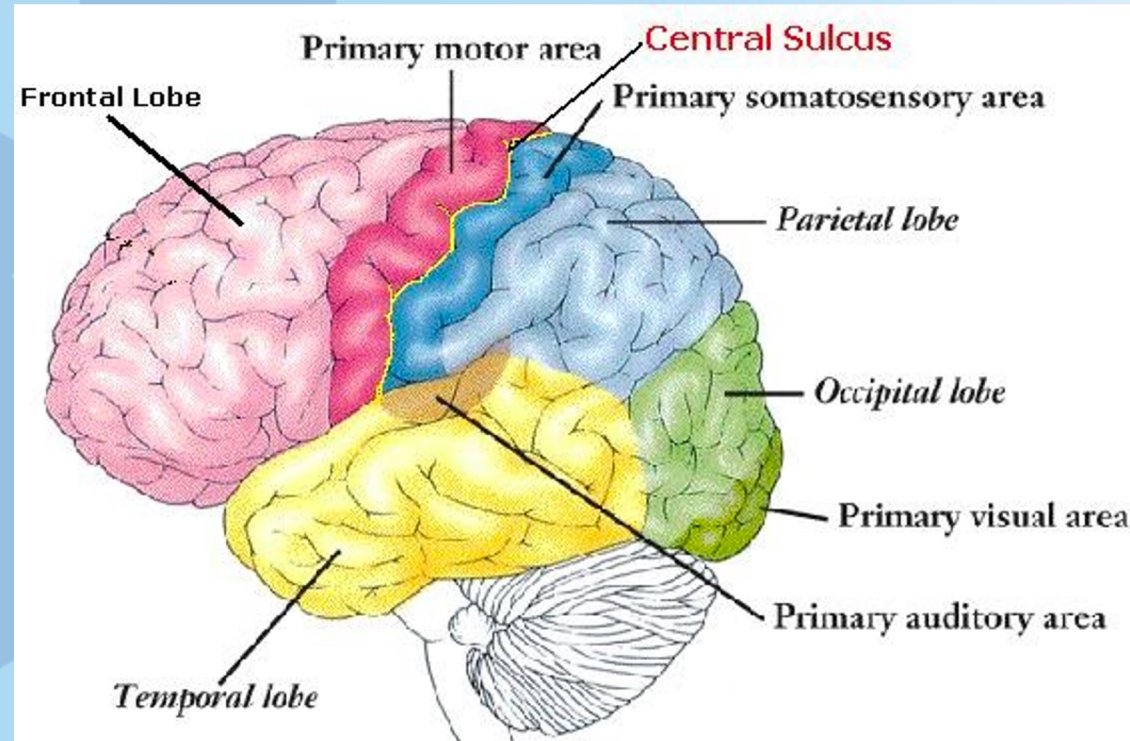
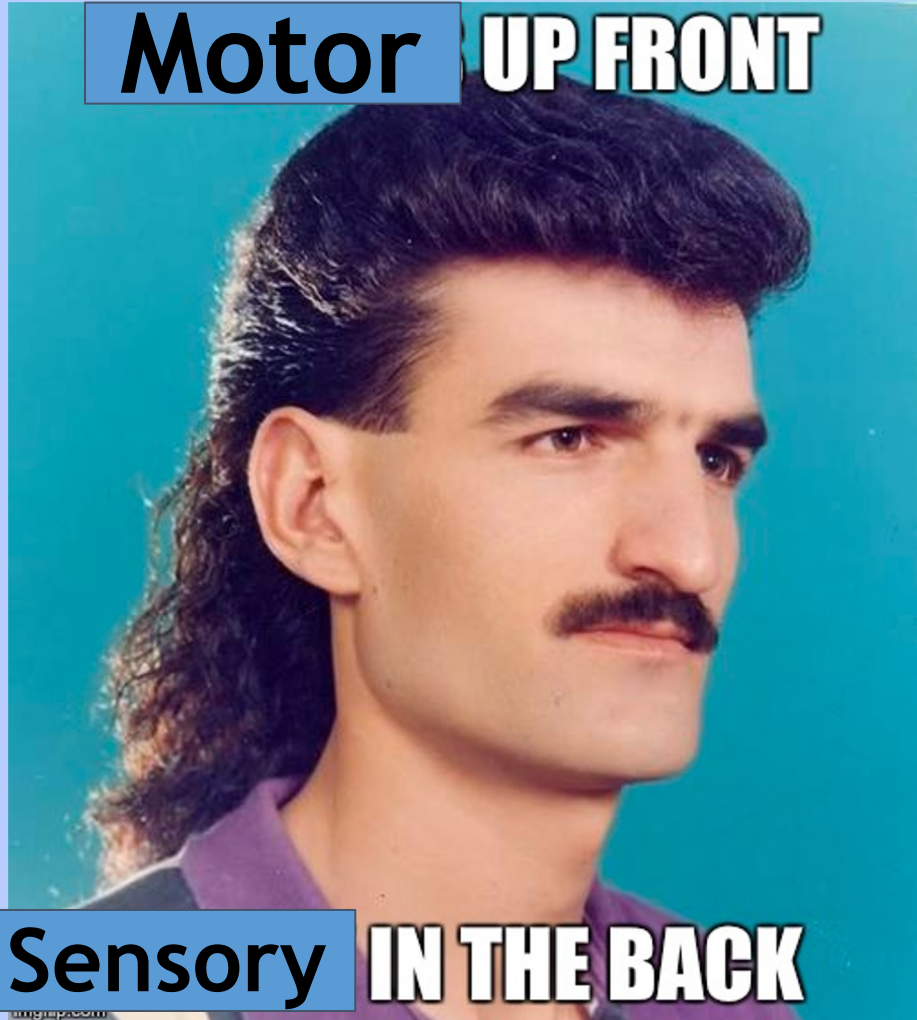


# Motor Axis

By Jacob Guzior

# Motor Cortex



- Located in the frontal lobe
- Involved in planning, controlling, and executing movements

# Types of Movement

## Voluntary Movement

- Pyramidal tract = corticospinal tr. + corticobulbar tr.  
ex: Smashing that like and subscribe button

## Involuntary Movement

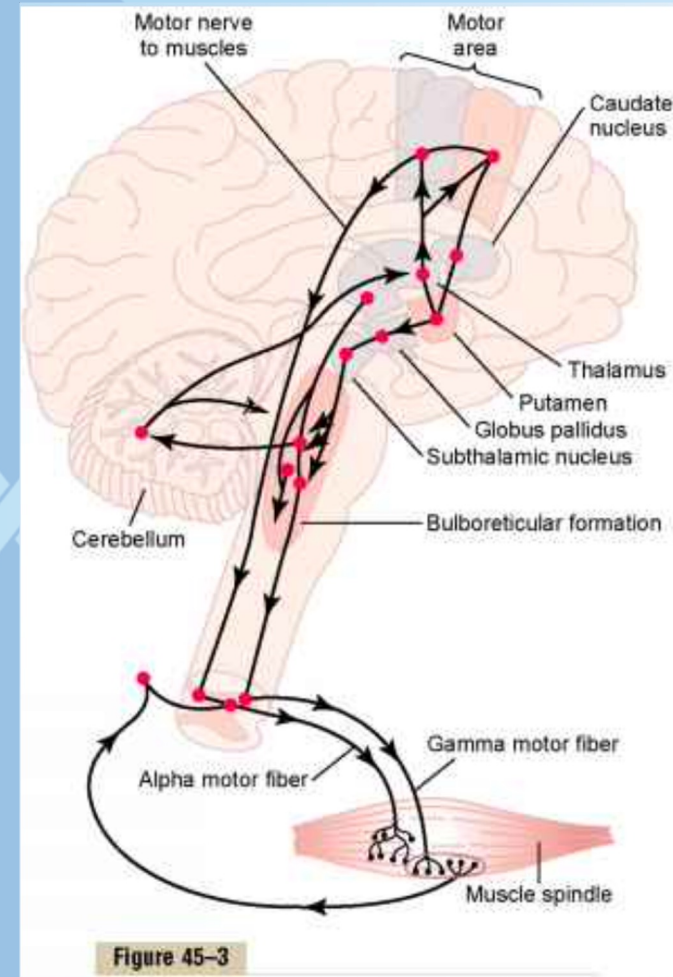
- Basal ganglia  
ex: Maintaining balance with eyes closed



