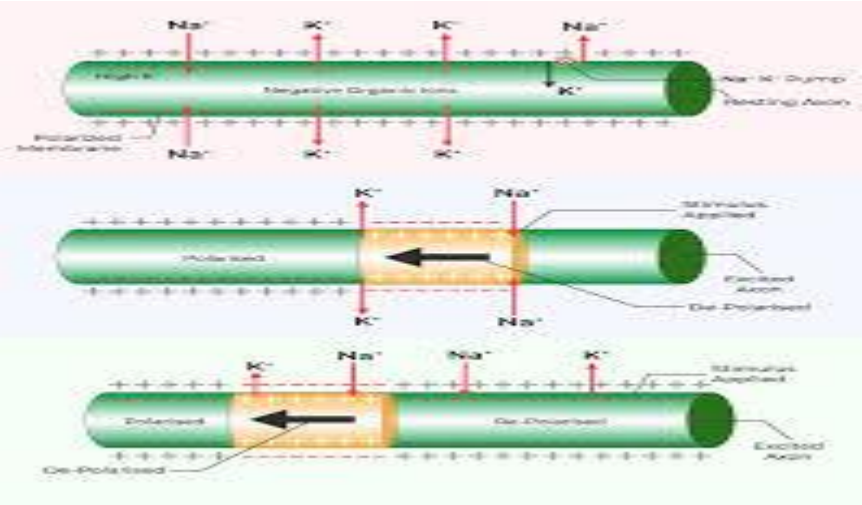
Nerve conduction and synapse

A nerve impulse is the electric signals that pass along the dendrites to generate a nerve impulse or an action potential. An action potential is due to the movement of ions in and out of the cell. It specifically involves sodium and potassium ions. They are moved in and out of the cell through sodium and potassium channels and sodium-potassium pump.

Conduction of nerve impulse occurs due to the presence of active and electronic potentials along the conductors. Transmission of signals internally between the cells is achieved through a synapse. Nerve conductors comprise relatively higher membrane resistance and low axial resistance. The electrical synapse has its application in escape reflexes, heart and in the retina of vertebrates. They are mainly used whenever there is a requirement of fast response and timing being crucial. The ionic currents pass through the two cell membrane when the action potential reaches the stage of such synapse.

Mechanism of Transmission of Nerve Impulse



The axon or nerve fibres are in the form of a cylinder wherein the interior of the axon is filled with axoplasm and the exterior is covered with axolemma. The nerve fibres are immersed in ECF. The solution is in the ionic form that is present in axoplasm and extracellular fluid or ECF.

Outside the axon, the negatively charged chloride ions are neutralized in the presence of positively charged sodium ions. Negatively charged protein molecules are neutralized in the presence of potassium ions within the axoplasm. The membrane of a neuron is -ve inside and +ve outside. Resting potential would be the difference in charge. The difference in charge might vary from seventy to ninety millivolts, as a result, the membrane would be polarized. Sodium potassium pump operates to keep resting potential in equilibrium.

The pump is placed on the axon membrane. Now the potassium ions are pumped from ECF to axoplasm and sodium ions are pumped from axoplasm to ECF.

The sodium-potassium pump stops operating when a stimulus is applied to a membrane of a nerve fibre. The stimulus could be either electrical, chemical or mechanical. The potassium ions rush outside the membrane and sodium ions rush inside the membrane as a result negative charges are present outside and positive charges are present inside.

The nerve fibres are either depolarized or they are said to be in the action potential. The action potential travelling along the membrane is called the nerve impulse. It is around + 30 mV. The sodium-potassium pump starts to operate once the action potential is completed. As a result, the axon membrane will obtain a resting potential by repolarization.

Now the process takes place in reverse order. It is a reversal of the process that has taken place during an action potential. Here, potassium ions will be rushed inside and sodium ions will be rushed outside. Impulse would not be transmitted through the nerve fibre during the refractory period.

