Calmodulin is most closely related, both structurally and functionally, to which of the following proteins?

A) G-actin

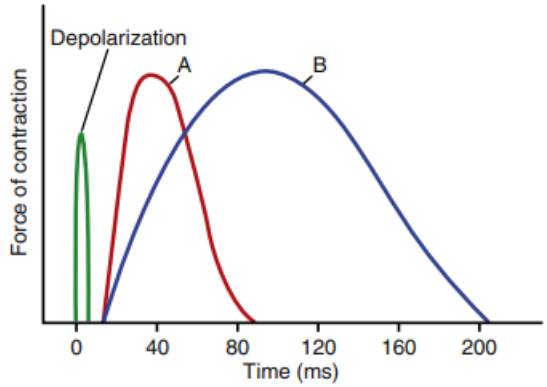
B) Myosin light chain

C) Tropomyosin

D) Troponin C

Answer: D

The two questions below relate to this graph



Which of the following best describes muscle B compared with muscle A?

A) Adapted for rapid contraction

B) Composed of larger muscle fibres

C) Fewer mitochondria

D) Innervated by smaller nerve fibres

E) Less extensive blood supply 30.

Answer: D

The delay between the termination of the transient depolarization of the muscle membrane and the onset of muscle contraction observed in both muscles A and B reflects the time necessary for which of the following events to occur?

A) ADP to be released from the myosin head

B) ATP to be synthesized

C) Ca++ to accumulate in the sarcoplasm

D) G-actin to polymerize into F-actin

E) Myosin head to complete one cross-bridge cycle

Answer: C

A 55-year-old woman visits her physician because of double vision, eyelid droop, difficulty chewing and swallowing, and general weakness in her limbs. All these symptoms worsen with exercise and occur more frequently late in the day. The physician suspects myasthenia gravis and orders a Tensilon test (Test where the patient is asked to move several muscles after injecting them with a drug). The test is positive for myasthenia gravis. **Use this information when answering the next three questions**

1. The increased muscle strength observed during the Tensilon test is due to an increase in which of the following?

A) Amount of acetylcholine (ACh) released from the motor nerves

B) Levels of ACh at the muscle end plates

C) Number of ACh receptors on the muscle end plates

D) Synthesis of norepinephrine

Answer: B

2. What is the most likely basis for the symptoms described in this patient?

A) Autoimmune response

B) Botulinum toxicity

C) Depletion of voltage-gated Ca++ channels in certain motor neurons

D) Development of macro motor units after recovery from poliomyelitis

E) Overexertion

Answer: A

3. Which of the following drugs would likely alleviate this patient's symptoms?

A) Atropine

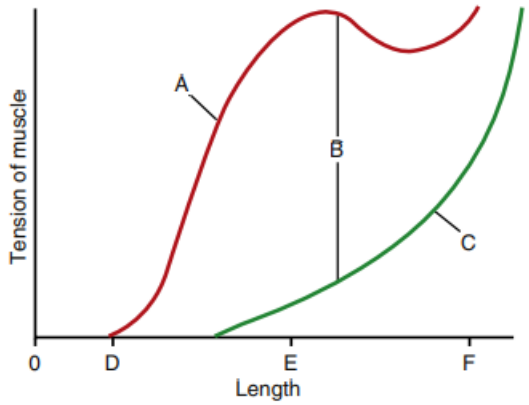
B) Botulinum toxin antiserum

C) Curare

D) Halothane

E) Neostigmine

Answer: E



The above figure illustrates the isometric length-tension relationship in a representative intact skeletal muscle. Match the descriptions in **Questions 1-3 to one of the points on the figure.**

1. So-called "active" or contraction-dependent tension

Answer: B

2. The muscle length at which active tension is maximal

Answer: E

3. The contribution of non-contractile muscle elements to total tension

Answer: C

A 56-year-old man sees a neurologist because of weakness in his legs that improves over the course of the day or with exercise. Extracellular electrical recordings from a single skeletal muscle fibre reveal normal miniature end plate potentials. Low-frequency electrical stimulation of the motor neuron, however, elicits an abnormally small depolarization of the muscle fibres. The amplitude of the depolarization is increased after exercise. **Use this information to answer Questions 1-3**

