

Physiology of brainstem

Resource: Dr.Hayam Gad's lecture, 2016

It includes 98% of the lecture's content.

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Brainstem	Midbrain → Pons → Medulla oblongata		
Midbrain (TeTeCe)			
	1- Tectum	2- Tegmentum	3- Cerebral Peduncle
	<p>A- <u>Superior colliculus</u>:</p> <ul style="list-style-type: none"> - Center for visual reflexes. - Sends its superior brachium to the lateral geniculate body of thalamus. * Optic nerve fibres from the eyes terminate at LGN. <p>B- <u>Inferior colliculus</u>:</p> <ul style="list-style-type: none"> - Auditory pathway. - Sends its inferior brachium to the medial geniculate body of thalamus - The cerebral aqueduct runs through midbrain, beneath to the colliculi. 	<ul style="list-style-type: none"> - Ventral to the cerebral aqueduct. - Contain several nuclei, tracts & reticular formation 	<ul style="list-style-type: none"> - The ventral side of midbrain is comprised of paired Cerebral Peduncles. These transmit axons of Upper Motor Neuron (UMN)
Midbrain internal structures			
Nucleus of:	Oculomotor N (III), Trochlear N (IV)		
Periaqueductal Gray	Around the cerebral aqueduct , contains neurons involved in the pain desensitization pathway.		
Red nucleus	Motor nucleus, sends a descending tract (Rubrospinal T)		
Substantia Nigra	A concentration of neurons in the ventral portion of midbrain that involved in Motor Function .		
Central tegmental tract	Directly anterior of the 4th ventricle , this is a <u>pathway</u> by which many tracts project up to the cortex & down to the spinal cord.		
Reticular formation	<p>Large area involved in various imp functions of midbrain:</p> <ul style="list-style-type: none"> - contain lower motor neurons (LMN) - pain desensitization. - Arousal & consciousness syst. - contain Locus ceruleus → involved in intensive alertness modulation in autonomic reflexes. 		
Pons			
<ul style="list-style-type: none"> - At the level of midpons → Trigeminal n (V) emerges. - Bet the basal pons, abducens n (VI), Facial n (VII) & Vestibulo-cochlear (VIII) emerge (Medial to lateral). 			
Medulla Oblongata			
Ventral view	<ul style="list-style-type: none"> - The most medial part of the medulla us → Anterior median fissure. (AMF) - Lateral to AMF → Pyramids contain fibers of pyramidal tract (corticospinal). - The anterolateral sulcus is lateral to the pyramids, emerging from them hypoglossal nerve (XII) rootlets. - Lateral to the anterolateral sulcus are the olives containing underlying inferior olivary nuclei & Afferent fibers. - Lateral (& dorsal) to the olives are the rootlets for glossopharyngeal (IX) & Vagus (X). 		
Dorsal view	<ul style="list-style-type: none"> - The most medial part of medulla is the posterior median fissure. (PMF) - Laterally to PMF → Fasciculus gracilis, lateral to it → Fasciculus cuneatus, superior to each fasciculus → gracile & cuneate tubercles (nuclei) - In the midline of the vagal trigone & superior to that is the hypoglossal trigone, underlying each of these are motor nuclei for the respective cranial nerves. 		

Functions of brainstem	
1- Conducting functions. 2- Provide the origin of cranial nerves (3 rd to 12 th) 3- Conjugate eye movement. 4- Integrative functions.	
1- Conduct functions	<ul style="list-style-type: none"> - All information related from the body to the cerebrum & cerebellum and vice versa, most transverse brainstem. A- <u>Ascending sensory pathways</u> → Spinothalamic tract, Dorsal columns. B- <u>Descending tracts</u> - Corticospinal tract → runs through crus cerebri (basal peduncle) , basal part of pons & medulla pyramids; 70-90% of fibers cross in pyramidal decussation to form the lateral corticospinal tract, synapse on LMN in ventral horn of spinal cord. - Upper motor neurons that originate in brain stem's vestibular, red, & reticular nuclei, which also descend & synapse in SC.
2- origin of cranial nerves	<ul style="list-style-type: none"> - provide the main motor & sensory innervation to the face & neck via cranial nerves (III-XII) either originate from, or terminating in, the cranial nerve nuclei in the brainstem. - <u>From Midbrain:</u> III (oculomotor) & IV (trochlear) → both move eyes, III constrict the pupils & accommodates. - <u>From Pons:</u> V (trigeminal) → chews & feels the front of the head. VI (abducens) → Moves eyes VII (facial) → moves the face, taste, salivates, cries (lacrimal glands) VIII (acoustic or vestibule-cochlear) → Hear, regulate balance. - <u>From Medulla:</u> IX (glossopharyngeal) → Taste, salivates, swallow, monitor carotid bodies & sinus. X (Vagus) → Taste, Swallows, lifts palate, talk, communication to and from thoraco-abdominal viscera. *بعض المصادر تقول إن بداية الفم (بوستيريير) مسؤول عنها الفيس للتذوق، وبعض المصادر تنفيه. XI (accessory) → Turns head, lifts shoulder. XII (hypoglossal) → Moves tongue.
Classification of the cranial nerves according to functions	
	<ul style="list-style-type: none"> - <u>Sensory:</u> I + II + VIII - <u>Motor:</u> III + IV + VI + XI + XII (III, IV, VI → eye movement) - <u>Mixed:</u> V + VII + IX + X
3- Conjugate eye move.	<ul style="list-style-type: none"> - Motor coordination of the eyes that allows bilateral fixation on a single object. (شرح للصورة الموجودة في سلايدز د. هيام) مثلاً أنت بتشوف للجهة اليمنى، تنتشط عندك ال FEF (frontal eye field) وترسل سيالات عصبية لـ PPRF (paramedian pontine reticular formation) بعدين راح ترسل سيالات عصبية بواسطة ال VI لجهتين، وحدة للعين اليمنى عشان تنتشط ال lateral rectus (تعتبر contralateral to FEF) وإشارة ثانية تمر بالعصب III للعين اليسرى لعضلة Medial rectus (تعتبر ipsilateral to FEF) في نفس الوقت، عشان يُحافظ على التوازن، نفس العصب VI يرسل إشارة تمر بالعصب III للعين اليمنى للعضلة medial rectus ويثبط عملها. وإشارة مثبتة ثانية لل Lateral rectus للعين اليسرى عشان يثبط عملها. عضلة medial rectus جاي لها III ، أما ال Lateral rectus هو VI

