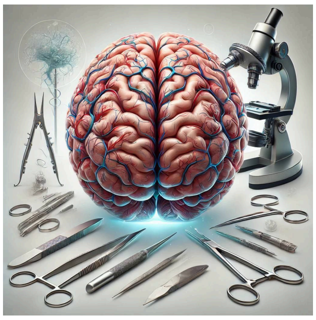

CNS—Anatomy~7
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What is the Brain Stem? is the lower part of the brain that connects the Cerebrum (the largest part of the brain) to the Spinal Cord. It plays a crucial role in controlling vital functions such as breathing, heart rate, and blood pressure. Additionally, it serves as the main pathway for transmitting neural signals between the brain and the rest of the body.

Parts of the Brain Stem - The brain stem is divided into three main sections:

1. Midbrain (Mesencephalon): Functions as a relay station for signals between the brain and spinal cord; Contains centers that control eye movement and responses to auditory and visual stimuli.

2. Pons: Acts as a bridge connecting the Midbrain to the Medulla Oblongata; Helps regulate breathing and transmits sensory and motor signals between the brain and Cerebellum.

3. Medulla Oblongata: Controls involuntary functions such as breathing, heartbeat, and blood pressure; Contains centers responsible for reflex actions like coughing, sneezing, and swallowing.

Main Functions of the Brain Stem: Regulating involuntary functions such as respiration, circulation, and digestion also Coordinating movement and balance in collaboration with the Cerebellum and Transmitting neural signals between the brain and spinal cord and Controlling Cranial Nerves, which are responsible for facial sensation, eye movement, tongue movement, and more.

Significance of the Brain Stem in Neurosurgery (This is my specialty - Dr.Ali): Any damage to the Brain Stem can lead to life-threatening conditions, such as respiratory failure or permanent unconsciousness (coma) also Due to its importance, the Brain Stem is one of the most sensitive areas in neurosurgery and Neurosurgeons use highly advanced techniques to operate in this region while minimizing the risk of complications that could affect vital functions.

Adding some details and returning the information will not cause harm.

Brain Stem; Structure and Connection: Stalk-like in shape, meaning it has a tube-like, elongated structure; Connects the spinal cord to higher centers of the forebrain, acting as a crucial bridge for transmitting neural signals between the central nervous system and the rest of the body.

Parts of the Brain Stem: Medulla Oblongata The lowest part of the brain stem, directly connected to the spinal cord, Controls involuntary functions such as breathing, heart rate, and blood pressure, Contains reflex centers for coughing, sneezing, swallowing, and vomiting; The second part is Pons, Located above the medulla oblongata, serving as a bridge connecting the midbrain, cerebellum, and spinal cord, Plays a key role in breathing regulation and motor coordination, Contains cranial nerve nuclei responsible for facial sensation, movement, and eye control; While the third part is Midbrain (Mesencephalon) The uppermost part of the brain stem, linking the pons to the cerebrum, Responsible for eye movement control and auditory-visual reflexes, Contains the substantia nigra, a structure important for movement regulation and dopamine production.

Importance of the Brain Stem: Regulates essential life-sustaining functions like breathing and heart rate; Acts as the main communication pathway between the brain and spinal cord; Houses nuclei for several cranial nerves, which control motor and sensory functions in the head and neck.

The Medulla Oblongata is the lower part of the brainstem and plays a crucial role in controlling involuntary functions such as breathing, heart rate, and blood pressure. Internally, it can be divided into different levels based on the structures present within it; Internal Levels of the Medulla:

1. Level of Decussation of Pyramids (Motor) – Closed Medulla: Located in the lower part of the medulla; This is where motor fibers from the cerebral cortex cross to the opposite side via the pyramidal tract; About 90% of corticospinal fibers decussate (cross), explaining why each hemisphere of the brain controls the opposite side of the body.

2. Level of Decussation of Lemnisci (Sensory) – Closed Medulla: Slightly above the pyramidal decussation; This is where sensory fibers from the dorsal column pathway (gracile and cuneate nuclei) cross over to the opposite side; After crossing, these fibers form the medial lemniscus, which carries fine touch, vibration, and proprioception signals to the thalamus.

