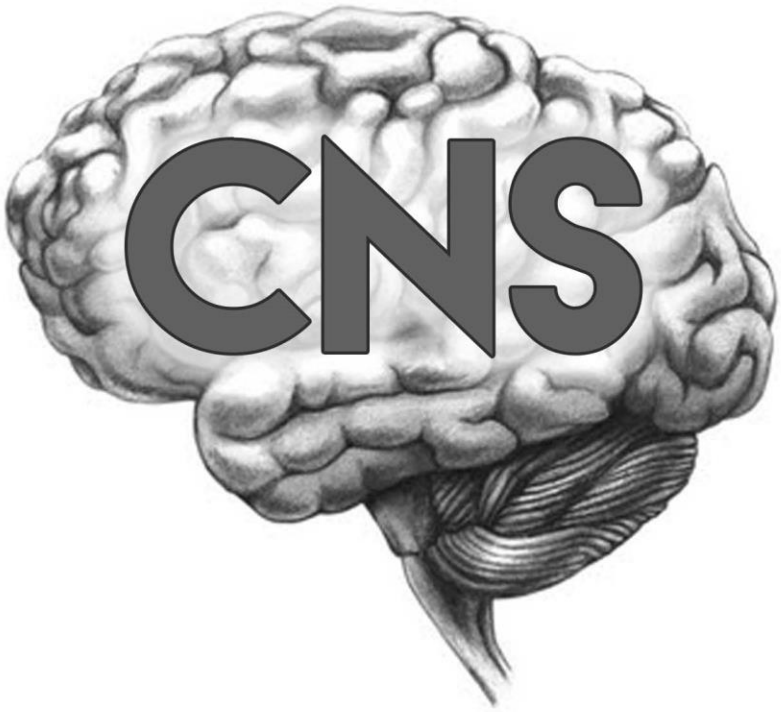

ANATOMY

☑ Sheet ○ Slide ○ Handout

Number

17

Subject

Cranial Nerves 1

Done By

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Date: **12/3/2017**

Price:

In the last lecture, we discussed that sound waves can be conducted in air, water and bones of the skull.

We also said that there are two types of deafness:

1- Conduction deafness.
2- Nerve (or Sensory neuron) deafness. ←← **More Dangerous**

Conduction deafness results from a problem in the external or middle ear. E.g.:

- Accumulation of earwax with dust (seen in construction workers) can close the external ear and prevent sound waves from entering
- **Otosclerosis,** i.e. Fibrosis in the joints between middle ear ossicles (malleus, incus, and stapes), also affect hearing.
- Acute otitis media in a children if not treated, can progress to chronic otitis media, which affects the ossicles of the middle ear and cause conduction deafness.

Nerve deafness results from a problem in:

- The nerve itself,
- The auditory receptors (hair cells) in the inner ear which may get destroyed by many drugs (e.g. Some Antibiotics specially **Streptomycin-** that used to treat TB-),
- or from congenital defects or complete absence of the cochlea.

❖ Tests of hearing:

There are two tests that help us to differentiate between the two types of deafness:

1- Weber test: Indicative for conduction or nerve deafness.
2- Rinne test: Compares air conduction with bone conduction.

Weber test:

Procedure: We strike the tuning fork and put it on patient's head, **normally it's heard to same degree in both ears** (it's not important if he hears it strongly or weakly, but it must be equal – **no laterlaization**).

- In nerve deafness: If it was in the right ear he will hear the sound from the left ear.
- In conduction deafness: If it was in the right ear (e.g. a problem in external or middle ear or the ear drum), he will hear it **louder on the right ear (on the affected side)**. Even his right ear is closed and cannot conduct sound, but he hears because the sound conducted through bone.

NOTES

The doctor just said that the sound will conduct in bone and heard louder. But I will quote a couple of theories from Wikipedia explaining this:

"A patient with a unilateral conductive hearing loss would hear the tuning fork loudest in the affected ear. This is because the ear with the conductive hearing loss is only receiving input from the bone conduction and no air conduction, and the sound is perceived as louder in that ear. This finding is because the conduction problem of the middle ear (incus, malleus, stapes, and eustachian tube) masks the ambient noise of the room, while the well-functioning inner ear (cochlea with its basilar membrane) picks the sound up via the bones of the skull, causing it to be perceived as a louder sound in the affected ear. Another theory, however, is based on the occlusion effect described by Tonndorf et al. in 1966. Lower frequency sounds (as made by the 256 Hz fork) that are transferred through the bone to the ear canal escape from the canal. If an occlusion is present, the sound cannot escape and appears louder on the ear with the conductive hearing loss."

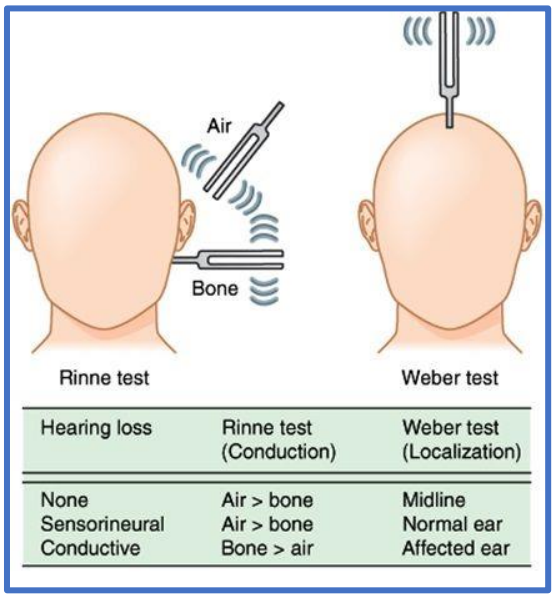
Rinne test:

Principle: In a Normal Ear, Air conduction is better than bone conduction (AC is better than BC).

