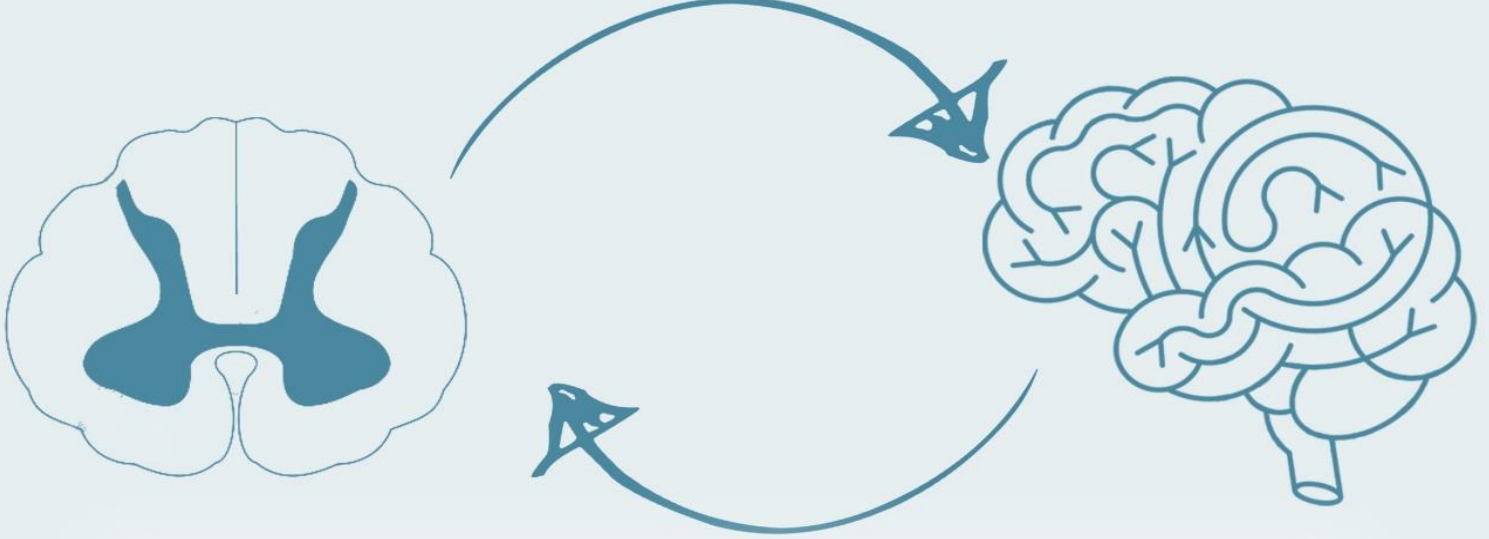




CNS

Anatomy

0 slides

0 sheets

▶ number

Lec#10 – Part 2

▶ Done by

Dawood Alatefi

▶ Correction

Mariam Hassouneh

▶ Doctor

Dr.Mohammed Al-Salem

This part's record is found on the Batch's channel as "LabA.3", starting from 0.00min until 26.20min. Hope this'll be an easy part on you; Take a deep breath :D

In this sheet we'll talk about ins and outs of the Last 4 cranial nerves:

1. Their emergence from the brain stem until reaching their exit to head and neck.
2. Their related nuclei which give unique fibers specific for each nucleus
3. The Intracranial "inside the skull", and -to a lesser extent- Extra cranial course.
4. The distribution of the fibers and their destinations whether motor or parasympathetic supply; afferent general or special sensation.

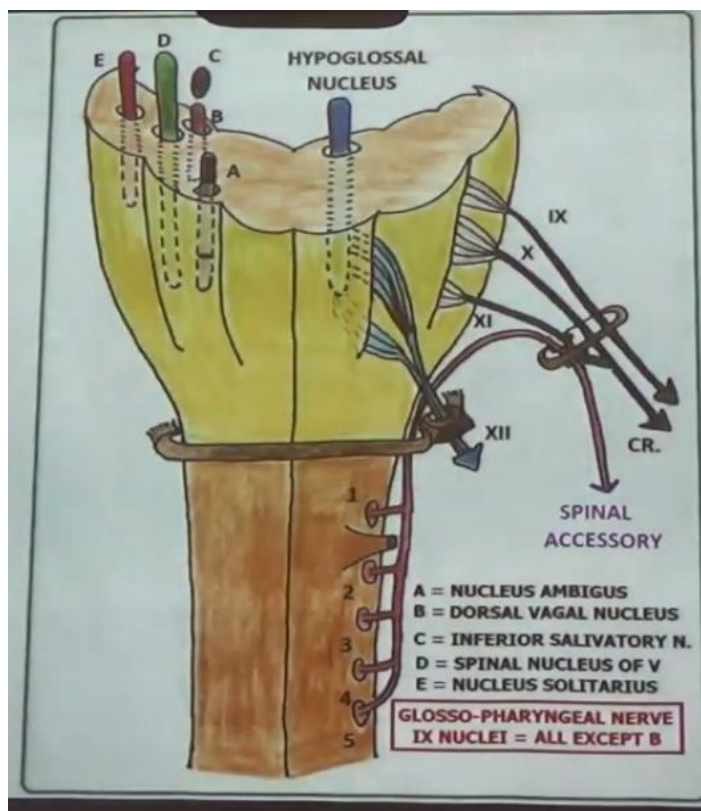
----- *Note: Anatomy atlas in the last page is for need :D*

Back in the old days: We'll first have to remind you with the places of birth!

Last four cranial nerves all emerged from medulla oblongata, the 9th, 10th, and -cranial root- of 11th cranial nerves emerged from the fissure between the olive and the posterior cerebellar peduncle "postero-lateral fissure", while the 12th - last cranial nerve- emerged from the fissure between the olive and the pyramid medially "antero-lateral fissure". They had all a special feature that distinguished them from the rest of the cranial nerves; they didn't emerge as a "single string خيط" but they emerged as many, these are what we called "ROOTLETS". (Figure 1)

You can see here as well the most important nuclei we'll talk about today!

Figure 1: Anterior view in Medulla oblongata and first part of spinal cord



Glossopharyngeal Nerve (IX C.N.)

Glossopharyngeal nerve is a motor and sensory nerve. It emerged as we took in Lab#1 from the Anterolateral surface of the upper part of the medulla oblongata in a Groove between the olive and the inferior cerebellar peduncle “postero-lateral fissure”. It then traveled all the way until it left the cranial cavity with 10th and 11th C.N.s through the Jugular foramen. (See Figure 1 please)

- Glossopharyngeal nerve nuclei (Figure 2):

The glossopharyngeal nerve has 4 nuclei: (1) main motor nucleus, (2) parasympathetic nucleus, (3) general sensation nucleus, and (4) Special sensation of taste nucleus.

Hint: it shares 3 nuclei “1+3+4” with Vagus!

