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6

Somatosensitivity, viscerosensititvity, proprioception and pain II

Viscerosensitivity

- An information from visceral and cardiovascular system
- Linked to the autonomic nervous system

- The most of information does not reach higher structures than hypothalamus

- The most of information does not reach consciousness

Viscerosensitivity

- An information from visceral and cardiovascular system
- Linked to the autonomic nervous system

- The most of information does not reach higher structures than hypothalamus

- The most of informatio

✓ Parasympathetic nervous system (VII., IX., **X., sacral PNS**)
– „Operational information“ (blood pressure, pO2, pCO2)

✓ Sympathetic nervous system
– „Potential danger“ (pressure, pain, cold)

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Proprioception

- Information from muscles, tendons and joints
- Important for precise coordination of movements
- Overload protection
- More will be discused in lecture about motor system

Somatosensory pathways

- Three systems

- (Archispinothalamic)
  - Interconnection of adjacent segments (tr. Spinospinalis)
- Paleospinothalamic
  - tr. Spinoreticularis, tr. Spinotectalis…
- Neospinothalamic
  - tr. Spinothalamicus
- Dorsal column system
  - tr. Spinobulbaris

Somatosensory pathways

- Three systems
- (Archispinothalamic)
  - Interconnection of adjacent
- Paleospinot
- Ne
  -
- Dors
  - tr.

EVOLUTION….

Evolutionary old structures have not been replaced by new ones during evolution, but the old has been kept and the new added

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Somatosensory pathways

- Paleospinothalamic
  - Low resolution – dull, diffuse pain („slow pain“)
- Neospinothalamic
  - High resolution – sharp, localized pain („fast pain“), temperature
  - Low resolution – touch
- Dorsal column system
  - High resolution – fine touch

Somatosensory pathways

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  - Low resolution – dull, diffuse pain („slow pain“)
- Neospinothalamic
  - High resolution – sharp, localized pain („fast pain“), temperature
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Immediate survival

Long-term survival

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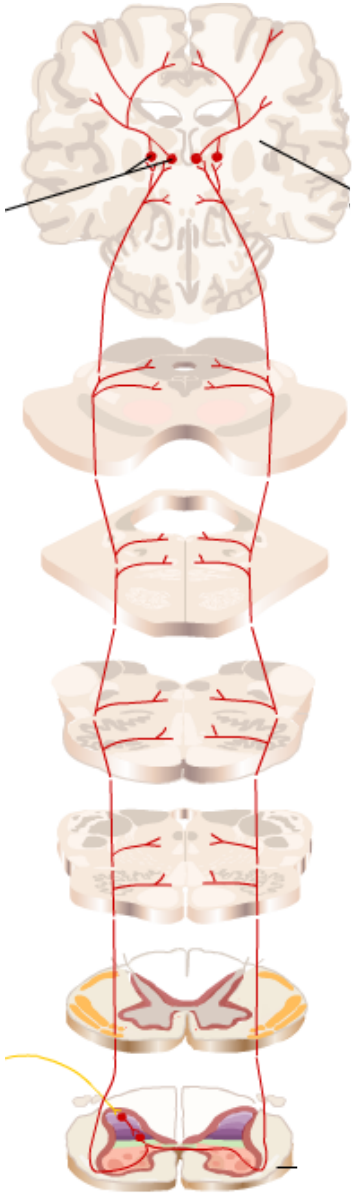
Paleospinothalamic system

- Tr. Spinoreticularis, spinotectalis…



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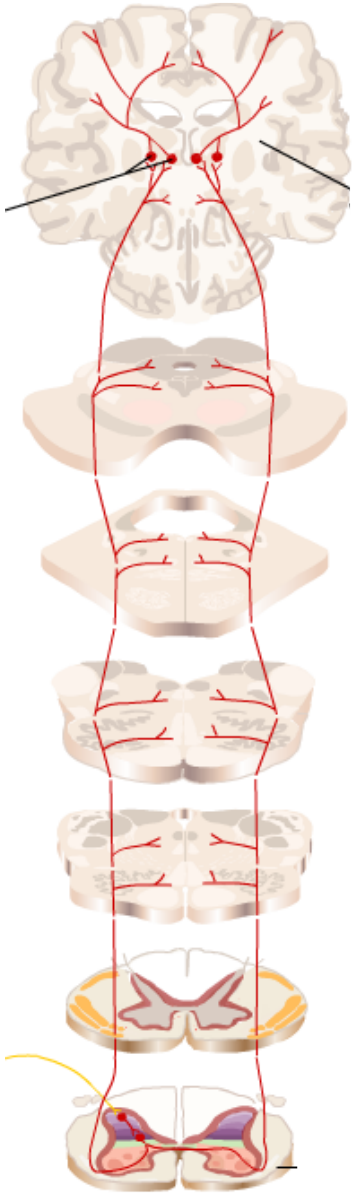
Paleospinothalamic system

- Tr. Spinoreticularis, spinotectalis…
- Evolved before neocortex



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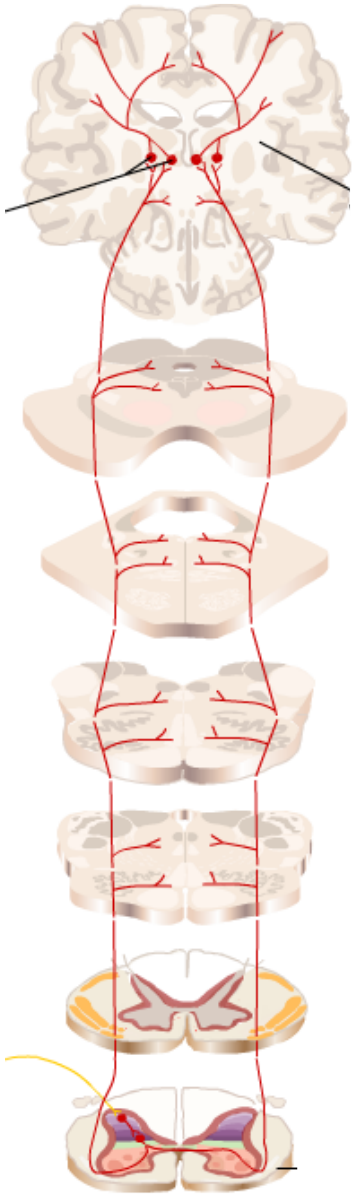
Paleospinothalamic system

- Tr. Spinoreticularis, spinotectalis…
- Evolved before neocortex
- The primary connection to the subcortical structures



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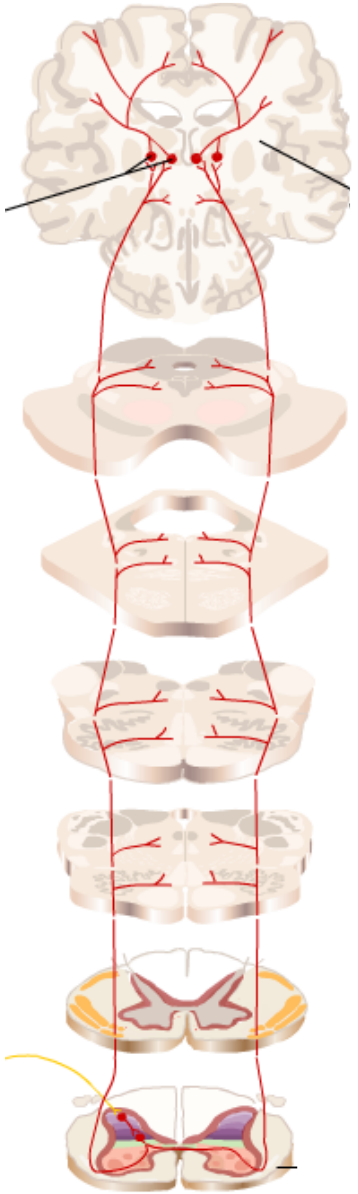
Paleospinothalamic system

- Tr. Spinoreticularis, spinotectalis…
- Evolved before neocortex
- The primary connection to the subcortical structures
- Basic defensive reactions and reflexes - vegetative response, reflex locomotion - opto-acoustic reflexes etc.



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Paleospinothalamic system

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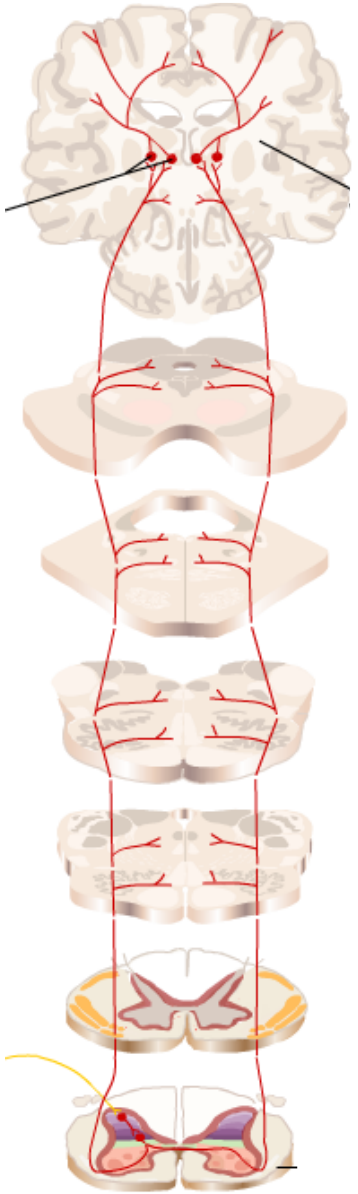

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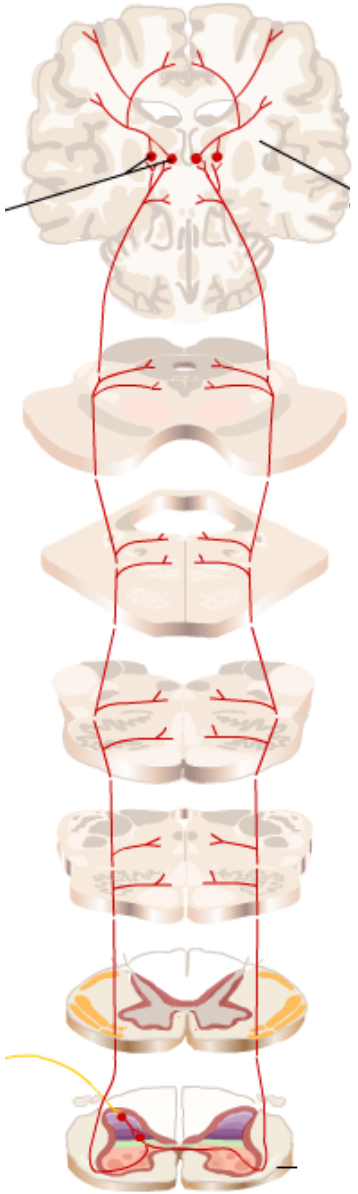
- This tract is not designed for „such a powerful processor as neocortex“



