

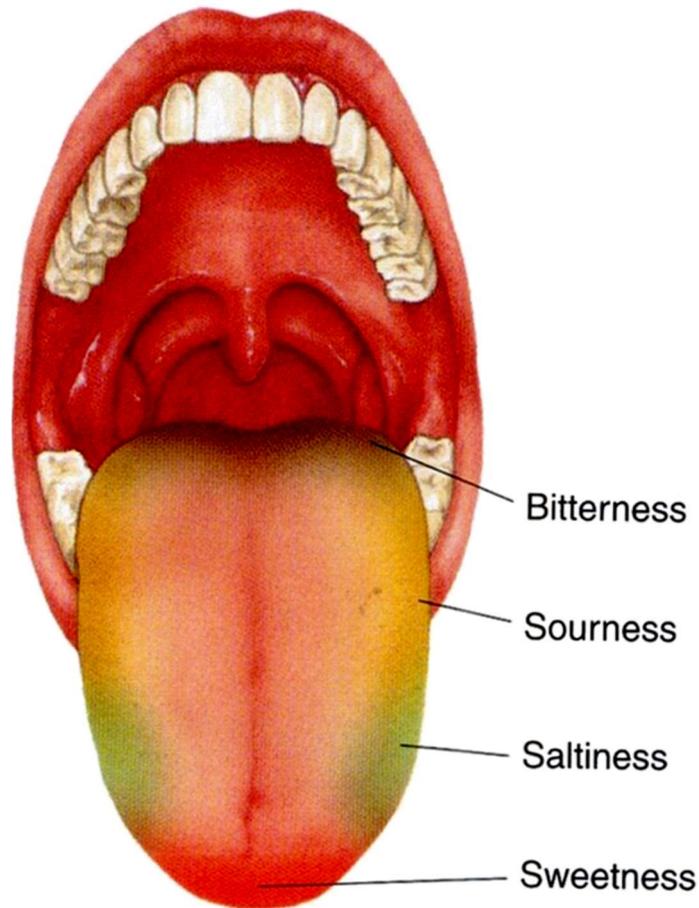
# **Chemical Senses: Taste and Smell**

**Phylogenetically Oldest and Most Common  
of the Sensory Systems !**

**Food – Poison – Sex**

**Strong and Direct Connections  
with our Most Basic Internal Needs  
(e.g., Thirst, Hunger, Emotion, Sex,  
Certain Forms of Memory)**

# Basic Tastes



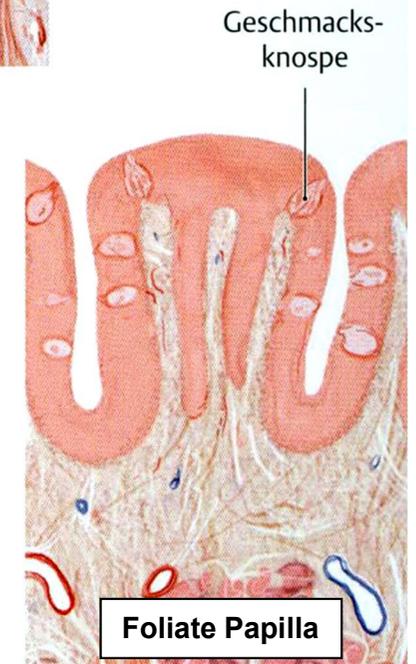
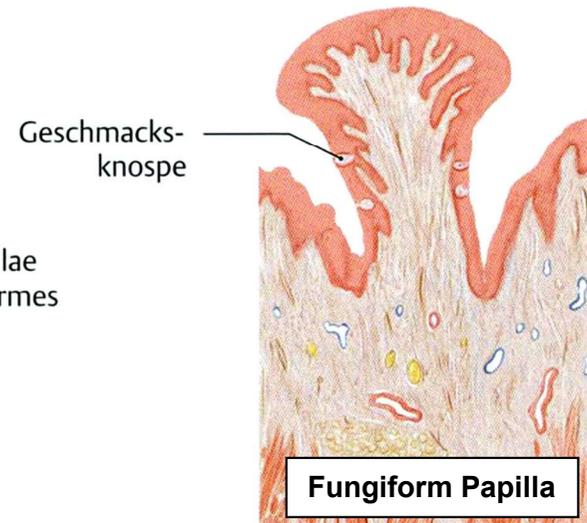
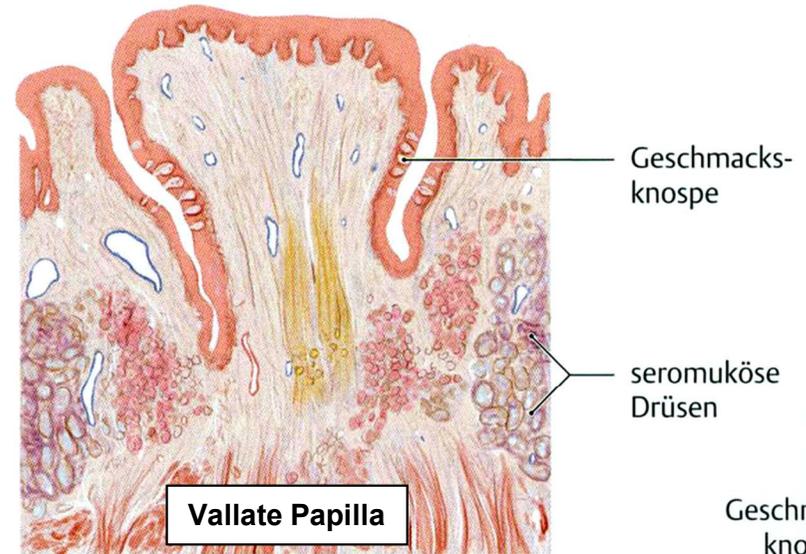
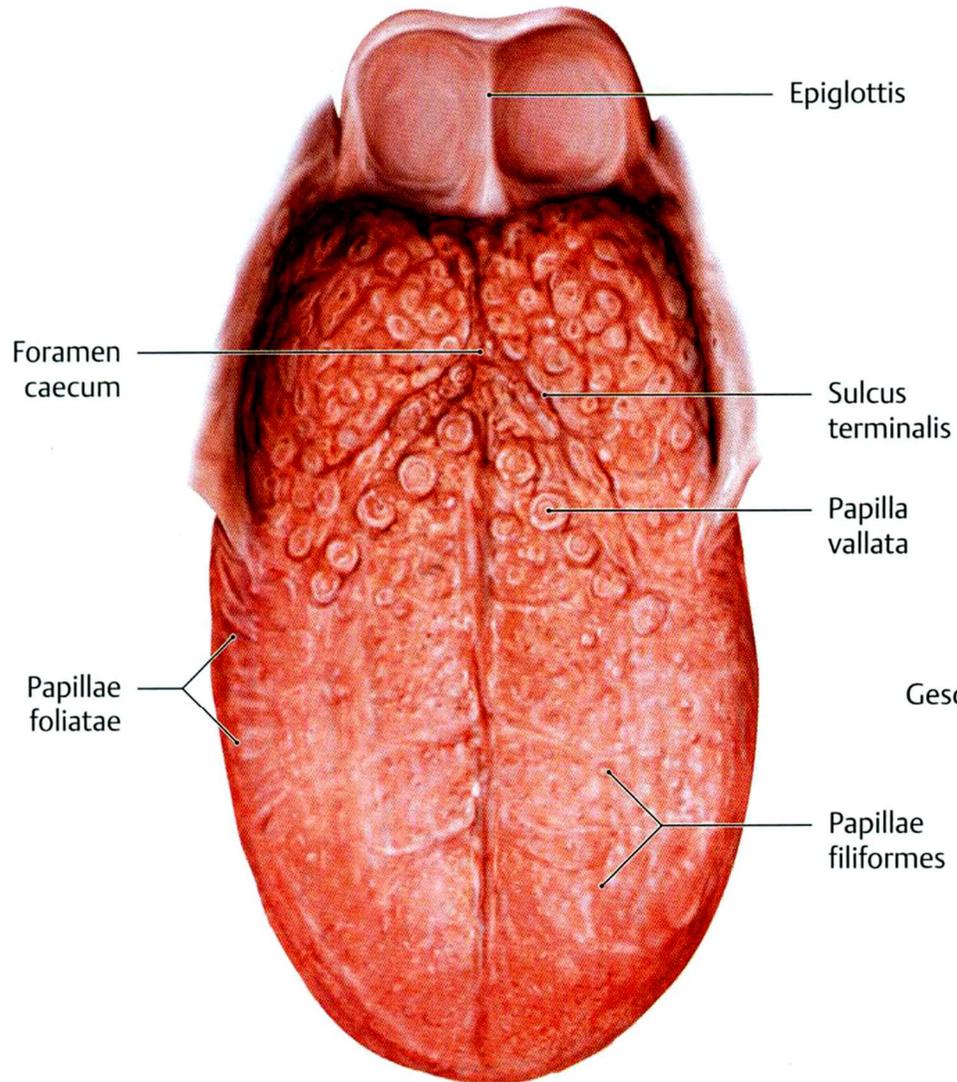
**4 Taste Qualities: Sweet, Sour, Salty, Bitter**

