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Muscle Contraction, Muscle Tissue & Tendons

Exam — Musculoskeletal System

60+ Pre-med/IB-style questions on skeletal muscle fiber anatomy, sliding filament theory, excitation-contraction coupling, motor units, energy systems, fiber types, smooth vs cardiac muscle basics, tendons, and biomechanics.

70 items — Printable Exam

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Generated February 20, 2026

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1 Which statement correctly distinguishes a tendon from a ligament?



- A Tendons connect bone to bone; ligaments connect muscle to bone.
- B Tendons connect muscle to bone; ligaments connect bone to bone.
- C Tendons are made of smooth muscle; ligaments are made of skeletal muscle.
- D Tendons contain neurons; ligaments contain red blood cells.
- E There is no difference - both terms mean the same structure.

2 Which order correctly represents the organization from smallest to largest in skeletal muscle?



- A Muscle -> fascicle -> muscle fiber -> myofibril -> myofilament
- B Myofilament -> myofibril -> muscle fiber -> fascicle -> muscle
- C Myofibril -> myofilament -> muscle fiber -> fascicle -> muscle
- D Muscle fiber -> myofilament -> myofibril -> fascicle -> muscle
- E Myofilament -> muscle -> fascicle -> myofibril -> muscle fiber

3 Which connective tissue layer surrounds a fascicle (bundle of muscle fibers) in skeletal muscle?



- A Endomysium
- B Perimysium
- C Epimysium
- D Sarcolemma
- E Myelin





4 The sarcolemma is best described as the:



- A Membrane of the sarcoplasmic reticulum
- B Plasma membrane of a muscle fiber
- C Connective tissue sheath around a fascicle
- D Protein that binds calcium on actin
- E Space between actin and myosin filaments

5 A sarcomere is defined as the region between two:



- A M lines
- B Z lines (Z discs)
- C H zones
- D A bands
- E T-tubules

6 Which pairing correctly matches the main proteins in thick vs thin filaments of skeletal muscle?



- A Thick = actin; Thin = myosin
- B Thick = myosin; Thin = actin (with troponin/tropomyosin)
- C Thick = collagen; Thin = elastin
- D Thick = keratin; Thin = tubulin
- E Thick = hemoglobin; Thin = myoglobin





7 Which muscle type is typically multinucleated (has many nuclei per cell)?



- A** Skeletal muscle fiber
- B** Cardiac muscle cell
- C** Smooth muscle cell
- D** Neuron
- E** Red blood cell

8 Which feature is most directly responsible for the striated appearance of skeletal and cardiac muscle?



- A** Random distribution of actin and myosin
- B** Regular repeating arrangement of sarcomeres
- C** Presence of a myelin sheath
- D** High amount of collagen in the cytoplasm
- E** Absence of mitochondria

9 Intercalated discs in cardiac muscle are important mainly because they:



- A** Store calcium for muscle contraction
- B** Provide strong mechanical attachment and electrical coupling between cells
- C** Secrete acetylcholine onto skeletal muscles
- D** Make cardiac muscle non-striated
- E** Prevent any ions from moving between cardiac cells





10 Gap junctions in cardiac muscle primarily allow:

- A** Direct flow of ions and electrical signals between adjacent cells
- B** Oxygen transport from blood to muscle
- C** Neurotransmitter storage in vesicles
- D** Attachment of tendons to bone
- E** Protein synthesis in the nucleus



11 During contraction of a skeletal muscle sarcomere, which region stays the **SAME** length?

- A** I band
- B** H zone
- C** A band
- D** Distance between Z lines
- E** The entire sarcomere always stays the same length



12 Which change occurs when a sarcomere contracts normally?

- A** The I band shortens
- B** The A band shortens
- C** The myosin filaments shorten
- D** The actin filaments shorten
- E** The Z lines move farther apart





13 At very strong contraction, which region may disappear because there is maximal overlap of actin and myosin?



- A** A band
- B** H zone
- C** Z line
- D** M line
- E** Sarcolemma

14 Which statement best describes the sliding filament theory?



- A** Actin and myosin filaments shorten by breaking into smaller pieces.
- B** Actin filaments slide past myosin filaments, increasing overlap and shortening the sarcomere.
- C** Myosin moves away from actin to lengthen the sarcomere.
- D** The sarcomere shortens because the Z lines dissolve.
- E** Calcium causes actin to be converted into myosin.

