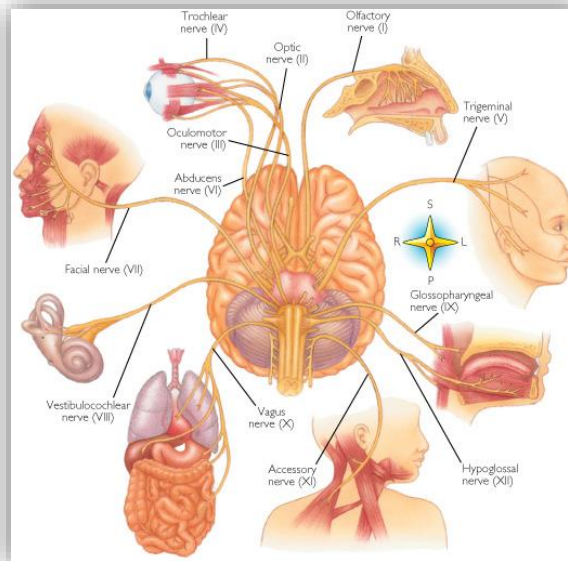




University of Diyala/ College of Medicine
Department of Physiology
Physiology Lab

Examination of the Cranial Nerves

Dr. Asmaa Abbas Ajwad



Cranial Nerves

The 12 pairs of cranial nerves (with the exception of the olfactory (I) and optic (II) pairs) arise from the brainstem . Some of them are sensory, some are motor, and others are mixed.

Number	Name	Component	Function
CN-I	Olfactory	Sensory	Smell
CN-II	Optic	Sensory	Vision
CN-III	Oculomotor	Motor	Raises upper eyelid, turns eyeball: upwards, downwards, medially and constricts pupil
CN-IV	Trochlear	Motor	Turns eyeball downward and medially
CN-V	Trigeminal		
		• Ophthalmic	Sensory Cornea, Skin of forehead, upper eyelids
		• Maxillary	Sensory Skin over maxilla, upper jaw, lower eyelids
		• Mandibular	Motor Muscles of mastication, mylohyoid, ant. Belly of digastric, tensor tympani
			Sensory Skin of cheek over the mandible, mucous membrane of the cheek
CN-VI	Abducent	Motor	Lateral rectus (turns eyeball laterally)
CN-VII	Facial	Motor	Muscle of face, posterior belly of digastric , stapedius
		Sensory	Taste from the ant. 2/3 of the tongue
		Secretomotor parasympathetic	Submandibular, sublingual, salivary glands, lacrimal gland
CN-VIII	Vestibulocochlear		
		• Vestibular	Sensory Equilibrium and sense of position
		• Cochlear	Sensory Hearing
CN-IX	Glossopharyngeal	Motor	<u>Stylopharyngeus</u>
		Secretomotor parasympathetic	Parotid salivary gland
		Sensory	Taste sensation from the post. 1/3 of the tongue
CN-X	Vagus	Motor & Sensory	Heart, respiratory passages, and most abdominal <u>vicera</u>
CN-XI	Accessory		
		• Cranial root	Motor Muscles of the soft palate except (tensor palatine) Pharynx except (<u>stylopharyngeous</u>) Larynx except (cricothyroid)
		• Spinal root	Motor Sternocleidomastoid , trapezius muscle
CN-XII	Hypoglossal	Motor	Muscle of tongue except <u>palatoglossus</u>

Reminders



Remember:

- Cranial nerves formed from sensory fibers only are CN: 1 (Olfactory), 2 (Optic), & 8 (Vestibulocochlear) (remember FIAT 128).



Remember:

- Cranial nerves which contain parasympathetic fibers are CN: 3 (Oculomotor), 7 (Facial), 9 (Glossopharyngeal), & 10 (Vagus) (Remember 1973).



Before examination, remember to:

- Wash hands, introduce yourself, confirm patient details (name, DOB), explain the examination you are going to do, and ask patients if they have a pain anywhere before you begin!.

Objectives

1

To learn how to examine functions of the 12 pairs of cranial nerves.

2

To understand the functions of the 12 pairs of cranial nerves.

3

Get an idea about some abnormalities associated with cranial nerves damage.

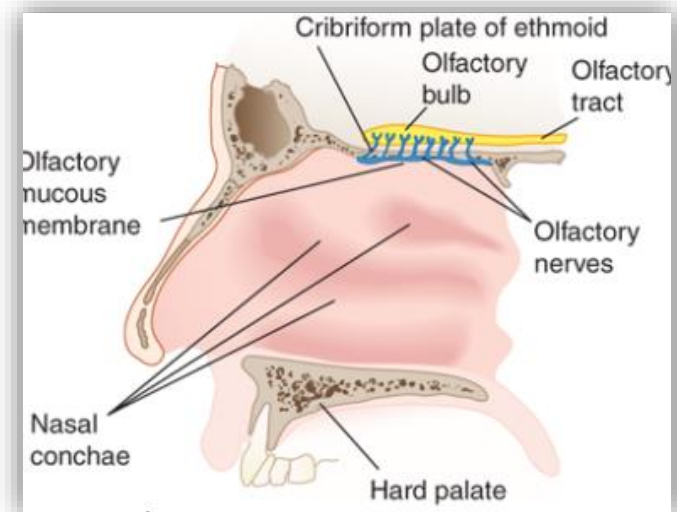
CN-I Olfactory Nerve

➤ **Sensory** only, **smell** sensation.

