Presentation by:
Abbas Aliaghaei, Ph.D. in Neuroscience, Anatomy and Cell Biology Department, School of Medicine, Shahid Beheshti University Of Medical Sciences

Spinal cord segments, nerves and vertebrae

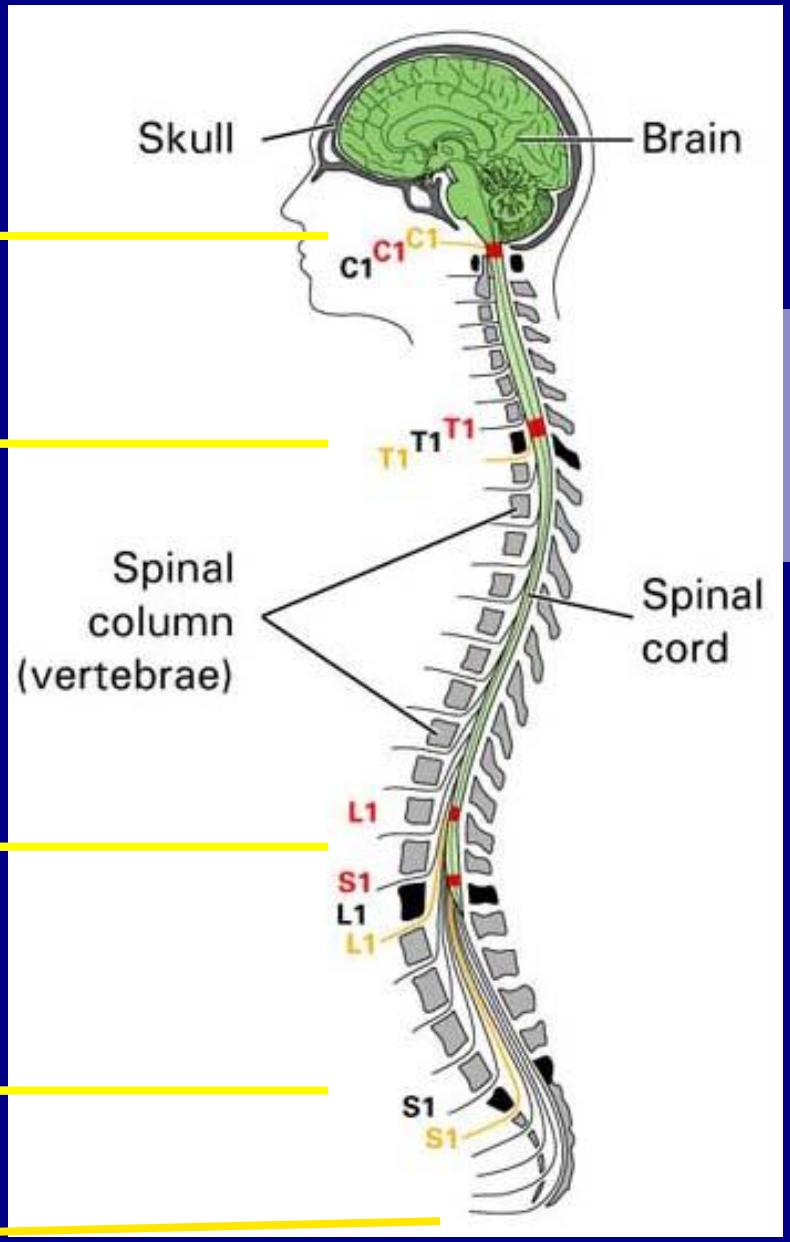
Cervical (C) - Neck
(C1-8)

Thoracic (T) - Chest
(T1-12)

Lumbar (L) - Back
(L1-5)

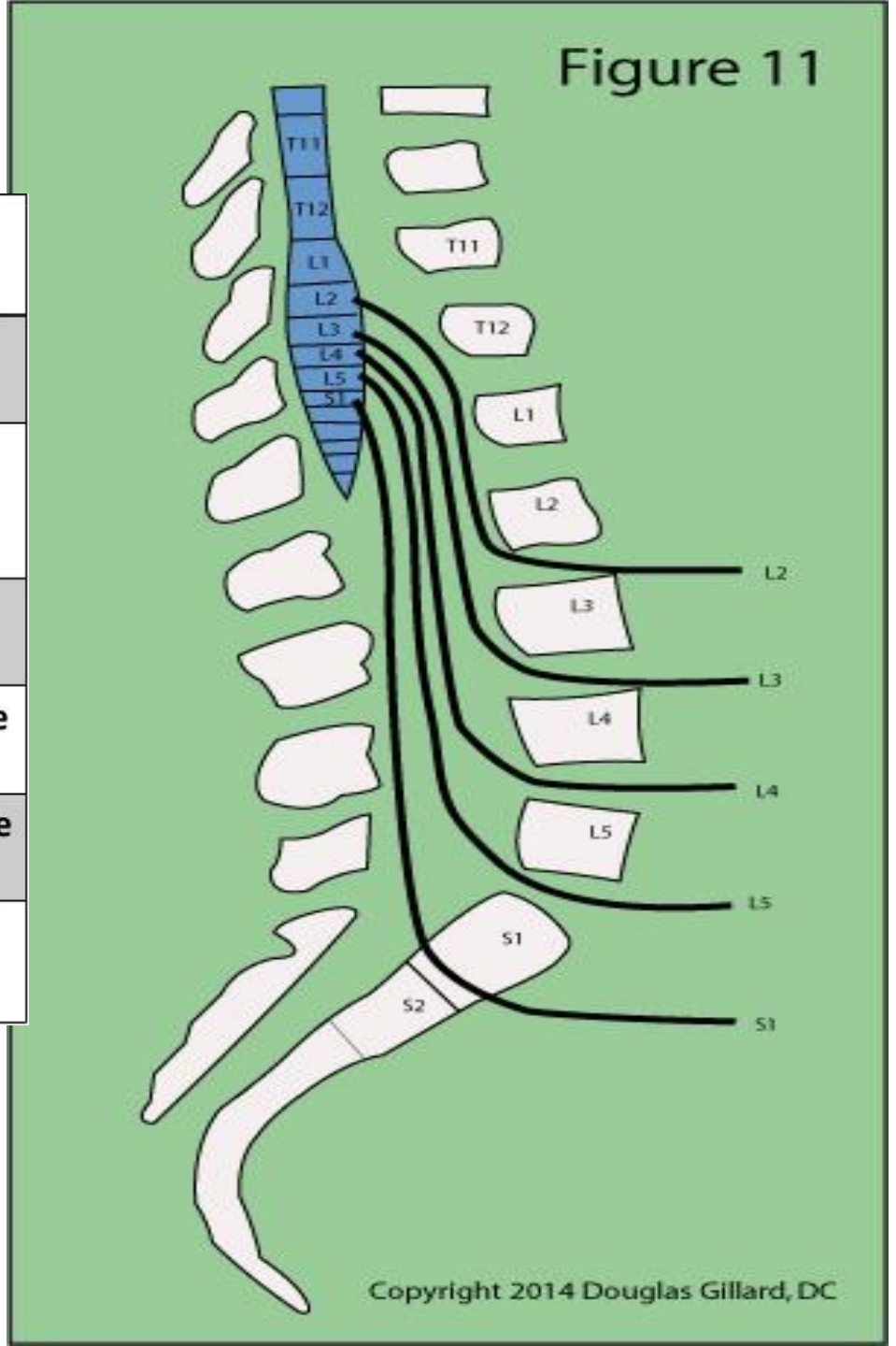
Sacral (S) - Pelvis
(S1-5)

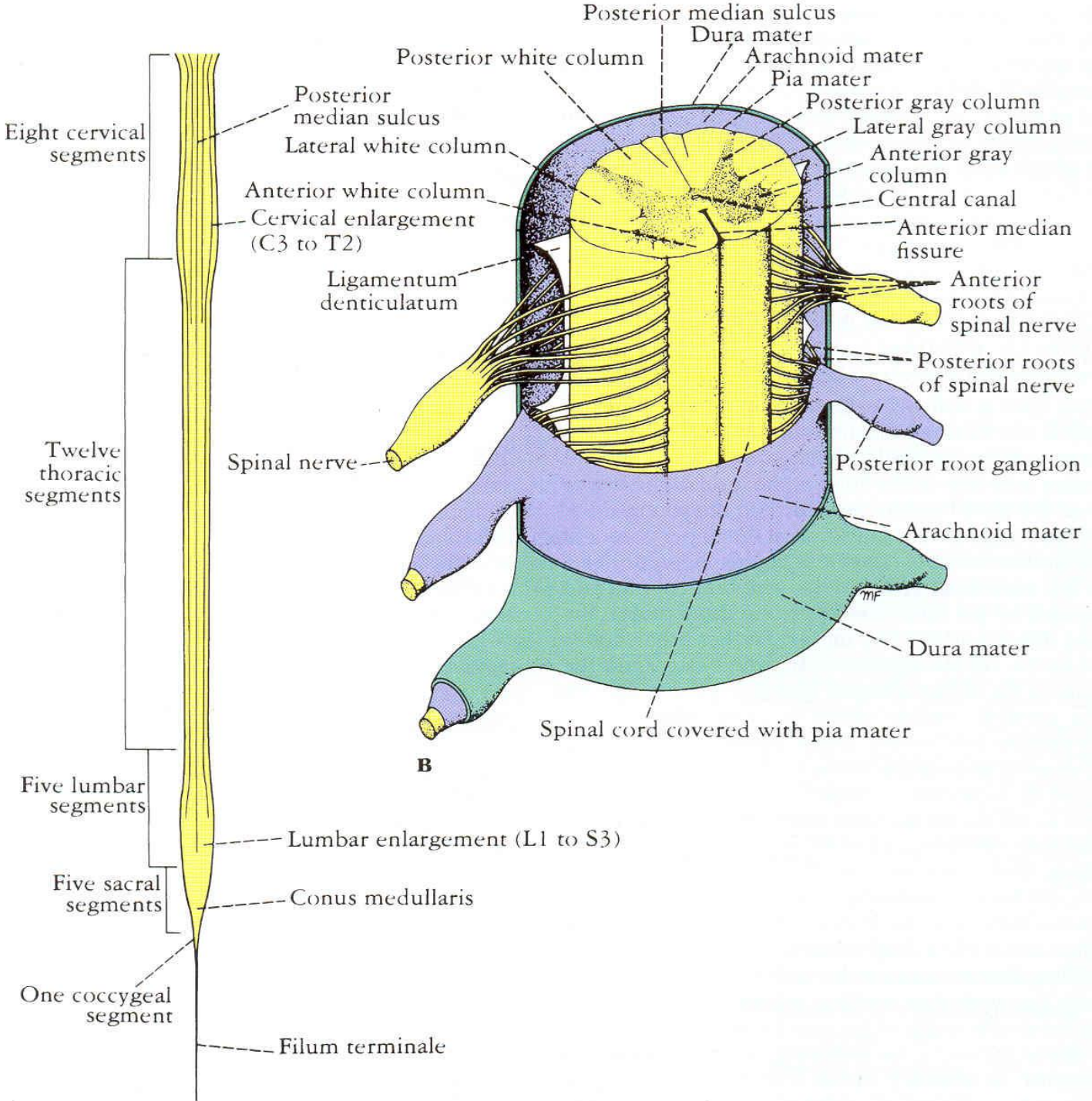
Coxygeal

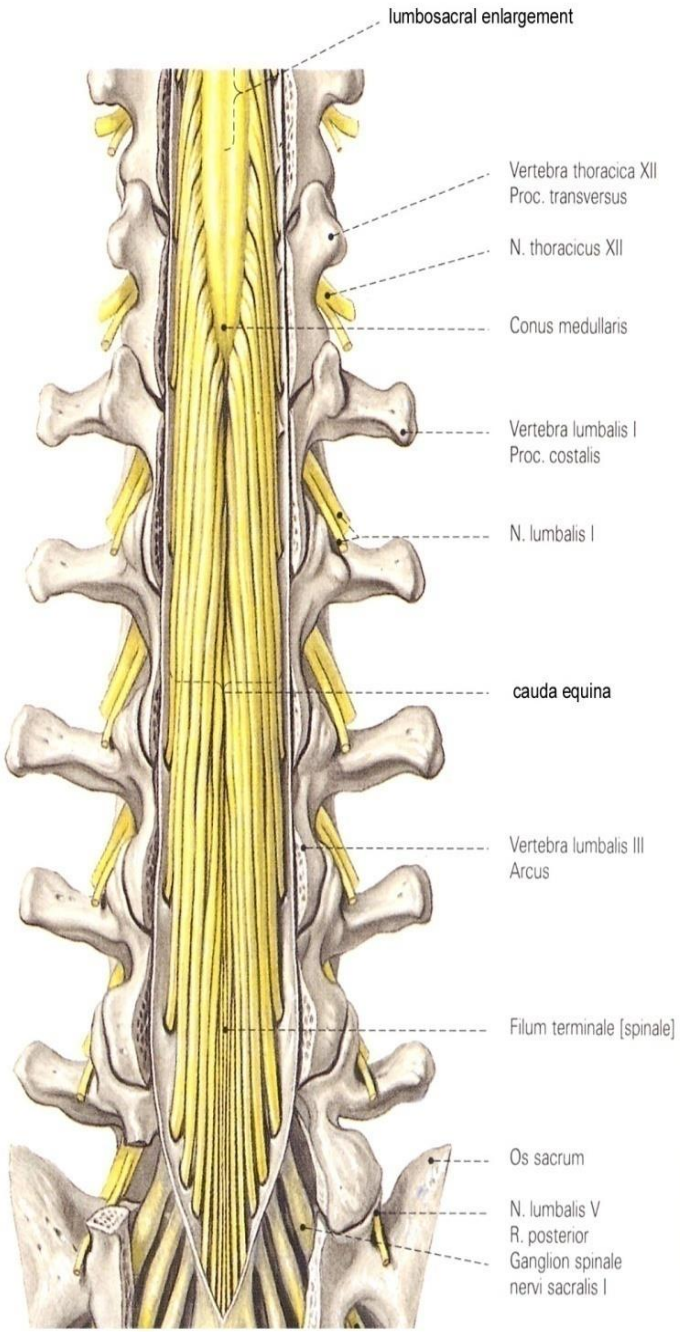


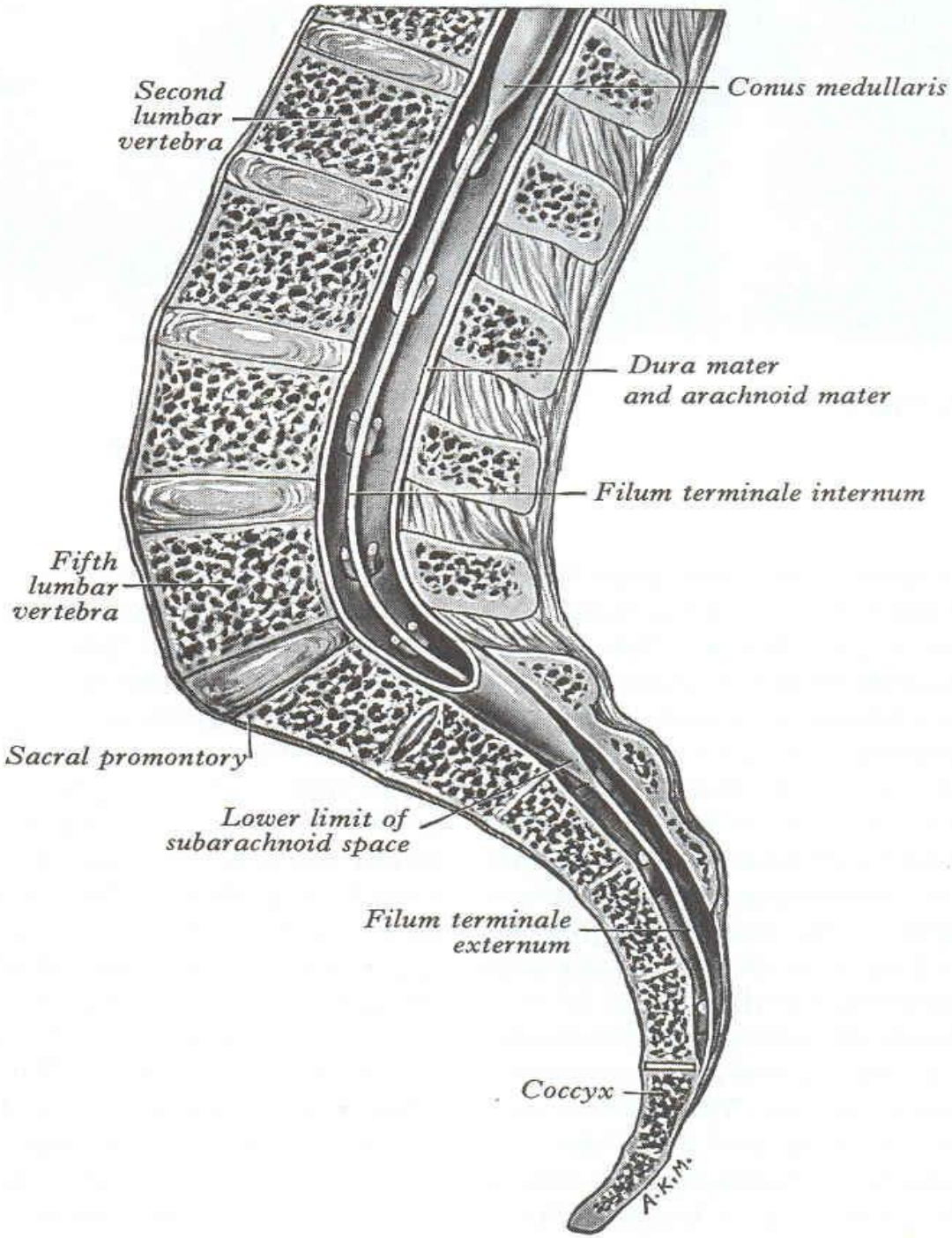
Vertebra
Spinal segment
Spinal root

REGIONS	SPINAL SEGMENTS	VERTEBRAL LEVEL	GENERAL RULE
Upper cervical	C2	C2	Same level
Lower cervical	C6	C5	One vertebra above
Upper thoracic	T5	T3	Two above
Lower thoracic	T10	T7	Three above
lumbar	L1 TO L5	T10 TO T11	Three to five above
Sacral and coccygeal	S1 TO S5 C X 1	T12 TO L1	Six to ten above

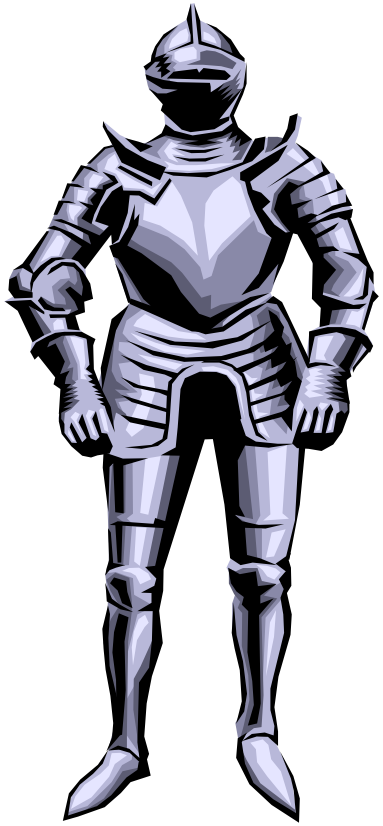


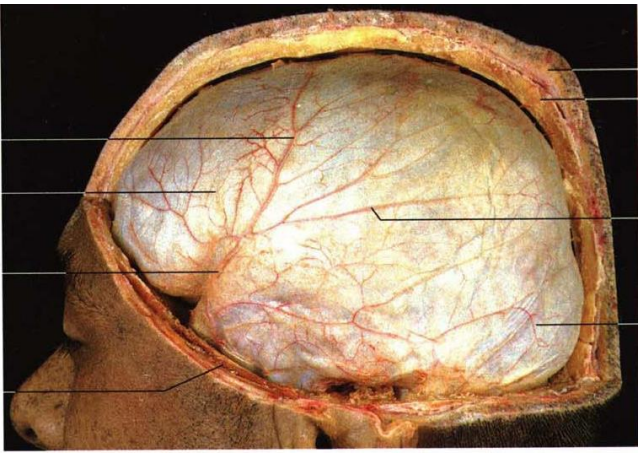

Posterior median sulcus
Dura mater
Posterior white column
Arachnoid mater
Pia mater
Posterior gray column
Lateral gray column
Posterior median sulcus
Eight cervical segments
Lateral white column
Anterior gray column
Anterior white column
Central canal
Cervical enlargement (C3 to T2)
Anterior median fissure
Ligamentum denticulatum
Anterior roots of spinal nerve
Posterior roots of spinal nerve
Twelve thoracic segments
Spinal nerve
Posterior root ganglion
Arachnoid mater
Dura mater
Spinal cord covered with pia mater
B
Five lumbar segments
Lumbar enlargement (L1 to S3)
Five sacral segments
Conus medullaris
One coccygeal segment
Filum terminale

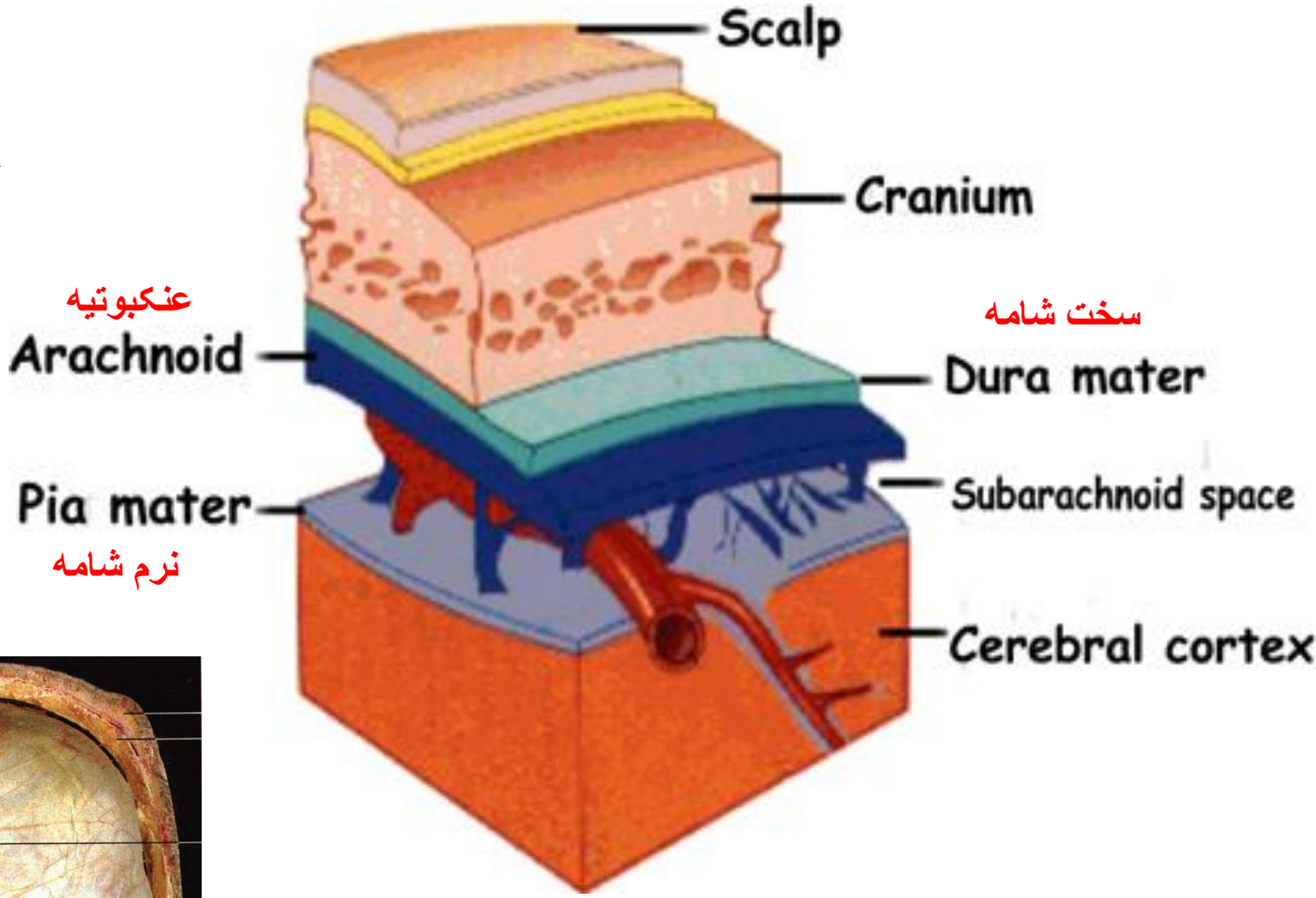

lumbosacral enlargement
Vertebra thoracica XII
Proc. transversus
N. thoracicus XII
Conus medullaris
Vertebra lumbalis I
Proc. costalis
N. lumbalis I
cauda equina
Vertebra lumbalis III
Arcus
Filum terminale [spinale]
Os sacrum
N. lumbalis V
R. posterior
Ganglion spinale
nervi sacralis I

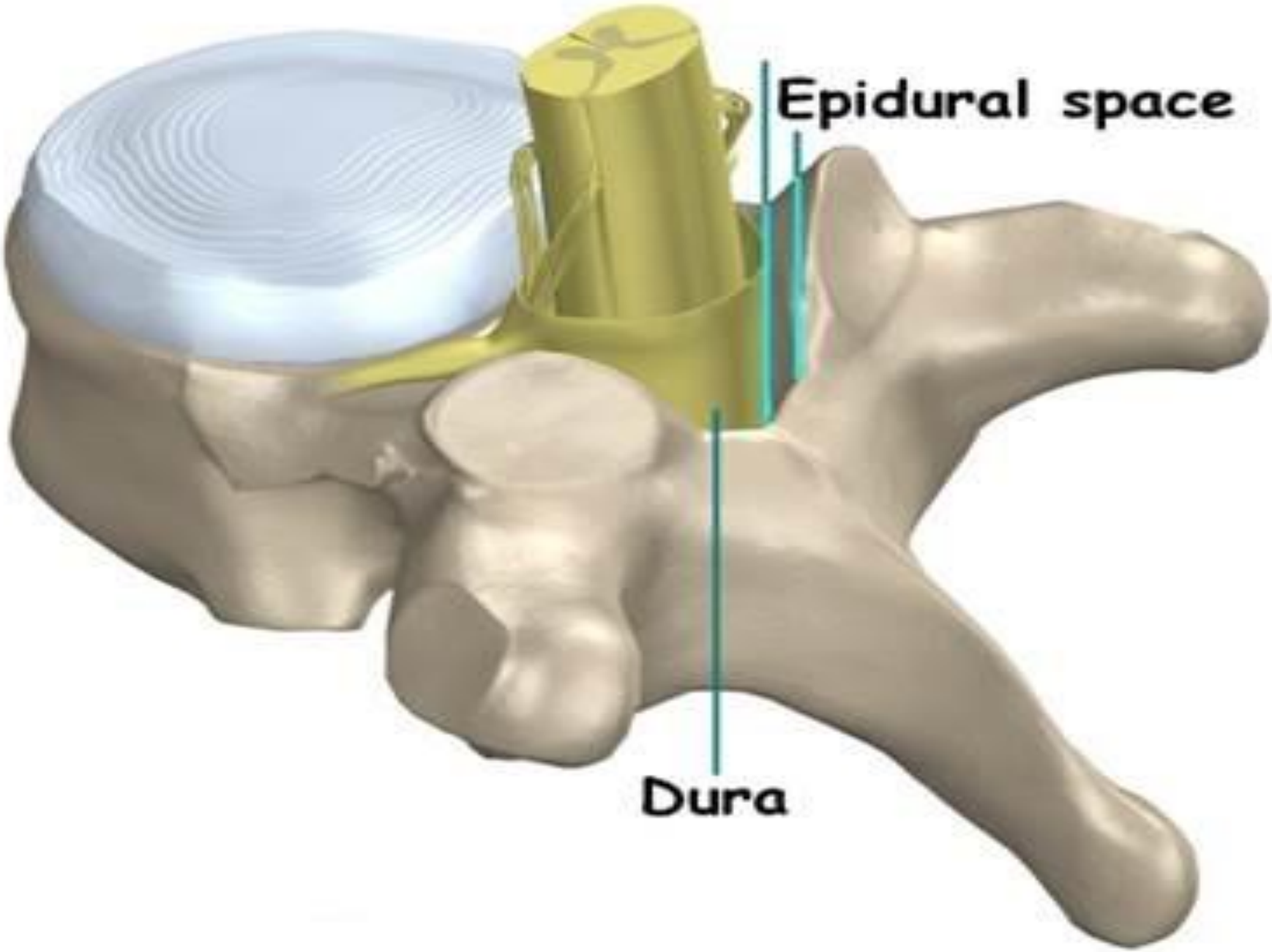

Second lumbar vertebra
Conus medullaris
Dura mater and arachnoid mater
Filum terminale internum
Fifth lumbar vertebra
Sacral promontory
Lower limit of subarachnoid space
Filum terminale externum
Coccyx
A.K.M.

منتژ

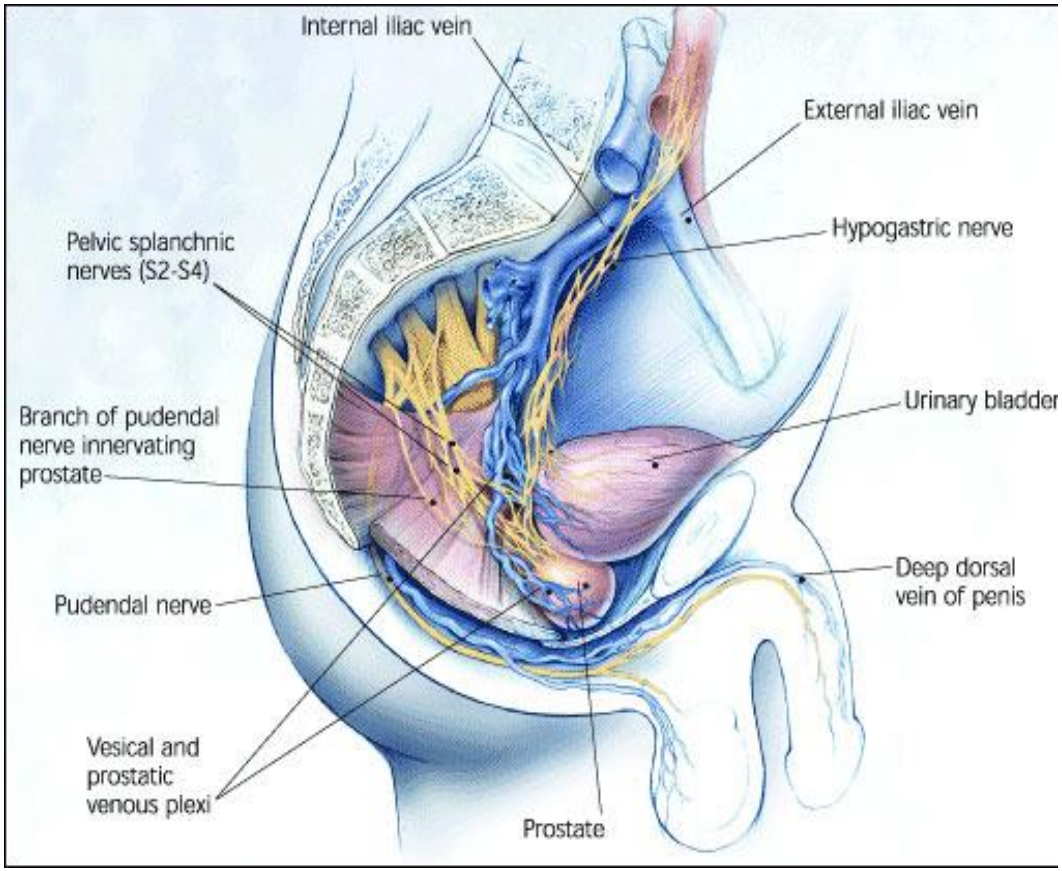


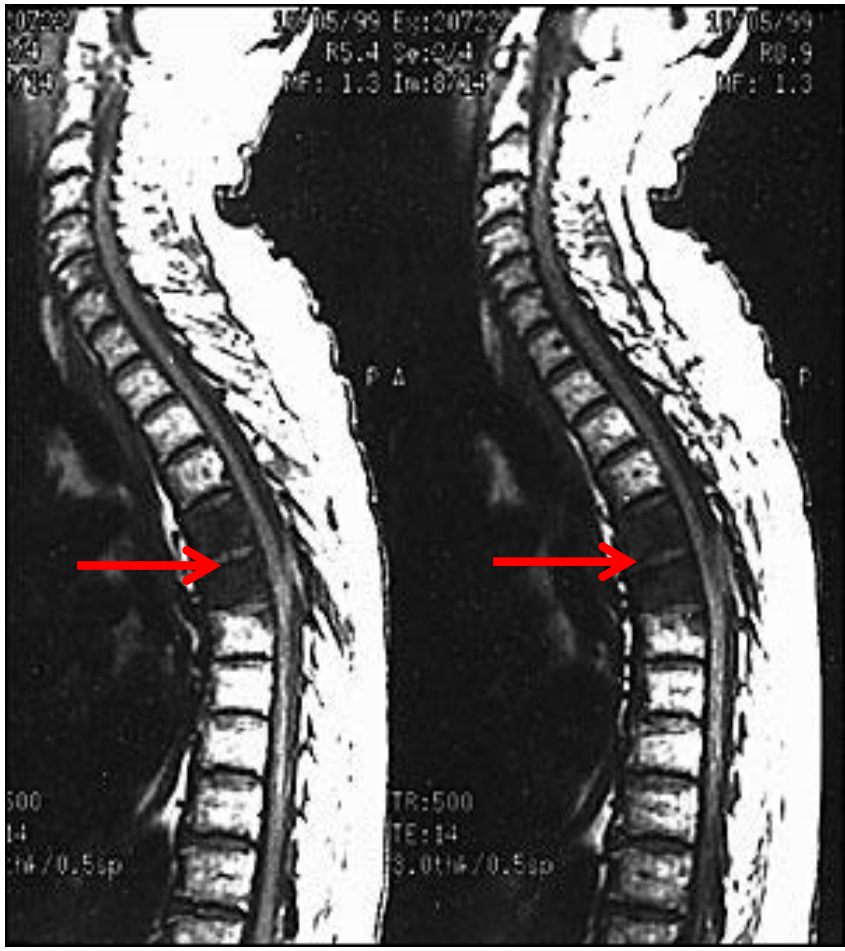


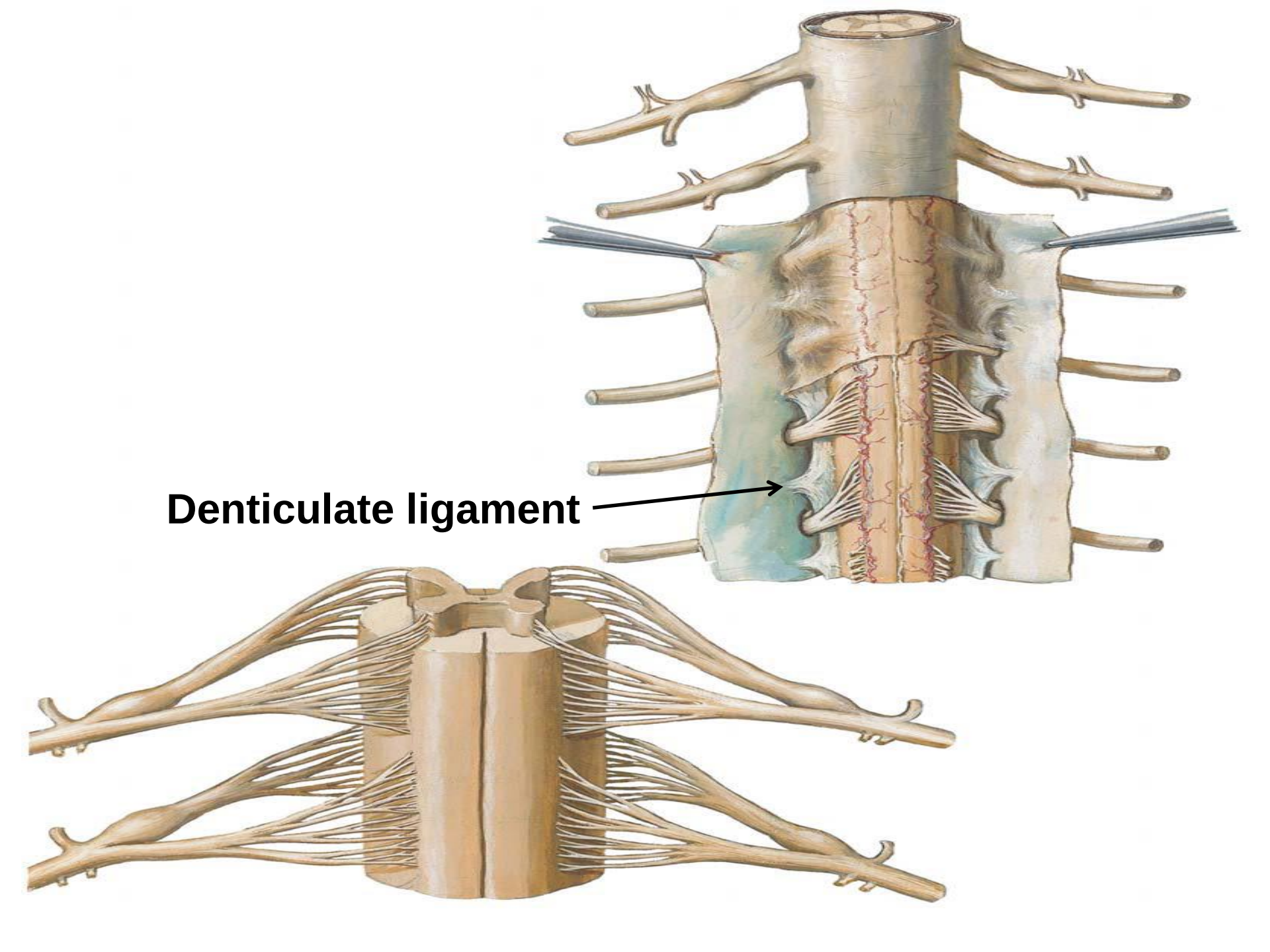

Scalp
Cranium
عنکبوتیه
Arachnoid
سخت شامه
Dura mater
Pia mater
نرم شامه
Subarachnoid space
Cerebral cortex

