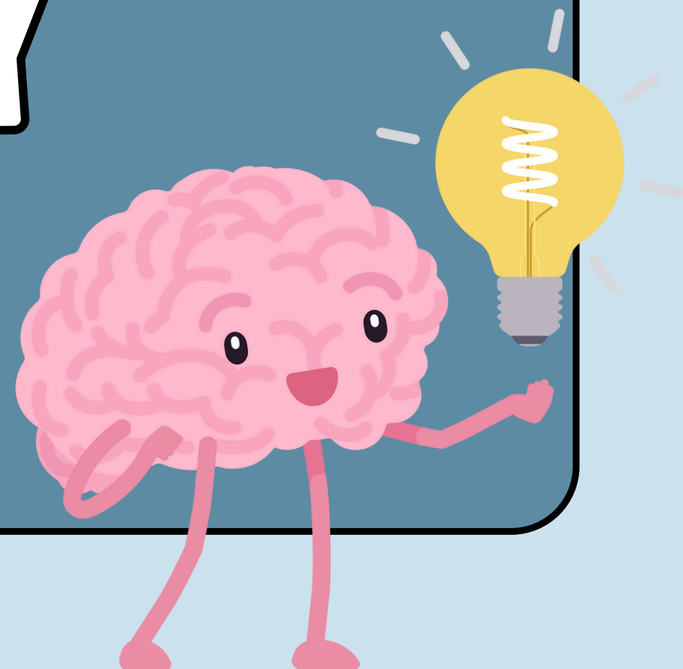
NEURO ANATOMY



Pre-central gyrus:

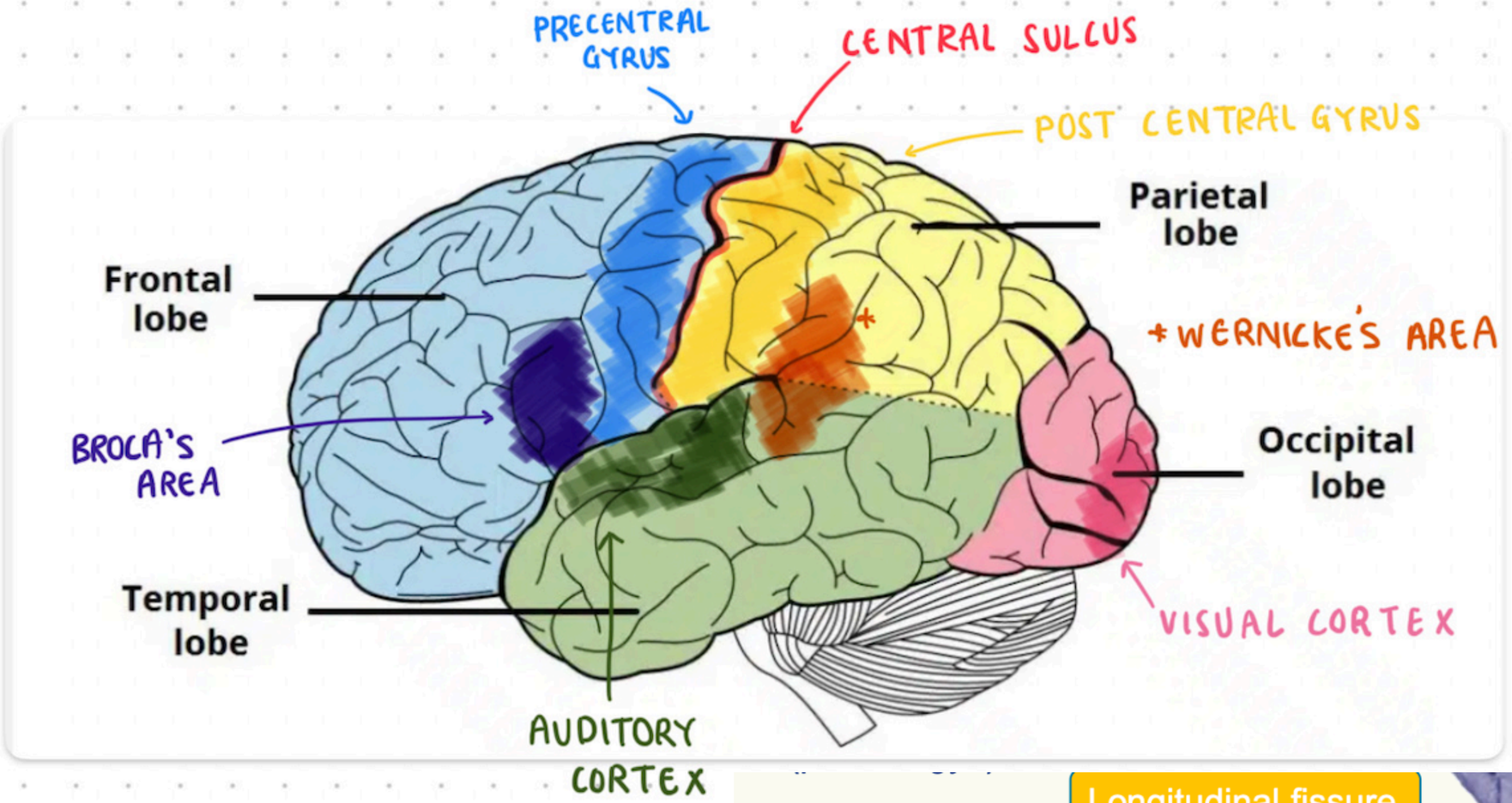
Contains the Primary **motor** cortex

Highest level in brain for movement control

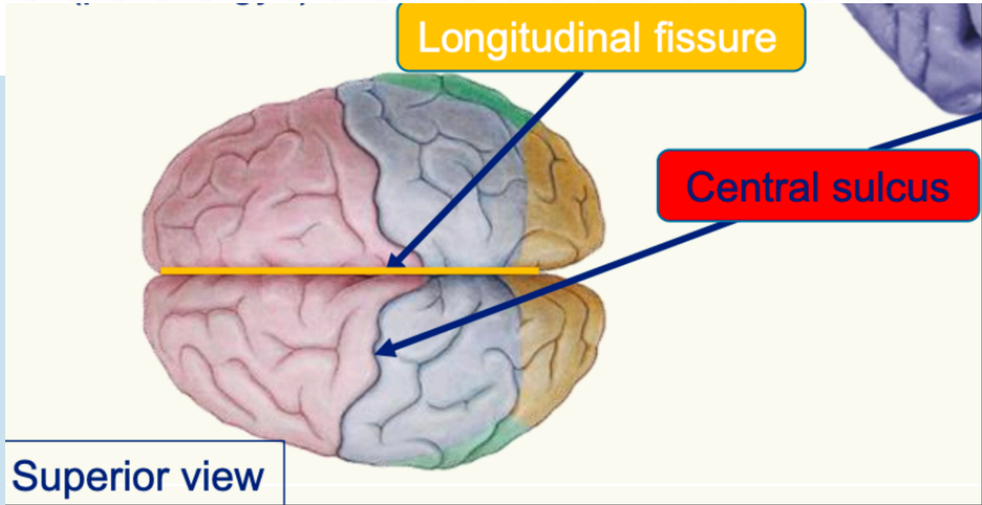
Post-central gyrus:

Primary **somatosensory** cortex

Touch,pressure, pain temperature



- The cerebrum splits into **2 cerebral hemispheres** in the sagittal plane by a **longitudinal fissure**
- They are connected by a bundle of nerve fibres called the **corpus callosum. This is commissural tissue**
- Ridges: **gyrus/gyri, functional areas of the brain**
- Fissures: **sulcus/sulci**



The cerebellum is joined to the brainstem by three bilaterally paired peduncles:
superior, middle and inferior attach to their respective portions of the brainstem

SUPERIOR = MIDBRAIN, CN 1,2,34

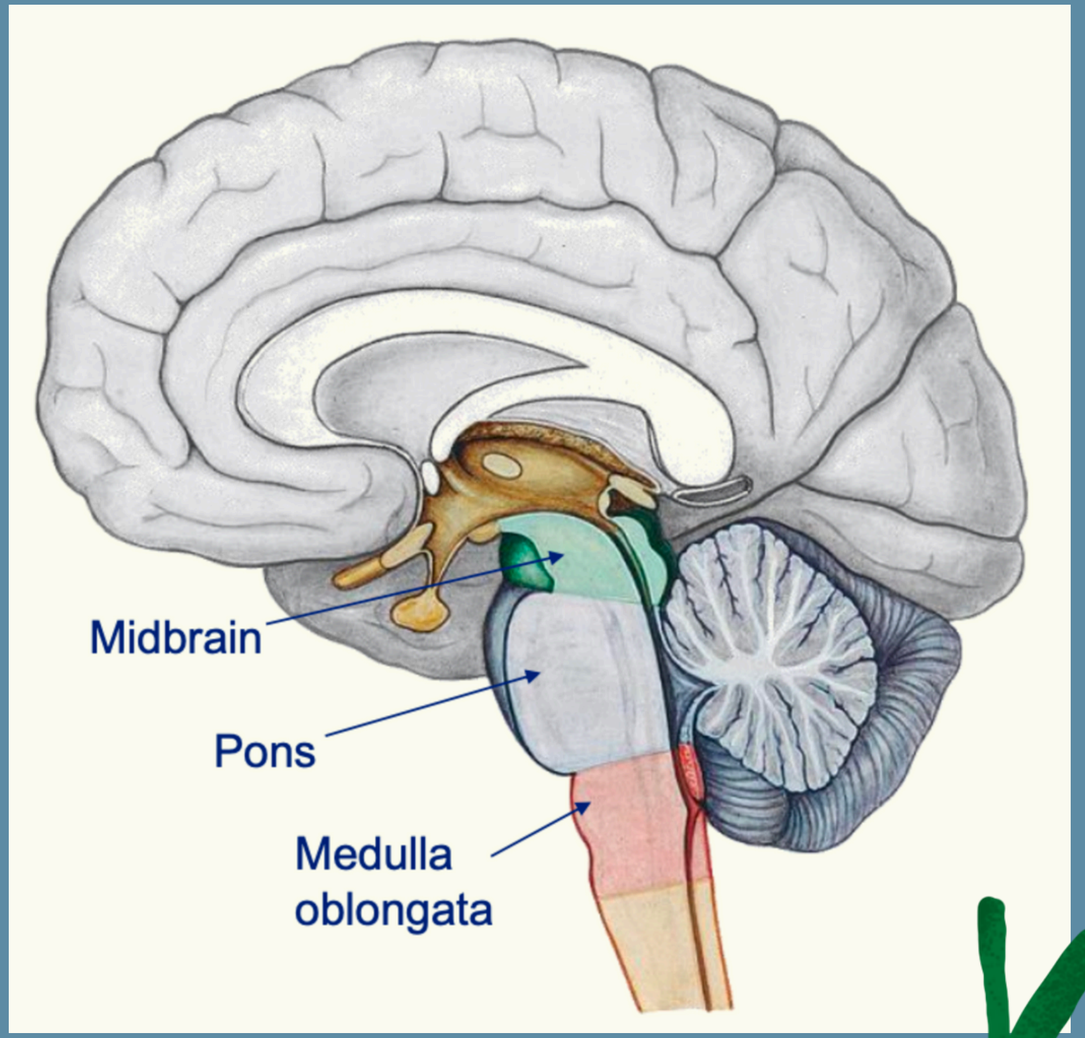
responsible for eye movements, auditory and visual processing + some motor movement and coordination

PONS= MIDDLE, CN 5,6,7,8

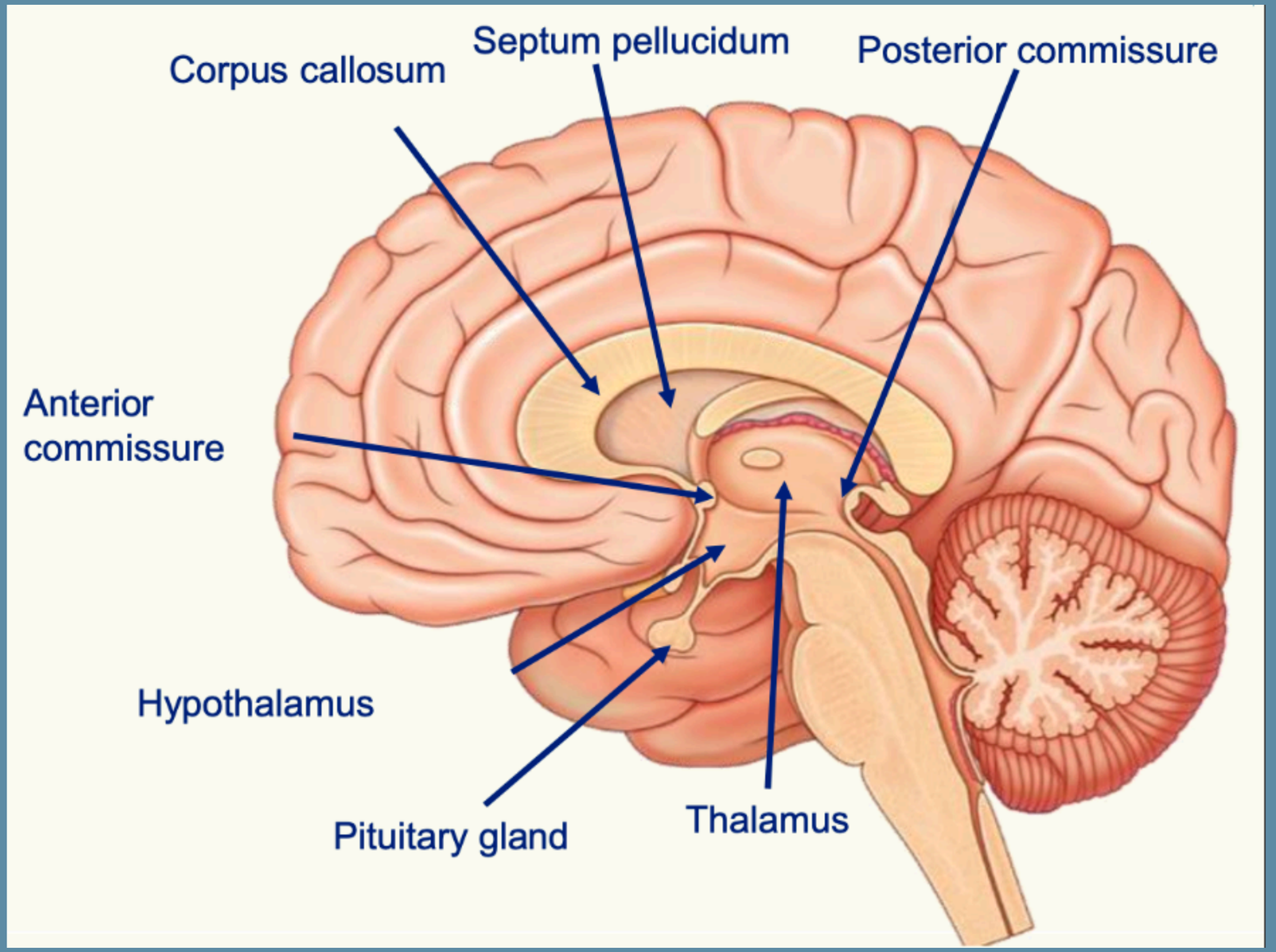
respiration, involuntary actions
sensory (hearing, balance, taste, face)
motor (eye, face, chewing, salivation, tears)

INFERIOR = MEDULLA, CN 9,10,11,12

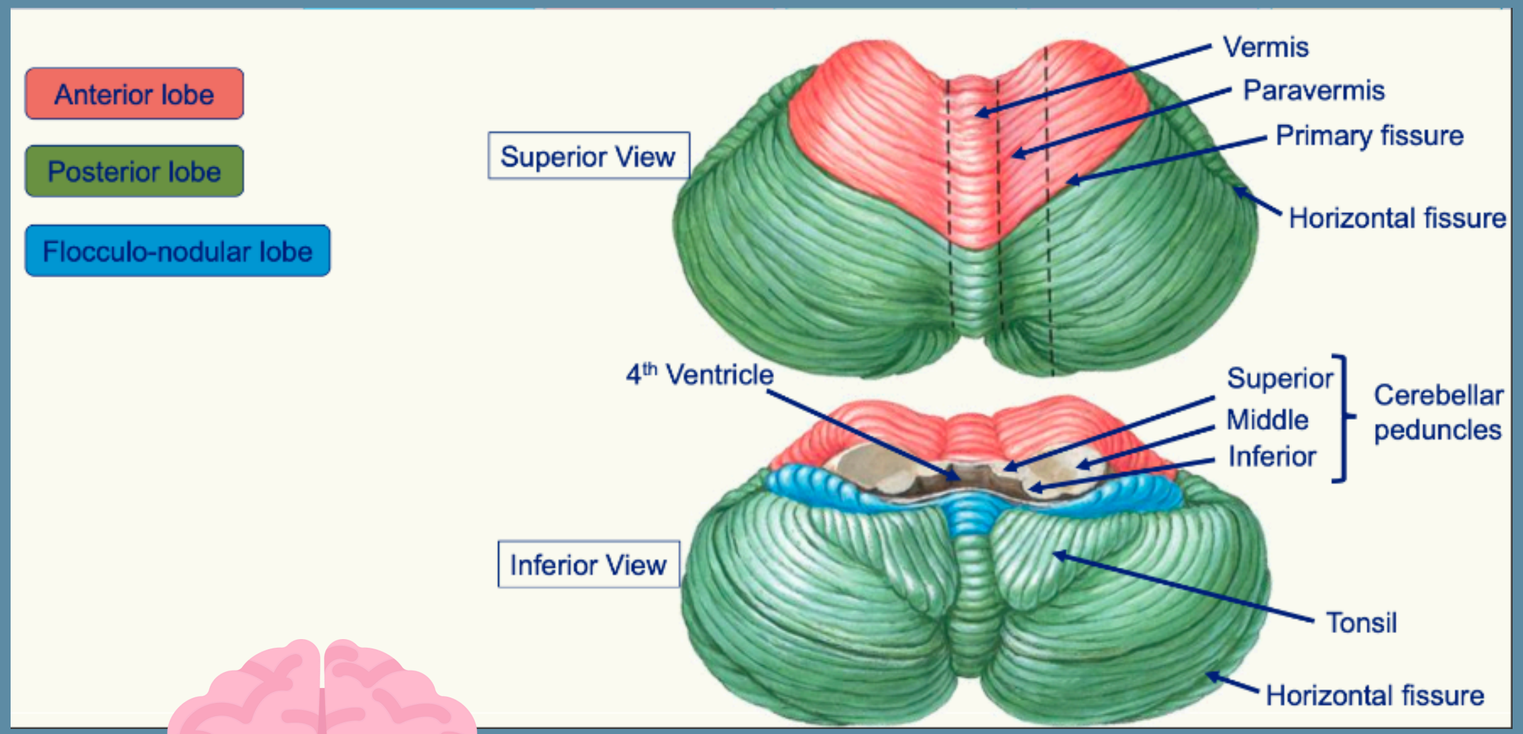
main control of autonomic nervous system
reflex centres of vomiting, coughing, sneezing and swallowing

