I. Announcements  
**Got Data?** Crucial for today’s lab! Q? If you want notebook to study for Exam I on Oct 27th, turn in prior lecture next Tuesday, Oct 20st. Sample Exam Q.

II. Nutritional Physiology in the News  
Shake the salt habit! Gain weight by drinking your calories? Coconuts are on a roll?  *UCB 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...  
   [http://www.cdc.gov/ulcer](http://www.cdc.gov/ulcer) Beyond the Basics LS p 456  
G. Large intestine? LS fig 15-24 pp 472-4
Lab 3: Nutritional Analyses via 2 Programs

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

ChooseMyPlate.gov

Diet Analysis+
VERSION 10.0

In Lab Today!
Sample Exam I Questions

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.
More Reasons to Shake the Salt Habit

1. **↓** blood vessel vasodilation within 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?

Stop me!

I'm outta here!!

UCB Wellness Letter Jun 2011 p 5
5 times per wk? \(\equiv 106,600 \text{ calories/yr } \equiv \pm 30.5 \text{ lb fat/yr}\)

- **Starbucks Cinnamon Dolce Latte, whipped cream, Venti (20 oz.)**: 410 calories
- **Jogging**: 50 min.

Better choices!
The Amazing BENEFITS of Coconut Oil

Nutritional Content in Coconut Oil:

- **Anti-oxidants**
- **MCT Medium-Chain Triglycerides**
- **Lauric Acid**
- **Caprylic Acid**
- **Capric Acid**

The Health & Healing Benefits of Coconut Oil:

**Skin Care**
The MCTs in Coconut oil act as a natural skin conditioner. Deeply penetrating & moisturizing, they protect against environmental & free radical damage. It also helps with anti-aging, eczema & even provides some sun protection.

**Weight Loss**
The Fatty Acids in coconut oil destroy candida, yeast overgrowth which triggers weight gain, carbohydrate cravings & fatigue. They're easily digested & converted into energy, which helps to speed up metabolism & help burn stored fat.

**Hair Care**
Coconut oil is one of the best ways to provide nutrients to your hair. The fatty acids condition deeply from the inside of the strands out. Providing protein, eliminating dandruff & aiding in re-growth. Many people use it as a conditioner!

**Immunity**
The unique saturated fats of coconut oil contain antibacterial, antiviral, anti-fungal, and anti-parasitic properties that help strengthen the immune system. Consuming coconut oil regularly will reduce incidences of sickness.

**Diabetes**
Coconut oil may improve insulin sensitivity & glucose tolerance over time. It helps regulate blood sugar levels & protects against insulin resistance. It can even help prevent Type II Diabetes.

**Stress Relief**
Coconut oil is very soothing. The natural aroma of coconut is also very soothing. You can apply the oil to your head & gently massage to help remove mental fatigue.

**Infections**
Lauric Acid (found only in breast milk & coconut oil) is converted into monolaurin in the body. This may destroy bacterial & viral infections like measles, influenza, hepatitis C & even HIV. Monolaurin may also eliminate Athlete’s foot.

**Heart Health**
The fat in coconut oil does not have a negative effect on cholesterol. In fact, it helps improve your cholesterol profile. It helps prevent heart attack & stroke and may even cure heart disease.

**Digestion**
MCT molecules in coconut oil are small so they are easily digested with less strain on the pancreas & digestive system. People suffering from diabetes, obesity, gallbladder disease, or Crohn's disease may benefit greatly from coconut oil.

**Sources**
http://www.coconutresearchcenter.org

**TIP:** Buy Organic, Unrefined, Cold-Pressed, Extra-Virgin Coconut Oil!
Kleiner's & Monaco's Top 10 Hit List for Nutrition Quackery

1. Treatment based on unproven theory calling for non-toxic, painless therapy.

2. Author's/purveyor's credentials aren't recognized in scientific community.

3. No reports in scientific, peer-reviewed literature but rather mass media used for marketing.

4. Purveyors claim medical establishment is against them & play on public's paranoia about phantom greed of medical establishment.

5. Treatments, potions, drugs manufactured according to secret formula.

6. Excessive claims promising miraculous cures, disease prevention or life extension.

7. Emotional images rather than facts used to support claims.

8. Treatments require special nutritional support including health food products, vitamins and/or minerals.

9. Clients are cautioned about discussing program to avoid negative.

10. Programs based on drugs or treatments not labeled for such use.
Many claims with little scientific, peer-reviewed, research support

Coconut Oil Health Benefits

- Improves or Reverses Alzheimer's Disease
- Improves Type 2 AND Type 1 Diabetes
- Improves or Heals Many Skin Diseases
  - Fungal Infections
  - Acne
  - Eczema
  - Keratosis Polaris
  - Psoriasis
  - Rosacea
- Provides Peak Performance Energy
  - Drug-free Energy
  - Longer Endurance
- Kills Candida Fungus
- Helps with Hypothroidism
  - Increases Metabolism
  - Raises Body Temperature
- Conditions and Strengthens Hair
  - Penetrates Roots
  - Kills Lice
  - Improves Dandruff
- Kills many Bacteria AND Viruses
- Promotes Weight Loss
  - Preserves Muscle Mass
  - Promotes Ketosis

Find all the research at: CoconutOil.com
Animal fats and the tropical oils of coconut and palm contain mostly saturated fatty acids.

<table>
<thead>
<tr>
<th>Fat</th>
<th>Saturated fatty acids</th>
<th>Monounsaturated fatty acids</th>
<th>Polyunsaturated, omega-6 fatty acids</th>
<th>Polyunsaturated, omega-3 fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut oil</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Butter</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Beef tallow (beef fat)</td>
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</tr>
<tr>
<td>Palm oil</td>
<td></td>
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<td></td>
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<tr>
<td>Lard (pork fat)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Chicken fat</td>
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</tr>
</tbody>
</table>

Some vegetable oils, such as olive and canola, are rich in monounsaturated fatty acids.

