Motor System

Dr. zaineb Adil

Physiology Department

College of Medicine\ University of Basrah

Lecture 3 motor cortex
Objectives

1. What is motor cortex
2. Main Motor cortex areas
3. Some specialized areas of motor cortex.

- The motor cortex is the region of the cerebral cortex involved in the planning, control, and execution of voluntary movements.

Motor Cortex

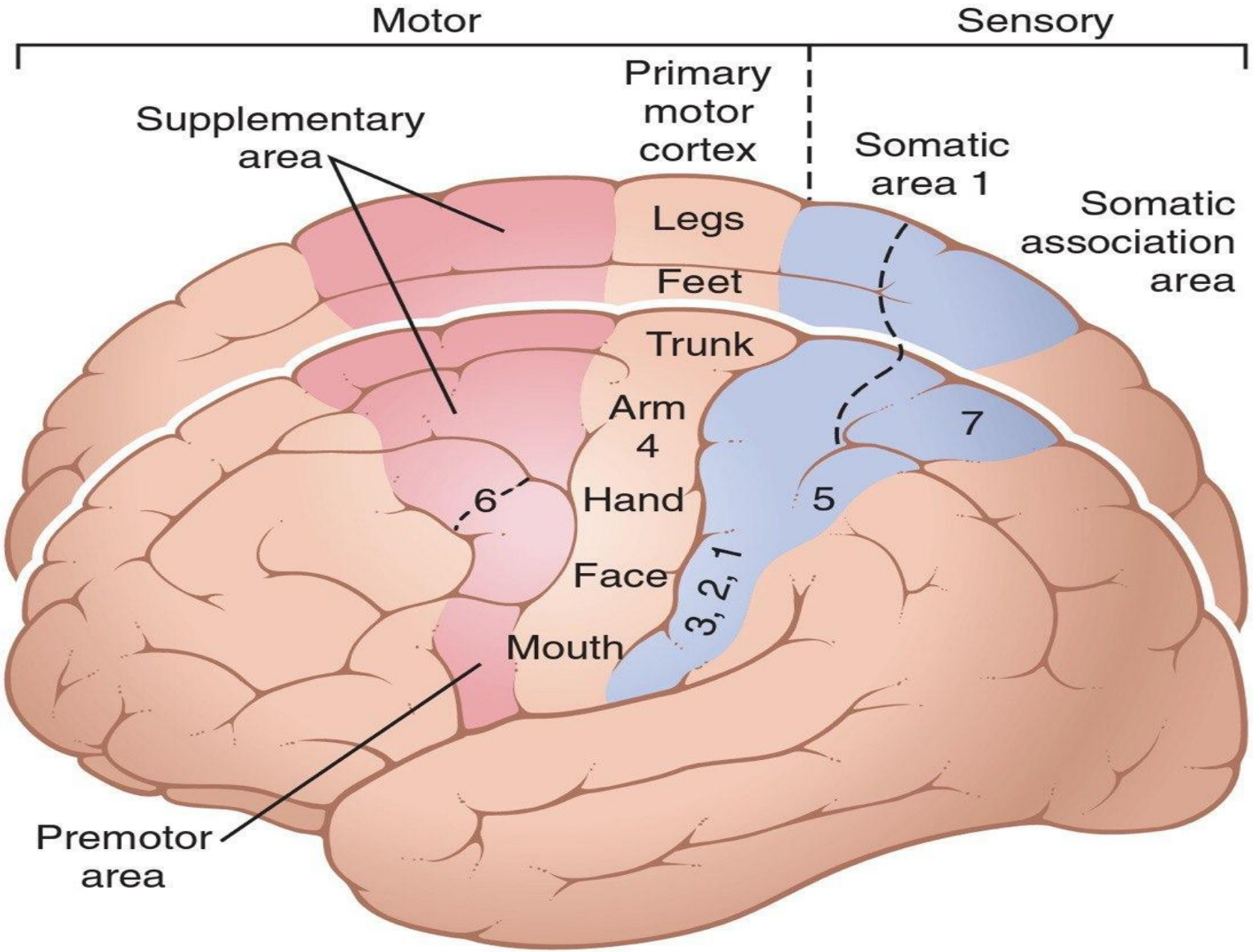
- Anterior to the central cortical sulcus, occupying approximately the posterior one third of the frontal lobes,

It divided in to 3 Areas:

1)primary motor cortex

2)premotor area

3)supplementary motor area

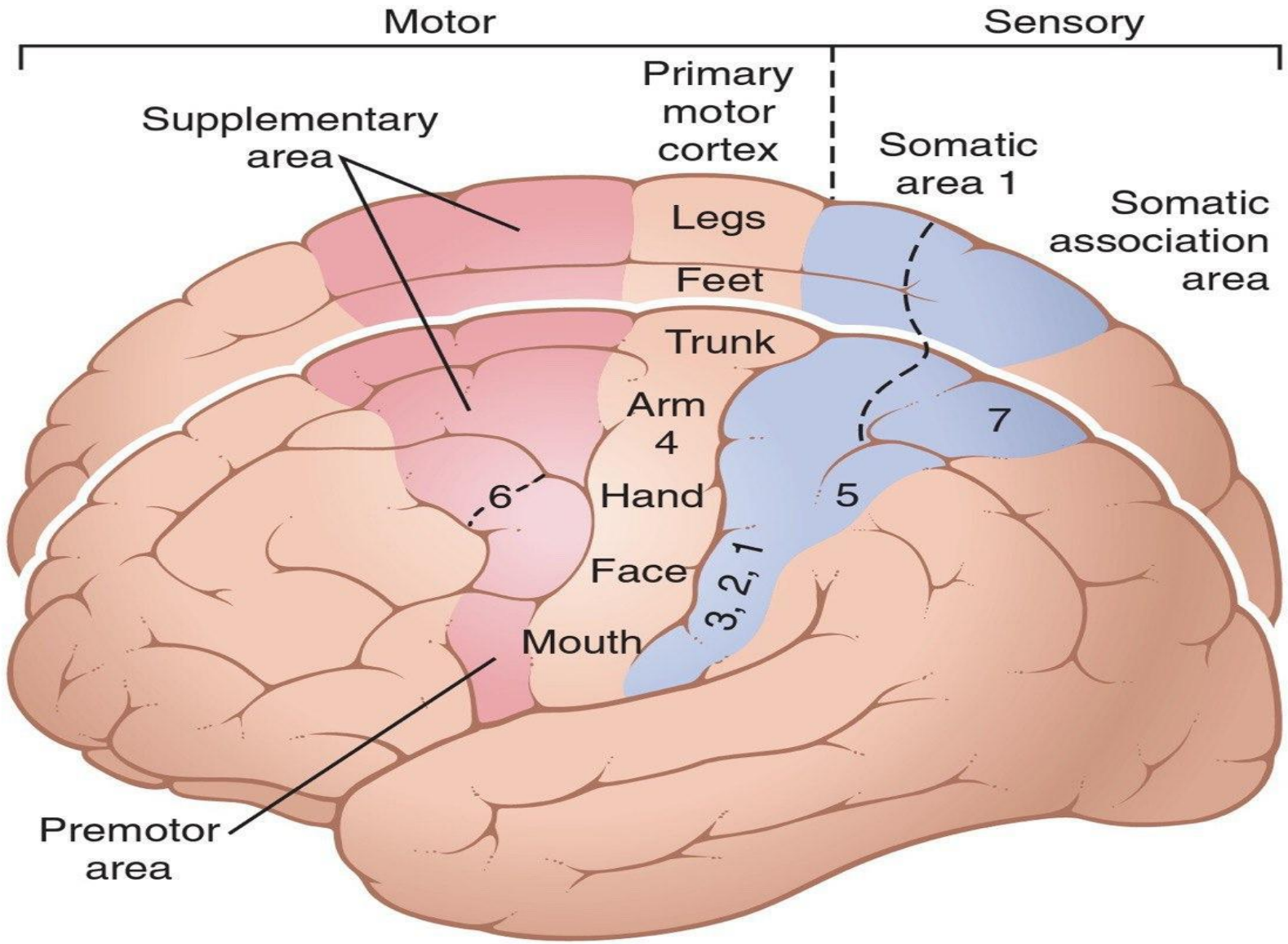

Motor
Sensory
Primary motor cortex
Supplementary area
Somatic area 1
Somatic association area
Legs
Feet
Trunk
Arm
4
Hand
Face
Mouth
6
7
5
3, 2, 1
Premotor area

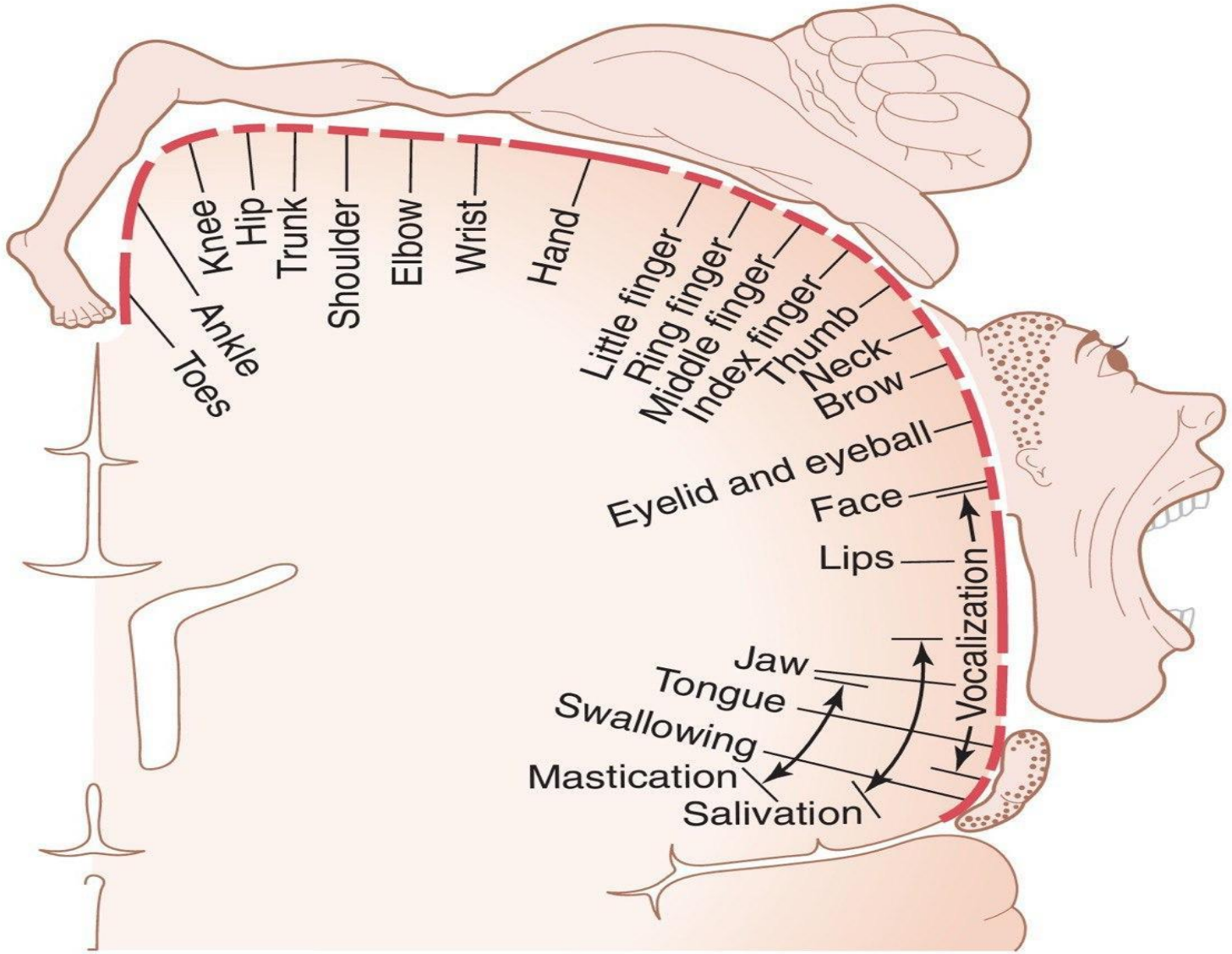
- Each has its own topographical representation of muscle groups and specific motor functions of the body.

