BASAL GANGLIA

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OBJECTIVES

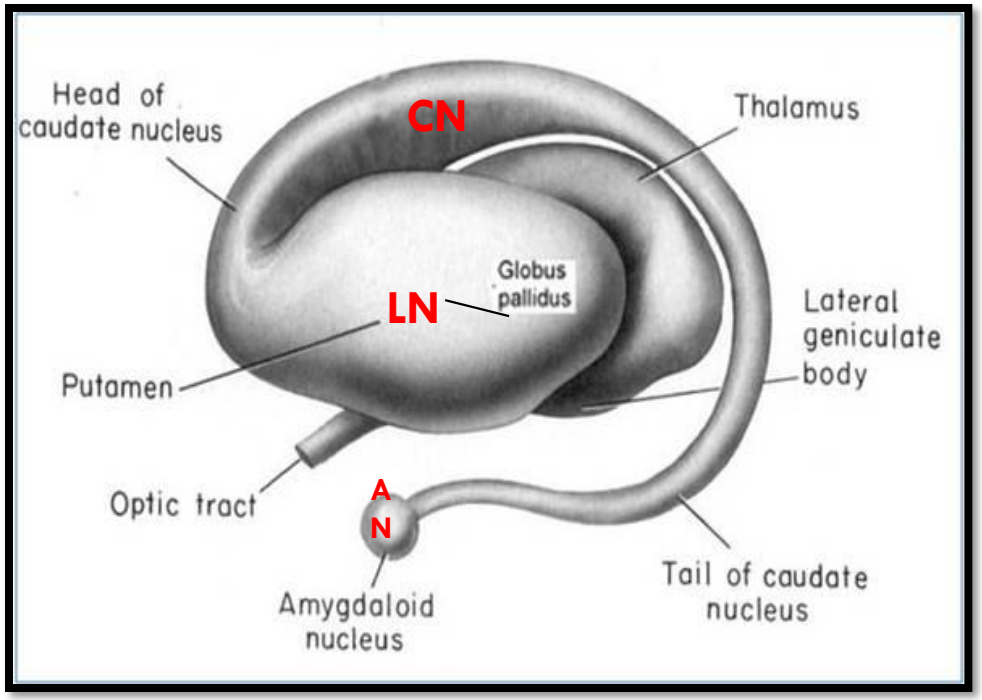
At the end of the lecture, the student should be able to:

- **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.**

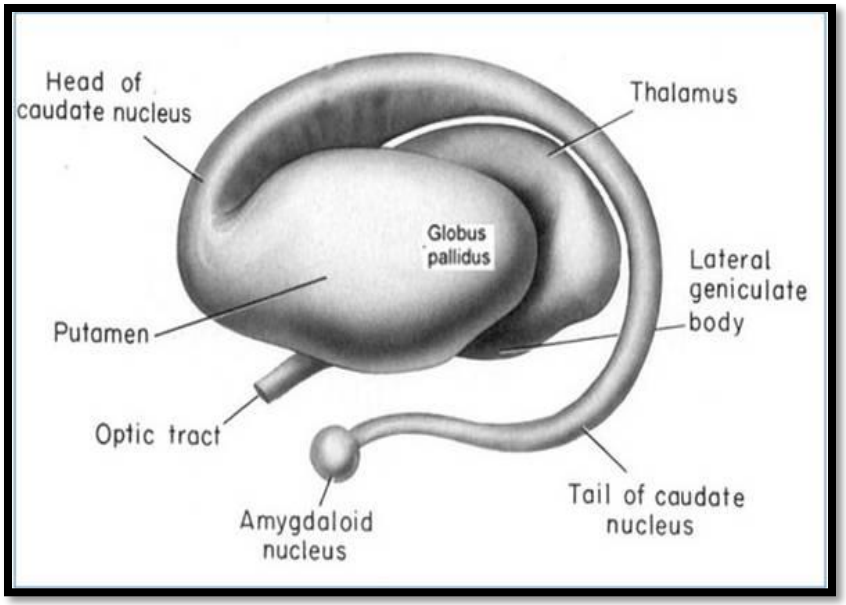
BASAL GANGLIA (NUCLEI)

- ***Group of nerve cells deeply situated in cerebral hemispheres***
- **Components:**

1. **Caudate Nucleus**
2. **Lentiform Nucleus: divided into *Putamen & Globus Pallidus***
3. **Amygdaloid Nucleus**



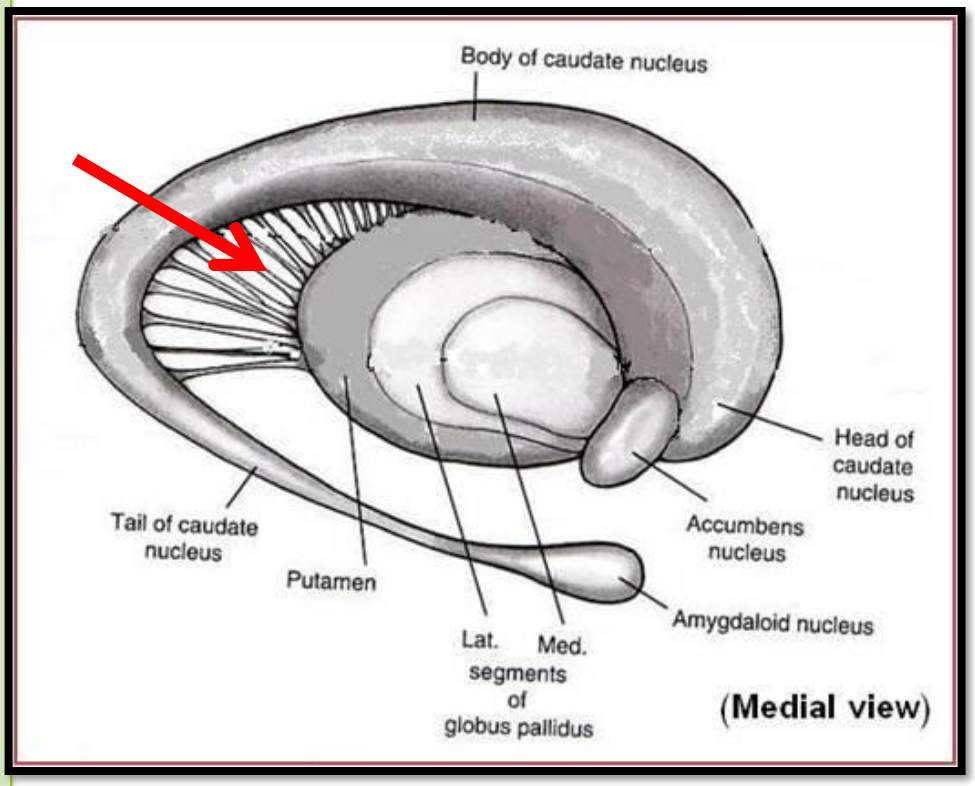
- **Caudate & Lentiform nuclei are functionally related to each other & called "*Corpus Striatum*":Part of *extrapyramidal motor system*, principally involved in the control of posture and movements (primarily by inhibiting motor functions)**



