Nervous system
CNS

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Lec. 12& 13

- **O B J E C T I V E S**
- Types of pain sensation
- • Identify the locations and functions of the different types

of neurons in the somatic sensory & somatic motor pathways.

- • Compare the locations and functions of the direct and indirect motor pathways.

Sensations (cont…)

- **<u>The amplitude</u>** of both graded potential (which are generated in receptors weather generator potentials and receptor potentials) varies with the **intensity of the stimulus**, with an intense stimulus producing a large potential and a weak stimulus eliciting a small one.

Similarly**, large** generator potentials or receptor potentials trigger nerve impulses at **high frequencies** in the first-order neuron, in contrast to small generator potentials or receptor potentials, which trigger nerve impulses at lower frequencies

Adaptation in Sensory Receptors

A characteristic of most sensory receptors is adaptation, in which the graded potential decreases **in amplitude** during a maintained, constant stimulus, this causes the frequency of nerve impulses in the first-order neuron <u>to decrease</u>. Because of adaptation, <u>the perception of a sensation may fade or disappear even though the stimulus Persists</u>

Rapidly adapting receptors. Receptors associated with pressure, touch, and smell are rapidly adapting.

Slowly adapting receptors,

e.g. some touch receptors stimuli associated with pain, body position, and chemical

• *Somatic sensations*

- **TOUCH**
- rapidly adapting touch receptors**. *in skin with no hair* Corpuscles of touch** or ***Meissner***

Corpuscles (fingertips, hands, eyelids, tip of the tongue)

- **Hair root plexuses in hairy skin .**
- slowly adapting touch receptors.
- **Type I & type II Cutaneous mechanoreceptors (***Ruffini corpuscles*)
- ***PRESSURE***
- **lamellated corpuscle or *pacinian corpuscle***
- ***Vibration***
- result from rapidly repetitive sensory signals from tactile receptors. The receptors for vibration sensations are corpuscles of touch and **lamellated (pacinion) corpuscles**
- ***Itch***
- The **itch** sensation results from stimulation of free nerve endings by certain chemicals
- ***Tickle***
- Free nerve endings are thought to mediate the **tickle** sensation.
- ***Thermoreceptors***
- free nerve endings

- **Pain** It serves a protective function by signaling the presence of noxious, tissue-damaging conditions.
- **Nociceptors**, the receptors for pain, are free nerve endings found in every tissue of the body except the brain
- **Types of pain**

fast pain The perception occurs **very rapidly**, usually within
0.1 second after a stimulus , because the nerve impulses propagate
along medium-diameter, **myelinated A fibers**.
This type of pain is also
known **as acute, sharp, or pricking pain**. The pain felt from a needle
puncture or knife cut to the skin is fast pain.
.Fast pain is well localized
Fast pain is not felt in deeper tissues of the body.

The perception of **slow pain**, begins a second or more after a stimulus is applied.
It then gradually increases in intensity over a period of several seconds
or minutes. Impulses for slow pain conduct along small diameter,
unmyelinated C fibers. This type of pain is chronic, burning, aching, or
throbbing pain. Slow pain can occur both in the skin and in deeper tissue .

Pain that arises from stimulation of **receptors in the skin** is called **superficial somatic pain**; stimulation of **receptors in skeletal muscles, joints, tendons, and fascia causes deep somatic pain**.

