Central Nervous System

Lecture 11: Limbic System & Basal Ganglia (nuclei)

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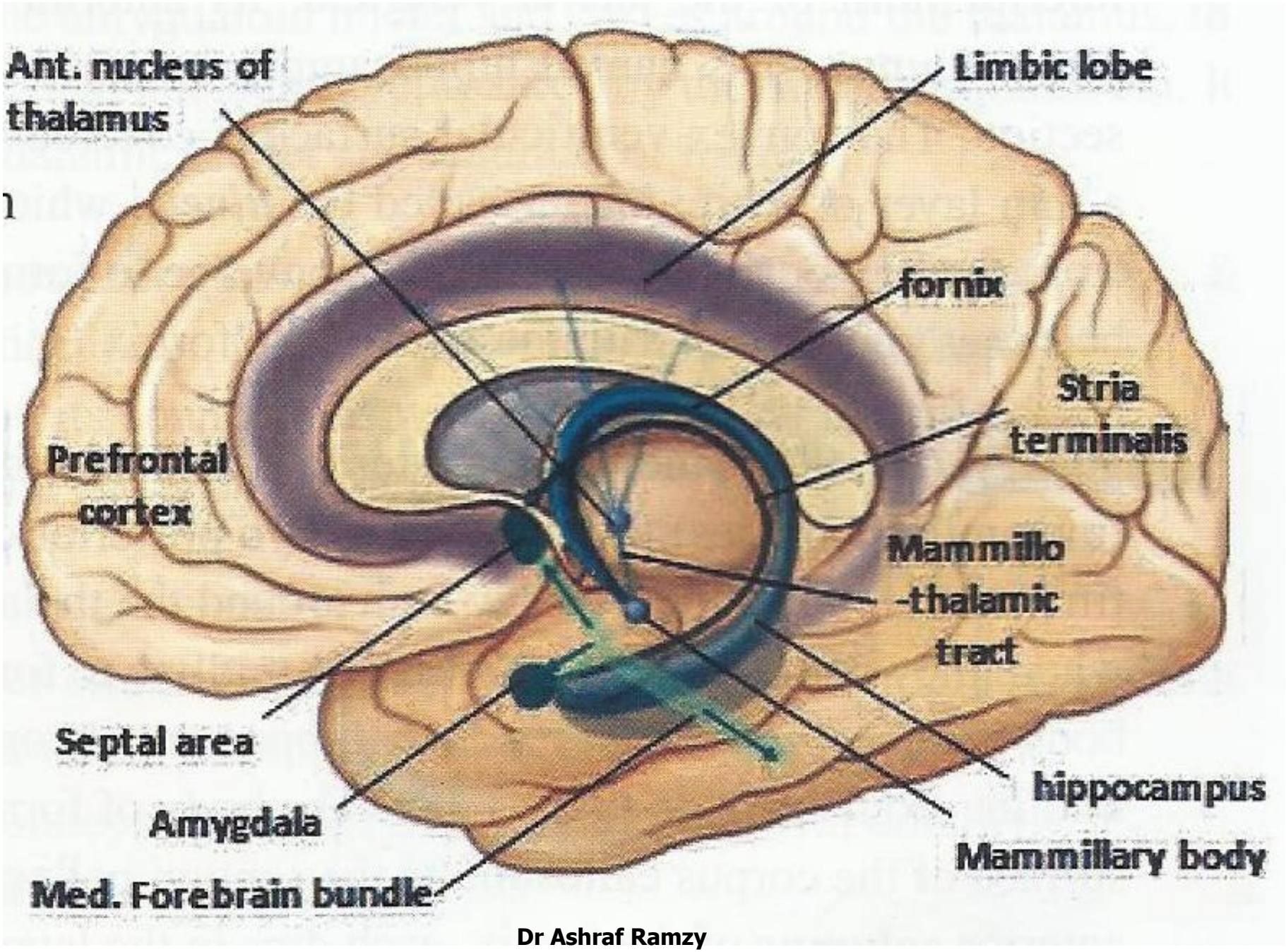
Limbic System

** A system concerned with emotions and memory.

** Has a close connection with the olfactory system.

** It includes a group of curved structures seen on the medial aspect of the cerebral hemisphere around the thalamus.


Ant. nucleus of thalamus
Limbic lobe
fornix
Stria terminalis
Prefrontal cortex
Mammillo -thalamic tract
Septal area
hippocampus
Amygdala
Mammillary body
Med. Forebrain bundle

Cortical Structures	Subcortical Structures	Connecting Pathways
a. Limbic lobe. b. Hippocampal formation (hippocampus & other structures). c. Septal areas. d. Prefrontal cortex.	a. Hypothalamus. b. Anterior nucleus of thalamus. c. Amygdaloid nucleus.	a. Fornix. b. Cingulum. c. Medial forebrain bundle. d. Stria medullaris thalami. e. Stria terminalis.

Limbic Lobe

** A C-shaped rim of cortex on medial surface of cerebral hemisphere surrounding the diencephalon. It consists of:

1. Subcallosal area

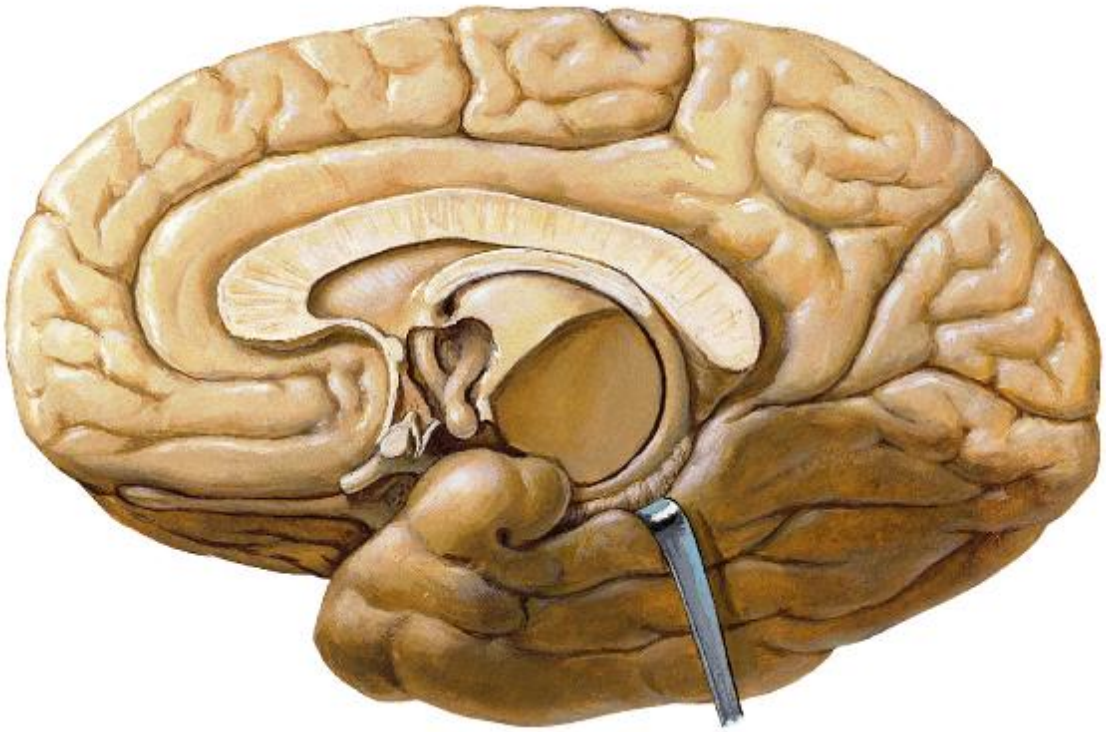
(Paraolfactory Gyrus).

2. Cingulate Gyrus.

3. Isthmus.

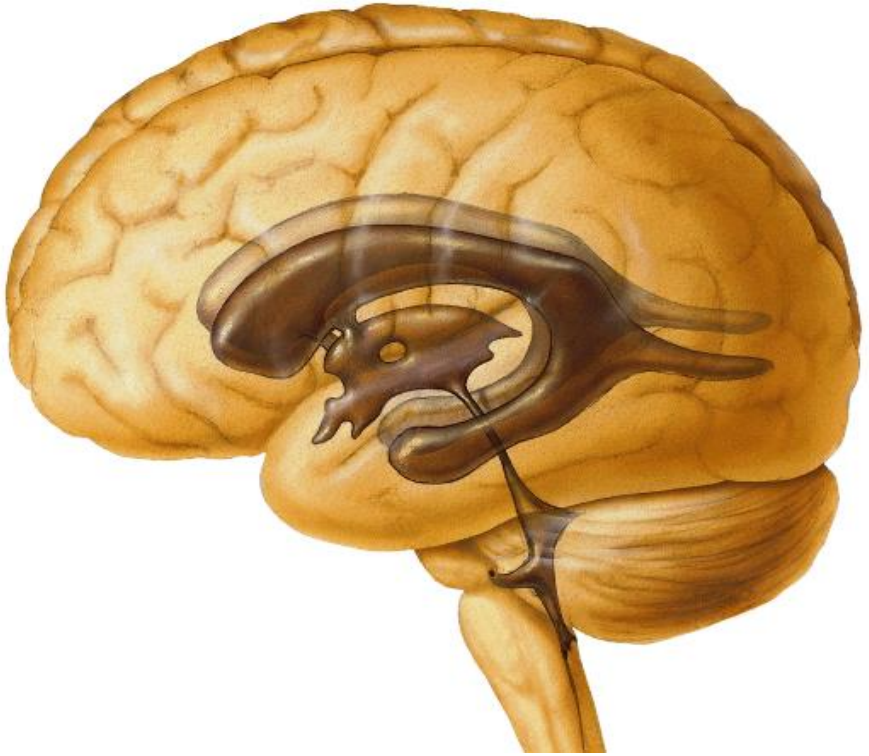
4. Parahippocampal G.

