Physiology of Motor Tracts

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

2012

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 activates 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-Pyramidal tracts = Corticospinal & 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

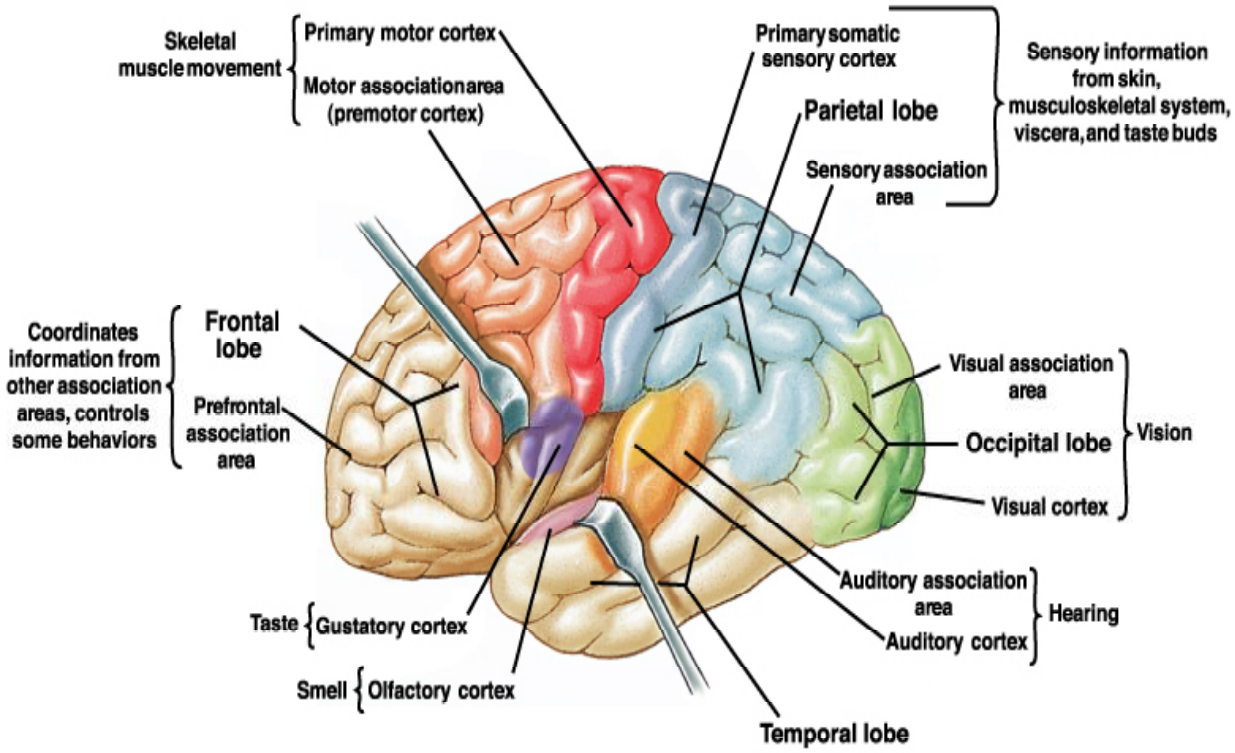
- Premotor area:- (motor association area) lies in front of the primary motor area & below supplementary motor area.

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

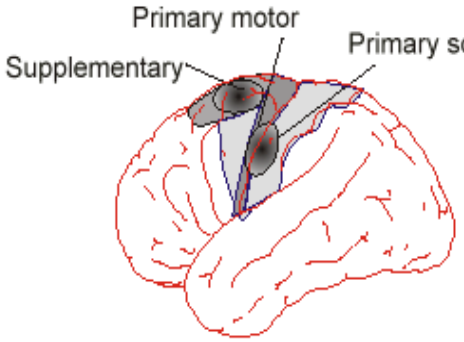
- Supplemetary cortex is a small area located on the lateral side of the brain in front of area 4 and above the pre-motor area & extends on medial side of the cerebral hemisphere.