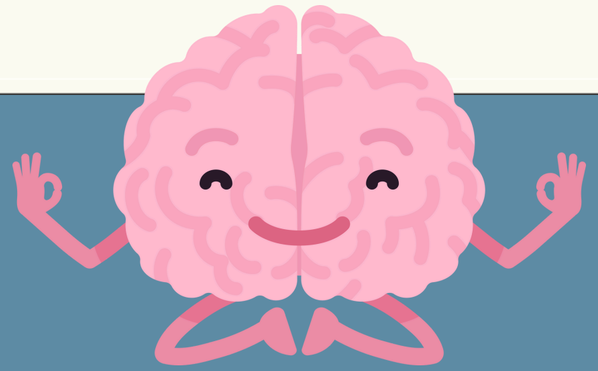


BRAINSTEM


Corpus callosum
Septum pellucidum
Posterior commissure
Anterior commissure
Hypothalamus
Pituitary gland
Thalamus

CEREBELLUM





SPINOCEREBELLUM

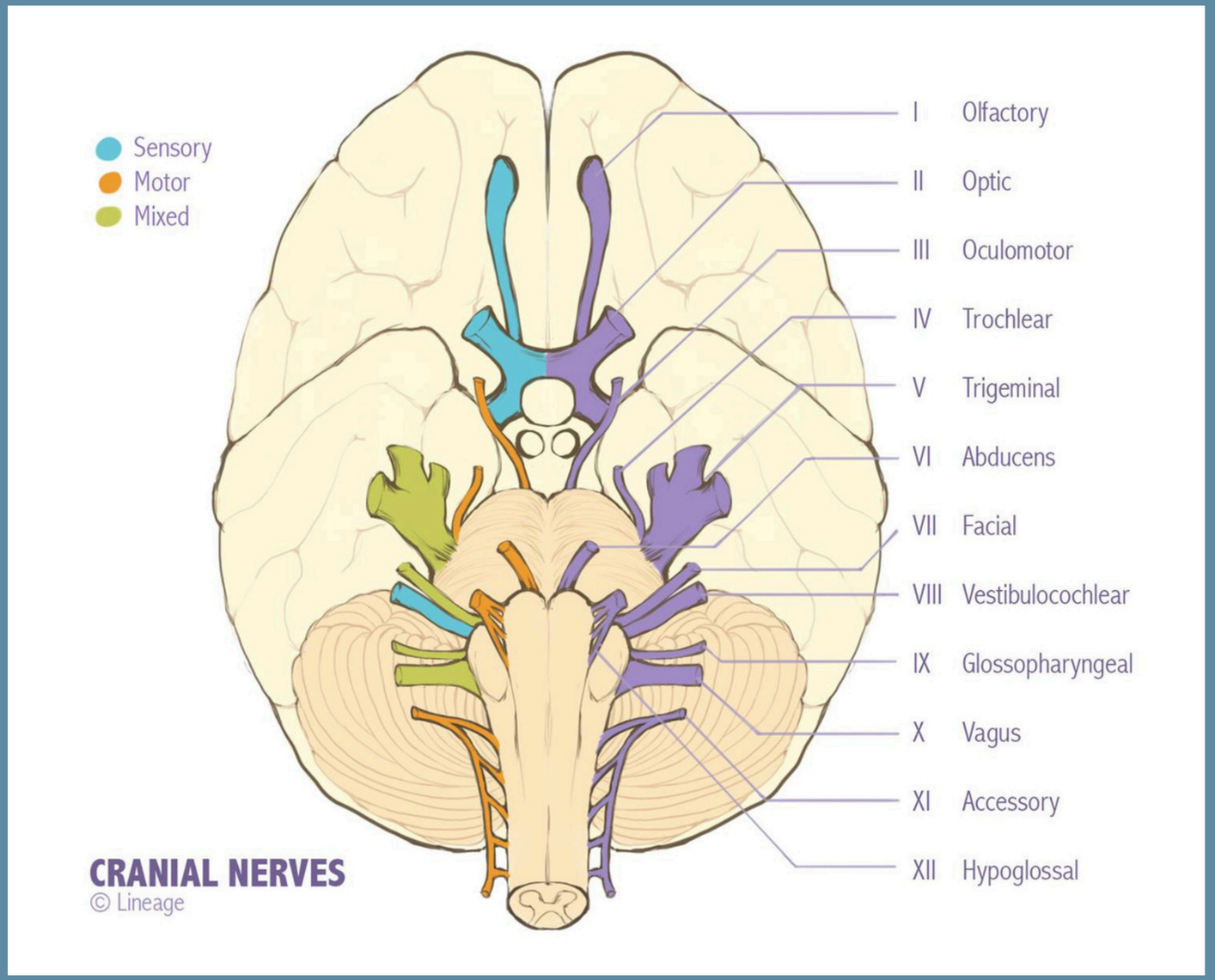
Located in Vermis and Paravermis
Responsible for regulating movements
and proprioception

VESTIBULOCEREBELLUM

Located in the Flocculonodular lobe
Responsible for balance and ocular reflexes

CEREBROCEREBELLUM

In Lateral hemispheres
Responsible for planning and coordinating movements, motor learning + visual guided movements



ONLY ONE OF THE TWO ATHLETES FELT VERY GOOD VICTORIUS AND HEALTHY

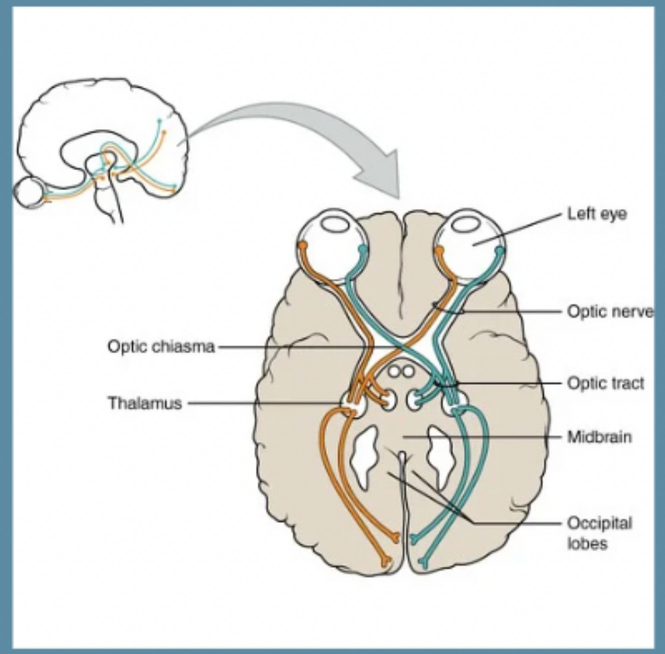
Number	Name	Component	Function
I	Olfactory	Sensory	Smell
II	Optic	Sensory	Vision
III	Oculomotor	Motor	Eye movement, pupil size and lens
IV	Trochlear	Motor	Eye movement (superior oblique)
V	Trigeminal	Mixed	Sensory to face, innervates muscles of mastication
VI	Abducens	Motor	Eye movement (lateral rectus)
VII	Facial	Mixed	Taste, facial expression, secretion
VIII	Vestibulocochlear	Sensory	Balance, hearing
IX	Glossopharyngeal	Mixed	Taste, monitors blood pressure and gases, swallowing and secretion for salivary glands
X	Vagus	Mixed	Taste, sensory to thoracic & abdominal viscera, movement and secretion (pharynx and larynx too)
XI	Accessory	Motor	Movement (neck)
XII	Hypoglossal	Motor	Movement (tongue)

SOME SAY MARRY MONEY BUT MY BROTHER SAYS BIG BRAINS MATTER MOST

UPPER CRANIAL NERVES

- The **oculomotor** nerve originates in **ventral midbrain** at the level of the superior colliculus
- The **superior** branch of the **oculomotor** nerve supplies the superior rectus and levator palpebrae superioris
- The **levator palpebrae superioris** elevates the eyelid superiorly
- The **inferior** branch of the **oculomotor** nerve supplies the inferior rectus, medial rectus and inferior oblique
- The **trochlear** nerve exits **dorsally**. It is located at the level of the inferior colliculus (lower midbrain). Trochlear motor neurones will innervate **superior oblique muscle**
- The **abducens** nerve is located at the inferior portion of the pons (pontomedullary junction) This is the only somatic motor neurone to innervate **lateral rectus muscle**

elevator= levator= elevates eyelid

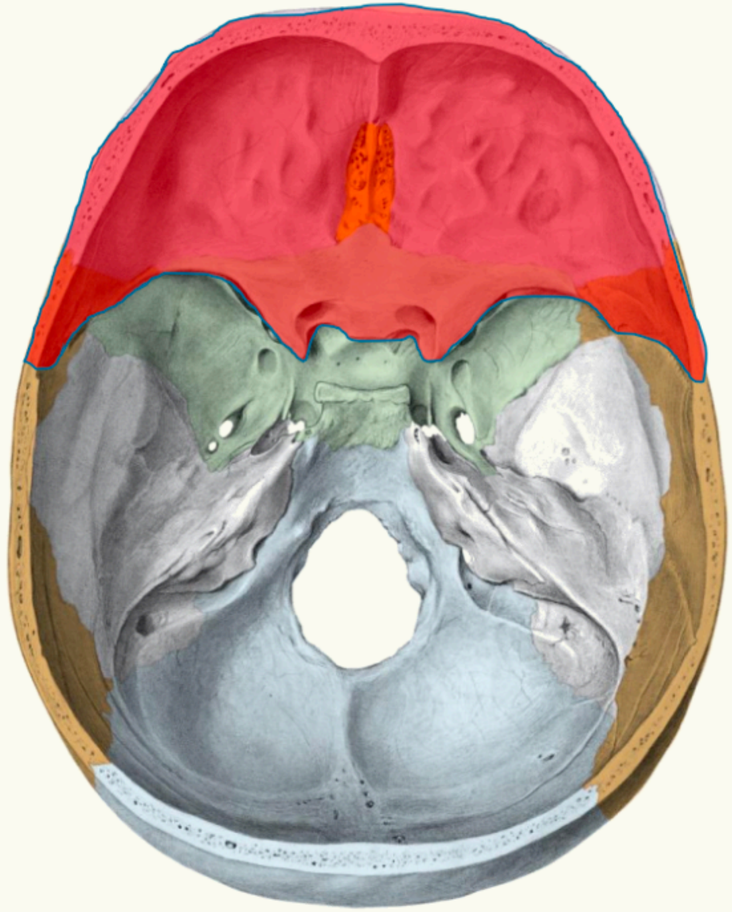


Where does the optic nerve take information to?

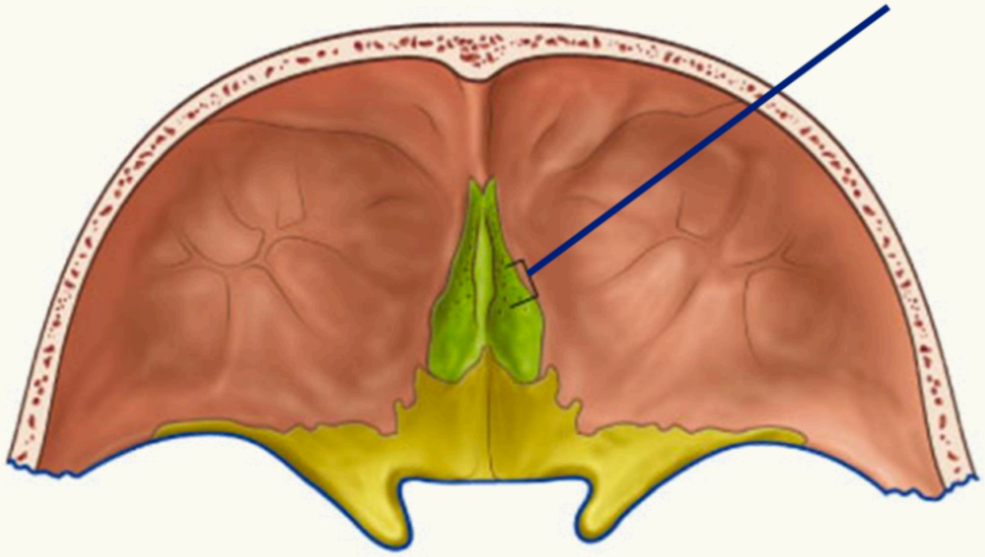
- Optic chiasma where some information decussates and some stays ipsilateral
- Information continues to travel posteriorly along optic tract to occipital lobe of the cerebrum

ANTERIOR CRANIAL FOSSA

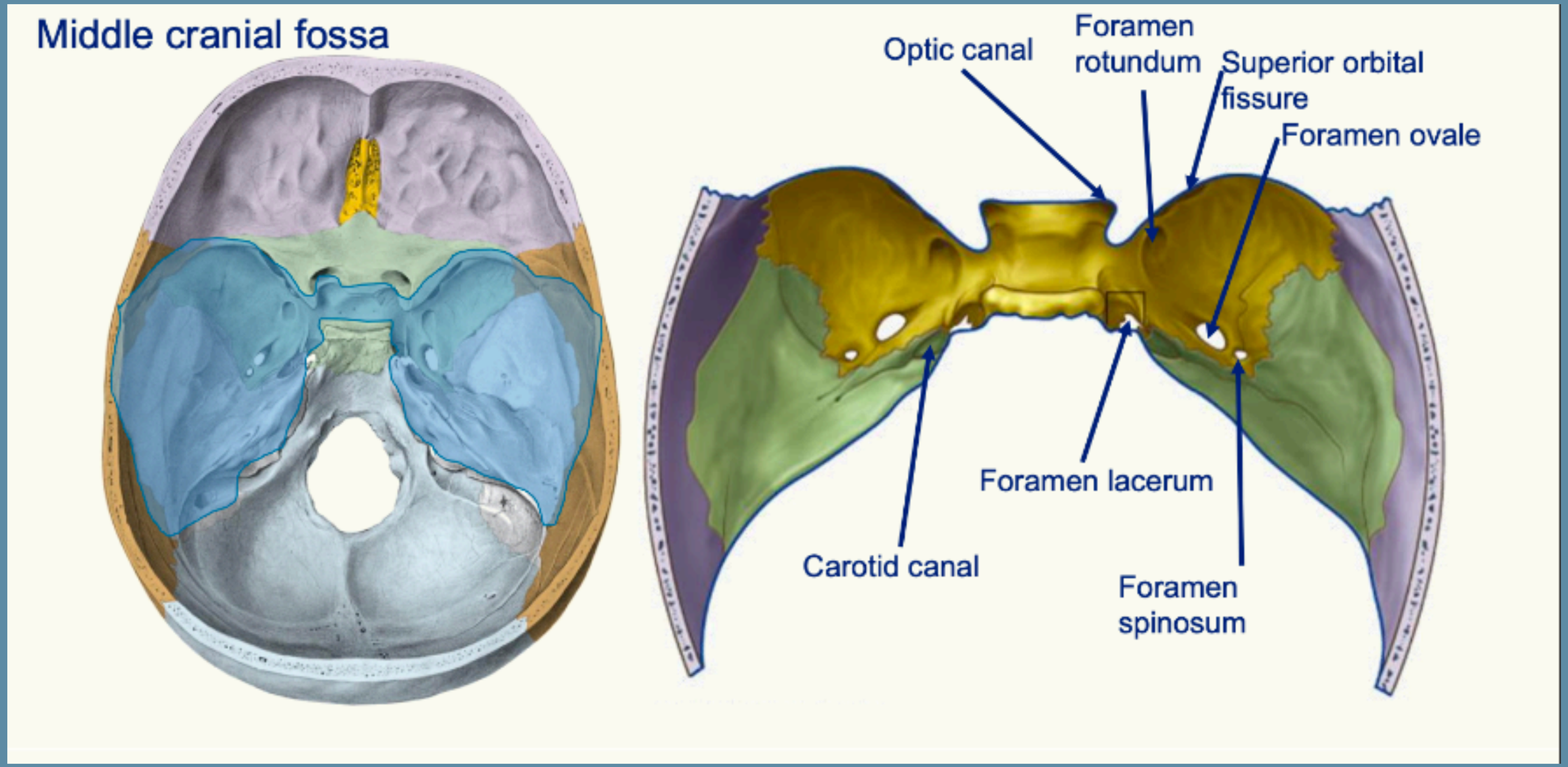
Anterior cranial fossa



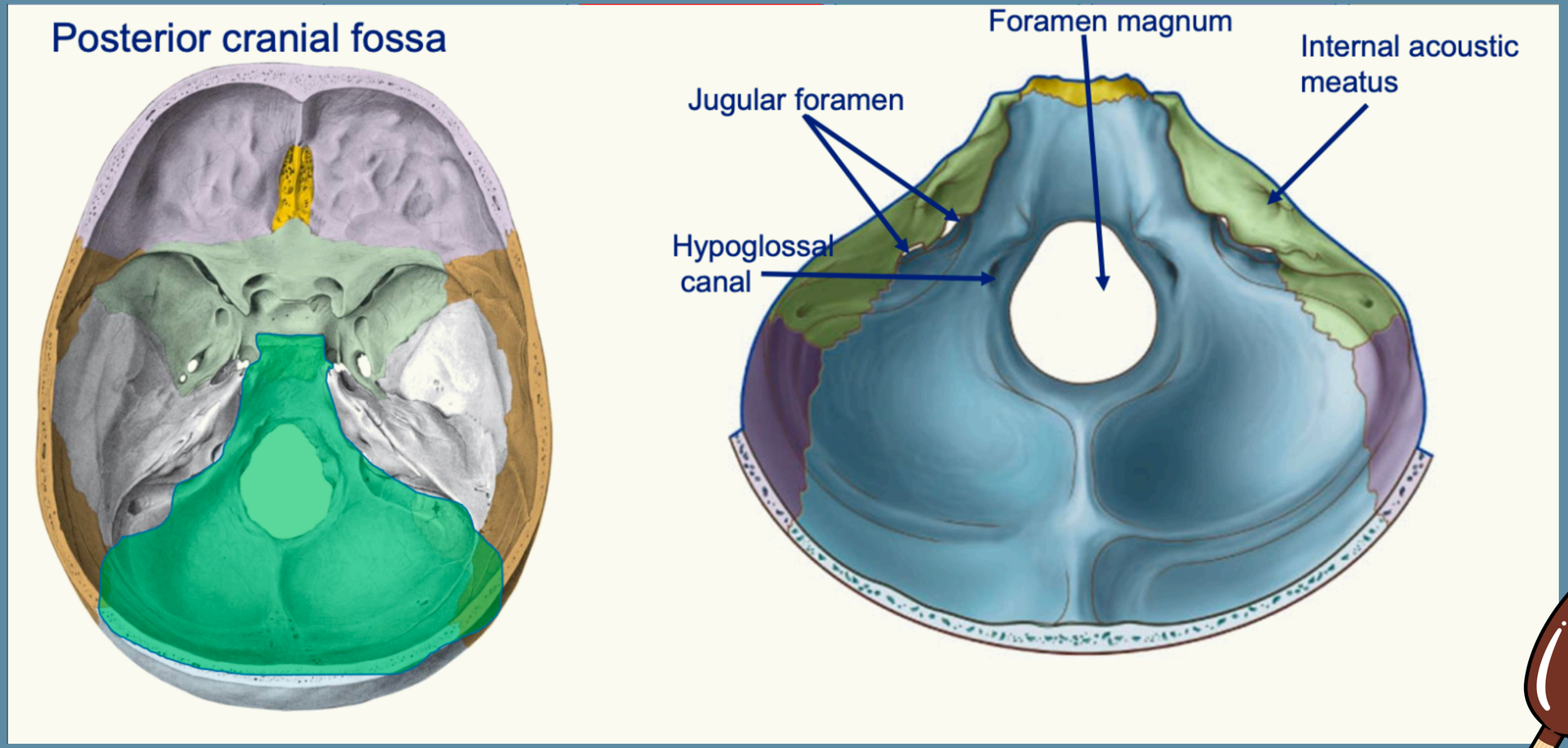
Sobotta – Atlas der Anatomie des Menschen, 23. A. 2010. © Elsevier GmbH, München



