Ascending Pathways

Professor Dr. Farah Nabil

MBChB, MSc, PhD

SENSORY PATHWAYS

(1) Specific Ascending Pathways

- Carry information of single types of stimulus.
- Pass to ➔ brainstem & thalamus ➔ different areas of cerebral cortex.
- Cross to the opposite side of the CNS.
- Pathways transmit information from the somatic receptors ➔ somatosensory cortex.
- Pathways transmit information from special sensory receptors ➔ special cortical areas.

SENSORY PATHWAYS

(2) Non-specific Ascending Pathways

- Activated by sensory units of several different types ➔
- Signal general information.
- Sensory information ➔ spinal nerves ➔ dorsal roots of spinal cord ➔ brain.

The Dorsal Columns-Medial Lemniscal System

- 1st order neuron: ascend up to the medulla oblongata
- 2nd order neuron: crosses through medial lemnsci to the thalamaus (ventrolateral complex).
- 3rd order neuron: somatosensory area I → to somatic sensory area II.

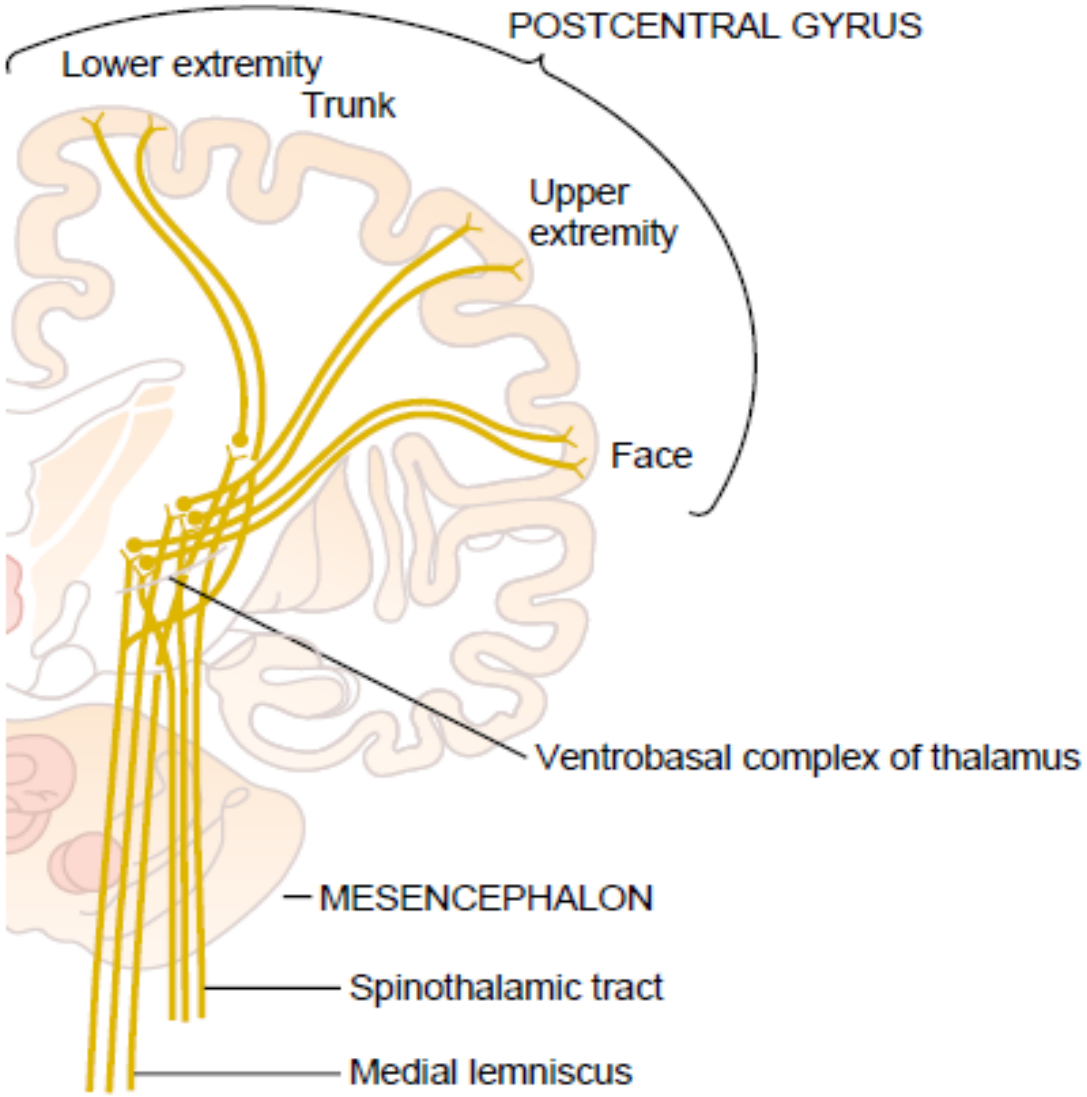


Figure 47–4

Projection of the dorsal column–medial lemniscal system through the thalamus to the somatosensory cortex. (Modified from Brodal A: Neurological Anatomy in Relation to Clinical Medicine. New York: Oxford University Press, 1969, by permission of Oxford University Press.)