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

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

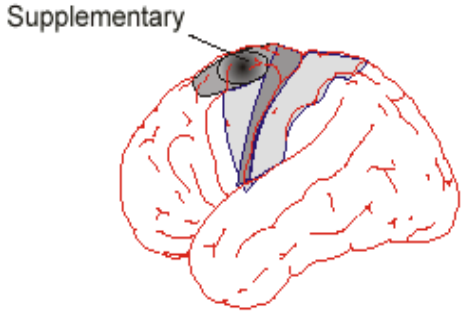
b) When the subject makes a complex finger movement sequence, such as opposing thumb with each finger in turn, activity is seen in the finger area of the primary motor cortex, the primary somatic sensory cortex, and the supplementary motor area.



Supplementary activity seen when making a sequence with either hand (as apposed to primary motor activity which is always contra lateral).

This bilateral activity is useful in movements that require both hands eg tying one's shoe laces.

c) When the subject imagines the complex finger movement sequence, activity is seen only in the supplementary motor area.



CONT//

- **3% of the pyramidal fibres are large myelinated, derived from the large , 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 Corticobulbar tract terminates on LMNs - (AHCs = cranial nerve nuclei of opposite side)-

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

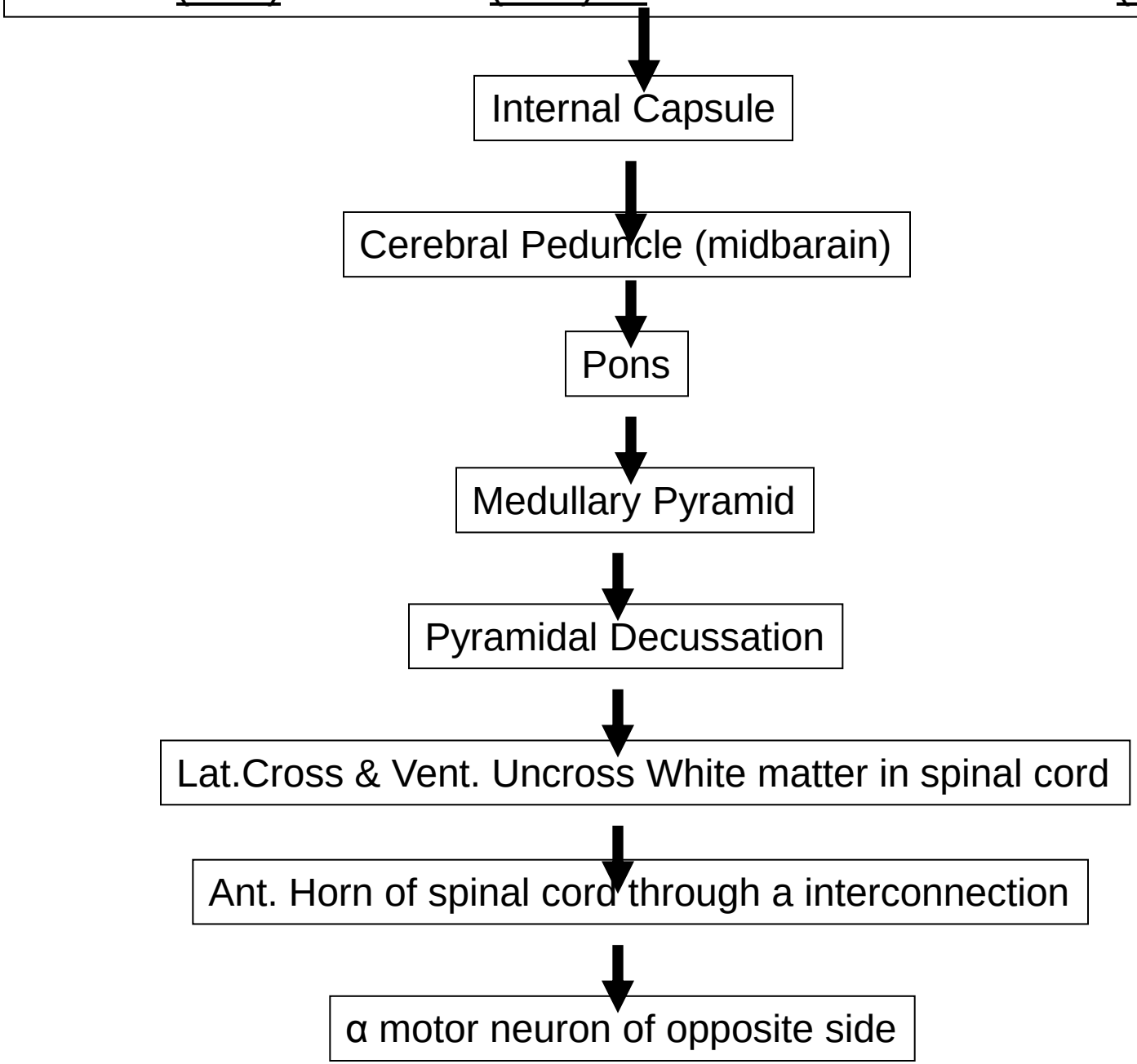
•

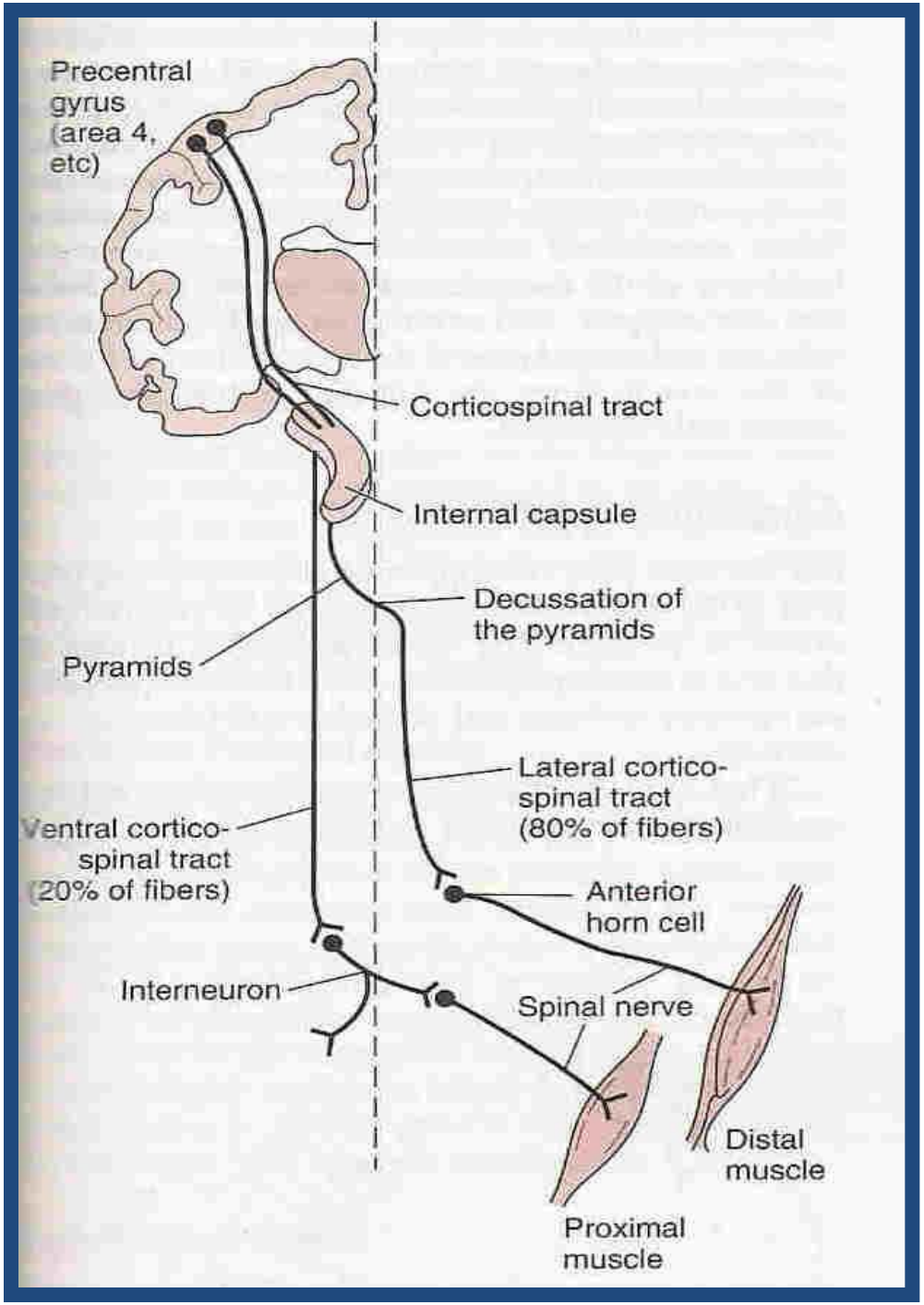
- In the lower medulla oblongata the fibers form pyramids so called pyramidal tract which divide into:-

