Chapter 8 a--Muscle Physiology

1. The striated appearance of skeletal muscle is due to the

   A. orderly arrangement of the T tubules
   B. orderly arrangement of the lateral sacs of the sarcoplasmic reticulum
   C. orderly arrangement of the thick and thin filaments into A and I bands
   D. orderly arrangement of the motor units
   E. presence of white and red muscle fibers within the muscle

2. Muscle fibers develop tension by

   A. contraction of sarcomeres
   B. shortening
   C. the pushing of myosin by actin
   D. contraction of sarcomeres and shortening
   E. none of these

3. Myosin

   A. is found in the A band
   B. is found in the I band
   C. is in the thin filaments
   D. contracts during muscle contraction because it is one of the contractile proteins
   E. none of these

4. Myosin is

   A. spherical
   B. attached to tropomyosin
   C. a regulatory protein
   D. all of these
   E. none of these

5. Actin

   A. has ATPase activity
   B. is spherical
   C. forms a helical chain that forms the main structural component of the thin filaments
   D. is spherical and forms a helical chain that forms the main structural component of the thin filaments
   E. all of these

6. Actin

   A. does not perform a power stroke during muscle contraction
   B. contains a globular head that forms the cross bridges between the thick and thin filaments
   C. is not found within A bands
   D. is inhibited by Ca^{2+}
   E. none of these

7. Thick filaments in skeletal muscle are composed of

   A. actin
   B. troponin and tropomyosin
   C. myosin
   D. actin, troponin, and tropomyosin
   E. all of these

8. Sarcomeres are arranged end to end as

   A. fascicles
   B. myofibrils
   C. bands
   D. perimysia
   E. none of these

9. The I band of the sarcomere is characterized by

   A. overlapping thin and thick filaments
   B. only the presence of thick filaments
   C. the presence of thin filaments and actin
   D. a dark coloration
   E. the presence of thin filaments, actin, and a dark coloration

10. Z lines

    A. are formed by the T tubules
    B. extend down the middle of the I band
    C. are formed by the cross bridges
    D. are the thin filaments
    E. extend down the middle of the sarcomere

11. Cross bridges

    A. bind to actin during muscle contraction
    B. consist of tropomyosin heads
    C. are globular heads made of myosin
    D. do not bend during muscle contraction
    E. bind to actin during muscle contraction and are globular heads made of myosin

12. Order the following muscle cell components from larger to smaller

1. troponin
2. myofibril
3. sarcomere
4. thin filament
5. muscle fiber

A. 3, 4, 1, 5, 2
B. 1, 2, 3, 5, 4
C. 5, 4 ,3 , 1, 2
D. 5, 2, 3, 4, 1
E. 3, 4, 5, 2, 1

13. Skeletal muscle fibers

A. have T tubules within their sarcomeres
B. have Z lines extending down the middle of the I bands
C. contain gap junctions
D. all of these
E. have T tubules within their sarcomeres, and Z lines extending down the middle of the I bands

14. The region between two Z lines is a

A. muscle fiber
B. myofibril
C. myofilament
D. sarcomere
E. sarcoplasmic reticulum

15. Skeletal muscle fibers

A. are some of the longest cells in the body
B. are attached end-to-end within a muscle
C. contain Z lines within their A bands
D. contain only one nucleus
E. all of these, except contain only one nucleus

16. Identify the characteristic(s) shared by all types of muscle tissues?

A. Every type is neurogenic.
B. Every type has T tubules.
C. Every type has tropomyosin.
D. All of these.
E. Every type has T tubules and tropomyosin.

17. The functional unit of skeletal muscle is the

    A. smallest contractile component of a muscle fiber
    B. area between two Z lines
    C. sarcomere
    D. area between two Z lines and sarcomere
    E. all of these

18. Troponin

    A. binds with calcium to allow sarcomere shortening
    B. breaks down myosin cross bridges
    C. is an enzyme in the sarcomere
    D. forms the boundaries of a sarcomere
    E. all of these, except forms the boundaries of a sarcomere

19. The smallest unit of contraction within a skeletal muscle is a

    A. myofibril
    B. muscle fiber
    C. sarcomere
    D. thin filament
    E. thick filament

20. A function of tropomyosin is to

    A. bind Ca^{2+}
    B. form attachments with myosin cross bridges
    C. prevent myosin cross bridges from attaching to the thin filaments
    D. act as an ATPase
    E. none of these

21. According to the sliding-filament mechanism, the

    A. A bands slide in closer between the I bands.
    B. Thin filaments slide inward toward the center of the A band.
    C. Z lines slide in between the T tubules.
    D. Contractile proteins contract, thus shortening the sarcomere.
    E. Filaments slide into the lateral sacs of the sarcoplasmic reticulum.

22. During contraction of skeletal muscle fibers, the

    A. Contractile proteins contract.
    B. Thin filaments slide inward toward the A band's center as a result of cycles of cross-bridge binding and bending.
    C. Thick and thin filaments become tightly coiled, thus shortening the sarcomere.
    D. I bands slide in between the A bands.
    E. Lateral sacs of the sarcoplasmic reticulum shrink, pulling the Z lines closer together.

23. Which molecules are involved with regulation of cross bridge attachment activity?

A. calcium ions
B. troponin
C. myosin
D. calcium ions and troponin
E. all of these

24. During muscle contraction, the

A. Z lines move farther away from the thick filaments.
B. A band becomes narrower.
C. H zone becomes narrower or disappears.
D. I band remains unchanged.
E. *Both* H zone becomes narrower or disappears, *and* I band remains unchanged.

25. The H zone

A. is the area within the middle of the A band where the thin filaments do not reach
B. shortens or disappears during contraction
C. contains only thick filaments
D. is in the middle of the A band
E. all of these

26. Which of the following changes in banding pattern occur during muscle relaxation?

A. Thin filaments stretch away from the Z lines.
B. I bands get wider.
C. H zones get narrower.
D. Thick filaments stretch and become longer.
E. I bands get wider and H zones get narrower.

27. During contraction, asynchronous cycling of crossbridges

A. prevents tetany
B. prevents thick filaments from slipping backwards
C. prevents thin filaments from slipping backwards
D. utilizes less ATP
E. none of these

28. During excitation-contraction coupling,

A. The action potential travels down the T tubules.
B. Ca^{2+} is released from the sarcoplasmic reticulum.
C. Ca^{2+} is taken up by the sarcoplasmic reticulum.
D. The action potential travels down the T tubules, and Ca^{2+} is released from the sarcoplasmic reticulum.
E. The action potential travels down the T tubules, and Ca^{2+} is taken up by the sarcoplasmic reticulum.

29. The T tubules

A. store Ca^{2+}
B. provide a means of rapidly transmitting the action potential from the surface into the central portions of the muscle fiber
C. store ATP
D. run longitudinally between the myofibrils
E. have expanded lateral sacs

30. Sequence the following events involved in muscle cell contraction:

1. Sodium channels open and sodium flows in.
2. Impulse reaches axon's synaptic knob.
3. ACh binds to receptors on the muscle cell membrane.
4. Synaptic vesicles fuse with neuron's membrane and release ACh via exocytosis.
5. If enough sodium moves in to the muscle cell, an impulse (action potential) develops.

A. 1, 2, 3, 4, 5
B. 2, 1, 3, 4, 5
C. 2, 4, 3, 1, 5
D. 3, 4, 5, 1, 2
E. 3, 5, 2, 1, 4

31. The T tubules

A. store Ca^{2+}
B. provide a means of rapidly transmitting ACh to the central portions of the muscle fiber
C. provide attachment sites for ACh
D. provide a means of rapidly transmitting ACh to the central portions of the muscle fiber and provide attachment sites for ACh
E. none of these

32. An action potential rapidly spreads to the central portions of a muscle cell by means of the

A. Z lines
B. sarcoplasmic reticulum
C. H zone
D. pores in the membrane surface
E. T tubules

33. Binding of ____ to myosin permits the cross-bridge to ____.

A. ATP; bind with actin
B. ATP; detach from actin
C. calcium; bind with actin
D. calcium; detach from actin
E. none of these

34. The sarcoplasmic reticulum stores ____ when a muscle is relaxed and releases it for binding to ____ during contraction.

A. calcium; troponin
B. calcium; tropomyosin
C. sodium; tropomyosin
D. potassium; tropomyosin
E. sodium; troponin

35. Of the steps in excitation-contraction below, which occurs before the others?

A. Exposed actin sites bind with myosin cross bridges.
B. Sodium channels open in the fiber's membrane.
C. Calcium is released from the sarcoplasmic reticulum.
D. Troponin binds calcium.
E. Attachment of ATP allows for cross bridge detachment.

36. Which is not characteristic of cross bridges?

A. They are a component of thin filaments.
B. They are comprised of myosin.
C. They have an actin binding site.
D. They have an ATPase binding site.
E. They provide power stroking.

37. Foot proteins

A. span the gap between a lateral sac of the sarcoplasmic reticulum and the adjacent T tubule
B. are believed to serve as Ca^{2+} channels
C. bind to and pull the thin filaments inward toward the A band's center during muscle contraction
D. span the gap between a lateral sac of the sarcoplasmic reticulum and the adjacent T tubule, and are believed to serve as Ca^{2+} channels
E. none of these

38. Which statement is incorrect about cross bridges?

A. They are globular myosin heads that protrude from the thick filaments.
B. They bend during muscle contraction.
C. They detach from actin during muscle contraction.
D. They are not found in the I band.
E. They bind with troponin during contraction.

