

## Anatomical Substrates of Somatic Sensation

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### The 2 principal somatic sensory systems:

- 1) Dorsal column-medial lemniscal system
- 2) Anterolateral system

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### Dorsal Column-Medial Lemniscal System

- Mediates mechanical sensations
  - touch, limb position sense, vibration sense
- Well established; clinical & experimental

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## Anterolateral System

- Mediates protective sensations
  - Pain
  - Temperature (cold & warmth)
  - Itch
- Not as definitively established as is the DC-ML system for touch

Why?

- Pain w/o tissue trauma
- Trauma w/o pain
- Cultural; pathological

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## Perspective:

- Peripheral somatic sensory receptors are sensitive to different stimulus qualities
  - Mechanical
  - Thermal (warm, cold)
  - Noxious (mechanical, thermal, polymodal)
- Different receptor classes provide input to different somatic sensory pathways
- Differential thalamic and cortical localization

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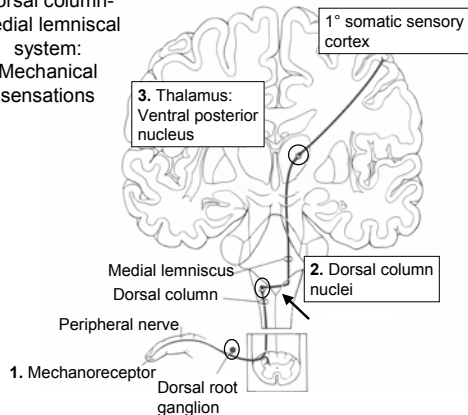
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Dorsal column-medial lemniscal system:  
Mechanical sensations



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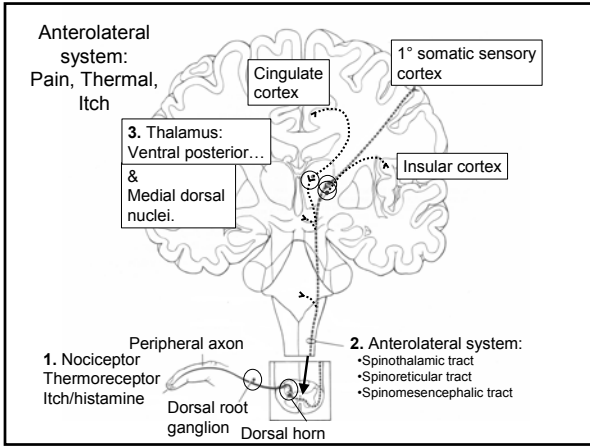
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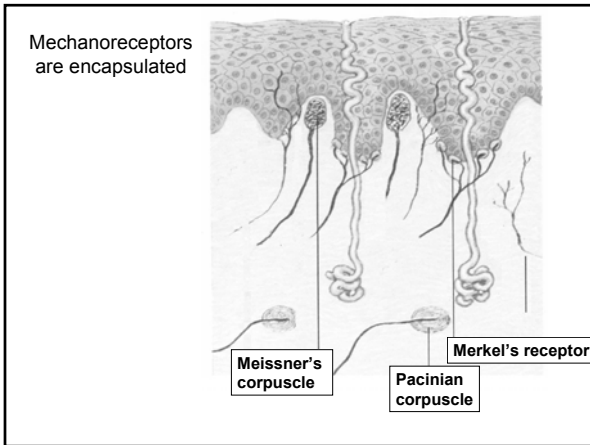
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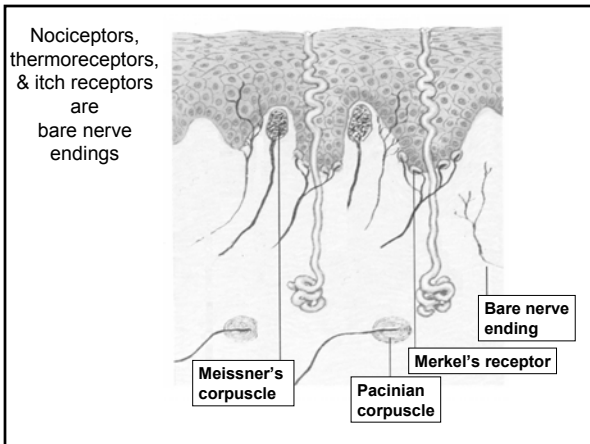
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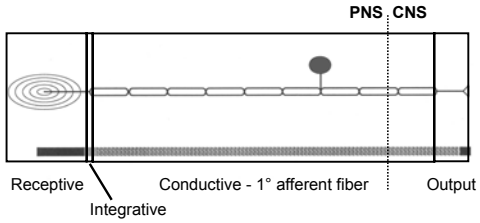
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# Dorsal root ganglion neuron



