

Week 7 Lecture 0

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1 Administrative drivel

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2 Anatomy and Physiology

2.1 Muscles

- The ends of the sarcomeres are referred to sometimes as zlines
- Contraction
 - Actin-myosin cycle:
 - * Myosin binds to actin
 - * myosin changes position, pulling on actin
 - * myosin releases actin, ATP binds at this final step
 - repeating this cycle shortens the sarcomere.
 - If ATP is absent, myosin cannot release
 - rigor mortis set in because after death ATP dwindles and eventually runs out
 - * myosin is left permanently bound to the actin
 - this is the same thing as a cramp!
 - Nerve cells stimulate muscle contraction:
 - * *Nerve* cells release neurotransmitter (chem. signal)
 - * It *Binds to receptors* in the plasma membrane of the muscle cell (fiber)
 - * Causes increases in calcium ions (CA^{2+}) inside the cell (stored in the smooth ER/ sarcoplasmic reticulum)
 - each actin is normally covered by an accessory protein, but the ions open up the actin for binding
 - * Calcium causes shift in protein (tropomyosin) that blocks myosin from binding to actin
 - * Myosin can interact with actin → contraction
 - Both CA^{2+} and ATP are involved
- Relaxation
 - Calcium is pumped back into the SER
 - w/o CA^{++} , calcium regulated protein blocks myosin binding site on actin
 - myosin cannot bind any more / no more contraction
 - Muscle relaxation occurs as antagonistic muscle does its job via the tendons, pulls the muscle back to the relaxed length

- To recap:
 - Basic structure: sarcomere
 - made of thin filament of actin, thick of myosin with movable heads
 - nervous system sends a neurotransmitter, traveling to a T tubule, down SER, leading to the release of Ca^{++}
 - the Ca^{++} acts on the accessory proteins
 - * 2 kinds: troponin and tropomyosin (former pulls on the latter to expose the binding sites on the actin when exposed to Ca^{++})
 - At the sarcomere, myosin heads 'walk' along actin filament
 - * myosin binds to actin
 - * ATP is broken, releasing the phosphate, moving the myosin head to the next binding site
 - 20 cm of contraction is spread across 100,000 sarcomeres
- Different types of muscle fiber: slow twitch and fast twitch
 - Almost all muscles have both, and one might dominate the other depending on use and genes, etc
 - slow twitch develops with aerobic, fast twitch with quick motions
 - slow twitch has high endurance relative to fast twitch
 - slow twitch
 - * lots of blood supply
 - * lots of mitochondria
 - * lots of myoglobin (binds to oxygen, much like hemoglobin)
 - * less glycogen
 - * more stamina
 - * less diameter
 - * less tension
 - * Aerobic – requires high O_2 delivery
 - O_2 present
 - $\text{Glucose} \rightarrow \text{pyruvic acid} + 2\text{ATP}$
 - $\text{pyruvic acid} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + 34 \text{ATP}$
 - * most of what we do is slow twitch
 - * small movements, sitting upright, endurance
 - fast twitch
 - * Lower blood supply
 - * fewer mitochondria
 - * Less myoglobin
 - * Lots of glycogen
 - * less stamina
 - * bigger diameter
 - * more tension
 - * anaerobic – does not require high O_2
 - O_2 absent
 - $\text{Glucose} \rightarrow \text{pyruvic acid} + 2 \text{ATP}$
 - $\text{pyruvic acid} \rightarrow \text{Lactic acid}$
 - (lactic acid is eventually split into pyruvic acid and put back through aerobic cycle)
 - * brief powerful movement

- **Hypertrophy** is due to increase in number of myofibrils, but not the number of cells (think body builders)
 - Each muscle cell has multiple myofibrils
- **Atrophy** loss of muscle mass is a normal part of aging, and is impacted by nutrition , exercise. Also occurs if a limb is inactive for several months
- Anabolic steroids:
 - Testosterone-like chemicals, stimulates actin and myosin production
 - cheating, long term side effects
- Clicker Q: calcium does NOT stimulate ATP breakdown
- end of play...

3 Cardiovascular system

3.1 Heart

- In the thoracic cavity and protected by the ribs
- has 4 pumps that push blood through the pulmonary and systemic circuits
- Cardio == heart
- vascular == blood vessels
- Functions of cardio system:
 - blood picks up all of the waste from cells/tissues (e.g. CO_2)
 - blood carries things to the cells/tissues (e.g. O_2 , glucose)
 - Transport immune cells
 - causes clotting
 - transport hormones
 - transports water
 - etc.
- What color is blood?
 - books show blood as red in the arteries, and blue in the veins
 - blood is *not* blue
 - oxygenated blood is bright red, deoxygenated blood is a little darker red