

Lecture:

Somatic Sensation

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الرجاء تحويل الجوال إلى وضع
الصامت مع الشكر



Classification of the Somatic Sensation

The somatic sensations can be classified in two ways:

A. According to the Site of the Sensation:

1. **Superficial (exteroceptive) sensations:** the sensations from the skin (pain, touch and temperature).
2. **Deep sensations:** the sensations from skeletal muscles, tendons, joints, bones and ligaments:
 - a. **Proprioceptive sensations:** sense of position and the sense of movement (kinesthetic sensation).
 - b. **Pressure sense.**
 - c. **Muscle tension sense.**
 - d. **Muscle sense.**

Sometimes the vibration sense is included in this group.

3. **Combined or synthetic senses:** stereognosis , tactile discrimination and vibration sense.

B. According to the Modality (type) of the Sensation: **(More common classification)**

I. Mechanoreceptive sensations: these include the:

1. Touch sensations.
2. Pressure sensations.
3. Muscle tension sense.
4. Vibration sensations.
5. Tickle and itch sensations.
6. Proprioceptive sensations.

II. Thermoreceptive sensations: heat and cold sensations.

III. Pain sensation.

SENSATION

Conscious

Exteroceptive

From external world, e.g.,
from body surface (touch,
pressure, temperature,
pain), vision, hearing

Proprioceptive

From within the body:
muscles, tendons, joints,
position sense

Conscious perception/appreciation of sensory information

Nonconscious

Enteroceptive

From the viscera

Homeostasis

Proprioceptive

From within the body:
muscles, tendons, joints,
position sense

Coordination and
refinement of movement

I. The Mechanoreceptive Sensations

1. Touch (Tactile) Sensation

There are 2 types of touch sensation:

a. Crude touch: this is a poorly-localized gross tactile sensation.

□ **Receptors:** free nerve endings and hair follicle endings.

□ **Afferent nerves:** A-delta nerve fibers.

□ **Central pathway:** ventral spinothalamic tract.

□ **Testing:** by stroking the skin lightly with a piece of cotton.

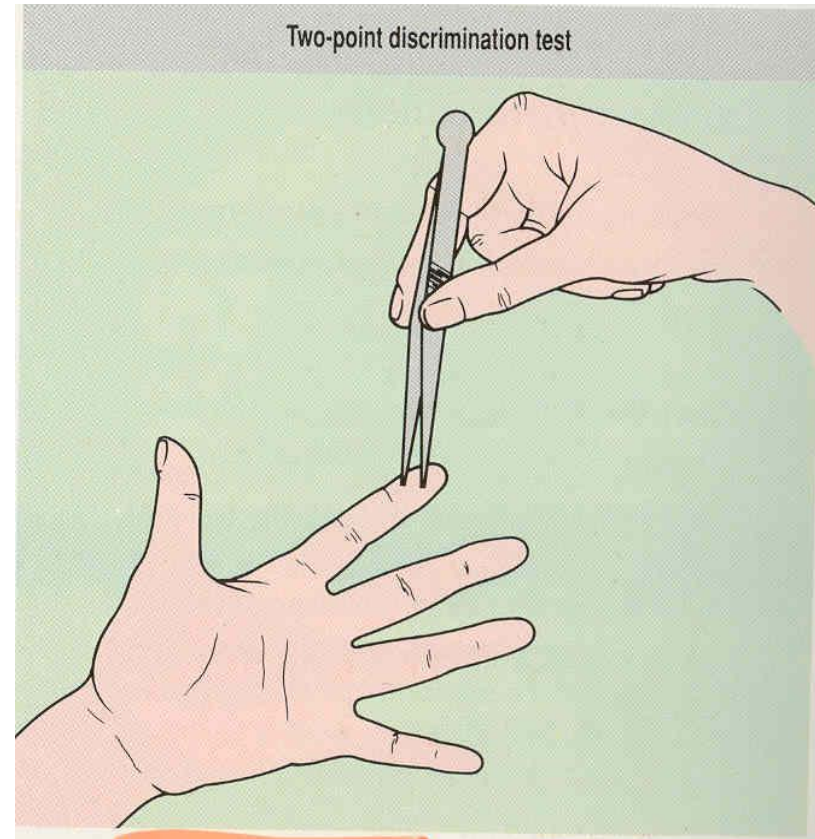
b. Fine touch: this is a good-localized tactile sensation.

□ **Receptors:** Meissner's corpuscles and Merkel's disks.

□ **Afferent nerves:** A-beta nerve fibers.

□ **Central pathway:** the Gracile and Cuneate tracts.

- **Tactile Localization (Topognosis):** the ability to localize a touched skin point while the eyes are closed.
- **Tactile Discrimination (2 point discrimination):** the ability to distinguish 2 separated point of touch (minimal distance between them i.e. 5 mm in finger & 5 cm over back).
- **Steriognosis:** the ability to recognize the nature of object (a familiar object) by touch without using vision.
- **The sense of texture of material:** is a type of **stereognosis**. It is the sensation evoked by touching materials and is concerned with identification.



2. The Pressure Sensation

- **Receptors:** Pacinian corpuscles and Ruffini's endings in the skin (**light pressure**) and subcutaneous tissues (**deep pressure**).
- **Tested by:** asking the patient to differentiate between various weights by place them in his hand **without moving** “**supported**” **the limb or hand** and with closed eyes.
- **There are two types of pressure sensations:**
 - a. **Fine pressure sensation:** Gracile and Cuneate tracts.
 - b. **Crude pressure sensation:** ventral spinothalamic tract.

3. The Muscle Tension Sense

- **Receptors:** Golgi tendon organs.
- **Pathway:** Gracile and Cuneate tracts.
- **Tested by:** asking the person to differentiate between various weight placed in his **unsupported hand**.

4. The Vibration Sense

◆ Receptors:

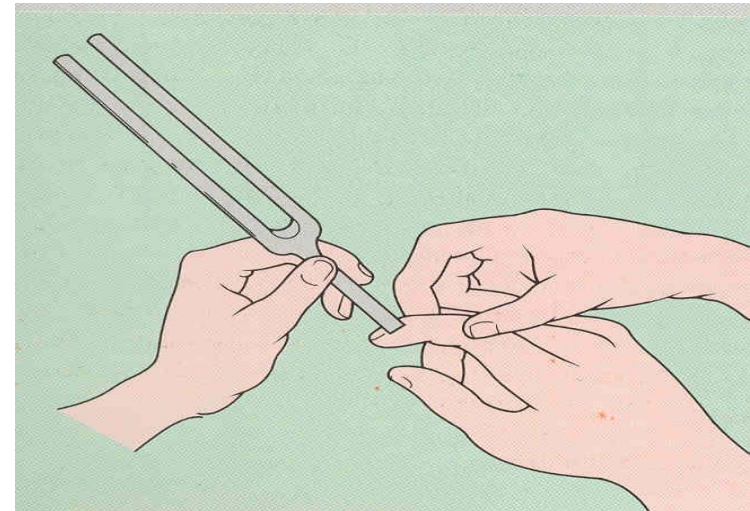
- Meissner's corpuscles (for vibration up to 80 Hz).
- Pacinian corpuscles (for vibration up to 800 Hz).

◆ Pathway: Gracile and Cuneate tracts.

◆ Vibration is closely related to **proprioception**.

◆ Tested by: place the tuning fork on a bony prominence.

◆ Decreased in cases with DM, tabes dorsalis, vit. B12 deficiency and posterior cord syndrome.



5. The Tickle and Itch Sensations

- ◆ **Tickle sensation:** is a pleasurable sensation that result from light tactile stimulation of the skin.
- ◆ **Itch sensation:** is annoying sensation that results from skin irritation by either moving tactile stimuli or certain chemical substances.
- ◆ **Receptors:**
 - Rapidly-adapting free nerve endings.
- ◆ **Afferent nerves:** Unmyelinated type C nerve fibers.
- ◆ **Pathway:** Ventral spinothalamic tract.

6. The Proprioceptive Sensations

❖ These sensations arise mainly from receptors in deep structures (especially the muscles and joints).

❖ **Receptors:**

- **In the muscle:** muscle spindles.
- **In the tendon:** Golgi tendon organs.
- **In the synovia of joint:** Ruffini's corpuscles.
- **In the ligaments of joints:** Pacinian corpuscles.

❖ **Pathway:** Gracile and Cuneate tracts.

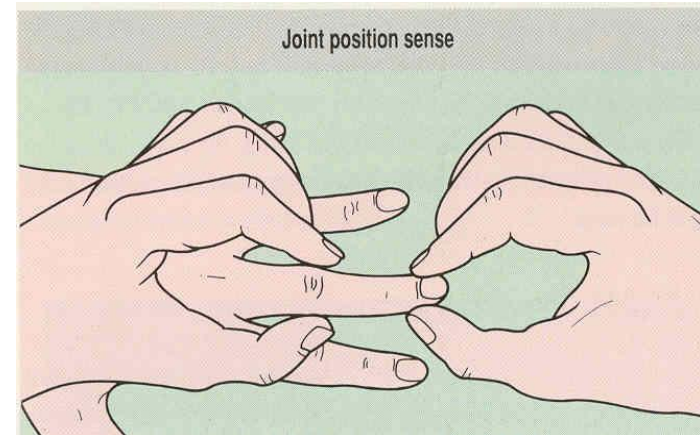
❖ **The proprioceptive sensation include two types:**

- a. Sense of position (static proprioception):** perception of the position of different parts of the body.
- b. Sense of movement (dynamic or kinesthetic proprioception):** sensation of movement of joints.

Joint Sense: "sense of movement".

Hold the big toe from each side (or the index finger in U.L.) and dorsiflexion or plantar flexion.

Ask the patient about which finger and direction of movement (with closed eyes).



Muscle Sense: done by pinching the calf or abdominal muscles.

II. The Thermoreceptive Sensations

◆ There are two types of thermoreceptors:

a. **Internal thermoreceptors:** located in the hypothalamus.

b. **External thermoreceptors:**

- Cold receptors.
- Heat receptors.
- Thermosensitive pain receptors.

◆ **Pathway:** lateral spinothalamic tract.

◆ **The warmth receptors:**

- They are free nerve endings.
- Respond to temperature from about **30 °C to 45 °C.**

◆ **The cold receptors:**

- They are free nerve endings.
- Respond to temperature from about **10 °C to 38 °C.**

◆ **The thermosensitive pain receptors:** respond to temperature below 10 °C and above than 45 °C.

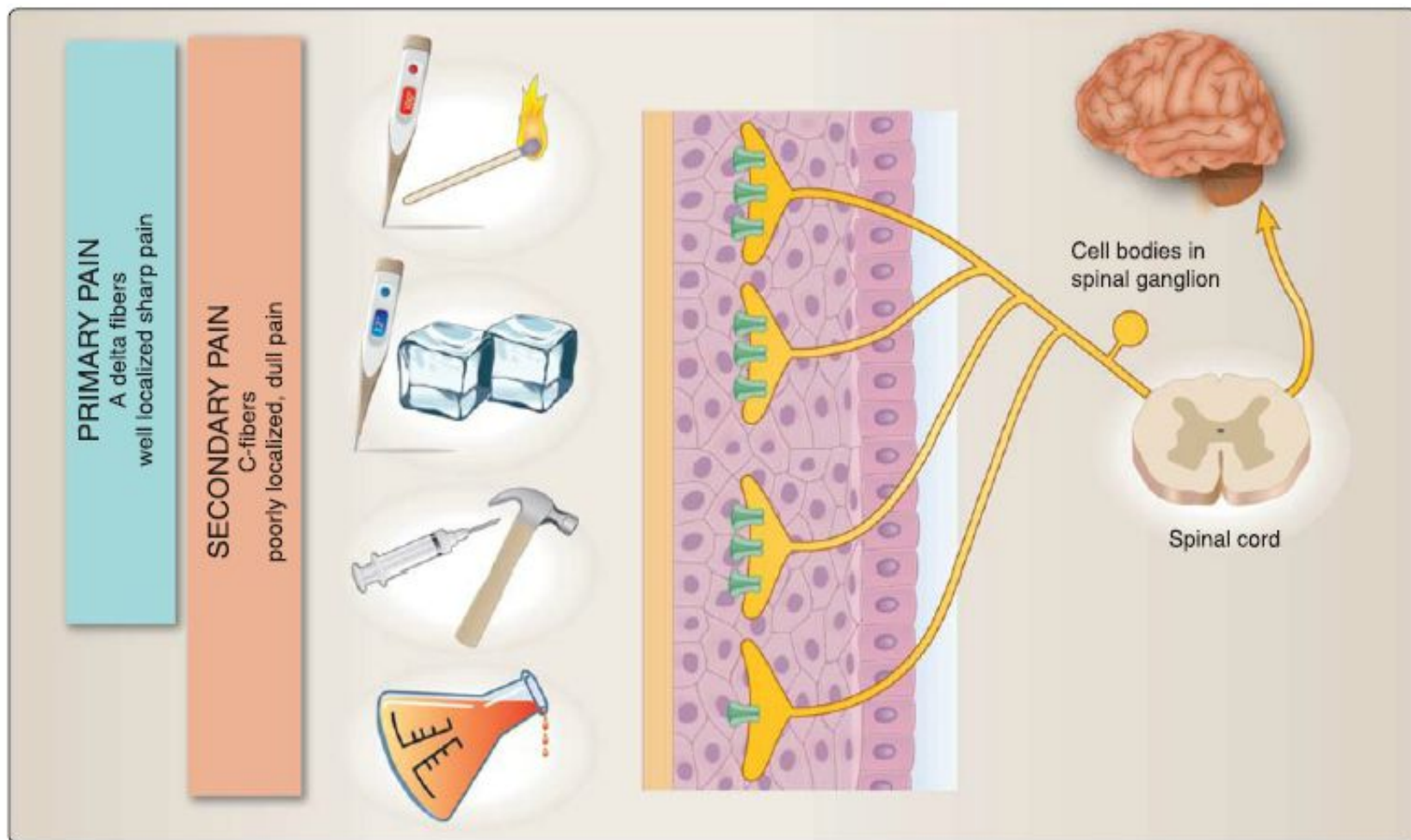
III. Pain Sensations

- ◆ **Pain Receptors(Nociceptors):** these are specific free endings (**3 types: thermo, chemo and mechano**-sensitive pain receptors).
- ◆ **According to its site, pain is classified into:**
 - Cutaneous pain.
 - Deep pain.
 - Visceral pain.
- ◆ **It is more frequently divided into:**
 - Fast pain.
 - Slow pain.
- ◆ **Pathway:** lateral spinothalamic tract.

Fast and Slow Pain Sensations

	Fast Pain or First Pain	Slow Pain or Second Pain
Site (Origin)	Only in the skin	Skin, deep tissue and viscera
Quality	Acute	Dull or chronic
Perception	0.1 sec after stimulation (immediate pain)	1 sec or more after stimulation (delayed pain)
Duration	Less than one second	Many seconds to a few min.
Localization	Well-localized	Diffuse (poorly-localized)
Afferent nerve	Type A-delta nerve fib.	Type C nerve fibers
Center in CNS	Cerebral cortex (postcentral gyrus)	Reticular formation & thalamus

Nociceptive Fibers



Central Perception of Pain Sensations

- ❖ Pain sensation is transmitted to higher centers along the **lateral spinothalamic tract** which consists of two parts:
 1. **Paleospinothalamic tract:** transmits **slow pain** and terminates subcortically (at reticular formation and thalamus).
 2. **Neospinothalamic tract:** transmits **fast pain** and relay in the thalamus and terminate in the cortical sensory areas.
- ❖ Removal of the cortical somatic sensory areas does not abolish perception of slow pain.
- ❖ Slow pain is generally perceived at a subcortical level.
- ❖ The cortical centers are for localization and discrimination of the quality of pain.

Cutaneous Pain

- ❖ It may be **fast or slow pain**.
- ❖ It is associated with:
 - a. **Somatic effect:** the withdrawal reflex.
 - b. **Autonomic effect:** usually sympathetic (vasocnstriction, tachycardia and increase the BP), but parasympathetic effect may occur in severe pain (Nausea, vomiting, vasodilatation, bradycardia and hypotension).
 - c. **Emotional effect:** anxiety and restless syndrome.
 - d. **Hyperalgesia:** This is a condition of hypersensitivity to pain.

Deep Pain

- ❖ This originates from muscles, joints, periosteum and other deep structures and is **characterized by:**
 - It is slow pain that is conducted by type C nerve fibers.
 - It is diffuse and dull.
 - Associated with muscle tenderness.
- ❖ Deep pain may result from trauma to deep structures, bone fractures, inflammation, arthritis, muscle injury and ischemia.

Ischemic Pain

- ❖ One type of **deep pain**.
- ❖ This occur due to either a severe muscle spasm “cramp” or an occlusive vascular disease due to accumulation of certain metabolite known as **Lewis P factor** (is most probably potassium) and **lactic acid**.
- ❖ At rest muscle ischemia decreased, so ischemic pain is usually absent during rest.
- ❖ **Example of ischemia pain:**
 1. Angina pectoris.
 2. Intermittent claudication (severe pain in the muscles of lower limbs during walking due to a vascular occlusive disease.

