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Olfactory and gustatory system

Olfaction and sense of taste are closely interconnected „chemical senses“

Olfaction and sense of taste are cl[…]onnected „chemical senses“

Odour lasts in time

Olfaction

- Ability to sense chemical compounds dispersed in the air

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- Influenced evolution of neocortex

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- Place identification
- Food identification

Olfaction

- Ability to sense chemical compounds dispersed in the air
- Influenced evolution of neocortex
- Place identification
- Food identification
- Humans are microolfactoric organisms
  - Loss of analytic capabilities led to a relative enhancement of psychological component

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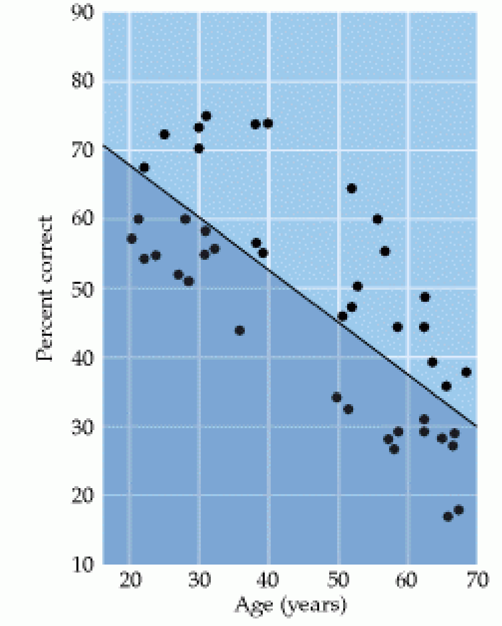
Olfaction

- Humans can distinguish about 80 chemicals and 144-10000 odors
- Better sensitivity to liposoluble molecules
- Olfaction degenerates with age



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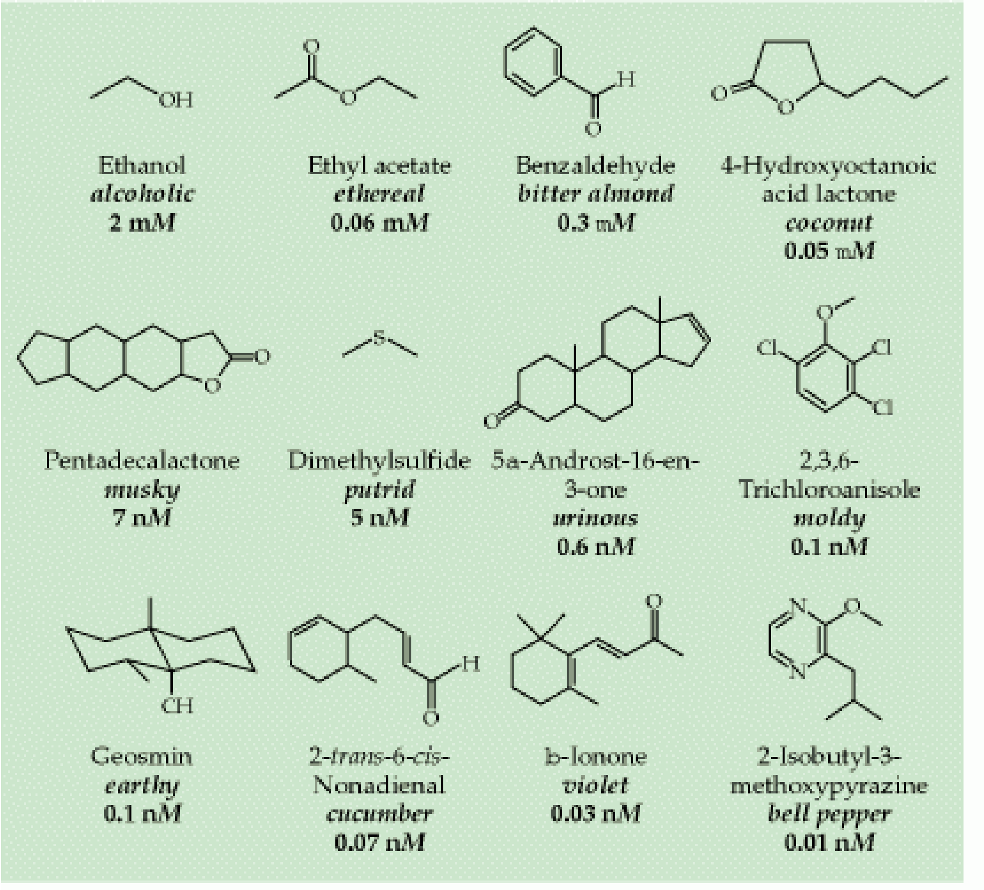

