I. Announcements Quiz 2 on Tuesday covers Lectures 4 & 5, GI Physiology & Nutrition. Discussion then white blood cell differential lab! Please read p 5-2 + articles sent by e-mail! Nutrition reports to Aleesa aleesas@uoregon.edu or Precious precious@uoregon.edu by 5 pm Tuesday. Outline update? Q?

II. Nutrition Connections Why plant-based?...exercise?...coconut?

III. Blood + Body Resistance to Infection I
G&H ch 32, 33, 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 413-9
   G&H fig 32-1 thru 32-6 +..., 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 433-7
   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

...Gorgeous photos by Lennart Nilsson of Nova fame!
http://www.lennartnilsson.com/human_body.html
Why More Fruits, Vegetables Whole Grains & Beans?
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!
Broccoli sprouts may contain ~10,000 unique phytochemicals!
A Wealth of Phytochemicals

All cruciferous vegetables contain powerful cancer-fighting phytochemicals, including: 

**diindolylmethane (DIM)**, one of many indoles found in these vegetables, has been shown to inhibit proteins associated with breast and ovarian cancers.

**crambene**, plentiful in Brussels sprouts, may offer the most preventive benefits when combined with **indole-3-carbinol (I3C)**.

**glucosinolates**, which turn into powerful protective agents called **isothiocyanates** when a cruciferous vegetable is chewed or chopped. May reduce inflammation, a factor in cancer development.
American Institute for Cancer Research
Foods that Fight Cancer

**Beans**  fiber, saponins, protease inhibitors, phytic acid.

**Berries**  fiber, vitamin C, ellagic acid, flavonoids

**Cruciferous Vegetables**  glucosinolates: glucoraphin → sulphoraphane, crambene, indole-3-carbinol & isothiocyanates

**Dark Green Leafy Vegetables**  fiber, folate, carotenoids: 10 lutein & zeaxanthin; saponins, flavonoids

**Flaxseed**  lignans (a phyto-E), α-linolenic acid (an Ω-3)

**Garlic**  organosulfurs: allicin, alliin, allyl sulfides; quercetin,...

**Grapes and Grape Juice**  resveratrol (a polyphenol)

**Green Tea**  catechins (class of flavonoids), polyphenols

**Soy**  isoflavones, saponins, phenolic acids, phytic acid, phytosterols, protein kinase inhibitors

**Tomatoes**  lycopene

**Whole Grain**  fiber, vitamins, minerals, 100s of phytochemicals:
   antioxidants, phenols, lignans (a phyto-E), saponins

http://www.aicr.org/site/PageServer?pagename=foodsthatfightcancer_home
≥ 5 tomato-containing meals per week may protect from cancers of the esophagus, stomach & prostate!
...but, the phytochemical candidate, **lycopene** with anti-oxidant activity is also in guava, papaya, pink grapefruit & watermelon!
# Common Foods Ranked by Antioxidant Content

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Blackberries</td>
</tr>
<tr>
<td>2.</td>
<td>Walnuts</td>
</tr>
<tr>
<td>3.</td>
<td>Strawberries</td>
</tr>
<tr>
<td>4.</td>
<td>Spinach</td>
</tr>
<tr>
<td>5.</td>
<td>Artichokes, prepared</td>
</tr>
<tr>
<td>6.</td>
<td>Cranberries</td>
</tr>
<tr>
<td>7.</td>
<td>Coffee</td>
</tr>
<tr>
<td>8.</td>
<td>Raspberries</td>
</tr>
<tr>
<td>9.</td>
<td>Pecans</td>
</tr>
<tr>
<td>10.</td>
<td>Blueberries</td>
</tr>
<tr>
<td>11.</td>
<td>Cloves, ground</td>
</tr>
<tr>
<td>12.</td>
<td>Grape juice, cranberry juice, pomegranate juice</td>
</tr>
<tr>
<td>13.</td>
<td>Chocolate, dark, unsweetened</td>
</tr>
<tr>
<td>14.</td>
<td>Cherries, sour</td>
</tr>
<tr>
<td>15.</td>
<td>Wine, red</td>
</tr>
</tbody>
</table>

Sizer & Whitney 2011 Table C2-3 p 64
Antioxidant Capacity Depends Upon Seasons, Storage, Testing Methods, Variety...

