Νευροφυσιολογία και Αισθήσεις

Διάλεξη 12

Σωματοαισθητικό Σύστημα

(Somatosensory System)

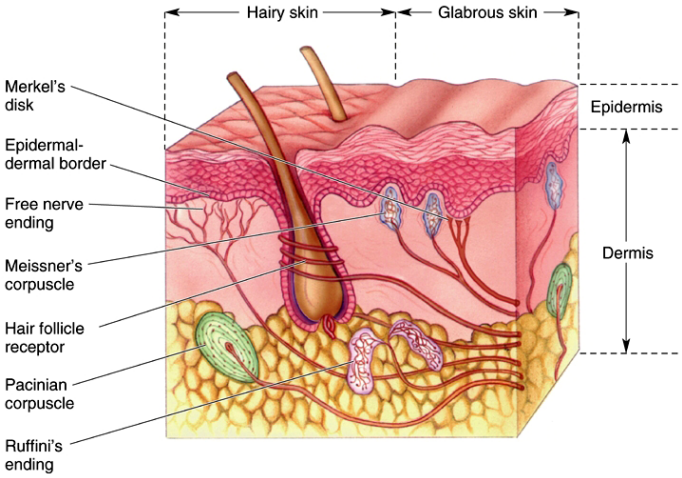
Biomedical Imaging & Applied Optics
University of Cyprus

Somatic Sensation

- **Enables body to feel, ache, chill**
- **Sensitive to stimuli**
- **Responsible for feeling of touch, pain and temperature**
- **Somatic sensory system: Different from other systems**
  - Receptors: Distributed throughout
  - Responds to different kinds of stimuli

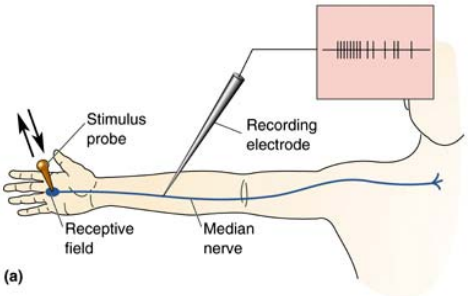
Touch

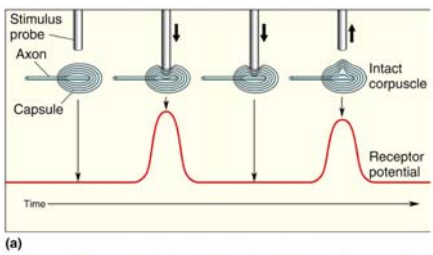
- **Types and layers of skin**
  - Hairy and glabrous (hairless)
  - Epidermis (outer) and dermis (inner)
- **Functions of skin**
  - Protective function
  - Prevents evaporation of body fluids
  - Provides direct contact with world
- **Mechanoreceptors**
  - Sensitivity: 0.006 mm high x 0.04 mm wide
  - Most somatosensory receptors are mechanoreceptors
  - Types
    - Pacinian corpuscles
    - Ruffini's endings
    - Meissner's corpuscles
    - Merkel's disks
    - Krause end bulbs

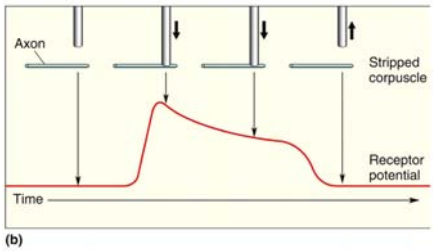


Touch

- **Characteristics of mechanoreceptors**
  - Receptive Fields
  - Adaptation
    - Role of onion-like structure







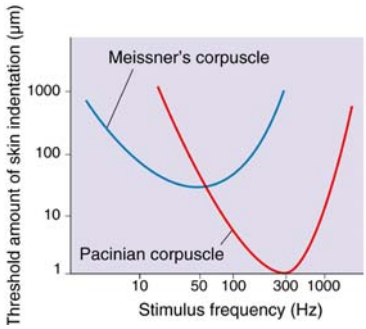
Adaptation	Receptive field size: Small	Receptive field size: Large
Rapid	Meissner's corpuscle	Pacinian corpuscle
Slow	Merkel's disk	Ruffini's ending

