The Brain and Cranial Nerves

Objectives
• Name the major regions of the brain and describe their functions.
• Discuss the formation, circulation, and functions of the CSF.
• List the main components of the medulla oblongata, the pons, the cerebellum, the mesencephalon, the diencephalon, and the limbic system and specify their functions.
• Identify the major anatomical subdivisions of the cerebrum.
• Locate the motor, sensory, and association areas of the cerebral cortex.
• Describe representative examples of cranial reflexes.

Major regions and landmarks
• Six regions in the adult brain
  • Cerebrum
  • Diencephalon
  • Mesencephalon or Midbrain
  • Pons
  • Cerebellum
  • Medulla oblongata
• Brain contains extensive areas of neural cortex
  • Layer of gray matter on the surface of the cerebellum and cerebrum

Ventricles of the brain
• Central passageway of the brain enlarges to form ventricles
  • Contain cerebrospinal fluid (CSF)
  • Lateral ventricles (2) in cerebral hemispheres
  • Third ventricle – in diencephalons
    • Communicates with lateral ventricles via interventricular foramen
  • Fourth ventricle – between pons and cerebellum
    • Communicates with third ventricle via cerebral aquaduct

The cranial meninges
• Continuous with the three layers of the spinal cord
• Folds of dura mater help stabilize the position of the brain
  • Falx cerebri
  • Tentorium cerebelli
  • Falx cerebelli

Cerebrospinal fluid (CSF)
• CSF cushions delicate neural structures
• Supports the brain
• Transports nutrients, chemical messengers, and waste products
• Pathway of CSF
• Produced at the Choroid plexus with the ventricles
• Travels through the lateral and medial apertures to the subarachnoid space
• Diffuses across the arachnoid granulations into the superior sagittal sinus

**Blood supply to the brain**
• Blood brain barrier isolates neural tissue from general circulation

**Medulla oblongata**
• Connects the brain with the spinal cord
• Contains relay stations and reflex centers

**Pons**
• Sensory and motor nuclei for four cranial nerves
• Nuclei that help control respiration
• Nuclei and tracts linking the cerebellum with the brain stem, cerebrum, and spinal cord
• Ascending, descending, and transverse tracts

**Cerebellum**
• Adjusts postural muscles and tunes on-going movements
• Cerebellar hemispheres
  • Anterior and posterior lobes
  • Vermis
  • Flocculonodular lobe
• Superior, middle, and inferior cerebellar peduncles link cerebellum with brain stem, diencephalon, cerebrum, and spinal cord
  • Interconnects the two cerebellar hemispheres

**Mesencephalon or midbrain**
• The tectum (roof) contains the corpora quadrigemina
  • Superior and inferior colliculi
• The mesencephalon controls:
  • Reflexes to visual stimuli
  • Auditory processing
  • Some muscle tone
  • Alertness and awareness via reticular activating system

**Diencephalon**
• Epithalamus
• Hypothalamus
• Thalamus

**Epithalamus**
• Contains portions of choroids plexus
• Contains the pineal gland which secretes melatonin that regulates circadian rhythm
**Thalamus**
- Final relay point for ascending sensory information
- Coordinates the activities of the cerebral cortex and basal nuclei

**Hypothalamus**
- Controls somatic motor activities at the subconscious level
- Controls autonomic function
- Coordinates activities of the endocrine and nervous systems
- Secretes hormones
- Produces emotions and behavioral drives
- Coordinates voluntary and autonomic functions
- Regulates body temperature
- Coordinates circadian cycles of activity

**The Limbic System**
A collection of nuclei and tracts along border between cerebrum and diencephalon.
Functions involve emotions, behavioral drives, memory storage and retrieval
The limbic system or motivational system includes
- Amygdaloid body
- Cingulated gyrus
- Parahippocampal gyrus
- Hippocampus
- Fornix

**Cerebrum**
Largest region of brain
Conscious thoughts and intellectual function

**Gray matter of the Cerebrum: The cerebral cortex**
- Collection of mostly neuronal cell bodies
- Surface contains gyri and sulci or fissures
  - Longitudinal fissure separates two cerebral hemispheres
  - Central sulcus separates frontal and parietal lobes
  - Temporal and occipital lobes also bounded by sulci

**White matter of the cerebrum contains**
- Association fibers
- Commissural fibers
- Projection fibers

**White matter of the cerebrum contains also contains the basal nuclei**
- Caudate nucleus, Globus pallidus, Putamen
  - Control muscle tone and coordinate learned movement patterns
Motor and sensory areas of the cortex
• Primary motor cortex of the precentral gyrus directs voluntary movements
• Primary sensory cortex of the postcentral gyrus receives somatic sensory information
  • Touch
  • Pressure
  • Pain
  • Taste
  • Temperature

The Cerebral Hemispheres

Association areas
• Control our ability to understand sensory information and coordinate a response
  • Somatic sensory association area
  • Visual association area
  • Somatic motor association area

General interpretive and speech areas
• General interpretive area
  • Receives information from all sensory areas
  • Present only in left hemisphere
• Speech center
  • Regulates patterns of breathing and vocalization

