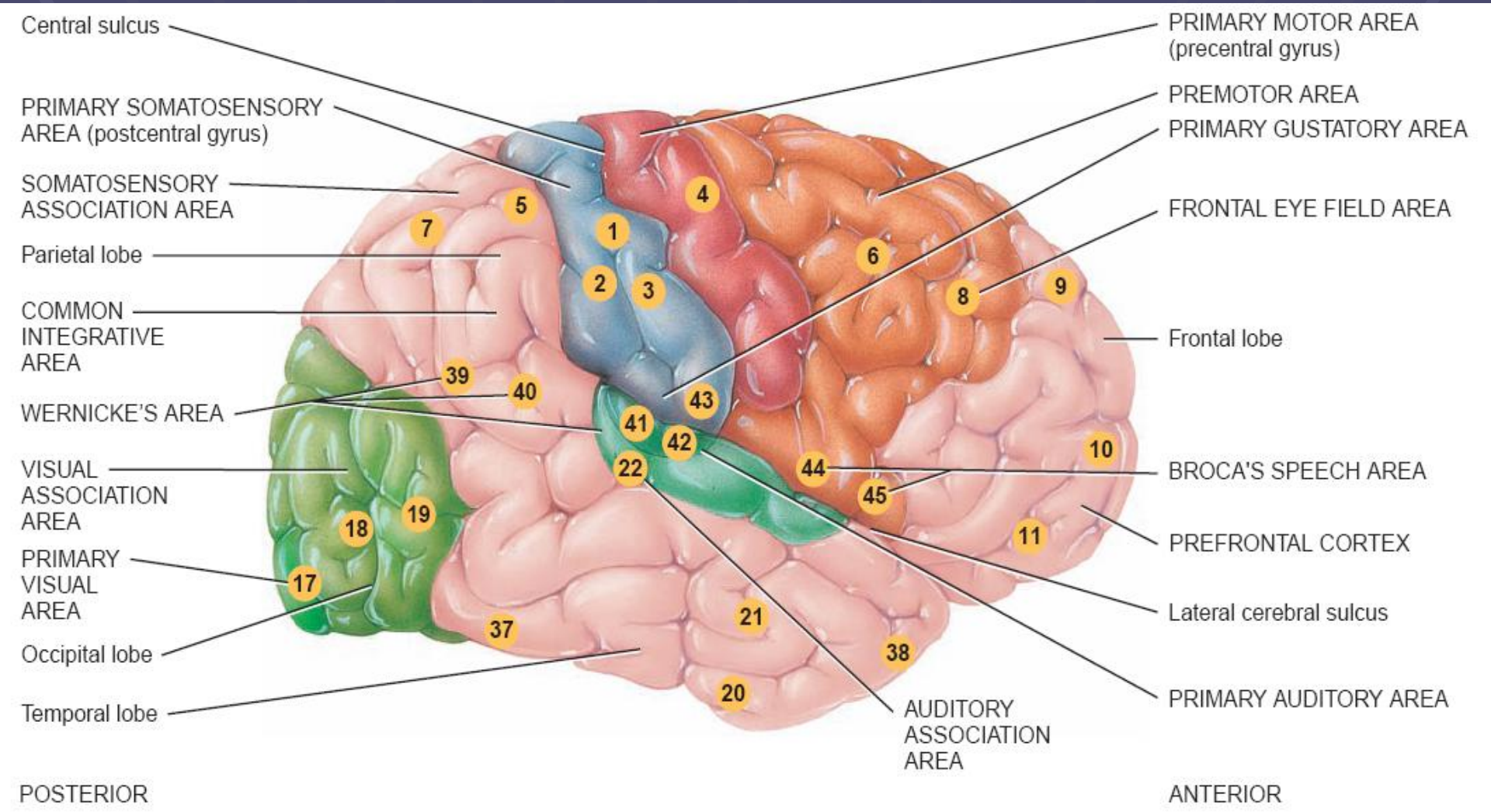
The special Senses

1) Olfaction & Taste

Primary, Secondary, and Association cortex



Lateral view of right cerebral hemisphere

Agnosia and Apraxia

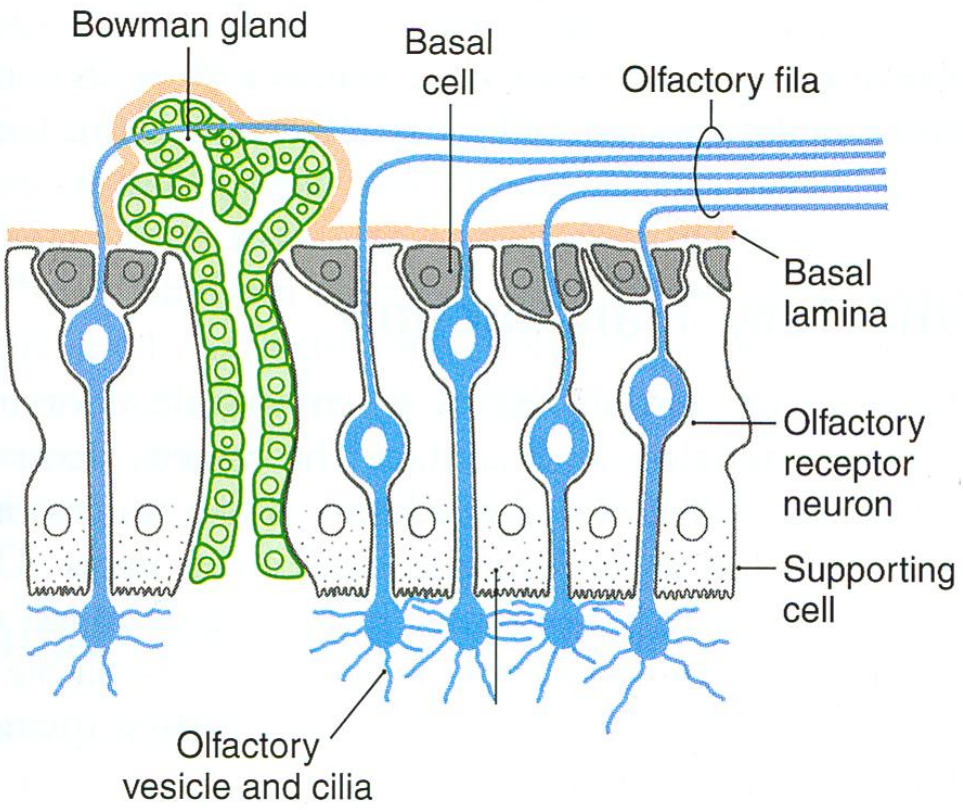
Definitions

- Olfaction: The ability to sense odors through the detection of substances which have been aerosolized into the environment.

- Gustation: The sensation which is produced by the interaction of taste receptors with solubilized chemical stimuli in the oropharyngeal cavity.