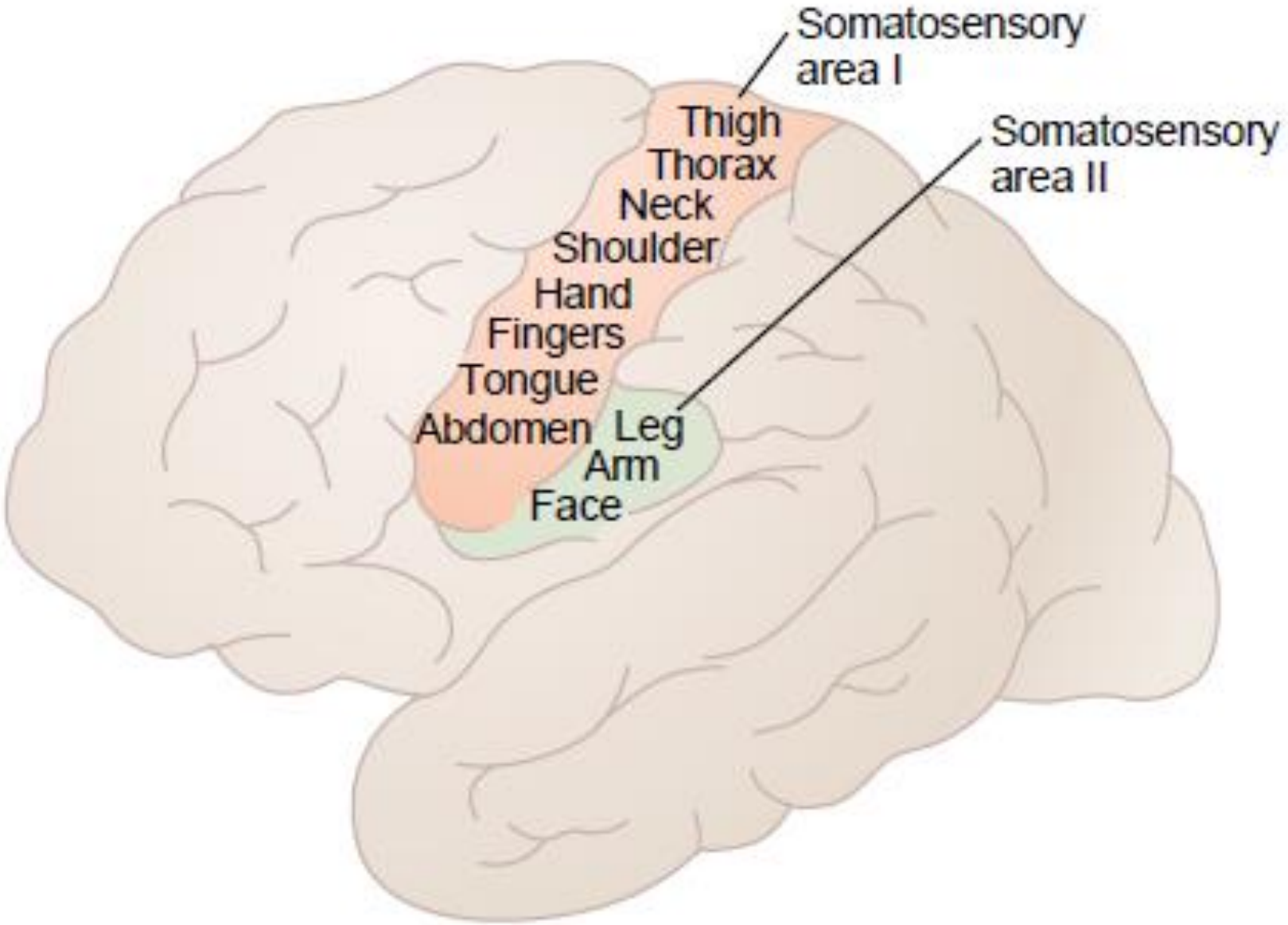


Figure 47–6

Two somatosensory cortical areas, somatosensory areas I and II.

The Dorsal Columns-Medial Lemniscal System

- Large myelinated nerve fibers (CV = 30-110 m/sec).
- High degree of spatial orientation of the nerve fibers with respect to their origin.
- More accurate intensity gradation (100 times)
- In the thalamus:

i. Tail end of the body represented by lateral portions
ii. Head and face represented in the medial components of the complex.

