Central pathways for special senses

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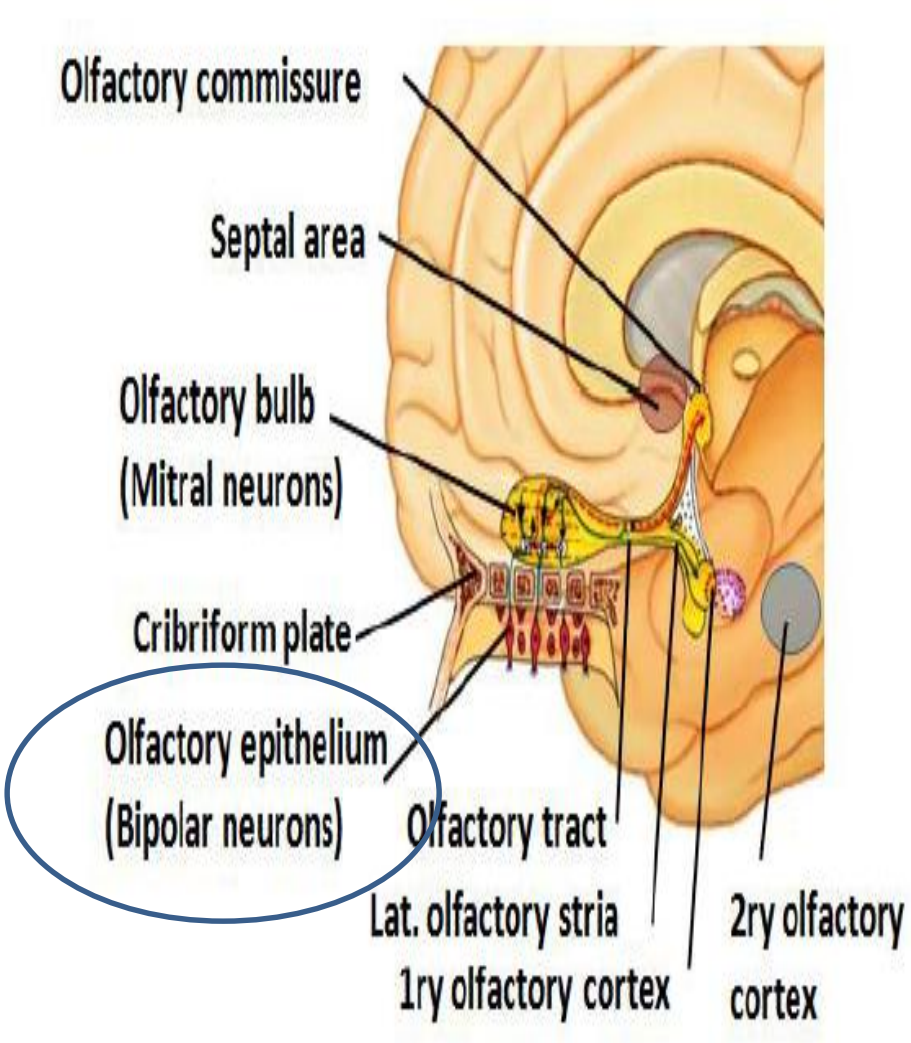
Objectives

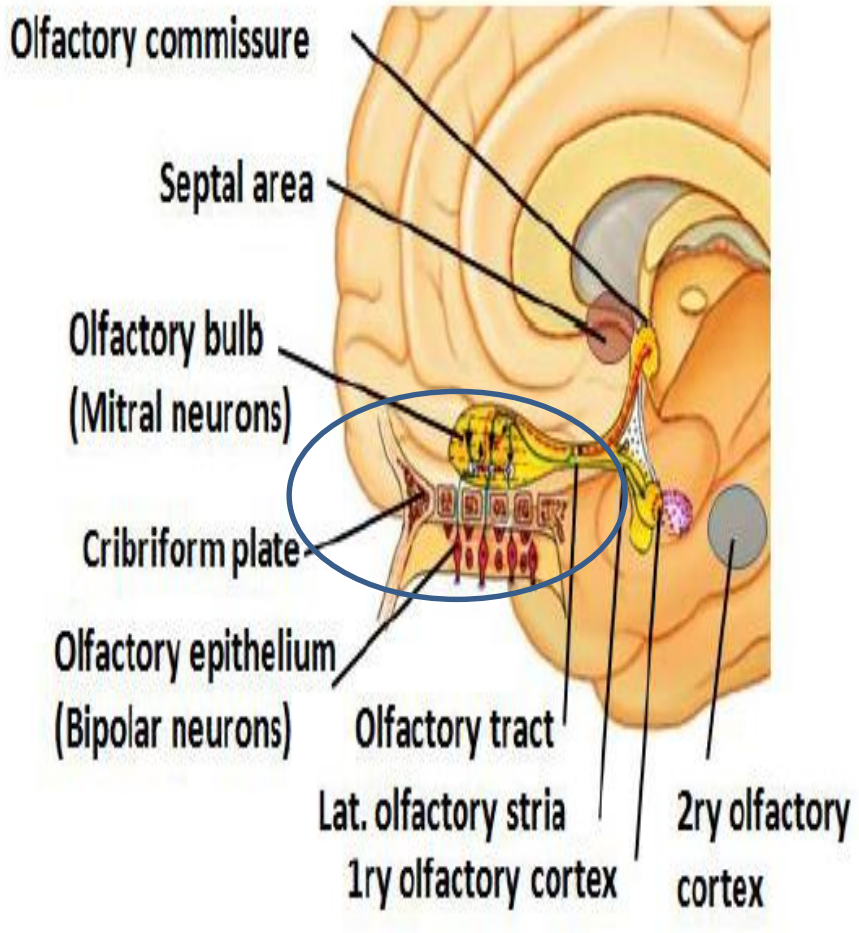
- Describe olfactory pathway.
- Describe taste pathway.
- Describe visual pathway.
- Describe auditory pathway.
-Describe vestibular pathway.

OLFACTORY PATHWAY

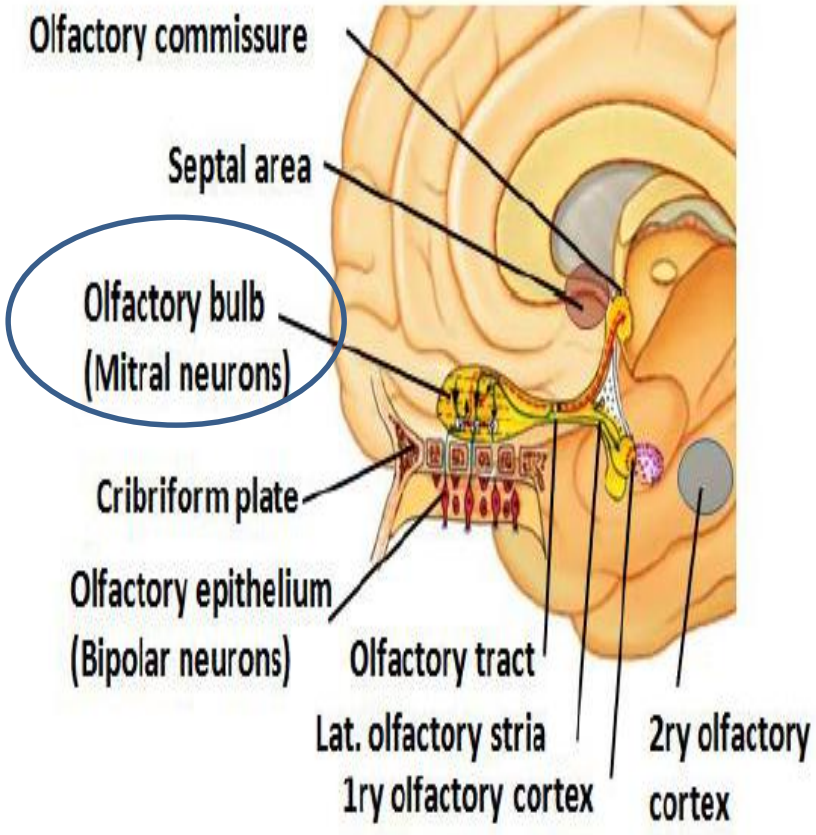
- **The olfactory epithelium** lines the roof of the nose extending slightly on the medial and lateral walls. It contains ***bipolar neurons*** whose peripheral processes are the olfactory receptors.



The olfactory nerve is formed by the central processes of the bipolar neurons which collect into 20 filaments that traverse the cribriform plate of ethmoid bone to end in the olfactory bulb.



- **The olfactory bulb** lies in the orbital sulcus on the orbital surface of the frontal lobe. The olfactory nerve fibers synapse with the ***mitral and tufted cells*** whose axons run in the olfactory tract.



The olfactory tract

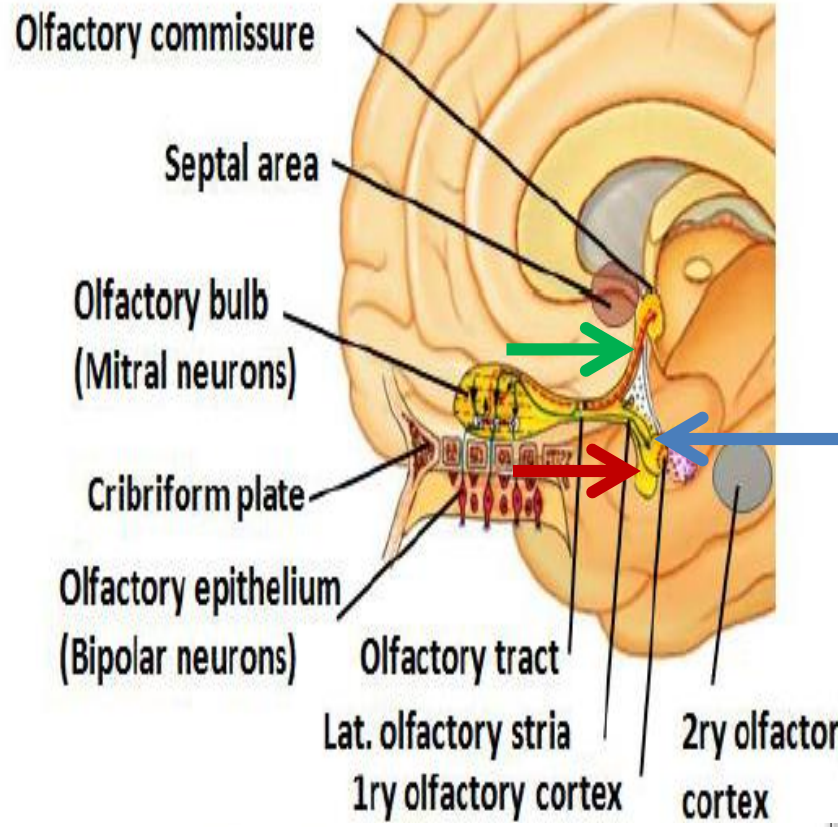
extends till the anterior perforated substance which is located lateral to the optic chiasma where it forms

