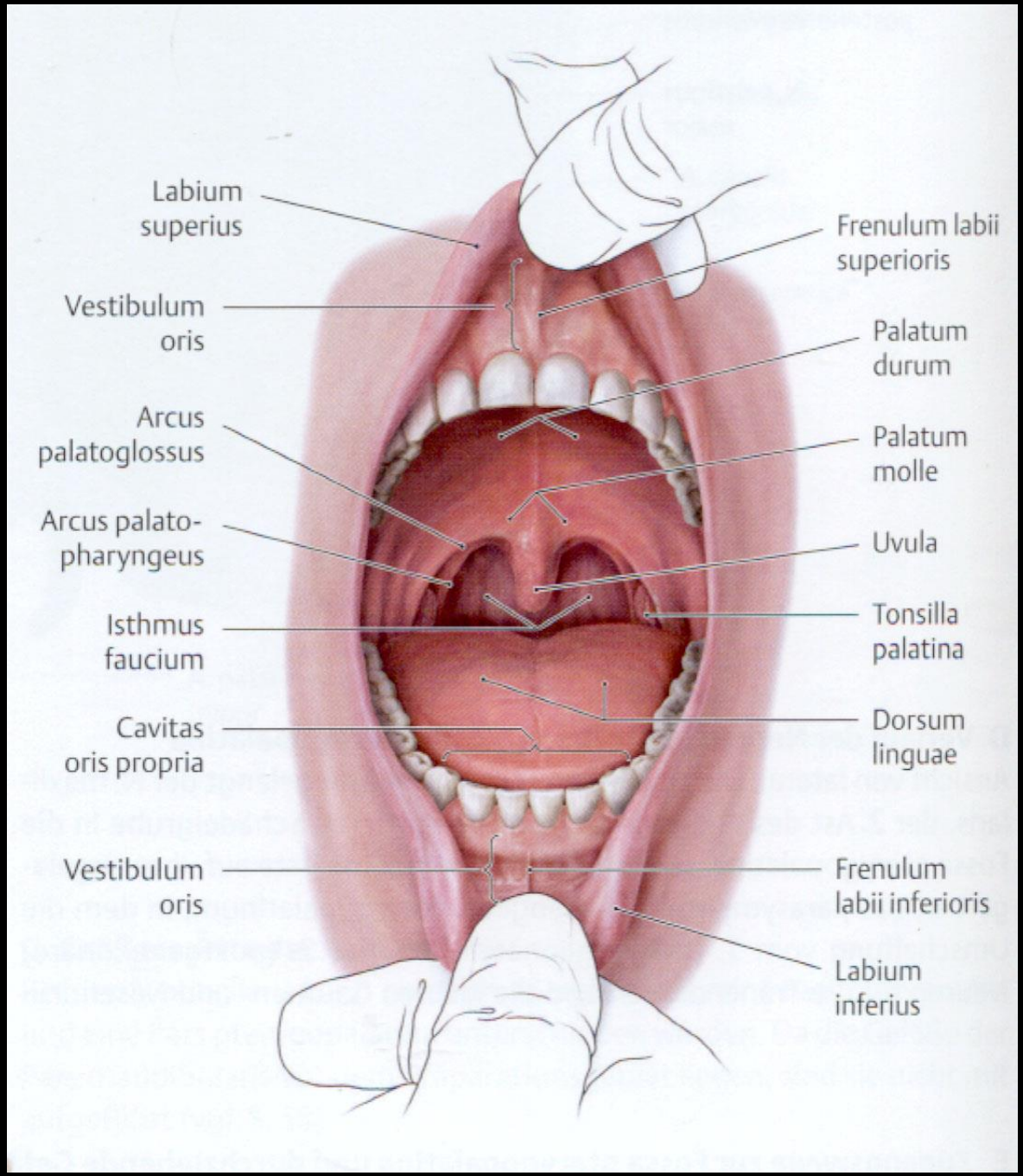
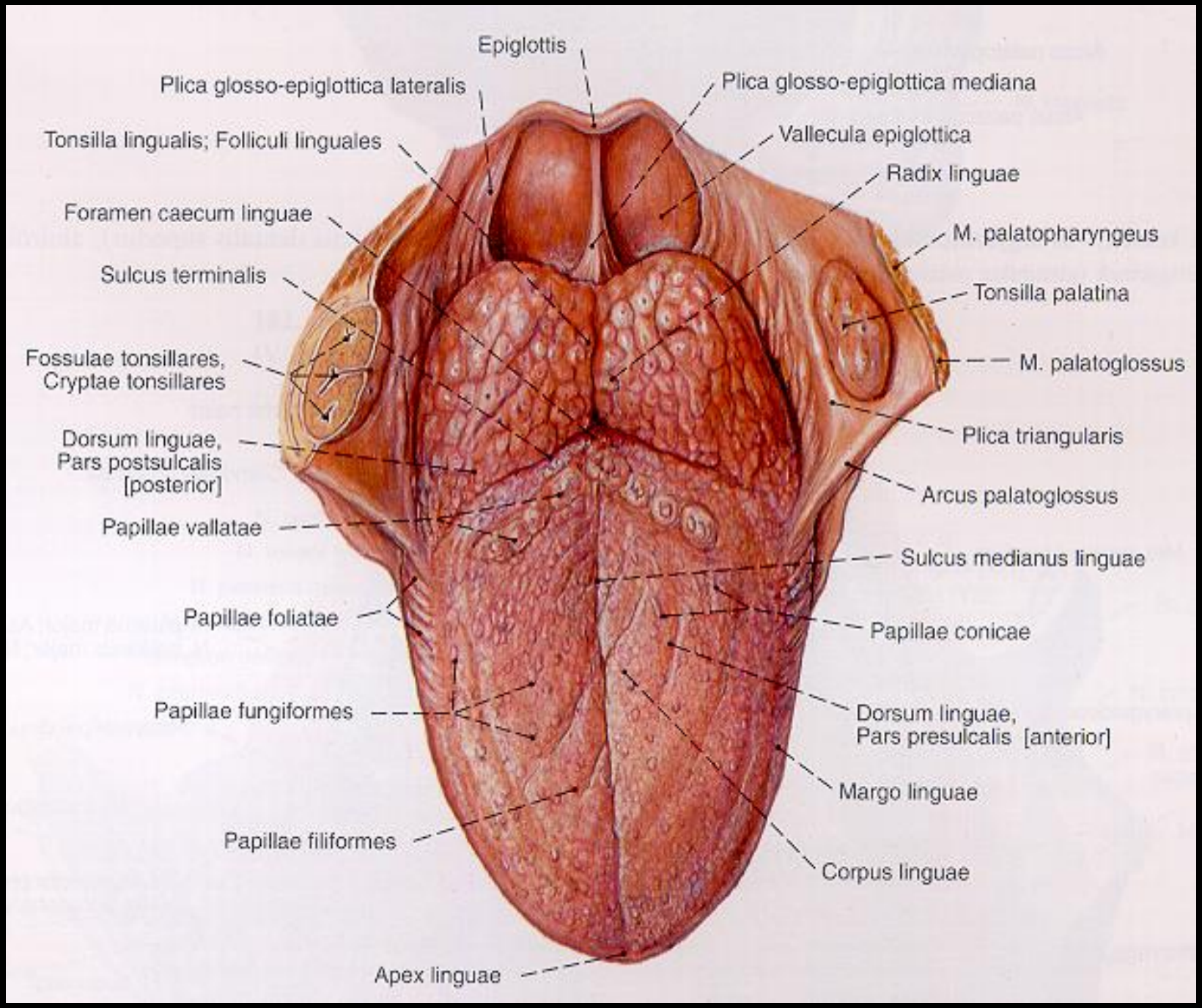
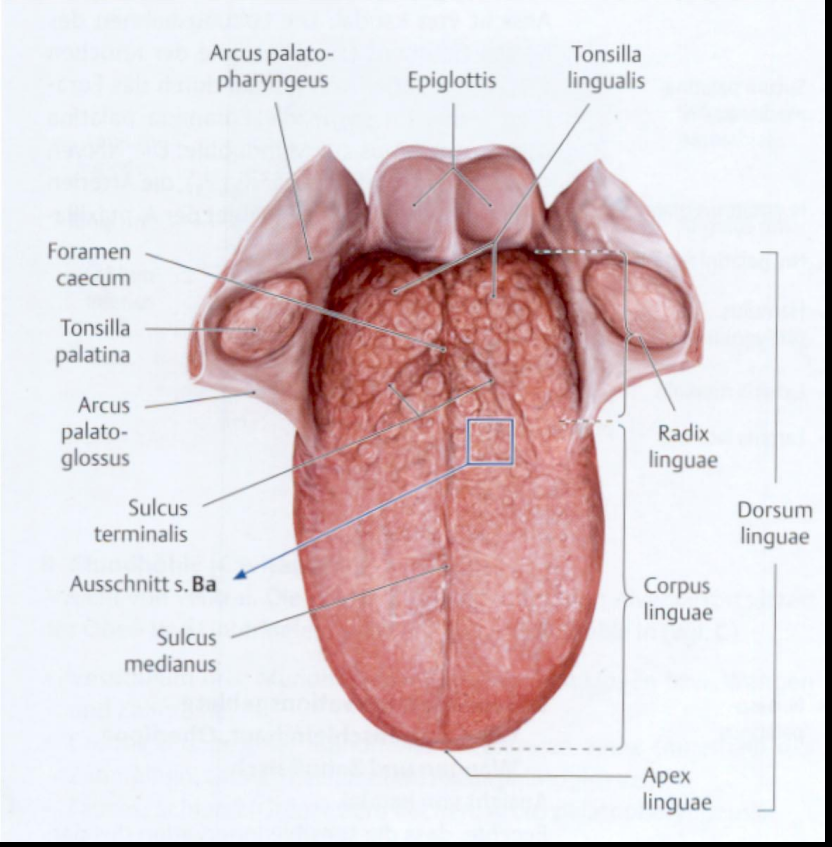
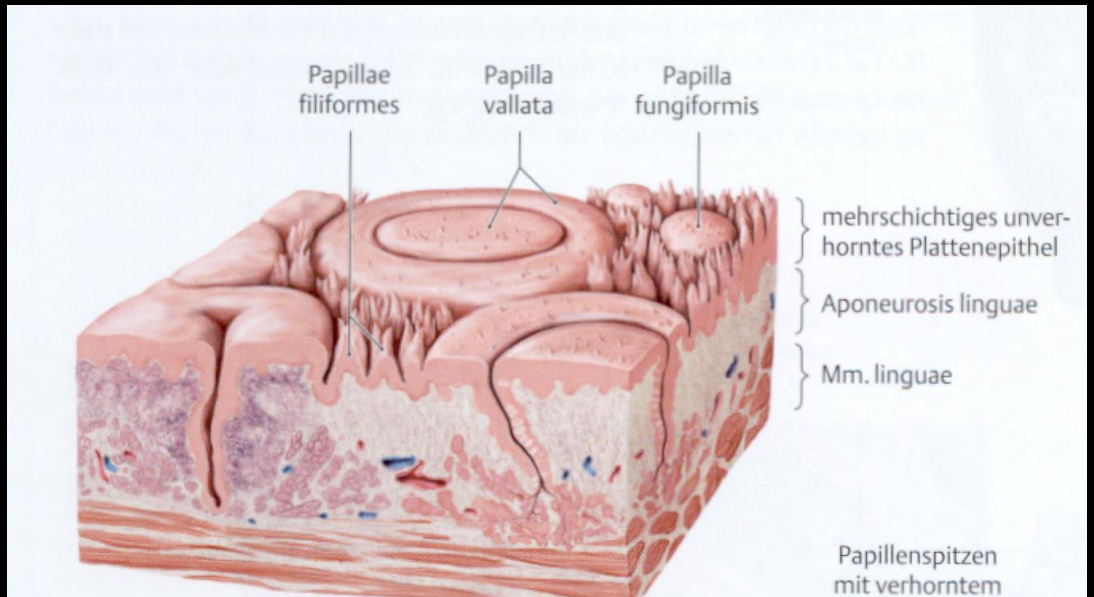
AZ ÍZÉRZŐRENDSZER

Barna János

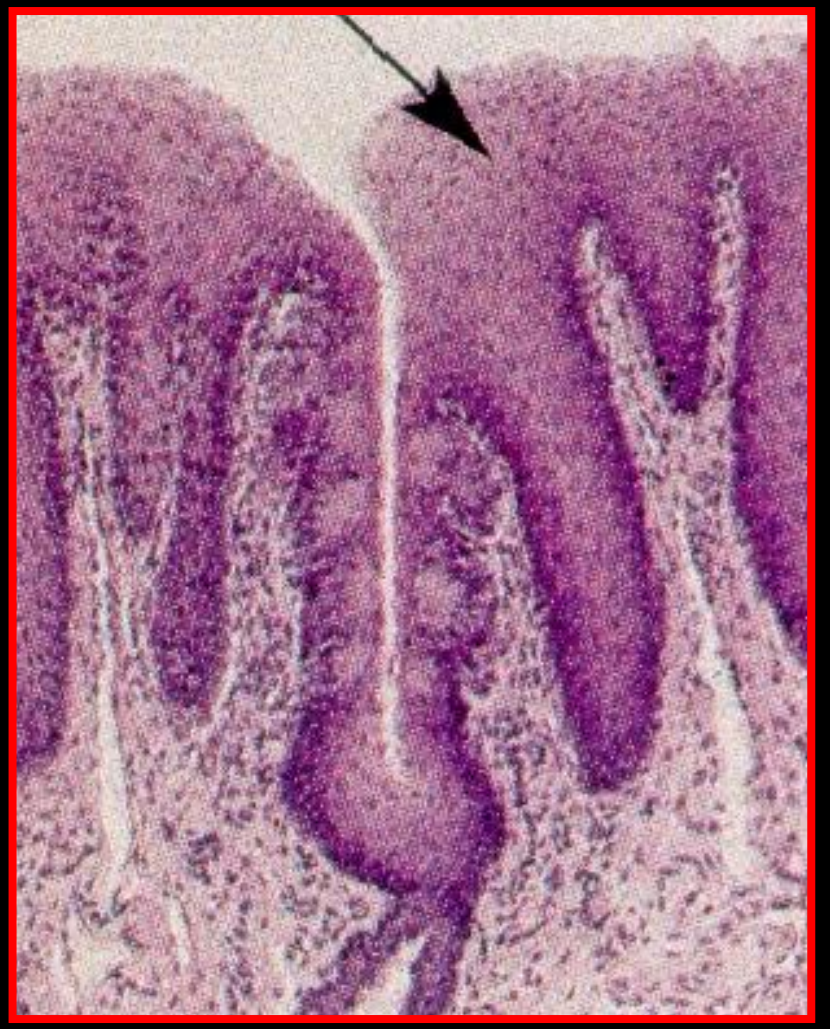

Labium superius
Vestibulum oris
Arcus palatoglossus
Arcus palato-pharyngeus
Isthmus faucium
Cavitas oris propria
Vestibulum oris
Frenulum labii superioris
Palatum durum
Palatum molle
Uvula
Tonsilla palatina
Dorsum linguae
Frenulum labii inferioris
Labium inferius