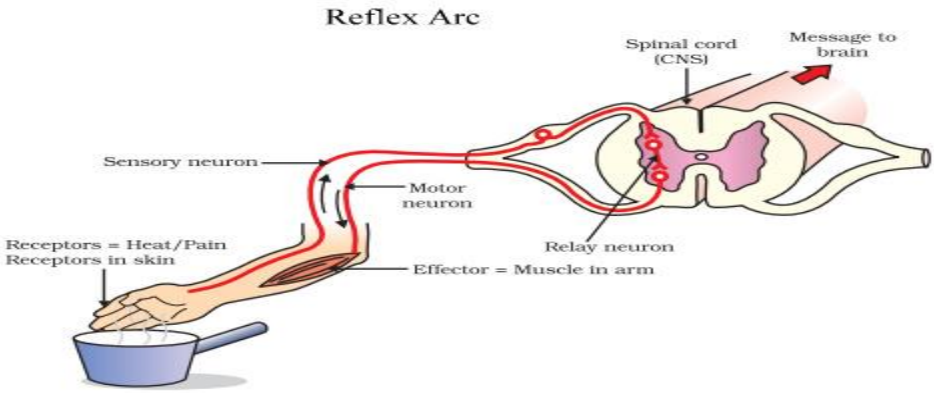
In the case of white fibres, saltatory propagation takes place. That is impulse jumps from node to node and it increases with increase in the speed of nerve impulse. It is around twenty times faster compared to that of the non-medullated nerve fibres. The transmission of nerve impulse would rely upon the diameter of the fibre. For instance, the nerve impulse of a mammal is one twenty meters per second whereas nerve impulse of a Frog is 30 meters per second.

Reflex action

Reflex is an involuntary and sudden response to stimuli. It happens to be an integral component of the famed survival instinct.

Most of the common reflexes are a response to all the well-trained, accumulated knowledge of caution that we have internalized. It could be anything and ranges from the reflex action of abruptly withdrawing the hand as it comes in contact with an extremely cold or hot object. This action is termed as the reflex action. It has a subtle relation to instinct.

A point to be thought upon is that we all have our instincts differently depending on our past experiences and understanding. A reflex is a reaction triggered by this instinct. At times, we have no prior knowledge if the pan is hot or not. In other words, instinct has little to do with reflex.



This labelled diagram of a reflex arc indicates the neural pathway controlling a reflex. It clearly indicates the route adapted when a stimulus occurs and how the reaction takes place.

From an evolutionary perspective, reflex action has played an important part in ensuring the survival of organisms as it has enabled quick reactions to certain situations where an organism's life could be at stake.

The Action of Neuron

Two neurons dominate the pathway, afferent nerves (receptor) and the efferent **nerves** (effector or excitor).

Below is a brief description of the events that take place:

- Firstly, it begins with receptor detecting the stimulus or a sudden change in the environment, where the instinct again has a role to play. The stimulus is received from a sensory organ.
- Then, the sensory neuron sends a signal to the relay neuron.
- This is followed with the relay neuron sending the signal to the motor neuron.
- Further, the motor neuron sends a signal to the effector.
- The effector produces an instantaneous response, for example, pulling away of the hand or a knee-jerk reaction.

From the above explanations, it can be clearly summarized that the moment the afferent neuron receives a signal from the sensory organ; it transmits the impulse via a dorsal nerve root into the **Central Nervous System.** The efferent neuron then carries the signal from the CNS to the effector. The stimulus thus forms a reflex arc.

In a reflex action, the signals do not route to the brain – instead, it is directed into the synapse in the spinal cord, hence the reaction is almost instantaneous.

Somatic and Autonomic Nervous system

The Somatic Nervous System is the part of the peripheral nervous system that handles voluntary control of body movements. ... The Autonomic Nervous System is the part of the peripheral nervous system that acts as an involuntary control system b(elow the level of consciousness), and controls visceral functions.

In somatic nervous system
In the process of voluntary movement, sensory neurons carry impulses to the brain and the spinal cord. After processing, a signal is sent back to the skeletal muscles, organs, and skin by way of the somatic motor neurons. The second function of the somatic nervous system is the process of the reflex arc.

In autonomic nervous system The autonomic nervous system (ANS) is still controlled by the brain too -- but is not conscious. The brain's hypothalamus is required to send signals to the heart, your glands, breathing, digestion etc.

The somatic nervous system is part of the peripheral nervous system and plays a role in voluntary movements and sensory processing.

The somatic nervous system carries motor and sensory signals to and from the central nervous system (CNS). Because of this bodily system, we are able to control our physical movements and process four of the five senses—smell, sound, taste, and touch.