Visceral pain results from stimulation of nociceptors in visceral organs

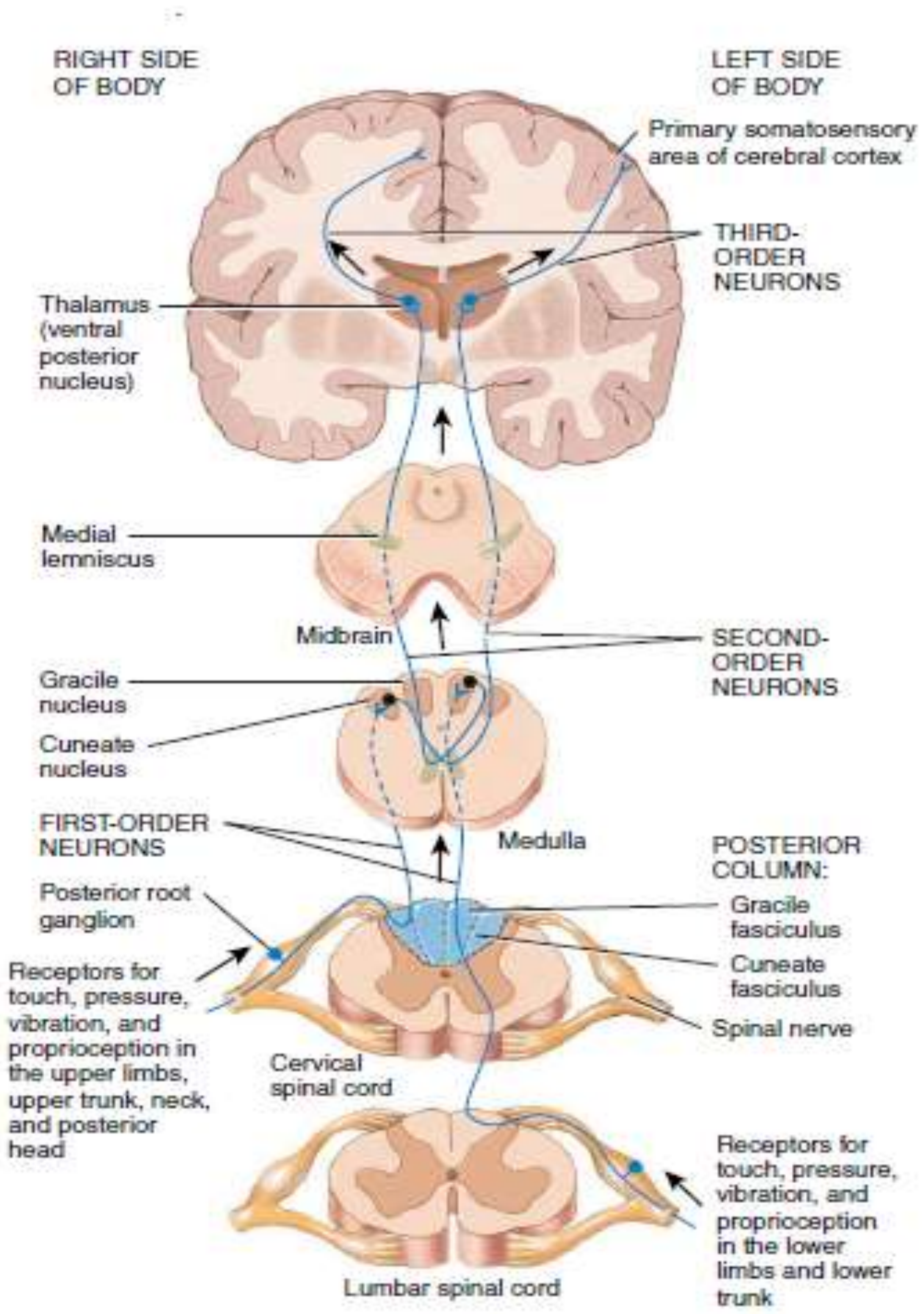
Summary of Receptors for Somatic Sensations

