

Muscular System worksheet

Name _____

Section A: Muscle Types – Use your notes to complete the questions.

1. Fill in the chart.

	Skeletal	Cardiac	Smooth
Striations or No striations?			
Cylindrical or Spindle shaped?			
Involuntary or voluntary?			
One nucleus or Multi-nuclei?			
Body movement or material transport?			

Section B: Muscle Types & Properties

- Which type of muscle tissue has the ability to cause blood vessels to dilate and constrict depending on external conditions? _____
- Which type of muscle tissue would be damaged if a person has a heart attack? _____
- While doing exercise, Sam pulled a muscle. Which type of muscle tissue was damaged?

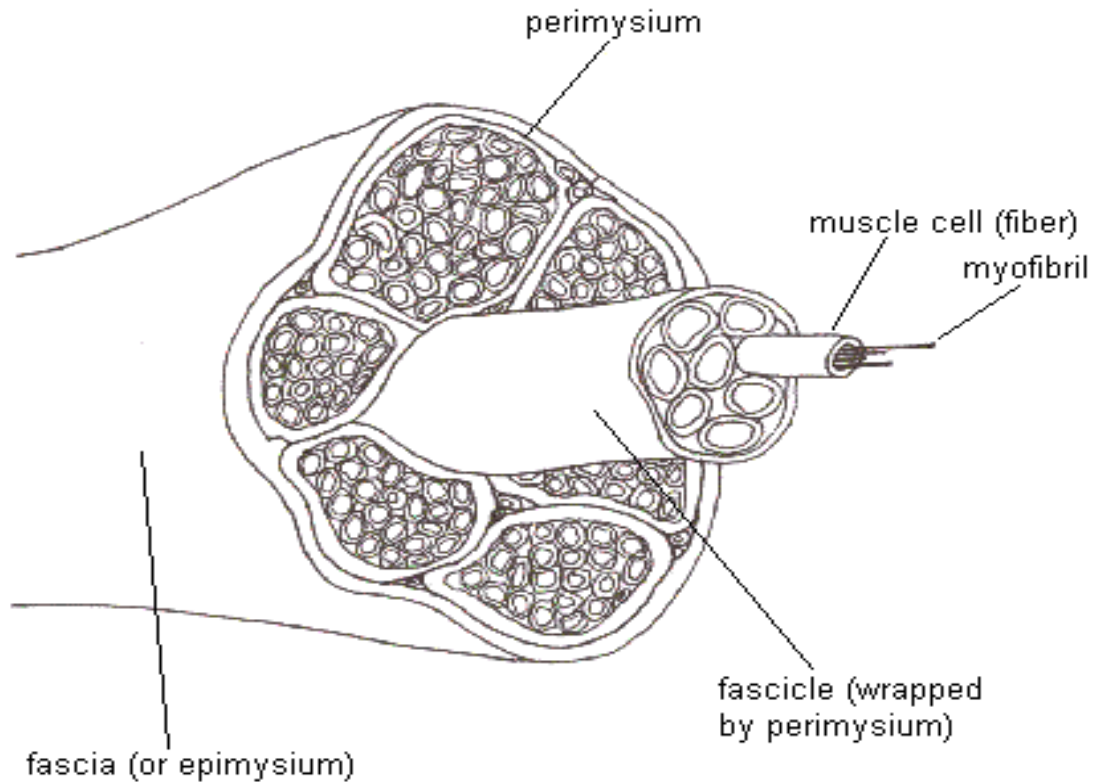
- Which of the following can best be used to distinguish cardiac muscle from smooth muscle?
 - Cardiac muscle is involuntary.
 - Cardiac muscle, unlike smooth muscle, has one nucleus.
 - Cardiac muscle is striated.
 - All of the above
- Which of the following is a shared characteristic of cardiac and skeletal muscle?
 - One nucleus
 - Branched cells
 - Intercalated discs
 - Striations
- Smooth muscle fibers are characterized by _____.
 - long, tapering, multinucleated cells.
 - forming contractile tissue of walls of most hollow organs.
 - possessing cross-striations.
 - contracting in response to our conscious will.
- List the 4 functions of skeletal muscle.
 - _____
 - _____
 - _____
 - _____
- Which of the following best describes this characteristic? irritability, contractility, elasticity, extensibility

Property	Descriptions
	Muscles have the ability to be stretched or extended.
	Muscles have the ability to shorten forcibly when adequately stimulated.
	Muscles have the ability to resume resting length after being stretched.
	Muscles have the ability to respond to stimulus.