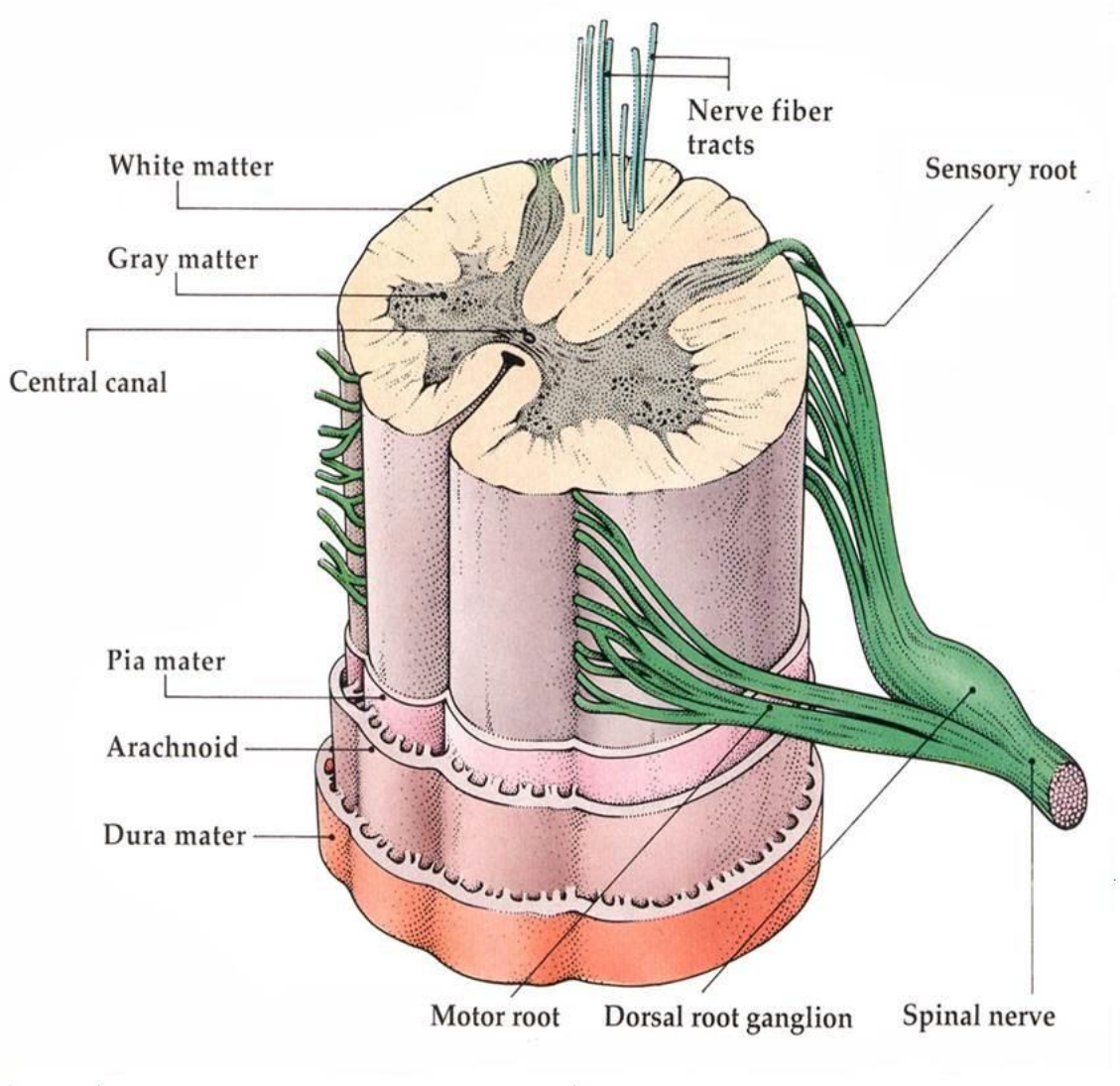

Epidural space
Dura

Batson venous plexus





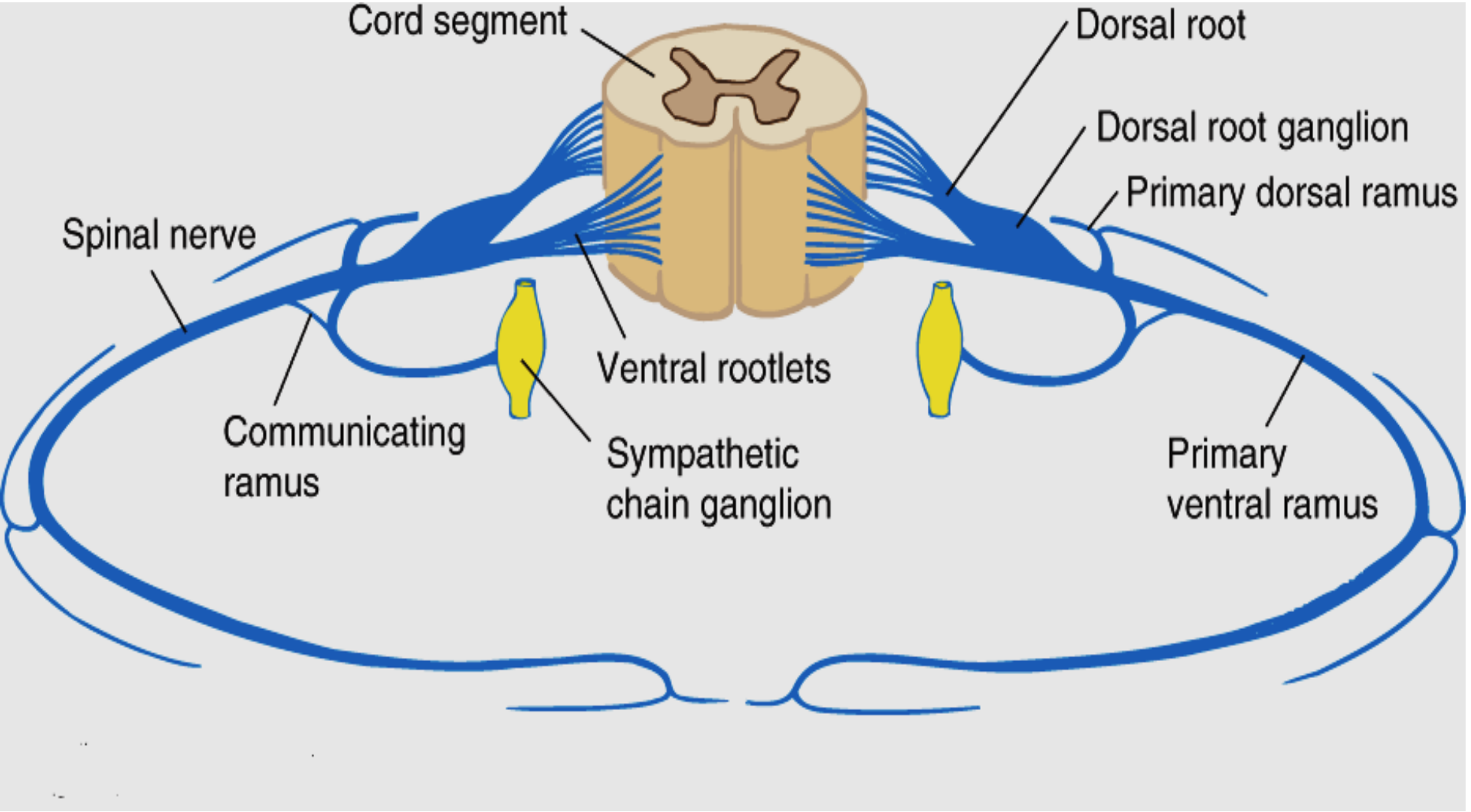

Denticulate ligament

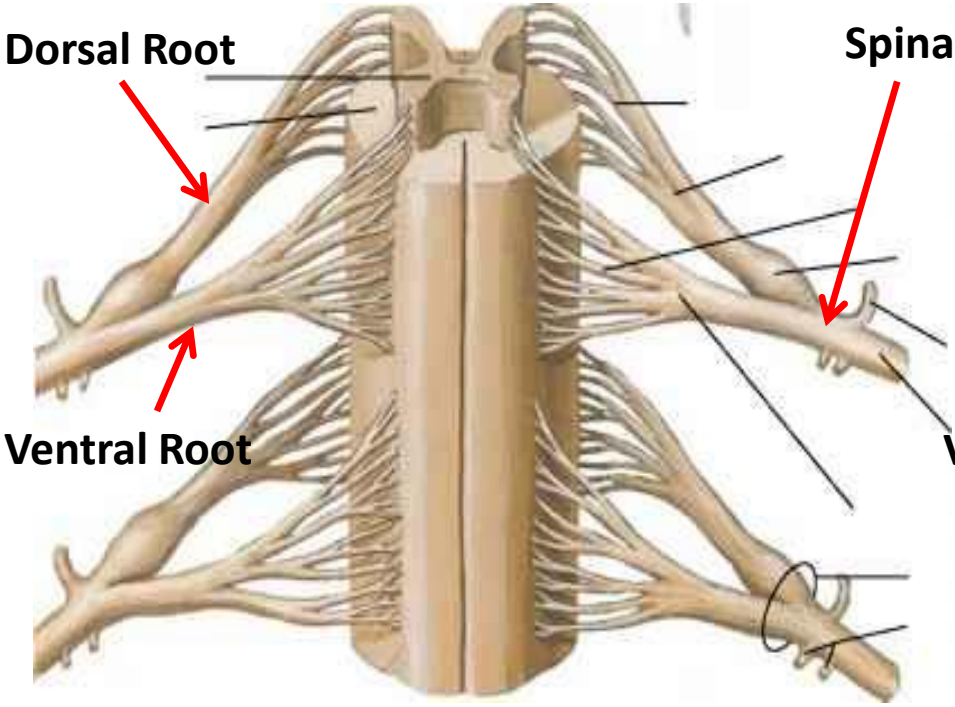


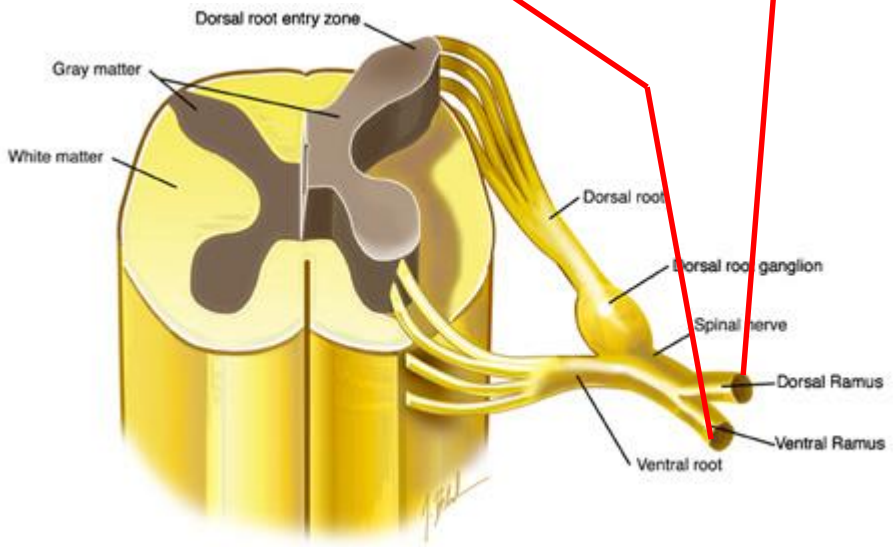
Spinal Cord

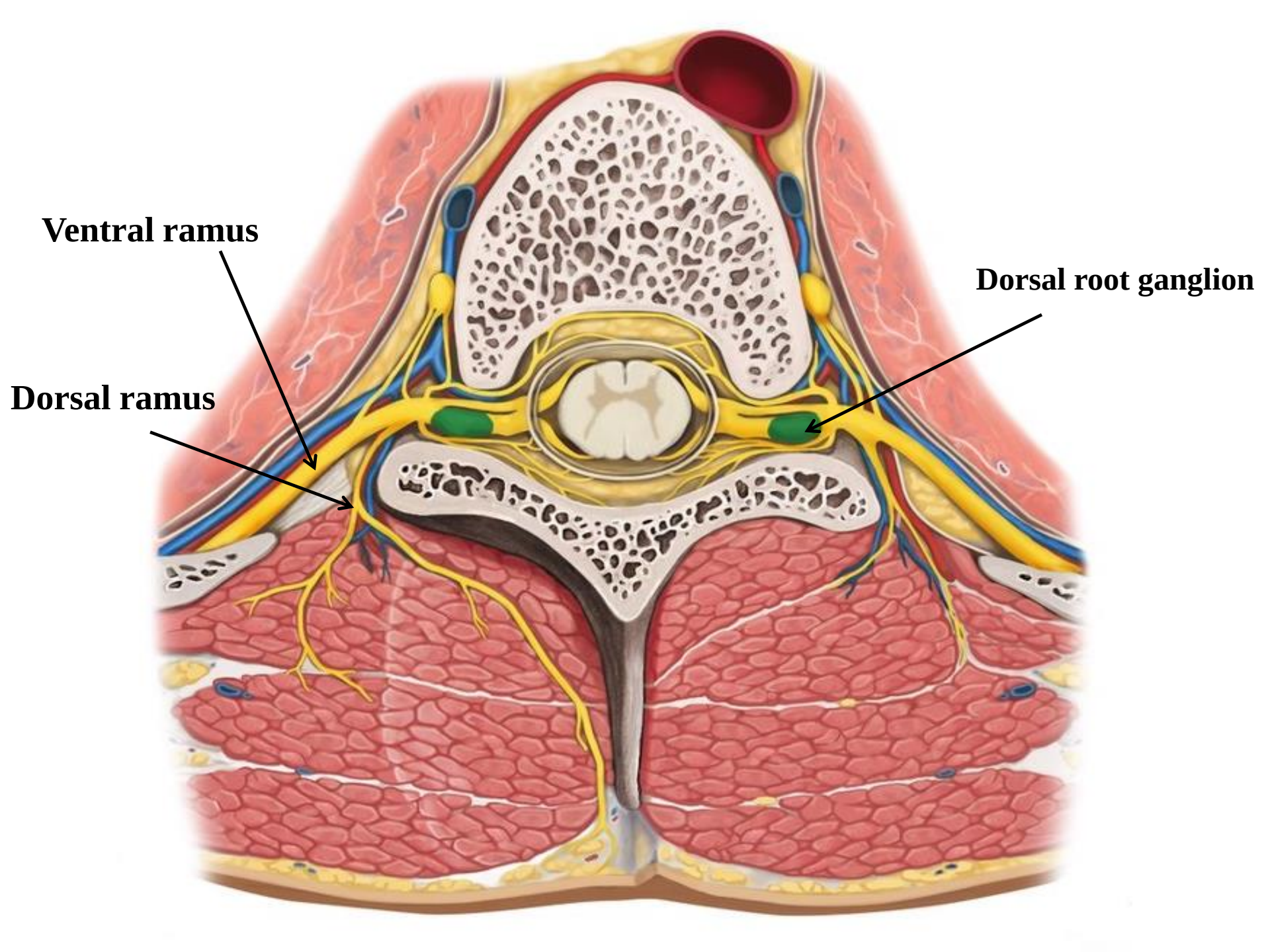
- ***anterior root:***
  - ***motor***
- ***posterior root:***
  - ***sensory***

Law of Bell-Magendie


Cord segment
Dorsal root
Dorsal root ganglion
Primary dorsal ramus
Spinal nerve
Ventral rootlets
Communicating ramus
Sympathetic chain ganglion
Primary ventral ramus

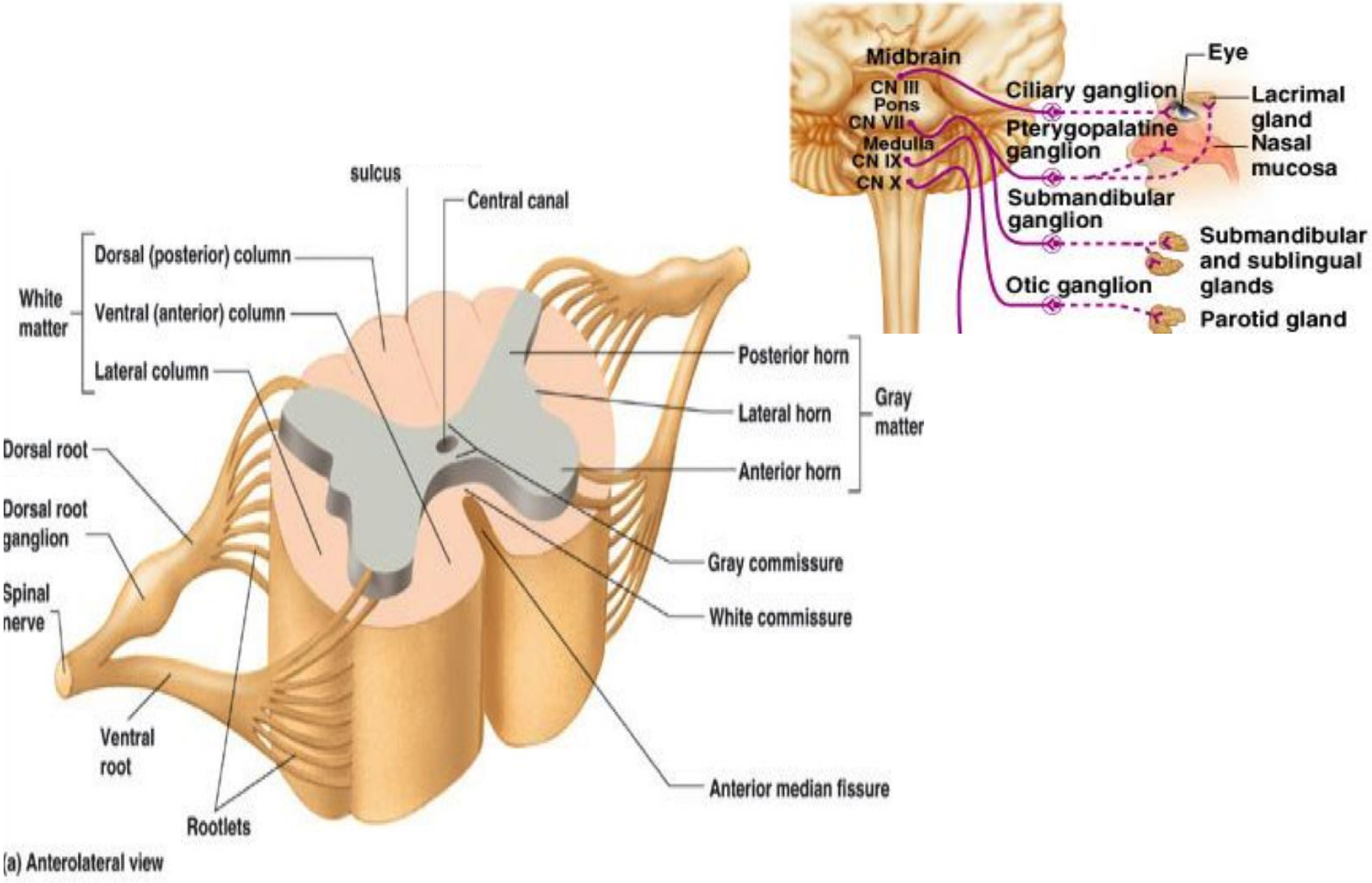

Dorsal Root
Spinal nerve
Ventral Root
Dorsal ramus
Ventral ramus


Dorsal root entry zone
Gray matter
White matter
Dorsal root
Dorsal root ganglion
Spinal nerve
Dorsal Ramus
Ventral Ramus
Ventral root

