Anatomy 9535. *Also* Neuroscience 500.

SOMATIC SENSORY PATHWAYS

Different sensory modalities

Discriminative touch – Two-point discrimination, recognition of textures, lateral movement of stimuli on skin

Conscious proprioception – This is awareness of position and movement of joints.

→ Medial lemniscus system (= posterior column system)

Simple or "crude" touch – Even light stimuli can be accurately localized, but without detailed recognition of the object that is in contact with the skin.

Thermal sensation. The skin recognizes differences in temperature, but absolute values cannot be accurately judged.

Pain – The conscious feeling of injurious stimuli.

→ Spinothalamic (anterolateral) system

General principles

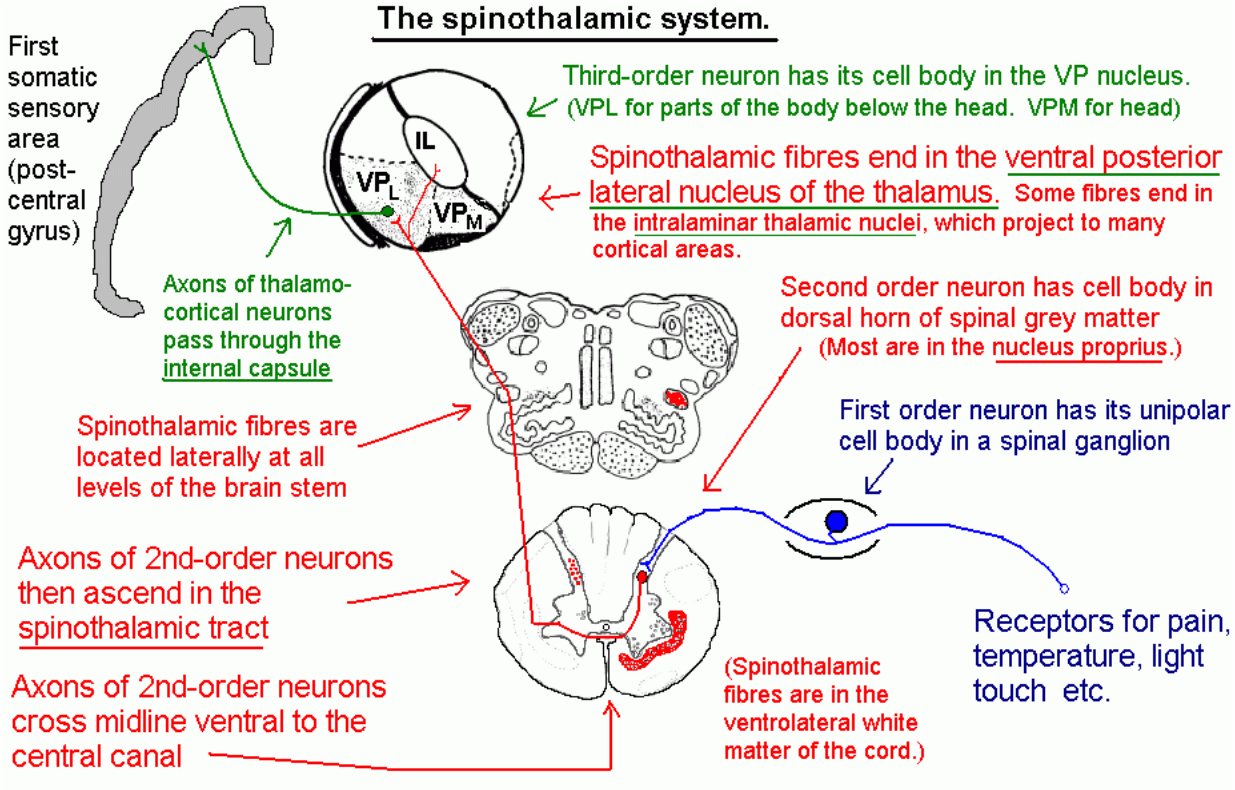
1. There are two pathways, which carry different types of sensation from skin, muscles etc (not internal organs) to the first somatic sensory area of the cerebral cortex.