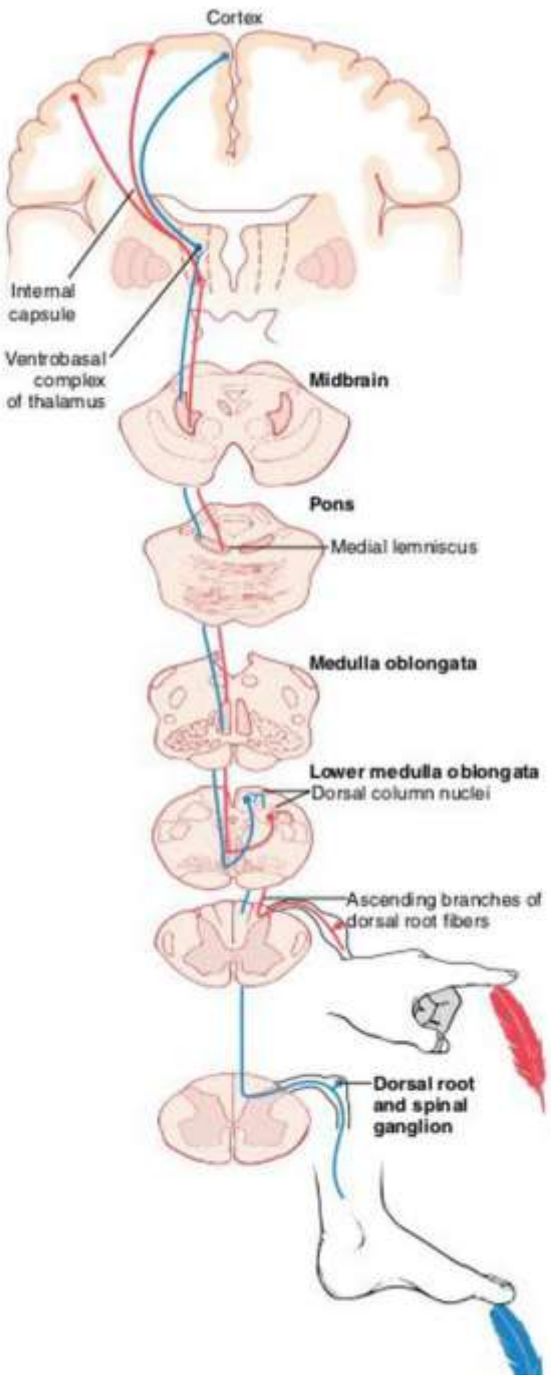
RECEPTOR TYPE	RECEPTOR STRUCTURE AND LOCATION	SENSATIONS	ADAPTATION RATE
TACTILE RECEPTORS			
Corpuscles of touch (Meissner corpuscles)	Capsule surrounds mass of dendrites in dermal papillae of hairless skin.	Touch, pressure, and slow vibrations.	Rapid.
Hair root plexuses	Free nerve endings wrapped around hair follicles in skin.	Touch.	Rapid.
Type I cutaneous mechanoreceptors (tactile discs)	Saucer-shaped free nerve endings make contact with tactile epithelial cells in epidermis.	Touch and pressure.	Slow.
Type II cutaneous mechanoreceptors (Ruffini corpuscles)	Elongated capsule surrounds dendrites deep in dermis and in ligaments and tendons.	Touch and stretching of skin.	Slow.
Lamellated (pacinian) corpuscles	Oval, layered capsule surrounds dendrites; present in dermis and subcutaneous layer, submucosal tissues, joints, periosteum, and some viscera.	Pressure and fast vibrations.	Rapid.
Itch and tickle receptors	Free nerve endings in skin and mucous membranes.	Itching and tickling.	Both slow and rapid.
THERMORECEPTORS			
Warm receptors and cold receptors	Free nerve endings in skin and mucous membranes of mouth, vagina, and anus.	Warmth or cold.	Initially rapid, then slow.
PAIN RECEPTORS			
Nociceptors	Free nerve endings in every body tissue except brain.	Pain.	Slow.
PROPRIOCEPTORS			
Muscle spindles	Sensory nerve endings wrap around central area of encapsulated intrafusal muscle fibers within most skeletal muscles.	Muscle length.	Slow.
Tendon organs	Capsule encloses collagen fibers and sensory nerve endings at junction of tendon and muscle.	Muscle tension.	Slow.
Joint kinesthetic receptors	Lamellated corpuscles, type II cutaneous mechanoreceptors, tendon organs, and free nerve endings.	Joint position and movement.	Rapid.

Somatic sensory pathway

1- Posterior Column–Medial Lemniscus Pathway

(highly localized)





