

Project 4.2.5: Rigor Mortis Models

Introduction

Think back to the last time you watched a crime scene investigation show on TV or a thriller at the movies. The coroner or medical examiner comes to examine the scene and states that a dead body is in “full rigor” or that “rigor mortis” has set in. You probably figured out that this means that the body is now stiff and the limbs are hard to move, but have you figured out what causes this change? The answer, of course, lies in the science. This stiffening is directly related to the chemical state of your muscles upon death.

In Activity 4.2.4, you learned that ATP is required for successful muscle contraction. Now you will zoom in on the sarcomere, the smallest unit of a muscle, and see exactly *how* ATP is used to make a muscle contract and relax. The sarcomere is made up of two important proteins, *actin* and *myosin*. You will investigate the movement of these two fibers in contraction as well as the role other ions, electric stimuli and body systems play in this process. Using your findings, you will design and build a 3D working model of muscle contraction. You will present your model on a segment of the fictitious show *CSI - The Science Revealed* targeted to middle and high school students. This model will be manipulated to show the sequence of events that occur during normal shortening of the sarcomere, as well as educate your audience on why the muscles can lock up after death.

Equipment

* Computer with Internet access
* Assorted modeling supplies
* Laboratory journal
* Design Process handout
* Reference textbook (optional)

Procedure

1. Use the Internet to research the mechanics of muscle contraction. Focus on what happens at the level of the sarcomere. This theory of muscle contraction is often called the “sliding filament theory.”
2. Find three legitimate sources of information that include diagrams, pictures or animations. Write the name of each site as well as the associated web address in your laboratory notebook.
3. Under the heading for each source, take notes on the process and make sketches of the stages of contraction. Pay attention to actin and myosin as well as other important proteins.
4. In groups of three, write a step-by-step description of the “sliding filament theory.” Think about the requirements for contraction. What stimuli, sources of energy and other ions are needed to shorten a muscle?
5. Take out the Design Process handout from your notebook.
6. Follow the Design Process to design a 3D working model of muscle contraction.
7. Read the criteria listed below.
* 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 (but is not limited to) the following components- **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.
1. Work your way through the steps of the design process, writing notes in your laboratory journal under a heading for each step.
2. At design step 5, generate a list of materials and supplies that will be needed. Some materials are available in class, but you may bring in other items from home. Share your list of materials with your teacher.
3. Design and sketch your model. Be creative and really think of a way to make the science clear. Once your plans are approved by your teacher, begin building.
4. Continue working through the design steps and make changes to your prototype as needed.
5. Remember that your model is to be used on a segment entitled *CSI - The Science Revealed*. Your job is to take the mystery out of rigor mortis. Your final product should be informative, entertaining and should be appropriate for your audience.
6. Present your model to the class in a three to five minute oral presentation. Use your model to teach your segment.
7. Answer the conclusion questions.

Conclusion

1. How do multiple human body systems work together to cause muscle contraction and movement of the body?
2. Your friend tried to convince you that the only reason to drink milk and to make sure you get enough calcium is so you can build strong bones. Can you offer him/her another reason?
3. Explain how it is that actin and myosin in the sarcomere never actually shorten and yet the muscle as a whole does.
4. How do ions and electrical charges play a role in communication with the muscle?
5. Summarize the science behind rigor mortis. Why is this state a temporary condition?
6. Using what you know about rigor mortis and about energy, what do you think happens inside your muscle when you get a muscle cramp? Why is this not a permanent condition?
7. What are two benefits and one drawback of using models to represent scientific processes?
8. Evaluate your model. Do you think you effectively conveyed the science behind muscle contraction and rigor mortis? What, if anything, would you go back and change?