MED437
KING SAUD UNIVERSITY

Revised By
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ANATOMY
Team 437

Basal Ganglia

Lecture (17)

- Important
- Doctors Notes
- Notes/Extra explanation

{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

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هذا العمل مبني بشكل أساسي على عمل دفعة ٤٣٦ مع المراجعة
والتدقيق وإضافة الملاحظات ولا يغني عن المصدر الأساسي للمذاكرة

Objectives

At the end of the lecture, students 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 terms of connections.
- ✓ State briefly functions & dysfunctions of Corpus Striatum.

Basal Ganglia

02:00

أشياء اكد عليها الدكتور:
-Striatum: caudate +putamen(because it's functionally connected)(it is the major input).
-corpus striatum: caudate + lentiform(the reason of this naming that there is grey matter connection).
-the space between (caudate and lentiform is the internal capsule).
-the degermation will happen to the connection between the striatum and the source of connection.

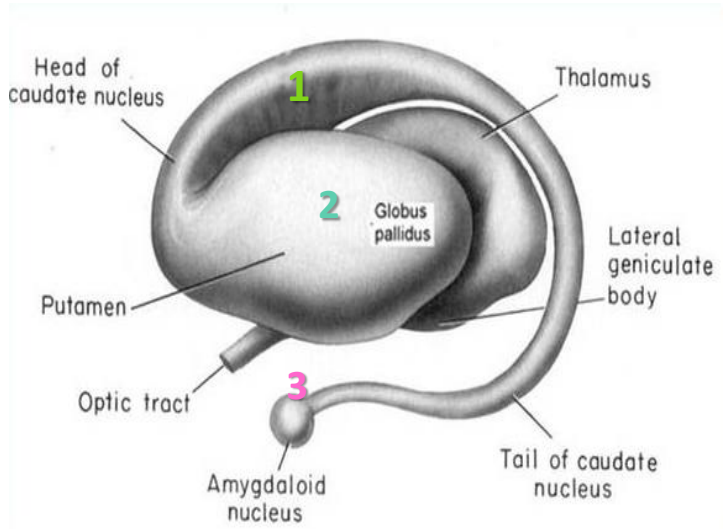
- BASAL GANGLIA (NUCLEI) : group of nerve cells deeply situated in cerebral hemispheres
- Components:

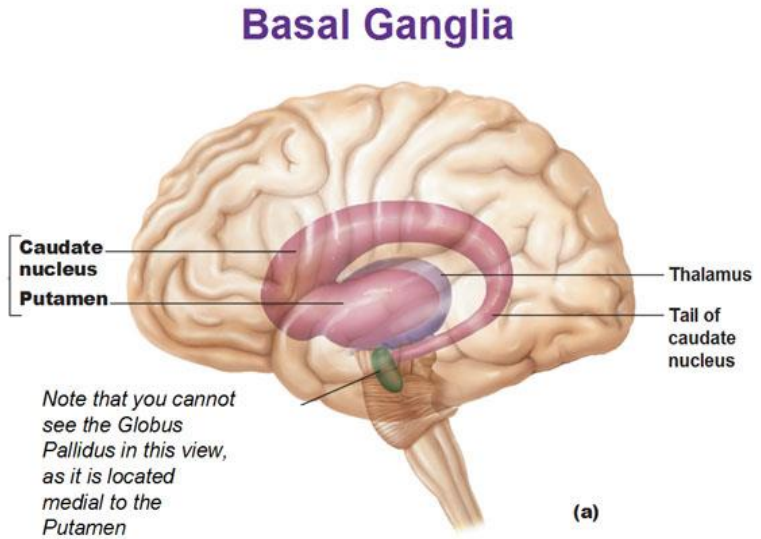
1. Caudate Nucleus	2. Lentiform Nucleus: divided into **Putamen** & **Globus Pallidus** (Lateral) (medial)

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 unwanted motor functions)

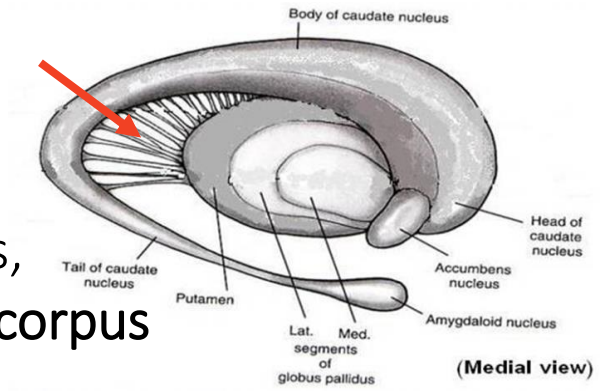
3. Amygdaloid Nucleus

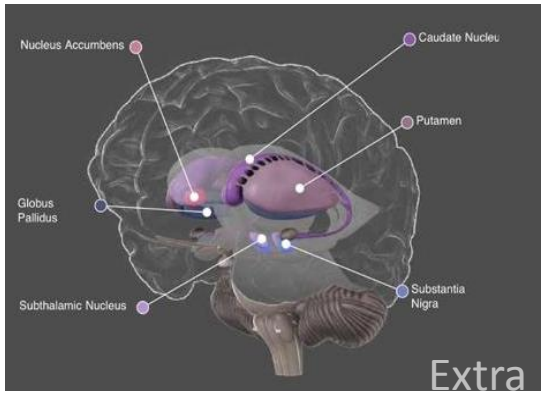
(function is different: part of limbic system) is only embryologically related to Corpus Striatum





Corpus Striatum

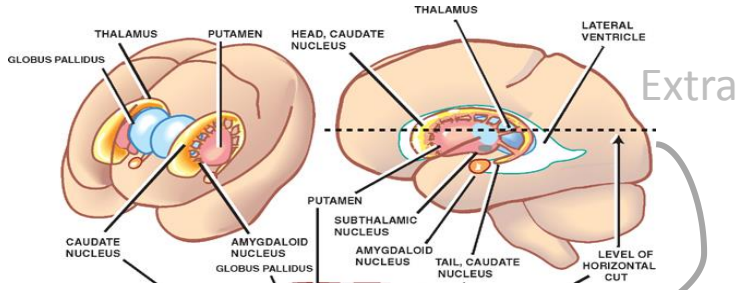




Nomenclature

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**.

