Gross Morphology of the Brain

* slides in bold

Principal Parts of the Brain

- Cerebrum: largest part of the brain
- Diencephalon
- Thalamus & hypothalamus
- Cerebellum: inferior to the cerebrum & posterior to the brainstem
- Brainstem
- medulla, pons & midbrain

-Cerebrum (Cerebral Hemispheres)

- Longitudinal fissure separates left & right cerebral hemispheres

Each hemisphere contain white & gray matter with the gray matter peripherally & the white internally with islets of gray matter.

- Corpus callosum is band of white matter connecting left and right cerebral hemispheres

- Cerebral cortex is gray matter overlying white matter
  - 2-4 mm thick containing billions of cells
  - grew so quickly formed folds (gyri) and grooves (sulci or fissures)

- Each hemisphere is subdivided into 4 lobes (frontal/parietal/occipital/temporal) & one hidden lobe called the insula within the lateral fissure.
-the cerebrum lies above the tentorium cerebella

Lobes and Fissures

Every elevated part of the cortex is called gyri & the depression between them is called sulcus.

**Longitudinal fissure (green)** ➔into which projects the falx cerebri

- **Frontal lobe** - **Central sulcus (yellow)**: the central sulcus between frontal & parietal lobe is the only sulcus that continue from the longitudinal fissure up to the lateral fissure without interruption.

- **precentral & postcentral gyrus**

- **Parietal lobe** - **Parieto-occipital sulcus** ➔begins from the lateral side but is clearer from the medial side so it’s much easier to differentiate parietal lobe from occipital lobe medially rather than laterally.

- **Occipital lobe** - **Lateral sulcus (blue)**

- **Temporal lobe**

- **Insula** ➔is a portion of the cerebral cortex folded deep within the lateral sulcus.(5th lobe)
Insula within Lateral Fissure

*parasagittal section →

Somatotopic Organization of Cortex (Homunculus)

**the size of the organ indicate number of neurons responsible for it **lower limb towards medial side.

The cerebral cortex is an aggregation of cell bodies that are distributed according to certain functions as nuclei – ex: first gyri in the frontal lobe anterior to the central sulcus is called the precentral gyri & is responsible for primary motor function so damage to this gyri could cause paralysis whereas the postcentral gyri which is located post to the central sulcus in the parietal lobe is responsible for somatic sensation & damage to this area can result in loss of sensation.

Cerebral White Matter

Divided into :

- Association fibers between gyri in same hemisphere
- Commissural fibers from one hemisphere to other
- Projection fibers form descending & ascending tracts
Commissural Fibers

Examples:

- **Corpus callosum**
  - **Ant**
    - **Rostrum** → connect right & left frontal lobe
    - **Genu** end with **Forceps minor** → most anterior part
    - **Body** → Connect the hemisphere of temporal & occipital lobe
  - **Post**
    - **Splenium** end with **Forceps major** → towards occipital lobe

- **Anterior commissure**: associated with olfaction.

- **Posterior commissure** • **Inferior to pineal gland**

- **Habenular commissure** • **Superior to pineal gland**

The epithalmus which is just above the midbrain posteriorly is composed of pineal gland & 2 lateral habenular nuclei connected together by habenular commissure fibers.

- **Fornix**: commissure fibers between rt & left fornix
  - From the hippocampus to temporal lobe towards mamillary body (part of the hypothalamus); & is part of the limbic system.

- There are other commissure fibers and membranes that circulate the 2 diencephalon to isolate the third ventricle which is located between them.
Projection Fibers → fibers that connect cerebral cortex with other parts of the brain or CNS in general; ex: corticospinal tract.

The projection fibers consist of efferent & afferent fibers uniting the cortex with lower part of the brain & SC.

- Corona radiata → Internal capsule → Crus cerebri → Pyramid

- Internal capsule → Anterior limb / Genu / Posterior limb - Optic radiation

- From different areas of the cerebral cortex, the projection fibers extend to SC; these fibers begin as a fan-shaped structure called the corona radiata; then they get smaller on their way to the brainstem or SC and when they reach the diencephalon they are called internal capsule; the fibers continue to the brainstem and when they reach midbrain they are called crus cerebri which continue as pyramid in front of the medulla oblongata where the axons cross each other so the left hemisphere controls the right side of the body & vice versa. They exit the brainstem to SC as corticospinal tract until they reach motor neurons.

