

Review questions for Muscular system lecture

Multiple choice review questions:

- 1) Another term for muscle cell is muscle _____.
 - A) myocyte
 - B) sarcomere
 - C) fiber
 - D) fascicle

- 2) Skeletal muscle cells are different from other cells in that they
 - A) lack sarcoplasmic reticulum.
 - B) have no mitochondria.
 - C) have multiple nuclei.
 - D) depend entirely on anaerobic respiration.

- 3) Within a muscle organ the cells grouped into larger bundles called _____, each surrounded by its own connective tissue sheath.
 - A) sarcomeres
 - B) sarcolemmas
 - C) myocells
 - D) fascicles

- 4) Skeletal muscle is connected to bones by
 - A) ligaments.
 - B) tendons.
 - C) adipose tissue.
 - D) looseareolar connective tissue.

- 5) When a skeletal muscle contracts, it usually moves one bone of a joint more than the other bone. The attachment of the muscle to the less movable bone is called its
 - A) ligament.
 - B) insertion.
 - C) flexor.
 - D) origin.

- 6) The thick protein filaments of muscle are composed of
 - A) tropomyosin.
 - B) actin.
 - C) troponin.
 - D) myosin.

- 7) The basic unit of muscle contraction is the sarcomere. Which choice below best describes the correct order of structures inside one sarcomere?
- A) Z-disc, actin stack, myosin stack, actin stack, z-disc
 - B) Actin stack, myosin stack, actin stack, myosin stack, actin stack, etc.
 - C) Actin stack, myosin stack
 - D) Myosin stack, Z-disc, actin stack, Z-disc
- 8) Skeletal muscle cells are striated that is, they have alternating dark and light bands called _____, respectively.
- A) A and I bands
 - B) H and M bands
 - C) Z and M lines
 - D) I and H bands
- 9) The I bands of skeletal muscle cells each have a dark line in the middle called a
- A) D line.
 - B) H line.
 - C) Z line.
 - D) X line.
- 10) The region of the resting sarcomere where the myosin filaments are is seen in the
- A) narrow dark line known as the Z line.
 - B) dark color of the I bands.
 - C) lighter region of the I bands.
 - D) dark color of the A bands.
- 11) Contraction in a muscle occurs because the
- A) Actin filaments get shorter.
 - B) Myosin filaments get shorter.
 - C) Actin filaments slide between the myosin filaments.
 - D) Z-discs pull on opposite ends of the sarcomere.
- 12) During contraction the
- A) actin filaments bind to myoglobin
 - B) I bands shorten.
 - C) sarcomeres do not change in length.
 - D) size of the Z line increases.
- 13) When a muscle cell is relaxed (not contracting), which protein is not in direct contact with the actin?
- A) tropomyosin.
 - B) myosin.
 - C) troponin.
 - D) Z disc protein.

- 14) The ability of myosin to bind with actin is regulated by the binding of
- A) Ca^{2+} to troponin.
 - B) ATP to actin.
 - C) Ca^{2+} to tropomyosin.
 - D) Z-discs to ATP.
- 15) A motor neuron and all the muscle cells it controls is called a
- A) filament unit.
 - B) motor unit.
 - C) muscle fascicle
 - D) neuromuscular junction.
- 16) A motor unit has ____ motor neuron(s) and ____ muscle cell(s).
- A) One, many
 - B) Many, many
 - C) Many, one
 - D) One, one
- 17) What is the neurotransmitter secreted into the neuromuscular junction?
- A) epinephrine
 - B) norepinephrine
 - C) dopamine
 - D) acetylcholine
- 18) Much of the calcium that binds to troponin to activate muscle contraction comes from storage sites within the muscle cell, called the _____.
- A) T tubules
 - B) Sacrolemma
 - C) synaptic vesicles
 - D) sarcoplasmic reticulum
- 19) The sarcoplasmic reticulum releases Ca^{2+} when the...
- A) Motor neuron secretes neurotransmitter
 - B) Z-disc meets the myosin filaments
 - C) Muscle cell depolarizes
 - D) ATP binds to the myosin heads
- 20) For skeletal muscle to contract what ion must be interact with one of the sarcomere proteins?
- A) K^+
 - B) Na^+
 - C) Ca^{2+}
 - D) Fe^{3+}

