



Smell sensation (Olfaction)

By

Dr. Amr Medhat Abbas

Professor of Medical Physiology



Learning outcomes:

- **At the end of the lecture, you will be able to:**

1. Describe the site, surface area, structure and innervation of the olfactory mucosa.
2. Explain the characters of the odorant substance.
3. Explain the mechanism of stimulation of the olfactory receptors.
4. Explain the olfactory cortex.
5. Explain the adaptation of olfaction.
6. Explain the olfactory discrimination.
7. Explain the significance of smell.
8. Explain the disturbances of olfaction.



Smell sensation

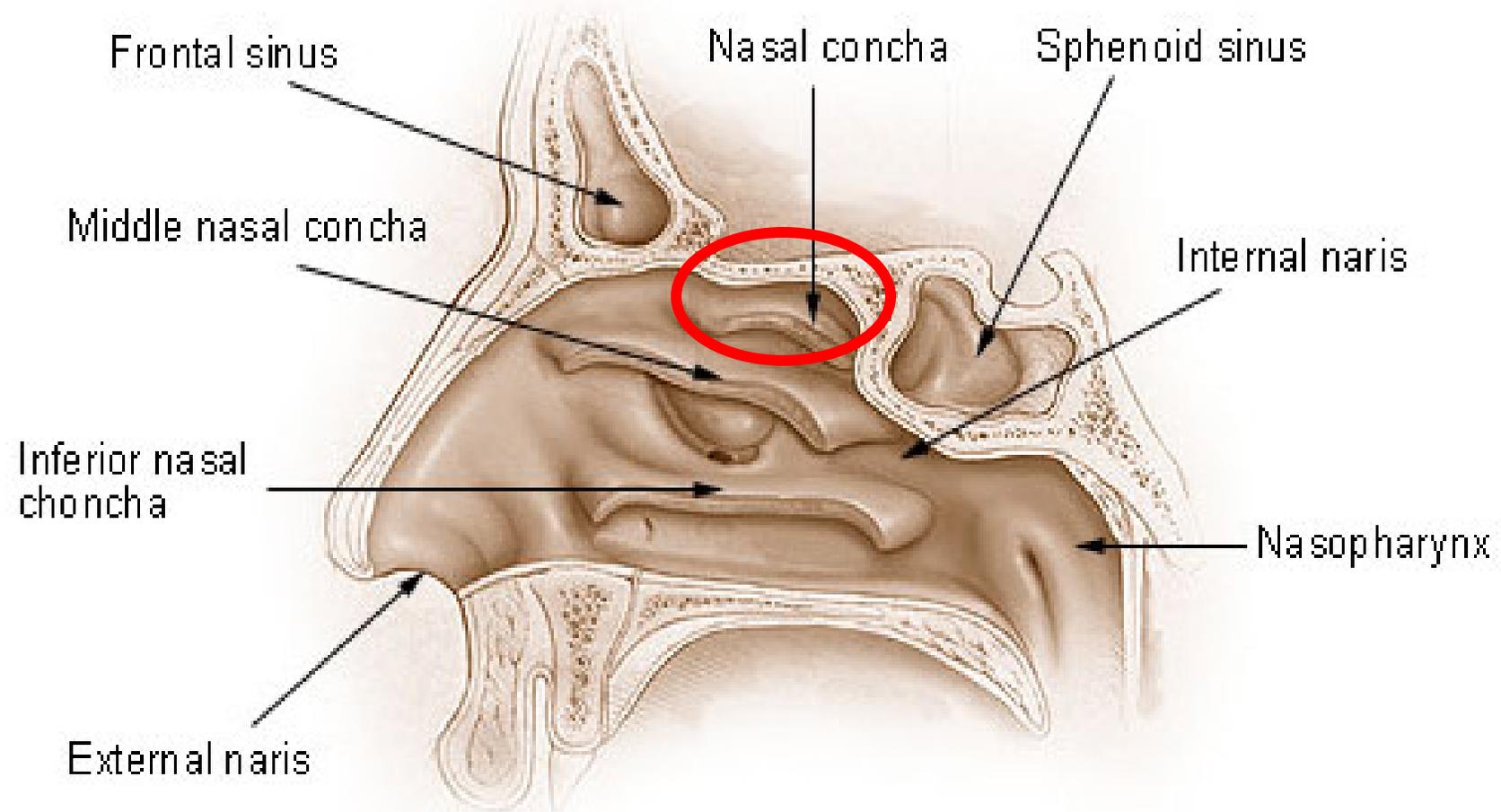
- **Def:** The olfactory (smell) sensation is a **chemical sense** involving receptors which are sensitive to volatile chemical substances.