Section C: Skeletal Muscle Structure

A skeletal muscle consists of bundles (fascicles) of muscle cells (fibers) each wrapped in their connective tissue sheath (epimysium, perimysium, endomysium). As the skeletal muscle approaches the attachment site, the muscle fibers end and connective tissue continues on as the tendon.

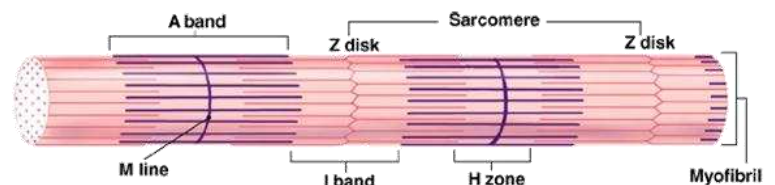
❖ Color the diagram – use a different color for each part.



Section D: Skeletal Muscle Anatomy

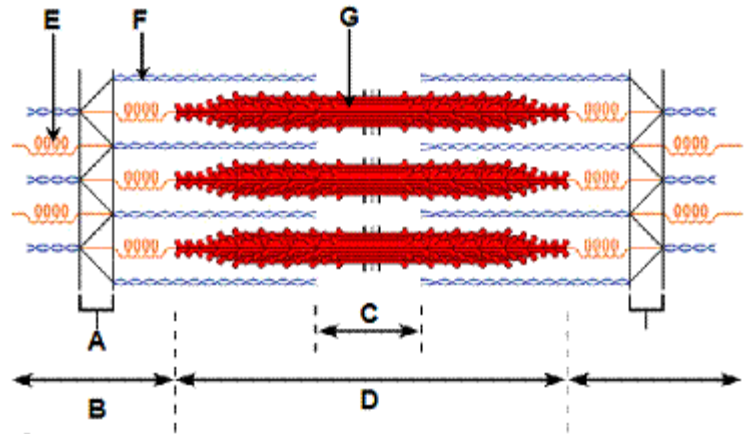
1. _____ is the membrane that surrounds a skeletal muscle.
2. _____ is the membrane that surrounds the fascicle.
3. _____ is the membrane that surrounds the muscle fiber.
4. What is the name of a bundle of muscle fibers? _____
5. What is the name of the organelle containing contractile units in a muscle cell? _____
6. What does a tendon connect? _____
7. What's the name of the cell membrane of a muscle fiber? _____
8. _____ are the contracting units that make up a myofibril.
9. What are the 2 bands that make up a sarcomere? _____
10. What fiber(s) does the I band contain? _____
11. What fiber(s) does the A band contain? _____
12. What fiber(s) does the H zone contain? _____
13. Which fiber connects to the Z line? _____
14. How are myosin and actin different? _____

15. Examine the myofibril. Are the sarcomeres contracting or relaxing?



16. Label the sarcomere.

- a. _____
- b. _____
- c. _____
- d. _____
- e. elastic filaments
- f. _____
- g. _____



17. Explain the sliding filament theory.

Section E: Sliding Filament Theory - The Importance of Calcium

An action potential rapidly spreads along the muscle cell and opens gates in the sarcoplasmic reticulum. Calcium ions flow into the cytoplasm, which is where the actin and myosin filaments are. Calcium ions bind to troponin-tropomyosin molecules located in the grooves of the actin filaments. Upon binding calcium ions, troponin changes shape and slides tropomyosin out of the groove, exposing the actin-myosin binding sites. Myosin interacts with actin by forming crossbridges. The muscle thereby creates force, and shortens. After the action potential has passed, the calcium gates close, and calcium pumps located on the sarcoplasmic reticulum remove calcium from the cytoplasm. As the calcium gets pumped back into the sarcoplasmic reticulum, calcium ions come off the troponin.

