BI 358 Lecture 6

I. **Announcements** Quiz 2 Tuesday covers GI Physiol + Nutrition ≡ Lectures 4, 5 + 6 (II. below). Discussion then wbc differential lab! Please read p 5-2 + articles sent by e-mail! Send nutrition reports to Kelsey *kschult7@uoregon.edu* or Hannah *hsoukup@uoregon.edu* by Tuesday 5 pm. Outline update. Q?

II. **Nutrition Connections** ↑Plants, ↓Na+, Fish?, ↓Sugar, ↑Exercise

III. **Blood + Body Resistance to Infection I**
G&H ch 33, 34, LS, Stuart Fox, Daniel Chiras (DC), Basiro Davey

A. Blood: cell + fragments vs liquid (plasma vs serum) LS
B. Red blood cells, white blood cells, platelets, Demo? LS, DC
C. Red blood cell production, hemoglobin G&H pp 445-51
   G&H fig 33-1 thru 33-6 +..., Fox
D. Pathogen? Microbe that causes disease, Davey pp 5-6
E. Barriers to infection Davey fig 2.1 p 12, fig 2.2 p 13
F. *National Geographic*, The Wars Within, Lennart Nilsson
G. WBC effectors: Innate & adaptive immunity G&H pp 455-64
   G&H fig 34-1 + Davey fig 2.2 p 13, fig 3.4 p 24, fig 3.12 p 36
H. *Medical Physiology News* Handwashing to prevent infection!
   US Centers for Disease Control
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

1. Vary your veggies. Fill ½ your plate with fruits & vegetables!
Recommendations for CANCER PREVENTION

1. Be as lean as possible without becoming underweight.
2. Be physically active for at least 30 minutes every day.
3. Avoid sugary drinks. Limit the consumption of energy-dense foods particularly processed foods high in added sugar, or low in fiber, or high in fat.
4. Eat more of a variety of vegetables, fruits, whole grains & legumes such as beans.
5. Limit consumption of red meats (such as beef, pork & lamb) & avoid processed meats.
6. If consumed at all, limit alcoholic drinks to 2 for men & 1 for women a day.
7. Limit consumption of salty foods & foods processed with salt (sodium).
8. Don't use supplements to protect against cancer.
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
Environmental Working Group Suggestions

Dirty Dozen!
Buy These Organic
• Apples
• Bell Peppers
• Celery
• Cherries
• Imported Grapes
• Nectarines
• Peaches
• Pears
• Potatoes
• Red Raspberries
• Spinach
• Strawberries

Clean 16!!
Not as Much Concern
• Asparagus
• Avocados
• Bananas
• Broccoli
• Cabbage
• Cantaloupe
• Cauliflower
• Corn (sweet)
• Eggplant
• Honeydew
• Kiwi
• Mangos
• Onions
• Papaya
• Pineapples
• Peas (sweet)

https://www.ewg.org/foodnews/dirty_dozen_list.php
https://www.ewg.org/foodnews/clean_fifteen_list.php
Dietary Approaches to Stop Hypertension (DASH)

Fruits & vegetables + low-fat dairy products

http://www.nhlbi.nih.gov/health/health-topics/topics/dash
More Reasons to Shake the Salt Habit

①↓blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+

②↑Ca^{2+} excretion ↑bone loss, risk of osteoporosis & fractures.

③May directly impair kidney function & ↑risk of kidney stones.

④GI cancer risk, inflammation?

UCB WellnessLetter Jun 2011, Jan 2012
Health Valley Organic

NO SALT ADDED Vegetable SOUP

NET WT 15 OZ (425g)

American Heart Association CERTIFIED Meets Criteria For Heart-Healthy Food

USDA ORGANIC

NUTRITION SCORECARD (PER SERVING)
- SODIUM 50mg
- FAT 2.5g
- FIBER 4g
- ANTIOXIDANT 45% RDI* (VITAMIN A)

15 OZ (425g)
Our Organic Vegetable Soup is made with the finest ingredients and has **No Salt Added**. It is also an excellent source of antioxidant vitamin C (20%) and antioxidant vitamin A (45%) and a good source of fiber (4g).

### Nutrition Facts

<table>
<thead>
<tr>
<th>Serving Size: 1 Cup (240g)</th>
<th>Servings: About 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories: 100</td>
<td></td>
</tr>
<tr>
<td>Fat Cal: 25</td>
<td></td>
</tr>
</tbody>
</table>

*Percent Daily Values (DV) are based on a 2,000 calorie diet.