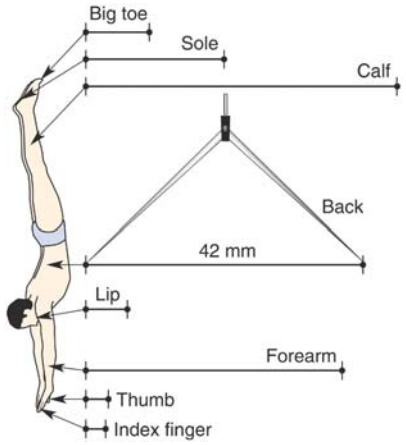
Stimulus probe movement

Axon firing

Touch

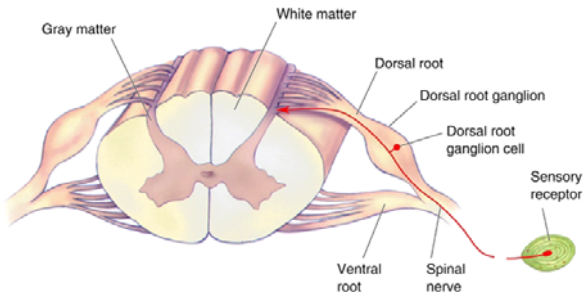
- **Response of mechanoreceptors**
  - Hair
    - Sensitive to movement
    - Exquisitely sensitive in some animals
  - Response to vibration frequency
    - Pancinian corpuscles
    - Meissner's corpuscles
    - Ruffini's endings
  - Two-point discrimination
    - Importance of fingertips over elbow

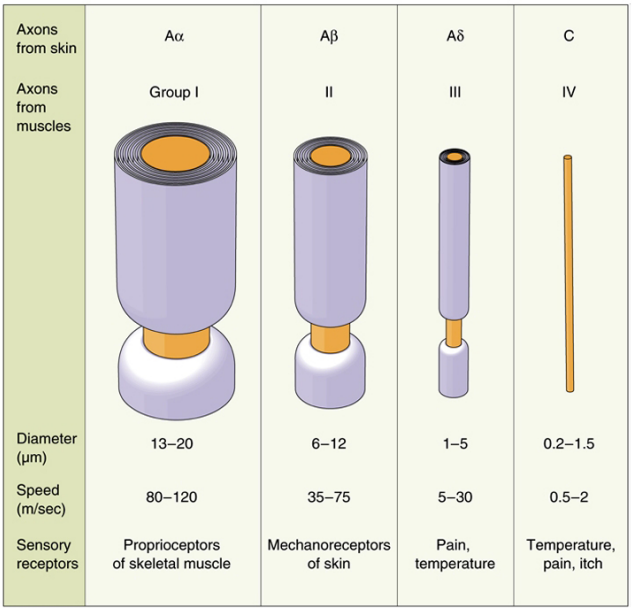




Touch

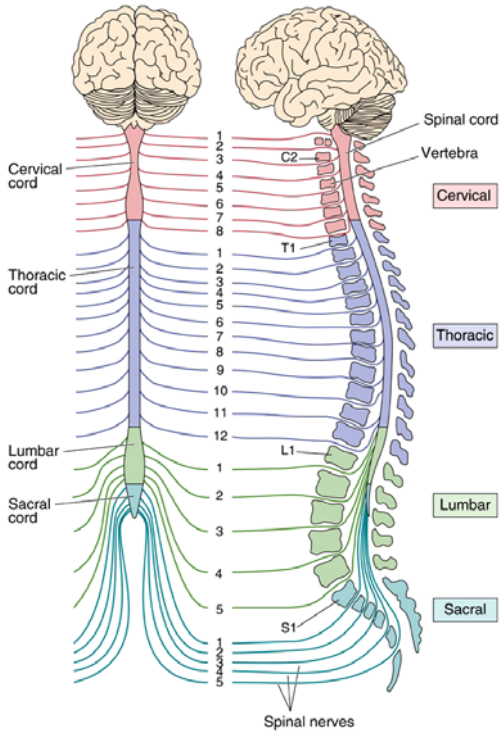
- **Primary Afferent Axons**
  - Aα, Aβ, Aδ, C
  - C fibers mediate pain and temperature
  - Aβ mediates touch sensations





