Lecture : 6

Physiology of Motor Tracts

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OBJECTIVES

At the end of this lecture, student should be able to describe:

-Describe the upper and lower motor neurons
-Understand the pathway of Pyramidal tracts (Corticospinal & corticobulbar tracts)
-Understand the lateral and ventral corticospinal tracts.
-Explain functional role of corticospinal & corticobulbar tracts
-Describe the Extrapyramidal tracts as Rubrospinal , Vestibulospinal ,Reticulospinal and Tectspinal Tracts.

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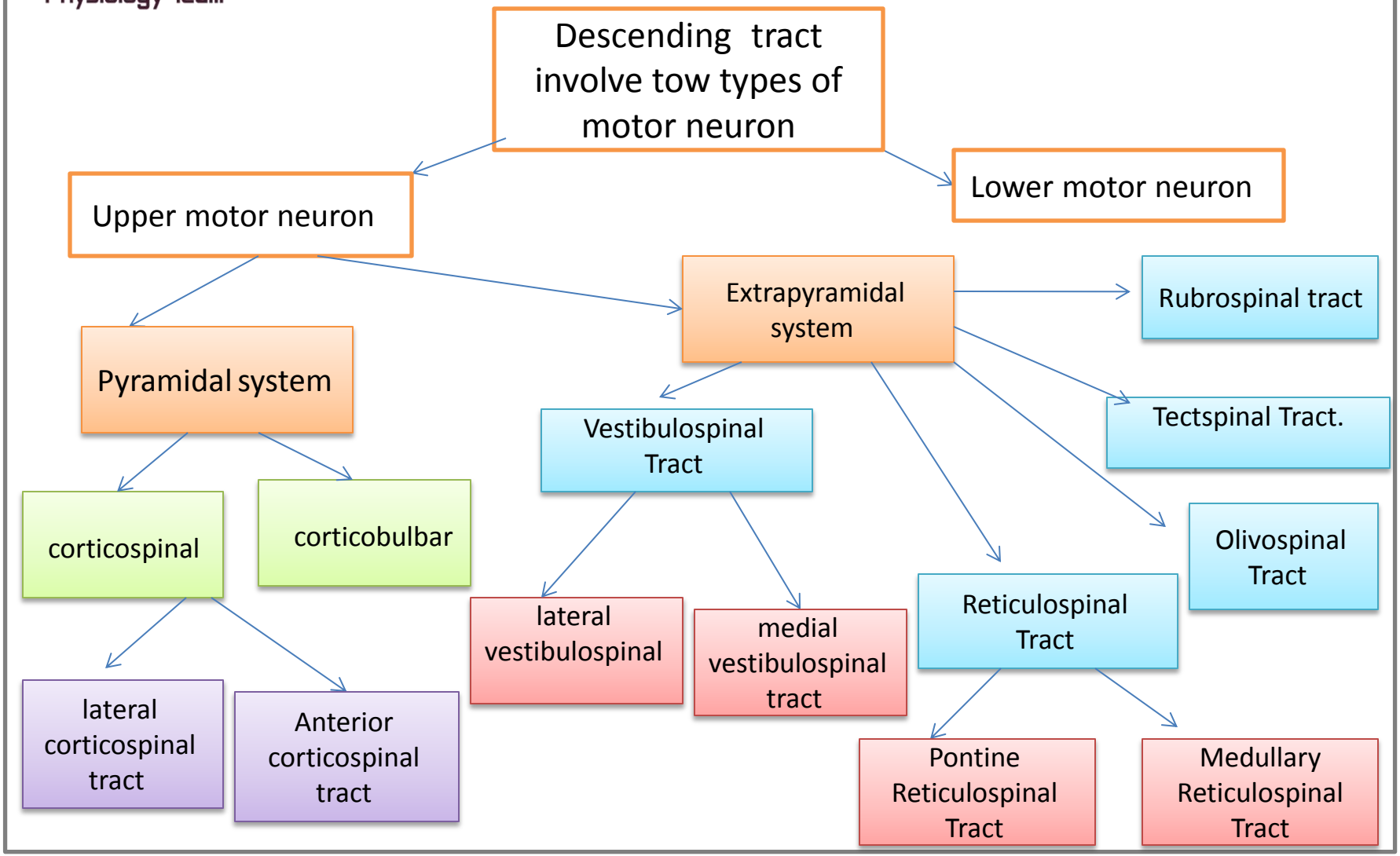
MIND MAP



■ Slides ■ Important ■ Doctor's Notes ■ Explanation ■ Boy's Slides

Upper & lower motor neurons

1-Upper motor neurons (UMN):-

Neurons of motor cortex & their axons that pass to brain stem and spinal cord to activate cranial (brain stem neurons) & spinal motor neurons

-There are two UMN Systems :

- 1-Pyramidal system (corticospinal tracts).
- 2-Extrapyramidal system

2-lower motor neurons(LMN) :

Spinal motor neurons (AHCs)in the spinal cord & cranial motor neurons in the brain stem that innervate muscles **directly**

✓The activity of the lower motor neuron (LMN, spinal or cranial) is influenced by →
(1) Upper Motor Neurons (UMNs) coming from supraspinal centers) via descending motor tracts .
(2) Interneurons
(3) Afferent (sensory nerves)

Upper and lower motor neuron difference

According to	Upper motor neuron	Lower motor neuron
Cell bodies	UMN cell bodies located in the cortex of the brain	are located in the grey matter of the spinal cord and brain stem.
Synapse	Upper motor neurons form synapses with the lower motor neurons	lower motor neurons form synapses with the muscles in the body.
classified	Upper motor neurons are classified according to the pathways they travel in. for example : corticospinal corticobulbar tract Etc… Upper motor neurons have six or seven pathways	Lower motor neurons are classified according to the type of muscle fiber they innervate as they have only one path which is called the final common pathway.. Lower motor neurons are divided into two groups, the alpha and gamma motor neurons.
Carried Information	Upper motor neurons carry information from brain centers that control the muscles of the body	lower motor neurons carry information passed to them from the upper motor neurons.

Descending Tracts

1-Pyramidal tracts (motor) = Corticospinal & corticobulbar tracts;

Origin of tracts

Origin = motor neuron

- 30% • motor area 4 (the primary motor area) (M1) . Occupies the precentral gyrus.
- 30% • from the premotor areas & supplemetary cortex
- 40% • parietal cortex (somatic sensory area 3,1,2)

Corticospinal : descending tract from cortex to alpha motor neuron of spinal

Cortecobulbar : descending tract from cortex to brainstem which send cranial nerves for head and neck

Parital cortex: they are sensory neurons but they give origin for descending (motor) tract to make balance between the sensory and motor impulses .

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What do you know about Premotor area & Supplemetary cortex ?

--Premotorarea:-(motor association area) lies in front of the primary motor area & below supplementary motor area.

• Stimulation of the premotor area produces complex coordinated movements, such as setting the body in a certain posture to perform a specific task.