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Paleospinothalamic system

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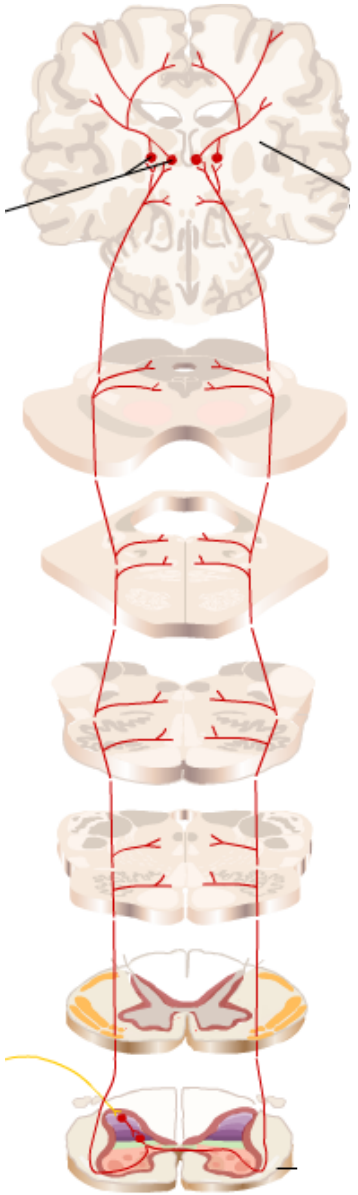
- Approximately half of the fibers cross the midline



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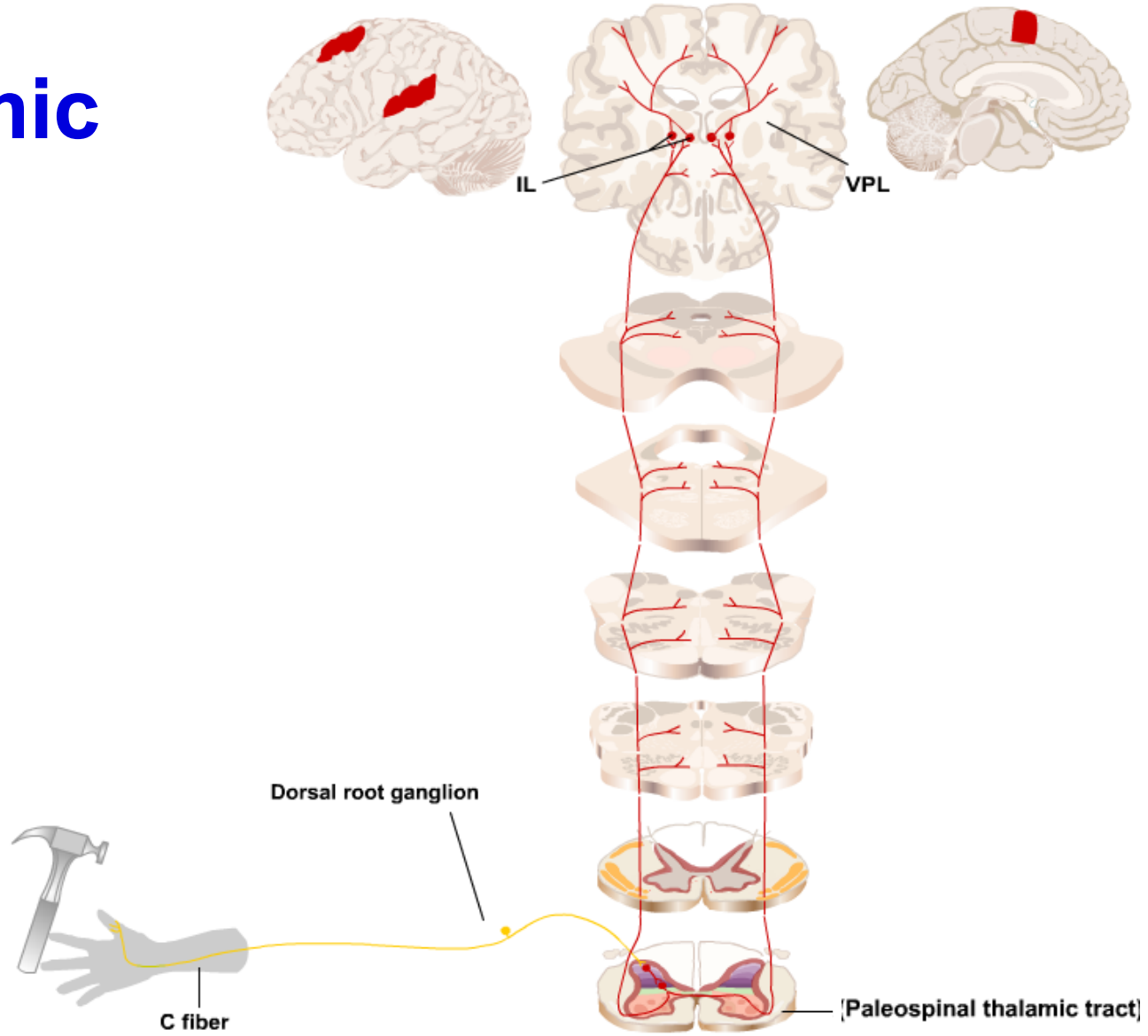
Paleospinothalamic system



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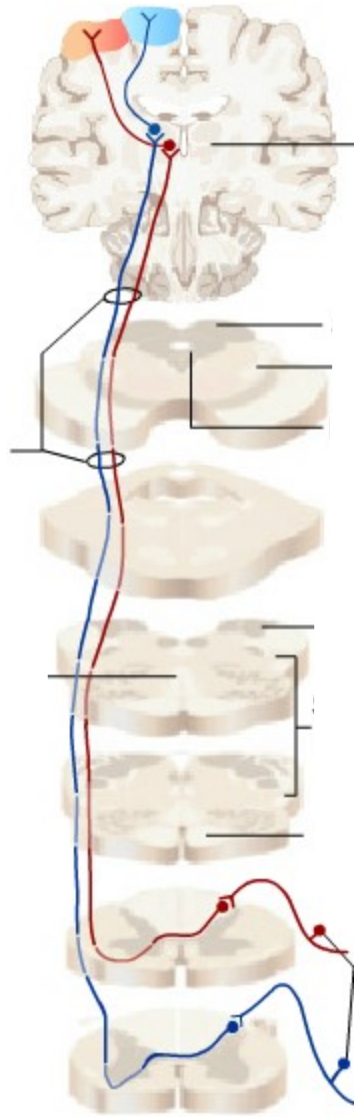
Neospinothalamic system

- Tr. Spinothalamicus



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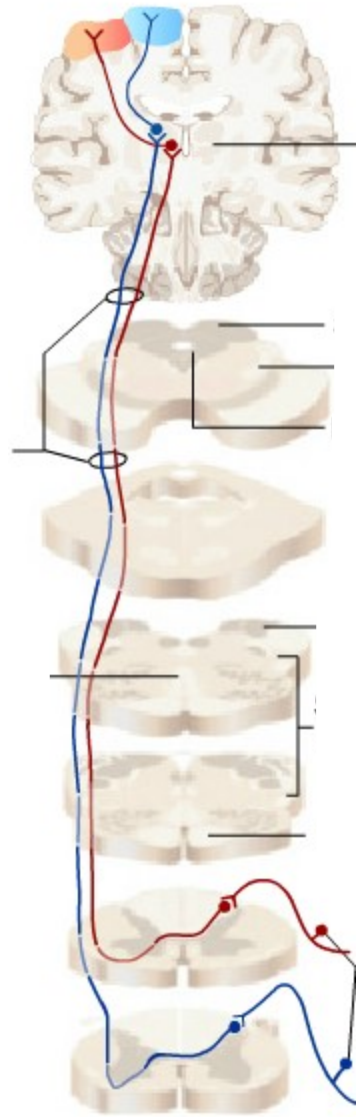
Neospinothalamic system

- Tr. Spinothalamicus
- Younger structure primarily connected to neocortex
- „High capacity/resolution“



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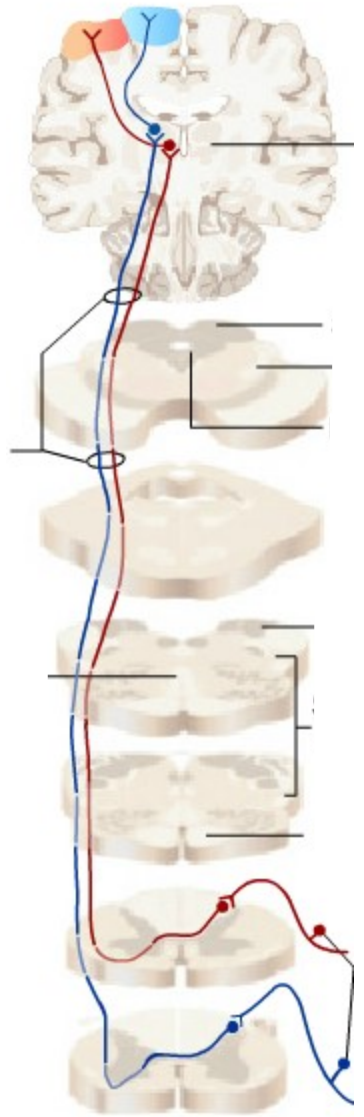
Neospinothalamic system

- Tr. Spinothalamicus
- Younger structure primarily connected to neocortex
- „High capacity/resolution“
- Detail information about pain stimuli (sharp, localized pain)
- Information about temperature



