

The Muscular System

HASPI Medical Anatomy & Physiology 09a

Lab Activity

Background

The Muscular System

The main function of the muscular system is movement. This includes walking, breathing, pumping the heart, and moving food through your digestive tract, just to name a few important examples. Muscles also create heat as they contract, helping to maintain a constant body temperature. Muscle tissue makes up nearly half of an individual's total body weight. Each muscle is an individual organ made up of muscle tissue, nerves, blood vessels, and connective tissue. There are three types of muscle tissue: skeletal, cardiac, and smooth.

Skeletal Muscle

Approximately 650 skeletal muscles are attached to bones by tendons. Skeletal muscles contract voluntarily, meaning that you can control them consciously. Skeletal muscle cells appear to be striped under the microscope, and these stripes are called striations. Most skeletal muscles are attached to two bones over a joint. When they contract, they pull the attachment points closer to one another.

Tendons are made up of extremely tough collagen fibers in the form of dense regular connective tissue. They attach to skeletal muscle fibers on one side and are intermeshed in bone on the other. Tendons must handle a great degree of strain when a muscle contracts. When identifying skeletal muscles and their function, the location, origin, and insertion are important. The location is the area of the body where the muscle is found, the origin is the point where the muscle connects to a stationary bone, and the insertion is the point where the muscle connects to a moving bone.



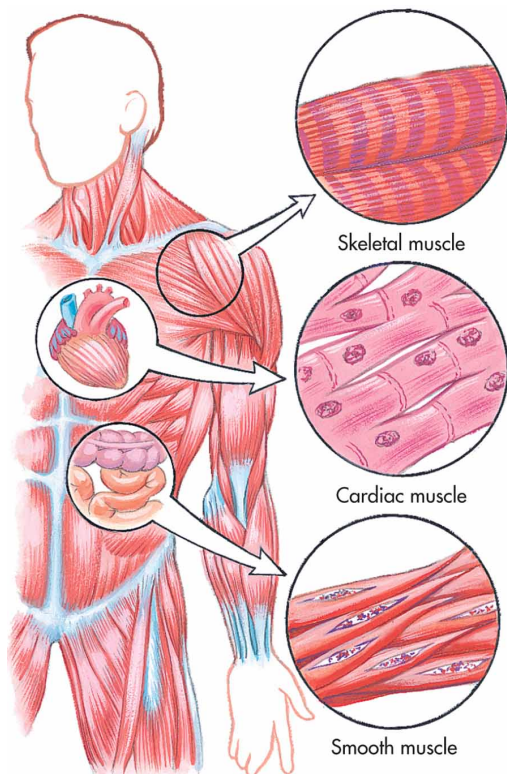
<http://www.fallinpixel.com/products/33817/main/s/0000-MaleMuscular-1.jpg>

Cardiac Muscle

Cardiac muscle is only found in the heart and continuously contracts and relaxes to push blood through the blood vessels of the body. Cardiac muscle contracts involuntarily, meaning that a person cannot control when they contract. The heart has its own pacemaker that initiates the consistent contraction of cardiac tissue. Cardiac muscle tissue is striated like skeletal muscle, but also has areas called intercalated disks. These disks are areas where cells interlock to form very tight bonds, allowing cardiac muscle tissue to withstand a great amount of pressure and force over an individual's lifetime.

Smooth Muscle

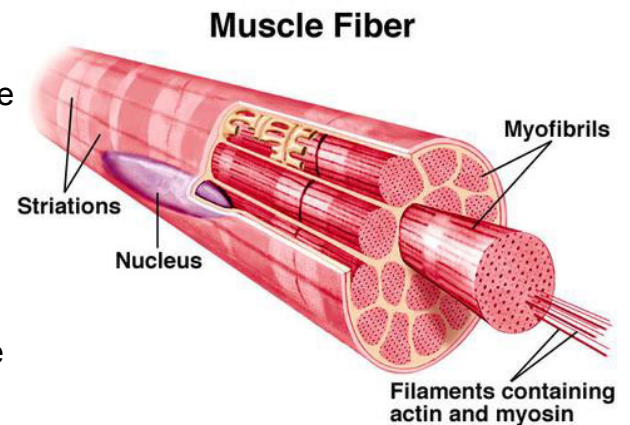
Smooth muscle, also known as visceral muscle, is the weakest of the muscle tissues and is found within organs. Smooth muscles also contract involuntarily. They can be found lining blood vessels, the gastrointestinal tract, and the bladder. When smooth muscle contracts it moves substances, such as blood or food, through the organ.