39. During a cross-bridge cycle in skeletal muscle, the

A. Cross bridge is energized when it hydrolyzes ATP.
B. Myosin cross bridge must bind with an ATPase before the cross bridge will experience a power stroke.
C. Ca^{2+} causes the troponin-tropomyosin complex to move off the actin-binding sites on myosin.
D. ADP binds to the cross bridge at the end of the power stroke.
E. Cross bridge is energized when it hydrolyzes ATP, and myosin cross bridge must bind with an ATPase before the cross bridge will experience a power stroke.

40. Cross bridge interaction between actin and myosin in skeletal muscle is directly blocked by

A. acetylcholine
B. triads
C. Z lines
D. calcium
E. tropomyosin

41. The energy for cross bridge cycling during muscle contraction is provided by:

A. acetylcholine
B. Ca^{2+}
C. ATP
D. myosin
E. actin

42. Which of the following is not involved in the relaxation of muscle?

A. synthesis of ACh by acetylcholinesterase
B. initiation of action potentials
C. the troponin-tropomyosin complex slipping back into its blocking position
D. detachment of actin from tropomyosin
E. T tubules actively absorbing Ca^{2+}

43. A lack of ATP in a skeletal muscle cell would most likely cause

A. tension to decrease
B. cross bridges to detach from actin
C. the sarcomeres to become longer
D. an increase in tension and an inability to relax
E. the sarcomeres to become longer, an increase in tension, and an inability to relax

44. Which of the following is involved in muscle relaxation?

A. Acetylcholinesterase destroys acetylcholine to allow the muscle membrane to return to resting potential.
B. Ca^{2+} is actively taken up by the lateral sacs of the sarcoplasmic reticulum when there is no longer a local action potential.
C. The cross bridges pull the filaments back to their original resting positions.
D. Acetylcholinesterase destroys acetylcholine to allow the muscle membrane to return to resting potential, and Ca^{2+} is actively taken up by the lateral sacs of the sarcoplasmic reticulum when there is no longer a local action potential.
E. All of these.

45. Whole muscle tension depends on all of the following *except*

A. number of muscle fibers contracting
B. tension produced by each contracting fiber
C. extent of motor-unit recruitment
D. frequency of stimulation
E. the proportion of each motor unit used at any given time

46. A motor unit refers to

A. a single motor neuron plus all of the muscle fibers it innervates
B. a single muscle fiber plus all of the motor neurons that innervate it
C. all of the motor neurons supplying a single muscle
D. a pair of antagonistic muscles
E. a sheet of smooth muscle cells connected by gap junctions

47. In twitch summation:

A. The muscle fiber is stimulated again before the action potential has returned to resting potential.
B. The muscle fiber is stimulated again before the filaments have completely returned to their resting position.
C. Stronger muscle contractions occur but stronger action potentials do not occur.
D. The muscle fiber is stimulated again before the action potential has returned to resting potential, and stronger muscle contractions occur but stronger action potentials do not occur.
E. The muscle fiber is stimulated again before the filaments have completely returned to their resting position, and stronger muscle contractions occur but stronger action potentials do not occur.

48. Twitch summation

A. is a means by which gradation of muscle contraction may be accomplished
B. results from the additional release of Ca^{2+} within the cytosol of muscle fibers
C. results from increasing the frequency at which motor units are firing within a muscle
D. is a means by which gradation of muscle contraction may be accomplished and results from increasing the frequency at which motor units are firing within a muscle
E. all of these

49. Twitch summation

A. results from increases in cytosolic calcium levels
B. pumping of calcium into the sarcoplasmic reticulum
C. can be enhanced by allowing a cell to completely relax
D. rarely results in tetany
E. none of these

50. To pick up something heavier than your pencil, your nervous system could

A. stimulate larger motor units
B. decrease the frequency of stimulation to allow a more prolonged contraction to occur
C. decrease the refractory periods
D. block acetylcholinesterase at the neuromuscular junction to allow acetylcholine to function longer
E. none of these

51. Based on the length-tension relationship,

A. Stretching a skeletal muscle 30% longer than the l_o results in a greater contraction.
B. Varying the amount of overlap of thick and thin filaments does not greatly affect contraction force as long as tension remains the same.
C. More tension develops if a muscle is 30%shorter than its resting length.
D. Muscle tension remains the same as long as the muscle's length is not more than ±30% of the resting length.
E. A resting muscle that is shorter or longer than its l_o will generate less tension at the onset of contraction.

52. Picking up a book at a constant speed requires that

A. muscle tension be equal to the book's weight
B. the muscle perform an eccentric contraction
C. the muscle perform an isometric contraction
D. the muscle perform a concentric contraction
E. muscle tension be equal to the book's weight and the muscle to perform a concentric contraction

53. Muscle tension

A. is created during muscle contraction as the tension generated by the contractile elements is transmitted via the connective tissue and tendons to the bones
B. is the force exerted on a muscle by the weight of an object
C. is greater than the load during an isometric contraction
D. all of these
E. none of these

54. The origin of a muscle is its

A. main, thickest part
B. middle, thinner part
C. movable end of attachment
D. source of development in the fetus
E. stationary end of attachment

55. During an isotonic contraction:

A. Filaments do not shorten in the muscle.
B. Movement does not occur inside the muscle.
C. The muscle does not change length.
D. The muscle's tension does not overcome a load.
E. The muscle's tension remains constant.

56. During an isometric contraction, the muscle

A. maintains a constant tension
B. shortens
C. moves a body part
D. maintains a constant length
E. tension is greater than the load

57. With eccentric muscle contractions:

A. Development of tension occurs at constant muscle length.
B. Muscle lengthens while contracting.
C. Muscle shortens while contracting.
D. Muscle length and tension vary throughout a range of motion.
E. None of these.

58. Submaximal isometric contractions are important for

A. moving large objects
B. walking
C. maintaining posture
D. writing
E. walking and maintaining posture

59. Muscles developing tension while lengthening are performing ____ contractions.

A. concentric
B. eccentric
C. isometric
D. fatiguing
E. oscillating

60. In a muscle fiber undergoing maximal tetanic stimulation, the velocity of shortening ____ as the load ____.

A. decreases; decreases
B. decreases; increases
C. increases; increases
D. remains constant; increases
E. remains constant; decreases

61. If the load on a muscle is increased, eventually a load will be reached at which the velocity of shortening becomes zero. At this point, the muscle contraction is referred to as

A. concentric
B. eccentric
C. isotonic
D. isokinetic
E. isometric

62. Energy sources available to form ATP in muscle fibers in the absence of oxygen include

A. creatine phosphate
B. chemiosmosis
C. glycolysis
D. creatine phosphate and glycolysis
E. chemiosmosis and glycolysis

63. The first means by which ATP is produced at the onset of contractile activity is

A. transfer of energy and phosphate from creatine phosphate to ADP
B. oxidative phosphorylation
C. glycolysis
D. degradation of myoglobin
E. none of these

64. During aerobic exercise, the primary means for ATP production in muscle fibers involves

A. creatine phosphate
B. fermentation
C. oxidative phosphorylation
D. glycolysis
E. myoglobin

65. Myoglobin

A. can store small amounts of O_2
B. increases the rate of O_2 transfer from the blood into muscle fibers
C. is abundant in fast-glycolytic fibers
D. can store small amounts of O_2 and increases the rate of O_2 transfer from the blood into muscle fibers
E. all of these

66. Select the correct statement about the summation of simple twitches.

A. They can occur because of the long duration of the action potential in a muscle fiber.
B. They reduce the tension in a muscle.
C. They result from the slow stimulation of a muscle fiber.
D. The effect is unrelated to the refractory periods of action potentials.
E. The twitches resulting from separate action potentials add together.

67. Which of the following statements about the different types of muscle fibers is incorrect?

A. The higher the ATPase activity, the faster the speed of contraction.
B. Muscles that have high glycolytic capacity and large glycogen stores are more resistant to fatigue.
C. Muscles with high ATP-synthesizing ability are more resistant to fatigue.
D. Oxidative types of muscle fibers contain myoglobin.
E. Muscle fibers containing large amounts of myoglobin have a dark red color in comparison to the paler fibers, which have little myoglobin.

68. Fast-glycolytic (type IIx) muscle fibers

A. have high myosin-ATPase activity
B. can carry out oxidative phosphorylation
C. fatigue rapidly
D. contain myoglobin
E. all of these

69. Fast-oxidative (type IIa) fibers

A. contain very few mitochondria
B. can be converted into fast-glycolytic fibers by regular resistance activities
C. are most abundant in muscles specialized for maintaining low-intensity contractions for long periods of time without fatigue
D. can be converted into fast-glycolytic fibers by regular resistance activities and are most abundant in muscles specialized for maintaining low-intensity contractions for long periods of time without fatigue
E. all of these

70. The muscle cells of a marathon runner's legs would exhibit all these characteristics except

A. high resistance to fatigue
B. low myoglobin content
C. low glycogen content
D. many mitochondria
E. slow speed of contraction

71. Fatigue is the failure of a muscle fiber to maintain ____ as a result of previous contractile activity.

A. excitability
B. muscle mass
C. tension
D. sarcomere number
E. mitochondria

72. Muscular fatigue can be caused by

A. lactic acid accumulation
B. depletion of ATP
C. depletion of ACh
D. all of these
E. lactic acid accumulation and depletion of ATP

73. Which of the following does not directly influence motor neurons?

A. primary motor cortex
B. cerebellum
C. brain stem
D. afferent neurons (through intervening interneurons)
E. none of these

74. When a muscle atrophies:

A. The muscle fibers split lengthwise.
B. It decreases in mass and becomes weaker.
C. Its fibers increase in diameter.
D. Its fibers undergo mitotic cell division.
E. The muscle fibers dissolve and are replaced by fibrous scar tissue.

