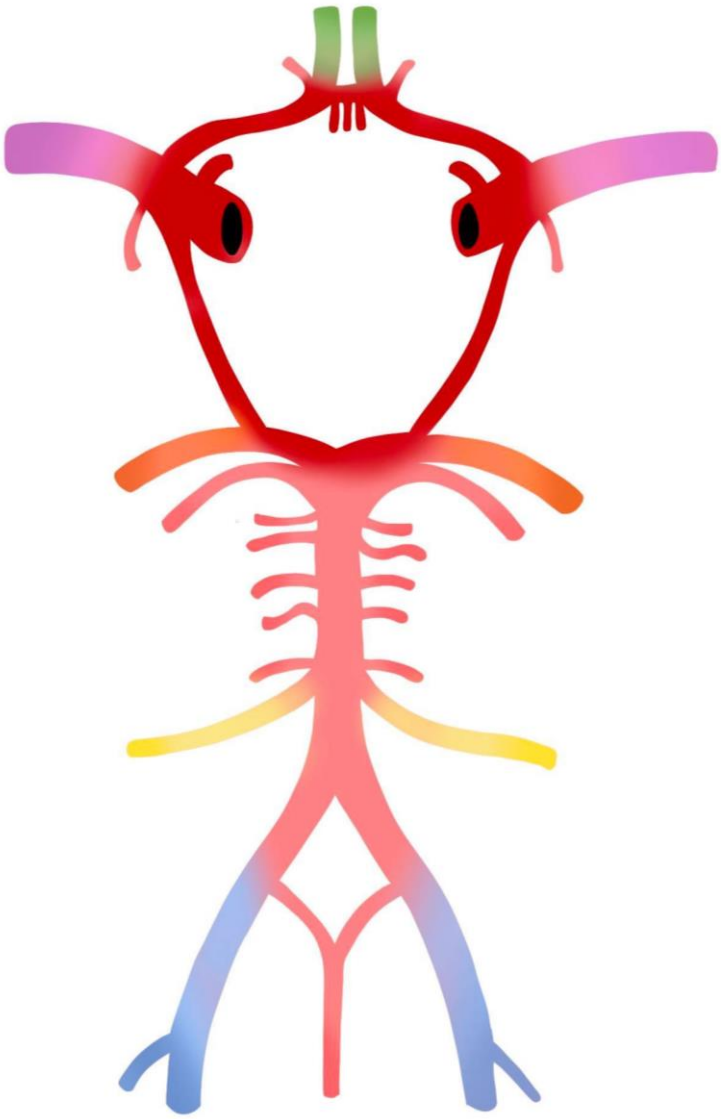

Neuroanatomy

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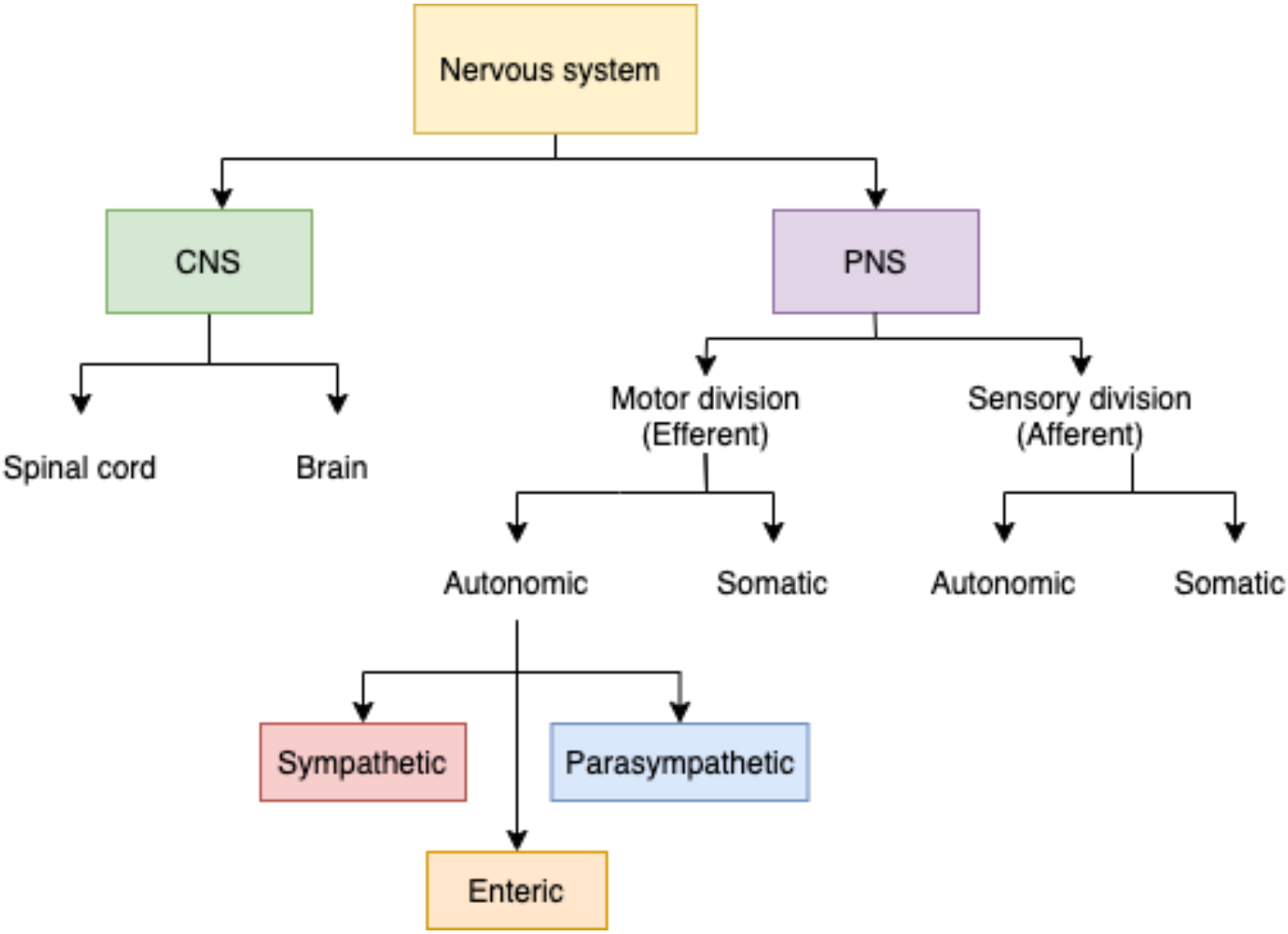
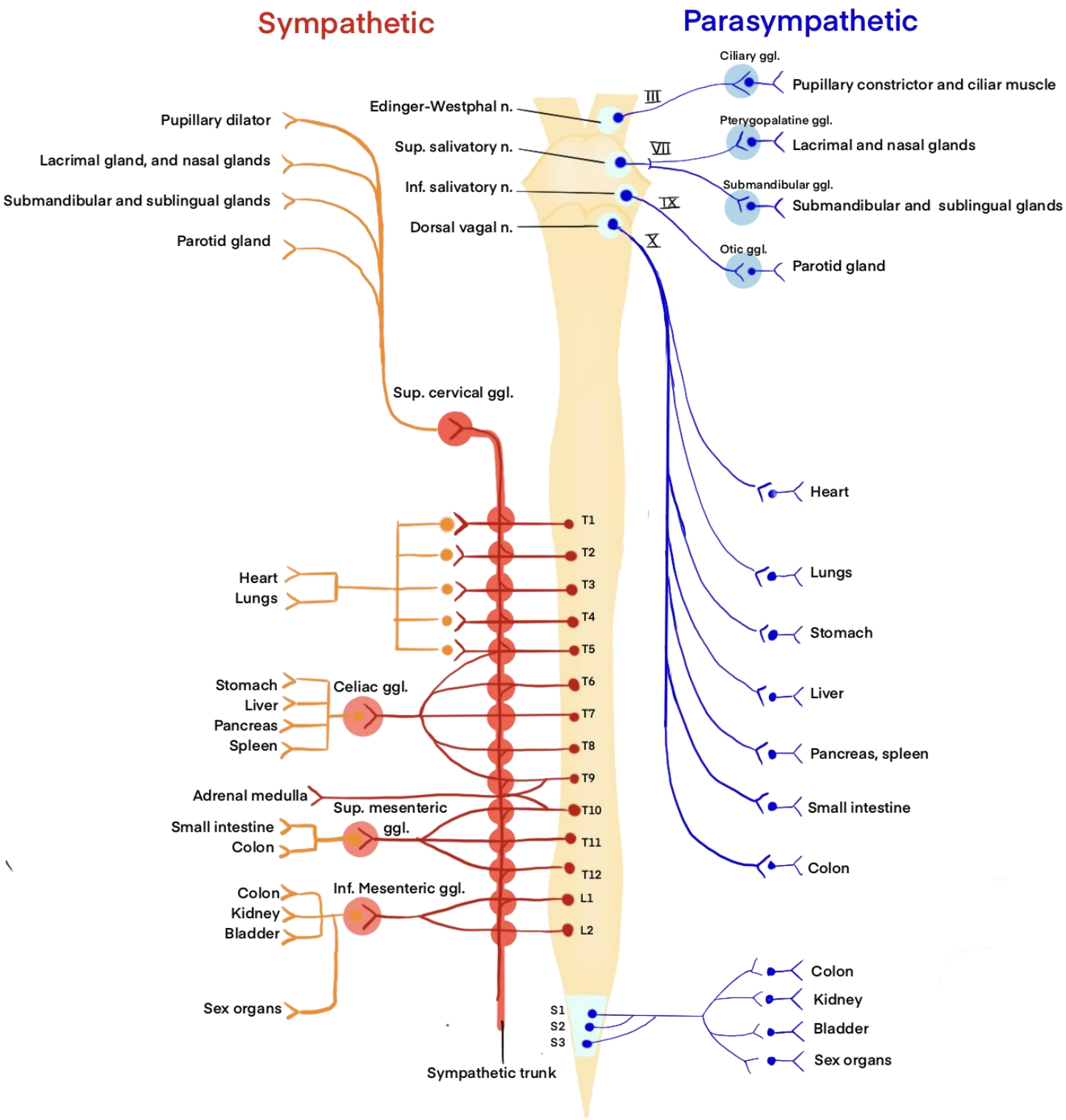
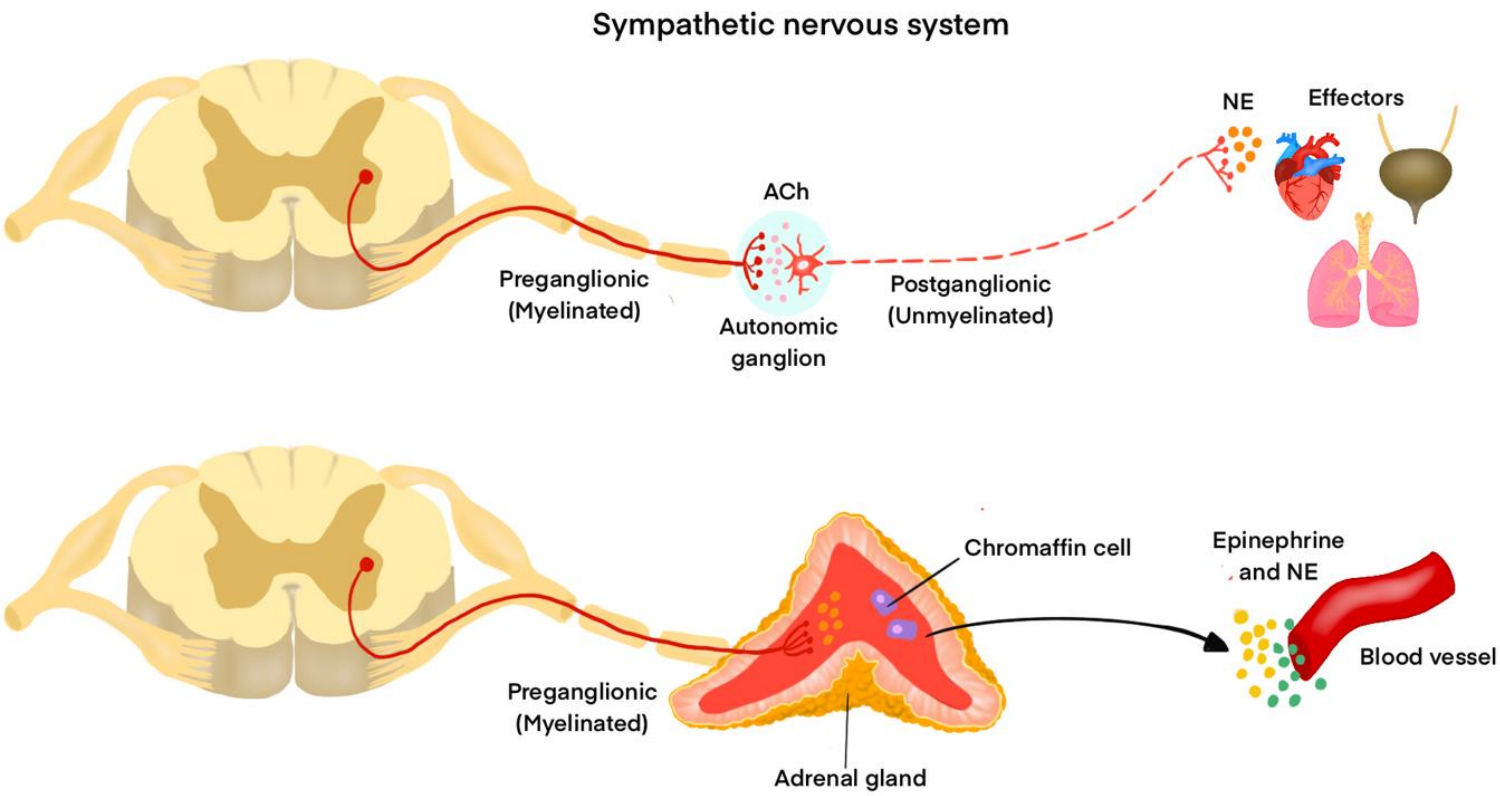


1.1 – Anatomy of the Autonomic Nervous System

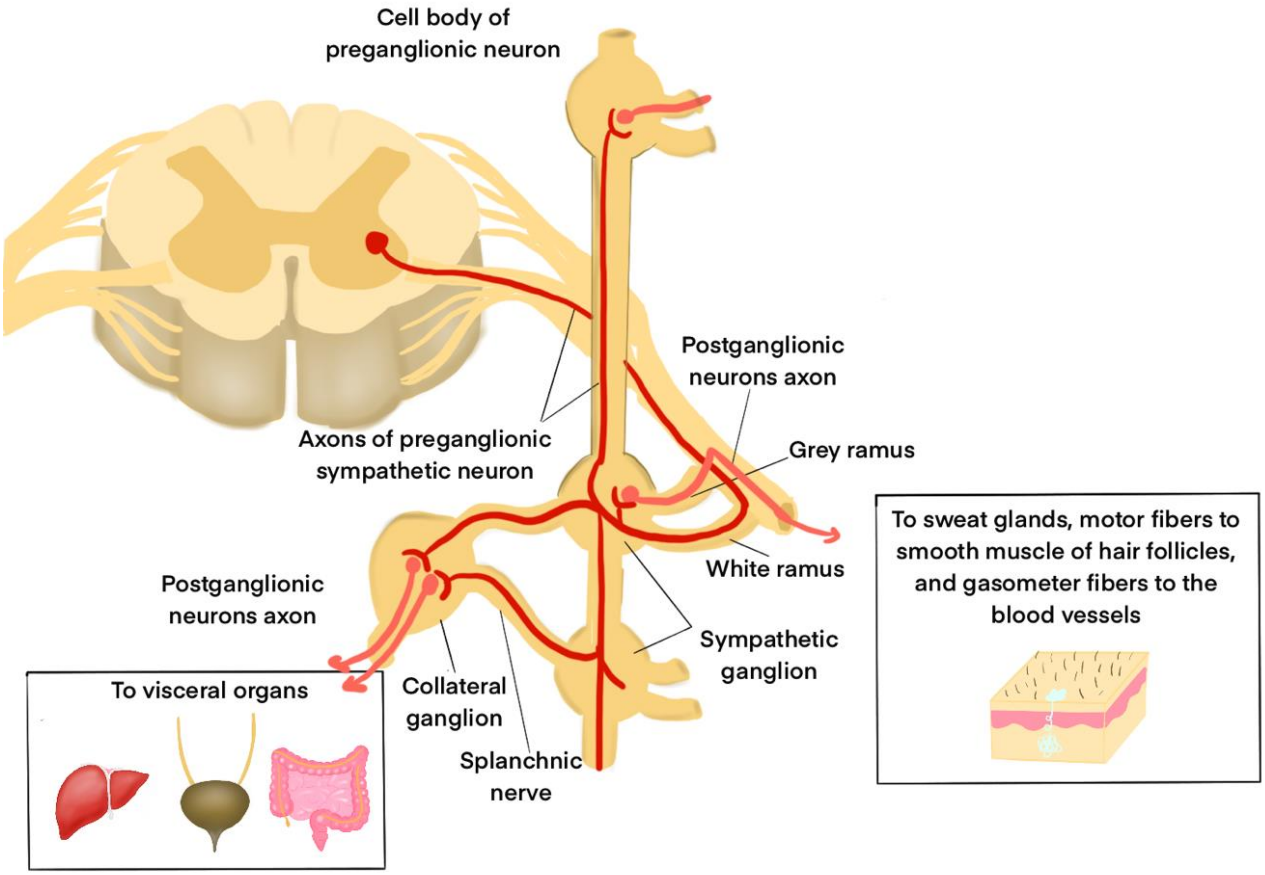


1.1.1 – Sympathetic Nervous System

- Adrenergic nerve fibers, activated in response to emergencies or energy consumption, to release norepinephrine
- Adrenergic stimulation also causes norepinephrine and epinephrine release from the adrenal medulla
- "Fight or flight"



I. Pathway of the sympathetic nerve fibers



Preganglionic fibers

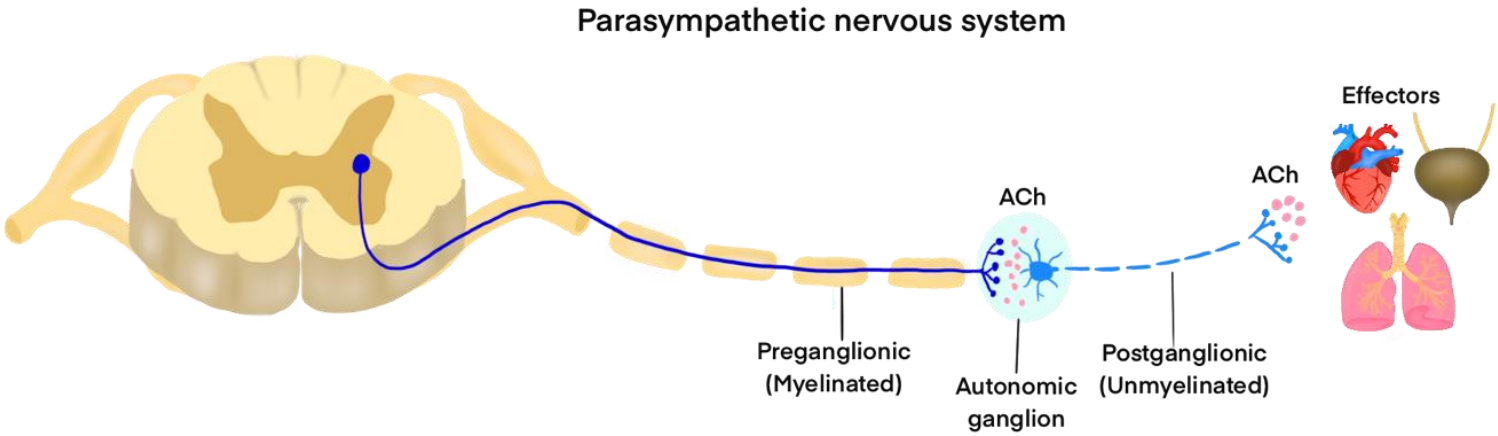
- Preganglionic nerve cell bodies of sympathetic nerve fibers are located in the lateral horn of the 12 thoracic and upper lumbar levels of the spinal cord
- The preganglionic fibers pass through ventral roots and spinal nerves and form white rami communicans
- From the white rami the **preganglionic fibers** can either:
    1. Enter adjacent sympathetic trunk ganglia where they synapse, or travel up or down in the sympathetic trunk to synapse in a ganglia further away.
    2. Run in the **splanchnic nerves** to synapse in collateral ganglia, located along the major abdominal blood vessels.
       Preganglionic sympathetic axons in the splanchnic nerves also project to the adrenal gland, where they synapse on chromaffin cells in the adrenal medulla, which then release epinephrine and norepinephrine.