3. Level of Olives – Open Medulla: Higher than the decussation of lemnisci, and at this level, the posterior median sulcus begins to disappear, making the medulla appear "open"; Contains the inferior olivary nucleus, which plays a key role in motor coordination by relaying signals to the cerebellum.

4. Level Just Inferior to the Pons: Located at the junction between the medulla and the pons; Contains important cranial nerve nuclei, such as the vagus nerve (CN X) and hypoglossal nerve (CN XII); Serves as a transition zone where more complex neural pathways emerge as the medulla connects to the pons.

Clinical Significance of This Division: Understanding the internal structure of the medulla is essential for recognizing how motor and sensory functions are organized; Lesions at these levels can cause serious neurological deficits, such as hemiplegia (paralysis on one side) or sensory loss on the opposite side of the body; The medulla is a critical area in neurosurgery and neurology, especially in conditions like stroke, multiple sclerosis, and neurodegenerative diseases.

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1. Decussation of Pyramids: Occurs in the lower part of the medulla oblongata, where approximately 90% of motor fibers from the cerebral cortex cross to the opposite side of the body; These fibers form the corticospinal tract, which is responsible for precise voluntary movements; This decussation explains why each hemisphere of the brain controls the opposite side of the body.

2. Fasciculus Gracilis and Fasciculus Cuneatus: Fasciculus Gracilis Carries sensory information from the lower limbs and lower trunk while Fasciculus Cuneatus Carries sensory information from the upper limbs and upper trunk; Both pathways transmit fine touch, vibration, and proprioception (sense of body position).

3. Nucleus Gracilis and Nucleus Cuneatus: These nuclei are located posterior to the central gray matter in the medulla; They serve as the termination points for sensory fibers coming from the spinal cord via the fasciculus gracilis and fasciculus cuneatus; After reaching these nuclei, sensory signals cross to the opposite side and form the medial lemniscus, which carries sensory information to the thalamus.

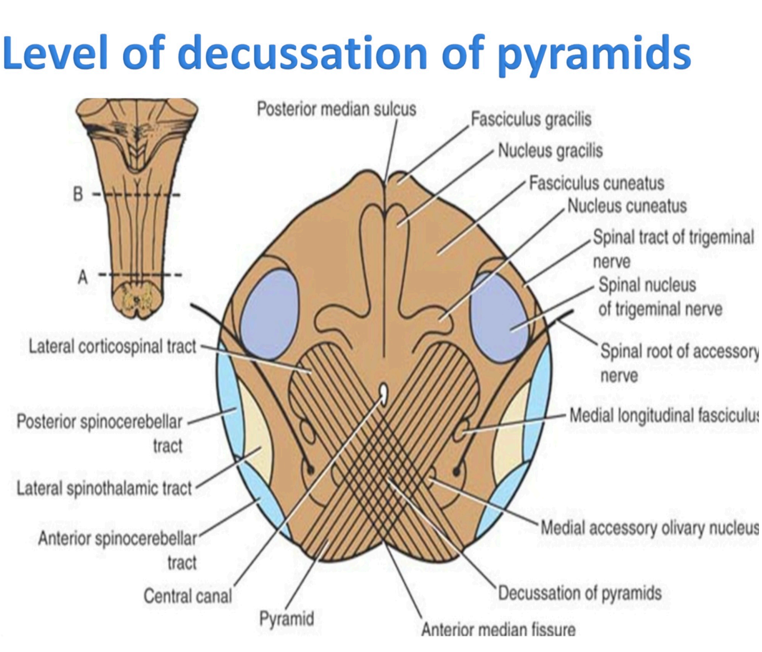
4. Spinal Nucleus of the Trigeminal Nerve: This nucleus processes pain, temperature, and crude touch sensation from the face, transmitted via the trigeminal nerve (Cranial Nerve V - CN V); It extends from the pons down to the upper spinal cord.

