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Ecological, Economic and Social Sustainability

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NEUROANATOMY

5th week – Ascending and Descending Pathways of the Medulla Spinalis

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LAMINATION OF WHITE MATTER

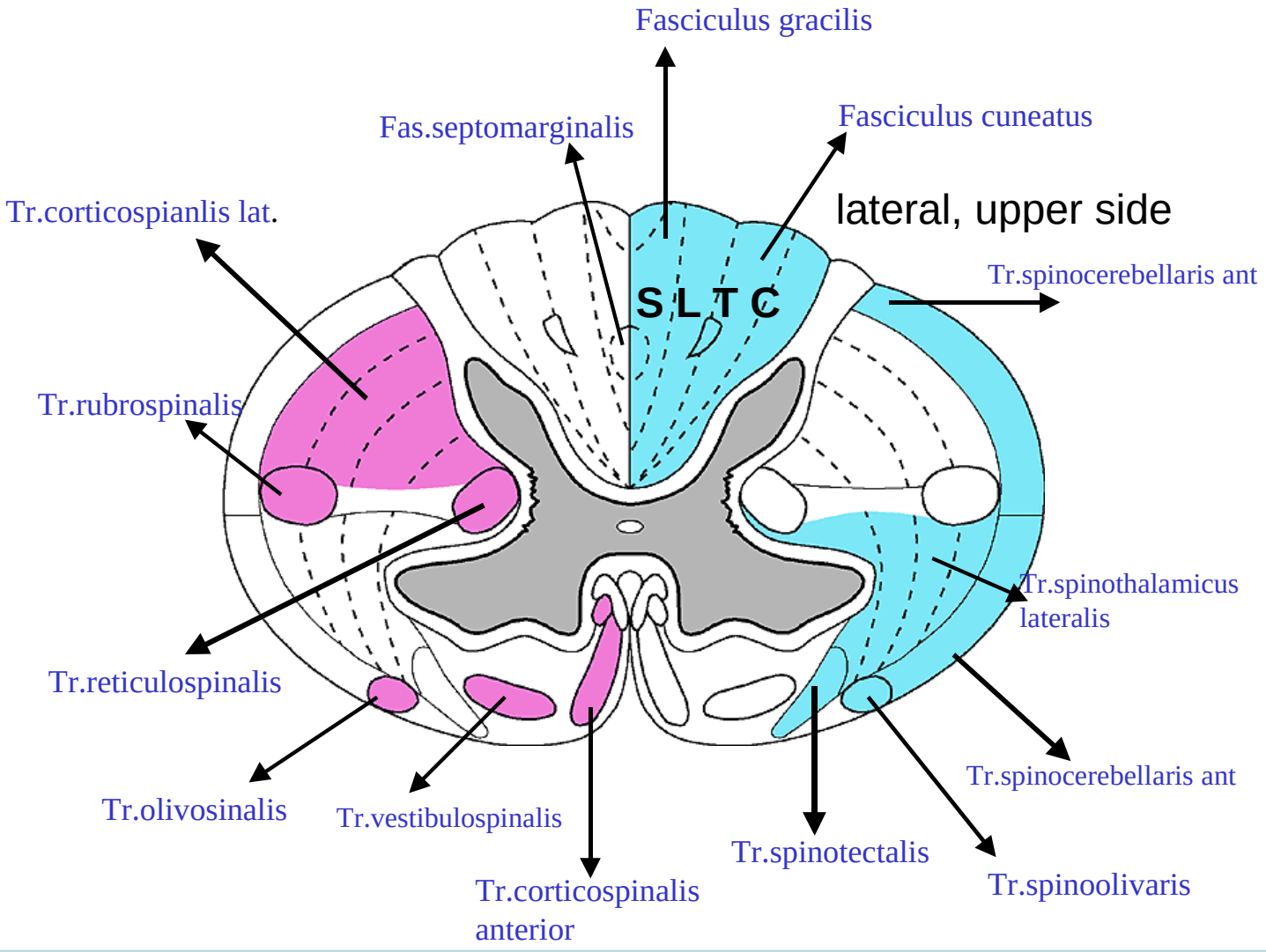
- As the medulla spinalis develops, newly formed ores are added to the outside of the old ones.
- Thus, fibers with the same function and of the same origin are arranged to form a layer.
- Fibers that go to the same place in the white matter, perform the same function or have the same origin, travel together to form tracts in the form of bundles.
- These fibers are myelinated.
- The tracts carry the senses in the spinal cord to the upper centers (Ascending tracts), or from the upper centers to the spinal cord (Descending tracts).
- The descending and ascending senses are carried in the funiculus anterior and lateralis. In the fasciculus posterior, there are only ascending tracts.

MEDULLA SPINALIS DESCENDENS AND ASCENDENS TRACTS

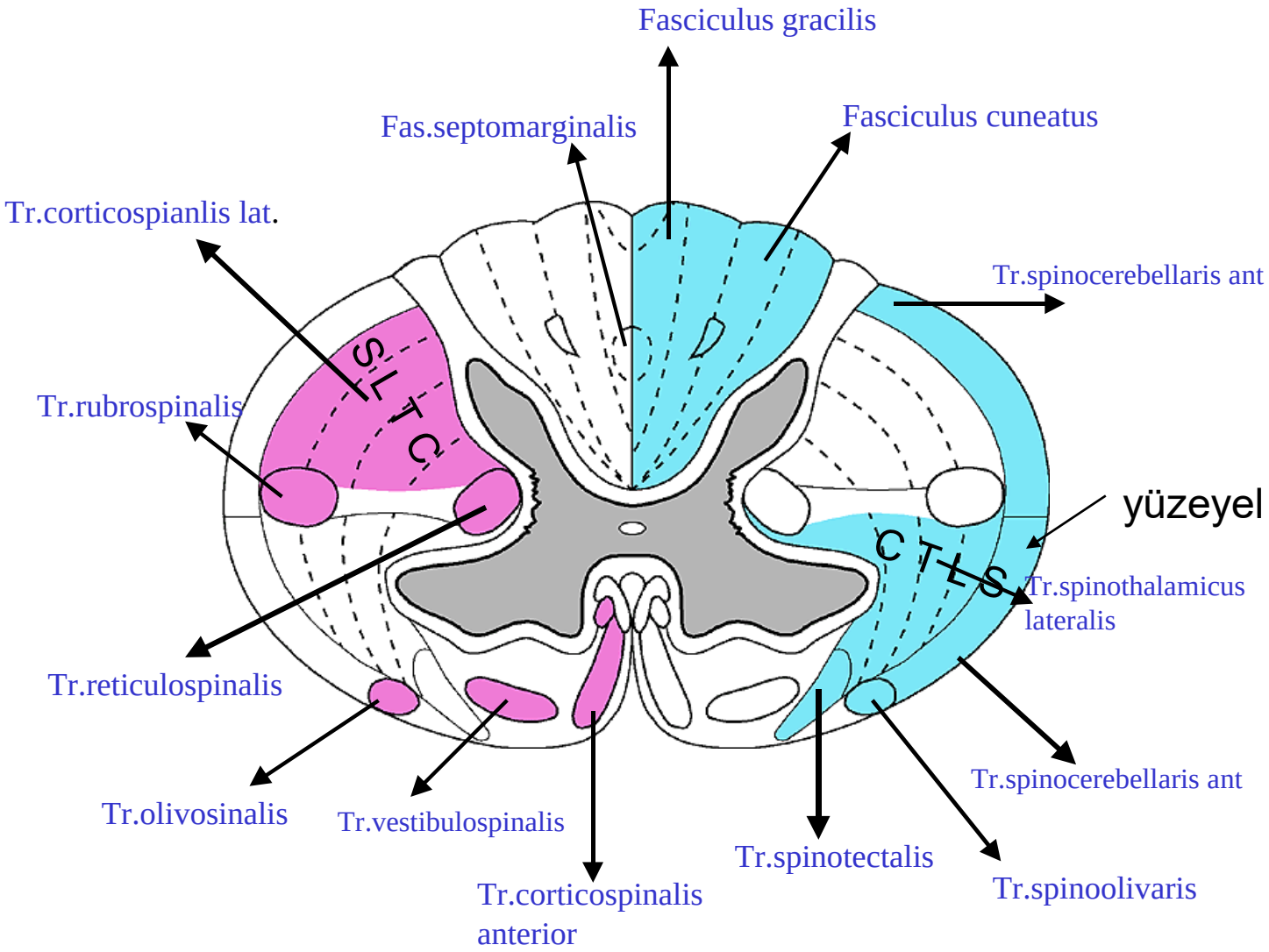
GENERAL INFORMATION

The descending pathways are formed by the axons of the upper centers such as the cerebrum, cerebellum, and brain sac descending to the spinal levels.

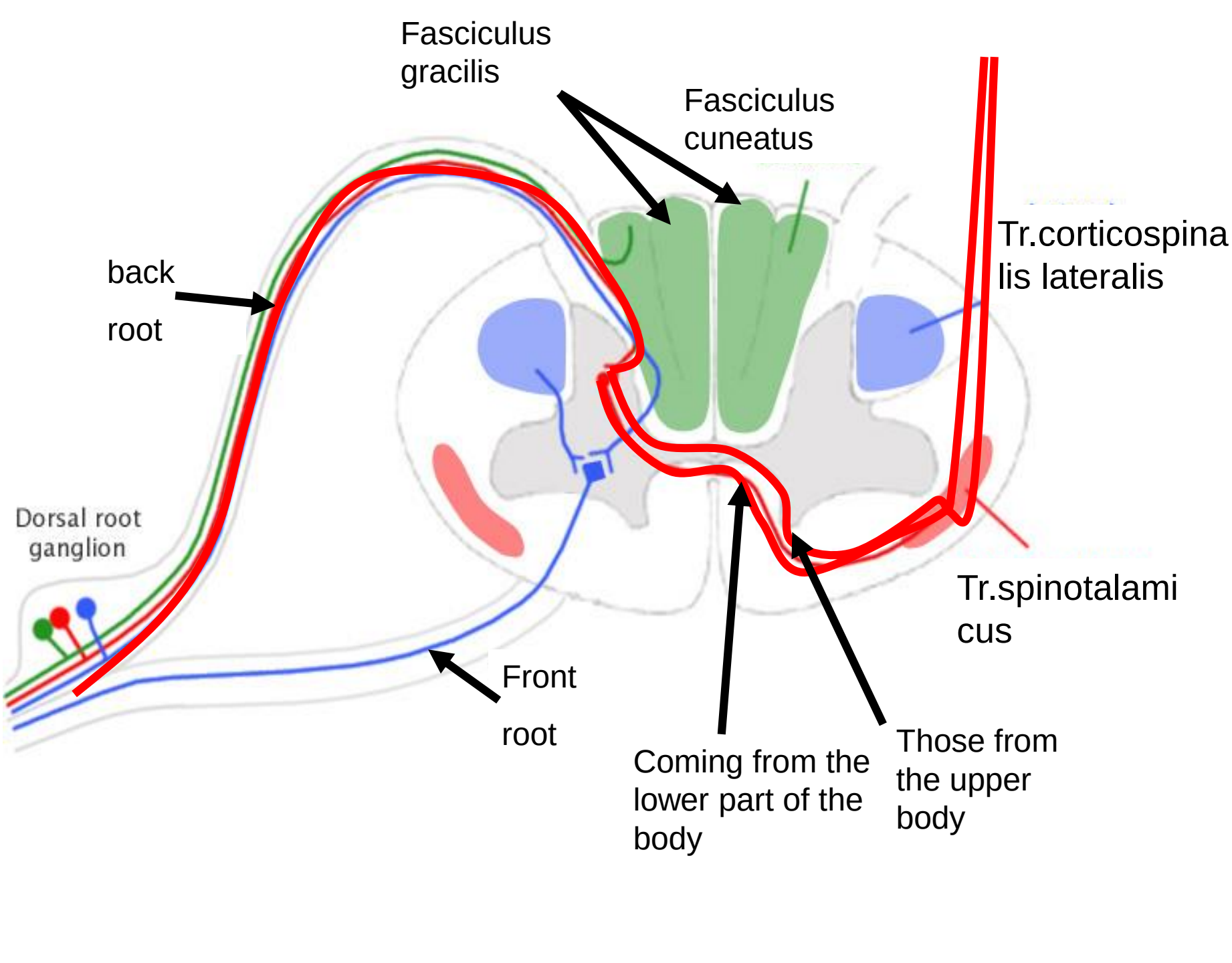
The ascending pathways generally form central extensions of pseudounipolar neurons in the ganglion spinal cord and extensions of second neurons, where they synapse in the gray matter lamina.

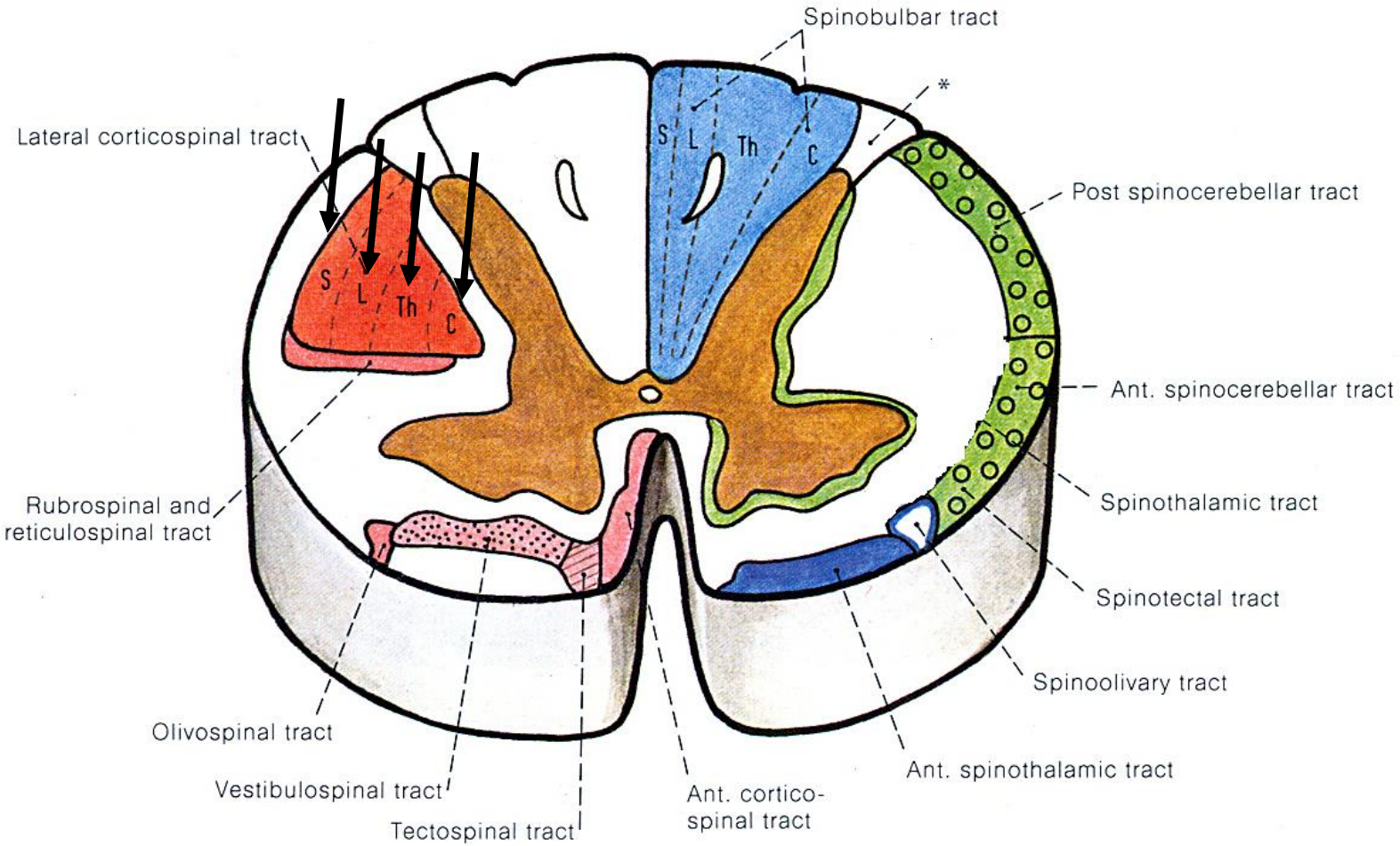


Of the fibers that enter the spinal cord from the posterior root and go up the posterior cord without entering the gray matter, the medial ones belong to the lower part of the body and the lateral ones belong to the upper part of the body. Therefore, when the lateral side of the posterior cord of the spinal cord is cut, the upper side senses are lost, when the medial is cut, the lower side senses are lost (tr.spinobulbaris).



After entering the spinal cord from the posterior root and changing neurons from the gray matter, the superficial fibers come from the lower part of the body and the deep ones are from the upper part.

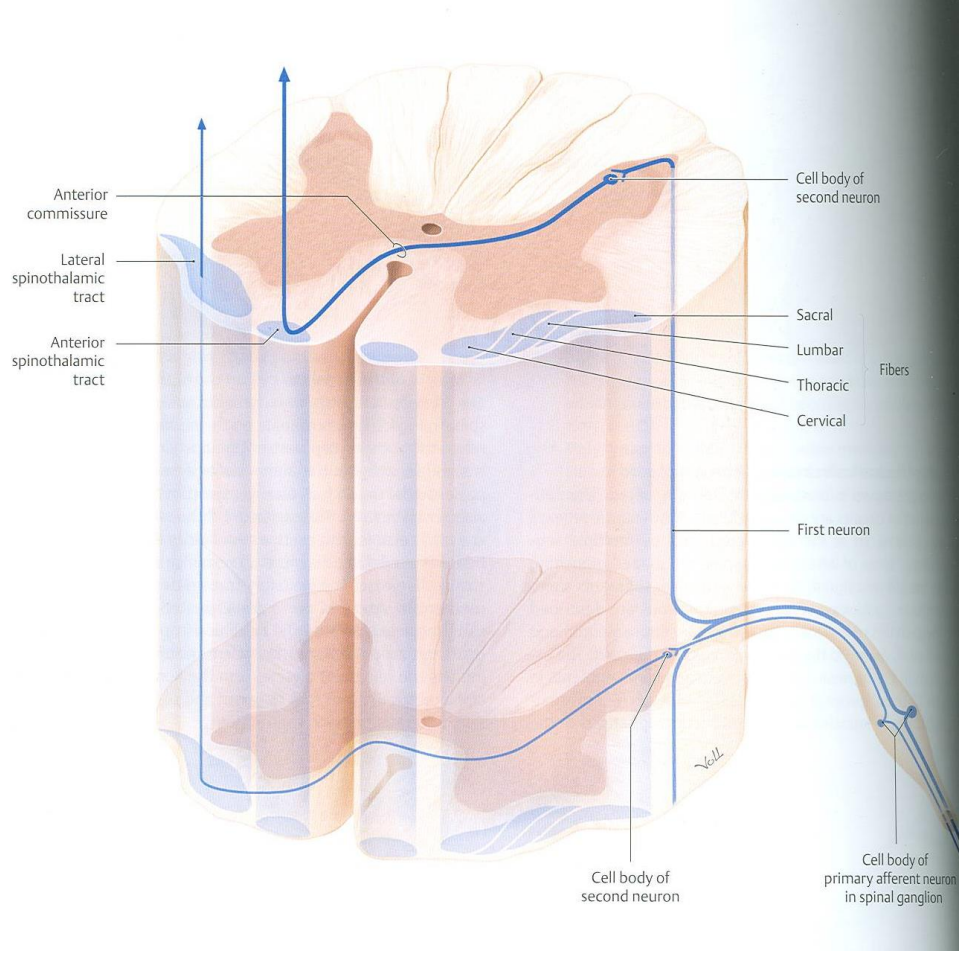

Fasciculus gracilis
Fasciculus cuneatus
Tr.corticospinalis lateralis
back root
Dorsal root ganglion
Front root
Tr.spinotalamicus
Coming from the lower part of the body
Those from the upper body



- The superficial fibers of the motor pathways (Tr.corticospinalis) that come out of the cerebral cortex and cross in the bulb are the fibers that go to the lower part of the body, and the deep fibers to the upper part.

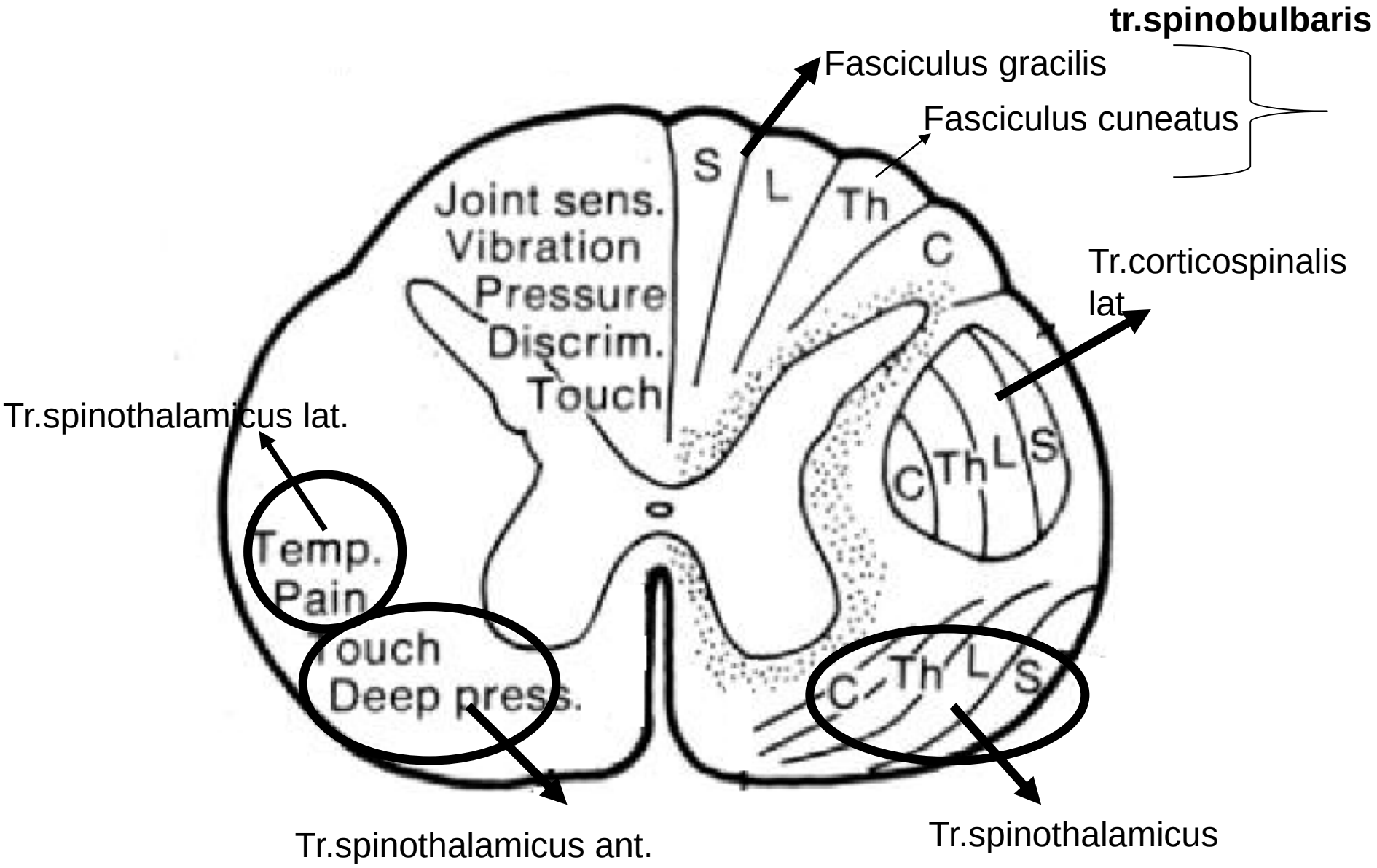
- **In the medulla spinalis, the longest fibers are those that come up from the conus medullaris and are located near the sulcus medianus posterior.**

- While some of the sensory impulses carried by the afferent pathways come to the cortex and become conscious, some of them pass through various neurons before they reach our consciousness and form what we call reflex.



- Pressure, contact, pain and temperature sensations are exteroceptive senses. It is transmitted by the tr.spinothalamicus.

Laminar organization of white matter



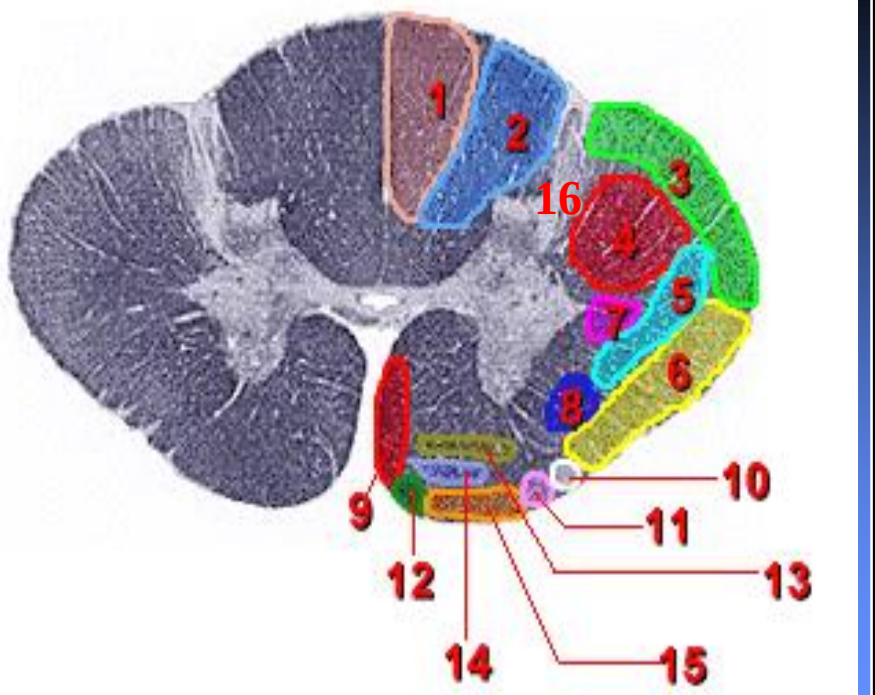
Descending Tracts

- **1.Tr. corticospinalis**
- **2. Tr. vestibulospinalis:**
- **3.Tr. reticulospinalis**
- **4.Tr. tectospinalis:**
- **5.Tr. olivospinalis:**
- **6.Tr. rubrospinalis:**
- **7. Descending tracts in funiculus posterior (Fasciculus interfascicularis, Fasciculus septomarginalis):**

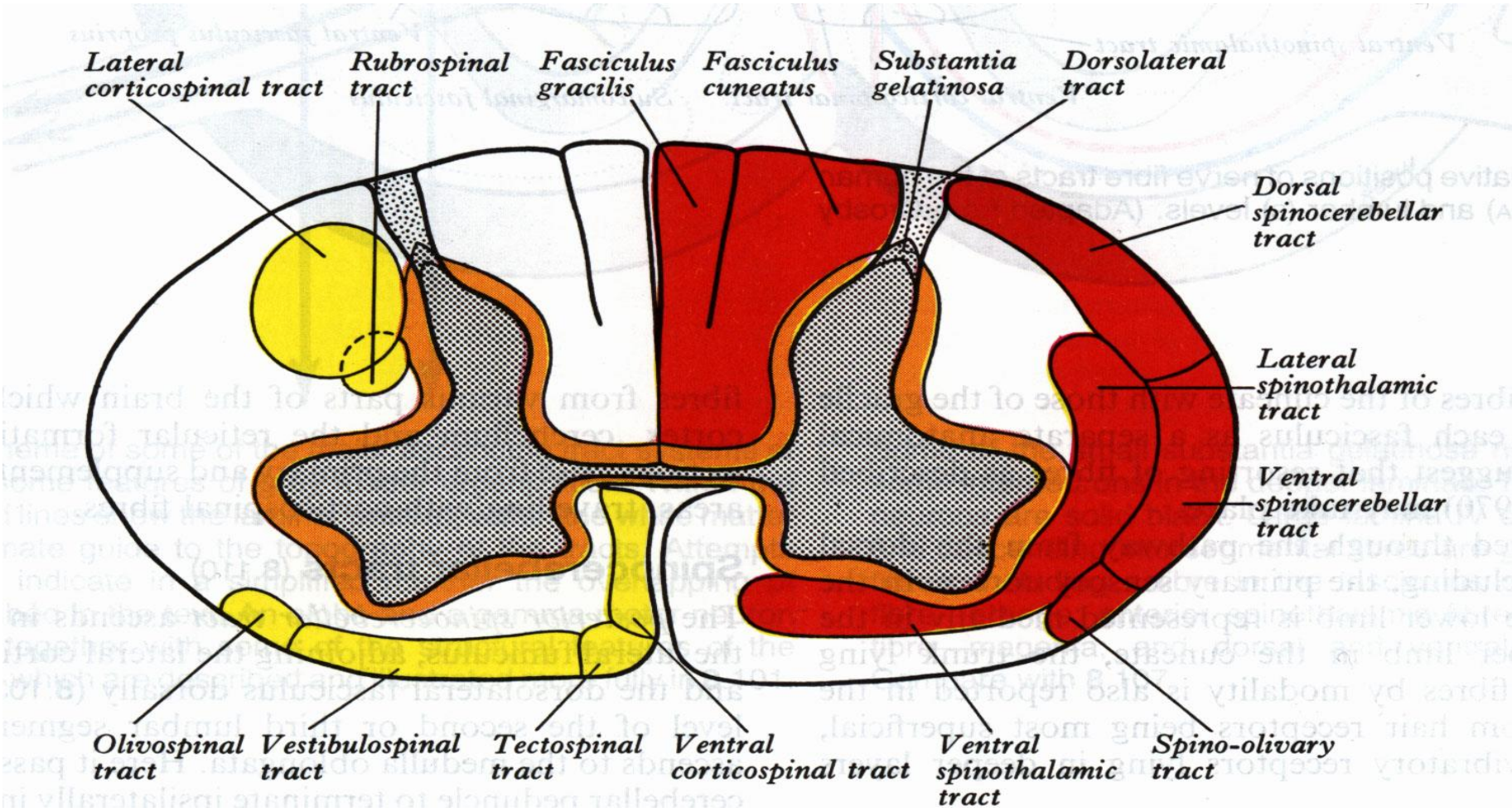
ASCENDİNG TRACTS

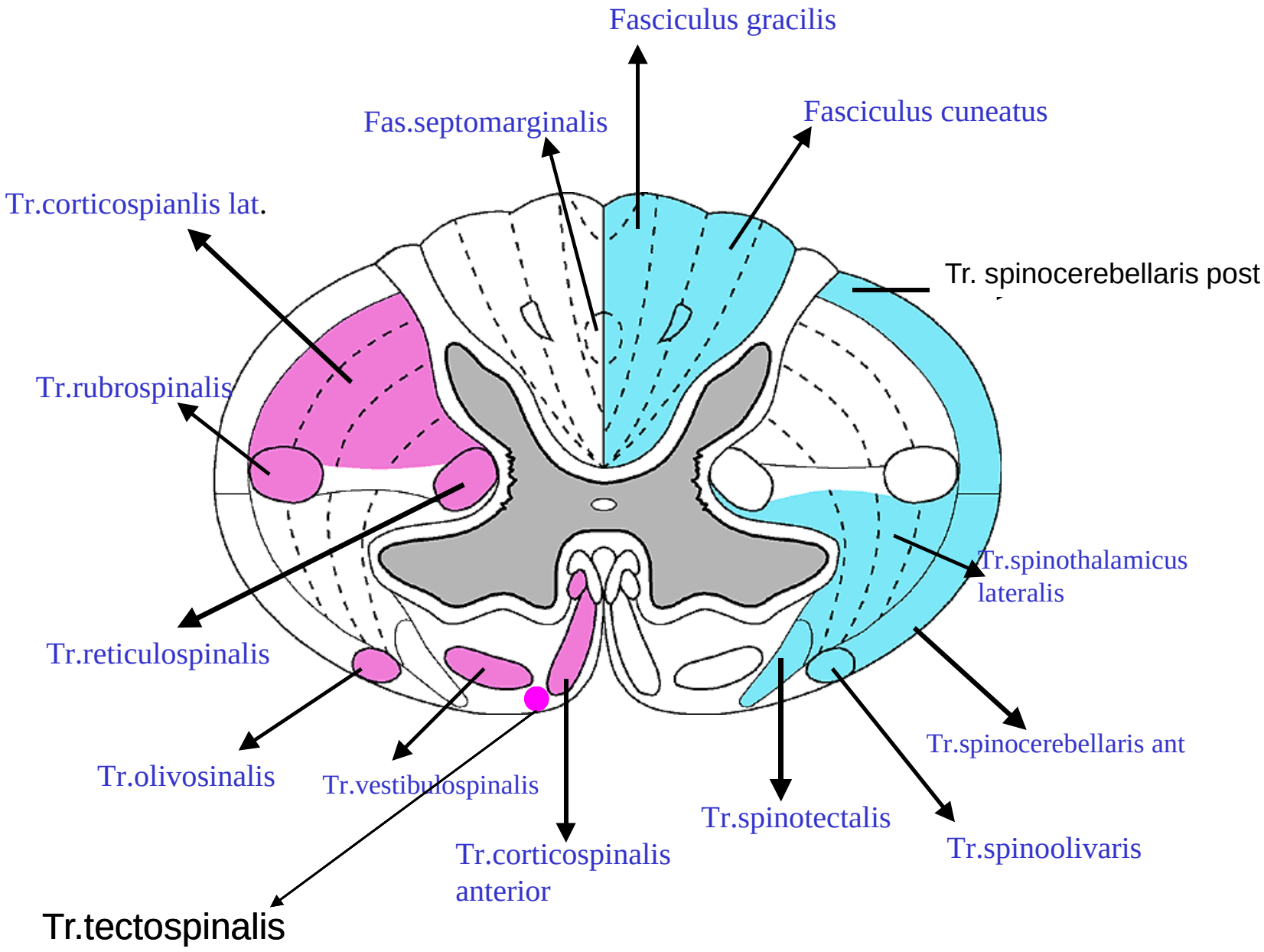
- 1-Tr. spinothalamicus lat.
- 2-Tr. spinotectalis
- 3-Tr. spinocerebellaris ant
- 4-Tr. spinocerebellaris pos
- 5- tr. spinolivaris
- 7-Tr. spinothalamicus anterior
- 8.Tr. spinoreticularis

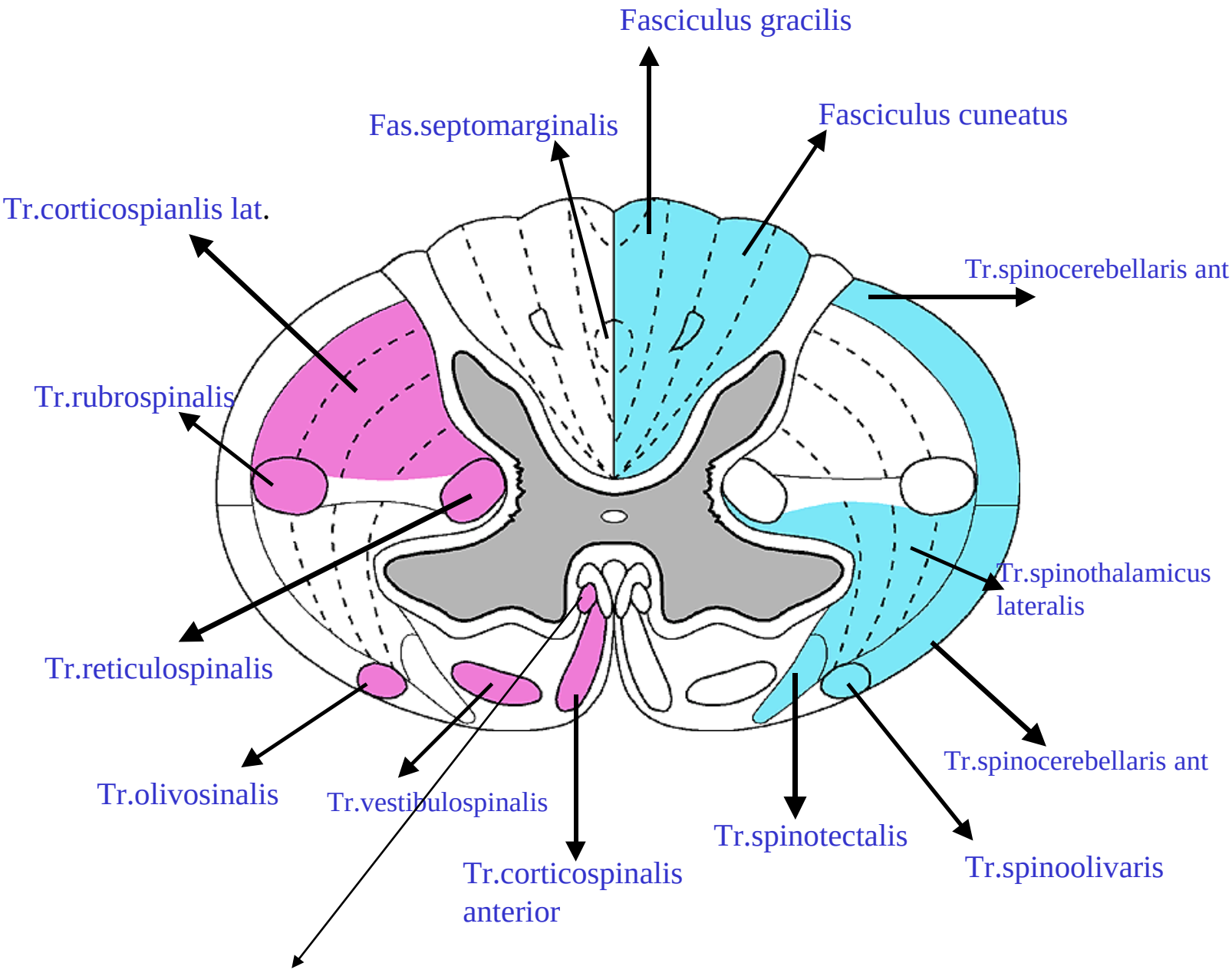
Tracts of the Spinal Cord



1. Fasciculus Gracilis
2. Fasciculus Cuneatus
3. Tractus spinocerebellaris post
4. Tractus corticospinalis lateralis
5. Tractus spinothalamicus lateralis
6. Tractus spinocerebellaris ant.
7. Tractus rubrospinalis
8. Tractus spinotectalis
9. Tractus corticospinalis anterior
10. Tractus olivospinalis
11. Tractus spinoolivaris
12. Tractus tectospinalis
13. Tractus reticulospinalis
14. Tractus vestibulospinalis
15. Tractus spinothalamicus anterior
16. *Raphe-spinal & Hypothalamospinal fibers*


Lateral corticospinal tract
Rubrospinal tract
Fasciculus gracilis
Fasciculus cuneatus
Substantia gelatinosa
Dorsolateral tract
Dorsal spinocerebellar tract
Lateral spinothalamic tract
Ventral spinocerebellar tract
Olivospinal tract
Vestibulospinal tract
Tectospinal tract
Ventral corticospinal tract
Ventral spinothalamic tract
Spino-olivary tract


Fasciculus gracilis
Fas.septomarginalis
Fasciculus cuneatus
Tr.corticospianlis lat.
Tr. spinocerebellaris post
Tr.rubrospinalis
Tr.spinothalamicus lateralis
Tr.reticulospinalis
Tr.spinocerebellaris ant
Tr.olivosinalis
Tr.vestibulospinalis
Tr.spinotectalis
Tr.spinoolivaris
Tr.corticospinalis anterior
Tr.tectospinalis


Fasciculus gracilis
Fas.septomarginalis
Fasciculus cuneatus
Tr.corticospianlis lat.
Tr.spinocerebellaris ant
Tr.rubrospinalis
Tr.spinothalamicus lateralis
Tr.reticulospinalis
Tr.spinocerebellaris ant
Tr.olivosinalis
Tr.vestibulospinalis
Tr.spinotectalis
Tr.spinoolivaris
Tr.corticospinalis anterior
Fasciculus longitudinalis medialis

FUNİCULUS ANTERİOR

DESCENDİNG TRACTS

1-Tr. Corticospinalis ant.
(Tr.pyramidalis ant.)
2-Tr. Vestibulospinalis
3-Tr. Reticulospinalis ant
(Tr.pontoreticulospinalis)
4-Tr. Tectospinalis
5-Tr.olivospinalis

ASCENDING TRACTS

1-Tr.Spinothalamicus ant.

