



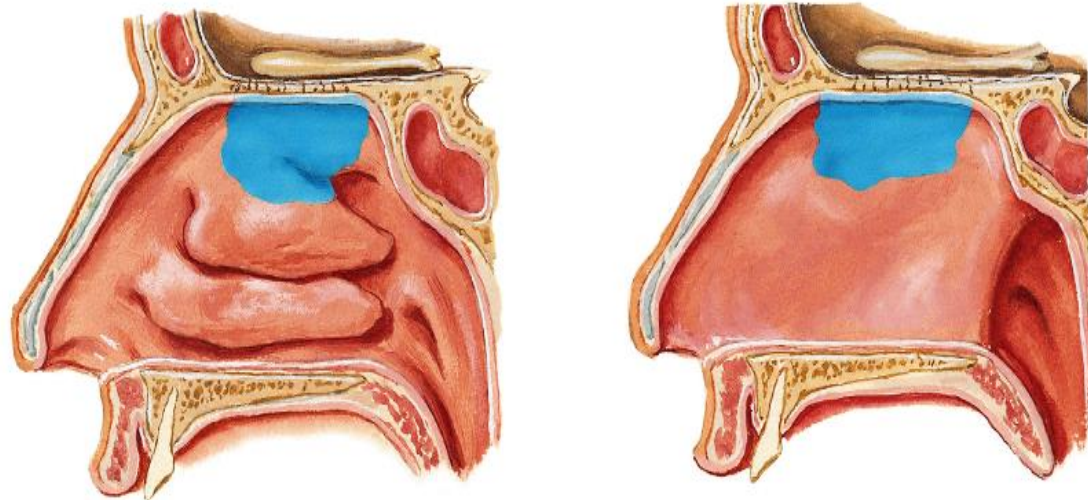
Central Nervous System

Lecture 15: Special Sensory Pathway

Dr. Ashraf Ramzy
Professor of Anatomy & Embryology
ash-ramzy@hotmail.com

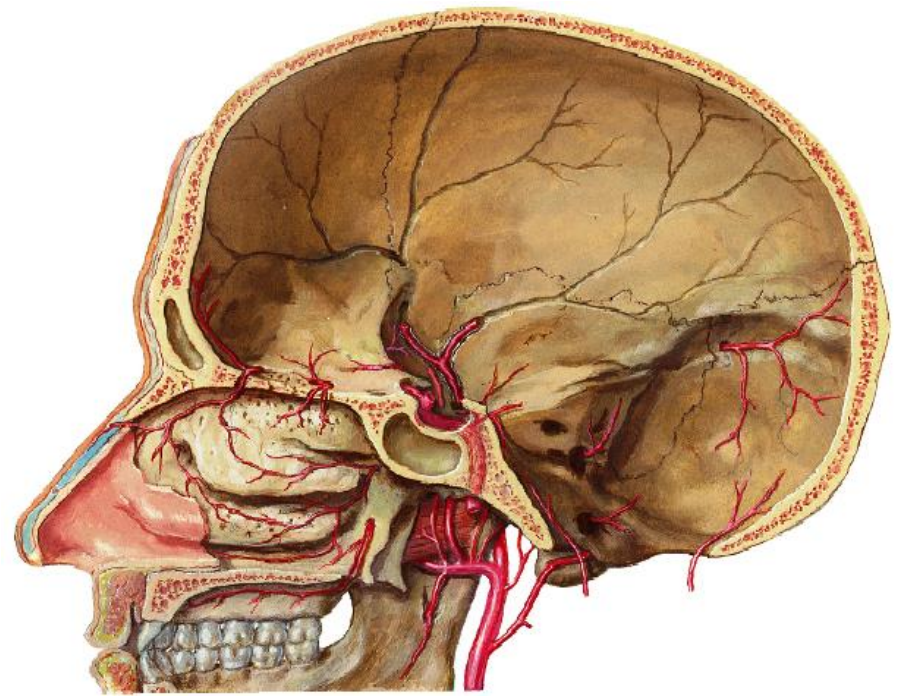
OLFACTORY PATHWAY

- ** **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.



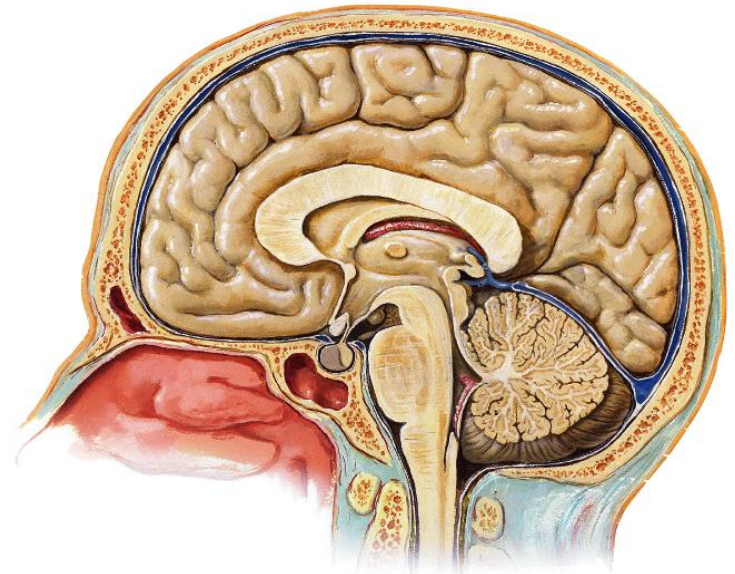
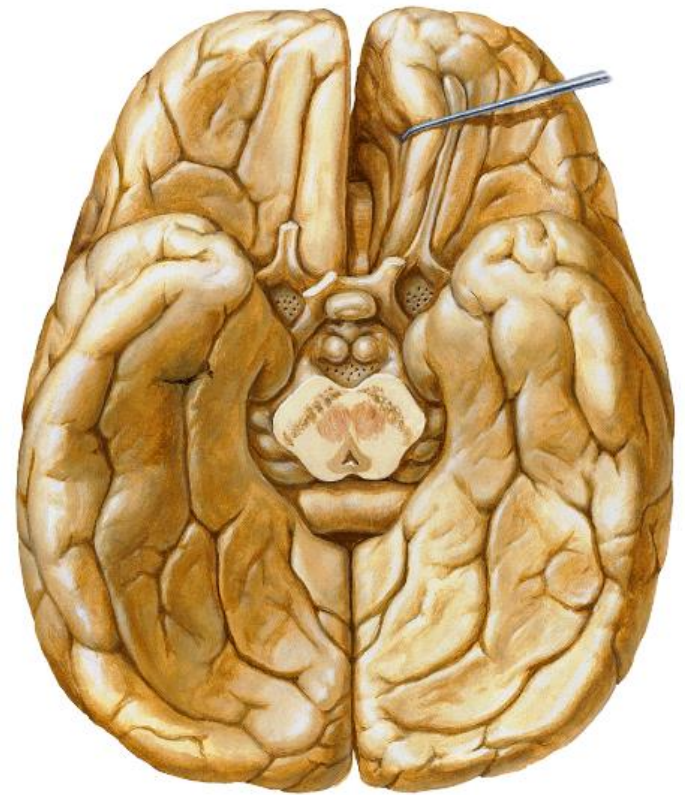
**** The olfactory nerve** is formed by the central processes of the bipolar neurons which collect into 20 filaments that traverse the cribriform plate of ethmoid bone to end in the olfactory bulb.

**** 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.

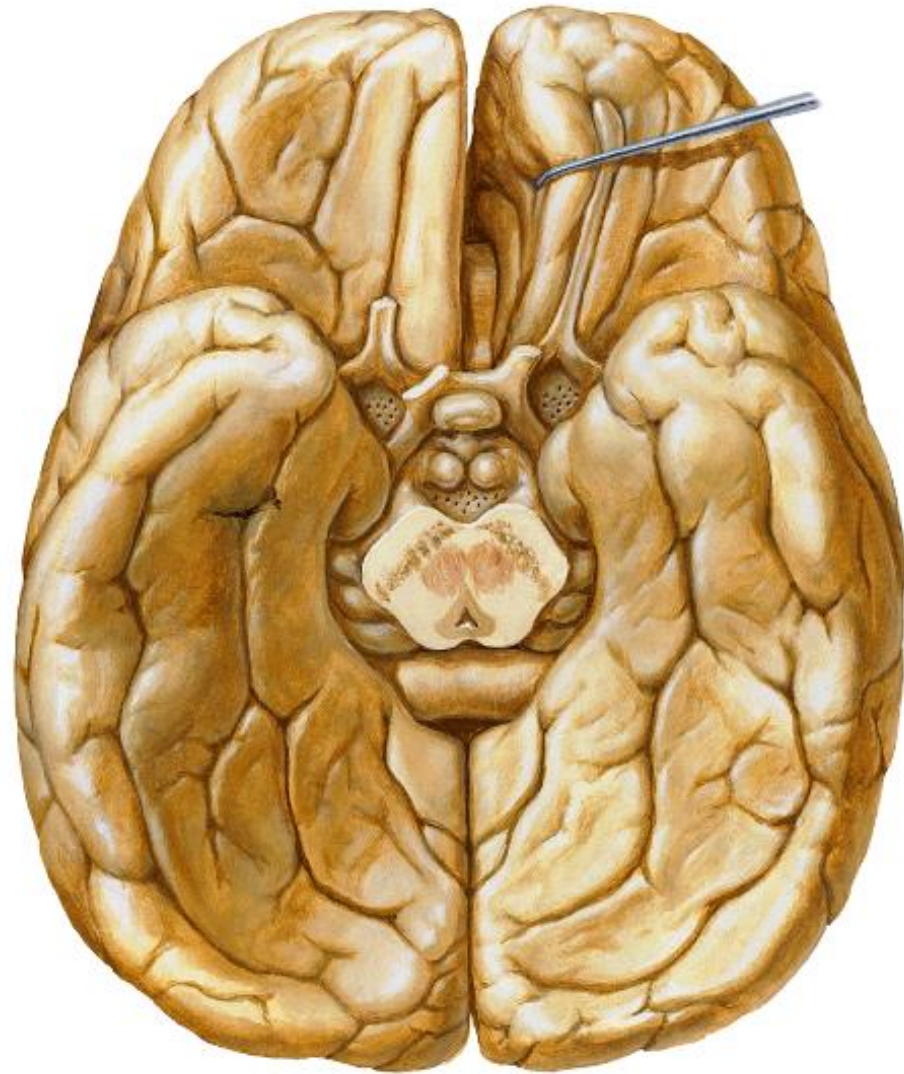


**** The olfactory tract** extends till the anterior perforated substance which is located lateral to the optic chiasma where it forms **3 olfactory stria** which terminate as follows:

- 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).**



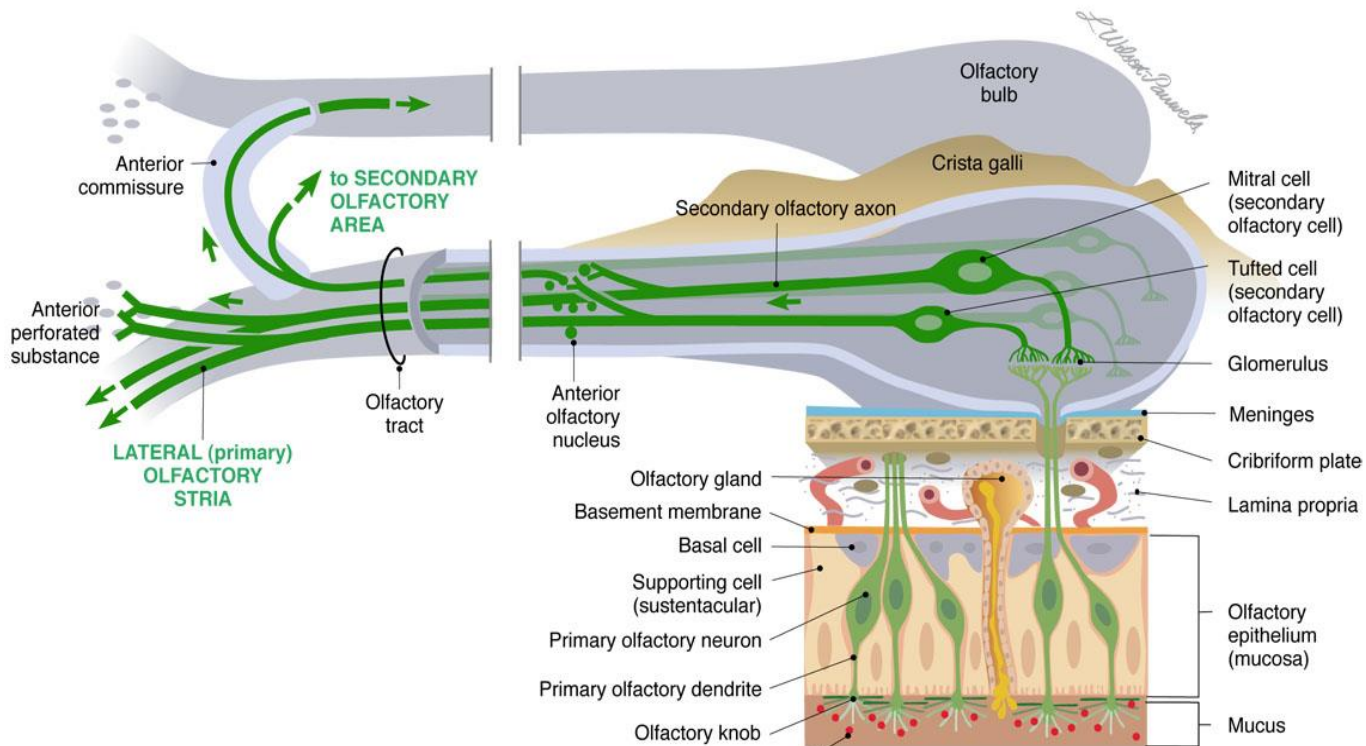
**** The olfactory pathway is linked to the limbic system.**

**** It is the only sensation that reaches the cortex without relaying in the thalamus.**

**** Applied anatomy: Anosmia (loss of smell) may be:**

1. Unilateral: due to frontal lobe tumor.

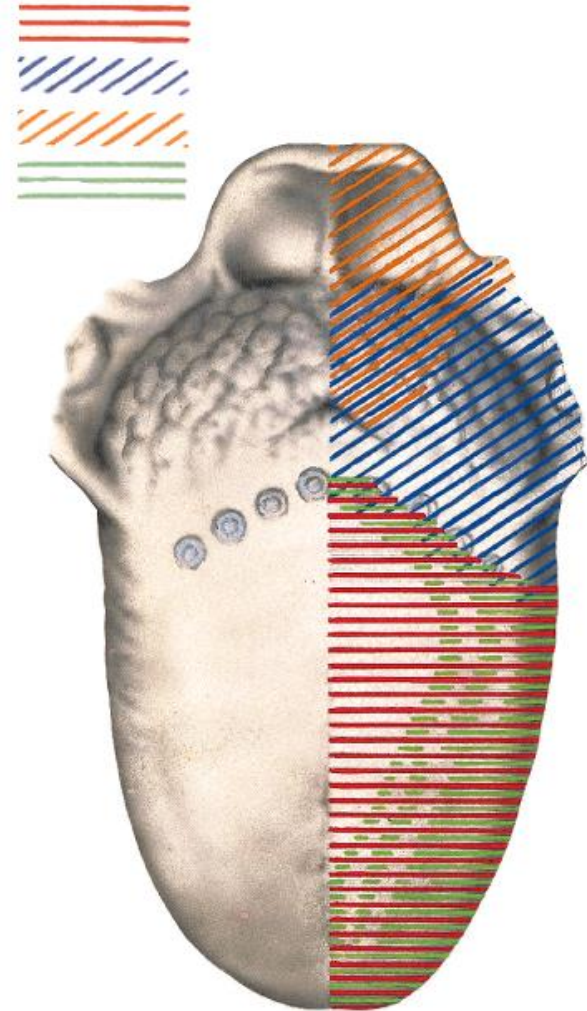
2. Bilateral: due to fracture of the cribriform plate of ethmoid.



TASTE PATHWAY

**** Taste receptors are present on the tongue, the epiglottis & the lingual surface of soft palate.**

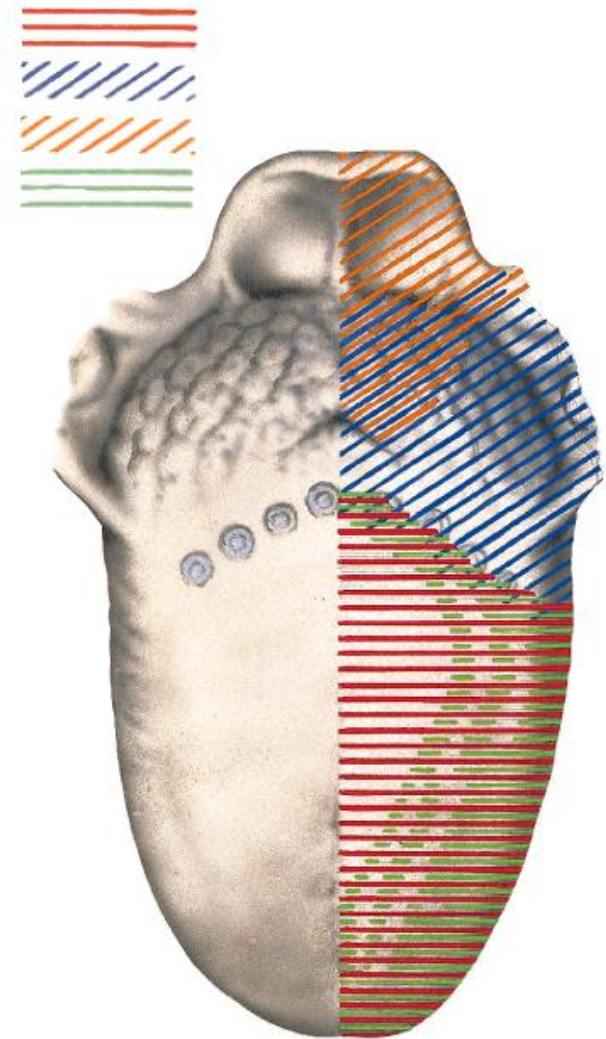
**** Taste sensation is carried by 3 cranial nerves: facial, glossopharyngeal & vagus.**



**** 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 N.: receiving taste from posterior 1/3 of tongue**
- 3. Inferior ganglion of vagus N.: receiving taste from most posterior part of tongue & epiglottis.**