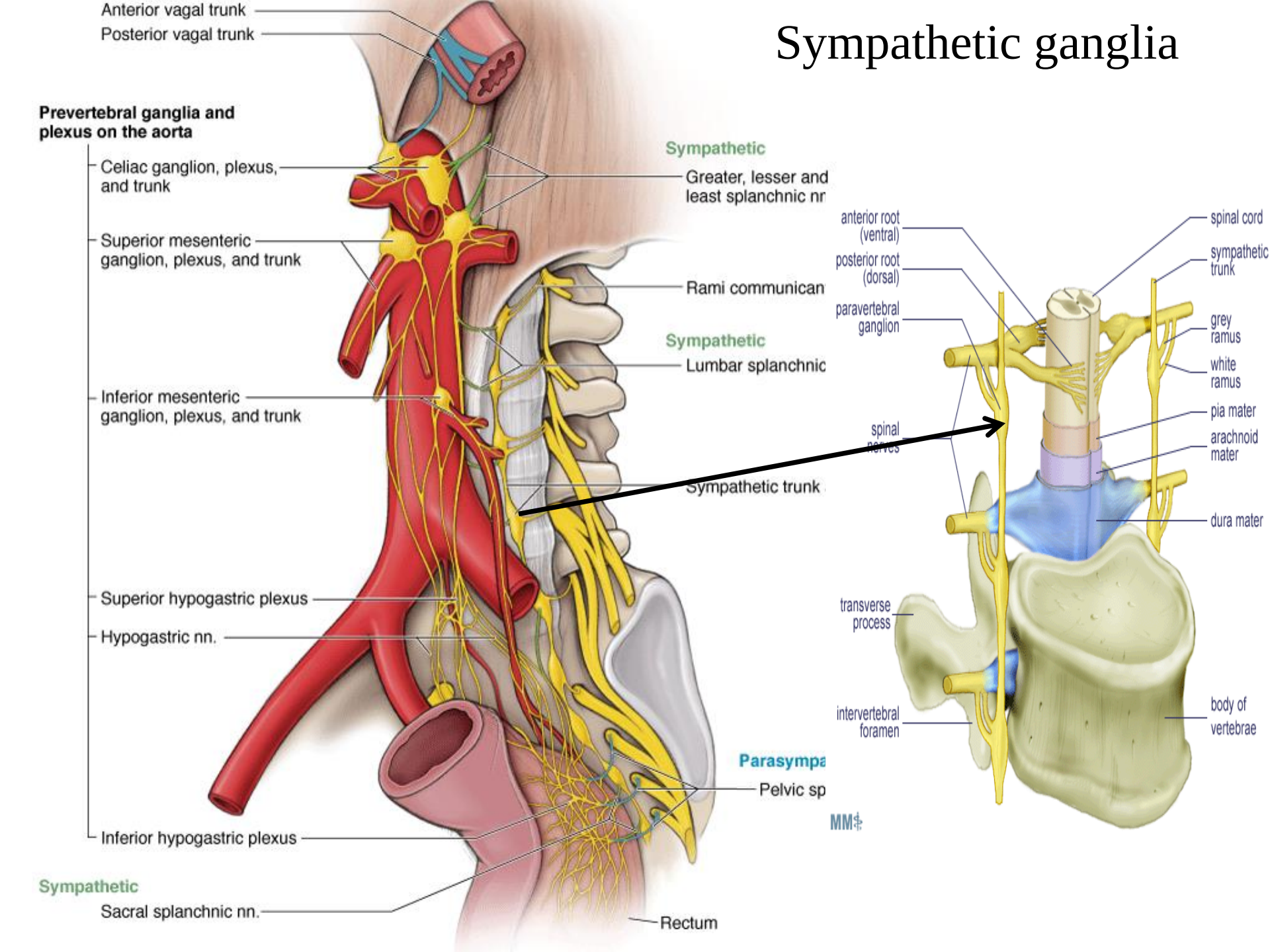

Ventral ramus
Dorsal root ganglion
Dorsal ramus

Autonomic Nervous System

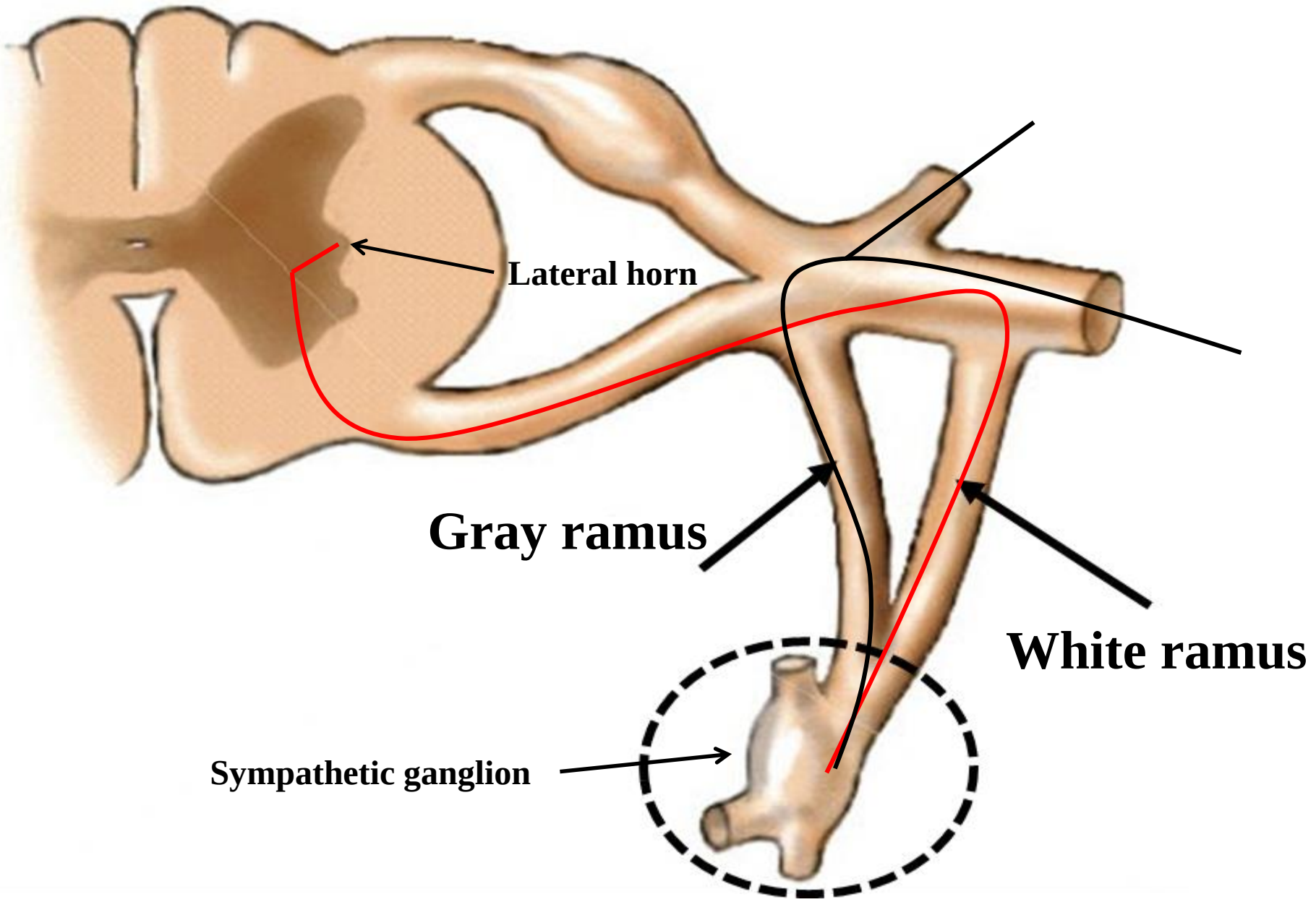
Sympathetic & Parasympathetic



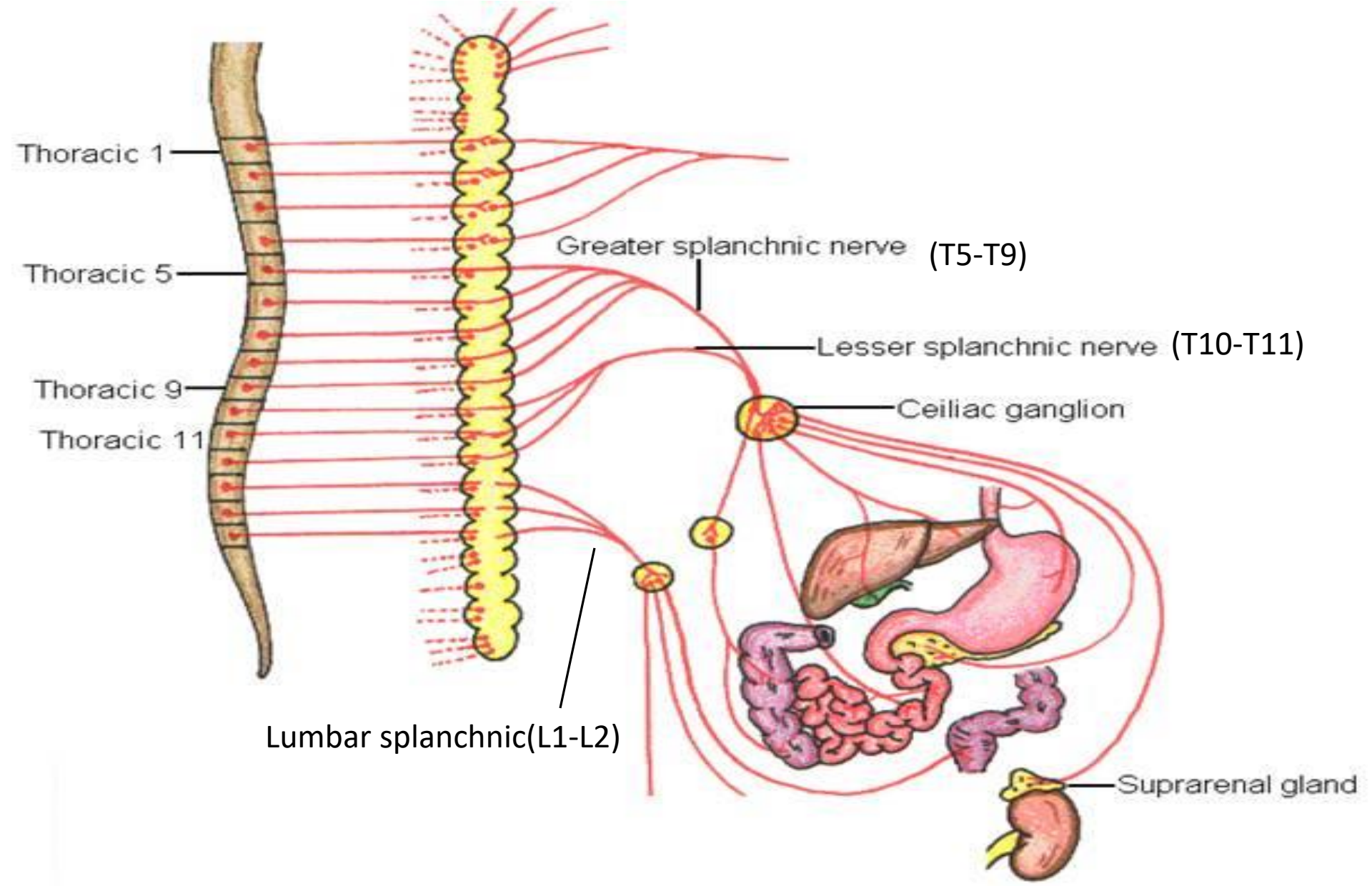
Sympathetic ganglia



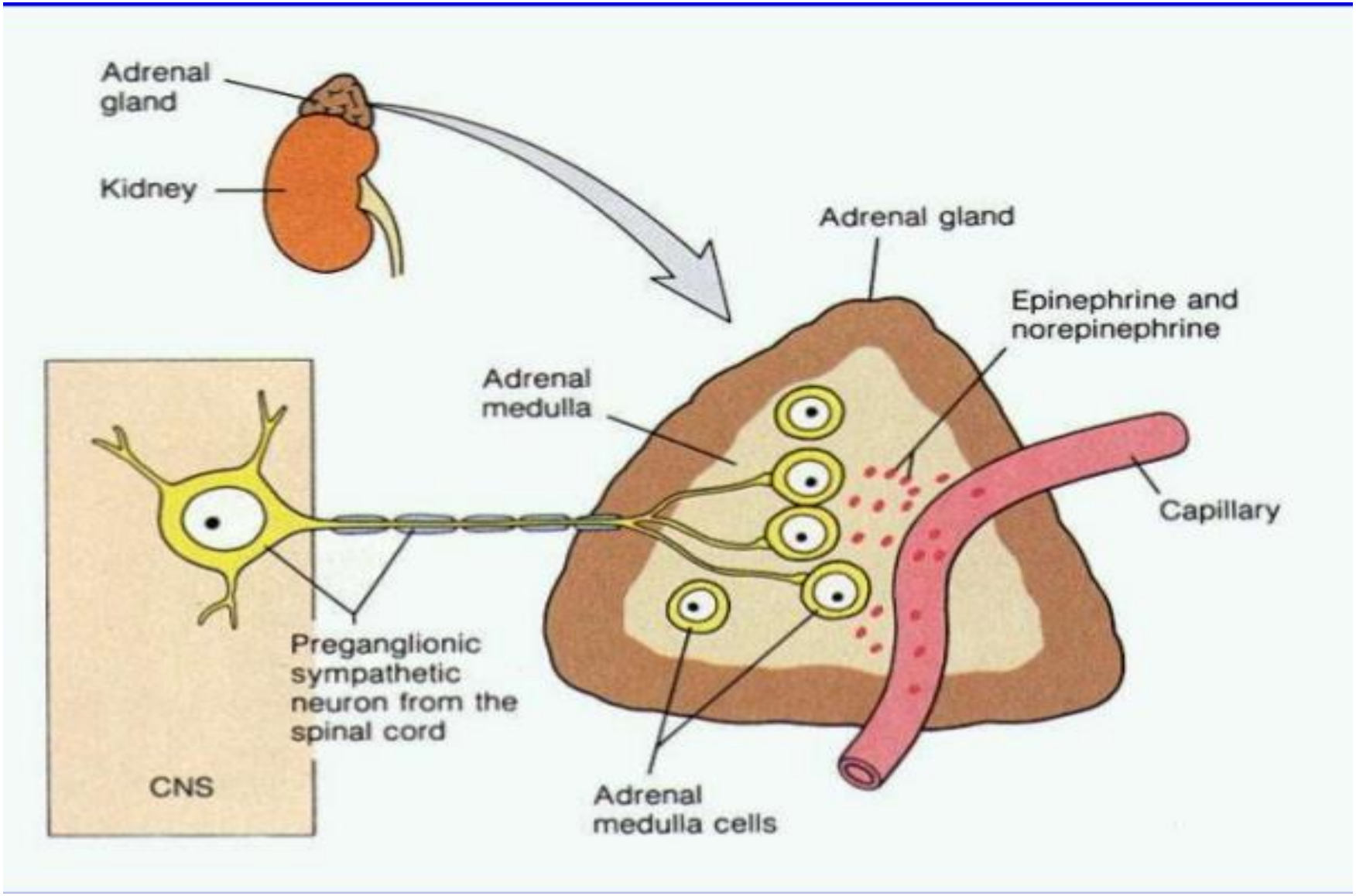
Sympathetic system



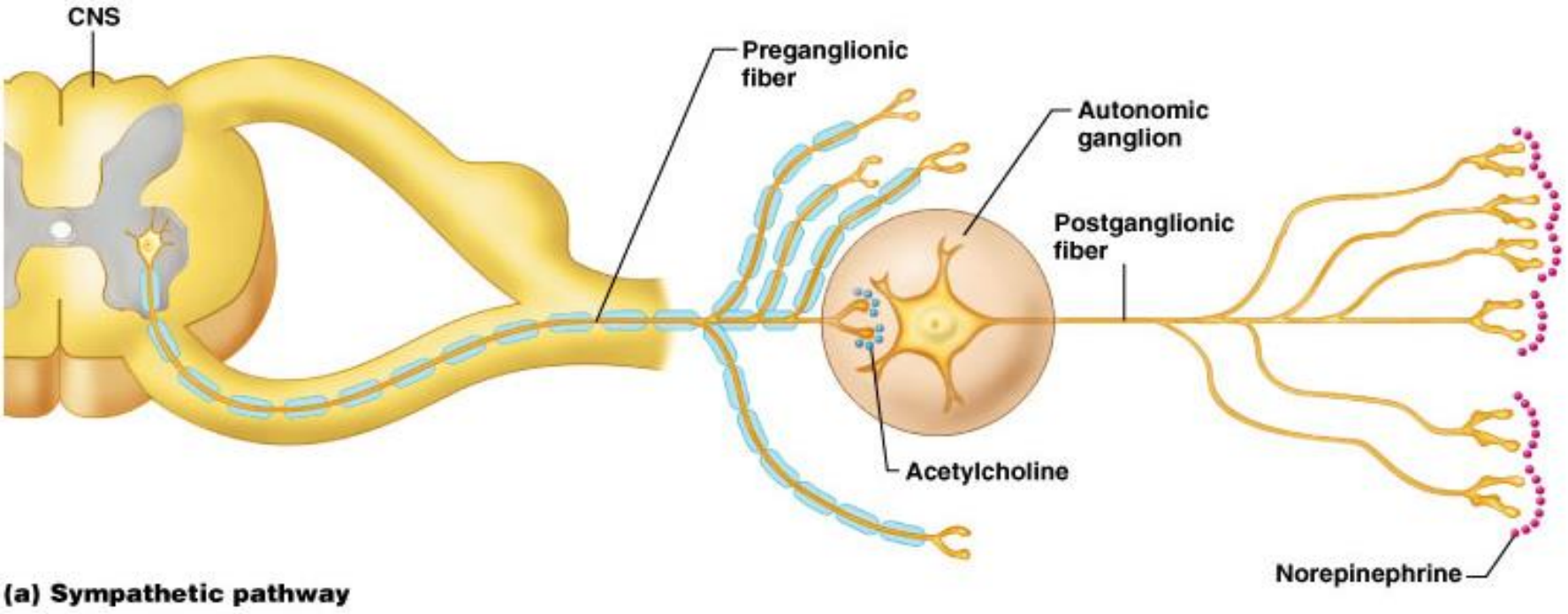
Splanchnic nerves



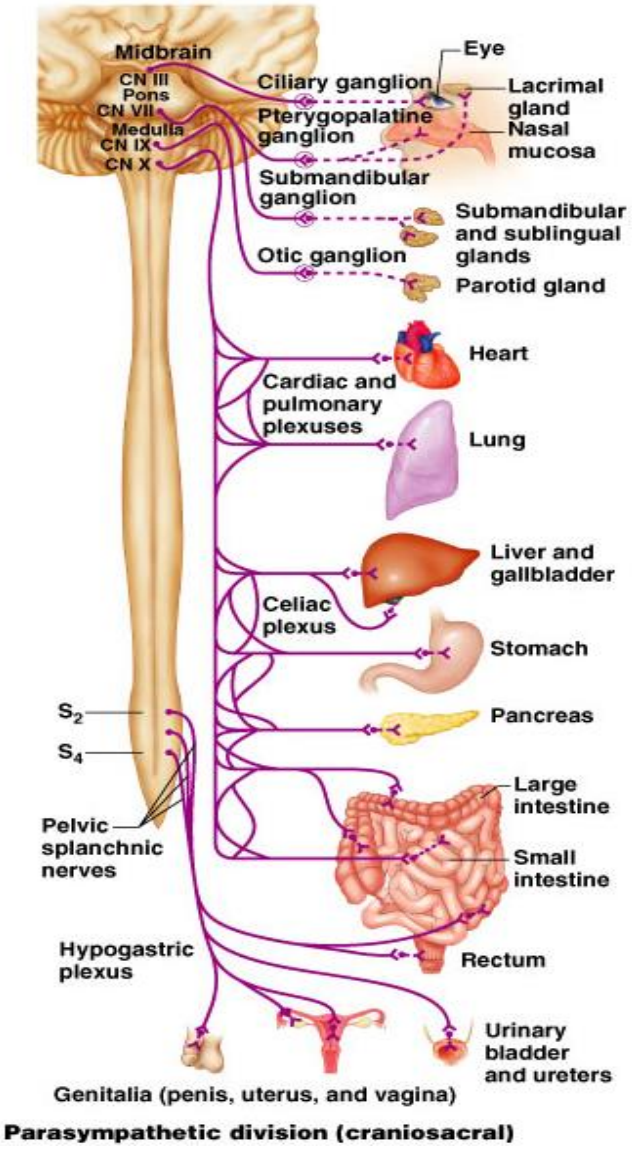
Adrenal medulla

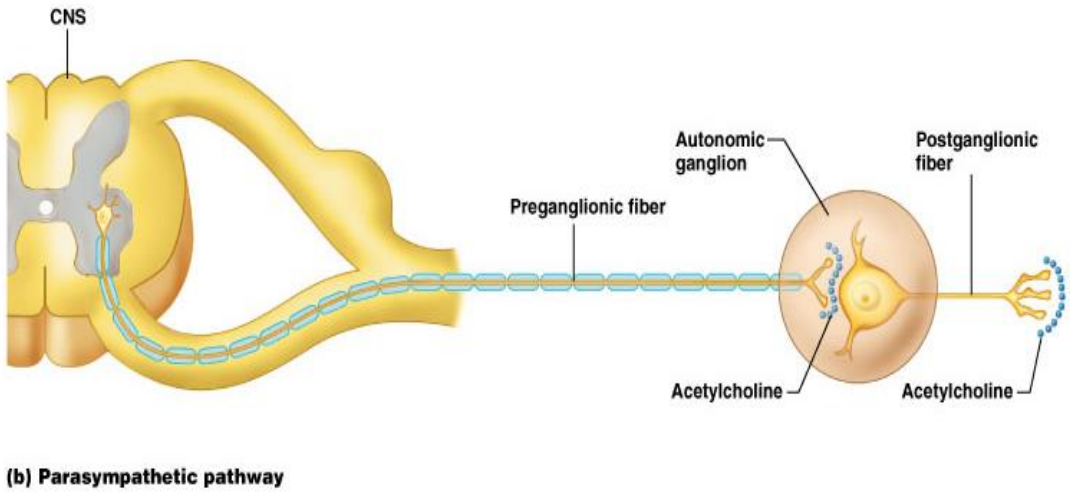


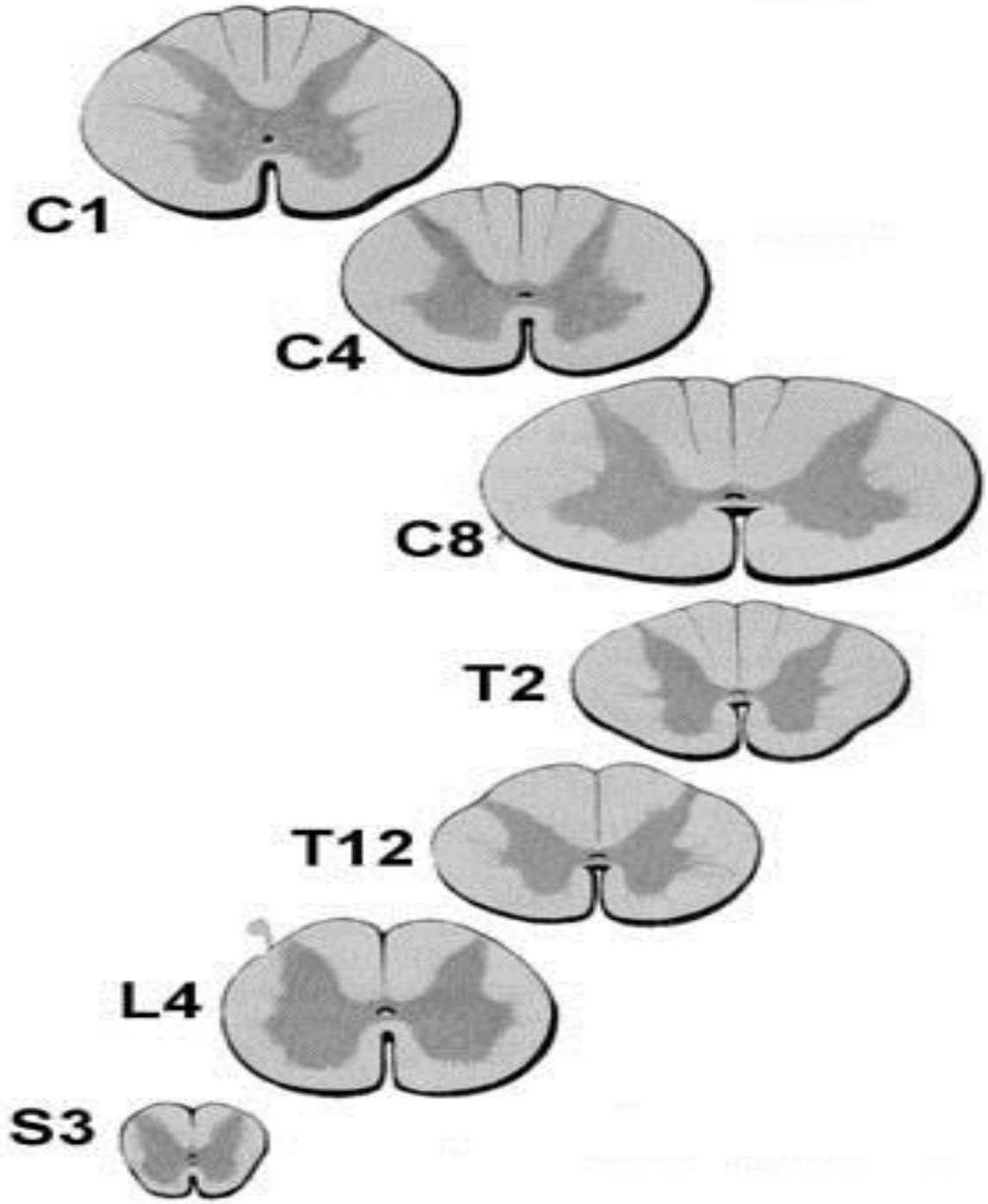
Sympathetic system



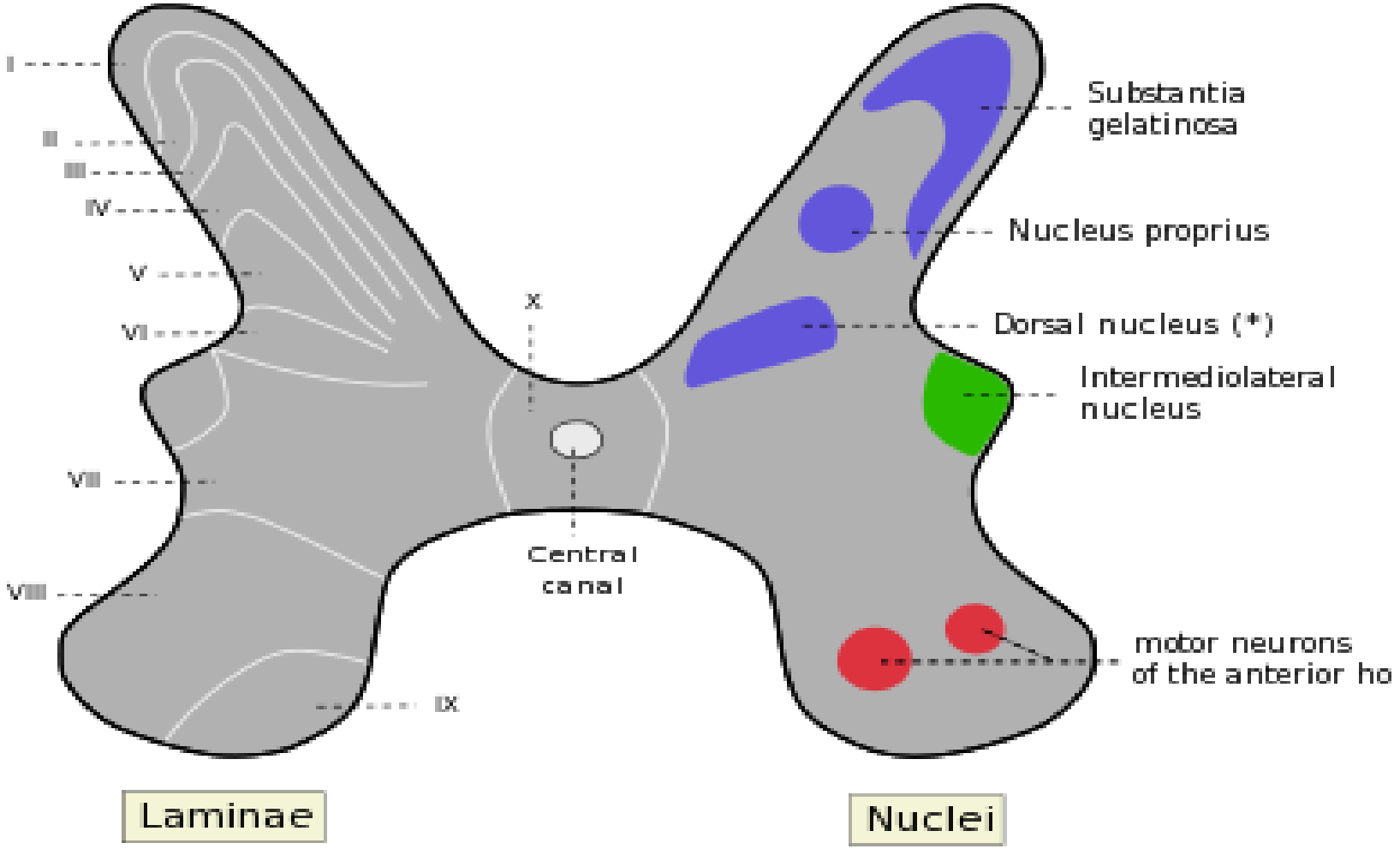
Parasympathetic system





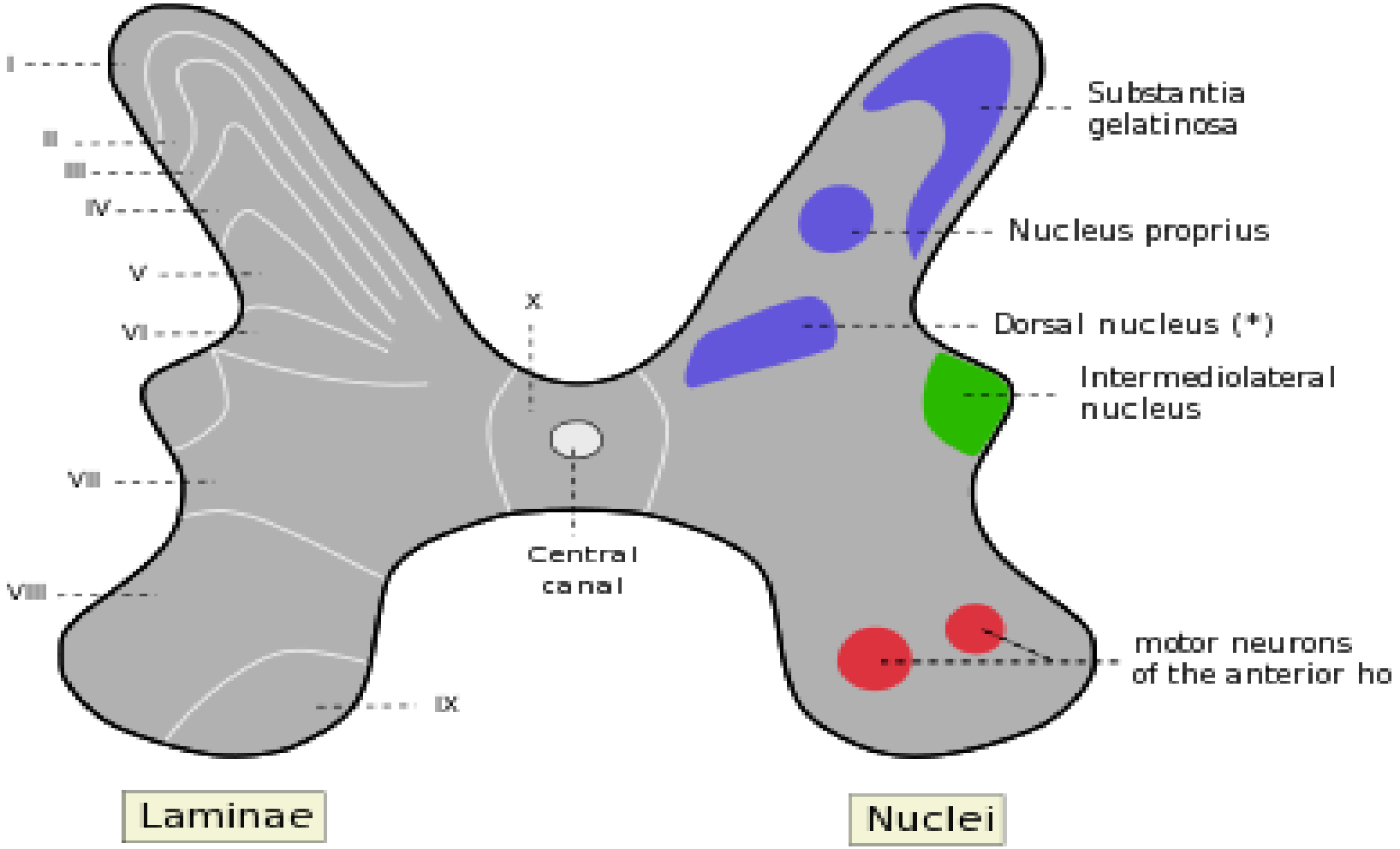

C1
C4
C8
T2
T12
L4
S3

هسته های ماده خاکستری نخاع، شاخ خلفی



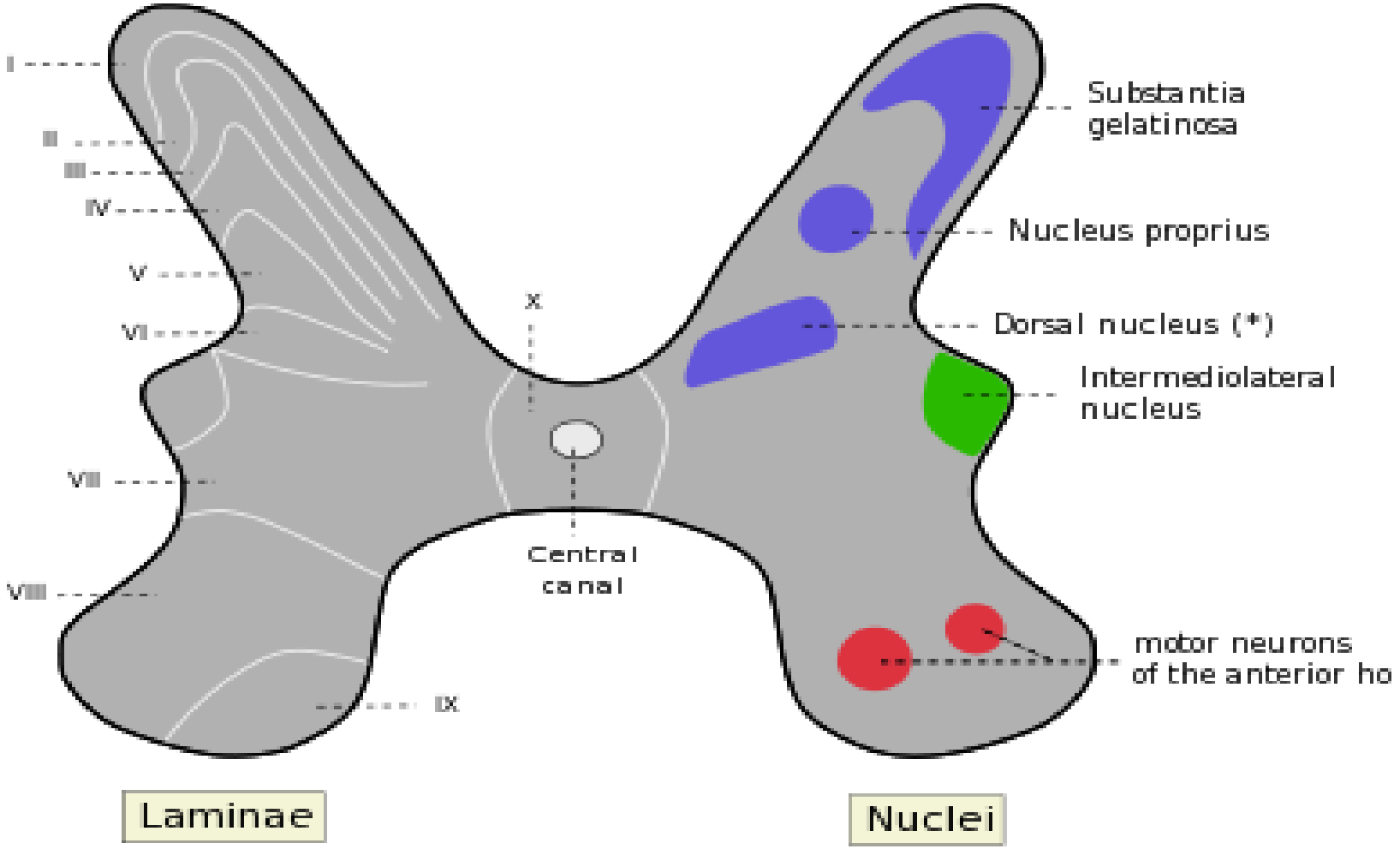
* Posterior thoracic nucleus or Column of Clarke

هسته های ماده خاکستری نخاع، شاخ قدامی



* Posterior thoracic nucleus or Column of Clarke

هسته های ماده خاکستری نخاع، شاخ جانبی



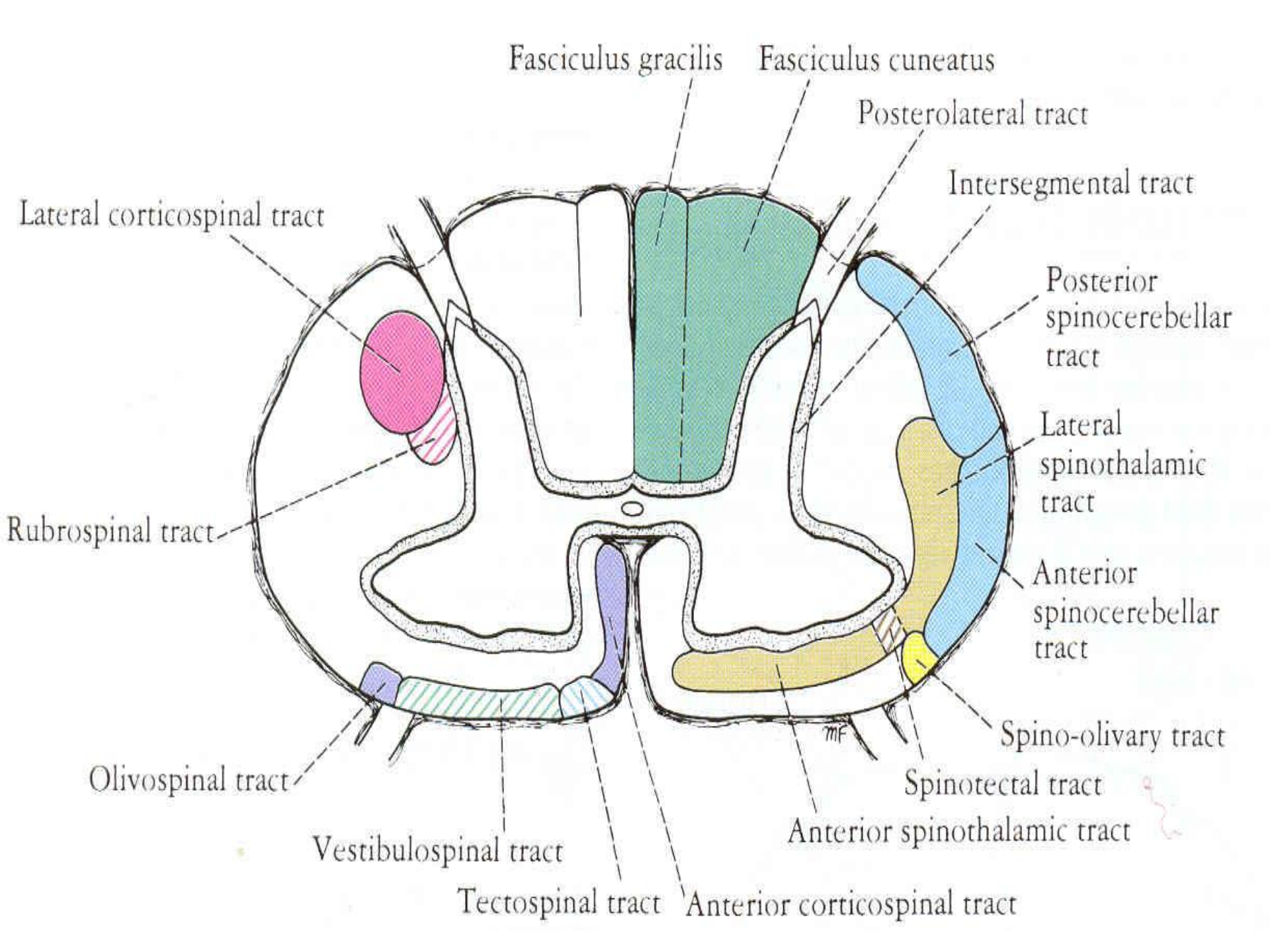
* Posterior thoracic nucleus or Column of Clarke

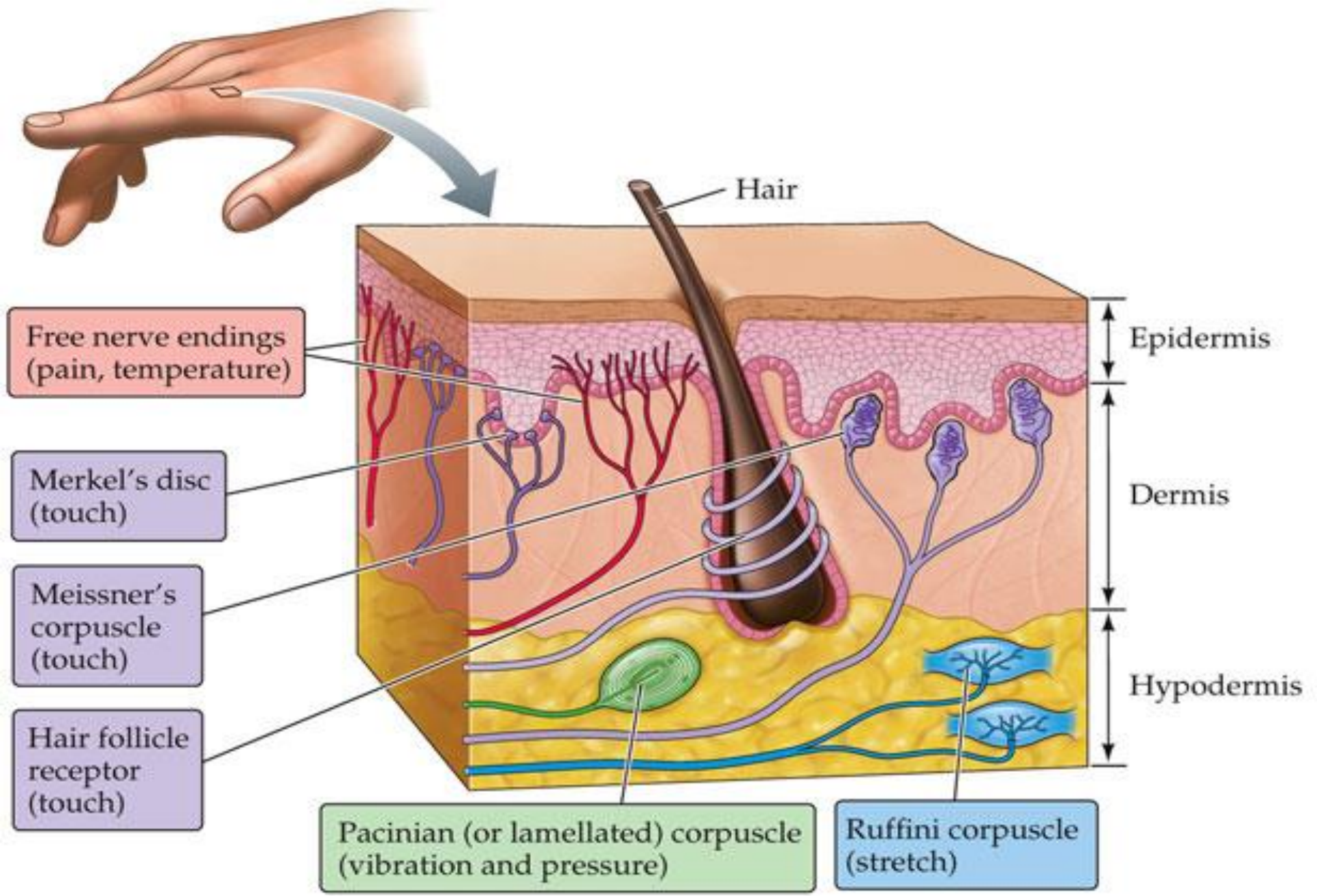
راههای نخاعی

- راههای نخاعی: **راههای صعودی ، راههای نزولی و راههای بین سگمانی**

- راههای صعودی: **انتریور اسپینوتالامیک، لترال اسپینوتالامیک، پوستریور فانیکولوس، انتریور اسپینوسربلار، پوستریور اسپینوسربلار، اسپینورتیکولار، اسپینو تکتال، اسپینواولیواری**

- راههای نزولی: **کورتیکواسپاینال لترال ، کورتیکو اسپاینال انتریور، روبرواسپاینال، وستیبولواسپاینال، اولیوواسپاینال، رتیکولواسپاینال**

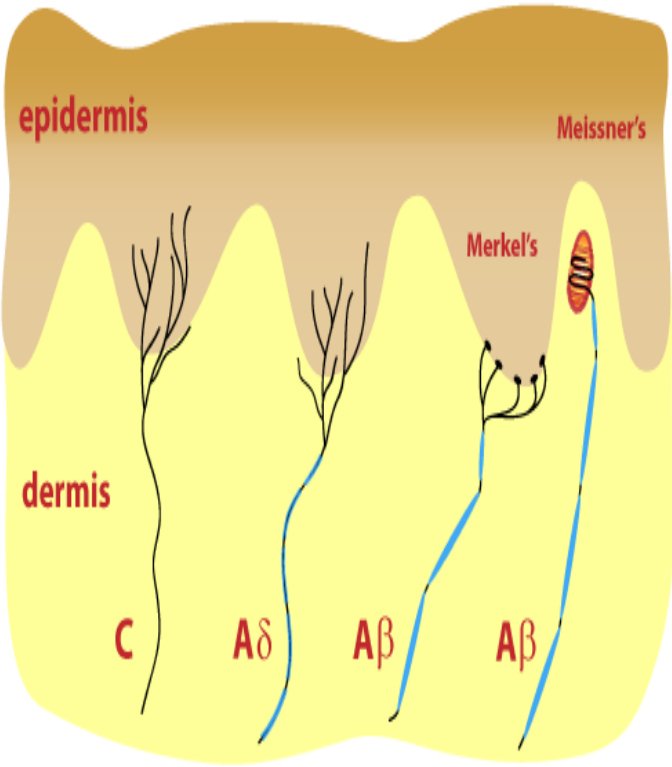

Fasciculus gracilis
Fasciculus cuneatus
Posterolateral tract
Intersegmental tract
Lateral corticospinal tract
Posterior spinocerebellar tract
Lateral spinothalamic tract
Rubrospinal tract
Anterior spinocerebellar tract
Spino-olivary tract
Olivospinal tract
Spinotectal tract
Anterior spinothalamic tract
Vestibulospinal tract
Tectospinal tract
Anterior corticospinal tract

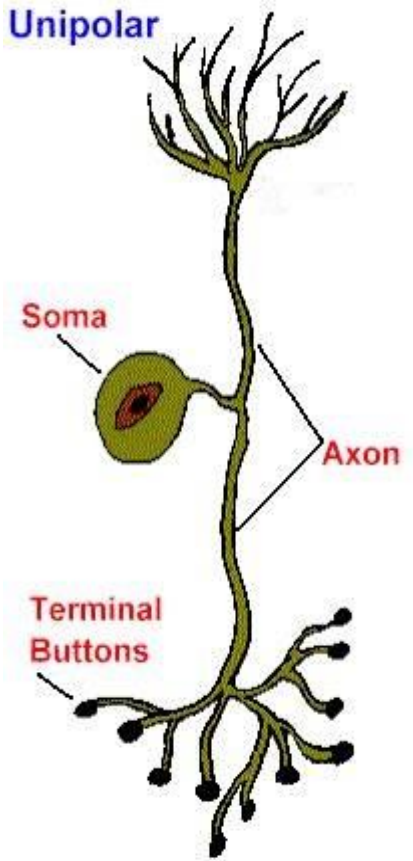


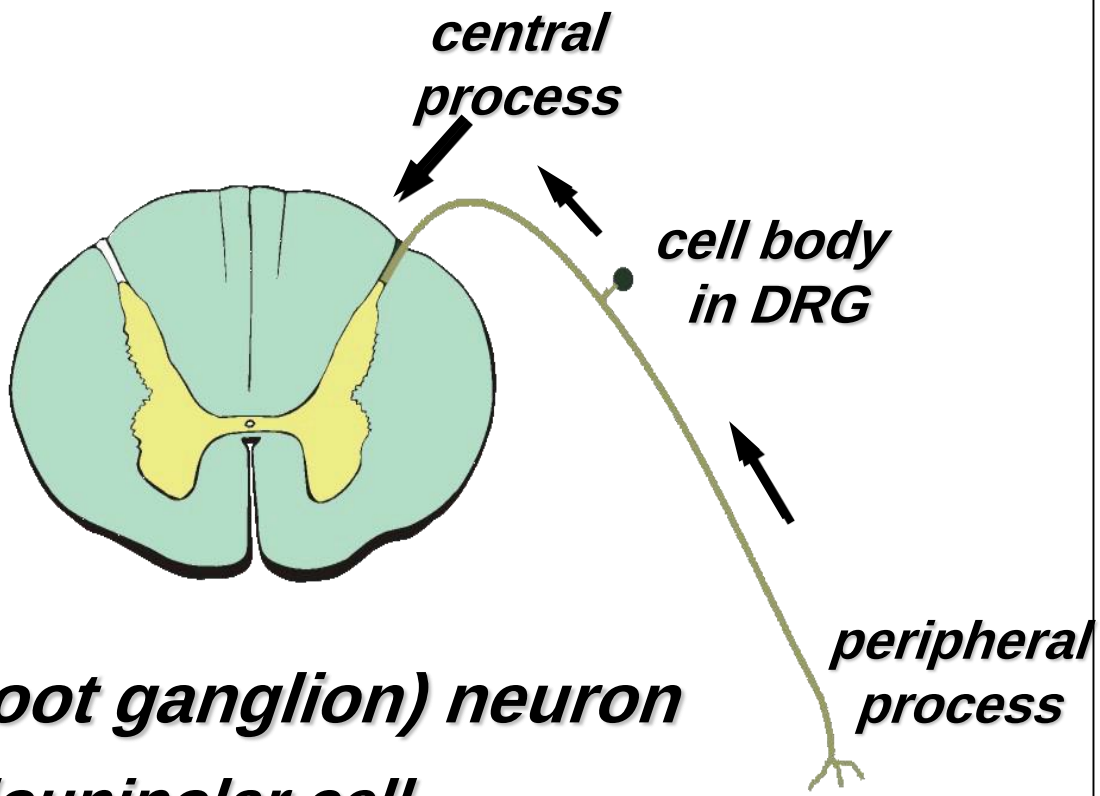
***THE MIND'S MACHINE 2e*, Figure 5.3**

Type of sensory fibers

Number	Origin	Fiber Type
Ia	Muscle spindle, annulo-spiral ending	A α
Ib	Golgi tendon organ	A α
II	Muscle spindle, flower-spray ending; touch, pressure	A β
III	Pain and cold receptors; some touch receptors	A δ
IV	Pain, temperature, and other receptors	Dorsal root C







DRG (dorsal root ganglion) neuron

pseudounipolar cell

انتریور اسپینوتالامیک (حس لمس خفیف)

