

LEC 5:

Spinocerebellar tract:

- in anterolateral columns of white matter
- don't reach cortex
- **modality**: muscle & joint sensation (unconscious proprioception)

1] posterior Spinocerebellar

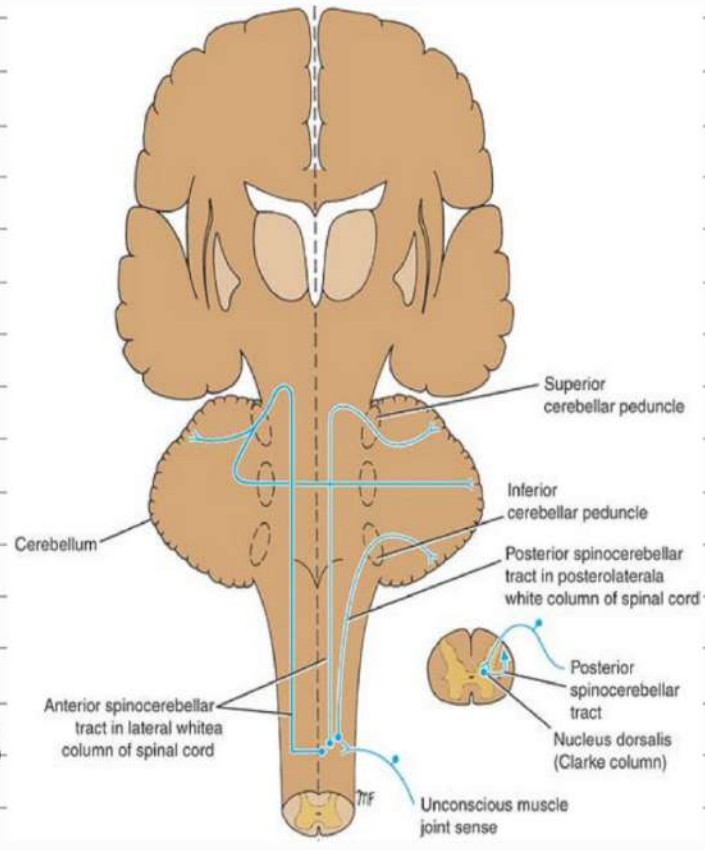
- **receptor**: most receptors except free nerve ending
- **1st Order Neuron**
terminate at base of post. grey column (nucleus dorsalis or Clarke nucleus in lamina 7)

• 2nd Order Neuron

axons enter posterolateral part of lat. white column on → ascend ipsilaterally as posterior spinocerebellar tract to medulla

• 3rd Order Neuron

terminates in cerebellar cortex through inf. cerebellar peduncle
 • axons of lower lumbar & sacral spinal nerves ascend in post. white column till L3-L4 then synapse with nucleus dorsalis



2] anterior Spinocerebellar tract:

• 1st Order Neuron:

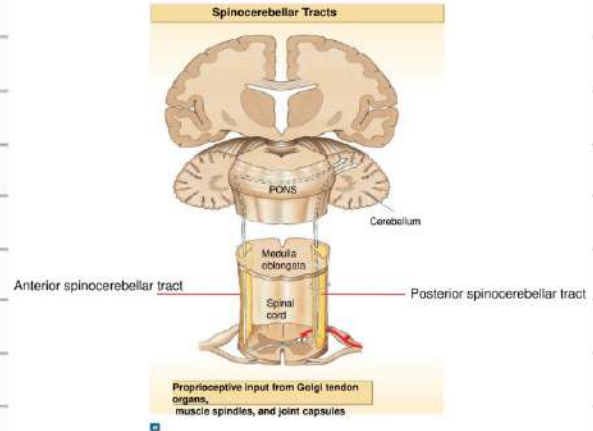
terminate at base of post. grey column (nucleus dorsalis)

• 2nd Order Neuron:

- 2 pathways before reaching medulla & pons
- majority → cross midline & ascend as anterior spinocerebellar tract in contralateral white column
- minority → ascend as ant. spinocerebellar tract ipsilaterally

• 3rd Order Neuron:

terminates in cerebellar cortex through sup. cerebellar peduncle, fibers that crossed midline cross back in cerebellum