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Neospinothalamic system

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- Detail information about pain stimuli (sharp, localized pain)
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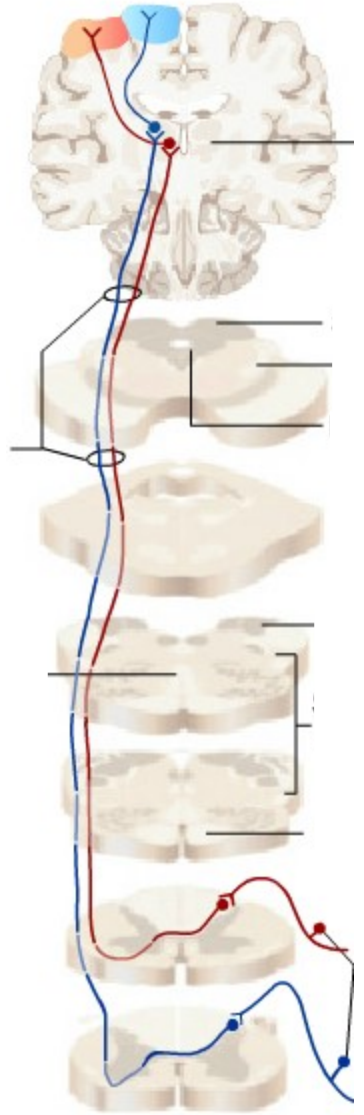
- Crude touch sensation



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Neospinothalamic system

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- Detail information about pain stimuli (sharp, localized pain)
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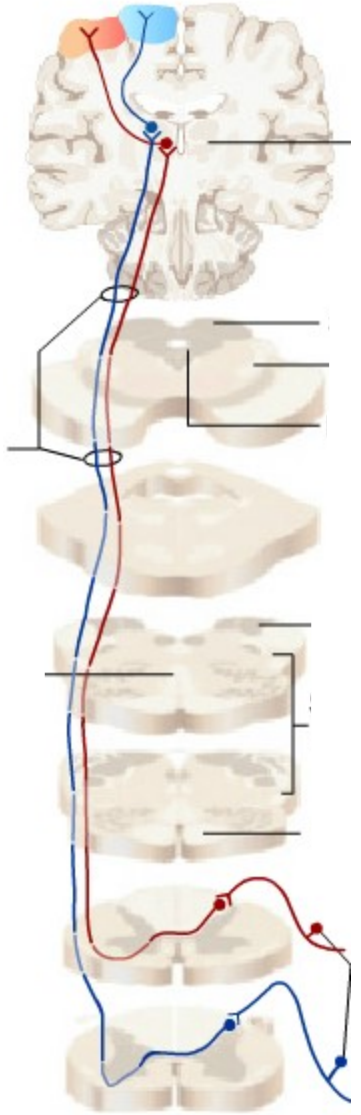
- Crude touch sensation
- The fibers cross midline at the level of entry segment



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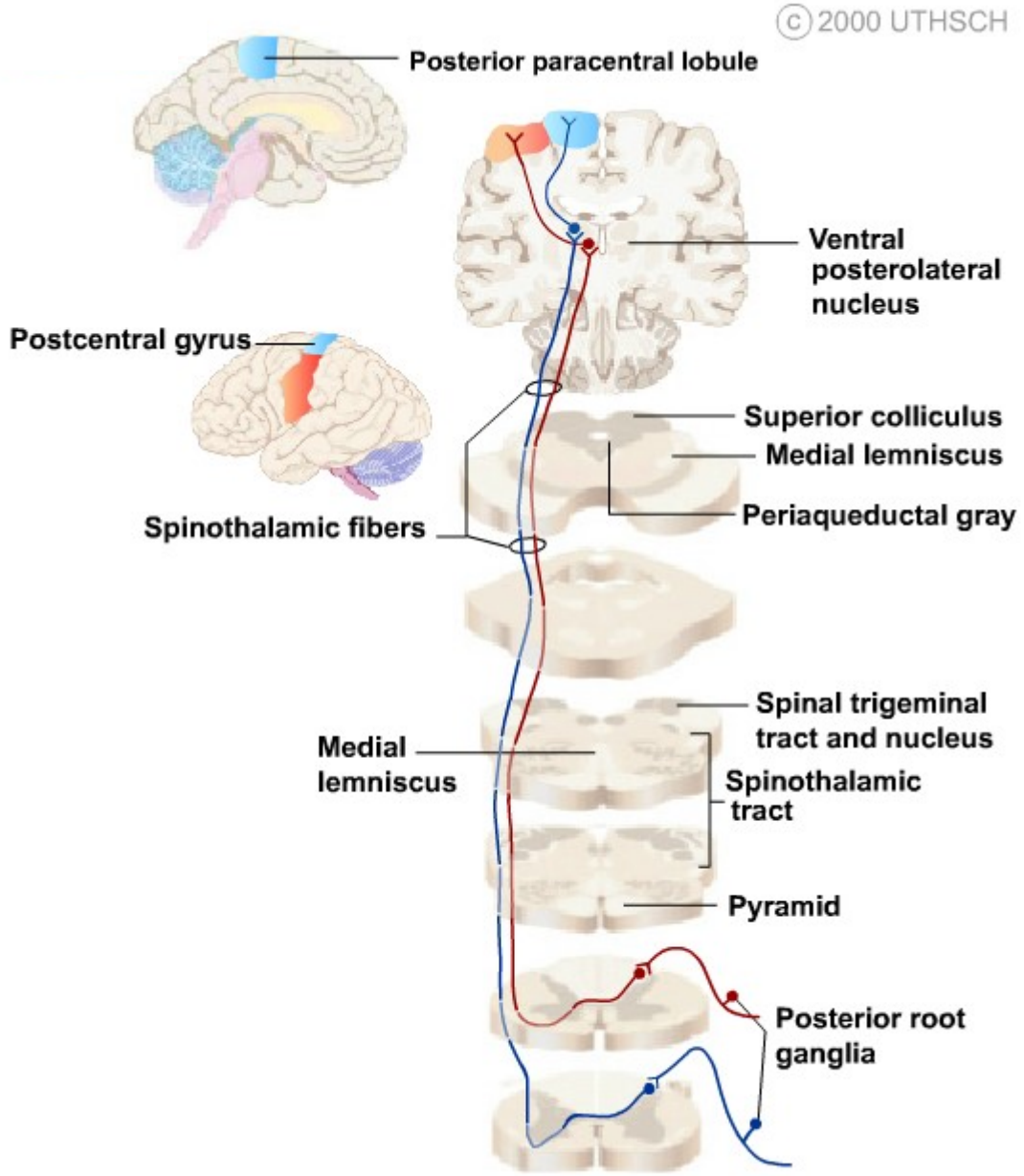
Neospinothalamic system



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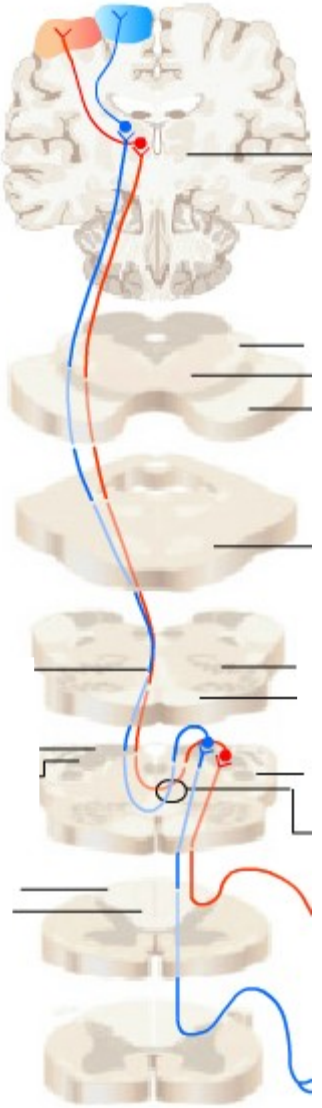
Dorsal column system

- Tr. Spinobulbaris



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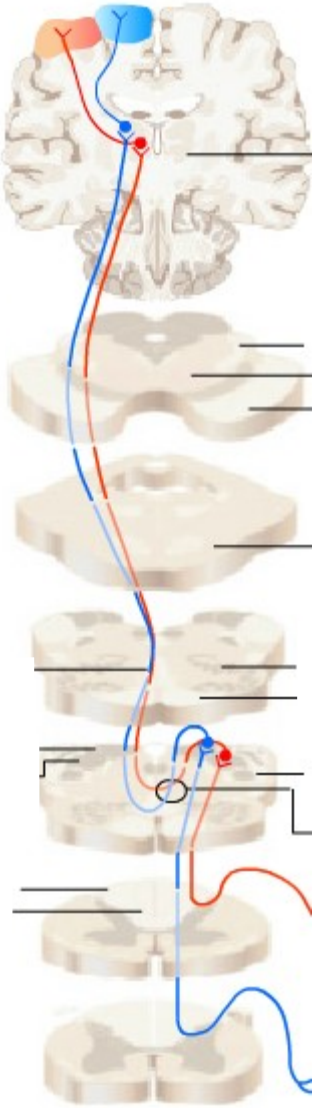
Dorsal column system

- Tr. Spinobulbaris
- The youngest system
- High capacity



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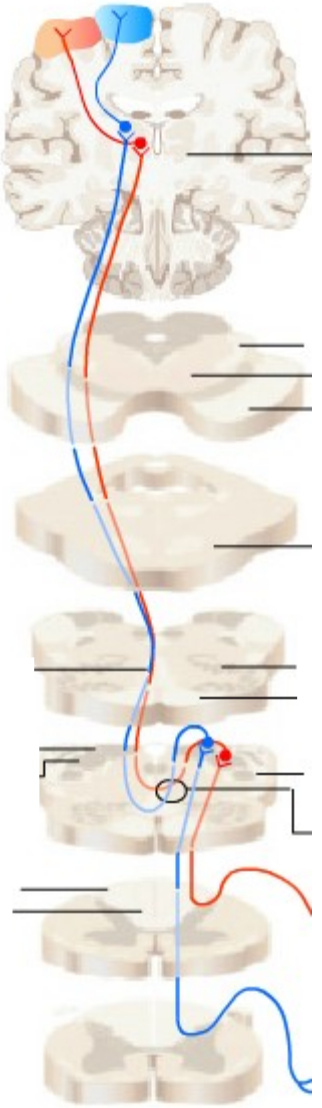
Dorsal column system