http://biology-forums.com/gallery/14755_30_09_12_4_31_30_89891069.jpeg

Skeletal Muscle Structure

Muscle cells, also known as myofibers, are specialized to contract and therefore look very different from neurons or skin cells. The cell membrane of a muscle cell is called the sarcolemma, and the cytoplasm is called sarcoplasm. Hundreds of long filaments, called myofibrils, extend the length of the cell. Each myofibril is made up of thick filaments, called myosin, and thin filaments, called actin, that are responsible for the actual muscle contraction. The arrangement of these filaments gives skeletal muscle its striated appearance. An entire muscle is actually made up of bundles of muscle cells held together by connective tissue.



<http://www.nvo.com/jin/nss-folder/scrapbookanatomy/muscle1fiber.jpg>

Muscular Disorders

Normal muscle function is crucial to overall health. A variety of abnormalities caused by disease or disorders can affect the ability of muscles to contract and perform daily functions. For example, paralysis of the diaphragm muscle would prevent respiration and result in death. The following table summarizes a few neuromuscular disorders. Prevalence and mortality is based on annual numbers from 2009 in the U.S.

Muscular Disorder	Description	Symptoms	Prevalence	Annual Mortality Rate
Muscular dystrophy (MD)	Genetic disease that damages the muscle fibers; 9 different forms	Muscle weakness, lack of coordination and mobility	1 in 6,000 males 5-24 y/o	45% by age 24
Cerebral palsy	Injury or abnormality to the brain that results in a disconnect between the brain and muscle movement	Spastic paralysis, muscle tightness, abnormal gait, joint contracture, seizures	1 in 278	8,000
Myasthenia gravis	Autoimmune disease that causes muscle weakness	Hemi-paralysis, muscle weakness,	1 in 20,000	N/A
Amyotrophic lateral sclerosis (ALS)	AKA Lou Gehrig's Disease; gradual degeneration of motor neurons	Muscle impairment, atrophy, weakness, and eventually paralysis	2 in 100,000	4,000
Fibromyalgia	Pain and tenderness of the muscles, joints, and soft tissues	Fatigue, headaches, muscle pain, joint pain	1 in 50	N/A
Myositis	Inflammation of the skeletal muscles caused by an infection	Muscle weakness, rash, fatigue, difficulty breathing	1 in 1,000,000	N/A

Diagnostic Tests for Muscular Disorders

There are many tests that can be performed to assess and treat neuromuscular disorders. The following list summarizes a few common procedures.

- **Manual Muscle Test** – This is the most common test for muscular disorders and involves clinical observation to determine muscle weakness, atrophy, or paralysis.
- **Electromyography** – Records the electrical activity of a muscle during contraction and relaxation.
- **Muscle Biopsy** – A section of muscle tissue is collected to test for abnormal cellular structures.
- **Nerve Conduction Study** – Tests whether the nerve fibers for a particular portion of the body are functioning normally.

Marieb, E. 2010. The Muscular System. Human Anatomy & Physiology, 8th edition, Benjamin Cummings.

Taylor, T. 1999. Muscular System. InnerBody, www.innerbody.com.

Materials

Station 1: Anatomy posters (4)
 Station 2: Clothespin, timer
 Station 3: Histology posters (4)

Station 4: N/A
 Station 5: Disease posters (5)
 Station 6: Tape Measure

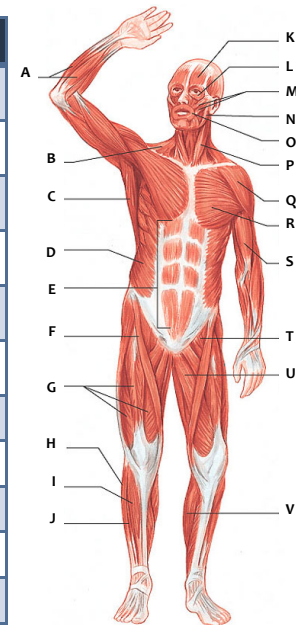
Procedure

This is a station lab activity. There are 6 stations setup around the classroom. Each station will take approximately 10-15 minutes.