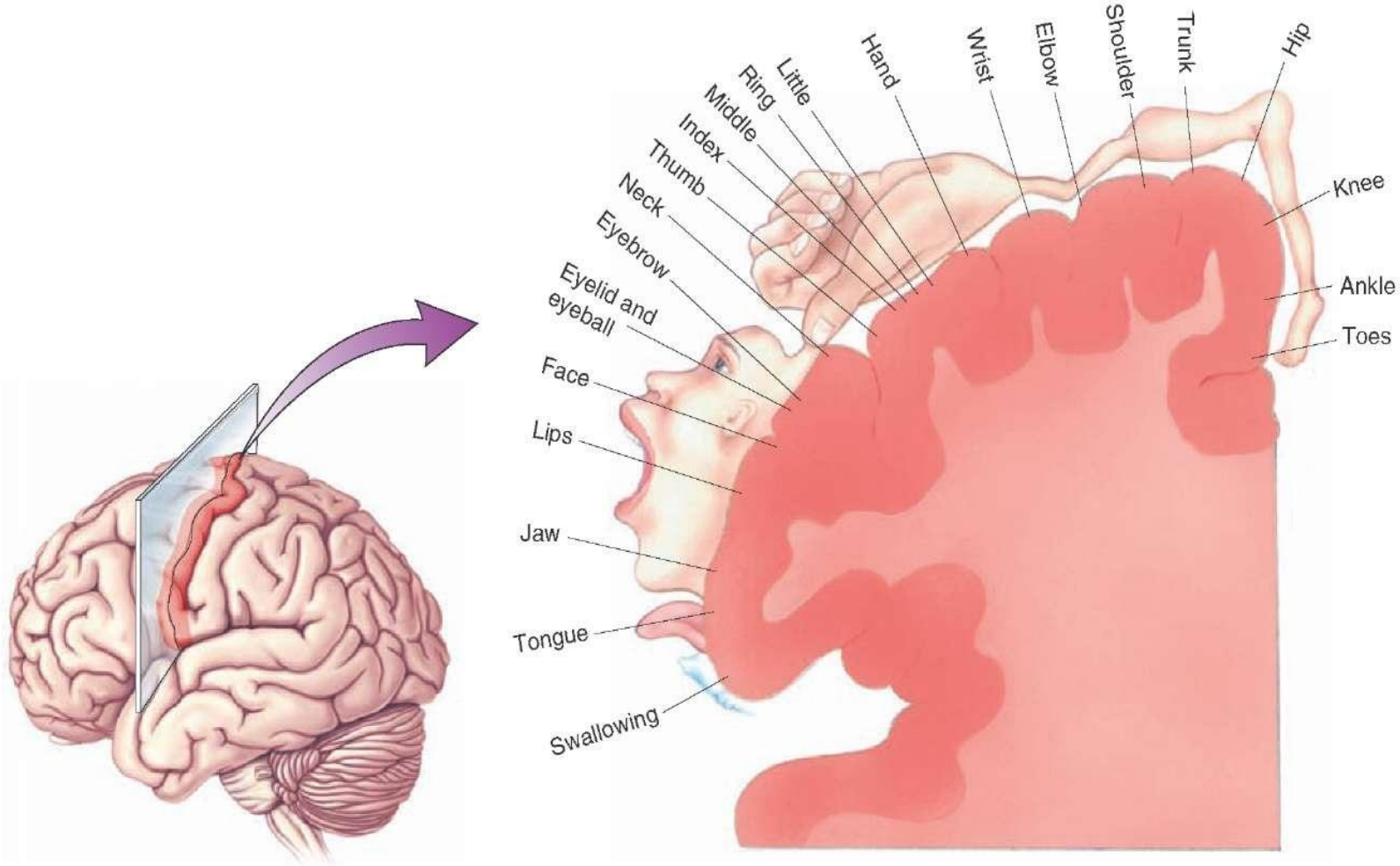
PRIMARY MOTOR CORTEX

- lies in the first convolution of the frontal lobes anterior to the central sulcus

- topographical representations of the different muscle areas of the body in the primary motor cortex


Motor
Sensory
Primary motor cortex
Supplementary area
Somatic area 1
Somatic association area
Legs
Feet
Trunk
Arm
Hand
Face
Mouth
4
6
7
5
3, 2, 1
Premotor area


Toes
Ankle
Knee
Hip
Trunk
Shoulder
Elbow
Wrist
Hand
Little finger
Ring finger
Middle finger
Index finger
Thumb
Neck
Brow
Eyelid and eyeball
Face
Lips
Jaw
Tongue
Swallowing
Mastication
Salivation
Vocalization

