Physiology of Motor Tracts

Dr. Faten Zakareia
Physiology Department , College of Medicine , King Saud University

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Objectives:

Upon completion of this lecture, students should be able to:

-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.

Upper & lower motorv 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 motorv neurons(LMN)

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

Descending Tracts

- **1-Corticospinal (Pyramidal tracts)& corticobulbar tracts;-**

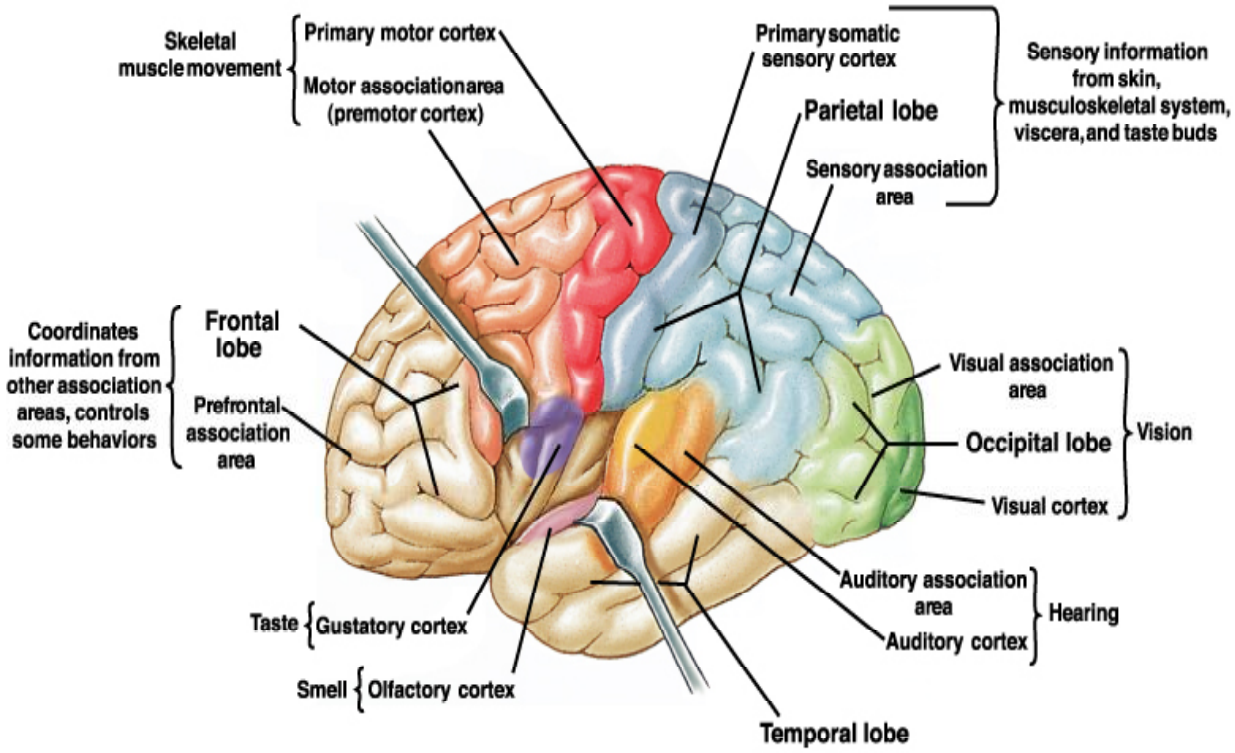
-Origin/

1- 30% motor area 4 (the primary motor area) (M1) . Occupies the precentral gyrus.

2- 30% from the premotor areas & supplemetary cortex

-What do you know about Premotor area& Supplemetary cortex ?

3- parietal cortex 40% (somatic sensory area 3,1,2)


Skeletal muscle movement
Primary motor cortex
Motor association area (premotor cortex)
Primary somatic sensory cortex
Parietal lobe
Sensory association area
Sensory information from skin, musculoskeletal system, viscera, and taste buds
Coordinates information from other association areas, controls some behaviors
Frontal lobe
Prefrontal association area
Visual association area
Occipital lobe
Visual cortex
Vision
Taste
Gustatory cortex
Smell
Olfactory cortex
Auditory association area
Auditory cortex
Hearing
Temporal lobe

CONT//

- **3% of the pyramidal fibres are large myelinated, derived from the large ,giant, highly excitable pyramidal Betz cells in motor area 4.**
- **These fibers form monosynaptic connections with motor neurons of the spinal cord**

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

CONT//-

-In the brain stem midbrain, pons & medulla oblongata -

1-Corticobulbar tract terminates on LMNs -

(AHCs = cranial nerve nuclei of opposite side) -

(decussating 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.

2- Corticospinal tracts (pyramidal) descends through the midbrain and pons.

