CNS
Doctor 2021

Physiology

Modified (3)

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Welcome يا غوالي to the third physiology lecture

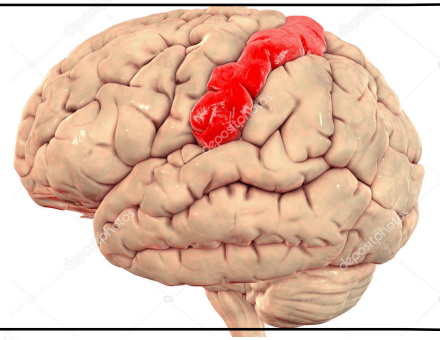
In this lecture, we will talk about the pathways that transmit somatic sensation from sensory receptors up to the center nervous system

Enjoy 🫠

The most important integrative part of the central nervous system for somatic sensation is the cerebral cortex. This bluish area (A) called
primary somatosensory area
that's located in the PostCentral gyrus of the parietal lobe

Cerebral cortex

Extra



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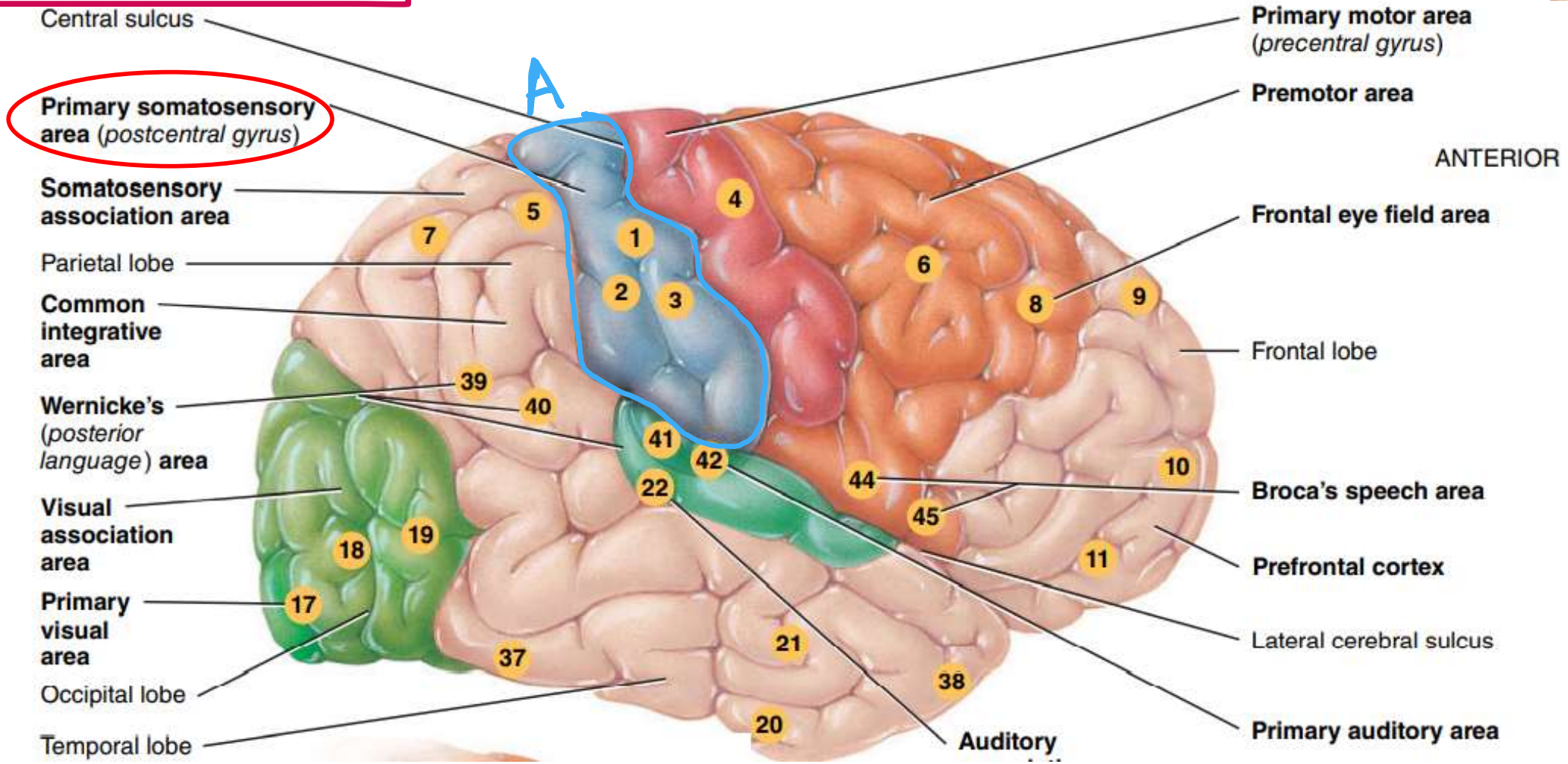
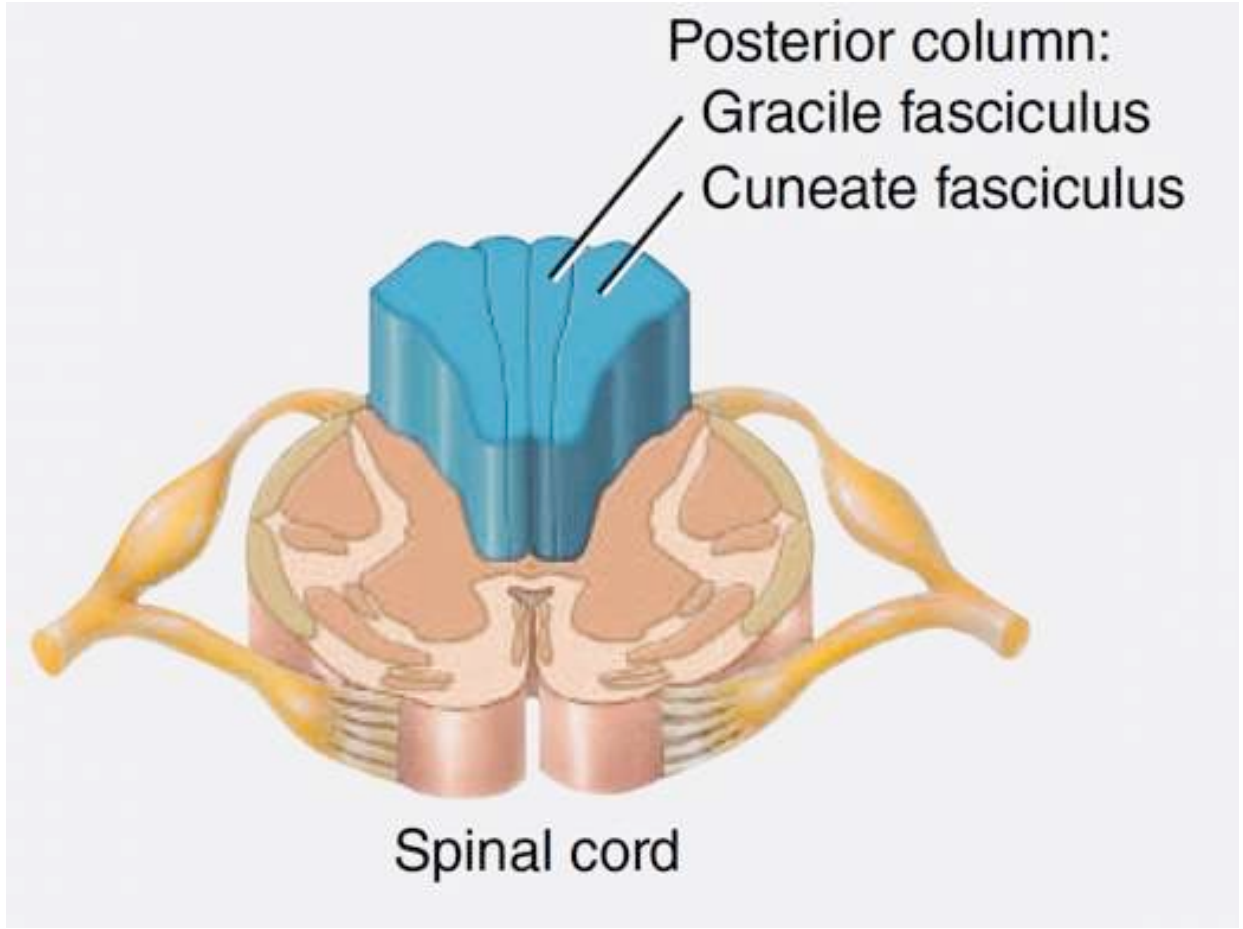
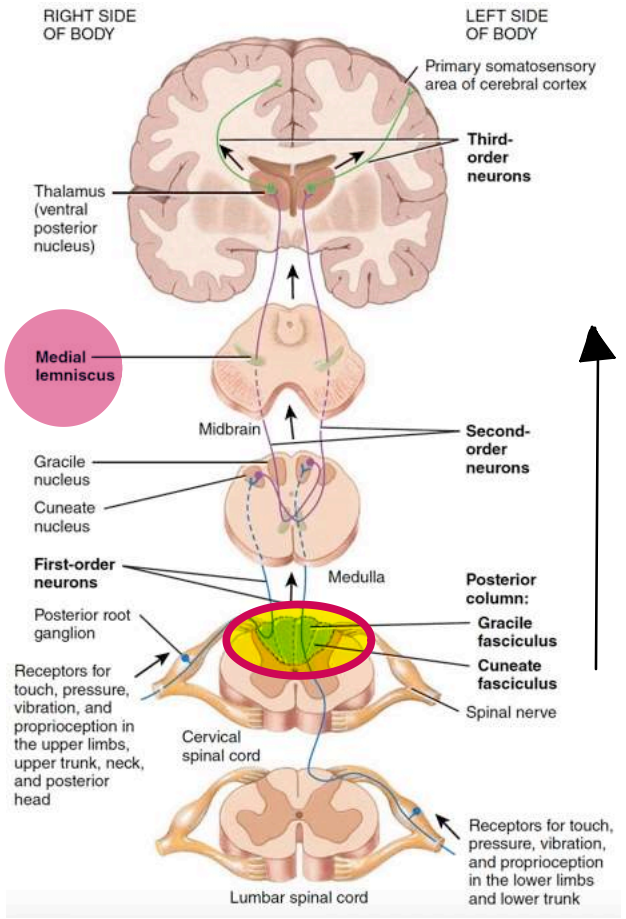


First pathway :

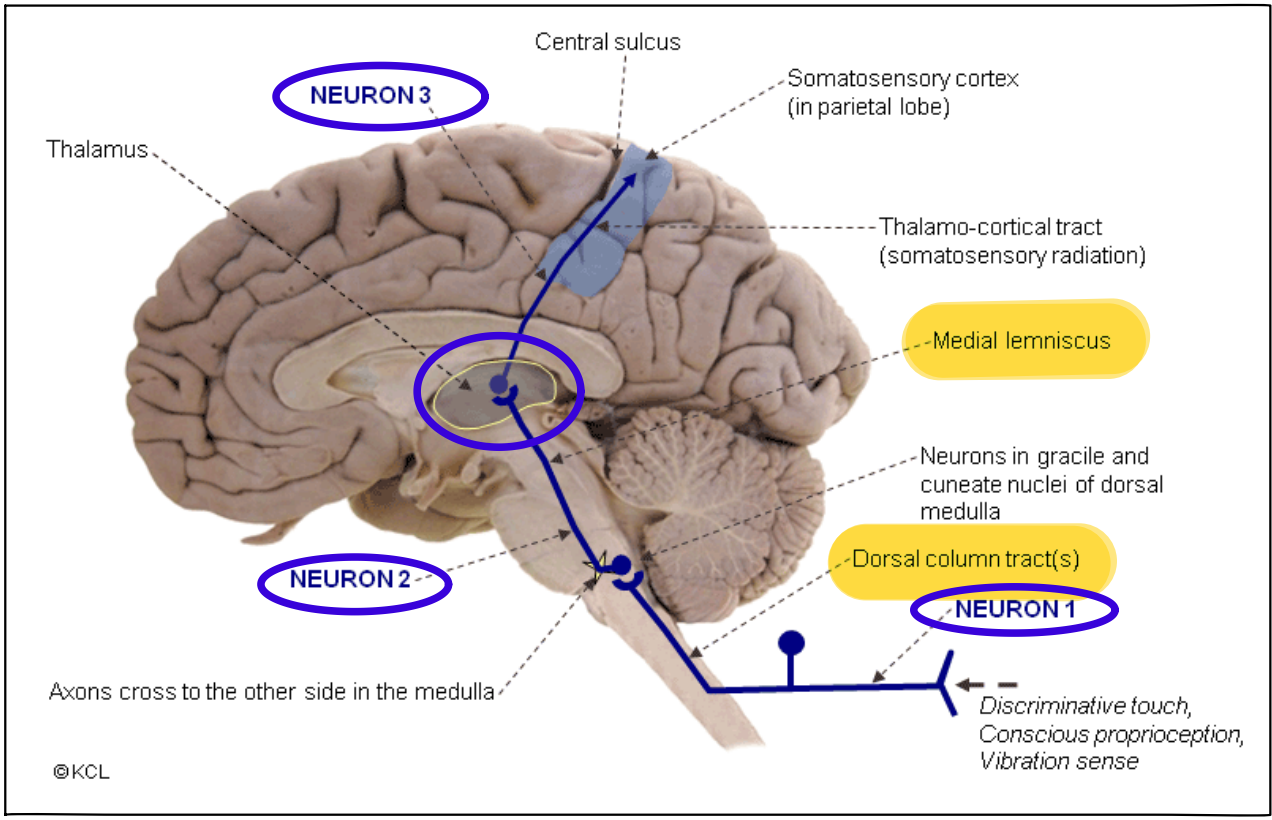
Posterior (Dorsal) Column- Medial Lemniscus Pathway





posterio column is this part in the white matter of the spinal Cord, neurons will go through this part, and then go to the medail lemniscus (which is a structure that is located in the brainstem)
This doesn't means that they are the only two structures that the pathway will pass through
But just two names within this pathway and the direction from the posterior column to the medial lemniscus is ascending so **this is a sensory pathway**

Extra



Notes about the previous slides

Somatic sensation are transmitted to the central nervous system through several pathways ,for example the pathway above is called Posterior (Dorsal) Column- Medial Lemniscus pathway .