➤ **Anatomy**: Smell receptors are highly located in the nasal cavity, these olfactory cells project axons through the cribriform plate of ethmoid bone to the olfactory bulb, then through olfactory tract to the olfactory cortex.

➤ **Examination (not routinely done)**:

- By using common known substances such as orange , soap, tobacco, coffee,..etc. (Do not use an irritating substance such as ammonia as this will stimulate the trigeminal nerve.
- Always begin by asking patient if he/she has had any decrease in ability to smell. Check that the nasal passages are clear, then start to test the sense of smell for each nostril separately by occluding one nostril and examining the other. Ask the patient (the eyes must be closed) to identify the scent of the non-irritating substance.
- Detect odor when presented @ 10cm (see next figure).



CN-I Olfactory Nerve

➤ Abnormalities:

- **Anosmia** : absence of the sense of the smell. Common causes are : nasal obstruction, head injury with damage of the olfactory nerve , meningiomas ...etc.
- **Hyposmia** : diminished olfactory sensitivity (reduction in ability to smell).
- **Parosmia**: smells are mixed up so that a pleasant aroma like that of a rose might smell bad , like rotting garbage.

Notes:

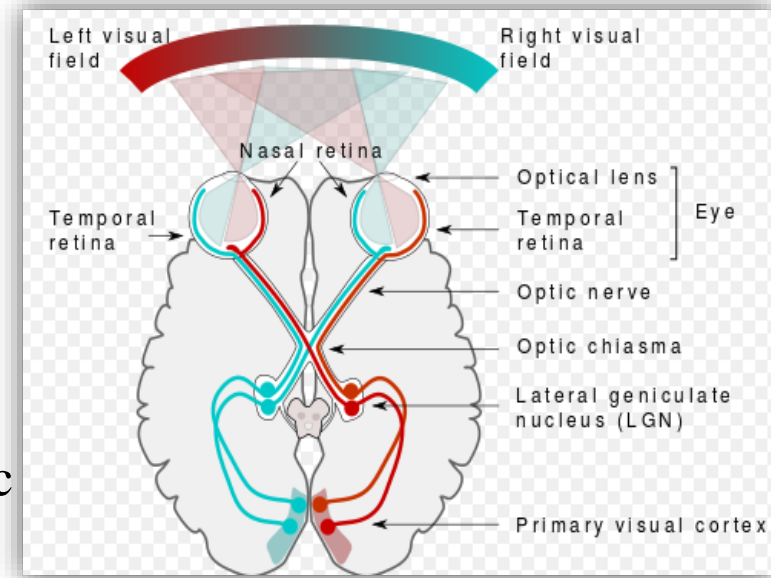
- Most of the time, anosmia and hyposmia are temporary and caused by inflammation in the nasal cavity (when you have a cold or sinus Infection). However, they can become permanent :damage of epithelial cells of the olfactory system by certain viruses, toxins, or trauma.
- Disturbance of smell may also occur in the presymptomatic stages of Parkinson's and Alzheimer's diseases.



CN-II Optic Nerve

➤ **Sensory** only, carries visual information from the retina to the brain.

➤ **Anatomy**: the nerve is formed by the axons of the retinal ganglion cells. It begins at the back of the globe and passes to the cranium through the optic canal where it joins with the contralateral nerve to form the optic chiasma, the optic tract then passes posteriorly to the lateral geniculate bodies of the thalamus and then to the primary visual cortex in the occipital lobe through the optic radiation.



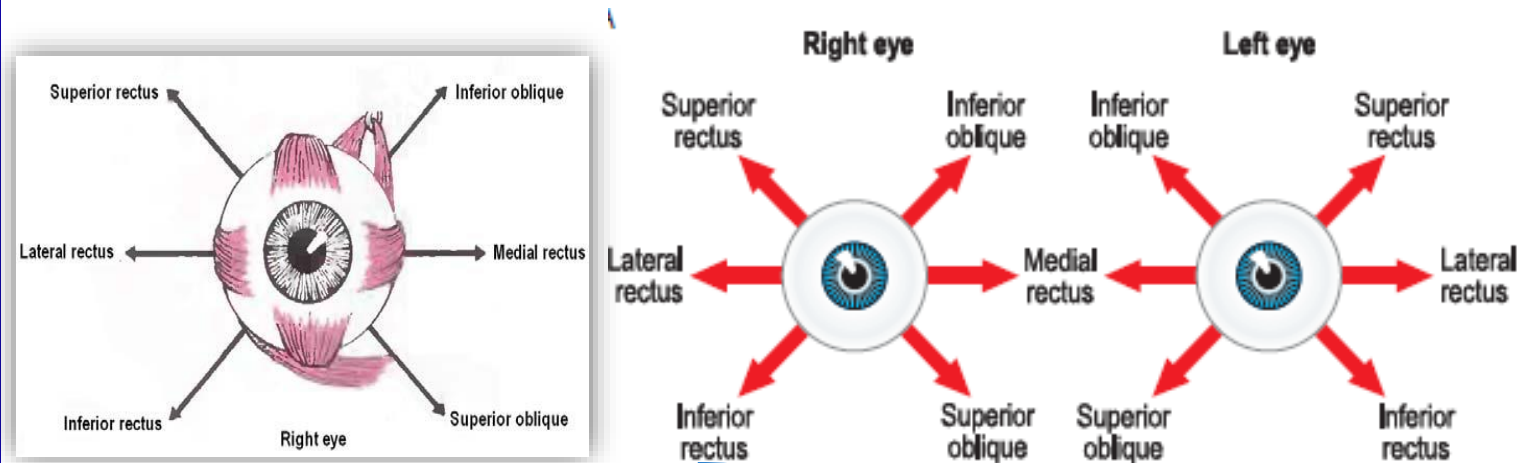
➤ **Examination of optic nerve includes testing of:**

- Visual acuity (Snellen chart)
- Visual field (confrontation)
- Color vision (Ishihara plates)
- Reflexes (Pupillary / Accommodation)
- Fundoscopy (Ophthalmoscope to visualize the optic disc)

Visual acuity, Reflexes, visual field, color vision, and fundoscopy will be covered in details later in a separate lab.