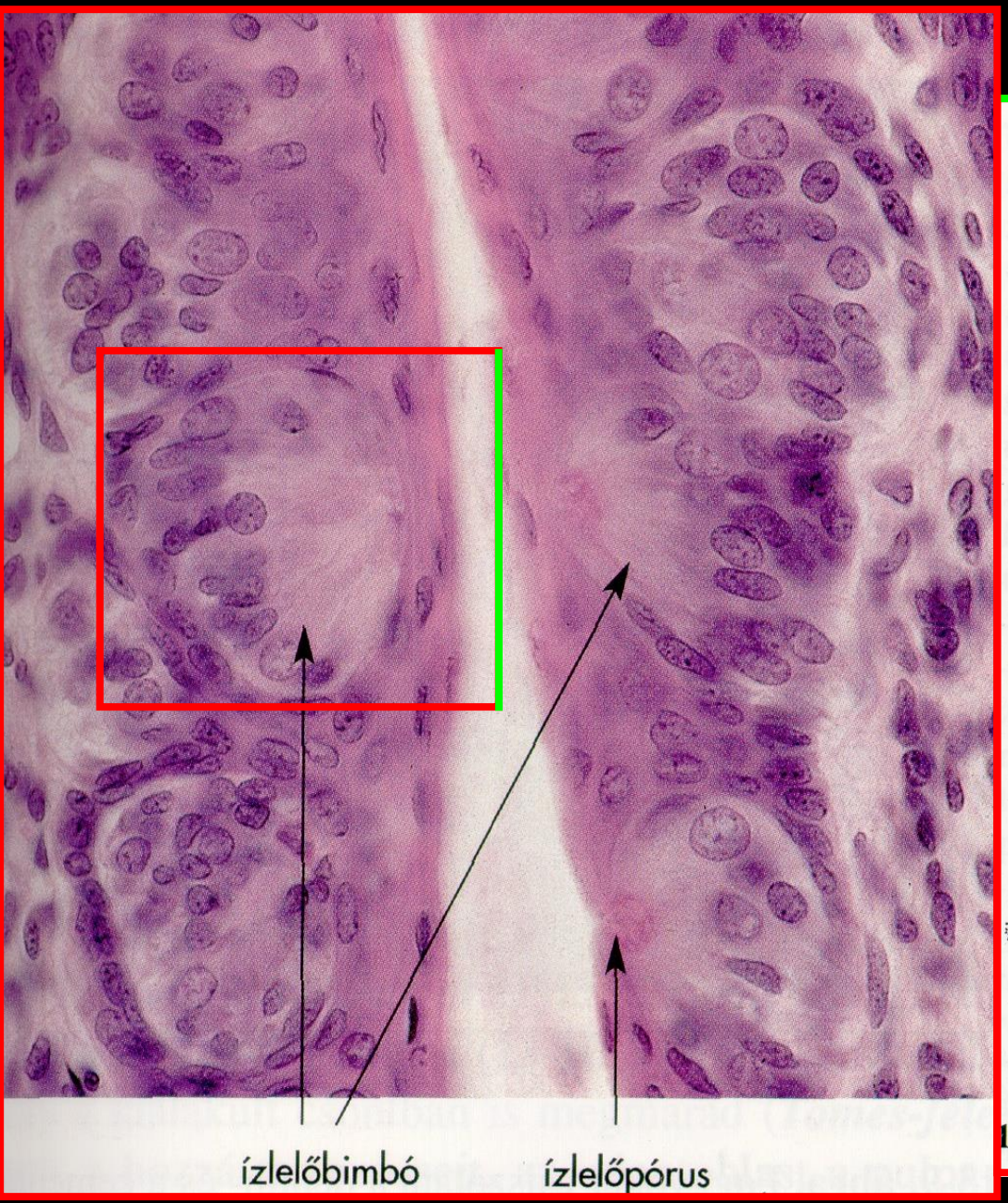

Epiglottis
Plica glosso-epiglottica lateralis
Plica glosso-epiglottica mediana
Tonsilla lingualis; Folliculi linguales
Vallecula epiglottica
Radix linguae
Foramen caecum linguae
M. palatopharyngeus
Sulcus terminalis
Tonsilla palatina
Fossulae tonsillares,
Cryptae tonsillares
M. palatoglossus
Plica triangularis
Dorsum linguae,
Pars postsulcalis
[posterior]
Arcus palatoglossus
Papillae vallatae
Sulcus medianus linguae
Papillae foliatae
Papillae conicae
Papillae fungiformes
Dorsum linguae,
Pars presulcalis [anterior]
Margo linguae
Papillae filiformes
Corpus linguae
Apex linguae

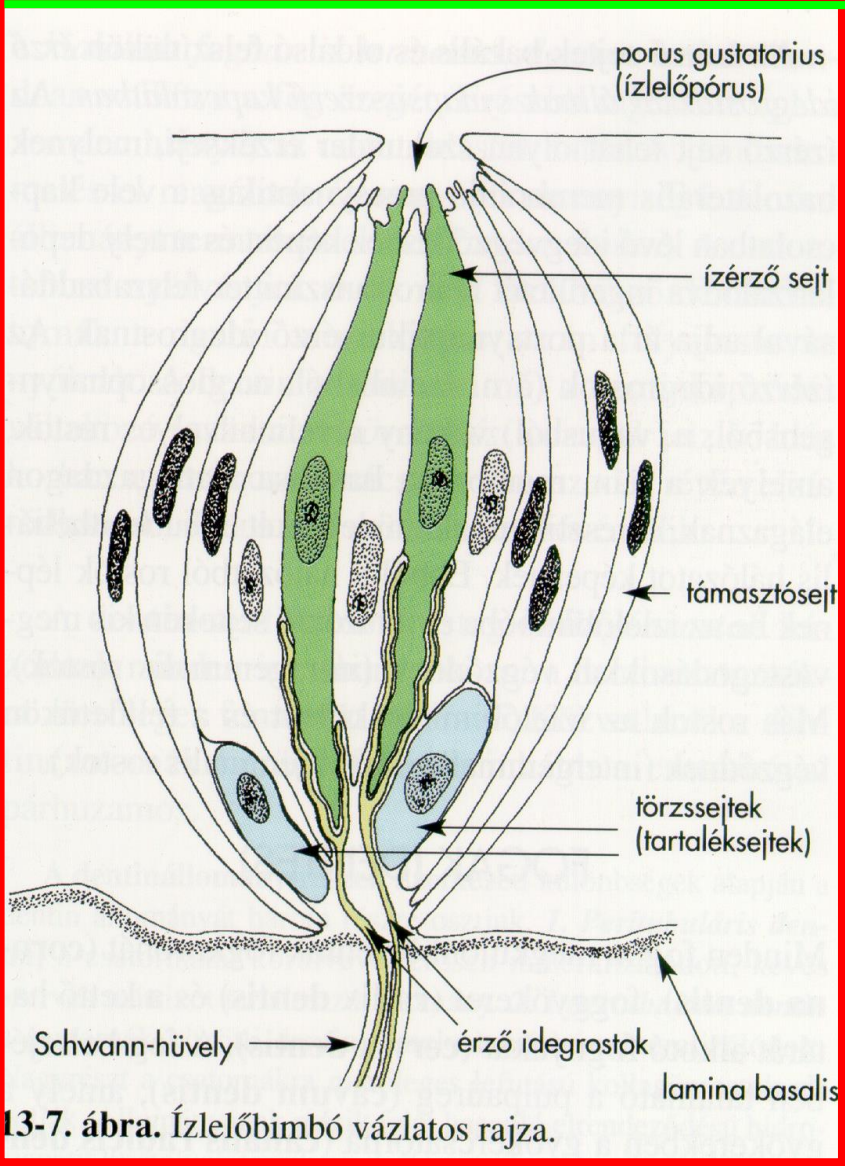

Arcus palato-
pharyngeus
Epiglottis
Tonsilla
lingualis
Foramen
caecum
Tonsilla
palatina
Arcus
palato-
glossus
Sulcus
terminalis
Ausschnitt s. Ba
Sulcus
medianus
Radix
linguae
Corpus
linguae
Apex
linguae
Dorsum
linguae


Papillae
filiformes
Papilla
vallata
Papilla
fungiformis
mehrschichtiges unver-
horntes Plattenepithel
Aponeurosis linguae
Mm. linguae
Papillenspitzen
mit verhorntem

13-4. ábra. Papillae foliatae (HE, 50x).





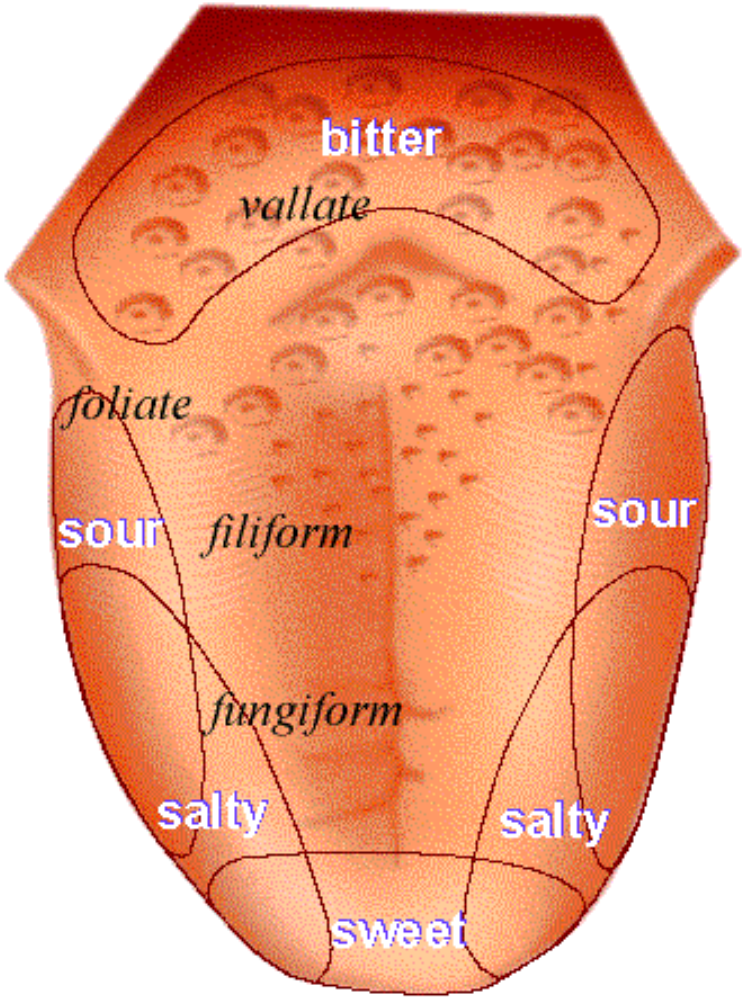


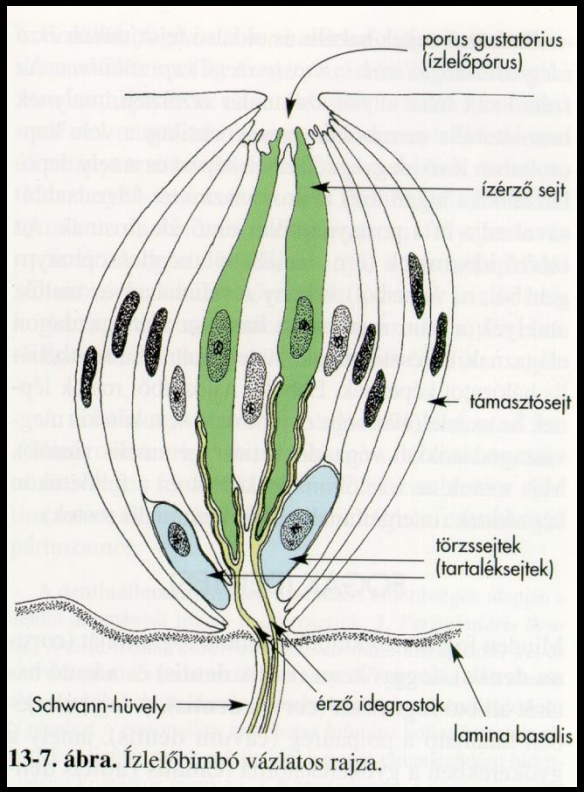
13-7. ábra. Ízlelőbimbó vázlatos rajza.

Gustus (ízlelés)