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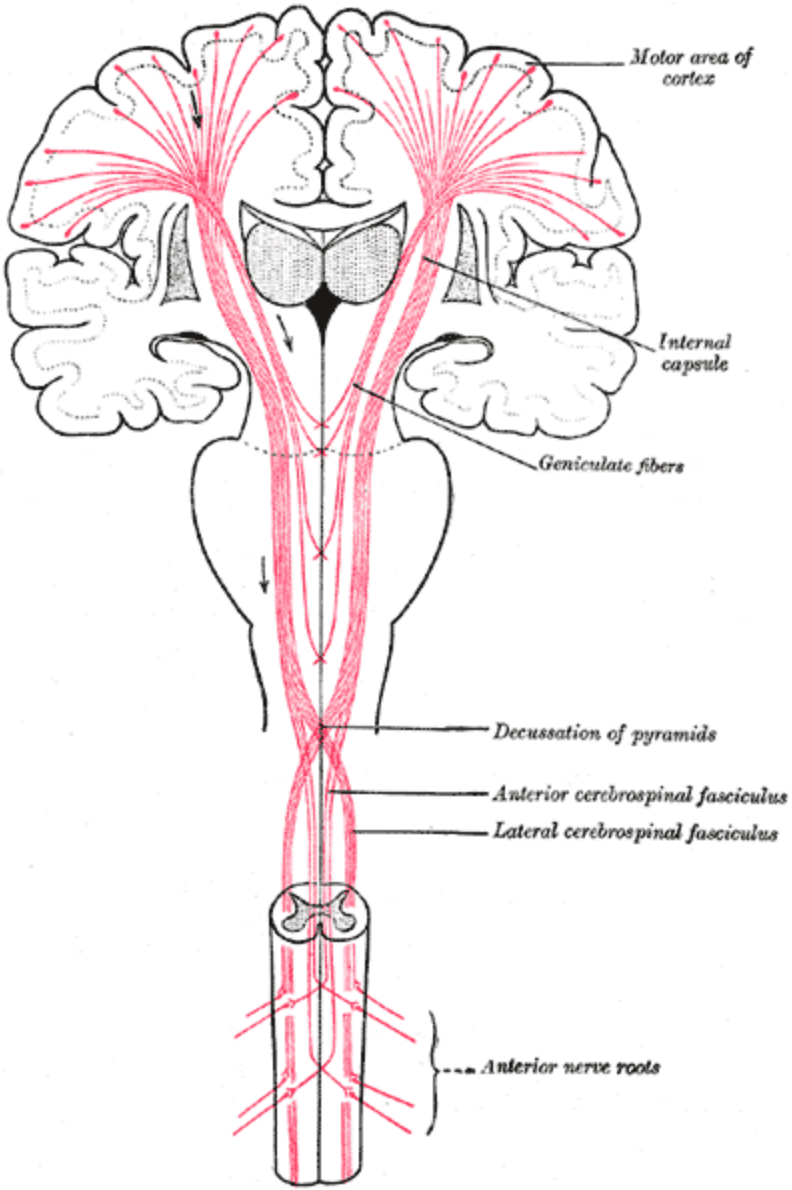
- Then in the lower medulla oblongata the fibers form pyramids so called pyramidal tract which divide into:-


Motor area of cortex
Internal capsule
Geniculate fibers
Decussation of pyramids
Anterior cerebrospinal fasciculus
Lateral cerebrospinal fasciculus
Anterior nerve roots

Origin – Sensory cortex, primary Motor Cortex, premotor & supplementary cortex

(40%) (30%) (30%)

Internal Capsule

Cerebral Peduncle (midbarain)