MIDDLE CRANIAL FOSSA



POSTERIOR CRANIAL FOSSA



Area of Cranium	Fossa(e)	Neurosensory Content of Fossa(e)	Cranial Nerve Number	Additional Content
Anterior Cranial Fossae	Cribriform plate	Olfactory	CN I (Sensory)	-
Middle Cranial Fossae	Optic Canal	Optic	CN II (Sensory)	-
	Superior Orbital Fissure	Occulomotor Trochlear Ophthalmic Branch of the Trigeminal Abducent	CN III CN IV CN V_1 CN VI	-
	Foramen Rotundum	Maxillary Branch of the Trigeminal	CN V_2	-
	Foramen Ovale	Mandibular Branch of the Trigeminal	CN V_3	
	Carotid Canal	-	-	Internal carotid artery
Posterior Cranial Fossae	Foramen Magnum	-	-	Meninges Vertebral Arteries Spinal Cord
	Internal Acoustic Meatus	Facial Vestibulocochlear	CN VII CN VIII	
	Jugular Foramen	Glossopharyngeal Vagus Accessory	CN IX CN X CN XI	Internal jugular vein
	Hypoglossal Canal	Hypoglossal	CN XII	

QUESTION

What is the Vestibulocerebellum responsible for?

A: PROPRIOCEPTION

B: BALANCE + OCULAR REFLEXES

C: MOVEMENT

D: MOTOR CO-ORDINATION

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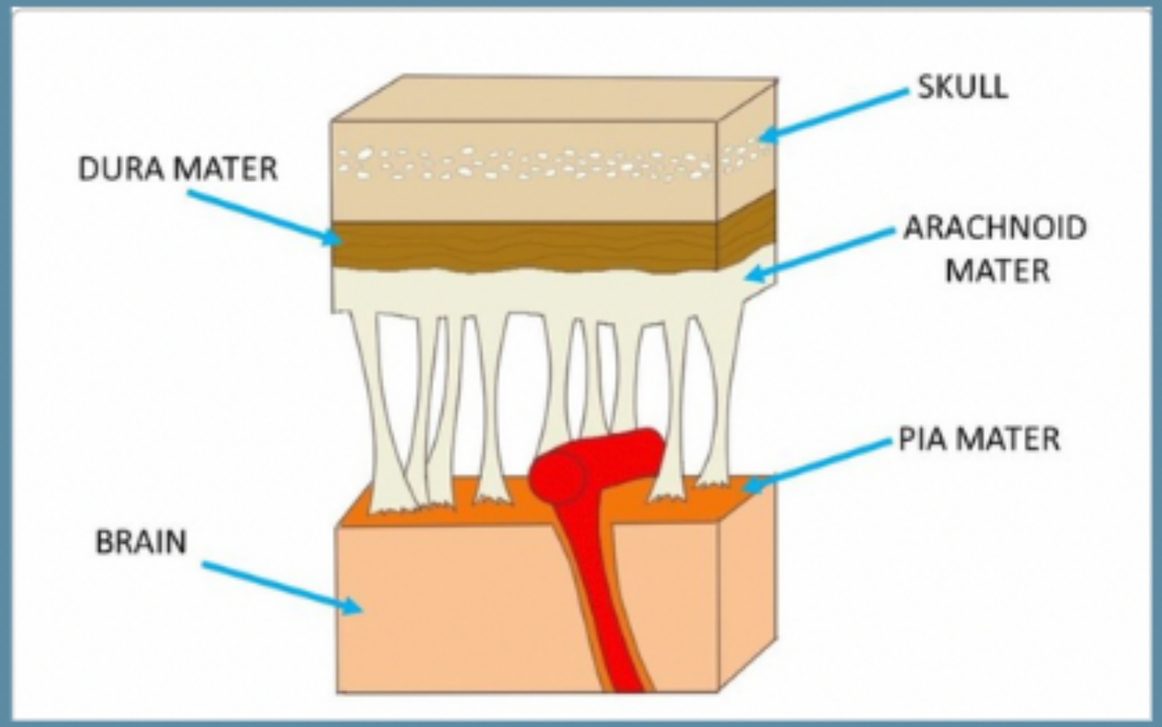
MENINGES

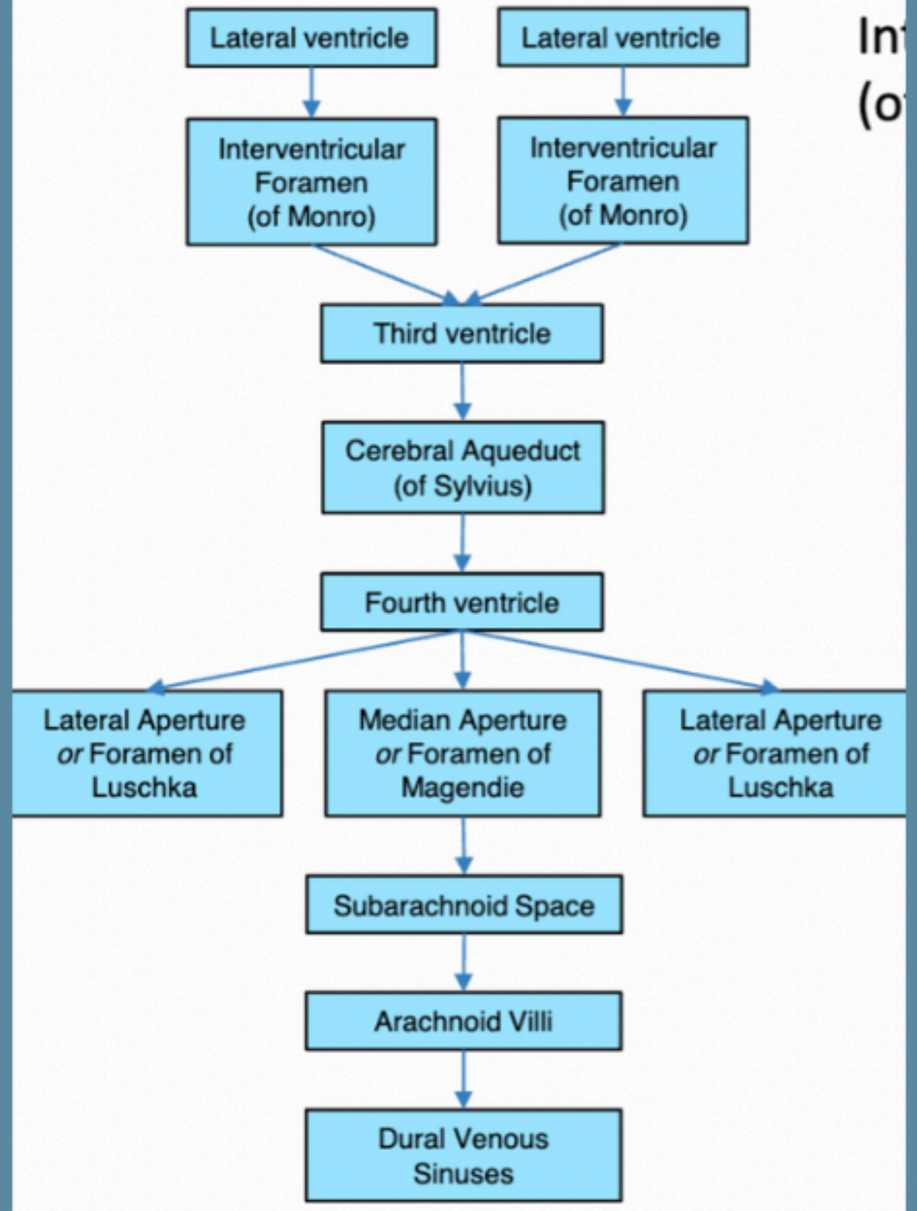


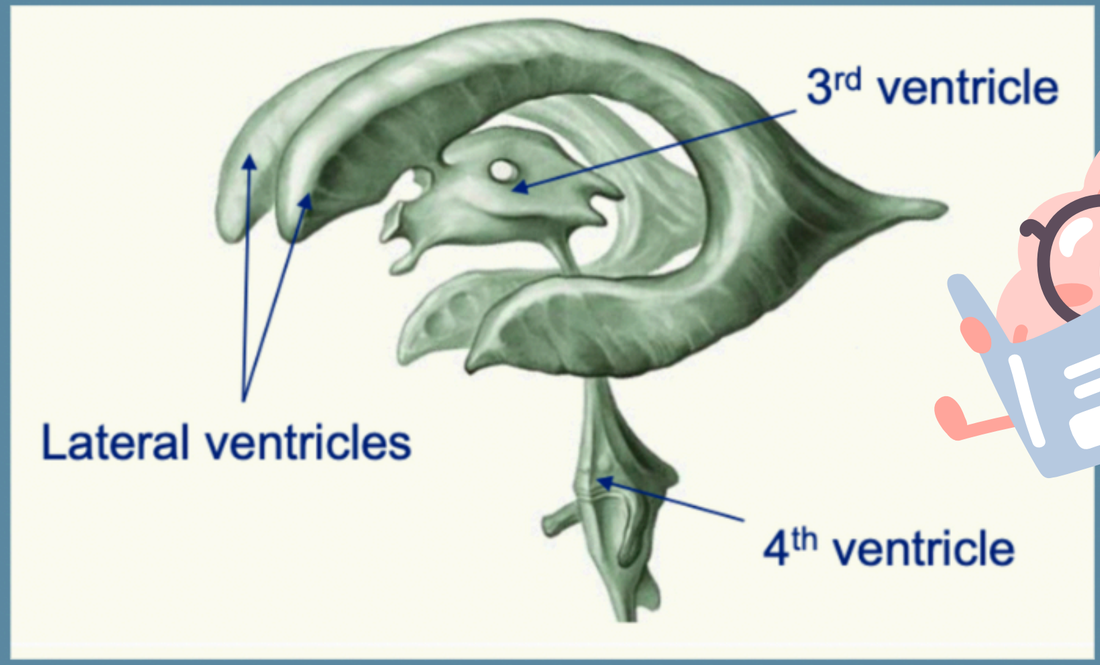
Dura:
Tough outer layer with many different reflections within the cranial cavity consisting of two layers; only one passes through the foramen magnum

Arachnoid:
Delicate middle layer which lines the dura mater
Deep to this is the sub-arachnoid with CSF

Pia: inner layer firmly attached to the surface of the brain and spinal cord
forms ligaments to attach to arachnoid and dura layers (denticulate ligaments)

Circulation of CSF





- VENTRICLES ARE RESPONSIBLE FOR THE PRODUCTION AND CIRCULATION OF CSF
- CSF RESPONSIBLE FOR CHEMICAL STABILITY NUTRIENTS AS WELL AS PROTECTION + SHOCK ABSORPTION
- CSF IS PRODUCED BY CHOROID PLEXUS IN ALL VENTRICLES, MOSTLY IN LATERAL (COS THERES 2)
- CHOROID PLEXUS: COLLECTION OF CELLS FOUND IN ALL 4 VENTRICLES
- CSF IS KEPT IN THE SUBARACHNOID SPACE
- APPROX 150M OF CSF IN THE COMBINED VENTRICULAR AND SUBARACHNOID SPACES

(MORE) CEREBROSPINAL FLUID

CSF →

1. Liquid containing essential nutrients and WBCs from blood to neurones and ganglia
2. Acts as a shock absorber and providers optimal conditions for neuronal signalling and circulates nutrients/waste
   - where can CSF also enter besides the superior sagittal sinus?
   - some enter small arachnoid villi projecting into spinal veins

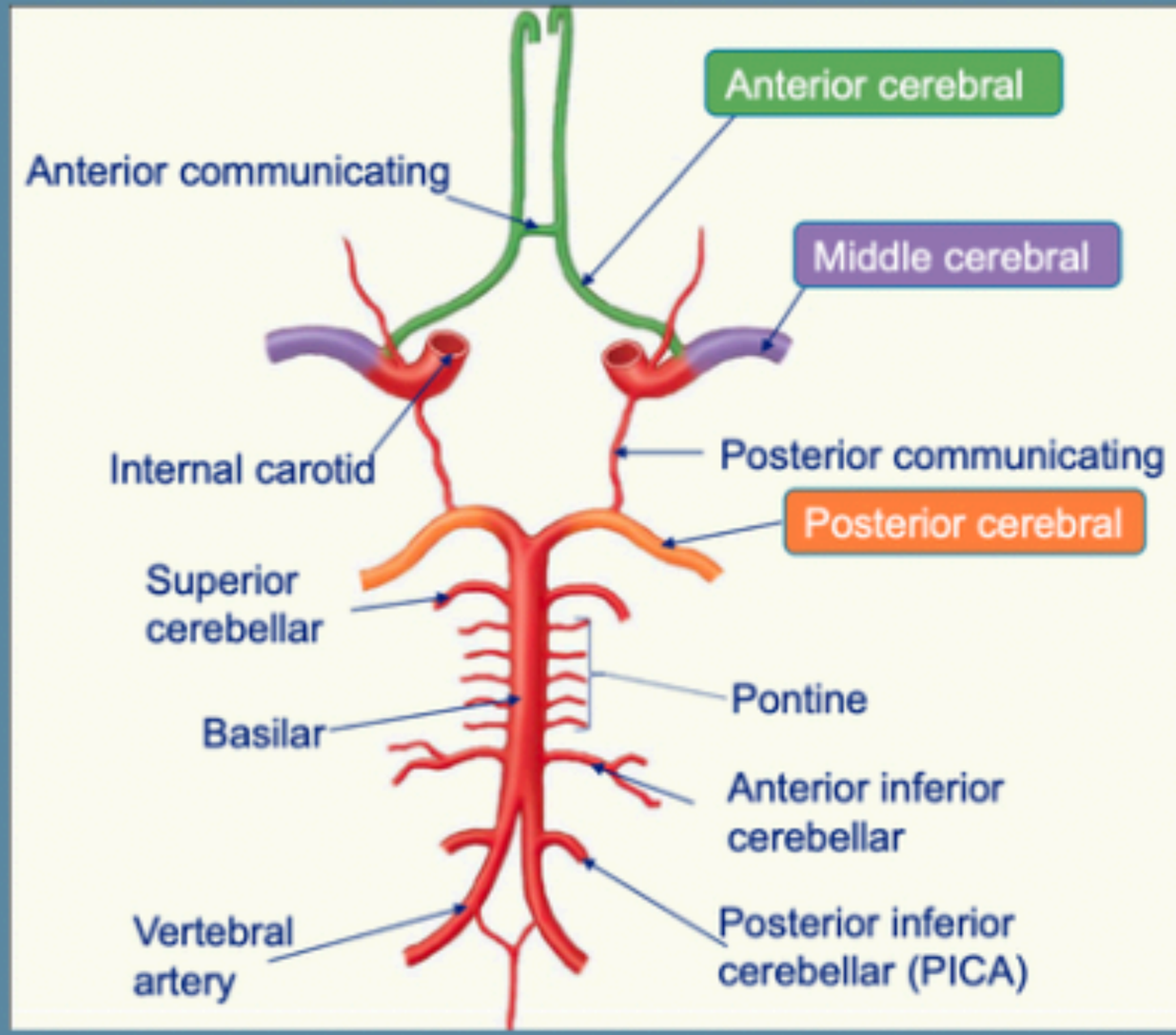
- **CSF** is produced by the **Choroid Plexus**, a membrane lining the Cerebral Ventricles that consists of blood capillaries covered by **Ependymal Cells**
- Tight Junctions between the Ependymal Cells establish a **strict Blood-CSF Barrier** that filters only selected substances from the blood plasma into the CSF in order to protect the Brain
- Waste products in the CSF can also exit the brain via the Blood-CSF Barrier
- CSF can also enter small arachnoid villi projecting into spinal veins besides the superior sagittal sinus
- CSF exits intervertebral foramina, lymphatics, the adventitia of arteries, at the base of the brain and in the epineurium of cranial nerves

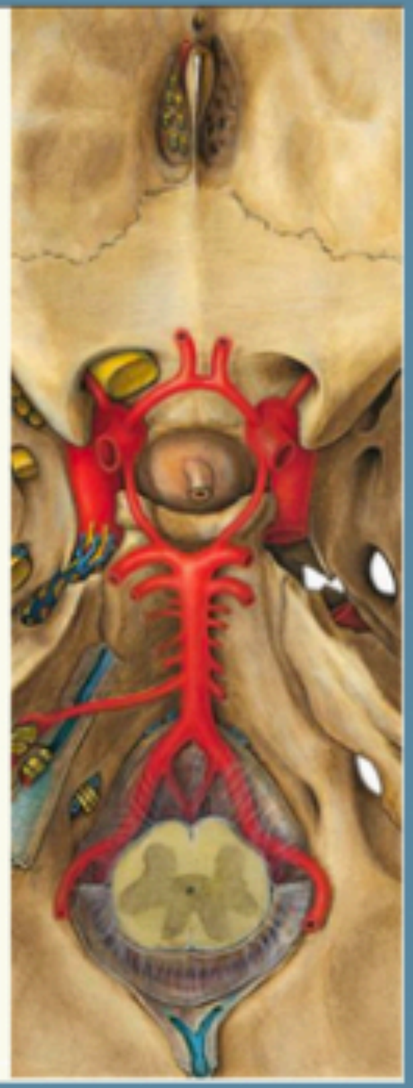
Falx cerebri: separates two hemispheres of the cerebrum

Falx cerebelli: separates two hemispheres of the Cerebral vein cerebellum

Tentorium cerebelli: separates the cerebellum (or lobe) from the cerebrum

CIRCLE OF WILLIS!