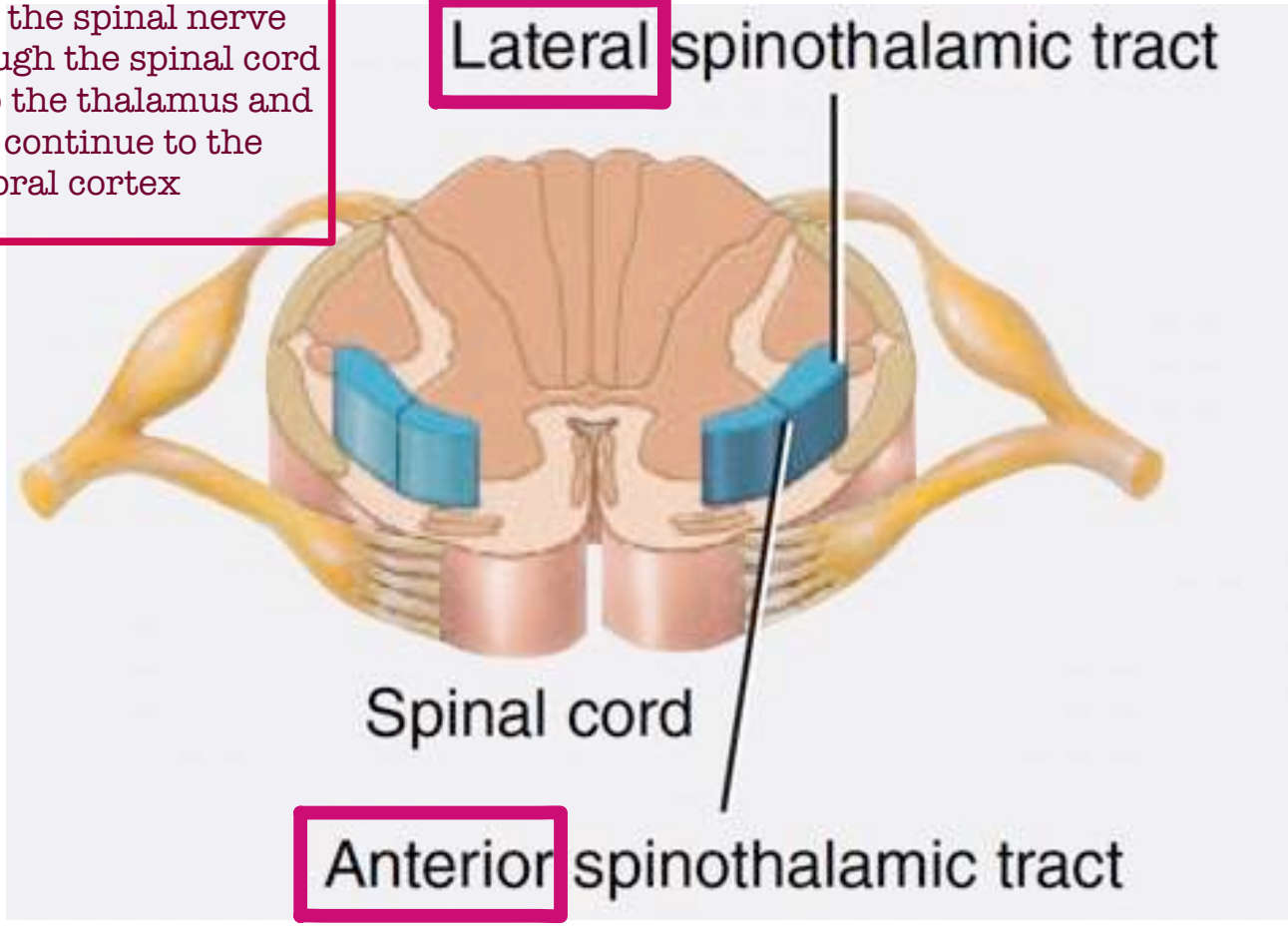
Note that the name of the pathway can tell you whether this pathway is **ascending** or **descending** (the direction to or from the central nervous system) and it also tells you the main structures that the neurons in this pathway will pass through.

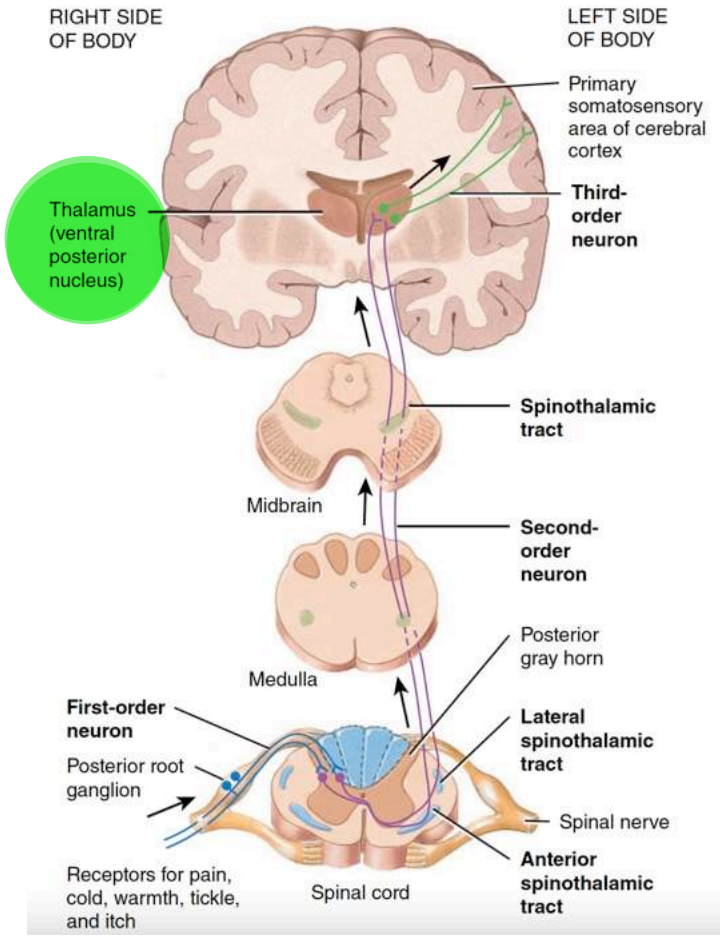
This pathway will transmit the information from sensory receptors in the periphery through the spinal nerve up to the **cerebral cortex**

second pathway :

Antero-Lateral Spinothalamic Pathways

Again ,this is another ascending pathway getting information from the spinal nerve through the spinal cord up to the thalamus and then continue to the cerebral cortex

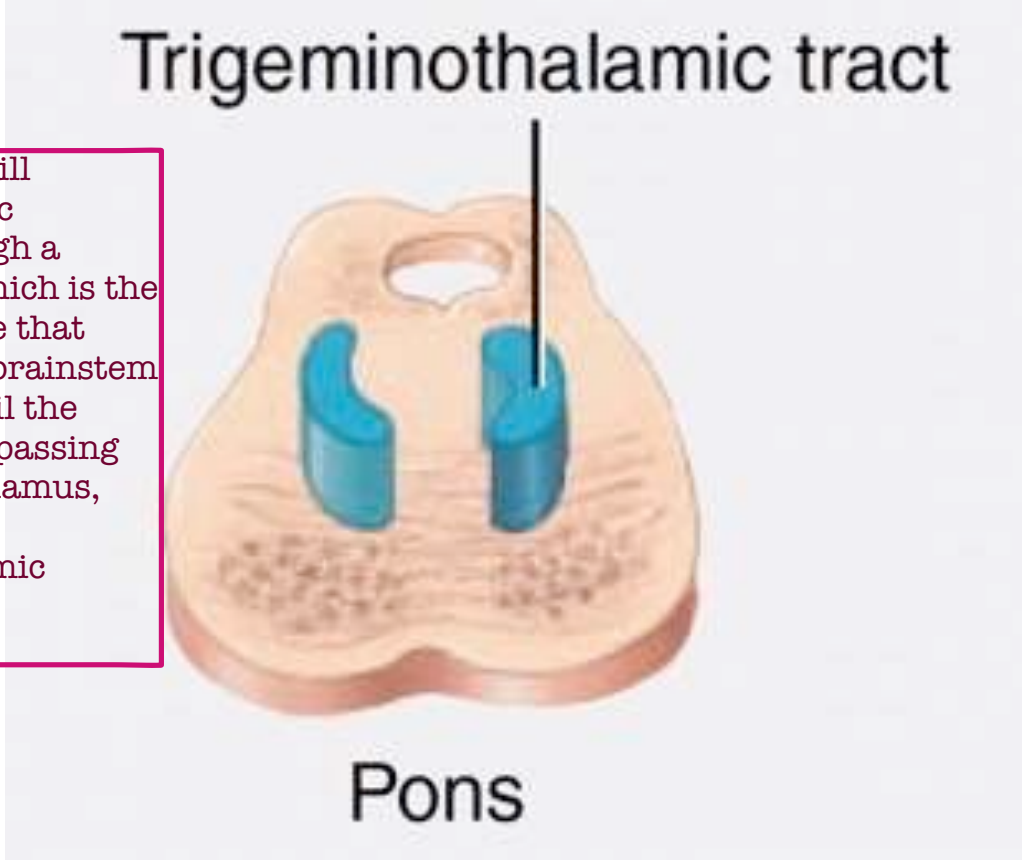


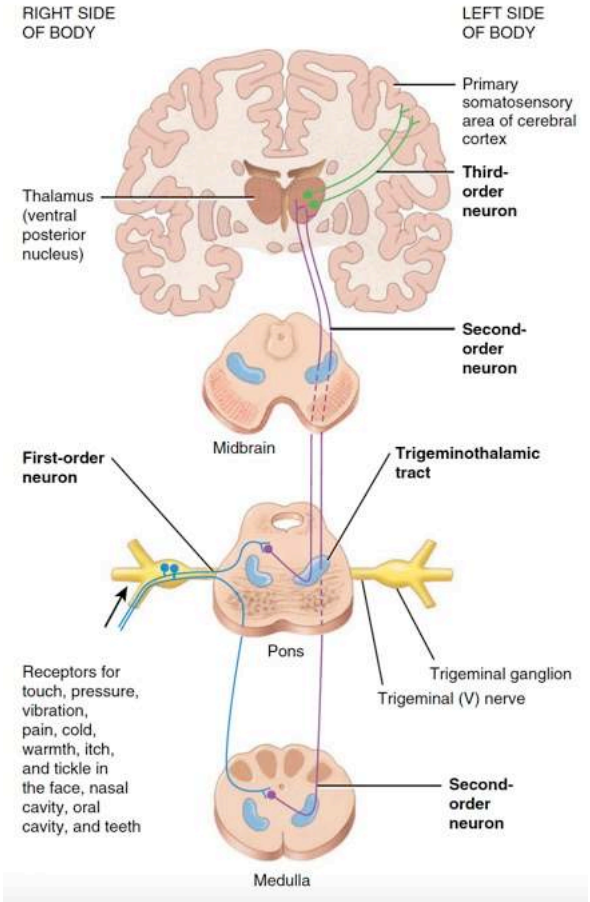


third pathway:

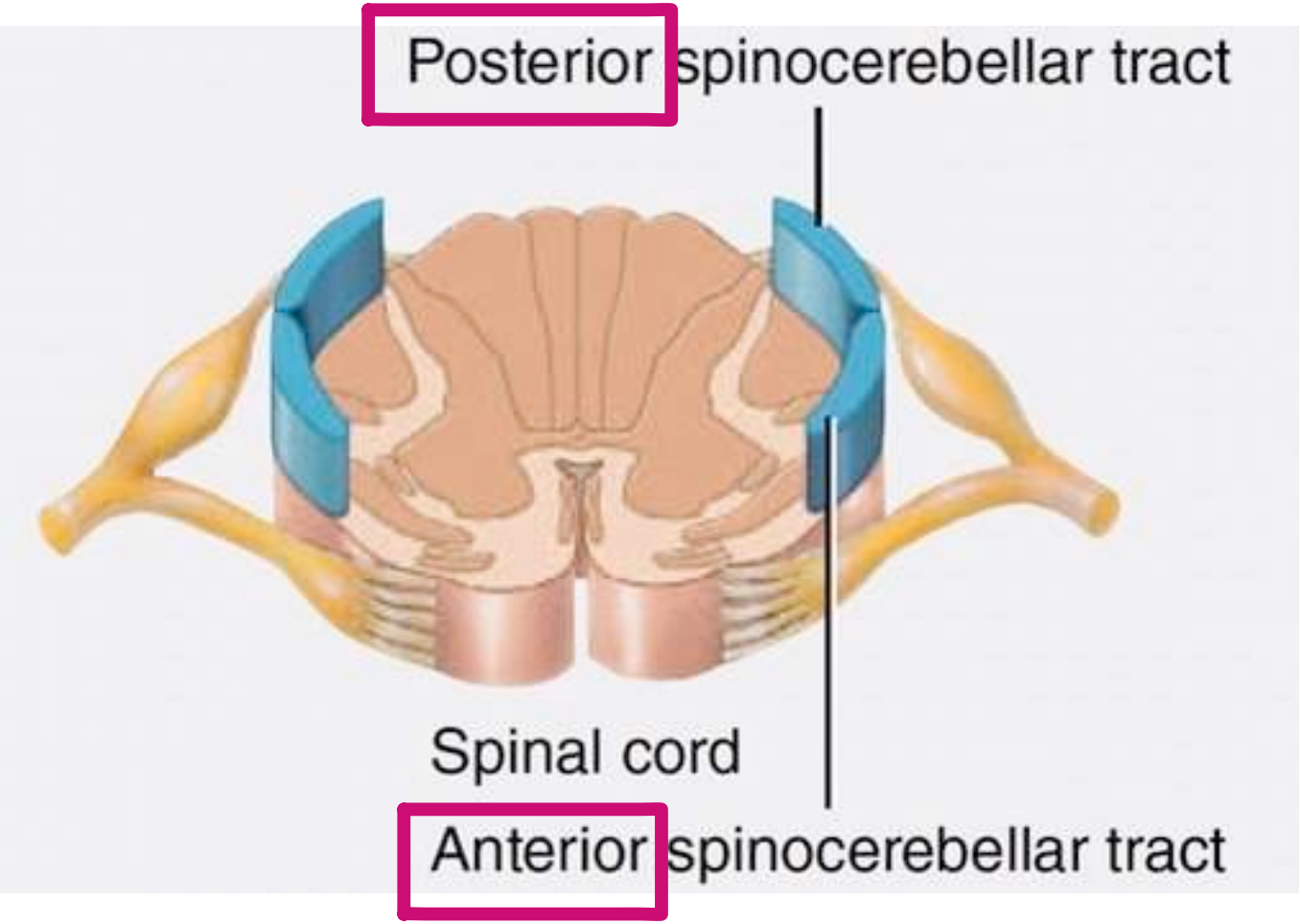
Trigeminothalamic Pathway

This pathway will transmit somatic sensation through a cranial nerve which is the trigeminal nerve that would go to the brainstem and then up until the cerebral cortex passing through the thalamus, hence the name Trigeminothalamic Pathway





Anterior and Posterior Spinocerebellar Pathways



Notes about the previous slide :

There are other pathways that can pass or integrated in another part of the central nervous system. For example, the cerebellum. in the pathway that's called (Anterior and Posterior Spinocerebellar Pathways)
nerves will carry somatic sensations, more specifically proprioceptive sensations up to the cerebellum to be integrated there. you can notice here because the integration is in the subcortical region you don't have the perception for the processing of this information. The other thing is these pathways are important for maintaining balance posture and coordination of skilled movement

Somatic sensation can go also be integrated in the spinal cord for spinal cord reflexes. Some branches will go to the reticular formation, but in this lecture, we will focus on the pathways that will be integrated in the somatic sensory area of the cerebral cortex.

Somatic sensory pathways

- A somatic sensory pathway to the cerebral cortex consist of thousands of **sets of three neurons**:

- a first-order neuron, a second-order neuron, and a third-order neuron.

Bringing information from the receptor, we call it a first-order neuron, which will synapse on the second-order neuron and then on the third-order neuron.

- Integration (processing) of information occurs at each synapse along the pathway.

First-order (primary) neurons

- Sensory neurons that conduct impulses from somatic sensory receptors into the brainstem or spinal cord.

though either
Spinal nerve
of Cranial nerve

- Somatic sensory impulses propagate along spinal or cranial nerves.

- All other neurons in a somatic sensory pathway are located completely within the CNS.

The second and the third order neuron are totally located within the central nervous system , but **part** of the first-order neuron located in the peripheral nervous system

Second-order (secondary) neurons

The thalamus is considered a major Relay Station for Sensory information, because most of the sensory information, the neurons carrying sensory information will Synapse within the thalamus

- Conduct impulses from the brainstem or spinal cord to the **thalamus**. In somatic sensation the synapses mainly will be in the ventrobasal complex

- Axons of second-order neurons **decussate** (cross over to the opposite side) as they course through the brainstem or spinal cord before ascending to the thalamus.