Pons

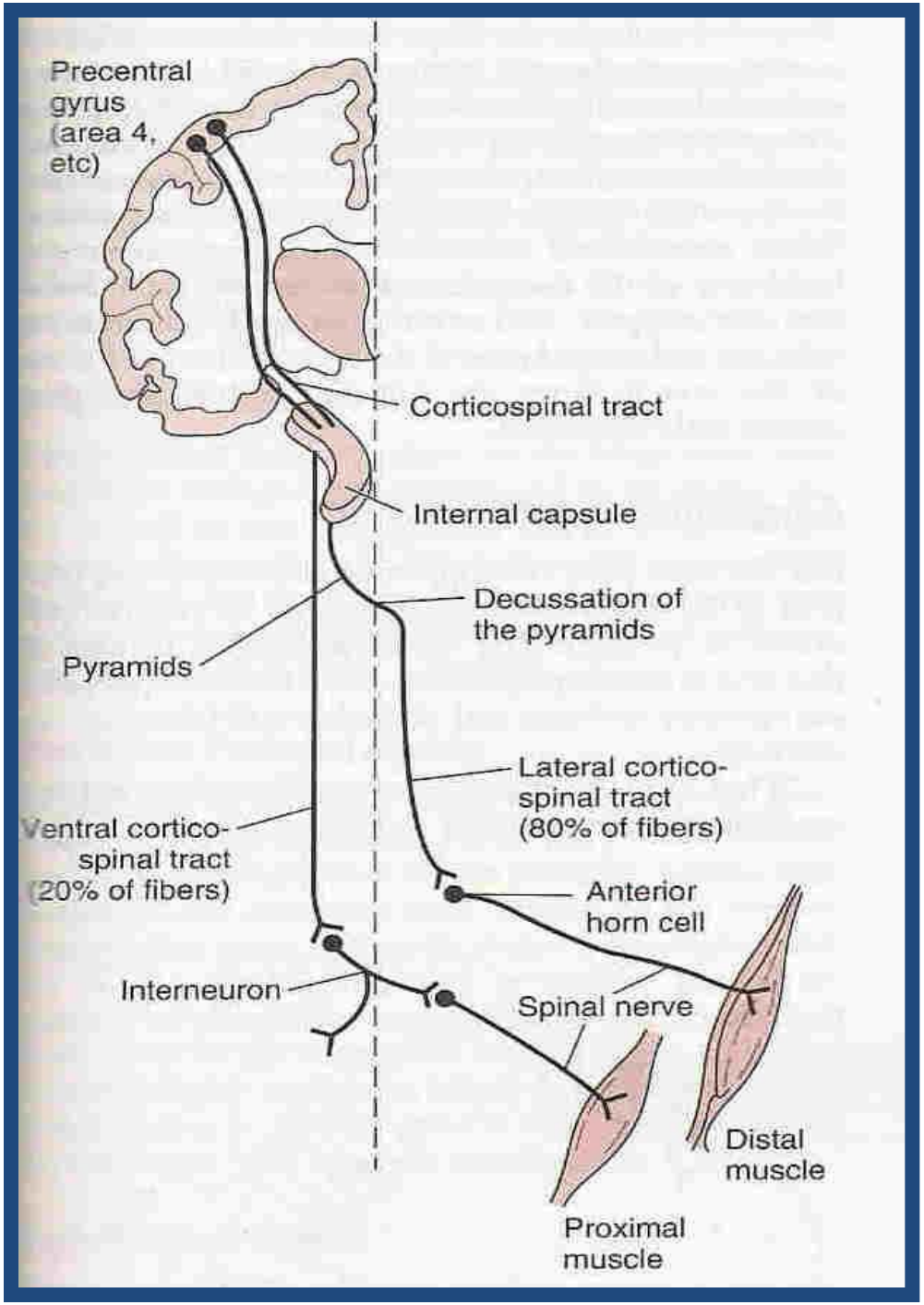
Medullary Pyramid

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


Precentral gyrus (area 4, etc)
Corticospinal tract
Internal capsule
Decussation of the pyramids
Pyramids
Lateral cortico-spinal tract (80% of fibers)
Ventral cortico-spinal tract (20% of fibers)
Anterior horn cell
Interneuron
Spinal nerve
Distal muscle
Proximal muscle

A-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.