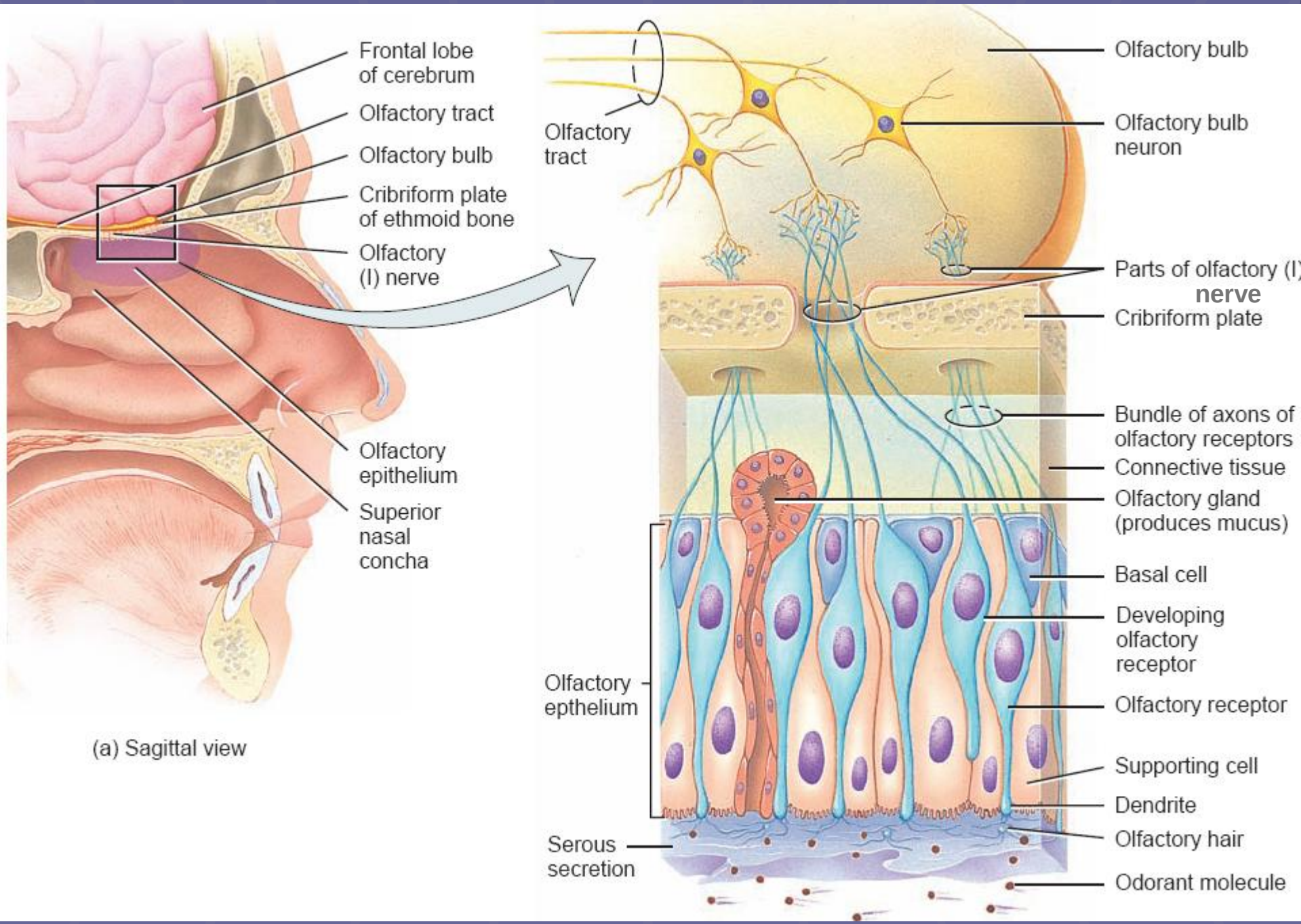
Olfactory System

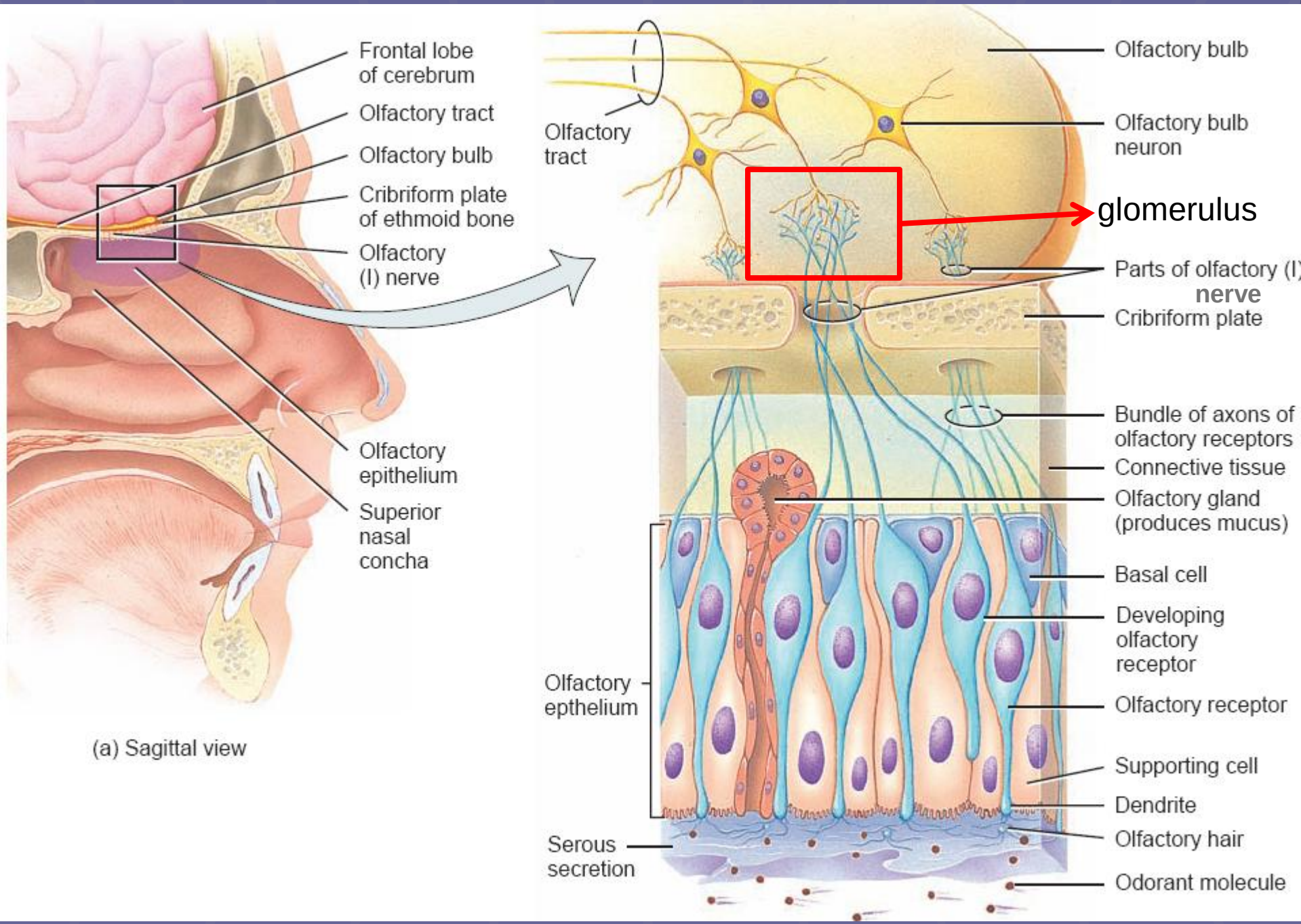
Olfactory Epithelium



containing 3 main cell types:

- **Olfactory receptor neurons**
- **Supporting cells**
- **Basal cells**


Frontal lobe of cerebrum
Olfactory tract
Olfactory bulb
Cribriform plate of ethmoid bone
Olfactory (I) nerve
Olfactory epithelium
Superior nasal concha
(a) Sagittal view
Olfactory tract
Olfactory bulb
Olfactory bulb neuron
Parts of olfactory (I) nerve
Cribriform plate
Bundle of axons of olfactory receptors
Connective tissue
Olfactory gland (produces mucus)
Basal cell
Developing olfactory receptor
Olfactory epithelium
Olfactory receptor
Supporting cell
Dendrite
Olfactory hair
Serous secretion
Odorant molecule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Basal cell
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Dendrite
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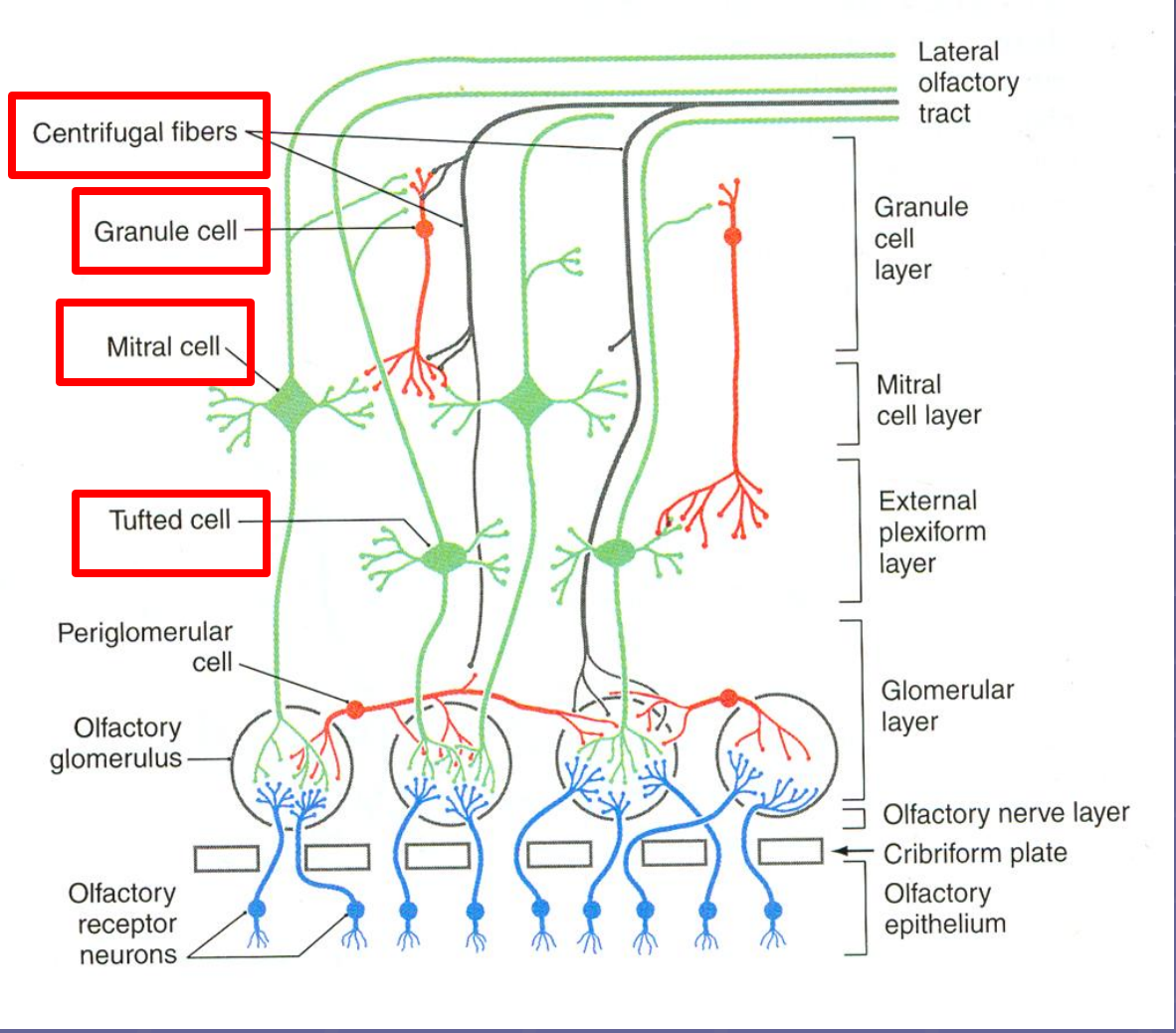
Odorant molecule

Olfactory Bulb (feedback and adaptation)



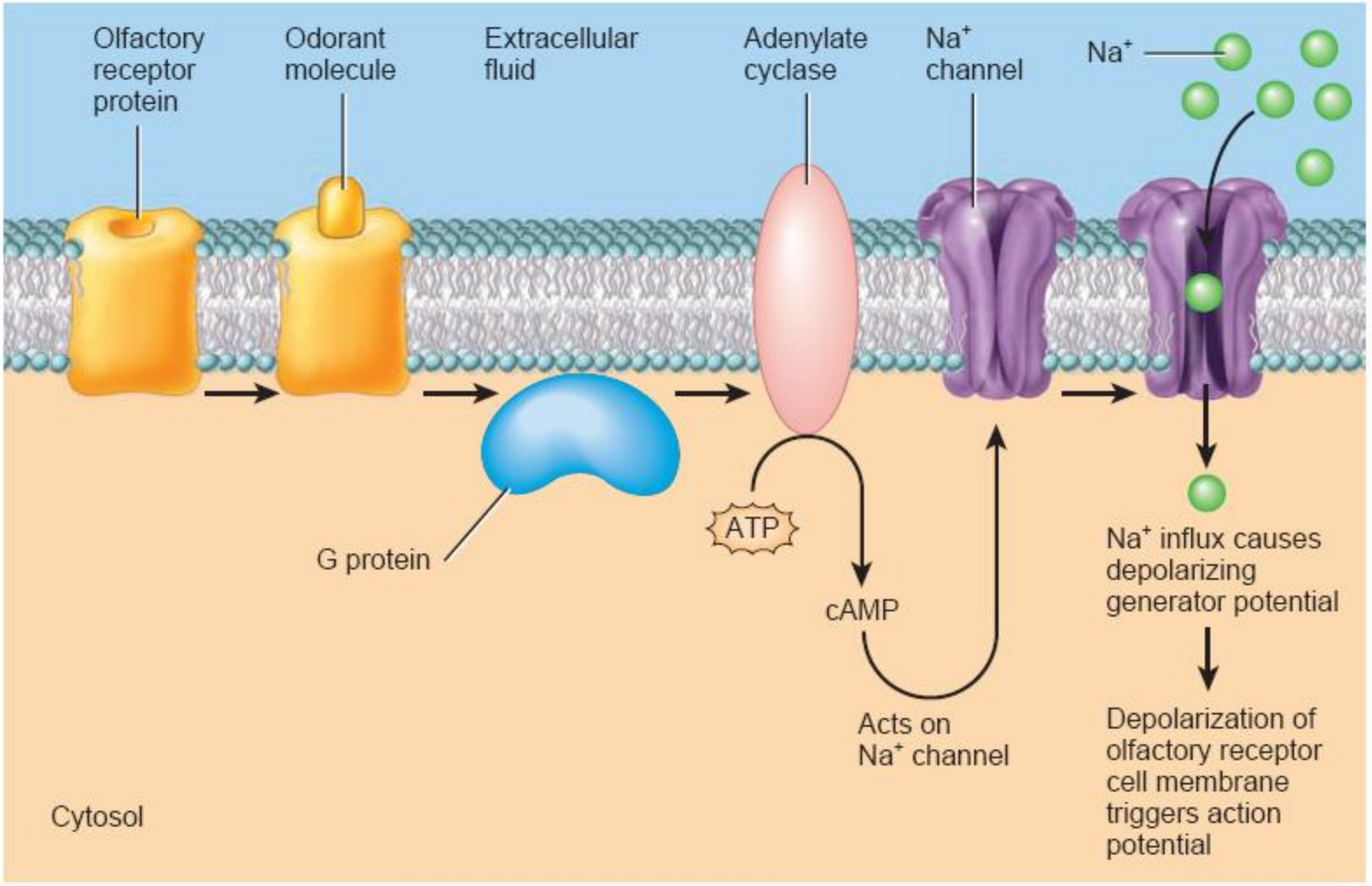
- Five well-defined layers of cells & fibers, which give a laminated appearance