5. Uncus.



The Hippocampus

* Is an elongated elevation of gray matter bulging in the floor of the inferior horn of the lateral ventricle.
* It is named hippocampus because it resembles a sea horse in coronal section.

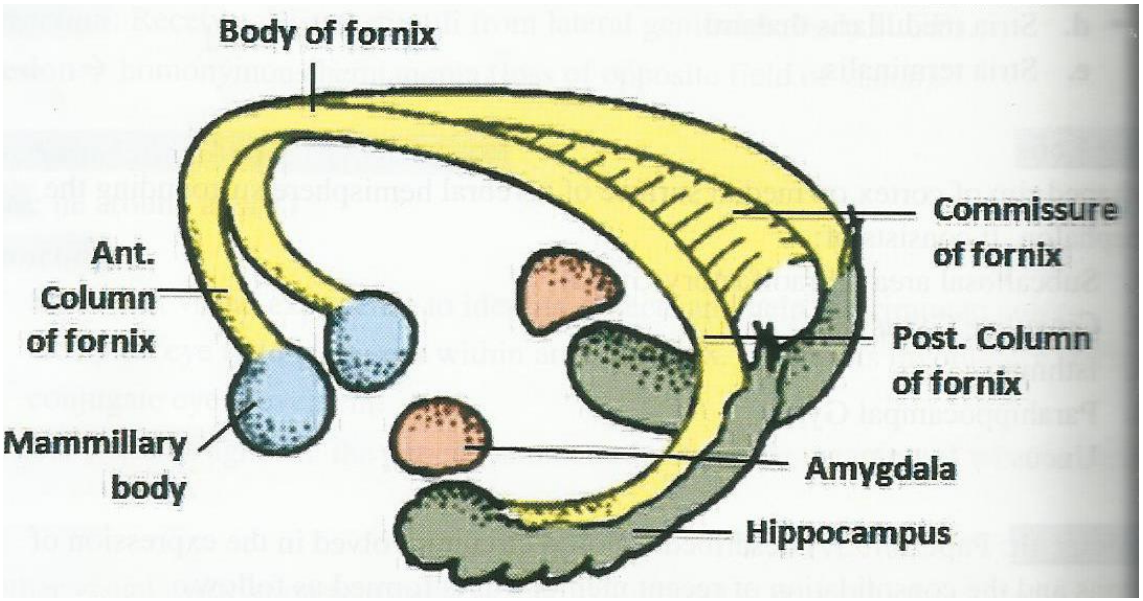


The Hippocampus (contd)

* Its anterior end is expanded to form the **pes hippocampus**.

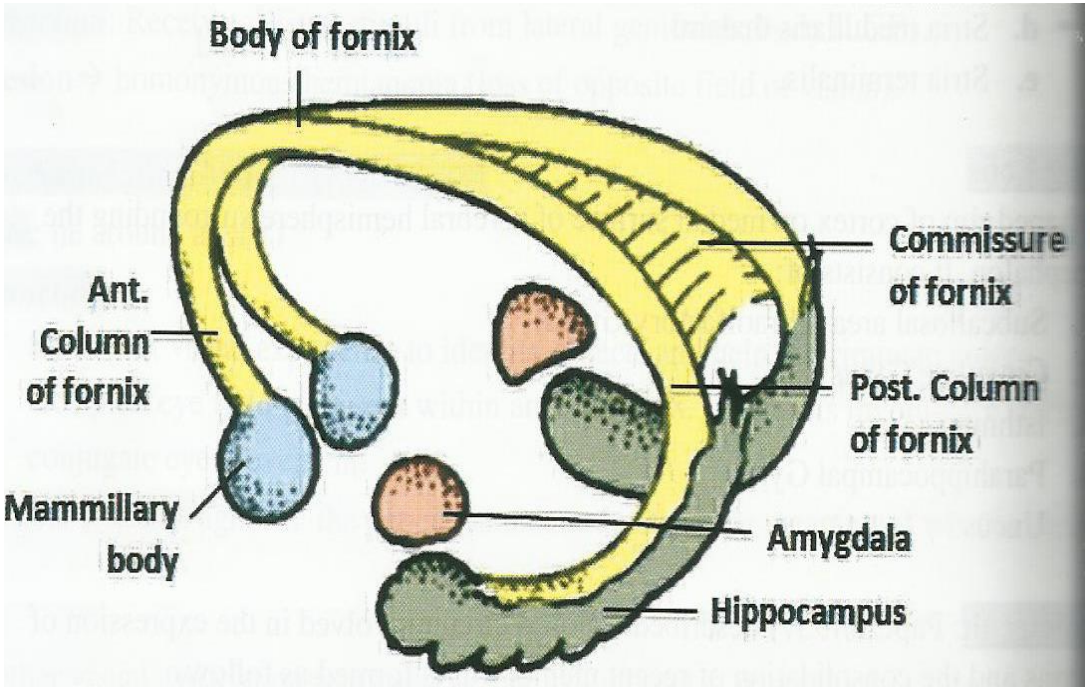
* **Efferent fibers arising from the hippocampus** form a layer of **white matter** called the **alveus .**

* **The alveus** converge to form a bundle called the **fimbria** which becomes continuous with the **crus of the fornix.**



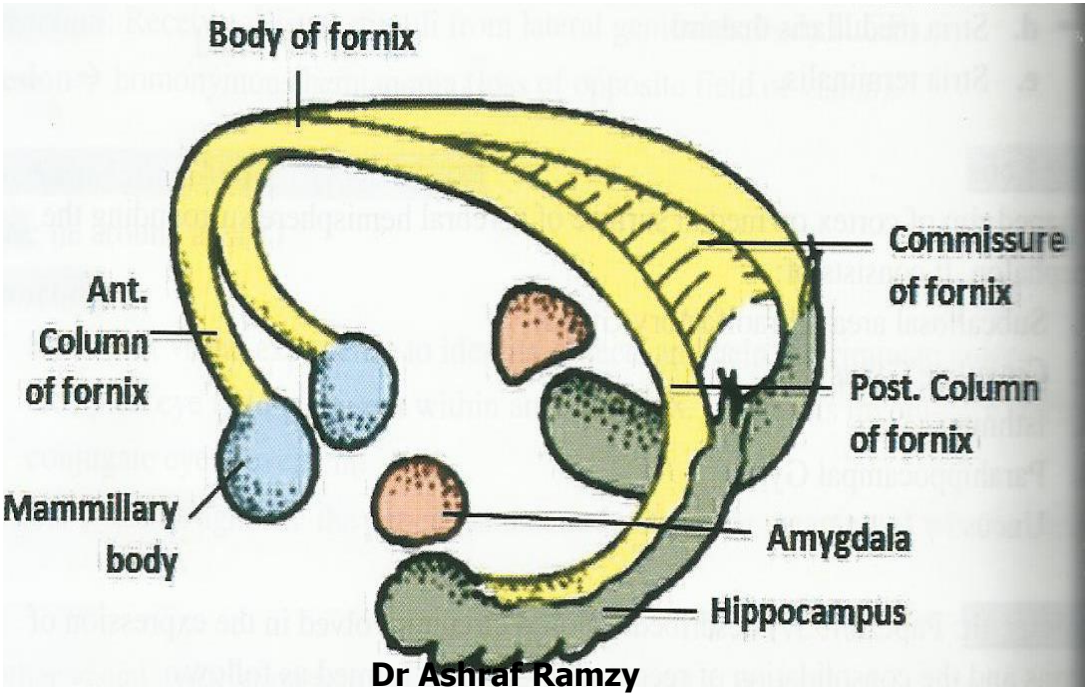
The Fornix

* It is the white matter that connects the hippocampus to hypothalamus (mammillary bodies). It is formed of two posterior columns (**crura)** that begin from **the fimbria of hippocampus.**