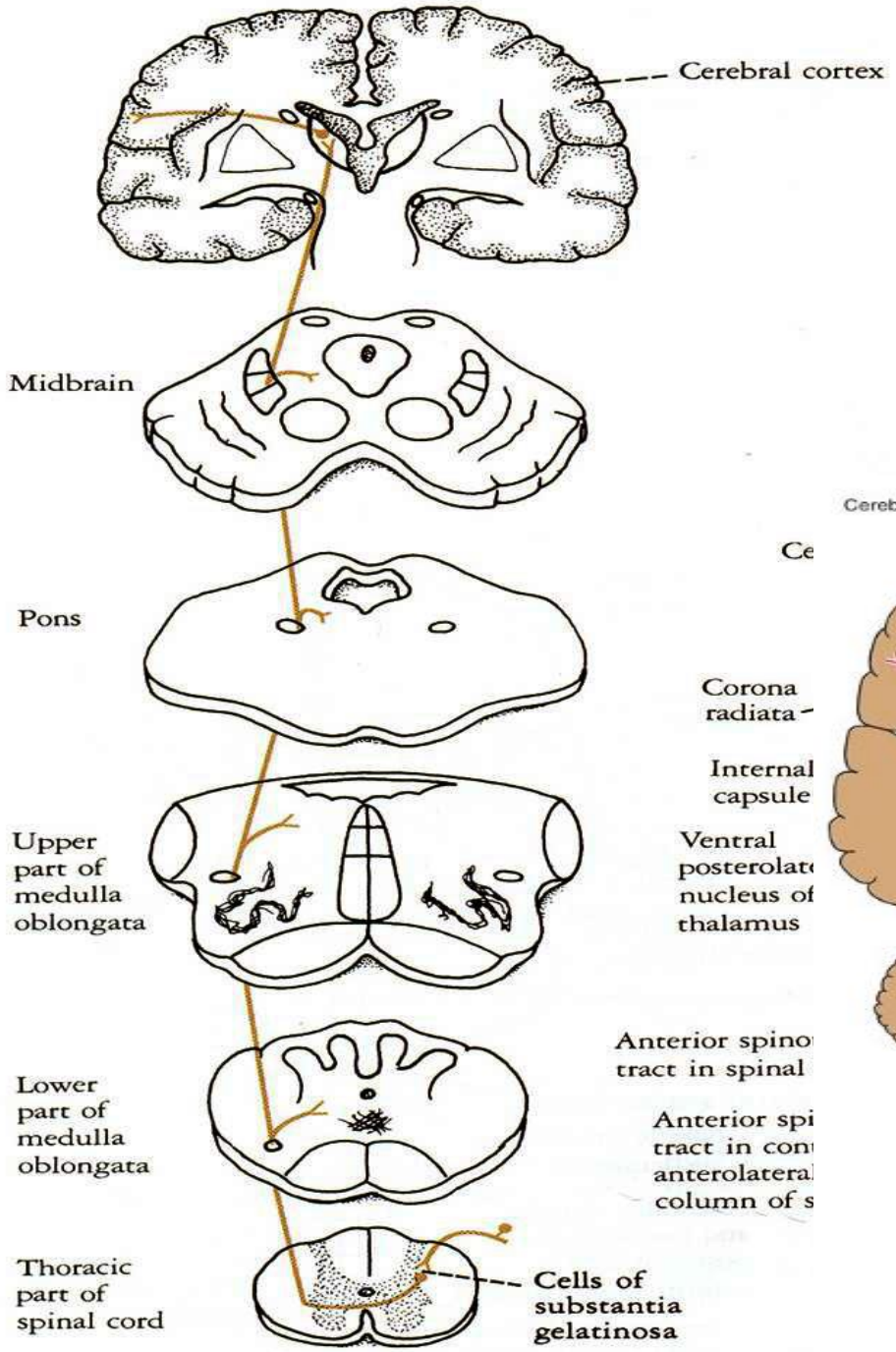
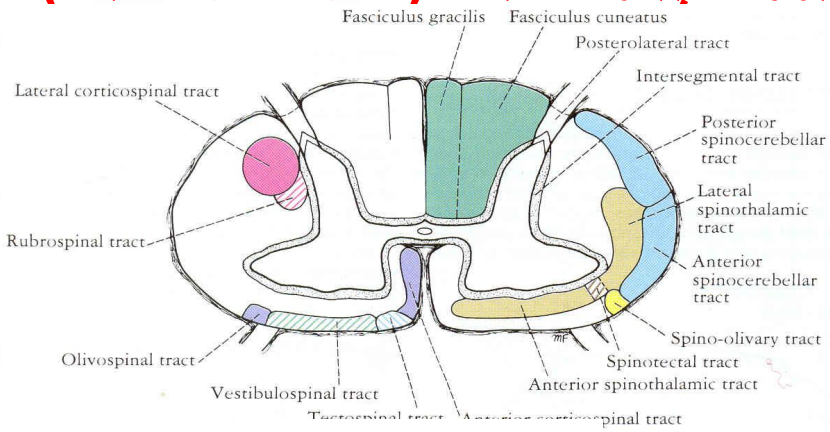
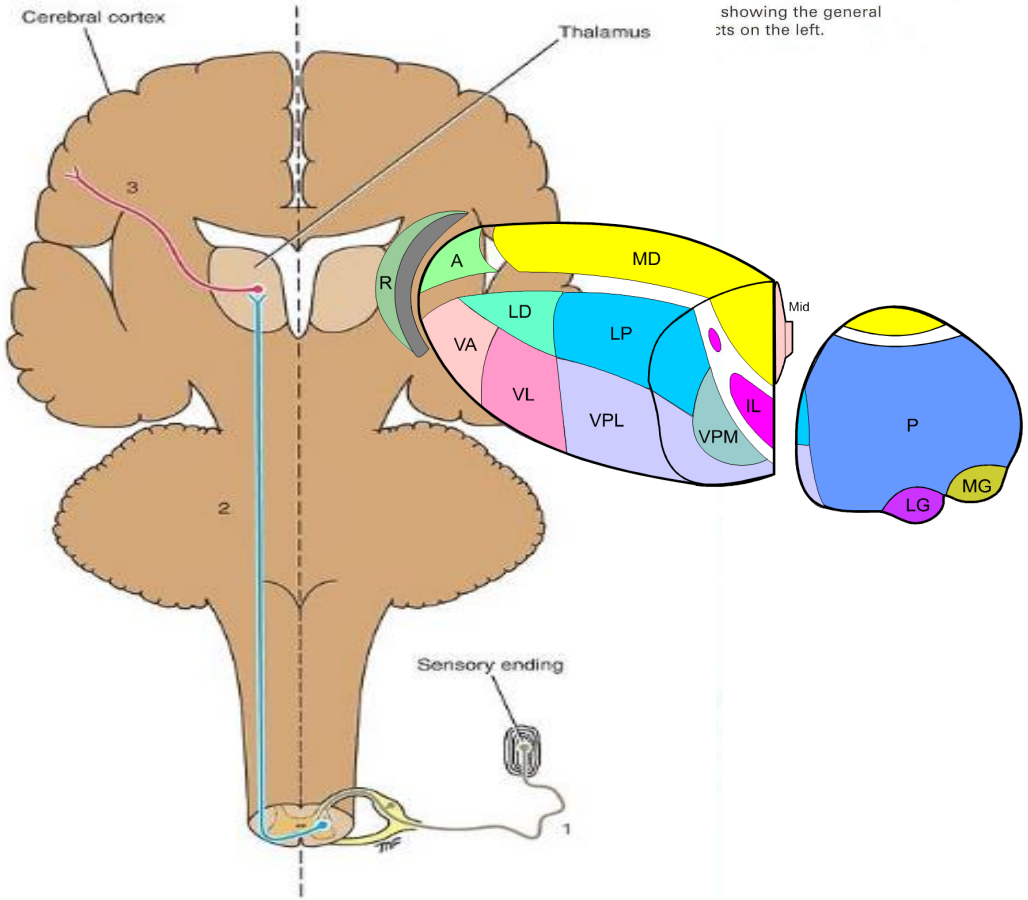
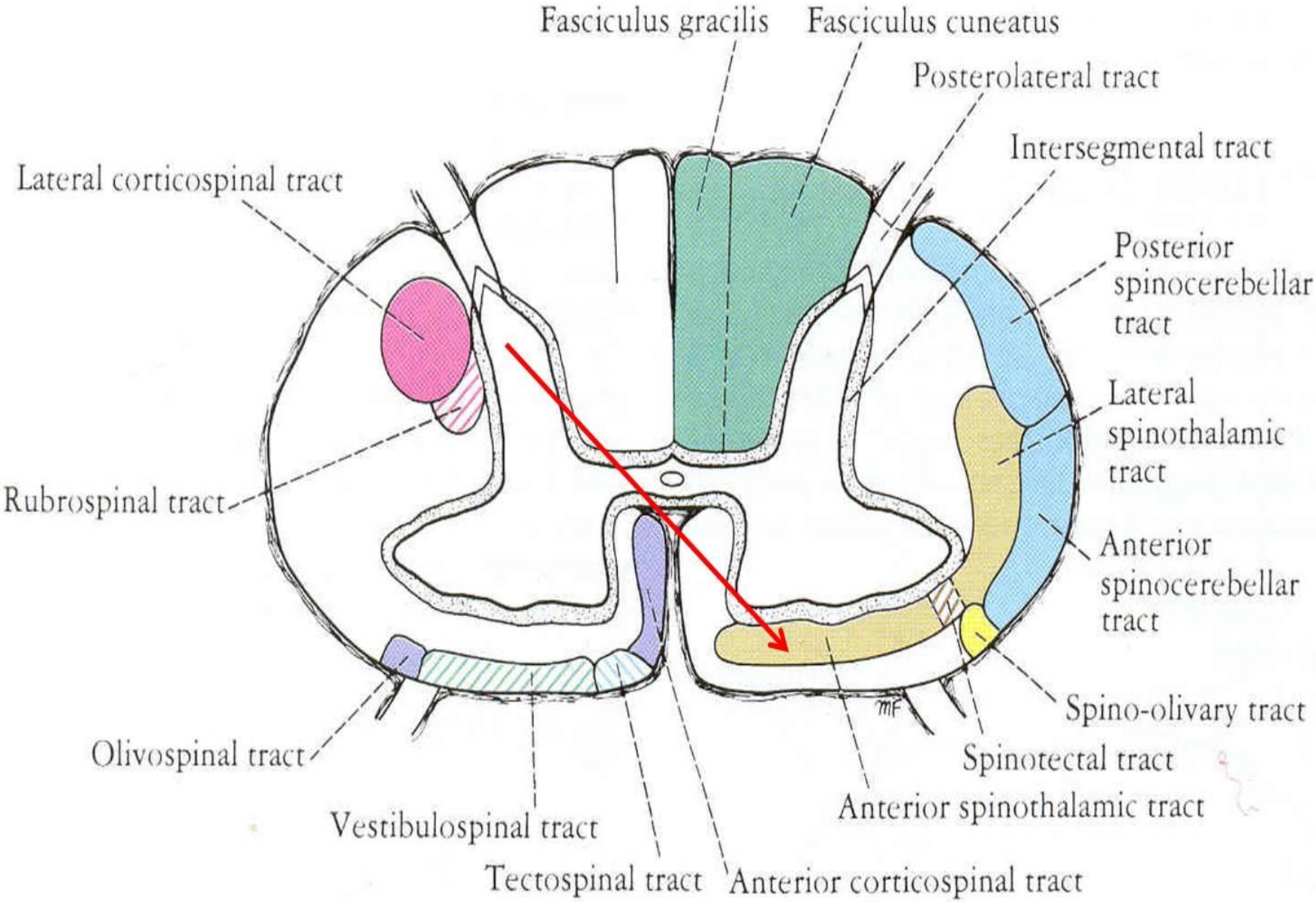


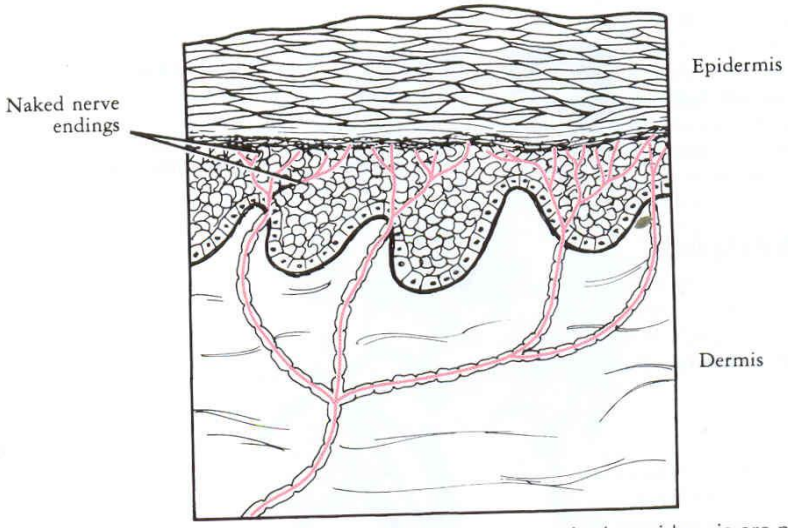
Figure 4–11 Light touch and



showing the general
ts on the left.




Fasciculus gracilis
Fasciculus cuneatus
Posterolateral tract
Intersegmental tract
Lateral corticospinal tract
Posterior spinocerebellar tract
Lateral spinothalamic tract
Rubrospinal tract
Anterior spinocerebellar tract
Spino-olivary tract
Olivospinal tract
Spinotectal tract
Anterior spinothalamic tract
Vestibulospinal tract
Tectospinal tract
Anterior corticospinal tract



jure 3–19 Free nerve endings in the skin. The nerve fibers in the epidermis are naked.

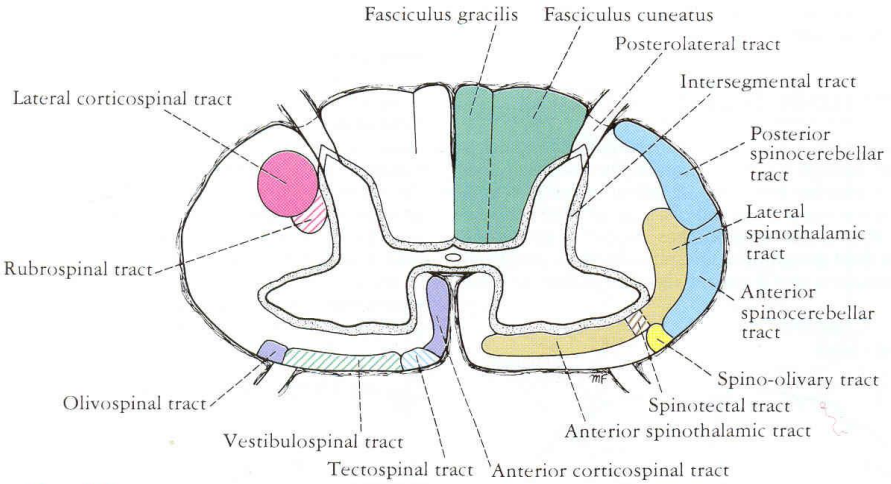
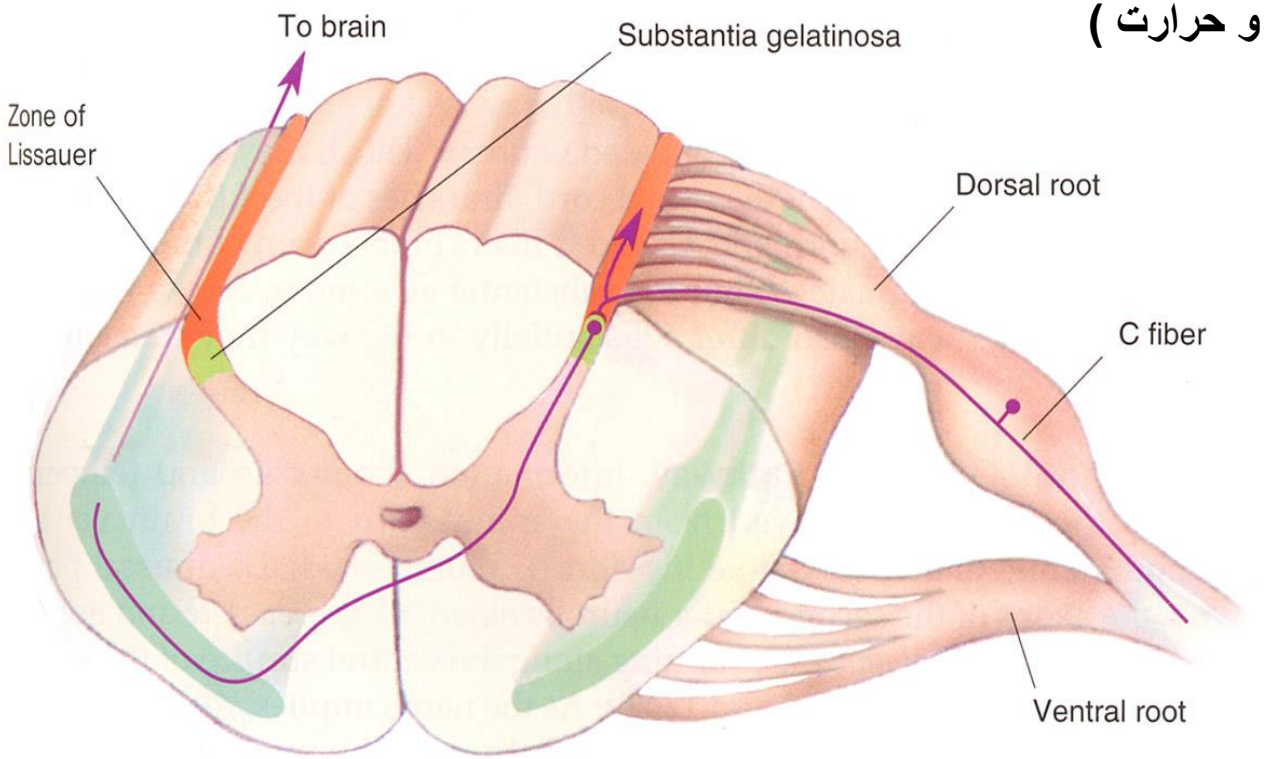


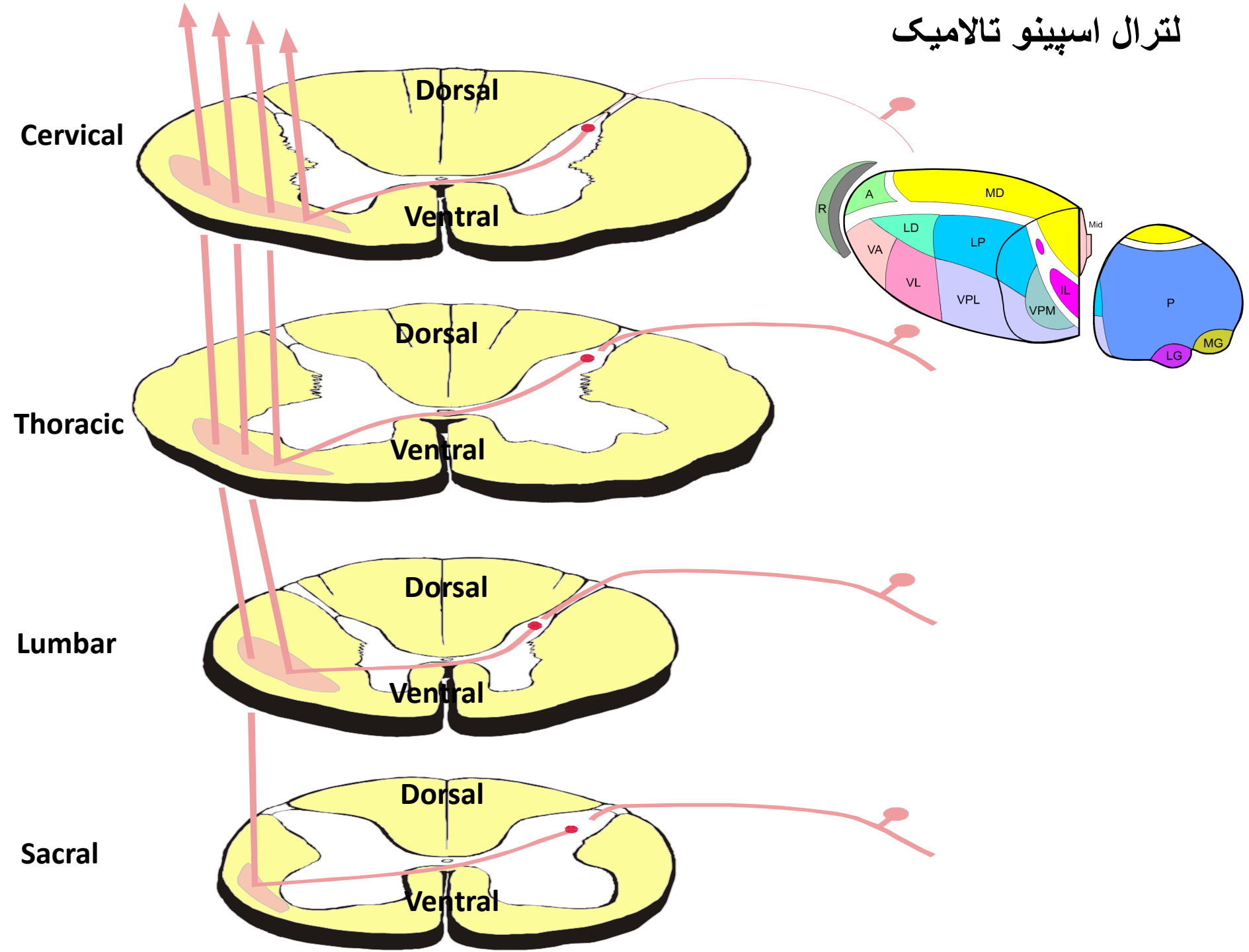
Figure 4–7 Transverse section of the spinal cord at the midcervical level, showing the general arrangement of the ascending tracts on the right and the descending tracts on the left.

اسپینوتالامیک لترال

(حس درد و حرارت)



لترال اسپینو تالامیک



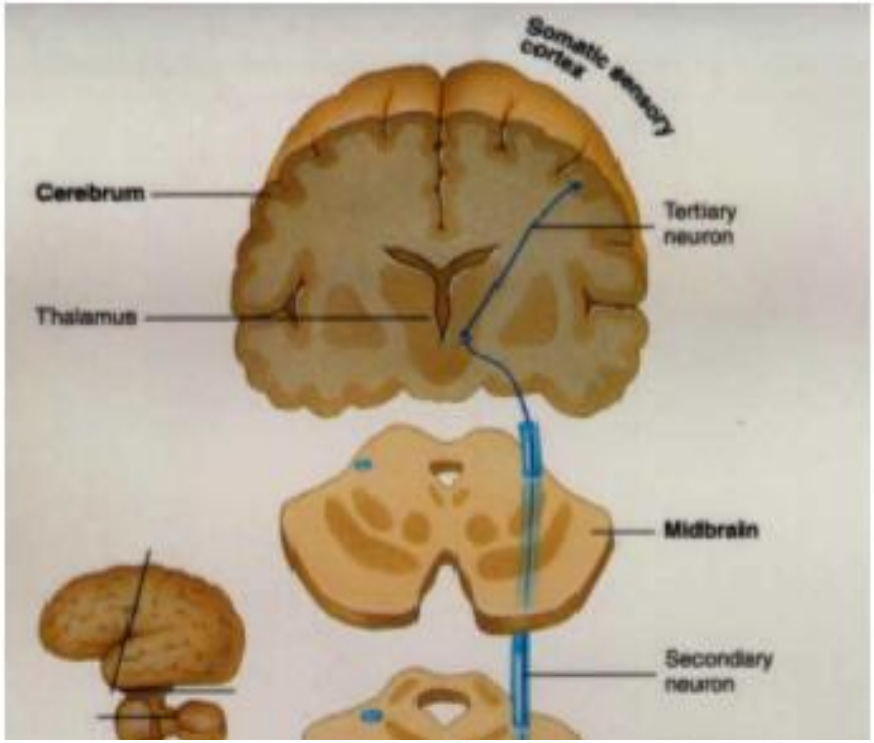
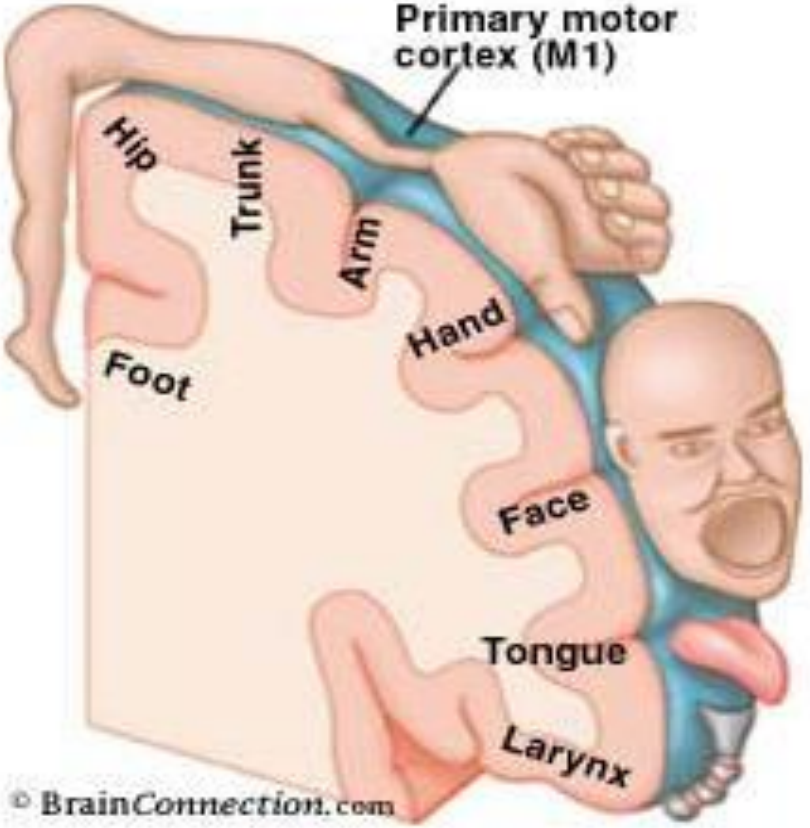
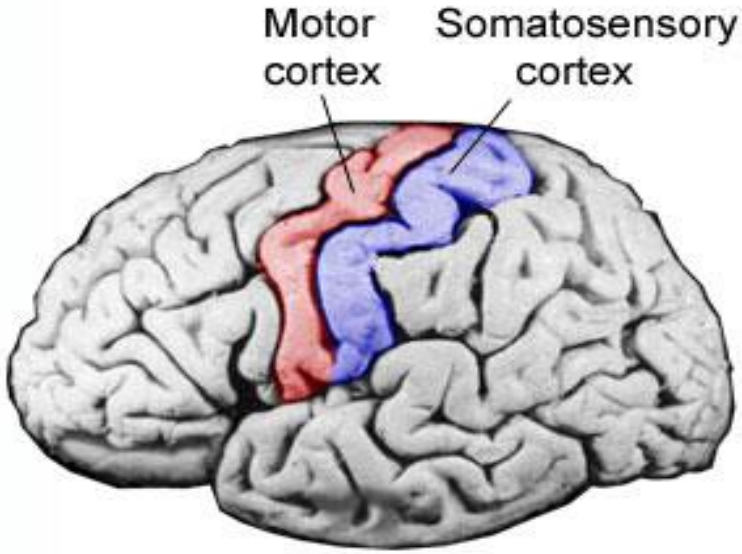
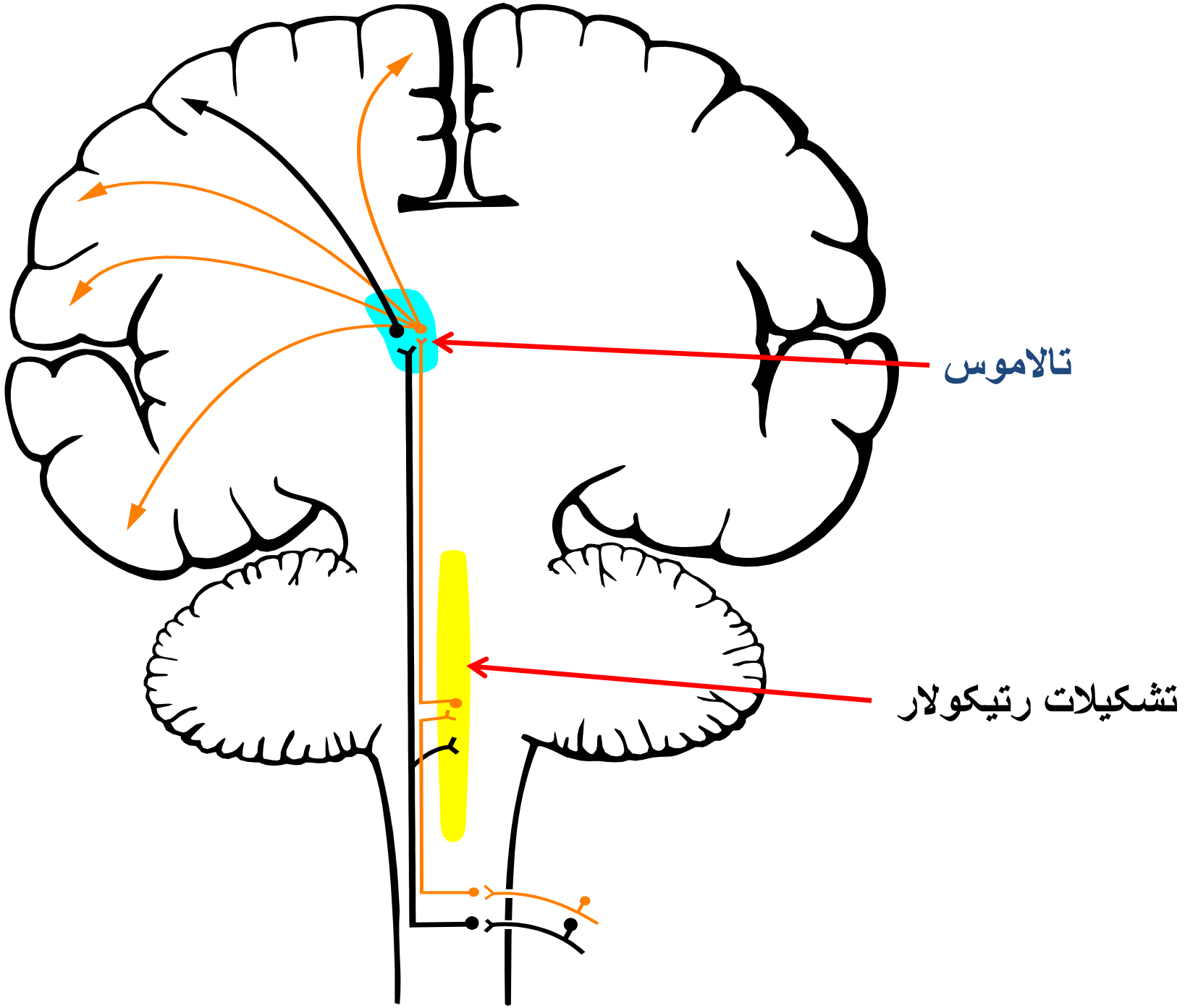


Figure F-3: Motor and Somatosensory Cortex

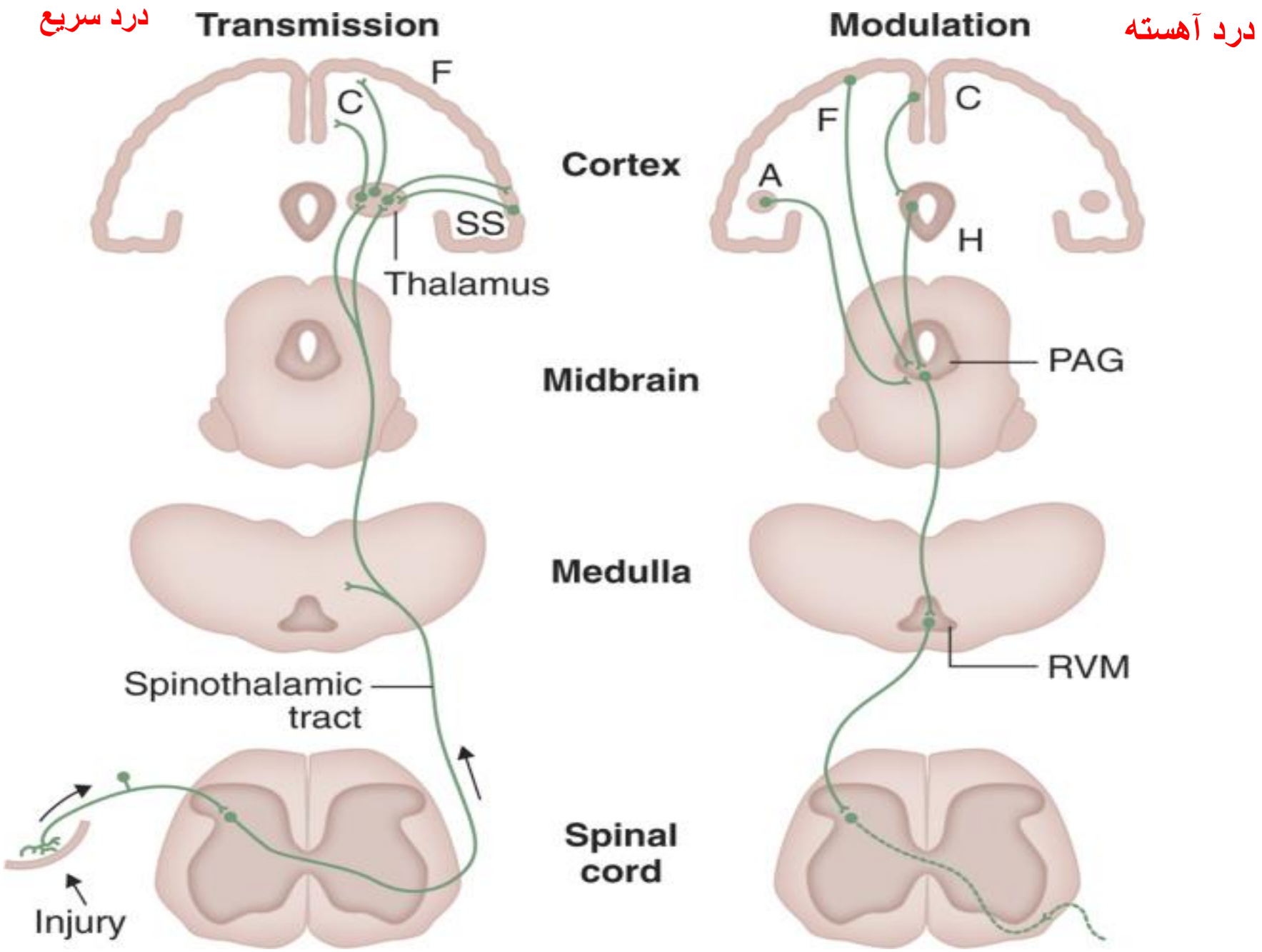




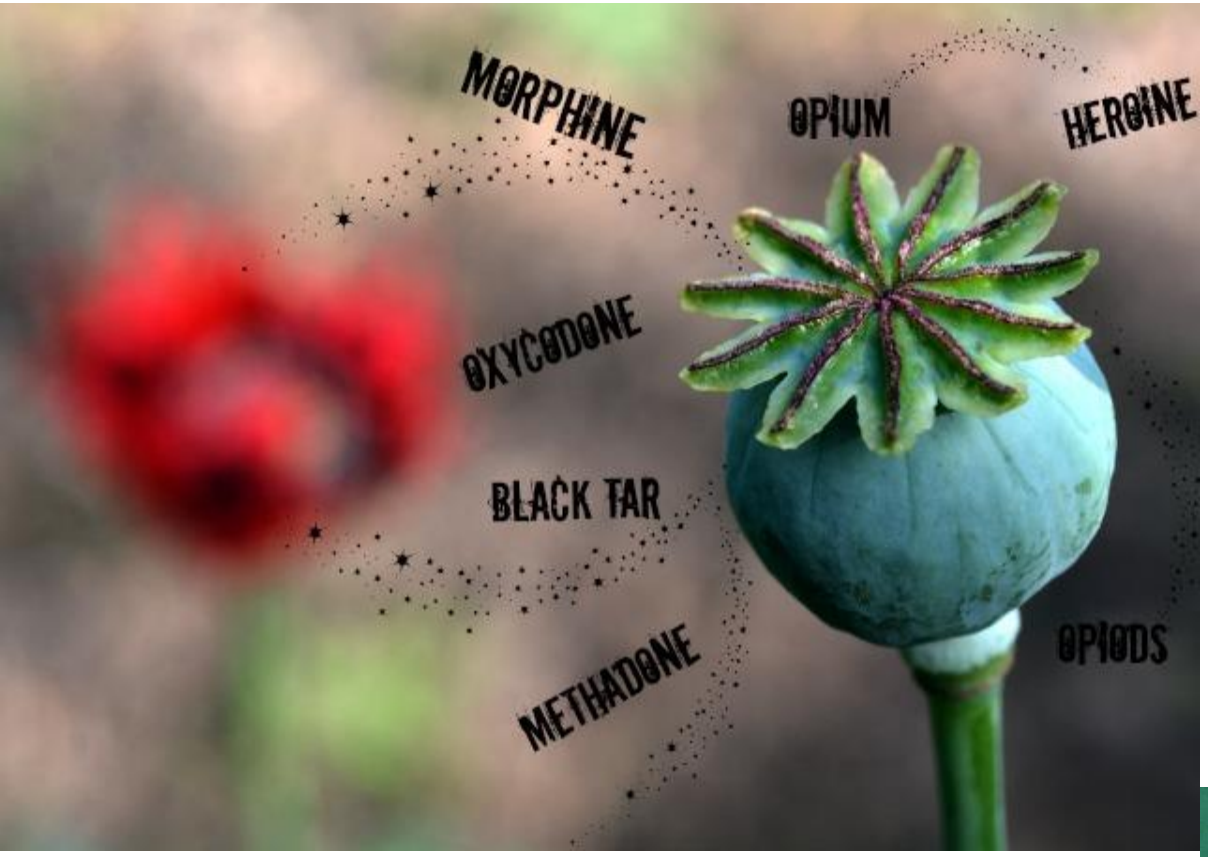

تالاموس
تشكيلات رتيكولار

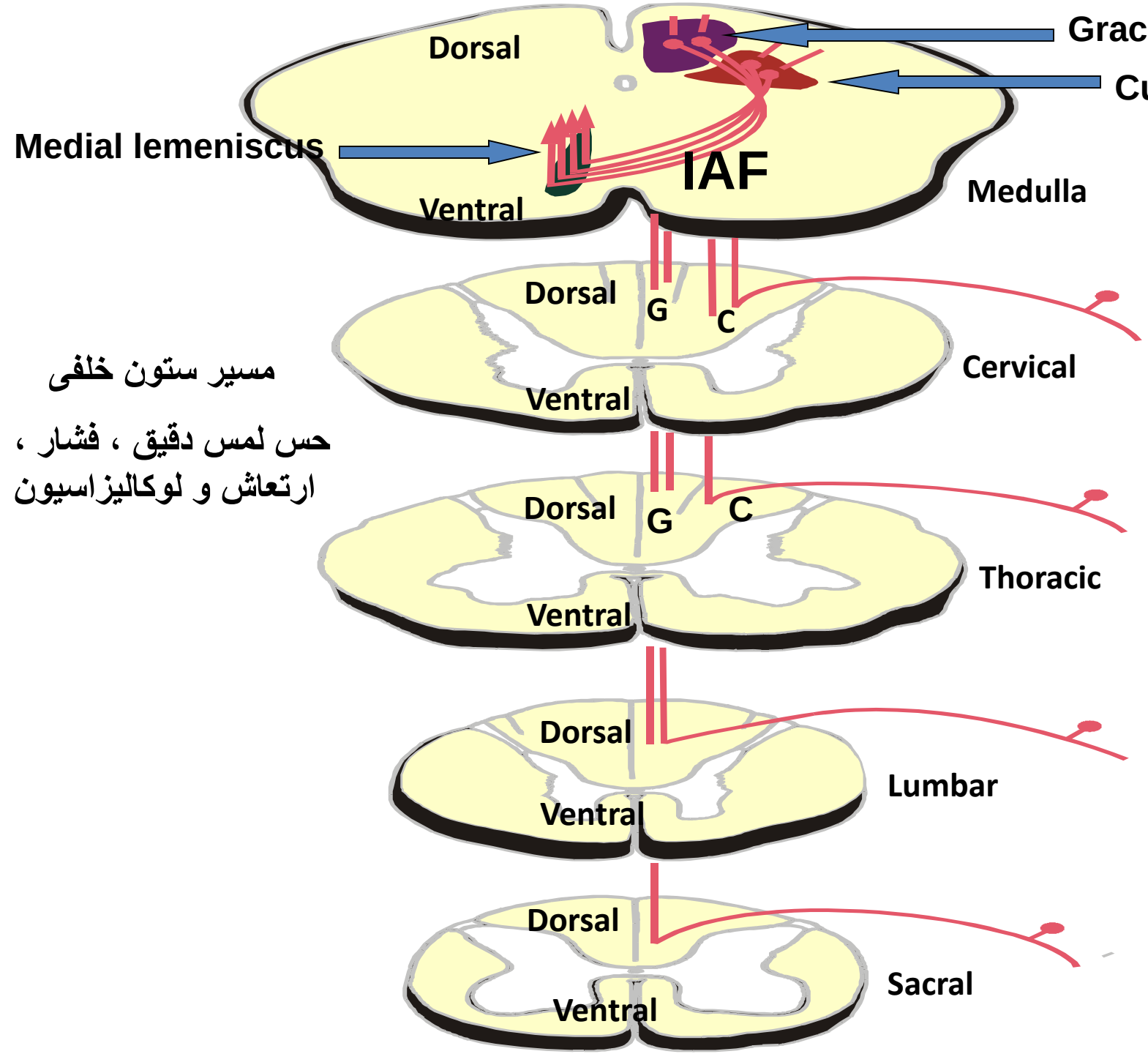
Glasgow Coma Scale(GCS)