- Olfactory nerve layer
- Glomerular layer
- External plexiform layer
- Mitral cell layer
- Granule cell layer

Important Points

- Olfactory receptor neuron axons converge to synapse on the apical dendrites of mitral, tufted, and periglomerular cells in core regions of the glomerular layer known as glomeruli

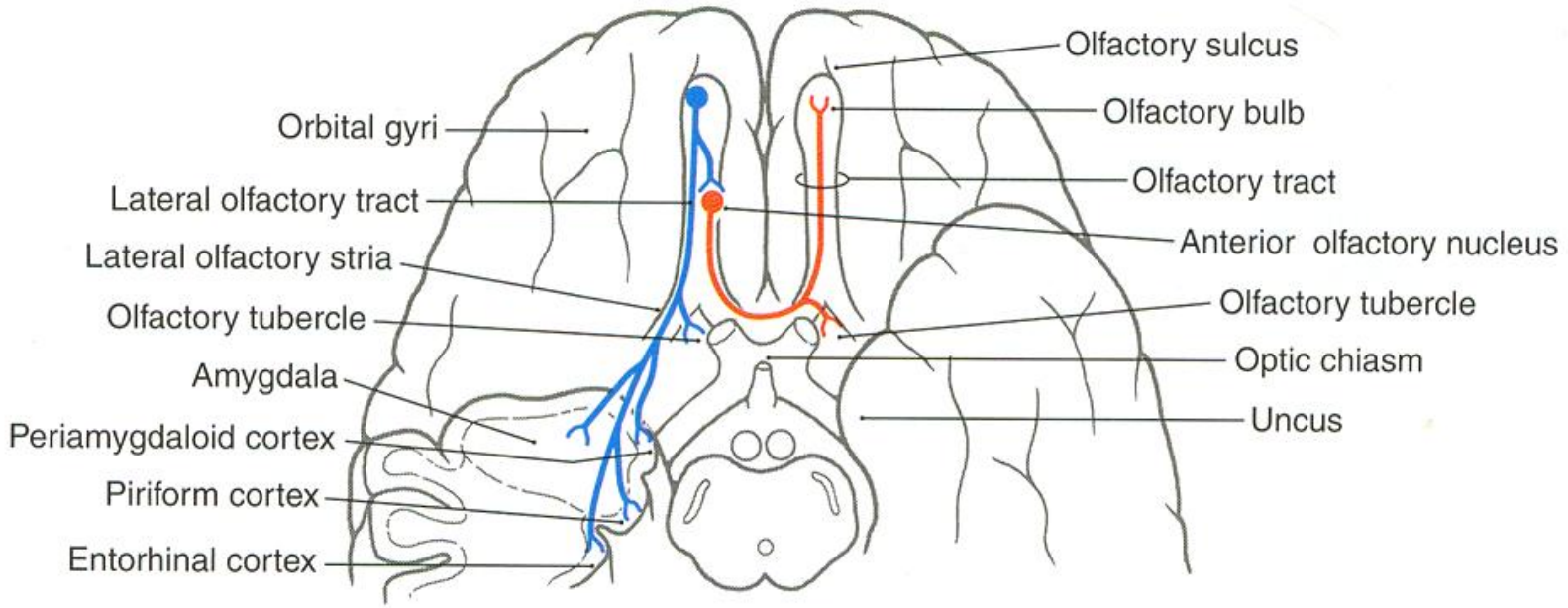
- Mitral and tufted cells form the efferent projection from the olfactory bulb


Olfactory receptor protein
Odorant molecule
Extracellular fluid
Adenylate cyclase
Na+ channel
Na+
G protein
ATP
cAMP
Acts on Na+ channel
Na+ influx causes depolarizing generator potential
Depolarization of olfactory receptor cell membrane triggers action potential
Cytosol

Chemical Sensation Complexity

- Presence of different subclasses of receptors.
- Activation in different combinations.
- Activation of different transduction mechanisms.

Projections of Olfactory Bulb



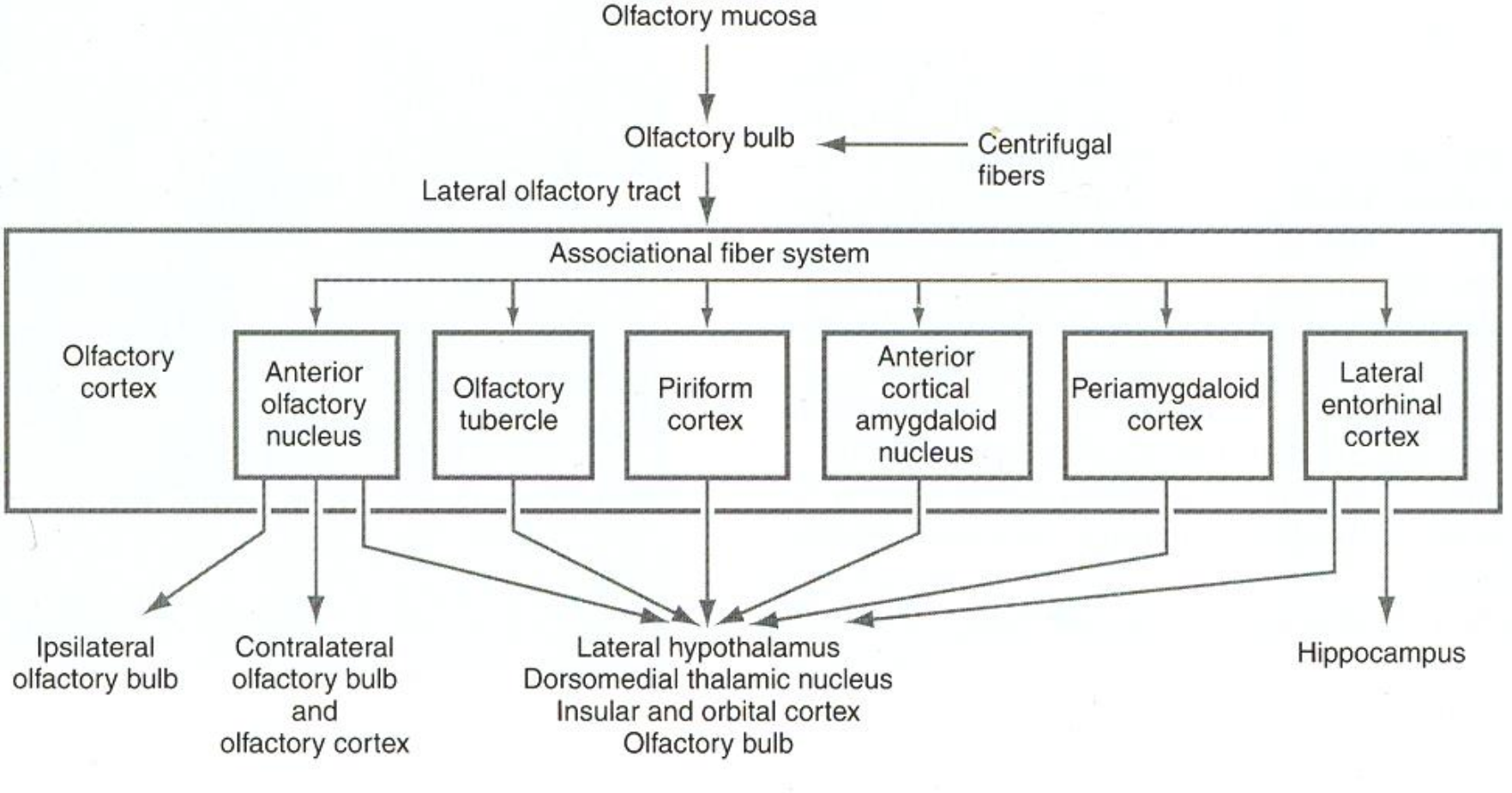
Axons leaving the olfactory bulb project to the anterior olfactory nucleus