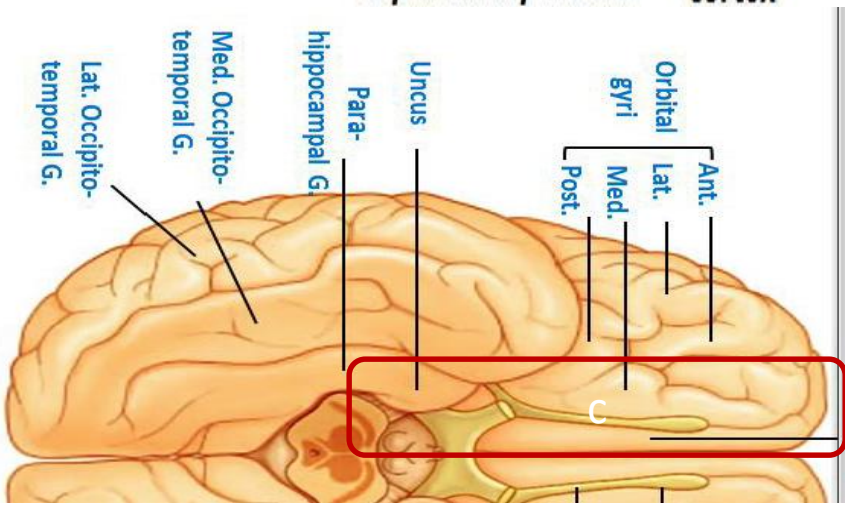
3 olfactory stria which terminate as follows:

1. Lateral olfactory stria to 1ry olfactory cortex

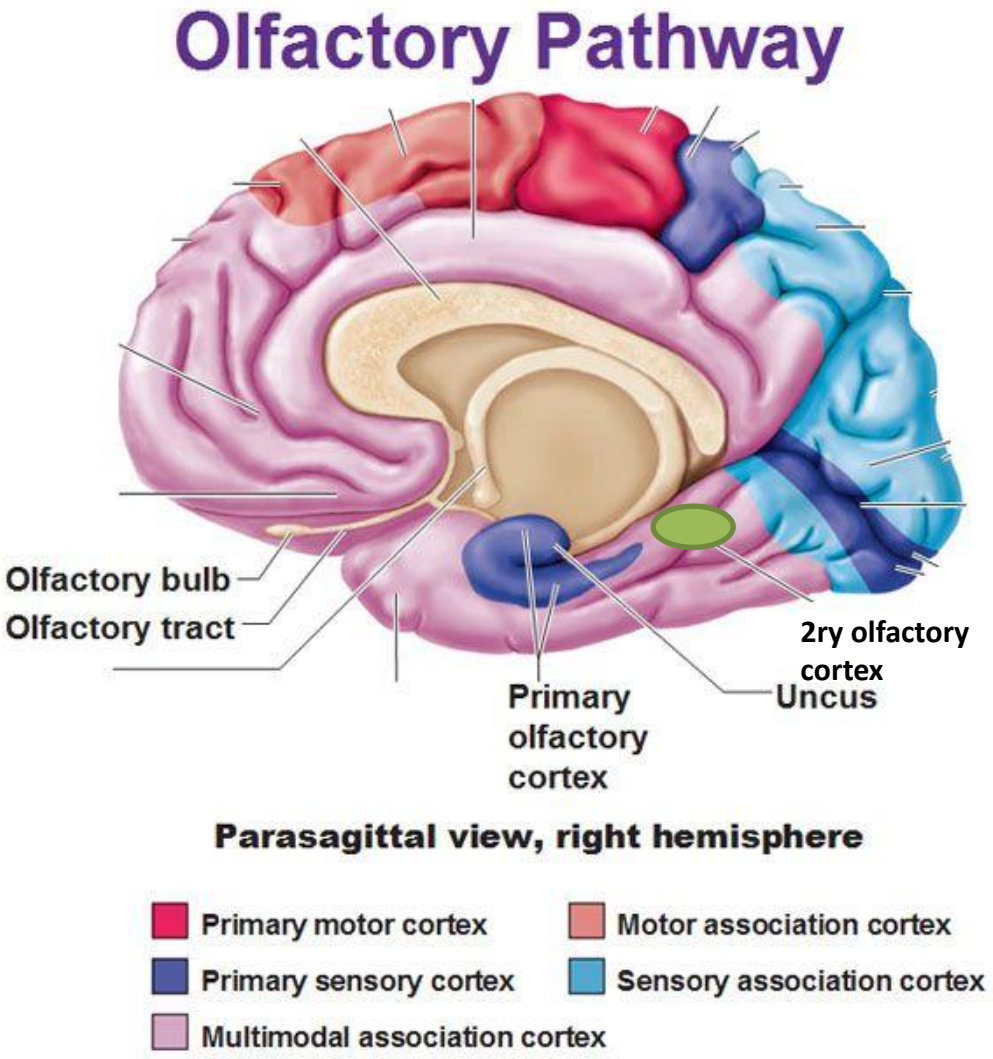
2. Intermediate olfactory stria (small) ends in a small tubercle (olfactory tubercle) in the anterior perforated substance.

3. Medial olfactory stria to paraterminal gyrus & paraolfactory gyrus (parts of the septal area) & anterior commissure.





- **The 1ry olfactory cortex** lies in 3 regions: uncus + part of amygdala + apex of insula) to
- **2ry olfactory cortex** (entorhinal area or area 28 in the anterior part of the parahippocampal gyrus).
- The olfactory pathway is linked to the limbic system.
- It is the only sensation that reaches the cortex without relaying in the thalamus **Applied anatomy:** Anosmia (loss of smell) may be:
- **-** Unilateral: due to frontal lobe tumor.
- **-** Bilateral: due to fracture of the cribriform plate of ethmoi



TASTE PATHWAY

- Taste receptors are present on **the tongue**, the **epiglottis** & the **lingual surface of soft palate**. Taste sensation is carried by 3 cranial nerves: **facial, glossopharyngeal & vagus. (7.9.10)**

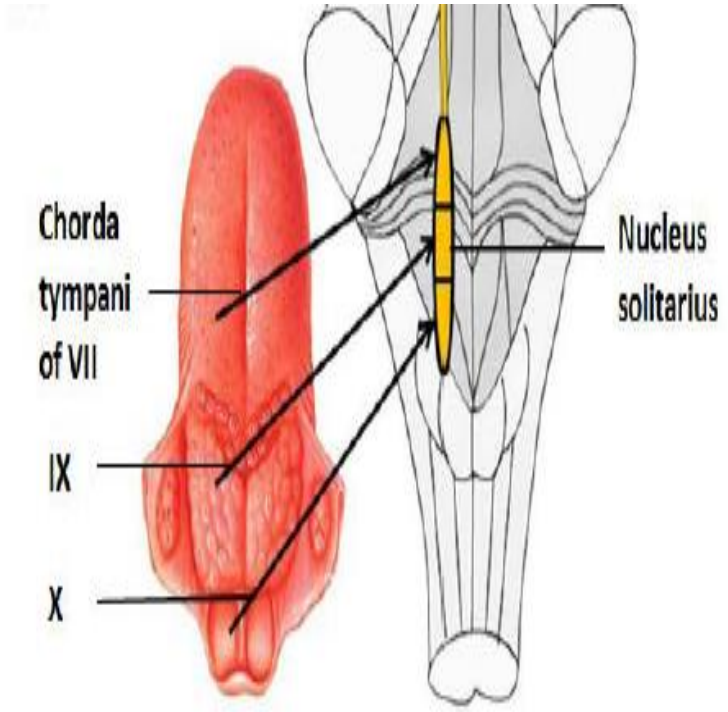
First Neuron

Pseudounipolar cells of:

1. Geniculate ganglion of facial nerve: receiving taste from anterior 2/3 of tongue + soft palate

2. Inferior ganglion of glossopharyngeal: receiving taste from posterior 1/3 of tongue

3. Inferior ganglion of vagus: receiving taste from most posterior part of tongue & epiglottis.

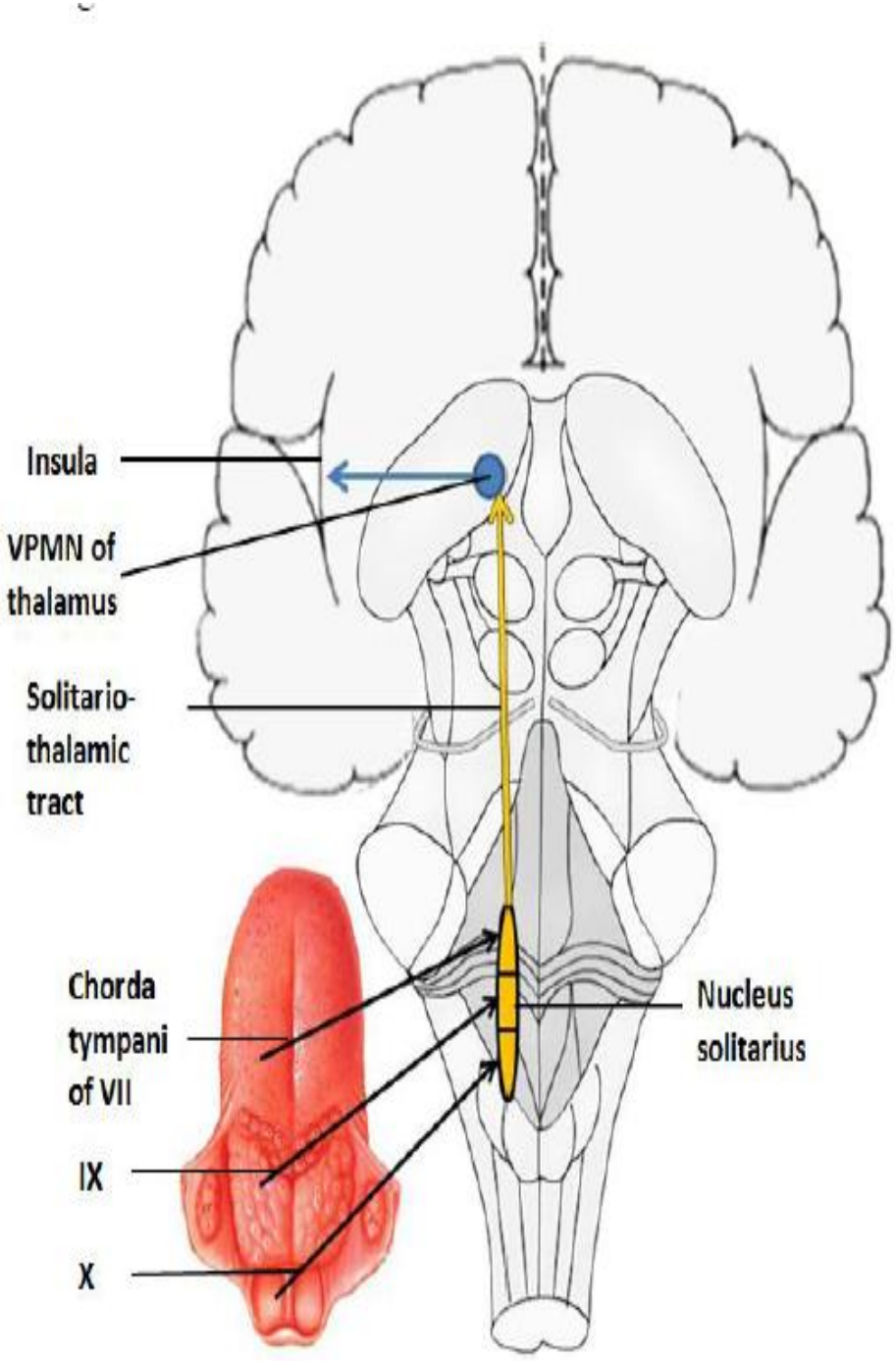


Second Neuron: Neurons of nucleus solitarius.