Visceral Pain

- ❖ Pain is almost the only sensation produced from the viscera.
- ❖ Some viscera are **pain insensitive** (e.g. the liver tissue, lung, alveoli) but the parietal layers of these membranes are very painful.
- ❖ **Characters of visceral pain:**
 - Slow pain and usually dull or spasmodic (colic pain).
 - Frequently referred to specific area in the skin.
 - Associated with nausea and parasympathetic effects.
 - Associated with some somatic effect e.g. contraction of the near abdominal muscles.

Visceral Afferent Nerves

1. **Autonomic Nerves:** by sympathetic and parasympathetic nerves.
2. **Somatic Nerves:** pain from the gall bladder is transmitted by the **phrenic nerves**. Also pain from the parietal layers of the pleura, peritoneum and pericardium is transmitted by **somatic spinal nerves**.

Causes of the visceral pain:

- a. **Visceral ischemia.**
- b. **Inflammation.**
- c. **Mechanical stimuli:** over distension and spasm of certain viscera
- d. **Chemical stimuli:** e.g. irritation of the parietal peritoneum by the gastric juice from a perforated peptic ulcer).

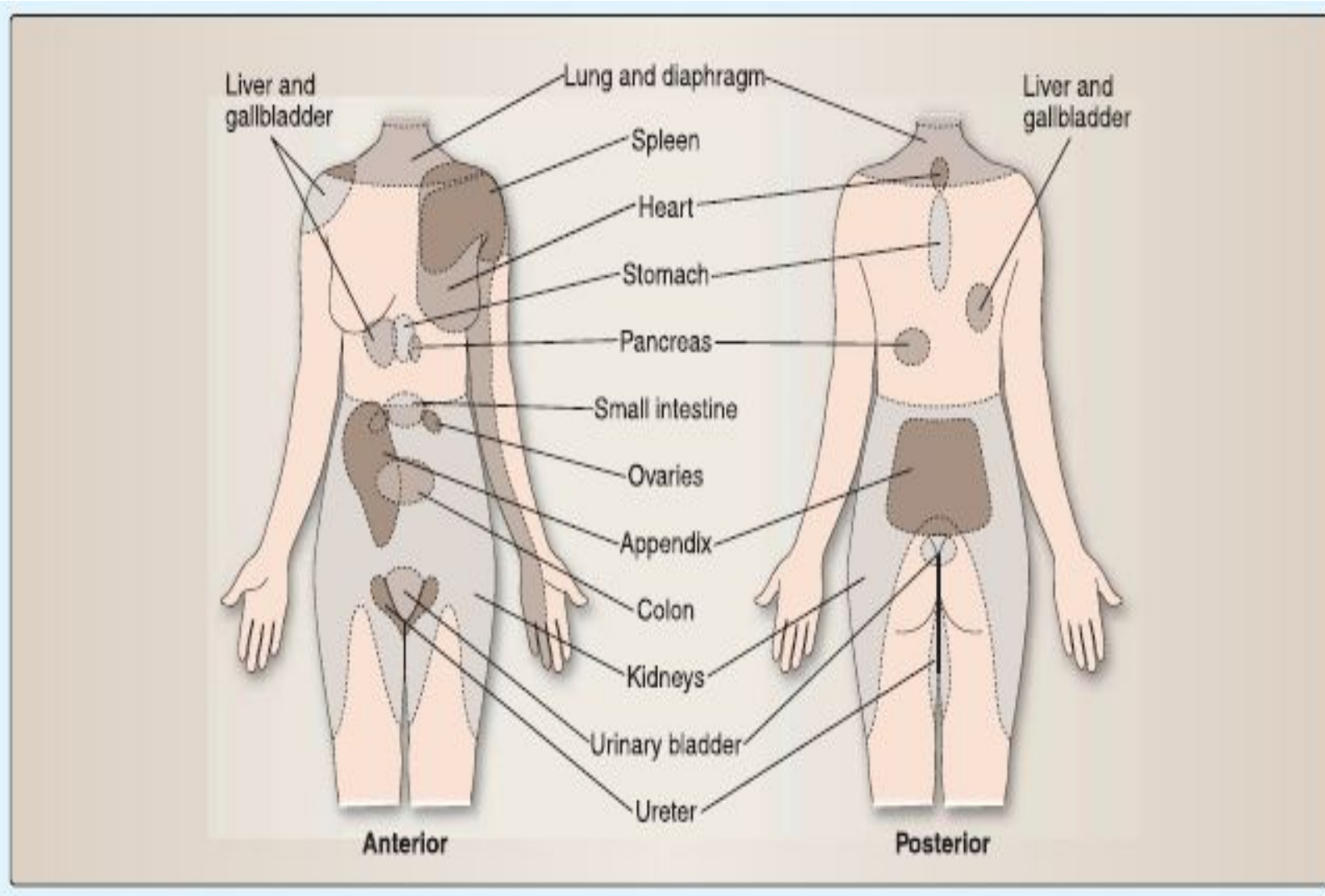
Referred Pain

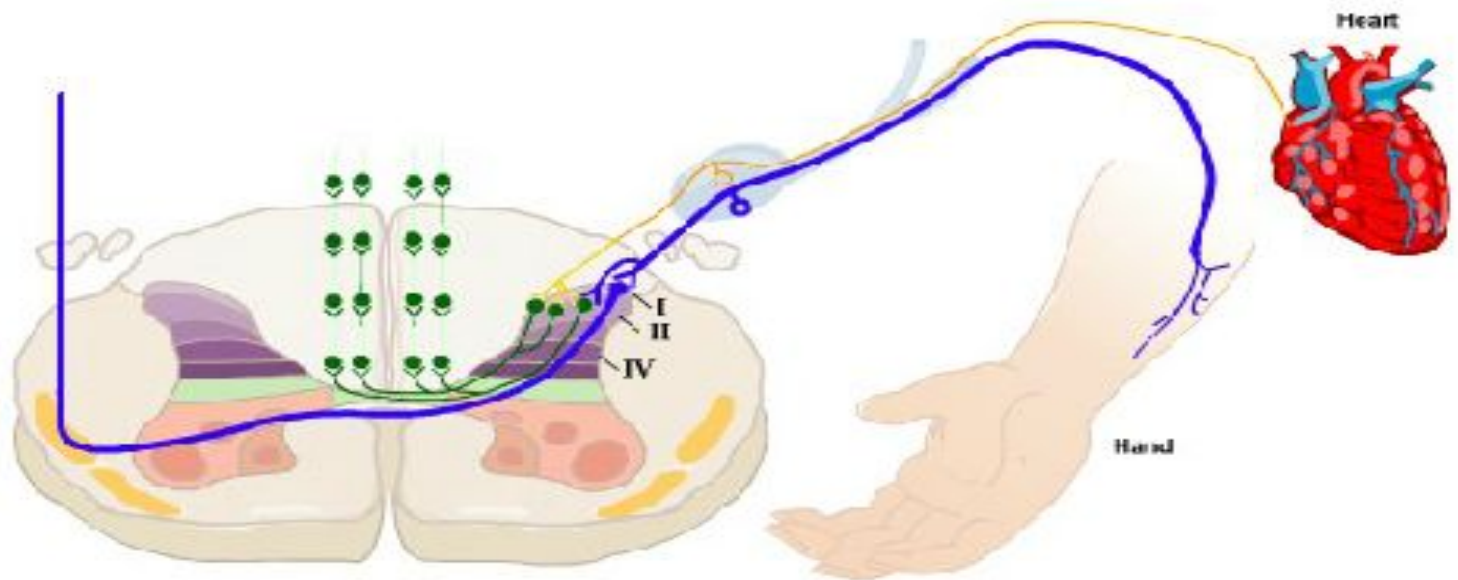
- ❖ Referred pain is pain perceived in an area of the body that is not directly innervated by the neurons exposed to the noxious stimulus.
- ❖ This is pain is felt away from its original site.
- ❖ It is most common with visceral pain.
- ❖ Pain is usually referred to a somatic structure or a dermatome that developed from the same embryonic segment in which pain originates “the spinal cord levels of the sympathetic fibers that supply those viscera”.

Example of Referred Pain

1. **Inflammation of gall bladder (cholecystitis):** is transmitted by phrenic nerve fibers (due to irritation of the diaphragm) to the 3rd, 4th cervical spinal segments **(usually to the tip of the right shoulder).**
2. **Cardiac pain:** is usually referred to the **left shoulder and inner side of the left arm** and less frequently to epigastrium.
3. **Gastric pain:** is referred to the **abdominal surface above the umbilicus.**
4. Pain from **kidney and urethra** is referred to the **inguinal and testicular regions.**
5. Pain of **appendicitis** is referred to the **umbilical region.**

Referred Pain





The Sensory Pathway or Axis

❖ A sensory pathway includes:

- a. Receptors.
- b. Afferent (sensory) nerve that transmits the signals to the CNS.
- c. Transmitting ascending tract.
- d. Cortical sensory areas.

❖ All somatic sensation (superficial and deep), pass through **three order neurons**, from receptors in the skin and tendons, to reach the cortical sensory area.

Anterolateral System

The anterolateral system:

- Carries pain and temperature, and nondiscriminative forms of touch sensations through the lateral spinothalamic and ventral (anterior) spinothalamic tracts.
- Transmitted through the slightly myelinated A-delta fibers or unmyelinated C fibers.

Pathway of the Superficial Sensation “Anterolateral System”

Pathway of Pain and Temperature sensations

1. The first order neuron:

Is the cell of **the posterior root ganglion** and its process.

This process divided into:

- **The lateral branch (Dendrite):** goes peripherally forming the afferent sensory nerve (the ends of this nerve are receptors of the skin).
- **The medial branch (Axon):** enters the spinal cord, forming Lissauer's tract and relays in the cells of the **Substantia Gelatinosa of Rolandi (S.G.R.)** in the posterior horn of the gray matter.

Pathway of the Superficial Sensation

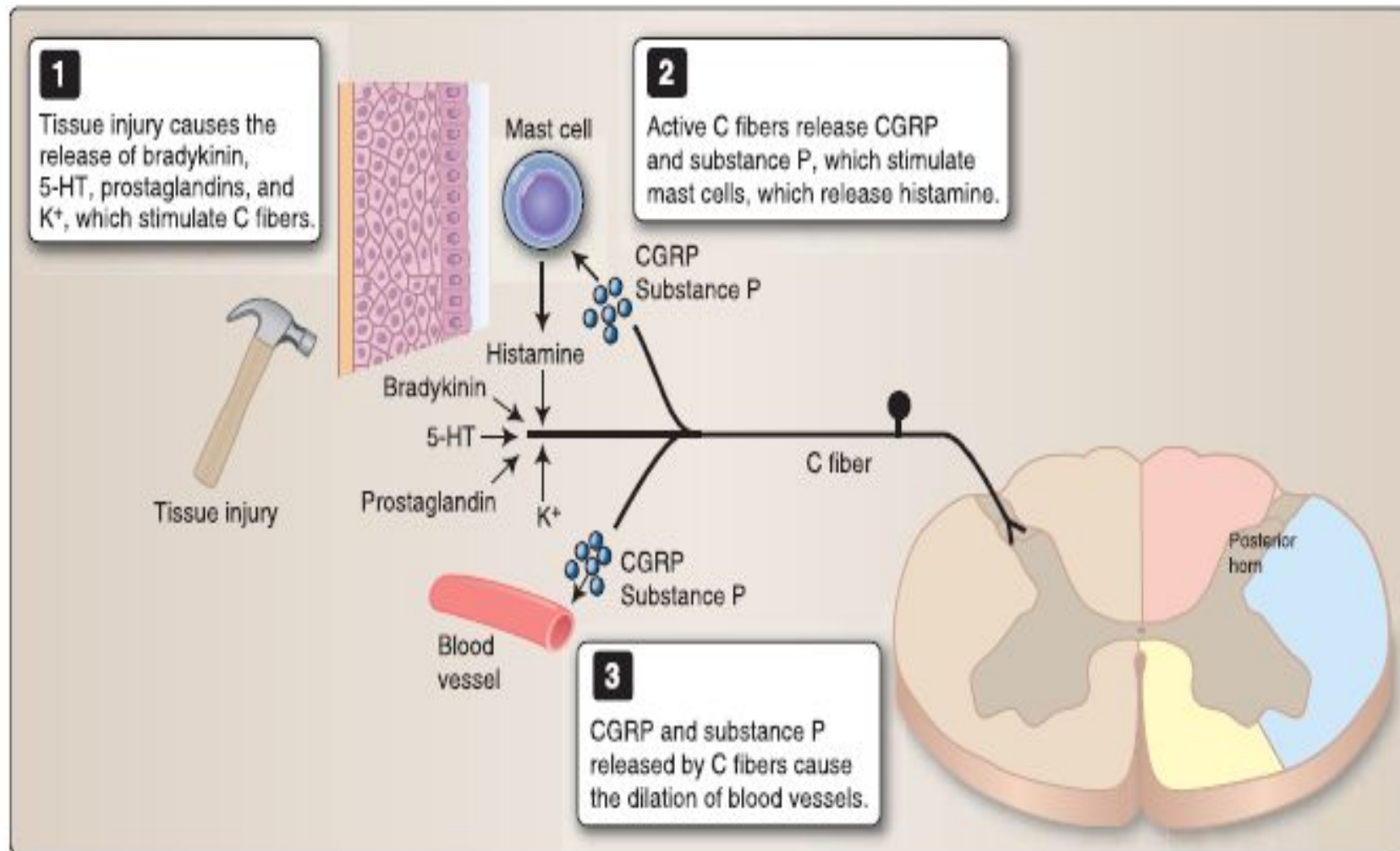
2. The second neuron:

Is the cells of **Substantia Gelatinosa of Rolandi** and its axon. This axon crosses to the opposite side cross the midline in the **ventral white commissure**, usually **within two to three segments** above the level of entry of the peripheral fibers and ascends in the lateral column of the SC as the **lateral spinothalamic tract** → medulla oblongata → the pons → the mid brain → to relay the sensory impulse at the thalamus.

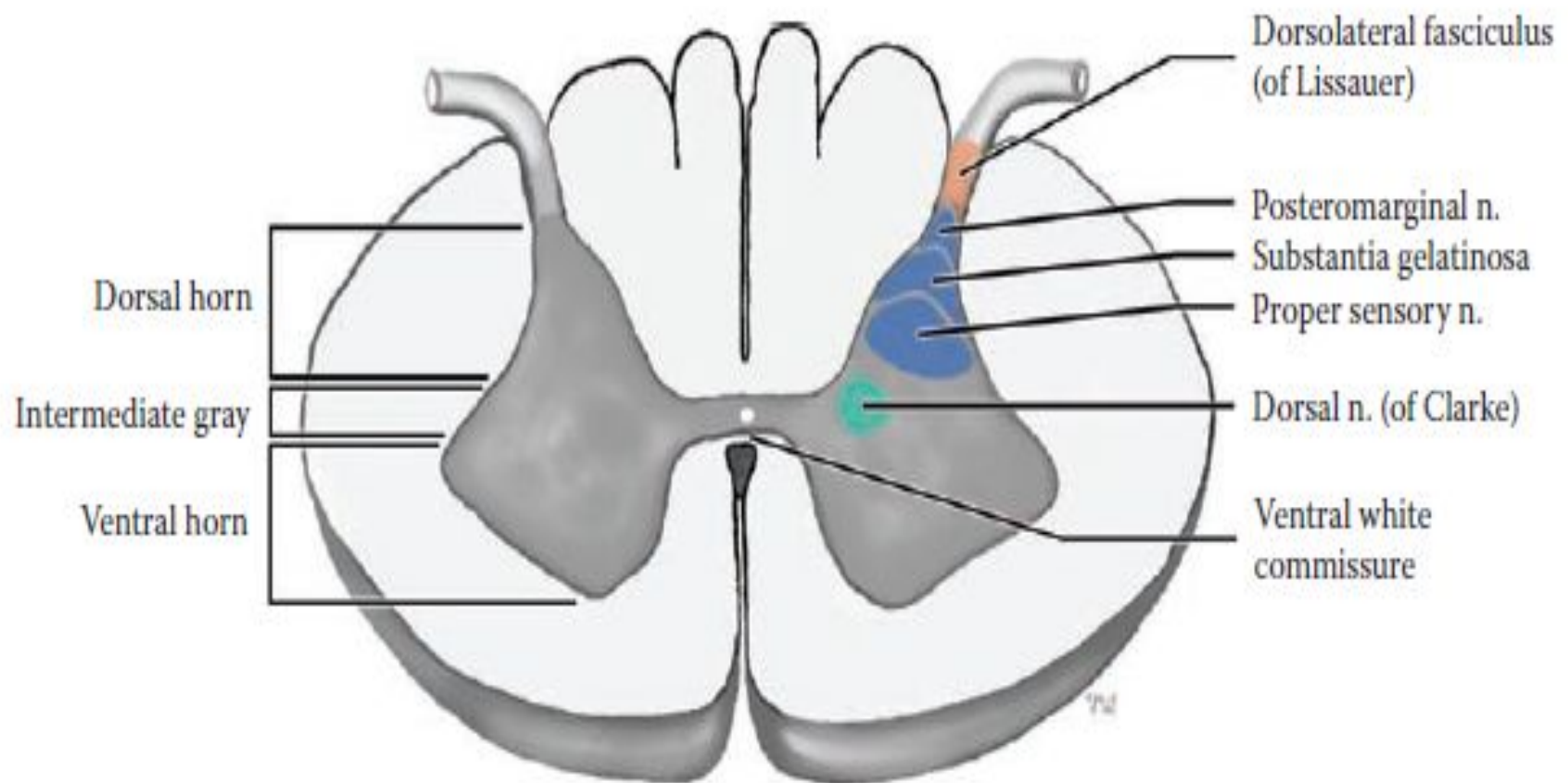
3. The third order neuron:

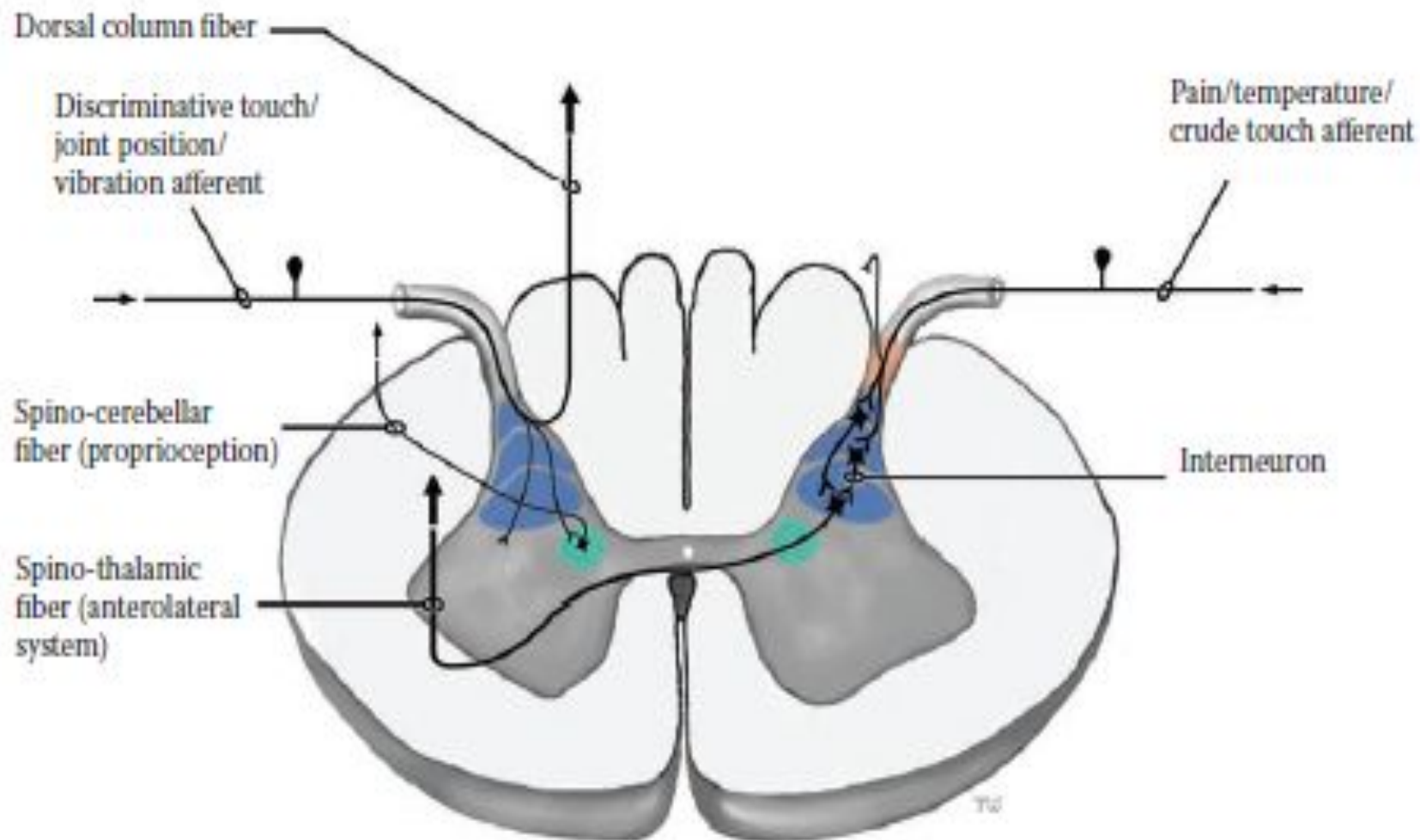
Starts in the cells of **the posterolateral ventral nucleus (PLVN) of the thalamus**, its axon ascends to pass through the posterior limb of the internal capsule conducting the impulse to the cortical somatic sensory area (1, 2, 3) in the upper 2/3rd of the postcentral gyrus of the parietal lobe.

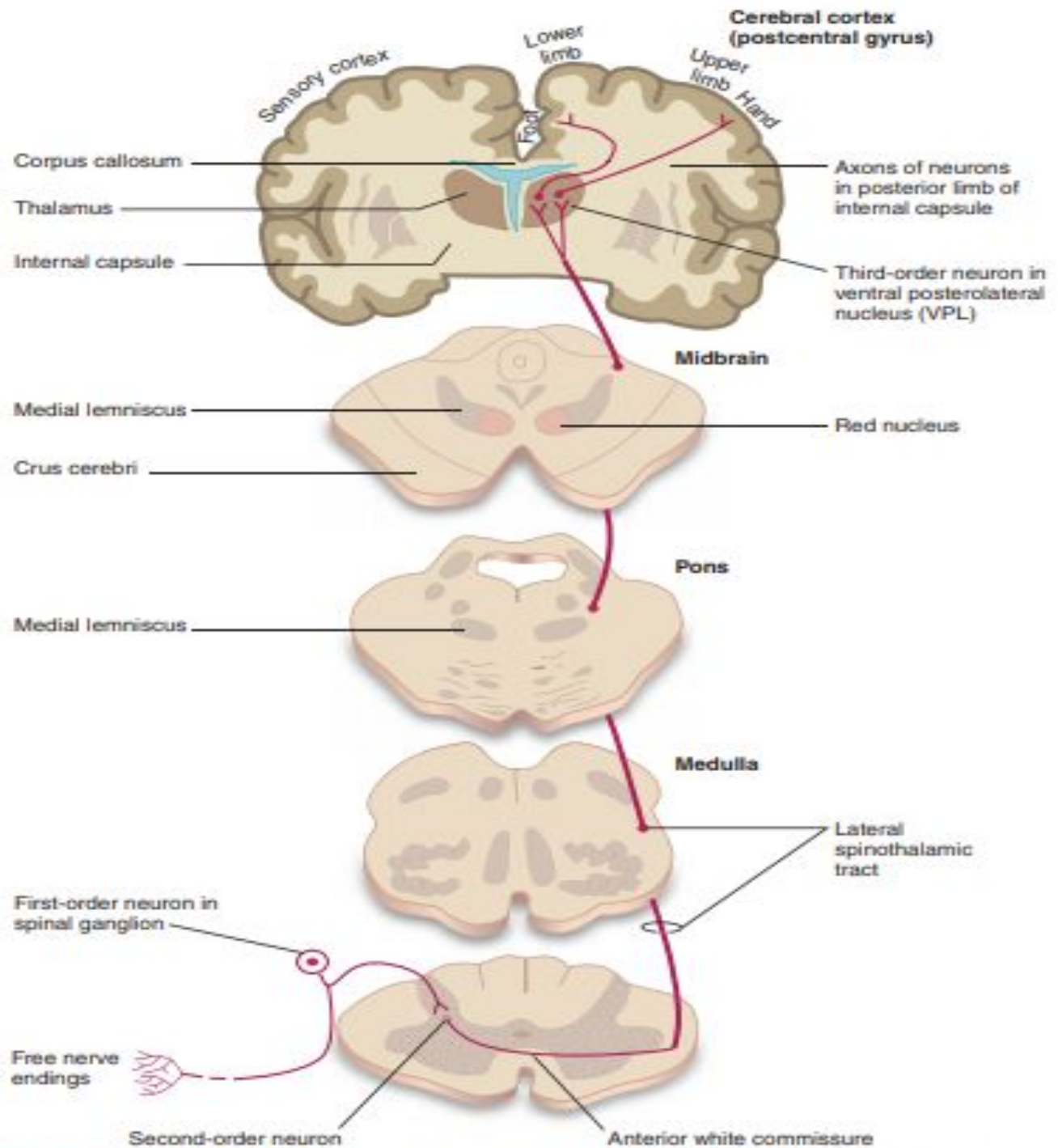
Principles of Peripheral Sensitization



Principles of peripheral sensitization. 5-HT = serotonin; CGRP = calcitonin gene-related peptide. Bradykinin stimulates C fibers through stimulation of mast cells.







5

The anterolateral tract terminates in the VPL of the thalamus. From the thalamus, fibers project through the internal capsule and corona radiata to terminate in the primary somatosensory cortex (postcentral gyrus).

4

In the pons and midbrain, the anterolateral tract lies lateral to the medial lemniscus.

3

In the rostral medulla, the anterolateral tract lies between the inferior olivary nucleus and the nucleus of the spinal tract of the trigeminal nerve.

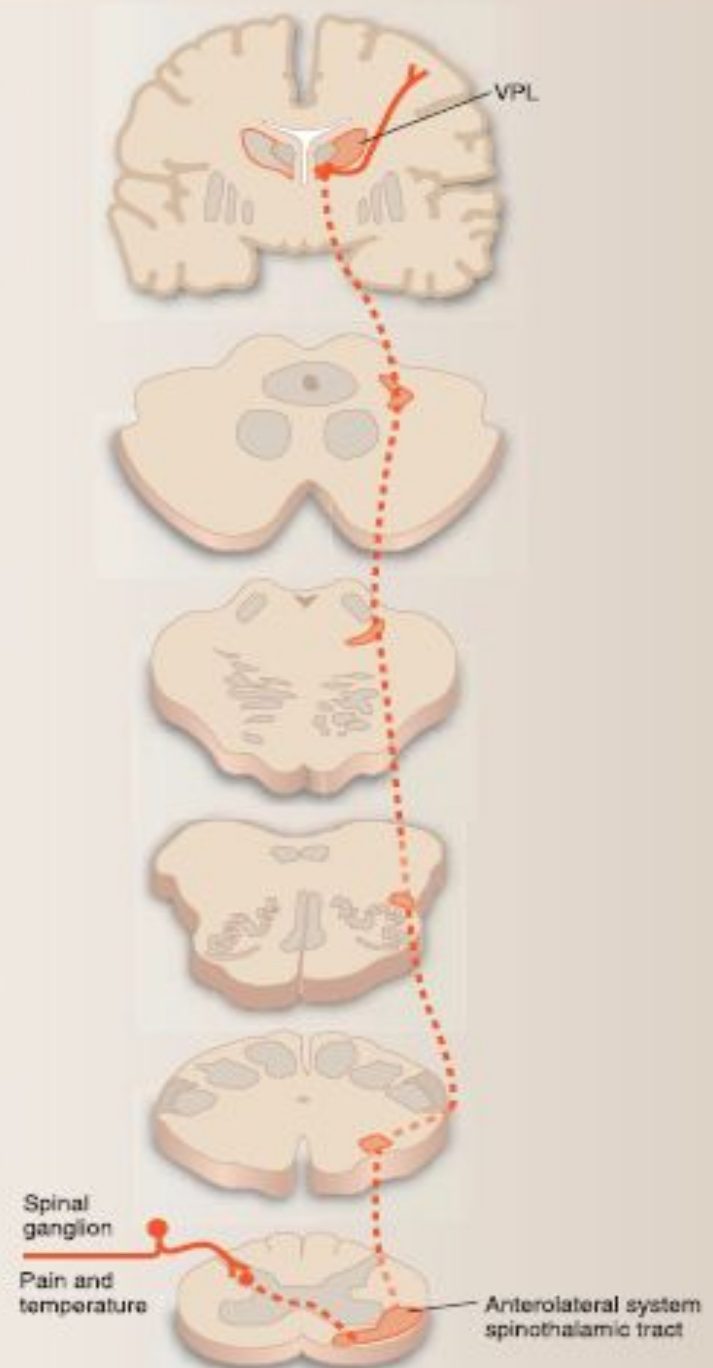
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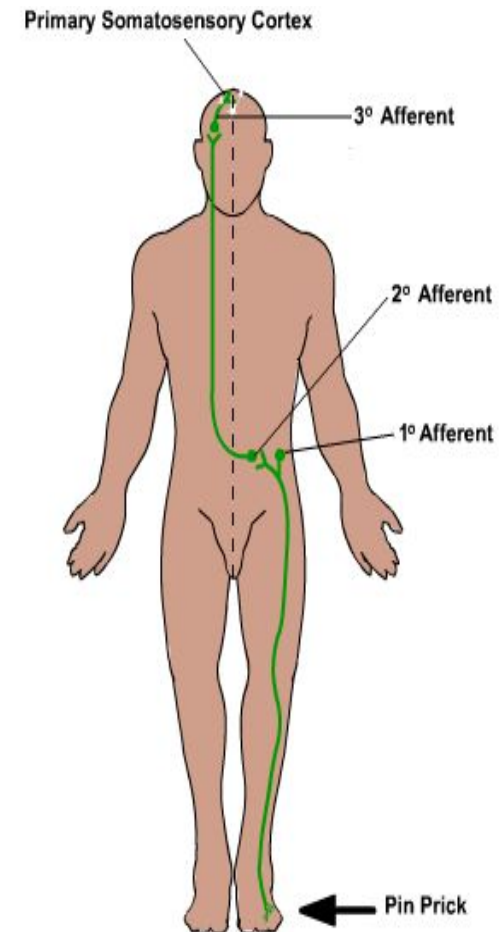
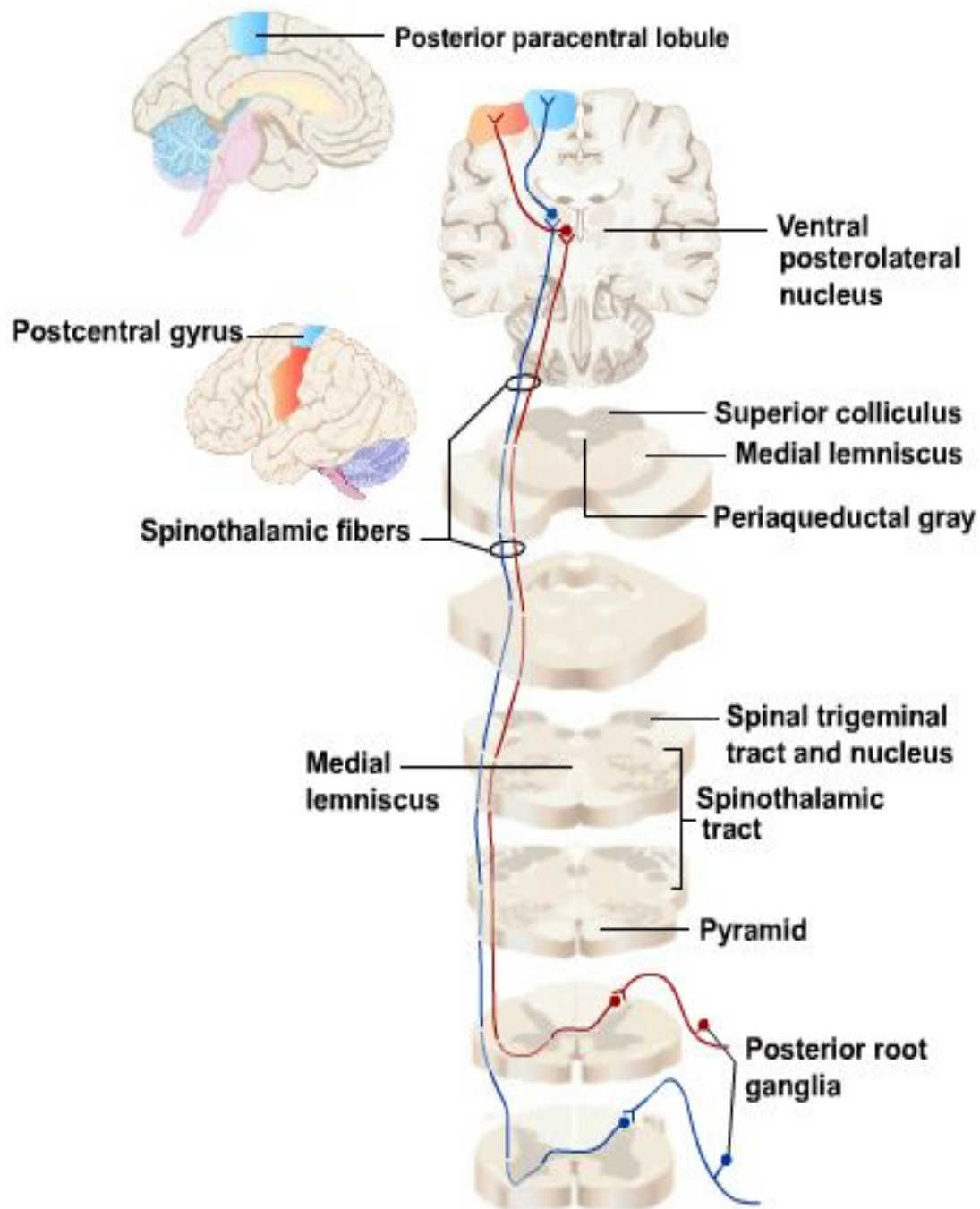
Anterolateral tract in the caudal medulla.