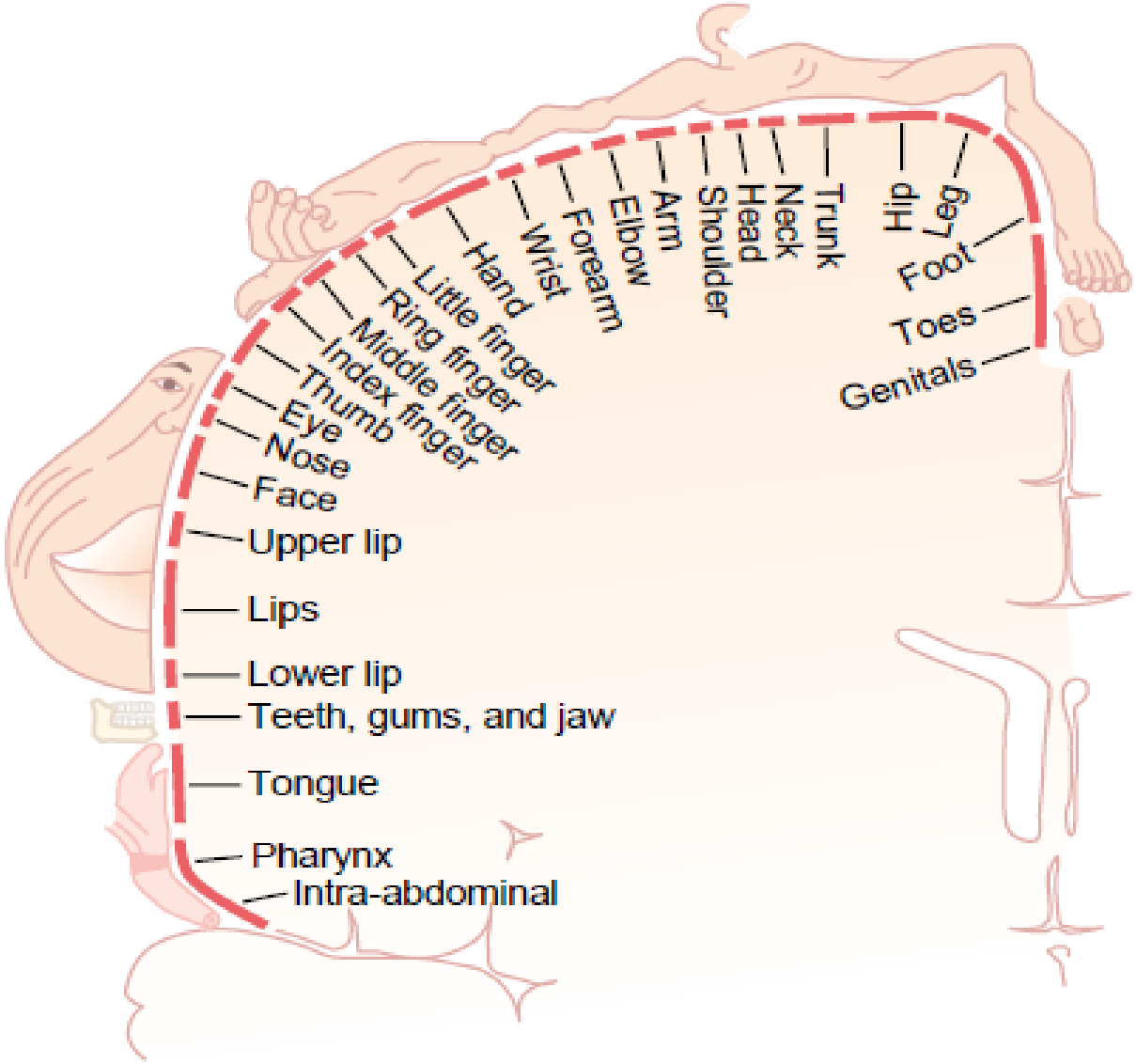


Figure 47–7

Representation of the different areas of the body in somatosensory area I of the cortex. (From Penfield W, Rasmussen T: Cerebral Cortex of Man: A Clinical Study of Localization of Function. New York: Hafner, 1968.)

The Dorsal Columns-Medial Lemniscal System