Their axons ascend in the solitariothalamic tract of the same side to the VPMN.

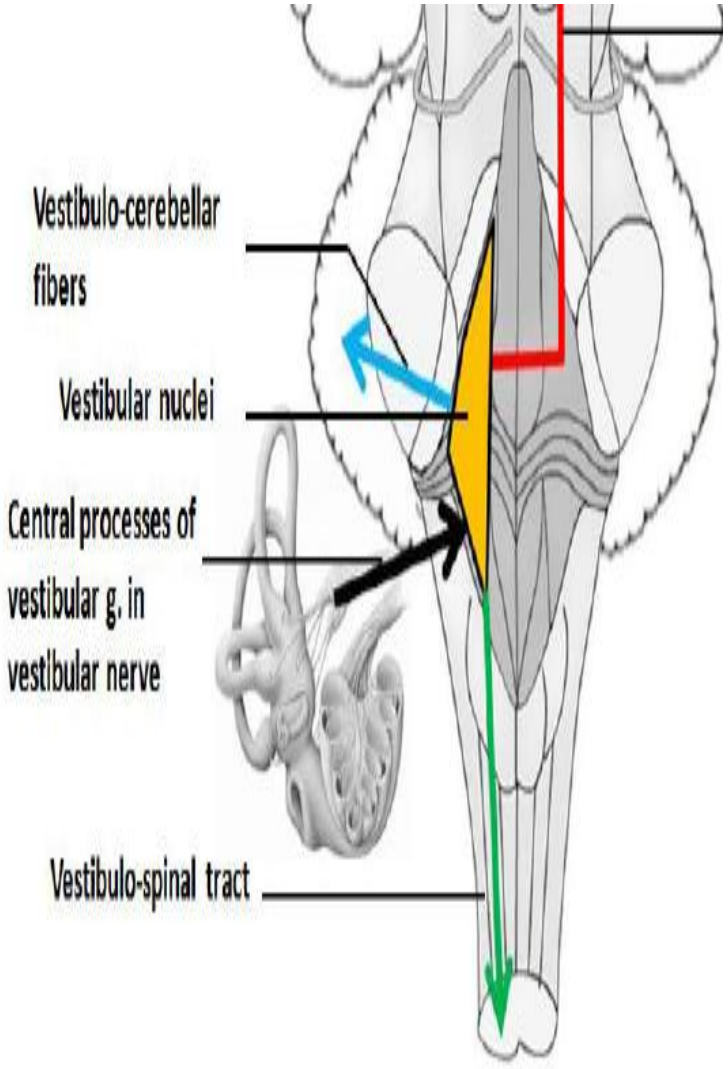
Third Neuron: Neurons of VPMN of thalamus whose axons project to the insula.

Both smell & taste end on the cortex of the same side.



VESTIBULAR PATHWAY

- **Receptors** are present in Semicircular canals (Ampullae) " Crista Ampularis" and in Saccule and Utricle (maculae)
- From these receptors impulses pass to the **vestibular ganglion**
- Central processes of vestibular ganglion form **vestibular nerve** that passes through internal auditory meatus to enter Pons where they end on the vestibular nuclei in Pons and Medulla
- There are four **vestibular nuclei**: superior, inferior, medial and lateral vestibular nuclei; all located beneath the lateral part of floor of fourth ventricle in Pons and Medulla



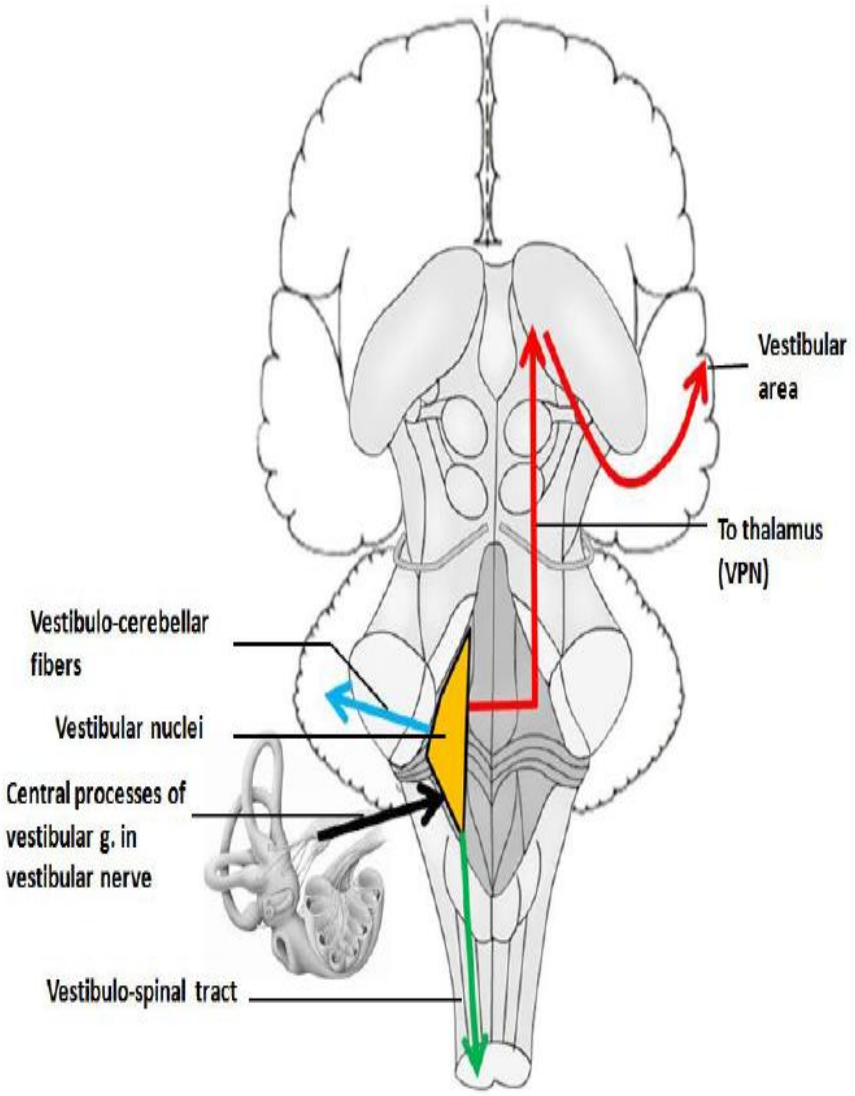
Connections of the vestibular nuclei

1. To cerebellum through ICP; vestibulo-cerebellar fibers end in the flocculonodular lobe to affect equilibrium

2. To spinal cord form vestibulo-spinal tracts to influence motor neurons concerned with control of posture and balance.

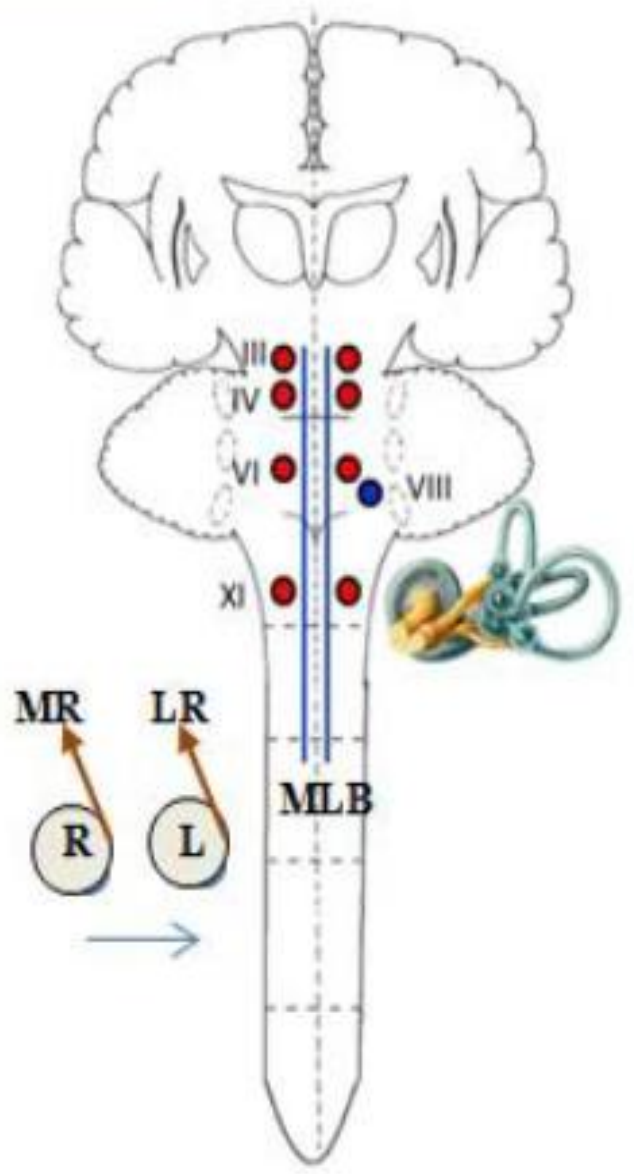
3. To Medial Longitudinal Bundle (MLB) to connect with nuclei of III, IV, VI for coordination of head and eye movement.

