I. **Announcements** Data + flash drive/e-mail for today’s lab! If you want to be sure to have your notebook to study for Exam I on Tuesday Oct 23rd, best to turn in prior to lecture next Tuesday Oct 16th. Review Session Sunday Oct 21st, 6-7 pm. Q? Sample Exam Q? Be sure to see *Active Learning Questions*!


III. **Gastrointestinal Physiology** DC Module 3 pp 17-23, LS ch 15+
A. Steps of digestion Dr. Evonuk + LS pp 437- 9; DC p 23
B. Hydrolysis + monomer to polymer: central linking themes!
C. What’s missing? LS fig 15-1 p 438
D. GI-Donut analogy Dr. Brilla @ WWU
E. Common control mechanisms
F. Gut layers & secretions LS p 438, 440-1
G. Organ-by-organ review LS tab 15-1 pp 440-1 + DC fig 3-1
H. Accessory organs of digestion
I. Ulcers? Causes?
DietController Software for Personal Nutrition Analyses!

No purchase necessary!
On computers in lab!
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.
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**  
↑ O₂ 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/grains-nutrients-health](https://www.choosemyplate.gov/grains-nutrients-health)
Dietary Composition & Physical Endurance

eg, Atkins!

High-fat diet

Normal mixed diet

High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:

57 min
114 min
167 min
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!!

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

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

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

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?
CALERIE STUDY
Comprehensive Assessment of Long-term Effects of Reducing Intake of Energy

- 2-yr kcal restriction, assess biomarkers longer, healthier life
- 218 people, 21 – 51 yr, ½ ~ overwt, ½ normal wt
- Usual diet or cut kcal by 25% (achieved ~ 12% so < ½ goal)
- If cut calories, lost 10% body wt ~ 17 lb & kept off for 2 yr
- Cardiometabolic ∆s: ↓ Cholesterol, ↓ Inflammatory markers, ↑ control blood sugar control w/o adverse sexual or immune function ∆s

Some bone loss, but attributed to weight loss.

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
5:2 Intermittent “Fasting”

600-CALORIE DAY

Breakfast
Oatmeal with peaches, berries, and milk
250 calories

Dinner
Baked salmon with asparagus and tomatoes
350 calories
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!


**NB**: Each group 500 kcal deficit/day, 16 weeks

Exercise is better than dieting in lowering body fat & preserving muscles!
Emphasize ABCs + Variety & Moderation!
All of these factors help to build a nutritious diet.
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.
Which Diets are Best?

Not Plant-based  
Lower Carbohydrate

Plant-based  
Lower Fat

Not Peer-Reviewed = Trade Book  
→ Opinion

Peer-Reviewed = Text Books  
→ Research

Nutrition and Physical Degeneration  
Weston A. Price, DDS

4 Blood Types, 4 Diets  
Eat Right for Your Type  
Dr. Peter J. D'Adamo

The Paleo Diet  
Loren Cordain, Ph.D.

No-Fad Diet  
American Heart Association

The South Beach Diet  
Barry Sears, Ph.D.

The DASH Diet Action Plan  
Marla Heller, MS, RD

The Mayo Clinic Diet  
By the weight-loss experts at Mayo Clinic

ChooseMyPlate.gov
How Did We Get Here?
Explaining the obesity epidemic

HOW TO EAT LESS

2018 Xtreme Eating Awards

Trans Fat R.I.P.
Calories in the food supply have risen consistently since the onset of the obesity epidemic!

Cheap, but calorie & fat dense!

Watch out for drinking your calories!
5 times per wk? \( \equiv 106,600 \text{ calories/yr} \equiv \pm 30.5 \text{ lb fat/yr} \)

Starbucks Cinnamon Dolce Latte, whipped cream
\(410 \text{ calories} \)

Jogging | 50 min.

Better choices!
### What's an Ultra-Processed Diet?

Here are two sample menus from Kevin Hall's study pitting an ultra-processed diet against an unprocessed diet.