- Tr. Spinobulbaris
- The youngest system
- High capacity
- Tactile sensation
- Vibration



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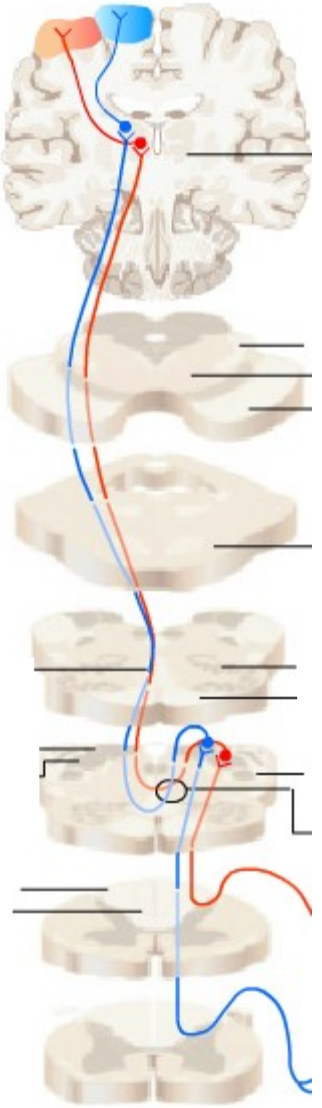
Dorsal column system

- Tr. Spinobulbaris
- The youngest system
- High capacity
- Tactile sensation
- Vibration
- Fine motor control
- Better object recognition
- Adaptive value



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Dorsal column system

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- The youngest system
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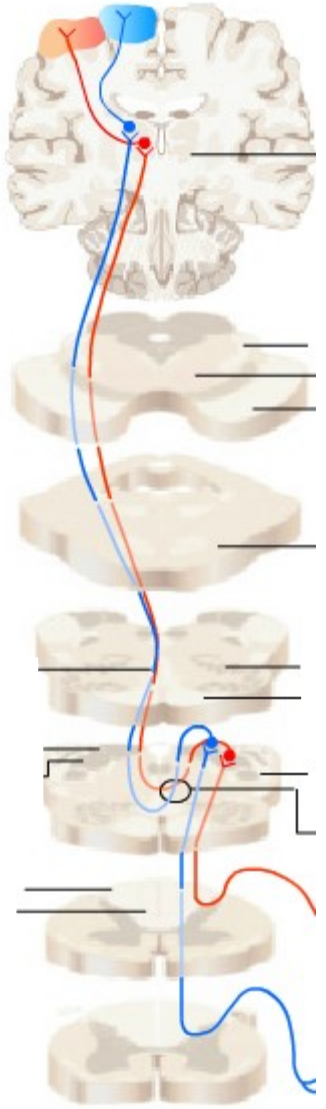
- Tactile sensation
- Vibration
- Fine motor control
- Better object recognition
- Adaptive value
- The fibers cross midline at the level of medulla oblongata



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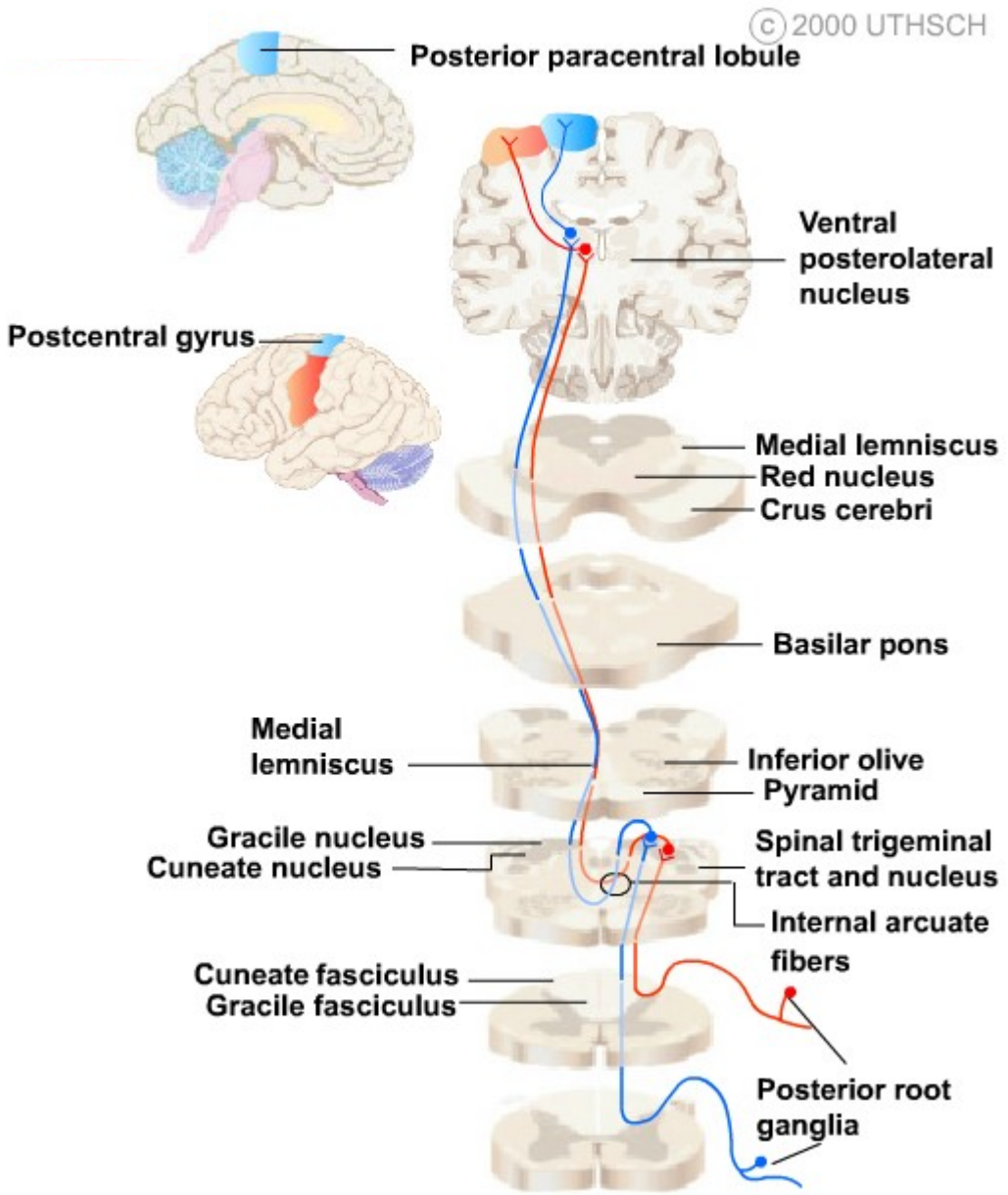
Dorsal column system



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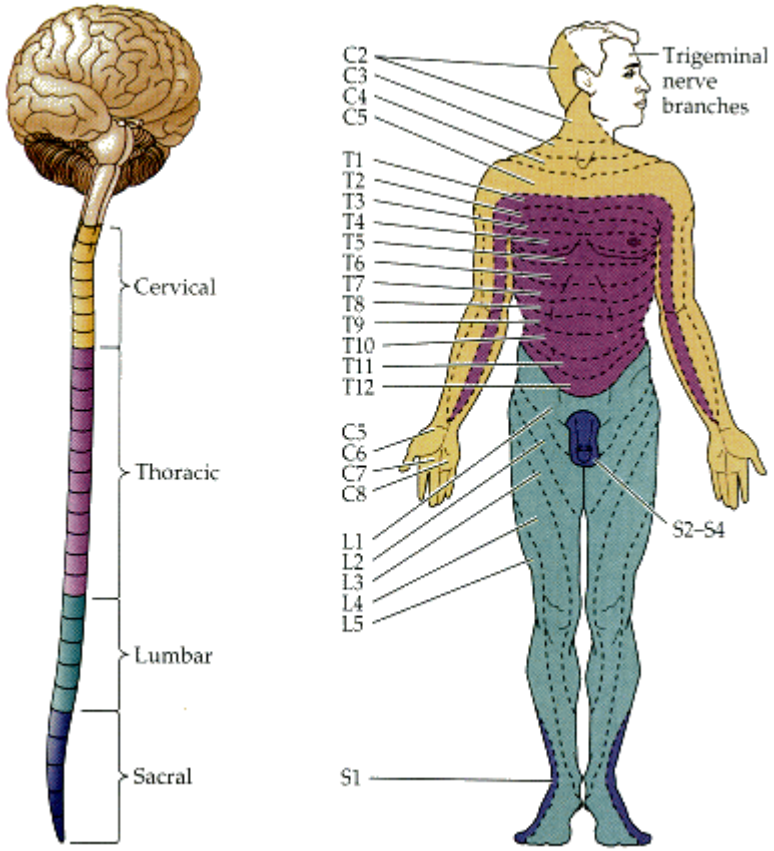
Dermatoms