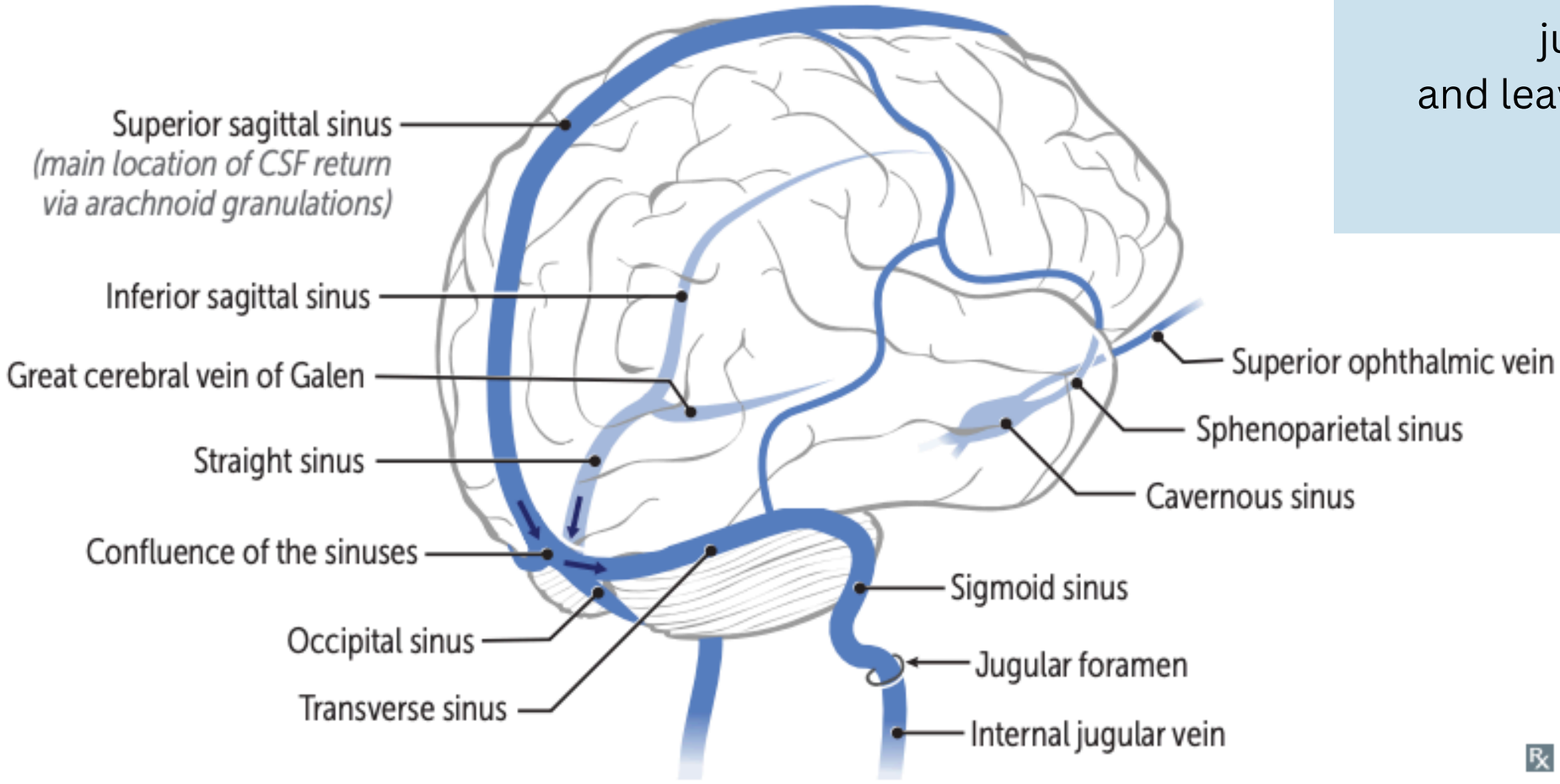


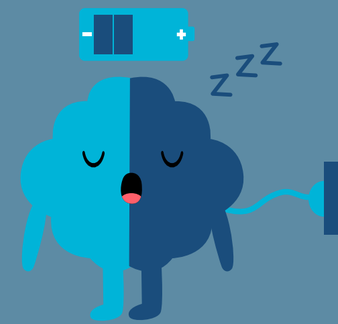
INTERNAL CAROTID COURSES DEEP AND ENTERS THE SKULL THROUGH THE CAROTID CANAL

COMMON CAROTID ARTERY BIFURCATES INTO INTERNAL AND EXTERNAL CAROTID ARTERY AT C4

VENOUS DRAINAGE

All veins come together at the confluence of sinuses to drain into the internal jugular vein and leave via the jugular foramen





QUESTION

From the lateral ventricles, the CSF enters the what?

A: THE THIRD VENTRICLE VIA INTERVENTRICULAR FORAMEN (OF MONRO)

B: FORAMEN OF LUSHKA

C: ARACHNOID VILLI

D: LATERAL APERTURE AKA THE FORAMEN OF LUSHKA

QUESTION

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B: FORAMEN OF LUSHKA

C: ARACHNOID VILLI

D: LATERAL APERTURE AKA THE FORAMEN OF LUSHKA

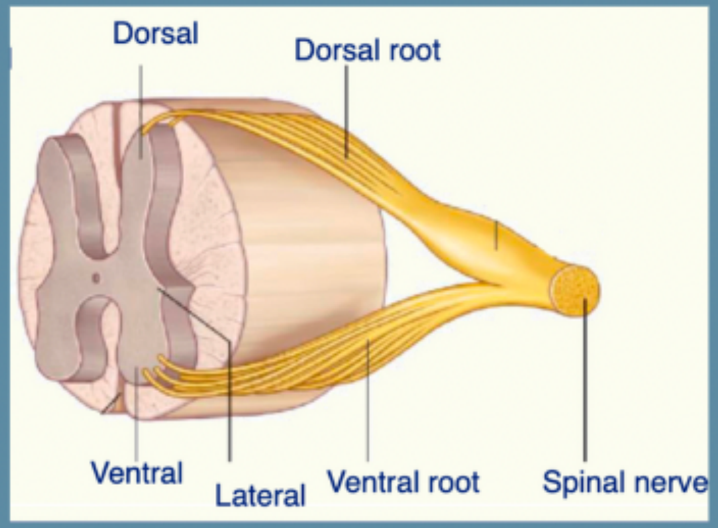
SPINAL CORD

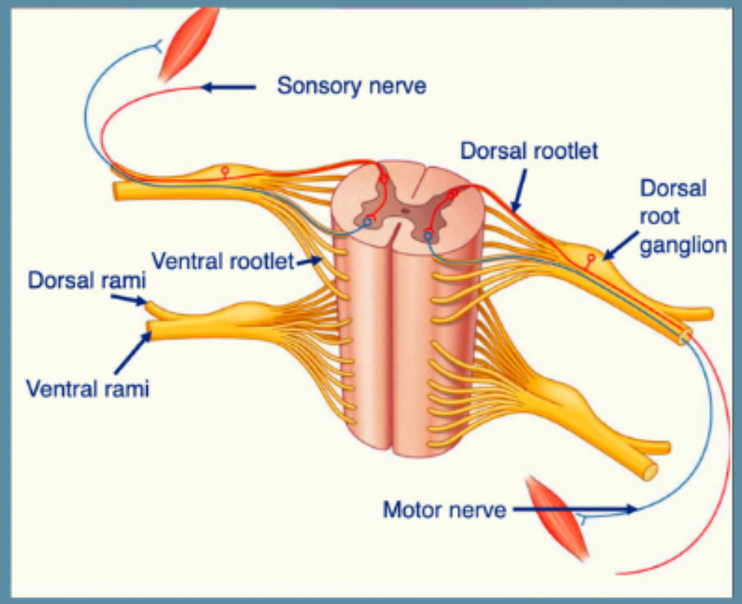
The dorsal root

- afferent sensory root
- carries signals towards the central nervous system (CNS) cell bodies can be seen clustered in spinal ganglions

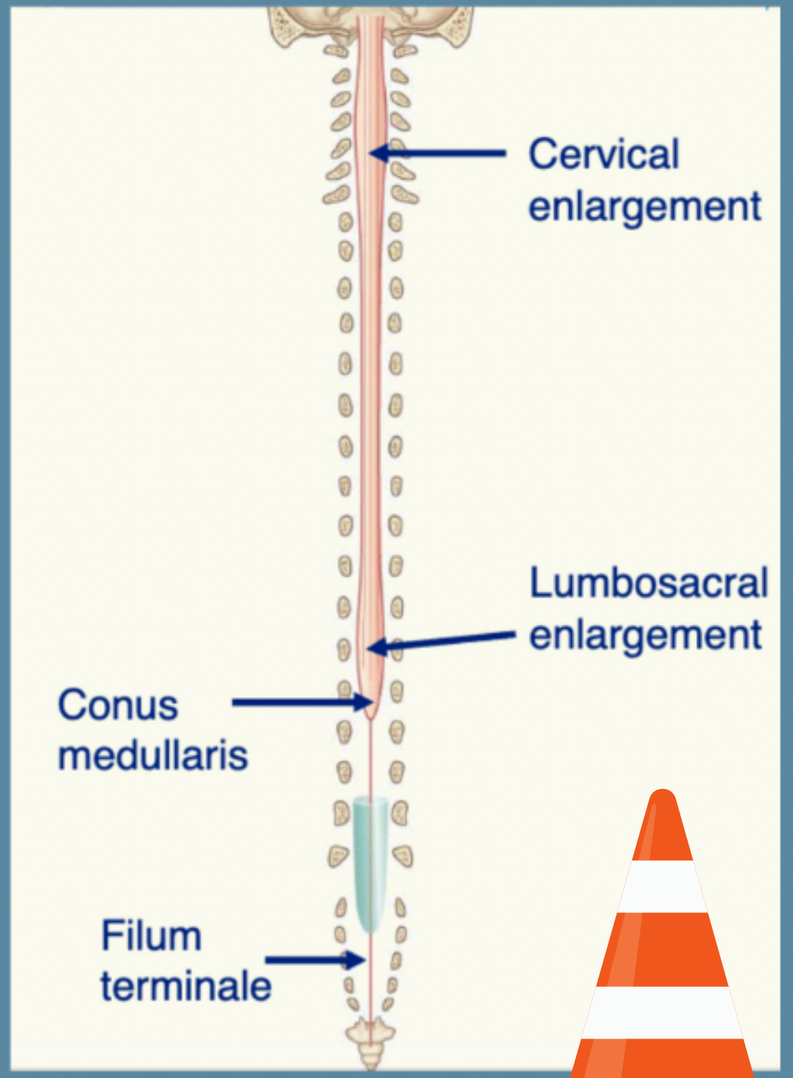
The ventral root

- efferent motor root
- contains motor nerve fibres taking signals away from the CNS



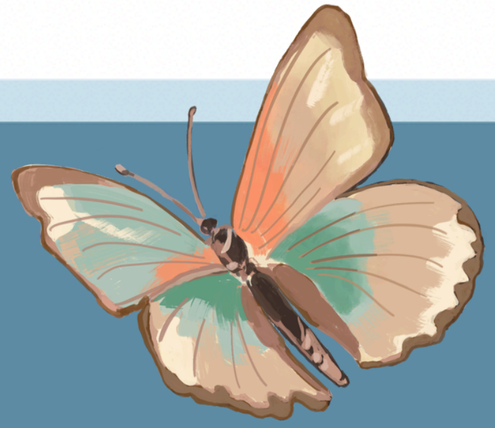


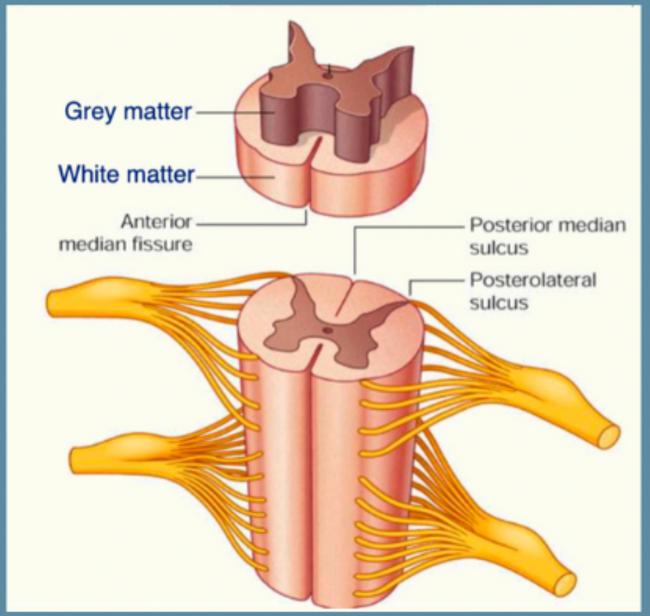
- There are **enlargements** in the **cervical and lumbosacral** regions due to increased innervation required for limbs
- Below the lumbosacral enlargement, the spinal cord tapers off at the **conus medullaris**
- The conus medullaris is anchored to the coccyx by a **fibrous strand of tissue called the <u>filum terminale</u>**



GREY/WHITE MATTER

- The Spinal Cord is a cylindrical structure **continuous with the medulla oblongata**
- Contains **grey central** matter and **white outer** matter
- **Grey matter:**
  - unmyelinated axons form longitudinal columns
  - contains numerous nerve cell bodies
- **White matter:**
  - myelinated axon tracts that ascend and descend along the spinal cord
  - they link spinal cord segments to one another and link the spinal cord to the brain
  - has a paler appearance due to fat
  - white matter forms the bulk of central part of brain

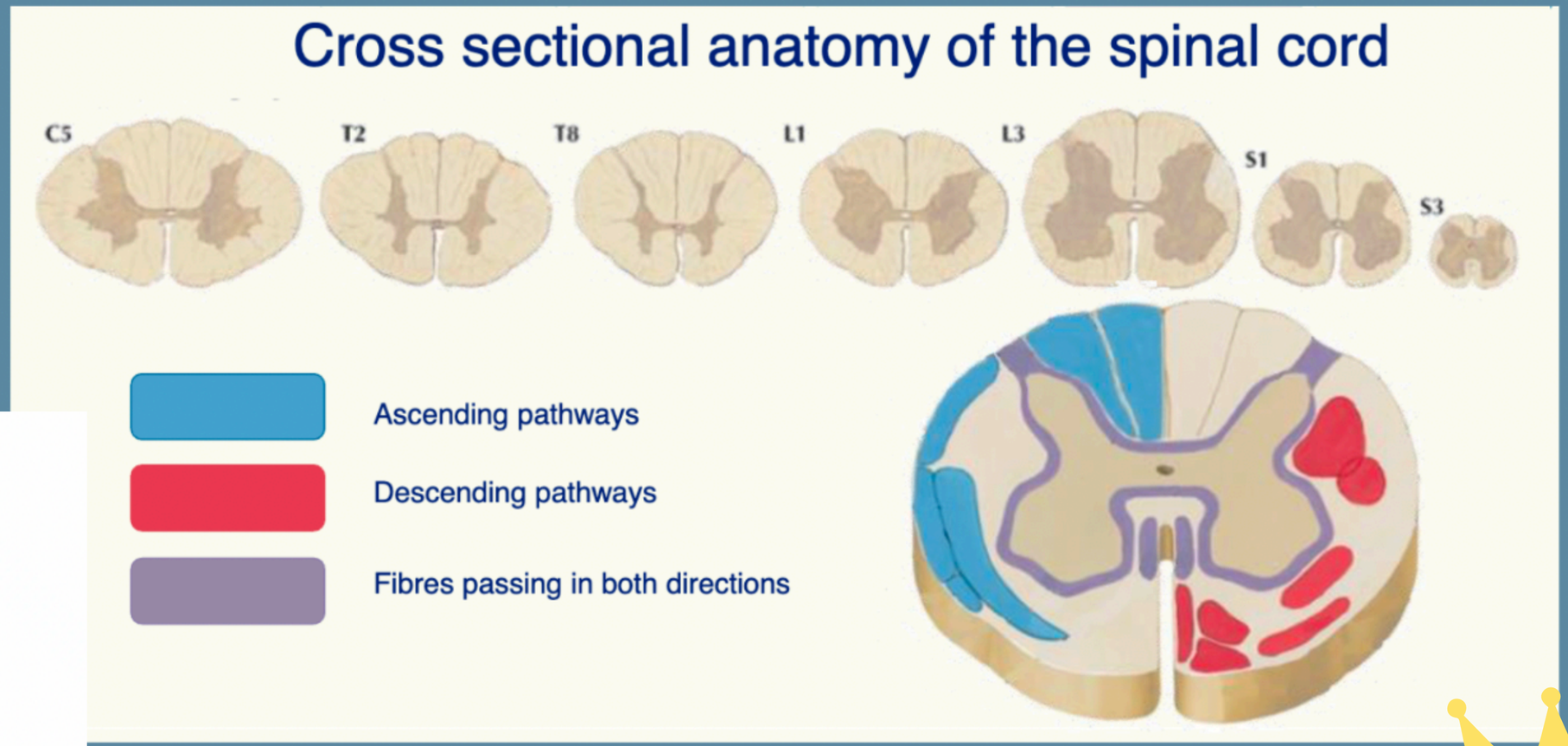


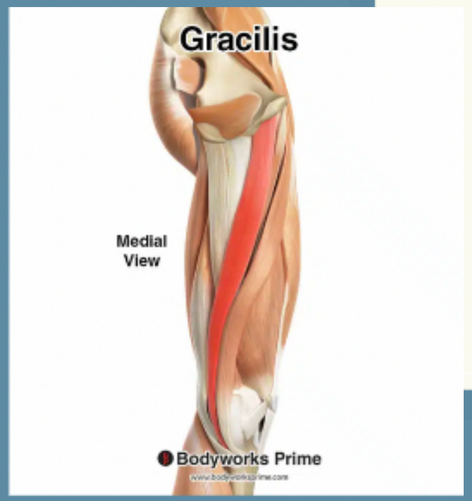


4 extensions of the central grey matter project dorsolaterally and ventrolaterally towards the lines of attachment

- **dorsal grey matter:** afferent neurones conveying impulses from the body and the site of ascending pathways towards the brain
- **ventral grey matter:** motor neurones that innervate skeletal muscle
- **lateral horn of the grey matter:**
  - present at thoracic and lumbar enlargements
  - contain pre-ganglionic neurones belonging to the sympathetic division of the autonomic nervous system

