PERIPHERAL NERVOUS SYSTEM

OPTIC NERVE & VISUAL PATHWAY
OLFACTORY PATHWAY

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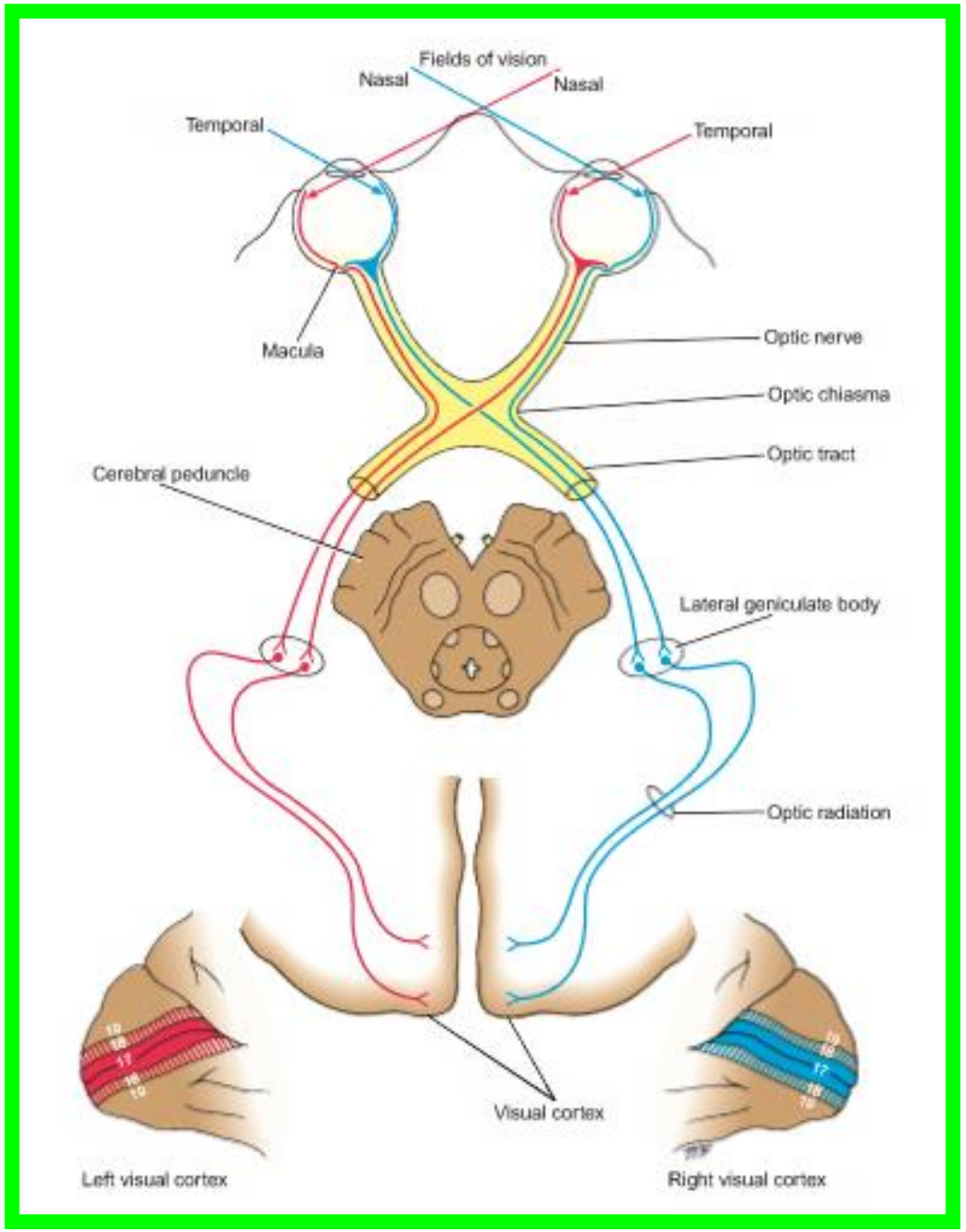
OPTIC NERVE (CRANIAL NERVE II)

✓ Origin of the Optic Nerve

✓The fibers of the optic nerve are the axons of the cells in the ganglionic layer of the retina.

✓They converge on the optic disc and exit from the eye, about 3 or 4 mm to the nasal side of its center, as the optic nerve

✓The optic nerve leaves the orbital cavity through the optic canal and unites with the optic nerve of the opposite side to form the optic chiasma.



OPTIC NERVE (CRANIAL NERVE II)

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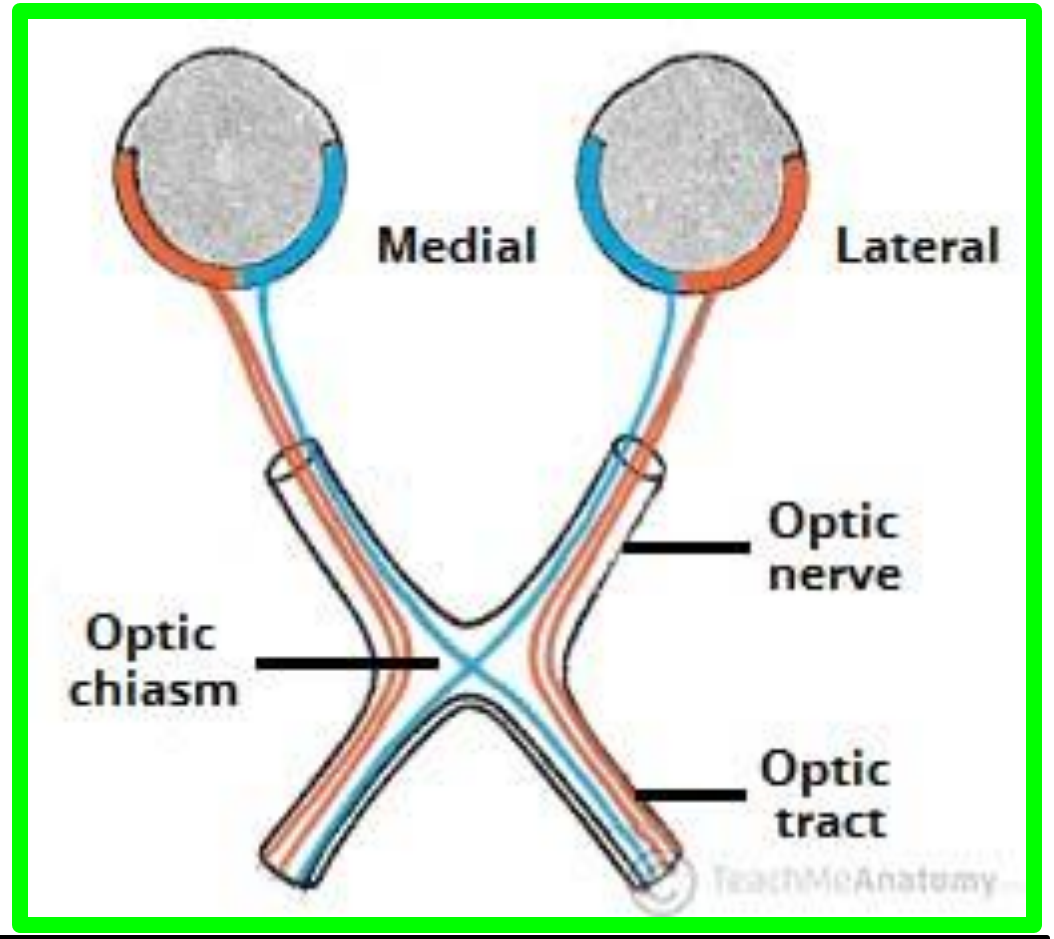
✓ Optic Chiasma

❖The optic chiasma is situated at the junction of the anterior wall and floor of the third ventricle.

❖Its anterolateral angles are continuous with the optic nerves, and the posterolateral angles are continuous with the optic tracts



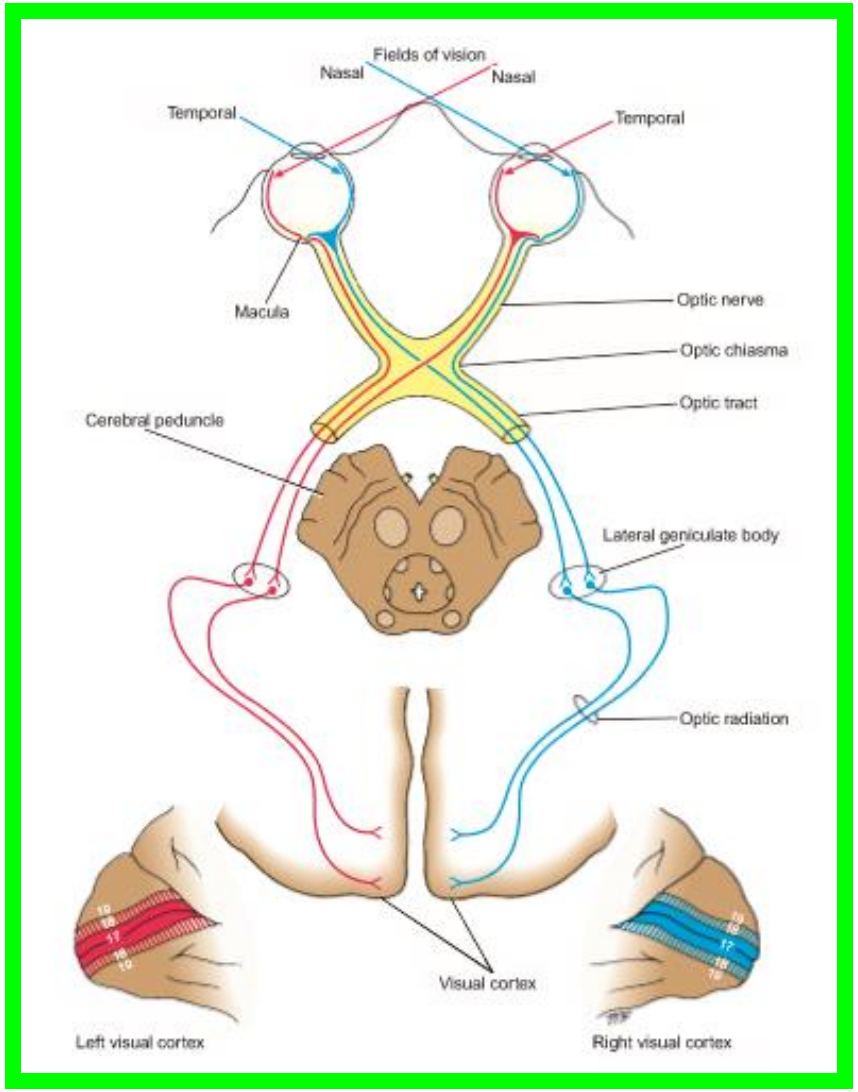
❖ In the chiasma, the fibers from the nasal (medial) half of each retina, including the nasal half of the macula, cross the midline and enter the optic tract of the opposite side, while the fibers from the temporal (lateral) half of each retina, including the temporal half of the macula, pass posteriorly in the optic tract of the same side.

OPTIC NERVE (CRANIAL NERVE II)

✓ Optic Tract

✓The optic tract emerges from the optic chiasma and passes Posterolaterally around the cerebral peduncle.

