DIVISIONS OF BRAIN: MIDBRAIN AND HINDBRAIN

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MIDBRAIN

Midbrain**,** or the *mesencephalon*, between the forebrain and hindbrain is a relatively small part located on the brain stem, is made up of the tectum and tegmentum primarily. The midbrain serves important motor functions like eye movements. It is also an important part in the processing of visual and auditory stimuli.

The *tectum* (from Latin for "roof") makes up the rear portion of the midbrain and is formed by two paired rounded swellings, the *superior and inferior colliculi* involved in vision and audition respectively. The superior colliculus receives input from the retina and the visual cortex and participates in a variety of visual reflexes, particularly the tracking of objects in the visual field i.e. head and eye coordination. The inferior colliculus receives auditory stimuli and projects upon the auditory relay nucleus of the thalamus. It is also responsive to sound amplitude, modulation, frequencies and this might be responsible for specific pitch detection. In addition, spatial localization by binaural hearing is a related function of inferior colliculus.

The *tegmentum* is located in front of the tectum. It consists of three regions distinguished by their colour—the red nucleus, the peri-aqueductal gray and the substantia nigra.

- The *red nucleus* is a large structure located centrally within the tegmentum that brings down motor information from the cerebral cortex in forebrain and cerebellum in hindbrain.

- The *periaqueductal gray region* of the tegmentum is made up of gray matter (neural tissue with relatively few axons covered in myelin) and surrounds the cerebral aqueduct, a short canal between the third and fourth ventricles of the brain. Its activation leads to pain suppression, a result of its naturally high concentration of endorphins.

- The *substantia nigra* is a large pigmented cluster of neurons that consists of two parts, the *pars reticulata* and the *pars compacta*. Cells of the pars compacta contain the dark pigment melanin; these cells synthesize dopamine and project to either the caudate nucleus or the putamen (of the basal ganglia) and are involved in mediating movement. By inhibiting the neuronal action in the caudate nucleus and the putamen, the dopaminergic cells of the pars compacta control the output of GABA (neurotransmitter).

HINDBRAIN

Hindbrain, or the *rhombencephalon*, is made up of three distinct parts: pons and cerebellum (together called the *metencephalon*) and the medulla oblongata (*myelencephalon*).

Pons is a bulge on the brain stem that connects the cortex and the cerebellum like a "bridge" as the meaning of the name suggests. The pons contains cranial nerve nuclei (V-VIII) that relay signals from the forebrain to the cerebellum and fundamentally helps in sensory analysis along with bladder contractions, sleep, respiration, audition and equilibrium, taste, eye movement, facial sensations and expressions, chewing, swallowing and posture.

Cerebellum is a close replication of the cerebrum with two hemispheres which are connected to the pons with the help of *cerebellar peduncles*. It has several functions concerning movement and coordination, including:

- Maintenance of balance: The cerebellum has special receptors that perceive shifts in balance and movement. It sends signals for the body to make adjustments accordingly and move.
- Coordination of movement: Most body movements require the coordination of multiple muscle groups. The cerebellum times muscle actions for smooth movement of muscles.
- Motor learning: The cerebellum helps the body to acquire movements that require practice and fine-tuning like swimming or dancing. Therefore, it is a storage of procedural memories.

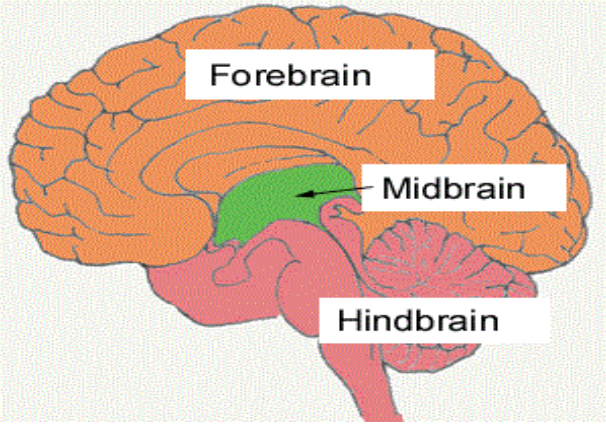
Extensive Damage to this part can lead to impairment in standing/walking or normal mobility while localized damages of the same can lead to uncoordinated, jerky, exaggerated body movements.