The second-order neuron once synapse with the first order neuron in either the spinal cord or the brain stem it will it decussate . This is an important term that means crossing over to the opposite side, and then it will continue up to the thalamus

EXTRA NOTE FOR BETTER UNDERSTANDING

The ventrobasal complex (VBC) is a part of your thalamus that acts like a sensory relay station. In simpler terms, it's like a busy intersection in your brain where information from different senses (touch, taste, pain, etc.) comes together before heading to other areas for further processing.

Third-order (tertiary) neurons

- Conduct impulses from the thalamus to the primary somatosensory area on the same side.

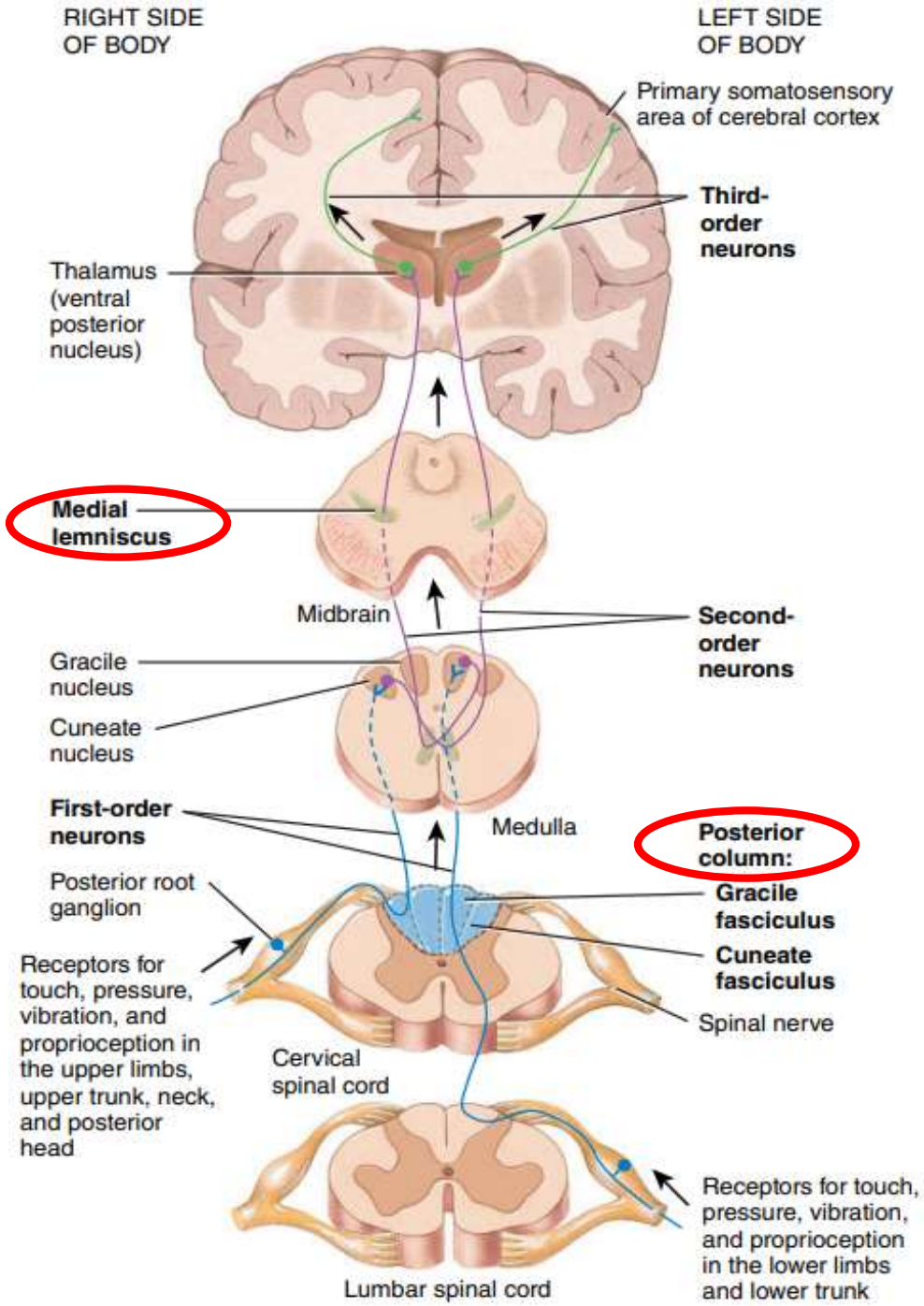
- Somatic sensory information on one side of the body is perceived by the primary somatosensory area on the opposite side of the brain.

Now the second-order neuron will synapse with the third-order neuron that will continue up to the primary somatosensory area to receive this perception of this sensory information

-Note here that the crossing will happen **only once** by the **Second- order neuron** which means that information from one side of the body will be perceived by the opposite side body of the brain within the primary somatosensory area

First pathway

Posterior column - medial lemniscus pathway



Posterior column - medial lemniscus pathway

Information in this pathway are coming from :

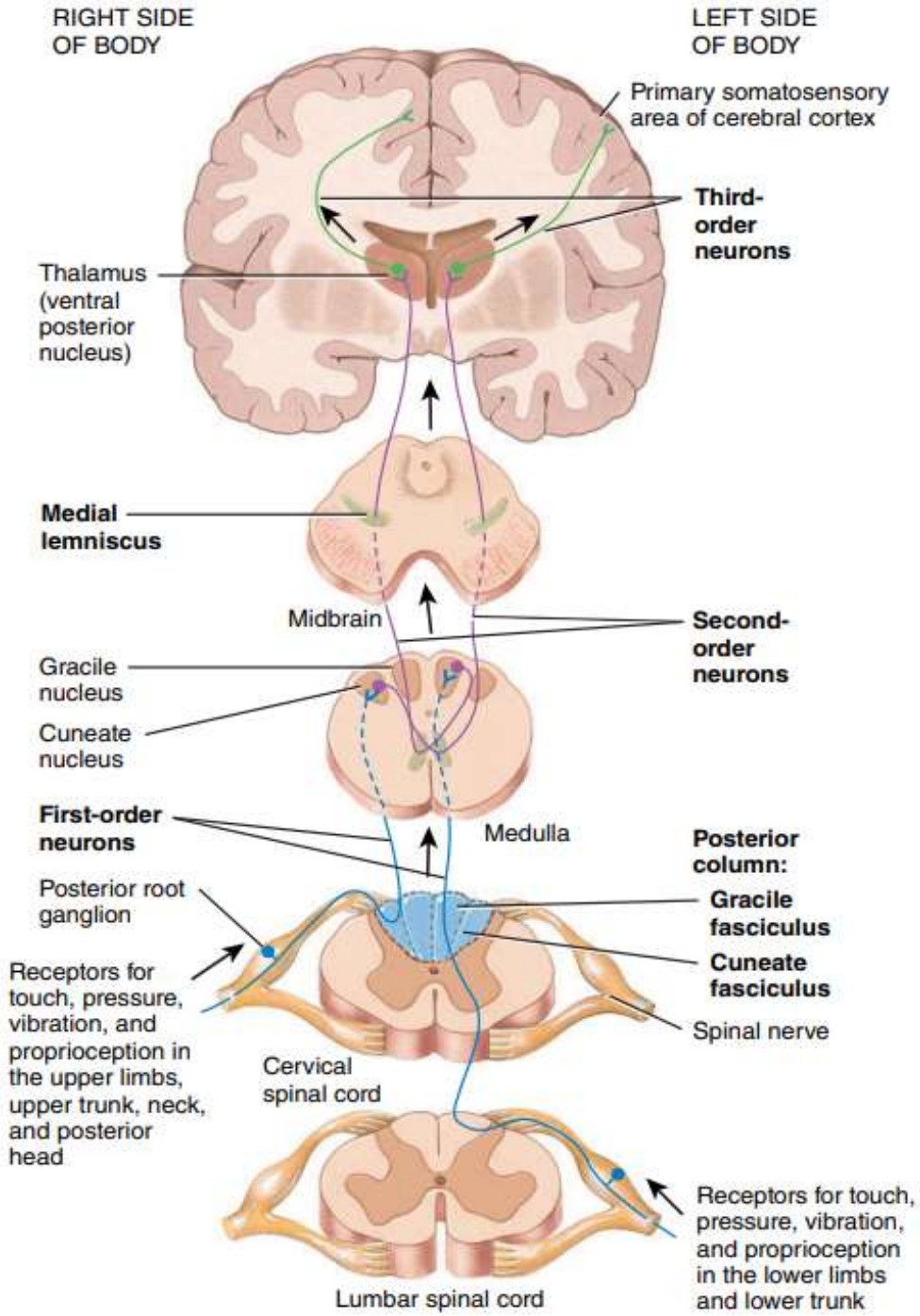
Limbs

Trunk

Neck

Posterior head

(posterior part of the head)