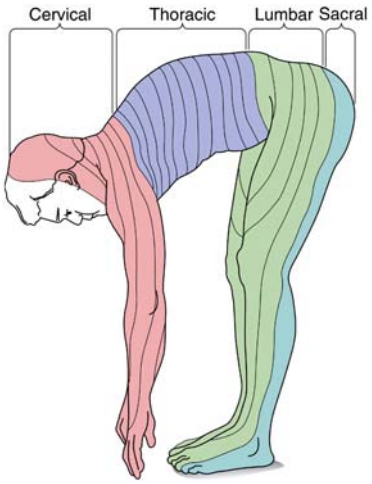
Touch

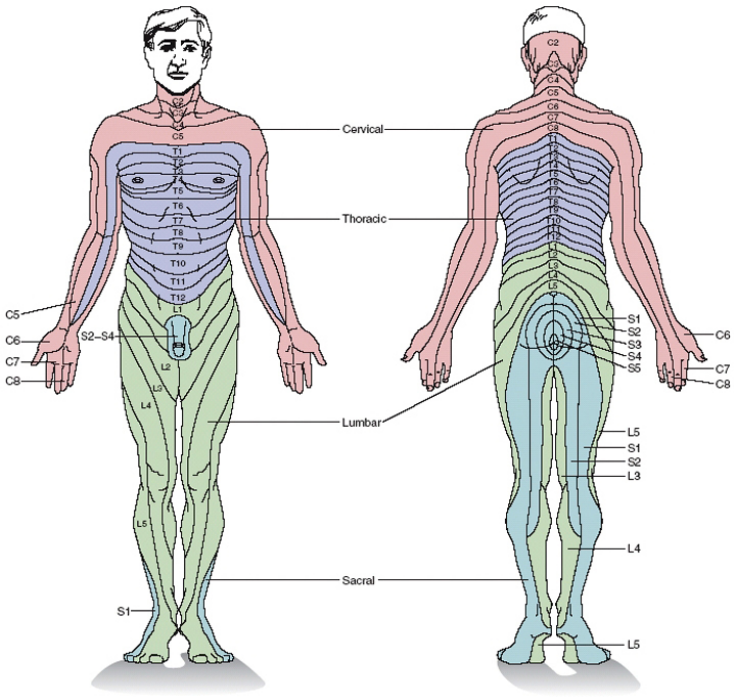
- **The Spinal cord**
  - Spinal segments (30)- spinal nerves within 4 divisions of spinal cord
  - Sensory Organization of the spinal cord
    - Divisions
      - Cervical (C)
      - Thoracic (T)
      - Lumbar (L)
      - Sacral (S)



Touch

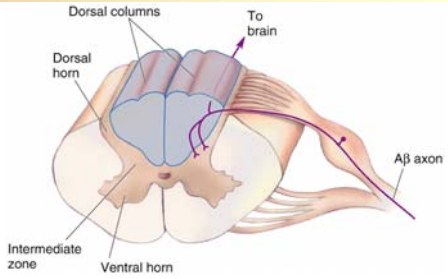
- **The Spinal cord**
  - Dermatomes- 1-to-1 correspondence with segments
    - Shingles

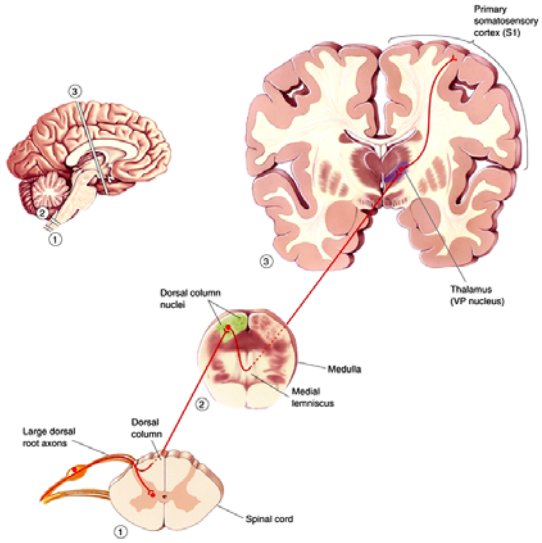




Touch

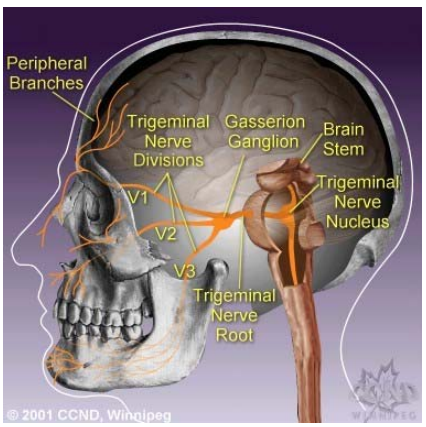
- **The Spinal cord**
  - Sensory Organization of the spinal cord
    - Division of spinal gray matter: Dorsal horn; Intermediate zone; Ventral horn
      - Myelinated Aβ axons (touch-sensitive)
- **Dorsal Column–Medial Lemniscal Pathway**
  - Touch information ascends through dorsal column, dorsal nuclei, medial lemniscus, and ventral posterior nucleus to primary somatosensory cortex