Postganglionic fibers

- From the sympathetic trunk ganglia, most fibers return to the spinal nerves by way of gray rami communicans and supply the skin with secretory fibers to sweat glands, motor fibers to smooth muscles of the hair follicles (arrectores pilorum) and vasomotor fibers to the blood vessels.
- From the collateral ganglia fibers project to abdominal and pelvic organs

1.1.2 – Parasympathetic Nervous System

- Cholinergic nerve fibers that release acetylcholine, and functions mainly in homeostasis or energy conservation
- "Rest and digest"
- Parasympathetic nerve fibers are only distributed to walls of visceral organs and glands, not to the periphery
- The preganglionic parasympathetic nerve fibers that arise from the brainstem (see Section 2.0.3), and from the sacral part of the spinal cord
- Characterized by long preganglionic fibers and short postganglionic fibers



1.1.3 – Enteric Nervous System

- Enteric = In gastrointestinal system
- Consists of enteric ganglia (Parasympathetic, postganglionic neuron cell bodies) and plexuses of the GI tract
    1. Myenteric (Auerbach's) plexus
    2. Submucosal (Meissner's) plexus
- Important for the control of GI motility and secretions
- Functions independently when deprived of CNS innervation

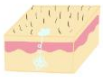
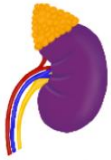
Check out Section 2 – Innervation of the Gastrointestinal Tract in the Studyaid Gastrointestinal physiology Booklet for more in-depth explanations about the enteric nervous system.

1.1.4 – Neurotransmitters

Neurotransmitters		
	Preganglionic	**Postganglionic**
Parasympathetic	Acetylcholine (ACh)	Acetylcholine (ACh)
Sympathetic	Acetylcholine (ACh)	Norephinephrine[1] Epinephrine

[1]Except sweat glands

1.2 – Parasympathetic and Sympathetic Functions

Parasympathetic		Sympathetic
Increases lacrimal secretion Constricts pupil Contracts ciliary muscles		Decreases lacrimal secretion Dilates pupil
Increases secretion of saliva and decreases viscosity		Decreases secretion of saliva and increases viscosity
		Sweat production
		Constricts blood vessels
Decreases heart rate and ventricular contractions		Increases heart rate and ventricular contractions
Constricts bronchi and increases secretion		Dilates bronchi and increases secretion
Increases GI mobility and secretions Relaxes sphincters		Inhibits GI mobility and secretions Constricts sphincters
Glycogen formation and bile secretion		Glycogen breakdown
Vasodilation of renal vascular bed		Reduces urine production
Urination		Constricts sphincter vesicae
Vasodilation and erection Relaxation of uterus		Vasoconstriction and ejaculation Uterine contractions

Organs	Parasympathetic actions	Sympathetic actions
Eyes	Constricts pupil Contracts ciliary muscles (accommodation)	Dilates pupil
Lacrimal gland	↑ Secretion of lacrimal fluid	↓ Secretion[1] of lacrimal fluid
Salivary gland	↑ Secretion of saliva ↓ Viscosity	↓ Secretion of saliva ↑ Viscosity
Sweat gland		↑ Secretion of sweat
Blood vessels		Constricts blood vessels
Heart	↓ HR and ventricular contractions Constricts coronary vessels	↑ HR and ventricular contractions Dilates coronary vessels
Bronchi	Constricts lumen ↑ Secretion	Dilates lumen ↓ Secretion
GI tract	↑ Motility and secretions Relaxes sphincters	Inhibits motility and secretions Constrict sphincters
Liver	↑ Formation of glycogen ↑ Secretion of bile	↑ Breakdown of glycogen
Suprarenal medulla		Secretion of epinephrine and norepinephrine
Kidney	May cause vasodilation of renal vascular bed	Reduces urine formation[2]
Urinary bladder	Relaxes sphincter vesicae Contracts detrusor muscle, causing urination	Contracts sphincter vesicae
Genital organs	Erection and vasodilation Relaxes uterus	Ejaculation and vasoconstriction Contractions of uterus

[1]Only slight reduction of secretion

[2]By constricting renal vessels

1.3 – Test Yourself

1) Fill in the blanks

Neurotransmitters		
	Preganglionic	**Postganglionic**
		Acetylcholine (ACh)
	Acetylcholine (ACh)	

2) Preganglionic fibers of the autonomic system are myelinated or unmyelinated?

3) Sympathetic nerve fibers that travel in the splanchnic nerves innervate the

_____

4) White ramus contains preganglionic or postganglionic sympathetic neurons?

5) Pair the functions with the right system

a) Sympathetic
b) Parasympathetic

1. Dilates the pupil
2. Increased heart rate
3. Constricts bronchi and increases secretion
4. Erection of the penis
5. Increases viscosity of saliva

Section 2 – Cranial Nerves

2.0 – Introduction to Cranial Nerves

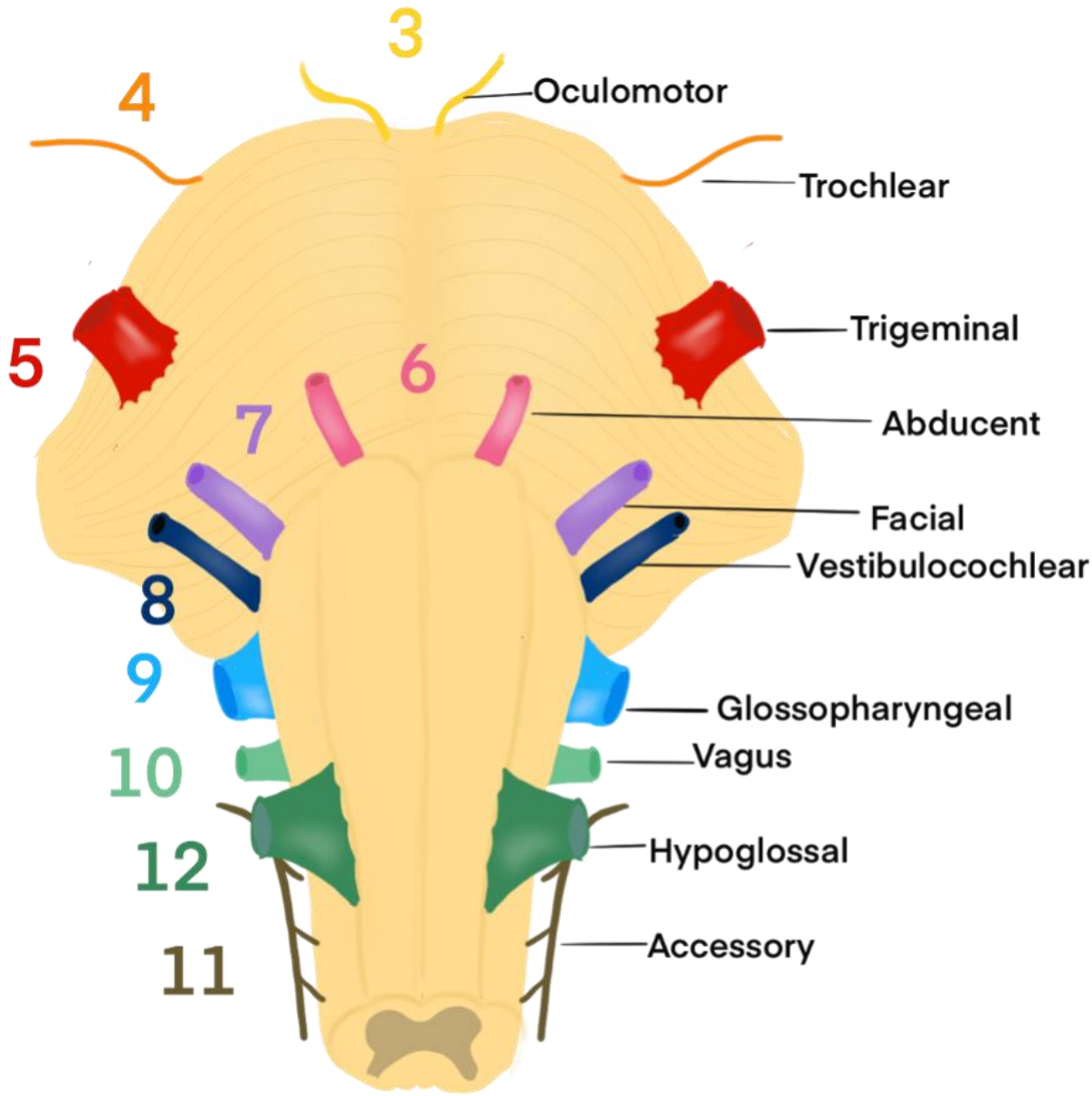
Cranial nerves (CN)			
Number	**Name**	**Main function**	**Cranial exit opening**
CN I	Olfactory	Sense of smell	Cribriform plate of ethmoid
CN II	Optic	Vision	Optic canal
CN III	Oculomotor	Eye movement	Superior orbital fissure
CN IV	Trochlear	Eye movement (Superior Oblique)	Superior orbital fissure
CN V	Trigeminal *Ophthalmic (V1)* *Maxillary (V2)* *Mandibular (V3)*	Sensation in the face Muscles of mastication (V3)	V1 – Superior orbital fissure V2 – Foramen rotundum V3 – Foramen Ovale
CN VI	Abducent	Eye movement (Lateral rectus)	Superior orbital fissure
CN VII	Facial	Muscles of facial expression	Stylomastoid foramen
CN VIII	Vestibulocochlear	Hearing and balance	Internal Acoustic meatus
CN IX	Glossopharyngeal	Taste and sensation of 1/3 posterior part of tongue Sensation in the upper part of the pharynx Innervation of the parotid gland	Jugular foramen
CN X	Vagus	Muscles of pharynx, larynx and soft palate. Taste from the epiglottis. Sensation from mucosa in the lower pharynx, larynx, trachea and esophagus.	Jugular foramen
CN XI	Accessory	Motor innervation of the trapezius muscle	Jugular foramen
CN XII	Hypoglossal	Movement of tongue	Hypoglossal canal

MNEMONIC

The cranial nerves

Oh, **O**h, **O**h **T**o **T**ouch **A**nd **F**eel **V**ery **G**ood **V**elvet. **A**h **H**eaven!

2.0.1 – Exit From the Brainstem



Trochlear nerve (CN IV) exits from the dorsal side of the brainstem

Cranial nerves in the brain stem: Rule of 4

	Cranial nerves
4 CN above pons	I, II, III, IV
4 CN emerging from pons	V, VI, VII, VIII
4 CN below pons	IX, X, XI, XII

2.0.2 – Type of Fibers in the Cranial Nerves

Some	Say	Money	Matters	But	My	Brother	Says	Big	Boobs	Matter	More
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII

S = Sensory
M = Motor
B = Both

Functional components of the cranial nerves		Fibers convey impulses from/innervate		Cranial nerves that carries the fibers
General Somatic Afferent	**GSA**	Pain, proprioception, temperature and touch		CN V, VII, IX, X
General Somatic Efferent	**GSE**	Innervate skeletal muscles of the	Eye	CN III, IV & VI
			Tongue	CN XII
General Visceral Afferent	**GVA**	Convey impulses from visceral and blood vessels		CN VII, IX, X
General Visceral Efferent	**GVA**	Innervate smooth muscle, cardiac muscle, intraocular muscles and glands		CN III, VII, IX, X
Special Somatic Afferent	**SSA**	Vision – convey information from the retina		CN II
		Hearing and equilibrium – convey information from the cochlea and vestibule		CN VIII
Special Visceral Afferent	**SVA**	Smell – convey impulses from olfactory mucosa		CN I
		Taste – convey impulses from taste buds		CN VII, IX & X
Special Visceral Efferent	**SVE**	Motor to skeletal muscles	of mastication	V3
			of facial expression	CN VII
			for movement of the pharynx and larynx	CN IX & CN X

2.0.3 – Parasympathetic Fibers in Cranial Nerves

I. 1973 – a year to remember

- 1973 is a mnemonic to remember the cranial nerves carrying parasympathetic component.
  1. This means that these nerves have other functions than just motor or sensory, for example secretion from glands (CN VII)

	1	0		
		9		
			7	
				3
=	**1**	**9**	**7**	**3**

2.0.4 – Cranial Nerve Reflexes

I. Afferent = Sensory

- Information moves towards the brain

II. Efferent = Motor/Parasympathetic

- Information moves from the brain to the innervated structure

Reflex	Afferent limb	Efferent limb
Pupillary light	CN II	CN III
Corneal (blink)	CN V1 (Nasociliary branch)	CN VII
Sneeze	CN V2	CN X
Jaw jerk	CN V3	CN V3
Gag	CN IX	CN X
Cough	CN X	CN X

2.1 – Olfactory Nerve (CN I)

Olfactory nerve	
Main function	Mediate the sense of smell
Type of fibers	Sensory *Special Visceral Afferent (SVA)*
	Arises from neurons of the olfactory area and the upper 1/3 of the nasal mucosa
Exit from the brain	Extension of telencephalon
Exit from the skull	Cribriform plate of ethmoid

2.1.1 – Lesions of the Olfactory Nerve

- Lesion manifests as loss of smell (anosmia)
    1. Most commonly due to a fracture of the ethmoid bone
- Injury to the olfactory nerve is commonly associated with the leakage of cerebrospinal fluid (CSF rhinorrrhea)

CLINICAL CORRELATION

Loss of smell is usually caused by the common cold, not an injury to the olfactory nerve.

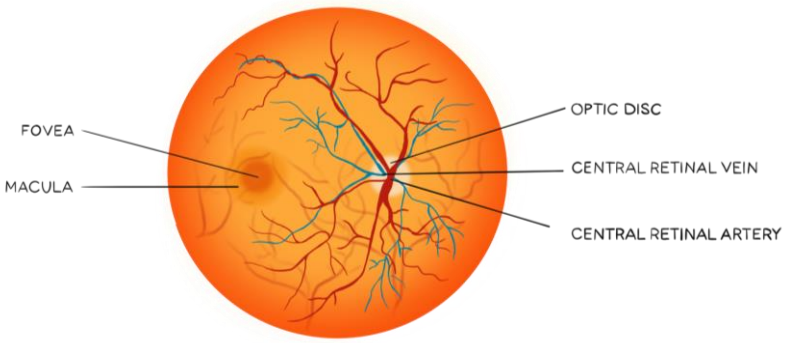
2.2 – Optic Nerve (CN II)

Optic nerve	
Main function	Responsible for vision
Type of fibers	Sensory *Special Somatic Afferent (SSA)*
Exit from the brain	Originates in the diencephalon
Exit from the skull	Optic canal (together with the ophthalmic artery)
Reflex	Pupillary light reflex

CLINICAL CORRELATION

Investigation of the retina

As the optic nerve is an extension of the brain, you can inspect a portion of the brain directly using an ophthalmoscope. This is important in the diagnosis of many neurological diseases. For example, diabetic retinopathy can be one of the first discoveries in untreated diabetes.



