Title of the Lesson Plan:
Muscle Anatomy - A focused look at Slow and Fast Fibers; their role and contribution to our functions throughout one's lifetime.

BIORETS Teacher's Name: Angela Krueger

Intended School Year and Marking Period: 2025-2026 2nd Semester

Subject and Grade Level: Anatomy/Physiology - 11th and 12th grade

Overview: In this lesson sequence embedded within the Muscular System Unit, students will begin by learning about the anatomy of a basic skeletal muscle. Students will then create three-dimensional models of a skeletal muscle to demonstrate their knowledge. Next, students will be introduced to the different muscle fiber types. Through the use of model building, students will engage in a guided activity Building Muscle Fibers. Next, students will work together to compare and contrast muscle fiber types with a sorting activity designed to reinforce the learning from the guided activity - Comparing and Contrasting muscle fiber types. Once students understand the basic anatomy of a muscle and the fiber types, students will research various muscles to determine the fiber type composition of each muscle. The culminating activity will be studying the effects of aging on the musculoskeletal system by reading graphs and interpreting images of individuals at stages throughout one's lifetime.

Essential Standards:

- HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

Learning Objectives:

- Describe the functions of the Muscular System.
- Model the structural components of a muscle.
- Describe the anatomy and functional features of a muscle fiber.
- Explain how the Muscular System works with other body systems to maintain homeostasis.
- Determine the structural and functional differences between the types of Muscle Fibers.
- Identify muscle fiber types from Confocal Microscopy Images.
- Hypothesize muscle function based on anatomical structures present.

Length of Lesson: 1 ½ Weeks of Instructional Time

Introduction/Background: The focus of this unit is the Muscular System as it relates to Skeletal Muscles. Skeletal Muscles are composed of several units of cylindrical units each bound by its own connective tissues. The basic skeletal muscle cell is known as a skeletal muscle fiber and various fiber types exist so that different motions such as endurance or quickness may occur. These fiber types have different structural features that allow specific functionality. Muscle composition of these three fiber types creates the overall basic muscle function. Muscles change throughout one's lifetime, due in large part to a change in activity level. Focusing on load bearing activities will stimulate muscles and reduce atrophy as aging occurs.

Key Concepts and Terms Covered: Muscle, Fascicles, Muscle Fiber, Myofibril, Mitochondria, Neuromuscular Junction, Epimysium, Perimysium, Endomysium, Nuclei, Myosin, Actin,

Myoglobin, Glycogen, Slow Muscle Fibers, Fast Muscle Fibers, Intermediate Muscle Fibers, Atrophy, Hypertrophy, Sarcopenia

Materials:
Activity #1 - Muscle Anatomy Model Building - A variety of craft materials such as - playdoh, stickers, popsicle sticks, pom poms, straws of 2 different sizes to represent the 2 main fiber types, different colors of construction paper or cellophane, glue, tape, pipe cleaners in a variety of colors, string.
Activity #2 - Creating Models of the Types of Muscle Fibers - Each group with need approximately 30 Straws, 4 rubber bands, several of 3 different Pom Pom Colors
Activity #3 - Sorting Activity - Descriptions of Muscle Fiber Types - Whiteboards, Photocopy of Fiber Type Descriptions for each group printed in color.
Activity #4 - Activity Levels of Muscle Fiber Types - Beans, Ice Water, Warm Water, Pencil
Activity #5 - Muscles - Fiber Type & Movement - Photocopied and Laminated Muscles from Rat Leg, Access to Internet or Anatomy Books for General Muscle Information.
Activity #6 - The Effects of Aging on the MusculoSkeletal System - Class set of Rulers

Activities of the Session:

Activity #1 - Muscle Anatomy Model Building
Activity #2 - Creating Models of the Types of Muscle Fibers
Activity #3 - Sorting Activity - Descriptions of Muscle Fiber Types
Activity #4 - Activity Levels of Muscle Fiber Types - Premade Activity
Activity #5 - Muscles - Fiber Type & Movement
Activity #6 - The Effects of Aging on the Musculoskeletal System

Engagement:
Students will be involved in a variety of activities that encourage critical thinking, student discussion, sorting, involvement in lab work through physical activity with data collection, analyzing data/images, and hypothesizing changes in muscles throughout one's lifetime. The variety of activities while working with peers will aid in keeping students engaged throughout the process of their learning about the anatomy and physiology related to skeletal muscles.