1

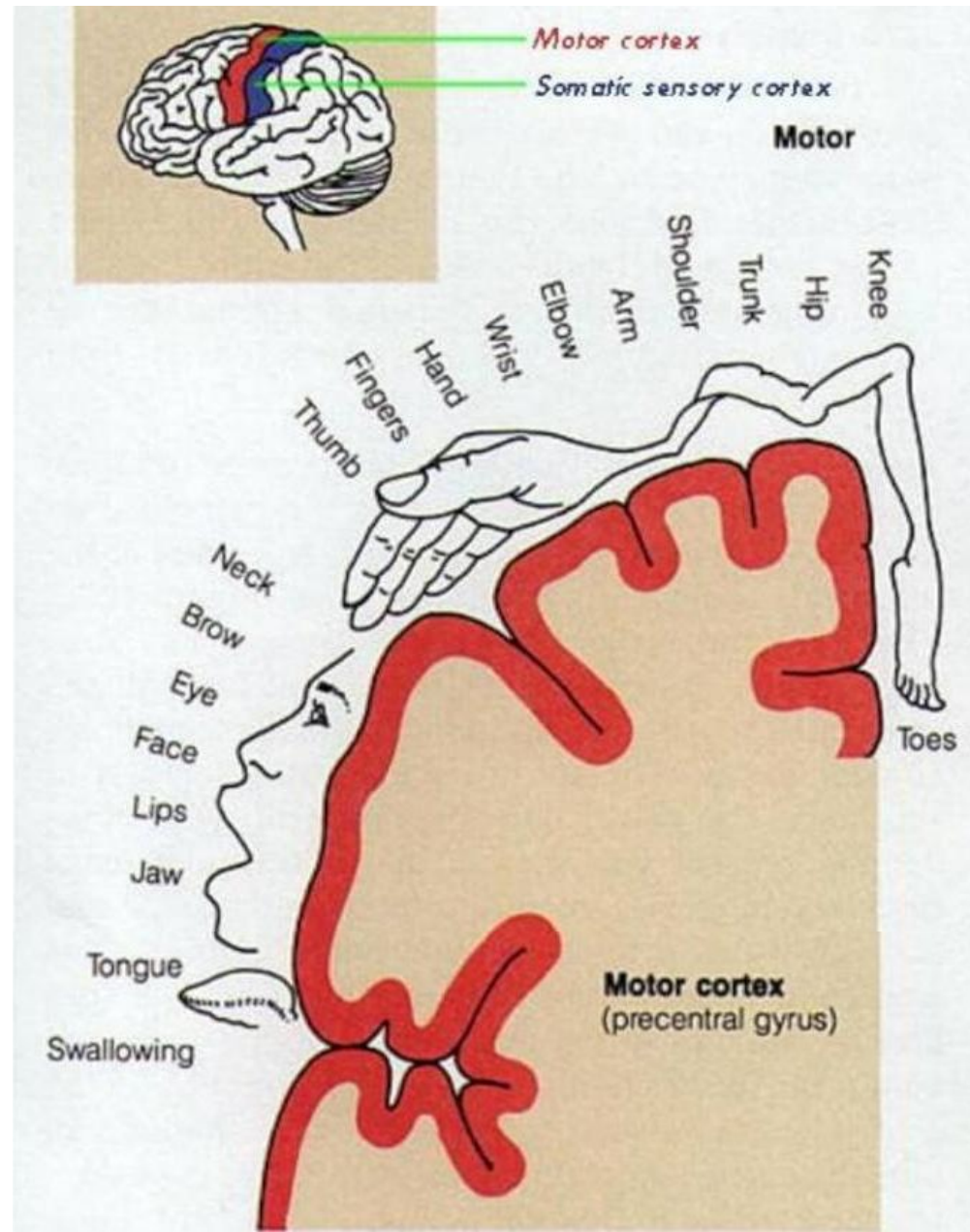
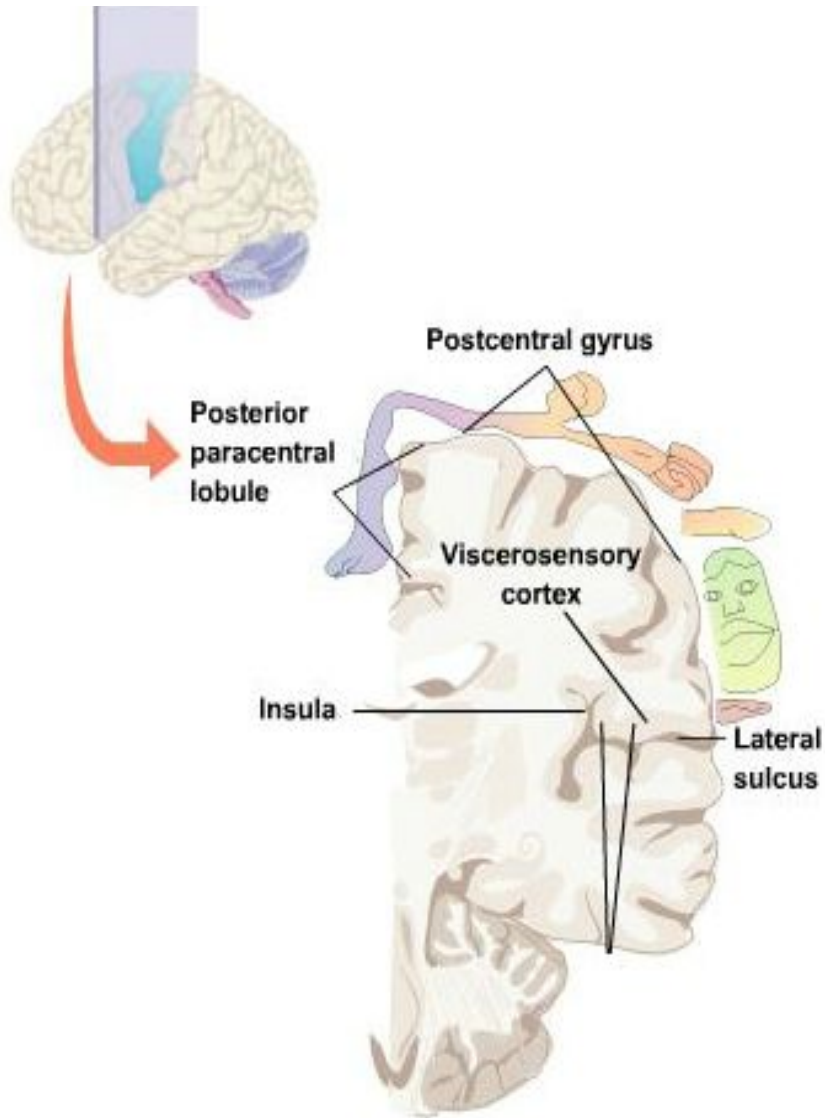
Axons enter the spinal cord from the spinal ganglia, travel up or down 1–2 segments in Lissauer tract, and then synapse in the posterior horn.

Axons of secondary neurons cross the midline in the anterior white commissure and ascend as the anterolateral tract in the spinal cord.





The Somatotopic Representation of the Body and Face in Primary Somatosensory Gyrus



Pathway of the Touch Sensation

1. **Crude Touch:** has the same pathway as pain and temperature but the second order neuron is **main sensory nucleus** in posterior horn cells. The axons crosses to the opposite side and ascends in the ventral column of the spinal cord as the **Ventral Spinothalamic Tract**.
2. **Fine Touch:** ascends in the **Gracile and Cuneate tracts** within the posterior column of the SC, with the fibers carrying deep sensation.

N.B. The spinal lemniscus= lateral spinothalamic tract + ventral spinothalamic tract

Lesions of the Anterolateral System

- **Lesions to the posterior horn cells:** **Ipsilateral at the same level** loss of pain and temperature, and nondiscriminative forms of touch sensations.
- **Lesions to the anterolateral spinothalamic tract:** **Contralateral loss** of pain and temperature, and nondiscriminative forms of touch sensations below the level of lesion.
- **Lesions thalamus and postcentral gyrus:** **Contralateral loss** of pain and temperature, and nondiscriminative forms of touch sensations.

Posterior Column Medial Lemniscus System

- The posterior column-medial lemniscus system carries general somatic afferent (general sensory) information about **discriminative touch, pressure, vibration and conscious proprioception.**
- Transmitted through the fast-conducting large-diameter fibers (**A-Beta fibers**).

Pathway of Deep Sensation

Posterior Column Medial Lemniscus System

1. The first order neuron:

Is the cells of **the posterior root ganglion** and its process.

This process divided into:

- **The lateral branch (Dendrite):** goes peripherally forming the afferent sensory nerve (the ends of this nerve are receptors of the tendon).
- **The medial branch (Axon):** enters the SC and ascends directly in the Gracile and Cuneate tracts within the posterior column on **the same side** to relay in the Gracile and Cuneate nuclei of the medulla.

Pathway of Deep Sensation

2. The second neuron:

Is the cells of **the Gracile and Cuneate nuclei** in the medulla → decussating (crossing) to the opposite side of the medulla oblongata ascends as **Medial Lemniscus through** → the pons → the mid brain → to relay in the thalamus.

3. The third order neuron:

Starts in the cells of **the posterolateral ventral nucleus (PLVN) of the thalamus**, its axon ascends to pass through the posterior limb of the internal capsule conducting the impulse to the cortical somatic sensory area (1, 2, 3) in the upper 2/3rd of the postcentral gyrus of the parietal lobe.

6

The medial lemniscus terminates in the VPL of the thalamus. From the thalamus, fibers project through the internal capsule and corona radiata to terminate in the primary somatosensory cortex (postcentral gyrus).

5

As the medial lemniscus continues to ascend through the rostral pons and midbrain, it moves laterally and becomes more vertical.

4

In the caudal pons, the medial lemniscus flattens horizontally.

3

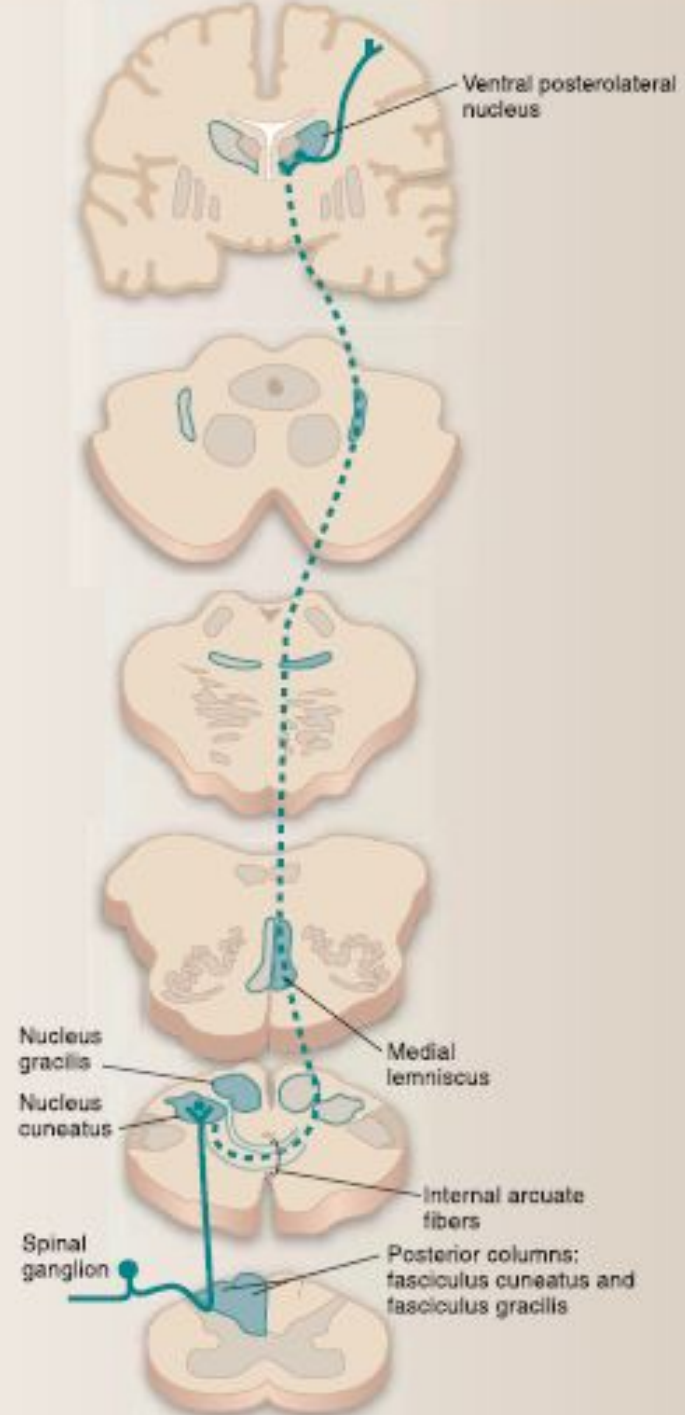
In the rostral medulla, the fibers travel as the medial lemniscus adjacent to the midline.