**** Second Neuron:**

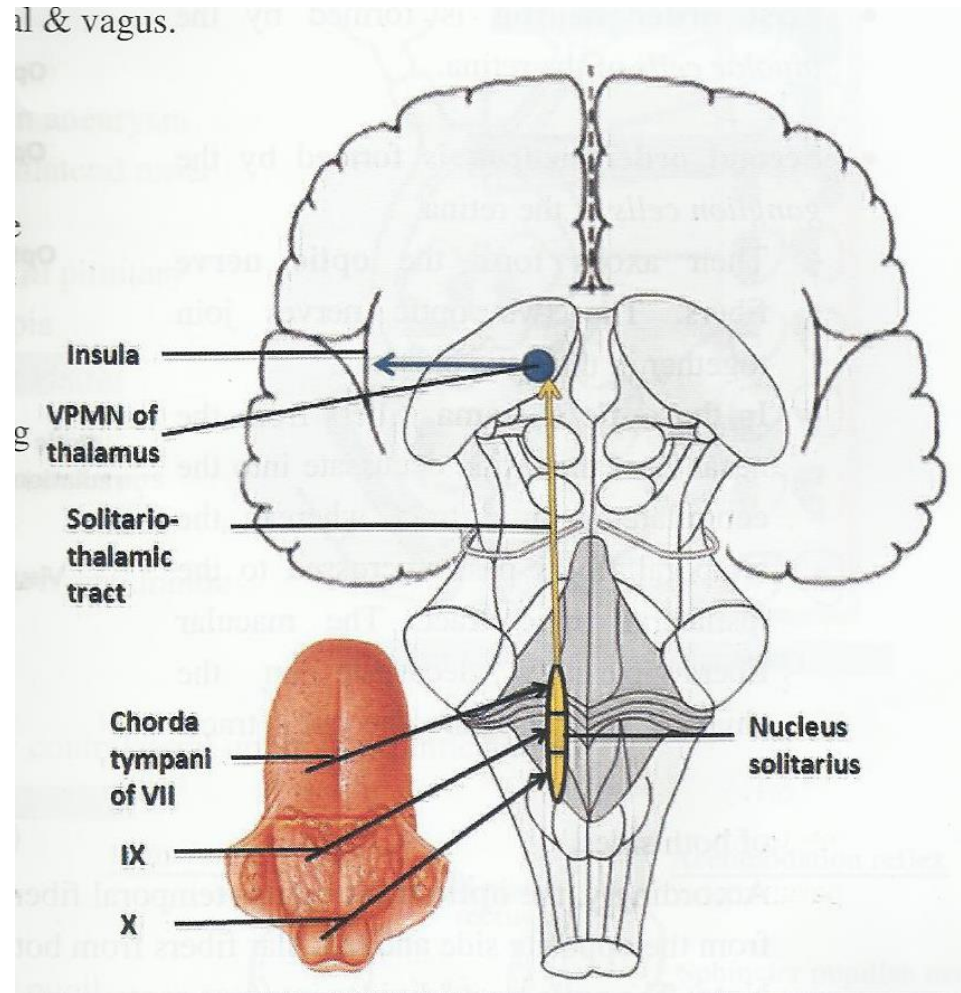
*** Neurons of nucleus solitarius:**

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

**** Third Neuron:**

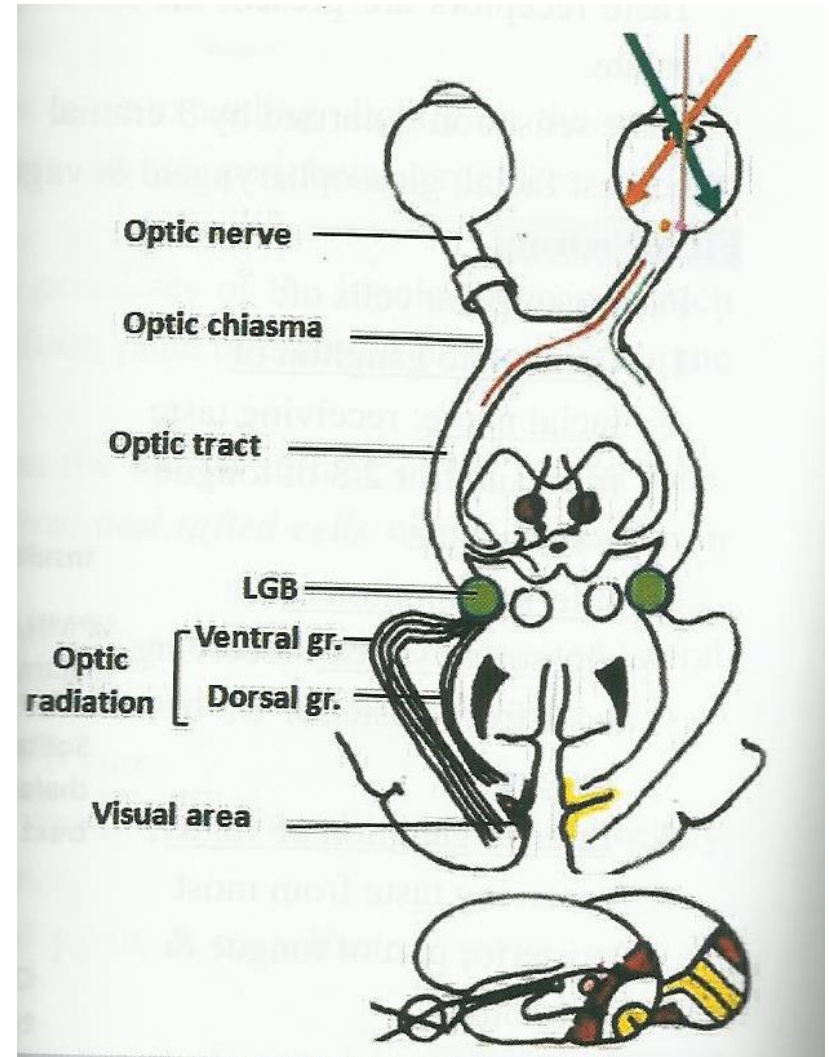
*** Neurons of VPMN of thalamus: whose axons project to the insula.**

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



VISUAL PATHWAY

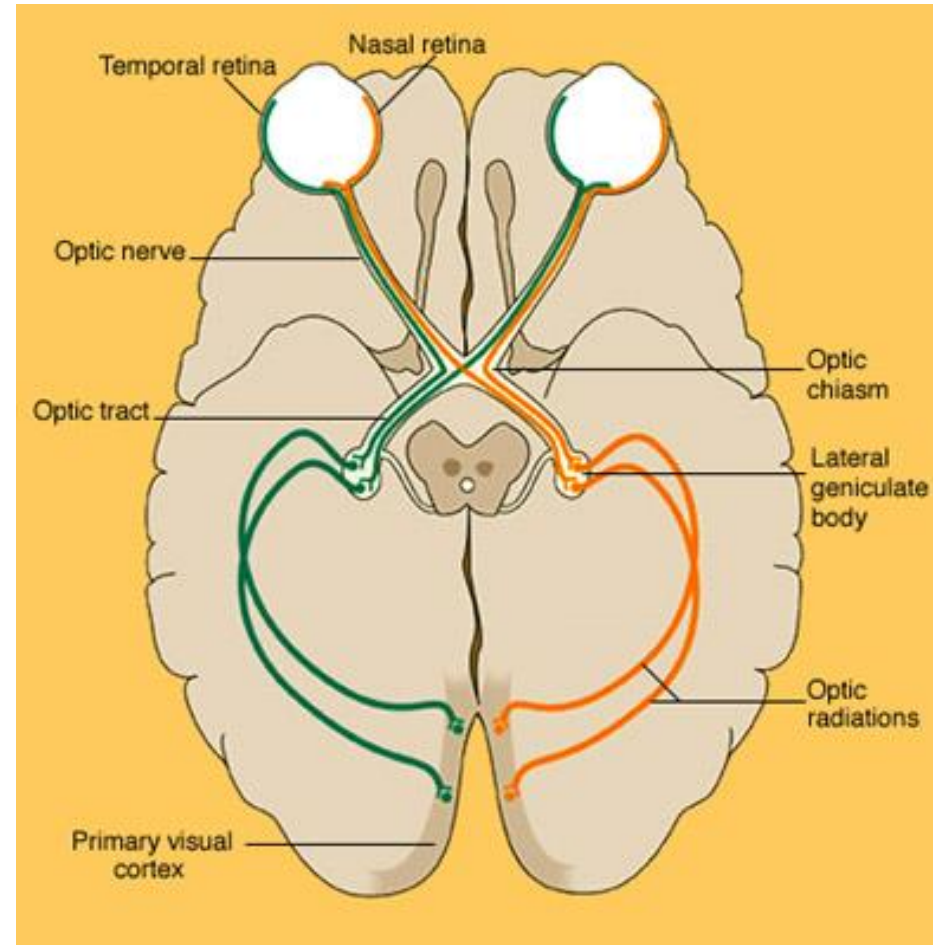
- ** Is formed of three successive neurons; two in the retina while the 3rd lies in the LGB.
- * First order neuron: is formed by the bipolar cells of the retina.



* **Second order neuron:** is formed by the ganglion cells of the retina: Their axons 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.

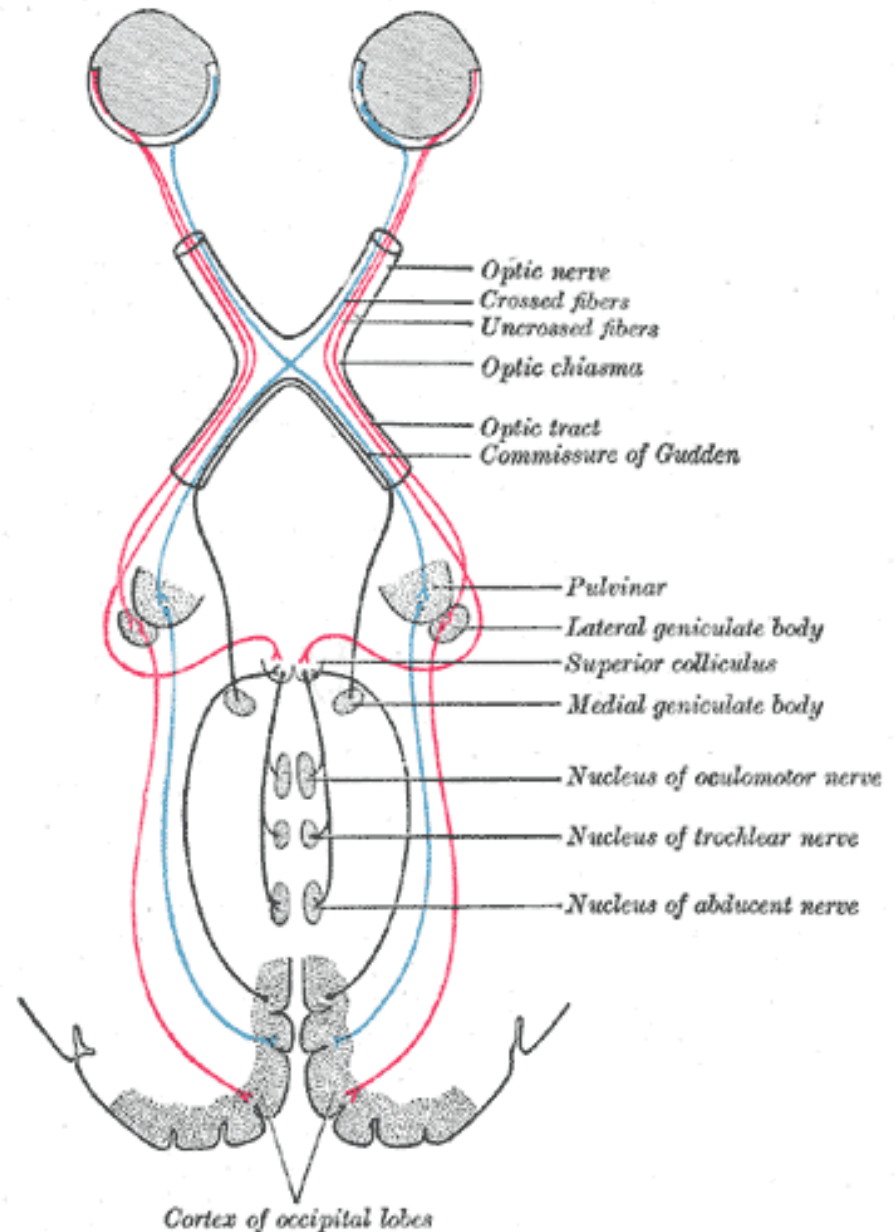
* **The macular fibers:** partially decussate in the chiasma and pass into the optic tracts of both sides.