1) Touch sensation requiring a high degree of localization of stimulus.
2) Touch sensation requiring transmission of fine gradations of intensity.
3) Vibratory sensations (phasic sensation).
4) Sensations signal movement against skin.
5) Position sensation from the joints.
6) Pressure sensations

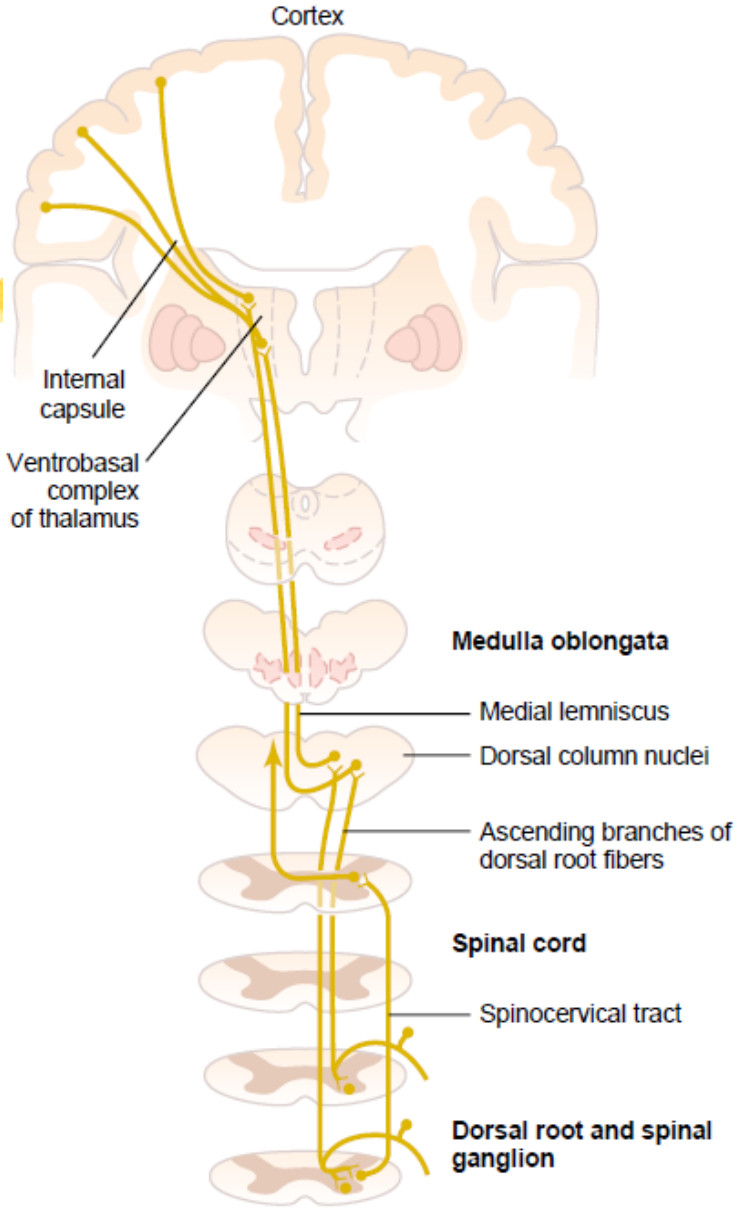
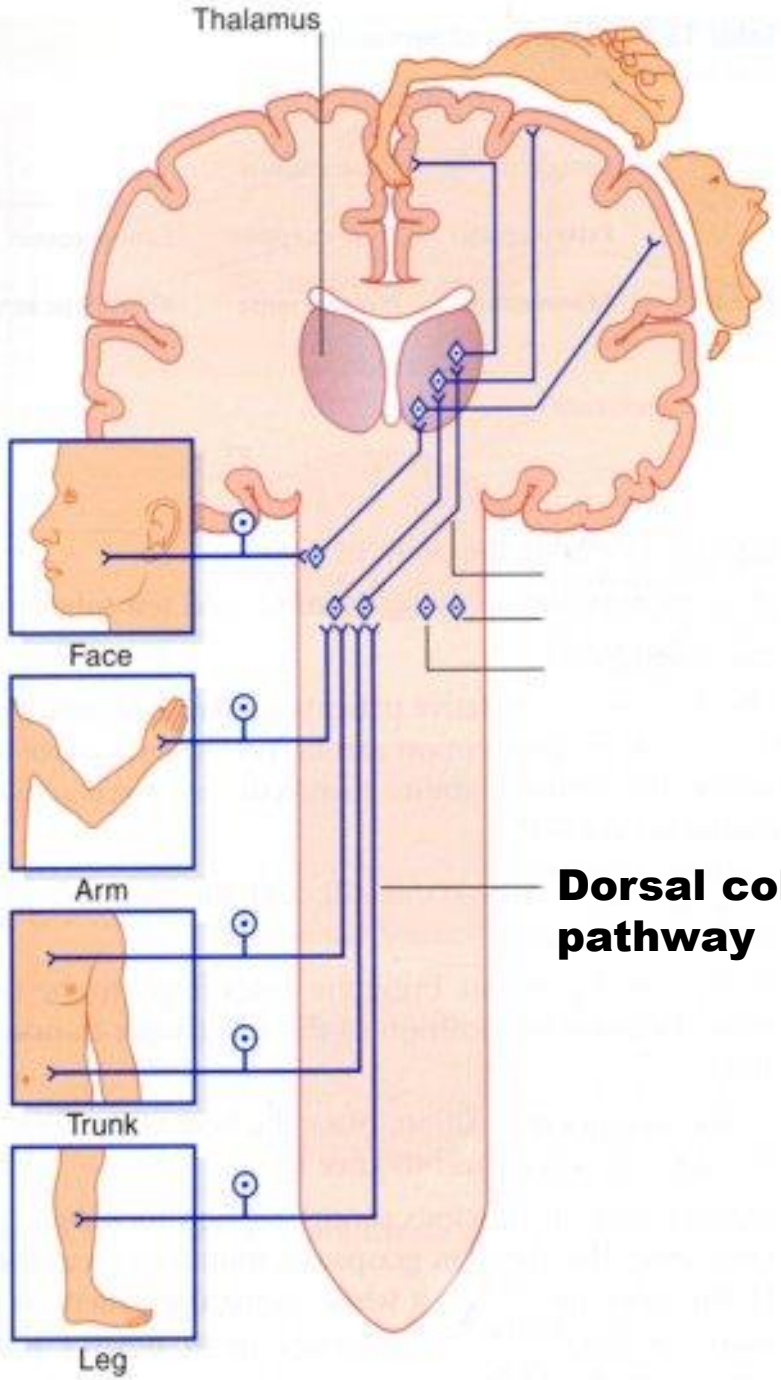