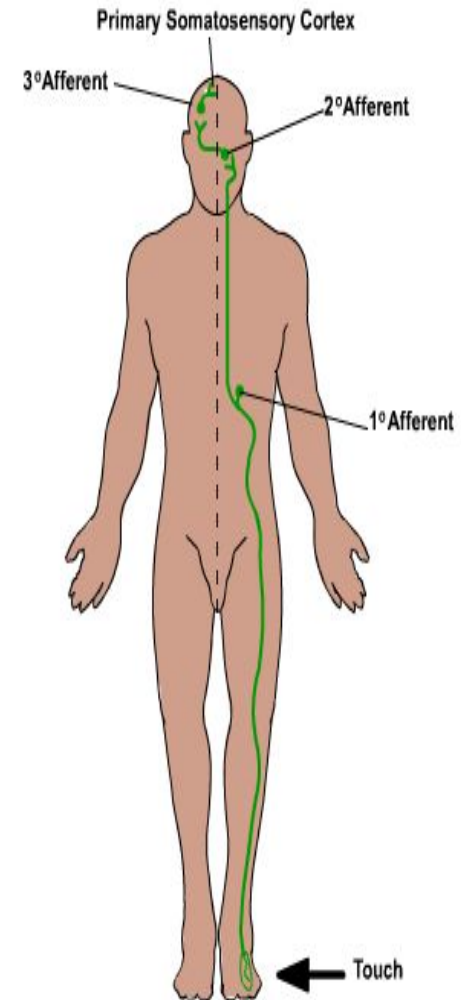
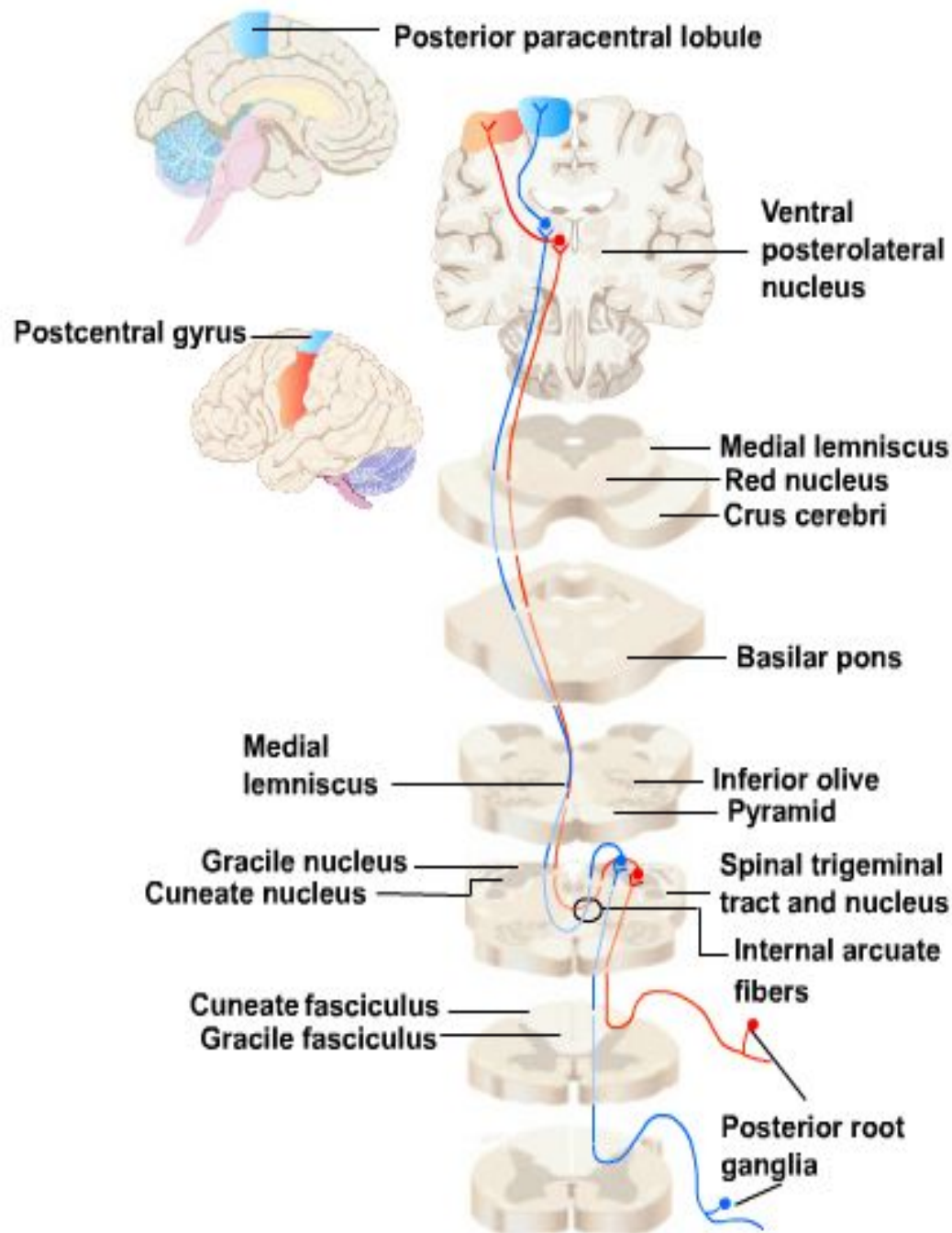
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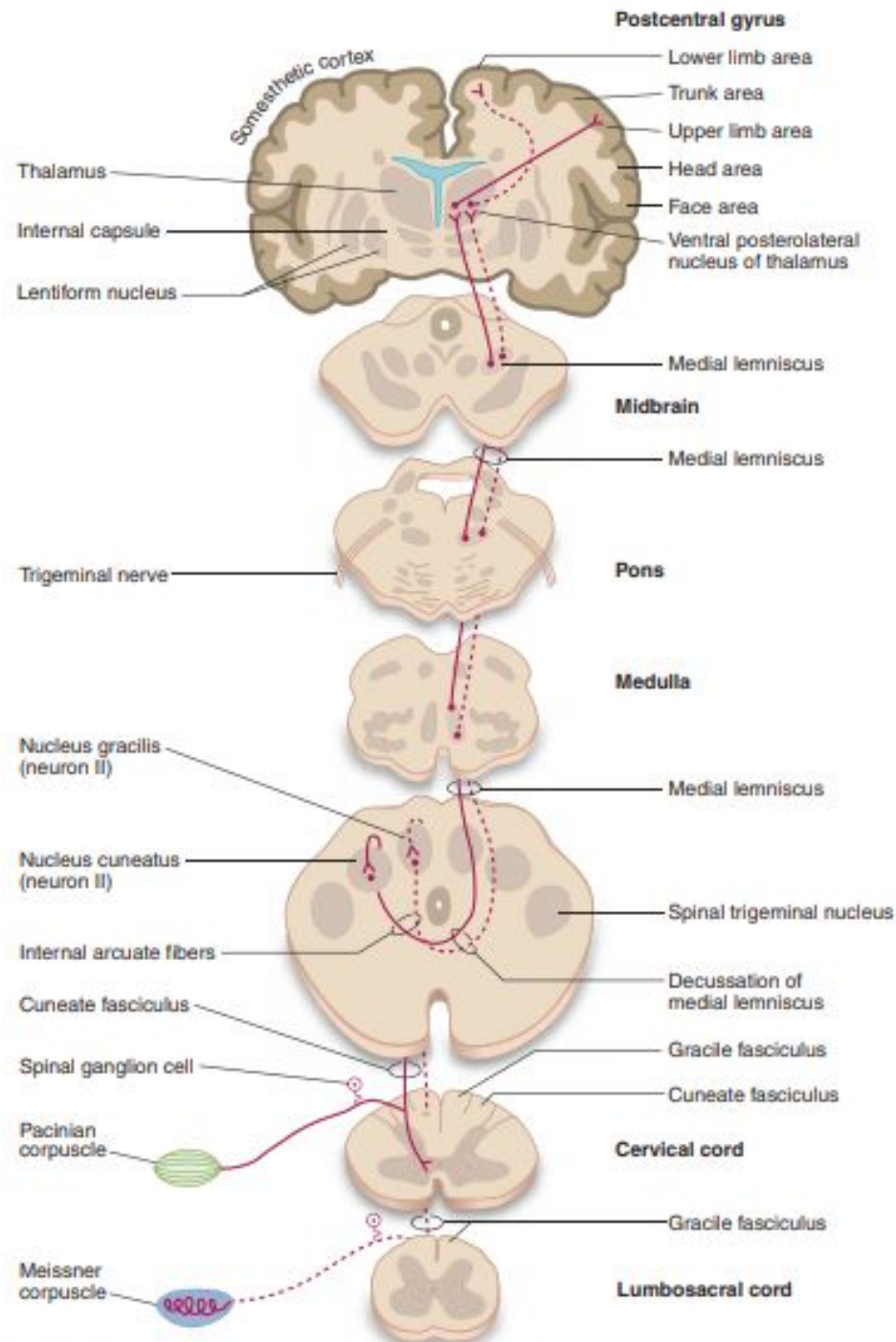
They terminate in nucleus gracilis and nucleus cuneatus. From these nuclei, axons of secondary neurons cross the midline as internal arcuate fibers and form the medial lemniscus.

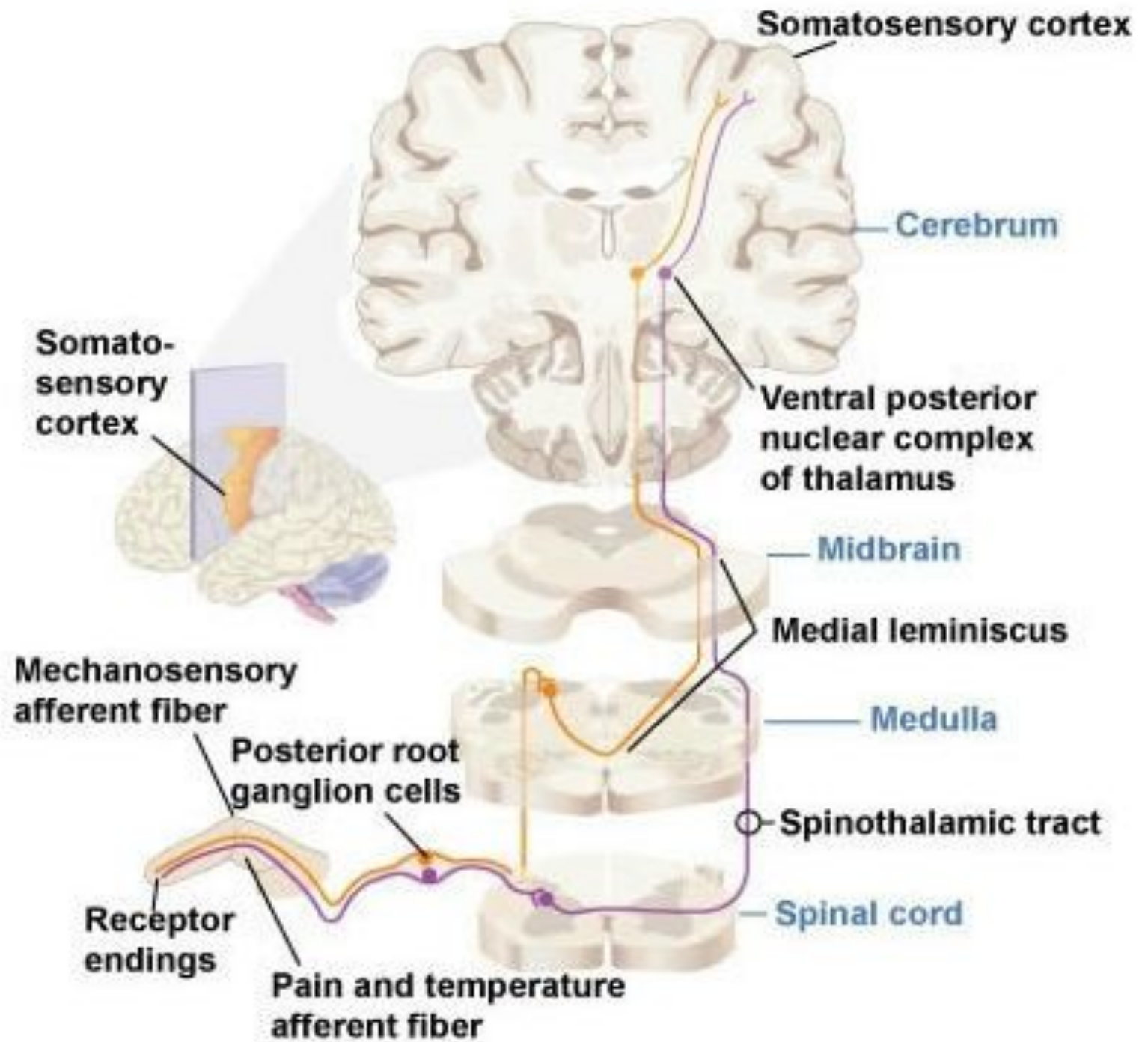
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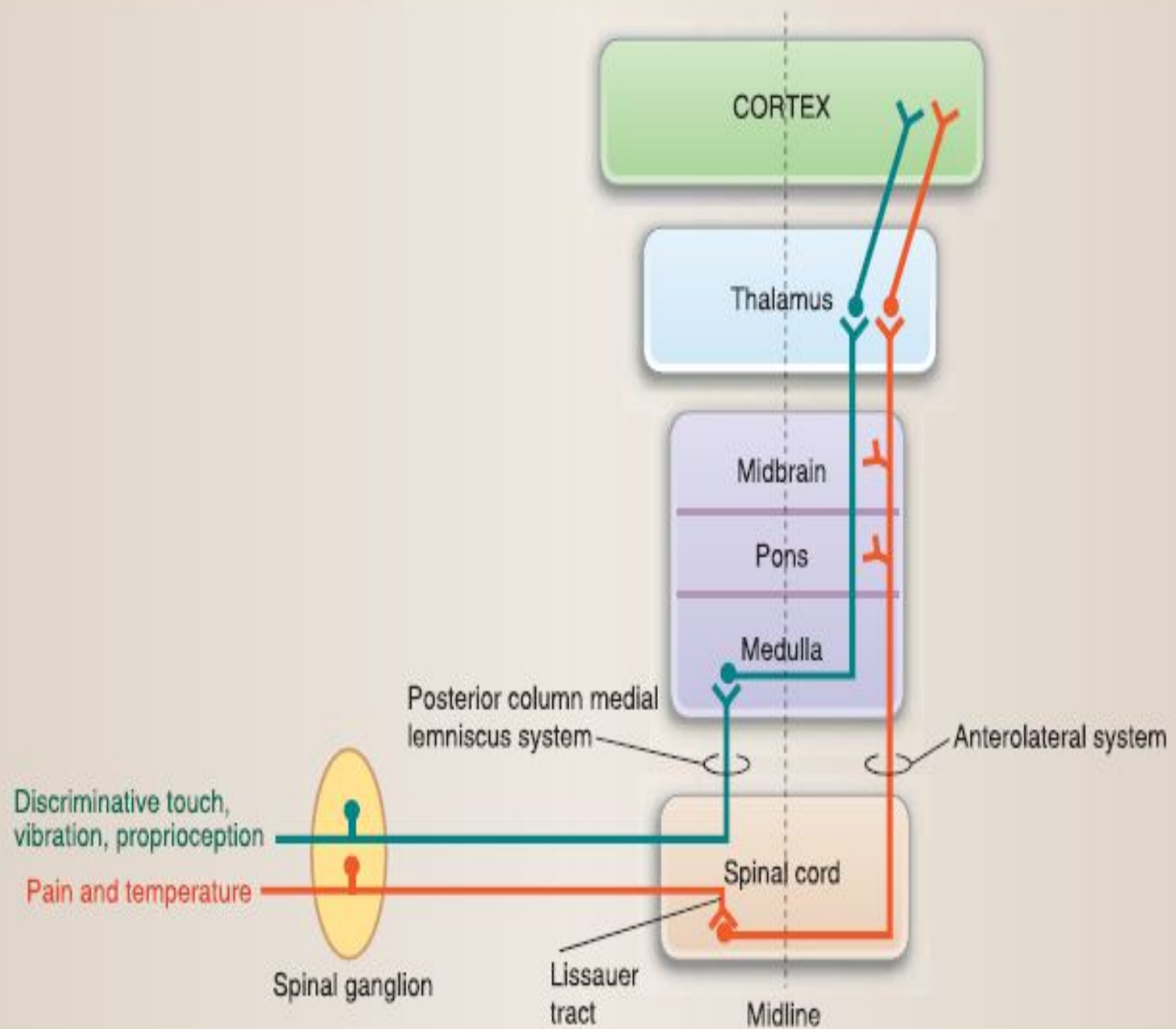
Axons enter the spinal cord from the spinal ganglia and pass directly to ipsilateral posterior column. Caudal fibers (up to and including T6) enter fasciculus gracilis (medial) and rostral fibers (above T6) enter fasciculus cuneatus to ascend.











Lamination of the Gracile and Cuneate Tracts

- ❖ **The Gracile Tract:** lies more medially and received impulses from the lower part of the body (the lower limbs and lower half of the trunk).
- ❖ **Cuneate Tract:** lies more laterally and received impulses from the upper part of the body (the upper limbs and upper half of the trunk).
- ❖ **From medial to lateral side:** sacral nerve fibers → lumbar nerve fibers → thoracic nerve fibers → cervical nerve fibers.

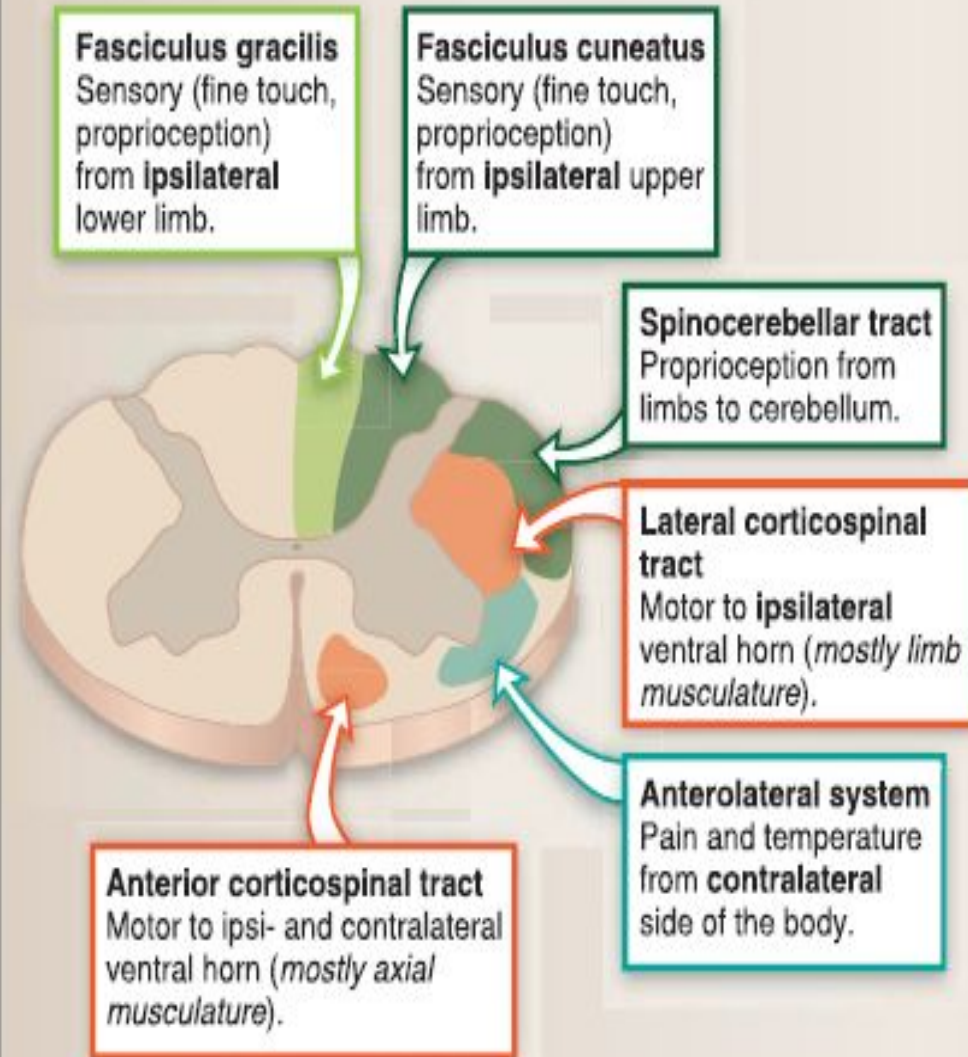
Lesions of the Posterior Column Medial Lemniscus System

- **Lesions to the posterior columns:** **Ipsilateral loss** of discriminative touch, pressure, vibration and conscious proprioception “Sensitive Ataxia”.
- **Lesions to the medial lemniscus, thalamus and postcentral gyrus:** **Contralateral loss** of discriminative touch, pressure, vibration and conscious proprioception “Sensitive Ataxia”.