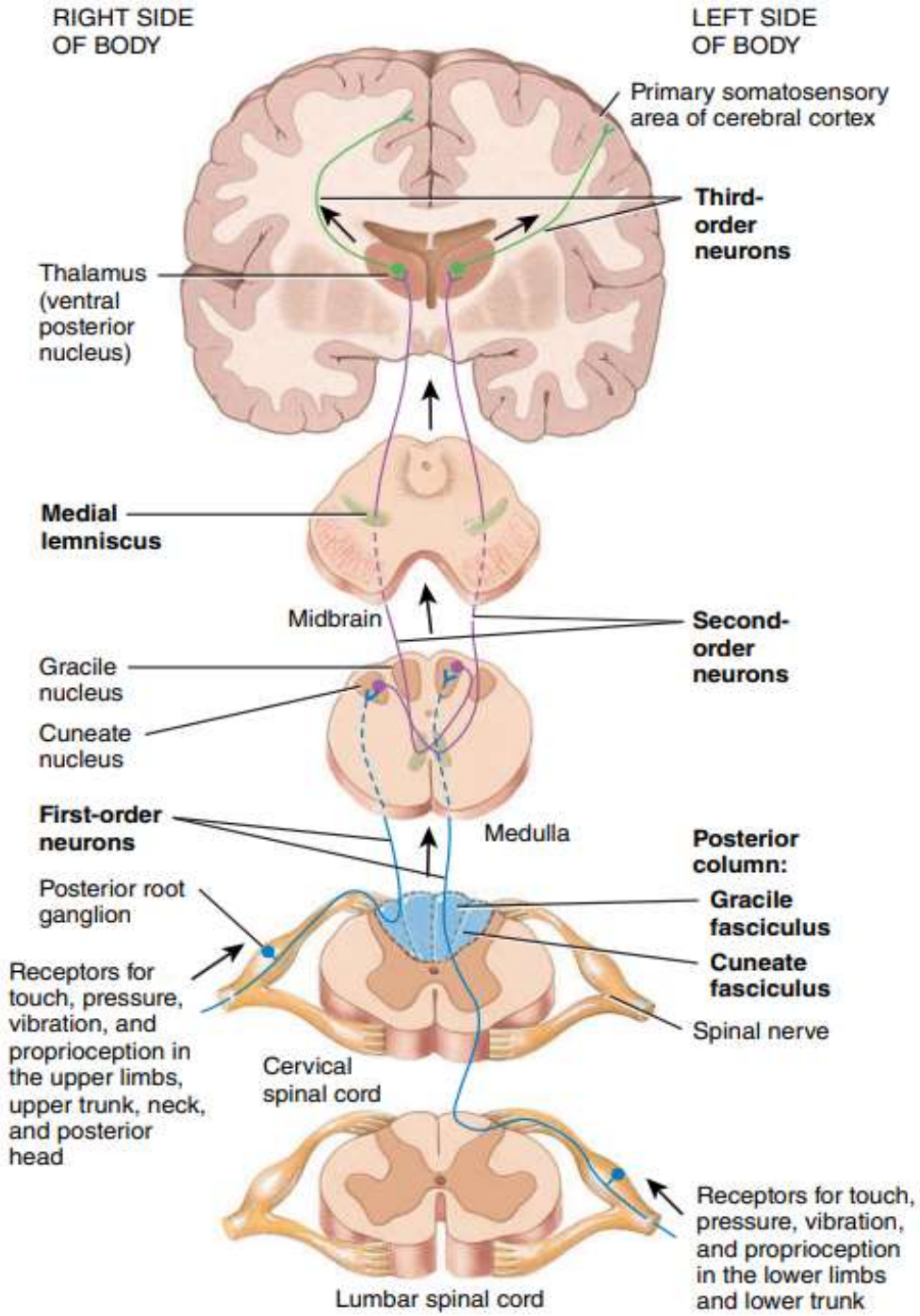


Posterio**r** column - medial lemniscus pathway

sensory modalities that are transmitted

Touch
Vibration
Pressure
Proprioception

Memorize it 😬

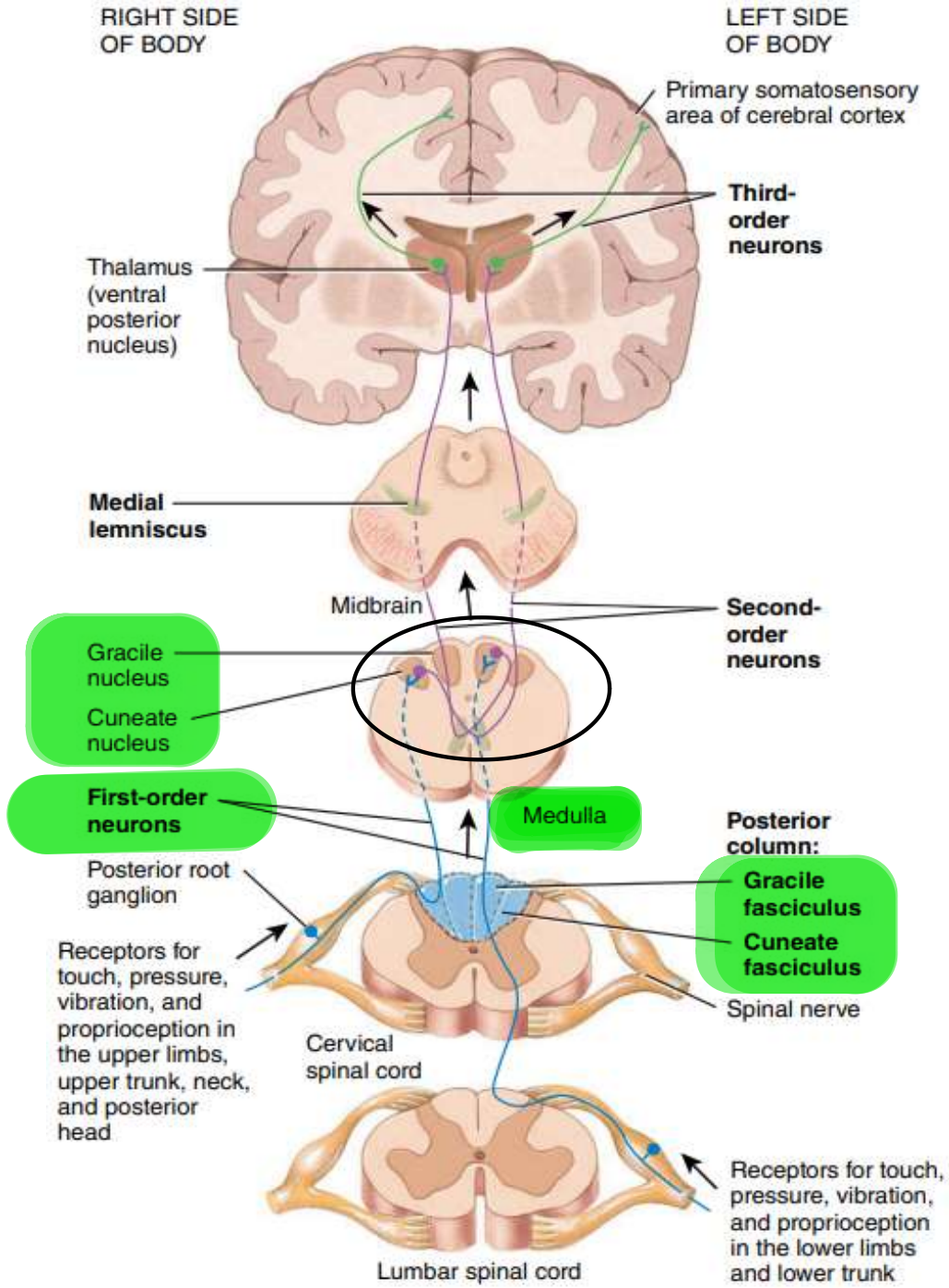


Posterior column - medial lemniscus pathway

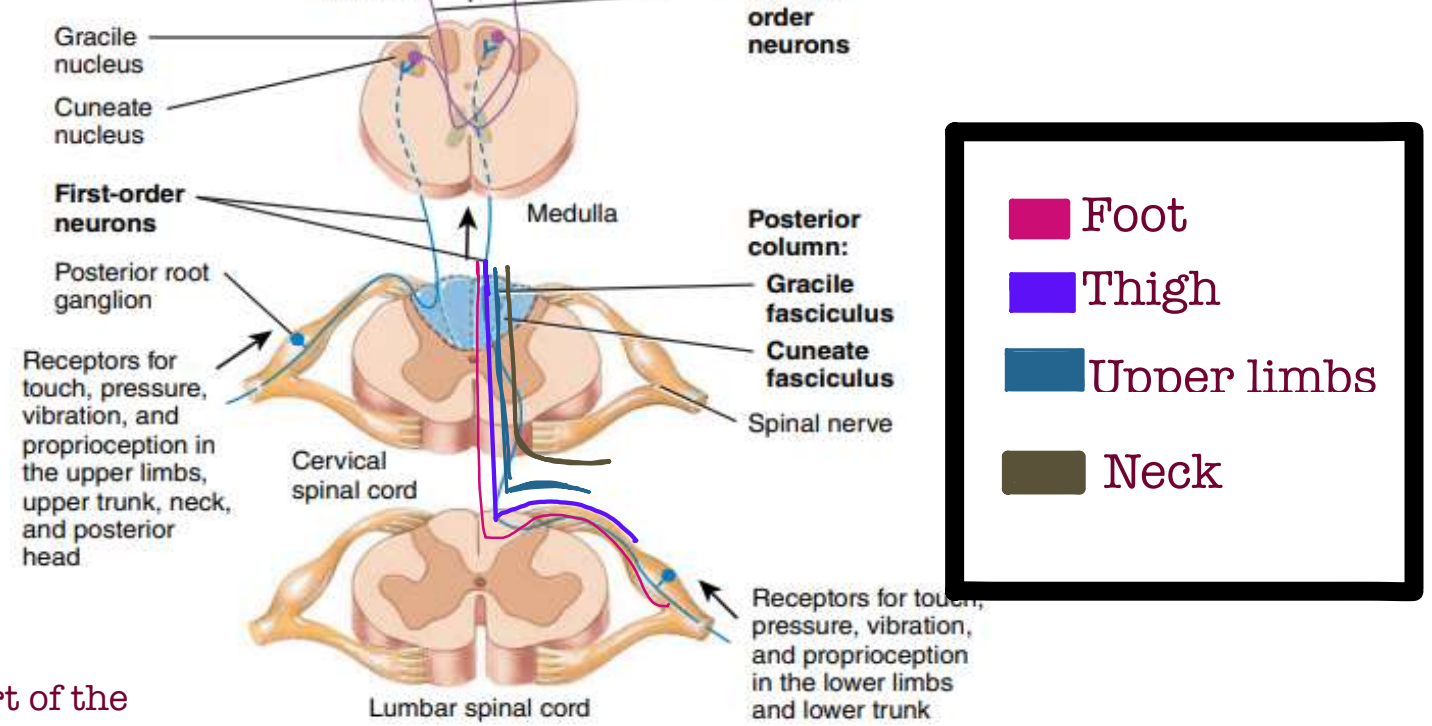
Information from these sensory modalities will enter the spinal cord through a spinal nerve to the posterior part of the spinal cord that's called the posterior column

You can see that the most medial part of the posterior column is called **Gracile fasciculus** and the lateral part is called **Cuneate fasciculus**

First-order neurons will continue up to the medulla where they synapse with the second -order neuron in the Gracile nucleus and the cuneate nucleus



Posterior column - medial lemniscus pathway



- See the peculiar spatial orientation in this pathway

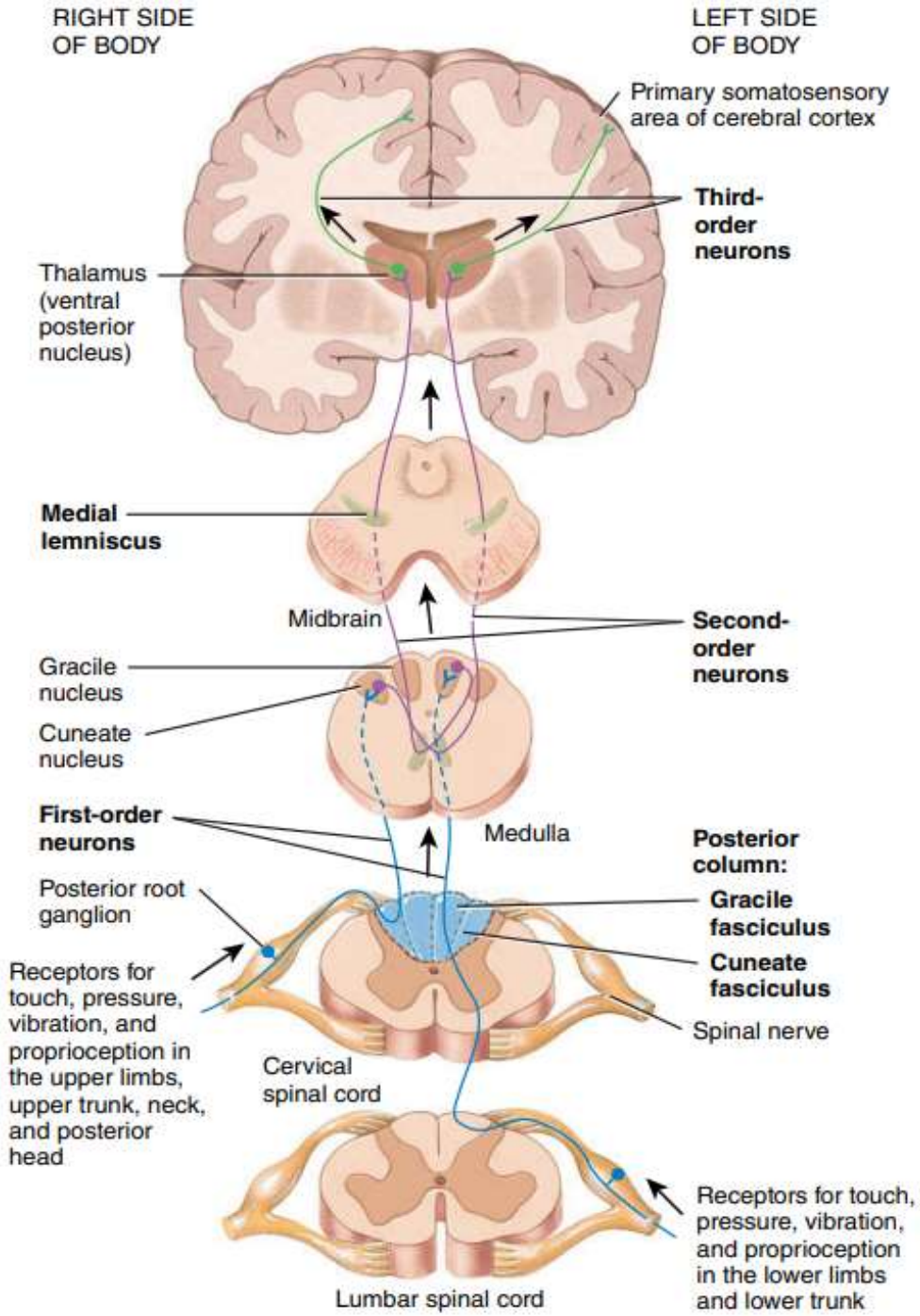
So as we go from down in the body up to the posterior part of the head . let's say we start in the foot, signals will go to the most medial part of the posterior column in the in Gracile fasciculus then the info from thigh will go more lateral to it, then the upper limb will go more lateral again and then the neck is the most literal.

As you can see, the information is arranged in layers, the most medial part is the lower part of the body and then the lateral part is the upper part of the body. This is important for the localization of the sensory modalities coming through this pathway.

Posterior column - medial lemniscus pathway

Decussation in the medulla

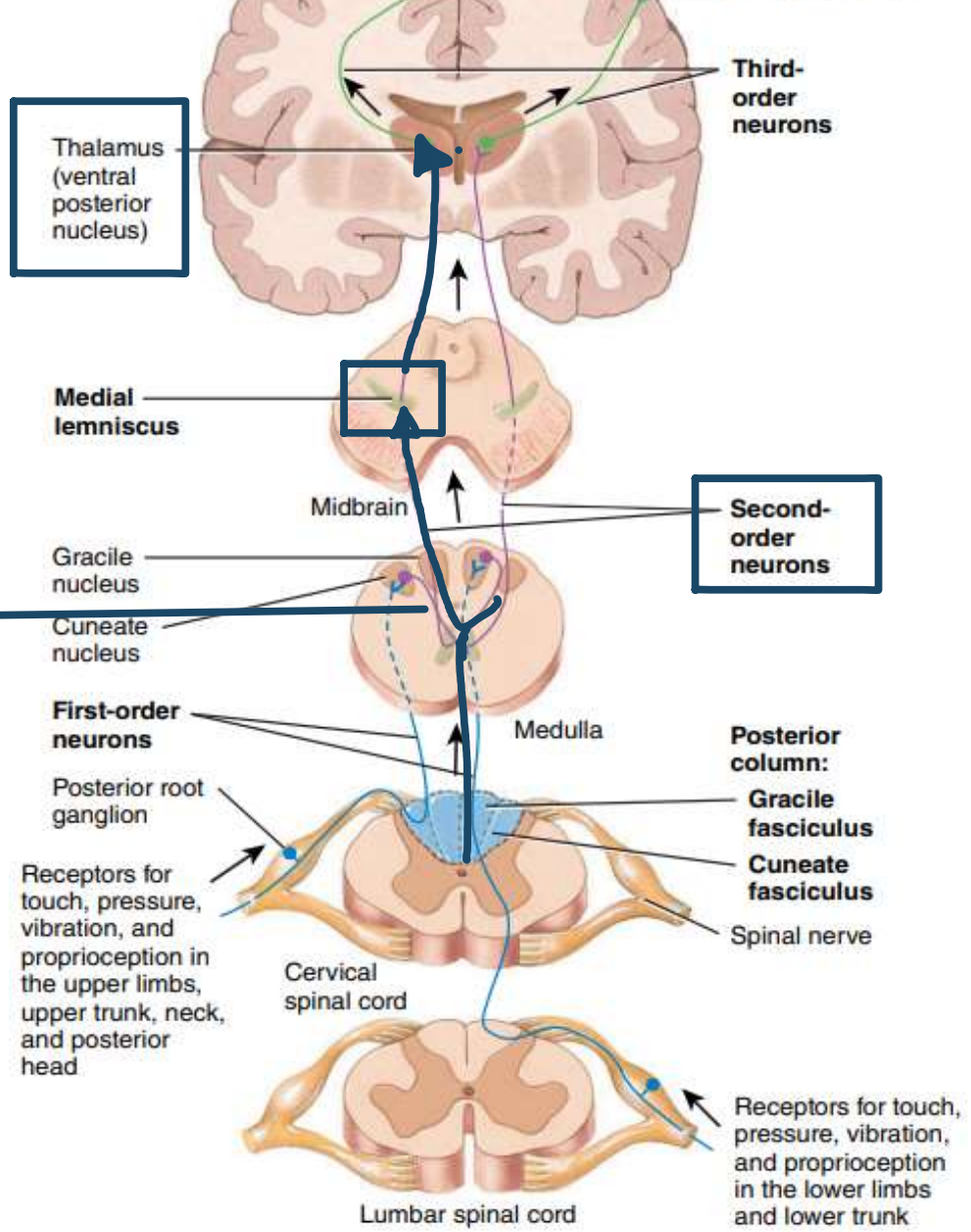
Now, first-order neuron will continue up to the medulla where there is the Gracile and Cuneate **nucleus** there will be the synapse with the second-order neuron at the level of the medulla and we said before that second-order neuron decussate once synapsing with the first-order neuron



Posterior column - medial lemniscus pathway

The decussation

Decussation in the medulla

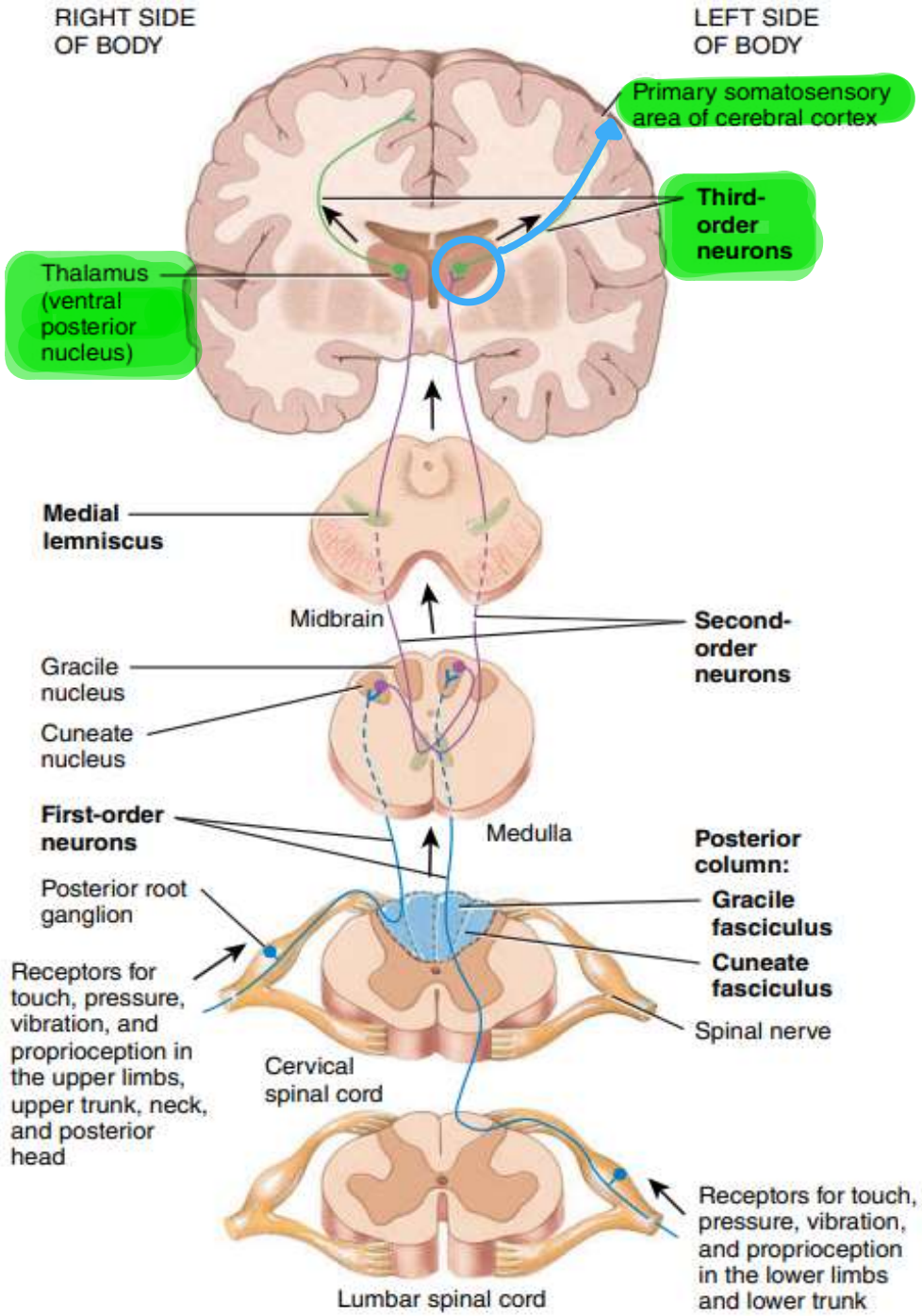


Knowing the level of decussation for all the pathways is very important

Posterior column - medial lemniscus pathway

Now third-order neurons start in the ventrobasal complex of the thalamus and then continue to the primary somatosensory area of the cerebral cortex