75. In the body's lever systems, the fulcrums are represented by the

A. joints
B. long bones
C. tendons
D. short bones
E. skeletal muscles

76. With the type of lever system exemplified by flexion of the elbow joint, when an object is held in the hand, the

A. power arm of the lever is the distance between the elbow joint and the insertion of the biceps muscle
B. load arm of the lever is the distance between the elbow joint and the hand
C. velocity and distance moved by the hand is amplified at the expense of the biceps muscle having to exert considerably greater force than the actual load that is moved
D. only two of these
E. all of these

77. Which statement below is characteristic of most of the body's lever systems?

A. They work at mechanical advantage.
B. They work at a mechanical disadvantage.
C. Muscles must exert greater forces than the load.
D. They work at mechanical advantage and at a mechanical disadvantage.
E. They work at a mechanical disadvantage, and muscles must exert greater forces than the load.

78. Enlargement of muscle due to weight lifting is primarily a result of

A. hypertrophy
B. hyperplasia
C. increased production of actin and myosin
D. increases in the number of cells
E. hypertrophy and increased production of actin and myosin

79. The corticospinal system

A. consists of fibers that originate within the primary motor cortex and terminate on motor neurons
B. involves the motor regions of the cortex, the cerebellum, the basal nuclei, and the thalamus
C. is primarily concerned with regulation of overall body posture
D. consists of fibers that originate within the primary motor cortex and terminate on motor neurons, and is primarily concerned with regulation of overall body posture
E. involves the motor regions of the cortex, the cerebellum, the basal nuclei, and the thalamus and is primarily concerned with regulation of overall body posture

80. Conscious initiation of muscle contraction is controlled by

A. the spinal cord
B. the brain stem
C. the cerebral cortex
D. the thalamus
E. none of these

81. Spastic paralysis occurs when

A. Descending excitatory pathways are destroyed.
B. Excitatory inputs to motor neurons are unopposed because of disruption of an inhibitory system in the brain stem.
C. Muscle spindles are destroyed.
D. The cerebellum is damaged.
E. The motor neurons are destroyed.

82. During coactivation

A. All of the muscle fibers in a skeletal muscle are activated simultaneously.
B. The gamma motor-neuron and alpha motor-neuron systems to a skeletal muscle are activated simultaneously.
C. All of the cross bridges within a single skeletal muscle are activated simultaneously.
D. The primary (annulospiral) and secondary (flower-spray) endings within a muscle spindle are activated simultaneously.
E. None of these.

83. Intrafusal muscle fibers

A. are supplied by alpha motor neurons
B. are found within muscle spindles
C. contain sensory nerve endings that are activated by stretch
D. are supplied by alpha motor neurons and contain sensory nerve endings that are activated by stretch
E. are found within muscle spindles and contain sensory nerve endings that are activated by stretch

84. The stretch receptors in the central portion of the muscle spindle can be activated by

A. passive stretch of the whole muscle, including stretch of the muscle spindle
B. contraction of the end portions of the muscle spindle
C. gamma motor neuron stimulation of the muscle spindle
D. all of these
E. none of these

85. Stretch reflexes are important

A. for maintaining balance and posture
B. for providing afferent information coordinating complex muscle activity
C. for determining the level of tone
D. for maintaining balance and posture, and for providing afferent information coordinating complex muscle activity
E. for providing afferent information coordinating complex muscle activity and for determining the level of tone

86. Calcium turns on cross bridges by physically repositioning the troponin-tropomyosin complex to uncover the actin cross-bridge binding sites in

A. skeletal muscle
B. cardiac muscle
C. smooth muscle
D. all of these
E. skeletal and cardiac muscles

87. Which is not characteristic of smooth muscle?

A. It is under involuntary control.
B. It does not have troponin.
C. Its contraction is initiated neurogenically only.
D. It is found in walls of hollow tube-like organs.
E. It is innervated by the ANS.

88. Cardiac muscle tissue

A. has well developed sarcoplasmic reticulum
B. has fast myosin ATPase activity
C. contracts only when stimulated neurogenically
D. has gap junctions
E. stores calcium in its T tubules

89. The regulation of smooth muscle contraction is mediated by the phosphorylation of ____ in response to calcium binding to ____.

A. myosin; calmodulin
B. actin; calmodulin
C. troponin; calmodulin
D. myosin; troponin
E. actin; troponin

90. Select the correct statement regarding smooth muscle.

A. It composes the walls of the heart.
B. It is absent in the walls of hollow organs.
C. Its cells are multinucleated.
D. Its cells are spindle-shaped.
E. Its cells lack actin and myosin.

91. ____ is not required for contraction of smooth muscle fibers.

A. Calcium
B. Calmodulin
C. Phosphate
D. ATP
E. Troponin

92. Calcium that enters the cell during smooth muscle excitation binds with

A. calmodulin
B. inactive myosin kinase
C. troponin
D. myosin
E. actin

93. Which of the following muscle types are myogenic?

A. cardiac muscle
B. single-unit smooth muscle
C. multi-unit smooth muscle
D. cardiac muscle and single-unit smooth muscle
E. single-unit smooth muscle and multi-unit smooth muscle

94. Multi-unit smooth muscle is

A. neurogenically activated
B. under ANS control
C. found in the iris of the eye
D. all of these
E. none of these

95. Single-unit smooth muscle

A. contains an abundance of gap junctions and forms functional syncytia
B. is self-excitable
C. is found in the walls of the digestive, reproductive, and urinary tracts and small blood vessels
D. all of these
E. contains an abundance of gap junctions and forms functional syncytia and is self-excitable

96. A functional syncytium

A. refers to a pair of antagonistic muscles that function together to move a joint in two opposite directions
B. can be excited to contract as a unit because action potentials can be conducted from one cell to adjacent cells through gap junctions
C. refers to the functional junction between a smooth muscle fiber and an autonomic nerve ending
D. all of these
E. none of these

97. What is responsible for initiating contraction of smooth muscle?

A. stimulation by motor neurons
B. inhibition of acetylcholinesterase
C. membrane potential drifting to threshold as a result of automatic changes in ion movement across the membrane
D. excitation of the gap junctions by transmitter substance
E. stimulation by the autonomic nervous system

98. Repaying the oxygen deficit after strenuous exercise involves

A. formation of lactate in the muscle cells
B. replenishing stores of creatine phosphate
C. replenishing stores of glycogen
D. replenishing stores of creatine phosphate and glycogen
E. all of these

99. Pacemaker activity

A. refers to spontaneous depolarizations of the membrane resulting from shifts in passive ionic fluxes accompanying automatic changes in channel permeability
B. refers to spontaneous depolarizations of the membrane due to cyclical changes in Na^+-K^+ pump activity
C. is characteristic of single-unit smooth muscle but not found in any other muscle type
D. refers to spontaneous depolarizations of the membrane resulting from shifts in passive ionic fluxes accompanying automatic changes in channel permeability, and is characteristic of single-unit smooth muscle but not found in any other muscle type
E. refers to spontaneous depolarizations of the membrane due to cyclical changes in Na^+-K^+ pump activity, and is characteristic of single-unit smooth muscle but not found in any other muscle type

100. Which statement is incorrect?

A. Smooth muscle can develop less tension per unit cross-sectional area compared to skeletal muscle.
B. Smooth muscle can maintain tension with comparatively less ATP consumption than skeletal muscle.
C. Smooth muscle lacks troponin and tropomyosin.
D. The range of lengths over which smooth muscle is able to develop near maximal tension is much greater than for skeletal muscle.
E. A hollow organ enclosed by smooth muscle accommodates variable volumes with little change in the pressure exerted on the contents.

101. A functional syncytium of cardiac muscles cells means that they

A. are striated
B. exhibit muscle tone
C. have a short refractory period
D. lack the stimulation of a pacemaker
E. work as a unit mechanically and electrically

102. Which one of the following statements about cardiac muscle is incorrect?

A. It contains gap junctions.
B. It is found only in the heart
C. It is self-excitable.
D. It is striated with intercalated disks.
E. It lacks tropomyosin.

103. Muscle cells are the only cell types that contain intracellular contractile proteins.

True False

104. All skeletal muscles are attached to the skeleton.

True False

105. Skeletal muscle fibers are formed during embryonic development by the fusion of many smaller cells.

True False

106. A single muscle cell is known as a myofibril.

True False

107. The H zone of the sarcomere consists of myosin but does not contain actin.

True False

108. The M line is formed by a flattened disc-like cytoskeletal protein that connects the thin filaments of two adjoining sarcomeres.

True False

109. Thin and thick filaments overlap in the A band.

True False

110. The thick filaments in a sarcomere contain cross bridges.

True False

111. Myosin is considered to be a regulatory protein because it plays an important role in the regulation of muscle contraction.