THE TWO BUMPS ON THE DORSAL SURFACE ON THE SPINAL CORD, KNOWN AS DORSAL COLUMNS

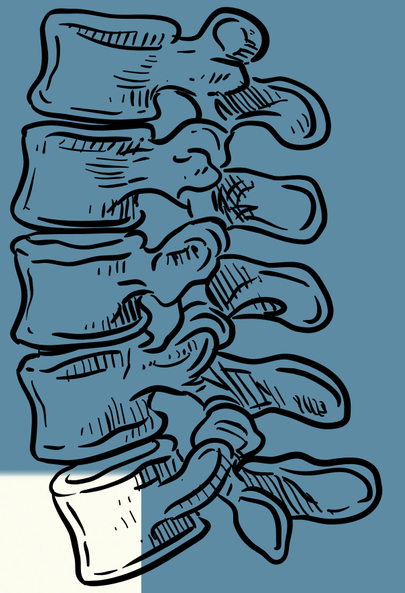


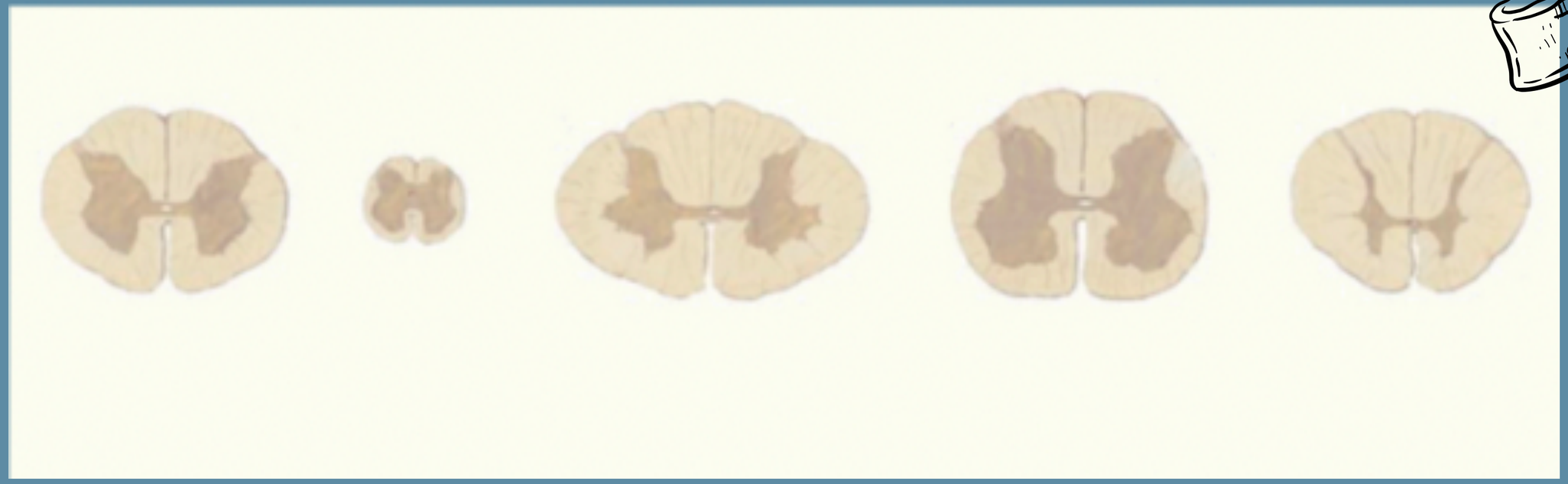


FASCICULUS CUNEATUS = UPPER LIMB

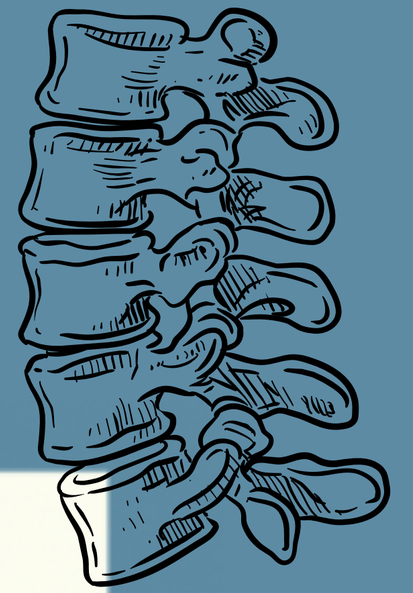
FASCICULUS GRACILIS = LOWER THORACIC REGION

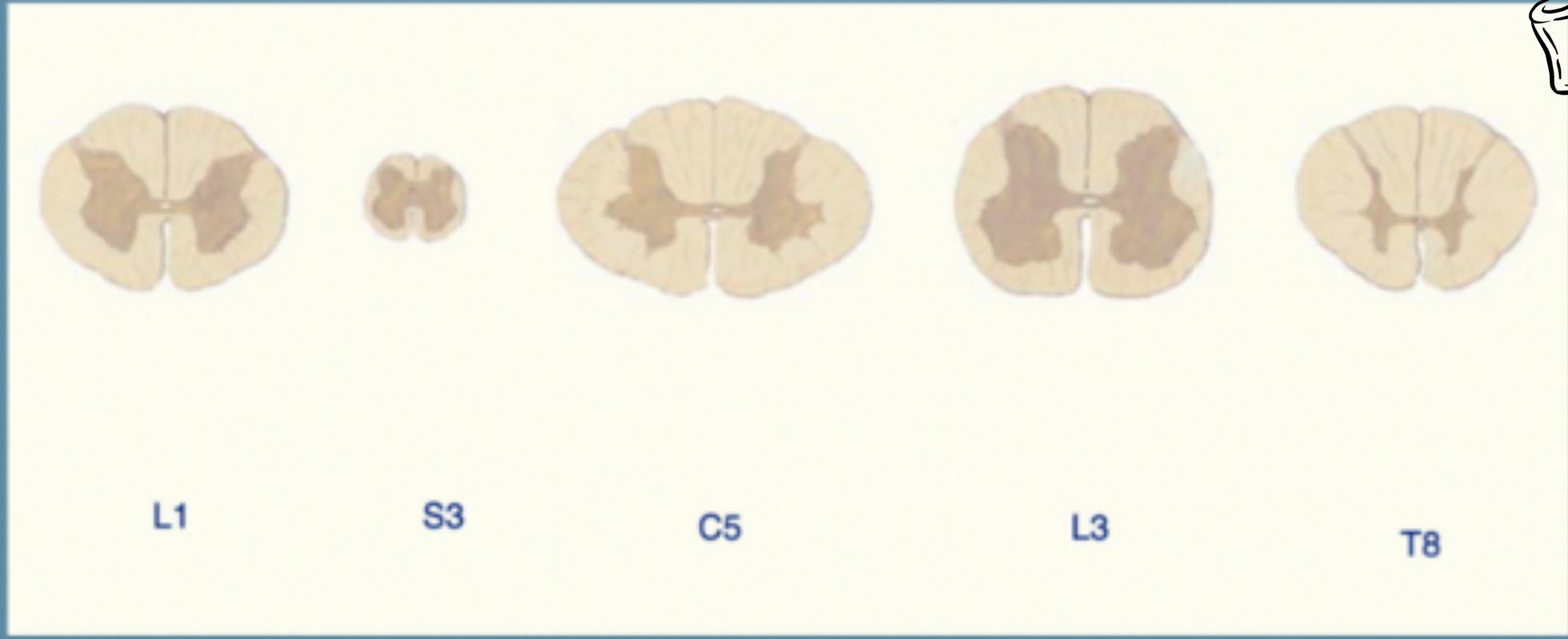
SPINAL CORD: WHICH LEVELS ARE THESE AT?





ANSWERS





QUESTION

How is the H shape of the grey matter made?

A: TRICK QUESTION, IT IS WHITE MATTER WHICH HAS THE H SHAPE

B: BY CONUS MEDULARIS

C: BY THE AXONS

D: THE SEPARATION OF CELL BODIES FROM NERVE FIBRES

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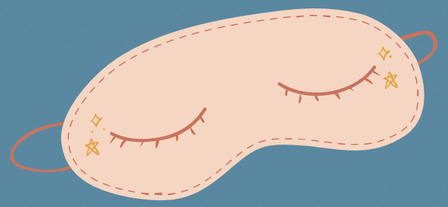
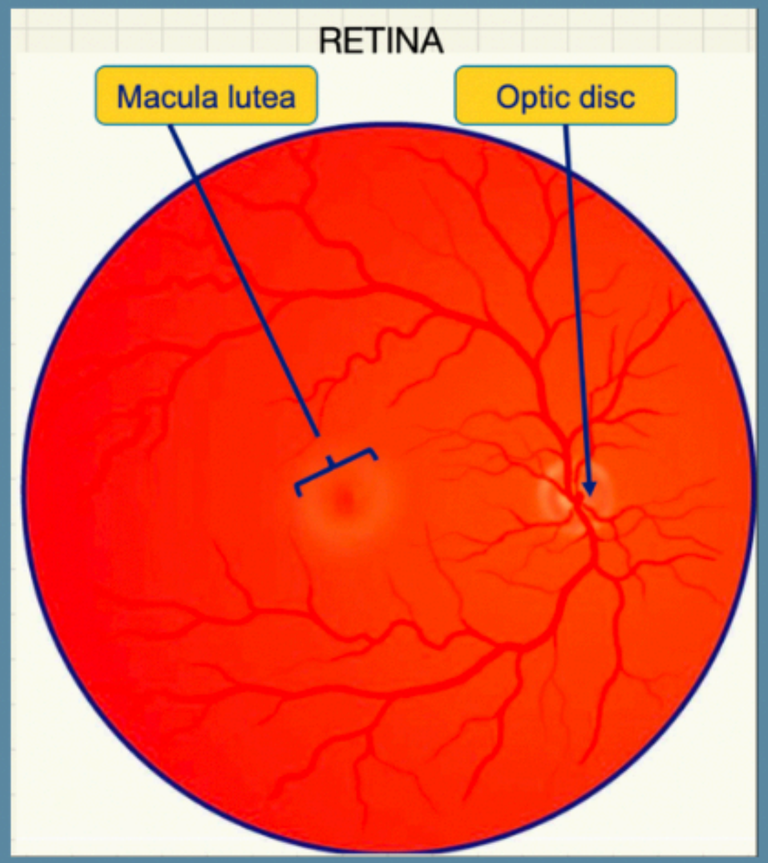
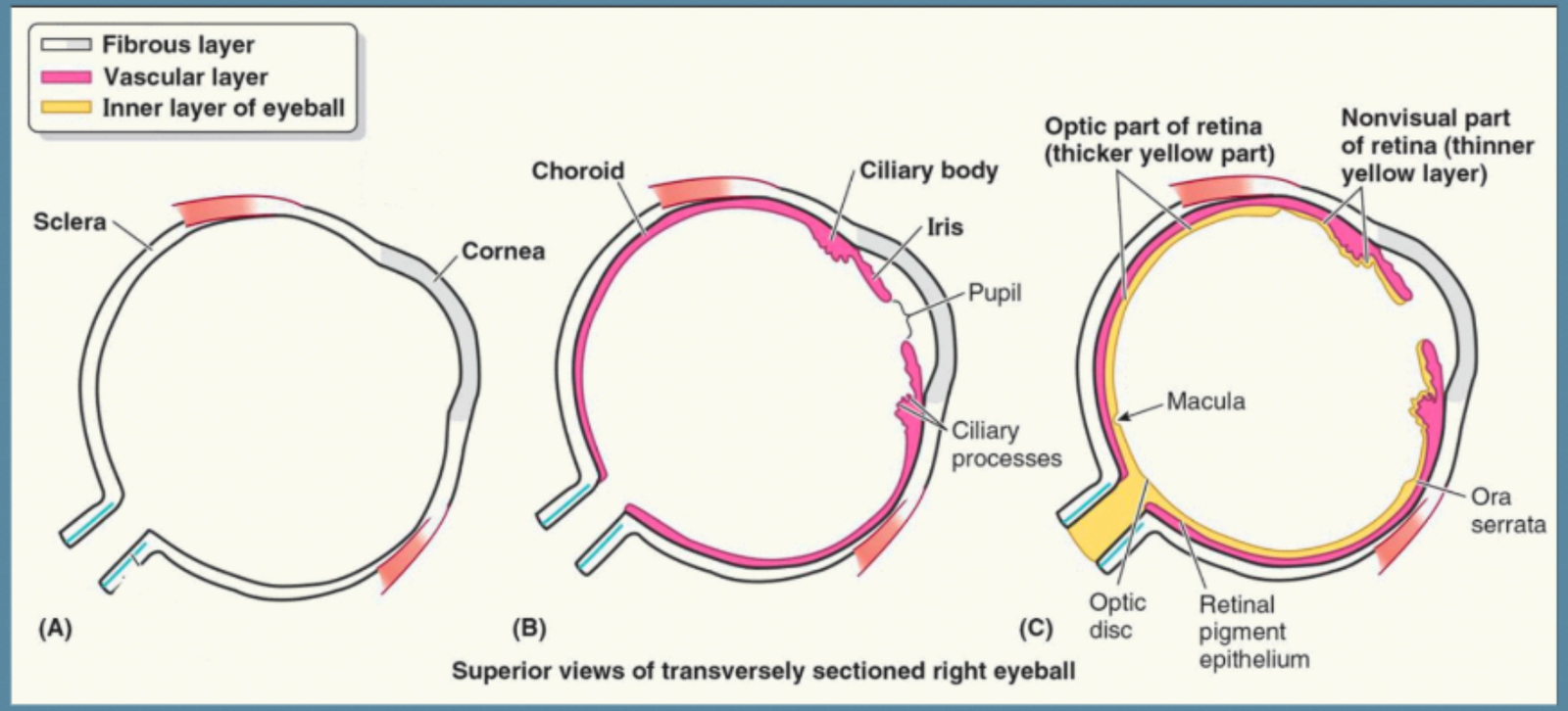
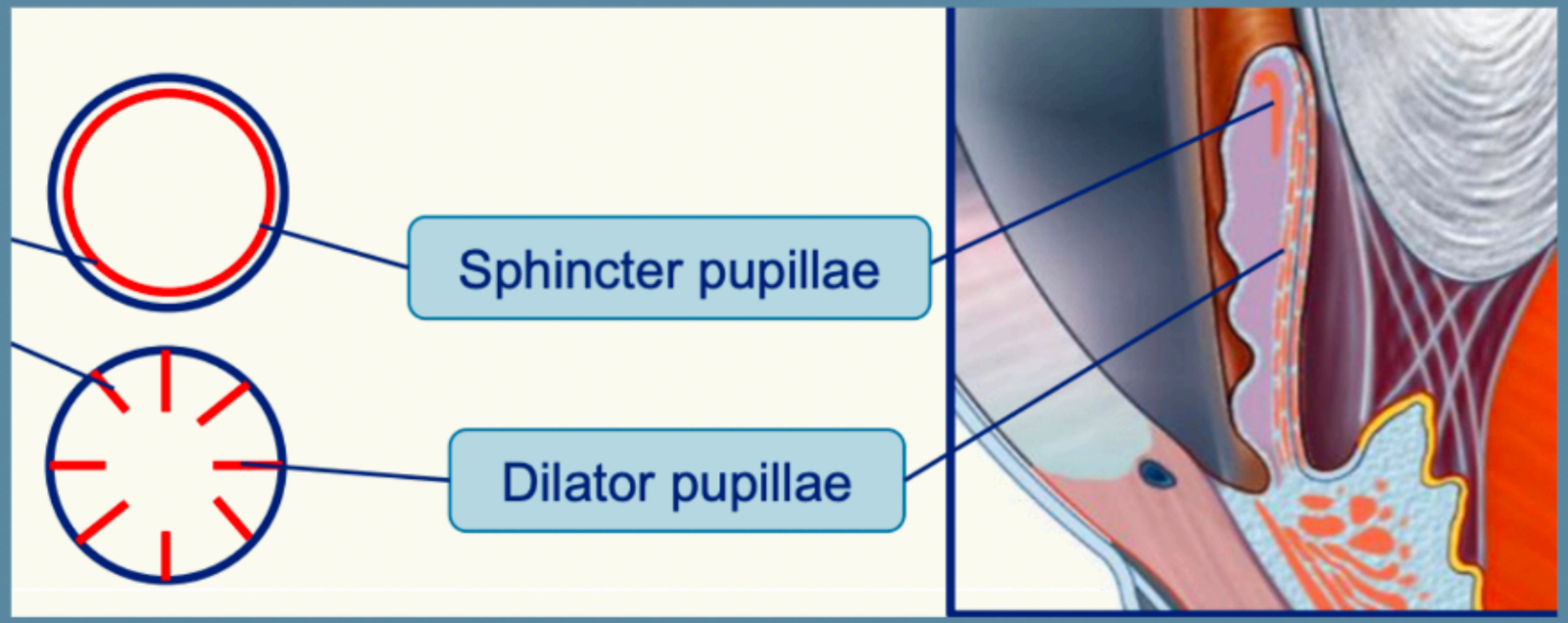


THE EYE


RETINA
Macula lutea
Optic disc


Fibrous layer
Vascular layer
Inner layer of eyeball
Sclera
Cornea
Choroid
Ciliary body
Iris
Pupil
Ciliary processes
Optic part of retina (thicker yellow part)
Nonvisual part of retina (thinner yellow layer)
Macula
Ora serrata
Optic disc
Retinal pigment epithelium
(A)
(B)
(C)
Superior views of transversely sectioned right eyeball


Sphincter pupillae
Dilator pupillae

EYE PART 2

PHOTOPIC VISION ⁀ VISION AT HIGHER LIGHT LEVELS

SCOTOPIC VISION ⁀ VISION AT LOW LIGHT LEVELS

Amacrine cells

- Receive signals from bipolar cells
- Involved in the regulation and integration of activity in bipolar and ganglion cells

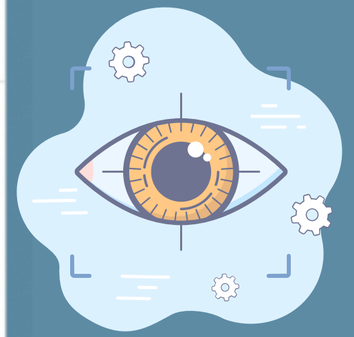
Horizontal cells

- Receive input from multiple photoreceptor cells, make adjustments and regulate activity in photoreceptor cells