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# Key Characteristics of DRG Neurons

- Peripheral receptive field
  - Spatial area within which stimulation activates the sensory neuron

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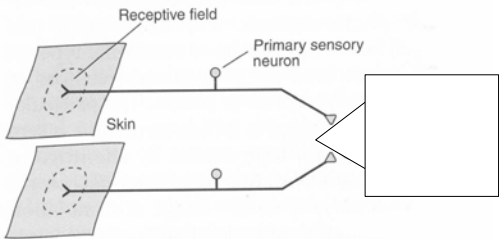
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# Receptive field



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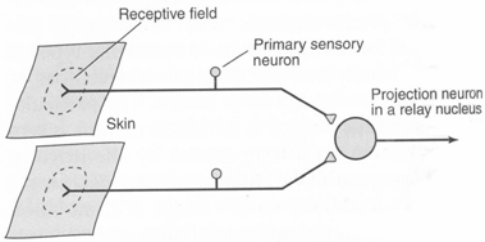
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## CNS Neurons have Receptive Fields




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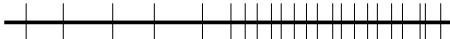
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## Key Characteristics of DRG Neurons

- Peripheral receptive field
  - Spatial area within which stimulation activates the sensory neuron
- Response to constant stimulation
  - Slow adaptation



- Rapid adaptation



Off

On

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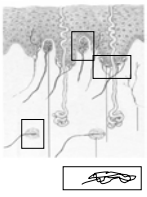
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## Mechano-receptor receptive fields

Rapidly adapting

Slowly adapting



Meissner's

Merkel

Pacinian

Ruffini




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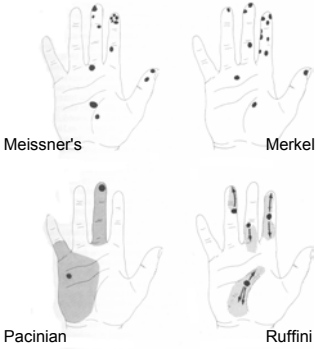
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# Mechano-receptor receptive fields

Rapidly adapting      Slowly adapting




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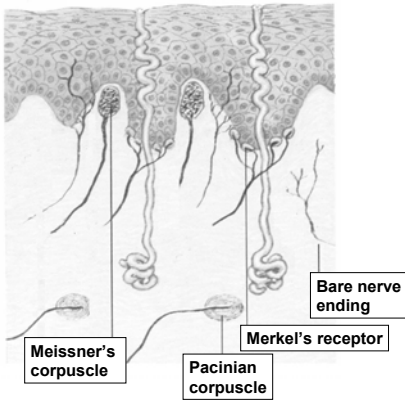
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Nociceptors, thermoreceptors, & itch receptors are bare nerve endings




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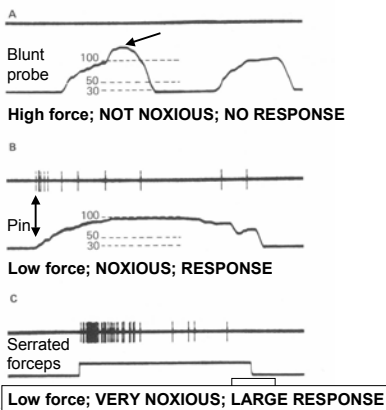
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# Nociceptors respond to noxious stimuli




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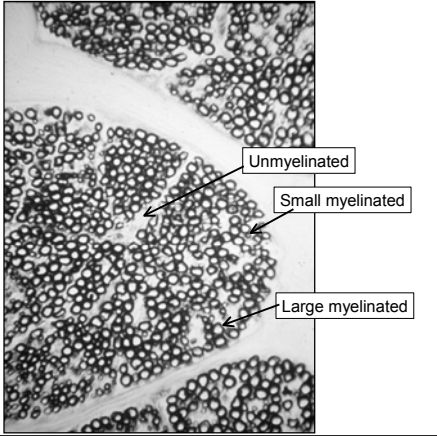
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Peripheral  
nerve  
cross  
section