Or

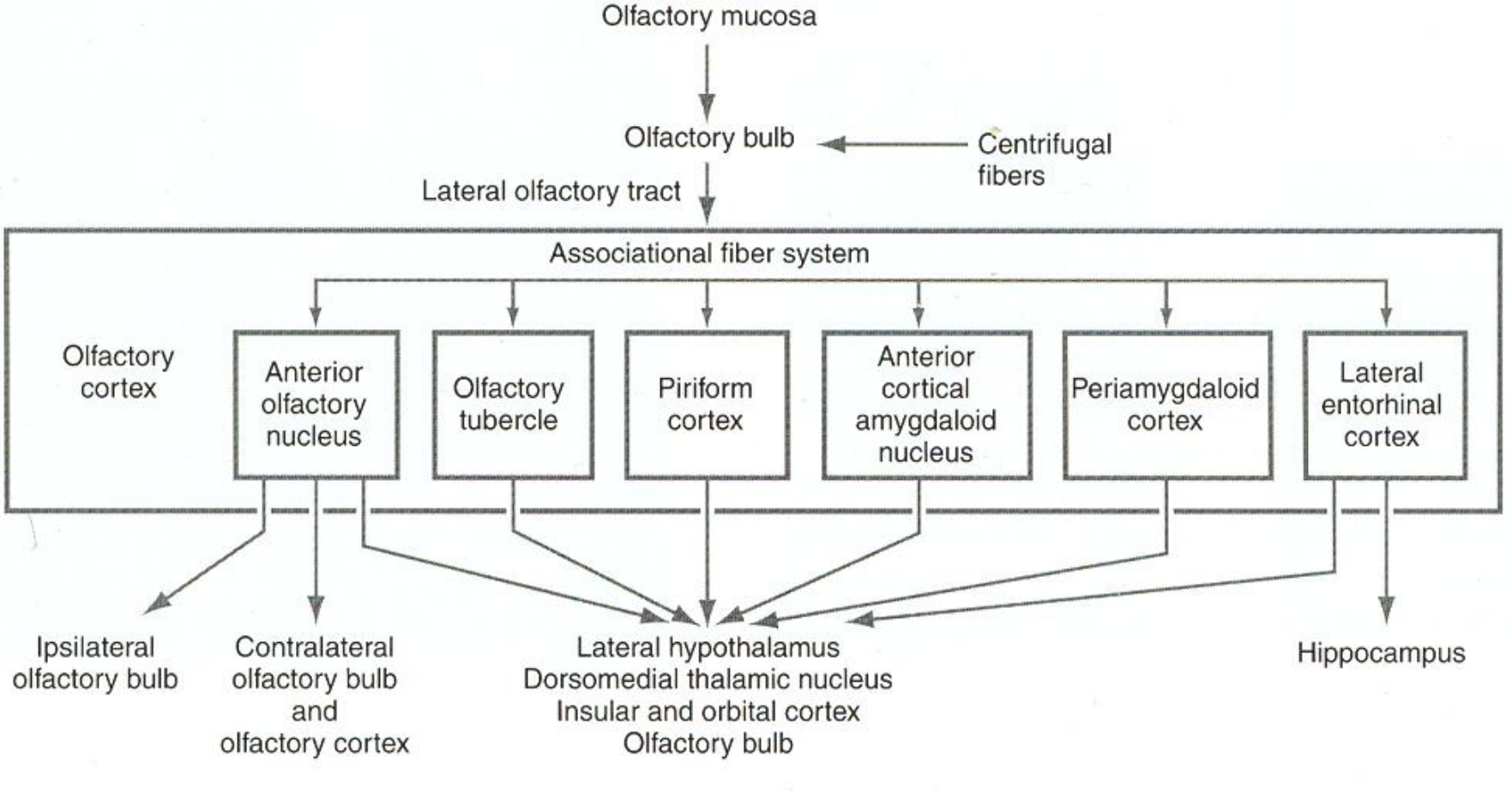
Travel via the lateral olfactory stria to the olfactory cortex on the ventral surface of the telencephalon

Olfactory cortex lies adjacent to the olfactory trigone: the triangle-shaped area at the intersection of the olfactory tract, lateral and medial olfactory stria and olfactory tubercle.

Associational Connections



Associational Connections



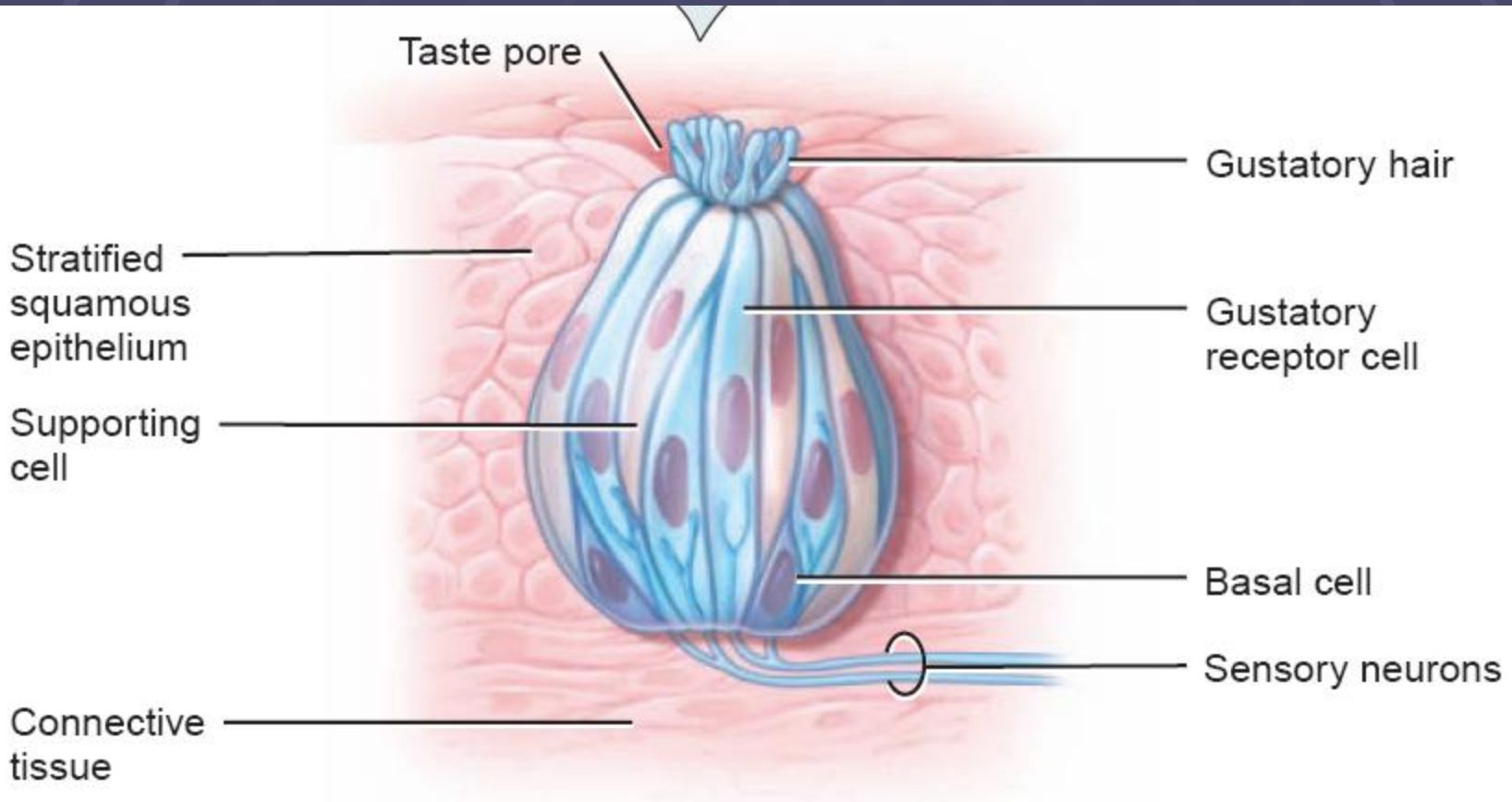
- Orbitofrontal cortex : one of olfactory association cortex.
  - Odors identification (right side)

Disorders of the Olfactory System

- Anosmia/Hyposmia: Loss/decreased sensitivity to odorants.
  - Access of odorants to olfactory epithelium is blocked.
    - Edema of olfactory epithelium.
    - Ex. Upper respiratory infections, sinus disease.
  - Head Trauma
    - Ex. Shearing movement of olfactory bulb relative to cribriform plate.
    - Boxers- transection of olfactory receptor axons in passage.
  - Patients with Alzheimer, Parkinson, Huntington chorea, epilepsy, and psychiatric disease.
  - Most patients with a loss of taste actually have a dysfunction of the olfactory system.

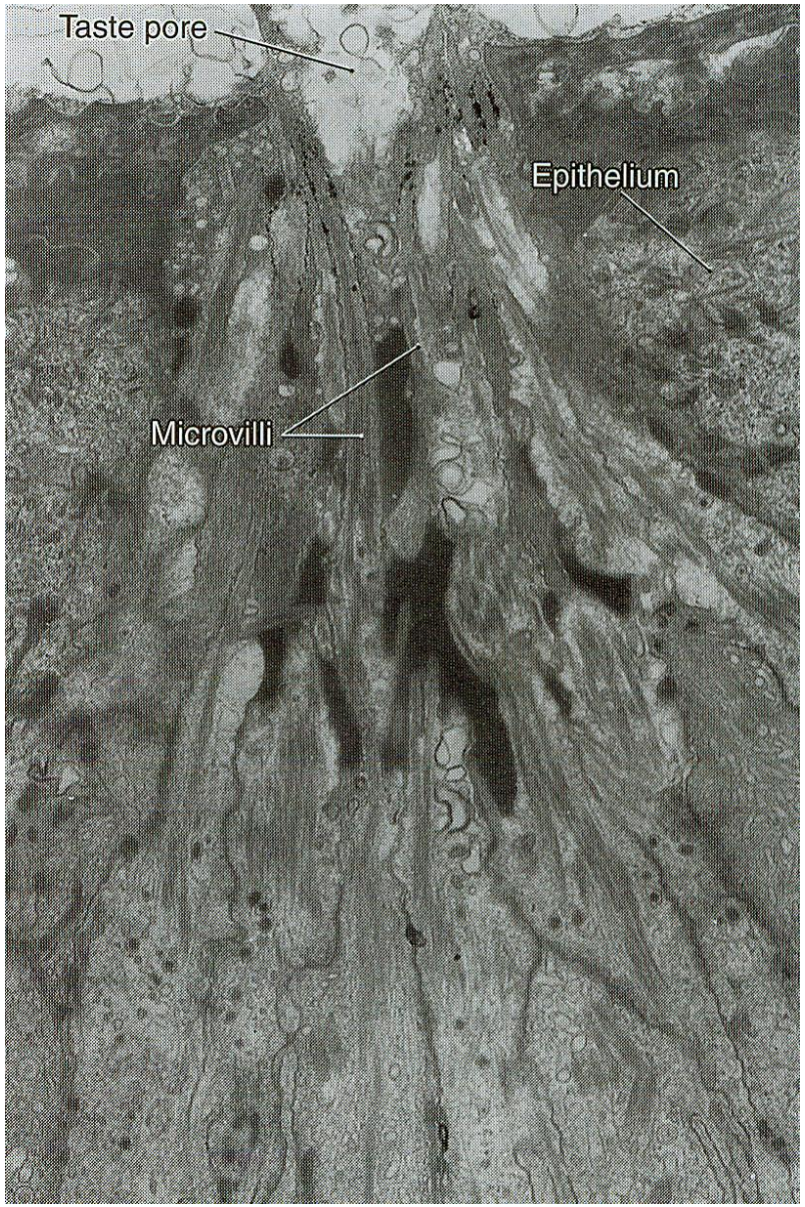
The Gustatory System

Taste receptors (taste buds)