Evaluation:
Each activity has built in formative assessment and additionally students will be assessed at the end of the entire muscle system unit with a summative written assessment.

Extensions and Modifications: An extension of the learning would involve students looking at current research abstracts of current research being done in the field of skeletomuscular aging. Students would then share their findings with their classmates and talk about their interest level in the projects.

Application: Muscle movement impacts our everyday lives and its functionality plays a large role for our quality of life as we age. Students will be exposed to direct ways they can improve muscle functioning through training, as well as become educated on how the muscular system changes throughout one's lifetime and behaviors to engage in to get maximal efficiency out of the system.

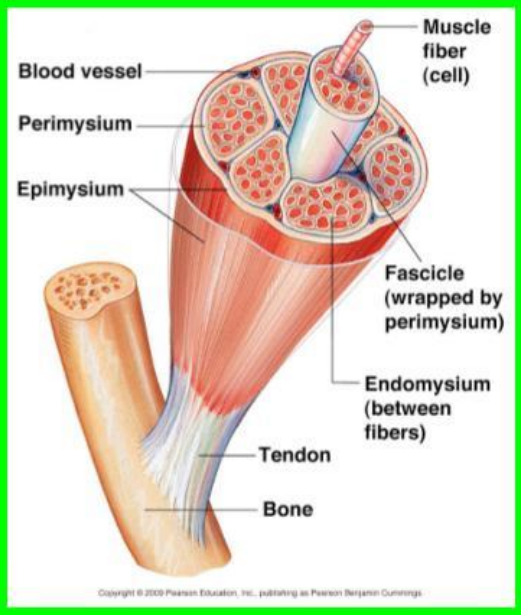
Resources:
Videos:

https://www.khanacademy.org/science/health-and-medicine/human-anatomy-and-physiology/introduction-to-muscles/v/type-1-and-2-muscle-fibers
https://www.youtube.com/watch?v=kNDVt0AgJ2w
Written Materials:
https://www.biologycorner.com/anatomy/muscles/muscles_coloring.html#google_vignette

ACTIVITY #1

Muscle Model

Assessment of the Gross Anatomy of a Muscle



Muscle Model Preparation & Creation

Step #1 - Working with your partner, gather materials to create a 3-Dimensional model of a Muscle attached to a bone. **The following Anatomical Parts of a muscle must be represented in your model:** Entire Muscle, A few Fascicles, Muscle Fibers, Epimysium, Perimysium, Endomysium, Tendon, Bone. (Think about what materials match the shape of a structure within the muscle as you are gathering your materials!)

Step #2 - Build the Muscle Model using your gathered materials.

Step #3 - Clearly Label the Anatomical Structures listed in Step #1 or create a Key.

Step #4 - Add the following Extra Credit Structures: Blood Vessels (distinguish between the two types), Nerves, Myofibril, Mitochondria.

Step #5 - Present your Model to the Class. Be ready for questions from your classmates as well as Mrs. Krueger regarding your knowledge of Muscle Anatomy shown in your model!

Muscle Model Grading Rubric

The following anatomical parts of a muscle must be represented in your model:

Entire Muscle, Fascicles, Muscle Fibers, Epimysium, Perimysium, Endomysium, Tendon, Bone. (+2) for each structure accurately represented.

Creativity and Appropriate use of materials to represent structures (+2)

Clearly and Accurately Labeled (+2)

Ability to answer questions regarding the model (+2)

Total = +22 Assessment Points

Extra Credit Structures : Blood Vessels, Nerves, Myofibril, Mitochondria (+1 each additional)

ACTIVITY #2

Name _____
Date _____

ALL ABOUT MUSCLE FIBERS! - Guided Activity

Directions - In this activity we will be investigating the **TYPES** of muscle fibers found within muscles. We will be working together to discover the structure of these muscle fibers.
Materials - craft materials provided at lab tables, and colored pencils for drawings.

1. **<u>Prior Knowledge Activation!</u>** Using the materials at your lab station, build a muscle fiber with your team. You may use all the materials or a portion of the materials - it is up to you and your team! Draw your model in the space below and create a key identifying the structure each item represents.

Discussion!

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2. Repurposing the same materials at your lab table, now with your team build the two different muscle fibers - **slow twitch and fast twitch.** Draw your models in the space below and create a key identifying the structure each item represents within your models.

Teacher Check _____

3. What is the role of **Mitochondria** in a muscle fiber? _____
4. Add to your physical models, the structure provided by your teacher that represents **Mitochondria.**

Discussion!