**5th Quality: Umami ("Delicious" in Japanese):**

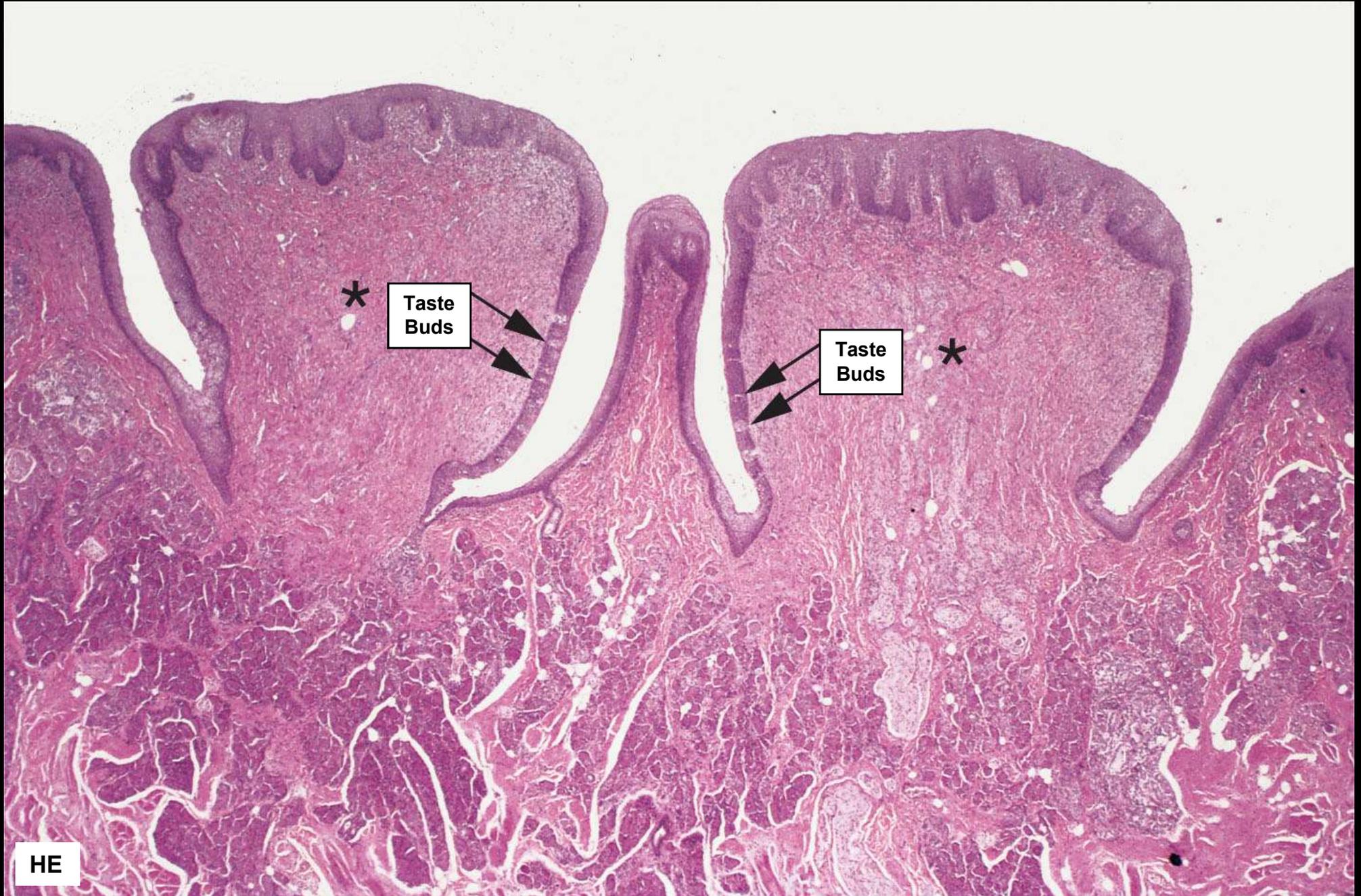
**Taste of Amino Acid Glutamate (Culinary Form: Monosodium Glutamate)**