Olfactory mucosa

- **Site:** It is located on the **superior nasal concha** and the **upper third of the nasal septum.**
- **Surface area:** The total area of the olfactory mucosa on both sides is about **5 cm².**

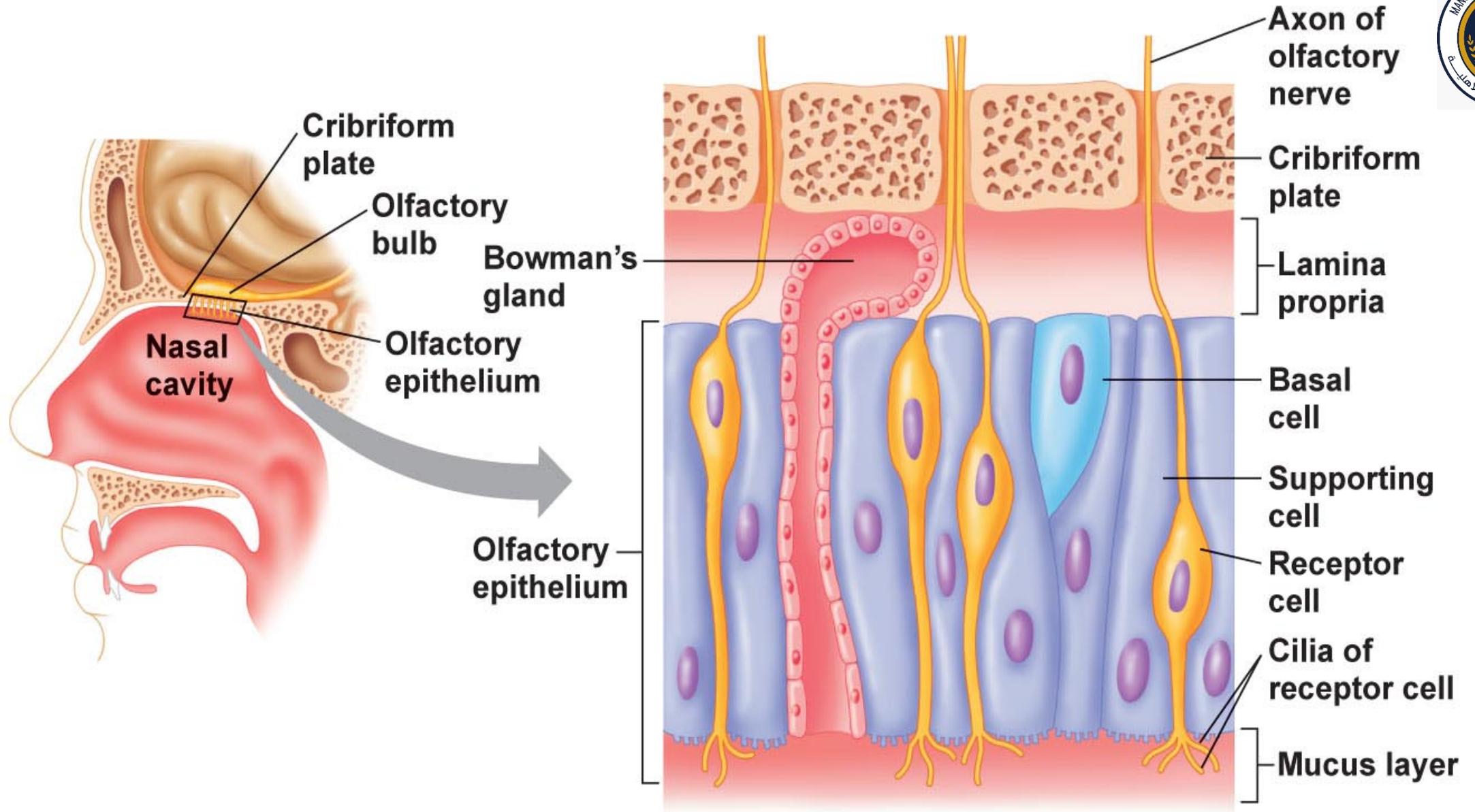
Nose and Nasal Cavities



➤ The olfactory mucosa is distinguished from the surrounding respiratory mucosa by:



- 1) Its distinctive *yellow-brown pigments*
- 2) The presence of many *tubular Bowman's glands*
- 3) *Absence of rhythmic ciliary movements* that characterize the respiratory mucosa





➤ The olfactory mucosa is innervated by:

a. Olfactory (cranial I) nerves which are stimulated by the odorant substances

b. Branches of the trigeminal (cranial V) nerve which are stimulated by the irritative effect of some odors as peppermint, menthol, and chlorine. They are responsible for initiating sneezing, lacrimation, respiratory inhibition, and other reflex responses to nasal irritants.