- Somatotopic organization somatosensitve nerves



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Dermatoms

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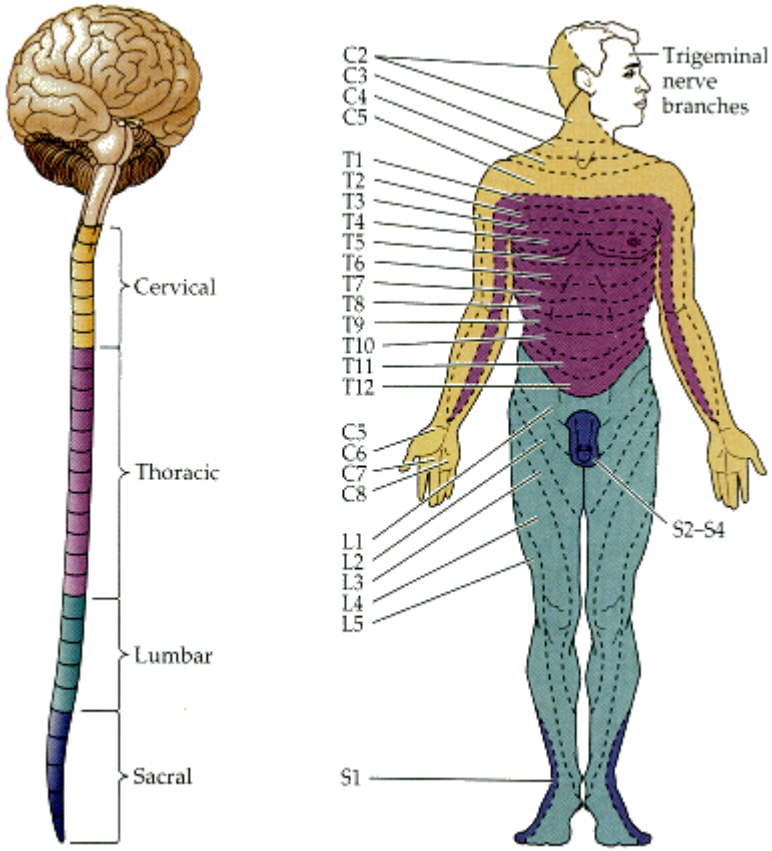

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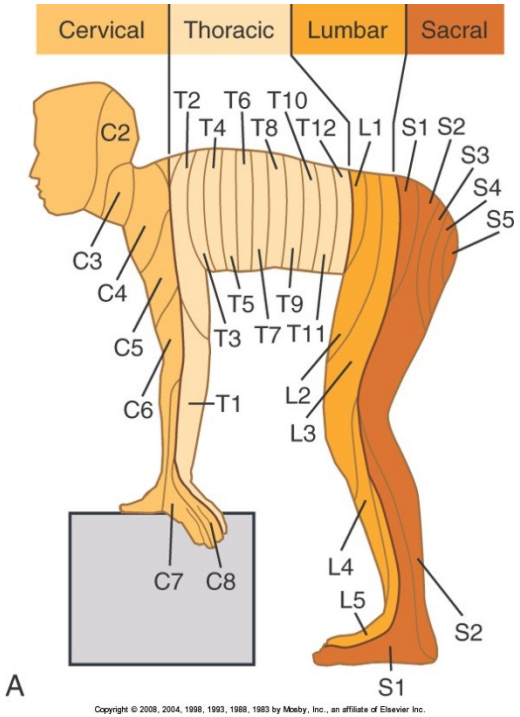

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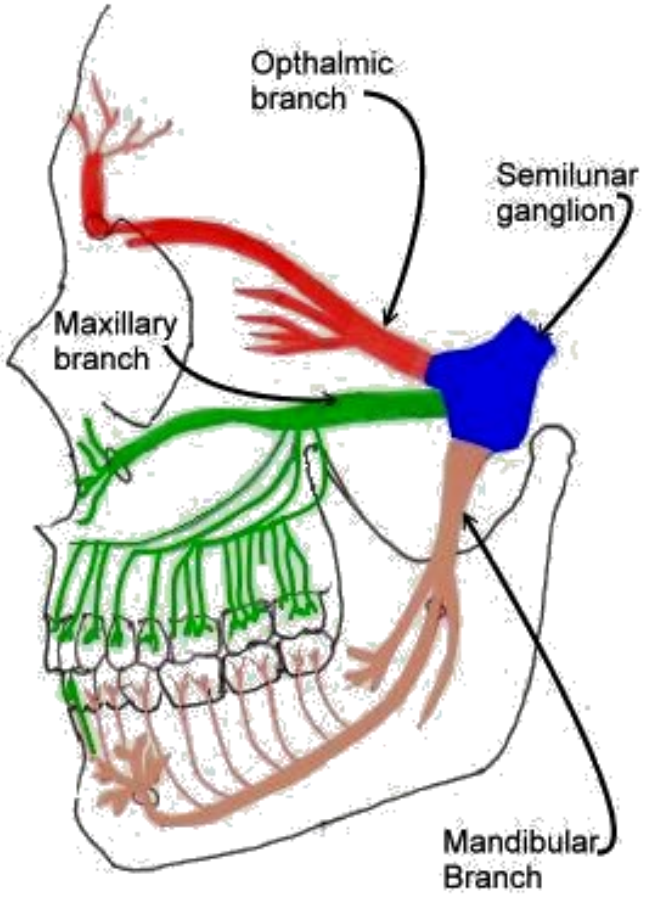
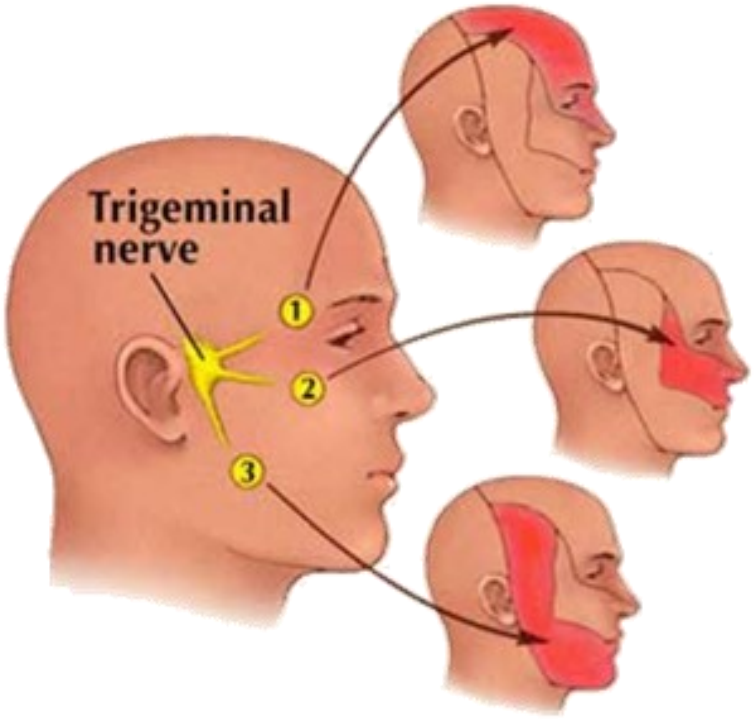
Trigeminal system

- Spinal TS
  - Pain, temperature
- Main sensory TS
  - Touch, proprioception





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Somatosensory pathways

Table I
The Sensory Modalities Represented by the Somatosensory Systems

Modality	Sub Modality	Sub-Sub Modality	Somatosensory Pathway (Body)	Somatosensory Pathway (Face)
Pain	sharp cutting pain		Neospinothalamic	Spinal Trigeminal
	dull burning pain		Paleospinothalamic	
	deep aching pain		Archispinothalamic	
Temperature	warm/hot		Paleospinothalamic	
	cool/cold		Neospinothalamic	
Touch	itch/tickle & crude touch		Paleospinothalamic	
	discriminative touch	touch	Tr. spinobulbaris	Main Sensory Trigeminal
		pressure		
		flutter		
		vibration		
Proprioception	Position: Static Forces	muscle length		
		muscle tension		
		joint pressure		
	Movement: Dynamic Forces	muscle length		
		muscle tension		
		joint pressure		
		joint angle		

http://neuroscience.uth.tmc.edu/s2/chapter02.html

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Trigeminal system

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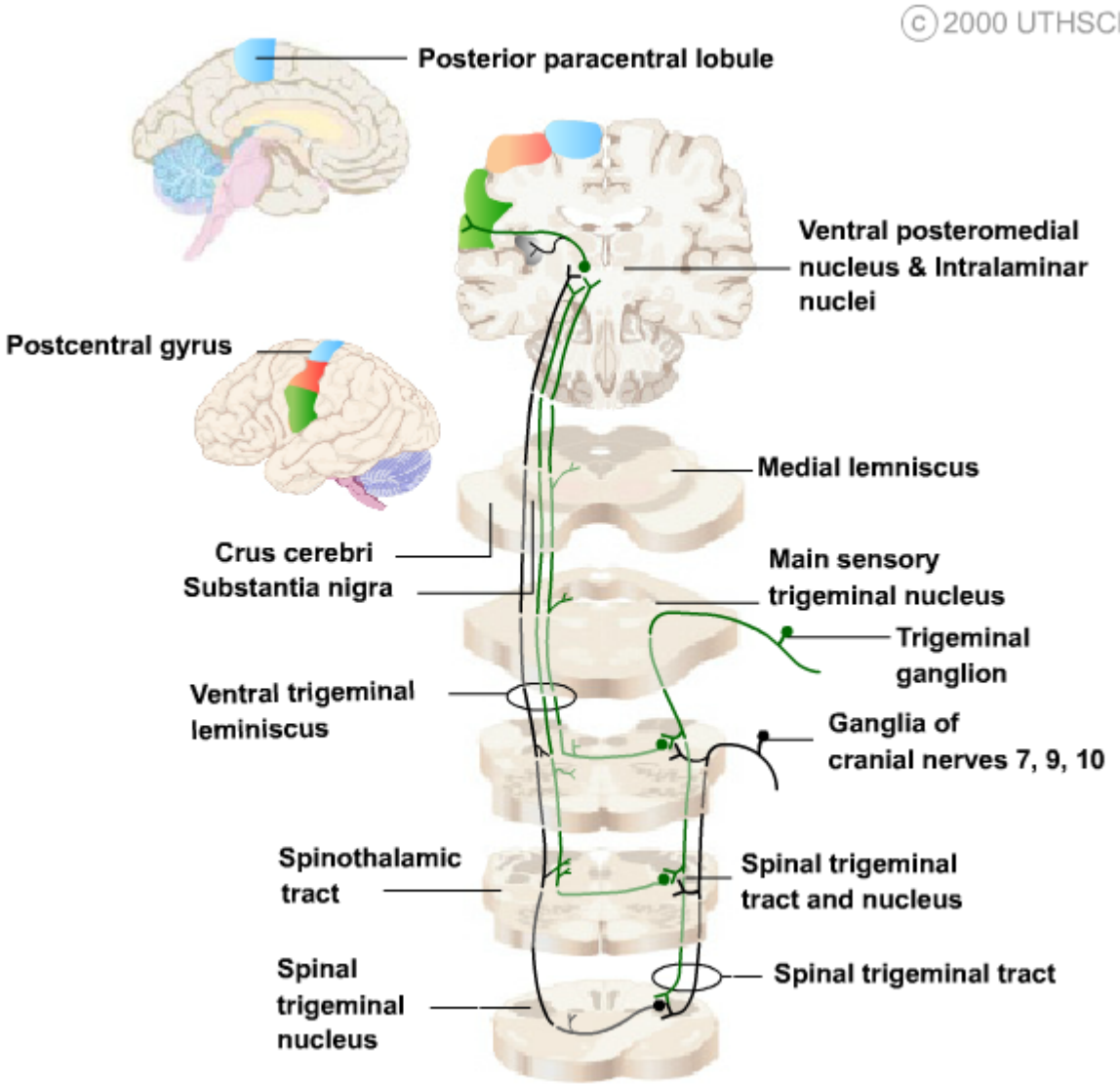