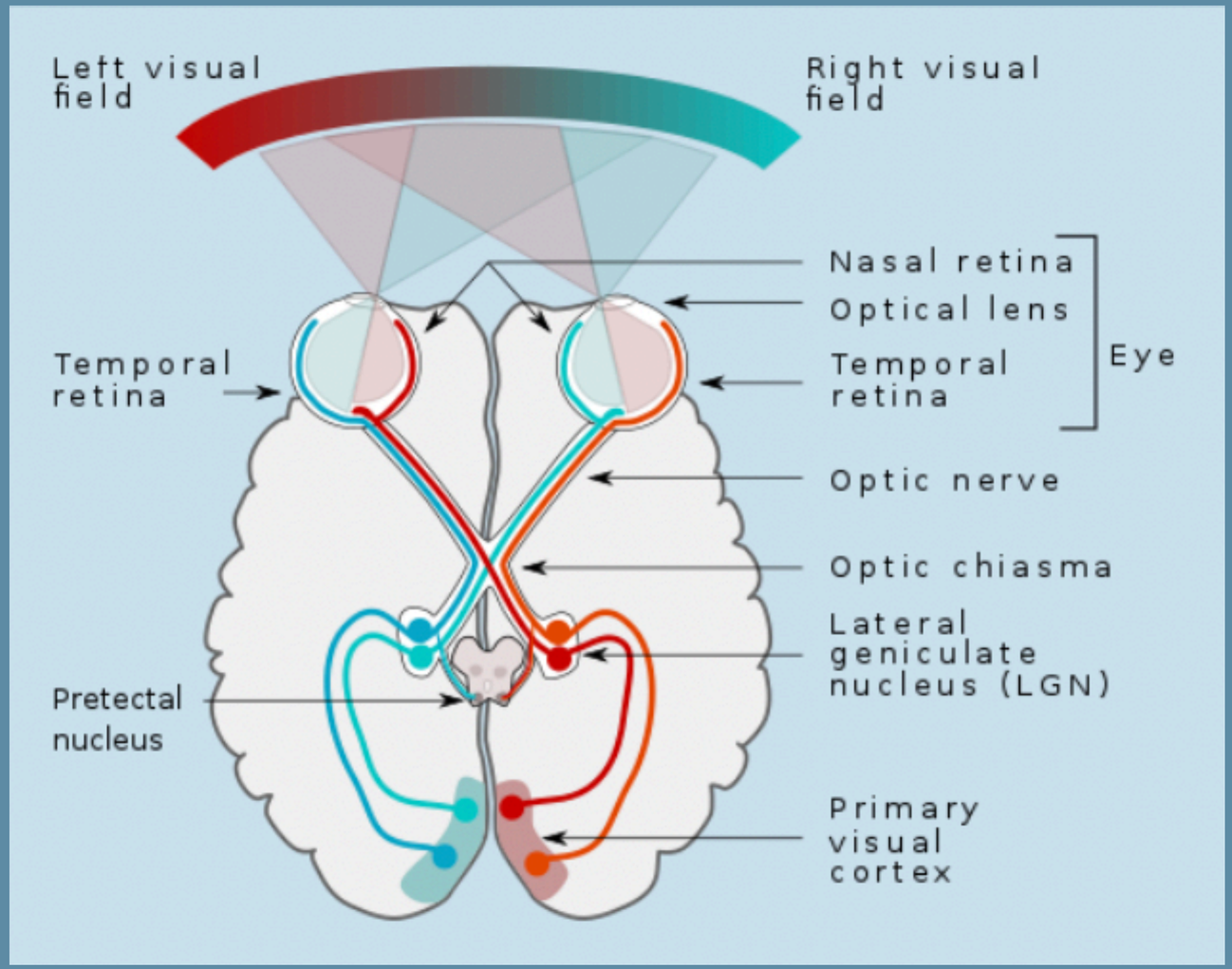
Neural layer of the Retina

- Is attached to the pigmental layer around optic nerve and ora serrata
- This layer is involved in detached retinas

CORNEA: fibrous layer	→ continuous with the sclera anteriorly (1/6th) → It is transparent and avascular → Responsible for the refraction of light entering the eye
SCLERA: fibrous layer	→ covers the posterior and lateral parts of the eyeball (5/6th of eyeball) → It is loosely attached to the choroid → It is pierced by the optic nerve
IRIS: vascular layer	→ coloured part of the eye → central opening is the pupil
CHOROID: vascular layer	→ firmly attached to the retina → it is composed of an outer pigmented layer (absorbs light) and inner highly vascular layer



OPTIC TRACT



The Retina

- Nasal retina perceives the temporal visual field
- Temporal retina perceives the nasal visual field

The Optic Nerve is made up of nasal and temporal fibres

Optic Chiasm

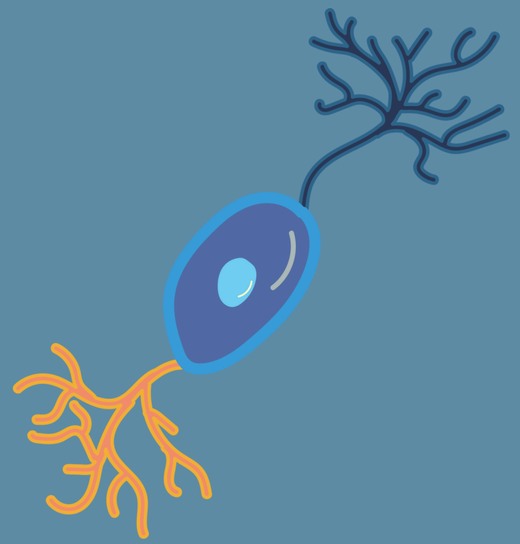
- ONLY THE NASAL FIBRES cross over in the optic chiasm
- Therefore disease of the optic chiasm causes defects in both temporal visual fields
- Bitemporal hemianopia: the pituitary gland sits underneath the optic chiasm and adenomas of the pituitary gland can press upwards and cause bitemporal hemianopia

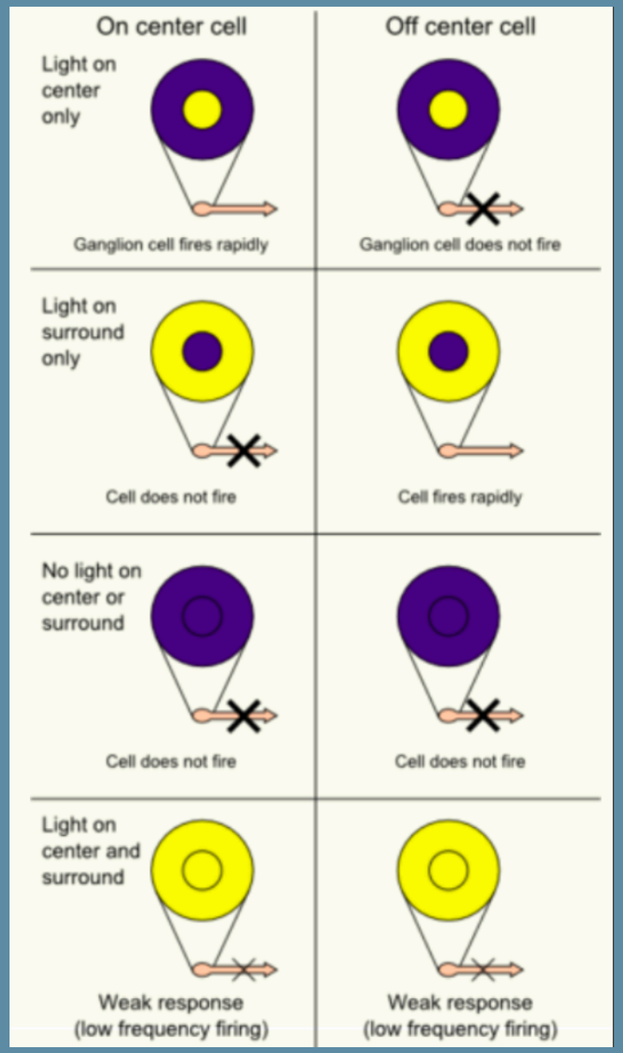
Optic Tract (behind optic chiasm)

- Axons synapse in the thalamus (lateral geniculate nucleus)
- The thalamus then sends more axons onto the primary visual cortex

Two types of bipolar cells that signal to retinal ganglion cells:

1. **<u>Off bipolar cells:</u>** preserve the sign of the cone and therefore hyper-polarised by light
2. **<u>On bipolar cells:</u>** reverse the sign of the cone and are depolarised by light





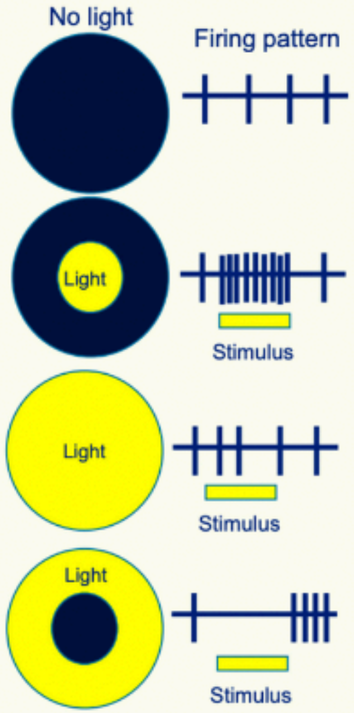
Retinal Ganglion Cells – Off Surround and On Centre

When there is no light stimulus the cell fires at a baseline rate

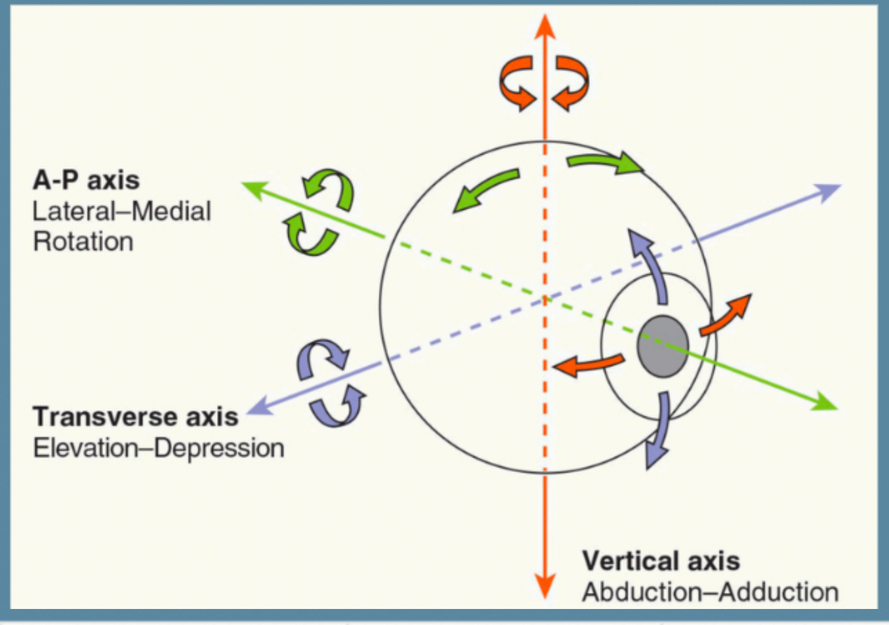
When a light spot coincides with an 'on centre' the firing rate is at a maximum during that stimulus

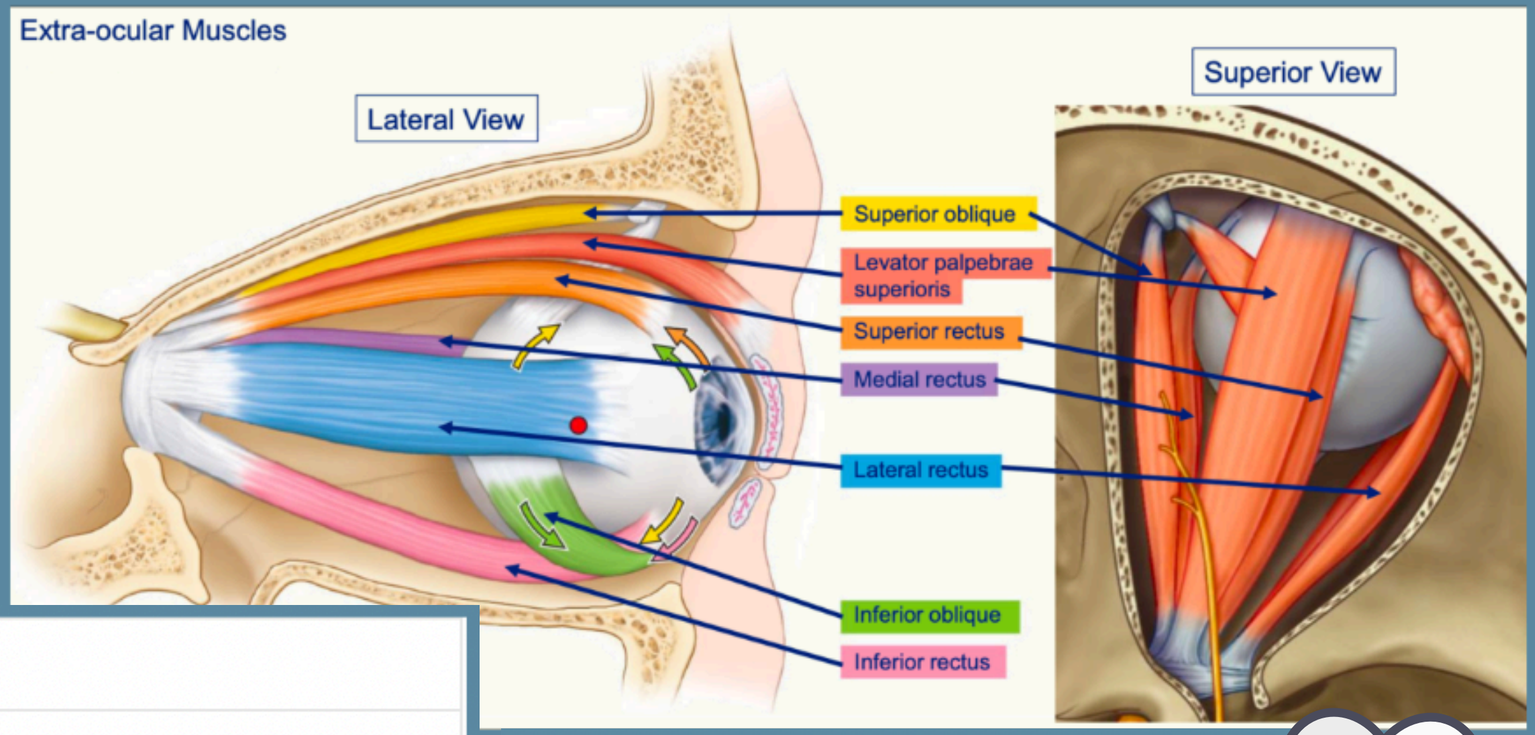
When a light circle expands and also covers the off surround the firing patterns slows right down close to baseline

When there is only light on the 'off surround' and none on the 'on centre' then the baseline levels are supressed during the stimulus



BIPOLAR CELLS





NAME	INNERVATION	ACTION
superior oblique	trochlear	depression, abduction, medial rotation (**intorsion**)
inferior oblique	oculomotor	elevation, abduction, lateral rotation (**extorsion**)
superior rectus	oculomotor	**elevation**🙄, adduction and intorsion
medial rectus	oculomotor	**adduction**
lateral rectus	abducens	**abduction**
inferior rectus	oculomotor	**depression**, adduction and extorsion

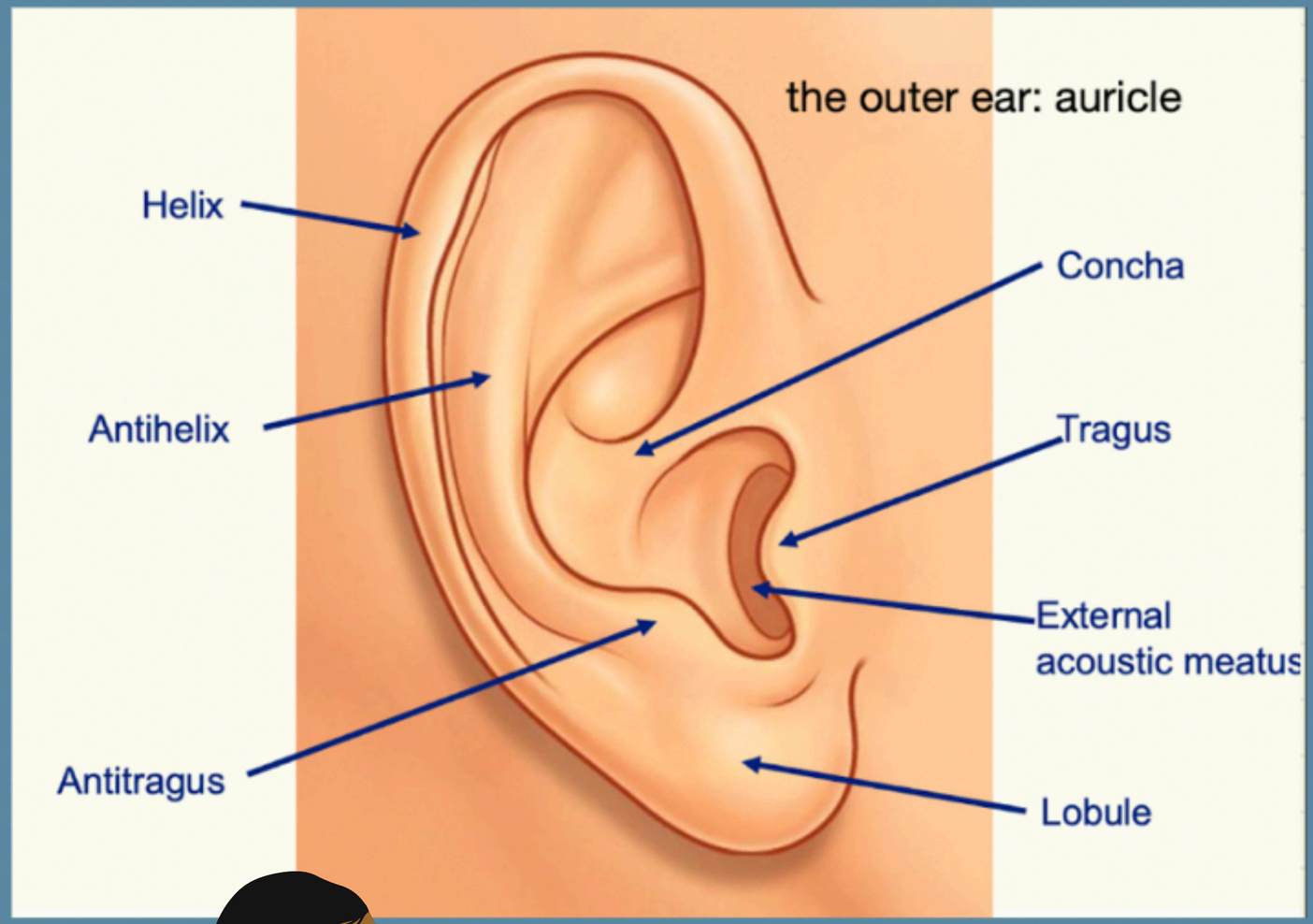
what is the mnemonic LR6SO4?