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

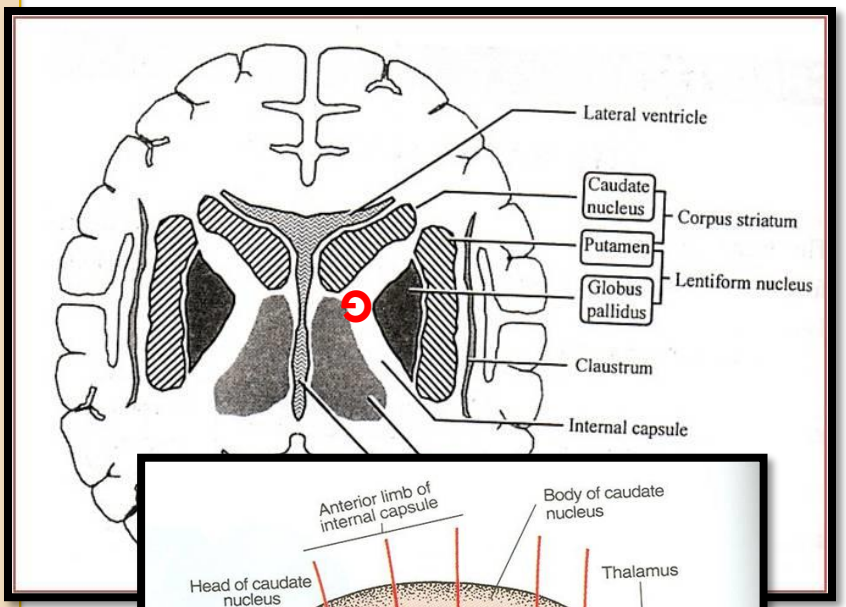
CORPUS STRIATUM (NOMENCLATURE)

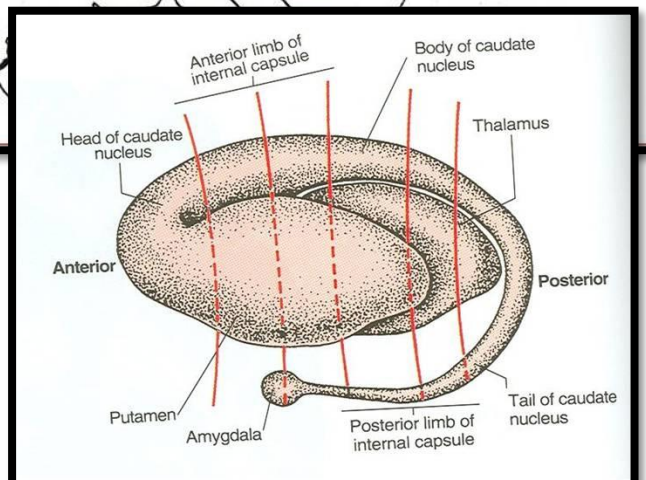
- Bands of grey matter pass from lentiform nucleus across the internal capsule to the caudate nucleus, giving the striated appearance hence, the name ***corpus striatum***.



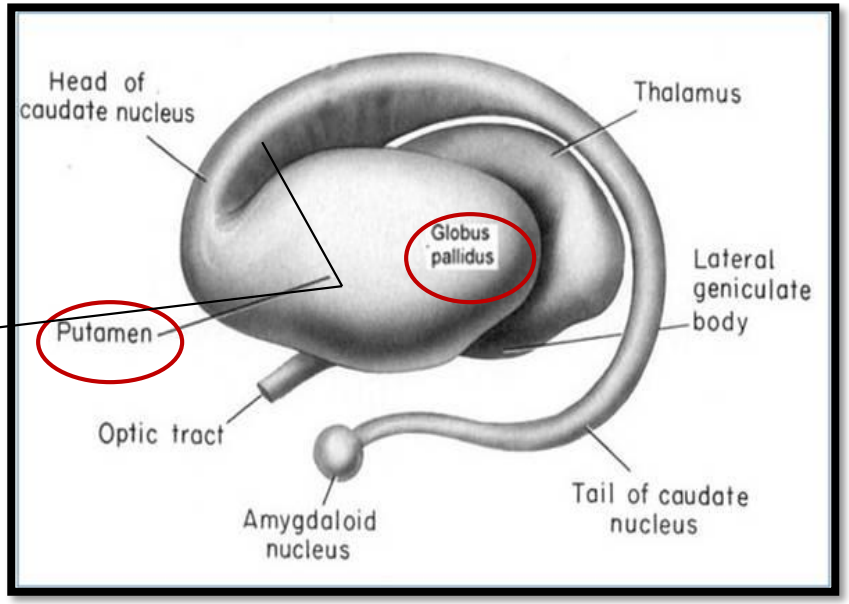
PARTS

- **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)



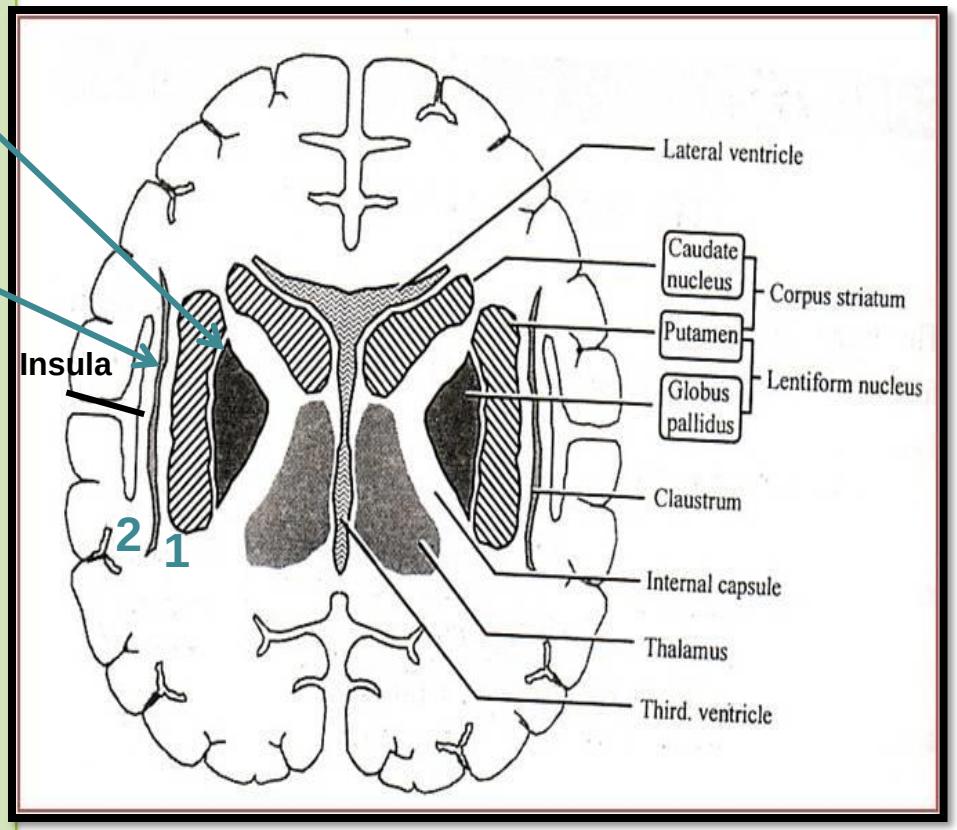


- **Putamen** is more closely related to **Caudate nucleus** (regarding development, function & connections) and together constitute the **Neostriatum** or **Striatum**.
- **Globus Pallidus** is the oldest part of corpus striatum and is called **Paleostriatum** or **Pallidum**