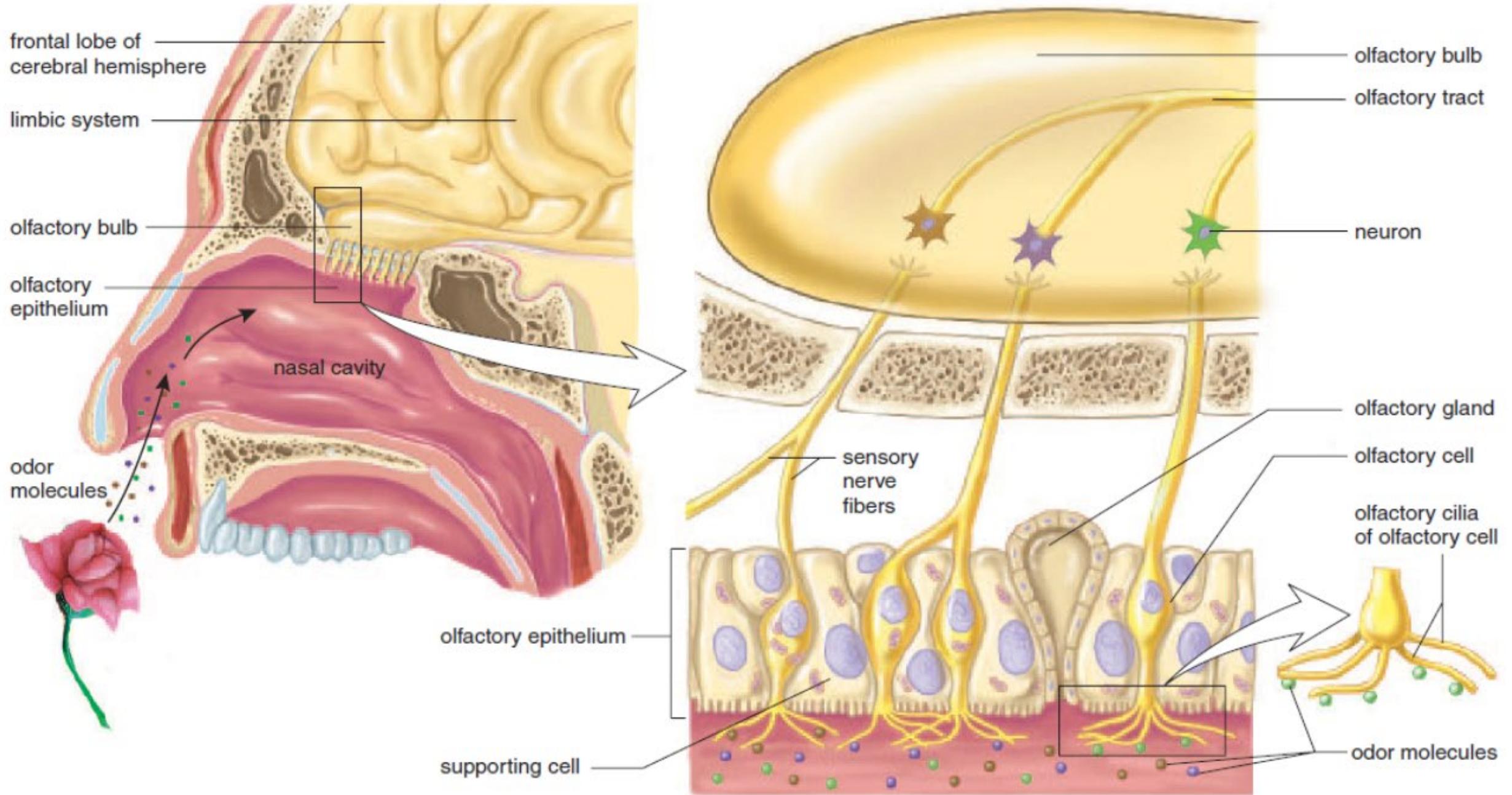
➤ Structure of olfactory mucosa:

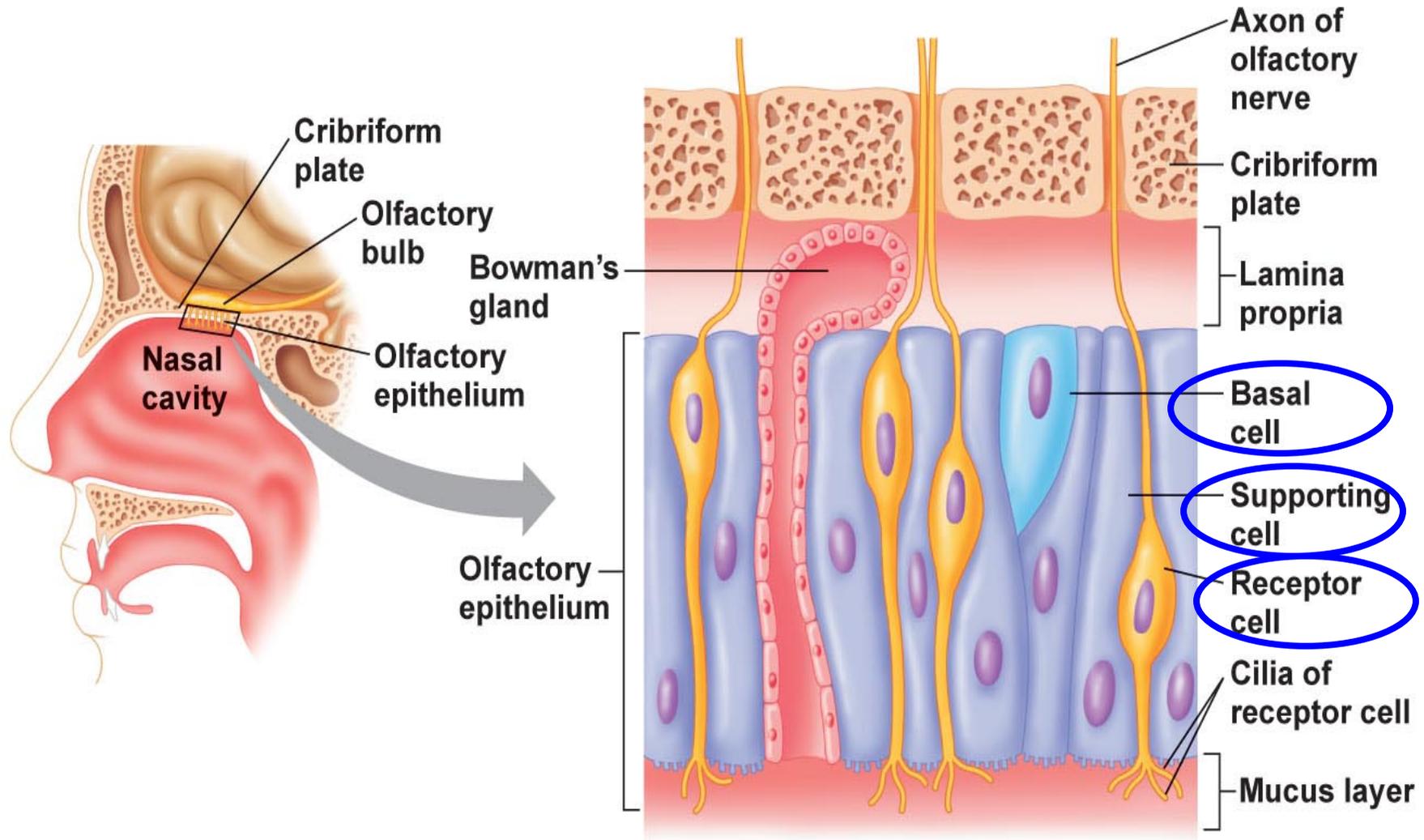
Histologically olfactory mucosa consists of **3 types of cells** and great number of mucus secreting glands (**Bowman's glands**):

a) Olfactory receptor cells:

* They are bipolar neurons which have:

❑ Dendrite: A short thick dendrite with an expanded end called **olfactory rod**. From these rods, **cilia (10-20 cilia per neuron)** project to the surface of mucus.





□ **Axon**: The axons of the olfactory receptor neurons pierce the **cribriform plate of the ethmoid bone** and enter the **olfactory bulbs**.

* Each olfactory mucosa contains **100 million olfactory cells**.

* These olfactory neurons are **continually regenerated throughout life** (their **life span** is about **60 days**).



b) Supporting cells.

c) Basal cells: They are the **stem** cells for the production of **new receptor** cells.

Bowman's glands

- They are **small mucus secreting glands** which are interspersed among the cells of olfactory epithelium
- They secrete a layer of **mucus** covering the surface of the olfactory membrane.