- 21) Muscle organs that moves bones of a joint in opposite directions are called _____ muscles.
- A) Isotonic
 - B) Antagonists
 - C) Isometric
 - D) Myosarcic
- 22) ATP is required by which part of the sarcomere for contraction of a muscle?
- A) The Z-disc
 - B) The myosin
 - C) The actin
 - D) The troponin
- 23) Sustained muscle activity may consume ATP faster than aerobic and anaerobic cellular respiration can produce it. In such circumstances, ATP can be made by combining ADP with phosphate groups borrowed from
- A) glucose phosphate
 - B) creatine phosphate
 - C) cyclic AMP
 - D) phospholipids
- 26) In lecture we learned that slow-twitch muscle cells
- A) have a relatively low aerobic respiration capacity.
 - B) are very resistant to fatigue.
 - C) have a high glycogen content.
 - D) have a high myosin content.
- 27) What does the body use to change the contraction strength of a muscle organ (for example, to change the amount of force the bicep muscle generates)?
- A) The number of motor units activated.
 - B) The number of fascicles.
 - C) The amount of calcium released from the sarcoplasmic reticulum.
 - D) The amount of depolarization in the motor neurons
- 28) The strength with which a given skeletal muscle contracts is affected by all of the following except the
- A) frequency of motor signals to the muscle.
 - B) the amount of actin and myosin inside each muscle cell.
 - C) the number of gap junctions between neighboring muscle cells
 - D) the number of motor units activated

30) Which of the following is not a factor in muscle fatigue?

- A) a drop in intracellular glycogen
- B) accumulation of lactic acid
- C) production of IPSPs by motor neurons

32) Intercalated discs are

- A) junctions between cardiac muscle cells.
- B) a unique type of motor end plate found in smooth muscle.
- C) found in place of the Z lines in cardiac muscle.

Answers to multiple choice questions:

1 = C

2 = C

3 = D

4 = B

5 = D

6 = D

7 = A

8 = A

9 = C

10 = D

11 = C

12 = B

13 = B

14 = A

15 = B

16 = A

17 = D

18 = D

19 = C

20 = C

21 = B

22 = B

23 = B

26 = B

27 = A

28 = C

30 = C

31 = B

32 = A

Fill-in-the-blank review questions:

1) _____ are the organs that provide force for movement.

2) Muscles cause movement by _____, which means getting shorter.

3) In addition to movement, muscle tissue is also responsible for generating much of the body's _____.

4) (True/False) A muscle cannot lengthen itself.

5) (True/False) After a muscle contraction ends and the muscle relaxes, it automatically recoils (returns) to its resting length.

6) Each muscle cell is also called a muscle _____.

7) What sends muscles the signal to contract? _____

8) There are two major types of protein filaments in muscle cells: _____ and _____.

- 9) The thin protein filaments in muscle cells are _____ protein.
- 10) The thick protein filaments in muscle cells are _____ protein.
- 11) Striations (stripes) are seen in _____ and _____ muscle cells.
- 12) Skeletal muscle fibers are formed when several stem cells merge: as a result, skeletal muscle fibers have _____, as opposed to smooth and cardiac muscle cells, which have only one.
- 13) Two unique characteristics of cardiac muscle cells include _____ shape and _____; the latter contain gap junctions which allow ions to move between cells.
- 14) _____ muscle cells lack striations and have only one nucleus.
- 15) The striations are seen in cardiac and skeletal muscles are the aligned stacks of _____ and _____ protein filaments.
- 16) _____ muscle cells have pointed ends.
- 17) _____ muscle is found in hollow organs whose contents must be moved.
- 18) _____ is involuntary muscle and is not found in the heart.
- 19) You can voluntarily control when you contract your bicep muscle. The bicep must therefore be made of _____ muscle tissue. (Note: understand the concept, the muscle name could be different on a test.)
- 20) Each skeletal muscle organ, such as the biceps, is made of several groups of muscle cells bundled together by dense connective tissue. Each bundle of muscle cells is called one _____, which means "bundle".
- 21) Skeletal muscle organs are connected to bones by _____, which are rope-like structures made of dense connective tissue.
- 22) Most skeletal muscle organs are attached to two bones of a joint. When the muscle contracts, it applies force to both bones but usually only one bone moves. The muscle's attachment to the more movable bone is called its _____. The muscle's attachment to the less movable bone is called its _____.
- 23) The movement of a joint's bones by a skeletal muscle organ is described by the phrase "The _____ moves towards the _____."
- 24) A _____ is the smallest contractile unit (the smallest thing that gets shorter during contraction of the muscle) inside a skeletal muscle cell.
- 25) By definition, the length of one sarcomere extends from one _____ to the next _____.

26) The proteins in one sarcomere are (in this order): Z disc, then a stack of _____ protein, then a stack of _____ protein, then another stack of _____ protein, then a Z disc.

27) Inside muscle cells, there are structures called _____ which are made of hundreds of sarcomeres are linked end to end.

