BI 121 Lecture 4

I. **Announcements** Nutrition Analysis Lab next Tuesday! Please record your diet on p 3-7 LM & begin analysis using [https://www.supertracker.usda.gov/](https://www.supertracker.usda.gov/) Estimating quantities. Q?

II. **Anaerobic & Aerobic Metabolism Connections** LS ch 2 +

III. **Introduction to Genetics** LS 2012 ch 2 p 20-1 + Appendix C
   A. What’s a gene? Where located? Why important? p A-18, fig C-2, C-3
   B. How does information flow in the cell? fig C-6
   C. How does DNA differ from RNA? pp A-20 thru A-22
   E. How & where are proteins made? fig C-7, C-9
   F. Class skit: Making proteins @ ribosomes!

IV. **Nutrition Primer** DC Module 2, Sizer & Whitney(S&W) Sci Lib
   A. Essential Nutrients: H₂O, 1° Carbohydrates, 2° Fats, 3° Proteins, Vitamins, Minerals; Macro- vs Micro-?
   B. Dietary Guidelines: USDA, AICR, Eat Like the **Rainbow**!
   D. Nutrition Quackery, Balanced Approach Kleiner, Monaco+
4 oz → 3 oz

Deck of Cards

≡ 1 c

raw → cooked

≡ 1/3 c

≡ 1 oz

≡ ¼ c

≡ 1.5 oz
ATP Supplied

Performance Time

Power Output

ATP-PC/Immediate

Glycolysis

Oxygen System

Mitochondria

Cytosol

15 - 30 s

1.5 – 3 m

> 3 – 5 m

Anaerobic

Aerobic

Modified after Mathews & Fox
ATP = Adenosine Tri Phosphate
The Common Energy Currency or the Cash Cells Understand!!
Cleave One High Energy Phosphate Bond To Do Work!!

7 – 10 KiloCalories/KCal

1. Synthesis of Macromolecules
   Make big things from little things!

2. Membrane Transport
   Move things! Microscopic!

3. Mechanical Work
   Move things! Macroscopic!
Anaerobic vs. Aerobic Metabolism

**Anaerobic Glycolysis**

"sugar dissolving" without O₂. Net of 2 ATP per molecule of glucose.

**Aerobic Metabolism**

+mitochondrial processing of glucose with O₂. Net of 32 ATP per molecule of glucose!
AEROBIC w/O₂

ANAEROBIC Immediate/ATP-PC

**Glycolysis**

**Cytoplasm**

**Mitochondria**
Stages of Cellular Metabolism/Respiration

**Anaerobic**
Glycolysis
Cytosol

**Aerobic**
Metabolism
Mitochondria

**Glycolysis**
- Glucose and other fuel molecules → Pyruvate
- 2 ATP

**Citric acid cycle**
- Pyruvate to acetate
- Acetyl-CoA
- Electrons carried by NADH and FADH$_2$
- 2 ATP

**Oxidative phosphorylation**
- (electron transport system and chemiosmosis)
- 28 ATP

*fig 2-9 LS 2012*
Glycolysis "sugar dissolving/splitting" produces small amounts of ATP
Citric Acid Cycle produces pairs of electrons for cashing in at the nearby electron transport chain (ETC)
Cashing in electrons at the Electron Transport Chain (ETC) produces an abundance of ATP energy molecules!

Cytosol

Outer mitochondrial membrane

fig 2-12 LS 2012
Goals of Aerobic Metabolism

AERobic = MITOCHONDRIOn
w/O₂

CITRIC ACID CYCLE
harvest electrons

ELECTRON TRANSPORT CHAIN

“cash in”
for ATP Energy!!
Cytoskeleton: Cell "Bone & Muscle"
Microtubular Highway!!
4th Component: Microtrabecular Lattice?
Time-out for questions!
What are DNA’s major functions?
Heredity + Day-to-Day Cell Function
What does DNA look like? Double-helix!!
Gene = Stretch of DNA that codes for a protein
What does DNA do, day-to-day?