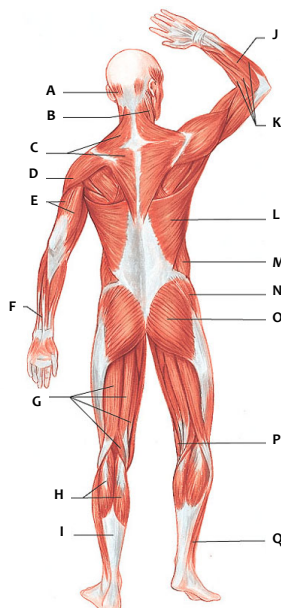
Station 1: The Muscular System

Muscular System Anterior – Using the “Anterior Muscle” chart, identify the labeled muscles A-V in Table 1 below. If there are any you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

A	L
B	M
C	N
D	O
E	P
F	Q
G	R
H	S
I	T
J	U
K	V



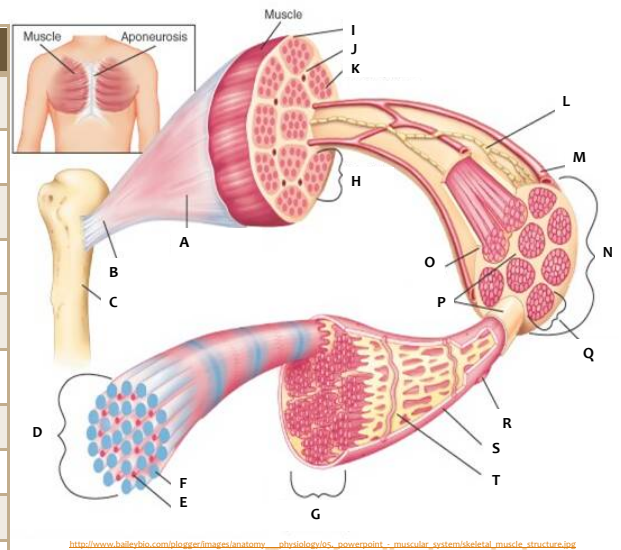
Muscular System Posterior – Using the “Posterior Muscle” chart, identify the labeled muscles A-Q in Table 2. If there are any you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.