# Control of movement

Necessary elements:

1. Cerebral cortex
2. Basal ganglia
3. Cerebellum
4. Spinal cord



**The right brain controls the left side of the body**



# Corticospinal Tracts

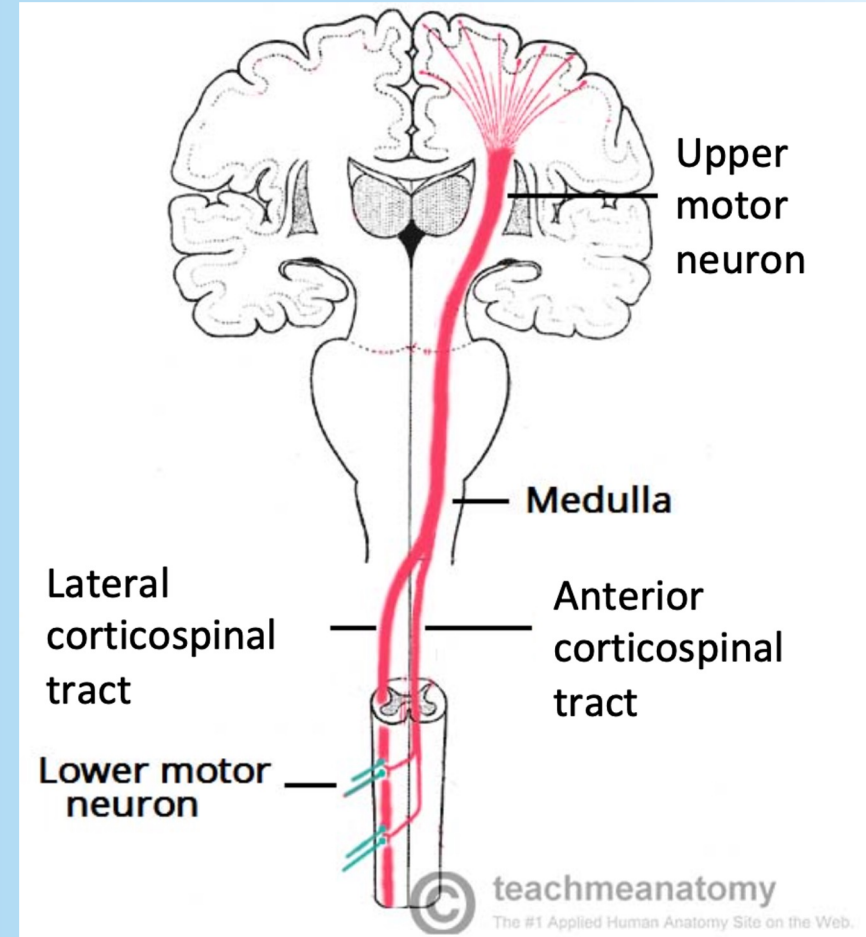
- Sends signals from motor cortex to spine
- First order neuron: UMN
- Second order neuron: LMN

## Lateral corticospinal tract:

- Movement of limbs
- Decussates at medulla

## Anterior corticospinal tract:

- Movement of trunk
- Decussates in spinal cord

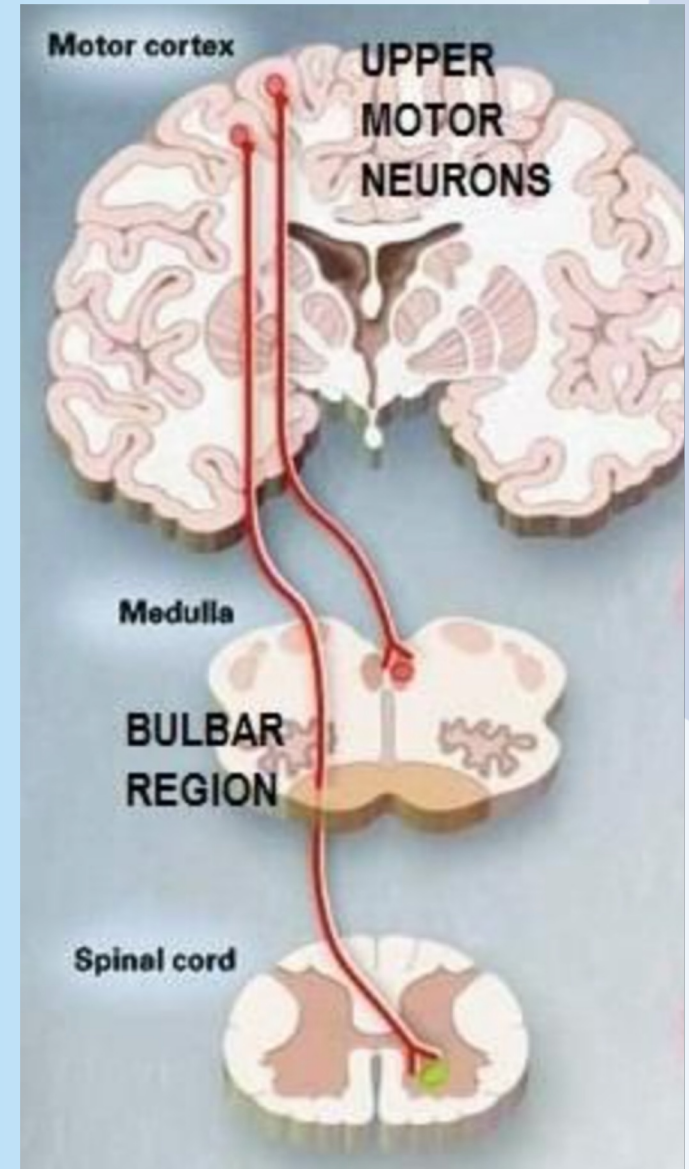


# Upper Motor Neurons

- Start in motor cortex or brain stem
- Send information to LMN

Upper motor neuron lesion:

- Loss of voluntary activity
- Increased muscle tone
- Increased reflexes (e.g. Increased deep tendon reflex)
- Babinski sign