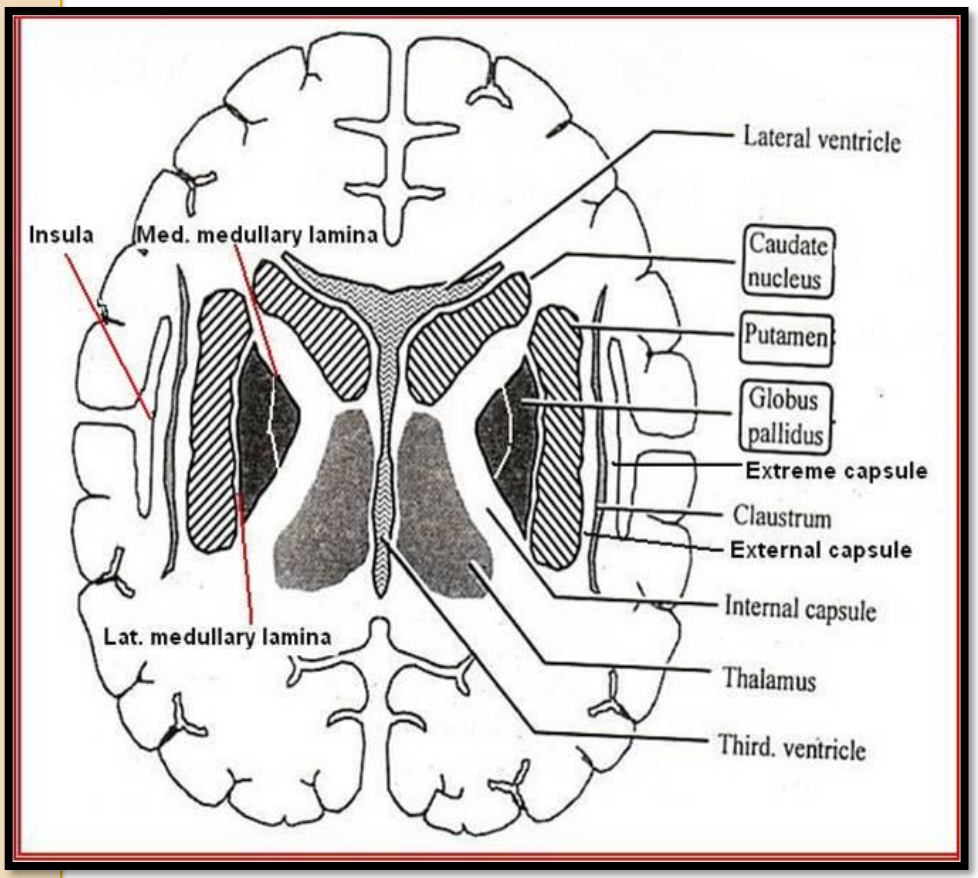
PUTAMEN

- 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 **Claustrum** 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

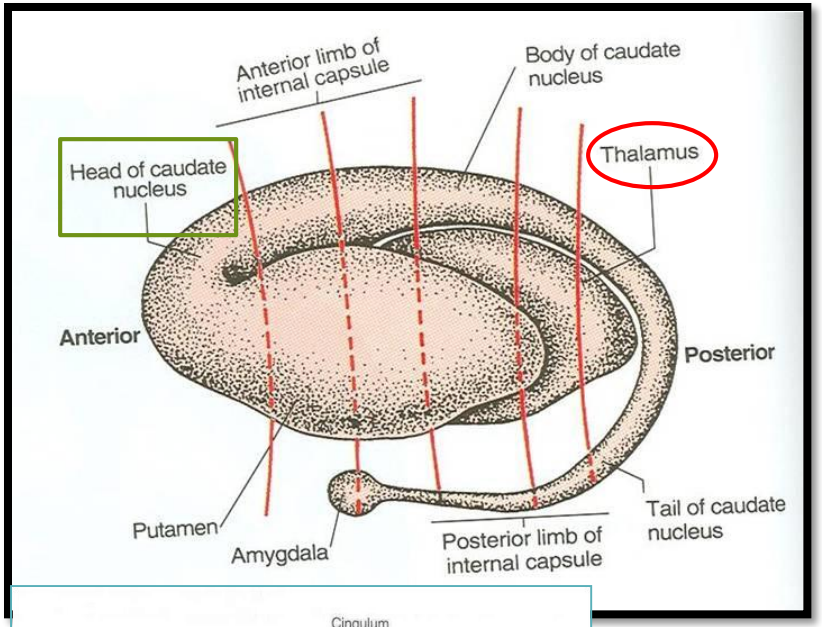
- **SHAPE:** C-shaped mass of grey matter
- **COMPONENTS:** *head, body & tail*

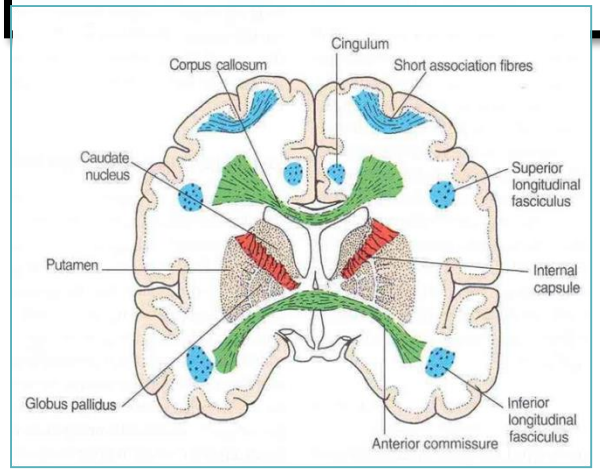
Head:

-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

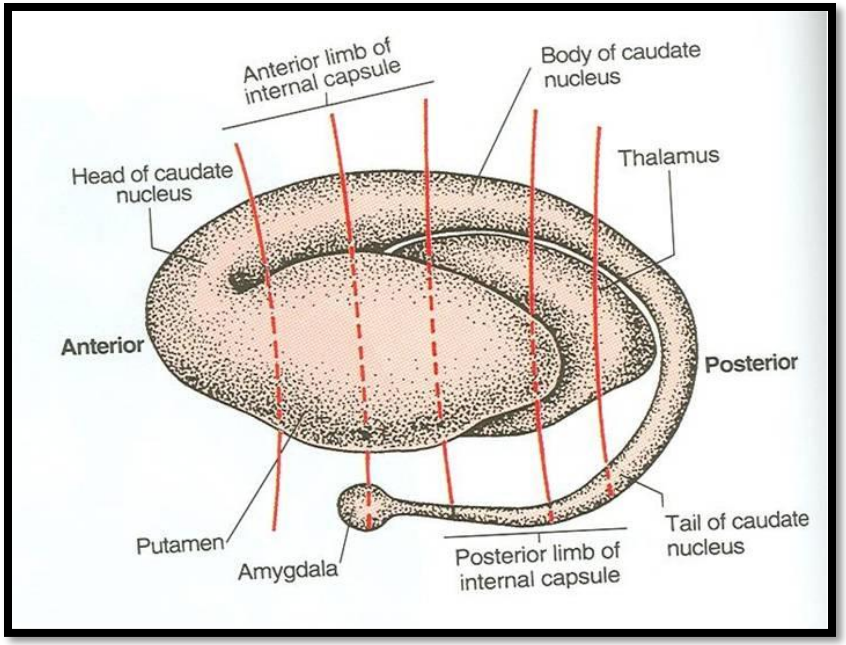
-Extends above thalamus (in parietal lobe)

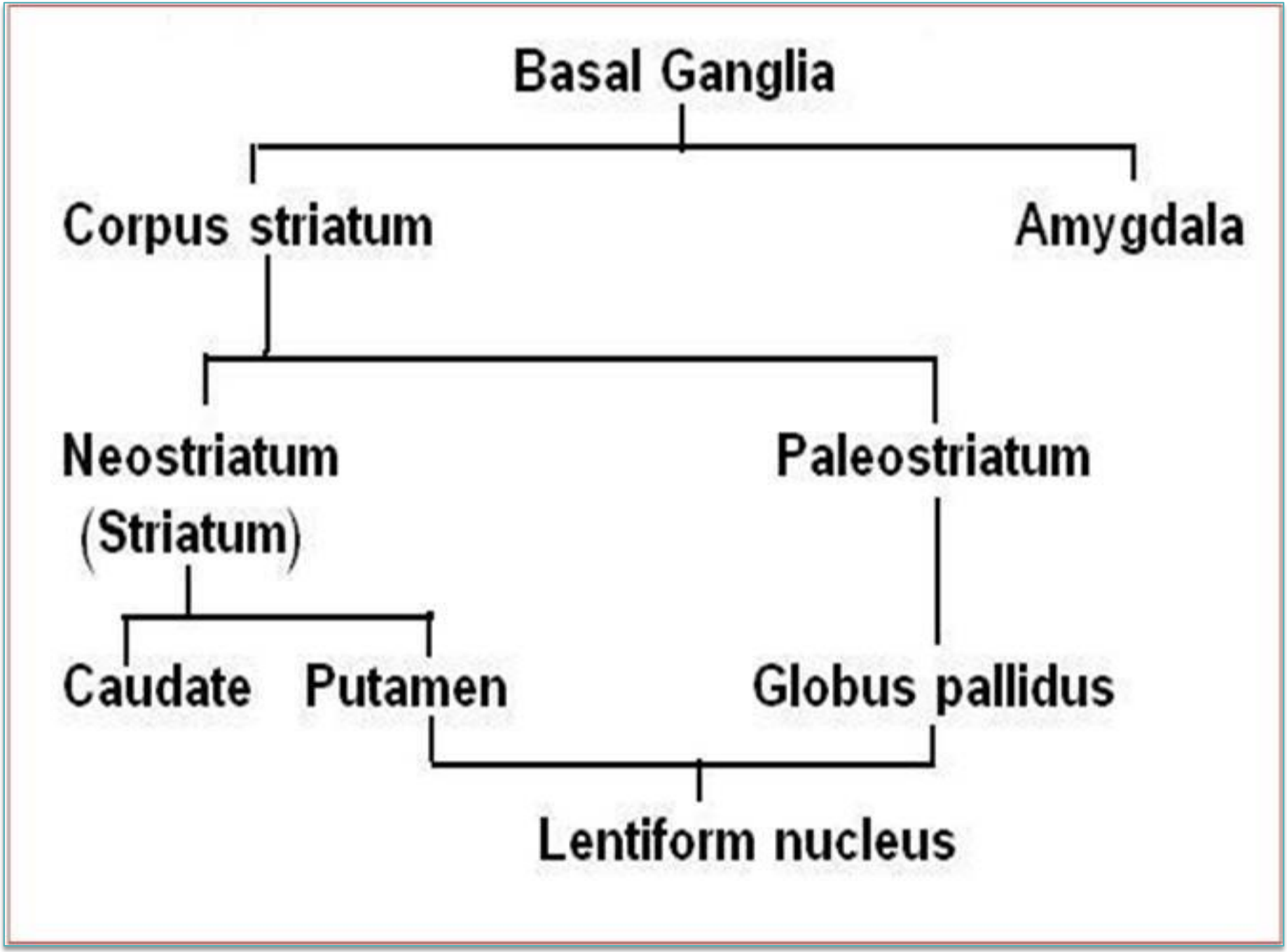
Tail:

-Long & tapering

-Descends into temporal lobe

-Continuous with Amygdaloid Nucleus




Basal Ganglia
Corpus striatum
Amygdala
Neostriatum
(Striatum)
Paleostriatum
Caudate
Putamen
Globus pallidus
Lentiform nucleus

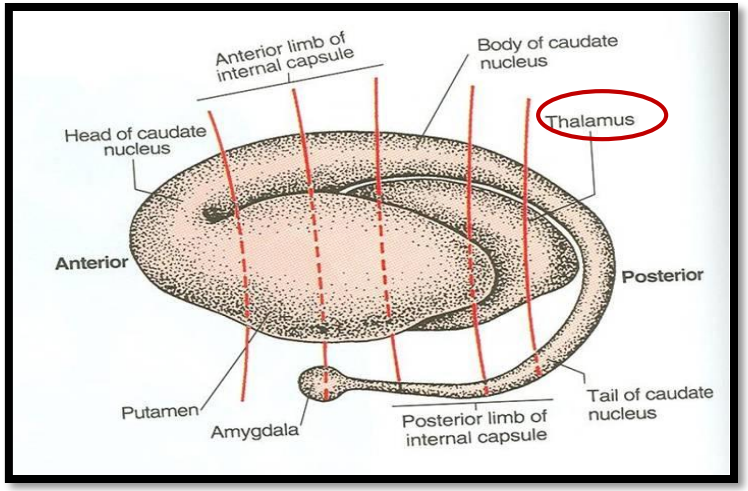
CORPUS STRIATUM (IMPORTANT RELATIONS)

