Objectives for Cranial Nerves: CNS Perspective

1. Be able to identify cranial nerves on gross brain specimens and identify cranial nerve nuclei within brainstem sections. Be able to write the cranial nerve as its proper name or as a Roman numeral. i.e. optic nerve or C.N. II

2. Describe the function and/or functions of each cranial nerve.

3. Be able to explain the pathway of each cranial nerve, i.e. describe where the cell bodies (within the CNS) are located, where the axons project to and synapse upon. (You will not be responsible for describing/identifying peripheral ganglion.)

4. Be able to identify cranial nerve lesions when given a case study and also to identify where the lesion is located. Or list the signs/symptoms a patient will have if a cranial nerve or nucleus is lesioned.

Outline

I. Cranial nerves overview

II. Cranial nerve I (olfactory nerve)
    A. Function
    B. Pathway
    C. Clinical correlations

III. Cranial nerve II (optic nerve)
    A. Function
    B. Pathway

IV. Cranial nerve III (occulomotor nerve)
    A. Function
    B. Pathway
        1. occulomotor pathway
    C. Clinical correlations

V. Cranial nerve IV (trochlear nerve)
    A. Function
    B. Pathway
    C. Clinical correlation

VI. Cranial nerve V (trigeminal nerve)
    A. Function
    B. Pathways
        1. Sensory
            a. Pain and temperature pathway
            b. Tactile, vibratory sensation pathway
            c. Proprioceptive pathway
        2. Motor pathway
    C. Clinical correlations

VII. Cranial nerve VI (abducens nerve)
    A. Function
    B. Pathway
    C. Clinical correlation

VIII. Cranial nerve VII (facial nerve)
    A. Function
    B. Pathways
        1. Motor efferent pathway
        2. Visceral motor efferent pathway
        3. General sensory pathway
        4. Special sensory pathway
    C. Clinical correlations
        1. Bell palsy

IX. Cranial nerve VIII (vestibulocochlear nerve)
    A. Function

X. Cranial nerve IX (glossopharyngeal nerve)
    A. Function
    B. Pathways
        1. General sensory pathway
        2. Visceral censory pathway
        3. Special sensory pathway
        4. Branchial motor pathway
        5. Visceral motor pathway
    C. Clinical correlations

XI. Cranial nerve X (vagus nerve)
    A. Function
    B. Pathways
        1. General sensory
        2. Visceral sensory
        3. Branchial motor
        4. Visceral motor
    C. Clinical correlations
        1. Gag reflex

XII. Cranial nerve XI (spinal accessory nerve)
    A. Function
    B. Pathway
    C. Clinical correlation

XIII. Cranial nerve XII (hypoglossal nerve)
    A. Function
    B. Pathway
    C. Clinical correlation

Cranial Nerves: CNS Perspective
Anatomy & Function

- There are 12 cranial nerves that emerge from the cranium.

- These nerves provide sensory and motor information for the head and neck

- There are 6 distinct modalities carried by the cranial nerves:
    1. General Sensory
    2. Visceral Sensory
    3. Special Sensory
    4. Somatic Motor
    5. Branchial Motor
    6. Visceral Motor

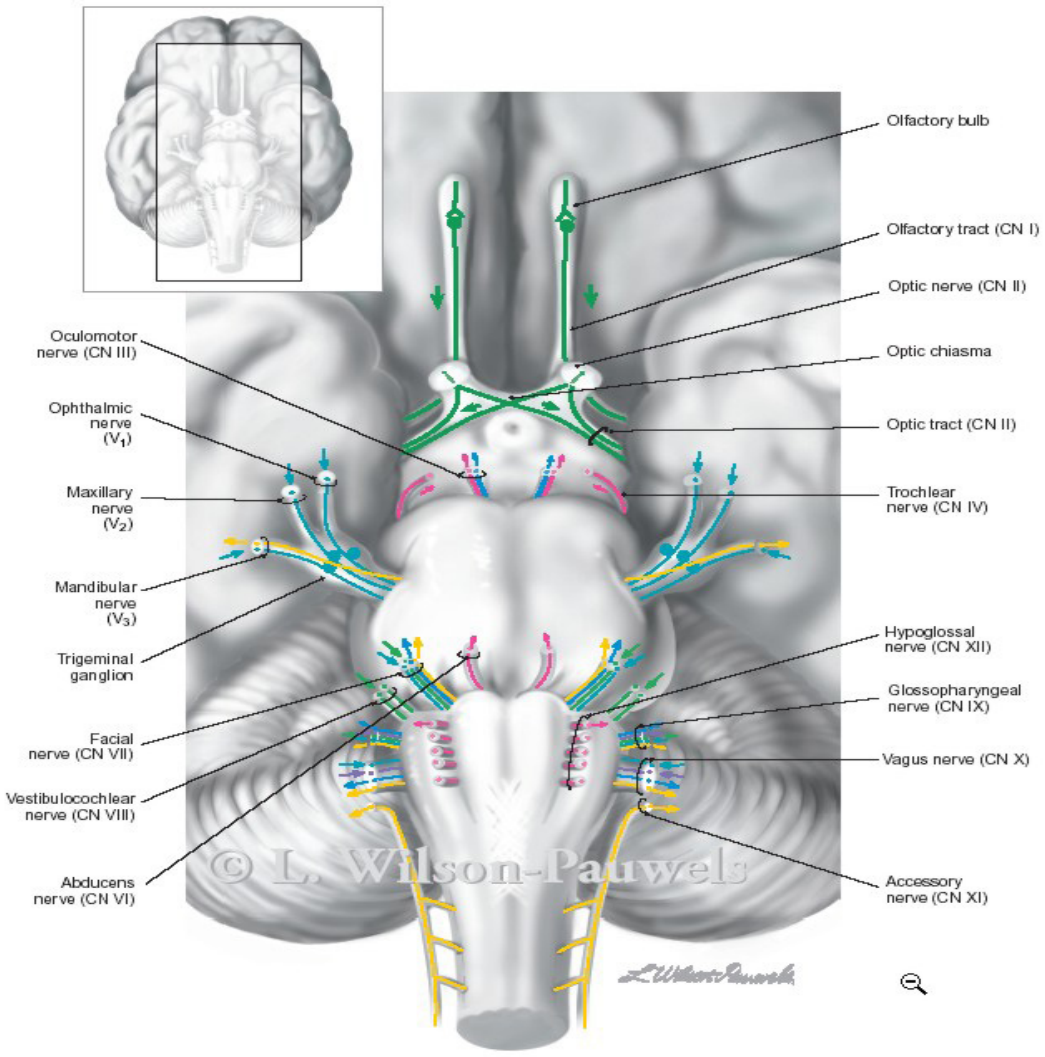


Figure 1 Basal view of the brain and brain stem (cropped).

Cranial Nerve I - Olfactory Nerve

Function: The Olfactory nerve **relays odorant information** from the olfactory epithelium to the pyriform cortex. (Special Sensory)
More information regarding special sense of olfaction will be presented later in the course.

Pathway:
The olfactory epithelium consists of CN I cell bodies whose axons project through the cribriform plate to synapse on the olfactory bulbs (cell bodies of second neuron in the olfactory pathway) whose axons (the olfactory tracts) will bifurcate at olfactory trigone into medial and lateral striae and synapse in the pyriform (pear shaped) area of the inferior temporal lobe.

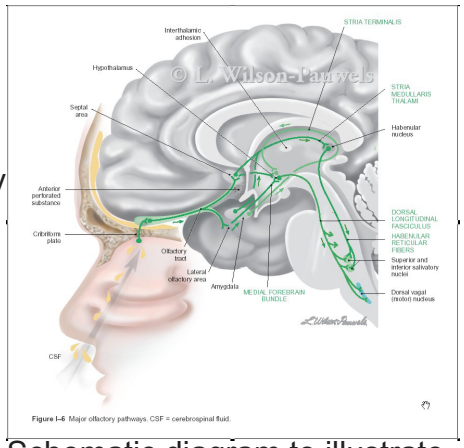


Figure I–6 Major olfactory pathways. CSF = cerebrospinal fluid.

Schematic diagram to illustrate the **location of CN I.**

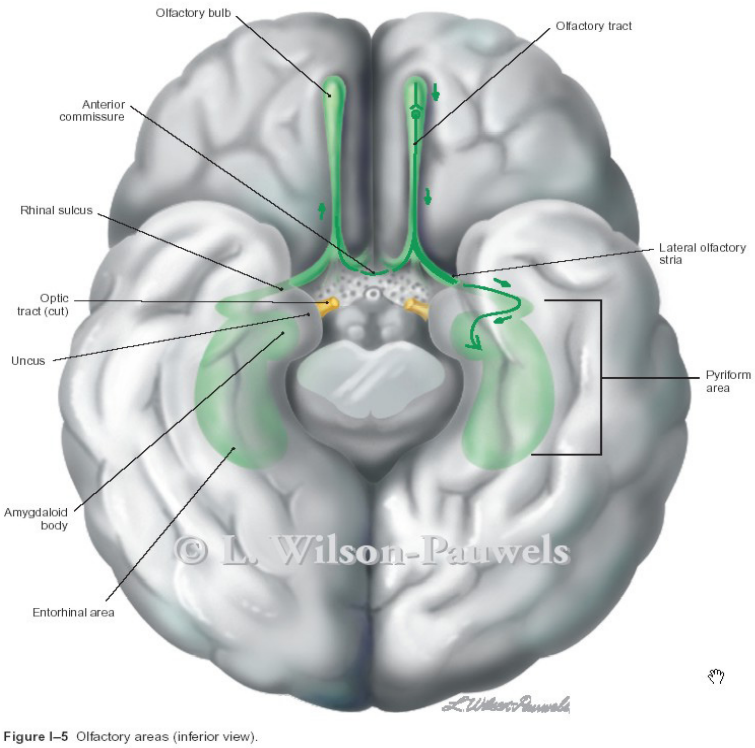


Figure I–5 Olfactory areas (inferior view).

Inferior brain view illustrating **olfactory bulbs, olfactory tracts, olfactory trigone and the pyriform area**

Clinical Correlations:
(detailed information regarding correlations will be presented by your clinical faculty)
An anteroposterior skull fracture parallel to the superior sagital suture can tear olfactory axons in the cribriform plate resulting in ipsilateral loss of smell = **anosmia**.

Frontal lobe tumors or meningiomas on the floor of the anterior cranial fossa can interfere with the transmission of olfactory information.

Damage to the primary cortical olfactory area in the temporal lobe from tumors or seizures can result in olfactory hallucinations (phantom smells).

Cranial Nerve II: The Optic Nerve

Function: CN II is part of the visual system which **transduces light energy into visual information.** You will learn the specifics of visual sensory transduction later in the course.

Pathway:
Light energy is transduced via rods and cones of the bipolar neurons which synapse onto the **ganglion cells (CN II cell bodies)** of the retina that projects its axons out of the eye as the **optic nerve** to the **optic chiasm** and **optic tract** which synapses onto the lateral geniculate nucleus of the thalamus whose axons project to the visual cortex in the occipital lobe.
You will learn the specifics of this pathway later in the course.