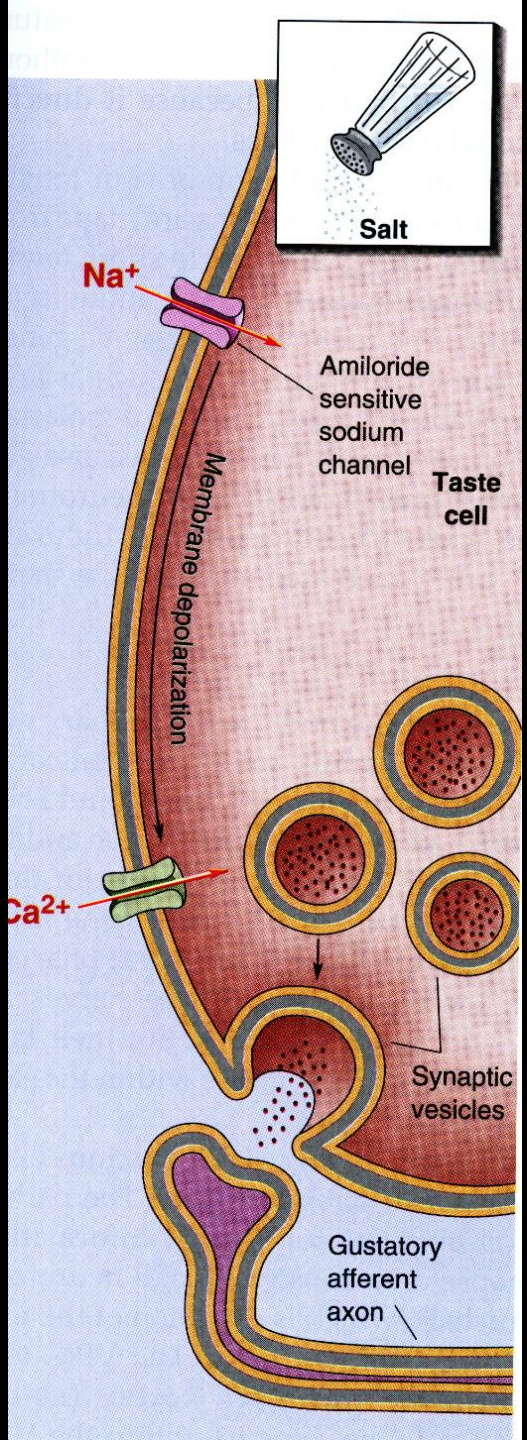
Alapízek

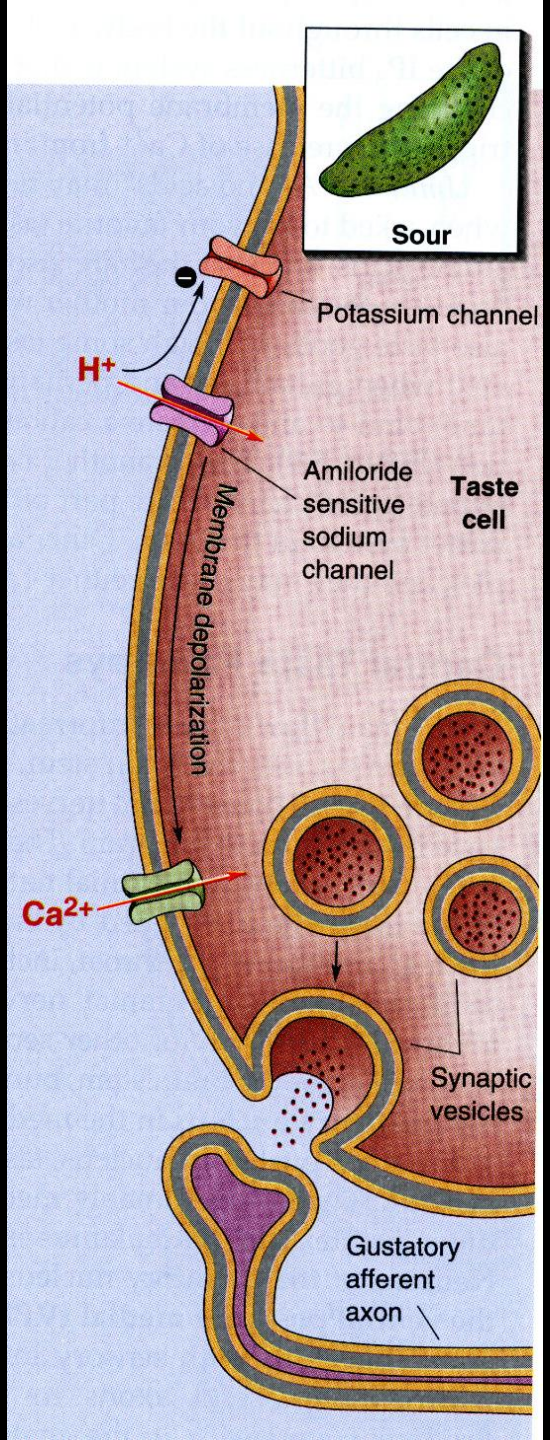
- keserű
- savanyú
- sós
- édes
- umami

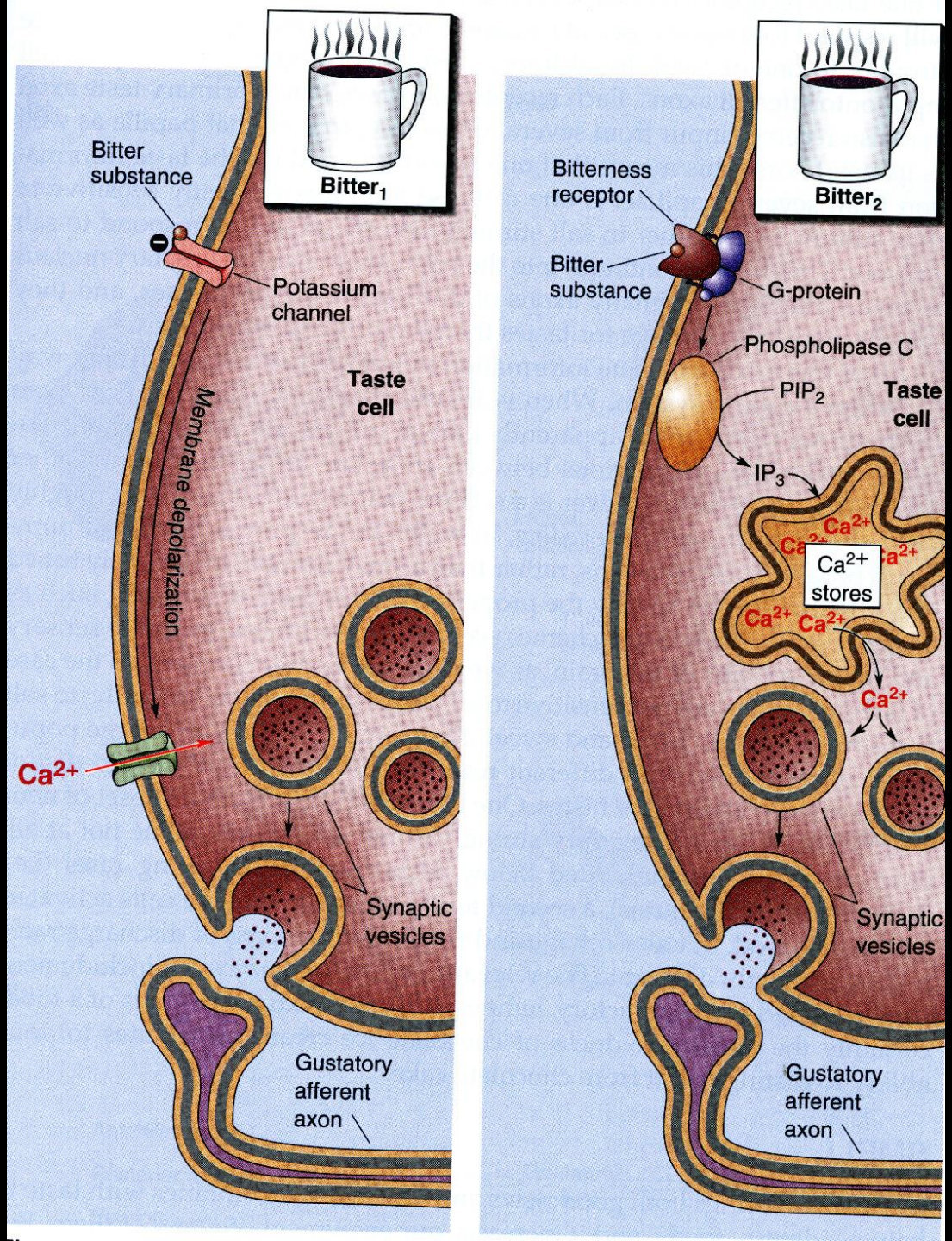

bitter
vallate
foliate
sour
filiform
sour
fungiform
salty
salty
sweet

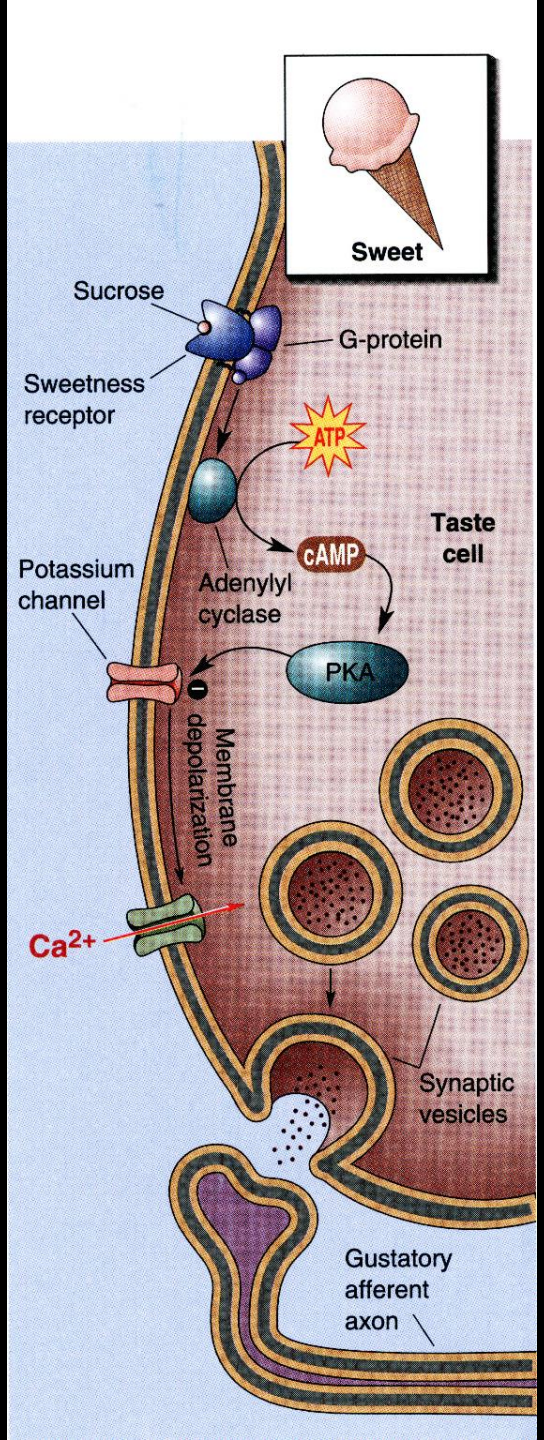


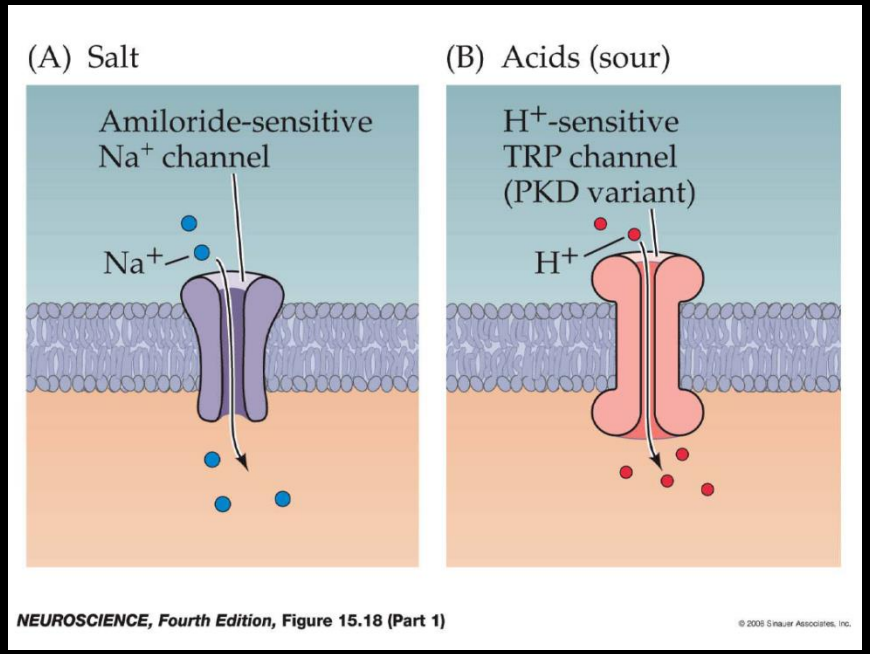
13-7. ábra. Ízlelőbimbó vázlatos rajza.



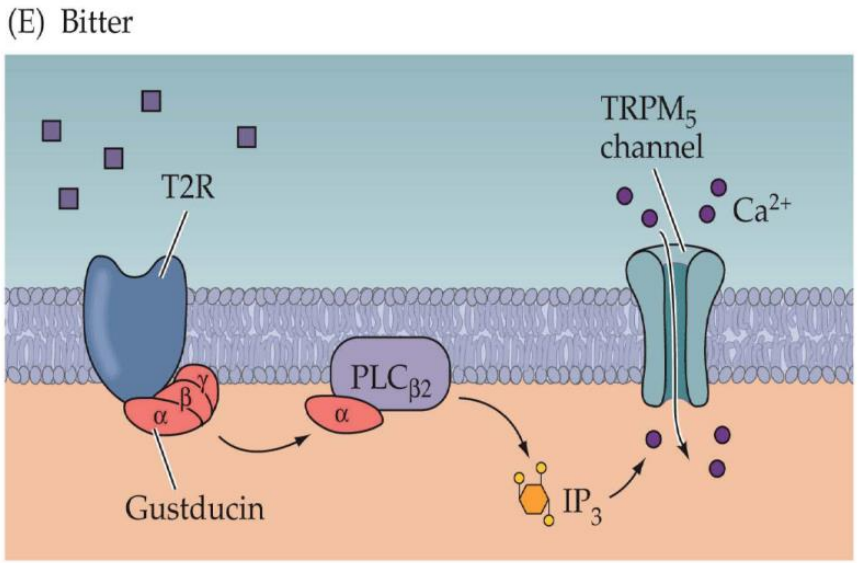

Sour
Potassium channel
H+
Amiloride sensitive sodium channel
Taste cell
Membrane depolarization
Ca2+
Synaptic vesicles
Gustatory afferent axon


Bitter substance
Bitter$_1$
Potassium channel
Taste cell
Membrane depolarization
Ca^{2+}
Synaptic vesicles
Gustatory afferent axon
Bitterness receptor
Bitter$_2$
Bitter substance
G-protein
Phospholipase C
PIP_2
Taste cell
IP_3
Ca^{2+} stores
Ca^{2+}
Synaptic vesicles
Gustatory afferent axon

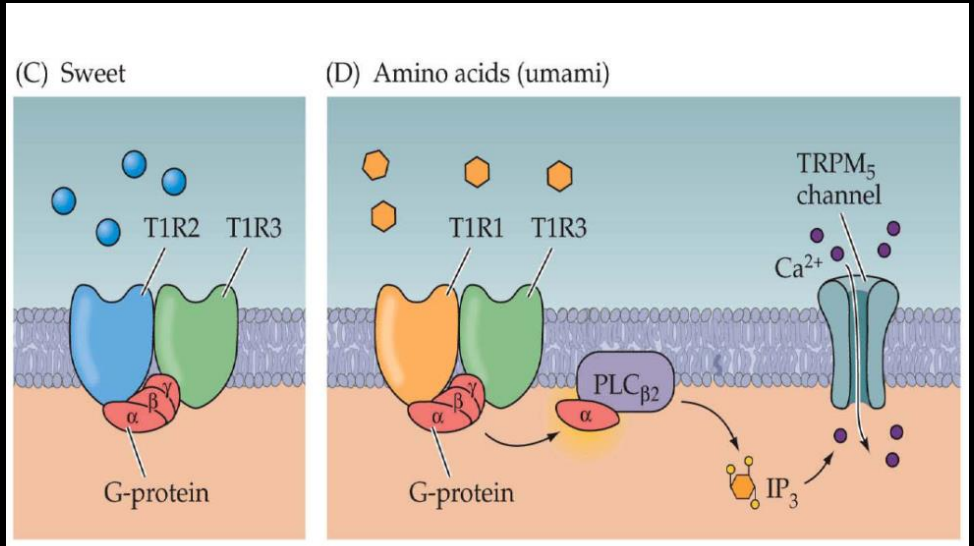

Sweet
Sucrose
G-protein
Sweetness receptor
ATP
Taste cell
cAMP
Potassium channel
Adenylyl cyclase
PKA
Membrane depolarization
Ca^{2+}
Synaptic vesicles
Gustatory afferent axon