✓Most of the fibers now terminate by synapsing with nerve cells in the lateral geniculate body, which is a small projection from the posterior part of the thalamus.(pulvinar)



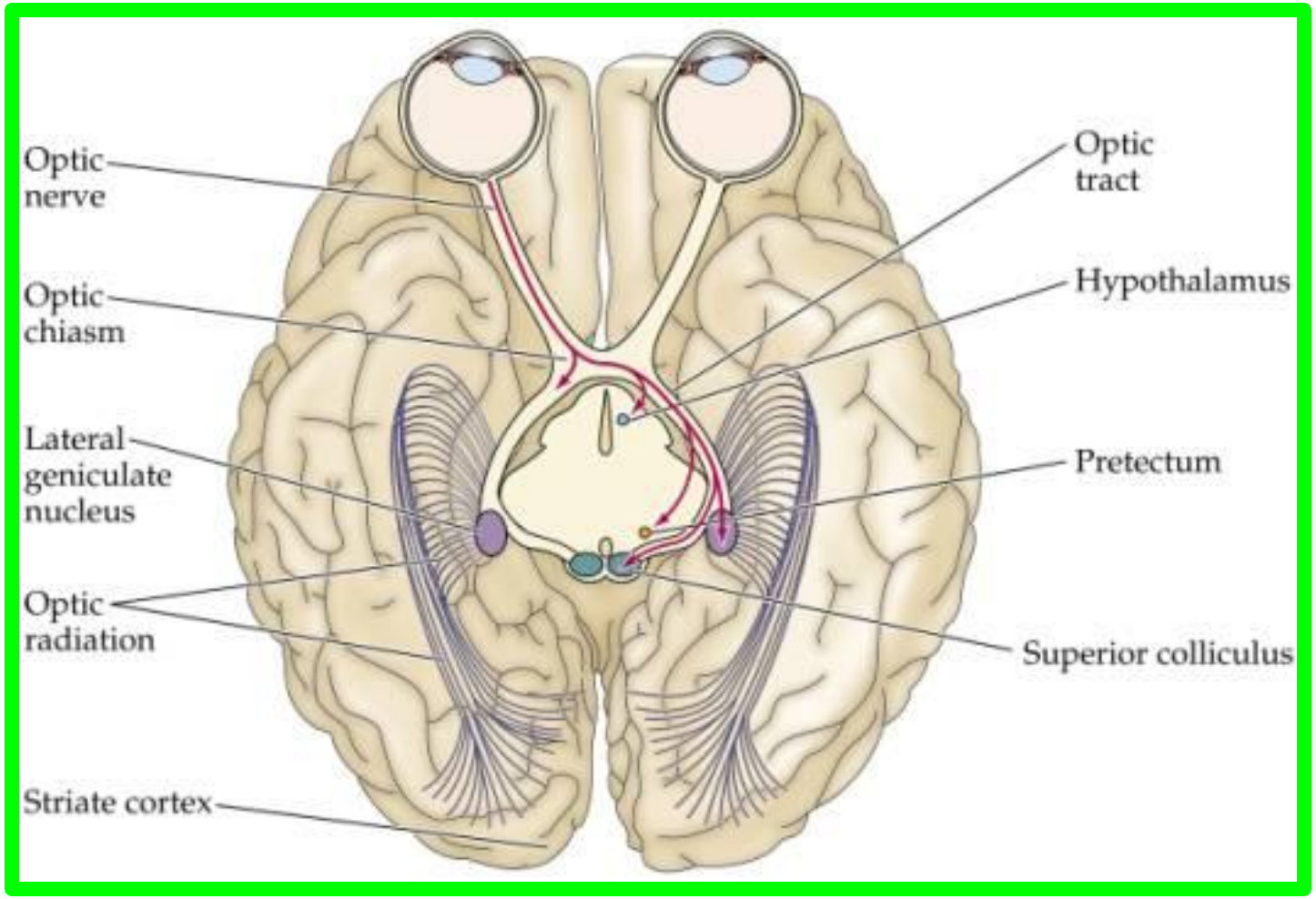
✓A few of the fibers pass to the pretectal nucleus and the superior colliculus of the midbrain and are concerned with light reflexes

OPTIC NERVE (CRANIAL NERVE II)

✓ Lateral Geniculate Body

✓The lateral geniculate body is a small, oval swelling projecting from the pulvinar of the thalamus.

✓It consists of six layers of cells, on which synapse the axons of the optic tract.



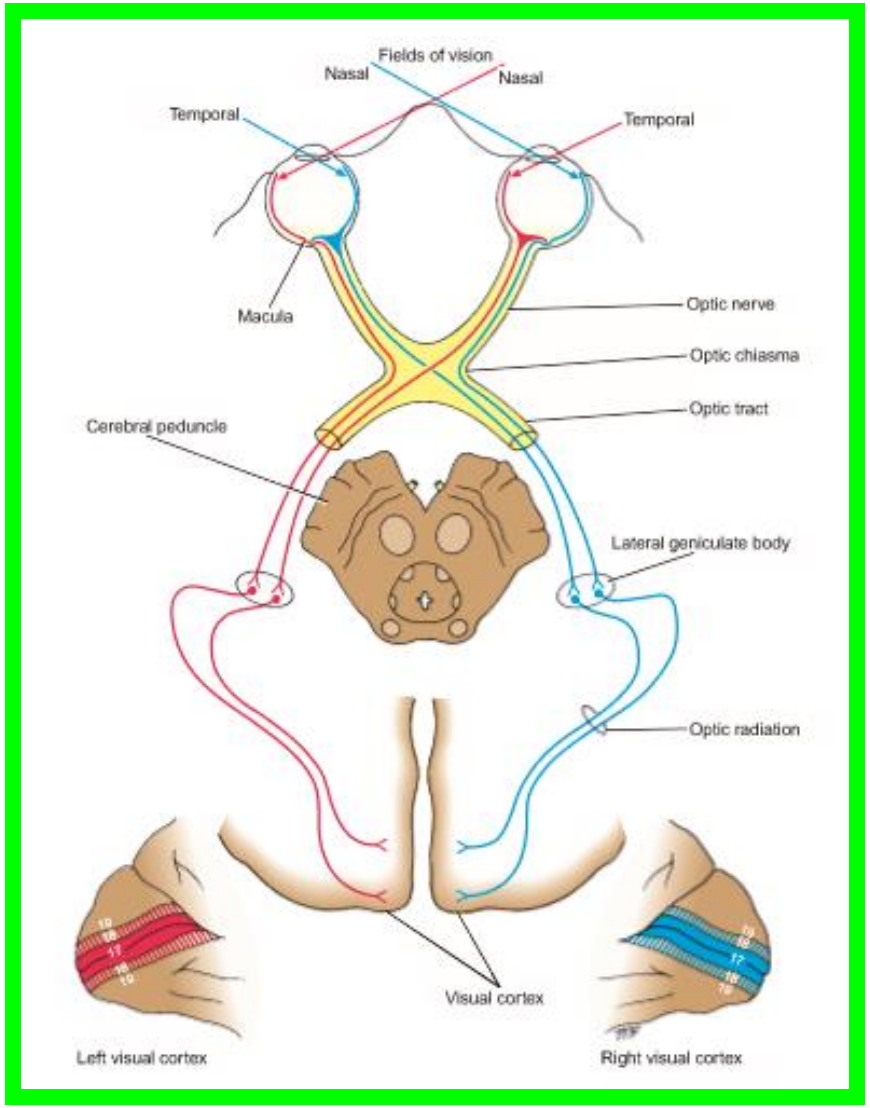
✓The axons of the nerve cells within the geniculate body leave it to form the optic radiation

OPTIC NERVE (CRANIAL NERVE II)

✓ Optic Radiation

❑The fibers of the optic radiation are the axons of the nerve cells of the lateral geniculate body.

❑The tract passes posteriorly through the retrolenticular part of the internal capsule and terminates in the visual cortex (area 17), which occupies the upper and lower lips of the calcarine sulcus on the medial surface of the cerebral hemisphere



❑The visual association cortex (areas 18 and 19) is responsible for recognition of objects and perception of color.

Neurons of the Visual Pathway and Binocular Vision

Four neurons conduct visual impulses to the visual cortex:

(1) rods and cones, which are specialized receptor neurons in the retina;

(2) bipolar neurons, which connect the rods and cones to the ganglion cells;

(3) ganglion cells, whose axons pass to the lateral geniculate body; and

(4) neurons of the lateral geniculate body, whose axons pass to the cerebral cortex.

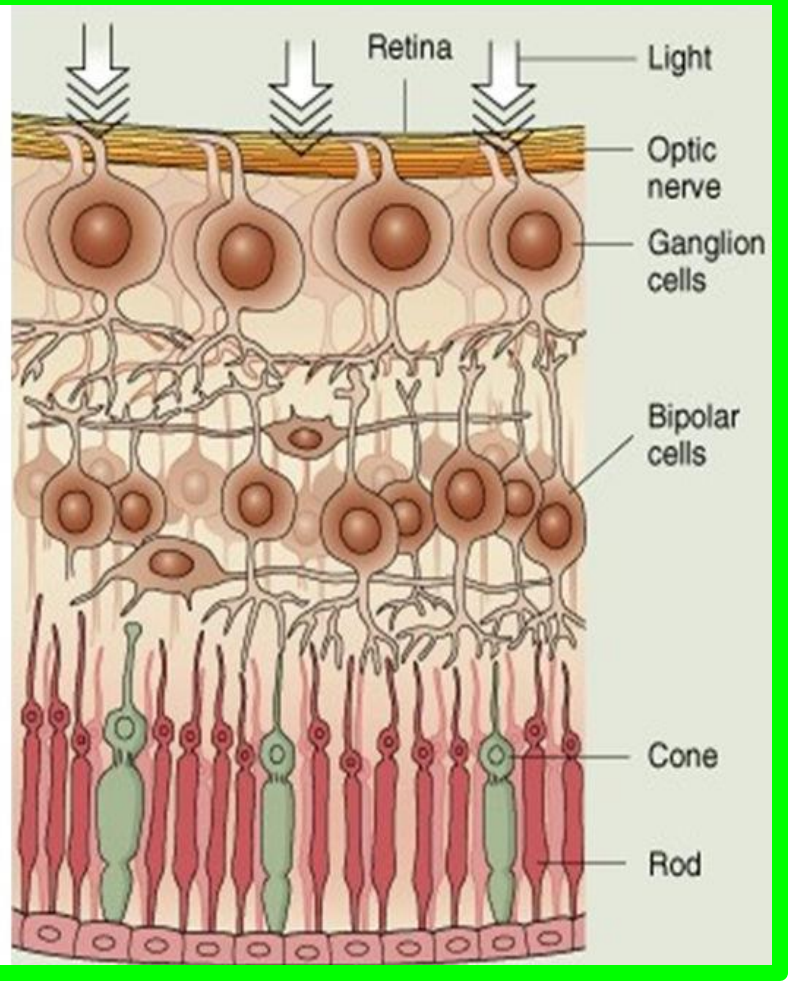
Visual Pathway

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.**

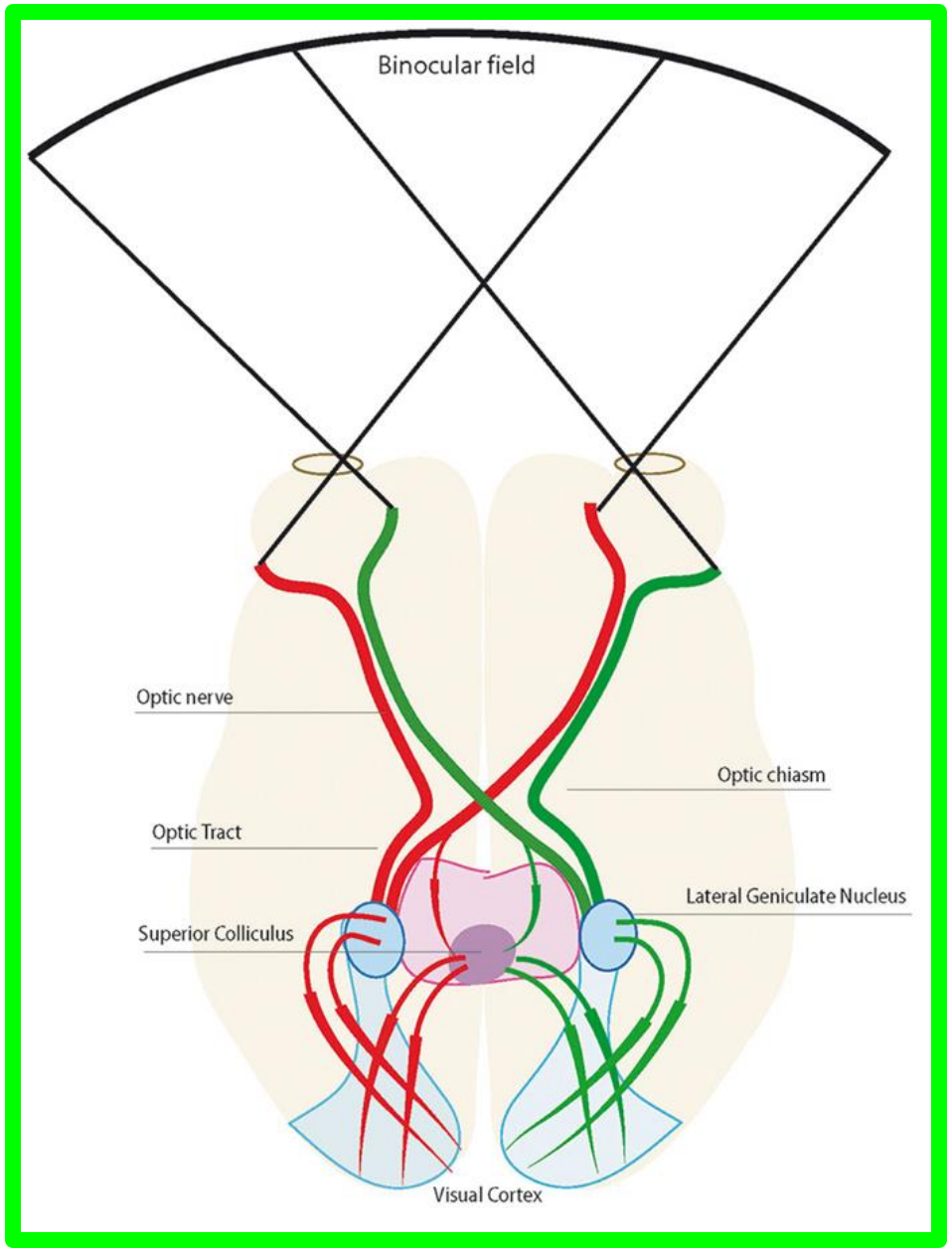


Neurons of the Visual Pathway and Binocular Vision

- In binocular vision, the right and left fields of vision are projected on portions of both retinae

- The image of an object in the right field of vision is projected on the nasal half of the right retina and the temporal half of the left retina.

