MOTOR SYSTEM

Motor system

- Concerned with the voluntary movements mediated by skeletal muscles.
- Translates thoughts,sensations and emotions in to actions
- Somatic motor activities
  - Depends on the pattern and rate of discharge of final common pathway

    -Alpha motor neurons

    -neurons in cranial motor nerves

Inputs to the motor neurons

- Arises from
  - Same spinal segment
  - Suprasegmental areas
    - other spinal segments
    - brain stem
    - cerebral cortex
- Effects mediates
  - Directly
  - Via interneurons
  - Via gamma efferents

Final common pathway

1. Corticospinal tract
2. Rubrospinal tract
3. Dorsal vestibulospinal tract
4. Olivospinal tract
5. Reticulospinal tract
6. Ventral vestibulospinal tract
7. Tectospinal tract
8. Sensory afferents

Control of voluntary activity

- Planned with in the Brain
- Commands are sent to the alpha motor neurons via descending tracts
  - Corticospinal tract
  - Corticobulbar tract

Inputs to the motor neurons

- bring about voluntary activity
- Adjust the body posture
- Coordinates the action of various muscles

Control of Body posture and coordination

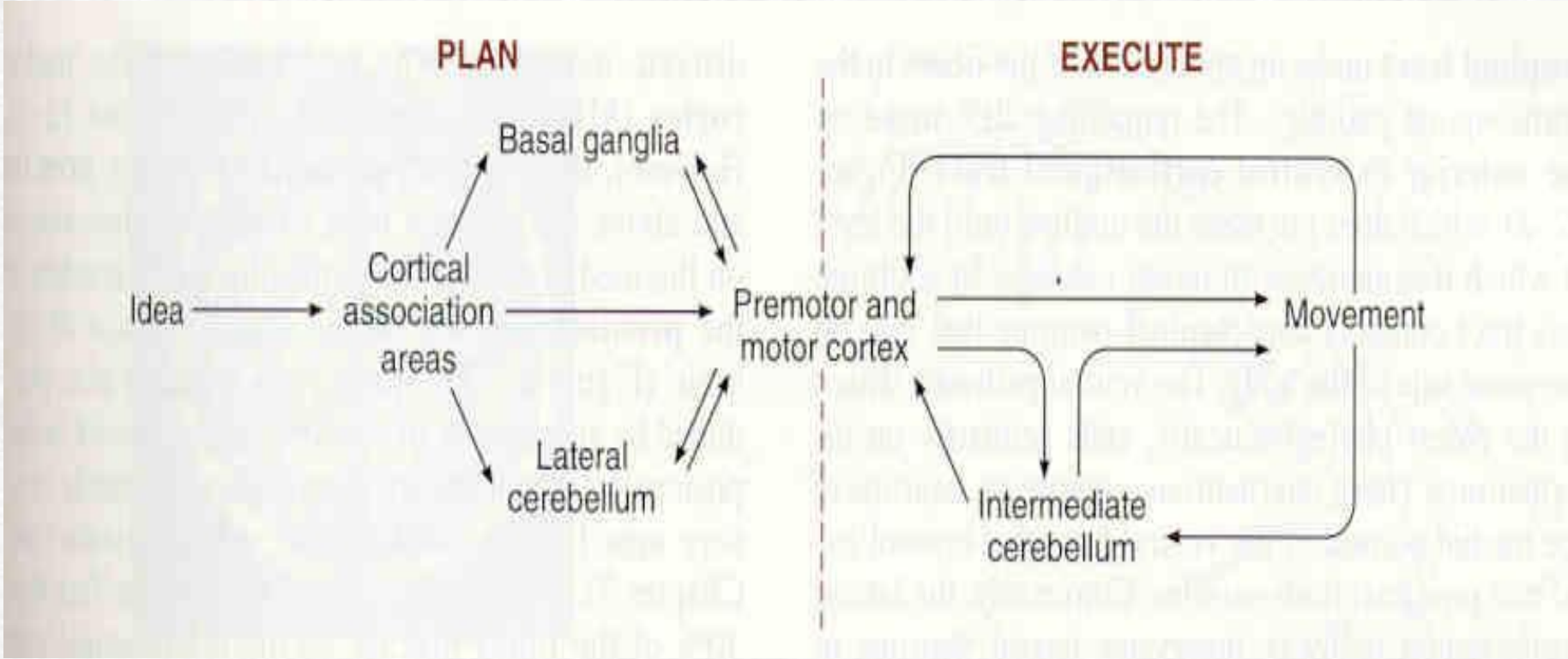
- Body posture adjustment
  - Continuously adjusted by posture regulating mechanism
- Coordination of the muscle activity
  - By basal ganglia and cerebellum.
- The main descending pathways are
  - Rubrospinal tract
  - Reticulospinal tract
  - Tectospinal tract
  - Vestibulospinal tract

