

# **BASAL GANGLIA**

**Prof. Musaad Alfayez**

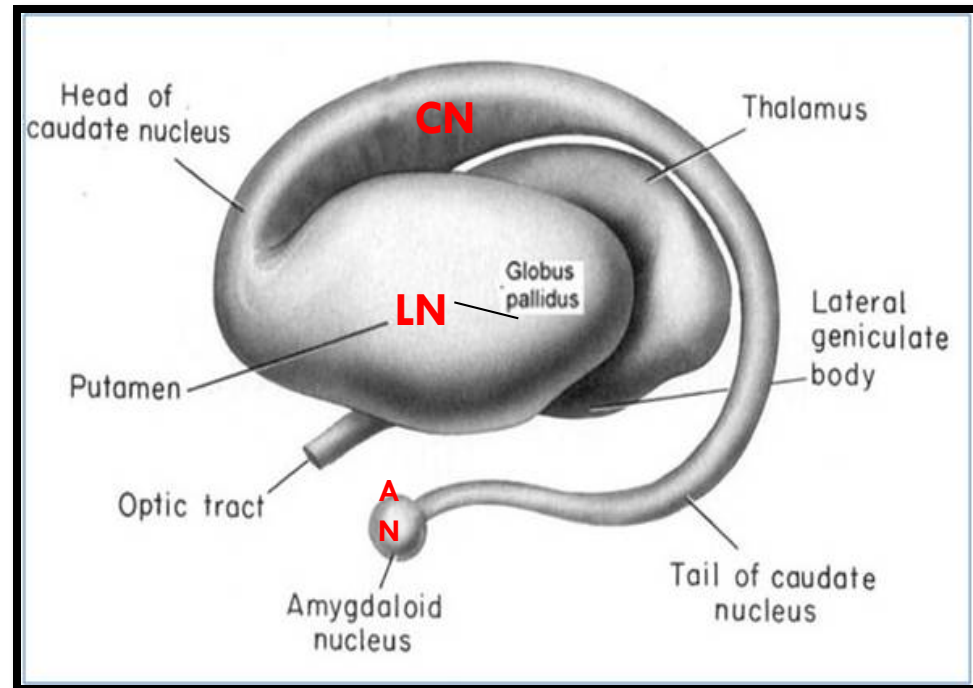
# OBJECTIVES

*At the end of the lecture, the student should be able to:*

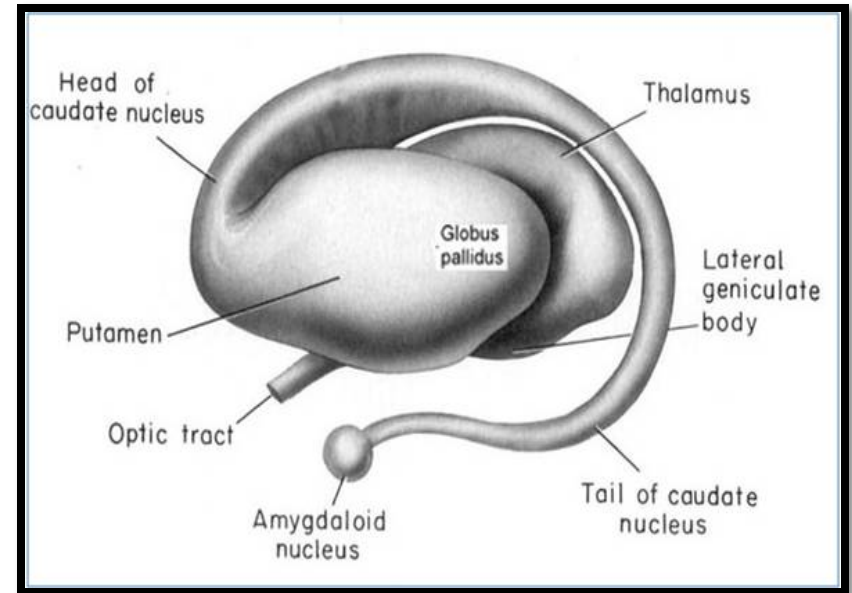
- ❑ Define “basal ganglia” and enumerate its components.
- ❑ Enumerate parts of “Corpus Striatum” and their important relations.
- ❑ Describe the structure of Caudate and Lentiform (Putamen & Globus Pallidus) nuclei.
- ❑ Differentiate between striatum & paleostriatum in term of connections.
- ❑ State briefly functions & dysfunctions of Corpus Striatum.

# BASAL GANGLIA (NUCLEI)

- *Group of nerve cells deeply situated in cerebral hemispheres*
- Components:
  1. **Caudate Nucleus**
  2. **Lentiform Nucleus:**  
*divided into Putamen & Globus Pallidus*
  3. **Amygdaloid Nucleus**



- Caudate & Lentiform nuclei are functionally related to each other & called “**Corpus Striatum**”: Part of **extrapyramidal motor system**, principally involved in the control of posture and movements (primarily by inhibiting motor functions)