---

5. Add **Mitochondria** to your drawn models in #2 mitochondria on each fiber type. Be sure to add it to your key as well

6. **Glycogen** is a series of bound glucose units found within muscle fibers. Discuss with your group and predict their function in the muscle fiber. _____
7. **Myoglobin** is a protein found within muscle fibers that holds oxygen. What color would you expect myoglobin to be? _____
8. Next, your teacher will provide you with **Glycogen** and **Myoglobin**. Add them to your muscle fibers. Think about amounts needed in each type of muscle fiber!

Discussion!

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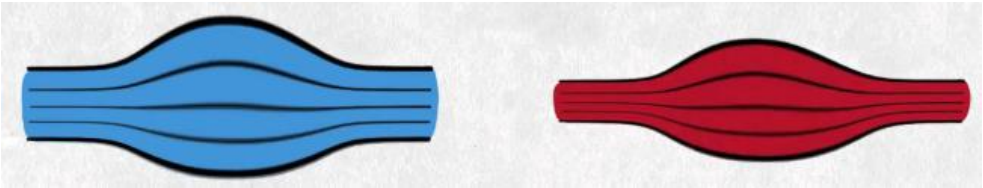
9. Add **Glycogen** and **Myoglobin** to your model drawings in #2. Be sure to add them to your key as well!
10. **Application -** Classify the types of fibers in the diagram below.



What evidence do you have to support your answer? _____

11. What is something new you learned about muscle fibers today? _____

_____

12. What is something you still wonder about muscle fibers? _____

_____

Name _____ TEACHER GUIDE!!!

Date _____

ALL ABOUT MUSCLE FIBERS! - Guided Activity

Directions - In this activity we will be investigating the **TYPES** of muscle fibers found within muscles. We will be working together to discover the structure of these muscle fibers.
Materials - craft materials provided at lab tables, and colored pencils for drawings.

1. **Prior Knowledge Activation!** Using the materials at your lab station, build a muscle fiber with your team. You may use all the materials or a portion of the materials - it is up to you and your team! Draw your model in the space below and create a key identifying the structure each item represents.
Provide each group with the following: Straws (used as myofibrils), rubber bands (used as sarcolemma), and yellow pom poms (used for nuclei). Students may vary from this - however you are looking just for basic anatomy and use of proper materials to represent each structure.

Discussion! - At this time review the basics of the muscle fiber model - sarcolemma, myofibril and nuclei. Choose two different models that were built to share with the class. One model should have more myofibrils than the other giving it a larger diameter. Ask - what is the difference between these two fibers? Ask - if there are more myofibrils in this one, how would this influence the role of the muscle fiber? Students should answer that the larger fiber would have more myofibrils, so therefore more proteins making for a more forceful contraction
Introduce to the students that there are two main muscle fiber types - one for endurance which are known as slow twitch fibers and one for power and quickness which are known as fast twitch fibers. Now have the students move on and make using the same amount of materials provided a slow twitch muscle fiber model and a fast twitch muscle fiber model.

2. Repurposing the same materials at your lab table, now with your team build the two different muscle fibers - **slow twitch and fast twitch.** Draw your models in the space below and create a key identifying the structure each item represents within your models.

Teacher Check _____ Be sure to check to see that one fiber is larger in diameter than the other because it has more myofibrils - this is the fast fiber!

13. What is the role of **Mitochondria** in a muscle fiber? __To provide energy to the cell for contraction _
14. Add to your physical models, the structure provided by your teacher that represents **Mitochondria.** Give your students several pom poms in yellow or gold that represent mitochondria.

Discussion! Discuss with students the addition of the mitochondria - did they add the same amount to each fiber? The slow fiber should have more mitochondria compared to the fast fiber. Discuss with students why this would be. Students should come to the conclusion that a slow fiber would need more because it is used for endurance and will require more energy throughout the activity in comparison to the fast fiber. Introduce the terms slow oxidative and fast glycolytic (remind students of glycolysis in cellular respiration which is an anaerobic process) Quick activities are not able to provide a good oxygen supply for long so therefore less mitochondria are present. Endurance activities are going to require lots of breathing and use of Krebs Cycle and ETC so therefore oxygen can be used readily by mitochondria to continue making supplies of ATP for the activity.