4. To Thalamus; Ventral Posterior Nucleus then to cerebral cortex "vestibular area"



Medial Longitudinal Bundle: MLB (fasciculus)

- A bundle of fibers extending longitudinally in the brainstem on each side of the median plane
- It extends upwards till the interstitial nucleus of Cajal in the posterior commissure & below it continues into the spinal cord as the medial vestibulospinal tract.
- It connects the vestibular and cochlear nuclei with motor nuclei of cranial nerves that move the eye III, IV, VI and with the spinal nucleus of accessory nerve that moves the head and the neck.



Function of MLB

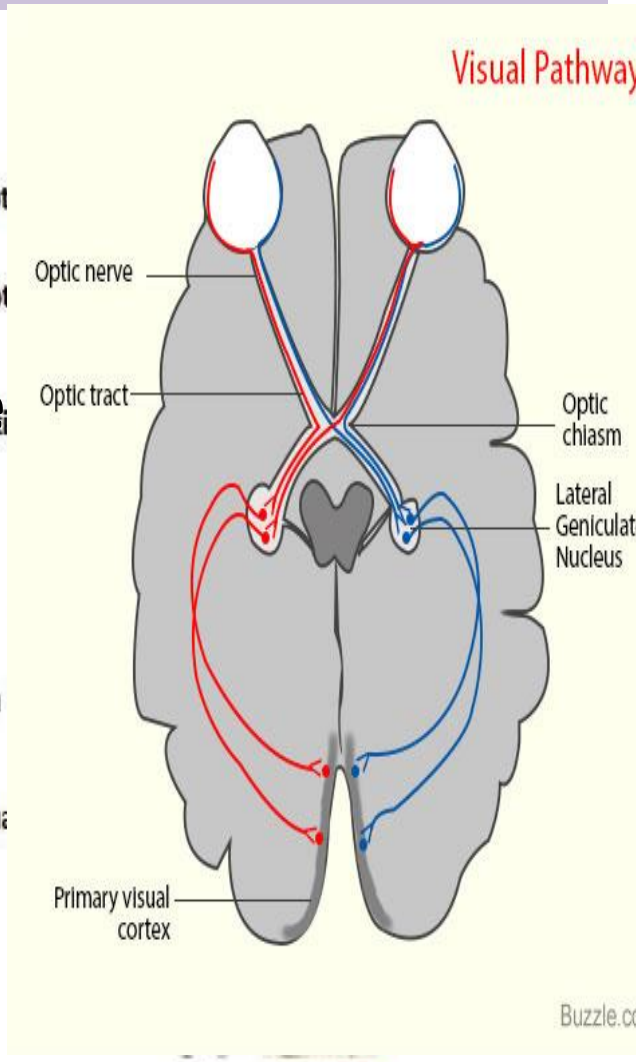
- Involved in coordinated movements of eyeball and head in response to vestibulo-cochlear stimuli
- Involved in pathway for conjugate lateral movements of the eye; i.e., it connects the abducent nucleus of one side with oculomotor nucleus of opposite side

Visual Pathway

Visual Pathway

It is formed of 3 neurons, the first and second neurons are in the retina while the third one is formed by cells of LGB.

- **1st order neuron: bipolar nerve cells of retina**
- **2nd order neuron: ganglion cells of retina whose axons form the optic nerve ➔ optic chiasma ➔ optic tract**
- **3rd order neuron: cells of lat. geniculate body , their axons form the optic radiation that passes in the retrolentiform part of internal capsule ➔ visual cortex.**



Visual Pathway

- **Photoreceptors:**

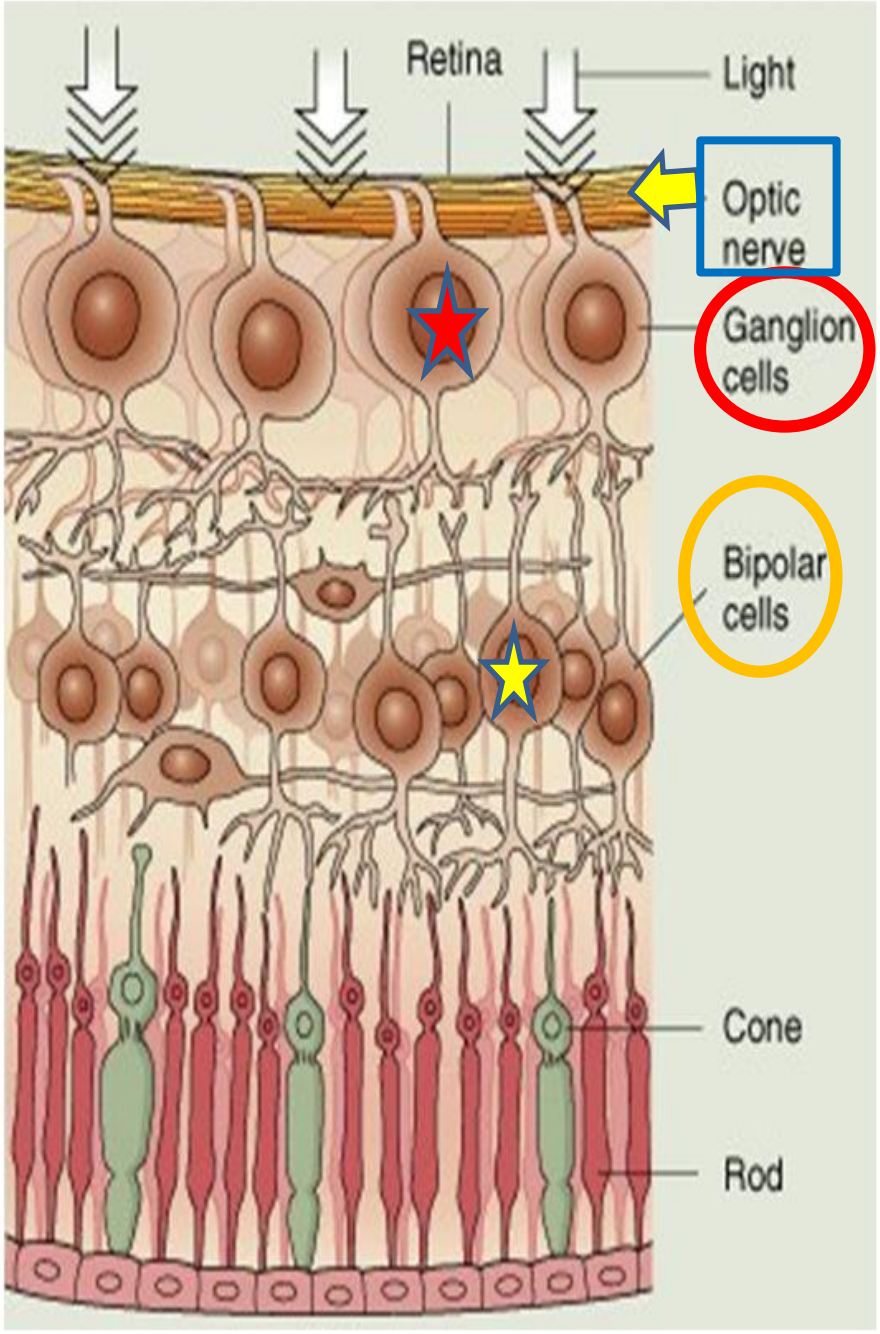
  Rods & Cones of retina

- **3 neuron pathway**
  - **1st order neurons:**

    Bipolar cells of retina.
  - **2nd order neurons:**

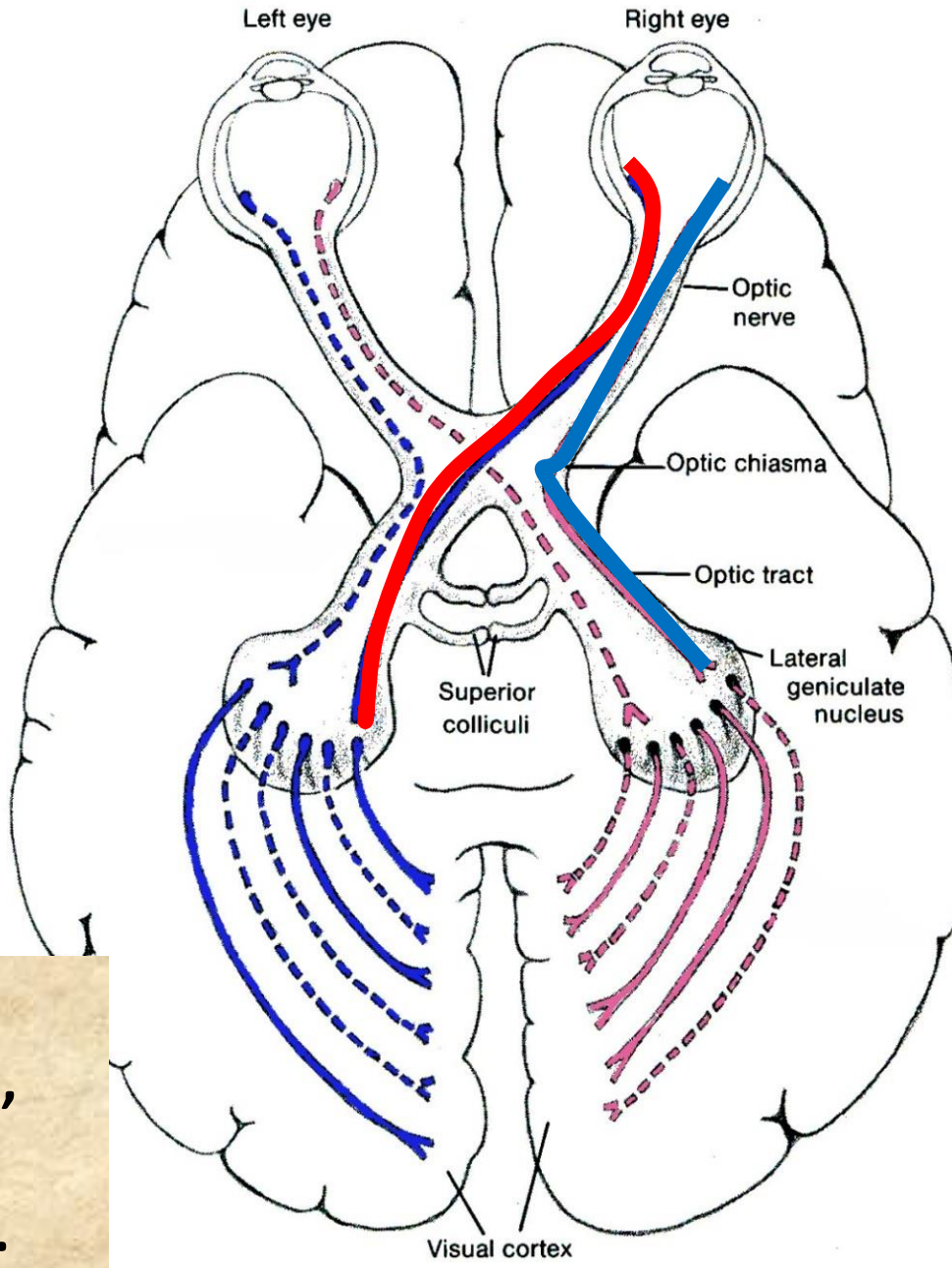
    Ganglion cells of retina. Their axons form the **optic nerve**
  - **3rd order neurons:**