15 In skeletal muscle, calcium (Ca^{2+}) initiates contraction most directly by binding to:



- A** Tropomyosin
- B** Troponin
- C** Myosin heads
- D** Acetylcholine





E ATP synthase

16 What is the main role of tropomyosin in a relaxed skeletal muscle fiber?



- A It breaks down ATP to provide energy.
- B It covers myosin-binding sites on actin, preventing cross-bridge formation.
- C It pumps Ca^{2+} back into the sarcoplasmic reticulum.
- D It releases acetylcholine at the neuromuscular junction.
- E It forms the thick filament backbone.

17 ATP binding to myosin is required most directly for which step of the cross-bridge cycle?



- A Power stroke (pulling actin)
- B Detachment of myosin from actin
- C Exposure of binding sites on actin
- D Release of Ca^{2+} from the sarcoplasmic reticulum
- E Diffusion of oxygen into mitochondria

18 ATP hydrolysis ($\text{ATP} \rightarrow \text{ADP} + \text{P}_i$) at the myosin head is used mainly to:



- A Pull actin inward during the power stroke
- B Detach myosin from actin





- C Re-cock (energize) the myosin head into a high-energy position
- D Bind Ca^{2+} to troponin
- E Create acetylcholine in the motor neuron

19 The 'power stroke' in skeletal muscle contraction occurs most directly when:



- A ATP binds to myosin
- B ADP and P_i are released from myosin after it binds actin
- C Ca^{2+} is pumped into the sarcoplasmic reticulum
- D Acetylcholine is broken down by acetylcholinesterase
- E The action potential reaches the brain

20 Rigor mortis occurs after death primarily because:



- A Too much ATP forces myosin to stay attached to actin
- B There is no ATP to detach myosin from actin, so cross-bridges remain locked
- C Acetylcholine is broken down too quickly
- D Actin filaments are destroyed, preventing overlap
- E The sarcomeres permanently lengthen due to excess Ca^{2+} pumping

21 If Ca^{2+} were suddenly removed from a contracting skeletal muscle fiber while ATP remained available, what would happen most immediately?





- A Myosin would keep cycling normally because Ca^{2+} is not needed once contraction begins
- B New cross-bridges would stop forming because tropomyosin would re-cover binding sites, and the muscle would relax
- C ATP would instantly disappear
- D The A band would shorten
- E The myosin filaments would disassemble

22 Which protein pump actively transports Ca^{2+} back into the sarcoplasmic reticulum to end contraction?



- A Na^+/K^+ ATPase
- B SERCA (Ca^{2+} ATPase)
- C ATP synthase
- D Myosin ATPase
- E Carbonic anhydrase

23 A drug inhibits SERCA pumps in skeletal muscle. Which outcome is most likely?



- A Faster relaxation because Ca^{2+} is removed more quickly
- B Slower relaxation and prolonged contraction because cytosolic Ca^{2+} stays high
- C No change because SERCA is not involved in Ca^{2+} handling
- D Immediate breakdown of actin filaments
- E More acetylcholine release at the neuromuscular junction





24 At the neuromuscular junction, acetylcholine (ACh) binds to receptors that are best described as:



- A Voltage-gated Na^+ channels
- B Ligand-gated cation channels (nicotinic ACh receptors)
- C G-protein coupled receptors that take minutes to respond
- D ATP-driven pumps that transport ACh into the cell
- E Receptors only found on the presynaptic membrane

25 The end-plate potential (EPP) at the neuromuscular junction is best described as:



- A An all-or-none action potential that always has the same amplitude
- B A graded depolarization that can trigger a muscle action potential if threshold is reached
- C A hyperpolarization caused by Cl^- influx only
- D A signal that travels down the optic nerve
- E A contraction of the tendon