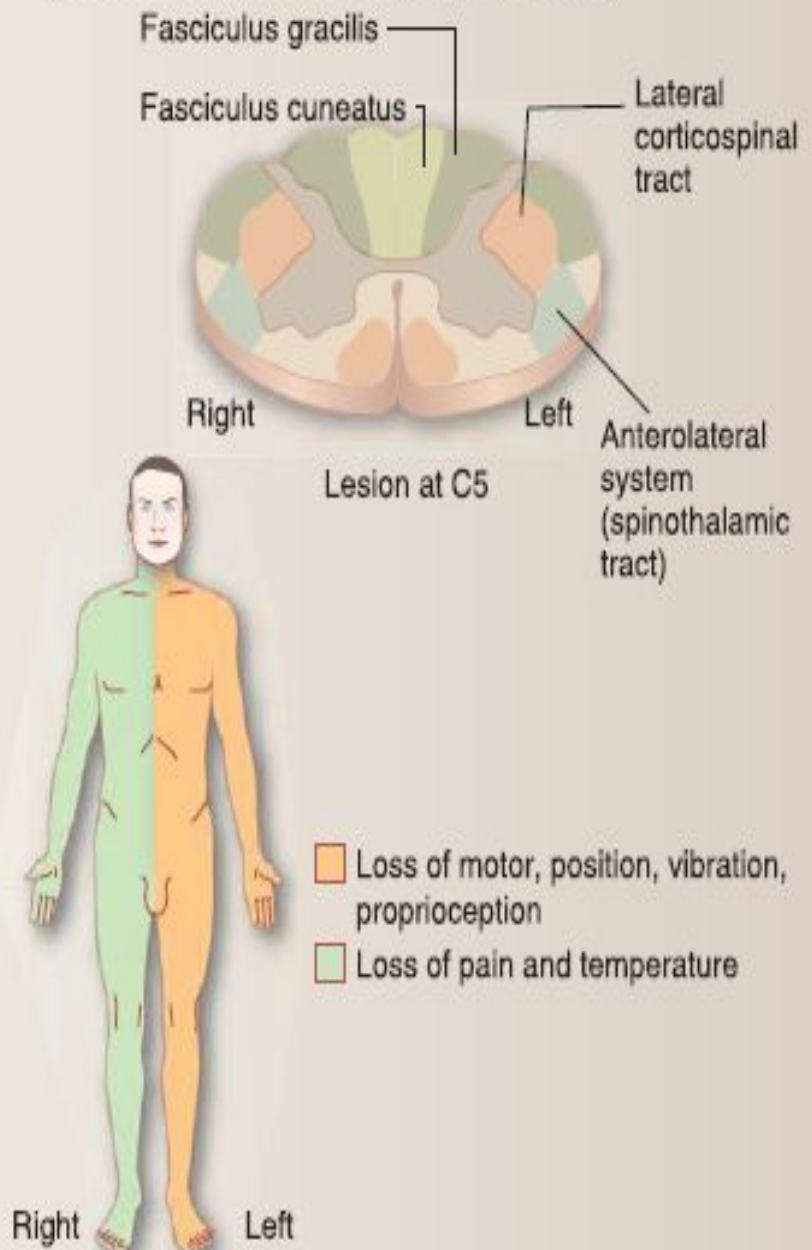
Brown-Sequard Syndrome

Below the level of lesion:

- ❑ Ipsilateral loss of proprioception & fine touch below the level of the lesion (due to damage of the dorsal column → cuneate and Gracile Tract).
- ❑ Ipsilateral upper motor neuron paralysis below the level of the lesion(due to damage of the lateral column → corticospinal tract).
- ❑ Contralateral loss of pain, temperature and crude touch sensations below the level of lesion (due to damage of lateral and ventral spinothalamic tract, which has decussated).



Hemisection (Brown-Séquard syndrome)



Pathway of Sensations from the Face and Scalp

“Trigeminal Pathway”

1. The first order neuron:

It is formed by the cells of **trigeminal ganglion** and its process divided into:

- **The peripheral or lateral processes (Dendrite):** of the cells of the trigeminal ganglion form of the **ophthalmic, maxillary and sensory part of the mandibular nerves**. These nerves carry pain, temperature and touch sensations from the face, cornea, mouth and greater part of the scalp and deep sensation.
- **The central or medial processes (Axon):** of the cells of the trigeminal ganglion form the sensory root of the **trigeminal nerve** which enters the pons and midbrain:
 - a. The Spinal (Descending) nucleus of trigeminal N.:**
for pain and temperature sensations.
 - b. The chief or main sensory nucleus:** for discriminative touch, vibration and conscious proprioception sensations.
 - c. Mesencephalic nucleus:** for nonconscious proprioception from muscles of mastication.

Pathway of Sensations from the Face and Scalp

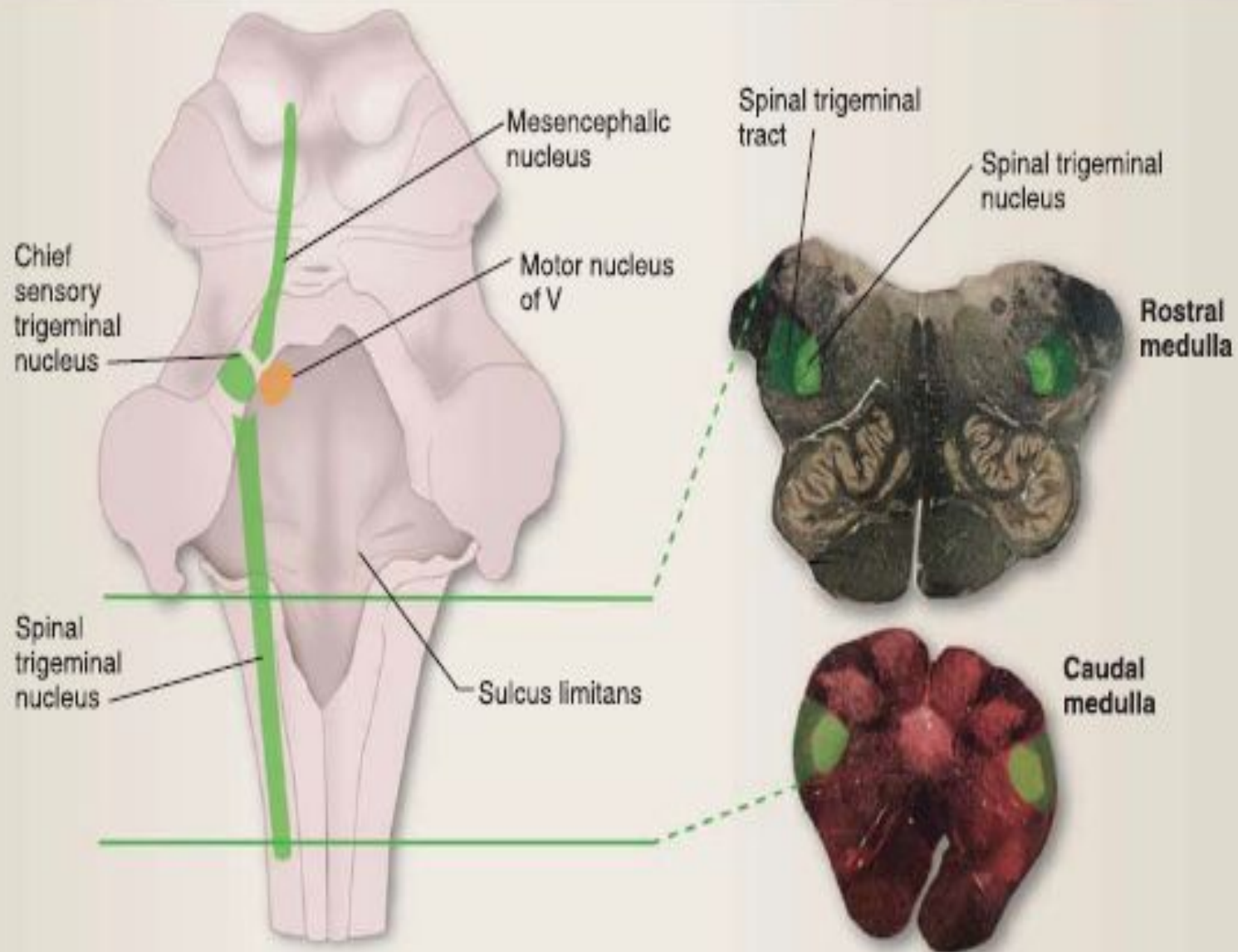
2. The second neuron:

- The axons of the cells of **the spinal descending nucleus and the main sensory nucleus** cross to the opposite side and join each other in the pons and ascend as **trigeminal lemniscus** in the pons → the mid brain → to relay the sensory impulse to posteromedial ventral nucleus (PMVN) of the thalamus.
- The axons of the cells of **mesencephalic nucleus travel** to the reticular formation, cerebellum and motor nucleus of trigeminal nerve.

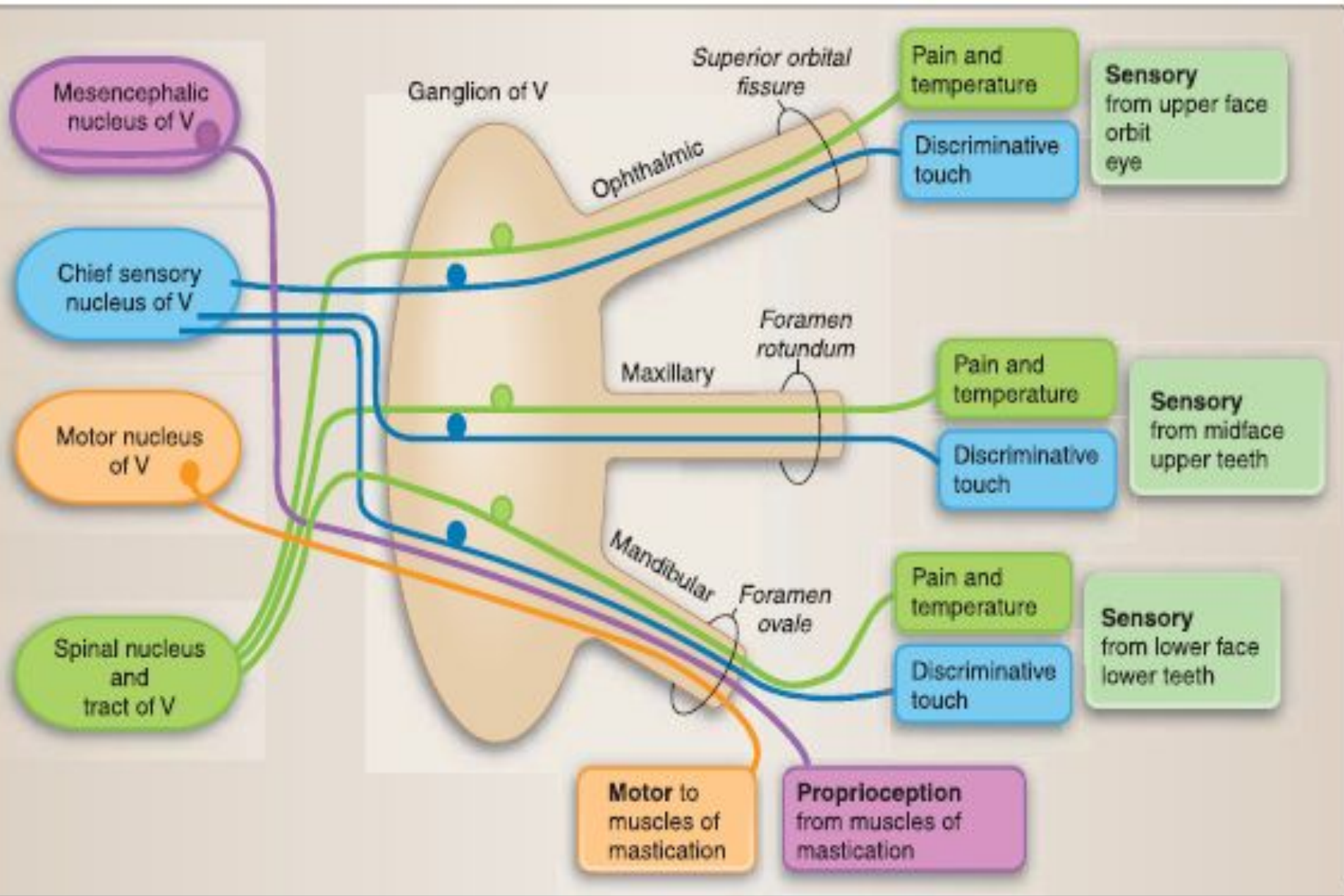
3. The third order neuron:

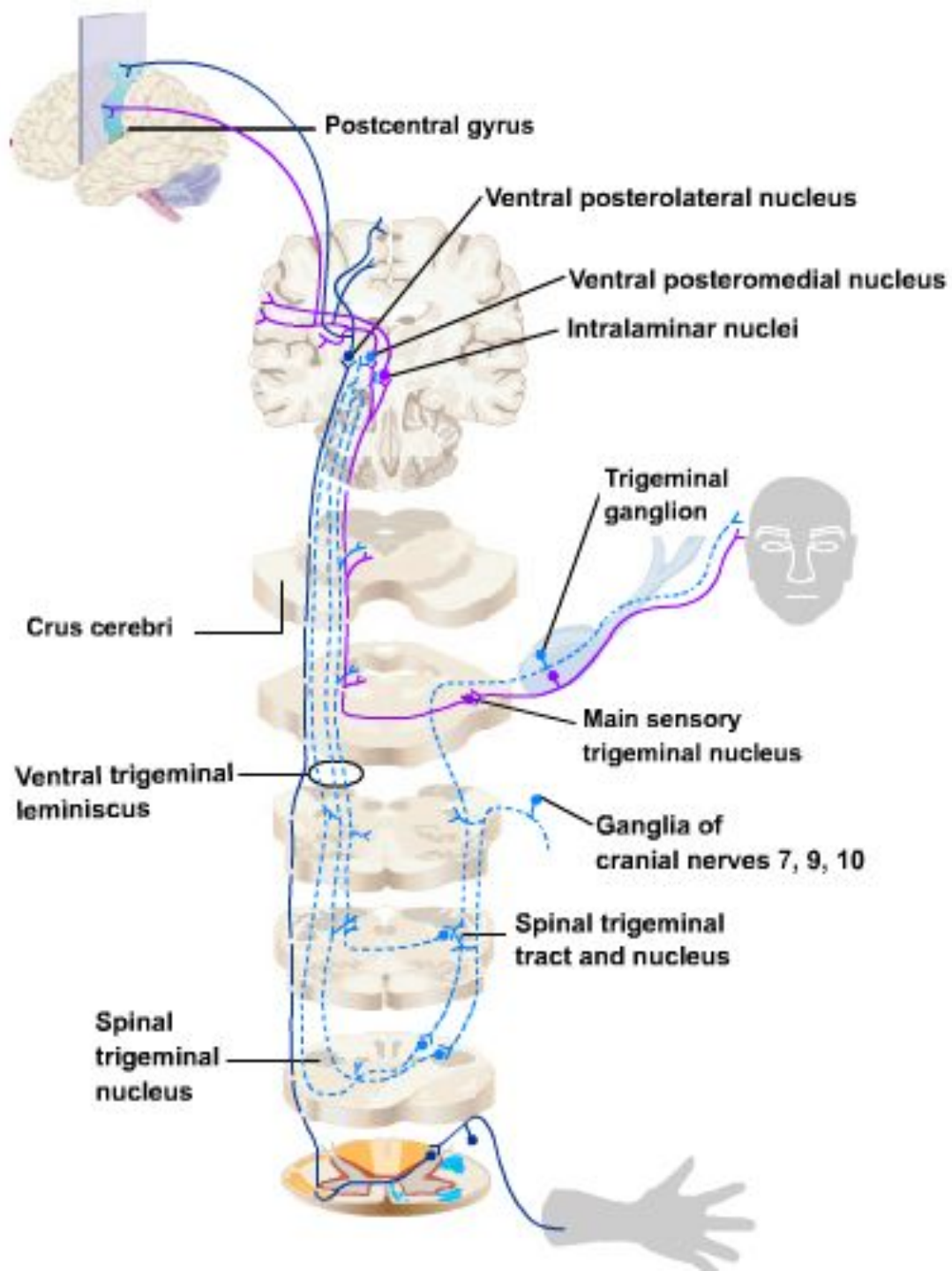
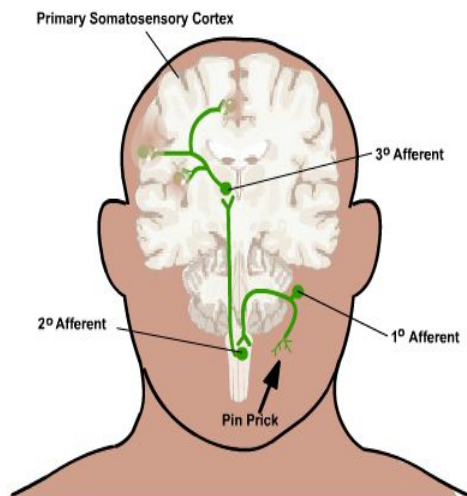
The axons of the cells of **the PMVN of the thalamus** ascend to pass through the **posterior limb** of the internal capsule conducting the impulse to the cortical somatic sensory area (1, 2, 3) in the lower 1/3 of postcentral gyrus of the parietal lobe.