CN-III Oculomotor, CN-IV Trochlear, CN-VI Abducent Nerves

- These 3 nerves innervate the muscles controlling the eye movement. We examine them together because of their close functional interrelationship. The following diagram helps you to work out which eye muscle is paretic.



- Superior rectus
Inferior rectus
Medial rectus
Inferior oblique
Levator palpebrae superioris
Sphincter pupillae superioris
- Lateral rectus supplied by abducent nerve (**LR6**).
- Superior oblique supplied by trochlear nerve (**SO4**).

CN-III Oculomotor, CN-IV Trochlear, CN-VI Abducent Nerves

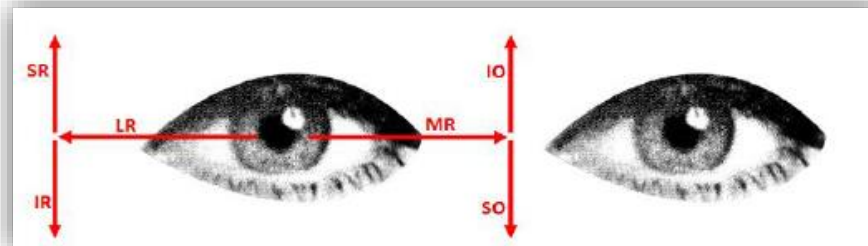
➤ *Examination:*

- *Primary position*

- Ask patients to fixate on tip of pen held 50cm in front of their nose.
- Inspect for **ptosis** (dropping of the upper eyelid seen with CN-III lesion as it supplies the levator palpebrae superioris), **squint(strabismus)** seen in lesion of any one of those nerves, and **Anisocoria** (inequality of the pupillary size)

- *Diplopia (double vision)*

- Ask about diplopia in the primary position
- With the patient head in the neutral position held by one of the examiner's hands on the crown of the head, ask the patient to fix the gaze on the examiner's finger held (50 cm) away and to follow the examiner's finger as it moves up and down, then to the right , up, and down, then to the left up and down "H pattern". Ask patient you if he/she experiences any pain or double vision. If any diplopia is noted try to match the associated lack of eye movement to a nerve lesion.
- We have to examine the pupillary reflexes also.



CN-III Oculomotor, CN-IV Trochlear, CN-VI Abducent Nerves



H – test technique showing the positions of the eyes during the test and the corresponding extraocular muscles.

CN-III Oculomotor, CN-IV Trochlear, CN-VI Abducent Nerves

➤ Abnormalities:

- Unilateral lesion of **oculomotor nerve** can cause: ptosis, weakness of superior; medial; and inferior eye movement, pupillary dilation of the affected eye (mydriasis), loss of the light reflex, and inferolateral squint.
- Unilateral lesion of **trochlear nerve** causes weakness when patient looks downward and medially leading to diplopia at this side.
- Unilateral lesion of **abducent nerve** causes weakness or inability to look outwards leading to diplopia at the side of the paretic lateral rectus and the eye will be adducted (medially deviated) due to the opposite action of the medial rectus (squint).
- What do you think about the following two pictures?



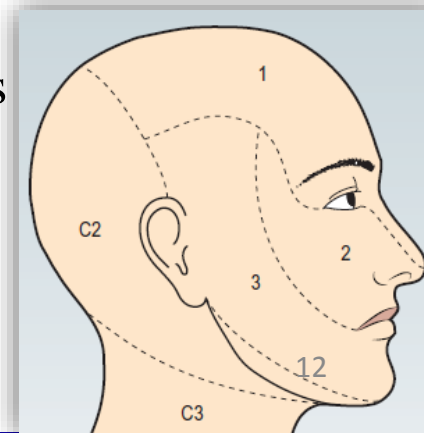
(a) ?

(b) ?

CN- V Trigeminal Nerve

- Trigeminal nerve is the largest cranial nerve that has both *sensory* and *motor* fibers. It contains four nuclei:
 - Main sensory nucleus (touch, joint position sense).
 - Spinal nucleus (pain and temperature) : this nucleus extends from pons to the second cervical segment of spinal cord, the upper part of the face is paradoxically represented in the caudal part of this nucleus.
 - Mesencephalic nucleus (unconscious proprioceptive).
 - Motor nucleus.

- Trigeminal nerve consists of three divisions :
 - ***Ophthalmic branch (V1)***: contains sensory fibers only. It supplies sensation to the skin of the upper nose, upper eyelid, forehead and scalp, eye (cornea and conjunctiva) and the mucous membranes of the sphenoidal and ethmoid sinuses and upper nasal cavity.
 - ***Maxillary branch (V2)***: contains sensory fibers only. It supplies sensation to the lower eyelid, skin of the temple, upper cheek and adjacent area of the nose and upper lip. Additionally, it supplies the mucous membrane of the mouth and upper teeth.