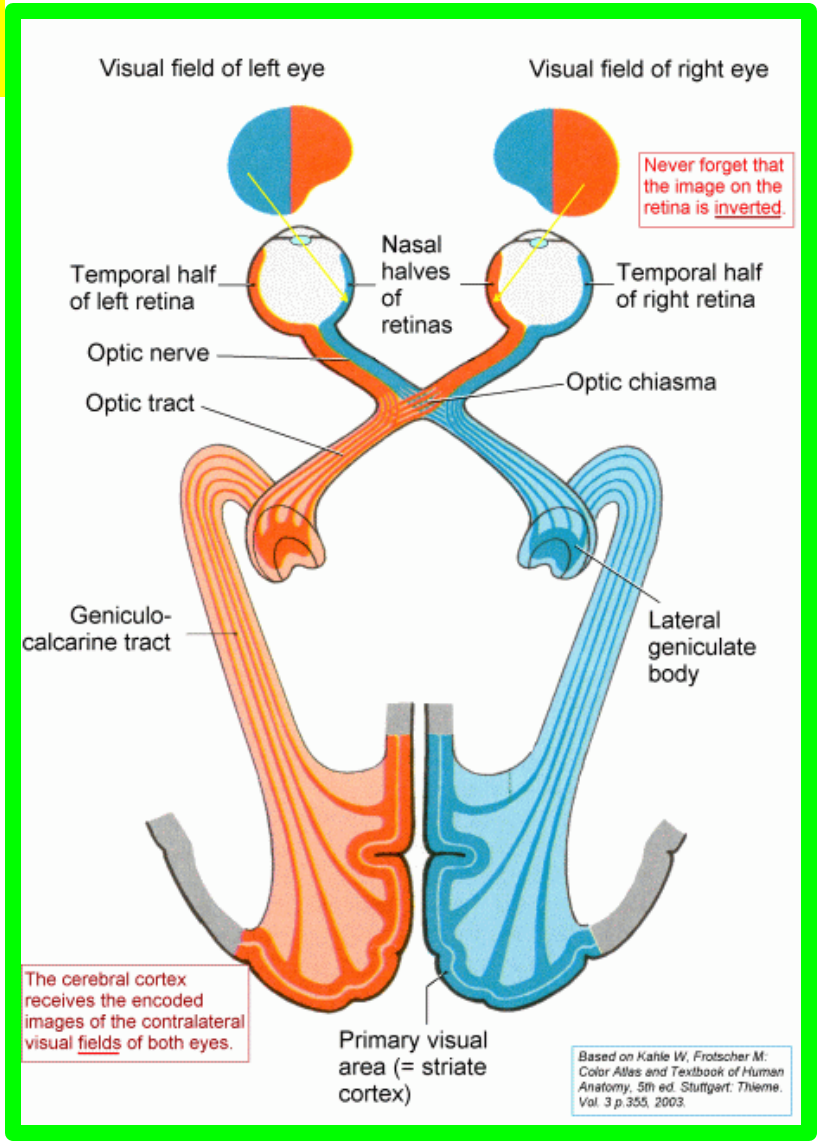
- In the optic chiasma, the axons from these two retinal halves are combined to form the left optic tract



Neurons of the Visual Pathway and Binocular Vision

- The lateral geniculate body neurons now project the complete right field of vision on the visual cortex of the left hemisphere and the left visual field on the visual cortex of the right hemisphere

- The lower retinal quadrants (upper field of vision) project on the lower wall of the calcarine sulcus, while the upper retinal quadrants (lower field of vision) project on the upper wall of the sulcus. (the image on the retina is inverted)



- Note also that the macula lutea is represented on the posterior part of area 17,and the periphery of the retina is represented anteriorly.

1. Visual Reflexes

Direct and Consensual Light Reflexes

✓If a light is shone into one eye, the pupils of both eyes normally constrict.

✓The constriction of the pupil on which the light is shone is called the direct light reflex; the constriction of the opposite pupil, even though no light fell on that eye, is called the consensual light reflex

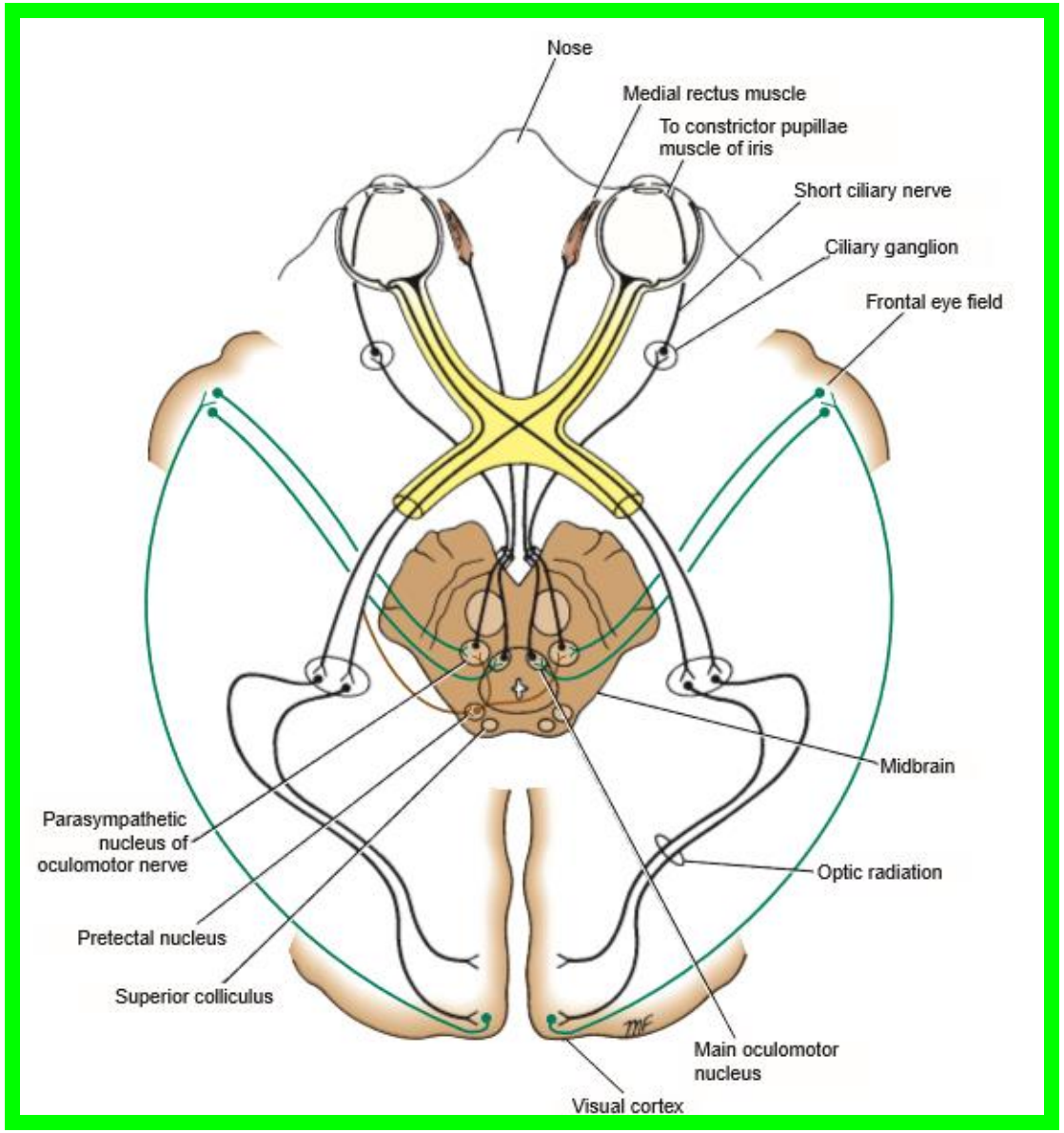
1. Visual Reflexes

Direct and Consensual Light Reflexes

✓The afferent impulses travel through the optic nerve, optic chiasma, and optic tract

✓Here, a small number of fibers leave the optic tract and synapse on nerve cells in the pretectal nucleus, which lies close to the superior colliculus.

The impulses are passed by axons of the pretectal nerve cells to the parasympathetic nuclei (EdingerWestphal nuclei) of the third cranial nerve on both sides.

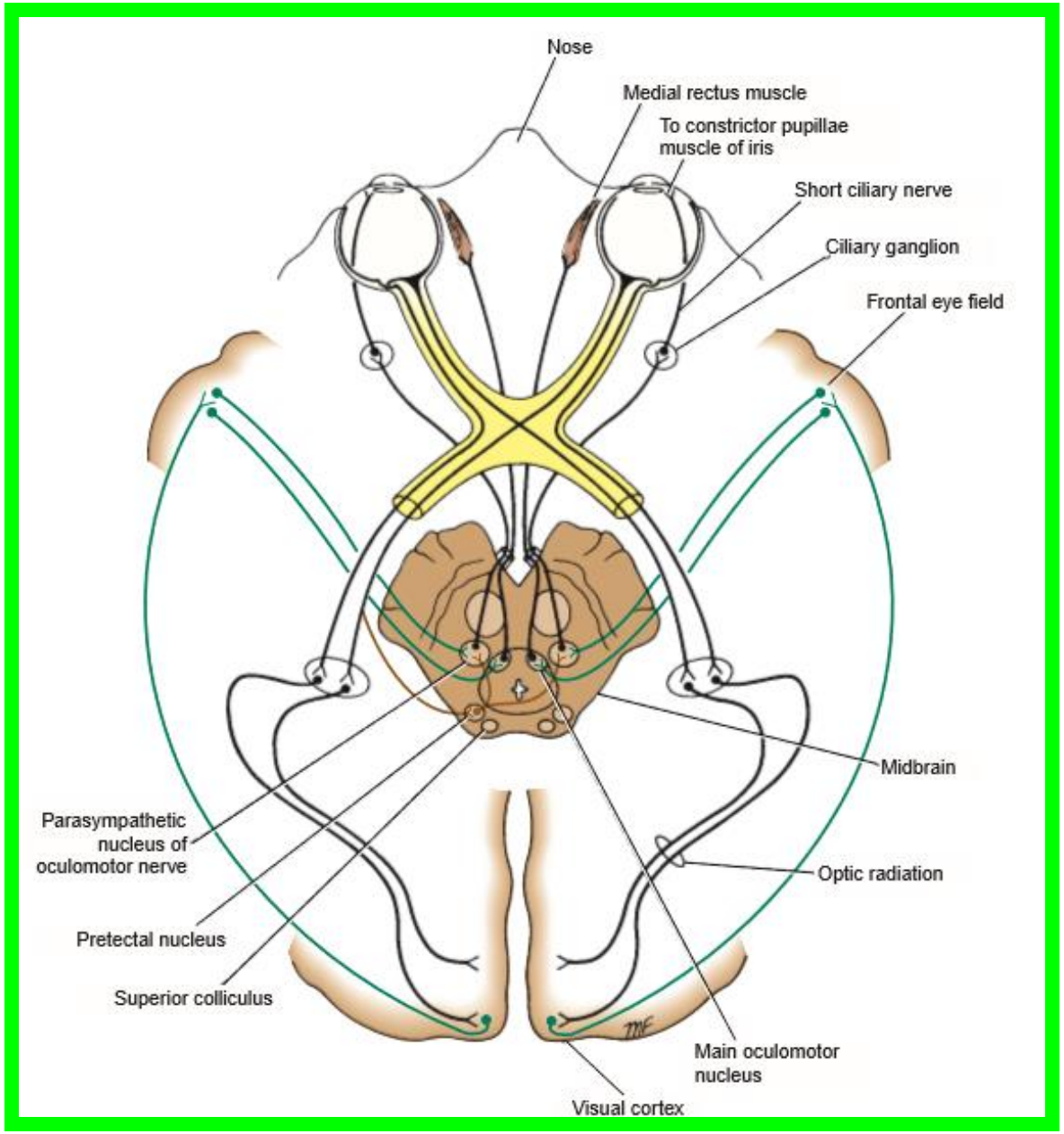


1. Visual Reflexes

Direct and Consensual Light Reflexes

Here, the fibers synapse and the parasympathetic nerves travel through the third cranial nerve to the ciliary ganglion in the orbit

✓Finally, postganglionic parasympathetic fibers pass through the short ciliary nerves to the eyeball and the constrictor pupillae muscle of the iris.



