The Brain and Cranial Nerves
Chapter 15

Introduction to the Brain
• Weighs about 3 lbs. in adults
• Structures
  – Divided into 5 areas
  – Contains ventricles
• Functions
  – Controls the bare necessities of life
  – Location for primal drives and emotions
  – Intellectual thought, imagination, perception, etc.

Development of the Brain

3-4 Weeks

4 Weeks

The brain develops as indexes and the hypothalamus. This is the brain's beginning. It establishes the foundation for the nervous system and the autonomic nervous system.

5 Weeks

Development of the brain continues as sensory and voluntary nerve cells grow. The hypothalamus, thalamus, and neostriatum develop within the brain. The basal ganglia, thalamus, and other structures begin to form. This is when the nervous system begins to develop.
The Adult Brain

**Adult Brain – Forebrain** (Prosencephalon)
- Cerebrum (telencephalon)
- Thalamus, hypothalamus (diencephalon)

**Adult Brain – Midbrain** (Mesencephalon)
- Processing of visual and auditory data
- Generation of reflexive somatic motor responses
- Maintenance of consciousness

**Adult Brain – Hindbrain** (Rhombencephalon)
- Pons and cerebellum (metencephalon)
- Medulla oblongata (myelencephalon)
Ventricles of the Brain

- **Lateral ventricles**
  - Separated by the *septum pellucidum*
  - Connects to third ventricle
    - **Interventricular foramen**
- **Third ventricle**
  - Connects to fourth ventricle
    - **Cerebral aqueduct**

- **Fourth ventricle**
  - Connects to the subarachnoid space and spinal canal
  - **Cerebrospinal fluid** circulates down through the ventricles and into the spinal cord.

Protections and Coverings

- **Cranial bones**
  - strong support
- **Cranial meninges**
  - shock absorbers
    - **Dura mater**
      - 2 layers
    - **Endosteal** *(periosteal)*
    - **Meningeal**
      - **Arachnoid**
      - **Pia mater**

Blood-Brain Barrier

- **Astrocytes**
  - Secrete chemicals that maintain the BBB
  - Absorb materials from blood
  - Extract materials from brain
- **Endothelial cells of capillaries form tight junctions**
  - Lipid-soluble compounds
  - Water-soluble compounds

Cerebrospinal Fluid

- **Composition**
  - Proteins, glucose, urea, salts
  - White blood cells
- **Functions**
  - Shock absorber
  - Medium of transport for nutrients, gases, etc.
- **Formed by the choroid plexus** (*"vascular braid"*)

Problems Associated with CSF

- **Hydrocephalus**
- **Meningitis**
- **Headaches**
The Parts of the Brain

Forebrain
Cerebrum, Hypothalamus, Thalamus

Cerebrum – Gray & White Matter
- Outer layer – cerebral cortex
  - Gray matter
- Inner portion
  - White matter
    - Projection tracts
    - Association tracts
    - Commissural tracts (corpus callosum)
  - Masses of gray matter
    - Cerebral nuclei

Cerebral Cortex
- Gyri are separated by grooves (sulci)
  - Fissures – deeper grooves
- Longitudinal fissure
  - Divides the cerebrum into cerebral hemispheres
- Central sulcus
  - Precentral gyrus
  - Post-central gyrus

Cerebral Lobes
- Frontal lobe
  - Decision-making, planning
    - Broca’s area
  - Primary motor cortex
- Parietal lobe
  - Speech comprehension, reading, taste
    - Primary sensory cortex
- Occipital lobe
  - Visual cortex
- Temporal lobe
  - Wernicke’s area
    - Olfactory cortex
    - Auditory cortex

Homunculus
Primary Motor Cortex
Primary Sensory Cortex

Cerebral Nuclei
- Collections of cell bodies (gray matter)
- Mostly control the movement of skeletal muscles
- Examples
  - Caudate nucleus
  - Amygdaloid body
Limbic System
- Functional unit
- Emotional part of the brain
  - Feelings of fear, loss, love, rage, etc.
- Includes parts of several anatomical structures
  - Cerebrum
  - Hypothalamus
  - Thalamus

Hypothalamus
- Location – floor of the third ventricle
- Structure
  - Mammillary bodies
  - Feeding reflexes
  - Infundibulum
  - Autonomic centers
  - Nuclei

Functions of Hypothalamus
- Initiates **primal drives**
  - Hunger, thirst, sex, rage, etc.
  - Controls *fight or flight* sympathetic response.
- Sets emotional states (with **limbic system**)
- Controls pituitary gland ("master gland" of endocrine system)
  - Secretes "releasing factors" and "inhibiting factors"
  - Infundibulum ("funnel") funnels secretions to the pituitary gland