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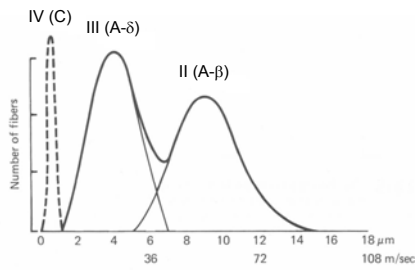
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Fiber Histogram: Sensory axon  
innervating the skin



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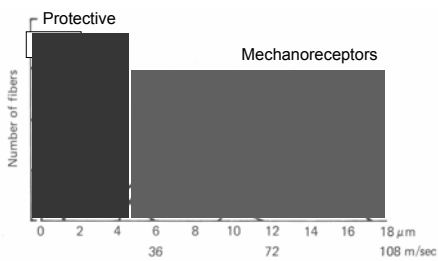
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Fiber Histogram: Sensory axon  
innervating a muscle



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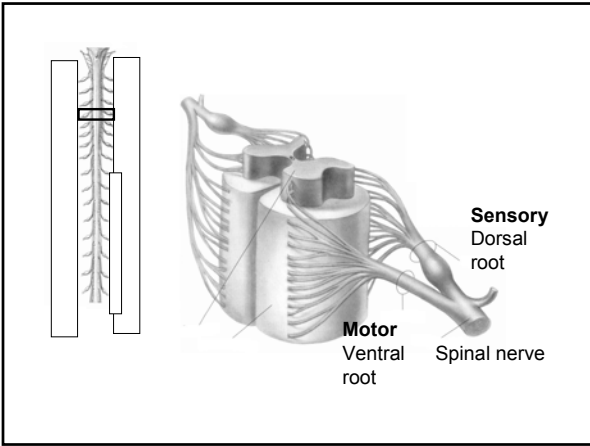
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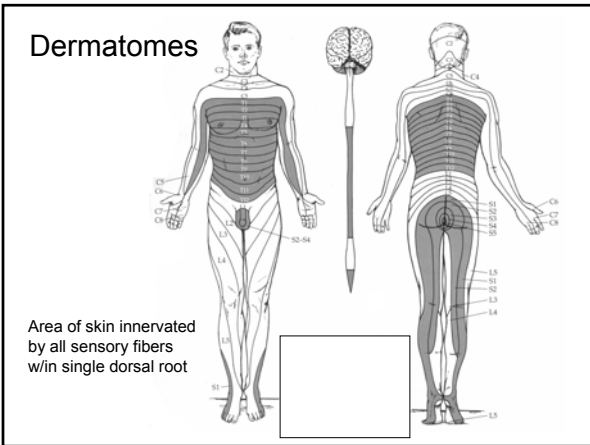
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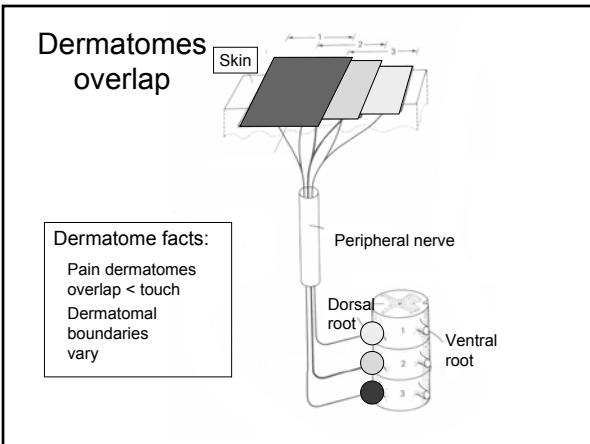
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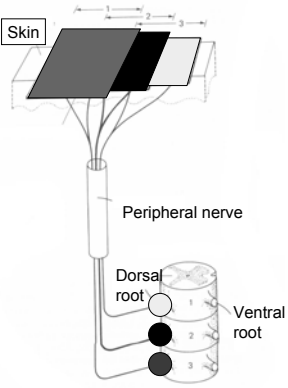
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# Dermatomes overlap