(c) Structure of a taste bud

Receptor Cells and Taste Buds



Receptor cells found in taste buds

Taste buds: most obvious on tongue

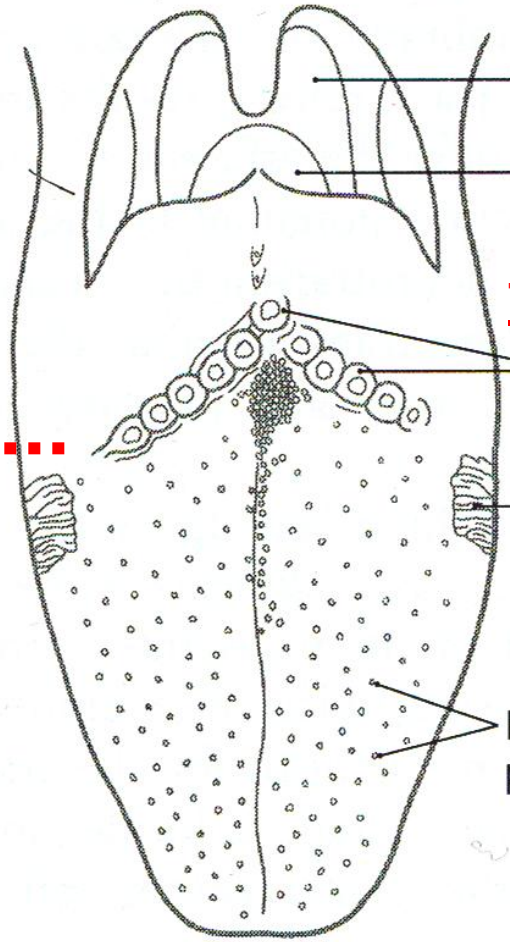
1 bud contains= 40-60 receptor cells

Microvilli found on apical end of receptor cells and extend into taste pore

Taste receptor cell life span: 10-14d

On the tongue, taste buds are found exclusively in papillae

Distribution of Papillae



Posterior 1/3 of tongue

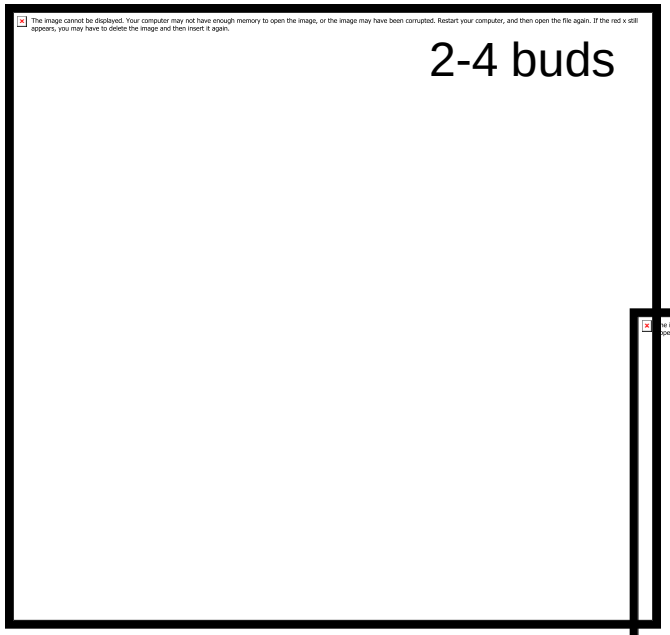
Anterior 2/3 of tongue

Three types of papillae

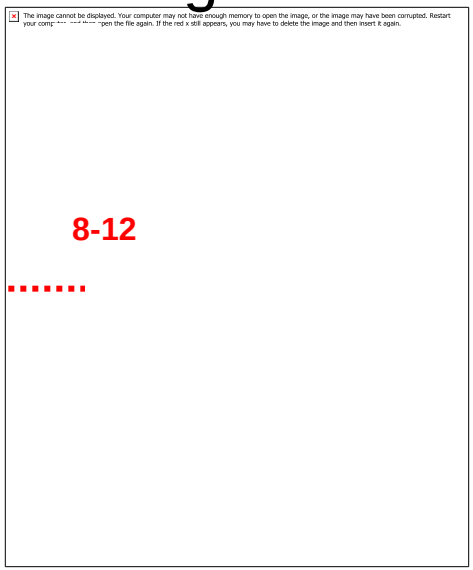
Dorsal surface of tongue at the junction of the oral & pharyngeal cavities

Subtypes of Papillae

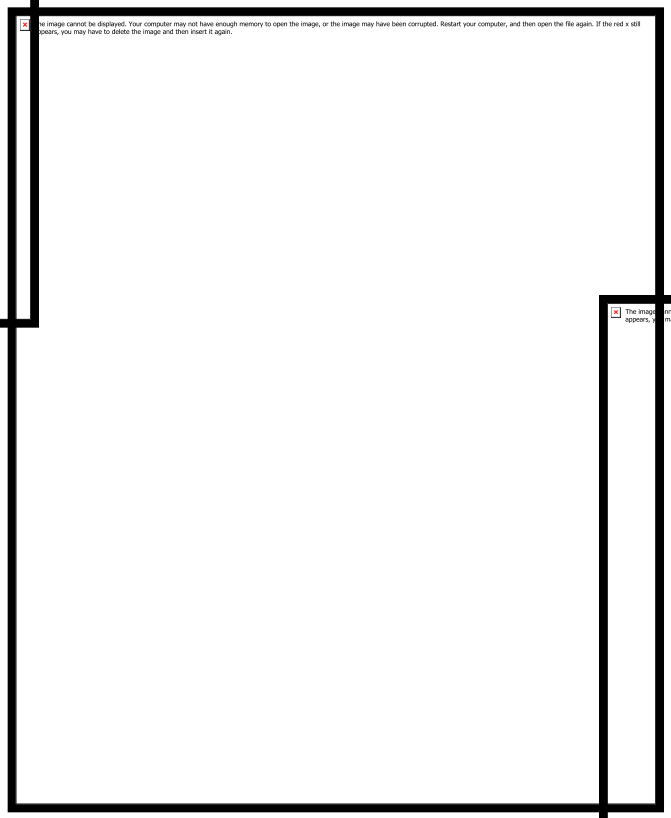
Text Fig. 23-11



Fungiform



Von Ebner salivary glands: drain into papillar clefts & influence local microenvironment

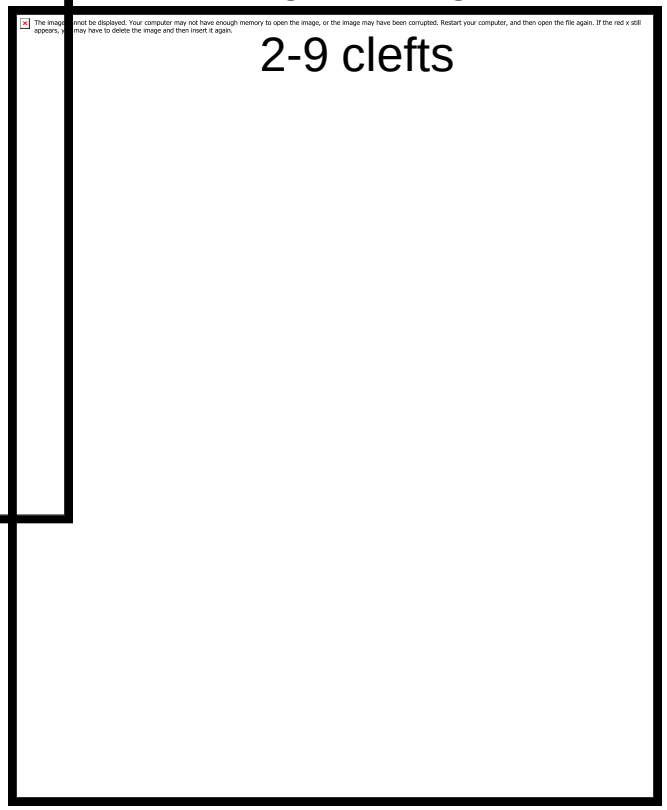


Vallate

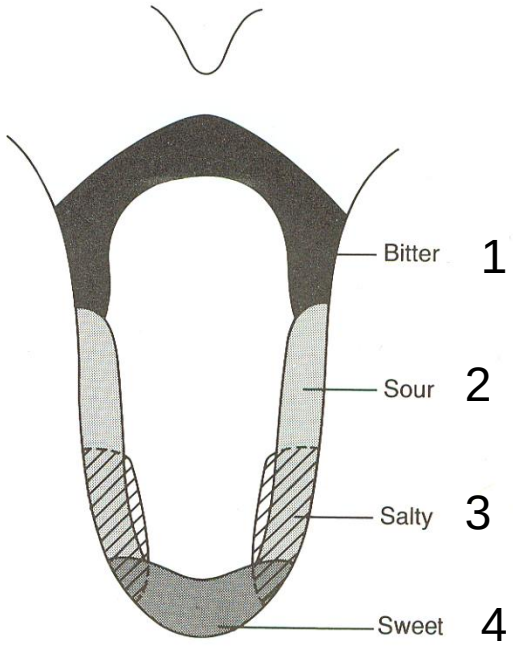
Central papilla surrounded by a cleft containing taste buds in epithelium

Foliate

Series of clefts along lateral margin of tongue



Regional Specialization for the Detection of Different Taste Qualities ?



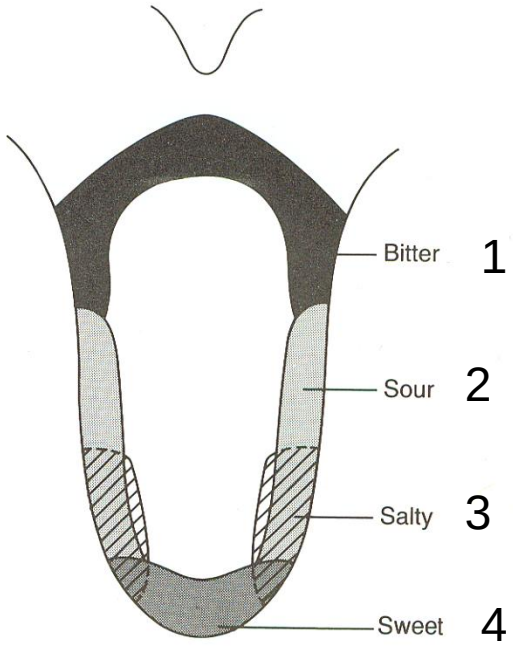
(Kandel, Schwartz & Jessup: Principles of Neural Science 3rd ed. Fig. 34-8)

All taste qualities are detected in all regions of the tongue, although sensitivity to the different taste qualities may vary by region

Regional Specialization for the Detection of Different Taste Qualities ?

