

Academic Review: Physiology of the Reflex



Reflex action is an automatic motor nerve response to a sensory nerve stimulus.

For example, when food is placed in the mouth, and passed into the throat, it is lost from our control. It is gripped by an involuntary group of muscles and is forced on into the stomach by peristalsis action. The contact of the food with the mouth and lining of the throat sends out a sensory nerve impulse that calls for muscular action provided by the impulse of the motor nerve in reply.

The *somatic division* of the peripheral nervous system possesses both an *afferent* (sensory) component and an *efferent* (motor) component. Structurally, the *afferent component* is in the dorsal and the ventral ramus of all spinal nerves and enters the spinal cord on the posterior side. It is involved with detecting sensations from special senses (vision, hearing, taste, smell and equilibrium) as well as other senses including pain, temperature, touch, plus sensations regarding muscle and joint position (proprioceptors).

Information from these receptors enters the spinal cord via the posterior root and synapses with a variety of association neurons in the grey matter that will be involved with delivering the information to neurons in the white matter that can take it to the brain.

All of the above-mentioned senses detected by the somatic system possess special sensory structures. These sensory structures synapse with the afferent neurons that take the information to the spinal cord. The cell bodies of these afferent neurons are in the posterior root ganglia. In this case, dendrites carry information to the ganglion and axons of the same neuron carry the information to the spinal cord. No synapse occurs within the posterior root ganglia, as was the case with the ganglia found within the autonomic nervous system.

The *efferent component* of the somatic nervous system is structured as simply as the *afferent component*. The effect of the efferent system is upon skeletal muscle. If the body desires a movement, a signal originates in the brain and travels down a descending pathway in the white matter of the spinal cord. This neuron will then synapse with an efferent neuron of the somatic system, which will exit the spinal cord via the anterior nerve root and travel into either the dorsal or ventral ramus (depending upon which muscles is to be stimulated). From here, it will travel to the intended muscle and produce a contraction.

Aside from the usual gathering of sensory information from the body and the distribution of motor impulses originating from motor areas within the brain, the *somatic division* of the peripheral nervous system also has the capability to execute *reflexes* that are important for protection from injury. If an appropriate stimulus such as a pinprick is sensed by a tactile receptor, an appropriate reflex will take place. The example of a pinprick produces a reflex called a flexor (withdrawal) reflex. The reflex operates on the premise that the part of the body pricked should move away from the source of injury.

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STRETCH REFLEX

This is ipsilateral, meaning it involves one side of the spinal cord only. It plays an important role in muscle tone and coordination during exercise. This reflex results in the contraction of a muscle when it is stretched suddenly.

This is a Monosynaptic Reflex arc thus it incorporates only two neurons. The afferent neuron arises from the Muscles Spindles, which is located among the muscle fibers close to the tendon. The muscle spindle monitors changes in the length of the muscles.

When a muscle is stretched, the receptors in the muscle spindle become excited and they generate an impulse along the afferent nerve. The nerve enters the posterior grey horn of the grey matter and synapses with an efferent neuron. If the stimulation is strong enough an impulse is created and transmitted along the efferent nerve to the muscle fibers of the same muscle containing the muscle spindle. This impulse is of the excitatory type and causes the muscle fibers to contract. It is this form of intrinsic treatment that is incorporated when applying isotonic mobilization.

The afferent neuron that communicates with the grey matter often has a collateral branch of its axon. The collateral branch will synapse with the efferent neurons, which communicate with the muscle fibers of the antagonistic muscle. This synapse establishes an inhibitor action and results in the relaxation of the antagonist permitting the contraction of the agonist. This antagonist—agonist interaction is called *reciprocal inhibition*.

We also find that within the muscle spindles are smaller motor neurons that communicate with the specialized muscle fibers. It is these specialized muscle fibers that are controlled directly by the brain, which controls the overall muscle tone.