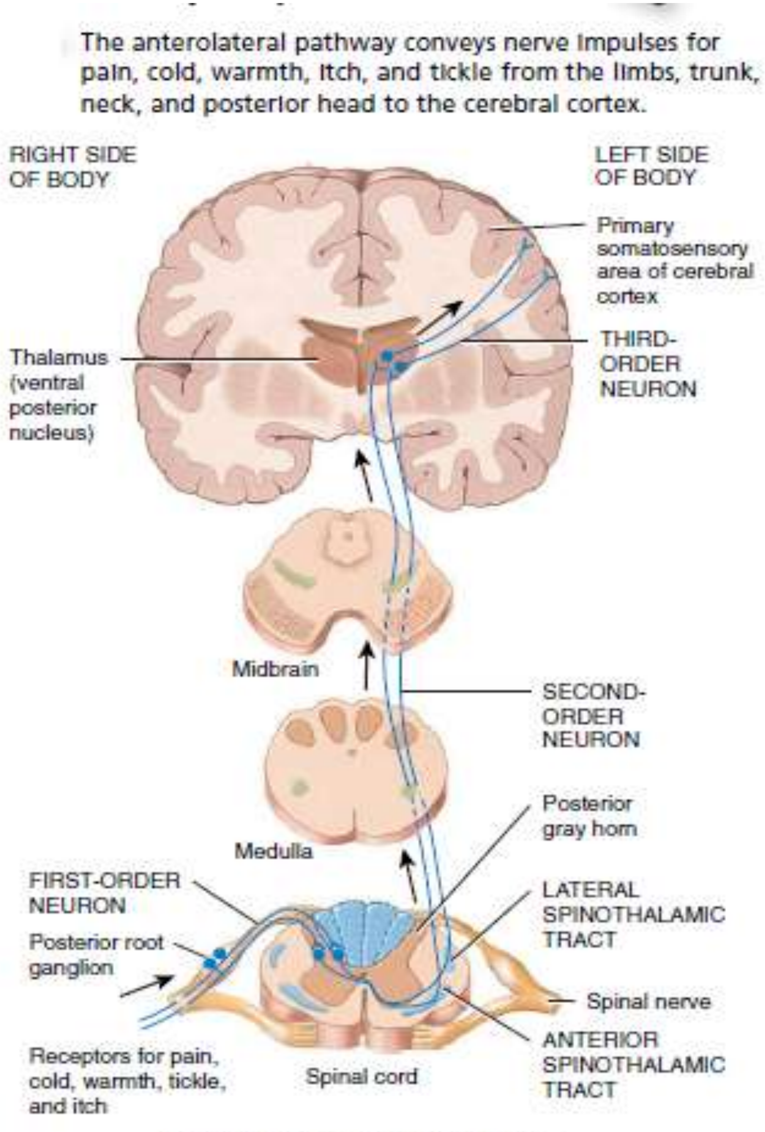
Cortex
Internal capsule
Ventrobasal complex of thalamus
Midbrain
Pons
Medial lemniscus
Medulla oblongata
Lower medulla oblongata
Dorsal column nuclei
Ascending branches of dorsal root fibers
Dorsal root and spinal ganglion

First-order neurons in the posterior column–medial lemniscus pathway extend from sensory receptors in the limbs, trunk, neck, and posterior head into the spinal cord ,In the spinal cord, their axons form the posterior (dorsal) columns, which consist of two parts: the gracile fasciculus ,and the cuneate fasciculus

