BASAL GANGLIA, LIMBIC SYSTEM AND CEREBELLUM

Use the *Powerpoint* file Neuro Module 4. Basal ganglia, limbic system and Cerebellum

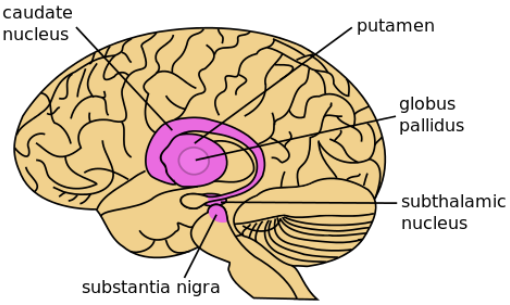
Notes before you begin:

On the coronal and horizontal sections identify components of the **basal ganglia** and the **limbic system.** Since these are 3 dimensional structures that reside deep in the brain (subcortical) they are difficult to appreciate from the a lateral, midsagittal, or inferior view. Note the relationships between the basal ganglia and the thalamus and lateral ventricle throughout the sections.

Learning objectives for Basal ganglia and Limbic system. SLIDES (2-9)

1. Recognize the three-dimensional relationship of the basal ganglia to the ventricular system and internal capsule.
2. Identify components of the basal ganglia in coronal and horizontal brain section.

Overview of the Basal Ganglia structures



Basal Ganglia Lateral by Badseed utilizing the work of Leevanjackson and John Henkel, December 16 2002. Public Domain

→ The basal ganglia (basal nuclei) consists of five major gray matter nuclei whose dysfunction produces abnormal movements

1. **Caudate nucleus**
2. **Putamen**
3. **Globus pallidus**
4. Subthalamic nucleus
5. **Substantia nigra**

→ The first three nuclei, caudate, putamen, and globus pallidus, are subcortical masses of gray matter deep within the cerebral hemispheres (telencephalon).

→ The subthalamic nucleus is located in the diencephalon and the substantia nigra is in the rostral midbrain

→ The caudate nucleus and putamen are often referred to together as the *striatum*

→ The putamen and globus pallidus are often referred to together as the *lenticular* (or lentiform) nucleus

1. Caudate Nucleus

→ The **caudate nucleus** consists of a large **head** (slides 3, 7&8) tapering to a **body** (slides 4&5) and curved **tail** (slide 5).

→ The head of the caudate nucleus is in the frontal lobe

- The head of the caudate is almost completely separated from the putamen by the internal capsule.
- The caudate nucleus and putamen are connected by bridges of gray matter giving the two nuclei a striated appearance and the two nuclei together are referred to as the *striatum*.

→ The head **caudate nucleus** tapers to a **body** that lies lateral to the **lateral ventricle**.

→ The body of the caudate nucleus is separated from the **putamen** and **globus pallidus** by the **genu of the internal capsule** (slides 7&8)
→ The body arches through the parietal lobe
→ The tail of the caudate is in the temporal lobe
    - At the rostral pole of the temporal lobe, the **tail** of the caudate abuts the **amygdala**-- a part of the limbic system.

2. Putamen (slides 3-5, 7&8)
The **putamen** lies lateral to the internal capsule and globus pallidus and is nestled in the "C"-shape of the caudate nucleus. The putamen and caudate nucleus are connected by cross-bridges of gray matter.

3. Globus Pallidus (slides 4, 7&8)

→ The **globus pallidus** lies medial to the putamen, separated from it by the lateral medullary lamina
→ The medial apex of the globus abuts the internal capsule
→ The globus pallidus consists of two divisions or segments, referred to as the **external segment** (or lateral segment) and the **internal segment** (or medial segment) (slide 4)
→ These are often abbreviated GPe and GPi

4. **Substantia nigra** (slides 5&9)
→ is a part of the midbrain and is found internal to the **crus cerebri** immediately caudal to the subthalamic nucleus
    - Histologically, the substantia nigra is divided into a reticulated part (pars reticulata) and a compact part (pars compacta) (not shown on slide)

Coronal sections

SLIDE 3
→ Rostrally the **head of the caudate** is continuous with the putamen through and beneath the anterior limb of the internal capsule
→ The fused area is known as the *nucleus accumbens* which has connections with the limbic system

SLIDE 4
Basal ganglia components
→ The globus pallidus lies medial to the **putamen**, separated from it by the lateral medullary lamina
→ The **globus pallidus** is separated into an **internal** and **external segment**
    - Each has important connections to thalamus
→ The medial apex of the globus abuts the **internal capsule**
→ The **body of the caudate** nucleus lies just lateral to the lateral ventricle

Limbic system components

→ The **amygdala** appears as a subcortical mass of gray matter
  - It lies anterior to the hippocampus and medial to the inferior horn of the lateral ventricle