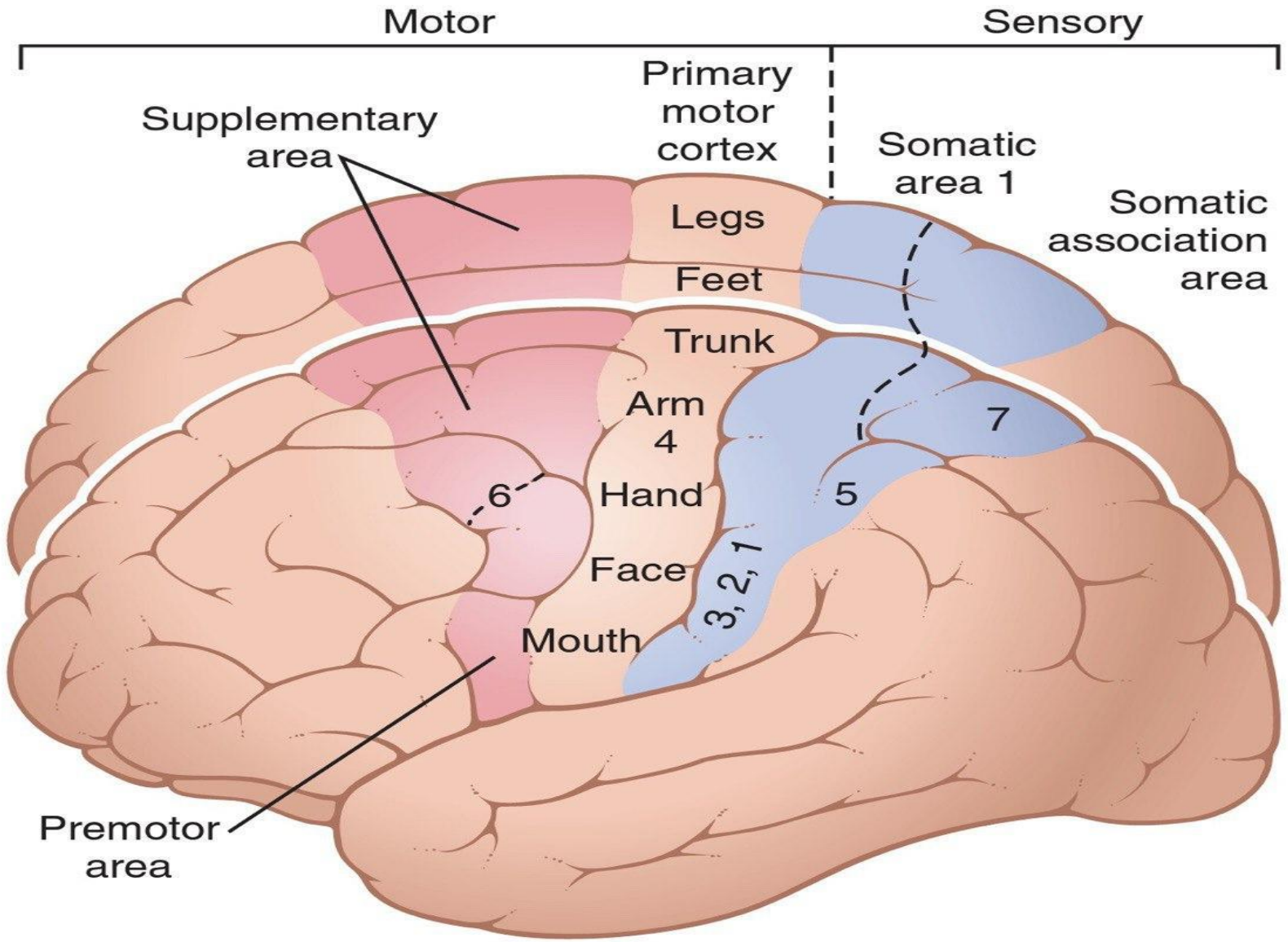

Hip
Trunk
Shoulder
Elbow
Wrist
Hand
Little
Ring
Middle
Index
Thumb
Neck
Eyebrow
Eyelid and eyeball
Face
Lips
Jaw
Tongue
Swallowing
Knee
Ankle
Toes

- Note that more than one half of the entire primary motor cortex is concerned with controlling the muscles of the hands and the muscles of speech.

- excitation of a single motor cortex neuron usually excites a specific movement rather than one specific muscle.

PREMOTOR AREA

- lies 1 to 3 centimeters anterior to the primary motor cortex.


Motor
Sensory
Primary motor cortex
Supplementary area
Somatic area 1
Somatic association area
Legs
Feet
Trunk
Arm
Hand
Face
Mouth
4
6
7
5
3, 2, 1
Premotor area

- The topographical organization of the premotor cortex is roughly the same as that of the primary motor cortex, with the mouth and face areas located most laterally.

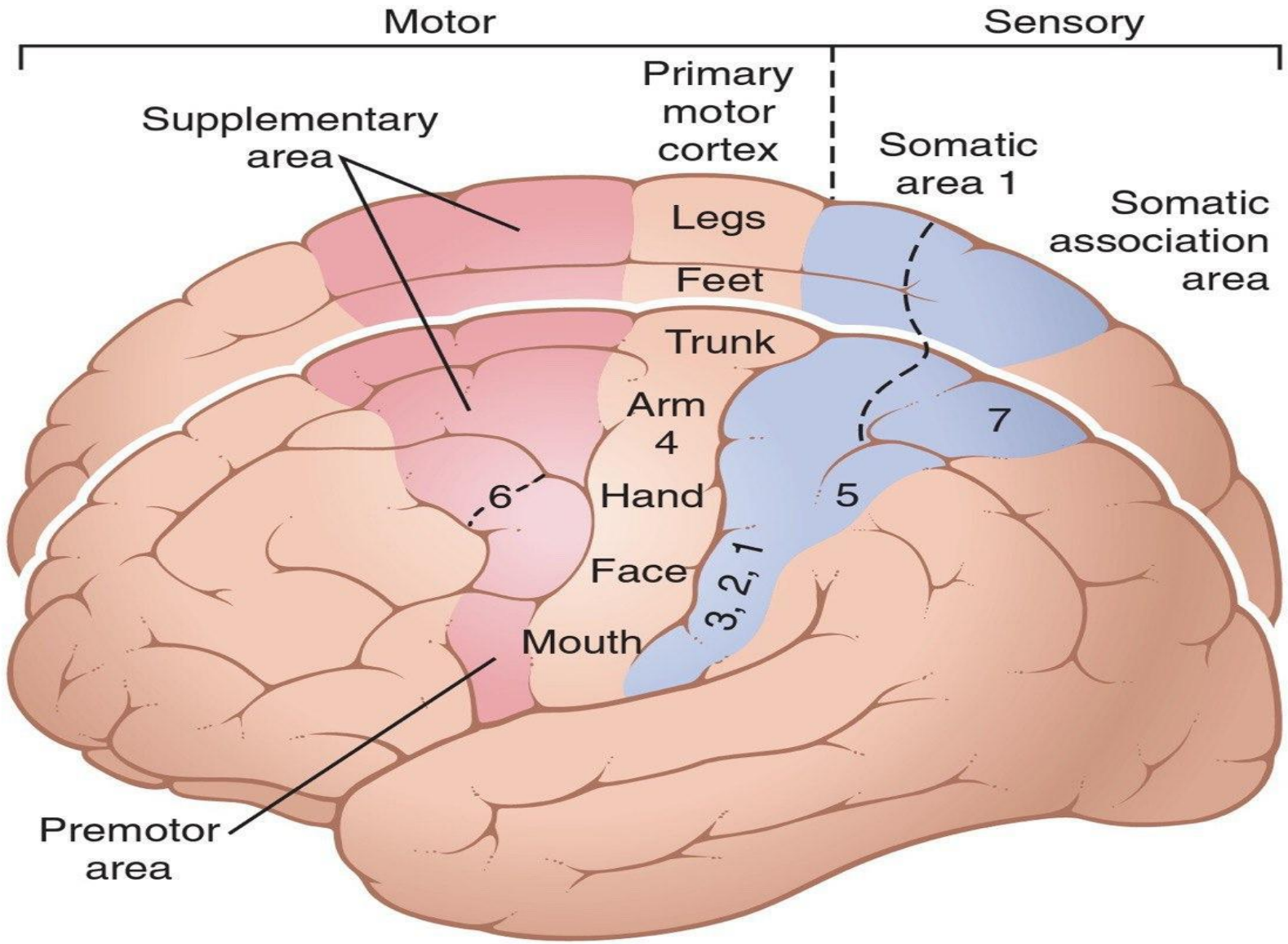
- Nerve signals generated in the premotor area cause much more complex “patterns” of movement than the that generated in the primary motor cortex.

- For instance, the pattern may be to position the shoulders and arms so that the hands are properly oriented to perform specific tasks.

SUPPLEMENTARY MOTOR AREA

- It extends a few centimeters onto the superior frontal cortex.

- The supplementary motor area has yet another topographical organization for the control of motor function.