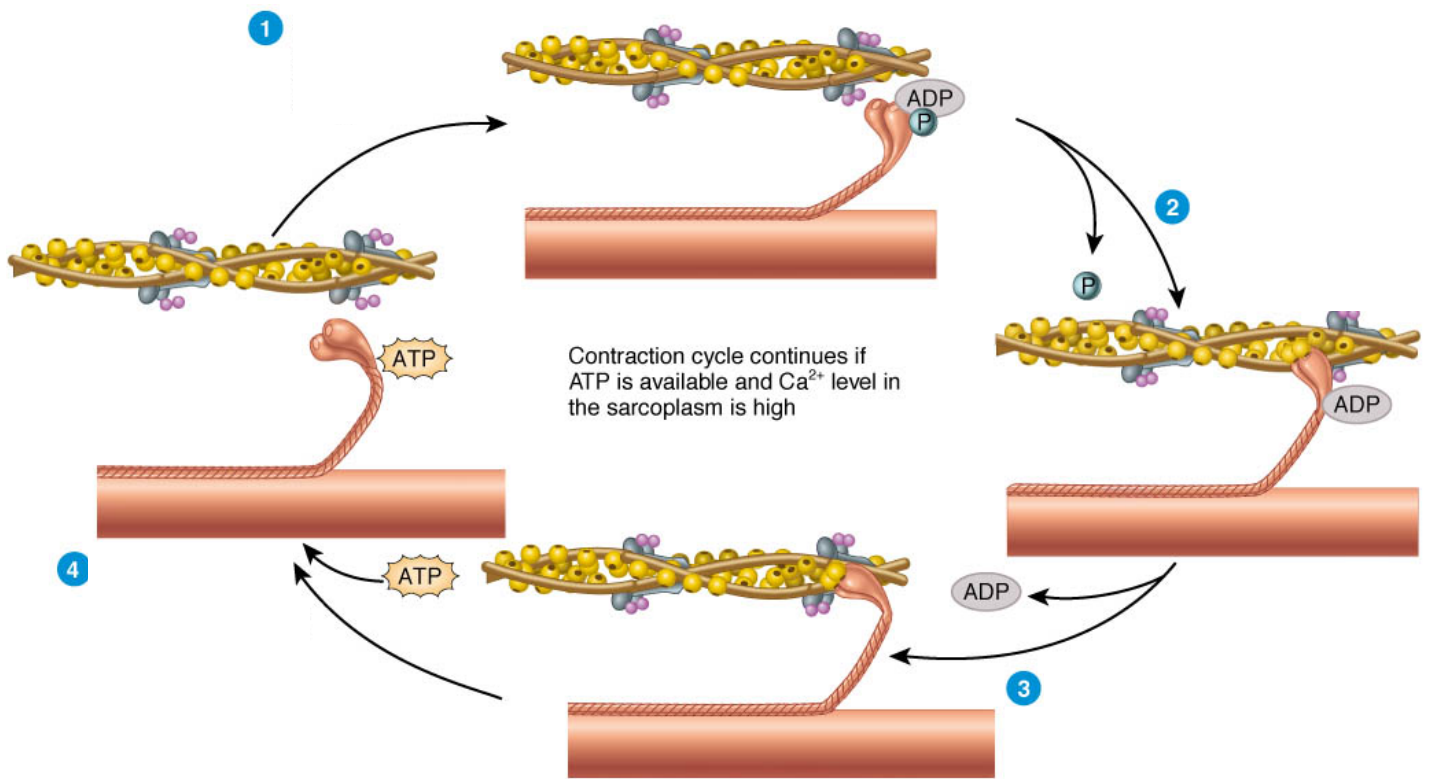
A	J
B	K
C	L
D	M
E	N
F	O
G	P
H	Q
I	

Muscle Structure – Using the “Muscle Structure” chart identify, the labeled muscles A-T in Table 3. If there are any you cannot identify, use a textbook or online resource. A smaller version of this chart is included for later review.

Table 3: Muscle Structure	
A	K
B	L
C	M
D	N
E	O
F	P
G	Q
H	R
I	S
J	T



Muscle Contraction – Using the “Muscle Contraction” chart, describe steps 1 - 4 of a muscle contraction next to each number on the chart below.



<http://classroom.sdmesa.edu/eschmid/Fo8.06.L.150.jpg>

Station 2: Muscle Fatigue

When a muscle is unable to contract with the same force, muscle fatigue occurs. Muscle fatigue can be caused by a variety of factors, but in this activity you will investigate exercise-induced muscle fatigue.