Back

lateral rectus innervated by CN6
superior oblique innervated by CN4

the rest of the extraocular muscles are going to be innervated by cranial 3

MUSCLES OF EYE



THE OUTER EAR

THE TYMPANIC MEMBRANE:

- IS A TRANSLUCENT MEMBRANE ARTICULATES WITH THE HANDLE OF THE MALLEUS
- AKA EAR DRUM
- CONNECTED TO THE SURROUNDING TEMPORAL BONE BY A FIBROCARTILAGINOUS RING

EXTERNAL AUDITORY CANAL: TUBE WHICH SITS INSIDE THE TEMPORAL BONE

AURICLE: FLAP OF ELASTIC CARTILAGE AND SKIN

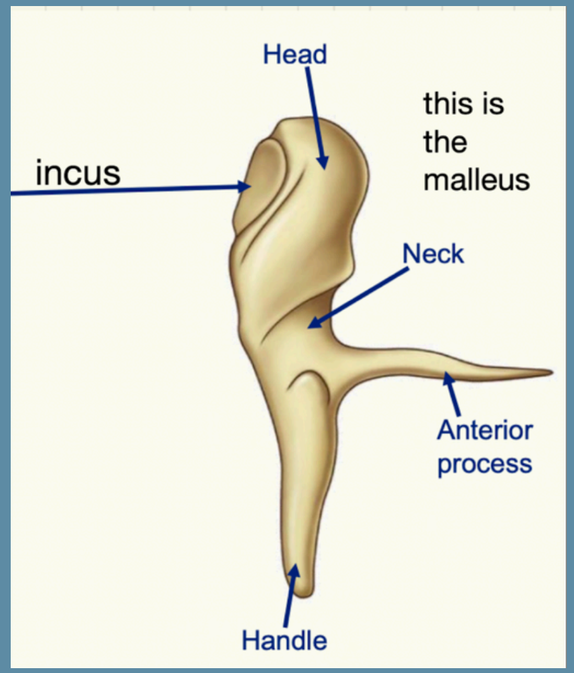
EXTERNAL ACOUSTIC MEATUS:

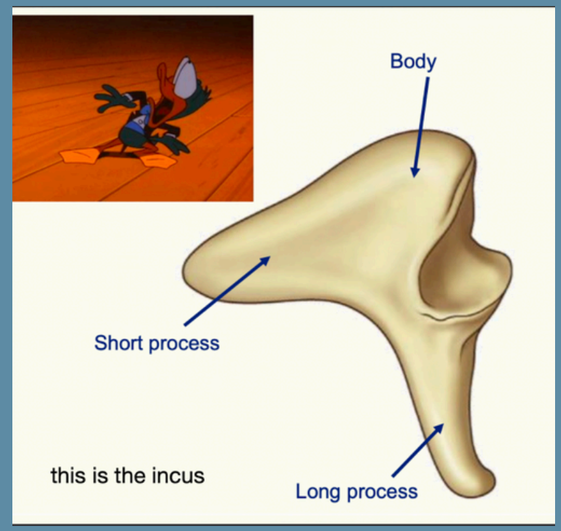
- LATERAL 1/3RD = CARTILAGE
- MEDIAL 2/3RDS = TEMPORAL BONE
- S- SHAPED
- ENDS AT THE TYMPANIC MEMBRANE

THE MIDDLE EAR

AUDITORY OSSICLES ARE A CHAIN OF 3 SMALL MOBILE BONES FOUND IN THE TYMPANIC CAVITY THEY TRANSFER SOUNDWAVES TO THE OVAL WINDOW (FENESTRA VESTIBULI)

- **Eustachian Tube:** connects the middle ear with nasopharynx
- The head of the malleus articulates with the body of the incus
- The body of the incus articulates with the head of the stapes
- The foot of the stapes articulates with the oval window
- **Mastoid air cells:** air to be released into the middle ear when pressure is too **low**
- **Pharyngotympanic tube (eustachian)** allows air to be released from the middle ear when pressure is too **high**

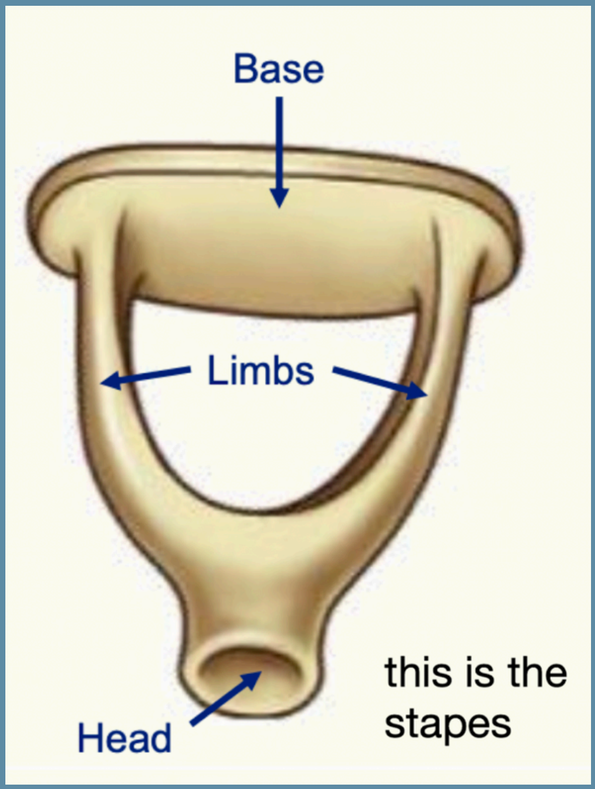




what is the middle ear made out of?

Back

- tympanic membrane
- auditory ossicles
- mastoid air cells
- pharyngotympanic tube



EAR ANATOMY: CN 8

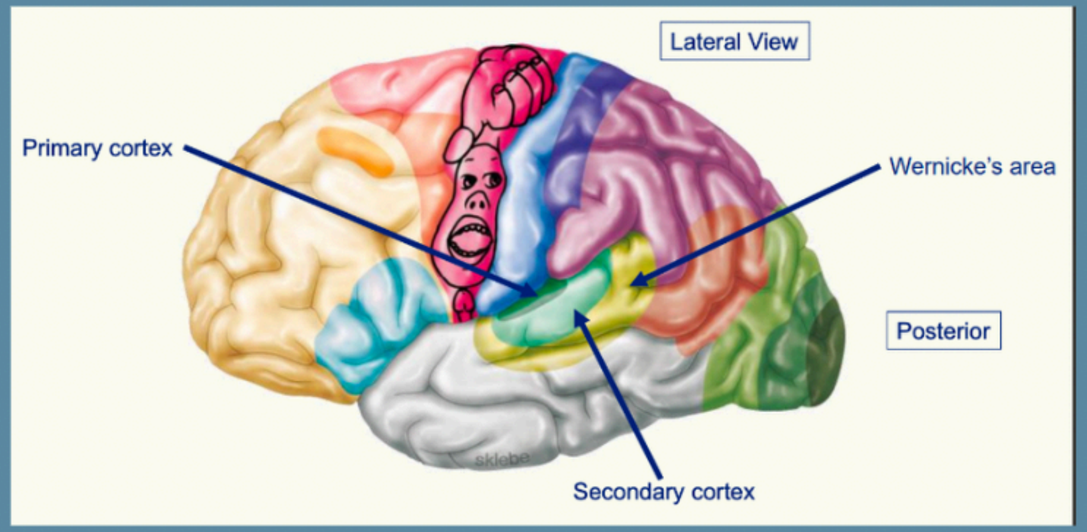
INFORMATION FROM BOTH EARS TRAVELS BILATERALLY

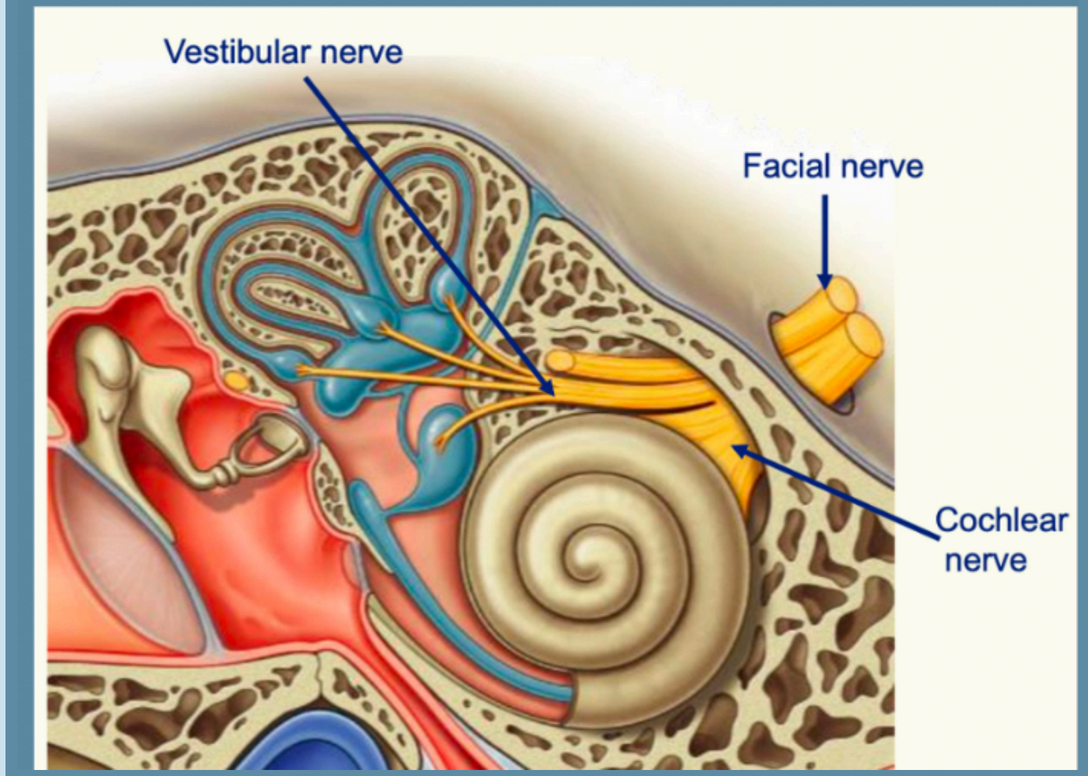
VESTIBULOCOCHLEAR NERVE (CN VIII) MADE UP OF

1. COCHLEAR NERVE FOR HEARING
2. VESTIBULAR NERVE FOR BALANCE

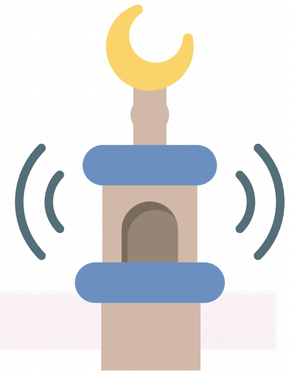
VESTIBULOCOCHLEAR FIBRES:

- MORE COMPLEX AND VARIABLE THAN OTHER GENERAL SENSORY PATHWAYS
- MANY LOCATIONS BETWEEN MEDULLA AND THALAMUS WHERE SYNAPSES OCCUR
- FIBRES ENTERS MEDULLA AT THE PONTOMEDULLARY JUNCTION
- THEY BIFURCATE AND END IN THE VENTRAL AND DORSAL COCHLEAR NUCLEI





Process of Hearing:



Ear is divided into:

1. Conducting system (external and middle ear)
2. Perceiving system (inner ear and central connections in the brain)

Conduction system:

External ear:

- Auricle collects air borne sound waves → sound enters external auditory canal(EAC) → EAC transmits sounds to the tympanic membrane (TM)

Middle ear:

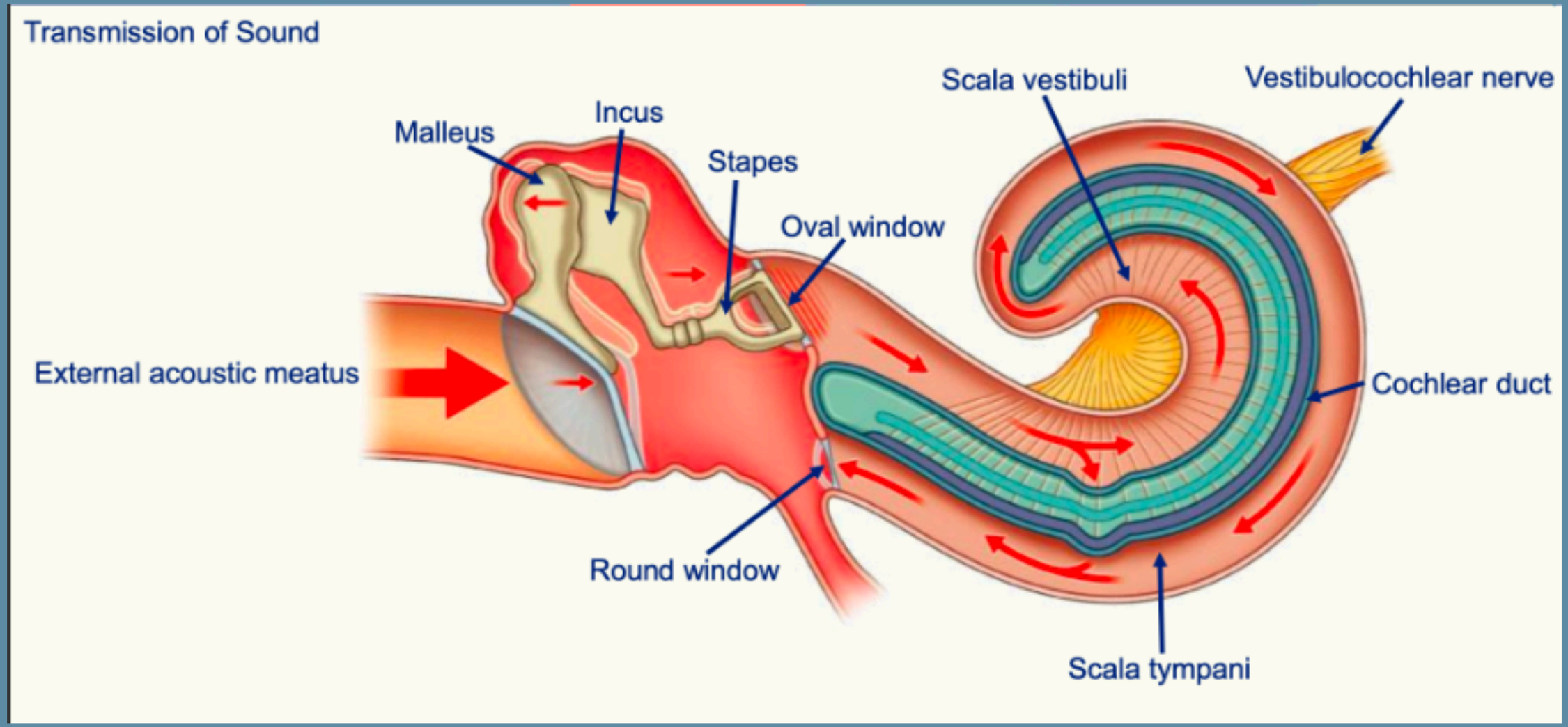
- Tympanic membrane (TM) vibrates and converts the sound waves into mechanical energy
- Ossicles transmit and amplify the sound waves to the cochlea
- Eustachian tube = ventilates the middle ear; important for free movement of the tympanic membrane

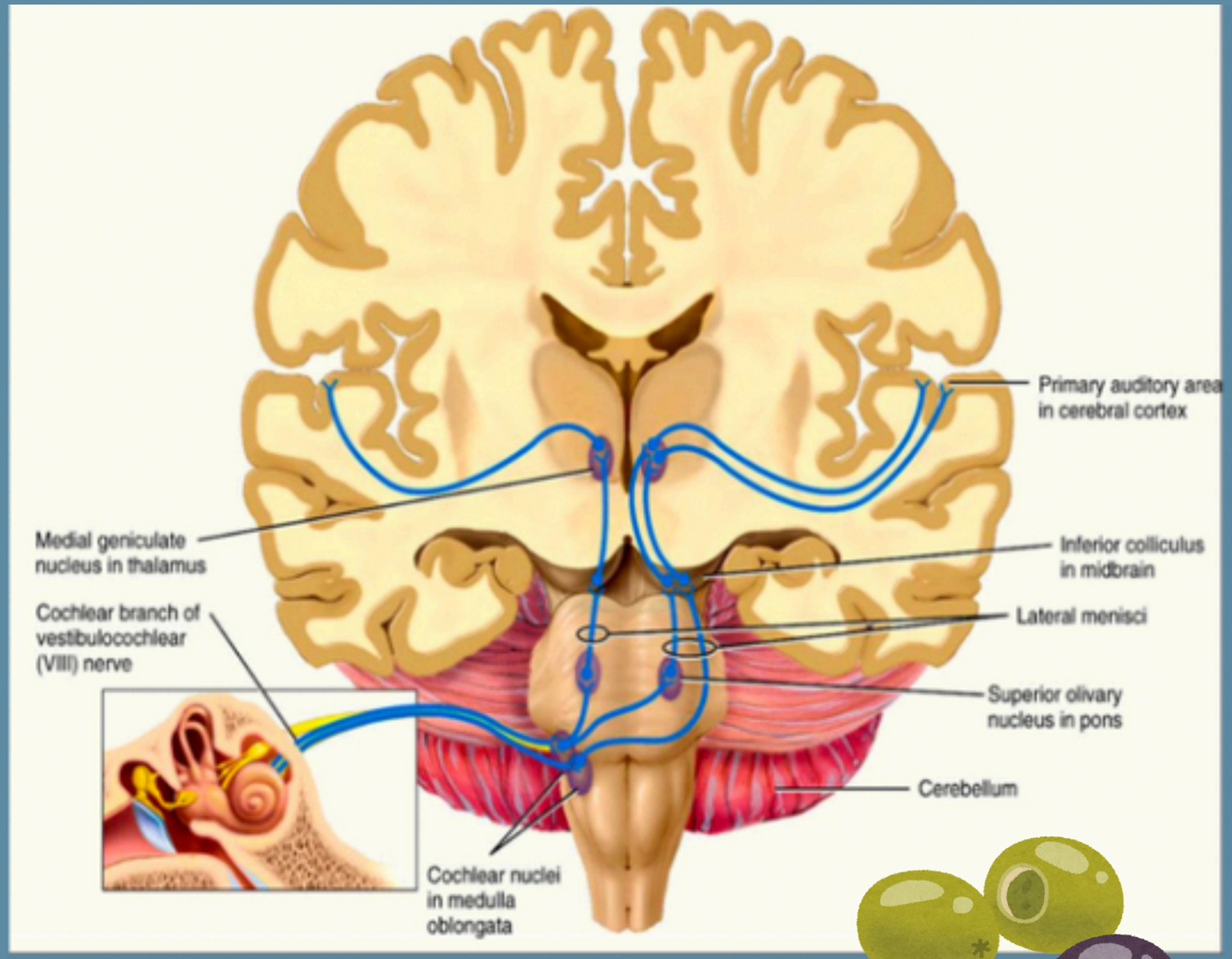
Perceiving system:

- The sensorineural part of the ear (inner ear) converts mechanical sound waves into electric impulses and sends to Brain.
- Vibration of stapes on both the oval windows causes changes in pressure in the perilymph of the scala vestibuli → transmitted to the scala tympani
- This distorts the vestibular membrane (scala vestibuli) and creates pressure waves in the endolymph of the cochlear duct
- Pressure waves in the endolymph cause the basilar membrane to vibrate → stimulates hair cells in the spiral organ → generates impulses in the cochlear nerve fibres.