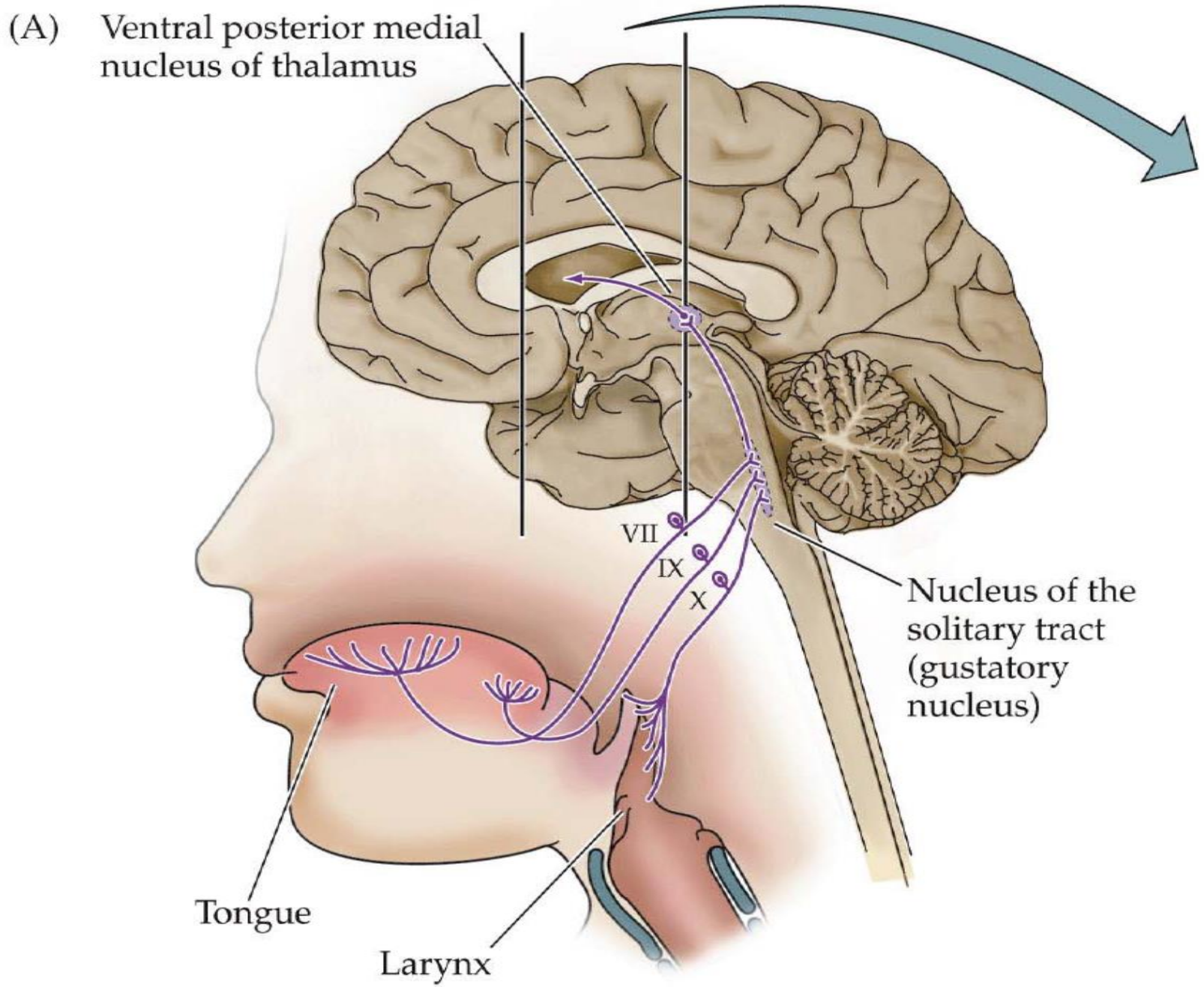
NEUROSCIENCE, Fourth Edition, Figure 15.18 (Part 1)

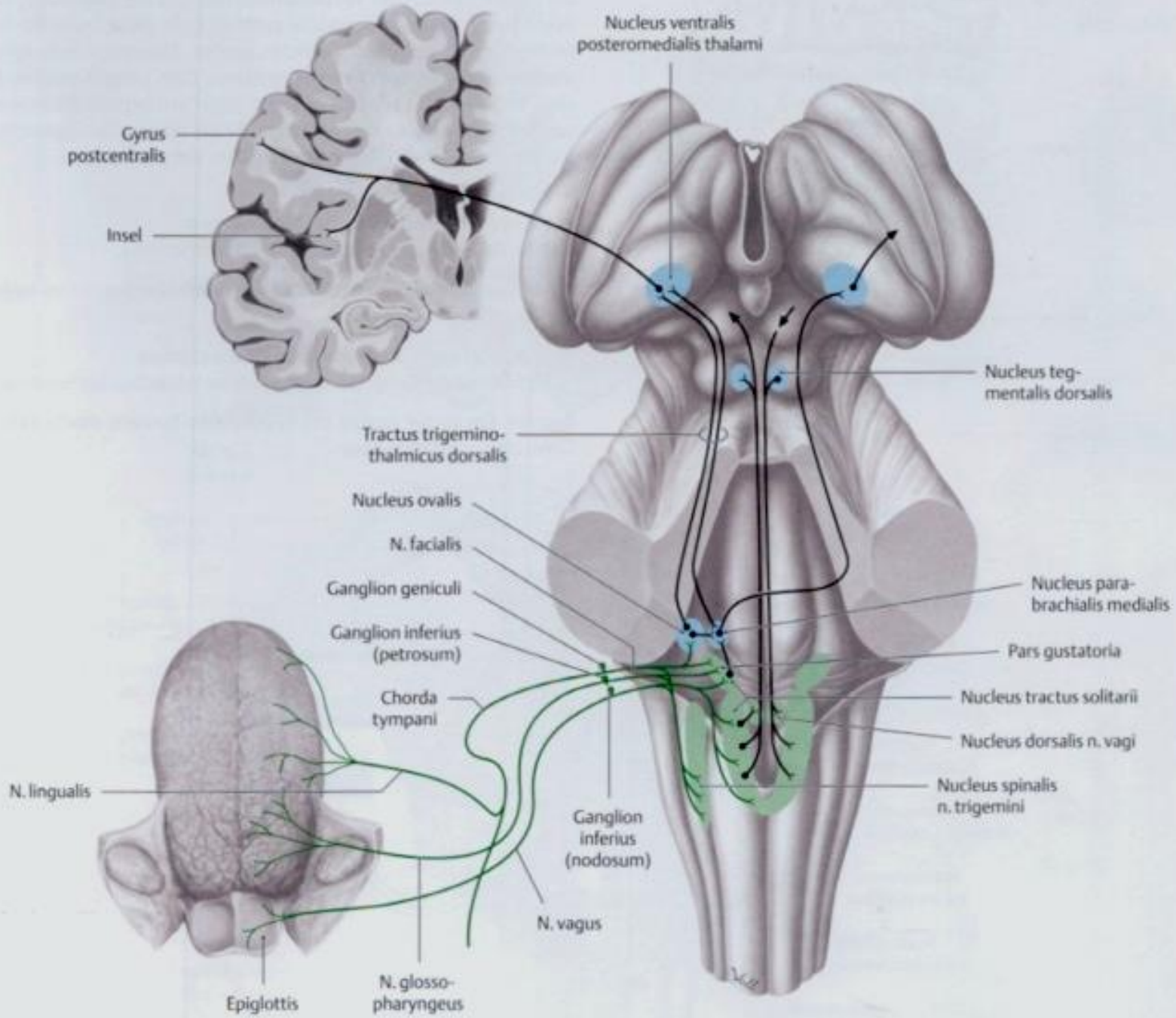


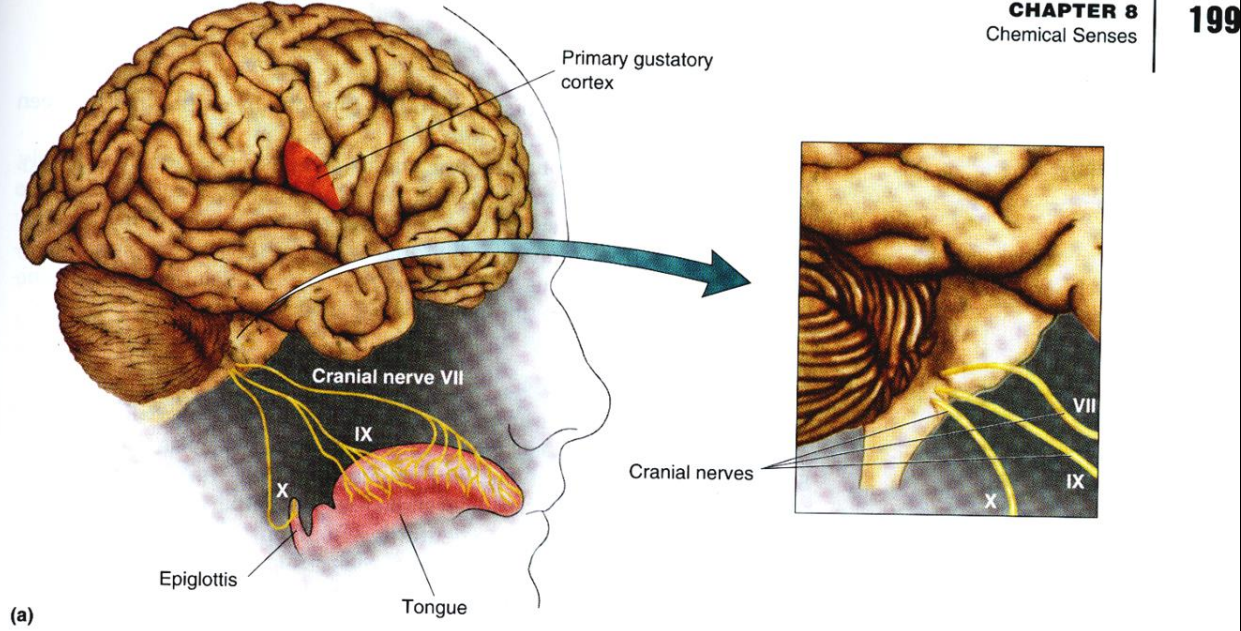
NEUROSCIENCE, Fourth Edition, Figure 15.18 (Part 3)



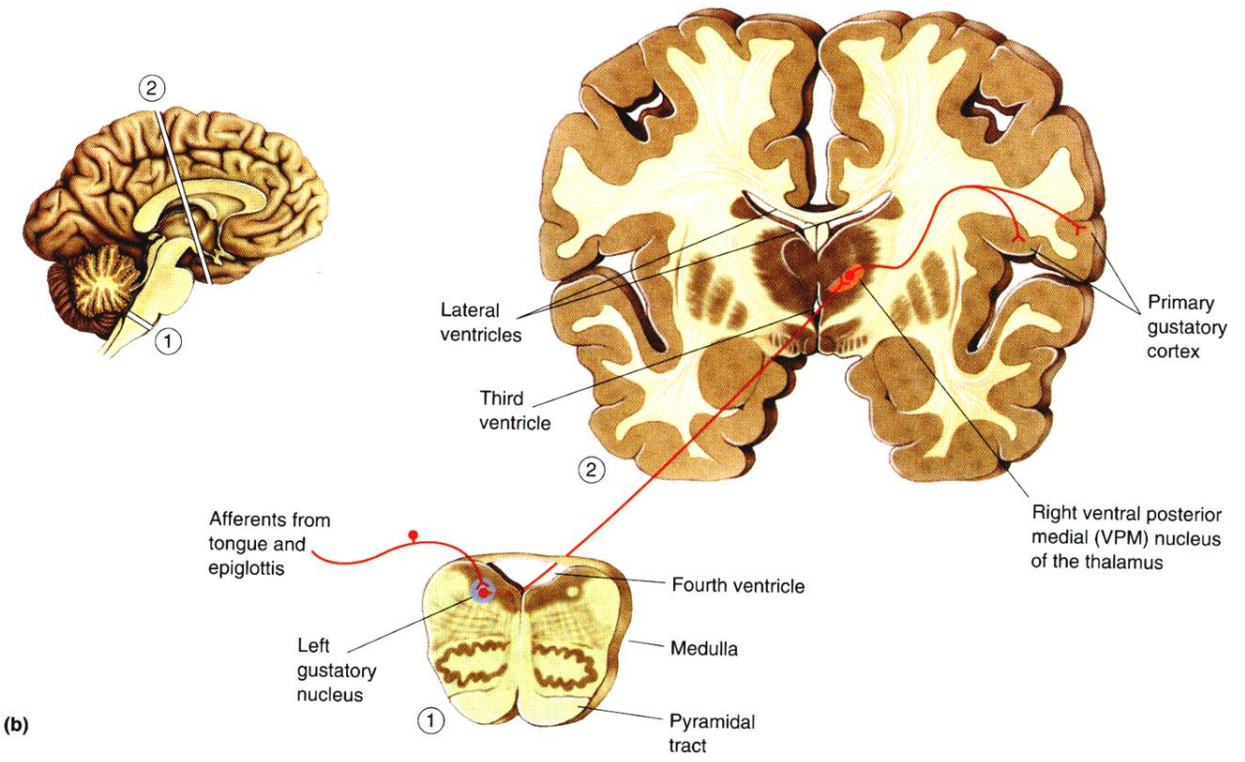
NEUROSCIENCE, Fourth Edition, Figure 15.18 (Part 2)


(A) Ventral posterior medial nucleus of thalamus
VII
IX
X
Nucleus of the solitary tract (gustatory nucleus)
Tongue
Larynx


Nucleus ventralis posteromedialis thalami
Gyrus postcentralis
Insel
Nucleus tegmentalis dorsalis
Tractus trigeminothalmicus dorsalis
Nucleus ovalis
N. facialis
Ganglion geniculi
Ganglion inferius (petrosum)
Chorda tympani
N. lingualis
Nucleus parabrachialis medialis
Pars gustatoria
Nucleus tractus solitarii
Nucleus dorsalis n. vagi
Nucleus spinalis n. trigemini
Ganglion inferius (nodosum)
N. vagus
Epiglottis
N. glossopharyngeus


Primary gustatory cortex
Cranial nerve VII
IX
X
Epiglottis
Tongue
Cranial nerves
VII
IX
X