Relevant ophthalmological terms

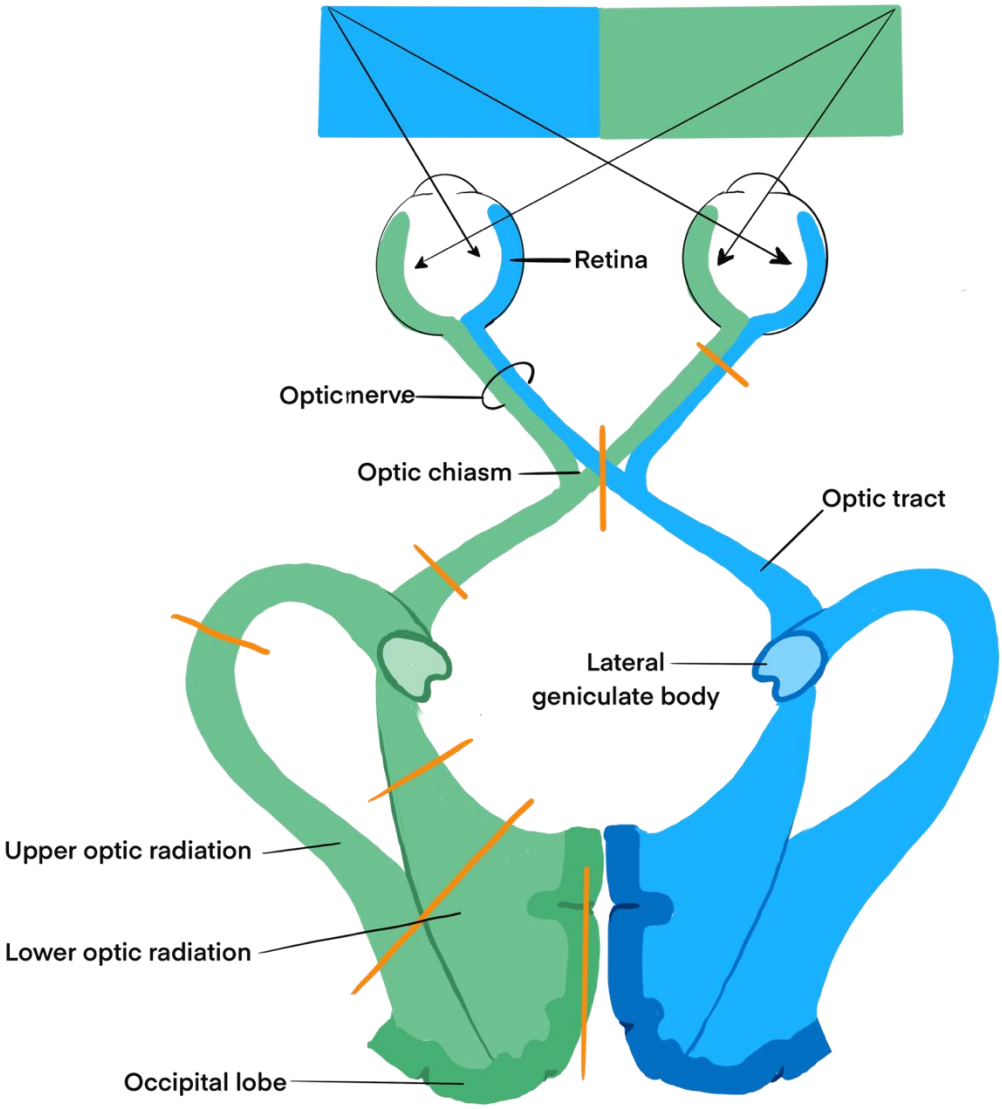
Anopia	Loss of vision
Hemianopia	Loss of vision in half of the visual field
Quadrantanopia	Loss of vision in one fourth of the visual field (one quadrant)
Homonymous hemianopia	Loss of vision on half of the visual field in both eyes on the same side

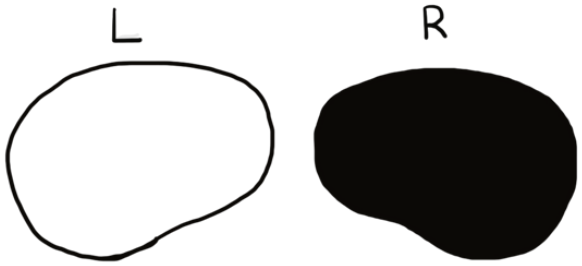
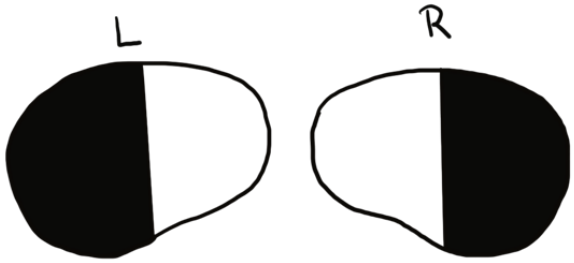
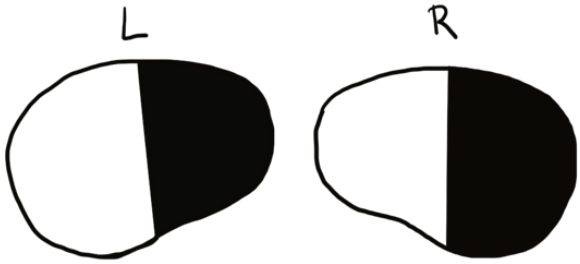
2.2.1 – Lesions of the Optic Pathway

- Lesions can manifest as partial or total loss of vision, as well as diminished visual acuity and lack of pupillary light reflex (loss of the afferent limb)
    1. Causes include inflammation, degeneration, or demyelination due to different disorders.
- Lesions in different places of the pathway will manifest as loss of vision in different visual fields

I. Visual pathway

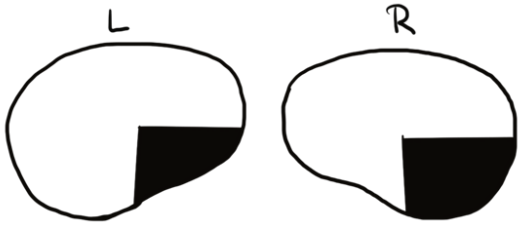
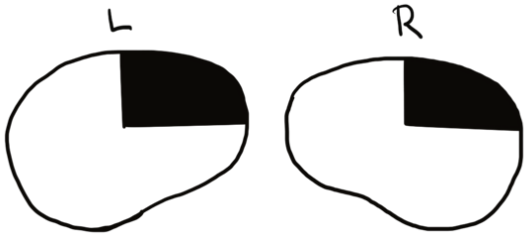
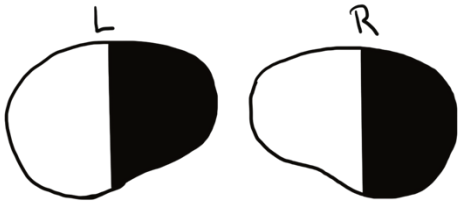
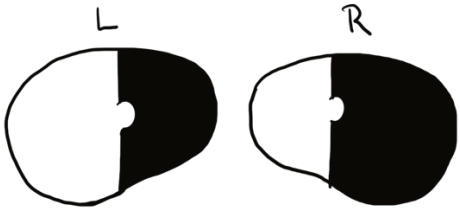
- Nasal retina looks at the temporal eye field
- Temporal retina looks at nasal eye field
- Fibers from nasal retinas (temporal vision fields) cross over in the optic chiasm
    1. Optic nerve contains nasal and temporal fibers from the same eye
    2. Optic chiasm contains crossing nasal fibers only (temporal fibers do not cross)
    3. Optic tract contains nasal fibers from contralateral eye and temporal fibers from ipsilateral eye



Lesion of optic nerve
Ipsilateral monocular anopia Complete loss of vision on the same eye that the lesion occurs - Most common cause is glaucoma - Others: trauma, tumors - Vision loss is usually progressive   
Lesion of optic chiasm
Bitemporal hemianopia (tunnel vision) Loss of nasal retinal fibers, gives loss of vision in the temporal visual fields - Lesion of nasal fibers (which cross in the optic chiasm) = Loss of temporal vision - Most common cause is pituitary tumor   
Lesion of optic tract
Contralateral homonymous hemianopia Loss of vision in one visual field. Left tract lesion gives loss of right visual field Caused by subcortical lesions - Stroke - Tumors - Infection - Congenital malformations   

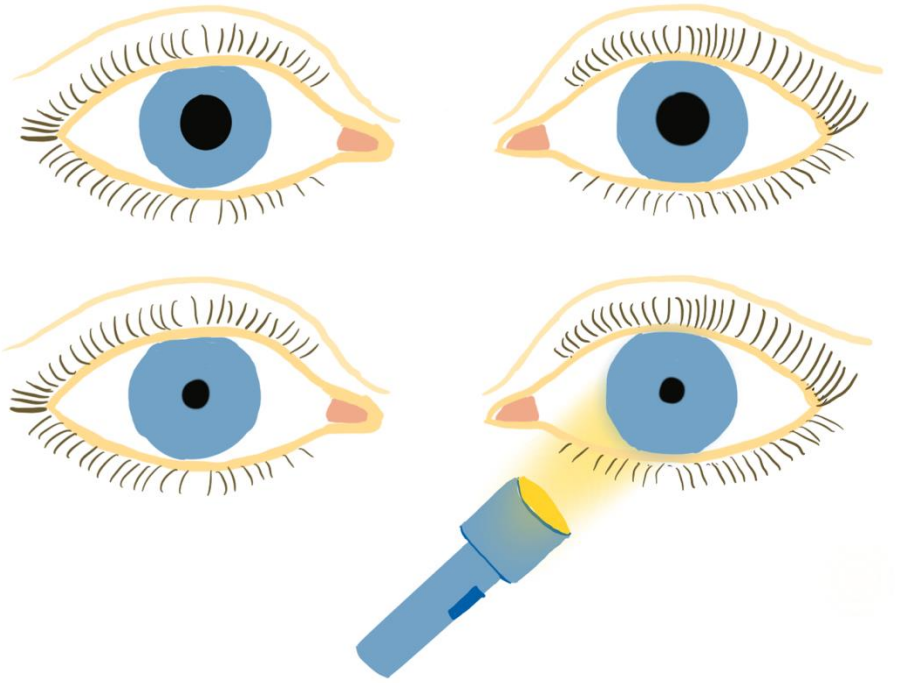
II. The optic radiation

- Upper pathway
    1. Baum's loop through *parietal lobe*
    2. Superior retinal fibers (Inferior quadrant visual field)
- Lower pathway
    1. Meyer's loop through *temporal lobe*
    2. Inferior retinal fibers (superior quadrant visual field)

Lesion of upper radiation
Contralateral lower Quadrantanopia Loss of lower quadrant visual field opposite to side of lesion - Bilateral lesion = lower altitudinal hemianopia 
Lesion of lower radiation
Contralateral upper quadrantanopia Loss of upper quadrant visual field contralateral side of lesion - Bilateral = upper altitudinal hemianopia 
Lesion of upper <u>and</u> lower radiation
Contralateral homonymous hemianopia Loss of one visual fields on contralateral side of the lesion - *Uwaga!* Can appear similar as a lesion of the optic tract 
Lesion of visual cortex
Contralateral homonymous hemianopsia with *macular sparing* Loss of vision from one visual field on the contralateral side of the lesion, but with macular sparing (central vision) - Intact pupillary reflex 

2.2.2 – Pupillary Light Reflex

- Afferent limb: Ipsilateral optic nerve (CN II)
- Efferent limb: Bilateral oculomotor nerves (CN III)
    1. Bilateral ciliary ganglia
    2. Bilateral short ciliary nerves
- Result: As we can see in this illustration, under physiological conditions, the pupil constricts in both eyes when light is placed in front of only one eye.



I. Malfunctioning pupillary light reflex

- With pathologies in either CN II or CN III the pupillary light reflex will be affected
- Optic nerve lesion
    1. Neither pupils will react when the light shines into the affected eye
    2. Both eyes will constrict when the light shines into the healthy eye
- Oculomotor nerve lesion
    1. Only the pupil of the healthy eye will constrict, no matter which eye the light shines into.

2.3 – Oculomotor Nerve (CN III)

Oculomotor nerve		
Main function	Movement of the eye, through contraction of all the extraocular muscles except for SO_4LR_6.[1]	
Type of fibers	**Motor** *General somatic efferent*	**Parasympathetic** *General visceral efferent*
Innervation	Superior, inferior and medial rectus Inferior oblique Levator palpebrae	Sphincter pupillae (miosis) Ciliary muscles (accommodation)
Exit from the brainstem	Midbrain	
Exit from the skull	**S**uperior **O**rbital **F**issure (**SOF**) through the common tendinous ring	
Reflex	Efferent limb of pupillary light reflex	

[1] SO_4LR_6 = Superior Oblique and Lateral Rectus muscles who are controlled by CN IV and CN VI

SUPERIOR ORBITAL FISSURE

Oculomotor nerve (CN III)
Trochlear nerve (CN IV)
Ophthalmic branch (V1 of CN V
Abducent nerve (CN VI)
Ophthalmic vein

2.3.1 – Eye Movements

I. Extraocular muscle innervation: $(SO_4LR_6)_3$

- Superior Oblique = CN 4
- Lateral Rectus = CN 6
- The rest of the eye muscles = CN 3

II. Oblique muscles

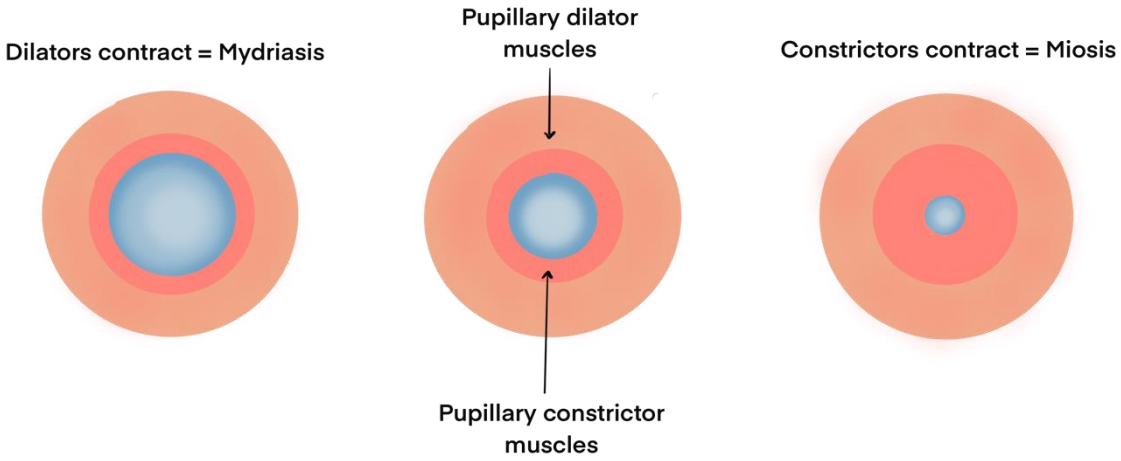
- Superior and inferior **O**blique muscles moves eye in **O**pposite direction
    1. Superior moves eye DOWN
    2. Inferior oblique moves the eye UP

2.3.2 – The Pupils

- Preganglionic parasympathetic fibers from the Edinger-Westphal (EW) nucleus supply the ciliary ganglion
- Post ganglionic fibers run in the short ciliary nerves to the ciliary smooth muscle and the sphincter papillae

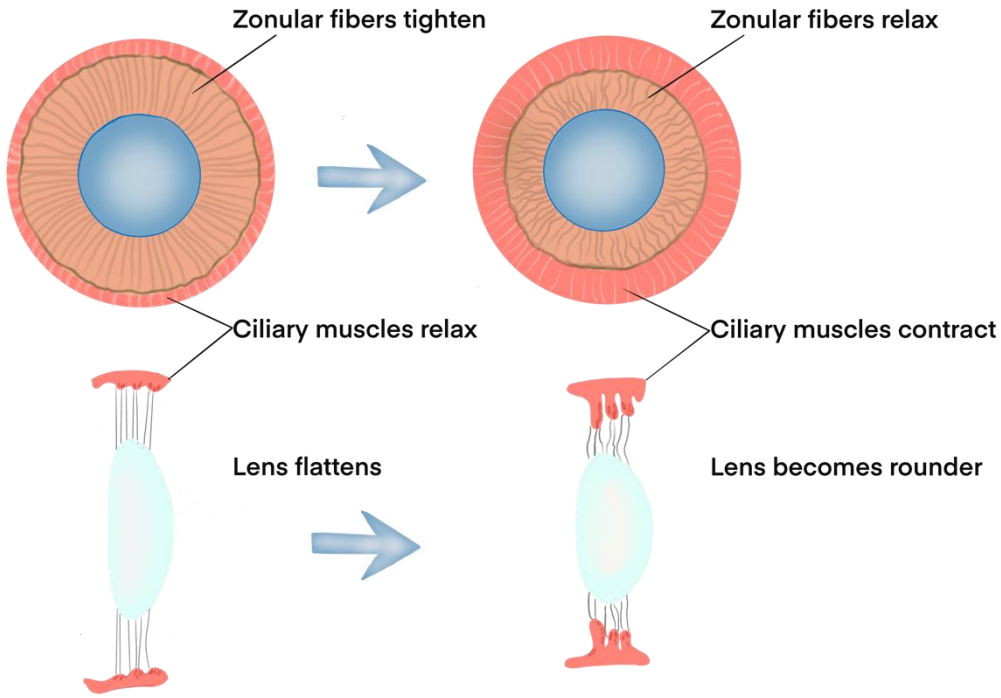
I. Constriction (miosis) and dilation (mydriasis) of the pupils

- Parasympathetic stimuli cause constriction of the pupil through stimuli of the sphincter pupillae
- Sympathetic stimuli causes dilatation (mydriasis) through the dilator pupillae.



II. Accommodation – Ciliary smooth muscles

- Far vision: Relaxation of ciliary muscles → tension of zonular fibers → stretched lens
- Near vision: Constriction of ciliary muscles → relaxation of zonular fibers → bulged lens



2.3.3 – Reflexes

- Oculomotor nerve is the efferent limb of the pupillary light reflex.
    1. Parasympathetic stimuli from the EW nucleus through the short ciliary nerves cause constriction of the pupil (miosis) in *both eyes*.

RECALL

Pupillary light reflex (Section 2.2.2)

2.3.4 – Lesion of the Oculomotor Nerve

I. The severity of oculomotor palsy will depend on the extent of the injury

What can we see in a patient?	What is the cause?
Pupil looks down and out	Unopposed lateral rectus (CN VI) and superior oblique (CN IV)
Ptosis[1]	Loss of innervation of levator palpebrae
Dilated "Blown" pupil	Loss of parasympathetic fibers and unopposed sympathetic stimuli
Decreased visual acuity	Loss of accommodation

[1] Drooping of the eyelid

II. Causes

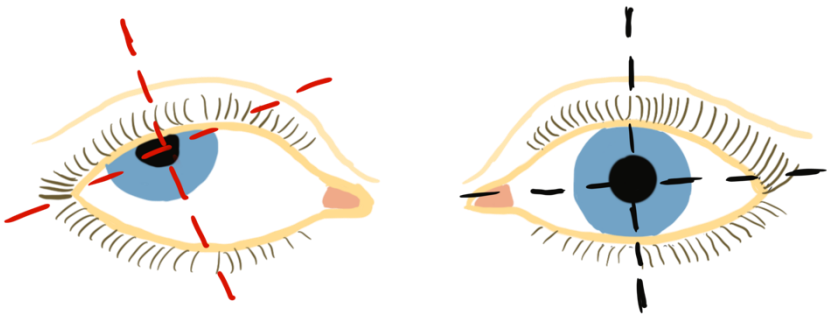
- Subdural or epidural hematoma
- Aneurysm of the internal carotid artery

2.4 – Trochlear nerve (CN VI)

Trochlear nerve	
Main function	Responsible for internal (medial) rotation, depression (look down) and abduction of the eyeball (look out)
Type of fibers	Motor *General somatic efferent*
Innervation	Superior oblique muscle
Exit from the brainstem	**Uwaga!** Only CN arising from the midbrain, on the **posterior** side of the brainstem
Exit from the skull	**S**uperior **O**rbital **F**issure **(SOF)** outside the common tendinous ring
Pathway	Emerges from the posterior side of the brainstem and has the longest intracranial course of the three extraocular motor nerves (CN III, IV & VI). It goes anteriorly around the brainstem and goes through the SOF outside the common tendinous ring before it innervates the Superior oblique.

