
بسم الله الرحمن الرحيم

GROSS ANATOMY OF
OLFACTORY NERVE

By

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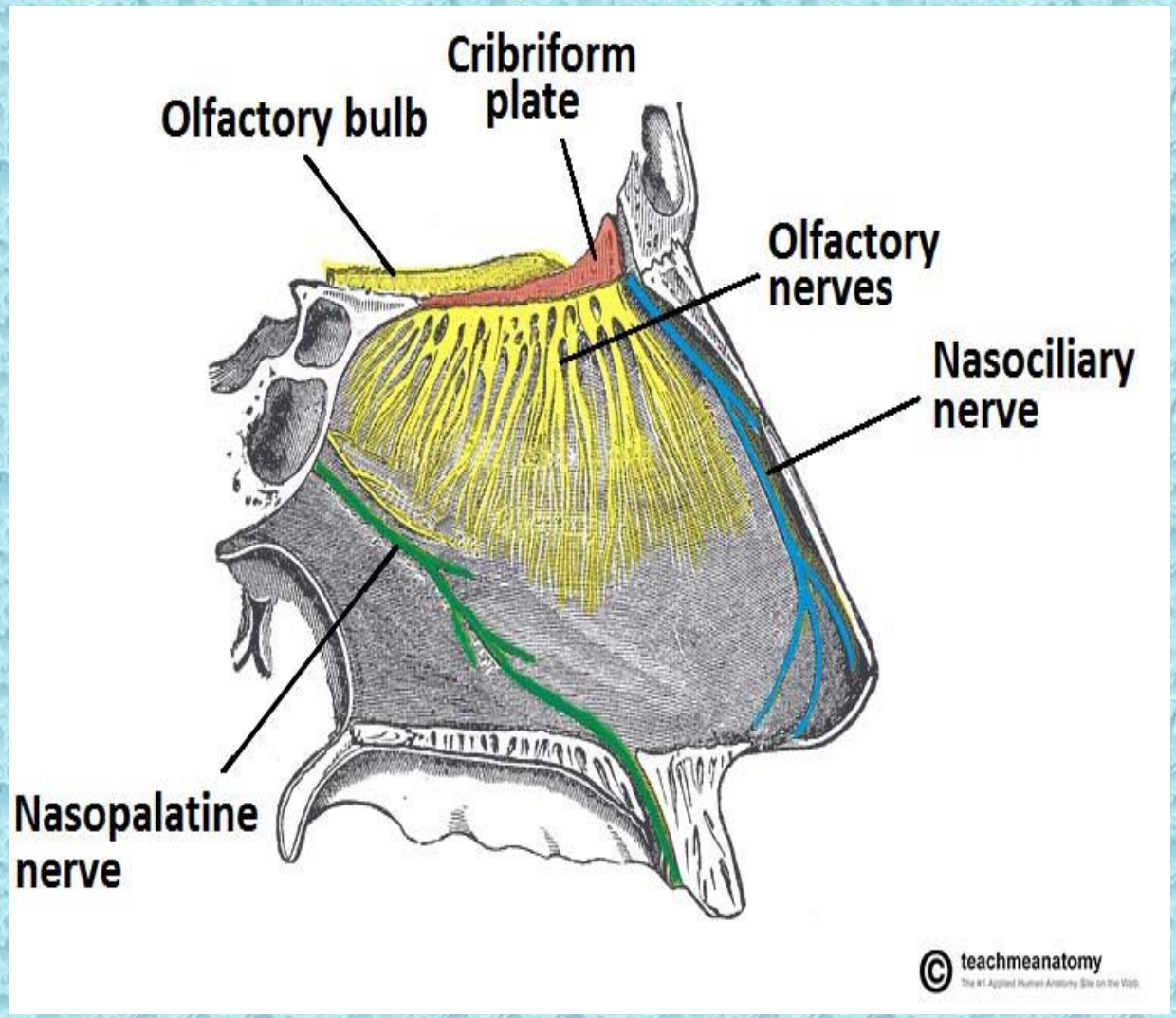
Anatomy and functions

First cranial nerve -- concerned with sense of smell.

- The olfactory nerve (CN I) is the first and shortest cranial nerve. It is a special visceral afferent nerve, which transmits information relating to **smell**.
- Embryologicallly, the olfactory nerve is derived from the **olfactory placode** (a thickening of the ectoderm layer), which also give rise to the glial cells which support the nerve.



Innervation of the nasal cavity. The olfactory nerve is responsible for the sense of smell. The nasociliary and nasopalatine nerves provide general sensation.

KEY FACTS ABOUT THE OLFACTORY NERVE AND PATHWAY

Function	Special sense of smell
Olfactory cells	Olfactory receptor cells (sense odor and contain cilia), supporting cells, basal (stem) cells (replacing old and damaged olfactory receptor cells).
Olfactory nerve	CN I formed out of a collection of olfactory receptor cell axons, which pass through the cribriform plate and into the roof of the nasal cavity.
Olfactory bulb	It is the relay station of the olfactory pathway and contains olfactory glomeruli.
Olfactory tract	It is made up of the axons of mitral relay neurons.
Olfactory striae	They are the medial and lateral divisions of the olfactory tract.
Olfactory cortex	Piriform cortex, amygdala, entorhinal cortex
Output destination	Orbitofrontal cortex,

PATHWAY

- **The pathway can be summarized as follows:**
- olfactory receptor cells.
- olfactory nerves.
- olfactory bulb.
- olfactory tract.
- olfactory striae.
- olfactory cortex.
- output targets of the olfactory cortex.

ANATOMICAL COURSE

The anatomical course of the **olfactory nerve** describes the transmission of special sensory information from the nasal epithelium to the primary olfactory cortex of the brain.