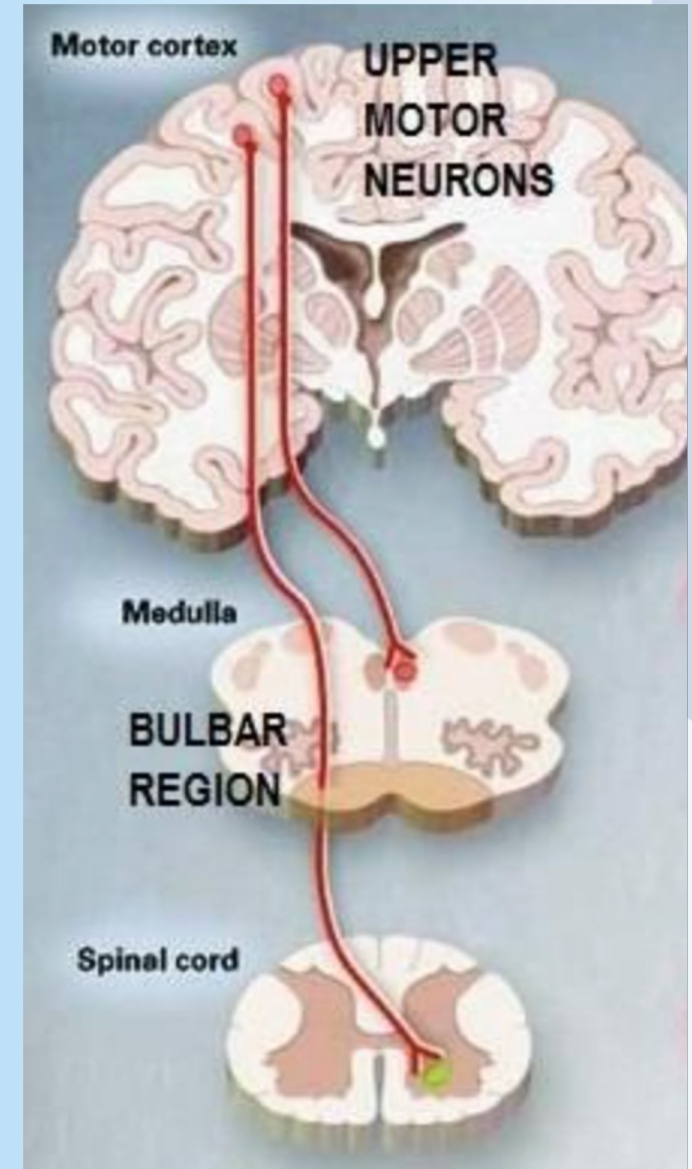
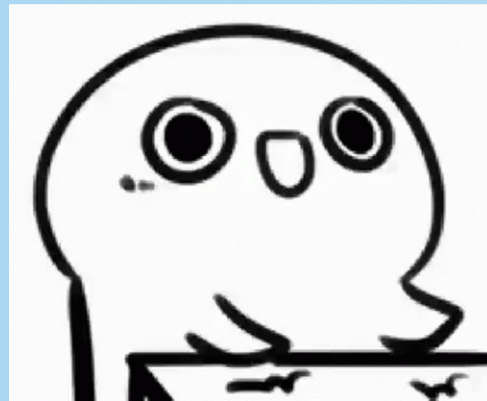


# Upper Motor Neurons

- Start in motor cortex or brain stem
- Send information to LMN

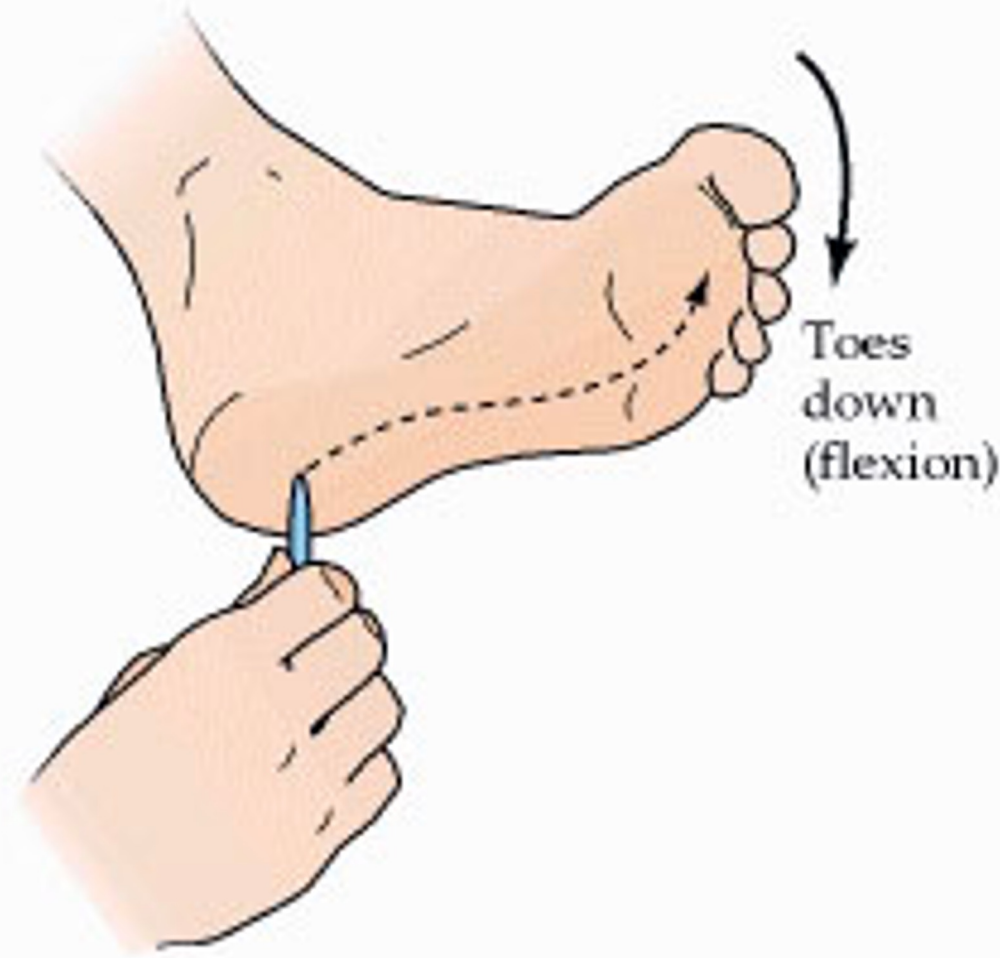
Upper motor neuron lesion:

- Loss of voluntary activity
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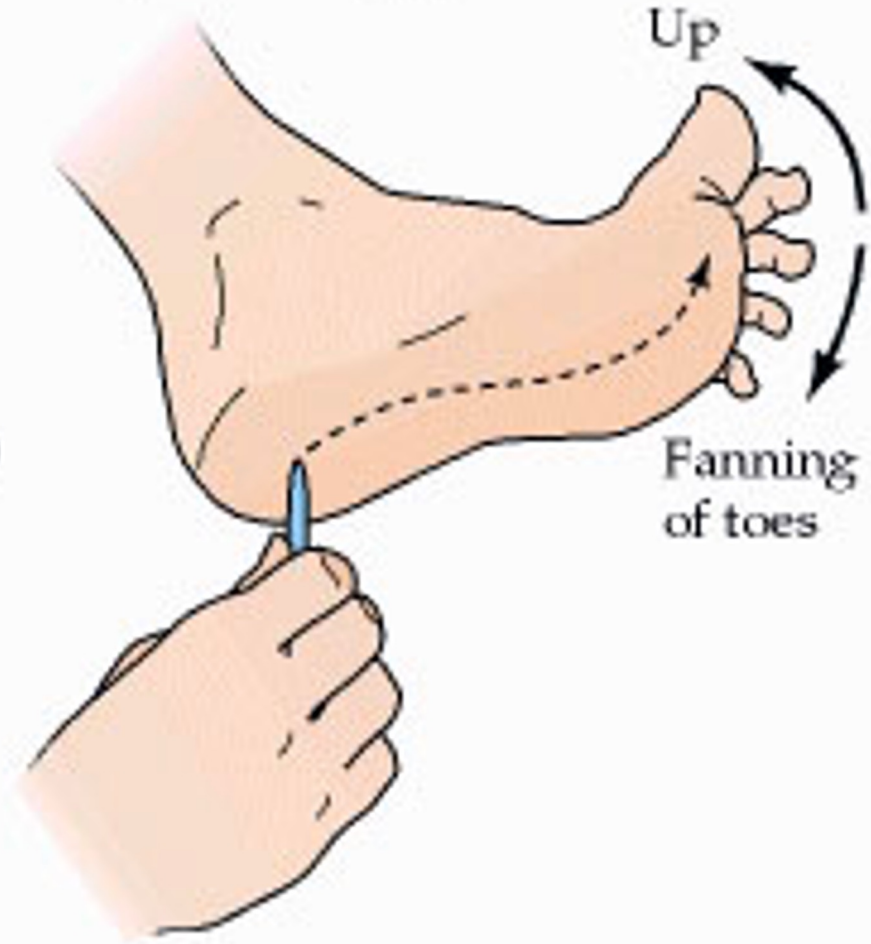




(A) Normal plantar response

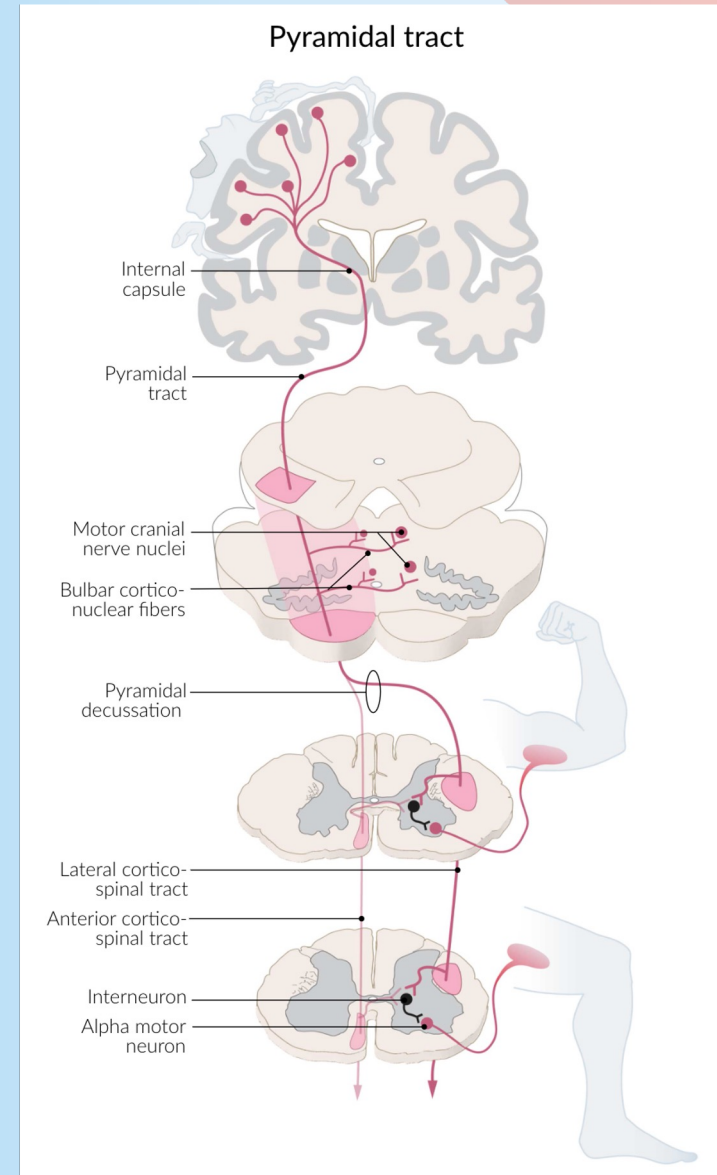


(B) Extensor plantar response (Babinski sign)



# Lower Motor neurons

- Located in:
  1. Cranial nerve nuclei of the brainstem-muscles of head and neck
  2. Anterior grey column (ventral horn)-muscles of the body
  3. Spinal lower motor neurons
- All voluntary movement relies on spinal lower motor neurons
- Act as a link between upper motor neurons and muscles
- Alpha, beta, gamma types



