated + trans fats + ↑ unsaturated/
   “good” fats, eg Ω-3 fish, walnuts.
6. Drink in moderation if at all.
7. Practice food safety.
2. **Focus on fruits.** Whole fruit preferable to juice, but any fruit counts! Fill ½ your plate with fruits & vegetables!

3. **Make at least ½ of your grains whole grains!**

4. **Go lean with protein.** Keep protein to < ¼ plate! Nuts, beans, peas, seeds, poultry, lean meat, seafood,…

5. **Get your calcium-rich foods.** Buy skim or 1% milk. Go easy on cheese!

MyPlate launched June 2, 2011

1. **Vary your veggies.** Fill ½ your plate with fruits & vegetables!
Diet & Health Guidelines for Cancer Prevention

1. Choose a diet rich in variety of plant-based foods.
2. Eat plenty of vegetables & fruits.
3. Maintain a healthy weight & be physically active.
4. Drink alcohol only in moderation, if at all.
5. Select foods low in fat & salt.

And always, remember...

Do not smoke or use tobacco in any form.

American Institute for Cancer Research (AICR)
Your plate should be the size of a Frisbee, not a manhole cover.

When it comes to colorful foods, Fruit Loops don’t count.

A surprising number of people get 1/5 of their calories from sodas or other liquids.

If you look at the label & need a chemistry degree to read it, put the item back on the shelf!

5 times per wk? $\equiv 106,600$ calories/yr $\equiv \pm 30.5$ lb fat/yr

Better choices!

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

eg, Atkins! ~ 1/3 endurance!

Maximum endurance time:
- 57 min
- 114 min
- 167 min

High-fat diet
Normal mixed diet
High-carbohydrate diet
Negative Effects of Low Carbohydrate

1. ↑ fatigue/exhaustion central & peripheral!
2. ↓ glucose – brain+spinal cord, rbcs thrive upon.
3. ↓ variety which reduces intake of phytochemicals, vitamins, minerals & fiber.
4. ↑ risk of respiratory infections.

+ gall stones, ↓ thermoregulation...
We’re better at storing fat vs carbohydrate!

Dietary Fat → 3% Kcal

Body Fat

Dietary Carbohydrate → 23% Kcal
To Help Lower Body Wt & %Fat
EXERCISE!! +Minimize These!!

- FAT 9 Kcal/g
- ETOH 7 Kcal/g
- CARB 4 Kcal/g
- PRO 4 Kcal/g

NB: Minimize not Eliminate! Moderation not Abstinence!!
I'm not sure I believe you! Why can't I just starve to lose weight?
TOTAL FAST = No Energy Nutrients (No Carbohydrates, Fats or Proteins)

ONLY

1. Water
2. Vitamins
3. Minerals

ML Pollock & JH Wilmore 1990.
60-day Fast???

Lost 60 lb!! Wow!!

Yet

\[
\begin{align*}
26 \text{ lb Water} \\
20 \text{ lb Lean Body Mass} \\
14 \text{ lb Fat}
\end{align*}
\]

Fat < \(\frac{1}{4}\) total wt loss!
You can lose weight by starving – but it's mostly water & muscle! Also, there can be complications!
Potential Complications of Total Fasting
Nausea, diarrhea, persistent vomiting, postural hypotension, nutritional deficiencies, menstrual irregularities, and...sudden death.

Positive Aspect??
General loss of appetite within first 2 days, maintained throughout fasting period.