General motor control

- Commands originate in the cortical association areas
- Movements are planned in the
  - Cerebral cortex
  - Basal ganglia
  - Lateral cerebellum
- Basal ganglia and cerebellum sends information to the
  - Premotor cortex
  - Motor cortex

- Motor commands from the motor cortex carried to the motor neurons via
  - **Corticospinal tracts**
  - **Corticobulbar tracts**
- **cortricospinal tract**
  - **To alpha motor neurons in the spinal cord**
- **Corticobilbar tract**
  - **To motor nuclei of cranial nerves**

General motor control



Control of axial and distal muscles

- **Axial and proximal muscles of limbs and gross movements**
  - Controlled by Medial and Ventral pathways in the brain stem and spinal cord
- **Distal limb muscles with fine skilled movements**
  - Controlled by lateral pathways in the brain stem and spinal cord

Lower motor neuron(LMN)

- Cranial and spinal motor neurons
  - Directly innervates the skeletal muscles
- Motor cranial nerve nuclei
  - Innervates the muscles of head and neck area
    - E.g. 3rd cranial nerve - extra occular muscles
      12th cranial nerve - tongue

Upper motor neuron(UMN)

- The neurons in the brain and spinal cord that influence the activity of LMN
- Consists of descending
  - Posture regulating pathways
  - Corticospinal and corticobulbar tracts
  - Cerebellar pathways

Lower motor neuron lesion

- Due to damage to the
  - Motor nuclei of - i. anterior horn cells in the spinal cord
    ii. cranial nerves
  - Axons of - i. cranial nerves
    ii. spinal motor nerves
- Results skeletal muscle denervation

Features of Lower motor neuron lesion

- Affected muscle or muscle groups will show
  1. Flaccid paralysis
  2. Muscular atrophy
  3. Decreased tone (hypotonia)
  4. Diminished or absent tendon reflexes
  5. Fasciculation-can be seen clinically
  6. Fibrillation -can only be detected with EMG

Lower motor neuron lesion

- Fasciculation – visible contractions of groups of muscles
  - Indicates anterior horn cell lesion
- Fibrillation
  - Increased muscle fiber excitability
  - Not visible
  - Detected using EMG

Upper motor neuron lesion

- Lesions of
  - Posture regulating pathways-cause spasticity
  - Cerebellar pathways – causes incoordination
  - Pure Corticospinal and
    corticobulbar tracts- results weakness(paresis)
    and hypotonia
- Corticospinal and corticobulbar tract lesions are considers as UMN lesions

Pure corticospinal and corticobulbar lesions are extremely rare.

Upper motor neuron lesion

- Normally lesions involves
  - corticospinal and corticobulbar fibers
  - With some posture regulating pathways
- Therefore features are mixed

Features of Upper motor neuron lesion

- Weakness(paresis)
- Spasticity
- Exaggerated tendon reflexes
- Clonus
- Positive Babinski sign
- Absent superficial abdominal reflexes

Spasticity

- Increased resistance to rapid muscle stretch

Corticospinal and corticobulbar tracts

- Both have fibers originating from the cortical motor areas
- **Corticospinal tract**
  - fibers pass form cortex to the spinal motor neurons
- two pathways
  - 1. Lateral corticospinal tact
  - 2. Anterior corticospinal tract