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

*** Note: The optic tract "divides into two roots:**

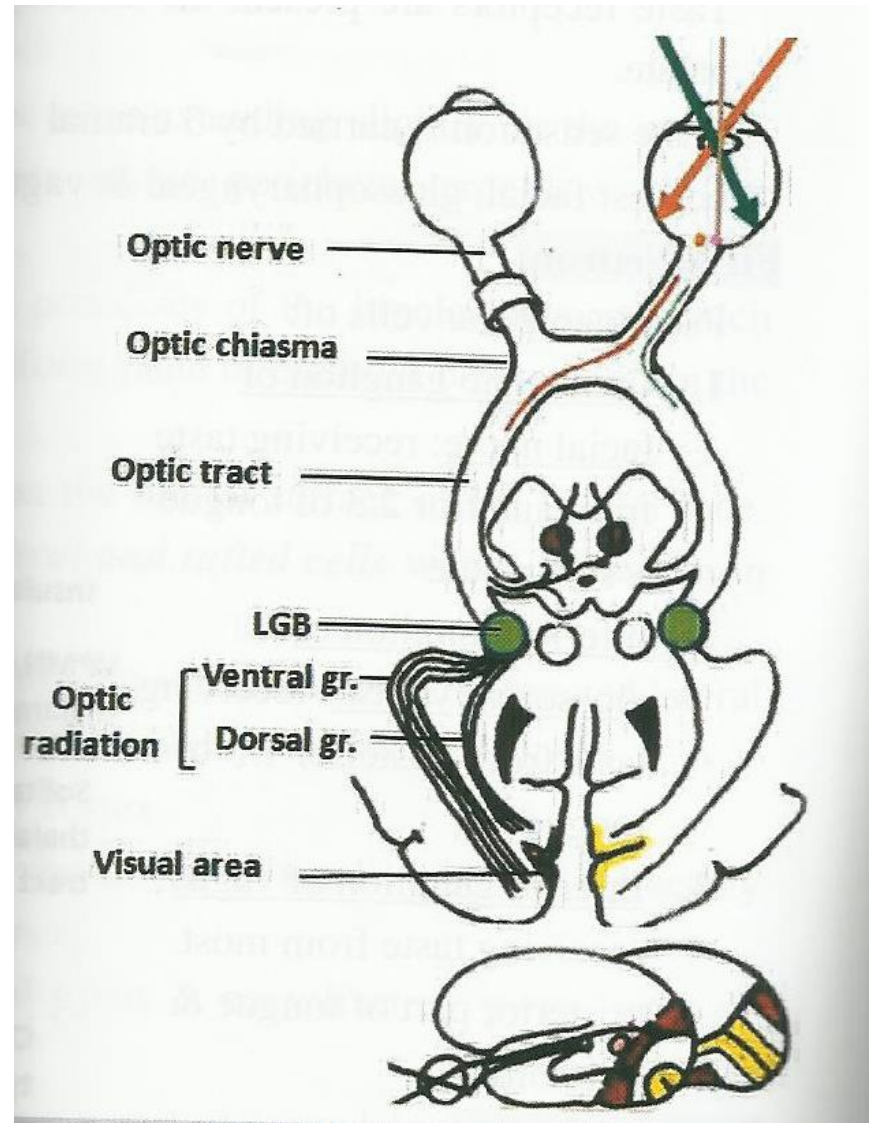
- 1. Medial root** → contains supraoptic commissural fibers (commissure of Gudden) which connect the two **medial geniculate bodies** together.
- 2. Lateral root** → contains visual fibers that terminate in the LGB. Some fibers of the lateral root pass to the **superior colliculus of midbrain and the pretectal nucleus**. These fibers are concerned with light reflexes.



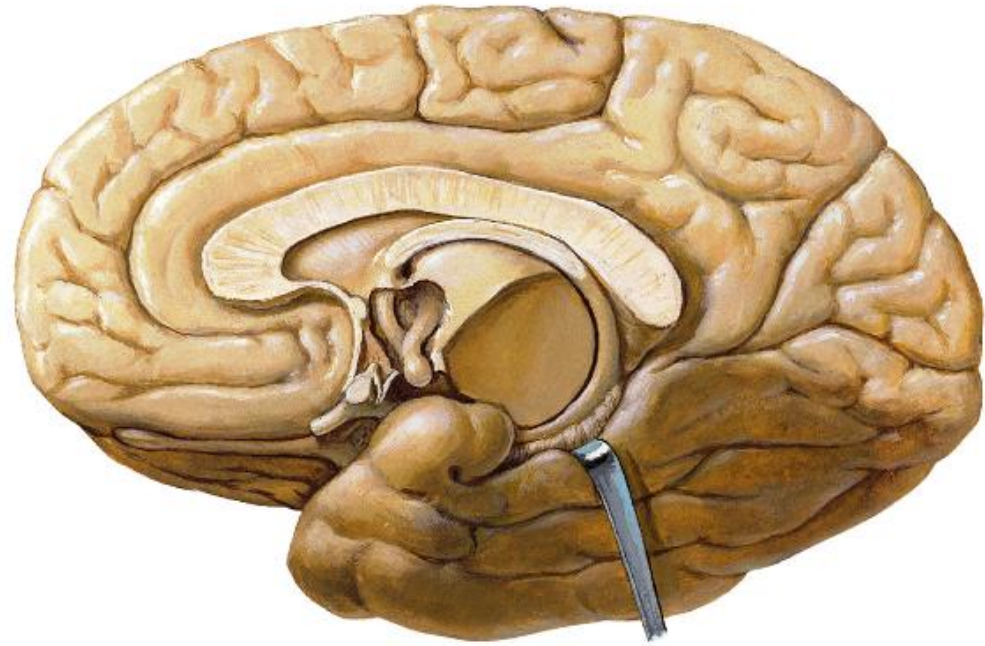
* **Third order neuron**: is formed by neurons of the LGB. Their axons form the optic radiation which passes through the retrolentiform part of internal capsule, splitting into two groups:

1. **Dorsal group** (from the upper quadrant of retina) → in the parietal lobe.
2. **Ventral group** (from the lower quadrant of retina) → make a loop in the temporal lobe (loop of Meyer).

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



- * **The visual area (area 17)** lies in the occipital lobe, below the precalcarine sulcus, and on both sides of the postcalcarine sulcus, extending to the occipital pole.
- * It is supplied by the posterior cerebral artery.



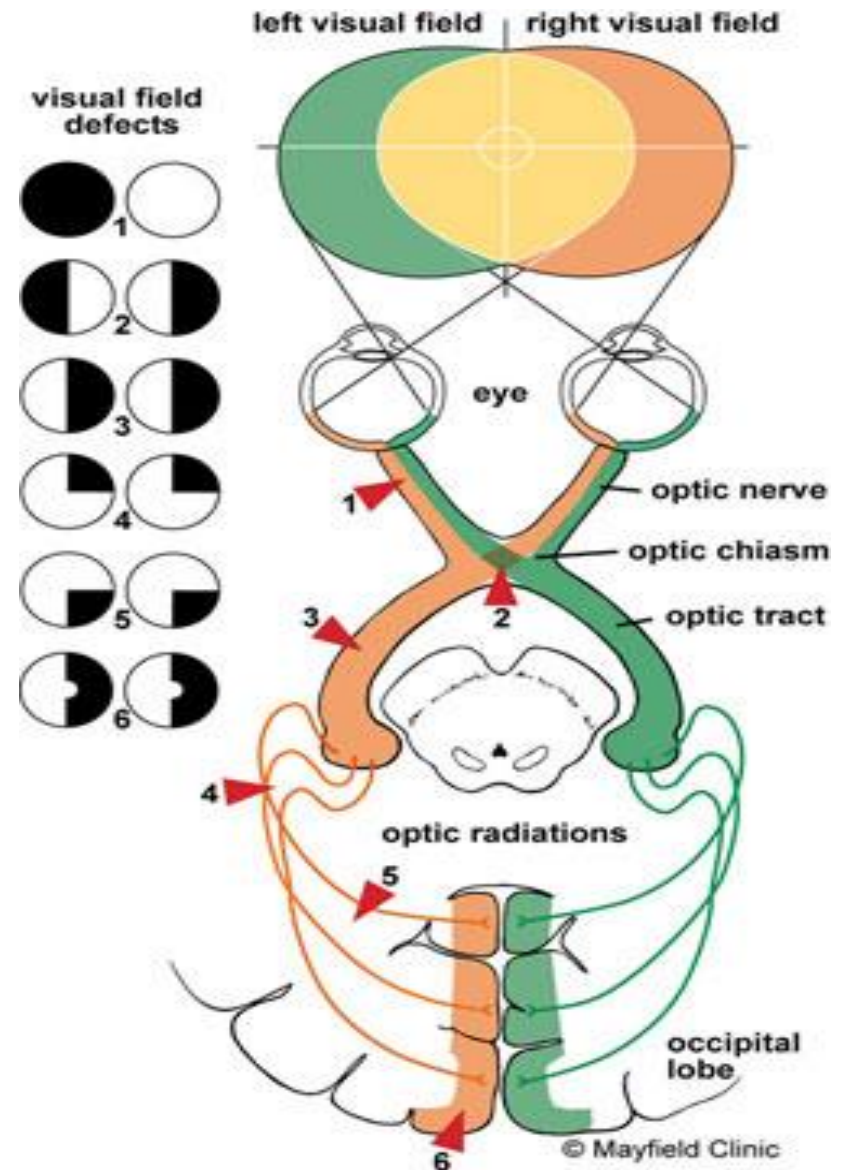
Lesions of Visual Pathway

** Optic nerve:

1. optic neuritis → circumferential blindness.
2. complete section of one optic nerve → ipsilateral total blindness.