.

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

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




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 so control distal limb muscles, so control fine skilled movements.

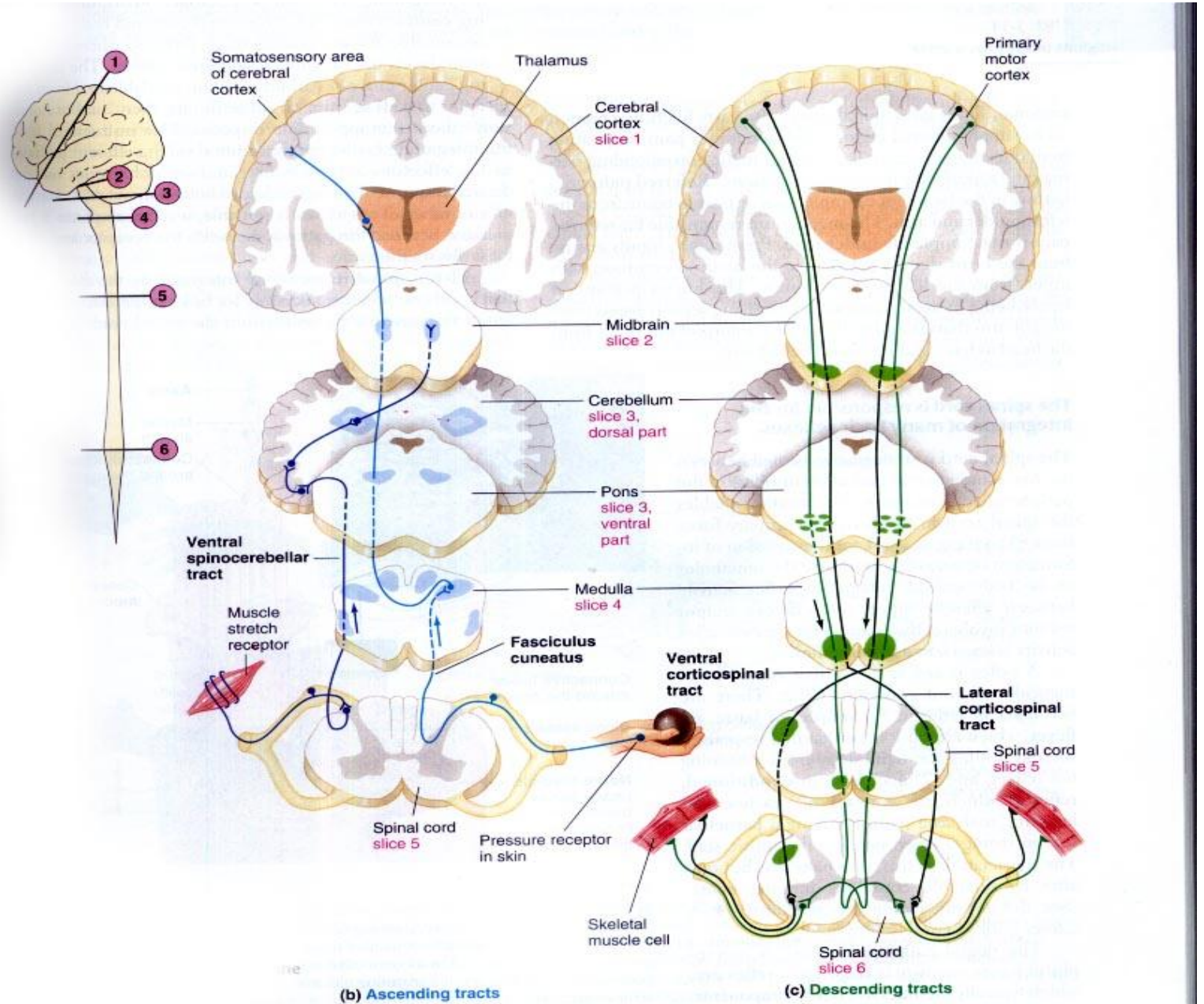
2- ventral (anterior) corticospinal tracts :-