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1. Visual Reflexes Direct and Consensual Light Reflexes

✓Both pupils constrict in the consensual light reflex because the pretectal nucleus sends fibers to the parasympathetic nuclei on both sides of the midbrain

✓The fibers that cross the median plane do so close to the cerebral aqueduct in the posterior commissure

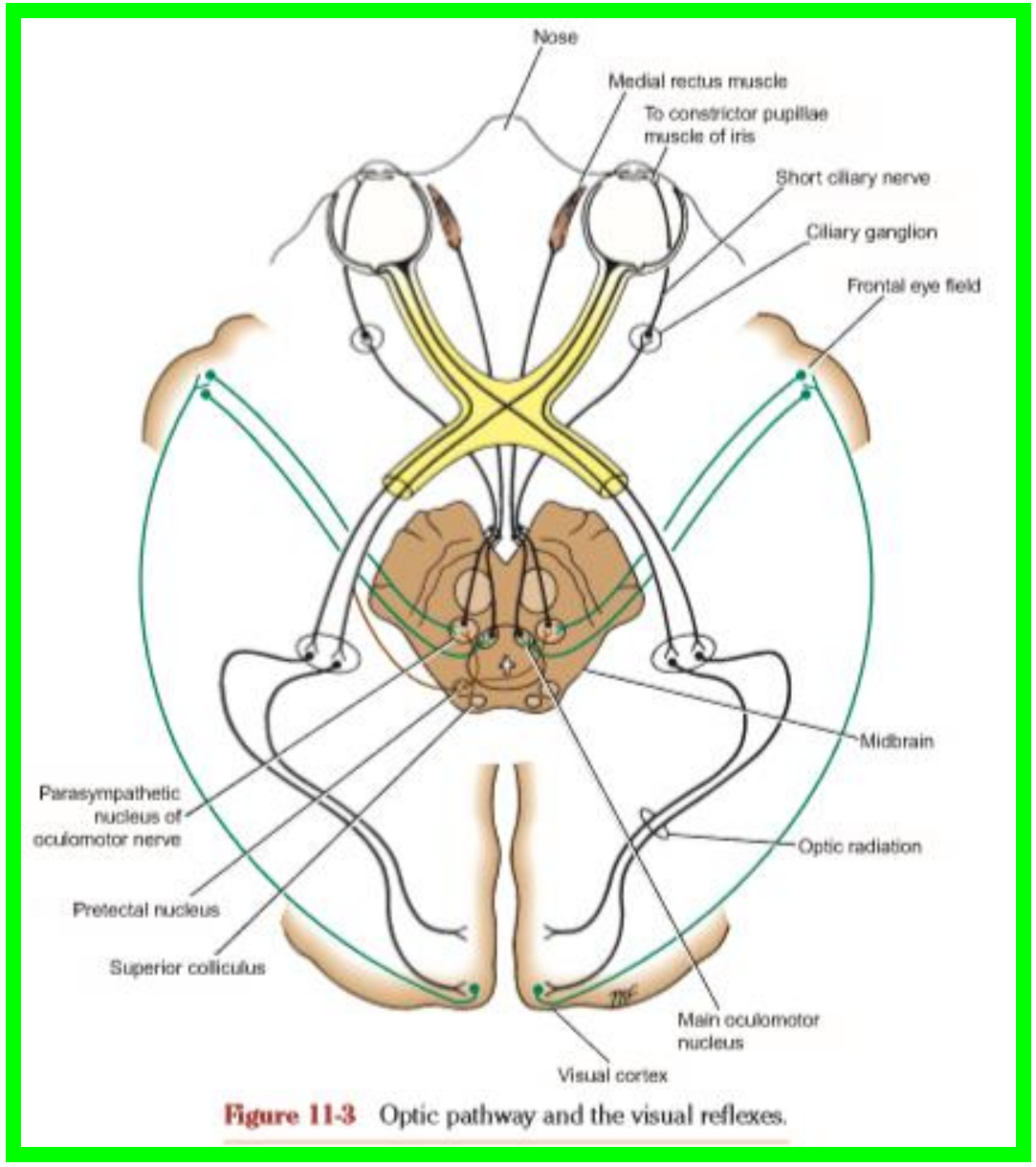

Figure 11-3 Optic pathway and the visual reflexes.

2. Accommodation Reflex

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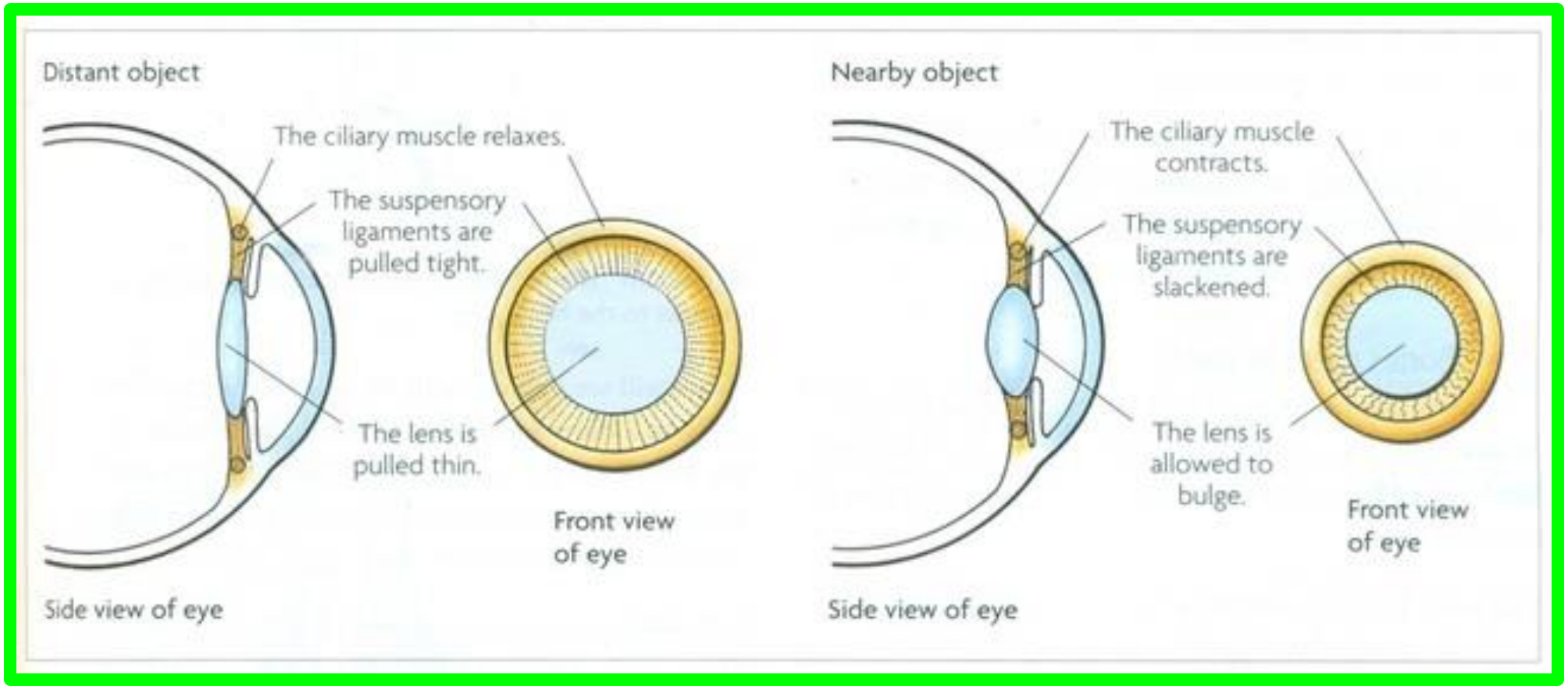
When the eyes are directed from a distant to a near object, contraction of the medial recti brings about convergence of the ocular axes; the lens thickens to increase its refractive power by contraction of the ciliary muscle; and the pupils constrict to restrict the light waves to the thickest central part of the lens.



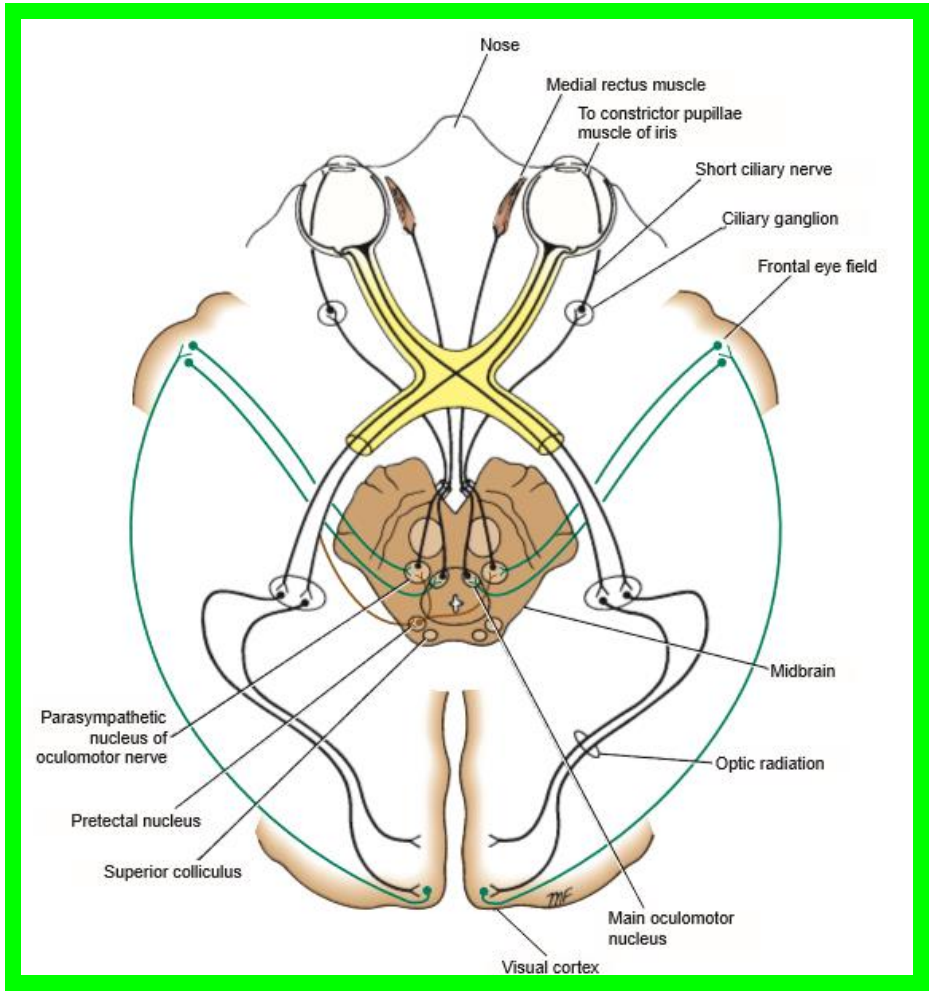
2. Accommodation Reflex

The afferent impulses travel through the optic nerve, the optic chiasma, the optic tract, the lateral geniculate body, and the optic radiation to the visual cortex. The visual cortex is connected to the eye field of the frontal cortex

- From here, cortical fibers descend through the internal capsule to the oculomotor nuclei in the midbrain.

