

Biophysical principles of muscle contraction

WHERE'S THE BIOPHYSICS? GOOGLE 'BIOPHYSICS OF MUSCLE CONTRACTION'

Article to be checked

Check of this article is requested.

Suggested reviewer: Carmeljcaruana

Types of muscle contraction

Voluntary muscle contraction : is controlled by the central nervous system. The brain transmits signals through the nervous system to the motor neuron that innervates several muscle fibers. Skeletal muscle is contracted voluntarily.

Involuntary muscle contraction : Contraction results of non-conscious brain activity or stimuli proceeding in the body to the muscle. For example the heart or smooth muscles in the gut and vascular system.

Structure of muscle fibers and process of muscle contraction

Muscles are composed of muscle fibers. The fibers are long cylindrical cells containing several nuclei. Each fiber consist of bundles of myofibrils that again are composed of contractile units, the sacromeres. These sacromeres are positioned adjacent to one another and contain alternating thick and thin protein filaments arranged in a specific order.

The thick filaments are named Myosin and the thin filaments Actin. Myosin is anchored to a middle line in the sacomere called the M-Line. Actin filaments are connected to the outer line of the sacromere called the Z-Line.

Each of these filaments have binding receptors for the other one on their surface. The myosin binding receptors (active sites) on the actin surface though are covered by a troponin- tropomyosin complex. Therefore they are not connected during relaxation of the muscle.

When the brain sends a stimulus to a nerve cell, the stimuli, which is called an action potential, travels down the axon to the axon terminal.

The axon terminals of the nerve cells carry vesicles which contain the neurotransmitter acetylcholine. Upon stimulations, the vesicles release the Ach into the synaptic cleft of the neuromuscular junction. Ach binds to Ach receptors on the surface of the muscle fiber. This allows the action potential to continue to propagate through the sarcolemma of the muscle fiber, along T- tubules. This whole process leads to a release of Calcium Ions from terminal cisternae into the sarcoplasm.

The Calcium Ions bind to the troponin located on the surface of the actin filaments to expose the myosin binding receptors. The heads of the myosin filaments attach to the exposed active sites on the actin filaments to form cross bridges.

At the same time ATP bound to the myosin heads is broken down into ADP and P. This causes a sliding movement of the actin filaments along the myosin. Due to this reaction and the fact that the actin filaments are connected to the Z- Line the whole sacromere gets shortened and the muscle contracts. This cycle continues as long as calcium ions remain bound to troponin to keep the active sites exposed and also as long as ATP is present.