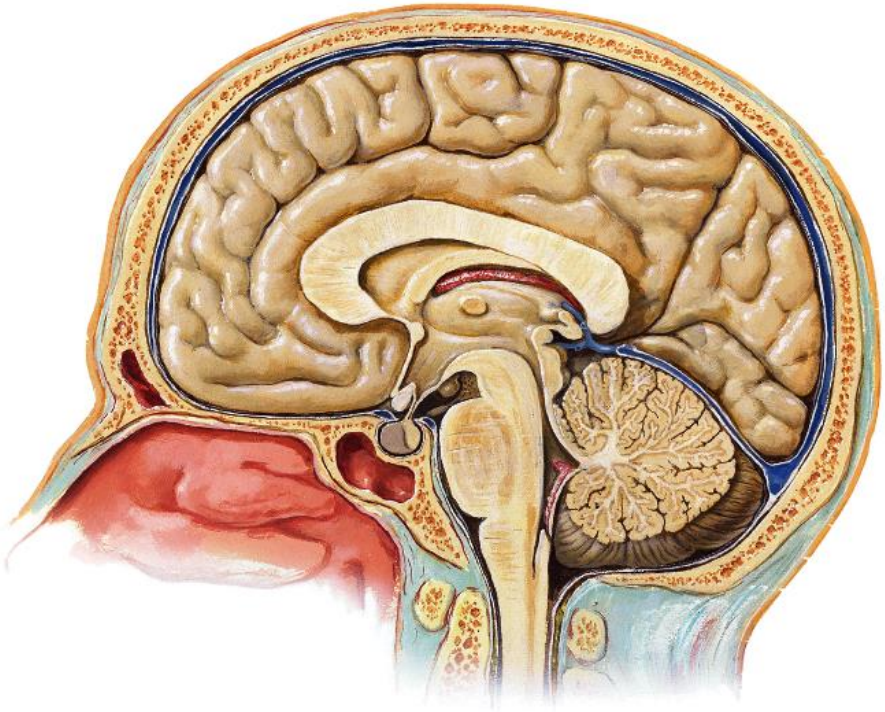
The Fornix (contd)

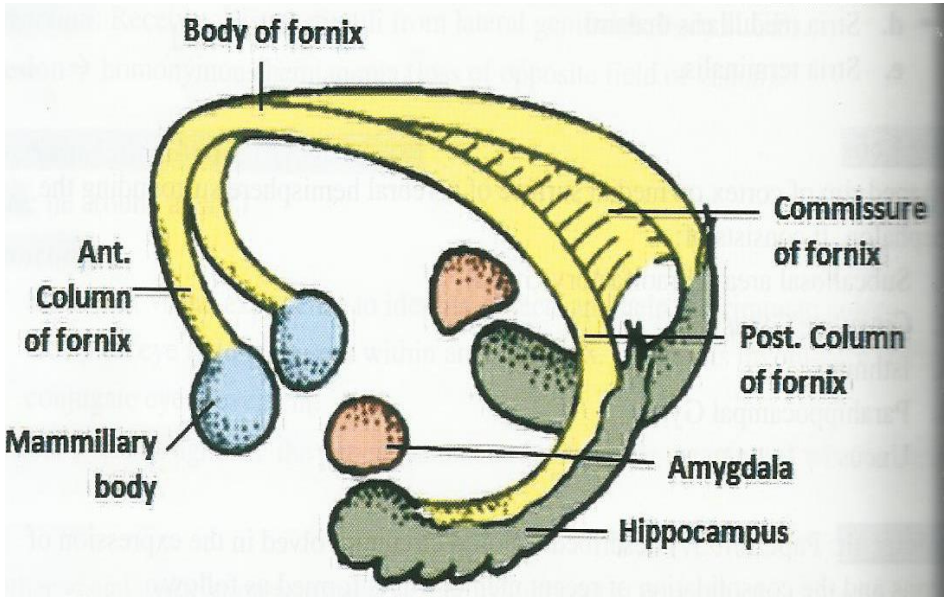
* They arch around the thalamus, below the corpus callosum, where they come close together in the midline to form the **body of fornix.** Behind the body is the commissure of fornix **(hippocampal commissure)** where fibers cross the midline from one side to the other.



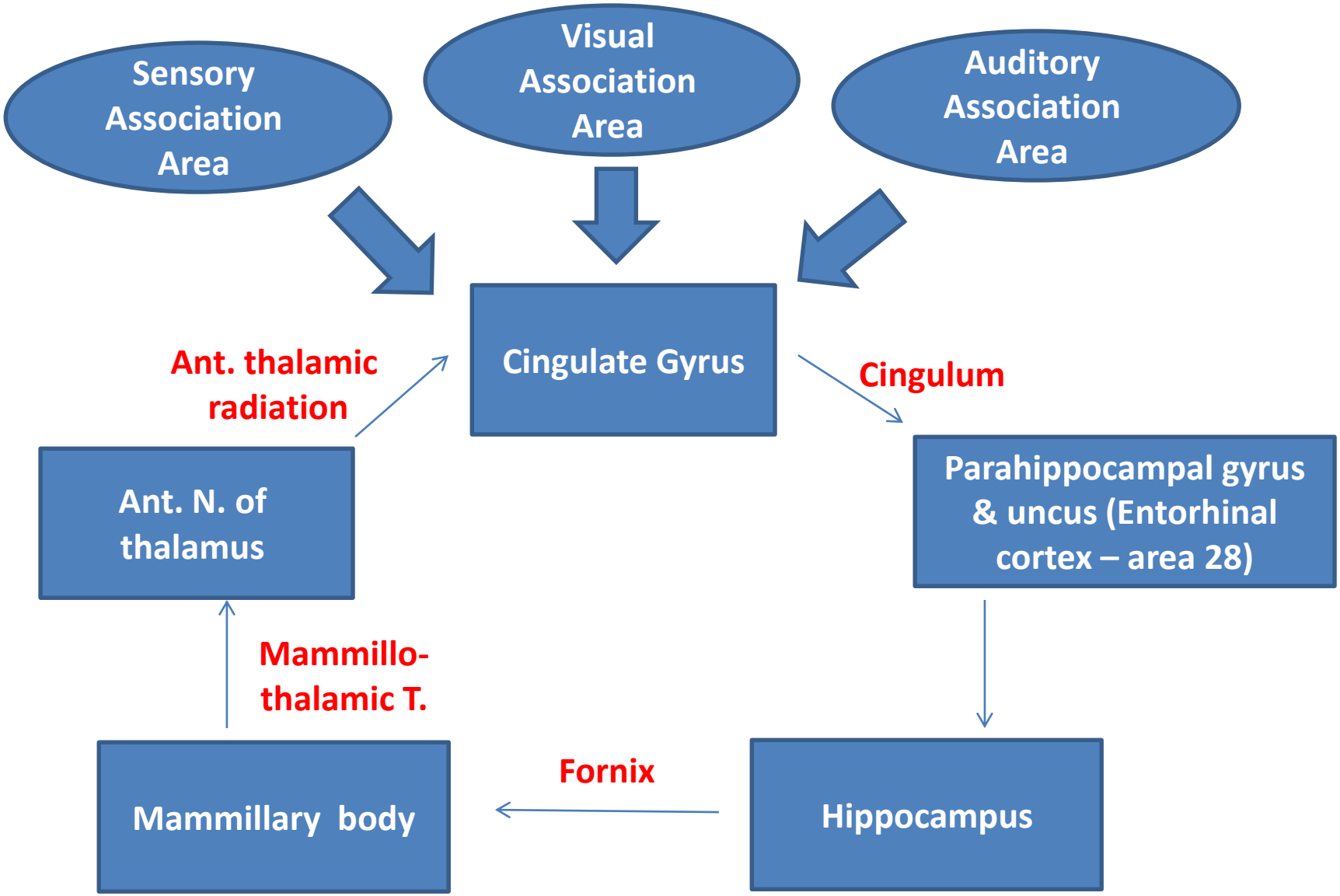
The Fornix (contd)

* The body of fornix is connected to the under surface of the corpus callosum by the **septum pellucidum.** It then splits anteriorly into two **anterior columns of the fornix,** which end in the **2 mammillary bodies.**