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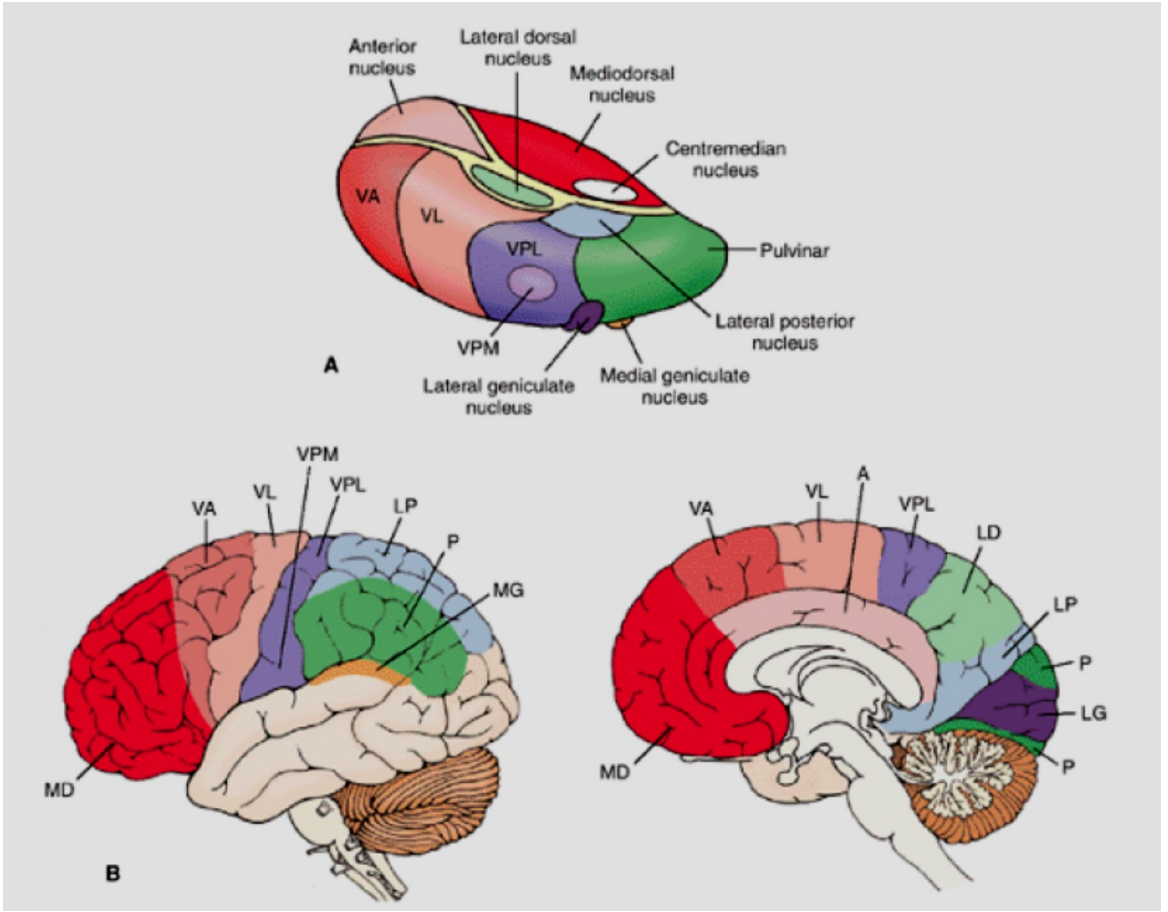
Thalamus and neocortex

- Almost all the afferent information gated in the thalamus
- Olfaction is an exception
- Bilateral connections between neocortex and thalamus



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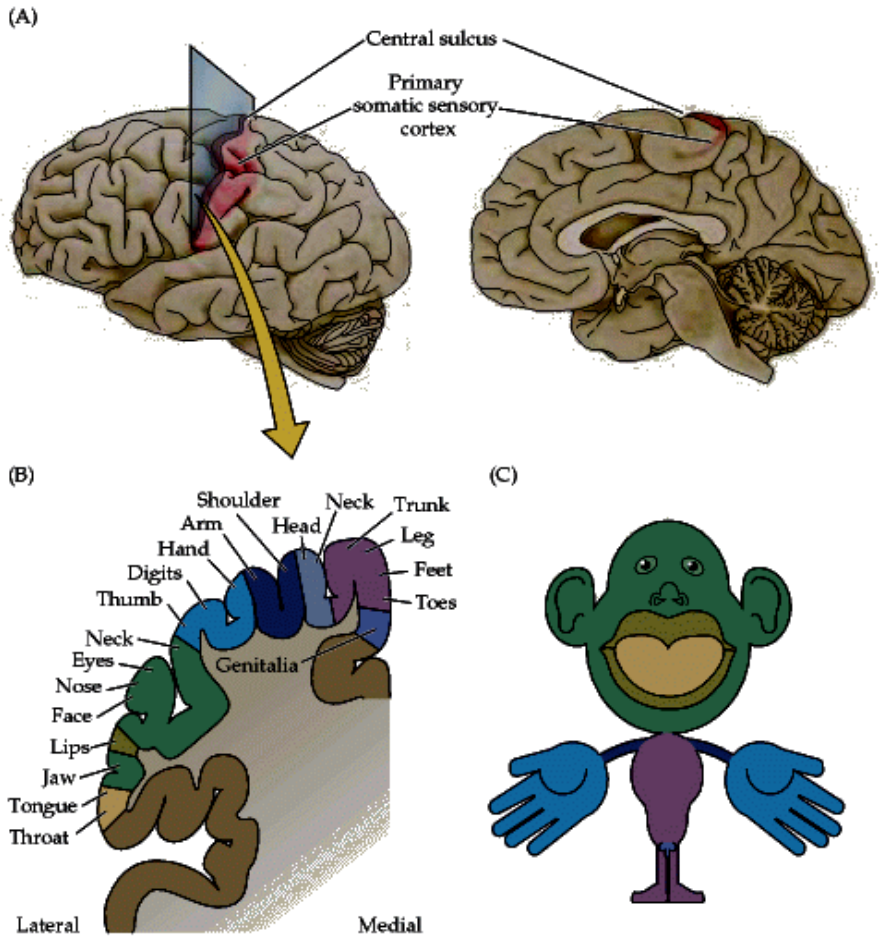
Neocortex

- Somatotopic organization
- Cortical magnification



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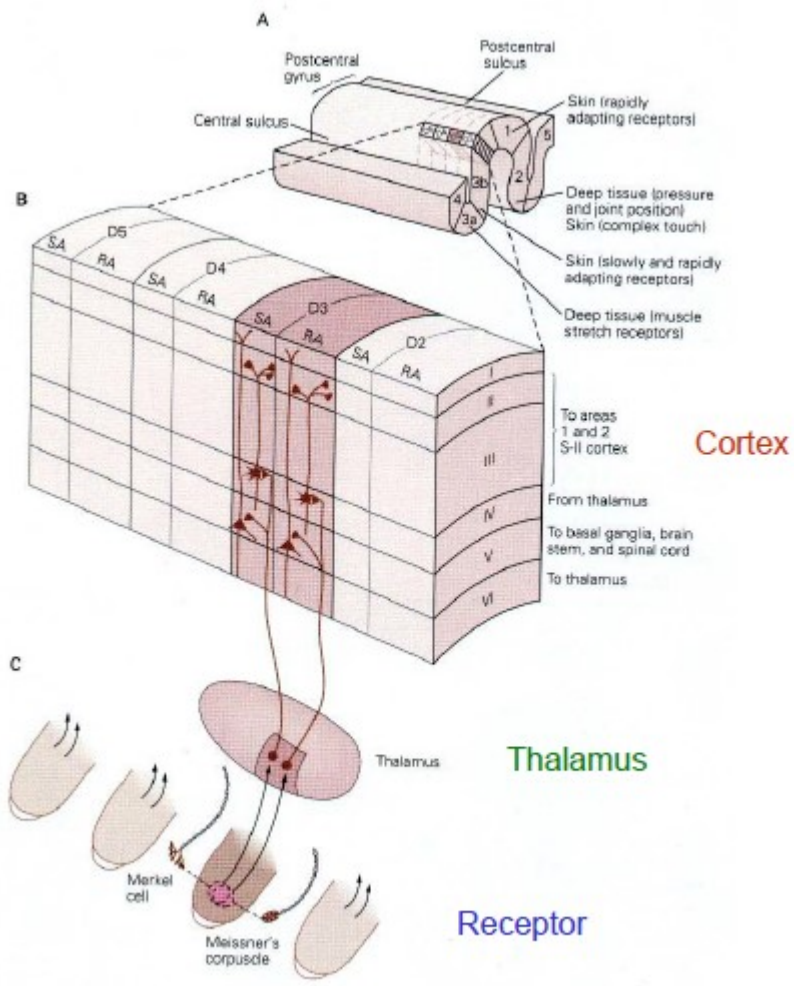

