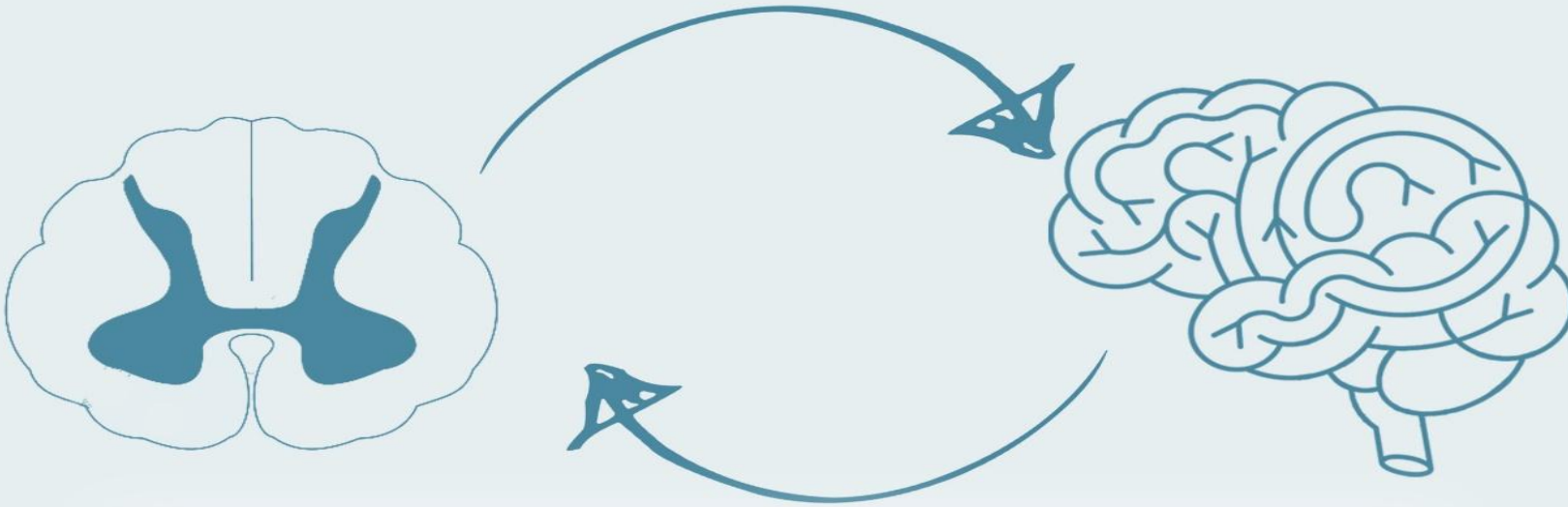


CNS

Anatomy

slides sheets

number 14

Done by Rana Najada

Correction Dr.Maha

Doctor Maha

In the previous lecture we talked about types of brain fibers :

a. Association fibers:
   -short association fibers forming the U shaped arcuate fibers.
   -long association fibers ; **the superior longitudinal bundle** which connects the frontal , parietal , temporal , and the occipital lobe . **The inferior longitudinal bundle, the cingulum and the uncinate fasiculus.**
b. Commissural fibers:
   - **the anterior commissure**it is located in front of the column of the fornix.
   - **the posterior commissure** it is located below the pineal gland and the **habenular commissure** that is located above the pineal gland.
   - **Corpus callossum**: the largest commissural fiber in the brain.
c. Projection fibers.

The Internal Capsule: is the largest projection fibers found in the brain, it's V-shaped bundle surrounded by gray matter.

It has three parts:

- Anterior limb : located between the head of caudate medially and the lentiform nucleus laterally.
- The Genu: between the lentiform nucleus laterally and thalamus and the head of caudate medially.
- Posterior limb: between the lentiform nucleus laterally and thalamus medially.
- Retrolinticular
- Sublenticular

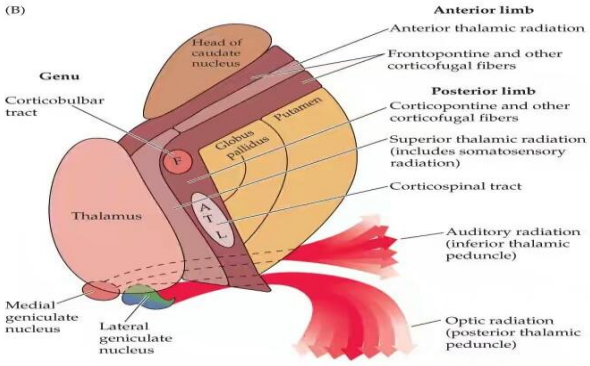
Fibers of internal capsule: are either ascending (sensory) or descending (motor)