Trigeminal Nuclei in the Brainstem



Modalities and Functions of the Trigeminal Nerve





Trigeminal Nuclei in the Brainstem

Nerve Fiber Modality	Nucleus	Associated Tract	Function
General somatic afferent (GSA)	Chief sensory nucleus of V	Second-order neurons travel in the contralateral trigeminal lemniscus and terminate in the VPM of the thalamus. Second-order neurons from afferents from inside of the mouth travel in the ipsilateral posterior trigeminothalamic tract.	Discriminative touch, vibration, conscious proprioception
General somatic afferent (GSA)	Spinal nucleus of V	Second-order neurons travel in the contralateral trigeminothalamic tract; collaterals to pain-modulating systems terminate in the VPM of the thalamus.	Pain and temperature
General somatic afferent (GSA)	Mesencephalic nucleus of V	Central processes travel to reticular formation, cerebellum, and motor nucleus of V.	Nonconscious proprioception from muscles of mastication
Special visceral efferent (SVE)	Motor nucleus of V	Afferents to motor neurons through bilateral innervation via the corticobulbar tract	Motor to muscles of mastication, tensor tympani

Comparison of Spinal Cord Structures to trigeminal Nuclear Complex

Spinal Cord		Trigeminal Nuclear Complex
Discriminative Touch, Vibration, and Proprioception		
Cell bodies	Spinal ganglion	Trigeminal ganglion, mesencephalic nucleus
Central processes	Fasciculus gracilis and cuneatus	Entering trigeminal fibers
Second-order neurons	Nucleus gracilis and cuneatus	Chief sensory nucleus of V
Ascending pathway	Medial lemniscus, crossed	Trigeminal lemniscus, crossed
Thalamic nucleus	Contralateral VPL	Contralateral VPM
Pain and Temperature		
Cell bodies	Spinal ganglion	Trigeminal ganglion
Central processes	Lissauer tract	Spinal tract of V
Second-order neurons	Posterior horn	Spinal nucleus of V
Ascending pathway	Spinothalamic tract, crossed	Trigeminothalamic tract, crossed
Thalamic nucleus	Contralateral VPL	Contralateral VPM

Headache

- ❖ This is a painful sensation at the head.
- ❖ Its causes are either intracranial or extracranial in origin.

I. Extracranial Causes:

- Eye disease: e.g. glaucoma.
- Teeth disease.
- Sinusitis.
- Ear inflammation: e.g. otitis media.
- Mastoiditis.
- Temporal arteritis.
- Tension “psychogenic headache”.
- Certain systemic diseases: e.g. anemia.

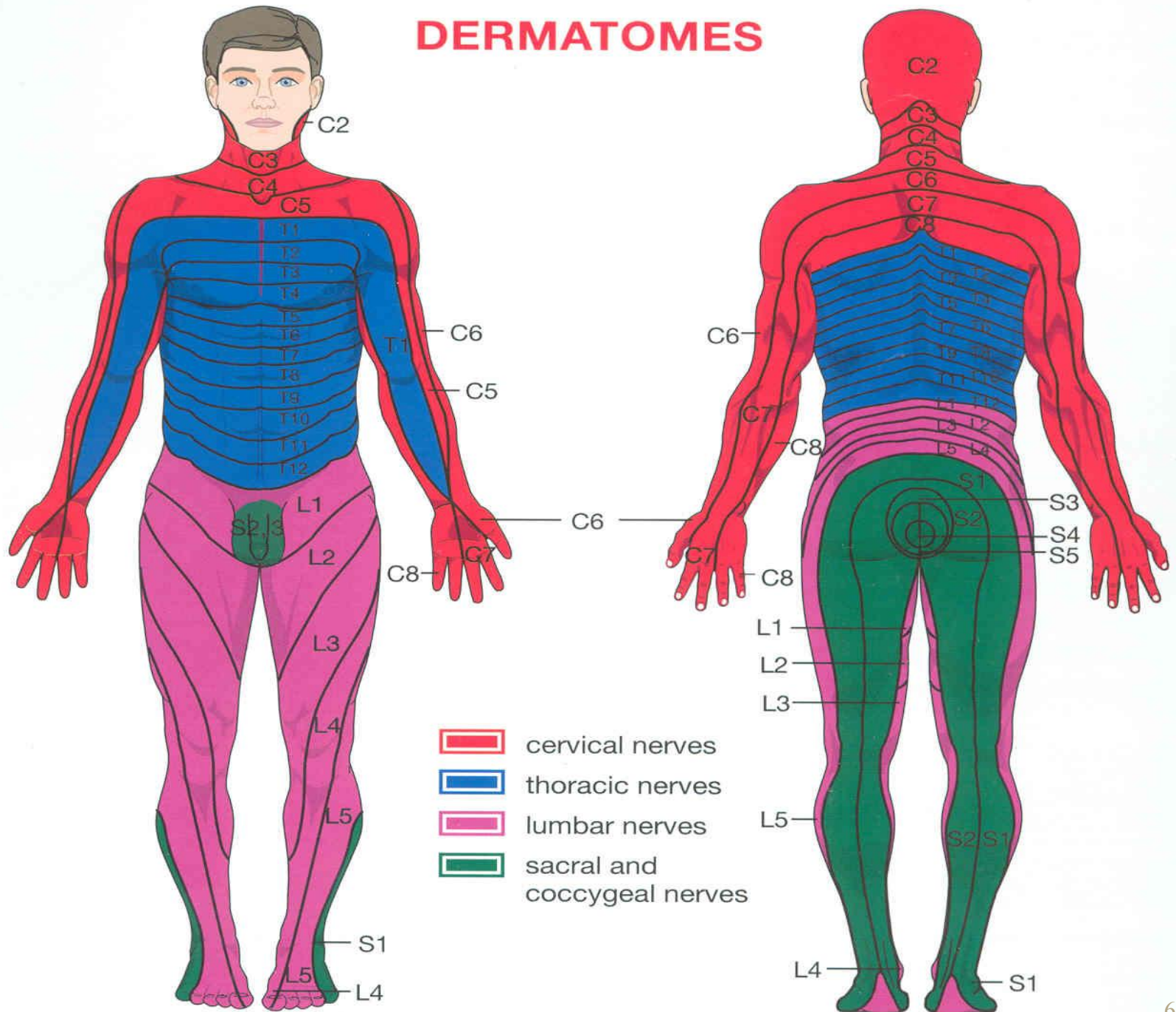
II. Intracranial Causes:

- Meningeal irritation: meningitis, subarachnoid hemorrhage.
- Decrease of CSF pressure: e.g. post LP headache.
- Increase of CSF pressure: e.g. brain SOL.
- Head trauma.
- Distention of the intracranial arteries: hypertension, fever, migraine.
- Venous sinus thrombosis.

Distribution of the Sensory Spinal Roots on the Surface of the Body

Roots	Sensory Distribution
V-nerve	Face and anterior surface of the head
C2	Posterior surface of head & lateral aspect of neck
C3,4	Anterioposterior surface of the neck
C5	Lateral surface of arm, the deltoid area
C6	Lateral (radial) surface of forearm thenar eminence and thumb
C7	Middle surface of forearm, middle of palm & middle 3 fingers
C8	Medial surface of forearm, hypothenar eminence and little finger
T1	Medial surface of the arm
T1-T7	Anterioposterior surface of the trunk T5 → The nipple
T8-T12	Anterioposterior surface of the abdomen T10 → The umbilicus T12 → The inguinal ligament

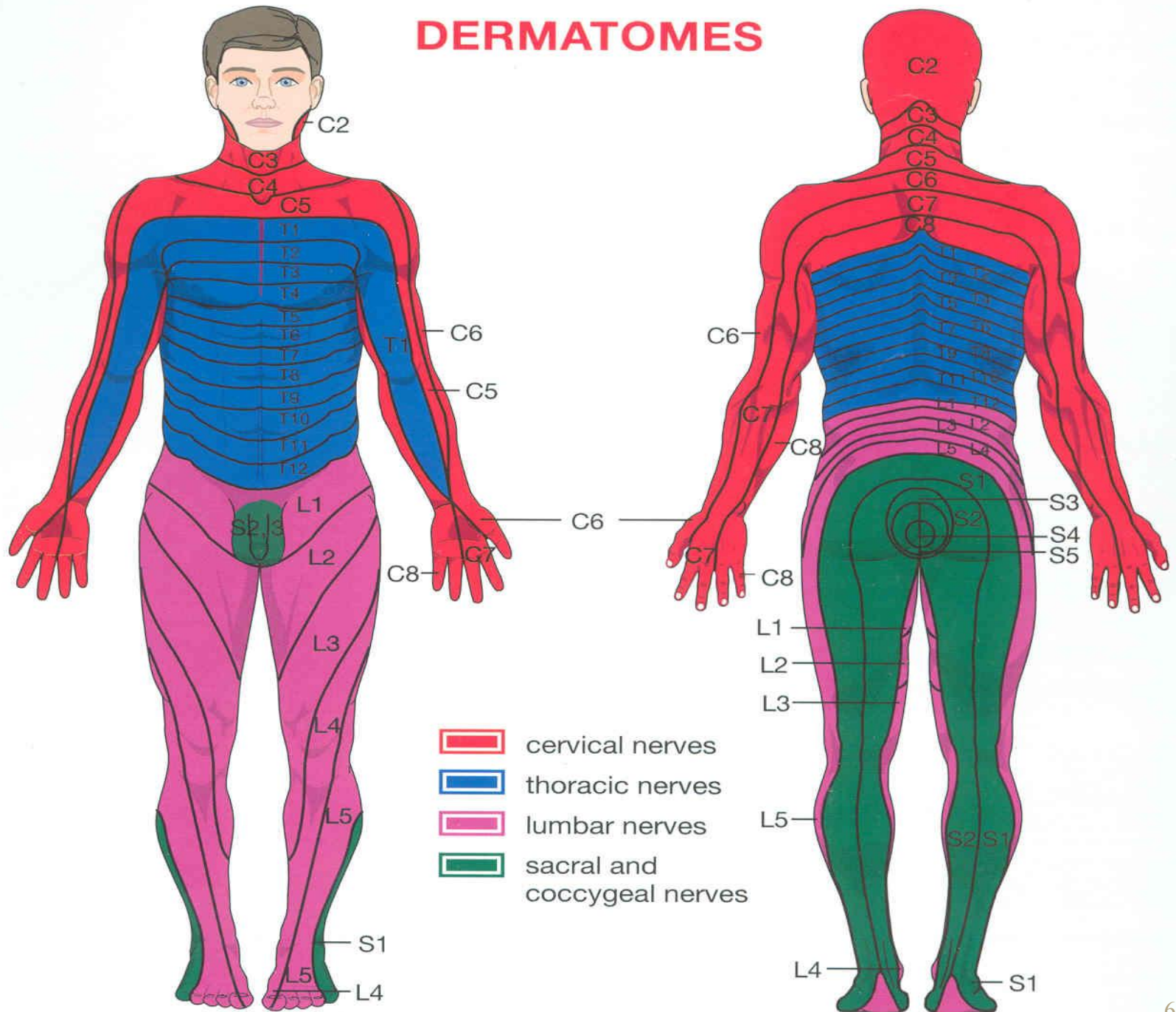
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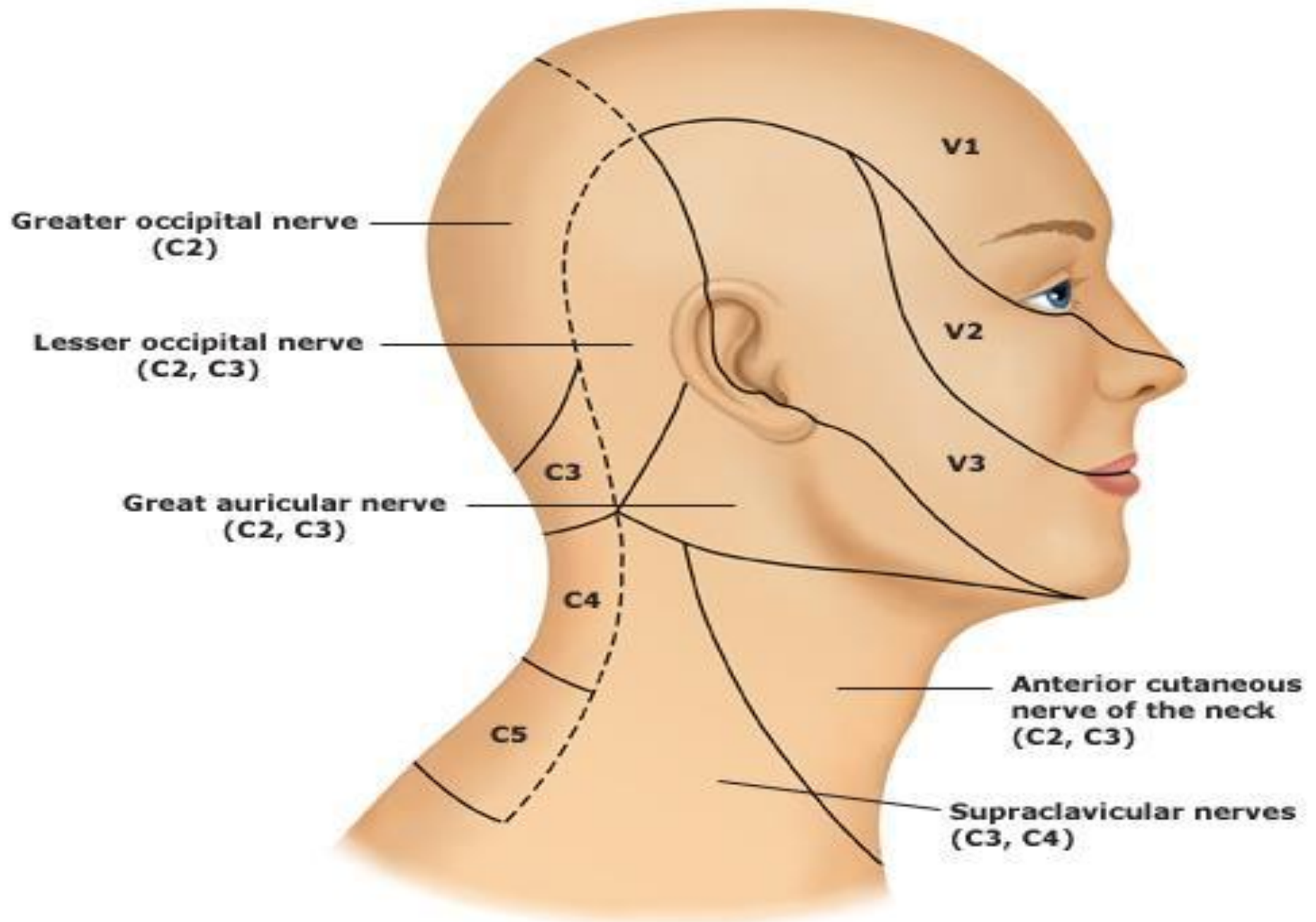