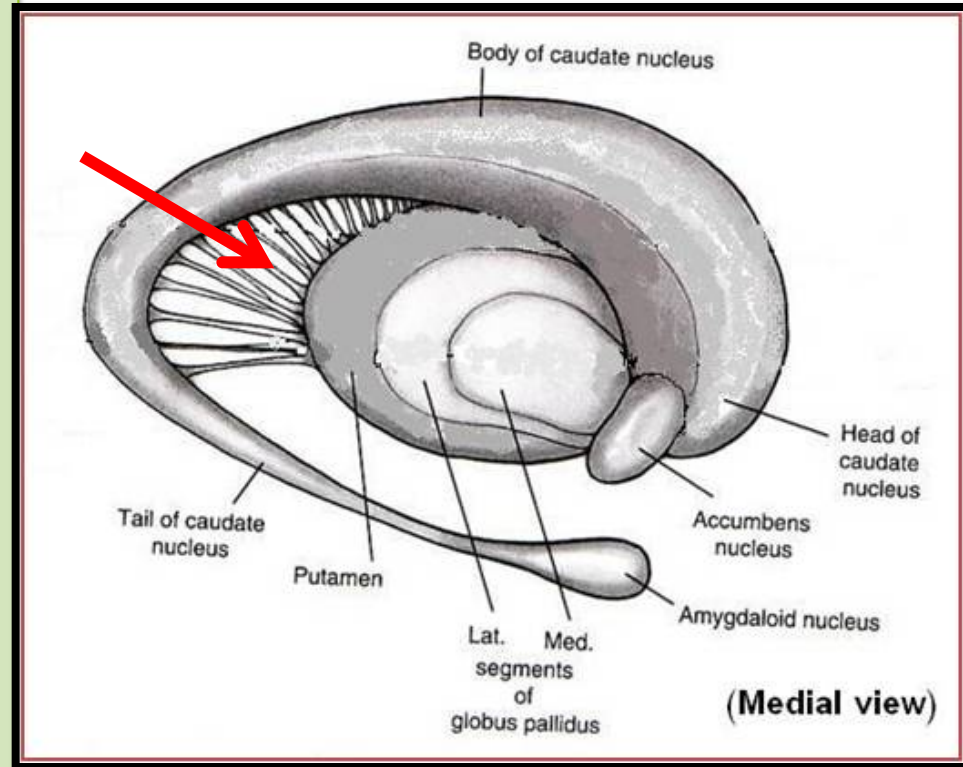


**Amygdaloid Nucleus** (part of limbic system) is only embryologically related to **Corpus Striatum**

# CORPUS STRIATUM

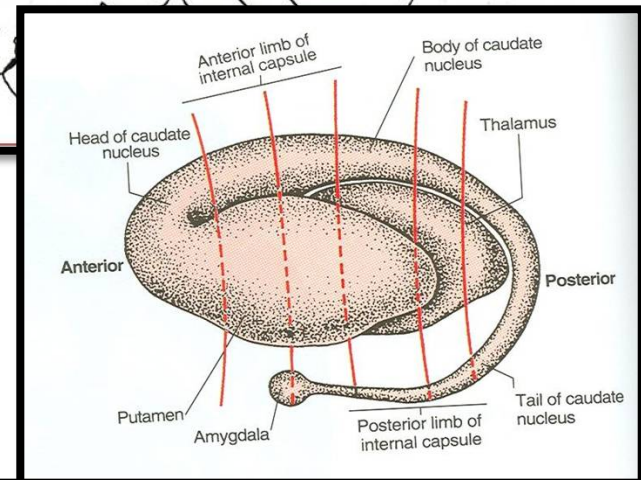
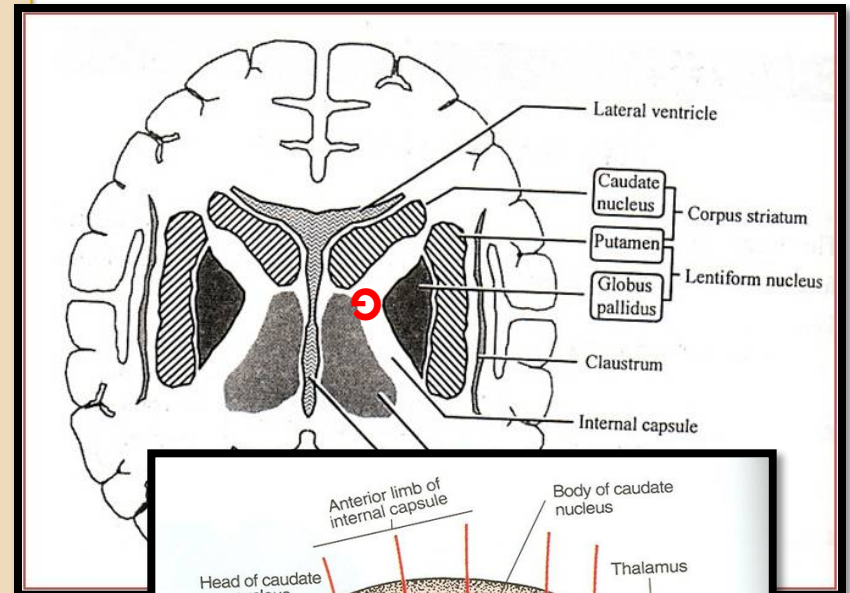
## *(Nomenclature)*

- Bands of grey matter pass from lentiform nucleus across the internal capsule to the caudate nucleus, giving the striated appearance hence, the name *corpus striatum*.



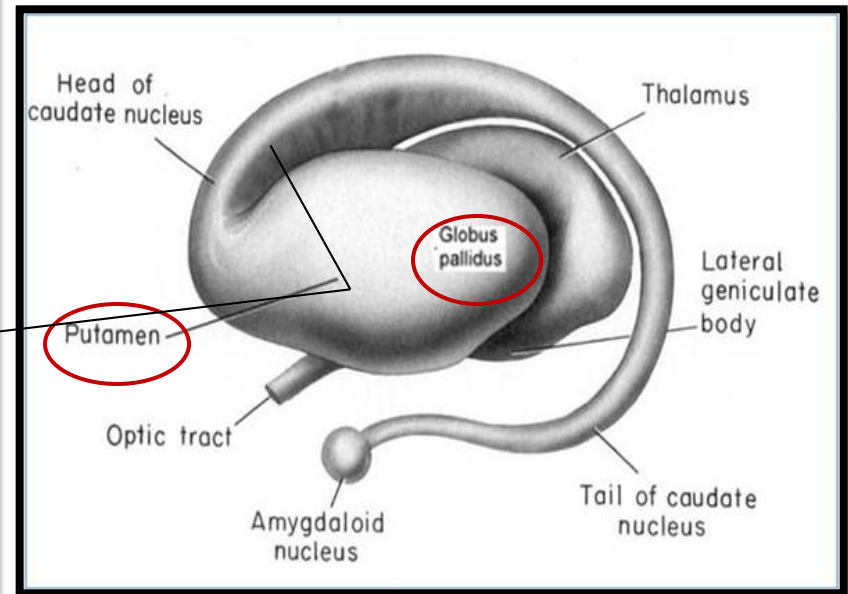
# PARTS

- ❑ **LENTIFORM NUCLEUS**
- ❑ **SHAPE:** three sided, wedge-shaped mass of grey matter, with a convex outer surface and an apex which lies against the genu of the internal capsule (G)
- ❑ **DIVISION:** divided into
  1. Larger darker lateral portion called **Putamen (P)**
  2. Smaller, lighter medial portion called **Globus Pallidus (g)**



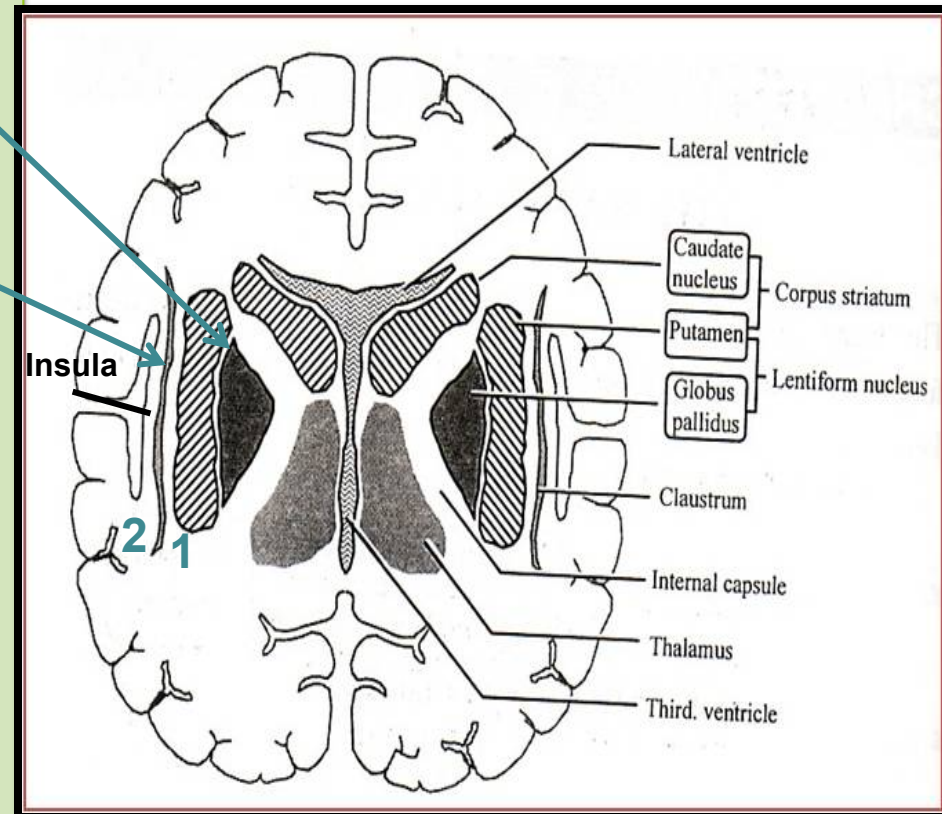
□ **Putamen** is more closely related to **Caudate nucleus** (regarding development, function & connections) and together constitute the **Neostriatum or Striatum**.