ML Pollock & JH Wilmore 1990.
Dietary Carbohydrate, Fat and Protein in Weight-Loss Diets: A Report and Insider’s Reflections on the Pounds Lost Trial
Frank M. Sacks, MD

Well-controlled studies of energy-reduced diets conducted in controlled environments showed that the macronutrient composition of the diet did not affect weight loss (1). Nonetheless, theories persisted that specific macronutrients would be superior for weight loss. For example, the traditional paradigm for low-fat, high-carbohydrate diets was based on the lower energy density of carbohydrate compared to fat, and the metabolic efficiency of converting dietary fat to body fat (2). Indeed strict vegetarians sustain lower body weight for years on low-fat diets (3). However, meaningful differences in body weight usually were not achieved in population-based trials of conventional low-fat diets (4). Thus, higher-fat, Mediterranean-style diets were proposed to be better for long-term weight loss because of their variety and satisfaction. Two trials found that Mediterranean diets were superior to low-fat diets for weight loss (5,6). Others claimed that a radically different approach that used low-carbohydrate, high-fat, and high-protein foods could produce weight loss without attention to reducing intake because of the satiety of protein-rich foods. Low-carbohydrate diets succeeded in the first few months with more rapid weight loss than low-fat diets but by one year, none of the trials found that weight loss on low-carbohydrate...
Dr. Sacks’ Conclusions:
We conclude that healthful diets with varying emphases on carbohydrate, fat & protein levels can all achieve clinically meaningful weight loss & maintenance of weight loss over a 2-yr period. The results give people who need to lose weight the flexibility to choose a diet that they can stick with, as long as it’s heart healthy. Such diets can also be tailored for individuals based on their personal & cultural preferences & in this regard may have the best chance for long-term success.
# US Dietary Recommended Intakes (DRI) Committee Acceptable Macronutrient Distribution Ranges (AMDR)

<table>
<thead>
<tr>
<th>Energy Nutrient</th>
<th>% Total Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>45-65%</td>
</tr>
<tr>
<td>Fat</td>
<td>20-35%</td>
</tr>
<tr>
<td>Protein</td>
<td>10-35%</td>
</tr>
</tbody>
</table>
Emphasize ABCs + Variety & Moderation!
All of these factors help to build a nutritious diet.
LOWER CARBOHYDRATE

ELIMINATE CALORIES or FOOD GROUPS
ENCOURAGE FASTING

LOWER FAT

ADEQUACY BALANCE CONSISTENCY & MODERATION

NOT PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TEXTS → RESEARCH

AHA + DASH + MAYO CLINIC
**Digestion Steps**

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

Hi gang!!
You need me
for digestion!!

\[ \text{H}_2\text{O} + \text{Enzyme} \]

Hydrolysis of Energy Nutrients
Disaccharide

Maltose

+ Water

Carbohydrate-digesting enzymes

Glucose + Glucose

Monosaccharides

Peptide
(portion of protein molecule)

+ Water

Protein-digesting enzyme

Amino acid + Amino acid

Fat

+ Water

Triglyceride-digesting enzyme

Fatty acids + Glycerol

SI Fox 2009 fig 18.1 p 614
What’s missing?

**FIGURE 15-1** An example of hydrolysis. In this example, the disaccharide maltose (the intermediate breakdown product of polysaccharides) is broken down into two glucose molecules by the addition of $\text{H}_2\text{O}$ at the bond site.
Polymer to Monomer (Many to One)

Carbohydrate

Protein + Fat

Fat

+ Protein

Glucose

Amino Acids

Fatty Acids + Glycerol

…Central-linking theme!!
GI-DONUT ANALOGY

GI LUMEN

BODY
Common Control Mechanisms

1. Local (autoregulation)
2. Nervous (rapidly-acting)
3. Hormonal (slower-acting/reinforcing)
- Body wall
- Serosa
- Submucosa
- Mucosa
- Lumen
- Outer longitudinal muscle
- Inner circular muscle
- Muscularis externa
- Myenteric plexus
- Submucous plexus

**LS 2012 fig 15-2 p 442**

- Longitudinal → Shortens L
- Circular → \( \downarrow \) d or Width

Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen
Muscularis Externa
Glands
Epithelium
Submucosa
Lumen
Lamina Propria
Longitudinal Muscle
Circular Muscle
Serosa

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

cf: G&H fig 62-2

H Howard 1990
# 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>
1. **Mouth**
   - **Ingestion** entry way
   - Salivary gland secretion mucus + enzymes
   - Enzymatic digestion: carbohydrate
   - Mastication = chewing
   - Deglutition = swallowing

2. **Esophagus**
   - **Rapid transit**
   - Peristalsis
   - Secretion mucus

3. **Stomach**
   - **Mixing** peristalsis
   - Secretion mucus + HCl + enzymes
   - Enzymatic digestion: protein + butter fat!