4- Integrative functions	<ul style="list-style-type: none"> - Control consciousness & sleep cycle (alertness and arousal) through reticular formation. - Has center of cardiovascular, respiratory & ANS. - Centers of cough, gag, swallow, & vomit. - Sense of body balance (by VIII) - Substantia nigra → part of basal ganglia, present in midbrain → involved in control of movement. - Midbrain contain Red nucleus → regulate the motor activity through cerebellum. - Inferior & superior colliculi are situated on the dorsal surface of the midbrain → involved in auditory & visual processing respectively. - Pain sensitivity control: Periaqueductal grey matter of mesencephalon (midbrain) is an area rich in endogenous opioid and is important in modulation of pain stimuli.
Functional organization of brainstem	
Ventral layer	Motor function.
Middle layer	Sensory function, contain medial lemniscus.
Function of Midbrain	
<ul style="list-style-type: none"> - Nerve pathway to cerebral hemispheres. - Auditory & visual reflex centers. - Cranial nerves: <ul style="list-style-type: none"> - III (Oculomotor) → Motor → related to eye movement. - IV (trochlear) → Motor → superior oblique muscle of the eye which rotates the eye down & out. (the only extraocular muscle supplied by IV) 	
Signs & symptoms of midbrain lesion	
<ul style="list-style-type: none"> - Cranial nerve deficits: Ipsilateral III, IV palsy and ptosis (drooping) - Pupils: <ul style="list-style-type: none"> - Size: Midposition to dilate. - Reactivity: Sluggish to fixed. - Movement: Abnormal extensor. - Respiratory: Hyperventilation. - LOC (loss of consciousness) → varies. 	
Functions of pons	
<ul style="list-style-type: none"> - Respiratory center. - Cranial nerves: <ul style="list-style-type: none"> - V (trigeminal) → motor & sensory → Skin of face, tongue, teeth; muscle of mastication) - VI (abducens) → motor → lateral rectus muscle of eye → rotate eye outward. - VII (Facial) → motor & sensory → Muscle of facial expression, taste. - VIII (acoustic) → sensory → hearing & balance. 	
Signs & symptoms of pons lesion	
<ul style="list-style-type: none"> - Pupil size → Pinpoint = constricted. - LOC: Semi-coma. - Movement: Abnormal extensor. - Respiratory: <ul style="list-style-type: none"> - Apneustic (abnormal respiration marked by sustained inhalation) - Hyperventilation. 	

Functions of medulla oblongata

- Crossing of motor tracts.
- Cardiac center.
- Respiratory center.
- Vasomotor center (nerves control blood vessel wall muscles)
- Centers for cough, gag, swallow, & vomit.
- Cranial nerves:
 - **IX** (glossopharyngeal) → mixed → muscles & mucous membrane of pharynx, the constricted openings from the mouth & the oral pharynx & taste of posterior 1\3 of tongue.
 - **X** (vagus) → mixed → pharynx, larynx, heart, lungs, stomach, speech.
 - **XI** (Accessory) → motor → rotation of head and shoulder.
 - **XII** (hypoglossal) → motor → intrinsic muscles of the tongue.

Signs & symptoms of medulla lesions

- Movement: Ipsilateral paralysis.
 - if the lesion found under the crossing → ipsilateral.
 - if the lesion found above the crossing → contralateral.
- Pupils:
 - Size: Dilated. حتى لو سلطنا عليها ضوء بتبقى متوسعة.
 - Reactivity: Fixed.
- Respiratory: Abnormal breathing patterns.
- CN palsies: Inability to control movement.
- Absent of cough and gag.
- LOC: comatose.

Brainstem function tests

Reticular formation	Alertness, Consciousness & sleep.
Corticospinal tract	Motor power, reflexes.
Pain response	Facial grimacing in firm pressure over the supra orbital ridge.
Respiratory centers	Look for normal pattern of respiration.
Cardiovascular center	Look for normal circulatory function.
Brainstem reflexes	<ul style="list-style-type: none"> - Pupillary & corneal reflexes. - Vestibu-ocular reflexes: injection of iced water into the ear will produce eye movement. - Oculo-cephalic reflexes: Eyes will be fixed when head is moved in one or another directions. - Gag reflex. - Cough reflex.

Good luck! ^^

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