Physiology of the sensory system
Two-point discrimination

- Number receptors / area

(receptive field of the receptor)
Smaller the receptive fields, greater the density of receptors. This relationship allows for greater discrimination in sensory inputs.
Two-point discrimination

- Number receptors / area
- Pathway arrangement
Compass with points separated by 20 mm

Primary sensory neurons

Secondary sensory neurons

One signal goes to the brain

Compass with points separated by 20 mm

Primary sensory neurons

Secondary sensory neurons

Two signals go to the brain
The Spinal Nerve

Text Fig. 9-6, Anatomical Orientation
Sensations modalities

Fast

- 2-point discrimination
- Vibration
- Prorioception

Slow

- Crud touch (itch & rub)
- Temperature
- Pain

Posterior Column-Medial lemniscus Pathway (PCML)
Sensations modalities

Fast

• 2-point discrimination
• Vibration
• Prrioception

Slow

• Temperature
• Crud touch (itch & rub)
• Pain

Antero-lateral system (ALS)
Other name: Spinothalamic pathway
Sensations modalities

Fast

• 2-point discrimination
• Vibration
• Prorioception

Posterior Column-Medial lemniscus
Pathway (PCML)

Slow

• Temperature
• Crud touch (itch & rub)
• Pain

Antero-lateral system (ALS)
Other name: Spinothalamic pathway

Pressure ???????
Posterior Column-Medial lemniscus Pathway (PCML)
Receptors for touch, pressure, vibration, and proprioception in the upper limbs, upper trunk, neck, and posterior head.

Receptors for touch, pressure, vibration, and stereognosis in the lower limbs and lower trunk.
Ascending and Descending Tracts of the Spinal Cord

Cervical

Thoracic

Lumbar

Extremity (UE)

Extremity (LE)
PCML Pathway
PCML Pathway

- Spinal trigeminal tract and nucleus (pars caudalis)
- Posterior root ganglia
- Thalamus (ventral poster nucleus)
- Media lemnis
- Gracile nucleus
- Cuneate nucleus
- FIRST-ORDER NEURONS
- Posterior root ganglion
- Receptors for touch, pressure, vibration, and proprioception in the upper limbs, upper trunk, neck, and posterior head
- Cervical spinal cord
- Lumbar spinal cord
- Receptors for touch, pressure, vibration, and stereognosis in the lower limbs and lower trunk
- POSTERIOR COLUMN:
  - Gracile fasciculus
  - Cuneate fasciculus
  - Spinal nerve

Pyramis

Right of B

Media lemnis

Gracile nucleus

Cuneate nucleus

FIRST-ORDER NEURONS

Posterior root ganglion

Receptors for touch, pressure, vibration, and proprioception in the upper limbs, upper trunk, neck, and posterior head

Cervical spinal cord

Lumbar spinal cord

Receptors for touch, pressure, vibration, and stereognosis in the lower limbs and lower trunk
PCML Pathway

Spinal trigeminal tract and nucleus (pars caudalis)

Posterior root ganglia

T4

L4

Thalamic (ventral posteromedial) nucleus

Medial lemniscus

Gracilis nucleus

Cuneate nucleus

CERVICAL SPINAL CORD

LUMBAR SPINAL CORD

Receptors for touch, pressure, vibration, and stereognosis in the lower limbs and lower trunk
Lumbar Levels
Thoracic Levels
Cervical Levels
MRI of PCML

Postcentral gyrus (middle third is upper extremity area of somatosensory cortex)

Thalamocortical fibers in posterior limb of internal capsule

Ventral posterolateral nucleus

Posterior paracentral gyrus (lower extremity area of somatosensory cortex)