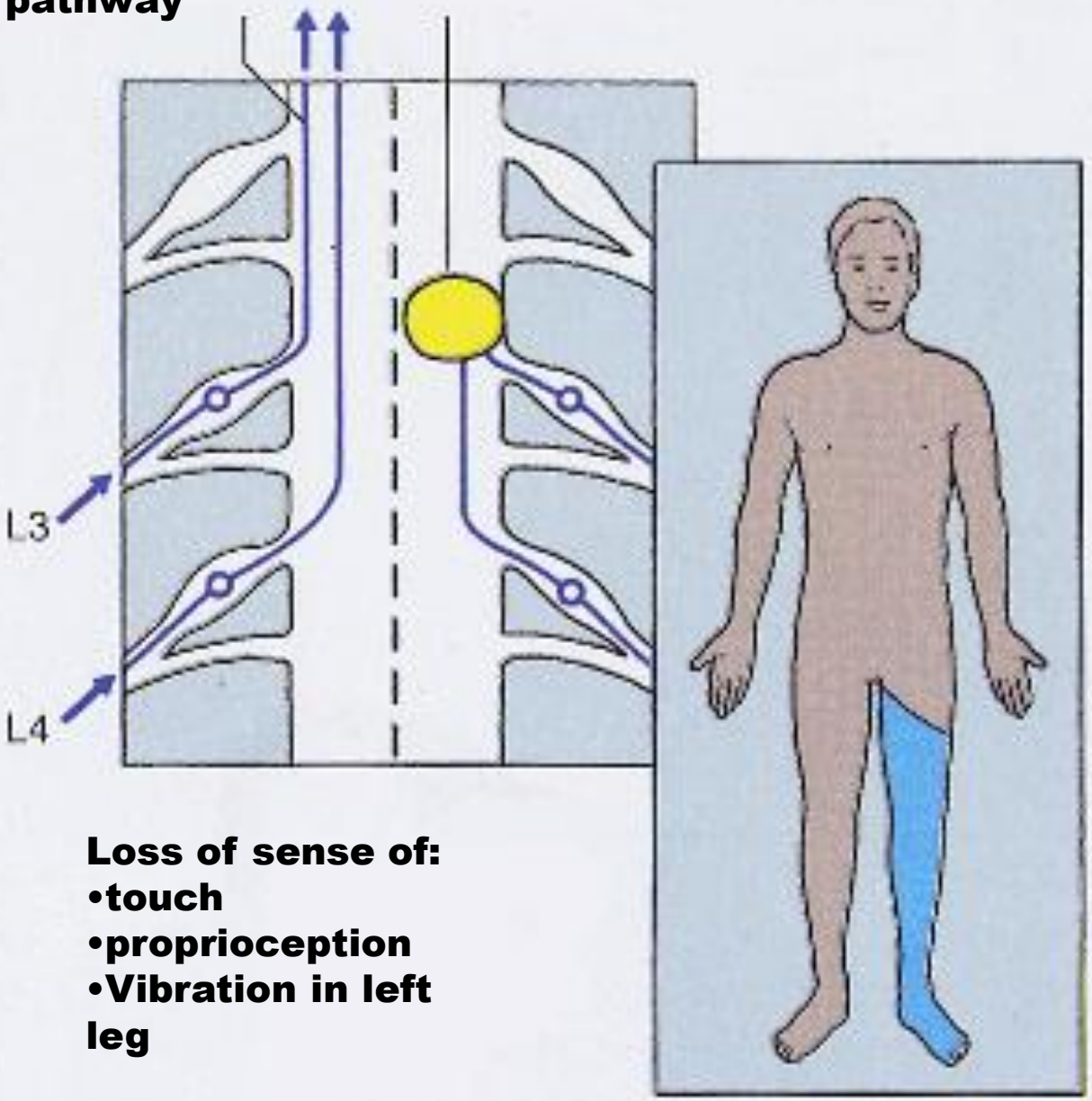
Figure 47–3

The dorsal column–medial lemniscal pathway for transmitting critical types of tactile signals. (Modified from Ranson SW, Clark SL: Anatomy of the Nervous System. Philadelphia: WB Saunders Co, 1959.)


Thalamus
Face
Arm
Trunk
Leg
Dorsal column pathway

dorsal column pathway

Left spinal cord injury



Loss of sense of:

- **touch**
- **proprioception**
- **Vibration in left leg**

Anterolateral System

- Composed of much smaller myelinated nerve fibers (CV = 8-40m/sec).
- Much smaller degree of spatial orientation
- Less accurate intensity gradation (10-20)
- Poor ability to transmit rapidly changing or rapidly repetitive signals

Anterolateral System

1) Pain sensation.
2) Thermal sensation (warm & cold sensations).
3) Crude touch and pressure sensations.
4) Tickle and itch sensation
5) Sexual sensations.

Anterolateral System

- 1st order neuron: signals originate in the dorsal horn of lamina I, IV, V, and VI
- 2nd order neuron: crosses to the opposite side of the spinal cord → ascend through anterior and lateral white matter → terminate at all levels of the brainstem and in the thalamus.

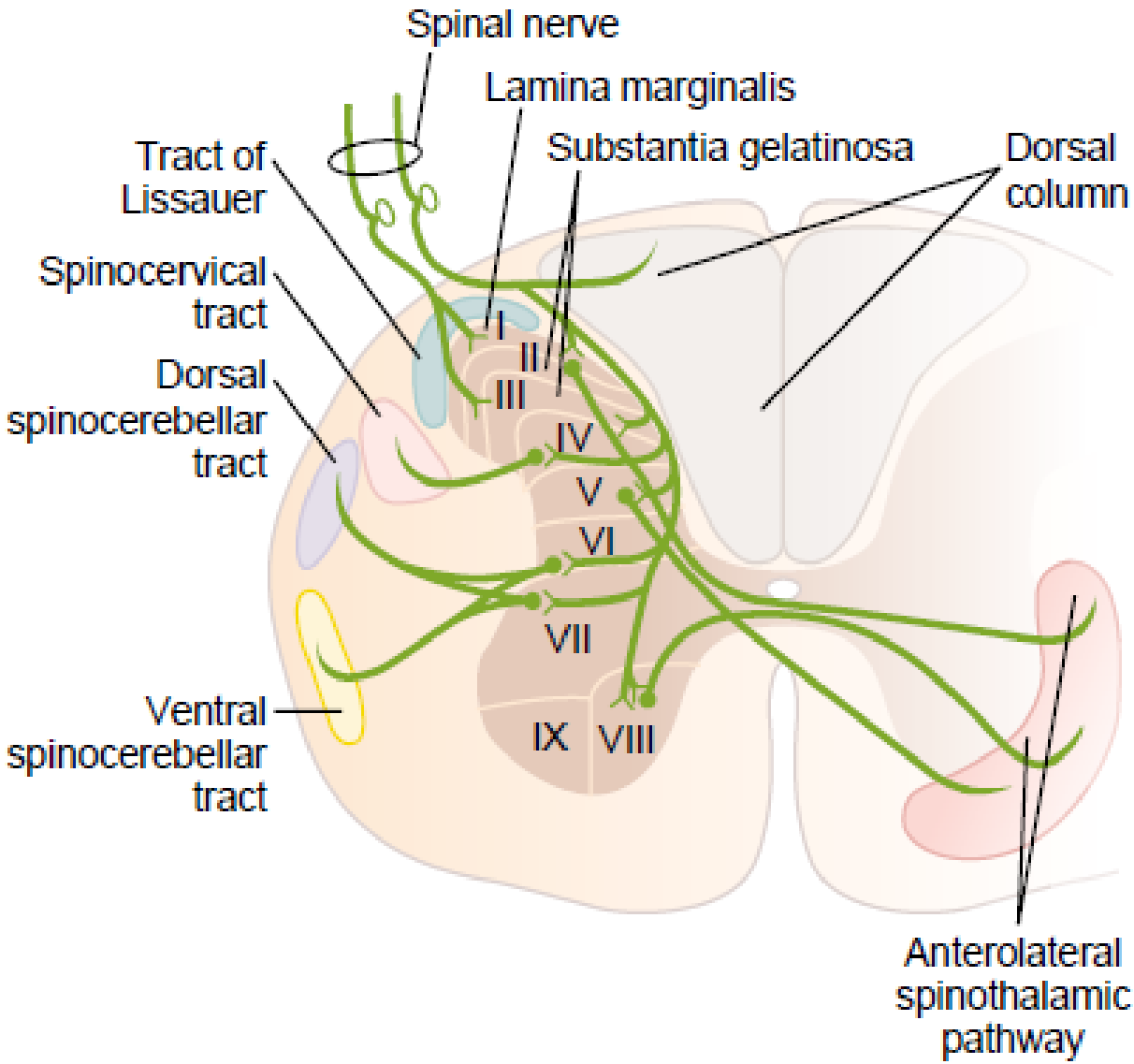


Figure 47–2

Cross section of the spinal cord, showing the anatomy of the cord gray matter and of ascending sensory tracts in the white columns of the spinal cord.