![Bar chart showing antioxidant capacity of various foods](image)

- 1 sm Apple, Red Delicious, w/skin
- 1 oz Chocolate, dark
- ½ c Plums, dried
- 5 fl oz Wine, red
- ½ med Artichokes, boiled
- 1 oz Pecans
- ½ c Blueberries, fresh
- 1 oz Walnuts, English
- ½ c Strawberries, sliced
- 1 med Sweet potato, baked

*a Measured in micromole TE (Trolox equivalents), a laboratory-derived value used to measure the antioxidant activity of foods. Other laboratory methods yield other results.

Environmental Working Group Suggestions

<table>
<thead>
<tr>
<th>12 Most Contaminated</th>
<th>12 Least Contaminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy These Organic</td>
<td>Not as Much Concern</td>
</tr>
<tr>
<td>• Apples</td>
<td>• Asparagus</td>
</tr>
<tr>
<td>• Bell Peppers</td>
<td>• Avocados</td>
</tr>
<tr>
<td>• Celery</td>
<td>• Bananas</td>
</tr>
<tr>
<td>• Cherries</td>
<td>• Broccoli</td>
</tr>
<tr>
<td>• Imported Grapes</td>
<td>• Cauliflower</td>
</tr>
<tr>
<td>• Nectarines</td>
<td>• Corn (sweet)</td>
</tr>
<tr>
<td>• Peaches</td>
<td>• Kiwi</td>
</tr>
<tr>
<td>• Pears</td>
<td>• Mangos</td>
</tr>
<tr>
<td>• Potatoes</td>
<td>• Onions</td>
</tr>
<tr>
<td>• Red Raspberries</td>
<td>• Papaya</td>
</tr>
<tr>
<td>• Spinach</td>
<td>• Pineapples</td>
</tr>
<tr>
<td>• Strawberries</td>
<td>• Peas (sweet)</td>
</tr>
</tbody>
</table>

http://www.foodnews.org/reportcard.php
Resveratrol, a flavonoid in purple grape juice & red wine may lower incidence of cardiovascular diseases.

*NB*: ...but typical serving amounts may be too small to benefit human health!...Alcoholism?
High doses of soy phytoestrogens may lower blood cholesterol

**NB**: ...but low doses of the phytoestrogen, *genistein* promotes breast cancer cell division (in lab cultures & mice).
Preventing Cancer: Strategies That Can Reduce Your Risk
UC Berkeley Wellness Reports, 2012

1. Don't smoke or use any tobacco product.
2. Keep the weight off.
3. Get off the couch.
4. Eat a healthy diet.
5. Drink less alcohol.
7. Limit sun exposure.
8. Limit radiation from medical imaging tests.
9. Test your home for radon.
10. Test your water for arsenic.
11. Decrease workplace exposure to carcinogens.
12. Limit your exposure to air pollution (outdoors & indoors).
1. **Use up at least as many calories as you take in!**

2. **Eat a variety of nutritious foods from all food groups.**

3. **Eat less of the nutrient-poor foods.**

4. **Don’t smoke tobacco — and stay away from tobacco smoke.**
1. Choose lean meats & poultry without skin & prepare them without added saturated & trans fat.
2. Select fat-free, 1 percent fat & low-fat dairy products.
3. Cut back on foods containing partially hydrogenated vegetable oils to reduce trans fat.
4. Cut back on foods high in dietary cholesterol. Aim to eat less than 300 milligrams of cholesterol each day.
5. Cut back on beverages and foods with added sugars.
6. Choose and prepare foods with little or no salt. Aim to eat less than 1,500 milligrams of sodium per day.
7. If you drink alcohol, drink in moderation. 1 drink/day if you’re a woman & 2 drinks/day if you’re a man.
8. Follow AHA recommendations when you eat out & keep an eye on portion sizes.
Why exercise?
THE REWARD OF FITNESS: LONGEVITY

![Bar graph showing death rates per 10,000 person years for different fitness levels, with women (3120) at each level.