Ex : if we want to sit properly and write, it help to make suitable muscle tone to have a good hand writing.

-Supplemetary cortex is a small area located on the lateral side of the brain in front of -area 4 and above the pre-motor area & extends on medial side of the cerebral hemisphere.

• This area projects mainly to M1 and is concerned with planning and -
-programming motor sequences.

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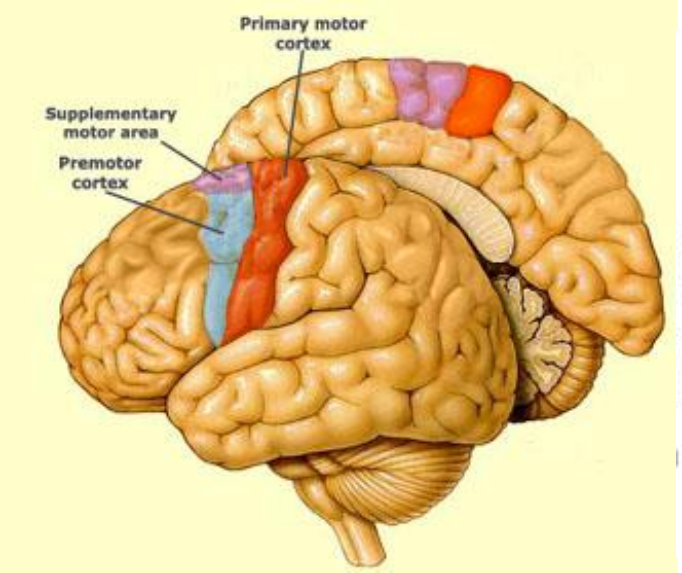
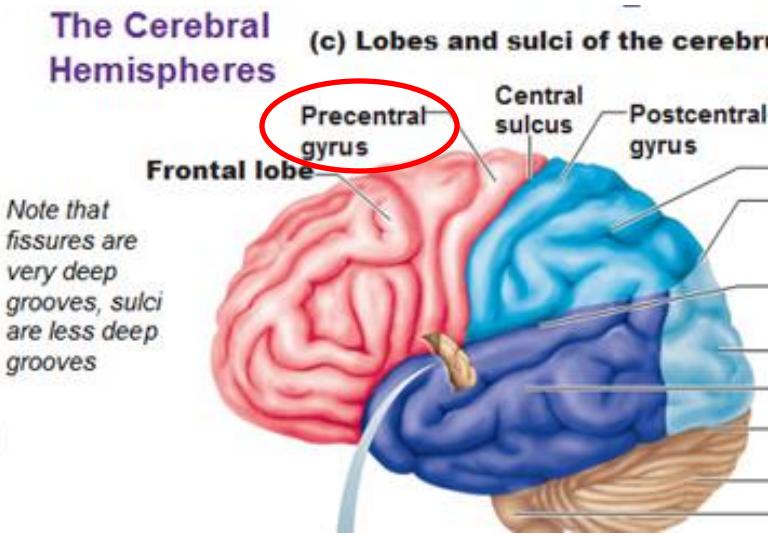


The supplementary motor area is in the medial side of the hemisphere , we have to open the two hemispheres to see it in the medial side



The motor area 4 Occupies the precentral gyrus

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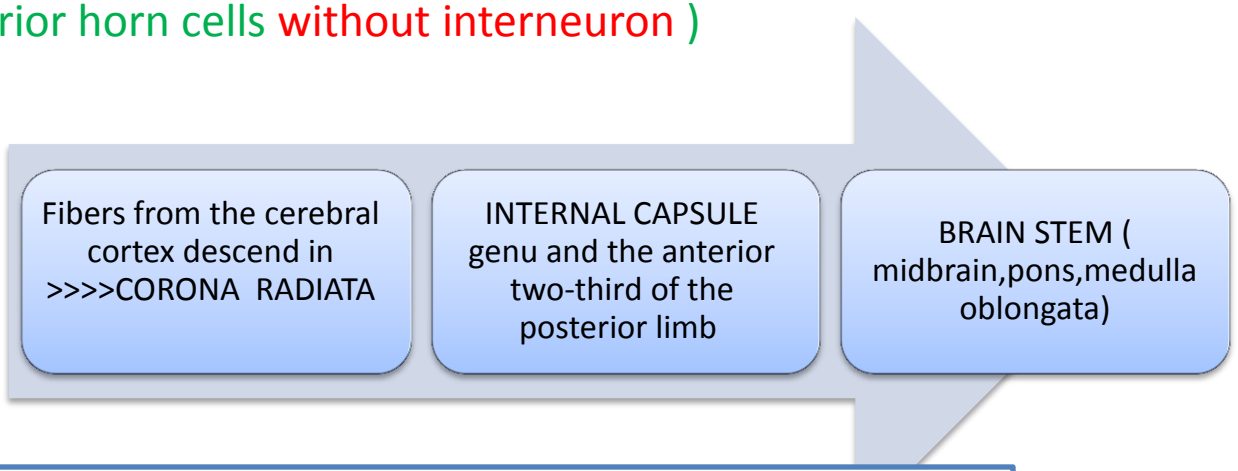
Impulses along the extrapyramidal tracts reach the muscles much faster than impulses passing along the pyramidal tracts