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10 basic categories of odors

- ✓ fragnant
- ✓ woody/resinous
- ✓ fruit (other than citrus)
- ✓ putrid
- ✓ chemical
- ✓ minty/peppermint
- ✓ sweet
- ✓ popcorn
- ✓ burning
- ✓ lemon

Categorical dimensions of human odor descriptor space revealed by non-negative matrix factorization.
Castro JB, Ramanathan A, **Chennubhotla** CS.
PLoS One. 2013 Sep 18;8(9):e73289. doi: 10.1371/journal.pone.0073289. eCollection 2013.
PMID:24058466

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10 largest-valued descriptors for each of the 10 basis vectors obtained from non-negative matrix factorization.

W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
FRAGRANT	WOODY, RESINOUS	FRUITY, OTHER THAN CITRUS	SICKENING	CHEMICAL	MINTY, PEPPERMINT	SWEET	POPCORN	SICKENING	LEMON
FLORAL	MUSTY, EARTHY, MOLDY	SWEET	PUTRID, FOUL, DECAYED	ETHERISH, ANAESTHETIC	COOL, COOLING	VANILLA	BURNT, SMOKY	GARLIC, ONION	FRUITY, CITRUS
PERFUMERY	CEDARWOOD	FRAGRANT	RANCID	MEDICINAL	AROMATIC	FRAGRANT	PEANUT BUTTER	HEAVY	FRAGRANT
SWEET	HERBAL, GREEN, CUT GRASS	AROMATIC	SWEATY	DISINFECTANT, CARBOLIC	ANISE (LICORICE)	AROMATIC	NUTTY (WALNUT ETC)	BURNT, SMOKY	ORANGE
ROSE	FRAGRANT	LIGHT	SOUR, VINEGAR	SHARP, PUNGENT, ACID	FRAGRANT	CHOCOLATE	OILY, FATTY	SULFIDIC	LIGHT
AROMATIC	AROMATIC	PINEAPPLE	SHARP, PUNGENT, ACID	GASOLINE, SOLVENT	MEDICINAL	MALTY	ALMOND	SHARP, PUNGENT, ACID	SWEET
LIGHT	LIGHT	CHERRY (BERRY)	FECAL (LIKE MANURE)	PAINT	SPICY	ALMOND	HEAVY	HOUSEHOLD GAS	COOL, COOLING
COLOGNE	HEAVY	STRAWBERRY	SOUR MILK	CLEANING FLUID	SWEET	CARAMEL	WARM	PUTRID, FOUL, DECAYED	AROMATIC
HERBAL, GREEN, CUT GRASS	SPICY	PERFUMERY	MUSTY, EARTHY, MOLDY	ALCOHOLIC	EUCALIPTUS	LIGHT	MUSTY, EARTHY, MOLDY	SEWER	HERBAL, GREEN, CUT GRASS
VIOLETS	BURNT, SMOKY	BANANA	HEAVY	TURPENTINE (PINE OIL)	CAMPHOR	WARM	WOODY, RESINOUS	BURNT RUBBER	SHARP, PUNGENT, ACID