26 Acetylcholinesterase (AChE) at the neuromuscular junction is important mainly because it:



- A Synthesizes acetylcholine in the muscle fiber
- B Breaks down acetylcholine in the synaptic cleft to terminate the signal
- C Pumps Ca^{2+} into the sarcoplasmic reticulum
- D Moves actin over myosin
- E Builds the myelin sheath around axons





27 If acetylcholinesterase were inhibited at the neuromuscular junction, the most likely immediate effect would be:



- A** Less stimulation of the muscle fiber and weaker contraction
- B** Prolonged stimulation of ACh receptors, causing sustained depolarization and muscle over-activation
- C** No effect because ACh breakdown is not required for signaling
- D** Instant destruction of troponin
- E** Only the tendon would contract, not the muscle

28 T-tubules are important in skeletal muscle because they:



- A** Store ATP for the cross-bridge cycle
- B** Carry the action potential deep into the muscle fiber so Ca^{2+} release occurs throughout
- C** Are the site where acetylcholine is made
- D** Connect muscle to bone
- E** Prevent any ions from moving within the cell

29 The sarcoplasmic reticulum (SR) in skeletal muscle is functionally most similar to which organelle?



- A** Golgi apparatus (protein secretion)
- B** Smooth endoplasmic reticulum (Ca^{2+} storage/handling)
- C** Mitochondrion (ATP synthesis)
- D** Nucleus (DNA storage)





E Lysosome (digestion)

30 Which event directly links the muscle action potential to the start of cross-bridge cycling in skeletal muscle?



- A ATP binding to myosin
- B Ca^{2+} release into the cytosol and binding to troponin
- C Glucose entering the muscle cell
- D CO_2 leaving the muscle cell
- E Protein synthesis in ribosomes

31 Botulinum toxin causes flaccid paralysis mainly because it prevents:



- A Ca^{2+} binding to troponin inside muscle fibers
- B Release of acetylcholine from the motor neuron terminal
- C ATP production in mitochondria of the muscle
- D Action potentials in the spinal cord only
- E Formation of tendons during development

32 Curare (a classic neuromuscular blocker) causes muscle weakness primarily by:



- A Breaking down acetylcholine too quickly
- B Blocking nicotinic acetylcholine receptors on the muscle end plate





- C Increasing Ca^{2+} release from the SR
- D Increasing ATP production in muscle
- E Strengthening tendon collagen fibers

33 A motor unit is defined as:



- A All the muscles in one limb
- B One motor neuron and all the muscle fibers it innervates
- C One sarcomere and the Z lines around it
- D One tendon and the bone it attaches to
- E One actin filament plus one myosin filament

34 Which muscle would generally have the **SMALLEST** motor units for the finest control?



- A Quadriceps (thigh)
- B Extraocular muscles (eye movement)
- C Gluteus maximus
- D Gastrocnemius (calf)
- E Diaphragm (always largest motor units)

35 A whole muscle can produce graded increases in force mainly by:





- A Making individual muscle fibers produce bigger action potentials
- B Recruiting more motor units and increasing firing frequency (summation)
- C Changing the length of actin filaments permanently
- D Switching from troponin to calmodulin
- E Letting tendons contract independently

36 Temporal summation in skeletal muscle increases force because:



- A The muscle fiber action potentials increase in size with repeated stimulation
- B Ca^{2+} does not fully return to baseline between stimuli, so more cross-bridges can form
- C Actin filaments grow longer with each stimulus
- D The A band shortens with each stimulus
- E Acetylcholine becomes permanently attached to receptors

37 A sustained maximal contraction caused by high-frequency stimulation with no relaxation is called:



- A A twitch
- B Tetanus
- C Refractory period
- D Accommodation
- E Diffusion





38 The length-tension relationship implies that maximal active force is produced when:



- A** There is no overlap between actin and myosin
- B** Sarcomere length is optimal for cross-bridge formation (neither too stretched nor too compressed)
- C** The sarcomere is stretched so far that actin detaches from the Z line
- D** The sarcomere is maximally shortened so myosin filaments fold
- E** Force is independent of overlap; only ATP matters