CONT//

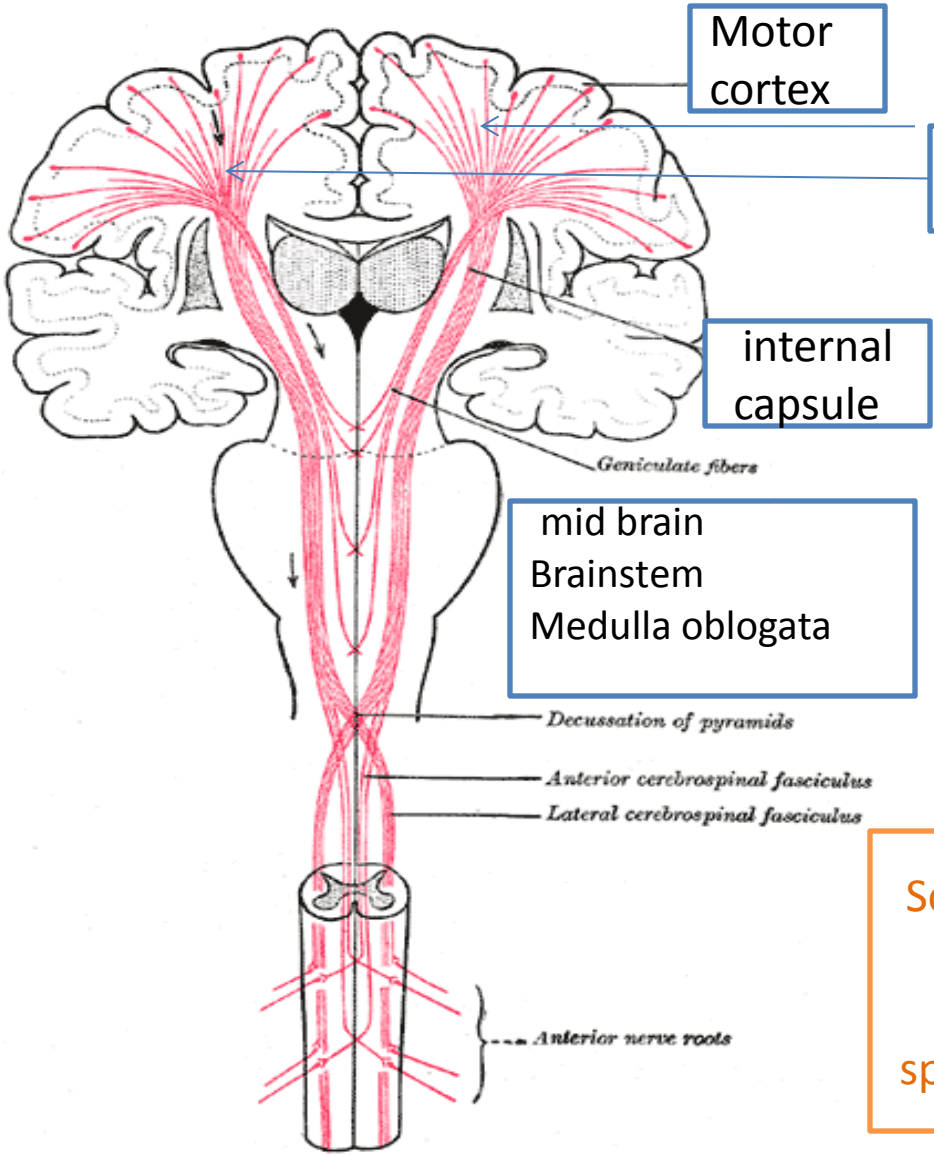
Neurons will give axons :

- 3% of the pyramidal fibers are large myelinated, derived from the large ,giant, highly excitable pyramidal Betz cells which found only in motor area 4.
- These fibers form monosynaptic connections with motor neurons of the spinal cord (fiber will descend and terminate directly on the anterior horn cells without interneuron)

The tracts pathway:



-Internal capsule : is a site of hemorrhage because it is rich in blood vessel and any injury will affect the pyramidal tract also .



Some of fiber end at brain stem (corticobulbar) And some descend to spinal cord (corticospinal)

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The termination of the tracts

1- corticobulbar tract : terminates on LMNs

-AHCs = cranial nerve nuclei of opposite side (AHC of the brain stem not in spinal cord)
-(decussating (cross) just before they reach their target nuclei.)
-The corticobulbar tract carries information to motor neurons of the cranial nerve nuclei, rather than the spinal cord.
(It cross the opposite side in the brain stem .It supply all cranial nerve except cranial nerves which is responsible for eye movement 3,4,6)

2-Corticospinal tracts (pyramidal):

descends through the midbrain and pons Then in the lower medulla oblongata the fibers form pyramid so called pyramidal tract (It cross the opposite side at the lower medulla)

. Then it divide into :

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CORTICOSPINAL TRACTS divides into:

1-lateral corticospinal tracts :--

80% of fibers cross midline in pyramids -Ends directly (not via interneurons = monosynaptic connections) on motor neurons (AHCs) of the opposite side- Pass laterally in spinal cord white matter. They control what?

To control fine skilled movements. Such as : writing ,typing ,knitting ..etc

control fine discrete skilled movements of what?

of the distal limb muscles

The fibers of the corticospinal tract terminate at different levels in the anterior horn of the grey matter of the spinal cord. Here the lower motor neurons (LMN) of the corticospinal cord are located. (it was upper then it reach the spinal cord and become lower)

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CORTICOSPINAL TRACTS divides into:

2-ventral (anterior) corticospinal tracts :-

-Remaining 20% fibers does not cross midline

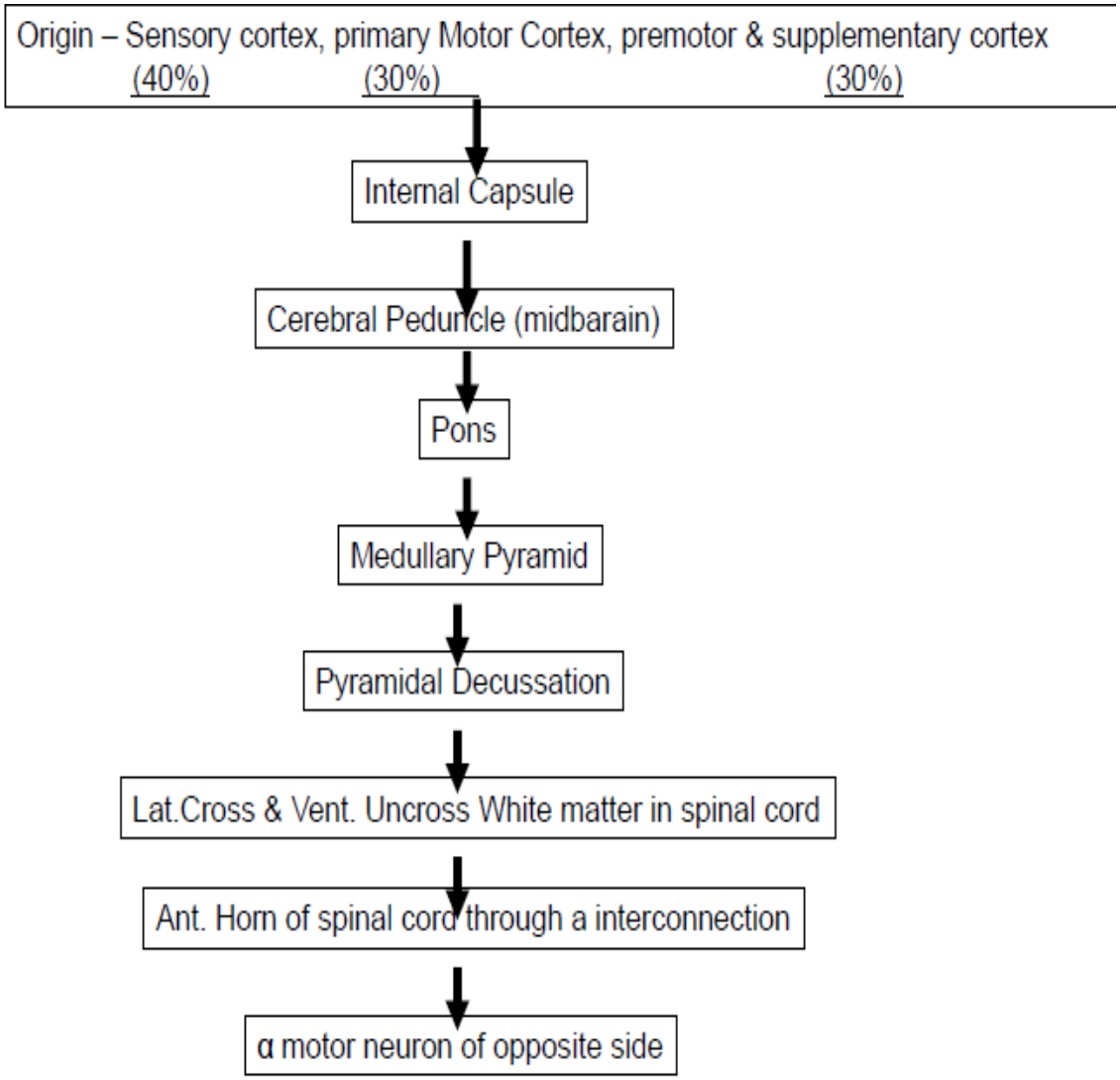
-Cross at level of termination to synapse with interneurons, that synapse with motor neurons (AHCs) of opposite side.(they continue without crossing and just before the termination it will cross to the opposite side)

