BI 121 Lecture 14

I. **Announcements**  Last Lab 6, Pulmonary Function Testing + Optional notebook ✓ this Thurs. Exam II Fri Dec 7, 8am Q?

II. **Nervous System Connections**  LS ch 3, 4 & 7; DC Module 9
   B. How does the signal cross the nerve-muscle gap?  LS p 185-92 fig 7-5 p 190; DC pp 69-71 fig 9-4
      1. Ca2+ bones!...but what else? LS p 190
      2. What do black widow spider venom, botulism, curare & nerve gas have in common? Botox LS pp 189-92

III. **Muscle Structure & Function**  LS ch 8 + DC Mod 12
   A. Muscle types: cardiac, smooth, skeletal  LS fig 8-1
   B. How is skeletal muscle organized? LS fig 8-2, DC fig 12-2
   C. What do thick filaments look like? LS fig 8-4, DC fig 12-4
   D. Thin filaments? Banding pattern LS fig 8-5, 8-3, 8-7
   E. How do muscles contract? LS fig 8-6, 8-10
   F. What's a cross-bridge cycle? LS fig 8-11 +...
Why are nerve & muscle unique?

They are excitable!!
Action Potentials ≡ Spikes ≡ Impulses

Ultra-short reversal of membrane potential
Only in nerve and muscle cells
Maintains strength over distance

Primary way nerves & muscles communicate!
"Resting"/Membrane Potential?

Cells are slightly **negative** inside!
Stimulate Cell @ Rest

- **Thermal**
- **Mechanical**
- **Electrical**
- **Chemical**

1
Changes Cell Membrane Permeability to Sodium/Na+!

+ Charges/Na+ Rushes In!
Action Potential has occurred!

Brief (1-2 ms) reversal to + inside cell!
Mechanical
Chemical
Electrical
Thermal

Triggering event

Depolarization (decreased membrane potential)

Influx of Na⁺ (which further decreases membrane potential)

Opening of some voltage-gated Na⁺ channels

Positive-feedback cycle!
- Action potential
- After hyperpolarization

Membrane potential (mV)

Time (msec)

1 msec

Na⁺ equilibrium

Threshold

Resting potential

K⁺ equilibrium

stimulus
Threshold

Resting potential

Caused by Na⁺ entry

Rising phase

Falling phase

Caused by K⁺ exiting

$P_{Na^+}$, $P_{K^+}$

Threshold

Time (msec)

Membrane potential (mV)
**Synapse**
Generic term = connection between excitable cells!

Chemical? or Electrical?
Synaptic Transmission

1. Voltage-gated Ca$^{2+}$ channel
2. Neurotransmitter molecule
3. Synaptic cleft
4. Chemically-gated ion channel for Na$^+$, K$^+$, or Cl$^-$
5. Receptor for neurotransmitter

NT Balance!

- Uptake
- Release

Presynaptic axon terminal

Synaptic knob

Synaptic vesicle

Subsynaptic membrane

Postsynaptic neuron

LS 2012 fig 4-14
Other Links That May Be Helpful!

https://www.youtube.com/watch?v=6RbPIOq0O3w
https://www.youtube.com/watch?v=mItV4rC57kM
https://www.youtube.com/watch?v=WhowH0kb7n0
http://sites.sinauer.com/psychopharm2e/animation03.01.html
https://www.youtube.com/watch?v=VitFvNvRlIY
Break for discussion/questions!
Striated muscle

Skeletal muscle

Cardiac muscle

Smooth muscle

Voluntary muscle

Involuntary muscle

https://www.youtube.com/watch?v=VVL-8zr2hk4

LS 2012 fig 8-1
Skeletal Muscles

**Homeostasis**
Skeletal muscles contribute to homeostasis by playing a major role in the procurement of food, breathing, heat generation for maintenance of body temperature, and movement away from harm.
Skeletal Muscle Histology: Microscopic Anatomy

Muscle fiber or cylindrical cell

“Threads” ≡ Myofibrils

Nuclei

Dark-Light...bands ≡ Overlapping thick & thin filaments

x1000

H Howard 1980.
Organ = Muscle

Cell = Myocyte = Fiber

Subcellular = Cytoskeleton

Molecules = Actin & Myosin

LS 2006, cf:
LS 2012 fig 8-2
DC 2013 fig 12-3
Whole Muscle

Myocyte or Muscle Fiber

Myofibril

Thick & Thin Filaments

Myosin & Actin

Organ

Cell

Cytoskeleton

Molecules
Golf Club Analogy?

(a) Actin binding site
Myosin ATPase site

(b) Cross bridges
Myosin molecules

LS 2006, cf:
LS 2012 fig 8-4
Broccoli Analogy?

Myosin Heads

Myosin Tails

Bare Zone

Myosin Heads

Actin molecules

Actin helix

Tropomyosin

Troponin

Thin filament
Triad $\equiv$ T tubule abutting cisternae

Mitochondria

Sarcomere

Myofibril
A Band = Dark Band
Anisotropic = Light Can’t Shine Through

I Band = Light Band
Isotropic = Light Can Shine Through
Discussion + Time for Questions!