<table>
<thead>
<tr>
<th>Amount/serving</th>
<th>% DV*</th>
<th>Amount/serving</th>
<th>% DV*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Fat</strong></td>
<td>2.5g</td>
<td><strong>Total Carb.</strong></td>
<td>18g</td>
</tr>
<tr>
<td>Sat. Fat</td>
<td>0g</td>
<td>Dietary Fiber</td>
<td>4g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
<td>Sugars</td>
<td>4g</td>
</tr>
<tr>
<td>Cholest.</td>
<td>0mg</td>
<td>Protein</td>
<td>3g</td>
</tr>
</tbody>
</table>

**Sodium**: 50mg

**Vitamin A**: 45%

**Vitamin C**: 20%

**Calcium**: 4%

**Iron**: 8%

**Nutrients Compared to Leading Brands**

- Sodium: 50mg per serving
- Total Fat: 2.5g
- Total Carb: 18g
- Cholesterol: 0mg
- Protein: 3g

*This Health Valley Organic® Soup contains 50 milligrams sodium per serving. Other leading brands contain 860 milligrams sodium or more per serving. This is not a sodium free food.

**MADE WITH NO GENETICALLY ENGINEERED INGREDIENTS.**

**Non-BPA Lining**: Can lining not derived from BPA

**Ingredients**: Filtered water, organic potatoes, organic carrots, organic celery, organic tomatoes, organic peas, organic green beans, organic corn, organic onions, organic tomato paste, organic corn starch, organic broccoli, organic red kidney beans, organic expeller pressed canola oil, organic evaporated cane juice, organic spinach, organic onion powder, organic garlic granules, organic spices, organic concentrated lemon juice, organic white pepper, organic cayenne pepper, vitamin A palmitate.

**Manufactured for Distribution by**

**The Hain Celestial Group Inc., Lake Success, NY 11042 USA**

**Certified Organic by Quality Assurance International (QAI)**

©2013 The Hain Celestial Group, Inc.
AHA Statistical Fact Sheet 2013 Update

What do Americans* eat per day?

**Whole grains:** 0.5-0.8 servings/d
Only 3-5% consume ≥ 3 servings/d

**Vegetables:** 1.3-2.2 servings/d
Only 3-7% consume ≥ 5 servings/d

**Fruits:** 1.1-1.8 servings/d
Only 6-11% consume ≥ 4 servings/d

**Fish & Shellfish** 1.2-1.7 servings/wk
75%-80% or more consume < 2 servings/wk

*Americans*
Fish Oil Intakes & Cardiovascular Death Rates

Cardiovascular Deaths per 100,000 Population

- Ireland: 0.09%
- USA: 0.13%
- France: 0.14%
- Japan: 0.37%

Sizer & Whitney 2011
fig 5-12 p 167
Species most heavily contaminated with mercury

Saltwater
- King mackerel
- Shark
- Swordfish
- Fresh tuna steaks
- Tilefish

Freshwater
- Largemouth bass
- Smallmouth bass
- Spotted bass

\(\textit{NB: KISSTT}\)

\(^{a}\text{Canned albacore ("white") tuna contains more mercury than light tuna varieties.}\)
Species lower in mercury:

Saltwater
- Canned light tuna
- Catfish
- Pollock
- Salmon
- Sardines
- Shrimp

Freshwater
- Brown trout
- Channel catfish
- Rainbow trout

\(^a\text{Canned albacore ("white") tuna contains more mercury than light tuna varieties.}\)
Each person in the US ingests $\sim \frac{3}{4}$ cup or 31 tsp of refined sugars added to foods & beverages each day $\equiv > 140$ lb per year!
Sugar in processed foods?

- 1 Tbs ketchup = 1 tsp sugar
- 1/2 cup canned corn = 1 tsp sugar
- 12 oz cola ≥ 10 tsp sugar
- 8 oz sweetened yogurt = 8 tsp sugar
- 2 oz chocolate = 8 tsp sugar

Sizer & Whitney 2011 fig 4-17 p 139
1994 Diabetes Prevalence in the US by State

2010 Diabetes Prevalence in the US by State

THE REWARD OF FITNESS: LONGEVITY

![Bar chart showing death rates per 10,000 persons per year across different fitness levels for women. The chart indicates higher death rates for those with lower fitness levels and lower death rates for those with higher fitness levels.]

Exercise is a must based on its insulin-like effect!
100s of other reasons! Exercise –

↑ lean body mass, ↑ cardiac output,
↑ myocardial contractility, ↑ central & peripheral blood flow, ↑ fibrinolytic activity,
↑ HDL cholesterol, ↑ work capacity,
↑ sleep quality, ↓ % body fat,
↓ TOT & LDL cholesterol, ↓ triglycerides, ↓ platelet aggregation, ↓ blood pressure,
↓ CVD risk,…
Guidelines: Healthy Adults < 65 yr

Do moderately intense aerobic exercise
30 min/d, 5 d/wk

OR

Do vigorously intense aerobic exercise
20 min/d, 3 d/wk

AND

Do 8-10 strength-training exercises
8-12 repetitions/each exercise, 2 d/wk

http://www.acsm.org/access-public-information/position-stands
http://www.acsm.org/access-public-information/brochures-fact-sheets/fact-sheets
Federal exercise guidelines include strength training for all


**Adults:** Moderate to Vigorous Exercise

≥ 30 min, 5 d/wk

**Children:** Moderate to Vigorous Exercise

≥ 60 min, 5 d/wk
Break for discussion/questions!
What's in Blood? Plasma & Blood Cells