-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 axial & proximal limb muscles & control posture

NB/So each corticospinal tract 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 skilled voluntary movements .(on which side?)

2- lateral corticospinal tracts (main bulk of the tract) control distal muscles of limb as fingers & thumb which concerned with fine skilled movement) e.g Painting ,writing, picking up of a small object etc.

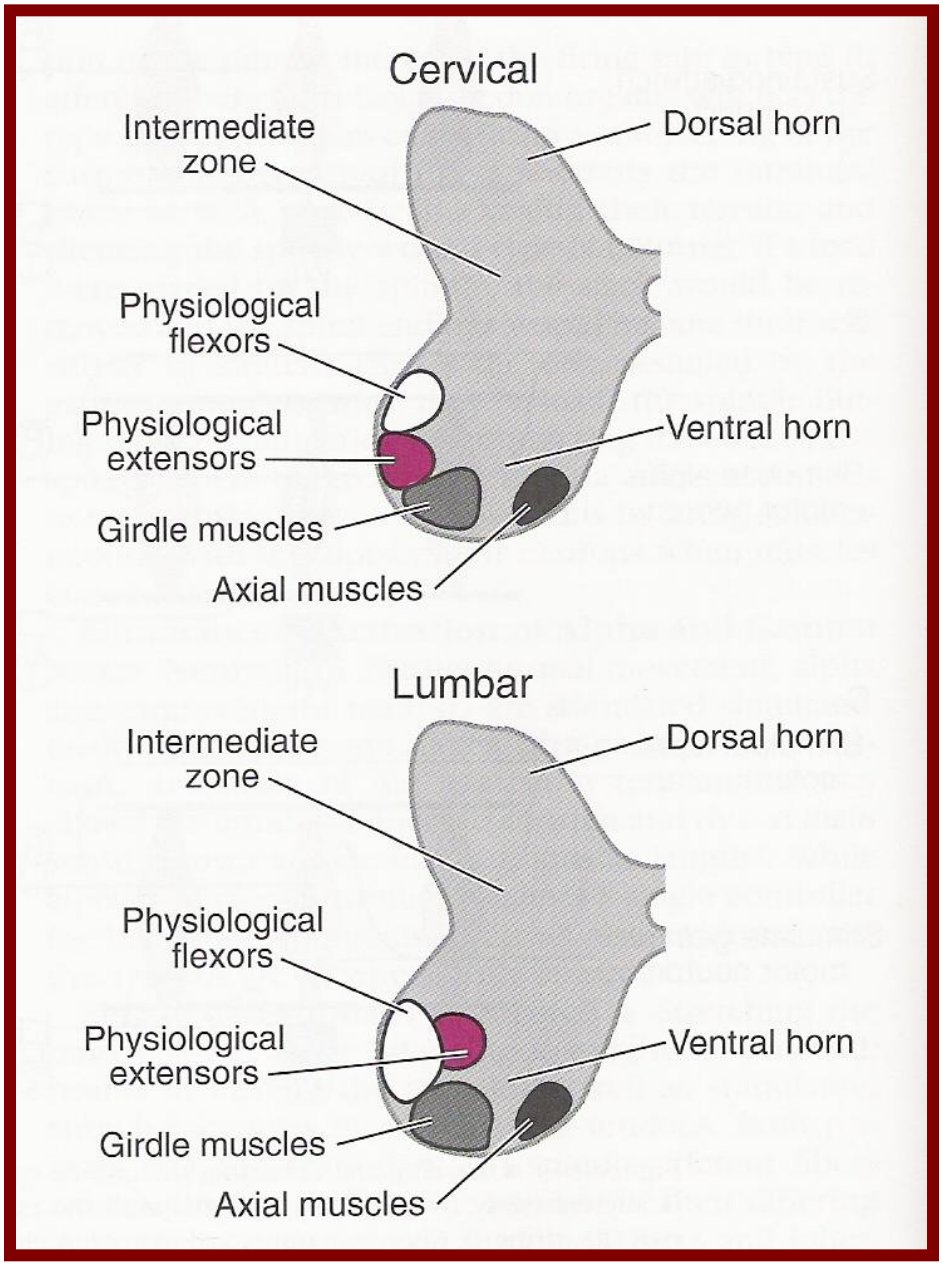
3- Ventral corticospinal tracts control posture of axial & proximal muscle for balance, climbing, walking