# Interneurons

## Fine Movements

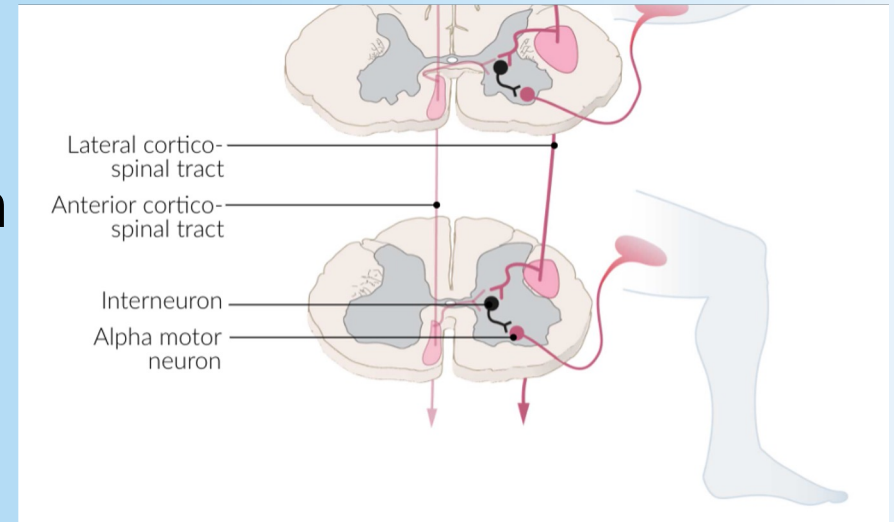
Lateral Corticospinal Tract

More likely to have direct synapse between  
UMN and LMN

## Trunk Movements

Anterior Corticospinal Tract

More likely to use interneuron



# Lower motor neuron lesion

## **\*Everything is Lowered !\***

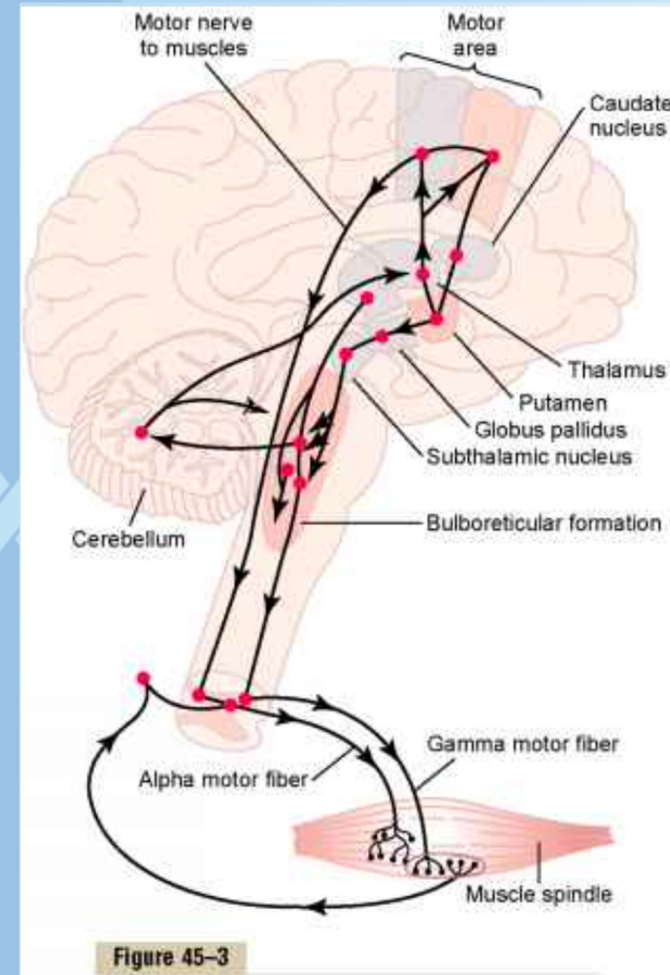
- Decreased reflexes
- Decreased muscle tone
- Flaccid paralysis
- Muscle atrophy possible (lack of innervation)
- Fasciculations
- Babinski sign negative