Lentiform Nucleus



Shape:

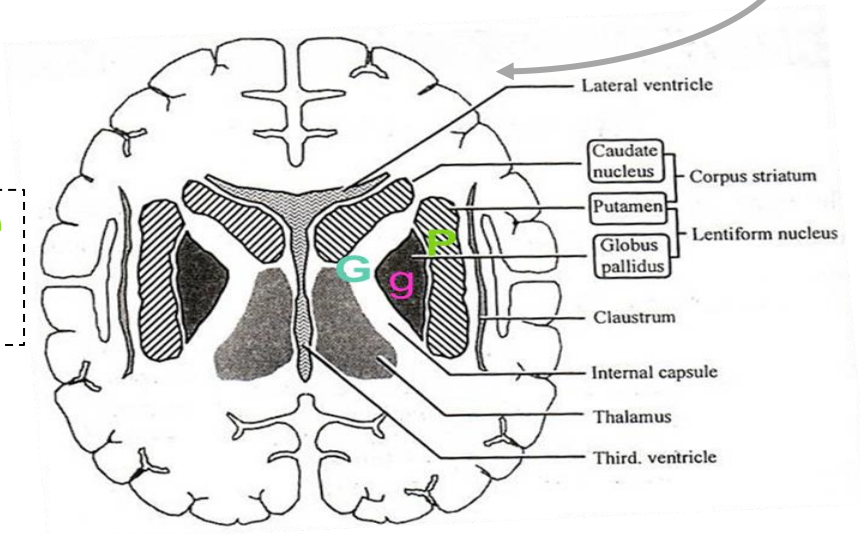
Three sided, wedge-shaped mass of grey matter, with a convex outer surface and an apex which lies against the genu of the internal capsule

(g) **genu** is a latin word for "**knee**".

في الصورة طالع العكس بس تجاهلوها الصح هو المكتوب هنا

Division: divided into

1. Larger darker lateral portion called **putamen** (p)
2. Smaller, lighter medial portion called **globus pallidus** (g)



Corpus Striatum
Lentiform Nucleus

Putamen

Separated from **globus pallidus** (g) by a thin sheath of nerve fibers, the **lateral medullary lamina**

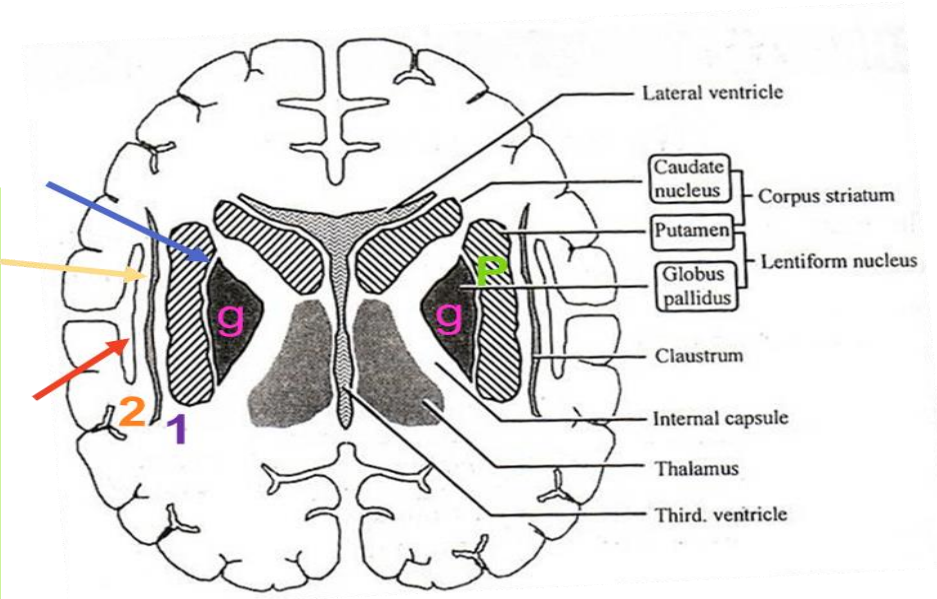
The white matter lateral to putamen is divided, by a sheath of grey matter, the **claustrum** into two layers:

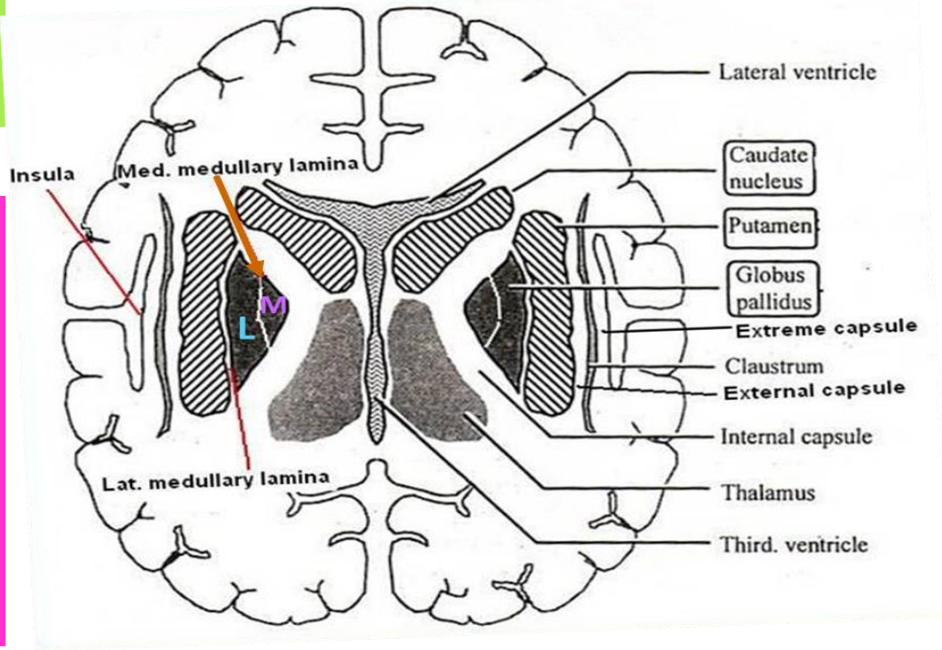
- external capsule (1) between the putamen and claustrum.
- extreme capsule (2) between the claustrum and the **insula**

We saw 3 capsules: internal, external, and extreme. All are **white** matter.

Globus Pallidus

- Consists of two divisions, the **lateral** (L) & the **medial** (M) **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