CN- V Trigeminal Nerve

- ***Mandibular branch (V3):*** contains sensory and motor fibers. The sensory part supplies sensation to the lower jaw, lower lip, mucous membrane of the ant. 2/3 of the tongue. The motor fibers supply : muscles of mastication, ant. belly of diaphragm, mylohyoid veli palatine, and tensor tympani.
- **Examination of sensory function:** Test light touch and pain sensation in the territory of the 3 sensory divisions.
 - Ask the patient to close his/her eyes and say 'yes' each time he/she feels you lightly touch them using a cotton wool tip. Do this in the areas of V1, V2 and V3.
 - Repeat using a fresh neurological pin, e.g. Neurotip, to test superficial pain.
 - Check sensation in each division and compare right side with the left one.

Corneal reflex:

1. Explain to the patient what you are going to do, and ask him/her to remove contact lenses.
2. Gently depress the lower eyelid while the patient looks upwards.
3. Lightly touch the lateral edge of the cornea with a wisp of damp cotton wool. Normally, there is a blinking on both side (direct and consensual corneal reflex).

Afferent limb of corneal reflex is the ophthalmic division of the ***trigeminal*** n.

Efferent limb of corneal reflex is ***facial*** n .

CN- V Trigeminal Nerve Examination



Left to right : test of light touch, pain, and corneal reflex.

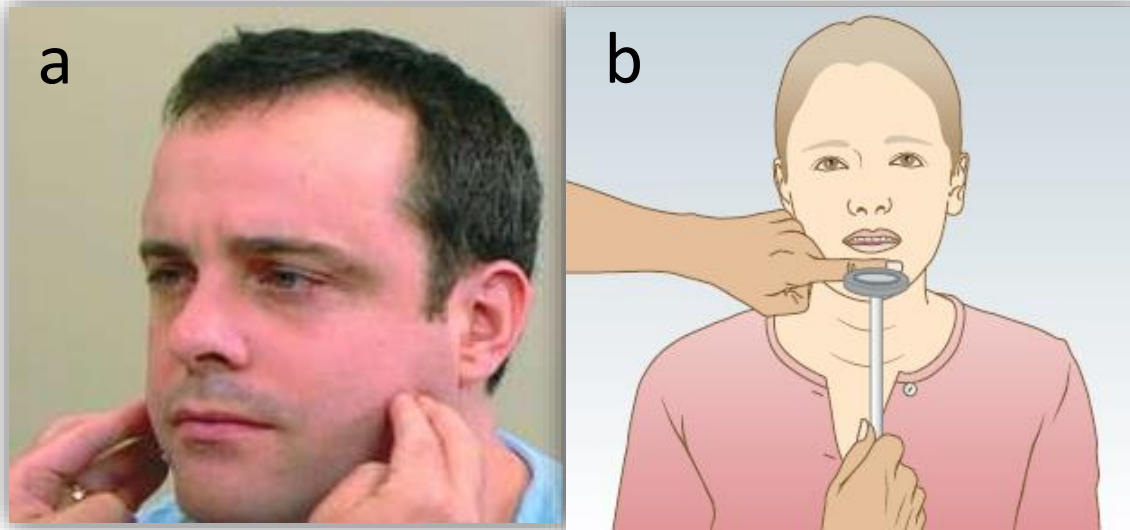
➤ Examination of motor function:

- Inspect muscles of mastication for wasting, and then ask the patient to open the jaw against resistance. Palpate the masseters for bulk and symmetry while the patient clenches his/her teeth.
- **Jaw Jerk:** Ask the patient to let his/her mouth hang loosely open. Then, place your forefinger in the midline between lower lip and chin. Tap your finger gently with the tendon hammer in a downwards direction. Normal response is a brisk contraction of the jaw muscles producing a closure of the jaw. Afferent and efferent limbs of this reflex are the *trigeminal nerve*.

CN- V Trigeminal Nerve Examination

➤ Abnormalities:

- Unilateral loss of sensory modalities in certain area usually indicating lesion to that nerve supplying this area accordingly.
- Unilateral loss of sensation in one or more branches of the V nerve may result from direct injury in association with facial fractures (particularly V2) or local invasion by cancer.
- Unilateral lesion in motor function usually causes the jaw to deviate to the weak side when the mouth is opened.



(a) Motor function examination of CN-V (b) Jaw jerk

CN- VII Facial Nerve Examination

- Facial nerve has both *sensory* and *motor* fibers. It contains 3 nuclei:
 - Main motor: supplies muscles of facial expression, stapedius and post. belly of digastric with stylohyoid muscles.
 - Parasympathetic : supplies the submandibular and lacrimal gland.
 - Sensory: ant. 2/3 of the tongue (taste sensation).
- **Examination** is usually confined to motor function; taste is rarely tested.
- ***Motor Function***
 - Inspect the face for asymmetry or differences in blinking or eye closure on one side. Note that minor facial asymmetry is common and rarely pathological.
 - Watch for spontaneous or involuntary movement.
 - Ask the patient to show his/her teeth.
 - Ask the patient to raise the eyebrows and observe for symmetrical wrinkling of the forehead.
 - Test power by saying:
'Screw your eyes tightly shut and stop me from opening them
 - Ask the patient to blow out the cheeks against closed mouth.