-Pass medially in ventral horn

so control what?

control axial(abdomin,chest ..) & proximal limb muscles & control posture.

--NB/So BOTH corticospinal tract(ANT& LAT) supply skeletal muscles of the opposite side


Origin – Sensory cortex, primary Motor Cortex, premotor & supplementary cortex
(40%) (30%) (30%)
Internal Capsule
Cerebral Peduncle (midbarain)
Pons
Medullary Pyramid
Pyramidal Decussation
Lat.Cross & Vent. Uncross White matter in spinal cord
Ant. Horn of spinal cord through a interconnection
α motor neuron of opposite side

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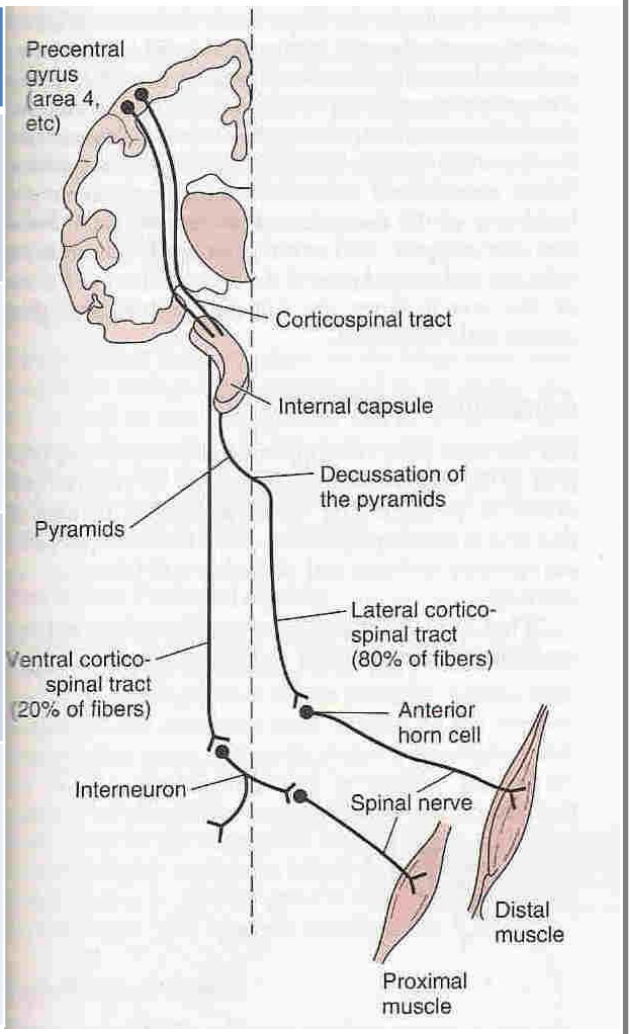
lateral corticospinal tract	Ventral corticospinal tract
80% of fibers which pass laterally	Remaining 20% fibers which pass medially
cross midline in pyramids	does not cross midline and cross at level of termination
control fine skilled movements of the distal limb muscles	control axial & proximal limb muscles & control posture.
Ends directly (not via interneurons = monosynaptic connections)	synapse with interneurons, that synapse with motor neurons (AHCs)



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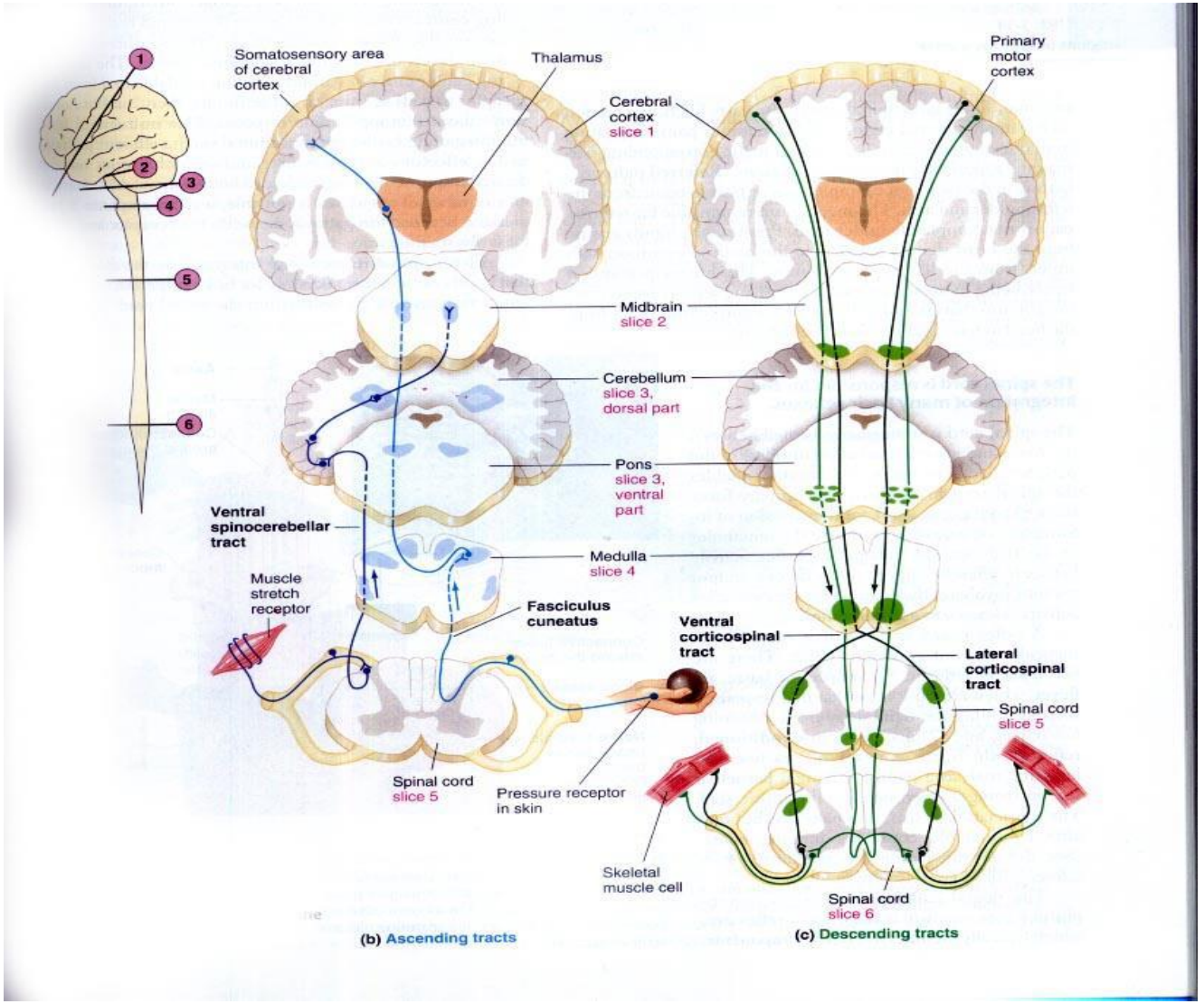