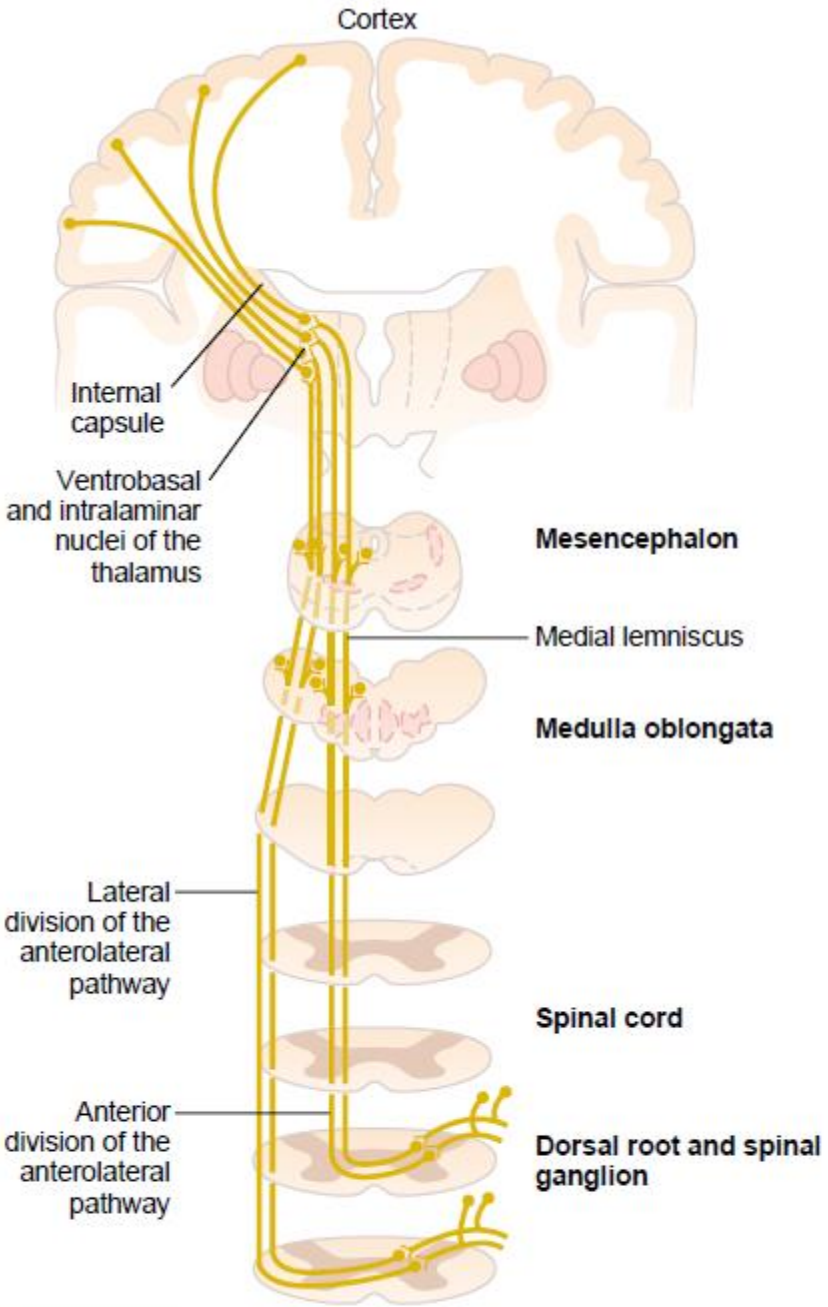
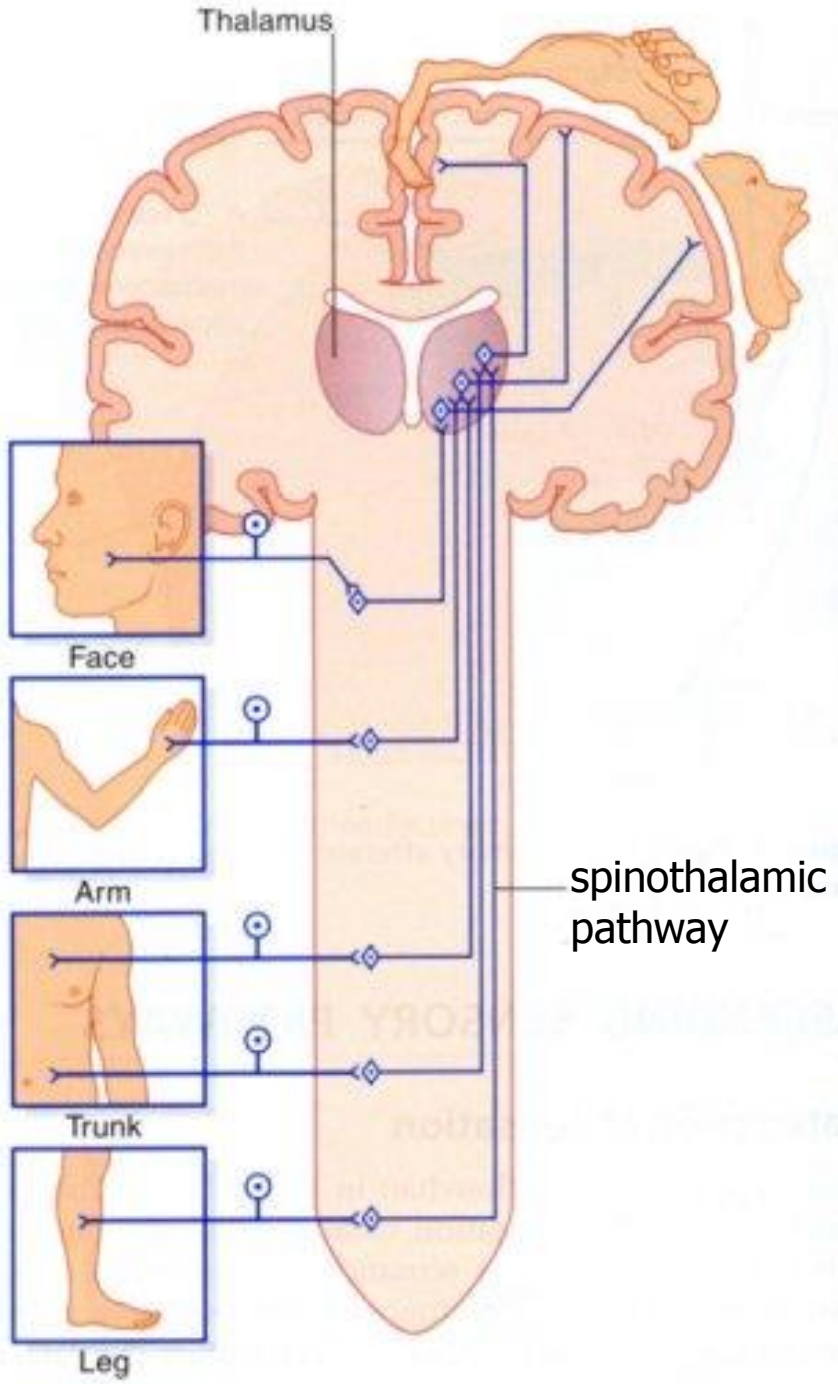