The type of nerve fibres in the Posterior (Dorsal) Column- Medial Lemniscus
that transmit this information are **large myelinated nerve fibers** which means that the conduction velocity in this pathway for this sensory modality is very high



Second pathway

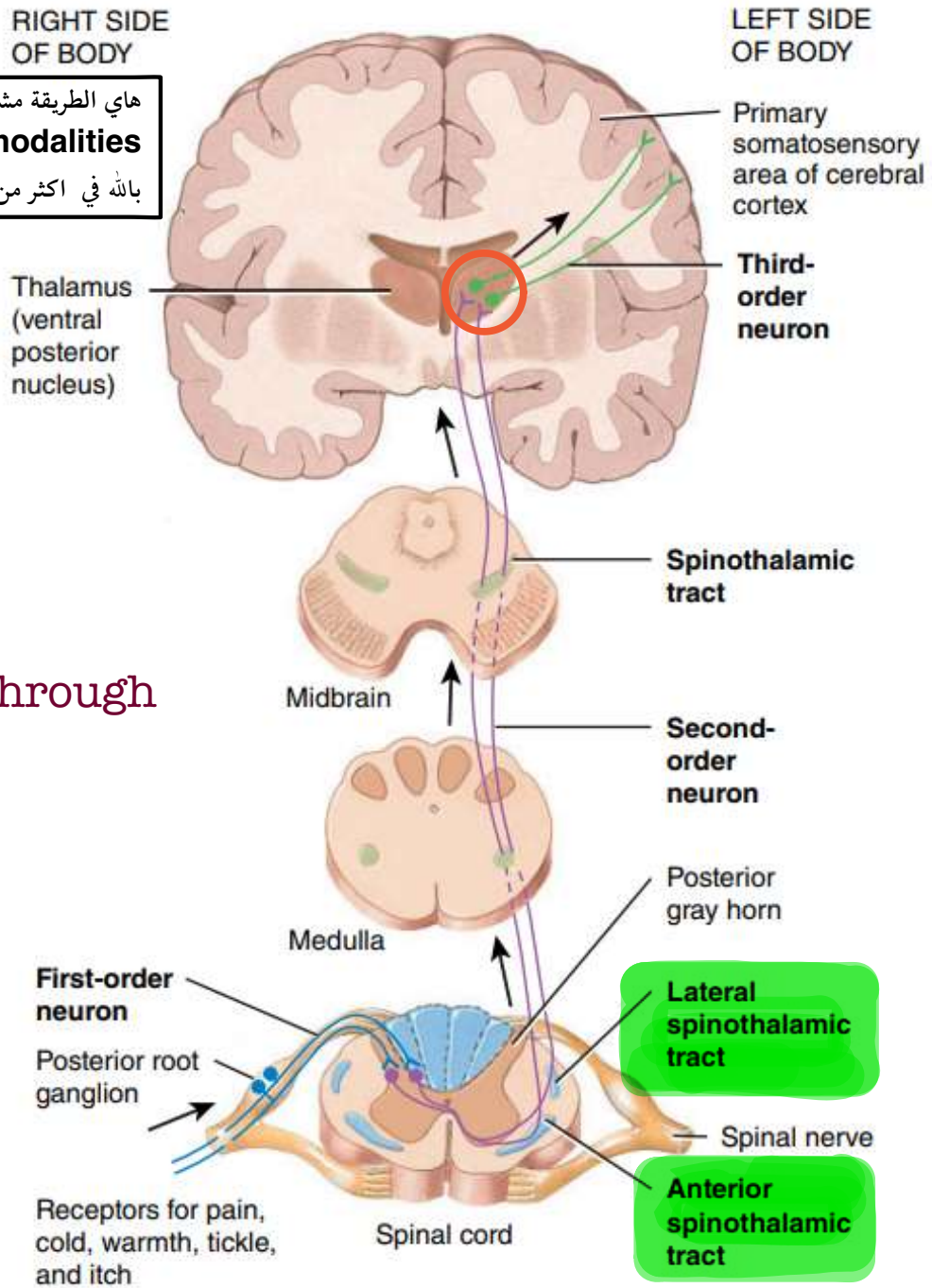
The nerve fibres that are transmitted through this pathway are small fibers so the conduction velocity in this pathway is much slower than the conduction velocity of the previous pathway and because it's smaller so it's (PETITE)

Anterolateral spinothalamic pathway

sensory modalities that are transmitted through this pathway are

Pain
Temperature
Itch
Tickle
+
Sexual sensation
Crude touch

هاي الطريقة مشان نحفظ ال
sensory modalities
بالله في اكثر من هيك دلال؟؟

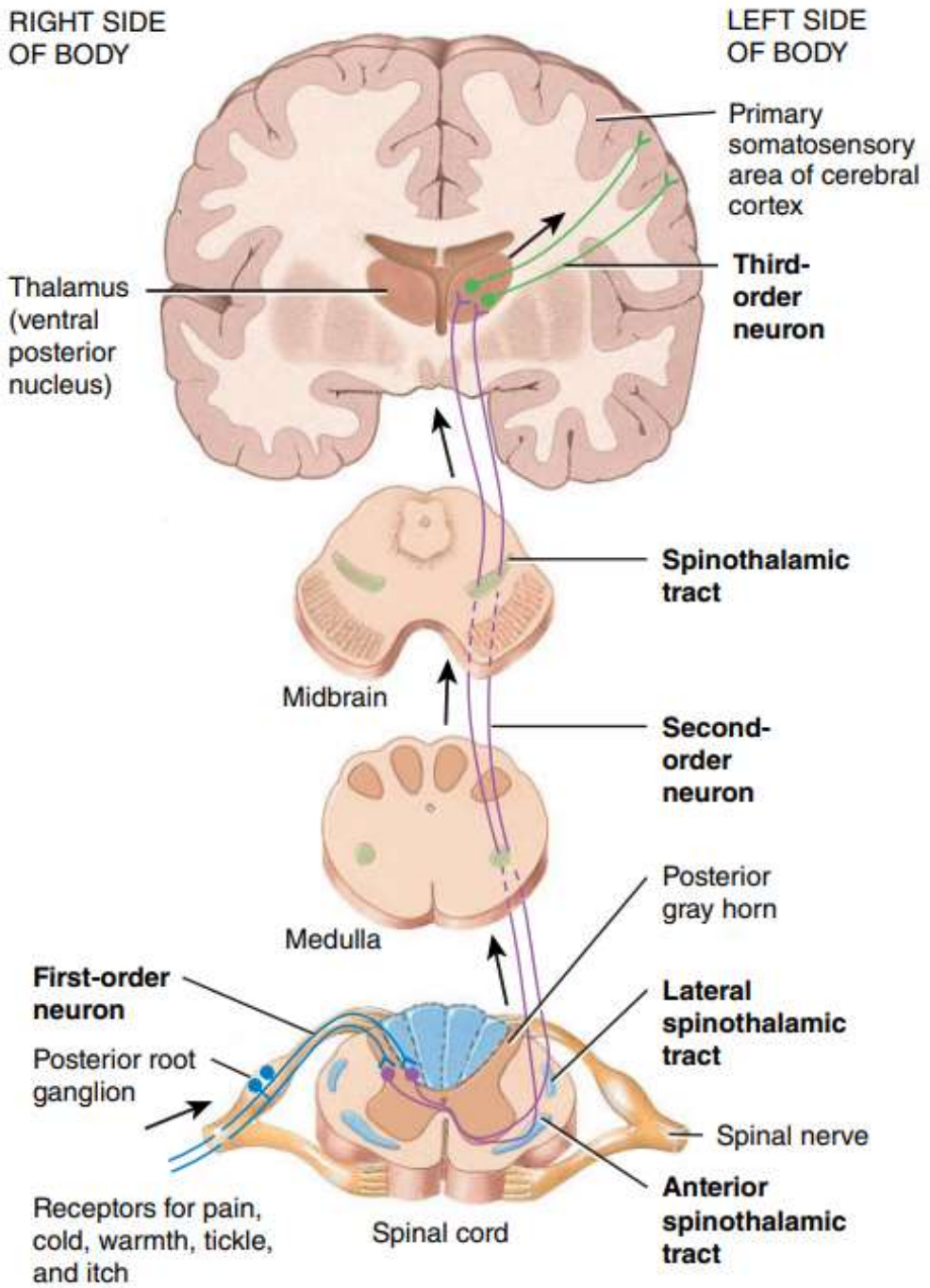


Anterolateral spinothalamic pathway

These are sensory modalities that are coming from the :

- The limbs
- The trunk
- The neck
- Posterior head

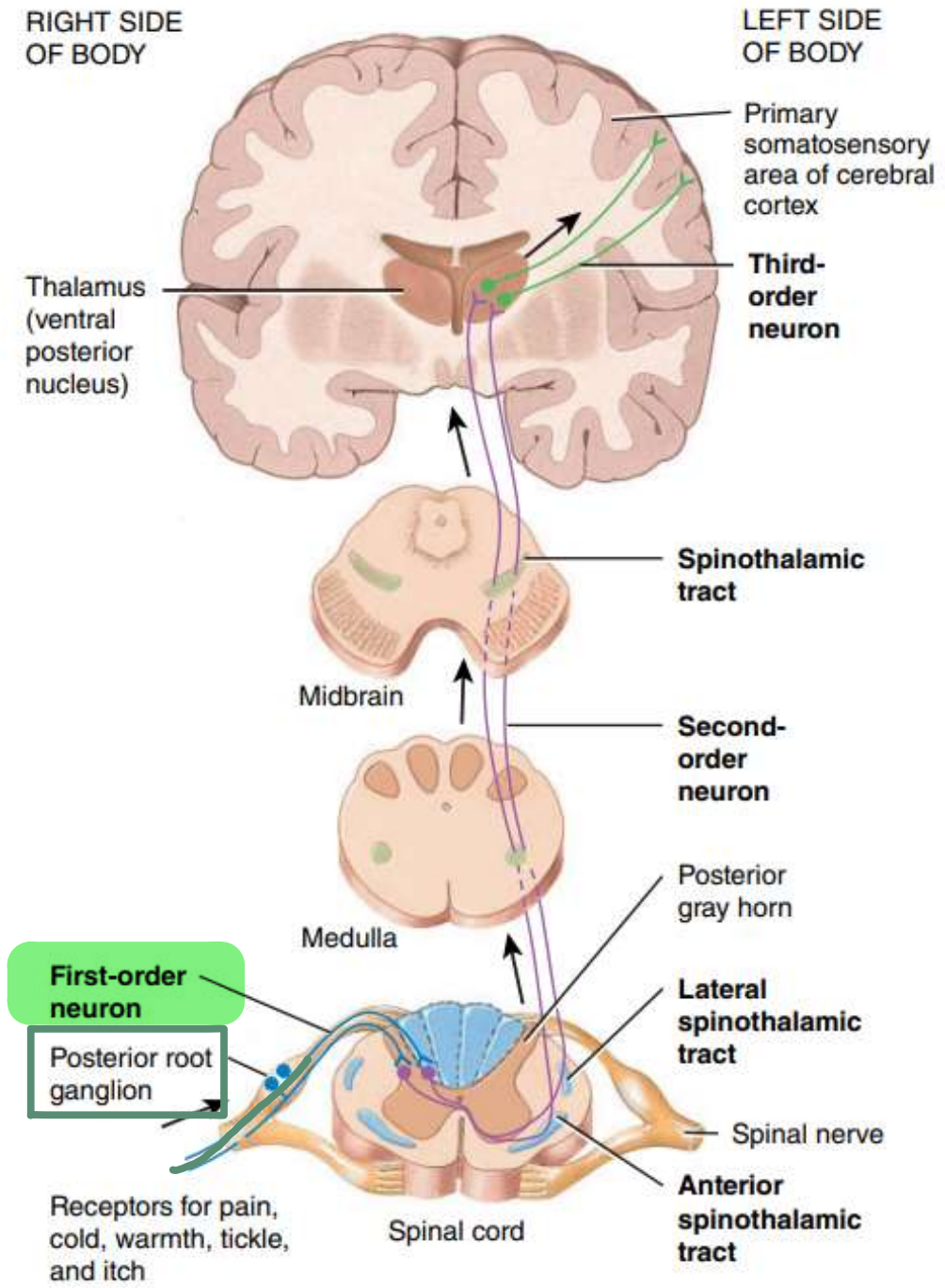
Just like the posterior column



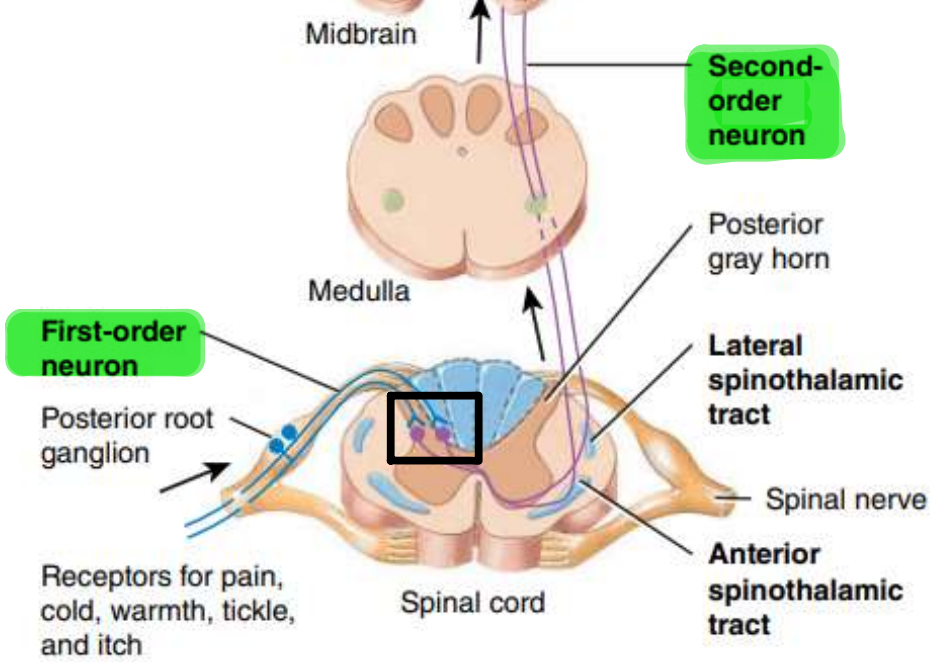
Anterolateral spinothalamic pathway

Synapse at dorsal horn of spinal gray matter

Now first - order neuron will come through the dorsal route ganglia into the spinal cord