Head of caudate nucleus

Anterior limb, internal capsule

Putamen

Genu, internal capsule

Ventral anterior thalamic nucleus

Posterior limb, internal capsule

Ventral lateral thalamic nucleus

Ventral posterolateral thalamic nucleus

ML in midbrain

ALS in midbrain

Red nucleus

Crus cerebri

Substantia nigra

Midbrain tegmentum

Inferior colliculus

Cerebral aqueduct

ML in pons

ALS in pons

Basilar pons

Pontine tegmentum

Fourth ventricle

Superior cerebellar peduncle

ML in medulla

Anterolateral system (ALS) in medulla

Spinal trigeminal tract and nucleus

Pyramid

Inferior olive

Retro-olivary sulcus

Restiform body

Fourth ventricle

Medial lemniscus (ML)

Sensory decussation

Internal arcuate fibers

Cuneate nucleus

Cuneate nucleus

Posterior root ganglia above T6

Posterior root ganglia below T6

Posterior columns

Gracile fasciculus

Cuneate fasciculus
Somatotopic organization of (PCML)
PCML Function

- 2-point discrimination
- Vibration
- Prrioception
PCML Function

- 2-point discrimination
- Vibration
- Prrioception

- STEREOGNOSIS
PCML Function

• 2-point discrimination
• Vibration
• Proriroception

❖ STEREOGNOSIS

❖ GRAPHESTHESIA
PCML Function

- 2-point discrimination
- Vibration
- Prorioception

- STEREOGNOSIS
- GRAPHESTHESIA
- Help in movement and Wight recognition
PCML lesion associated symptoms

- Loss of 2-point discrimination sensation
- Loss of Vibration sensation
- Loss Prorioception sensation
PCML lesion associated symptoms

- Loss of 2-point discrimination sensation
- Loss of Vibration sensation
- Loss Proriocception sensation

❖ ASTEROGNOSIS / STEREOGNOSIA
PCML lesion associated symptoms

- Loss of 2-point discrimination sensation
- Loss of Vibration sensation
- Loss Prrioioception sensation

- ASTEREOGNOSIS / STEREOGNOSIA
- AGRAPHESTHESIA
- ABAROGNOSIS
- SENSORY ATAXIA
PCML lesion associated symptoms

- Loss of 2-point discrimination sensation
- Loss of Vibration sensation
- Loss Proriioception sensation

- **ASTEREOGNOSIS / STEREOGNOSIA**
- **AGRAPHHESTHESIA**
- **ABAROGNOSIS**
- **SENSORY ATAXIA**
PCML lesion associated symptoms

- Loss of 2-point discrimination sensation
- Loss of Vibration sensation
- Loss Prorioception sensation

- ASTEROGNOSIS / STEREOGNOSIA
- AGRAPHESTHESIA
- ABAROGNOSIS
- SENSORY ATAXIA
Case Study
Antero-lateral system (ALS)
Sensations modalities

Fast

• 2-point discrimination
• Vibration
• Prorioception

Slow

• Temperature
• Crud touch (itch & rub)
• Pain

Antero-lateral system (ALS)
Other name: Spinothalamic pathway
Syringomyelia and the ALS

Spinal cord Hemisection and the ALS
The ALS in the Spinal Cord, Medulla and Pons
The ALS in the Midbrain, Thalamus and Cerebral Hemisphere
Dermatomes
Dermatomes
Dermatomes
Dermatomes
Dermatomes
Dermatomes

- Shoulder (C5-C6)
- Hand (C6-C8): 6= thumb the, 7= index finger, 8= small finger
- Nipple (T4),
- Umbilicus (T10),
- Inguinal region (T12-L1),
- Along the pelvic rim L1
- Knee (L3, L4),
- The big toe (L4-L5)
- The genitalia and anus (S4 and S5)
Visceral sensory & referred pain
Visceral sensory & referred pain
Visceral sensory & referred pain
Visceral sensory & referred pain
Referred pain
Visceral sensory & referred pain

- Esophagus
- Heart
- Urinary/bladder

- Left ureter
- Right prostate
Visceral sensory & referred pain

Referred pain. The sites for referred pain from various organs are shown.