5

- **Umami: a recently described taste sensation for meaty sensation, that exemplifies the taste of monosodium glutamate & is important in the identification of amino acids.**



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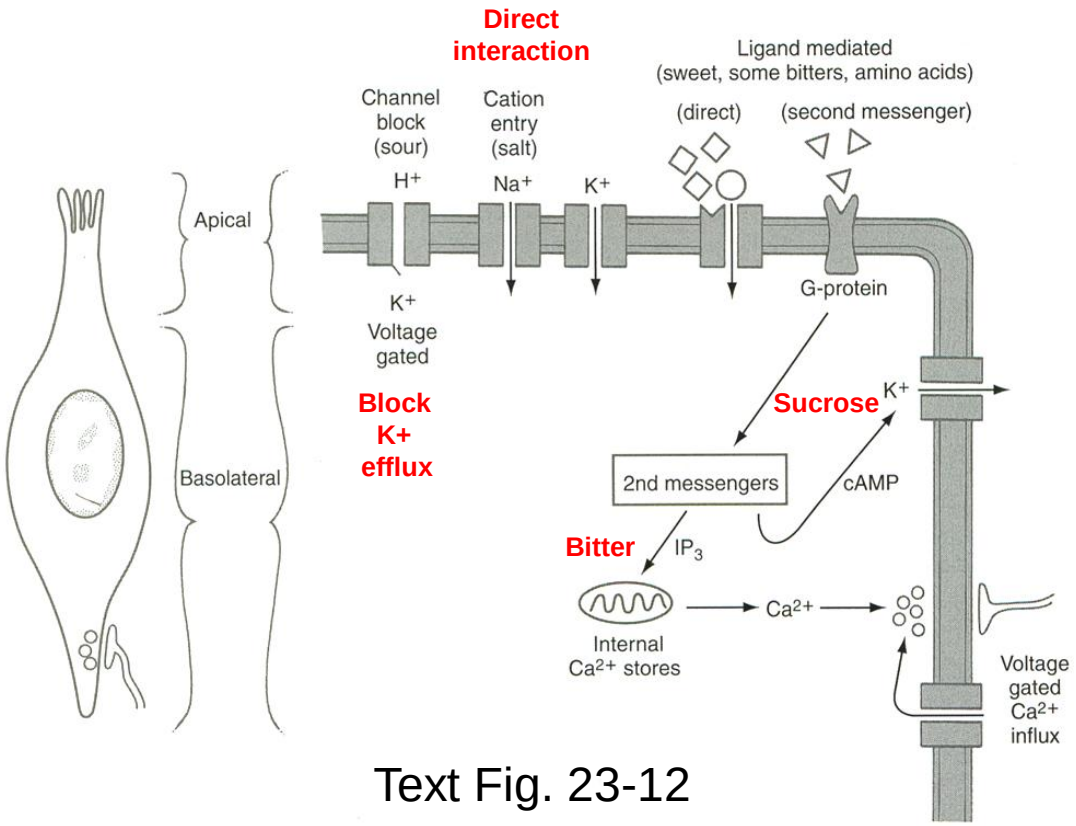
Pathways of Transduction in Taste Receptors



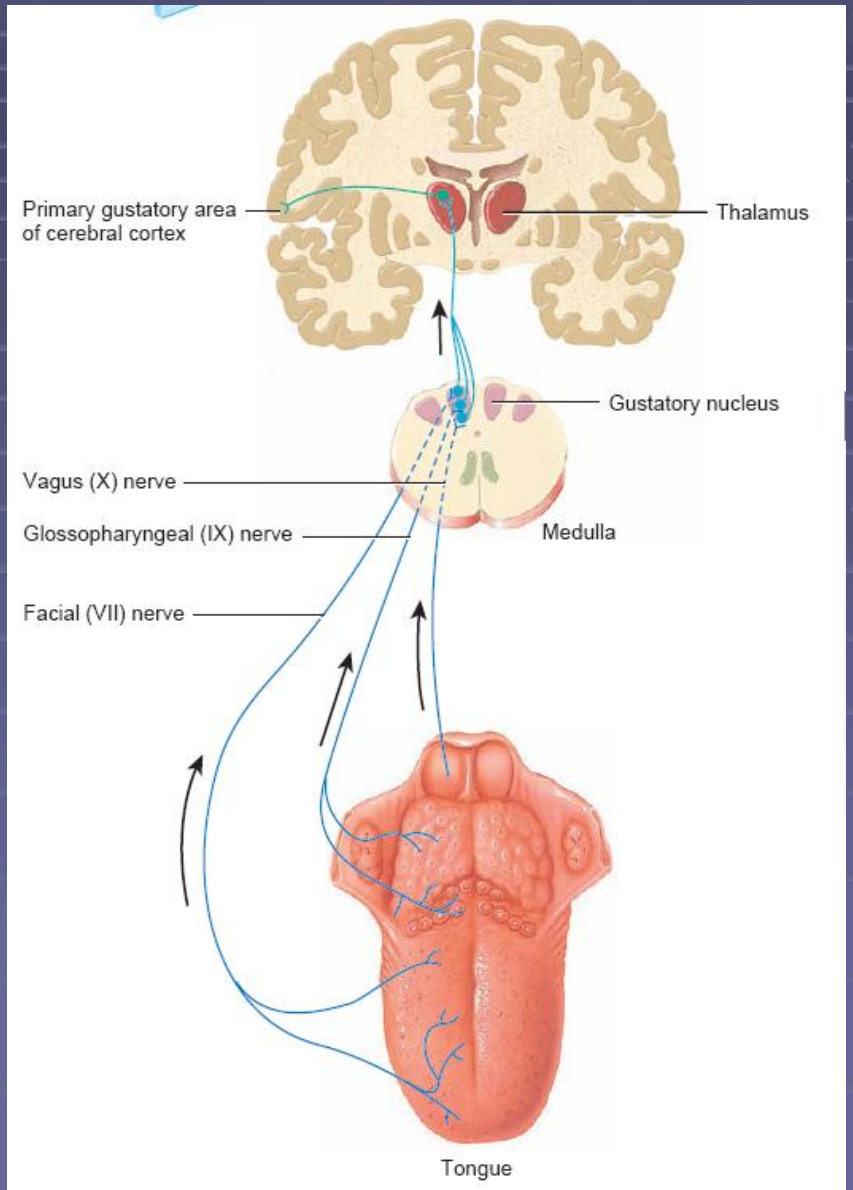
Text Fig. 23-12

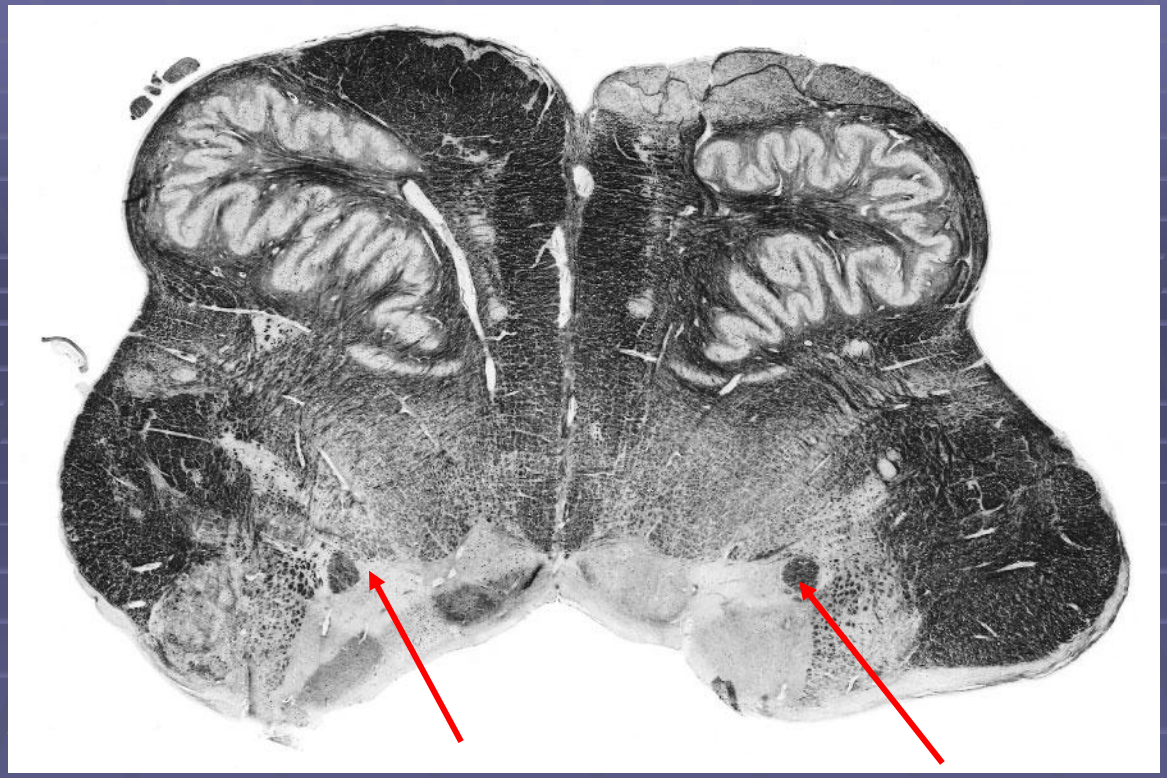
Umami:

Transduced: via a G-protein linked glutamate receptor that stimulates phosphodiesterase → reduction in intracellular cAMP

- **Begins when a soluble chemical interacts with taste receptors**
- **Results in a depolarization or hyperpolarization of the receptor cell microvilli**
- **Sufficiently large depolarizations will result in action potential generation**
- **Produce an increase in intra-cellular Ca++ either by release from internal stores or by activation of voltage gated Ca++ channels.**
- **Ca++ release results in the liberation of chemical transmitters at the afferent synapse, which in turn leads to an action potential in the afferent fiber.**