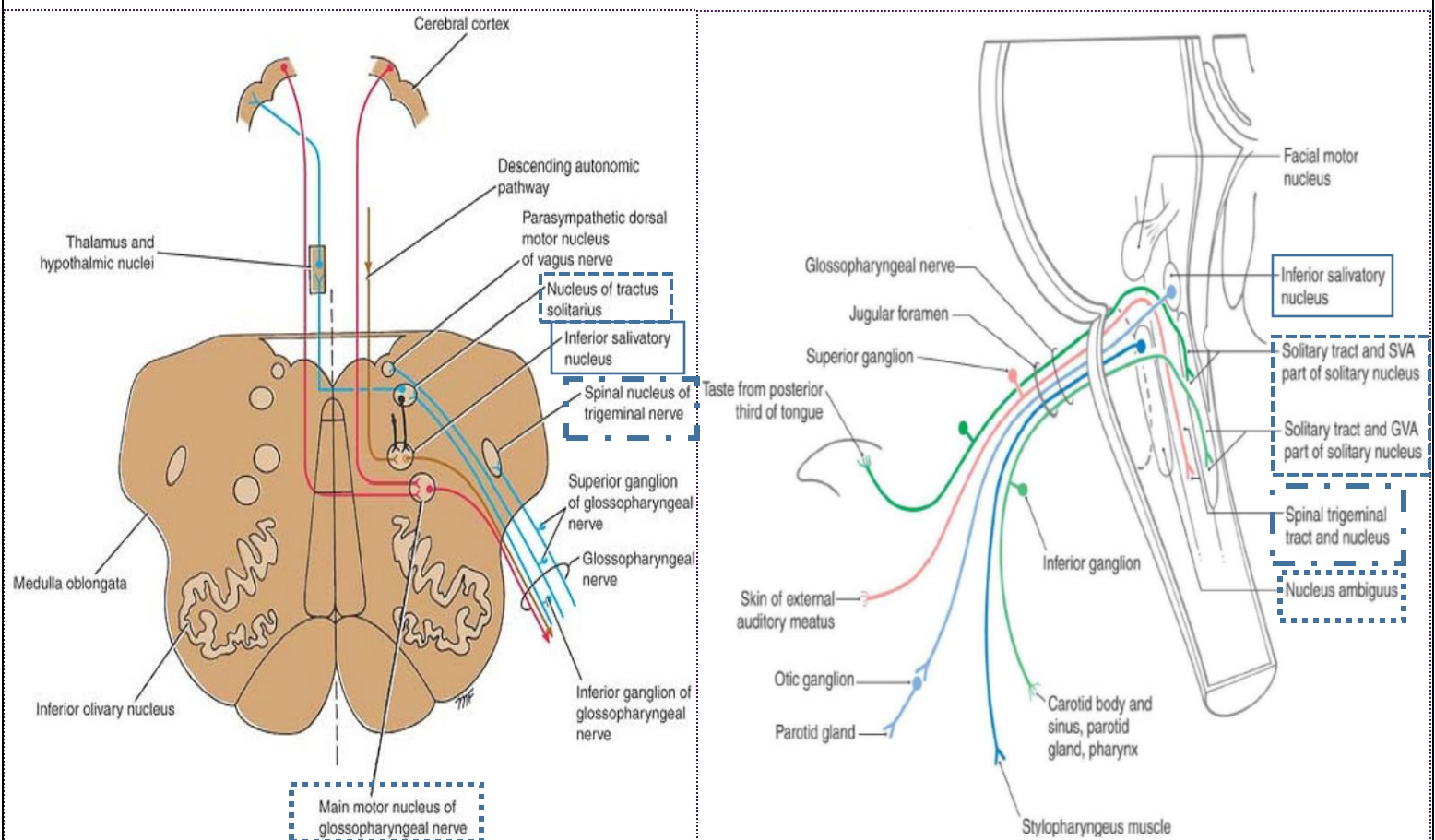


Figure 2: Sections in the brainstem at the level of the 4th ventricle; Nuclei of IX nerve.

Left: X-Section, Right: Sagittal section

In the figure: SVA; special visceral sensation, GVA; general visceral sensation

Note: ALL will be explained later, just take a fast look, then refer after wrapping up the whole part.

1. Main motor nucleus “Of Nucleus Ambiguus”

The main motor nucleus of IX lies deep in the reticular formation of the medulla oblongata and it forms the superior end of the nucleus ambiguus. It receives corticonuclear “Cortex to Nuc. Amb.” fibers from **both** cerebral hemispheres. The efferent fibers supply **Stylopharyngeus muscle ONLY**.

2. Parasympathetic nucleus “Inferior salivatory nucleus”

Parasympathetic Nucleus of the glossopharyngeal nerve is **inferior** salivatory nucleus, which is posterior to nucleus ambiguus in the section (figure1), it supplies the **parotid gland** and it receives afferent fibers from the **hypothalamus**.

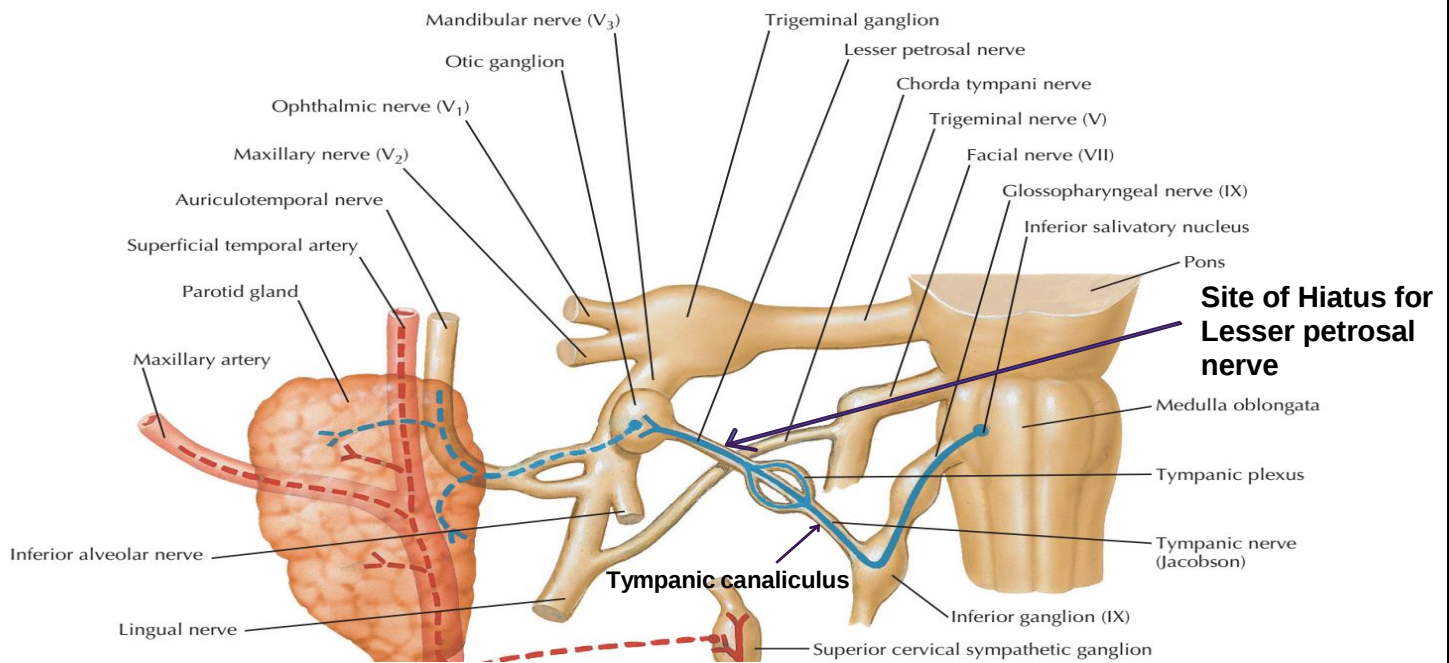


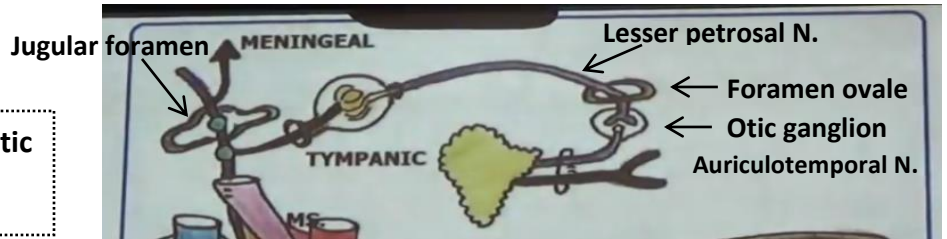
Figure 3: Pathway of parasympathetic fibers of IX nerve

PLEASE Remember that: the superior salivatory and lacrimal nucleus was for the facial nerve VII which supplies the submandibular and sublingual glands; also remember that the facial nerve pass through the parotid gland but do not supply it. Last remember P: remember that three cranial nerve leave the skull through jugular foramen which are 9th, 10th, and 11th CNs.