Then fibers pass up to the medulla, where they synapse **in the *dorsal column nuclei* (the *cuneate* and *gracile nuclei*).** From there *second-order neurons* decussate immediately to the opposite and continue upward **through the *medial lemnisci* to the thalamus**

the axon terminals of second-order neurons synapse with third-order neurons, in thalamus then ascend to the primary somatosensory area .

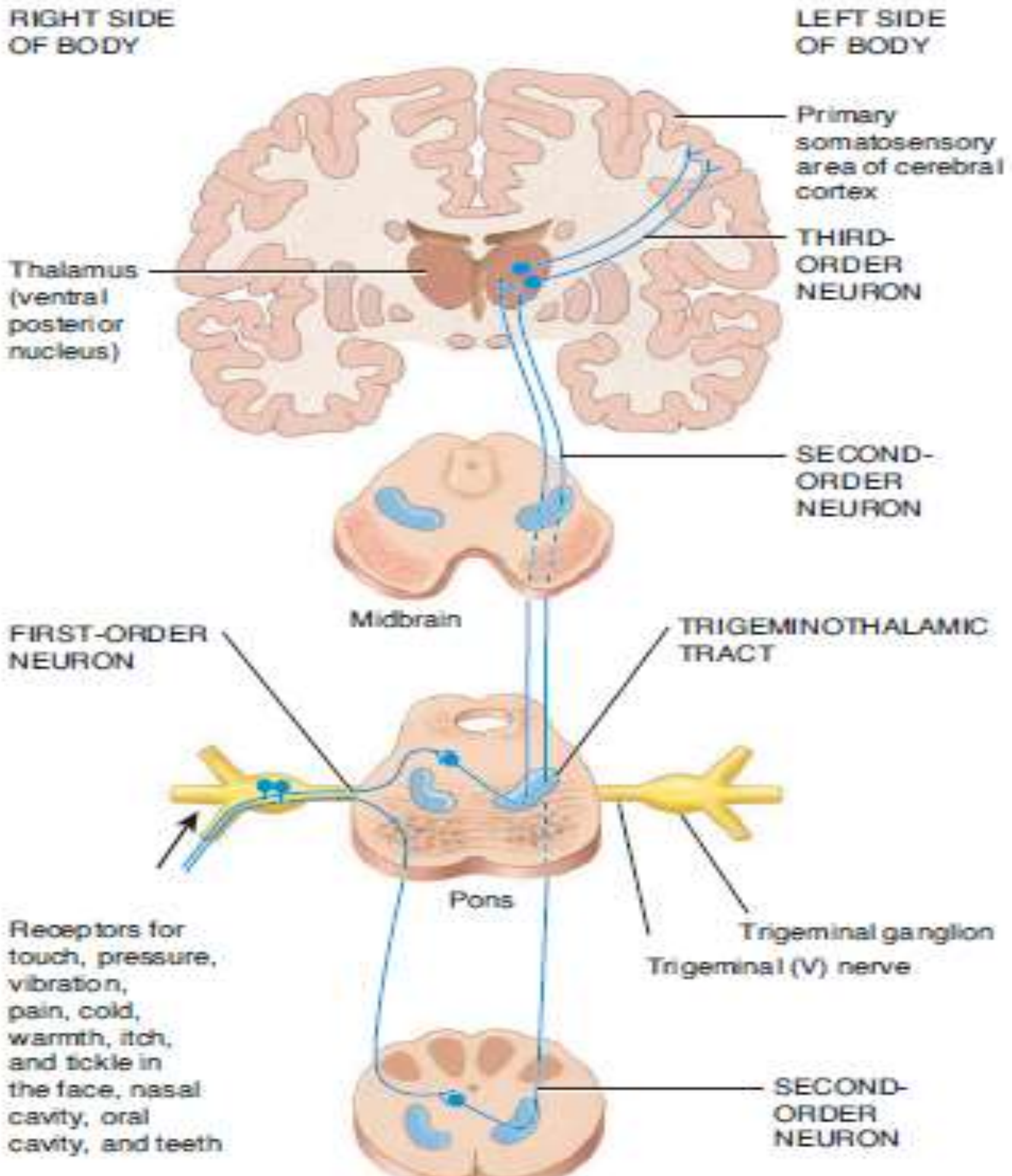
2- Anterolateral (spinothalamic) pathway (poorly localized)