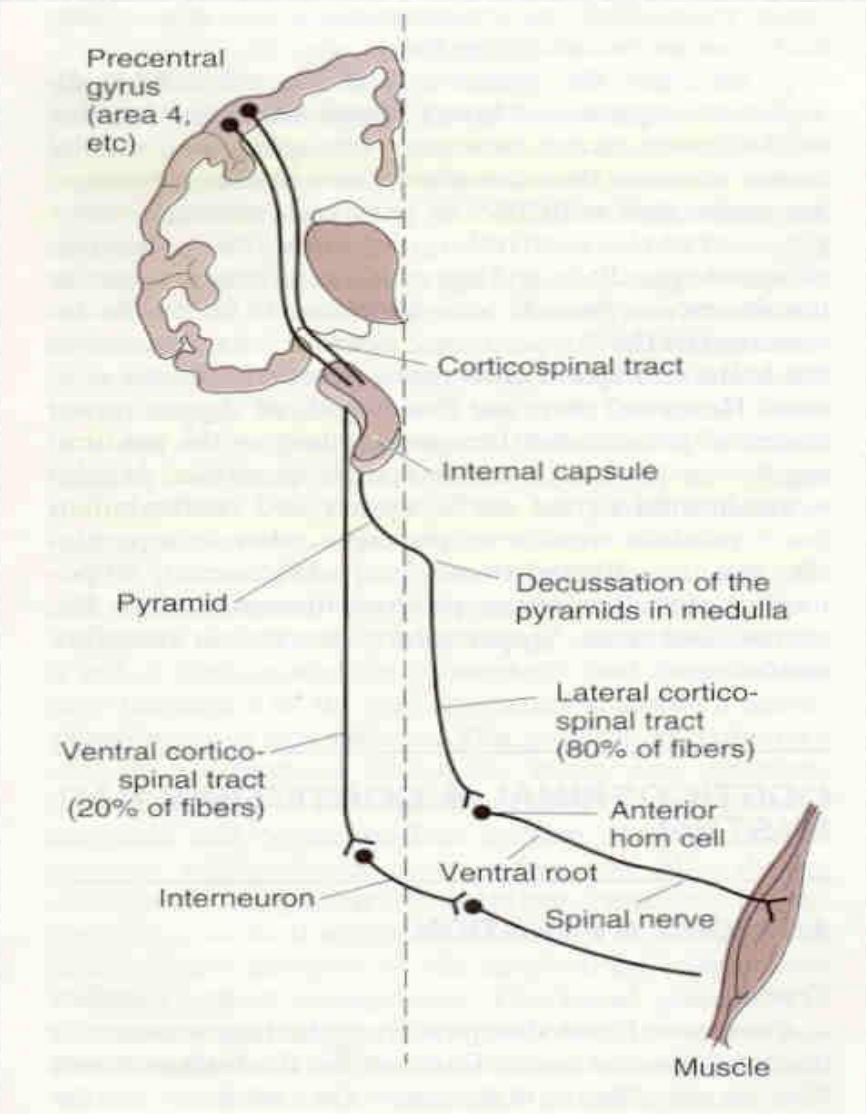
Lateral corticospinal tract(pyramidal tract)

- forms pyramid in the medulla and known as pyramidal tract
- 80% of fibers cross the midline in the medulla
- Directly control the distal limb muscles
- Initiate skilled fine voluntary movements
- Facilitatory to alpha motor neurons

Anterior corticospinal tract

- Consists rest of 20% of fibers
- Remain uncrossed
- Cross the midline at the level of the synapses with motor neurons
- ends primarily on interneurons
- controls axial and proximal limb muscles
- concerned with posture adjustments and gross movements