5. Central Canal: A continuation of the central canal of the spinal cord, containing cerebrospinal fluid (CSF); Plays a role in maintaining chemical balance and protecting neural tissue within the medulla.

6. The Lateral and Anterior White Columns of the Spinal Cord Remain Unchanged: These columns contain ascending and descending nerve pathways that transmit signals between the brain and spinal cord; At the level of pyramidal decussation, these columns remain relatively unaffected, as many neural tracts continue functioning without major structural changes.

Clinical Importance of This Level in Neurology and Neurosurgery: Any injury at this level can result in hemiplegia (paralysis on one side of the body) due to the crossing of motor fibers and Understanding this decussation is crucial when diagnosing brain injuries and strokes, as it helps determine the site of neurological damage and its impact on motor function also This level is a key focus in studying sensory and motor pathways in the central nervous system.

The image is a diagram illustrating the level of decussation of the pyramids in the brainstem. The diagram shows a cross-section of the brainstem at the level of the pyramidal decussation, where the pyramidal nerve fibers from the right cerebral hemisphere cross over to the left side of the spinal cord, and vice versa. The diagram also shows the locations of several other nerve tracts in this region, including:



Lateral corticospinal tract: The major tract responsible for voluntary movement.

Posterior spinocerebellar tract: Carries sensory information from the body to the cerebellum.

Lateral spinothalamic tract: Carries sensory information about pain and temperature.

Anterior spinocerebellar tract: Carries sensory information from the body to the cerebellum.

Fasciculus gracilis and Fasciculus cuneatus: Carry sensory information about touch, pressure, and proprioception.

Nucleus gracilis and Nucleus cuneatus: Process sensory information from the fasciculus gracilis and fasciculus cuneatus.

Spinal tract of trigeminal nerve: Carries sensory information from the face.

Spinal nucleus of trigeminal nerve: Processes sensory information from the spinal tract of the trigeminal nerve.

Spinal root of accessory nerve: Controls muscles of the neck and shoulders.

Medial longitudinal fasciculus: Involved in coordinating eye and head movements.

Medial accessory olivary nucleus: Involved in regulating balance.

Anterior median fissure: The deep groove that divides the spinal cord into two halves.

Central canal: A small canal in the center of the spinal cord.

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1. Sensory Decussation: This decussation occurs in the upper part of the medulla oblongata, and it is distinct from the pyramidal decussation, as it is responsible for sensory (not motor) fibers; At this level, sensory fibers cross over to the opposite side to transmit information to the brain.

2. Lemnisci Formation: The medial lemniscus is formed by internal arcuate fibers, which are responsible for transmitting fine touch, vibration, and proprioception (sense of body position); These fibers form the main sensory pathway for these types of sensations.

3. Internal Arcuate Fibers: These fibers originate from the anterior aspect of the nucleus gracilis and nucleus cuneatus; After crossing over, these fibers form the medial lemniscus, which carries the sensory signals to the thalamus for further processing.

4. Location of Decussation: The decussation of sensory fibers takes place posterior to the pyramids, meaning the sensory decussation happens behind the motor decussation; This ensures that sensory information from the body is transmitted to the opposite side of the brain.

5. Spinal Nucleus of the Trigeminal Nerve: This nucleus is located laterally to the internal arcuate fibers; It is responsible for transmitting pain, temperature, and crude touch sensations from the face through the trigeminal nerve (Cranial Nerve V).

6. Spinal Lemniscus: The spinal lemniscus lies lateral to the decussation of the lemnisci; It carries sensory signals related to pain, temperature, and crude touch from the body to the thalamus.