15. Add **Mitochondria** to your drawn models in #2 mitochondria on each fiber type. Be sure to add it to your key as well

16. **Glycogen** is a series of bound glucose units found within muscle fibers. Discuss with your group and predict their function in the muscle fiber. Glucose is sugar and sugar provides energy to start the process of cellular respiration within the cell to make supplies of ATP for use in activity_____ _
17. **Myoglobin** is a protein found within muscle fibers that holds oxygen. What color would you expect myoglobin to be? Red - based on oxygenated blood is a dark red color._____
18. Next, your teacher will provide you with **Glycogen** and **Myoglobin**. Add them to your muscle fibers. Think about amounts needed in each type of muscle fiber! Provide students with several pom poms in the color White for glycogen and Red for Myoglobin.

Discussion! Discuss with students their additions - More glycogen should be added to the fast muscle fiber due to its nature to do the first part of cellular respiration - glycolysis the most. The majority of myoglobin would be found in slow fibers because slow fibers can produce lots of ATP using the oxidative reactions throughout the activity because breathing is still occurring.

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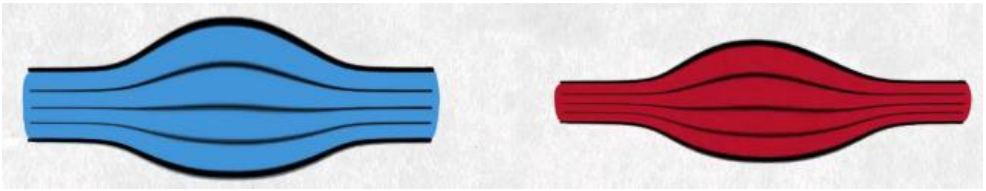
19. Add **Glycogen** and **Myoglobin** to your model drawings in #2. Be sure to add them to your key as well!
20. **Application -** Classify the types of fibers in the diagram below.



Fast Fibers on left - Muscle is larger due to larger fibers and more myofibrils
Slow Fibers on right - Muscle is smaller due to smaller fibers and less myofibrils.

What evidence do you have to support your answer? _____

21. What is something new you learned about muscle fibers today? _____

_____

22. What is something you still wonder about muscle fibers? _____

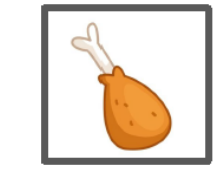
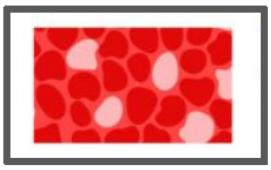
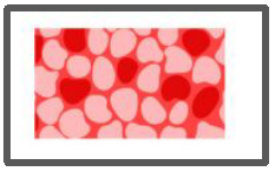
ACTIVITY #3

Pieces for Muscle Fiber Type Sorting on Whiteboards

Fiber Small In Diameter	Dense Amt of Glycogen
Contracts in 0.01 sec.	Dense Amt of Myofibrils
Makeup of Majority of Chicken Wing	Used for Short Bursts of Activities

Dense in Mitochondria	Fiber Large in Diameter
Forceful Contractions	Contracts in 0.03 sec.
Makes up Majority of Eye & Hand Muscles in Humans	Uses Oxidative Cycles for ATP production

Appears as Dark Meat	Few Mitochondria
Small Amt of Glycogen	Best for Endurance
Makes up the Majority of Back and Calf Muscles in Humans	Uses Glycolytic Cycles for ATP Production

High amount of Myoglobin		
Low amount of Myoglobin		
Majority of Leg Muscles of Chicken		

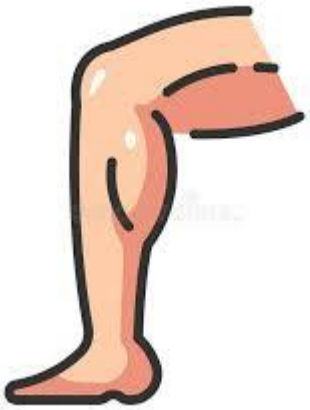
ACTIVITY #4 - Premade Activity -

https://med.libretexts.org/Learning_Objects/Laboratories/Anatomy_and_Physiology_1_Lab_Manual_(Robinson)/02%3A_Lab_Exercise/2.09%3A_Lab_Exercise_11-_Muscle_Fatigue_and_Physiology