2. Each pathway consists of three populations of neurons :–

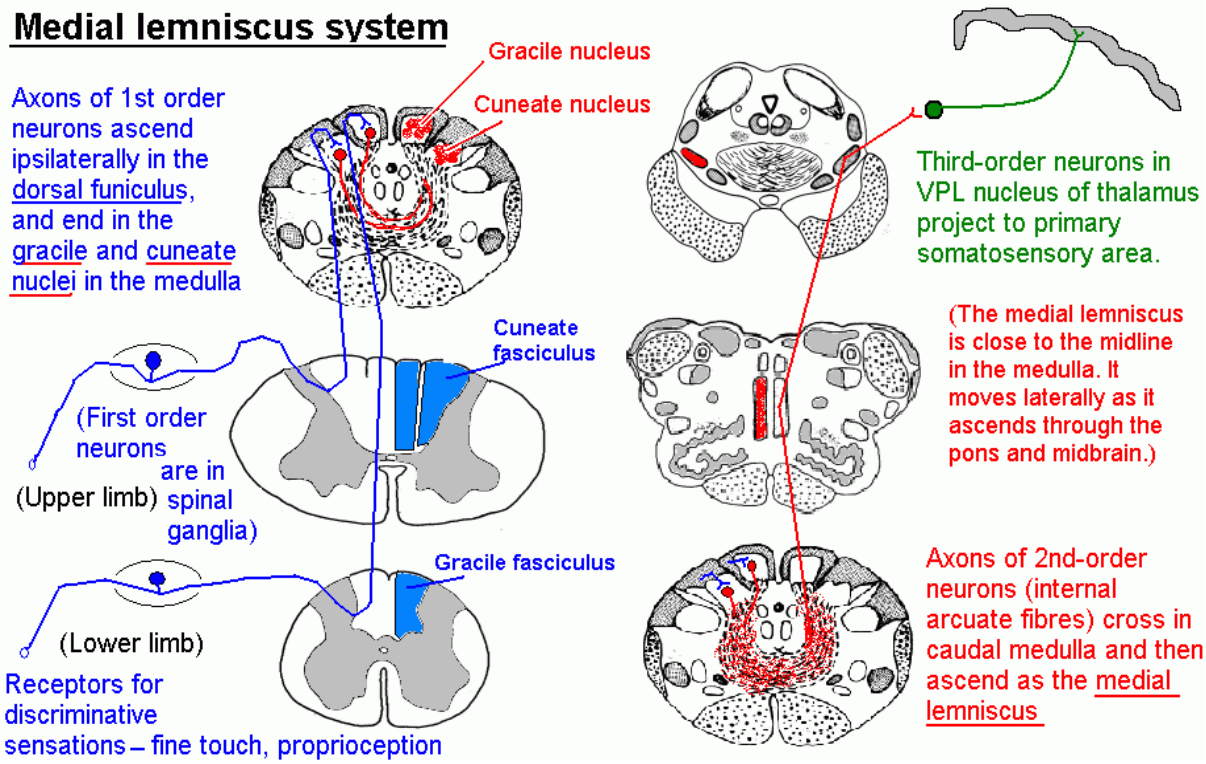
First-order, Second-order and Third-order.

- First-order: Unipolar, with its cell body in a sensory ganglion
- Second-order: Its axon
  - decussates.
  - ends in the thalamus.
- Third-order: Cell body in thalamus. Axon ends in cortex.