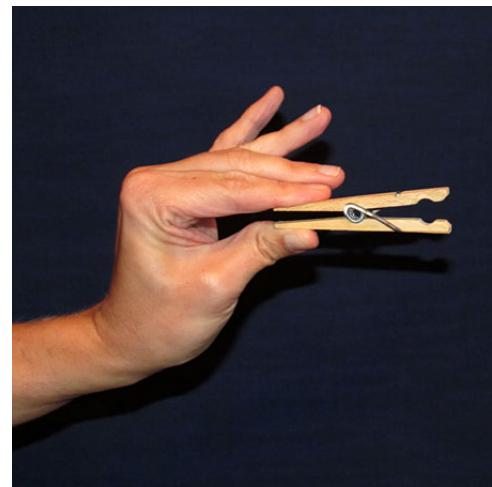
Directions

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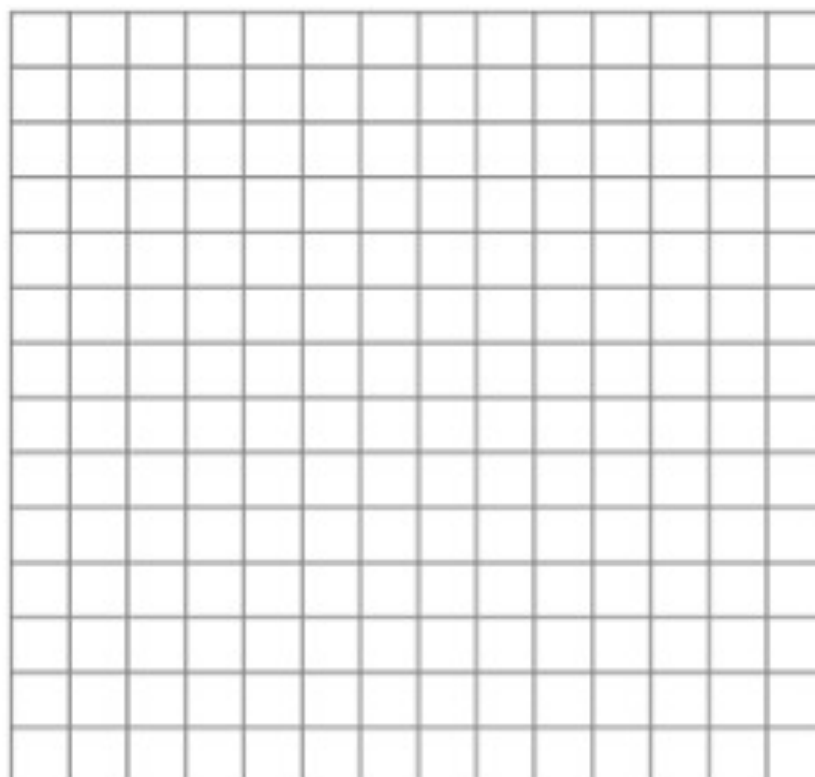
Step 1	Obtain a partner, a clothespin, and a timer.	
Step 2	Have your partner set the timer. Grasp the clothespin between the thumb and forefinger of your dominant hand, as shown in the image below.	
Step 3	When your partner says "GO!" start squeezing the clothespin open and closed for 15 seconds, counting the number of squeezes.	
Step 4	At 15 seconds stop squeezing the clothespin. Tell your partner the number of squeezes so he or she can record the number in Table 4 for Trial 1.	
Step 5	REST ONLY 5 SECONDS and then repeat Step 4. Continue with a 15-second test and 5-second rest interval for a total of 10 trials. Record the trials in Table 4.	
Step 6	Graph your results on the graph provided.	

Table 4. Muscle Fatigue

Trial	# of Clothespin Squeezes
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	



<http://www.kneessoftware.com/Portals/105407/Images/Clothespin%20pinch%20%20copy.jpg>



Station 3: Muscular System Histology

The cell and tissue structure of muscle types is suited for the function each performs. Redraw and label Image B from the posters below. Image A on each chart is for reference!

Smooth Muscle

Using colored pens/pencils, draw the histology Image B from the "Smooth Muscle" chart in the space below. Using Image A as a reference, label your drawing with the cell nuclei and blood vessel.



Cardiac Muscle

Using colored pens/pencils, draw the histology Image B from the "Cardiac Muscle" chart in the space below. Using Image A as a reference, label your drawing with the nucleus and intercalated disk.



Skeletal Muscle

Using colored pens/pencils, draw the histology Image B from the "Skeletal Muscle" chart in the space below. Using Image A as a reference, label your drawing with the capillaries, myocyte nuclei, I-bands, and A-bands.



Skeletal Muscle Cross-section

Using colored pens/pencils, draw the histology Image B from the "Skeletal Muscle Cross-section" chart in the space below. Using Image A as a reference, label your drawing with the capillaries, myofibrils, endomysium, and peripherally placed nuclei.











Station 4: Manual Muscle Testing

Manual muscle testing (MMT) can be used to determine whether a patient is experiencing muscle weakness, atrophy, and/or paralysis. It is often used during a physical examination. In this activity you will conduct an MMT on a patient (a partner preferably of the same sex). There are several variations of MMT, but for this activity you will conduct an MMT8, which will cover 8 muscle groups.