2.4.1 – Lesions of the Trochlear Nerve

What can we see in the patient?	What is the cause?
Inability to look down and out	Unopposed action of the inferior oblique
Head tilt	The patient tries to compensate
Difficulty walking down the stairs	Patients has diplopia, which becomes worse when looking down



2.4.2 – Unique Features of the Trochlear Nerve

- Cranial nerve with the smallest diameter (thinnest)
- Longest intracranial course of the three extraocular motor nerves
- Exits the brainstem posteriorly (on the dorsal aspect)
- Decussates in the brain stem

2.4.3 – Common Tendinous Ring

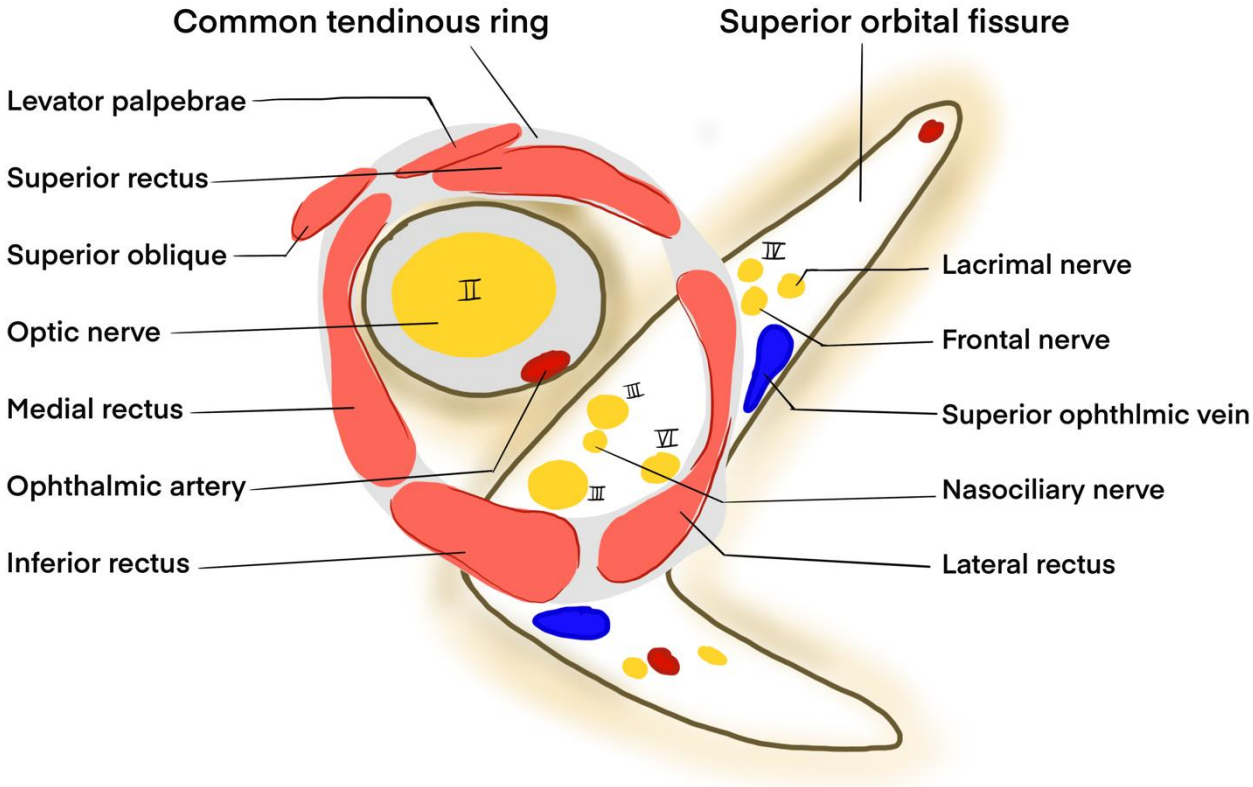
- Fibrous ring that surrounds the optic canal, and the medial part of SOF.
- Site of origin of the lateral, medial, inferior and superior rectus muscles.

I. Structures that pass <u>inside</u> the common tendinous ring

- Oculomotor (CN III) , abducent (CN VI) and nasociliary nerves (V1) from the SOF
- Optic nerve (CN II), ophthalmic artery and central artery and vein of the retina from the optic canal

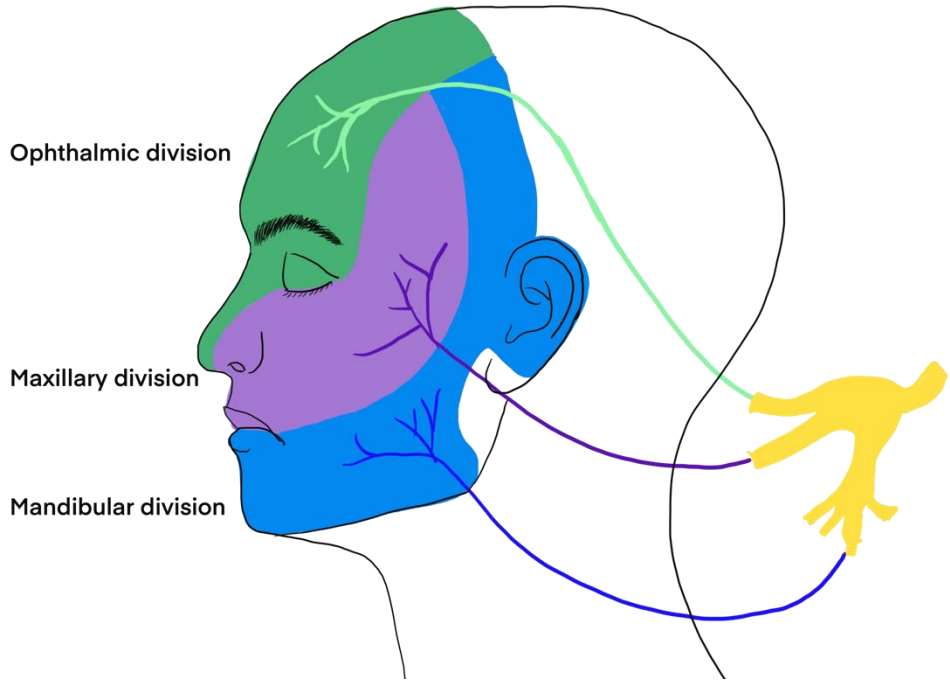
II. Structures that pass inside SOF, but <u>outside</u> the common tendinous ring

- Trochlear nerve (CN IV), frontal and lacrimal nerves (V1)
- Superior ophthalmic vein



2.5 – Trigeminal Nerve (CN V)

Trigeminal nerve	Ophthalmic branch (V1)	Maxillary branch (V2)	Mandibular branch (V3)
Main function	Sensation in the **upper** 1/3 of the face	Sensation in the **middle** 1/3 of the face	Sensation in the **lower** 1/3 of the face. Innervates the muscles of mastication
Type of fibers	Sensory *GSA*	Sensory *GSA*	Sensory and motor *GSA & GSE*
Exit from the brainstem	Anterior to the pyramidal eminence of pons		
Exit from the skull	Superior orbital fissure	Foramen Rotundum	Foramen Ovale
Reflex	Afferent limb of the corneal reflex (blink reflex)	Afferent limb of sneeze reflex	Afferent and efferent limb of the jaw jerk reflex.



2.5.1 – Ophthalmic Branch (V1)

- Runs in the lateral wall of the cavernous sinus
- Sensory innervation of
    1. Eyeball
    2. Tip of the nose
    3. Skin of face above eyes

Scandale Royal Orgy

V1 – Superior orbital fissure
V2 – Foramen Rotundum
V3 – Foramen Ovale

Exit of the branches from the skull

2.5.2 – Maxillary Branch (V2)

- Runs through the lateral wall of the cavernous sinus, exits through foramen rotundum and enter the pterygopalatine fossa
- Sensory innervation of
    1. Skin of the face between the eyes and the upper lip
    2. Palate
    3. Paranasal sinuses
    4. Maxillary teeth

2.5.3 – Mandibular Branch (V3)

- Motor and sensory fibers

<table>
<tr><th colspan="2">Motor fibers innervate</th><th>Sensory fibers convey information from</th></tr>
<tr><td colspan="2">Anterior belly of digastric
Mylohyoid
Tensor veli palatini
Tensor tympani</td><td rowspan="5">Anterior ear
Teeth and gums of mandible
Skin of the face below the lower lip
Sensation of the 2/3 anterior part of the tongue</td></tr>
<tr><td colspan="2">Muscles of mastication</td></tr>
<tr><td>Masseter</td><td rowspan="3">Moves the mandible UP</td></tr>
<tr><td>Medial pterygoid</td></tr>
<tr><td>TeMporalis</td></tr>
<tr><td>Lateral pterygoid</td><td>Lowers the mandible</td><td></td></tr>
</table>

2.5.4 – Lesions of the Trigeminal Nerve

I. Clinical presentation: Depends on location

- Loss of general sensation from the skin of the face and from mucous membranes of the oral and nasal cavities
- Loss of corneal reflex (V1)
- Flaccid paralysis of muscles of mastication
- Deviation of the jaw to the to the weak side
- Paralysis of tensor tympani and tensor palatini

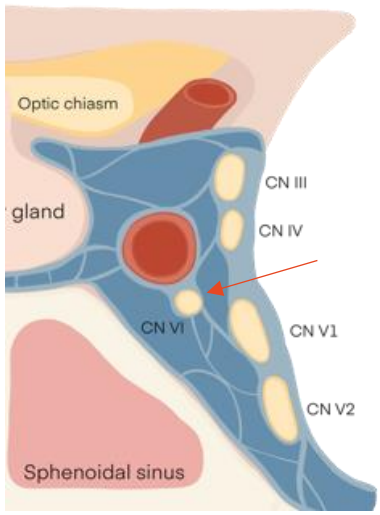
II. Causes

- Trauma
- Tumors
- Meningitis

2.6 – Abducent Nerve (CN VI)

Abducent nerve	
Main function	Pulls the eyeball laterally
Type of fibers	General somatic efferent (GSE)
Innervation	Innervates the lateral rectus (LR_6)
Exit from the brainstem	Pontomedullary junction (bulbopontine sulcus)
Exit from the skull	**S**uperior **O**rbital **F**issure (**SOF)**
Pathway	Goes inside the cavernous sinus[1], close to the internal carotid

[1] See section 6.2 – Cavernous Sinus

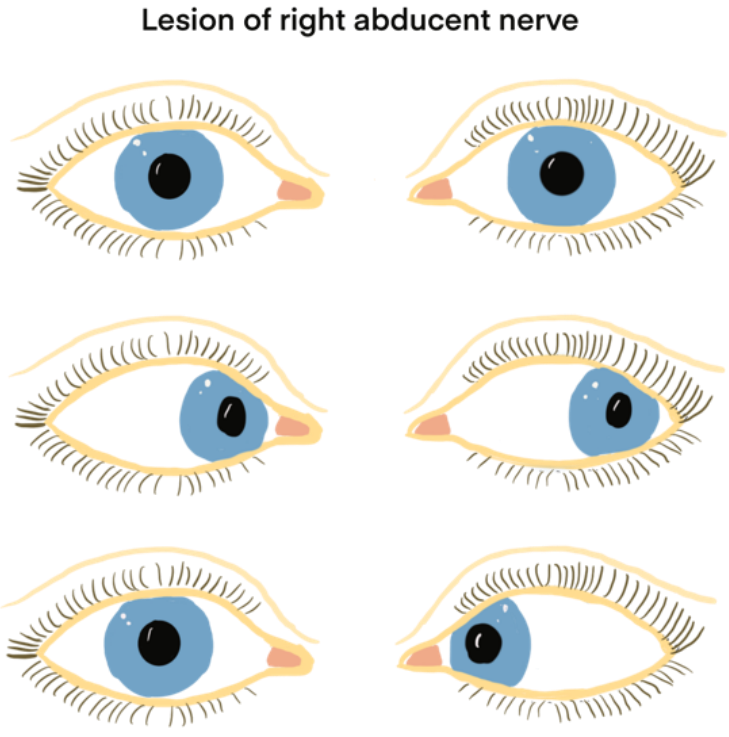


2.6.1 – Lesions of the Abducent Nerve

- Inability to move the eyeball laterally: Eyeball looks medially, normal pupil
- Diplopia: Worst when patient is looking *towards* the side of the paralyzed muscle

I. Causes

- Brain tumors
- Aneurysms of the internal carotid artery
- Increased intracranial pressure
    1. Extra sensitive to increases in ICP due to the sharp turn it takes leaving the brainstem.



The illustration shows the movements of the eyes in the case of an injured right abducent nerve. The right eye will not be able to move laterally.

2.7 – Facial Nerve (CN VII)

Facial nerve		
Main function		Movement of facial muscles, taste from anterior 2/3 of the tongue, and innervation of all glands of the head except for the parotid gland
Type of fibers		**Innervation**
Sensory	SVA	Taste fibers from anterior 2/3 of tongue (Chorda tympani) (**Uwaga!** sensation through V3)
	GVA	Palate and nasal mucosa
	GSA	External acoustic meatus, auricle
Motor	SVE	Muscles of facial expression Stapedius muscle
Parasympathetic	GVE	All glands of the head EXCEPT the parotid Lacrimal, submandibular, sublingual, nasal and palatine glands
Exit from the brainstem		Cerebellopontine angle (with vestibulocochlear nerve, CN VIII)
Exit from the skull		Stylomastoid foramen
Reflex		Efferent limb of corneal (blink) reflex

I. Terminal branches

- **T**wo **Z**ygomatic **B**ones **M**akes **C**
- Innervates muscles of facial expression
  1. **T**emporal
  2. **Z**ygomatic
  3. **B**uccal
  4. **M**arginal mandibular
  5. **C**ervical

II. Parasympathetic fibers to the salivary glands

- CN **S**even control **S**alivation by innervating **S**ubmandibular and **S**ublingual glands

CLINICAL CORRELATION

Parotid gland surgery

The facial nerve goes through but *does not innervate* the parotid gland.

Surgery of the parotid gland can injure the facial nerve resulting in partial facial paralysis.

2.7.1 – Lesions of the Facial Nerve

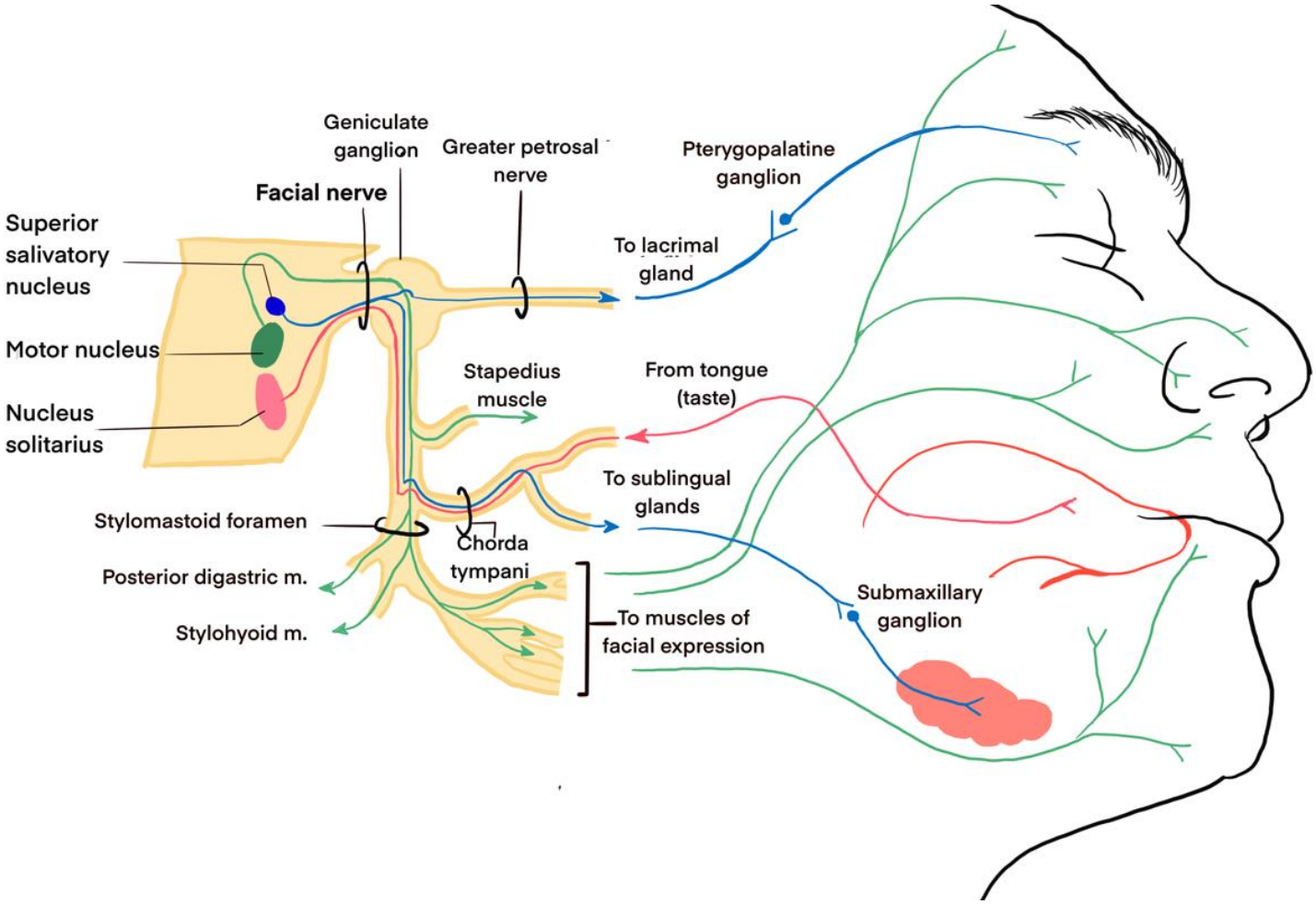
- Flaccid paralysis of the muscles of facial expression (upper and lower face)
- Loss of efferent limb of corneal (blink) reflex
- Loss of taste from the anterior 2/3 of the tongue
- Hyperacusis
- Dry eye due to lack of lacrimation
- Dry mouth from absence of salivation

I. Branching pattern

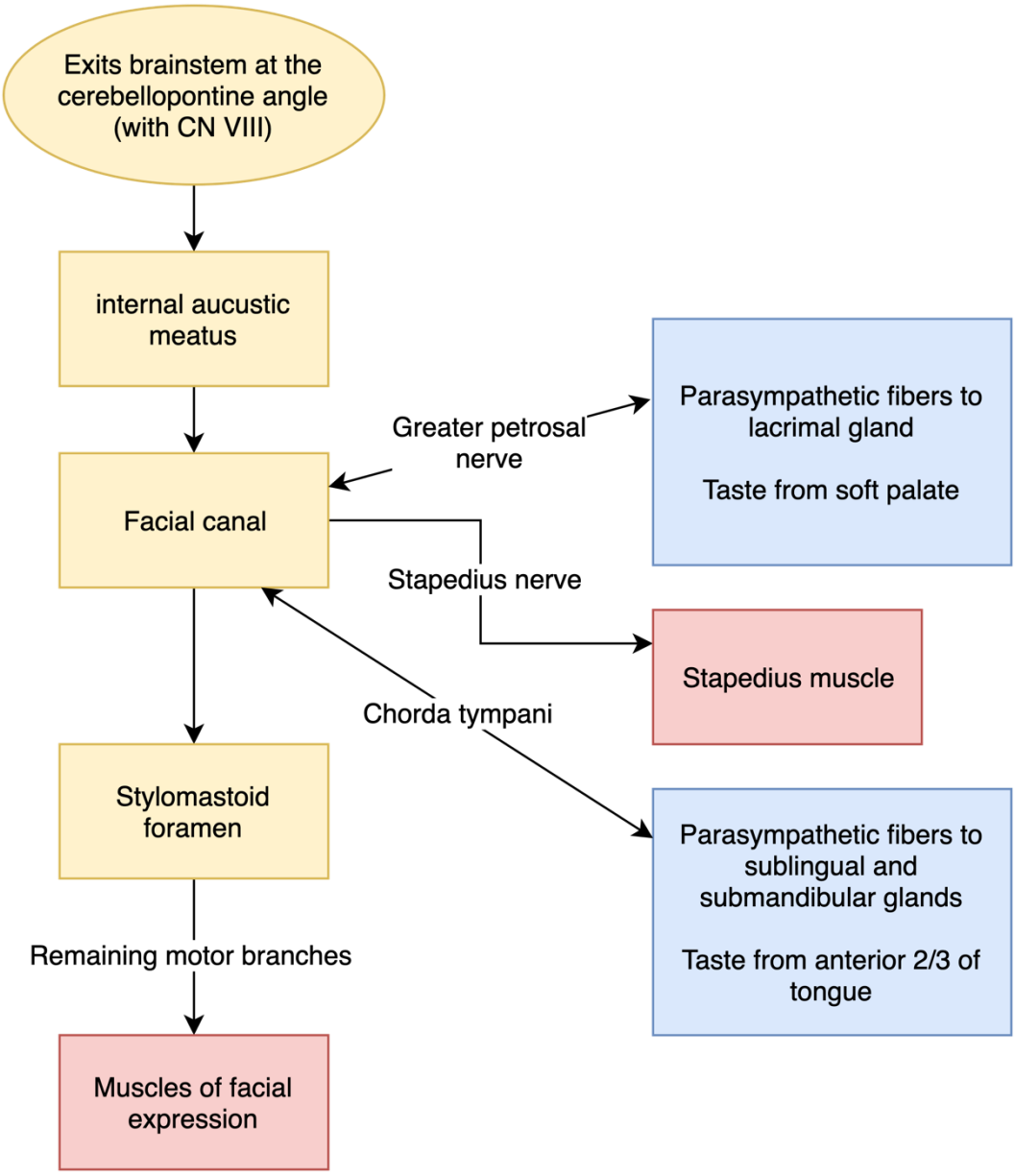
- Branching pattern is of diagnostic significance in temporal bone fractures
    1. The closer to the brain the lesion appears, the more structures are affected.