True False

112. Tropomyosin covers the cross bridge binding sites on the thick filaments when a sarcomere is not contracting.

True False

113. All cross bridges within a sarcomere stroke in unison when pulling the actin filaments.

True False

114. Foot proteins link the actin molecules together within a thin filament.

True False

115. The functional unit of skeletal muscle is the myofibril.

True False

116. According to the sliding filament mechanism of muscle contraction, the thick filaments slide in closer together to shorten the sarcomere.

True False

117. The T tubule is lined with the muscle cell's membrane.

True False

118. According to the sliding filament mechanism of muscle contraction, the muscle fibers of one motor unit slide in closer together between the muscle fibers of adjacent motor units.

True False

119. The thick filaments within a myofibril have ATPase activity.

True False

120. Cross bridges have actin binding sites that are normally covered by troponin and tropomyosin except during excitation-contraction coupling.

True False

121. During muscle contraction, the A band becomes shorter.

True False

122. Muscle relaxation does not take place until all of the ATP is used up.

True False

123. In order for relaxation to occur, ACh must be removed from the muscle cell's receptors.

True False

124. Acetylcholinesterase removes ACh from receptors.

True False

125. The contraction phase of a muscle cell lasts longer than the refractory period.

True False

126. Rigor mortis occurs when Ca^{2+} links actin and the myosin globular head together in a rigor complex.

True False

127. Muscle cells require ATP in order to relax, following a contraction.

True False

128. More tension is developed during twitch summation than during a single twitch because the duration of elevated cytosolic Ca^{2+} concentration increases during summation, thus increasing the availability of cross-bridge binding sites.

True False

129. Gradation of muscle contraction can be accomplished by stimulating variable portions of each muscle fiber.

True False

130. Summation events result from increasing amounts of cytoplasmic calcium levels.

True False

131. A motor unit is a single muscle plus all of the motor neurons that innervate it.

True False

132. Muscles that have a fine degree of control have small motor units.

True False

133. The larger the motor units within a muscle, the more precisely controlled the gradations of contraction.

True False

134. Increasing the number of recruited motor units in a muscle increases its force or strength of contraction.

True False

135. With twitch summation, the muscle fiber is stimulated so rapidly that it does not have an opportunity to return to resting potential between stimuli.

True False

136. Tetanus occurs when a muscle fiber is stimulated so rapidly that it is not allowed to relax between stimulations, resulting in a smooth, sustained contraction.

True False

137. The shorter a muscle fiber is before the onset of a contraction, the greater the force that can be developed upon the subsequent contraction because the thin filaments are already partially slid inward.

True False

138. The metabolic capability of a muscle fiber can affect the degree of tension it can develop.

True False

139. Denervated muscle fibers become progressively smaller and their content of actin and myosin decreases.

True False

140. A skeletal muscle produces motion by pulling the origin toward its insertion.

True False

141. Bones serve as fulcrums for muscle action.

True False

142. Most muscle-lever systems work at a mechanical disadvantage.

True False

143. Muscle tension does not change in isometric contractions.

True False

144. The skeletal muscle shortens during concentric, isotonic contraction.

True False

145. In an isotonic contraction, about 50 percent of the energy consumed is realized as external work and the remaining 50 percent is converted to heat.

True False

146. The work performed by a muscle is the force it develops divided by distance.

True False

147. Oxidative phosphorylation occurs within the mitochondria of muscle cells.

True False

148. Repaying the oxygen deficit involves the formation of lactate in fatigued muscles.

True False

149. Anaerobic exercise is endurance-type exercise.

True False

150. Central fatigue of a muscle directly results from the accumulation of lactic acid in the muscle.

True False

151. Slow-oxidative muscle fibers have high resistance to fatigue.

True False

152. Fast-oxidative muscle fibers have a high concentration of mitochondria.

True False

153. Fast-glycolytic muscle fibers do not require as much oxygen use as slow-oxidative fibers.

True False

154. Slow-oxidative muscle fibers would be found in high density in the leg muscles of Olympic sprinters.

True False

155. A skeletal muscle undergoes hypertrophy mainly by producing many more muscle fibers.

True False

156. Atrophy can develop in a muscle by either denervation or disuse.

True False

157. Skeletal muscles are capable of limited repair after injury.

True False

158. Single-unit smooth muscle has no innervation.

True False

159. The lever system at the elbow joint provides a mechanical advantage so that when the biceps muscle contracts to flex the elbow joint and lift an object in the hand, the force developed in the biceps can be considerably less than the actual load that is moved.

True False

160. The corticospinal system controls fine, discrete, voluntary body movements.

True False

161. The two types of fast twitch fibers are interconvertible depending on the type of conditioning they receive.

True False

162. Single-unit smooth muscle and cardiac muscle are both self-excitable.

True False

163. Both multi-unit and single-unit smooth muscle are under motor control from the autonomic nervous system.

True False

164. All smooth muscle is myogenic.

True False

165. The strength and rate of contraction of the heart can be influenced by the autonomic nervous system.

True False

166. The heart initiates its own action potentials without any external stimulation.

True False

167. **Complete each of the following statments.**

The three types of muscle tissue are _____, _____, and _____.

_____

168. **Complete each of the following statments.**

Thick filaments are made up of the protein _____, whereas thin filaments are composed of the three proteins _____, _____, and _____.

_____

169. **Complete each of the following statments.**

_____ and _____ are referred to as contractile proteins, whereas _____ and _____ are referred to as regulatory proteins.

_____

170. **Complete each of the following statments.**

After the power stroke, _____ binds with the cross bridge, which causes the cross bridge to detach from the _____, which is part of the thin filament.

_____

171. **Complete each of the following statments.**

The neurotransmitter called _____ stimulates skeletal muscles to contract.

_____

172. **Complete each of the following statments.**

_____ refers to the series of events linking muscle excitation to muscle contraction.

_____

173. **Complete each of the following statments.**

_____ proteins function as calcium-release channels in the muscle cell.

_____

174. **Complete each of the following statments.**

_____ ions function as the intracellular signal for contraction.

_____

175. **Complete each of the following statments.**

The _____ stores calcium ions inside muscle cells.

_____

176. **Complete each of the following statments.**

If a muscle cell is excited adequately, _____ is released from the sarcoplasmic reticulum.

_____

177. **Complete each of the following statments.**

The functional unit of skeletal muscle is a(n) _____, and these units attach end-to-end to form a(n) _____.

_____

178. **Complete each of the following statments.**

The gradation of whole-muscle tension depends on the number of _____ that are stimulated.

_____

179. **Complete each of the following statments.**

The contractile response of a muscle fiber to a single action potential is called a(n) _____.

_____

180. **Complete each of the following statments.**

A(n) _____ is a motor neuron and all the muscle fibers it recruits.

_____

181. **Complete each of the following statments.**

The only energy source that can be used directly by the contractile machinery of a muscle fiber is _____.

_____

182. **Complete each of the following statments.**

In a state of _____, a muscle cannot maintain any kind of tension.

_____

183. **Complete each of the following statments.**

Twitch summation is similar to the _____ summation of EPSPs.

_____

184. **Complete each of the following statments.**

The immediate source for supplying additional ATP at the onset of exercise is _____.

_____

185. **Complete each of the following statments.**

For every muscle there is an optimal length at which maximum _____ is achieved.

_____

186. **Complete each of the following statments.**

The _____ component is the noncontractile tissue part of a muscle.

_____

187. **Complete each of the following statments.**

For a(n) _____ isotonic contraction, the contraction resists the stretching of the muscle.

_____

188. **Complete each of the following statments.**

The additional oxygen that must be taken into the body after strenuous exercise in order to return the tissues to pre-exercise conditions is called the _____.

_____

189. **Complete each of the following statments.**

The metabolic process called _____ provides the most ATP molecules for use by muscle fibers contracting over a long period of time.

_____

190. **Complete each of the following statments.**

The most common need for additional oxygen after rigorous exercise is for the repayment of the _____, when activity was being supported by creatine phosphate and glycolysis.

_____

191. **Complete each of the following statments.**

_____ occurs when acetylcholine is no longer available in adequate amounts to stimulate muscle fibers.

_____

192. **Complete each of the following statments.**

_____ is the pigment that can store small amounts of oxygen in the skeletal muscle.

_____

193. **Complete each of the following statments.**

Slow-oxidative fibers are type _____ fibers; fast glycolytic fibers are type _____ fibers; and fast, oxidative fibers are type _____ fibers.

_____

194. **Complete each of the following statments.**

The _____ is the descending motor pathway that mediates performance of fine, discrete voluntary movements of the hands.

_____

195. **Complete each of the following statments.**

_____ is the descending pathway that is primarily concerned with regulation of posture involving involuntary movements of the trunk and limbs.

_____

196. **Complete each of the following statments.**

_____ refers to paralysis of the legs resulting from lower spinal cord injury.

_____

197. **Complete each of the following statments.**

The _____ is the extensor muscle found in the thigh that contracts during the patellar tendon reflex.

_____

198. **Complete each of the following statments.**

In smooth muscle, Ca^{2+} binds with the protein _____, which is structurally similar to troponin.

_____

199. **Complete each of the following statments.**

The major source of calcium in smooth muscle is from the _____.