28) Within a sarcomere, the dark bands are designated by the letter _____, and the light bands are designated by the letter _____.

29) Dark striations called A bands are formed by the _____ protein filaments.

30) Light striations called I bands are formed by the _____ protein filaments.

31) In the description of a sarcomere, the center of each I band has a thin, dark line called a _____ line .

32) The Z discs attach to and hold the _____ proteins of the sarcomere.

33) In the blank space after each muscle term on the left, write the letters of all descriptions on the right that match it. Some descriptions may match more than one term. Write the letters of all matching descriptions.

A band _____

I band _____

Z line _____

b) It is a disc where the actin filaments are attached

c) It gets smaller when a muscle contracts

d) It is an area of myosin filaments

e) It is an area of actin filaments not overlapping with myosin filaments

f) It marks the end of a sarcomere

g) It is caused by (and as long as) the myosin filaments

34) Place the following in order from smallest to largest: myofibril, actin, myosin, muscle organ, fascicle, muscle fiber, sarcomere.

35) In a skeletal muscle cell, extensions of the myosin molecules called _____ can bind to grooves in the actin proteins.

36) When the muscle cell is relaxed, the myosin heads are blocked from binding to actin because a protein called _____ blocks the binding sites on the actin. This blocking protein is held onto the actin by another protein called _____.

37) One of the first steps in muscle contraction is when _____ (an ion) binds with _____ protein, which causes the protein to release _____ (another protein) from the actin's binding site.

38) Once the tropomyosin has moved out of the actin binding sites, the myosin heads can bind to the actin. When the myosin heads bind to the actin, we say a(n) _____ has formed between the myosin heads and the actin.

39) Once the myosin heads bind to actin, the myosin heads pull the actin inward. This movement is called the _____. It requires _____ as an energy source.

40) Indicate the size of the following muscle components from smallest to largest, by writing the numbers 1 - 8 after each term.

Actin _____
Myosin heads _____
Myofibril _____
Muscle fiber _____
Myosin _____
Sacromere _____
Fascicle _____
Calcium ions _____

41) The type of neuron that controls muscle contraction is called a _____.

42) Contraction of a muscle organ is done by groups of cells called motor units. A motor unit consists of one _____ together with all the _____ that it controls.

43) Each muscle organ has one/many (circle one) motor unit(s) that control it. Each motor unit has one/many (circle one) motor neuron(s). Each motor unit has one/many (circle one) muscle cell(s).

44) The synapse between a motor neuron and a muscle cell is called a _____.

46) To make a skeletal muscle cell contract, a motor neuron releases _____ (a neurotransmitter) into the neuromuscular junction. The neurotransmitters cause an action potential in this region by opening _____ (an ion) channels.

50) The endoplasmic reticulum of the muscle cell is called its _____.

51) The major function of the sarcoplasmic reticulum in muscle cells is to store _____, which is an ion used in contraction of the sarcomeres.

52) When the voltage-gated Ca^{2+} channels in the muscle cell open, calcium channels in the _____ (an organelle inside the muscle cell) release calcium ions.

54) A muscle contraction involves all of the following events. Using the numbers 1-7, indicate the order they occur in.

I bands begin to decrease in size _____

Calcium levels increase _____

Myosin heads bind actin _____

ATP is consumed _____

Nerve signal reaches muscle _____

Actin and myosin at maximum overlap _____

Tropomyosinprotein leaves actin fibers _____

55) Three methods used by muscle cells to regenerate ATP are _____, _____ and _____.

56) The fastest way muscles can recharge their ATP is by transferring phosphates from _____ directly to ADP.

58) In _____, energy from glucose is used to recharge ATP; No oxygen is needed and lactic acid is made as a product.

59) In _____, energy from glucose is used to recharge ATP; Oxygen is needed. CO₂ and H₂O are made as products.

64) The major health benefit of aerobic exercise is to increase the efficiency and health of the body's _____ system.

65) The two major direct effects of resistance training (which is usually anaerobic exercise) on muscle are to increase the _____ and _____ of the muscle cells.

66) In the blank space after each term on the left, write the letters of all descriptions on the right that match it.

Aerobic respiration _____

a) Causes lactic acid in muscles

Anaerobic respiration _____

b) Increases muscle size but not endurance

Easy aerobic exercise _____

c) Builds up an oxygen debt

Intense aerobic exercise _____

d) Usually involves isometric contractions

Resistance training _____

e) Lowers chances of heart attack and stroke

f) Produces 36 ATP per glucose

g) Produces 2 ATP per glucose

67) If a muscle cell is the type that uses mostly anaerobic respiration and is white colored, it is a fast/slow (circle one) twitch muscle cell. This kind is also called a type _____ muscle cell.