Thalamus and Epithalamus
- **Thalamus**
  - Superior brain stem
  - Relay station between the body and cerebral cortex
  - Emotion (limbic system)
  - Integrates visual & auditory reflexes
- **Epithalamus**
  - Roof of third ventricle
  - Contains pineal body
  - Secretes melatonin
  - Contains choroid plexus

Midbrain
- **Cerebral peduncles** – on anterolateral surface
  - Motor neurons from cerebral cortex to pons and spinal cord
  - Sensory neurons to the thalamus
- **Corpora quadrigemina**
  - Superior colliculi
    - Receive visual information
  - Inferior colliculi
    - Receive auditory information
Nuclei of Midbrain

- **Substantia nigra**
  - secretes dopamine
  - Modifies muscle tone & motor activity
  - **Parkinson’s disease**
- **Red nucleus** – highly vascularized
  - Integrates information from cerebrum & cerebellum
  - Maintains muscle tone & posture

Hindbrain
Cerebellum, Pons, & Medulla Oblongata

Cerebellum

- 2nd largest structure of the brain
- Separated from cerebrum by transverse fissure
- Divided into 2 lateral hemispheres
  - **Vermis** = "worm-shaped"
- Cortex – gyri & sulci

Pons

- Pons = "bridge"
  - Consists of white fibers with scattered nuclei
- Functions
  - Controls respiration rate (with medulla)
  - Contains nuclei for several cranial nerves

Medulla Oblongata

- Continuation of spinal cord
- Forms the base of the "brain stem"
- **Pyramids**
  - Just above the spinal cord
  - Large tracts cross from one side to the other
- Contains reflex centers
  - Cardiac center, vasomotor center, respiratory rhythmicity center
Cranial Nerves

Introduction to the Cranial Nerves
- 12 pairs
- Leave the skull through foramina
- Types
  - Mixed
  - Sensory
  - Motor
- Part of the somatic nervous system
  - Some fibers of the ANS bundled with those of the cranial nerves

Cranial Nerve I – Olfactory Nerve
- Sensory
- Function – smell

Cranial Nerve II – Optic Nerve
- Sensory
- Function – vision

Nerves Controlling Extrinsic Eye Muscles (III, IV, VI)
- Cranial Nerve III – oculomotor nerve
  - Motor
  - Function – controls raising of upper eyelid, movements of eyeball
  - Parasympathetic fibers to lens and pupil

Nerves Controlling Extrinsic Eye Muscles (III, IV, VI)
- Cranial Nerve IV – trochlear nerve
  - Motor
  - Function – movements of eyeball
- Cranial Nerve VI – Abduces
  - Motor
  - Function – movements of eyeball
Cranial Nerve V – Trigeminal Nerve

- Mixed
- Sensory fibers receive information from cornea, scalp, forehead, face, teeth
- Motor fibers to the muscles of mastication (control chewing)

Cranial Nerve VII – Facial Nerve

- Mixed
- Sensory fibers
  - Taste from anterior 2/3 of the tongue
- Motor fibers
  - Facial expression
- Parasympathetic fibers to:
  - Lacrimal glands
    - Tears
  - Submandibular and submaxillary salivary glands
    - Salivation

Cranial Nerve VIII – Auditory Nerve (Vestibulocochlear Nerve)

- Sensory
- Function – hearing and balance

Cranial Nerve IX – Glossopharyngeal Nerve

- Mixed
- Sensory fibers
  - Taste and touch from posterior 1/3 of the tongue and pharynx
- Motor fibers to pharyngeal muscles
  - Swallowing
- Parasympathetic fibers to the parotid gland – salivation

Cranial Nerve X – Vagus Nerve

- Mixed
- Sensory fibers from external ears (hearing), rear of tongue (taste), viscera
- Motor fibers to the muscles of the pharynx and larynx (motor)
- Parasympathetic fibers to viscera

Cranial Nerve XI – Spinal Accessory Nerve

- XI – Spinal accessory nerve
  - Motor to trapezius and sternocleidomastoid muscles
  - Function – head movements

Cranial Nerve XII – Hypoglossal Nerve

- XII – Hypoglossal nerve
  - Motor to muscles of tongue
  - Function – speech and swallowing
Cranial Nerves

"On old Olympus' towering top, a Finn and German viewed a hawk."

- Olfactory tract, terminating in olfactory bulbs
- Olfactory tract
- Optic tract
- Optic nerve
- Interpeduncular
- Oculomotor nerve (III)
- trochlear nerve (IV)
- Trigeminal nerve (V)
- Abducens nerve (VI)
- Facial nerve (VII)
- Vestibulocochlear nerve (VIII)
- Glossopharyngeal nerve (IX)
- Vagus nerve (X)
- Hypoglossal nerve (XII)
- Accessory nerve (XI)