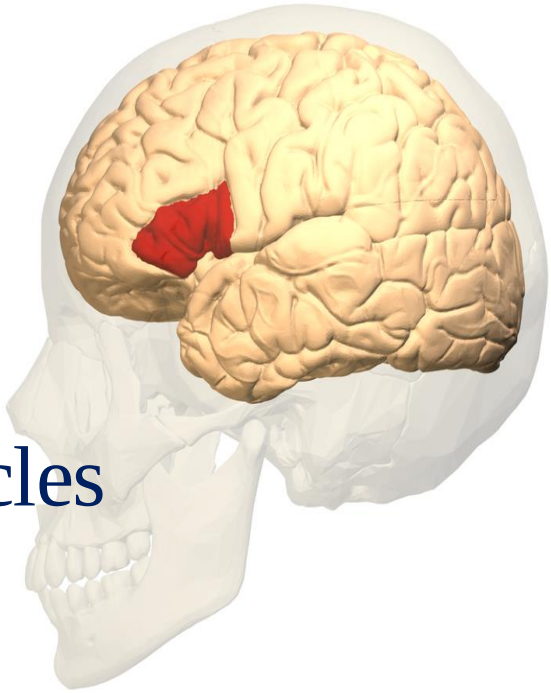

Motor
Sensory
Primary motor cortex
Supplementary area
Somatic area 1
Somatic association area
Legs
Feet
Trunk
Arm
Hand
Face
Mouth
4
6
7
5
3, 2, 1
Premotor area

.this area functions in concert with the premotor area to provide body-wide attitudinal movements, fixation movements of the different segments of the body, positional movements of the head and eyes.

SOME SPECIALIZED AREAS OF MOTOR CONTROL FOUND IN THE HUMAN MOTOR CORTEX

- control specific motor functions.

Broca's Area (Motor Speech Area)



It's the site for expression of words by exciting simultaneously the laryngeal muscle, respiratory muscles and muscles of the mouth.

Damage to this area → **motor aphasia**

Damage to this area does not prevent a person from vocalizing, but it does make it impossible for the person to speak whole words.

Voluntary” Eye Movement Field

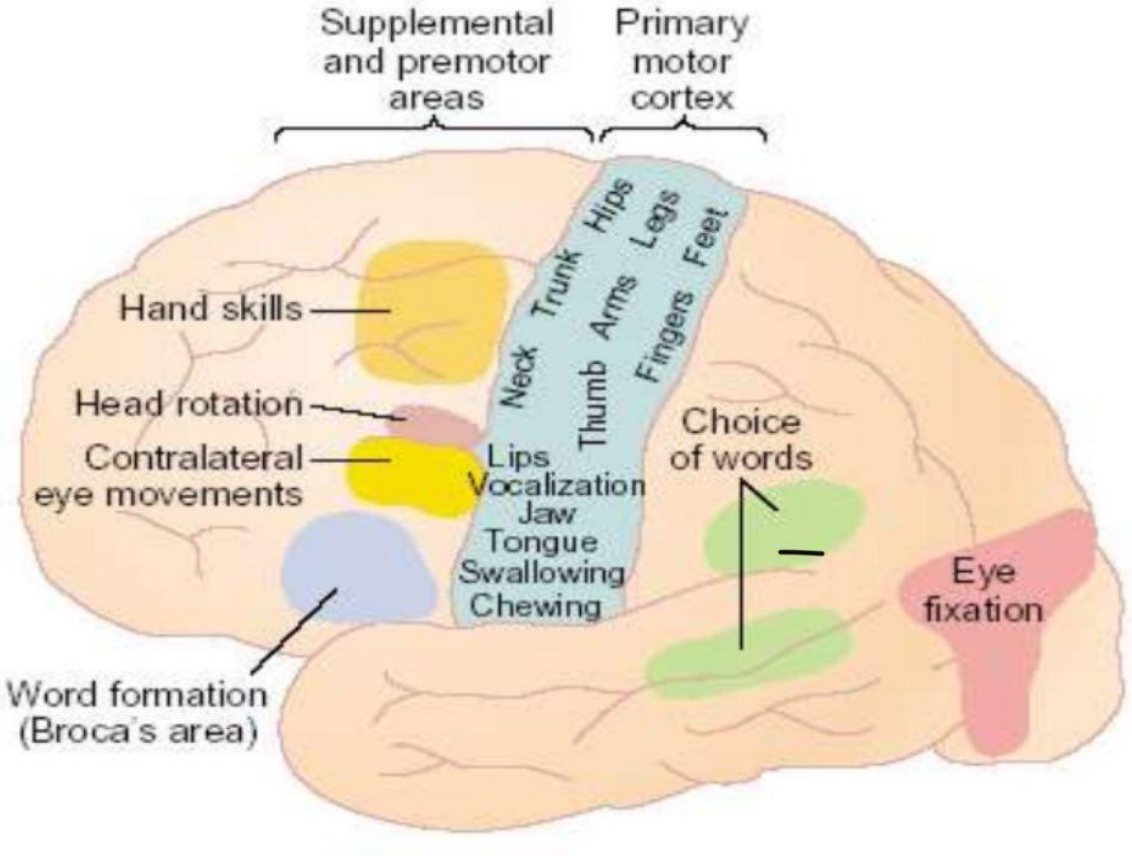
In the premotor area immediately above Broca’s area

a locus for controlling voluntary eye movements.

Damage to this area prevents a person from voluntarily moving the eyes toward different objects.

Head rotation area

Its closely associated with eye movement field and related to directing the head toward different objects.



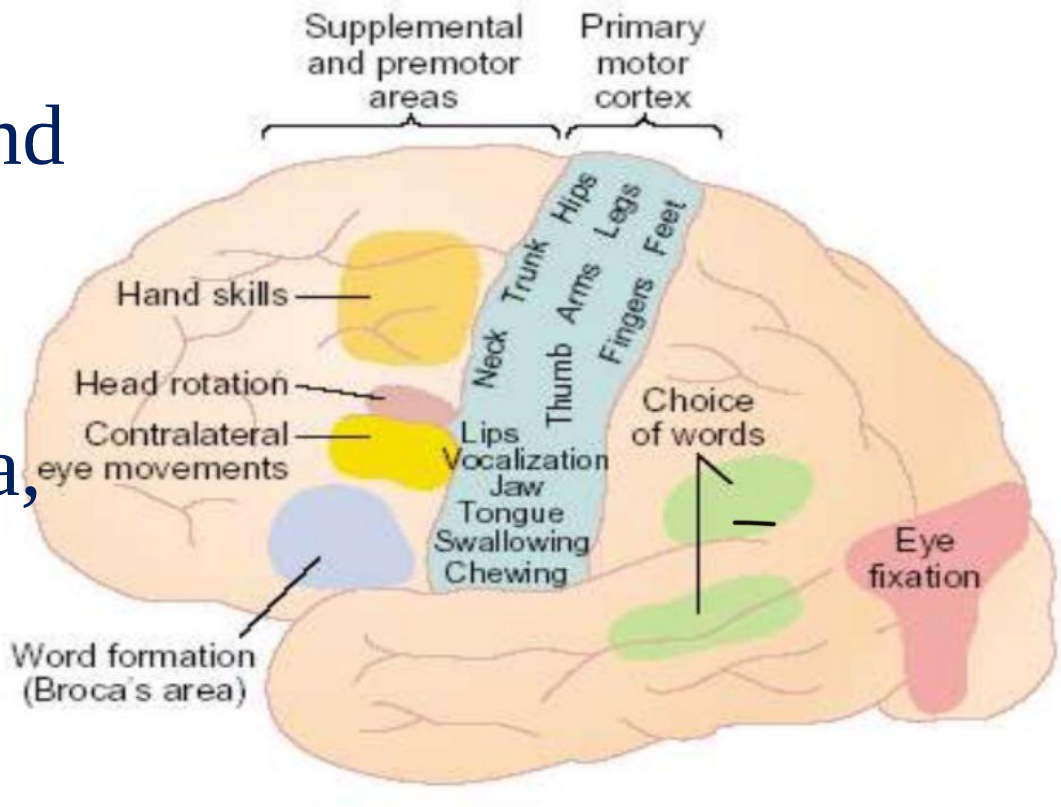
Area for hand skills

In the premotor area .