(a)


2
1
Lateral ventricles
Third ventricle
Primary gustatory cortex
Right ventral posterior medial (VPM) nucleus of the thalamus
Afferents from tongue and epiglottis
Fourth ventricle
Left gustatory nucleus
Medulla
Pyramidal tract

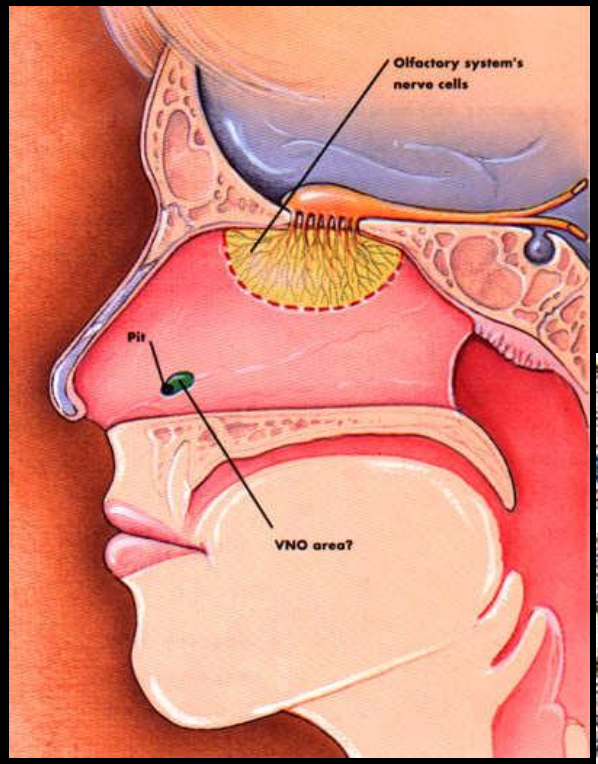
(b)

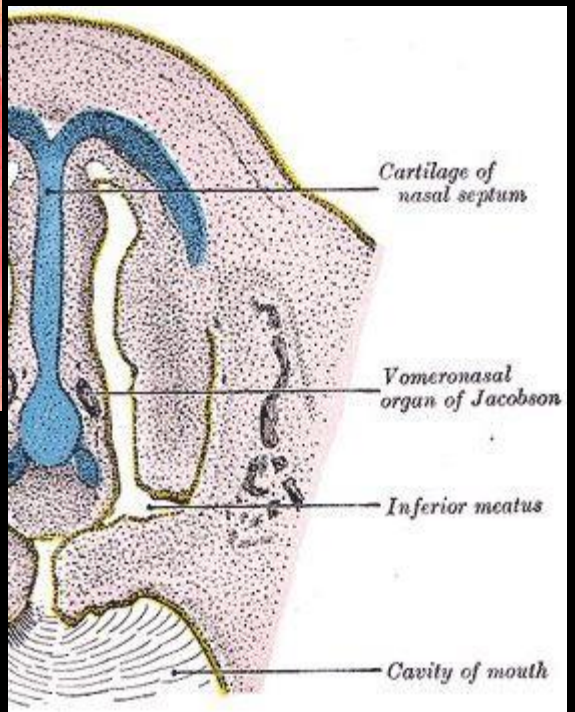
A ízérzőrendszer zavara

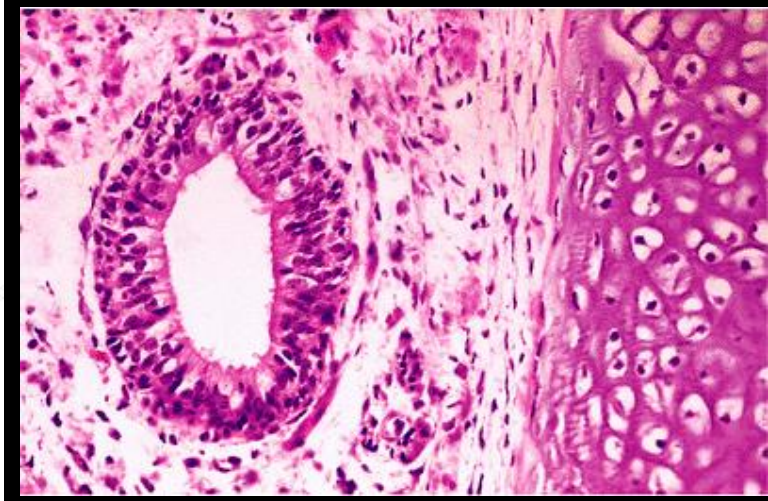
ageusia

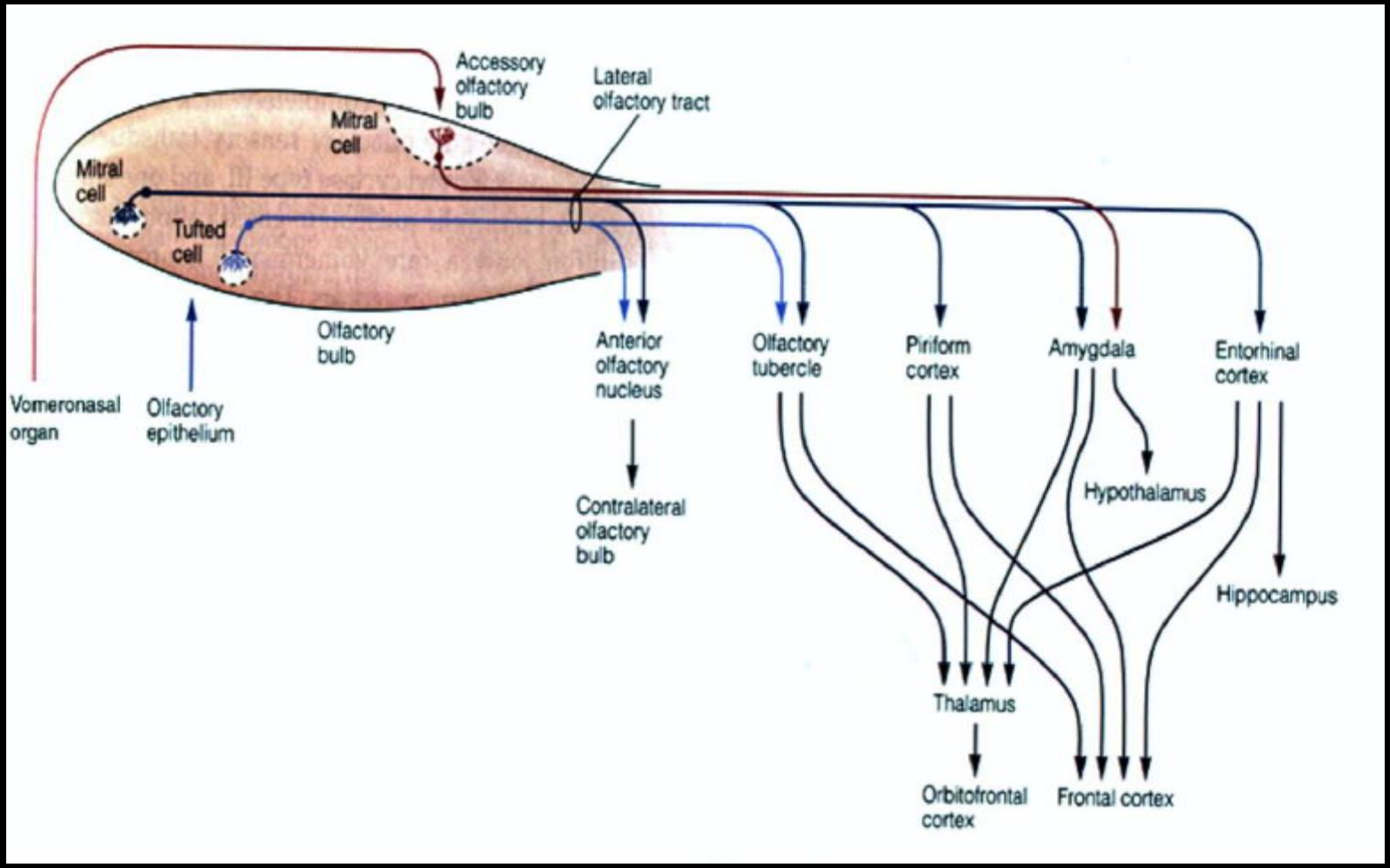
A SZAGLÓRENDSZER

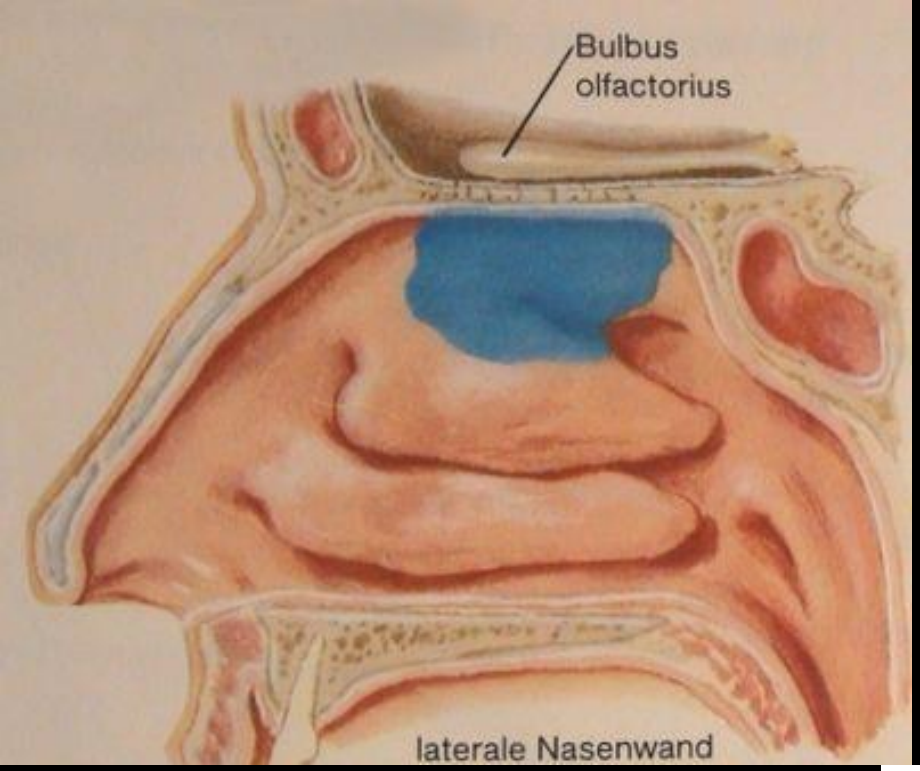
Vomeronasalis szerv (Jacobson-szerv)

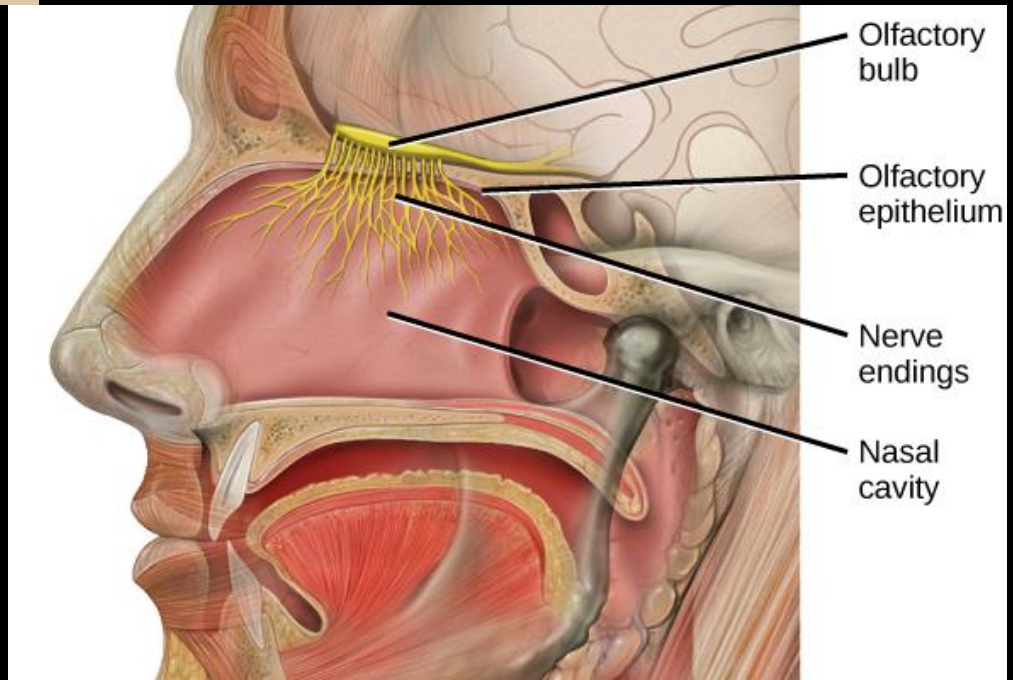


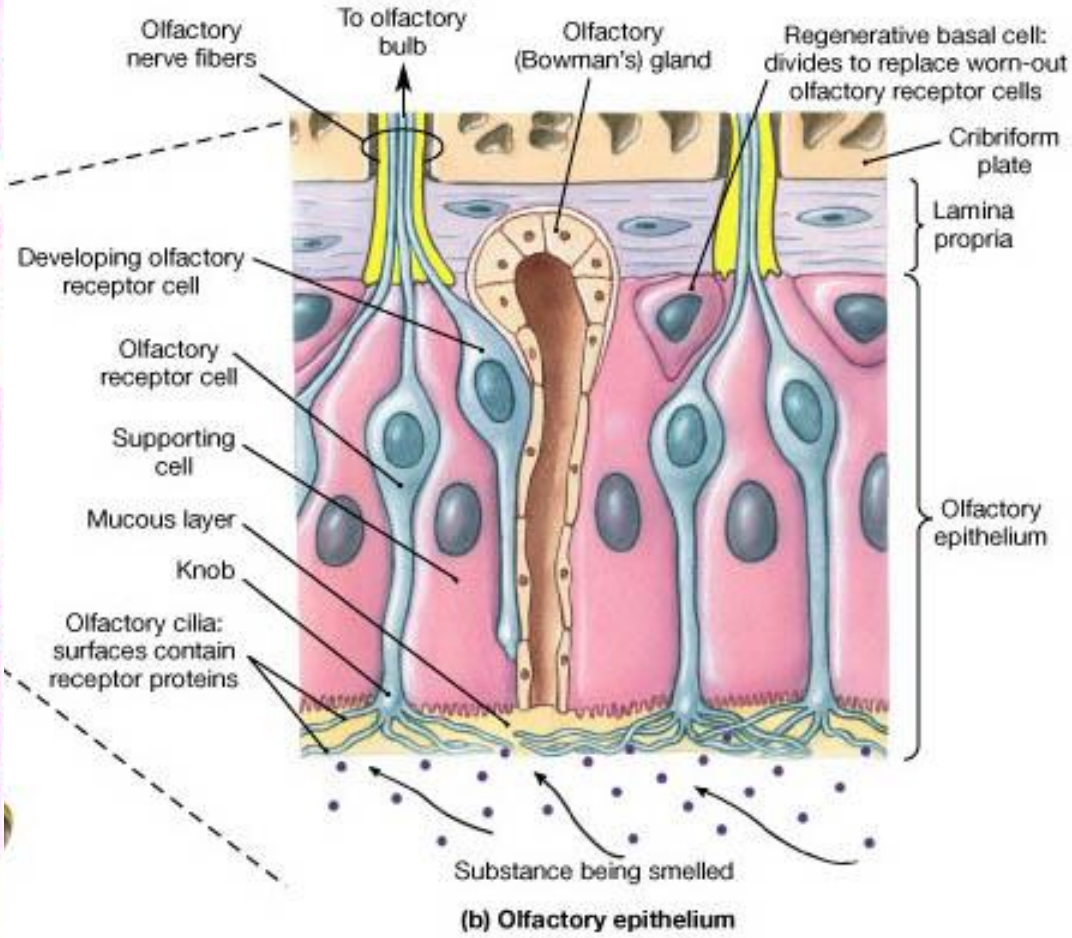





Accessory olfactory bulb
Lateral olfactory tract
Mitral cell
Mitral cell
Tufted cell
Olfactory bulb
Vomeronasal organ
Olfactory epithelium
Anterior olfactory nucleus
Olfactory tubercle
Piriform cortex
Amygdala
Entorhinal cortex
Contralateral olfactory bulb
Hypothalamus
Hippocampus
Thalamus
Orbitofrontal cortex
Frontal cortex