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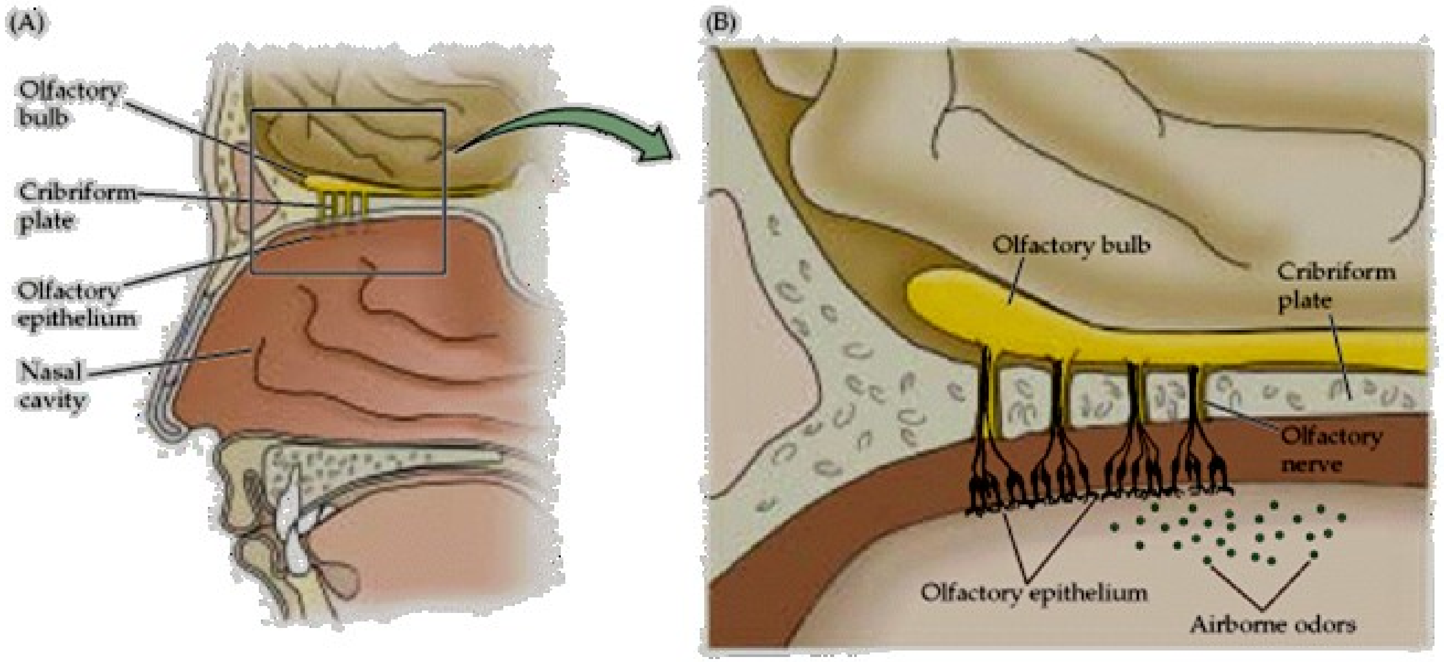
Olfaction