Anterolateral spinothalamic pathway

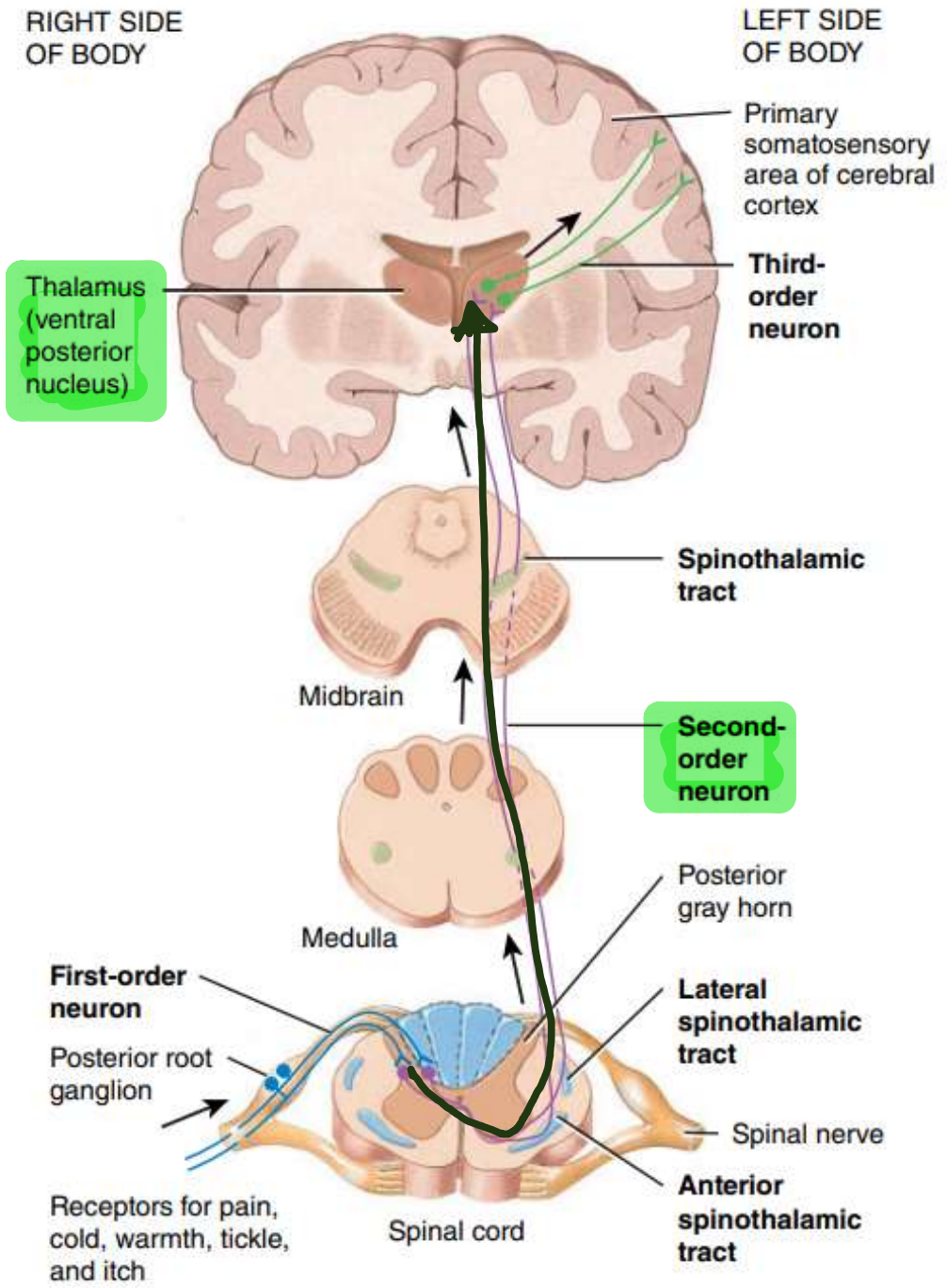


Here, first order - neuron will shortly synapes with the second - order neuron in the dorsal horn of the gray matter of the spinal cord
And again the second order neuron will decussate immediately to the othere side to join the anterior column or the later coulmn of the spinothalamic tracts up to the thalamus

This is the pathway of the second order neuron , it's a long neurons and it's important to know the decussation level in this pathway which is in the spinal cord (diffirent from the posterior column pathway which was at the level of the medulla)

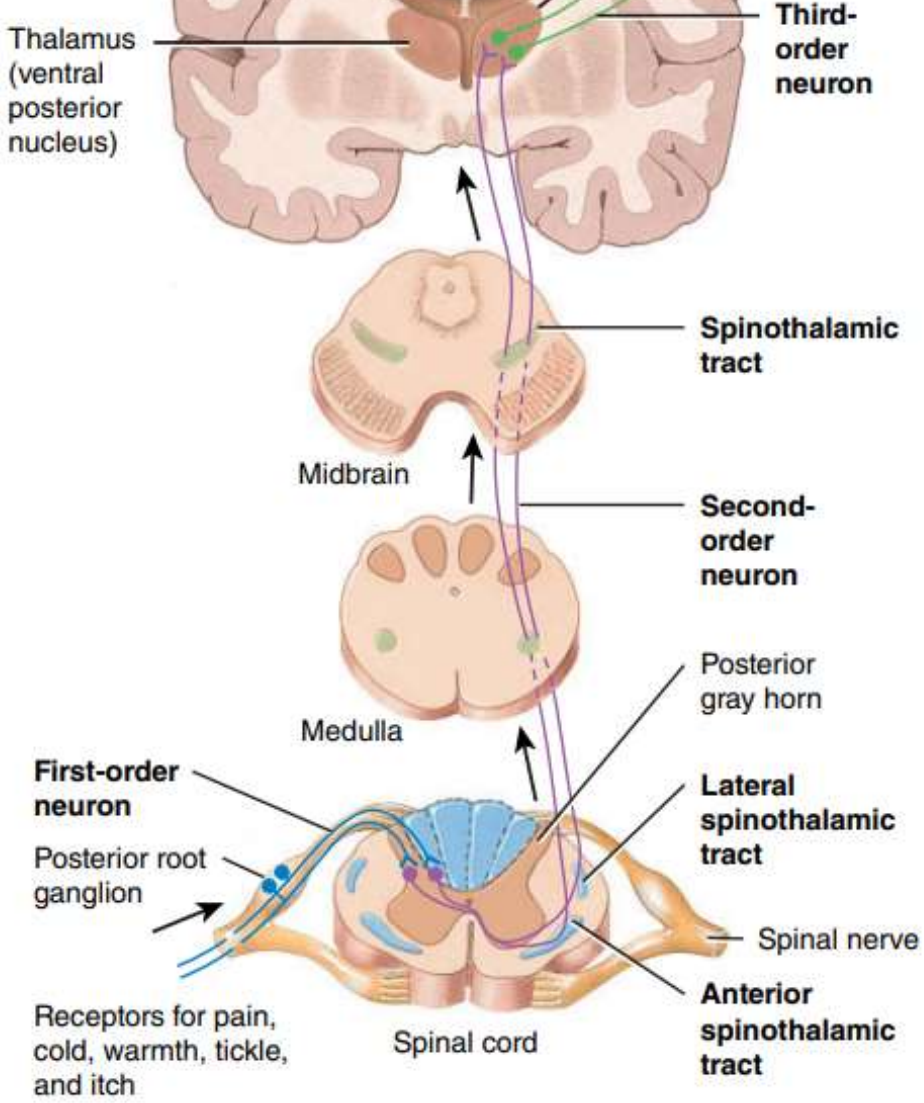
Anterolateral spinothalamic pathway

Decussation in spinal cord



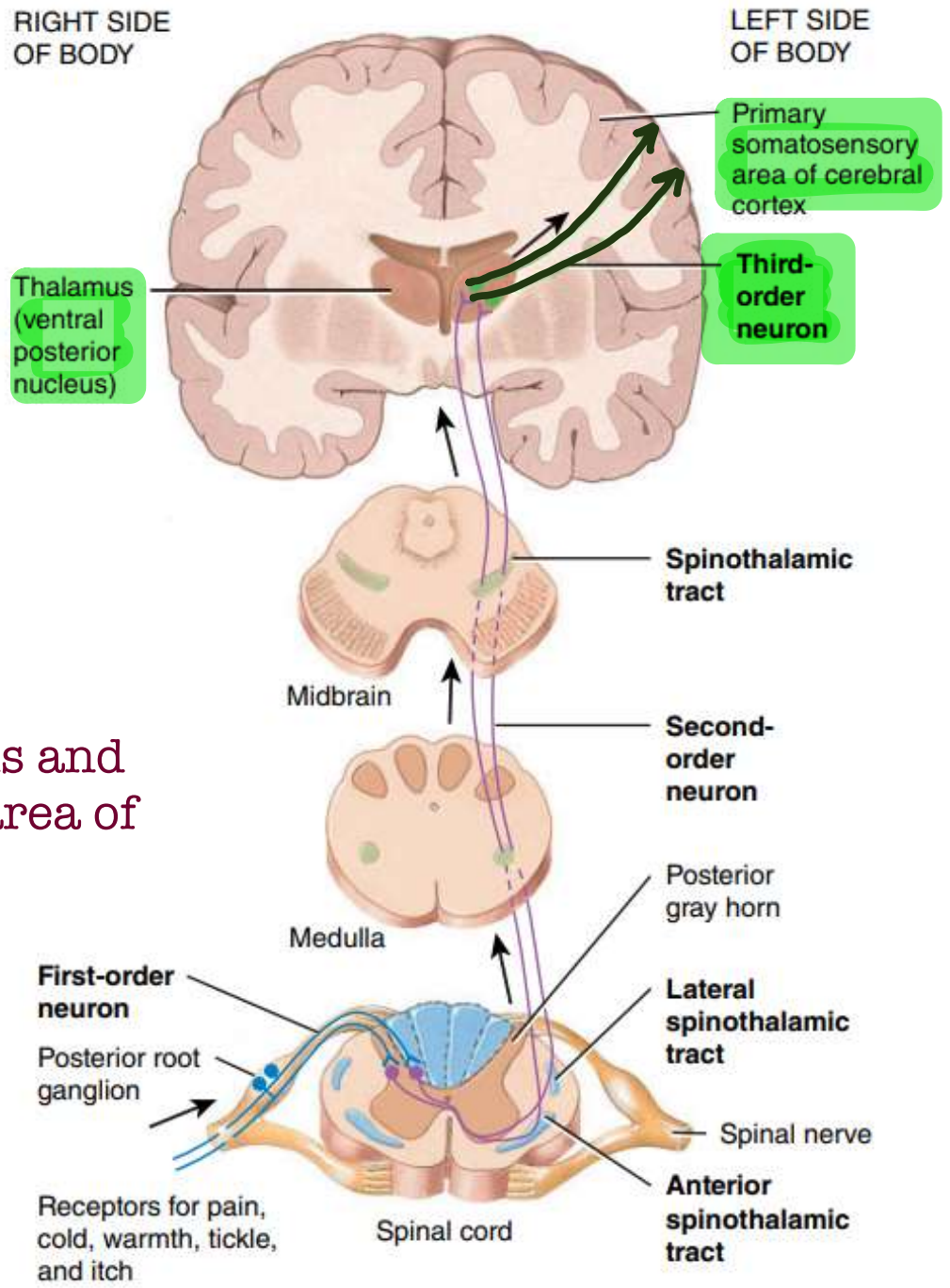
Anterolateral spinothalamic pathway

Decussation in spinal cord



Anterolateral spinothalamic pathway

Again للمرة المليون
Third-order neuron will start in the thalamus and continue up to the primary somatosensory area of the cerebral cortex
(in the next lecture we will talk about pain pathway)



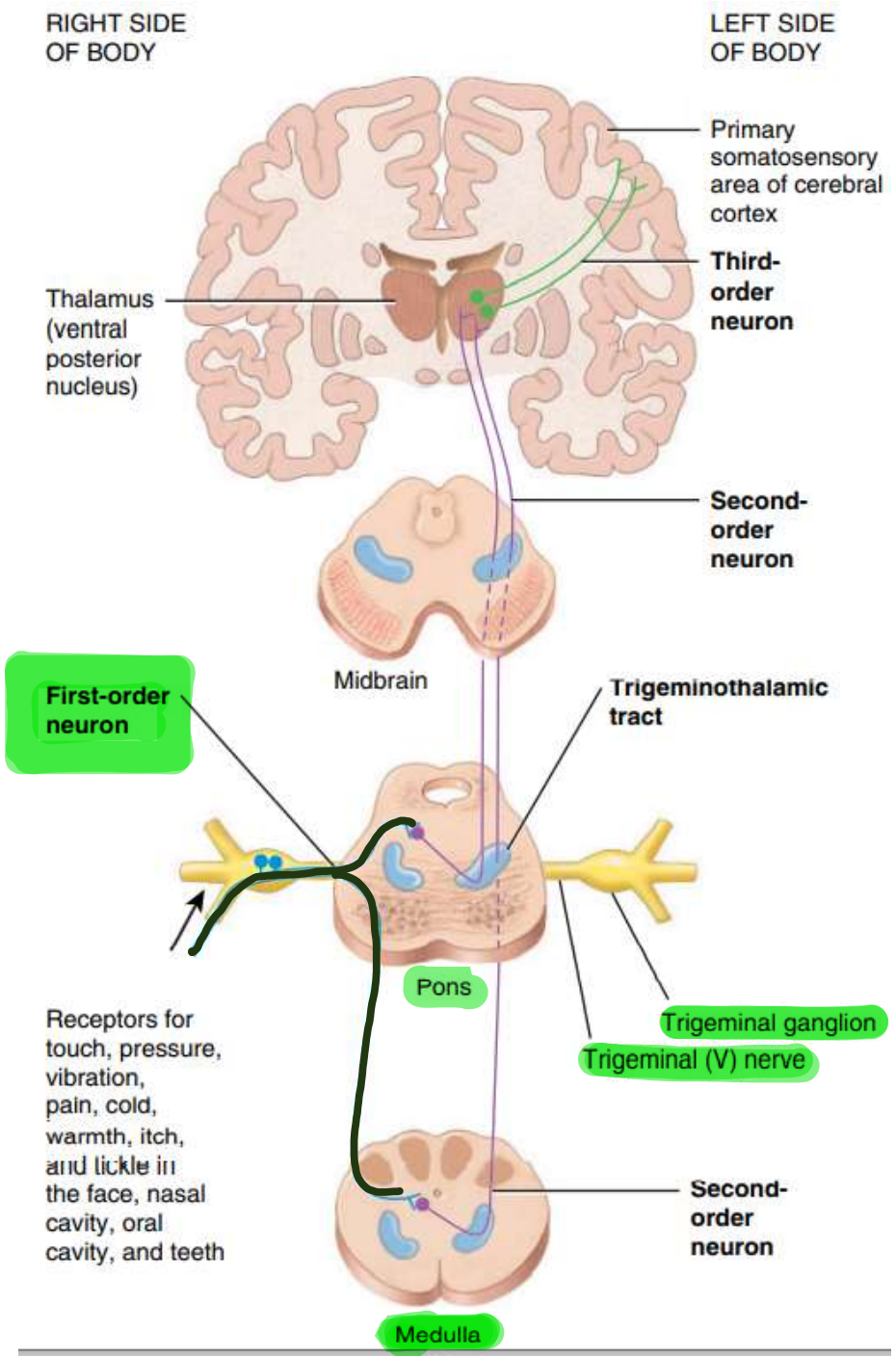
هاي صورة الدولمة مشان تفتح نفسكم وتكملوا المحاضرة

Third pathway :