The troponin returns to its normal shape and allows tropomyosin to cover the actin-myosin binding sites on the actin filament. Because no binding sites are available now, no crossbridges can form, and the muscle relaxes. As you can see, muscle contraction is regulated by the level of calcium ions in the cytoplasm. In skeletal muscle, calcium ions work at the level of actin. They move the troponin-tropomyosin complex off the binding sites, allowing actin and myosin to interact.

1. What opens the sarcoplasmic reticulum? _____
2. Which fiber does Calcium bind to? _____
3. Once Calcium binds, what is formed? _____
4. What would happen to a muscle contraction if there was a lack of Calcium? _____
5. What would happen to a muscle contraction if there was an excess amount of Calcium? _____

Section F: Neuromuscular Junction – Muscle Contraction

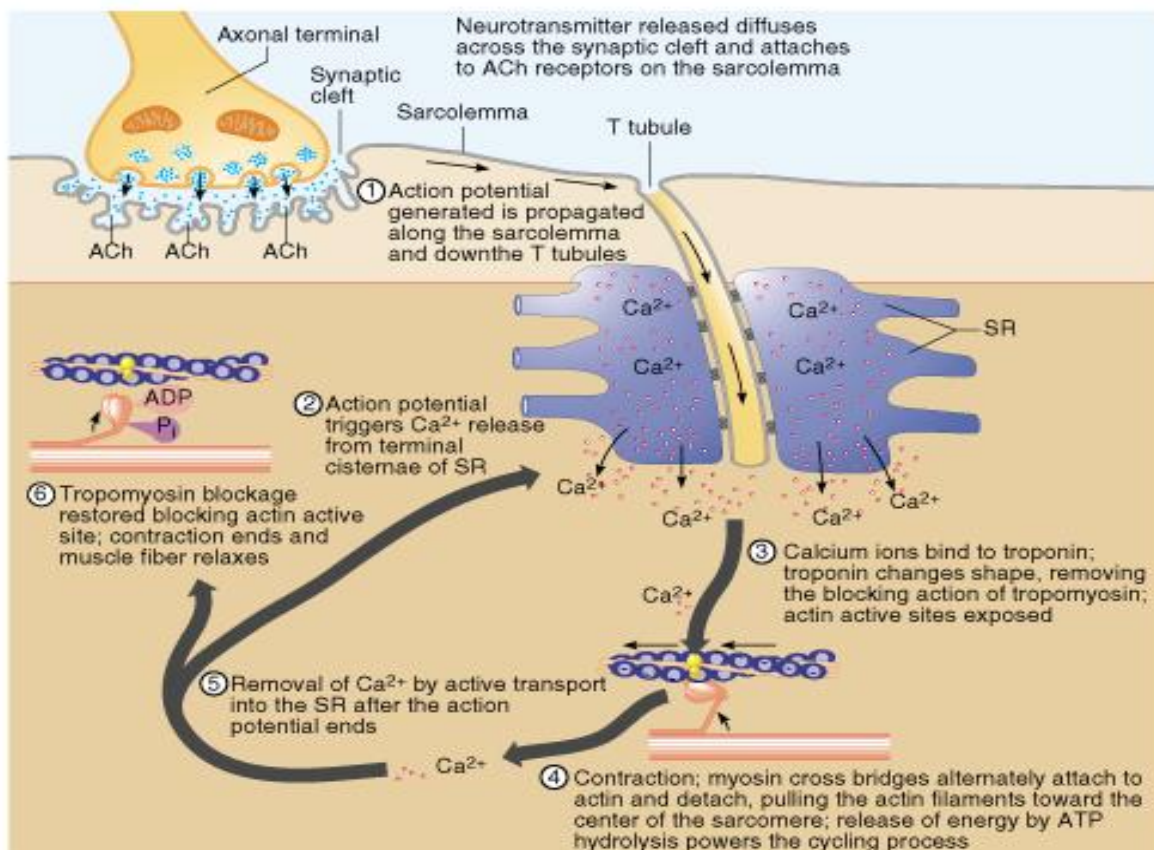
1. What structures are found at a neuromuscular junction? _____
2. What is released from synaptic vesicles when an action potential reaches an axon ending (end of neuron)? _____
3. When ACh crosses the synaptic cleft, what does it attach to? _____
4. What is the synaptic cleft? _____
5. What happens to the sarcolemma? _____
6. What is the sarcolemma? _____