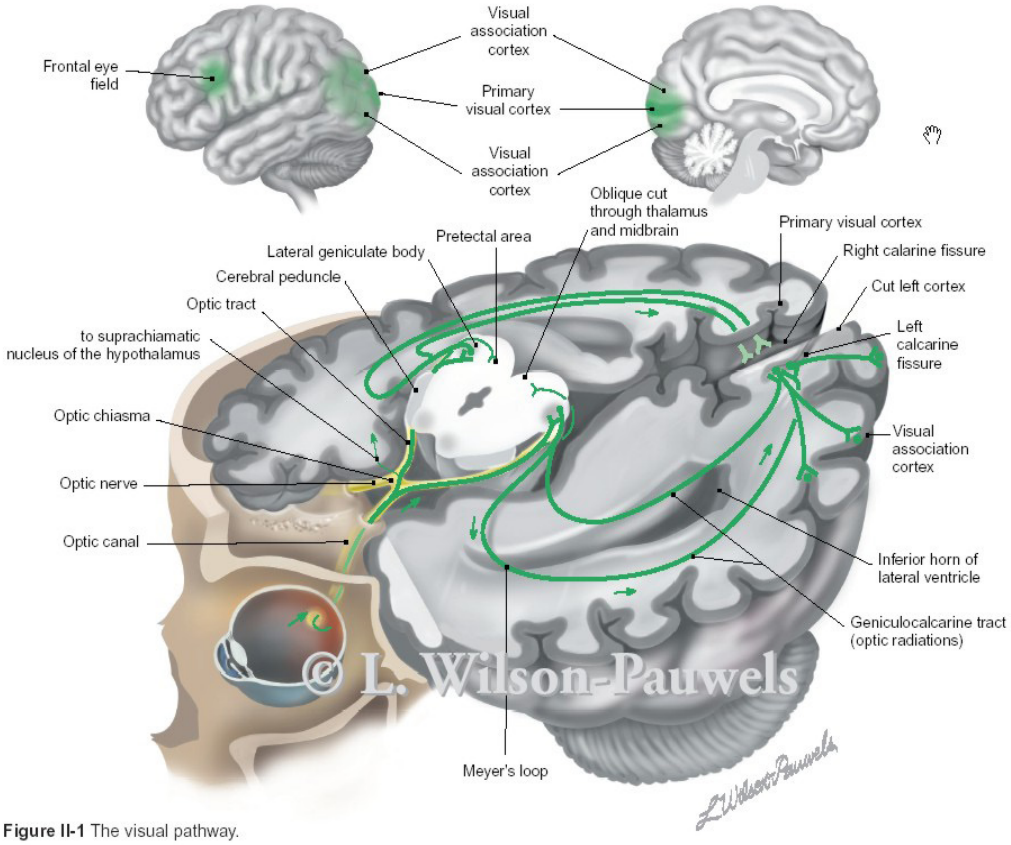
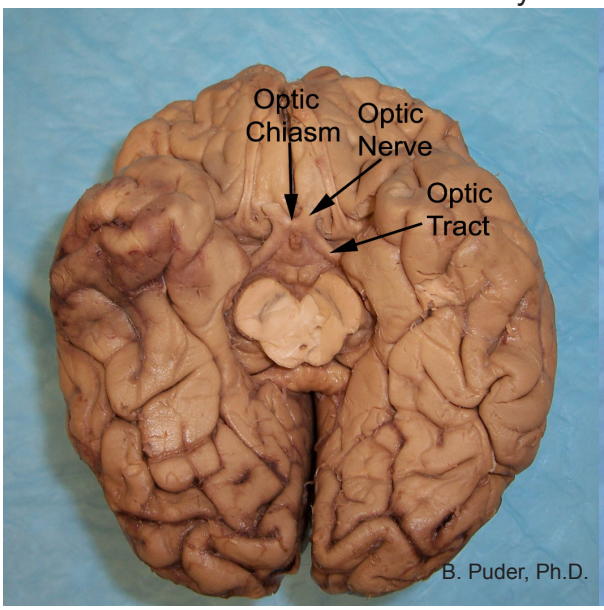


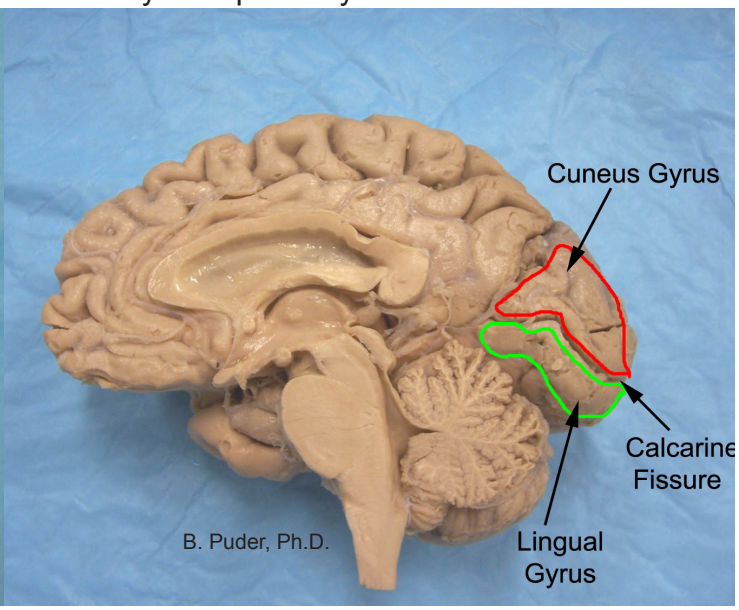
Figure II-1 The visual pathway.

Schematic illustration depicting the visual pathway. You will learn the specifics of this pathway later in the course. Today, we are using this image to depict CN II cell bodies in the retina and **CN II axons** are called the **optic nerve, optic chiasm,** and **optic tract**.

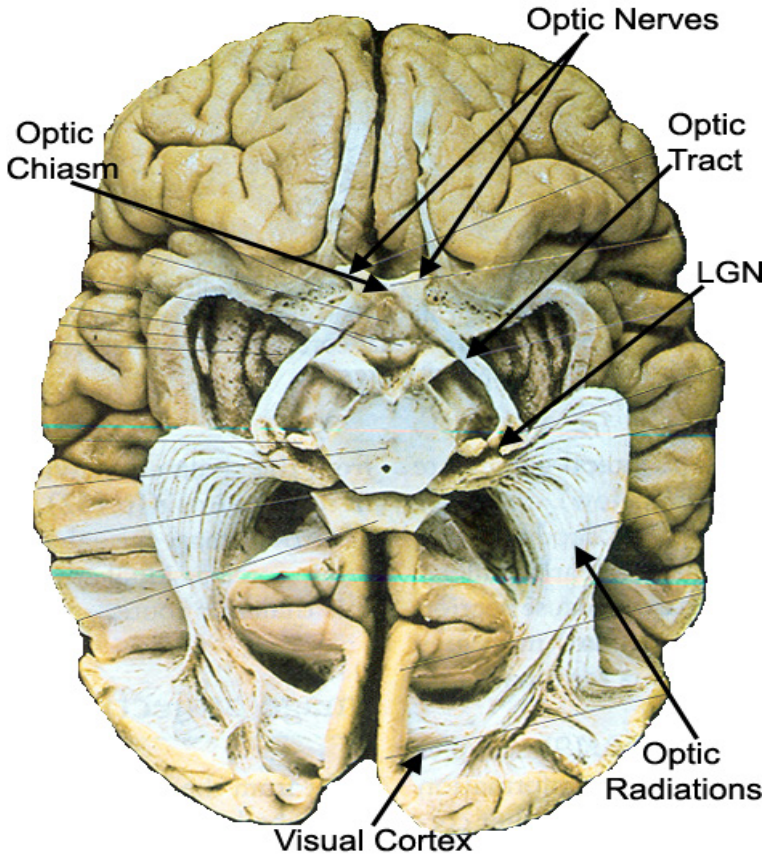
Gross anatomy of the visual system pathway



Inferior view of **optic nerves, chiasm,** and **tracts**



Mid-sagittal view of **occipital lobe, cuneus** and **lingual gyri,** and **calcarine fissure**



Special dissection depicting the visual system pathway

Clinical Correlate:
Damage to CN II results in ipsilateral blindness.
Lesions involving the rest of the visual system pathway will be discussed later in the course.

Cranial Nerve III - Occulomotor Nerve

Function: The Occulomotor nerve **innervates 4 of the 6 eye muscles necessary for eye movement** and the s**uperior eyelid muscle** - **levator palpebrae superioris**.

There is also a parasympathetic visceral motor component which **innervates intrinsic ocular muscles necessary for pupillary constriction.**

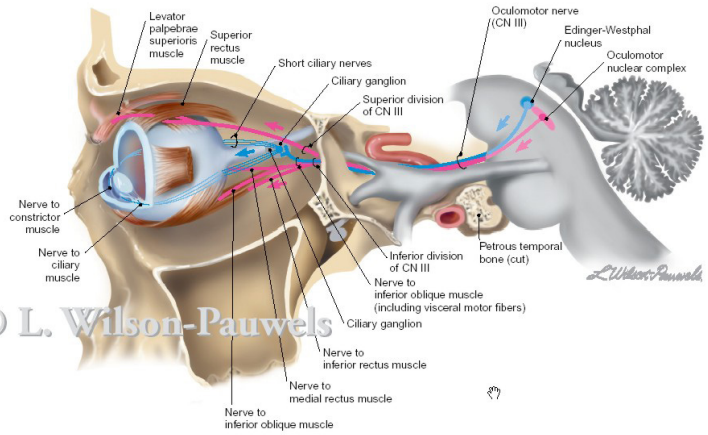


Figure III–1 Overview of the oculomotor nerve.

Schematic Illustration used for gross anatomy review.

Occulomotor Nerve Pathway: Anatomy Review

The Occulomotor nerve exits the midbrain through the interpeduncular fossa, pierces dura mater and travels through the cavernous sinus to the superior orbital fissure and through the tendinous ring in the orbit where the nerve divides into a superior and inferior division.

The superior division innervates the superior rectus m., and levator palpebrae superioris m. The inferior division innervates the inferior rectus m., inferior oblique m., and medial rectus m.

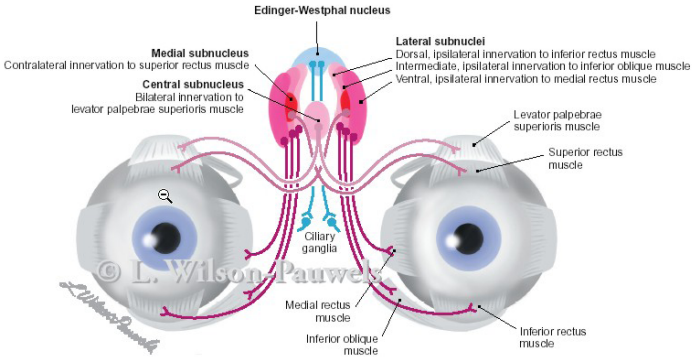
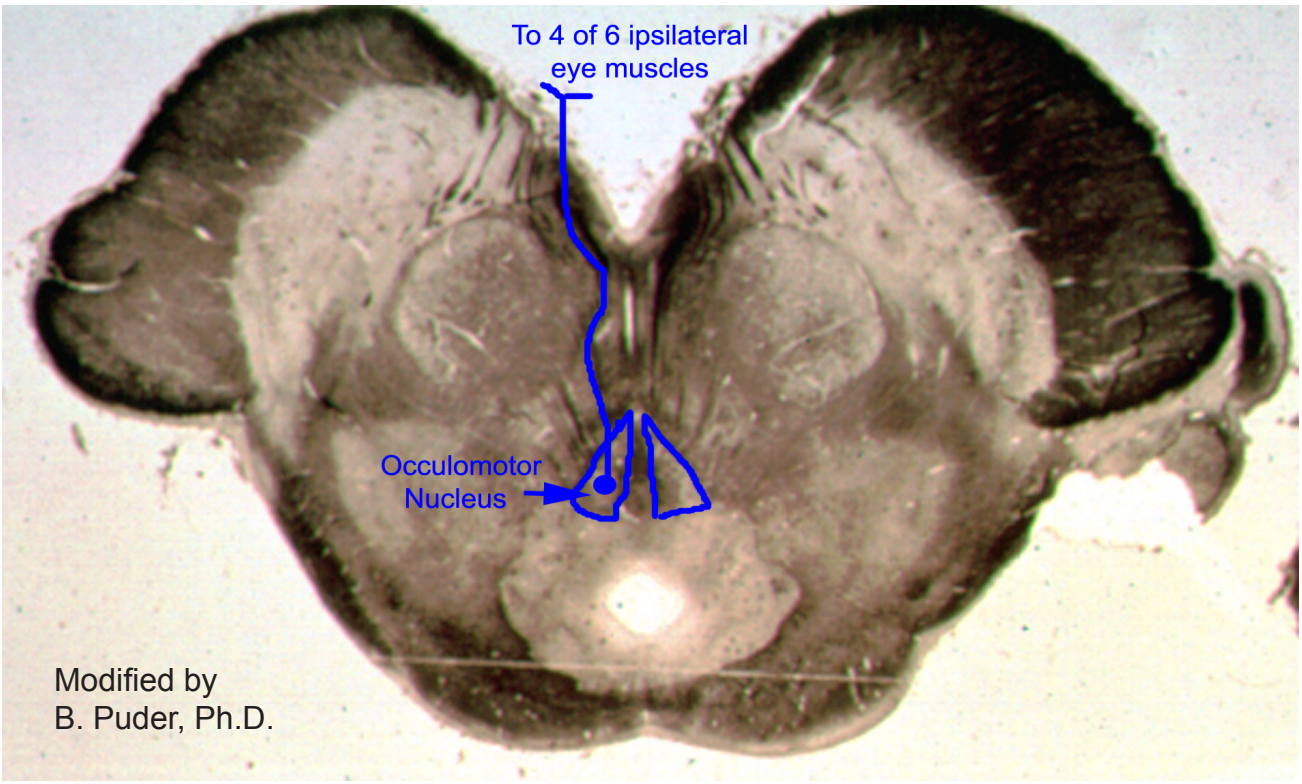


Figure III–3 Oculomotor nuclear complex and schematic innervation of extraocular muscles (the functions of the Edinger-Westphal nucleus are discussed with the visceral motor component of cranial nerve III).

Schematic Illustration used for gross anatomy review.

Occulomotor nucleus and nerve Pathway



Rostral Midbrain depicting the **occulomotor nucleus** and its **axons (occulomotor nerve)** projecting out to 4 extraocular eye muscles and the upper eyelid muscle.

Clinical Correlate:
A lesion to the occulomotor nucleus or nerve results in **paralysis of 4 of the 6 ipsilateral eye muscles** causing the **ipsilateral eye to be in a downward, abducted position** resulting in **strabismus and diplopia** (double vision).
Ptosis (eyelid droop) will also be present because innervation to the eyelid muscle is lost.