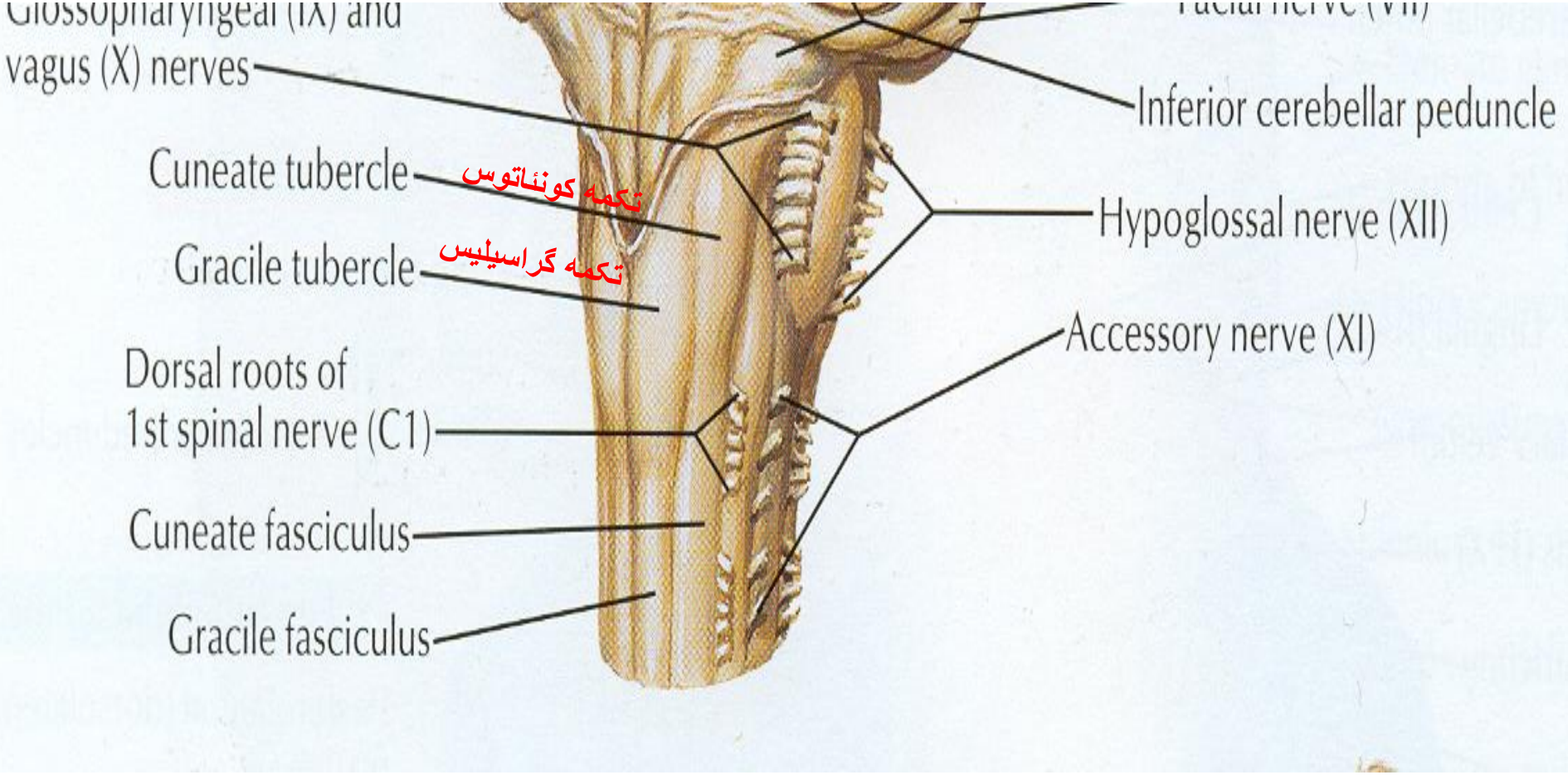
Glasgow Coma Scale		
Response	Scale	Score
Eye Opening Response	Eyes open spontaneously	4 Points
	Eyes open to verbal command, speech, or shout	3 Points
	Eyes open to pain (not applied to face)	2 Points
	No eye opening	1 Point
Verbal Response	Oriented	5 Points
	Confused conversation, but able to answer questions	4 Points
	Inappropriate responses, words discernible	3 Points
	Incomprehensible sounds or speech	2 Points
	No verbal response	1 Point
Motor Response	Obeys commands for movement	6 Points
	Purposeful movement to painful stimulus	5 Points
	Withdraws from pain	4 Points
	Abnormal (spastic) flexion, decorticate posture	3 Points
	Extensor (rigid) response, decerebrate posture	2 Points
	No motor response	1 Point
Minor Brain Injury = 13-15 points; **Moderate Brain Injury** = 9-12 points; **Severe Brain Injury** = 3-8 points		

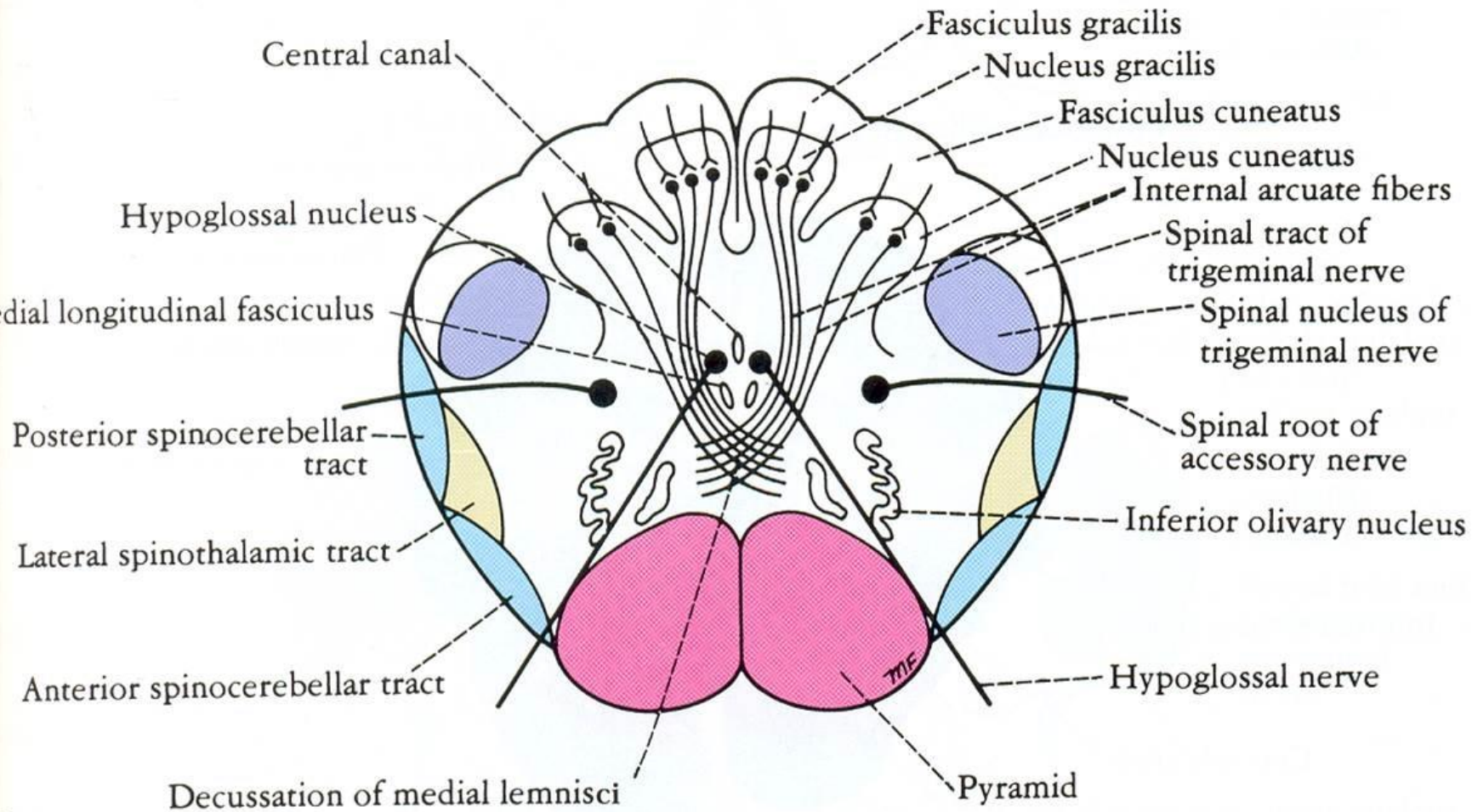

درد سریع
Transmission
Modulation
درد آهسته
F
C
SS
Thalamus
Cortex
A
F
C
H
PAG
Midbrain
Medulla
RVM
Spinothalamic tract
Spinal cord
Injury

Analgesic drugs (Opium)



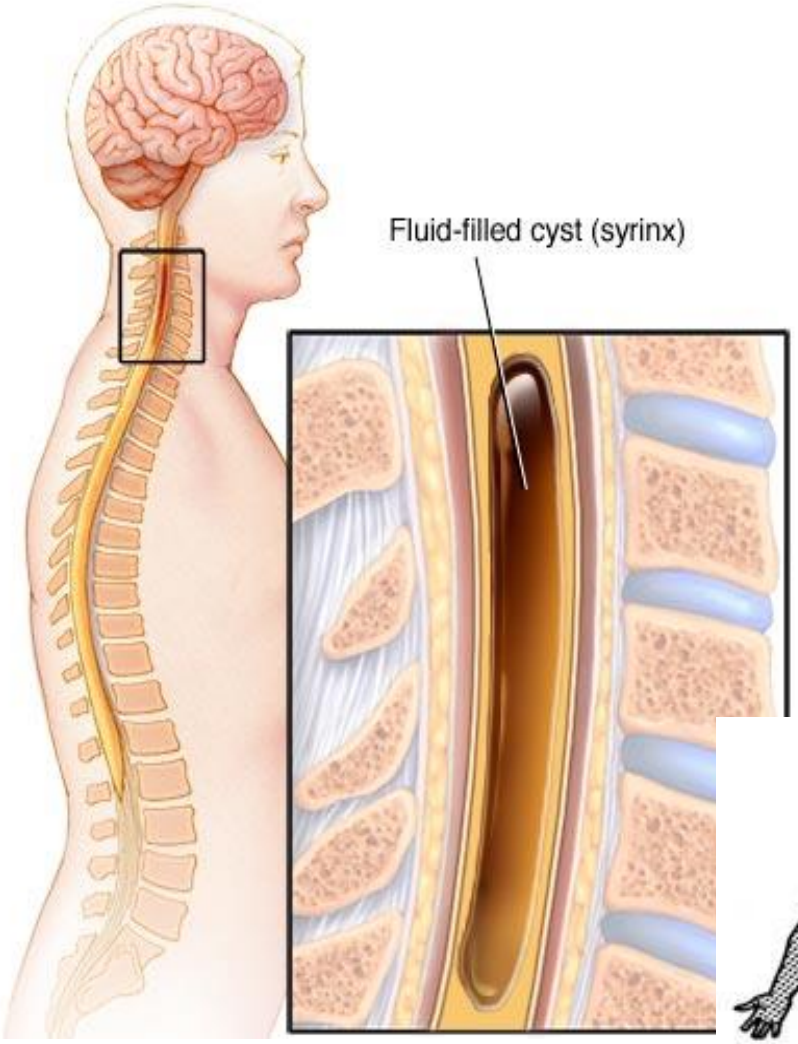

Gracile N.
Cuneatus N.
Medial lemeniscus
IAF
Dorsal
Ventral
Medulla
Dorsal
G
C
Ventral
Cervical
مسير ستون خلفى
حس لمس دقيق ، فشار ،
ارتعاش و لوكاليزاسيون
Dorsal
G
C
Ventral
Thoracic
Dorsal
Ventral
Lumbar
Dorsal
Ventral
Sacral

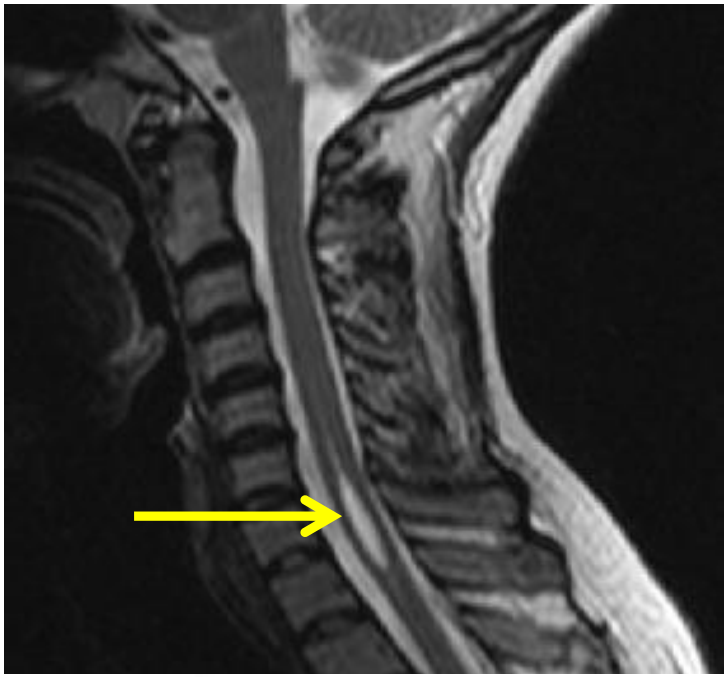

Glossopharyngeal (IX) and
vagus (X) nerves
Cuneate tubercle
تکمه کونئاتوس
Gracile tubercle
تکمه گراسیلیس
Dorsal roots of
1st spinal nerve (C1)
Cuneate fasciculus
Gracile fasciculus
Inferior cerebellar peduncle
Hypoglossal nerve (XII)
Accessory nerve (XI)

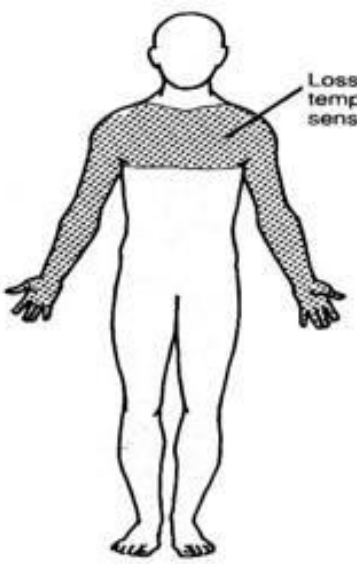

Central canal
Fasciculus gracilis
Nucleus gracilis
Fasciculus cuneatus
Nucleus cuneatus
Internal arcuate fibers
Hypoglossal nucleus
Spinal tract of trigeminal nerve
edial longitudinal fasciculus
Spinal nucleus of trigeminal nerve
Posterior spinocerebellar tract
Spinal root of accessory nerve
Inferior olivary nucleus
Lateral spinothalamic tract
Anterior spinocerebellar tract
Hypoglossal nerve
Decussation of medial lemnisci
Pyramid
B

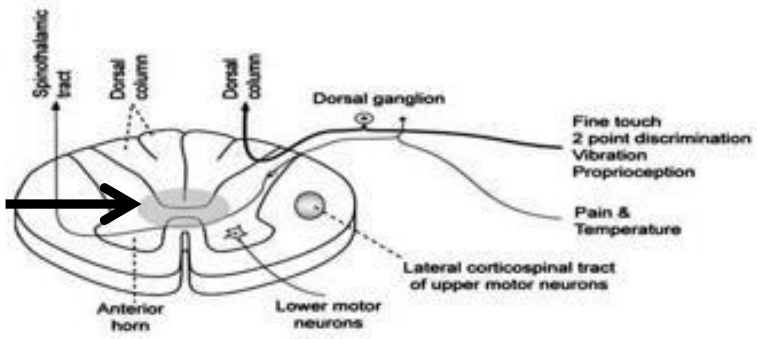
Sensory Ataxia

Syringomyelia

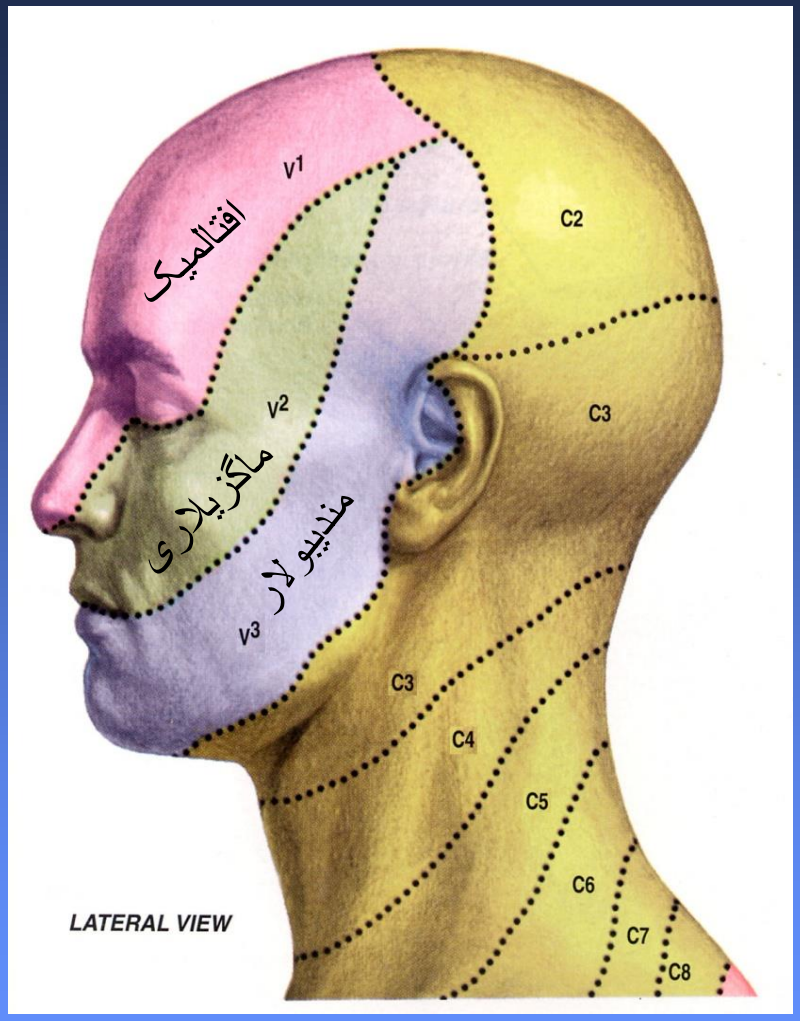


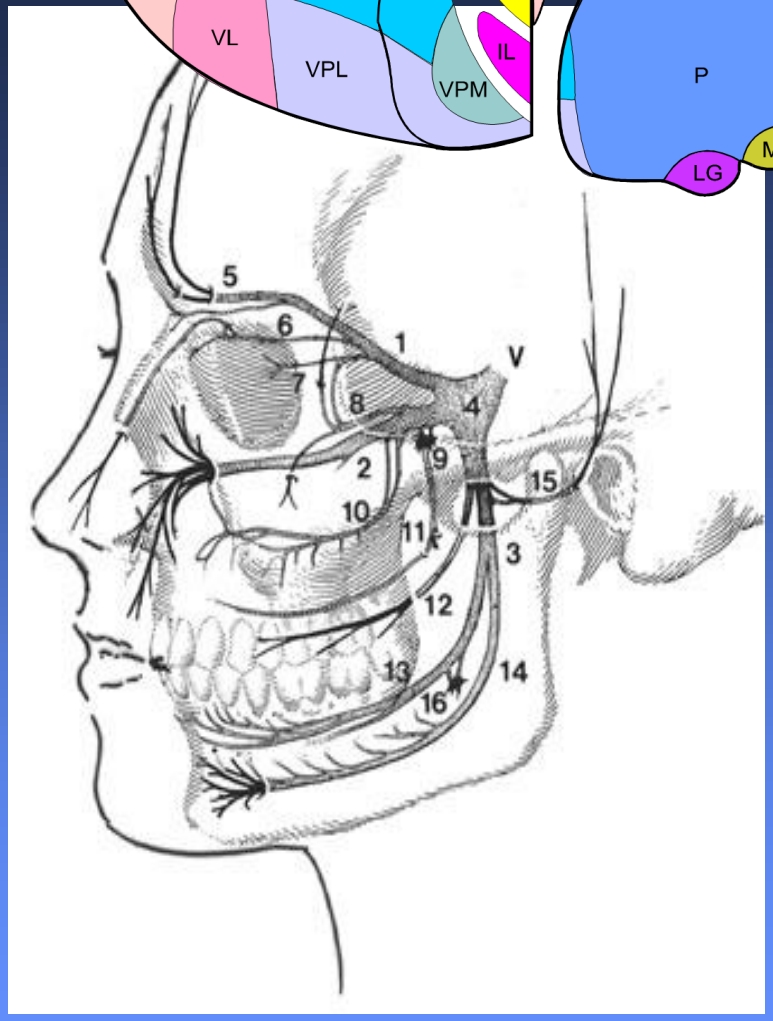






مسیر تریجمینوتالامیک





انتریور اسپینوسربلار

هسته کونئاتوس فرعی

انتریور اسپینوسربلار،
پوستریور اسپینو سربلار ،
کونئوسربلار

Medulla

Cervical

Thoracic

Lumbar

Sacral

Dorsal

Ventral

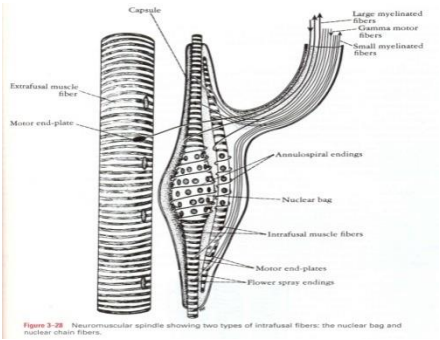


Figure 3-28 Neuromuscular spindle showing two types of intrafusal fibers: the nuclear bag and nuclear chain fibers.

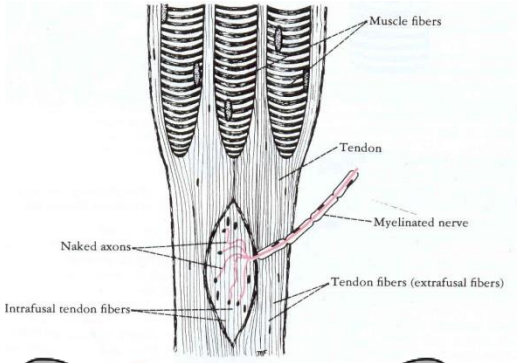
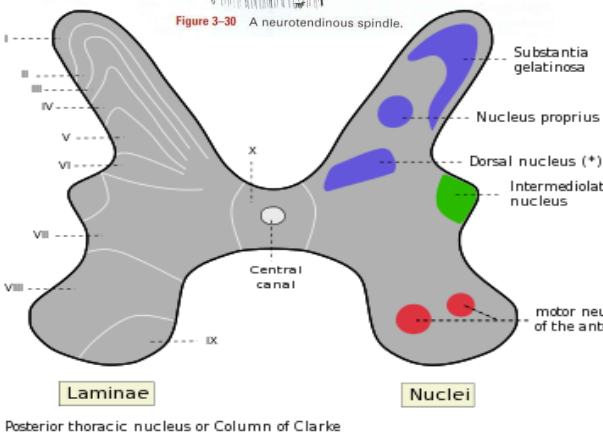
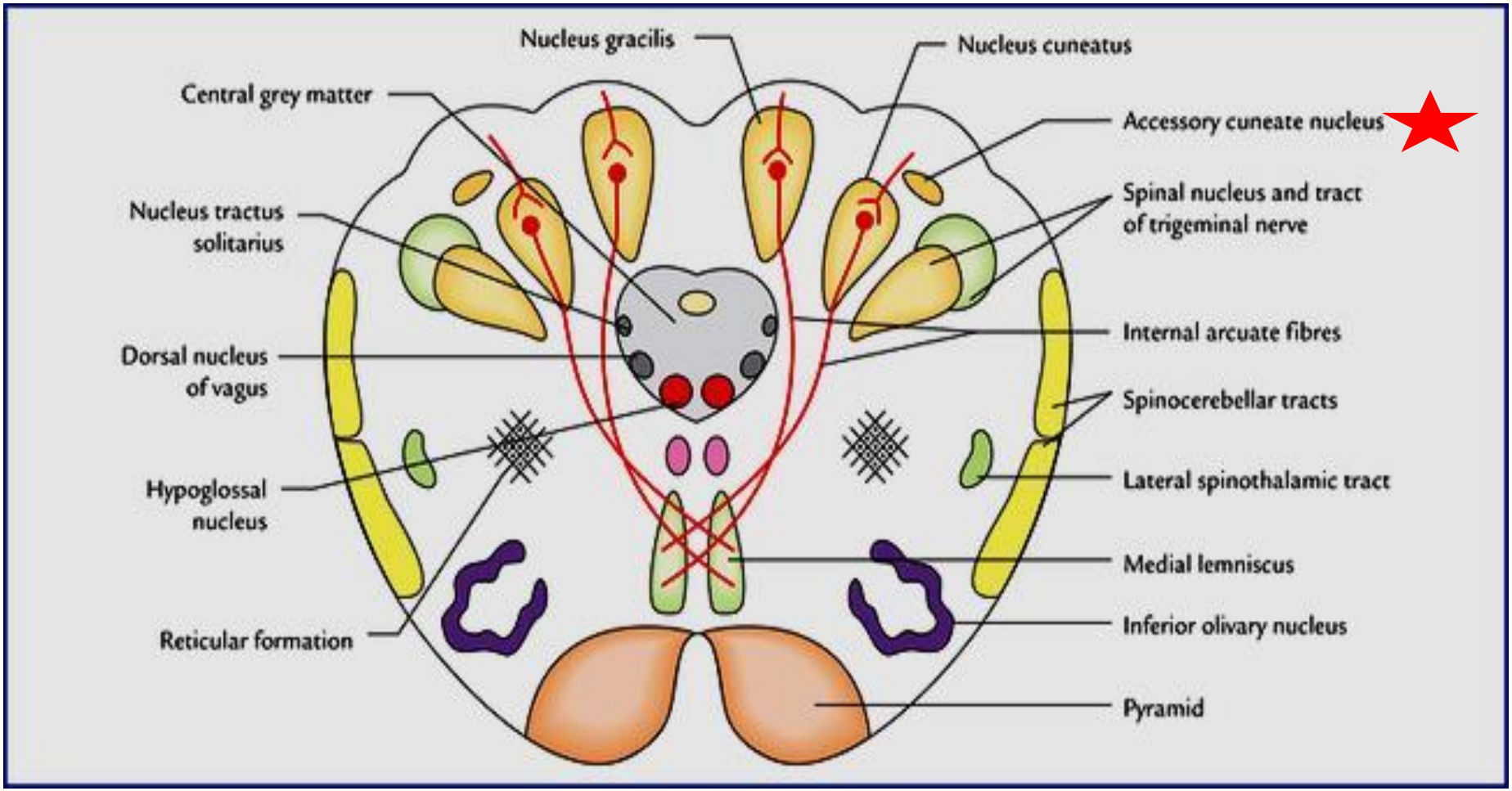


Figure 3–30 A neurotendinous spindle.

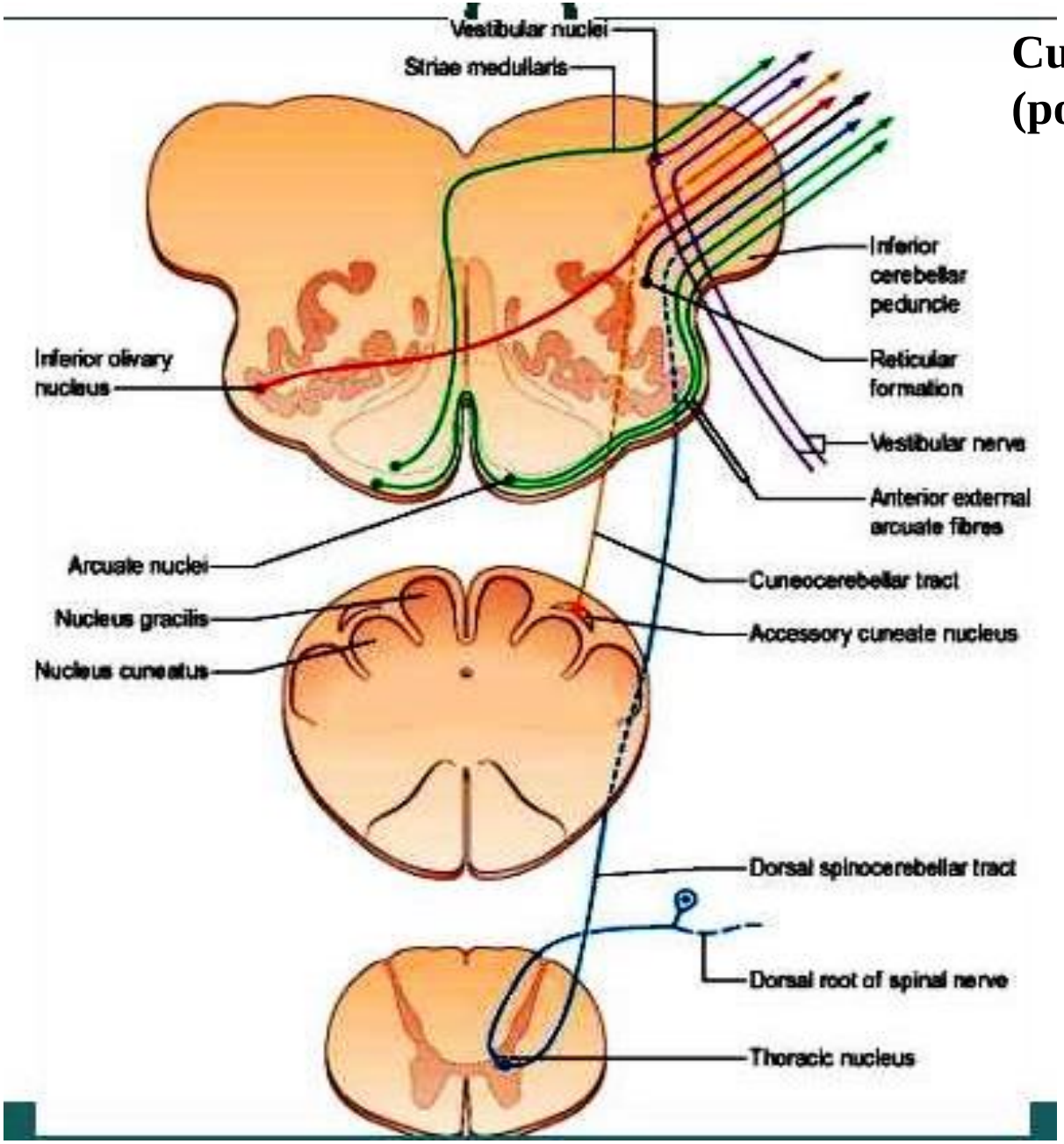


* Posterior thoracic nucleus or Column of Clarke

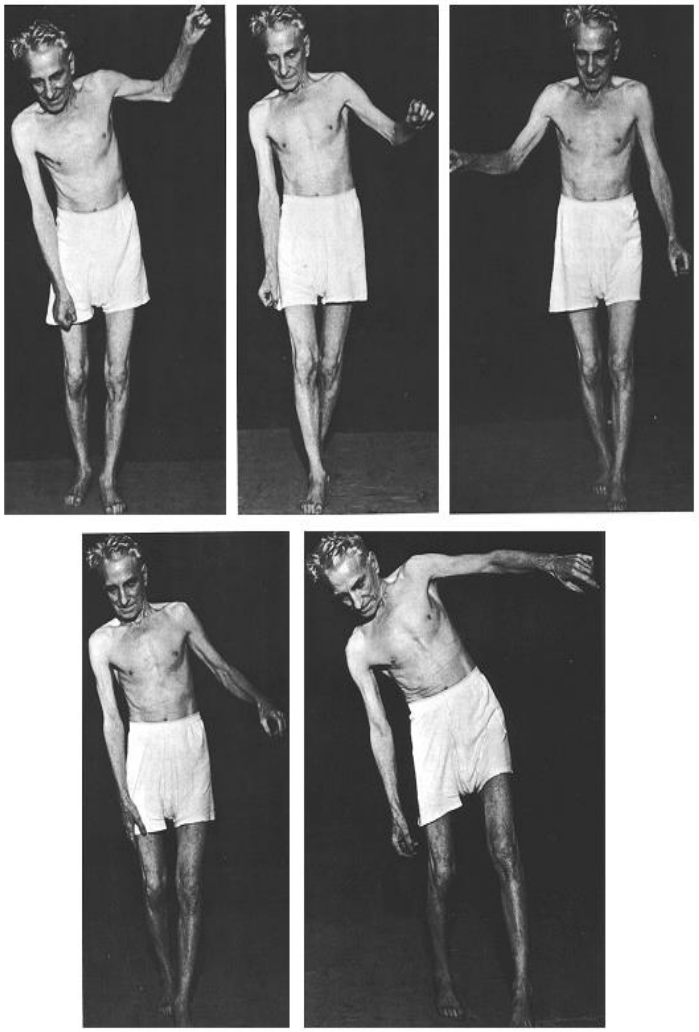
Accessory cuneate nucleus



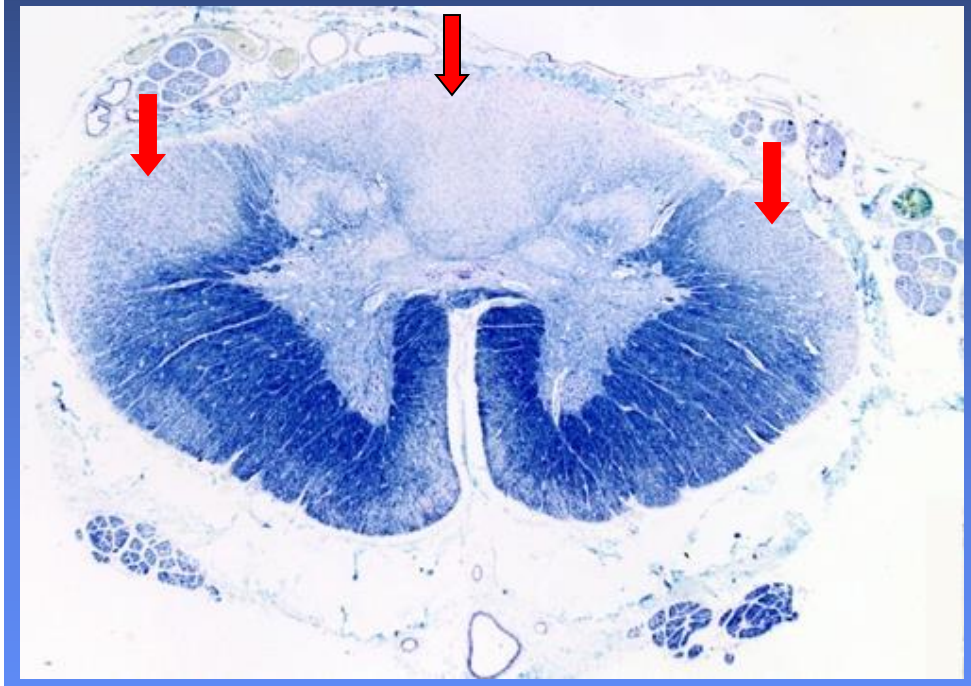
Cuneocerebellar
(posterior external arcuat fiber)