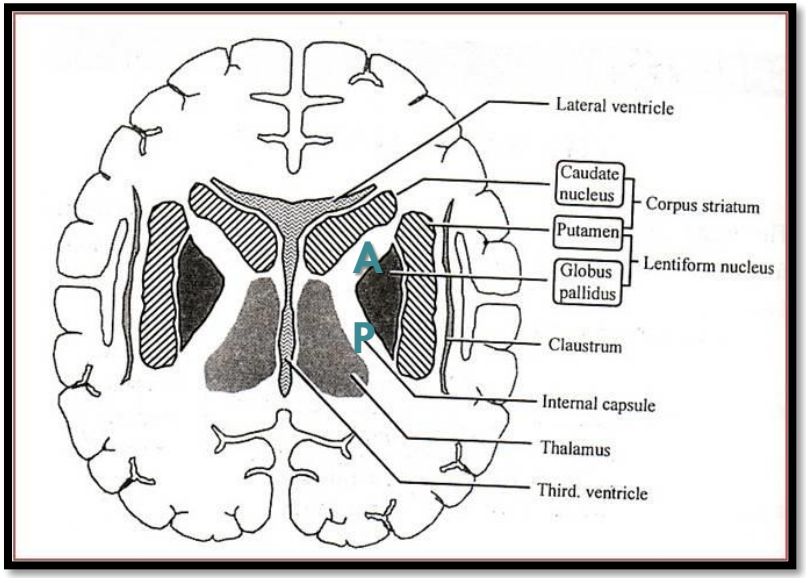
Head of Caudate Nucleus lies:

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

Lentiform Nucleus:

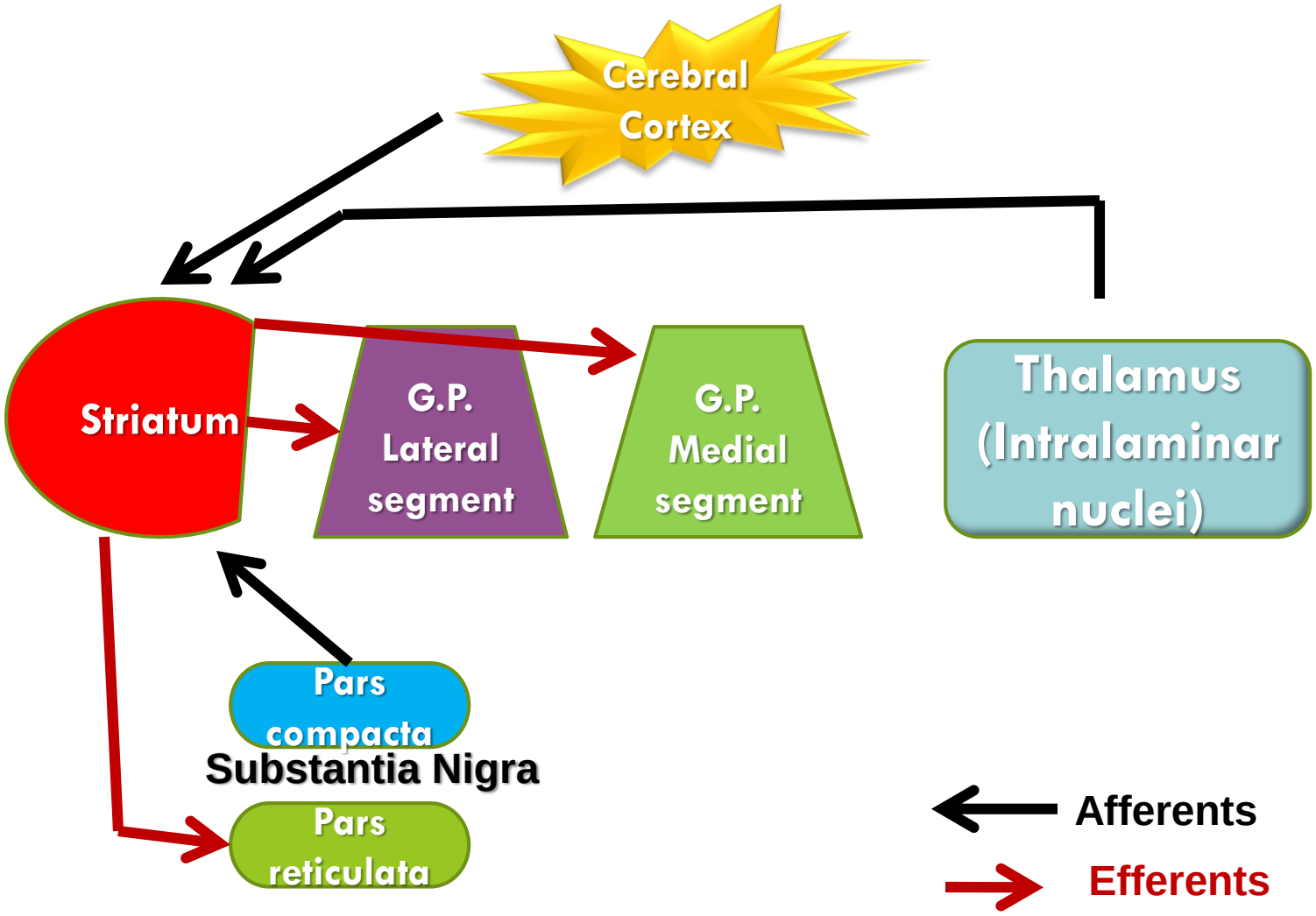
- **Lateral** to thalamus & separated from it by *posterior limb of internal capsule* (P)