**Subjective Perception of a Specific Flavor is Usually a Combination of Taste and Smell**

# Organs of Taste: Papillae of the Tongue



# Vallate Papillae

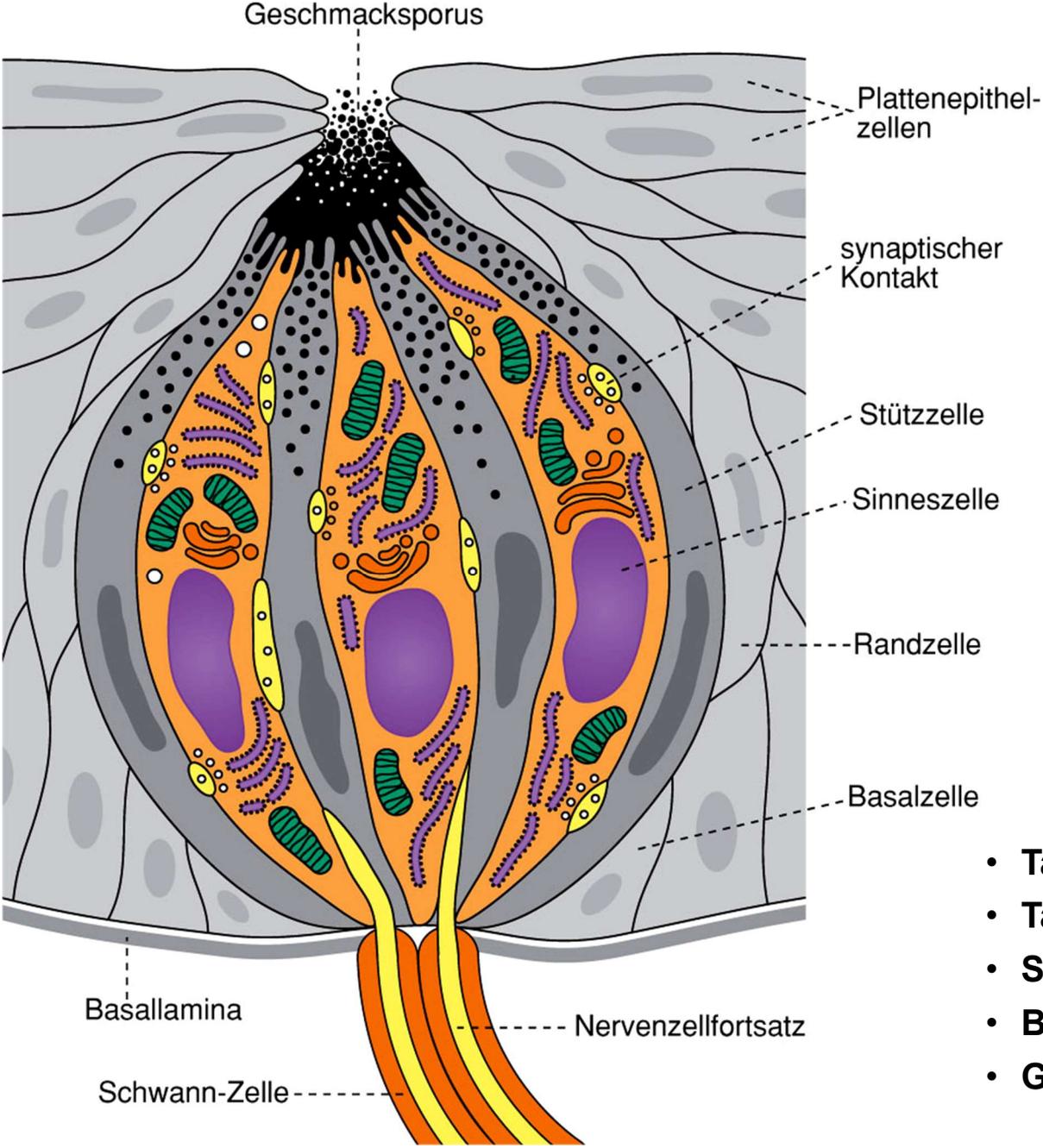


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# Foliate Papillae

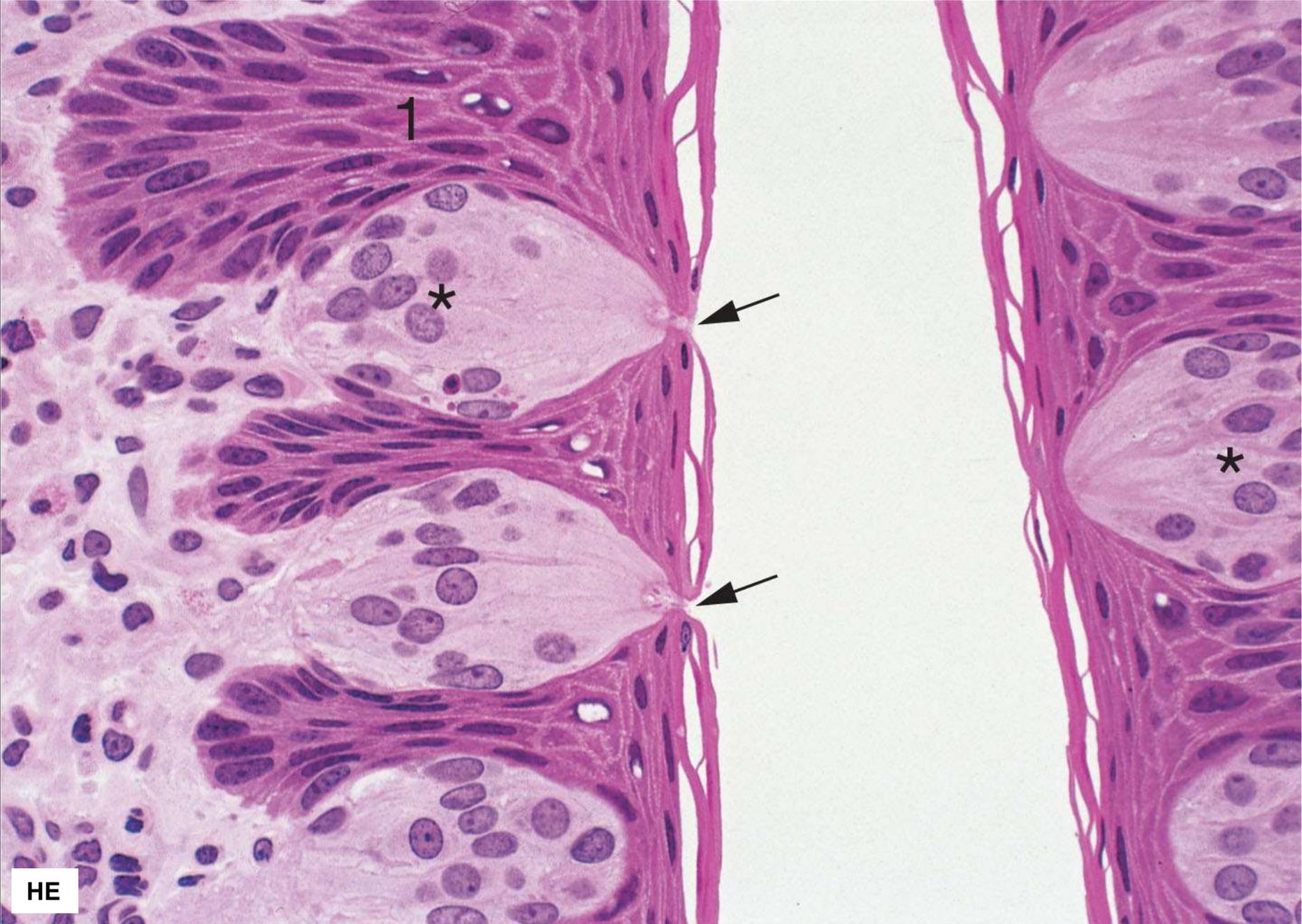


# Taste Bud



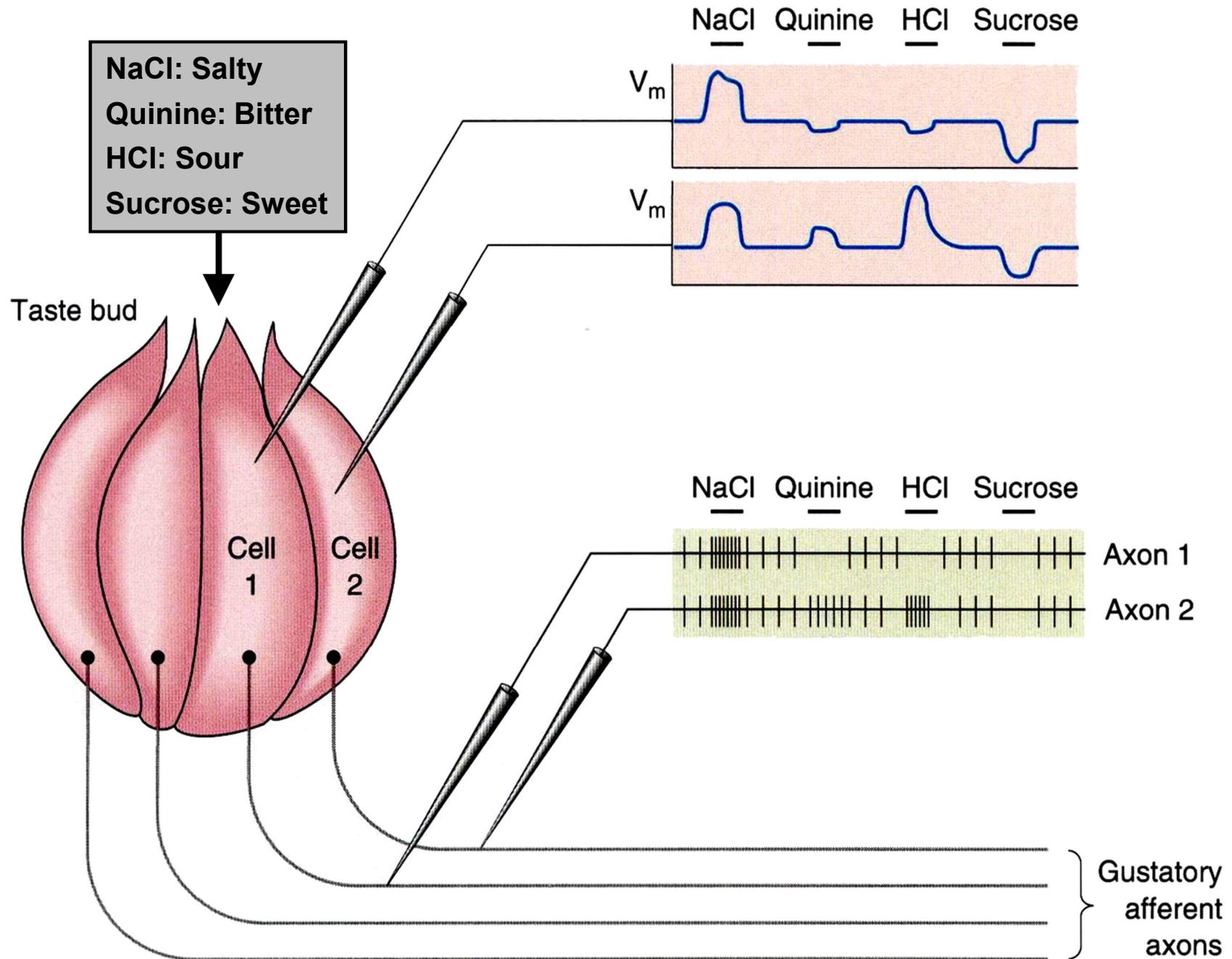
- Taste Pore
- Taste Receptor Cells
- Supporting Cells
- Basal Cells
- Gustatory Afferent "Axons"

# Taste Buds

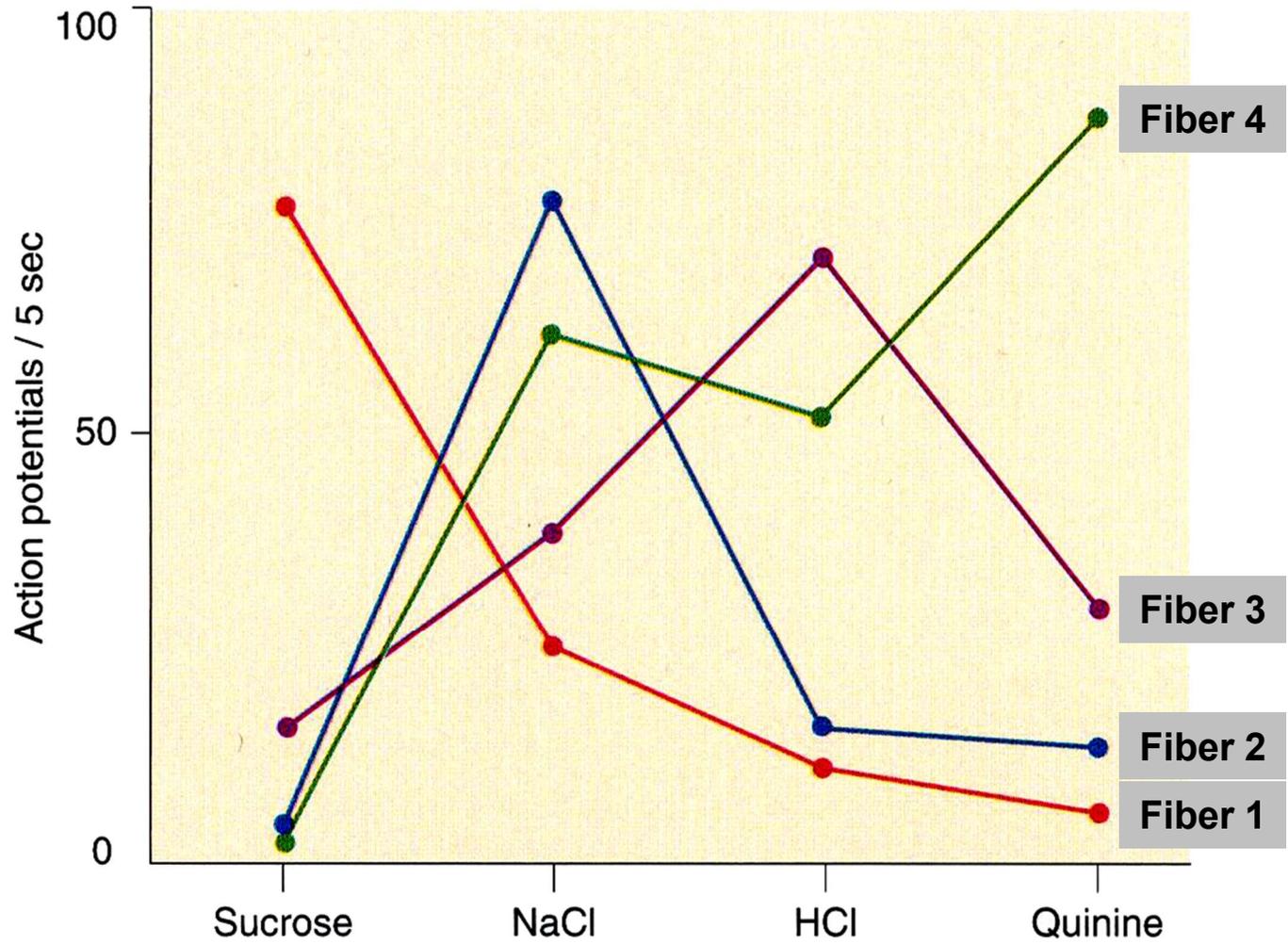


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# Taste Responsiveness of Taste Cells and Gustatory "Axons"