ACTIVITY #5

Name _____

Date _____



Muscles - Fiber Typing and Movement

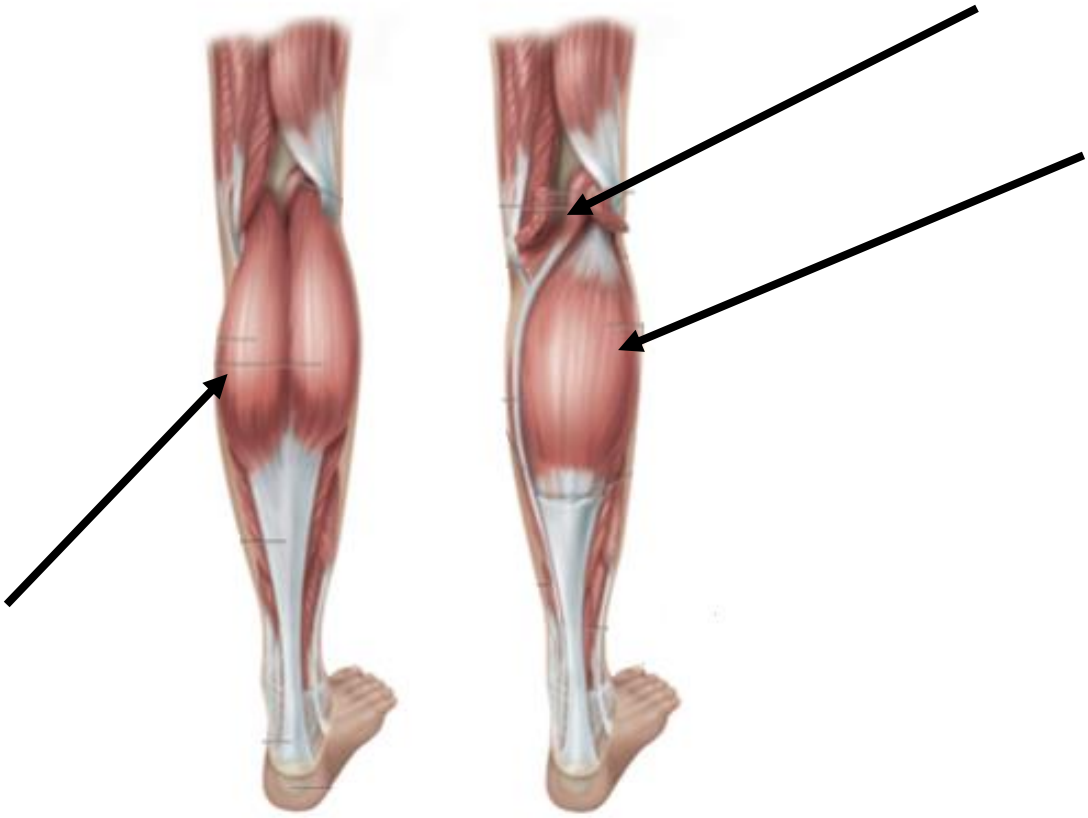
Directions: Complete the following activity regarding muscle function and makeup in a human and a rat.

1. The following pictures show the muscles of a human from the dorsal side. Use resources to label and color the following muscles:

Gastrocnemius - Green

Plantaris - Red

Soleus - Blue



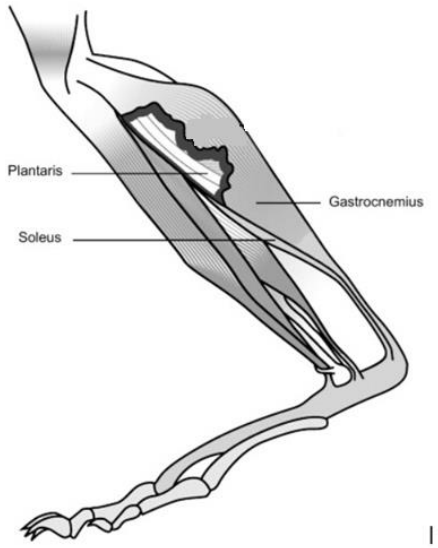
2. Relate the **location of the following muscles** to each other by inserting the proper **directional term** in the statements below.
The **gastrocnemius** is _____ to the **soleus.**
The **plantaris** is _____ to the **gastrocnemius.**
The **soleus** is _____ to the **plantaris**.