Additionally, there is a small group of cell bodies called the Edinger-Westphal nucleus which contain the visceral motor (parasympathetic) component of CN III.
The Edinger-Westphal nucleus is located near the occulomtor nucleus - but too small to identify on our midbrain section. These axons project out to the pupillary constrictor and ciliary muscles of the ipsilateral eye causing pupillary constriction and accomodation.
A lesion to the Edinger-Westphal nucleus and nerve results in a dilated pupil and loss of accomodation.

The Edinger-Westphal pathway and function and dysfunction will be discussed in complete detail during the eye movements and future clinical lectures.

Cranial Nerve IV: Trochlear Nerve

Function:

The Trochlear nerve **innervates the superior oblique muscle** of the eye.

The **action** of the **superior oblique muscle** is for **inward rotation and downward movement of the eye.** (the eye movement used when trying to walk down a set of steps)

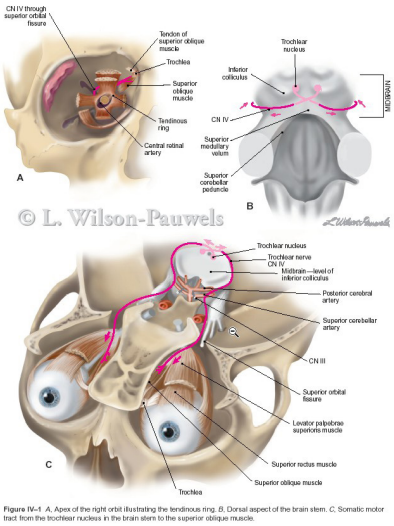
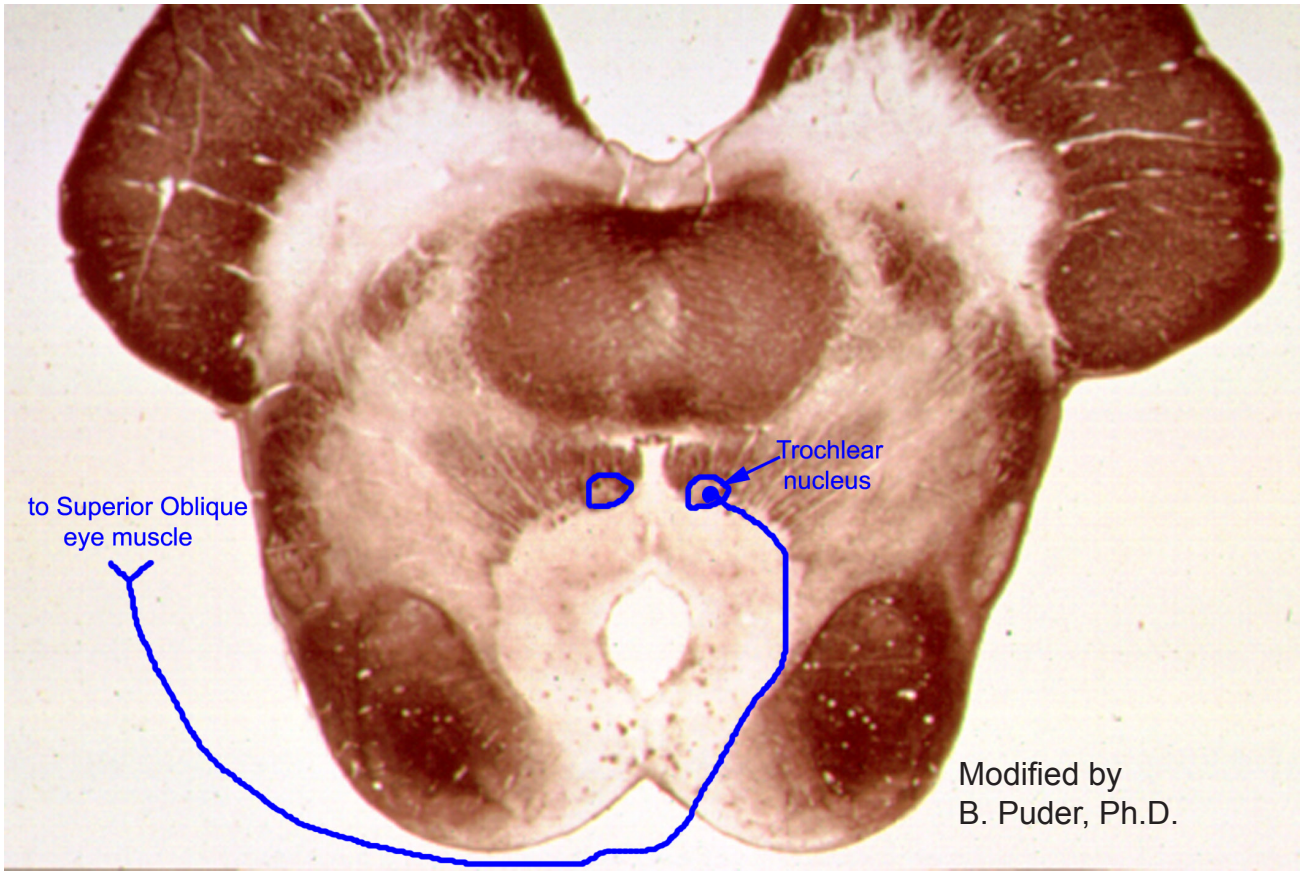


Figure IV–1 *A*, Apex of the right orbit illustrating the tendinous ring. *B*, Dorsal aspect of the brain stem. *C*, Somatic motor tract from the trochlear nucleus in the brain stem to the superior oblique muscle.

Schematic Illustration used for gross anatomy review of trochlear nerve pathway

Trochlear nucleus and nerve Pathway



Caudal Midbrain section depicting the **trochlear nucleus** and its **axon (trochlear nerve)** which exits posteriorly and crosses to innervate the contralateral superior oblique eye muscle.

Clinical Correlations:

A vascular lesion such as an aneurysm of the posterior cerebral or superior cerebellar arteries could damage CN IV.

A pathological lesion in the cavernous sinus or superior orbital fissure could also affect CN IV (as well as CN II, III, V_1, V_2& VI).

A lesion of CN IV would exhibit lower motor neuron symptoms.

- Outward rotation of the eye
- Diplopia
- Weakness of downward gaze

A patient with a lesion of the Trochlear nucleus/nerve will tilt their head to the unaffected side to correct the diplopia.

**Please note: a trochlear nucleus lesion would result in contralateral deficits whereas a trochlear nerve (the axons) will result in ipsilateral deficits. (Please refer to the midbrain section on the previous page to understand this concept). The trochlear nucleus is the only cranial nerve nucleus that is contralateral to its nerve component.

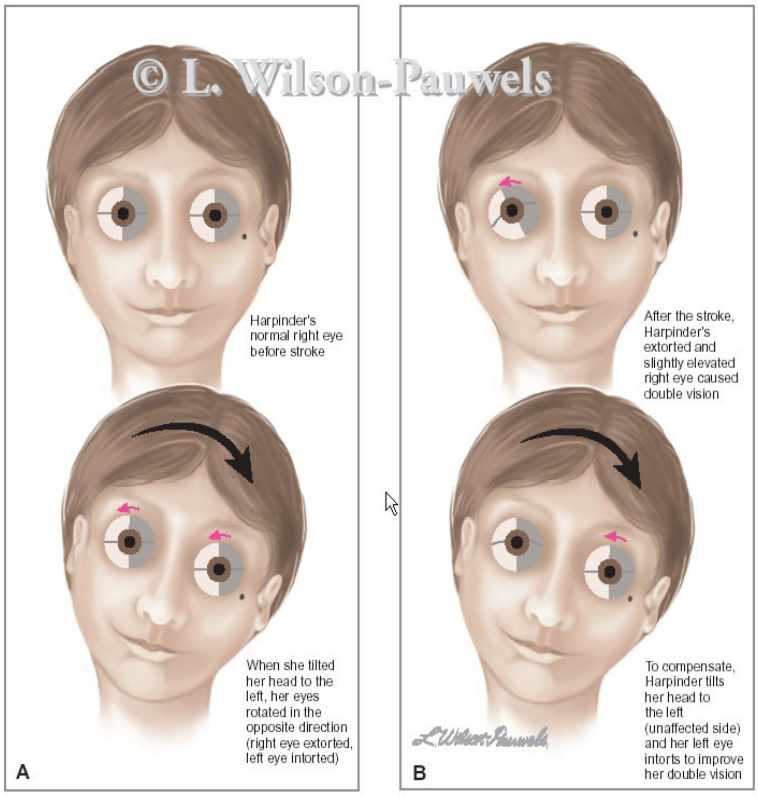


Figure IV–5 Ocular rotation. *A*, Before Harpinder's stroke; *B*, after Harpinder's stroke.

Cranial Nerve V: Trigeminal Nerve

Function:

The trigeminal nerve (3 twins) has 3 major divisions:

1. Ophthalmic (V_1)
2. Maxillary (V_2)
3. Mandibular (V_3)

2 modalities are represented in the Trigeminal Nerve:

1. **General Sensory** (V_1, V_2,V_3)
2. **Branchial Motor** (V_3)

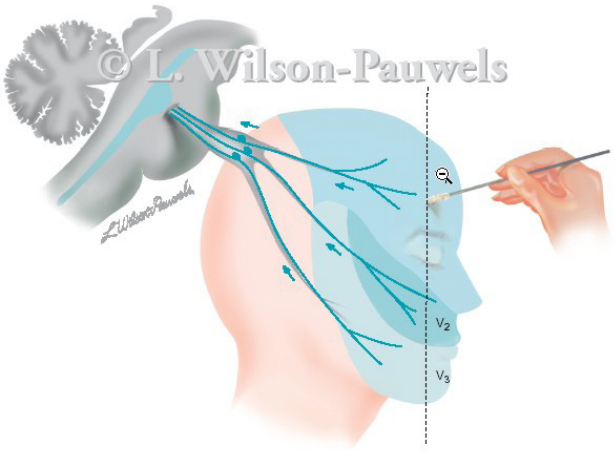


Figure V–19 Clinical testing for sensation.

Schematic illustration to depict the V_1, V_2, V_3

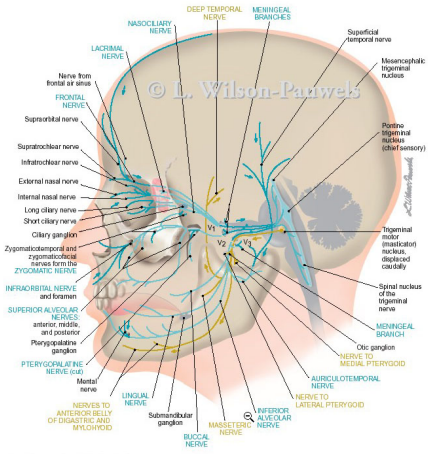


Figure V–2 Overview of the trigeminal nerve.

Schematic Illustration used for gross anatomy review of Trigeminal nerve pathway

Clinical Correlations:

<u>Sensory Lesions</u>

tic doloureux (trigeminal neuralgia)

episodes of lancinating, severe pain of unknown etiology

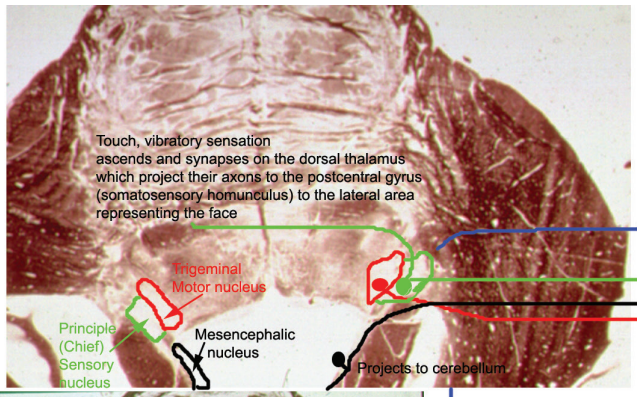
<u>Motor Lesions</u>

Lower motor neuron lesion to muscles of mastication

Characterized by paralysis, atrophy of muscles, and decreased strength of bite

Trigeminal nerve: Central nervous system nuclei and Trigeminal pathways

Mid Pons



Pain and Temperature from ipsilateral face

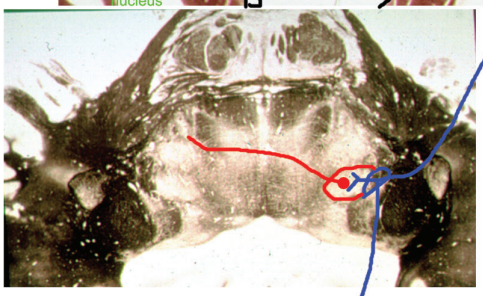
Touch, Vibratory sense from ipsilateral face

Trigeminal Motor Neuron

Muscles of Mastication

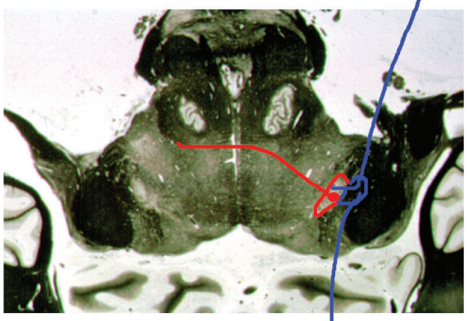
Proprioceptive Information from muscle spindles in mastication muscles