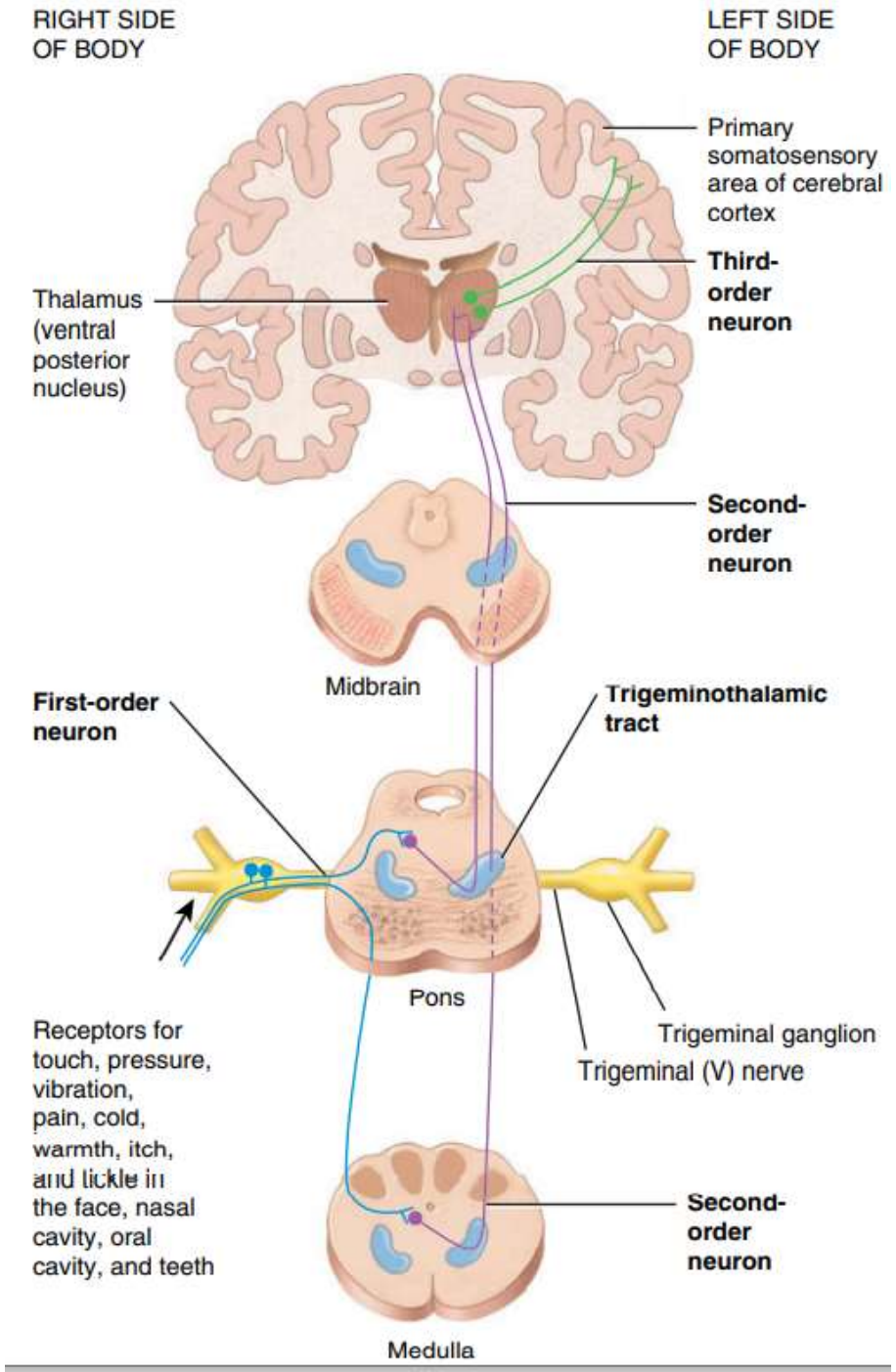
Trigeminothalamic pathway

If you wonder لا سمح الله about
how the somatic sensations coming from the face ,nasal cavity ,oral cavity and teeth are transmitted
We got u يا مفكر 😉
They are actually transmitted through cranial nerves, the trigeminal nerve, and in the pathway, that's called
Trigeminothalamic pathway

It almost carries all the somatic sensation from these areas. first- order neurons will enter through the trigeminal ganglion to the brainstem and its synaps with the second-order neuron at the level of the pons and medulla



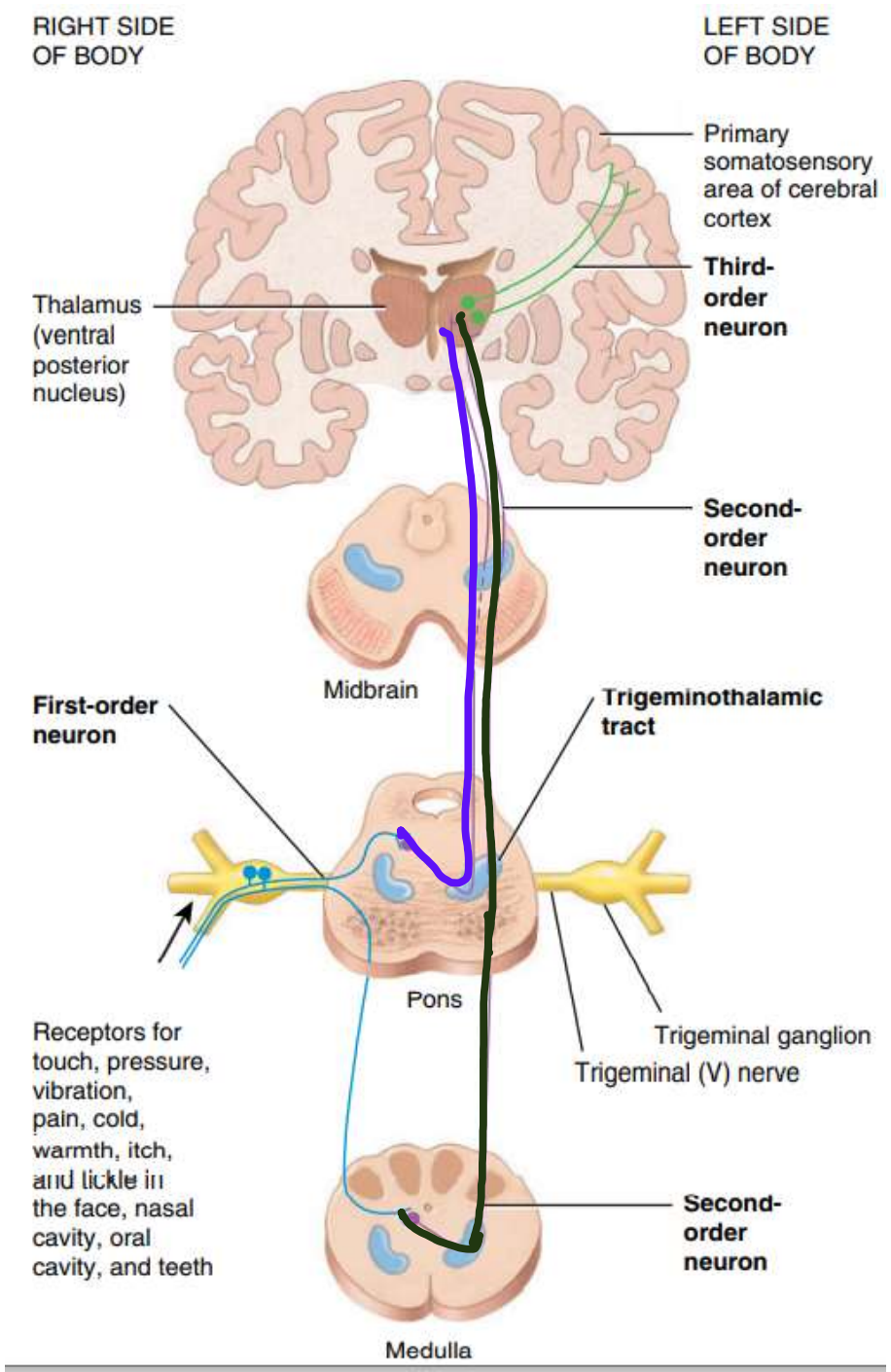
Trigeminothalamic pathway



As we learn before second-order neuron once synapsing with the first-order neuron they will decussate at the level of the pons and the medulla then continue up to the thalamus there it will join the somatic sesnation from the body where we said that the thalamus is the major relay station for sensation in general .

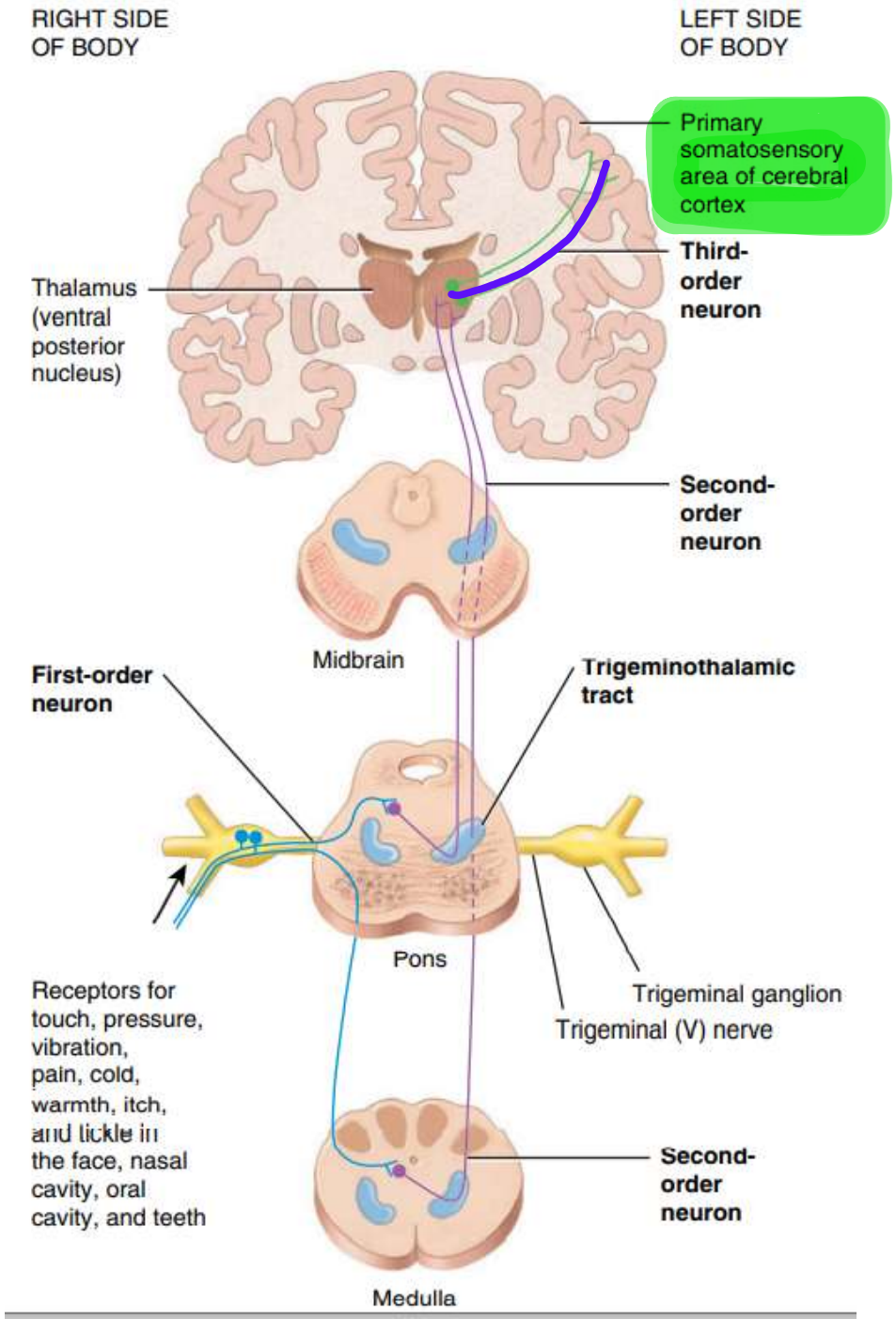
Trigeminothalamic pathway

Decussation



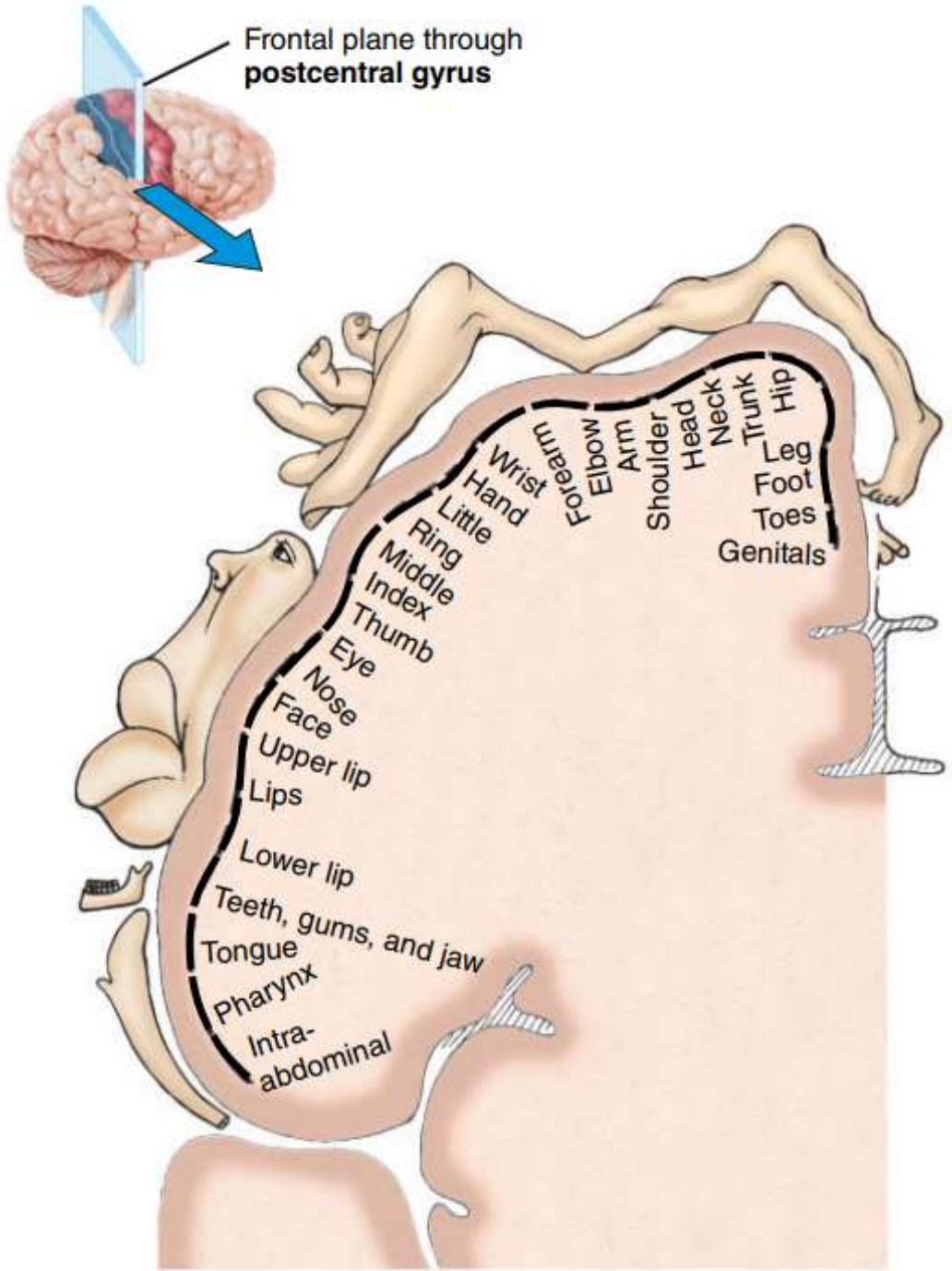
Trigeminothalamic pathway

Third-order neuron will continue from the
thalamus and Up to the
primary somatosensory area of
the cerebral cortex for the Perception
and integration of info