    Neurons in the lateral geniculate body. Their axons terminate in **primary visual cortex.**



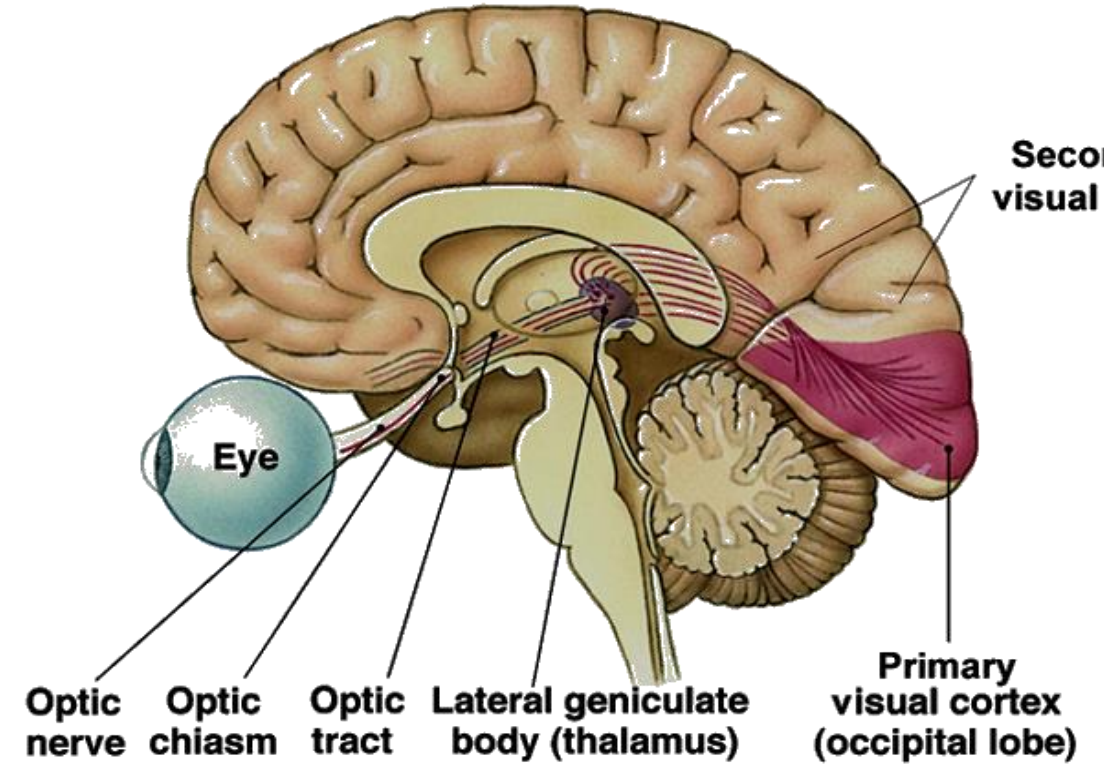
▪2nd order neuron:

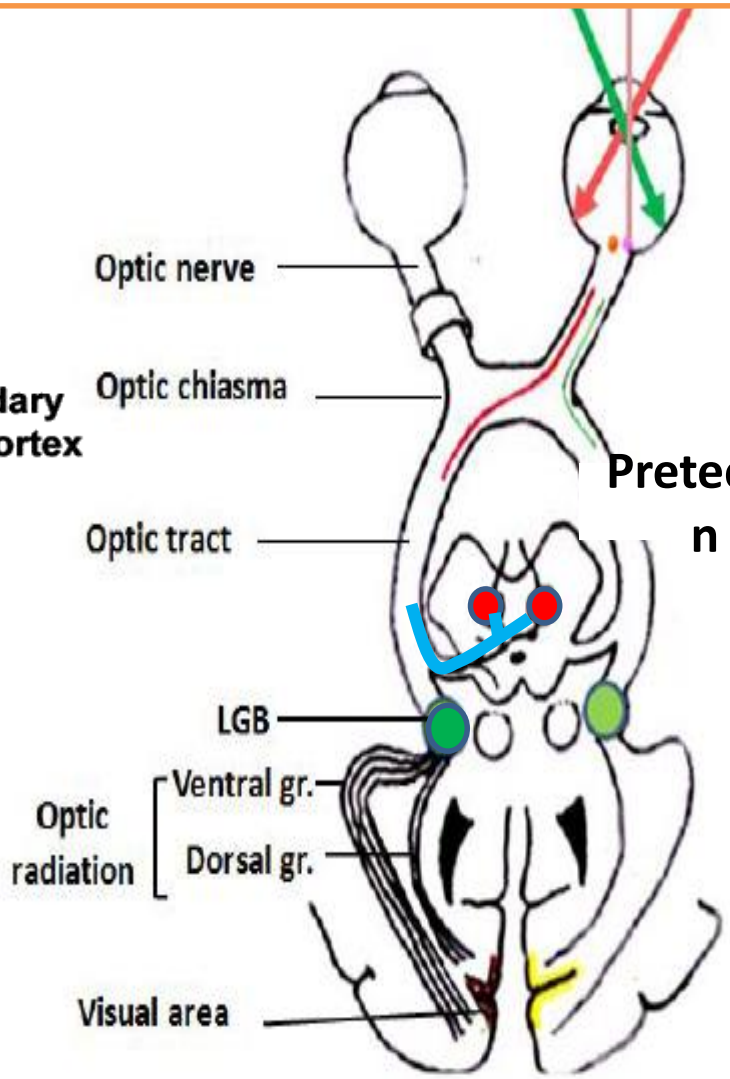
- Axons of ganglionic cells in the retina form the optic nerve fibers.
- The two optic nerves join together in the optic chiasma.
- In the optic chiasma, fibers from the nasal ½ of the retina decussate into the contralateral optic tract whereas the temporal fibers pass uncrossed to the ipsilateral optic tract. The macular fibers partially decussate in the chiasma and pass into the optic tracts of both sides.



Accordingly, the optic tract carries temporal fibers from the same side, nasal fibers from the opposite side and macular fibers from both sides.

The optic tract contains visual fibers that terminate in the LGB. Some fibers pass to the superior colliculus of midbrain and the pretectal nucleus (these fibers are concerned with light reflexes).





Pretecta
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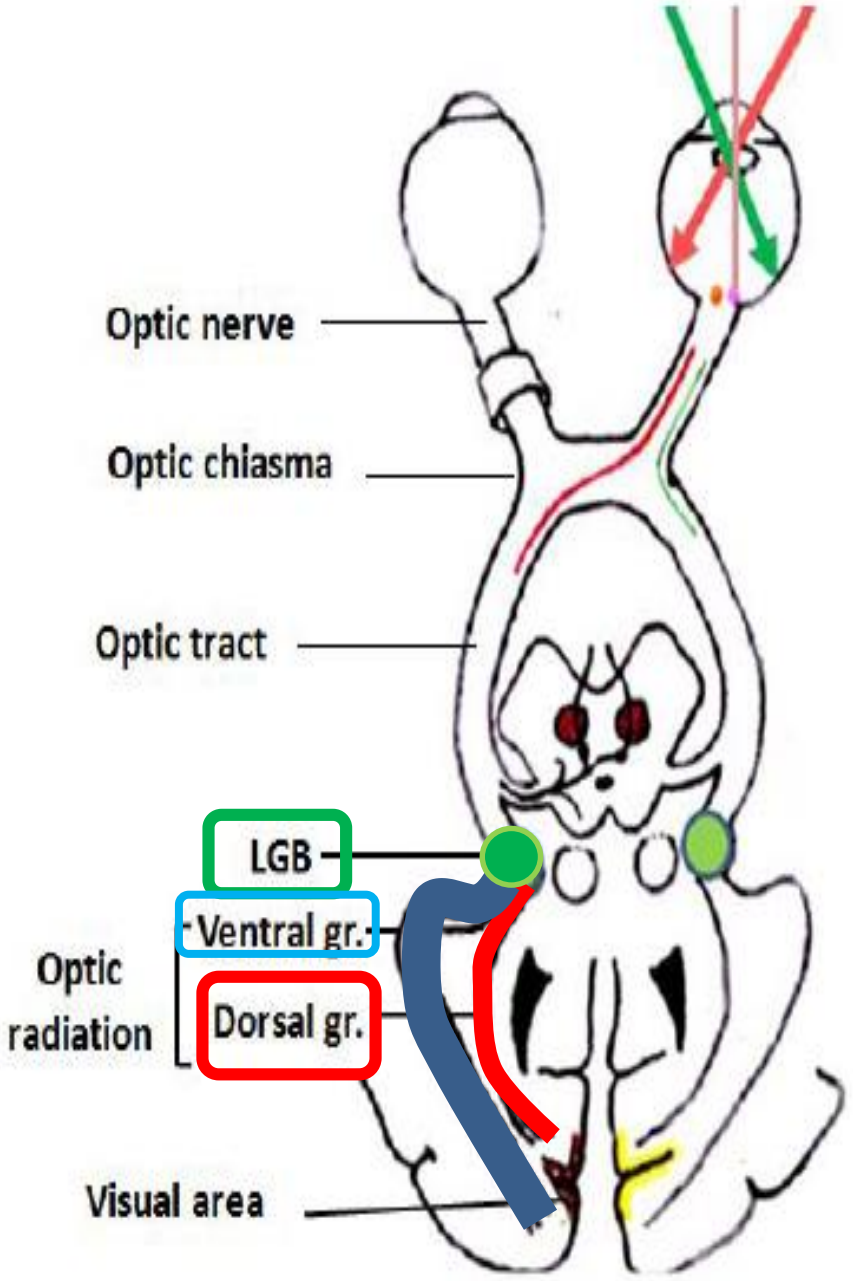
3rd order neuron:

- Is formed by neurons of the LGB. Their axons form the optic radiation which passes through the retrolentiform part of internal capsule, splitting into two groups:

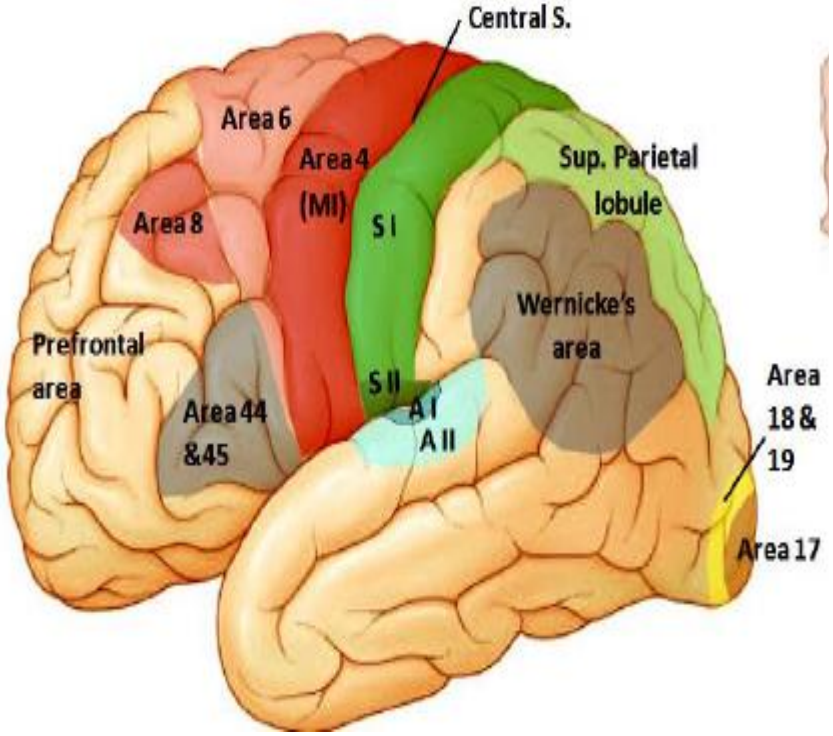
1. Dorsal group from the upper quadrant of retina
2. Ventral group from the lower quadrant of retina

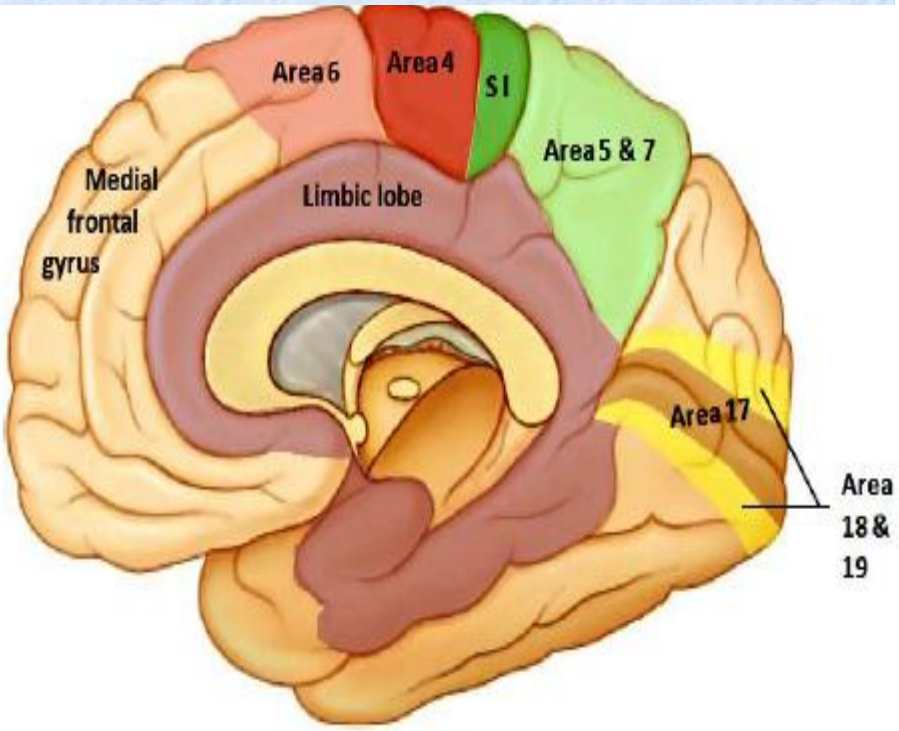
- Both groups join together in the occipital lobe to end in the cortical visual area.



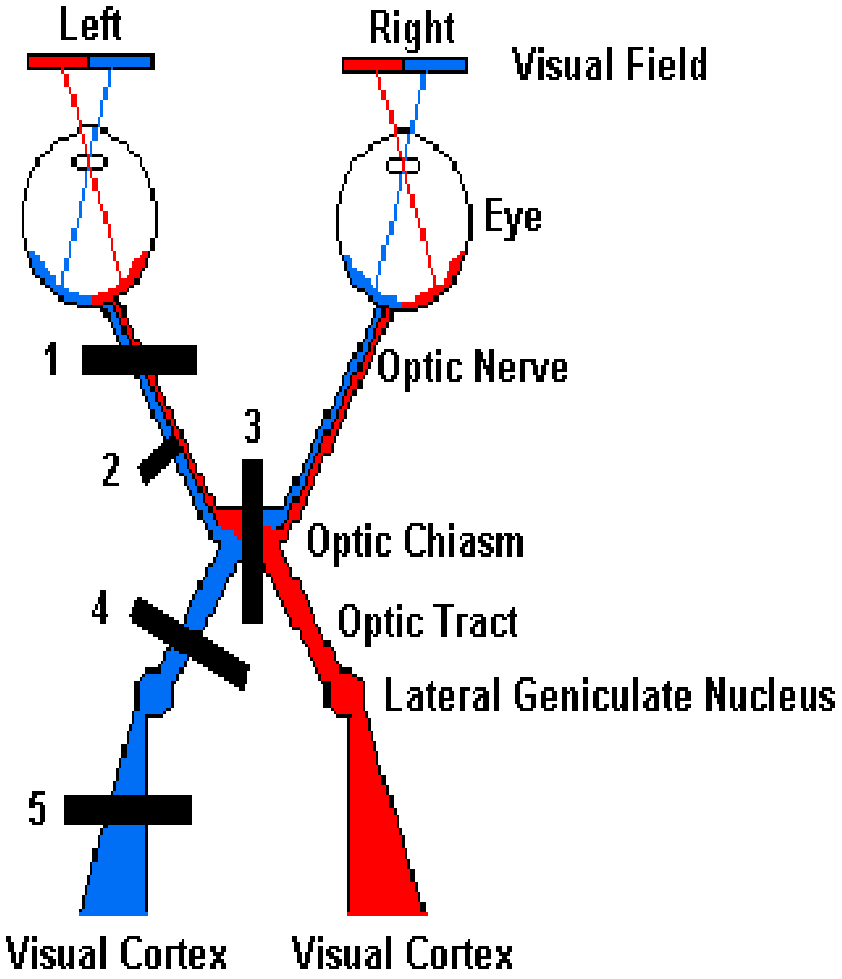
▪Visual cortex:

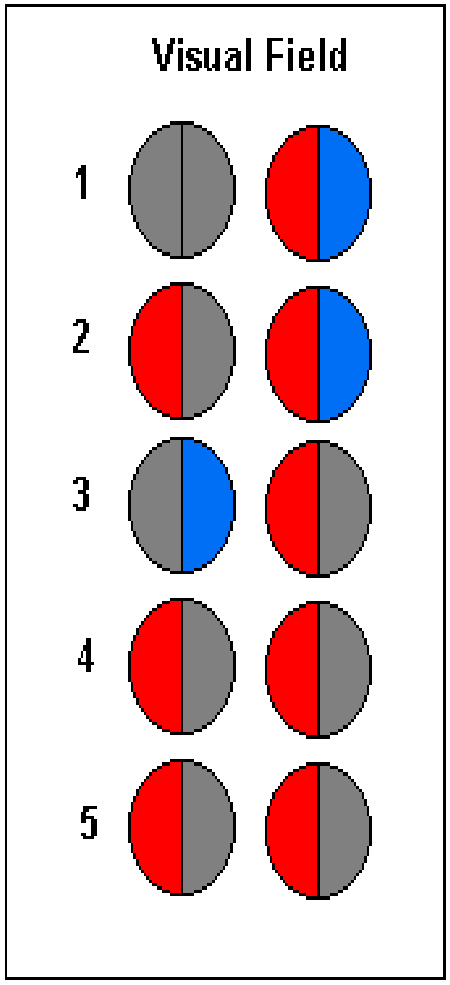
Lies in the occipital lobe, below precalcarine sulcus & on both sides of the postcalcarine sulcus, extending to the occipital pole. It is supplied by the posterior cerebral artery.





LESIONS of VISUAL PATHWAY





Lesions in the Optic Pathway

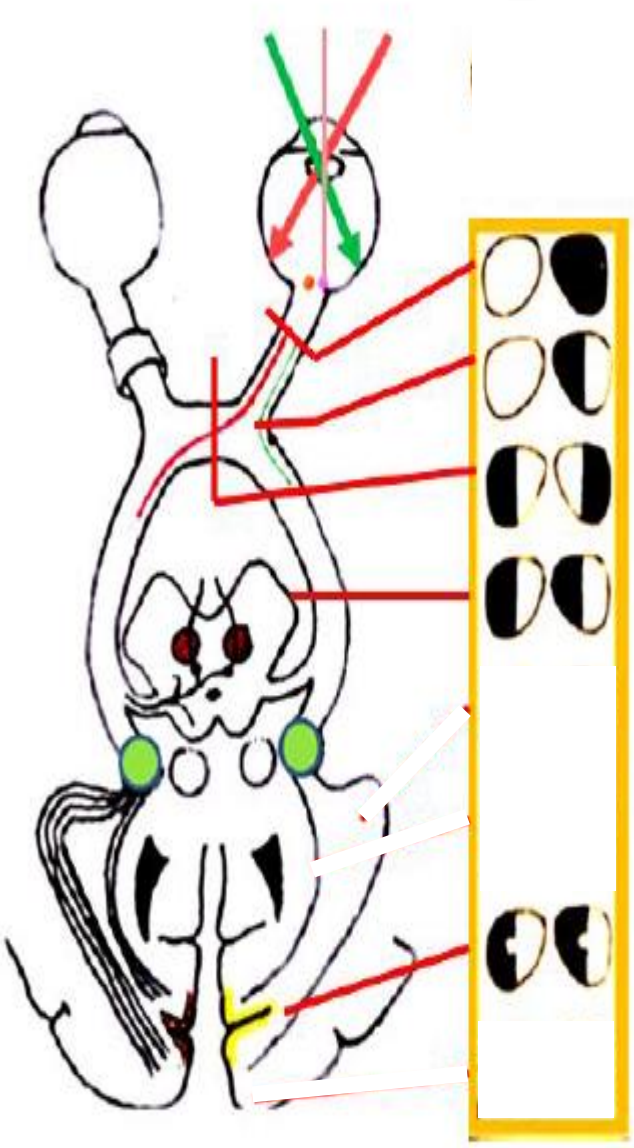
- **Optic nerve → ipsilateral total blindness**
- **Optic chiasma:**