_____

Chapter 8 a--Muscle Physiology Key

1. The striated appearance of skeletal muscle is due to the

   A. orderly arrangement of the T tubules
   B. orderly arrangement of the lateral sacs of the sarcoplasmic reticulum
   C. orderly arrangement of the thick and thin filaments into A and I bands
   D. orderly arrangement of the motor units
   E. presence of white and red muscle fibers within the muscle

2. Muscle fibers develop tension by

   A. contraction of sarcomeres
   B. shortening
   C. the pushing of myosin by actin
   D. contraction of sarcomeres and shortening
   E. none of these

3. Myosin

   A. is found in the A band
   B. is found in the I band
   C. is in the thin filaments
   D. contracts during muscle contraction because it is one of the contractile proteins
   E. none of these

4. Myosin is

   A. spherical
   B. attached to tropomyosin
   C. a regulatory protein
   D. all of these
   E. none of these

5. Actin

   A. has ATPase activity
   B. is spherical
   C. forms a helical chain that forms the main structural component of the thin filaments
   D. is spherical and forms a helical chain that forms the main structural component of the thin filaments
   E. all of these

6. Actin

A. does not perform a power stroke during muscle contraction
B. contains a globular head that forms the cross bridges between the thick and thin filaments
C. is not found within A bands
D. is inhibited by Ca^{2+}
E. none of these

7. Thick filaments in skeletal muscle are composed of

A. actin
B. troponin and tropomyosin
C. myosin
D. actin, troponin, and tropomyosin
E. all of these

8. Sarcomeres are arranged end to end as

A. fascicles
B. myofibrils
C. bands
D. perimysia
E. none of these

9. The I band of the sarcomere is characterized by

A. overlapping thin and thick filaments
B. only the presence of thick filaments
C. the presence of thin filaments and actin
D. a dark coloration
E. the presence of thin filaments, actin, and a dark coloration

10. Z lines

A. are formed by the T tubules
B. extend down the middle of the I band
C. are formed by the cross bridges
D. are the thin filaments
E. extend down the middle of the sarcomere

11. Cross bridges

A. bind to actin during muscle contraction
B. consist of tropomyosin heads
C. are globular heads made of myosin
D. do not bend during muscle contraction
E. bind to actin during muscle contraction and are globular heads made of myosin

12. Order the following muscle cell components from larger to smaller

1. troponin
2. myofibril
3. sarcomere
4. thin filament
5. muscle fiber

A. 3, 4, 1, 5, 2
B. 1, 2, 3, 5, 4
C. 5, 4 ,3 , 1, 2
D. 5, 2, 3, 4, 1
E. 3, 4, 5, 2, 1

13. Skeletal muscle fibers

A. have T tubules within their sarcomeres
B. have Z lines extending down the middle of the I bands
C. contain gap junctions
D. all of these
E. have T tubules within their sarcomeres, and Z lines extending down the middle of the I bands

14. The region between two Z lines is a

A. muscle fiber
B. myofibril
C. myofilament
D. sarcomere
E. sarcoplasmic reticulum

15. Skeletal muscle fibers

A. are some of the longest cells in the body
B. are attached end-to-end within a muscle
C. contain Z lines within their A bands
D. contain only one nucleus
E. all of these, except contain only one nucleus

16. Identify the characteristic(s) shared by all types of muscle tissues?

A. Every type is neurogenic.
B. Every type has T tubules.
C. Every type has tropomyosin.
D. All of these.
E. Every type has T tubules and tropomyosin.

17. The functional unit of skeletal muscle is the

A. smallest contractile component of a muscle fiber
B. area between two Z lines
C. sarcomere
D. area between two Z lines and sarcomere
E. all of these

18. Troponin

A. binds with calcium to allow sarcomere shortening
B. breaks down myosin cross bridges
C. is an enzyme in the sarcomere
D. forms the boundaries of a sarcomere
E. all of these, except forms the boundaries of a sarcomere

19. The smallest unit of contraction within a skeletal muscle is a

A. myofibril
B. muscle fiber
C. sarcomere
D. thin filament
E. thick filament

20. A function of tropomyosin is to

A. bind Ca^{2+}
B. form attachments with myosin cross bridges
C. prevent myosin cross bridges from attaching to the thin filaments
D. act as an ATPase
E. none of these

21. According to the sliding-filament mechanism, the

A. A bands slide in closer between the I bands.
B. Thin filaments slide inward toward the center of the A band.
C. Z lines slide in between the T tubules.
D. Contractile proteins contract, thus shortening the sarcomere.
E. Filaments slide into the lateral sacs of the sarcoplasmic reticulum.

22. During contraction of skeletal muscle fibers, the

A. Contractile proteins contract.
B. Thin filaments slide inward toward the A band's center as a result of cycles of cross-bridge binding and bending.
C. Thick and thin filaments become tightly coiled, thus shortening the sarcomere.
D. I bands slide in between the A bands.
E. Lateral sacs of the sarcoplasmic reticulum shrink, pulling the Z lines closer together.

23. Which molecules are involved with regulation of cross bridge attachment activity?

A. calcium ions
B. troponin
C. myosin
D. calcium ions and troponin
E. all of these

24. During muscle contraction, the

A. Z lines move farther away from the thick filaments.
B. A band becomes narrower.
C. H zone becomes narrower or disappears.
D. I band remains unchanged.
E. *Both* H zone becomes narrower or disappears, *and* I band remains unchanged.

25. The H zone

A. is the area within the middle of the A band where the thin filaments do not reach
B. shortens or disappears during contraction
C. contains only thick filaments
D. is in the middle of the A band
E. all of these

26. Which of the following changes in banding pattern occur during muscle relaxation?

A. Thin filaments stretch away from the Z lines.
B. I bands get wider.
C. H zones get narrower.
D. Thick filaments stretch and become longer.
E. I bands get wider and H zones get narrower.

27. During contraction, asynchronous cycling of crossbridges

A. prevents tetany
B. prevents thick filaments from slipping backwards
C. prevents thin filaments from slipping backwards
D. utilizes less ATP
E. none of these

28. During excitation-contraction coupling,

A. The action potential travels down the T tubules.
B. Ca^{2+} is released from the sarcoplasmic reticulum.
C. Ca^{2+} is taken up by the sarcoplasmic reticulum.
D. The action potential travels down the T tubules, and Ca^{2+} is released from the sarcoplasmic reticulum.
E. The action potential travels down the T tubules, and Ca^{2+} is taken up by the sarcoplasmic reticulum.

29. The T tubules

A. store Ca^{2+}
B. provide a means of rapidly transmitting the action potential from the surface into the central portions of the muscle fiber
C. store ATP
D. run longitudinally between the myofibrils
E. have expanded lateral sacs

30. Sequence the following events involved in muscle cell contraction:

1. Sodium channels open and sodium flows in.
2. Impulse reaches axon's synaptic knob.
3. ACh binds to receptors on the muscle cell membrane.
4. Synaptic vesicles fuse with neuron's membrane and release ACh via exocytosis.
5. If enough sodium moves in to the muscle cell, an impulse (action potential) develops.

A. 1, 2, 3, 4, 5
B. 2, 1, 3, 4, 5
C. 2, 4, 3, 1, 5
D. 3, 4, 5, 1, 2
E. 3, 5, 2, 1, 4

31. The T tubules

A. store Ca^{2+}
B. provide a means of rapidly transmitting ACh to the central portions of the muscle fiber
C. provide attachment sites for ACh
D. provide a means of rapidly transmitting ACh to the central portions of the muscle fiber and provide attachment sites for ACh
E. none of these

32. An action potential rapidly spreads to the central portions of a muscle cell by means of the

A. Z lines
B. sarcoplasmic reticulum
C. H zone
D. pores in the membrane surface
E. T tubules

33. Binding of ____ to myosin permits the cross-bridge to ____.

A. ATP; bind with actin
B. ATP; detach from actin
C. calcium; bind with actin
D. calcium; detach from actin
E. none of these

34. The sarcoplasmic reticulum stores ____ when a muscle is relaxed and releases it for binding to ____ during contraction.

A. calcium; troponin
B. calcium; tropomyosin
C. sodium; tropomyosin
D. potassium; tropomyosin
E. sodium; troponin

35. Of the steps in excitation-contraction below, which occurs before the others?

A. Exposed actin sites bind with myosin cross bridges.
B. Sodium channels open in the fiber's membrane.
C. Calcium is released from the sarcoplasmic reticulum.
D. Troponin binds calcium.
E. Attachment of ATP allows for cross bridge detachment.

36. Which is not characteristic of cross bridges?

A. They are a component of thin filaments.
B. They are comprised of myosin.
C. They have an actin binding site.
D. They have an ATPase binding site.
E. They provide power stroking.

37. Foot proteins

A. span the gap between a lateral sac of the sarcoplasmic reticulum and the adjacent T tubule
B. are believed to serve as Ca^{2+} channels
C. bind to and pull the thin filaments inward toward the A band's center during muscle contraction
D. span the gap between a lateral sac of the sarcoplasmic reticulum and the adjacent T tubule, and are believed to serve as Ca^{2+} channels
E. none of these

38. Which statement is incorrect about cross bridges?

A. They are globular myosin heads that protrude from the thick filaments.
B. They bend during muscle contraction.
C. They detach from actin during muscle contraction.
D. They are not found in the I band.
E. They bind with troponin during contraction.

39. During a cross-bridge cycle in skeletal muscle, the

A. Cross bridge is energized when it hydrolyzes ATP.
B. Myosin cross bridge must bind with an ATPase before the cross bridge will experience a power stroke.
C. Ca^{2+} causes the troponin-tropomyosin complex to move off the actin-binding sites on myosin.
D. ADP binds to the cross bridge at the end of the power stroke.
E. Cross bridge is energized when it hydrolyzes ATP, and myosin cross bridge must bind with an ATPase before the cross bridge will experience a power stroke.