Is a region that is important for “hand skills.”

lesions cause destruction in this area, hand movements become uncoordinated and non purposeful,

a condition called **motor apraxia**



Recap

- Motor cortex: Anterior to the central cortical sulcus, occupying approximately the posterior one third of the frontal lobes.
- PRIMARY MOTOR CORTEX,
- PREMOTOR AREA
- SUPPLEMENTARY MOTOR AREA
- Broca's Area (Motor Speech Area): expression of words.
- Voluntary" Eye Movement Field: controlling voluntary eye movements.
- Head rotation area: eye movement field and related to directing the head.
- Area for hand skills(control hand movement).

Lecture 4 transmission of motor signals

Objectives

- Direct: Pyramidal pathway.
- Pyramidal pathway fibers.
- The pathway from motor cortex down to muscle.
- Indirect : extrapyramidal tract : Red nucleus

Motor signals are transmitted

- Directly from the cortex to the spinal cord through the corticospinal tract **(Pyramidal)**

- Indirectly through multiple accessory pathways that involve the basal ganglia, cerebellum, and various nuclei of the brain stem *(* **Extrapyramidal)**

Corticospinal (Pyramidal) Tract

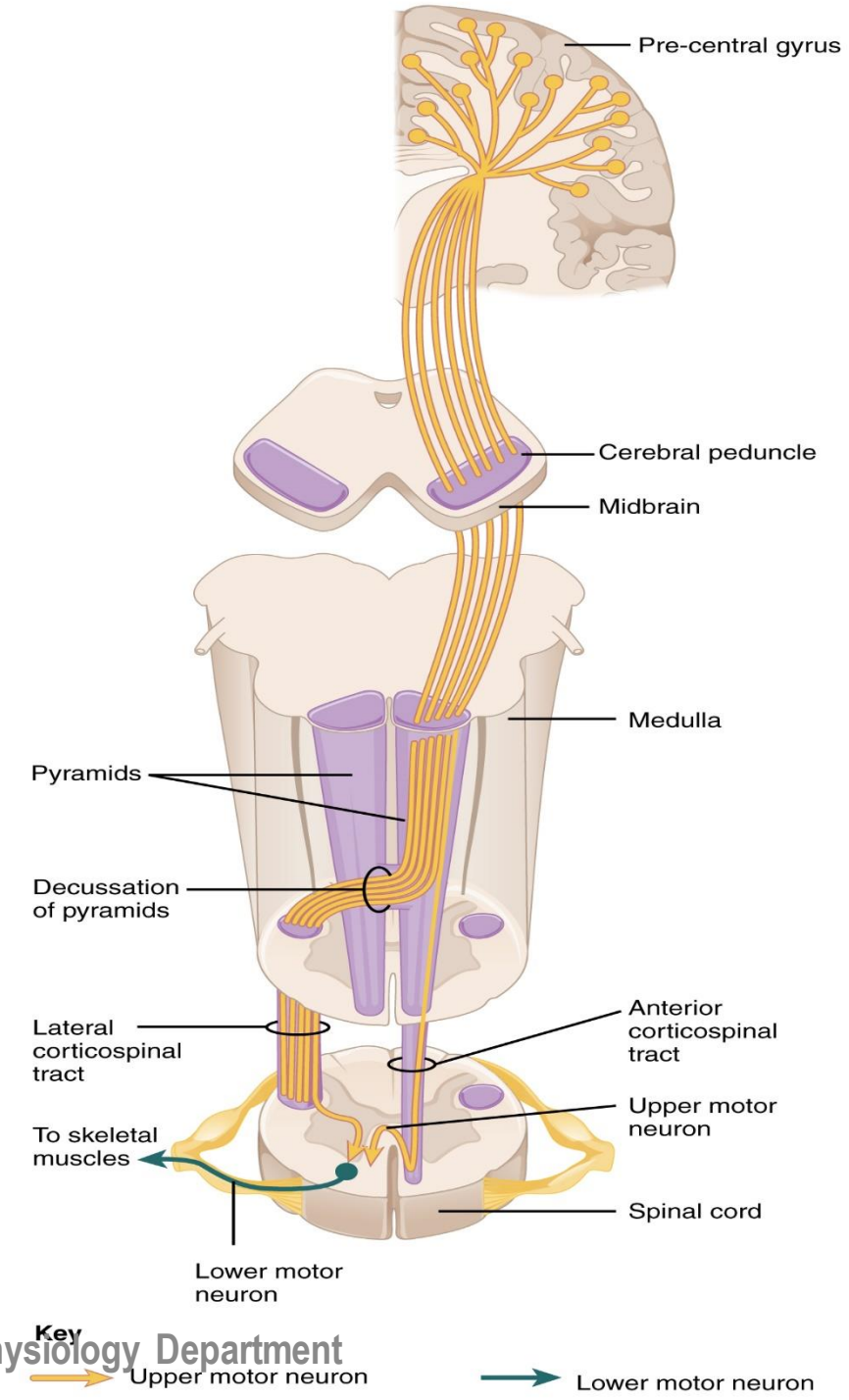
- The most important output pathway from the motor cortex

- Its originates about:
- 30 percent from the primary motor cortex
- 30 percent from the premotor and supplementary motor areas
- and 40 percent from the somatosensory areas posterior to the central sulcus.