39 An isometric contraction is one in which:



- A** The muscle shortens while force stays constant
- B** The muscle length stays constant while tension increases or is maintained
- C** The muscle lengthens with no force produced
- D** The tendon shortens but the muscle does not
- E** No cross-bridges form

40 Which description correctly matches concentric vs eccentric contraction?



- A** Concentric: muscle lengthens; Eccentric: muscle shortens
- B** Concentric: muscle shortens while producing force; Eccentric: muscle lengthens while resisting a load
- C** Concentric occurs only in smooth muscle; eccentric only in skeletal muscle
- D** Eccentric contractions require no ATP
- E** Eccentric contractions cannot produce high force





41 Eccentric contractions are often associated with greater muscle soreness the next day mainly because they:



- A Stop Ca^{2+} release from the SR permanently
- B Cause more micro-tears and mechanical stress in muscle fibers while producing high force
- C Prevent oxygen from entering blood
- D Destroy actin filaments instantly
- E Occur only during sleep

42 ATP is required in skeletal muscle contraction for BOTH of the following processes:



- A Myosin detachment from actin and Ca^{2+} reuptake into the SR
- B Actin synthesis and oxygen diffusion into blood
- C Troponin production and tendon stretching
- D Opening of acetylcholine receptors and closing of the pupil
- E Breaking down glucose in the intestine and pumping Na^+ in kidneys

43 During the first few seconds of an all-out sprint, the most immediate way muscle regenerates ATP is primarily through:



- A Oxidative phosphorylation in mitochondria
- B Creatine phosphate (phosphocreatine) donating phosphate to ADP
- C Conversion of lactic acid into glucose in the intestine
- D Protein breakdown into amino acids for energy





E Photosynthesis inside muscle fibers

44 Which statement correctly compares anaerobic glycolysis with aerobic respiration in muscle?



- A Anaerobic glycolysis is slower but yields much more ATP per glucose
- B Anaerobic glycolysis is faster but yields less ATP per glucose than aerobic respiration
- C Aerobic respiration produces ATP without oxygen
- D Anaerobic glycolysis happens only in mitochondria
- E Aerobic respiration produces no CO₂

45 A major reason muscles fatigue during intense short-term exercise is that:



- A ATP is never used during contraction
- B Accumulation of H⁺ (lower pH) can interfere with enzyme function and contraction processes
- C Actin filaments permanently disappear after a few contractions
- D Myosin turns into collagen
- E The sarcomere becomes longer because ATP stretches it

46 'Oxygen debt' after exercise refers mainly to the extra oxygen needed to:



- A Convert oxygen into glucose
- B Restore phosphocreatine stores, process lactate, and replenish oxygen stores in tissues





- C Break down acetylcholine at the NMJ
- D Increase the number of sarcomeres
- E Make tendons shorter

47 Which skeletal muscle fiber type is generally MOST fatigue-resistant and rich in mitochondria and myoglobin?



- A Type I (slow oxidative)
- B Type IIx/IIb (fast glycolytic)
- C Type II (fast) always has zero mitochondria
- D All fiber types have identical mitochondria and myoglobin
- E Smooth muscle fibers only

48 Which fiber type is best suited for very fast, powerful movements (e.g., short sprints) but fatigues quickly?



- A Type I (slow oxidative)
- B Type IIx/IIb (fast glycolytic)
- C Smooth muscle
- D Cardiac muscle
- E Type I has the highest sprint power





49 Endurance training most directly increases which adaptations in skeletal muscle?



- A Decrease in capillary density and mitochondria
- B Increase in capillary density and mitochondrial content
- C Replacement of skeletal muscle with smooth muscle
- D Permanent shortening of actin filaments
- E Loss of myoglobin to reduce oxygen use

50 Strength training typically leads to muscle growth mainly by:



- A Hyperplasia (making many new muscle fibers in large numbers)
- B Hypertrophy (increasing the size of existing fibers by adding myofibrils/proteins)
- C Replacing tendons with bone
- D Shortening the A band permanently
- E Turning slow fibers into neurons

51 According to the 'size principle' of motor unit recruitment during increasing force demands, which motor units are typically activated first?