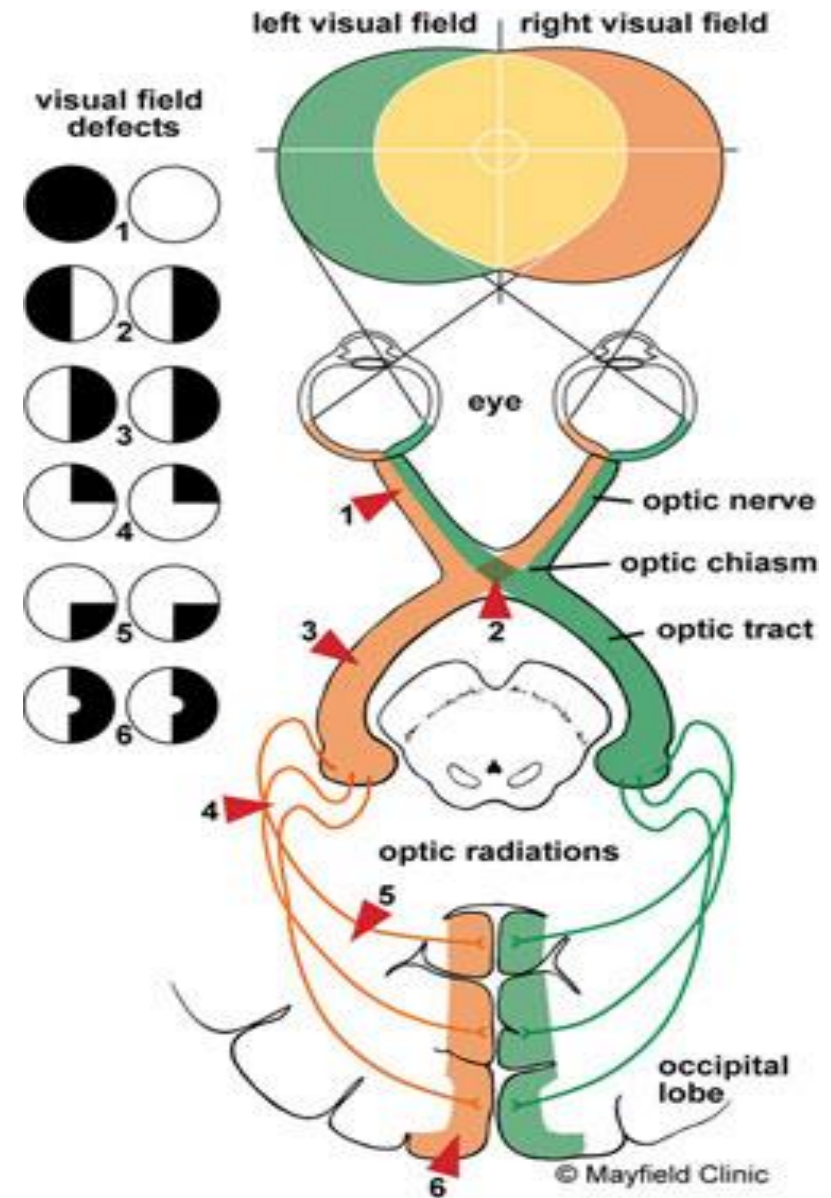
** Optic chiasma:

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:**

- 1. total lesion** →
contralateral
homonymous
hemianopia
- 2. upper lesion** →
contralateral lower
quadrantic anopia.
- 3. lower lesion (Meyer's loop)** →
contralateral
upper quadrantic anopia.



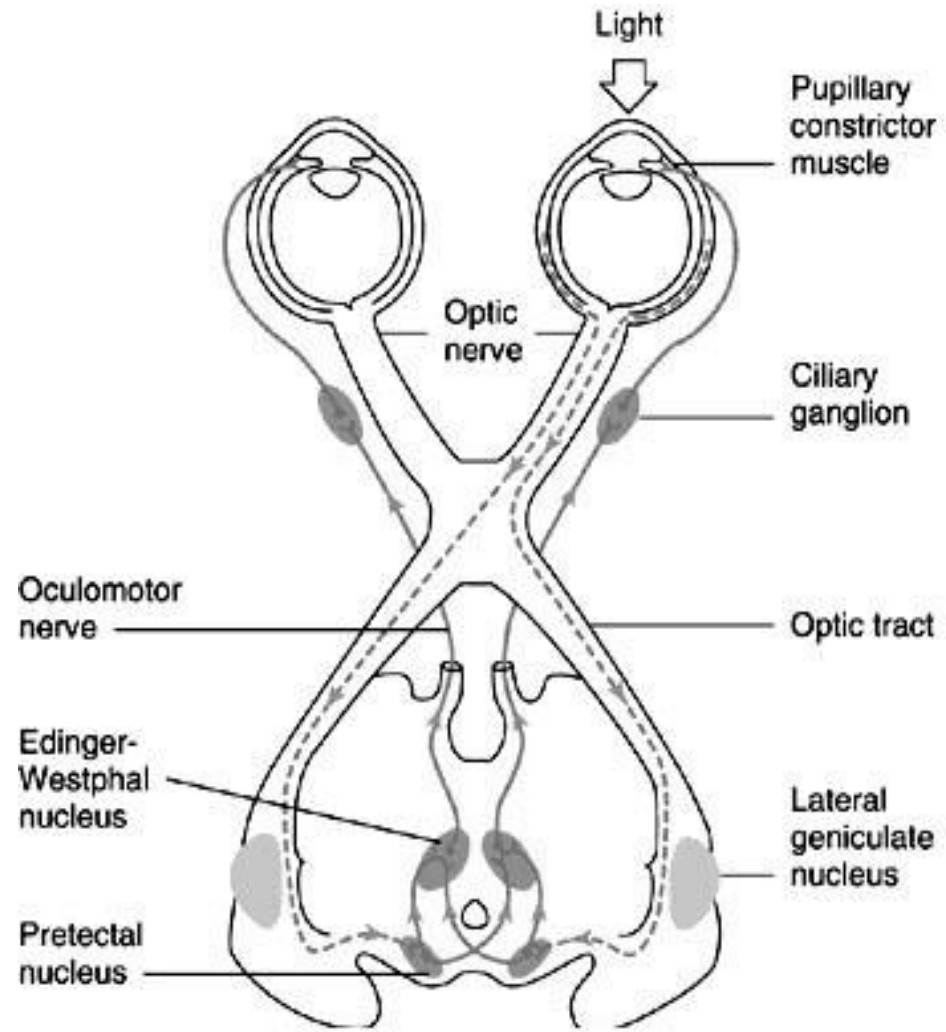
VISUAL REFLEXES

1. Light reflexes:

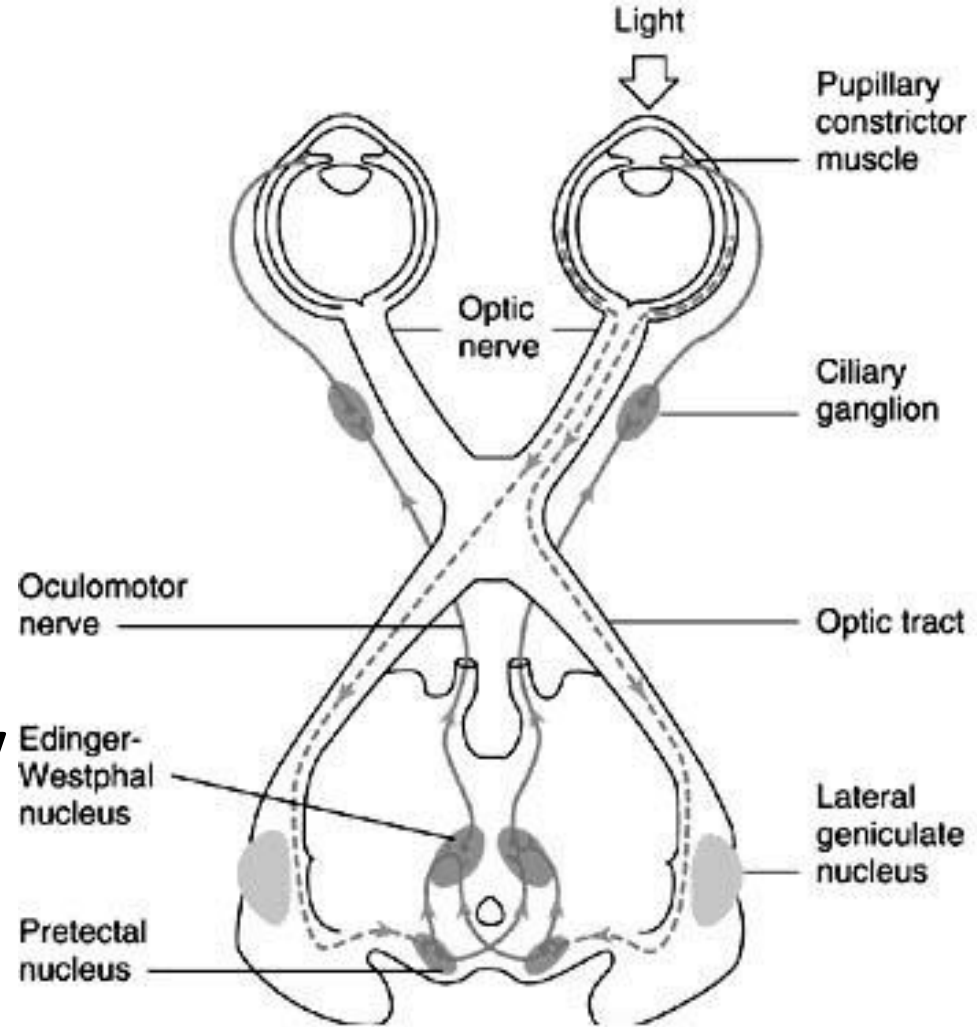
* Light stimulation of one eye

→ constriction of ipsilateral pupil (direct light reflex) and contralateral pupil (indirect or consensual light reflex).