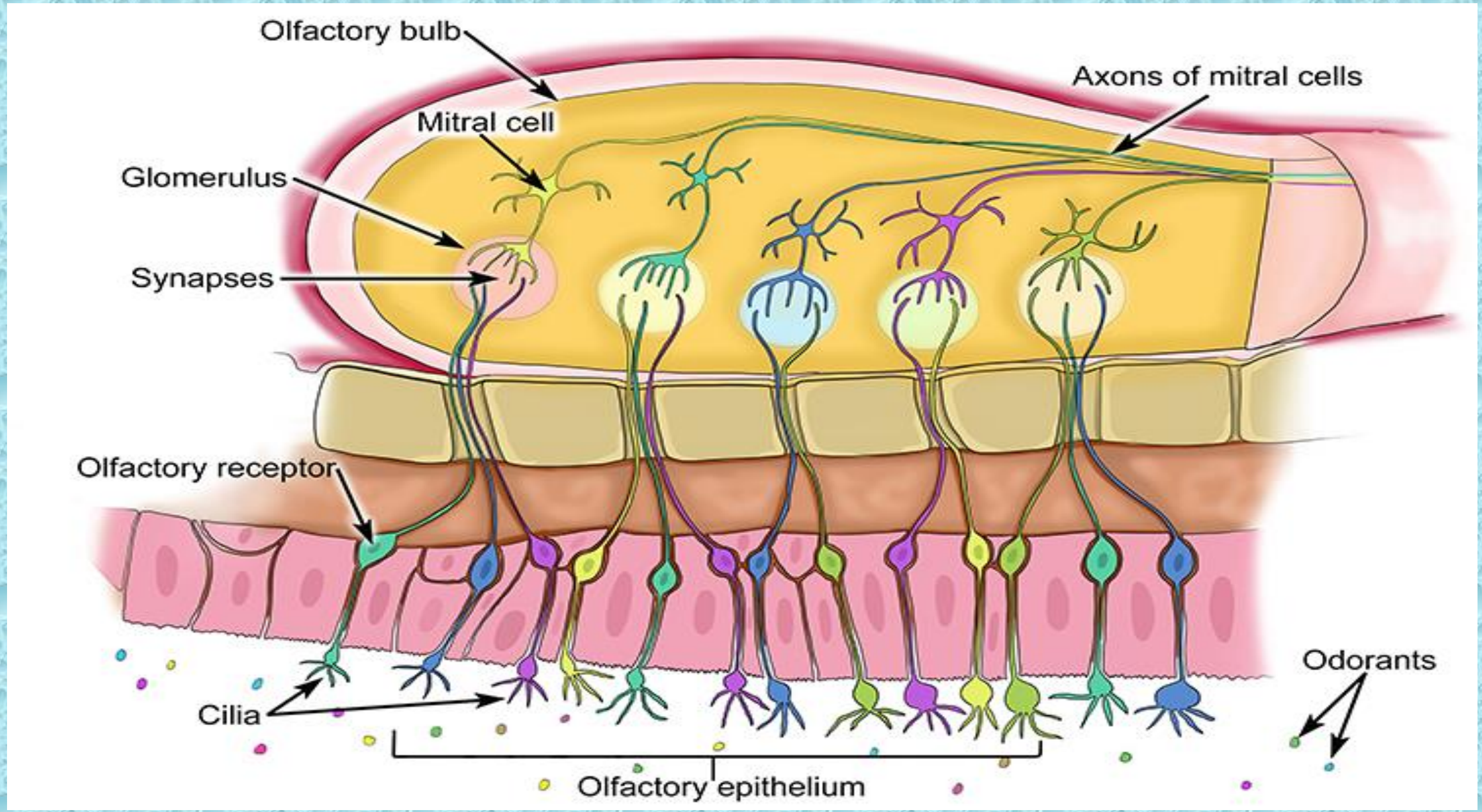
- **NASAL EPITHELIUM**

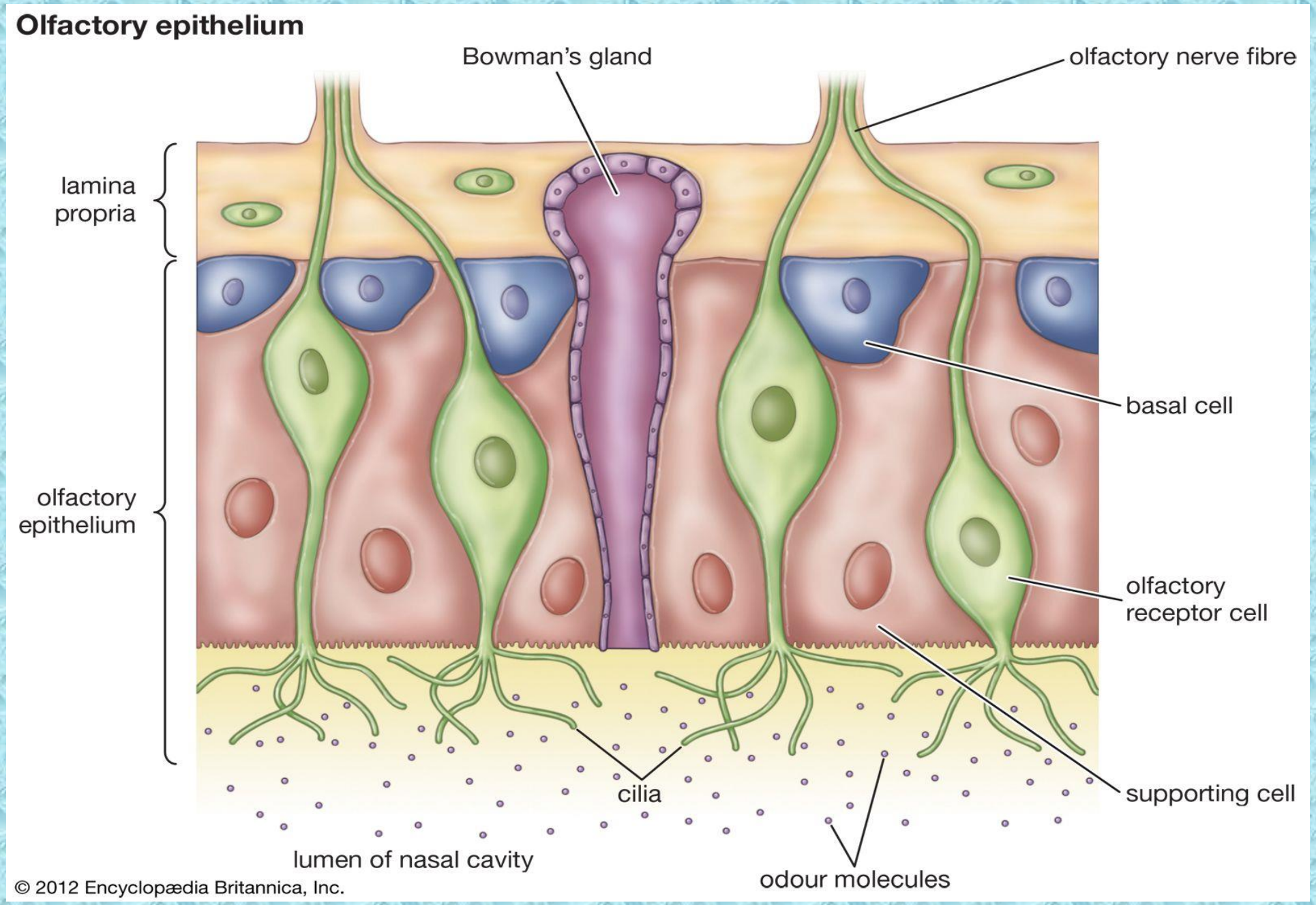
The sense of smell is detected by olfactory receptors located within the **nasal epithelium**. Their axons (fila olfactoria) assemble into small bundles of true olfactory nerves, which penetrate the small foramina in the cribriform plate of the ethmoid bone and enter the cranial cavity.