7. What is the role of the neurotransmitter, Acetylcholine? _____
8. When ACh changes the permeability of the sarcolemma, what rushes into the cell? _____
What is this influx called? _____
9. After Na⁺ rush into the cell, what ion rushes out of the cell? _____ What is this called? _____
10. What is an action potential? _____
11. What creates the action potential? _____
12. What does the "All-or-None" law state? _____
13. What is the role of calcium in muscle contraction? What organelle releases calcium? _____

14. What is the role of ATP in muscle contractions? _____
15. Explain the interaction of actin and myosin during the sliding filament theory. _____

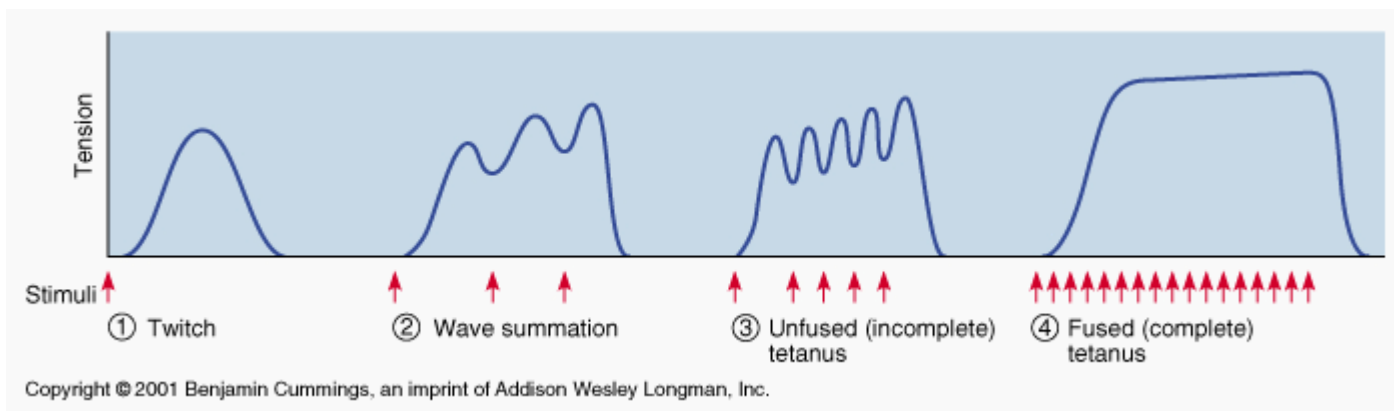
16. Explain why a lack of Potassium K⁺ can cause a muscle to cramp. _____
17. If the sodium-potassium pump doesn't reinstate the ions, will the muscle fiber be able to contract again? _____
18. What would happen if a drug blocked the receptors on the sarcolemma? _____
19. Drugs are used to relax muscles during major surgery. Which of the two chemicals described would make the best muscle relaxant and why? Chemical A binds and blocks acetylcholine receptors in muscle cells OR Chemical B floods the cytoplasm of muscle cells with calcium ions. _____

❖ Below is a summary of the events at the neuromuscular junction.



Section G: Muscle Action

1. What is the all or none law? _____
 Does it apply to the muscle fiber or the entire muscle? _____
2. What is a motor unit? _____
3. A whole muscle reacts with different degrees of shortening called a _____.
 For example, a bicep contracts with various degrees depending on the circumstance.
4. How can a graded response be different?
 - a. _____
 - b. _____
5. What is the difference between a tetanus and a twitch? (Use the diagram to help with your explanation.)