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Functions of corticospinal tracts:-

1-Initiation of fine ,discrete, skilled voluntary movements .
(on which side? The opposite side)

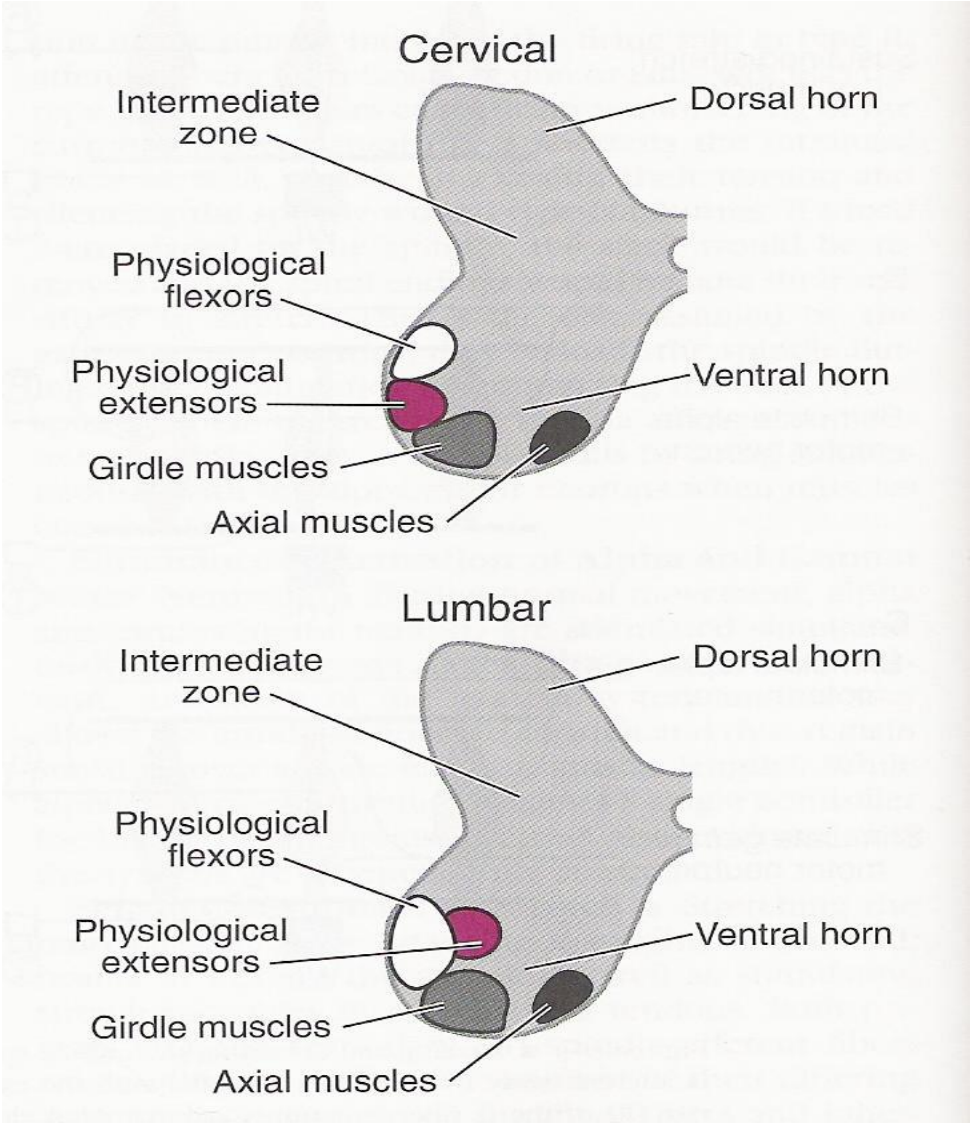
2-lateral corticospinal tracts (main bulk of the tract =80%) control distal muscles of limb as fingers & thumb& toes (like ballerina)which concerned with what? fine skilled movement

3-Ventral corticospinal tracts controls what? postureof axial & proximal muscle for balance, climbing, walking (need large muscles)

4-Effect on stretch reflex:--Facilitate muscle tone (prevent hypertonia or hypotonia) through gamma motor neurons

5-those fibers originate from parietal lobe are for what?
sensory-motor coordination in final common pathway (alpha motor neuron)

6-corticobulbar tracts/control face & neck muscles(talking ..smiling ..) & facilitate their tone, and are involved in what?


Cervical
Intermediate zone
Dorsal horn
Physiological flexors
Physiological extensors
Ventral horn
Girdle muscles
Axial muscles
Lumbar
Intermediate zone
Dorsal horn
Physiological flexors
Physiological extensors
Ventral horn
Girdle muscles
Axial muscles

Extrapyramidal tracts

-Extrapyramidal tracts :-Tracts other than corticospinal tract & are outside pyramids

Origin	Pathway	function
motor area 4, premotor area 6, 4 Suppressor	>>>>CORONA RADIATA>>>>INTERNAL CAPSULE>>>>BASAL GANGLIA>>BRAIN STEM >>>BULBOSPINAL TRACTS descend to spinal cord :- Depending on the nuclei of the basal ganglia it divides to : A-Rubrospinal tract. B-Vestibulospinal Tract. C-Reticulospinal Tract D-Tectspinal Tract. E-Olivospinal Tract	(1) sets the postural background needed for performance of skilled movements (2) controls subconscious gross movements. Such as walking ,we do not think about which leg we will move.