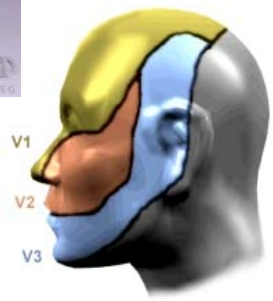


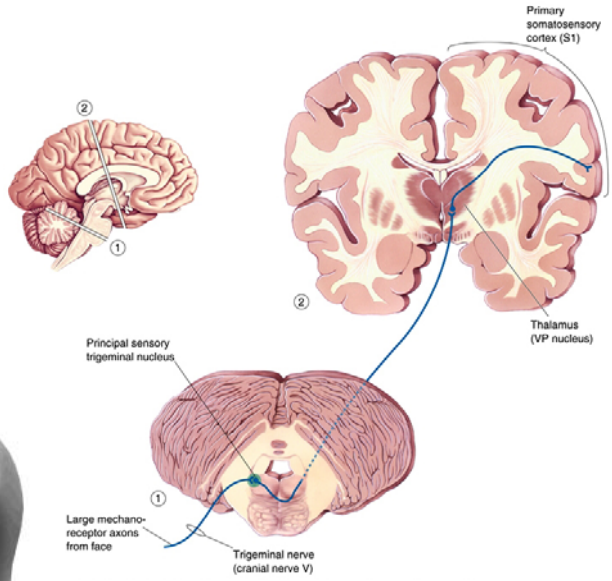


Touch

- **The Trigeminal Touch Pathway**
  - Trigeminal nerves
  - Cranial nerves

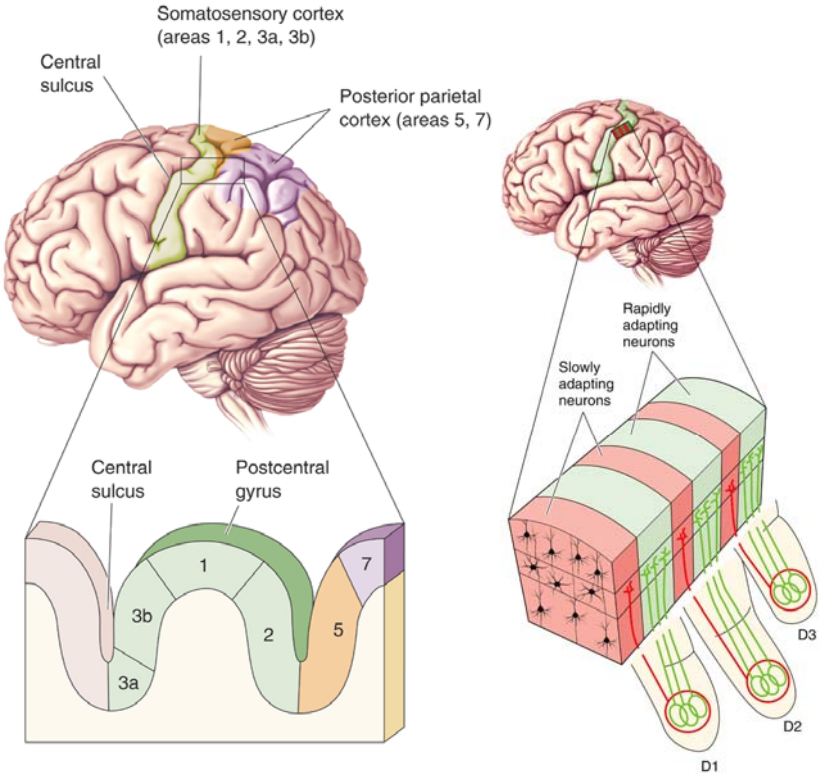






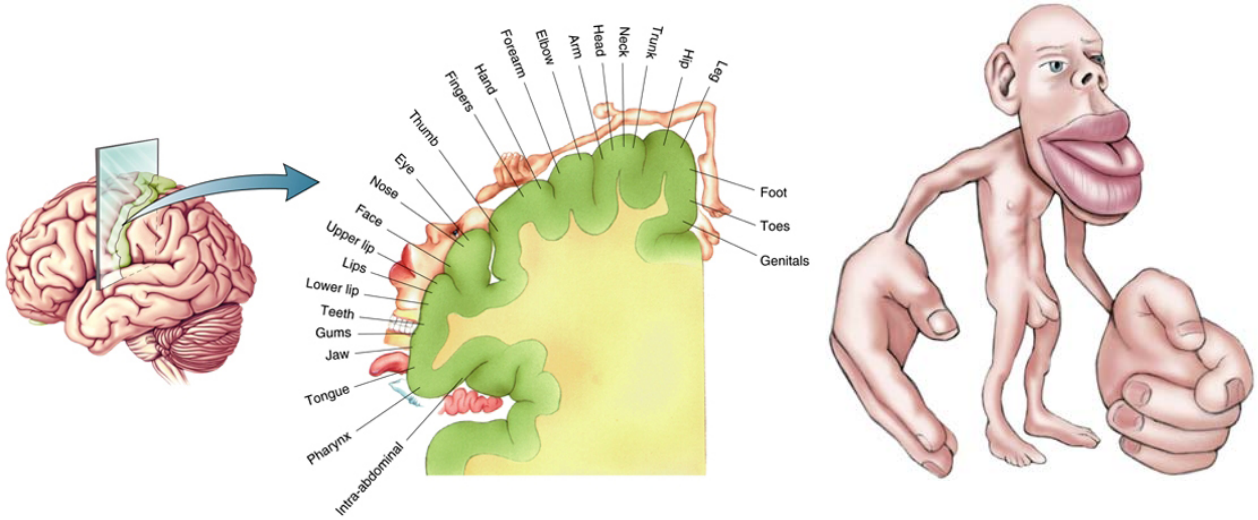
Touch

- **Somatosensory Cortex**
  - Primary
  - Other areas
    - Postcentral gyrus
    - Posterior Parietal Cortex
  - Brodmann's Area 3b (or S1): Primary somatosensory cortex
    - Receives dense input from VP nucleus of the thalamus
    - Neurons: Responsive to stimuli
    - Lesions impair somatic sensations