68) If a muscle cell is the type that uses mostly aerobic respiration and is red colored, it is fast/slow (circle one) twitch muscle cell. This kind is also called a type _____ muscle cell.

69) The muscle cell type with the most endurance is slow/fast (circle one) twitch muscle.

70) The duration of muscular effort will be increased/decreased (circle one) if oxygen is not available.

71) The duration of slow twitch muscular cells is higher because they rely on _____ respiration for generation of ATP.

73) The amount of fast twitch and slow twitch muscle cells in a person is controlled by _____ and _____.

74) The ability of a muscle organ to change the amount of force it generates is called its ability to perform _____ contractions.

75) If the number of motor units that are activated increases, the muscle's force of the contraction will increase/decrease (circle one).

76) A _____ means the amount that a muscle cell contracts due to one single nerve signal.

77) One twitch only causes partial contraction of the sarcomeres, not full contraction. To cause full contraction of the sarcomeres in the muscle cell, what must occur (in regards to nerve signals)?

78) If the frequency of nerve signals increases beyond a certain point, the muscle cell reaches its maximum contraction force (because its sarcomeres are fully contracted). The term _____ refers this state of sustained maximum muscle contraction.

79) In summary, there are two ways muscles can vary the amount of force they generate. The force can be changed by increasing the number of _____ that are recruited in the muscle organ, and the force can be changed by increasing the _____ of nerve signals reaching each muscle cell in the organ.

80) The term for the decrease in a muscle's force because of prolonged use (in other words, the term for a muscle getting tired) is _____.

81) One cause of fatigue is that the muscle runs low on _____, which is the glucose polymer that the muscle uses as stored fuel.

- 82) Another cause of muscle fatigue is when the amount of _____ increases in the muscle.
- 83) When muscle uses anaerobic respiration and therefore makes lactic acid from glucose, the lactic acid does/doesn't (circle one) decrease the muscle's force of contraction.
- 86) Contractions that cause movement of substances through hollow organs are the specialty of _____ muscle tissue.
- 92) In cardiac muscle tissue, each muscle cell has dark-staining structures called _____ located at the borders between neighboring muscle cells. These structures contain many _____, a term that means membrane passages that connect the cytoplasm of one cell to another cell.
- 93) The gap junctions of intercalated discs are important because they allow cardiac muscle cells to _____. This allows large sections of the heart to contract in unison.

Answers to fill-in-the-blank review questions:

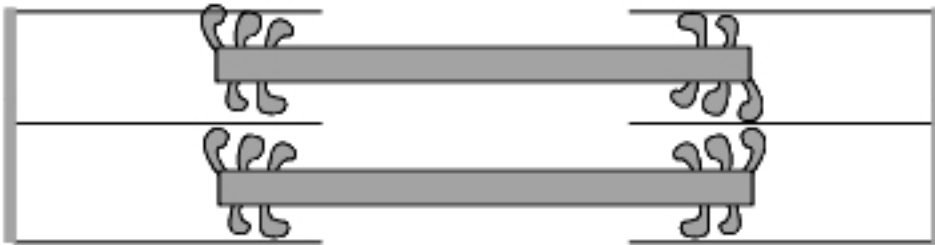
- | | |
|---------------------------|------------------|
| 1) Muscles | 23) Insertion |
| 2) Contracting | Origin |
| 3) Heat | 24) Sarcomere |
| 4) True | 25) Z-disc |
| 5) False | Z-disc |
| 6) Fiber | 26) Actin |
| 7) Nervous system/Neurons | Myosin |
| 8) Actin | Actin |
| Myosin | 27) Myofibrils |
| 9) Actin | 28) A |
| 10) Myosin | I |
| 11) Skeletal muscle | 29) Myosin |
| Cardiac muscle | 30) Actin |
| 12) Multiple nuclei | 31) Z-line |
| 13) Branched | 32) Actin |
| Intercalated discs | 33) G |
| 14) Smooth muscle | CE |
| 15) Actin | BF |
| Myosin | 34) Actin |
| 16) Smooth muscle | Myosin |
| 17) Smooth muscle | Sarcomere |
| 18) Smooth muscle | Myofibril |
| 19) Skeletal muscle | Muscle fiber |
| 20) Fascicle | Fascicle |
| 21) Tendons | Muscle organ |
| 22) Insertion | 35) Myosin heads |
| Origin | 36) Tropomyosin |
| | Troponin |