After the 9th leaves the skull through jugular foramen, it'll reach its own two **ganglia** “cell bodies in PNS”, both of them are **sensory** (superior and inferior glossopharyngeal sensory ganglia; they receive two types of sensation; will be discussed more later). Since they're both sensory, we can conclude that **no autonomic synapsis will ever happen there** (i.e.: the preganglionic parasympathetic fibers بمرور الكرام). Almost at the level of inferior ganglion there is a branch called tympanic branch, which contains the preganglionic parasympathetic fibers, which through tympanic canaliculus (small canal in the temporal bone) go back to the skull to the cavity of the middle ear where it meets tympanic plexus and gives it a branch called **LESSER petrosal N.**

So until now: Preganglionic Parasympathetic fibers traveled through the tympanic branch of the glossopharyngeal nerve, to the tympanic plexus, and then as the lesser petrosal nerve.

Tiny figure 4: pathway of parasympathetic fibers of IX



Now the efferent **preganglionic** parasympathetic fibers of lesser petrosal N. will then travel until it leaves the cavity of the middle ear through Hiatus for lesser petrosal which is a passage between the middle ear and the middle cranial fossa, so the lesser petrosal will reach to the middle cranial fossa “inter the skull” and it will leave the middle cranial fossa again “exit the skull” through foramen ovale which is a passage between the middle cranial fossa and infratemporal fossa. (Another structure leaves through the foramen ovale, which is the mandibular branch of trigeminal nerve). In the infratemporal fossa it will face **OTIC** ganglion (parasympathetic ganglion) which is its synopsis site with the post ganglionic fibers. (Figure 4)

There in the otic ganglion there will be a synopsis between the preganglionic lesser petrosal and postganglionic fibers. The postganglionic fibers go with a branch of the mandibular nerve called auriculotemporal nerve which does not contain parasympathetic fibers bet it receives parasympathetic from the lesser petrosal. (remember when we talked about the trigeminal nerve, we said that it has 3 sensory nuclei and one motor but no parasympathetic, but now you know that it receives parasympathetic fibers from the lesser petrosal). Now it will go with the auriculotemporal nerve, which is covering the skin of the parotid gland and supplying the parotid gland, so the parasympathetic innervation of the parotid gland is from glossopharyngeal nerve through the lesser petrosal. (Figure 3)

Remember that: Greater petrosal N. is → Preganglionic parasympathetic of Facial N. Lesser petrosal N. is → Preganglionic parasympathetic of Glossopharyngeal N.	Remember that Parasympathetic ganglia in the head and neck area are: 1) Ciliary ganglion→ orbit 2) Pterygopalatine ganglion→ Pterygopalatine fossa 3) Submandibular ganglion 4) Otic ganglion→ infratemporal fossa
---	--

Small reminder: Even though facial nerve inters the parotid and gives its branches through it, it didn't supply it!

3. Special Sensation nucleus “Of Tractus solitarius”:

The special sensation of the glossopharyngeal nerve is **taste** from the **posterior one third of the tongue**.

Remember that you're tracing a nerve for sensation so our pathway will start from the organ itself!

The afferent fibers “peripheral processes” go with the glossopharyngeal nerve toward the brainstem, with their cell bodies situated in the **inferior glossopharyngeal ganglion** (as do the vagus with its ganglia, the inferior ganglion is always for taste and visceral sensation).

The central processes of these cells synapse with 2nd order neuron's cells bodies in the middle part of **nucleus of the tractus solitarius** (underneath the floor of the 4th ventricle, remember the order from medial to lateral: hypoglossal nucleus → dorsal vagal nucleus → nucleus of tractus solitarius → nucleus ambiguus ; figure 1). The pathway ends in the lower part of the postcentral gyrus “**remember**: it's like a flipped man; the head and face are represented in the lower part of primary somatosensory cortex”.

The nucleus of the tractus solitarius is concerned with taste and visceral sensation, from there comes the close relation of **IX** with the carotid sinus. Remember the story of common carotid artery and how it bifurcates at the upper border of thyroid cartilage?? At this bifurcation you'll find a dilation, which is what we call “carotid sinus”. Afferent **visceral** impulses are carried from the carotid sinus, which is filled with baroreceptors situated at the bifurcation of the common carotid artery, through a branch of the glossopharyngeal called the **carotid sinus nerve**. This branch's cell body will “for sure” be found in the **inferior glossopharyngeal ganglion** and its relay station “where it synapses with 2nd order neuron” is again in the **nucleus of tractus solitarius**.

This should “or might not :P” remind you with something called carotid sinus **REFLEX**.

Physiologically, when the blood pressure increases there will be activation of these baroreceptors; in this case the afferent limb “process” will be from the glossopharyngeal nerve, while the efferent would be of the vagus -by the dorsal vagal nucleus which is parasympathetic; by that, Vagus nerve will give parasympathetic to lower the blood pressure. (This is used clinically in severe tachycardia, where they do massage تدليك to the carotid sinus to press on it like a fake pressure to stimulate this reflex, but beware that pressing **must not be bilateral**, why?? to avoid severe bradycardia or shock.)

- Small info: in martial arts “not sure which one”, there's a “finish-him” move where they hit a specific part of the neck corresponding deeply to carotid sinus area, so the other fighter's body will initiate the reflex and he'll shortly fall after that strike.

This is all about the visceral sensory.

4. General Sensation nucleus “Of Spinal nucleus of trigeminal”:

There is also general sensation. The external auditory meatus, middle ear, mucosa of the pharynx (oro- and laryngo- pharynx) - the nasopharynx is supplied by branch from the maxillary nerve of trigeminal system), and posterior one third of the tongue (general sensory beside taste). Fibers from all of these sites are collected together, with their cell bodies being in the **superior Glossopharyngeal ganglion**. The nucleus for them is **the spinal nucleus of trigeminal** (Remember that: *this nucleus also gives general sensory for 5th, 9th, and 10th CNs which have general sensory*)

****Notice that there's no special nucleus of general sensation for glossopharyngeal N.**

Always remember: Superior G.Pharyngeal ganglion receives the fibers of general sensation, and the inferior G.pharyngeal ganglion receives the visceral sensation and taste

Now, you can get back if you wish to figure 2 to see the fibers and corresponding nuclei, and to the amazing figure below as a summary!