1. Pressure on its lateral side (as in aneurysm of internal carotid artery) → ipsilateral nasal hemianopia

2. Pressure on its central part (as in pituitary tumors) → bitemporal hemianopia

- **Optic tract or optic radiation or visual cortex:**

Total lesion → contralateral homonymous hemianopia



Visual Reflexes

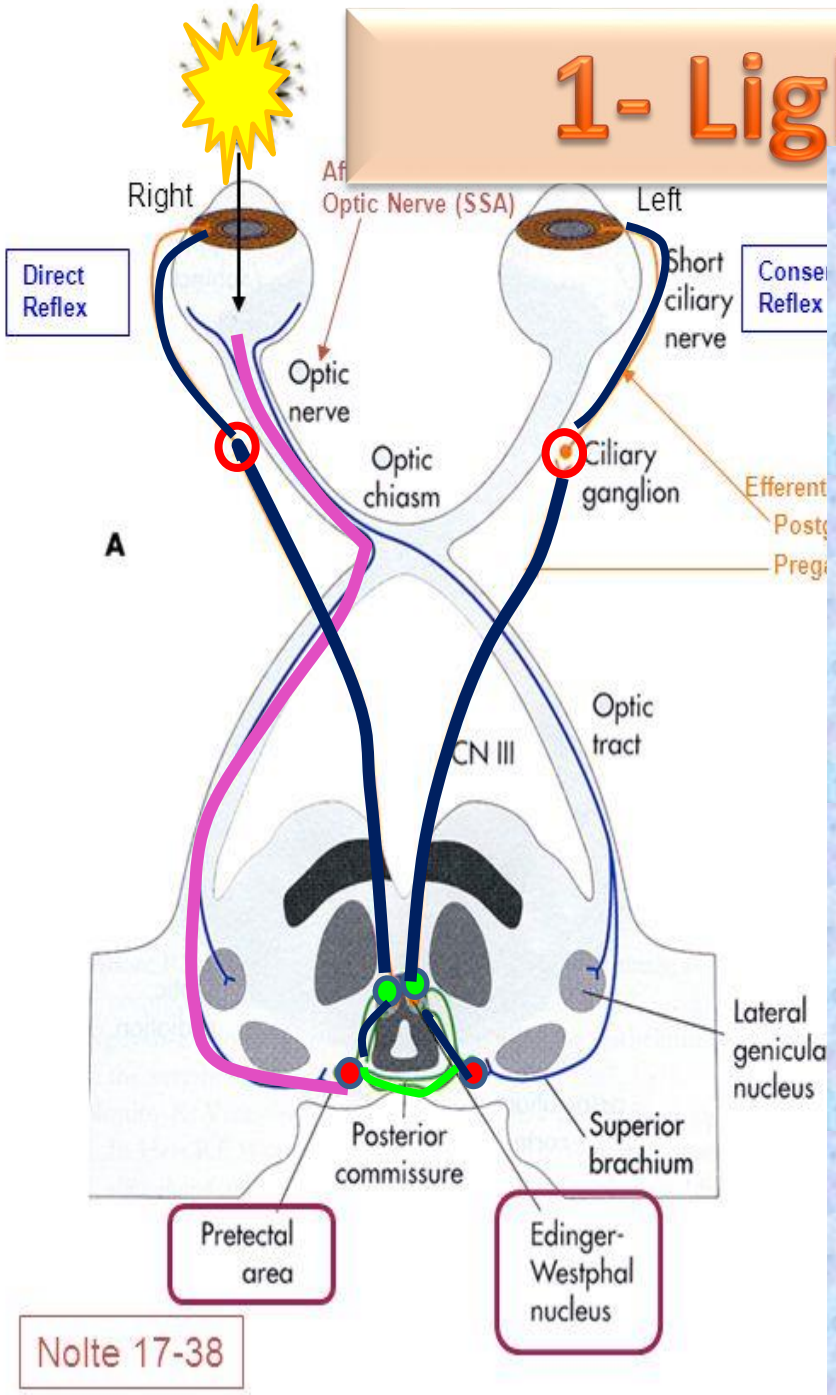
1) Light Reflex

- Light stimulation of one eye → constriction of ipsilateral pupil (direct light reflex) & contralateral pupil (indirect light reflex)

2) Accomodation Reflex

3) Corneal Reflex

1- Light Reflex



Pathway: Impulses from retina pass through optic nerve ➔ optic chiasma ➔ optic tract ➔pretectal nuclei of both ipsilateral side (for direct reflex) and contralateral side for indirect reflex. Axons of neurons of pretectal nuclei ➔Edinger Westphal nucleus of oculomotor n ➔ its inferior division ➔nerve to inferior oblique ➔relay in ciliary ganglion ➔ short ciliary nerves to sphincter pupillae muscle.

2- Accomodation Reflex:

Looking at near objects leads to:

1) Convergence of both eyes (medial recti)

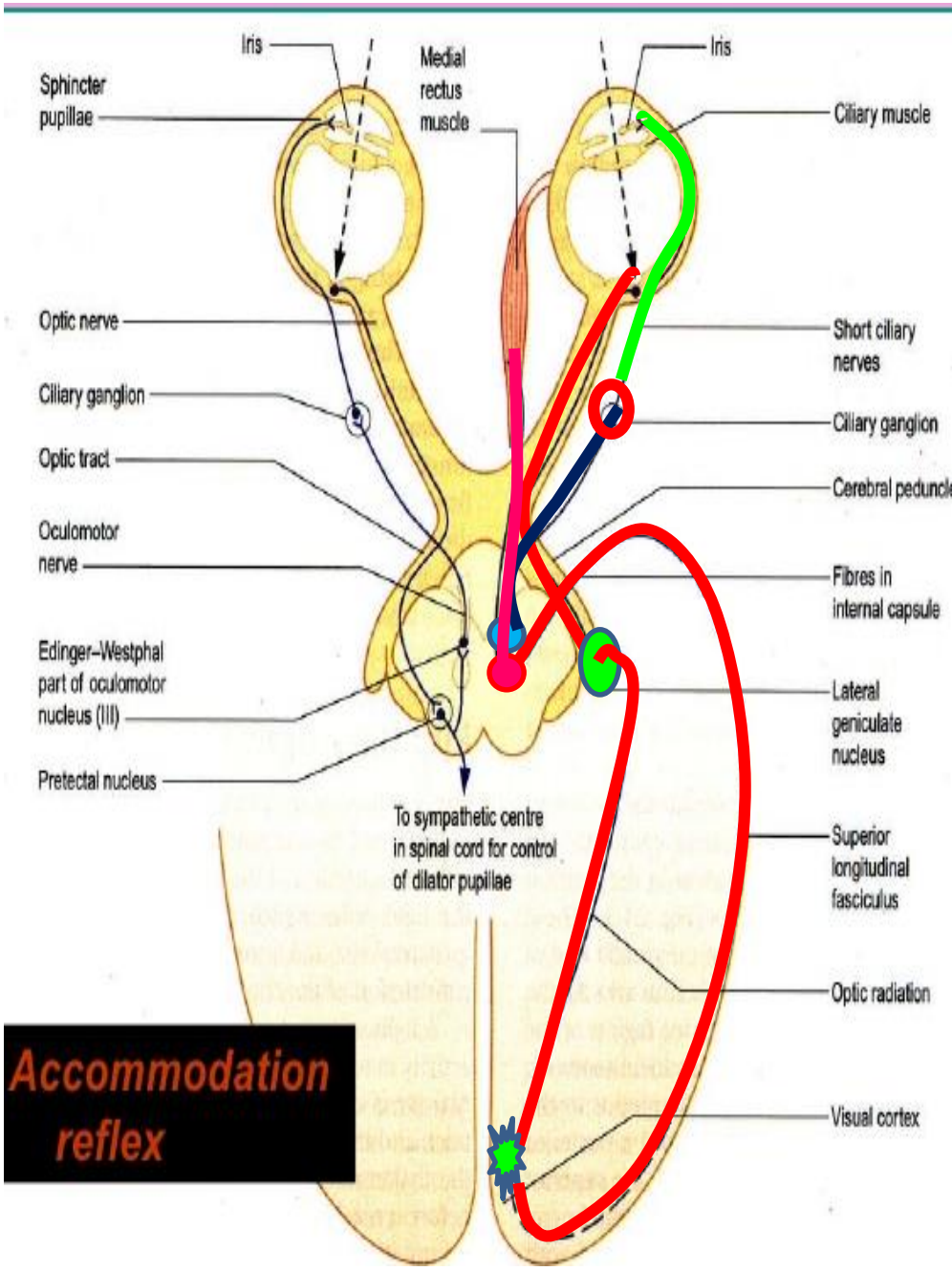
2) Lens becomes more convex (ciliary muscle)

3) Pupillary constriction (sphincter pupillae muscles)