4- Effect on stretch reflex:-

- Faccilitate muscle tone through gamma motor neurons

5- those fibers originate from parietal lobe are for sensory-motor coordination

6- corticobulbar tracts /control face & neck muscles & faccilitate their tone


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. 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 Postural & righting reflexes.

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

3- Control eye movements.

Functions of Vestibulospinal Tracts

- **The lateral vestibulospinal**

- **Cells of origin : Lateral Vestibular Nucleus**
- **Axons desend 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 that link vestibular nuclei to nuclei supplying the extra-ocular muscles for coordination of head and eye movements**

3- Tectospinat tracts:-

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

- Ends on **Contralateral cervical motoneurons**

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:

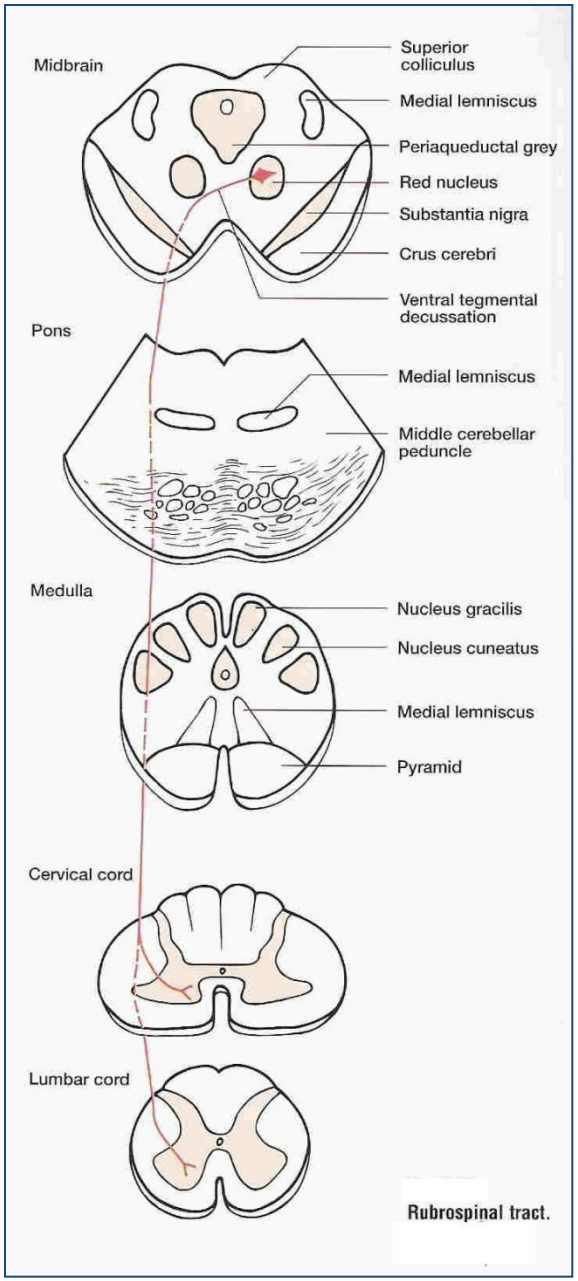
- Cells of origin: Pontine Reticular Formation
- Axons descend in ventral white column of spinal cord
- Axons terminate in ipsilateral spinal motoneurons
- Pontine Reticulospinal Tract increases Gamma efferent activity ,(excitatory = increases muscle tone)

