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! By 5 pm Tuesday send nutrition reports to Stacy aleviche@uoregon.edu or Conor conoro@uoregon.edu. Outline update? Q?

II. **Nutrition Connections**
Sodium, US diabetes trends, exercise?

III. **Blood + Body Resistance to Infection**
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
Health Valley Organic

NO SALT ADDED Vegetable SOUP

NET WT 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**

- **Serv. Size**: 1 Cup (240g)
- **Calories**: 100
- **Fat Cal.**: 25
- **Total Fat**: 2.5g (4% DV)
- **Sat. Fat**: 0g (0% DV)
- **Trans Fat**: 0g
- **Cholesterol**: 0mg (0% DV)
- **Total Carb.**: 18g (6% DV)
- **Dietary Fiber**: 4g (16% DV)
- **Sugars**: 4g
- **Protein**: 3g (5% DV)
- **Sodium**: 50mg (2% DV)
- **Vitamin A**: 90%
- **Vitamin C**: 40%
- **Calcium**: 4%
- **Iron**: 8%

**INGREDIENTS**:

**MADE WITH NO GENETICALLY ENGINEERED INGREDIENTS.**

**CERTIFIED ORGANIC BY QUALITY ASSURANCE INTERNATIONAL (QAI)**

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1994 Diabetes Prevalence in the US by State

Key:
- Yellow: <4.5%
- Light Blue: 4.5%–5.9%
- Medium Blue: 6.0%–7.4%
- Purple: 7.5%–8.9%
- Green: ≥9%

Source: Centers for Disease Control, Division of Diabetes Translation, [http://www.cdc.gov/diabetes/statistics](http://www.cdc.gov/diabetes/statistics), S&W 2014 fig 4-15 p139A.
2010 Diabetes Prevalence in the US by State

Source: Centers for Disease Control, Division of Diabetes Translation, [http://www.cdc.gov/diabetes/statistics](http://www.cdc.gov/diabetes/statistics), S&W 2014 fig 4-15 p139B.
When insulin docks in the receptors on cell membranes, that should signal glucose transporters to let glucose (blood sugar) into the cell. But if you are insulin resistant, some glucose transporters never get the message. (Others don’t need insulin to let glucose in.) That leaves excess glucose in the blood, so the pancreas has to pump out more insulin. If it can’t keep up, blood sugar rises and you have diabetes.
WHERE'S THE FAT?

Muscle Fat
Liver Fat
Visceral Fat
Subcutaneous Fat

Surplus calories are turned into fat and stored in your subcutaneous and visceral fat cells. When those cells fill up, the body stashes fat in muscles and the liver. A fatty liver and visceral fat are most closely linked to insulin resistance and diabetes.

The Bottom Line

- The best way to dodge diabetes is to lose (or not gain) extra pounds.
- Limit sweets, especially sugar-sweetened drinks. Even the naturally occurring sugars in 100% fruit juice may raise your risk.
- Eat leafy greens, whole grains, beans, and nuts to boost your magnesium.
- Get the RDA for vitamin D (600 IU a day up to age 70 and 800 IU over 70) from supplements or foods fortified with vitamin D.
- Do at least 30 minutes of brisk walking or other aerobic exercise every day.
- Shoot for 2 or 3 strength training sessions a week. Each should include 8 to 12 repetitions of 8 to 10 exercises.

Why exercise?
THE REWARD OF FITNESS: LONGEVITY

![Bar chart showing death rates by fitness level for women.](chart)

- **DEATH RATES**
  - 10,000 person yr

- **FITNESS LEVEL**
  - Low
  - High

- **WOMEN (3120)**
  - Low: 39.5
  - Medium: 20.5
  - High: 12.2

**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

http://www.cdc.gov/physicalactivity/everyone/guidelines/index.html
http://www.health.gov/paguidelines/
What’s in Blood? Plasma & Blood Cells

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

![Dermal bone production of red blood cells](image_url)
Pluripotent Hematopoietic Stem Cell Lines

G&H 2011 fig 32 p 414

G&H 2016 fig 33-2 p 446
Red Blood Cell Genesis

- Proerythroblast
  - Basophil erythroblast
  - Polychromatophil erythroblast
    - Orthochromatric 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

- Erythropoietin
- Hematopoietic Stem Cells
  - Proerythroblasts
  - Red Blood Cells
  - Tissue Oxygenation

- Kidney
- Decreases

Factors that decrease oxygenation:
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 + Fe^{++} → heme

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

V. 2 α chains + 2 β chains → hemoglobin A
NB: CO carbon monoxide binds with ~200-fold greater 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
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
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
- Bone marrow cells
- Red blood cells
- Platelets
- Leukocytes
  - Lymphoid cells
    - Small lymphocytes
    - Large granular lymphocytes
  - Granulocytes
    - Neutrophils
    - Eosinophils
    - Basophils and mast cells
  - Monocytes
    - Macrophages

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

http://www.squidsoap.com/