ANATOMICAL COURSE CONTD

OLFACTORY BULB

- Once in the cranial cavity, the fibres enter the **olfactory bulb**, which lies in the olfactory groove within the anterior cranial fossa.
- The olfactory bulb is an ovoid structure which contains specialised neurones, called **mitral cells**. The olfactory nerve fibres synapse with the mitral cells, forming collections known as **synaptic glomeruli**. From the glomeruli, second order nerves then pass posteriorly into the olfactory tract.


Olfactory bulb
Axons of mitral cells
Mitral cell
Glomerulus
Synapses
Olfactory receptor
Odorants
Cilia
Olfactory epithelium


Olfactory epithelium
Bowman's gland
olfactory nerve fibre
lamina propria
olfactory epithelium
basal cell
olfactory receptor cell
supporting cell
cilia
lumen of nasal cavity
odour molecules
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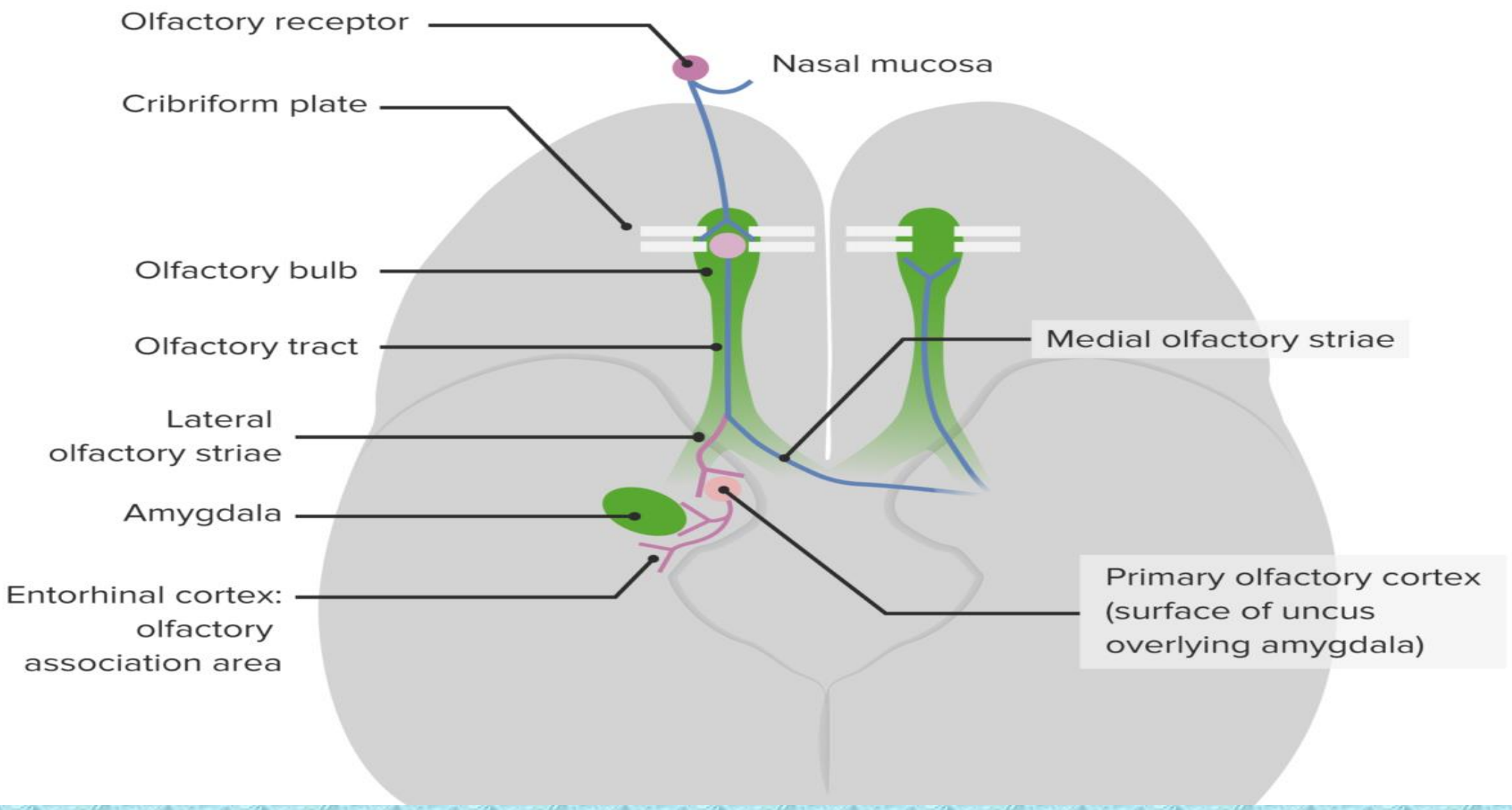
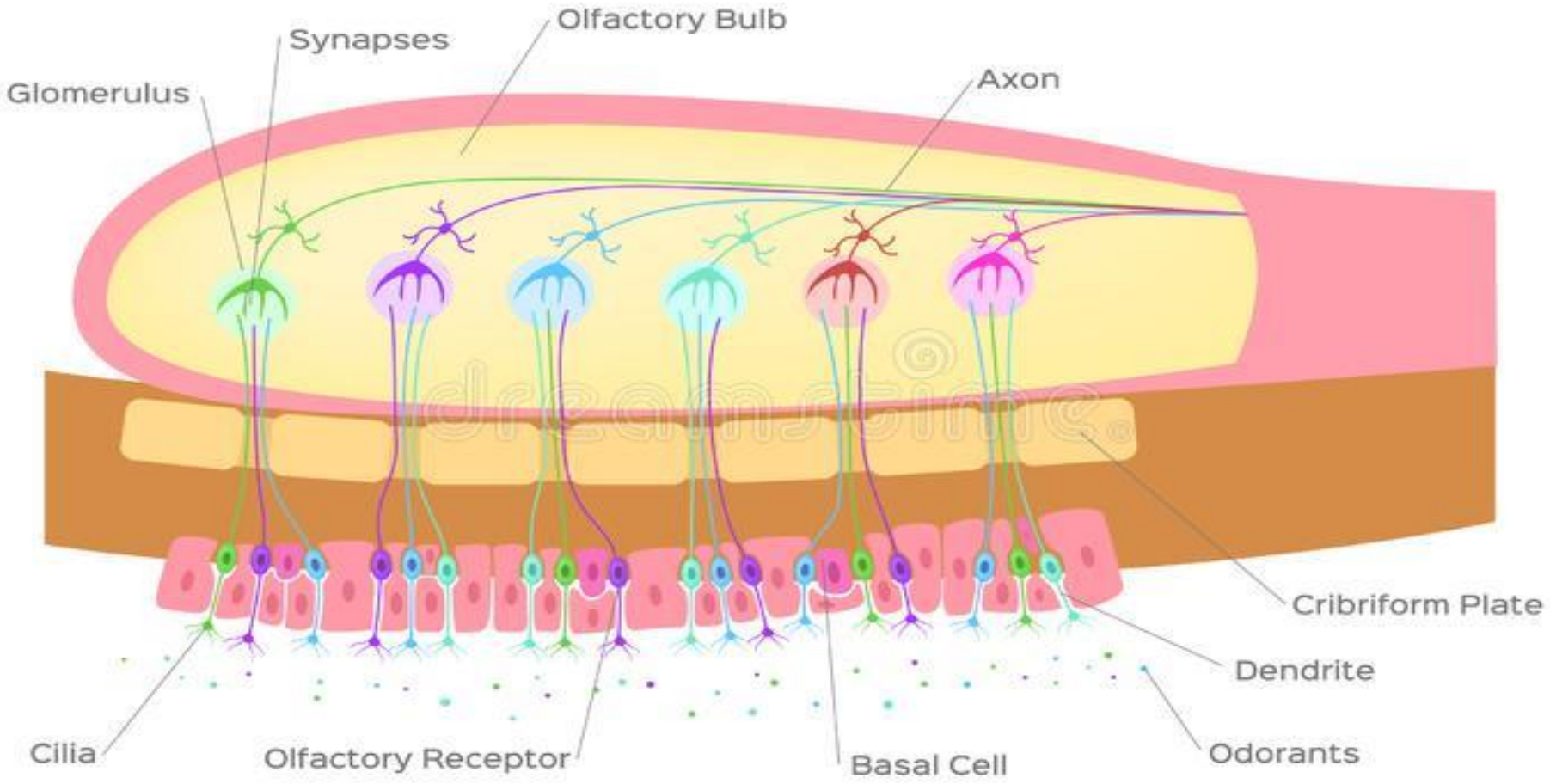
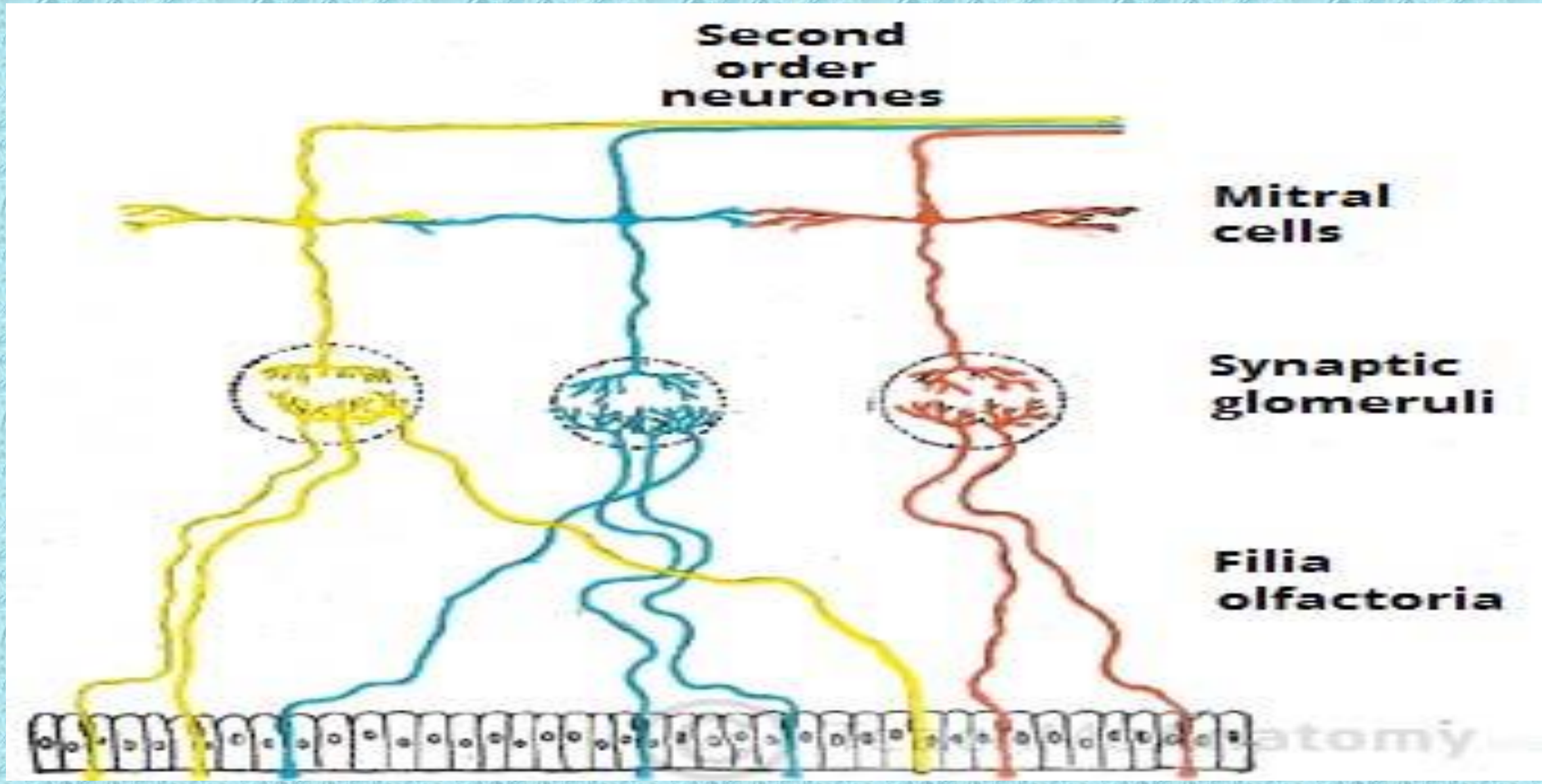
Olfaction