- **Positive Rinne test: (Normal people)**
  1- We strike the tuning fork and put it on the mastoid process. The person will hear the sound for a period of time, the sound will decline gradually from the fork, you ask him to tell you when he is not hearing any more. Note that he is now hearing using bone conduction.
  2- After the sound disappears. Put the fork in front of the ear, the person will hear again because AC is better than BC. This is **positive Rinne test** and this happens in normal people.

- **Negative Rinne test:**
  1- Same as above.
  2- Same as above. However, when you put the fork in front of the ear, **the patient will not hear again.**
  3- Now to confirm the negative result, you do the opposite. Put the fork in front of the ear at first, and ask the patient to tell you when he stops hearing.
  4- When no more sound heard, you put the fork on the mastoid process. The patient will hear the sound again. This indicates that the patient is hearing from the bone better than air. This is negative Rinne test which **indicates that the patient has a conduction problem.**

"هاي الفحوصات ليس سرًا سؤال امتحان مؤكّد، لأنه الها تطبيقات في المستشفى"



Hearing loss	Rinne test (Conduction)	Weber test (Localization)
None	Air > bone	Midline
Sensorineural	Air > bone	Normal ear
Conductive	Bone > air	Affected ear

CLINICAL CORRELATE

Please note that this tests don't replace clinical examination, they must be done side by side. Example:

A Patient will tell the doctor that he is not hearing well in his left ear. The doctor uses the otoscope and finds accumulation of earwax, and remove it by ear lavage.
In this example the doctor diagnosed the problem and treated it without using the above tests.

Note: Ear Lavage is a dangerous procedure because the Vagus nerve may be stimulated during it, this is due to the fact that the Vagus has branches that reach the external ear (will be discussed later in this sheet), so if it was stimulated it can cause **severe bradycardia to the degree of shock.** You must take your precautions when doing it such as using warm water and pump it gently.

END OF AUDITORY PATHWAY

❖ Cranial Nerves:

Important note: Before discussing the cranial nerves, the doctor gave an introduction, you may find it hard at the beginning, but when we discuss each cranial nerve alone, most of the information will be revised again.

Functional components of nerves:

- Spinal nerves:

Each spinal nerve has a dorsal root (sensory) and a ventral root (motor).

All spinal nerves have a dorsal root ganglion (which contains the "mothers" / cell body of the sensory fibers) because all spinal nerves carry sensory fibers.

The ventral root originates from Alpha and Gamma motor neurons.

Each type of fiber has a certain name according to its function:

DEFINITIONS

Fibers innervating the body wall = Somatic
Fibers innervating the viscera = Visceral
Afferent = Sensory
Efferent = Motor

- **General Afferent Fibers** [DORSAL ROOT] : (again, cells of origin are in the ganglia)
  1- General somatic afferent (GSA): Sensory fibers from the body wall –skin, muscles or joints = Extreroceptive (pain, touch and temperature) and Proprioceptive.
  2- General visceral afferent (GVA)

Remember: The cell's peripheral process reaches the receptor and the central process to the spinal cord forming spinothalamic tract or the dorsal column system.

- **General Efferent Fibers** [VENRTAL ROOT]:
  1- General Somatic Efferent (GSE): to skeletal muscles **derived from body myotomes.** (E.g. biceps, triceps, extraocular muscles, muscles of the tongue→ originated from the occipital myotome)
  2- General Visceral Efferent (GVE): These are the **autonomic fibers** to smooth muscles, glands and cardiac muscles.

Note: Cell bodies of sympathetic are in the intermediolateral horn (T1-L2) and parasympathetic in a similar region in (S2-S4). Originate as **preganglionic** and must synapse in a autonomic ganglion during their course.

So, the **four components of the spinal nerves**: GSA GVA GSE GVE

NOTES

There are muscles **that are not derived** from the body myotomes, instead:

1- Derived from branchial arches.
2- Supplied by cranial nerves (whereas general muscles could be supplied by spinal or cranial nerves).

- Cranial nerves:

Cranial nerves could be motor, sensory or both.