Anterolateral (spinothalamic) pathways

3- Trigeminothalamic Pathway

- The trigeminothalamic pathway conveys nerve impulses for most somatic sensations (tactile, thermal, pain, and proprioceptive) from the face, nasal cavity, oral cavity, and teeth to the cerebral cortex.



Somatosensary pathways to cerebellum :

Anterior and posterior spinocerebellar:

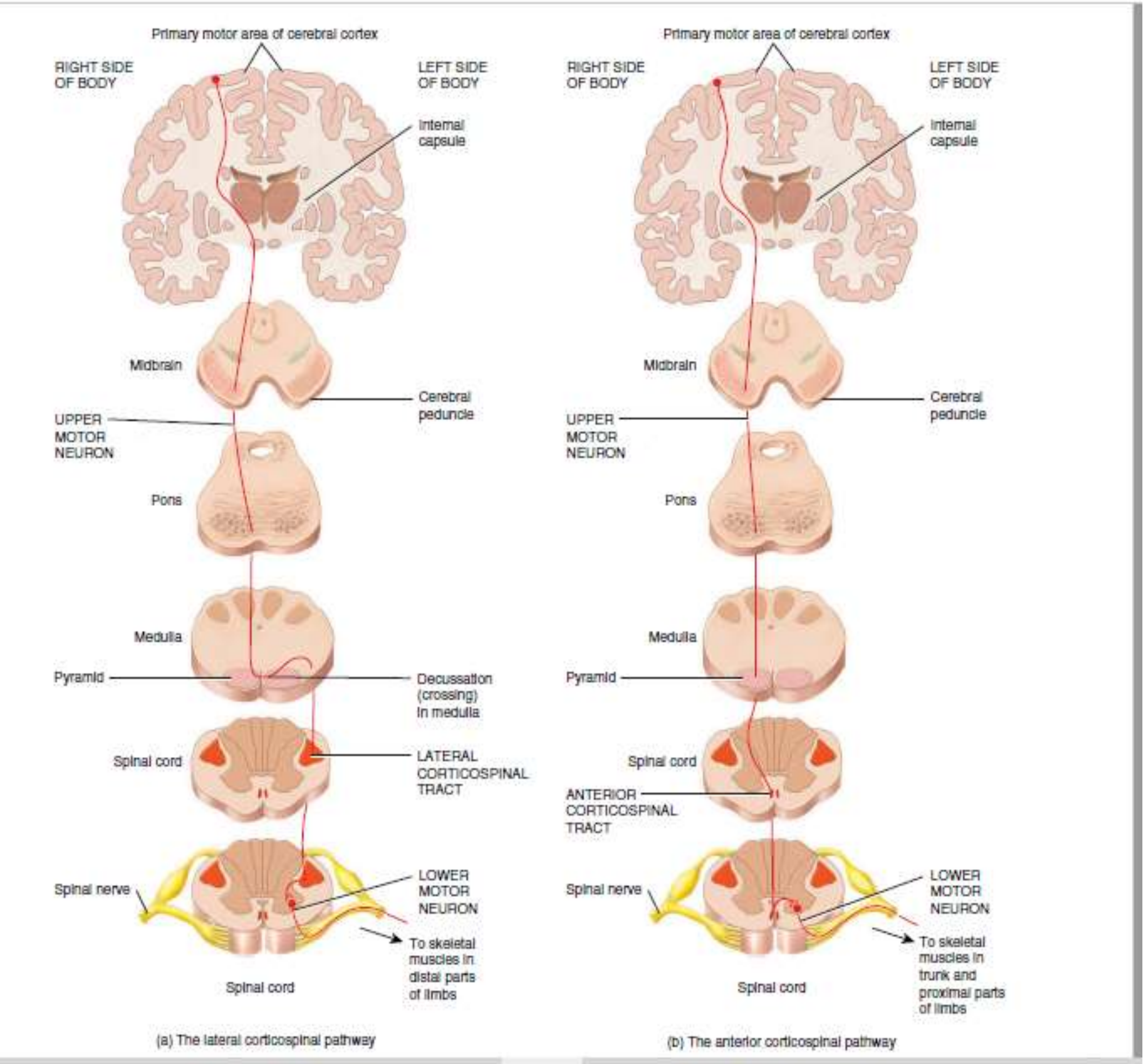
Convey nerve impulses from **proprioceptors in trunk and lower limb of one side of body to same side of cerebellum.**