    - Electrical stimulation evokes sensory experiences



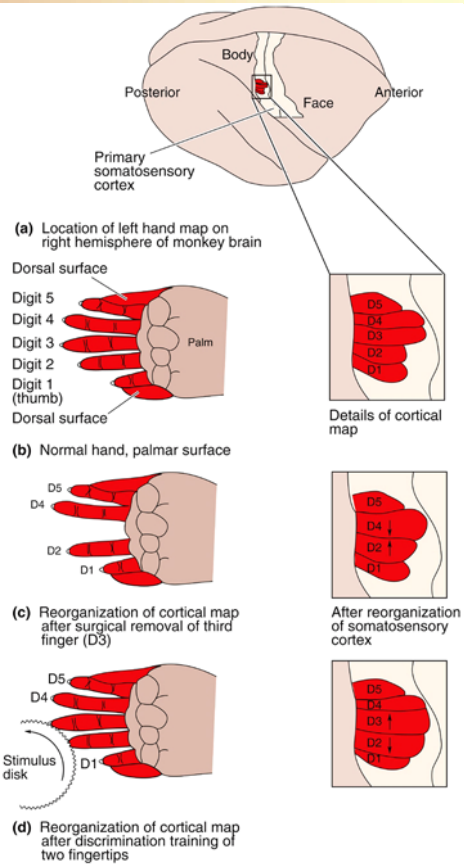
Touch

- **Somatosensory Cortex**
  - Cortical Somatotopy
    - Homunculus
    - Importance of mouth
      - Tactile sensations: Important for speech
      - Lips and tongue: Last line of defense



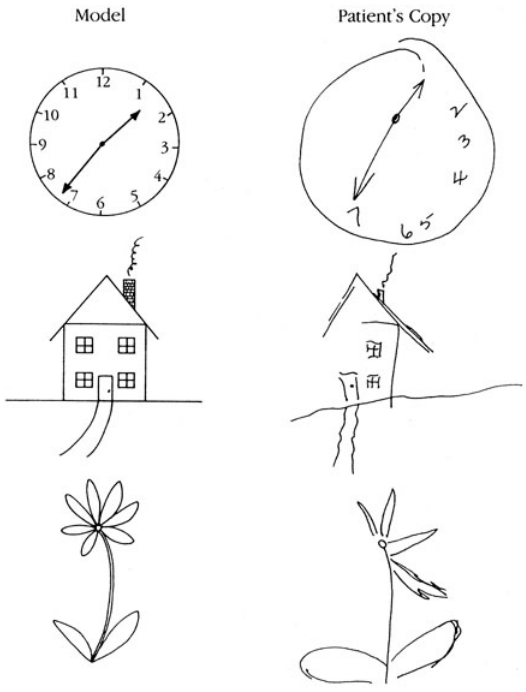
Touch

- **Somatosensory Cortex**
  - Cortical Map Plasticity
  - Remove digits or overstimulate – examine somatotopy before and after
    - Conclusions of experiments
      - Reorganization of cortical maps
        - Dynamic
        - Adjust depending on the amount of sensory experience



