NAME: ADESOYE RAHEEMAT OLAMIDE

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DEPARTMENT: NURSING

The somatosensory pathway

Pathways of somatosensory system convey the information sensory receptors in skin, skeletal muscles and joints. Pathways of this system are constituted by somatic nerve fibres called somatic afferent nerve fibres.

Each sensory pathway is constituted by two or three groups of neurons:

I. First order neurons

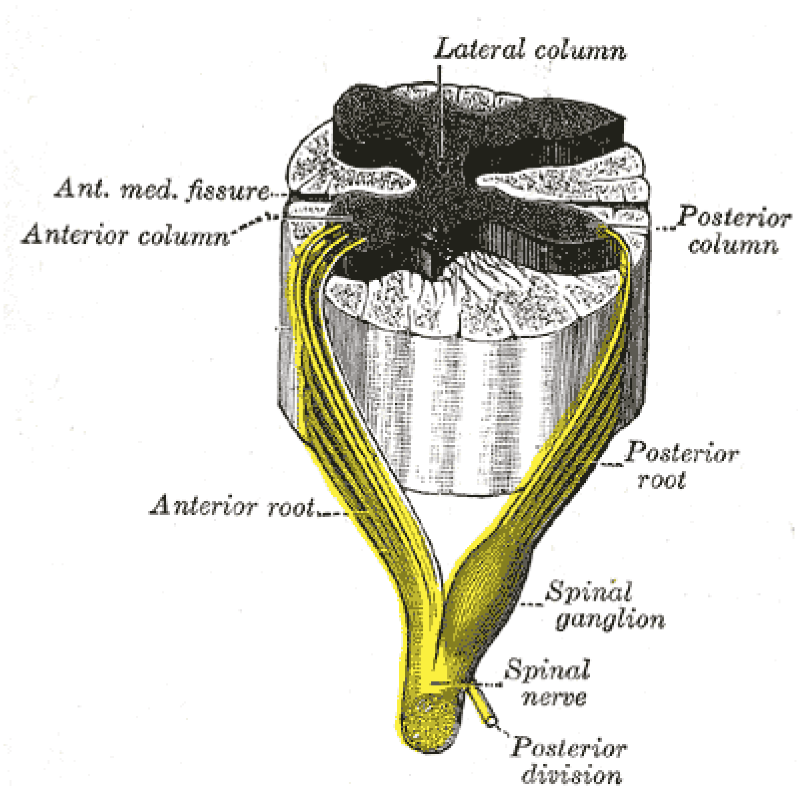
ii. Second order neurons

iii. Third order neurons.

Pathways of some sensations like kinesthetic sensation have only first and second order neurons. Details of pathways are given in the Table below

The somatosensory pathway is composed of three neurons located in the dorsal root ganglion, the spinal cord, and the thalamus

A somatosensory pathway will typically have three long neurons: primary, secondary, and tertiary. The first always has its cell body in the dorsal root ganglion of the spinal nerve.



Dorsal root ganglion: Sensory nerves of a dorsal root ganglion are depicted entering the spinal cord.

The second has its cell body either in the spinal cord or in the brainstem; this neuron's ascending axons will cross to the opposite side either in the spinal cord or in the brainstem. The axons of many of these neurons terminate in the thalamus, and others terminate in the reticular activating system or the cerebellum.

In the case of touch and certain types of pain, the third neuron has its cell body in the ventral posterior nucleus of the thalamus and ends in the postcentral gyrus of the parietal lobe.

In the periphery, the somatosensory system detects various stimuli by sensory receptors, such as by mechanoreceptors for tactile sensation and nociceptors for pain sensation. The sensory information (touch, pain, temperature, etc.,) is then conveyed to the central nervous system by afferent neurons, of which there are a number of different types with varying size, structure, and properties.

Generally, there is a correlation between the type of sensory modality detected and the type of afferent neuron involved. For example, slow, thin, unmyelinated neurons conduct pain whereas faster, thicker, myelinated neurons conduct casual touch.

Ascending Pathways

In the spinal cord, the somatosensory system includes ascending pathways from the body to the brain. One major target within the brain is the postcentral gyrus in the cerebral cortex. This is the target for neurons of the dorsal column–medial lemniscal pathway and the ventral spinothalamic pathway.

Note that many ascending somatosensory pathways include synapses in either the thalamus or the reticular formation before they reach the cortex. Other ascending pathways, particularly those involved with control of posture, are projected to the cerebellum, including the ventral and dorsal spinocerebellar tracts.

Another important target for afferent somatosensory neurons that enter the spinal cord are those neurons involved with local segmental reflexes.

Parietal Love: Primary Somatosensory Area

The primary somatosensory area in the human cortex is located in the postcentral gyrus of the parietal lobe. This is the main sensory receptive area for the sense of touch.

Like other sensory areas, there is a map of sensory space called a homunculus at this location. Areas of this part of the human brain map to certain areas of the body, dependent on the amount or importance of somatosensory input from that area.

For example, there is a large area of cortex devoted to sensation in the hands, while the back has a much smaller area. Somatosensory information involved with proprioception and posture also target an entirely different part of the brain, the cerebellum.

Cortical Homunculus

This is a pictorial representation of the anatomical divisions of the primary motor cortex and the primary somatosensory cortex; namely, the portion of the human brain directly responsible for the movement and exchange of sensory and motor information of the body.

Thalamus

The thalamus is a midline symmetrical structure within the brain of vertebrates including humans; it is situated between the cerebral cortex and midbrain, and surrounds the third ventricle.

Its function includes relaying sensory and motor signals to the cerebral cortex, along with the regulation of consciousness, sleep, and alertness.

TABLE 144.1: Sensory pathways

Sensation	Receptor	First order neuron in	Second order neuron in	Third order neuron in	Center
Fine touch Tactile localization Tactile discrimination Vibratory sensation Stereognosis	Meissner corpuscles and Merkel disc	Posterior nerve root ganglion – Fibers form Fasciculus gracilis and Fasciculus cuneatus	Nucleus gracilis and Nucleus cuneatus – Fibers form internal arcuate fibers	Ventral posterolateral nucleus of thalamus	Sensory cortex
Pressure Crude touch	Pacinian corpuscle	Posterior nerve root ganglion	Chief sensory nucleus – Fibers form anterior spinothalamic tract	Ventral posterolateral nucleus of thalamus	Sensory cortex
Temperature	Warmth – Ruffini end bulb Cold – Krause end bulb	Posterior nerve root ganglion	Substantia gelatinosa – Fibers form lateral spinothalamic tract	Ventral posterolateral nucleus of thalamus	Sensory cortex
Conscious kinesthetic sensation	Proprioceptors – Muscle spindle Golgi tendon apparatus	Posterior nerve root ganglion – Fibers form Fasciculus gracilis and Fasciculus cuneatus	Nucleus gracilis and Nucleus cuneatus – Fibers form internal arcuate fibers	Ventral posterolateral nucleus of thalamus	Sensory cortex
Subconscious kinesthetic sensation	Proprioceptors – Muscle spindle Golgi tendon apparatus	Posterior nerve root ganglion	Nucleus of Clarke and Marginal nucleus – Fibers form dorsal and ventral spinocerebellar tracts	–	Anterior lobe of cerebellum
Pain	Free nerve endings	Posterior nerve root ganglion Fast pain – A δ-fibers Slow pain – C fibers	Fast pain – marginal nucleus in spinal cord Slow pain – substantia gelatinosa of Rolando Fibers form lateral spinothalamic tract	Ventral posterolateral nucleus of thalamus, reticular formation and midbrain	Sensory cortex