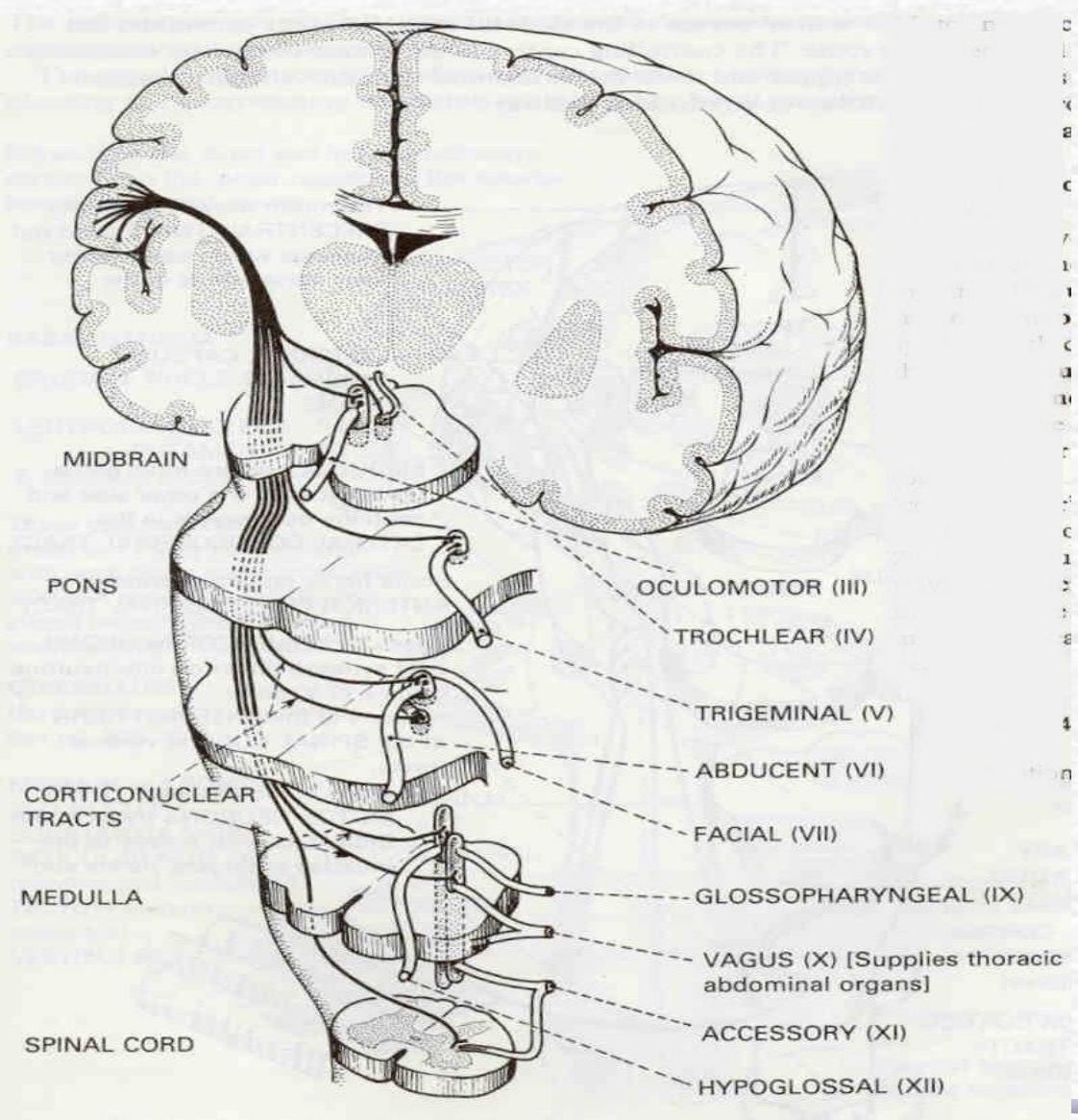
The corticospinal tracts



Corticobulbar tract

- Fibers originates in the cortical motor areas
- pass to the cranial motor nuclei in the brain stem

