BI 121 Lecture 5

Nutrition Lab 3 tomorrow!
Exam I this Wednesday, July 3rd!!...

I. **Announcements** Data + Flashdrive for Nutrition Lab! Q?

II. **Sample Exam Q + Q about Exam?**

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

A. Essential Nutrients: H$_2$O, 1$^0$ Carbohydrates, 2$^0$ Fats, 3$^0$ Proteins, Vitamins, Minerals; Macro- vs Micro-?

B. Dietary Guidelines: HHS-USDA, AICR, Eat the *Rainbow*!

C. **Blue Zones**? Habits of longest lived people?

D. Okinawan Longevity Diet?

E. Pondering Paleo? Marlene Zuk, U Minn

F. Animals vs. Plants? Protein, WHO, Meat?

G. TMAO, Neu5GC and Inflammation?

H. Carbohydrate Confusion. Why Plants & Whole Grains?

I. Exercise, Carbohydrates & Fats

J. How Optimal % Body Fat US Wt Registry, Zuti & Golding

IV. **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 + …
### 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**
1. **Vary your veggies.** Fill ½ your plate with fruits & vegetables!

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!

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*MyPlate launched June 2, 2011*
A healthy eating pattern includes:

- **Variety of vegetables** from all subgroups: dark green, red & orange, legumes, starchy & other
- **Fruits**, especially whole fruits
- **Grains**, at least half of which are whole grains
- **Fat-free or low-fat dairy**, including milk, yogurt, cheese &/or fortified soy beverages
- **Variety of protein foods** including seafood, lean meats & poultry, eggs, legumes & nuts, seeds & soy products
- **Oils** (healthy)

A healthy eating pattern limits:

- **Saturated fats** & **trans fats**, added **sugars** & **sodium**
- **Balance calories with physical activity** to manage weight.

http://health.gov/dietaryguidelines/2015/
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!

The World’s Longest-Lived People!  ○ Blue Zones!  ○

Lomo Linda, CALIFORNIA

Sardinia, ITALY

Okinawa, JAPAN

Nicoya, COSTA RICA

Ikaria, GREECE


M Poulain & Coworkers. Experimental Gerontology, Sep 2004
1. Eat a little bit better!
2. Move a little bit more!
3. Socialize more!
4. Strong sense of purpose!

Plant-based!

https://en.wikipedia.org/wiki/Blue_Zone
https://bluezones.com/
70% Sweet Potatoes
12% Rice
7% Grains & Wheat
6% Soy & legumes
4% Additional vegetables
3% Fruit
2% Oils
1% Nuts (Protein)
1% Other potatoes
1% Seaweed
1% Sugars
1% Fish
1% Dairy
1% Eggs
1% Pork-Meat
1% Flavorings & Alcohol

85% Carbohydrates
9% Protein
6% Fat
85-10-5
1785 Calories

96% Vegan Diet
98% Vegetarian
99% PescaVeg
<4% Animal Prod
<1% Fish
<1% Meat-Pork

Note: These are the Actual Food Measurements of the Centenarians, not the diet of All island Okinawans or the ones who died, but the ones who lived.
Pondering Paleo?

Evolutionary Biologist
Behavioral Ecologist
U Minnesota

http://www.nutritionaction.com/daily/how-to-diet/pondering-paleo/
How much protein do you need?

50 kg or 110 lb female? ~ 40 g/d

80 kg or 176 lb male? ~ 64 g/d

Boneless, skinless, cooked chicken breast 6-8 oz, 53-70 g of protein!

Average US woman gets 35% > RDA!
Average US man 65% > RDA!
Dietary Protein, Shakes, Supplements &…?

Dietary Protein and EARLY Cancer

http://www.aicr.org/about/advocacy/the-china-study.html
http://www.nutritionfacts.org/
Red Meat, Processed Meat & Cancer Incidence

Total cancer mortality & cancers of:

Colon & rectum
Esophagus
Liver
Pancreas
Kidney
Prostate
Lung
Breast

WHO says to cut down on meat?

When I saw the headlines in October that meat was linked to cancer, I braced myself for the inevitable brouhaha. The news was that the International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO), concluded that processed meats like hot dogs, bacon, and ham almost certainly increase the risk of colorectal cancer—by 18% per daily serving—and that red meat probably does as well.

But we've heard about this link many times before. Over the past 20 years, many observational studies have found that people who regularly eat red or processed meats have higher rates of several cancers, notably of the colon and rectum. And lab studies have shown that compounds formed when meat is processed (that is, smoked, salted, or cured) or cooked at high temperatures can cause cancer in animals or cells. All that research served as the basis of the IARC conclusions. But even in 2007 the World Cancer Research Fund, another key group of experts, concluded that there was “convincing” evidence that these meats increase the risk of colorectal cancer. And since 2002, WHO has advised people to moderate their consumption of processed meat, as do the still-pending 2015 Dietary Guidelines for Americans.

