Chapter 14
The Brain and Cranial Nerves

- Largest organ in the body?
- Brain functions in sensations, memory, emotions, decision making, behavior

Embryonic Brain Development

Principal Parts of the Brain

- Cerebrum
- Diencephalon
  - thalamus
  - hypothalamus
  - Epithalamus
  - Pineal gland
- Cerebellum
- Brainstem:
  - Medulla oblongata
  - pons
  - midbrain

Protective Coverings of the Brain

- Bone, meninges & CSF
- Meninges same as around the spinal cord
  - dura mater
  - arachnoid mater
  - pia mater

Meninges of the Brain

Figure 14.5
Blood Supply to Brain

- 2% of weight - uses 20% of our oxygen
- Internal carotid & vertebral arteries to circle of Willis
- Vessels on surface of brain—penetrate tissue
- Blood-brain barrier (BBB)
  - protects cells from some toxins and pathogens
  - a couple of areas without BBB (glucose, pH, osmolarity)
- Blood-CSF barrier at ependymal cells of choroid plexus

Cerebrospinal Fluid (CSF) 80 -150 ml (3 – 5 oz)

- Clear liquid – water, oxygen, glucose, proteins, & ions
- Continuously circulates around brain (ventricles, central canal, subarachnoid space)
- Functions:
  - Buoyancy
  - Mechanical protection
  - Chemical protection (homeostasis)
    - ionic concentrations for AP’s
    - removes some metabolic products from nervous tissue

Ventricles

- 2 lateral ventricles, one within each cerebral hemisphere, 3rd ventricle, fourth ventricle
- CSF produced by choroid plexus (ependymal cells)
- Circulation

Flow of Cerebrospinal Fluid

- CSF is reabsorbed through arachnoid villi

Principal Parts of the Brain

- Brain stem
  - Medulla oblongata
    - Relays motor & sensory - brain and spinal cord
    - all fibers going to/from brain/spinal cord
    - consciousness/alert
    - cardiovascular center
    - respiratory center
    - bv diameter
    - motor control
    - sensory info.
**Brain Stem: Medulla Oblongata**

- One inch long
- Tracts (a & d)
- Respiratory nuclei
- Sensory info to cerebellum
- Trigeminal (V) (head & face)
- Abducens (VI) eye movement
- Facial Nerves (VII) head and face, chew, taste
- Vestibulocochlear (VIII) equilibrium

**Brain Stem: Pons**

- One inch long
- Tracts (a & d)
- Respiratory nuclei
- Sensory info to cerebellum
- Trigeminal (V) (head & face)
- Abducens (VI) eye movement
- Facial Nerves (VII) head and face, chew, taste
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**Brain Stem: Midbrain (Mesencephalon)**

- One inch in length
- Extends from pons to diencephalon
- Cerebral peduncles connect 3rd to 4th ventricle
- Cerebral peduncles:
  - anchor cerebrum to brainstem
  - impulses to/from cerebellum
  - inhibitory signals to thalamus
- Relays sensory & motor impulses
- Tectum:
  - superior and inferior colliculi (reflexes)
  - Oculomotor (III) eye movement & sight
  - Trochlear (IV) eye movements

**Midbrain -- Cross Section**

1. Tegmentum - with cerebellum for fine motor control
2. Substantia nigra
   - motor center relays inhibitory signals to thalamus & basal nuclei preventing unwanted body movement
3. Cerebral crus: fibers that connects cerebrum to the pons carries corticospinal tracts

**Medulla and Pons**

- Spinal cord
- Medulla oblongata
- Cerebral peduncle
- Infundibulum
- Mammillary body
- Cerebral peduncle:
  - anchor cerebrum to brainstem
  - impulses to/from cerebellum
  - inhibitory signals to thalamus
  - relays sensory & motor impulses
  - Tectum:
    - superior & inferior colliculi (reflexes)
    - Oculomotor (III) eye movement & sight
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**Regions of the Brainstem**

- Midbrain
- Pons
- Medulla oblongata

- Midbrain:
  - Cross Section
  - Tegmentum
  - Substantia nigra
  - Cerebral crus

- Pons:
  - Spinal cord
  - Medulla oblongata

- Medulla oblongata:
  - Cerebral peduncle
  - Infundibulum
  - Mammillary body

- Cranial nerves:
  - Oculomotor nerve (III)
  - Optic nerve (II)
  - Trochlear nerve (IV)
  - Trigeminal nerve (V)
  - Abducens nerve (VI)
  - Facial nerve (VII)
  - Vestibulocochlear nerve (VIII)
  - Glossopharyngeal nerve (IX)
  - Vagus nerve (X)
  - Accessory nerve (XI)
  - Hypoglossal nerve (XII)