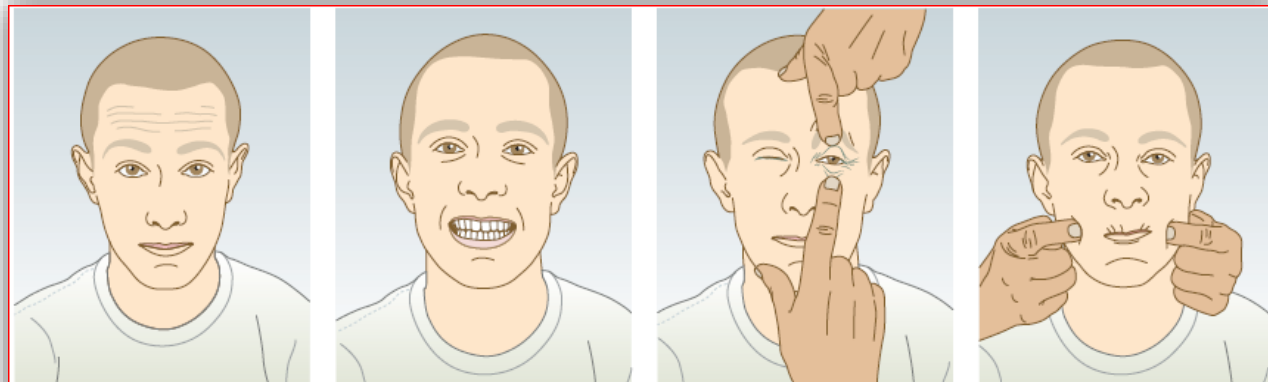
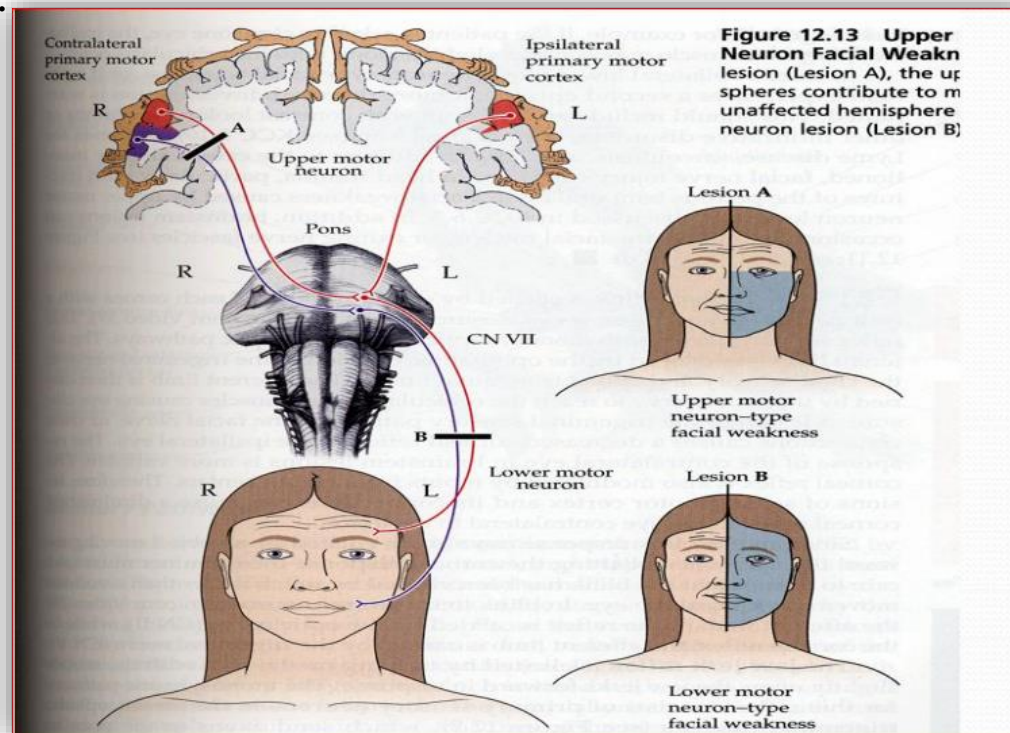


Fig. 11.11 Testing the motor function of the facial nerves. (A) Ask the patient to raise his eyebrows. (B) Ask him to show his teeth. (C) Ask him to close eyes against resistance. (D) Ask him to blow out his cheeks.

CN- VII Facial Nerve Examination

➤ Abnormalities:

- Upper motor neuron (supranuclear) lesion as in patient with stroke. This type of lesion involves the corticobulbar pathways and result in a contralateral weakness of the lower face with normal function of the upper face. The patient still able to wrinkle the forehead. This is related to the bilateral innervation of the upper face by the corticobulbar fibers. The lower face has only unilateral innervation from contralateral cortical centers.
- Lower motor neuron (infranuclear) lesion in which the facial weakness produces total involvement of the ipsilateral facial muscles, with no area being spared. This may result from lesions of the nerve as it exists from the skull or from involvement of the facial nucleus in the pons.



CN- VII Facial Nerve Examination

Bell's palsy is a common condition presenting with acute lower motor neuron VII nerve paralysis, often preceded by mastoid pain. Bell's phenomenon occurs when the patient is unable to close his eye.