Caudal Pons



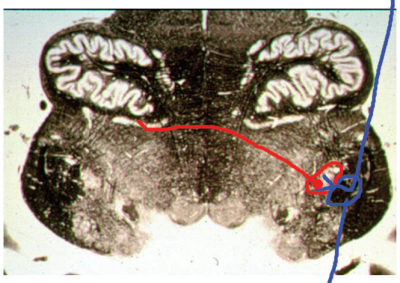
Spinal Trigeminal nucleus and tract

Rostral Medulla



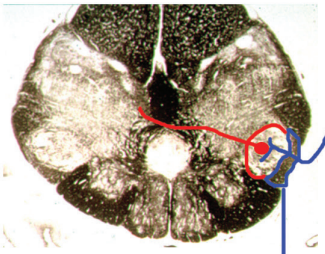
Spinal Trigeminal nucleus and tract

Mid Medulla



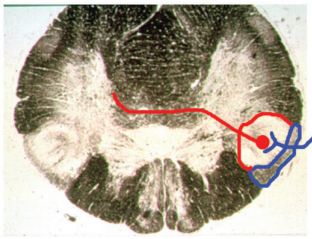
Spinal Trigeminal nucleus and tract

Caudal Medulla



Spinal Trigeminal nucleus and tract

Caudal Medulla



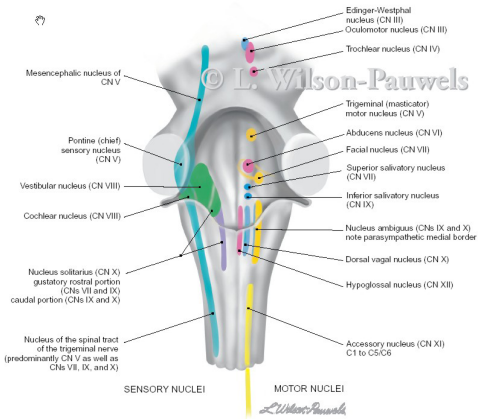


Figure 4 Cranial nerve nuclei (dorsal view of brain stem).

Schematic illustration depicting the CNS brainstem nuclei and tracts

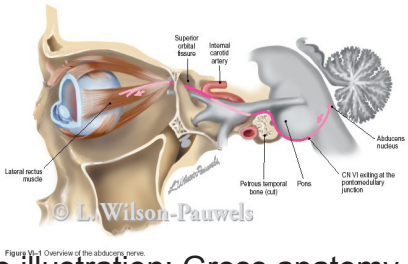
Pain and temperature sensation is relayed
via the axons of the spinal trigeminal tract to synapse
on the spinal trigeminal nucleus whose axons decussate
and ascend and synapse on the contralateral dorsal thalamus
whose axons project to the postcentral gyrus lateral area representing the face

Modified by B. Puder, Ph.D.

Detailed information regarding the trigeminal pathways will be presented during the trigeminal pathways lecture.

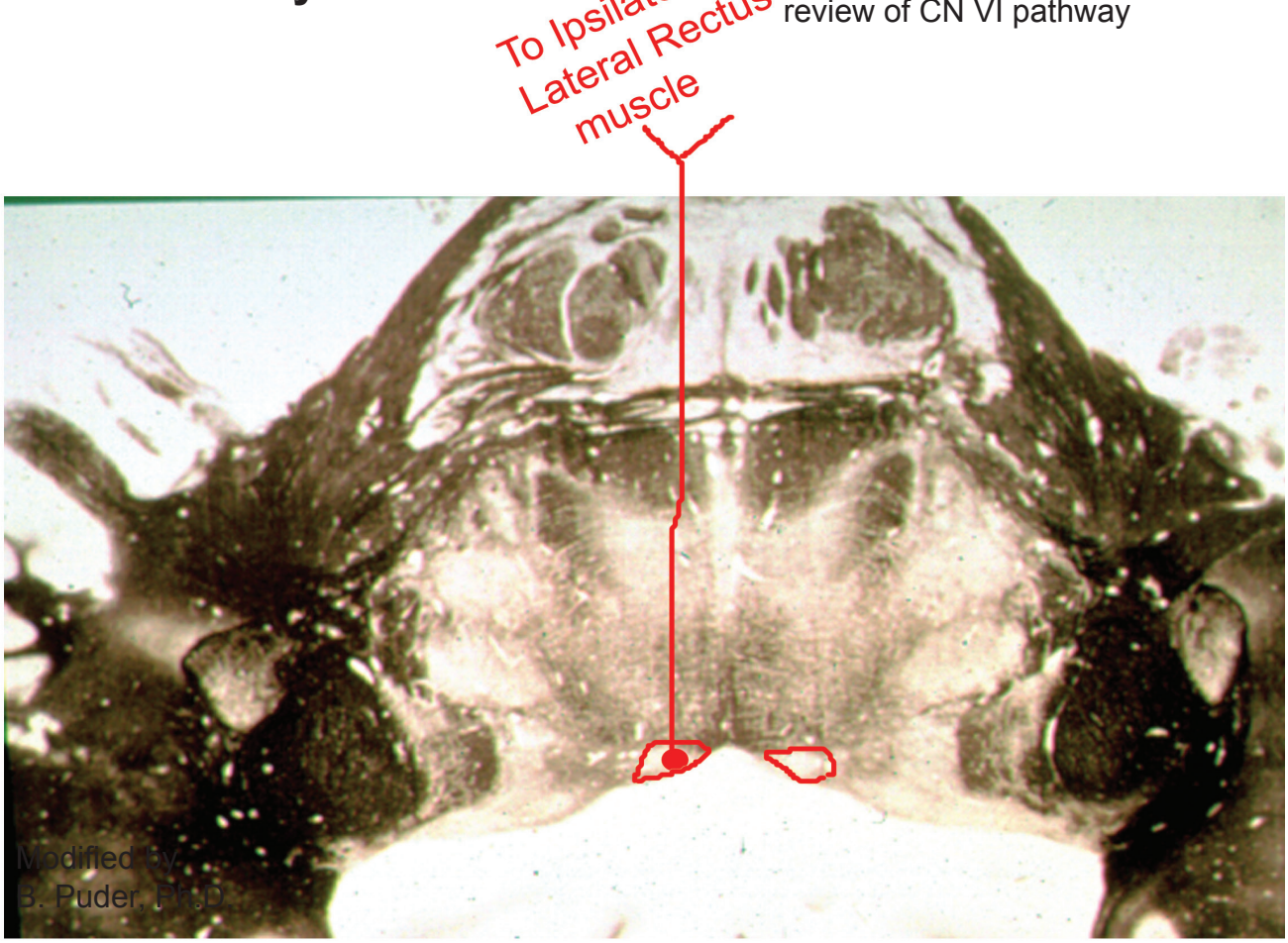
Cranial Nerve VI: Abducens Nerve

Function:
The Abducens nerve **innervates the lateral rectus muscle** of the eye.
The lateral rectus m. **rotates the eye laterally - abducts.**



CN VI: Abducens nucleus and nerve Pathway

Above illustration: Gross anatomy review of CN VI pathway



Caudal Pons section depicting the **abducens nucleus** and its axon **(abducens nerve)** projecting out to innervate the ipsilateral lateral rectus eye muscle

Clinical Correlations:

Lesions of CN VI can be caused by:
- aneurysms of PICA, Basiliar, or Internal carotid artery
- pathological conditions in the cavernous sinus

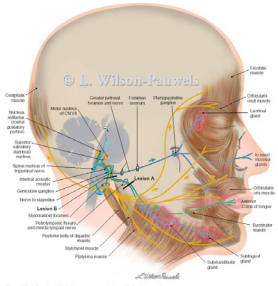
Lesions to CN VI would exhibit lower motor neuron symptoms
-medial (internal) strabismus
-diplopia

Cranial Nerve VII: Facial Nerve

Function:

Cranial nerve VII (the facial nerve) consists of 4 modalities:

1. **Branchial motor efferents to the muscles of facial expression**
2. Visceral motor efferents **(parasympathetic) to glands and mucous membranes**
3. General **sensory afferents from the ear**
4. Special sensory afferents **(taste from anterior 2/3 of tongue)**



Above illustration: Gross anatomy review of CN VII pathways

CN VII: Motor Efferent Pathway

ANATOMY REVIEW:

The efferent motor component of the facial nerve:

-emerges at the pontine level of the brainstem
-enters the internal acoustic meatus through the facial canal (the nerve to the stapedius muscle branches here)
-emerges through the stylomastoid foramen
-gives off branches to the stylohyoid m., posterior belly of the digastric m., and occipitalis m.
-passes through the parotid gland to give off 5 branches which will innervate muscles of facial expression:

temporal, zygomatic, buccal, mandibular, cervical

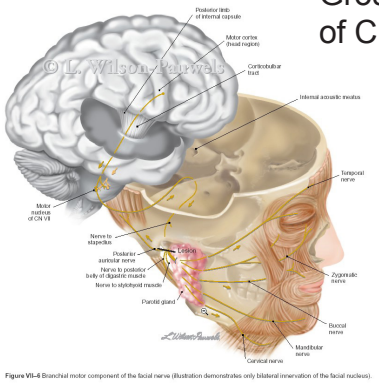
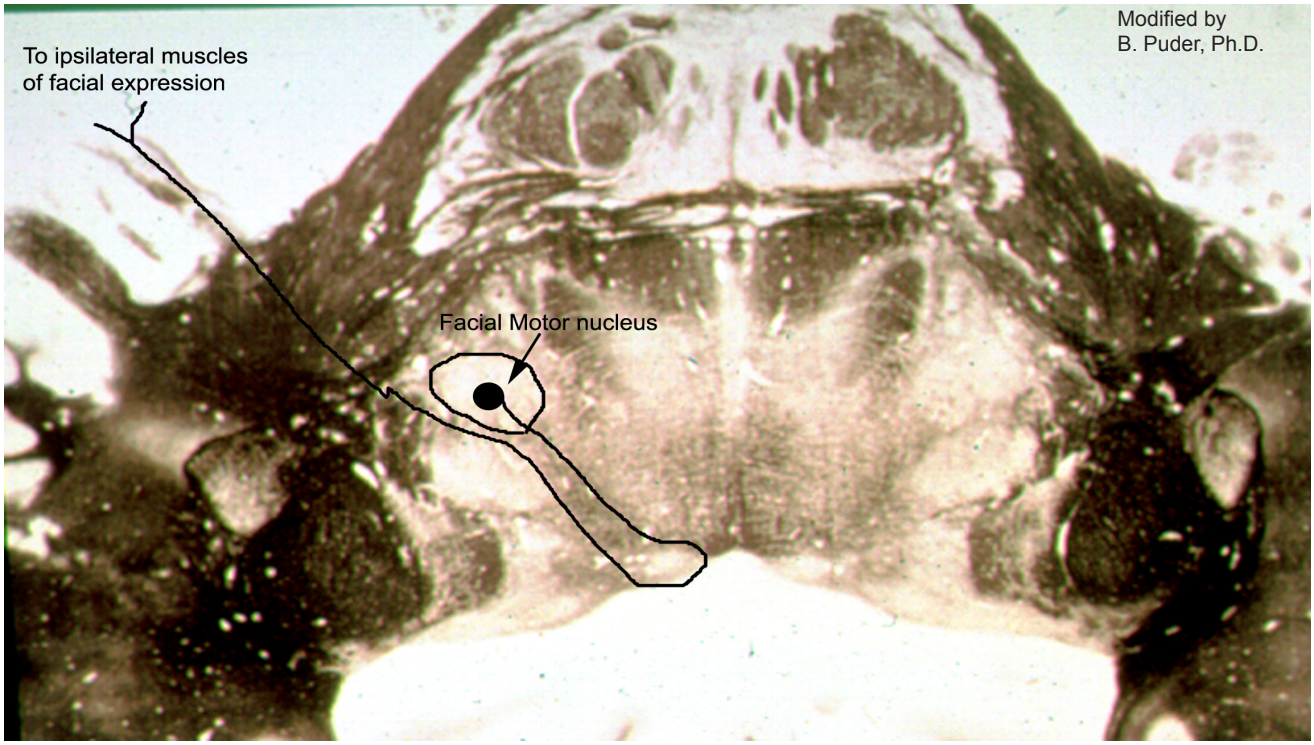


Illustration on the left: Gross anatomy review of CN VII motor efferent pathway

CN VII: Motor Efferent Pathway



Caudal Pons section depicting the **facial motor nucleus and nerve.**

CN VII:Visceral Motor Efferent Pathway

The visceral motor route consists of parasympathetic preganglionic cell bodies located in the superior salivatory nucleus in the Pons - this is a small nucleus and we did not identify it on our brainstem sections.