40. Cross bridge interaction between actin and myosin in skeletal muscle is directly blocked by

A. acetylcholine
B. triads
C. Z lines
D. calcium
E. tropomyosin

41. The energy for cross bridge cycling during muscle contraction is provided by:

A. acetylcholine
B. Ca^{2+}
C. ATP
D. myosin
E. actin

42. Which of the following is not involved in the relaxation of muscle?

A. synthesis of ACh by acetylcholinesterase
B. initiation of action potentials
C. the troponin-tropomyosin complex slipping back into its blocking position
D. detachment of actin from tropomyosin
E. T tubules actively absorbing Ca^{2+}

43. A lack of ATP in a skeletal muscle cell would most likely cause

A. tension to decrease
B. cross bridges to detach from actin
C. the sarcomeres to become longer
D. an increase in tension and an inability to relax
E. the sarcomeres to become longer, an increase in tension, and an inability to relax

44. Which of the following is involved in muscle relaxation?

A. Acetylcholinesterase destroys acetylcholine to allow the muscle membrane to return to resting potential.
B. Ca^{2+} is actively taken up by the lateral sacs of the sarcoplasmic reticulum when there is no longer a local action potential.
C. The cross bridges pull the filaments back to their original resting positions.
D. Acetylcholinesterase destroys acetylcholine to allow the muscle membrane to return to resting potential, and Ca^{2+} is actively taken up by the lateral sacs of the sarcoplasmic reticulum when there is no longer a local action potential.
E. All of these.

45. Whole muscle tension depends on all of the following *except*

A. number of muscle fibers contracting
B. tension produced by each contracting fiber
C. extent of motor-unit recruitment
D. frequency of stimulation
E. the proportion of each motor unit used at any given time

46. A motor unit refers to

A. a single motor neuron plus all of the muscle fibers it innervates
B. a single muscle fiber plus all of the motor neurons that innervate it
C. all of the motor neurons supplying a single muscle
D. a pair of antagonistic muscles
E. a sheet of smooth muscle cells connected by gap junctions

47. In twitch summation:

A. The muscle fiber is stimulated again before the action potential has returned to resting potential.
B. The muscle fiber is stimulated again before the filaments have completely returned to their resting position.
C. Stronger muscle contractions occur but stronger action potentials do not occur.
D. The muscle fiber is stimulated again before the action potential has returned to resting potential, and stronger muscle contractions occur but stronger action potentials do not occur.
E. The muscle fiber is stimulated again before the filaments have completely returned to their resting position, and stronger muscle contractions occur but stronger action potentials do not occur.

48. Twitch summation

A. is a means by which gradation of muscle contraction may be accomplished
B. results from the additional release of Ca^{2+} within the cytosol of muscle fibers
C. results from increasing the frequency at which motor units are firing within a muscle
D. is a means by which gradation of muscle contraction may be accomplished and results from increasing the frequency at which motor units are firing within a muscle
E. all of these

49. Twitch summation

A. results from increases in cytosolic calcium levels
B. pumping of calcium into the sarcoplasmic reticulum
C. can be enhanced by allowing a cell to completely relax
D. rarely results in tetany
E. none of these

50. To pick up something heavier than your pencil, your nervous system could

A. stimulate larger motor units
B. decrease the frequency of stimulation to allow a more prolonged contraction to occur
C. decrease the refractory periods
D. block acetylcholinesterase at the neuromuscular junction to allow acetylcholine to function longer
E. none of these

51. Based on the length-tension relationship,

A. Stretching a skeletal muscle 30% longer than the l_o results in a greater contraction.
B. Varying the amount of overlap of thick and thin filaments does not greatly affect contraction force as long as tension remains the same.
C. More tension develops if a muscle is 30%shorter than its resting length.
D. Muscle tension remains the same as long as the muscle's length is not more than ±30% of the resting length.
E. A resting muscle that is shorter or longer than its l_o will generate less tension at the onset of contraction.

52. Picking up a book at a constant speed requires that

A. muscle tension be equal to the book's weight
B. the muscle perform an eccentric contraction
C. the muscle perform an isometric contraction
D. the muscle perform a concentric contraction
E. muscle tension be equal to the book's weight and the muscle to perform a concentric contraction

53. Muscle tension

A. is created during muscle contraction as the tension generated by the contractile elements is transmitted via the connective tissue and tendons to the bones
B. is the force exerted on a muscle by the weight of an object
C. is greater than the load during an isometric contraction
D. all of these
E. none of these

54. The origin of a muscle is its

A. main, thickest part
B. middle, thinner part
C. movable end of attachment
D. source of development in the fetus
E. stationary end of attachment

55. During an isotonic contraction:

A. Filaments do not shorten in the muscle.
B. Movement does not occur inside the muscle.
C. The muscle does not change length.
D. The muscle's tension does not overcome a load.
E. The muscle's tension remains constant.

56. During an isometric contraction, the muscle

A. maintains a constant tension
B. shortens
C. moves a body part
D. maintains a constant length
E. tension is greater than the load

57. With eccentric muscle contractions:

A. Development of tension occurs at constant muscle length.
B. Muscle lengthens while contracting.
C. Muscle shortens while contracting.
D. Muscle length and tension vary throughout a range of motion.
E. None of these.

58. Submaximal isometric contractions are important for

A. moving large objects
B. walking
C. maintaining posture
D. writing
E. walking and maintaining posture

59. Muscles developing tension while lengthening are performing ____ contractions.

A. concentric
B. eccentric
C. isometric
D. fatiguing
E. oscillating

60. In a muscle fiber undergoing maximal tetanic stimulation, the velocity of shortening ____ as the load ____.

A. decreases; decreases
B. decreases; increases
C. increases; increases
D. remains constant; increases
E. remains constant; decreases

61. If the load on a muscle is increased, eventually a load will be reached at which the velocity of shortening becomes zero. At this point, the muscle contraction is referred to as

A. concentric
B. eccentric
C. isotonic
D. isokinetic
E. isometric

62. Energy sources available to form ATP in muscle fibers in the absence of oxygen include

A. creatine phosphate
B. chemiosmosis
C. glycolysis
D. creatine phosphate and glycolysis
E. chemiosmosis and glycolysis

63. The first means by which ATP is produced at the onset of contractile activity is

A. transfer of energy and phosphate from creatine phosphate to ADP
B. oxidative phosphorylation
C. glycolysis
D. degradation of myoglobin
E. none of these

64. During aerobic exercise, the primary means for ATP production in muscle fibers involves

A. creatine phosphate
B. fermentation
C. oxidative phosphorylation
D. glycolysis
E. myoglobin

65. Myoglobin

A. can store small amounts of O_2
B. increases the rate of O_2 transfer from the blood into muscle fibers
C. is abundant in fast-glycolytic fibers
D. can store small amounts of O_2 and increases the rate of O_2 transfer from the blood into muscle fibers
E. all of these

66. Select the correct statement about the summation of simple twitches.

A. They can occur because of the long duration of the action potential in a muscle fiber.
B. They reduce the tension in a muscle.
C. They result from the slow stimulation of a muscle fiber.
D. The effect is unrelated to the refractory periods of action potentials.
E. The twitches resulting from separate action potentials add together.

67. Which of the following statements about the different types of muscle fibers is incorrect?

A. The higher the ATPase activity, the faster the speed of contraction.
B. Muscles that have high glycolytic capacity and large glycogen stores are more resistant to fatigue.
C. Muscles with high ATP-synthesizing ability are more resistant to fatigue.
D. Oxidative types of muscle fibers contain myoglobin.
E. Muscle fibers containing large amounts of myoglobin have a dark red color in comparison to the paler fibers, which have little myoglobin.

68. Fast-glycolytic (type IIx) muscle fibers

A. have high myosin-ATPase activity
B. can carry out oxidative phosphorylation
C. fatigue rapidly
D. contain myoglobin
E. all of these

69. Fast-oxidative (type IIa) fibers

A. contain very few mitochondria
B. can be converted into fast-glycolytic fibers by regular resistance activities
C. are most abundant in muscles specialized for maintaining low-intensity contractions for long periods of time without fatigue
D. can be converted into fast-glycolytic fibers by regular resistance activities and are most abundant in muscles specialized for maintaining low-intensity contractions for long periods of time without fatigue
E. all of these

70. The muscle cells of a marathon runner's legs would exhibit all these characteristics except

A. high resistance to fatigue
B. low myoglobin content
C. low glycogen content
D. many mitochondria
E. slow speed of contraction

71. Fatigue is the failure of a muscle fiber to maintain ____ as a result of previous contractile activity.

A. excitability
B. muscle mass
C. tension
D. sarcomere number
E. mitochondria

72. Muscular fatigue can be caused by

A. lactic acid accumulation
B. depletion of ATP
C. depletion of ACh
D. all of these
E. lactic acid accumulation and depletion of ATP

73. Which of the following does not directly influence motor neurons?

A. primary motor cortex
B. cerebellum
C. brain stem
D. afferent neurons (through intervening interneurons)
E. none of these

74. When a muscle atrophies:

A. The muscle fibers split lengthwise.
B. It decreases in mass and becomes weaker.
C. Its fibers increase in diameter.
D. Its fibers undergo mitotic cell division.
E. The muscle fibers dissolve and are replaced by fibrous scar tissue.