Papez Circuit



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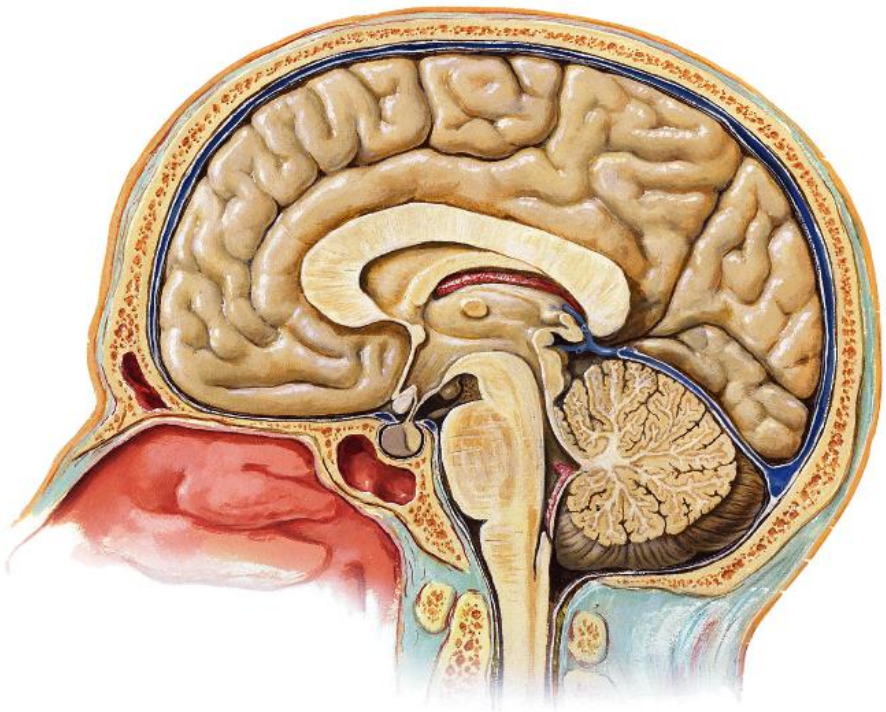
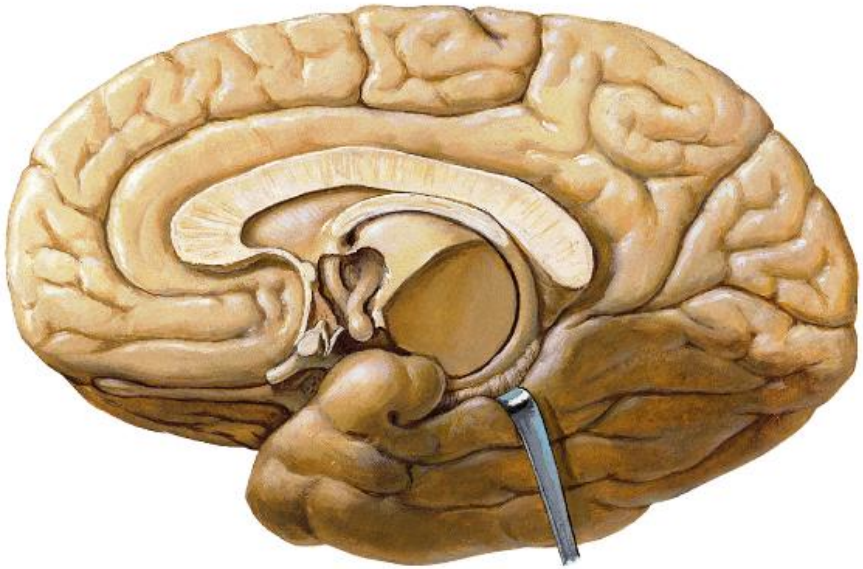
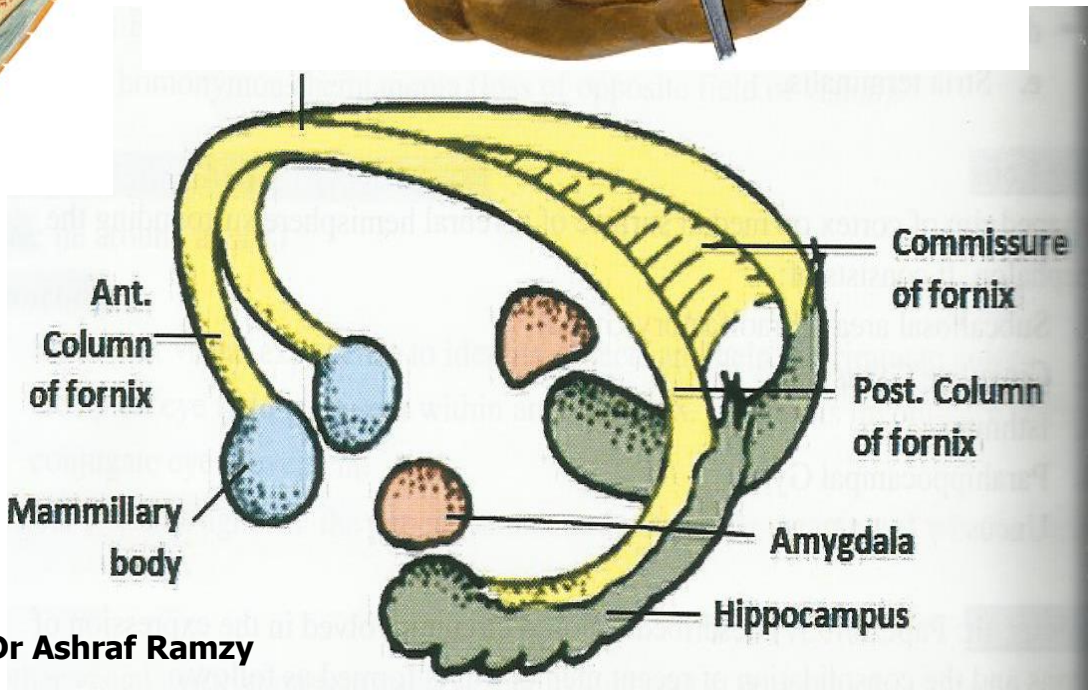
Papez Circuit







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Papez Circuit

* **A closed circuit involved in:**

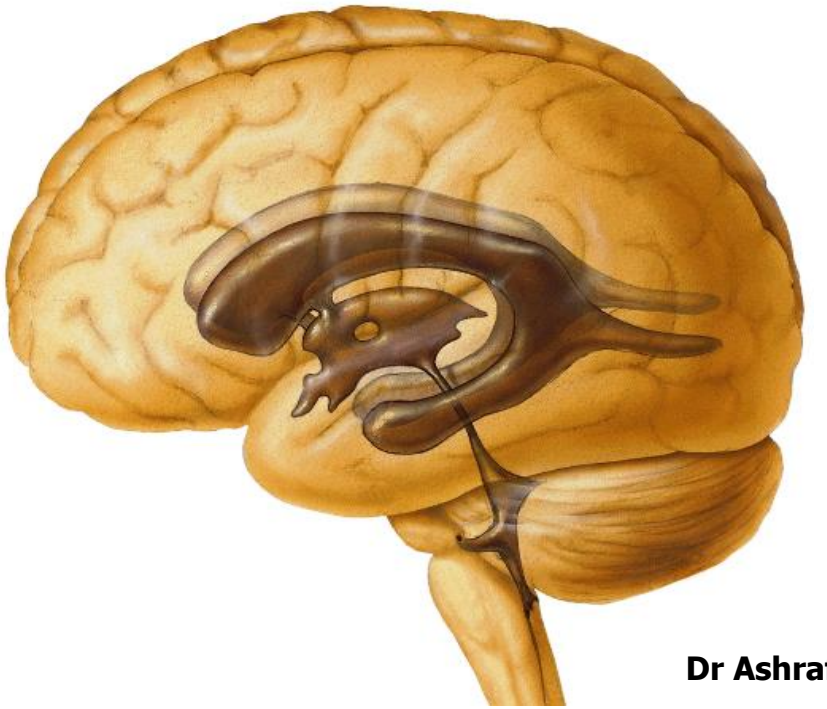
1. The expression of emotions.
2. Consolidation of recent memory.

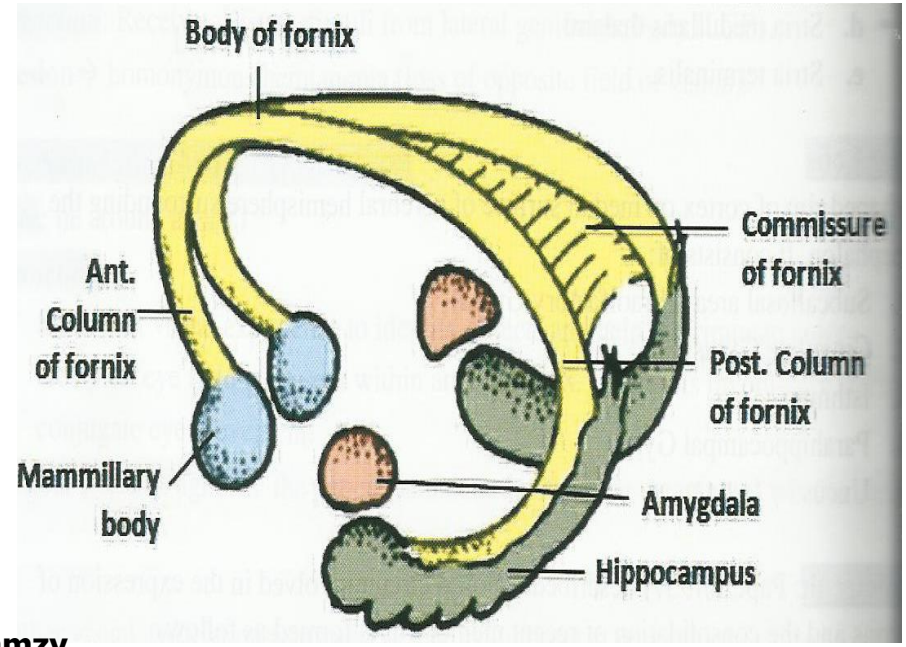
* **Papez proposed that:**

1. Emotional expression is experienced in the cingulate gyrus.
2. Organized in the hippocampus.
3. Expressed via the mammillary bodies then through descending autonomic outflow → peripheral expression of emotion occurs.