- Plasma (55% of whole blood)
- Buffy coat: platelets and leukocytes (<1% of whole blood)
- Erythrocytes (45% of whole blood)
- Platelets
- Leukocytes (white blood cells)
- Erythrocytes (red blood cells)
Dermal bone production of red blood cells

Cellularity (percent) vs. Age (years) for different bone locations:
- Vertebra
- Sternum
- Rib
- Tibia (shaft)
- Femur (shaft)

G&H 2011 fig 32-1 p 414
G&H 2016 fig 33-1 p 446
**Pluripotent Hematopoietic Stem Cell Lines**

- **PHSC** (Pluripotent hematopoietic stem cell)
- **CFU-S** (Colony-forming unit–spleen)
- **CFU-B** (Colony-forming unit–blast)
- **CFU-E** (Colony-forming unit–erythrocytes)
- **CFU-GM** (Colony-forming unit–granulocytes, monocytes)
- **CFU-M** (Colony-forming unit–megakaryocytes)

- **Erythrocytes**
- **Granulocytes** (Neutrophils) (Eosinophils) (Basophils)
- **Monocytes** → **Macrocytes**
- **Megakaryocytes** → **Platelets**
- **T lymphocytes**
- **B lymphocytes**
Red Blood Cell Genesis

Proerythroblast

→ Basophil erythroblast

→ Polychromatophil erythroblast

→ Orthochromatobic erythroblast

→ Reticulocyte

→ Erythrocytes

Microcytic, hypochromic anemia

Sickle cell anemia

Megaloblastic anemia

Erythroblastosis fetalis

G&H 2016 fig 33-3 p 447

G&H 2011 fig 32-3 p 415
**Erythropoietin Regulates RBC Production**

- **Kidney** produces **Erythropoietin**.
- **Erythropoietin** regulates the production of **Hematopoietic Stem Cells**.
- **Hematopoietic Stem Cells** differentiate into **Proerythroblasts**.
- **Proerythroblasts** develop into **Red Blood Cells**.
- **Red Blood Cells** contribute to **Tissue Oxygenation**.
- **Tissue Oxygenation** decreases the production of **Erythropoietin**.
- Factors that decrease oxygenation include:
  1. Low blood volume
  2. Anemia
  3. Low hemoglobin
  4. Poor blood flow
  5. Pulmonary disease
Hemoglobin Formation

Citric Acid Cycle

I. 2 succinyl-CoA + 2 glycine →

II. 4 pyrrole → protoporphyrin IX

III. protoporphyrin IX + Fe²⁺ → heme

IV. heme + polypeptide → hemoglobin chain (α or β)

V. 2 α chains + 2 β chains → hemoglobin A

G&H 2016 fig 33-5 p 449  
G&H 2011 fig 32-5 p 417
Heme Structure

NB: CO carbon monoxide binds w/~200-fold > affinity than O₂
What a difference one amino acid can make!

Amino acid sequence of normal hemoglobin:
Val → His → Leu → Thr → Pro → Glu → Glu

Amino acid sequence of sickle-cell hemoglobin:
Val → His → Leu → Thr → Pro → Val → Glu
Megakaryocyte

Platelets/Thrombocytes

Immune Response

1. Detect invader or ID toxic product.

2. Communicate to network.

3. Recruit coordinated, multi-pronged attack.

4. Amplify & if yes to success, then –

5. Suppress

Davey 1990 p 6
Pathogen?

Microbes that cause disease!

- Bacteria
- Viruses
- Protozoa
- Fungi
- + Multicellular Parasites, e.g., ticks & lice

Davey 1990 p 5
Pathogens & Parasites Cause:

1. 70-80% of deaths in less developed countries

2. Tens of millions of deaths due to infectious diseases

3. > 20 million childhood deaths per year in Asia, Africa & Latin America due to diarrheal infections alone

4. Yet < 2% deaths in modern, industrialized countries!

World Health Organization 2016 Statistics

Davey 1990 p 5
Why such striking differences across the world?

1. Poor sanitation
2. Contaminated water supply
3. Contaminated food supply
4. Malnutrition
5. Existing infections
6. Patchy, inadequately-funded vaccinations
7. AIDS superimposed on top of 1-6!

Davey 1990 p 5
FIGURE 2.1 Summary of the main physical, chemical and mechanical barriers to infection entering the human body.
Good phagocytes!
Figure 33-2  Movement of neutrophils by diapedesis through capillary pores and by chemotaxis toward an area of tissue damage.  G&H 2011
Hand-washing

The right way to wash your hands:

Thoroughly wash with soap and warm running water — rubbing your hands together for at least 10 seconds.

Hand-washing is the single most effective thing you can do to reduce the spread of colds and other infectious disease.

It’s not necessary to use anti-bacterial soaps when washing up. Regular soap and water do the job just fine.

Also, using germicidal soaps too often may produce antibiotic-resistant bacteria.

Source: Hospital Infections Program, U.S. Centers for Disease Control and Prevention

http://www.squidsoap.com/