(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) .

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



Red Nucleus in Midbrain

↓

Decussation at the level of red nucleus

↓

Pass down through Pons & Medulla

↓

Ends in ant. Horn of spinal cord

↓

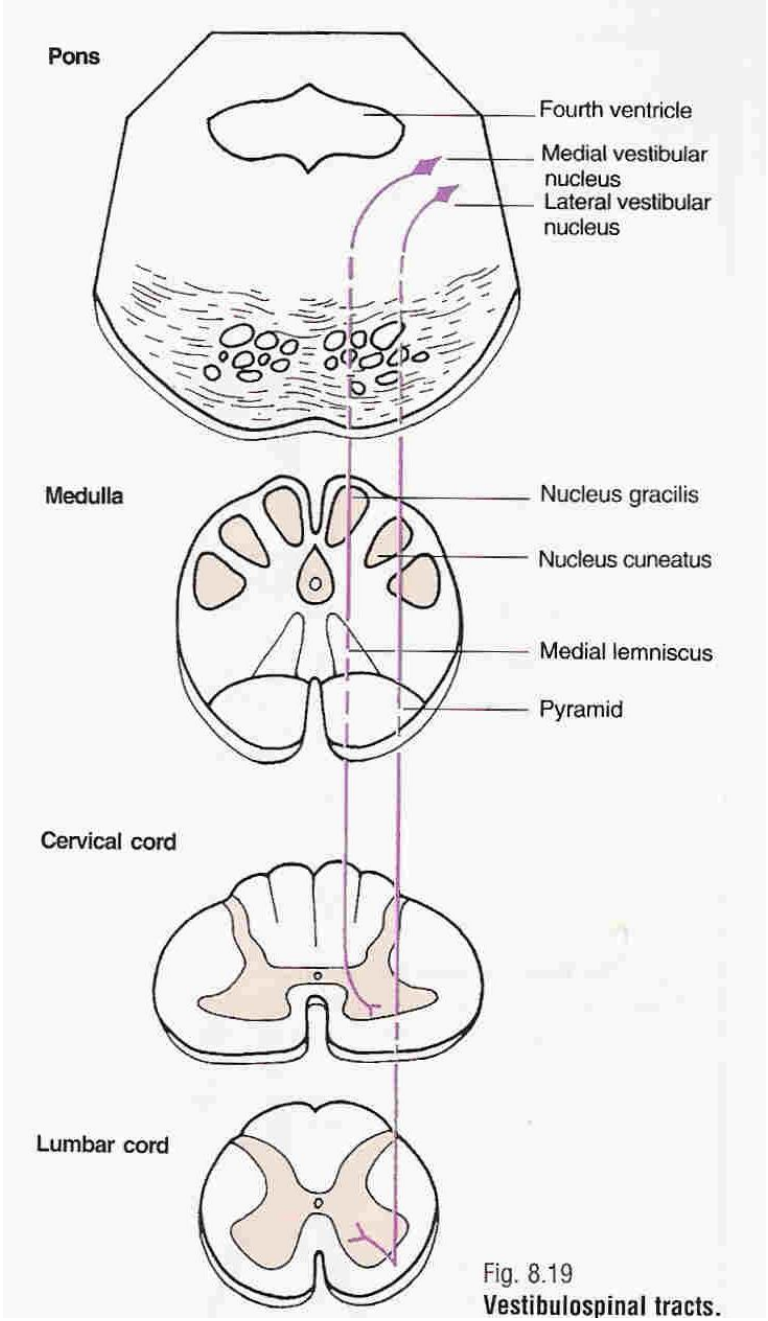


Fig. 8.19
Vestibulospinal tracts.