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1-Rubrospinal tracts(INHIBITORY):-

•Origin	Pathway	Function
From Red nucleus (in mid brain tegmentum) which is connected by fibers with cerebral cortex	The fibers pass laterally in the spinal cord .	Its motor function is inhibitory to Distal limb motor neurons & control skilled movements.

it opposes the lateral corticospinal tract , both control the skilled movement but the corticospinal tract excitatory while the rubrospinal tracts are inhibitory ,their location are close to each other *See picture slide 22 & they link by interneurons to make a balance.

2-Vestibulospinal tracts:-

•Origin	Pathway	Function
From vestibular nucleus (situated in the pons & medulla)	fibers originate in vestibular nuclei in pons (which receive inputs from inner ear ,Vestibular Apparatus and cerebellum) -Axons descend in the **ipsilateral** ventral white column of spinal cord	1-Controls eye movements, postural & righting reflexes. 2-Excitatory to ipsilateral spinal motor neurons-that supply axial & postural muscles

Cont >Vestibulospinal Tracts•

	The lateral vestibulospinal tract	The medial vestibulospinal tract
Cells of origin	Lateral Vestibular Nucleus	Medial Vestibular Nucleus
Pathway	Axons descend in the ipsilateral ventral white column of spinal cord	• As its axons desend ipsilaterally in the ventral white column of spinal cord , they form part of the Medial Longitudinal Fasciculus fibers in brain stem that link vestibular nuclei to nuclei supplying the extra-ocular muscles
Function	This tract mediates excitatory influences upon extensor motor neurones to maintain posture	they form part of the Medial Longitudinal Fasciculus fibers in brain stem for what? for coordination of head and eye movements

Medial and lateral vestibulospinal tracts are both not crossing (ipsilatral =same side) , the difference is : medial vestibulospinal terminate as Medial Longitudinal Fasciculus to supply head and control eye movement .

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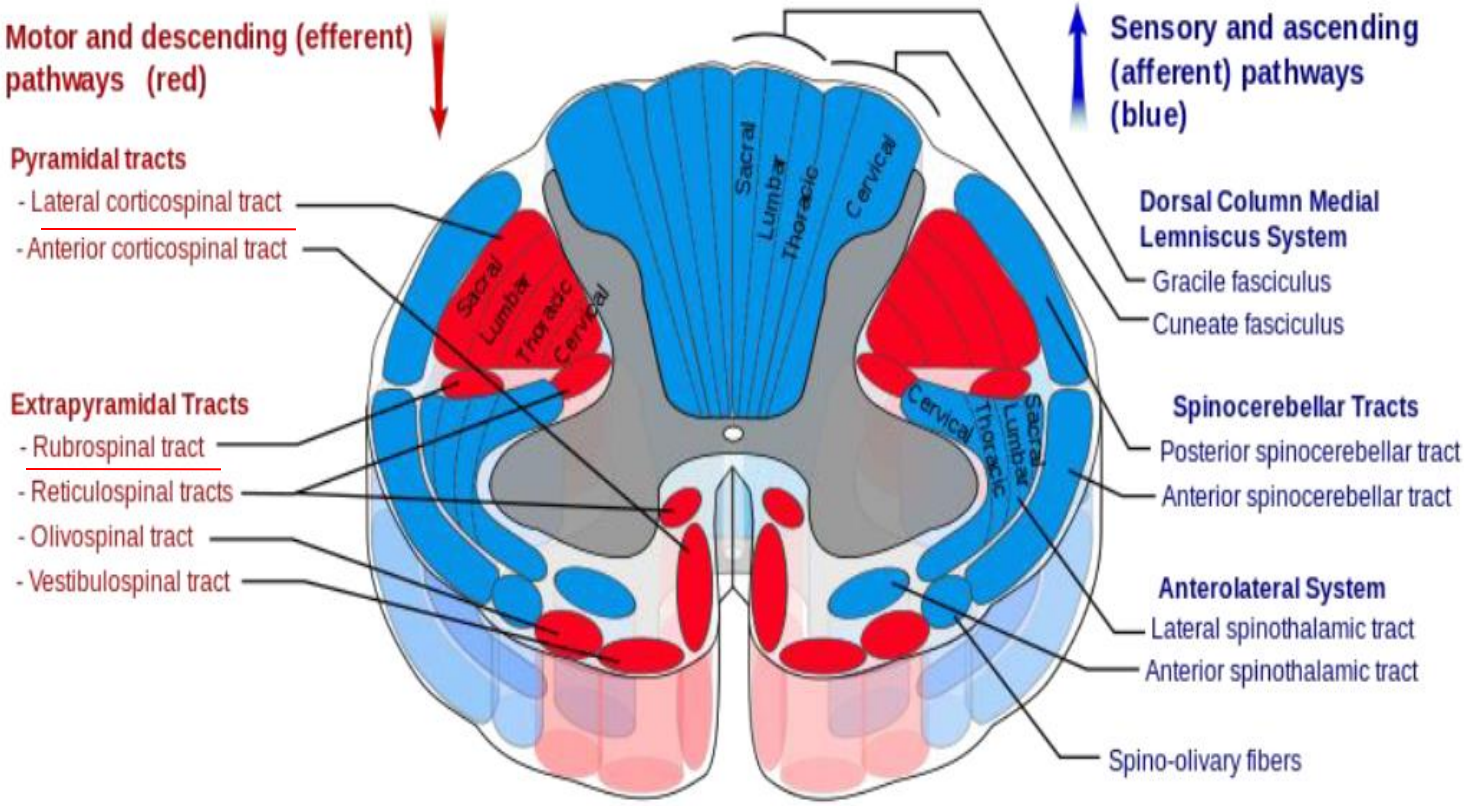

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3- Tectospinal tracts (excitatory):--

•Origin	Pathway	Function
-from superior (VISUAL) & inferior colliculi (AUDITORY) of midbrain. both are excitatory	Ends on Contralateral cervical motor neurons.	Mediate/facilitate turning of the head in response to visual or Auditory stimuli if I see a lion the superior Tectospinal tract help to move the head to search for a safe place . or if I hear danger alarm , inferior tectospinal help to move the head to search for a safe place .

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4-Reticulospinal Tract :--

The reticular formation (collection of neurons in brainstem)makes up a central core of the brainstem. It contains many different neuronal groups.- Pontine and medullary nuclei projects to the AHCs of the spinal cord via Reticulospinal Tract

Functions:

1-Influence motor functions as voluntary & reflex movement

2-Excitatory or inhibitory to muscle tone

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Types of reticulospinal tracts:-

	Pontine **(Medial)** Reticulospinal Tract	Medullary **(Lateral)** Reticulospinal Tract
Cells of origin	Pontine Reticular Formation	Medullary Reticular Formation
Pathway	-Axons descend in ventral white column of spinal cord - Axons terminate in ipsilateral spinal motor neurons	-Axons descend in ventral white column of spinal cord on both sides - Axons terminate in ipsilateral & contralateral ventral horn cells of spinal cord.
Function	Pontine Reticulospinal Tract increases Gamma efferent activity ,(excitatory = increases muscle tone) -Exciting anti-gravity, extensor muscles.	Medullary Reticulospinal Tract, inhibits Gamma efferent activity (inhibitory= decreases muscle tone) . -Inhibiting anti-gravity, extensor muscles

NOTE : No reticulospinal tract in midbrain

5-Olivospinal Tract :-

Cells of origin : It arises from inferior olivary Neuclus of the medulla & is found only in the cervical region of the spinal cord (supply neck muscles)
Function : of unknown function(intermediate pathway in the strio-olivo-spinal connections)
function are unknown yet but it said that it make a link between basal ganglia , inferior olivary nucleus and spinal cord .