A. The Genu: the most important fibers that run through it are the corticobulbur fibers (coricinuclear) which are descending fibers of pyramidal tract specialized for the cranial nuclei in brainstem (does not reach the spinal cord).
B. Posterior limb contains:
   -Descending anterior half which are the anterior and lateral corticospinal fibers that pass from motor area 4 in cortex to the anterior horn of spinal cord.
   -Ascending posterior half, carries the largest ascending sensory fibers which

are called superior thalamic radiation because its fibers ascend from ventral posterior nuclei of thalamus to the post central gyrus.

C. Anterior limb contains:
   -descending frontopontine fibers (fronto-ponto-cerebellar) project from cortex to pons directly.
   -ascending thalamocortical fibers also called the anterior thalamic radiation: these are fibers that connect the anterior nuclei of thalamus to the frontal lobes and the limbic system especially the cingulate gyrus .
D. The retrolinticular part it's caudal to the lenticular nucleus, contains fibers of the optic radiation which connect the lateral geniculate nucleus of thalamus with the occipital lobe. Also called the posterior thalamic radiation.
E. The sublenticular part located below the lenticular nucleus, contains the auditory radiation which connects the medial geniculate nucleus of thalamus with temporal lobe. Also called the inferior thalamic radiation.

- From the points mentioned above the thalamic radiation is the term that describes the fibers that project from the thalamic nuclei to different areas in cortex. see the figure :



Blood Supply of the Internal Capsule:

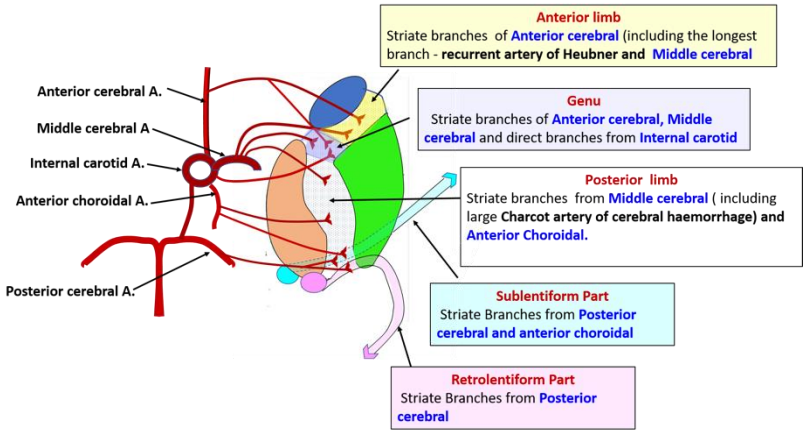
Blood supply of internal capsule will be discussed later in more details, but it is now important to relate the anatomy of internal capsule with its blood supply:

Recall that the blood supply of the central nervous system is of two systems;

a. The vertebrobaislar system.
b. The internal carotid system : the internal carotid artery (a branch of the common carotid artery) it passes through the carotid canal and enters cavernous sinus then at the outer border of cavernous sinus it divides into

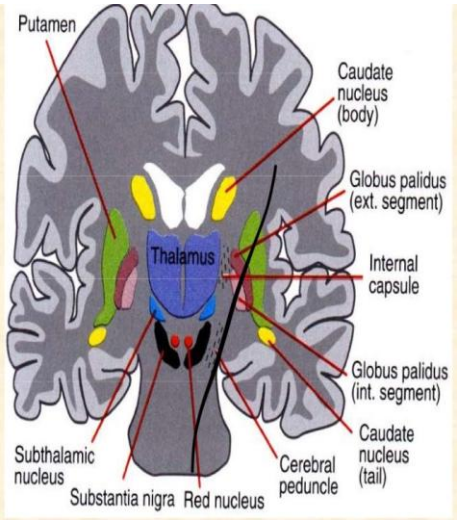
its two terminal branches; **Anterior and middle cerebral arteries** which supply the main part of the brain and its internal structures.