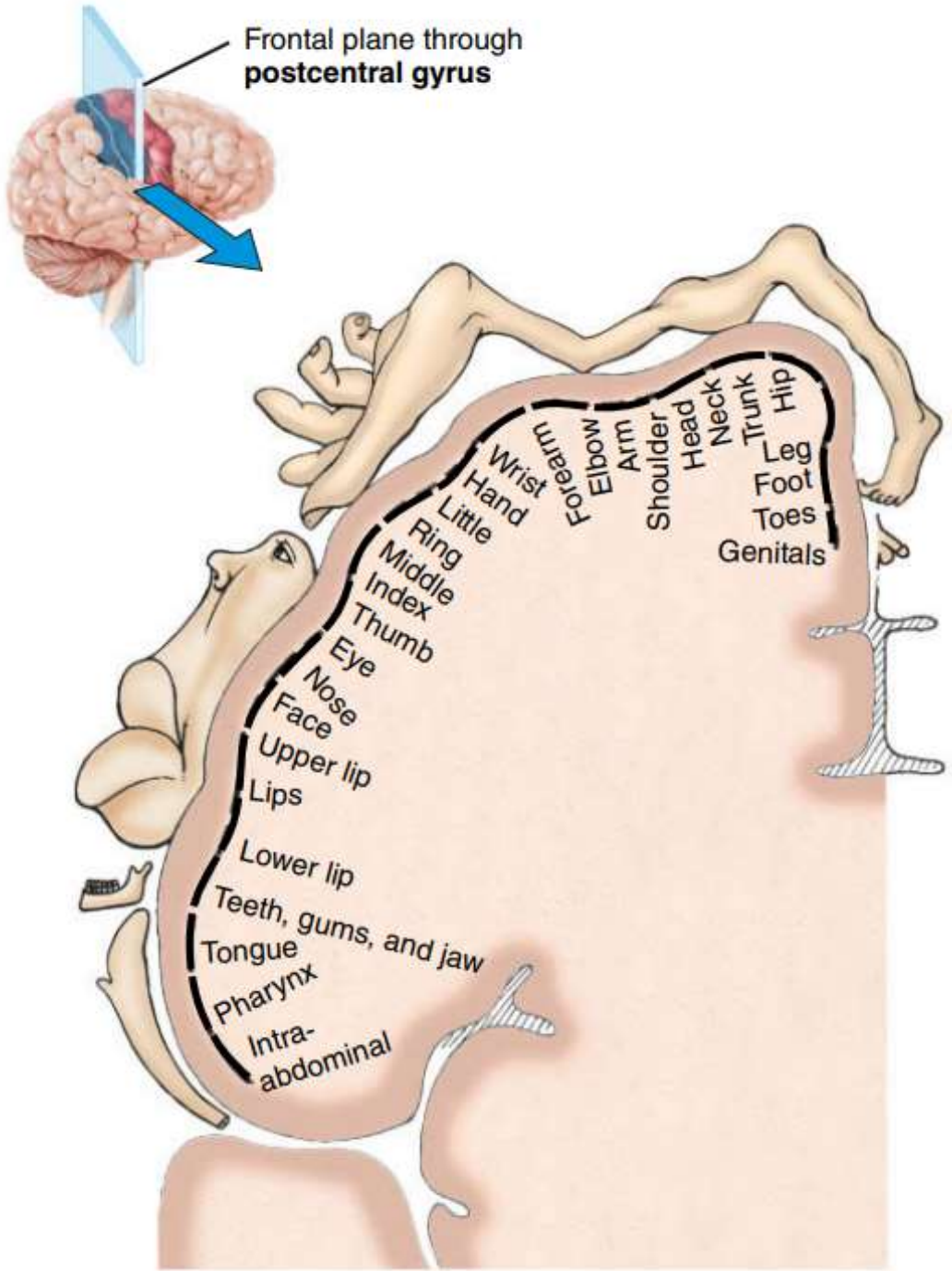


Mapping of the primary somatosensory area in the cerebral cortex

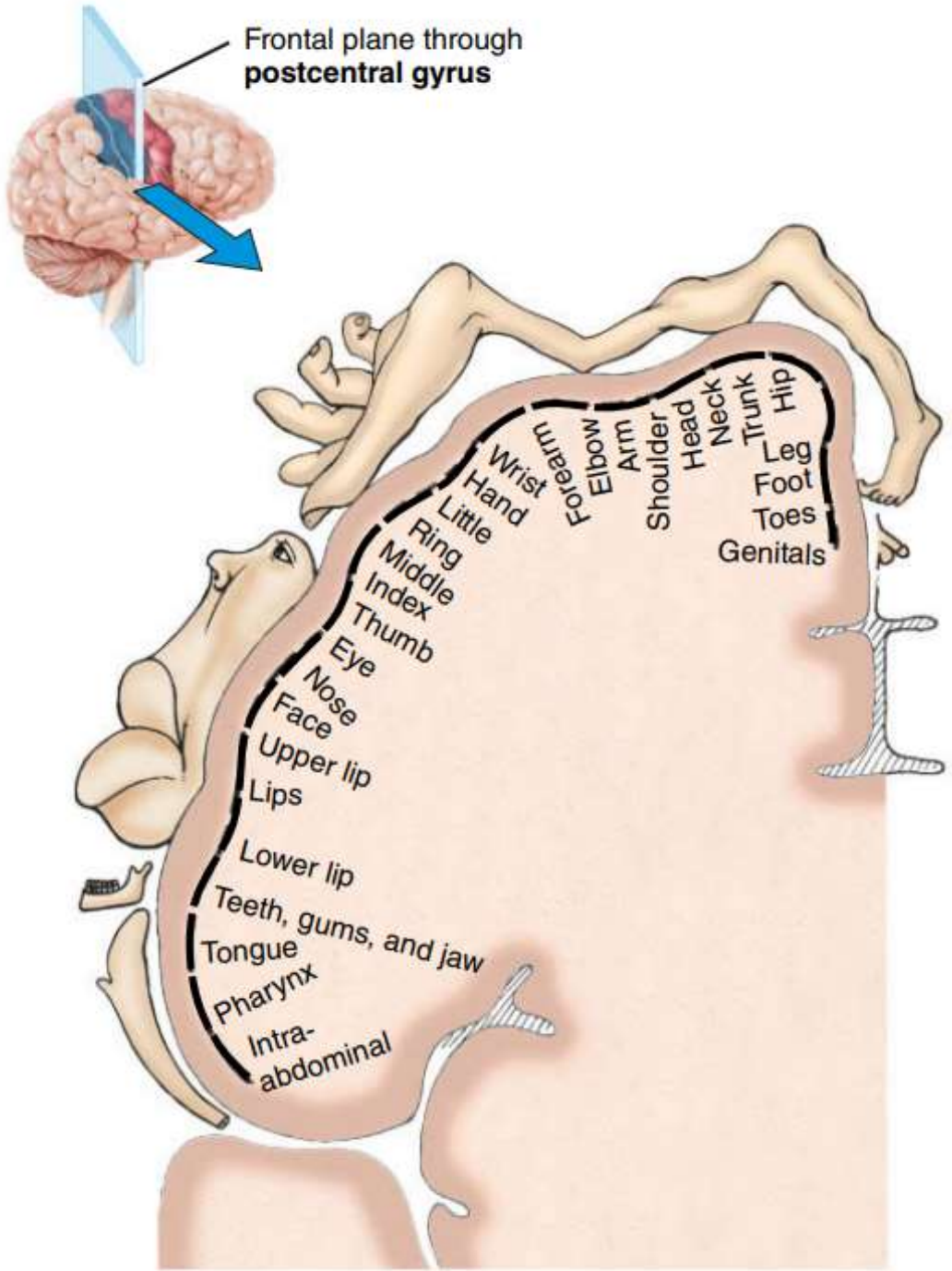
-As you Know From the explanation of the pathways, decussation happens once during these pathways (during the ascending pathway) So that means once the info reaches this part of the cerebral cortex they are coming from the opposite part of the body



Located in postcentral gyri of the parietal lobes of the cerebral cortex.



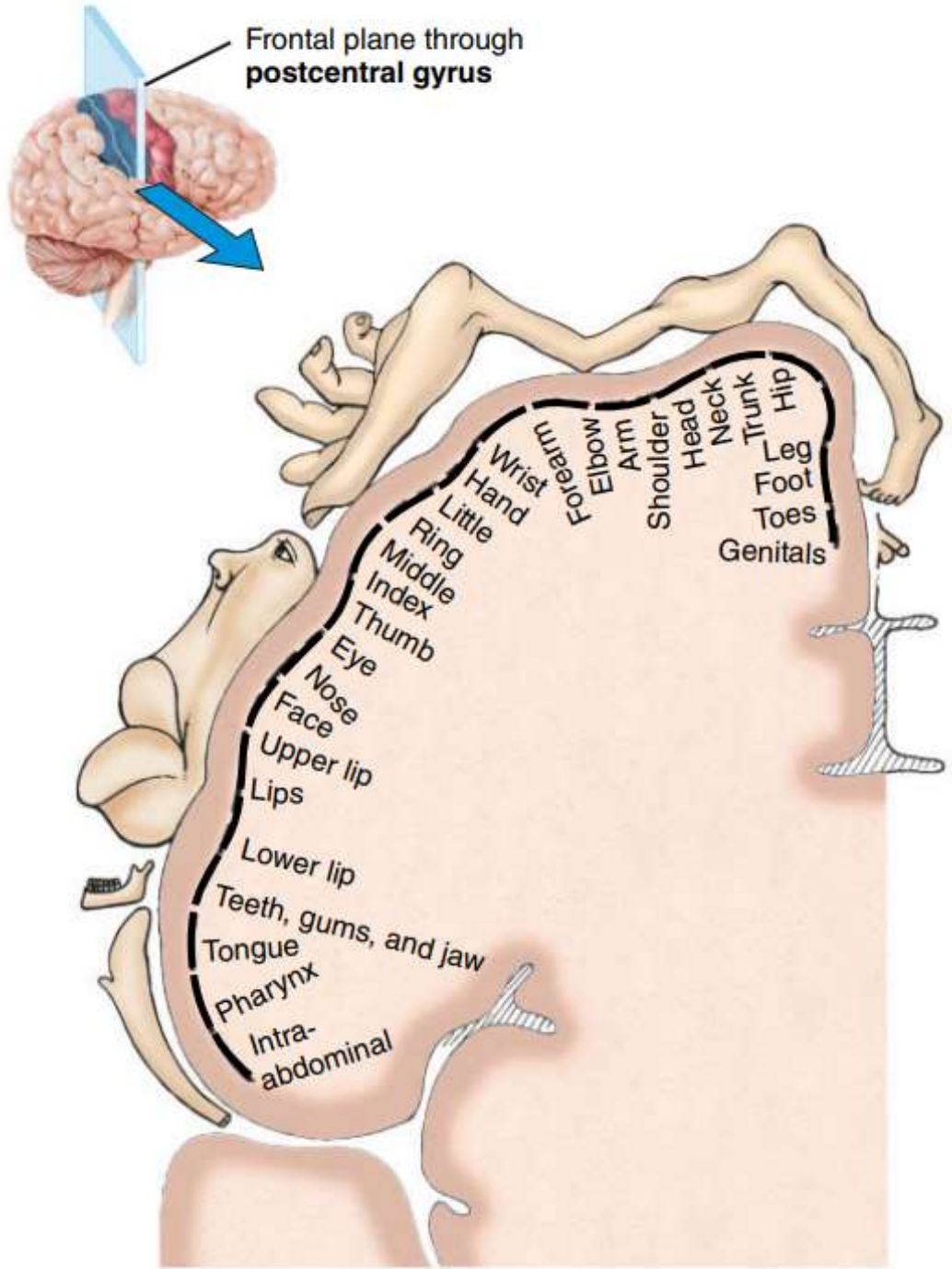
The left cerebral hemisphere receives sensory input from the right side of the body



Distorted somatic sensory map of the body: **Sensory homunculus**.

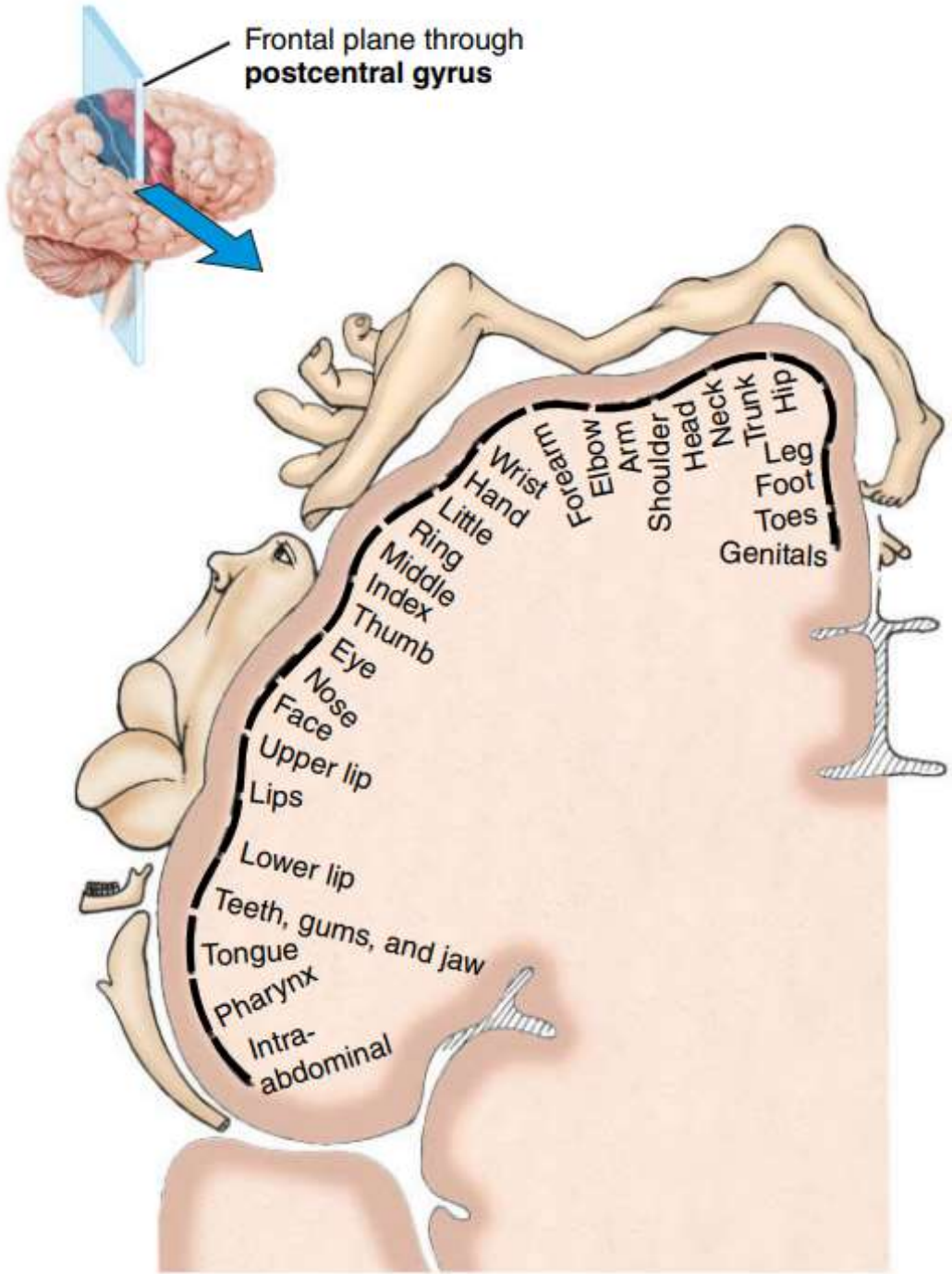
As you see here it looks like there's a map of the body parts so sensory information will come from spsefic part of the body to a specific location that's represent by the cerebral

In thr first lecture as we explained why this map is distorted or why the it's disproportionate to the actual sizes of the body parts.



Think about this:

What will happen to this map if the quantity of sensory impulses received from certain body part changed significantly?



لا تنسوا الدعاء لأهلنا في غزة