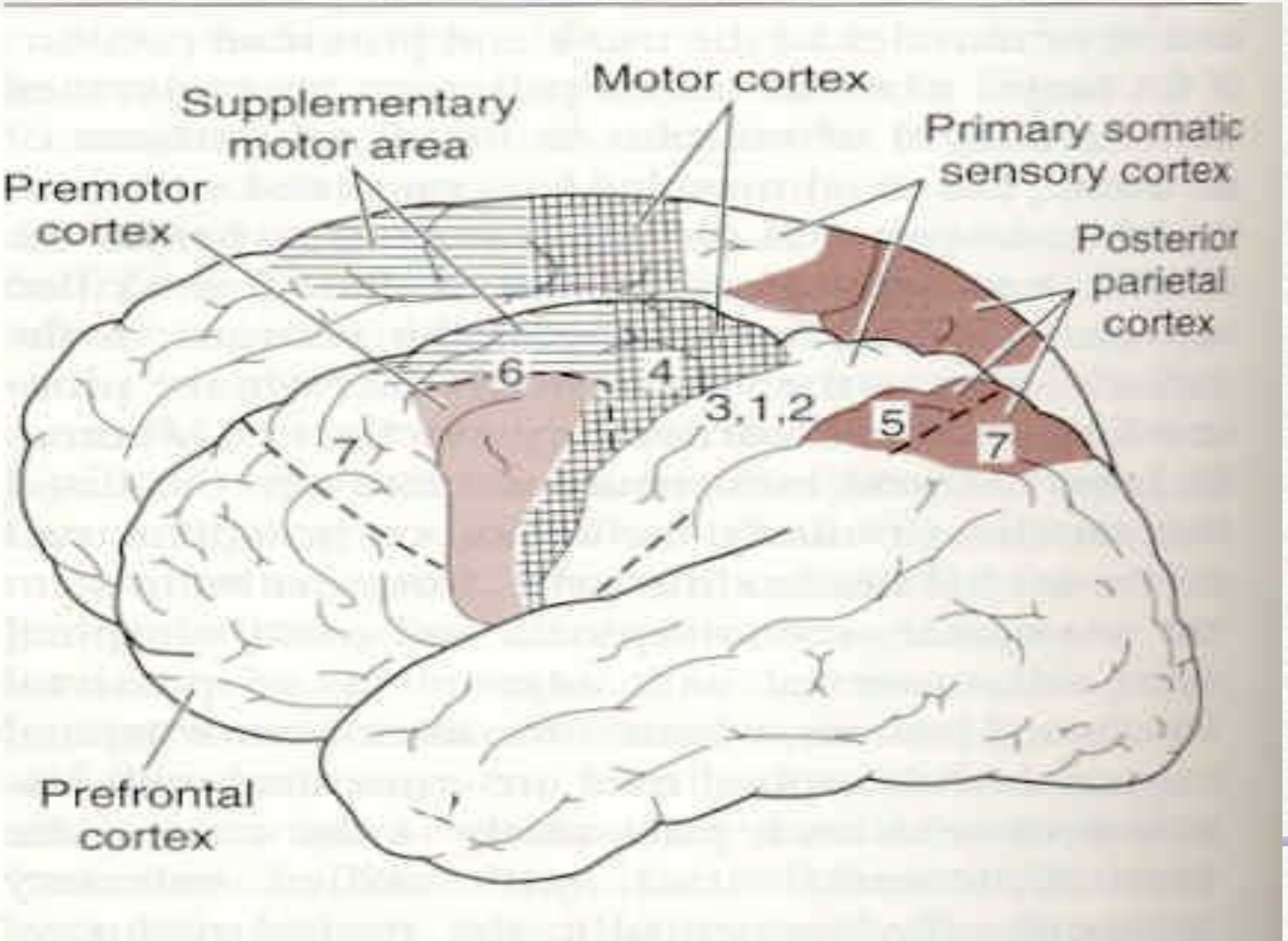
Corticobulbar tract



Cortical motor areas

- Influences motor activity via corticospinal and bulbar tracts
- Important areas
  - Primary motor cortex
  - premotor cortex
  - supplementary motor cortex
  - Posterior pareital cortex
  - Primary somatic sensory cortex
  - Areas for specific motor function
    - e.g. speech- Broca's area