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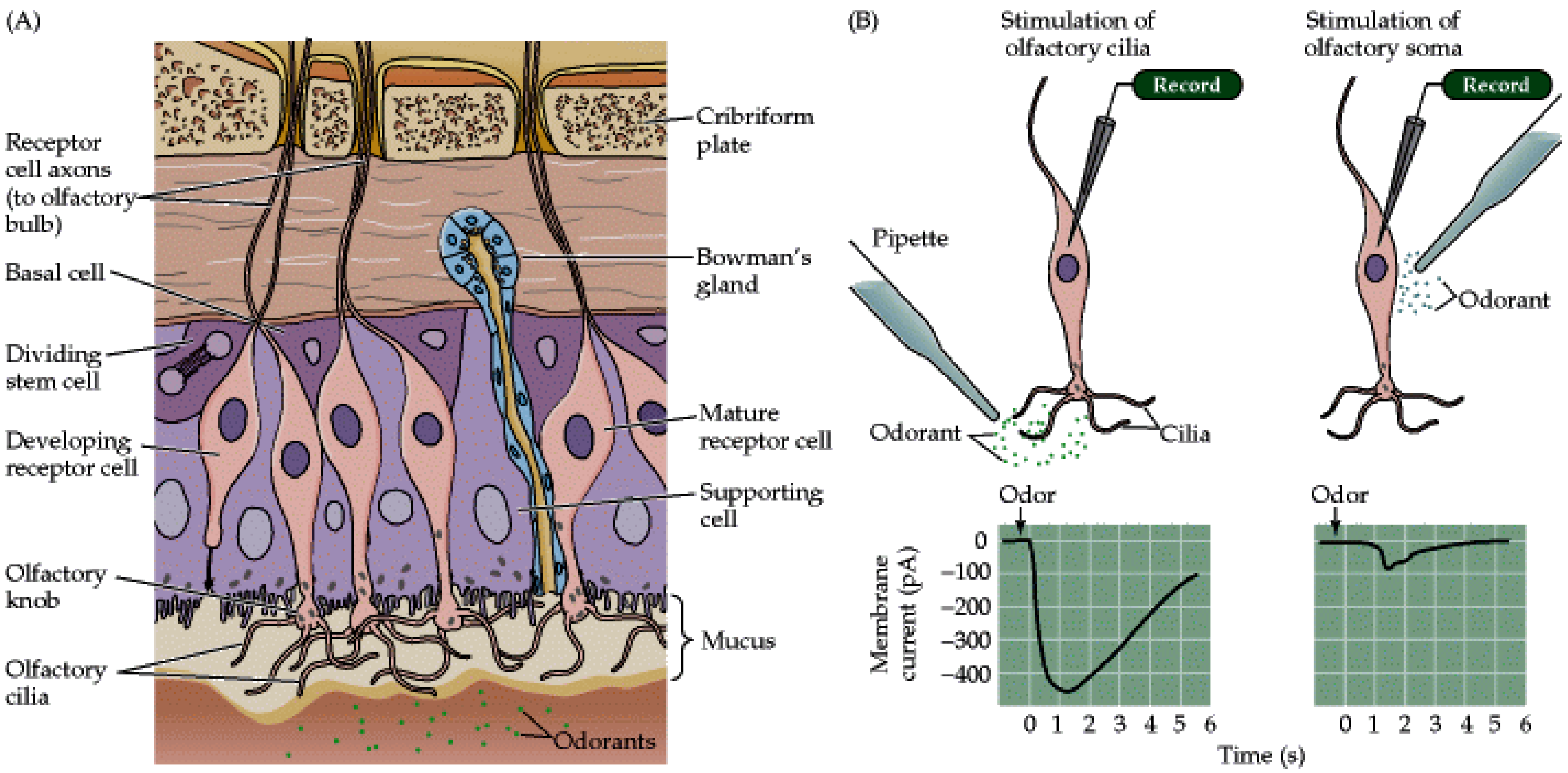
Olfaction