FUNİCULUS LATERALİS

DESCENDİNG TRACTS

1-Tr. Corticospinalis lat.

(Tr.pyramidalis lat.)

2-Tr. Rubrospinalis

3-Tr. Reticulospinalis lat.

(Tr. Bulboreticulospinalis)

4-Tr. Olivospinalis

ASCENDING TRACTS

1-Tr.Spinothalamicus lat.

2-Tr. spinotectalis

3-Tr.spinocerebellaris ant

4-Tr.spinocerebellaris pos

5.Tr.Spinoolivaris

6. Tr.spinoreticularis

FUNİCULUS POSTERİOR

DESCENDING TRACTS

1-Fas. septomarginalis

2-Fas.interfasicularis

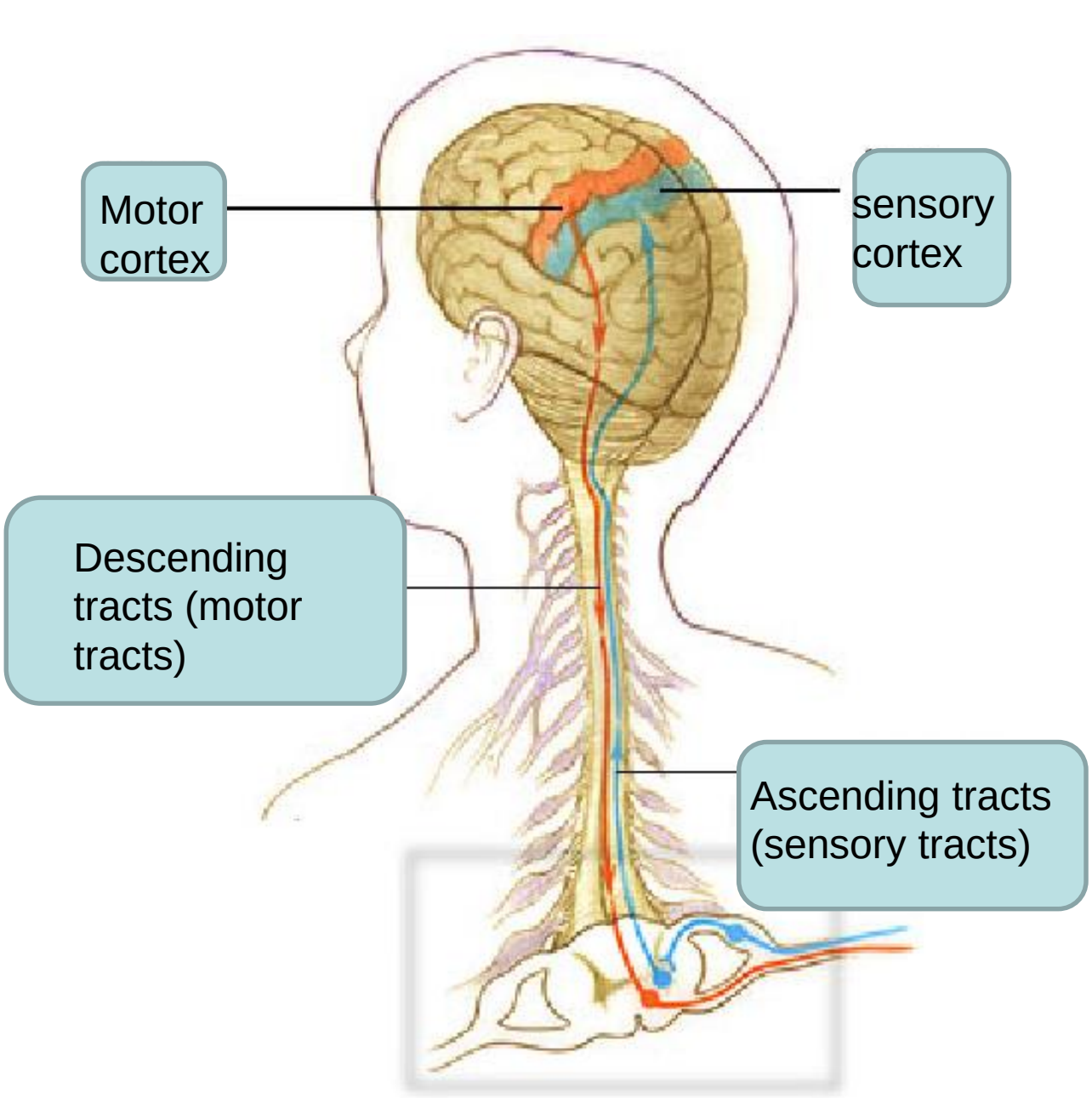
ASCENDING TRACTS

1- Fasciculus Gracilis (Gowers)

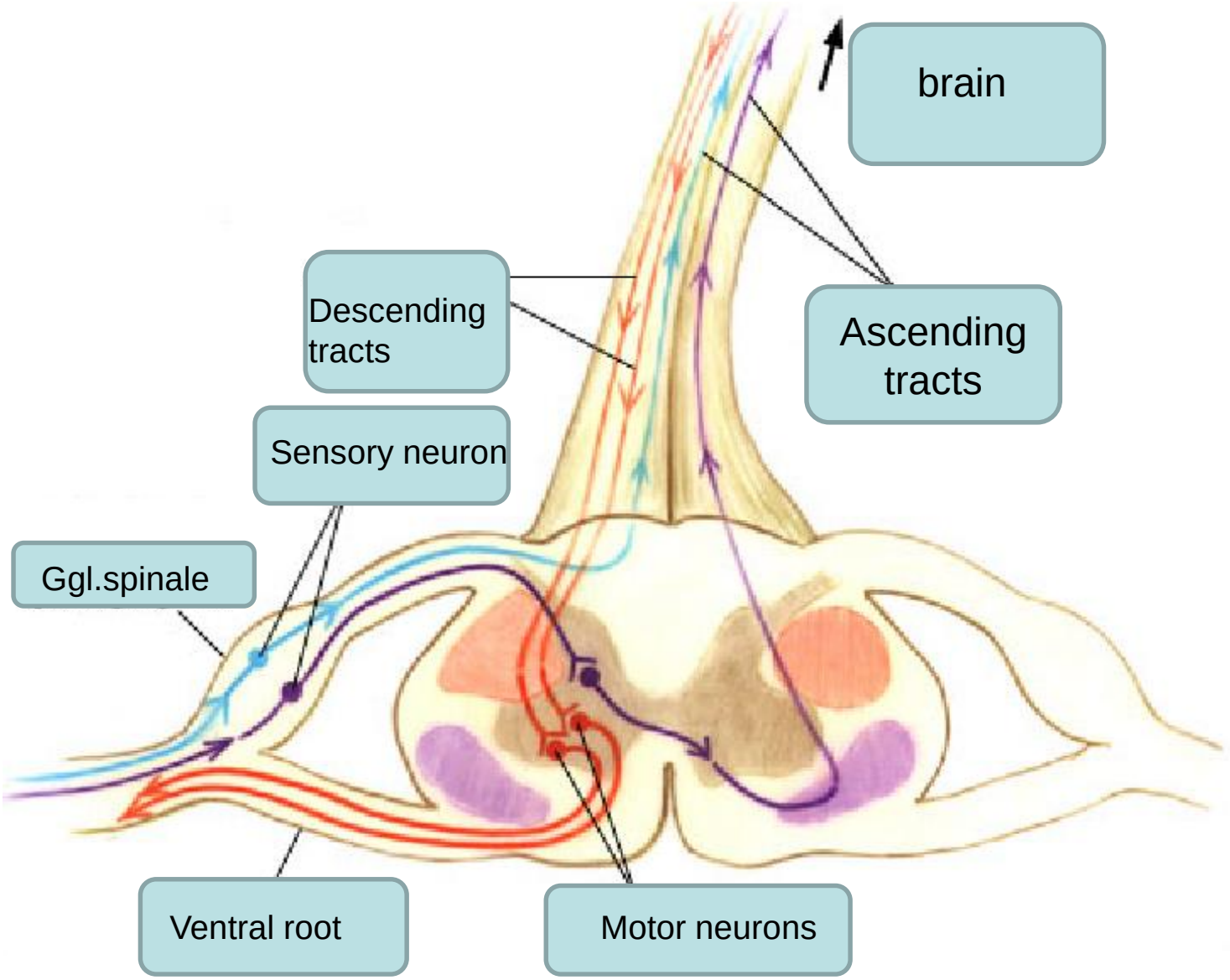
2- Fasciculus Cuneatus (Flechsig)

3- Tr. cuneocerebellaris

Descending and Ascending Tracts



Descending and Ascending Tracts



Ascendens Tracts (Afferent tracts)

Modality: ***touch, pain, temperature, kinesthetic senses***

Receptor: ***Exteroceptor, Interoceptor, Proprioceptor***

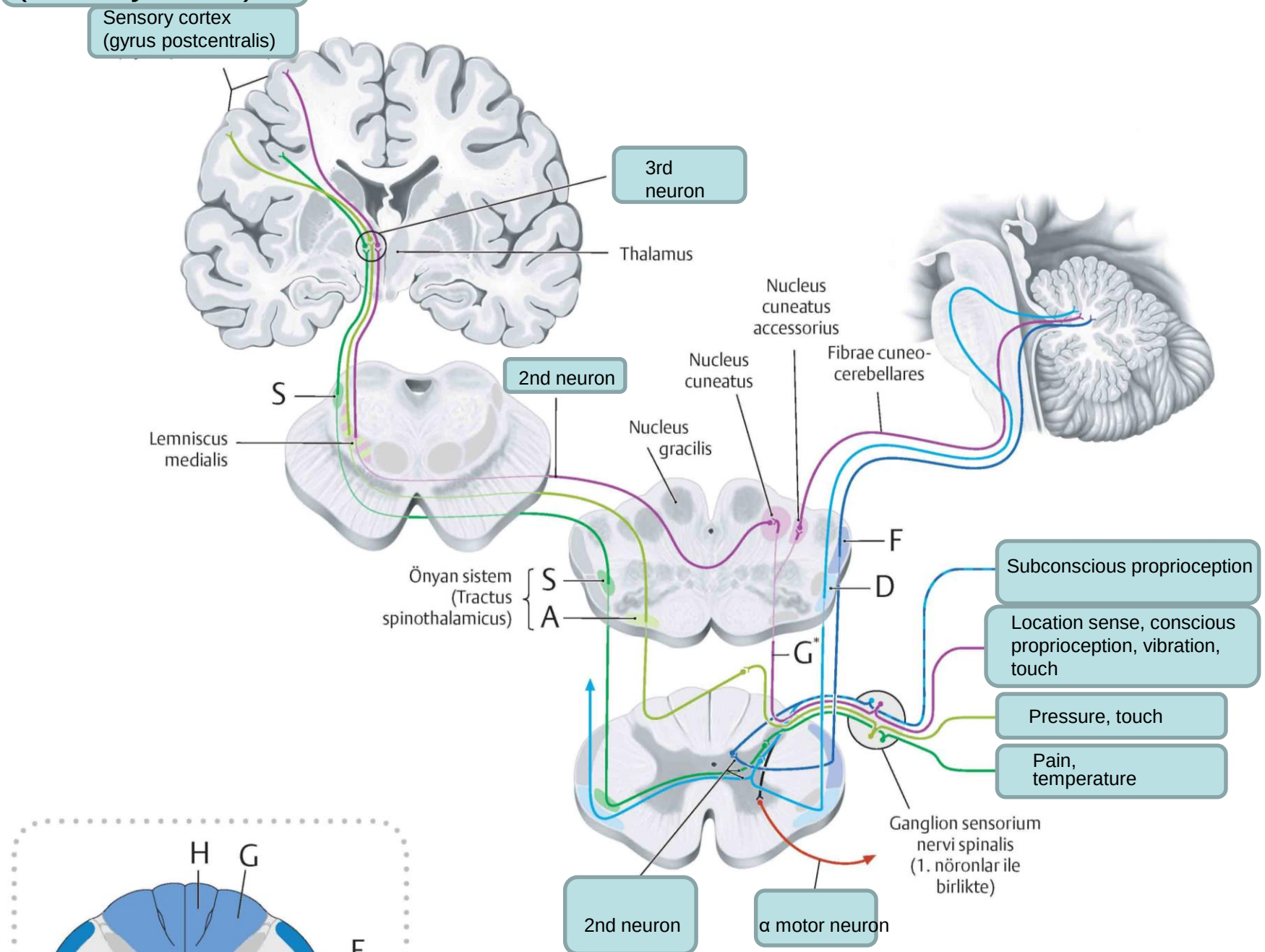
First Neuron: ***Ganglion Spinale***

Second neuron: ***Spinal Cord or Brain Stem***

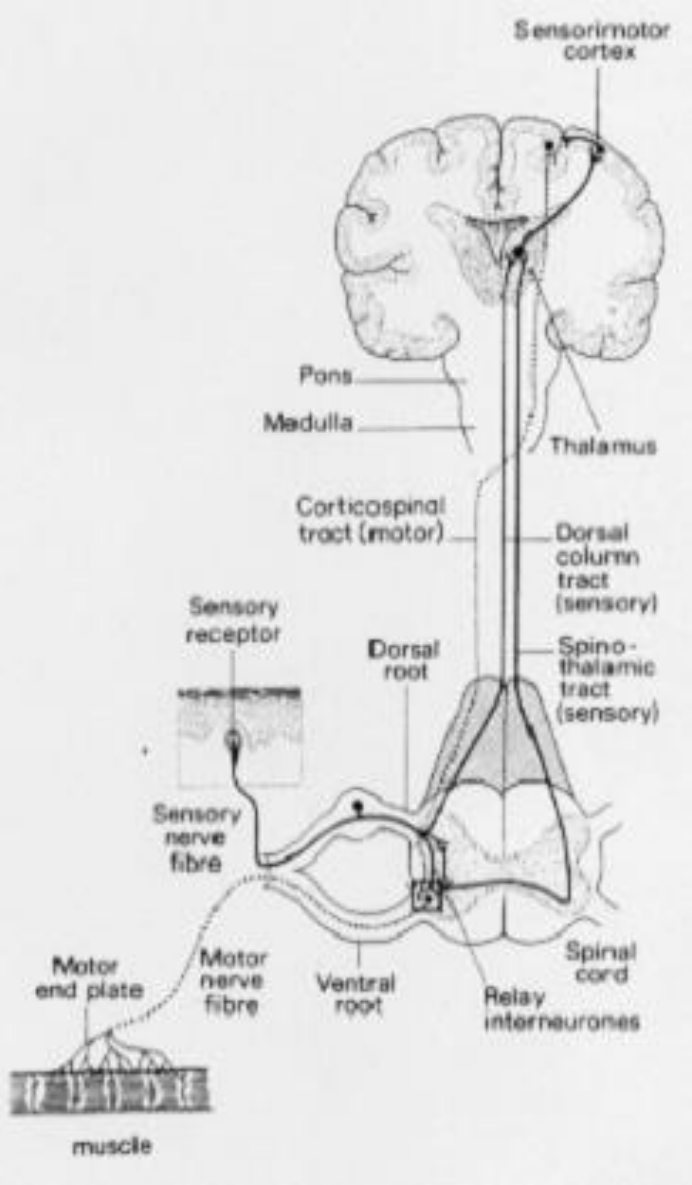
Third neuron: ***Thalamus (Ventrobasal Nuclear Complex)***

where it ends : ***Cerebral Cortex, Cerebellar Cortex, or brainstem***

Ascending tracts (sensory tracts)



Ascending (afferent) pathways in the medulla spinalis



A sense received from the periphery is conveyed to our consciousness in its simplest form, **with 3 neurons.**

- The cell body of the **1st neuron** is located in the **ggl. spinale** in the dorsal root. The peripheral extension of this neuron starts from receptors in various structures. Its central extension enters the spinal cord from the posterior root and synapses with the **2nd Neuron** in different laminae, usually in the posterior horn.

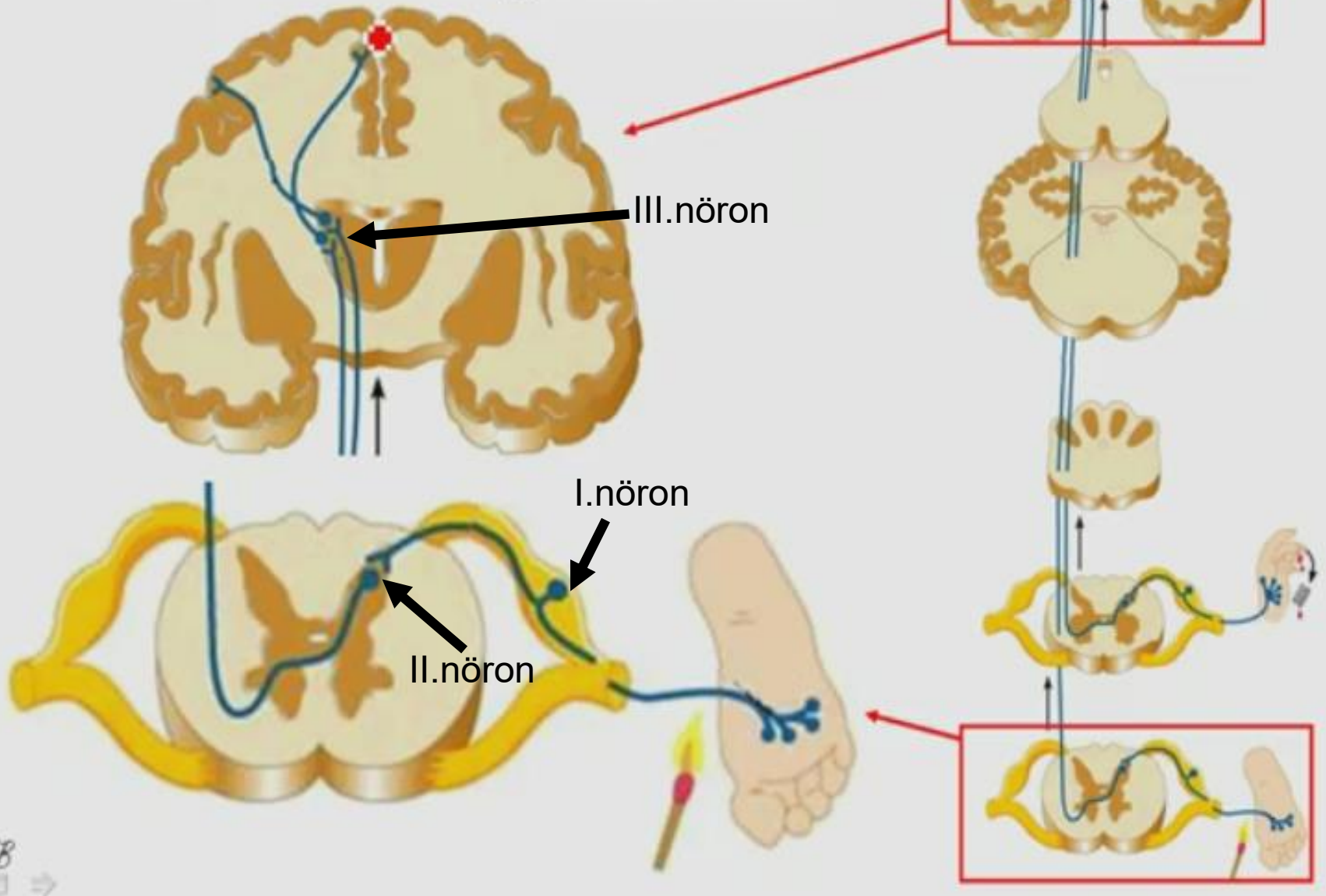
-The axon of the **2nd neuron** crosses the midline and passes to the opposite side (there are also fibers that come out without crossing) and goes up from here to synapse with the **3rd neuron** in the higher centers. The 3rd neuron is usually found in the **nuc. ventralis posterolateralis** of the thalamus.

-*The axons of the **3rd neuron** are connected to the sensitive fields **(3rd, 1st and 2nd fields)** in the cerebral cortex.*

-But there are senses carried by more or less neurons.

Ascending pathways

- General organization



Senses from the medulla spianlis

Superficial (exteroceptive) senses: These are the superficial senses such as **pressure, contact, pain, temperature.**

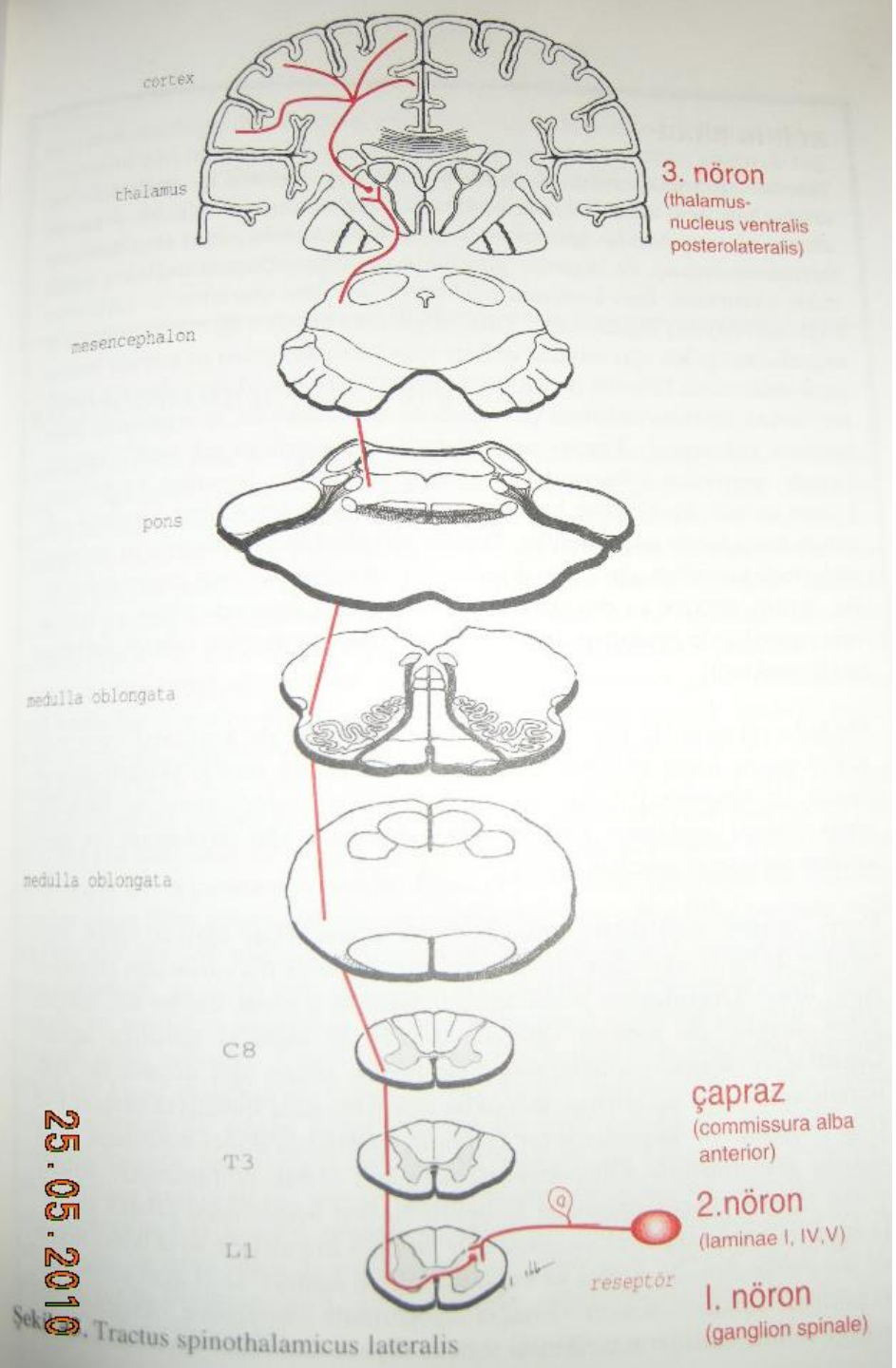
Discriminative sense: *These are the senses that give information about the place of origin of the sense of contact, the shape and intensity of the stimulus,*

two-point discrimination: *It is the senses used to perceive two stimulated points as separate points.*

vibration sense: *one after the other at equal intervals*

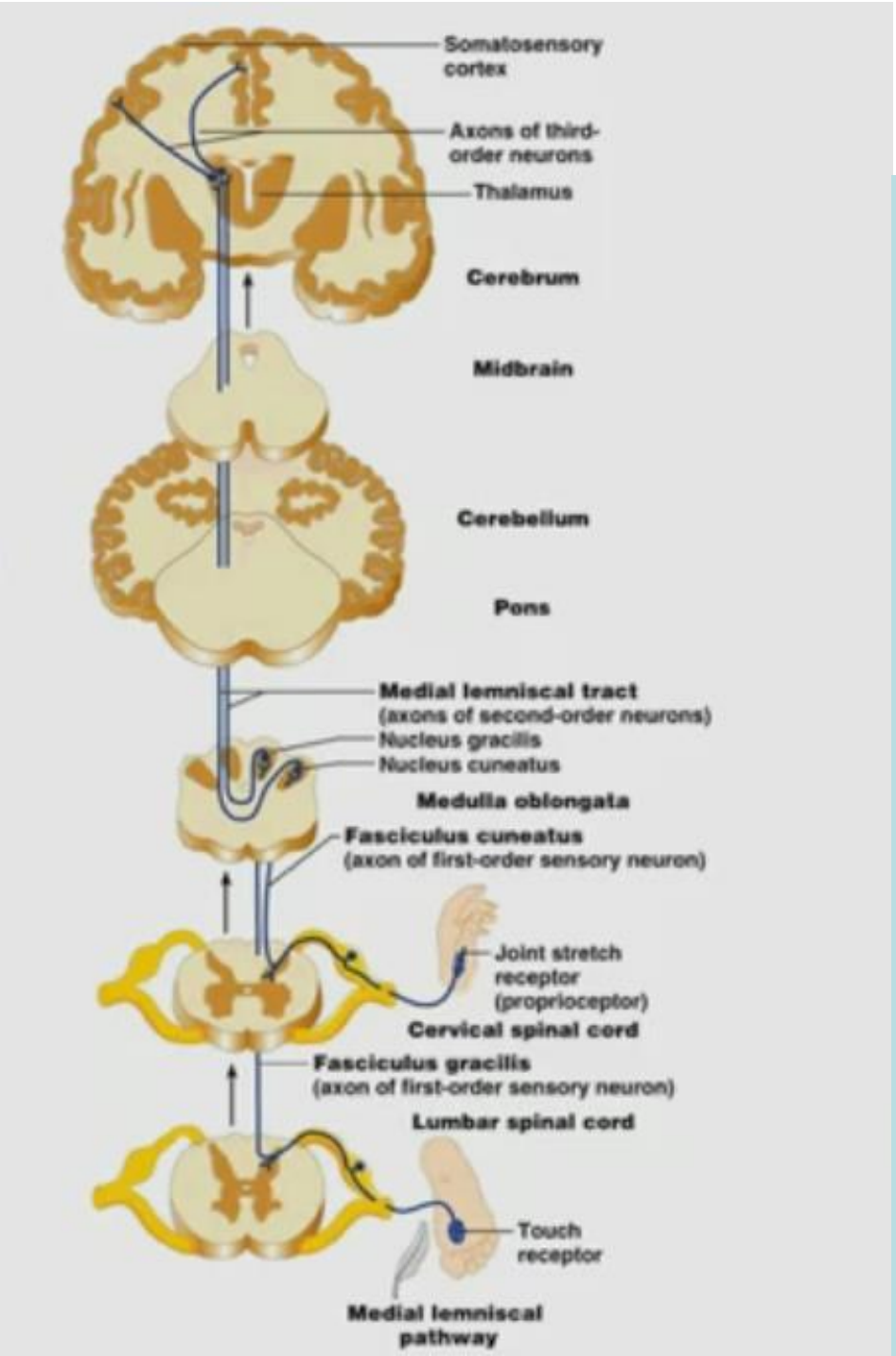
Deep (interoceptive) sense: senses originating from the internal organs

Proprioceptive (kinesthetic) sense: *It is the senses related to our* ***position coming from muscles, tendons, connective tissue and joint capsule.***



Function of afferent tracts

Generally, the sense of pressure and contact are carried by the tr.spinothalamicus anterior in the anterior cord, and the sense of pain and temperature by the tr.spinothalamicus lateralis and tr.spinoreticularis in the funiculus lateralis.Conscious proprioceptive, tactile discrimination, and vibration sense are transmitted in the posterior cord by tr.spinobulbaris in the funiculus posterior. Unconscious proprioceptive sensations from muscles, joints, and skin are carried in the funiculus lateralis, along with the tr. spinocerebellaris anterior and posterior.



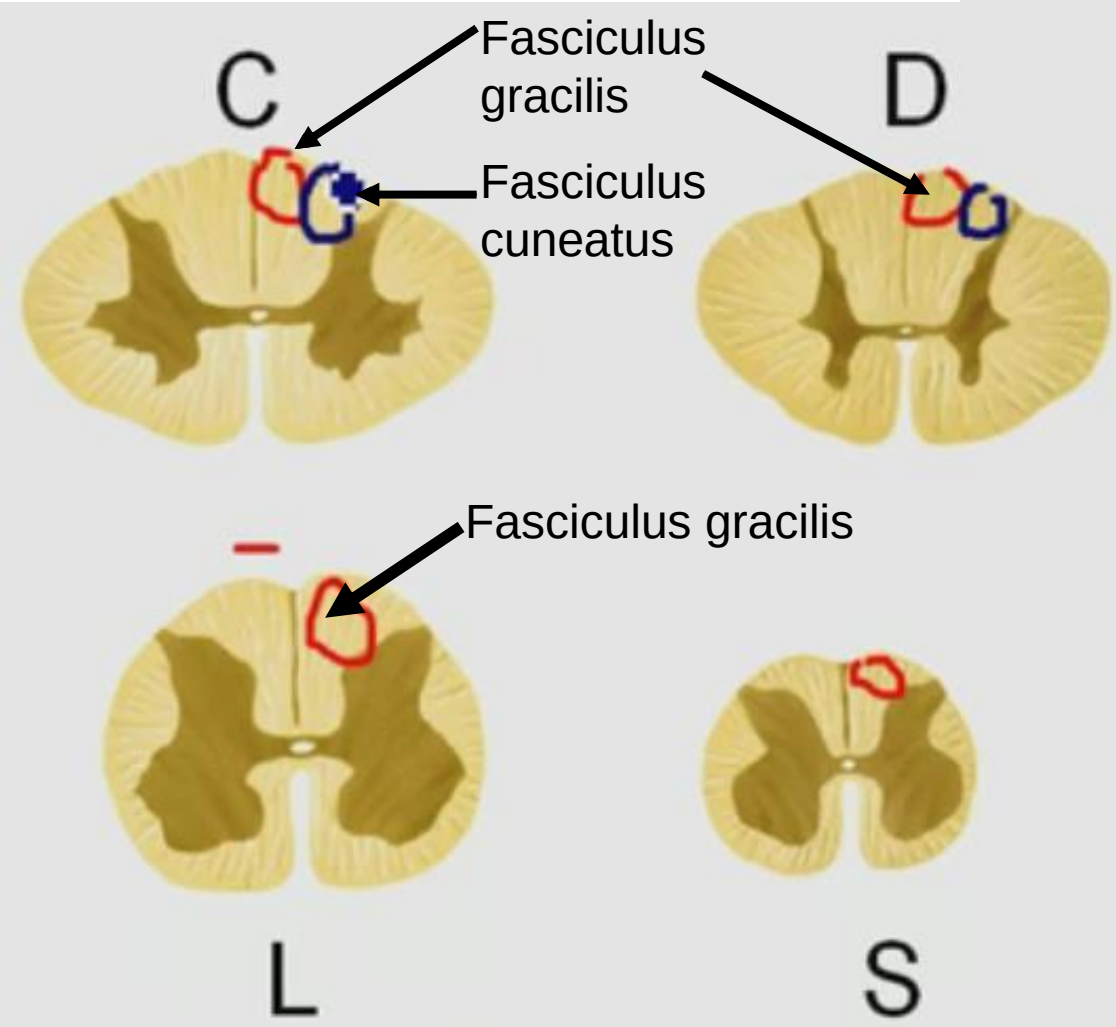
FASCİCULUS GRACİLİS and FASCİCULUS CUNEATUS (Tr. spinobulbaris)

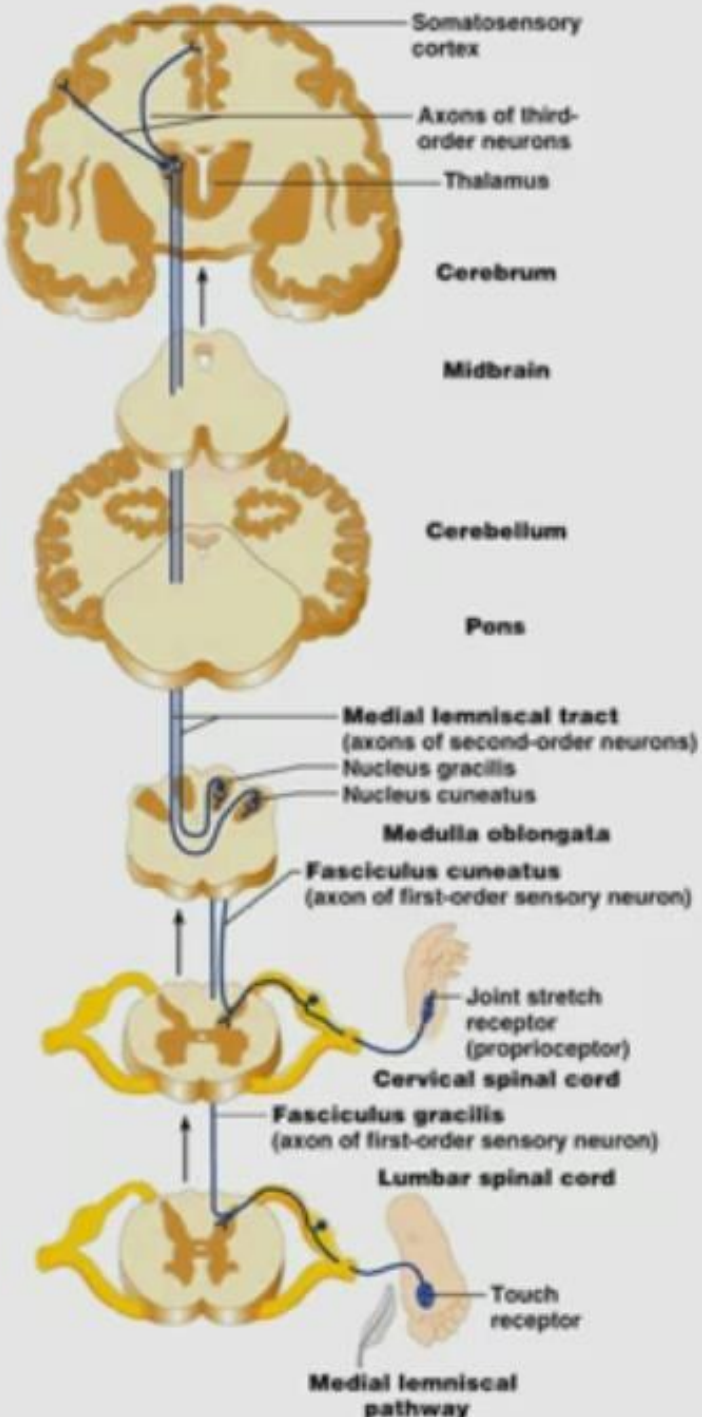
It is located in the funiculus posterior. On the outside is the fasciculus cuneatus and on the inside is the fasciculus gracilis.