Section H: What causes Rigor Mortis? (<http://chemistry.about.com/cs/biochemistry/a/aa061903a.htm>)

A few hours after a person dies, the joints of the body stiffen and become locked in place. This stiffening is called *rigor mortis*. Depending on temperature and other conditions, rigor mortis lasts approximately 72 hours. The phenomenon is caused by the skeletal muscles partially contracting. The muscles are unable to relax, so the joints become fixed in place. More specifically, what happens is that the membranes of muscle cells become more permeable to calcium ions. Living muscle cells expend energy to transport calcium ions to the outside of the cells. The calcium ions that flow into the muscle cells promote the cross-bridge attachment between actin and myosin. The muscle fibers ratchet shorter and shorter until they are fully contracted or as long as the neurotransmitter acetylcholine and the energy molecule adenosine triphosphate (ATP) are present. However, muscles need ATP in order to release from a contracted state (it is used to pump the calcium out of the cells so the fibers can unlatch from each other). ATP reserves are quickly exhausted from the muscle contraction and other cellular processes. This means that the actin and myosin fibers will remain linked until the muscles themselves start to decompose. The onset of rigor mortis may range from 10 minutes to several hours, depending on factors including temperature. Maximum stiffness is reached around 12-24 hours post mortem. The joints are stiff for 1-3 days, but after this time general tissue decay and leaking of lysosomal intracellular digestive enzymes will cause the muscles to relax.

Use the information above to answer this question.

1. When a suicide victim was found, the coroner was unable to remove the drug vial clutched in his hand. Explain the reason for this. If the victim had been discovered three days later, would the coroner have had the same difficulty? _____

Section I: Energy used in Muscle Contractions

- ❖ Creatine phosphate (CP) is stored in larger amounts than ATP and can rapidly resynthesis ATP anaerobically. Breakdown of CP within skeletal muscle occurs quickly during high intensity exercise.
- ❖ Glycolysis is a form of anaerobic metabolism. Glucose, obtained mainly from intramuscular glycogen stores, is metabolized to lactic acid under conditions of short duration, high intensity exercise when oxygen supply is limited. Glycolysis provides ATP more rapidly than oxidative metabolism.
- ❖ As the duration of exercise continues, oxygen availability to contracting muscles increases and aerobic metabolism provides most of the energy for skeletal muscle contraction. Carbohydrate and fat are the major fuel substrates for oxidative metabolism. Significantly more energy (36 ATP) is obtained from aerobic metabolism of a glucose molecule than from anaerobic metabolism (2 ATP).

1. What are the predominant fuel sources used by an ice hockey player who engages in repeated bouts of high intensity, fast skating maneuvers during a typical game? Explain. _____

2. What are the predominant fuel sources used by a cross-country skier who skis continuously for two hours during a training exercise? Explain. _____

3. When Ms. Gunderson returned from jogging, she was breathing heavily and sweating profusely and complained that her legs ached and felt weak. Her husband poured her a sport drink and urged her to take it easy until she could ‘catch her breath’. What factors have contributed to her muscle fatigue?

Section J: Muscle Fatigue LAB

In order to contract, your muscles require energy in the form of ATP. Muscles can produce ATP by using oxygen (aerobic respiration) or not (anaerobic respiration). Anaerobic respiration in muscle cells produces lactic acid. When muscles do a lot of work quickly, the build-up of lactic acid reduces their ability to contract, until eventually exhaustion sets in and contraction stops altogether. This is called muscle fatigue.

Trial	1	2	3	4	5	6	7	8	9	10
Dominant Hand Number of times you could close the clothes pin										
Non-Dominant Hand Number of times you could close the clothes pin										

Questions:

- (a) What happened to your strength as you progressed through each trial?

- (b) Did you build up any lactic acid?

Section K: Muscle Fiber Types (HONORS ONLY)

Read the article and fill in the information.