- 37) Ca^{2+}
Troponin
Tropomyosin
- 38) Cross bridge
- 39) Power stroke
ATP
- 40) 3
2
6
7
4
5
8
1
- 41) Motor neuron
- 42) Motor neuron
Muscle cells
- 43) Many
One
Many
- 44) Neuromuscular junction
- 46) Acetylcholine
 Na^+
- 50) Sarcoplasmic reticulum
- 51) Ca^{2+}
- 52) Sarcoplasmic reticulum
- 54) 6
2
4
5
1
7
3
- 55) Creatine phosphate
Cellular anaerobic respiration
Cellular aerobic respiration
- 56) Creatine phosphate
- 58) Cellular anaerobic respiration
- 59) Cellular aerobic respiration
- 64) Cardiovascular system
- 65) Size
Power
- 66) F
ACG
E
ACE
ABD
- 67) Fast
Type II
- 68) Slow
Type I
- 69) Slow
- 70) Decreased
- 71) Aerobic
- 73) Their genes
The type of exercise they do
- 74) Graded
- 75) Increase
- 76) Twitch
- 77) The frequency of nerve signals must increase
- 78) Tetanus
- 79) Motor units
Frequency
- 80) Fatigue
- 81) Glycogen
- 82) Lactic acid
- 83) Doesn't (it merely causes a burning sensation)
- 86) Smooth
- 92) Intercalated discs
Gap junctions
- 93) Pass contraction signals from cell to cell

Short answer review questions:

1) Sketch the three types of muscles cells below. In each drawing, show the nucleus (or more than one, if appropriate) and the striations (if present). Under each drawing, write the correct name of the muscle cell type and name an organ in the body where that muscle cell type is found.

2) The diagram below shows a sacromere. Follow the directions below the drawing.



- a) Circle one actin protein. b) Draw a T on the region that has tropomyosin.
 c) Draw an X on one region that uses ATP to contract the muscle. d) Draw a Z on one Z-disc.

3) Fill in the table below about the three ways muscles recharge their ATP supply. In each blank, write Yes if the recharge method has that trait, write No if it does not have the trait.

	<u>Creatine phosphate</u>	<u>Anaerobic respiration</u>	<u>Aerobic respiration</u>
Requires O ₂ ?	_____	_____	_____
Requires glucose?	_____	_____	_____
Makes lactic acid?	_____	_____	_____
Makes CO ₂ ?	_____	_____	_____

4) There are two ways we can change the amount of force a muscle generates. Describe both ways. For each way, be sure to state how it increases the force of the muscle.

5) Fast twitch muscle cells are used for fast muscle contractions. People with many fast twitch muscle cells excel at sports that require fast contractions, such as sprinting. The drawback of this type of muscle cell is that it has very little endurance. Slow twitch muscle cells do not contract as quickly, but they have

much more endurance. People with many slow twitch muscle cells excel at sports that require endurance, such as marathon races. Do these athletes excel because they were born with the right kind of muscle cells for their respective sports, or did they develop the right kind of muscle cells because they practiced at these sports? Justify your answer.

Answers to short answer review questions:

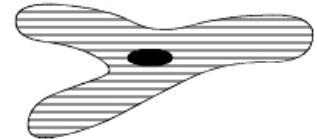
1)



Skeletal muscle
Example organs:
Bicep, quadriceps



Smooth muscle
Example organ:
Stomach, intestines



Cardiac muscle
Example organ:
Heart

2)



3) Fill in the table below about the three ways muscles recharge their ATP supply. In each blank, write Yes if the recharge method has that trait, write No if it does not have the trait.

	<u>Creatine phosphate</u>	<u>Anaerobic respiration</u>	<u>Aerobic respiration</u>
Requires O ₂ ?	No	No	Yes

Requires glucose?	No	Yes	Yes
Makes lactic acid?	No	Yes	No
Makes CO ₂ ?	No	No	Yes

4) One way we change the amount of force a muscle generates is by changing the number of motor units we recruit for the contraction. One motor unit is one neuron and the group of muscle cells controlled by that neuron. Each muscle organ has many motor units. The more motor units recruited the more muscle cells in the organ contract, and more force is generated.

The second way we change the force a muscle generates is by changing the frequency of nerve signals sent to the muscle cells. The greater the frequency of nerve signals, the more fully the sarcomeres in each muscle cell, and therefore the greater the contraction force.

5) Both answers are correct. Different people are born with different amounts of fast twitch and slow twitch muscle cells, so some people are “born” to be great sprinters or great marathon runners. The amount of fast and slow twitch muscle cells, however, can be changed by the style of athletic training. Training by sprinting increases the amount of fast twitch muscle cells, and training by running marathon races increases the amount of slow twitch muscle cells.