The Amygdala

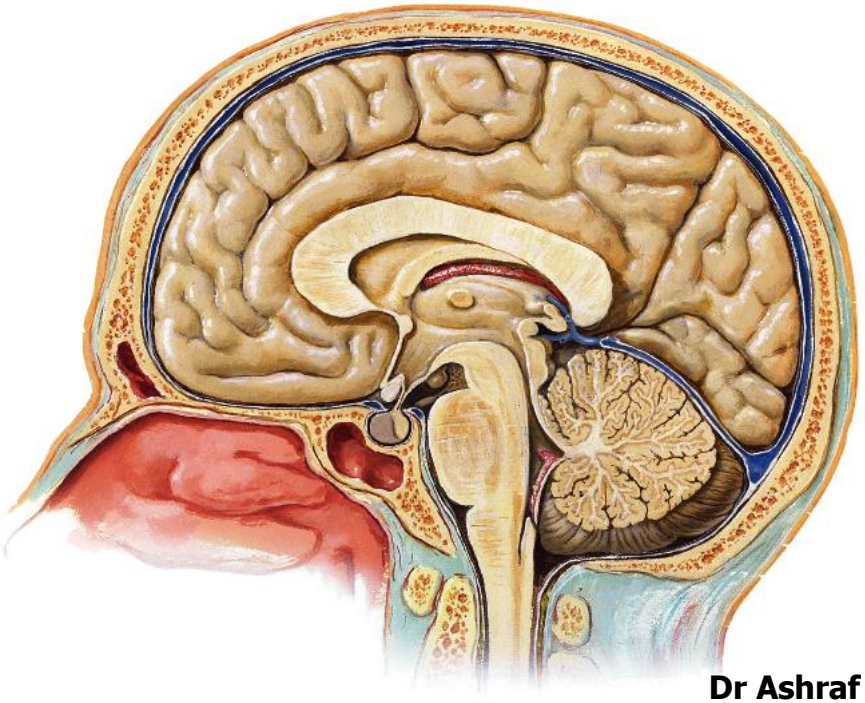
* Is a group of nuclei that lie close to the tail of the caudate nucleus and anterior to the hippocampus, in relation to the tip of inferior horn of the lateral ventricle.
* It was first regarded as a part of the basal ganglia but now it is considered part of the limbic system.

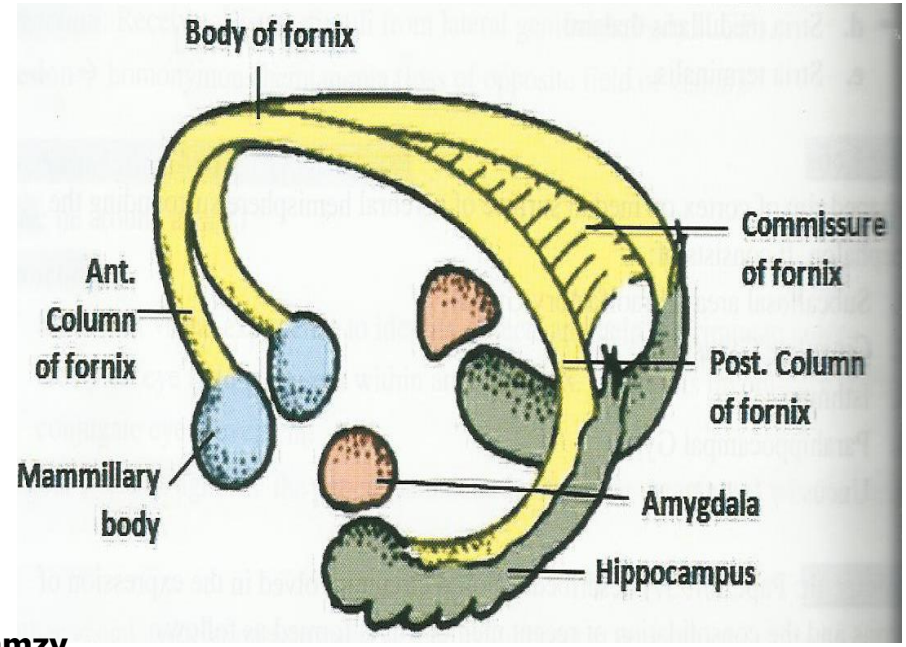




The Amygdala (contd)

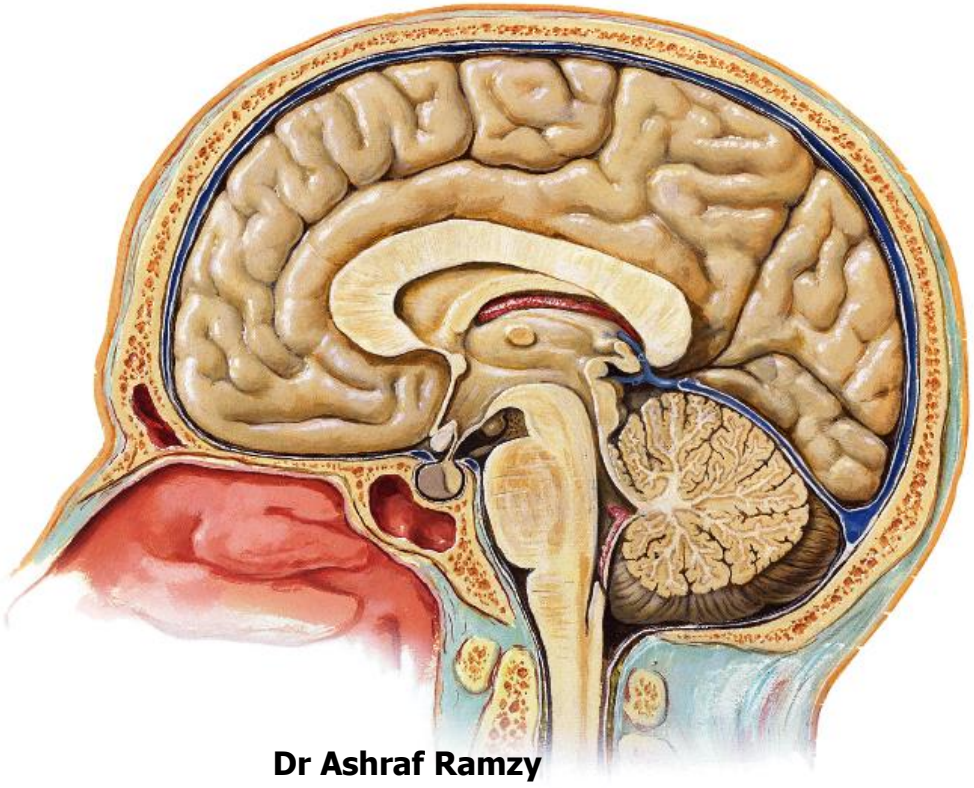
* **Stria Terminalis: starts from the amygdaloid nuclei and curves around the thalamus, in the groove between it & the caudate nucleus accompanied by the thalamostriate vein. It ends on the septal areas, hypothalamic nuclei and columns of fornix.**





Septal Areas

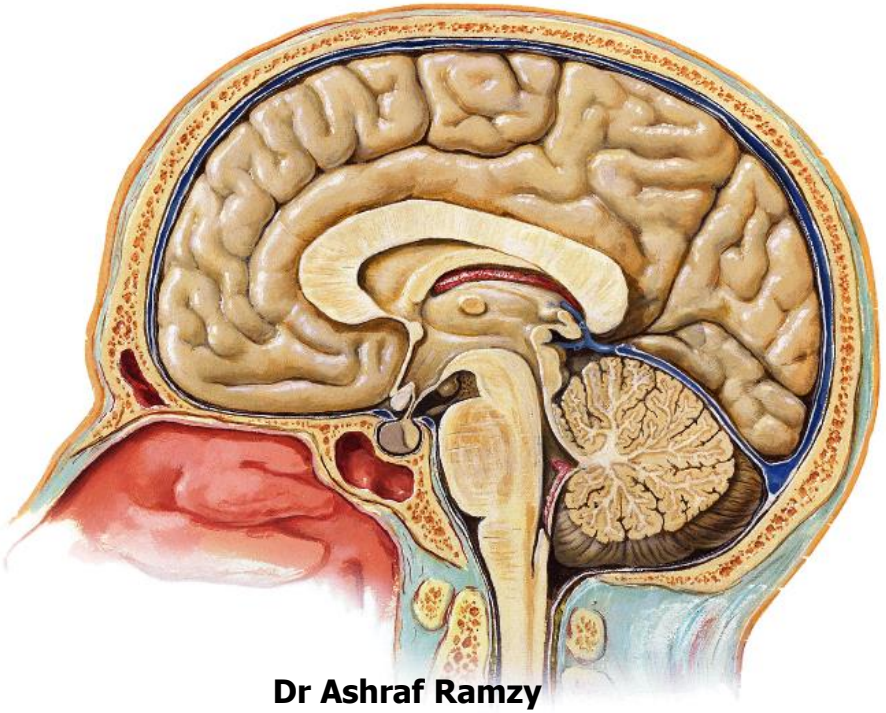
* It is formed of sparse grey matter that lies in the septum pellucidum and just infront of the lamina terminalis.
* It contains the center of pleasure.