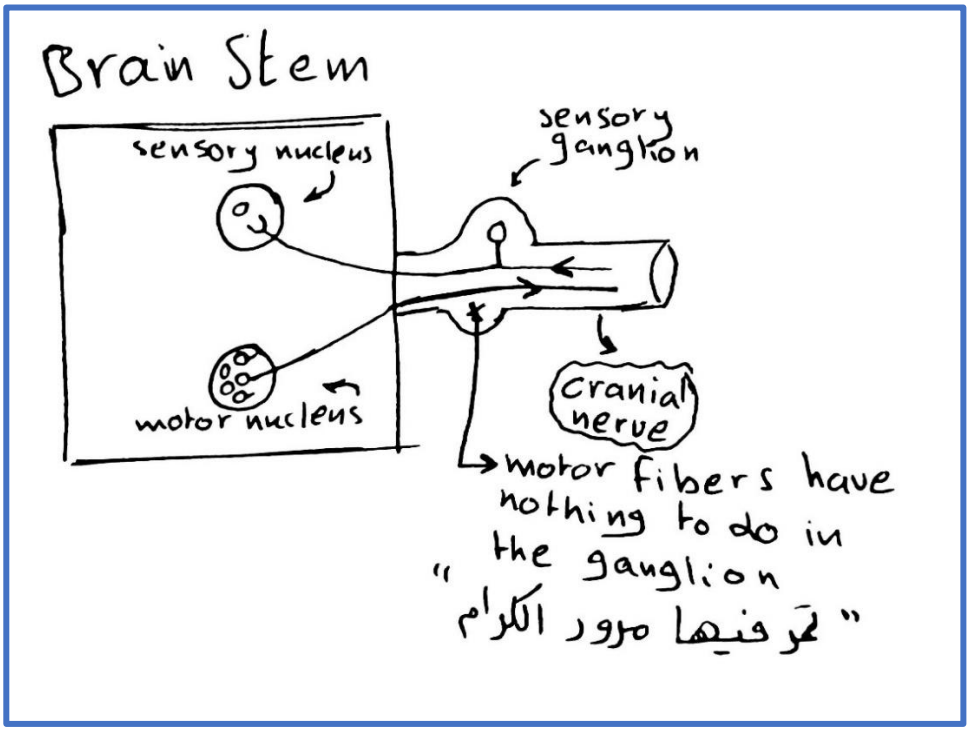
Motor fibers originate from motor nuclei in the brain stem (which contain Alpha and Gamma).

Sensory fibers, just like spinal nerves, originate from ganglia, the difference is that the central process enters a sensory nucleus. which is the 2nd order neuron in a sensory pathway.

So the sensory nucleus is nothing but the **second order neurons.**

From sensory nucleus fibers should cross and go up to the third order neuron in the thalamus.

Note: Not all cranial nerves have ganglia, but if it carries sensory fibers it must have a ganglion or more during it course. e.g. The ganglion of Trigeminal (the largest ganglion) found at the apex of petrous part of temporal bone in the base of the skull (also called semilunar ganglion or Gasserian ganglion).



The cranial nerves components are the same of spinal nerves (GSA GVA GSE GVE) in addition to three components:

Note: GVE fibers in cranial nerves **are only parasympathetic**.

1- Special Somatic Afferent (SSA): carry **vision** (in Optic nerve), as well as **hearing** and **equilibrium** (in Vestibulocochlear nerve). But our most concern when saying SSA is hearing and equilibrium.
   Note: Special: refers to special senses. Somatic: because the receptors are near the body wall (in the inner ear near).

2- Special Visceral Afferent (SVA): carry **olfaction** and **taste**.
   Note: Visceral: because the receptors are found in the beginning of the viscera; Olfaction is at the beginning of RS and taste in GI.

3- Special Visceral Efferent (SVE): motor to **special muscles** i.e. that are derived from branchial arches.
   Examples: Motor part of Mandibular (or Trigeminal) innervates muscles of the first arch –muscles of mastication.

   Motor part of Facial innervate muscles derived from the second arch –muscles of facial expression with addition to other muscles (posterior belly of digastric, stylohyoid, occipitofrontalis… عضلات راح نتكلم عنها بالتفصيل)
   Note: Not all muscles in the face region derived from the second arch. The exceptions are muscles of the tongue as well as extra-ocular muscles, these are derived from **myotomes** (supplied by GSE).

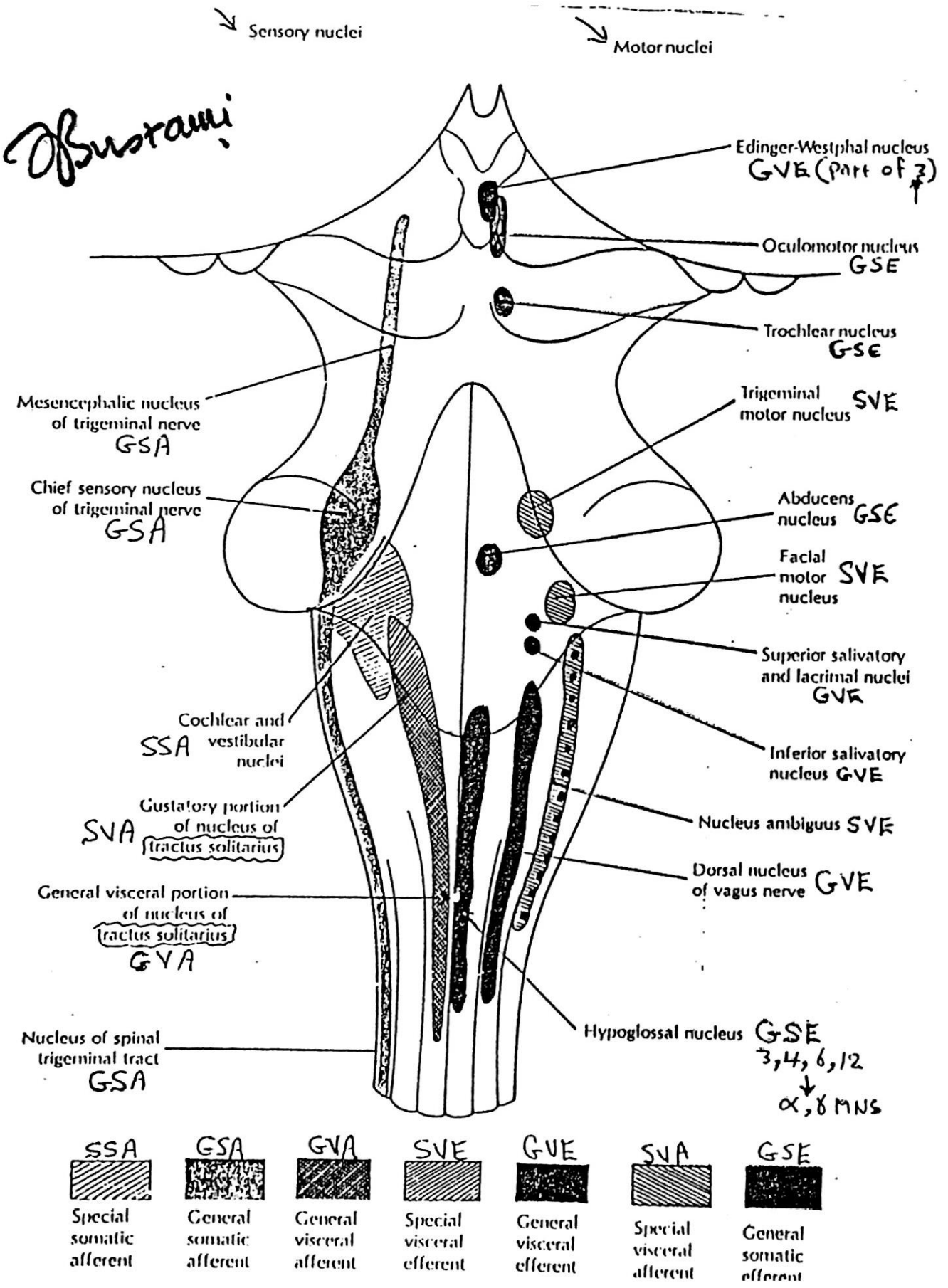
   3^{rd} 4^{th} 5^{th} arches are innervated by 9^{th} 10^{th} 11^{th} cranial nerves (Glossopharyngeal, Vagus and Cranial part of Accessory) –muscles of the pharynx, larynx and palate.