As you can see from the figure most of the blood supply to internal capsule is coming from the middle cerebral artery that gives an important branch which is the Charcot artery also called the artery of cerebral hemorrhage . this branch is responsible for the blood supply of the posterior limb of internal capsule. It's a fragile artery because of its thin walls thus a hypertensive patient with fluctuations in his/her blood pressure is at risk of forming a lesion in charcot's artery which might cause cerebral hemorrhage in the posterior limb of internal capsule leading to contralateral hemiplegia and hemianathesia. The posterior limb therefore is the most common site for cerebral hemorrhage in internal capsule.



Remember: brain hemorrhage is classified into extradural, subdural, subarachnoid and cerebral hemorrhage.

The Human Basal Nuclei: collection of masses of gray matter suspended within the base of the brain.
Ps: the basal nuclei was also called the basal ganglia but since it is inside the CNS the term basal nuclei is more suitable.



Anatomical Classification of the Basal Nuclei:

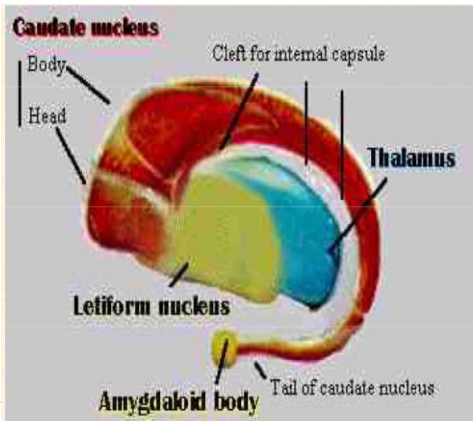
It has five important parts:

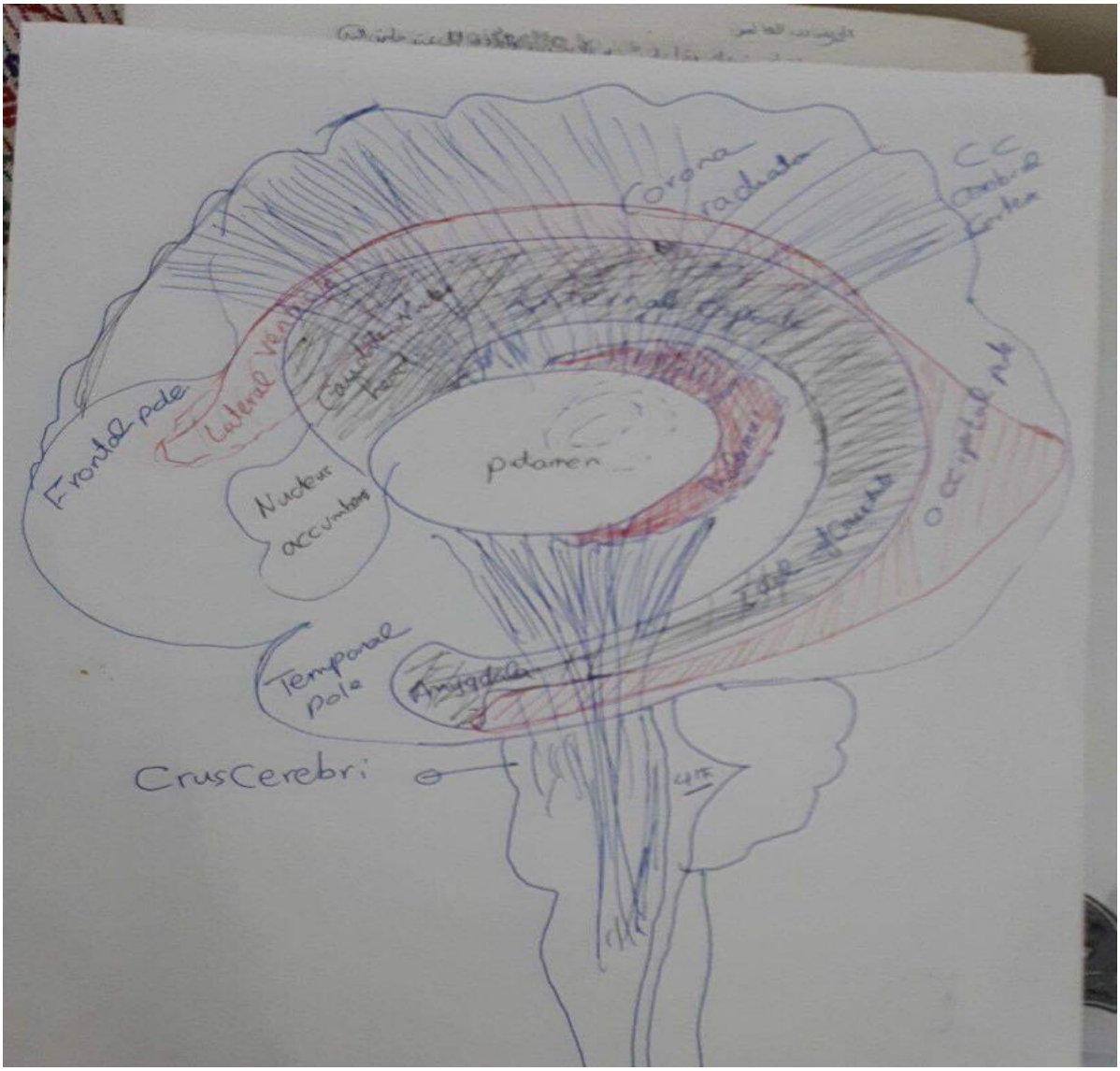
1. Lentiform nucleus
2. Cuadate nucleus
3. Amygdala
4. Claustrum
5. Nucleus accumbus