3. Using your resources, determine the **origin and insertion** of each muscle below.

Muscle	Origin	Insertion
Gastrocnemius		
Plantaris		
Soleus		

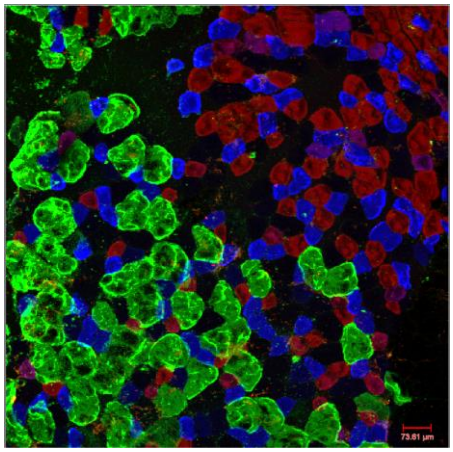
3. In muscle contraction the origin of a muscle is stationary, while the insertion of the muscle moves towards the origin during movement. Using this information, as well as other resources, explain the **movement** created by each muscle. Use **anatomical terminology** in your answer.
Gastrocnemius - _____
Plantaris - _____
Soleus - _____

4. View the Diagram of the Leg of a Rat below. Color the muscles, the following colors:
Gastrocnemius - Green
Plantaris - Red
Soleus - Blue



5. Predict how the same three muscles in a rat would compare/contrast to the same muscles in a human._____

6.Using the rat muscle image below that shows the three different muscle fiber types, **predict and label** a Fast Fiber, an Intermediate fiber, and a Slow Fiber.



7. Provide support evidence for your predictions

8. Using the Rat Muscle Images you are provided, observe the fiber type distribution within each muscle. Note that each muscle is named on the image and a key is present as well for the various fiber types.
Write a **claim** regarding the overall fiber composition of any given muscle?
Claim = _____
_____

7. Based on the the information from the last question, what muscle has the:

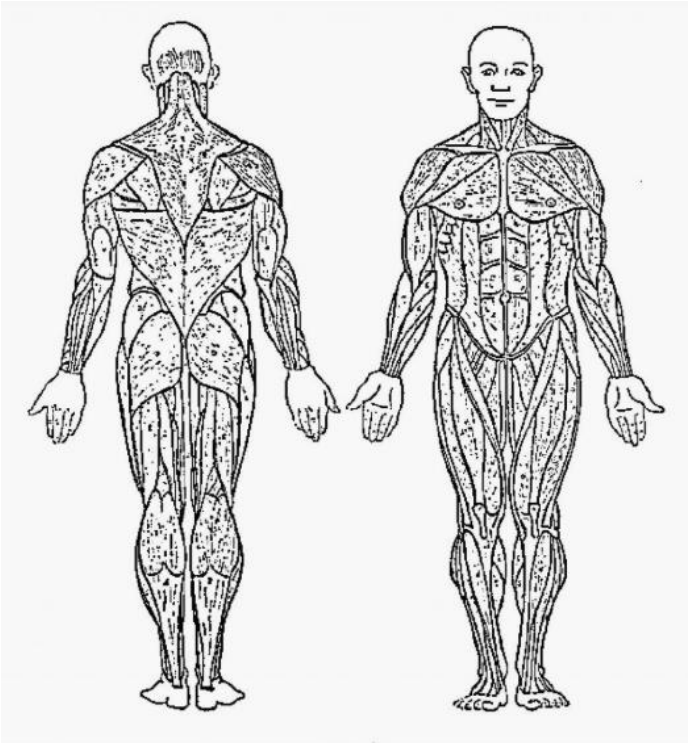
A. Highest % of **Fast Fibers** _____
B. Highest % of **Slow Fibers** _____
C. Even % of the 3 Fiber Types _____