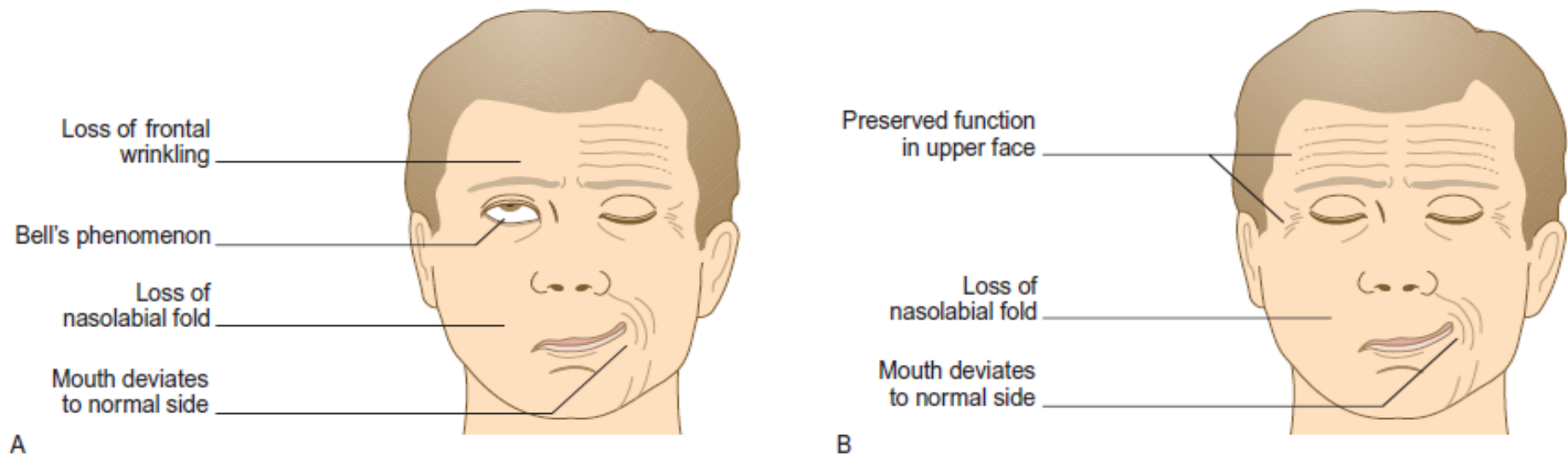
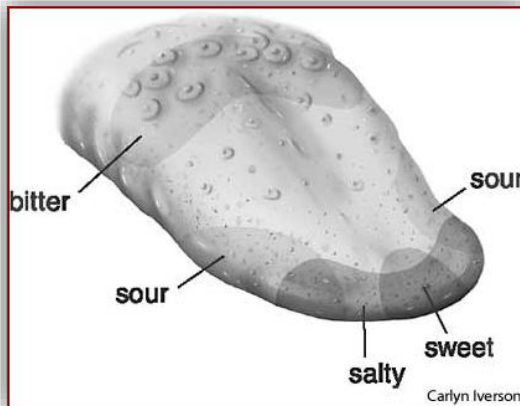


Fig. 11.12 Types of facial weakness. (A) Right-sided lower motor neurone lesion (within facial nerve or nucleus); Bell's phenomenon is also shown. **(B)** Right-sided upper motor neurone lesion.

CN- VII Facial Nerve Examination

- **Taste Function** :gently hold the protruded tongue, put test substances (sweet, salt, bitter, and sour) on the ant. 2/3 of each side of the tongue. Ask the patient to identify the taste. In between each taste, tongue should be cleared with water. The four primary taste sensations are sweet that mainly felt by the tip of tongue, sour on the sides of the tongue, salt on the dorsum of the tongue, and bitter on the post. part of the tongue (see figure below).
- **Schirmer's test** : Hook a small strip of notched blotting paper ~40 *mm* long over the lower eyelid while the patient looks upwards. The notch is ~5 *mm* from one end of the strip and is where the strip is bent over the eyelid. Ask the patient to close the eye. Wait for exactly 5 minutes, then remove the strip. Normally at least 10 *mm* of the paper will be dampened by tears.



Location of different taste modalities on the tongue surface



Schirmer's test

CN- VIII Vestibulocochlear Nerve

This nerve consists of two distinct parts : vestibular nerve and cochlear nerve. While the cochlear nerve is responsible for special sense of hearing, vestibular nerve is responsible for special sense of posture and equilibrium.

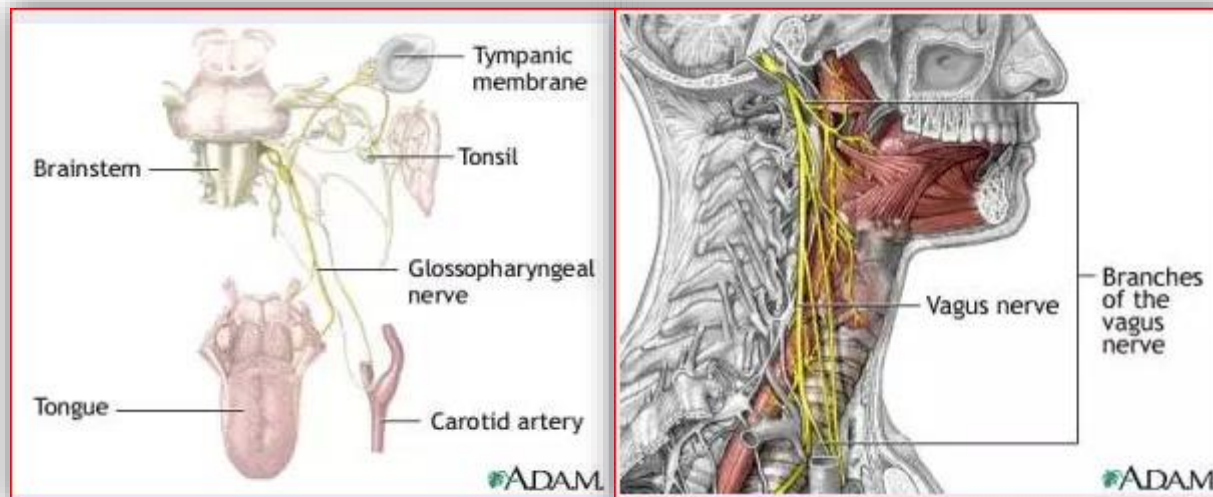
Examination of Vestibulocochlear Nerve includes testing of:

- **cochlear nerve**
- **vestibular nerve**

Examination details will be covered later in a separate lab.