→ The **fornix** (pl.fornices) is a prominent paired fiber bundle ,mostly containing hippocampal efferents, that interconnects the hippocampus of each temporal lobe with the ipsilateral septal area and **mammillary bodies**

→ In coronal sections the **hippocampus** often appears as a seahorse in the most medial portion of the temporal lobe

SLIDE 5

Basal ganglia components

→ The globus pallidus is no longer present

→ The **putamen** is separated from the thalamus the **posterior limb of the internal capsule**

→ The **body of the caudate** lies just superior to the thalamus and will begin to transition into the tail as it bends inferiorly

→ The **tail of the caudate** nucleus follows the curvature of the lateral ventricle
  - It will descend into the temporal lobe where it lies in the roof of the *inferior horn of the lateral ventricle*

Limbic system components

→ The **substantia nigra** is now visible, just medial to the crus cerebri

→ The **hippocampus** in the temporal lobe appears as a seahorse tail in both coronal and horizontal sections

Horizontal sections

SLIDE 7

Basal ganglia components

→ These slides of horizontal sections show the relationship between the **putamen**, caudate **nucleus** and thalamus

→ Study the relationship between the basal ganglia and the parts of the **internal capsule**
  - The **anterior limb** lies between the **head of the caudate** and the putamen
  - The **genu** is found at the junction of the caudate and thalamus
  - The **posterior limb** lies between the thalamus and the putamen

Limbic components

→ The **body** and **crus of the fornix**

SLIDE 8

Basal ganglia components

→ These slides of horizontal sections show the relationship between the **putamen**, **caudate nucleus** and thalamus

→ Study the relationship between the basal ganglia and the parts of the **internal capsule**

- The **anterior limb** lies between the head of the caudate and the putamen
- The **genu** is found medial to the **globus pallidus**
- The **posterior limb** is now between the thalamus and the globus pallidus

Limbic components

→ **Body of the fornix**

SLIDE 9

This section has been taken inferior enough to include the midbrain and the cerebellum.

Limbic components

→ **Mamillary bodies**

→ **Hippocampus**

→ **Amygdala**

→ **Substantia nigra**

CEREBELLUM

Learning Objectives for the Cerebellum

1. Identify the external anatomical features of the cerebellum in images of gross specimens and MRI.

Sagittal and Ventral Views of the Cerebellum SLIDES 10-13

The cerebellum is the largest part of the hindbrain. It consists of **two cerebellar hemispheres** (lateral hemisphere) united by a central, median **vermis** (vermis = worm-like). It is also divided into three lobes: anterior, posterior and flocculonodular lobe. The surface of the cerebellum is deeply folded to increase surface area.

→ On a ventral view, with the brainstem in place, most of the vermis cannot be seen but from a midsagittal view, most of what is seen is the vermis

→ On the hemisected brain image, locate the **primary fissure—**separates the anterior and posterior fissure

→ Portions of the cerebellum rostral to this fissure constitute the **anterior lobe**. The remainder of the cerebellum, caudal to the primary fissure is the **posterior lobe**.

→ On the midsagittal brain image, the **cerebellar tonsils** of the lateral hemispheres are just visible inferior to the cut vermis

- With increased intracranial pressure from a stroke or injury, the tonsil can herniate downward through the foramen magnum and enter the spinal canal. This is called a **tonsillar herniation**.

→ A portion of the flocculonodular lobe**, the flocculus,** is visible on the ventral view of the cerebellum

- Two portions of the vermis constitute a cerebellar lobe called the flocculonodular lobe. This lobe consists of the central nodulus (covered here by the brainstem) and the two **flocculi** (sing. **flocculus**; flocculus = tuft of wool).
- This portion of the cerebellum connects with the vestibular system and is concerned with equilibrium

MRI Sagittal View of the Cerebellum SLIDE 12

- → Since this section is in the midline, the **vermis** is the most prominent structure of the cerebellum
- → Identify the **anterior** and **posterior lobes** of the cerebellum, divided by the primary fissure
- → Identify the **tonsil** is visible

Horizontal sections of the cerebellum SLIDE 13

These images are taken along the horizontal plane, such that the relationship of the cerebellum with the brainstem can be appreciated.

- → Identify the **lateral hemispheres** and the **middle cerebellar peduncles** that can be seen connecting the brainstem to the cerebellum
    - o There are three cerebellar peduncles: *superior, middle and inferior* and each convey different tracts
    - o Portions of the **inferior cerebellar peduncles** as they originate in the medulla are visible on *left* image
- → Identify the vermis midline to the lateral hemispheres
- → The **flocculus** and the **nodulus** of the floccular nodule lobe
    - o The flocculus is found just lateral to the brainstem
    - o The nodulus is found midline and protruding into the 4th ventricle