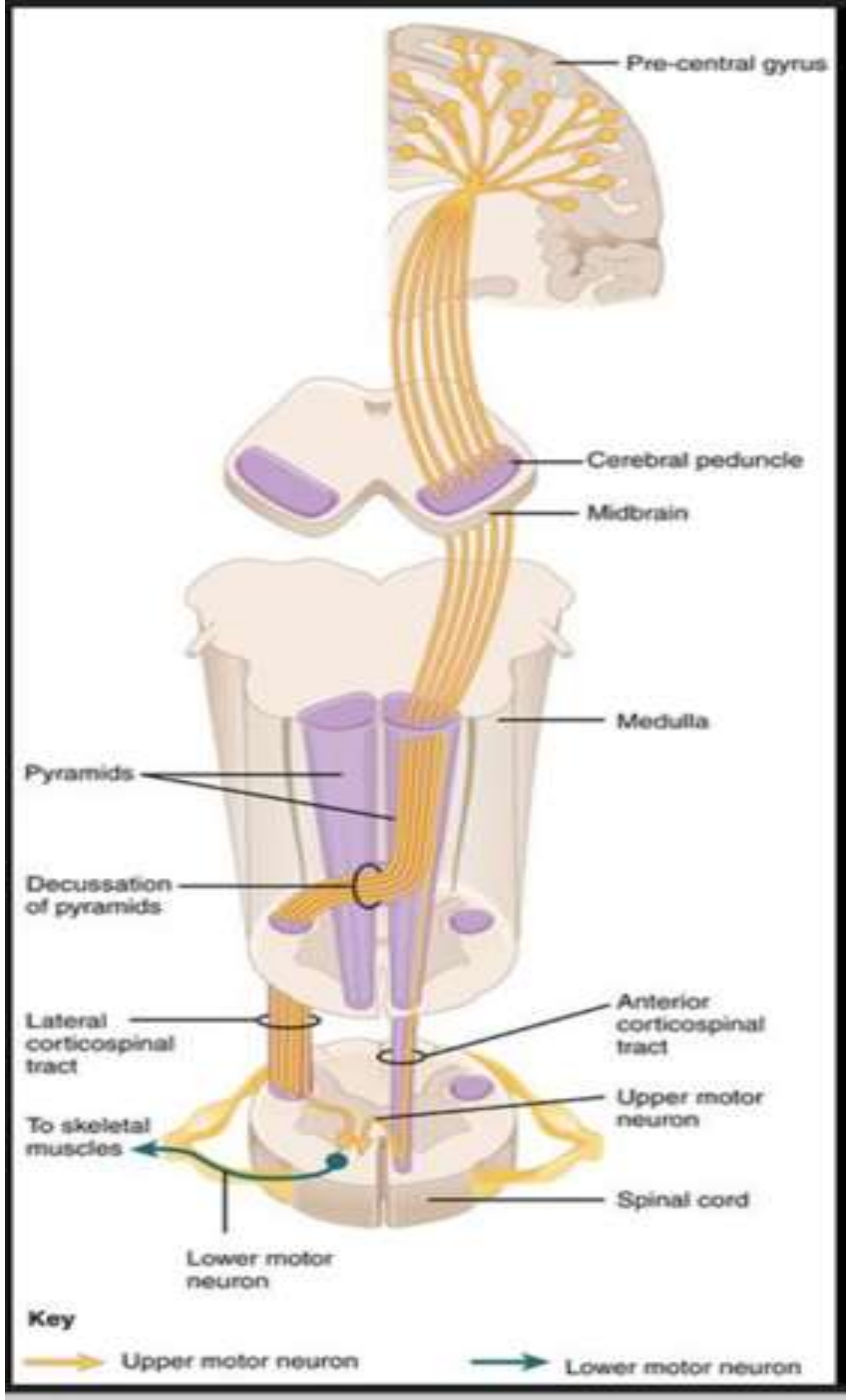
Proprioceptive input informs cerebellum of actual movements, allowing it to coordinate, smooth, and refine skilled movements and maintain posture and balance.