Olfactory receptor
Nasal mucosa
Cribriform plate
Olfactory bulb
Olfactory tract
Medial olfactory striae
Lateral olfactory striae
Amygdala
Entorhinal cortex: olfactory association area
Primary olfactory cortex (surface of uncus overlying amygdala)


Olfactory Bulb
Synapses
Glomerulus
Axon
Cribriform Plate
Dendrite
Odorants
Basal Cell
Olfactory Receptor
Cilia



INITIAL OLFACTORY NERVE FIBRE COURSE

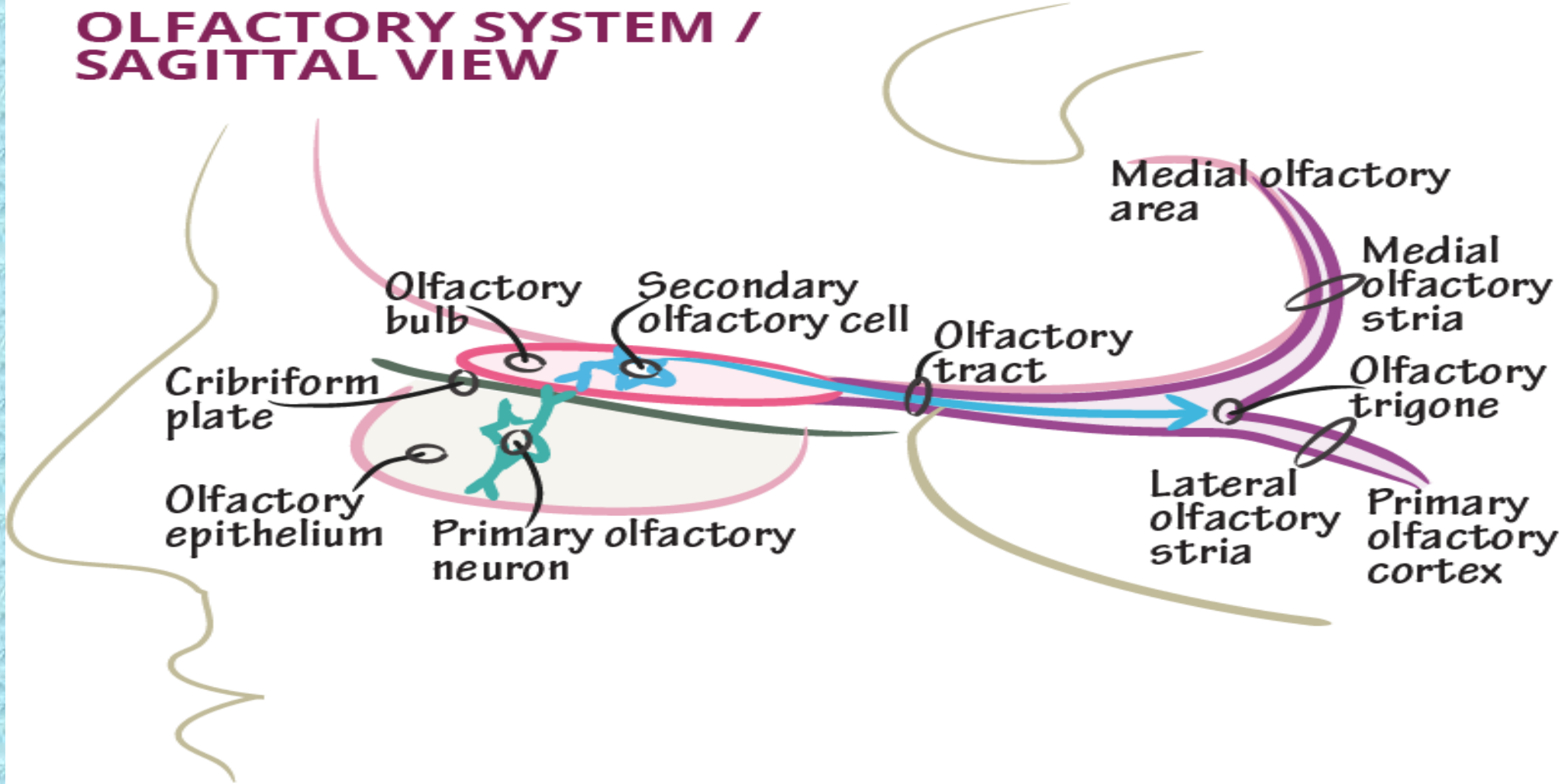
OLFACTORY STRIA

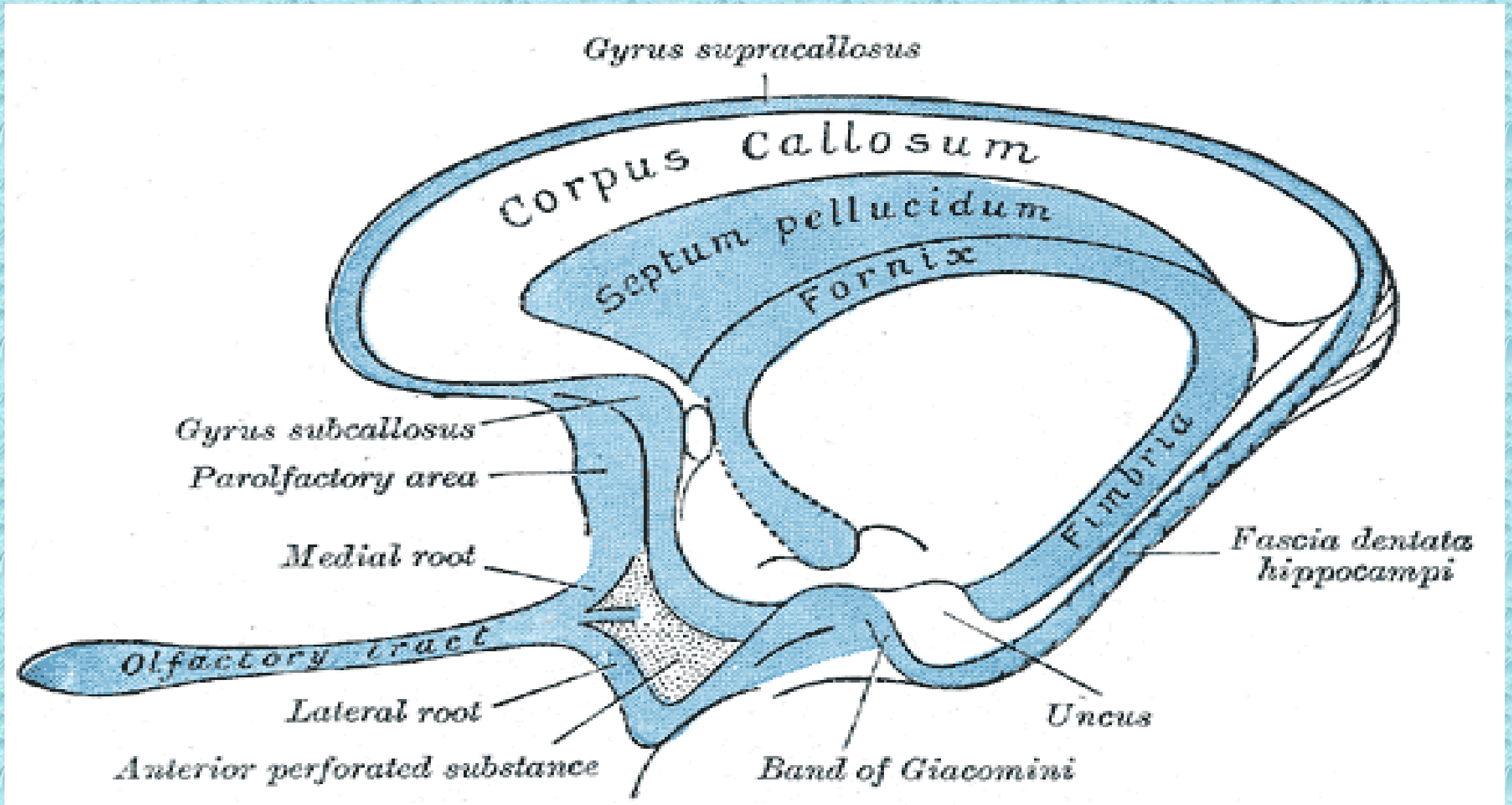
- Posterior and anterior to the optic chiasm,
- the olfactory tract on both sides divides into medial and lateral olfactory striae.
- The medial stria projects to the anterior commissure, and subsequently, to contralateral olfactory structures. They terminate on sub callosal gyrus on medial side of frontal lobe(septal area)