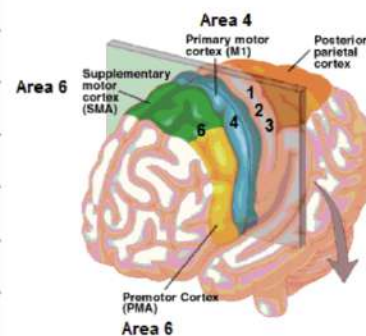


* Descending motor tracts:

- Smooth muscles are totally supplied by Autonomic NS
- motor System Starts at frontal cortex (Ant. to Central Sulcus)

• Motor Areas:

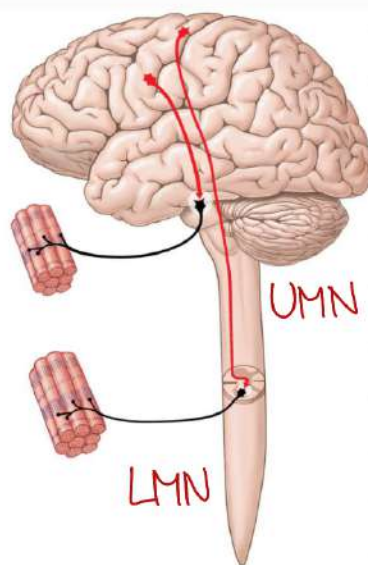
- ① Area 4 →
 - Precentral gyrus (1° motor Cortex)
 - mainly for pyramidal tracts
 - damage → paralysis
- ② Area 6 →
 - Coordination of skeletal M movement
 - mainly for extrapyramidal tract
 - damage → NO paralysis, but loss of coordination
 - Premotor area (lat.) → ext. cues (vision, hearing)
 - Supplementary Motor Area (med.) → int. cues (memory)
- ③ Area 3/2 → Some motor neurons start from 1° Sensory area!!



- Cerebral cues: Ant. portion of cerebellar peduncle (basis pedunculi) has white matter of lat. corticospinal tract, needed for the ability to transfer sensory input into motor activity

III pyramidal tract:

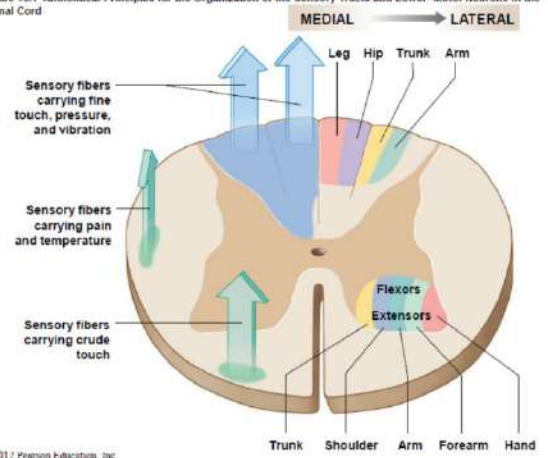
- types: Corticospinal (anterior & lateral), Corticonuclear (functionally)
- fxn: Conscious control of skeletal M
- journey:
 - upper motor neuron (from cortex, mainly Area 4) → pass through Ant. aspect of medulla (2 pyramids, rt & lt) to spinal cord → synapse with interneuron (lamina 8) → activation of lower motor neuron (its cell body in Ant. horn / lamina 9) → to skeletal M



II extrapyramidal tracts:

- types: Vestibulospinal, reticulospinal, rubrospinal, tectospinal
- fxn: Subconscious control of skeletal M (balance, muscle tone, eye, hand, upper limb position)
- journey: Arise in brain stem → descend to spinal cord (under influence of cerebral cortex, area 6) so it's actually cortico-type-spinal

Figure 15.1 Anatomical Principles for the Organization of the Sensory Tracts and Lower-Motor Neurons in the Spinal Cord



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Motor horns:

① anterior horn:

- Somatotropic principle

a) medial part (ant. corticospinal)

- supplies med. axial muscles, coarse moves (trunk & shoulder)
- related to vertebral column
- present in all segments
- movement: upright posture & balance

b) lateral part (lat. corticospinal)

- supplies distal muscles, precise moves (hand & forearm)
- present only in enlargements
- movement: skilled (writing, playing, ...)