DNA → RNA → Protein

Transcription

Translation @ ribosomes

Replication

Nucleus → Cytoplasm

cf: LS fig C-6
DNA vs RNA?

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

1. Single-stranded
2. Ribose (with oxygen)
3. A, U, C, G
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>
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<th>DNA code word</th>
<th>mRNA codon</th>
<th>tRNA anti-codon</th>
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<tr>
<td>TAT</td>
<td>AUA</td>
<td>UAU</td>
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<tr>
<td>ACG</td>
<td>UGC</td>
<td>ACG</td>
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<tr>
<td>TTT</td>
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<td>UG A</td>
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<td>UG G</td>
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Translation? Ribosomes Make Proteins

1. Large subunit
2. Small subunit
3. Amino acid
4. tRNA
5. Anticodon
6. mRNA
7. Leader sequence
8. First codon
9. Second codon
10. Ribosome
11. First ribosomal binding site
12. Second ribosomal binding site
13. Steps 5 through 8 are repeated

LS 2012 fig C-7
Class Skit, Questions & Discussion!

What's a ribosome?

A protein synthesizing factory, where translation takes place!

You rock, baby!

What’s a ribosome?
Transfer RNA (tRNA)
A Polyribosome. Which Way is Synthesis?
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**
USDA Food Pyramid 1992

- **Fats, oils, and sweets**: Use Sparingly
- **Milk, yogurt, and cheese group**: 2-3 Servings
- **Vegetable group**: 3-5 Servings
- **Meat, poultry, fish, dry beans, eggs, and nuts group**: 2-3 Servings
- **Fruit group**: 2-4 Servings
- **Bread, cereal, rice, and pasta group**: 6-11 Servings

**Key**
- Fat (naturally occurring and added)
- Sugars (added)
US Modifications to 1992 Food Pyramid 2005

- **Fats, oils, and sweets**: Use sparingly
- **“good” fats!**
- **saturated & trans fats!**
- **Milk, yogurt, and cheese group**: 2–3 servings
- **Vegetable group**: 3–5 servings
- **3 or more!**
- **5 or more!**
- **Meat, poultry, fish, dry beans, eggs, and nuts group**: 2–3 servings
- **Fruit group**: 2–4 servings
- **Bread, rice, pasta group**: 6–11 servings
- **½ whole grain**

**Regular Physical Activity: Exercise! Exercise!!**

**KEY**
- □ Fat (naturally occurring and added)
- □ Sugars (added)
Dietary Guidelines for Americans
2005 Food Guidance System

1. ↑emphasis on ↓kcal + ↑exercise. 😊
2. 9-A-Day! 4 fruit + 5 vegetable servings.
3. ≥ 3 of 6 whole grains → ½ whole grains!
4. 3 servings of dairy, eg 3 c fat-free milk.
5. ↓saturated + trans fats + ↑unsaturated/
   “good” fats, eg Ø-3 fish, walnuts.
6. Drink in moderation if at all.
7. Practice food safety.

Hooray!
MyPlate launched June 2, 2011!

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!
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!


NB: Each group 500 kcal deficit/day, 16 weeks
Compared to dieting, exercise is superior in inducing % body fat reduction & preserving lean body mass!
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!
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

76.7%

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

Fat < \frac{1}{4} \text{ 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.
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...
**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.
<table>
<thead>
<tr>
<th>Energy Nutrient</th>
<th>% Total Calories</th>
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<tbody>
<tr>
<td>Carbohydrate</td>
<td>45-65%</td>
</tr>
<tr>
<td>Fat</td>
<td>20-35%</td>
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<tr>
<td>Protein</td>
<td>10-35%</td>
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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.
LOWER CARBOHYDRATE
ELIMINATE CALORIES or FOOD GROUPS
ENCOURAGE FASTING

LOWER FAT
ADEQUACY
BALANCE
CONSISTENCY & MODERATION

NOT PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TEXTS → RESEARCH

AHA + DASH + MAYO CLINIC

NOT PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TEXTS → RESEARCH

AHA + DASH + MAYO CLINIC