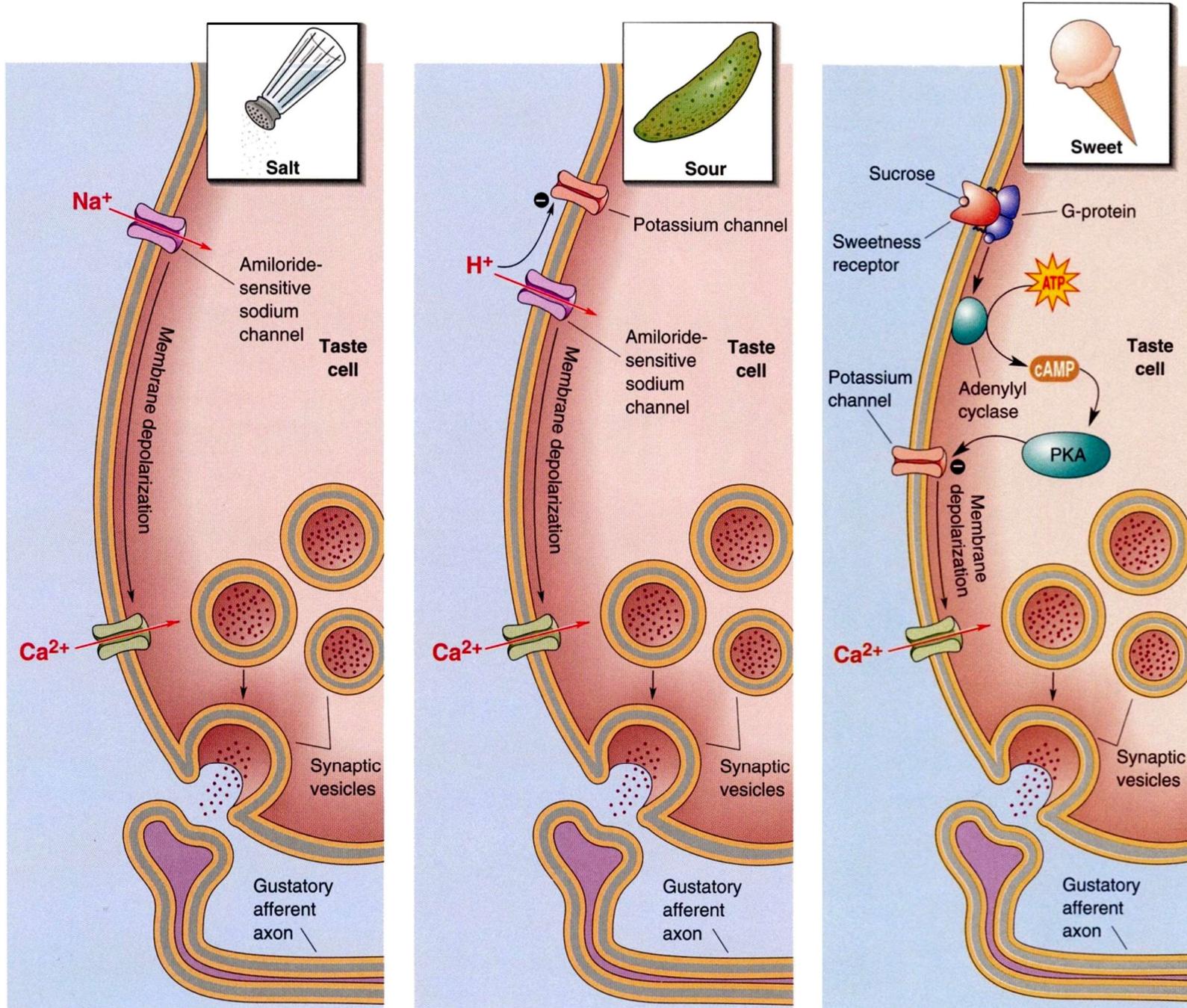


# Firing Rates of Four Different Gustatory Nerve Fibers

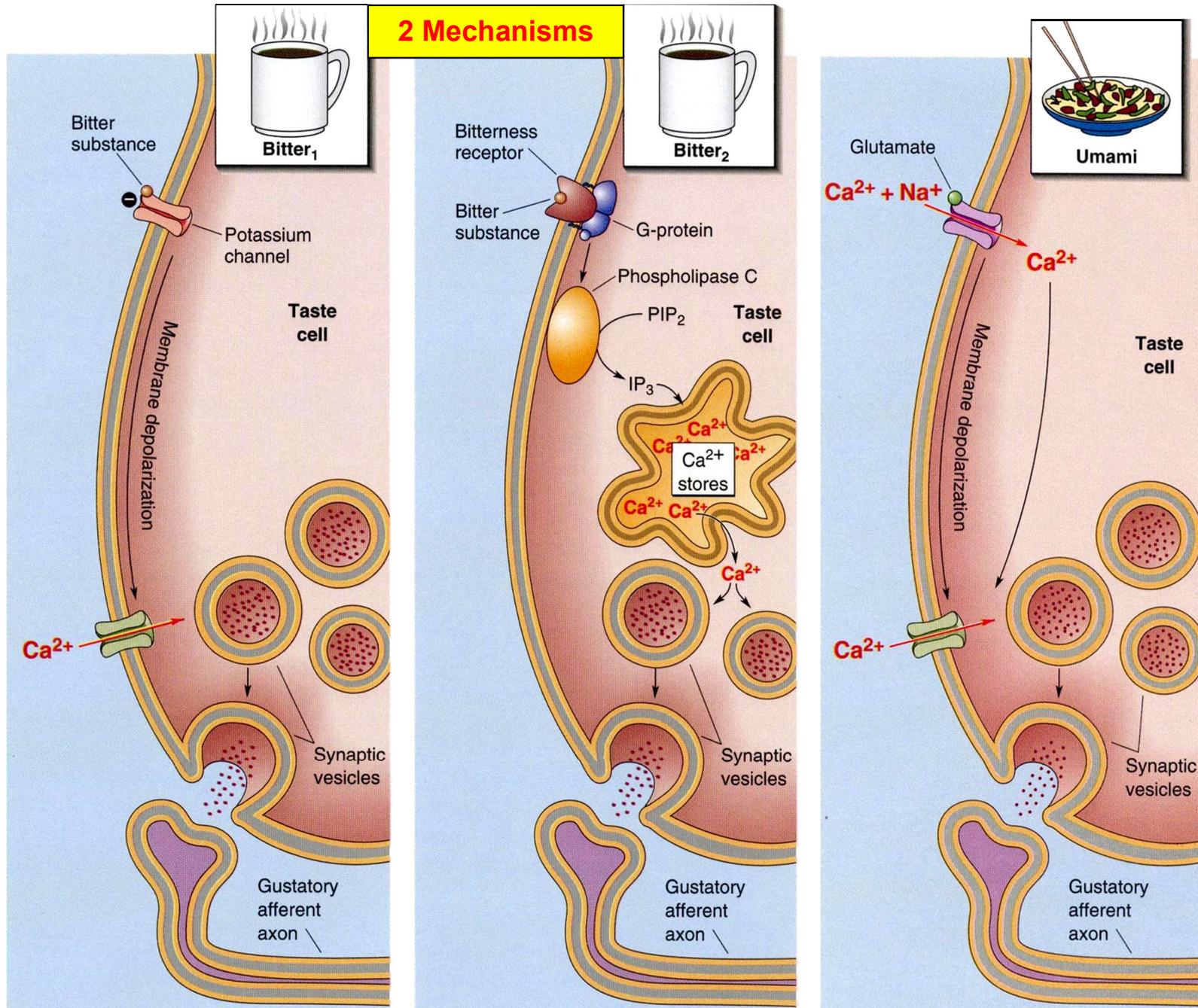


**Most Taste Receptor Cells are Not Monospecific**  
**Receptor Cells with Different Response Properties Occur in a Taste Bud**