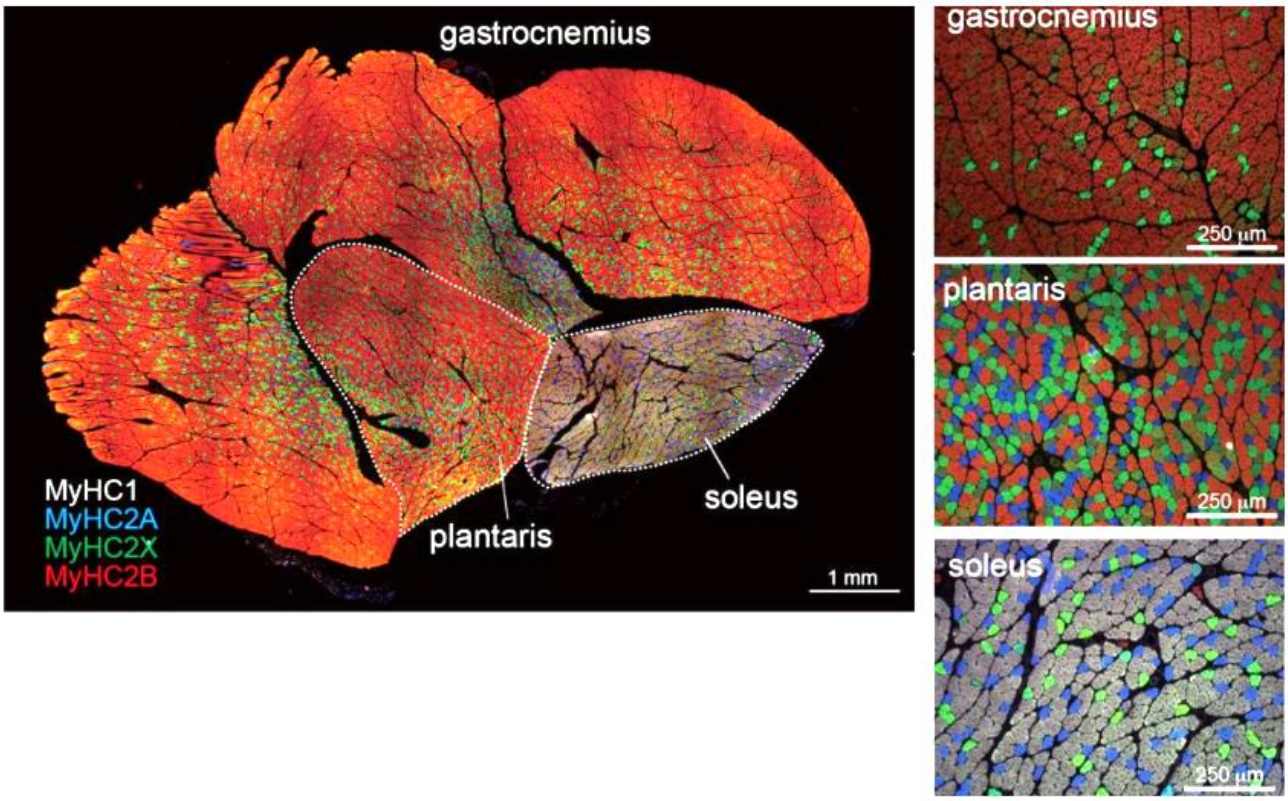
8. Classify the **Gastrocnemius, Plantaris and Soleus** according to which would perform each function listed below **BEST**:

A. Maintaining Posture (standing) - _____
B. Quick Movement (running) - _____
C. Assisting with both stop and go activities - _____

9. Choose **8 different muscles** on the body to research their Location, Fiber Makeup, and Function.

A. First, **color the muscles** each with a different color and record on the chart.
B. Next, research and fill in the chart with the **origin, insertion, and function** of each muscle.
C. Additionally, based on function, **predict** whether the muscle is made up of **primarily of** slow fibers, fast fibers, or an equal combination. Record your prediction in the chart.
D. Finally, research the muscle fiber makeup of each muscle and **accept/reject** your prediction.