Any of the cranial nerves may contain one or more of the above 7 components **but not all of them.** e.g. Oculomotor: GSE + GVE / Trochlear only GSE / Vagus GSA + GVA + SVA +GVE + SVE / Olfactory only SVA / Optic only SSA.

The following figure shows how the nuclei are arranged in the brain stem, and which fibers come out or enter them. Motor nuclei shown in the right half and sensory nuclei in the left half for simplicity, but all nuclei are found in both sides.

The nuclei are arranged as **columns** in the brain stem.

Have a look to the figure while reading the notes and after you finish them.


Sensory nuclei
Motor nuclei
Bustami
Edinger-Westphal nucleus
GVE (part of 3)
Oculomotor nucleus
GSE
Trochlear nucleus
GSE
Trigeminal motor nucleus SVE
Abducens nucleus GSE
Facial motor nucleus SVE
Superior salivatory and lacrimal nuclei
GVE
Inferior salivatory nucleus GVE
Nucleus ambiguus SVE
Dorsal nucleus of vagus nerve GVE
Hypoglossal nucleus GSE
3,4,6,12
α, γ MNs
Mesencephalic nucleus of trigeminal nerve
GSA
Chief sensory nucleus of trigeminal nerve
GSA
Cochlear and vestibular nuclei
SSA
Gustatory portion of nucleus of tractus solitarius
SVA
General visceral portion of nucleus of tractus solitarius
GVA
Nucleus of spinal trigeminal tract
GSA
SSA
Special somatic afferent
GSA
General somatic afferent
GVA
General visceral afferent
SVE
Special visceral efferent
GVE
General visceral efferent
SVA
Special visceral afferent
GSE
General somatic efferent

Sensory Nuclei:

- Nuclei that receive **GSA**: represented by 3 sensory nuclei belonging to the Trigeminal nerve.

  The first nucleus is in the **pons**, called **chief sensory nucleus.** Receive touch from the face.

  The second nucleus is in the **midbrain**, called **mesencephalic nucleus of trigeminal**, receive proprioception from face muscles.

  The third one is below in the **spinal cord,** called **spinal trigeminal nucleus**.

- Medial to GSA, there are nuclei that receive **SSA**: represented by cochlear and vestibular nuclei (2 cochlear -dorsal and ventral- and 4 vestibular nuclei -superior and lateral in pons- / -inferior and medial in medulla-).

- **SVA and GVA**: both are represented by the **solitary nucleus** (or nucleus solitarius), its rostral part for SVA and the caudal part GVA. Remember: SVA carry olfaction and taste.

Motor nuclei:

- **GSE**: - Nucleus of hypoglossal (C12) in medulla, that supply muscle of the tongue.
  - Abducent (C6) nucleus in pons, that supply lateral rectus muscle.
  - Trochlear (C4) nucleus in midbrain, that supply superior oblique muscle.
  - **Part** of Oculomotor (C3) nucleus, that supply all extraocular muscle except lateral rectus and superior oblique. (because it also has GVE fibers)

- **SVE:** (motor to special muscles)

Represented in medulla by **1.Nucleus Ambiguous:** gives part of 9^{th} 10^{th} and cranial part of 11^{th} to pharynx, larynx and palate muscles.

This is an important nucleus. If damaged patient can't swallow so and must be fed by nasogastric tube.

Represented In pons by : **2.Facial** motor nucleus and **3.Trigeminal** motor nucleus.