# Taste Transduction Mechanisms

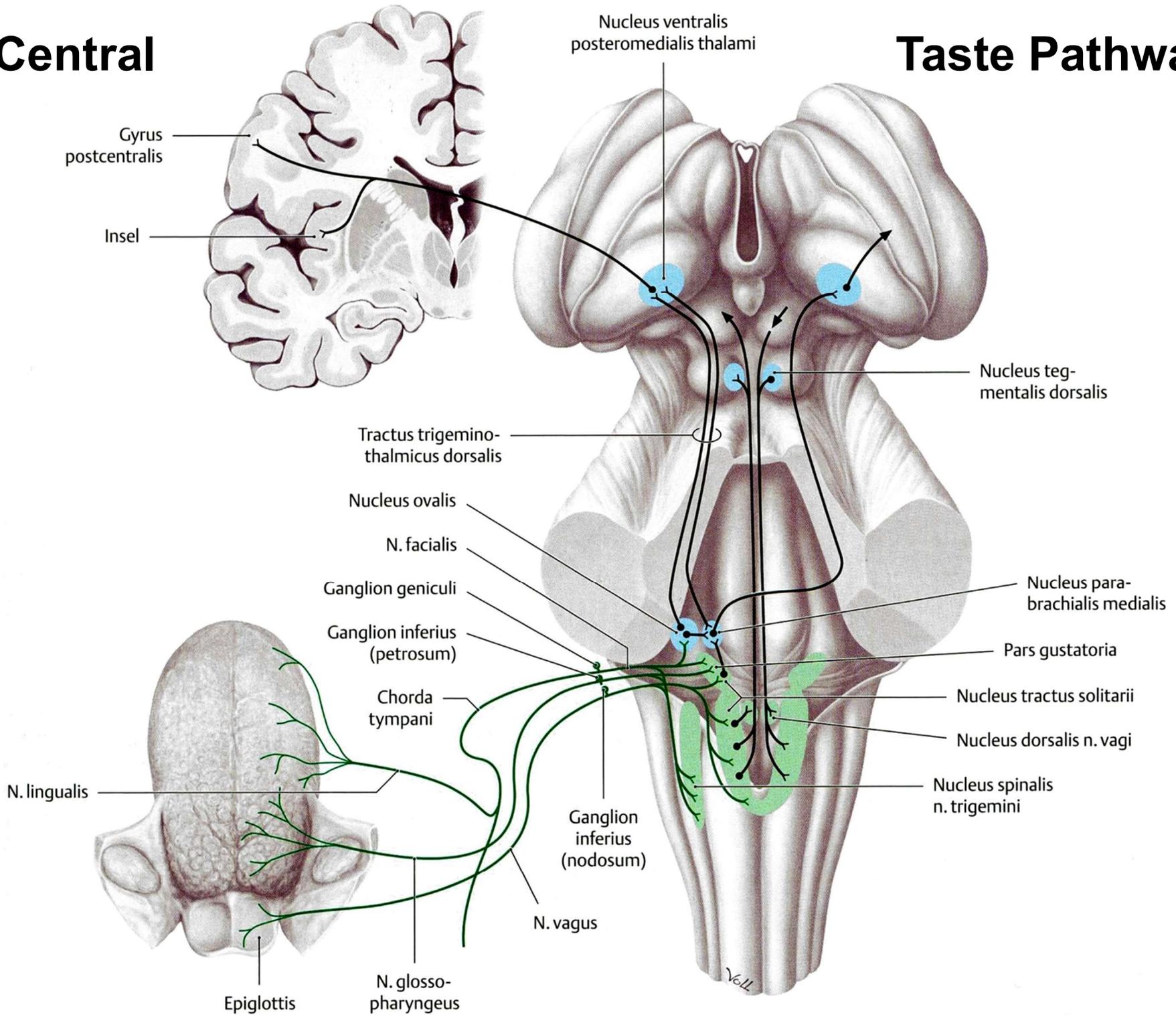


# Taste Transduction Mechanisms

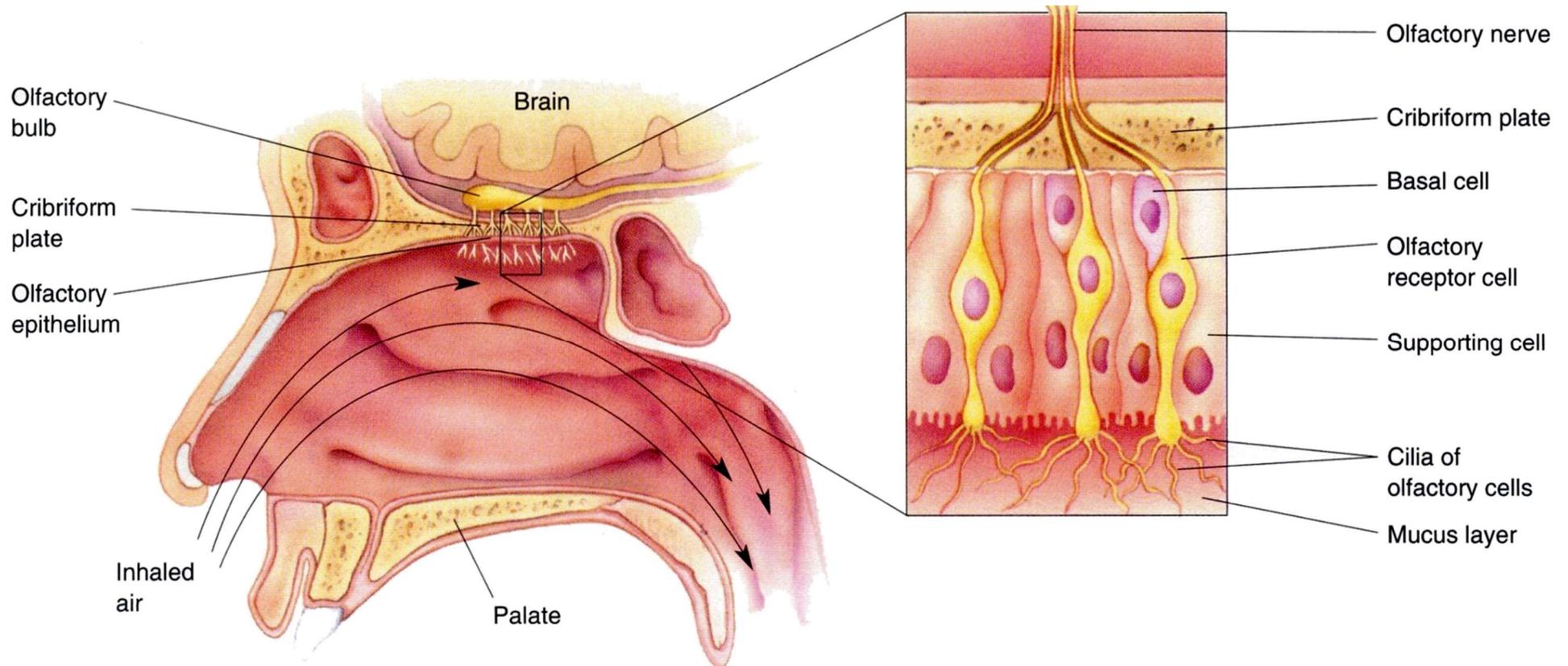


# Central

# Taste Pathways



# Smell



**No Elementary Smell Qualities (In Contrast to Taste)**

**Humans Can Smell Several Hundred Thousand Substances  
(Only about 20% Are Pleasant)**

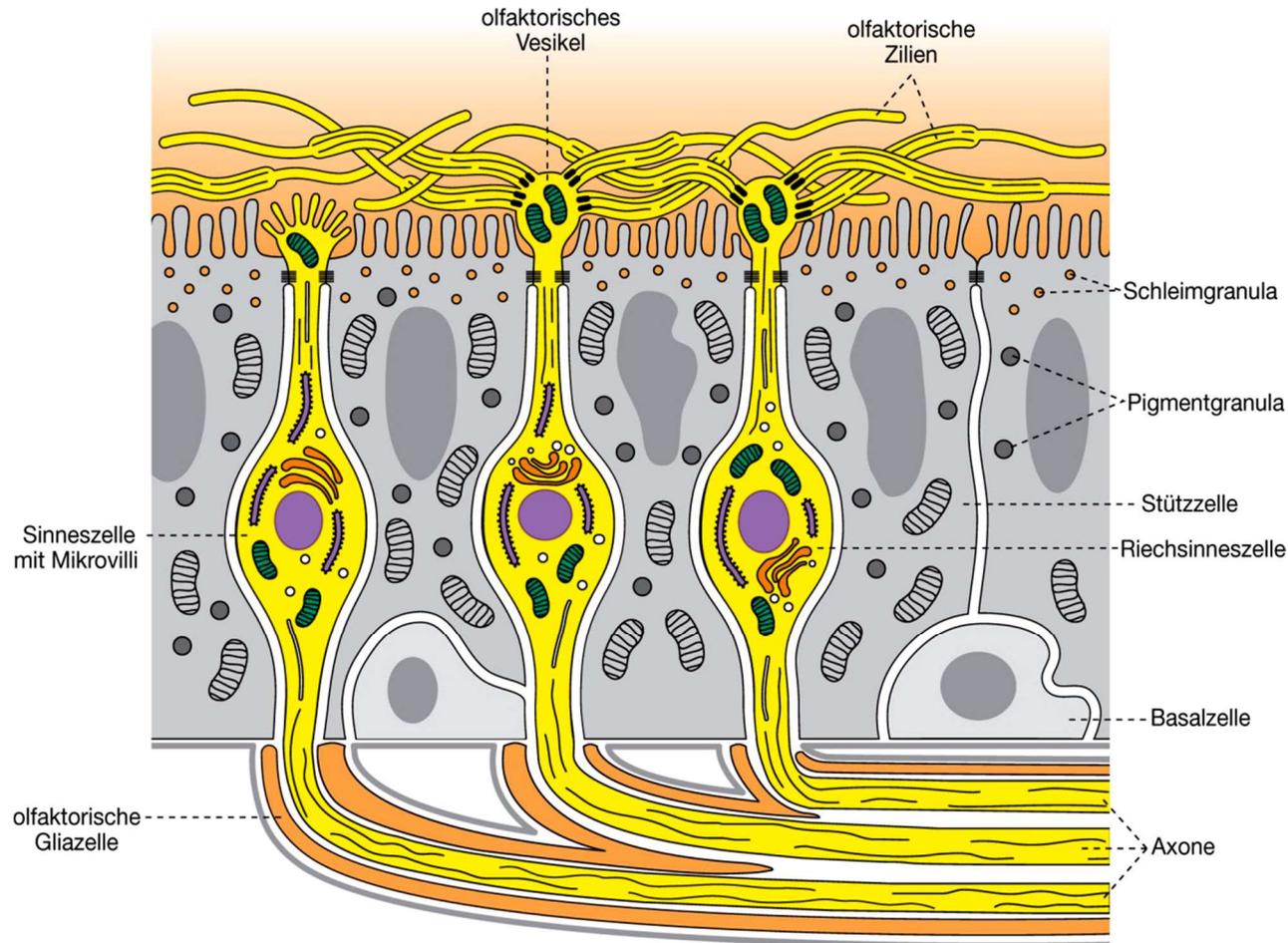
**Plasticity: Practice Helps in Olfaction (e.g., Professional Perfumers, Whiskey Blenders)**