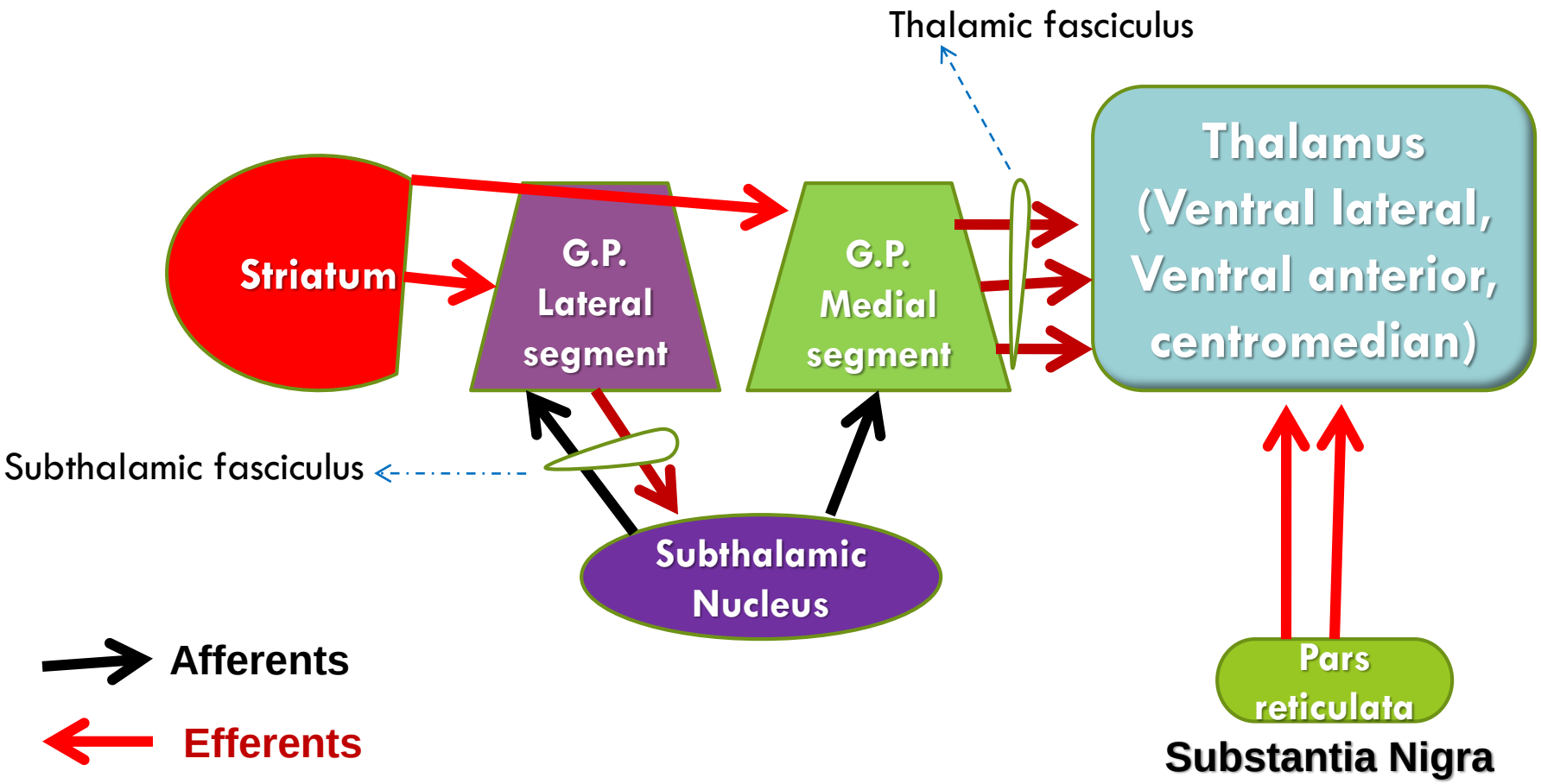
STRIATUM (CAUDATE & PUTAMEN)

"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."

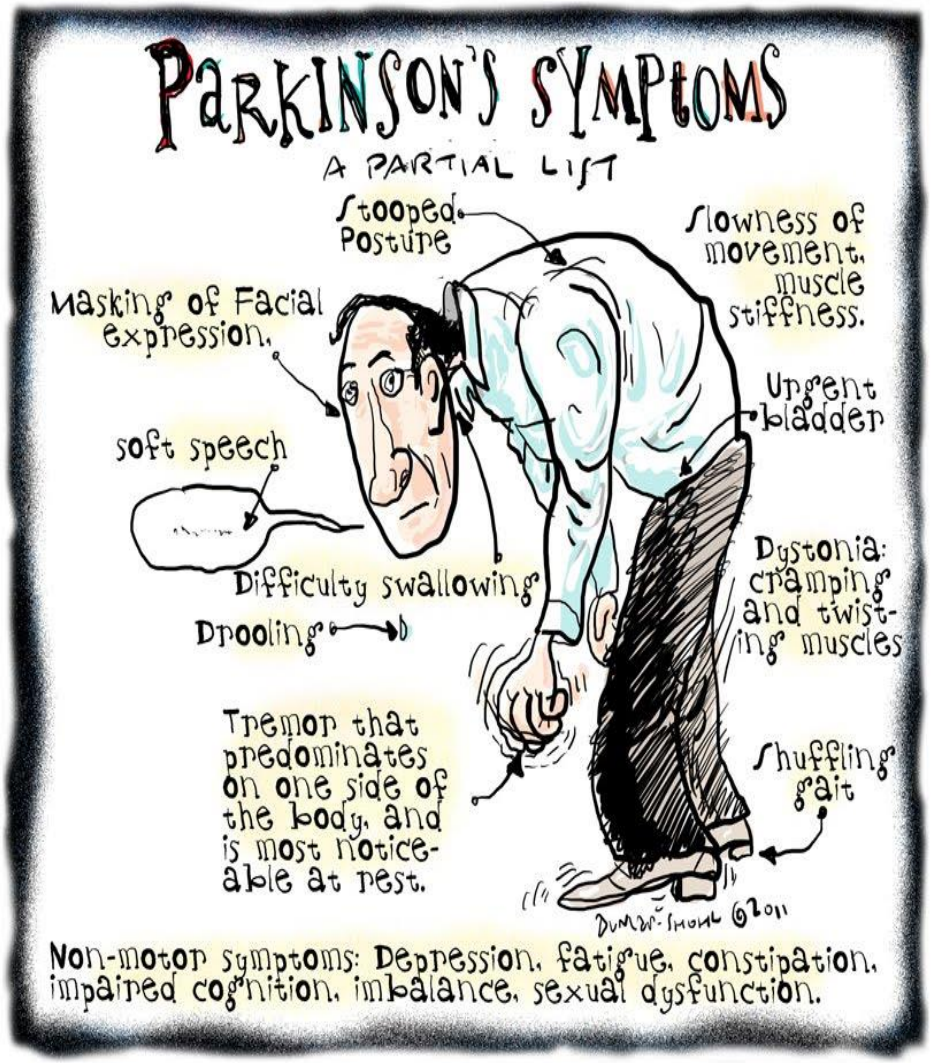


CORPUS STRIATUM
FUNCTION

- 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 corpus 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.