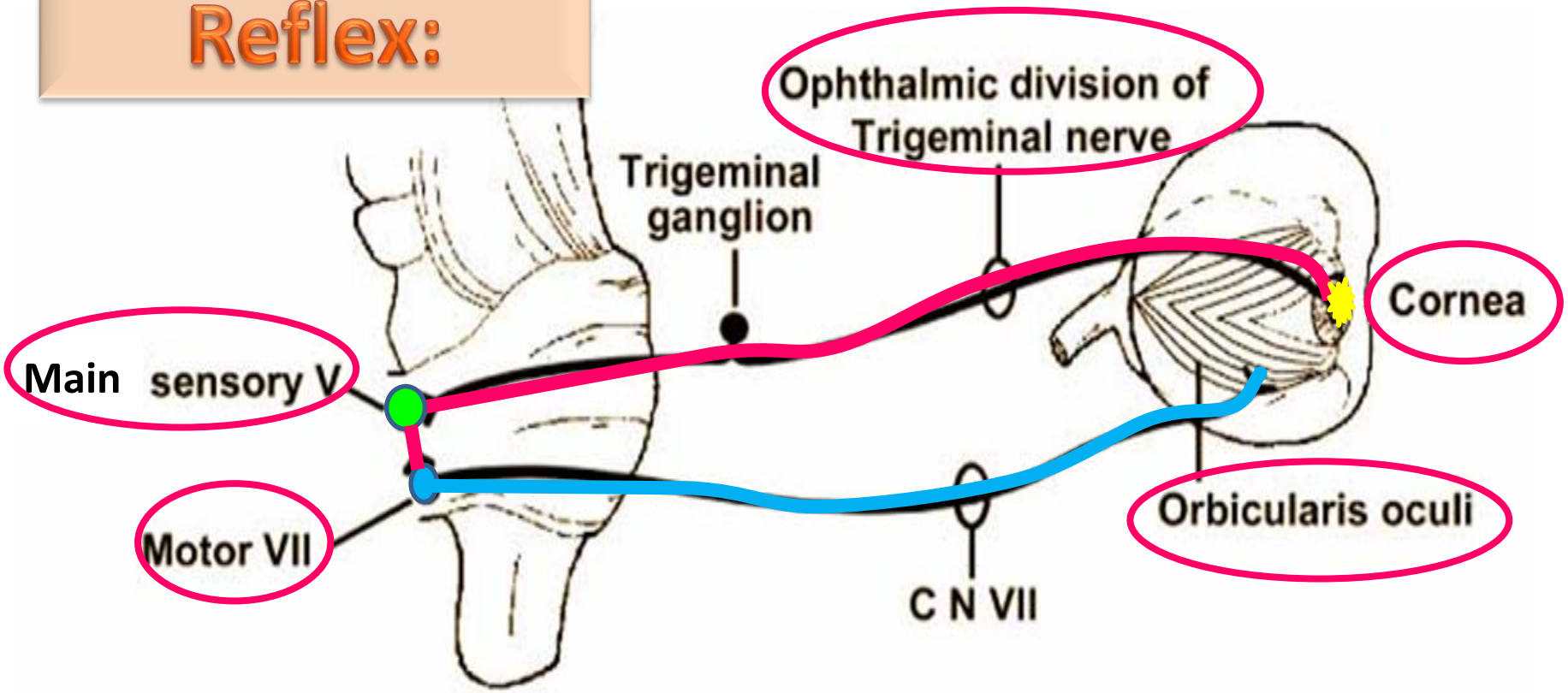
Pathway: Impulses from retina→ optic nerve→ optic chiasma→ optic tract → LGB → optic radiation → visual area in the occipital lobe → frontal eye field in the frontal lobe → oculomotor nuclei:

*Edinger Westphal nucleus → sphincter pupillae and ciliary muscles.

*Motor Nucleus of III → medial recti.



3) Corneal Reflex:



- Light touch of cornea as by a delicate piece of cotton results in blinking of eyelids.

- Pathway: along ophthalmic n → main sensory n of V → motor n of facial n on both sides → orbicularis oculi → closure of eyelids.

Auditory pathway

1st order neuron:

bipolar Cells of the spiral ganglion

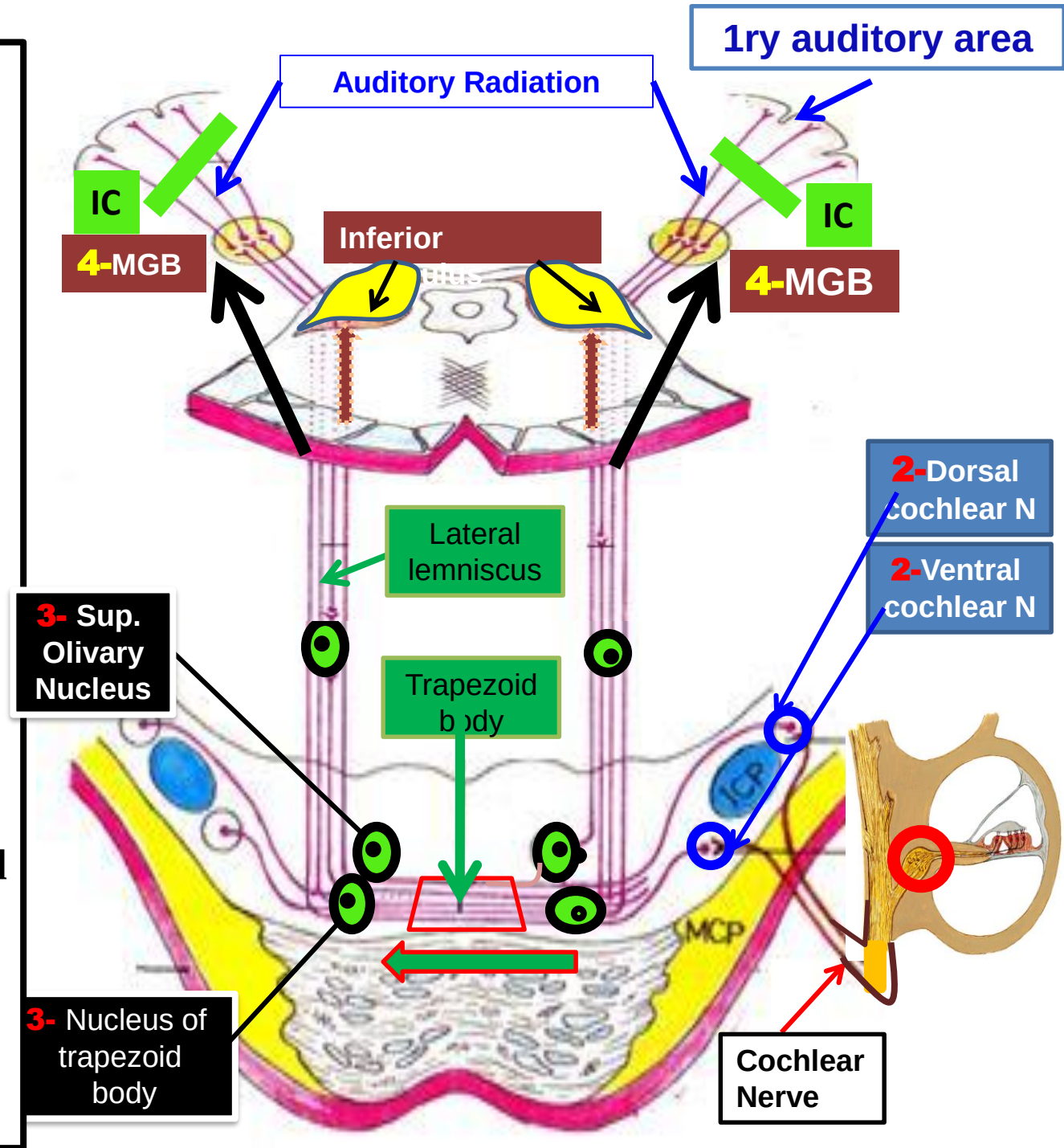
2nd order neuron:

neurons of the dorsal & ventral cochlear Nuclei.

3rd order neuron:

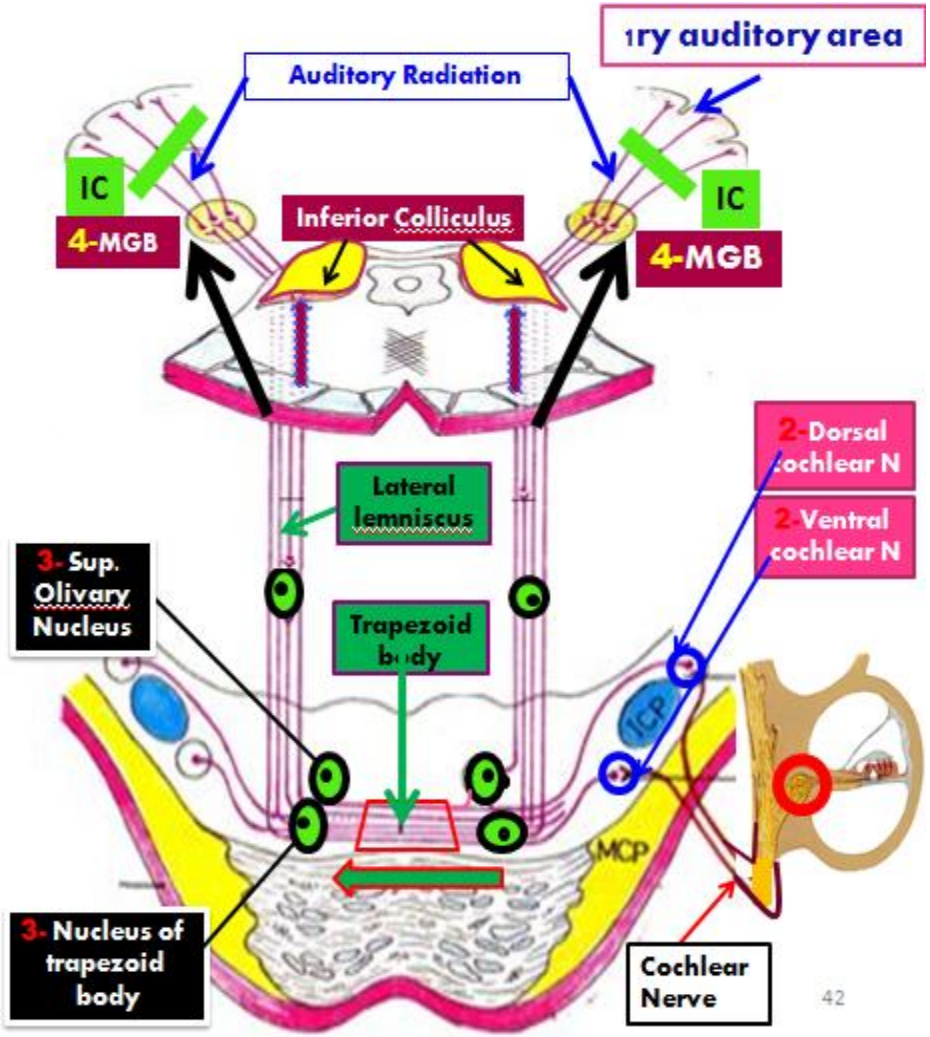
neurons of Superior olivary nucleus Or nucleus of trapezoid body.

4th order neuron: Cells of MGB



Lesions of the auditory pathway

- **Lesion in the cochlea, cochlear nerve or cochlear nuclei: complete ipsilateral deafness.**
- **Lesion in the lateral lemniscus, MGB or auditory area: bilateral partial deafness mainly on the opposite side.**



79-year-old man is brought to a family practice office by his wife because he "keeps running into things" on his right side. His wife also reports that he seems

to ignore objects on his right. Testing his vision in each eye his physician determines that the patient cannot see anything in the right visual field of either eye. The physician orders a head MRI because he suspects which one of the following?

a. A pituitary tumor compressing his optic chiasm

b. A tumor in the medial wall of the right orbit compressing the optic nerve

c. An aneurysm of the left middle cerebral artery compressing the left optic tract

d. A tumor in the middle cranial fossa compressing the right optic tract

e. An aneurysm in the arterial supply to the visual cortex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Thank you!