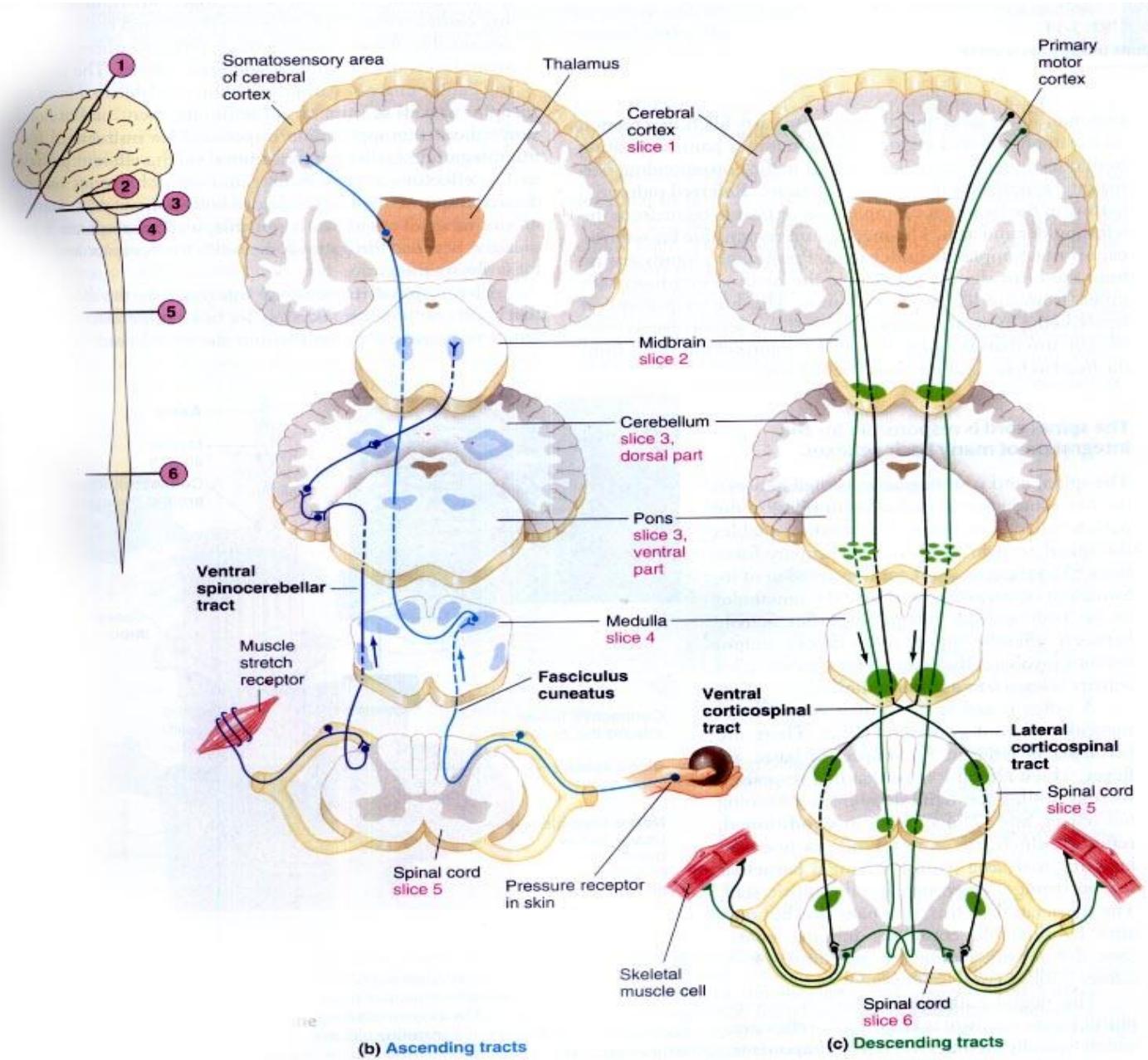
They control what?-

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.

- - control fine discrete skilled movements of what?

- **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.
  -Pass medially in ventral horn so control what?
  NB/So BOTH corticospinal tract(ANT& LAT) supply skeletal muscles of the opposite side


1
2
3
4
5
6
Somatosensory area of cerebral cortex
Thalamus
Cerebral cortex slice 1
Primary motor cortex
Midbrain slice 2
Cerebellum slice 3, dorsal part
Pons slice 3, ventral part
Medulla slice 4
Ventral spinocerebellar tract
Muscle stretch receptor
Fasciculus cuneatus
Spinal cord slice 5
Pressure receptor in skin
Ventral corticospinal tract
Lateral corticospinal tract
Spinal cord slice 5
Skeletal muscle cell
Spinal cord slice 6
(b) Ascending tracts
(c) Descending tracts

Functions of corticospinal tracts:-

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

2- lateral corticospinal tracts (main bulk of the tract) control distal muscles of limb as fingers & thumb& toes which concerned with what?

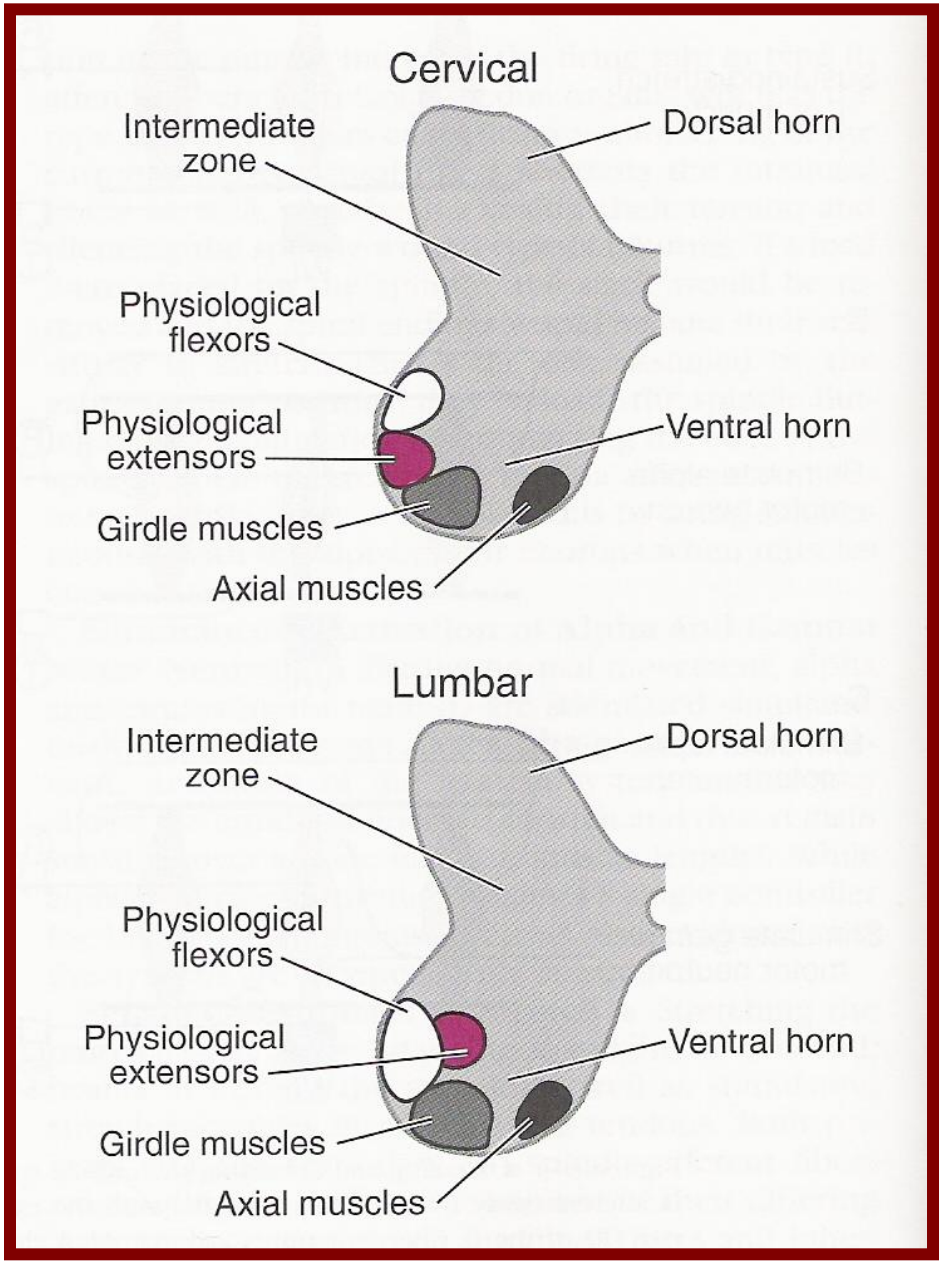
3- Ventral corticospinal tracts controls what?

