

# Sensory pathways of the CNS

**CNS sensory pathways** are pathways that carry information from receptors in the skin, muscles, and tendons, to the brain. The dendrites of the first neuron are sensitive peripheral nerves and their body is located in the sensory ganglion in the posterior root of the spinal cord or in the corresponding ganglion of a sensory cranial nerve. The first-order neuron is always pseudounipolar.

## Spino-bulbo-thalamo-cortical Tract (Tr. spino-bulbo-thalamo-corticalis)

The spino-bulbo-thalamo-cortical tract (a.k.a. posterior spinal cord pathway, lemniscal system) is a pathway conveying fine-touch sensations and proprioception from the body. **The first-order neuron is a pseudounipolar neuron in the spinal ganglion**, as with the other sensitive spinal pathways. Fibers of the first-order neuron enter the spinal cord through the posterior roots and continue somatotopically (in a specific organisation with respect to the specific sensory location) in the posterior cords as the medial *fasciculus gracilis* (gracile fasciculus) and the lateral *fasciculus cuneatus* (*cuneate fasciculus*) (lateral and medial with respect to each other). Fibers lead most medially from the sacral region, most laterally from the cervical region (as part of the somatotopic organisation). The fasciculus gracilis and cuneatus separate the spinal cord from the outside by the intermediate sulcus (sulcus intermedius).

The cell body (soma) of the **second-order neuron** of this pathway is located in the medulla oblongata - ncl. gracilis and cuneatus (Gracile and Cuneate Nuclei). The axons of these neurons cross in the medulla oblongata (*decussatio lemniscorum*) and continue through the brainstem into the thalamus as the *lemniscus medialis* (medial lemniscus). The **third-order neuron** is located in the *ncl. ventralis posterolateralis* (ventral posterolateral nucleus) of the thalamus and runs as *tr. thalamocorticalis* (as part of the thalamocortical radiation) to the cortex - **Brodman's area 3, 1, 2 (primary somatosensory cortex)**.

This pathway sends collaterals at the level of the second neuron to the cerebellum (*tr. bulbo-cerebellaris*), *tectum* and *ncl. ruber* (*red nucleus*). Some fibers from the thalamus lead to association areas of the cortex and to area SII (area 40).

## Anterolateral System

**The anterolateral system** includes three pathways conveying **coarse touch, heat, and pain** from the body - *tr. spinothalamicus*, *tr. spinoreticularis* and *tr. spinotectalis* (Spinothalamic tract, Spinoreticular tract, and Spinotectal tract, respectively). They run through the spinal cord in the lateral and anterior spinal tracts.

### Spinothalamic Tract (Tr. spinothalamicus)

Tractus **spinothalamicus (Spinothalamic tract)** conducts **gross skin sensitivity (coarse touch), "fast pain", and heat** from skin receptors to the thalamus. The pathway has fewer synapses and pain sensation is conducted via fast-conducting myelinated Aδ fibers (therefore it is referred to as "fast pain"). The **first-order neuron** (pseudounipolar) has a body in the ggl. spinal (i.e. dorsal root ganglion).

The **second-order neuron** of this pathway is the ncl. proprius columnae posterioris of Rexed's laminae IV. and V (i.e. tract cells). The axons of the second neuron cross in the respective spinal cord segment, therefore they have the contralateral **somatotopic arrangement** compared to the previous pathway - that is, the fibers from the cervical regions are the most medial (and sacral fibers are lateral). It passes through the trunk laterally to the medial lemniscus towards the ncl. *ventralis posterolateralis thalami* (ventral posterolateral thalamic nuclei - the **third-order neuron**). From there the fibers continue to the cortex (SI).

### Spinoreticular Tract (Tr. spinoreticularis)

Tractus **spinoreticularis (spinoreticular tract)** primarily conveys **"slow pain"**. It is a phylogenetically older pathway than the previous one and is dominated by unmyelinated fibers of type C (hence the *"slow"* categorisation). The pathway ends in the medial nuclei of the reticular formation and from there the so-called ARAS - ascending activation system of the reticular formation. The **first-order neuron** is a pseudounipolar neuron of the spinal ganglion.

The **second-order neuron** is located in the posterior spinal horn, part of its axons cross and run in the anterior and lateral spinal cords.

### Spinotectal tract (Tr. spinotectalis)

Tractus **spinotectalis (spinotectal tract)** conducts impulses from the skin to the tectum, where they are integrated with visual and auditory information in the *superior and inferior colliculus*.

## Sensitive pathways of cranial nerves

**The sensory pathways of the cranial nerves** convey sensory information from the skin, muscles of the head, and the mucous membranes of the oral cavity, nasal cavity, pharynx and larynx, and the cornea. This is mediated by cranial nerves **CN V, CN VII, CN IX, and CN X**. The connection takes place in the respective sensory ganglia of each nerve- *ggl. geniculi* (Geniculate ganglion), *ggl. trigeminal* (Trigeminal ganglion), and *ggl. superius n. IX* (*Superior ganglion of the Glossopharyngeal Nerve*) and *X* (*Superior ganglion of the Vagus Nerve*). As with the first-order neurons of the sensory pathways mentioned above, the first-order nuclei of the sensory cranial nerves are **pseudounipolar**.. The axons of these cells collectively lead to the *ncl. principalis* (a.k.a. "pontine nucleus" or "main sensory nucleus" or "primary nucleus" or "principal nucleus") and *solitary nucleus for CN IX and X*. From there fibers such as *lemniscus trigeminalis* (*trigeminal lemniscus*) lead to the *ncl. ventralis posteromedialis* (*Ventral posteromedial nucleus*) of the thalamus. From there, the information is routed to the lower third *postcentral gyrus* through the *thalamocortical radiation tracts*.

## Links

### Related articles

- Spinal tracts

### References

- DRUGA, Rastislav – GRIM, Miloš. *Anatomie centrálního nervového systému*. 1. edition. Galén; Karolinum, 2011. 219 pp. ISBN 978-80-7262-706-6.
- GANONG, William F. *Přehled lékařské fyziologie*. 20. edition. Galén, 2005. 890 pp. ISBN 80-7262-311-7.