Prefrontal Cortex (Anterior Association Area)

- Located in the anterior portion of the frontal lobe
- Most complicated cortical region
- Involved with intellect, cognition, recall, and personality
- Necessary for judgment, reasoning, persistence, and conscience
- Matures slowly, dependent on positive/negative feedback
Posterior Association Area

- Region encompassing parts of: temporal, parietal, and occipital lobes

- Involved in recognizing patterns, surroundings, bringing different sensory inputs into a whole

- Brings conscious attention to an area in space or to an area of one’s own body
  - Problems here can result in a smelly, half naked lady!
Language Areas

- Located in a large area surrounding the left (or language-dominant) lateral sulcus

- Major parts and functions:
  - Wernicke’s area – sounding out unfamiliar words
  - Broca’s area – speech preparation and production
  - Lateral prefrontal cortex – language comprehension and word analysis
  - Lateral and ventral temporal lobe – coordinate auditory and visual aspects of language
Lateralization of Cortical Function

- Lateralization – each hemisphere has abilities not shared with its partner

- Cerebral dominance – designates the hemisphere dominant for a given task

- Left hemisphere – controls language, math, and logic

- Right hemisphere – controls visual-spatial skills, emotion, and artistic skills

- Most “righties” are left cerebral dominant, while most “south paws” are right cerebral dominant.
Cerebral White Matter

- Located deep to the cortical grey matter
- It is responsible for communication between the cerebral cortex and lower CNS center, and areas of the cerebrum
- Consists of deep myelinated fibers and their large tracts
Cerebral White Matter

- Tracts are classified according to the direction in which they run
- Types include:
  - Commissures – connect corresponding gray areas of the two hemispheres.
    - E.g. corpus collosum
    - Fibers run horizontally
  - Association fibers – connect different parts of the same hemisphere
    - E.g. connect adjacent gyri
    - Long fibers can connect different cortical lobes
    - Fibers run horizontally
  - Projection fibers – enter the hemispheres from lower brain or cord centers
    - Tie the cortex to the rest of the nervous system and to the body’s receptors and effectors
    - E.g. corona radiata: fan like projection of fibers from the brain stem to the cortex
    - Fibers run vertically
Section 12.10a: Fiber Tracts in White Matter

**Figure 12.10a**

- Association fibers
- Projection fibers
- Thalamus and internal capsule
- Corpus callosum (commissural fibers)
- Projection (internal capsule) fibers

**Figure 12.10b**

- Basal nuclei (ganglia)
- Corpus callosum (commissural fibers)
- Corona radiata
- Gray matter
- White matter
- Lateral ventricle
- Fornix
- Third ventricle
- Thalamus
- Internal capsule
- Projection fibers
- Decussation of pyramids
- Medulla oblongata
- Superior
- Longitudinal fissure

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Basal Nuclei

- Masses of gray matter found deep within the cortical white matter

- The corpus striatum (striped appearance) is composed of three parts
  - Caudate nucleus
  - Lentiform nucleus – composed of the putamen and the globus pallidus
  - Fibers of internal capsule running between and through caudate and lentiform nuclei
Basal Nuclei
Functions of Basal Nuclei

- Nuclei of the corpus striatum receive input from the entire cerebral cortex.

- Output nuclei of the basal nuclei project to the premotor and prefrontal cortices and influence muscle movements directed by the primary motor cortex.

- No direct access to the motor pathways.

- Disorders of the B.N. result in too much or too little movement.
Diencephalon

- Central core of the forebrain
- Surrounded by the cerebral hemispheres
- Consists of three paired structures – thalamus, hypothalamus, and epithalamus
- Encloses the third ventricle
Thalamus

- Paired, egg-shaped masses that form the superolateral walls of the third ventricle
- Connected at the midline by the intermediate mass
- Contains four groups of nuclei – anterior, ventral, dorsal, and posterior
- Nuclei project and receive fibers from the cerebral cortex
Thalamus

