

# Central nervous system: movement of muscles in the body



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Picking up a box from the floor and placing it on a shelf Light entering the eye forms an upside-down image on the retina. The retina transforms the light into nerve signals for the brain. The brain then turns the image right-side up and tells us what we are seeing. Our brain then computes to pick up the box. When a message comes into the brain from anywhere in the body, the brain tells the body how to react. the brain as a central computer that controls all bodily functions, then the nervous system is like a network that relays messages back and forth from the brain to different parts of the body. It does this through the spinal cord, which runs from the brain down through the back and contains nerves that branch out to every organ and body part. In the inner part of the forebrain sits the thalamus. The thalamus carries messages from the sensory organs like the eyes, ears, nose, and fingers to the cortex. The midbrain, located underneath the middle of the forebrain, acts as a master coordinator for all the messages going in and out of the brain to the spinal cord The hindbrain sits underneath the back end of the cerebrum, and it consists of the cerebellum, pons, and medulla. The cerebellum is responsible for balance, movement, and coordination. The pons and the medulla, along with the midbrain, are often called the brainstem. The brainstem takes in, sends out, and coordinates all of the brain's messages. The skeletal system is moved by the constriction of the skeletal muscle. The skeletal muscle constricts because of the signal sent by neurotransmitter, acetylcholine. This signal is sent by the nervous system which wants the muscle to constrict so the bone can bend. The nervous system controls everything. Muscle contraction is initiated when calcium is made available within the muscle fiber. This calcium is then used to initiate contraction, given the affinity of troponin to calcium. As troponin attaches <https://assignbuster.com/central-nervous-system-movement-of-muscles-in-the-body/>

to calcium, it produces a movement of the tropomyosin molecule that frees up the actin site so that the charged cross-bridge can contact the site resulting in the liberation of energy from the adenosine triphosphate (ATP) molecule. Nerve impulses are sent from the motor cortex of the brain through the spinal cord. The musculocutaneous nerve continues the wave of axon depolarization to individual muscle fibers via motor units. Each motor unit has so many number of motor nerves that extend to individual muscle fibers by way of a neuromuscular junction called the synapse. When the motor nerve is depolarized, acetylcholine is released from the axon terminals at the neuromuscular junction. . The acetylcholine binds to the receptor sites on the motor end plate membrane. The neurotransmitter, acetylcholine, increases the motor end plate's permeability to sodium and potassium ions, which produces an end-plate potential. This potential depolarizes the sarcolemma that creates a muscle action potential that is propagated throughout the muscle membrane causing depolarization of the transverse tubules. All the muscles that are included in this action are: biceps, pectoral, quadriceps, shoulder, abs, gastrocnemius, erector spinae, lastissimus dorsi, gluteus maximus, medius, and minimus.

1. Label structures from the following parts of the nervous system that are involved in the movement:
  - a. At least five structures of the afferent division of the peripheral nervous system (i. e., sense organs and afferent nerves)
  - b. At least two structures of the central nervous system
  - c. At least seven structures of the efferent division of the peripheral nervous system
2. Label structures from the following parts of the skeletal system that are involved in the movement:
  - a. At least thirteen bones
  - b. At least five joints
3. Label at least thirteen muscles from the muscular system that are involved in the

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movement. B. Analyze (suggested length of 1—2 pages) the functions and interactions of the structures of the skeletal, muscular, and nervous systems involved in the movement you chose in part A. Read more: [http://wiki.](http://wiki.answers.com/Q/How_are_the_skeletal_system_the_muscular_system_and_the_nervous_system_connected#ixzz1FT7Q84O0)

[answers.](http://wiki.answers.com/Q/How_are_the_skeletal_system_the_muscular_system_and_the_nervous_system_connected#ixzz1FT7Q84O0)

