

Chapter 12 ...continued

THE BRAIN STEM is composed of three parts...the midbrain, the pons and the medulla oblongata. The BRAIN STEM produces the rigidly programmed, automatic behaviors necessary for survival. It also provides a pathway for fiber tracts running between higher and lower neural centers. Also, brain stem nuclei are associated with 10 of the 12 pairs of cranial nerves, so it is highly involved with innervation of the head.

The MIDBRAIN is made up of the following anatomical features:

- CEREBRAL PEDUNCLES are on the ventral surface. They contain descending corticospinal tracts (white tracts)
- CEREBRAL AQUEDUCT is a.k.a. mesencephalic duct. This is a small channel that connects the third and fourth ventricle.
- CRANIAL NERVE NUCLEI in the midbrain are CN III and IV.
- RED NUCLEUS is pigmented and is the motor pathway relay center of the brain. It is involved in limb flexion.
- RETICULAR FORMATION is a functional brain system that runs throughout the brainstem, and its most significant active part is in the midbrain!
- SUBSTANTIA NIGRA is also pigmented (melanin). It is the precursor to serotonin. It is functionally linked to the basal nuclei (works with basal nuclei), and is involved in coordination of motor output. Degeneration of these neurons leads to Parkinson's Disease.
- CORPORA QUADRIGEMINA is on the dorsal surface of the midbrain. It is the four little mounds in two pairs. The SUPERIOR COLLICULI is involved with visual tracking, while the INFERIOR COLLICULI is related to reflexive response to sound.

The PONS (latin for "bridge" because it is a connecting region)

- As part of the FOURTH VENTRICLE, the pons forms most of the anterior wall of the fourth ventricle.
- CRANIAL NERVE NUCLEI in the pons are V-VII and part of VIII.
- PONTINE RESPIRATORY GROUP modulates rhythm of breathing
- RETICULAR FORMATION is also present here...more on this later.
- RELAY NUCLEI in the pons connect the cerebellum and motor cortex.
- MIDDLE CEREBELLAR PEDUNCLE are white tracts connecting pontine nuclei and bilaterally connecting the cerebellar hemispheres

The MEDULLA OBLONGATA

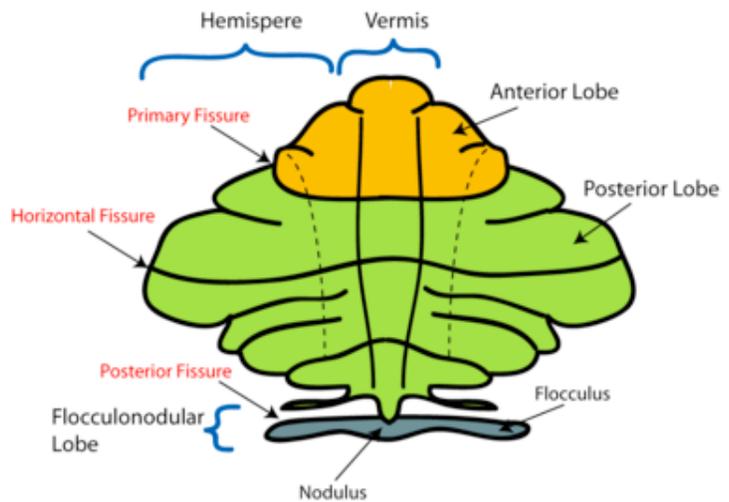
- As part of the FOURTH VENTRICLE, the medulla oblongata forms the lower portion of the anterior wall of the fourth ventricle.
- The PYRAMIDS are paired ridges along the ventral surface. These are inferior continuation of the cerebral peduncles.
- CRANIAL NERVES in the medulla are VIII-XII (parts of VIII)
- The medulla has CENTERS FOR PATTERNED MOTOR RESPONSE, such as vomiting, hiccupping, swallowing, coughing and sneezing.

