NERVOUS SYSTEM:
THE BRAIN

Human Anatomy
Unit 4
In Anatomy Today
Ventricles of the Brain

• Lateral ventricles
  – 2 ventricles shaped like “ram horns”
  – Separated by the septum pellucidum
• Third ventricle
  – Surrounds thalamus diencephalon and brain stem
• Fourth ventricle
  – Anterior to cerebellum
  – Contains 3 apertures leading to the “subarachnoid space”
  ❖ Cerebral aqueduct
    – Canal between third and fourth ventricle
Ventricles of the Brain
Cerebrospinal Fluid (CNS)

- Ventricles lined with choroid plexus
  - Ependymal cells
  - Produce cerebrospinal fluid (CSF)
  - Produces 500 ml/day
  - 150 mL in circulation

- Surrounds and bathes exposed surfaces of the CNS
  - Prevents friction
  - Support
  - Regulation of microenvironment
Circulation of CSF

• CSF circulates throughout ventricles, subarachnoid space and central canal

• CSF is returned to general circulation
  – Arachnoid granulations
  – Project into the dural sinus
Circulation of CSF

- Superior sagittal sinus
- Arachnoid granulation
- Subarachnoid space
- Meningeal dura mater
- Right lateral ventricle
- Choroid plexus
- Interventricular foramen
- Third ventricle
- Cerebral aqueduct
- Lateral aperture
- Median aperture
- Fourth ventricle
- Central canal
The Cranial Meninges

- Cerebellum
- Medulla oblongata
- Cerebral cortex
- Dura mater (meningeal layer)
- Dura mater (endosteal layer)
- Dural sinus
- Cranium
- Subarachnoid space
- Arachnoid mater
- Subdural space
- Pia mater
- Spinal cord

(a) Lateral view

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Cranial Meninges

Dura Mater

- “Tough mother”
  - Dense irregular connective tissue
  - Outermost meninge
    - outer = periosteal layer
    - inner = meningeal layer
      - “falx cerebri”
  - 2 layers form a space between which are the dural sinuses
Cranial Meninges
Arachnoid and Pia Mater

- “Spidery mother”
- Arachnoid granulations
  - for return of CSF to general circulation
- “Delicate mother”
- Indissectable from surface of the brain
- Loose connective tissue

Superior sagittal sinus
Subdural space
Arachnoid granulation
Falx cerebri
Subarachnoid space

Dura mater
Arachnoid mater
Arachnoid trabeculae
Pia mater
Cerebral cortex

Coronal section
Falx Cerebri

Falx cerebri is formed as an extension of the meningeal layer of the dura mater.
Blood Vessels of the Brain

- Internal carotid arteries
- Vertebral arteries
- Jugular veins
- Drain the dural sinuses

(a) Veins of the head and neck, lateral view
(b) Arteries of neck and head, an oblique lateral view from the right side
Major Divisions of the Brain

CEREBRUM
- Conscious thought processes, intellectual functions
- Memory storage and processing
- Conscious and subconscious regulation of skeletal muscle contractions

Diencephalon

Thalamus
- Relay and processing centers for sensory information

Hypothalamus
- Centers controlling emotions, autonomic functions, and hormone production

Mesencephalon
- Processing of visual and auditory data
- Generation of reflexive somatic motor responses
- Maintenance of consciousness

Pons
- Relays sensory information to cerebellum and thalamus
- Subconscious somatic and visceral motor centers

Medulla Oblongata
- Relays sensory information to thalamus and to other portions of the brain stem
- Autonomic centers for regulation of visceral function (cardiovascular, respiratory, and digestive system activities)

Cerebellum
- Coordinates complex somatic motor patterns
- Adjusts output of other somatic motor centers in brain and spinal cord
Cerebrum

• Cerebral hemispheres
  – Left and right halves
  – Separated by longitudinal fissure
  – Connected by tracts

• Divided into functional lobes

• Contain “higher brain centers”
  – Nuclei responsible for motor coordination and control of memory, emotion and other functions
Cerebral Cortex

- Gray Matter
- Gyrus (gyri p.)
  - folds of the cerebral surface
- Sulcus (sulci p.)
  - grooves between gyri
- Fissure
  - deep groove
The Cerebral Lobes

- 5 major divisions in each hemisphere
- 4 named after bones under which they lie
  - Frontal
  - Parietal
  - Occipital
  - Temporal
- 1 on interior
  - Insula
Frontal Lobe