Please pay attention to the pictures while reading the following :

1. The doctor started by the most lateral part of the basal nuclei which is the lentiform nucleus .
   -this nucleus is lens shaped and it is located behind the insula hence by removing the posterior ramus of the lateral fissure we will first see the insula then by removing the insula we will see the lentiform nucleus which is made from two parts :
   - large lateral dark part which is the Putamen.
   - small medial pale part which is the globus pallidus which is further divided into lateral globus pallidus (external) and medial globus pallidus (internal).
   - it is surrounded by an external capsule separating it from the claustrum (lateral) and an internal capsule which separates it from thalamus and caudate nucleus (medial) .

2. The caudate nucleus it is C-shaped,it encircles the upper and inferior border of thalamus . It has three parts :
   -Head , in the frontal lobe.
   -Tail, in the occipital lobe.
   - End of tail, in the temporal lobe fused with the amygdala (which is number 3).
3. Amygdaloid nucleus; in the temporal lobe (uncus) connected to caudate tail forming the amygdala.





The picture above is the Doctor's drawing, it is a sagittal section of the brain showing the internal structures **from Lateral to medial**:

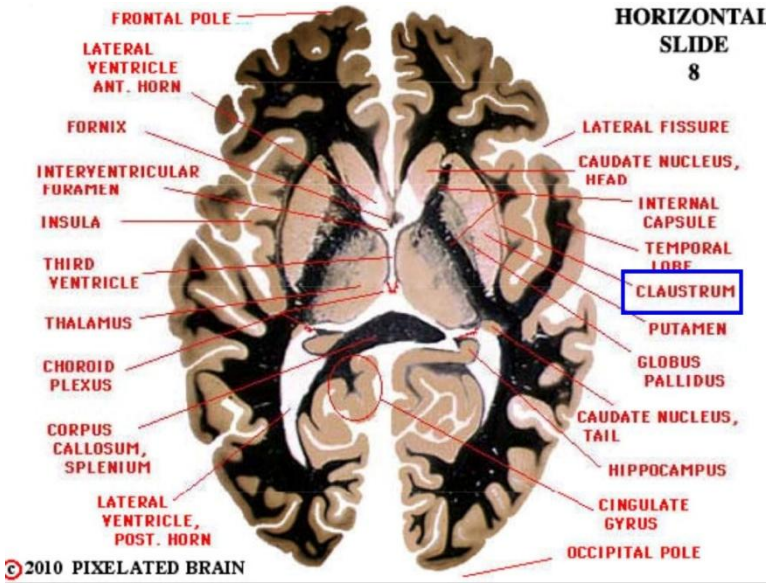
Starting by the putamen the most lateral part then the head of caudate which is fused with the anterior part of putamen. The most medial part in picture above is the thalamus which forms the lateral wall of the third ventricle.

Notice the corona radiate which forms the internal capsule in relation with thalamus and basal nuclei , thus by following the drawing above from lateral to medial we can see that :

- The structure between the lentiform nucleus and the caudate nucleus is the anterior limb of internal capsule. And that between the thalamus medially and the lentiform nucleus laterally is the posterior limb of internal capsule, and what's between the lentiform , caudate , and thalamus is the genu . the sublentifom and the retrolentiform are not shown in the sagittal section.