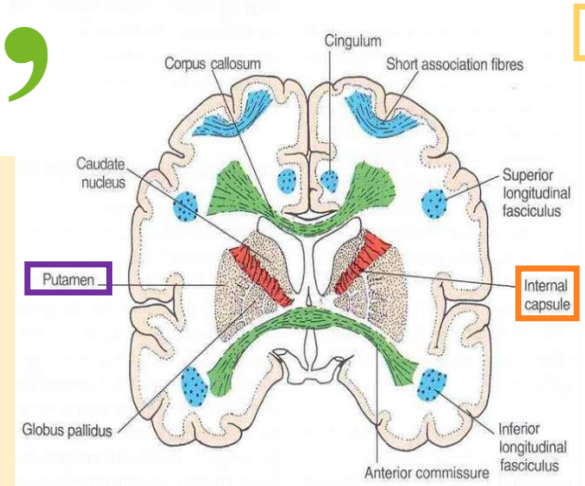
Corpus Striatum
Caudate Nucleus

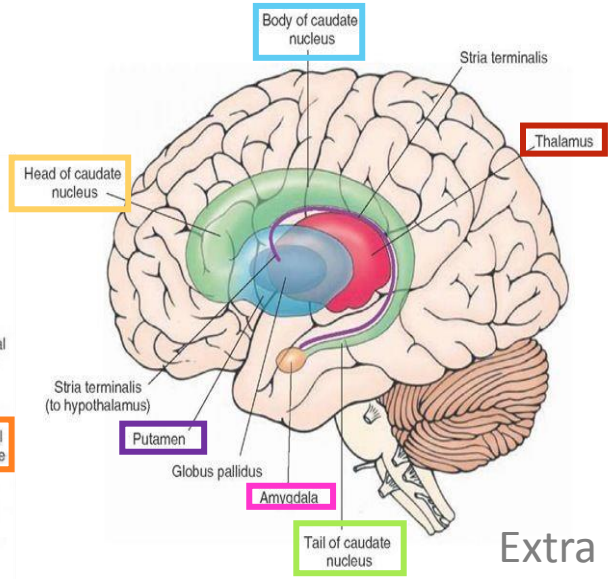
- Shape: C-shaped mass of grey matter Looks like com
- Components: head, body & tail

1. **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

2. **Body:**
   - Long & narrow
   - Extends above thalamus (in parietal lobe)

3. **Tail:**
   - Long & tapering
   - Descends, below thalamus, into temporal lobe
   - Continuous with Amygdaloid Nucleus (part of limbic system)





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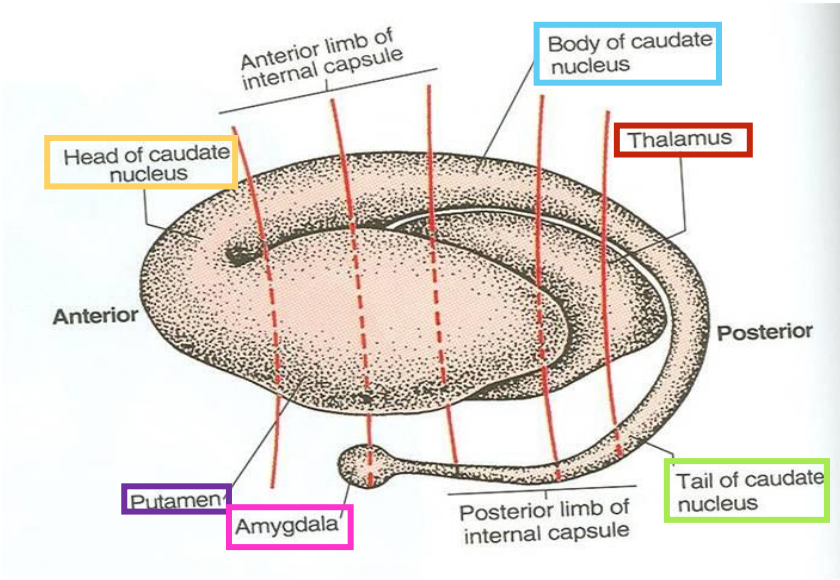
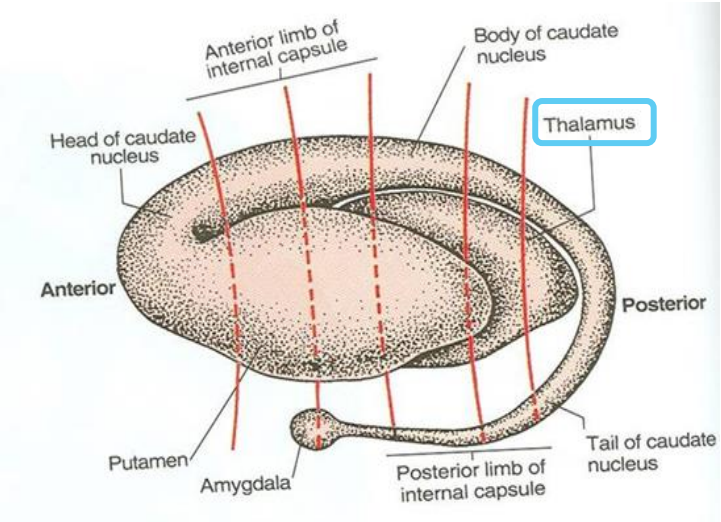


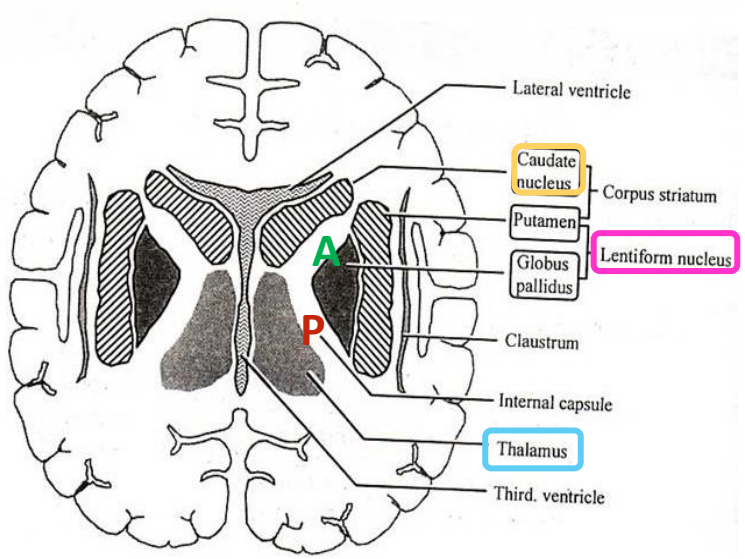
Corpus Striatum
Important relations

01:55

Head of Caudate Nucleus:
- 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)