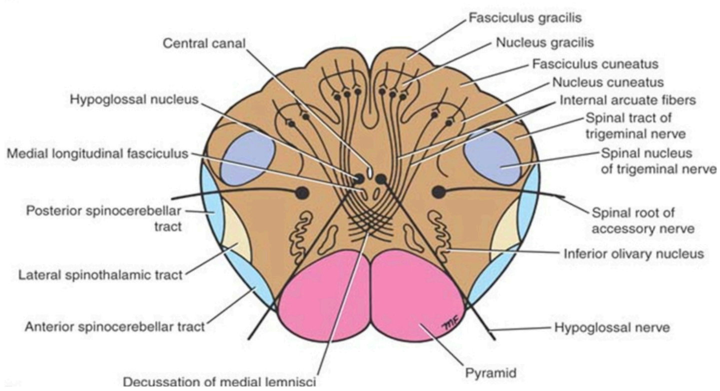
7. Anterolateral Tracts these include important pathways: Spinocerebellar Tract Carries information for motor coordination and balance to the cerebellum and Vestibulospinal Tract Helps control body balance and posture by regulating muscle activity and Rubrospinal Tract Involved in voluntary motor coordination and muscle regulation.

8. Central Canal: is a continuation of the spinal cord's central canal, filled with cerebrospinal fluid (CSF); It helps protect and maintain the chemical balance of the central nervous system.

Clinical Significance: Any lesion in this area could result in sensory loss on the opposite side of the body due to the crossing of sensory fibers; This level is crucial for understanding neurological disorders like spinal cord injuries or strokes affecting sensory pathways; It helps clinicians locate neurological damage based on sensory loss in specific body regions.

The image shows a cross-section of the brainstem at the level of sensory decussation. This section specifically focuses on the area of the medial lemniscus decussation, a major nerve tract that carries tactile, vibratory, and proprioceptive sensory information from the lower half of the body to the thalamus; Important details in the image:

Level of sensory decussation



Pyramid: The pinkish structure at the bottom of the image, representing a collection of descending motor fibers from the cerebral cortex. A portion of these fibers decussate at this level.

Decussation of medial lemnisci: The main focus of the image, where sensory fibers from the right side of the body cross over to the left side of the brain, and vice versa. This crossing allows for processing of sensory information in the opposite cerebral hemispheres.

Nucleus gracilis and Nucleus cuneatus: These nuclei are relay stations for ascending sensory fibers before they decussate in the medial lemniscus. The nucleus gracilis receives information from the lower half of the body, while the nucleus cuneatus receives information from the upper half.

Fasciculus gracilis and Fasciculus cuneatus: These tracts carry sensory information from the body to the nucleus gracilis and cuneatus, respectively.

Lateral spinothalamic tract: Carries sensory information about pain and temperature.

Anterior spinocerebellar tract and Posterior spinocerebellar tract: Carry sensory information from the body to the cerebellum.

Inferior olivary nucleus: Involved in regulating balance.

Hypoglossal nucleus: Controls the muscles of the tongue.

Spinal root of accessory nerve: Controls muscles of the neck and shoulders.

Central canal: A small canal in the center of the spinal cord.

Level of Olives (Open Medulla)

1. Inferior Part of the 4th Ventricle: This area is part of the open medulla, where it forms the floor of the 4th ventricle, It plays a crucial role in connecting the brainstem to various parts of the brain and spinal cord, as well as in motor functions and coordination.

2. Pyramids: contain the motor fibers that originate in the brain and descend through the brainstem, ultimately controlling voluntary motor movement; These fibers include the corticospinal tracts, which are responsible for fine motor control.

3. Inferior Cerebellar Peduncle (ICP): Located at the posterolateral corner of the medulla, the ICP connects the spinal cord and the cerebellum; It plays a role in balance, motor coordination, and conveying sensory information.

4. Medial Lemniscus: is a sensory pathway located behind the pyramids, carries fine touch, vibration, and proprioception (sense of body position) signals from the body to the brain.

5. Reticular Formation (RF): is a network of nerve fibers extending through the brainstem, involved in regulating alertness, consciousness, and motor control.

6. Spinal Nucleus of the Trigeminal Nerve and Its Tract: Located anterior-medially to the ICP, this nucleus is responsible for processing sensory information such as pain, temperature, and crude touch from the face, transmitted via the trigeminal nerve (Cranial Nerve V).