Cortex functions and hemispheric differences
• Prefrontal cortex
  • Coordinates information from secondary and special association areas
  • Performs abstract intellectual functions
• Hemispheric differences
  • Left hemisphere typically contains general interpretive and speech centers and is responsible for language based skills
  • Right hemisphere is typically responsible for spatial relationships and analyses

Electroencephalogram (EEG)
• Measures brain activity
  • Alpha waves = resting adult
  • Beta waves = concentrating adult
  • Theta waves = normal children
  • Delta waves = normal during sleep

Cranial nerves
• Twelve pairs of cranial nerves
  • Each attaches to the ventrolateral surface of the brainstem near the associated sensory or motor nuclei
Olfactory nerves (I)
• Carry sensory information for the sense of smell, synapses with the olfactory bulb

Cranial nerves II, III, IV
• Optic nerves (II)
  • Carry visual information from special sensory receptors in the eyes
• Oculomotor nerves (III)
  • Primary source of innervation for four of the extraocular muscles
• Trochlear nerves (IV)
  • Innervate the superior oblique muscles

Cranial nerves V, VI, VII
• Trigeminal nerves (V)
  • Missed nerves with ophthalmic, maxillary, and mandibular branches
• Abducens nerve (VI)
  • Innervates the lateral rectus muscles
• Facial nerves (VII)
  • Mixed nerves that control muscles of the face and scalp
  • Provide pressure sensations over the face and taste information from the tongue

Cranial nerves VIII, IX
• Vestibulocochlear nerves (VIII)
  • Vestibular branch monitors balance, position, and movement
  • Cochlear branch monitors hearing
• Glossopharyngeal nerves (IX)
  • Mixed nerves that innervate the tongue and pharynx, controls swallowing

Cranial nerves X
• Vagus nerves (X)
  • Mixed nerves
  • Vital to the autonomic control of visceral function

Cranial nerves XI, XII
• Accessory nerves (XI)
  • Internal branches
    • Innervate voluntary swallowing muscles of the soft palate and pharynx
  • External branches
    • Control muscles associates with the pectoral girdle
• Hypoglossal nerves (XII)
  • Provide voluntary motor control over tongue movement

Cranial reflexes
• Involve sensory and motor fibers of cranial nerves
Identify the Below Landmarks in Superficial Lateral Brain View

Frontal lobe
Parietal lobe
Temporal lobe
Occipital lobe
Lateral sulcus
Central sulcus
Precentral gyrus
Postcentral gyrus
Medulla oblongata
Pons
Cerebellum

Identify the Below Landmarks in Superficial Superior Brain View

Longitudinal fissure
Left and right cerebral hemispheres
Corpus callosum

Identify the Below Landmarks in Midsagittal Brain Section

Central sulcus
Precentral gyrus
Postcentral gyrus
Fornix
Thalamus
Hypothalamus
Pineal gland
Hypothalmus
Corpora quadrigemina
  Superior colliculus
  Inferior colliculus
Mesencephalic (cerebral) aquaduct
Cerebellum
  Arbor vitae
Ventricles
  Lateral, Third, Interventricular
  foramen, Mesencephalic
  (cerebral) aqueduct, Fourth
Brain stem
  Medulla oblongata, Pons,
  Mesencephalon (midbrain)
Optic chiasim
  Septum pellucidum
  Corpus callosum
  Fornix
  Infundibulum
  Pituitary

Identify the Below Landmarks in Inferior Brain View

Brain stem
  Medulla oblongata, Pons,
  Mesencephalon (midbrain)
Cerebellum
Spinal cord
Olfactory Nerve (I)

Olfactory Tract
Olfactory bulb
Optic Nerve (II)
Optic chiasm
### List of Cranial Nerves and Function

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<th>Function</th>
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<td>Optic (II)</td>
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<td>Oculomotor (III)</td>
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<td>Trochlear (IV)</td>
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<td>Mastication – motor</td>
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<td>Vestibulocochlear (VIII)</td>
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<td>Glossopharyngeal (IX)</td>
<td>Taste/tongue – sensory</td>
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<td>Swallowing – motor</td>
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<td>Vagus (X)</td>
<td>Sensory &amp; motor functions in pharynx &amp;</td>
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<td>Accessory (XI)</td>
<td>Pharyngeal &amp; sternocleidomastoid muscles –</td>
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<td>Hypoglossal (XII)</td>
<td>Tongue musculature – motor</td>
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### Identify the Below Landmarks in Spinal Cord Cross Section View

- Anterior gray horn
- Lateral gray horn
- Posterior gray horn
- Gray commissure
- Central canal
- Anterior white column
- Lateral white column
- Posterior white column
- Anterior median fissure
- Posterior median sulcus
- Spinal nerve
  - Ventral root
  - Dorsal root
  - Dorsal root ganglion
  - Meninges
    - Dura mater
    - Arachnoid
    - Pia mater
  - Epidural space (with adipose tissue)
  - Subdural space
  - Subarachnoid space (with CSF)
  - Autonomic (sympathetic) ganglia