- The OLIVES are bilateral external swellings on the medulla. They overlie the INFERIOR OLIVARY NUCLEI, and relay *proprioceptive* information to cerebellum.
- SOMATOSENSORY RELAY NUCLEI are the:
 - *Nuclei gracilis*
 - *Nucleus cuneatus*
- The CARDIOVASCULAR CENTER alters heart rate, depth of contraction and vessel diameter.
- The RESPIRATORY CENTER controls the rate and depth of breathing
- RETICULAR FORMATION is also present in the medulla

Proprioceptive relates to where the joints and muscles are in space; how much stretch is on a muscle.

THE CEREBELLUM is made up of two hemispheres.

- The VERMIS is the wormlike midline connection
- FOLIA are the transverse gyri of the cerebellum. They have a uniform arrangement
- The PRIMARY FISSURE divides the cerebellum into the *anterior lobe* and the *posterior lobe*
- The FLOCCULONODULAR lobe is deep to the vermis and posterior lobe.
- ARBOR VITAE are the internal white matter tracks “tree of life”...resembles branches of a tree deep in the cerebellum.
- CEREBELLAR PEDUNCLES are white tracts connecting the cerebellum to the cortex and brainstem.
 - SUPERIOR CEREBELLAR PEDUNCLES send signals from the cerebellum to the motor cortex via the thalamus.
 - MIDDLE CEREBELLAR PEDUNCLES relay motor information from the pons
 - INFERIOR CEREBELLAR PEDUNCLES receive *proprioceptive signals* from the spinal cord. They also receive *equilibrium signals* from vestibular nuclei



FUNCTIONS OF THE CEREBELLUM

- Coordination of muscle movement: balance, rhythm, movement
- Processes information from the motor cortex, proprioceptive info from joints/muscles, visual information and equilibrium information.
- It influences motor cortex and brainstem nuclei

Info from the motor cortex goes to the cerebellum for processing. The cerebellum plans it out!

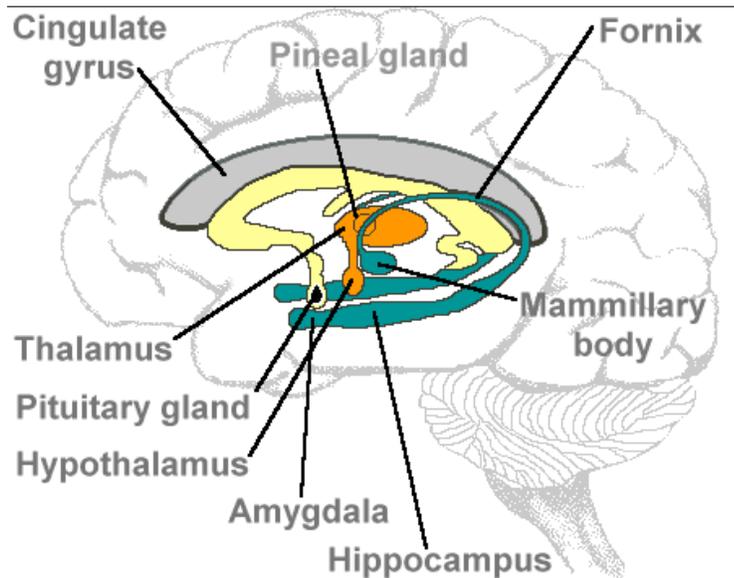
- Cognition: the planning of complex movements, word association and puzzle solving.

FUNCTIONAL BRAIN SYSTEMS

LIMBIC SYSTEM

Made up of diffuse medial structures in the CEREBRUM and DIENCEPHALON. It processes emotional response.

- Structures included are the:
 - AMYGDALA (basal nuclei). It processes the fear response
 - CINGULATE GYRUS (above corpus callosum)
 - FORNIX (a white tract below corpus callosum)
 - HYPOTHALAMUS
 - HIPPOCAMPUS (memory formation along with the amygdala)



The Limbic System

RETICULAR FORMATION

A collection of loosely clustered neurons throughout the brainstem. It creates diffuse connections to the cerebrum, cerebellum, thalamus, hypothalamus and spinal cord...connections all throughout the brain!