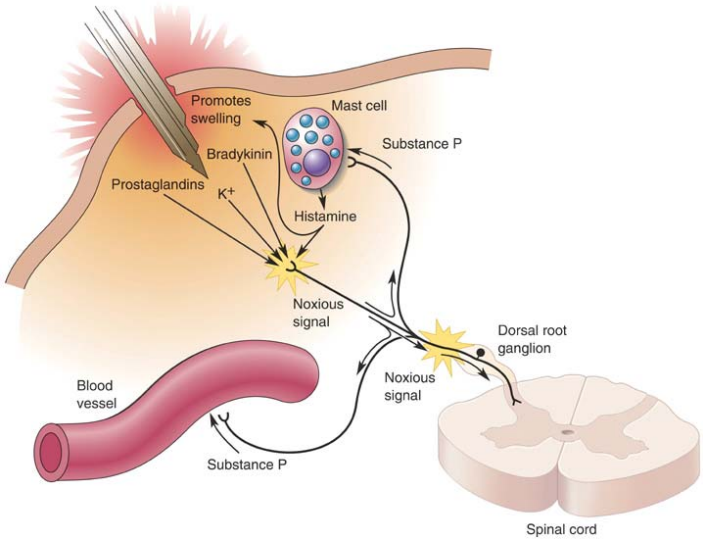
Touch

- **Somatosensory Cortex**
  - The Posterior Parietal Cortex
    - Involved in somatic sensation, visual stimuli, and movement planning
    - Agnosia
    - Astereoagnosia
    - Neglect syndrome



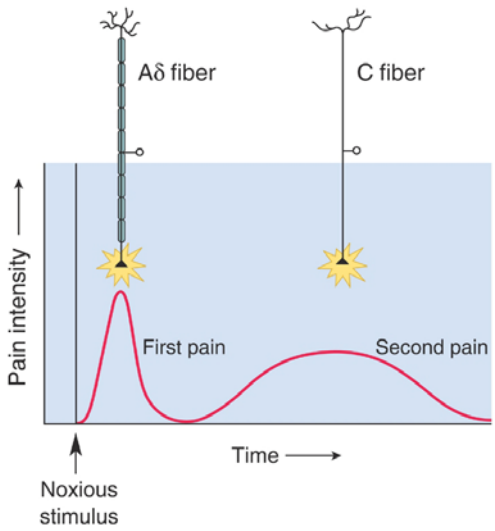
Pain

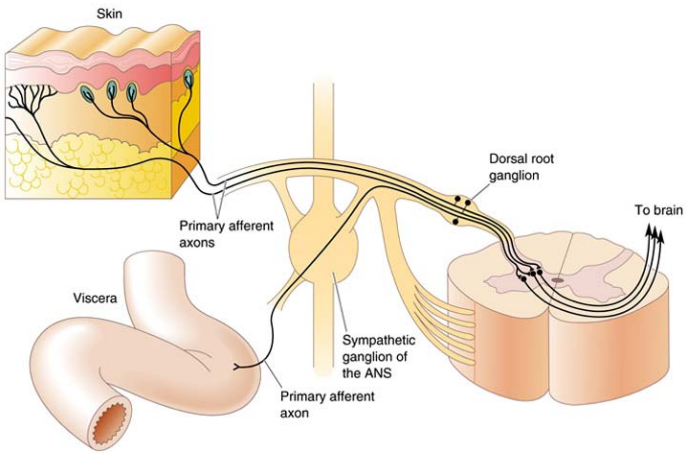
- **Nociceptors**
  - Polymodal
  - Mechanical
  - Thermal
  - Chemical
- **Pain and nociception**
  - Pain - feeling of sore, aching, throbbing
  - Nociception - sensory process, provides signals that trigger pain
- **Nociceptors: Transduction of Pain**
  - Bradykinin
  - Mast cell activation: Release of histamine
  - Hyperalgeia
    - Painful damaged or sourrounding areas
    - Primary and secondary hyperalgesia
    - Bradykinin, prostaglandins, and substance P



