4.2.5 Rigor Mortis Models

**Sliding Filament Theory**

- how muscles produce force or shorten
- the thick and thin filaments in a sarcomere slide past each other, shortening the length of the sarcomere.
- to slide past each other, the myosin heads interact with actin filaments and using ATP bend to pull past the actin

**Steps**

- nerve impulse arrives at a neuromuscular junction causing the release of acetylcholine leading to the influx of calcium released by the sarcoplasmic reticulum to expose myosin
- Calcium binds to troponin which is found on tropomyosin on the actin molecule
- Binding of ATP (myosin head has “low energy” and a free ATP site, so ATP binds to it so it can gain more energy, and release the myosin from the actin)
- Hydrolysis of ATP (hydrolyzes the ATP to return to its high energy state)
- Binding of myosin to actin
- the power stroke (myosin immediately starts to pull on actin)
- Releases ADP and P
- Myosin forms a cross bridge with the actin
- When myosin releases, ATP binds to it, and it goes back to its original from
- The actin filament is pushed toward the middle of the sarcomere and slides past the myosin filament.
- The transport of excess calcium ions back to the sarcoplasmic reticulum

[http://faculty.stcc.edu/AandP/AP/AP1pages/Units5to9/unit8/sliding.htm](http://faculty.stcc.edu/AandP/AP/AP1pages/Units5to9/unit8/sliding.htm)

- Calcium is required by troponin and tropomyosin that regulate muscle contractions by preventing myosin from binding to actin
  - Tropomyosin blocks the binding of myosin to actin
  - it has to rotate around actin filaments to expose myosin binding sites


- Animation
http://www.wellcome.ac.uk/Education-resources/Education-and-learning/Bi
g-Picture/All-issues/Exercise-energy-and-movement/WTDV033020.htm

http://faculty.sdmiram.edu/faculty/sdccd/kpetti/Bio160/MiscImages/SlidingFilament-2.jp

g

on.jpg

http://www.nature.com/scitable/content/ne0000/ne0000/ne0000/ne0000/14624780/f4_good
y_nsb1003-773-F1_1_2.jpg
Design Process

1. How the sliding filament theory helps contract the muscles.
   - Students who need to know how muscles contracts
   - Craft supplies and knowledge on muscle contraction. The model must be constructed out of materials easily accessible at home or at school. The model must have moveable parts. You can manipulate these parts to show the process of muscle contraction. The model must show actin, myosin, troponin, tropomyosin, Ca2+ ions, ATP, neuromuscular junction, and sarcoplasmic reticulum. Each component of the model should be clearly labeled. The model must clearly show the sequence of events that must occur for a sarcomere to shorten and to go back to its original length. This same model should be able to be altered to show what happens to muscles at death and how/why the process of contraction is halted to lock up muscles. The terminology and explanation used in your model should be appropriate for your target audience.
   - Theories and historical evidence explaining how and why muscles contract
   - Yes because it helps advance our scientific knowledge on human anatomy
   - The limitations are the model is not a direct representation of the muscles and the model cannot demonstrate all of the functions in the body that are working at the same time.

2. Research and Ideas
   - Research started with the Medical chemistry university Szeged and their study of two proteins, myosin, and actin, and how they caused muscles to contract.
   - Possible new solutions could be a process, chemical, or protein that has not been discovered yet
   - Additional design goals could include using materials that clearly demonstrate the process of the sliding filament theory when put together

   
<table>
<thead>
<tr>
<th>Materials</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>- pipe cleaners</td>
<td>- demonstrates the process</td>
<td>- not a direct representation of the sliding filament structures</td>
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<tr>
<td>- pom poms</td>
<td>- simple so it is easy to understand</td>
<td></td>
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<tr>
<td>- beads</td>
<td></td>
<td></td>
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<tr>
<td>- construction paper</td>
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   - Our approach is the one described above

3. We will design a model to demonstrate the sliding filament theory
   - We will work on each step of the construction process as a group, and the model will be completed between Thursday and Monday
     - Construction paper - red
     - attach red pipe cleaners to the middle of the box opening
     - attach green pipe cleaners to side of open box
- put beads on green pipe
- take strings or pipe cleaners at the back of the box
- create an axon finger
- use blue pompoms for Ca2+ and purple for acetylcholine

- **Materials**
  - construction paper
  - pipe cleaners
  - beads
  - pom poms

- **Sketch**

- **Justification:**
  - The red box will be constructed out of construction paper and be able to move the sides. The sides will have green pipe cleaners which will be the actin filaments with light blue beads. The beads will serve as troponin and the string will be wrapped around the green pipe cleaners as tropomyosin. The black pipe cleaner will be the sarcoplasmic reticulum and the black pipe cleaners (will be red on the actual model but we had to change the color because of the red box) will be the myosin filaments. This design will allow the filaments to move together by pushing on the sides of the paper box and demonstrate the movement of muscles.

4. Construct and test a prototype
**Conclusion Questions**

1. Multiple muscle system work together to move the body because the nervous system sends signals to the muscular system to react to a stimulus. In order for the body to react to the stimulus, the muscles must undergo the process of the sliding filament theory for the muscles to contract and relax.

2. Calcium plays a major role in the contraction of a muscle, which is why drinking milk doesn't only help strengthen muscles. The calcium plays a major role in the contracting of muscles, because it help expose the myosin so the actin is able to bind to it.

3. The actin and myosin never actually shorten during the process but the actual muscle does because the actin and myosin pull past each other, instead of shortenind when they are pulled closer.

4. Ions and electrical charges play a role in communication because the calcium that exposes the myosin is actually the calcium ion, and the electrical charges come from the electrical impulses from the neuron, and the charges of the ions.

5. Rigor mortis is when a dead body’s muscles become extremely stiff. It is only a temporary condition because the excess and stored lactic acid begins to deteriorate the muscles.

6. When a muscle gets a cramp, it is from the a decrease of the intake of oxygen, which causes lactic acid to build up, as well as a slowed ATP production. Becuase of these two factors, the muscle cramps us and becomes stiff, but as breathing pattern return to normal, so does the muscles relaxation.

7. Two benefits of using models to represent this process is 1) it allows for us to have a visual of the process and 2) we are able to understand better. However one drawback would be that it does not show the other processes happening in the body that also helps play a role in the process.

8. I think our model conveys the sliding filament theory very well, and I would not go back to change anything.