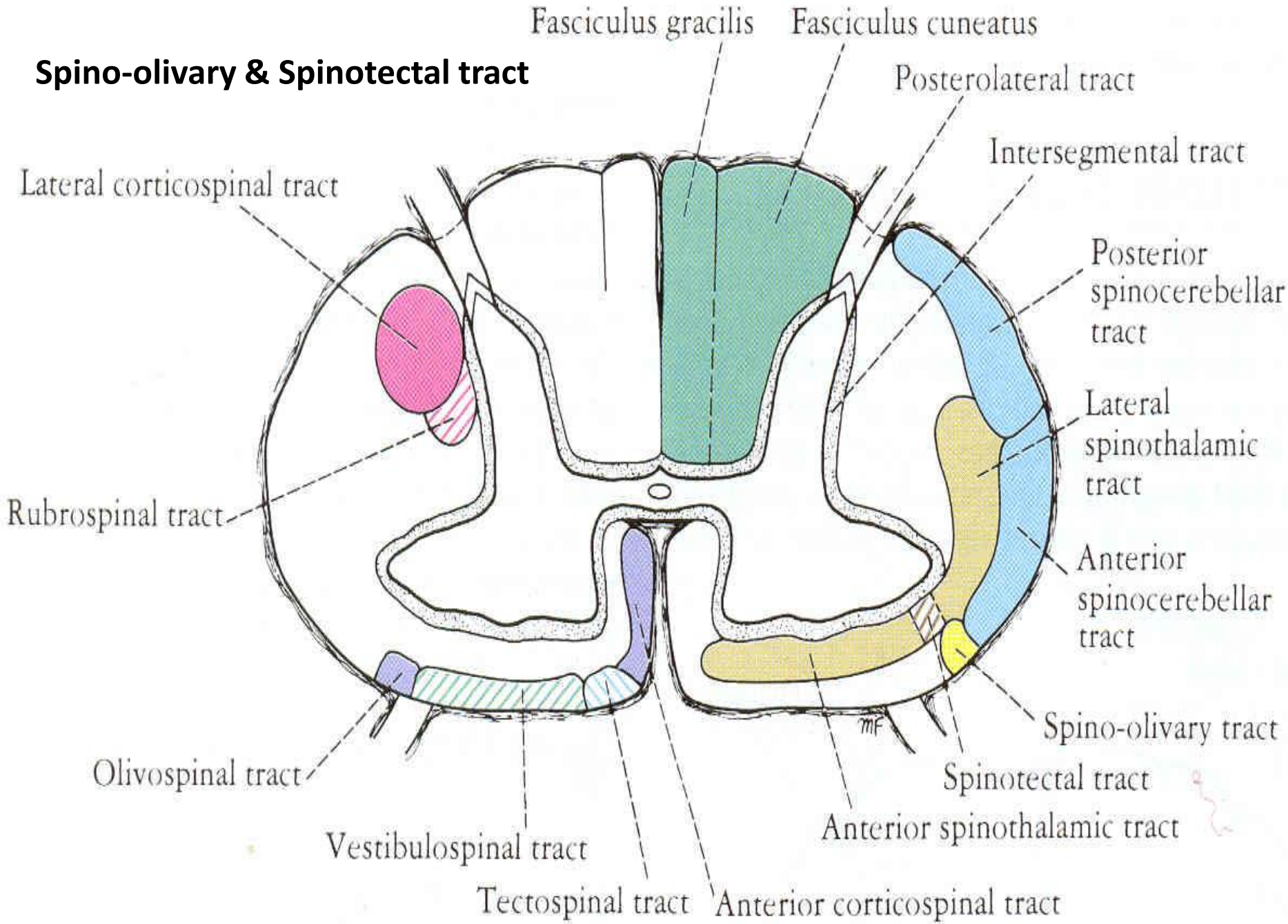
Posterior Column Ataxia



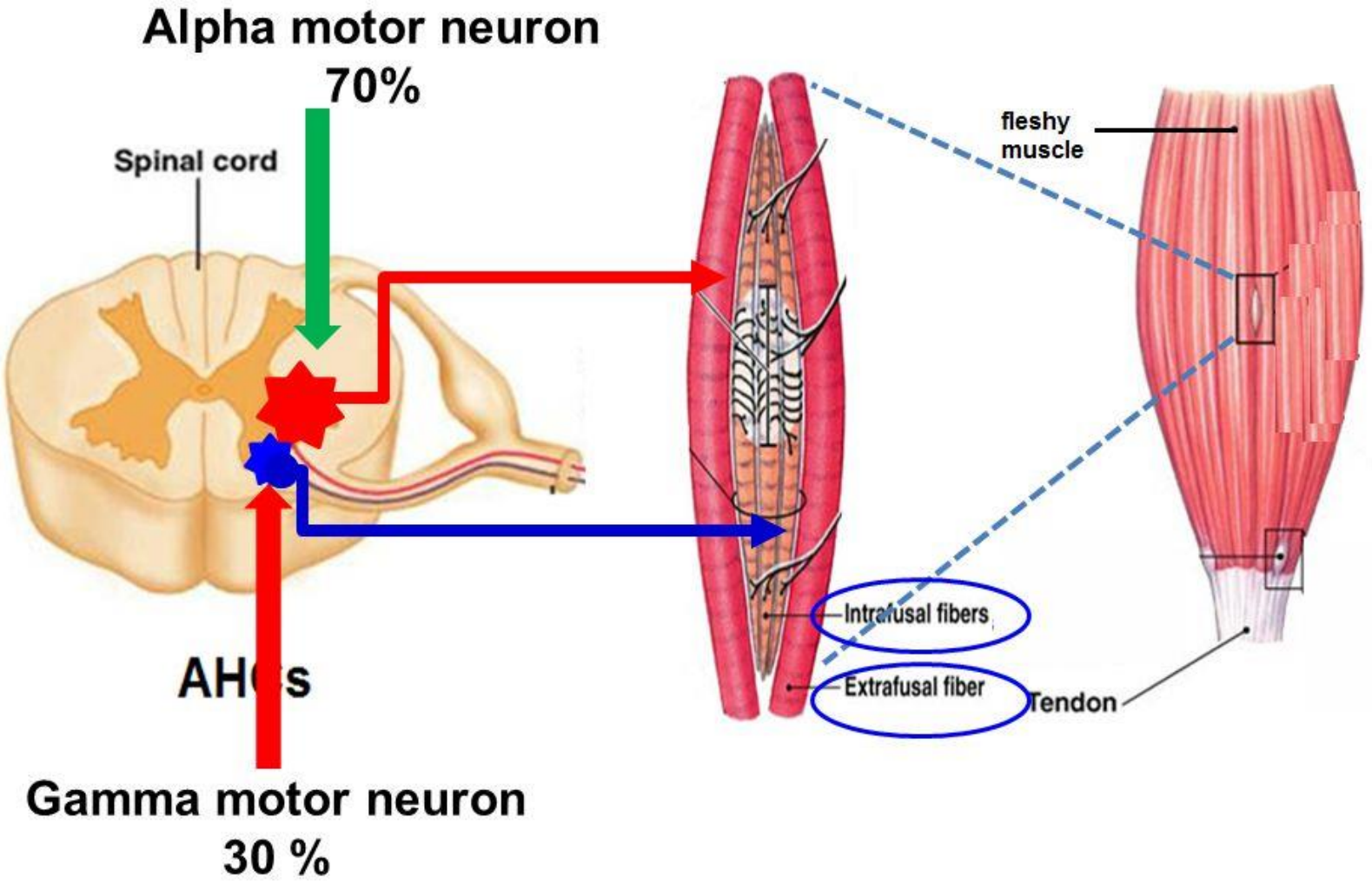
Friedreich's ataxia



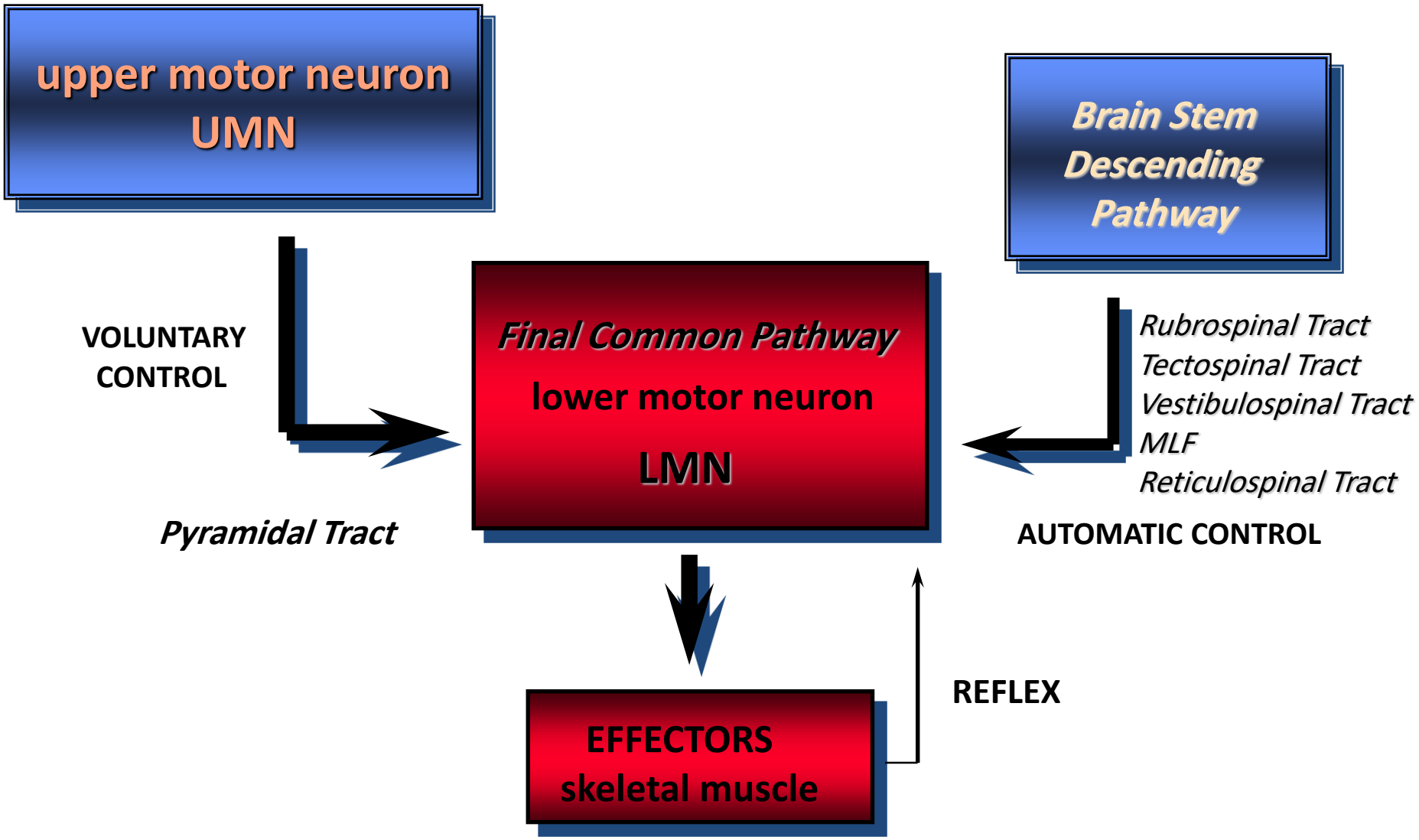
Spino-olivary & Spinotectal tract

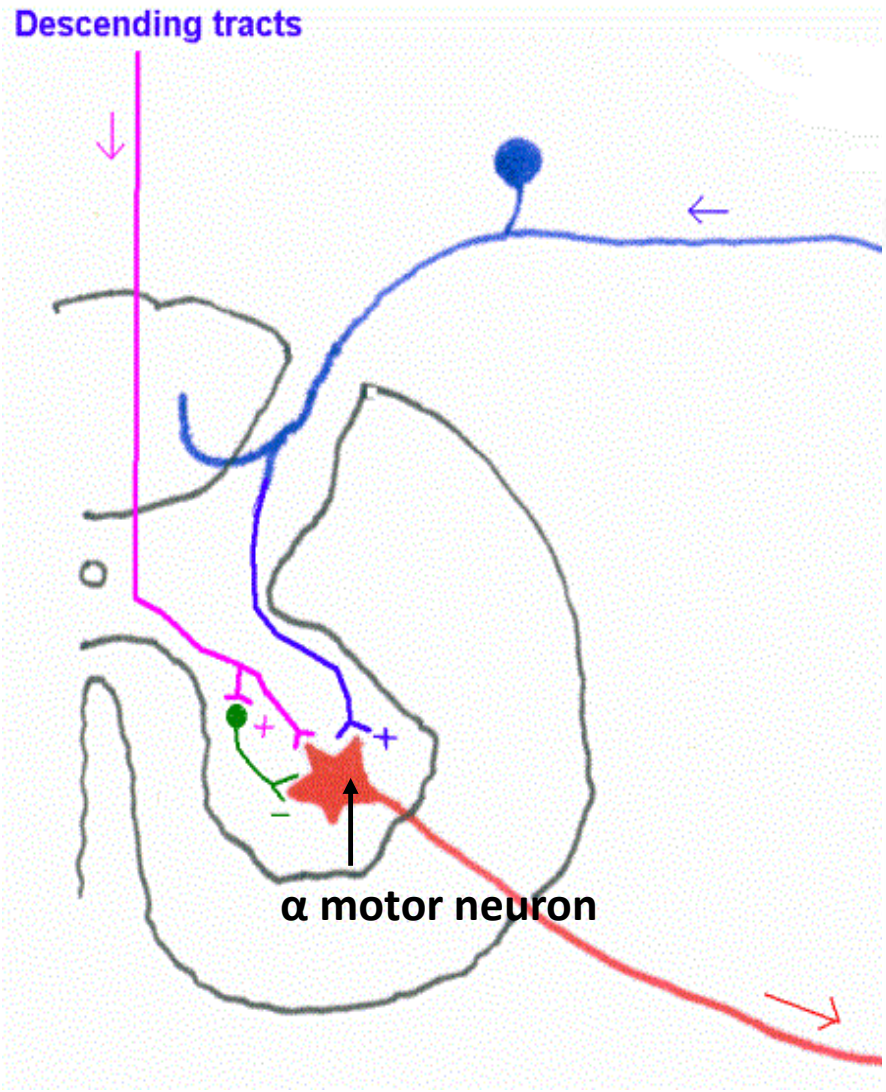


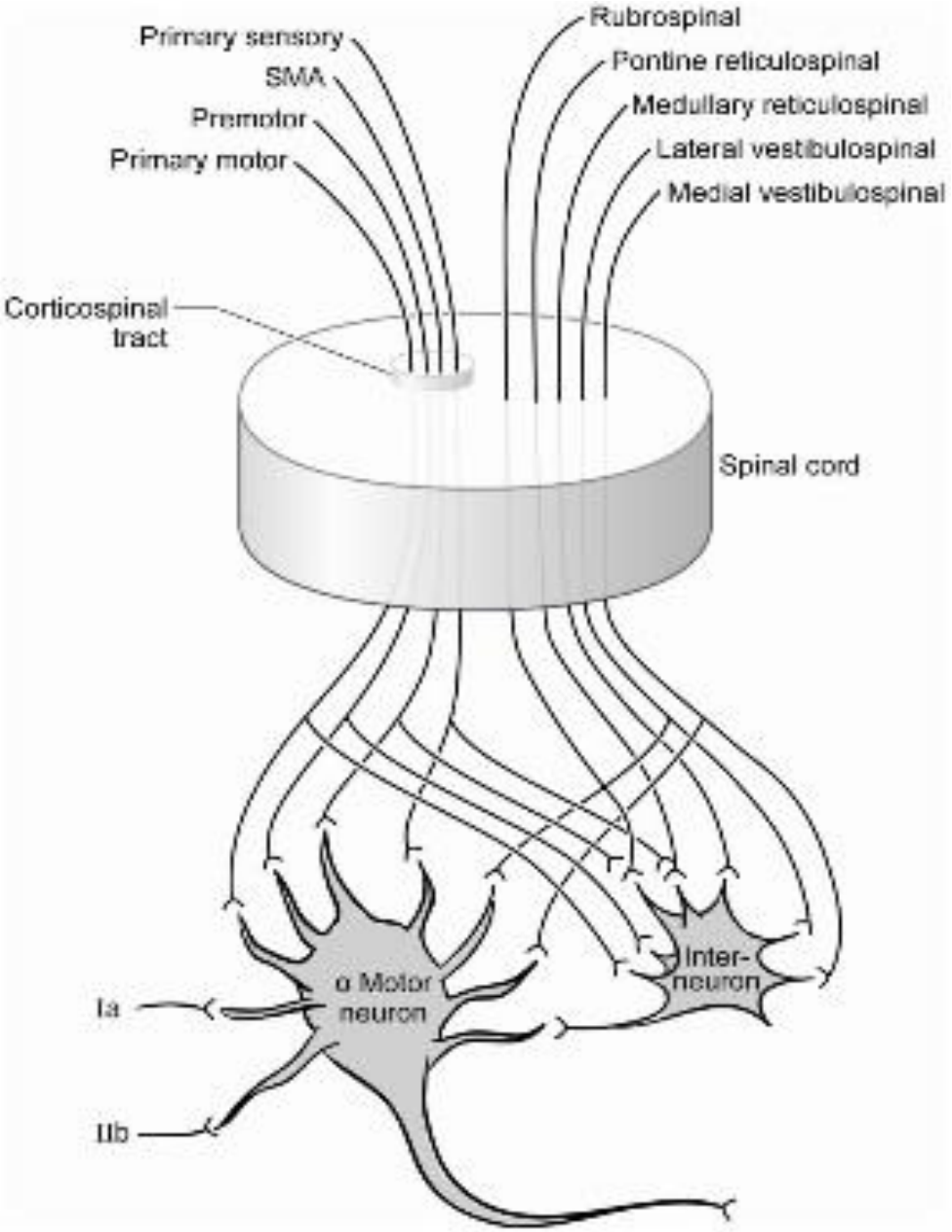
Type of neuron in anterior horn of spinal cord



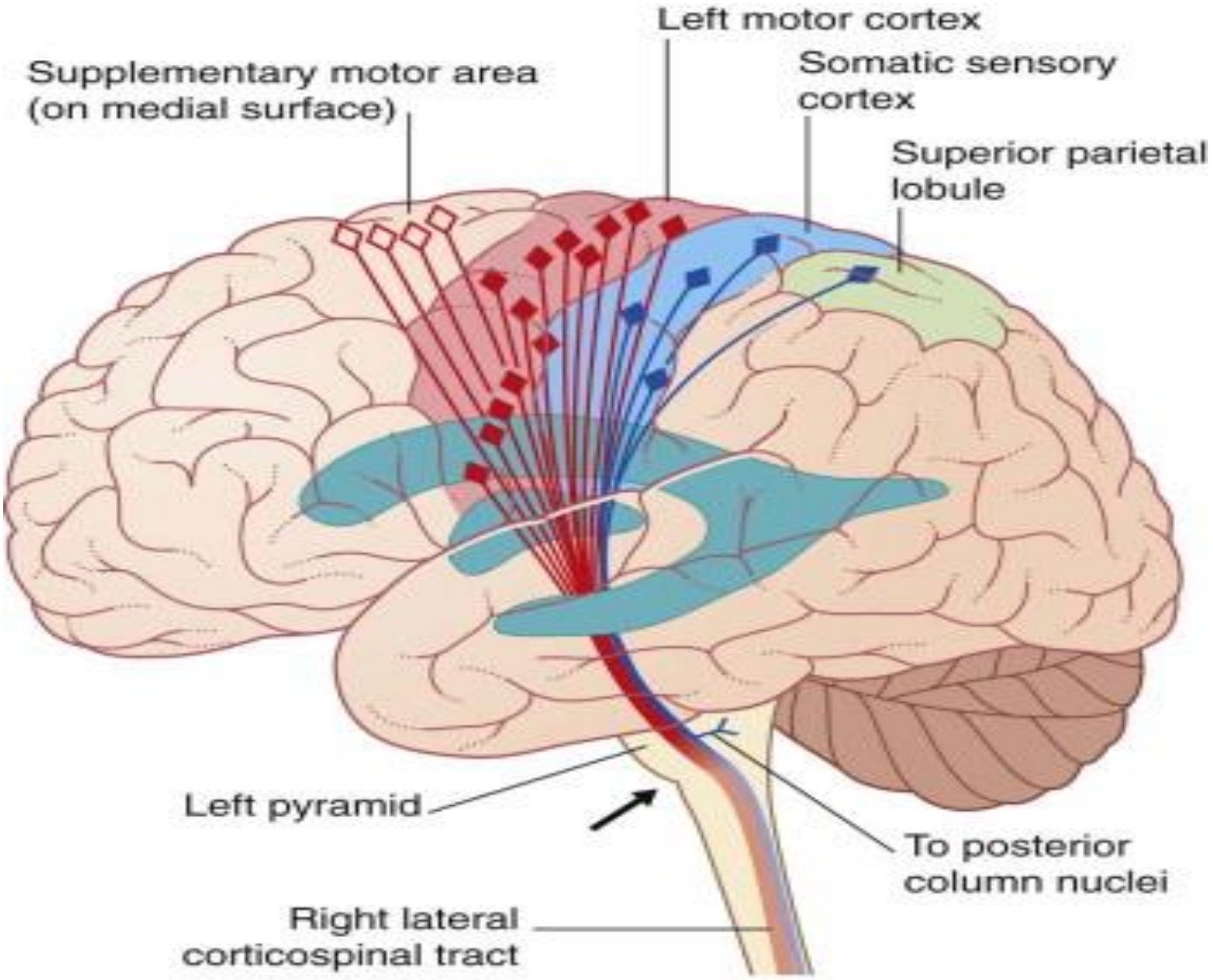
SOMATIC MOTOR SYSTEM

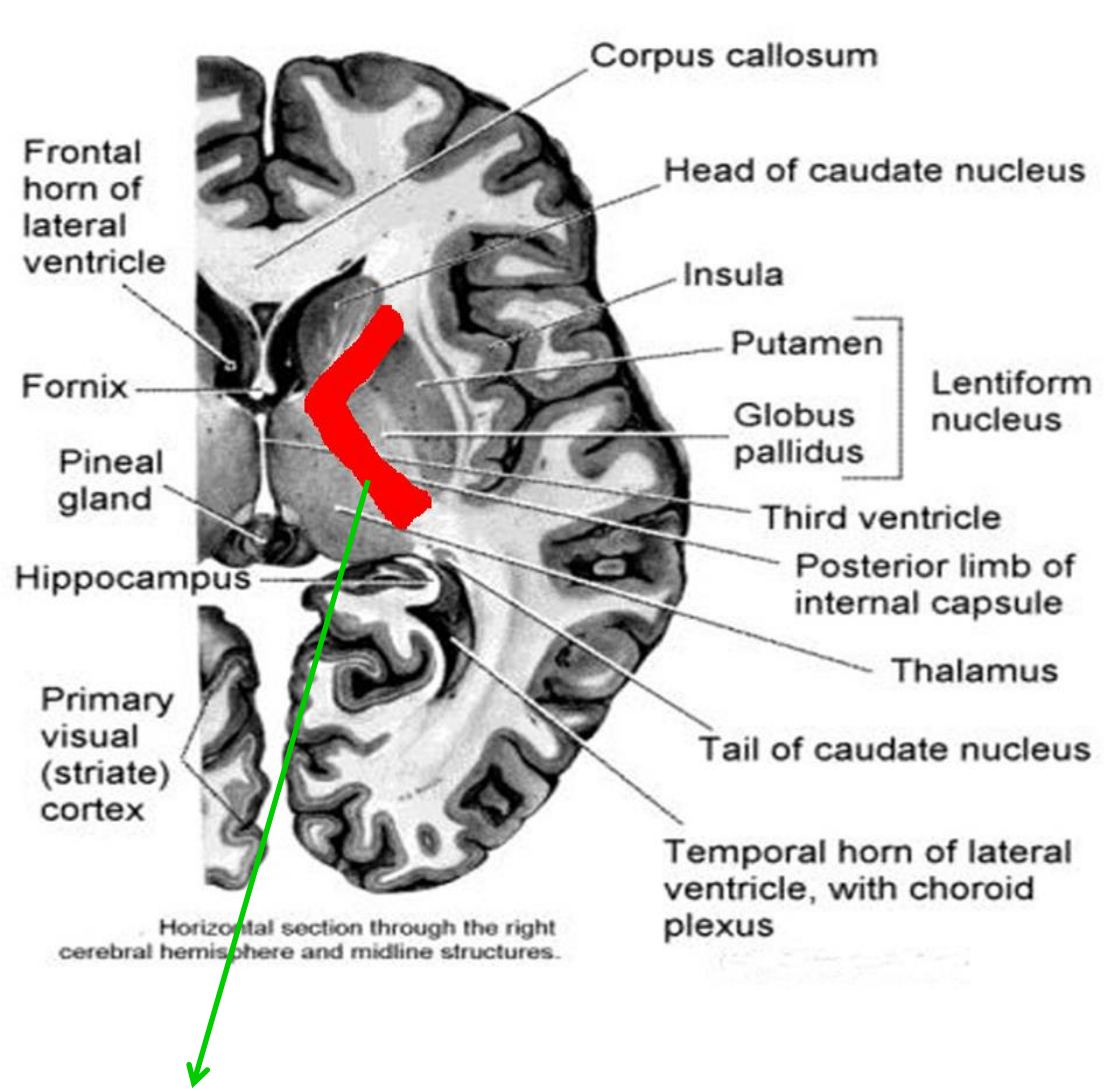


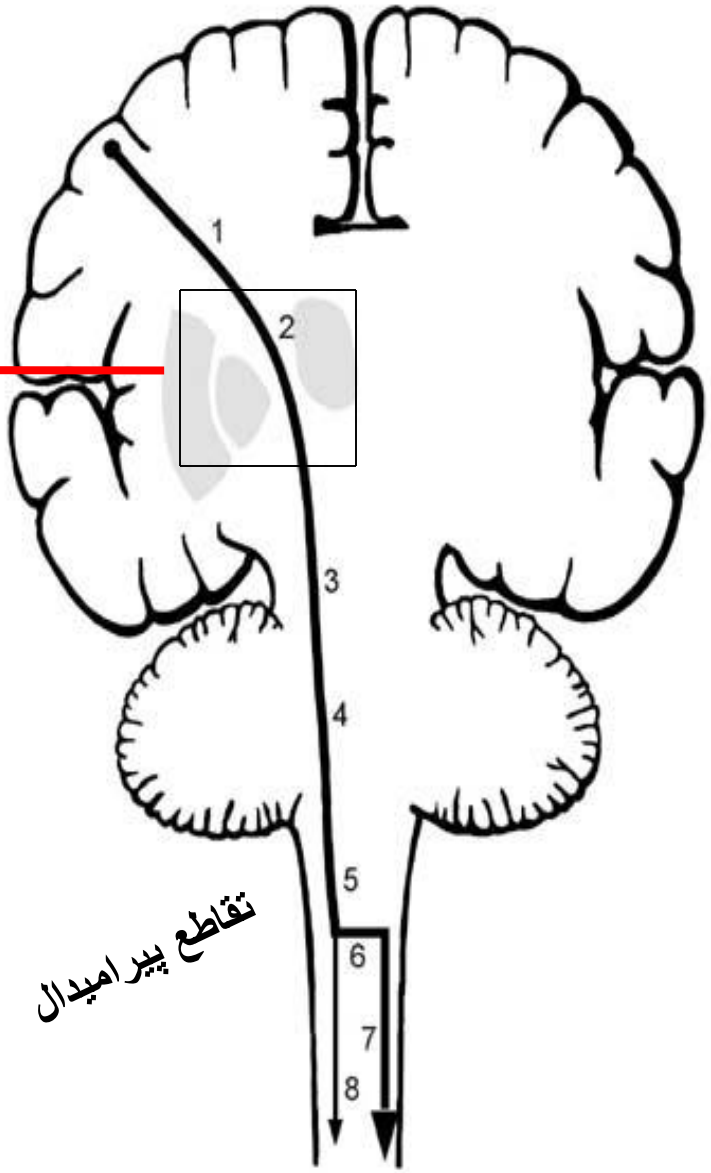

Descending tracts
α motor neuron


Primary sensory
SMA
Premotor
Primary motor
Rubrospinal
Pontine reticulospinal
Medullary reticulospinal
Lateral vestibulospinal
Medial vestibulospinal
Corticospinal tract
Spinal cord
α Motor neuron
Inter-neuron
Ia
IIb

Corticospinal tract مسیر کورتیکو اسپاینال

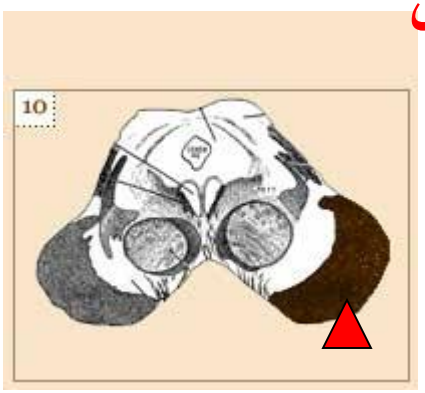


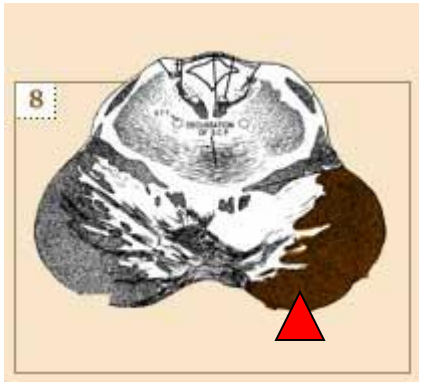




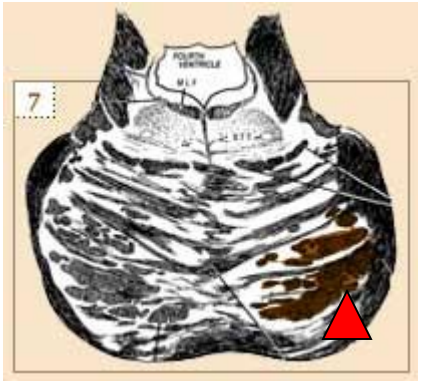
Internal Capsule

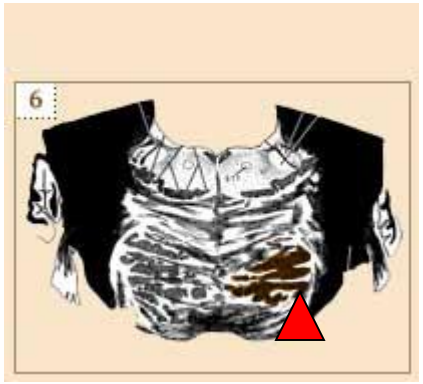
مسیر کورتیکو اسپاینال

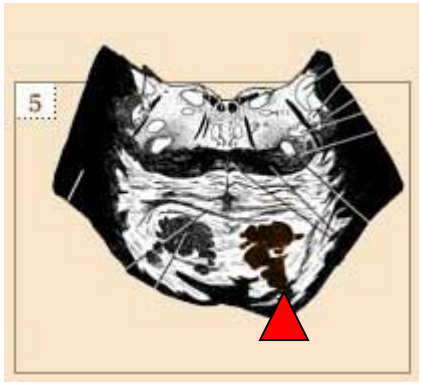




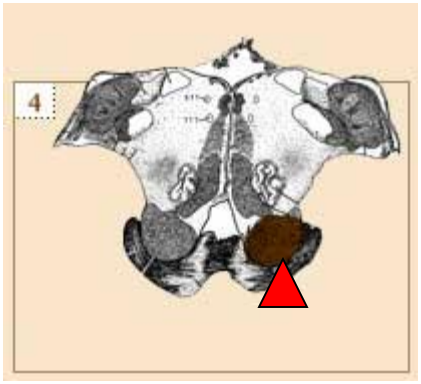
مغز میانی

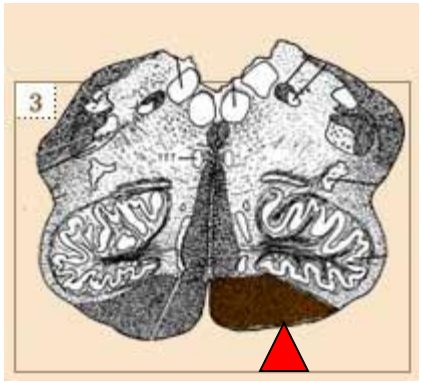


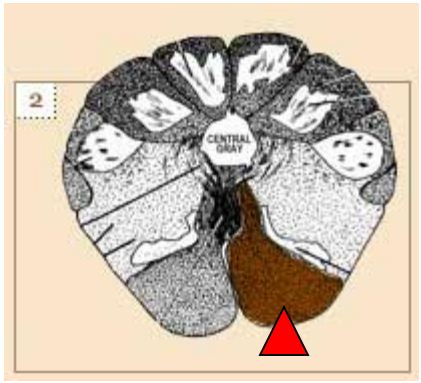




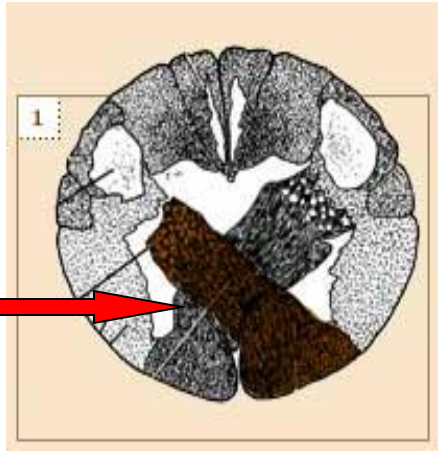
پل مغزی



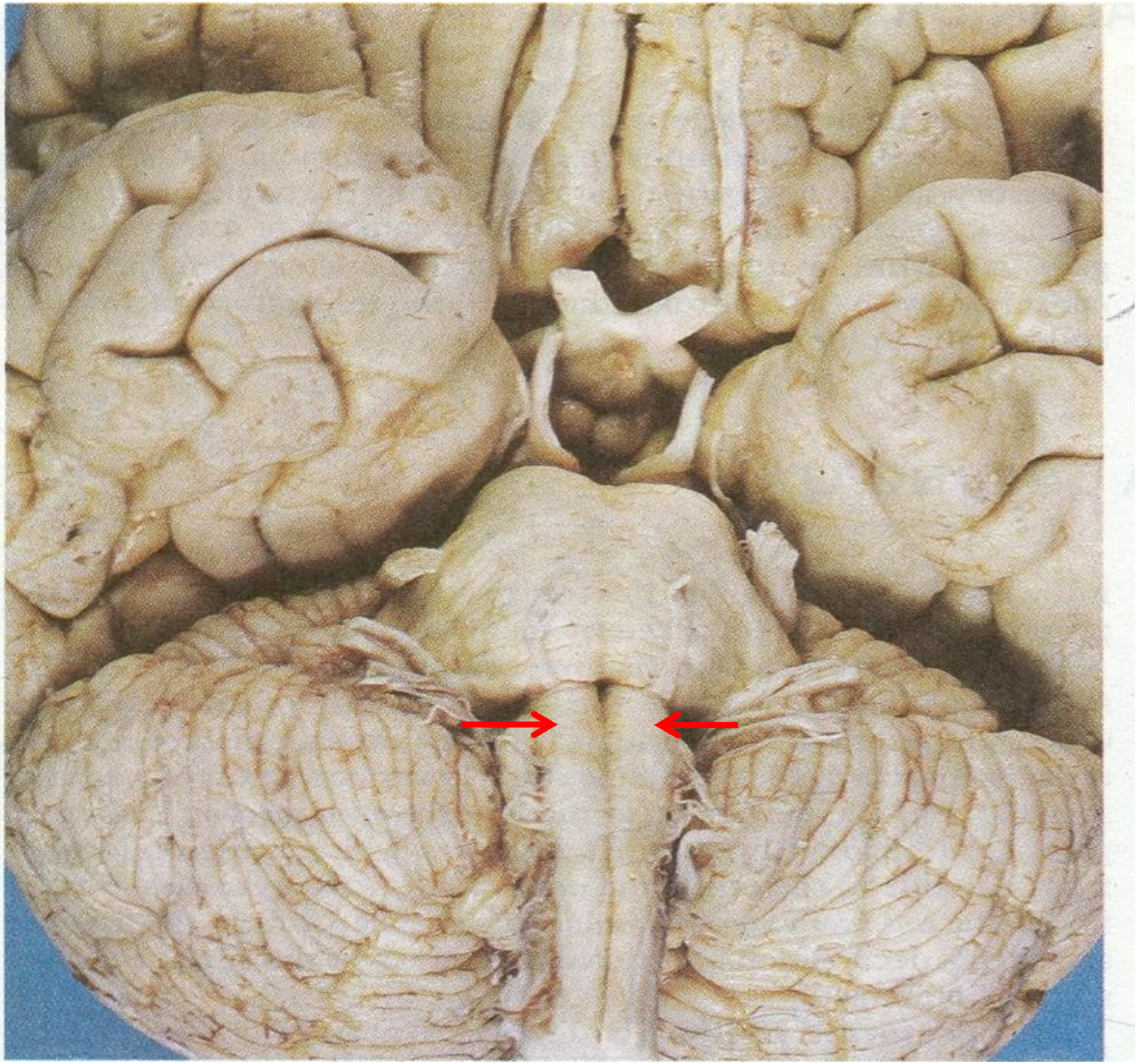


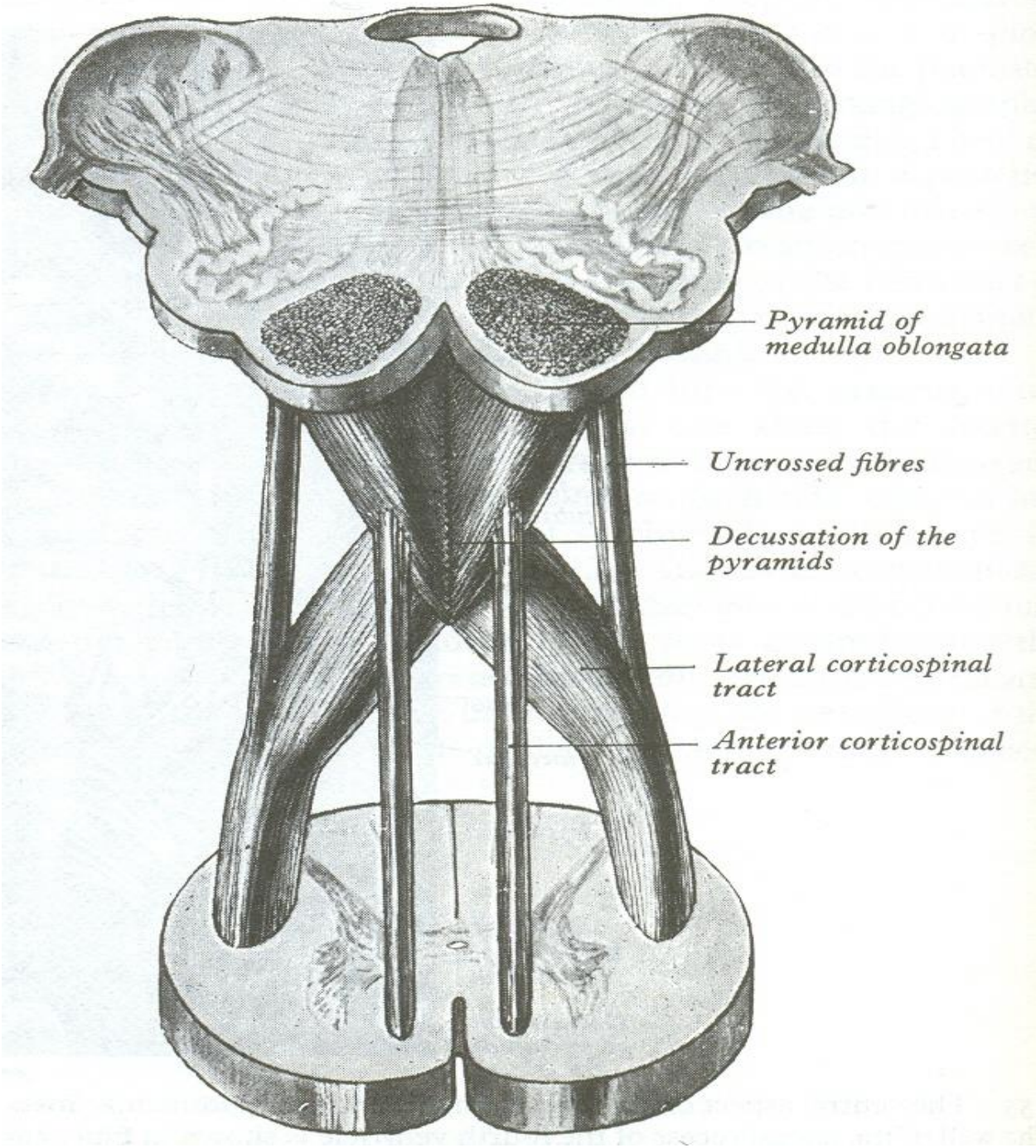


بصل النخاع

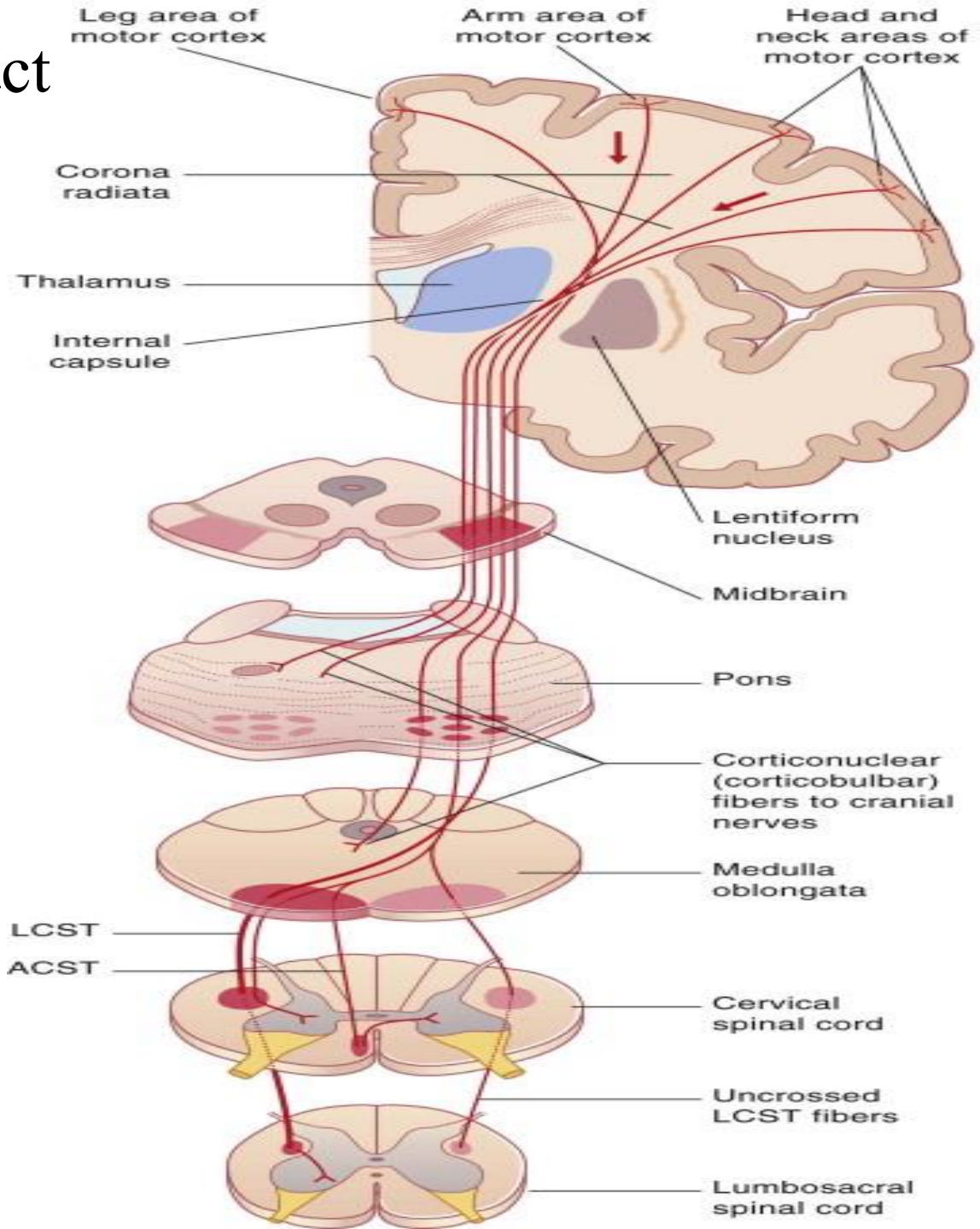


تقاطع پیرامیدال

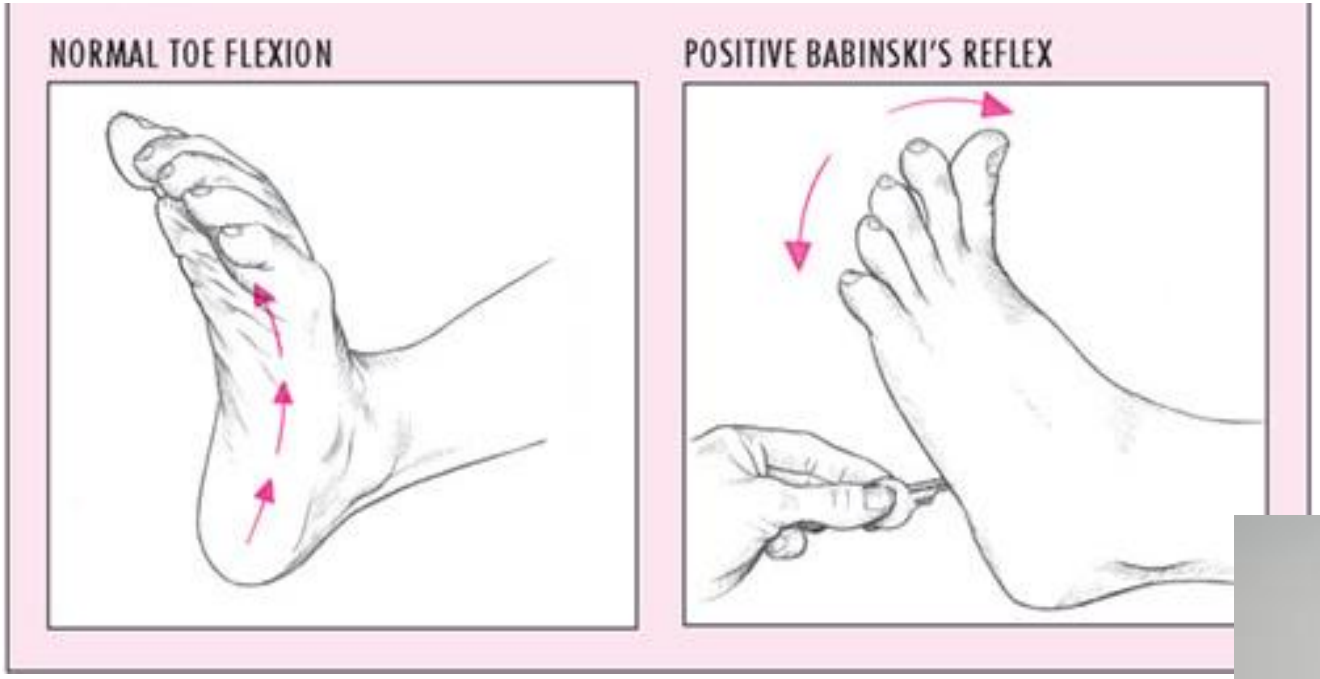



Pyramid of medulla oblongata
Uncrossed fibres
Decussation of the pyramids
Lateral corticospinal tract
Anterior corticospinal tract