* Pathway: Impulses from the retina pass through the optic nerve → optic chiasma → optic tract → lateral root of optic tract → pretectal nuclei of both sides; ipsilateral side (for direct reflex) and contralateral side (passing through the posterior commissure) for the indirect reflex.



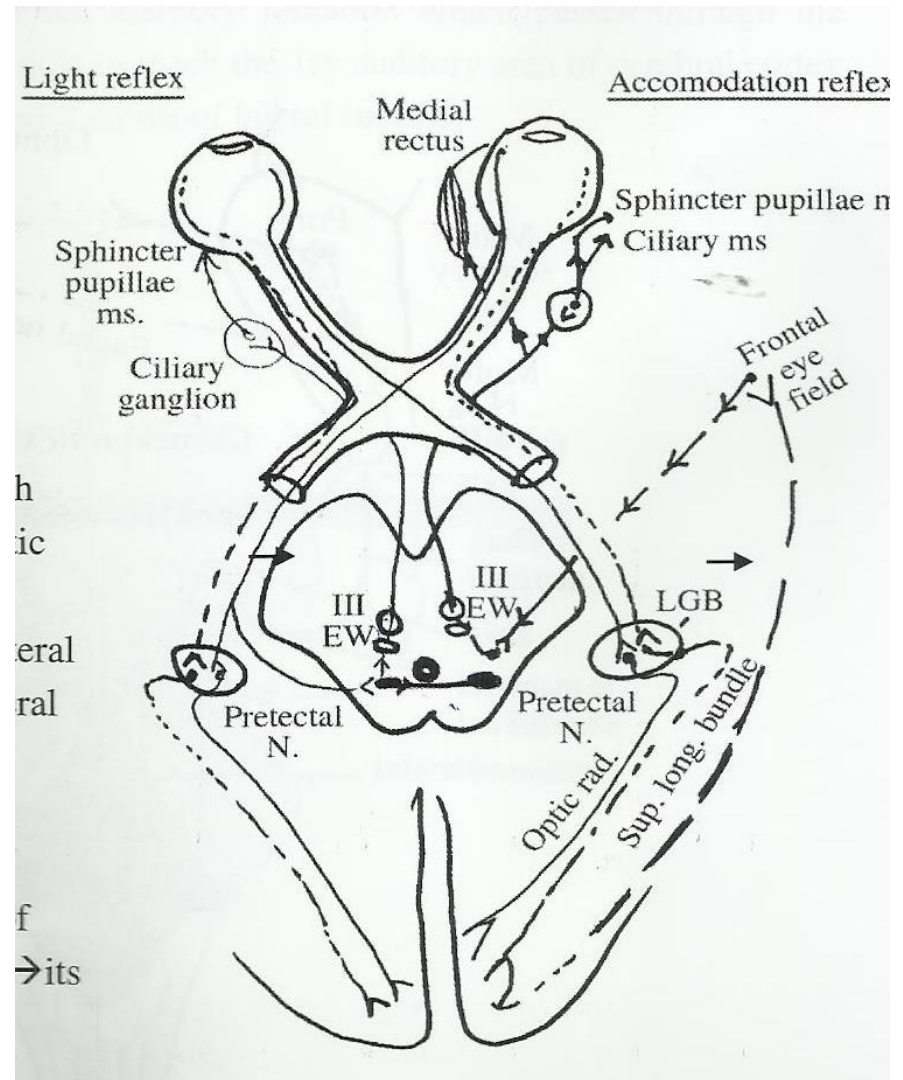
*** Axons of the neurons of pretectal nuclei → Edinger Westphal nucleus of oculomotor nerve → its inferior division → nerve to inferior oblique → relay in ciliary ganglion → postganglionic fibers pass through short ciliary nerves to supply sphincter pupillae muscle.**



2. Accommodation reflex:

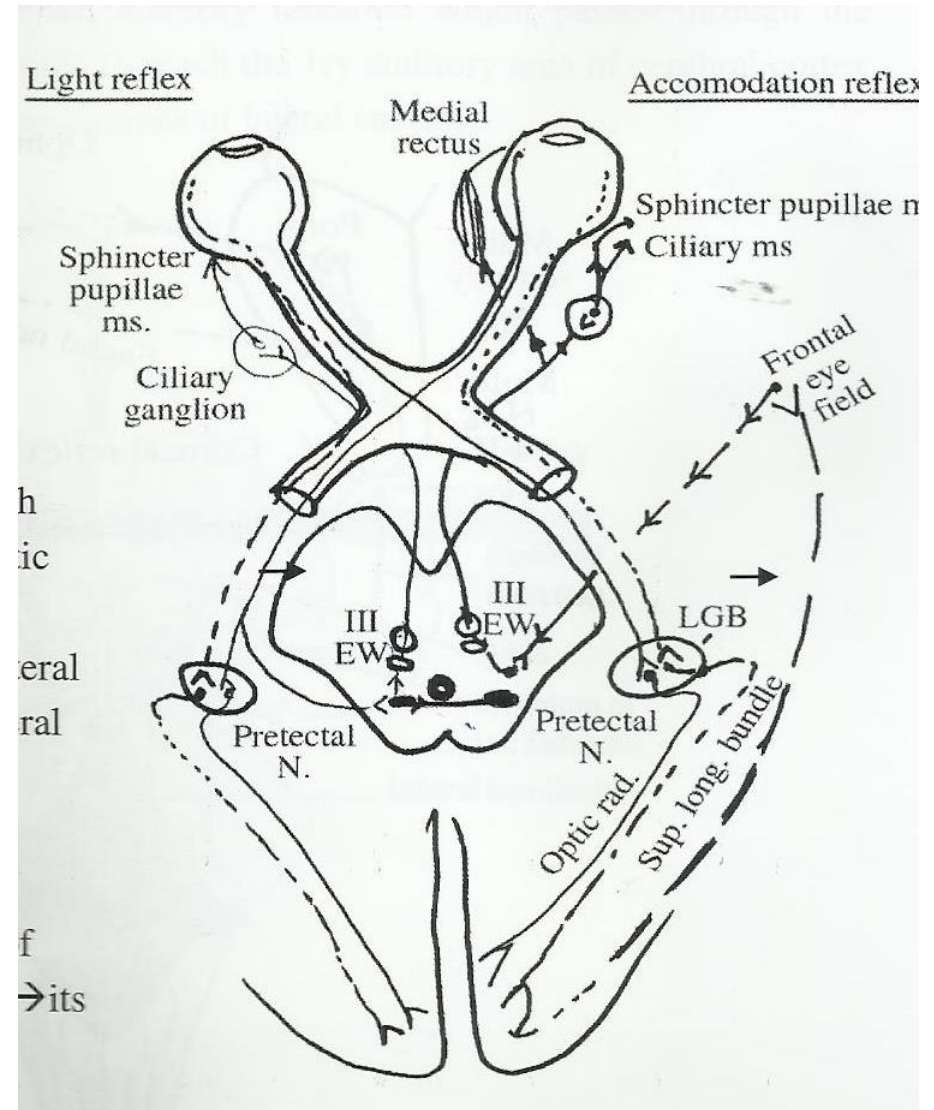
* Looking at near objects leads to:

1. Convergence of both eyes (medial recti).
2. Increased refractive power as the lens becomes more convex (ciliary muscle).
3. Pupillary constriction (sphincter pupillae muscles).



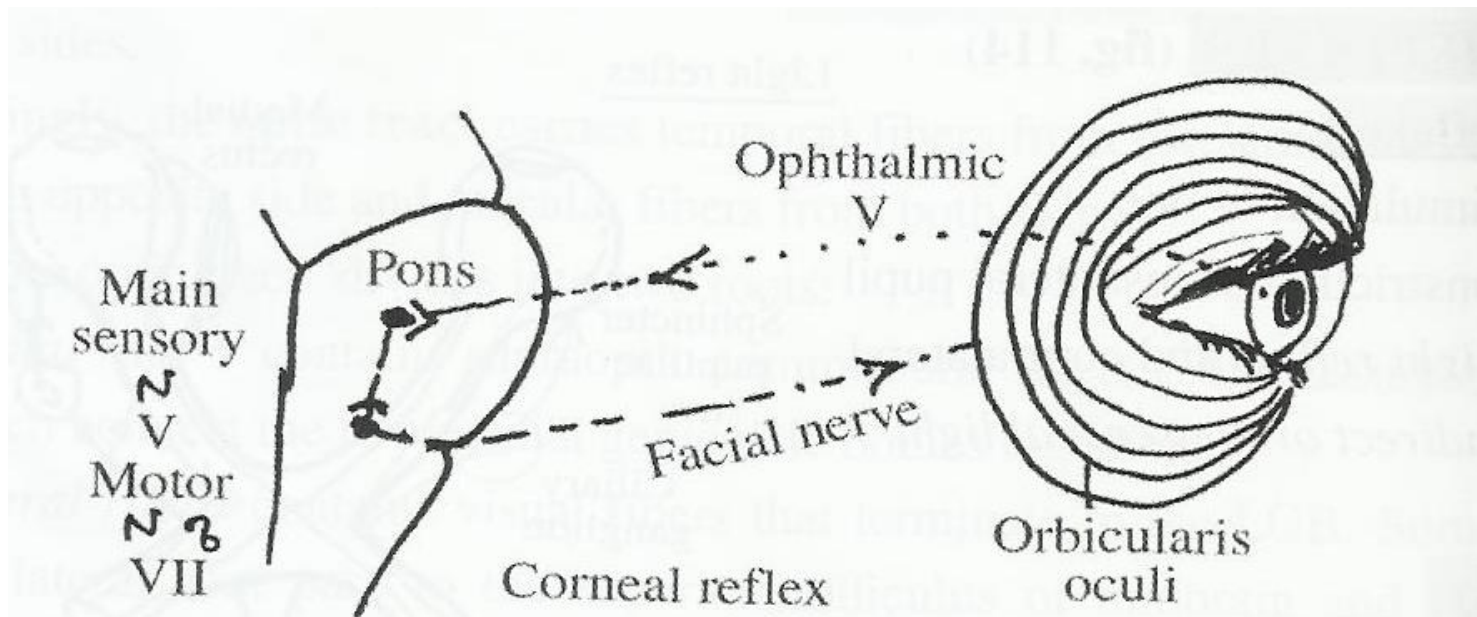
* **Pathway:** Impulses from the retina → optic nerve → optic chiasma → optic tract → lateral root of optic tract → LGB → optic radiation → visual area in the occipital lobe → frontal eye field in the frontal lobe through the superior longitudinal bundle → descend in the internal capsule → relay on nuclei in pretectal area → oculomotor nuclei: -

1. Edinger Westphal nucleus → sphincter pupillae and ciliary muscles.
2. Motor Nucleus of III → medial recti.



3. Corneal (conjunctival) reflex:

- * Light touch of the cornea or conjunctiva (e.g. by a delicate piece of cotton) results in blinking of the eyelids.
- * Pathway: Afferent impulses along the ophthalmic nerve to the main sensory nucleus of trigeminal nerve → pass via interneurons to the motor nucleus of facial nerve on both sides → orbicularis oculi muscle → closure of eyelids.