4- Effect on stretch reflex:-

- Faccilitate muscle tone through gamma motor neurons

5- those fibers originate from parietal lobe are for what?

6- corticobulbar tracts /control face & neck muscles & faccilitate 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 :-

Tracts other than corticospinal tract & are outside pyramids

Origin/ motor area 4, premotor area 6, 4 Suppressor >>>>CORONA RADIATA>>>>INTERNAL CAPSULE>>>>BASAL GANGLA>>BRAIN STEM >>>BULBOSPINAL TRACTS descend to spinal cord :-

A- Rubrospinal tract.

B- Vestibulospinal Tract.

C- Reticulospinal Tract

D- Tectspinal Tract.

E- Olivospinal Tract

Extrapyramidal system :

(1) sets the postural background needed for performance of skilled movements

(2) controls subconscious gross movements.

1-Rubrospinal tracts (INHIBITORY):-

-From Red nucleus which is connected by fibers with cerebral cortex. The fibers pass laterally in the spinal cord .Its motor function is inhibitory to Distal limb motorneurons & control skilled movements

2- Vestibulospinal tracts:-

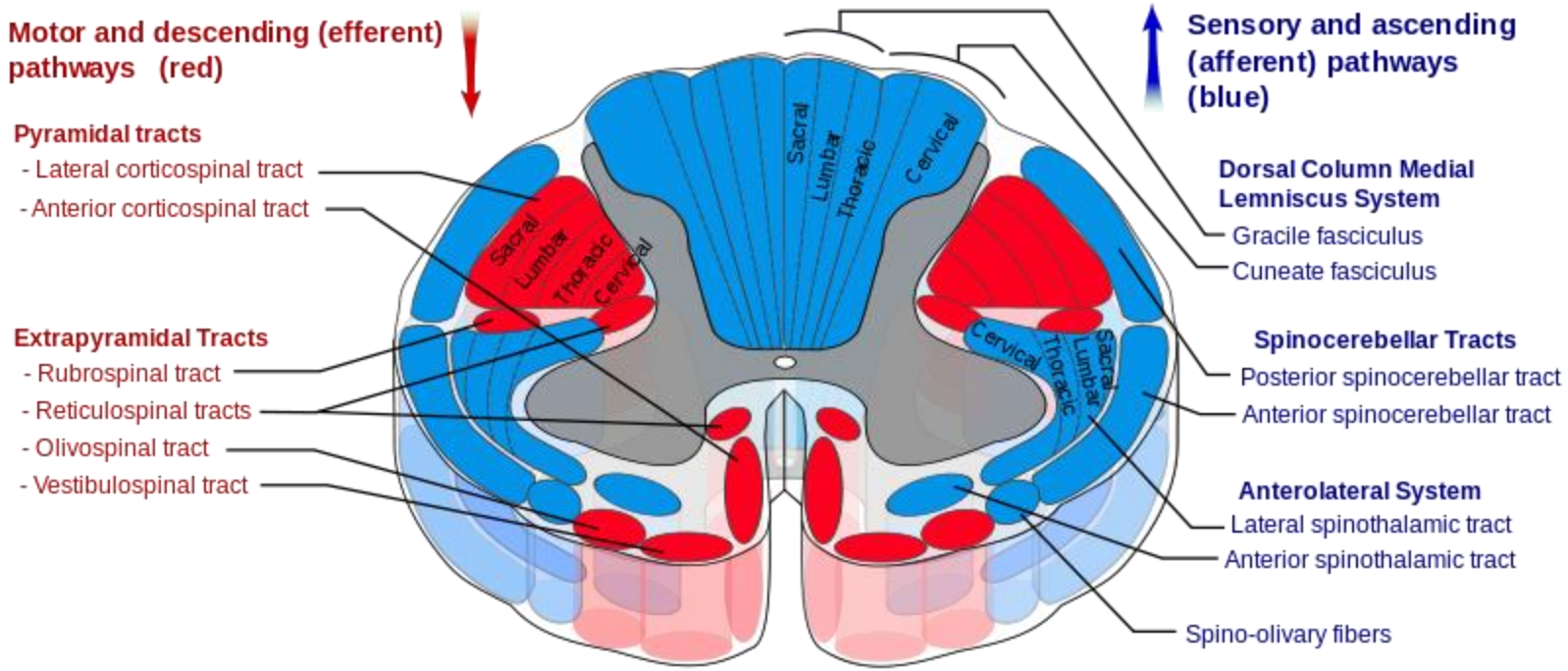
-From vestibular nucleus. fibers originate in vestibular nuclei in pons (which receive inputs from inner ear ,VestibularApparatus and cerebellum)