Medulla oblongata is inferior to the pons and anterior to the cerebellum. It is the lowest portion of the hindbrain which continues into the spinal cord. This portion of the brain controls autonomic functions of the body and is directly involved in regulation of vital functions. It serves the following fundamental roles as:

- Respiratory centre controlling respiration
- Vasomotor centre controlling vasorestriction and vasodilation
- Cardiovascular centre controlling sympathetic and parasympathetic regulation of heartbeat and pulse rate

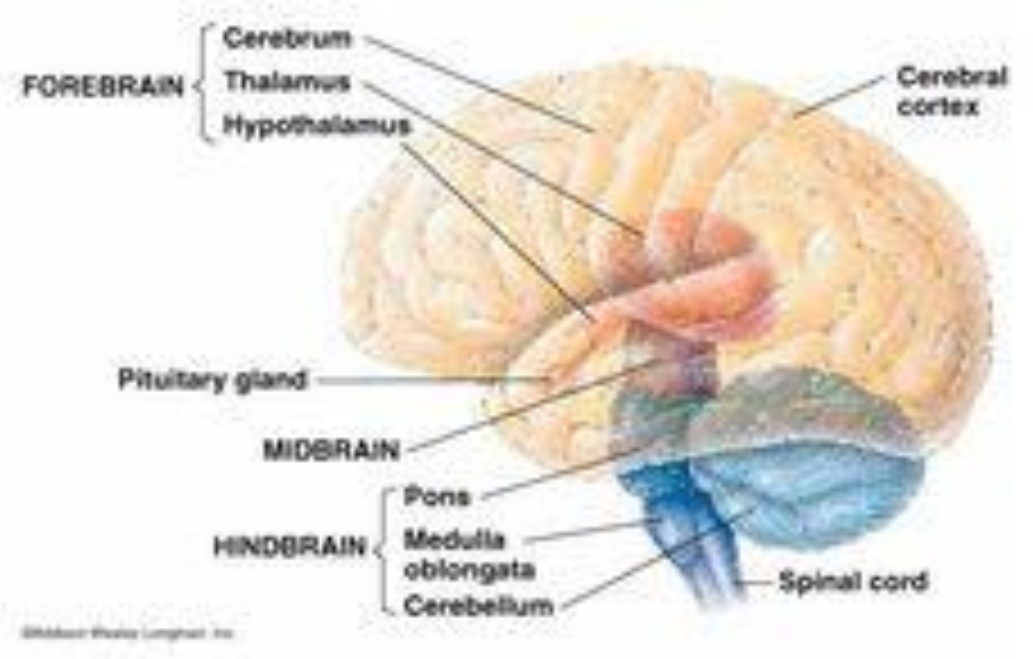
- Reflex centre controlling coughing, sneezing, vomiting, swallowing.

Clinical complications of the medulla oblongata may result in a number of sensory-related problems. Non-fatal complications include paralysis, difficulty in swallowing, acid reflux and motor control damage. As the medulla also controls vital autonomic functions, injury of this area may prove fatal.



LOCATION OF MIDBRAIN AND HINDBRAIN

[Ref: Hindbrain- structure and functions: https://youtu.be/x2g-HpxLtDw]



HINDBRAIN WITH PONS, CEREBELLUM AND MEDULLA OBLONGATA

BRAIN STEM

The brain stem is predominantly composed of the *Reticular Activating System* (RAS) which is a web-like network of interconnected neural fibres in ascending and descending pathways to the upper part of midbrain and spinal cord respectively. It has projections to the thalamus and cerebrum that makes it potent enough to perceive and sense objects in our conscious attention. It plays a key role in mediation of consciousness (sleep and alertness) and regulation of arousal. This is also the part that enables the brain to screen out repetitive signals while remaining sensitive to others. Injury to the brain stem may result in irreversible coma.

[Ref: Midbrain and Reticular Formation: https://youtu.be/nZdS6u7hzBc]