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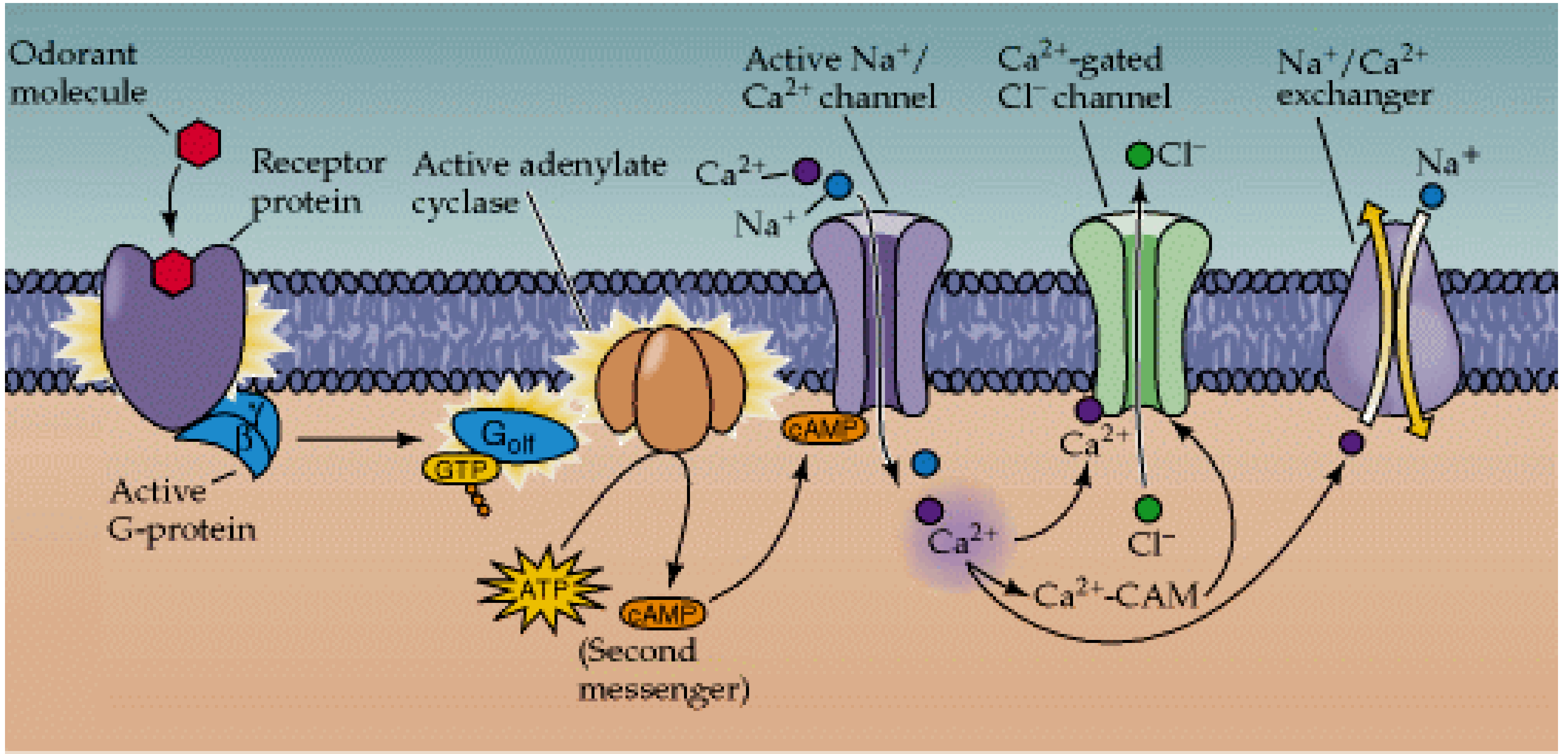
Olfaction

(A)