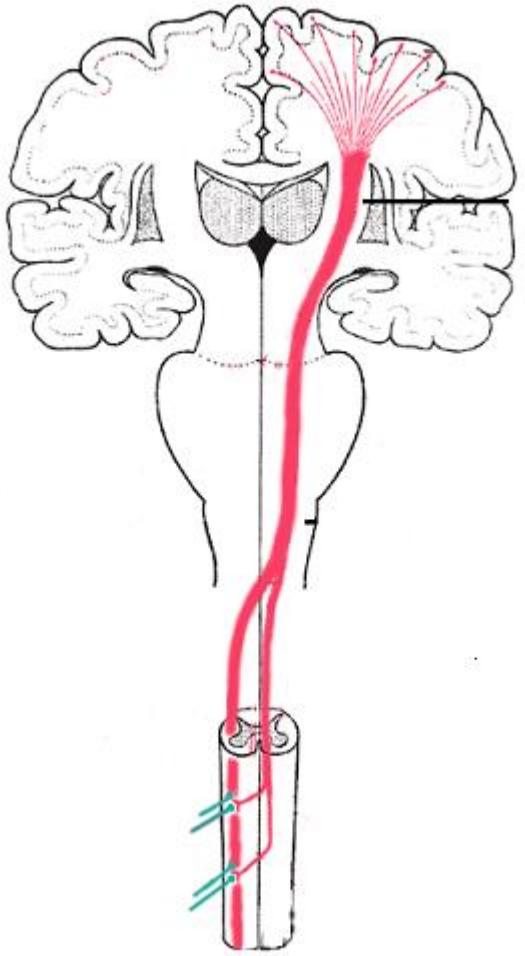
Pyramidal tract fibers

- Large fibers (3%)
- 16 μm in diameter
- originating from Betz cells
- Faster conduction (70m/sec)
- Ends directly in the α motor neuron

- Other fibers (97%)
- 4μm in diameter
- Slower conduction
- Synapse with interneurons which in turn synapse with α or γ motor neuron.

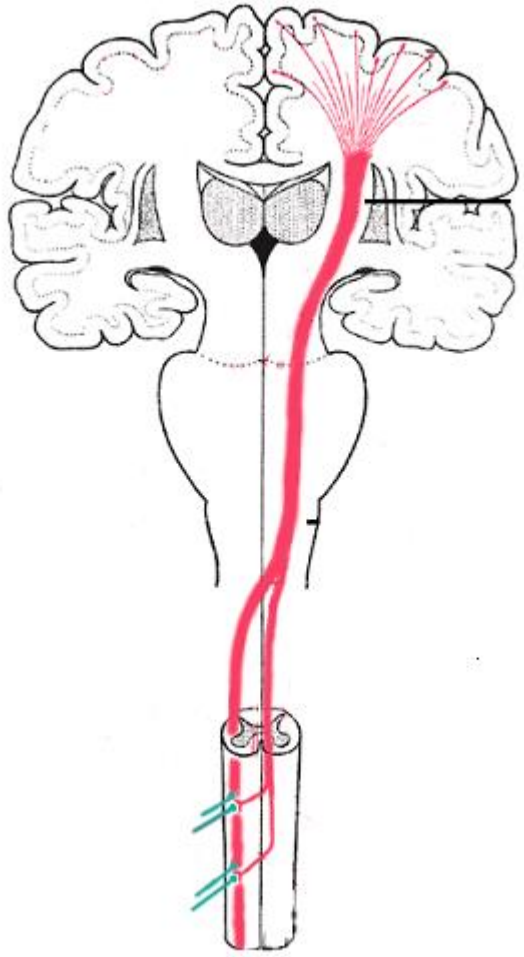

Pre-central gyrus
Cerebral peduncle
Midbrain
Medulla
Pyramids
Decussation of pyramids
Lateral corticospinal tract
Anterior corticospinal tract
Upper motor neuron
To skeletal muscles
Spinal cord
Lower motor neuron
Key
Upper motor neuron
Lower motor neuron

- The majority of the pyramidal fibers then cross in the lower medulla to the opposite side and descend into the lateral corticospinal tracts of the cord, finally terminating principally on the interneurons in the intermediate regions of the cord gray matter



- A few of the fibers do not cross to the opposite side in the medulla but pass ipsilaterally down the cord in the (ventral or anterior corticospinal tracts.)

- Many, if not most, of these fibers eventually cross to the opposite side of the cord either in the neck or in the upper thoracic region.



“Extrapyramidal” System

_All descending tracts other than the pyramidal tract called extrapyramidal tracts

_Pyramidal and extrapyramidal tracts should function together for smooth activity

_Background tone, posture, equilibrium etc., are maintained by extrapyramidal system

