How Muscle Contracts & Relaxes – A Simplified Explanation

The axons of nerve cells in the spinal cord branch and attach to each muscle fiber creating an end point called the neuromuscular junction.

To initiate contraction of the muscle, a signal – called the action potential - passes down the nerve to the neuromuscular junction (NJ).

In that NJ calcium (Ca) is released from the sarcoplasmic reticulum (SR) and acetylcholine (Ach) is released into the synaptic cleft.

Ach binds with receptors and allows sodium (Na) ions to be released and depolarize the sarcolemma T-tubules.

Ca is now available to catalyze cross-bridging of the thin actin and thick myosin filaments.

Tropomyosin blocks the acting binding site, but Ca unblocks it by attaching to troponin and allows myosin head to attach to the actin.

The actin filament is pulled toward the center of the sarcomere (muscle shortens) and is powered by adenosine triphosphate (ATP). This process splits the three phosphate ATP to ADP (two phosphates) + P (one phosphate).

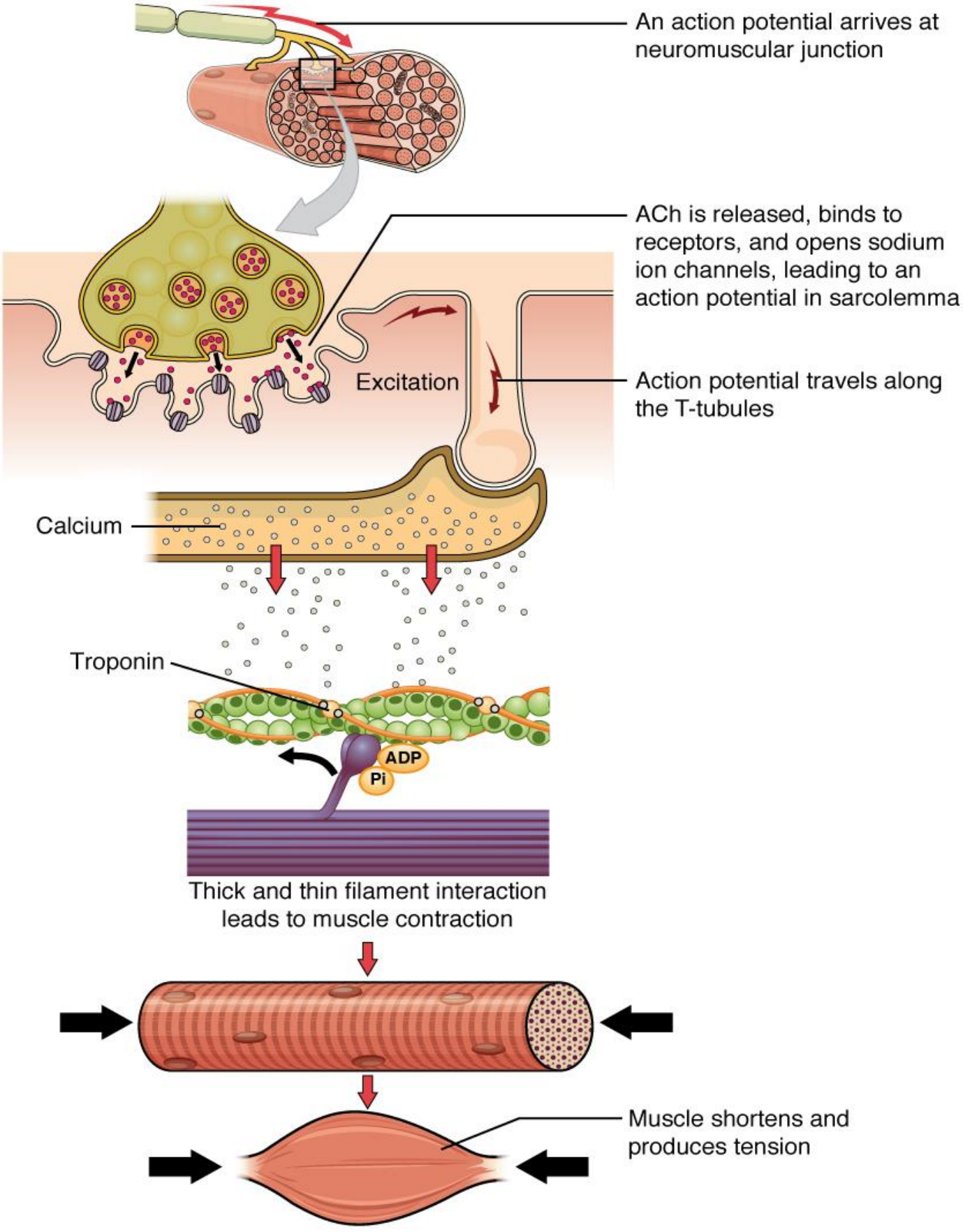
New ATP binds to the myosin cross-bridge to break the actin-myosin bond and the myosin cocks back ready for another cycle of cross-bridging.

Ca moves back to the SR and the muscle relaxes as the inhibition of the troponin-tropomyosin relationship is restored.

Provided Ca is present to inhibit the binding of the troponin-tropomyosin system, the actin-myosin cross-bridging/muscle shortening process can be repeated, fueled by the breakdown (hydrolysis) of ATP to ADP + P.

That is pretty much way it works. The diagram below will make it more understandable. If you want to get into the complete details of the process, click on this link:

https://opentextbc.ca/anatomyandphysiology/chapter/10-3-muscle-fiber-contraction-and-relaxation/


An action potential arrives at neuromuscular junction
ACh is released, binds to receptors, and opens sodium ion channels, leading to an action potential in sarcolemma
Excitation
Action potential travels along the T-tubules
Calcium
Troponin
ADP
Pi
Thick and thin filament interaction leads to muscle contraction
Muscle shortens and produces tension