- The oculomotor nerve travels to the medial recti muscles

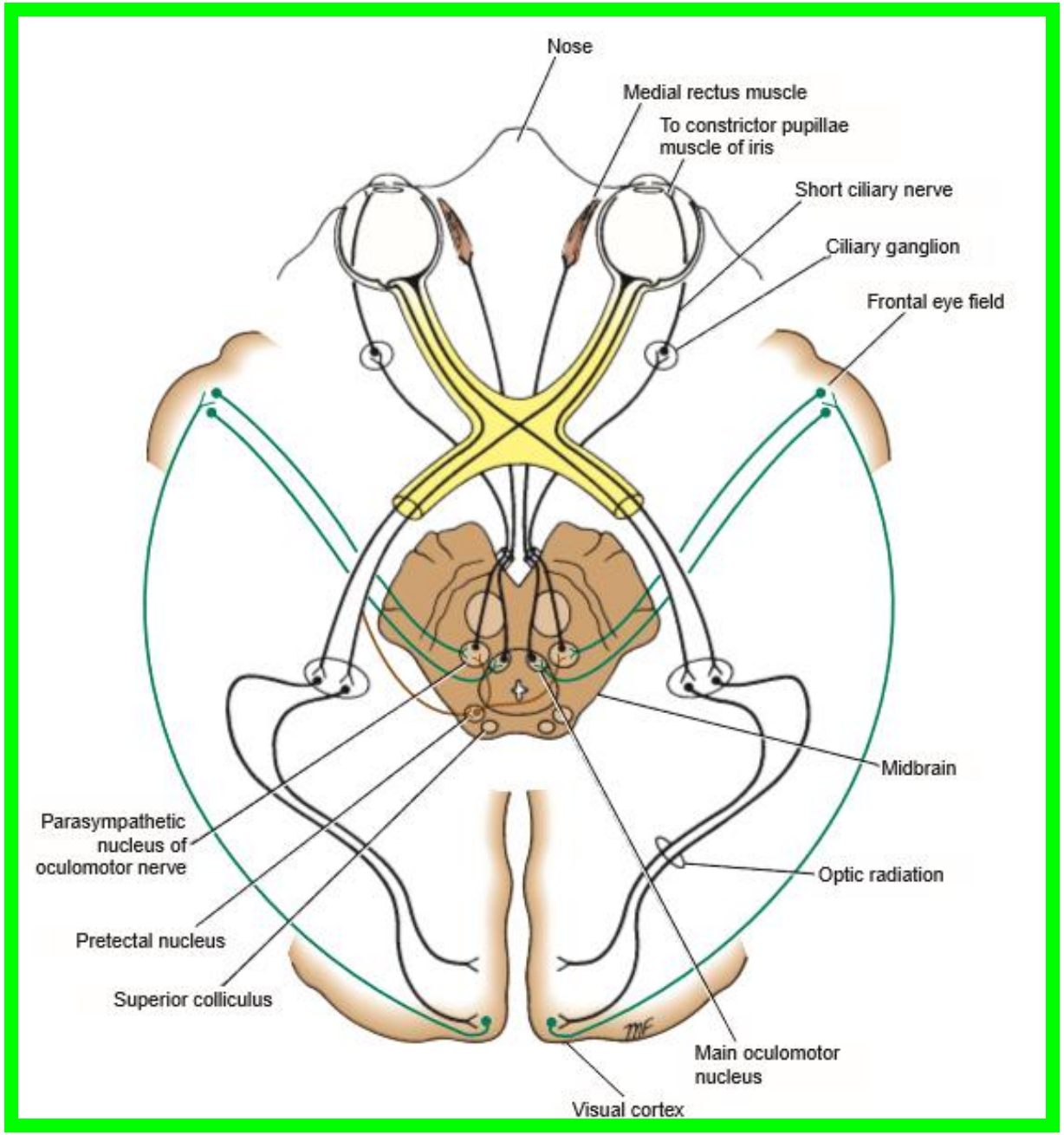
- Some of the descending cortical fibers synapse with the parasympathetic nuclei (Edinger-Westphal nuclei) of the third cranial nerve on both sides



2. Accommodation Reflex

- Here, the fibers synapse, and the parasympathetic nerves travel through the third cranial nerve to the ciliary ganglion in the orbit.

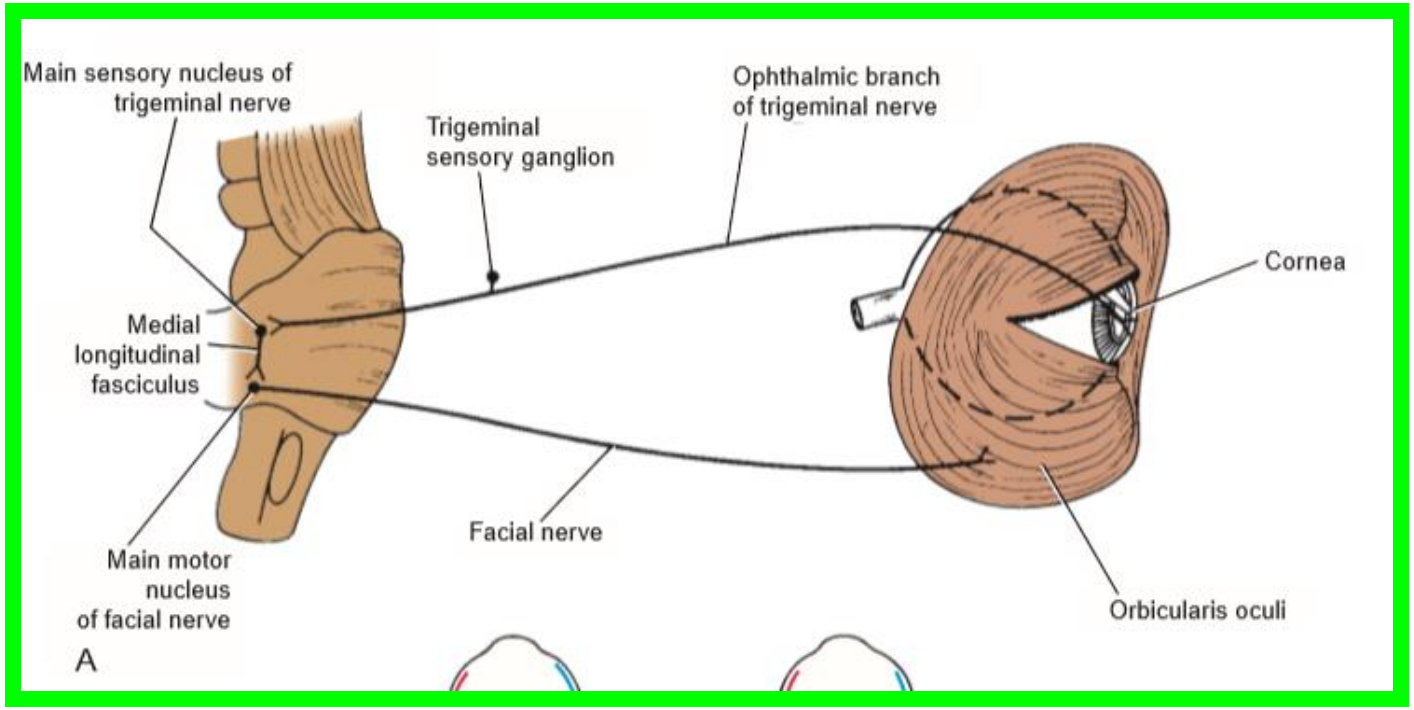
- Finally, postganglionic parasympathetic fibers pass through the short ciliary nerves to the ciliary muscle and the constrictor pupillae muscle of the iris



3. Corneal Reflex

❖Light touching of the cornea or conjunctiva results in blinking of the eyelids.

❖Afferent impulses from the cornea or conjunctiva travel through the ophthalmic division of the trigeminal nerve to the sensory nucleus of the trigeminal nerve

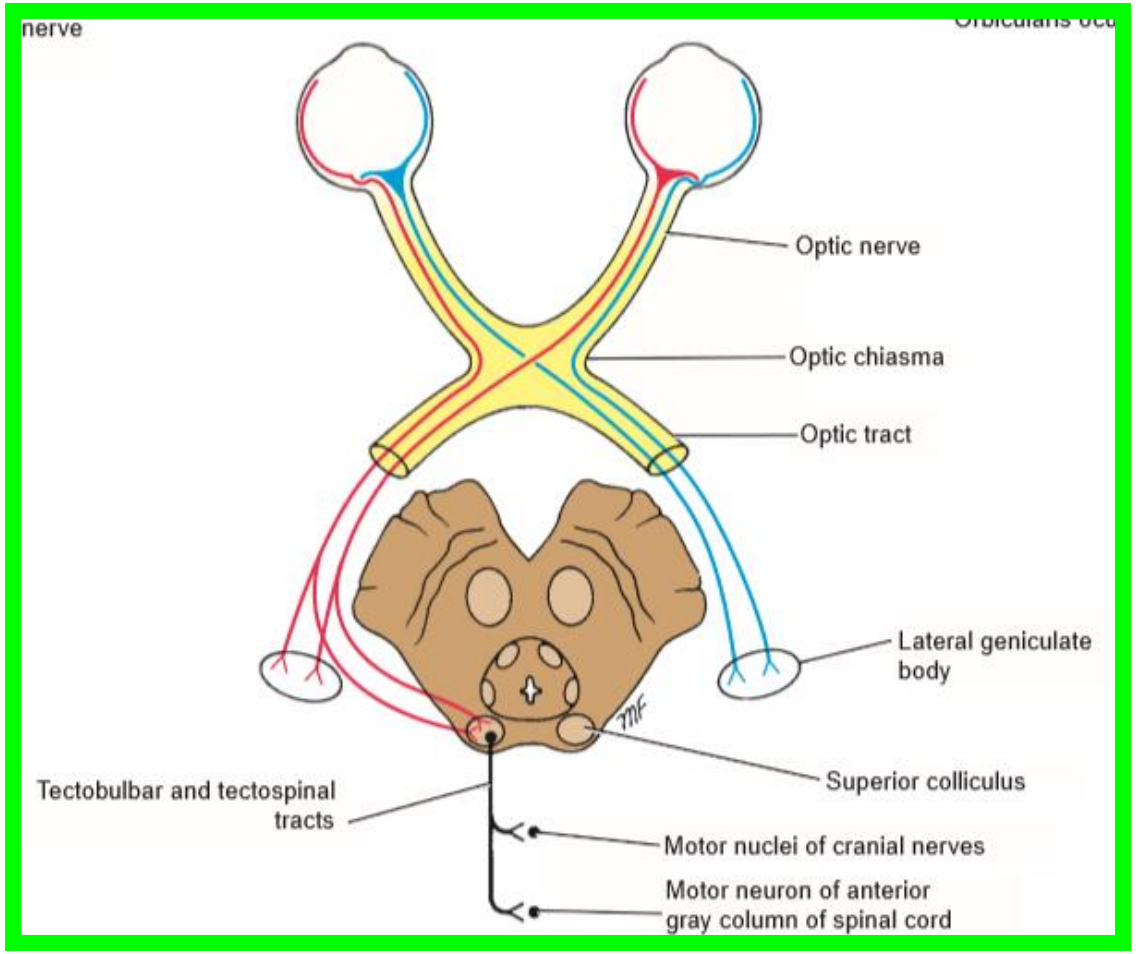


❖Internuncial neurons connect with the motor nucleus of the facial nerve on both sides through the medial longitudinal fasciculus.

❖The facial nerve and its branches supply the orbicularis oculi muscle, which causes closure of the eyelids.