II. Facial nerve pathway

- Originates in the cerebellopontine angle together with the vestibulocochlear nerve (CN VIII)
- Goes through the internal acoustic meatus
- Continues through the facial canal where 3 branches exit:
    1. Greater petrosal nerve: Contains parasympathetic fibers for innervation to the lacrimal and nasal glands and conveys taste from the palate
    2. Stapedius nerve: Innervates the stapedius muscle
    3. Chorda tympani: Contains parasympathetic fibers to the sublingual and submandibular glands and conveys taste from the 2/3 anterior part of the tongue



Facial nerve pathway



2.7.2 – Upper Motor Lesion vs. Lower Motor Lesion

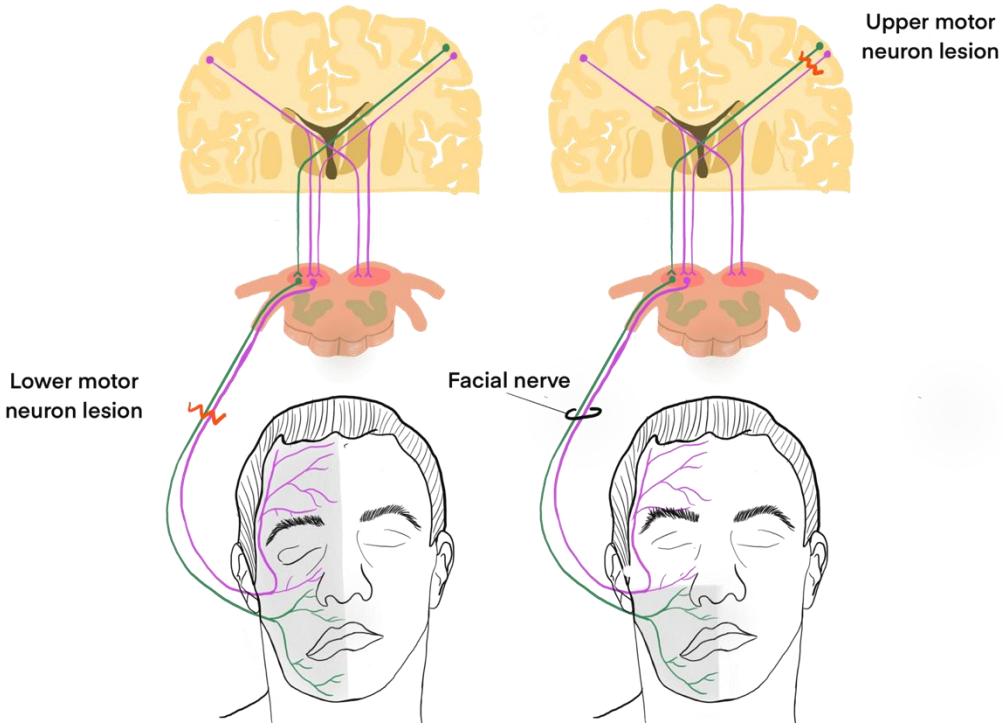
- The upper part of the face has dual innervation (i.e innervated by UMNs from both sides of the brain), while the lower face has contralateral innervation *only*

I. Upper motor neuron lesion

- CONTRALATERAL paralysis of lower face only
- Because only the lower face is affected, this might look like a less severe paralysis than when the entire half of the face is paralyzed like in Bell palsy. The reality, on the other hand, is that paralysis to the lower face alone, indicates upper motor neuron damage, which typically indicates stroke rather than the more benign Bell palsy.

II. Lower motor neuron lesion (Bell palsy)

- Ipsilateral paralysis of entire half of the face
- Idiopathic appearance of facial paralysis is called Bell palsy



CLINICAL CORRELATION

Stroke: A cause of facial nerve UMN lesion

FAST – mnemonic to recognize a stroke

Face drooping

Arm weakness

Speech difficulties

Time to call 911

If you have a patient that has newfound difficulties with speaking, raising their arms or sudden drooping of the corner of their mouth you should suspect a stroke and immediately start treatment.

2.8 – Vestibulocochlear Nerve (CN VIII)

Vestibulocochlear nerve	
Main function	Hearing and balance
Type of fibers	Sensory *Special somatic efferent (SVE)*
Innervation	2 branches: Cochlear branch: innervates the cochlea – responsible for hearing Vestibular branch: innervates the vestibule – responsible for balance
Exit from the brainstem	Cerebellopontine angel
Exit from the skull	Does not leave the skull
Pathway	Goes through the internal acoustic meatus and innervates sensory cells of the inner ear

2.8.1 – Lesions of the Vestibulocochlear Nerve

- Partial or complete loss of hearing
- Tinnitus
- Disequilibrium, vertigo and nystagmus

2.9 – Glossopharyngeal Nerve (CN IX)

Glossopharyngeal nerve		
Main function		Sensory innervation of pharynx Innervation of carotid body and sinus Taste from 1/3 posterior part of tongue
Type of fibers		**Innervation**
Sensory	**SVA**	Taste 1/3 posterior part of tongue and vallate papillae
	GVA	1/3 posterior part of tongue and pharyngeal wall Tympanic cavity and auditory tube Carotid sinus Palatine tonsil and soft palate
	GSA	External acoustic meatus
Motor	**SVE**	Innervation of stylopharyngeus
Parasympathetic	**GVE**	Parotid gland
Exit from the brainstem		Postolivary sulcus
Exit from the skull		Jugular foramen
Reflexes		Afferent limb of the carotid sinus and body reflexes Afferent limb of the gag reflex

2.9.1 – Lesions of the Glossopharyngeal Nerve

- Loss of gag reflex
- Loss of carotid sinus reflex
- Loss of taste from posterior 1/3 of the tongue
- Glossopharyngeal neuralgia

JUGULAR FORAMEN

3 cranial nerves exit the skull through the jugular foramen

Glossopharyngeal (CN IX)
Vagus (CN X)
Accessory nerve (CN XI

2.10 – Vagus Nerve (CN X)

Vagus nerve		
Main function		Taste from epiglottis, swallowing, and soft palate elevation.
Type of fiber		**Innervation**
Sensory	**GVA**	Mucosa of lower pharynx, larynx, esophagus, trachea and thoracoabdominal viscera.
	SVA	Taste from the epiglottis
	GSA	Auricle and external acoustic meatus
Motor	**SVE**	Muscles of pharynx[1], larynx, and palate[2].
	GVE	Smooth muscles and glands in the thoracoabdominal cavity and viscera
Parasympathetic		Secretory innervation in thoracic and abdominal viscera, except descending and sigmoid colons and other pelvic viscera[3]
Exit from the brainstem		Postolivary sulcus
Exit from the skull		Jugular foramen
Reflexes		Afferent and efferent limb of the cough reflex Efferent limb of the sneeze reflex Efferent limb of the gag reflex.

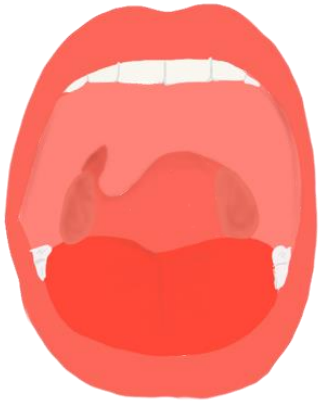
[1]Stylopharyngeus is innervated by the glossopharyngeal nerve

[2]Tensor veli palatini is innervated by the mandibular branch of trigeminal nerve (V3)

[3]Complete functions of the vagal nerve in the thorax and abdomen will not be discussed in this booklet.

2.10.1 – Lesions of the Vagus Nerve

- Loss of reflexes
    1. Cough reflex
    2. Sneeze reflex
    3. Gag reflex
- Ipsilateral paralysis of soft palate, pharynx and larynx → dysarthria, dysphagia, dysphonia
    1. Visible as the uvula will deviate *away* from the lesion , towards the *healthy* side when the patient says “aaa” (Illustration shows left sided vagal paralysis)



2.11 – Accessory Nerve (CN XI)

Accessory nerve	Cranial portion	Spinal portion[1]
Type of fibers	Motor	
	SVE	GSE
Innervation	Joins the vagus in the recurrent laryngeal nerve and innervates the larynx	Innervates the trapezius and sternocleidomastoid muscles
Exit from brainstem/spinal cord	Postolivary sulcus	C2-C5/6
Exit from the skull	Jugular foramen	

[1] Exits spinal cord, goes through foramen magnum and joins the cranial root inside the skull

2.11.1 – Lesions of the Accessory Nerve

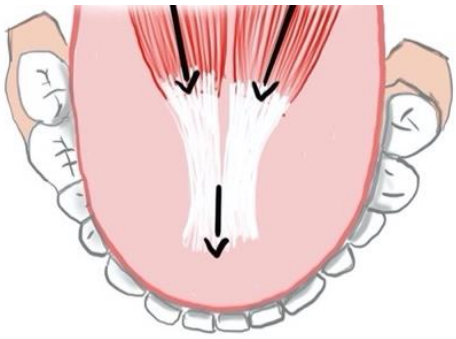
- Due to paralysis of trapezius muscle and sternocleidomastoid muscle, lesion can present with:
    1. Drooping of the shoulder and inability to shrug on ipsilateral side
    2. Weakness in head rotation towards the opposite side

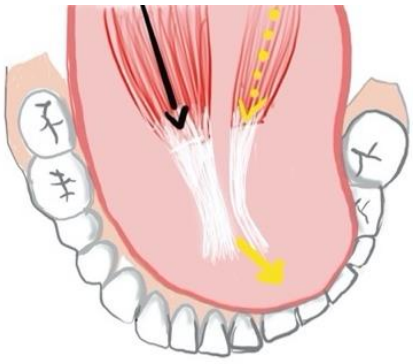
2.12 – Hypoglossal Nerve (CN XII)

Hypoglossal nerve	
Main function	Control the intrinsic and extrinsic muscles of the tounge All except palatoglossus (CN X)
Type of fibers	Motor *General somatic efferent*
Innervation	Muscles of the tongue
Exit from the brainstem	Preolivary sulcus of the medulla
Exit from the skull	Hypoglossal foramen

2.12.1 – Lesions of the Hypoglossal Nerve

- Hemiparalysis of the tongue
- Tongue will deviate to the injured side: “Lick your wounds” can be a useful role of thumb to remember that your tongue will deviate *towards* the lesion (the “wound”**)**





2.13 – Test Yourself

1) Which 4 nerves contain parasympathetic fibers?

a) CN II, IV, VII, IX

b) CN III, V, VII, XII

c) CN III, VII, X, XI

d) CN III, VII, IX, X

2) The afferent limb of the pupillary light reflex is the _____ nerve and the efferent limb is the _____ nerve

3) Fill in the blanks

Olfactory nerve	
Main function	
Type of fibers	Sensory *Special Visceral Afferent (SVA)*
Origin	
Exit from the brain	Extension of telencephalon
Exit from the skull	

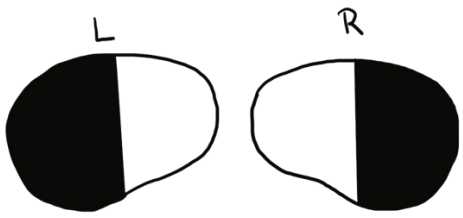
4) Bilateral hemianopia, which is loss of temporal vision, is caused by a lesion of?

a) Optic nerve

b) Optic tract

c) Optic chiasm

d) Upper radiation



5) The oculomotor nerve carries parasympathetic fibers that are responsible for

a) Elevation of the eyelid

b) Mydriasis

c) Miosis

d) Accommodation

e) C and D are correct

6) With a lesion of the 4th cranial nerve we can see

a) Inability to move the eye laterally

b) Ptosis and loss of accommodation

c) Inability to look down and out

d) Pupil looks down and out

7) With a lesion of the ophthalmic branch of the trigeminal nerve you will experience loss of sensation:

a) On the skin of the cheeks
b) On skin of the chin
c) On the skin of the lower eye lid
d) On the eyeball

8) Which of the cranial nerves exit the brainstem from the dorsal side?

---

9) With a lesion of the facial nerve above where the chorda tympani branches of in the facial canal, which functions will be lost?

---

10) With lesion of the hypoglossal nerve, the tongue will deviate towards the <u>healthy or injured</u> side?

11) Afferent and efferent limb of the gag reflex is:

a) Both are vagus
b) Afferent: IX, Efferent X
c) Afferent: X, Efferent IX
d) Both are glossopharyngeal

12) The posterior 1/3 of the tongue is innervated by which nerve?

a) Hypoglossal
b) Glossopharyngeal
b) Vagus
c) Facial

Section 3 – Cranial Nerve Nuclei

3.1 – Test Yourself

I. **Motor nuclei** – gives rise to efferent (motor) fibers
   - Impulses goes from the nuclei to the organ

II. **Sensory nuclei** – where afferent (sensory) fibers terminate
   - Impulses goes from the organ to the nuclei

Nerve	Nuclei	Fibers	Function	Location
CN III	Motor nucleus of oculomotor	M	Movement of eye muscles	Midbrain
	Edinger-Westphal	PS	Papillary sphincter & ciliary muscles	
CN IV	Motor nucleus of trochlear	M	Movement of eye muscles (Superior oblique)	Midbrain
CN V	Trigeminal motor nucleus	M	Muscles of mastication	Pons Sensory nucleuses stretch through the whole brainstem
	Mesencephalic	S	Proprioceptive afferent fibers from muscles of mastication	
	Pontine (Principal)		Touch, vibration and joint position	
	Spinal		Pain and temperature sensation in the head	
CN VI	Motor nucleus of Abducent	M	Movement of eye muscles (Lateral rectus)	Pons
CN VII	Solitary nucleus	S	Taste	Border between medulla and pons Pons
	Motor of facial	M	Facial muscles	
	Superior salivatory	PS	Submandibular and sublingual glands	
CN VIII	Anterior cochlear Posterior cochlear	S	Hearing	Pons
	Superior vestibular *Inferior vestibular* *Lateral vestibular* *Medial vestibular*		*Sense of balance*	

Nerve	Nuclei	Fibers	Function	Location
CN IX	Solitary nucleus	S	Taste	Border between medulla and pons
	Nucleus ambiguous	M	Pharyngeal and laryngeal muscles	
	Inferior salivatory	PS	Parotid gland	Medulla
CN X	Solitary nucleus	S	Taste	Border between medulla and pons
	Nucleus ambiguous	M	Pharyngeal and laryngeal muscles	
	Dorsal vagal nucleus	PS	Viscera	Medulla
CN XI	Nucleus ambiguous	M	Cranial root: Pharyngeal and laryngeal muscles	Medulla
	Motor nucleus of accessory		Spinal root: Movement of shoulder muscles	
CN XII	Motor nucleus of Hypoglossal	M	Movement of lingual muscles	Medulla

I. **Solitary nucleus** – (VII, IX, X) – transmits the sensation of taste, and sensation from the pharynx and larynx.
   - Superior part – special visceral afferent from (taste) VII, IX & X
   - Inferior part – general visceral afferent (sensation) from IX & X

II. **Nucleus ambiguous** – (IX, X, XI Cranial root) – Movement of muscles in pharynx and larynx

3.1 – Test Yourself

1) Edinger Westphal nucleus supplies _____ fibers to the _____

2) Which nucleus is responsible for transmission of taste fibers to the VII, IX and X?

a) Nucleus ambiguous
b) Solitary nucleus
c) Superior salivatory
d) Dorsal vagal nucleus

2) The trigmenial nerve has 3 sensory nuclei, which one is responsible for the fibers that relay information about touch, vibration and joint position.

a) Pontine
b) Mesencephalic
c) Spinal

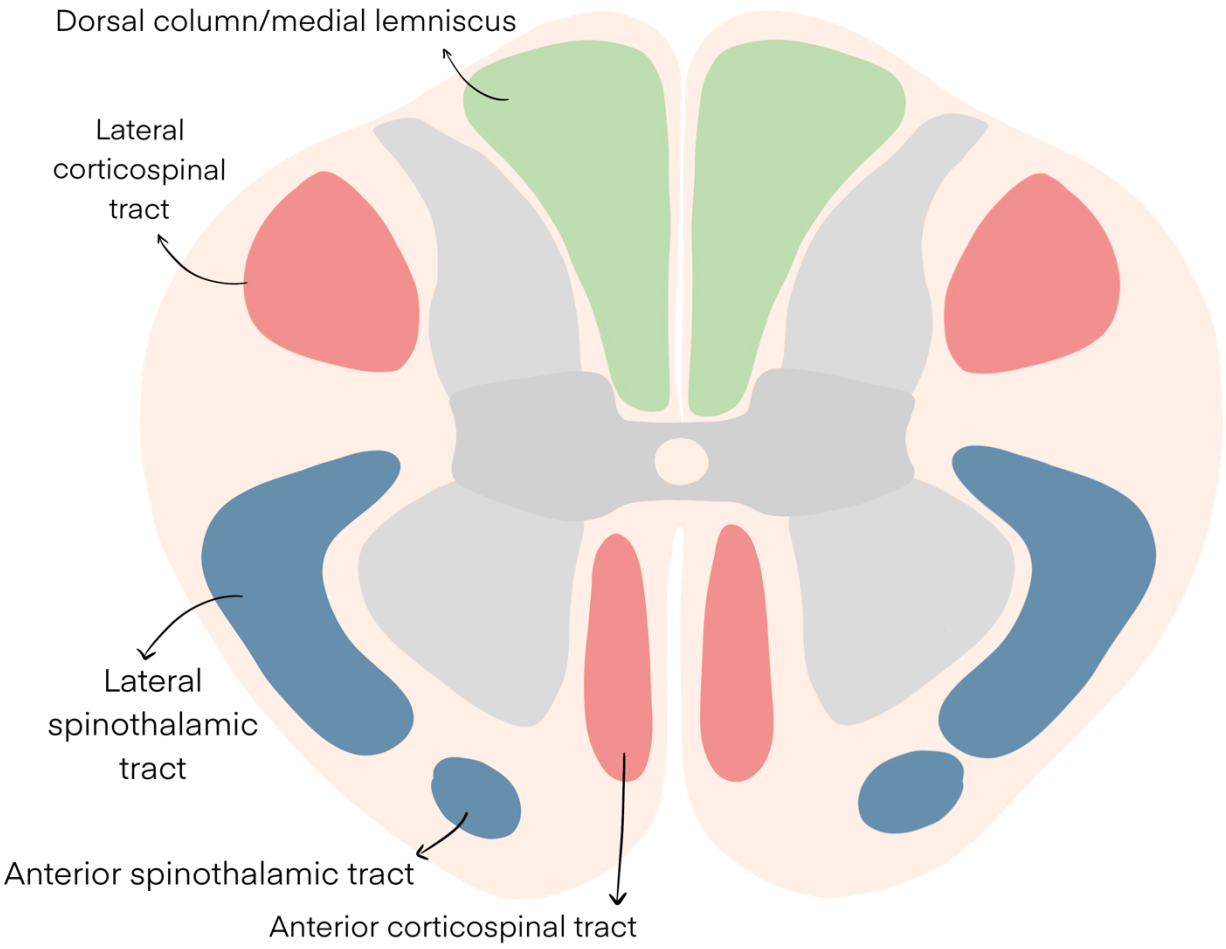
3) The superior salivatory nucleus is responsible for supplying fibers that innervate which glands?