- The lateral stria continues on to structures associated with the olfactory cortex.(inferior surface of temporal lobe)

OLFACTORY CORTEX

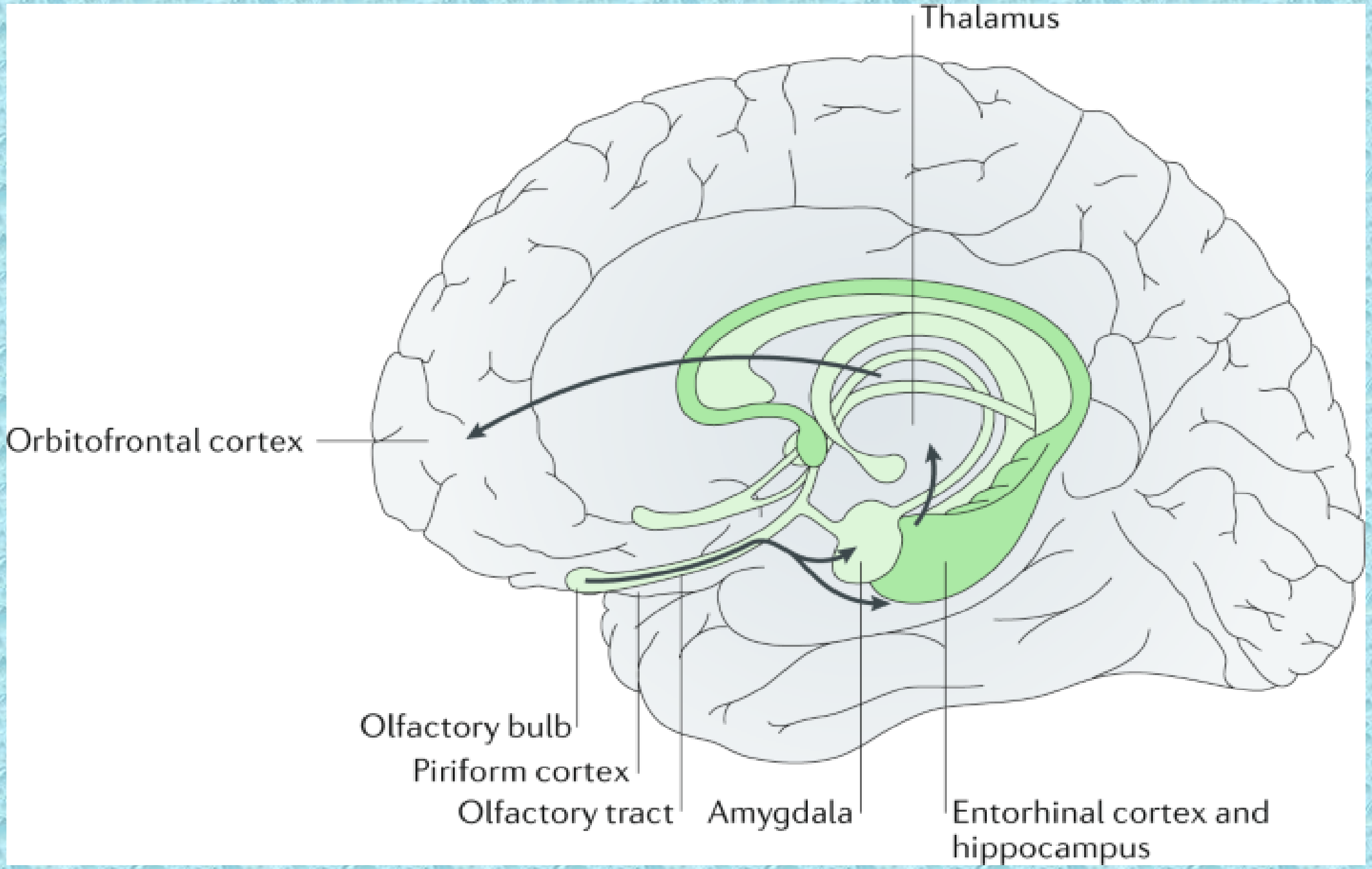
- This cortex is not a single structure, rather, it is defined as the combined areas of the cerebral cortex (generally within the temporal lobe) that receive input directly from the olfactory bulb. These regions include the:
- Piriform cortex: which is located below the lateral olfactory stria.
- Amygdala: which is located anterior to the temporal/inferior horn of the lateral ventricle, and is associated with the emotion of fear.
- Entorhinal cortex: which is the anterior part of the parahippocampal gyrus, and is involved in the formation of memory