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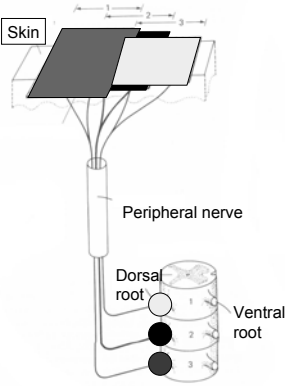
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# Dermatomes overlap



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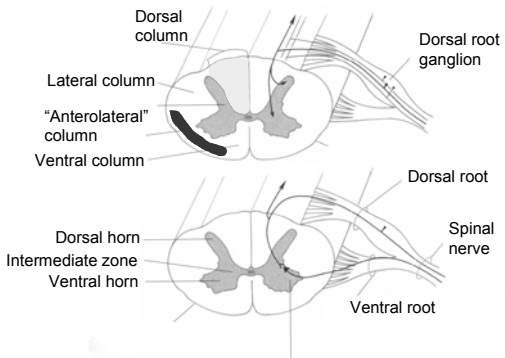
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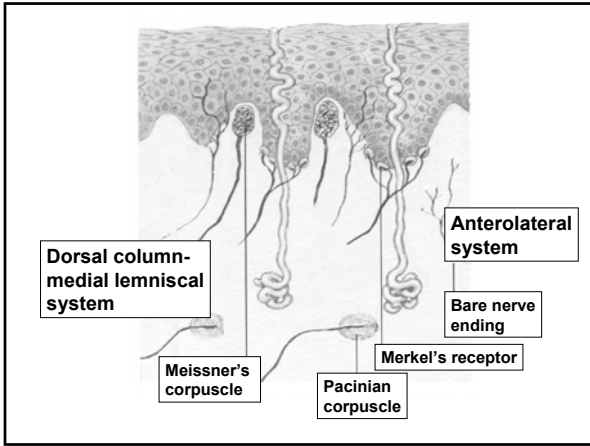
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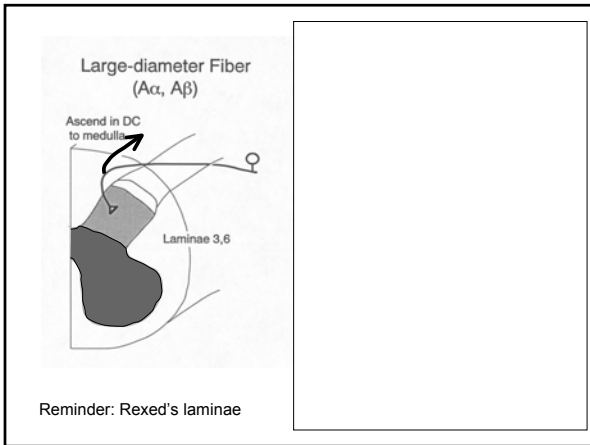
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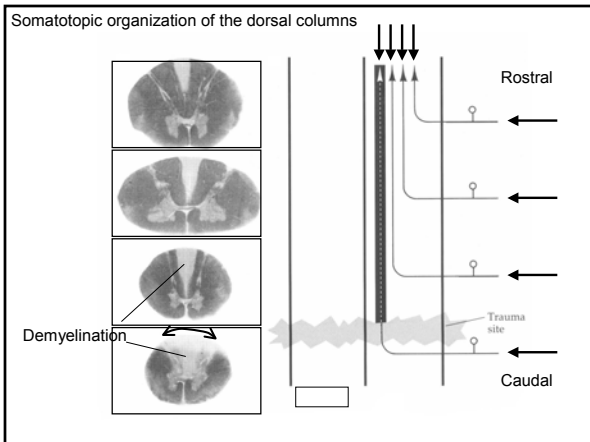
