



How the Muscle Really Contracts by Rob Nix, CPT

Most of us live our lives without ever conceiving what happens in our bodies. The muscular system is an amazing piece of machinery. Further reading will expose you to the intricate system of what almost seems to be a series of chain reaction switches and levers. One action happens and begins a snowball effect, ultimately leading to a muscle's contraction. Before we get started, first let's understand that the brain first thinks "I should contract" this is named an *action potential*, since in fact it is still a thought neurologically. The setting for the muscle contraction begins inside the nervous system. The nervous system works very similar to a battery. It is a closed system that holds an electrical charge. The charge can be positive or negative and it is the switch of polarization which actually initiates the entire contraction! Secondly let's move to the grey matter that fills the spinal column. The small nervous system unit inside the matter is called a *Neuron* which has many arms, *Axons*, which connect to the muscles at its tips. The connection of the "fingertips" is not an actual physical connection, it instead gets microscopically close, but the axon has an *end plate*. The scientific world refers to this connection as innervation. Now you can picture the tiny microscopic level which we are going to imagine as I further explain how the physiological contraction occurs.

When you go to squeeze those biceps, jump off the sofa or the hasty dive for the remote control, your brain says "Go!" The signal goes from the brain to the spinal cord and down to the nerves. In the spinal column's grey matter the axon comes to life! A sudden influx of sodium (that's right! SALT!) as an outflow of Potassium (vit.K) occurs. This switch changes the electrical charge and polarizes the system. This blockade allows the action potential to now flow down the axon to the end plate. As this happens, the chemical acetylcholine is released at the nerve terminal area. Now on the muscle fibers, the muscle's sarcolemma gets excited from the electrical impulse and stimulates a release of Calcium. The Calcium is actually stored inside the muscle cells sarcoplasmic reticulum. Don't you find it amazing that the vitamins and minerals we try to eat daily are now playing such crucial roles?

To step away for a moment, let's discuss the muscle itself. It is as if you essentially took a straw or rope piece and grouped a handful together in to a bundle, then took a few of these newly tied groupings and bundled them into another clustered grouping. There are 5 stages of these bundles which all form to create a muscle belly and connect to the bones. When you refer to how the muscle contracts, you also need to analyze the structure of a muscle cell at its smallest unit. The operational aspect of a muscle contraction is noted to be the *sliding filament theory*. If you can briefly imagine

that you were holding a heavy rope in your hands and began to pull the ropes weight closer to you one hand over the other. In essence this is an over simplified analogy. Your hands would be *actin* and your rope holds would be *myosin*. These 2 structures are the reason your muscles have the ability to contract and produce power. Now that you understand basic muscle structure, let's begin again when the action potential jumps onto the muscle and the Calcium is released. The Calcium now finds its match and bonds with a protein, troponin, which is found connected to the actin. This in turn bonds the actin, troponin and Calcium. This bond acts like a precursor. It allows another protein, tropomyosin, to shift out of the way, thus exposing the heads of myosin (the rope holds from the analogy). The heads of the myosin, as if waking up, lift and swivel then attach pulling the actin filaments. The pulling motion is the actual shortening of your muscle. Once pulled, ATP is released to detach and recock making a new binding site. To revisit the rope pulling analogy, every time you pulled the rope closer, one hand would be released as it grabs a further section and pull again. Every time a new hand pull happens, it represents the cycle of the actin & myosin bond with the break via ATP and then another reformation. This cycle continues until the muscle reaches the desired contraction or power output. The contraction would continue and repeat indefinitely so long as Calcium stays present signaling and exciting the sarcolemma. Relaxation occurs once the Calcium is no longer released. This step happens when the nervous system changes signals to "stop contraction" which makes the Calcium go back into storage, and the troponin and tropomyosin now create a blockade to prevent any contractions. Now your muscles are at rest.

Great work out! After reading the physiology of muscle stimulus, your work outs may not be drastically changed. You may not ever think about the microscopic levels but if you can imagine that all this happens many times, over millions of neurons all signaling simultaneously and contracting a muscle. Out of this, we hope that at least you now fully understand WHY you need to eat Calcium, Potassium and Sodium. When you exhaust your body's surplus of any of these 3, cramping tends to occur. To further relate this into your life, think of heavy exercise and sport drinks like Gatorade. The main ingredients are usually sugars, sodium, and potassium. Food for thought.

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