Stimulation of the olfactory receptors:

- *The odorant substance must be:*

1. Volatile in order to be sniffed into the nose to reach the olfactory receptors.

2. Sufficiently water soluble in order to pass through mucous layer coating the mucosa to reach the olfactory cells

3. Lipid soluble in order to penetrate the cells membrane of the olfactory cells.

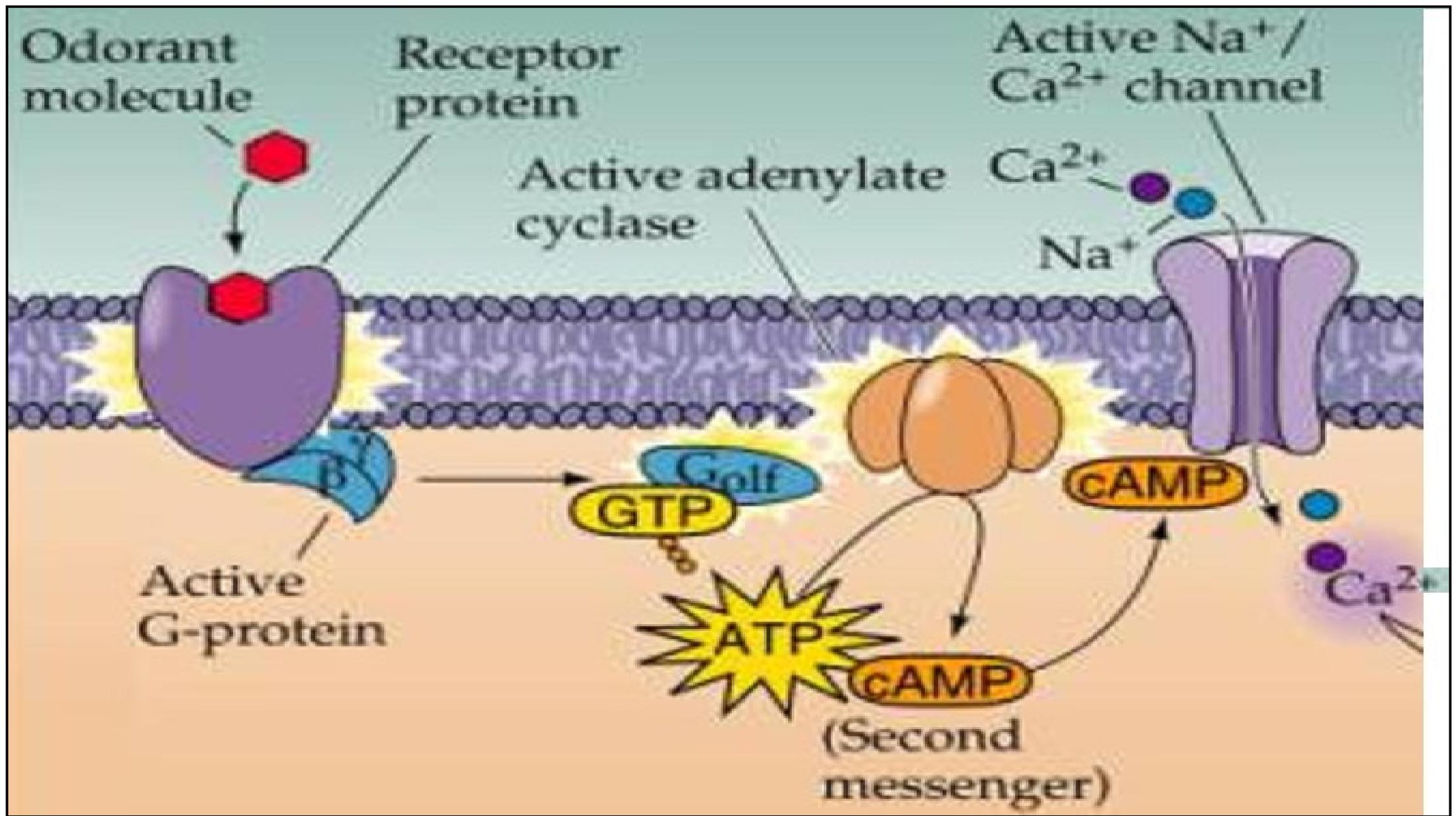
- The olfactory cells are stimulated when **air blasts upwards** into the superior region of **the nose**. The amount of air reaching this region is greatly increased by **sniffing**.

Mechanism of stimulation of olfactory receptors

- The odorant substance, on coming in contact with the olfactory mucosa, → first diffuses into the mucus that covers the cilia, → then binds with odorant-binding proteins (OBP) that trap and concentrate the substances and transfer them to the olfactory receptors.



- The odorant receptors are **G-protein coupled receptors**. The specific G-protein in olfactory receptors is called **Golf** (G-protein in olfactory receptor). Binding the odour to the receptor → activates Golf → stimulates **adenylate cyclase** → **↑cAMP** → **opens Na, Ca channels** → **depolarization** and generation of **receptor potential** which at threshold levels will fire an **action potential**.