ANATOMY REVIEW:

-the axons of the cell bodies in the superior salivatory nucleus project to the facial canal
-the nerve divides into the greater petrosal and chorda tympani nerves
-the greater petrosal nerve:
enters the pterygopalatine canal and synapses on the pterygopalatine ganglion
(note: sympathetic nerves that travel with the internal carotid artery enter the pterygopalatine fossa and are called the deep petrosal nerve)
-parasympathetic postganglionic axons project to the lacrimal gland and mucous glands of the nasal and oral cavities
-the chorda tympani nerve:
passes through the petrotympanic fissure, travels through the floor of the oral cavity, synapses on the submandibular ganglion
parasympathetic postganglionic axons innervate the submandibular and sublingual glands

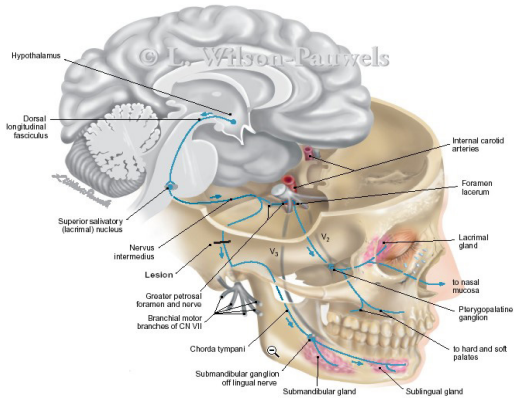


Figure VII–9 Visceral motor component of the facial nerve.

Illustration on the left: Gross anatomy review of CN VII visceral motor efferent pathway

CN VII: General Sensory Pathway

ANATOMY REVIEW:
General sensory afferents from the wall of the external acoustic meatus and external surface of the tympanic membrane enter the stylomastoid foramen.

The cell bodies are located in the geniculate ganglion which projects its axons to the spinal trigeminal nucleus in the brainstem.

CN VII: Special Sensory Pathway

ANATOMY REVIEW:
Sensory afferents relay taste information from the taste buds on the anterior 2/3 of the tongue via the chorda tympani nerve.

Cell bodies are located in the geniculate ganglion.

Axons project to the medulla and synapse in the nucleus solitarius. (NEW Information)

Gustatory (taste) pathway and physiology will be discussed in later lectures.

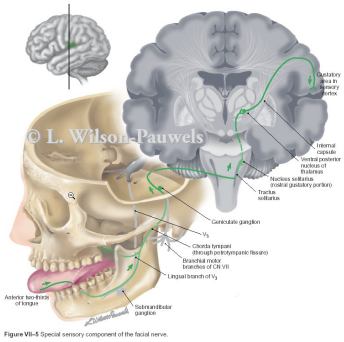
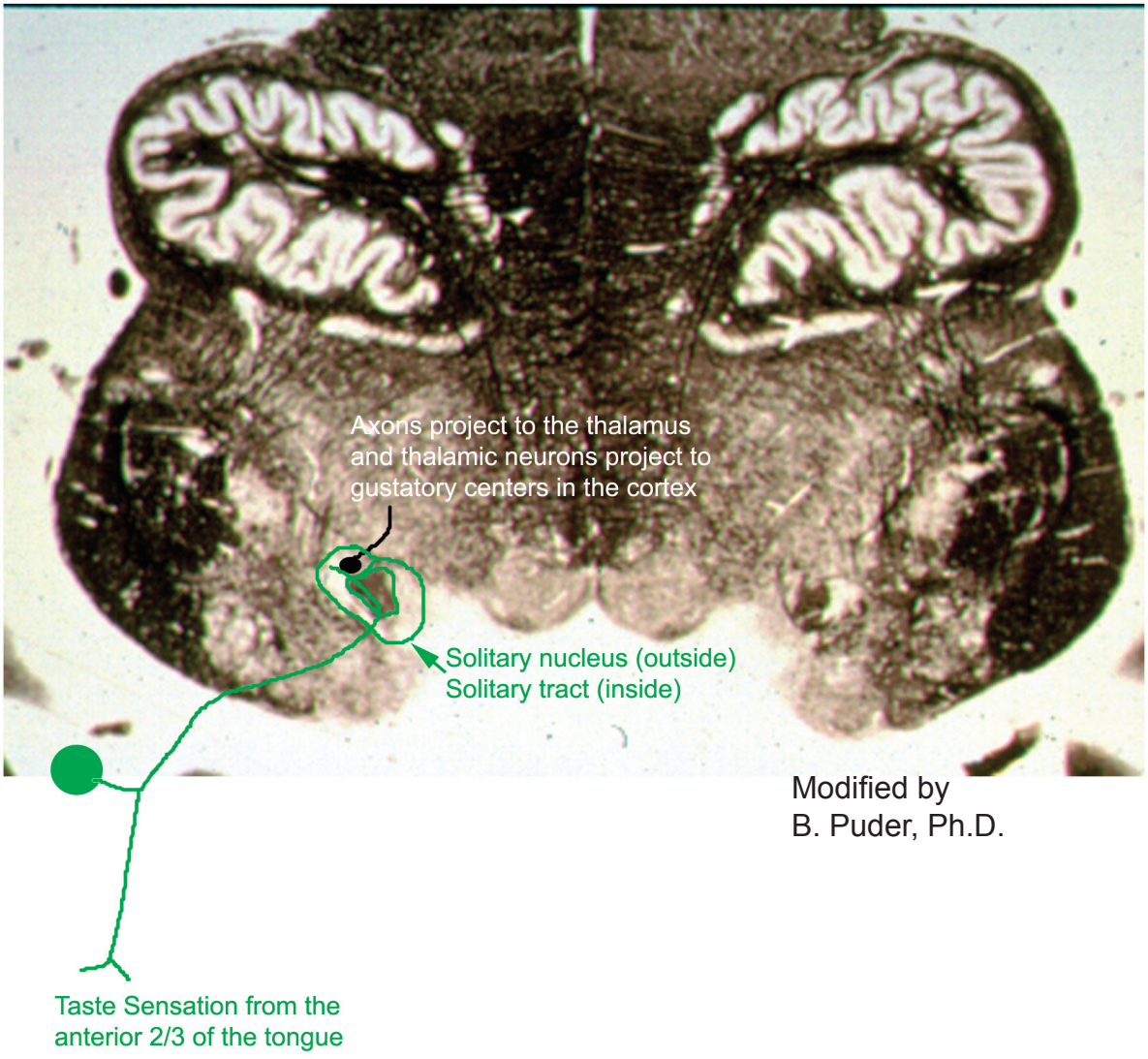


Illustration on the left: Gross anatomy review of CN VII special sensory pathway



Modified by
B. Puder, Ph.D.

Mid-medulla depicting cranial nerve VII (carrying taste sensation from the anterior 2/3 of the tongue) entering as the **solitary tract** and synapsing on the **solitary nucleus**

Clinical Correlations

A lesion to the **Facial Motor nucleus** or these nerve branches of VII will result in **ipsilateral paralysis of the face. (Bell palsy)**

These axons are also part of the **corneal blink reflex: CN V_1 (sensory) & VII (closes eyelids** - blink) - so blink reflex would be nonfuctional as well.

Lesions to the visceral motor pathway (parasympathetic) will result in lack of production of tears, nasal mucous, and saliva.

Lesions to the special sensory axons of VII will result in loss of taste = Aguesia

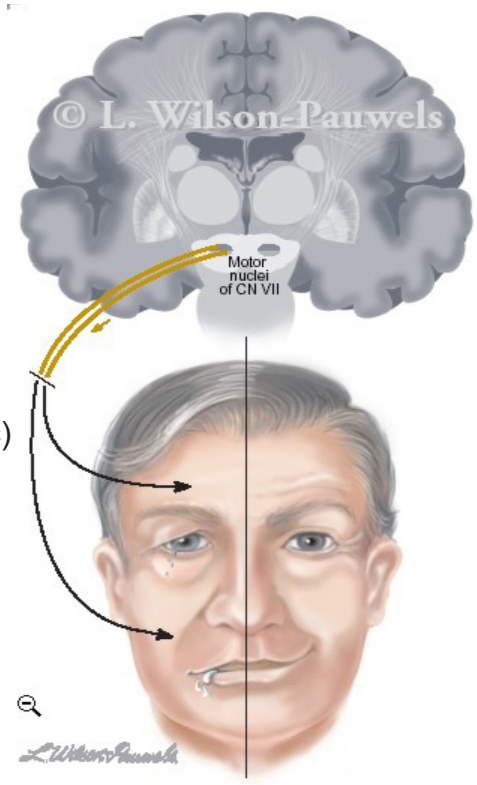
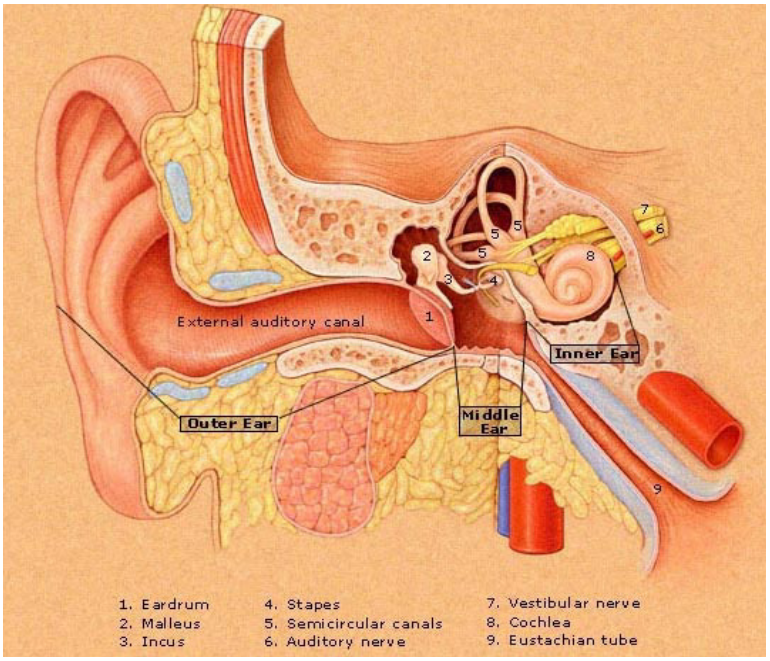


Figure VII–14 Lower motor neuron lesion in Bell's palsy with facial asymmetry—ipsilateral paralysis of upper and lower quadrants.

Cranial Nerve VIII: Vestibulocochlear Nerve

Function:
The vestibulocochlear nerve is a special sensory afferent necessary for **vestibular (balance and posture) and auditory (hearing) processing.**
CN VIII in more detail in the sensory systems lectures.



Cranial Nerve IX: Glossopharyngeal Nerve

Function:
The glossopharyngeal nerve consists of 5 modalities:

1. **General sensory - from posterior 1/3 of tongue, skin and external ear, internal surface of tympanic membrane and pharynx**

2. **Visceral sensory - from carotid body and sinus**

3. Special sensory - **taste from posterior 1/3 of tongue**

4. Branchial **motor - to stylopharyngeus muscle**

5. Visceral Motor - **(parasympathetic) to parotid gland**

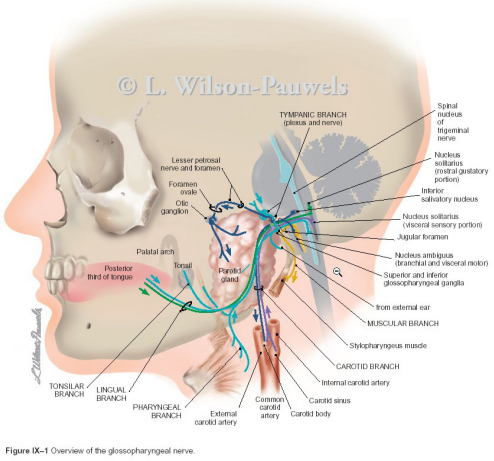


Figure IX–1 Overview of the glossopharyngeal nerve.

Schematic illustration depicting CN IX pathways

CN IX: General Sensory Pathway

ANATOMY REVIEW:
Sensory information from the external ear, inner surface of the tympanic membrane, posterior 1/3 of the tongue, and upper pharynx is carried by the glossopharyngeal nerve.

Cell bodies are located in the inferior glossopharyngeal ganglion and their axons project and synapse on the spinal trigeminal nucleus in the brainstem.

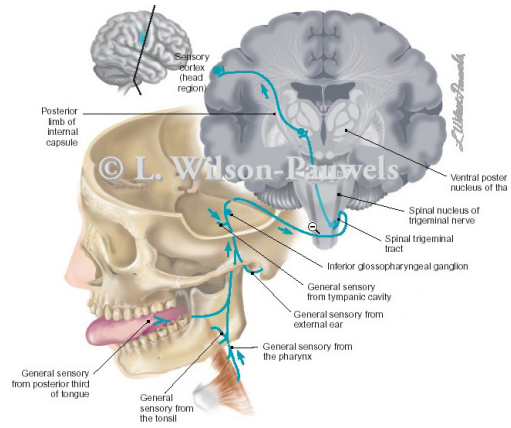


Figure IX–3 General sensory component of the glossopharyngeal nerve.