[com/Q/How\\_are\\_the\\_skeletal\\_system\\_the\\_muscular\\_system\\_and\\_the\\_nervous\\_system\\_connected#ixzz1FT7Q84O0](http://wiki.answers.com/Q/How_are_the_skeletal_system_the_muscular_system_and_the_nervous_system_connected#ixzz1FT7Q84O0) All myofibrils are composed of smaller myofilaments (actin and myosin) that give rise to a repeating pattern along the length of the myofibril. Individual contractile units called sarcomeres constitute the organization of thick (myosin) and thin (actin) filaments. Myosin is located in the central region of the sarcomere, where they give rise to the A bands. The actin proteins give rise to the I band. They are attached at one end to the transverse tubules (known as the Z line) that originate with the infoldings at the surface of the fiber. The rest of the filament is free to interact with the cross-bridges that extend from the myosin proteins, which are surrounded by six equally spaced thin filaments on each end. The cross-bridges interdigitate with active actin sites located on the actin molecules that extend into the middle of each sarcomere. Each actin filament is associated with two additional proteins called tropomyosin and troponin. They are involved in regulating muscle contraction. Muscle Contraction According to the sliding filament theory of muscle contraction, individually linked sarcomeres shorten (contract), a condition that results when the filaments slide past each other. The movement of the actin filaments towards the middle of the sarcomere occurs as the myosin cross-bridges attach themselves to the actin sites. Muscle contraction

(shortening) is reflected in the sarcomere as a decrease in the I band as the Z lines (which are located at the ends of the actin filaments) move closer <https://assignbuster.com/central-nervous-system-movement-of-muscles-in-the-body/>

together. The width of the A band (the myosin filament) remains unchanged. Muscle contraction is initiated when calcium is made available within the muscle fiber. The release of calcium from the sarcoplasmic reticulum (SR), a tubule system within individual fibers that run lengthwise with the fibers, increases the concentration of calcium within the fiber. This calcium is then used to initiate contraction, given the affinity of troponin to calcium. As troponin attaches to calcium, it produces a movement of the tropomyosin molecule that frees up the actin site so that the charged cross-bridge can contact the site resulting in the liberation of energy from the adenosine triphosphate (ATP) molecule. The energy is used to drive the cross-bridge inwardly towards the mid-line of the sarcomere. This is the reason, therefore, that the Z lines are required to move to the middle of the myosin filament. The release of calcium from the SR system is linked directly to the nervous system. As an example, with contraction of the biceps brachii, nerve impulses are sent from the motor cortex of the brain through the spinal cord. At the level of C5-7, the peripheral nervous system is activated. The musculocutaneous nerve continues the wave of axon depolarization to individual muscle fibers via motor units. Each motor unit has "x" number of motor nerves that extend to individual muscle fibers by way of a neuromuscular junction (also called synapse). The electric events at the synapse initiate the stepwise actions that result in muscle contraction (otherwise known as excitation-contraction coupling). When the motor nerve is depolarized, acetylcholine is released from the axon terminals at the neuromuscular junction. The acetylcholine binds to the receptor sites on the motor end plate membrane (a specialized connecting point of the muscle's sarcolemma with the axon terminal). The neurotransmitter, acetylcholine, <https://assignbuster.com/central-nervous-system-movement-of-muscles-in-the-body/>