Olfactory cortex

A) Medial olfactory area:

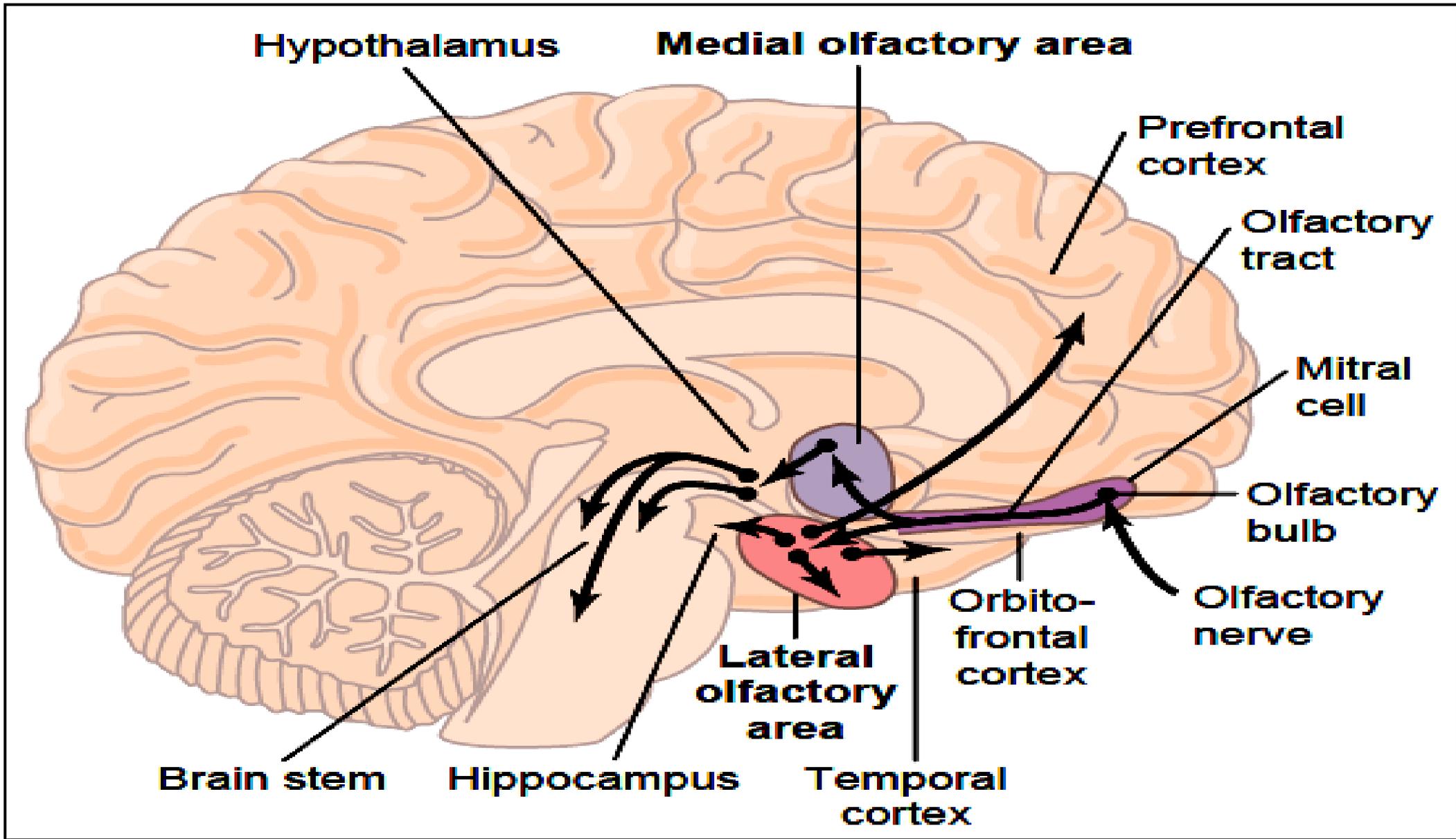
- The medial olfactory area **consists of** a group of nuclei immediately anterior to hypothalamus
e.g. *septal nuclei*, and portions of limbic system.



- This olfactory area is **concerned with:**

a. Primitive responses to olfaction, such as licking the lips, salivation caused by the smell of food.