- That drawing brings us to the fifth part of the basal nuclei which is the Nucleus Accumbus it is the anterior portion of the putamen fused with head of caudate nucleus(5). As shown in the drawing.

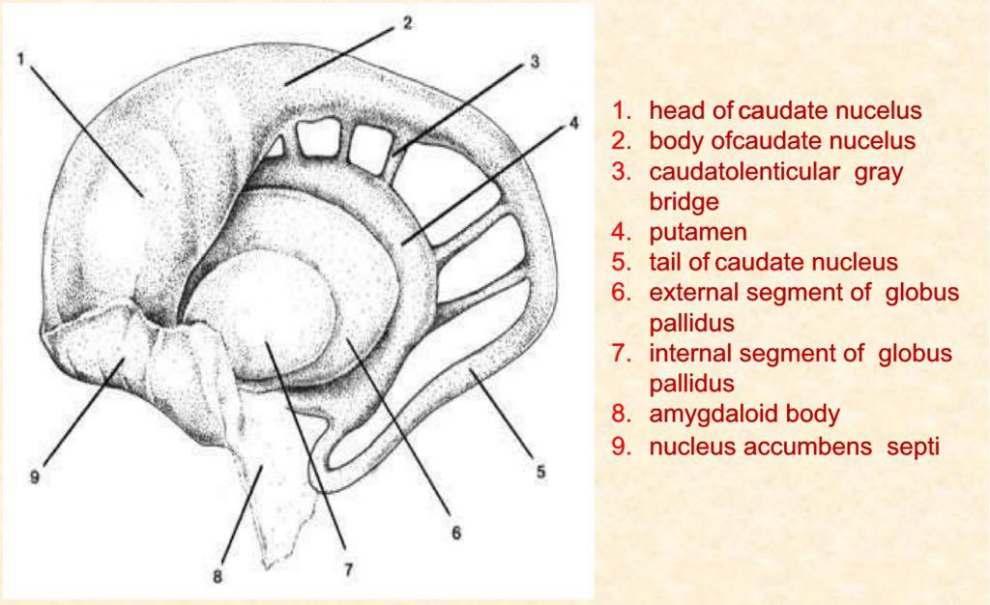
- Now let's view the 4th part which is the Claustrum it is only seen in a transverse section of the brain :
  the picture shows the white matter in a black color and the gray matter in a brownish color.



Thus the claustrum is the most lateral part of the basal nuclei and it is a sheet of gray matter of unknown function . it's located lateral to the putamen which it is separated from by an external capsule. And medial to the insula which is separated from the claustrum by the extreme capsule .thus the claustrum lies between the two capsules (external and the extreme which are white matter). also from the figure you can see the V-shaped internal capsule as well as the thalamus surrounding the third ventricle. now try naming the objects from **medial to lateral** as shown in the figure above : you will see the following:

first we have the thalamus -> the internal capsule -> globus pallidus medial -> globus pallidus lateral -> putamen ->external capsule -> claustrum -> extreme capsule -> insula .
* a note that will be discussed later : the fornix and the septum leucidum form the medial wall of the lateral ventricle .

This figure below shows the structures from **medial to lateral** :



- Regarding the third numbered structure in the figure, it is the Corpus Striatum part of basal nuclei formed by the putamen and bridging fibers which are bundles of gray matter separated by white matter connect the putamen with caudate nucleus . it is the most important part in basal nuclei because it receives all the afferent fibers coming from the cortex , thalamus or brainstem thus it is the major afferent pathway. On the other hand the efferent fibers leave through the globus pallidus internal .

- **Function of the Basal Nuclei:**

1. Voluntary movement;
   a. initiation of movement , in order for a movement to happen an idea of the movement must be formed in the prefrontal cortex then fibers pass from prefrontal cortex to area 6 (premotor) and area 4 (primary motor area) then from these areas they pass to two important structures (just before the start of movement); the cerebellum and the basal nuclei , these two are considered the consultants for the motor orders initiated in prefrontal cortex their job is to adjust the movement program and prevent any motor dysfunction that could happen, therefore they correct the motor orders then these orders are returned back to cortex where they descend to the anterior horn of spinal cord.
   b. change from one pattern to another.
   c. programming and correcting movement while in progress.
   d. learning skills (football, drawing, singing ,..)
2. Postural control;
   control the axial (proximal) parts of shoulders and hips also the automatic associated movement like walking and dancing.
3. Conjugated movement of both eyes.