75. In the body's lever systems, the fulcrums are represented by the

A. joints
B. long bones
C. tendons
D. short bones
E. skeletal muscles

76. With the type of lever system exemplified by flexion of the elbow joint, when an object is held in the hand, the

A. power arm of the lever is the distance between the elbow joint and the insertion of the biceps muscle
B. load arm of the lever is the distance between the elbow joint and the hand
C. velocity and distance moved by the hand is amplified at the expense of the biceps muscle having to exert considerably greater force than the actual load that is moved
D. only two of these
E. all of these

77. Which statement below is characteristic of most of the body's lever systems?

A. They work at mechanical advantage.
B. They work at a mechanical disadvantage.
C. Muscles must exert greater forces than the load.
D. They work at mechanical advantage and at a mechanical disadvantage.
E. They work at a mechanical disadvantage, and muscles must exert greater forces than the load.

78. Enlargement of muscle due to weight lifting is primarily a result of

A. hypertrophy
B. hyperplasia
C. increased production of actin and myosin
D. increases in the number of cells
E. hypertrophy and increased production of actin and myosin

79. The corticospinal system

A. consists of fibers that originate within the primary motor cortex and terminate on motor neurons
B. involves the motor regions of the cortex, the cerebellum, the basal nuclei, and the thalamus
C. is primarily concerned with regulation of overall body posture
D. consists of fibers that originate within the primary motor cortex and terminate on motor neurons, and is primarily concerned with regulation of overall body posture
E. involves the motor regions of the cortex, the cerebellum, the basal nuclei, and the thalamus and is primarily concerned with regulation of overall body posture

80. Conscious initiation of muscle contraction is controlled by

A. the spinal cord
B. the brain stem
C. the cerebral cortex
D. the thalamus
E. none of these

81. Spastic paralysis occurs when

A. Descending excitatory pathways are destroyed.
B. Excitatory inputs to motor neurons are unopposed because of disruption of an inhibitory system in the brain stem.
C. Muscle spindles are destroyed.
D. The cerebellum is damaged.
E. The motor neurons are destroyed.

82. During coactivation

A. All of the muscle fibers in a skeletal muscle are activated simultaneously.
B. The gamma motor-neuron and alpha motor-neuron systems to a skeletal muscle are activated simultaneously.
C. All of the cross bridges within a single skeletal muscle are activated simultaneously.
D. The primary (annulospiral) and secondary (flower-spray) endings within a muscle spindle are activated simultaneously.
E. None of these.

83. Intrafusal muscle fibers

A. are supplied by alpha motor neurons
B. are found within muscle spindles
C. contain sensory nerve endings that are activated by stretch
D. are supplied by alpha motor neurons and contain sensory nerve endings that are activated by stretch
E. are found within muscle spindles and contain sensory nerve endings that are activated by stretch

84. The stretch receptors in the central portion of the muscle spindle can be activated by

A. passive stretch of the whole muscle, including stretch of the muscle spindle
B. contraction of the end portions of the muscle spindle
C. gamma motor neuron stimulation of the muscle spindle
D. all of these
E. none of these

85. Stretch reflexes are important

A. for maintaining balance and posture
B. for providing afferent information coordinating complex muscle activity
C. for determining the level of tone
D. for maintaining balance and posture, and for providing afferent information coordinating complex muscle activity
E. for providing afferent information coordinating complex muscle activity and for determining the level of tone

86. Calcium turns on cross bridges by physically repositioning the troponin-tropomyosin complex to uncover the actin cross-bridge binding sites in

A. skeletal muscle
B. cardiac muscle
C. smooth muscle
D. all of these
E. skeletal and cardiac muscles

87. Which is not characteristic of smooth muscle?

A. It is under involuntary control.
B. It does not have troponin.
C. Its contraction is initiated neurogenically only.
D. It is found in walls of hollow tube-like organs.
E. It is innervated by the ANS.

88. Cardiac muscle tissue

A. has well developed sarcoplasmic reticulum
B. has fast myosin ATPase activity
C. contracts only when stimulated neurogenically
D. has gap junctions
E. stores calcium in its T tubules

89. The regulation of smooth muscle contraction is mediated by the phosphorylation of ____ in response to calcium binding to ____.

A. myosin; calmodulin
B. actin; calmodulin
C. troponin; calmodulin
D. myosin; troponin
E. actin; troponin

90. Select the correct statement regarding smooth muscle.

A. It composes the walls of the heart.
B. It is absent in the walls of hollow organs.
C. Its cells are multinucleated.
D. Its cells are spindle-shaped.
E. Its cells lack actin and myosin.

91. ____ is not required for contraction of smooth muscle fibers.

A. Calcium
B. Calmodulin
C. Phosphate
D. ATP
E. Troponin

92. Calcium that enters the cell during smooth muscle excitation binds with

A. calmodulin
B. inactive myosin kinase
C. troponin
D. myosin
E. actin

93. Which of the following muscle types are myogenic?

A. cardiac muscle
B. single-unit smooth muscle
C. multi-unit smooth muscle
D. cardiac muscle and single-unit smooth muscle
E. single-unit smooth muscle and multi-unit smooth muscle

94. Multi-unit smooth muscle is

A. neurogenically activated
B. under ANS control
C. found in the iris of the eye
D. all of these
E. none of these

95. Single-unit smooth muscle

A. contains an abundance of gap junctions and forms functional syncytia
B. is self-excitable
C. is found in the walls of the digestive, reproductive, and urinary tracts and small blood vessels
D. all of these
E. contains an abundance of gap junctions and forms functional syncytia and is self-excitable

96. A functional syncytium

A. refers to a pair of antagonistic muscles that function together to move a joint in two opposite directions
B. can be excited to contract as a unit because action potentials can be conducted from one cell to adjacent cells through gap junctions
C. refers to the functional junction between a smooth muscle fiber and an autonomic nerve ending
D. all of these
E. none of these

97. What is responsible for initiating contraction of smooth muscle?

A. stimulation by motor neurons
B. inhibition of acetylcholinesterase
C. membrane potential drifting to threshold as a result of automatic changes in ion movement across the membrane
D. excitation of the gap junctions by transmitter substance
E. stimulation by the autonomic nervous system

98. Repaying the oxygen deficit after strenuous exercise involves

A. formation of lactate in the muscle cells
B. replenishing stores of creatine phosphate
C. replenishing stores of glycogen
D. replenishing stores of creatine phosphate and glycogen
E. all of these

99. Pacemaker activity

A. refers to spontaneous depolarizations of the membrane resulting from shifts in passive ionic fluxes accompanying automatic changes in channel permeability
B. refers to spontaneous depolarizations of the membrane due to cyclical changes in Na^+-K^+ pump activity
C. is characteristic of single-unit smooth muscle but not found in any other muscle type
D. refers to spontaneous depolarizations of the membrane resulting from shifts in passive ionic fluxes accompanying automatic changes in channel permeability, and is characteristic of single-unit smooth muscle but not found in any other muscle type
E. refers to spontaneous depolarizations of the membrane due to cyclical changes in Na^+-K^+ pump activity, and is characteristic of single-unit smooth muscle but not found in any other muscle type

100. Which statement is incorrect?

A. Smooth muscle can develop less tension per unit cross-sectional area compared to skeletal muscle.
B. Smooth muscle can maintain tension with comparatively less ATP consumption than skeletal muscle.
C. Smooth muscle lacks troponin and tropomyosin.
D. The range of lengths over which smooth muscle is able to develop near maximal tension is much greater than for skeletal muscle.
E. A hollow organ enclosed by smooth muscle accommodates variable volumes with little change in the pressure exerted on the contents.

101. A functional syncytium of cardiac muscles cells means that they

A. are striated
B. exhibit muscle tone
C. have a short refractory period
D. lack the stimulation of a pacemaker
E. work as a unit mechanically and electrically

102. Which one of the following statements about cardiac muscle is incorrect?

A. It contains gap junctions.
B. It is found only in the heart
C. It is self-excitable.
D. It is striated with intercalated disks.
E. It lacks tropomyosin.

103. Muscle cells are the only cell types that contain intracellular contractile proteins.

FALSE

104. All skeletal muscles are attached to the skeleton.

FALSE

105. Skeletal muscle fibers are formed during embryonic development by the fusion of many smaller cells.

TRUE

106. A single muscle cell is known as a myofibril.

FALSE

107. The H zone of the sarcomere consists of myosin but does not contain actin.

TRUE

108. The M line is formed by a flattened disc-like cytoskeletal protein that connects the thin filaments of two adjoining sarcomeres.

FALSE

109. Thin and thick filaments overlap in the A band.

TRUE

110. The thick filaments in a sarcomere contain cross bridges.

TRUE

111. Myosin is considered to be a regulatory protein because it plays an important role in the regulation of muscle contraction.

FALSE

112. Tropomyosin covers the cross bridge binding sites on the thick filaments when a sarcomere is not contracting.

FALSE

113. All cross bridges within a sarcomere stroke in unison when pulling the actin filaments.

FALSE

114. Foot proteins link the actin molecules together within a thin filament.

FALSE

115. The functional unit of skeletal muscle is the myofibril.

FALSE

116. According to the sliding filament mechanism of muscle contraction, the thick filaments slide in closer together to shorten the sarcomere.

FALSE

117. The T tubule is lined with the muscle cell's membrane.

TRUE

118. According to the sliding filament mechanism of muscle contraction, the muscle fibers of one motor unit slide in closer together between the muscle fibers of adjacent motor units.