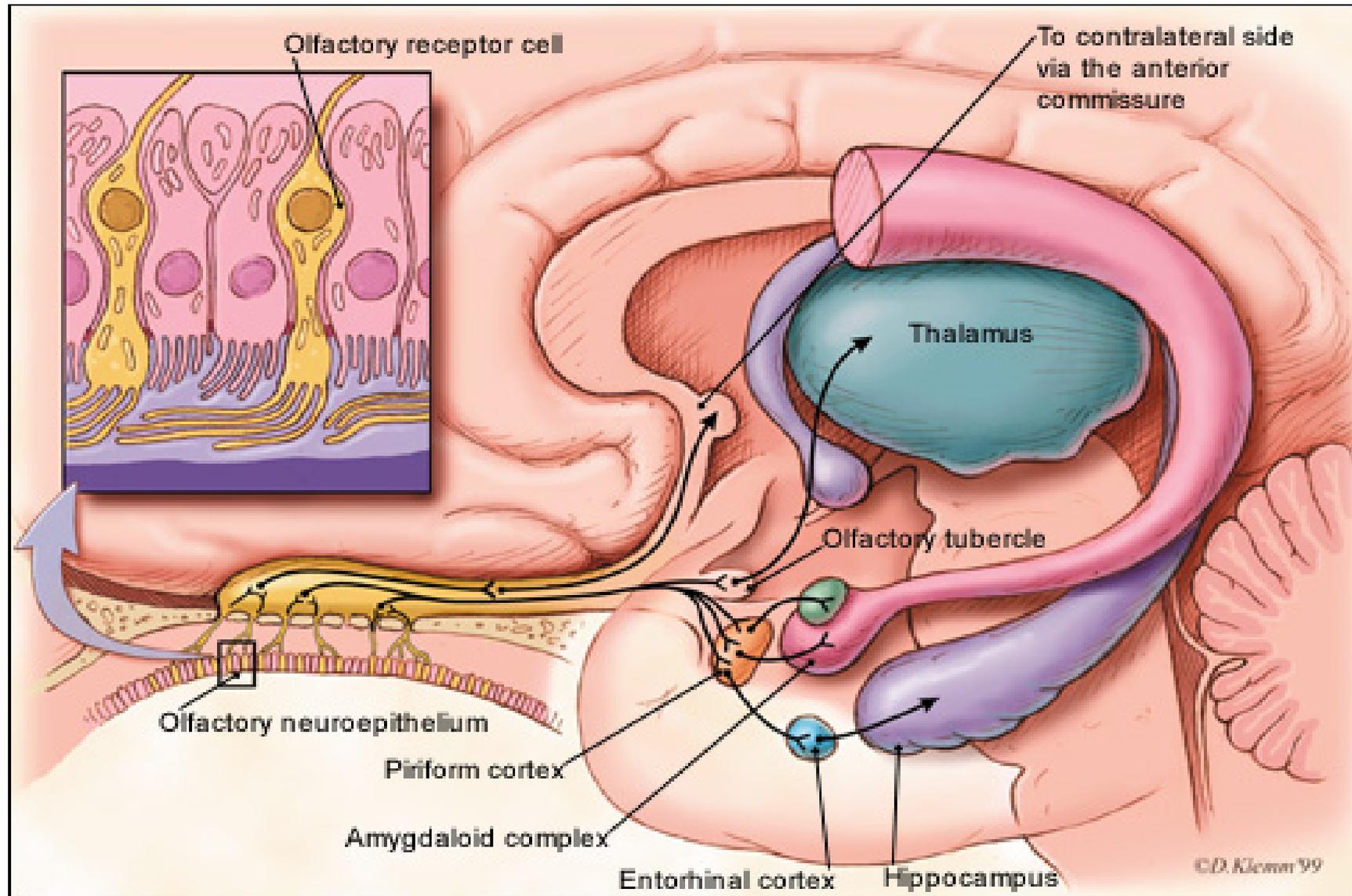
b. Primitive emotional drives associated with smell.



B) Lateral olfactory area:

In the lateral olfactory area, fibers may take one of **2 pathways:**

1) To Prepyriform and pyriform cortex and the amygdaloid nuclei: → all portions of **limbic system,** especially the **hippocampus.**



- It is **concerned with:**

a. Learning to like or dislike certain foods.