Source: SN Blair & associates, JAMA, 1989, 263(15), 2395-401.]
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
Animal fats and the tropical oils of coconut and palm contain mostly saturated fatty acids.

<table>
<thead>
<tr>
<th>Fat</th>
<th>Saturated fatty acids</th>
<th>Polyunsaturated, omega-6 fatty acids</th>
<th>Monounsaturated fatty acids</th>
<th>Polyunsaturated, omega-3 fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef tallow (beef fat)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palm oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lard (pork fat)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken fat</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Some vegetable oils, such as olive and canola, are rich in monounsaturated fatty acids.

<table>
<thead>
<tr>
<th>Oil</th>
<th>Monounsaturated fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil</td>
<td></td>
</tr>
<tr>
<td>Canola oil</td>
<td></td>
</tr>
<tr>
<td>Peanut oil</td>
<td></td>
</tr>
</tbody>
</table>

Many vegetable oils are rich in omega-6 polyunsaturated fatty acids.

<table>
<thead>
<tr>
<th>Oil</th>
<th>Omega-6 polyunsaturated fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safflower oil</td>
<td></td>
</tr>
<tr>
<td>Sunflower oil</td>
<td></td>
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<tr>
<td>Corn oil</td>
<td></td>
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<tr>
<td>Soybean oil</td>
<td></td>
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<tr>
<td>Walnut oil</td>
<td></td>
</tr>
<tr>
<td>Cottonseed oil</td>
<td></td>
</tr>
</tbody>
</table>

Only a few oils provide significant omega-3 polyunsaturated fatty acids.

<table>
<thead>
<tr>
<th>Oil</th>
<th>Omega-3 polyunsaturated fatty acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaxseed oil</td>
<td></td>
</tr>
<tr>
<td>Fish oil</td>
<td></td>
</tr>
</tbody>
</table>

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a These families of polyunsaturated fatty acids are explained in a later section.
b Salad or cooking type over 70% linoleic acid.
c Fish oil average values derived from USDA data for salmon, sardine, and herring oils.
The Amazing
BENEFITS
of Coconut Oil

Nutritional Content in Coconut Oil:

- **Anti oxidants**
- **MCT Medium-Chain Triglycerides**
- **Lauric Acid**
- **Caprylic Acid**
- **Capric Acid**

The Health & Healing Benefits of Coconut Oil:

- **Skin Care**
The MCT in Coconut oil act as a natural skin conditioner. Deeply penetrating & moisturizing, they protect against environmental & free radical damage, it also helps with anti-aging, eczema & even provides some sun protection.

- **Hair Care**
Coconut oil is one of the best ways to provide nutrients to your hair. The fatty acids condition deeply from the inside out. Providing protein, eliminating dandruff & aiding in re-growth. Many people use it as a conditioner!

- **Weight Loss**
The Fatty Acids in coconut oil destroy candida (yeast overgrowth) which triggers weight gain, carbohydrate cravings & fatigue. They’re easily digested & converted into energy, which helps to speed up metabolism & help burn stored fat.

- **Immunity**
The unique saturated fats of coconut oil contain antibacterial, antiviral, anti-fungal, and anti-parasitic properties that help strengthen the immune system. Consuming coconut oil regularly will reduce incidences of sickness.

- **Stress Relief**
Coconut oil is very soothing. The natural aroma of coconut is also very soothing. You can apply the oil to your head & gently massage to help remove mental fatigue.

- **Infections**
**Laurie Acid** (found only in breast milk & coconut oil) is converted into monolaurin in the body. This may destroy bacterial & viral infections like measles, influenza, hepatitis C & even HIV. Monolaurin may also eliminate Athlete’s foot.