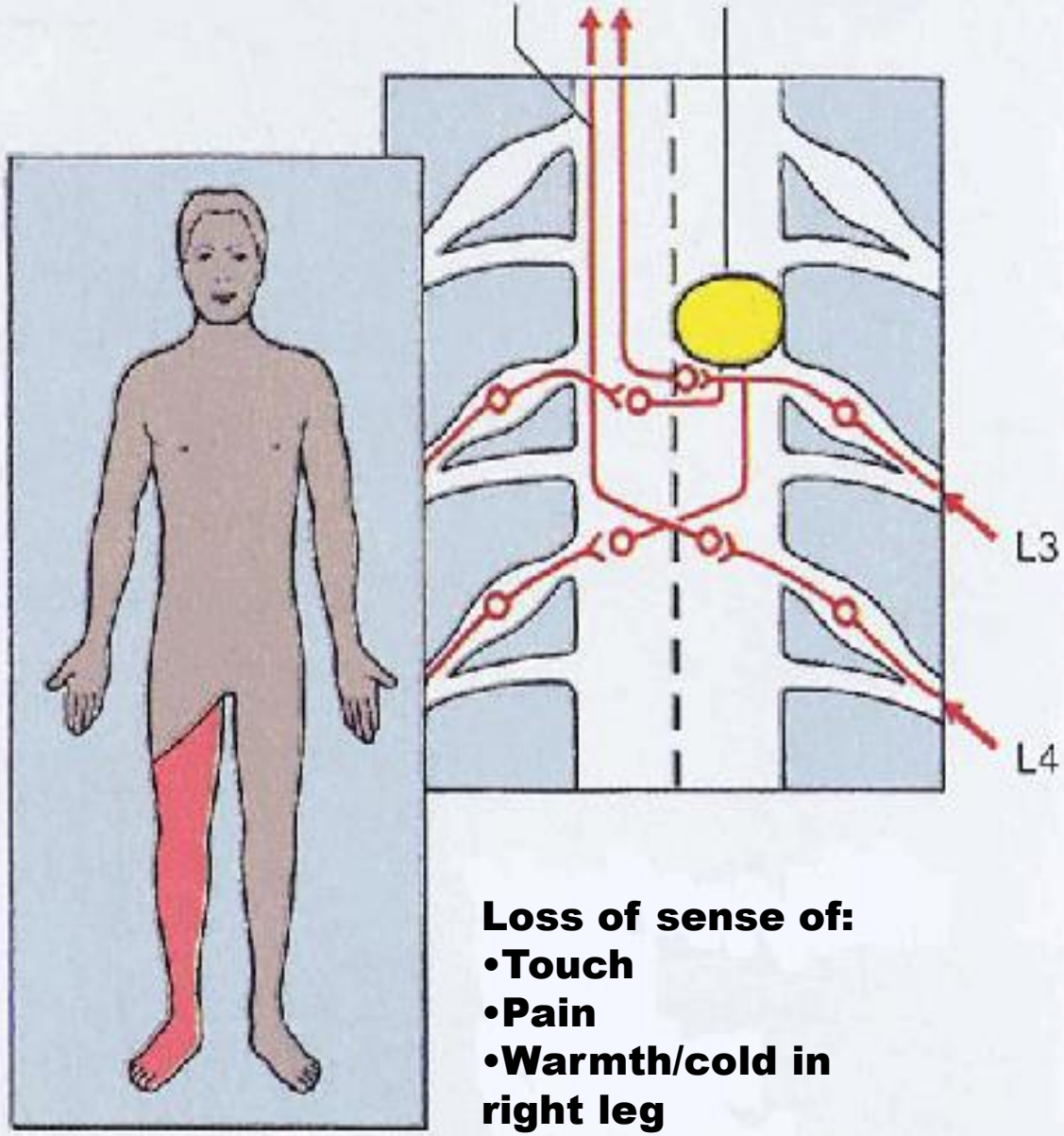
Figure 47–13

Anterior and lateral divisions of the anterolateral sensory pathway.