Septal Areas (contd)

* **It has the following connections:**

1. **Medial Forebrain Bundle: connect the septal areas and amygdaloid nuclei with the hypothalamus.**
2. **Stria medullaris Thalami (habenular stria): connect septal areas to the habenular nuclei.**



Functions of limbic system

* Include Emotions, Instinct & Memory.
* Emotions (e.g., fear & anger) and behaviors based on instinct (e.g., feeding, drinking, mating & mothering) are expressed via the hypothalamus and its connections with the outflow of the autonomic nervous system and its control of the endocrine system.

Applied Anatomy

* **Lesion of hippocampus or Papez circuit (in chronic alcoholism) → anterograde amnesia (loss of recent memory & preservation of old memory).**
* **Bilateral amygdalectomy in monkeys → Kluver-Bucy syndrome with docility, hyperphagia, increased sexuality.**

BASAL NUCLEI (BASAL GANGLIA)

** They are masses of grey matter lying within each cerebral hemisphere near its base.

** **<u>They include</u>:**

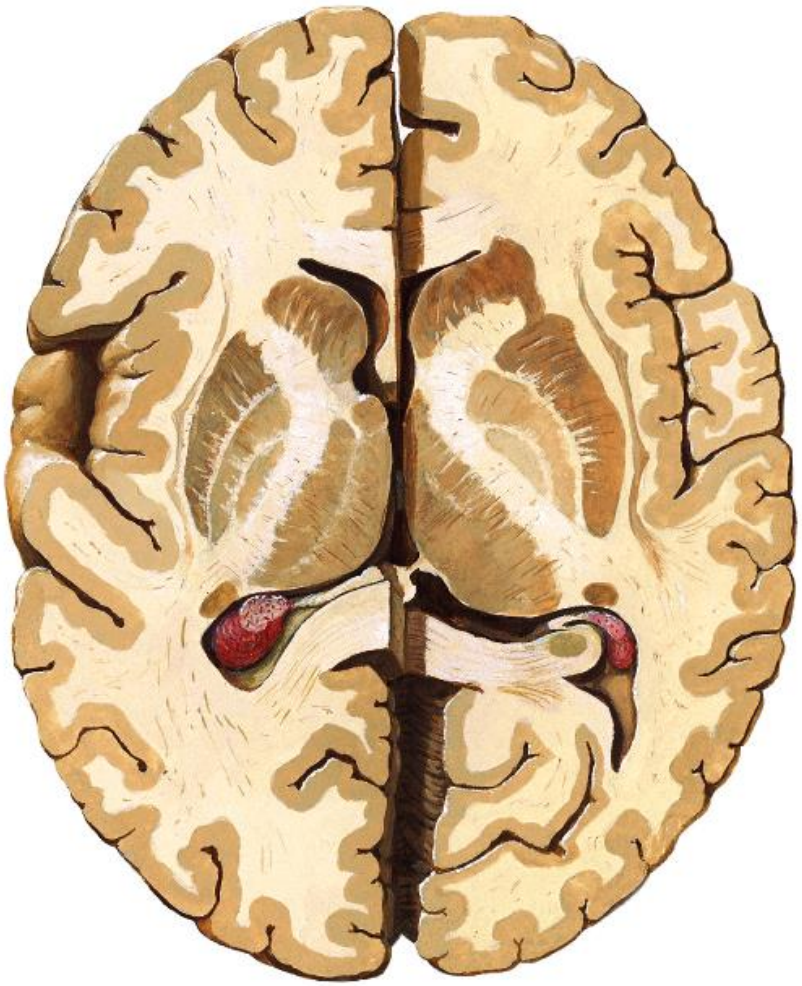
1. Corpus striatum:

a. Caudate Nucleus

b. Lentiform Nucleus (formed of putamen laterally & globus pallidus medially).

2. Amygdaloid Nuclei (part of limbic system).

3. Claustrum (grey matter that lies lateral to Lentiform N. and is separated from it by external capsule). It is separated from grey matter of insula by the extreme capsule. It is of unknown function.