- **Diabetes**
Coconut oil may improve insulin sensitivity & glucose tolerance over time. It helps regulate blood sugar levels & protects against insulin resistance. It can even help prevent Type II Diabetes.

- **Heart Health**
The fat in coconut oil does not have a negative effect on cholesterol. In fact, it helps improve your cholesterol profile. It helps prevent heart attack & stroke and may even cure heart disease.

TIP: Buy Organic, Unrefined, Cold-Pressed, Extra-Virgin Coconut Oil!

**SOURCES:**
http://www.coconutchocolatecenter.org
http://www.naturalnews.com
www.NaturalHealthyConcepts.com
Many claims with little scientific, peer-reviewed, research support

Coconut Oil
Health Benefits

- Improves or Reverses Alzheimer's Disease
- Improves Type 2 AND Type 1 Diabetes
- Improves or Heals Many Skin Diseases
  - Fungal Infections
  - Acne
  - Eczema
  - Keratosis Polaris
  - Psoriasis
  - Rosacea
- Provides Peak Performance Energy
  - Drug-free Energy
  - Longer Endurance
- Kills Candida Fungus
- Helps with Hypothyroidism
  - Increases Metabolism
  - Raises Body Temperature
- Conditions and Strengthens Hair
  - Penetrates Roots
  - Kills Lice
  - Improves Dandruff
- Kills many Bacteria AND Viruses
- Promotes Weight Loss
  - Preserves Muscle Mass
  - Promotes Ketosis

Find all the research at: CoconutOil.com

http://www.doctoroz.com/videos/surprising-health-benefits-coconut-oil
Coconut Oil
Nutritional Wonder?

Claims?
http://coconutoil.com/about-us/

Review articles, last 5 yr (1) on health benefits?

Other articles?

The bottom line?
http://www.cspinet.org/nah/articles/coconut-oil.html
http://health.clevelandclinic.org/2012/05/heart-healthy-cooking-oils-101/
http://en.wikipedia.org/wiki/Smoke_point
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

![Graph showing the percentage of cellularity in different bone types over age.](G&H 2011 fig 32-1 p 414)
Red Blood Cell Genesis

Proerythroblast

↓

Basophil erythroblast

↓

Polychromatophil erythroblast

↓

Orthochromatotic erythroblast

↓

Reticulocyte

↓

Erythrocytes

Microcytic, hypochromic anemia

Sickle cell anemia

Megaloblastic anemia

Erythroblastosis fetalis

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

Hematopoietic Stem Cells

Proerythroblasts

Red Blood Cells

Tissue Oxygenation

Factors that decrease oxygenation
1. Low blood volume
2. Anemia
3. Low hemoglobin
4. Poor blood flow
5. Pulmonary disease

Kidney

Erythropoietin

Decreases

Decreases

G&H 2011 fig 32-4 p 416
Hemoglobin Formation

Citric Acid Cycle

I. 2 succinyl-CoA + 2 glycine →

II. 4 pyrrole → protoporphyrin IX

III. protoporphyrin IX + Fe^{++} → heme

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

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

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

NB: CO carbon monoxide binds with ~200-fold greater affinity than O₂
Hemoglobin Structure

L Sherwood 2011 fig 11-2
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
NEUTROPHILS

EOSINOPHILS

BASOPHILS

LYMPHOCYTES

MONOCYTES

PLATELETS

ERYTHROCYTES

SI Fox 1987 p 376
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
- Fungi
- Protozoa
- + 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 2011 Statistics +
http://www.who.int/bulletin/volumes/86/9/07-050054.pdf*

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!

multipotent stem cells

red blood cells

platelets

leukocytes

lymphoid cells

granulocytes

monocytes

small lymphocytes

large granular lymphocytes

eosinophils

neutrophils

basophils and mast cells

macrophages

adaptive immunity

innate immunity

Davey 1990 p 13
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

NB: Happy Birthday Song 20-30 sec!!!

http://www.squidsoap.com/