4. Visual Body Reflexes

The automatic scanning movements of the eyes and head that are made when reading, the automatic movement of the eyes , head, and neck toward the source of the visual stimulus, and the protective closing of the eyes and even the raising of the arm for protection are reflex actions that involve the following reflex arcs

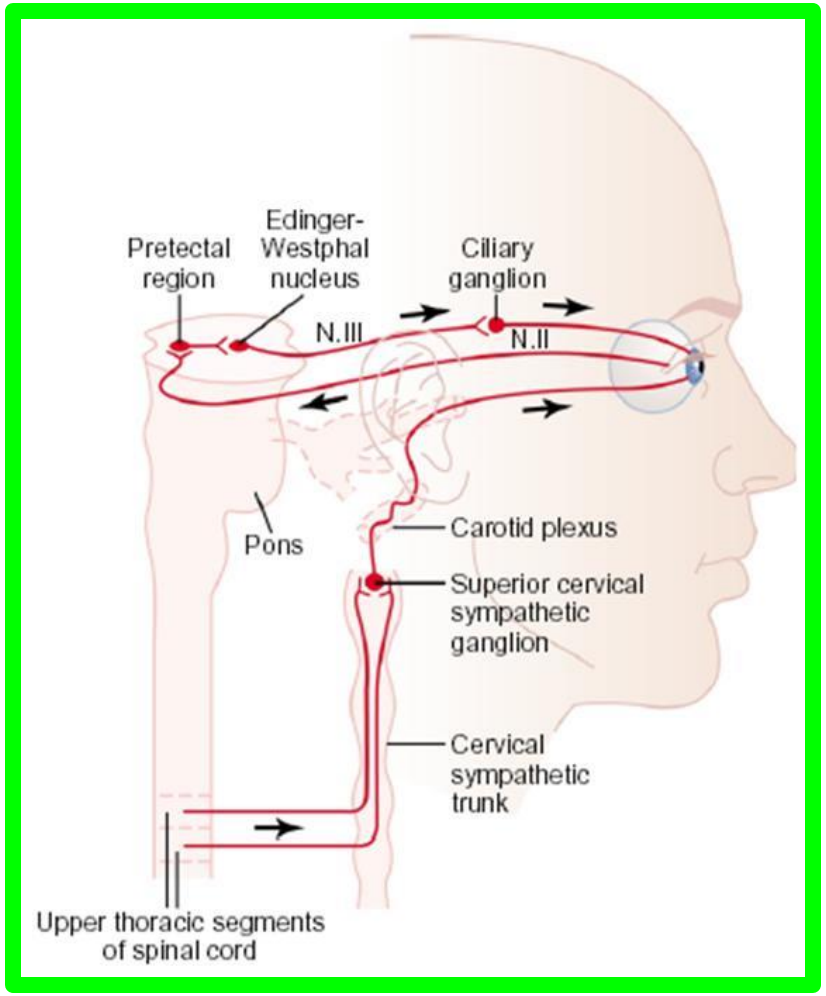


The visual impulses follow the optic nerves, optic chiasma ,and optic tracts to the superior colliculi. Here, the impulses are relayed to the tectospinal and tectobulbar (tectonuclear) tracts and to the neurons of the anterior gray columns of the spinal cord and cranial motor nuclei.

5. Pupillary Skin Reflex

The pupil will dilate if the skin is painfully stimulated by pinching. The afferent sensory fibers are believed to have connections with the efferent preganglionic sympathetic neurons in the lateral gray columns of the first and second thoracic segments of the spinal cord

- ✓ The white rami communicantes of these segments pass to the sympathetic trunk, and the preganglionic fibers ascend to the superior cervical sympathetic ganglion.
- ✓ The postganglionic fibers pass through the internal carotid plexus and the long ciliary nerves to the dilator pupillae muscle of the iris



OLFACTORY NERVES (CRANIAL NERVE I)

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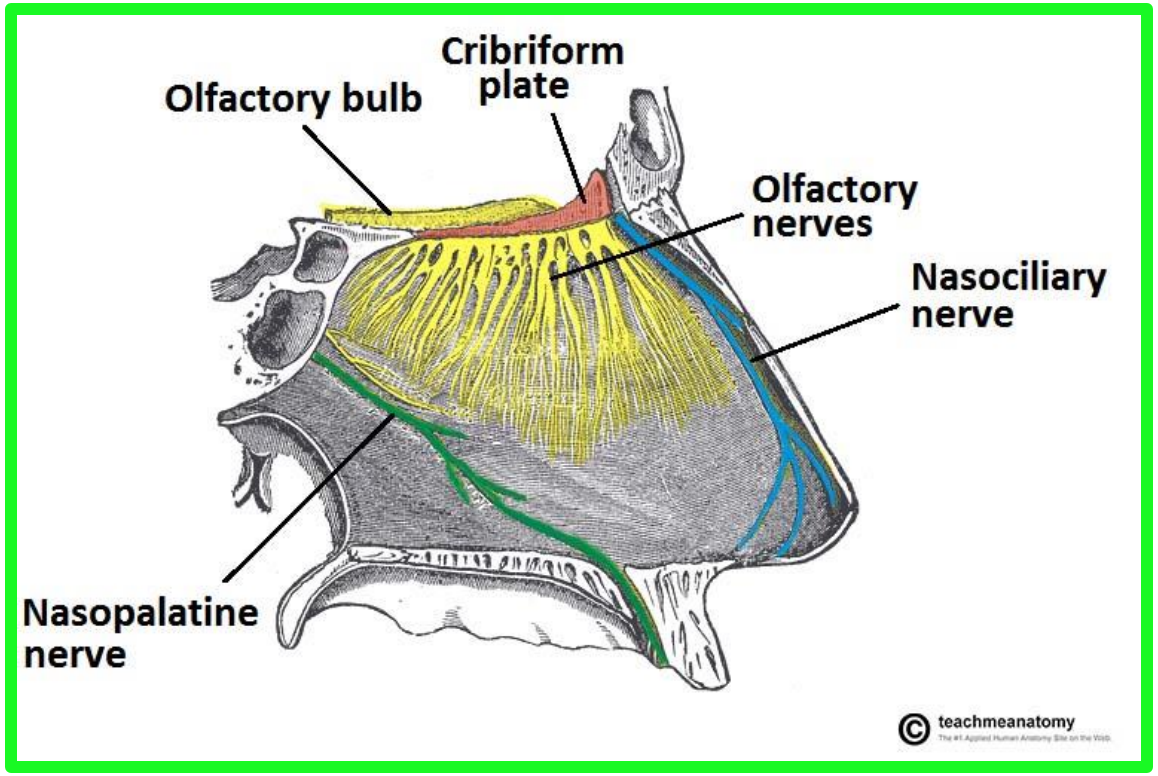
The olfactory nerves arise from the olfactory receptor nerve cells in the olfactory mucous membrane located in the upper part of the nasal cavity above the level of the superior concha.

- The fine central processes form the olfactory nerve fibers.

- Bundles of these nerve fibers pass through the openings of the cribriform plate of the ethmoid bone to enter the olfactory bulb.

- The olfactory nerve fibers are unmyelinated and are covered with Schwann cells.

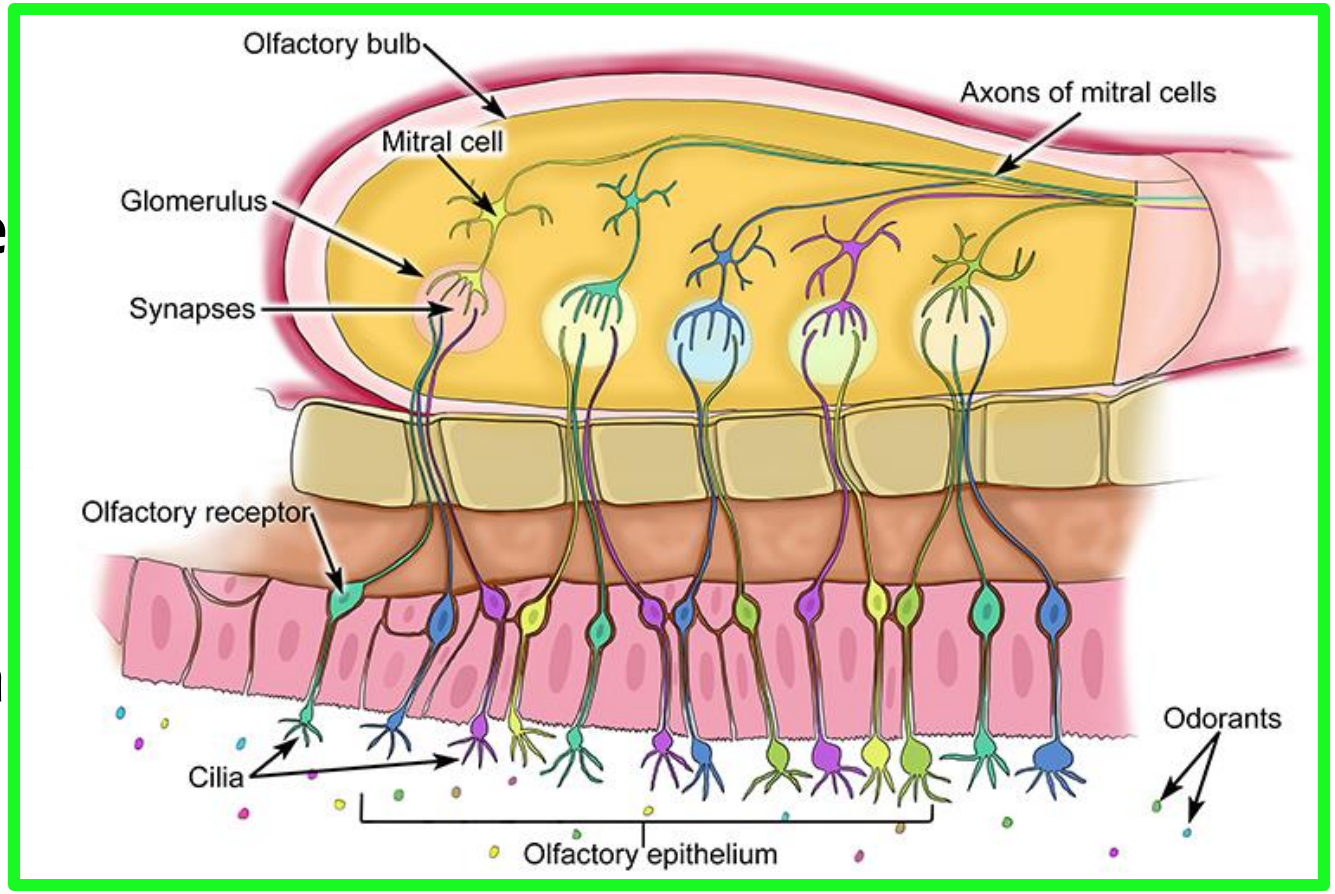


Olfactory Bulb

This ovoid structure possesses several types of nerve cells, the largest of which is the mitral cell. The incoming olfactory nerve fibers synapse with the dendrites of the mitral cells and form rounded areas known as synaptic glomeruli.

Smaller nerve cells, called tufted cells and granular cells, also synapse with the mitral cells.

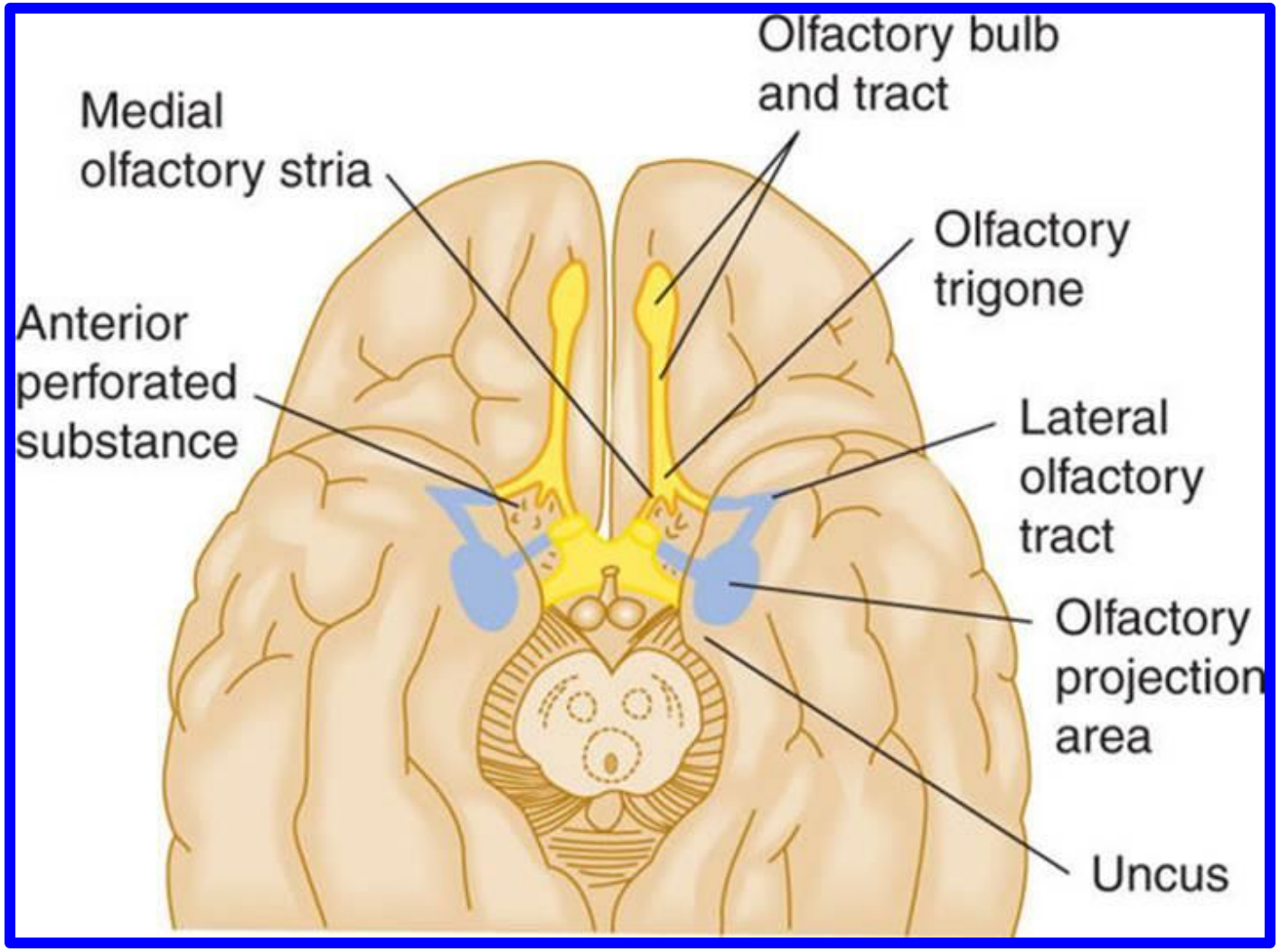
The olfactory bulb, in addition, receives axons from the contralateral olfactory bulb through the olfactory tract.