**Olfactory Epithelium = Regio Olfactoria: Superior Concha and Opposite Part of the Nasal Septum**

**Humans are Microsmatic Beings (Olfactory Epithelium  $\approx 10 \text{ cm}^2$ )**

**Certain Dogs: More than  $170 \text{ cm}^2$  and 100 Times More Receptors per  $\text{cm}^2$**

# Olfactory Epithelium = Regio Olfactoria

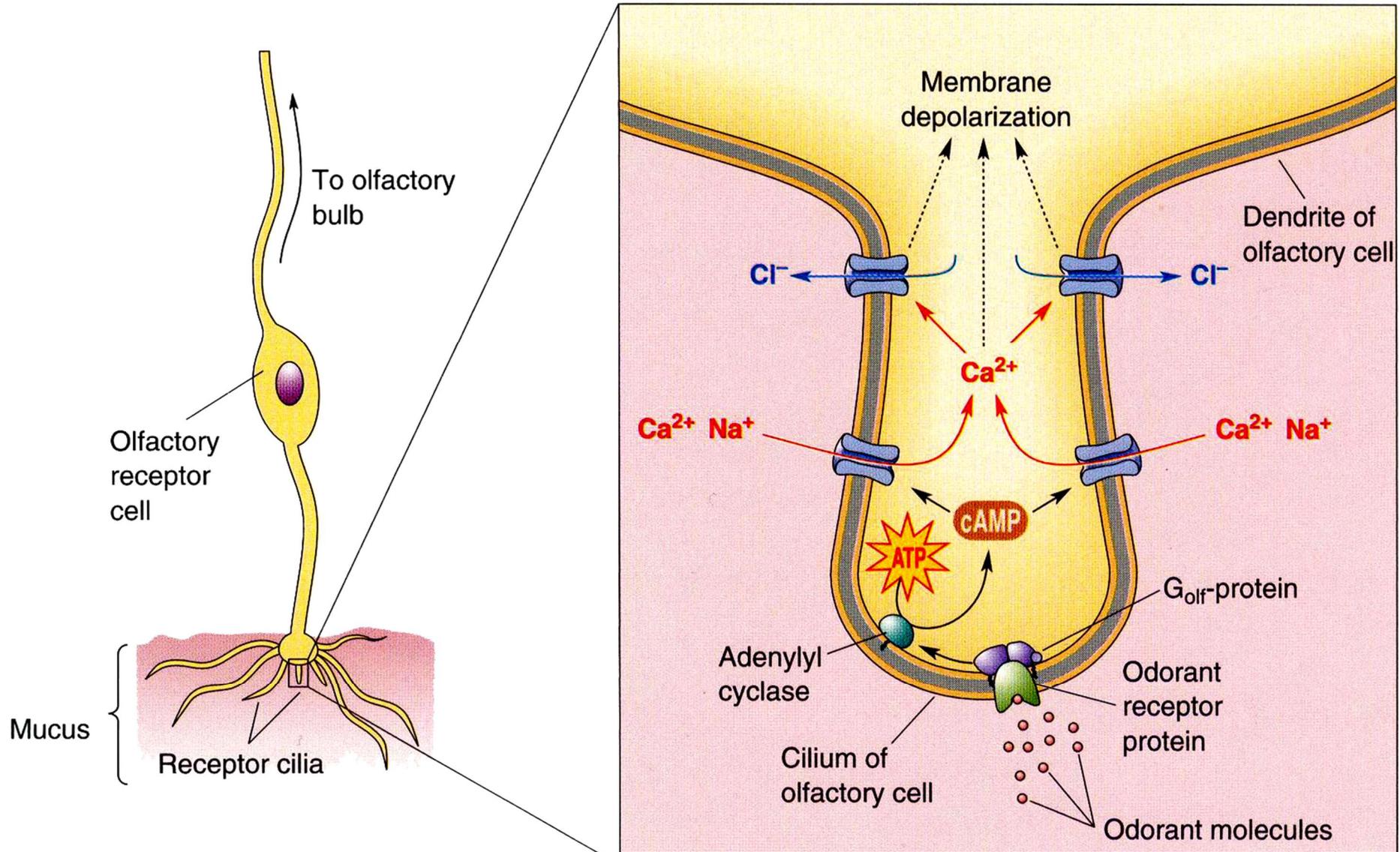


- **Olfactory Receptor Cells: Genuine Bipolar Neurons !**
    - **Dendrite**: Characteristic Ending (Knob) with Non-Motile Cilia (Embedded in a Layer of Mucus)
    - **Axon**: Unmyelinated – Penetrates Cribriform Plate of the Ethmoid Bone
  - **Supporting Cells**: Produce Mucus (In which Odorants Dissolve)
  - **Basal Cells**: Source of New Receptor Cells
- Olfactory Receptor Cells are Neurons that are Regularly Replaced throughout Life !**

# Olfactory Epithelium = Regio Olfactoria

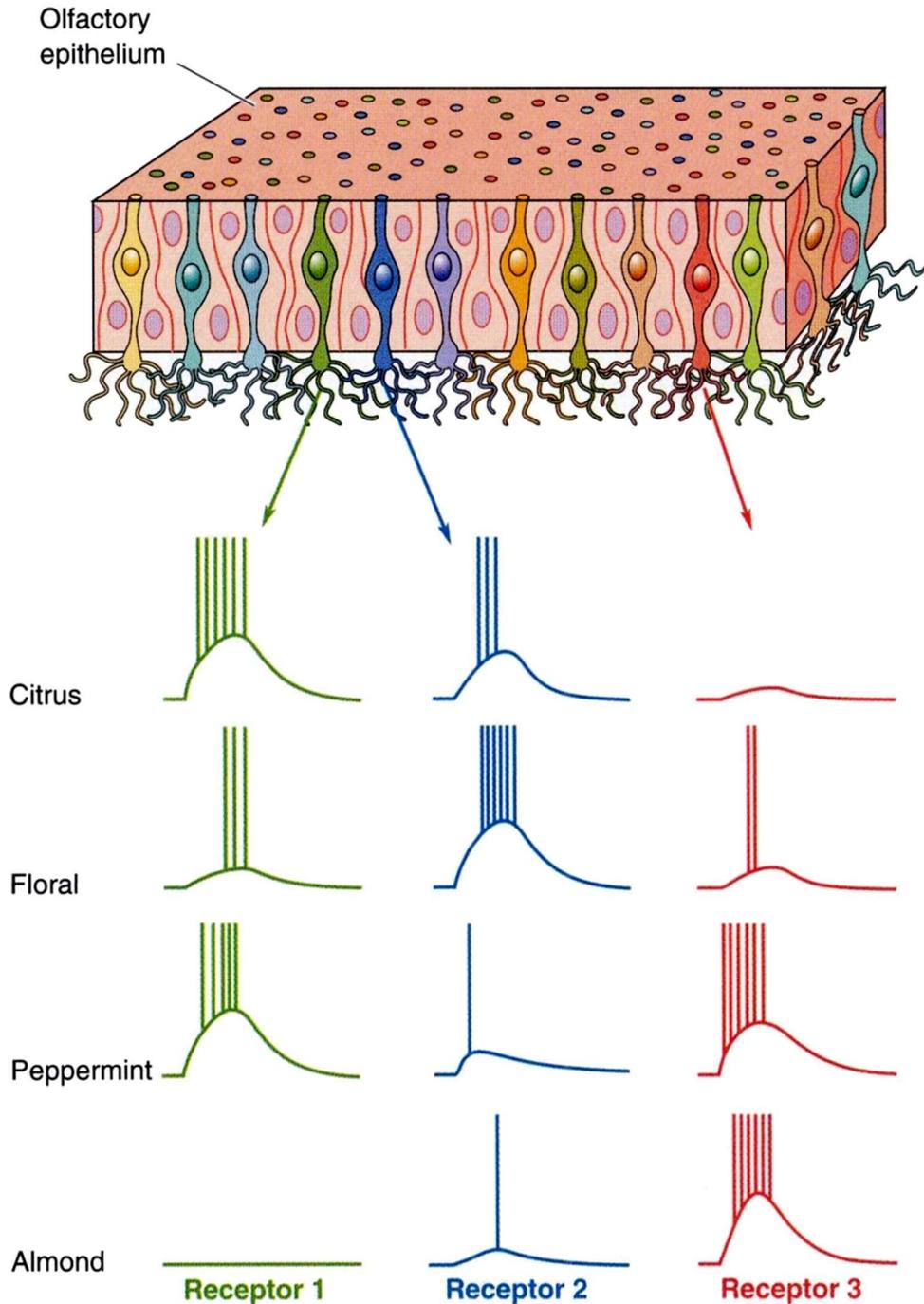


# Transduction Mechanism of Receptor Cells



Probably only One Transduction Mechanism (In Contrast to Taste)