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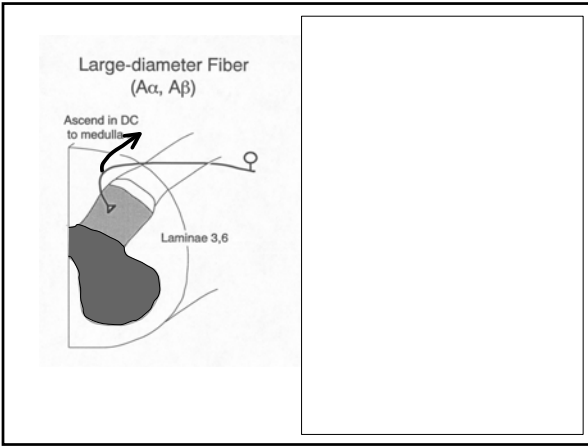
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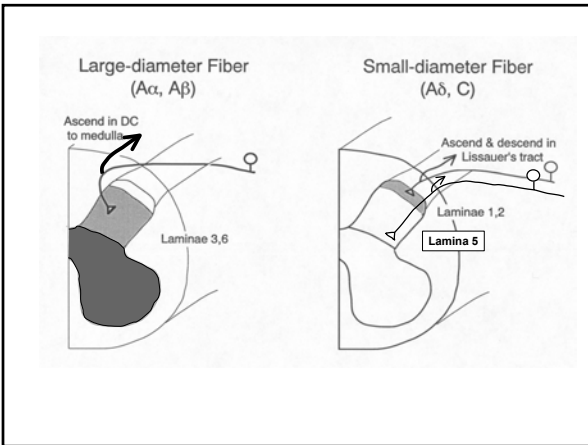
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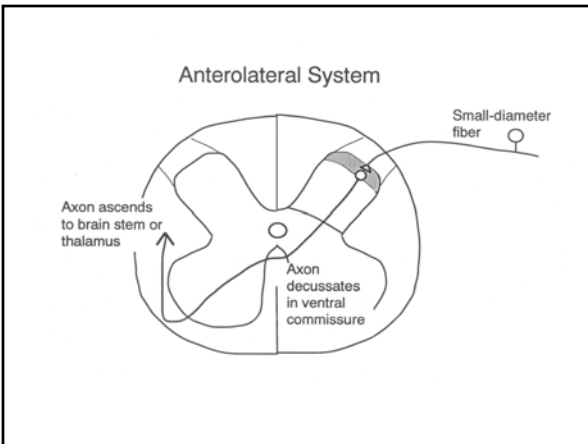
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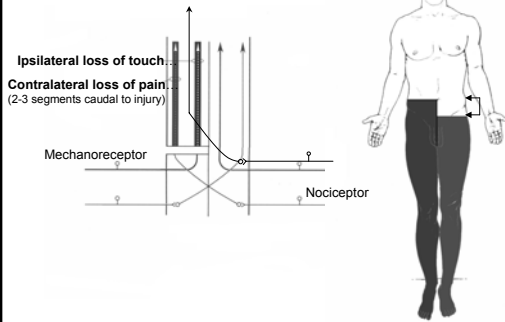
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## Spinal Hemisection