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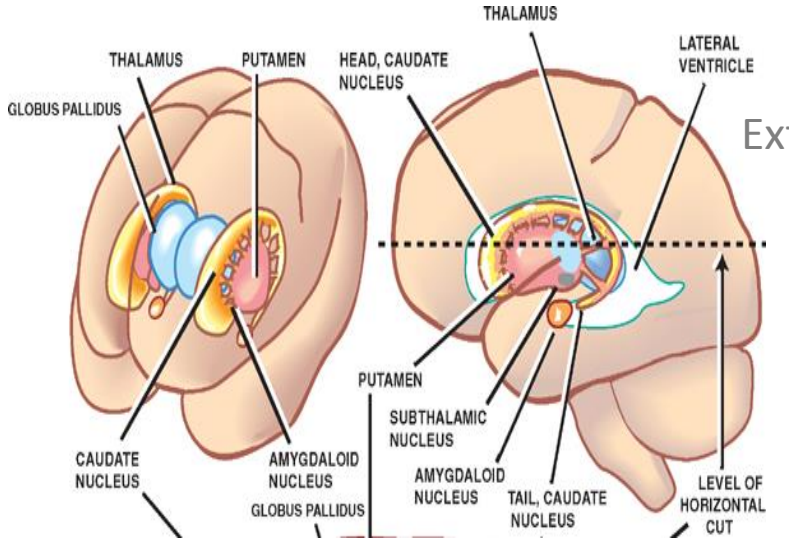
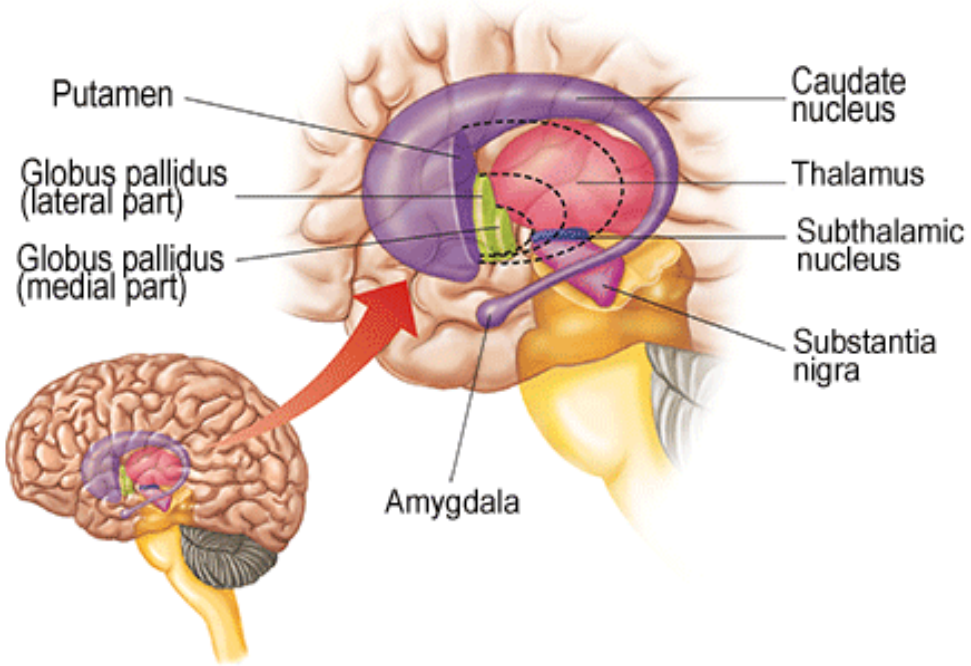


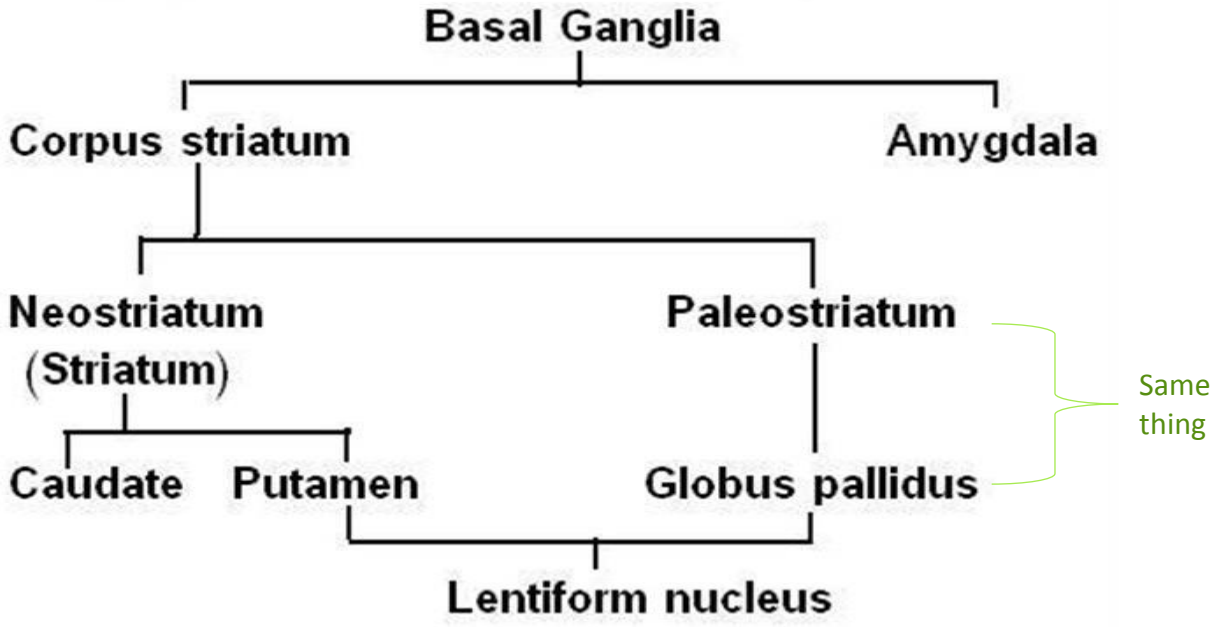
Corpus Striatum

1- The input to striatum is from:
-cortex
-thalamus
-substantial nigra
-midbrain
2- Striatum projects to:
-Globus pallidus
-substantia nigra

IMPORTANT

- **Putamen** is more closely related to **Caudate nucleus** (regarding development, function & connections) and together constitute the **neostriatum** or **striatum**.
- The **globus pallidus** is the oldest part of **corpus striatum** and is called **paleostriatum** or **pallidum.**