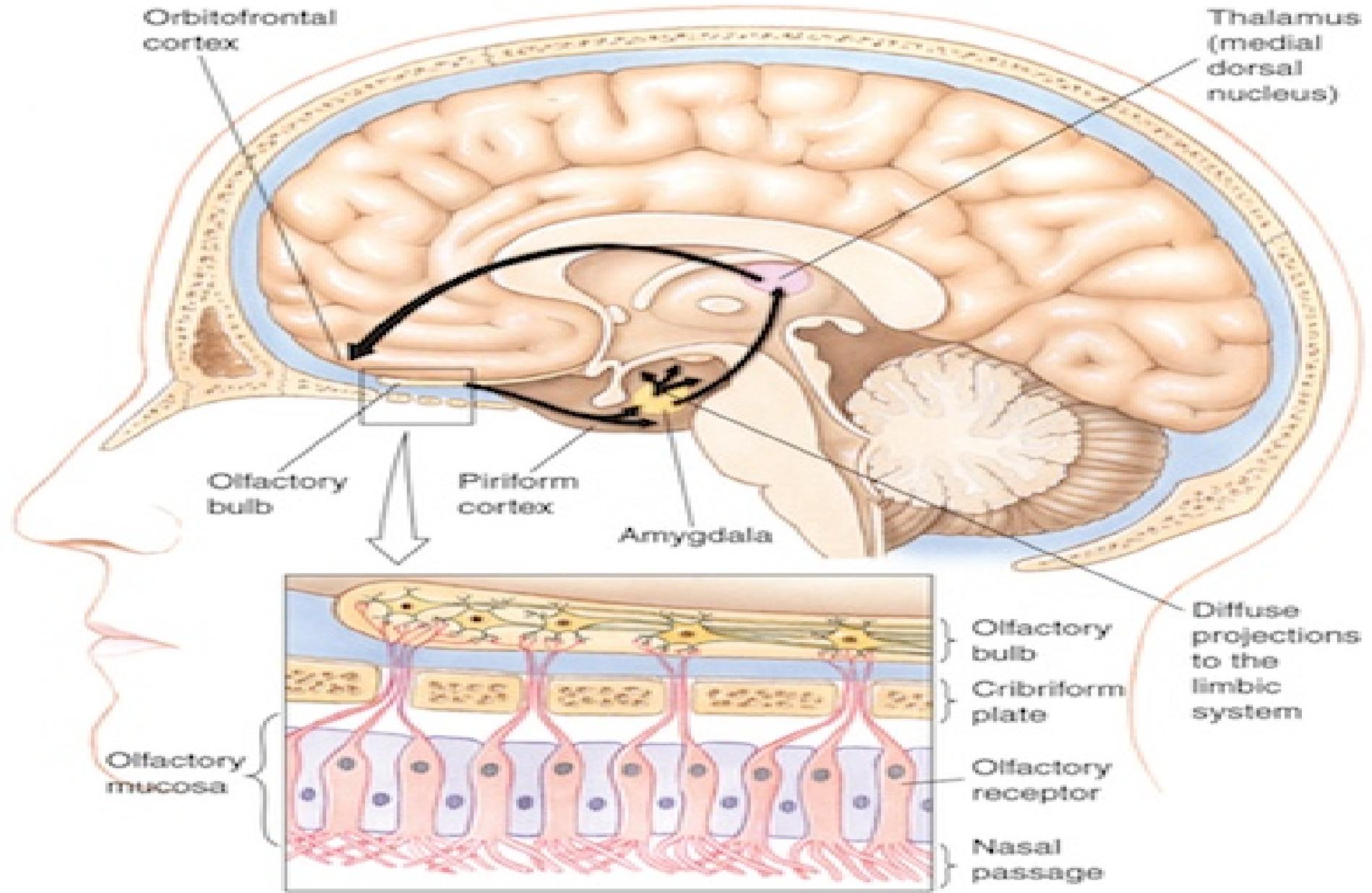
b. Behavioral responses to food e.g. development of absolute aversion to foods that have caused nausea and vomiting

c. Olfactory conditioned reflexes.

2) To dorsomedial thalamic nucleus and

then project to **orbitofrontal cortex.**

- This system is **responsible for** the **conscious perception of olfaction** i.e. analysis, interpretation and significance of the odour.





Adaptation of olfaction

- Adaptation of olfactory receptors is:

- ❑ Specific i.e. it occurs for this odour only and not for the other odours

- ❑ Rapid i.e. occurs within few minutes.

- ❑ Mechanisms:

- Central mechanism (mainly).

- Peripheral mechanism due to an odorant eating enzymes in the mucus layer

Olfactory discrimination



- The olfactory receptors in man can recognize more than 10,000 different odors.
- However, the determination of differences in the intensity of any given odor is poor.

- The concentration of an odor-producing substance must be changed by about 30% before a difference can be detected.
- So, the olfactory receptors are concerned mainly with detection of the presence or absence of the odours rather than with detection of their intensities.



Significance of smell

1. Stimulation of all GIT secretions e.g. salivary secretion through conditioned reflexes
2. Determination of the flavor of food with taste
3. Selection of the type of food.
4. Control of sexual functions particularly in animals.

Disturbance of olfaction

- 1) Anosmia: complete absence of the sense of smell
- 2) Hyposmia: diminished olfactory sensitivity.
- 3) Dysosmia: distorted sense of smell e.g.
 - a) Olfactory hallucinations due to lesion in prepyriform cortex.
 - b) Hypersensitivity for both smell and taste as in Addison disease.



References

1. Costanzo, Linda S. "BRS Physiology (Board Review Series)." (2018).
2. Ganong, William F. "Review of medical physiology." (2020).
3. Hall, John E and Hall, Micheal E. "Guyton and Hall Textbook of medical physiology." (2021).