The RETICULAR ACTIVATING SYSTEM (RAS) sends continuous signals to cortex. It maintains consciousness and alertness. It helps us focus by filtering out repetitive, weak sensory signals. However, it is inhibited by sleep centers so we can sleep 😊

BRAIN PROTECTION

The brain has three methods of protection: 1) the meninges, 2) the cerebrospinal fluid and 3) the blood brain barrier

PROTECTION #1: The MENINGES are connective tissue coverings of the brain and spinal cord. From the inside to the outside, the meninges are: Dura mater, Arachnoid mater and Pia mater.

Outer layer of meninges

The DURA MATER (tough mother) is the tough, leathery outer layer. It is also the strongest of all the meninges. It is made up of two layers:

- Periosteal layer is fused to the periosteum of inner surface of cranial bones. It covers the brain only, not the spinal cord
- Meningeal layer is the inner layer that face the meninges...covers both the brain and spinal cord.

These two dural layers are fused together, except in certain areas where they separate to enclose DURAL SINUSES that collect venous blood from the brain and direct it into internal jugular veins of the neck. The sinuses are:

- Superior sagittal sinus
- Inferior sagittal sinus
- Straight sinus (connects superior and inferior)

In some areas, the meningeal dura mater extend inward to form flat partitions that subdivide the cranial cavity. These fibrous sheets support the brain and limit brain movement. They are called DURAL SEPTAE and there are three:

- Falx cerebri: between cerebral hemisphere
- Falx cerebelli: separate two cerebellar hemispheres along the vermis
- Tentorium cerebelli: between cerebrum and cerebellum, sits in transverse fissure

Middle layer of meninges

The ARACHNOID MATER is made up of loose connective tissue.

- The SUBDURAL SPACE is the space between dura mater and arachnoid mater. It contains thin film of serous fluid
- The SUBARACHNOID SPACE is the space between arachnoid mater and pia mater. It is transversed by web-like extensions and cerebral blood vessels. The space is filled with cerebrospinal fluid (CSF)
- The ARACHNOID VILLI project through the dura mater into the dural sinuses, so the CSF is directly next to the blood. This allows drainage of CSF.

The inner layer of meninges

The PIA MATER is delicate connective tissue that holds small blood vessels to the surface of the brain. It follows gyri into the sulci for a very snug fit against the brain.

PROTECTION #2: The CEREBROSPINAL FLUID flows between meninges and surrounds the brain, and fills the ventricles. Its composition is similar to blood plasma. It is actually derived from plasma, but it has less proteins and a different pH & ionic concentrations. It is produced by the CHOROID PLEXUSES, which are located in each ventricle of the CSF (floor of lateral ventricles, roofs of 3rd and 4th ventricles). Its functions are:

- Supports weight of brain
- Protects from trauma, provides cushioning
- Nourishes neural tissue
- May carry chemical signals (hormones)

The CHOROID PLEXUS is a network of permeable capillaries surrounded by ependymal cells that actively filter capillary plasma.

The CSF flows through the ventricles in order of number (lateral to 3rd to 4th). A small amount flows down the central canal of the spinal cord. Its path takes it into the subarachnoid space through apertures in the 4th ventricle. It drains back into the blood at the dural sinuses through the ARACHNOID VILLA, which act as vents.

PROTECTION #3: The BLOOD BRAIN BARRIER is a protective mechanism that helps maintain a stable environment for the brain. In other body regions, the extracellular concentrations of hormones, amino acids and ions are in constant flux. If the brain were exposed to such chemical variations the neurons would fire uncontrollably.

The neurons are separated from the blood by:

- Continuous capillary endothelium with tight junctions
- Thicker basal lamina on these squamous cells
- Extensions of astrocytes that wrap around capillaries

The BBB is not an absolute barrier. The capillaries can select substances that can cross. Alcohol, CO₂, and fatty substances can cross directly. The BBB is also not uniform throughout the brain. It is less rigid in the hypothalamus (regulates water balance, body temp) and the vomiting center, which monitors the blood for poisonous substances.