□ **Globus Pallidus** is the oldest part of corpus striatum and is called **Paleostriatum or Pallidum**



# PUTAMEN

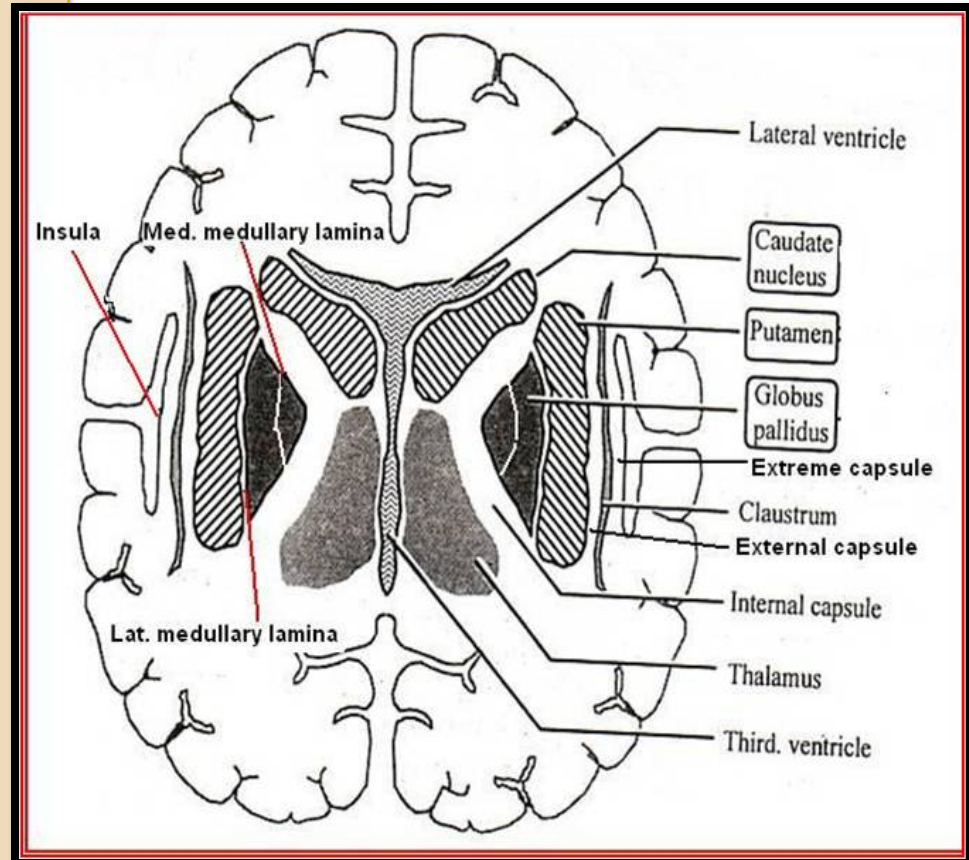
- Separated from globus pallidus by a thin sheath of nerve fibers, the **Lateral Medullary Lamina**
- The white matter lateral to putamen is divided, by a sheath of grey matter, the **Clastrum** into two layers:
  - **External capsule (1)** between the putamen and claustrum and
  - **Extreme capsule (2)** between the claustrum and the insula





# GLOBUS PALLIDUS

- Consists of two divisions, the Lateral & the Medial segments, separated by a thin sheath of nerve fibers, the **Medial Medullary lamina**.
- The medial segment is similar, in terms of cytology and connections with the **pars reticulata of substantia nigra**

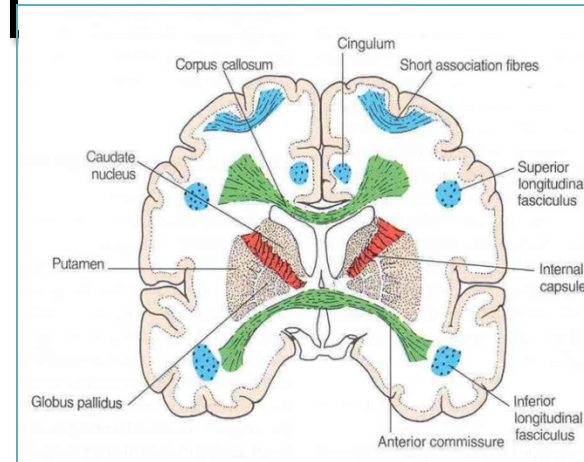
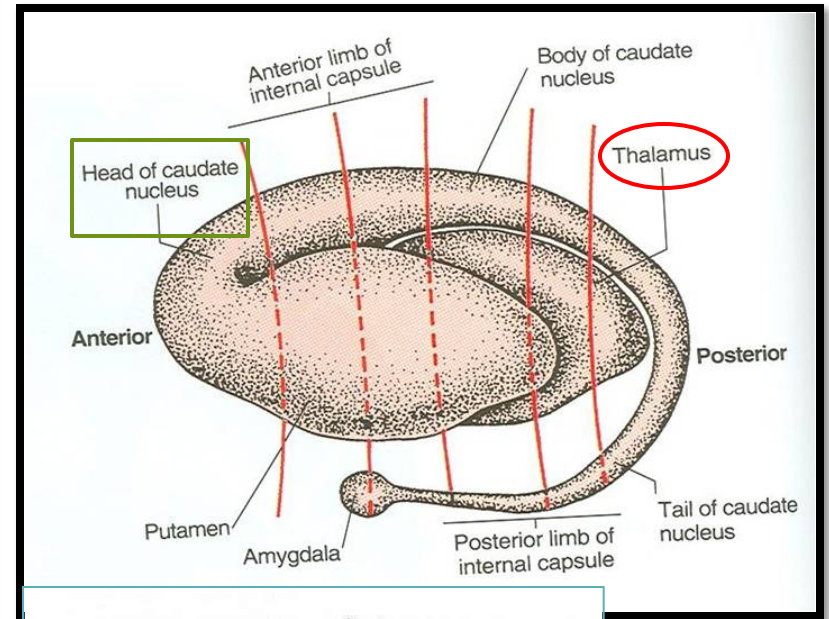


# CAUDATE NUCLEUS

- **SHAPE:** C-shaped mass of grey matter
- **COMPONENTS:** *head, body & tail*

## Head:

- Rounded in shape
- Lies anterior to thalamus (in frontal lobe)
- Completely separated from the putamen by the **internal capsule** except rostrally where it is continuous with the putamen