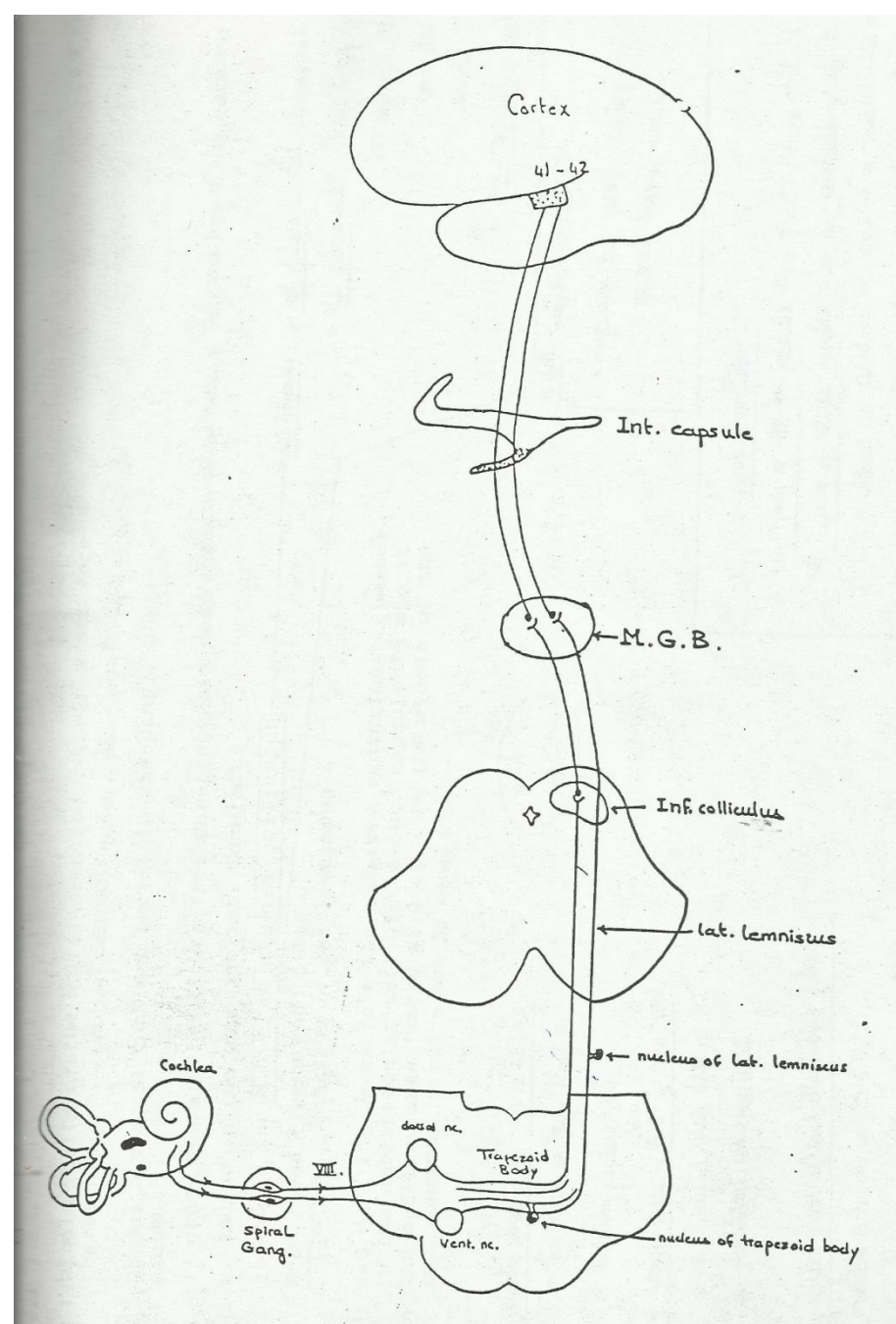
AUDITORY PATHWAY

1. First order neuron:

- * Central processes of the bipolar neurons of the spiral ganglion of the inner ear.
- * They leave the petrous temporal bone through the internal acoustic meatus and enter the pons.

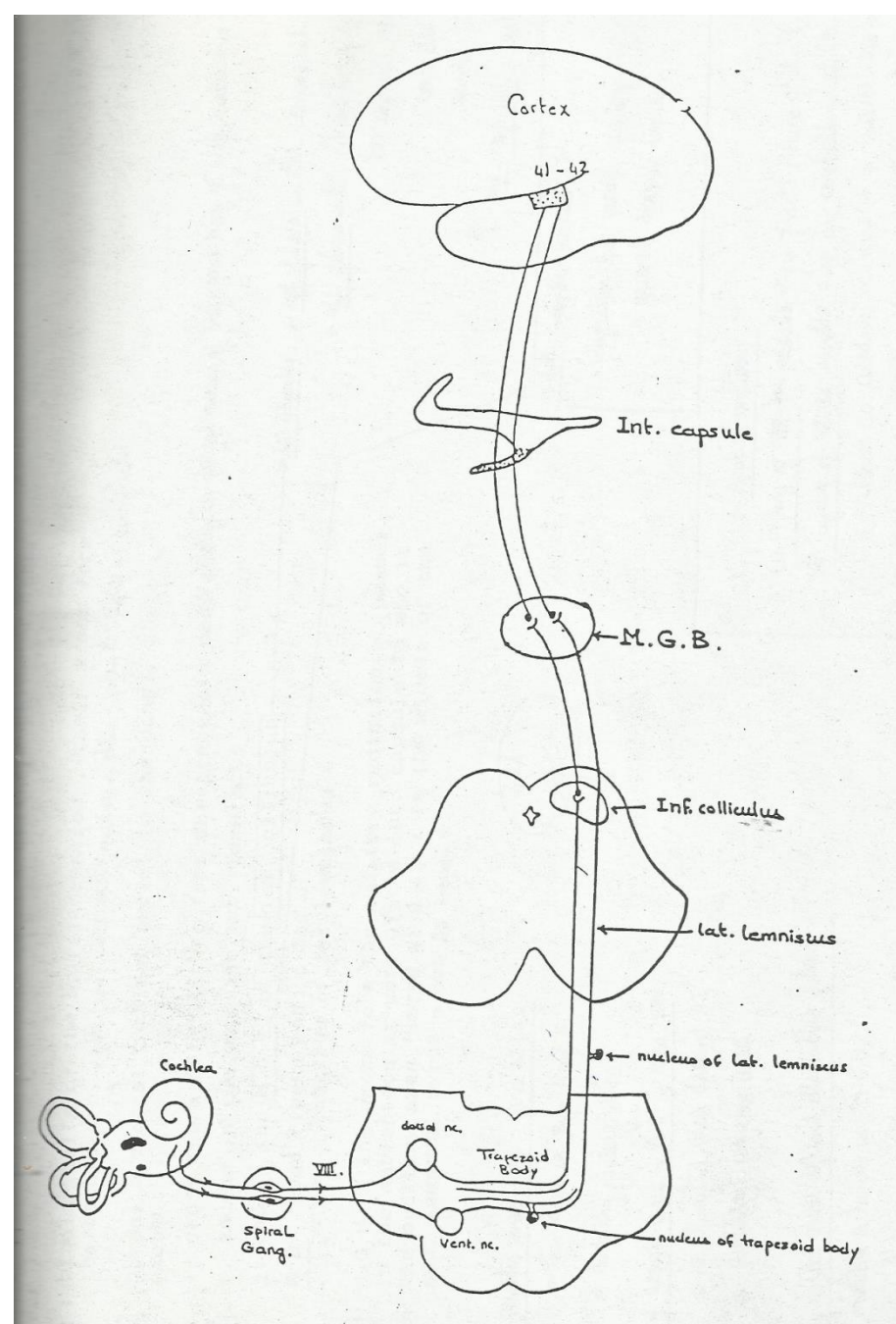
2. Second order neuron:

- * The fibers entering the pons divide into 2 branches which synapse with dorsal or ventral cochlear nuclei.
- * Axons of the cochlear nuclei pass in the pons forming the trapezoid body.
- * Fibers of the trapezoid body synapse with superior olivary nucleus or trapezoid nucleus of the same or opposite side.