- Spinal nerves
Reticular Formation

- reticular formation – loosely organized web of gray matter that run vertically through all levels of the brainstem
- has connections with many areas of cerebrum and cerebral cortex

Functions of Reticular Formation

- Somatic motor control
  - adjust muscle tension (maintain tone, balance, and posture)
  - relays signals from eyes and ears to the cerebellum
- integrates visual, auditory, and balance and motion stimuli into motor coordination
- cardiovascular control: cardiac and vasomotor centers of M.O.
- pain modulation
  - One route pain signals may take to reach cerebral cortex
- sleep and consciousness
  - central role in states of consciousness!!!!!!!
- Habituation (filter)

Cerebellum

- 2 cerebellar hemispheres and vermis (central area)
- Function
  - Sensory input from muscles
  - Receives fibers from cerebral cortex associated with vision, hearing, coordination
  - i.e., correct voluntary muscle contraction and posture & balance
  - skilled “fine tuned” movements indirectly by sending information to midbrain
  - knowledge/language/emotional component??

The Forebrain

1. diencephalon
   - encloses the third ventricle
   - 3 major areas
     - thalamus
     - hypothalamus
     - epithalamus

2. Telencephalon
   - cerebrum

Diencephalon
Thalamus: Gateway to the Cerebral Cortex

- 1 inch long mass of gray matter
- Relay station for sensory information on way up to cerebral cortex
- Motor control: relay information from cerebellum to cerebrum
- Crude perception of some sensations

Thalamus

- Relays auditory and visual impulses, taste and somatic sensations, touch, pain, temperature
- Receives sensory impulses from cerebellum re. motor control
- Autonomic activities & consciousness (RAS)

Hypothalamus

- Many nuclei (masses of grey matter)
- Major regulator of homeostasis!!!!!!!

Functions of Hypothalamus

- Controls & integrates activities of ANS
- Synthesizes hormones that controls the anterior pituitary
- Regulates rage, aggression, pain, fear, pleasure, contentment
  - even arousal & orgasm
- Feeding, thirst & satiety centers
- Controls body temperature
- Sleep and circadian rhythms
- Memory

Cerebrum

- Composed of 2 cerebral hemispheres
- Cerebral cortex is gray matter – 2 - 4 mm thick contains billions of cells
- Folds (gyri) & grooves (sulci or fissures)

Cerebral hemispheres

- Longitudinal fissure: separates L & R Cerebral Hemispheres
- Corpus callosum: band of white matter connects L & R cerebral hemis.
- Each hemisphere is subdivided into 4 lobes
Lobes and Fissures

- Longitudinal fissure (green)
- Frontal lobe
- Central sulcus (yellow)
- Parietal lobe
- Parieto-occipital sulcus (red)
- Occipital lobe
- Lateral sulcus (blue)
- Temporal lobe
- Insula

Cerebral Cortex

- 2 principal types of neurons:
  1. Stellate cells
     - receive sensory input & process information on a local level
  2. Pyramidal cells
     - tall, conical.
     - output neurons of the cerebrum
     - only neurons that leave the cortex and connect to other parts of CNS

- Neocortex – six layered tissue that constitutes about 90% of the human cerebral cortex

Cerebral White Matter

1. Association fibers - between gyri in same hemi.
2. Commissural fibers - from one hemi. to other
3. Projection fibers - form descending & ascending tracts (info to and from whole body)

The Basal Nuclei

- Masses of gray matter buried deep in white matter, lateral to the thalamus
  - receive & send info to midbrain & motor areas of cerebral cortex
  - involved in motor control
- At least three areas form basal nuclei
  - caudate nucleus
  - putamen
  - globus pallidus

Limbic System

- Amygdala, cingulate gyri, & hippocampus
- Emotional brain—intense pleasure & intense pain
- Strong emotions increase efficiency of memory

Important center of emotion and learning

- Most anatomically prominent components are:
  - Cingulate gyrus – arches over the top of the corpus callosum in the frontal and parietal lobes
  - Hippocampus – in the medial temporal lobe - memory
  - Amygdala – immediately rostral to the hippocampus - emotion
- Limbic system components are connected through complex loop of fiber tracts.
- Limbic system structures have centers for both gratification and aversion
  - Gratification – sensations of pleasure or reward
  - Aversion – sensations of fear or sorrow

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Functional organization of the cerebral cortex

- Written & spoken language: Speech
- Understanding
- Feelings
- Judgment
- Thought
- Recognition
- Emotions
- Memory
- Sensations: Touch, Pain, Temp.
- Forethought
- Movements

Lateral view of right cerebral hemisphere