BI 121 Lecture 6  Nutrition Lab 3 today! More personal data…

I. Announcements Data + flash drive/e-mail for today’s lab! To have your notebook returned to study for Exam I on Tues Oct 29th, best to submit prior to lecture next Tues Oct 22nd. Review Session Sunday Oct 27th, 6-7:30 pm. Sample Exam Q? Be sure to see Active Learning Questions! Drink your calories?

II. Nutrition Connections Plants, Whole Grains, Exercise, Dieting?

III. GI (Gut) Structure & Function DC Module 3, LS 2012 ch 15
   A. Gut Doughnut Analogy + Secretions L Brilla WWU
   B. Digestion Steps Dr. Evonuk + LS pp 437- 439; DC p 23
   C. Hydrolysis + Polymer → Monomer: Central Themes!
      LS p 438, SI Fox 2009 + …
   D. Gut control mechanisms
   E. Histology of the gut LS fig 15-2, 15-3 p 442-3
   F. Organ-by-organ review
   G. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
      Beyond the Basics LS p 456, Mayo Clinic on Ulcers
   J. Summary of chemical digestion LS tab 15-5 p 466
   K. Large intestine? LS fig 15-24 pp 472-4
DietController Software for Personal Nutrition Analyses!

On computers in lab!
No purchase necessary!
Sample Exam I Questions

Sample 1. What is *human physiology*? (+2) How does it differ from *human anatomy*? (+2)

Sample 2. What happens to *blood pressure* when you stand up? (+2) To compensate, how do *heart rate* and *blood vessel diameter* change? (+2)

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

**Starbucks Cinnamon Dolce Latte, whipped cream**

| 410 calories |

**Jogging**

| 50 min. |

Better choices!
Carbohydrate Confusion

Should you avoid carbs at all costs?

No, ↑ complex
↓ simple!

Emphasize a plant-based diet!
I prefer glucose!

Me too!

Me three!

Me too!
Phytochemicals ≡ Plant chemicals

- **1. Anti-oxidants**
  - protect DNA from oxidative damage

- **2. Protein synthesis**
  - regulation/control

- **3. Hormone-like action**
  - endocrine mimicry

- **4. Blood effects**
  - modify blood chemistry

Potential regulators of health!

10s of thousands!

Phytochemicals ≡ Plant chemicals

aroma, color, taste
Broccoli sprouts may contain ~ 10,000 unique phytochemicals!
≥ 5 tomato-containing meals per week may protect from cancers of the esophagus, stomach & prostate!
...but, the phytochemical candidate, **lycopene** with anti-oxidant activity is also in guava, papaya, pink grapefruit & watermelon!
**Why Eat Whole Grains?**

Based on existing evidence, eating whole grains is definitely good for our health.  
*Shengmin Sang, Professor of Food Science & Human Health North Carolina A&T*

**Fiber**  
↑ fullness, motility, beneficial bacteria, wt control  
↓ cholesterol, insulin response, inflammation, diabetes and CVD risk…

**B-vitamins**  
thiamin, niacin, riboflavin  
↑ energy metabolism

**Folate**  
↑ red blood cells,  
↓ neural tube defects

**Iron**  
↑ O$_2$ carrying,  
↓ iron-deficiency anemia in women

**Magnesium**  
↑ bone building & muscle energy release

**Selenium**  
an anti-oxidant, protects body cells & ensures a healthy immune system…

[https://www.choosemyplate.gov/eathealthyl/grains](https://www.choosemyplate.gov/eathealthyl/grains)
With the right food choices, physical activity, and not smoking, we could prevent about 90% of diabetes, 80% of heart disease and 70% of strokes!
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...
Dietary Composition & Physical Endurance

- High-fat diet: eg, Atkins!
- Normal mixed diet
- High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:
- 57 min
- 114 min
- 167 min
To Help Lower Body Wt & %Fat
EXERCISE!! +Minimize These!!

<table>
<thead>
<tr>
<th></th>
<th>Kcal/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAT</td>
<td>9</td>
</tr>
<tr>
<td>ETOH</td>
<td>7</td>
</tr>
<tr>
<td>CARB</td>
<td>4</td>
</tr>
<tr>
<td>PRO</td>
<td>4</td>
</tr>
</tbody>
</table>

**NB:** Minimize not Eliminate! Moderation not Abstinence!!

**DIETFITS (2018)**
+ Pounds Lost Trial (2009) indicate that reducing overall calories is more important than macronutrient composition of the diet!

We’re better at storing fat vs carbohydrate!

Dietary Fat -> 3 % Kcal

Body Fat

Dietary Carbohydrate -> 23 % Kcal
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.
An Anti-Aging Diet?
5:2 Intermittent “Fasting”

2 Days a Week

500-CALORIE DAY

Breakfast
Plain low-fat yogurt with berries
200 calories

Dinner
Mixed greens with grilled chicken
300 calories

NAHL 2017 May
Human Intermittent Fasting Studies

- ~100 overweight or obese women
- ½ cut 25% kcal every day
- ½ ate normally 5 d, but only 650 kcal/d for 2 d/wk
- After 3 – 6 mo, each group lost ~ same amount of wt but women on 5:2 diet had better insulin function!
- Likely easier for most humans to restrict for only 2 d/wk!


Successful Dieting – National Weight Control Registry

- 5000 people, ≥ 30 lb weight loss, ≥ 5 yr
- High-carbohydrate (55-60%), low-fat (24%) diet with the rest (~16-21%) from protein
- Wholesome vs. high-sugar carbohydrates including fruits, vegetables, high-fiber foods
- Conscious of calories knowing that total calories count, no matter what diet type
- Eight of 10 ate breakfast daily which may help better manage calories during the day
- Self-monitor, weigh themselves ≥ 1x/wk & many still keep food dairies
- Much planned physical activity, 60-90 min/d, 10 walking + looked for other ways to be active

http://www.nwcr.ws/Research/published%20research.htm

UC Berkeley Wellness Engagement Calendar, September 2013
Which Diets are Best?

- Not Plant-based
- Lower Carbohydrate

Peer-Reviewed = Text Books → Research

- Plant-based
- Lower Fat

Not Peer-Reviewed = Trade Book → Opinion

Mediterranean Diet

NB: Each group 500 kcal deficit/day, 16 weeks
Exercise is better than dieting in lowering body fat & preserving muscles!
Questions + Discussion
GI-Doughnut Analogy

GI Lumen

Body

Me?
# 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>
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!!

$\text{H}_2\text{O} \quad + \quad \text{Enzyme} \quad = \quad \text{Hydrolysis of Energy Nutrients}$
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 H₂O at the bond site.
Polymer to Monomer  
(Many to One)

- Carbohydrate
  - Glucose

- Protein + Fat
  - Amino Acids
  - Fatty Acids + Glycerol

...Central-linking theme!!
Common Control Mechanisms

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

Circular $\rightarrow$ ↓d or Width
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:
     - carbohydrate, fat, protein

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

Gallbladder

Duodenum

Pancreas

Common bile duct

Pancreatic duct
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!!
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></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</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>
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<td></td>
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<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
Ascending portion of large intestine

Ileum of small intestine

Cecum

Appendix