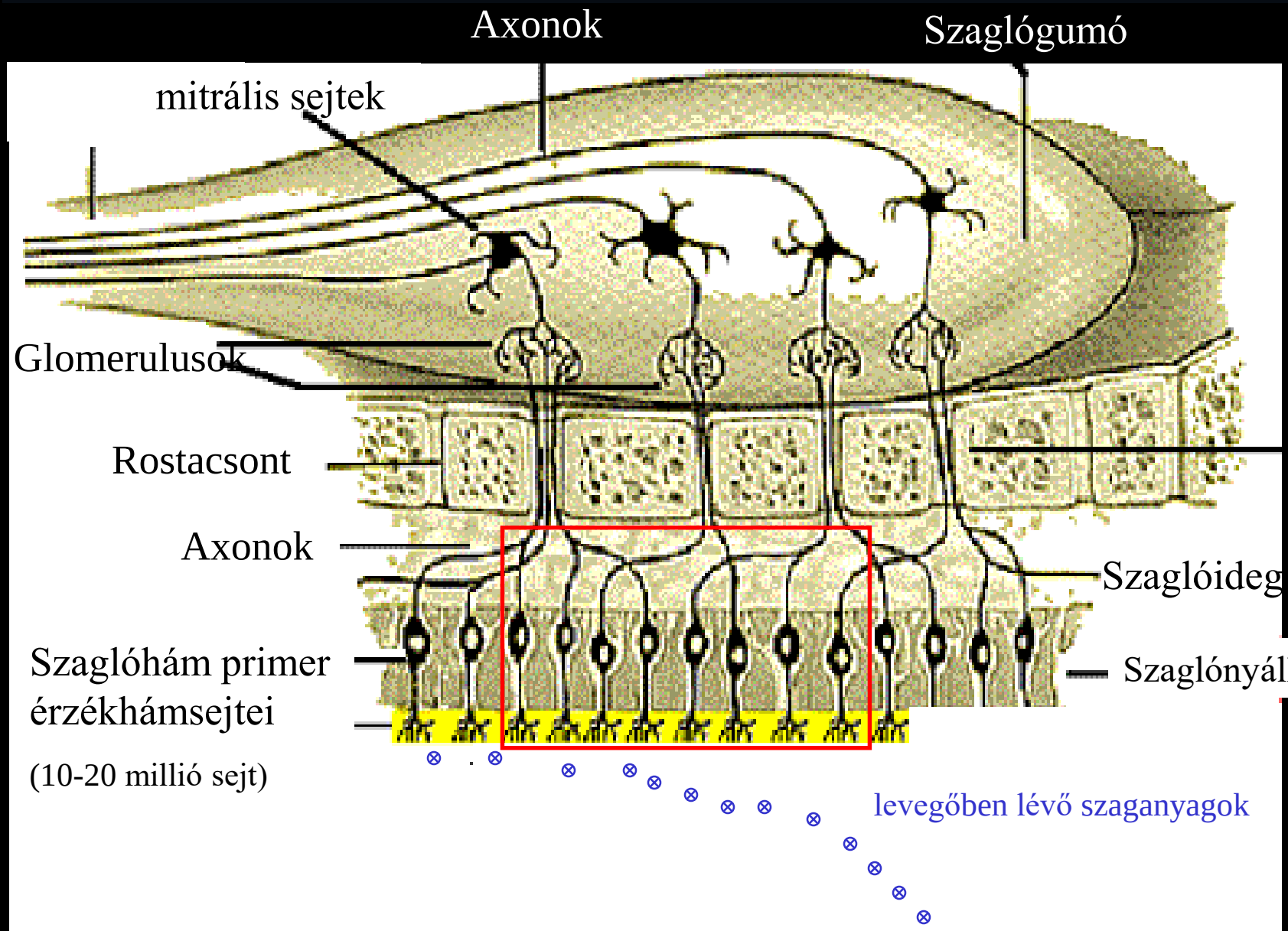

Bulbus
olfactorius
laterale Nasenwand


Olfactory
bulb
Olfactory
epithelium
Nerve
endings
Nasal
cavity

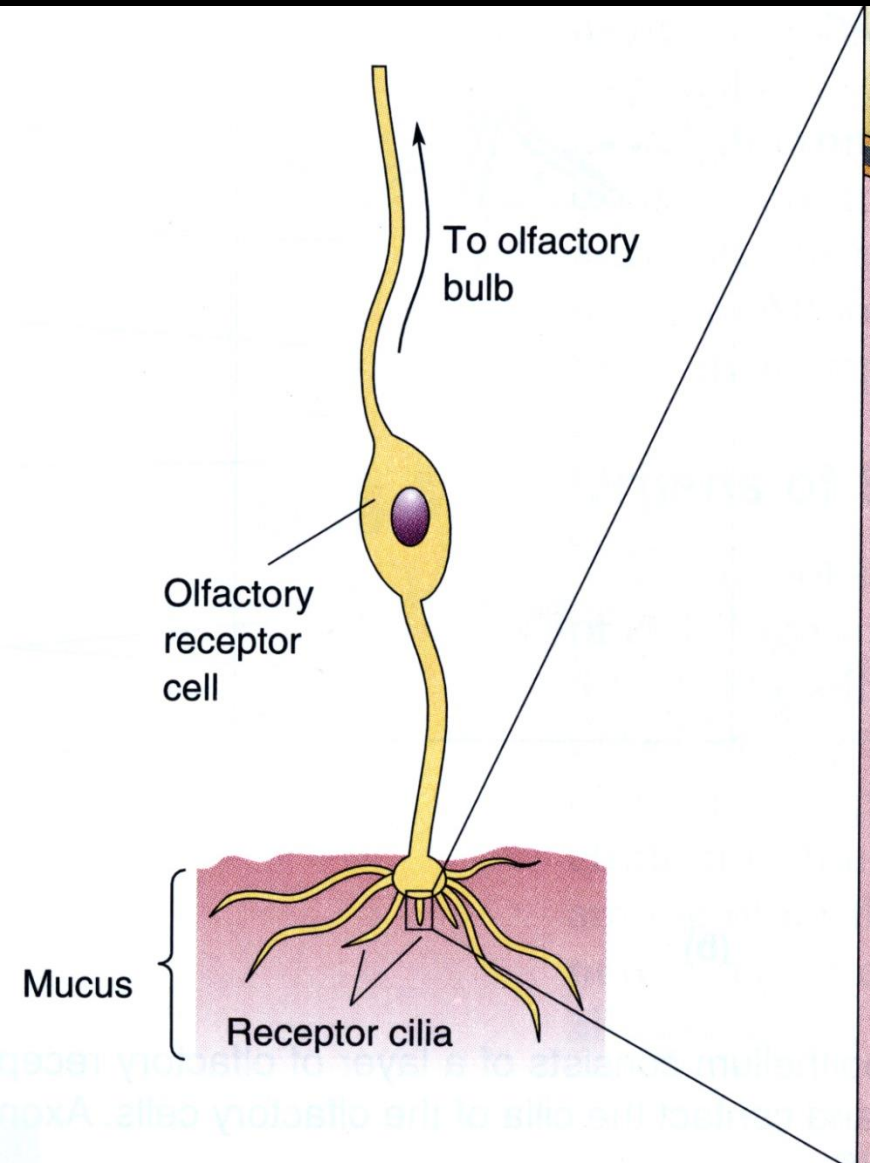


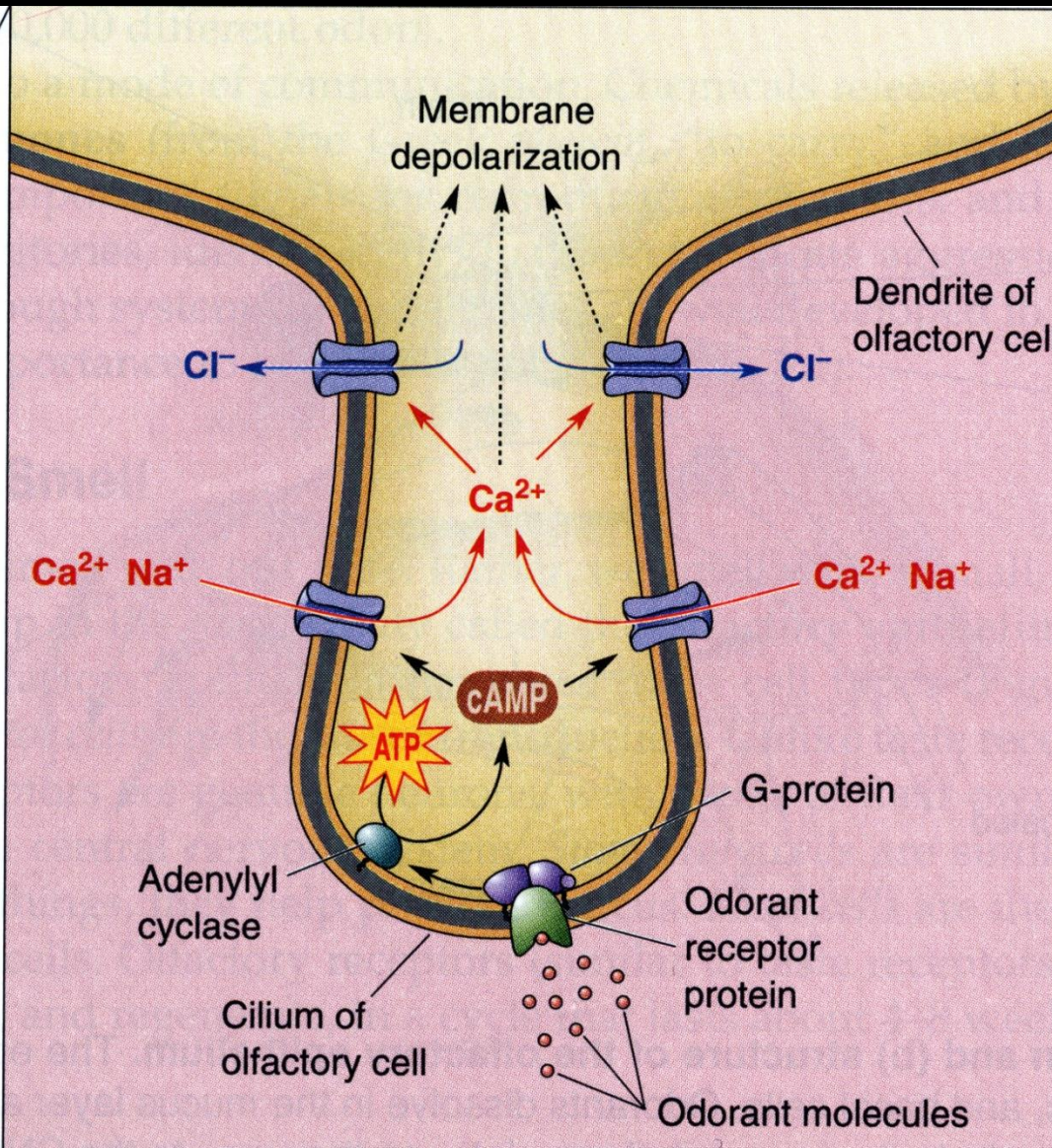
(b) Olfactory epithelium

A szaglónyálkahártya és a szaglógumó felépítése



A szaglóreceptorok membránreceptorai





A szaglóreceptorok membránreceptorai

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A Novel Multigene Family May Encode Odorant Receptors: A Molecular Basis for Odor Recognition

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*Department of Biochemistry and Molecular Biophysics
†Howard Hughes Medical Institute
College of Physicians and Surgeons
Columbia University
New York, New York 10032

Summary

The mammalian olfactory system can recognize and discriminate a large number of different odorant molecules. The detection of chemically distinct odorants presumably results from the association of odorous ligands with specific receptors on olfactory sensory neurons. To address the problem of olfactory perception at a molecular level, we have cloned and characterized 18 different members of an extremely large multigene family that encodes seven transmembrane domain proteins whose expression is restricted to the olfactory epithelium. The members of this novel gene family are likely to encode a diverse family of odorant receptors.

Introduction

In vertebrate sensory systems, peripheral neurons respond to environmental stimuli and transmit these signals to higher sensory centers in the brain where they are processed to allow the discrimination of complex sensory information. The delineation of the peripheral mechanisms by which environmental stimuli are transduced into neural information can provide insight into the logic underlying sensory processing. Our understanding of color vision, for example, emerged only after the observation that the discrimination of hue results from the blending of information from only three classes of photoreceptors (Rushton, 1955, 1965; Wald et al., 1955; Nathans et al., 1986). The basic logic underlying olfactory sensory perception, however, has remained elusive. Mammals possess an olfactory system of enormous discriminatory power (for reviews see Lancet, 1986; Reed, 1990). Humans, for example, are thought to be capable of distinguishing among thousands of distinct odors. The specificity of odor recognition is emphasized by the observation that subtle alterations in the molecular structure of an odorant can lead to profound changes in perceived odor.