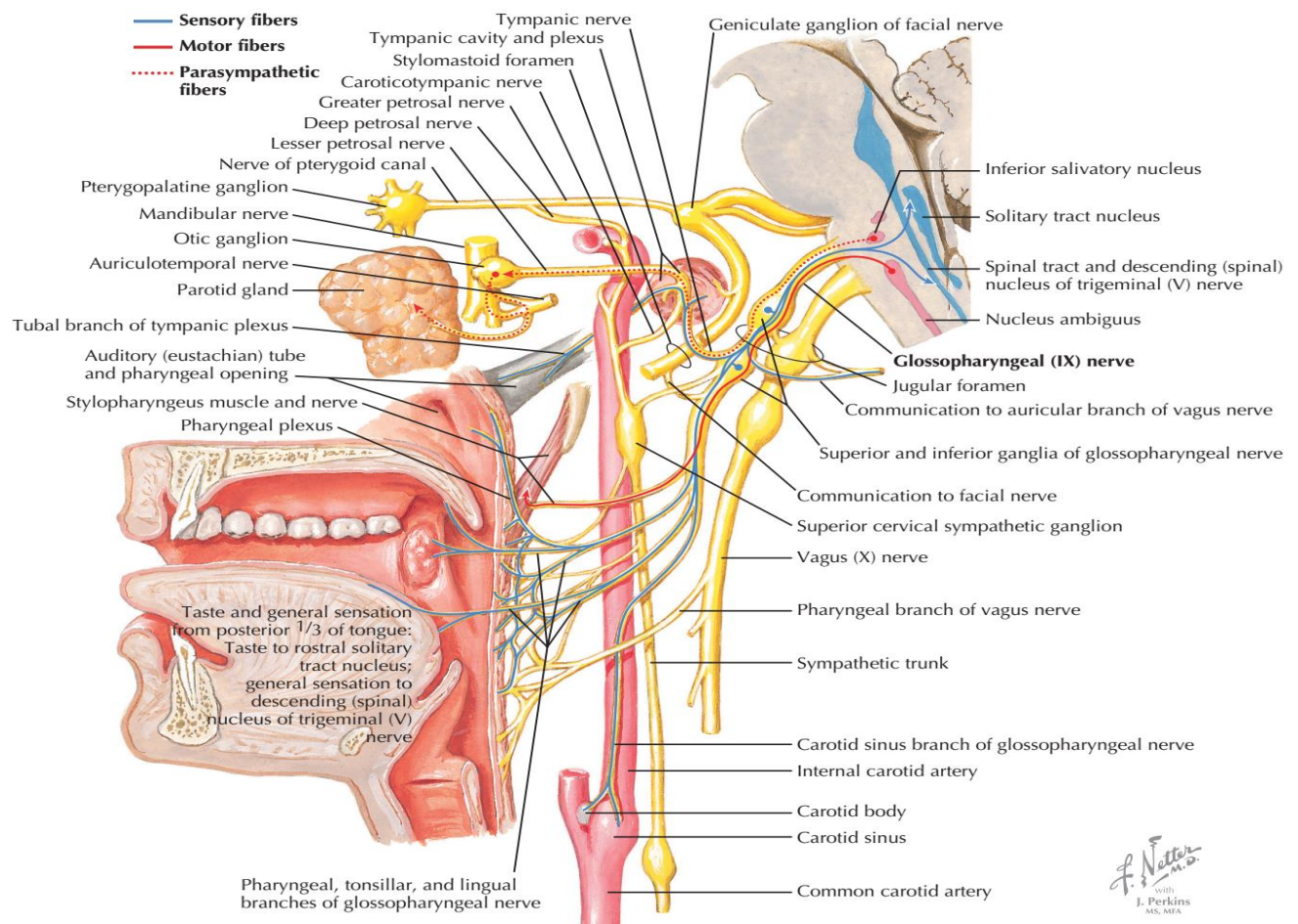


Figure 5: summary of sensory and motor distribution of IX nerve

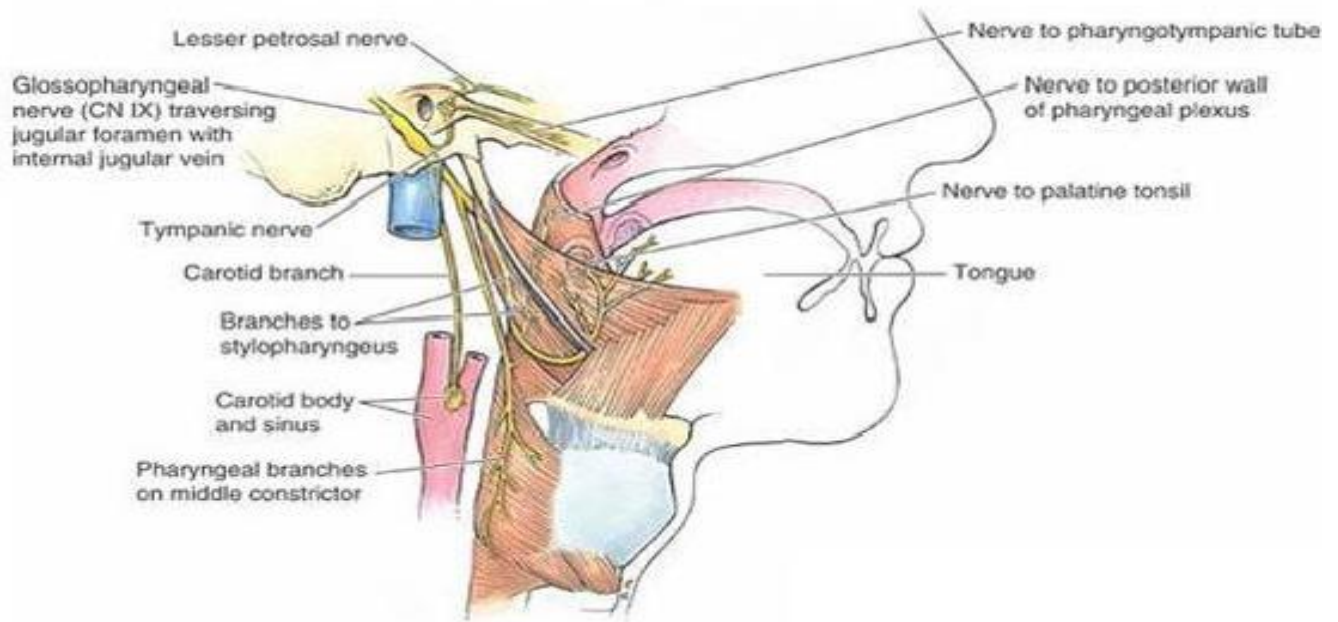


Figure 6: The Extracranial course of **IX** nerve; for “**reading and enjoying only**”!!

In the slides: **IX** leaves the skull through the jugular foramen; Travels on the Posterior border of the stylopharyngeus muscle “and supplying it” between the superior and middle constrictors.

- Another reflex attributed to **IX** is called **GAG reflex** (الاستفراغ أو التقيؤ):

If you tried to put your finger on the roof of your mouth to get a stuck foreign body you suspected its there, there’ll be a site where you’ll touch and immediately cough or vomit. The Afferent nerve in this case is Glossopharyngeal nerve (C.N. **IX**), while the Efferent is Vagus nerve (C.N. **X**)

You can clearly now conclude that if there is a **lower motor neuron lesion** for the glossopharyngeal, these **reflexes will be lost**. Also, in areas targeted by its fibers, there’ll be **loss** of taste, common sensation, and motor supply carried by the 9th C.N.

To sum up: if you got back to “figure2; right” you’ll be able to observe all modalities with the nuclei they belonged to in brain stem. Plus, some notes:

1. Stylophayngeus muscle nerve being the only one travelling from the upper part of nucleus ambiguus where we can find its cell body.
2. Parasympathetic fibers getting out of inferior G.Pharyngeal ganglion “to reach the Otic ganglion for synapsis, then to stuff themselves in the sheath of auriculotemporal nerve which is a branch of mandibular of trigeminal”
3. Fibers taking general sensory from skin of external auditory meatus will have their cell bodies located in the superior ganglion “Remember: Taste and visceral sensation in inferior ganglion”.

0.00min-11.45min/ Slides covered “1-9”

Vagus Nerve (X CN)

As do the 9th and 11th cranial nerves, the vagus (10th) nerve also leaves the brainstem between the inferior cerebellar peduncle and olive, but in a lower level than the 9th (Figure 1).

- Vagus nerve nuclei (Figure 7):

Vagus nerve has 4 nuclei: (1) main motor nucleus, (2) parasympathetic nucleus, (3) general sensation nucleus, and (4) Special sensation of taste nucleus.

Before we start, remember that it has shared 1+3+4 with glossopharyngeal!!