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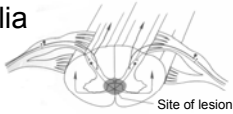
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## Syringomyelia



- Bilateral loss of pain & thermal senses
- Preservation of mechanosensations




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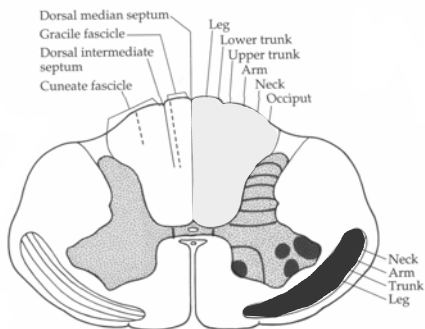
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## Somatotopy of spinal paths




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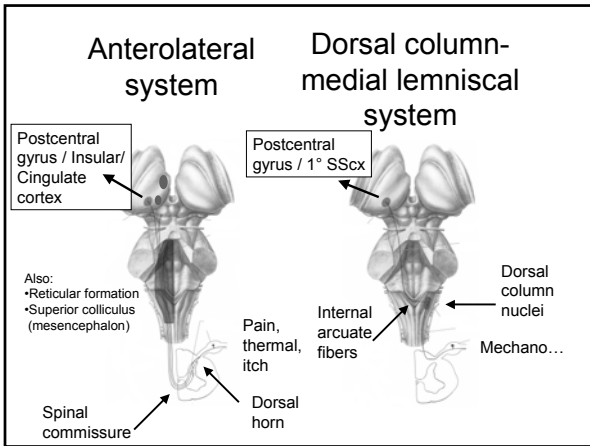
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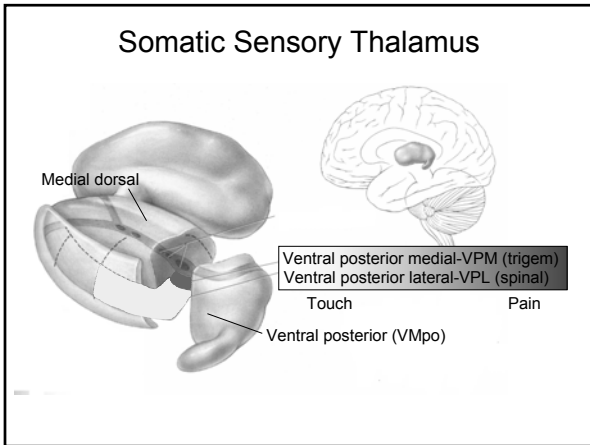
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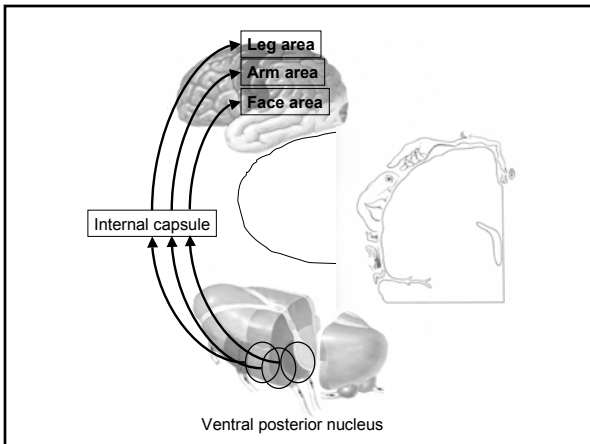
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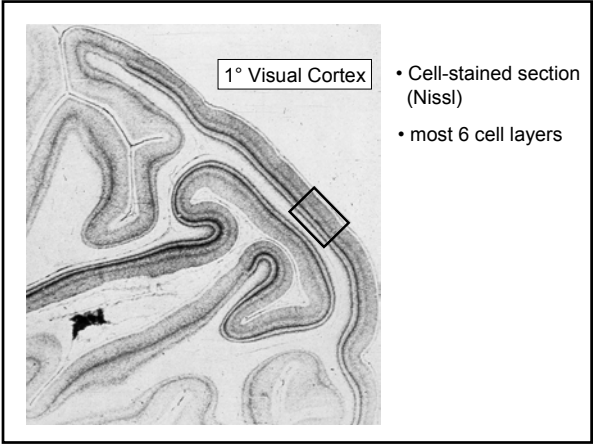
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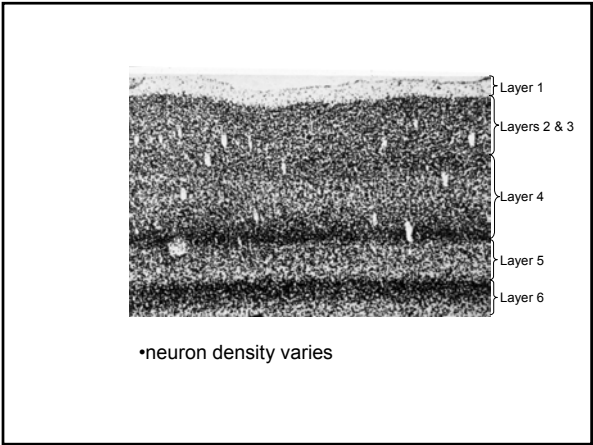
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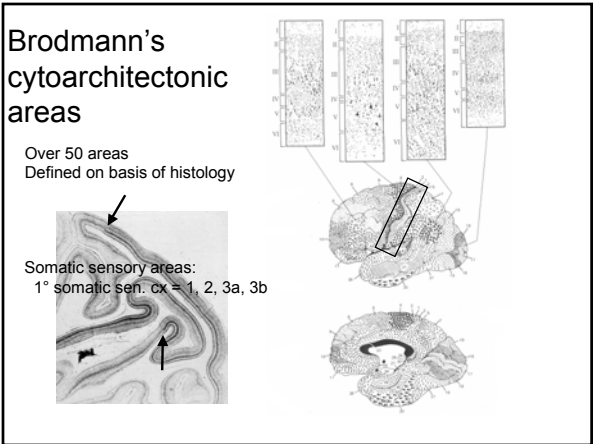
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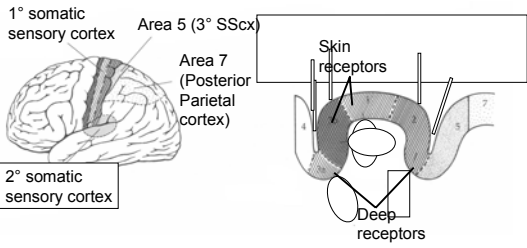
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### Somatic Sensory Cortical Areas for Mechanosensations