- A Large fast glycolytic motor units
- B Small slow oxidative motor units
- C Only the largest motor units in all cases
- D Motor units are recruited randomly
- E Cardiac motor units





52 Which characteristic best fits Type I (slow oxidative) fibers compared with Type II (fast) fibers?



- A** Fewer mitochondria and more fatigue
- B** More mitochondria, more myoglobin, and greater fatigue resistance
- C** Higher maximum shortening velocity and highest power output
- D** No capillary supply
- E** They contract only when the person is asleep

53 Which muscle type is under voluntary control and attached to bones via tendons?



- A** Smooth muscle
- B** Skeletal muscle
- C** Cardiac muscle
- D** All muscle types are voluntary
- E** No muscle type is voluntary

54 Which statement is correct about smooth muscle contraction regulation compared with skeletal muscle?



- A** Smooth muscle uses troponin to move tropomyosin, just like skeletal muscle
- B** Smooth muscle typically uses Ca^{2+} -calmodulin and myosin light-chain kinase (MLCK) rather than troponin
- C** Smooth muscle cannot use Ca^{2+} for contraction
- D** Smooth muscle always has sarcomeres and striations





- E** Smooth muscle contraction depends on acetylcholine only and never on hormones

55 A key reason cardiac muscle cannot undergo sustained tetanus like skeletal muscle is that cardiac muscle:



- A** Has no actin and myosin
- B** Has a long refractory period that overlaps contraction
- C** Has no calcium in cells
- D** Is not excitable electrically
- E** Cannot produce ATP

56 Which statement best compares the source of Ca^{2+} used for contraction in skeletal vs cardiac muscle?



- A** Both rely only on extracellular Ca^{2+} entering from blood
- B** Skeletal muscle relies mainly on Ca^{2+} release from the SR; cardiac muscle uses extracellular Ca^{2+} entry to help trigger SR release
- C** Skeletal muscle cannot store Ca^{2+} in the SR
- D** Cardiac muscle has no SR at all
- E** Neither muscle type uses Ca^{2+} for contraction

57 The 'latch state' (important in some smooth muscles) is useful because it allows:



- A** Rapid powerful contractions at very high ATP cost





- B Sustained tension with relatively low ATP consumption
- C Contraction without any actin or myosin
- D Muscles to store oxygen like hemoglobin
- E Voluntary control of the heart rate

58 Which receptor detects muscle stretch (length change) and helps trigger the stretch reflex?



- A Golgi tendon organ
- B Muscle spindle
- C Pacinian corpuscle (skin pressure)
- D Photoreceptor
- E Alveolus

59 Golgi tendon organs are most directly specialized to detect:



- A Muscle fiber membrane potential
- B Tension/force in the tendon during contraction
- C Light intensity in the retina
- D Blood glucose concentration
- E Temperature of the skin only





60 Tendons have high tensile strength mainly because they are composed primarily of:



- A** Dense regular connective tissue with parallel collagen fibers
- B** Smooth muscle fibers arranged in sarcomeres
- C** Cartilage with chondrocytes in lacunae
- D** Keratinized epithelial cells
- E** Nervous tissue with myelin

61 An aponeurosis is best described as:



- A** A flat, sheet-like tendon that attaches muscle to bone or to another muscle
- B** A nerve ending that detects pain in the tendon
- C** A type of cartilage at joints
- D** The synapse between motor neuron and muscle
- E** A region of the sarcomere where only actin is present

62 Which example best illustrates tendons storing and releasing elastic energy to improve movement efficiency?



- A** Achilles tendon stretching and recoiling during running/jumping
- B** Myosin detaching from actin using ATP
- C** Acetylcholine being broken down in the synaptic cleft
- D** Ribosomes translating protein in a muscle cell
- E** Red blood cells carrying oxygen





