Announcements 

Nutrition Analyses this Thursday! Please record diet on p 3-7 LM & begin analysis using https://www.supertracker.usda.gov/ Bring flash drive? Q?

Metabolism Connections 

Mitochondrial metabolism +

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!

Nutrition Primer 

Sizer & Whitney (S&W) Sci Lib

A. Essential Nutrients: \(H_2O\), \(^1^0\) Carbohydrates, \(^2^0\) Fats, \(^3^0\) Proteins, Vitamins, Minerals; Macro- vs Micro-?
B. Dietary Guidelines: USDA, AICR, Eat Like the Rainbow!
D. Beware of Nutrition Quackery S. Kleiner & Monaco 1990!

Nutrition in the News 

Gain weight by drinking calories?

Introduction to Digestion 

Steps + hydrolysis
Stages of Cellular Metabolism/Respiration

**Anaerobic Glycolysis**

Cytosol

- Glycolysis
  - Glucose and other fuel molecules
  - Pyruvate

**Aerobic Metabolism**

Mitochondria

- Pyruvate to acetate
  - Acetyl-CoA
  - Electrons carried by NADH and FADH$_2$
- Citric acid cycle
- Oxidative phosphorylation (electron transport system and chemiosmosis)

fig 2-9 LS 2012
Cashing in electrons at the Electron Transport Chain (ETC) produces an abundance of ATP energy molecules!

Cytosol

Outer mitochondrial membrane

Rod Capaldi
U of O Biology

fig 2-12 LS 2012
Goals of Aerobic Metabolism

AEROBIC = MITOCHONDRION

w/O₂

CITRIC ACID CYCLE

harvest electrons "cash in"

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
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

Replication

Transcription

Translation @ ribosomes

Nucleus

Cytoplasm

cf: LS fig C-6
## DNA vs RNA?

<table>
<thead>
<tr>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double-stranded</td>
<td>1. Single-stranded</td>
</tr>
<tr>
<td>2. Deoxyribose (without oxygen)</td>
<td>2. Ribose (with oxygen)</td>
</tr>
<tr>
<td>4. Self-replicative (can copy itself)</td>
<td>4. Needs DNA as template</td>
</tr>
<tr>
<td>5. Nucleus (+mitochondria)</td>
<td>5. 1&lt;sup&gt;0&lt;/sup&gt; Cytoplasm (but Nucleus origin)</td>
</tr>
<tr>
<td></td>
<td>6. mRNA, rRNA, tRNA</td>
</tr>
</tbody>
</table>
**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>First base of codon</td>
<td>Second base of codon</td>
<td>Third base of codon</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>U</strong></td>
<td><strong>UUU</strong> UUC UUA UUG</td>
<td><strong>Phe</strong></td>
</tr>
<tr>
<td></td>
<td><strong>UCU</strong> UCC UCA UCG</td>
<td><strong>Ser</strong></td>
</tr>
<tr>
<td></td>
<td><strong>UAU</strong> UAC UAA UAG</td>
<td><strong>Tyr</strong> Stop</td>
</tr>
<tr>
<td></td>
<td><strong>UGU</strong> UGC UGA UGG</td>
<td><strong>Cys</strong> Stop Trp</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td><strong>CUU</strong> CUC CUA CUG</td>
<td><strong>Leu</strong></td>
</tr>
<tr>
<td></td>
<td><strong>CCU</strong> CCC CCA CCG</td>
<td><strong>Pro</strong></td>
</tr>
<tr>
<td></td>
<td><strong>CAU</strong> CAC CAA CAG</td>
<td><strong>His</strong> Gln</td>
</tr>
<tr>
<td></td>
<td><strong>CGU</strong> CGC CGA CGG</td>
<td><strong>Arg</strong></td>
</tr>
<tr>
<td><strong>A</strong></td>
<td><strong>AUU</strong> AUC AUA AUG</td>
<td><strong>Ile</strong> Met Start</td>
</tr>
<tr>
<td></td>
<td><strong>ACU</strong> ACC ACA ACG</td>
<td><strong>Thr</strong></td>
</tr>
<tr>
<td></td>
<td><strong>AAU</strong> AAC AAA AAG</td>
<td><strong>Asn</strong> Lys</td>
</tr>
<tr>
<td></td>
<td><strong>AGU</strong> AGC AGA AGG</td>
<td><strong>Ser</strong> Arg</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td><strong>GUU</strong> GUC GUA GUG</td>
<td><strong>Val</strong></td>
</tr>
<tr>
<td></td>
<td><strong>GCU</strong> GCC GCA GCG</td>
<td><strong>Ala</strong></td>
</tr>
<tr>
<td></td>
<td><strong>GAU</strong> GAC GAA GAG</td>
<td><strong>Asp Glu</strong></td>
</tr>
<tr>
<td></td>
<td><strong>GGU</strong> GGC GGA GGG</td>
<td><strong>Gly</strong></td>
</tr>
</tbody>
</table>

Translation? Ribosomes Make Proteins

Translation process:
1. mRNA binds to the ribosome.
2. tRNA specific for the first codon binds to the ribosome.
3. Ribosomal binding site for the first codon is occupied.
4. tRNA specific for the second codon binds.
5. Ribosomal binding site for the second codon is occupied.
6. tRNA specific for the third codon binds.
7. Ribosomal binding site for the third codon is occupied.
8. Steps 5 through 8 are repeated.
9. Translation continues until a stop codon is reached.