Directions

✓ when complete

Step 1	<p>Choose who will be the conducting the exam and who will be the patient. Have the patient sit. For each of these tests the exam conductor will be applying opposing pressure. The pressure should start out light, and increase in strength over a 3-5 second period.</p>		
Step 2	<p>For each test/step, read the directions and observe the image to get an idea of the expected motion. Read the prompt to your patient/partner and then perform the exercise. Use Table 5 to grade your patient's muscle movement and record the grades in Table 6. Repeat each test on the right and left sides except for the neck flexor test.</p>		
Step 3	<p>Deltoid Have the patient sit and extend the arm perpendicular to the body with the palm facing down. Stand to the side or behind the patient and place one hand on the shoulder and the other on the elbow. Push down on the elbow as the patient resists.</p> <ul style="list-style-type: none"> • <i>Tell the patient</i>, "I am going to push down and I want you to resist." 		
Step 4	<p>Biceps Have the patient sit and extend the arm forward with the elbow bent and the palm facing up. Stand to the side of the patient and place one hand on the elbow and the other on the wrist. Push down on the wrist as the patient resists.</p> <ul style="list-style-type: none"> • <i>Tell the patient</i>, "Bend your elbow and hold it. Don't let me pull it down." 		
Step 5	<p>Wrist Extensors Have the patient sit and extend the forearm on the table with the palm facing down. Stand to the side of the patient and place one hand on the forearm and the other on the hand. Push down on the hand as the patient resists.</p> <ul style="list-style-type: none"> • <i>Tell the patient</i>, "Bring your wrist up and hold it. Don't let me push it down." 		
Step 6	<p>Quadriceps Have the patient sit on a stable table/desk with the feet hanging freely. Stand to the side of the patient and place one hand on the knee and the other on the shin. Push down on the shin as the patient pushes the leg up.</p> <ul style="list-style-type: none"> • <i>Tell the patient</i>, "Straighten your knee and hold it. Don't let me bend it." 		

<p>Step 7</p>	<p>Ankle Dorsiflexors Have the patient sit on a stable table/desk with the feet hanging freely. Stand to the side of the patient and place one hand on the ankle and the other on the top of the foot. Push down on the top of the foot as the patient pushes the foot up.</p> <ul style="list-style-type: none"> • <i>Tell the patient, "Pull your foot up to the ceiling."</i> 		
<p>Step 8</p>	<p>Neck Flexors Have the patient lie down on his or her back on a table/floor. Stand or kneel at the side of the head and place one hand on the abdomen and the other on the forehead. Push down on the forehead as the patient pushes the head up.</p> <ul style="list-style-type: none"> • <i>Tell the patient, "Lift your head from the table. Don't let me push your head down."</i> 		
<p>Step 9</p>	<p>Gluteus Medius Have the patient lie down on his or her side on a table/floor with the legs extended. Stand or kneel at the side of the hip and place one hand on the hip and the other on the thigh. Push down on the thigh as the patient pushes the leg up.</p> <ul style="list-style-type: none"> • <i>Tell the patient, "I am going to push down on your leg and I want you to resist me."</i> 		
<p>Step 10</p>	<p>Gluteus Maximus Have the patient lie down on his or her stomach on the table/floor. Stand or kneel at the side of the hip and place one hand on the lower back and one hand on the calf. Push down on the calf as the patient lifts the leg upwards.</p> <ul style="list-style-type: none"> • <i>Tell the patient, "Lift your leg towards the ceiling and keep your knee straight."</i> 		

All images from <http://at.uwa.edu/>

Muscle Movement	Grade
No contractions felt in the muscle and unable to bring to test position	0
Tendon becomes prominent or little contraction felt in the muscle; no visible movement and unable to bring to test position	Trace
Moves through partial range of motion to test position	Poor -
Moves through complete range of motion to test position	Poor
Gradual release from test position with no pressure	Fair -
Holds test position with no pressure	Fair
Holds test position against slight pressure	Fair +
Holds test position against slight to moderate pressure	Good -
Holds test position against moderate pressure	Good
Holds test position against moderate to strong pressure	Good +
Holds test position against strong pressure	Normal

Muscle Group Tested	Right Grade	Left Grade
Deltoid		
Biceps brachii		
Wrist extensors		
Quadriceps		
Ankle dorsiflexors		
Neck flexors		
Gluteus medius		
Gluteus maximus		

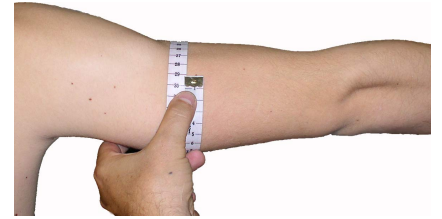
Station 5: Muscular Disease

Using the “Muscular Disease Charts,” complete the following table. List ONLY THREE Causes or Risk Factors, Symptoms, and Treatment Options for each disease.

