

The Central Nervous System

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Central Nervous System (CNS)

- CNS – composed of the brain and spinal cord
- Cephalization
 - Elaboration of the anterior portion of the CNS
 - Increase in number of neurons in the head
 - Highest level is reached in the human brain

The Brain

- Composed of wrinkled, pinkish gray tissue
- Surface anatomy includes cerebral hemispheres, cerebellum, and brain stem

Embryonic Development

- During the first 26 days of development:
 - Ectoderm thickens along dorsal midline to form the neural plate
 - The neural plate invaginates, forming a groove flanked by neural folds
 - The neural groove fuses dorsally and forms the neural tube

Embryonic Development

Primary Brain Vesicles

- The anterior end of the neural tube expands and constricts to form the three primary brain vesicles
 - Prosencephalon – the forebrain
 - Mesencephalon – the midbrain
 - Rhombencephalon – hindbrain

Neural Tube and Primary Brain Vesicles

Secondary Brain Vesicles

- In week 5 of embryonic development, secondary brain vesicles form
 - Telencephalon and diencephalon arise from the forebrain
 - Mesencephalon remains undivided
 - Metencephalon and myelencephalon arise from the hindbrain

Secondary Brain Vesicles

Adult Brain Structures

- Fates of the secondary brain vesicles:
 - Telencephalon – cerebrum: cortex, white matter, and basal nuclei
 - Diencephalon – thalamus, hypothalamus, and epithalamus
 - Mesencephalon – brain stem: midbrain
 - Metencephalon – brain stem: pons
 - Myelencephalon – brain stem: medulla oblongata

Adult Neural Canal Regions

Space Restriction and Brain Development

Basic Pattern of the Central Nervous System

- Spinal Cord
 - Central cavity surrounded by a gray matter core
 - External to which is white matter composed of myelinated fiber tracts
- Brain
 - Similar to spinal cord but with additional areas of gray matter
 - Cerebellum has gray matter in nuclei
 - Cerebrum has nuclei and additional gray matter in the cortex

Ventricles of the Brain

- Arise from expansion of the lumen of the neural tube
- The ventricles are:
 - The paired C-shaped lateral ventricles
 - The third ventricle found in the diencephalon
 - The fourth ventricle found in the hindbrain dorsal to the pons

Ventricles of the Brain

Cerebral Hemispheres

- Form the superior part of the brain and make up 83% of its mass
- Contain ridges (gyri) and shallow grooves (sulci)
- Contain deep grooves called fissures
- Are separated by the longitudinal fissure
- Have three basic regions: cortex, white matter, and basal nuclei

Major Lobes, Gyri, and Sulci of the Cerebral Hemisphere

- Deep sulci divide the hemispheres into five lobes:
 - Frontal, parietal, temporal, occipital, and insula
- Central sulcus – separates the frontal and parietal lobes

Cerebral Cortex

- The cortex – superficial gray matter; accounts for 40% of the mass of the brain

- It enables sensation, communication, memory, understanding, and voluntary movements
- Each hemisphere acts contralaterally (controls the opposite side of the body)
- Hemispheres are not equal in function
- No functional area acts alone; conscious behavior involves the entire cortex

Functional Areas of the Cerebral Cortex

- The three types of functional areas are:
 - Motor areas – control voluntary movement
 - Sensory areas – conscious awareness of sensation
 - Association areas – integrate diverse information

Functional Areas of the Cerebral Cortex

Functional Areas of the Cerebral Cortex

Cerebral Cortex: Motor Areas

- Primary (somatic) motor cortex
- Premotor cortex
- Broca's area
- Frontal eye field

Primary Motor Cortex

- Located in the precentral gyrus
- Composed of pyramidal cells whose axons make up the corticospinal tracts
- Allows conscious control of precise, skilled, voluntary movements

Premotor Cortex

- Located anterior to the precentral gyrus
- Controls learned, repetitious, or patterned motor skills (typing, piano playing etc.)
- Coordinates simultaneous or sequential actions
- Involved in the planning of movements

Broca's Area

- Broca's area
 - Located anterior to the inferior region of the premotor area
 - Present in one hemisphere (usually the left)
 - A motor speech area that directs muscles of the tongue
 - Is active as one prepares to speak

Frontal Eye Field

- Frontal eye field
 - Located anterior to the premotor cortex and superior to Broca's area
 - Controls voluntary eye movement

Sensory Areas

- Primary somatosensory cortex
- Somatosensory association cortex
- Visual and auditory areas
- Olfactory, gustatory, and vestibular cortices

Sensory Areas

Primary Somatosensory Cortex

- Located in the postcentral gyrus, this area:
 - Receives information from the skin and skeletal muscles
 - Exhibits spatial discrimination

Somatosensory Association Cortex

- Located posterior to the primary somatosensory cortex
- Integrates sensory information
- Forms comprehensive understanding of the stimulus
- Determines size, texture, and relationship of parts

Visual Areas

- Primary visual (striate) cortex
 - Seen on the extreme posterior tip of the occipital lobe
 - Receives visual information from the retinas
- Visual association area
 - Surrounds the primary visual cortex
 - Interprets visual stimuli (e.g., color, form, and movement)

Auditory Areas

- Primary auditory cortex
 - Located at the superior margin of the temporal lobe
 - Receives information related to pitch, rhythm, and loudness
- Auditory association area
 - Located posterior to the primary auditory cortex
 - Stores memories of sounds and permits perception of sounds

Association Areas

- Prefrontal cortex
- Language areas
- General (common) interpretation area
- Visceral association area

Association Areas

Prefrontal Cortex

- Located in the anterior portion of the frontal lobe
- Involved with intellect, cognition, recall, and personality
- Necessary for judgment, reasoning, persistence, and conscience
- Closely linked to the limbic system (emotional part of the brain)