1 Based on these findings, which of the following is the most likely cause of this patient's leg weakness?

A) Acetylcholinesterase deficiency

B) Blockade of postsynaptic acetylcholine receptors

C) Impaired presynaptic voltage-sensitive Ca++ influx

D) Inhibition of Ca++ re-uptake into the sarcoplasmic reticulum

E) Reduced acetylcholine synthesis

Answer: C *(The normal miniature end-plate potentials indicate sufficient synthesis and packaging of ACh and the presence and normal function of ACh receptor channels. The most likely explanation for this patient's symptoms is a presynaptic deficiency—in this case, an impairment of the voltage-sensitive Ca++ channels responsible for the increase in cytosolic Ca++ that triggers the release of ACh into the synapse. The increase in postsynaptic depolarization observed after exercise is indicative of an accumulation of Ca++ in the presynaptic terminal after multiple action potentials have reached the nerve terminal.)*

2: A preliminary diagnosis is confirmed by the presence of which of the following?

A) Antibodies against the acetylcholine receptor

B) Antibodies against the voltage-sensitive Ca++ channel

C) Mutation in the gene that codes for the ryanodine receptor

D) Relatively few vesicles in the presynaptic terminal

E) Residual acetylcholine in the neuromuscular junction

Answer: B

3: The molecular mechanism underlying these symptoms is most similar to which of the following?

A) Acetylcholine

B) Botulinum toxin

C) Curare

D) Neostigmine

E) Tetrodotoxin

Answer: B

An apparently healthy 15-year-old boy dies during a minor surgical procedure while under general anaesthesia. The boy's grandfather had also died during a surgical procedure. A clinical assessment team determines that the child had malignant hyperthermia (MH). MH is an inherited disease in which triggering agents, such as certain anaesthetics, stimulate calcium release from storage sites in muscle, leading to elevated concentrations of myoplasmic calcium. The MH crisis is most likely to be associated with which of the following?

A) Decreased anaerobic metabolism

B) Decreased CO_2 production by muscles

C) Decreased lactic acid production by muscles

D) Defective calsequestrin

E) Defective dihydropyridine receptors

F) Defective ryanodine receptors

Answer: F

A 24-year-old woman is admitted as an emergency to University Hospital after an automobile accident in which severe lacerations to the left wrist severed a major muscle tendon. The severed ends of the tendon were overlapped by 6 cm to facilitate suturing and reattachment. Which of the following would be expected after 6 weeks compared with the preinjured muscle? Assume that series growth of sarcomeres cannot be completed within 6 weeks.

A) Passive tension decreases, maximum active tension decrease

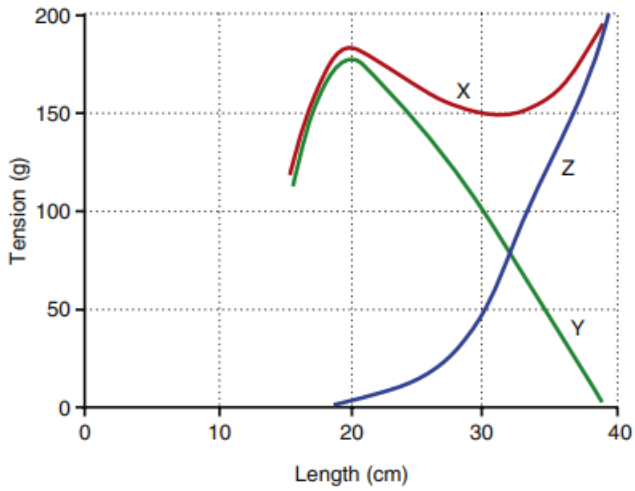
B) Passive tension decreases, maximal active tension increases

C) Passive tension increases, maximal active tension increase

D) Passive tension increases, maximal active tension decreases

E) No change in passive tension, no change in maximal active tension

Answer: D *(Stretching the muscle to facilitate reattachment of the tendons leads to an increase in passive tension or preload. This increase in passive tension increases the muscle length beyond its ideal length, which in turn leads to a decrease in the maximal active tension that can be generated by the muscle. The reason maximal active tension decreases is that interdigitation of actin and myosin filaments decreases when the muscle is stretched; the interdigitation of a muscle is normally optimal at its resting length.)*



The length-tension diagram above was obtained from a skeletal muscle with equal numbers of red and white fibres. Supramaximal tetanic stimuli were used to initiate an isometric contraction at each muscle length studied. The resting length was 20 cm. What is the maximum amount of active tension that the muscle is capable of generating at a preload of 100 grams?