- **GVE:** In medulla: **Dorsal nucleus of Vagus,** gives parasympathetic to effector organs in thorax and abdomen

In pons: **Inferior salivatory nucleus –**parasympathetic of Glossopharyngeal n. (to the parotid gland).

Also in pons: **Superior salivatory nucleus** –parasympathetic of Facial n. to all glands in the face except parotid gland (lacrimal, nasal, palatal, submandibular, sublingual…).

In midbrain: **Edinger-Westphal nucleus** of oculomotor, give parasympathetic to two smooth intraocular muscles i.e. **constrictor pupillae and ciliary muscle**.

VAGUS NERVE

Vagus n. has more than one sensory ganglia situated below the jugular foramen, called superior and inferior ganglia (in the figure below they are represented as one ganglion).

As said before, the ganglion contains the mother cells for sensory fibers.

Motor fibers cross the ganglion without doing anything, it's not related to it as its mother cells in are in brain stem (medulla).

Sensory Components

As we said that each sensory cranial fiber has peripheral process goes to the periphery, and central process that synapse with sensory nucleus (2nd order neuron).

Type of fibers	Ganglion (not imp.)	Nucleus (Central process reaches…)	Distribution (Receive sensation from…)
GSA	Superior (Jugular)	Spinal **Trigeminal**	External ear
GVA	Inferior (Nodose)	Solitary (Caudal)	Pharynx, Larynx, Thoracic and Abdominal viscera
SVA	Inferior	Solitary (Rostral)	Taste from epiglottis

Notes:

GSA fibers of Vagus "intrude" (يتطفل) on one of the Trigeminal nuclei.

GSA fibers are important because they reach the external ear, **ear lavage or a hit on ears can excite Vagus causing bradycardia to the degree of shock.**

GVA receive from pharynx, larynx and thoracic and abdominal viscera (lungs, heart, stomach, small intestines and the greater part of large intestines [foregut + midgut]).

Motor Components

Type of fibers	Nucleus (Fibers originate from…)	Distribution
GVE	Dorsal Nucleus of Vagus (located in the Medalla)	Parasympathetic to effector organs in thorax and abdomen (e.g. lungs, heart, increase HCl secretion in stomach, increase intestines movement)
SVE	Nucleus Ambiguus (located in the Medalla)	Pharynx, Larynx, Thoracic and Abdominal viscera

Notes:

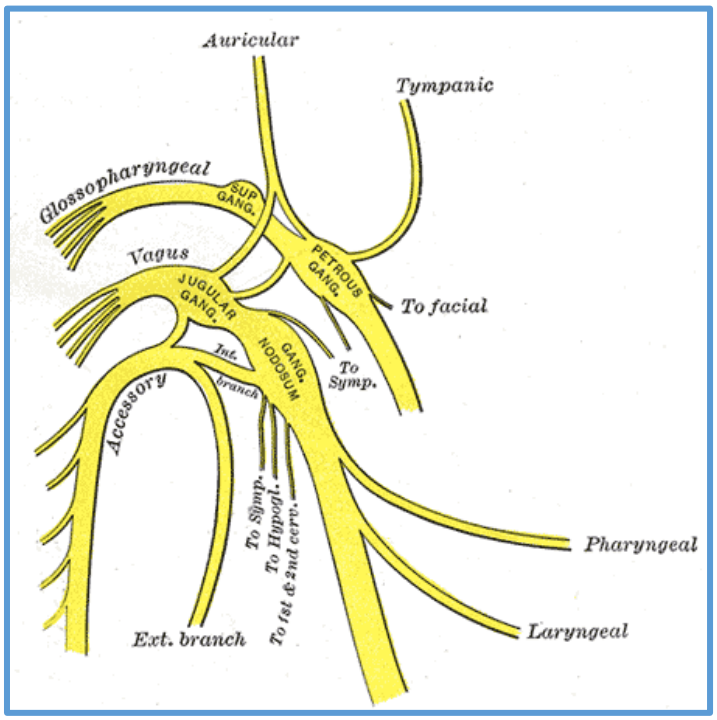
SVE give all muscles of pharynx except stylopharyngeus (supplied by glossopharyngeal), all muscles of the larynx, and all palate muscles except tensor palati.

معلومات سنة ثانية

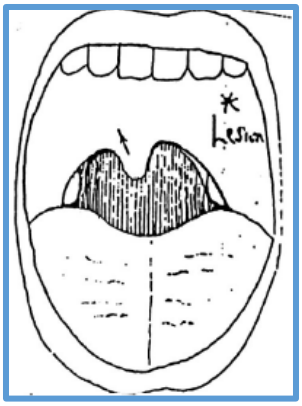
Accessory nerve has two parts; spinal and cranial. The spinal part comes from the cervical region and supplies Trapezius and Sternocleidomastoid.

The cranial part originates from nucleus Ambiguus.

The two parts travel with each other for a short distance, then they separate. The cranial part fibers **join Vagus nerve as a complement to it** (and hence called accessory), **so you can't see the Cranial Accessory**, it spreads with the Vagus to muscles of pharynx and larynx. e.g. Pharyngeal branch of Vagus, Superior laryngeal and Recurrent laryngeal branches of Vagus, **these branches apparently come out of Vagus, but actually their fibers are from Cranial Accessory!** (See the figure, the Int. branch is the cranial part and the Ext. branch is the spinal part).



Lesion of Vagus n. (or Vagus infranuclear lesion):



-Uvula deviates to the healthy side.

-Hoarseness of voice as larynx muscles are affected.

