Gross Morphology of the Brain
Lecture Objectives

• Demarcate the major lobes, gyri and sulci of the cerebral hemisphere.
• Describe the organization of the cerebral hemisphere into cerebral cortex, white matter and nuclei.
• Describe the types of fibers in the white matter of the cerebral hemisphere: projection (internal capsule), commissural and association fibers.
• Identify the basal ganglia nuclei.
• Identify main parts of the diencephalons and name the main functions of each part.
• Define parts of the brainstem and briefly describe its internal structure.
• Identify the superficial attachments of the cranial nerves.
Principal Parts of the Brain

- Cerebrum
- Diencephalon
  - thalamus & hypothalamus
- Cerebellum
- Brainstem
  - medulla, pons & midbrain
• **Longitudinal fissure** separates left & right cerebral hemispheres

• **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
Lobes and Fissures

- Longitudinal fissure (green)
  - Frontal lobe
- Central sulcus (yellow)
  - Precentral & postcentral gyrus
  - Parietal lobe
- Parieto-occipital sulcus
  - Occipital lobe
- Lateral sulcus (blue)
  - Temporal lobe
  - Insula
Insula within Lateral Fissure
Somatotopic Organization of Cortex (Homunculus)
• **Association fibers** between gyri in same hemisphere
• **Commissural fibers** from one hemisphere to other
• **Projection fibers** form descending & ascending tracts
Commissural Fibers

- Corpus callosum
  - Rostrum
  - Genu
    - Forceps minor
  - Body
  - Splenium
    - Forceps major
- Anterior commissure
- Posterior commissure
  - Inferior to pineal gland
- Habenular commissure
  - Superior to pineal gland
- Fornix
Projection Fibers

- Corona radiata
- Internal capsule
  - Anterior limb
  - Genu
  - Posterior limb
    - Optic radiation
- Crus cerebri
- Pyramid
Somatotopic Organization of Internal Capsule
Association Fibers

- Short association fibers
  - Connect adjacent gyri
  - Close to cortex
- Long association fibers
  - Connect the lobes
Association Fibers: long fibers

- Superior longitudinal fasciculus
  - Connects the 4 lobes together
  - Arcuate fasciculus
    - Broca’s & Wernicke’s
- 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
  - Cuneus & lingual gyri
Basal Ganglia

- Connections to red nucleus, substantia nigra & subthalamus
- Input & output with cerebral cortex, thalamus & hypothalamus
- Control large automatic movements of skeletal muscles
Corpus Striatum

• Lentiform (putamen+globus pallidus) and caudate nuclei are known as the corpus striatum.
  • 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
(e) Oblique section of brain
Diencephalon

- Surrounds 3rd ventricle
- Superior part of walls is thalamus
- Inferior part of walls & floor is hypothalamus
• 1 inch long mass of gray matter in each half of brain (connected across the 3rd ventricle by intermediate mass)
• 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.
Epithalamus

- 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

- Habenular nuclei
- Pineal gland
- Corpora quadrigemina: Superior colliculi, Inferior colliculi
- Third ventricle
- Thalamus
- Lateral geniculate nucleus
- Medial geniculate nucleus
- Trochlear (IV) nerve
- Median eminence
- Superior cerebellar peduncle
- Middle cerebellar peduncle
- Inferior cerebellar peduncle
- Facial (VII) nerve
- Vestibulocochlear (VIII) nerve
- Glossopharyngeal (IX) nerve
- Vagus (X) nerve
- Accessory (XI) nerve
- Posterior median sulcus
- Fasciculus cuneatus
- Fasciculus gracilis
- Spinal nerve C1
Subthalamus

• The *subthalamus* lies immediately inferior to the thalamus and includes tracts and the paired subthalaric nuclei, which connect to motor areas of the cerebrum.
  • The subthalaric 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: 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 4th ventricle below
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

- Parahippocampal & cingulate gyri & hippocampus
- Emotional brain--intense pleasure & intense pain
- Strong emotions increase efficiency of memory
Limbic Lobe

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.
Limbic System