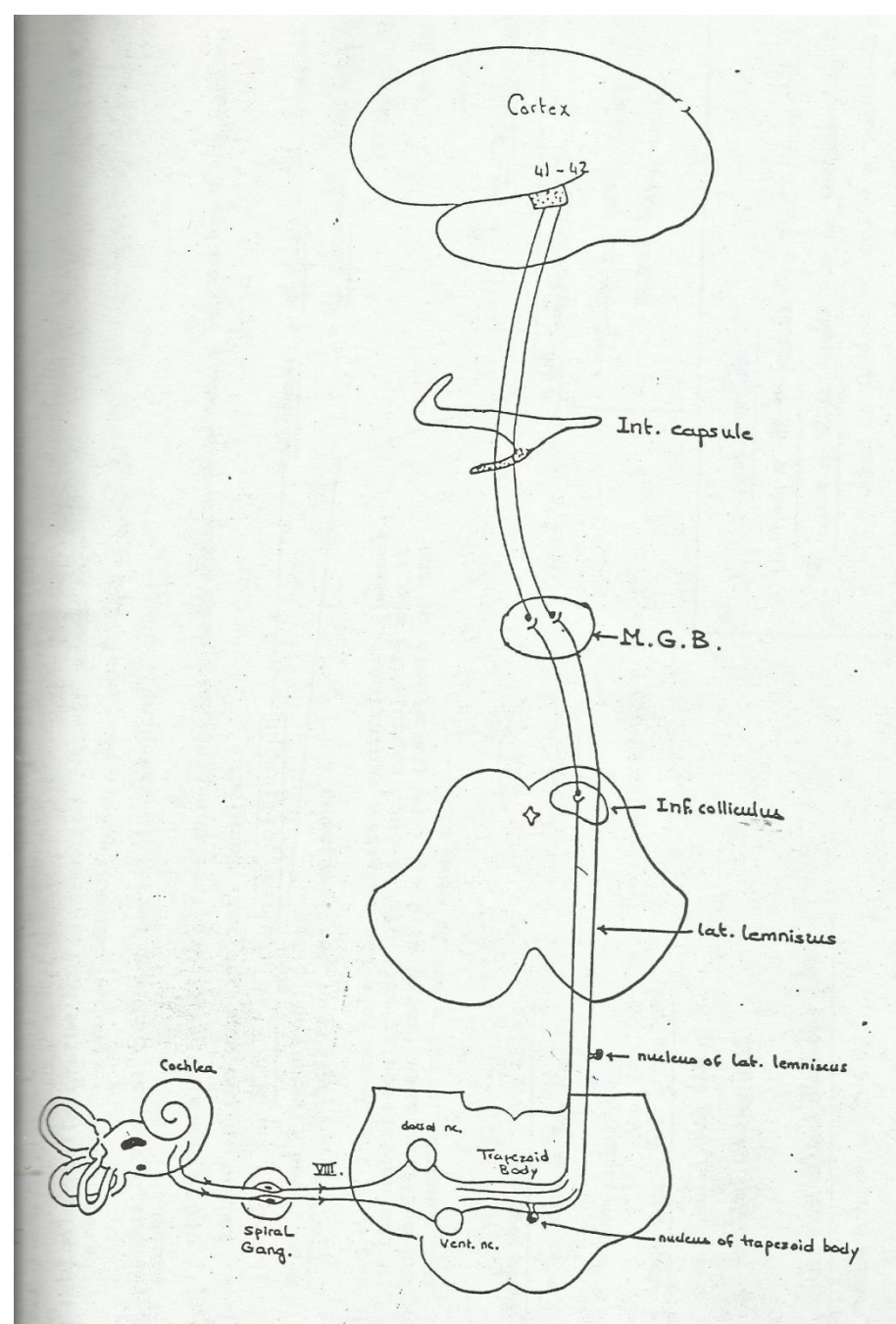
3. Third order neuron:

- * Axons of the superior olivary nucleus or the nucleus of the trapezoid body of the same or opposite side ascend as the lateral lemniscus.
- * Some fibers synapse in the nucleus of lateral lemniscus.
- * Other fibers ascend and some synapse in the inferior colliculus of midbrain while other fibers pass through the brachium of inferior colliculus to synapse in the medial geniculate body (MGB).



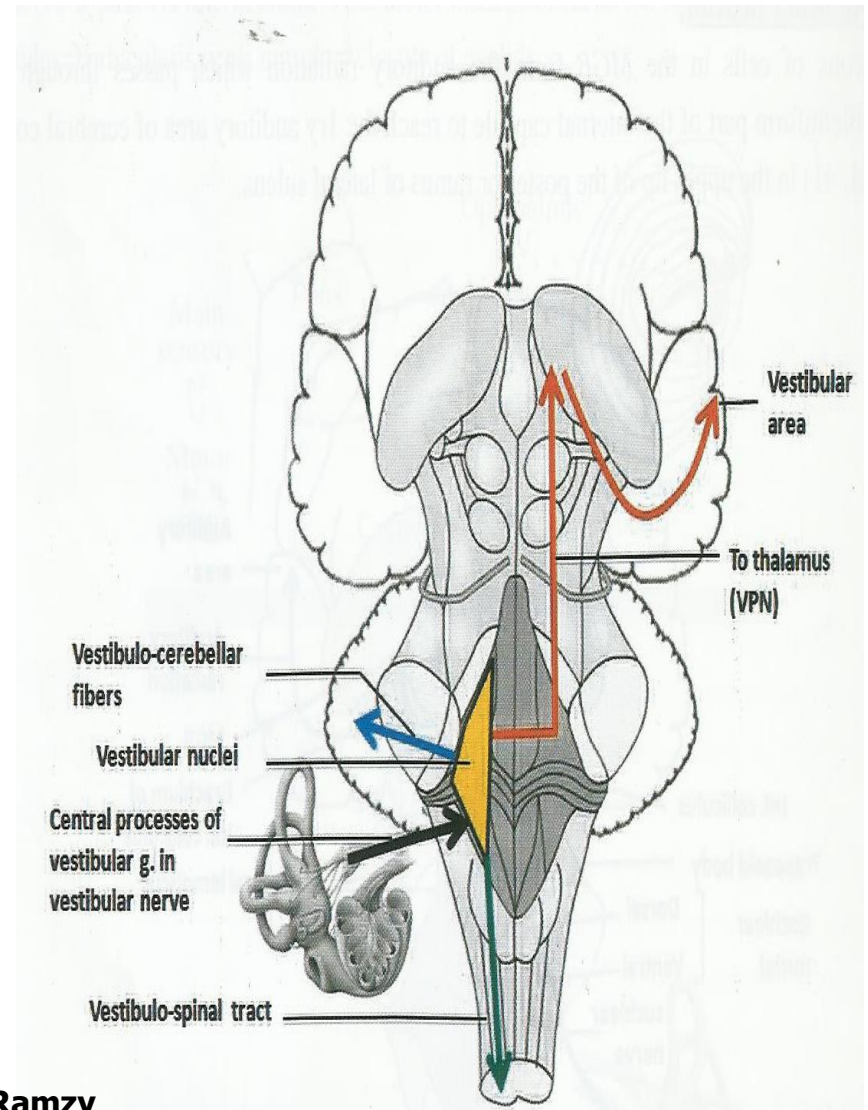
4. Fourth order neuron:

- * Axons of cells in the MGB form the auditory radiation which passes through the sublenticular part of the internal capsule to reach the 1ry auditory area of cerebral cortex (A1, 41) in the upper lip of the posterior ramus of lateral sulcus.



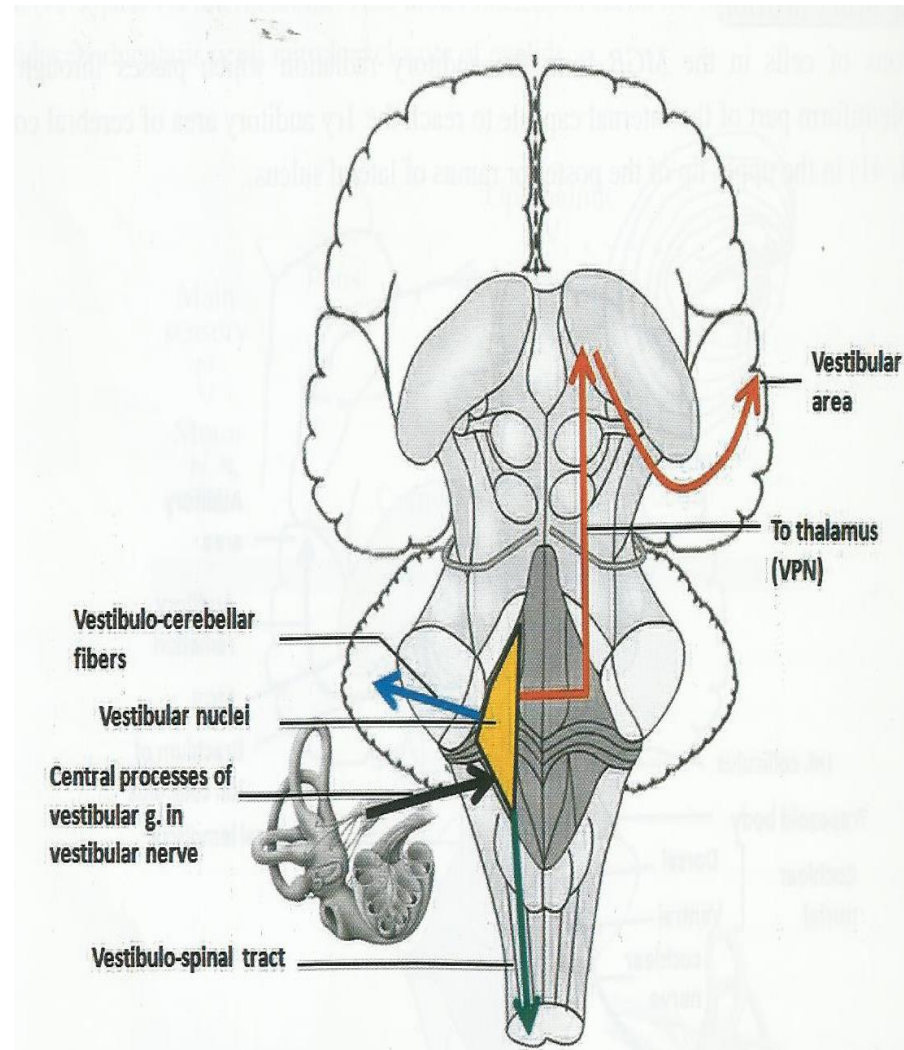
VESTIBULAR PATHWAY

- * Receptors are present in:
Semicircular canals (Ampullae) 'Crista Ampularis' and in Sacculae and Utricule (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'.



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