OLFACTORY SYSTEM / SAGITTAL VIEW

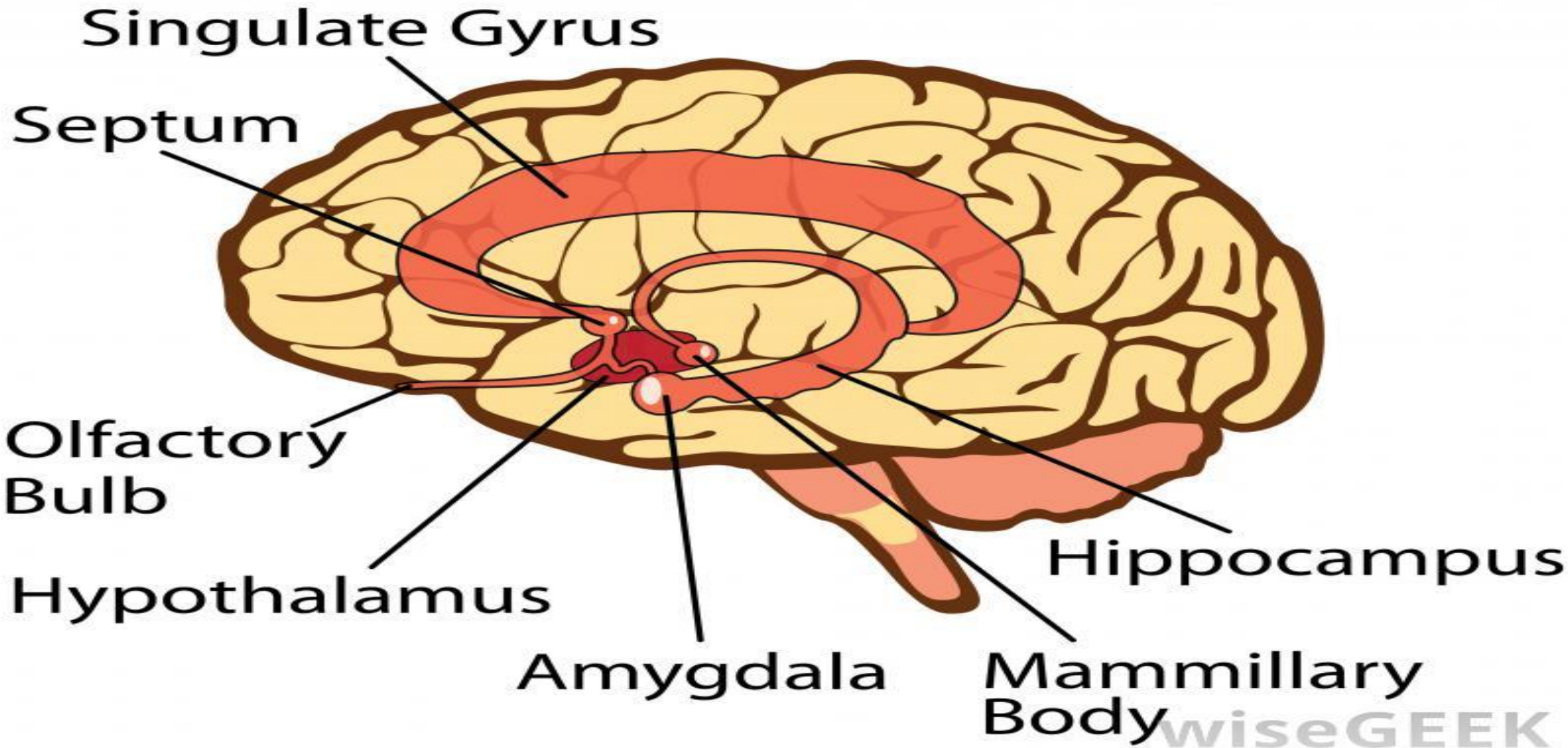



Gyrus supracallosus
Corpus callosum
Septum pellucidum
Fornix
Fimbria
Gyrus subcallosus
Parolfactory area
Medial root
Olfactory tract
Lateral root
Anterior perforated substance
Band of Giacomini
Uncus
Fascia dentata hippocampi

- From the olfactory cortex (Primary olfactory cortex)information about smell is sent to the orbitofrontal cortex (secondary olfactory cortex)via the dorsal medial nucleus of the thalamus.
- The orbitofrontal cortex is a portion of the prefrontal cortex that is located on the underside of the frontal lobe and situated over the eye orbit.
- Lesions of this cortical region can result in an inability to distinguish different odors. Odor information is also sent to portions of the hypothalamus and brainstem that trigger autonomic responses involved in appetite, salivation, and gastric contraction.


Thalamus
Orbitofrontal cortex
Olfactory bulb
Piriform cortex
Olfactory tract
Amygdala
Entorhinal cortex and hippocampus

LIMBIC SYSTEM STRUCTURES



OLFACTORY TRACT

The olfactory tract travels posteriorly on the inferior surface of the **frontal lobe**. As the tract reaches the anterior perforated substance (an area at the level of the optic chiasm) it divides into medial and lateral stria**:**

