Name:
Problem Set 1

1. Compared to terrestrial animals, fish have a very reduced skeleton—most prominently consisting of a skull, a long, thin spine, and wispy ribs. This skeleton actually provides little structural support to most of the body. This means fish bodies behave more like a muscular organism, with a mostly-fluid filled sac in the center called the viscera (that contains all its mostly-fluid organs). Fish muscles are actually organized in a zigzag fashion, with thick, tough connective tissue in between. Unlike tendons, this connective tissue is **not** stretchy, allowing muscles to generate tension by contracting against them. (Remember, in order to generate movement, actuators must move against a rigid body.)

   Based on this description, the *entire* fish body is like what biological structure?

   Bonus: Name one human body part that has this structure, or organism that is this biological structure.

2. You and your research team discover a new mutation in humans. People with this mutation have all the same overall bodily proportions and mass as a typical human, except some of their muscles are quite different in structure. The muscles on the upper leg, the quadriceps and hamstring, in typical humans are commonly used for walking and standing. Compared to typical human, this individual's quad and hamstring muscles are:
   a. much larger in volume, so they noticeably bulge more than "normal". Upon dissecting a biopsied tissue, you find there are large muscle fascicles.
   b. appear to have a large number of neurons innervating the muscle (and therefore a large number of neuromuscular junctions and motor units).
   c. are much paler in color, barely even pink!

   What twitch type will this muscle likely be?

   What general behaviors will this muscle be used for (power, endurance, both)? (Examples of behaviors are acceptable, too.)

   Bonus: What do you think their super power is?

Name:
Problem Set 1

3. Superheroes Thor and Black Lightning are able to shoot lighting bolts (electrical currents) from their hands at bad guys. In this way, Thor and Black Lightning are very much like strongly electric fish. These fish have aggregates of specialized cells called **electrocytes** that can send an electrical pulse (Electric Organ Discharge, or EOD) to stun or kill small prey. Electrocytes are modified muscle tissue, and an EOD has the duration as an action potential. What do you think happens to the electrocytes and surrounding muscle when an EOD is produced?

   Bonus: How do you think this will affect how Black Lightning or Thor will move when they are shooting bolts at baddies? (Assume they produce electricity the same way as electric fish.)