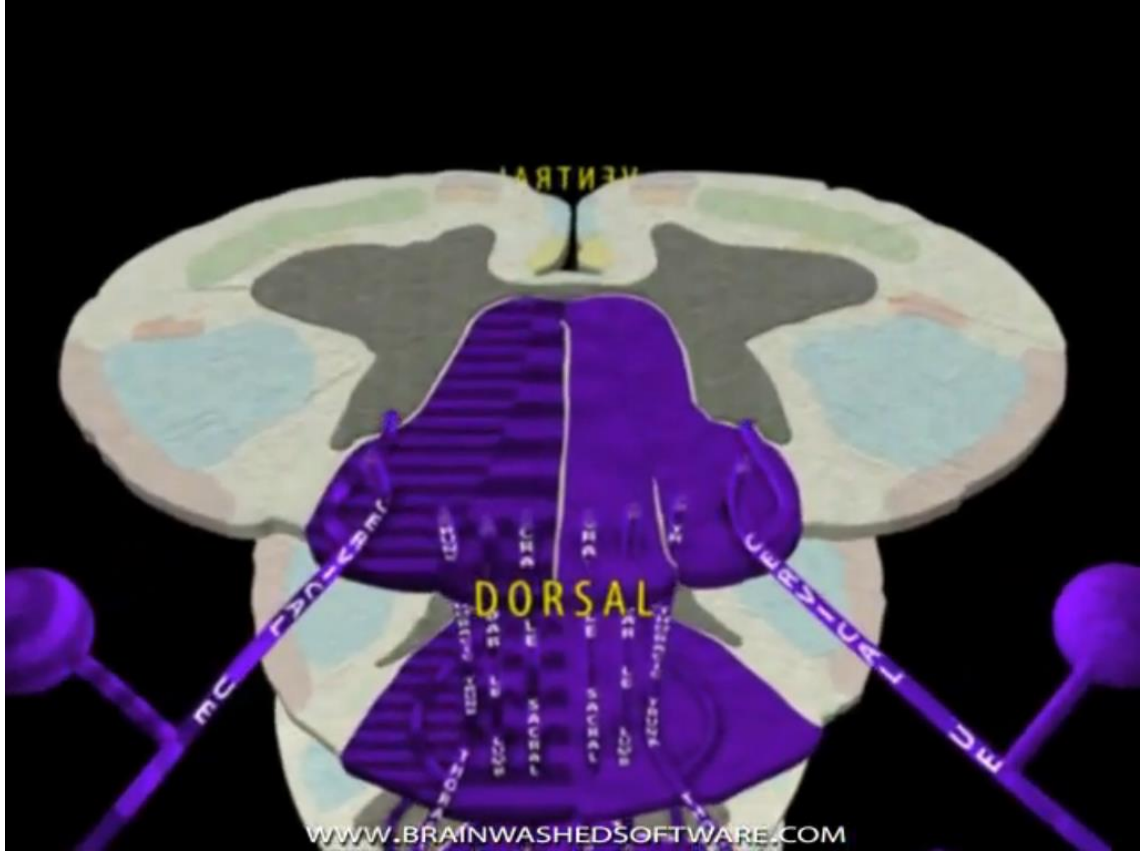
Fasciculus gracilis It is found throughout the spinal cord of the medulla. It consists of spinal nerve fibers coming below the 6th thoracic segment. this pathway carries the proprioceptive sense of our position, the vibration sense and the tactile discrimination sense coming from the muscles, tendons, ligaments and joint capsules of the lower extremity. These senses are conscious.

Fasciculus cuneatus It consists of spinal nerve fibers coming from above the 6th thoracic segment.

Tr. spinobulbaris



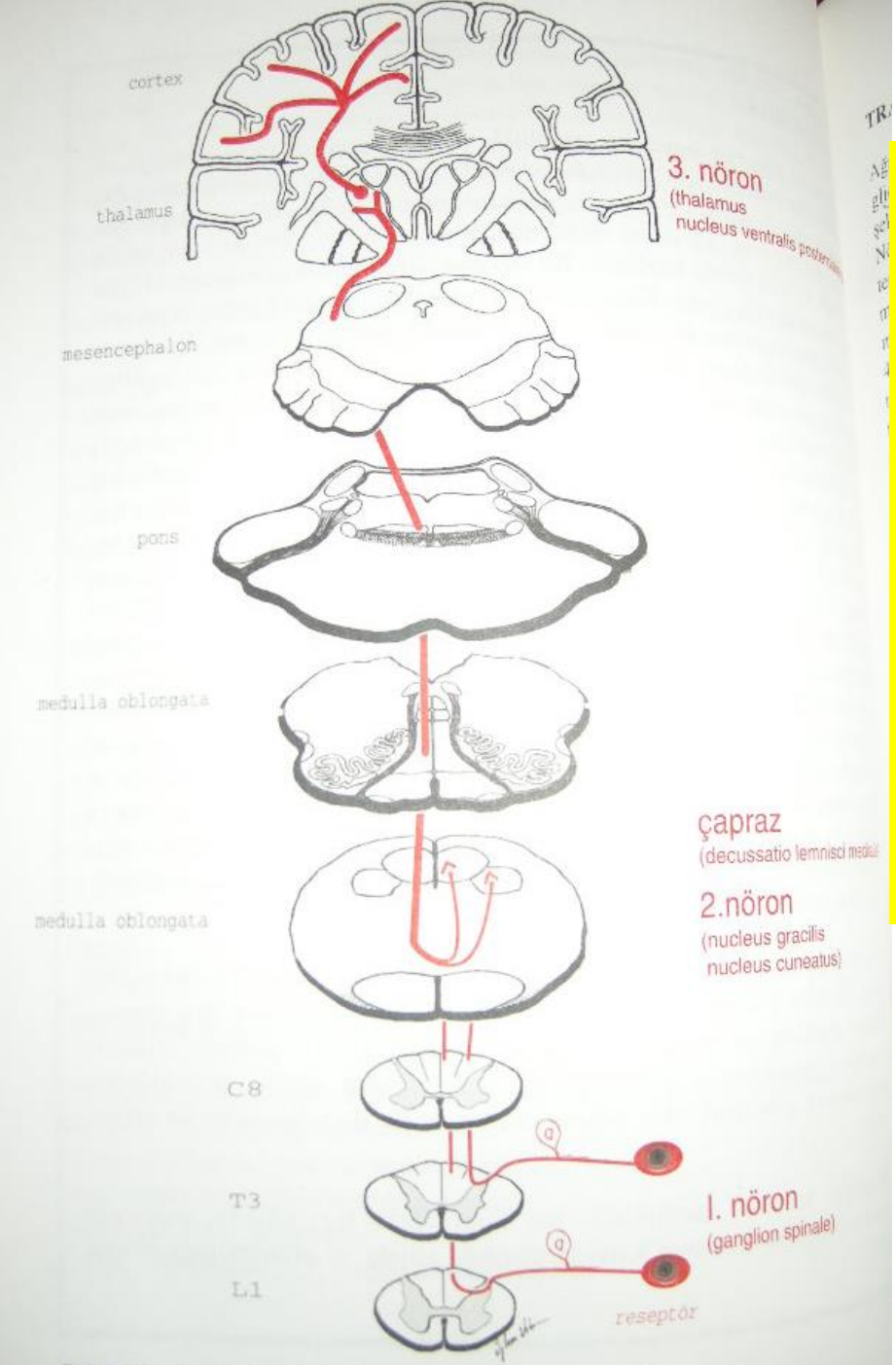




- The first neuron of this pathway is the ganglion spinale. The central extension of the I. neuron entering the dorsal root divides into descending and ascending branches without entering the gray matter. The descending short branches are related to the intersegmental reflexes. Its descending fibers form pathways called fasciculus interfascicularis and fasciculus septomarginalis.

- The ascending branches go up to the bulbus in the funiculus posterior. It synapses with the second neuron in the nucleus gracilis and nucleus cuneatus here. The axons of the second neuron cross with the same fibers of the opposite side under the name of fibrae arcuatae interna. This cross is called the decussatio lemnisci medialis. The part of the axons of the second neuron after the diagonal forms the lemniscus medialis and synapses with the third neuron in the nucleus ventralis posterolateralis in the thalamus. The extensions of the 3rd neuron go to the sensory area 3,1,2 in the cortex.

- Tractus spinothalamicus also joins Lemniscus medialis in the upper part of the pons. When entering the pons from the bulbus, the fibers rotate around their own axis, and unlike the posterior cord, the fibers of the lower side are on the outside and the fibers of the upper side are on the inside.



Şekil 41. Fasciculus gracilis ve fasciculus cuneatus

Senses: *conscious proprioceptive sense, discriminative sense, vibration sense with two-point discrimination.*

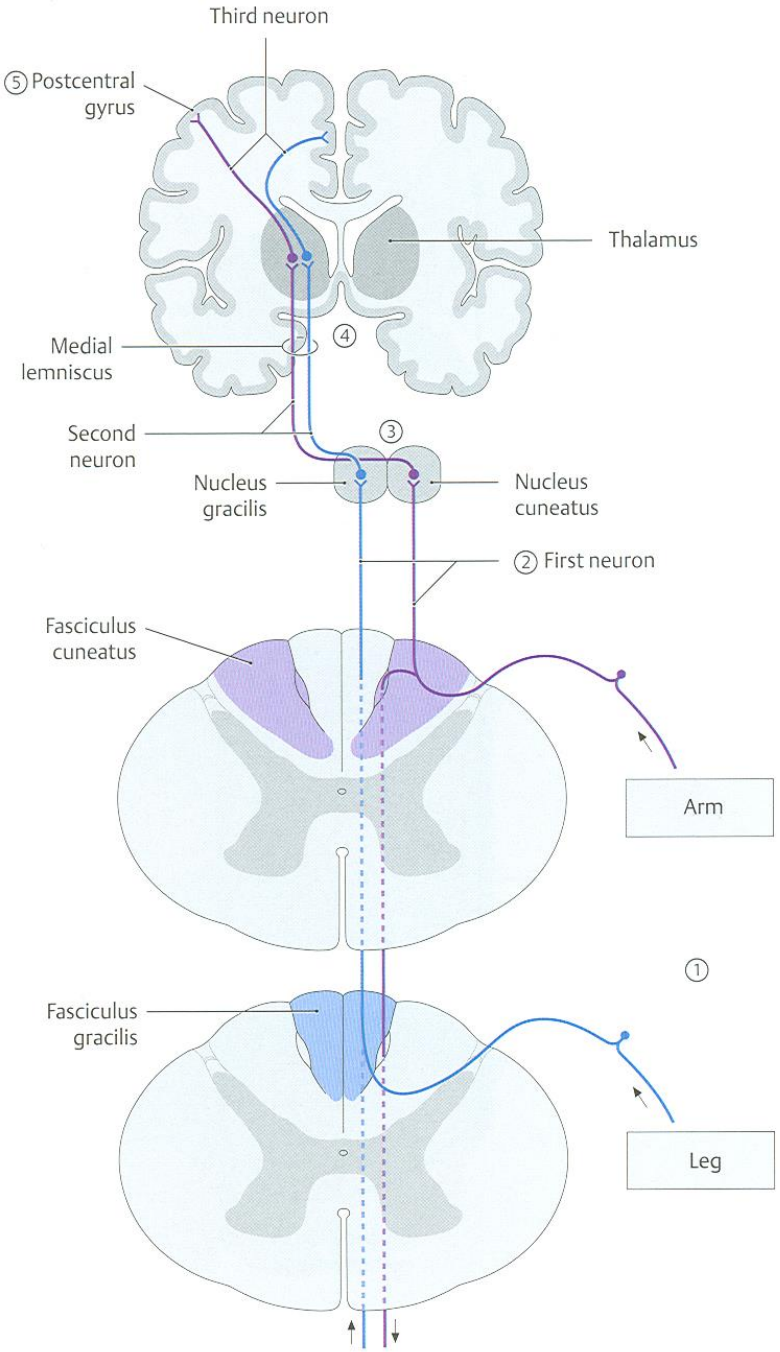
I. Neuron: ganglion spinale

II. Neuron : nuc. gracilis and cuneatus (bulbus)

Decussatio: decussatio lemnisci medialis

III. Neuron : nuc. ventralis posterolateralis (thalamus)

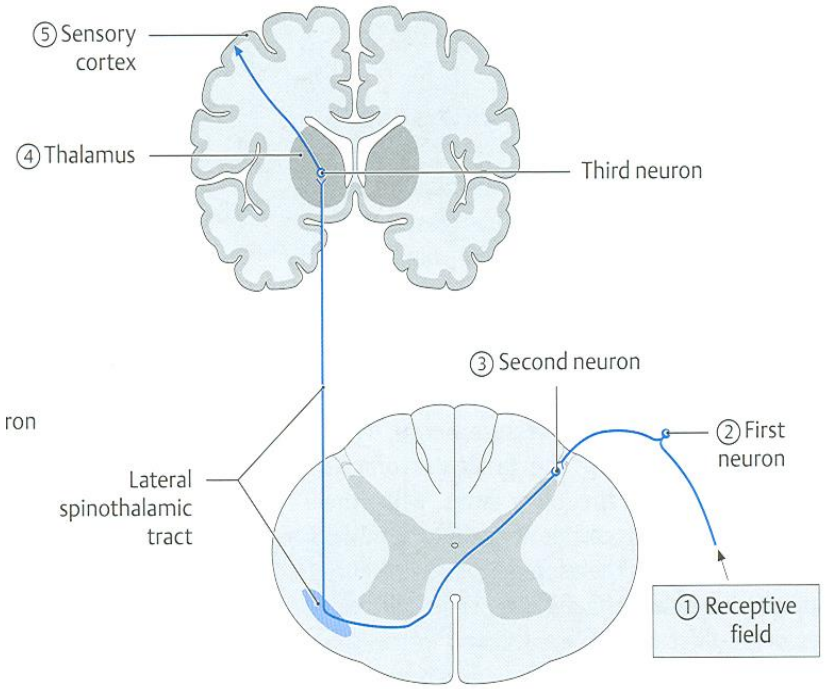
Cortex: 3rd, 1st and 2nd fields (gyrus postcentralis)


Third neuron
5 Postcentral gyrus
Thalamus
4
Medial lemniscus
Second neuron
3
Nucleus gracilis
Nucleus cuneatus
2 First neuron
Fasciculus cuneatus
Arm
1
Fasciculus gracilis
Leg

Tractus spinothalamicus lateralis

- It is a pathway that transmits ***pain and temperature*** sensations. The cell body of the ***1st neuron*** of this pathway is found in ***ggl.spinale***.
- The 1st neuron, which enters the spinal cord ***with the posterior root***, divides into its descending and ascending branches, and enters the cornu posterius from its posterior end, after a few segments extend.
- Here it divides into many branches and most of these branches II. lamina, and some ends in I., IV. and V. laminae.
- The axons of the ***2nd neuron*** starting from here pass from the anterior commissura alba anterior to the opposite side and ascend in the funiculus lateralis and ***terminate in the nuc. ventralis posterolateralis*** of the thalamus.

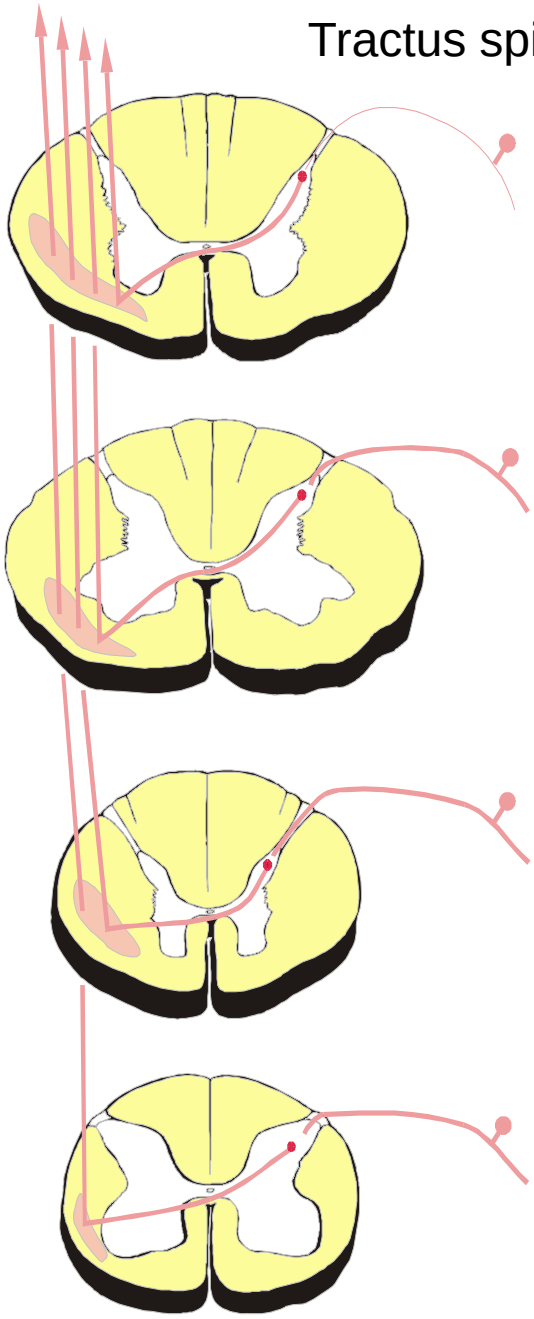
- Fibers that carry the sensations related to ***burn pain*** also connect with the formatio reticularis in the bulb.
- Because of this connection, burn pain is transmitted to the entire nervous system. Thus, we feel the pain in a wider area.
- If the tractus spinothalamicus lateralis is cut unilaterally, pain and temperature sensations below a lower segment of the incision site and on the opposite side are lost, whereas when the tractus spinothalamicus anterior is cut in the same way, the sense of touch carried by this tract is not completely lost, since it is also carried in the posterior cord.

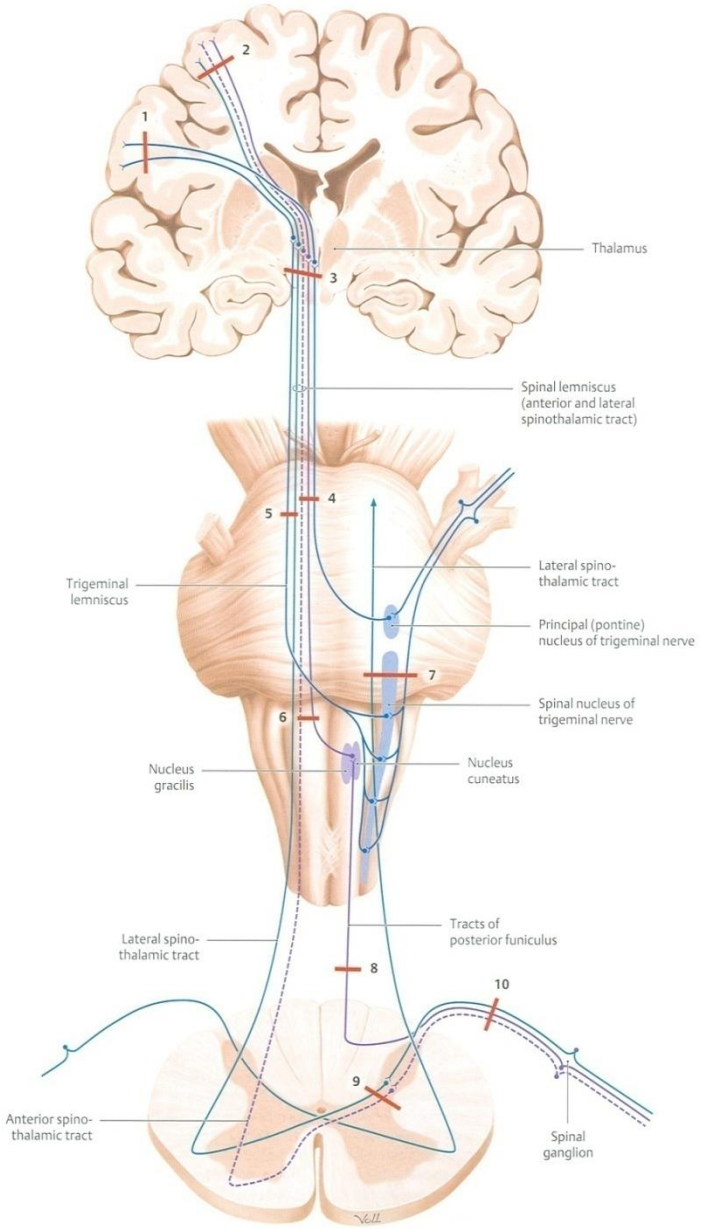


Tractus spinothalamicus lateralis

- ***The senses it carries:*** pain, heat
- ***1st neuron:*** Ganglion spinale
- ***2nd neuron:***Laminae II, IV and V
- ***Decussatio.*** Commissura alba anterior
- ***3rd neuron:***VPL (thalamus)
- ***Cortex.*** Brodmann 3,1,2 (gyrus postcentralis)

Tractus spinothalamicus lateralis





Tr. spinothalamicus anterior:

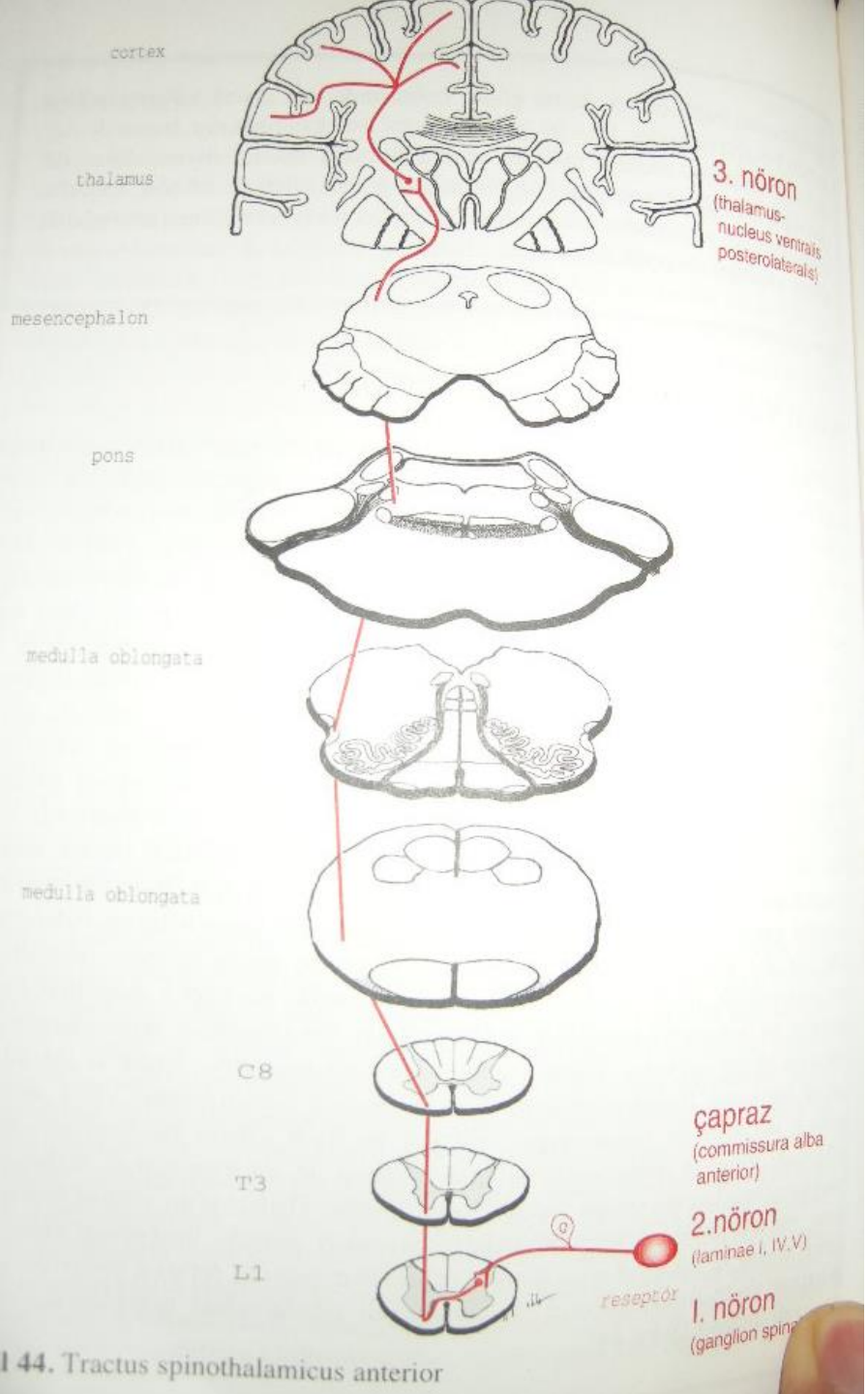
It is a pathway that transmits the sense of ***pressure and contact***. It is located just on the sides of the fissura mediana anterior, close to the anterior surface, partially intertwined with the tractus vestibulospinalis.

The cell body of the 1st neuron is located in the ***ganglion spinale***, and its central extensions enter the spinal cord from the sulcus posterolateralis and terminate in cells in the 1st, 2nd and 5th laminae of the posterior horn.

The second neurons starting from these laminae pass through the commissura alba and grisea to the anterior funiculus of the opposite side. forms the spinothalamicus anterior.

- This pathway terminates in the **nuc. ventralis posterolateralis** of the thalamus.
- The **3rd neuron starting from this nucleus reaches the gyrus postcentralis via tractus thalamocorticalis** (3rd, 1st and 2nd fields).
- **The second neuron gives collaterals to the gray matter around the formatio reticularis** and aquaductus mesencephali in the bulbus and pons.

- The location, type, and severity of the pressure and contact sensation received in this way can only be roughly defined if the discriminative sensation transmitted in the funiculus posterior does not contribute.
- However, the discriminative sense of light contact is transmitted here.
- Therefore, although there is little loss of pressure and contact sensation in the lesion of tractus spinothalamicus anterior, the slight touch sensation disappears below the lesion site and on the opposite side.



l 44. Tractus spinothalamicus anterior

Tractus spinothalamicus anterior

The senses it carries. light touch

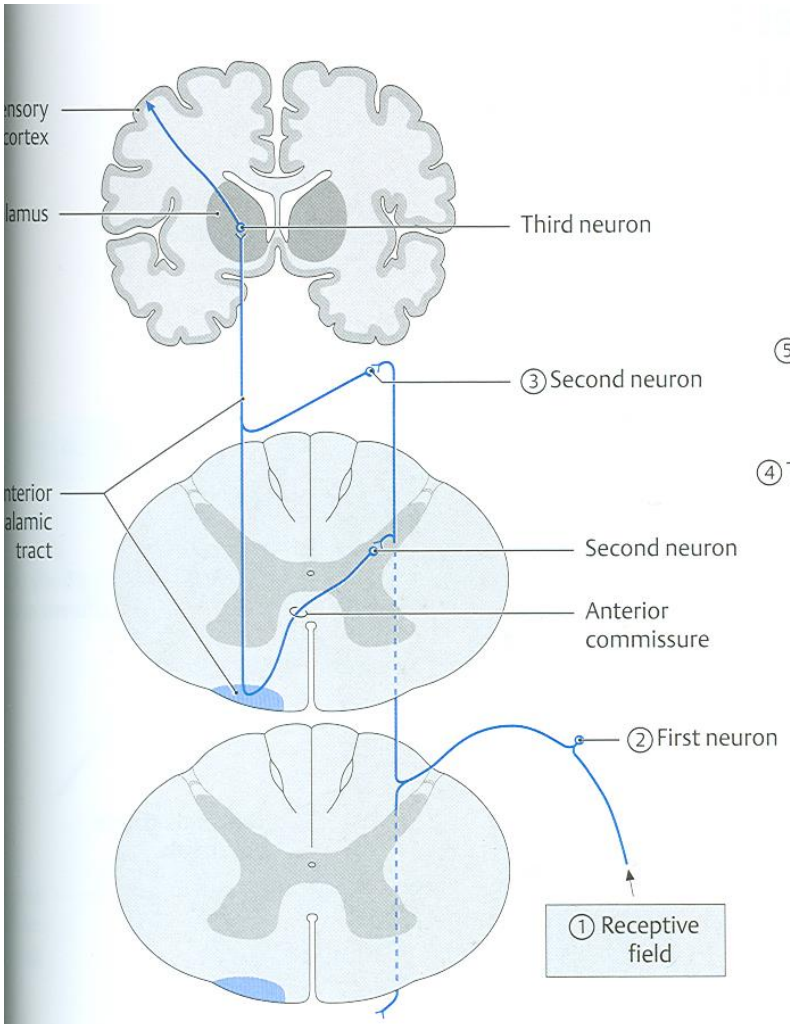
1st neuron: Ganglion spinale

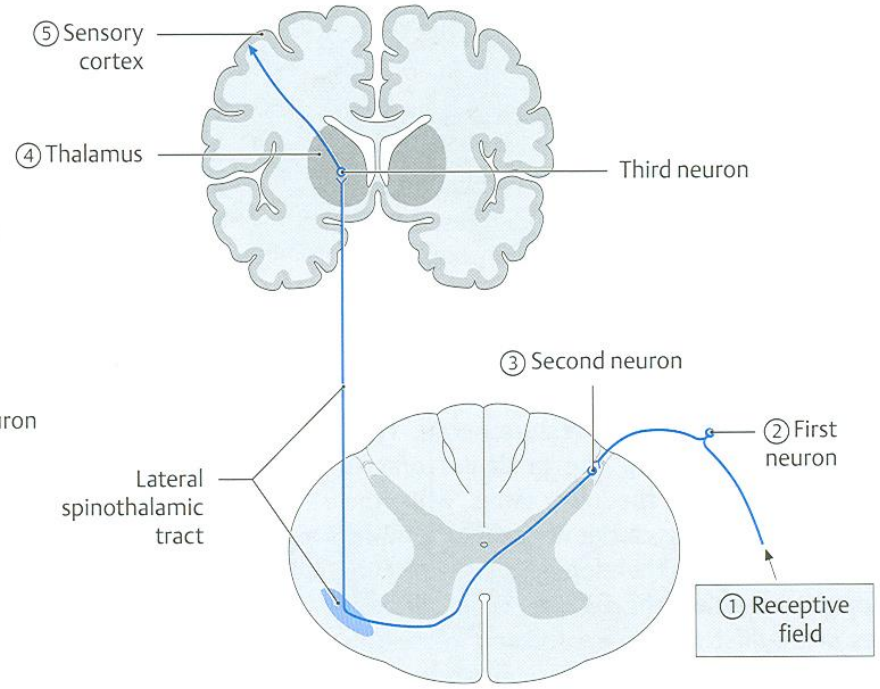
2nd neuron:Laminae II, IV and V

Decussatio. Commissura alba anterior

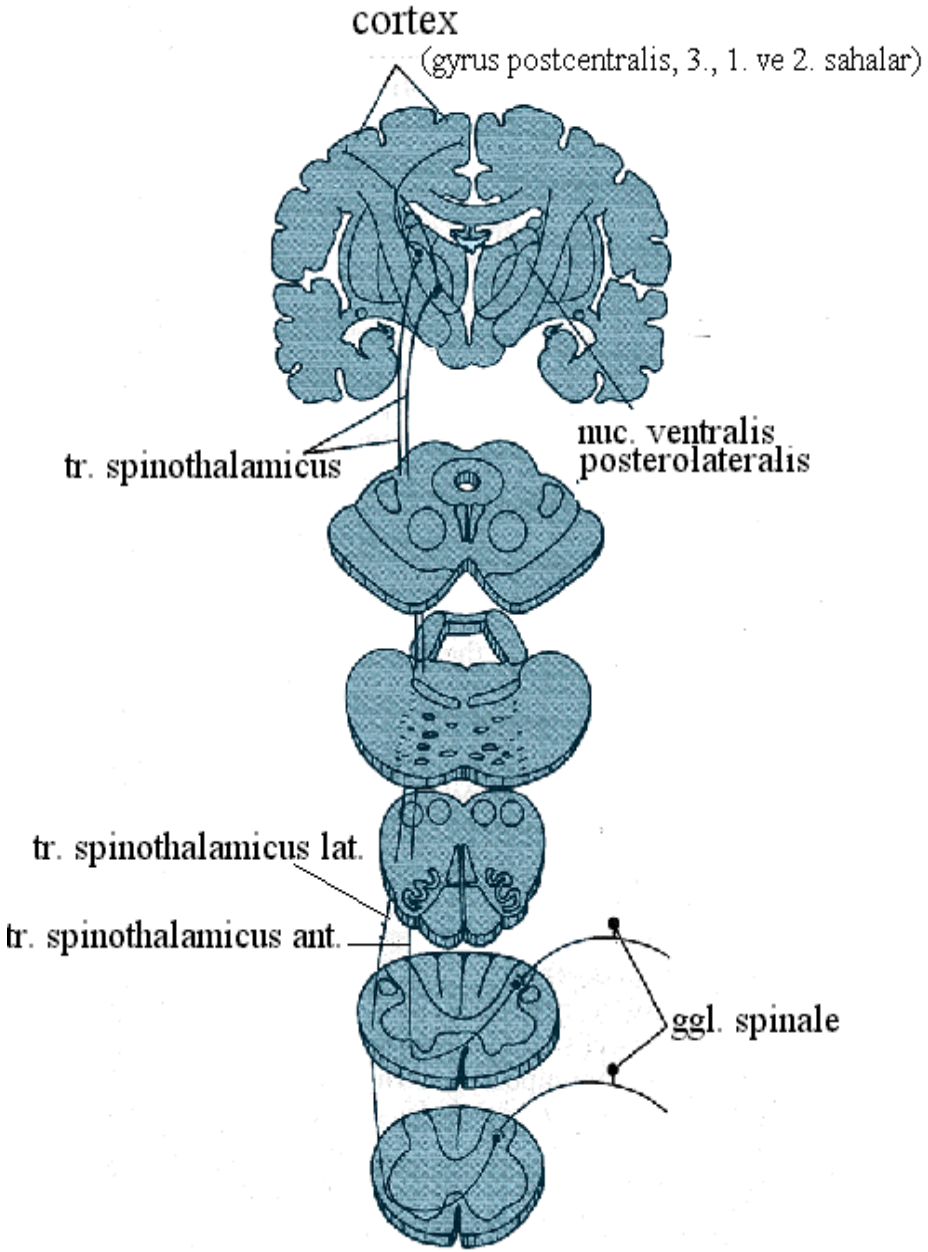
3rd neuron:VPL (thalamus)

Cortex. Brodmann 3,1,2 (gyrus postcentralis)


nsory
cortex
lamus
Third neuron
③ Second neuron
nterior
lamic
tract
Second neuron
Anterior
commissure
② First neuron
① Receptive
field


⑤ Sensory
cortex
④ Thalamus
Third neuron
③ Second neuron
② First
neuron
Lateral
spinothalamic
tract
① Receptive
field

Tr. spinothalamicus



The senses it carries :

Tr. spinothalamicus ant: pressure and contact

Tr .spinothalamicus lat: pain and heat

1st neuron : ganglion spinale

2nd neuron:

Tr. spinothalamicus ant: lamina I, II and IV

Tr .spinothalamicus lat: lamina II, I, IV and V

Decussatio:
Tr. spinothalamicus ant: commissura alba ve grisea
Tr .spinothalamicus lat: commissura alba ant.

3rd neuron: nuc. ventralis posterolateralis (thalamus)

Cortex: 3rd, 1st and 2nd areas (gyrus postcentralis)

Tr. spinocerebellaris posterior (Flechsig):

It carries unconscious proprioceptive impulses from lower extremity muscles, tendons and joints to the cerebellum. The cerebellum evaluates these sensations from muscles, tendons and joints together with sensations from other sources. Thus, it plays an important role in maintaining the position of the body by regulating the coordinated contraction and tone of the muscles.

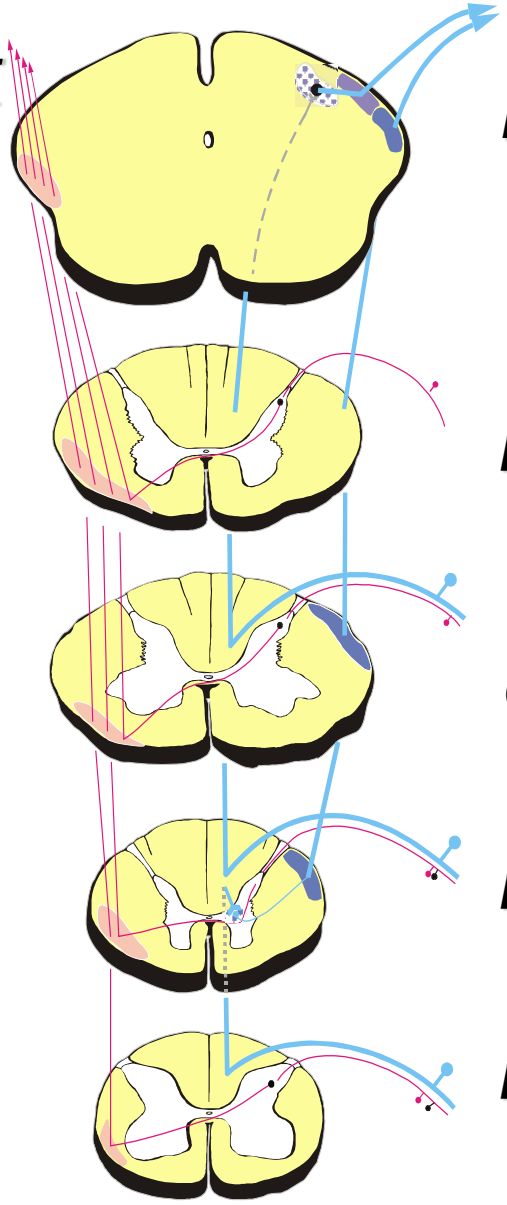
The **first neuron body of this pathway is located in the ggl.spinale** and enters the spinal cord via the posterior root and synapses in the **nuc. thoracicus**. The **axon of the second neuron**, starting from this nucleus, ascends in the **posterior outer part of the funiculus lateralis of the same side** and comes to the bulb. From here, it terminates in the cortex of the **cerebellar vermis via the pedunculus cerebellaris inferior**. The sensations carried by the **tr. spinocerebellaris posterior** are received by muscle spindles, Golgi tendon organs, and contact and pressure (especially from the sole) receptors. These sensory impulses do not go to the cortex, so they are not perceived.