LS 2012 fig C-7
Transfer RNA (tRNA)
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**

- **H₂O/Water**
- **1⁰ Carbohydrates**
- **2⁰ Fats/Triglycerides/Lipids**
- **3⁰ 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**
Willett & Stampfer Suggestions 2003

- Multiple vitamins FOR MOST
- Alcohol in moderation UNLESS CONTRAINDIATED
- Fish, poultry, and eggs 0 TO 2 SERVINGS

- Fruit 2 TO 3 SERVINGS
- Plant oils (olive, canola, soy, corn, sunflower, peanut, and other vegetable oils) AT MOST MEALS

- Whole grain foods AT MOST MEALS

- Vegetables IN ABUNDANCE

- Nuts and legumes 1 TO 3 SERVINGS

- Dairy or calcium supplement 1 TO 2 SERVINGS

- Red meat and butter USE SPARINGLY

- White rice, white bread, potatoes, pasta, and sweets USE SPARINGLY

Daily exercise and weight control

NEW FOOD PYRAMID
US Modifications to 1992 Food Pyramid 2005

- Regular Physical Activity: Exercise! Exercise!!
- Use sparingly
  - Fats, oils, and sweets
  - “good” fats!
  - saturated & trans fats!
  - 3 or more!
  - 5 or more!
- 4 or more!
- Fruit group
  - 2–4 servings
- Meat, poultry, fish, dry beans, eggs, and nuts group
  - 2–3 servings
- Bread, rice, pasta, and cereal group
  - 6–11 servings
  - 1/2 whole grain
- 2–3 servings
- 3–5 servings
- 2–4 servings
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 Ω-3 fish, walnuts.
6. Drink in moderation if at all.
7. Practice food safety.

Hooray!
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
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
Exercise is better than dieting in lowering body fat & preserving muscles!
Dietary Composition & Physical Endurance

- eg, Atkins!

High-fat diet: ~ 1/3 endurance!

Normal mixed diet: 57 min

High-carbohydrate diet: 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

Body Fat

Dietary Carbohydrate

3 % Kcal

23 % Kcal
To Help Lower Body Wt & %Fat
EXERCISE!! +\textit{Minimize} These!!

\begin{itemize}
\item \textbf{FAT} \quad 9 \text{ Kcal/g}
\item \textbf{ETOH} \quad 7 \text{ Kcal/g}
\item \textbf{CARB} \quad 4 \text{ Kcal/g}
\item \textbf{PRO} \quad 4 \text{ Kcal/g}
\end{itemize}

\textbf{NB:} \textit{Minimize} not \textit{Eliminate!}  \\
\textit{Moderation} not \textit{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

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

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.
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 diets
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.
### US Dietary Recommended Intakes (DRI) Committee Acceptable Macronutrient Distribution Ranges (AMDR)

<table>
<thead>
<tr>
<th>Energy Nutrient</th>
<th>% Total Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>45-65%</td>
</tr>
<tr>
<td>Fat</td>
<td>20-35%</td>
</tr>
<tr>
<td>Protein</td>
<td>10-35%</td>
</tr>
</tbody>
</table>
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.
NOT PEER-REVIEWED =
TRADE BOOKS

LOWER CARBOHYDRATE
ELIMINATE CALORIES
or FOOD GROUPS
ENCOURAGE FASTING

PEER-REVIEWED =
TEXTS → RESEARCH

AHA + DASH +
MAYO CLINIC

LOWER FAT
ADEQUACY
BALANCE
CONSISTENCY
& MODERATION
5 times per wk? \equiv 106,600 \text{ calories/yr} \equiv \pm 30.5 \text{ lb fat/yr}

Starbucks Cinnamon Dolce Latte, whipped cream (Venti 20 oz.) 410 calories

Jogging 50 min.

Better choices!
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!!

Hi There!!
You need me for digestion!!

H₂O + Enzyme

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 $\text{H}_2\text{O}$ at the bond site.
Polymer to Monomer
(Many to One)

Carbohydrate

Protein + Fat

Fat + Protein

Glucose

Amino Acids

Glycerol

Fatty Acids

...Central-linking theme!!