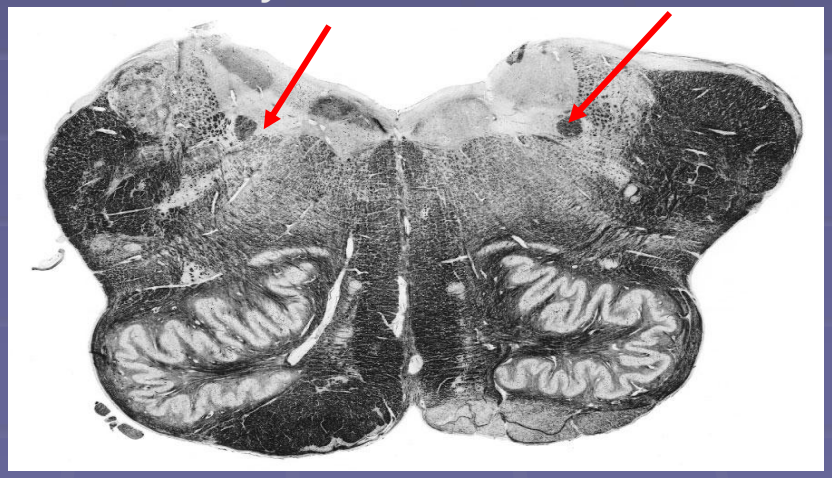
Taste pathway



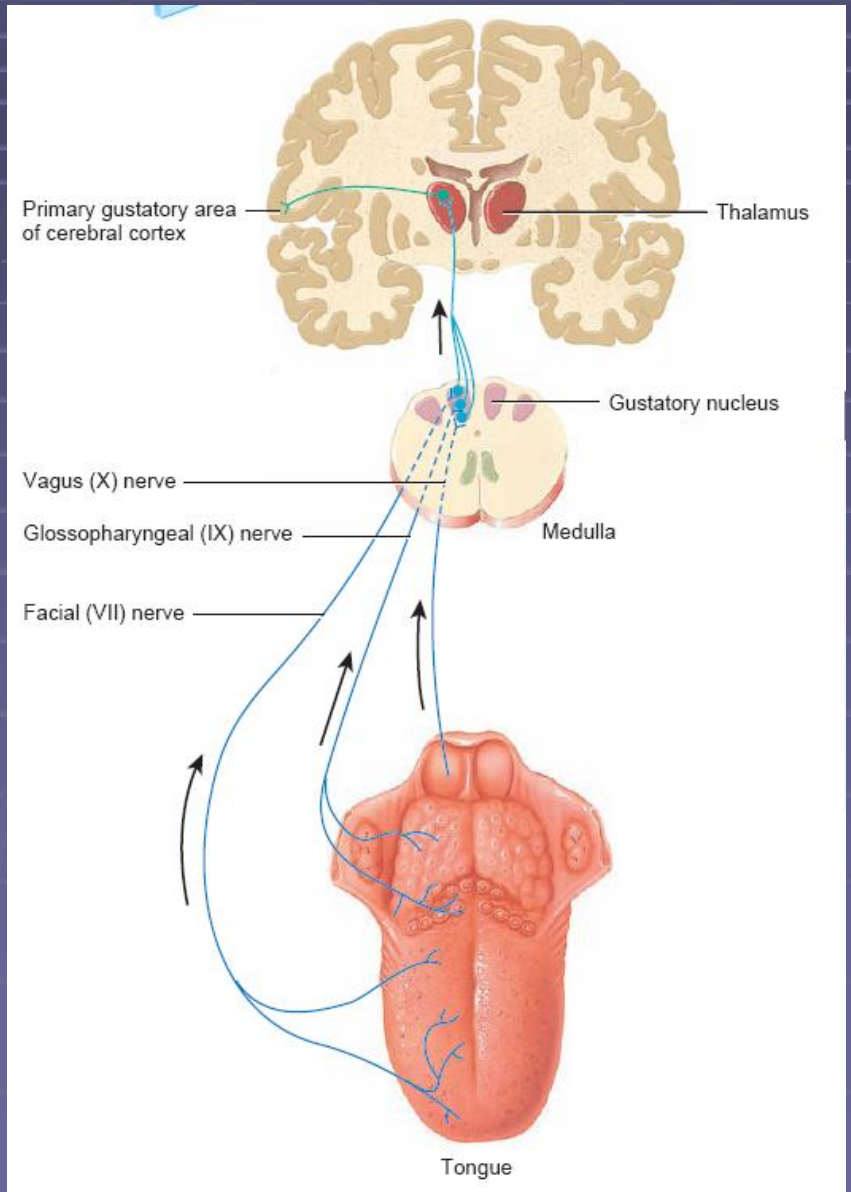


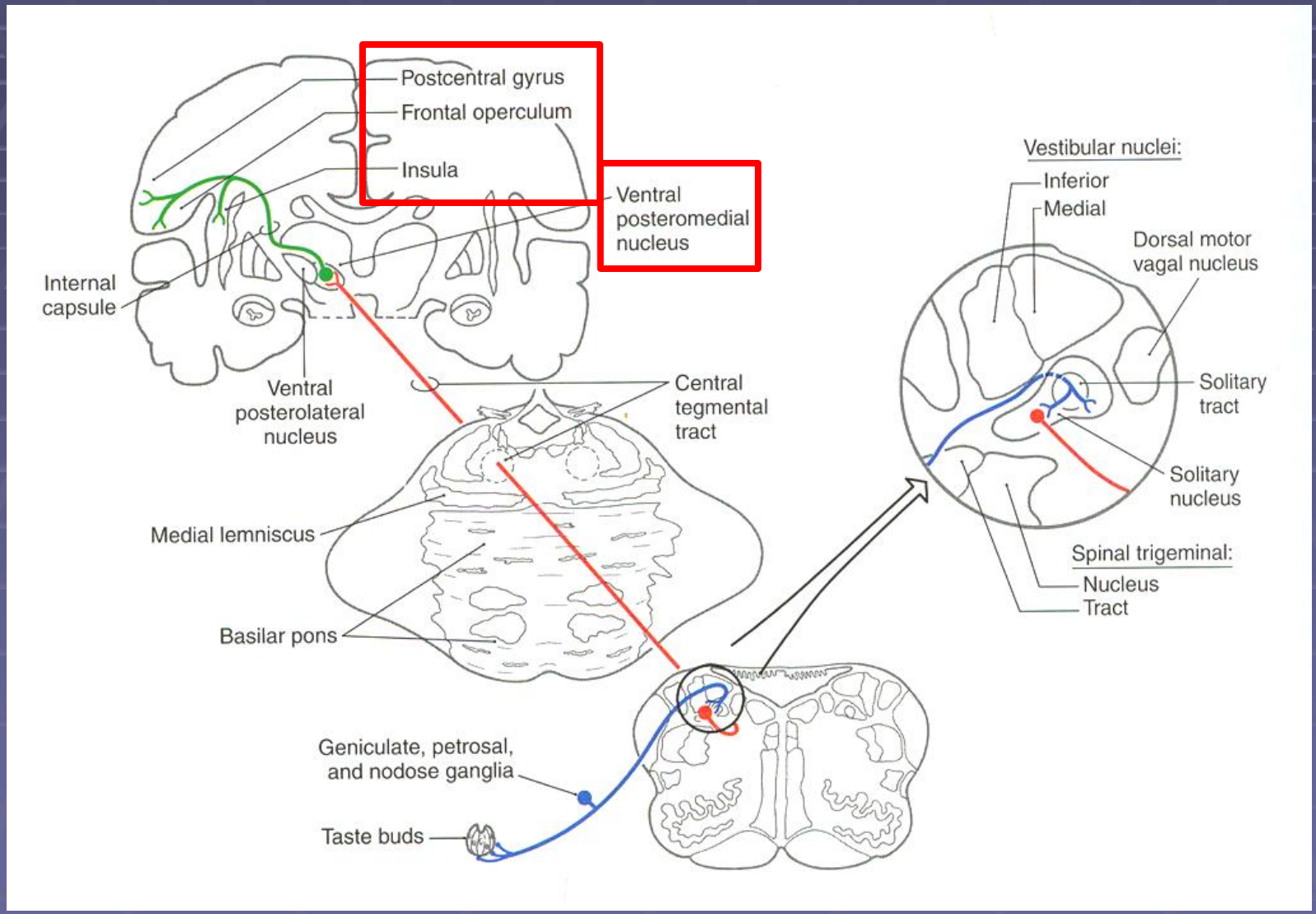
Nucleus of the Solitary tract

Solitary Tract



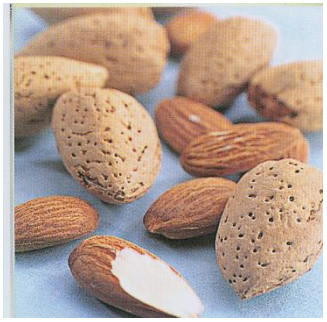
Taste pathway

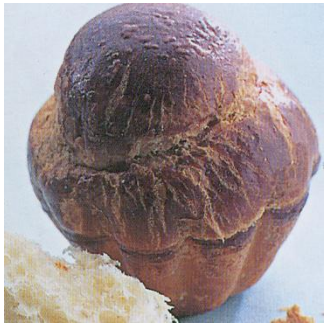


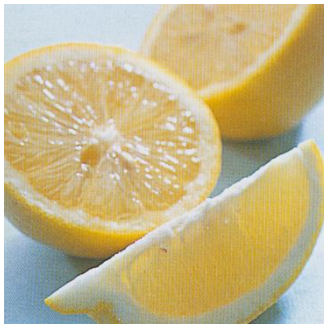

Postcentral gyrus
Frontal operculum
Insula
Ventral posteromedial nucleus
Internal capsule
Ventral posterolateral nucleus
Central tegmental tract
Medial lemniscus
Basilar pons
Geniculate, petrosal, and nodose ganglia
Taste buds
Vestibular nuclei:
Inferior
Medial
Dorsal motor vagal nucleus
Solitary tract
Solitary nucleus
Spinal trigeminal:
Nucleus
Tract

Disorders of Taste

- Ageusia: Complete loss of taste.
- Hypoageusia: Decreased taste sensitivity.
- Examples:
  - Cancer patients undergoing radiation or chemotherapy.
  - Medications.
  - Progressive loss of taste in diabetic patients.