BASAL GANGLIA

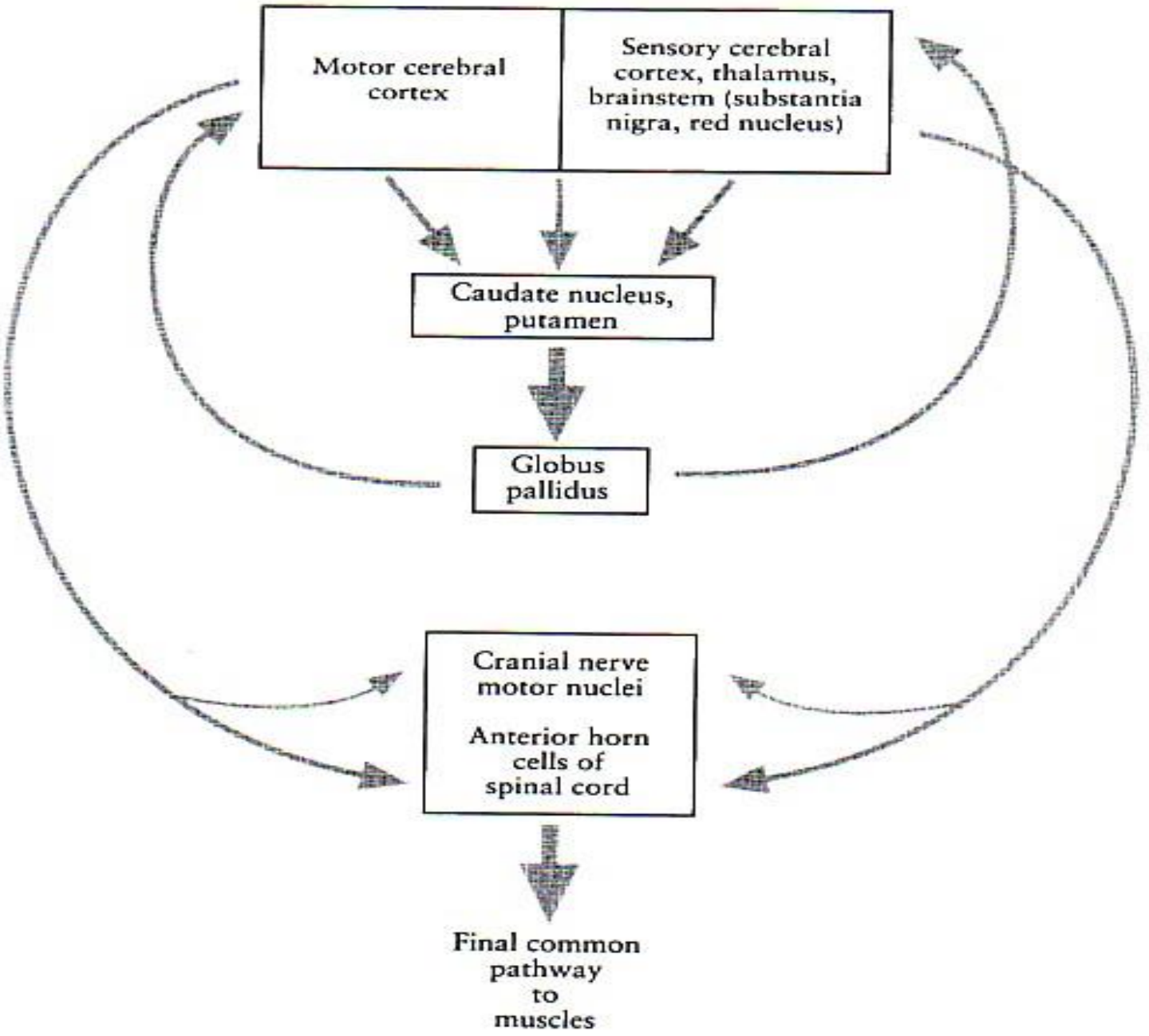
FUNCTIONS

- **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 corpus 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.


Motor cerebral cortex
Sensory cerebral cortex, thalamus, brainstem (substantia nigra, red nucleus)
Caudate nucleus, putamen
Globus pallidus
Cranial nerve motor nuclei
Anterior horn cells of spinal cord
Final common pathway to muscles

- **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.

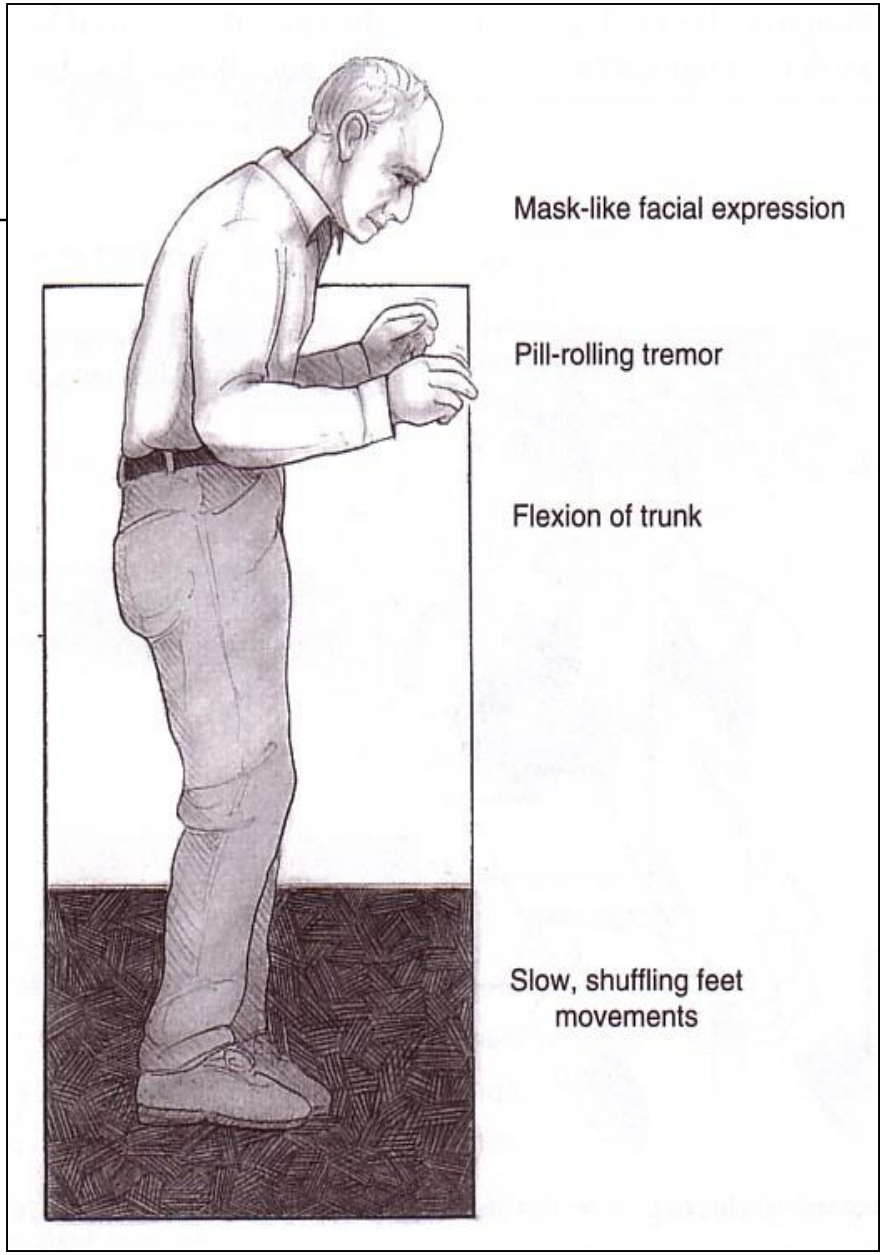
2- **Rigidity:**

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.