# Control of movement

## Necessary elements:

1. Cerebral cortex
2. Basal ganglia
3. Cerebellum
4. Spinal cord

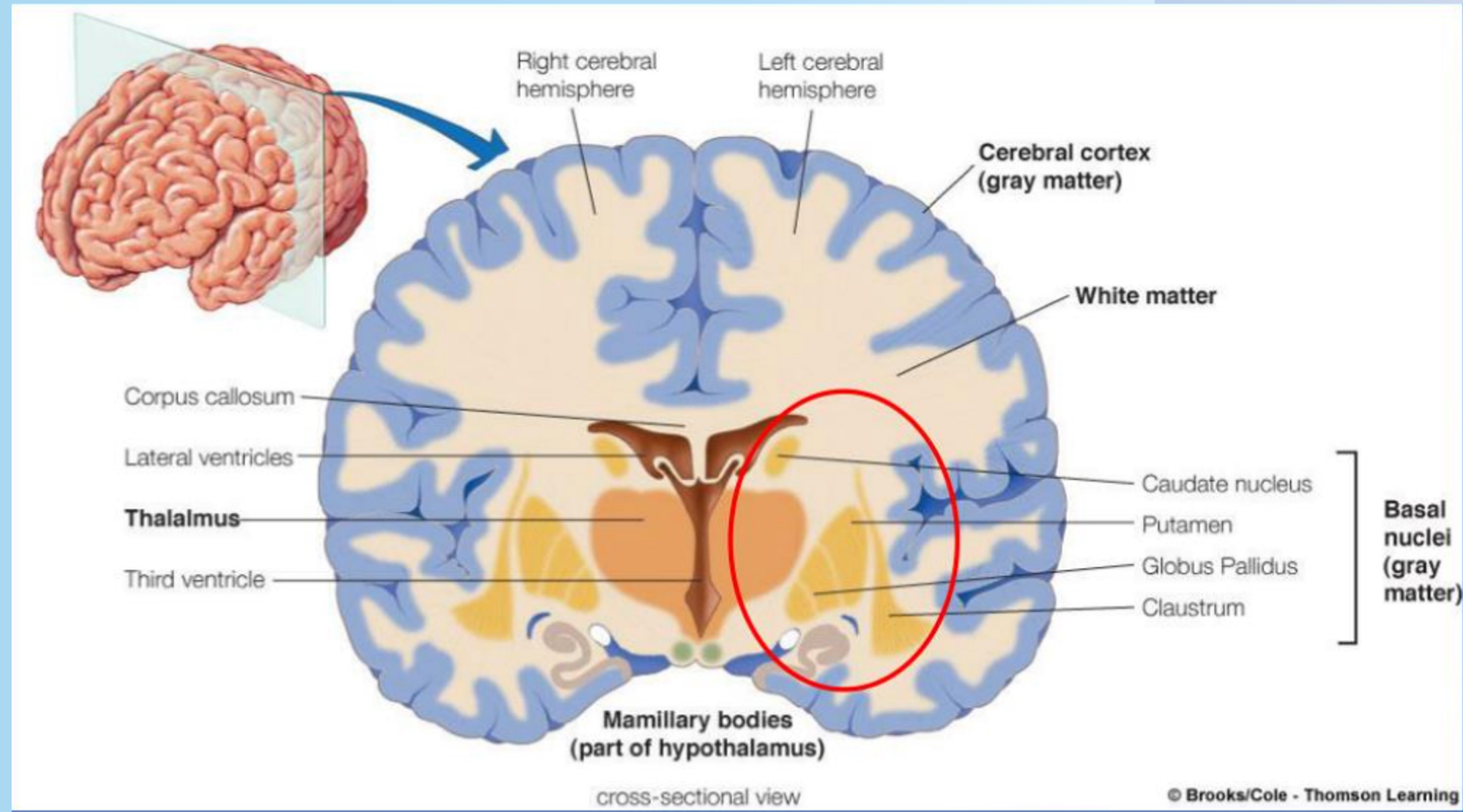


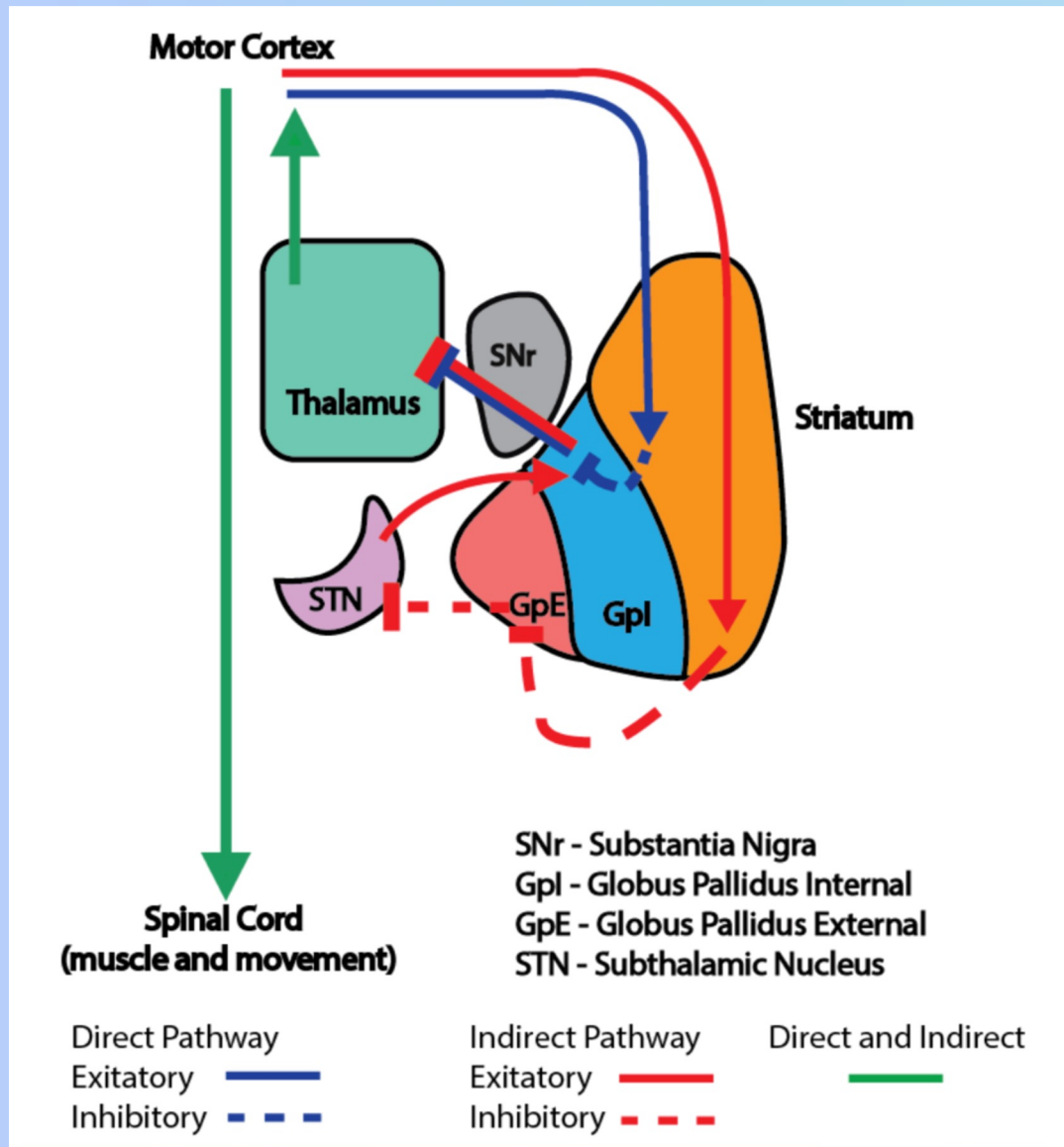
# Basal ganglia

- Control scale of voluntary movement; combine planning with action
- Adjust cortical impulses with negative feedback

- Five key components

1. Caudate nucleus
2. Putamen
3. Globus pallidus
4. Subthalamic nucleus
5. Substantia Nigra





Striatum = putamen + caudate nucleus

# Basal Ganglia Pathways

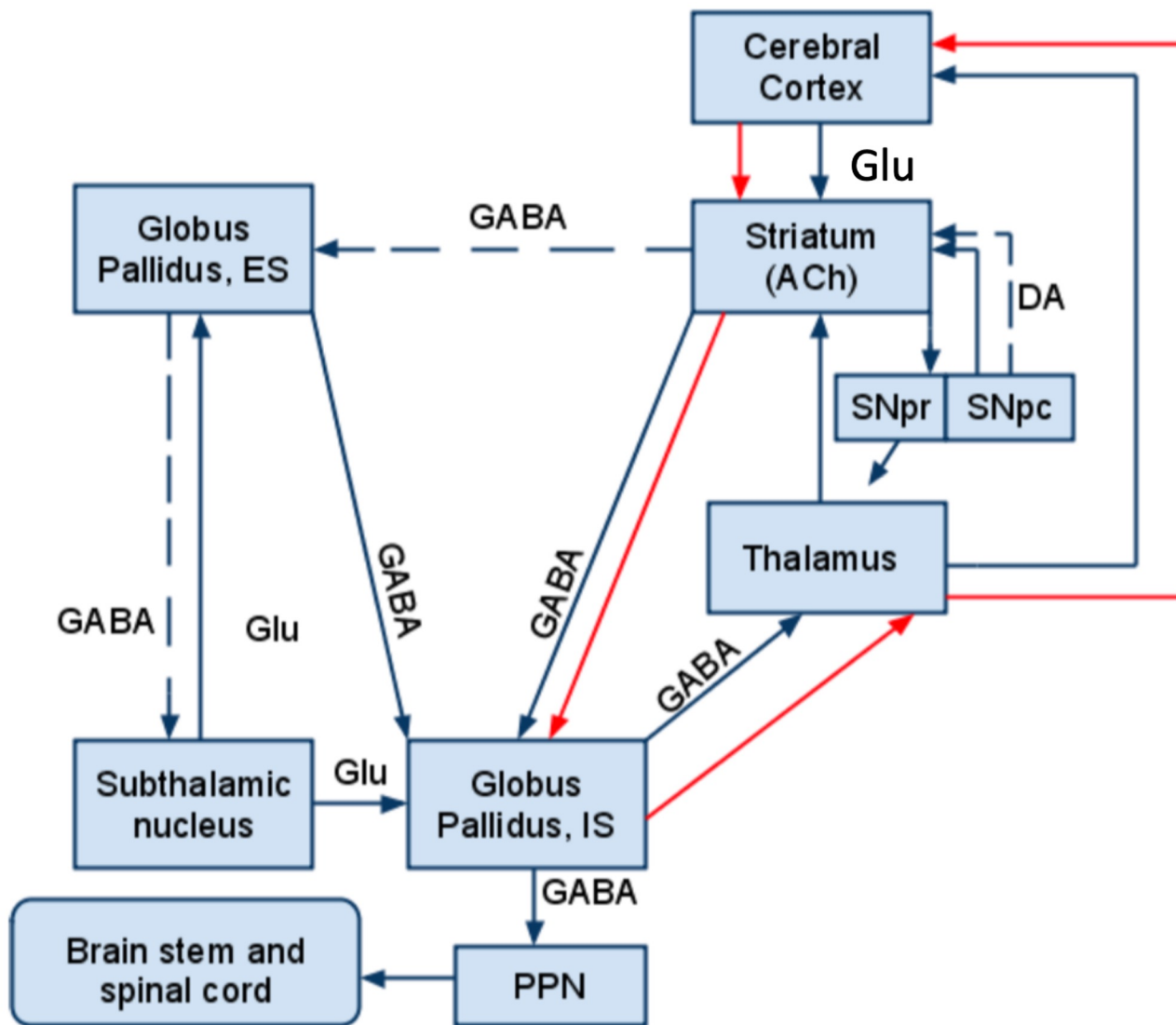
## Direct pathway

- Excites motor cortex
- Allows us to make wanted movements
- D1 receptors on axons of striatum
- “D1RECT pathway”
- Hyperkinesia