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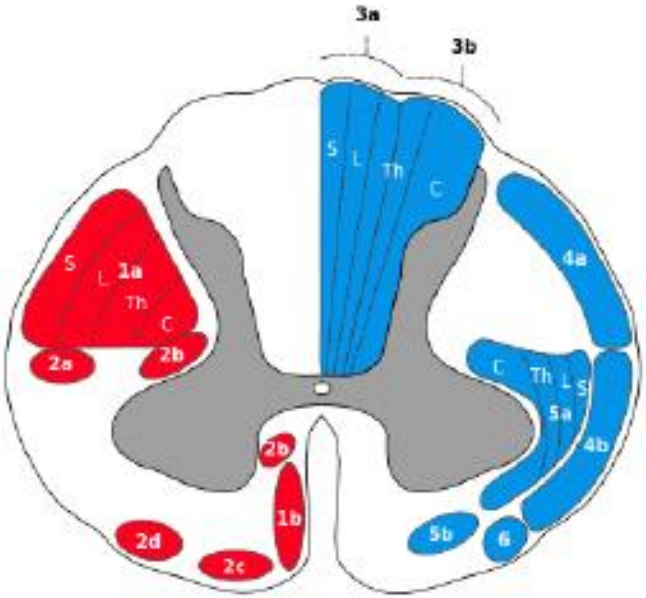

Motor and decending (efferent) pathways (left, red)	Sensory and ascending (afferent) pathways (right, blue)
1. Pyramidal Tracts	**3. Dorsal Column Medial Lemniscus System**
1a. Lateral corticospinal tract	3a. Gracile fasciculus
1b. Anterior corticospinal tract	3b. Cuneate fasciculus
2. Extrapyramidal Tracts	**4. Spinocerebellar Tracts**
2a. Rubrospinal tract	4a. Posterior spinocerebellar tract
2b. Reticulospinal tract	4b. Anterior spinocerebellar tract
2c. Vestibulospinal tract	**5. Anterolateral System**
2d. Olivospinal tract	5a. Lateral spinothalamic tract
	5b. Anterior spinothalamic tract
Somatotopy Abbreviations:	6. Spino-olivary fibers
S: Sacral, **L: Lumbar**	
Th: Thoracic, **C: Cervical**	