Schematic illustration depicting CN IX general sensory pathway

CN IX: Visceral Sensory Pathway

ANATOMY REVIEW:
Chemoreceptors in the carotid body (monitor oxygen in the blood) and baroreceptors in the carotid sinus (monitor arterial blood pressure) project information via the glossopharyngeal nerve.
Cell bodies are located in the inferior glossopharyngeal ganglion and axons project and synapse on the nucleus solitarius.

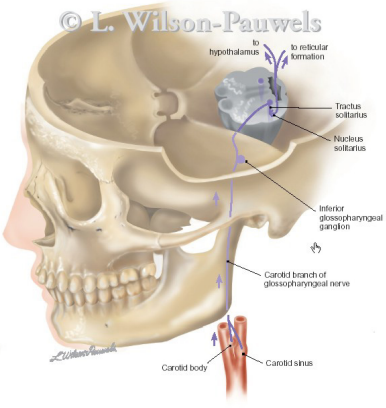


Figure IX–5 Visceral sensory component of the glossopharyngeal nerve—elevated brain stem.

Schematic illustration depicting CN IX visceral sensory pathway

CN IX : Special Sensory Pathway

Taste information from the posterior 1/3 of the tongue is carried by the glossopharyngeal nerve.

Cell bodies are located in the inferior glossopharyngeal ganglion and axons project and synapse on the nucleus solitarius in the medulla.

Detailed information regarding the taste pathway will be presented in the sensory systems lectures.

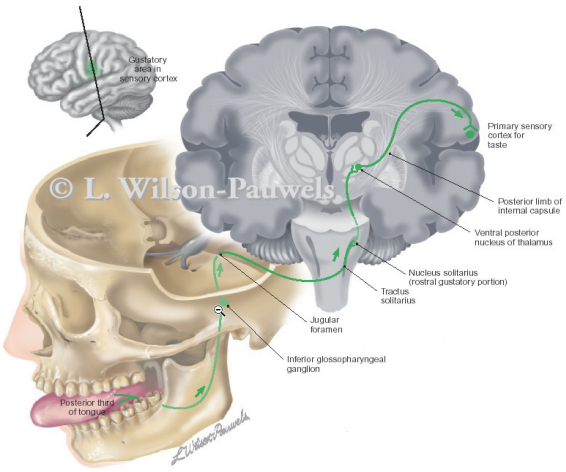
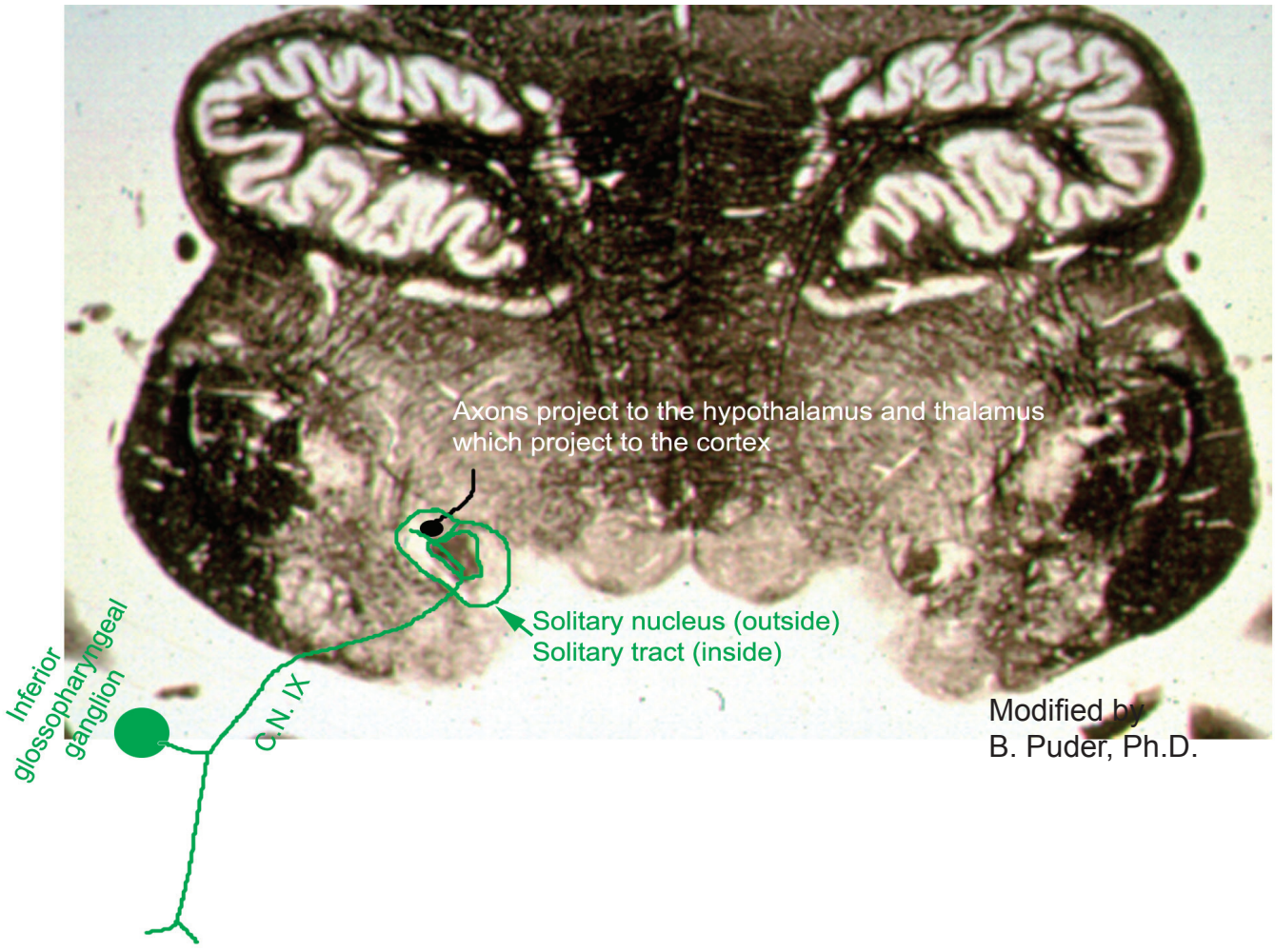


Figure IX–7 Special sensory component (for taste) of the glossopharyngeal nerve.

Schematic illustration depicting CN IX special sensory pathway



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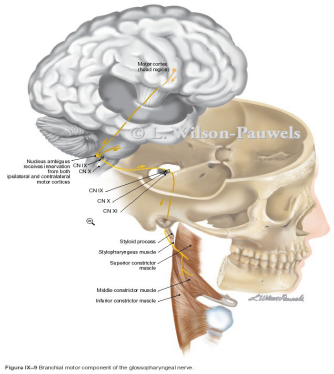
Taste Sensation and general sensation from the posterior 1/3 of the tongue,

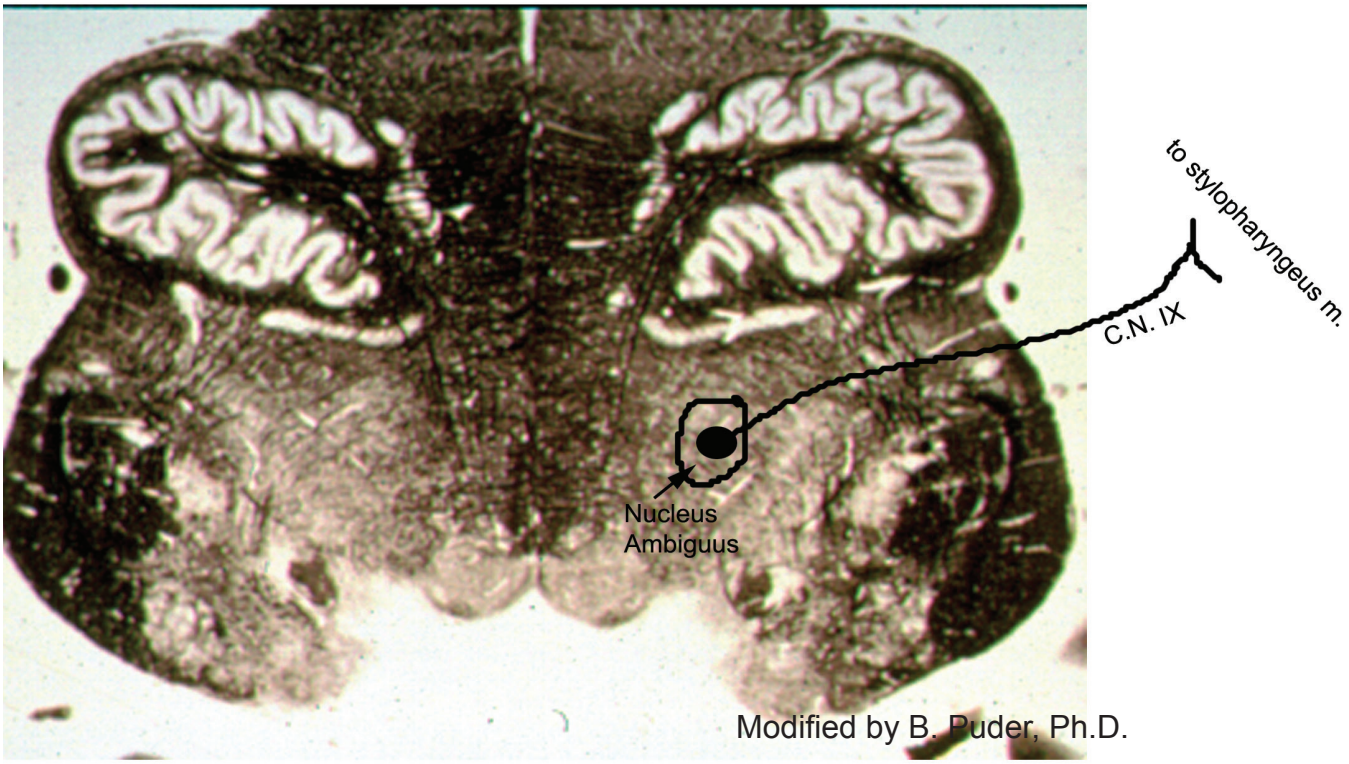
Mid-medulla depicting **cranial nerve IX relaying taste** from the posterior 1/3 of the tongue and carotid body. Taste information will enter the CNS as the **solitary tract** and synapse on the **solitary nucleus**.



CN IX: Branchial Motor Pathway

Corticobulbar (corticonuclear)tracts synapse bilaterally on the rostral nucleus ambiguous which contains cell bodies of the lower motor neurons that innervate the stylopharyngeus muscle.

Image on the left: Schematic illustration depicting CN IX brancial motor pathway



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Mid-medulla section depicting the **nucleus ambiguous cell bodies of cranial nerve IX** which will project to the stylopharyngeus muscle.

CN IX: Visceral Motor Pathway

ANATOMY REVIEW:
Preganglionic parasympathetic cell bodies located in the inferior salivatory nucleus in the medulla project their axons (the lesser petrosal nerve) out the jugular foramen and in through the foramen ovale to synapse on the otic ganglion where the postganglionic neuron will innervate the parotid gland.

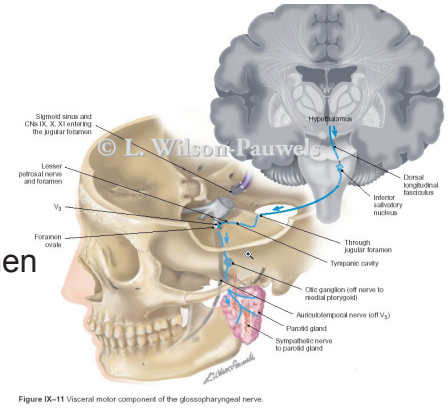


Figure IX–11 Visceral motor component of the glossopharyngeal nerve.

Schematic illustration depicting CN IX visceral motor pathway

Clinical Correlations for CN IX

Glossopharyngeal neuralgia is characterized by a sharp lancinating pain in the tonsil region that radiates to the ear. Pain sensation is triggered by yawning, swallowing, or food in the tonsilar region. No cause can usually be identified for glossopharyngeal neuralgia, but sometimes is caused by compression of CN IX caused by carotid aneursyms, oropharyngeal malignancies, peritonsillar infections, or lesions at the base of the skull.

The Gag reflex is a protective reflex that prevents entry of foreign objects into the alimentary and respiratory passages. The reflex is initiated by CN IX which relays sensation of the presence of a foreign object from the back of the mouth. The information is relayed to cranial nerve nuclei X and XII so that respiratory and alimentary passages are closed and the tongue protrudes to expel the object.

Cranial Nerve X: The Vagus Nerve

The vagus nerve (wanderer) travels from the brain-stem to the splenic
flexure of the colon to innervate visceral organs and relays sensory information from visceral organs to the brainstem.