CN-IX Glossopharyngeal and CN-X Vagus Nerves

- Since these nerves are intimately related anatomically and functionally, they will be considered together. These two nerves are both sensory and motor.
- The glossopharyngeal nerve innervates the stylopharyngeus muscle (motor part) and its sensory part transmits sensation from the post. 1/3 of the tongue, mucosa of pharynx, and tonsillar region and conveys taste from the post. 1/3 of the tongue.
- The vagus nerve innervates the muscles of upper pharynx and soft palate as well as the intrinsic muscles of larynx and cricothyroid. While the sensory part transmits sensation from external auditory meatus, the vagus has also an extensive connection with heart, lung, and intestine.



CN-IX Glossopharyngeal and CN-X Vagus Nerves

➤ Examination:

- Assess the volume and equality of the patient's speech (altered voice equality results from weakness of the muscles moving the vocal cord and palate).
- Ask the patient to swallow .

Dysphagia = difficulty in swallowing due to palatal paresis.

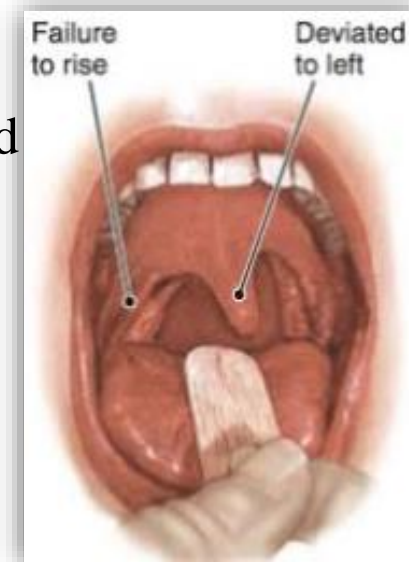
- Assess tonsillar and palatal tactile sensation using swab stick and tongue depressor.
- Elicit **gag reflex** by touching either the tonsil or pharynx or palate, test each side separately.

Afferent limb of gag reflex is the *glossopharyngeal* nerve.

Efferent limb of gag reflex is the *vagus* nerve.

- Ask him/her to say 'Ah'; look at the movements of the palate and uvula using a torch. Normally, both sides of the palate elevate symmetrically and the uvula remains in the midline.

In a patient with **right side palsy** , the uvula deviates to the left side and the palate on right side not elevated, and vice versa.