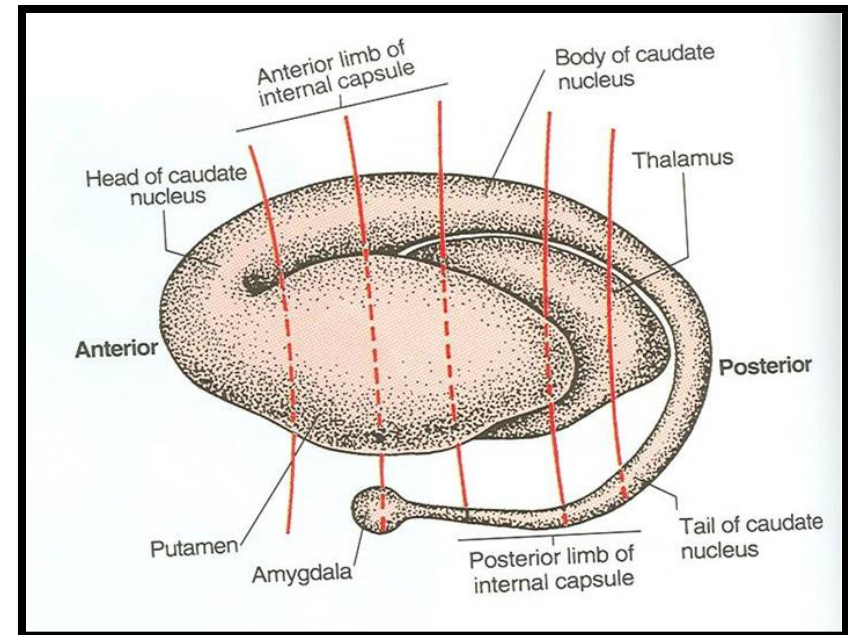
# CAUDATE NUCLEUS

## Body:

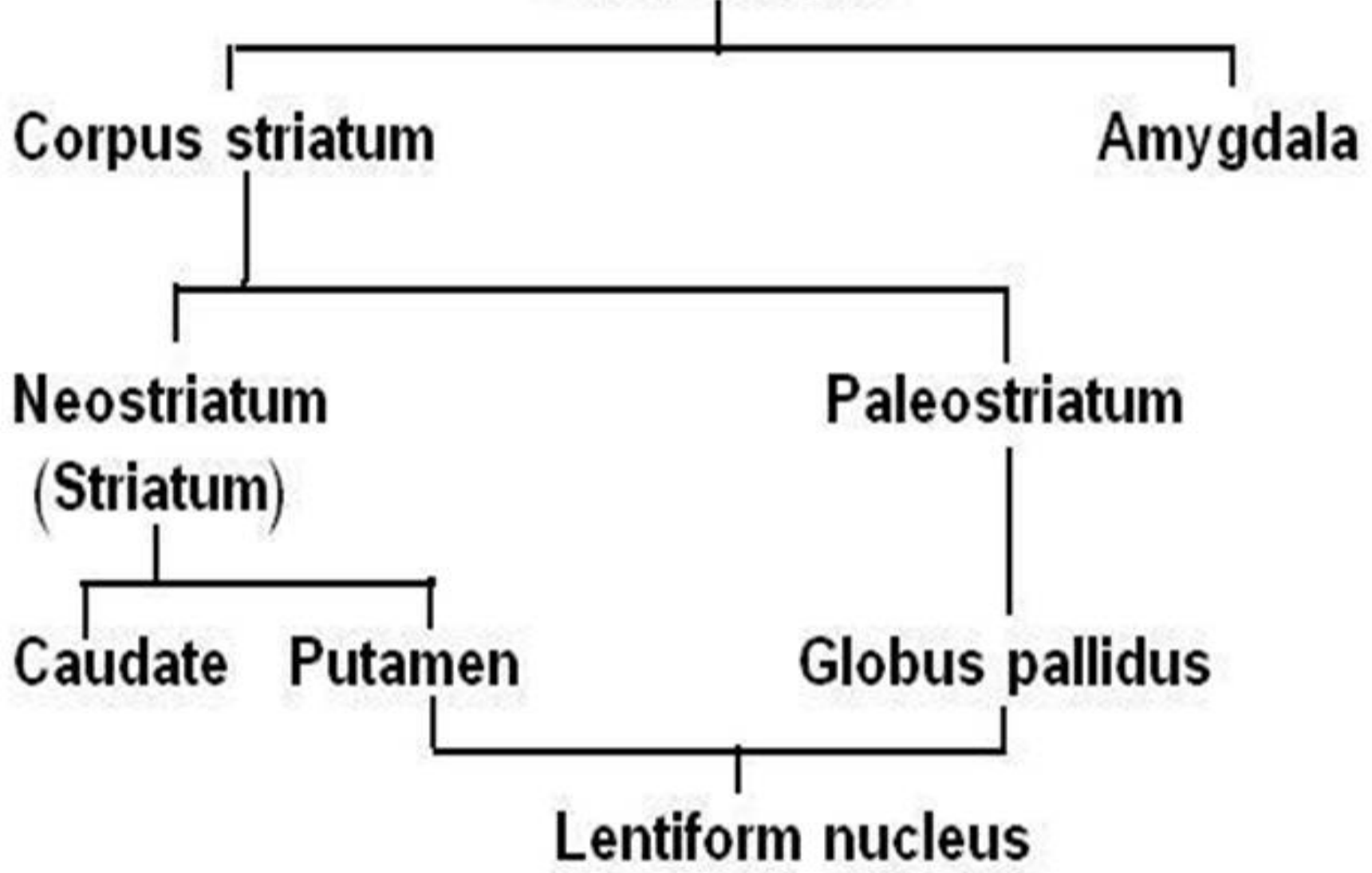
- Long & narrow
- Extends above thalamus (in parietal lobe)

## Tail:

- Long & tapering
- Descends into temporal lobe
- Continuous with Amygdaloid Nucleus



# Basal Ganglia



# CORPUS STRIATUM

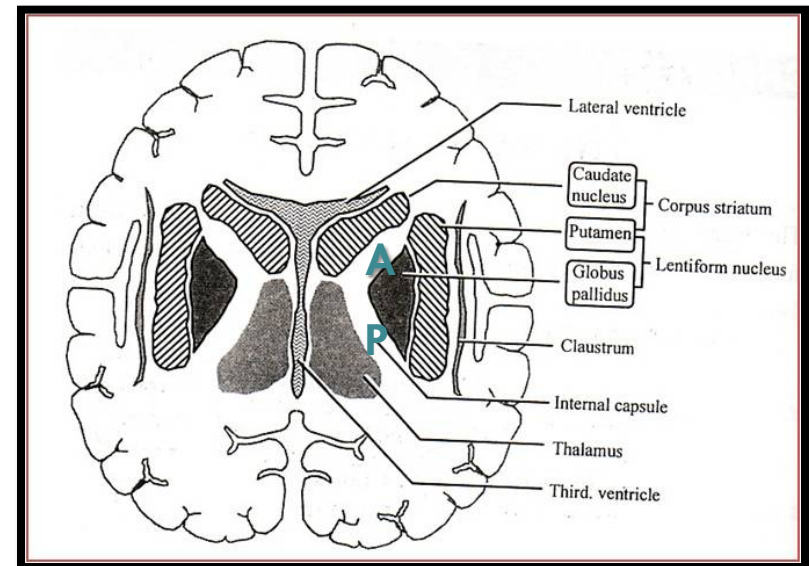
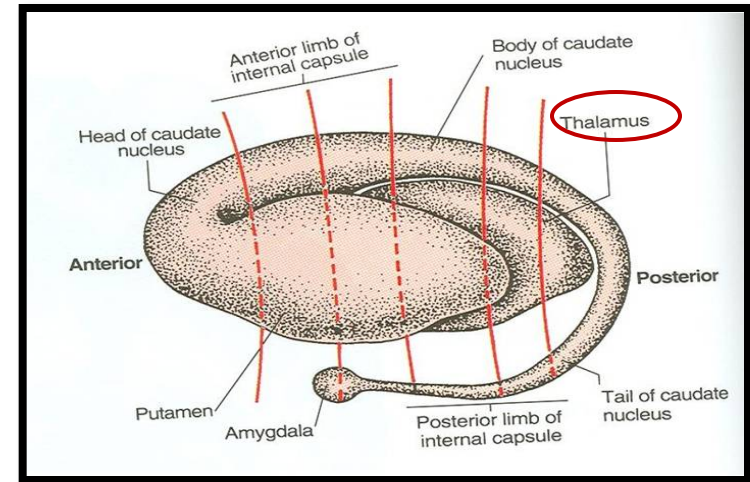
## (Important relations)