-Axons descend in the ipsilateral ventral white column of spinal cord

-Functions:-

1- Controls eye movements, postural & righting reflexes.

2-Excitatory to ipsilateral spinal motor neurons-that supply axial & postural muscles


Motor and descending (efferent) pathways (red)
Pyramidal tracts
- Lateral corticospinal tract
- Anterior corticospinal tract
Extrapyramidal Tracts
- Rubrospinal tract
- Reticulospinal tracts
- Olivospinal tract
- Vestibulospinal tract
Sacral
Lumbar
Thoracic
Cervical
Sensory and ascending (afferent) pathways (blue)
Dorsal Column Medial Lemniscus System
Gracile fasciculus
Cuneate fasciculus
Spinocerebellar Tracts
Posterior spinocerebellar tract
Anterior spinocerebellar tract
Anterolateral System
Lateral spinothalamic tract
Anterior spinothalamic tract
Spino-olivary fibers

Functions of Vestibulospinal Tracts

- **The lateral vestibulospinal**

- **Cells of origin : Lateral Vestibular Nucleus**
- **Axons descend in the ipsilateral ventral white column of spinal cord .**
- **This tract mediates excitatory influences upon extensor motor neurones to maintain posture**

- **The medial vestibulospinal tract :**

- **Cells of origin : Medial Vestibular Nucleus**
- **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 for what?**

3- Tectospinat tracts:-

-from superior (VISUAL) & inferior colliculi (AUDITORY) of midbrain

- Ends on **Contralateral cervical motor neurons**

Function: Mediate/facilitate turning of the head in response to visual or Auditory stimuli

4- Reticulospinal Tract :-

-The reticular formation 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

Types of reticulospinal tracts:-

(1) Pontine (Medial) Reticulospinal Tract:

- Cells of origin: Pontine Reticular Formation
- Axons descend in ventral white column of spinal cord
- Axons terminate in ipsilateral spinal motoneurons
- Pontine Reticulospinal Tract increases Gamma efferent activity ,(excitatory = increases muscle tone)

-Exciting anti-gravity, extensor muscles.

(1) Medullary (Lateral) Reticulospinal Tract:

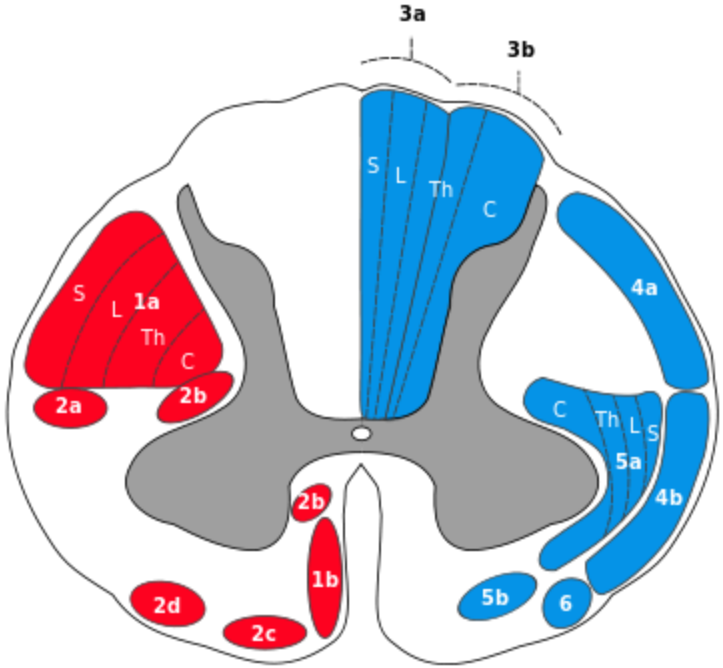
- Cells of origin: Medullary Reticular Formation
- Axons descend in ventral white column of spinal cord on both sides

- Axons terminate in ipsilateral & contralateral ventral horn cells of spinal cord
- Medullary Reticulospinal Tract, inhibits Gamma efferent activity (inhibitory= decreases muscle tone).