Since the **nucleus thoracicus** is located in the C8-L2(3) medulla spinalis segments, we can only see the **tr. spinocerebellaris posterior** from the level of the 2nd (3rd) lumbar segment. The central extensions of the 1st neuron below the 3rd lumbar segment first ascend in the **fasciculus gracilis,** L3. When it reaches the segment level, it enters the gray matter from the posterior horn and synapses in the nucleus thoracicus. The central extensions of the 1st neuron from the segments above the C8 level, on the other hand, rise in the **fasciculus cuneatus** and synapse in the **nuc. cuneatus accessorius** in the medulla oblongata. Extensions of neurons here form another pathway called **tractus cuneocerebellaris.**

- **Tractus spinocerebellaris posterior**
- ***The senses it carries:*** Subconscious proprioception
- ***Nöron I.*** Ganglion spinale
- ***Nöron II.*** Nucleus thoracicus posterior (Clarke's nucleus)
- ***Decussatio.*** Nope
- ***3rd neuron*** Vermis cerebelli

Spinocerebellar Tract

Anterior SCbllT	Posterior SCbllT
(superior cerebellar peduncle)	Inferior cerebellar peduncle
anterior spinocerebellar tract	cuneocerebellar tract (upper body)
anterior white commissure	posterior white column
posterior root	posterior root



Inferior cerebellar peduncle

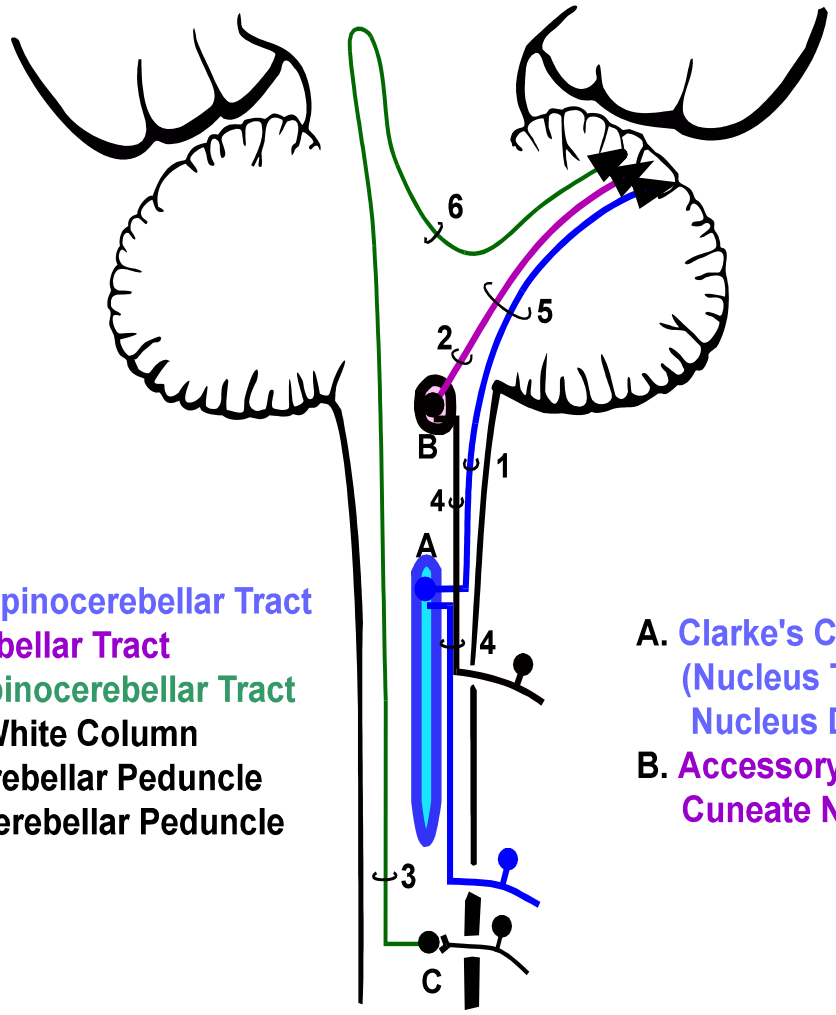
posterior spinocerebellar tract

Clarke's column

posterior white column

posterior root

Spinocerebellar Tract



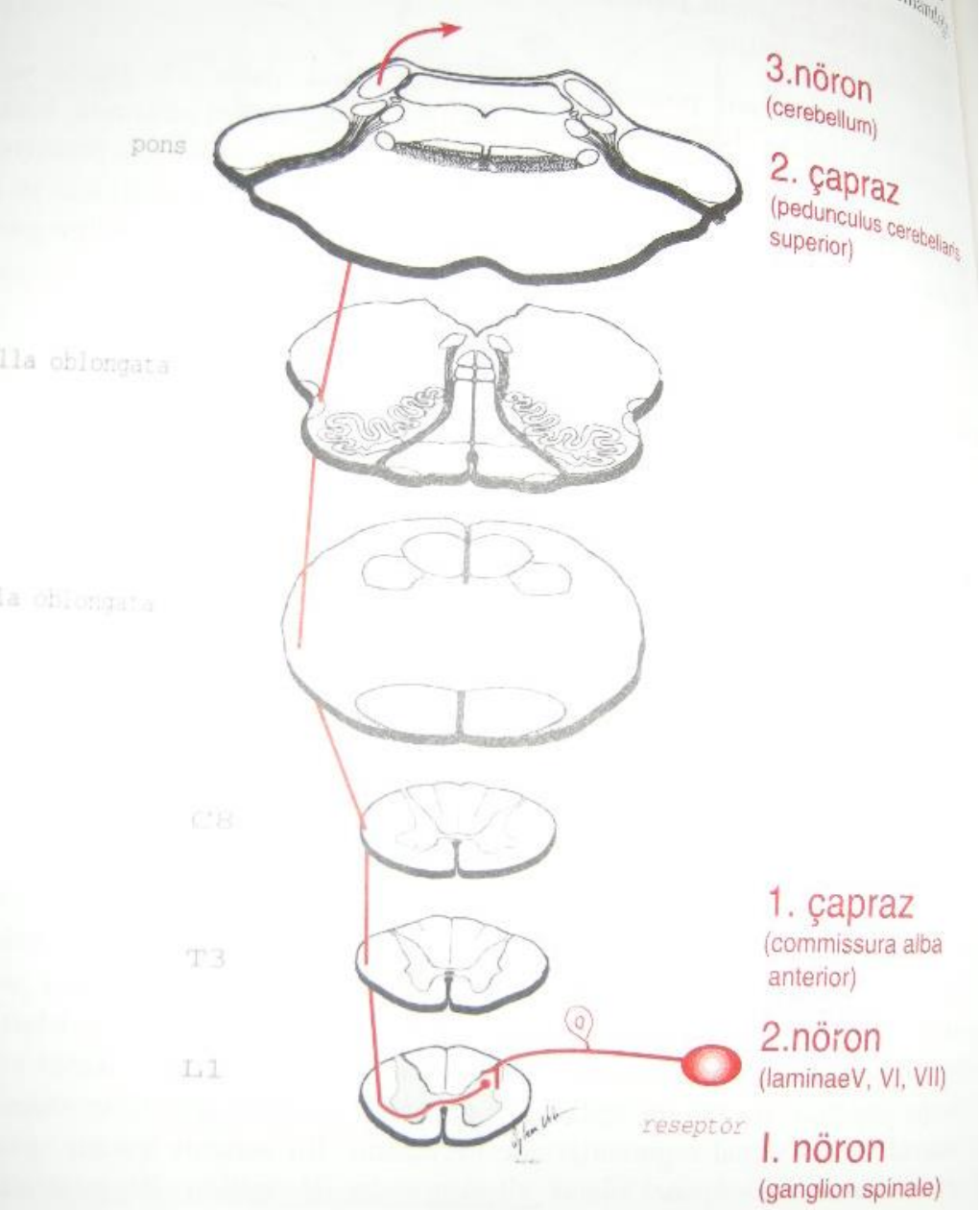
1. Posterior Spinocerebellar Tract
2. Cuneocerebellar Tract
3. Anterior Spinocerebellar Tract
4. Posterior White Column
5. Inferior Cerebellar Peduncle
6. Superior Cerebellar Peduncle

A. Clarke's Column (Nucleus Thoracis, Nucleus Dorsalis)
B. Accessory (Lateral) Cuneate Nucleus

Tr. spinocerebellaris anterior (Gowers):

This pathway, which is seen starting from the **2nd (3rd) lumbar spinalis segment** in the medulla spinalis, carries proprioceptive impulses coming from the muscles and joints of the lower extremity to the medulla spinalis to the cerebellum. This sense is also called the unconscious proprioceptive sense because it does not go to the cortex and is not perceived. This pathway informs the cerebellum about the state and position of the body part from which the sensation originates. It also brings pressure and contact sensations from the skin and superficial fascia.

- The cell body of the **1st neuron**, which brings sensation from muscles, tendons and joints, is located in the **ganglion spinale**. The 1st neuron, which **enters the spinal cord with the dorsal root**, synapses in the nucleus thoracicus in the dorsal horn.
- Starting from the **nucleus thoracicus**, most of the 2nd neuron passes from the **comissura alba anterior** to the **opposite side, and a small part** of it runs upward, forming the tractus spinocerebellaris anterior of the same side.
- This path, which passes through the bulbus, pons and mesencephalon without interruption, passes through the **pedunculus cerebellaris superior** and ends in the **cerebellar cortex**.
- The fibers that **cross in the spinal cord** pass back to the opposite side in the cerebellum. Therefore, tractus spinocerebellaris anterior transmits the sensation it receives from one side to the cerebellum half of the same side.



6. Tractus spinocerebellaris anterior

Tractus spinocerebellaris anterior

The senses it carries:

Şuuraltı proprioception

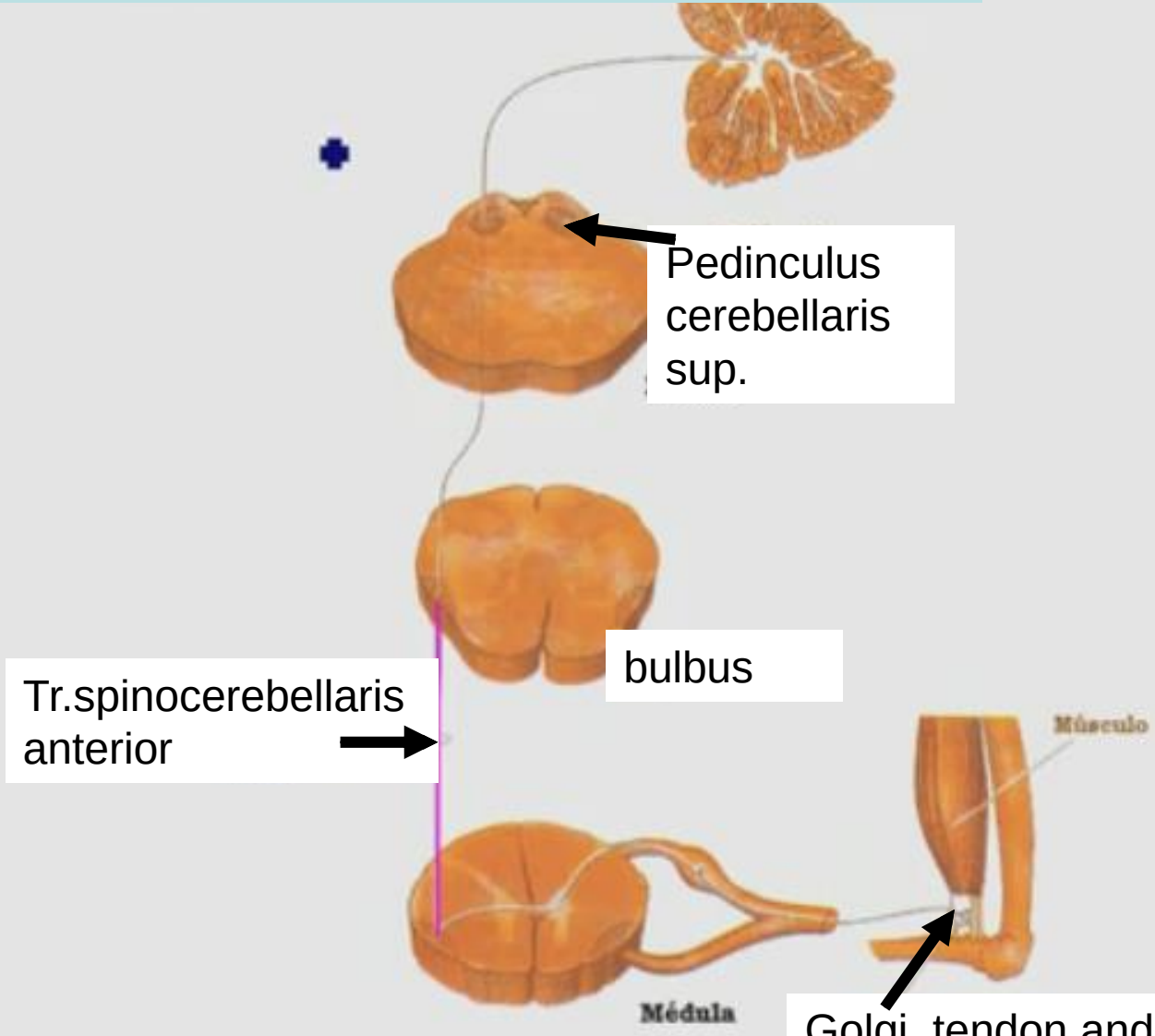
1st neuron:Ganglion spinale

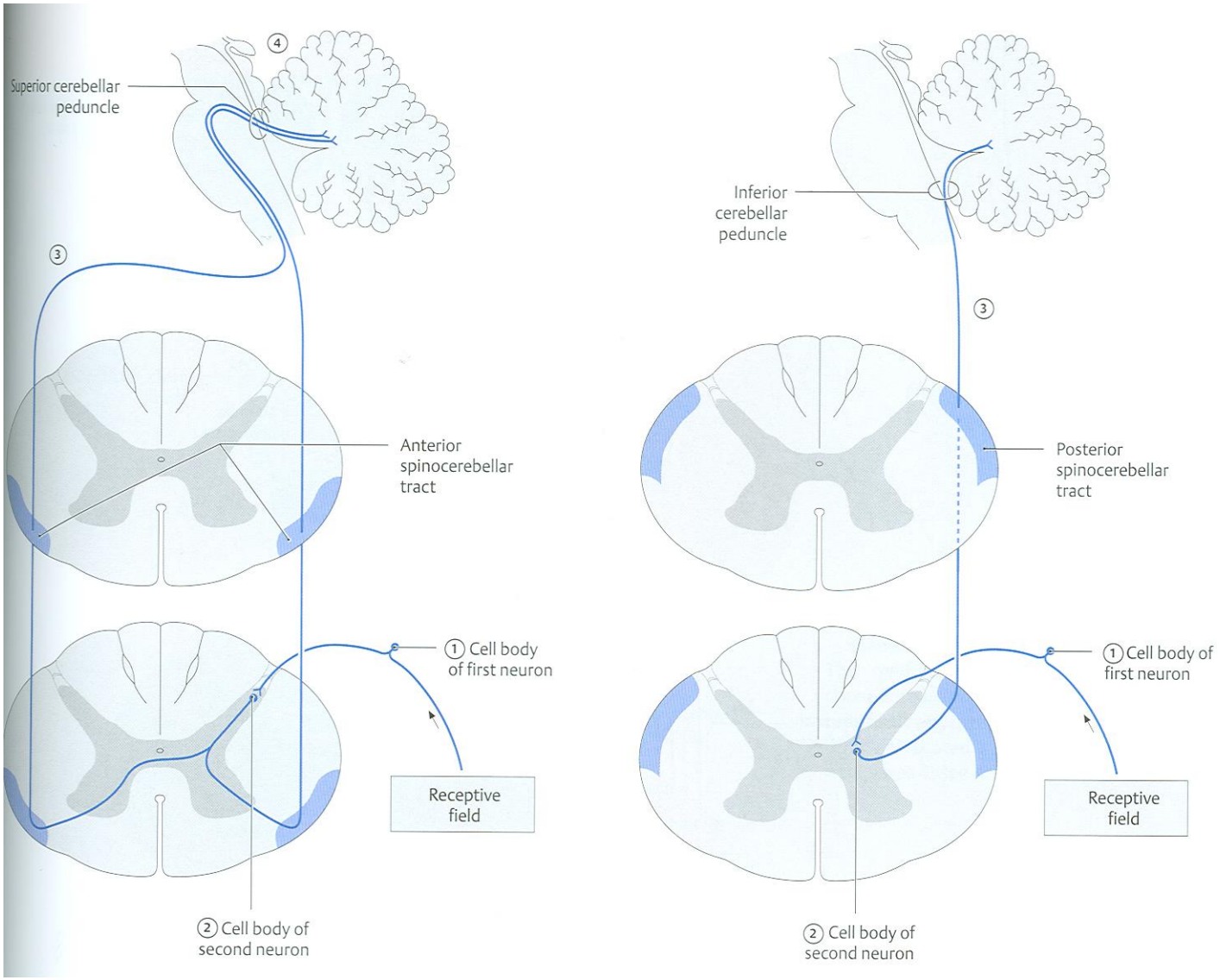
2nd neuron:Clarke's nucleus

Decussatio. Commissura alba anterior

3rd neuron: Vermis cerebelli

Tr.spinocerebellaris anterior




4
Superior cerebellar peduncle
3
Anterior spinocerebellar tract
1 Cell body of first neuron
Receptive field
2 Cell body of second neuron
Inferior cerebellar peduncle
3
Posterior spinocerebellar tract
1 Cell body of first neuron
Receptive field
2 Cell body of second neuron

Tr. spinocerebellaris

Tr. spinocerebellaris ant.

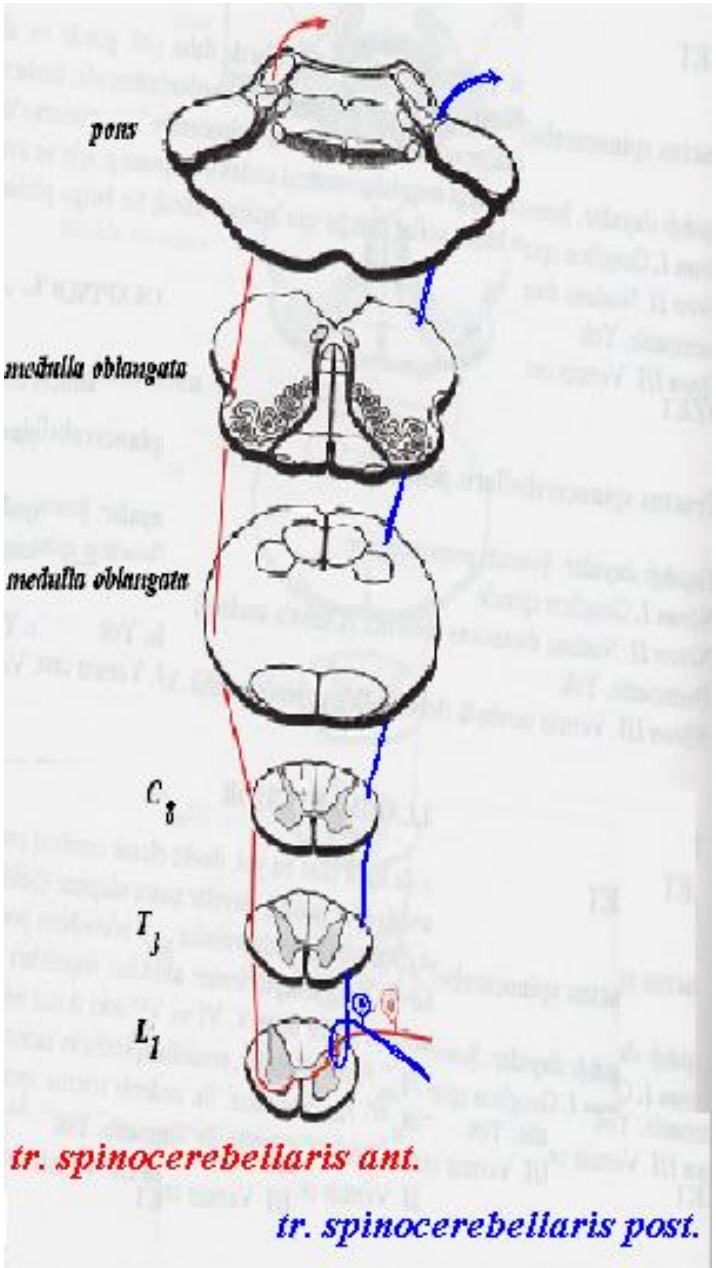
The senses it carries: unconscious proprioceptive of lower extremity

1st neuron:ggl. spinale

2nd neuron: lamina V, VI and VII (nuc. thoracicus)

Decussatio: commissura alba ant.

-pass through to ***pedinculus cerebellaris superior***
Cortex: vermis cerebelli



Tr. spinocerebellaris posterior

The senses it carries : unconscious proprioceptive of lower extremity

1st neuron: ggli spinale

2nd neuron : lamina V, VI and VII (nuc. thoracicus)

Decussatio: nope

- *pass through to* ***pedinculus cerebellaris inferior***
- ***Cortex:*** vermis cerebelli

Tractus cuneocerebellaris

- It is related to the subconscious proprioception sense coming from the upper extremity.
- It is functionally similar to **tractus spinocerebellaris posterior.**
- The first neurons of this pathway are located in the **ganglion spinale**.
- Their central extensions join the **fasciculus cuneatus** on the same side and go to the **Nucleus cuneatus accessorius in the bulb.**

Tractus cuneocerebellaris

- The nucleus cuneatus accessorius, where the second neurons of the tractus cuneocerebellaris are located, is the equivalent of the nucleus thoracicus posterior (Clarke's nucleus) located between the C8-L3 segments of the spinal cord.
- The axons of the second neurons are named fibrae arcuatae externae posteriores and pass through the ipsilateral pedunculus cerebellaris inferior and terminate in the cerebellar cortex.

Tractus cuneocerebellaris

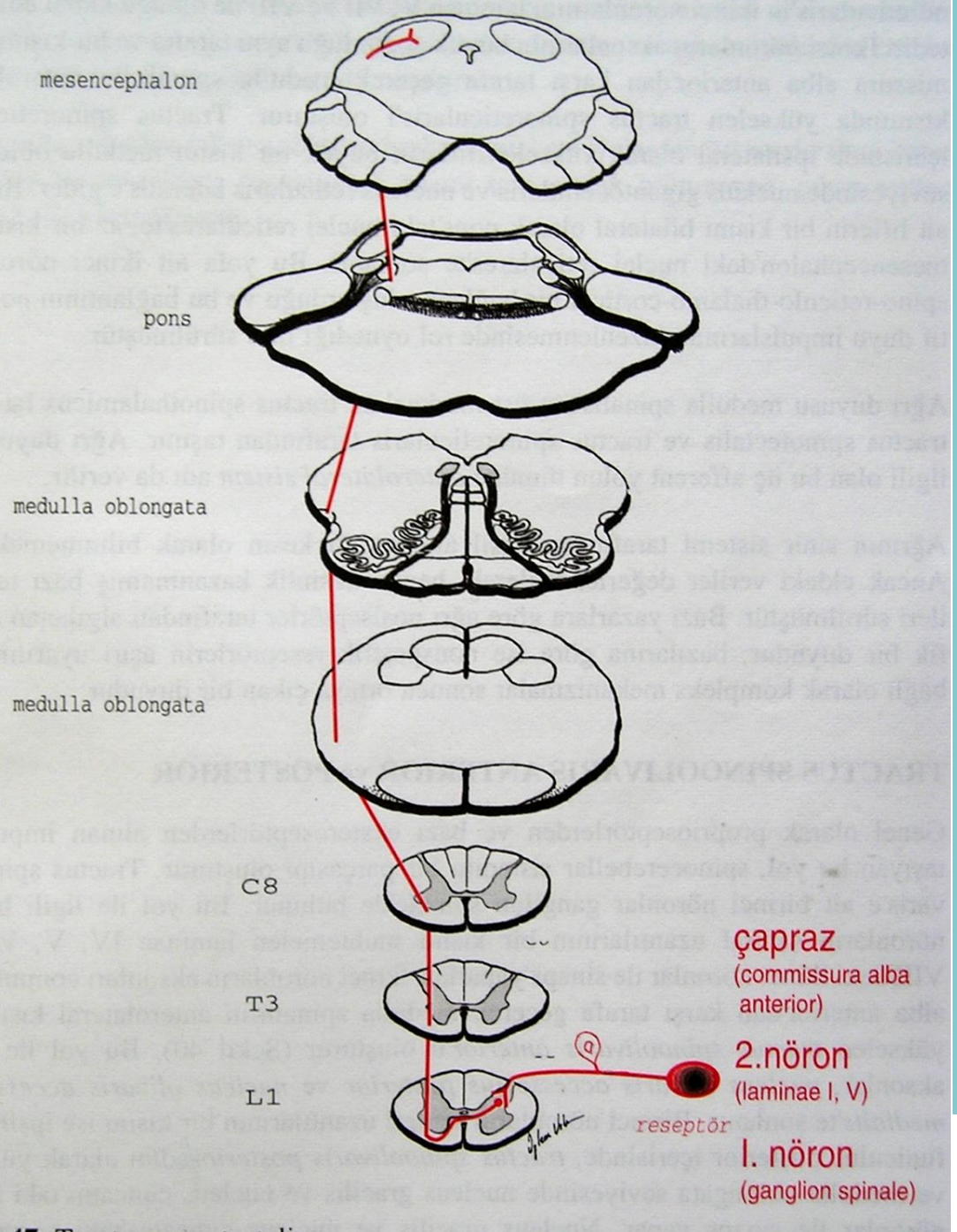
- **SUMMARY**
- **Tractus cuneocerebellaris**
- ***The senses it carries:*** subconscious proprioception
- ***1st neuron:*** Ganglion spinale
- ***2nd neuron:***Nucleus cuneatus accessorius
- ***Decussatio.*** nope
- ***3rd neuron:*** Cerebellar cortex (lobulus V)

Tractus spinotectalis

This pathway carries **nociceptive impulses** caused by **excessive heat-cold** and mechanical stimuli that cause tissue damage.

The **1st neurons** related to this pathway are found in the ganglion spinal cord. The central extensions of the 1st neuron transmit the impulses they receive to the second neuron in the **substantia grisea**. The 2nd neurons of this pathway are thought to be located in lamina I and V, although it is not certain. The axons of the second neurons cross the **commissura alba anterior** and ascend upward. It crosses the bulbus and pons and terminates in the **colliculus superior** in the mesencephalon.

Tractus spinotectalis is related to the **spinovisual reflex**, and it transmits the sensation it receives from the **periphery** to the **colliculus superior**, allowing the eye, head and neck to reflexively turn towards the factor that stimulates the tractus spinotectalis. For example; like when we reflexively look at an object sinking on our back and move away from it.



47. Tractus spinotectalis

The senses it carries: excessive hot-cold and pain

1st neuron: ganglion spinale

2nd neuron: lamina I and V

Decussatio: commissura alba ant.

3rd neuron: colliculus sup. (mesencephalon)

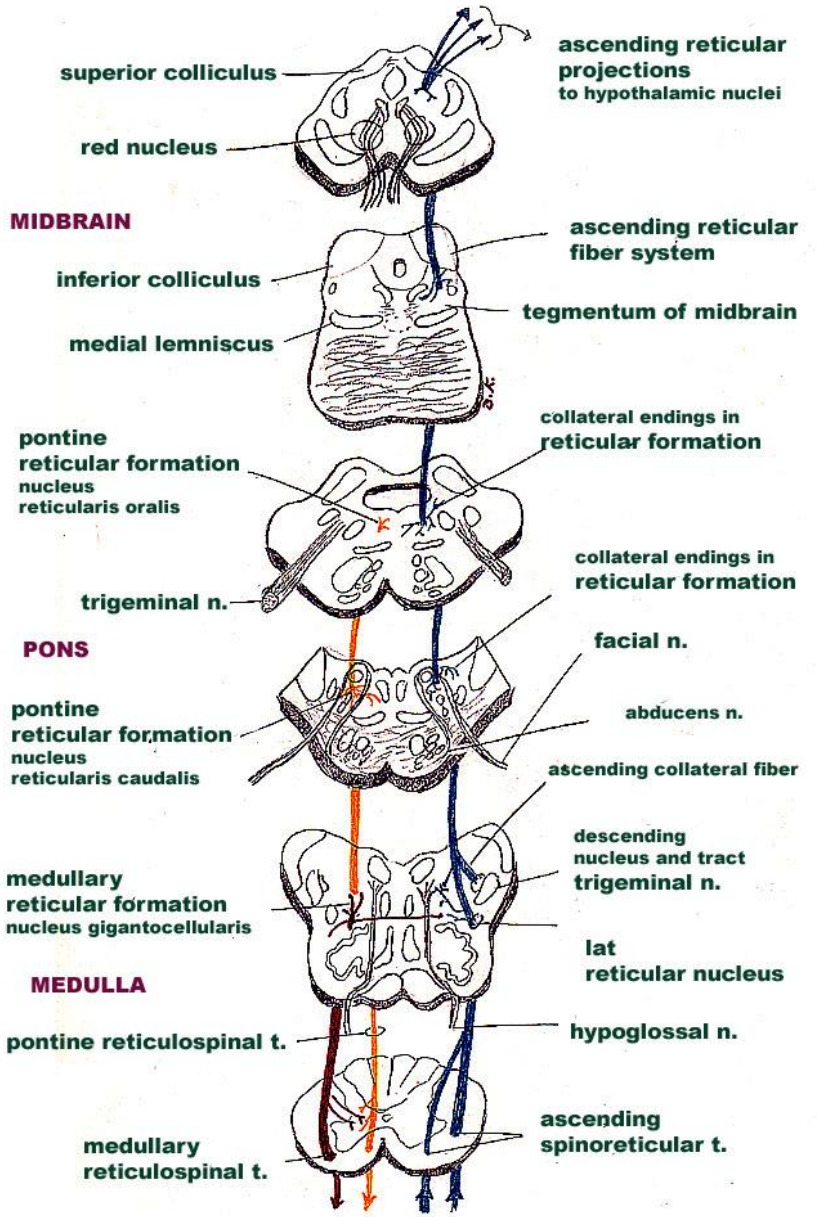
Cortex: 3., 1. and 2. areas (gyrus postcentralis)

Tr. spinoreticularis:

It progresses as **mixed with the fibers of the tractus spinothalamicus lateralis** and carries the sensation of pain.
The **1st neuron** of this pathway enters from the posterior root and synapses in the posterior horn (lamina V-VIII). **Most of the 2nd neurons starting from here and forming the tractus spinoreticularis** terminate bilaterally in the formatio reticularis in the bulb (nuc. reticularis gigantocellularis) and the rest in the formatio reticularis in the pons without crossing. A few parts terminate in the formatio reticularis in the mesencephalon.

Neurons originating from these areas project to secondary sensory cortical areas after neuronal replacement in the **nuc. ventralis posterior and nuc.intralaminaris of the thalamus.** This pathway plays an important role in the degree of our consciousness in this regard, by carrying all kinds of external and visceral sensations, especially those related to pain.

Tr. spinoreticularis



The sense it carriers: ağrı

1st neuron: ganglion spinale

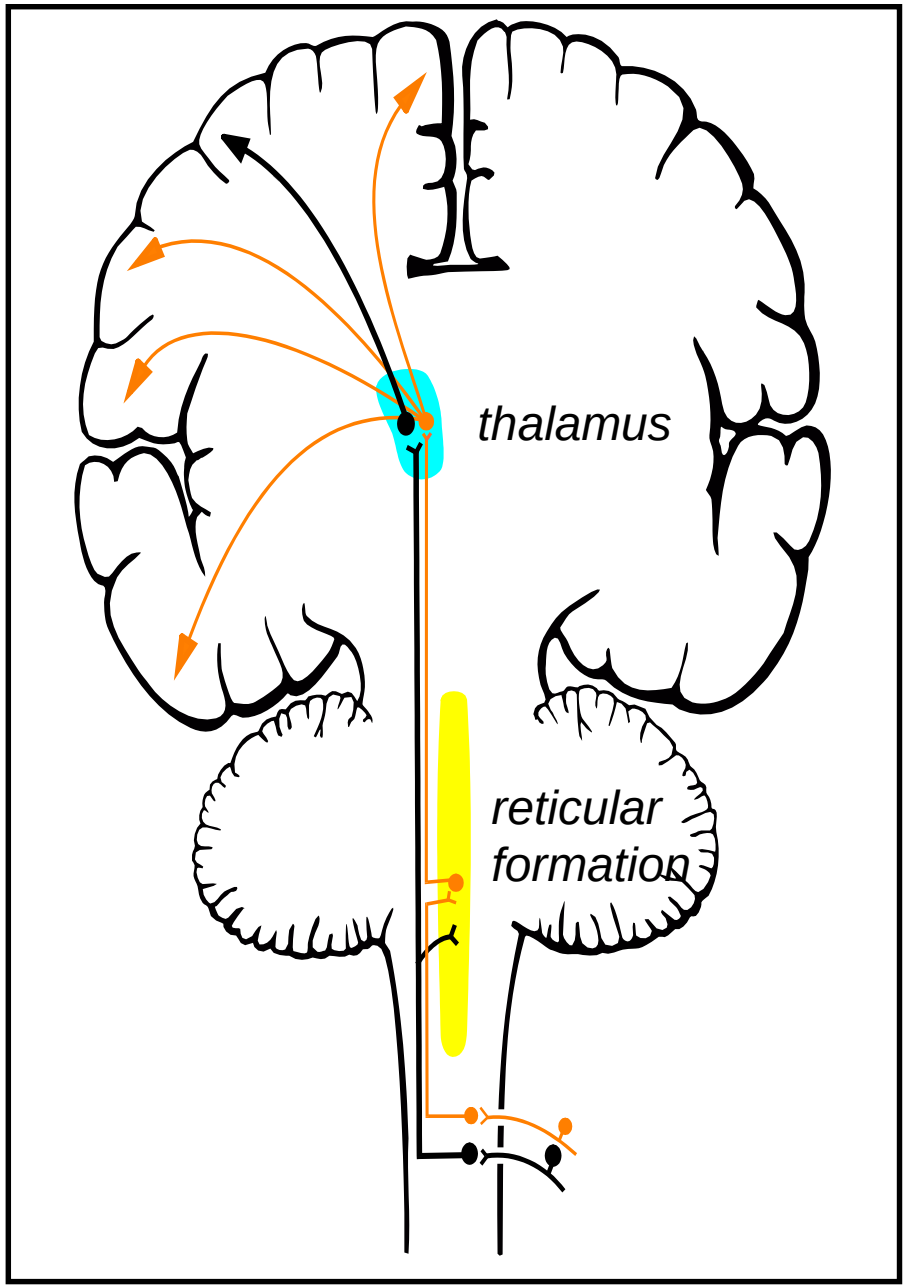
2nd neuron: lamina V-VIII

Decussatio: most fibers do not cross

3rd neuron: It terminates in the formatio reticularis in the bulbus, pons, and mesencephalon. It plays an important role on the degree of our consciousness in this regard, by carrying all kinds of external and visceral senses, especially related to pain.

Tractus spinoreticularis

This pathway is part of the reticular formation. (regulation of sensory and cortical activities in relation to the environment)



Tractus spinoolivaris ant. and post.

- **This pathway, which carries impulses from proprioceptors in general and some exteroceptors, forms part of the spinocerebellar system.**
- The first neurons of Tractus spinoolivaris are found in the ganglion spinale.
- Some of the central extensions of the first neurons involved in this pathway probably synapse with the second neurons in the laminae IV, V, VII, and VIII.
- The axons of the second neurons pass from the commissura alba anterior to the opposite side and form the **tr. spinoolivaris anterior**, which ascends in the anterolateral part of the spinal cord.
- Axons related to this pathway terminate in the **nucleus olivaris accessorius posterior and nucleus olivaris accessorius medialis.**

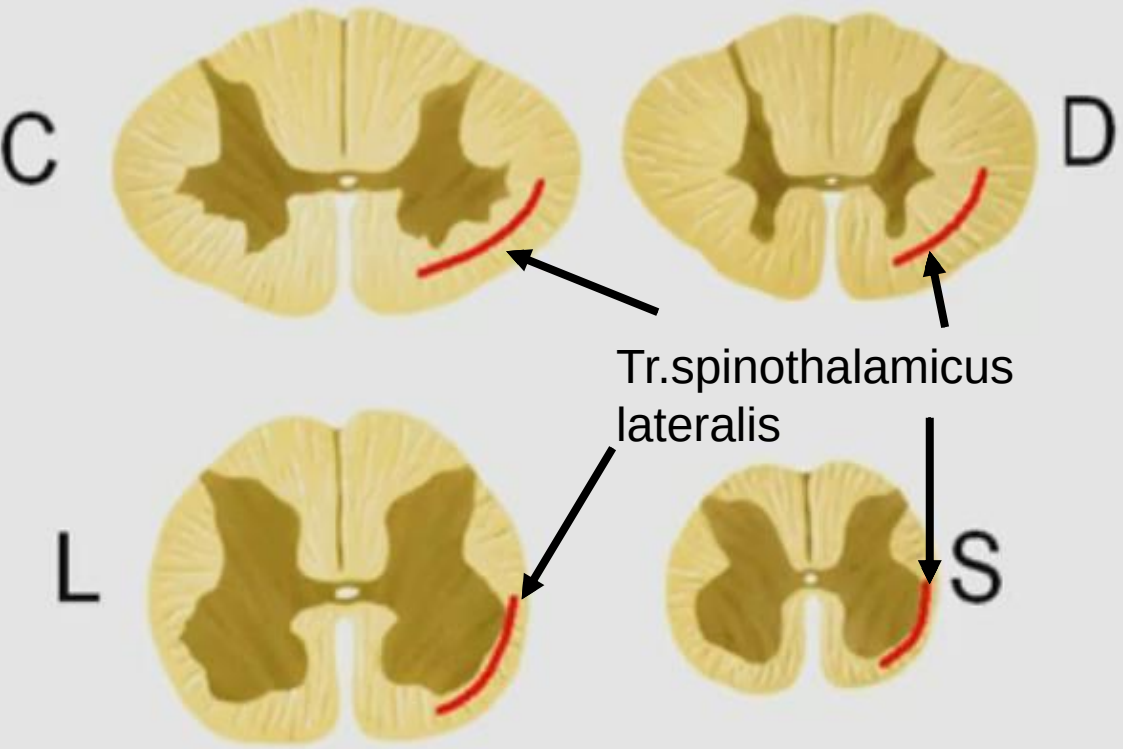
Tractus spinoolivaris ant. and post.