Note:

- recall that the prefrontal cortex is the area of execution , planning , change from one pattern to another like in dancing and learning new skills.

- The cerebellum has more control over the posture.
- There is no direct connection between the basal nuclei nor the cerebellum with the spinal cord or the brain stem, there is no cerebello-spinal tract or caudate-spinal tract.

- **Clinical Classification of the Basal Nuclei :** is the clinician classification of the basal ganglia .

a. Corpus striatum (neostriatum) ; the putamen and the bridging fibers connecting the caudate nucleus. (neo means it's the latest discovered part)
b. Pallio striatum (pallidum) ; the globus pallidum

c. Lentiform nucleus; putamen lateral and globus pallidus medial.
d. Archistiatum ; amygdala, it was the first discovered part by experiments done on animals and from here its association with smell was observed.
e. Substantia nigra; anatomically it is related to the midbrain but functionally to basal nuclei.
f. Subthalamic nucleus, found in the subthalamus between midbrain and thalamus.
*e and f were added recently to basal nuclei.

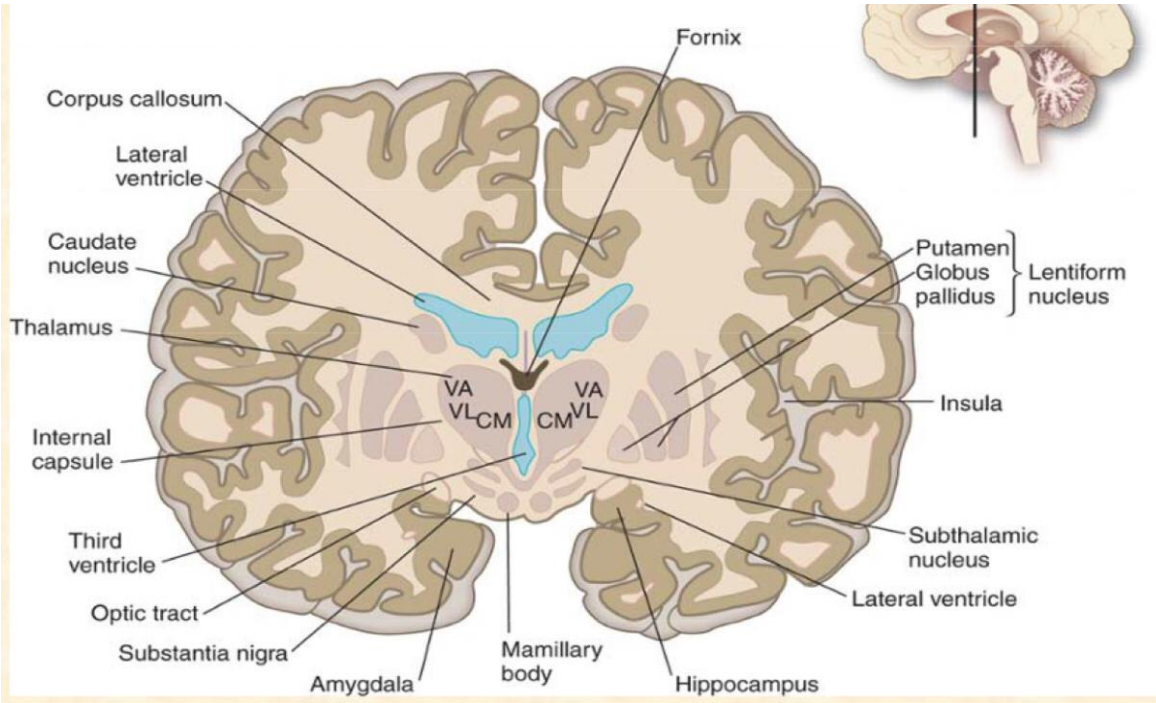
- ❖ The doctor mentioned here another example about the order of the structures in a coronal section, which will be displayed at the end of the sheet.