Sterocilia

- Hairs on the walls/membranes of the scala vestibuli and scala tympani which are the sensory receptors for sound and they connect to neurones.
- Eventually all of the neurones connect to form the 'cochlear' branch of the Vestibulocochlear Nerve (CN VIII)


Transmission of Sound
Scala vestibuli
Vestibulocochlear nerve
Incus
Malleus
Stapes
Oval window
External acoustic meatus
Cochlear duct
Round window
Scala tympani



MEDIAL GENICULATE BODY IS WHERE THE FIBRES OF THE COCHLEAR NERVE SYNAPSE IN THE THALAMUS TO THE PRIMARY AUDITORY CORTEX

Dorsal cochlear nucleus:

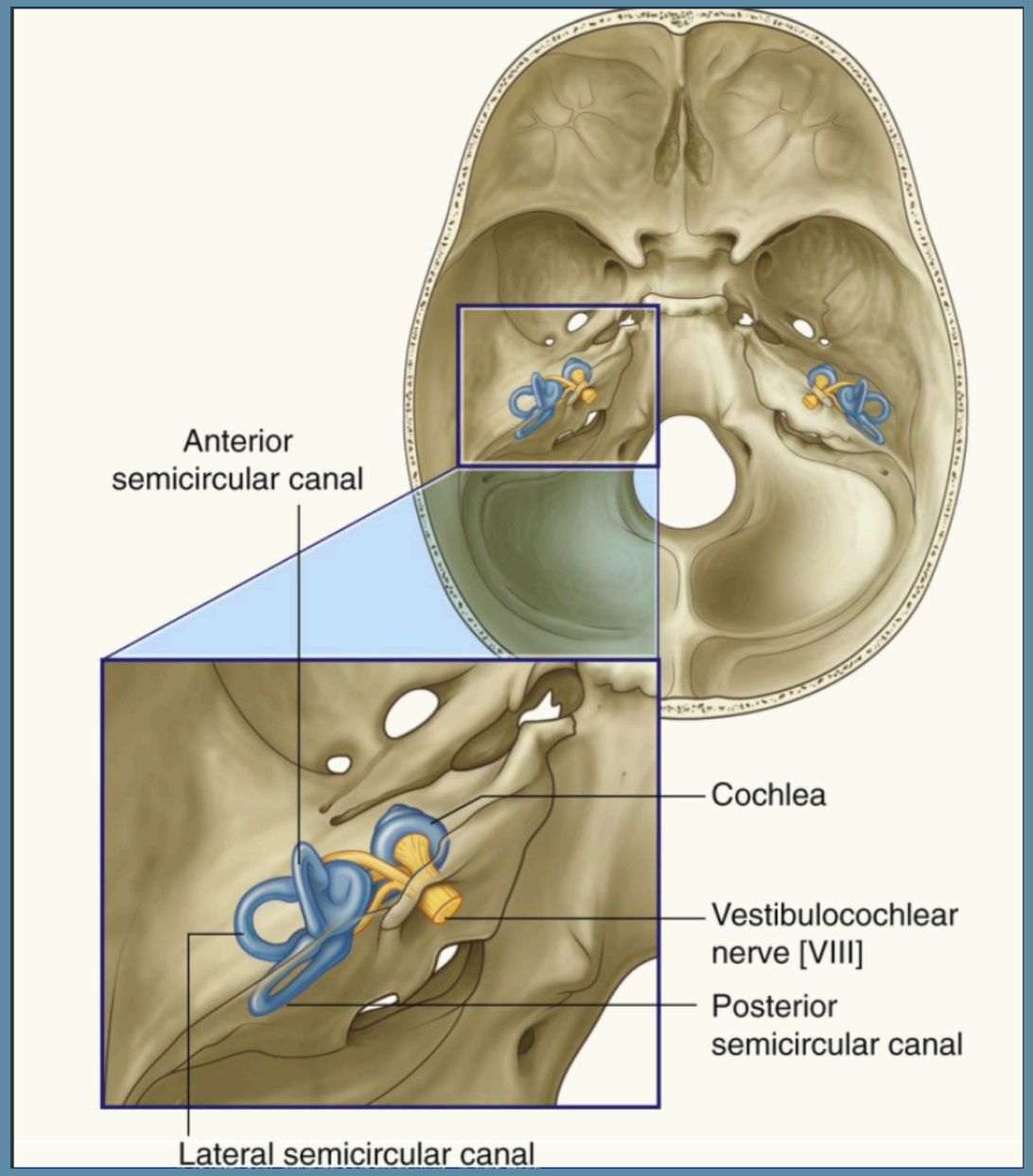
Most fibres decussate and ascend in the contralateral lateral lemniscus
some stay ipsilateral

Ventral cochlear nucleus:

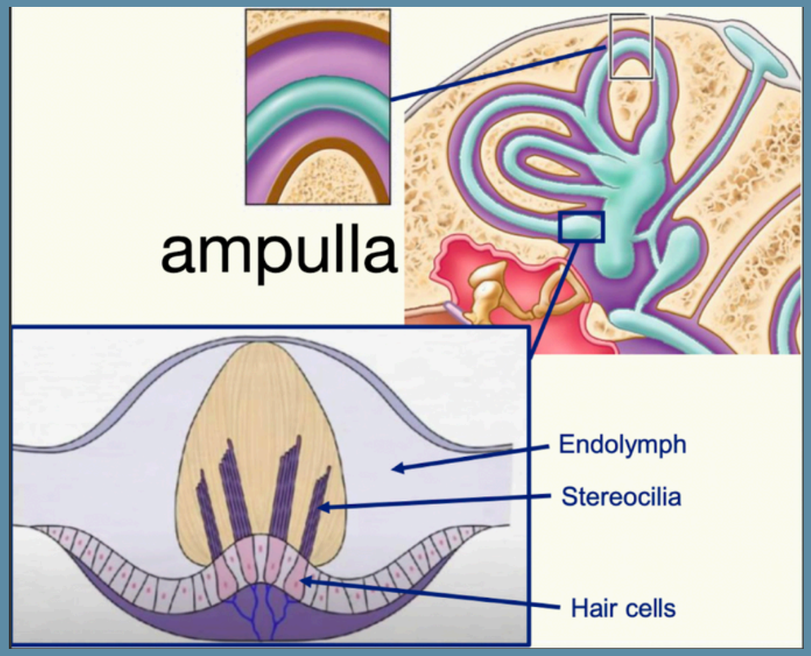
- Some fibres ascend ipsilateral too
- Most decussate to contralateral superior olivary nucleus

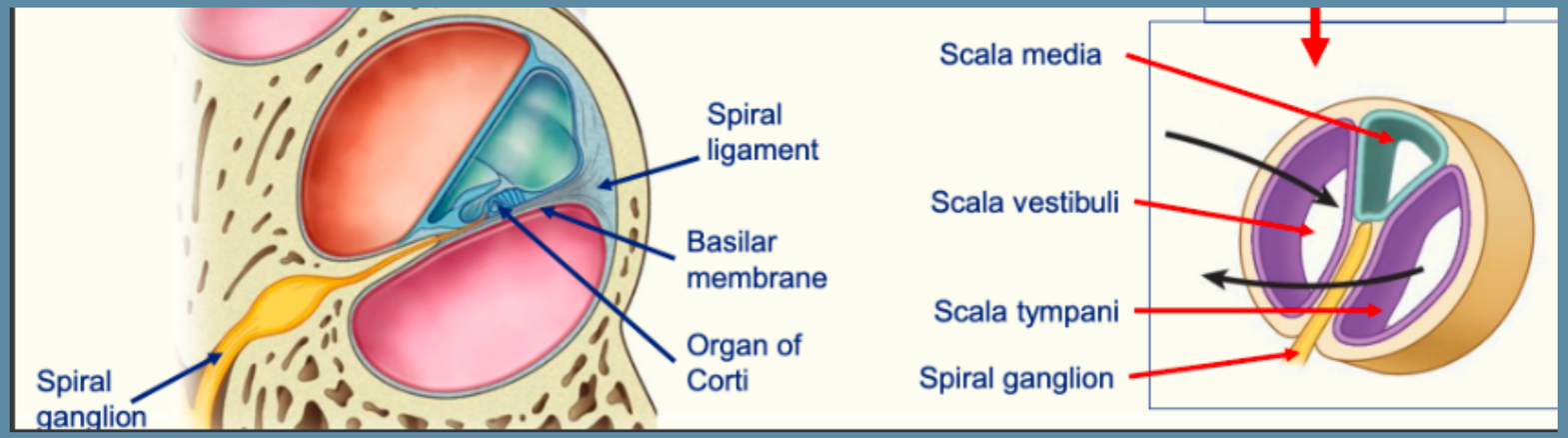
Inferior colliculus:

- Fibres ascend through the lateral lemniscus from both cochlear nuclei and superior olivary nuclei arrive at the inferior colliculus where these converge
- These fibres project to the ipsilateral medial geniculate body



- SEMICIRCULAR CANALS SITUATED AT RIGHT ANGLES TO EACH OTHER WITH A SWELLING AT ONE END KNOWN AS THE AMPULLA
- THE AMPULLA CAN DETECT MOVEMENT IN ANY DIRECTION
- AMPULLA STIMULATES THE RELEASE OF NEUROTRANSMITTERS TO SEND INFORMATION ABOUT THE PLANE OF MOVEMENT TO THE BRAIN
- SEMICIRCULAR CANALS CONTAIN THE SEMICIRCULAR DUCTS WHICH ARE RESPONSIBLE FOR BALANCE ALONG WITH UTRICLE AND SACCULE





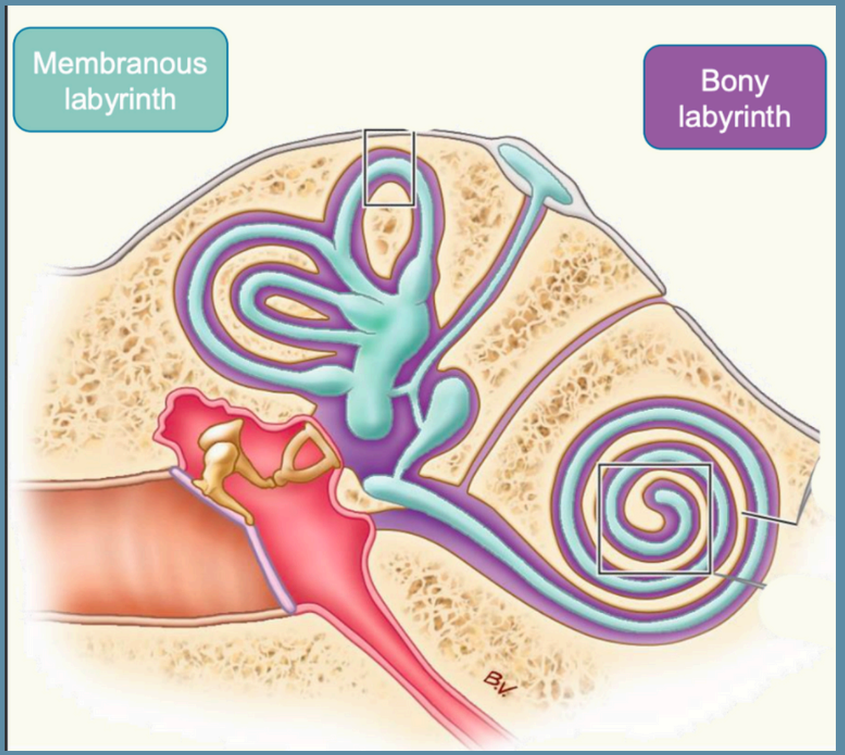
INNER EAR

Bony labyrinth is in the temporal bone and consists of 3 parts:

1. **<u>Vestibule</u>** (connection to the middle ear) -> Central part which allows communication to the SCC superiorly and the cochlea anteriorly
2. **<u>Semi-circular canals</u>** (balance)
3. **<u>Cochlea</u>** (hearing)

<u>The cochlea:</u>

1. **Scala vestibuli:** bony labyrinth; ends at the oval window
2. **Scala tympani:** bony labyrinth; ends at the round window
3. **Cochlear duct:** membranous labyrinth



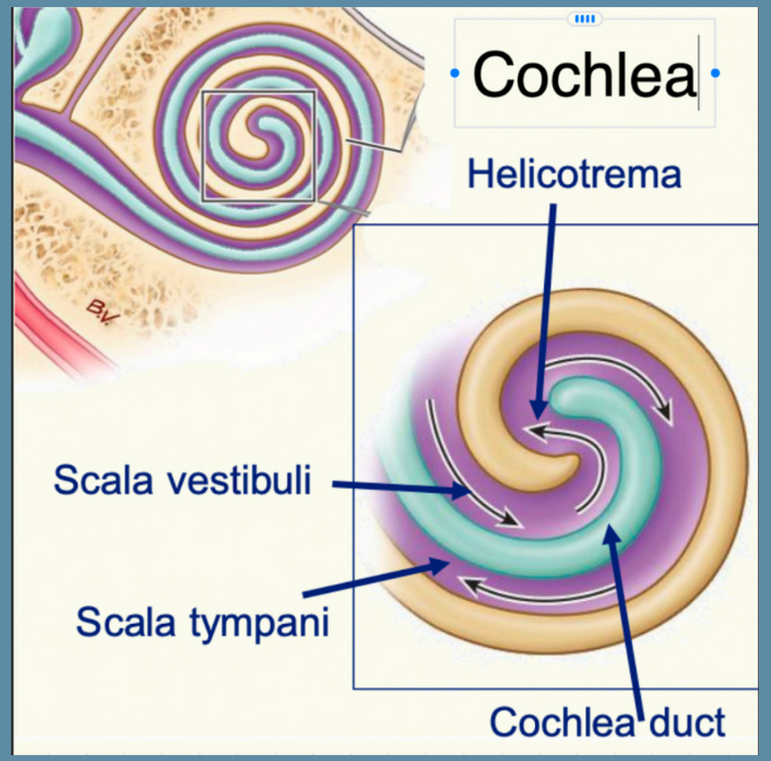
INNER EAR 2

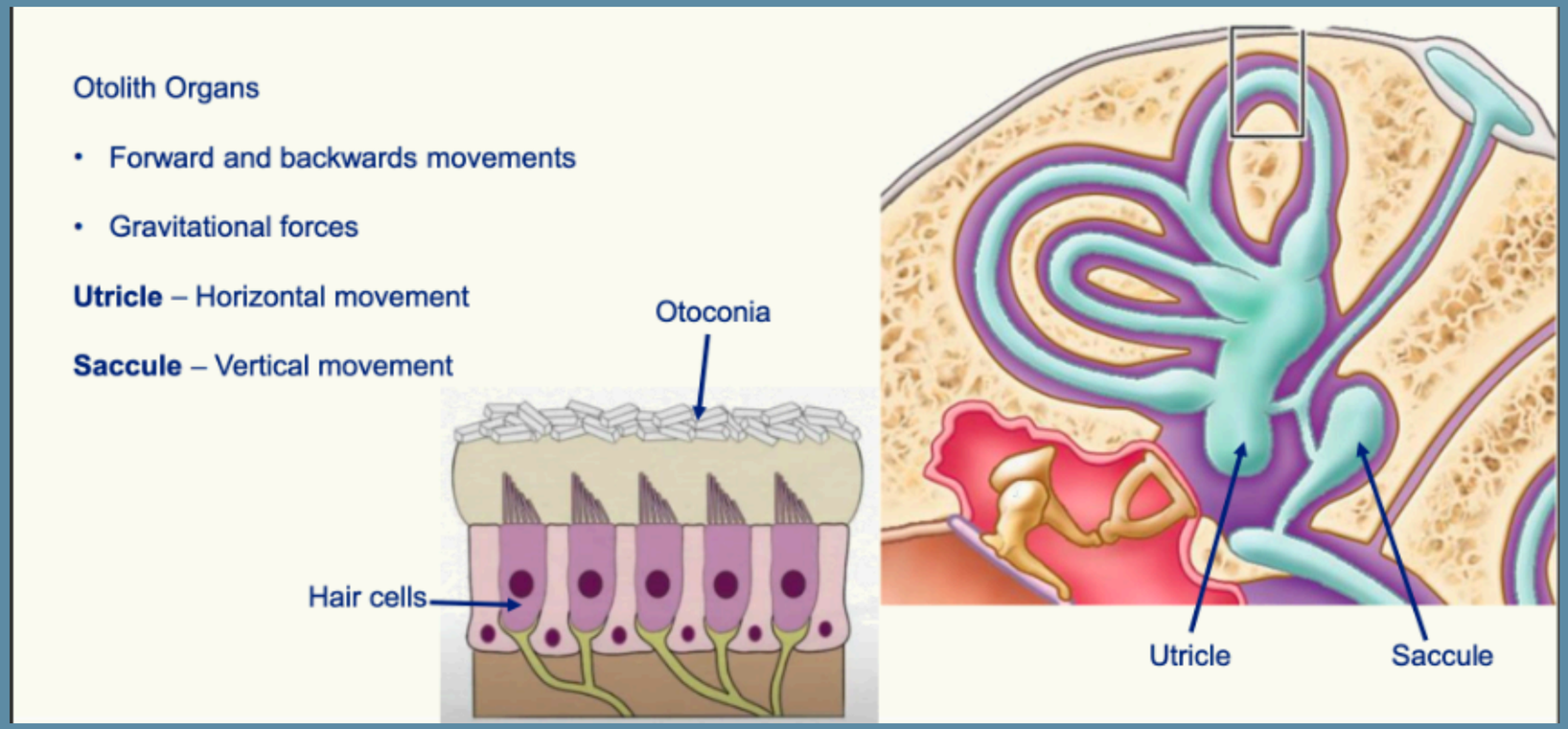
Inner ear:

1. Outer bony labyrinth (Perilymph)
2. Inner membranous labyrinth (Endolymph)

What is the membranous labyrinth composed of?

- semicircular ducts
- saccule: can detect vertical linear linear acceleration
- utricle: detect horizontal linear acceleration
- cochlear duct





THANKYOU