# Broad Tuning of Single Olfactory Receptor Cells



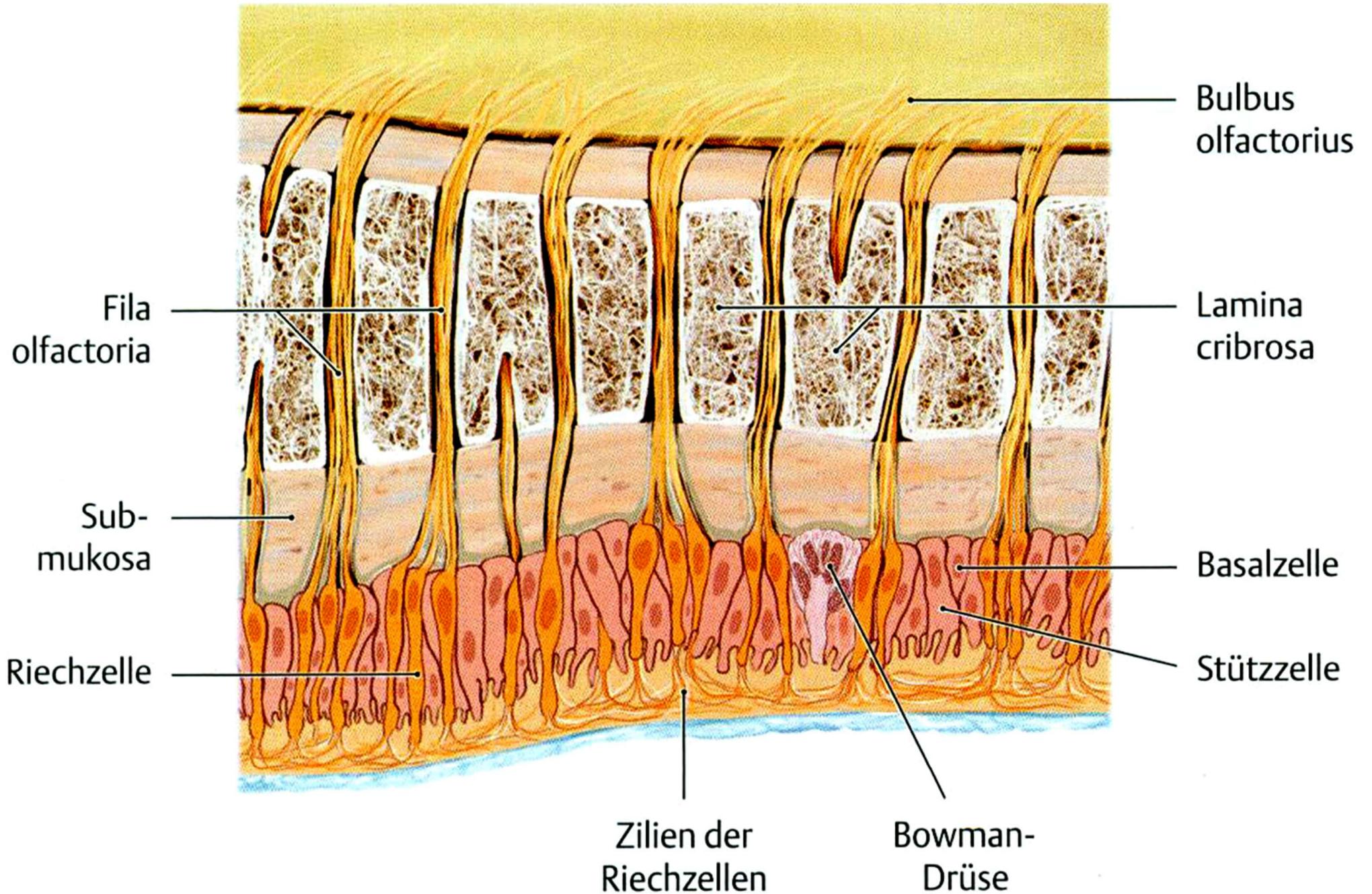
More than 1000 Different Odorant Receptor Genes in Rodents



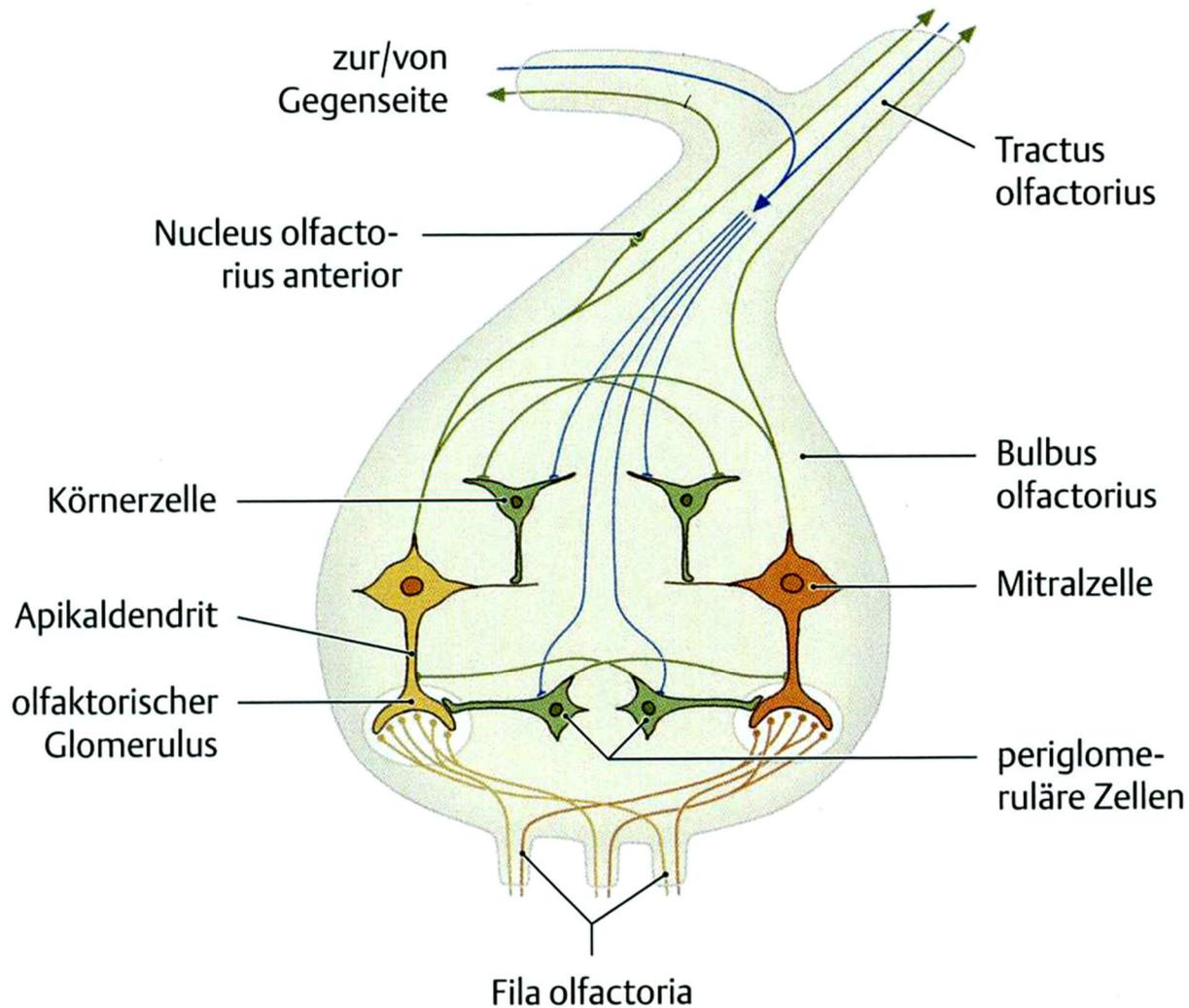
More than 1000 Different Receptor Cells (Possibly Expression of only One Gene per Cell)