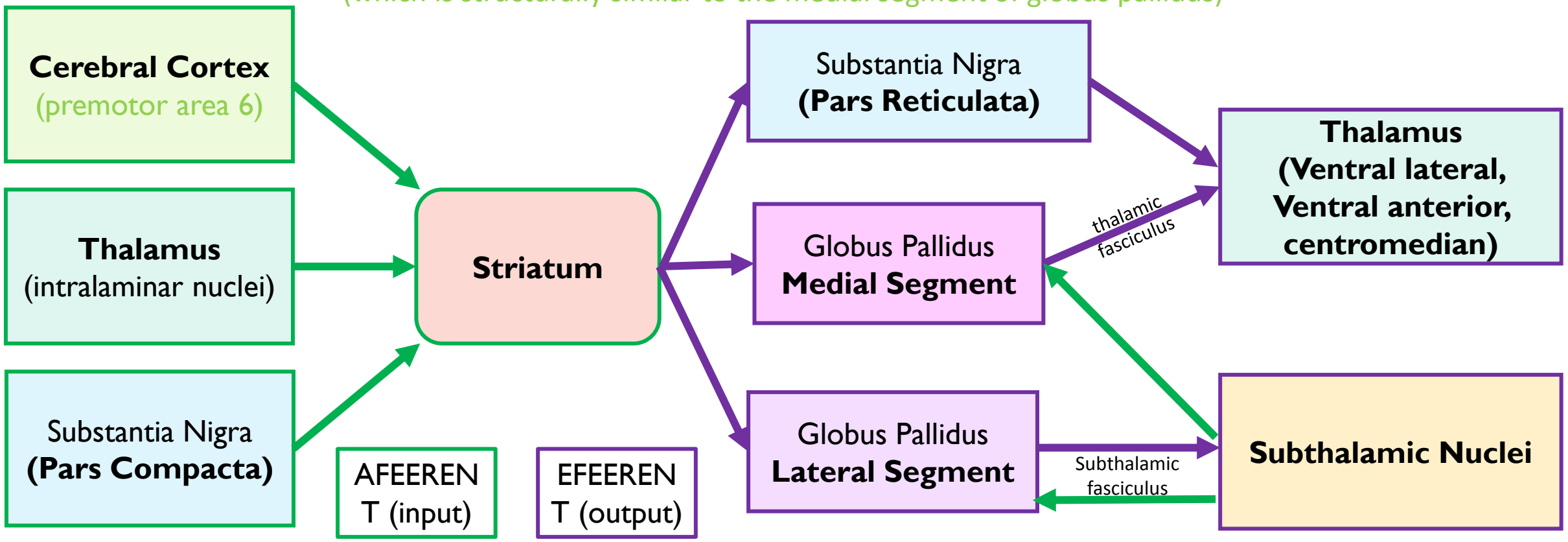
IMPORTANT

Corpus Striatum

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.*"

*Substantia Nigra is divided into Pars Compacta and Pars Reticulata
(which is structurally similar to the medial segment of globus pallidus)



Corpus Striatum

Static tremor: in basal ganglia dysfunction (like Parkinson), while he is setting, but with movement it disappears.
Intension tremor: tremor with movement (with cerebellar injury).

Function

- The corpus striatum assists in regulation of voluntary movement and learning of motor skills.
- Their function is to facilitate behavior and movement that are required and appropriate, and **inhibit** unwanted or inappropriate movement.

Dysfunction = Parkinsonism

- Its dysfunction **does NOT cause paralysis, sensory loss or ataxia**
- Its dysfunction **leads** to:
  - Abnormal motor control: emergence of abnormal, involuntary movements (**dyskinesias**)
  - Alteration in muscle tone: **hypertonia/hypotonia**
  - Soft speech, slow steps, tremor at rest
  - Stooped posture
  - Nonmotor symptoms: depression, constipation, fatigue.

*Mohammed Ali, the famous boxer, had parkinsonism.

Connection Of Corpus Striatum

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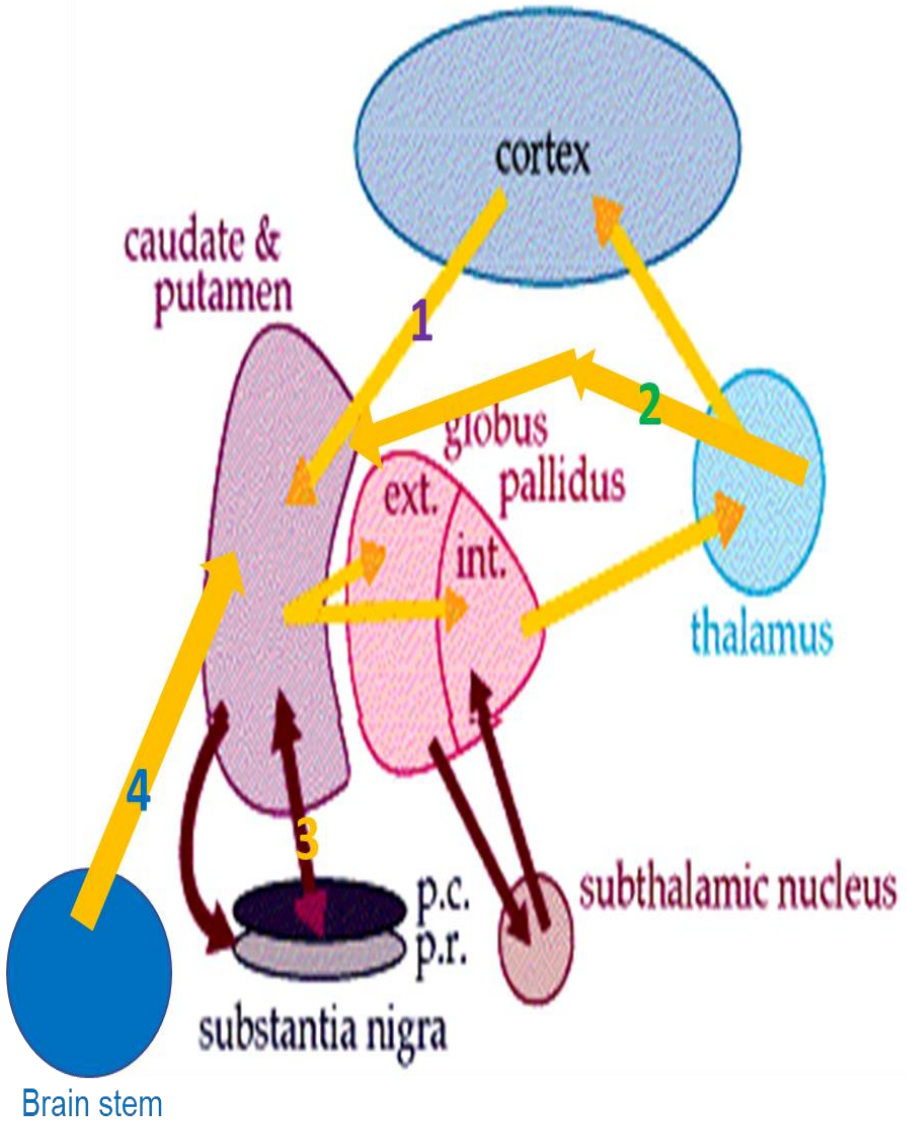
فقط و السلايدات المتوافقة مع البنات هي المعتمدة

Afferent Fibers (input)
1- 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.
2-Thalamostriate Fibers : • **From** intralaminar nuclei of thalamus axons pass • **To** caudate nucleus and putamen.
3- Nigrostriate Fibers : • Axons **from** Substantia nigra of midbrain pass • **To** caudate nucleus and putamen. • Neurotransmitter is *Dopamine*. (the problem with Parkinson's is here)
4- Brain stem Strial Fibers (raphe nucleus) : • 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