4. **Liver-Gall Bladder**
   - **Emulsification** = detergent action of bile + secretion

5. **Small Intestine**
   - **Absorption**
   - Secretion mucus + enzymes
   - Enzymatic digestion: carbohydrate, fat, protein
   - Peristalsis

6. **Large Intestine**
   - **Dehydration**
   - Secretion + absorption
   - Storage + peristalsis
Where does enzymatic digestion of protein begin?
FIGURE 15-7

- Esophagus
- Fundus
- Smooth muscle
- Gastroesophageal sphincter
- Body
- Stomach folds
- Pyloric sphincter
- Oxyntic mucosa
- Antrum
- Duodenum
- Pyloric gland area
Zymogen = an inactive precursor

LS 2012 fig 15-9 p 452
Why is the *pancreas* so unique?
Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!
What are other accessory organs of digestion, that is, off-shoots of the primary tube?
Stomach (partly removed to show underlying pancreas)

Liver

Common bile duct

Pancreatic duct

Gallbladder

Duodenum

Pancreas
Liver: Amazing Recycling of Bile Salts!

1. Secreted bile salts consist of 95% old, recycled bile salts and 5% newly synthesized bile salts.

2. 95% of bile salts are reabsorbed by terminal ileum.

3. Reabsorbed bile salts are recycled by enterohepatic circulation.

4. 5% of bile salts are lost in feces.
What is the **major function** of the small intestine?

Absorption!!
http://www.cdc.gov/ulcer/
Ulcer Facts

• Most ulcers are caused by an infection, not spicy food, acid or stress.
• The most common ulcer symptom is burning pain in the stomach.
• Your doctor can test you for *H. pylori* infection.
• Antibiotics are the new cure for ulcers.
• Eliminating *H. pylori* infections with antibiotics means that your ulcer can be cured for good.
Clipping a Duodenal Ulcer

Peering through the pylorus into the duodenum, we see some blood and a vessel sticking out of the wall, just at the front edge of a small but deep ulcer.

In the second photograph, a disposable metal clip is applied to the ulcer. The patient remained well and left hospital three days later.
<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Enzymes for Digesting the Nutrients</th>
<th>Source of Enzymes</th>
<th>Site of Action of Enzymes</th>
<th>Action of Enzymes</th>
<th>Absorbable Units of the Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Amylase</td>
<td>Salivary glands</td>
<td>Mouth and (mostly) body of stomach</td>
<td>Hydrolyzes polysaccharides to disaccharides (maltose)</td>
<td>Monosaccharides, especially glucose</td>
</tr>
<tr>
<td></td>
<td>Disaccharidases (maltase, sucrase, lactase)</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Hydrolyze disaccharides to monosaccharides</td>
<td></td>
</tr>
<tr>
<td>Proteins</td>
<td>Pepsin</td>
<td>Stomach chief cells</td>
<td>Stomach antrum</td>
<td>Hydrolyzes protein to peptide fragments</td>
<td>Amino acids</td>
</tr>
<tr>
<td></td>
<td>Trypsin, chymotrypsin, carboxypeptidase</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Attack different peptide fragments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aminopeptidases</td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</td>
<td>Hydrolyze peptide fragments to amino acids</td>
<td>Amino acids</td>
</tr>
<tr>
<td>Fats</td>
<td>Lipase</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Hydrolyzes triglycerides to fatty acids and monoglycerides</td>
<td>Fatty acids and monoglycerides</td>
</tr>
<tr>
<td></td>
<td>Bile salts (not an enzyme)</td>
<td>Liver</td>
<td>Small-intestine lumen</td>
<td>Emulsify large fat globules for attack by pancreatic lipase</td>
<td></td>
</tr>
</tbody>
</table>
Large Intestine Structure & Function