- Some of the central extensions of the first neurons rise in the ipsilateral funiculus posterior, taking the name **tractus spinoolivaris posterior**, and synapse with the second neurons in the nucleus gracilis and nucleus cuneatus at the level of the medulla oblongata.
- The axons of the neurons in the nucleus gracilis and nucleus cuneatus cross to the opposite side and terminate in the **nucleus olivaris accessorius posterior** and **nucleus olivaris accessorius medialis.**

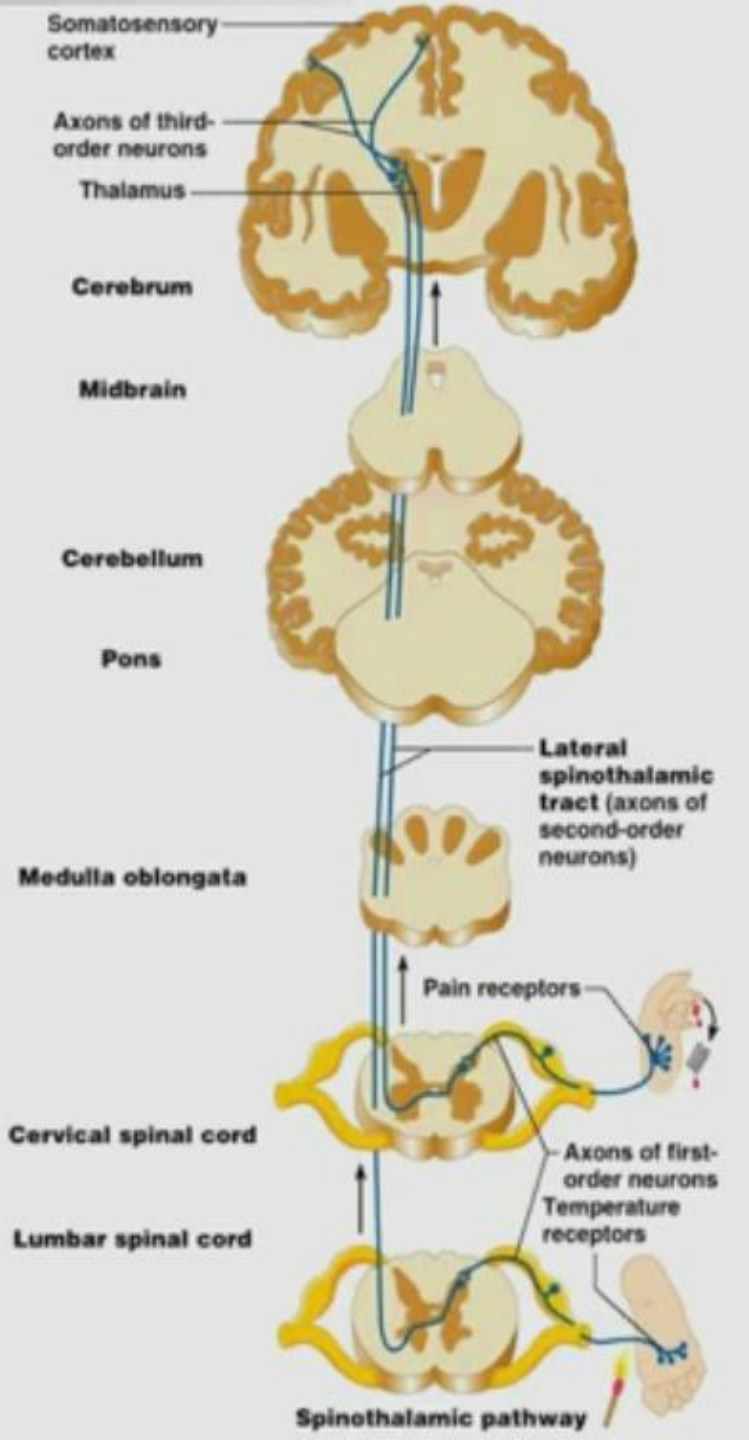
Tractus spinoolivaris ant. ve post.

- **The tractus olivocerebellaris**, formed by fibers starting from the nucleus olivaris accessorius posterior and nucleus olivaris accessorius medialis, passes through the pedunculus cerebellaris inferior and terminates in the lobus cerebelli anterior.
- Thus, tractus spinoolivaris and tractus olivocerebellaris together form another pathway that carries impulses from the spinal levels to the cerebellum, apart from tractus spinocerebellaris anterior and tractus spinocerebellaris posterior.

Anterolateral system



- Spino-thalamic tract
- Spino-reticulo-thalamic
- Spino-tectal tract
- Spino-olivary tract



General rules about afferent

-All sensory fibers enter the spinal cord through the posterior root.

-The senses we perceive reach the cerebral cortex via the posterior nuc.ventralis of the thalamus.

-The proprioceptive impulses that we cannot comprehend going to the cerebellum play a role in maintaining position and balance by enabling the muscles to work in a coordinated manner.

-Impulses to the colliculus superior in the mesencephalon form the visual reflex.

-Impulses to the Formatio reticularis affect the entire nervous system.

- Some of all kinds of impulses coming to the spinal cord are connected to the reflex arcs at the level of the spinal cord.

General rules about afferent II

- Tractus spinocerebellaris carries unconscious proprioceptive sensations from the muscles and joints of the anterior and posterior lower extremities from the spinal cord to the cerebellum. The unconscious proprioceptive senses of the upper extremity are conveyed to the cerebellum by tr.cuneocerebellaris.
- The conscious proprioceptive, two-point discrimination, and vibration senses are connected to the thalamus and cortex by the tractus spinobulbaris (fasciculus garcilis and fasciculus cuneatus).
- **The sensation of pain is conveyed from the spinal cord to the upper centers by tractus spinothalamicus lateralis, tractus spinoreticularis, and tractus spinotectalis.**
- **In the bulb, tractus spinotectalis forms lemniscus spinalis together with tractus spinothalamicus anterior and lateralis.**

General rules about afferent III

- The first neuron of the tracts named Tractus spinotectalis, Tractus spinoolivaris anterior, Tractus spinocerebellaris anterior, **Tractus spinothalamicus lateralis-anterior** enters the spinal cord from the posterior root and passes to the opposite side in the **commissura alba anterior** and goes to the relevant places in the brain.
- The first neuron of the tractus spinoreticularis enters the medulla spinalis from the posterior root, and most of its extensions pass on the same side, and some of them pass to the opposite side in **the commissura alba anterior**, forming the **tractus spinoreticularis** in the anterolateral of the medulla spinalis.
- Central extensions of the first neurons of the tractus spinocerebellaris posterior synapse in the nucleus thoracicus. **The axons of the 2nd neurons coming out from here go up in the funiculus lateralis of the same side and come to the cerebellum via the pedunculus cerebellaris inferior.**

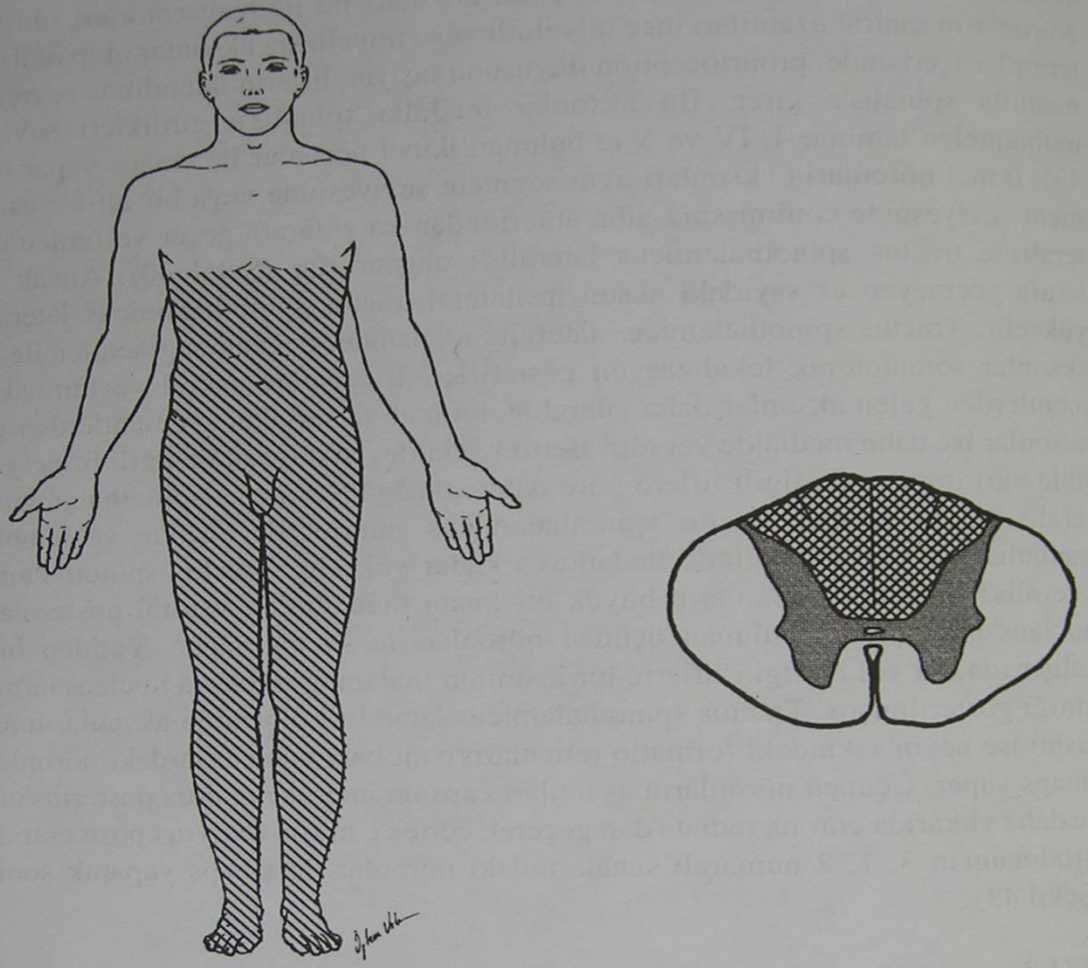
- The sense of pain is transmitted from the spinal cord to the upper centers by **tractus spinothalamicus lateralis**, **tractus spinotectalis, and tractus spinoreticularis.** All of these pathways are called the **anterolateral system.**

FASCİCULUS GRACİLİS and FASCİCULUS CUNEATUS

- **CLINICAL INFORMATION**
- Funiculus posterior lesions usually occur in diseases such as tabes dorsalis seen in syphilis and subacute combined sclerosis seen in pernicious anemia.
- In posterior funiculus lesions, the senses of position, kinesthesis, vibration, and two-point discrimination are lost below the level of the lesion and on the same side.
- These losses are particularly evident in the distal parts of the extremities.

- These patients have great difficulty in performing movements that require maintaining a balanced body position such as standing and walking **(funiculus posterior ataxia)** and cannot assess the position of their body parts in space with their eyes closed.

- While standing with their feet together and eyes closed, these patients may lose their balance and sway or even fall. This is called the **Romberg sign.**



Şekil 42. Bilateral funiculus posterior lezyonu

- **CLINICAL INFORMATION**
- Unilateral cutting of the tractus spinothalamicus lateralis at any level of the spinal cord causes loss of pain and temperature sensation, usually below one segment of the lesion and on the opposite side **(analgesia and thermoanesthesia)**.
- The process of surgically cutting tracts in the spinal cord or destroying them with radiofrequency is called **cordotomy.**
- In some cases where severe pain cannot be relieved with drugs, tractus spinothalamicus lateralis can be destroyed by **anterolateral cordotomy**, preventing the transfer of pain sensation to the upper centers.

- The pain perceived by the nociceptors in the deep visceral structures causes pain in the skin areas related to certain segments, which is called **referred pain.**

General course of efferent (descending) tracts

These pathways are related to movements of skeletal muscles, autonomic innervation of organs and muscle tone.

Impulses that move skeletal muscles and coordinate these movements originate from the cortex cerebri, nucleus ruber, lamina tecti (colliculus superior), nucleus olivaris inferior, nucleus vestibularis lateralis, and formatio reticularis.

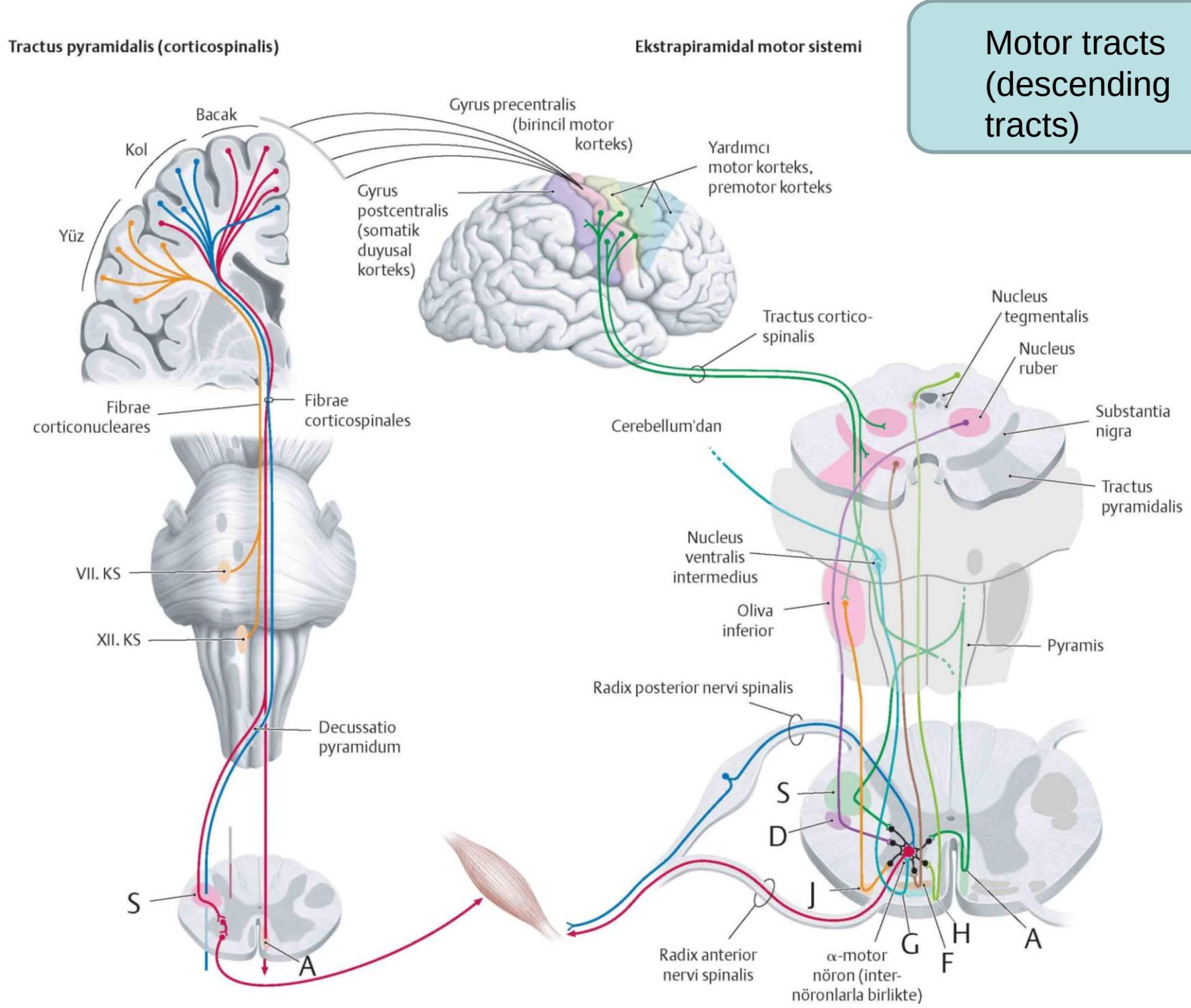
Those that originate in the cerebral cortex are called pyramidal tracts, and the others are called extrapyramidal tracts.

Those that originate in the cerebral cortex are called pyramidal tracts, and the others are called extrapyramidal tracts.

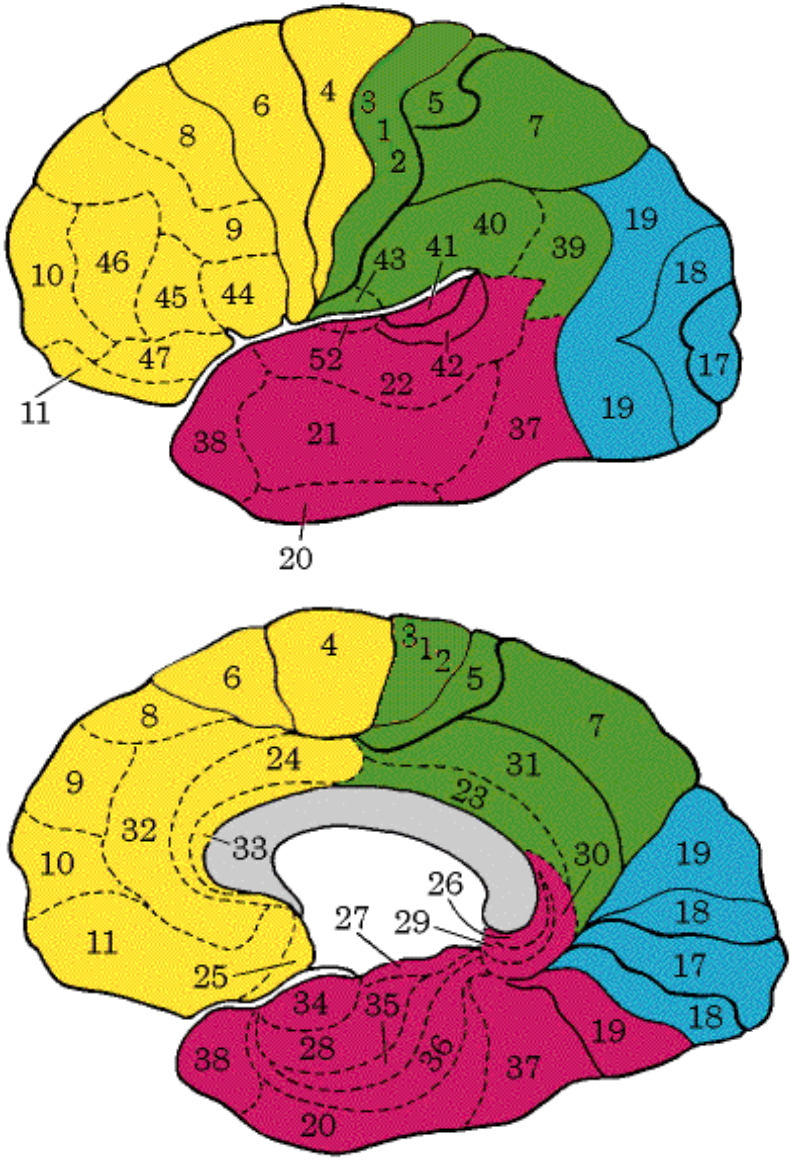
The cell body of the 1st neuron (upper motor neuron) is located in the cerebral cortex, and its axon extends to the spinal cord and synapses with an interneuron.

This interneuron also synapses with the second neuron (lower motor neuron) in the anterior horn. Sometimes the 1st neuron synapses directly with the lower motor neuron without using an interneuron.

Motor tracts (descending tracts)



cortical areas in the brain



Frontal Lobe: thinking, planning and motor function

Parietal Lobe: Sense and balance

Temporal Lobe: Speech, hearing, memory and emotionality

Occipital Lobe: Seeing

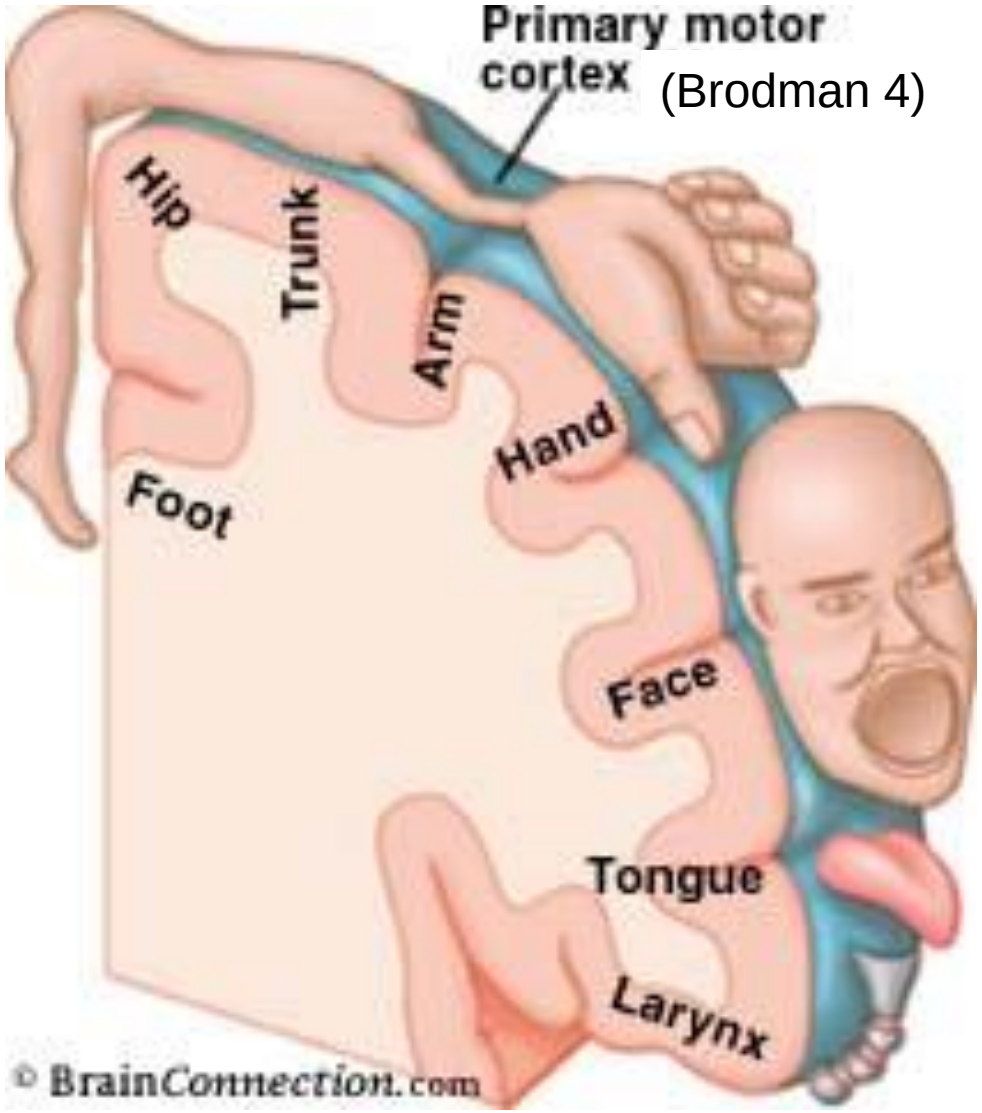
Görevi	Brodmann Alanı
Seeing	
Primary	17
Secondary	18, 19, 20, 21, 37
Hearing	
Primer	41
Sekonder	22, 42
Duyu	
Primary	1, 2, 3
Secondary	5, 7
Tertiary	7, 22, 37, 39, 40
Motor	
Primary	4
Secondary	6
Eye movement	8
Speaking	44
Motor, tertiary	9, 10, 11, 45, 46, 47

Motor areas of the cerebral cortex

Primer motor fields (4th fields): *It is located in the anterior part of the gyrus precentralis and lobulus paracentralis.* *The primary motor area is represented by an image of a freakish human with head, face, larynx, and hand turned upside down and disproportionately disproportionate in size (motor homonculus).

Secondary motor fields: *It is found in the anterior part of the gyrus precentralis and the parts of the gyrus postcentralis close to the temporal lobe.* *The premotor area (a part of the 6th field and 8th field), located in front of the primary motor field, as well as a section of the 44th and 45th fields are included in the secondary motor field.

30% of the pyramidal paths originate from the 4th field, 30% from the 6th and 8th fields and 40% from the front part of the 3rd, 1st and 2nd fields.*The fibers coming out of the 3rd, 1st and 2nd fields do not directly connect to the motor neurons, but by connecting to the afferent pathways, they adjust the intensity by positively affecting the impulses coming to the cortex via the thalamus.



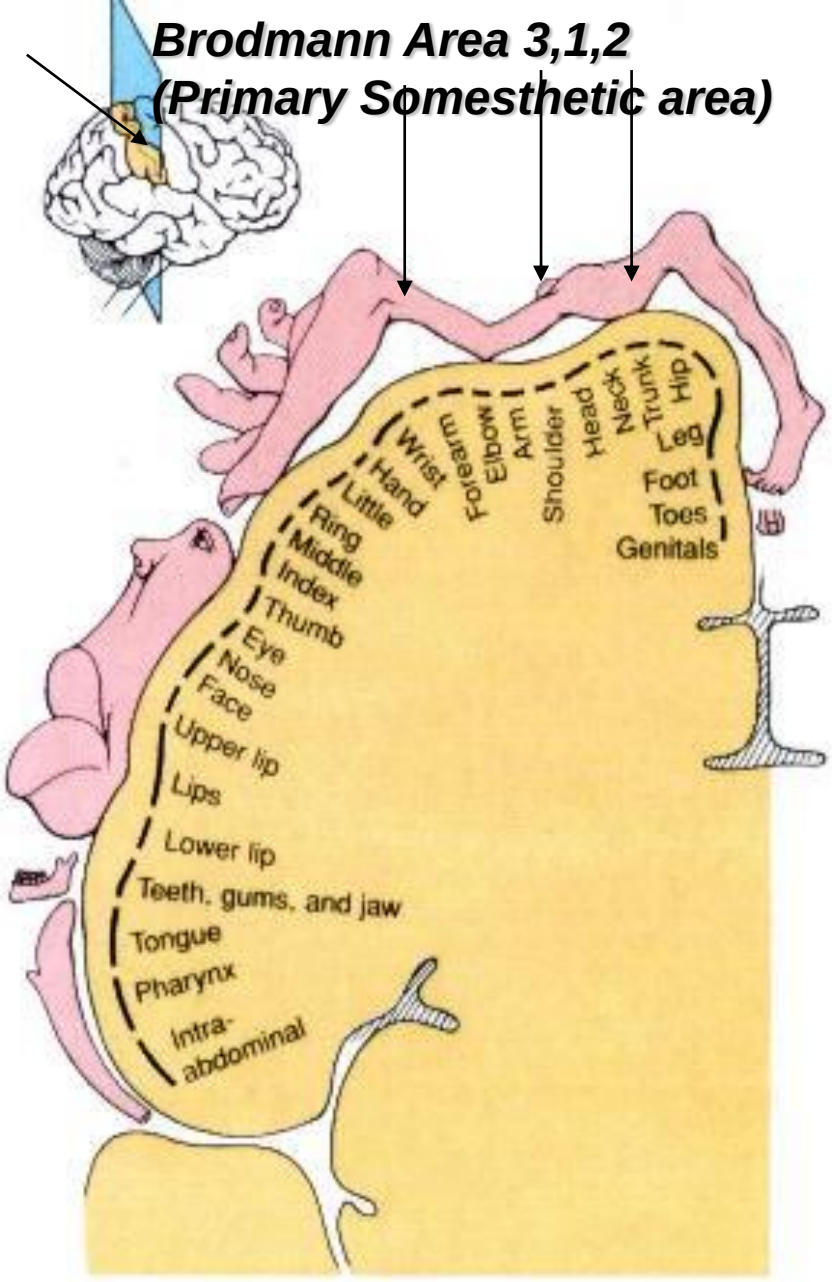
Primary motor field (4th field), head, face, larynx, and the lower part of the hand are upside down and are represented by a picture of a freakish person whose dimensions are disproportionate (motor homonculus).

- The Motor Cortex is a region in the upper-front part of our brain, which is of fundamental importance for the control and planning of our bodily movements. All of the skeletal muscles in our body are moved through the neural circuits here. The motor cortex contains a complete "motor map" of our body. Known as the homunculus, meaning "little man", in this chart, areas that need fine control, such as the hands and face, occupy the largest areas.

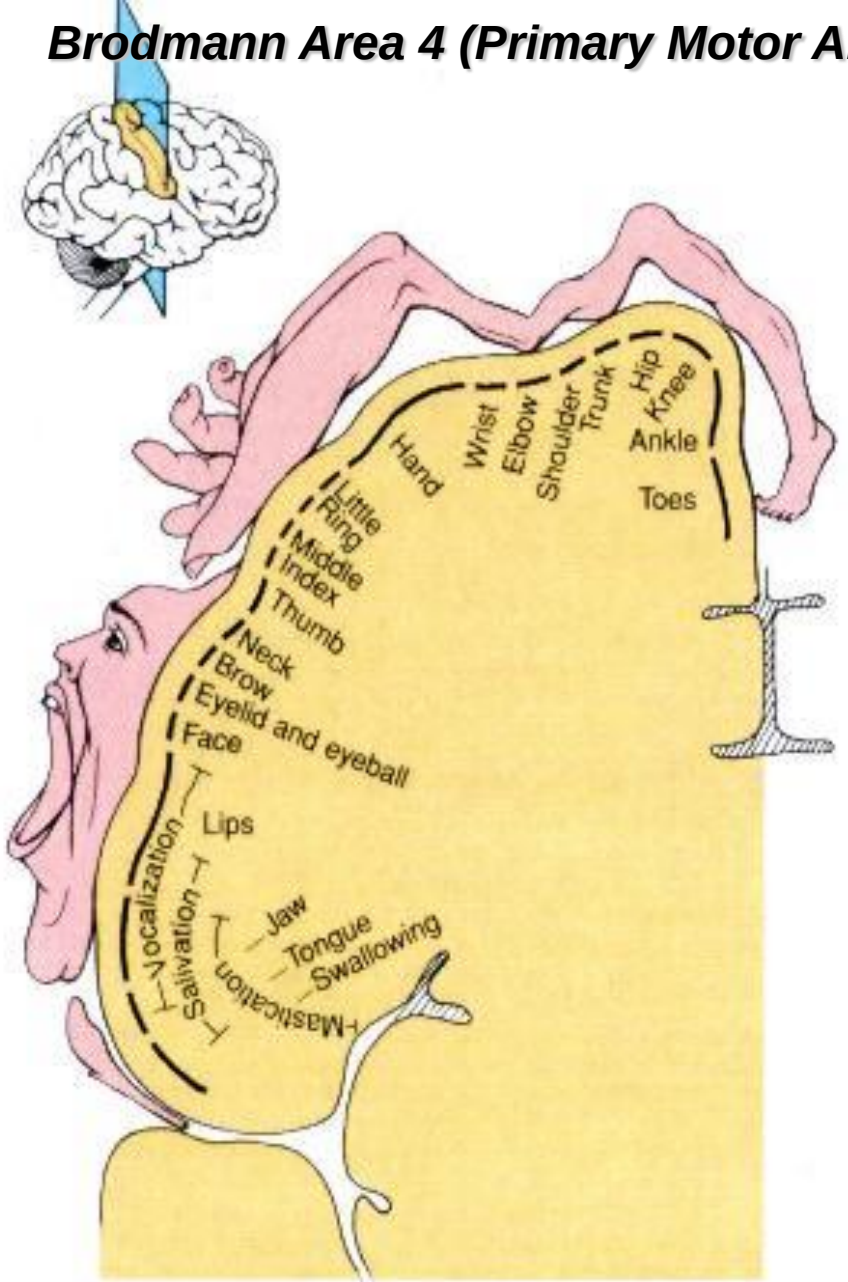
- The motor cortex, like many other parts of the brain, has a high degree of changeability, that is, "plasticity". When an exercise with your fingers (such as playing the piano) is continued for 1-2 weeks, the representation areas of the operated fingers grow measurably. This change forms the basis for our acquisition of new motor skills. It changes as we learn, and we learn as we change.

Brodmann Area 3,1,2
(Primary Somesthetic area)

Brodmann Area 4 (Primary Motor Area)

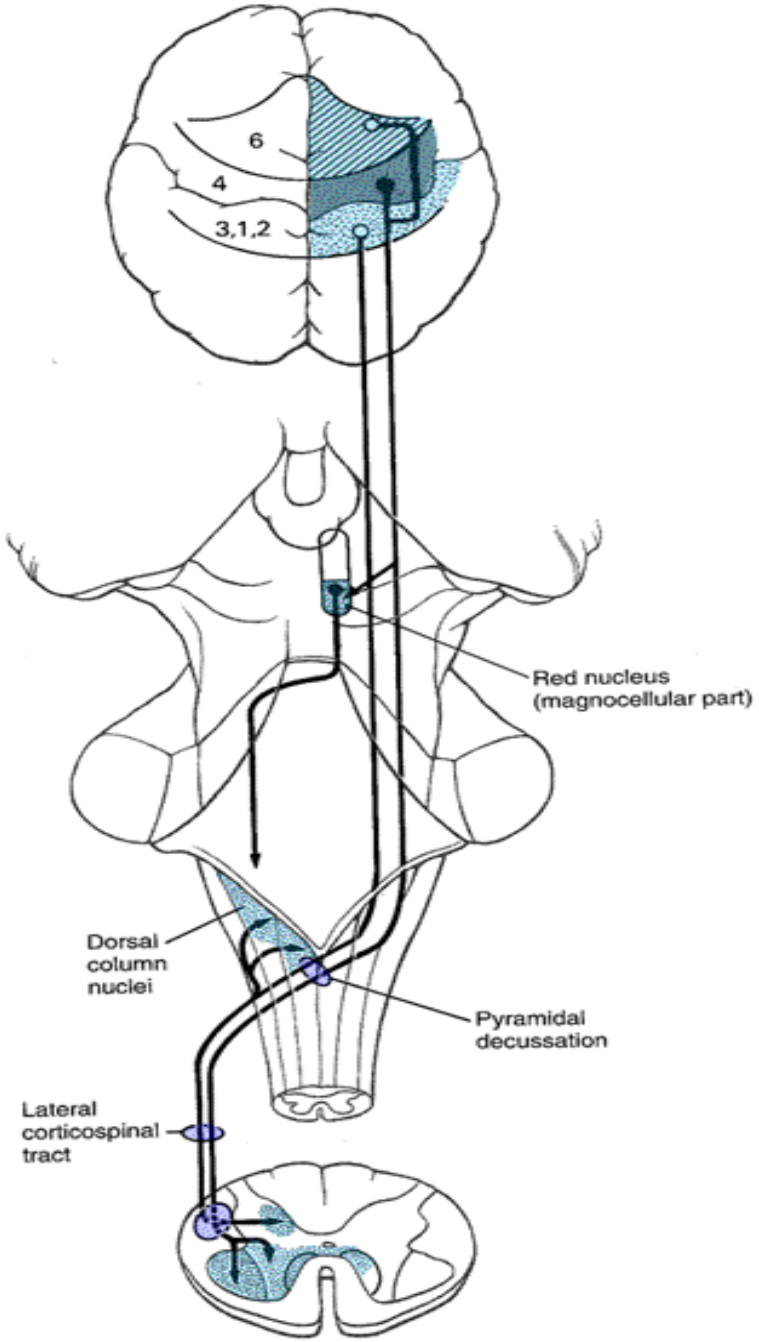


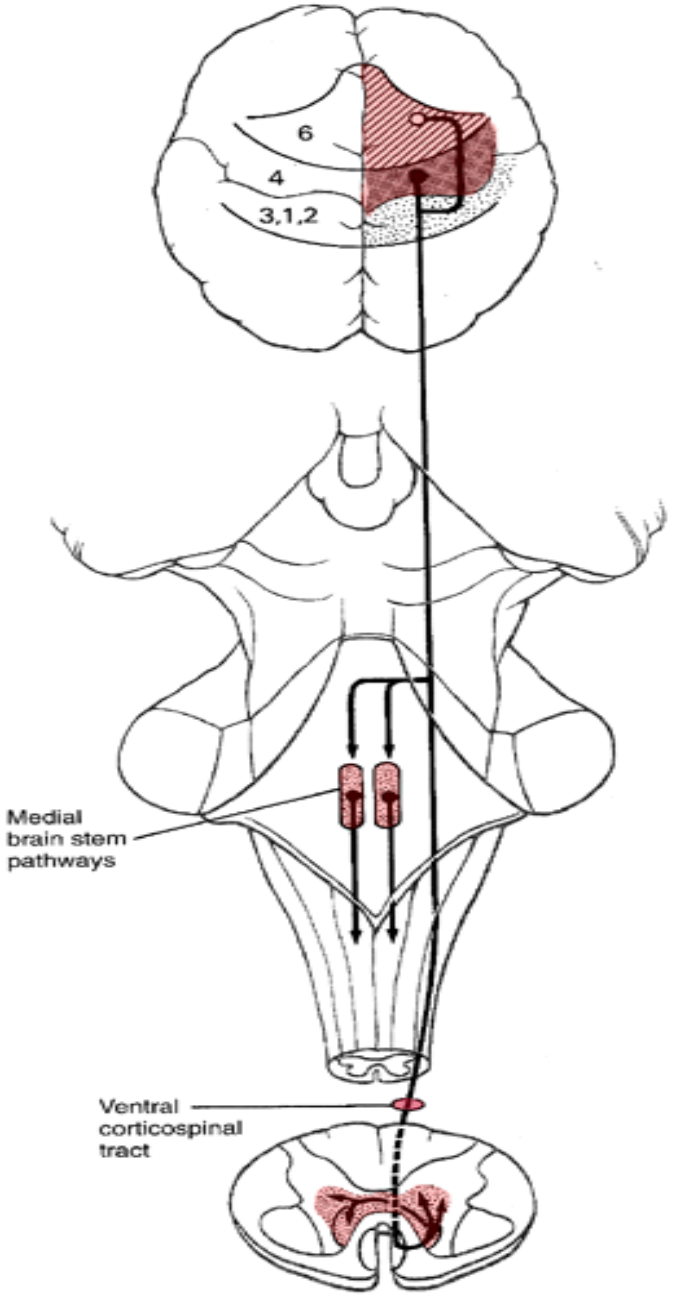
(a) Somatosensory cortex in right cerebral hemisphere