## Indirect pathway

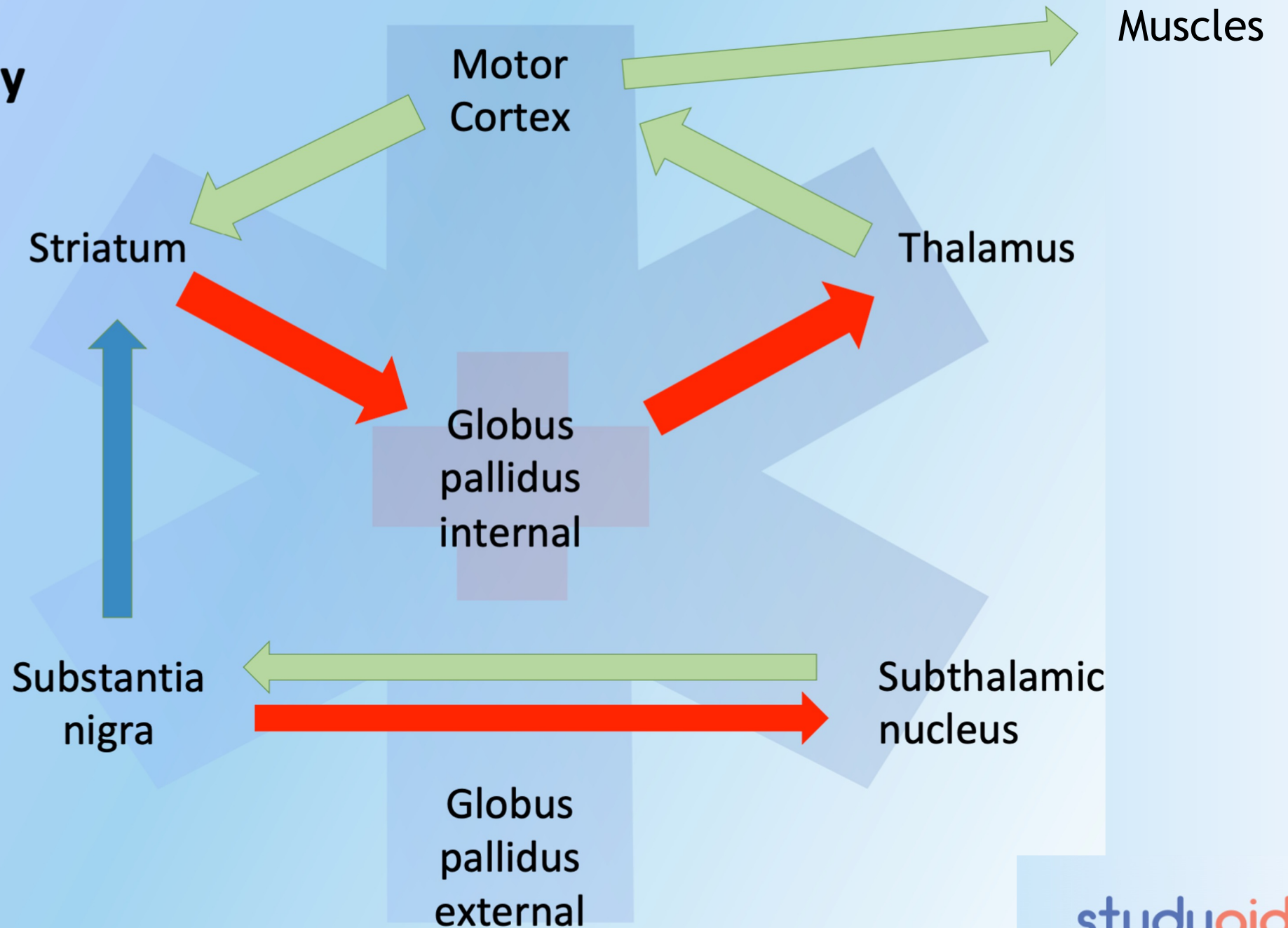
- Inhibits motor cortex
- “INdirect is INhibitory”
- Allows us to NOT make unwanted movements
- D2 receptors on axons of striatum
- Hypokinesia



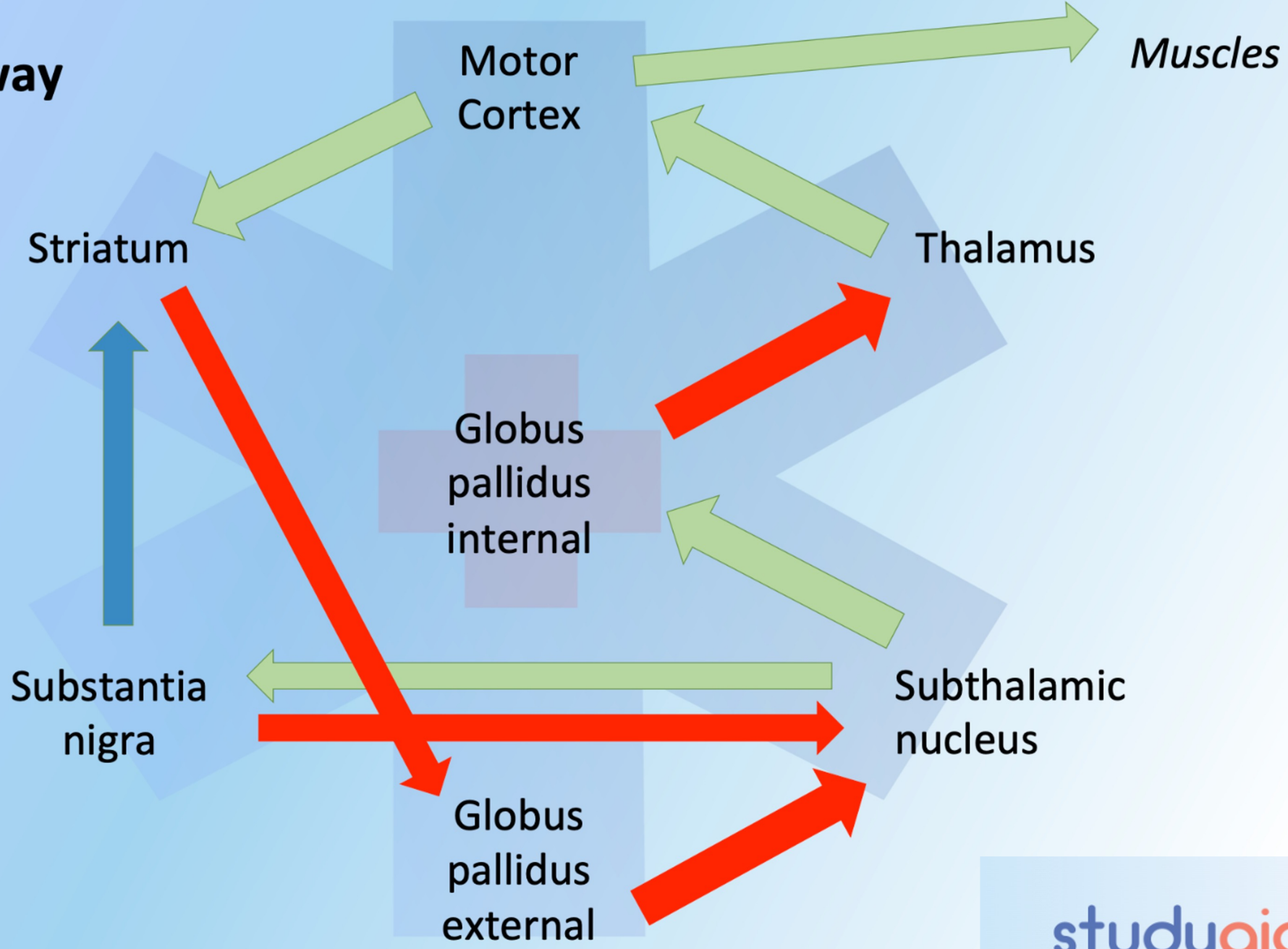


**GABA - inhibitory**  
**Glutamate - excitatory**

# Direct Pathway





# Indirect Pathway



# Basal Ganglia Dysfunction

## Huntington's Disease

- CAG nucleotide repeat (chromosome 4)
- Caudate loses Ach and GABA
-  Dopamine,  Cholinergic and GABAergic release
- Repetitive/ rapid movements, decreased muscle tone
- Cognitive changes