---

4) A patient comes in and after a neurological surgery in the left jugular canal. He presents with no gag reflex on the left side, and the uvula was deviated to the right. Which nuclei will contain the neural cell bodies for the motor supply of the paralyzed muscles?

a) Nucleus solitary
b) Nucleus ambiguous
c) Dorsal vagal nucleus
d) Trigeminal motor nucleus

Section 4 – Spinal Tracts



4.1 – Ascending Tracts

- Sensory information transmitted from the body to the brain

4.1.1 – Dorsal Column/Medial Lemniscus

- Called dorsal column in spinal cord and medial lemniscus in medulla, pons + midbrain
- Fasciculus cuneatus: has a lateral location in the spinal cord and transmits sensory information from the upper body (T6 and up)
- Fasciculus Gracilis: has a medial location in spinal cord and transmits sensory information from the lower body (T7 and down)
- Decussate as internal arcuate fibers in the medulla

CLINICAL CORRELATION

Tabes dorsalis

It is a rare finding in the developed world today, but untreated syphilis can cause damage to the dorsal column of the spinal cord.

When syphilis reaches this stage, it is called tertiary syphilis. It also presents with damage to other organs, like the cardiovascular system and skin.

Tabes dorsalis presents as progressive sensory ataxia due to the loss of proprioception. On physical examination you will find a positive Romberg sign and absent deep tendon reflexes.

MNEMONIC

Location of the dorsal column tracts

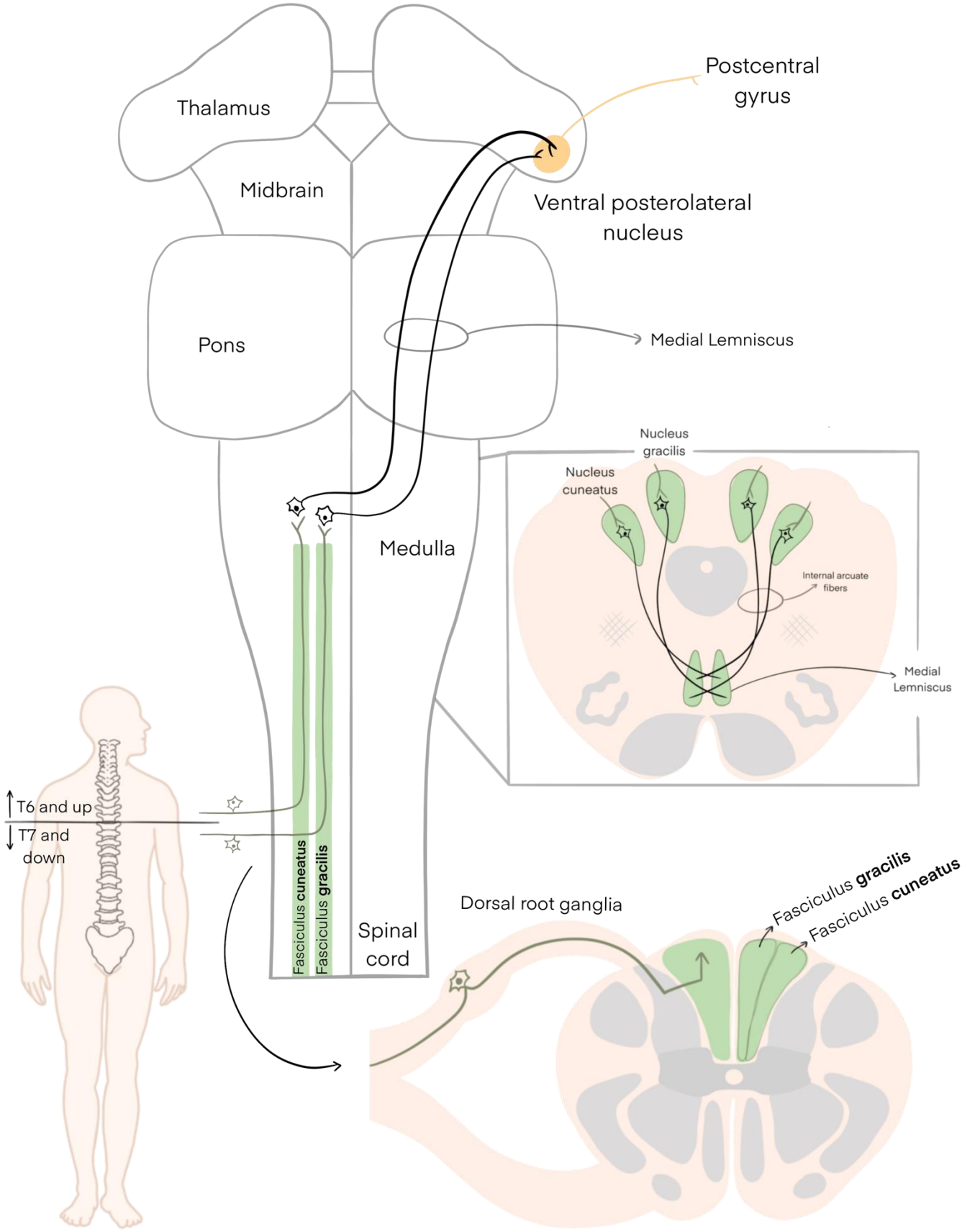
Graci**L**is – **L**ower body

Cuneat**U**s – **U**pper body

Dorsal column tracts are organized like us:

Legs inside: Graci**L**is has a medial position in the spinal cord

Arms outside: Cune**A**tus has a lateral position in the spinal cord


Thalamus
Postcentral gyrus
Midbrain
Ventral posterolateral nucleus
Pons
Medial Lemniscus
Nucleus gracilis
Nucleus cuneatus
Internal arcuate fibers
Medial Lemniscus
Medulla
T6 and up
T7 and down
Fasciculus cuneatus
Fasciculus gracilis
Spinal cord
Dorsal root ganglia
Fasciculus gracilis
Fasciculus cuneatus

4.1.2 – Spinothalamic Tracts

- Lateral: Pain, Temperature
- Anterior: **C**rude touch, pressure

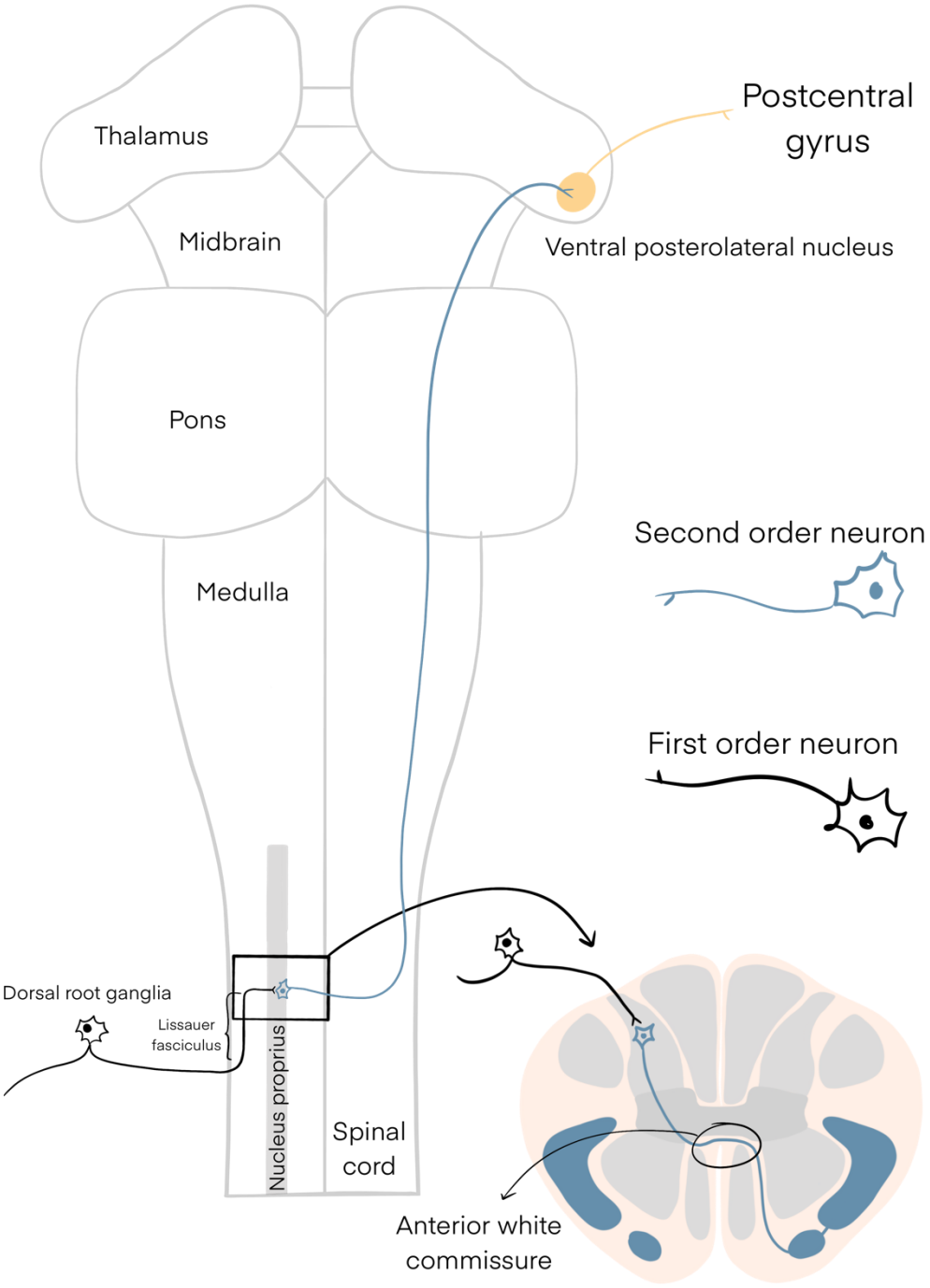
MNEMONIC

Sensations in the lateral spinothalamic tract
Lateral: **P**ain, **T**emperature
I **L**augh at **P**ain! You can't take the **heat**?

MNEMONIC

Sensations transmitted by the spinothalamic tracts
Pain, **P**ressure
Temperature
Crude touch

sPinoThalamiC

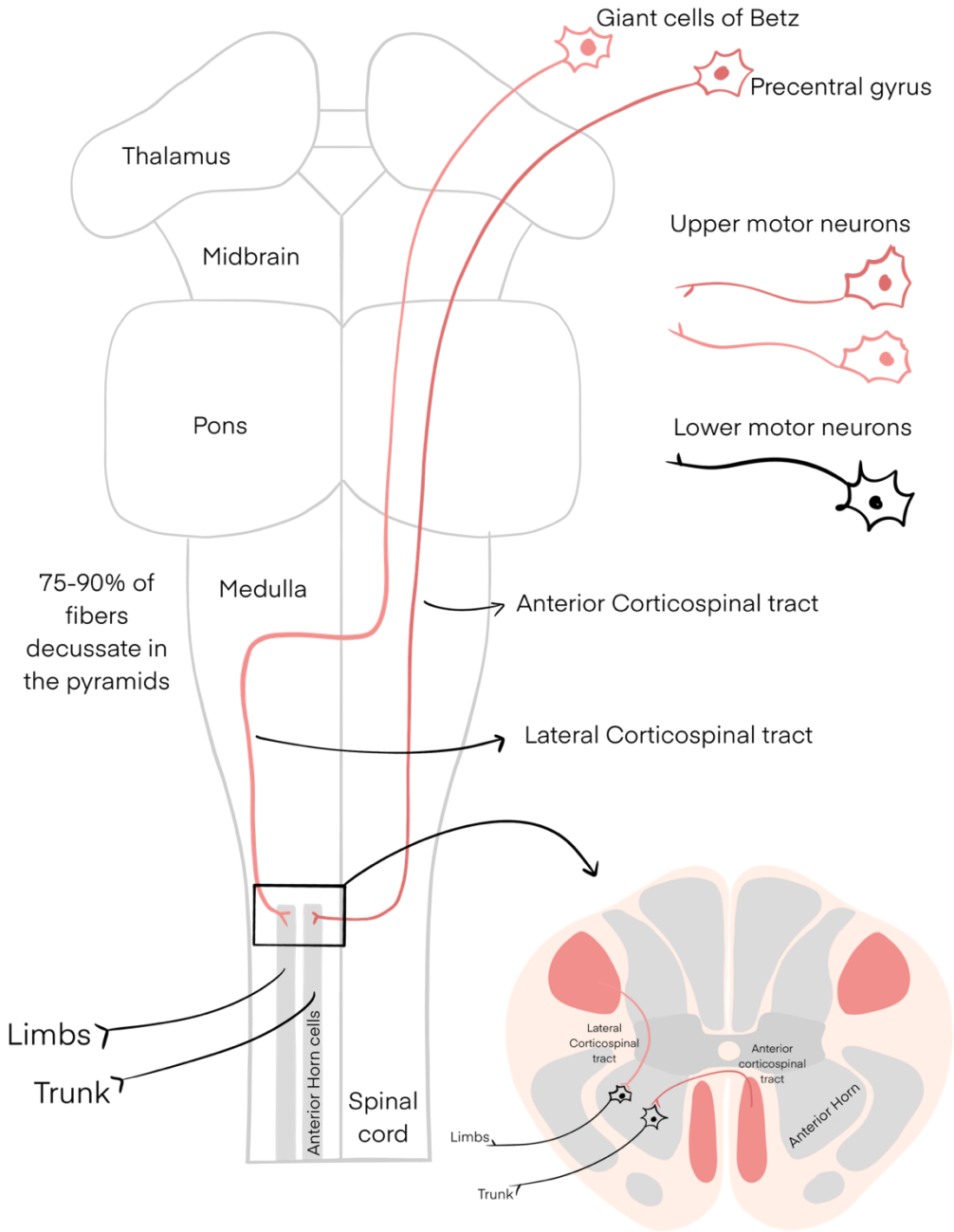


4.2 – Descending Tracts

- Motor signals transmitted from the brain to the body

4.2.1 – Corticospinal Tracts

- = Pyramidal tracts
- Motor fibers transmitting information (“orders”) from the brain to the body
- Lateral corticospinal tract is responsible for advanced movement, and provides motor fibers to extremities: **In corticospinal tracts, arms and legs are lateral**
- Anterior corticospinal tract is responsible for primitive movement, and provides motor fibers to trunk and neck



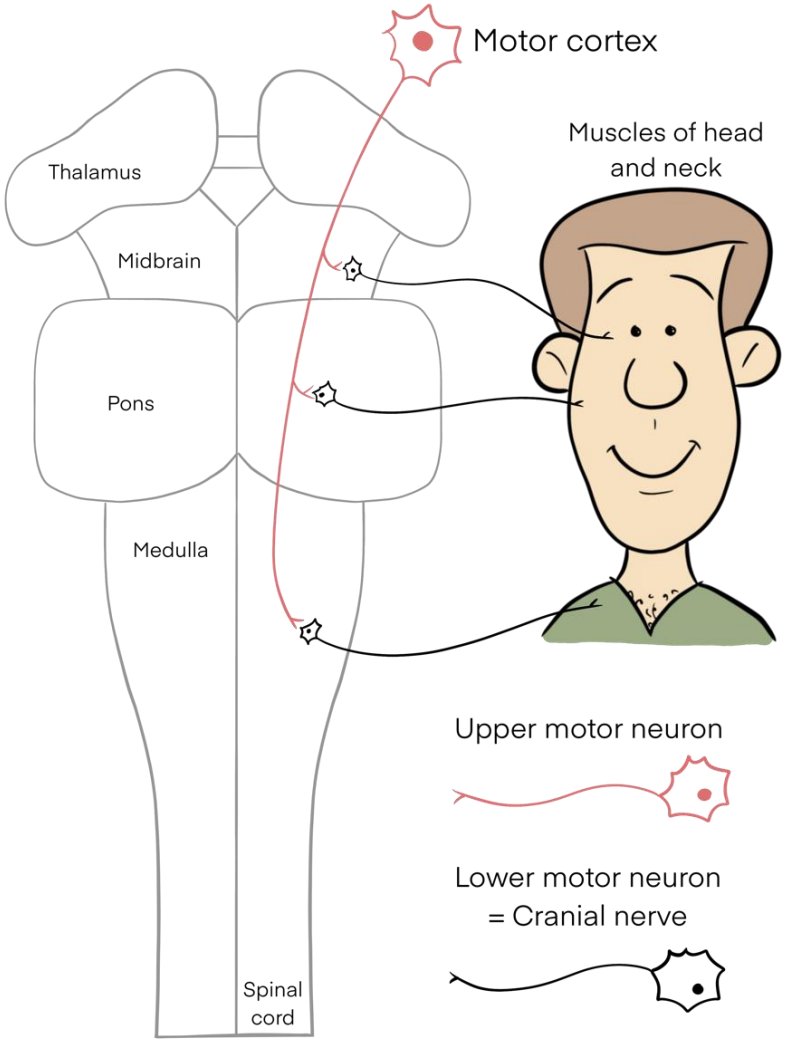
4.2.2 – Corticobulbar Tracts

- = Pyramidal tracts
- Upper motor neurons from the motor cortex synapse with the cranial nerve nuclei in the brain stem
- Corticobulbar axons leave the brain stem at all levels to synapse on cranial nerve nuclei
- Controls muscles of the head and neck
- About 50% of the nerve fibers decussate (compared to the corticospinal tract where most of the fibers decussate). Decussations are not shown in the illustration below. (For an example of decussation, see the illustration in Section 2.7 – Facial Nerve)

Cranial nerves in the brain stem: Rule of 4

	Cranial nerves	Motor function
4 CN above pons	I, II, **III**, **IV**	**III + IV**: Eye movement
4 CN emerging from pons	**V**, **VI**, **VII**, VIII	**V**: Mastication, dampening loud noises **VI**: Eye movement **VII**: Facial movement, eye closing, volume modulation
4 CN below pons	**IX**, **X**, **XI**, **XII**	**IX:** Elevation of pharynx and larynx **X**: Swallowing, talking (++)

Bolded cranial nerves are lower motor neurons of the corticobulbar tract



4.3 – Test Yourself

1) Where does the dorsal column/medial lemniscus tract decussate?