(b) Motor cortex in right cerebral hemisphere

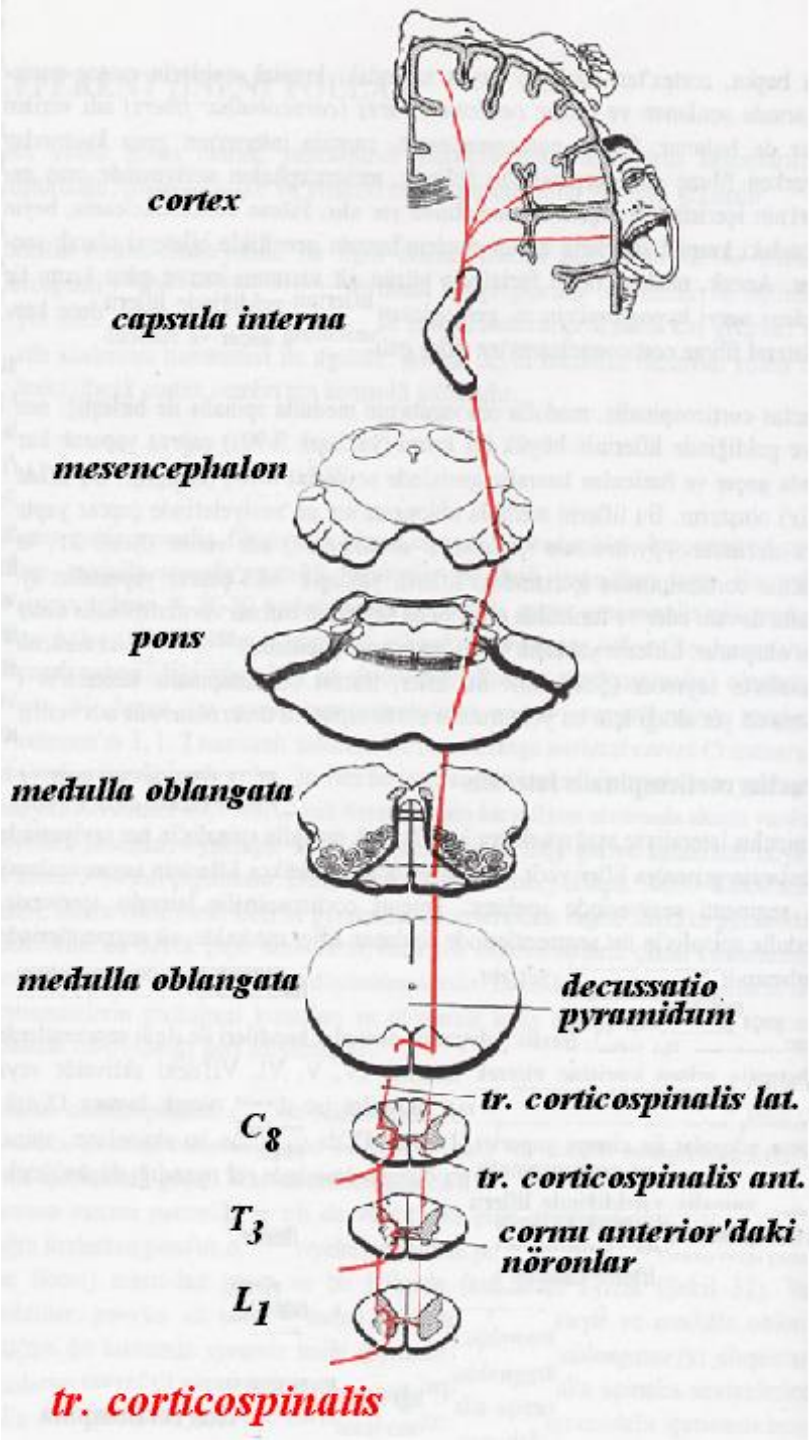
Pyramidal tracts

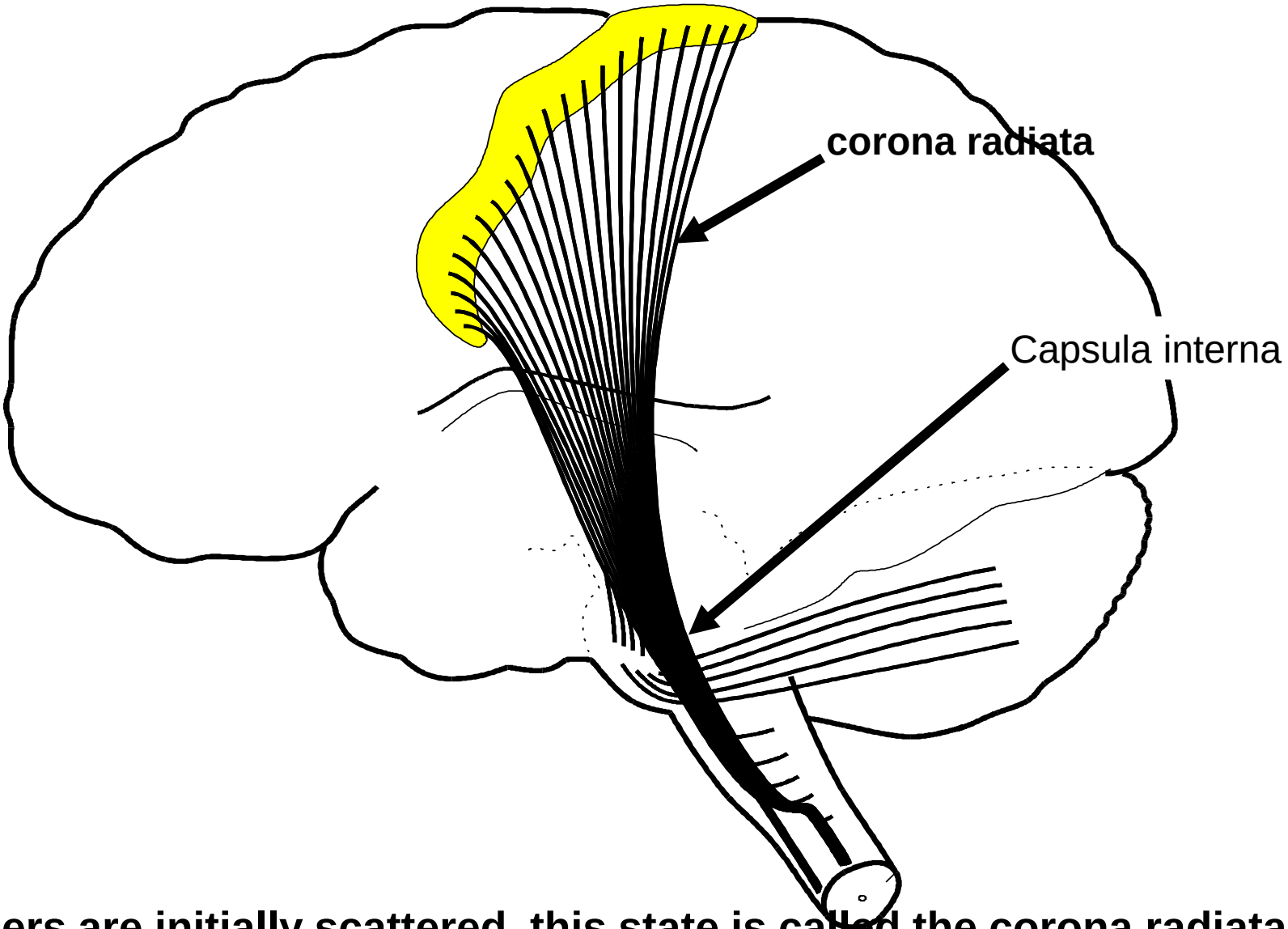




Tr. corticospinalis [pyramidalis]

The first neuron of this pathway is the pyramidal cells in the primary and secondary motor areas in the frontal and parietal lobes. 30% of the fibers originate from the primary motor cortex (4th), 30% from the premotor cortex (6 and 8), the remaining 40% from the somesthetic area (3, 1, 2) in the parietal lobe. The axons of the pyramidal cells extend from the capsula interna (crus posterius), the mesencephalon (from the crus cerebri), the pons and the upper part of the bulb, without crossing yet, only as tractus corticospinalis.





The fibers are initially scattered, this state is called the corona radiata. These fibers gather and pass through the capsula interna. While passing through the interna of the capsula, the fibers of the trunk muscles pass behind this structure, and the fibers belonging to the lower side pass behind it.

Since the axons of the pyramidal cells have not yet crossed in the upper 2/3 of the capsula interna, pedunculus cerebri, pons and medulla oblongata, they are simply **named tractus corticospinalis.**

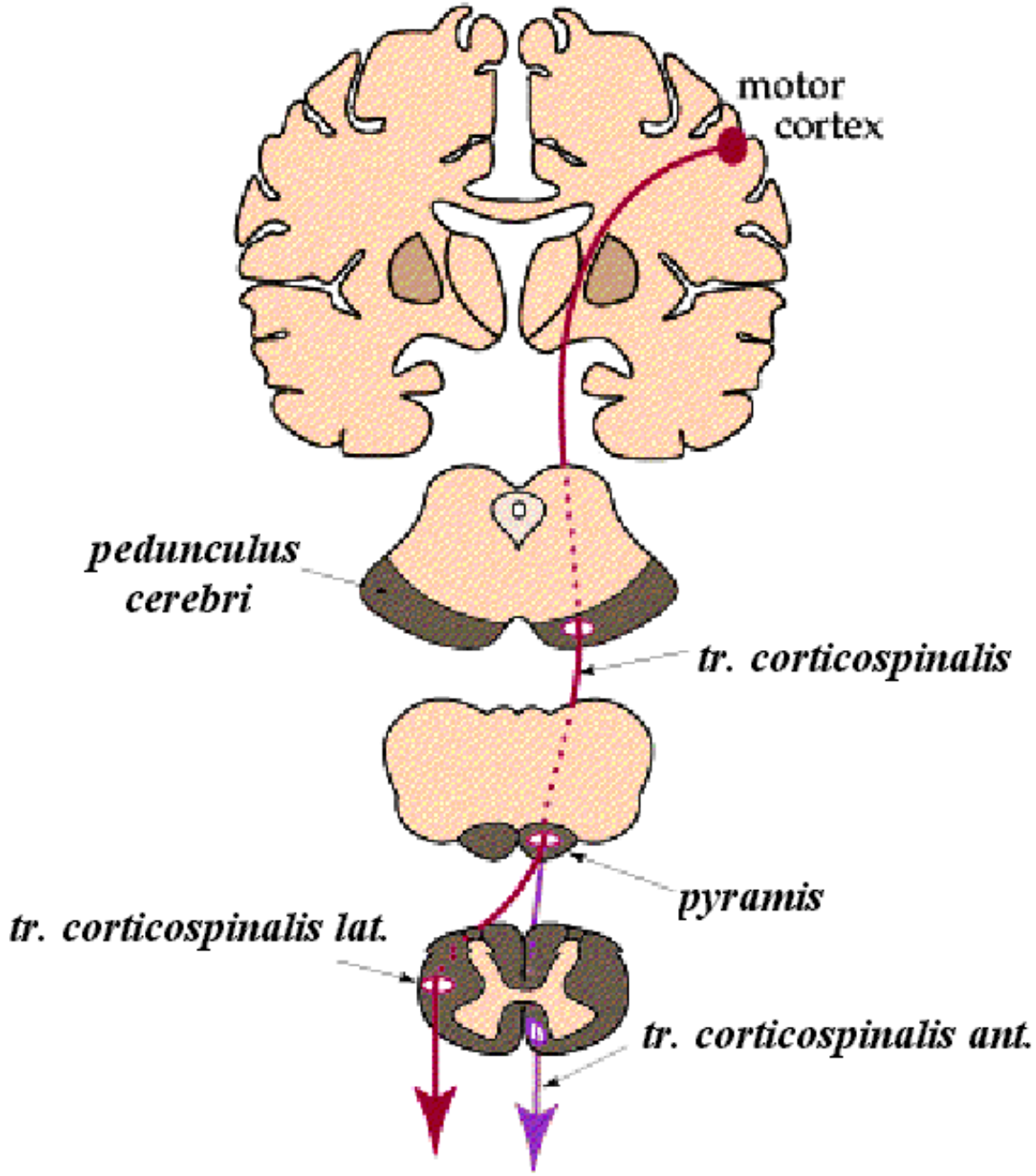
In the **decussatio pyramidum**, located at the junction of the upper 2/3 of the medulla oblongata and the lower 1/3, approximately 90% of the fibers of the **tr. corticospinalis** cross the midline and pass to the opposite side.

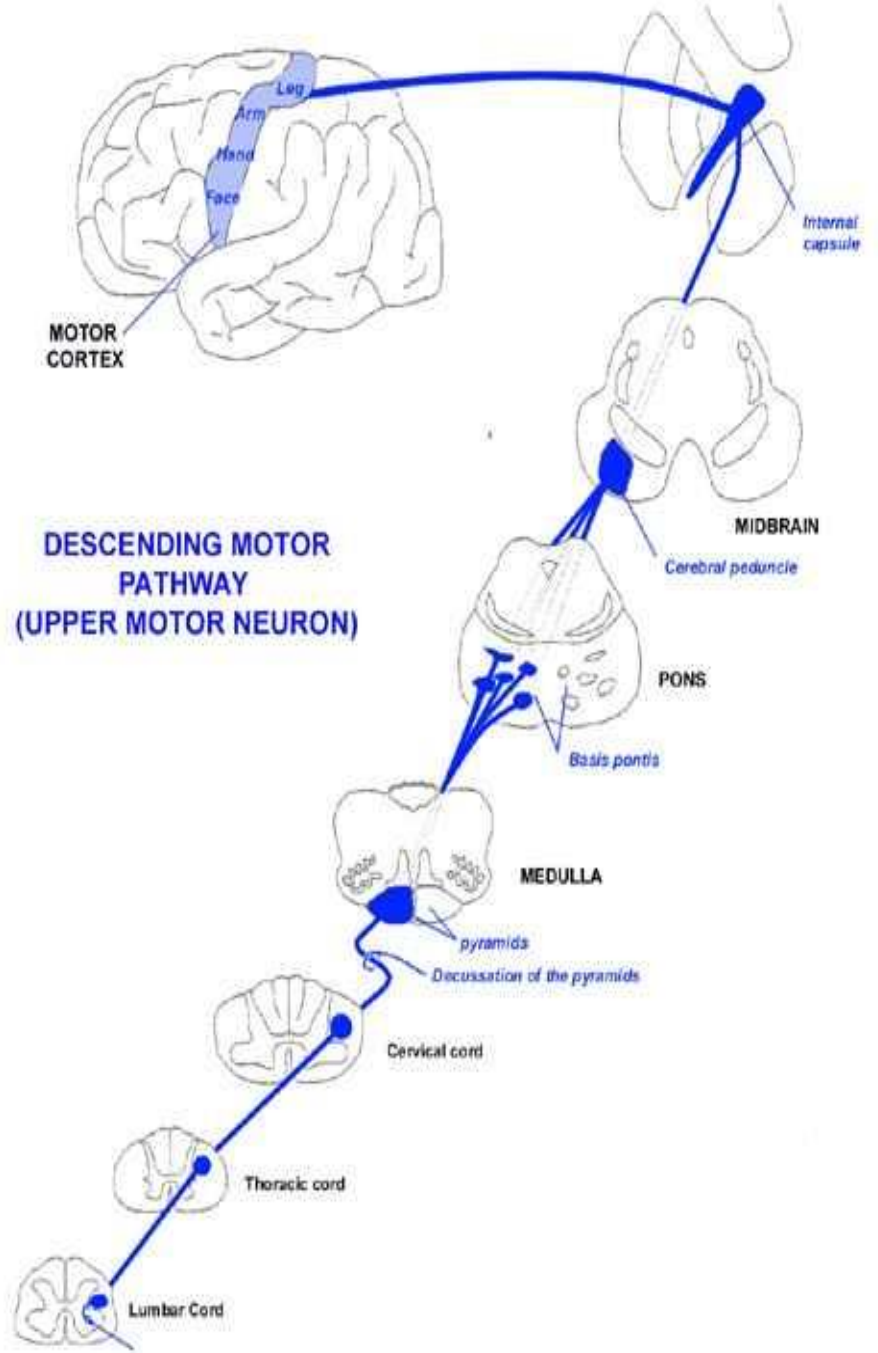
These fibers running in the funiculus lateralis are called **tr. corticospinalis lateralis.**

The remaining 10% goes down without crossing. Of these non-crossing fibers, 8% lie in the **tr. corticospinalis anterior** in the funiculus anterior, and 2% in the funiculus lateralis, and some sources call these fibers **tr. corticospinalis anterolateralis.**

Tractus corticospinalis anterolateralis *lies in the most anterior part of the funciculus lateralis. These fibers, which do not cross above, do not cross in the spinal cord segment where they will terminate.*

Accordingly, 8% fibers (**tr. corticospinalis anterior**) cross in the medulla spinalis segment where they will terminate, and 2% fibers connect to somatomotor neurons without crossing.

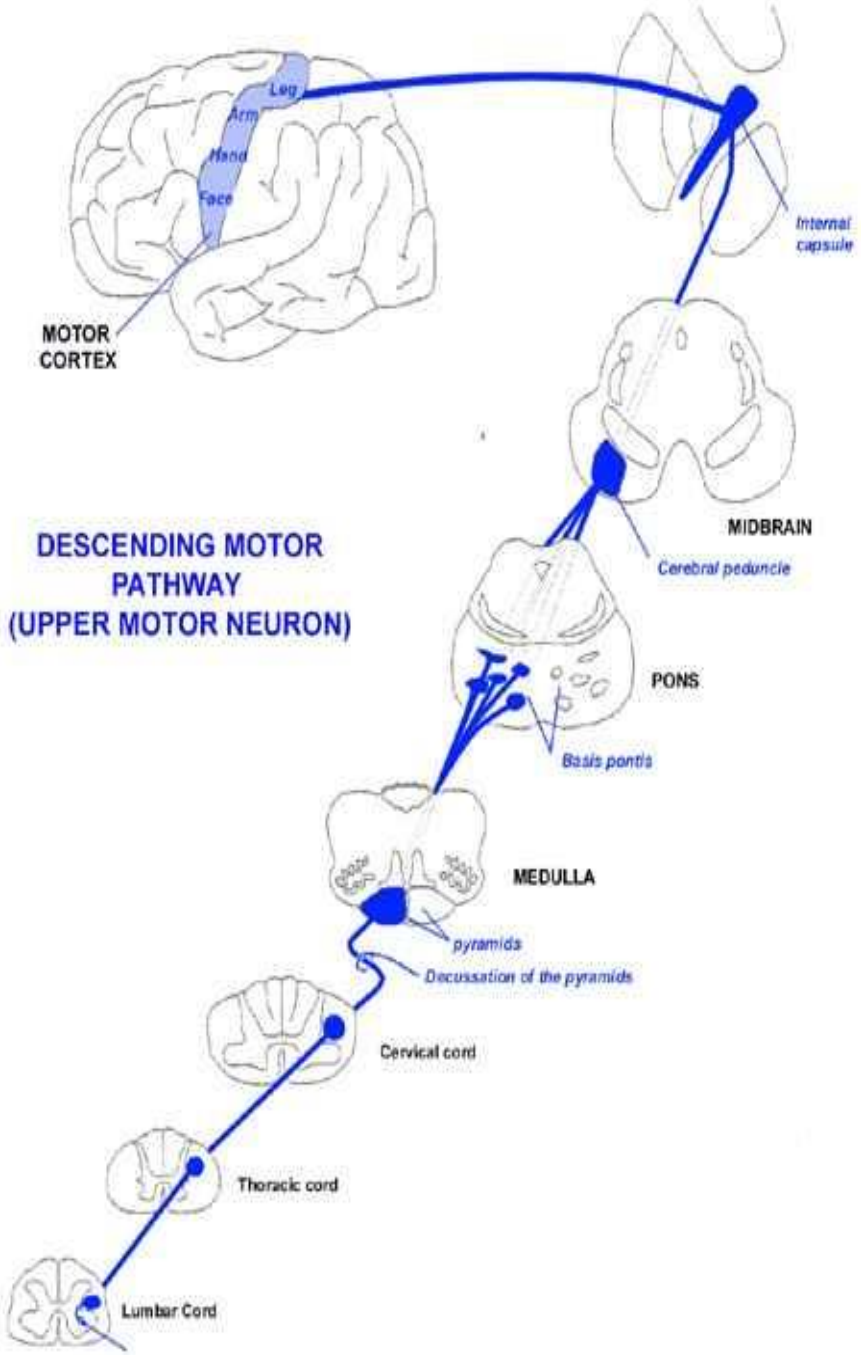

motor
cortex
pedunculus
cerebri
tr. corticospinalis
pyramis
tr. corticospinalis lat.
tr. corticospinalis ant.



DESCENDING MOTOR PATHWAY (UPPER MOTOR NEURON)

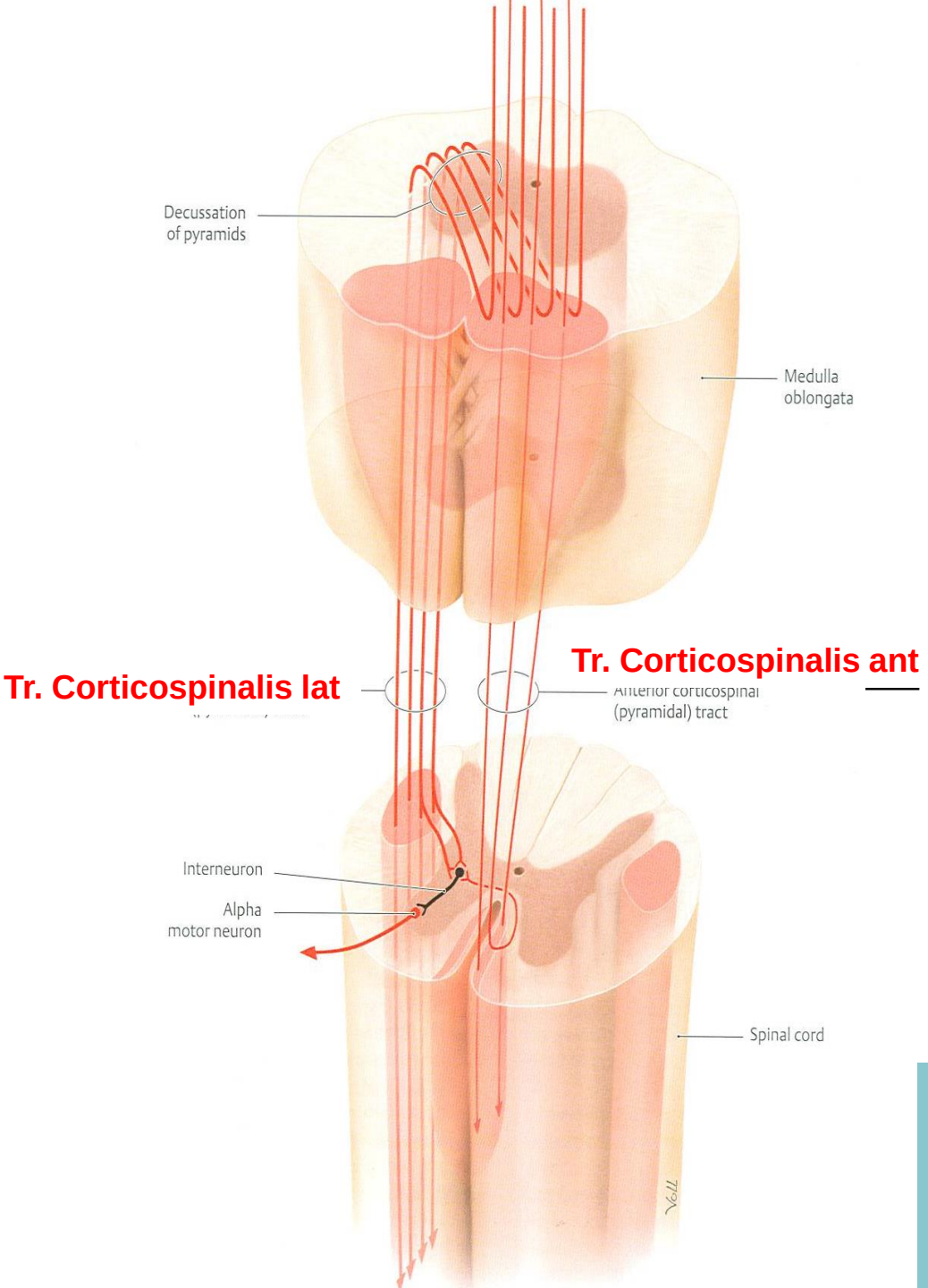
Tr. corticospinalis (pyramidalis) lateralis:

The fibers of the **tr.corticospinalis crossed in the decussatio pyramidum tr. It is called corticospinalis lateralis.** Tr. corticospinalis lateralis is located most lateral to the funiculus lateralis. This path, which runs along the entire spinal cord, plays the most important role in voluntary movements. **The 1st neuron (upper motor neuron) of this pathway starts from the pyramidal cells in the primary and secondary (premotor) motor areas of the parietal and frontal lobes.**



DESCENDING MOTOR PATHWAY (UPPER MOTOR NEURON)

Tractus corticospinalis lateralis enters the segment where it will terminate, and synapses with an interneuron in the posterior horn (IV., V. VI. and VII. laminae), and some **directly with the anterior horn motor cell (2nd neuron or lower motor neuron). Thus, the right side of the brain controls the left side of the body and the left side controls the right side skeletal muscles.** 55% of the tractus corticospinalis terminates in the cervical, 20% in the thoracic and 25% in the spinal cord segments in the lumbosacral region. The parts of the tractusccorticospinalis that connect directly with the anterior horn motor neuron without using an interneuron send impulses to the muscles in the distal parts of the extremities, and those connected by the interneurons to the muscles in the proximal parts of the trunk and extremities.

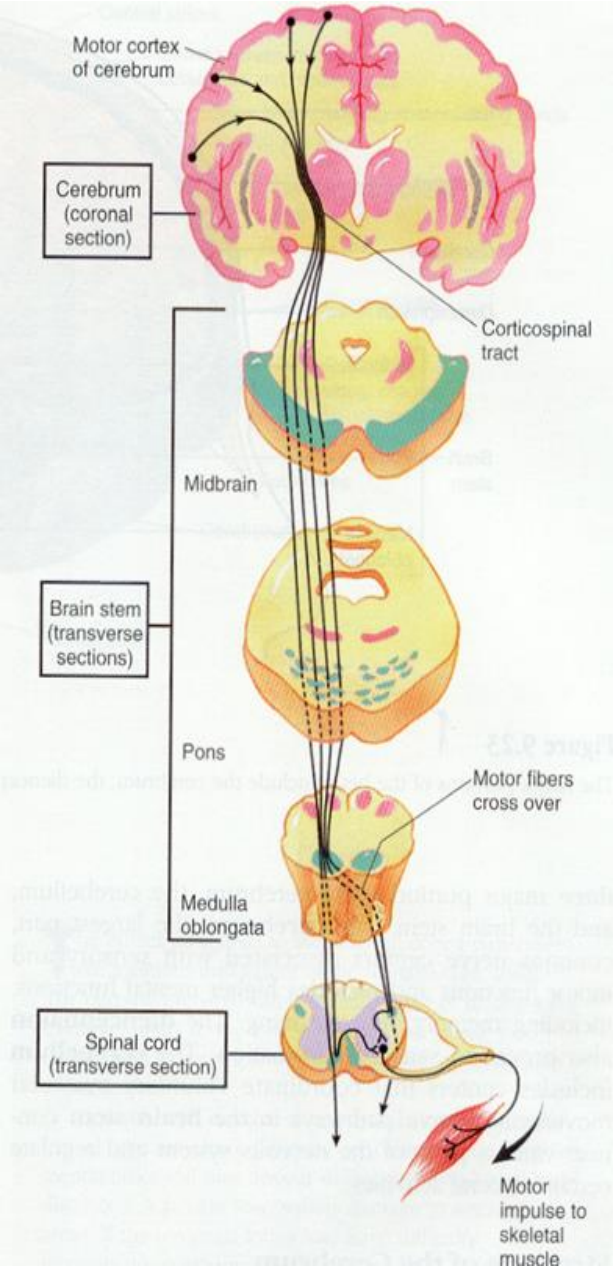


Tr.corticospinalis anterior:

Neuron I starts from the pyramidal cells in the gyrus precentralis in the brain. The axons of the first neuron go down without crossing (8%) in the bulb. By crossing in the spinal cord segment where it will terminate, most of them synapse via an interneuron, and some of them directly synapse with motor cells of the anterior horn. Starting from the anterior horn motor cells, the 2nd neuron leaves the spinal cord at the anterior root and goes to the skeletal muscles in the upper parts of the neck and chest.

This pathway is located on either side of the fissura mediana anterior. It extends to the middle of the thoracic segment.

Tr. corticospinalis lateralis



1st Neuron(umn): motor cortex

Decussatio: decussatio pyramidum

İnterneuron: lamina IV, V, VI and VII

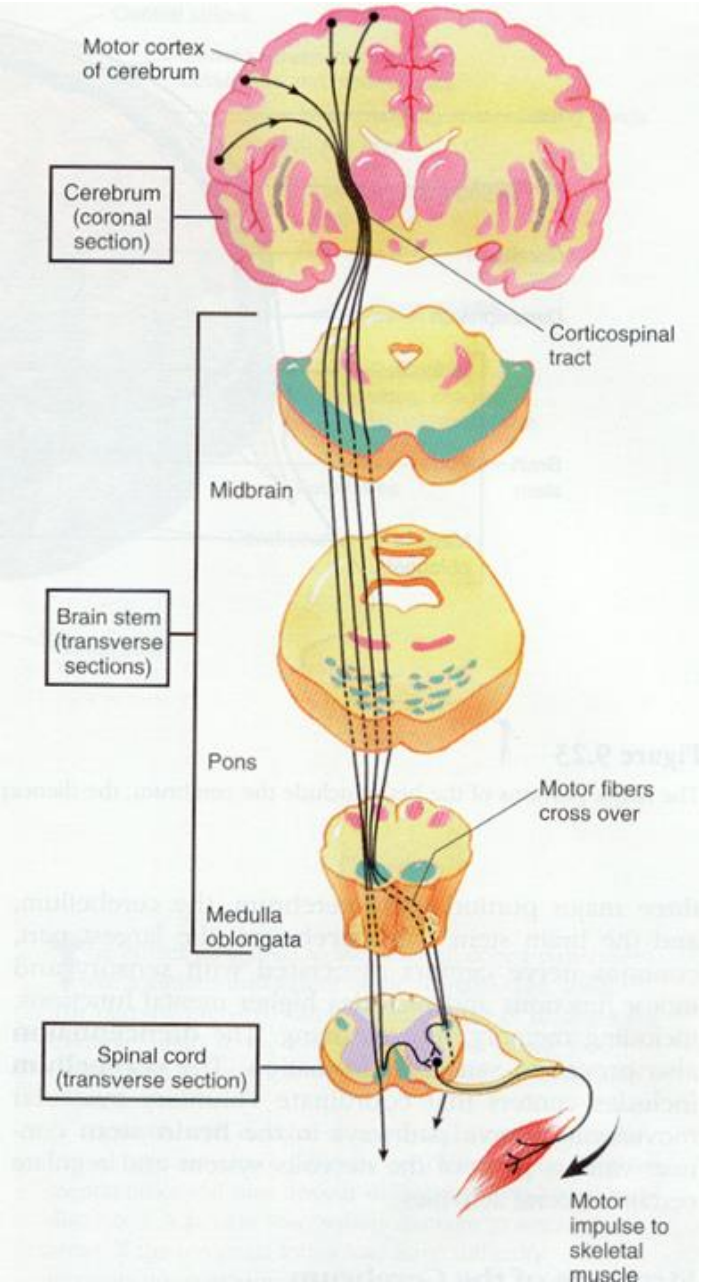
some directly(without pass through interneuron)

2nd neuron(lmn): cornu anterior

Its track in the spinal cord : funiculus lateralis

55% of the tractus corticospinalis terminates in the cervical, 20% in the thoracic and 25% in the spinal cord segments in the lumbosacral region. **It carries voluntary motor commands to the extremity muscle.**

Tr. corticospinalis anterior



1st Neuron(umn): motor cortex

Decussatio: commissura alba ant.

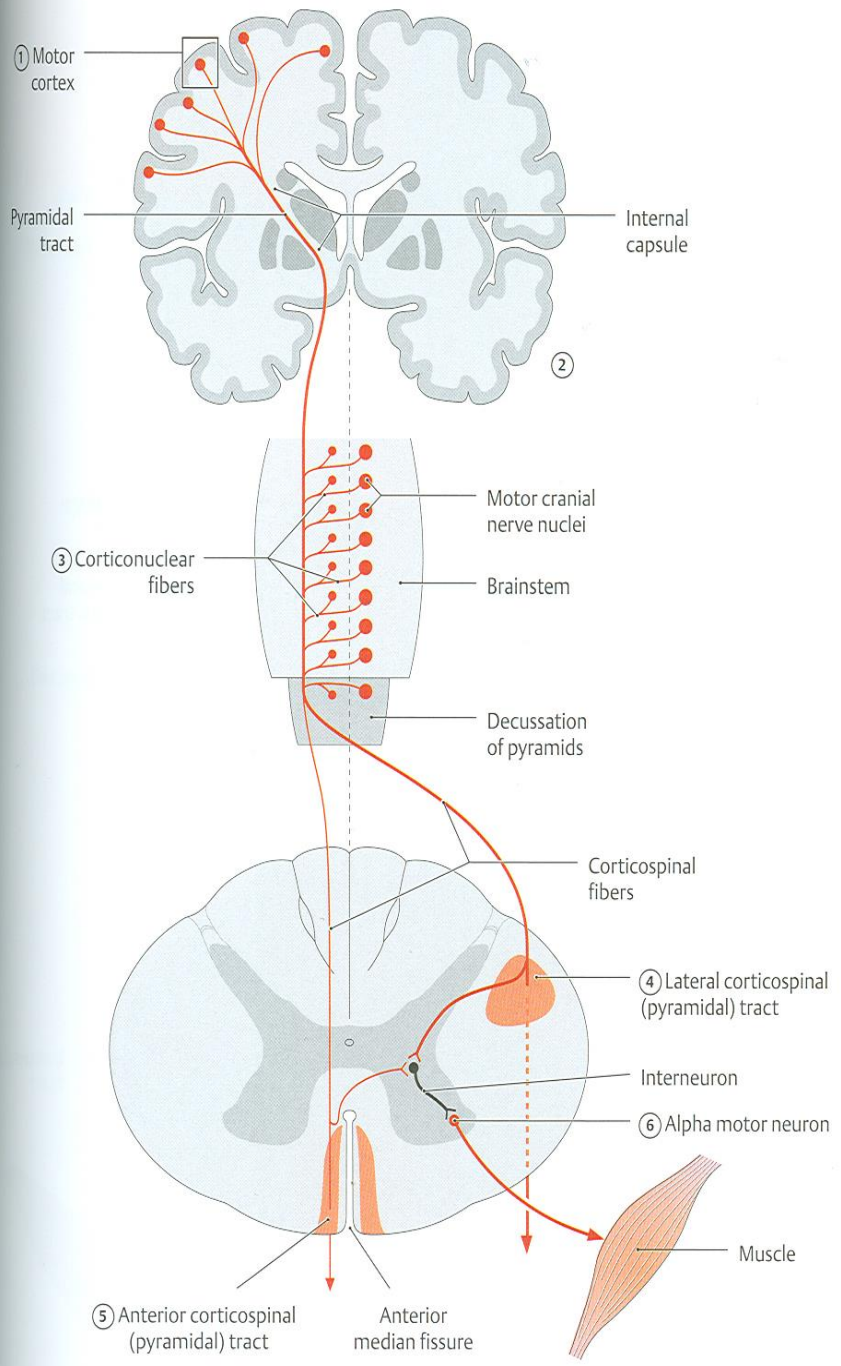
İnterneuron : lamina IV, V, VI and VII

some directly(without pass through interneuron)

2nd neuron(lmn): cornu anterior

Its track in the spinal cord : funiculus anterior

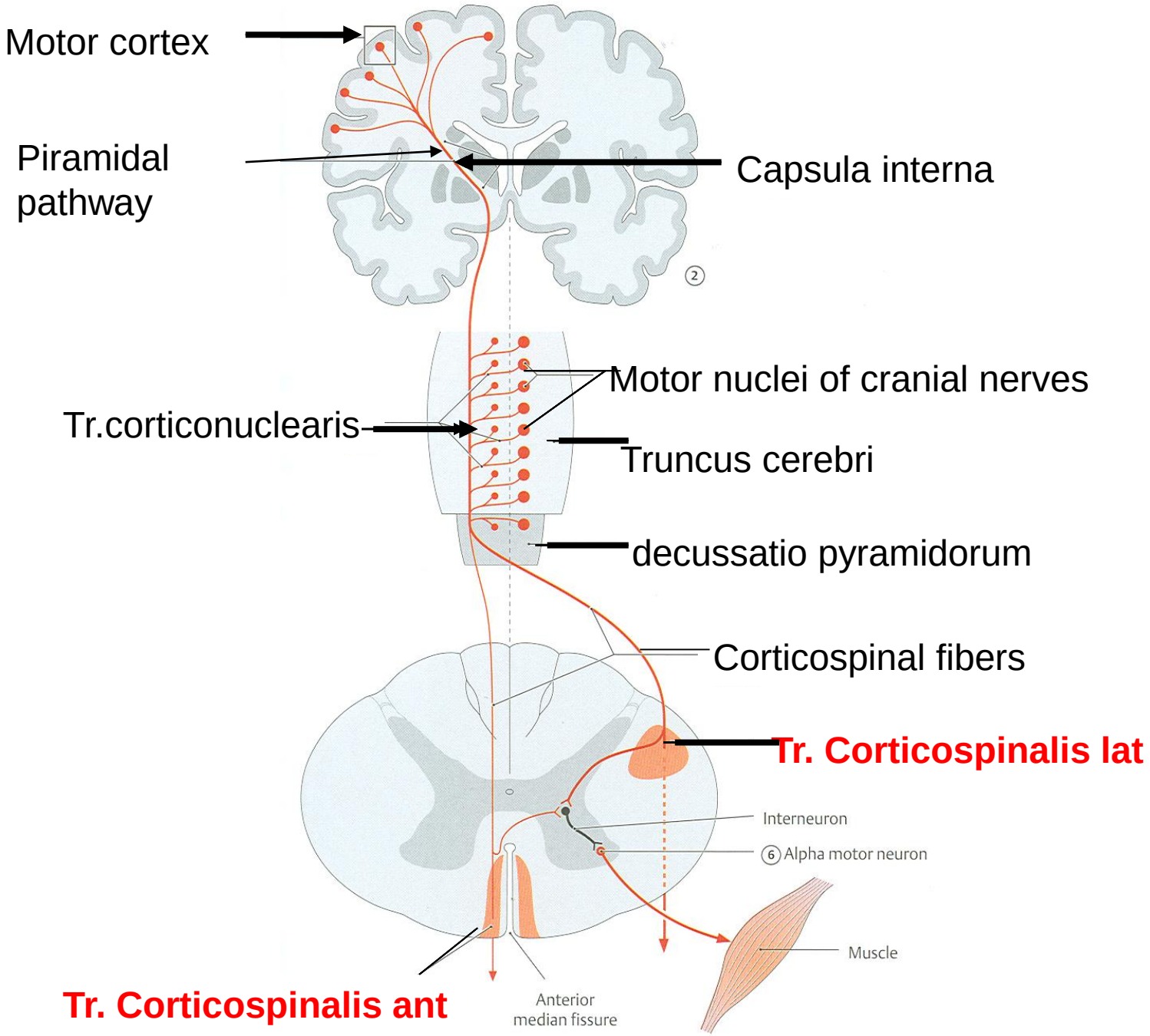
It leaves the spinal cord at the anterior root and goes to the skeletal muscles in the neck and upper chest. It carries voluntary motor commands to the trunk muscles.