How are the diversity and specificity of olfactory perception accomplished? The detection of chemically distinct odorants presumably results from the association of odorous ligands with specific receptors on olfactory neurons, which reside in a specialized epithelium in the nose. Since these receptors have not been identified, it has been difficult to determine how odor discrimination might be achieved. It is possible that olfaction, by analogy with color vision, involves only a few odor receptors, each capable of interaction with multiple odorant molecules. Alternatively, the sense of smell may involve a large number of distinct receptors each capable of associating with one or a small number of odorants. In either case, the brain must distinguish which receptors or which neurons have been activated to allow the discrimination between different odorant stimuli. Insight into the mechanisms underlying olfactory perception is likely to depend upon the isolation of the odorant receptors and the characterization of their diversity, specificity, and patterns of expression.

The primary events in odor detection occur in a specialized olfactory neuroepithelium located in the posterior recesses of the nasal cavity. Three cell types dominate this epithelium (Figure 1A): the olfactory sensory neuron, the sustentacular or supporting cell, and the basal cell, which is a stem cell that generates olfactory neurons throughout life (Moulton and Beidler, 1967; Graziadei and Monti Graziadei, 1979). The olfactory sensory neuron is bipolar: a dendritic process extends to the mucosal surface, where it gives rise to a number of specialized cilia that provide an extensive, receptive surface for the interaction of odors with the cell. The olfactory neuron also gives rise to an axon that projects to the olfactory bulb of the brain, the first relay in the olfactory system. The axons of the olfactory bulb neurons, in turn, project to subcortical and cortical regions where higher-level processing of olfactory information allows the discrimination of odors by the brain.

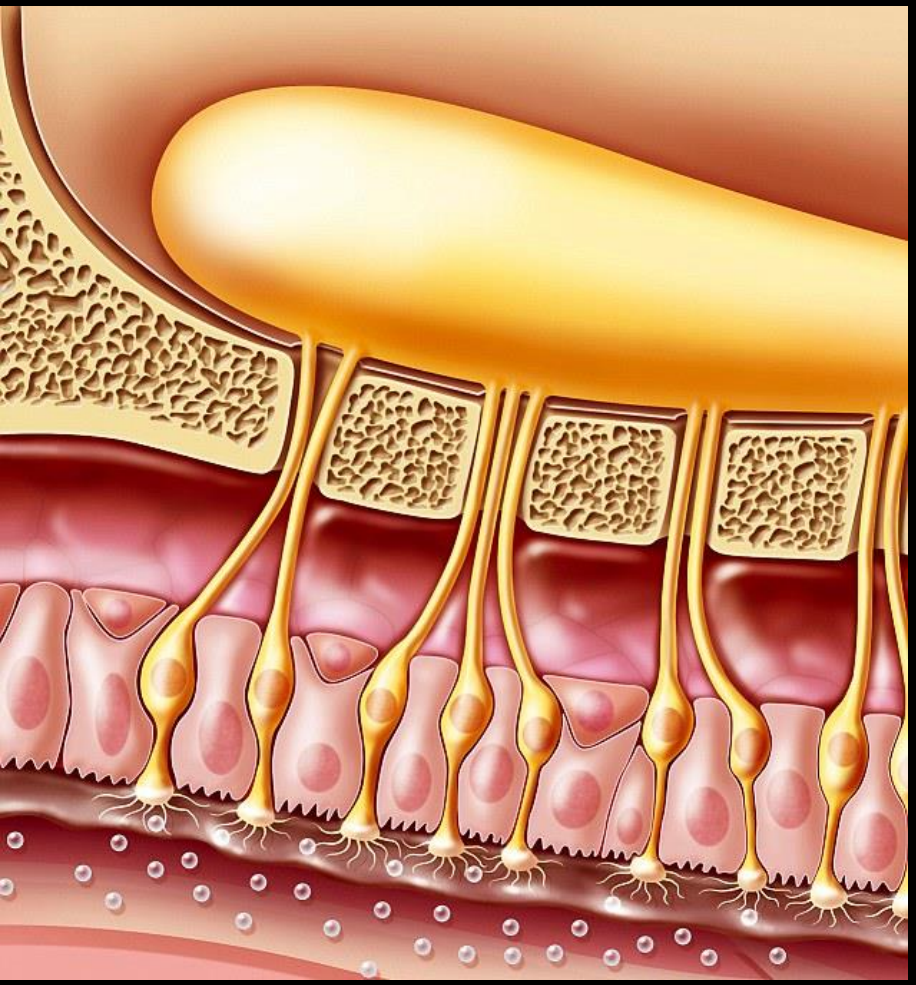
The initial events in odor discrimination are thought to involve the association of odors with specific receptors on the cilia of olfactory neurons. Selective removal of the cilia results in the loss of olfactory responses (Bronshtein and Minor, 1977). Moreover, in fish, whose olfactory system senses amino acids as odors, the specific binding of amino acids to isolated cilia has been demonstrated (Rhein and Cagan, 1980, 1983). The cilia are also the site of olfactory signal transduction. Exposure of isolated cilia from rat olfactory epithelium to numerous odorants leads to the rapid stimulation of adenylyl cyclase and elevations in cyclic AMP (an elevation in inositol trisphosphate in response to one odorant has also been observed) (Pace et al., 1985; Sklar et al., 1986; Breer et al., 1990; Boekhoff et al., 1990). The activation of adenylyl cyclase is dependent on the presence of GTP and is therefore likely to be mediated by receptor-coupled GTP-binding proteins (G proteins) (Jones and Reed, 1989). Elevations in cyclic AMP, in turn, are thought to elicit depolarization of olfactory neurons by direct activation of a cyclic nucleotide–gated, cation-permeable channel (Nakamura and Gold, 1987; Dhallan et al., 1990). This channel is opened upon binding of cyclic nucleotides to its cytoplasmic domain, and can therefore transduce changes in intracellular levels of cyclic AMP into alterations in the membrane potential.

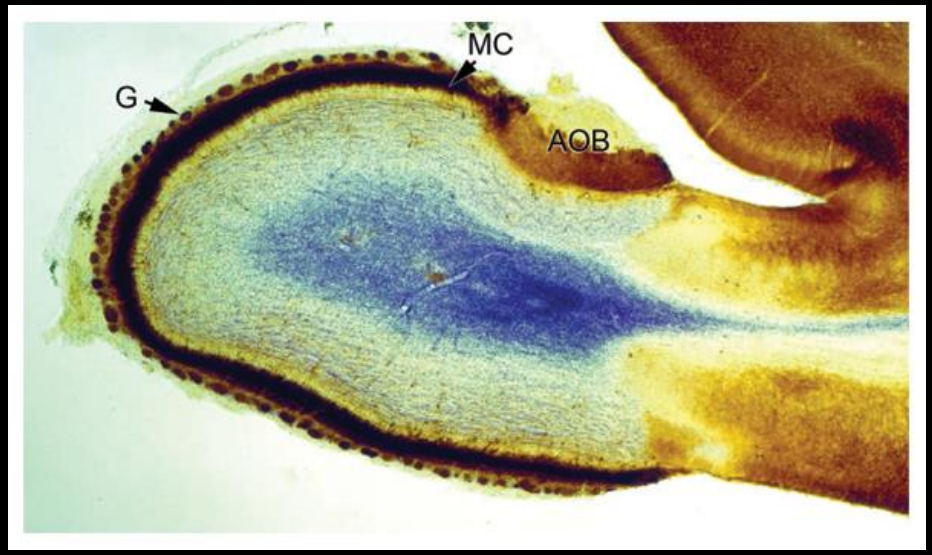
These observations suggest a pathway for olfactory signal transduction (Figure 1B) in which the binding of odors to specific surface receptors activates specific G proteins. The G proteins then initiate a cascade of intracellular signaling events leading to the generation of an action potential that is propagated along the olfactory sensory axon