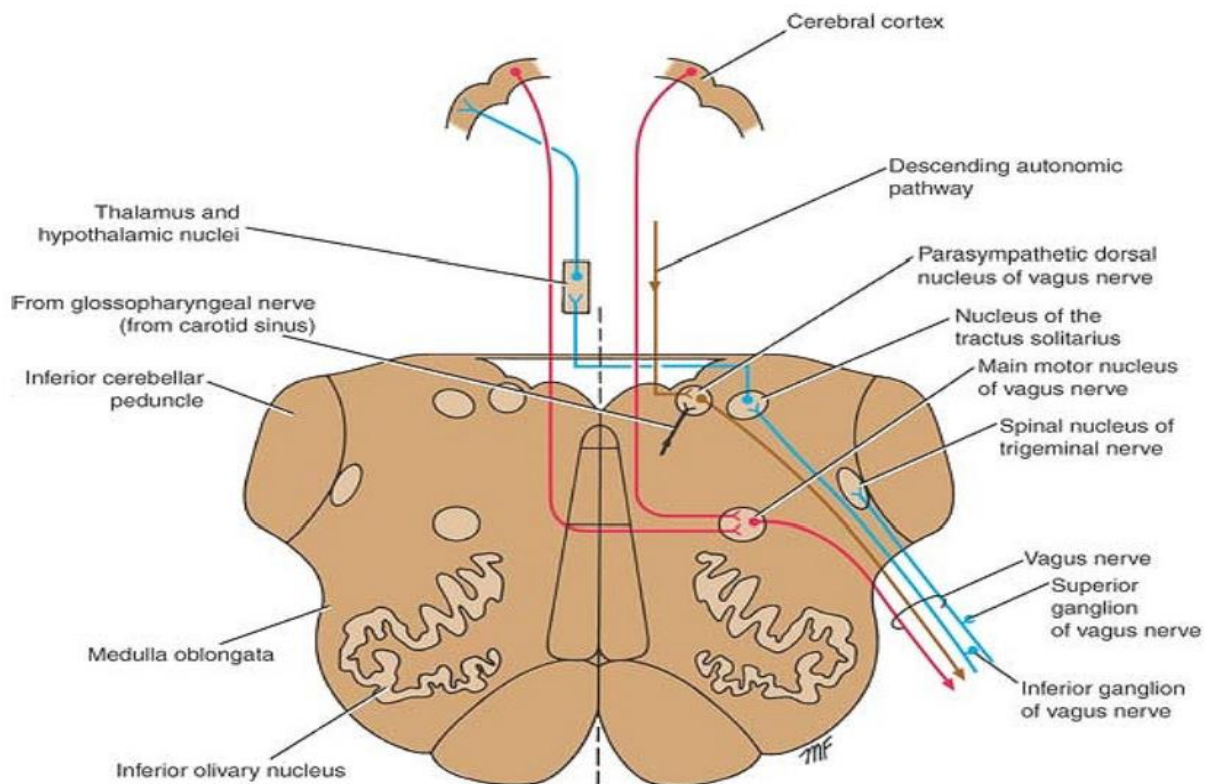


Figure 7: X-section in medulla oblongata at the level of the 4th ventricle; Vagus nuclei

1. Main motor nucleus “Of Nucleus ambiguus”:

The main motor nucleus lies deep in the reticular formation of the medulla oblongata. The vagus nerve is the only C.N. which leaves the cranial cavity and continues downward in head and neck area “Vagus continues mainly for the parasympathetic component; remember reaching G.I.T and thorax”. Vagus nerve has a motor component which supplies the constrictor muscles of **pharynx** (Except stylopharyngeus; 9th), intrinsic muscles of **larynx**, and muscles of the **soft palate** (Except tensor veli palatini → mandibular nerve of trigeminal system).

2. Parasympathetic nucleus “Dorsal vagal nucleus”:

Preganglionic parasympathetic fibers start from **dorsal vagal nucleus** (A.K.A: parasympathetic nucleus of vagus nerve) which is present in the central gray matter underneath the floor of the lower part of 4th ventricle. The preganglionic fibers go with the distribution of the vagus nerve which is very long course, where it goes **vertically** through the carotid sheath between the carotid A. and the jugular V.; then goes through the thorax behind the hilum of the lungs; then to the abdomen to continue as far as the distal one third of the transverse colon. So, it gives parasympathetic stimulation to the viscera of the thorax, viscera of the abdomen. “Remember that after all: left Vagus’ course is not identical to right Vagus”

3. Special sensation nucleus “Of tractus solitaries”:

The sensory nucleus is the **lower** part of the nucleus of the tractus solitaries “by that we end it”

The vagus nerve receives taste from **taste buds on the epiglottis**. The vagus leaves through the jugular foramen, and it also has two ganglia after it leaves the jugular foramen like 9th C.N., which are superior and inferior ganglia of vagus. The **inferior** contains the cell bodies of the taste fibers, and these fibers’ relay station in the brainstem is the same as 9th CN (Nucleus of tractus solitarius)

Remember: The Three cranial nerves receiving taste (Figure 8):

- 1) Anterior 2/3 of the tongue → facial nerve via corda tympani
- 2) Posterior 1/3 → glossopharyngeal
- 3) The epiglottis → Vagus

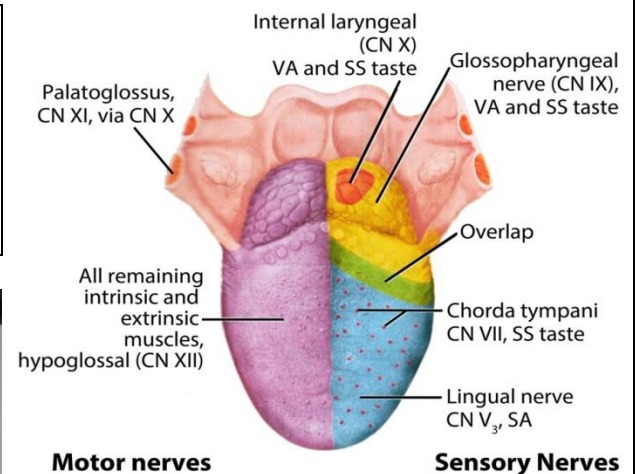
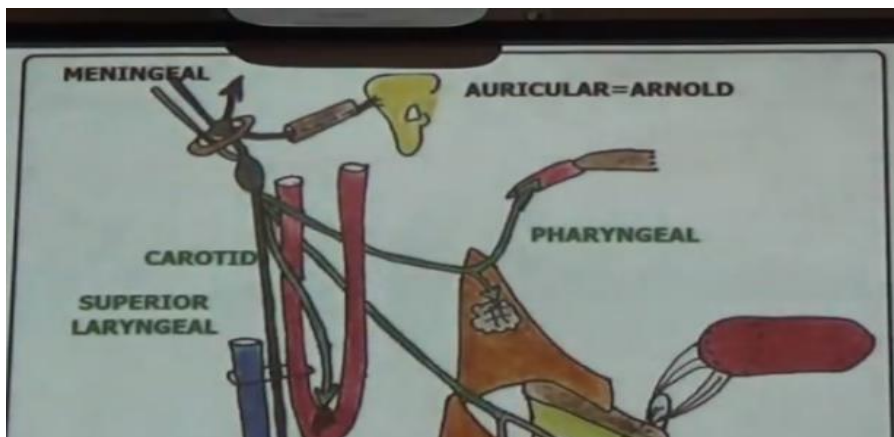


Figure 8: Motor and sensory innervation of the tongue

Figure 9: Superior part of Vagus N. Extracranial distribution; meningeal N. and superior and inferior ganglia can be seen.

4. Common (general) sensation nucleus “Of spinal nucleus of Trigeminal”:

Vagus receives from most of the **outer ear, mucosa of the larynx** (above the vocal cords from internal laryngeal and below from recurrent laryngeal, both of which are from vagus nerve), and **dura of the posterior cranial fossa** (by a branch called meningeal branch of vagus nerve; remember that dura mater is sensitive to stretch; Figure 9). The cell bodies of these fibers are in the superior ganglion and the relay station is the spinal nucleus of trigeminal nerve.

That's all for sensory.

An important NOTE: Nucleus ambiguus is a →motor nucleus in the brainstem which receives efferent from the two cortices. This was the general rule, and the only exceptions in Snell text book were the lower part of face and genioglossus muscle, which received from the contralateral side. There is a report, however, that the Uvula also receives from the opposite side (contralateral).

- In lower motor neuron lesions in the vagus:

1) The **Uvula** deviates to the healthy side because there will be more tension “pulling due to normal contraction of Musculi Uvuli” from the healthy side than the affected side and so the result will be **deviation toward the healthy side**.

2) *Hoarseness* of the voice: in the case of surgery of the thyroid “thyroidectomy”, this could happen because of injuring the recurrent laryngeal nerve that supplies the vocal cords “it’s very close to thyroid gland”.

3) Dysphagia in case of lesions in the vagus causing nasal regurgitation ارتجاع “supply to muscles of the pharynx is gone”.

Normally there is elevation in the soft palate In case of swallowing, where closing of the nasopharynx by the oropharynx prevents the food from going to the nasopharynx. If this mechanism got disrupted, this elevation is now not functioning, causing food to go up to the nasopharynx.