Function:
The vagus nerve carries 4 modalities:

1. **General sensory - from the posterior meninges, external ear, pharynx and larynx**

2. **Visceral sensory - from larynx, trachea, esophagus, thoracic and abdominal visceral, stretch and chemoreceptors in the aortic arch and body**

3. **Branchial motor - to muscles of the larynx and pharynx**

4. **Visceral motor - to smooth muscles and glands of larynx and pharynx, thoracic and abdominal viscera and cardiac muscle**

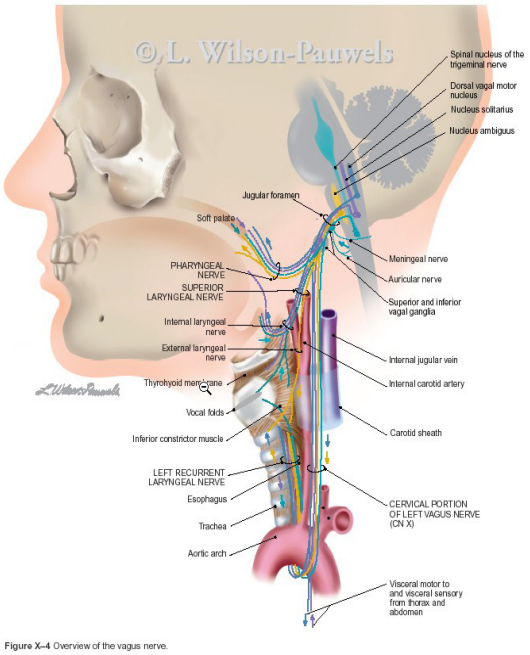


Figure X–4 Overview of the vagus nerve.

Schematic illustration of CN X pathways

CN X: General Sensory Pathway

ANATOMY REVIEW:

General sensory information from the larynx and pharynx travel via the vagus (internal laryngeal nerve) and becomes the superior laryngeal nerve where cell bodies are located in the inferior vagal ganglion.

General sensory information from the external ear and external auditory canal travel to the superior vagal ganglion where the cell bodies are located. The central processes pass through the jugular foramen and synapse in the spinal trigeminal ganglion in the brainstem.

Schematic Illustration on the right depicts CN X general sesnsory pathway

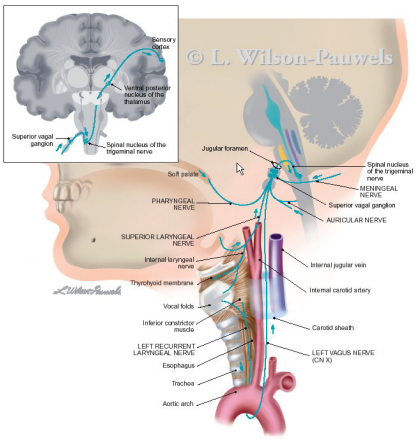


Figure X–6 General sensory component of the vagus nerve.

CN X: Visceral Sensory Pathway

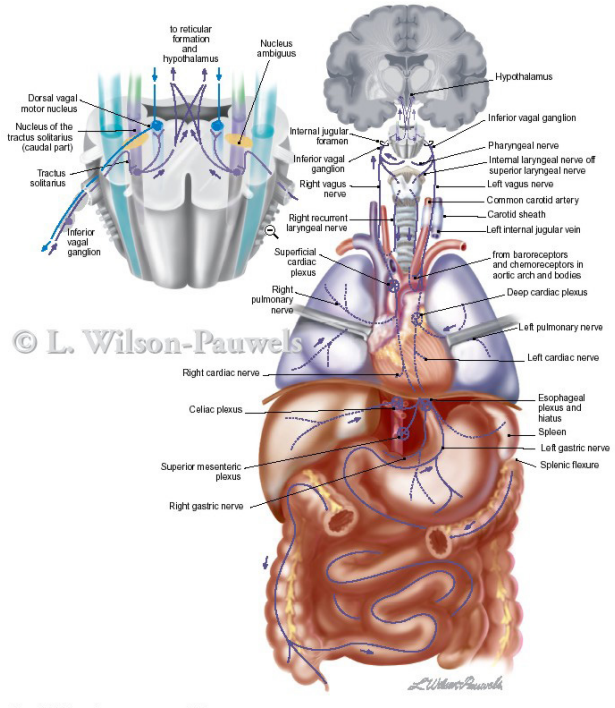


Figure X–7 Visceral sensory component of the vagus nerve.

Schematic illustration of CN X visceral sensory pathway

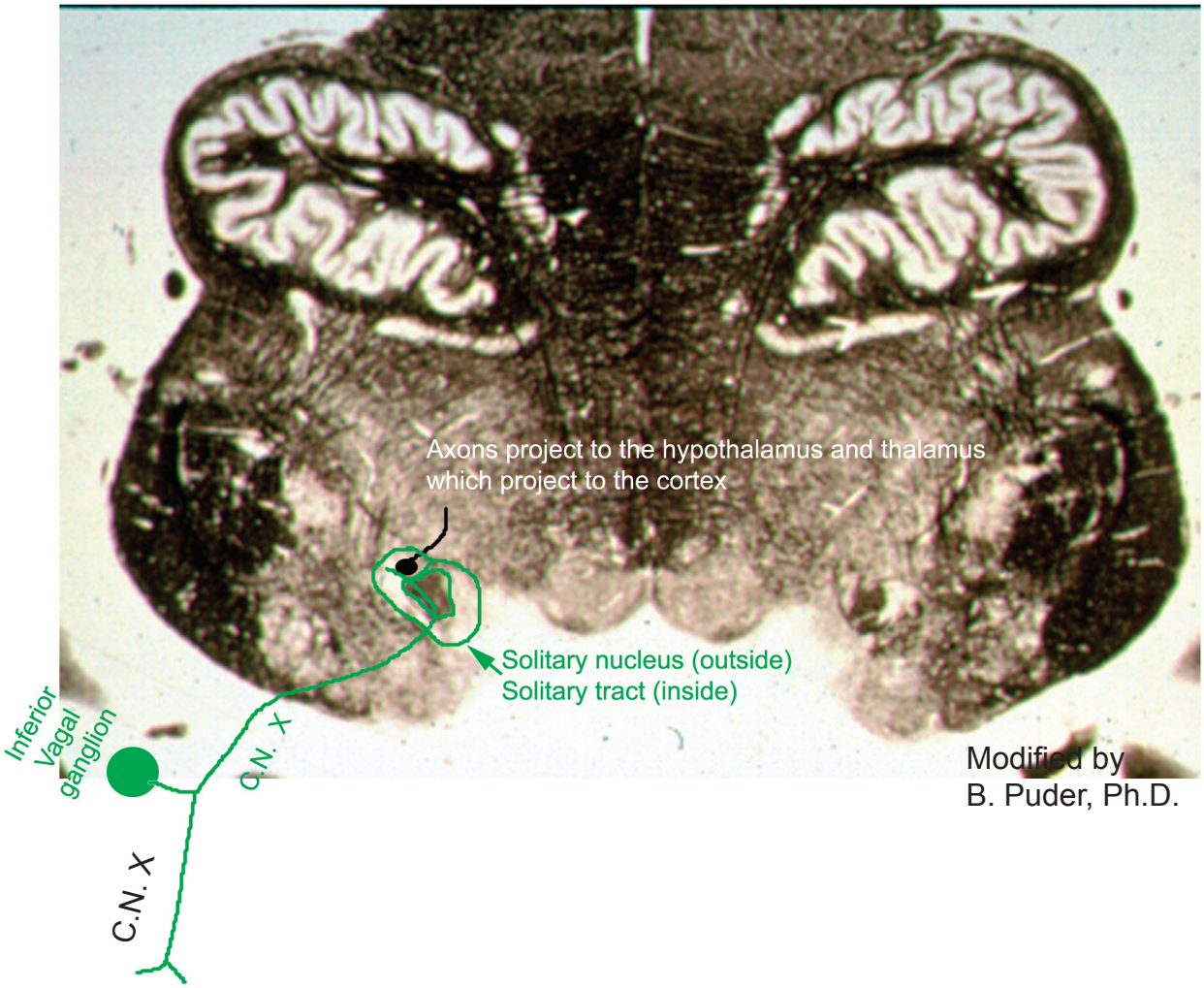
Visceral sensory information:

ANATOMY REVIEW:

-travels via the vagus nerve from the abdominal viscera via the left and right gastric nerves of the vagus
-through the esophageal hiatus
-continues up through the thorax as the right and left vagus nerves
-right and left vagus nerves are joined by nerves carrying sensory information from baroreceptors and chemoreceptors in the aorta, larynx (below the vocal cords via the recurrent laryngeal nerve), larynx above the vocal folds via the internal laryngeal nerve, and sensory information from the epiglottis, base of the tongue, and aryepiglottic folds via the pharyngeal plexus

Cell bodies located in the inferior vagal ganglion enter the brainstem and synapse on the **nucleus solitarius**.

CN X Visceral Sensory Pathway



Sensation from the pharynx, larynx, aortic bodies, thoracic and abdominal viscera

Mid-medulla section depicting **cranial nerve X relaying visceral sensory information** into the medulla via the **solitary tract** and then synapsing on the **solitary nucleus** which will project its axons to the hypothalamus and thalamus.

CN X: Branchial Motor Pathway

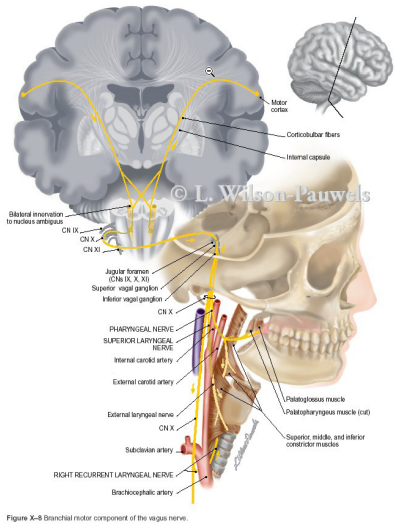
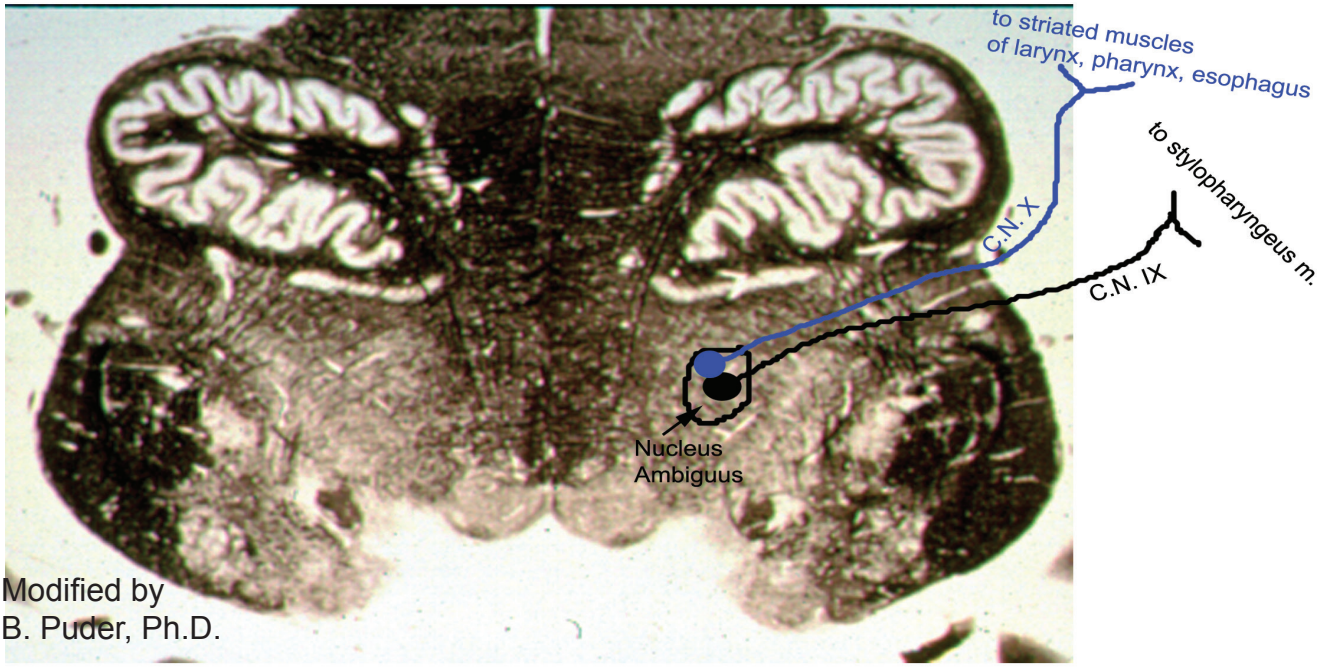


Figure X–8 Branchial motor component of the vagus nerve.