- -Inhibiting anti-gravity, extensor muscles

5-Olivospinal Tract :- It arises from inferior olivary N of the medulla & is found only in the cervical region of the spinal cord (supply neck muscles) of unknown function

(**intermediate pathway in the strio-olivo-spinal connections)**



Motor and decending (efferent) pathways (left, red)

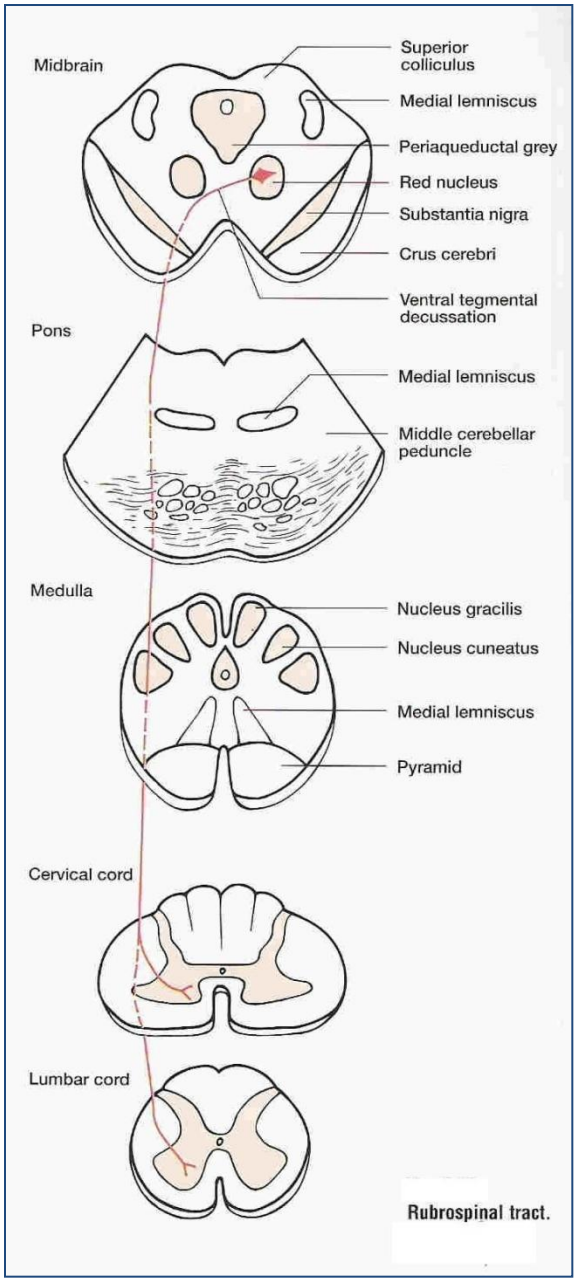
1. Pyramidal Tracts
1a. Lateral corticospinal tract
1b. Anterior corticospinal tract
2. Extrapyramidal Tracts
2a. Rubrospinal tract
2b. Reticulospinal tract
2c. Vestibulospinal tract
2d. Olivospinal tract

Somatotopy Abbreviations:
S: Sacral, **L: Lumbar**
Th: Thoracic, **C: Cervical**

Sensory and ascending (afferent) pathways (right, blue)

3. Dorsal Column Medial Lemniscus System
3a. Gracile fasciculus
3b. Cuneate fasciculus
4. Spinocerebellar Tracts
4a. Posterior spinocerebellar tract
4b. Anterior spinocerebellar tract
5. Anterolateral System
5a. Lateral spinothalamic tract
5b. Anterior spinothalamic tract

6. Spino-olivary fibers



Red Nucleus in Midbrain

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Decussation at the level of red nucleus

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Pass down through Pons & Medulla