< Is restricted between the basal ganglia & the thalamus >
Somatotopic Organization of Internal Capsule

Association Fibers
- Short association fibers
  - Connect adjacent gyri within the lobe itself.
  - Close to cortex
- Long association fibers
  - Connect the lobes → connect different gyri in different lobes.

Association Fibers: long fibers
Ex: • Superior longitudinal fasciculus (fasciculus: bundles of fibers)
  → Connects the 4 lobes together
  
  Part of it is the Arcuate fasciculus which connect Broca’s & Wernicke’s areas together

• Uncinate fasciculus
  → Orbital frontal gyri with temporal pole

• Occipitofrontal fasciculus
  → Occipital & frontal
• Inferior longitudinal fasciculus
  → Occipital & temporal lobes

• Cingulum
  → Cingulate gyrus, parahippocampal gyrus & septal area

• Calcarine fasciculus is related only to occipital lobe.
  → Cuneus & lingual gyri

-in order to serve a certain function the brain act in circuits and association fibers are responsible for connecting these circuits.

Basal Ganglia → ganglia is a collection of cell bodies outside of the CNS but the basal ganglia is an exception of that =basal nucleus

Basal ganglia is islets of cell bodies/nuclei within white matter of the brain, is distant from cerebral cortex but still closer compared to other parts of the brain & close to the diencephalon.

• Connections to red nucleus, substantia nigra & subthalamus

• Input & output with cerebral cortex, thalamus & hypothalamus

• Control large automatic movements of skeletal muscles → fine movement (toning of motor function)

The main components of the basal ganglia – as defined functionally – are the striatum; both dorsal striatum (caudate nucleus and putamen) and ventral striatum (nucleus
Corpus Striatum

- Lentiform (putamen+globus pallidus) and caudate nuclei are known as the corpus striatum.

Caudate nuclei: is C-shaped nuclei and internal to it there is the Lentiform they are separated from the thalamus by internal capsule.

Other C-shaped structure: lateral ventricles and corpus callosum which are related with each other. (we'll talk about later)

- Nearby structures functionally linked to the basal ganglia are the substantia nigra and the subthalamic nuclei.
- They are responsible for helping to control muscular movements.
- Damage to the basal ganglia results in tremor, rigidity, and involuntary muscle movements. In Parkinson’s disease neurons from the substantia nigra to the putamen and caudate nucleus degenerate.
- Basal ganglia also help initiate and terminate some cognitive processes: Obsessive compulsive disorder, schizophrenia, chronic anxiety are thought to involve dysfunction of the circuits between the basal ganglia and limbic system.
Diencephalon
- Surrounds 3rd ventricle
- Superior part of walls is thalamus (the largest part)
- Inferior part of walls & floor is hypothalamus (anteroinferior to the thalamus and it’s connected to the pituitary gland anterior to the midbrain)

Thalamus
- 1 inch long mass of gray matter in each half of brain (connected across the 3rd ventricle by intermediate mass)
  * is egg-like structure.
  * connects cerebrum with other parts of the brain.
- Relay station for sensory information on way to cortex
- Crude perception of some sensations
Thalamic Nuclei
• Nuclei have different roles
• relays auditory and visual impulses, taste and somatic sensations
• receives impulses from cerebellum or basal ganglia
• anterior nucleus concerned with emotions, memory and acquisition of knowledge (cognition)

Hypothalamus
• Dozen or so nuclei in 4 major regions
• mammillary bodies are relay station for olfactory reflexes; infundibulum suspends the pituitary gland
• Major regulator of homeostasis
• receives somatic and visceral input, taste, smell & hearing information; monitors osmotic pressure, temperature of blood
Functions of Hypothalamus
• Controls and integrates activities of the ANS which regulates smooth, cardiac muscle and glands
• Synthesizes regulatory hormones that control the anterior pituitary
• Contains cell bodies of axons that end in posterior pituitary where they secrete hormones
• Regulates rage, aggression, pain, pleasure & arousal
• Feeding, thirst & satiety centers
• Controls body temperature
  • Regulates daily patterns of sleep