Pain

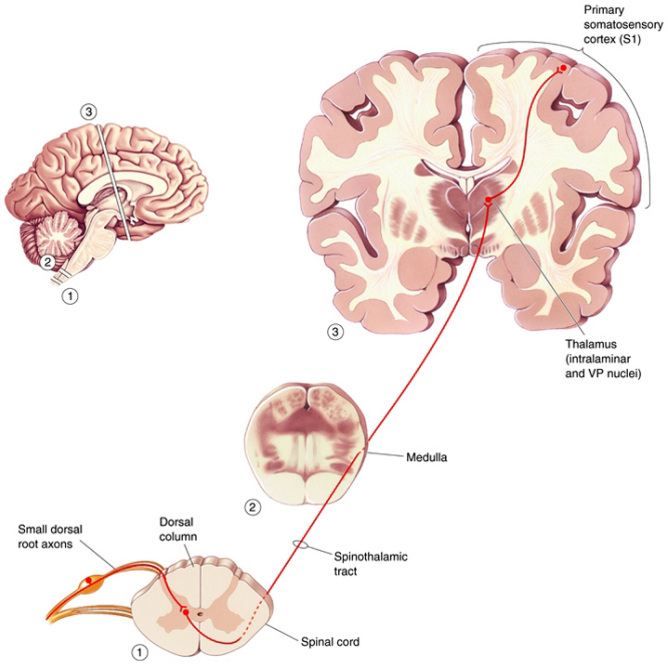
- **Primary Afferents and Spinal mechanisms**
  - First pain and second pain
  - Referred pain: Angina



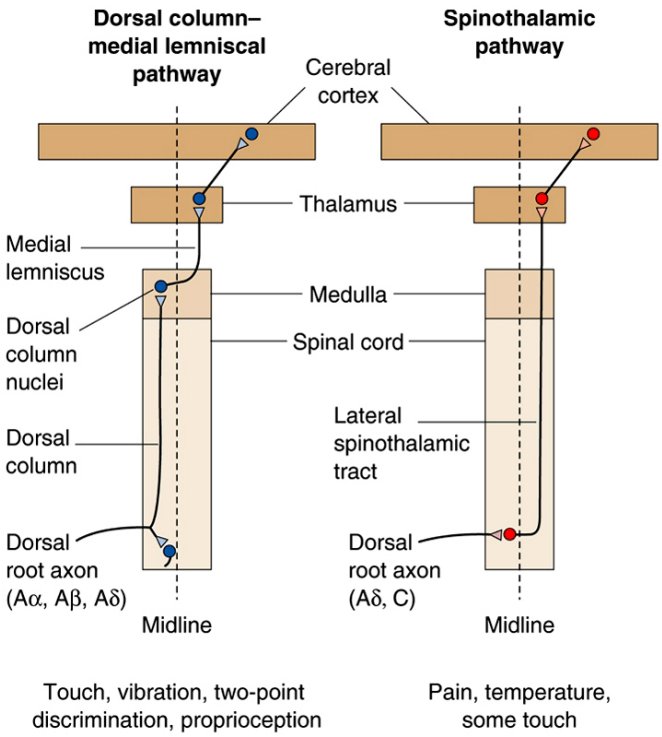


Pain

- **Ascending Pain Pathways**
  - Differences between touch and pain pathway
    - Nerve endings in the skin
    - Diameter of axons
    - Connections in spinal cord
      - Touch – Ascends Ipsilaterally
      - Pain – Ascends Contralaterally
  - Spinothalamic Pain Pathway
    - Cross at spinal level
  - The Trigeminal Pain Pathway
    - Pain and temperature sensation of face
  - The Thalamus and the Cortex
    - Touch and pain systems remain segregated
    - Pain and temperature information sent to various cortical areas



Pain



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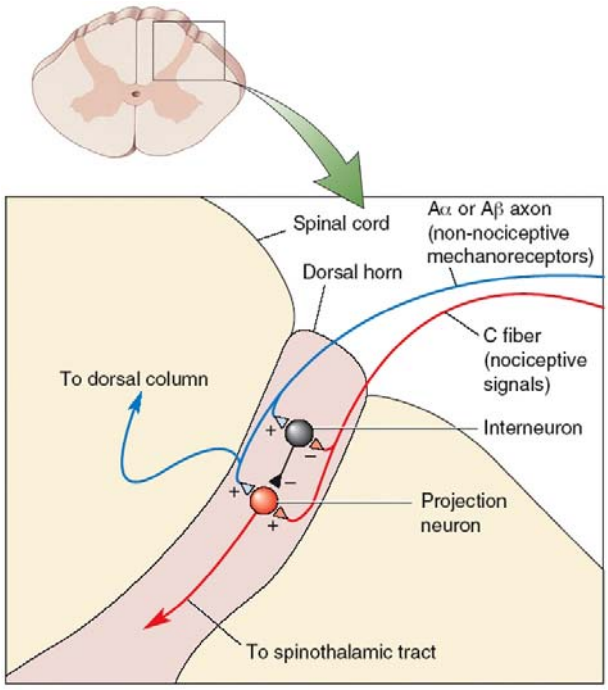
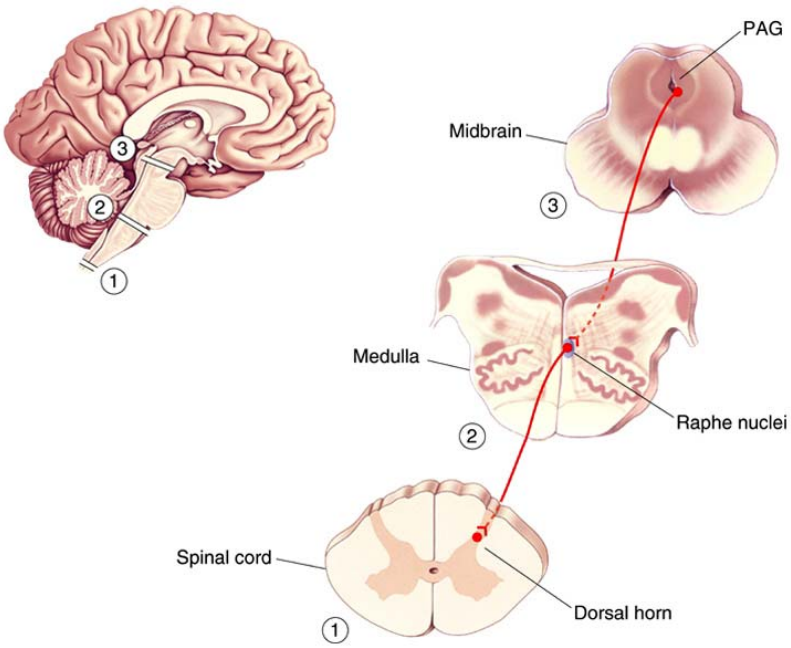
Pain