The nucleus ambiguous (medulla) contains cell bodies of motor efferents of the the vagus that leave the brainstem as 3 major branches:
(ANATOMY REVIEW)

1. Pharyngeal branch - motor to the pharynx
2. Superior laryngeal branch - divides in to internal (sensory) and external (motor) laryngeal nerves to innervate the inferior constrictor and cricothyroid muscles
3. Recurrent laryngeal branch - has a different path on the right and left sides of the body. Right recurrent laryngeal nerve arises anterior to the subclavian artery and hooks back under and ascends posteriorly. The left recurrent laryngeal nerve arises from the left vagus on the aortic arch and hooks back under the arch and ascends through the superior mediastinum. Both right and left recurrent laryngeal nerves supply the muscles of the larynx (except the cricothyroid muscle).

Image on the left: Schematic illustration of CN X branchial motor pathway



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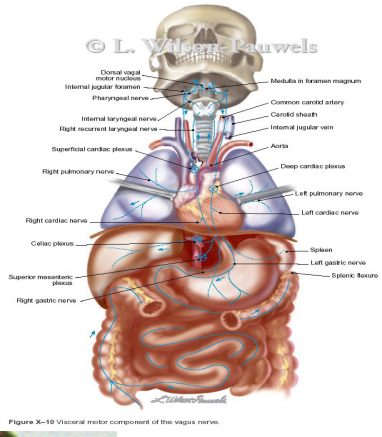
B. Puder, Ph.D.

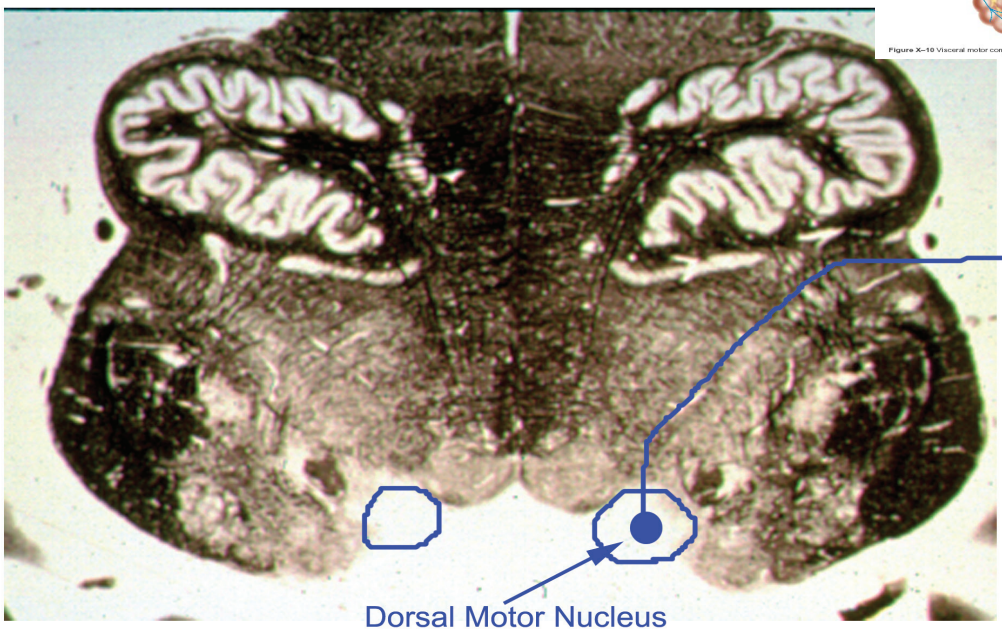
Mid-medulla section depicting the **nucleus ambiguous** whose axons project as cranial nerves IX and X.

CN X: Visceral Motor Pathway

Parasympathetic preganglionic cell bodies are located in the dorsal motor nucleus of the vagus in the medulla. The axons project to the ganglia located on or near the organ which is to be innervated.

Image to the right: Schematic Illustration of CN X visceral motor pathway





C.N. X

Preganglionic Parasympathetic neuron

Dorsal Motor Nucleus of the Vagus

Modified by
B. Puder, Ph.D.

Preganglionic neuron will synapse on a postganglionic neuron which will innervate thoracic and abdominal viscera, smooth and cardiac muscle, glandular epithelium

Postganglionic neuron

Clinical Correlations for CN X

Perform the Gag reflex to test the integrity of CN IX (sensory component) and CN X (motor component)
- Touch the right and left sides of the pharynx. If circuitry is intact, pharyngeal wall contracts when touched.

To test the integrity of CN X
- Observe posterior pharynx at rest and during phonation (contraction of superior pharyngeal muscle)

If lesioned, the uvula deviates towards the normal side.

Cranial Nerve XI: Spinal Accessory Nerve

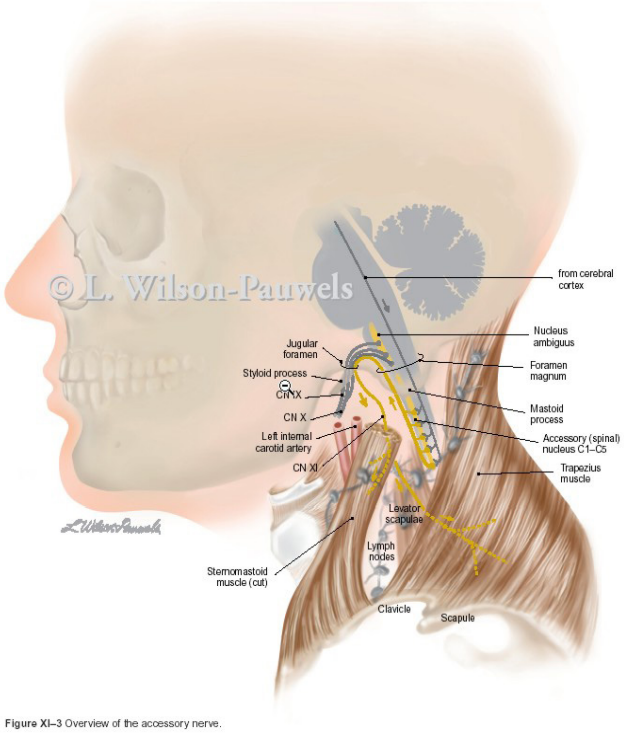


Figure XI–3 Overview of the accessory nerve.

Function:
The spinal accessory nerve is a branchial motor efferent with cell bodies located in the anterior horn of spinal cord segments C1-C5.

The axons travel up through the foramen magnum and out the jugular foramen to **innervate the sternocleidomastoid and trapezius muscles.**

Image on the left: Schematic Illustration of CN XI pathway.

Clinical correlations for CN XI

Damage to the spinal accessory nerve causes lower motor neuron symptoms to the ipsilateral trapezius and sternocleidomastoid muscles.

The patient would not be able to raise the affected shoulder (loss of innervation to the trapezius m.) or turn their to the opposite side (loss of innervation to the sternocleidomastoid m.) if CN XI is lesioned.

Cranial Nerve XII: The Hypoglossal Nerve

Function:
The **hypoglossal nucleus** located in the medulla contains **cell bodies of lower motor neurons that project their axons** through the hypoglossal canal **to innervate the intrinsic and extrinsic tongue muscles.**

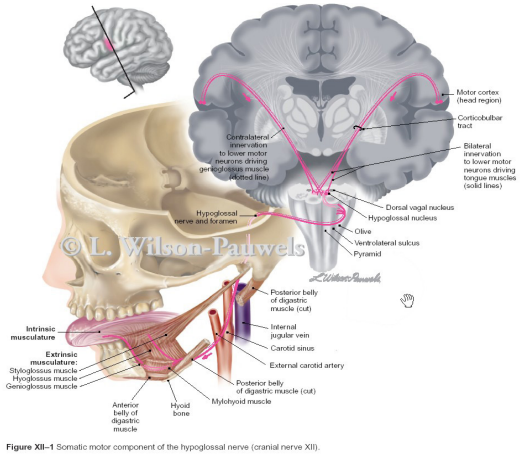
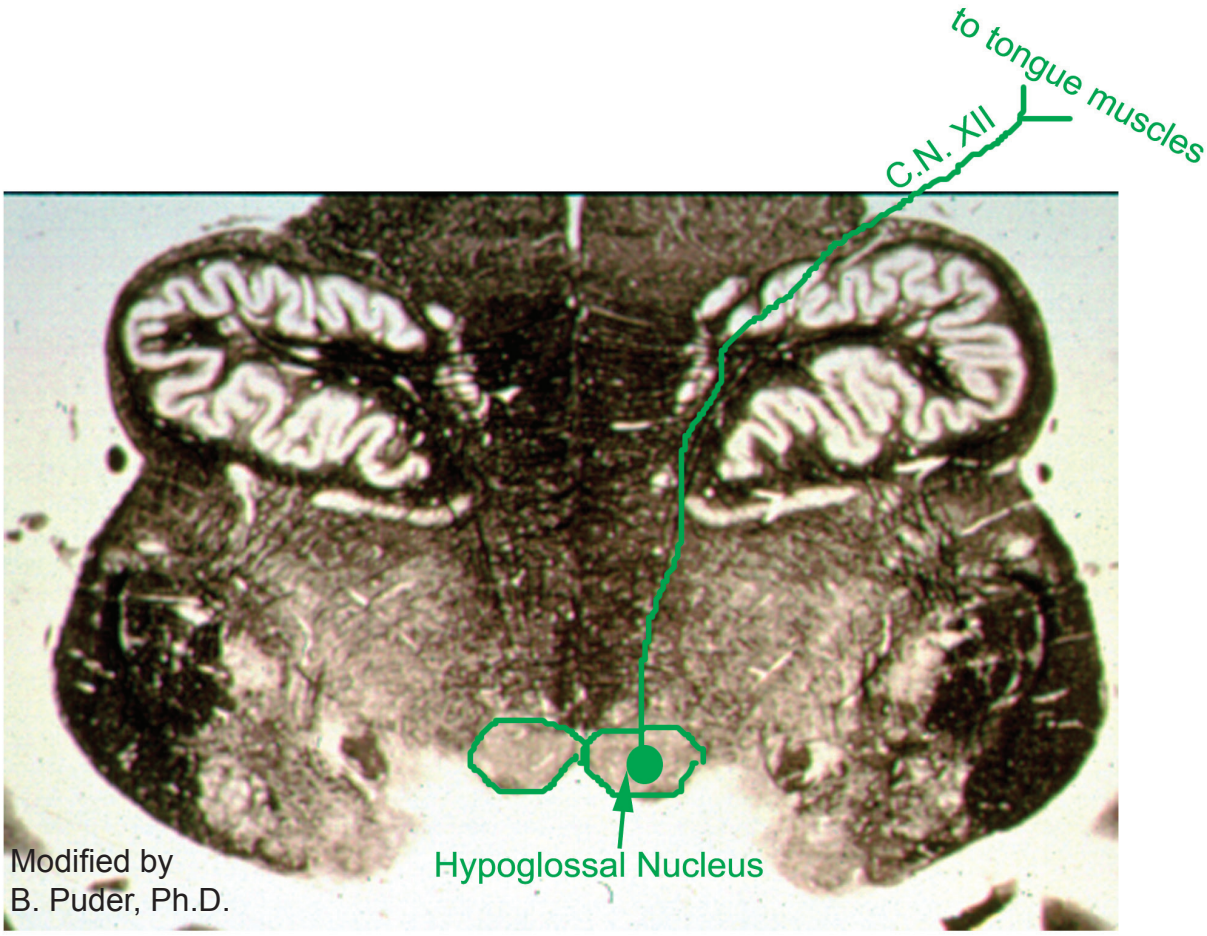


Figure XII–1 Somatic motor component of the hypoglossal nerve (cranial nerve XII).

Schematic Illustration of CN XII pathway.

CN XII Pathway



Mid-medulla section depicting the **hypoglossal nucleus** and its axons **(hypoglossal nerve)** projecting out between the pyramid and olive as it goes out to innervate the extrinsic tongue muscles.

Clinical Correlation for CN XII

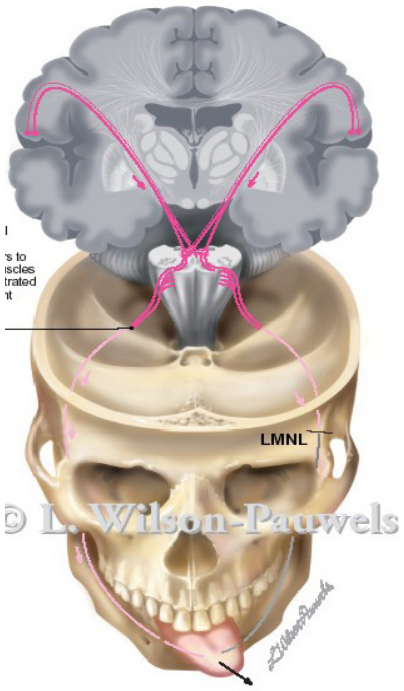


Figure XII–7 Lower motor neuron lesion (LMNL). The tongue deviates to the same side as the lesion (this is Todd's lesion).

Lesions to the hypoglossal nucleus or the axons that project to the extrinsic tongue muscles would cause muscle weakness on the ipsilateral side, thereby causing the tongue to deviate to the affected (lesioned) side when protruded.

Observe tongue for fasciculations and atrophy lower motor neuron signs)

Instruct patient to stick out tongue - If a LMN lesion is present, the tongue will deviate to the lesioned side.