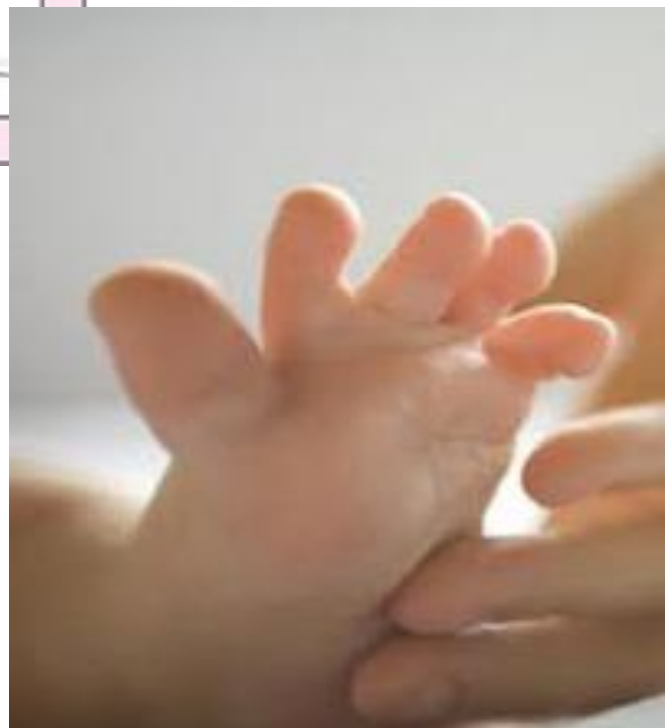
Corticobulbar tract



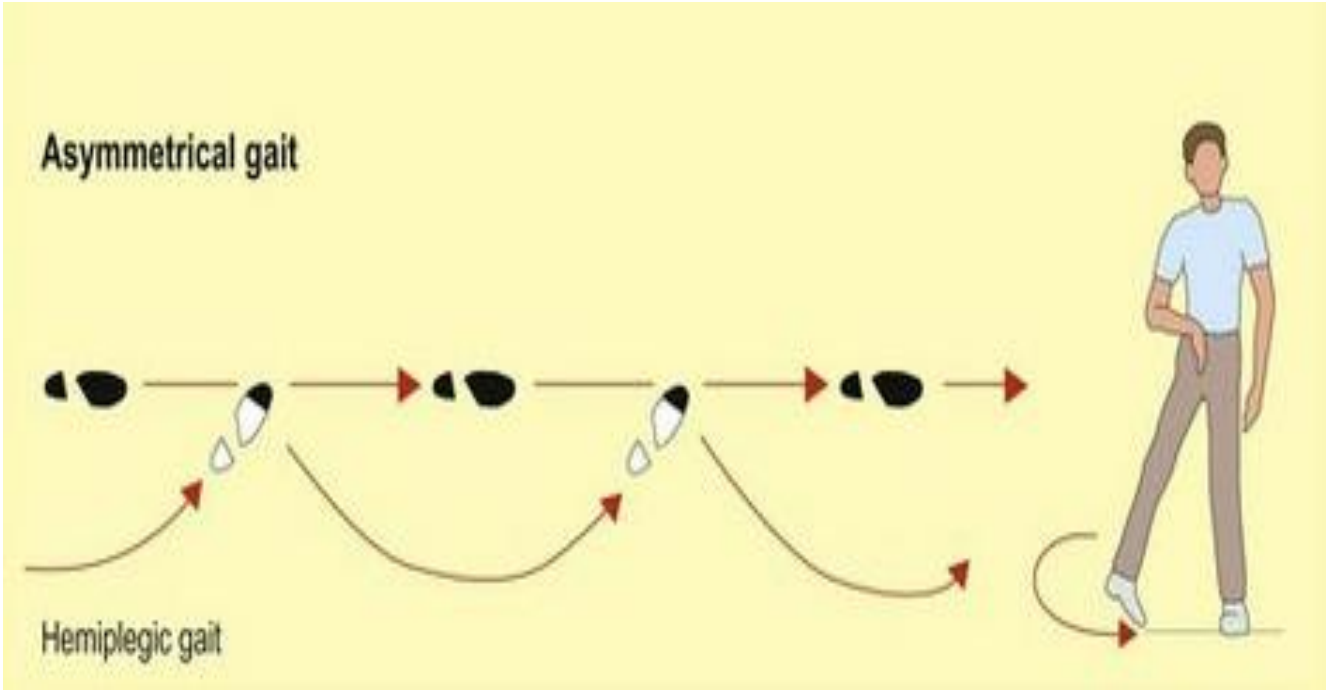
آسیب به مسیر کورتیکو اسپاینال – علامت بابینسکی



Babinski reflex in infants



- Gait
- **Corticospinal lesions**
- **Circumduction gait**
- **scissors-like gait**



Vestibulospinal Tract

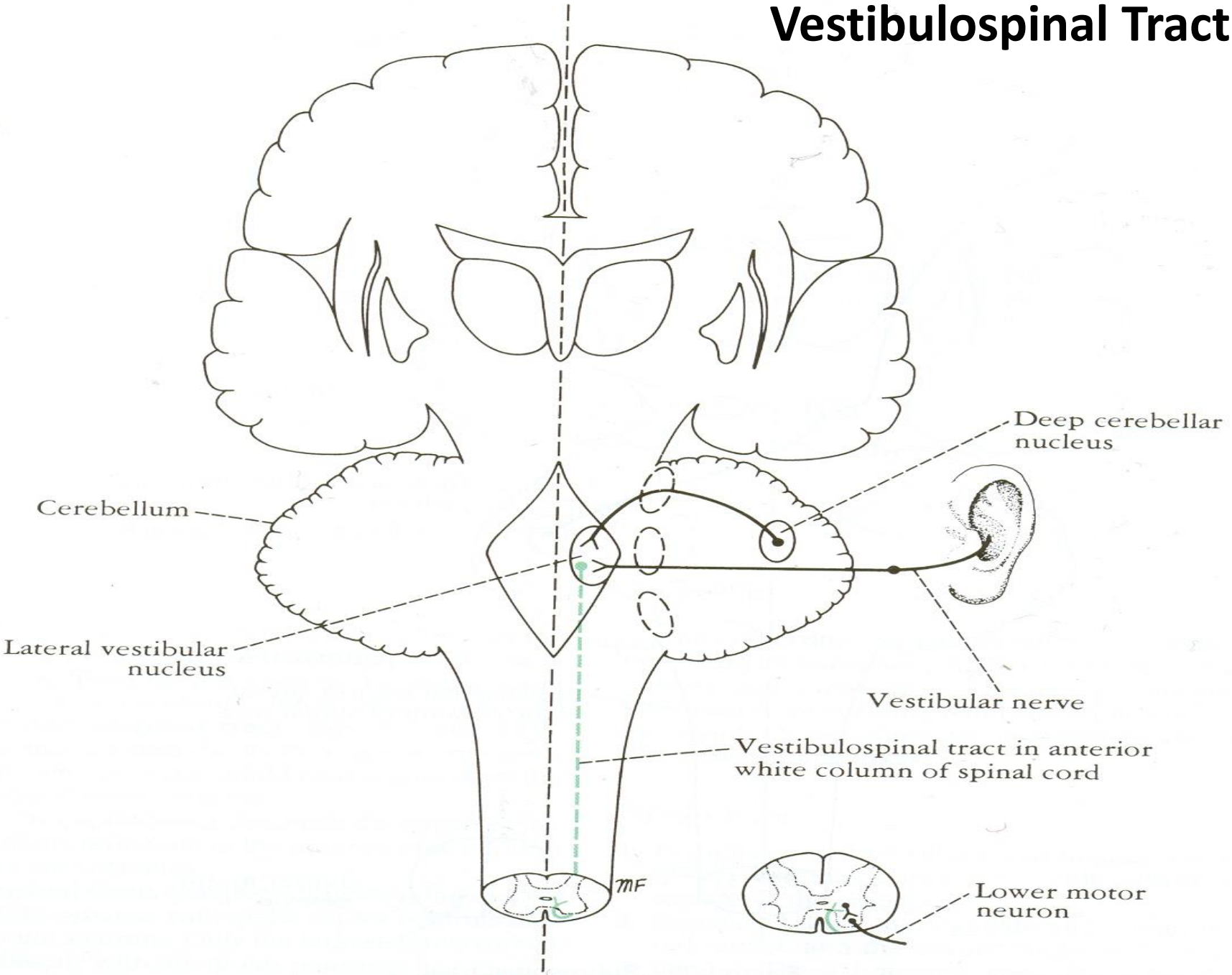
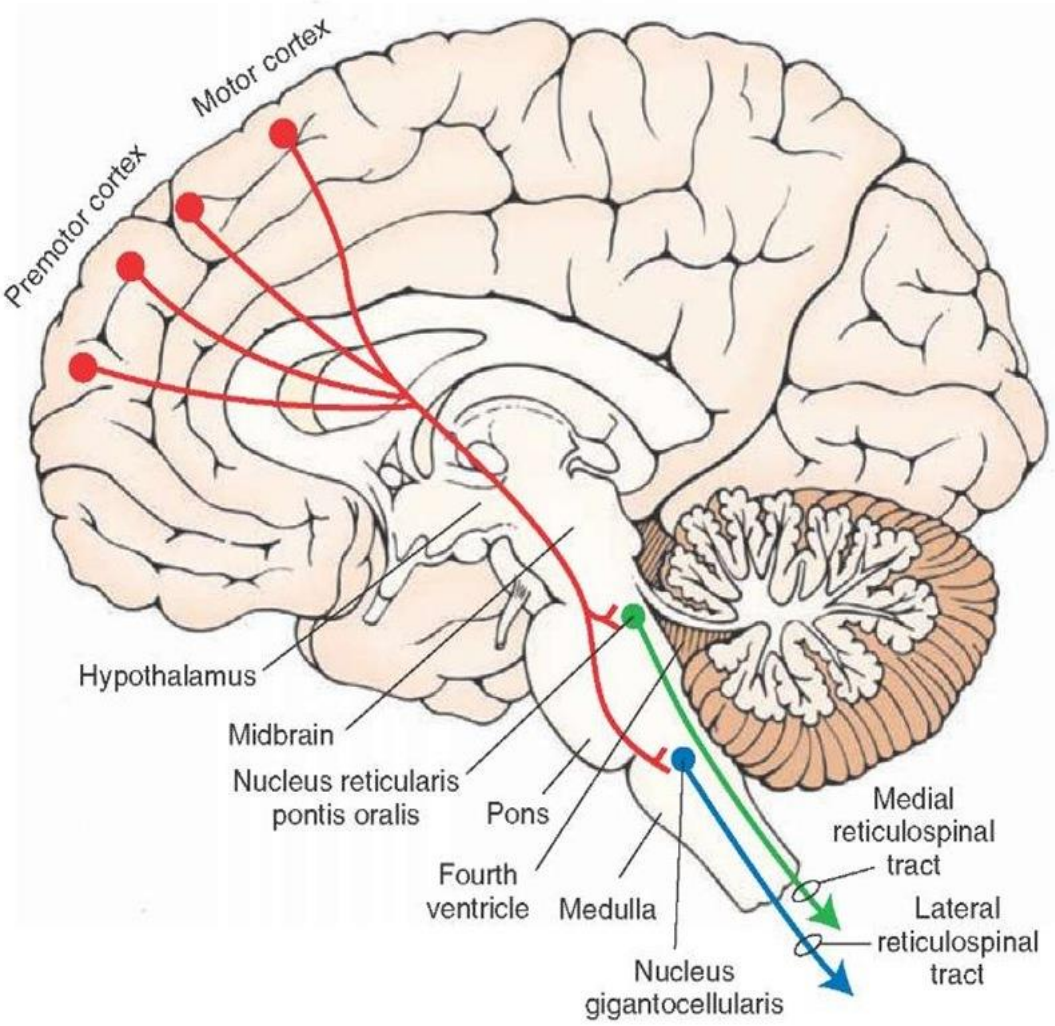
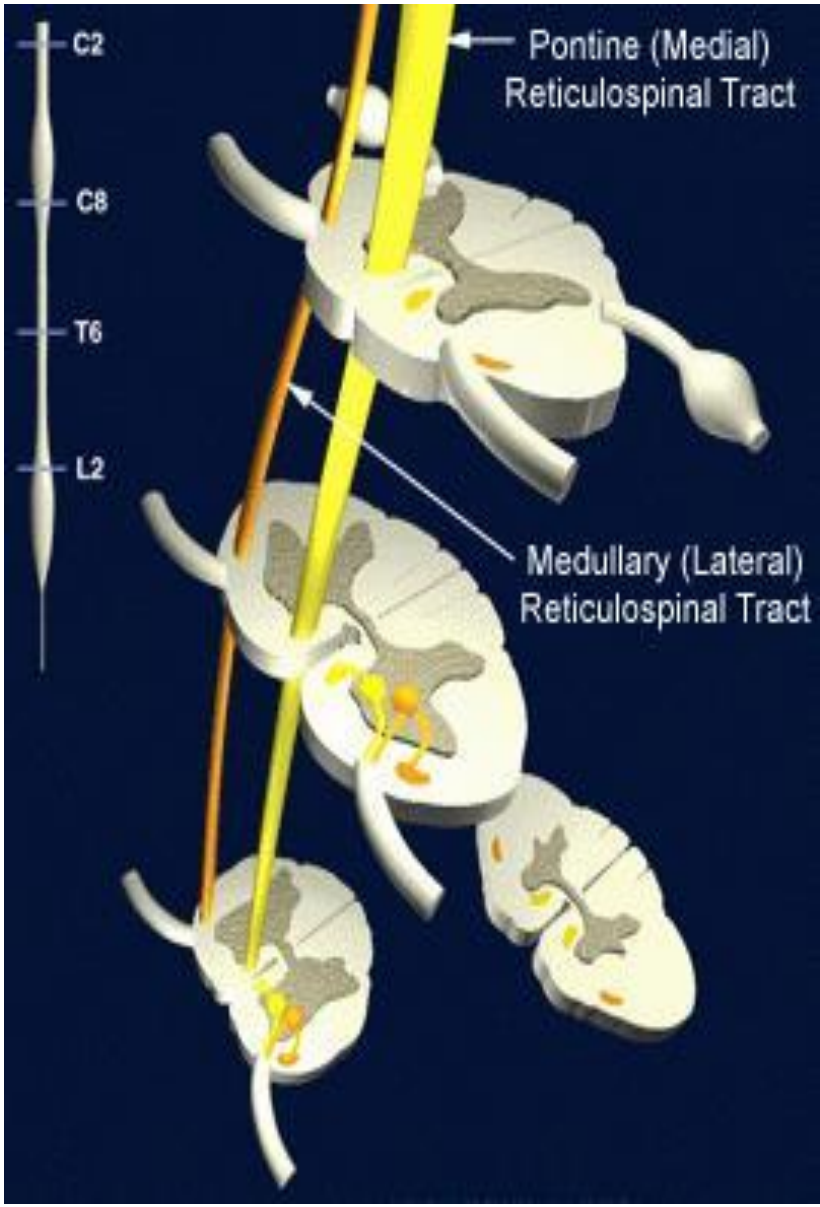


Figure 4–21 Vestibulospinal tract.

Reticulospinal Tract





مسیر تکتواسپاینال

مسیر روبرواسپاینال

هسته های تکتال

هسته قرمز

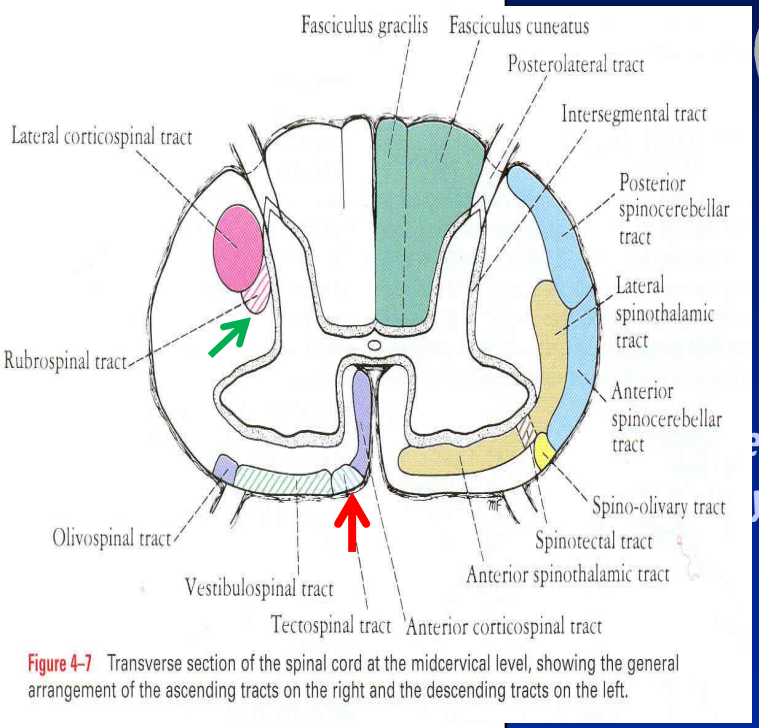
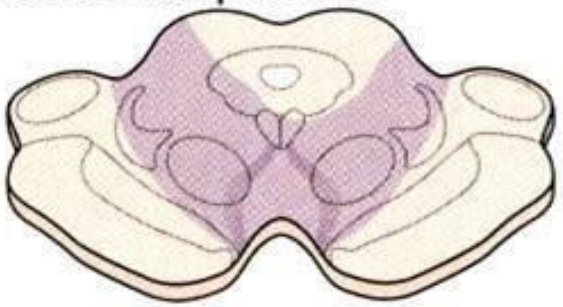


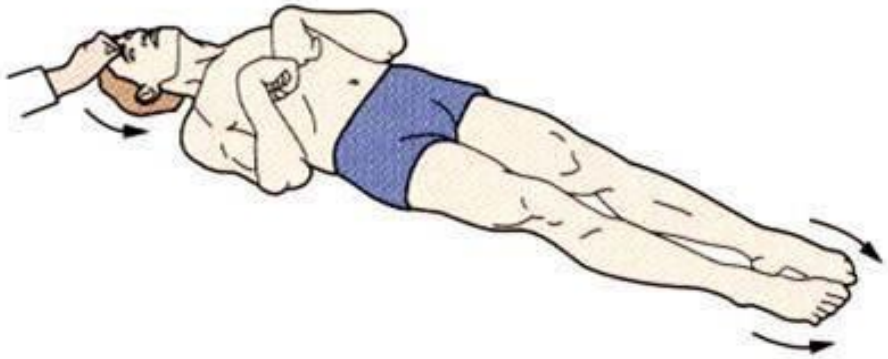
Figure 4–7 Transverse section of the spinal cord at the midcervical level, showing the general arrangement of the ascending tracts on the right and the descending tracts on the left.

Decorticate and decerebrate posture

Upper midbrain damage
Decorticate posture

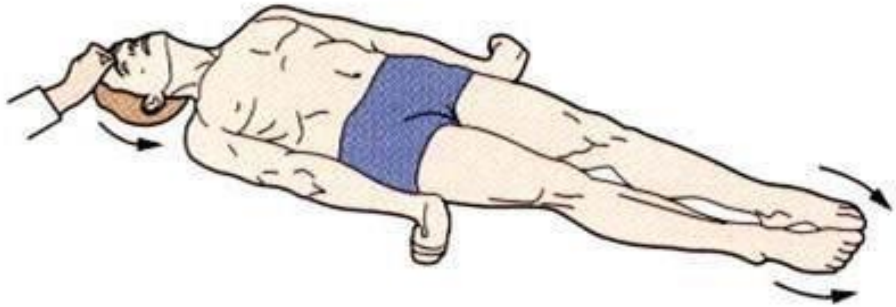


Rubrospinal tract

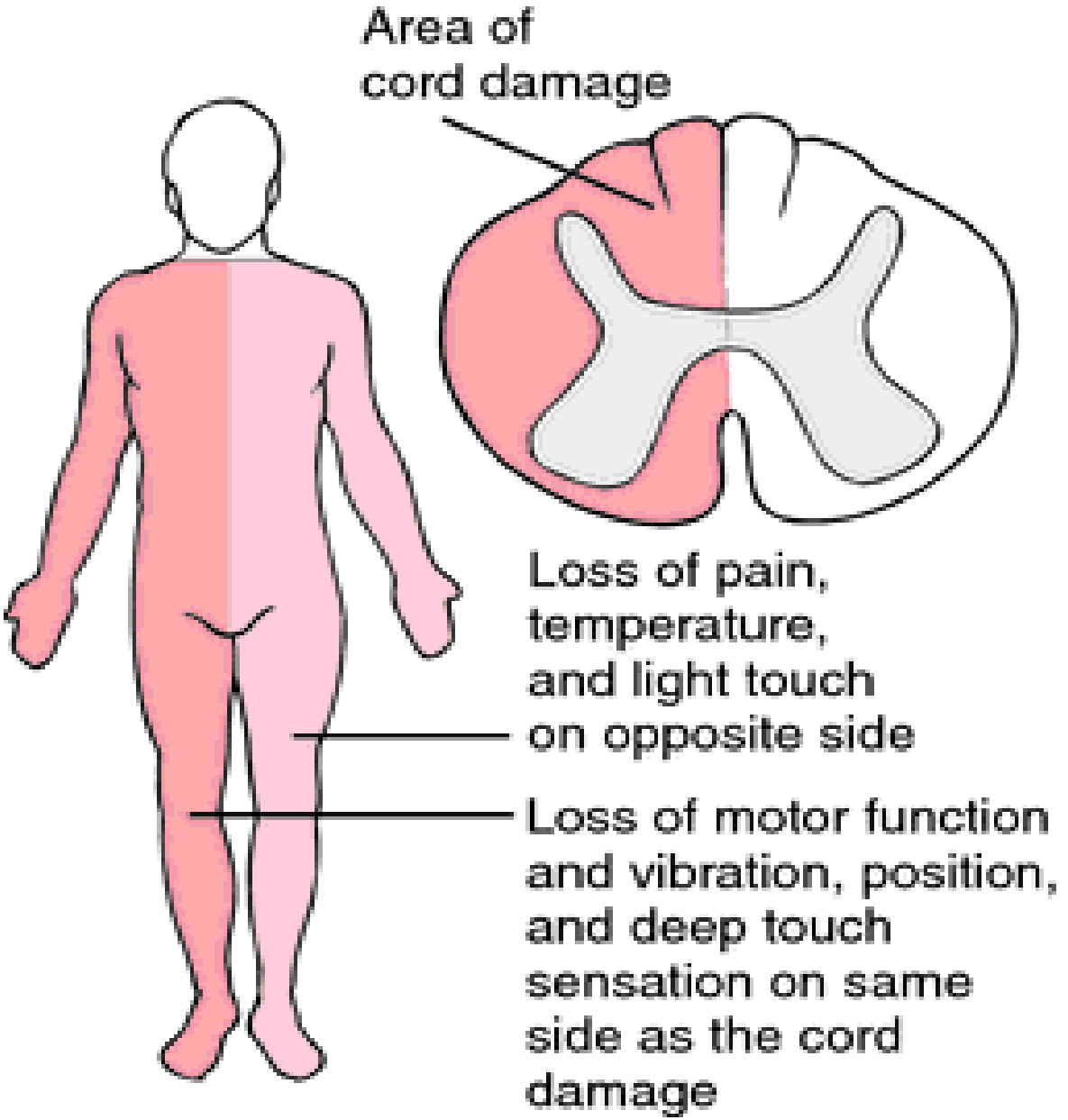


Upper pontine damage
Decerebrate posture

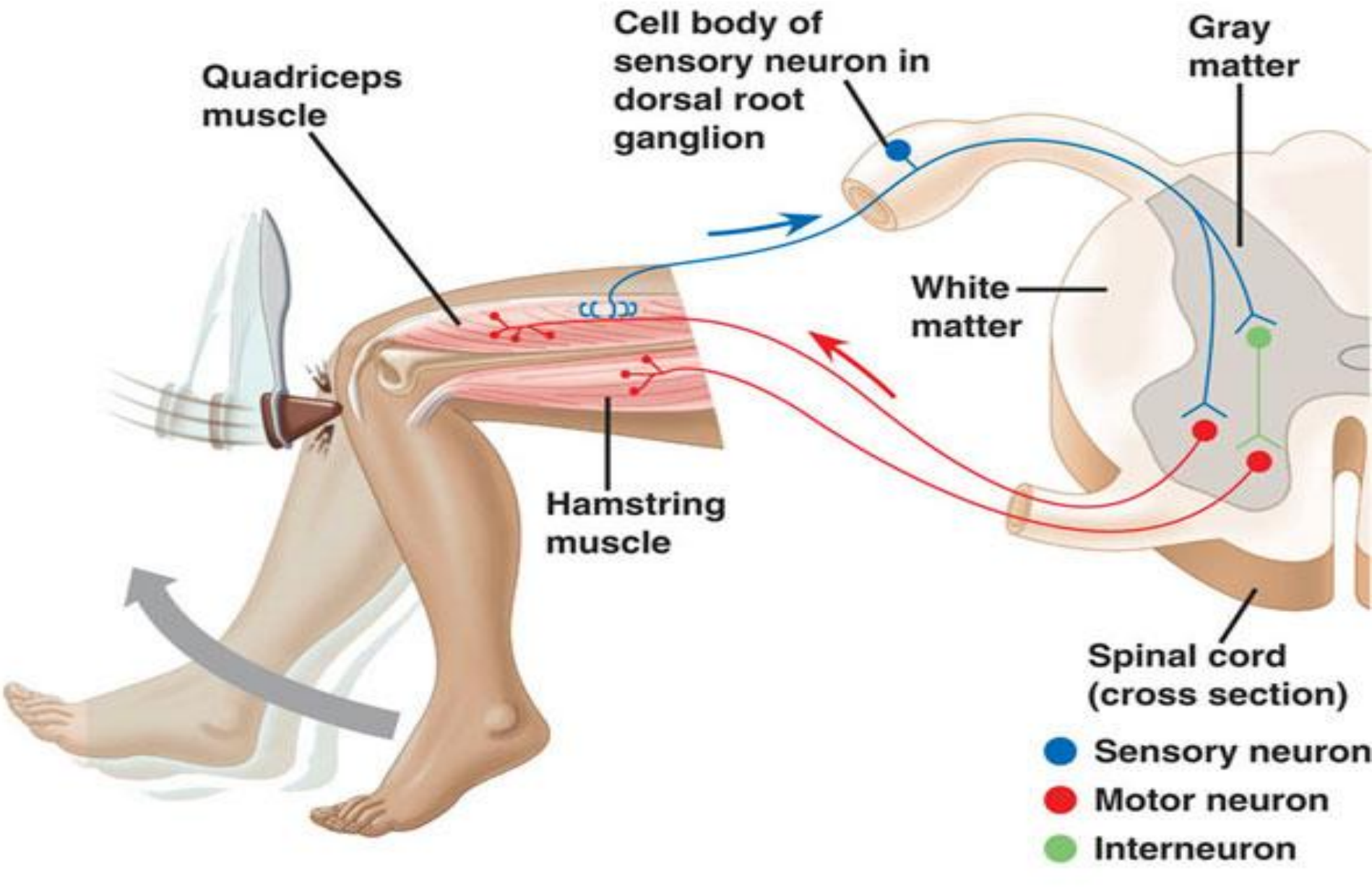
Vestibulospinal tract



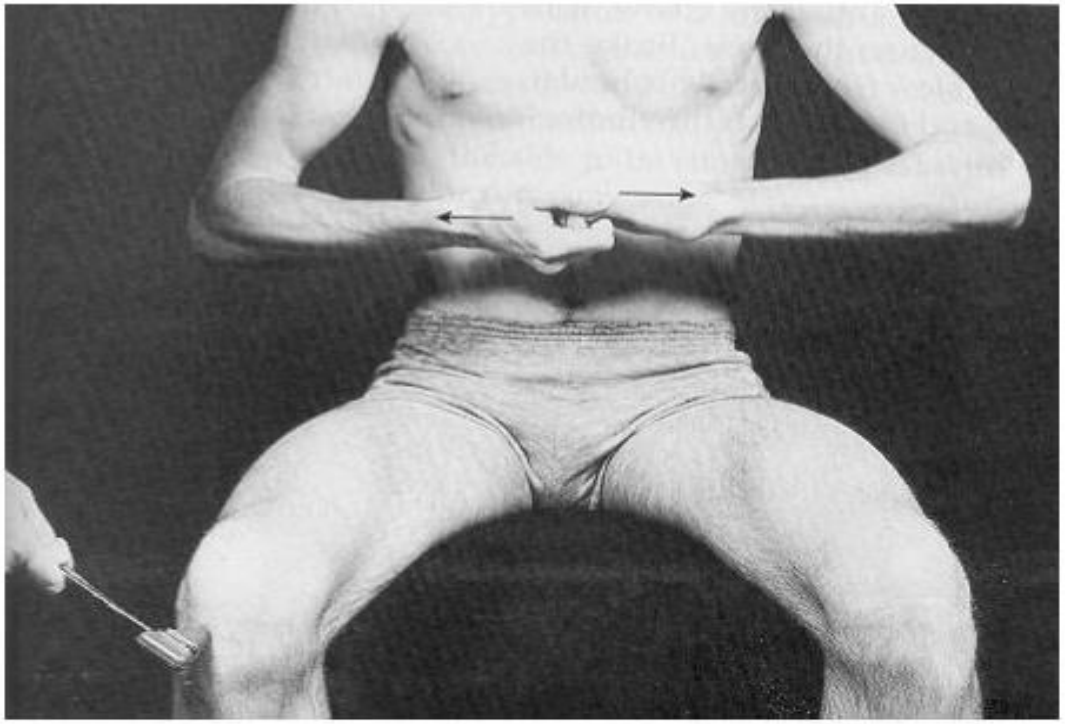
Brown-Séquard syndrome



Deep Tendon Reflex (DTR)

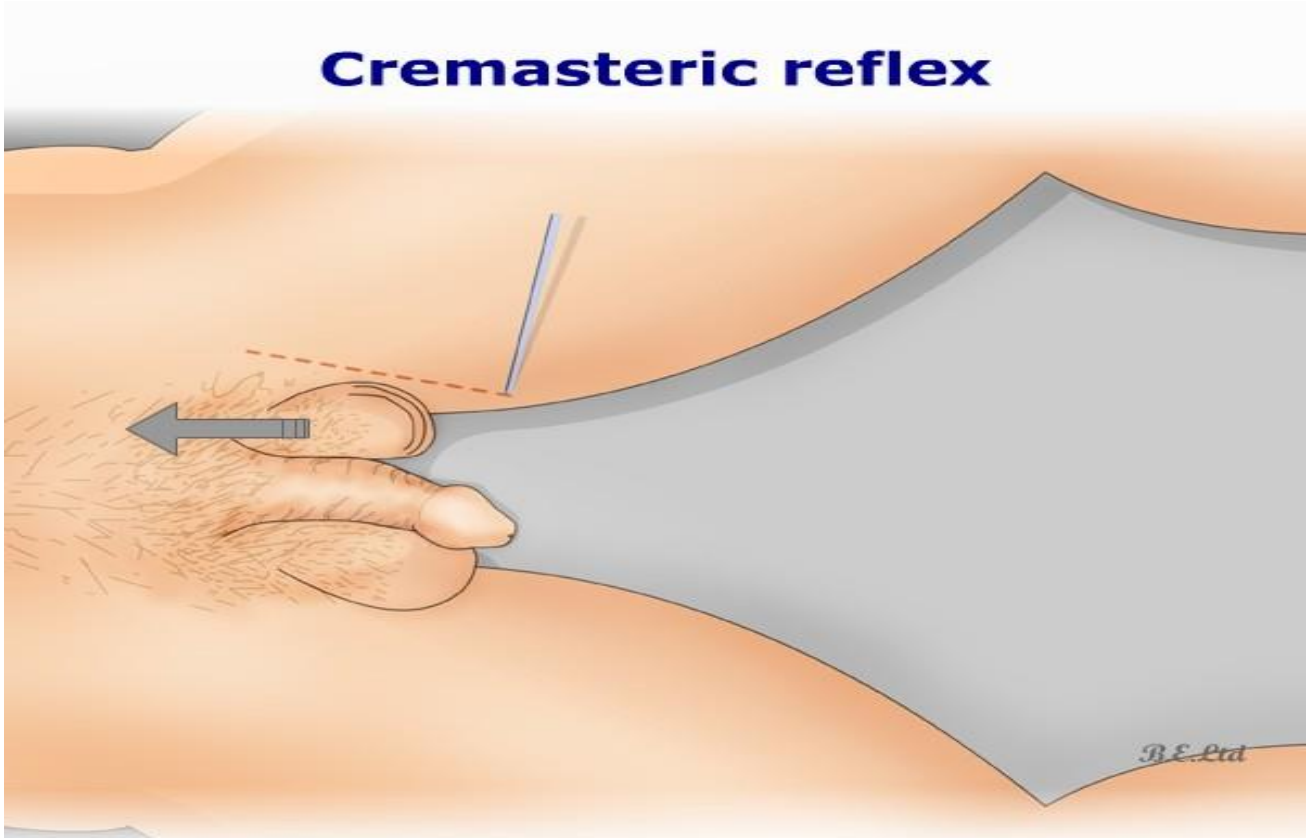


- **Areflexia**
- **Jendrassik maneuver**



Superficial Reflexes

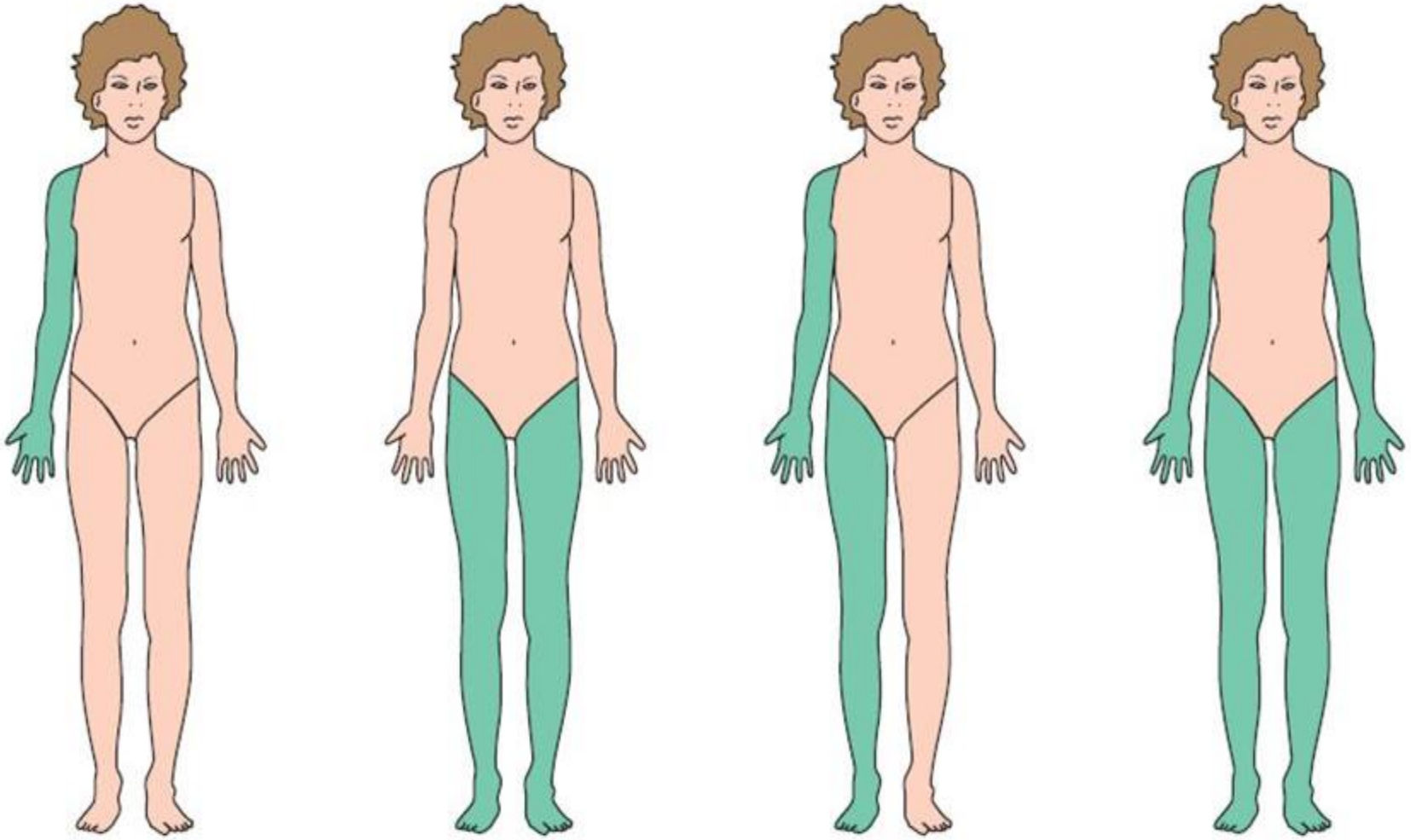
Cremasteric reflex



Cremasteric reflex

Upper Motor Neuron (UMN) vs Lower Motor Neuron (LMN) Syndrome

	UMN syndrome	*LMN Syndrome*
Type of Paralysis	*Spastic Paresis*	*Flaccid Paralysis*
Atrophy	No (Disuse) Atrophy	Severe *Atrophy*
Deep Tendon Reflex	*Increase*	Absent DTR
Pathological Reflex	Positive *Babinski* Sign	Absent
Superficial Reflex	Absent	Present