Figure 12.13a

Dorsal nuclei

Medial Lateral Lateral

dorsal posterior

Pulvinar

Anterior nuclear group

Reticular nucleus

Ventral anterior Ventral lateral Ventral posterior lateral

Ventral nuclei

Medial geniculate body

Lateral geniculate body

Figure 12.13a
Thalamic Function

- Afferent fibers from all senses and all parts of the body converge and synapse in the thalamus
- Impulses of similar function are sorted out, edited, and relayed as a group
- All inputs ascending to the cerebral cortex pass through the thalamus
- Mediates sensation, motor activities, cortical arousal, learning, and memory
  - Thalamus is the “gateway” to the cerebral cortex
Hypothalamus

- Located below the thalamus, it caps the brainstem and forms the inferolateral walls of the third ventricle
- Extends from the optic chiasma to the posterior margin of the mammillary bodies
- Mammillary bodies
  - Small, paired nuclei bulging anteriorly from the hypothalamus
  - Relay station for olfactory pathways
- Infundibulum – stalk of the hypothalamus; connects to the pituitary gland
  - Main visceral control center of the body
  - Vital for homeostasis
Hypothalamic Nuclei

Anterior commissure
Preoptic nucleus
Anterior hypothalamic nucleus
Supraoptic nucleus
Suprachiasmatic nucleus
Optic chiasma
Infundibulum (stalk of the pituitary gland)
Paraventricular nucleus
Fornix
Dorsomedial nucleus
Posterior hypothalamic nucleus
Lateral hypothalamic area
Ventromedial nucleus
Mammillary body
Arcuate nucleus
Pituitary gland
(b)
Hypothalamic Function

- Autonomic control center: controls autonomic nervous system.
  - Regulates cardiac and smooth muscle
  - Regulates gland secretion
  - Influences blood pressure, heartbeat rate, digestive tract motility, eye pupil size
- Emotional response center
  - Center for pleasure, fear, rage
- Body temperature regulation
  - Sweating, shivering
- Regulation of food intake
  - Regulates the feeling of hunger and satiation
- Regulation of water balance and thirst
  - Regulates release of antidiuretic hormone causing kidneys to retain water
- Regulates sleep wake cycle
Endocrine Functions of the Hypothalamus

- Releasing hormones control secretion of hormones by the anterior pituitary gland
- The supraoptic and paraventricular nuclei produce ADH and oxytocin
Epithalamus

- Most dorsal portion of the diencephalon; forms roof of the third ventricle
- Pineal gland – extends from the posterior border and secretes melatonin
  - Melatonin – a hormone involved with sleep regulation, sleep-wake cycles, and mood
- Choroid plexus – a structure that secretes cerebral spinal fluid (CSF)
Epithalamus

- Septum pellucidum
- Interthalamic adhesion (intermediate mass of thalamus)
- Frontal lobe of cerebral hemisphere
- Interventricular foramen
- Anterior commissure
- Hypothalamus
- Optic chiasma
- Pituitary gland
- Temporal lobe of cerebral hemisphere
- Mammillary body
- Pons
- Medulla oblongata
- Spinal cord
- Parietal lobe of cerebral hemisphere
- Corpus callosum
- Fornix
- Choroid plexus
- Occipital lobe of cerebral hemisphere
- Thalamus (encloses third ventricle)
- Posterior commissure
- Pineal body/gland (part of epithalamus)
- Corpora quadrigemina
- Midbrain
- Cerebral aqueduct
- Arbor vitae
- Fourth ventricle
- Choroid plexus
- Cerebellum

Figure 12.12
Brain Stem

- Consists of three regions – midbrain, pons, and medulla oblongata
- Similar to spinal cord but contains embedded nuclei
- Controls automatic behaviors necessary for survival
- Provides the pathway for tracts between higher and lower brain centers
- Associated with 10 of the 12 pairs of cranial nerves
Brain Stem

(a) Ventral view

- Optic chiasma
- Thalamus
- Optic tract
- Infundibulum (pituitary removed)
- Oculomotor nerve (III)
- Crus cerebri of cerebral peduncles (midbrain)
- Trochlear nerve (IV)
- Pons
- Middle cerebellar peduncle
- Hypoglossal nerve (XII)
- Pyramid
- Decussation of pyramids
- Spinal cord
- Trigeminal nerve (V)
- Abducens nerve (VI)
- Facial nerve (VII)
- Vestibulocochlear nerve (VIII)
- Glossopharyngeal nerve (IX)
- Vagus nerve (X)
- Accessory nerve (XI)
- Ventral root of first cervical nerve