(Decussation = a place where axons from L & R sides cross the midline)


The spinothalamic system.
First somatic sensory area (post-central gyrus)
Third-order neuron has its cell body in the VP nucleus.
(VPL for parts of the body below the head. VPM for head)
IL
VPL
VPM
Spinothalamic fibres end in the ventral posterior lateral nucleus of the thalamus. Some fibres end in the intralaminar thalamic nuclei, which project to many cortical areas.
Axons of thalamo-cortical neurons pass through the internal capsule
Second order neuron has cell body in dorsal horn of spinal grey matter
(Most are in the nucleus proprius.)
First order neuron has its unipolar cell body in a spinal ganglion
Spinothalamic fibres are located laterally at all levels of the brain stem
Axons of 2nd-order neurons then ascend in the spinothalamic tract
Receptors for pain, temperature, light touch etc.
(Spinothalamic fibres are in the ventrolateral white matter of the cord.)
Axons of 2nd-order neurons cross midline ventral to the central canal

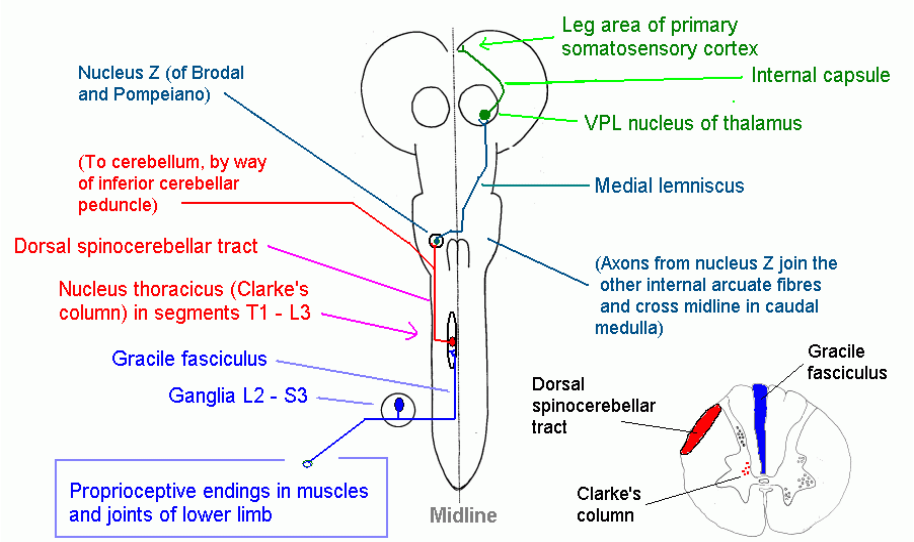
Medial lemniscus system



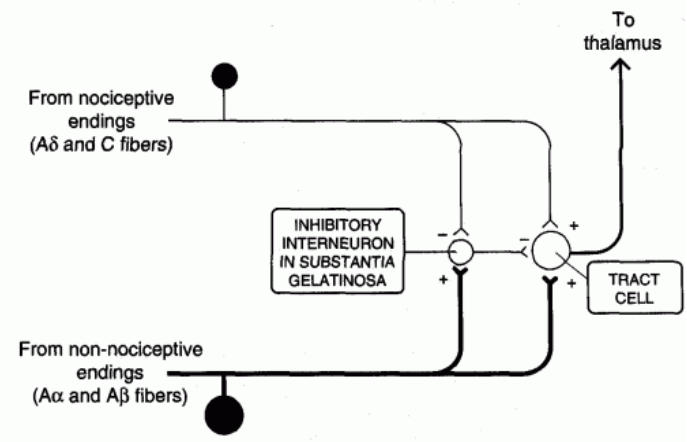
Comparison of the anterolateral with the dorsomedial system