FALSE

119. The thick filaments within a myofibril have ATPase activity.

TRUE

120. Cross bridges have actin binding sites that are normally covered by troponin and tropomyosin except during excitation-contraction coupling.

FALSE

121. During muscle contraction, the A band becomes shorter.

FALSE

122. Muscle relaxation does not take place until all of the ATP is used up.

FALSE

123. In order for relaxation to occur, ACh must be removed from the muscle cell's receptors.

TRUE

124. Acetylcholinesterase removes ACh from receptors.

TRUE

125. The contraction phase of a muscle cell lasts longer than the refractory period.

FALSE

126. Rigor mortis occurs when Ca^{2+} links actin and the myosin globular head together in a rigor complex.

FALSE

127. Muscle cells require ATP in order to relax, following a contraction.

TRUE

128. More tension is developed during twitch summation than during a single twitch because the duration of elevated cytosolic Ca^{2+} concentration increases during summation, thus increasing the availability of cross-bridge binding sites.

TRUE

129. Gradation of muscle contraction can be accomplished by stimulating variable portions of each muscle fiber.

FALSE

130. Summation events result from increasing amounts of cytoplasmic calcium levels.

TRUE

131. A motor unit is a single muscle plus all of the motor neurons that innervate it.

FALSE

132. Muscles that have a fine degree of control have small motor units.

TRUE

133. The larger the motor units within a muscle, the more precisely controlled the gradations of contraction.

FALSE

134. Increasing the number of recruited motor units in a muscle increases its force or strength of contraction.

TRUE

135. With twitch summation, the muscle fiber is stimulated so rapidly that it does not have an opportunity to return to resting potential between stimuli.

FALSE

136. Tetanus occurs when a muscle fiber is stimulated so rapidly that it is not allowed to relax between stimulations, resulting in a smooth, sustained contraction.

TRUE

137. The shorter a muscle fiber is before the onset of a contraction, the greater the force that can be developed upon the subsequent contraction because the thin filaments are already partially slid inward.

FALSE

138. The metabolic capability of a muscle fiber can affect the degree of tension it can develop.

TRUE

139. Denervated muscle fibers become progressively smaller and their content of actin and myosin decreases.

TRUE

140. A skeletal muscle produces motion by pulling the origin toward its insertion.

FALSE

141. Bones serve as fulcrums for muscle action.

FALSE

142. Most muscle-lever systems work at a mechanical disadvantage.

TRUE

143. Muscle tension does not change in isometric contractions.

FALSE

144. The skeletal muscle shortens during concentric, isotonic contraction.

TRUE

145. In an isotonic contraction, about 50 percent of the energy consumed is realized as external work and the remaining 50 percent is converted to heat.

FALSE

146. The work performed by a muscle is the force it develops divided by distance.

FALSE

147. Oxidative phosphorylation occurs within the mitochondria of muscle cells.

TRUE

148. Repaying the oxygen deficit involves the formation of lactate in fatigued muscles.

FALSE

149. Anaerobic exercise is endurance-type exercise.

FALSE

150. Central fatigue of a muscle directly results from the accumulation of lactic acid in the muscle.

FALSE

151. Slow-oxidative muscle fibers have high resistance to fatigue.

TRUE

152. Fast-oxidative muscle fibers have a high concentration of mitochondria.

TRUE

153. Fast-glycolytic muscle fibers do not require as much oxygen use as slow-oxidative fibers.

TRUE

154. Slow-oxidative muscle fibers would be found in high density in the leg muscles of Olympic sprinters.

FALSE

155. A skeletal muscle undergoes hypertrophy mainly by producing many more muscle fibers.

FALSE

156. Atrophy can develop in a muscle by either denervation or disuse.

TRUE

157. Skeletal muscles are capable of limited repair after injury.

TRUE

158. Single-unit smooth muscle has no innervation.

FALSE

159. The lever system at the elbow joint provides a mechanical advantage so that when the biceps muscle contracts to flex the elbow joint and lift an object in the hand, the force developed in the biceps can be considerably less than the actual load that is moved.

FALSE

160. The corticospinal system controls fine, discrete, voluntary body movements.

TRUE

161. The two types of fast twitch fibers are interconvertible depending on the type of conditioning they receive.

TRUE

162. Single-unit smooth muscle and cardiac muscle are both self-excitable.

TRUE

163. Both multi-unit and single-unit smooth muscle are under motor control from the autonomic nervous system.

TRUE

164. All smooth muscle is myogenic.

FALSE

165. The strength and rate of contraction of the heart can be influenced by the autonomic nervous system.

TRUE

166. The heart initiates its own action potentials without any external stimulation.

TRUE

167. **Complete each of the following statments.**

The three types of muscle tissue are _____, _____, and _____.

skeletal, smooth, cardiac

168. **Complete each of the following statments.**

Thick filaments are made up of the protein _____, whereas thin filaments are composed of the three proteins _____, _____, and _____.

myosin, actin, tropomyosin, troponin

169. **Complete each of the following statments.**

_____ and _____ are referred to as contractile proteins, whereas _____ and _____ are referred to as regulatory proteins.

Myosin, actin, tropomyosin, troponin

170. **Complete each of the following statments.**

After the power stroke, _____ binds with the cross bridge, which causes the cross bridge to detach from the _____, which is part of the thin filament.

ATP, actin

171. **Complete each of the following statments.**

The neurotransmitter called _____ stimulates skeletal muscles to contract.

ACh

172. **Complete each of the following statments.**

_____ refers to the series of events linking muscle excitation to muscle contraction.

Excitation-contraction coupling

173. **Complete each of the following statments.**

_____ proteins function as calcium-release channels in the muscle cell.

Foot

174. **Complete each of the following statments.**

_____ ions function as the intracellular signal for contraction.

Calcium

175. **Complete each of the following statments.**

The _____ stores calcium ions inside muscle cells.

sarcoplasmic reticulum (or SR)

176. **Complete each of the following statments.**

If a muscle cell is excited adequately, _____ is released from the sarcoplasmic reticulum.

calcium

177. **Complete each of the following statments.**

The functional unit of skeletal muscle is a(n) _____, and these units attach end-to-end to form a(n) _____.

sarcomere, myofibril

178. **Complete each of the following statments.**

The gradation of whole-muscle tension depends on the number of _____ that are stimulated.

muscle fibers or motor units

179. **Complete each of the following statments.**

The contractile response of a muscle fiber to a single action potential is called a(n) _____.

twitch

180. **Complete each of the following statments.**

A(n) _____ is a motor neuron and all the muscle fibers it recruits.

motor unit

181. **Complete each of the following statments.**

The only energy source that can be used directly by the contractile machinery of a muscle fiber is _____.

ATP

182. **Complete each of the following statments.**

In a state of _____, a muscle cannot maintain any kind of tension.

fatigue

183. **Complete each of the following statments.**

Twitch summation is similar to the _____ summation of EPSPs.

temporal

184. **Complete each of the following statments.**

The immediate source for supplying additional ATP at the onset of exercise is _____.

creatine phosphate

185. **Complete each of the following statments.**

For every muscle there is an optimal length at which maximum _____ is achieved.

force (or tension)

186. **Complete each of the following statments.**

The _____ component is the noncontractile tissue part of a muscle.

series-elastic

187. **Complete each of the following statments.**

For a(n) _____ isotonic contraction, the contraction resists the stretching of the muscle.

eccentric

188. **Complete each of the following statments.**

The additional oxygen that must be taken into the body after strenuous exercise in order to return the tissues to pre-exercise conditions is called the _____.

excess postexercise oxygen consumption (or EPOC)

189. **Complete each of the following statments.**

The metabolic process called _____ provides the most ATP molecules for use by muscle fibers contracting over a long period of time.

oxidative phosphorylation

190. **Complete each of the following statments.**

The most common need for additional oxygen after rigorous exercise is for the repayment of the _____, when activity was being supported by creatine phosphate and glycolysis.

oxygen deficit

191. **Complete each of the following statments.**

_____ occurs when acetylcholine is no longer available in adequate amounts to stimulate muscle fibers.

Neuromuscular fatigue

192. **Complete each of the following statments.**

_____ is the pigment that can store small amounts of oxygen in the skeletal muscle.

Myoglobin

193. **Complete each of the following statments.**

Slow-oxidative fibers are type _____ fibers; fast glycolytic fibers are type _____ fibers; and fast, oxidative fibers are type _____ fibers.

I, IIx, IIa

194. **Complete each of the following statments.**

The _____ is the descending motor pathway that mediates performance of fine, discrete voluntary movements of the hands.

corticospinal (pyramidal) system

195. **Complete each of the following statments.**

_____ is the descending pathway that is primarily concerned with regulation of posture involving involuntary movements of the trunk and limbs.

Multineuronal (extrapyramidal) system

196. **Complete each of the following statments.**

_____ refers to paralysis of the legs resulting from lower spinal cord injury.

Paraplegia

197. **Complete each of the following statments.**

The _____ is the extensor muscle found in the thigh that contracts during the patellar tendon reflex.

quadriceps femoris

198. **Complete each of the following statments.**

In smooth muscle, Ca^{2+} binds with the protein _____, which is structurally similar to troponin.

calmodulin

199. **Complete each of the following statments.**

The major source of calcium in smooth muscle is from the _____.

extracellular fluid (or ECF)