(←) Receptor Cells are Not Monospecific

# Cribriform Plate of the Ethmoid Bone



# Olfactory Bulb

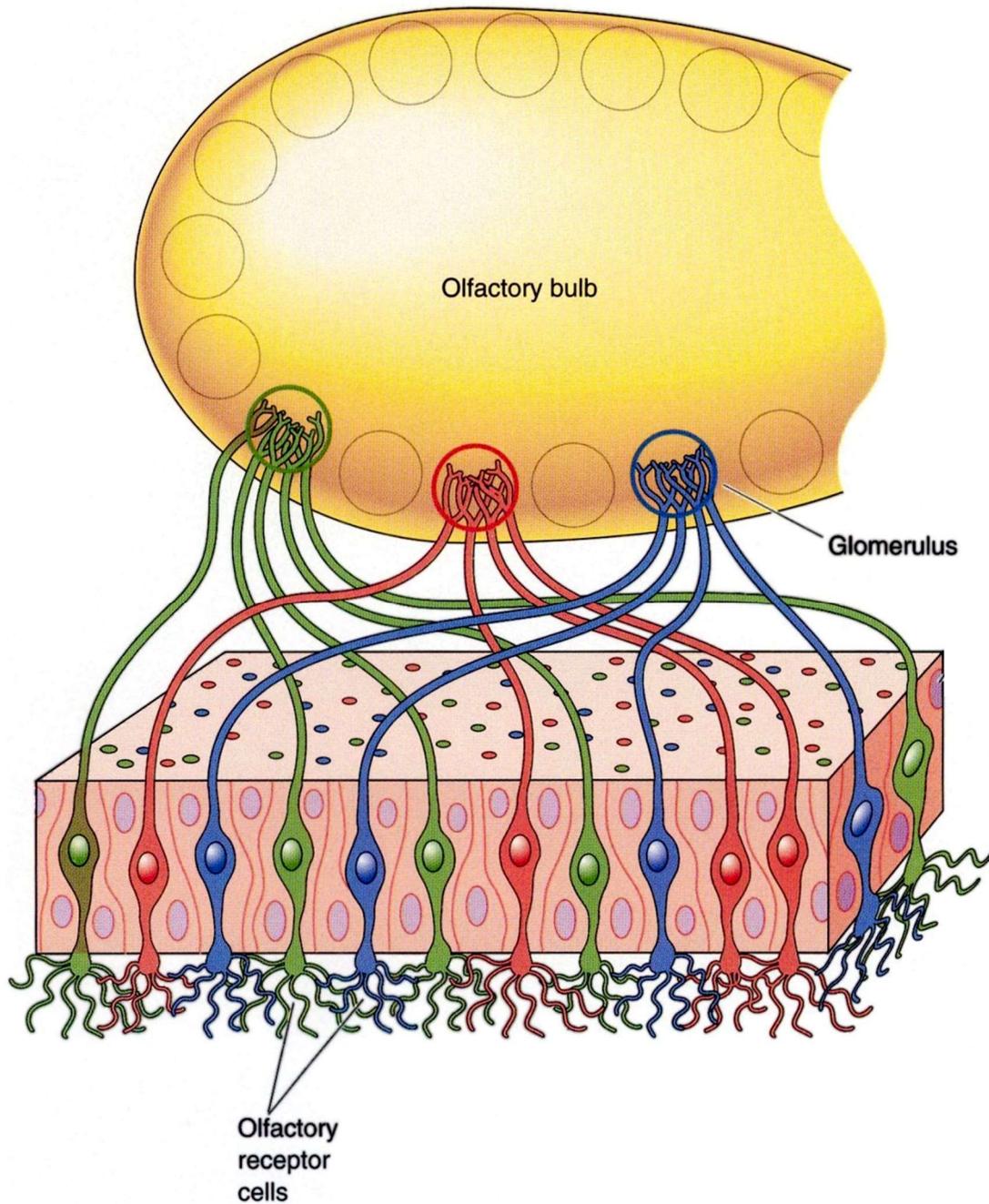


About 2000 Spherical Structures: Glomeruli (Diameter 50 – 200  $\mu\text{m}$ )

Within Each Glomerulus: About 25000 Primary Olfactory Axons (from Receptor Cells) →  
Dendrites of about 100 Mitral Cells (Second-Order Olfactory Neurons)

Mitral Cell Axons → Olfactory Tract

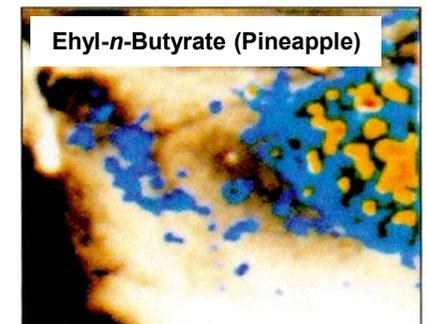
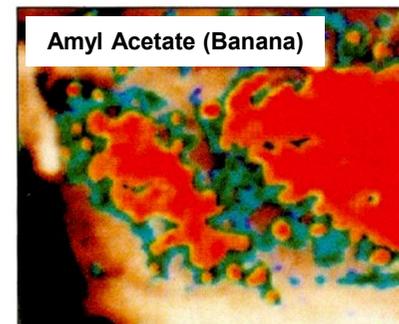
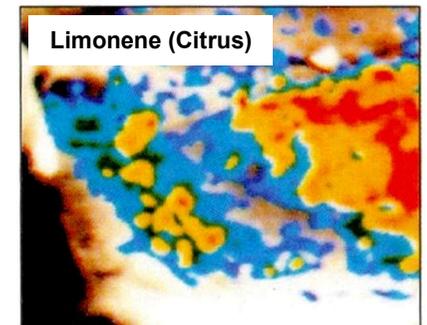
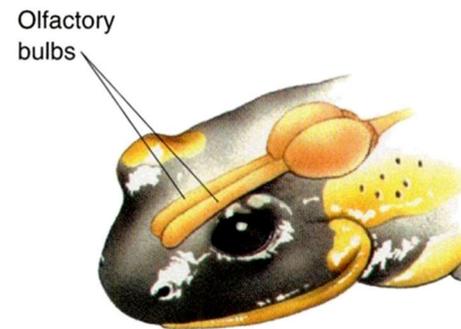
# Specific Mapping of Receptor Cells onto Glomeruli



Each Glomerulus Receives Input only from Receptor Cells Expressing a Particular Receptor Gene

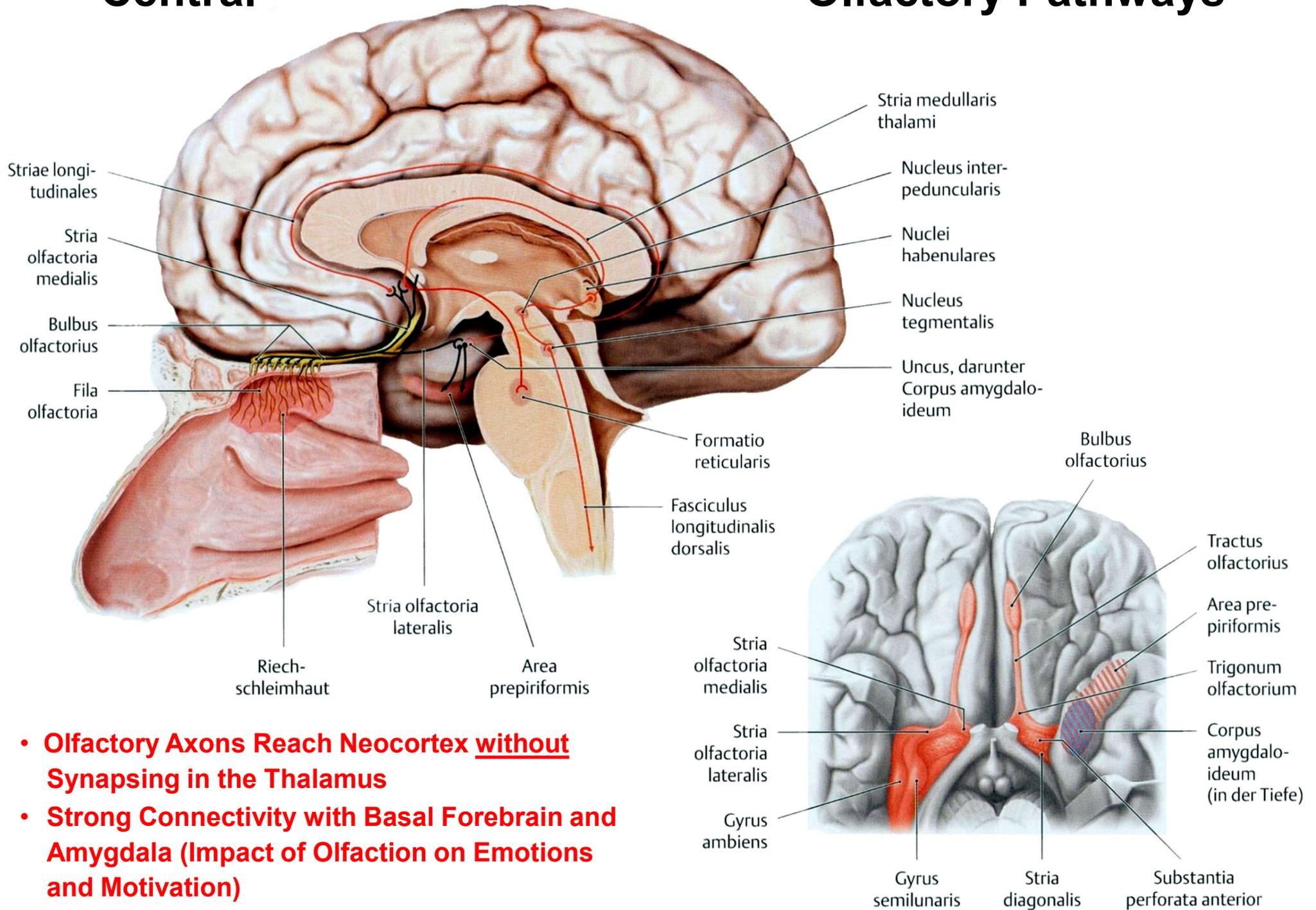


Spatial Arrangement of Glomeruli = Olfactory Map ("Olfactotopy")



# Central

# Olfactory Pathways



- **Olfactory Axons Reach Neocortex without Synapsing in the Thalamus**
- **Strong Connectivity with Basal Forebrain and Amygdala (Impact of Olfaction on Emotions and Motivation)**