increases the motor end plate's permeability to sodium and potassium ions, which produces an end-plate potential. This potential depolarizes the sarcolemma that creates a muscle action potential that is propagated throughout the muscle membrane causing depolarization of the transverse tubules. This leads to the release of calcium from the terminal cisternae of the sarcoplasmic reticulum. Calcium binds to troponin, which is responsible for the movement of tropomyosin away from the actin receptor site. The myosin cross-bridges then bind to the actin filament. Actin activates the myosin ATPase found on the myosin cross-bridge. ATP (the energy currency of the muscle fiber) is hydrolyzed to adenosine diphosphate (ADP) and phosphate. The splitting of ATP releases stored energy to produce movement of the myosin cross-bridges, which produces sliding of the thick and thin filaments past each other. Then, breaking of the actin-myosin connection to allow for another actin combination with myosin requires another ATP on the myosin cross-bridge. Cycling of binding and unbinding of actin with myosin cross-bridges along the actin filament is continued with high sarcoplasmic concentration of calcium. With a decrease in the depolarization of the motor axon, there is less acetylcholine released to initiate the excitation-contraction coupling steps. As the transverse tubules depolarize less frequently, there is less a direct effect on the release of calcium ions from the sarcoplasmic reticulum surrounding the myofibrils. The concentrations of calcium ions fall as they are pumped into the sarcoplasmic reticulum. The result is that calcium dissociates from troponin, thus allowing tropomyosin to keep the myosin cross-bridges from connecting with the actin receptor sites. The actin filament slides back, the sarcomere lengthens, and the muscle fiber relaxes. The Role of the Nervous System in <https://assignbuster.com/central-nervous-system-movement-of-muscles-in-the-body/>

Muscle Contraction Muscles are robots ready to contract when a nerve impulse initiates the excitation-contraction coupling. Without the direct connection of nerves, muscles do not contract (at least not voluntarily). An injury to a nerve that results in either a loss of motion or significantly reduced motion can take place at the pre-central gyrus of the motor cortex of the frontal lobe or throughout the length of either the axon of the upper motor neuron (i. e., brain and spinal cord) or the axon of the lower motor neuron (peripheral nerves). In other words, an injury could involve the central nervous system or the peripheral nervous system; the latter being defined specifically by the brachial plexus (nerves the upper body) and the lumbar-sacral plexuses (nerves to the lower body). As an example, the peripheral nerve responsible for initiating muscle contraction of the biceps brachii to flex the elbow and shoulder joints is the musculocutaneous nerve. This nerve is part of the brachial plexus. Although the descending pathway (i. e., the lateral corticospinal track) of motor nerves from the brain is working fine, an injury to the spinal cord at the anterior horn level might be expected to involve the spinal contributions to the shoulder flexor nerve(s). This would result in either a loss of the nerve (and other nerves to the upper limb) or a decrease in the force of contraction of the biceps brachii. The integrity of the nervous system is critical to the functioning of the skeletal muscle. Regarding the biceps brachii, as an example, on average there are 500, 000 muscle fibers. This number is present at birth and remains essentially unchanged throughout life. With growth of the muscles during puberty or during athletics, the increase in the size of the muscles result from the increase in myofibrils. The number of muscle fibers does not increase with age or muscular training. On average, each muscle fiber

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contains 2000 myofibrils, and each myofibril contains on average 2000 myofilaments. The muscle is anchored superiorly at two points: the long head arises from the supraglenoid tubule and the short head arises from the coracoid process). It inserts on the radial tuberosity of the lateral forearm bone. When it contracts at the shoulder joint, the short head produces flexion, inward rotation, and adduction. The long head produces shoulder flexion, inward rotation, and abduction. At the elbow joint, both heads produce flexion and, if necessary or required, supination of the forearm and hand. The specific motions are guided by the need for graded contractions. The motor unit, which comprises a single motor nerve and all of the muscle fibers innervated by it, controls the graded response. With reference to the biceps brachii, a single motor unit may innervate on average 150 fibers. This means that the muscle has approximately 3,300 motor units. Hence, the number of motor unit involvement during contraction defines the intensity of contraction. Since a muscle fiber can only contract all-or-none, given the interconnectedness of the myofibrils within the fiber, a nerve impulse through a nerve that innervates 150 fibers results in 100% contraction of at least 150 muscle fibers. The contraction results in a certain increase in power that is used to overcome the inertia of the musculoskeletal mass. If additional force is required to lift a greater mass or to move the resistance through a determined range of motion with increased velocity, then more motor units must be initiated via the motor cortex of the brain. By increasing the number of motor units activated at a given time, both the quality of the contraction and the precision of the motion are increased. The increased recruitment of motion units is consistent with great force and, thus the display of strength. 90 thrasher way

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