Connection Of Corpus Striatum

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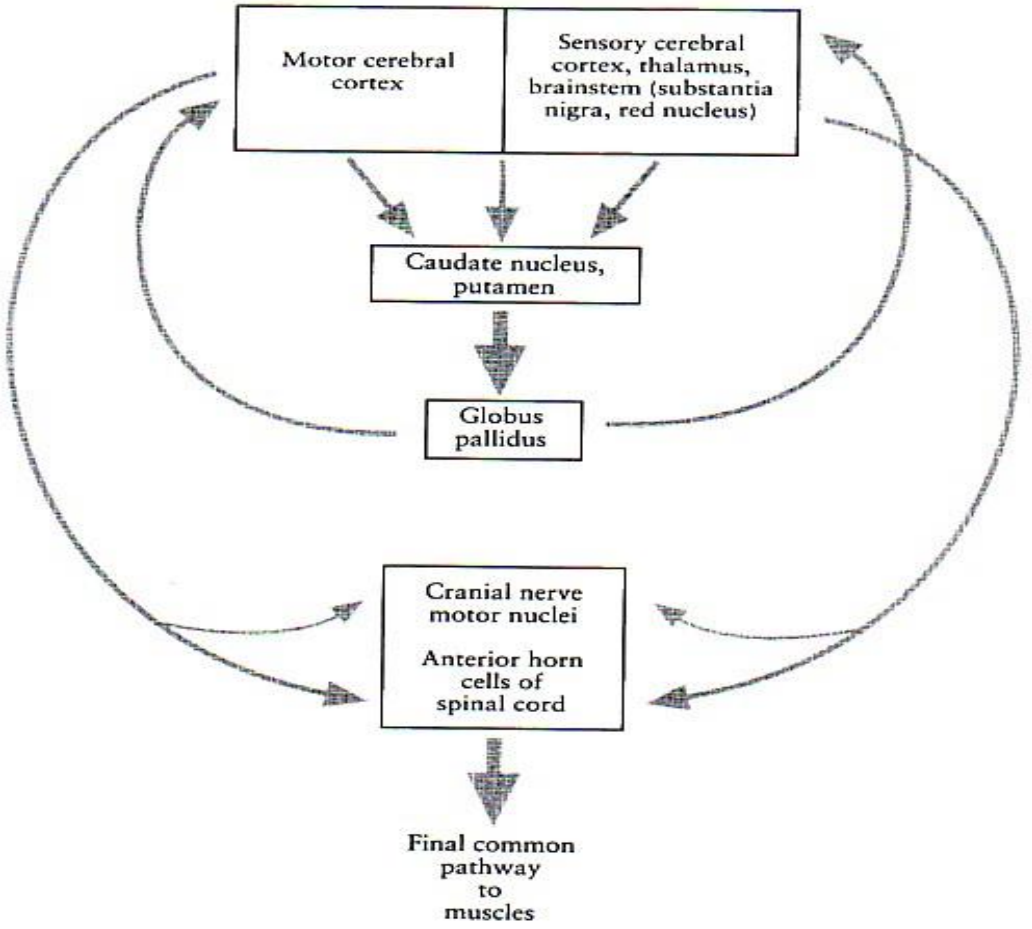
Efferent Fibers (Output)
1-Striatopallidal fibers: • These fibers pass **from** corpus striatum (caudate nucleus & putamen) • **To** globus pallidus. • Gamma-aminobutyric acid (GABA) is the neurotransmitter.
2-Striatonigral fibers: • These fibers pass **from** caudate nucleus & putamen • **To** Substantia nigra. • Some fibers use GABA as a neurotransmitter, and others use substance p.



Functions of Basal Ganglia

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

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.

Functions of basal ganglia:

- **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.

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Parkinsonism
(Parkinson's disease, paralysis Agitans)

- **Described by James Parkinson**
- **Lesion:** Neuronal degeneration* in **substantia nigra** leading to **reduction of dopamine** within corpus striatum.
- **Features:**

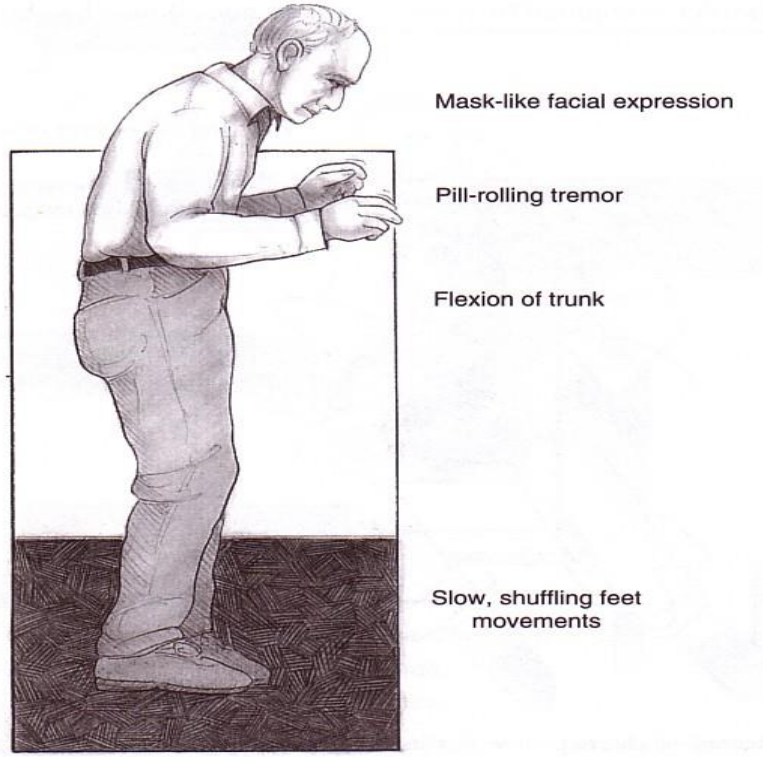
1- Tremors: Pill-rolling, involuntary, rhythmic, oscillating movements. It occurs during waking time during rest, it is called static tremors.

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 (يجر رجله).