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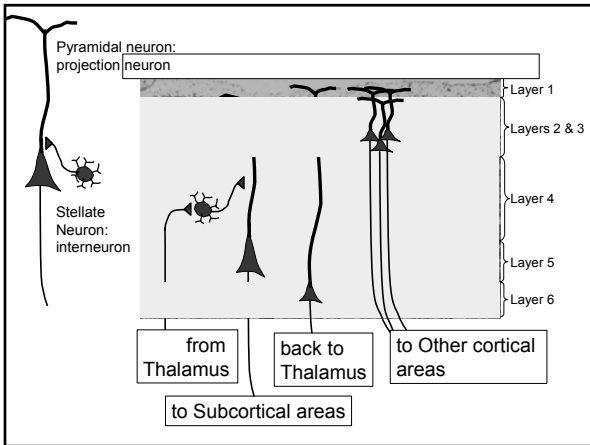
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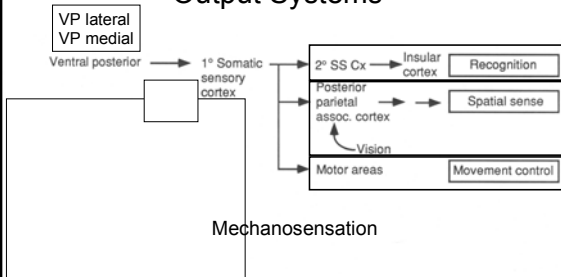
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### 1° Somatic Sensory Cortex Output Systems




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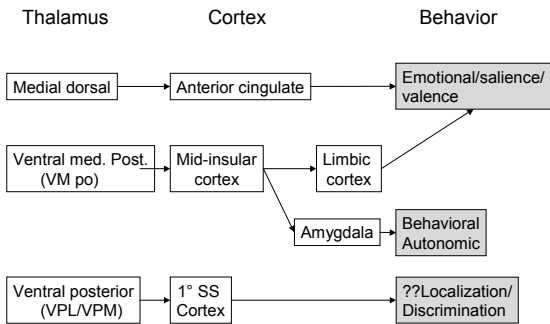
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## Cortical Pain Representations




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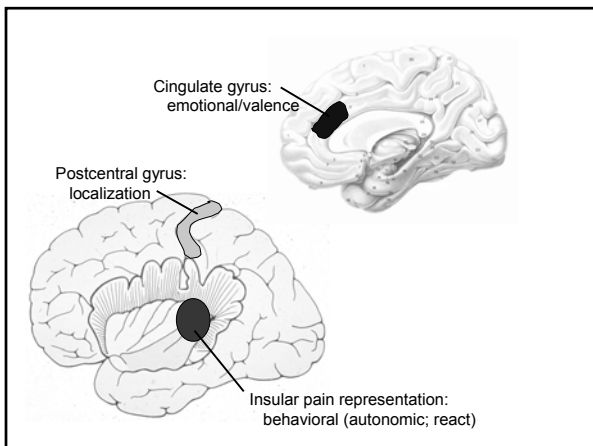
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## Summary

- Early morphological specialization of DRG neurons sets stage for separate mechanosensory and pain/temp/itch systems
- Different ascending pathways to distinct subcortical and cortical sites
- Single thalamic mechanosensory nucleus and 1° ctx
- Multiple thalamic pain nuclei and cortical areas
- Parietal lobe projections may play role in stimulus localization, esp. for touch
- Cortical pain representations closely tied to emotions

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