	When recruited?	Fatigue?	Activities best suited for?
Slow Oxidative Fibers – Type 1			
Fast Oxidative Fibers – Type IIa			
Fast Glycolytic Fibers – Type IIb			

❖ What is muscle hypertrophy? _____

Section L: Exercise & Muscles

- An _____ contraction is any contraction in which a muscle shortens to overcome resistance. Does this cause movement or no movement? _____
- An _____ contraction occurs when your muscles push against a fixed resistance. Does this cause movement or no movement? _____
- List an example of isometric and isotonic contractions.
 - Isometric _____
 - Isotonic _____
- What is muscle tone? _____
- Why is muscle tone important for our body? _____
- What happens to your muscles due to inactivity? _____
- What is the difference between aerobic and resistance exercise? _____
- Derek broke his clavicle after being hit with a ball during a game. His right arm was immobilized for 8 weeks to allow for proper healing of the bone. Of the 2 types of exercise what specific type of exercise will he need to do in order to gain strength? _____
- Garrett decided that his physique left much to be desired, so he joined a local health club and began 'pump iron' three times weekly. After three months of training, during which he was able to lift increasingly heavier weights, he noticed that his arm and chest muscles were substantially larger. Explain the structural and functional basis of these changes. _____

Section M: Body Movements & Types of Muscles

➤ Under the 'Human A&P' page, click on 'Websites'...go to the link 'Body Movements'. Go through the tutorial – you will be teaching yourself these terms.

- The bicep connects to the skeleton: at the scapula & at the radius and ulna. Which region is the origin? _____ Which region is the insertion? _____
- Muscles usually work in pairs – quadriceps and the hamstrings. Which muscle is the prime mover (agonists) while doing a squat? _____ Which muscle is the antagonist? _____
- Which type of muscles contract at the same time to hold the body in position so the prime mover can work smoothly? _____
- Which type of muscle provides the necessary support to assist in holding the rest of the body in place while the movement occurs? _____

Section N: At the Clinic



1. A nerve injury may paralyze the muscle it supplies. How would you explain to a patient the importance of moving the disabled muscles passively or contracting them using electrical stimulation?

2. Alex is very interested in getting Botox injections. She makes an appointment with the doctor to discuss how her muscles will be affected and what these injections do. As her doctor, you will need to do prior research before her consultation. You will research what Botox is and its affects to the neuromuscular junction and the muscle fibers. _____

3. Old Farmer Brown complains that at age 88, "I can't get around like I used to." What changes in his muscle tissue might make this true? _____

4. Diego was seriously out of shape the day he joined his friends for a game of touch football. While he was running pell-mell for the ball, his left calf began to hurt. He went to the clinic the next day and was told he had a strain. Diego insisted that this must be wrong, because his joints did not hurt. Clearly, Diego was confusing a strain with a sprain. Explain the difference. _____

5. Parents of a 3 year old noticed that the daughter was walking 'on her toes', had a waddling gait, fell frequently and had difficulty getting up again, and was not able to run because of the difficulty in raising her knees. At age five, there was progressive muscular weakness and muscle wasting. Weakness of the trunk muscles led to increased lordosis and a protuberant abdomen. At age nine, she was confined to a wheelchair. Contractures appeared, first in her feet, as the gastrocnemius muscles tightened. What muscular disease does this girl have? _____
6. Marvin is a 58-year-old business executive who experiences muscle weakness and fatigue. He has trouble holding his eyes open and his facial muscles sag such that his mouth turns downward. Swallowing can be difficult and Marvin has been eating slowly to prevent choking. One evening, feeling very tired, he starts seeing double. He can eliminate this problem, called diplopia, by closing one eye. He feels stronger the next morning but makes an appointment with his physician, Dr. Goodchild. At the physical examination, Dr. Goodchild notes a "snarling" expression when Marvin tries to smile; weakness of the tongue; double vision after repetitive eye movements; and normal deep tendon reflexes and sensations. Dr. Goodchild orders a series of diagnostic tests. As a result of the tests, Marvin is diagnosed with myasthenia gravis. Myasthenia gravis is a condition of long-term tiredness and muscle weakness. What does the disease do to the neuromuscular junction? How does this disorder affect the transmission of an impulse? _____

Practice Quiz:

- http://highered.mheducation.com/sites/0072507470/student_view0/chapter9/multiple_choice_quiz_1.html

GROSS ANATOMY OF SKELETAL MUSCLES – Put numbers beside the lines and use this as a practice quiz.