- **Four cardinal symptoms:**

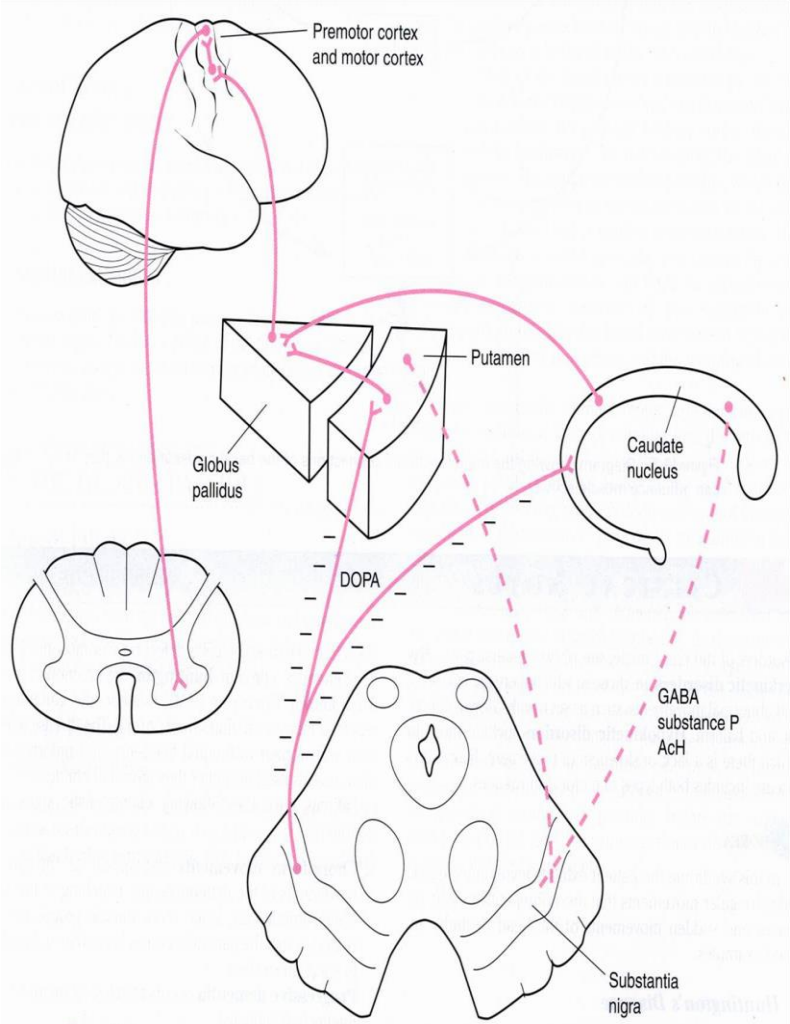
1. Tremor & Rigidity
2. Akinesia & Bradykinesia
3. Postural Changes
4. Speech Changes



أعراض المرض لا تظهر إلا بعد ما يحصل:

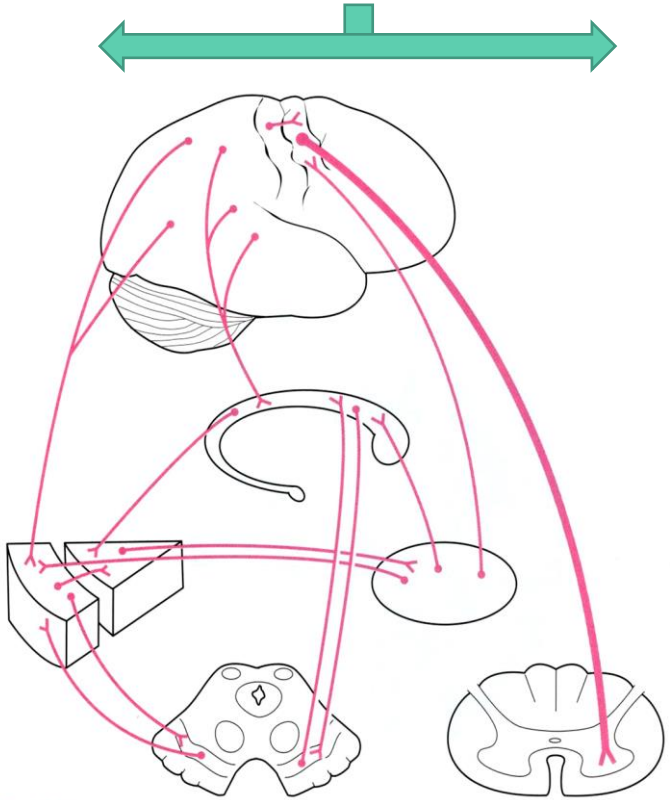
- Degeneration of dopaminergic nigrostriatal
- Neurons (60-80 %).
- Methyl-Phenyl-Tetrahydro-Pyridine (MPTP).
- The oxidant MPP+ is toxic to SN.

Huntington's Disease:
degeneration of inhibitory pathway between <u>corpus striatum & Substantia nigra</u>



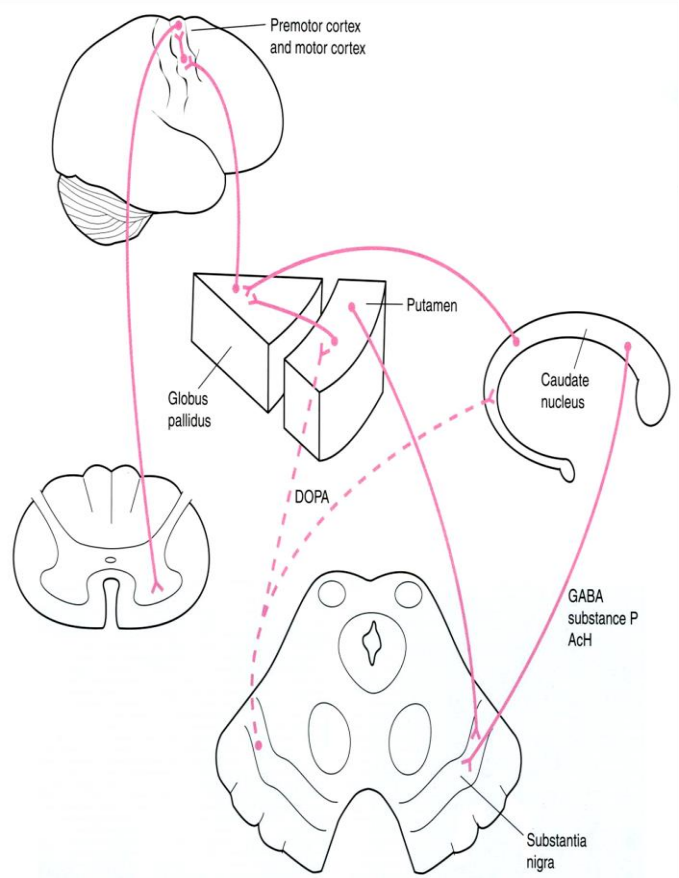
Main Connections between Cortex, basal Nuclei, Thalamic Nuclei Brainstem & Spinal Cord

These are the normal connections. Any degeneration will lead to



Important:
- Parkinsonism: degermation of the pathway between substantial nigra and striatum
- Huntington's: the opposite

Parkinson's Disease:
degeneration of inhibitory pathways between <u>Substantia Nigra & corpus striatum</u>