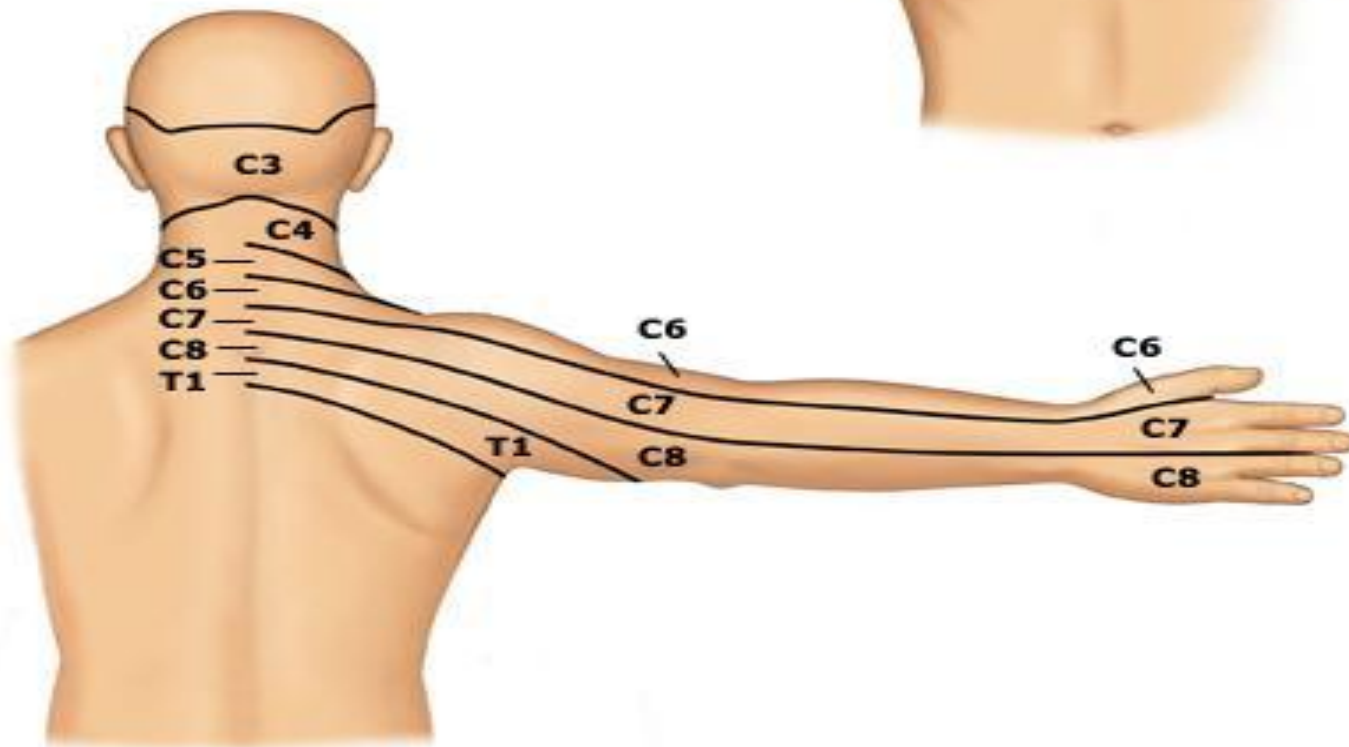
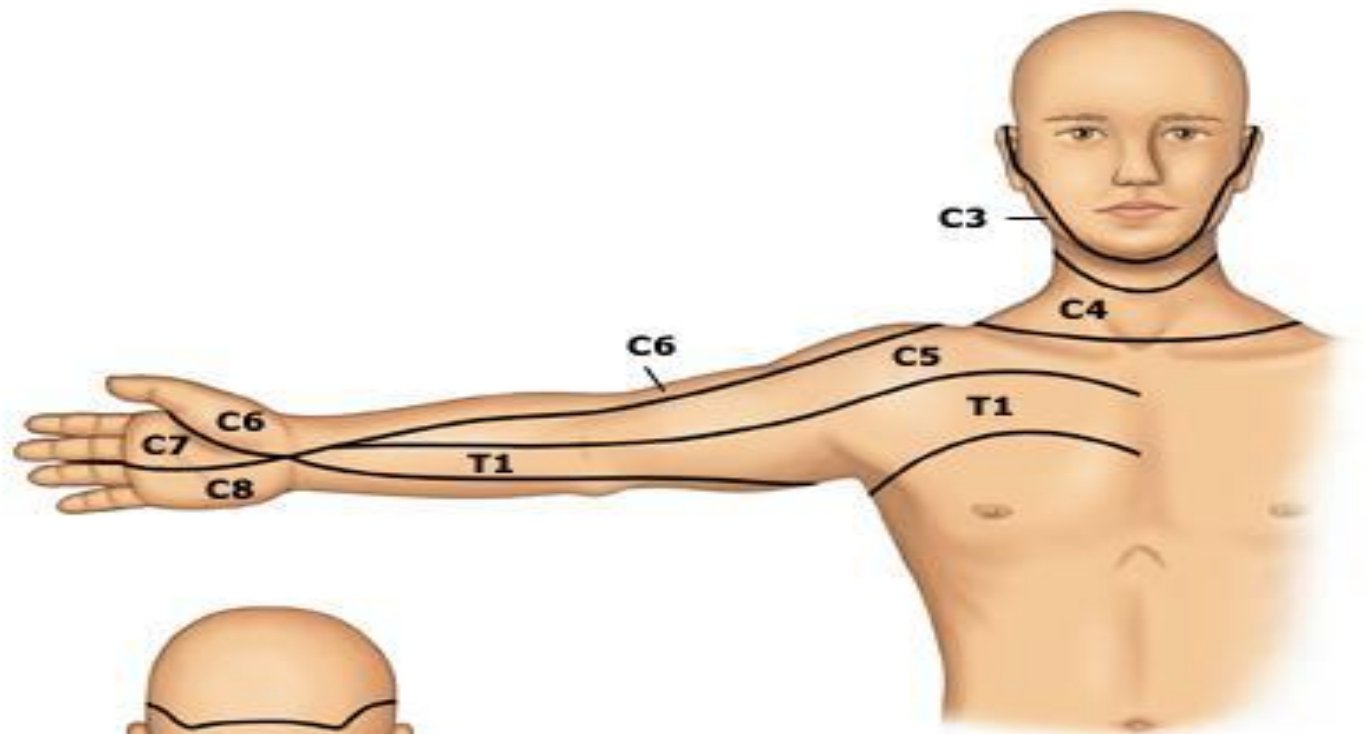
Distribution of the Sensory Spinal Roots on the Surface of the Body

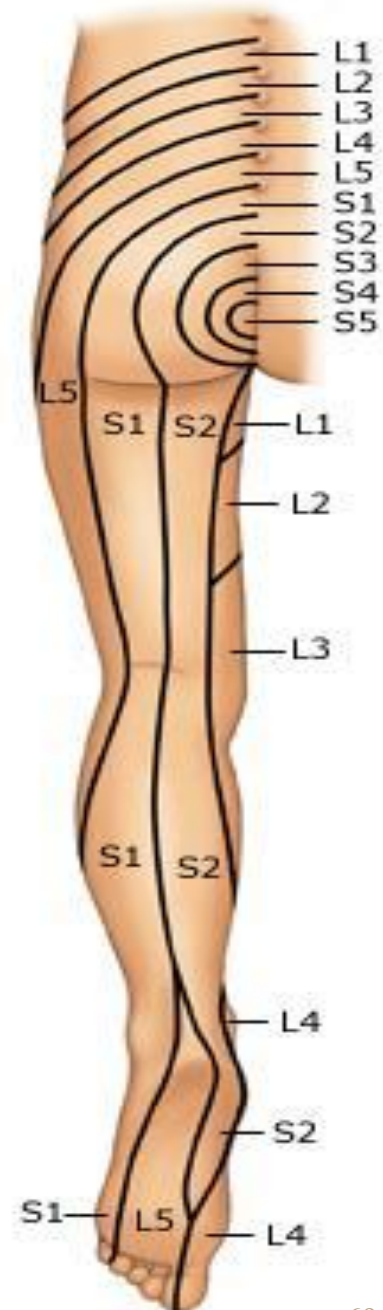
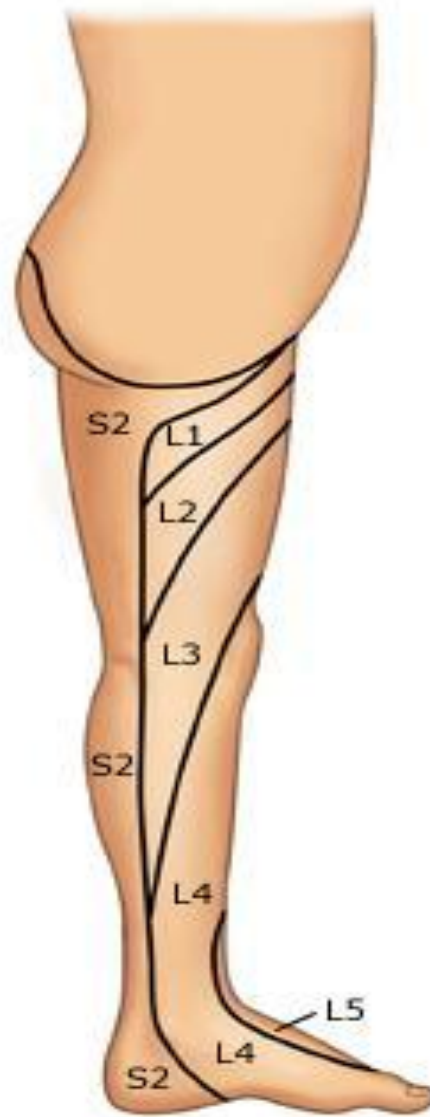
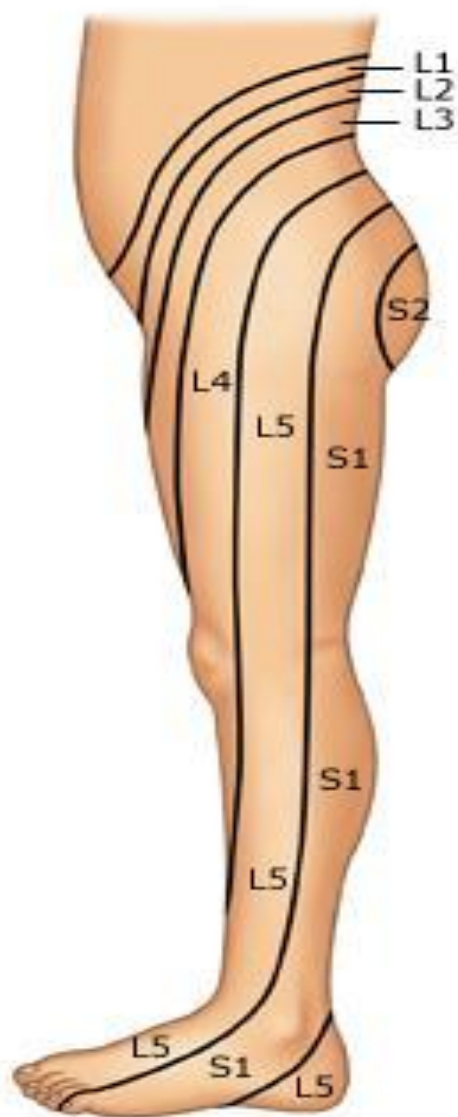
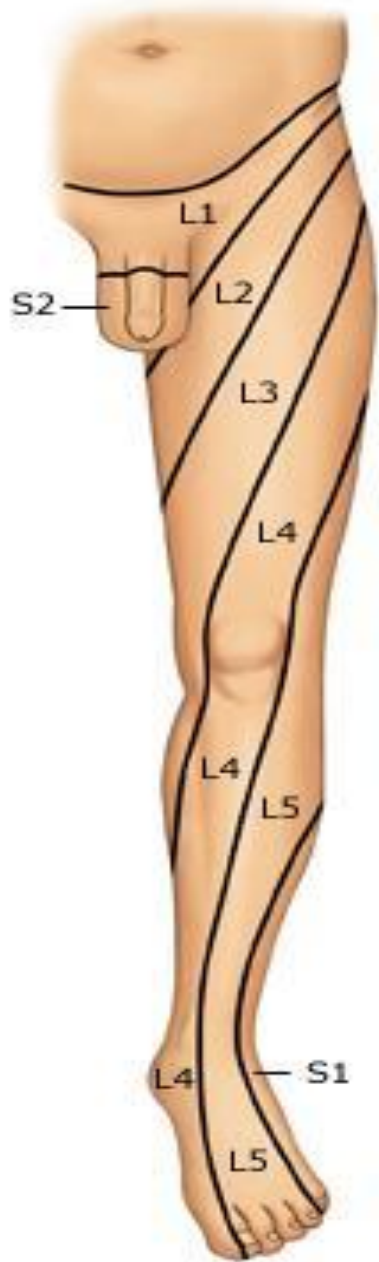
Roots	Sensory Distribution
L1	Upper 1/3 of front of the thigh
L2	Middle 1/3 of front of the thigh
L3	Lower 1/3 of front of the thigh, medial side of the knee
L4	Lower anterolateral surface of the thigh, front surface of the knee, anteromedial aspect of the leg
L5	Lateral aspect of thigh & leg, middle 1/3 of dorsum of the foot & middle 3 toes, big toe
S1	Postereolateral surface of the thigh, leg, and foot & little toe
S2	Posterior aspect of thigh, leg & sole of foot
S3,4,5	Anal, perianal and gluteal region (saddle area)

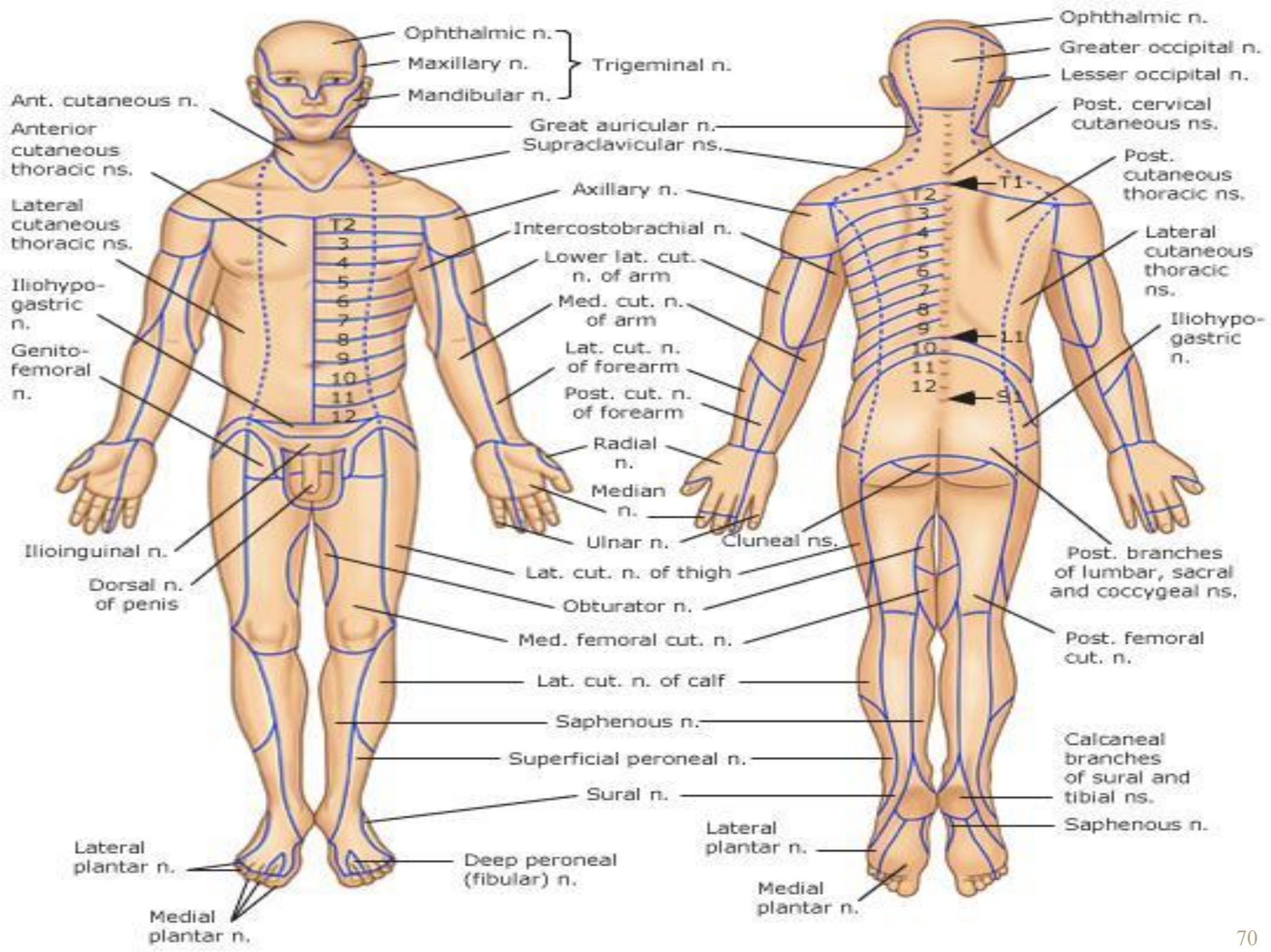
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Thank You