	Spinothalamic system	Medial lemniscus system
First order neurons	• Detect pain, temperature and non-discriminative touch. • Project to dorsal horn of spinal grey matter.	• Detect discriminative tactile features and position and movement of joints. • Long axons ascend in dorsal column, to end in the gracile and cuneate nuclei in medulla.
Second order neurons	• Axons decussate in spinal cord, ascend as contralateral spinothalamic tract. • Project to VPL thalamic nucleus; (also to IL nuclei). • Spinothalamic fibres have branches to reticular formation and periaqueductal grey matter.	• Axons decussate in caudal medulla, ascend as the medial lemniscus. • Project only to the VPL thalamic nuclus. • Axons do not have collateral branches in brain stem. • In dorsal column nuclei, feed-forward and feedback inhibition sharpen localization of most strongly stimulated part of the receptive field.
Third order neurons	• In ventral posterior nucleus of thalamus (lateral division). • Project to primary somatic sensory area (postcentral gyrus). • Intralaminar nuclei → whole cortex.	• In ventral posterior nucleus of thalamus (lateral division). • Project to primary somatic sensory area (postcentral gyrus).

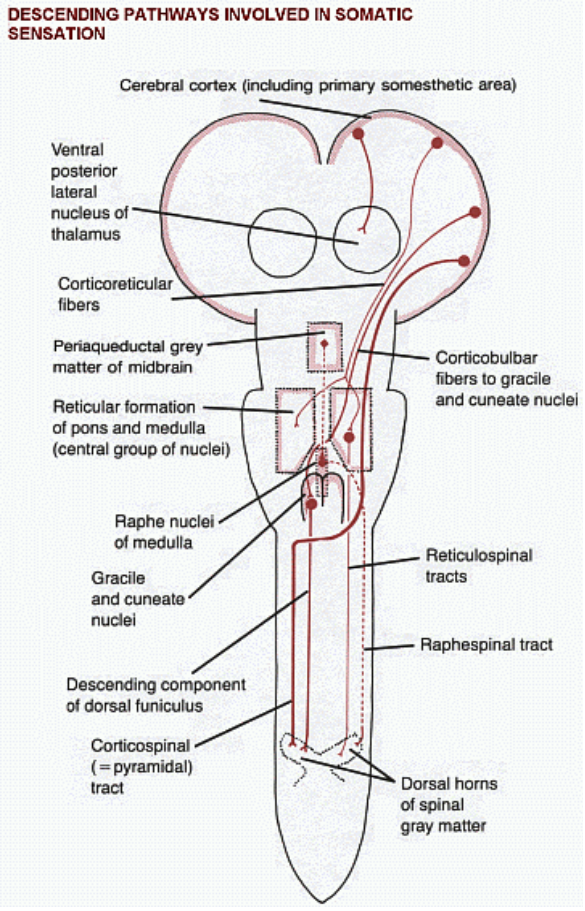
There is an additional pathway for conscious proprioception from the lower limb.



PAIN.