- **Connections of Basal Nuclei:**

- It receives input by Corpus striatum (major afferent) which could be coming from:
-Corticostriatum (cortex)
-Thalamostriate (thalamus)
-Nigrostriatum (substantia nigra)
-Brainstem striatal fibers.
-Subthalamic nucleus,

- It sends Output through globus pallidus by pallidofugal fibers which are fibers moving from the pallidus to cortical structures, more details will be discussed later when studying the subthalamus which has three fasciculi (white matter connecting between different structures):
a. Ansa lenticularus ; coming from lentiform nucleus.
b. Fasciculus lenticularis
c. Subthalamic fasiculus (between the basal ganglia and the subthalamus)

- **Diseases of Basal Nuclei :** to understand the diseases of basal nuclei we have to discuss briefly the internal connections of BN which are the direct and the indirect pathways. These pathways are involved in the contraction and relaxation of antagonistic muscles for example extensors and flexors so normally when a muscle is contracted the antagonist muscle will relax in order for the desired action to happen. The direct pathway is what mediate the desired contraction of the contracted muscle by direct contact of basal nuclei with cortex, in between this path relies the indirect pathway which provides inhibitory signals to antagonistic muscle causing it to relax . It is indirect because the path involves subthalamus. To sum up the direct pathway is excitatory to muscle action whereas the indirect pathway is inhibitory.
- There is another structure involved in mediating this inhibition and excitation circle which is Substantia Nigra it has a part called the pars compacta which releases dopamine that has an excitatory effect on direct pathway and inhibitory effect on indirect pathway, therefore if we inhibited the dopamine release there will be inhibition to direct pathway causing hypokinesia, and if we inhibited indirect pathway by dopamine this will cause inhibition to the inhibitory (indirect) pathway leading to hyperkinesia.
- Now coming to the diseases of BN which can cause hyperkinesia or hypokinesia depending on the pathway affected:
  A. **Parkinson disease** (hypokinetic, hypertonic) caused by a lesion in the direct pathway .
  B. **Sydenham Chorea** (hyperkinetic, hypotonic) caused by a lesion in the indirect pathway ,characterized by excessive involuntary movement often called the dancing like phenomenon.
  Also **the Hemiballism** which causes hyperkinesia in one half of the body, it is caused by a lesion in the subthalamus.
  -note: the doctor said that she wants us to know the examples if they are hyper or hypo and their lesions more than their symptoms.



- The figure above is a coronal section of the brain

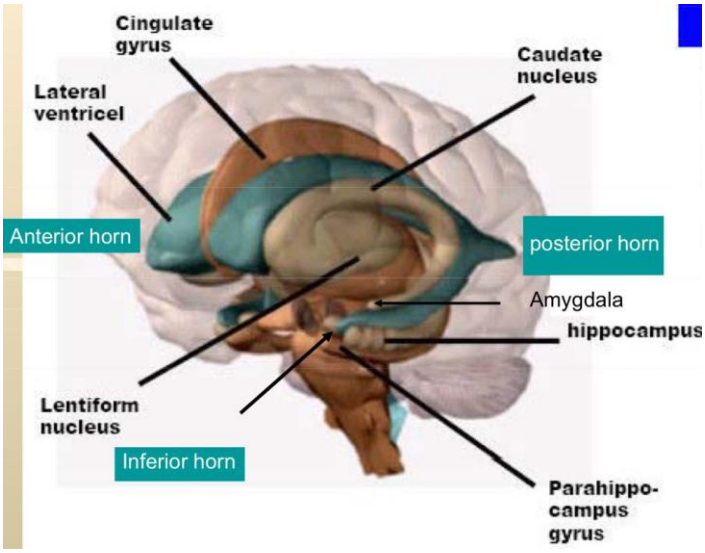
Again you can see the following structures from medial to lateral :

Thalamus > internal capsule > head of caudate > internal globes pallidus > external globus pallidus > putmen > external capsule > claustrum > extreme capsule > insula. (all are shown in the figure)

Also the Substantia Nigra and the subthalamic nuclei (red nuclei) are seen.

-amygdaloid is also seen in the coronal section which is shown in the roof of the inferior horn of lateral ventricle.

In short the doctor talked about the lateral ventricle using the following figure :



- The lateral ventricle has three horns , an anterior horn projected towards the frontal lobe ,a posterior horn towards the occipital lobe and an inferior horn in the temporal lobe . therefore identifying which horns are seen in a brain section depends on the section itself:
  -If it's coronal then the anterior and inferior horns are shown , if it is a transverse section then the anterior and posterior horns.
- From the figure above you can see the following relations:
  head of caudate lies in the floor and lateral wall of anterior horn of the lateral ventricle. Also body of caudate forms the floor of central part of lateral ventricle and tail of caudate forms the roof of the inferior horn of lateral ventricle. Lastly the floor of the lateral ventricle is made by the hippocampus.

~ Best of luck