Somatic motor pathway

Direct pathway (pyramidal pathways)

lateral & Anterior corticospinal tract



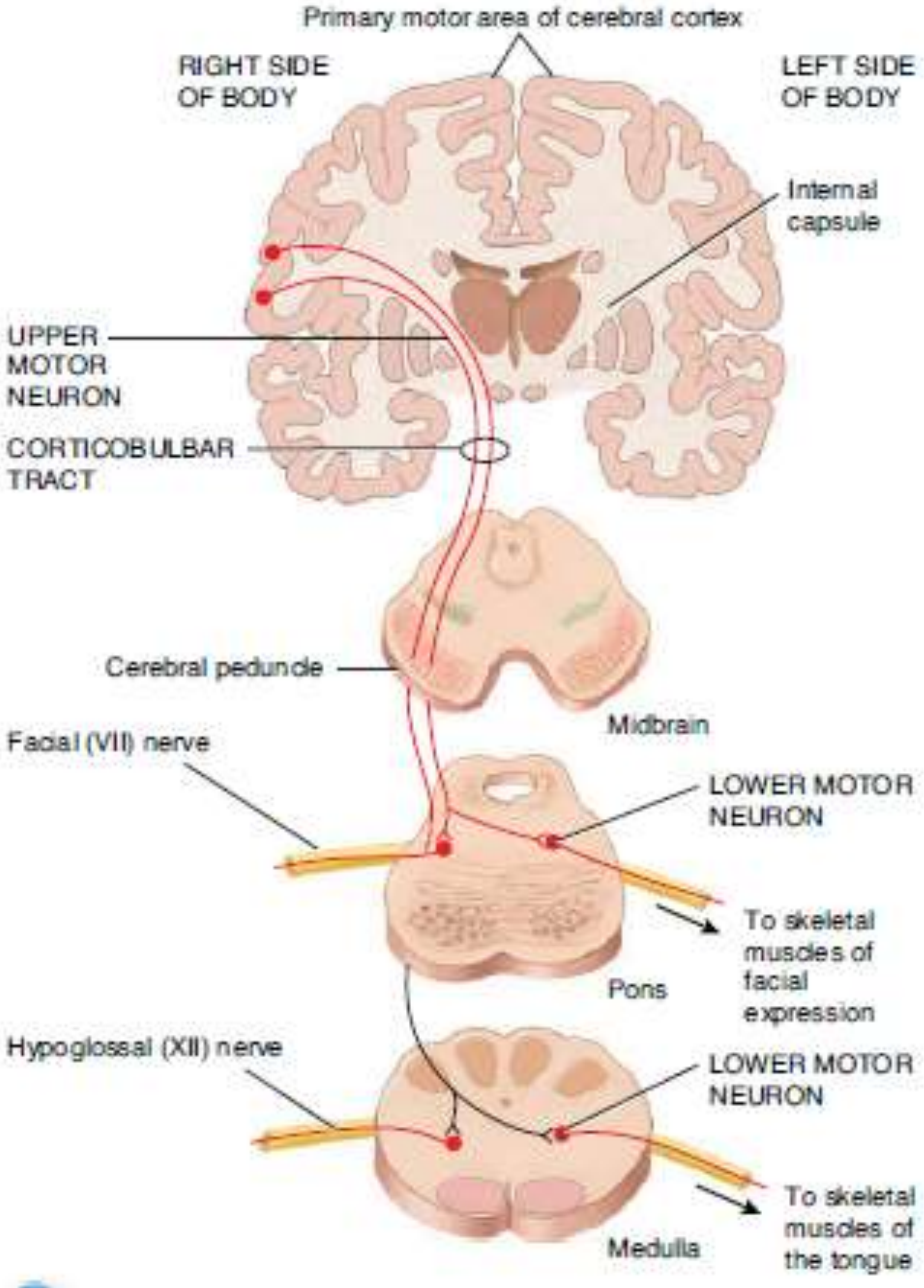


Pre-central gyrus
Cerebral peduncle
Midbrain
Medulla
Pyramids
Decussation of pyramids
Lateral corticospinal tract
Anterior corticospinal tract
Upper motor neuron
To skeletal muscles
Spinal cord
Lower motor neuron
Key
Upper motor neuron
Lower motor neuron

Corticobulbar Pathway

Bulbar = medulla

The corticobulbar pathway conducts nerve impulses for the control of skeletal muscles in the head.



Corticobulbar Pathway

conducts impulses for the control of skeletal muscles in the head. Axons of upper motor neurons from the cerebral cortex ,Some of the axons of the corticobulbar tract decussate; others do not.

The axons terminate in the motor nuclei of nine pairs of cranial nerves in the brain stem: the oculomotor (III), trochlear (IV), trigeminal (V), abducens (VI), facial (VII), glossopharyngeal (IX), vagus (X), accessory (XI), and hypoglossal (XII). The lower motor neurons of the cranial nerves convey impulses that control precise, voluntary movements of the eyes, tongue, and neck, plus chewing, facial expression, speech, and swallowing.

Indirect motor pathways or extrapyramidal pathways

Include axons of upper motor neurons that give rise to the indirect motor pathways descend from various nuclei of the **brain stem** into five major tracts of the **spinal cord** and terminate on

lower motor neurons. These tracts

Rubrospinal: Conveys nerve impulses from red nucleus at mid brain (which receives input from cerebral cortex and cerebellum) to contralateral skeletal muscles that govern precise, voluntary movements of distal parts of upper limbs.

Tectospinal: Conveys nerve impulses from superior colliculus(M.B) to **contralateral** skeletal muscles that reflexively move **head, eyes, and trunk** in response to visual or auditory stimuli.

Vestibulospinal: Conveys nerve impulses from vestibular nucleus at medulla (which receives input about head movements from inner ear) to ipsilateral skeletal muscles of trunk and proximal parts of limbs for maintaining posture and balance in response to head movements.

Medial and lateral reticulospinal: Conveys nerve impulses from reticular formation to ipsilateral skeletal muscles of trunk and proximal parts of limbs for maintaining posture and regulating muscle tone in response to ongoing body movements.

- **Brown-Séquard Syndrome**
- If the spinal cord is transected entirely, all sensations and motor functions **distal** to the segment of transection are blocked, but if the spinal cord is transected on only one side, the *Brown-Séquard syndrome* occurs. The effects of such transection can be predicted from knowledge of the cord fiber tracts .

All motor functions are blocked on the side of the transection in all segments below the level of the transection. Yet, only some of the modalities of sensation are lost on the transected side, and others are lost on the opposite side. The sensations of pain, heat, and cold—sensations served by the spinothalamic pathway—are lost *on the opposite side of the body* in all dermatomes two to six segments below the level of the transection. By contrast, the sensations that are transmitted only in the dorsal and dorsolateral columns—kinesthetic and position sensations, vibration sensation, discrete localization, and two-point discrimination—are lost *on the side of the transection* in all dermatomes below the level of the transection. Discrete “light touch” is impaired on the side of the transection because the principal pathway for the transmission of light touch, the dorsal column, is transected. That is, the fibers in this column do not cross to the opposite side until they reach the medulla of the brain. “Crude touch,” which is poorly localized, still persists because of partial transmission in the opposite spinothalamic tract.

Amyotrophic lateral sclerosis (ALS)

is a progressive degenerative disease that **attacks motor areas of the cerebral cortex, axons of upper motor neurons in the lateral white columns (corticospinal and rubrospinal tracts), and lower motor neuron cell bodies**. It causes progressive muscle weakness and atrophy. ALS often begins in sections of the spinal cord that serve the hands and arms but rapidly spreads to involve the whole body and face, without affecting intellect or sensations


Thank you