**Head of Caudate Nucleus**  
**lies:**

- **Anterior to thalamus**
- **Medial to Lentiform & separated from it by *anterior limb of internal capsule* (A)**

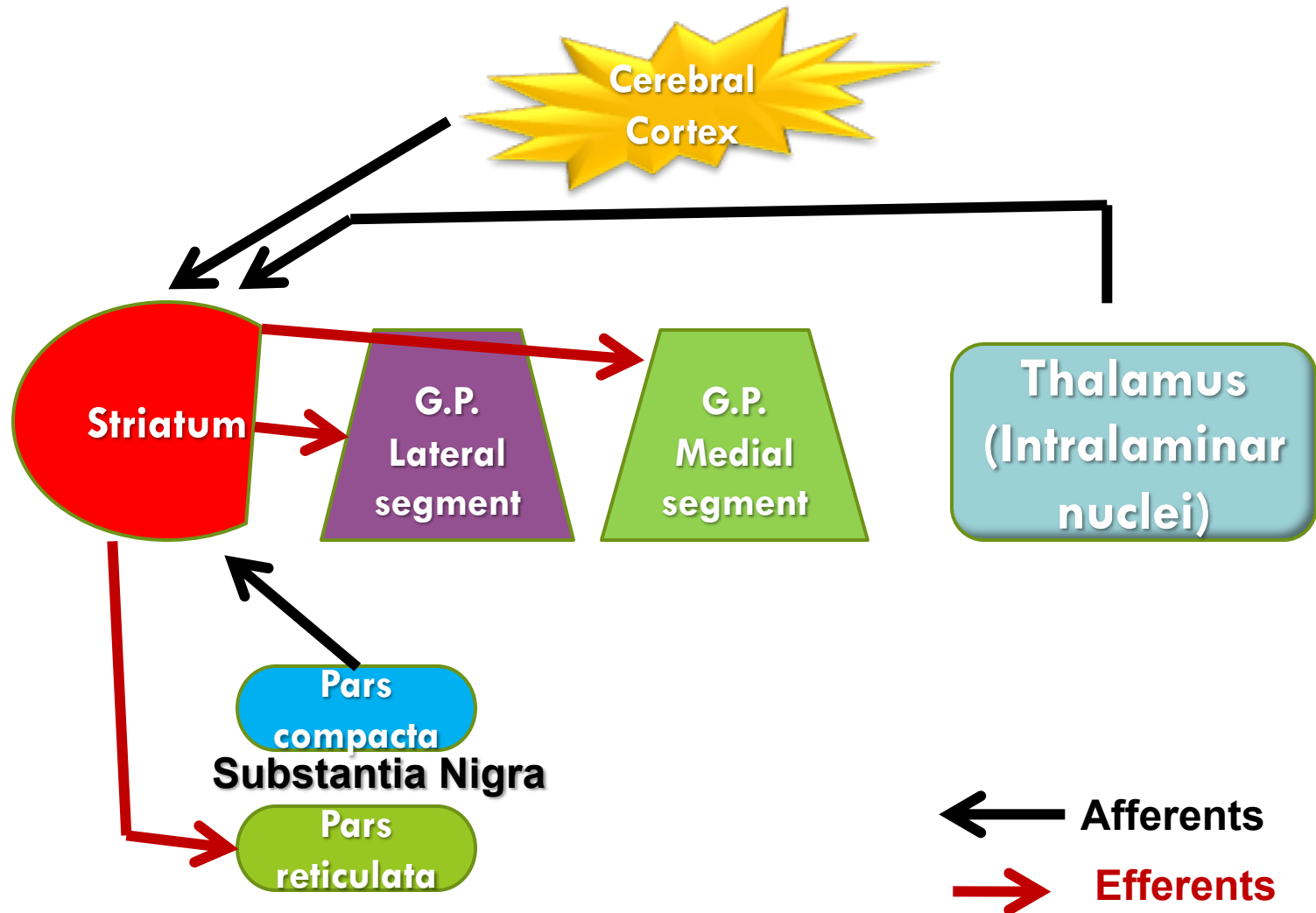
**Lentiform Nucleus:**

- **Lateral to thalamus & separated from it by *posterior limb of internal capsule* (P)**



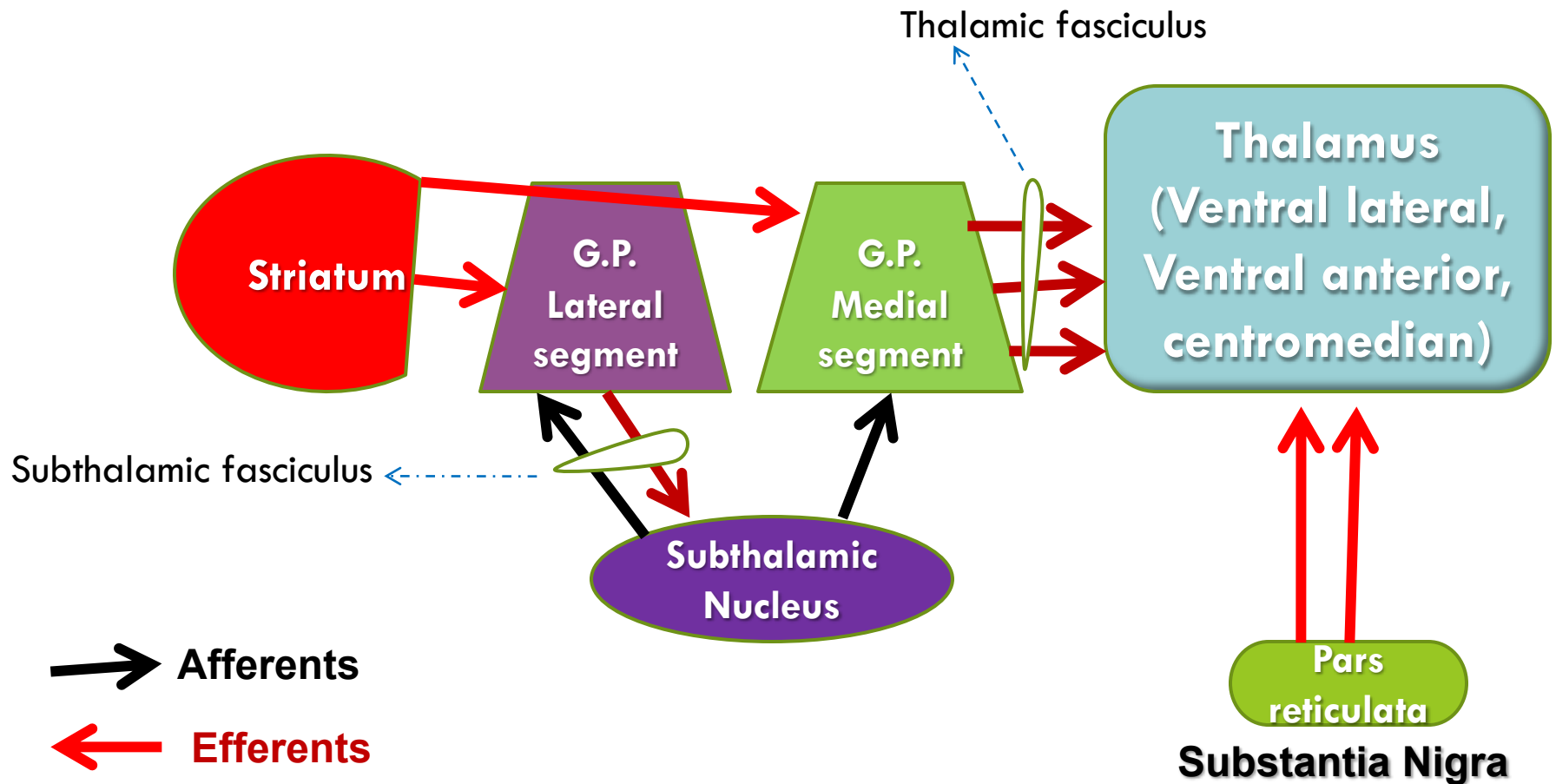
# STRIATUM (CAUDATE & PUTAMEN)