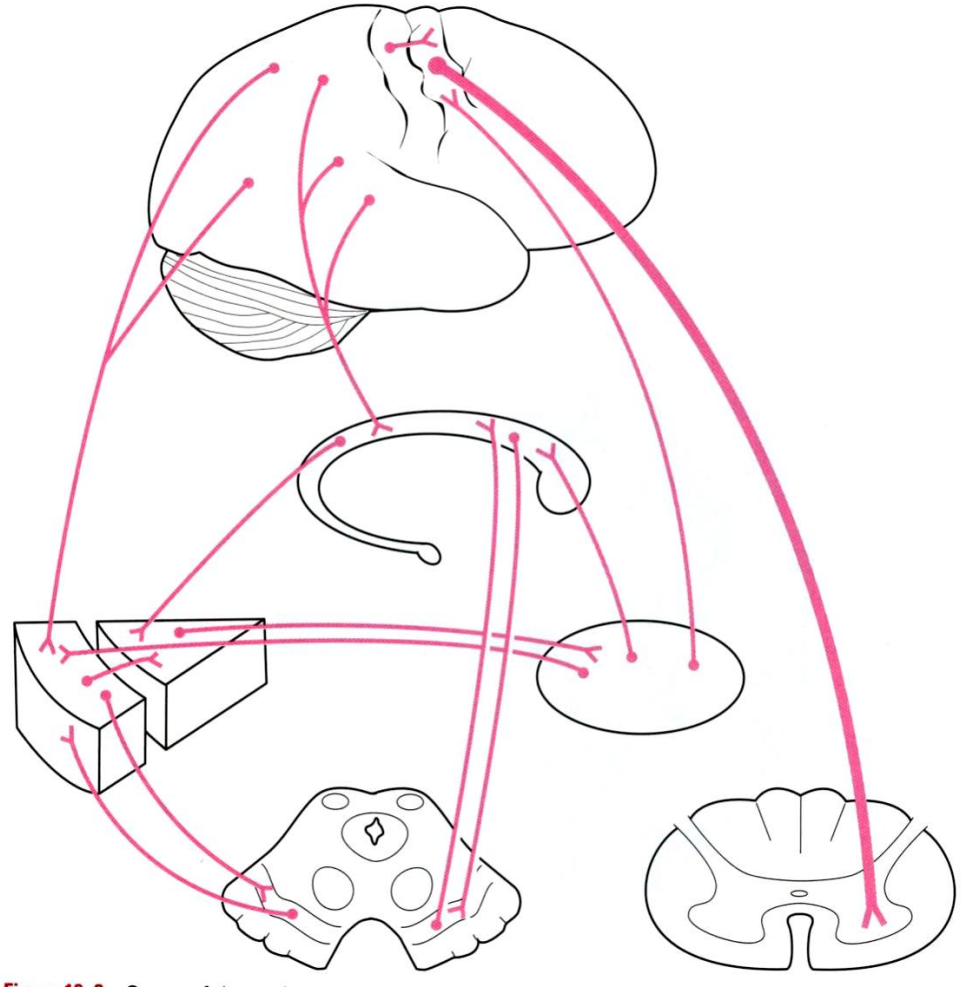
Parkinsonism



Parkinson's Disease

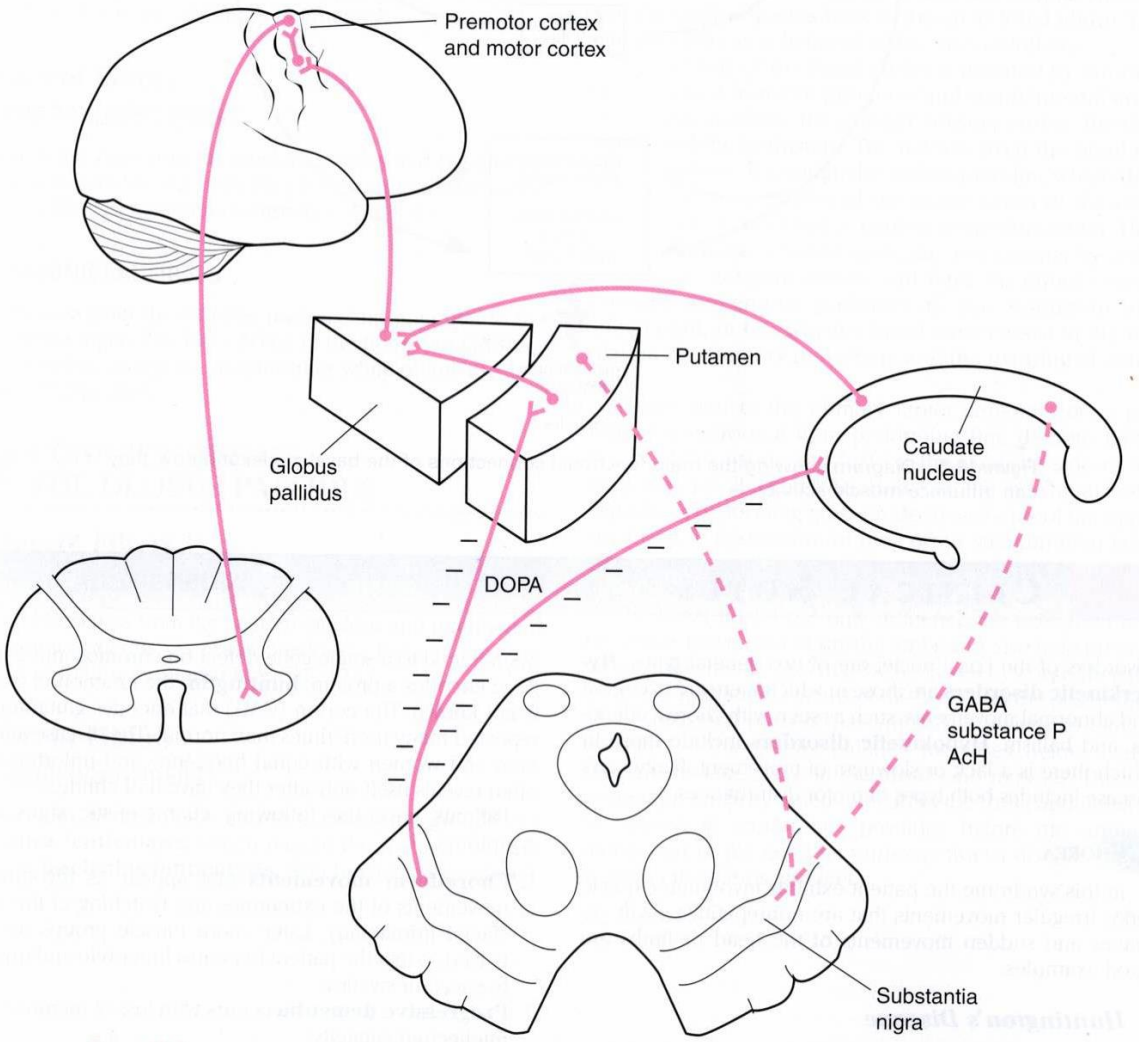
- Described by James Parkinson
- Degeneration of dopaminergic nigrostriatal neurons (60-80 %).
- Methyl-Phenyl-Tetrahydro-Pyridine (MPTP). The oxidant MPP+ is toxic to SN.
- Four cardinal symptoms
  - Tremor
  - Rigidity
  - Akinesia & Bradykinesia
  - Postural Changes
  - Speech Changes

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



Huntington's Disease:

degeneration of inhibitory pathway between corpus striatum & S nigra



degeneration of inhibitory pathways between S Nigra & corpus striatum