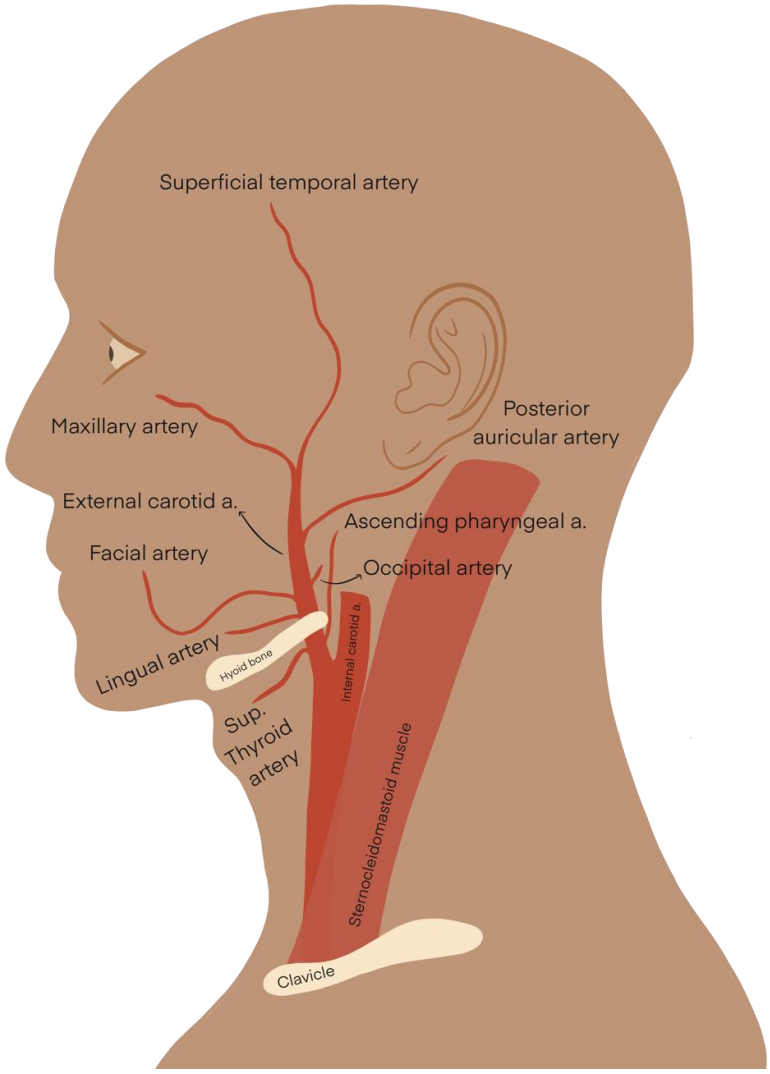
a) Spinal cord
b) Medulla
c) Pons
d) Midbrain

2) Which tract is known as the pyramidal tract?

a) Dorsal column/medial lemniscus
b) Spinothalamic
c) Corticospinal
d) Corticobulbar
e) a and b
f) c and d

Section 5 – Arterial Blood Supply

5.1 – External Carotid Artery
5.2 – Basilar Artery
5.3 – Circle of Willis
5.4 – Test Yourself



5.1 – External Carotid Artery

- Branches
  1. **S**up. Thyroid artery
  2. **L**ingual artery
  3. **F**acial artery
  4. **M**axillary artery
  5. **S**uperficial temporal artery
  6. **P**osterior auricular artery
  7. **O**ccipital artery
  8. **A**scending pharyngeal artery

MNEMONIC

(in order)
Sister **L**ucy **F**inds **M**any **S**ad **P**eople **O**n the **A**lter

5.1.1 – Brain Hematomas

	Cause	Notes
Epidural hematoma	Rupture of middle meningeal artery (branch of maxillary artery)	"Talk and die" syndrome: Brief loss of consciousness followed by a "lucid interval"[1] → Rapid deterioration and death
Subdural hematoma	Rupture of bridging veins	Acute: Trauma Chronic: In alcoholics and elderly people due to cerebral atrophy and stretching of the vessels

[1] Patient feels better for a few hours

5.2 – Basilar Artery

- Branches
    1. **P**osterior cerebral artery
    2. **S**uperior cerebellar artery
    3. **P**ontine arteries
    4. **L**abyrinthine artery
    5. **A**nterior inferior **C**erebellar arteries (AICA)

MNEMONIC

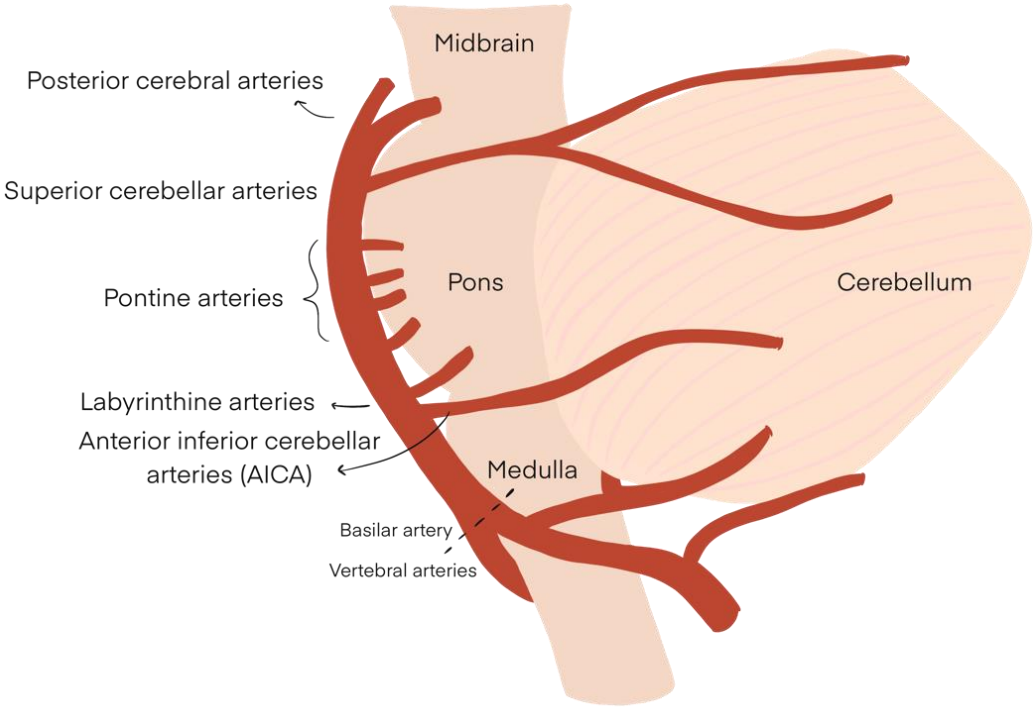
The **P**olice **S**ays: **P**lease **L**eave **A**ll **C**ars!

CLINICAL CORRELATION

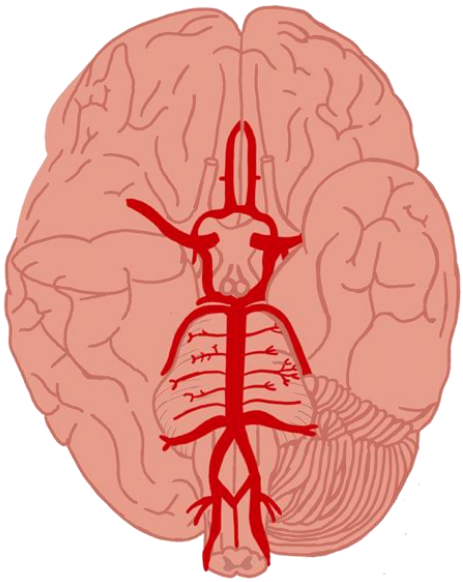
Locked in syndrome

A stroke in the basilar artery can lead to quadriplegia and inability to speak. This produces a state the patient looks like they are in a coma, but they are cognitively intact. Movement of the eyes is often retained.

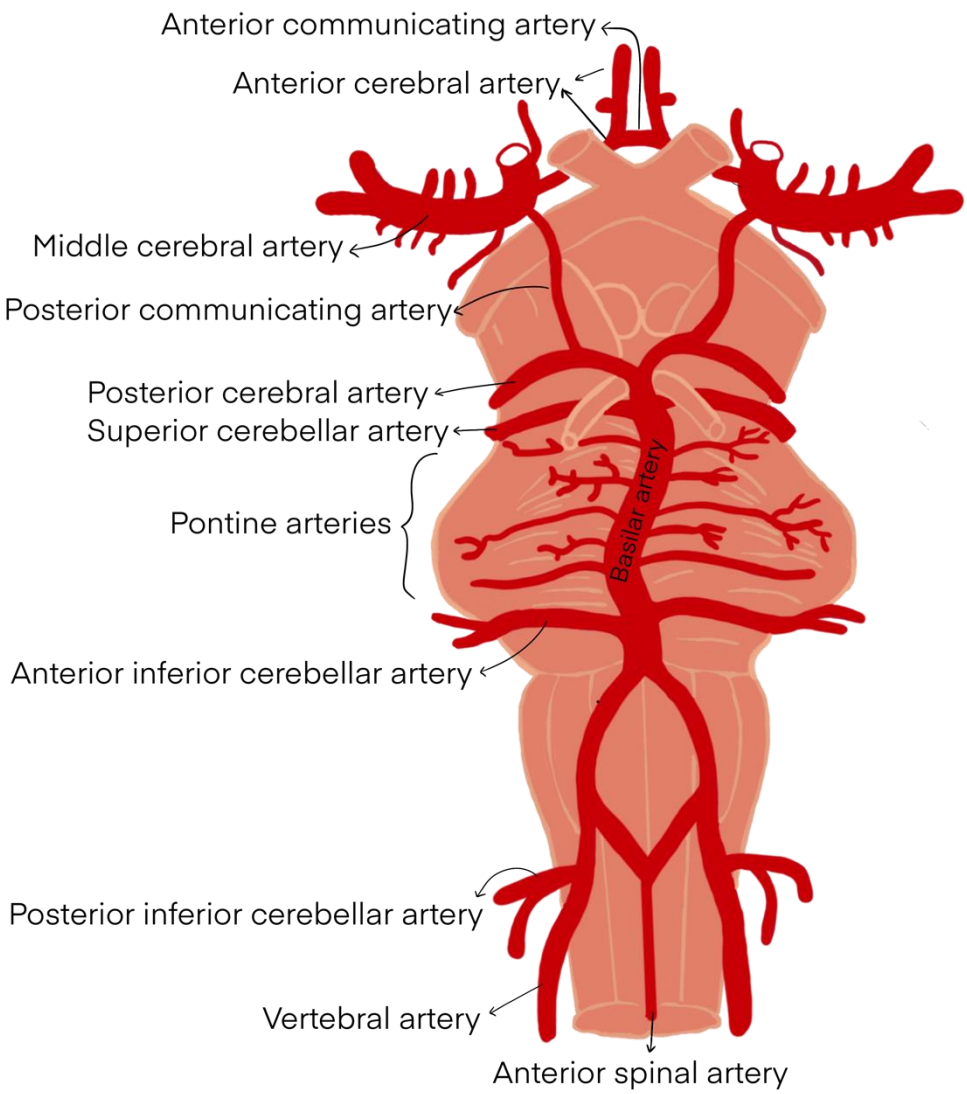
In one study, it took almost 3 months to diagnose the condition for some patients.



5.3 – Circle of Willis



- Formed by:
    1. Anterior cerebral artery (ACA)
    2. Anterior communicating artery (ACom)
    3. Interior carotid artery (ICA)
    4. Posterior communicating artery (PCom)
    5. Posterior cerebral artery (PCA)
- Middle cerebral artery is *not* a part of Circle of Willis
- The most common site of a saccular ("Berry") aneurysm is at the ACA
    1. Can lead to subarachnoid hemorrhage: Typically presents with "the worst headache of my life" and yellow CSF on spinal tap
- Aneurysms at PCA can cause CN III palsy with the classical "down and out" gaze (*recall from Section – 2.3.4)*

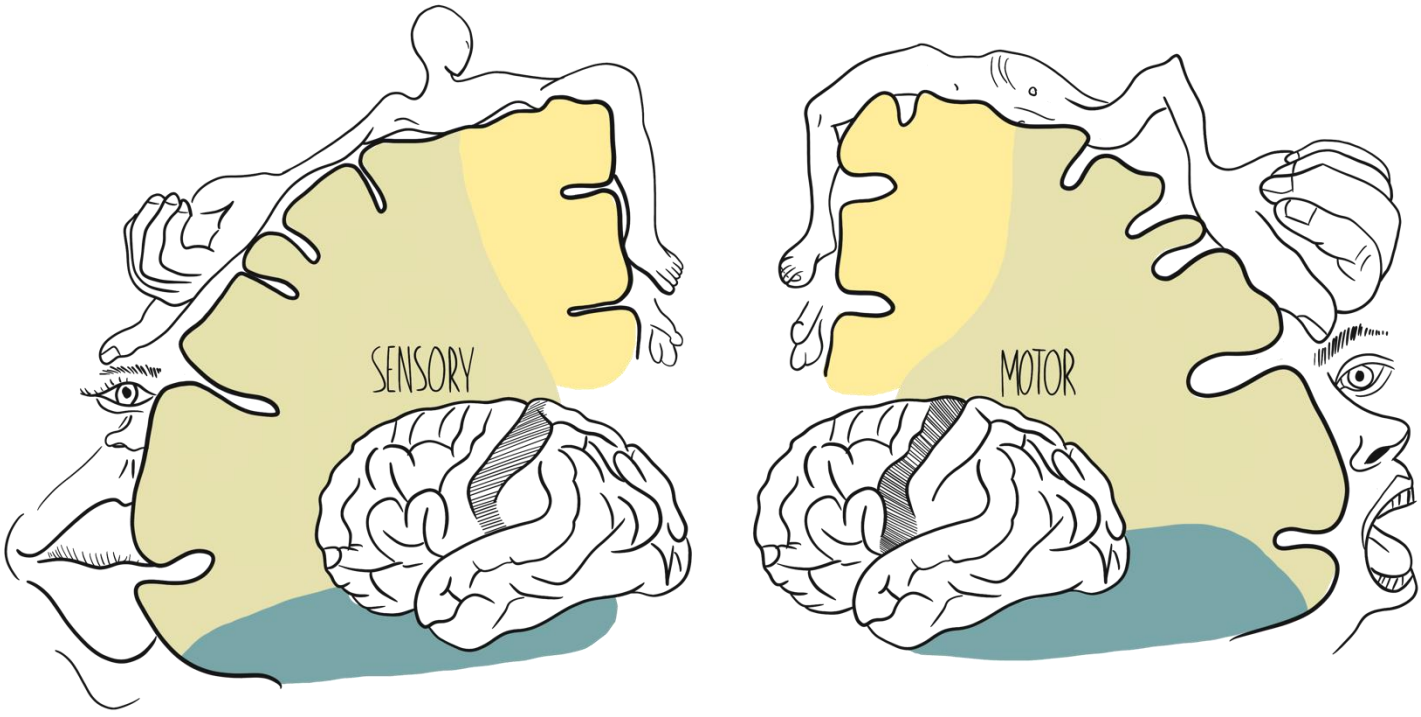


5.3.1 – Cerebral Arteries and Stroke Syndromes

Cerebral artery	Brain surface	Symptoms of stroke in the area
Anterior	**Anter**omedial	Contralateral leg paresis Urinary incontinence Personality changes
Middle	Lateral	Contralateral arm paresis Symptoms of upper motor neuron lesion Aphasia Hemineglect: Absence of awareness of items on one side Gaze preference
Posterior	**Posterior** and inferior	Homonymous hemianopia If a clot dislodges → Amaurosis fugax: Obstruction of retinal artery yielding painless vision loss

- Use the homunculus to visualize how symptoms can indicate the location of a cerebral stroke:

	Anterior cerebral artery
	Middle cerebral artery
	Posterior cerebral artery



5.4 – Test Yourself

1) What causes the "talk and die" syndrome?

a) Subarachnoid hemorrhage

b) Subdural hemorrhage

c) Epidural hemorrhage

d) Ischemic stroke

2) Which of the following arteries are <u>not</u> a part of the Circle of Willis?

a) Anterior cerebral artery
b) Internal carotid artery
c) Middle cerebral artery
d) Posterior cerebral artery

3) Aneurysms at which artery can cause the classical "down and out" gaze from CNIII damage?

a) Anterior cerebral artery
b) Internal carotid artery
c) Middle cerebral artery
d) Posterior cerebral artery

4) What is the most common location for a Berry aneurysm?

a) Anterior cerebral artery
b) Internal carotid artery
c) Middle cerebral artery
d) Posterior cerebral artery