4) Arrhythmias in the heart, due to Sympathetic tone now taking over the heart rhythm.

5) Irregularities in the GI.

4 and 5 happen because the vagus gives parasympathetic to the viscera of the thorax and the abdomen.

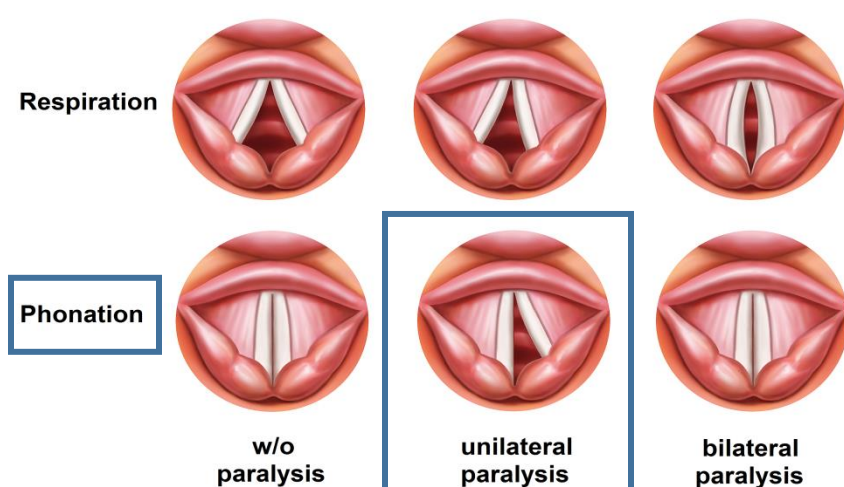
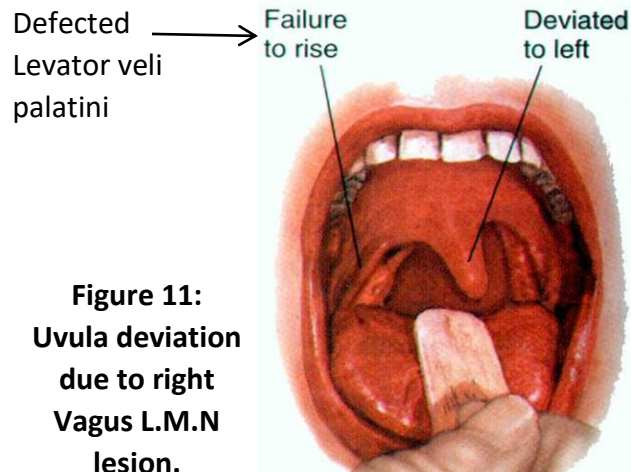


Figure 10: Cases of R.L.N. injury; hoarseness of voice



**Figure 11:
Uvula deviation
due to right
Vagus L.M.N
lesion.**

From the slides:

- Parasympathetic ganglia receive afferents from: Hypothalamus, and glossopharyngeal nerve (in carotid sinus reflex).” Figure 7”

It sends efferent to involuntary muscle of the bronchi, heart, esophagus, stomach, small intestine, and large intestine as far as the distal one-third of the transverse colon.

- After synapsing with nucleus of tractus solitaries, 2nd order neurons go to thalamus, and then 3rd order neurons ascend until reaching post central gyrus.

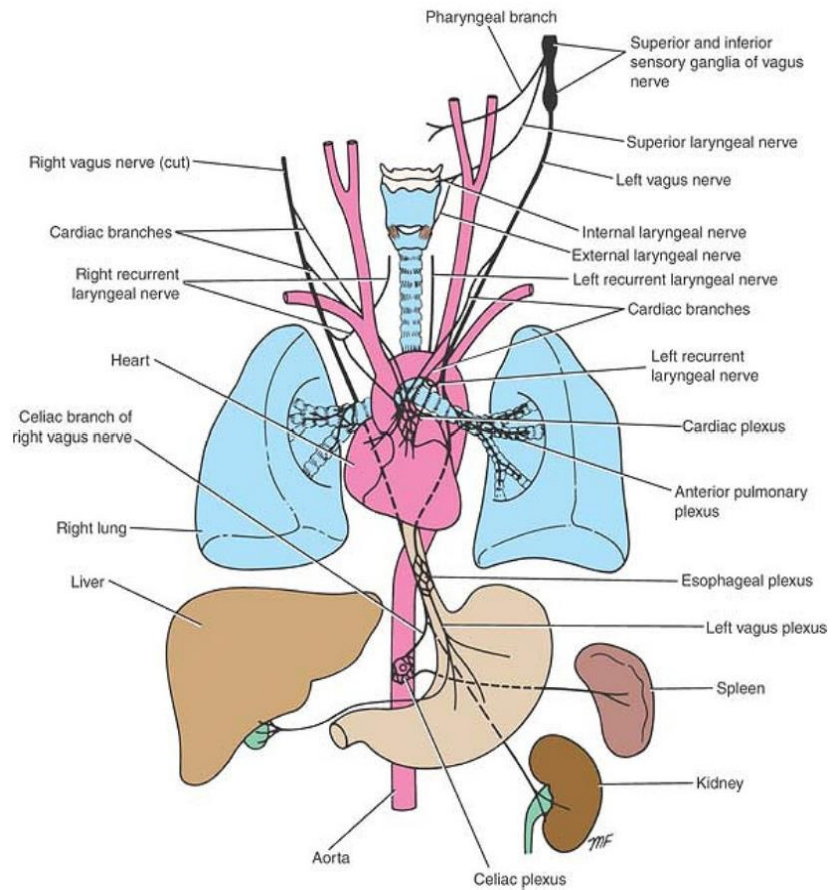


Figure 12: Extracranial course of Vagus; For “Reading and enjoying”!

Accessory nerve (XI C.N.)

The accessory nerve is a **MOTOR** nerve that is formed by the union of a cranial and spinal root.

Cranial root:

The cranial root is formed from the axons of nerve cells in nucleus ambiguus “for sure since it’s a motor nerve”. The nucleus receives corticonuclear fibers from both hemispheres. The efferent fibers of the nucleus emerge from the anterior surface of the medulla oblongata between the olive and the inferior cerebellar peduncle.

Spinal root:

The spinal root is formed from axons of nerve cells in the spinal accessory nucleus in lamina 9, which is situated in the anterior horn of gray matter of the spinal cord in the

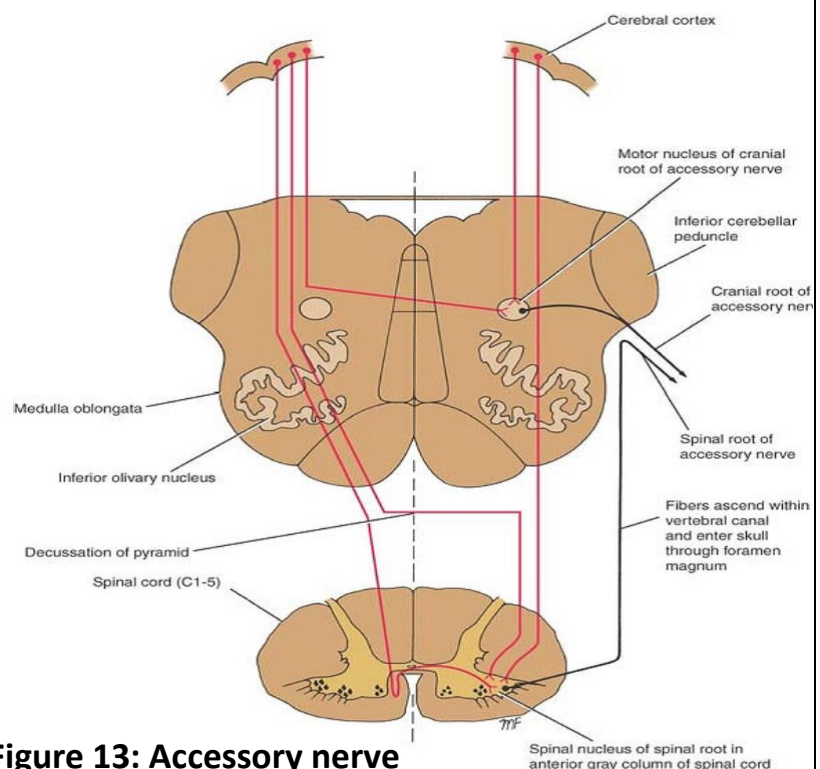


Figure 13: Accessory nerve

upper five cervical segments (Figure 14, and 1). The spinal root is thought to also receive corticonuclear fibers bilaterally.