- A motor cortex
- Pre-central gyrus is where the primary motor cortex is located
  - Controls voluntary movements
- Also made up of mostly Dopamine sensitive neurons
  - Short term memory
  - Reward
  - Learning
  - Emotions
  - Motivation
- Major motor pathway is the corticospinal tract
Parietal Lobe

- Sensory Cortex
- The post central gyrus is where the somato-sensory cortex is located
  - Involved in integrating sensory information
    - Skin
    - Proprioception
- Language processing
Occipital Lobe

• Maps mostly to the occipital bone
• Is the visual cortex
  – Receives, integrates and processes visual information
  – Clinically referred to as Brodmann area 17
Temporal Lobe

- Auditory cortex
- Processes visual information into memories
- Language comprehension
- Emotion associations
- Declarative (long-term) memory
  - Facts and events
Insula

- Small lobes deep in lateral sulcus beneath temporal lobes
- Involved in consciousness
  - Emotion, homeostasis, self awareness, cognitive functioning
- Gustatory cortex

New study suggests that the insula is involved in smoking addiction...
Cerebral Medulla

• Myelinated axons = white matter
• Arranged into tracts connecting different parts of the CNS
• Association tracts
  – Connect regions of cortex within same hemisphere
• Commissural tracts
  – Bridges between cerebral hemispheres
  – Ex) corpus callosum
• Projection tracts
  – Between cerebral cortex, caudal brain, and spinal cord
Cerebral White Matter

(a) Lateral view

(b) Anterior view
Basal Nuclei

- Paired, irregular masses of gray matter
- Connected to cerebrum, thalamus, brainstem
- Involved in
  - Motor programs
  - Procedural learning
  - Routine behaviors or habits
  - Eye movements
  - Emotion
Limbic System

• Large group of nuclei throughout different parts of the brain
• Responsible for control of
  – Emotion
  – Sex drive
  – Aggression
  – Memory consolidation...among other functions
• Hippocampus
  – Responsible for memory consolidation
Limbic System
Diencephalon

• “in-between” brain
• Components
  – Epithalamus
  – Thalamus
    • Paired R/L
  – Hypothalamus
Epithalamus

- Connects the limbic system to other parts of the brain
- Covers 3rd ventricle
- Posterior portion
  - Pineal gland
    - Melatonin
    - Circadian rhythms
  - Habenular nucleus
    - Relay station for limbic system
    - Visceral and emotional response to odors
Thalamus

- Clusters of nuclei organized into groups
- Major relay station for sensory information
- Gray matter on both sides of third ventricle
Hypothalamus

- Contains many diverse nuclei controlling
  - Body temperature
  - Sex drive
  - Feeding
  - Drinking
  - Thirst sensation
  - Pituitary secretions
- Forms the inferior walls of the third ventricle
Brain Stem

• Connects forebrain (cerebrum, diencephalon) and cerebellum to spinal cord
• 3 parts
  – Midbrain
  – Pons
  – Medulla oblongata
Midbrain

- Corpora Quadrigemina
  - Superior colliculus
  - Inferior colliculus
- Cerebral peduncles
- Nuclei involved in:
  - vision, hearing
  - sleep/wake cycles
  - Alertness
  - Body temperature regulation
  - Motor programs
Pons

- Contains sensory and motor tracts
- Relay signals from cerebrum and diencephalon to the cerebellum
- Autonomic nuclei
  - Sleep, respiration, swallowing, bladder control, hearing, equilibrium, taste, eye movement, facial expressions, facial sensation and posture
  - Plays a role in dreaming
- Origin for cranial nerves V-VIII
Medulla Oblongata

• The inferior most region of the brain stem
• Autonomic centers
  – Respiration, vomiting, sneezing, cardiovascular functions
• Medullary pyramids house the pyramidal tracts
  – Decussation of the pyramids
• Origin cranial nerves IX-XII
The Cerebellum

- Second largest single structure of the brain
- Three lobes
- Arbor vitae
  - “the tree of life”
  - White matter of the cerebellum
- Folia
- Involved in motor control of coordination, timing and precision of skeletal muscle activity
Histology of the Cerebellum

- **White matter** (*medulla*)
  - Myelinated nerve fibers

- **Gray matter** (*cortex*)
  - Granular layer
    - Granule cells
      - Smallest neurons and most numerous neurons in the brain
  - Purkinje layer
    - Purkinje cells
      - Processes form the dendritric tree of the molecular layer
      - > 200 synapses

- Molecular layer
  - Dendritic tree