*“The input portion of Corpus striatum”*



# PALEOSTRIATUM (GLOBUS PALLIDUS)

*“The output portion of corpus striatum:  
medial segment of G.P. + Pars Reticulata of S.N.”*



# **CORPUS STRIATUM**

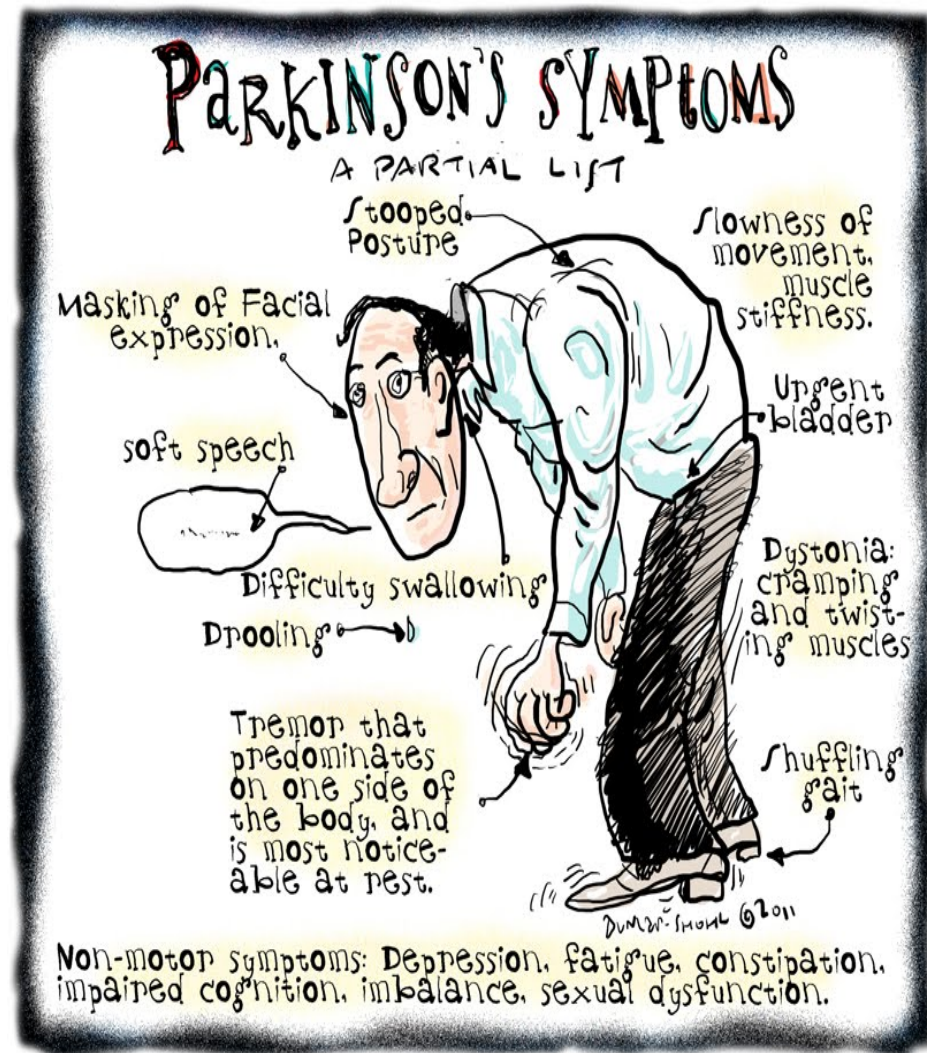
## ***Function***

- ❑ **The corpus striatum assists in regulation of voluntary movement and learning of motor skills as they:**
- ❑ **Facilitate behavior and movement that are required and appropriate.**
- ❑ **Inhibit unwanted or inappropriate movement.**



# Dysfunction

- Its dysfunction does NOT cause: **paralysis, sensory loss or ataxia**
- It leads to:
  - I. Abnormal motor control: emergence of abnormal, involuntary movements (dyskinesias)
  - II. Alteration in muscle tone: hypertonia/hypotonia



# Connection Of Corpus Striatum

## Afferent Fibers ( Input):

**I- Corticostriate** Fibers: From all parts of cerebral cortex (mostly from sensory- motor cortex) axons pass to caudate nucleus and putamen.

Glutamate is the neurotransmitter of this fibers.

**II-Thalamostriate Fibers** : From intralaminar nuclei of thalamus axons pass to caudate nucleus and putamen.

○ **III- Nigrostriate Fibers** : Axons from Substantia nigra of midbrain pass to caudate nucleus and putamen.

○ Neurotransmitter is Dopamine.

**IV Brain stem Strial Fibers** : Ascending fibers from brain stem end in caudate nucleus & putamen.

○ Serotonin is the neurotransmitter.

○ It is believed that the last 2 groups are inhibitory in function

## ○ Efferent fibers (Output):

### 1-Striatopallidal fibers:

These fibers pass from striatum (caudate nucleus & putamen) to globus pallidus.

- Gamma-aminobutyric acid (GABA) is the neurotransmitter.

### ○ 2-Striatonigral fibers:

- These fibers pass from caudate nucleus & putamen to Substantia nigra.
- Some fibers use GABA as a neurotransmitter, and others use substance p.