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Rubrospinal tracts

Red Nucleus in Midbrain

↓

Decussation at the level of red nucleus

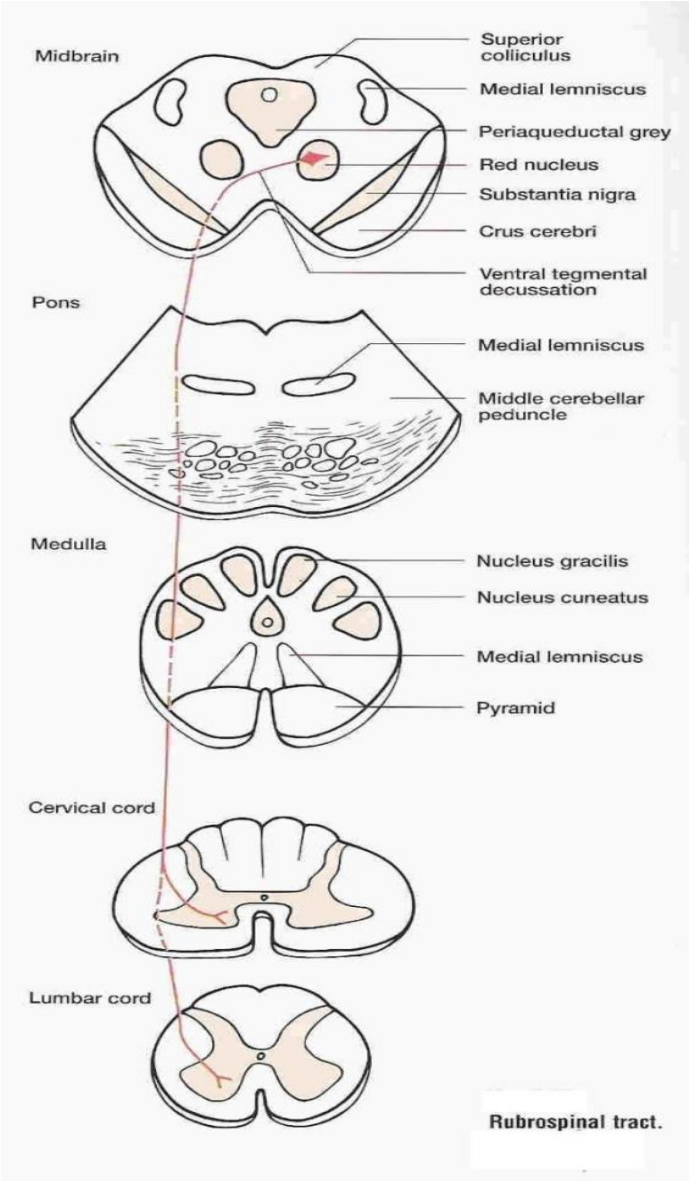
↓

Pass down through Pons & Medulla

↓

Ends in ant. Horn of spinal cord

↓



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Vestibulospinal Tracts

Afferent from cerebellum, vestibular apparatus & vestibular nuclei

↓

Spinal motor neuron

↓

Innervating axial & postural muscles

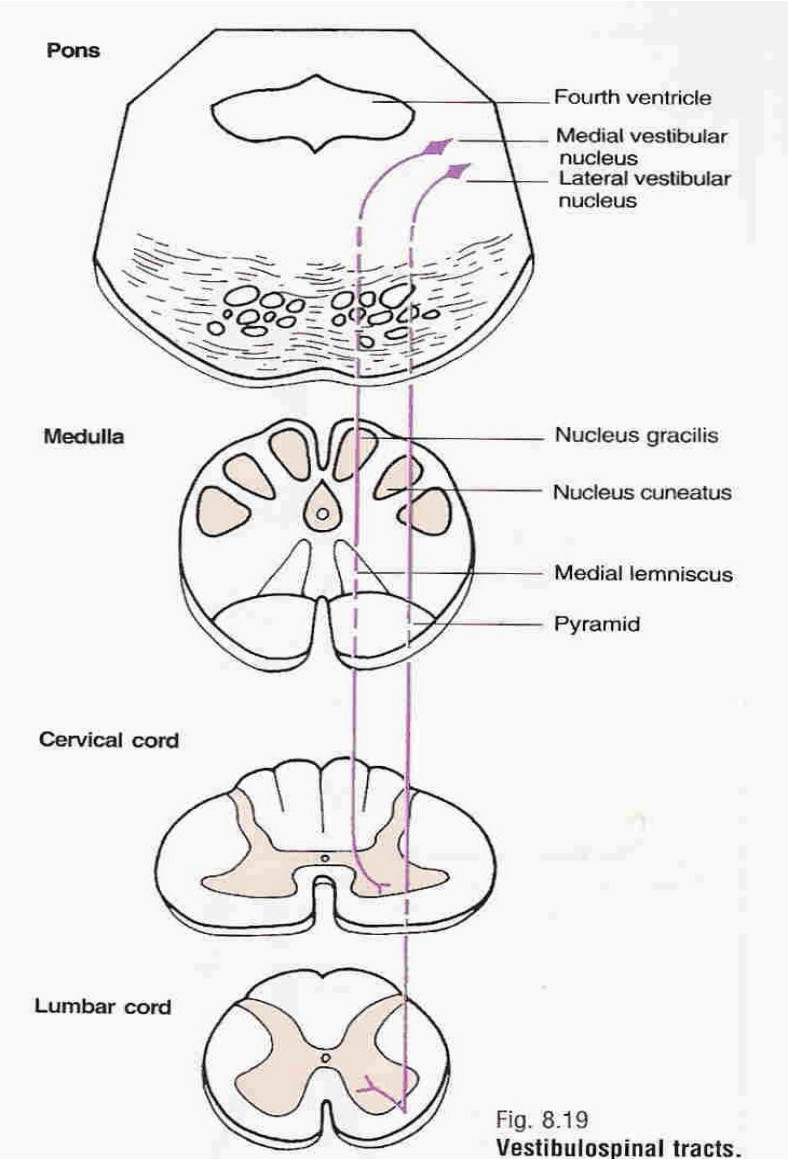

Fig. 8.19
Vestibulospinal tracts.

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Tectospinat tracts

Superior & Inferior collicili in midbrain>>>>>

Near Medial longitudinal fasiculus>>>>

Cervical spinal motor neuron of anterior horn

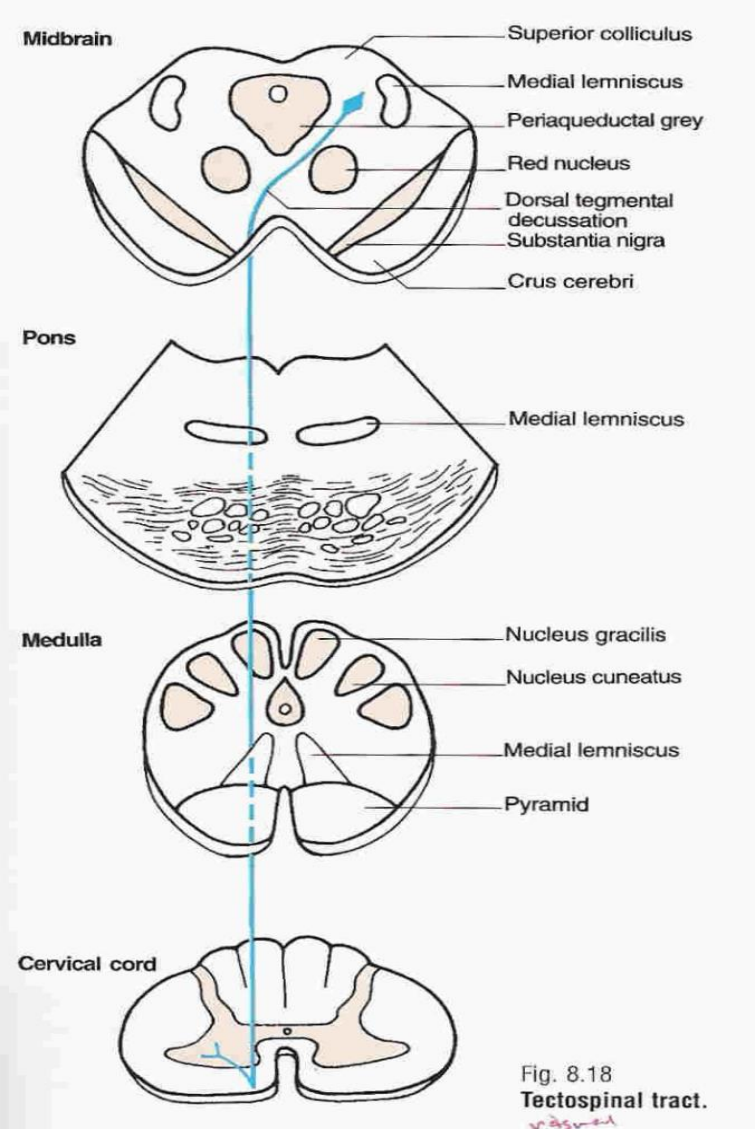

Fig. 8.18
Tectospinal tract.

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SUMMARY

-Descending tracts are divide into: Upper motor tract and lower motor tract.
-upper motor tract divide into : pyramidal and extrapyramidal tracts
-pyramidal tracts :

-Origin :

motor area 4 ,premotor areas & supplemetary
cortex and parietal cortex

-Pathway :

Fibers from the cerebral cortex descend in >>>>CORONA RADIATA
INTERNAL CAPSULE genu and the anterior two-third of the posterior limb
BRAIN STEM (midbrain,pons,medulla oblongata

- **termination:** the termination are different in corticospinal and corticobulbar tracts slide11
Corticospinal tracts subdivide into :
Lateral corticospinal tract slide12 and ventral corticospinal tract slide 13

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SUMMARY

-Function of the pyramidal tracts: slide 17,18

extrapyramidaltracts:

A-Rubrospinal tract.
B-Vestibulospinal Tract.
C-Reticulospinal Tract.
D-Tectspinal Tract.
E-Olivospinal

For each tract you must know the origin, pathway & termination ,and the function

-Tracts which terminate early :

Corticobulbar tract ,medial vestibular tract ,tectospinal tract, Olivospinal Tract

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QUESTIONS

1-Which one of the following is an excitatory tract ?
A-Rubrospinal tract.
B- medullary Reticulospinal Tract
C-pontine Reticulospinal Tract.

2-corticobulbar tract terminate at ?
A-AHC of spinal cord
B-Medial Longitudinal Fasciculus
C-AHC of the brain stem = cranial nerve nuclei of opposite side

3- posture , axial & proximal limb muscles are control by ?
A-lateral corticospinal tract
B-Ventral corticospinal tract
C-medial vestibulospinal tract

1-C 2-C 3-B

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THE END

If there are any Problems or Suggestions,
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THANK YOU