Olfactory Tract

- This narrow band of white matter runs from the posterior end of the olfactory bulb beneath the inferior surface of the frontal lobe of the brain

- It consists of the central axons of the mitral and tufted cells of the bulb and some centrifugal fibers from the opposite olfactory bulb.



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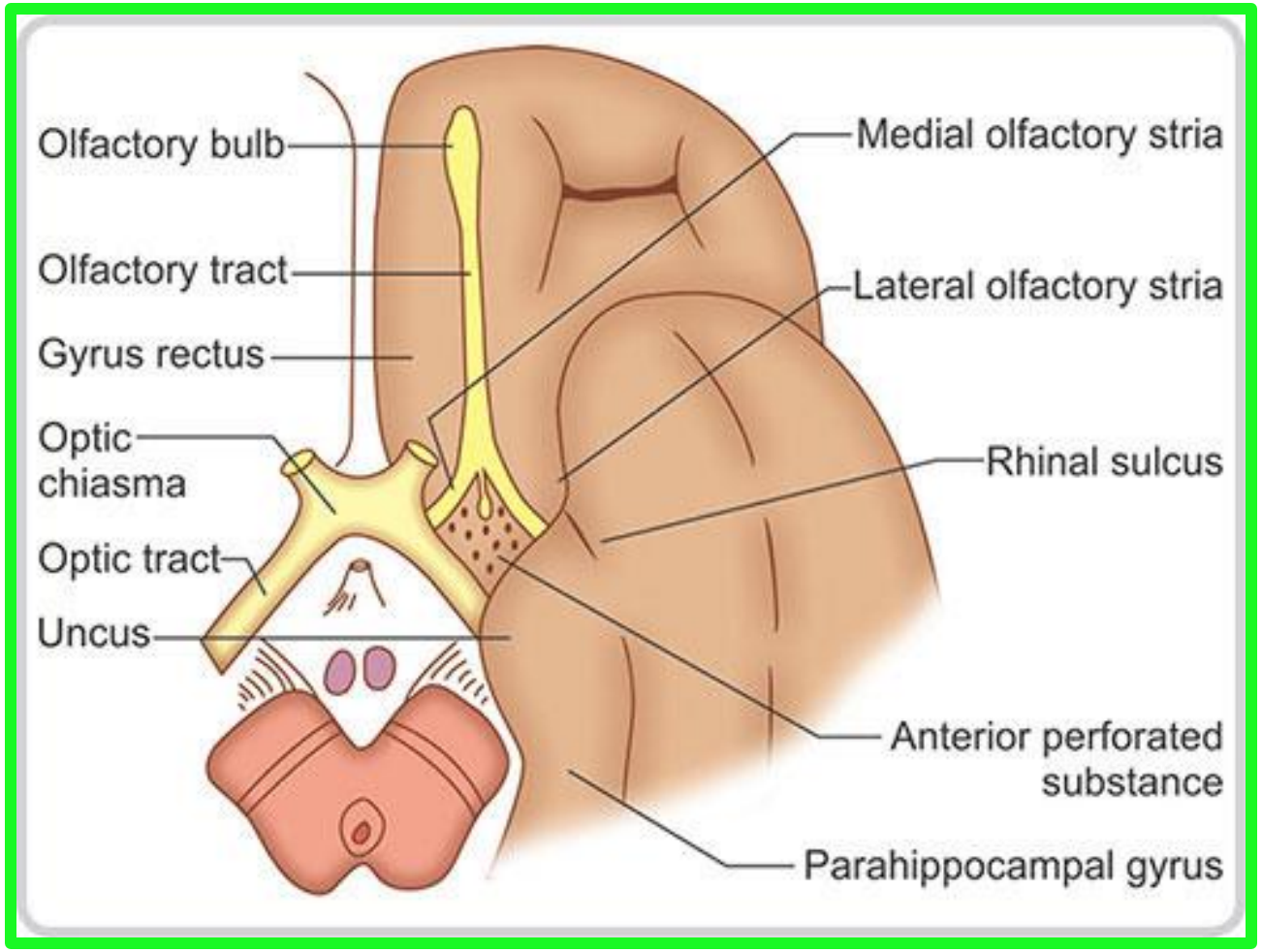
Olfactory Tract

- ✓ As the olfactory tract reaches the anterior perforated substance, it divides into medial and lateral olfactory striae.

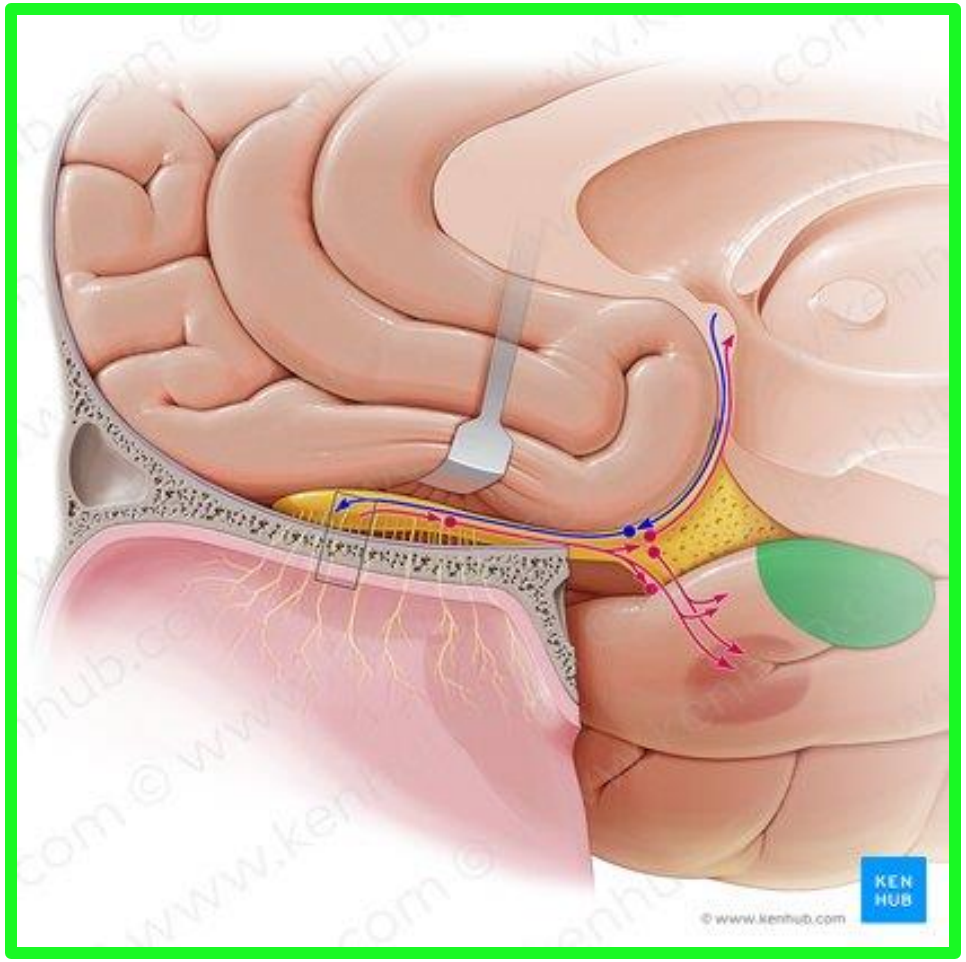
- ✓ The lateral stria carries the axons to the olfactory area of the cerebral cortex, namely, the periamygdaloid and prepiriform areas

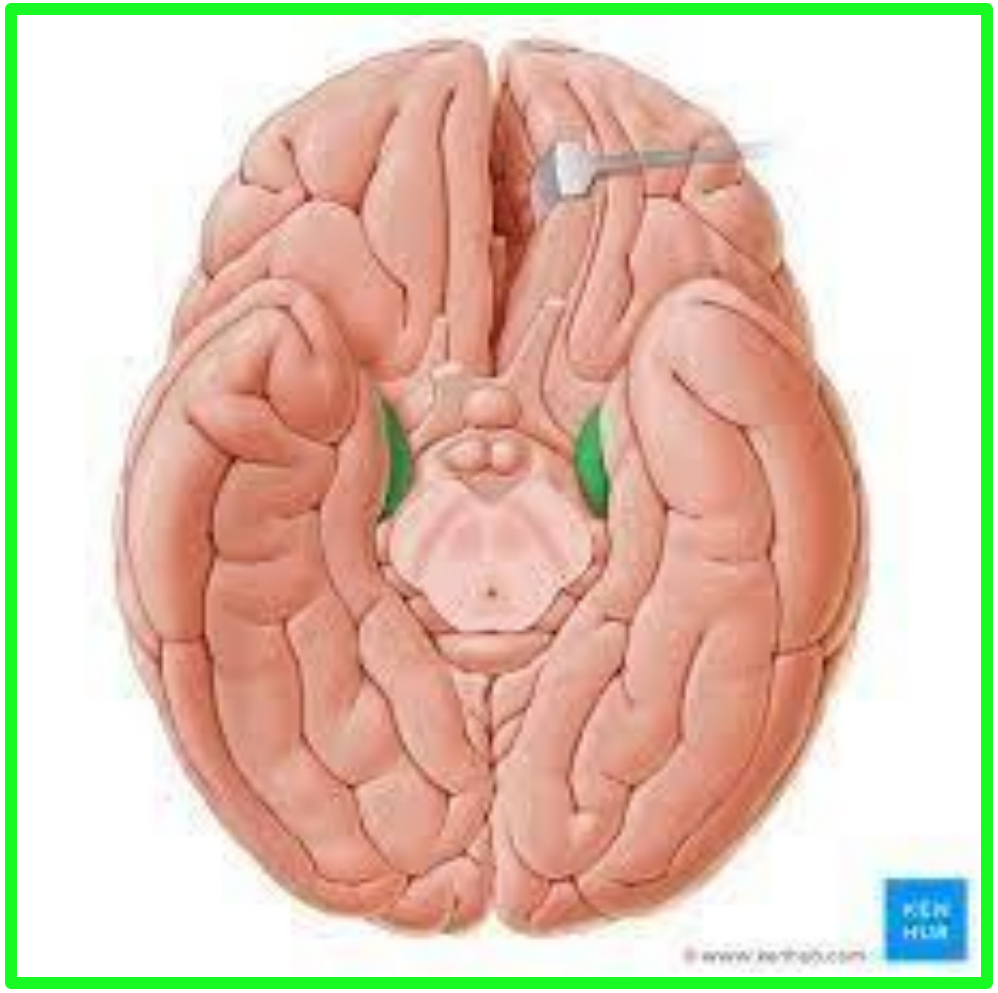


- ✓ The medial olfactory stria carries the fibers that cross the median plane in the anterior commissure to pass to the olfactory bulb of the opposite side.