Tr. corticonuclearis:

The fibers originating from the 4th and 6th fields and the 8th field and connecting with the nuclei of the head pairs and with the formatio reticularis are called tractus corticonuclearis.

The fibers of this pathway coming out of the 8th field connect with the nerves that go to the muscles that move the eye (n.occulomotorius, n.trochlearis, n.abducens). It connects with the colliculus superior and nucleus pretectalis, which are also related to the reflex movements of the eye.


Motor cortex
Piramidal pathway
Capsula interna
Motor nuclei of cranial nerves
Tr.corticonuclearis
Truncus cerebri
decussatio pyramidorum
Corticospinal fibers
Tr. Corticospinalis lat
Interneuron
6 Alpha motor neuron
Muscle
Tr. Corticospinalis ant
Anterior median fissure

İnter neuron

Upper motor neuron (in the motor cortex)

sensory cortex neuron

3rd order afferent (sensory) neuron

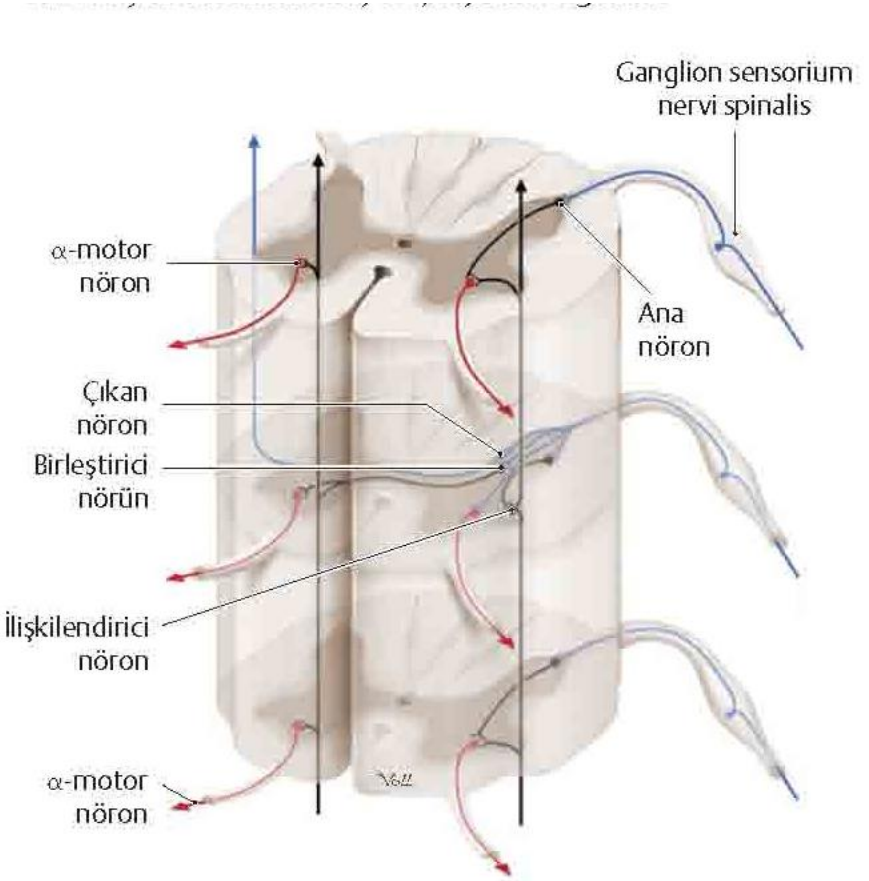
2nd order afferent (sensory) neuron

Motor interneuron

Lower motor neuron

1st order afferent (sensory) neuron

Overview of sensory motor integration

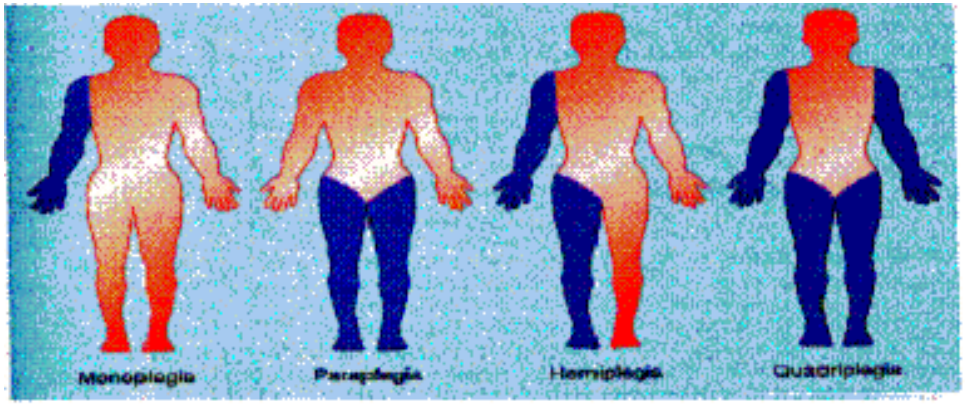


1. Motor neuron: It is the first neuron of the pathway that provides voluntary movement. It is also called upper motor neuron, central motor neuron.

2. Motor neuron: Also called lower motor neuron or peripheral motor neuron. They are located in the anterior horn extending along the spinal cord or in the nuclei of motor cranial nerves (III., IV., V., VI., IX., X., XI., and XII. cranial pairs) in the brain stem.

Reduction or complete loss of muscle strength in a part of the body is the most common symptom in nervous system diseases. In neurology, the first of these is paresis; The second, that is, paralysis, we call paralysis and plegia.

Types of paralysis



Hemiplegia: Paralysis of one half of the body.

Monoplegia: Paralysis of the upper or lower extremities of only one side.

Diplegia: Paralysis of the upper or lower extremities only.

Paraplegia: Paralysis of the lower or upper extremities on both sides

In the destruction of the upper motor neuron

1-Flakid (loose) paralysis on the opposite side of the body

2-Hipotonia (decreased muscle tone)

3- Loss of superficial abdominal reflex and cremaster reflex

4-Increased deep tendon reflex

5-Babinski positive

In lower motor neuron damage

1-Flakcid paralysis

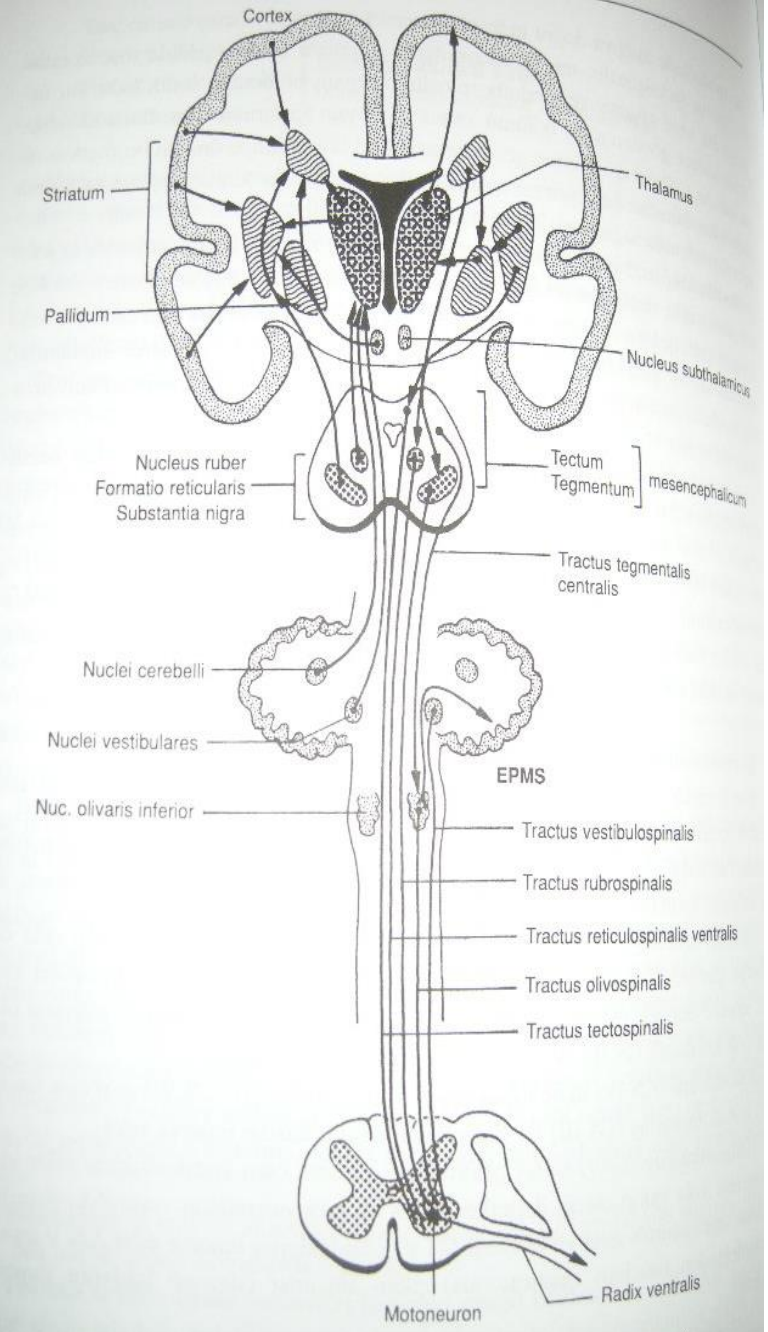
2-Atrophy in the muscles

3- Loss of all reflexes

4-Muscle fasciculation (in the gradual destruction of the lower motor neuron)

5-Muscle contracture (antagonists of the paralyzed muscle shorten)

6-Degeneration reaction [(A muscle with normal innervation will contract as long as a fluctuating (faradic) current is given. When a direct current (galvanic) is given, it only contracts when it is given and cut off.]



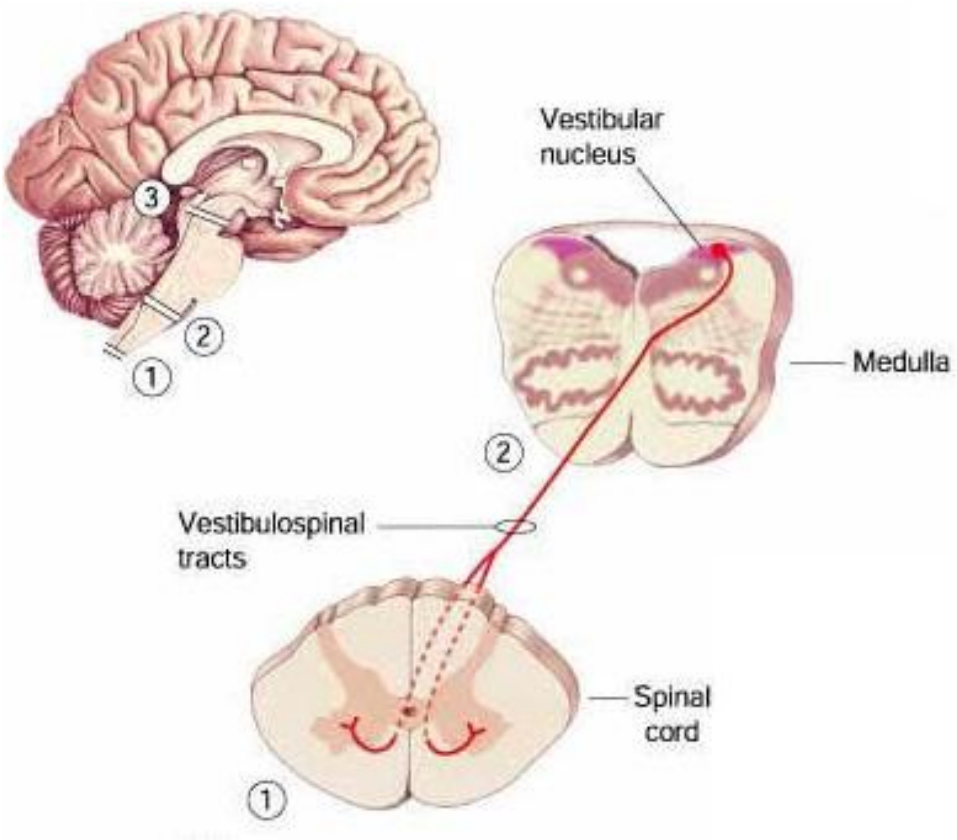
Şekil 15-6. Ekstrapiramidal motor sistem yapıları (Schumacher'den).

Tr. vestibulospinalis:

Located in the anterior funiculus, this pathway extends through the entire spinal cord. The first neuron of this pathway is the nucleus vestibularis lateralis located in the medullaoblangata. Here, afferent fibers come from the inner ear and cerebellum. The fibers leaving the nucleus vestibularis lateralis descend on the same side (ipsilateral) without crossing. Most of these are connected directly or via an interneuron with somotomotor neurons in the cervical and lumbosacral segments below in the spinal cord. The axons of the 2nd neurons starting from here leave the spinal cord at the anterior root and end in the skeletal muscles.

This pathway plays a role in regulating muscle tone and maintaining the balance of the body. This pathway causes activation of motor neurons innervating extensor muscles and inhibition of neurons innervating flexor muscles.

Tr. vestibulospinalis (med. and lat).



1st Neuron(UMN): nuclei vestibularess

Decussatio: nope

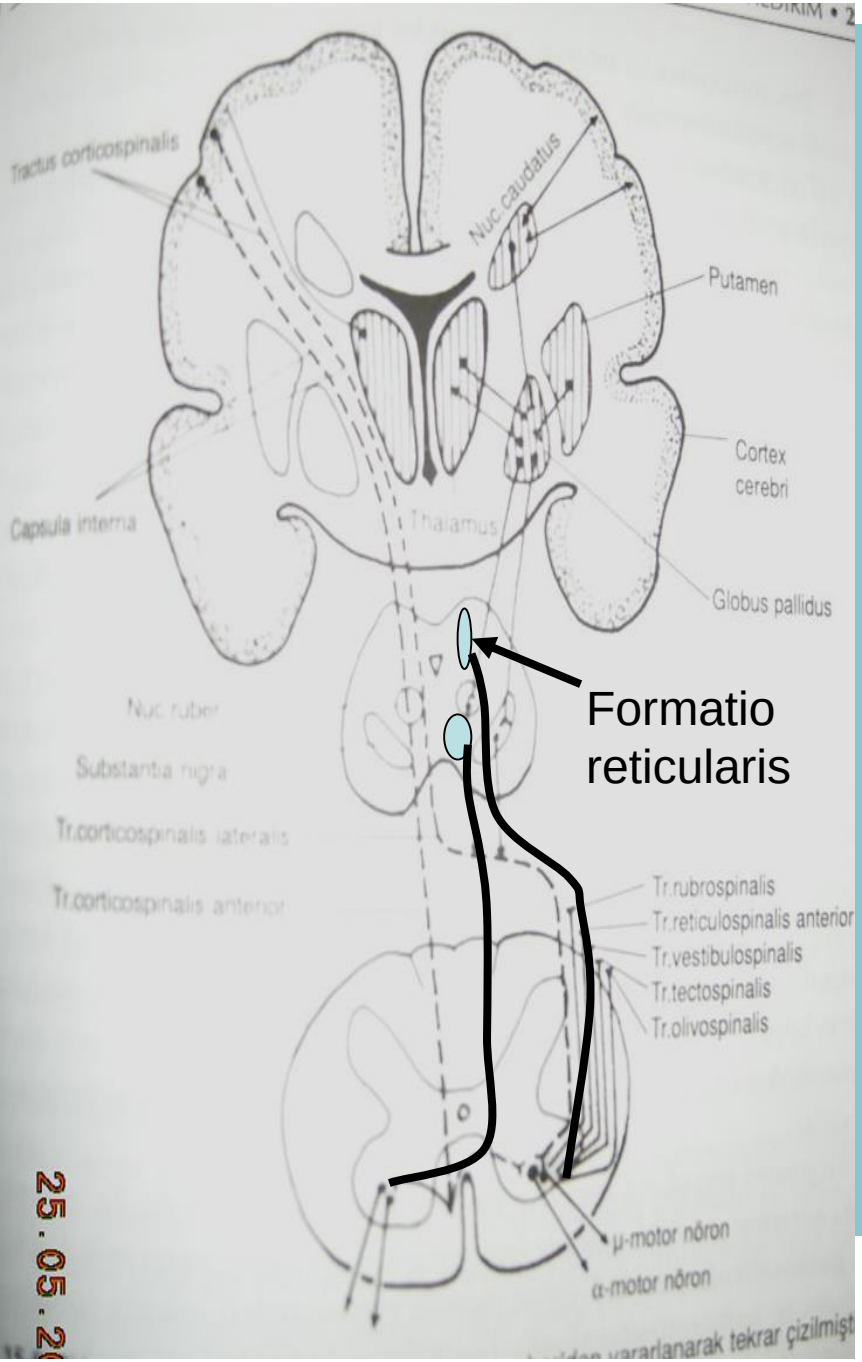
İnter neuron: lamina VII and VIII

very few directly

2nd Neuron(lmn): cornu anterior (servical and lumbosacral segments)

Track in medulla spinalis:funiculus anterior

tr. vestibulospinalis helps balance the body. This pathway is related to extensor muscle tone. It facilitates (activates) the movements of the extensor muscles and inhibits those of the flexors.



Tr.reticulospinalis

This road has two parts. The first is the formatio reticularis of the pons (**Tractus pontoreticulospinalis)**, the other is the formatio reticularis in the bulb (**Tractus bulboreticulospinalis)**.

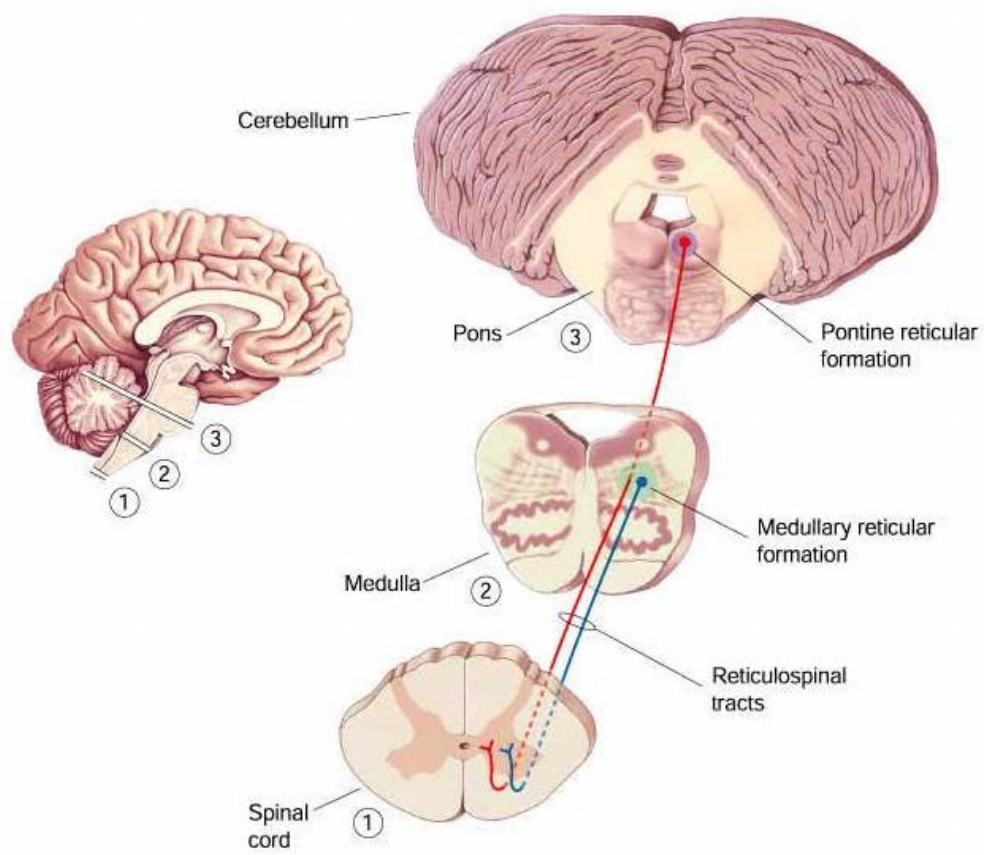
Starting from the reticulospianlis of the pons (Tractus pontoreticulospinalis anterior), almost all of the I. neuron is on the same side and a very small part of it passes to the opposite side in the commissura alba anterior near the segment where it will terminate and descends down to the anterior horn motor cells via a neuron.

Fibers starting from the formatio reticularis of the bulbus travel from the funiculus lateralis, and most of the fibers of this pathway cross, passing to the opposite side (Contralateral) and ending.

- Since it originates from the excitatory part of the tractus pontoreticulospinalis formatio reticularis, it has an enhancing effect on the muscles. Tractus bulboreticulospinalis, on the other hand, has an inhibitory effect on the muscles as it emerges from the inhibitory part.

- **Tractus reticulospinalis is involved in the regulation of voluntary motor movements and reflex movements related to posture. It also provides coordinated movement of the extremities, as in walking, running and swimming.**
- Formatio reticularis receives afferent fibers from autonomic centers. These impulses, which are organized in the formatio reticularis and transmitted to the medulla spinalis within the tractus reticulospinalis, play a role in the regulation of respiration and circulation.

Tr. reticulospinalis ant. (tr. pontoreticulospinalis)



1st neuron(umn):pons (formatio reticularis)

Decussatio: nope

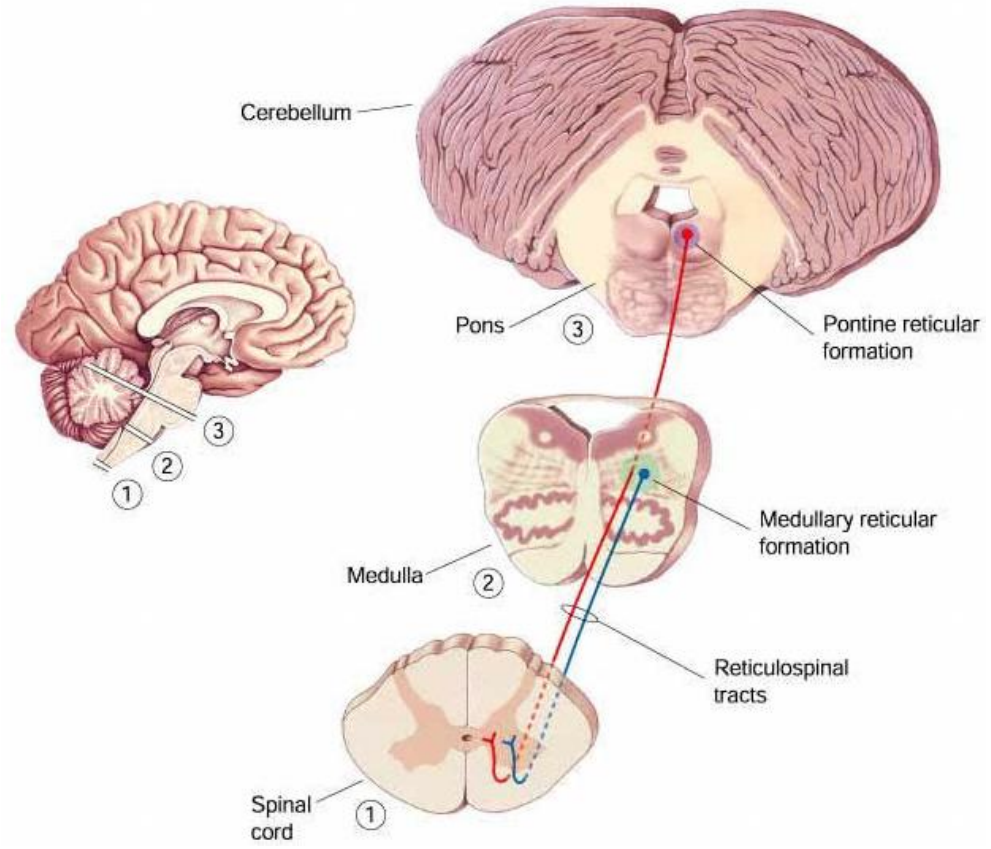
İnter neuron : lamina VII and VIII

2nd Neuron(lmn): cornu anterior

Track in medulla spinalis: funiculus ant.

Since some fibers terminate in the motor nuclei of the n. phrenicus and n. intercostalis, it is also considered as a respiratory pathway. It allows the limbs to move in a coordinated manner, as in walking, running, and swimming. It also contains efferent fibers belonging to the autonomous system.

Tr. reticulospinalis lat. (tr. bulboreticulospinalis)



1st neuron(umn): bulbus (formatio reticularis)

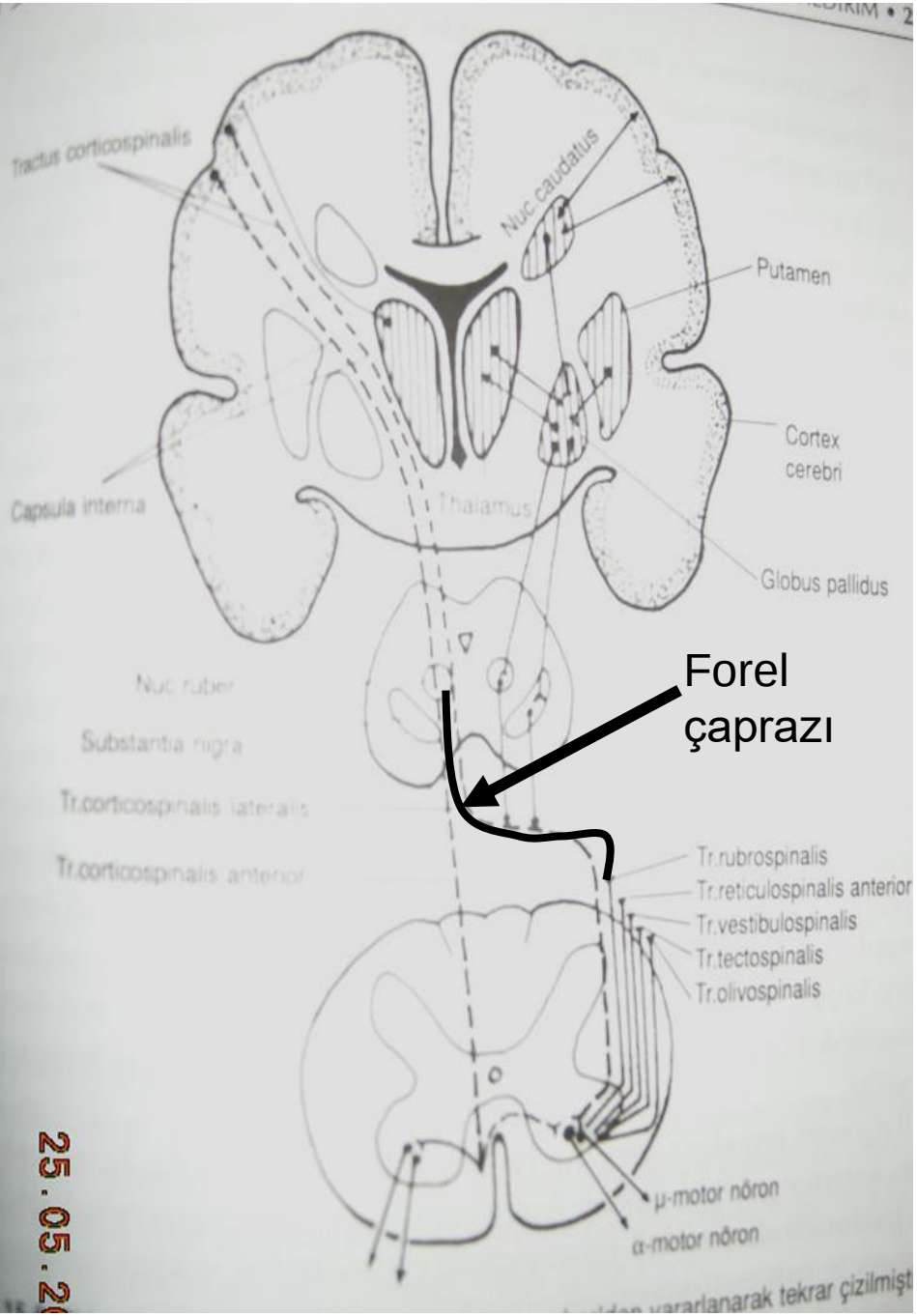
Decussatio: Most of the fibers are at the level of the bulb

İnter neuron : lamina VII, VIII and IX

2nd Neuron(lmn): cornu anterior

Track in medulla spinalis : funiculus lateralis

It has an inhibitory effect on the muscles. It affects voluntary movements and reflex activity. It allows the limbs to move in a coordinated manner, as in walking, running, and swimming. It specifically controls the proximal parts of the trunk and extremities.



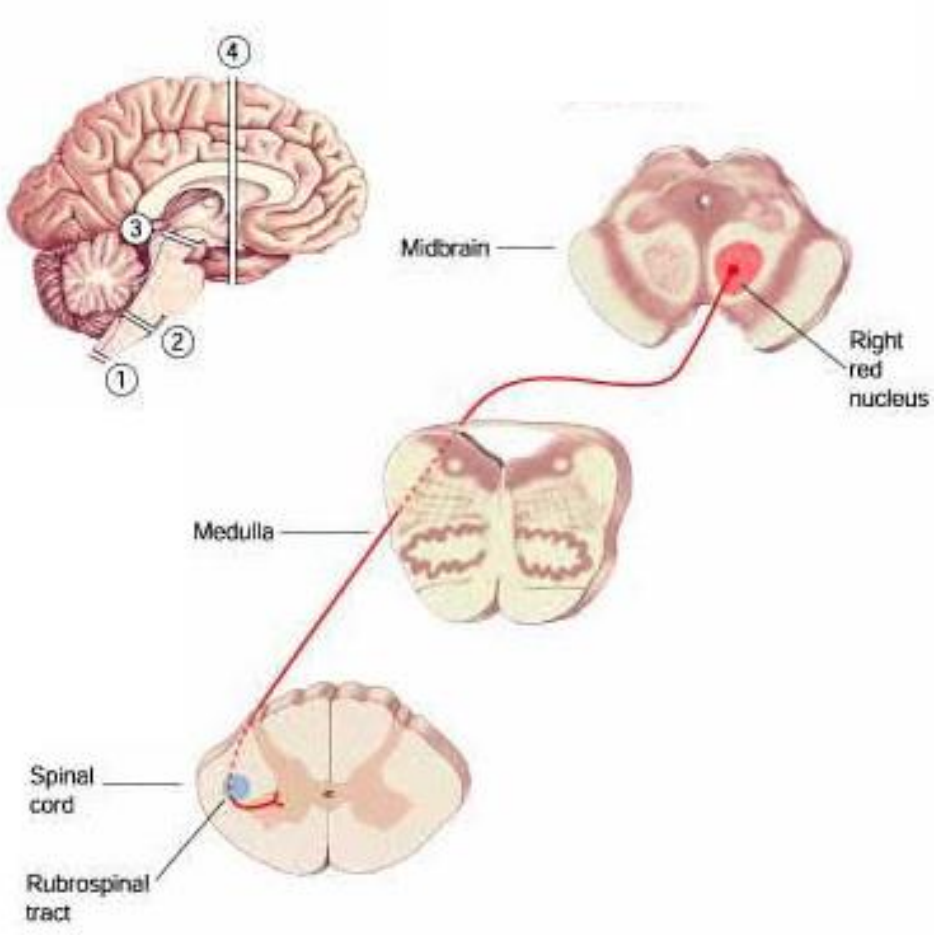
Tr.rubrospinalis:

Starting from the **nucleus ruber**, located at the level of the superior colliculus in the mesencephalon, **this entire path crosses as soon as it exits the nucleus {Forel cross=decussatio tegmentalis (ventralis)},** passes through the pons and medulla oblongata and lies in the funiculus lateralis of the spinal cord. However, it can be easily followed up to the second cervical segment.

Nucleus ruber sends the senses it receives from the cortex and cerebellum to the related motor neurons directly or via an interneuron through the tractus rubrospinalis.

Stimulation of the nucleus ruber has a facilitating effect on the flexor muscles of the contralateral side and an inhibitory effect on the extensor muscles. The most important function of the tractus rubrospinalis is to control the tone of the flexor muscle groups.

Tr. rubrospinalis (Monakow beam)



1st neuron(umn): nucleus ruber (Nuc. ruber, cerebral korteks ve beyincik'ten duyular alır .)

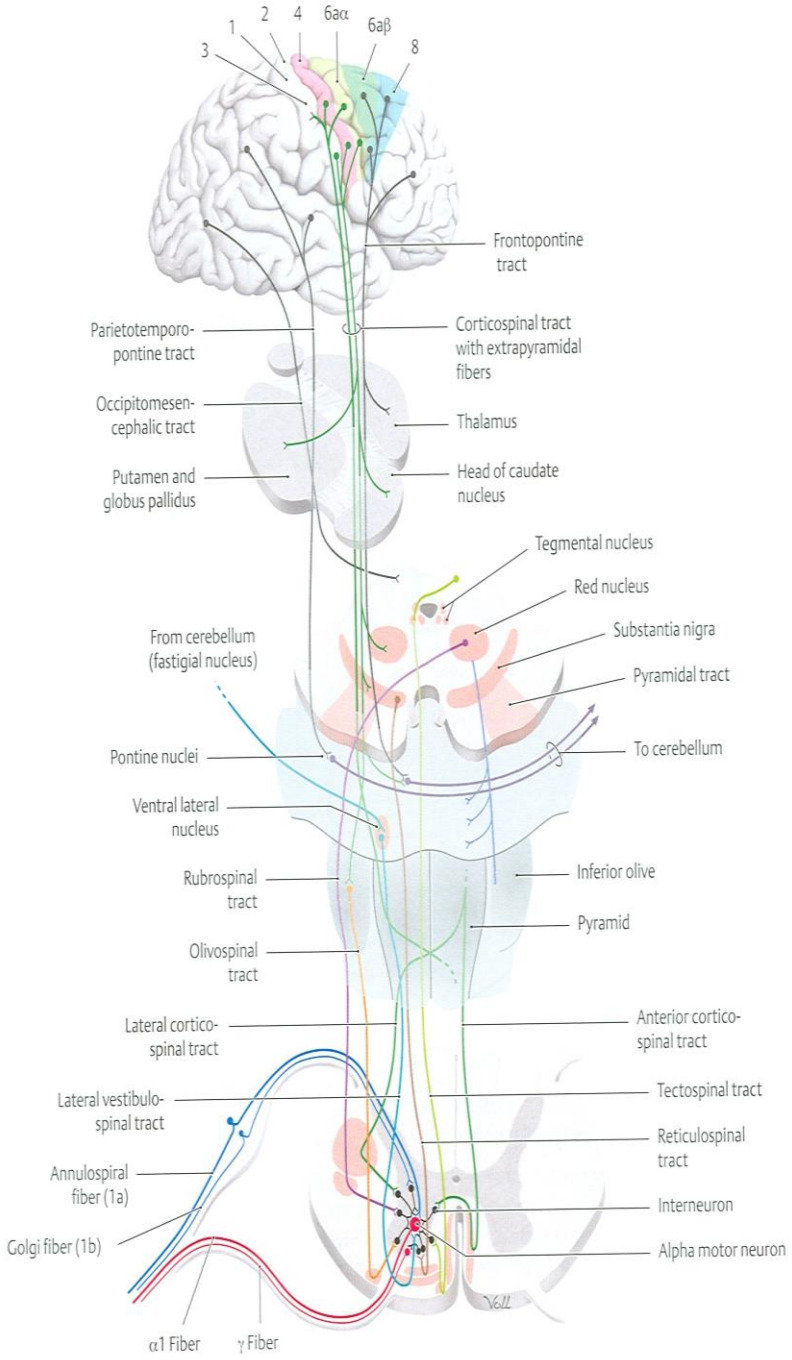
Decussatio: decussatio tegmentalis ant. (Forel)

İnter neuron : lamina V-VII

2nd Neuron(lmn): cornu anterior

Track in medulla spinalis: funiculus lateralis

Stimulation of the nuc. ruber has a facilitating effect on the flexor muscles of the contralateral side and an inhibitory effect on the extensor muscles. The most important function of the tr. rubrospinalis is to control the tone of the flexor muscle groups.