KEY
Slow Fiber = MyHC1
Intermediate = MyHC2A and MyHC2X
Fast = MyHC2B

ACTIVITY #6

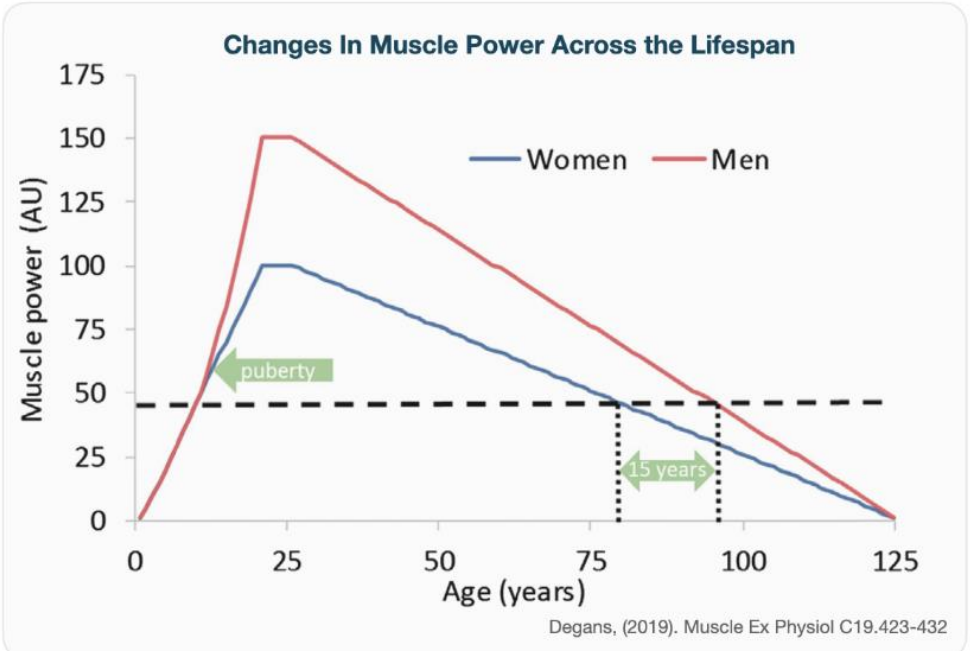
Name _____
Date _____

The Effects of Aging on the Musculoskeletal System

Introduction: The Musculoskeletal System is one that is of great importance, as we depend on its efficiency throughout our lifetime in our everyday movement activities. In this activity you will analyze data collected on the skeletomuscular system over time in humans and other species.

Question: How does Skeletal Muscle Anatomy change over one's lifetime?

Hypothesis: _____
_____



AU = Arbitrary Unit

1. Using the graph above, between what ages does the most muscle power exist for males and females?

2. Predict two factors that could be causing this increase in muscle power?

3. Identify an anatomical difference between male and female muscles that could be causing males to have a higher peak in muscle power?

Information: ***Hypertrophy*** is the anatomical term used to describe muscle size increase. Hypertrophy causes the muscle to become larger due to an increase in muscle fiber size, NOT the accumulation of more muscle fibers.

4. If a muscle is undergoing hypertrophy, what anatomical changes might be occurring?

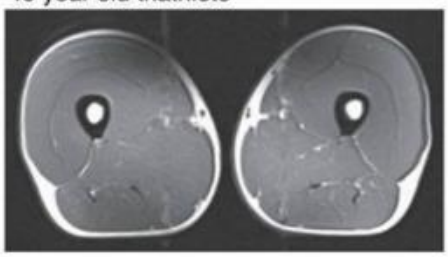
5. Predict two factors that could be causing a decrease in muscle power amongst both males and females.

6. Thinking of overall muscle anatomy, how might muscles anatomically be changing during this degradation of muscle power?

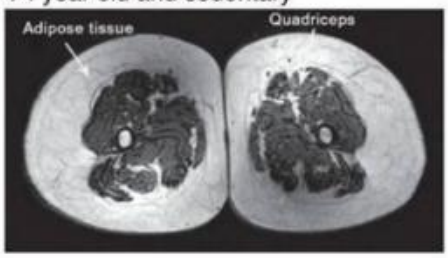
Information: ***Atrophy*** is the anatomical term that is used to describe muscle wasting or thinning. **Sarcopenia** is atrophy of muscles due to the aging process.
Review the images below and answer the questions that follow.

7. What muscle has undergone atrophy?

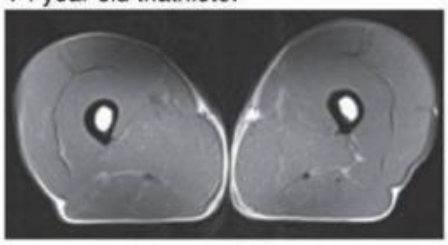
40 year old triathlete



74 year old and sedentary



74 year old triathlete:



Images courtesy of Dr. J Spitsbergen

8. Explain how the atrophied muscle is different from the others.

9. Construct a claim about the 74 triathlete's muscle composition versus the 74 year old sedentary individual's muscle.

10. How could you get quantitative data from the images to support your claim?

11. Complete the process from #10 and state your evidence to support your claim below.

12. Given the information you have gathered from this activity, what prediction would you make regarding the composition of muscle fiber types of a young person compared to that of a sedentary aged adult?
Provide reasoning for your answer.

EXTENSION ACTIVITY! - Choose 4 different species of Animals and research the process of aging for each species. Make a chart and include information about the species to include, but not limited to, Average Lifespan, Body Size, Reproductive Age, Traits that hinder or help lifespan, and Efficiency issues as aging occurs, and any other pertinent information.