-Normally, Palate separates the oropharynx from the nasopharynx. Paralysis of palate results in dysphagia called **nervous type of dysphagia (most imp.).** When the patient drinks, **liquids** (problem only with liquids!) will regurgitate from nose (**nasal regurgitation**).

-Arrhythmia in heart and irregularity in GI tract because of parasympathetic loss.

Table 36-3 Effects of unilateral infranuclear vagal paralysis

Symptom	*Paralyzed element*
Nasal speech, nasal regurgitation of fluids	Soft palate
Movement of uvula to normal side	Soft palate
Hoarseness of speech	Larynx
Paralysis of vocal cord	Larynx
Cardiac, alimentary irregularity	Parasympathetic

Nuclei also can be injured in motor neuron disease. e.g. Nucleus Ambiguus lesion will result in nervous type of dysphagia (because it supplies pharynx, larynx and palate through 9, 10 and 11).

GLOSSOPHARYNGEAL NERVE

Sensory Components

Type of fibers	Ganglion (not imp.)	Nucleus (Central process reaches…)	Distribution (Receive sensation from…)
GSA	Superior	Spinal **Trigeminal**	External ear (retroauricular region)
GVA (most imp.)	Inferior	Solitary	- Pain, touch & temp. from posterior 1/3 of tongue - Upper part of the pharynx including tonsillar area - Eustachian tube and middle ear
SVA	Inferior	Solitary	Circumvallate papillae

Notes:

GVA fibers also reach carotid sinus (control B.P) and carotid body (chemoreceptors control respiration).

GSA to external ear is not important like Vagus (doesn't cause bradycardia like Vagus).

GSA fibers of Glossopharyngeal "intrude" on one of the Trigeminal nuclei, just like Vagus.

Note: Usually, we say 9th cranial nerve receives sensation and taste from the posterior 1/3 of tongue. This is not accurate regarding to taste. Posterior third of the tongue actually doesn't contain taste buds, but there are taste buds situated in sulcus terminalis (the border between the anterior two thirds and the posterior third), these buds called circumvallate papillae.

Most important component of glossopharyngeal is GVA.

CLINICAL CORRELATE

Carcinoma of the tongue cause refered pain to the ear (both innervated by 9).

Child with acute tonsillitis will complain from his ear.

Motor Components

Type of fibers	Nucleus (Fibers originate from…)	Distribution
GVE	Inferior Salivatory Nucleus	Parasympathetic to Parotid gland
SVE	Nucleus Ambiguus	One muscle: Stylopharyngeus (not imp.)

Notes:

How parasympathetic fibers reach parotid gland: Glossopharyngeal exit from jugular foramen and give a branch called tympanic branch which move in the jugular fossa, reaches middle ear and enters the tympanic plexus, leaves the plexus as lesser petrosal nerve which moves in the base of skull and exit through foramen oval. Until now the fibers **still preganglionic**, the lesser petrosal synapse in **otic ganglion.** Post ganglionic fibers reach the parotid gland **by a branch of the trigeminal called auriculotemporal**.

So the Glossopharyngeal fibers intrude the Trigeminal nerve, GSA use the spinal trigeminal nucleus and GVE uses the auriculotemporal branch.

Important note: Although Trigeminal doesn't have parasympathetic fibers, a branch of it in the face actually has.

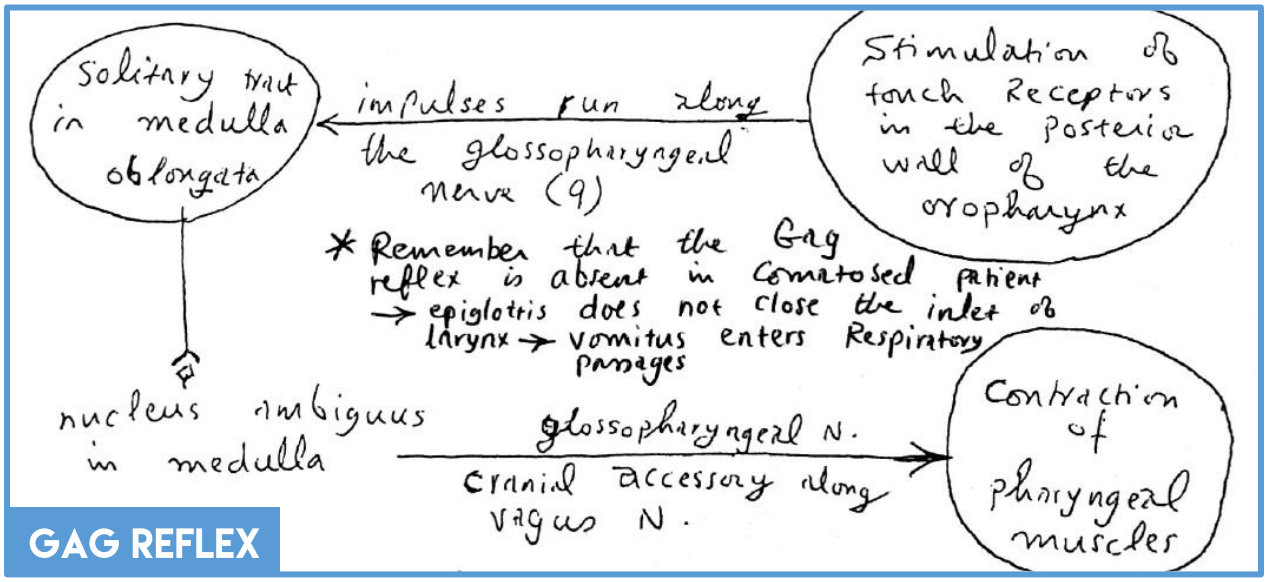
Unilateral lesion of the glossopharyngeal nerve:

1- **Loss of pharyngeal reflex (gag reflex).**
2- **Loss of carotid sinus reflex.**
3- **Loss of taste in the posterior third of tongue (Vallate papillae).**

Gag reflex: Touching the oropharynx by a spatula (tongue depressor) will cause contraction and elevation of the pharynx, and nauseating sense. Also absent in comatose patients and patients under anesthesia.