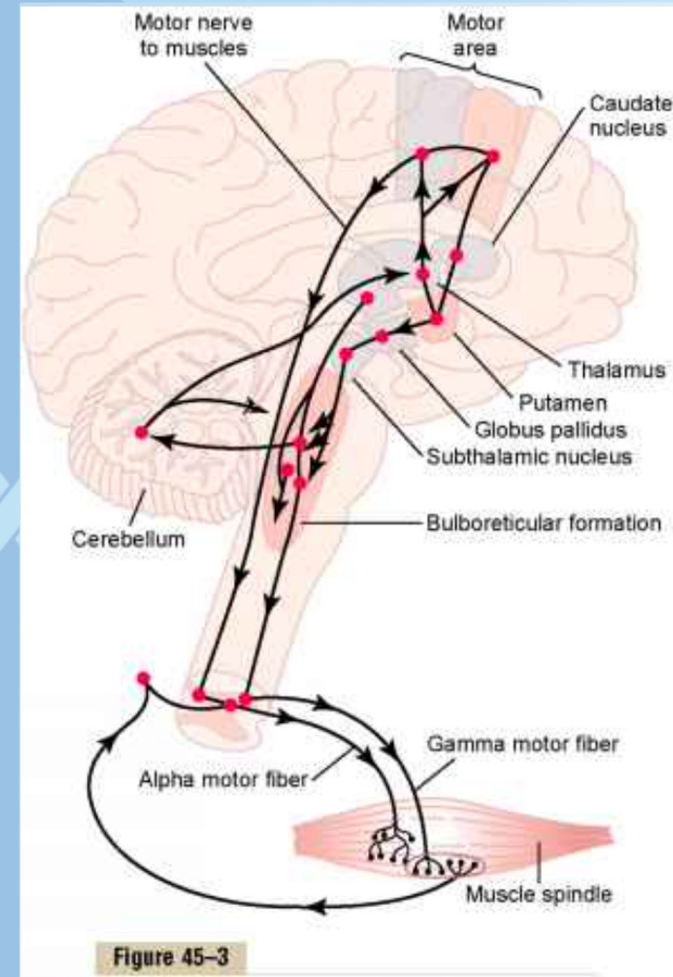
## Parkinson's Disease

- Loss of dopaminergic neurons in substantia nigra
- Slowed/ decreased movements
- **TRAP**
- Tremor
- Rigidity
- Akinesia
- Postural instability

# Control of movement

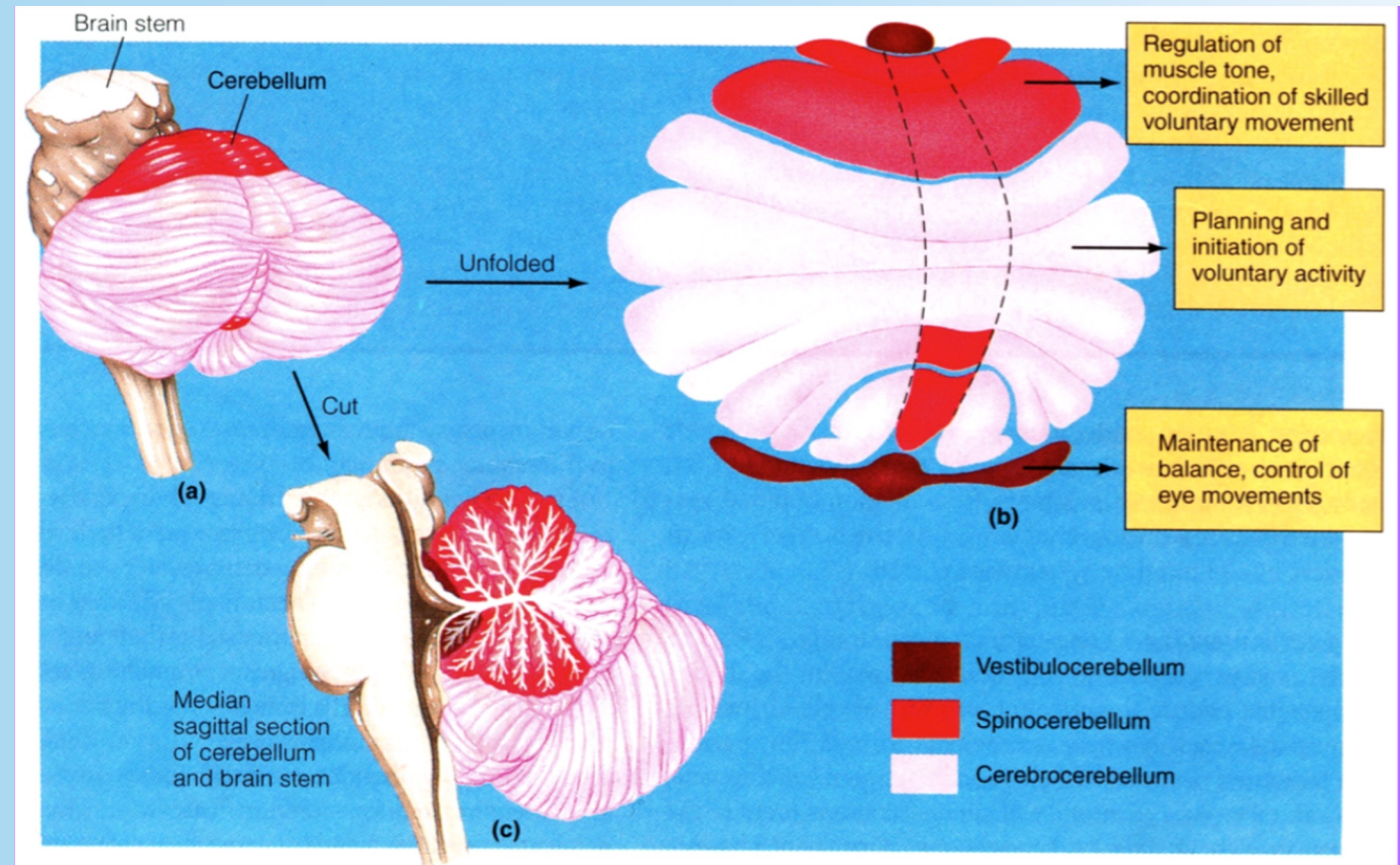
## Necessary elements:

1. Cerebral cortex
2. Basal ganglia
3. Cerebellum
4. Spinal cord



# Cerebellum

- Coordinates voluntary movements, balance, posture, making them smooth and precise



# Cerebellar Tracts

- Ventral spinocerebellar tract
- Tectocerebellar tract
- Cuneocerebellar tract
- Cerebello-ponto-cortical tract
- Cortico-ponto-cerebellar tract
- Dorsal spinocerebellar tract
- Olivocerebellar tract
- Vestibulocerebellar tract

You **DO NOT** have to learn these!



# Control of Equilibrium

- Balances agonist and antagonist muscle activities during rapid change in position
- Signals:
  1. Inform how fast movement is happening, and in which direction
  2. Inform about effector's (i.e muscle's) position, tone
  3. Relay planned sequences of movement

This is what influences interneurons in anterior corticospinal tract!





# Control of movement

## Role:

- Controls muscle tone
- Postural control
- Controls muscle contraction
- Assists in planning/ sequencing movement

## Lesions:

- Disturbed equilibrium
- Dysmetria
- Ataxia
- Dysdiadochokinesis
- Dysarthria
- Intention tremor
- Nystagmus



# For More Information:

American Academy of Neurology (AAN) Neurobytes Medical Student Series  
-Free Membership for Medical Students

Link: <https://www.aan.com/membership>