Section 6 – Venous Drainage and Cerebrospinal Fluid

6.1 – Cerebrospinal Fluid

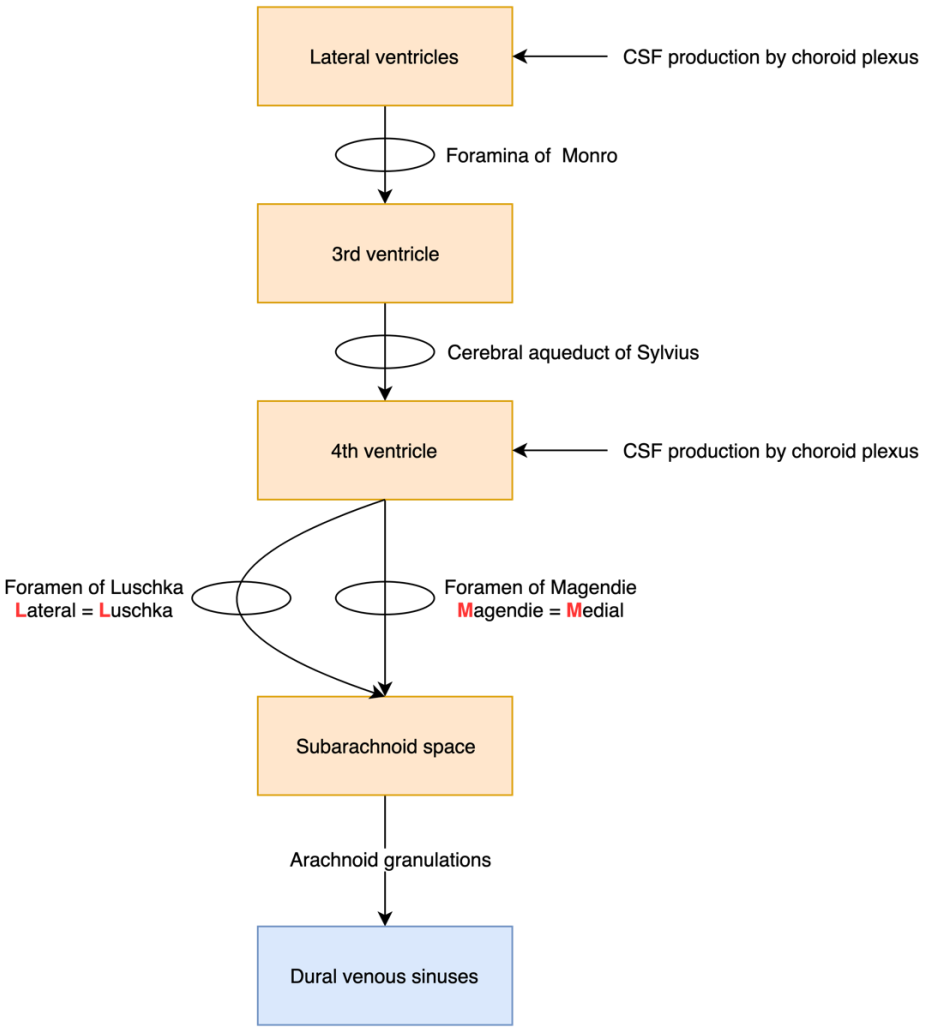
- Obstruction of the CSF flow causes hydrocephalus

I. Choroid plexus

- Specialized ependymal cells that produce CSF
- Localized in the lateral and 4th ventricles

II. Arachnoid granulations

- Also called arachnoid villi
- Extensions of the arachnoid mater into the venous dural sinuses
- Allows the CSF to flow into the venous dural sinuses from the subarachnoid space
- Most abundant at the superior sagittal sinus, but can be found in all the venous dural sinuses



6.2 – Cavernous Sinus

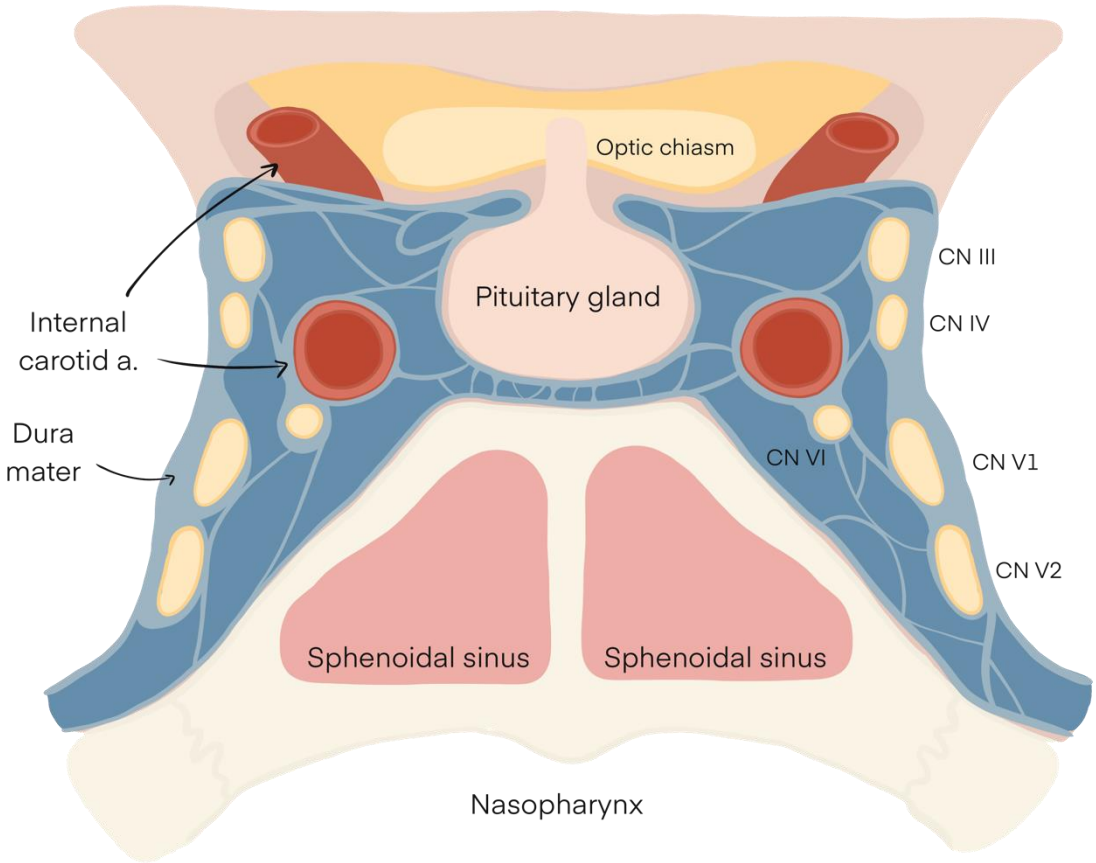
- A paired set of sinuses located lateral to the Sella Turcica
- One of the venous dural sinuses
- Receives blood from the eye and superficial cortex
- Drains into the internal jugular vein via the inferior petrosal sinuses
- Nerves: CN III, CN IV, CN V_1 + V_2, CN VI

CLINICAL CORRELATION

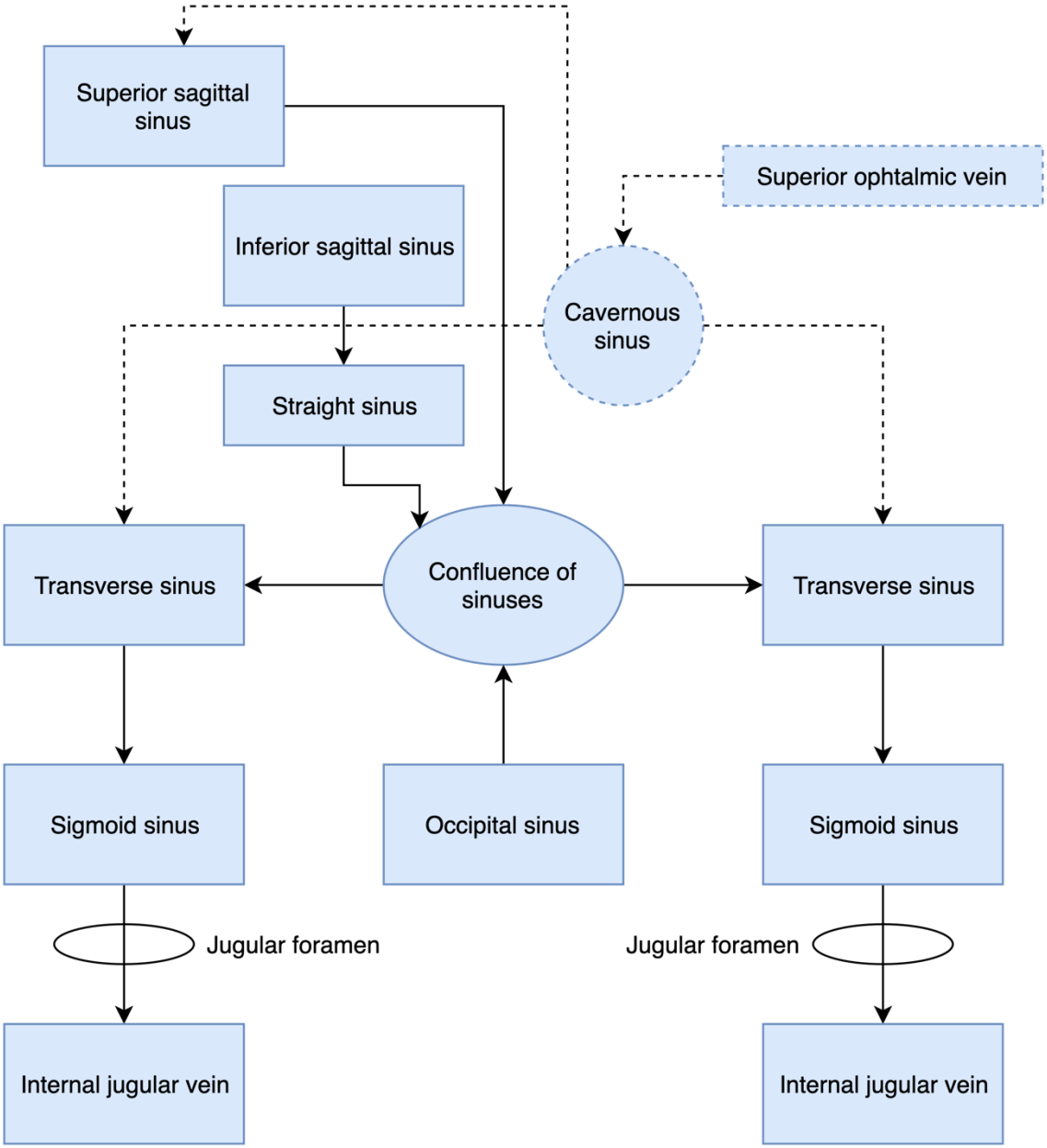
Pituitary tumor: Cavernous sinus syndrome
The paired cavernous sinuses surrounds the pituitary gland. If a tumor arises in the pituitary gland, a pituitary adenoma for example, we can see symptoms that reflect the structures in the cavernous sinus

Ophthalmoplegia:
Compression of CN III, IV and VI

Loss of sensation in the face and eyes:
Compression of the V_1/V_2 branches of CN V



6.3 – Dural Venous Sinuses



- The cerebral veins drain into the venous dural sinuses
- Receive cerebrospinal fluid (CSF) from the arachnoid granulations
- Confluence of sinuses is the meeting point of:
    1. Superior sagittal sinus
    2. Straight sinus
    3. Occipital sinus
    4. Transverse sinuses
- Sigmoid sinus becomes the internal jugular vein

6.4 – Test Yourself

1) What happens if CSF flow is obstructed?
a) Nothing it's ok ☺
b) Hydrocephalus
c) Orthostatic hypotension
e) Meningitis

2) What is the choroid plexus
a) Nerve plexus in the brain stem
b) A collection of veins in the dura mater
c) Specialized ependymal cells
d) Cells that produce neurotransmitters for the brain

3) What are arachnoid villi?
a) Arachnoid granulations
b) Extentions of the arachnoid mater into the dural venous sinuses
c) A passage for CSF into the venous system
d) All of the above

4) Which cranial nerves passes through the cavernous sinus?

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5) Which venous sinuses merge in the confluence of sinuses?
a) Sigmoid sinus + straight sinus + transverse sinus
b) Transverse sinus + Occipital sinus + Cavernous sinus + Superior sagittal sinus
c) Transverse sinus + Occipital sinus + Straight sinus + Superior sagittal sinus
d) Occipital sinus + Cavernous sinus

Section 7 - Pharynx and Larynx

7.1 – Muscles of the Pharynx

	Muscle	Innervation	Action
Circular muscles	Superior constrictor	Vagus	Constricts upper pharynx
	Middle constrictor		Constricts lower pharynx
	Inferior constrictor	Vagus + recurrent and external laryngeal nerve	
Longitudinal muscles	Palatopharyngeus	Vagus	Elevates pharynx and larynx
	Salpingopharyngeus		Elevates pharynx and larynx Closes nasopharynx
	Stylopharyngeus	Glossopharyngeal	Elevates pharynx Opens auditory tube

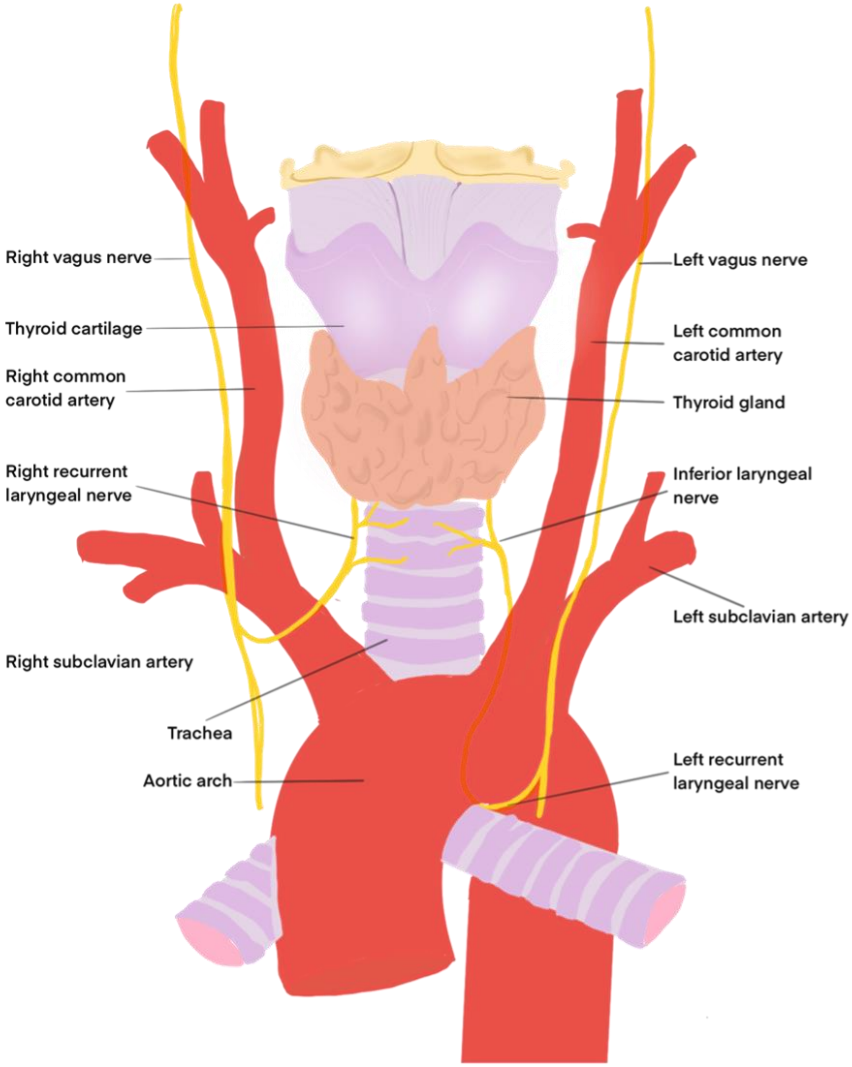
7.2 – Muscles of the Larynx

Muscle	Action	Innervation
Cricothyroid	Tenses, adducts, elongates	External laryngeal nerve
Posterior cricothyroid	**Abducts** Opens rima glottidis	Recurrent laryngeal nerve
Lateral cricoarytenoid	Adducts Closes rima glottidis	
Transverse artytenoids		
Oblique arytenoids		
Aryepiglottic	Adducts	
Thyroarytenoid	Adducts Relaxes	
Thyroepiglottic	Adducts	
Vocalis	Adducts Tenses – anterior part Relxes - posterior part Controls pitch	

All intrinsic muscles of the larynx are innervated by the recurrent laryngeal nerve, EXCEPT for cricothyroid which is innervated by the external laryngeal nerve.
All muscles of the larynx adduct, EXCEPT for posterior cricothyroid which abducts.

7.2.1 – Recurrent Laryngeal Nerve

- Innervates all intrinsic muscles of the larynx, EXCEPT cricothyroid
- Supplies sensory innervation below the vocal cords
- **Right** recurrent laryngeal nerve passes underneath the subclavian artery before it travels up towards the larynx.
- **Left** recurrent laryngeal travels under the aortic arch before it travels up.

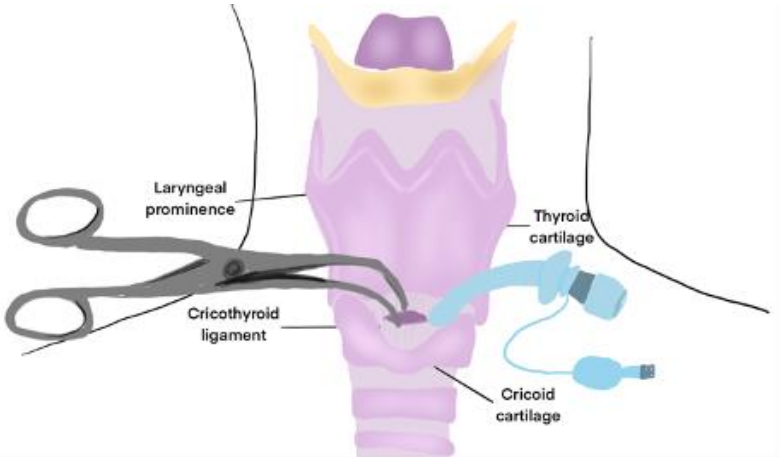


CLINICAL CORRELATION

Damage to the recurrent laryngeal nerve

After a thyroidectomy or a cricothyrotomy, or by an aortic aneurysm, the recurrent laryngeal nerve can be injured.

A lesion can produce respiratory obstruction, hoarseness, inability to speak and loss of sensation below the vocal cord.



7.3 – Test Yourself

1) What is the function of the circular muscles of the pharynx?
a) Elevation of the pharynx
b) Lowering the pharynx
c) Constrict the pharynx
d) Dilate the pharynx

2) What is the function of the longitudinal muscles of the pharynx?
a) Elevation of the pharynx
b) Lowering the pharynx
c) Constrict the pharynx
d) Dilate the pharynx

3) All intrinsic muscles of the larynx are innervated by the recurrent laryngeal nerve, EXCEPT for _____ which is innervated by the external laryngeal nerve

4) Which structure does the right recurrent laryngeal nerve pass inferior to before ascending?
a) Right subclavian artery
b) Right external carotid artery
c) The aortic arch
d) The bifurcation of the trachea

5) Which structure does the left recurrent laryngeal nerve pass inferior to before ascending?
a) Right subclavian artery
b) Right external carotid artery
c) The aortic arch
d) The bifurcation of the trachea

6) The posterior cricothyroid muscle is responsible for <u>abduction or adduction</u>?

7) The stylopharyngeus muscle is innervated by
a) Vagus nerve
b) External laryngeal
c) Recurrent laryngeal
d) Glossopharyngeal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