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Figure 12.15a
Brain Stem

Figure 12.15b

(b) Left lateral view
Brain Stem

(c) Dorsal view

- Third ventricle
- Thalamus
- Superior colliculus
- Corpora quadrigemina of tectum
- Inferior colliculus
- Trochlear (IV) nerve
- 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 (dorsal) root of first cervical nerve

- Pineal gland
- Lateral geniculate nucleus
- Medial geniculate nucleus
- Anterior wall of fourth ventricle
- Choroid plexus (fourth ventricle)
- Posterior median sulcus
- Fasciculus cuneatus
- Fasciculus gracilis

Midbrain
Pons
Medulla

Figure 12.15c
Midbrain

- Located between the diencephalon and the pons
- Midbrain structures include:
  - Cerebral peduncles – two bulging structures that contain pyramidal motor tracts descending toward the spinal cord
  - Cerebral aqueduct – hollow tube that connects the third and fourth ventricles
  - Various nuclei
Midbrain Nuclei

- Corpora quadrigemina – four domelike protrusions of the dorsal midbrain (superior and inferior colliculi)
- Superior colliculi: visual reflex centers
- Inferior colliculi: auditory relay (startle reflex)
Midbrain Nuclei

- 2 pigmented nuclei:
  - Substantia nigra – pigmented from melanin
    - Precursor of dopamine released here. Disorders here, e.g. Parkinson’s disease
  - Red nucleus – largest nucleus of the reticular formation
    - red coloration due to high degree of vascularization
Pons

- Bulging brainstem region between the midbrain and the medulla oblongata
- Forms part of the anterior wall of the fourth ventricle
- Formed of tracts coursing in 2 directions
  - Deep projections: connect higher brain centers and spinal cord
  - Superficial projections relay between the motor cortex and the cerebellum
Medulla Oblongata

- Most inferior part of the brain stem
- Along with the pons, forms the ventral wall of the fourth ventricle
- Contains a choroid plexus of the fourth ventricle
- Pyramids – two longitudinal ridges formed by corticospinal tracts
- Decussation of the pyramids – crossover points of the corticospinal tracts
Medulla Nuclei

- Inferior olivary nuclei – gray matter that relays sensory information on the state of stretch of muscles and joints to the cerebellum

- Cochlear nuclei: auditory relays

- Vestibular nuclear complex – synapses that mediate and maintain equilibrium

- Nucleus gracilis and caneatus: where somatic sensory information ascends from the spinal cord to the somatosensory cortex
**Medulla Nuclei**

- Involved in autonomic reflex center involved in homeostasis
  - Cardiovascular control center – adjusts force and rate of heart contraction
  - Respiratory centers – control rate and depth of breathing
  - Additional centers – regulate vomiting, hiccupsing, swallowing, coughing, and sneezing
The Cerebellum

- Located dorsal to the pons and medulla
- Protrudes under the occipital lobes of the cerebrum
- Makes up 11% of the brain’s mass
- Provides precise timing and appropriate patterns of skeletal muscle contraction
  - E.g. coordination
- Cerebellar activity occurs subconsciously
The Cerebellum

Anterior lobe

Posterior lobe

Horizontal fissure

Vermis

Figure 12.17b
Anatomy of the Cerebellum

- Two bilaterally symmetrical hemispheres connected medially by the vermis
- Contains folia – transversely oriented gyri
- Fissures subdivide each hemisphere into three lobes – anterior, posterior, and flocculonodular
- Neural arrangement – gray matter cortex, internal white matter, scattered nuclei
- Arbor vitae – distinctive treelike pattern of the cerebellar white matter
Cerebellar Peduncles

- Three paired fiber tracts that connect the cerebellum to the brain stem
- All fibers in the cerebellum are ipsilateral
- Superior peduncles connect the cerebellum to the midbrain
- Middle peduncles connect the pons to the cerebellum
- Inferior peduncles connect the medulla to the cerebellum
Cerebellar Processing

- Cerebellum receives impulses of the intent to initiate voluntary muscle contraction
- Proprioceptors and visual signals “inform” the cerebellum of the body’s condition
- Cerebellar cortex calculates the best way to perform a movement
- A “blueprint” of coordinated movement is sent to the cerebral motor cortex