http://www.shadmehrlab.org/Courses/physfound_files/wang_5.pdf

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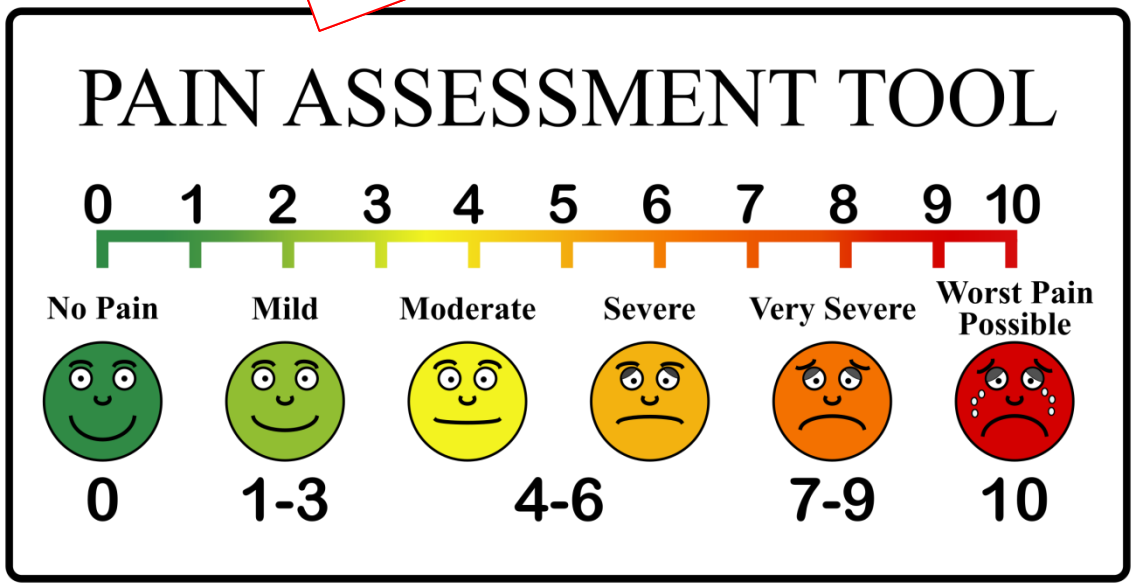
Pain

- Distressing feeling associated with real or potential tissue damage
- Sensor x psychological component
- Physiological pain (nociceptor activation)
- Pathological pain (not mediated by nociceptors)
- Acute (up to 6months) – „activiting“
- Chronic (more than 6 months) – „devating“

Subjective character



https://www.cheatography.com/uploads/davidpol_1460561912_Pain_Scale__Arvin61r58.png

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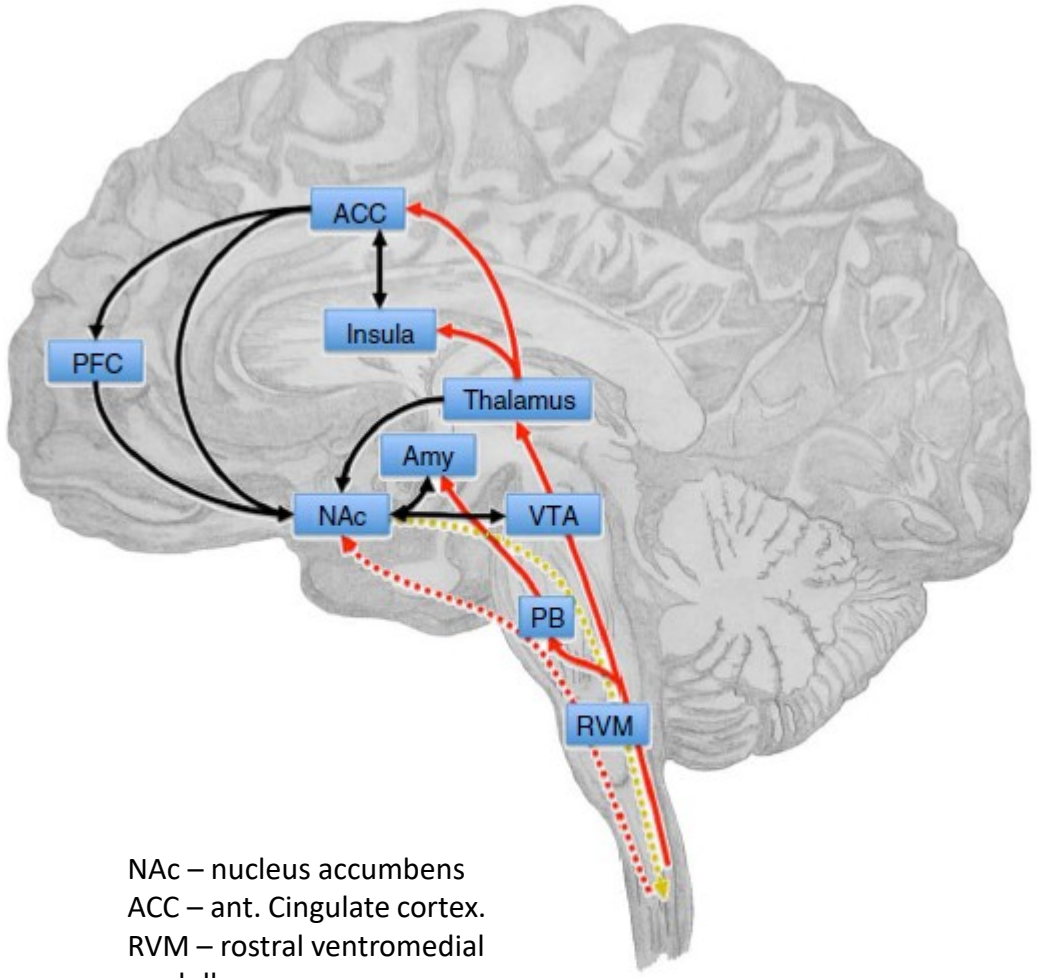
Pain and limbic system

Navratilova E, Porreca F.
Reward and motivation
in pain and pain relief.
Nat Neurosci.
2014;17:1304–1312.

Figure 1 The corticolimbic circuit integrates motivationally salient information, including pain, and makes decisions about action selection. The NAc receives afferent nociceptive information through connections with the thalamus, parabrachial area (PB), amygdala (Amy) and ACC. Direct projections from the spinal cord to the NAc may be postulated on the basis of findings in rodents[47] (red lines). VTA dopaminergic inputs to the NAc signal saliency, as well as the value of pain or relief. Corticostriatal connections from prefrontal, orbitofrontal and anterior cingulate cortices contribute to affective, emotional and cognitive control of pain perception and are involved in motivational decision-making. In the NAc, glutamatergic outputs from the amygdala converge on dopaminergic terminals from the VTA and influence motivated behavior in response to stress and anxiety (black lines). A descending pathway from the NAc that can modulate spinal nociceptive signals, possibly via the RVM, has been suggested[109] (gold dotted line). Chronic pain states are characterized by anatomical and functional reorganization of the corticolimbic circuit, including changes in gray matter density in the PFC, ACC and NAc and increased functional connectivity between the PFC and NAc[108].



NAc – nucleus accumbens
ACC – ant. Cingulate cortex.
RVM – rostral ventromedial medulla

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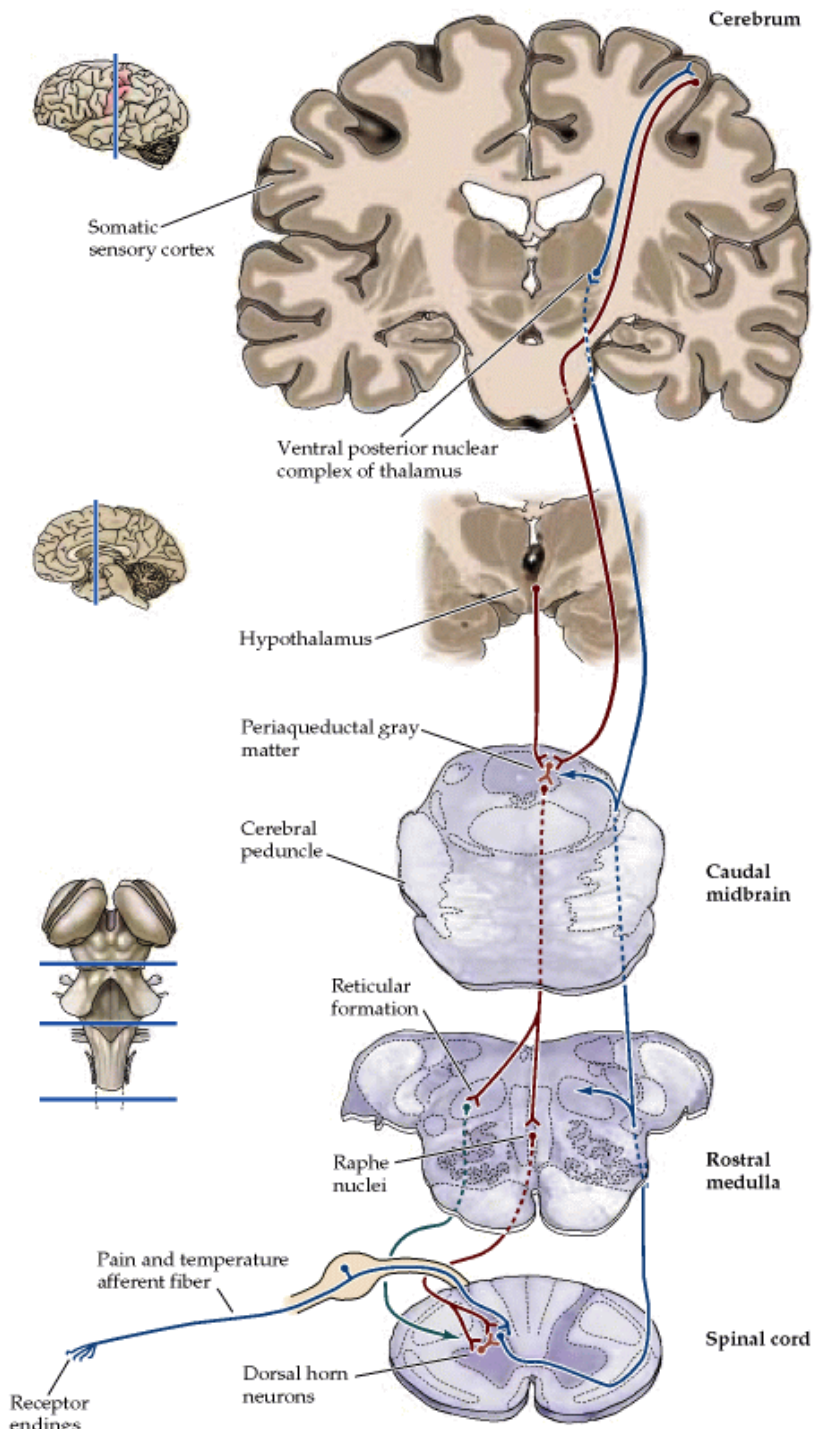
Descendent pathways modulating pain