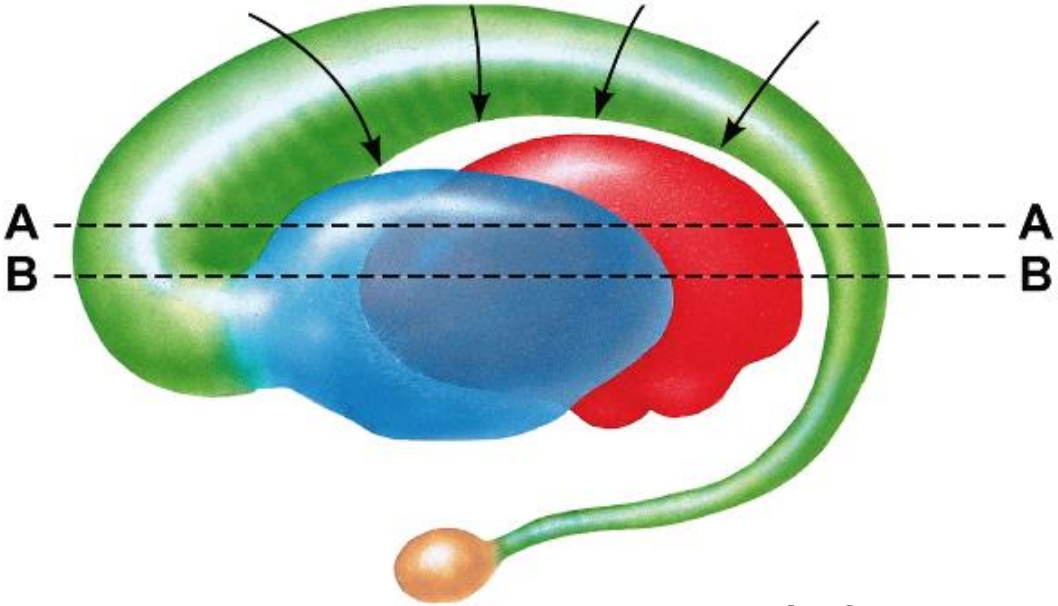


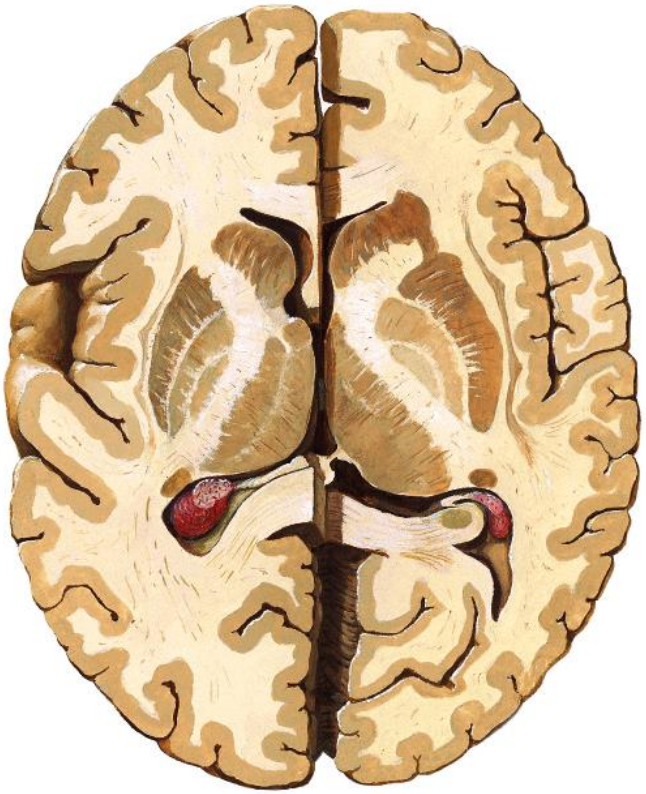
Caudate Nucleus

** It is a **C-shaped** Nucleus.

** It has a **head, body and tail.**

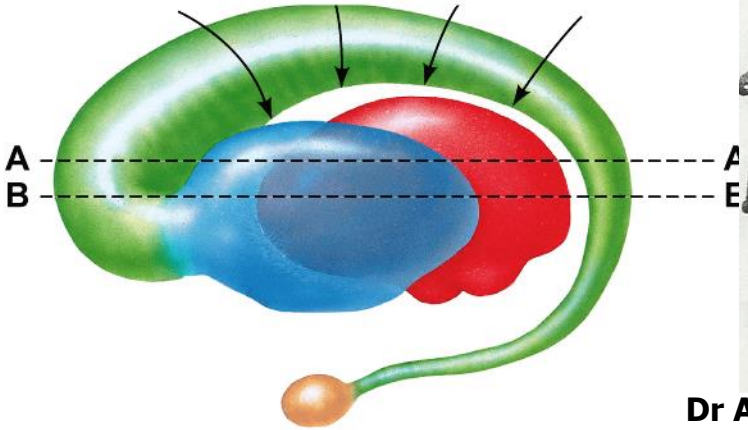
** The head of caudate N. is continuous with putamen of lentiform N.

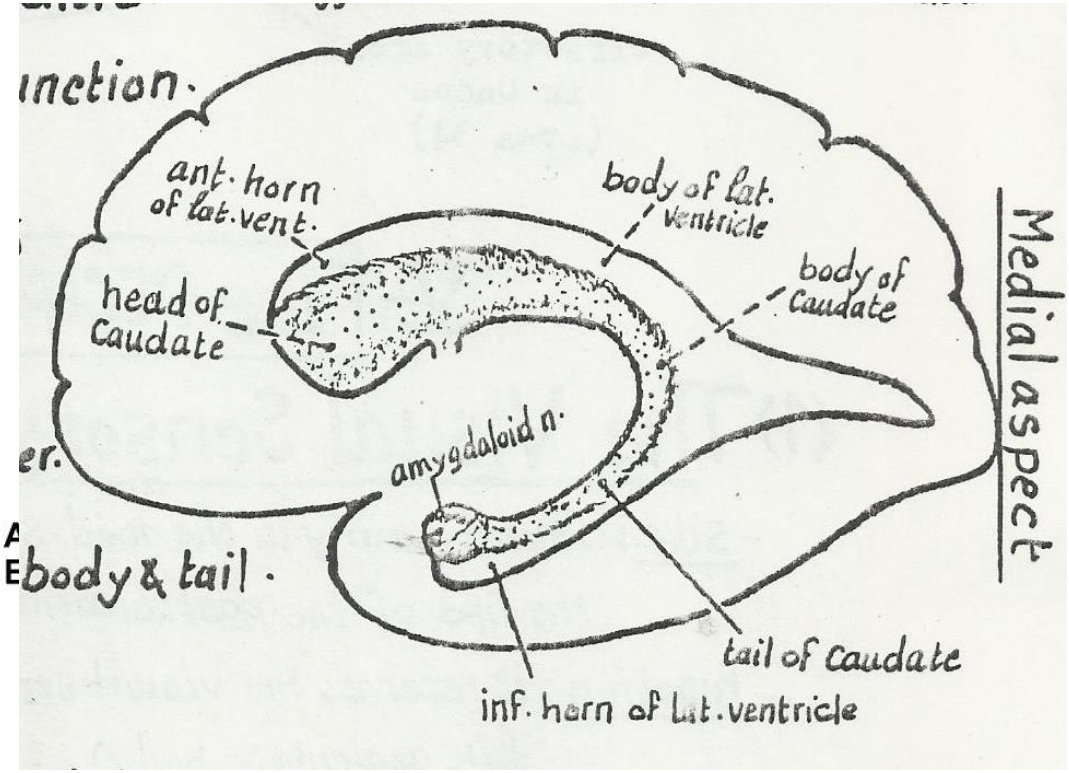




Caudate Nucleus

* The head bulges into the ant. horn of the lateral ventricle.
* Its body lies in the floor of the body of lateral ventricle.
* Its tail lies in the roof of the inferior horn of lateral ventricle.
* The tip of the tail is continuous with amygdaloid nuclei.





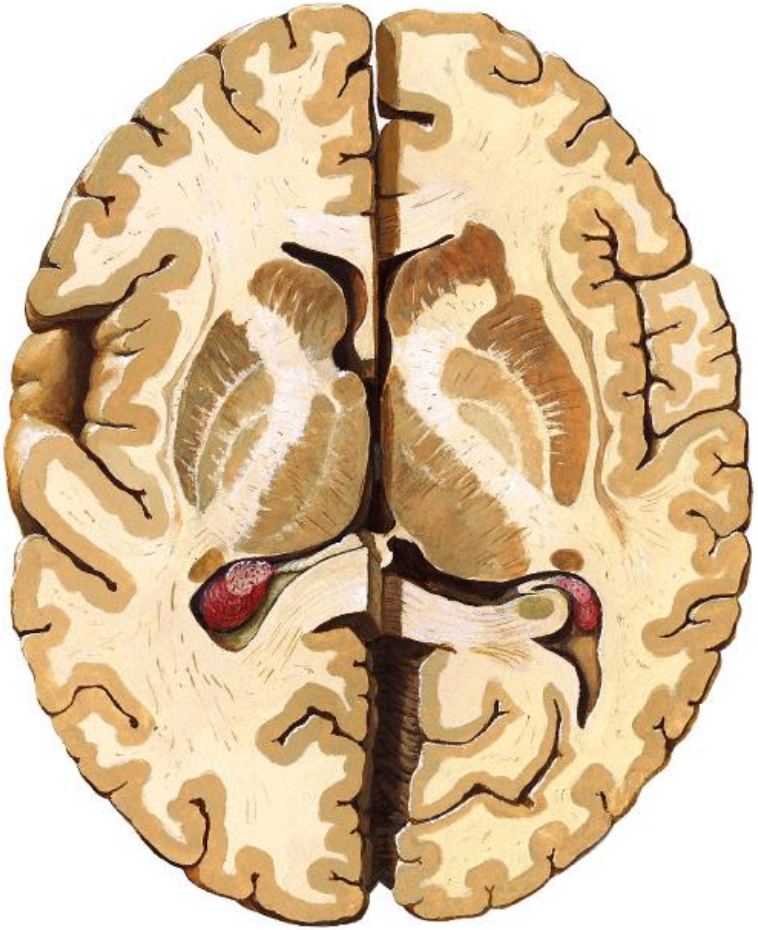
Lentiform Nucleus

** It looks like a biconvex lens.

** It is enclosed between the external capsule (laterally) and the internal capsule (medially).

** It is divided by external medullary lamina into:

1. **Putamen** (laterally).
2. **Globus Pallidus** (medially) → appears white due to rich myelin content.



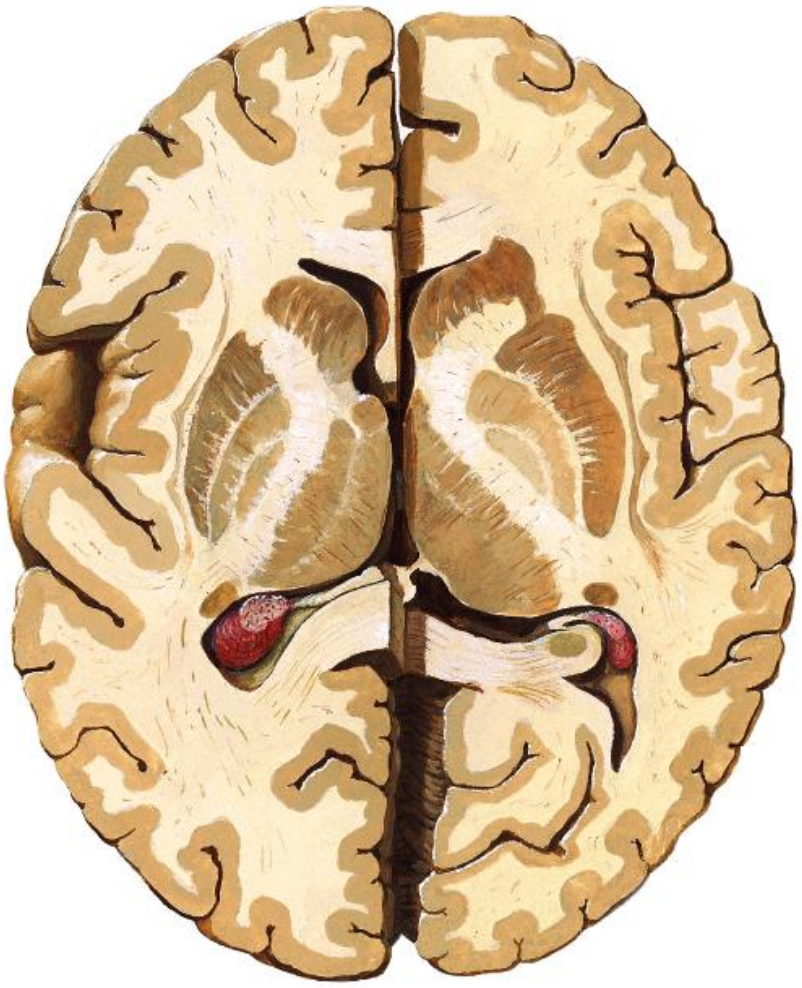
BASAL NUCLEI (BASAL GANGLIA)

** **It is formed of:**

1. **Neostriatum (Striatum):**
   - **a. Caudate N.**
   - **b. Putamen.**

* They are similar in structure. Neostriatum receives afferents and projects to **Paleostriatum (Globus Pallidus)**

2. **Paleostriatum (Pallidum)** → **Globus pallidus:** sends all efferents.