- can also be divided into:

a) anterior part → extensors

b) posterior part → flexors

laminae of motor system:

- lamina 8 → motor interneurons, internucleus

- lamina 9 → ventral horn, cell body of LMN

↳ ventromedial nuclei → all segments / extensors of vertebral column

↳ dorsomedial → T₁-L₂ (intercostals & abdominal muscles)

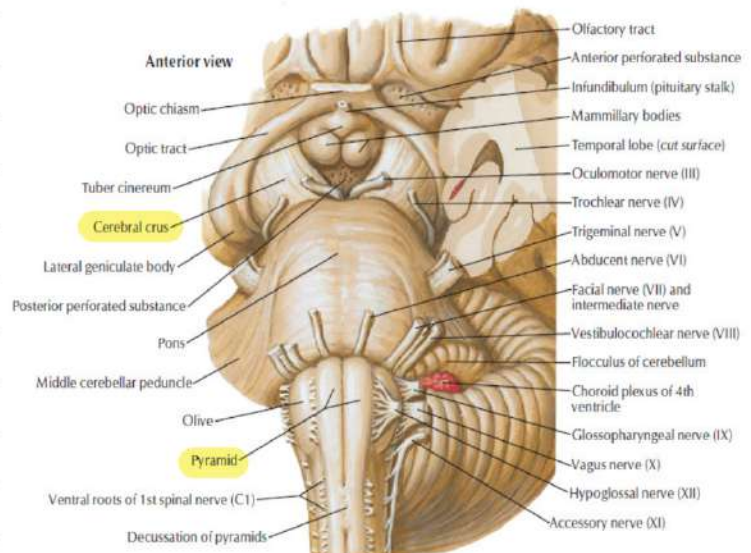
↳ ventrolateral → C₅-C₈ (arm), L₂-S₂ (thigh)

↳ dorsolateral → C₅-C₈ (forearm), L₃-S₃ (leg)

↳ retrodorsolateral → enlargements: C₈-T₁ (hand), S₁-S₂ (foot), for skilled movement (mainly flexors)

↳ central → C₃-C₅, activates LMN of diaphragm (phrenic)

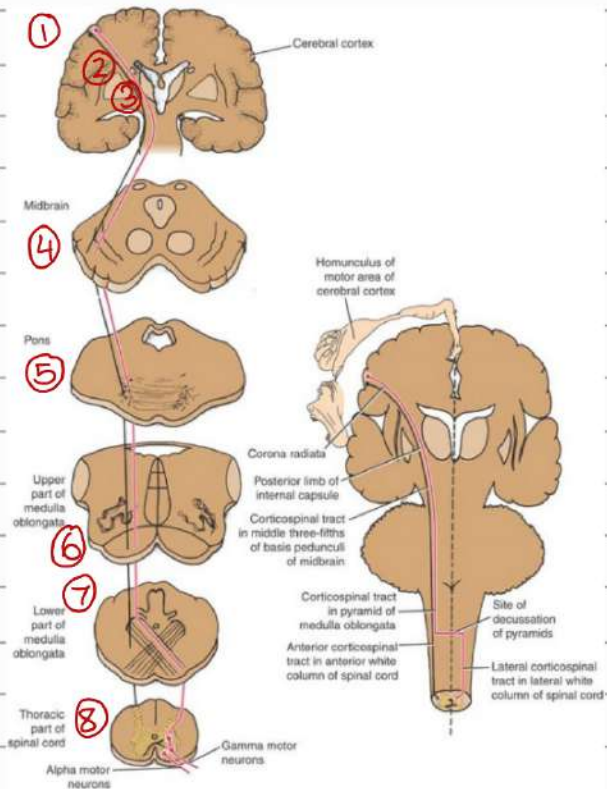
- lamina 10 → surrounds central canal, grey commissure
fxn not clear



Pyramidal tracts:

Anterior & lateral Corticospinal tracts:

- ① UMN (from Precentral gyrus, 1° Motor Cortex, Area 4)
- ② Corona radiata
- ③ int. Capsule to midbrain
- ④ middle 3/5 of Cerebral crus
- ⑤ pons (get scattered bet. pontine nuclei of ant. (basilar) part of pons, because of Cortico-ponto-Cerebellar fibers which intersect with tract as its going posteriorly & transverse)
- ⑥ Upper part of medulla (fibers reconnect forming the pyramids)
- ⑦ lower part of medulla
 - ↳ 85 fibers → cross to other side & descend contralaterally in lat. funiculus as the lateral Corticospinal tract
 - ↳ 15% fibers → descend ipsilaterally as the anterior Corticospinal tract
- ⑧ descending in spinal cord leaving it gradually to synapse on interneurons in ant. grey horn (some synapse directly on α & γ motor neurons)

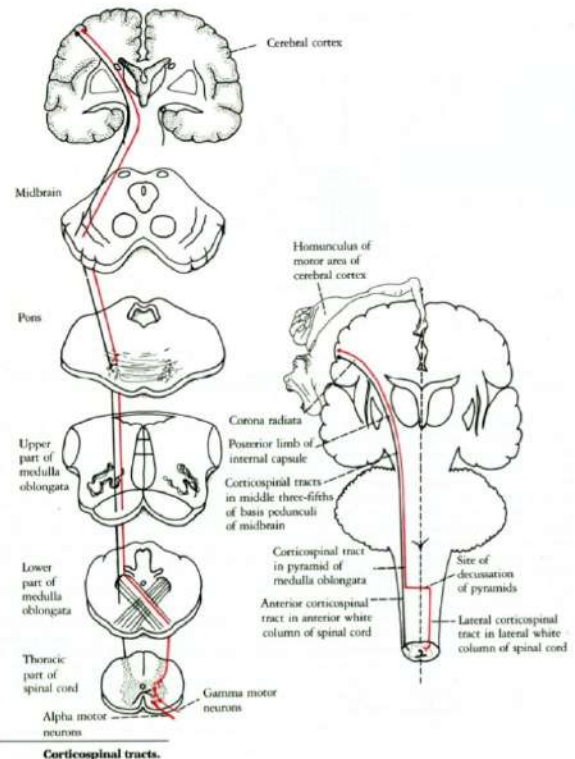


• **Modality:** fine skilled movements (since most fibers are lateral & descend full length of spinal cord as LCST & synapse with α & γ nuclei of:

- a) cervical region (55%) → effect on upper limb (most skilled moves)
- b) thoracic region (20%) → trunk
- c) lumbar & sacral region (25%) → leg & foot

• lat. corticospinal tract synapses mainly by inter neurons in laminae 4, 5, 6, 7, 8 (although 8 is the only motor one but this tract also ascends from area 3/2 (sensory))

• 3% originate from 5th layer of area 4 (giant cells of betz), synapse directly without synapsing in inter neurons (very accurate moves)



LEC 6:

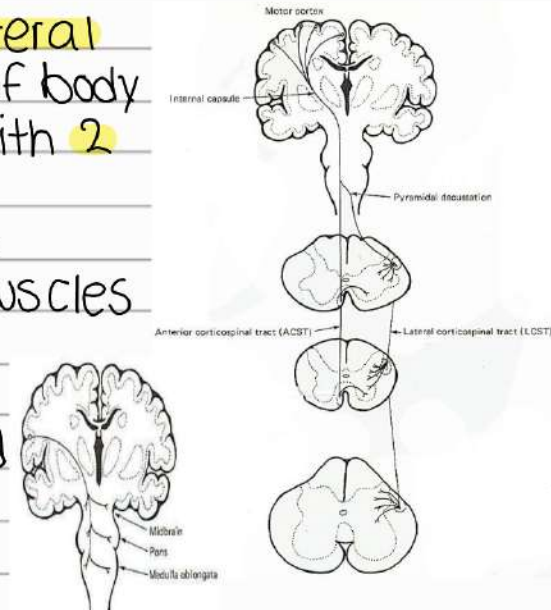
2] Corticonuclear tract (corticobulbar)