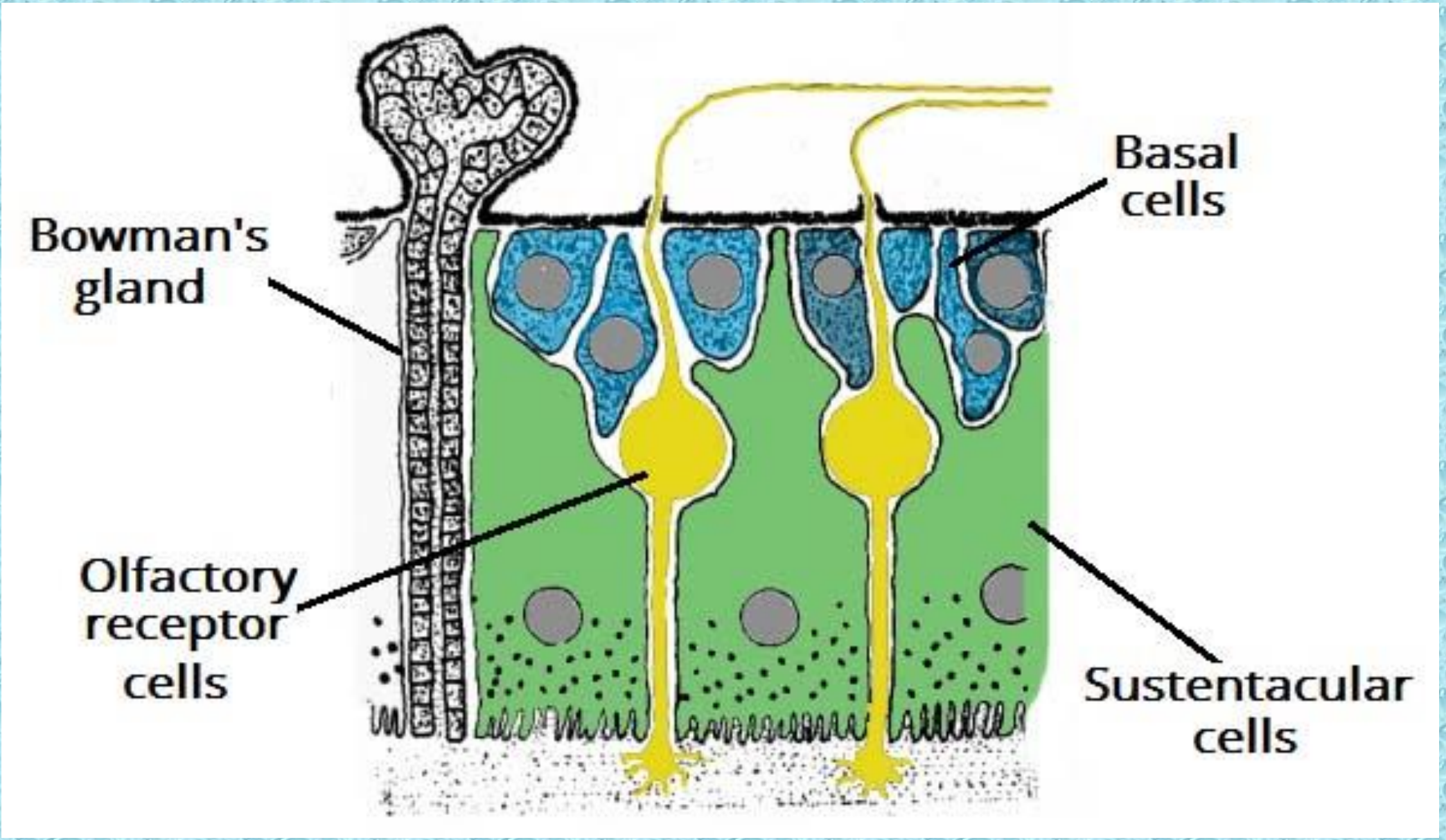
- **LATERAL STRIA** – carries the axons to the primary olfactory cortex, located within the uncus of temporal lobe.
- **MEDIAL STRIA** – carries the axons across the medial plane of the anterior commissure, where they meet the olfactory bulb of the opposite side.
- The primary olfactory cortex sends nerve fibres to many other areas of the brain, notably the piriform cortex, the amygdala, olfactory tubercle and the secondary olfactory cortex. These areas are involved in the memory and appreciation of olfactory sensations.

SENSORY FUNCTION

- The sensory function of the olfactory nerve is achieved via the **olfactory mucosa**. This mucosal layer not only senses smell, but it also detects the more advanced aspects of taste.
- It is located in the roof of the nasal cavity and is composed of **pseudostratified columnar** epithelium which contains a number of cells:
- **Basal cells** – form the new stem cells from which the new olfactory cells can develop.
- **Sustentacular cells** – tall cells for structural support. These are analogous to the glial cells located in the CNS.

SENSORY FUNCTION CONTD

- **OLFACTORY RECEPTOR CELLS** – bipolar neurons which consist of two processes:
  - Dendritic process projects to the surface of the epithelium, where they project a number of short cilia, the olfactory hairs, into the mucous membrane. These cilia react to odors in the air and stimulate the olfactory cells.
  - Central process (also known as the axon) projects in the opposite direction through the basement membrane.
- In addition to the epithelium, there are **Bowman's glands** present in the mucosa, which secrete mucus.



THE CELLS OF THE OLFACTORY EPITHELIUM

INTERPRETATIONS

- **The following terms are used to describe the degree of smell aberration**

1) Anosmia: Absence of smell sensation.
2) Hyposmia: Diminished sense of smell.
3) Parosmia: Peverted sense of smell.
4) Cacosmia: Perception of unpleasant odour in the absence of olfactory stimuli.

INTERPRETATIONS

5) Hyperosmia: Acute sense of smell (lowered threshold of odour)
6) Presbyosmia: Decrease in sense of smell due to aging
7) Coprosmia: Cacosmia with a fecal sent.
8) Phantosmia: Perception of smell that is not real.

CLINICAL RELEVANCE: ANOSMIA

- Anosmia is defined as the absence of the sense of smell. It can be temporary, permanent, progressive or congenital.
- **Temporary** anosmia can be caused by infection (e.g. meningitis) or by local disorders of the nose (e.g. common cold)
- **Permanent** anosmia can be caused by head injury, or tumours which occur in the olfactory groove (e.g. meningioma).
- Anosmia can also occur as a result of **neurodegenerative conditions**, such as Parkinson's or Alzheimer's disease. In these conditions, the anosmia is **progressive** and precedes motor symptoms but it is **not often noticed by the patient**.

CLINICAL RELEVANCE
OLFACTORY NERVE EXAMINATION

- Assessment of the olfactory nerve is an important part of a complete **cranial nerve examination**.
- First, the patient should be asked if they have noticed any changes in their taste or sense of smell. Then each nostril should be tested, asking the patient to **identify a certain smell** (peppermint or coffee are often used). The eyes should be closed for this part of the examination.


ThankYou!