↓

Ends in ant. Horn of spinal cord

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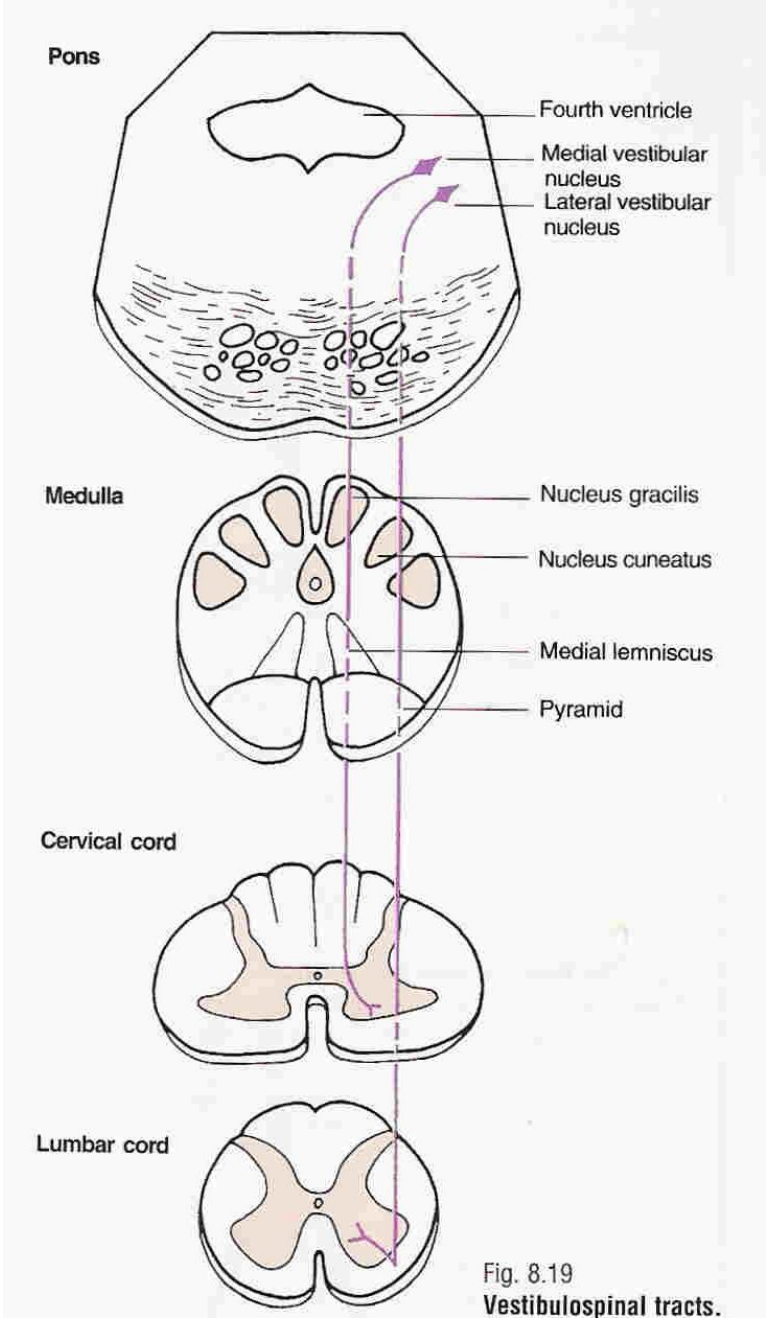

Fig. 8.19
Vestibulospinal tracts.

Afferent from cerebellum, vestibular apparatus & vestibular nuclei

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Spinal motor neuron

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Innervating axial & postural muscles

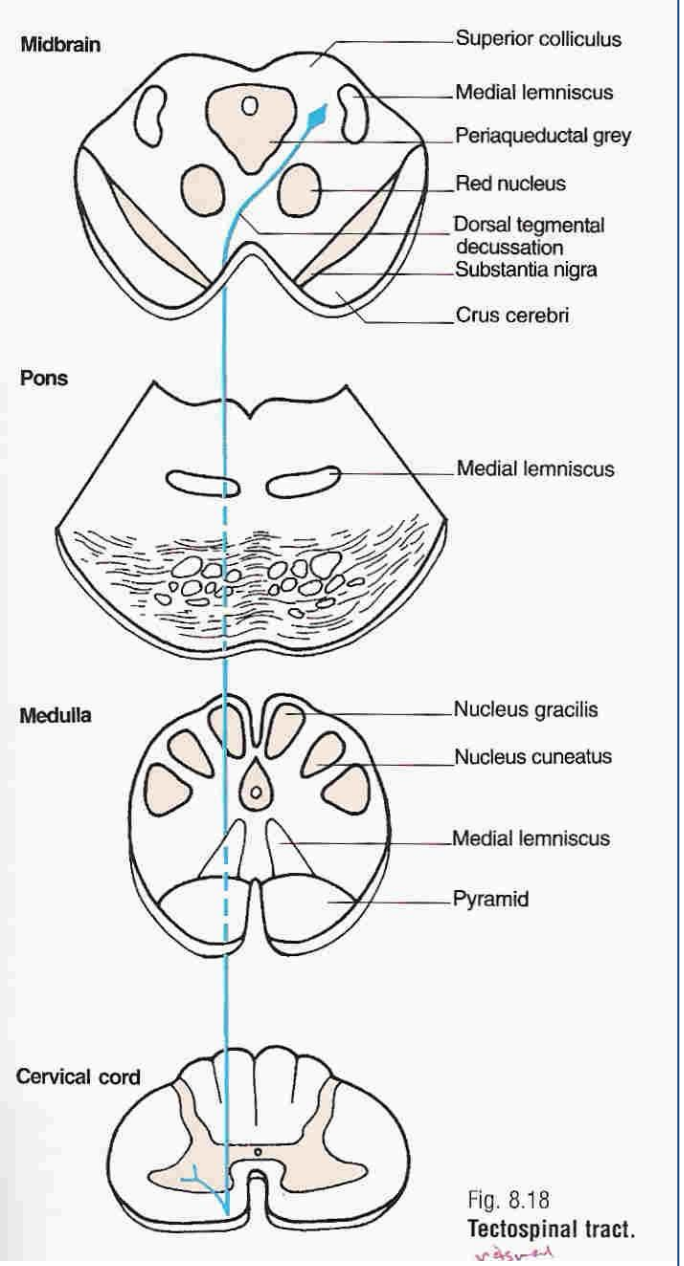

Fig. 8.18
Tectospinal tract.

Superior & Inferior collicili in midbrain>>>>>

Near Medial longitudinal fasiculus>>>>

Cervical spinal motor neuron of anterior horn