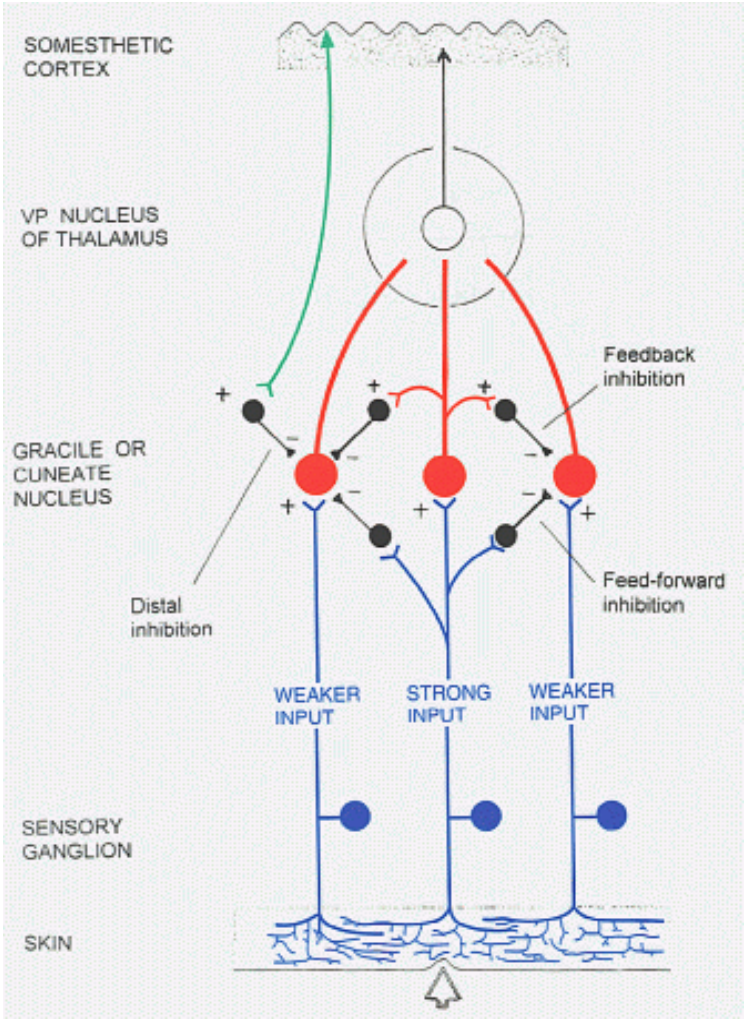


Simple illustration of the gate control theory of pain. Non- nociceptive sensory fibers stimulate the inhibitory interneurons, whereas nociceptive afferents inhibit them. An increase in non-nociceptive input will reduce the rate of firing of the spinothalamic tract neurons.



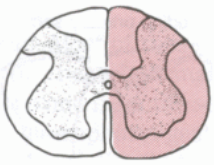
Perception of pain is suppressed by activity of neurons in the periaqueductal grey and serotonergic neurons of medullary raphe nuclei.

LATERAL INHIBITION occurs in all sensory systems, serving to emphasize the onward transmission of the most significant signals. It occurs, for example, in the retina, thalamus and cerebral cortex. The gracile and cuneate nuclei provide examples of three types of lateral inhibition.

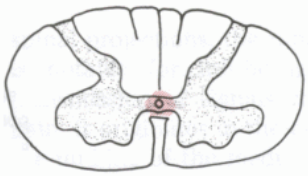


Clinical significance of the somatic sensory pathways

Coloured shading indicates the site of a destructive lesion.

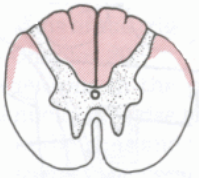


Spinal hemisection



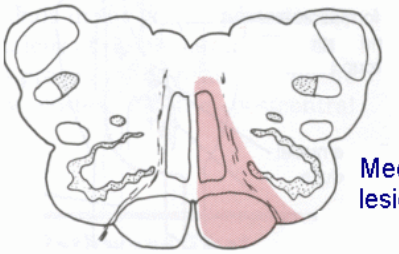
Syringomyelia

Which somatic sensory pathways are transected, and what are the functional consequences?



Subacute combined degeneration

Lateral medullary lesion



Medial medullary lesion

ANSWERS. **These apply only to sensory defects.** The lesions also affect motor pathways, cranial nerves etc.

Spinal hemisection. Below the level of the lesion: loss of pain and temperature sensations contralaterally and of discriminative touch and proprioception ipsilaterally.

Syringomyelia (early lesion illustrated). Bilateral loss of pain and temperature sensation in the dermatomes of the segments that include the lesion.

Subacute combined degeneration. With the illustrated lesion, loss of discriminative touch and proprioception, bilaterally. Upper and lower limbs are affected. Notice that the ancillary proprioceptive pathway for the lower limb is included in the lesion.

Medial medullary lesion. Loss of discriminative touch and proprioception contralaterally. Normal pain and temperature perception.

Lateral medullary lesion. Loss of pain and temperature sensation l contralaterally below the head. (Also ipsilaterally in the head, due to involvement of spinal trigeminal nucleus. Discriminative touch and proprioception are spared.)