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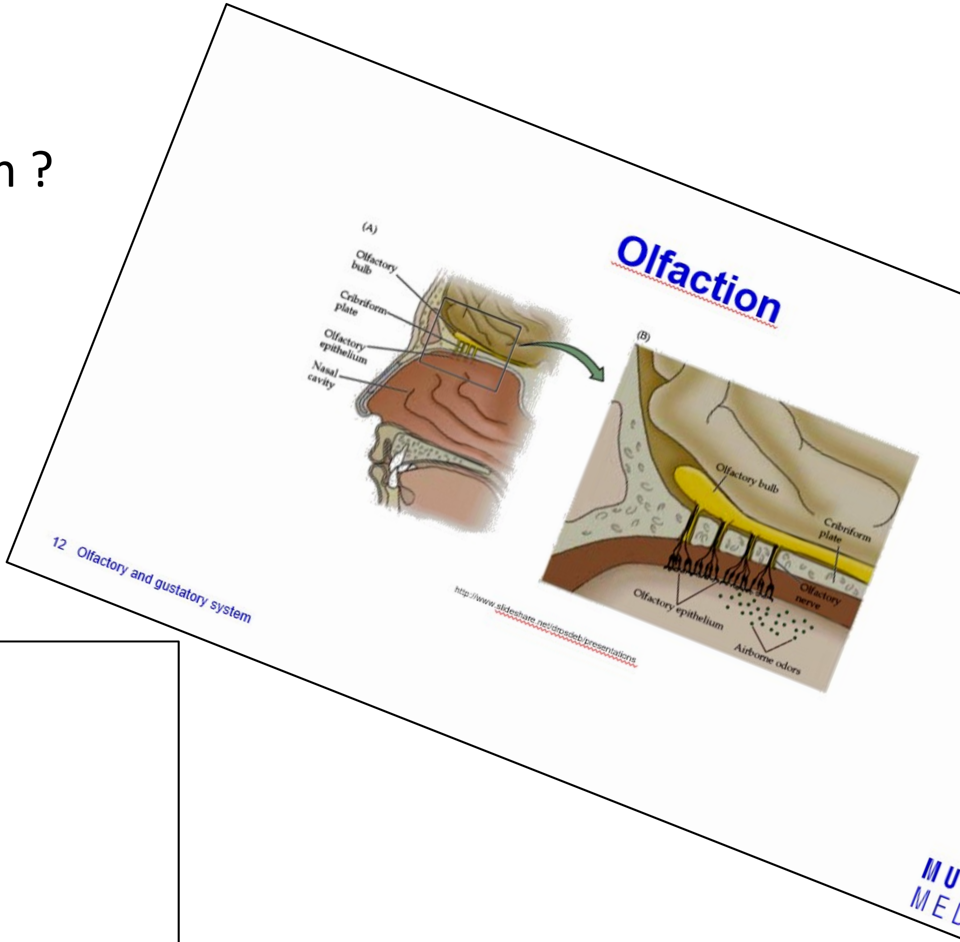
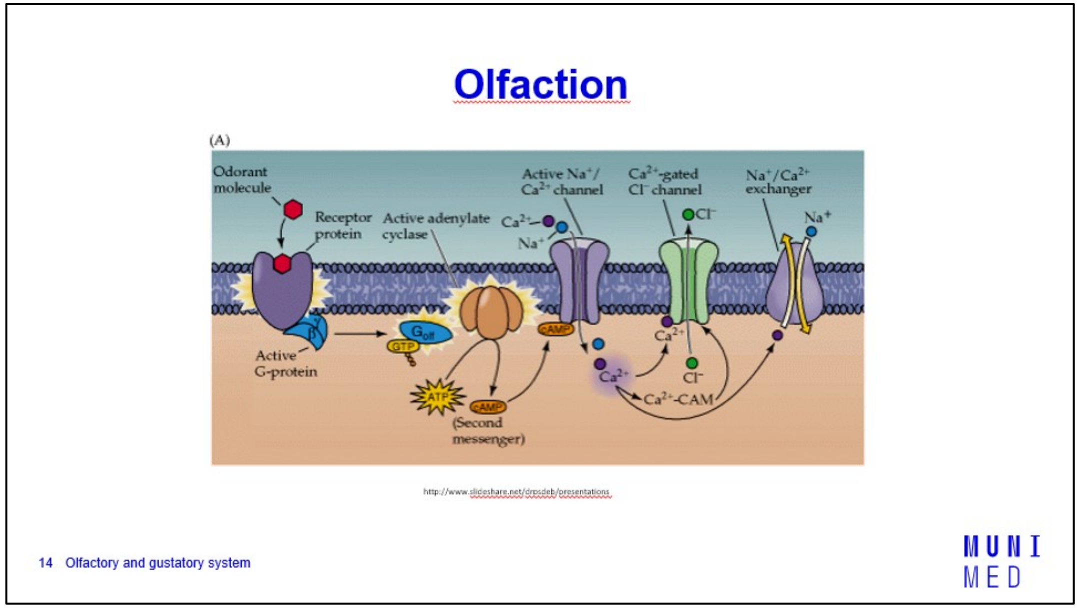
Olfaction

- Molecular structure detection ?
  - Functional group ?
  - Molecular shape ?