- in the brain stem (where cranial nerves arise) there is no ant. & post. horns as in Spinal Cord, but there are motor nuclei that does the same fxn as ant. horn
- **journey**: fibers descend from Cortex (lower 1/4) to motor Nucleus
- **cranial nerves** (head & neck muscles), terminate in motor nuclei

Nerve	Supplies	termination
Oculomotor (3)	eye muscles except Sup. Oblique & lat. rectus	mid brain
trochlear (4)	Sup. Oblique	midbrain
trigeminal (5)	mastication muscles (tensor tympani, tensor vili palatini, ant. belly of digastric, mylohyoid)	pons
abducent (6)	lat. rectus	pontomedullary junction
facial (7)	facial expression muscles (Orbicularis oculi, Oris, Zygomaticus major & minor, risorius, platysma, buccinator)	pontomedullary junction
hypoglossal (12)	tongue	medulla (nerves 9-12)

- **Corticospinal (ant. & lat.) tracts** → **Contralateral**
- **Corticonuclear** → **bilateral** (each side of body is innervated by both Rt & Lt nerves, with **2 exceptions** (contralateral))
 - ① part of facial N → lower facial muscles
 - ② part of hypoglossal → genioglossus muscles

• although corticonuclear tract doesn't pass pyramids, it's functionally considered a pyramidal tract



Extrapyramidal tracts:

• extrapyramidal tracts fxn:

- ① axial muscles that maintain balance & posture
- ② muscles controlling coarse movements of proximal portions of limbs
- ③ head, neck, eye movement

▣ rubrospinal tract

- **rubro** → red nucleus in midbrain at level of sup. colliculus
- **synapses** with α & γ through through interneurons
- **journey:**

red nucleus receives input from Cerebral Cortex & Cerebellum
→ to cord (through white column)

• Cerebellum:

- very important receiver of data (spino cerebellar tract senses muscle/joint by muscle spindle & tendon)
- very aware of our current position
- has 4 deep nuclei: **dentate, emboliform, globose, fastigial** (don't eat greasy food)
- emboliform + globose nuclei = interposed nuclei → there is a pathway emerging from them & goes to red nucleus: **globose-emboliform-rubral pathway**

• rubrospinal tract is an exception of extrapyramidal tracts

- it's related to lat. corticospinal tract & with lat. corticospinal cord they're called: lat. motor system
- supplies distal flexors with \downarrow effect on proximal ones.

• fxn:

- activate flexors (mainly distal ones) & inhibit extensors (skilled movement is mainly flexion)
- very early crossing of midline