Olfactory Tract

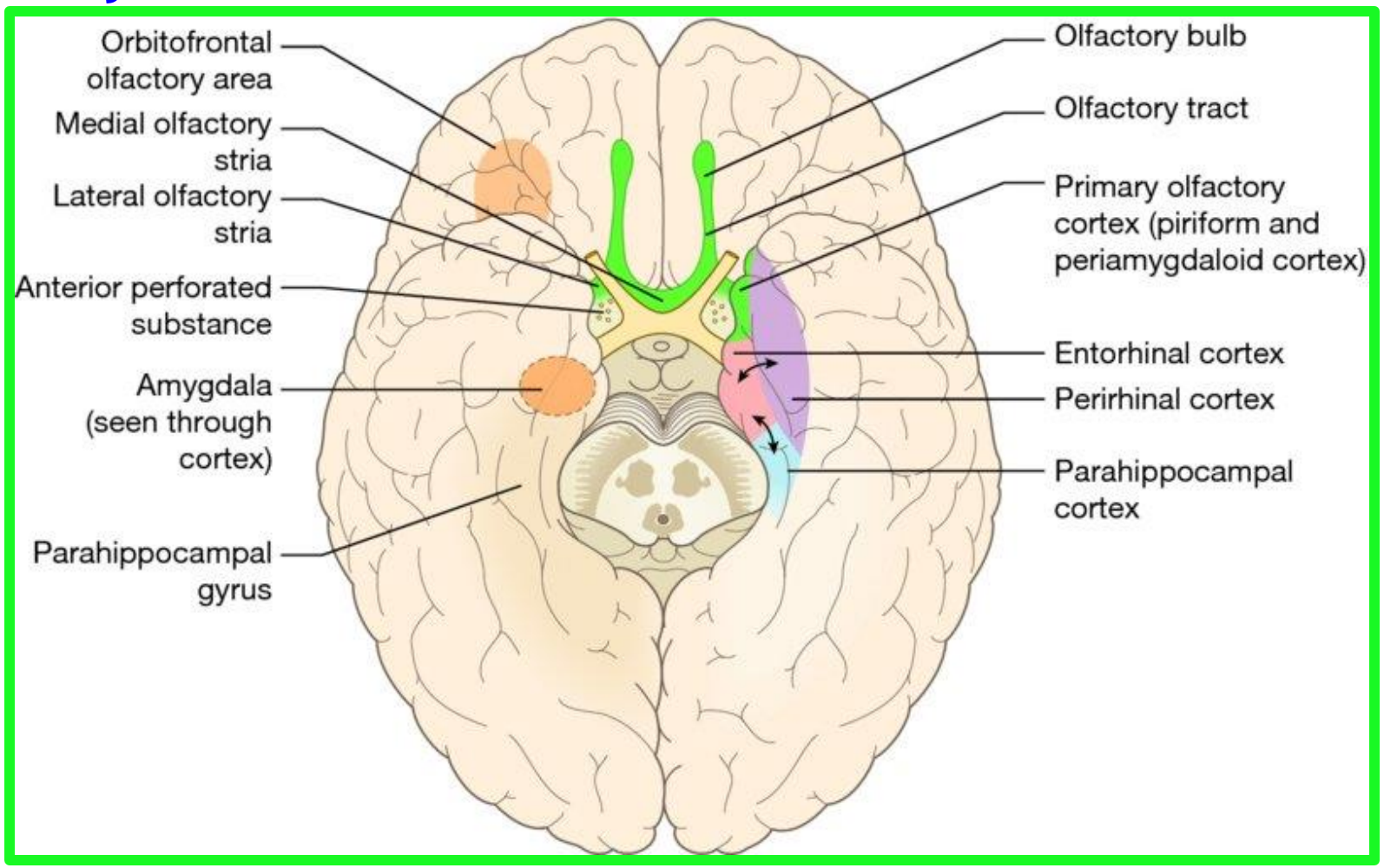
- ✓ **The periamygdaloid and prepiriform areas of the cerebral cortex are often known as the primary olfactory cortex. (Uncus and anterior perforated substances)**





Olfactory Tract

- ✓ **The entorhinal area (area 28) of the parahippocampal gyrus, which receives numerous connections from the primary olfactory cortex, is called the secondary olfactory cortex.**



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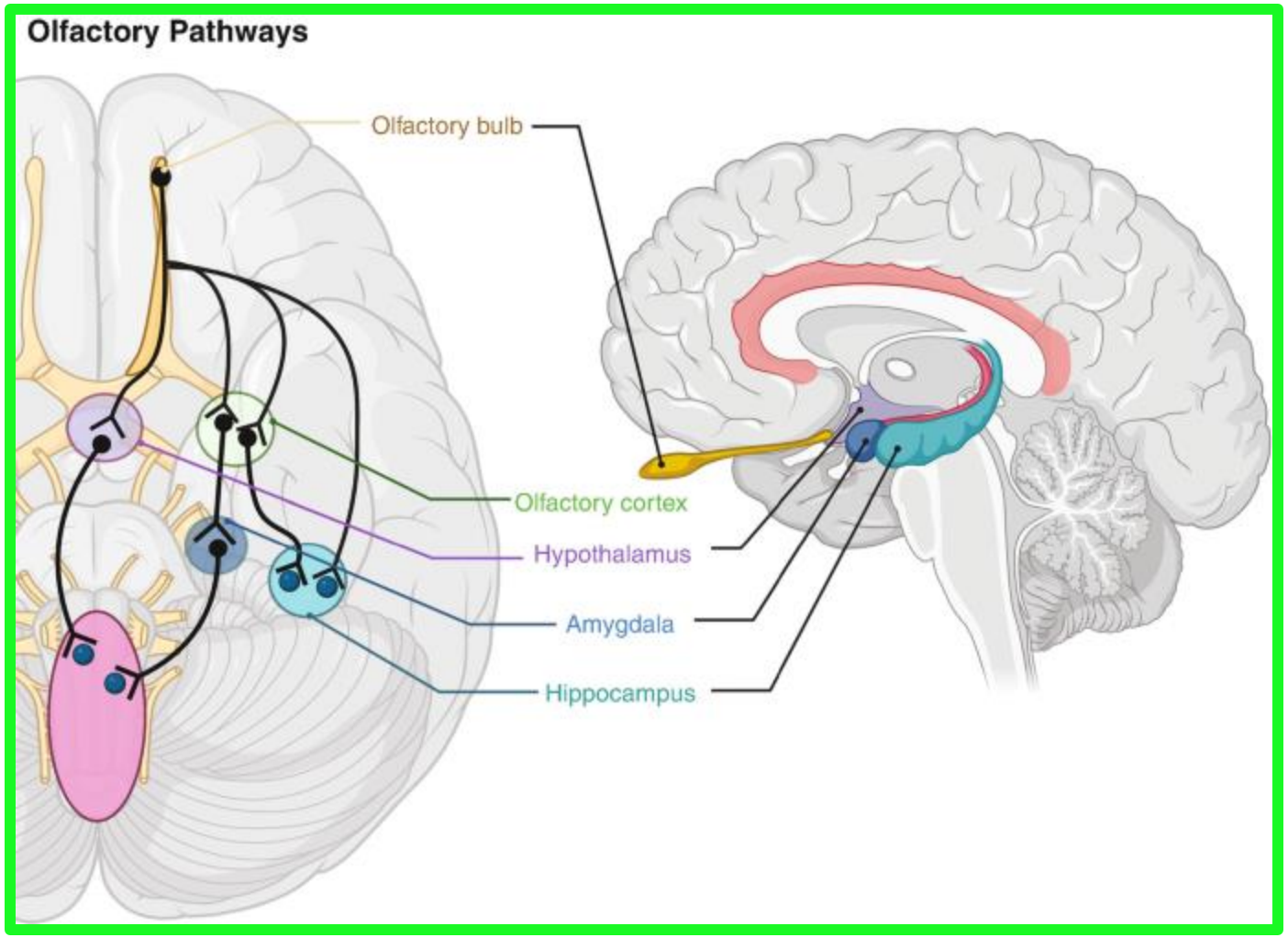
Olfactory Tract

- ✓ These areas of the cortex are responsible for the appreciation of olfactory sensations



- ✓ Note that in contrast to all other sensory pathways, the olfactory afferent pathway has only two neurons and reaches the cerebral cortex without synapsing in one of the thalamic nuclei.

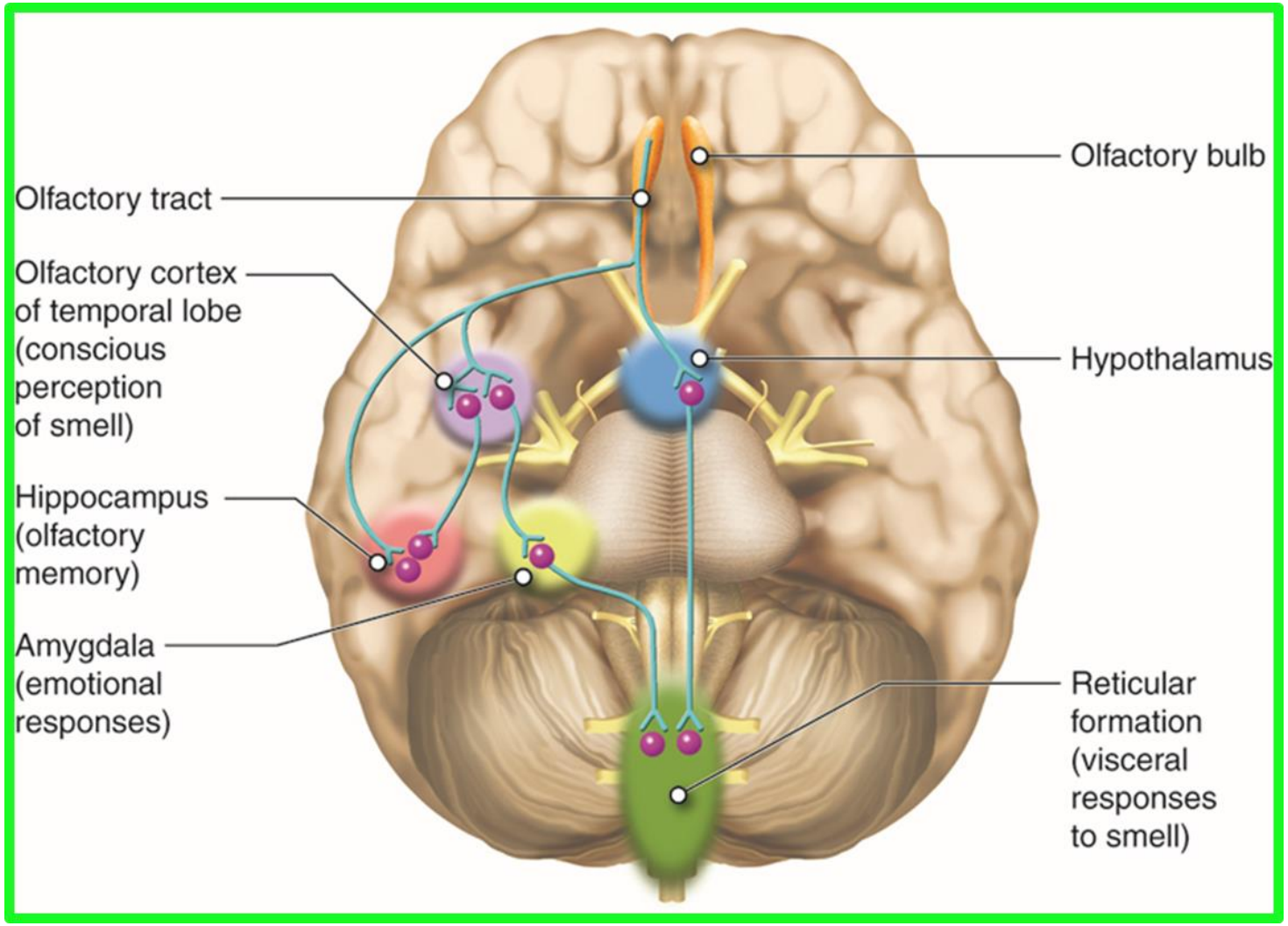
Olfactory Tract

The primary olfactory cortex sends nerve fibers to many other centers within the brain to establish connections :

A. **Hypothalamus and Amygdaloidal body(Limbic System) for Emotional response to smell**

B. **Reticular formation for autonomic response to smell like gastric secretion**

C. **Hippocampus for Olfactory memory**

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