_Voluntary activity is controlled by pyramidal system

- Extrapyramidal fibers arise from

1. Cerebral cortex

2. Subcortical structures

Basal Ganglia

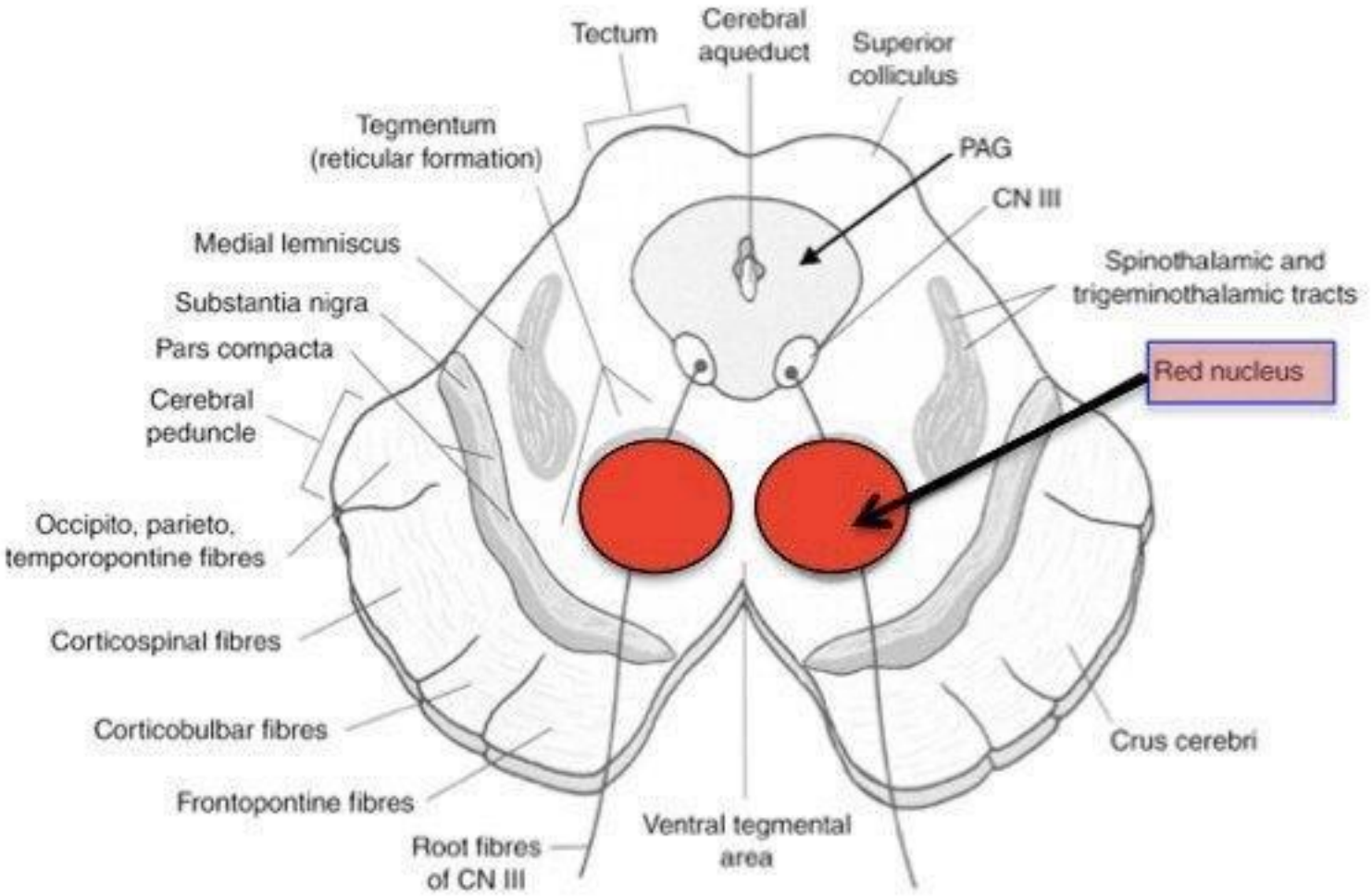
Reticular formation of brain stem

vestibular nuclei

Red Nucleus

And others like tectal nucleus and olivary nucleus

Red Nucleus


Tectum
Cerebral aqueduct
Superior colliculus
Tegmentum (reticular formation)
PAG
CN III
Medial lemniscus
Spinothalamic and trigeminothalamic tracts
Substantia nigra
Pars compacta
Red nucleus
Cerebral peduncle
Occipito, parieto, temporopontine fibres
Corticospinal fibres
Corticobulbar fibres
Crus cerebri
Frontopontine fibres
Ventral tegmental area
Root fibres of CN III

THE RED NUCLEUS

- Structure in the rostral midbrain involved in motor coordination

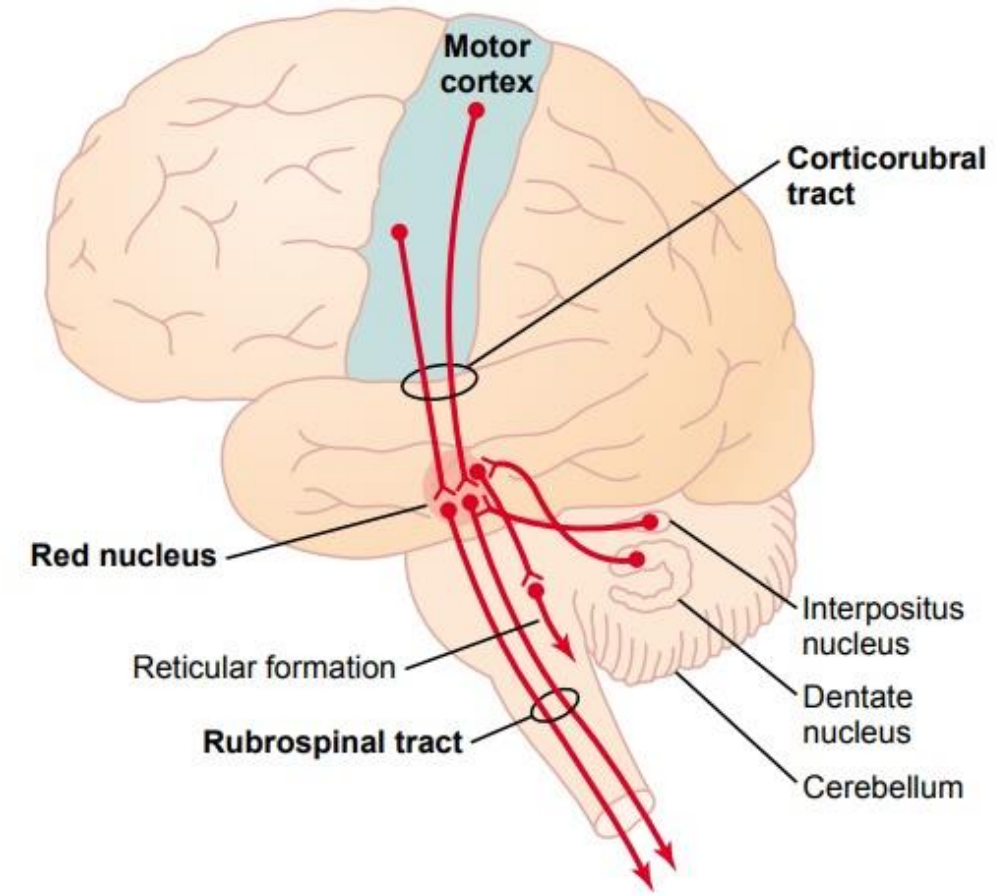
SERVES AS AN
ALTERNATIVE PATHWAY FOR
TRANSMITTING CORTICAL SIGNALS
TO THE SPINAL CORD

Corticorubrospinal

Fibers from primary motor cortex synapse with large neurons in magnocellular portion of red nuceus → **corticorubral tract**

Fibers from red nucleus to spinal cord → **rubrospinal tract**

Which crosses to the opposite side in the lower brain stem and follows a course immediately adjacent and anterior to the corticospinal tract .


Motor cortex
Corticorubral tract
Red nucleus
Reticular formation
Rubrospinal tract
Interpositus nucleus
Dentate nucleus
Cerebellum

Functions of Corticorubrospinal tract

- It has a representation of all the muscles of the body, as is true of the motor cortex.

  The representation of the different muscles is far less developed than in the motor cortex (it is relatively small in human beings)

- The corticorubrospinal pathway serves as an accessory route for transmission of signals from the motor cortex to the spinal cord.

- When the corticospinal fibers are destroyed but the corticorubrospinal pathway is intact,

discrete movements can still occur, except that the movements for fine control of the fingers and hands are considerably impaired.

Recap

1. Pathways of motor transmission : direct Pyramidal and indirect Extrapyramidal .

2.corticospinal tract :The majority will cross in the lower medulla to the opposite side and descend into the lateral corticospinal tracts of the cord, terminating on the interneurons in the intermediate regions of the cord gray matter.

few of the fibers do not cross to the opposite side in the medulla but pass ipsilaterally down the cord in the (ventral or anterior corticospinal tracts.)

3. Red nucleus: Structure in the rostral midbrain involved in motor coordination, transmission of discrete signals from the motor cortex to the spinal cord.