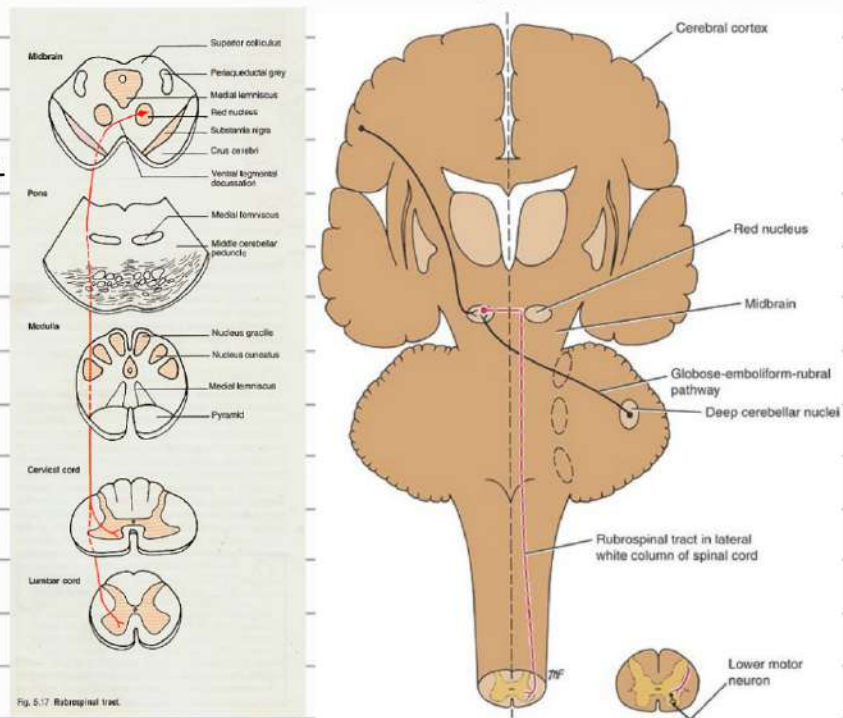


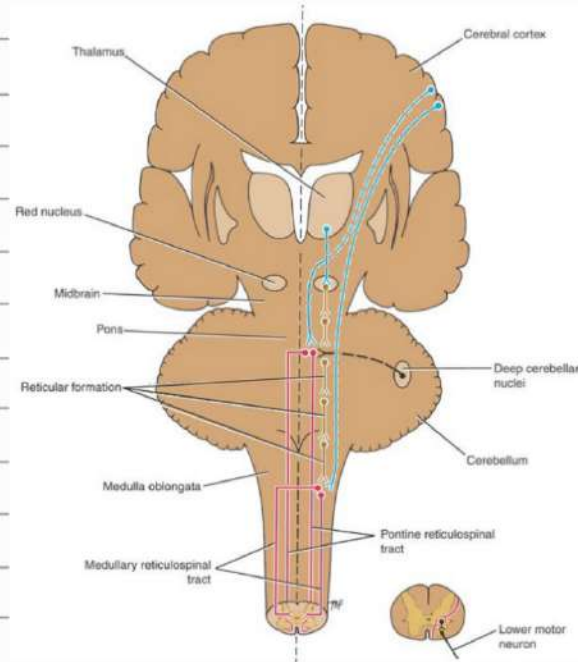
Fig. 5-17 Rubrospinal tract.

2] reticulospinal tract

- location: Core of brainstem
- 2 parts (According to place & fxn): pontine & medullary (they work opposite to each other, agonist & antagonist)

a) pontine reticulospinal tract:

- from pons to ant. white column (always uncrossed)
- **tonically active** (disinhibition mechanism), like the **car on downhill** (stop pressing the break to speed up)
- **normally inhibited** by cortex → if effect of cortex is removed (decorticate) → overfiring of pontine reticulospinal tract → rigidity
- **fxn**: activate axial & proximal limb extensors (**antigravity muscles**) to stand up (knee very extended, quadriceps femoris (ant to knee) is contracted)

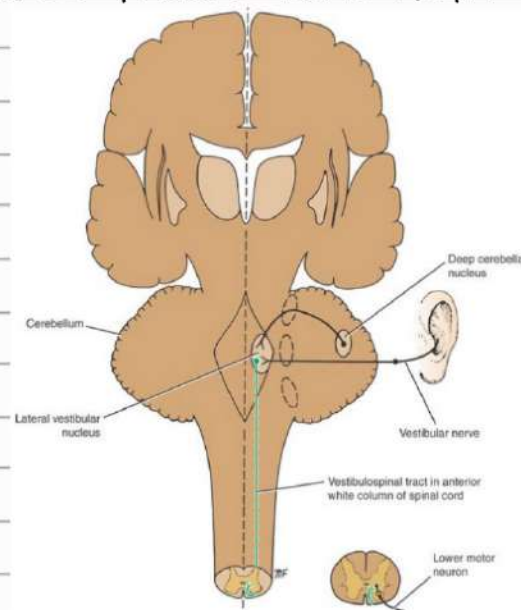


b) medullary reticulospinal tract

- opposite to pontine
- from medulla to lat. white column (some fibers cross & some don't)
- **not tonically active**
- **normally stimulated**
- **fxn**: inhibit axial & proximal limb extensors
- reticulospinal tract has also **descending autonomic fibers** providing a pathway for hypothalamus to control symp. & sacral parasymp. outflow (most of these fibers are from lat. white column)

3] vestibulospinal tracts

- from vestibular nuclei in brain stem (pons & medulla beneath floor of 4th ventricle, sensory nuclei) → descends uncrossed through ant. white column
- **fxn**: activate extensors & inhibit flexors & maintain balance
- this tract + pontine reticulospinal → **antigravity** & opposite to medullary reticulospinal



• Vestibular Nuclei received sensory input from:

- ① inner ear (from vestibule, semicircular canals which has liquid & hair cells that are affected by head movement (firing), by vestibular nerve, sense of balance & gravity)
- ② deep cerebellar nucleus (fastigial nuclei), sense of position

4] tectospinal tracts:

• tectum has 4 nuclei:

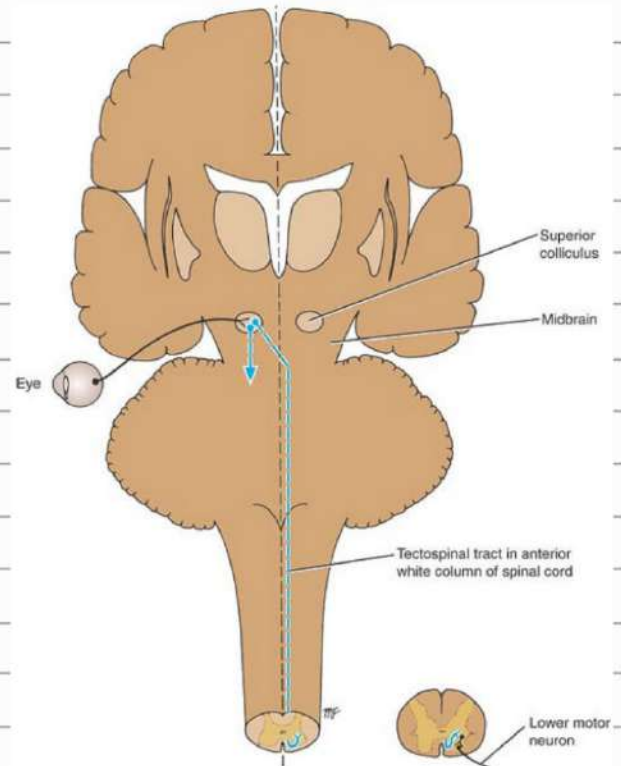
- 2 Superior → Visual reflexes (*)
- 2 inferior → Auditory reflexes

• mainly crossed

• descends in ant. white column
Close to ant. median fissure

• fxn: reflex movement of head & neck in response to visual stimulus (visuospinal reflex)

• termination: mostly ant. grey column (cuz head & neck is supplied by upper cervical segments)



* to sum up:

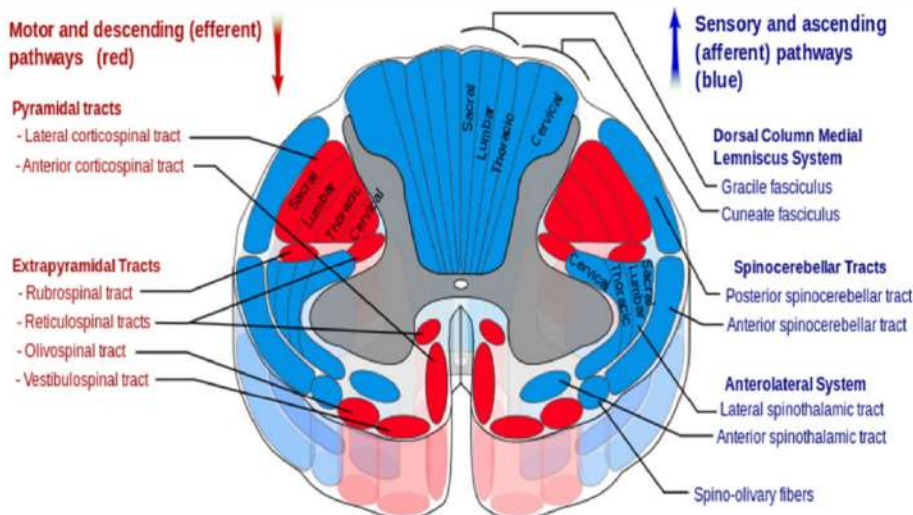
motor pathway is classified into:

① medial motor system: axial & proximal muscles:

- a) ant. corticospinal (pyramidal)
- b) extra pyramidal in general

② lateral motor system: distal muscles

- a) lat. corticospinal (pyramidal)
- b) rubrospinal tract (mainly distal muscles)



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