I. **Announcements** Nutrition Analyses this Thursday! Please record diet on p 3-7 LM. Bring flash drive. Q?

II. **Introduction to Genetics** LS 2012 ch 2 p 20-1 + Appendix C
A. How does DNA differ from RNA? pp A-20 thru A-22
C. How & where are proteins made? fig C-7, C-9
D. Class skit: Making proteins @ ribosomes!

III. **Nutrition Primer** Sizer & Whitney (S&W) Sci Lib
A. Essential Nutrients: $H_2O$, $^{1}$ Carbohydrates, $^{2}$ Fats, $^{3}$ Proteins, Vitamins, Minerals; Macro- vs Micro-?
B. Dietary Guidelines: USDA, AICR, Eat Like the **Rainbow**!
C. **Blue Zones**? Pondering Paleo, Marlene Zuk, **NAHL** 2015…
D. How much protein? Excess animal protein & disease?
E. Carbohydrate confusion. Minimize what? Simple sugars
F. Anti-aging diets, total vs intermittent fasting? **NAHL** 2018
G. **Beware of Nutrition Quackery** S. Kleiner & Monaco
H. Best diets? Exercise? Practical guidelines for wt loss!

IV. **Introduction to Digestion** Steps + hydrolysis
What does DNA do, day-to-day?

DNA → Transcription → RNA → Translation → Protein

Replication

@ ribosomes

Nucleus → Cytoplasm

cf: LS fig C-6
DNA vs RNA?

1. **Double-stranded**
2. **Deoxyribose** (without oxygen)
3. A, T, C, G
   - **Thymine**
4. **Self-replicative** (can copy itself)
5. **Nucleus** (+mitochondria)

1. **Single-stranded**
2. **Ribose** (with oxygen)
3. A, U, C, G
   - **Uracil**
4. **Needs DNA as template**
5. **1° Cytoplasm** (but Nucleus origin)
6. mRNA, rRNA, tRNA
**Triplets of bases code for amino acids, the building blocks of proteins**

<table>
<thead>
<tr>
<th>DNA code word</th>
<th>mRNA codon</th>
<th>tRNA anti-codon</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAT</td>
<td>AUA</td>
<td>UAU</td>
</tr>
<tr>
<td>ACG</td>
<td>UGC</td>
<td>ACG</td>
</tr>
<tr>
<td>TTT</td>
<td>AAA</td>
<td>UUU</td>
</tr>
<tr>
<td>TAC</td>
<td>AUG</td>
<td>UAC</td>
</tr>
<tr>
<td>Second base of codon</td>
<td>U</td>
<td>C</td>
</tr>
<tr>
<td>----------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>U</td>
<td>Phe</td>
<td>UCU</td>
</tr>
<tr>
<td>U</td>
<td>Leu</td>
<td>UCC</td>
</tr>
<tr>
<td>U</td>
<td>UUA</td>
<td>UCA</td>
</tr>
<tr>
<td>U</td>
<td>UUG</td>
<td>UCG</td>
</tr>
<tr>
<td>C</td>
<td>Leu</td>
<td>CCU</td>
</tr>
<tr>
<td>C</td>
<td>CUC</td>
<td>CAC</td>
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<tr>
<td>C</td>
<td>CUA</td>
<td>CAA</td>
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<td>C</td>
<td>CUG</td>
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<td>A</td>
<td>ACC</td>
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<td>GUA</td>
<td>GAA</td>
</tr>
<tr>
<td>G</td>
<td>GUG</td>
<td>GAG</td>
</tr>
</tbody>
</table>

Translation? Ribosomes Make Proteins

1. Large subunit
2. Small subunit
3. tRNA
4. Anticodon
5. mRNA
6. Leader sequence
7. First codon
8. Second codon
9. Steps 5 through 8 are repeated

First ribosomal binding site
Second ribosomal binding site

LG 2012 fig C-7
A Polyribosome. Which Way is Synthesis?
What's a ribosome?

A protein synthesizing factory, where translation takes place!

You rock, baby!
Questions + Discussion
Macronutrients & Micronutrients
Essential for Life

**Macronutrients**

- H$_2$O/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$^+$, Ca$^{2+}$, Mg$^{2+}$, Fe$^{2+}$, Zn$^{2+}$,...)

**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!

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)
Eating the Rainbow Hawaiian Style!!

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!


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!

Loma Linda, United States

Plant-based!

Sardinia, Italy

Okinawa, Japan

https://en.wikipedia.org/wiki/Blue_Zone
https://bluezones.com/
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
Pondering Paleo?

Evolutionary Biologist
Behavioral Ecologist
U Minnesota

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

Not much! 0.8 g/kg or 0.36 g/lb of body wt/d

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!
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 $\rightarrow$ L-Carnitine & Choline $\rightarrow$ Trimethyl Amine (TMA) $\rightarrow$ TMAO $\rightarrow$ Inflammation & Atherosclerosis

Dietary Choline & L-Carnitine

Gut Flora

Hepatic FMOs

TMA = Trimethyl Amine

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

Choline

TMAO

Heart Failure

Kidney Disease

Atherosclerosis

Red Meat-Derived Glycan Promotes Inflammation & Disease

N-Glycolylneuramic acid (Neu5GC)

Ab to Neu5GC
Neu5GC Ab

Atherosclerosis
Cancer

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

Immune System

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
Carbohydrate Confusion
Should you avoid carbs at all costs?

No, ↑ complex ↓ simple!
Emphasize a plant-based diet!
Dietary Composition & Physical Endurance

- High-fat diet
- Normal mixed diet
- High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:

- 57 min
- 114 min
- 167 min

eg, Atkins!
Negative Effects of Low Carbohydrate

1️⃣ ↑ fatigue/exhaustion  
   central & peripheral!

2️⃣ ↓ glucose – brain+spinal cord, rbcs thrive upon.

3️⃣ ↓ variety which reduces intake of phytochemicals, vitamins, minerals & fiber.

4️⃣ ↑ 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!!

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

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

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.
Apples to Watermelon: Rating fruit
Two super salads: Good for the Gut?

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 Δs: ↓ Cholesterol, ↓ Inflammatory markers, ↑ control blood sugar control w/o adverse sexual or immune function Δs

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

**Figure 4–9.** Changes in body weight, body fat, and lean body weight for diet, exercise, and combination groups. (From Zuti W. B., and Golding, L. A.: Comparing diet and exercise as weight reduction tools. *Phys. Sportsmed.* 4:49–53, 1976.)
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
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? ≡ 106,600 calories/yr ≡ ± 30.5 lb fat/yr

Better choices!

Starbucks Cinnamon Dolce Latte, whipped cream

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

Hi gang!!
You need me for digestion!!

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