63 In human biomechanics, the biceps brachii acting at the elbow is most commonly considered a third-class lever. This means:



- A** The load is between the fulcrum and effort
- B** The effort is between the fulcrum and load, favoring speed and range of motion over force
- C** The fulcrum is between the load and effort, maximizing force
- D** There is no fulcrum in the elbow joint
- E** Third-class levers always maximize mechanical advantage for lifting heavy loads

64 Which statement correctly describes the relationship between tendons and muscles during movement?



- A** Tendons actively contract; muscles are passive cables
- B** Muscles generate force; tendons transmit that force to bones to produce movement
- C** Bones generate force; tendons generate ATP
- D** Tendons store DNA used to repair muscle
- E** Tendons replace the need for motor neurons

65 Dystrophin (linked to certain muscular dystrophies) is important mainly because it:



- A** Carries oxygen in muscle cytoplasm
- B** Links the muscle cell cytoskeleton to the membrane/extracellular matrix, helping protect fibers from damage during contraction
- C** Is the neurotransmitter released at the neuromuscular junction
- D** Is the enzyme that breaks down acetylcholine





- E Is the Ca^{2+} pump of the sarcoplasmic reticulum

66 At the neuromuscular junction, what triggers acetylcholine release from the motor neuron terminal?



- A Ca^{2+} influx into the presynaptic terminal when the action potential arrives
- B Na^{+} leaving the motor neuron terminal through ligand-gated channels
- C ATP leaving the motor neuron terminal by diffusion
- D Ca^{2+} binding to troponin in the muscle fiber
- E Chloride entering the muscle cell nucleus

67 Which statement about neuromuscular junctions in skeletal muscle is generally correct?



- A One muscle fiber is normally controlled by many different motor neurons at the same time
- B Each skeletal muscle fiber typically has one neuromuscular junction, but a motor neuron can branch to innervate many fibers
- C Skeletal muscles do not need motor neurons to contract
- D Neuromuscular junctions use only electrical synapses (gap junctions)
- E Acetylcholine is released from the muscle to stimulate the neuron

68 Which sarcomere region contains ONLY thin (actin) filaments and no thick filaments?



- A A band





- B I band
- C H zone
- D M line
- E All regions contain both filaments equally

69 Which structure anchors thin filaments and forms the boundary of a sarcomere?



- A M line
- B Z line (Z disc)
- C H zone
- D T-tubule
- E Intercalated disc

70 A person completely tears the Achilles tendon. Which statement is MOST accurate about the immediate effect on the associated calf muscles?



- A The calf muscles cannot generate force at all because actin and myosin stop working
- B The calf muscles may still contract internally, but their force cannot be effectively transmitted to the foot for normal plantarflexion
- C Only the bones stop working; tendons are not involved in movement
- D The neuromuscular junction stops releasing acetylcholine immediately because the tendon is torn
- E The sarcomeres in the calf muscles permanently disappear







#	Ans	Answer Text
	B	
2	B	Myofilament -> myofibril -> muscle fiber -> fascicle -> muscle
	B	
4	B	Plasma membrane of a muscle fiber
	B	
6	B	Thick = myosin; Thin = actin (with troponin/tropomyosin)
	A	
8	B	Regular repeating arrangement of sarcomeres
	B	
10	A	Direct flow of ions and electrical signals between adjacent cells
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	B	
22	B	SERCA (Ca ²⁺ ATPase)
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24	B	Ligand-gated cation channels (nicotinic ACh receptors)
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26	B	Breaks down acetylcholine in the synaptic cleft to terminate the signal
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28	B	Carry the action potential deep into the muscle fiber so Ca ²⁺ release oc...
	B	
30	B	Ca ²⁺ release into the cytosol and binding to troponin
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34	B	Extraocular muscles (eye movement)
	B	
36	B	Ca ²⁺ does not fully return to baseline between stimuli, so more cross-br...
	B	
38	D	Sarcomere length is optimal for cross-bridge formation (neither too stre...



