I. **Announcements** Notebooks? Exam II, Dec 13th Friday 8 am. Review session in class next Thurs. Q?

II. **Muscle Contraction & Adaptation** LS ch 8, DC Mod 12
   A. Summary of skeletal muscle contraction
      Malcolm Campbell & David Bolinsky videos
   B. Exercise adaptation variables: *mode, intensity, duration, frequency, distribution, individual & environmental char...*?
   C. Endurance vs. strength training continuum? fiber types...

III. **Respiratory System** LS ch 12, DC Module 7, Fox +...
   A. Steps of respiration? External vs. cellular/internal?
      LS fig 12-1 pp 345-347
   B. Respiratory anatomy LS fig 12-2 p 347, DC, Fox +...
   C. Histology LS fig 12-4 pp 347-349, DC
   D. How do we breathe? LS fig 12-12, fig 12-25 pp 349-356, pp 373-378
Be safe in travel! Peace! Have a Happy Turkey Day!!!
Adaptations to Exercise?
Mode, Intensity, Duration, Frequency, Distribution of Training Sessions? Conditions of Environment? Individual?
Adaptations to Exercise?

Body Levels of Organization?

Which Body System?

Molecular

Cell/Tissue

Organ

Body System
Muscle Adaptations to Exercise
As muscles tug on bones, bones get stronger, too!...many systems adapt!!
Echocardiography documents hypertrophy...
Cardiac Adaptations to Exercise: ① Endurance vs. ② Strength Training

**NB:** ① > ↑ LBM
Atrophy
*decrease in size & strength*

Hypertrophy
*increase in size & strength*
Skeletal Muscle

Atrophy

Hyperplasia

Hypertrophy
Women & Hypertrophy?
What happens in muscles at cellular & subcellular levels?
Hypertrophy: Increased Number of Myofibrils
Thick & Thin Filaments
Myosin & Actin Molecules
### Characteristics of Skeletal Muscle Fibers

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Slow Oxidative (Type I)</th>
<th>Fast Oxidative (Type IIa)</th>
<th>Fast Glycolytic (Type IIb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myosin-ATPase Activity</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Speed of Contraction</td>
<td>Slow</td>
<td>Fast</td>
<td>Fast</td>
</tr>
<tr>
<td>Resistance to Fatigue</td>
<td>High</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>Aerobic Capacity</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Anaerobic Capacity</td>
<td>Low</td>
<td>Intermediate</td>
<td>High</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Many</td>
<td>Many</td>
<td>Few</td>
</tr>
<tr>
<td>Capillaries</td>
<td>Many</td>
<td>Many</td>
<td>Few</td>
</tr>
<tr>
<td>Myoglobin Content</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Color of Fibers</td>
<td>Red</td>
<td>Red</td>
<td>White</td>
</tr>
<tr>
<td>Glycogen Content</td>
<td>Low</td>
<td>Intermediate</td>
<td>High</td>
</tr>
</tbody>
</table>
AEROBIC (Oxidative Energy System)

- PRIMARY FUEL: FAT, CARBOHYDRATE & PROTEIN (Small Amounts)
- ACTIVITY: Marathon, Cross-Country Skiing
- TIME: 135:00

ANAEROBIC (Immediate & Non-Oxidative Energy Systems)

- PRIMARY FUEL: CARBOHYDRATE (Glucose & Glycogen)
- ACTIVITY: 2-Mile Run, 800-Meter Swim, Boxing, Circuit Weight Training
- TIME: 3:45

- PRIMARY FUEL: ATP, ADP & Creatine Phosphate (CP)
- ACTIVITY: Basketball, Volleyball, 200-Meter Dash, Conventional Weight Training
- TIME: 0:20

MITOCHONDRIA

- CYTOSOL
- Glycolysis

Immediate/ATP-PC
Muscle Changes Due to Strength Training

- Size of larger fast vs smaller slow fibers
- CP as well as creatine phosphokinase (CPK) which enhances short-term power output
- Key enzymes which help store and dissolve sugar including glycogen phosphorylase (GPP) & phosphofructokinase (PFK)
- Mitochondrial # relative to muscle tissue
- Vascularization relative to muscle tissue
- Splitting of fast fibers? Hyperplasia?
- With growth hormone (GH), androgenic-anabolic steroids (AAS)?
Muscle Changes Due to Endurance Training

↑ Mitochondria, # & size
↑ Mitochondrial (aerobic) enzymes including those specific for fat burning
↑ Vascularization of muscles (better blood flow)
↑ Stores of fat in muscles accompanied by
↓ Triglycerides/fats in bloodstream
↑ Enzymes: activation, transport, breakdown (β-oxidation) of fatty acids
↑ Myoglobin (enhances O₂ transport)
↑ Resting energy levels which inhibit sugar breakdown
↑ Aerobic capacity of all three fiber types.
Which end of continuum?

+ 

Which energy nutrient/s?
+ Which specific muscles?
Dancing can be super aerobic exercise, too, & you don’t have to be a star!
Extremes of the energy continuum!
Discussion + Time for Questions!
Hey baby, what's your sign?

Cancer.
Lombo’s simplified steps!

1. Breathe in & out!

2. Cross membranes!

3. Move with blood!
   Go with the flow!

4. Cross membranes!

LS 2012 fig 12-1 modified
**NB:** *In vivo,* Cupola or peak of each lung goes into neck > clavicle line!
16-20 C-shaped bars of hyaline cartilage to prevent collapse
Vocal cords approximate (move closer together) during *Valsalva’s* maneuver!
Pulmonary Latex Cast with Colored Segmentation
Bronchograms (posteroanterior)

Source: Gardner, Gray, O’Rahilly, Anatomy, fig 29-11, p 295.
No Gas Exchange

Gas Exchange

1st alveolar outpouching!
The last cilium on a smoker's lung

Shoot... If only I had a red five.
Capillaries with rbcs!

← Alveoli → White Blood Cell
NB: Diaphragm is the chief muscle of ventilation!
**Inhale (active)**

Contract & flatten diaphragm

**Exhale (passive @ rest)**

Relax & pouch up diaphragm!
Brain stem ≡ Control Center for automatic breathing!
Respiratory membrane separates air from blood, is 6 layers, yet 1/50th thickness of tracing paper!
Alveoli are surrounded by jackets of capillaries!
Across pulmonary capillaries:
O₂ partial pressure gradient from alveoli to blood = 60 mm Hg (100 → 40)
CO₂ partial pressure gradient from blood to alveoli = 6 mm Hg (46 → 40)

Across systemic capillaries:
O₂ partial pressure gradient from blood to tissue cell = 60 mm Hg (100 → 40)
CO₂ partial pressure gradient from tissue cell to blood = 6 mm Hg (46 → 40)

Numbers are mm Hg pressure.

Gas Exchange

cf: LS 2012 fig 12-19