

# Biophysical events of contraction-relaxation in muscle tissue

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- A motor neuron plus the muscle fibers it innervates is called a motor unit.
- The axon terminals of a motor neuron contain vesicles .The vesicles contain the neurotransmitter acetylcholine (ACh).
- The region of the muscle fiber plasma membrane that lies directly under the terminal portion of the axon is known as the motor end plate.
- The junction of an axon terminal with the motor end plate is known as a neuromuscular junction.

- When an action potential in a motor neuron arrives at the axon terminal, it depolarizes the plasma membrane of the axon terminal, thereby releasing ACh into the extracellular cleft
- The binding of ACh opens an ion channel in motor end plate.
- A local depolarization of the motor end plate known as an end-plate potential (EPP) occurs.
- One EPP is normally more than sufficient to depolarize the muscle plasma membrane adjacent to the end-plate membrane to its threshold potential, initiating an action potential in muscle.

- In all muscle cells, contraction depends on an increase in cytosolic calcium concentration.
- The action potential stimulates L-type calcium channels or also known as dihydropyridine receptors.
- In skeletal muscle, these are mechanically coupled to the sarcoplasmic reticulum (SR) ryanodine receptors (RyRs) and open them directly. There is no need to rush of calcium ions through the calcium channels.
- In contrast , in cardiac muscle, calcium influx through the L-type channels opens RyRs via calcium-induced calcium release (CICR).

- Once intracellular calcium levels are raised, calcium binds troponin C on actin filaments.
- In striated muscle, calcium causes a shift in the position of the troponin complex on actin filaments, which exposes myosin-binding sites.
- Myosin bound by ADP and inorganic phosphate (Pi) can then form cross-bridges with actin, and the release of ADP and Pi produces the power stroke that drives contraction.
- This force causes the thin actin filament to slide past the thick myosin filament and shortens the muscle.

- A contraction continues until calcium is removed from troponin, and this is achieved by lowering the calcium concentration in the cytosol back to its pre release initial level.
- The membranes of the SR contain primary active-transport proteins—Ca<sup>2+</sup>-ATPases—that pump calcium ions from the cytosol back into the lumen of the SR.

- The force exerted on an object by a contracting muscle is known as muscle tension and the force exerted on the muscle by an object (usually its weight) is the load.
- The mechanical response of a single muscle fiber to a single action potential is known as a twitch.
- Since a single action potential in a skeletal muscle fiber lasts 1 to 2 ms but the twitch may last for 100 ms, it is possible for a second action potential to be initiated during the period of mechanical activity.
- The increase in muscle tension from successive action potentials occurring during the phase of mechanical activity is known as summation

- A maintained contraction in response to repetitive stimulation is known as a tetanus
- During a tetanic contraction, the successive action potentials each release calcium from the SR before all the calcium from the previous action potential has been pumped back into the reticulum. Therefore, the contraction force increases.