- Somatosemcoric cortex
- Hypotalamus
- Periaquaeductal gray
- Nuclei raphe



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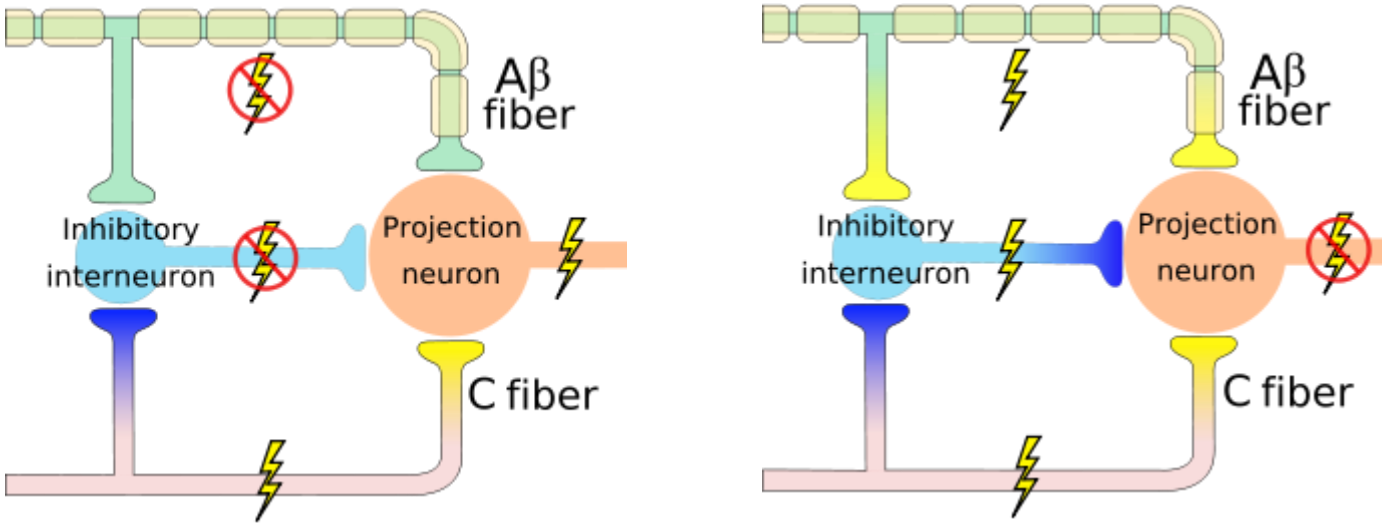
Pain modulation on the spinal level

Gate control theory of pain



https://en.wikipedia.org/wiki/Gate_control_theory

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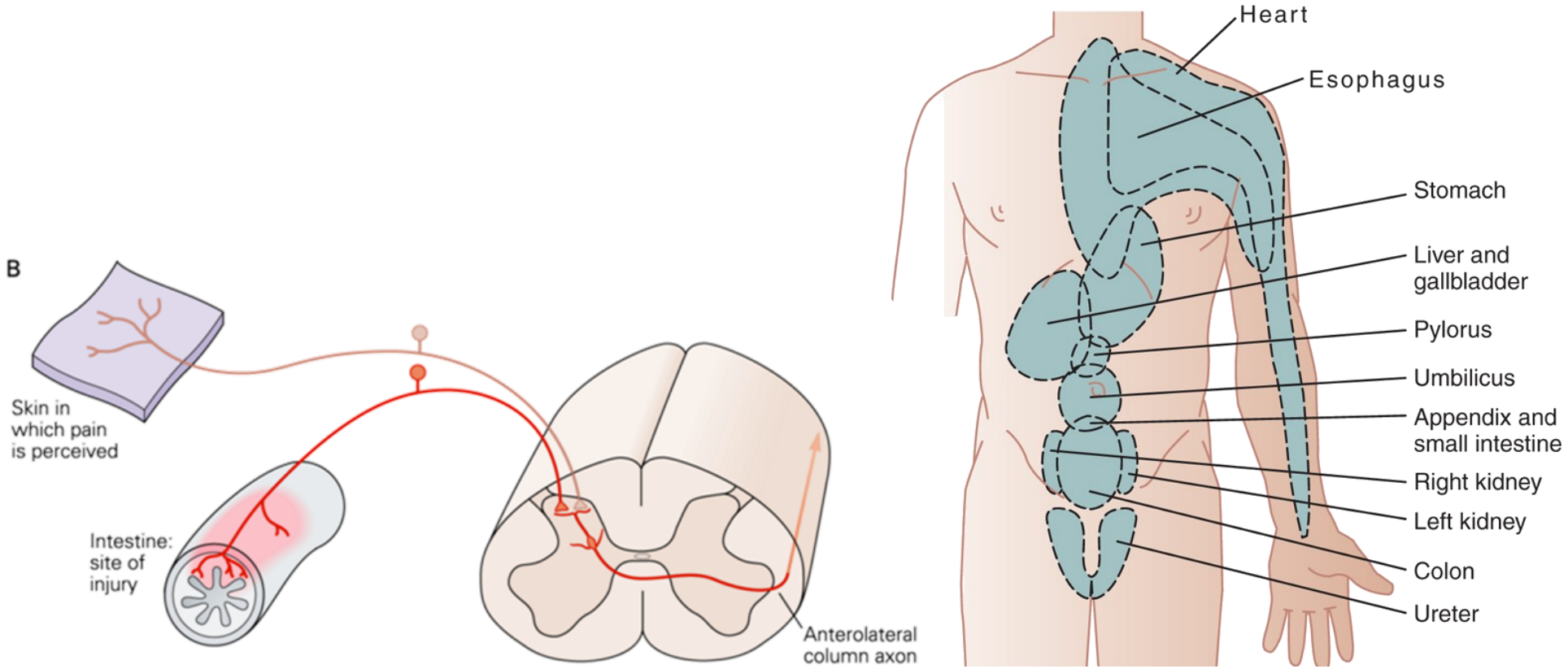
Referred pain



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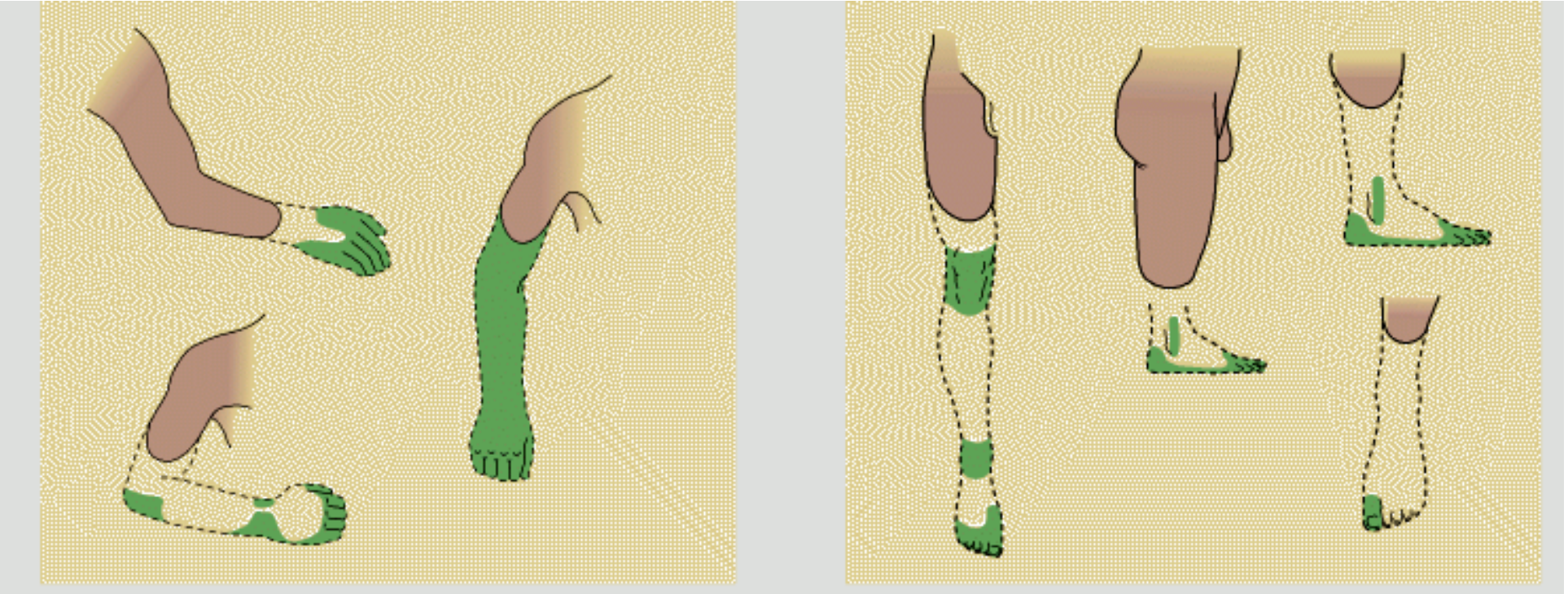
Phantom limb pain



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73. Basic functional comparison of somatosensitivity, viscerosensitivity and proprioception, the importance of sensitivity for immediate and long-term survival

- ✓ Somatosensitivty vs. viscerosensitivty vs. proprioception
  - Definition, fuctional comparison
- ✓ Somatosensory pathways (three systems)
  - Function/resolution
  - Importance for survival (i.e. pain for immediate, proprioceptirn for better adaptation)
- ✓ Optionaly brief overview of proprioception
  - Muscle spindles vs. Golgi tendon organs (Motor system I)

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74. Pain

- ✓ Definition of pain
- ✓ Classification of pain (physiological, pathological, acute, chronic)
- ✓ Somatosensory pathways involved in pain perception
  - Fast vs. slow pain
- ✓ Pain modulation
  - Overview of structures involved in pain modulation
  - Gate control theory
- ✓ Referred pain vs. phantom limb pain

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