Cortical motor areas



Primary motor cortex

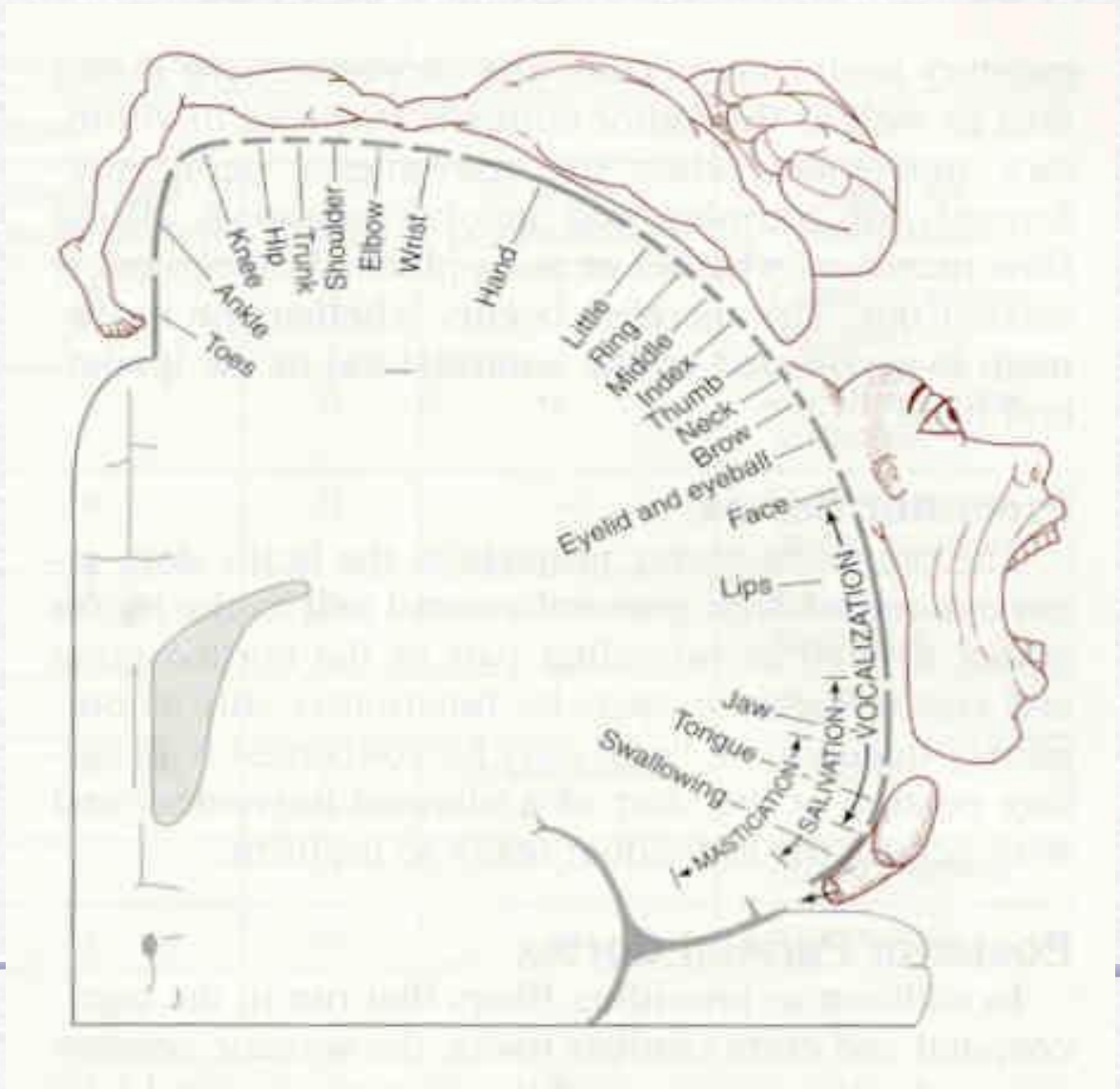
- In the precentral gyrus
- Various parts of the contralateral body is represented
- shows somatotrophic localization
- facial area represented bilaterally
- cortical representation of body part
  - is proportionate in size to the skill with which the part is used for
- fine voluntary movements are represented in a large cortical area

Primary motor cortex

- Speech and hand movements are represented in a large areas
- concerned with movements of
  - lips,tongue,and pharynx
- Of the hand thumb has a greater representation than the fingers

- cells are arranged in columns
- receive extensive sensory inputs
- Produces discrete skilled movements

Cortical representation of the body



Premotor cortex

- On the lateral surface of the brain
- concerned with postural control
- provides part of the corticospinal and corticobulbar out put.

Posterior pareital cortex

- Project the premotor cortex
- concern with execution of learned sequence of movements

Supplementary motor area

- On the medial side of the hemisphere
- projects to the prermotor cortex on the lateral surface

Primary somatic sensory area

- on the post central gyrus
- areas I and II

Corticospinal and corticobulbar tracts

- 30% of fibers from motor cortex
- 30% from premotor cortex
- 40% from pareital lobe

Extra pyramidal system

- Descending tract that do not pass through the pyramids
- consists of many different pathways
- concerned with postural control
- Main tracts are
  - Rubrospinal tract
  - Reticulospinal tract
  - Tectospinal tract
  - Vestibulospinal tract
  - Olivospinal tract