Afferent fibers are carried by 9th cranial nerve and efferents are carried by 10th cranial nerve (originate from nucleus ambiguous, mainly cranial Accessory which joins the Vagus. See figure below). **So gag reflex tests 9 and 10.**

Carotid sinus reflex: these are baroreceptors that are activated by stretch when blood pressure is elevated.



CLINICAL CORRELATE

- If a patient has severe tachycardia you can stop his condition by a maneuver called carotid sinus massage. Vagus will be stimulated and reverse tachycardia. But don't massage both sides because the response may be strong and you get severe bradycardia instead.
- Some people has hypersensitive carotid sinus, this is called **carotid sinus syndrome**. Any pressure on the carotid sinus may cause shock. A sharp shirt collar (قبة القميص) can do this also!

ACCESSORY NERVE

Consists of two parts: Spinal part and Cranial part.

The spinal part originates from **special neurons in the upper five cervical segments** (does not arise from anterior and posterior roots, it arises between them). Enters foramen magnum and moves with the cranial part for a short distance then they separate from each other. Then the spinal part exits from the jugular foramen and supplies two muscles in the neck region; Sternocleidomastoid and Trapezius.

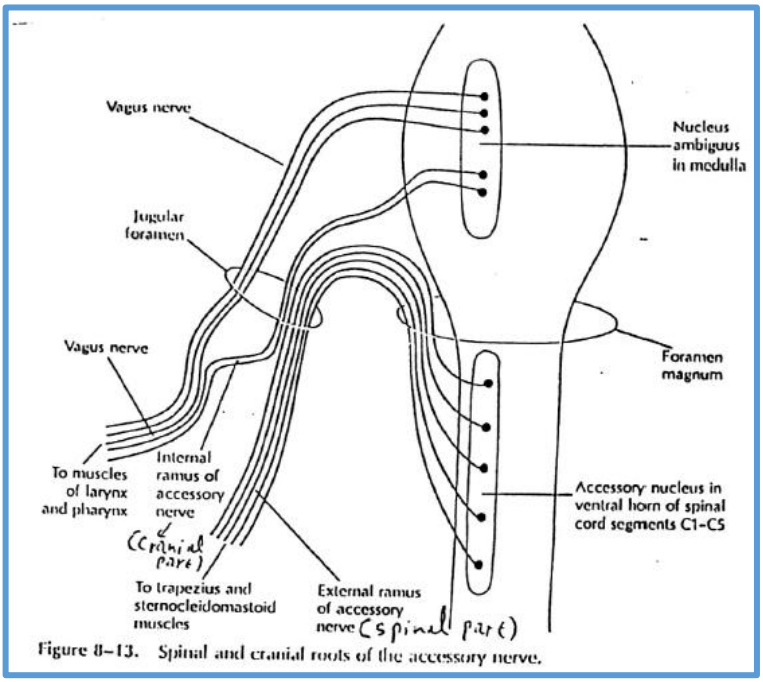


Figure 8–13. Spinal and cranial roots of the accessory nerve.

The cranial originates from the caudal part of nucleus ambiguus [SVE] (Vagus comes from rostral part).

Cranial Accessory fibers join the Vagus n. for muscles of the pharynx and larynx.

<u>Applied Anatomy:</u> Stab wound in the neck or surgical procedure (removing cancerous lymph nodes in the neck for example), can cut the **spinal Accessory.** If the lesion was beginning of the nerve, this will cause paralysis of Sternocleidomastoid and Trapezius. If the lesion is in the posterior triangle, only Sternocleidomastoid is affected. (Reed text below figure)