<table>
<thead>
<tr>
<th></th>
<th>ULTRA-PROCESSED</th>
<th>UNPROCESSED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td>Pancakes with margarine and syrup</td>
<td>Oatmeal with blueberries and almonds 2% milk</td>
</tr>
<tr>
<td></td>
<td>Turkey sausage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tater tots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apple juice</td>
<td></td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td>Turkey sandwich with American cheese and mayo on</td>
<td>Entrée salad with grilled chicken breast, farro,</td>
</tr>
<tr>
<td></td>
<td>white bread</td>
<td>apples, grapes, and lemon vinaigrette</td>
</tr>
<tr>
<td></td>
<td>Baked potato chips</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diet ginger ale</td>
<td></td>
</tr>
<tr>
<td><strong>Dinner</strong></td>
<td>Cheeseburger</td>
<td>Beef tender roast</td>
</tr>
<tr>
<td></td>
<td>French fries and ketchup</td>
<td>Couscous with lemon and garlic</td>
</tr>
<tr>
<td></td>
<td>Diet ginger ale</td>
<td>Green beans</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Side salad with honey vinaigrette</td>
</tr>
<tr>
<td><strong>Snack</strong></td>
<td>Sweetened greek yogurt</td>
<td>Carrots</td>
</tr>
<tr>
<td></td>
<td>Canned peaches in heavy syrup</td>
<td>Black bean hummus</td>
</tr>
</tbody>
</table>


Eat Breakfast, Eat Early, Downsize, Go Low!

Eating early & less late (< ~ 6:30 pm) may help insulin work efficiently!

Smaller **amount** vs plate size!

**Fruits & vegetables** for low-calorie density!

Sleep More, Eat Less

Wondering why you’re so hungry? Maybe it’s because you’re not getting enough sleep.

Researchers allowed 12 healthy young lean men to sleep for either four or eight hours in a laboratory. After one night of four hours of sleep, the men ate 22 percent more calories the next day than they did after eight hours. They also reported being more hungry before breakfast and dinner.

In a separate study, scientists found that a single night with only four hours of sleep led to insulin resistance in nine healthy lean men and women in their 40s. After the night of restricted sleep, the participants were less able to move blood sugar into their cells, which suggests that their bodies were at least temporarily resistant to insulin. Insulin resistance can lead to heart disease, diabetes, and possibly breast cancer.

What to do: Get enough sleep. Most adults need 7 to 8 hours a night. (School-aged children need at least 9 hours.) Other studies that limit adults’ sleep find higher levels of ghrelin (which makes people hungry) and lower levels of leptin (which makes people feel full) in their blood. Changes in ghrelin, leptin, and insulin resistance may explain why studies find a higher risk of obesity, heart disease, diabetes, and high blood pressure in people who get too little sleep.

http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/gi/ghrelin.html
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, 10,000 steps walking + looked for other ways to be active

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

UC Berkeley Wellness Engagement Calendar, September 2013
Digestion Steps

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

Hydrolysis of Energy Nutrients

Hi gang!!
You need me for digestion!!

The ENZYME data bank

H₂O + Enzyme
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 $H_2O$ at the bond site.
Polymer to Monomer
(Many to One)

Carbohydrate

Glucose

Protein + Fat

Amino Acids

Fatty Acids + Glycerol

…Central-linking theme!!
GI-Doughnut Analogy

GI Lumen

Body

Me?
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
- Myenteric plexus
- Submucous plexus
- Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen
**Myenteric motor plexus!**

- Serosa
- Epithelium
- Submucosa
- Lumen
- Lamina Propria
- Longitudinal Muscle
- Circular Muscle
- Muscularis Externa
- Glands

- Meissner’s sensory & secretory plexus!

*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. **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

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?
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
- = Enterohepatic circulation of bile salts

LS 2012 fig 15-11 p 462
What is the **major function** of the small intestine?

Absorption!!
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
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.