What elicited the most heated reaction in the press and blogosphere and especially from the meat industry was the fact that the IARC put processed meats in its Group 1—“carcinogenic to humans”—which includes tobacco smoking and asbestos. (It put red meats in Group 2A—“probably carcinogenic.”) The IARC clearly explained that this classification merely indicates the strength of the evidence that something causes cancer, not the degree of risk. In fact, it said that the increased risk from red or processed meat is “small” for individuals, though potentially important for public health since so many people eat meat.

What about that 18% increase in risk? The IARC estimated that for every serving of processed meat (just under 2 ounces) or red meat (3½ ounces) eaten daily for years, the lifetime risk of colorectal cancer goes up by about 18%. But this is what's known as relative risk, which can be misleading. For instance, the lifetime risk of developing colorectal cancer in the U.S. is about 5%. An 18% increase does not mean 5% + 18% = 23%, but rather 5% + (18% of 5%) = 6%. That means one extra case of colorectal cancer per 100 meat eaters. In contrast, smoking increases the lifetime risk of lung cancer by roughly 2,000%—from about 1 per 100 people to about 20 per 100. So while IARC may classify both processed meat and smoking as Group 1 carcinogens, there's no comparison in their risks.

In fact, IARC cited estimates that 34,000 cancer deaths per year worldwide can be attributed to diets high in processed meat. In contrast, tobacco causes nearly 2 million cancer deaths per year.

I should add that I don't think it has been clearly established that meat causes cancer. Proving that foods cause or help prevent cancer is difficult for many reasons. Notably, the observational studies upon which the IARC classifications were largely based can only find associations—they cannot prove cause and effect.

That said, there are plenty of other reasons to moderate your intake of red meats and limit processed ones. There's strong evidence linking them to cardiovascular disease and a variety of other disorders, though it's not clear which compounds in them are the possible culprits. What's more, eating more plant-based foods and less meat is better for the planet, resulting in less greenhouse gas production.

And there's a far surer way to reduce the risk of colorectal cancer than tinkering with your diet: Get screened.
Gut Bacteria Involved in *Inflammation & Atherosclerosis*?

Meat & Eggs → L-Carnitine & Choline → Trimethyl Amine (TMA) → TMAO → *Inflammation & Atherosclerosis*

Dietary Choline & L-Carnitine

Gut Flora

The pathway linking diet, gut microbes and TMAO to a growing collection of disease states

Choline

TMAO

TMA = Trimethyl Amine

Hepatic FMOs

Heart Failure

Kidney Disease

Atherosclerosis

http://www.nejm.org/doi/full/10.1056/NEJMo1oa1109400#t=article
Red Meat-Derived Glycan Promotes Inflammation & Disease

N-Glycolylneuraminic acid (Neu5GC)

Ab to Neu5GC
Neu5GC Ab

Immune System

Atherosclerosis

Cancer

Chronic Inflammation
Amyloid-A +
Acute Phase Proteins
IL-6

Xeno Auto-Antigen!
Anti-Neu5GC Ab

Source: After AN Samraj, *PNAS*, 2015, 112(2), 542-7. [http://m.pnas.org/content/112/2/542.long](http://m.pnas.org/content/112/2/542.long)
Environmental Impact

Grain required for:

~61 kg 1 kg of Beef
~38 kg 1 kg of Pork
~13 kg 1 kg of Fish

~33% of H₂O farm animal footprint due to beef production

Carbohydrate Confusion
Should you avoid carbs at all costs?

No, ↑ complex↓ simple!
Emphasize a plant-based diet!

Our Planet AT RISK
The Best SPREADS
3 Veggie Dips
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**
- ↑ 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)
With the right food choices, physical activity, and not smoking, we could prevent about 90% of diabetes, 80% of heart disease, about 80% of diabetes, and 70% of stroke!
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

eg, Atkins!

High-fat diet
Normal mixed diet
High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:
57 min
114 min
167 min
American Institute for Cancer Research

http://www.aicr.org/reduce-your-cancer-risk/recommendations-for-cancer-prevention/
We’re better at storing fat vs carbohydrate!

- Dietary Fat -> 3 % Kcal
- Body Fat
- Dietary Carbohydrate -> 23 % Kcal
LIPID MEMBRANE MAINTENANCE
LIPID INSULATION PADDING
LIPID CARRIERS

FLAVOR AROMA SATIETY

FAT SOLUBLE VITAMIN
To Help Lower Body Wt & %Fat

EXERCISE!! + Minimize These!!

<table>
<thead>
<tr>
<th></th>
<th>Calories/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>
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</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

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

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.
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 diaries
- 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
Which Diets are Best?

- Plant-based Lower Fat
- Not Plant-based Lower Carbohydrate

Not Peer-Reviewed = Trade Book → Opinion

Peer-Reviewed = Text Books → Research

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. H$_2$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!!

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

Monosaccharides

Peptide

Amino acid

Fat

Fatty acids

Glycerol
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

Protein + Fat

Fat + Protein + Carbohydrate

Amino Acids

Glucose

Fatty Acids + Glycerol

Central-linking theme!!
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

7. **Large Intestine**
   - *Dehydration*
   - Secretion + absorption
   - Storage + peristalsis