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# **BASAL GANGLIA**

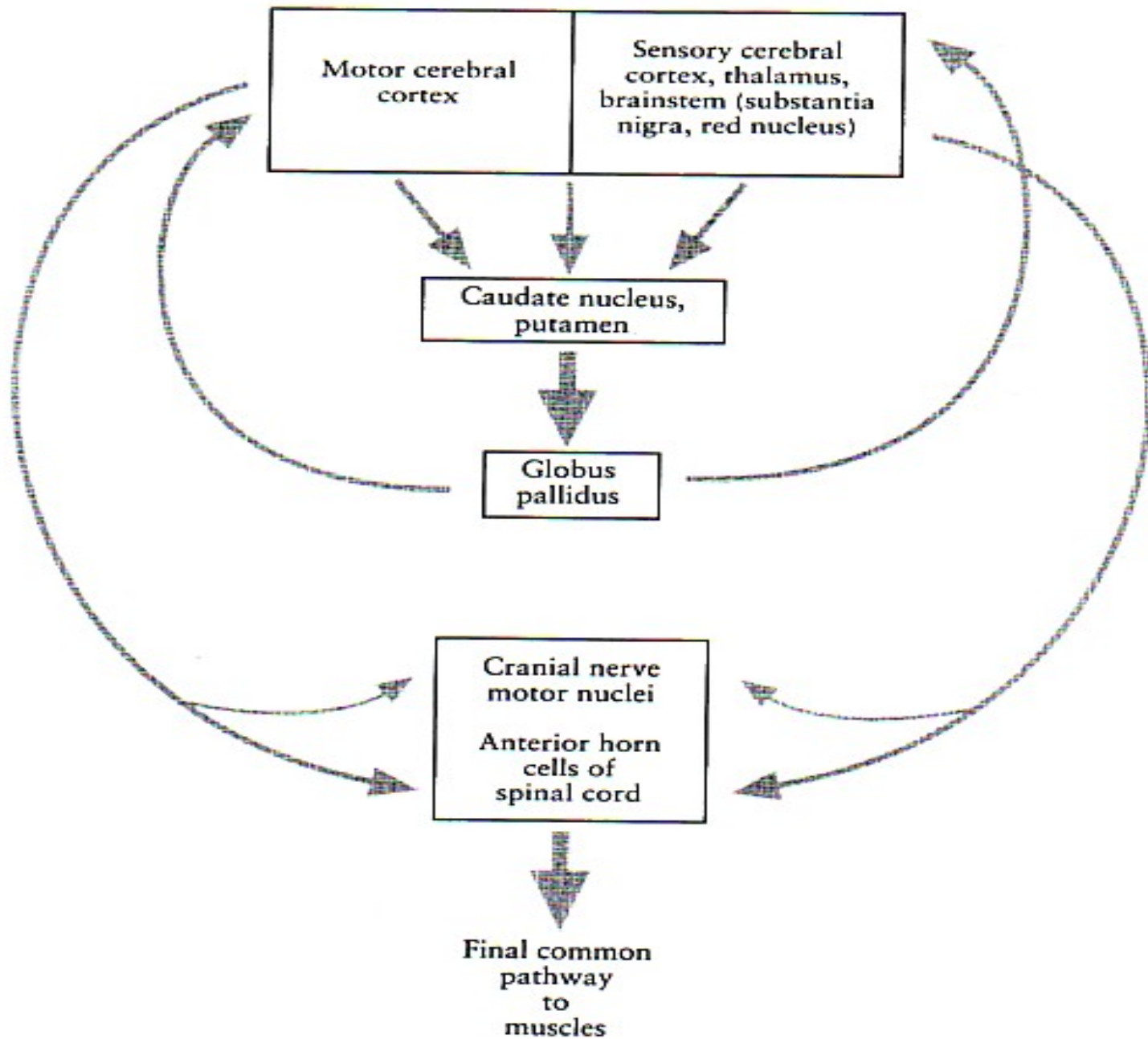
## **FUNCTIONS**

- **Control of movements**
- **Planning and programming of movements**
- **Cognition**

# Introduction to function of basal Nuclei

Basically the activity of basal nuclei begins by information received from sensory cortex, thalamus, substantia nigra, and red nucleus, according to thoughts of mind.

- These information is integrated within striatum and channeled within globus pallidus and outflow back to motor areas of cerebral cortex, and other motor areas in brain stem.
- Thus the basal nuclei can control muscular movement through its effect on cerebral cortex
- So basal nuclei assist in regulation of voluntary movement and learning of motor skills.



## Functions of basal ganglia:

1- Design of plans, which convert thoughts and ideas into motor actions: to produce a coordinated organized purposeful movement.  
e.g. dressing.

○ Determining the timing and scale of movement: to what extent the movement will be fast, and how long it will last.

○ Storage of motor programs of familiar motor actions: e.g. signature.

# Parkinsonism

## Parkinson's disease, paralysis Agitans

- **Lesion:**

- Neuronal degeneration in substantia nigra leading to reduction of dopamine within corpus striatum.

- **Features:**

- 1- **Tremors:**

Pill-rolling, involuntary, rhythmic, oscillating movements. It occurs during rest, it is called static tremors.

- 2- **Rigidity:**

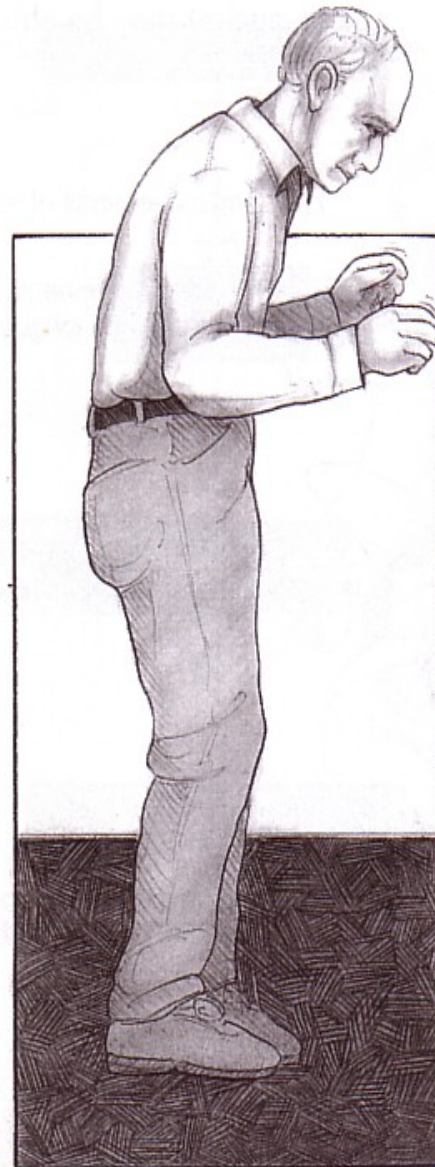
It occurs in both flexors, and extensors, but more in flexors giving flexion attitude. It is called lead pipe rigidity.

- 3- **Akinesia:**

it means lack of movement; Absence of swinging arm during walking, mask face, low- volume slow monotonous speech, and shuffling gait.