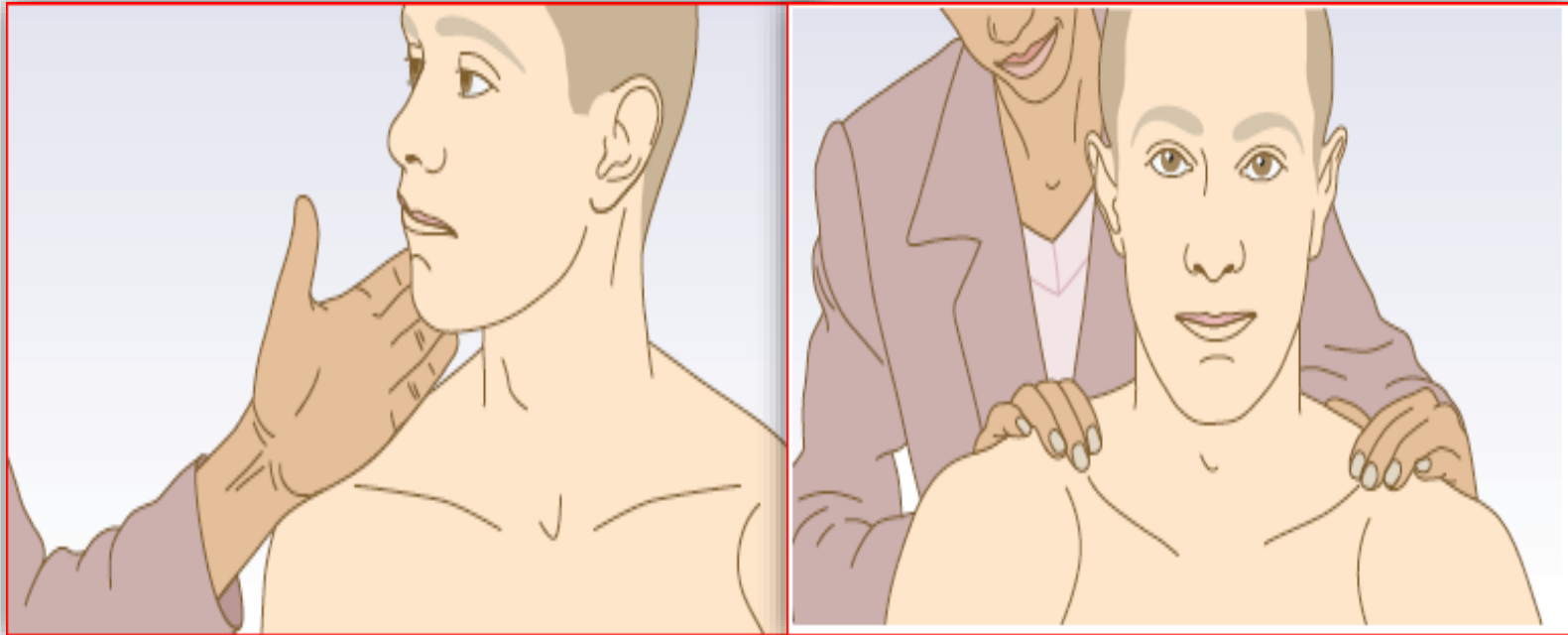


right side palsy

CN- XI Accessory Nerve

- This nerve is a motor nerve that is formed by the union of cranial and spinal roots. The *cranial root* joins the vagus nerve and is distributed in its pharyngeal and recurrent laryngeal branches to the muscles of soft palate, pharynx, and larynx. The *spinal root* arises from the upper fifth cervical spinal segment supplying sternocleidomastoid and trapezius muscles.
- **Examination**
 - Face the patient and inspect the sternocleidomastoid muscles for wasting or hypertrophy; palpate them to assess their bulk.
 - Stand behind the patient to inspect the trapezius muscle for wasting or asymmetry.
 - Ask the patient to shrug the shoulders, then apply downward pressure with your hands to assess the power. Unilateral lesion leads to weakness on that side with dropping of shoulder at that side.
 - Test power in the left sternocleidomastoid by asking the patient to turn the head to the right while you provide resistance with your hand placed on the right side of the patient's chin. Reverse the procedure to check the right sternocleidomastoid

CN- XI Accessory Nerve Examination



Testing the left sternocleidomastoid and trapezius muscles

CN- XII Hypoglossal Nerve Examination

- This is a motor nerve that supplies the muscles of tongue.
- **Examination:**
 - Ask the patient to open his mouth. Look at the tongue for wasting, fasciculation or involuntary movement.
 - Ask the patient to put out his tongue. Look for deviation or involuntary movement.
 - Ask the patient to move the tongue quickly from side to side.
 - Test power by asking the patient to press the tongue against the inside of each cheek in turn while you press from the outside with your finger
- *Normally* when the tongue is protruded, it must be *symmetrical* and in the *midline*.
- **Abnormalities:**
 - Unilateral hypoglossal nerve paralysis will produce a deviation of the tip of the tongue toward the paralyzed side.
 - The presence of *fasciculation on the tongue or wasting indicate lower motor neuron lesion. With upper motor neuron lesion, there is no fasciculation or wasting.*

CN- XII Hypoglossal Nerve Examination

➤ **Remember:**

- Lesion of the V and XII cranial nerves leads to a **deviation toward the abnormal side** (side of lesion). $5+12=17$
- Lesion of the VII and X cranial nerves leads to a **deviation toward the normal side** (intact side). $10+7=17$



Figure 1 Tongue deviated to the left side.



Figure 2 Atrophy of the left side of the tongue.



Figure 3 Atrophy of left side of tongue, fissures on left side of tongue.

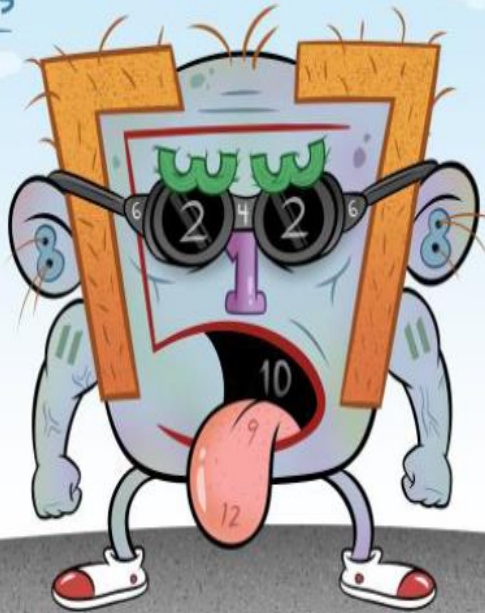
Sum up of CN reflexes

Summary of the afferent and efferent limbs of the cranial nerves:

Reflex	Afferent limb	Efferent limb
Jaw jerk reflex	Trigeminal n. (V3)	Trigeminal n. (V3)
Accommodation reflex	Optic n., tract.	Oculomotor n.
Pupillary light reflex	Optic n.	Oculomotor n.
Corneal reflex	Ophthalmic division of trigeminal nerve.	Facial n.
Gag reflex	Glossopharyngeal n.	Vagus n.

CRANIAL NERVES

1. OLFACTORY
2. OPTIC
3. OCULOMOTOR
4. TROCHLEAR
5. TRIGEMINAL
6. ABDUCENS



7. FACIAL
8. ACOUSTIC
9. GLOSSOPHARYNGEAL
10. VAGUS
11. ACCESSORY
12. HYPOGLOSSAL

REMEMBER ME...

- SOME
- SAYS
- MONEY
- MATTERS
- BUT
- MY
- BROTHER
- SAYS
- BIG
- BRAIN
- MATTERS
- MOST



- **S**-SENSORY
- **M**- MOTOR
- **B**- BOTH

All in
sequence