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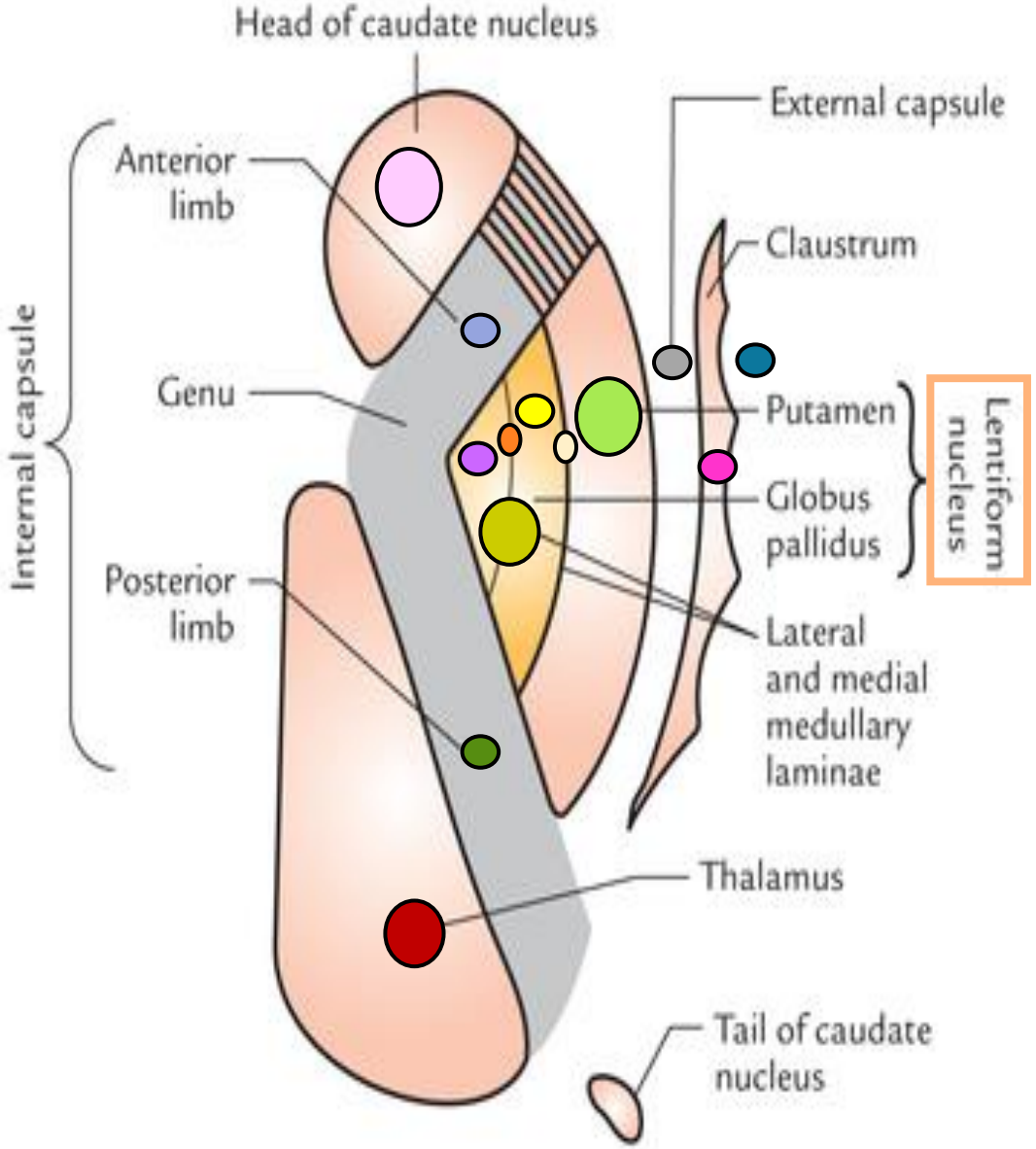
Summary

Basal Ganglia			
Corpus Striatum			Amygdaloid
Caudate	Lentiform		
	Putamen	Globus Pallidus	
Neostriatum		Paleostriatum	

Structure	Separates	
Claustrum	Extreme capsule	External capsule
Lateral medullary lamina	Putamen	Globus pallidus
Medial medullary lamina	Lateral segment of globus pallidus	Medial segment of globus pallidus
Anterior limb of internal capsule	Lentiform	Caudate (head)
Posterior limb of internal capsule	Lentiform	Thalamus



Corpus striatum are primarily concerned with control of posture & movement.

The **striatum** is the **input** region of corpus striatum,

while the medial segment of **globus pallidus** & pars reticulata of **substantia nigra** are the **output** portion.

Afferent fibers of striatum come from:

1. cerebral cortex.
2. intralaminar nucleus of thalamus.
3. pars compacta of substantia nigra.

Afferent fibers of both lateral & medial segments of globus pallidus come from:

1. Striatum 2. Subthalamic nucleus.

Efferent fibers of striatum is directed to

1. globus pallidus.
2. pars reticulata of substantia nigra.

Efferent fibers of **lateral** segment is directed to subthalamic nucleus.

Efferent fibers of **medial** segment is directed to

1. ventral lateral,
2. ventral anterior &
3. centromedian nucleus of thalamus.

MCQs

(1) What is the caudate nucleus shaped like?

A) C-shaped mass of white matter
B) C-shaped mass of grey matter
C) G-shaped mass of grey matter
D) None are correct

(2) The Lentiform Nucleus is related to the thalamus?

A) Medially
B) Superior to the thalamus
C) laterally
D) Inferior to

(3) The two division of the globus pallidus are seperated by?

A) The medial medullary lamina
B) The lateral medullary lamina
C) Insula
D) Lateral ventricle

(4) What part of the caudate nucleus is continues with the amygdaloid nucleus?

A) Body
B) Head
C) A and b
D) Tail

(5) What does the dysfunction of the corpus straitum lead to?

A) Paralysis
B) Hypertonia
C) Ataxia
D) Sensory loss

(6) Corpus striatum is ?

A) Lentifrom and Caudate
B) Caudate and glopus pallidus
C) Caudate and putamen
D) Putamen and glopus Pallidus

6) Striatum is ?

A) Lentifrom and Caudate
B) Caudate and glopus pallidus
C) Caudate and putamen
D) Putamen and glopus Pallidus

(8) The major input for basal ganglia goes to ?

A) Lentifrom and Caudate
B) Caudate and glopus pallidus
C) Caudate and putamen
D) Glopus Pallidus

(8) One of the major output for basal ganglia is?

A) Lentifrom and Caudate
B) Caudate and glopus pallidus
C) Caudate and putamen
D) Glopus Pallidus

(10) Pallidum is ?

A) Lentifrom and Caudate
B) Caudate and glopus pallidus
C) Caudate and putamen
D) Glopus Pallidus

Answers

(1) B
(2) C
(3) A
(4) D
(5) B
(6) A
(7) C
(8) C
(9) D
(10) D

SAQ

(1) What are the components of the basal ganglia?

1. Caudate Nucleus
2. Lentiform Nucleus
3. Amygdaloid Nucleus

(2) What is the oldest part of corpus striatum?

The globus pallidus

Good luck
Special thank for team436 ❤

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- References:
  1. Girls' & Boys' Slides
  2. Greys Anatomy for Students
  3. TeachMeAnatomy.com

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