This root has a very weird path; it first ascends upward from the spinal cord -between the anterior and posterior nerve roots of the cervical spinal nerves- until it reaches foramen magnum to enter through it to the skull, then it unites with the cranial root but for a **very short distance** where after that spinal accessory nerve leaves through jugular foramen to the head and neck area; so accessory immediately divides again. The spinal root of

accessory continues in the posterior triangle deep to the **sternocleidomastoid** and supplies it; also, it goes to the **trapezius muscle** and supplies it, while the cranial root goes with the vagus hiding in its sheath to travel with it to same distributions of Vagus. So actually “and please focus here well”, when there is a cut in the vagus nerve, as when we talked about lower motor lesions in the vagus nerve, **the cranial root of accessory will ALSO get cut**, unless someone cut the cranial root selectively.

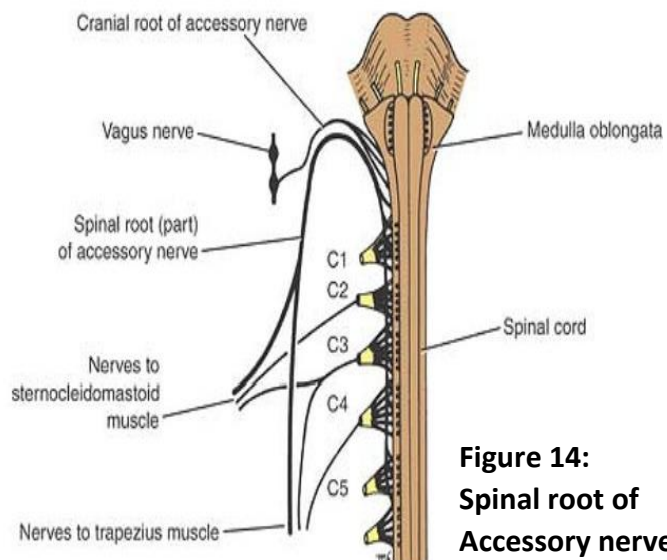


Figure 14:
Spinal root of
Accessory nerve

- In this figure you can observe the following:
 1. The origin of the SPINAL ROOT XI nerve (C1-C5)
 2. The ascending of spinal root through jugular foramen to enter the skull
 3. The ultra-short joining of spinal and cranial roots then splitting at the border of jugular foramen
 4. The entrance of cranial root fibers into vagus nerve sheath
 5. The descending spinal root and 2 muscles it innervates “sternocleidomastoid and Trapezius muscle”.

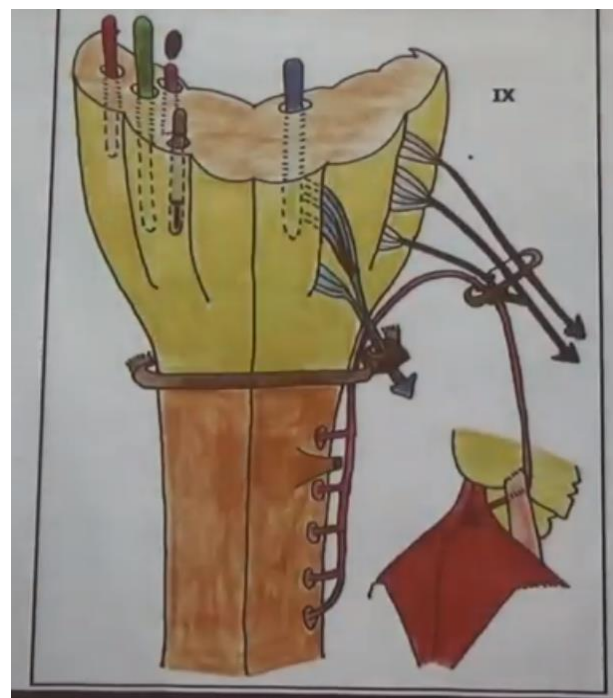


Figure 15: Spinal root of Accessory nerve

- Spinal Accessory L.M.N. lesion produces symptoms mainly ipsilateral to site of injury.

Hypoglossal nerve (XII C.N.)

The hypoglossal nerve is a **MOTOR** nerve that supplies all the intrinsic muscles of the tongue as well as the extrinsic muscles which are styloglossus, hyoglossus, and genioglossus muscle, except palatoglossus "by vagus".

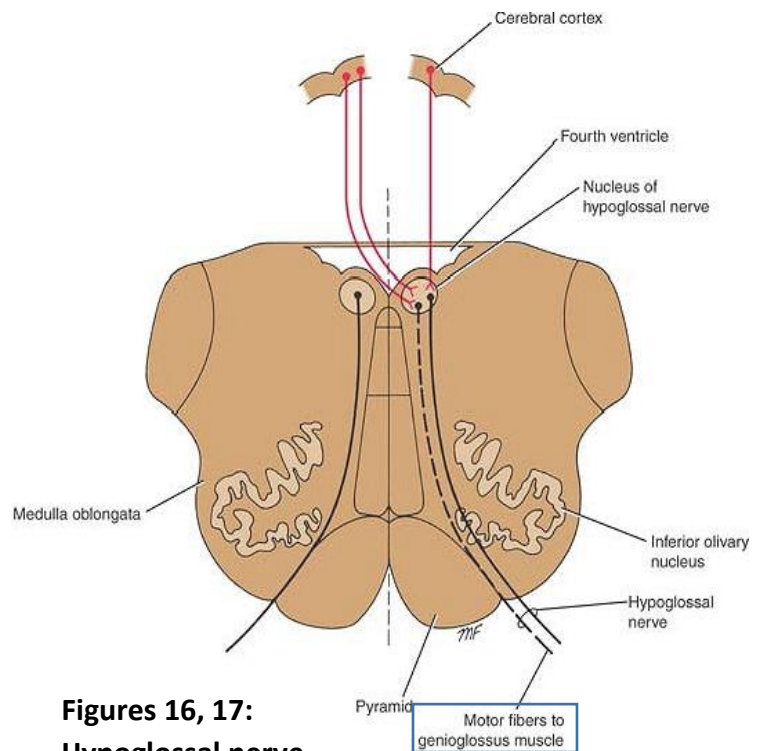
Hypoglossal nucleus (figure 16):

The hypoglossal nucleus is situated close to the midline immediately beneath the floor of the lower part of the 4th ventricle. It receives corticonuclear fibers from both cerebral hemispheres. **However, the cells responsible for supplying the genioglossus muscle only receive corticonuclear fibers from the opposite cerebral hemisphere (contralateral).**

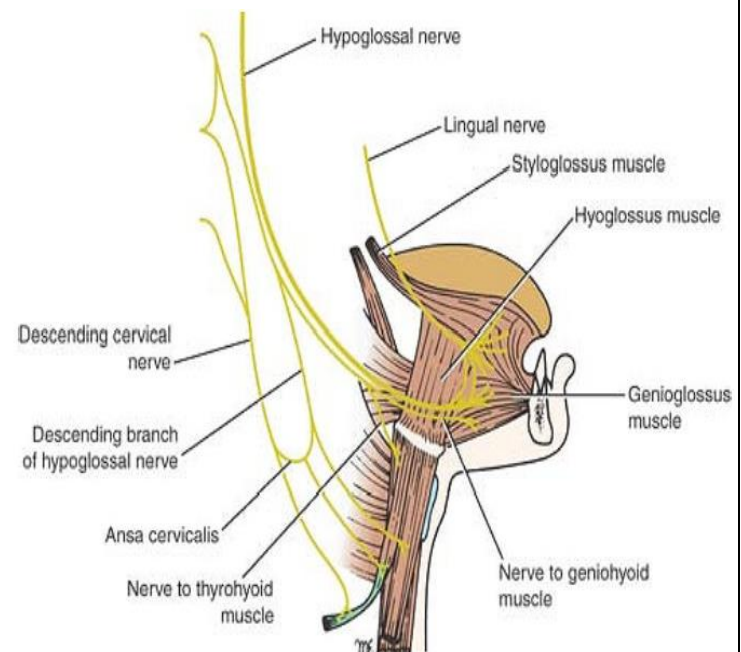
Course (Figure 17):

The hypoglossal fibers emerge on the anterior surface of the medulla oblongata between the pyramid and the olive "anterolateral fissure". Then the nerve crosses the posterior cranial fossa and leaves the skull through the hypoglossal canal; descend between the internal carotid artery and the internal jugular vein to travel then uniquely in a horizontal fashion until reaching below the tongue to supply it. "Hence: Hypo...glossal!"