Tr. tectospinalis:

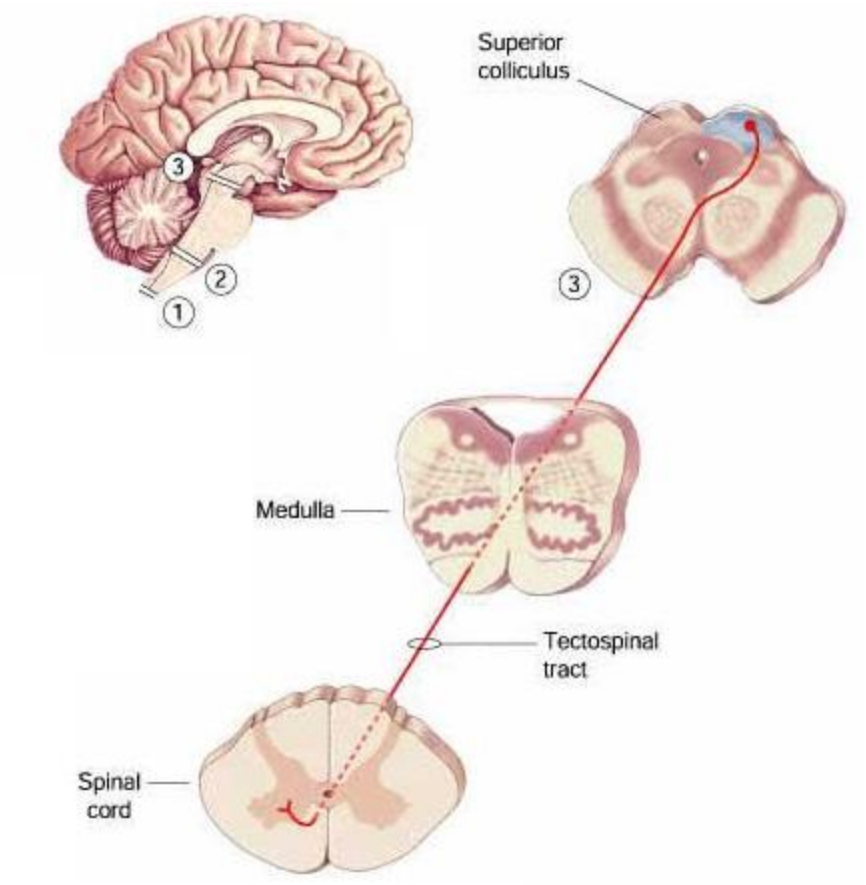
Funiculus is located anteriorly. It consists of fibers arising from the superior colliculus. It also contains fibers related to the sense of hearing, originating from the colliculus inferior and passing through the colliculus superior. Most of the fibers emerging from the superior colliculus cross immediately.

This cross is called decussatio tegmentalis (dorsalis) or **Meynert's cross**. In the brainstem, it descends down the funiculus anterior near the fasciculus longitudinalis medialis.

It only communicates with somatomotor neurons in the cervical segments via an interneuron.

It makes reflex movements of the head, neck and upper extremities related to light and sound. Such as the protective movements we make with the head, neck and upper extremity in the presence of a strong light, the reflex following of a shooting star or a flying object in the air, or the reflex movements made by our head and neck in the presence of a sudden sound.

Tr. tectospinalis



1st neuron(umn): **colliculus superior** (Also includes the auditory fibers that originate from the colliculus inferior and pass through the colliculus superior.)
Decussatio: decussatio tegmentalis post. (Meynert)

İnter neuron : lamina IV-VII

2nd Neuron(lmn): cornu anterior **(only cervical segments)**

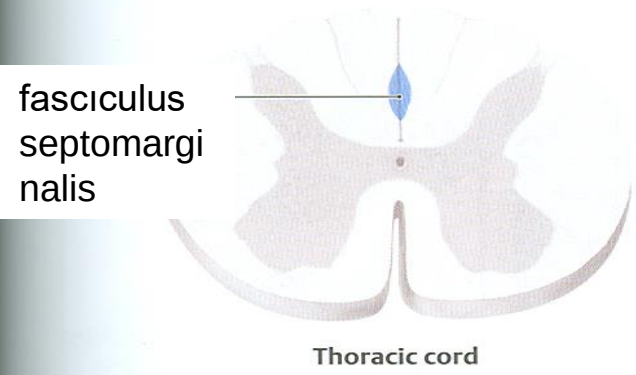
Track in medulla spinalis : funiculus anterior

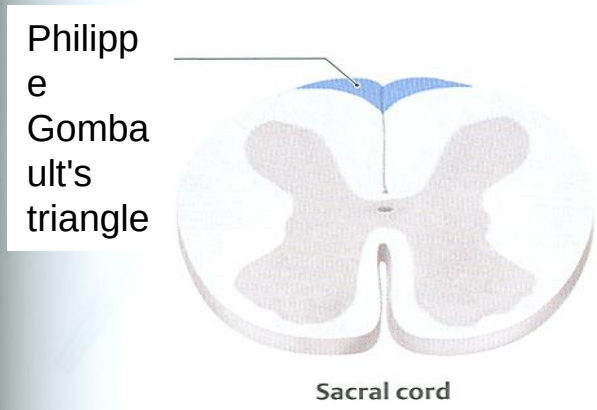
It makes reflex movements of the head, neck and upper extremities related to light and sound. Such as the protective movements we make with the head, neck and upper extremity in the presence of a strong light, the reflex following of a shooting star or a flying object in the air, or the reflex movements made by our head and neck in the presence of a sudden sound.

Tr. olivospinalis (Helweg beam): It is thought to arise from the nucleus olivaris inferior in the bulbus. Its fibers are found just outside-posterior to anterior root fibers in the spinal cord. It contains fibers belonging to tractus spino-olivaris. Although the existence and function of this path, which can only be seen in the upper part of the neck, is not known exactly, it is thought to be related to head and neck movements.

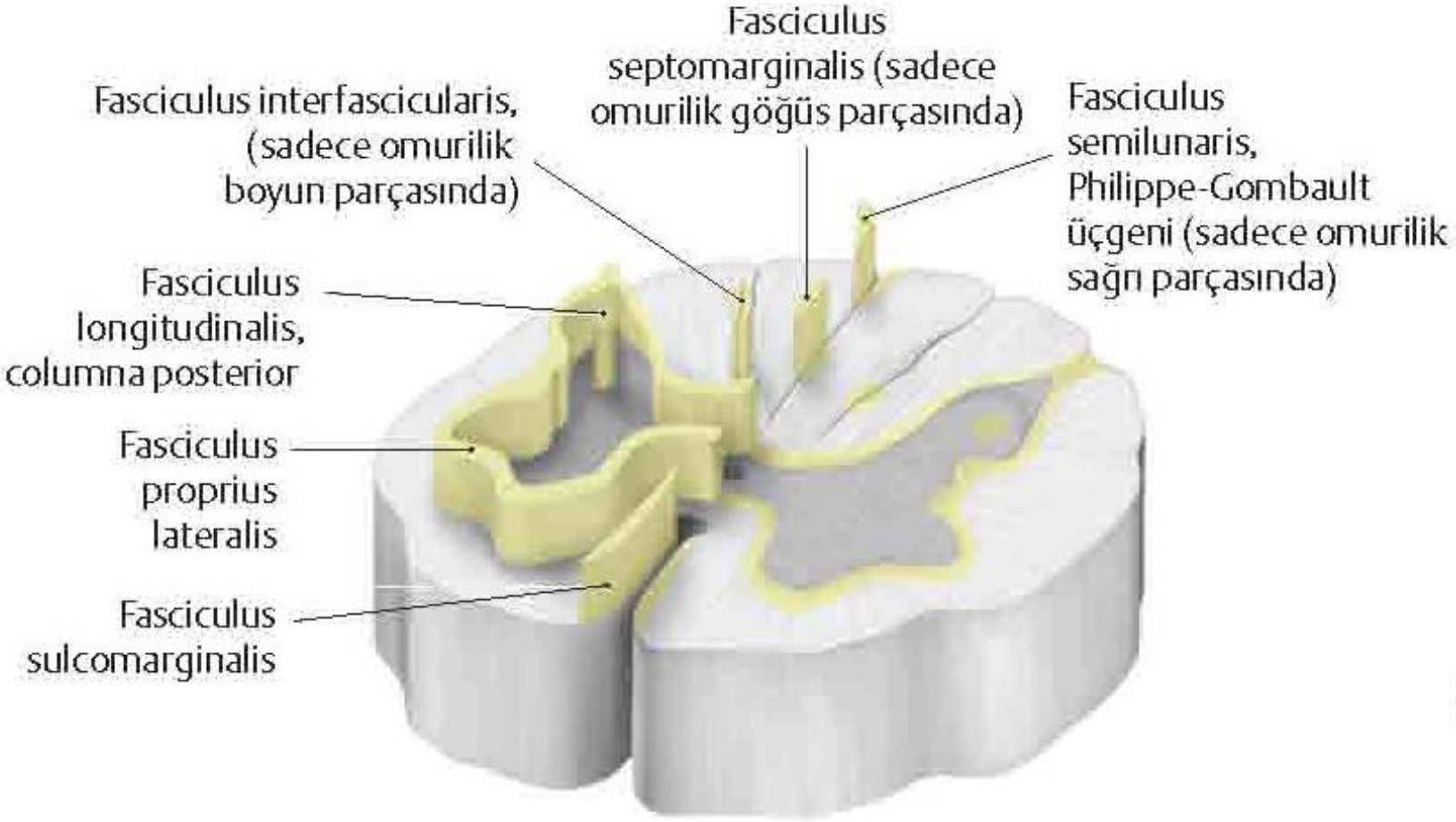
Descending autonomic fibers: Based on clinical and physiological information, it has been understood that unilateral or bilateral visceral centers in the brain stem make connections with neurons belonging to the preganglionic autonomic system in the spinal cord through these fibers. However, these fibers are known to descend in the **tractus reticulospinalis** in **the funiculus lateralis**. Its distribution and termination patterns are unknown. Such fibers are also found in small amounts in the funiculus anterior.

Descending tracts in funiculus posterior





Afferent fibers entering the funiculus posterior divide into long ascending and short descending branches. The long fibers form the **fasciculus gracilis and fasciculus cuneatus**. Descending fibers appear as small areas in the spinal cord. The fibers trapped between **fas.gracilis and cuneatus** in the thoracic region are seen as commas in the sections. For this reason, it is called **Schultz's comma bundle (Fasciculus interfascicularis**), and in the lower half of the thoracic region, it is Fasciculus inte**called fasciculus septomarginalis. Fasciculus septomarginalis, on the other hand, is called Flech's oval area because it is oval in the lower half of the thoracic region, and Philipe Gombault's triangle because it resembles a triangle in the sacral region.** rfascicularis consists of descending parts of fibers that come to the spinal cord with posterior roots and divide into descending and ascending branches in the posterior cord. Fasciculus septomarginalis, on the other hand, mostly consists of fibers connecting the medulla spinalis segments.


Fasciculus septomarginalis (sadece omurilik göğüs parçasında)
Fasciculus interfascicularis, (sadece omurilik boyun parçasında)
Fasciculus semilunaris, Philippe-Gombault üçgeni (sadece omurilik sağrı parçasında)
Fasciculus longitudinalis, columna posterior
Fasciculus proprius lateralis
Fasciculus sulcomarginalis

intersegmental fibers

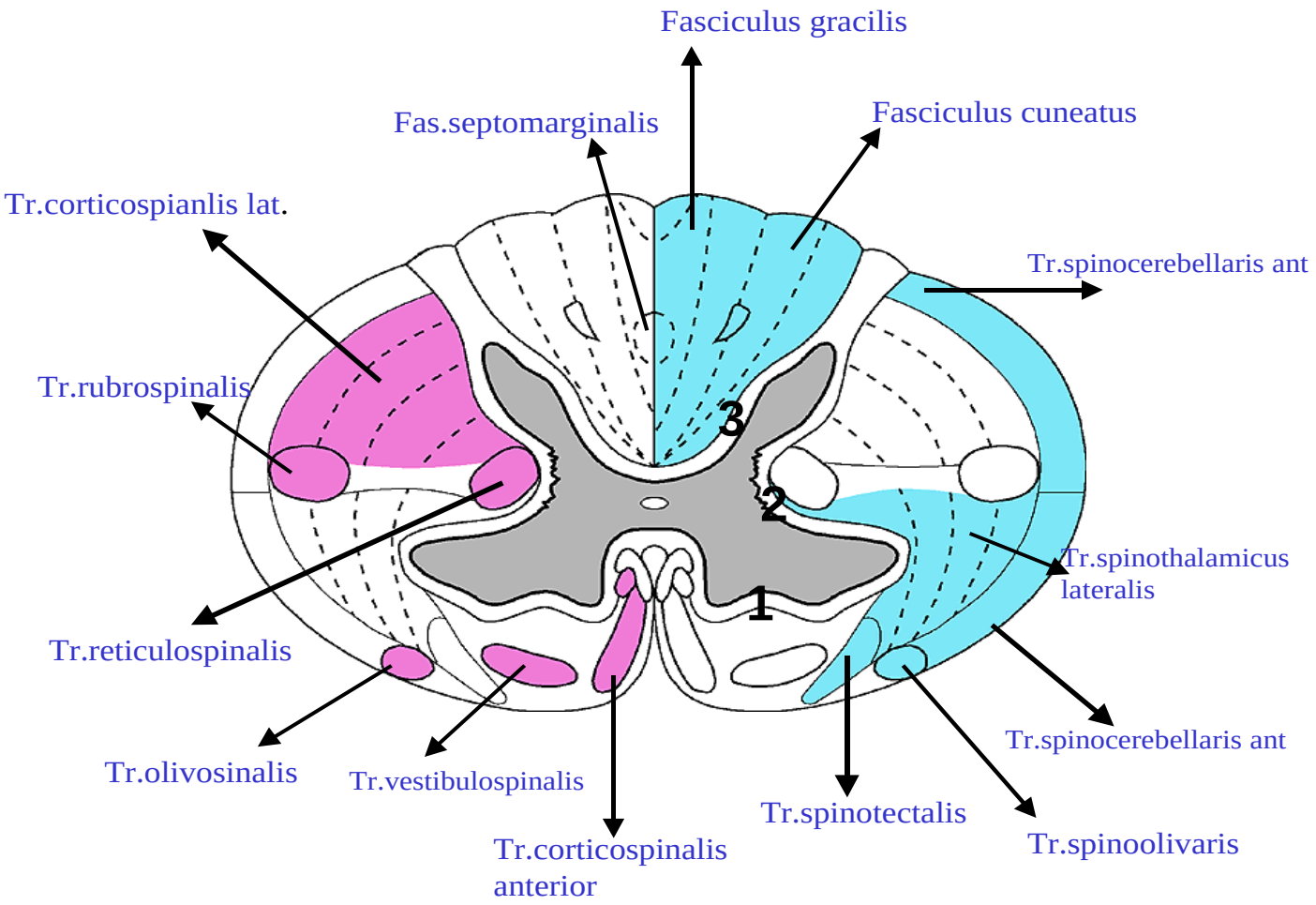
1- Tr. intersegmentalis posterior (fasciculi proprii posteriores)

2- Tr. intersegmentalis anterior (fasciculi proprii anteriores)

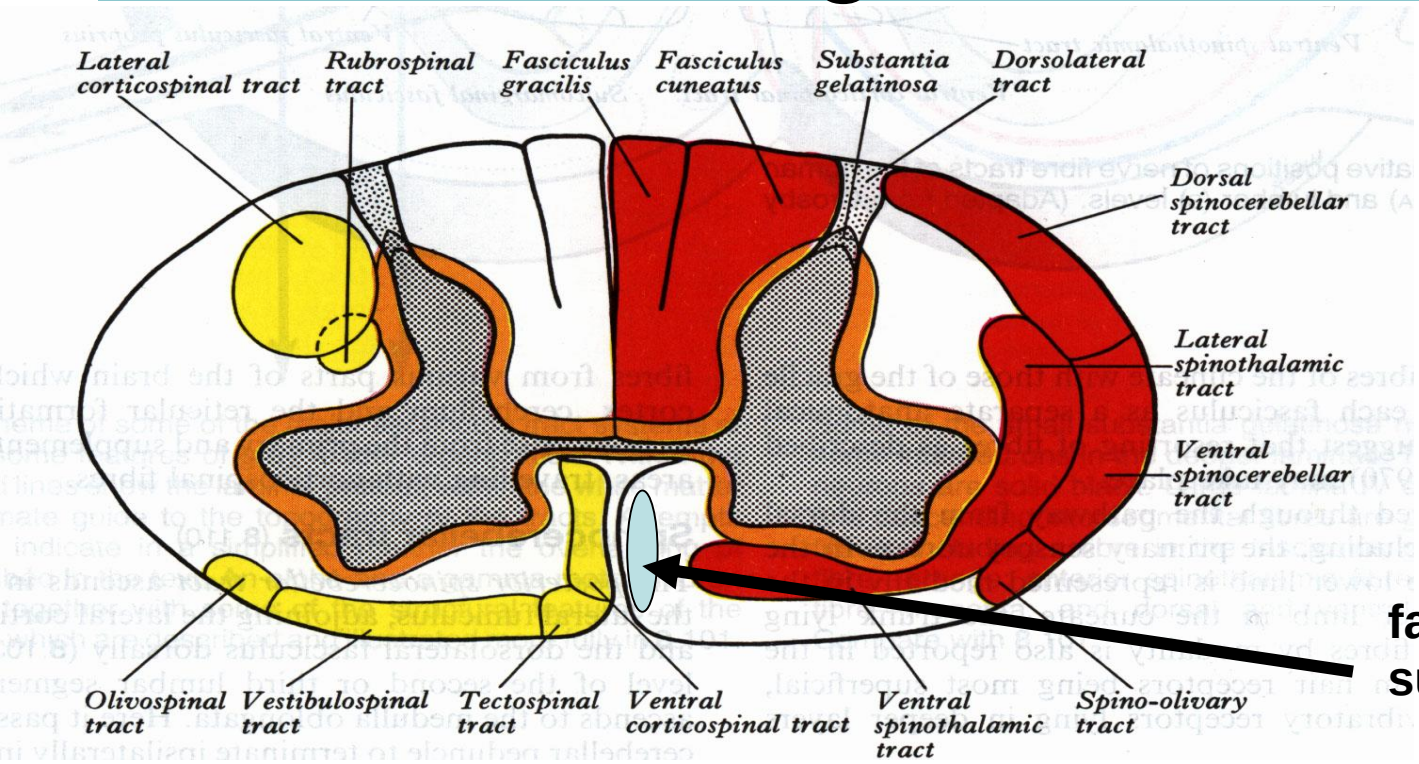
3- Tr. İntersegmentalis lateralis (fasciculi proprii laterales)

These fibers are located in the funiculus anterior, posterior, and funiculus lateralis and connect the spinal cord segments to each other. These fibers originate from cells in the columna anterior and columna posterior. They are found close to the gray matter and divide into ascending branches in the white matter. These fibers play an important role in the formation of **spinal reflexes.**

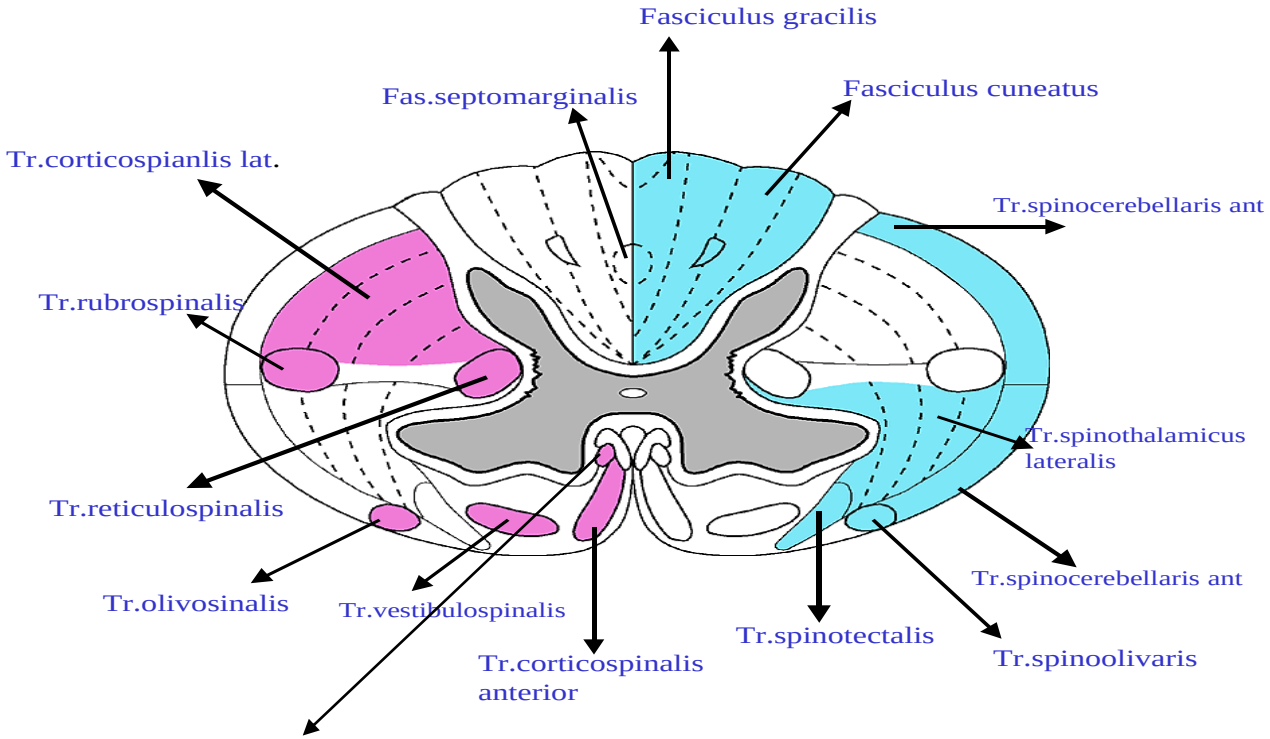
Fasciculi proprii anteriores (1), laterales (2), posteriores (3)



Faciculus longitudinalis medialis



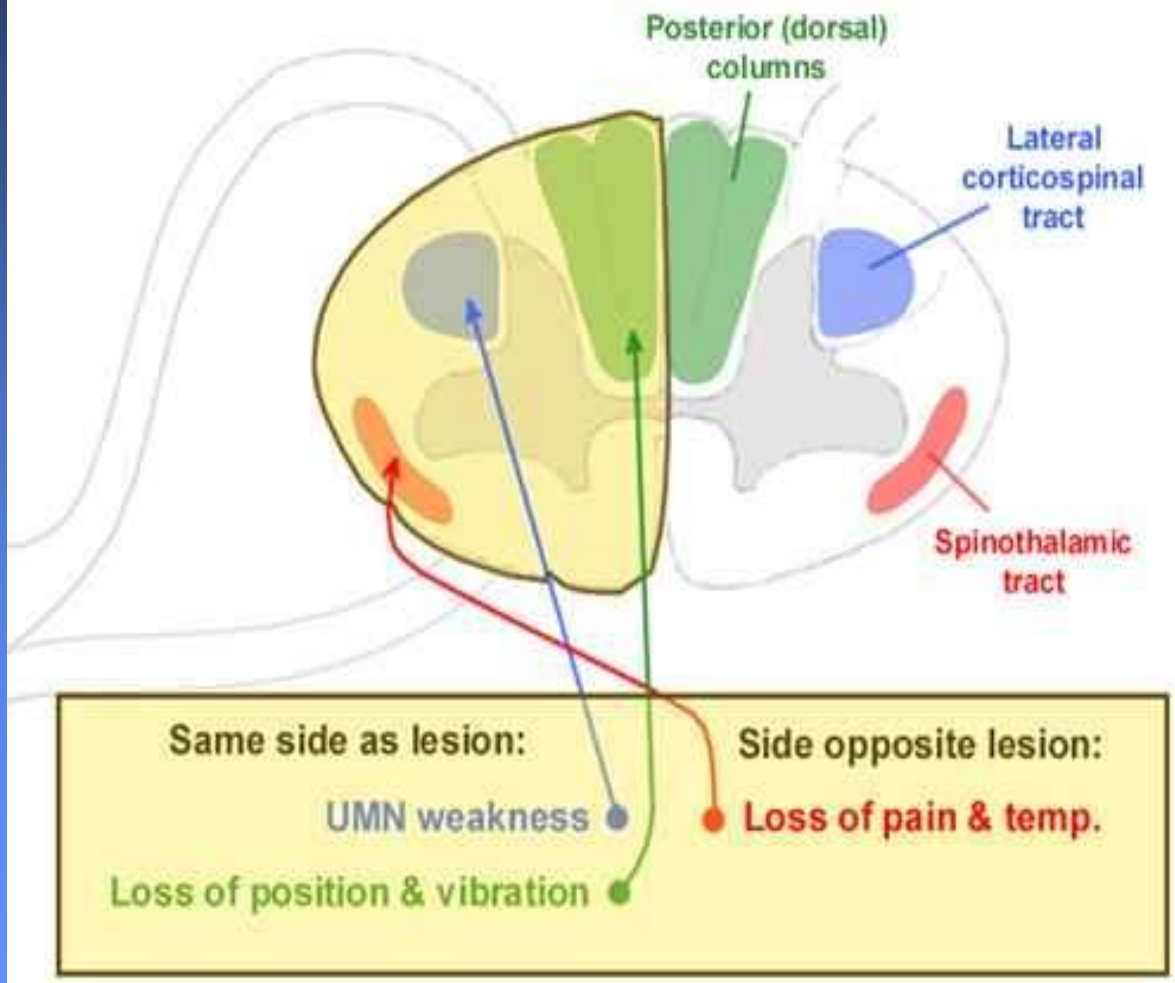
- Extending through the brain stem and spinal cord, this pathway is a fasciculus formed by descending and ascending axons that originate from various nuclei at different levels of the brainstem. The continuation of the fasciculus longitudinalis medialis in the spinal cord is the fasciculus sulcomarginalis. This structure, which is evident only in the neck region, extends on both sides of the fissura mediana anterior.

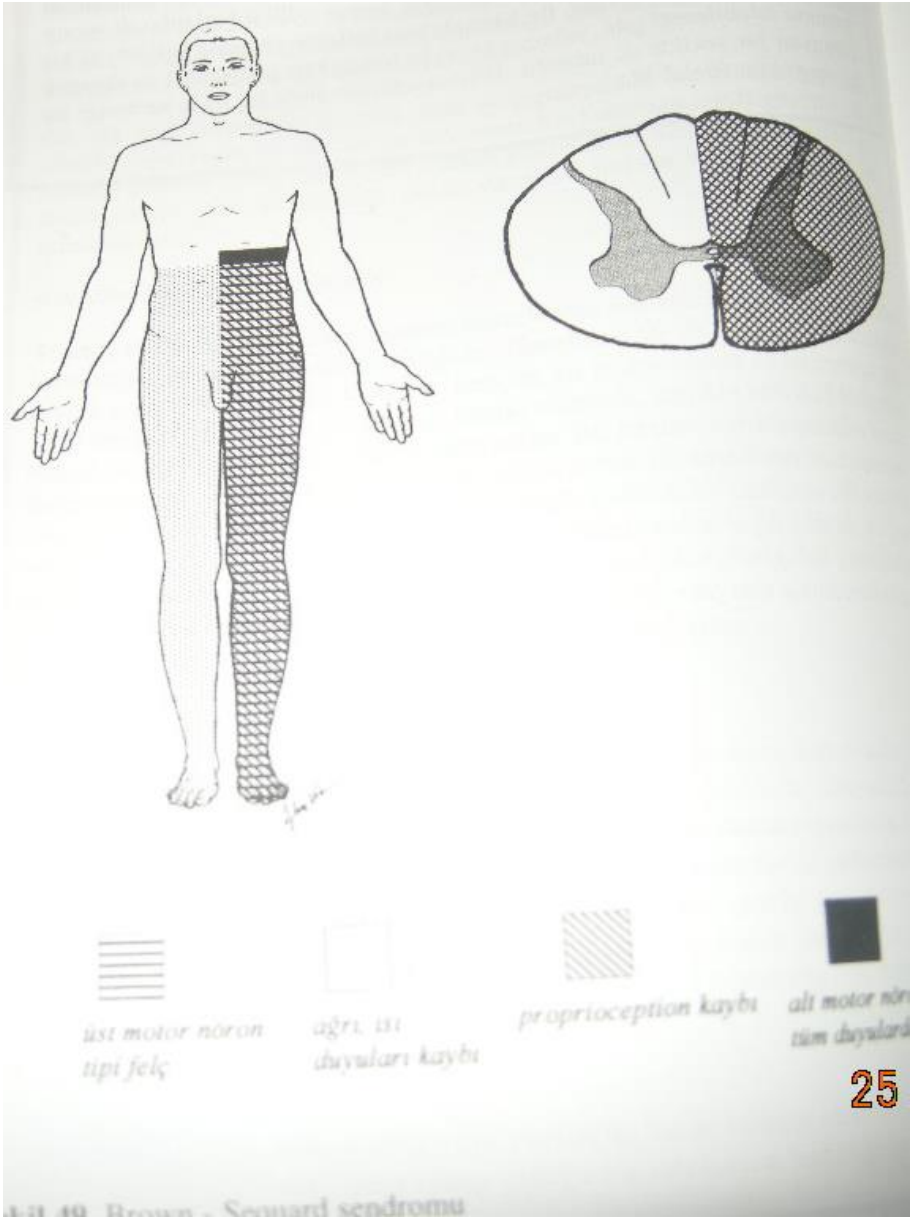


Fasciculus longitudinalis medialis

- Extending along the brain stem and spinal cord, this pathway starts from the **nucleus cinterstitialis, colliculus superior, formatio reticularis pontis, nucleus vestibularis medialis.**
- Axons starting from these nuclei form the tractus tectospinalis, tractus vestibulospinalis and tractus pontoreticulospinalis, which run in the faciculus longitudinalis medialis. It connects some pairs of heads in the brainstem (**n. oculomotorius, n. trochlearis, n. abducens, n. facialis, n. hypoglossus).**
- It provides coordinated movement of the eyes, head, neck and upper extremities together with the fasciculus sulcomarginalis, which is the continuation of the spinal cord.

Brown-Sequard Syndrome of Spinal Cord Hemisection





Şekil 49. Brown - Sequard sendromu

Brown-Sequard Syndrome: It is a syndrome that occurs as a result of complete damage to the right and left halves of one or more segments at any level of the spinal cord.

- A) Upper motor neuron-type paralysis develops below the level of the lesion and on the same side, due to the truncation of the tractus corticospinalis.
- B) Depending on the damage to the gray matter at the level of the lesion, lower motor neuron type paralysis on the same side where this segment or segments innervate; Vasamotor paralysis develops in the skin innervated by sympathetic presynaptic cells.
- C) Loss of all senses on the same side due to damage to the fibers entering the radix posterior and medulla spinalis at the level of the lesion

Brown-Sequard Syndrome

- D) Loss of pain and temperature sensation on the contralateral side and below the lesion level, usually under a dermatome, due to injury to the tractus spinothalmicus lateralis formed by the fibers coming from the opposite side
- E) Loss of conscious proprioceptive sensation due to the interruption of the funiculus posterior tracts on the same side at and below the lesion level.

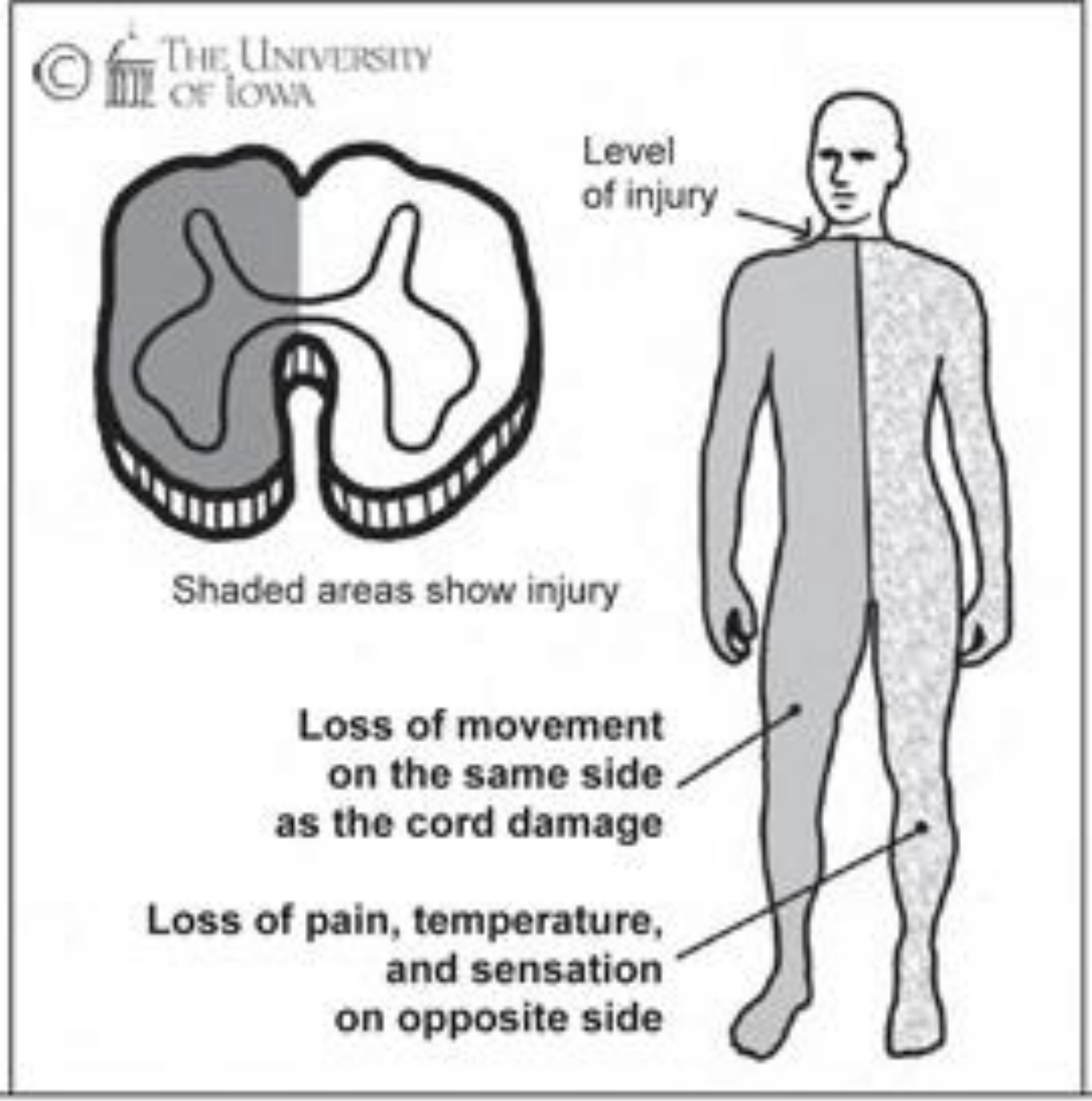
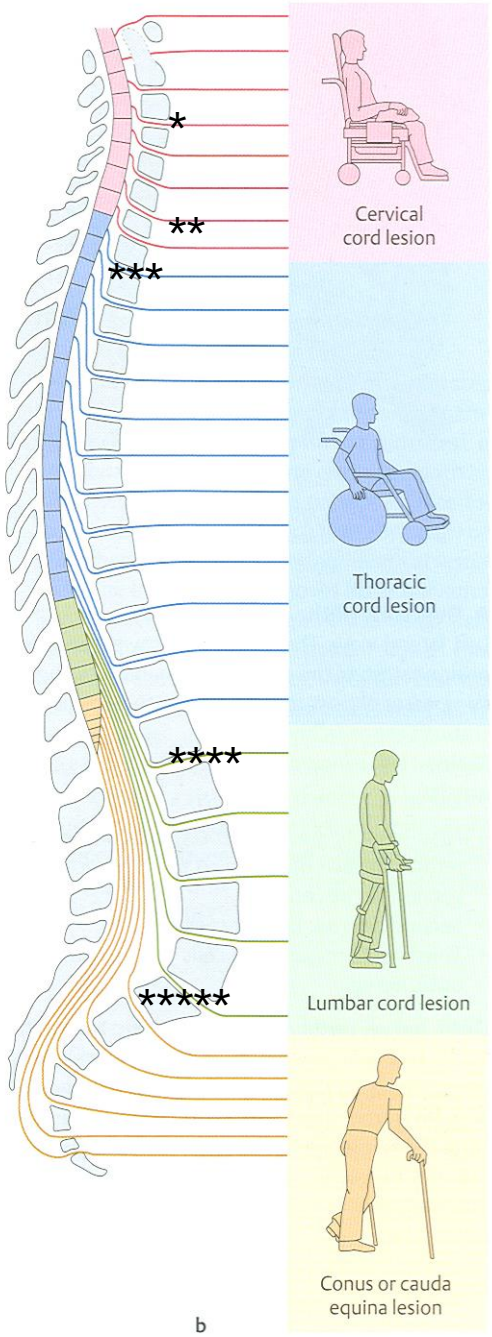


Figure 12. Brown-Séquard Syndrome



MEDULLA SPINALIS COMPLETE INCITS

*If there is a **complete** incision of the spinal cord at or above the **C4 segment** level, respiratory failure and death occur due to n.phrenicus and nn.intercostales paralysis.

•An incision at the **C5 level** causes complete paralysis of all extremity and trunk muscles. There is also a complete loss of sensation in these regions.

•****An incision at **level C7** causes paralysis in the hands and wrists, trunk and legs.

•***In cuts at the **T1 level**, paralysis is in the small muscles of the hand, trunk and lower extremities.

•Upper extremity muscles are unaffected by incisions in the thoracic segments below the T1 level.

*****Paralysis (paraplegia) is observed in only two lower extremities in cuts in the **L2** medulla spinalis segment. At the same time, there is a complete loss of sensation in these two extremities.

******S1** medulla spinalis segment is approximately at the level of the thoracolumbal joint. In cuts at this level, paralysis is observed in the muscles below the knee. Injuries to the medulla spinalis often occur at or near this level.

Levels of Injury and Extent of Paralysis