<table>
<thead>
<tr>
<th>Oil</th>
<th>Saturated fatty acids</th>
<th>Monounsaturated fatty acids</th>
<th>Polyunsaturated, omega-6 fatty acids</th>
<th>Polyunsaturated, omega-3 fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Canola oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Peanut oil</td>
<td></td>
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</tr>
</tbody>
</table>

Many vegetable oils are rich in omega-6 polyunsaturated fatty acids.\(^a\)

<table>
<thead>
<tr>
<th>Oil</th>
<th>Saturated fatty acids</th>
<th>Monounsaturated fatty acids</th>
<th>Polyunsaturated, omega-6 fatty acids</th>
<th>Polyunsaturated, omega-3 fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safflower oil(^b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn oil</td>
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<tr>
<td>Soybean oil</td>
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<td></td>
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<tr>
<td>Walnut oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottonseed oil</td>
<td></td>
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</tr>
</tbody>
</table>

Only a few oils provide significant omega-3 polyunsaturated fatty acids.\(^a\)

<table>
<thead>
<tr>
<th>Oil</th>
<th>Saturated fatty acids</th>
<th>Monounsaturated fatty acids</th>
<th>Polyunsaturated, omega-6 fatty acids</th>
<th>Polyunsaturated, omega-3 fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaxseed oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish oil(^c)</td>
<td></td>
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</tr>
</tbody>
</table>

\(^a\)These families of polyunsaturated fatty acids are explained in a later section.

\(^b\)Salad or cooking type over 70% linoleic acid.

\(^c\)Fish oil average values derived from USDA data for salmon, sardine, and herring oils.
Coconut Oil
Nutritional Wonder?

Claims?
http://coconutoil.com/about-us/

Review articles: calves, hamsters, mice… rare humans

The bottom line?
http://www.cspinet.org/nah/articles/coconut-oil.html
http://health.clevelandclinic.org/2012/05/heart-healthy-cooking-oils-101/
http://en.wikipedia.org/wiki/Smoke_point
Coconuts are on a roll?

1. **Blood Cholesterol & Health?** Lauric acid, 1\(^0\) saturated fat may ↑ HDL good > LDL bad cholesterol, but depends on fat replaced. Neutral effect? Still don’t really know!

2. **Weight Loss?** Medium change fatty acids metabolized uniquely. Few human studies on body weight have had inconsistent results. Like all edible oils, high in kcal (120/Tbsp) so counterproductive.

UCB Wellness Letter Nov 2014 p 1 & 5
http://www.berkeleywellness.com/healthy-eating/diet-weight-loss/food/nutrition/article/coconut-oil-all-its-cracked-be
Dietary Composition & Physical Endurance

- High-fat diet: approximately 1/3 endurance
- Normal mixed diet: 57 min
- High-carbohydrate diet: 114 min
- Maximum endurance time: 167 min

Note: eg, Atkins!
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: 23 % Kcal
- Dietary Carbohydrate
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!

> $\frac{3}{4}$
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

Continued on page 26
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.
NOT PEER-REVIEWED = TRADE BOOKS

LOWER CARBOHYDRATE

ELIMINATE CALORIES or FOOD GROUPS

ENCOURAGE FASTING

PEER-REVIEWED = TEXTS → RESEARCH

AHA + DASH + MAYO CLINIC

LOWER FAT

ADEQUACY

BALANCE

CONSISTENCY & MODERATION
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!!

H₂O + Enzyme

Hydrolysis of Energy Nutrients
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 → Glucose

Protein + Fat → Amino Acids

Polymer → Monomer

…Central-linking theme!!
GI-DONUT ANALOGY

GI LUMEN

BODY
Common Control Mechanisms

1. Local (autoregulation)
2. Nervous (rapidly-acting)
3. Hormonal (slower-acting/reinforcing)
Longitudinal → Shortens L

Circular → ↓ d or Width

Body wall
Serosa
Submucosa
Outer longitudinal muscle
Inner circular muscle
Muscularis externa
Mucosa
Lumen
Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen
Myenteric plexus
Submucous plexus
Myenteric motor plexus!

Meissner’s sensory & secretory plexus!

Serous

Epithelium

Submucosa

Lumen

Lamina Propria

Longitudinal Muscle

Circular Muscle

Muscularis Externa

Glands

H Howard 1990

cf: G&H fig 62-2
### 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. $\text{H}_2\text{O}$, 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. **Pancreas**
   - Secretion: mucus + NaHCO₃ + enzymes
   - Enzymatic digestion: carbohydrate, fat, protein

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

7. **Large Intestine**
   - Dehydration
   - Secretion + absorption
   - Storage + peristalsis
Where does enzymatic digestion of protein begin?
Zymogen = an inactive precursor
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

Gallbladder

Pancreatic duct

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.

KEY

- Blue arrows = Enterohpetic circulation of bile salts
What is the **major function** of the small intestine?

Absorption!!
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 \textit{H. pylori} infection.
• Antibiotics are the new cure for ulcers.
• Eliminating \textit{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 15-5  Digestive Processes for the Three Major Categories of Nutrients

<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></td>
</tr>
<tr>
<td></td>
<td>Trypsin, chymotrypsin, carboxy- peptidase</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

- Transverse colon
- Haustra
- Descending colon
- Ascending colon
- Ileocecal valve
- Cecum
- Appendix
- Rectum
- Sigmoid colon
- Internal anal sphincter (smooth muscle)
- External anal sphincter (skeletal muscle)
- Anal canal

LS 2012 fig 15-24 p 472