Afferent from cerebellum, vestibular apparatus & vestibular nuclei

↓

Spinal motor neuron

↓

Innervating axial & postural muscles

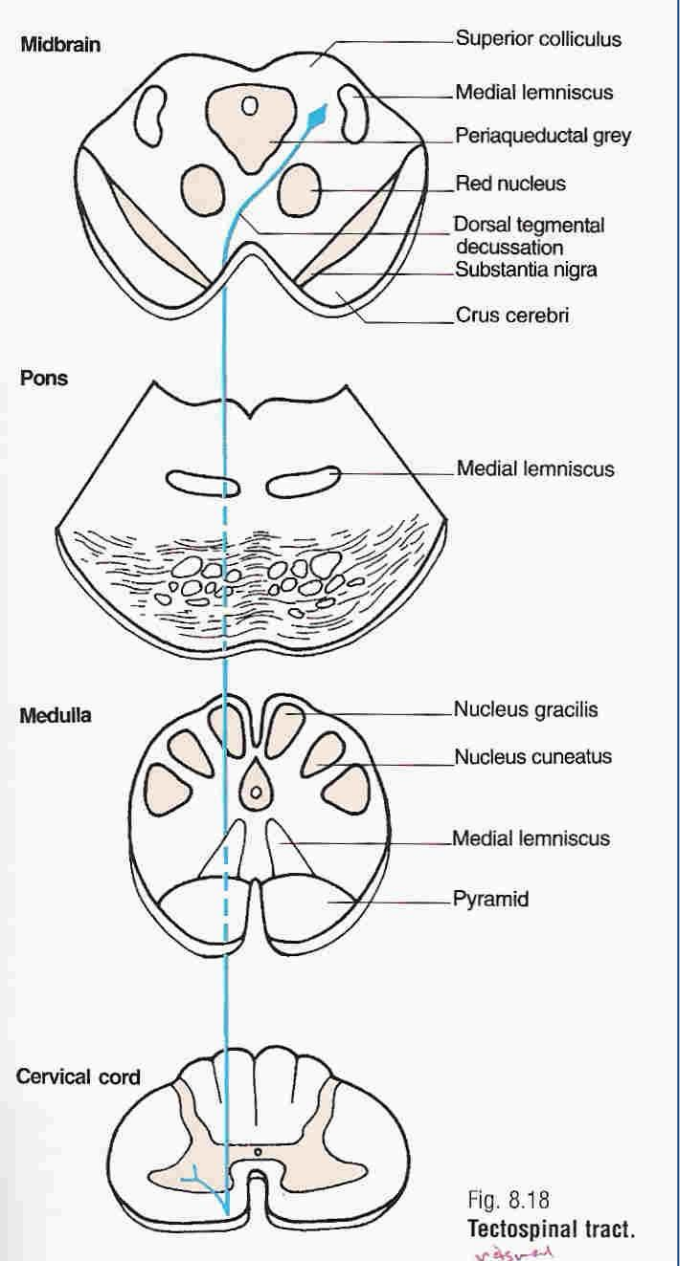


Fig. 8.18
Tectospinal tract.

Superior & Inferior collicili in midbrain>>>>>

Near Medial longitudinal fasiculus>>>>

Cervical spinal motor neuron of anterior horn