Somatic Nervous System Location

The somatic nervous system includes all of the nerves that extend from the brain and spinal cord. It does not include the brain and spinal column themselves, both of which are part of the central nervous system. There are two types of somatic nerves: cranial and spinal.

Cranial Nerves

The somatic nerves that extend from the brain are known as *cranial nerves* and are located on the back of the head and neck. There are 12 pairs of cranial nerves in total, each of which splits to carry signals between both sides of the brain and body. These nerves are often involved in neuromuscular disorders.[1]

Spinal Nerves

The somatic nerves that extend from the spinal column are known as *spinal nerves*. There are 31 pairs of spinal nerves. Eight come from the cervical portion of the spine, 12 are in the thoracic region, both the lumbar and sacral regions have five spinal nerves, and one is near the tailbone. A disease or injury in any of these areas can result in a loss of sensation and function below that area.[2]

Somatic Nervous System Function

If you're wondering what the somatic system does, it has two basic functions:[3]

- **Movement control**: The somatic nervous system plays a vital role in initiating and controlling the movements of your body. This system is responsible for nearly all voluntary muscle movements.
- **Sensory input**: The somatic system is also responsible for processing sensory information that arrives via external stimuli. It processes the senses of hearing, smell, taste, and touch.

The somatic nervous system is not involved in the processing of sight as this sense is controlled directly by the brain.[4]

How exactly does this complex system work? Answering this question requires a closer look at its key parts.

Parts of the Somatic Nervous System

The term somatic is drawn from the Greek word *soma*, which means "body." This is appropriate considering that it is this system that transmits information back and forth between the CNS and the rest of the body.

The somatic nervous system contains two main types of neurons (nerve cells):

- **Sensory neurons**, also known as afferent neurons, are responsible for carrying information from the body to the CNS.
- **Motor neurons**, also known as efferent neurons, are responsible for carrying information from the brain and spinal cord to muscle fibers throughout the body.

The neurons that make up the somatic nervous system project outward from the CNS and connect directly to the muscles of the body. They carry signals from muscles and sensory organs back to the central nervous system.

The body of the neuron is located in the CNS and the axon (a portion of the neuron that carries nerve impulses away from the cell body) projects and terminates in the skin, sensory organs, or muscles.[5]

Other components of the somatic nervous system include:

- **Ganglia**, which are large groups of nerve cells that are closely related
- **Glial cells**, which don't actively transmit signals but, instead, support nervous system cell functions
- **Nuclei**, or nerve cell clusters that share the same function or connections

Reflex Arcs

In addition to controlling voluntary muscle movements, the somatic nervous system is also associated with involuntary movements known as reflexes (or reflex actions). These reflexes are controlled by a neural pathway known as a reflex arc.

Reflex arcs include sensory nerves that carry signals to the spinal cord, often connect with interneurons there, then immediately transmit signals down the motor neurons to the muscles that triggered the reflex.[5]

During a reflex, muscles move involuntarily without input from the brain; you don't have to think about doing these things. This occurs when a nerve pathway connects directly to the spinal cord. Examples of reflex actions include:

- Jerking your hand back after accidentally touching a hot pan
- Involuntary jerking when your doctor taps on your knee

Reflex arcs that impact the organs are called *autonomic reflex arcs* while those that affect the muscles are referred to as *somatic reflex arcs*.

Somatic vs. Autonomic Nervous Systems

The somatic and autonomic nervous systems are both parts of the peripheral nervous system, which allows the brain and spinal cord to receive and send information to other areas of the body. However, they have different functions.

Somatic Nervous System

- Connects CNS with muscles and skin
- Controls voluntary movements

Autonomic Nervous System

- Connects CNS with visceral organs
- Regulates involuntary body processes

The somatic nervous system connects the central nervous system with the body's muscles and skin. Its primary function is to control voluntary movements and reflex arcs, while also helping us process the senses of touch, sound, taste, and smell.

An example of a somatic system function is if you are out for a jog in the park one brisk winter morning and as you run, you step on a patch of slick ice. Once your foot starts to slip, your somatic nervous system carries a message to the muscles in your legs, enabling you to catch yourself and avoid a fall.

In comparison, the autonomic nervous system connects the CNS with visceral organs (heart, stomach, etc.) This system regulates a variety of involuntary body processes, some of which include heartbeat, blood flow, breathing, body temperature, and emotion response.