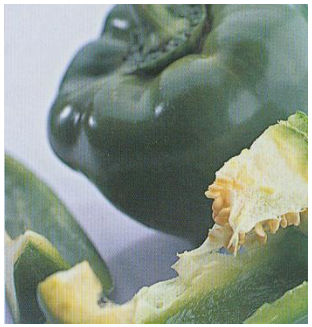






Aromas & Flavors

Almond
Apple
Apricot
Asparagus
Banana
Biscuit
Blackberry
Black currant bread
Brioche
Bubble gum
Butter
Cat's pee
Cedarwood
Cherry
Chestnut
Chocolate
Clove
Coffee beans
Cream
Currant leaf
Earth/gravel/stone
Eucalyptus
Flint
Floral
Game
Gasoline
Gooseberry
Grape
Grapefruit
Grass
Herbaceous
Honey
Lanolin
Leather
Lemon
Licorice
Lychee
Melon
Mineral
Mint
Nivea
Nut
Oak
Olive
Orange
Peach
Pear
Pepper
Plum
Quince
Raisin
Raspberry
Rose
Salt
Smoke
Spice
Strawberry
Tar
Toast
Tobacco
Turkish delight
Vanilla
Yeast



Taste smell interaction

- Although anatomically distinct systems, the modalities of taste and smell work well together

- Flavor:
  - Incorrectly mistaken as taste
  - A sensory experience which results from the combination of olfactory and taste cues.

Olfaction >>>>> taste

potent

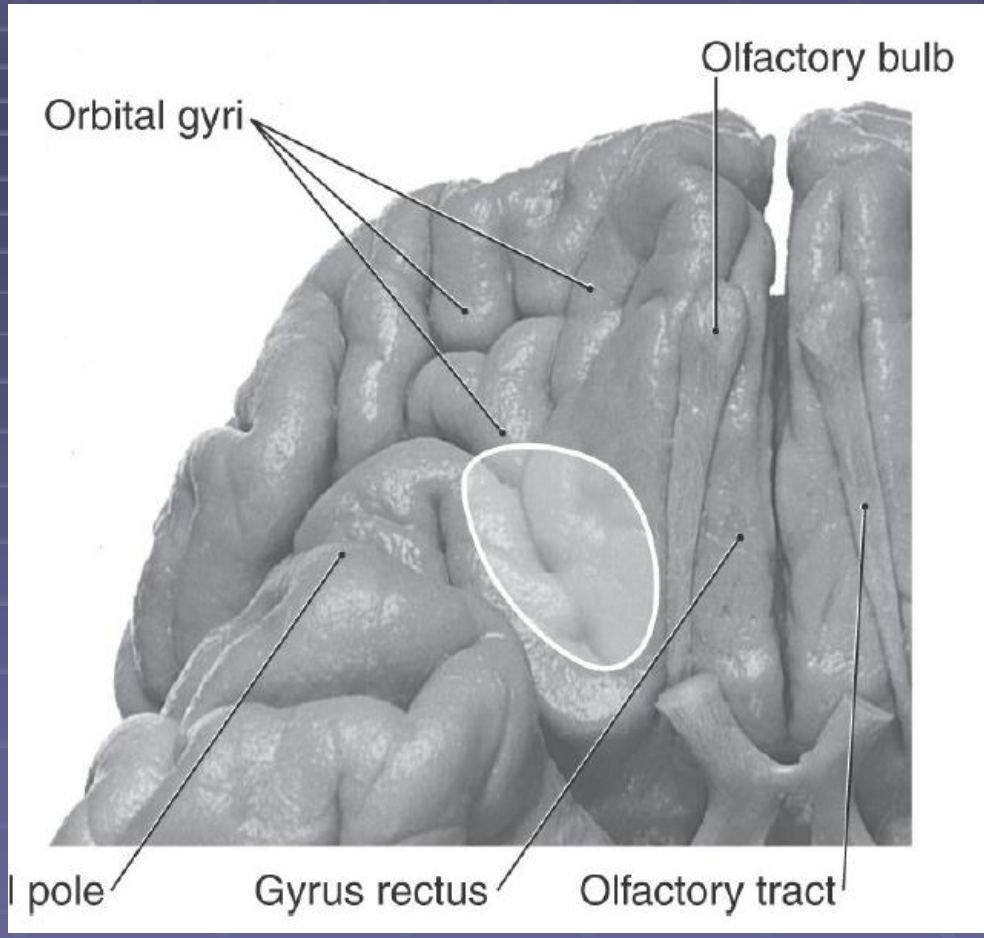
insular cortex and orbitofrontal cortex

- The **medial orbitofrontal cortex**

&

lateral posterior orbitofrontal cortex

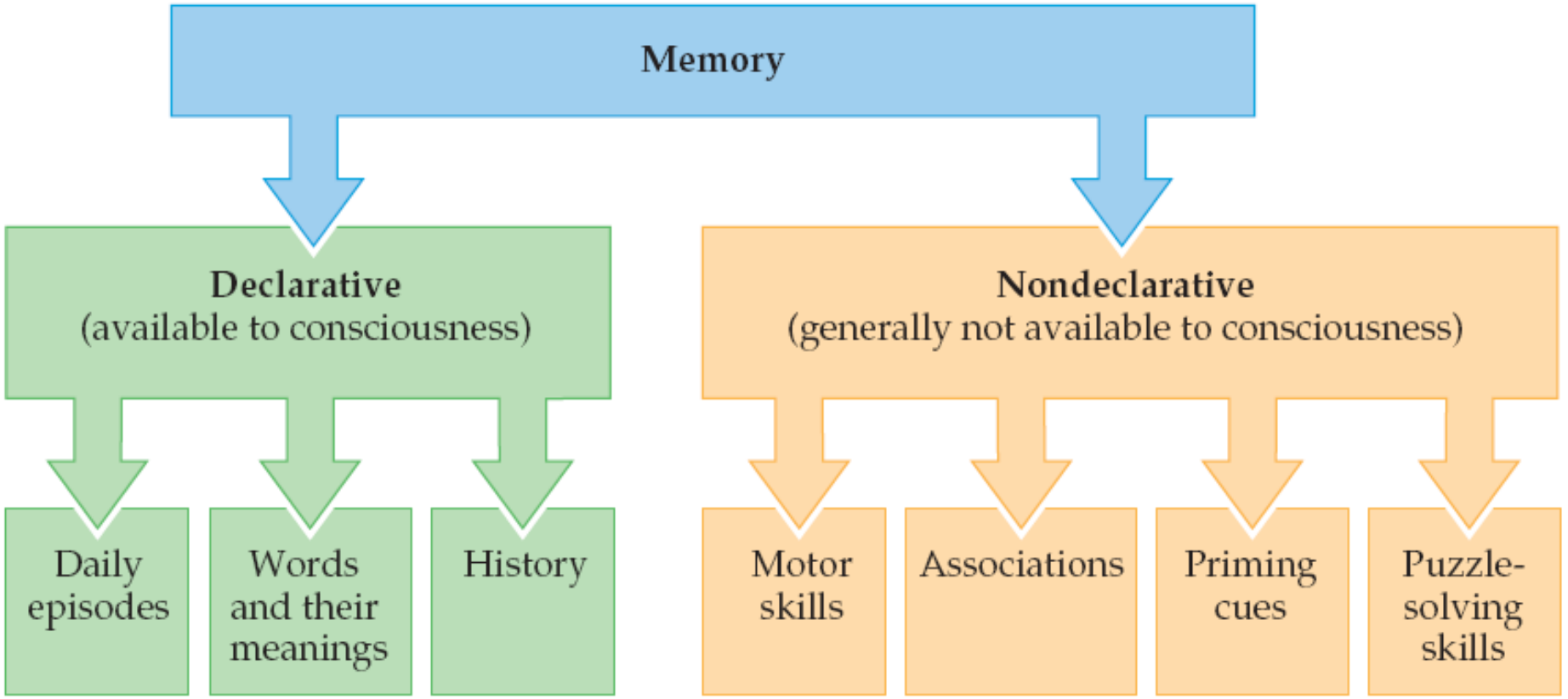
play an important role in integrating olfactory, taste, and other food-related cues that produce the experience of flavor

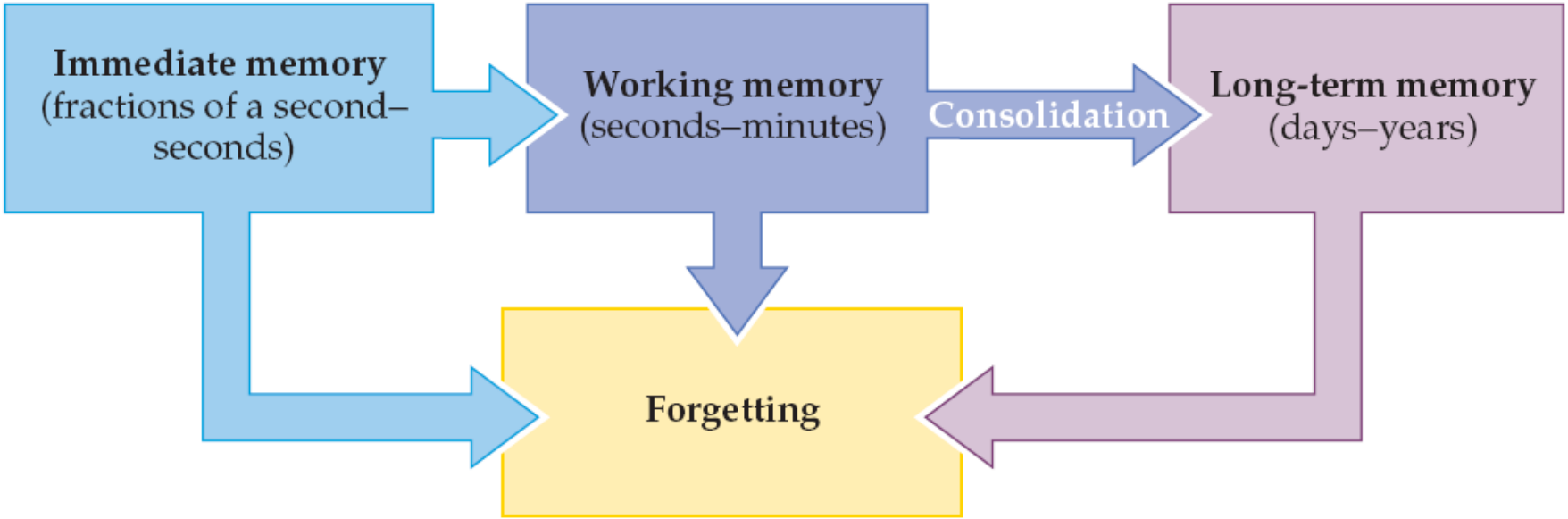


- ***Disorders of the Olfactory System (page 704-707)***

- ***Disorders of the Gustatory System*** (page 716)

Memory


Memory
Declarative
(available to consciousness)
Nondeclarative
(generally not available to consciousness)
Daily episodes
Words and their meanings
History
Motor skills
Associations
Priming cues
Puzzle-solving skills


Immediate memory
(fractions of a second–seconds)
Working memory
(seconds–minutes)
Consolidation
Long-term memory
(days–years)
Forgetting