- It supplies all muscles of the tongue **except palatoglossus**.
- If there is a **lower motor neuron** lesion to the hypoglossal nerve "Ex. Trauma to the skull that resulted in hypoglossal canal fracture", Genioglossus muscle will become atrophic on the **ipsilateral** side, so the tongue will deviate **toward the paralyzed side**. The tongue will be smaller on the side of the lesion, owing to muscle atrophy.
- If there is an **upper motor neuron** lesion "corticonuclear fibers got injured", there will be no atrophy or fibrillation but there will be spasticity "remember that corticonuclear fibers are pyramidal", and upon protrusion, the tongue will deviate to the side opposite to the lesion because the genioglossus takes from the opposite.



Figures 16, 17:
Hypoglossal nerve



To make things clear: if right U.M.N. got injured, spasticity will happen to the left, and so when protruding the tongue, left genioglossus will be spastic and so the deviation will by default be on the contralateral side “which is the left side”.

A picture suggesting either a L.M.N.L in the left hypoglossal nerve, or an U.M.N.L in the right cortico-nuclear fibers going to the left XII nucleus.



11.45min-26.20min/ Slides covered “10-18”

- **Note:** The doctor said that extracranial courses of CNs are not required except what we talked about in facial, greater petrosal, corda tympani, and lesser petrosal.

** The table below summarizes most important things in this sheet

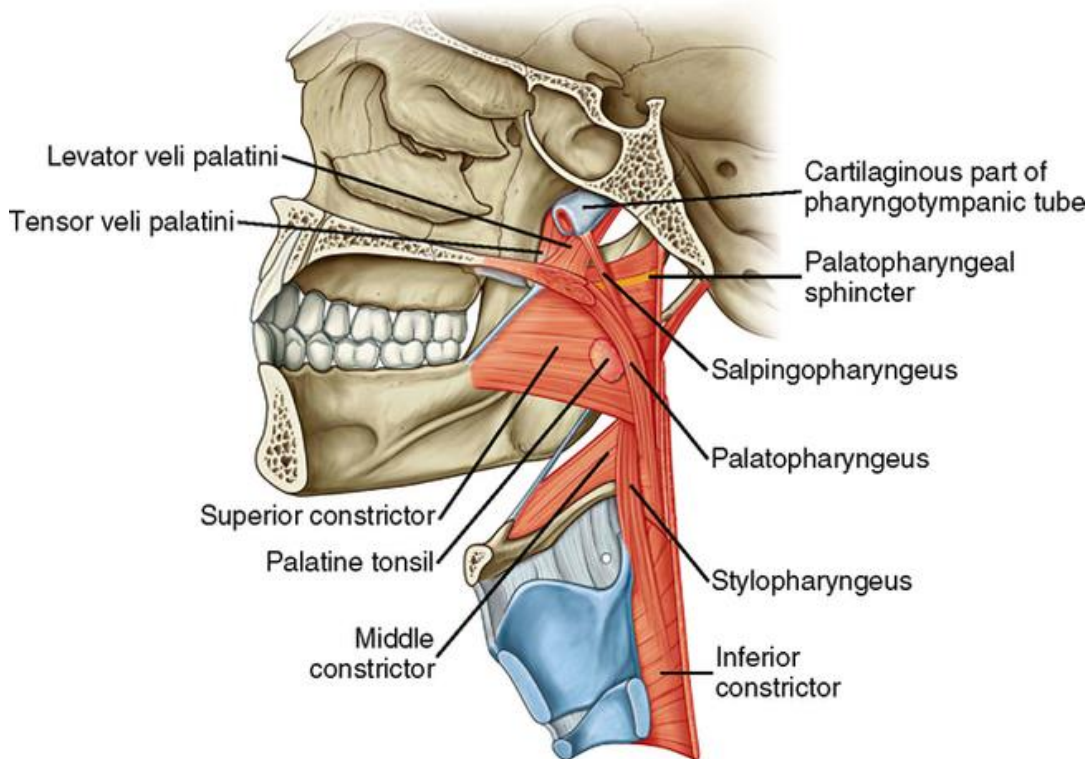
Nerve	NUCLEI	MODALITY	Cell body site	Fibers carrying the modality	Destination “supply, or taking sensation from”
Glosso-pharyngeal	Inferior salivatory nucleus	Parasympathetic	Pre :Inferior salivatory nucleus Post: otic ganglion	Tympanic to lesser petrosal then inside sheath of auriculotemporal	parotid gland
	Solitary nucleus (nucleus of tractus solitarius)	Taste	Inferior glossopharyngeal ganglion	Fibers from IX nerve	Posterior 1/3 of tongue
		Visceral sensation	Inferior glossopharyngeal ganglion	Carotid sinus nerve	Carotid sinus
	Spinal nucleus of the trigeminal nerve	Common sensation	Superior glossopharyngeal ganglion	Nerves to the assigned destinations.	The external auditory meatus, middle ear, mucosa of the pharynx (oro- and laryngo-pharynx) and posterior one third of the tongue.
	Nucleus ambiguus	Motor	Nucleus ambiguus	Nerve to stylopharyngeus	Stylopharyngeus muscle

Vagus “+ cranial root of accessory travelling in vagus’ sheath” **Note: cranial root of accessory carries <u>motor</u> fibers “figure 13”.	Solitary nucleus (nucleus of tractus solitarius) (vagus)	Taste	Inferior ganglion of vagus	Branch to epiglottis	Taste buds in the epiglottis
	dorsal vagal nucleus (vagus)	Parasympathetic	Pre:dorsal vagal nucleus Post: destination specific	Destination specific branches	involuntary muscle of the bronchi, heart, esophagus, stomach, small intestine, and large intestine as far as the distal one-third of the transverse colon
	Spinal nucleus of the trigeminal nerve (vagus)	Common sensation	Superior ganglion of vagus	Destination specific branches	outer ear, mucosa of the larynx (above the vocal cords from internal laryngeal and below from recurrent laryngeal, both of which are from vagus nerve), and dura of the posterior cranial fossa
	Nucleus ambiguus (vagus and cranial root of accessory)	Motor	Nucleus ambiguus (vagus and cranial root of accessory)	Destination specific branches	constrictor muscles of pharynx (Except stylopharyngeus; 9th), intrinsic muscles of larynx, and muscles of the soft palate (Except tensor veli palatine; 5 th)
Spinal root of accessory	Spinal accessory nucleus of C1-C5 (lamina 9)	Motor	Spinal accessory nucleus of C1-C5 (lamina 9)	Nerve to trapezius, nerve to cleidomastoid	Trapezius muscle and cleidomastoid muscle
Hypoglossal	Motor nucleus of hypoglossal	Motor	Motor nucleus of hypoglossal	Destination specific branches	all the muscles of the tongue except palatoglossus.

Thank you for your time ♥ and we hope this sheet was easy on you and you found it as useful as possible “we know you’re exhausted great hero :D”. Please forgive if any mistake was found, and never hesitate to inform us with! May Allah bless your times ♥

Anatomy Atlas

1. Tensor veli palatini and external pharyngeal muscles



2. Extrinsic and Intrinsic Muscles of the tongue