7. Cranial Nuclei of 12th, 11th, 10th, and 9th: These cranial nerve nuclei are situated within the medulla oblongata and control muscles responsible for speech, swallowing, and head movements; The relevant cranial nerves include: Hypoglossal (12th), Accessory (11th), Vagus (10th), Glossopharyngeal (9th).

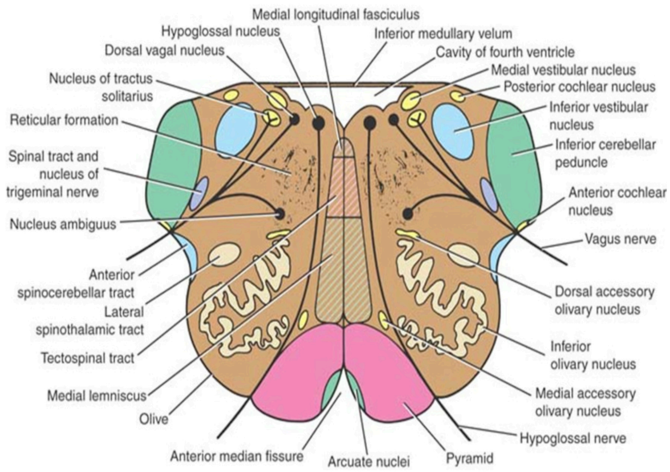
8. Inferior Olivary Nucleus: The inferior olivary nucleus is shaped like a crumpled bag and is located in the medulla, It is responsible for motor coordination and has connections with the spinal cord, cerebellum, and cortex.

9. Olive Nuclear Complex: consists mainly of the inferior olivary nucleus, plays a key role in the regulation of voluntary muscle movements, making it important for motor coordination and muscle function.

10. Medial Longitudinal Fasciculus (MLF): is a small nerve tract located along the midline of the brainstem, posterior to the medial lemniscus and anterior to the 12th nucleus, is composed mainly of ascending fibers that carry signals from the vestibular nuclei and cochlear nuclei to motor nuclei of cranial nerves (third, fourth, and sixth), which control eye movement.

11. Central Gray Matter: This region lies beneath the floor of the 4th ventricle and contains nuclei involved in a variety of important functions; The central gray matter is responsible for coordinating motor and autonomic functions through its connections with different nuclei such as: Hypoglossal nucleus (12th cranial nerve), Dorsal nucleus of the vagus (10th cranial nerve), Solitary nucleus (taste and visceral sensations), Vestibular nuclei (balance and coordination)

Clinical Significance: Lesions in this region can cause impairments in voluntary motor movement, balance, and coordination due to damage to the olivary nucleus, the cerebellum, or the pathways involving cranial nerves and Disruption of cranial nerve functions can result in difficulty with speech, swallowing, and muscle control and Understanding the anatomy of this area is essential for diagnosing and treating brainstem disorders, motor impairments, and coordination issues.



The image shows a cross-section of the medulla oblongata at the level of the olives. The olives are the olivary nuclei, located laterally on each side of the anterior median fissure. There are three main types of olivary nuclei at this level:

Inferior olivary nucleus: This is the largest and most prominent olivary nucleus in this section. It is located laterally on each side of the anterior median fissure and has a characteristic olive-shaped appearance. The inferior olivary nucleus is a crucial part of the motor system, sending signals to the cerebellum via olivocerebellar fibers. These signals are important for regulating and coordinating fine motor movements.

Medial accessory olivary nucleus: This nucleus is typically located within the inferior olivary nucleus and is smaller in size. Its function is similar to that of the inferior olivary nucleus, but its role is less clearly defined.

Dorsal accessory olivary nucleus: This nucleus is located slightly lateral to the inferior olivary nucleus and is smaller than both the inferior and medial accessory olivary nuclei. Its function is also related to the motor system, but its role is less well understood than the other olivary nuclei.