A) 145 to 155 grams

B) 25 to 35 grams

C) 55 to 65 grams

D) 95 to 105 grams

E) Cannot be determined

Answer: C *(The figure shows the relationship between preload or passive tension (curve Z), total tension (curve X), and active tension (curve Y). Active tension cannot be measured directly: it is the difference between total tension and passive tension. To answer this question, the student must first find where 100 grams intersects the preload curve (passive tension curve) and then move down to the active tension curve. One can see that a preload of 100 grams is associated with a total tension of a little more than 150 grams and an active tension of a little more than 50 grams. Note that active tension equals total tension minus passive tension, as previously discussed. Drawing these three curves in a manner that is mathematically correct is not an easy task. The student should thus recognize that active tension may not equal total tension minus passive tension at all points on the figure shown here)*

4. The correct temporal sequence for events at the neuromuscular junction is

(A) action potential in the motor nerve; depolarization of the muscle end plate; uptake of Ca^{2+} into the presynaptic nerve terminal

(B) Uptake of Ca^{2+} into the presynaptic terminal; release of acetylcholine (ACh); depolarization of the muscle end plate

(C) Release of ACh; action potential in the motor nerve; action potential in the muscle

(D) uptake of Ca^{2+} into the motor end plate; action potential in the motor end plate; action potential in the muscle

(E) Release of ACh; action potential in the muscle end plate; action potential in the muscle

Answer: B

6. Repeated stimulation of a skeletal muscle fibre causes a sustained contraction (tetanus). Accumulation of which solute in intracellular fluid is responsible for the tetanus?

(A) Na^{+}

(B) K^{+}

(C) Cl^{-}

(D) Mg^{2+}

(E) Ca^{2+}

(F) Troponin

(G) Calmodulin

(H) Adenosine triphosphate (ATP)

Answer: E

8. A 42-year-old man with myasthenia gravis notes increased muscle strength when he is treated with an acetylcholinesterase (AChE) inhibitor. The basis for his improvement is increased

(A) Amount of acetylcholine (ACh) released from motor nerves

(B) Levels of ACh at the muscle end plates

(C) Number of ACh receptors on the muscle end plates

(D) Amount of norepinephrine released from motor nerves

(E) Synthesis of norepinephrine in motor nerves

Answer: B

21. At the muscle end plate, acetylcholine (ACh) causes the opening of

(A) Na+ channels and depolarization toward the Na+ equilibrium potential

(B) K+ channels and depolarization toward the K+ equilibrium potential

(C) Ca2+ channels and depolarization toward the Ca2+ equilibrium potential

(D) Na+ and K+ channels and depolarization to a value halfway between the Na+ and K+ equilibrium potentials

(E) Na+ and K+ channels and hyperpolarization to a value halfway between the Na+ and K+ equilibrium potentials

Answer: D

24. Which of the following temporal sequences is correct for excitation– contraction coupling in skeletal muscle?

(A) Increased intracellular [Ca2+]; action potential in the muscle membrane; cross-bridge formation

(B) Action potential in the muscle membrane; depolarization of the T tubules; release of Ca2+ from the sarcoplasmic reticulum (SR)

(C) Action potential in the muscle membrane; splitting of adenosine triphosphate (ATP); binding of Ca2+ to troponin C

(D) Release of Ca2+ from the SR; depolarization of the T tubules; binding of Ca2+ to troponin C

Answer: B

26. In skeletal muscle, which of the following events occurs before depolarization of the T tubules in the mechanism of excitation– contraction coupling?

(A) Depolarization of the sarcolemmal membrane

(B) Opening of Ca2+ release channels on the sarcoplasmic reticulum (SR)

(C) Uptake of Ca2+ into the SR by Ca2+ - adenosine triphosphatase (ATPase)

(D) Binding of Ca2+ to troponin C

(E) Binding of actin and myosin

Answer: A