# Parkinsonism



Mask-like facial expression

Pill-rolling tremor

Flexion of trunk

Slow, shuffling feet  
movements

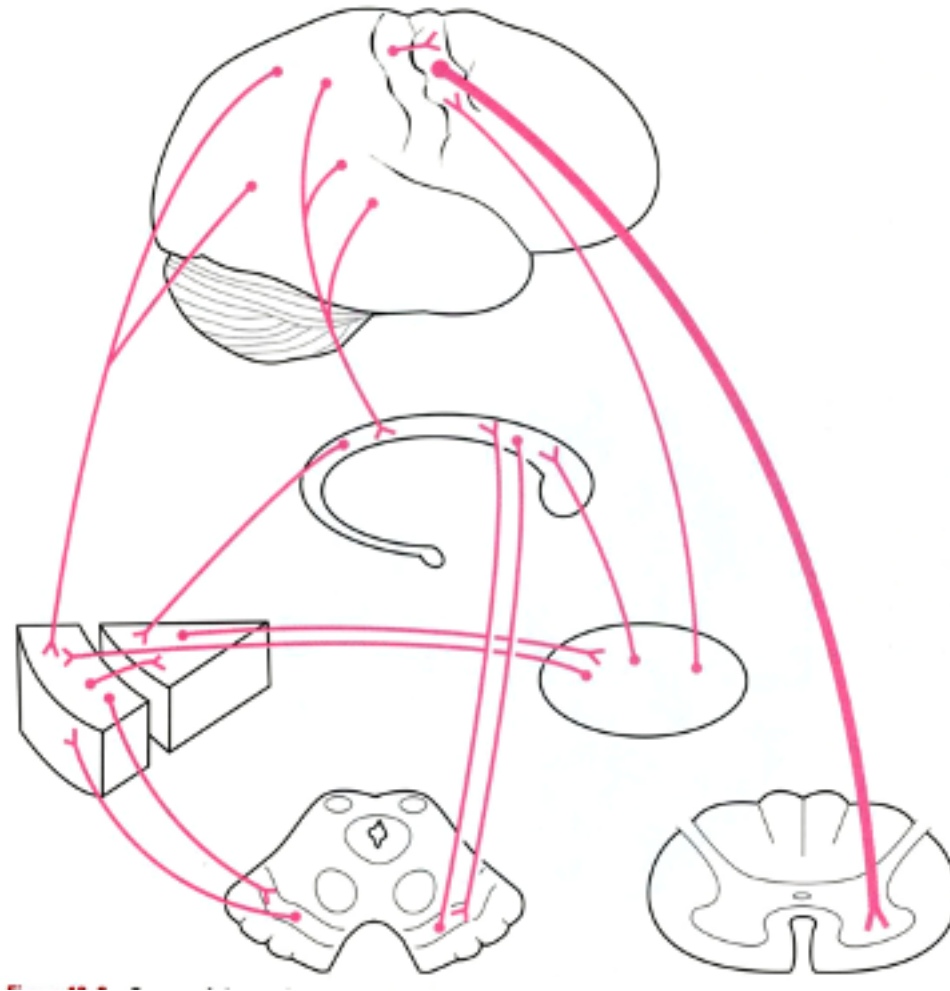
# Parkinson's Disease

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- Described by James Parkinson
- Degeneration of dopaminergic nigrostriatal neurons (60-80 %).
- Methyl-Phenyl-Tetrahydro-Pyridine (MPTP). The oxidant MPP<sup>+</sup> is toxic to SN.
- Four cardinal symptoms
  - Tremor
  - Rigidity
  - Akinesia & Bradykinesia
  - Postural Changes
  - Speech Changes

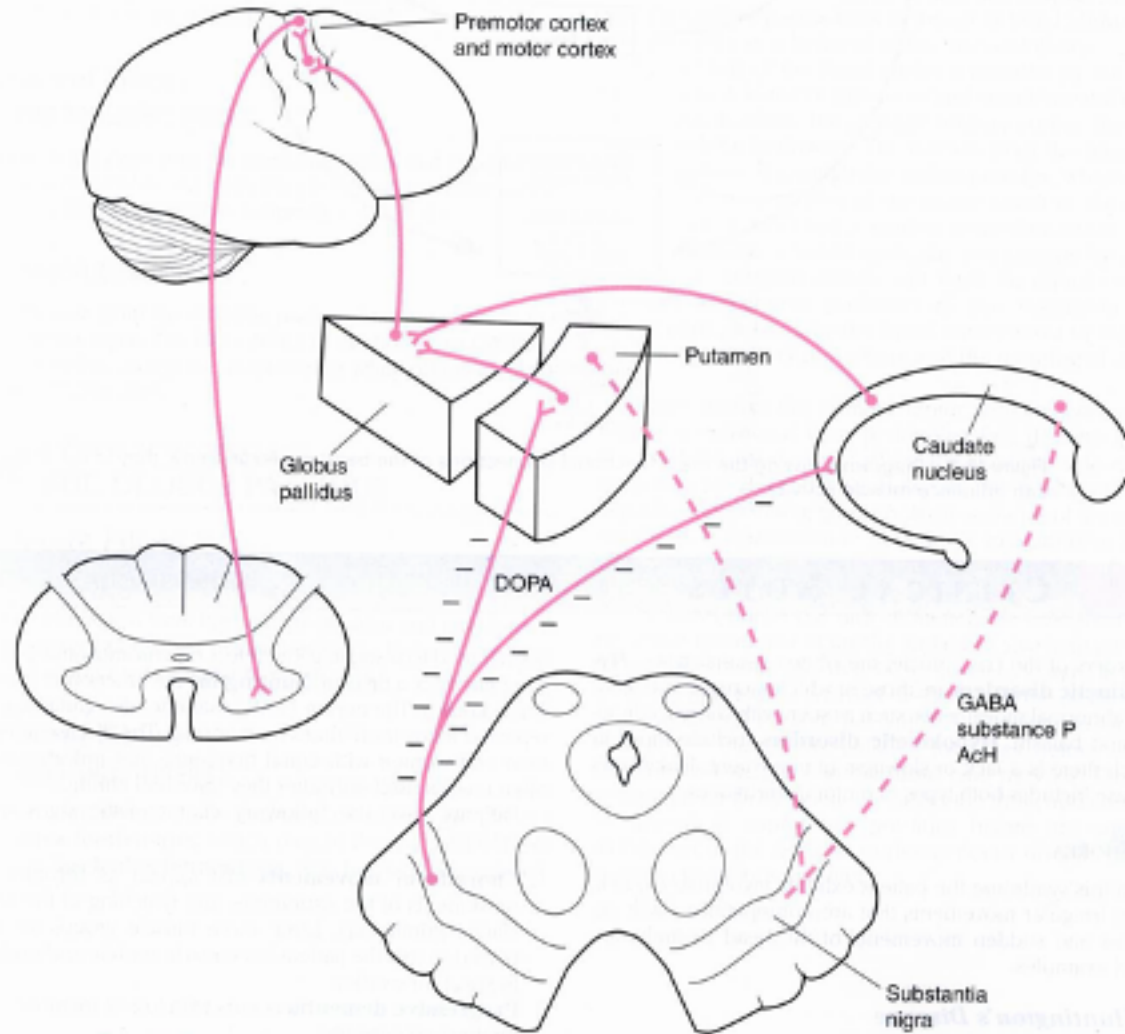
# Main Connections between Cortex, basal Nuclei, Thalamic Nuclei Brainstem & Spinal Cord

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# Huntington's Disease:

degeneration of inhibitory pathway  
between corpus striatum & S nigra



# Degeneration of inhibitory pathways between S Nigra & corpus striatum