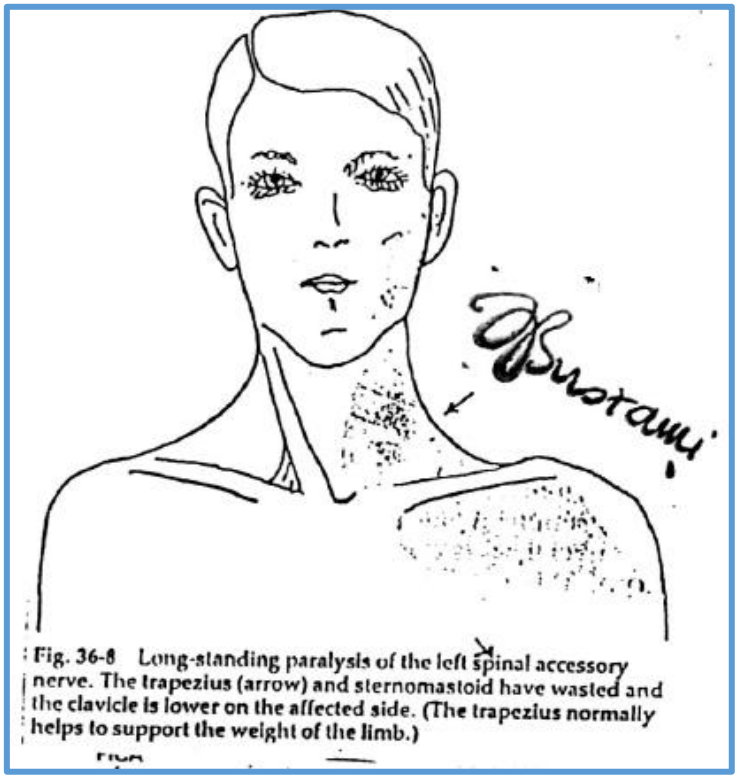


Fig. 36-8 Long-standing paralysis of the left spinal accessory nerve. The trapezius (arrow) and sternomastoid have wasted and the clavicle is lower on the affected side. (The trapezius normally helps to support the weight of the limb.)

Normally, right Sternocleidomastoid rotates your head to the left, and left Sternocleidomastoid rotates your head to the right.

Test for Sternocleidomastoid: If the **right** is paralysed for example, you say to him rotate your head to the **left** and you try to resist his movement, you will find weakness in the muscle.

<u>Applied Anatomy:</u>

A branch of the vertebral artery, called posterior inferior cerebellar artery **(PICA),** may have a weird course and descends below, in this case it may press on the rootlets of the spinal Accessory (that passes between dorsal and ventral roots of spinal nerve) and cause weakness in muscles supplied by it.

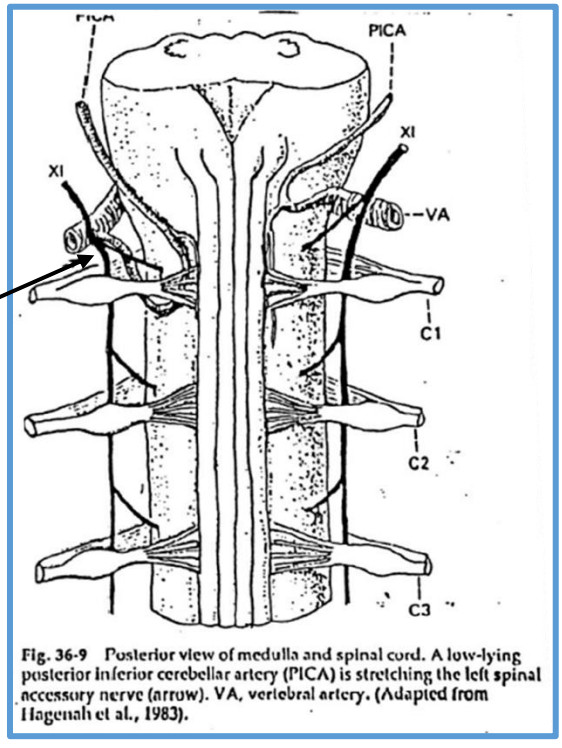


Fig. 36-9 Posterior view of medulla and spinal cord. A low-lying posterior inferior cerebellar artery (PICA) is stretching the left spinal accessory nerve (arrow). VA, vertebral artery. (Adapted from Hagenah et al., 1983).

HYPOGLOSSAL NERVE

Its nucleus extends the length of the medulla. (except the lower and upper parts. see page7)

Only one component: GSE

(Not important: it's also thought that it has GSA fibers from muscle spindles in the tongue but not all books accept this ← GSE ال على ونركز ننساها)

To all extrinsic and intrinsic muscles of the tongue except palatoglossus.

Our most concern is a muscle called genioglossus

This muscle protrudes the tongue out and **to the opposite side**.

To test for nerve lesion, you ask the patient to protrude his tongue, if the lesion was in the right, the left genioglossus will push the tongue to the right side **(to the affected side).**

CLINICAL CORRELATE

The hypoglossal n. arises from its nucleus and runs in its course in the medulla obliganta lateral to the medial lemniscus and emerge on the ventral surface of the medulla between pyramid and inferior olive. (So it moves near to Medial lemniscus and Pyramid)

Blood supply may cease to this three structures together, seen in anterior spinal artery occlusion. This results in **Medial Medullary Syndrome.**

<u>Medial Medullary Syndrome:</u>

Affected areas: - Medial Lemniscus – Pyramid and surrounding reticuler formation
-Hypoglossal n. ↘ (extrapyramidal)

Results in:

- Contralateral loss of discriminative touch, proprioception and stereognosis.

- Contralateral spastic paralysis (+ hyperreflexia + positive Babinski)

- **Ipsilateral** Hypoglossal injury. (Paralysis of the ipsilateral half of the tongue of lower motor neuron type [weakness, atrophy and fibrillation]).

A **nucleus** or **infranuclear lesion** of the hypoglossal Nerve →lower motor neroun lesion of the tongue muscles **Ipsilatral** to the lesion, manifested by the following :

1. Atrophy of the affected side of the tongue.
2. Deviation of the protruding tongue to the atrophic side.
3. Fasciculation (spontaneous activity of muscle fiber at rest), is best seen when the tongue is only slightly protruded.

This figure shows **atrophy** and **fasciculation** of the left half of the tongue. This suggest lower motor neuron lesion.

These signs mostly present Early in injury of the nucleus, suggesting motor neuron disease. It is worthy to test other cranial nerve, because the disease that damaged the Hypoglossal may affect other nuclei**. So this may be accompanied with difficulty in swallowing and nasal regurgitation**.

.40 Left hypoglossal nerve lesion.

The End.