- **The Regulation of Pain**
  - Afferent Regulation
    - Hyperalgesia and down regulation? (i.e. rubbing skin around)



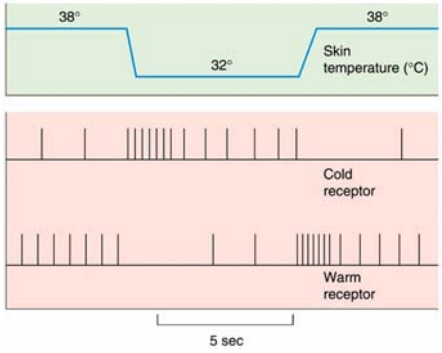
Pain

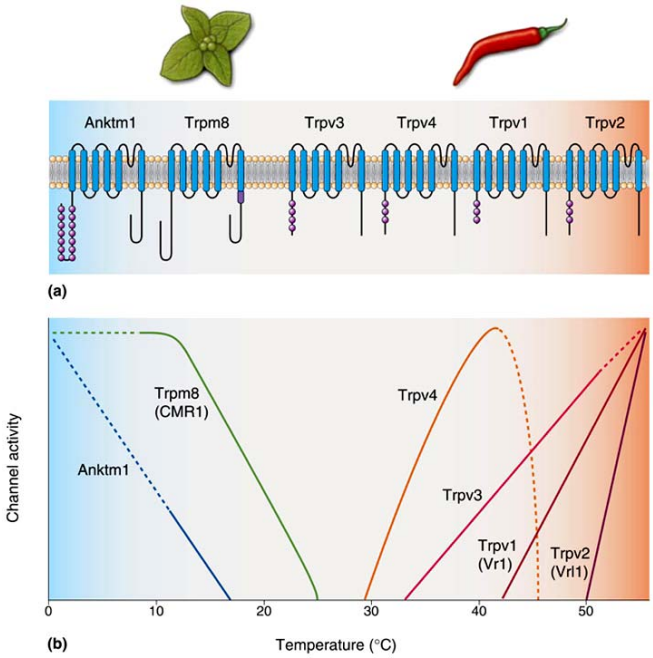
- **The Regulation of Pain**
  - Descending Regulation
    - Periaquaductal gray matter
    - The endogenous opiates
      - Opioids and endomorphins



Temperature

- **Thermoreceptors**
  - "Hot" and "cold" receptors
  - Varying sensitivities
  - Perceive changes as low as 0.01 ºC
  - Adaptation
- **The Temperature Pathway**
  - Organization of temperature pathway
    - Identical to pain pathway
  - Cold receptors coupled to Aδ and C
  - Hot receptors coupled to C





Conclusion

- **Sensory systems exhibit similar organization and function**
- **Sensory types are segregated within the spinal cord and cerebral cortex**
- **Repeated theme**
  - Parallel processing of information
- **Perception of object involves the seamless coordination of somatic sensory information**

Επόμενη Διάλεξη …

Διάλεξη 13

Κίνηση από τον Νωτιαίο Μυελό

(Spinal Control of Movement)