Linda B. Buck

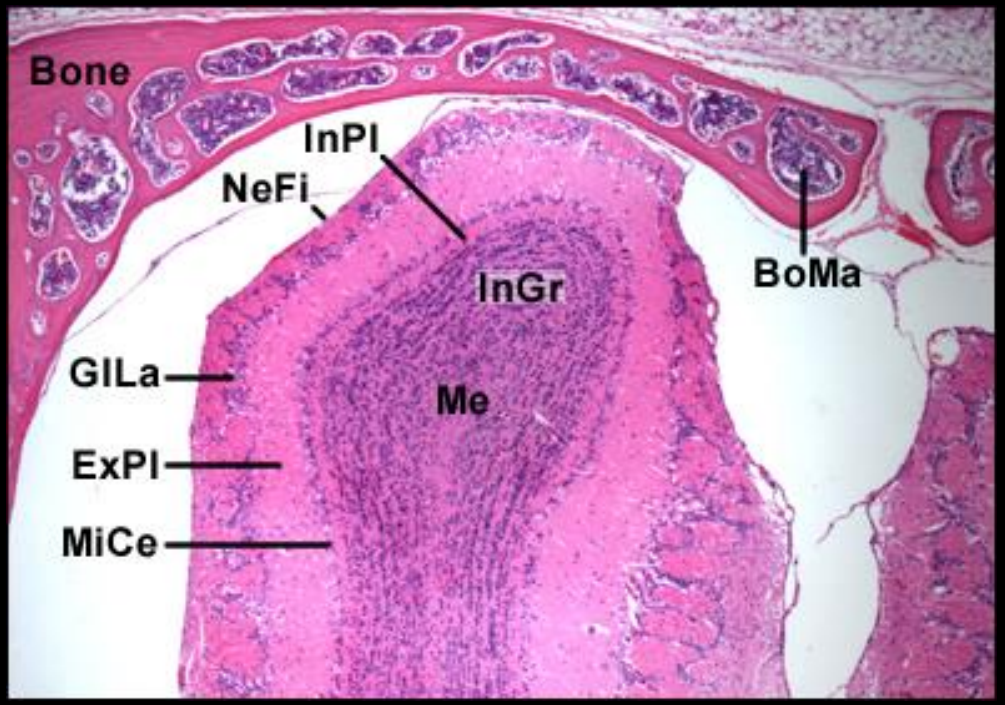
Richard Axel

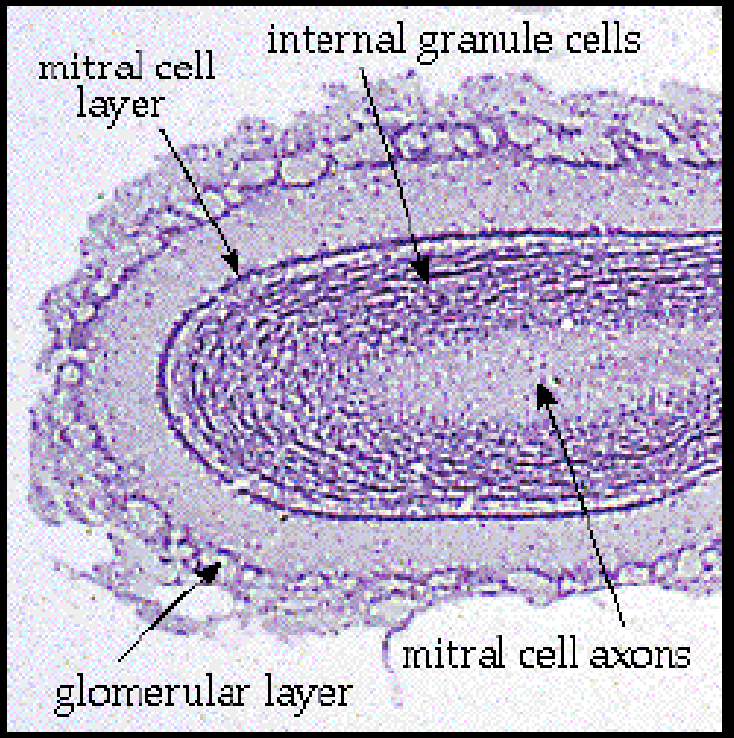
A szaglórendszer részei



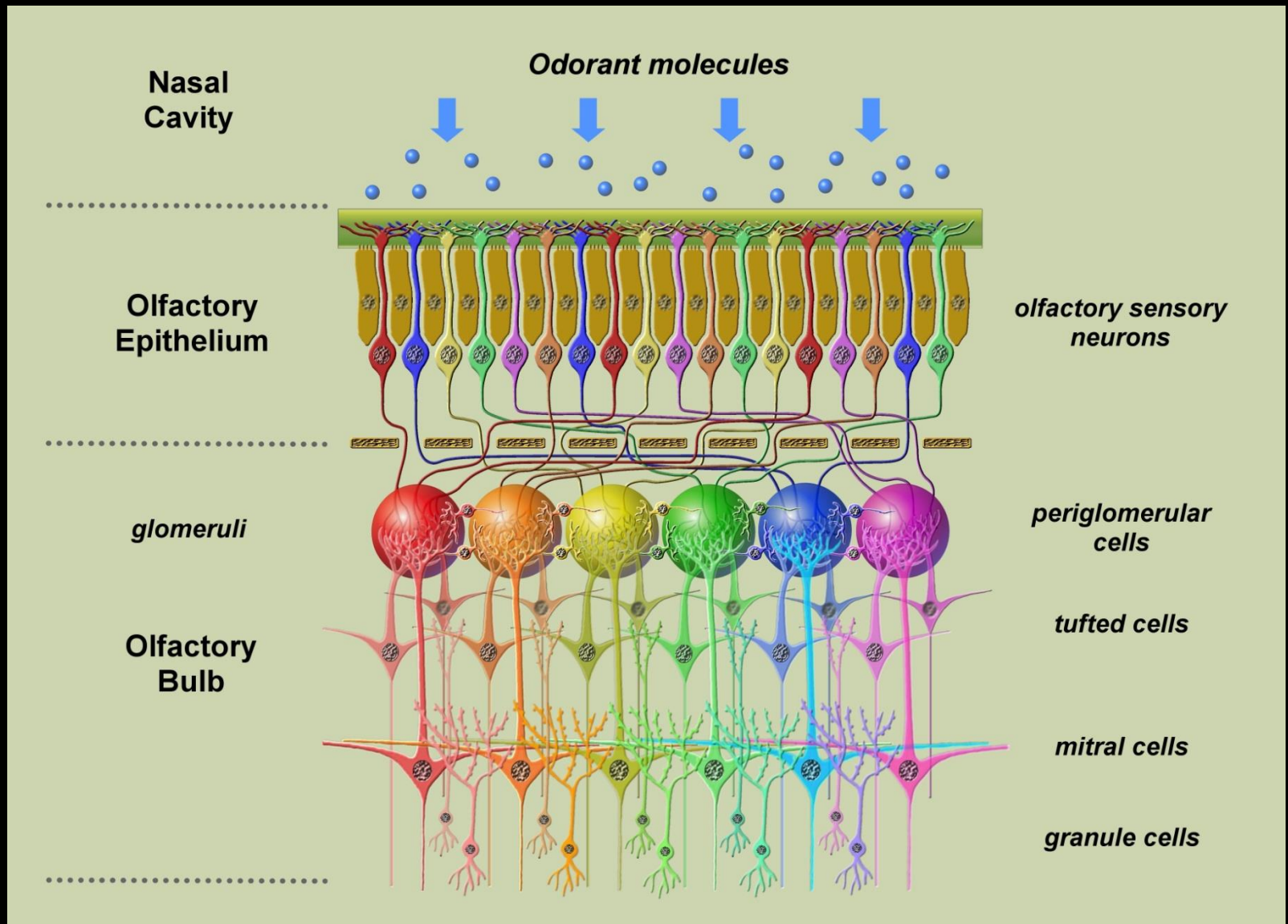


Bulbus olfactorius





Bulbus olfactorius



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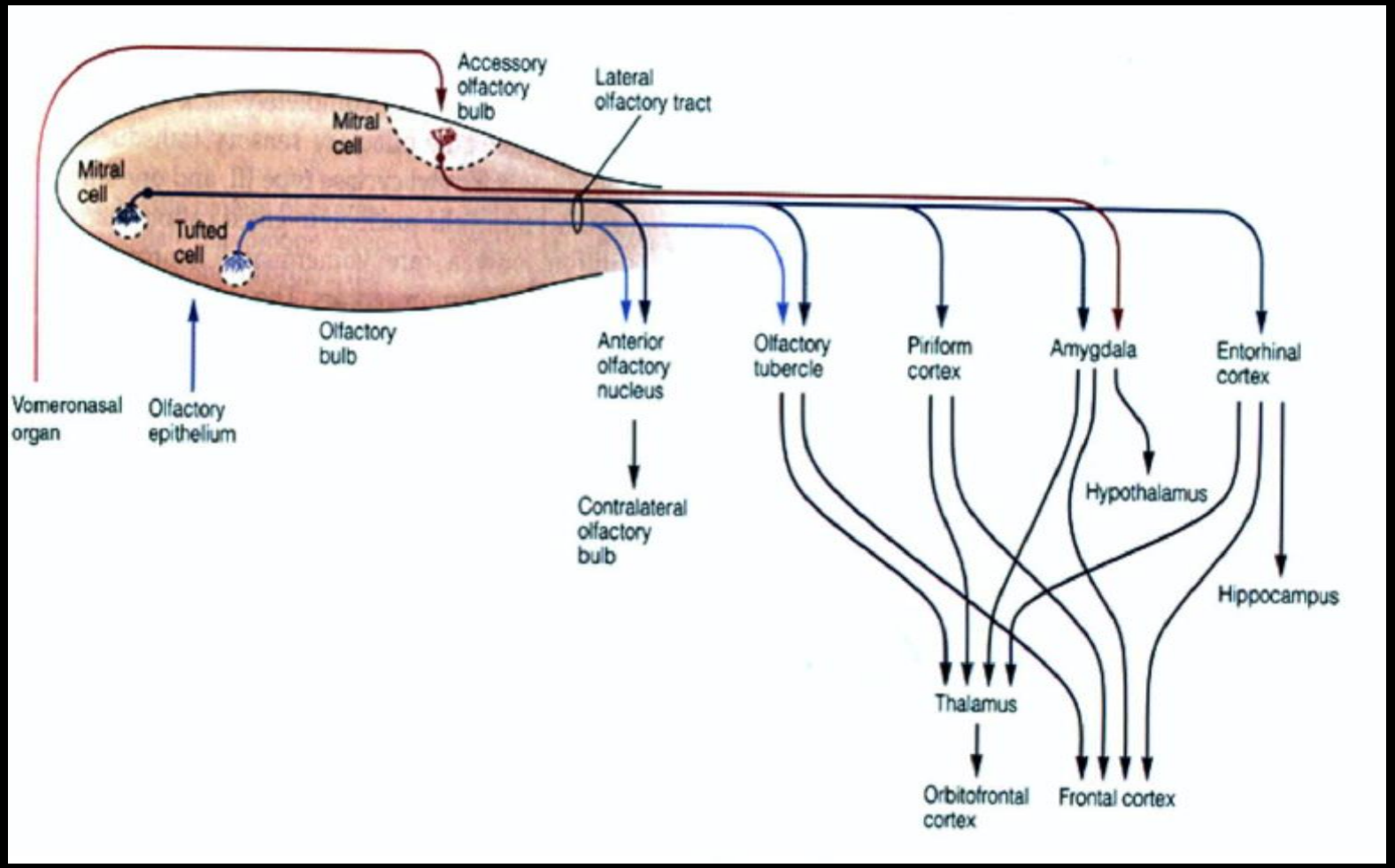
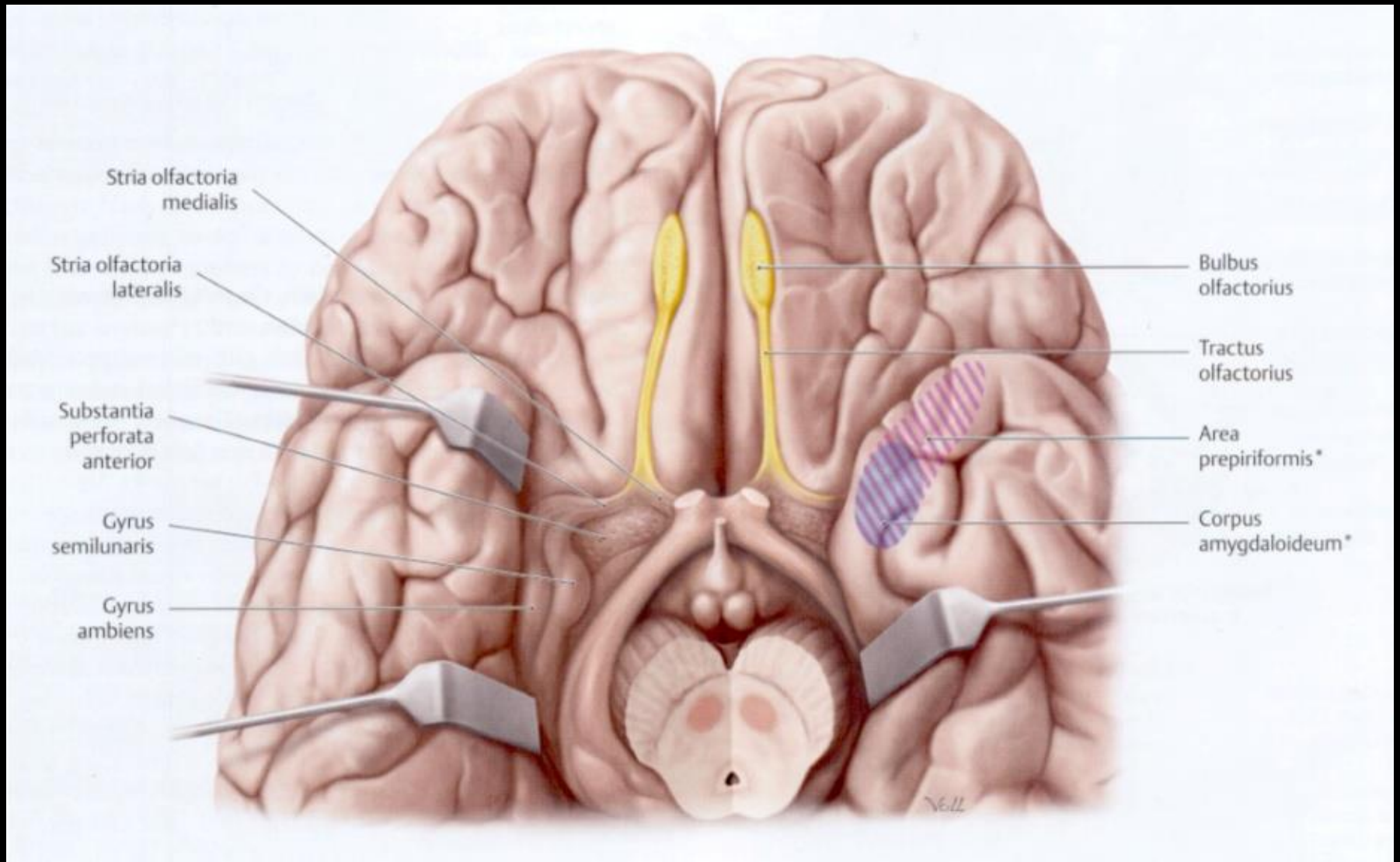


A szaglórendszer részei



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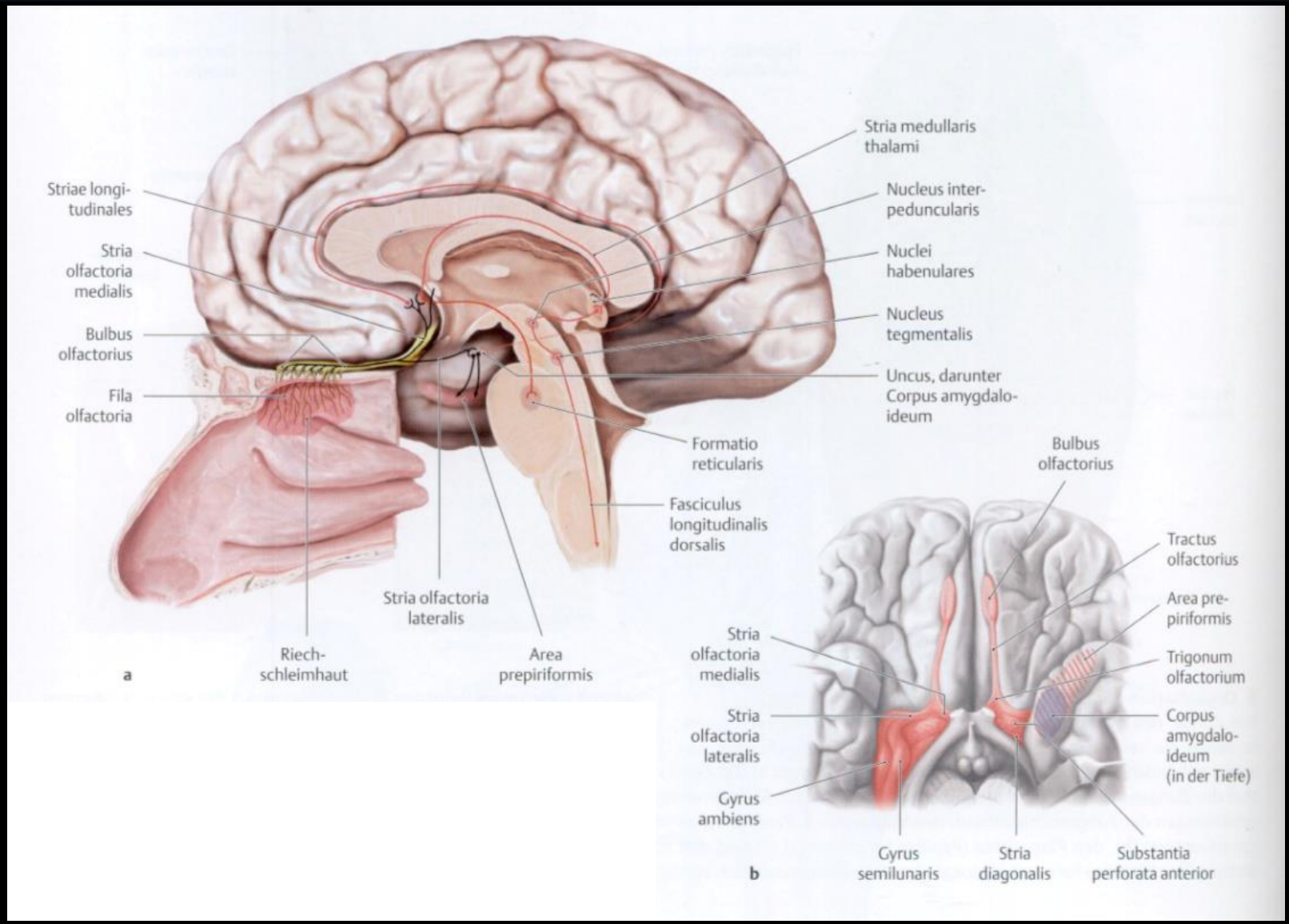

Proust effektus

(Marcel Proust: Az eltűnt idő nyomában – 1909 -1922)

Madeleines

(1871-1922)

„A tea mellé anyám egy kis madeleine-nek nevezett süteményt hozatott, amelynek kicsi, dundi formája mintha csak egy rovátkás kagylóhéjba lenne kisütve. S mindjárt, szinte gépiesen, fáradtan az egyhangú naptól s egy szomorú holnap távlatától, ajkamhoz emeltem egy kanál teát, amelybe előtte már beáztattam egy darabka süteményt. De abban a pillanatban, amikor ez a korty tea, a sütemény elázott morzsáival keverve, odaért az ínyemhez, megremegtem, mert úgy éreztem, hogy rendkívüli dolog történik bennem. Bűvös öröm áradt el rajtam, elszigetelt mindentől, és még csak az okát sem tudtam. Azonnal közömbössé tett az élet minden fordulata iránt, a sorscsapásokat hatástalanná, az életnek rövidségét egyszerű káprázattá változtatta, éppúgy, mint a szerelem, s mint hogyha csak megtöltött volna valami értékes eszenciával: jobban mondva, az eszencia nem bennem volt, én voltam az.

Proust effektus

(Marcel Proust: Az eltűnt idő nyomában – 1909 -1922)

Madeleines

(1871-1922)

S hirtelen megjelent az emlék. Ez az íz annak a darabka madeleine-nek az íze volt, amit Combray-ban, vasárnaponként (mert olyankor mise előtt sose hagytam el a házat) Léonie néném szokott adni, ha felmentem köszönni a szobájába, miután előbb beáztatta a teájába vagy a hársfateába. A kis madeleine látványa semmire se emlékeztetett, amíg meg nem kóstoltam; talán mert azóta sokszor láttam, anélkül hogy megízleltem volna, a cukrászdákban, és így a képe elhagyta a combray-i napokat, hogy más, újabb napokhoz kapcsolják; talán mert az emlékekből, amelyek oly régóta kívül estek az emlékezetemen, semmi se maradt életben, mindannyi százfelé hullott; formáik - e kis cukros kagylóé is, amely pedig oly buján érzékies, szigorú és ájtatos redői alatt - vagy megszűntek, vagy elszunnyadtak, elvesztették terjeszkedő erejüket és így nem voltak képesek feljutni az öntudathoz. De mikor a régmúltból többé már semmi se marad, az élőlények halála után, a dolgok pusztulása után, egyedül az íz és az illat élnek még tovább sokáig, törékenyebben, de elevenebben, anyagtalanabbul, szívósabban és hívebben mindennél - mintha csak lelkek volnának, amelyek idézik, várják, remélik, minden egyébnek romjai felett, s amelyek moccanás nélkül tartják majdnem megfoghatatlan harmatjukon az emlék óriás épületét."

Fordította: Gyergyai Albert Bp., Európa Kiadó, 1969.)