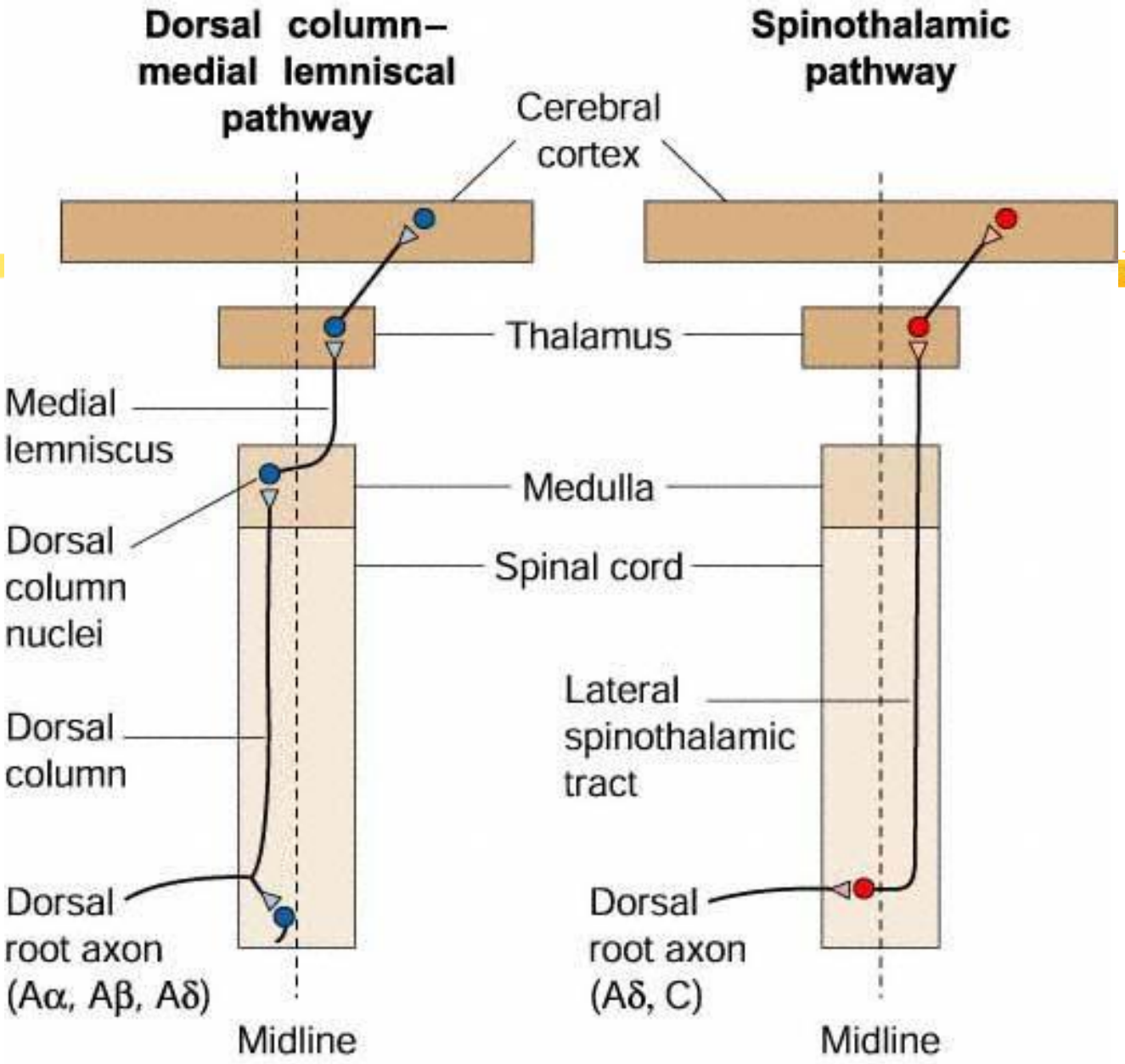

Thalamus
Face
Arm
Trunk
Leg
spinothalamic pathway

spinothalamic pathway

Left
spinal cord injury



Loss of sense of:
- **Touch**
- **Pain**
- **Warmth/cold in right leg**


Dorsal column–medial lemniscal pathway
Spinothalamic pathway
Cerebral cortex
Thalamus
Medial lemniscus
Medulla
Dorsal column nuclei
Spinal cord
Lateral spinothalamic tract
Dorsal column
Dorsal root axon (Aα, Aβ, Aδ)
Dorsal root axon (Aδ, C)
Midline
Midline
Touch, vibration, two-point discrimination, proprioception
Pain, temperature, some touch

Syringomyelia

- Destruction of central canal and its surrounding areas → injury to anterior white commissure which contains crossing anterior spinothalamic tracts.
- Results:
  - Bilateral loss of pain and temperature sensations below the lesion
  - Other sensations are preserved in uncrossed tracts of posterior column (dissociated sensory loss).

Tabes Dorsalis

- Tertiary syphilitic degeneration of posterior white columns which only sensory tracts.
- Results:

1) Loss of tactile discrimination,
2) Loss of vibration sense
3) Loss of position sense.
4) Rhomberg's sign is positive.