At this level, the olivary nuclei are surrounded by several other important structures, including: Pyramids Located anterior (ventral) to the olives, these are bundles of descending motor nerve fibers; Corticospinal tract Runs through the pyramids; Hypoglossal nucleus Located anterior to the olives; Nucleus ambiguus Located posterior to the olives; Ascending sensory tracts Run posterior to the olives.

Level Just Inferior to the Pons

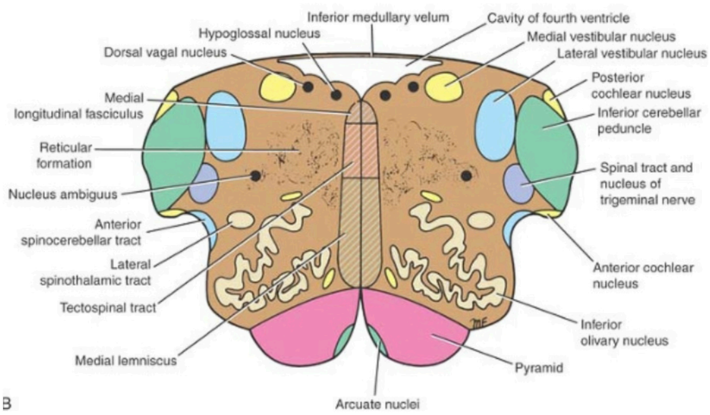
1. No Major Changes: At this level, no significant changes occur compared to the higher parts of the medulla; The structures remain generally similar, though some neural transitions may begin to gradually appear.

2. Lateral Vestibular Nucleus Replaces the Inferior Vestibular Nucleus: At this level, the lateral vestibular nucleus takes over the function of the inferior vestibular nucleus; The lateral vestibular nucleus plays an important role in maintaining balance and posture by regulating the adaptive movements required to stabilize the body's position.

3. Cochlear Nuclei Visible: The cochlear nuclei become visible on both the anterior and posterior surfaces of the inferior cerebellar peduncle; These nuclei are crucial for auditory processing, as they receive sound signals from the inner ear and process them before sending them to the brain for further interpretation.

Clinical Significance: Any damage or injury in this area can lead to balance and auditory disorders; Problems with the lateral vestibular nucleus could cause dizziness or difficulty in motor coordination, while damage to the cochlear nuclei may impair sound processing.

The image shows a cross-section of the brainstem at the inferior level of the pons. This section focuses on the transitional zone between the pons and the medulla oblongata, showing the intermingling of neural structures between these two regions; Important details at this inferior pontine level:



Pyramid: A portion of the pyramid is visible at the bottom of the image; it is a bundle of descending motor fibers from the cerebral cortex. This represents a continuation of the corticospinal tract.

Inferior Olivary Nucleus: Clearly shown in this section, it is a structure with a characteristic olive shape. This nucleus participates in the regulation and coordination of movement and sends signals to the cerebellum.

Cranial Nerve Nuclei: Portions of several cranial nerve nuclei are visible at this level, which overlap with the medulla oblongata, such as: Hypoglossal nucleus Controls the muscles of the tongue, Nucleus ambiguus Controls muscles of swallowing and the pharynx, Dorsal vagal nucleus Involved in regulating gastrointestinal functions.

Tracts: Numerous ascending and descending tracts pass through this level, including: Corticospinal tract The major pathway for voluntary movement and Spinocerebellar tract Carries sensory information from the body to the cerebellum and Spinothalamic tract Carries sensory information about pain and temperature and Tectospinal tract Carries visual and auditory information to the spinal cord and Medial lemniscu Carries sensory information about touch, pressure, and proprioception.

Reticular formation: A portion of the reticular formation is visible in this section; it is a complex network of neurons involved in many functions, including wakefulness, sleep, and respiration.

Fourth Ventricle: A portion of the fluid-filled cavity of the fourth ventricle is visible.

In my specialized field of neurosurgery, there may be times when boredom or mental fatigue sets in due to the constant pressure and complex challenges. To combat this, try to remind yourself of the bigger goal behind every surgery and every patient you treat. Every step you take contributes to improving a patient's life, which serves as a great motivation to keep going.