Epithalamus
• The epithalamus lies superior and posterior to the thalamus and contains the pineal gland and the habenular nuclei.
• The pineal gland secretes melatonin to influence diurnal cycles in conjunction with the hypothalamus.
• The habenular nuclei are involved in olfaction, especially emotional responses to odors. (If the habenular nuclei damage, we can still recognize different odors but we have no emotional response to them)

Pineal gland
• endocrine gland the size of small pea
• secretes melatonin during darkness
• promotes sleepiness & sets biological clock
• Habenular nuclei
  • emotional responses to odors
Epithalamus

Subthalamus (some anatomists consider subthalamus as part of diencephalon whereas the other consider it as part of basal ganglia)

- The subthalamus lies immediately inferior to the thalamus and includes tracts and the paired subthalamic nuclei, which connect to motor areas of the cerebrum.
- The subthalamic nuclei and red nucleus and substantia nigra of the midbrain work together with the basal ganglia, cerebellum, and cerebrum in control of body movements.
Brainstem: Medulla Oblongata
- Continuation of spinal cord
- Ascending sensory tracts
- Descending motor tracts
- Nuclei of 5 cranial nerves
- Cardiovascular center
  - force & rate of heart beat
  - diameter of blood vessels
- Respiratory center
  - medullary rhythmicity area sets basic rhythm of breathing
- Information in & out of cerebellum
- Reflex centers for coughing, sneezing, swallowing etc.

Brainstem has all motor and sensory nuclei of cranial nerves from 3th up to 12th

Cranial nerve are very important diagnostic tools for lesions in brainstem

Brainstem: Pons
- One inch long
- White fiber tracts ascend and descend
- Pneumotaxic & apneustic areas help control breathing
- Middle cerebellar peduncles carry sensory info to the cerebellum
- Cranial nerves 5 thru 7
**Brainstem: Midbrain**
- One inch in length
- Extends from pons to diencephalon
- Cerebral aqueduct connects 3rd ventricle above to 4thventricle below.

Superior: diencephlon --------------------------Posterior : cerebellum

![Brainstem Diagram]

In terms of specific cranial nerve nuclei, the **midbrain** of the brainstem has the nuclei of the oculomotor nerve (III) and trochlear nerve (IV); the **pons** has the nuclei of the trigeminal nerve (V), abducens nerve (VI), facial nerve (VII) and vestibulocochlear nerve (VIII); and the **medulla** has the nuclei of the glossopharyngeal nerve (IX), vagus nerve (X), accessory nerve (XI) and hypoglossal nerve (XII). The fibers of these cranial nerves exit the brainstem from these nuclei.

**Midbrain in Section**
- Cerebral peduncles---clusters of motor & sensory fibers
- Substantia nigra---helps controls subconscious muscle activity
- Red nucleus-- rich blood supply & iron-containing pigment
- Cortex & cerebellum coordinate muscular movements by sending information here from the cortex and cerebellum
Cerebellum
- 2 cerebellar hemispheres and vermis (central area)
- Function:
  - correct voluntary muscle contraction and posture based on sensory data from body about actual movements
  - sense of equilibrium

Limbic System
The limbic system is a set of brain structures located on both sides of the thalamus, immediately beneath the cerebrum. It has also been referred to as the paleomammalian cortex. ... The limbic system supports a variety of functions including emotion, behavior, motivation, long-term memory, and olfaction.

- Parahippocampal & cingulate gyri & hippocampus
- Emotional brain--intense pleasure & intense pain
- Strong emotions increase efficiency of memory
connect different sensory & motor nuclei all over the brain where there is a nuclei it’s part of the limbic system:

- thalamus -------- ant thalamic nucleus
- hypothalamus ------ mamillary bodies
- temporal lobe ------- hippocampus (responsible for memory
- cerebrum – cingulate gyri

**Fig. 3:** Limbic lobe on the medial aspect of cerebral hemisphere. The 3 parts of the limbic lobe (cingulate gyrus, parahippocampal gyrus and septal cortex) are connected by fibers of the cingulum.