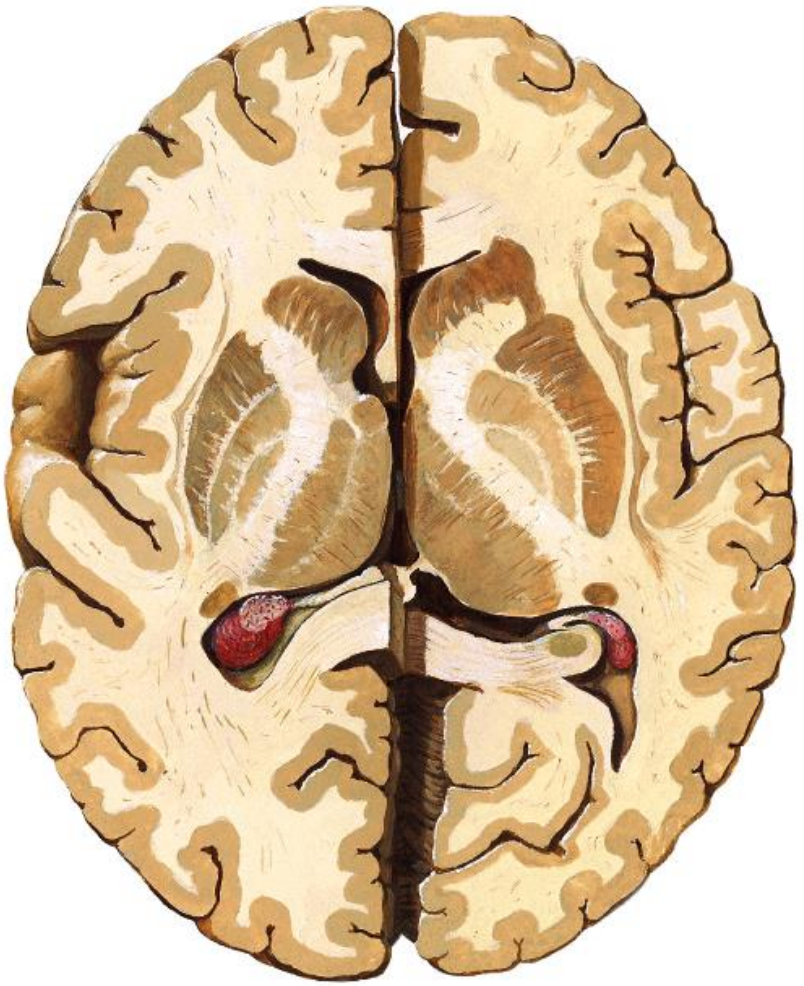


BASAL NUCLEI (BASAL GANGLIA)

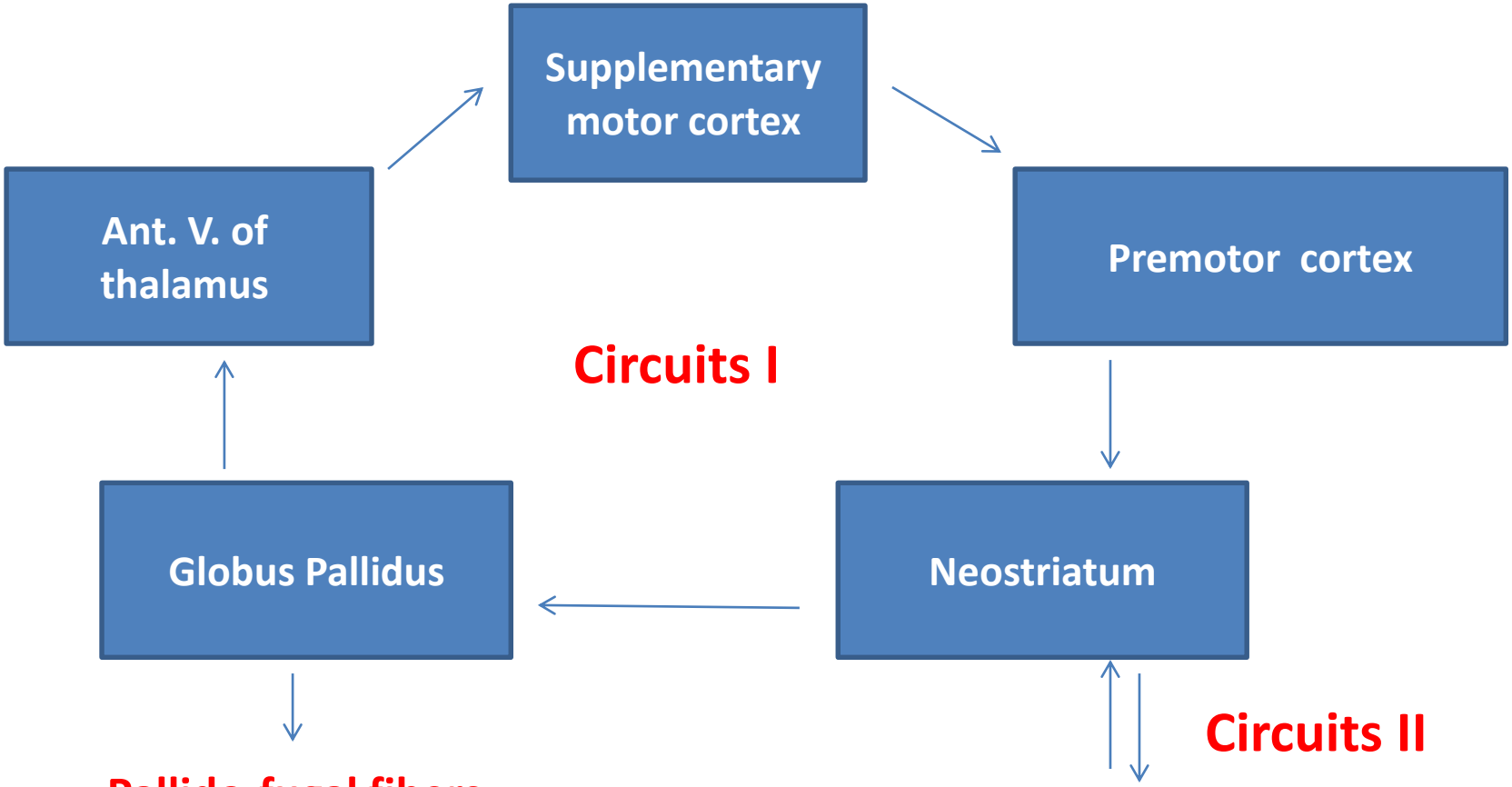
** **Functions:**

* Concerned with muscular activity.

* They help the motor cortex in learning of motor skills (e.g., writing the alphabet) & also prepare the body posture to suit the movement.



Connections of Basal Ganglia



Pallido-fugal fibers

* **Arising from G. pallidus & going to:**

1. **Thalamus & subthalamus.**
2. **Red nucleus & substantia nigra.**
3. **Inf. Olivary N. & R.F.**

** **Blood Supply:** Central branches of ant. & middle cerebral arteries.

** **Veins:** drain into →thalamostriate vein.

** **Lesions in Corpus Striatum:**

* **Caudate N.** → **Chorea (quick, jerky, purposeless, movement in proximal parts of limbs).**

* **Putamen** → **Athetosis (slow, sinuous, writhing movement in distal parts of limbs)**

* **Substantia nigra (or nigro-striatal dopaminergic fibers)** → **Parkinsonism:**

a. Static tremor at rest in the form of pill rolling or money counting.

b. Cog-wheel rigidity and Mask face.

c. Loss of automatic associated movements as arm swinging during walking.

* **Subthalamic nucleus** → **hemiballismus.**

THANK YOU