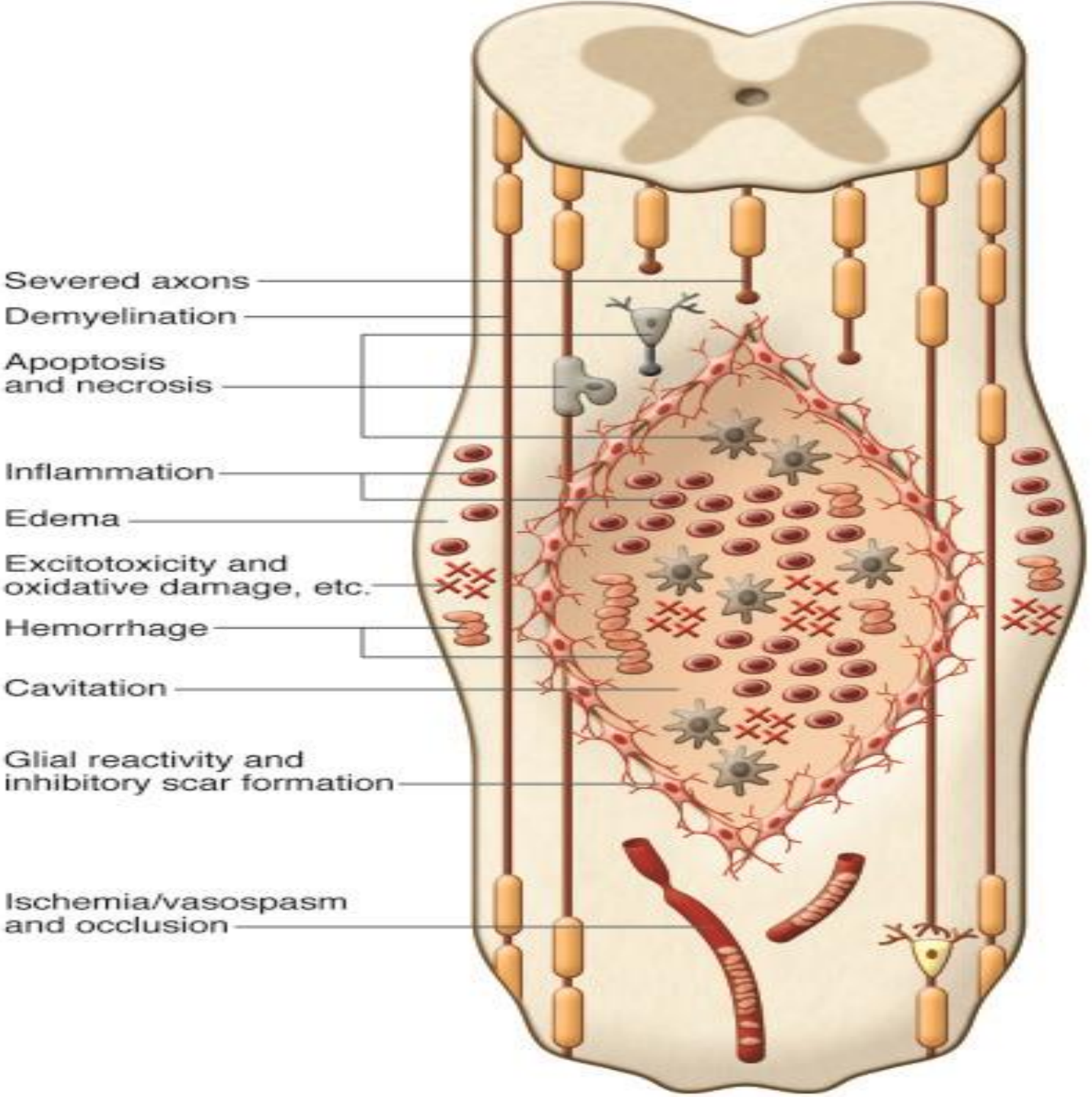

Monoplegia
Paraplegia
Hemiplegia
Quadriplegia

Spinal Cord Disorders (Myelopathy)

- Spinal cord disorders can lead to motor, sensory, or sphincter disturbances
- Lesion above C5 may cause an ipsilateral hemiparesis or quadriparesis
- Lesion below T1 affects only the lower limbs on one or both sides
- **Spasticity**

Total Cord Transection

- spinal shock
- spastic paraplegia or quadriplegia
- Flexor or extensor spasms of the legs

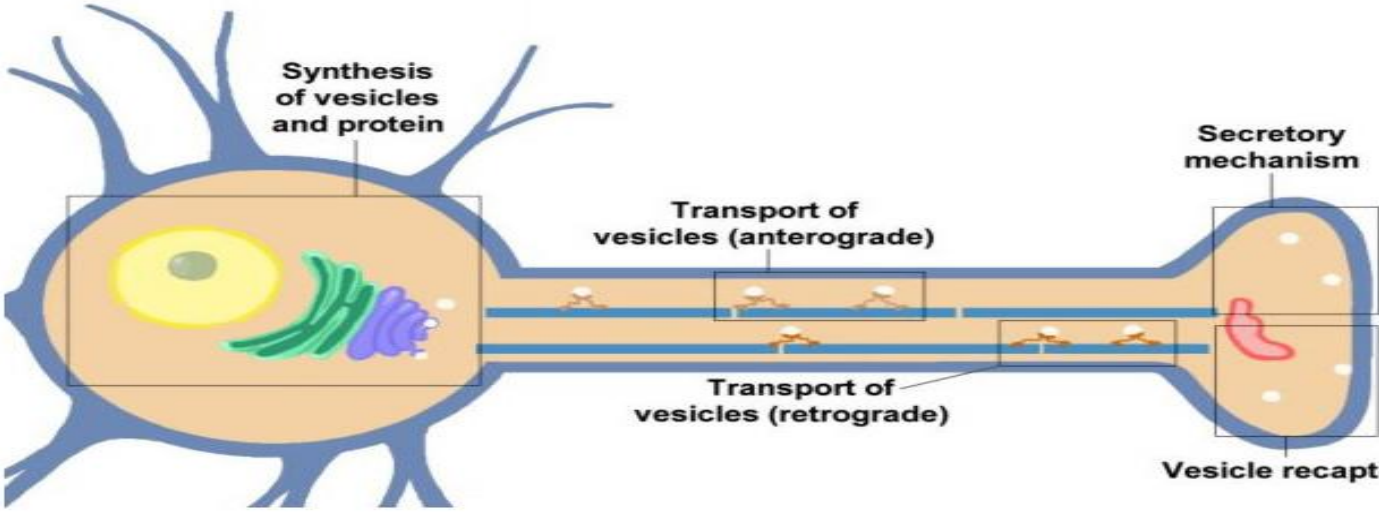

Severed axons
Demyelination
Apoptosis
and necrosis
Inflammation
Edema
Excitotoxicity and
oxidative damage, etc.
Hemorrhage
Cavitation
Glial reactivity and
inhibitory scar formation
Ischemia/vasospasm
and occlusion

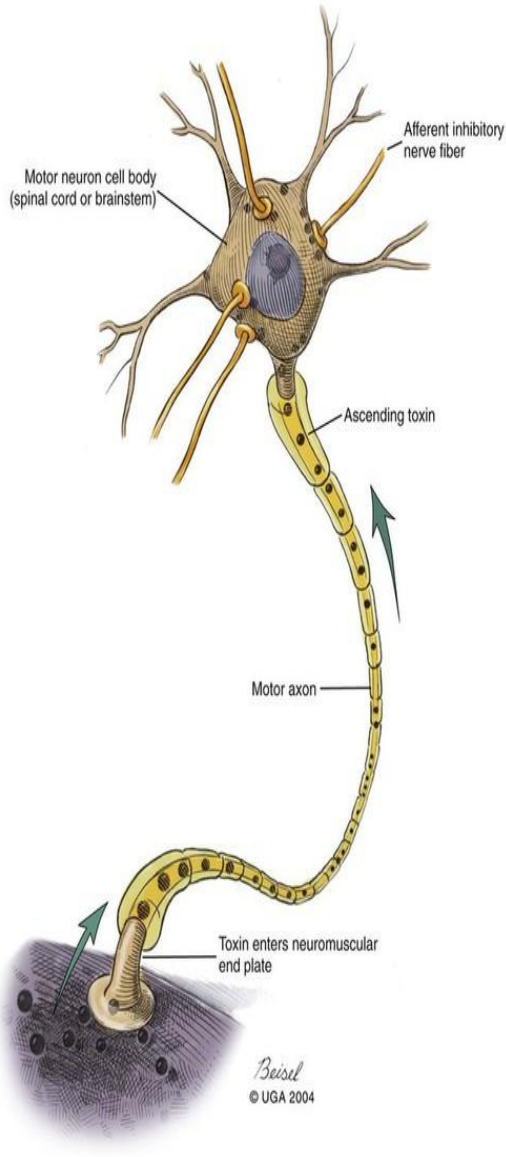
Tetanus

Infective or Inflammatory Myelopathies

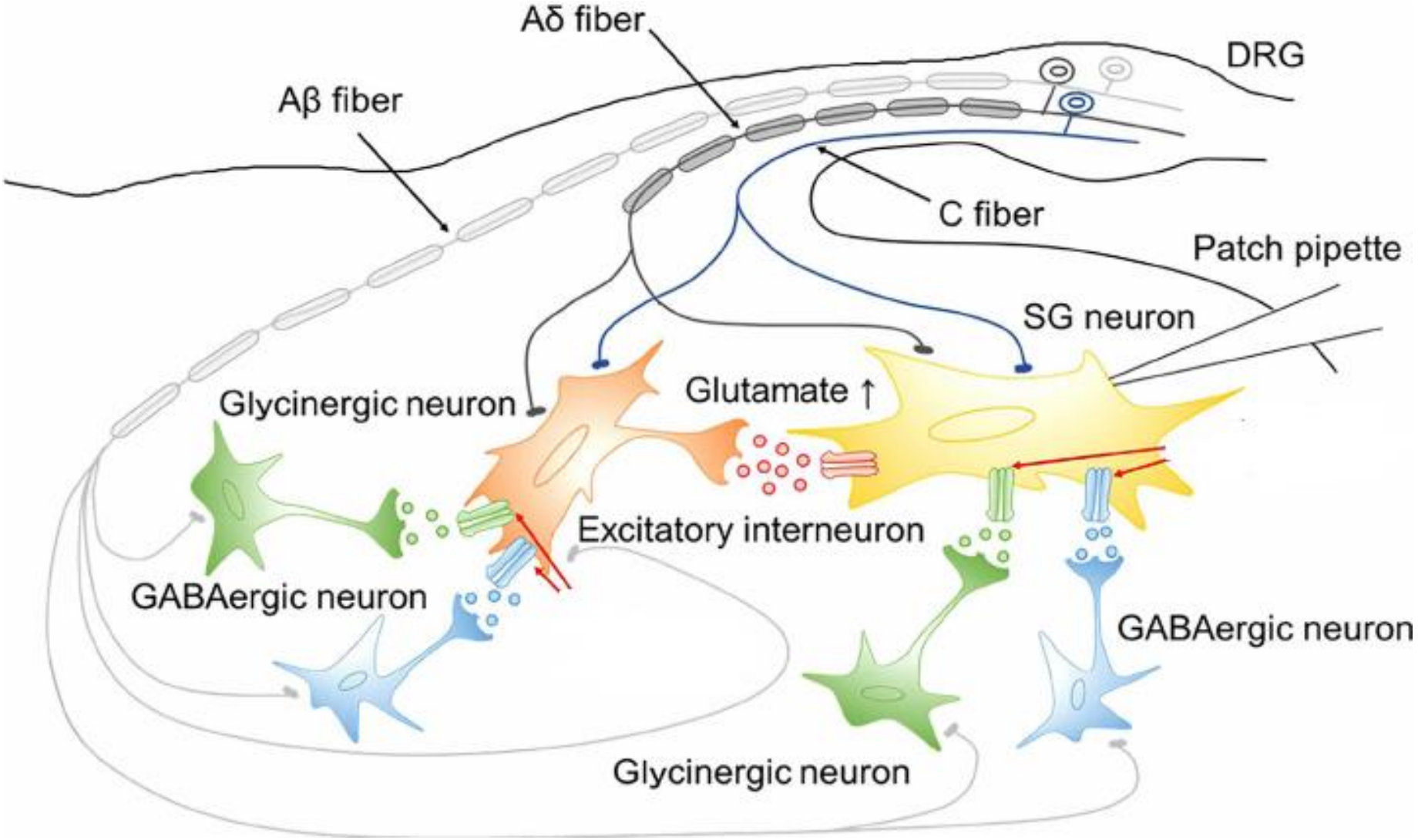
Clostridium tetani

Retrograde transport





Mechanism of alpha motor neurons activity (Glycinergic and GABAergic neurons)



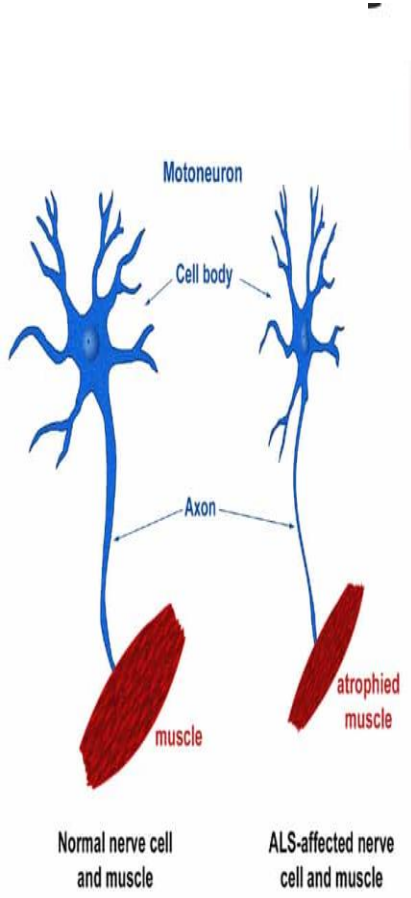
Risus sardonicus

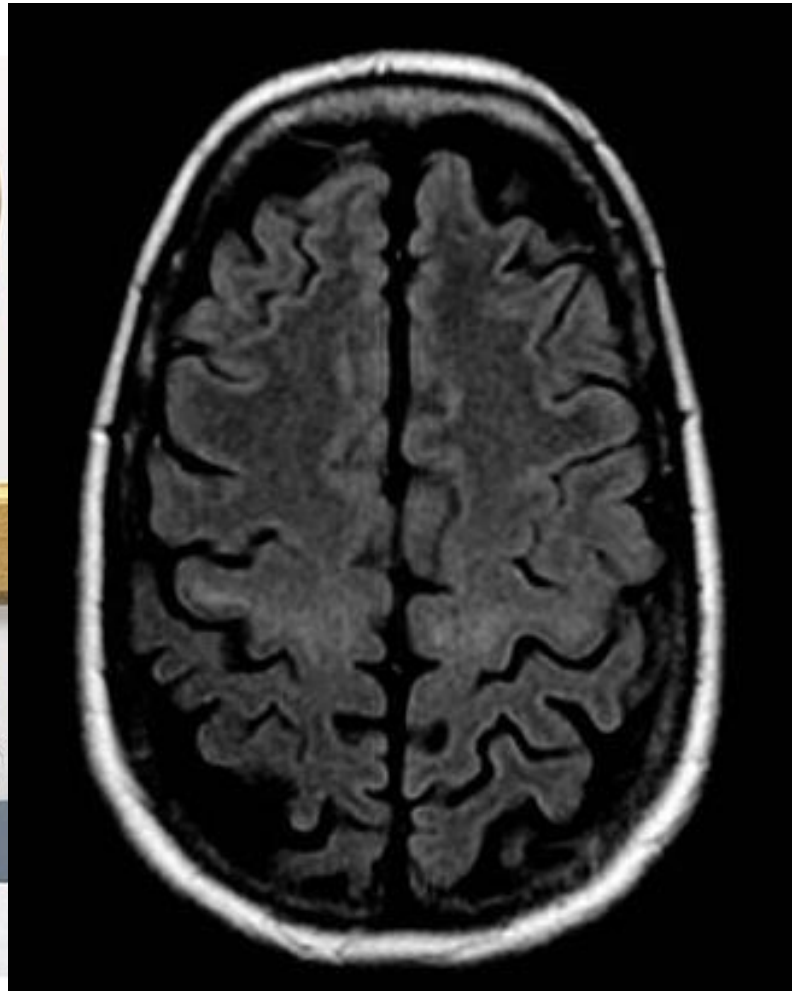
Amyotrophic lateral sclerosis(ALS)

lou gehrig

stephen hawking

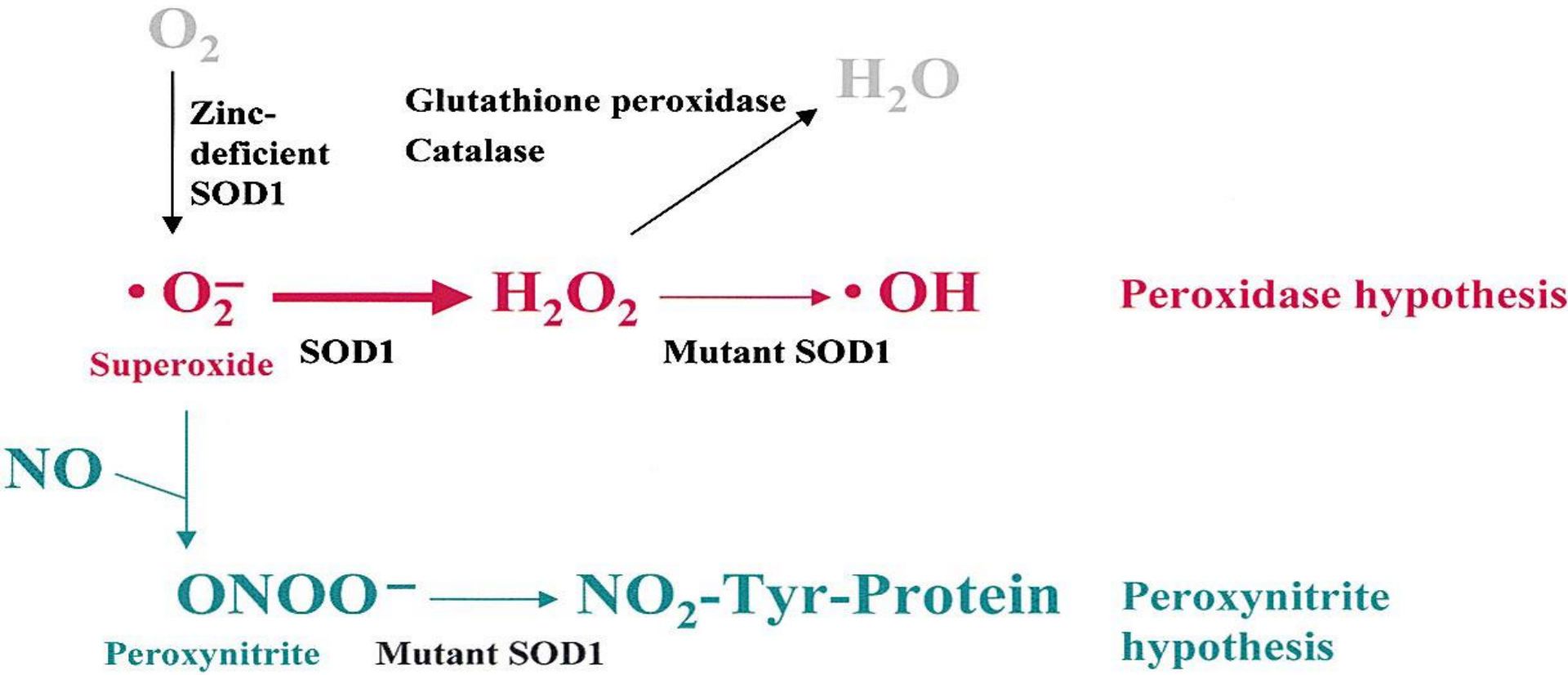
Amyotrophic lateral sclerosis(ALS)



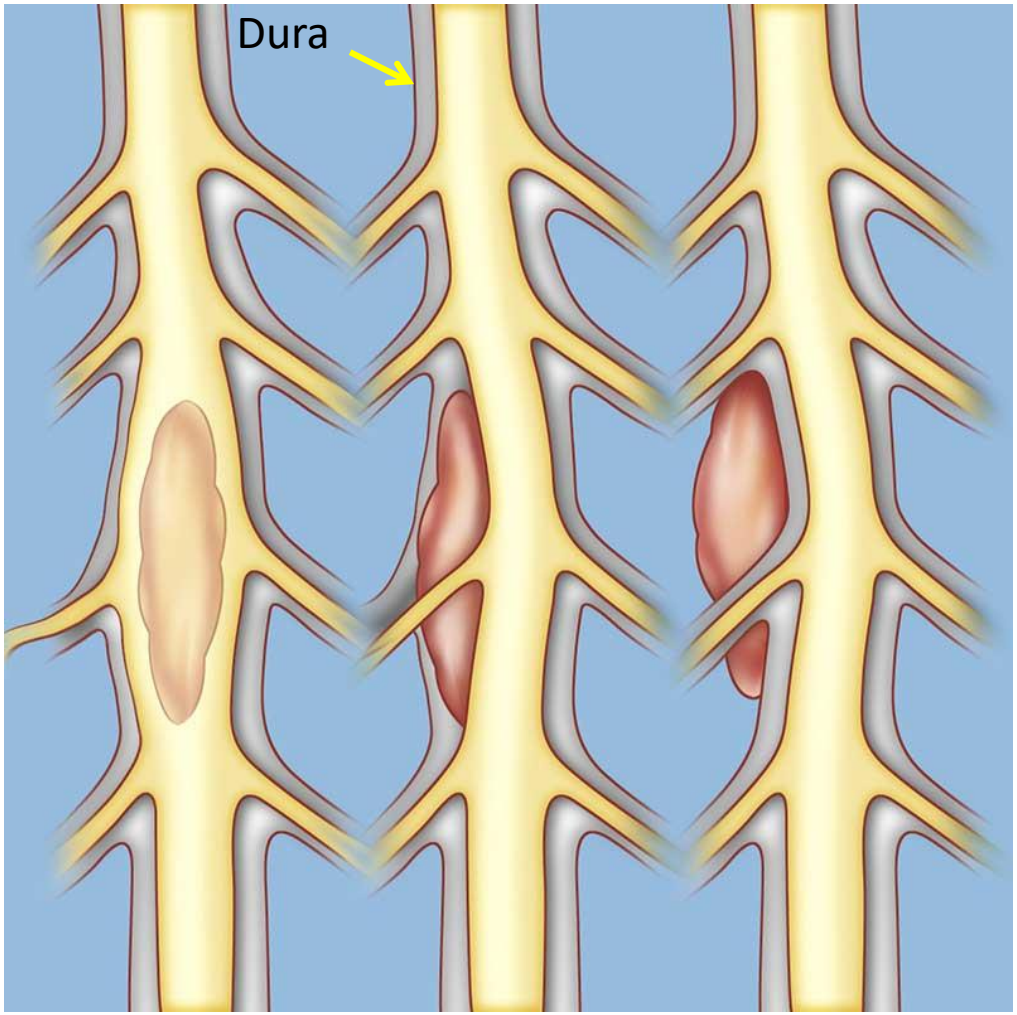


Amyotrophic lateral sclerosis

- **The discovery of missense mutations in the gene coding for the Cu/Zn superoxide dismutase 1 (SOD1)**



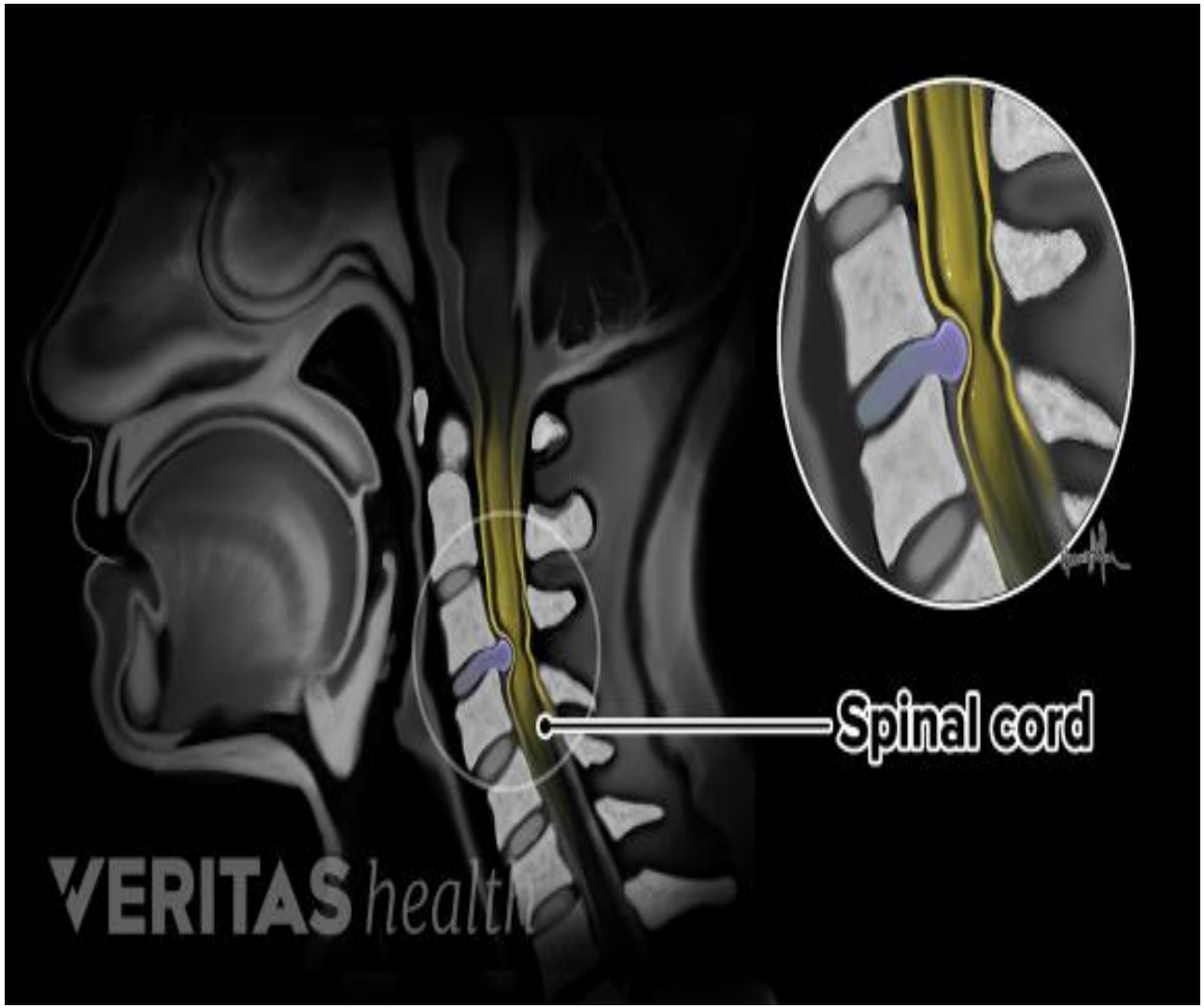
Spinal cord tumor



Intramedullary Intradural Extradural

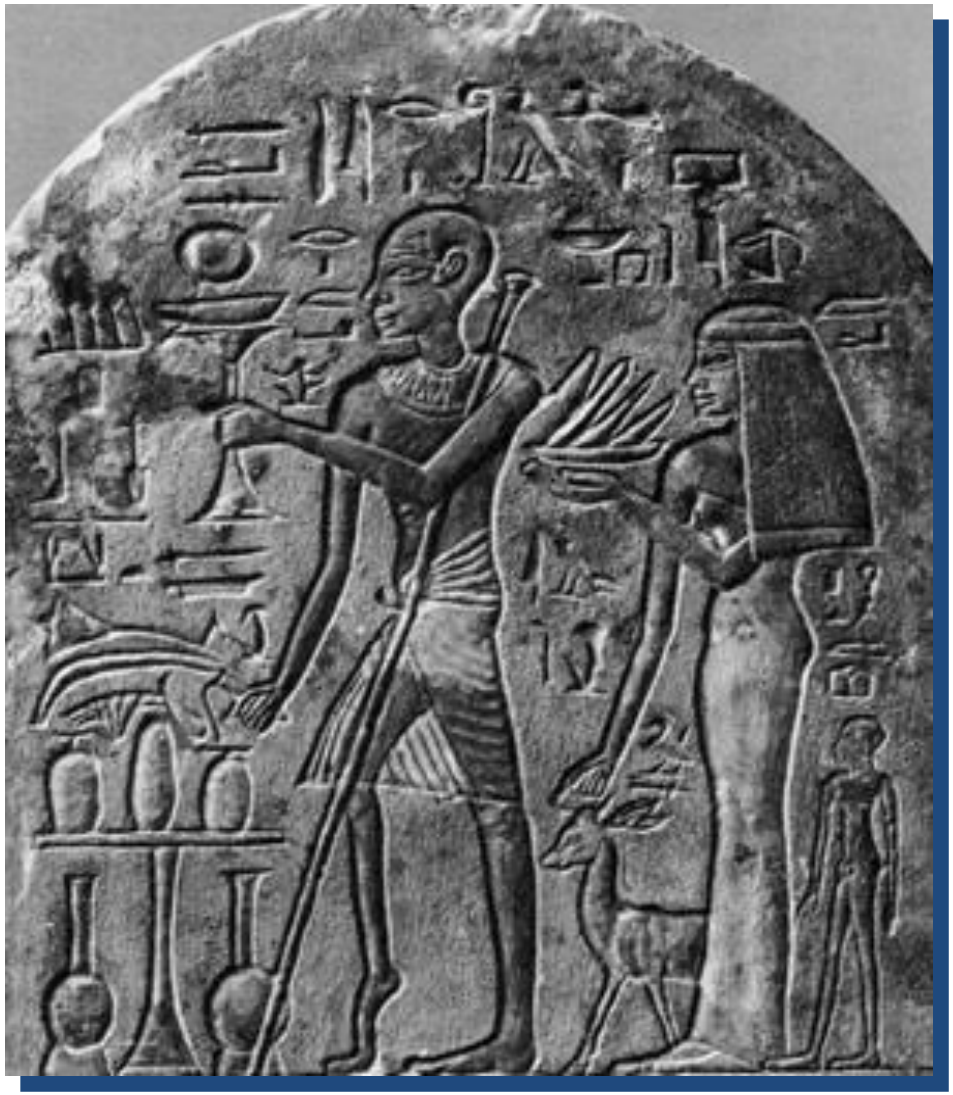
(a)

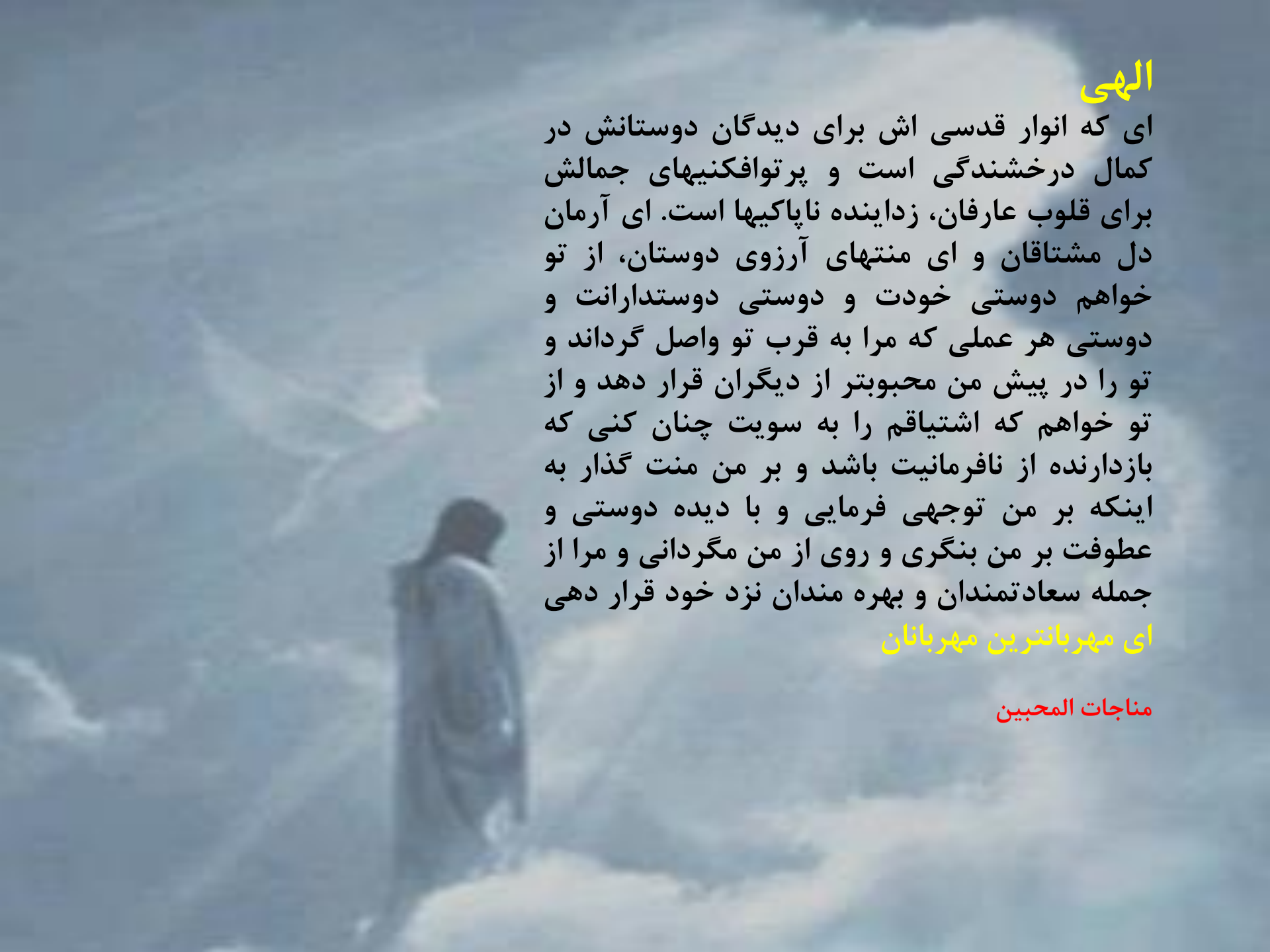
Cervical spondylosis



Infective Anterior Horn Cell Disorders

- **Polio Virus Infection**





الهی

ای که انوار قدسی اش برای دیدگان دوستانش در کمال درخشندگی است و پرتوافکنیهای جمالش برای قلوب عارفان، زداینده ناپاکیها است. ای آرمان دل مشتاقان و ای منتهای آرزوی دوستان، از تو خواهم دوستی خودت و دوستی دوستدارانت و دوستی هر عملی که مرا به قرب تو واصل گرداند و تو را در پیش من محبوبتر از دیگران قرار دهد و از تو خواهم که اشتیاقم را به سویت چنان کنی که بازدارنده از نافرمانیت باشد و بر من منت گذار به اینکه بر من توجهی فرمایی و با دیده دوستی و عطوفت بر من بنگری و روی از من مگردانی و مرا از جمله سعادتمندان و بهره مندان نزد خود قرار دهی

ای مهربانترین مهربانان

مناجات المحبین