BI 121 Lecture 4

Anatomy & Physiology Lab today!


II. **Cell Metabolism Connections** LS 2012 fig 2-9 thru 2-12 +…

III. **Introduction to Genetics** LS ch 2 p 20-1 + Appendix C
   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, 1⁰ Carbohydrates, 2⁰ Fats, 3⁰ Proteins, Vitamins, Minerals; Macro- vs Micro-?
   B. Dietary Guidelines: USDA, AICR, Eat Like the Rainbow!
   D. Nutrition Quackery, Balanced Approach Kleiner, Monaco+
4 oz $\rightarrow$ 3 oz

raw $\rightarrow$ cooked

Deck of Cards

1 oz

1/3 c

1/4 c

1.5 oz
Stages of Cellular Metabolism/Respiration

Anaerobic Glycolysis
Cytosol

Glycolysis
Glucose and other fuel molecules
Pyruvate

2 ATP

Pyruvate to acetate
Acetyl-CoA

Aerobic Metabolism
Mitochondria

Citric acid cycle
Electrons carried by NADH and FADH₂

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!

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!!
Cytoskeleton: Cell "Bone & Muscle"

Microtubule

Intermediate filament

Microfilament

Tubulin subunit

Polypeptide strand

Actin subunit

LS 2012 fig 2-17
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 $\rightarrow$ RNA $\rightarrow$ Protein

Replication

Transcription

Translation

@ ribosomes

Nucleus

Cytoplasm

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

<table>
<thead>
<tr>
<th><strong>DNA</strong></th>
<th><strong>RNA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double-stranded</td>
<td>1. Single-stranded</td>
</tr>
<tr>
<td>2. Deoxyribose</td>
<td>2. Ribose</td>
</tr>
<tr>
<td>(without oxygen)</td>
<td>(with oxygen)</td>
</tr>
<tr>
<td>Thymine</td>
<td>Uracil</td>
</tr>
<tr>
<td>(can copy itself)</td>
<td></td>
</tr>
<tr>
<td>5. Nucleus (mitochondria)</td>
<td>5. 1° Cytoplasm</td>
</tr>
<tr>
<td></td>
<td>(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>U</td>
<td>C</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>U</td>
<td>UUU</td>
<td>UCU</td>
</tr>
<tr>
<td></td>
<td>UUC</td>
<td>UCC</td>
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<tr>
<td></td>
<td>UUA</td>
<td>UCA</td>
</tr>
<tr>
<td></td>
<td>UUG</td>
<td>UCG</td>
</tr>
<tr>
<td>C</td>
<td>CUU</td>
<td>CCU</td>
</tr>
<tr>
<td></td>
<td>CUC</td>
<td>CCA</td>
</tr>
<tr>
<td></td>
<td>CUU</td>
<td>CCG</td>
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<tr>
<td></td>
<td>CUC</td>
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</tr>
<tr>
<td>A</td>
<td>AUU</td>
<td>ACU</td>
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<tr>
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<td>AUC</td>
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<td>AUA</td>
<td>ACA</td>
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<tr>
<td></td>
<td>AUG</td>
<td>ACG</td>
</tr>
<tr>
<td>G</td>
<td>GUU</td>
<td>GCU</td>
</tr>
<tr>
<td></td>
<td>GUC</td>
<td>GCC</td>
</tr>
<tr>
<td></td>
<td>GUA</td>
<td>GCA</td>
</tr>
<tr>
<td></td>
<td>GUG</td>
<td>GCG</td>
</tr>
</tbody>
</table>

Second base of codon

- U: Phe, Leu
- C: Ser, Pro
- A: Tyr, His, Asn, Thr
- G: Cys, Gln, Arg, Lys, Gly

Stop codons: UAA, UAG, UGA

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

Steps 5 through 8 are repeated.

LS 2012 fig C-7
Transfer RNA (tRNA)
A Polyribosome. Which Way is Synthesis?
Class Skit, Questions & Discussion!

What's a ribosome?

A protein synthesizing factory, where translation takes place!

What's a ribosome?

You rock, baby!
Macronutrients & Micronutrients
Essential for Life

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Sample Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O/Water</td>
<td>Water, other drinks, fruits &amp; vegetables</td>
</tr>
<tr>
<td>✓1⁰ Carbohydrates</td>
<td>Grains, vegetables, fruits, dairy products</td>
</tr>
<tr>
<td>✓2⁰ Fats/Triglycerides/Lipids</td>
<td>Meats, full-fat dairy products, oils</td>
</tr>
<tr>
<td>✓3⁰ Proteins</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamins (A, D, E, K; C + B)</td>
<td>Vegetables, vegetable oils, fruits, citrus, grains, dairy</td>
</tr>
<tr>
<td>Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺, Fe²⁺, Zn²⁺,...)</td>
<td>Fruits, vegetables, grains, nuts, dairy, meats, processed foods</td>
</tr>
</tbody>
</table>

NB: Need only minute quantities!

✓ Energy nutrients = yield ATP
Willett & Stampfer Suggestions 2003

- Red meat and butter: Use sparingly
- White rice, white bread, potatoes, pasta and sweets: Use sparingly
- Dairy or calcium supplement: 1 to 2 servings
- Fish, poultry and eggs: 0 to 2 servings
- Nuts and legumes: 1 to 3 servings
- Vegetables: In abundance
- Whole grain foods: At most meals
- Daily exercise and weight control
- Plant oils (olive, canola, soy, corn, sunflower, peanut and other vegetable oils): At most meals
- Alcohol in moderation: Unless contraindicated
- Multiple vitamins: For most
US Modifications to 1992 Food Pyramid 2005

- Regular Physical Activity: Exercise! Exercise!!
- "good" fats!
- saturated & trans fats!
- 3 or more!
- 5 or more!
- 4 or more!
- eg, fish, nuts
- 1/2 whole grain
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.
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)
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
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

23% Kcal

Dietary 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

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

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.
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>
</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

PEER-REVIEWED = TEXTS → RESEARCH

LOWER CARBOHYDRATE

ELIMINATE CALORIES or FOOD GROUPS ENCOURAGE FASTING

LOWER FAT

ADEQUACY BALANCE CONSISTENCY & MODERATION

AHA + DASH + ❤

ChooseMyPlate.gov