TENDON REFLEX

It prevents damage to muscles and tendons as a result of stretching. It causes a muscle to relax in order to protect it. This reflex also is ipsilateral as it affects the same side of the spinal cord. Here we find that afferent neurons arise from the *Golgi Tendon Organs (GTO)*. These are located in the tendon of a muscle close to the muscular tendon junctions. Unlike the muscle spindle that monitors muscle length, the GTO monitors the muscle tension.

As a muscle increases in tension, the amount of pressure on the GTO increases as it nears the threshold. Once the threshold is obtained, an impulse is sent along the afferent neurons to the posterior horn of the grey matter. Here they synapse with association neurons. These association neurons inhibit the efferent neurons that supply the muscle under which tension has increased. This inhibitor action results by hyperpolarizing the efferent neurons membrane and requiring a larger amount of neurotransmitters to establish an efferent impulse in the neuron. The end result is that due to the decreased amount of stimulus occurring at the muscle fibers, the muscle tends to relax.

The afferent neuron also synapses with an excitatory association neuron for the antagonistic muscle in the grey matter. This results in an increase of neuron-stimulus to the efferent neurons, which causes the antagonistic muscle to contract. A third track provides information to the brain by way of the ascending

Doctors engaging in treating nervous disorders us the test known as the “knee-jerk” . One knee is placed across the other, the foot hanging loose and swinging. A sharp tap is given to a spot just below the patella, causing the leg and foot to extend. This is caused by a sensory nerve contacting a reflex center in the spinal cord, which immediately sends out a motor nerve stimulus, causing muscular action.



pathways.

Reciprocal innervation is also present in this form of reflex arc. Because this process requires an increase in tension on the tendon, we can see that isometrics incorporate this form of intrinsic mobilization.

FLEXOR REFLEX

This is another type of ipsilateral reflex, which is protective. This type of reflex causes the body part to be moved to avoid pain.

This is primarily believed to be a protective reflex. If we are placed in a situation of danger, we will see that there is a far wider response than if we simply have an increase in a muscle's tension or stretch.

This type of reflex incorporates a receptor that is stimulated, often one associated with pain. The impulse is sent along afferent neurons to the posterior horn of the grey matter. Here it synapses with several association neurons. The association neurons communicate with motor neurons of different levels of the spinal column by way of ascending and descending pathways. This results in the efferent nerves for several different muscles being stimulated and the entire limb becomes withdrawn from the danger. Because there is communication with different levels of the spinal column it is said to be an inter-segmental reflex arc.

CROSSED EXTENSOR REFLEX

This is contra-lateral, meaning it involves both sides of the spinal cord. As pain stimulus arrives at the spinal cord, a stimulus travels across to the other side causing a motor response that contracts muscles to allow for the action of moving a threatened limb.

These are *polysynaptic reflex arcs* and require the involvement of an association neuron.

This is a balancing reflex that often occurs in conjunction with the flexor reflex. As the stimulus enters the spinal column, we see that association neurons that synapse with the afferent neuron cross over to the opposite side of the spinal column. These association neurons synapse with efferent neurons, which supply extensor muscles of the opposite side of the body to extend in order to maintain balance.

Thus we can see that it is this cross extensor reflex that is primarily responsible for the situation we refer to as the tower system. Remember that stepping on a tack may be a traumatic and visual examples, but these balancing reflexes are constantly occurring with any situation that causes a loss of balance.

Because the reflex results in a crossing from one side of the spinal cord to the other, it is said to be contra-lateral.

INHIBITION

The brain exerts a power over all actions by *inhibition*. It controls *over*-activity in response to nerve stimulation, preventing the uncontrolled power of the spinal cord. When connection between the brain and the spinal cord is severed as in some injuries or disease, the knee-jerk is very much increased, as the inhibition of the brain is absent, and the spinal cord has full control. This occurs in a case of Paraplegia, where there is degeneration of the spinal cord, and the application of the knee-jerk test causes violent reaction. If one side of the spinal cord is diseased, we have unequal "knee-jerks". When the sensory nerves are affected, such as in Locomotor Ataxia, there is no knee-jerk at all, where disease to the posterior roots of the spinal nerves prevents an impulse from reaching the spinal cord. □

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