Lateral corticospinal tract Damage

Babinski sign

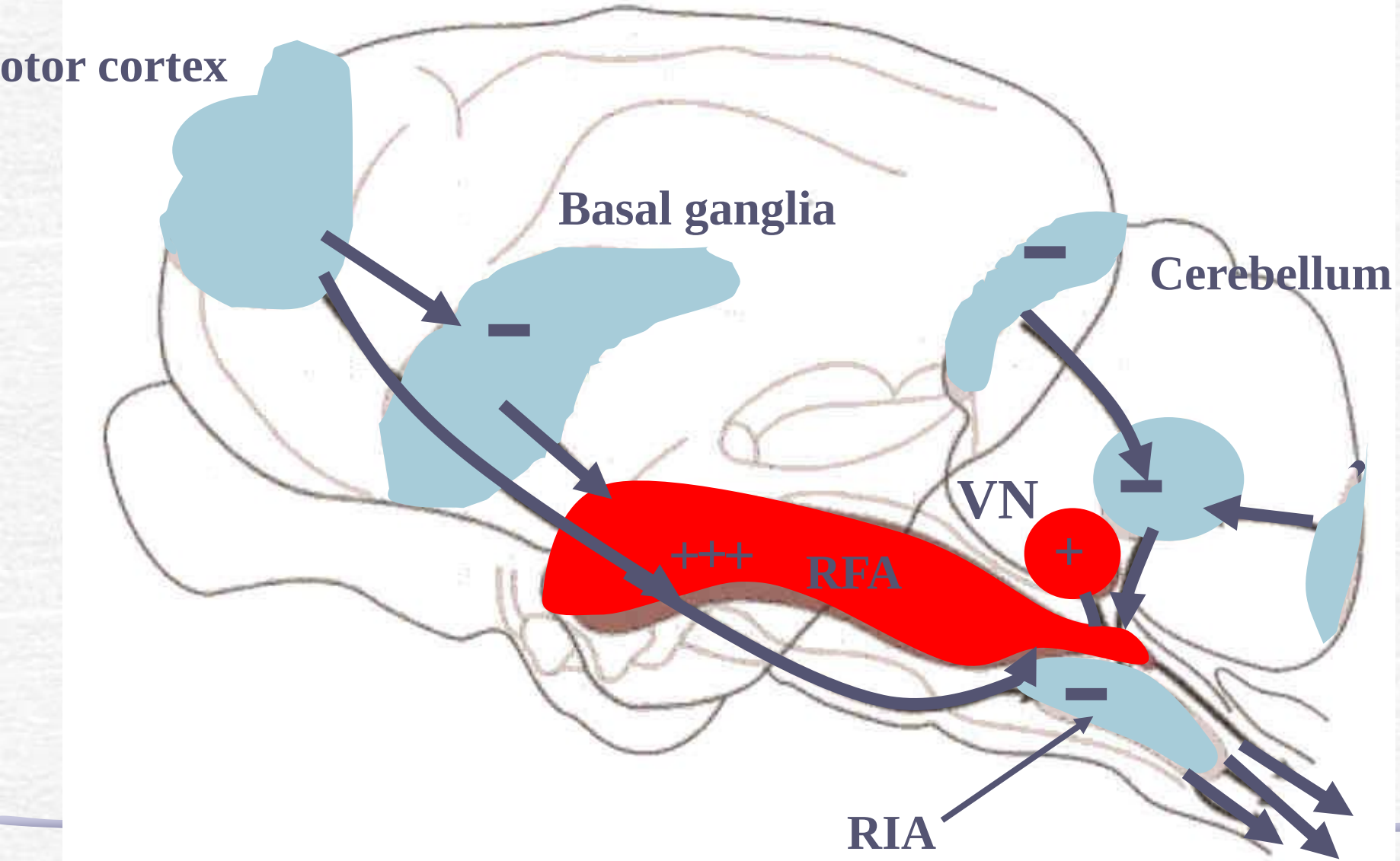
- when lateral aspect of the sole is scratched
- dorsiflexion of the great toe and fanning of the other toes occurs

- suggestive of lateral corticospinal tract lesion
- has a localization value

Supraspinal Regulation of stretch reflex

- Cortical and brain stem areas
  - facilitates and inhibits the stretch reflex
  - increase or decrease the spindle sensitivity
- **facilitation areas**
  - reticular facilitatory area (RFA)
  - vestibular nuclei
- **Inhibitory areas**
  - motor cortex
  - basal ganglia
  - cerebellum
  - reticular inhibitory area (RIA)

Regulatory areas of stretch reflex



Supraspinal Regulation of stretch reflex

- Reticular facilitatory area discharges spontaneously-stimulates γ efferents
- Reticular inhibitory area driven by motor cortex and cerebellum
- Inhibition by basal ganglia act through descending tracts

Effects of damage to regulatory areas

- Damage to inhibitory areas results

Removal of inhibition to the Reticular facilitatory area

- Removal of inhibition to the γ efferents
- γ efferent discharge is increased
- Muscle spindle sensitivity increased
- Reflexes become hyperactive- Exaggerated reflexes
- Muscle tone become increased

Removal of inhibition to the vestibular nuclei

- Facilitation of stretch reflex
- Increased excitability of alpha motor neurons
- Resulting rigidity