Muscular Dystrophy			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
If a mother and father are both carriers for Duchennes muscular dystrophy, what is the chance they will have a child with MD?			
Fibromyalgia			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What is the most common symptom for fibromyalgia?			
Myasthenia Gravis			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What psychiatric disorder is most commonly associated with myasthenia gravis?			
Cerebral Palsy			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
How many children are estimated to have cerebral palsy?			
Myositis			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What is the most common type of myositis?			

Station 6: Muscle Contraction and Size

As a muscle contracts, multiple actin and myosin fibers throughout the muscle are being grabbed and pulled, causing the entire muscle to shorten. This creates firmness and sometimes the appearance of a bulge in the center of the muscle. In this activity you will investigate the relationship between a muscle contraction and the size of the muscle.



http://www.tonflyusa.com/images/618/res390551_measure-3.jpg

Directions

✓ when complete

Step 1	Choose a partner and a tape measure. All measurements for this activity will be in centimeters.	
Step 2	Have your partner sit and rest his or her forearm on a desk or table. Ask your partner to relax the arm as much as possible. Wrap the tape measure around the upper arm and measure the circumference. Record in Table 7 for "Bicep/Tricep" in the "Circumference Relaxed" column.	
Step 3	Have your partner put his or her hand under the desk/table with palm up and pull up hard against the desk/table to contract the biceps. Measure the circumference and record in Table 7 for "Circumference Contracted."	
Step 4	Have your partner push the palms down hard on the desk/table to contract the triceps and measure the circumference. Record in Table 7.	
Step 5	Measure the circumference of the forearm while relaxed. Have your partner make a fist to contract the forearm and measure the circumference of the forearm while contracted. Record both measurements in Table 7.	
Step 6	While still sitting, ask your partner to relax the leg as much as possible and measure the circumference of the upper leg. Record in Table 7 for "Quadriceps/Hamstrings" in the "Circumference Relaxed" column.	
Step 7	Have your partner flex the quadriceps as tightly as possible (the knee should be straight) and measure the circumference. Record in Table 7.	
Step 8	Have your partner stand and bend the knee to the "glutes" while contracting the hamstrings as much as possible. Measure the circumference and record in Table 7.	
Step 9	Measure the circumference of the calf relaxed. Have your partner do a calf-raise (on the toes) to contract the calf and measure the circumference of the calf contracted. Record both measurements in Table 7.	
Step 10	For each muscle, subtract the circumference contracted from the circumference relaxed to determine the difference in size between the relaxed and contracted muscle.	
Step 11	Use a textbook to determine ALL of the muscles involved in each movement performed in this activity.	

Table 7. Muscle Contraction and Size

	Circumference Relaxed (cm)	Circumference Contracted (cm)	Difference (cm)	List all of the muscles contracting in the movement
Bicep				
Tricep				
Forearm				
Quadricep				
Hamstring				
Calf				

Review Questions - *on a separate sheet of paper complete the following*

1. What is the main function of the muscular system? Give two examples.
2. What are the three types of muscle?
3. How many skeletal muscles are in the human body?
4. What attaches muscle to bone?
5. Which muscles are voluntary? Which muscles are involuntary?
6. Compare and contrast skeletal, smooth, and cardiac muscle.
7. What is a myofiber and what is it specialized for?
8. What are the sarcolemma and sarcoplasm?
9. What is a myofibril?
10. How do myosin and actin work together?
11. From the table in the background section, what muscular disorder was most prevalent in 2009? Least prevalent?
12. Choose two of the most common diagnostic procedures and summarize their uses.