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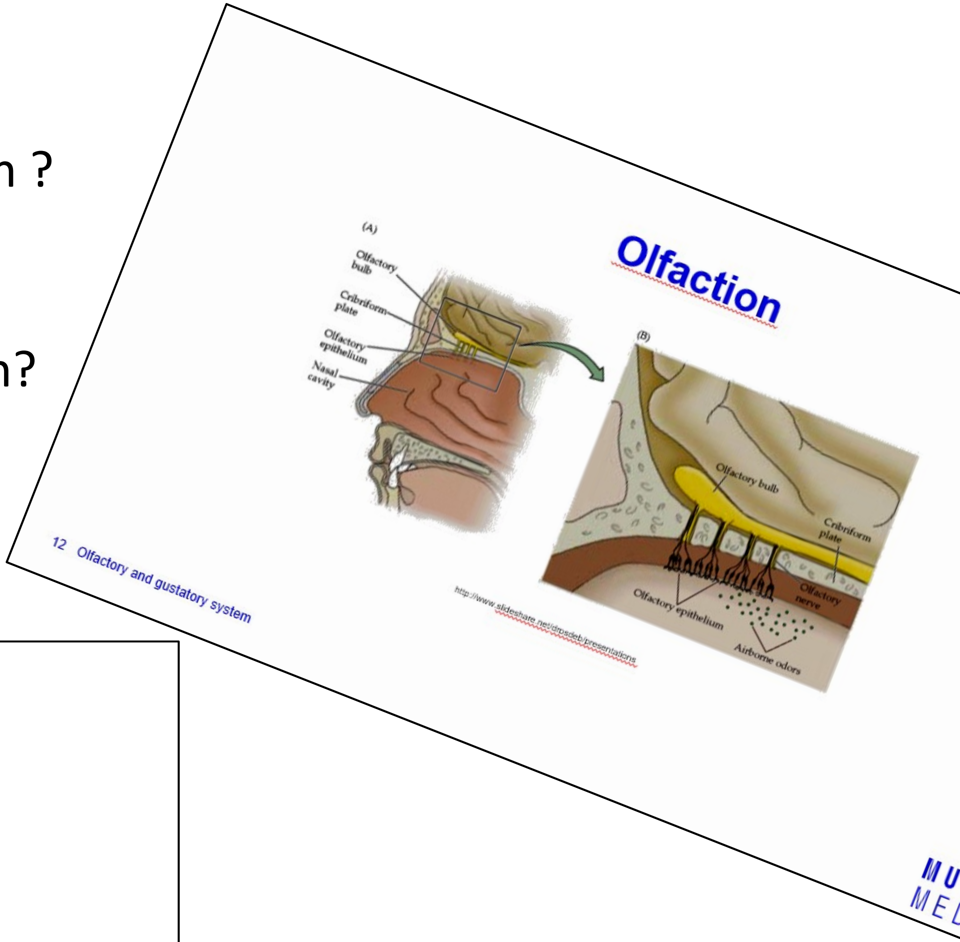
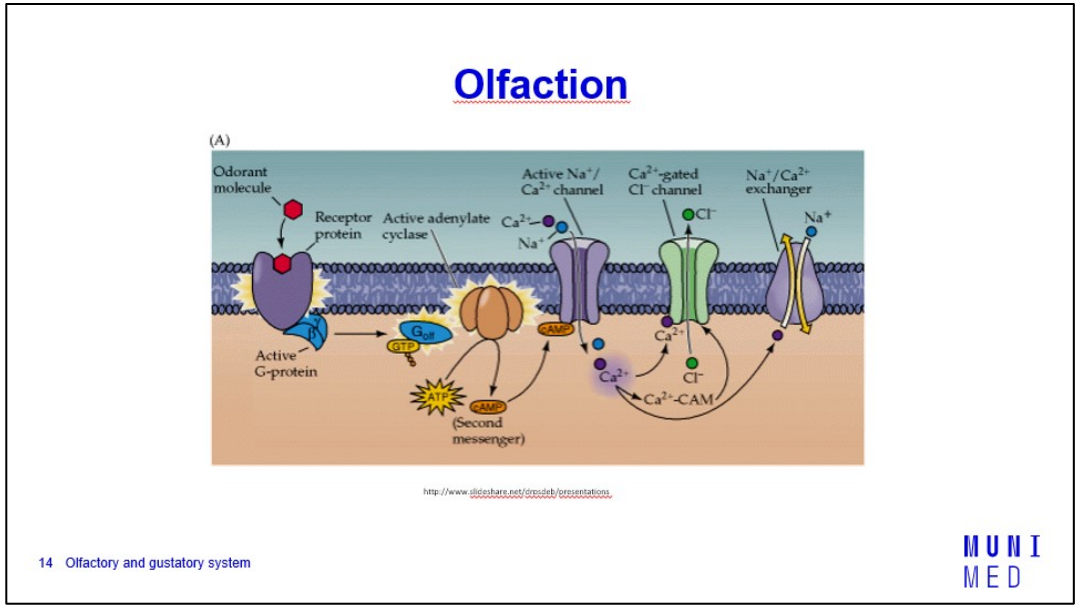
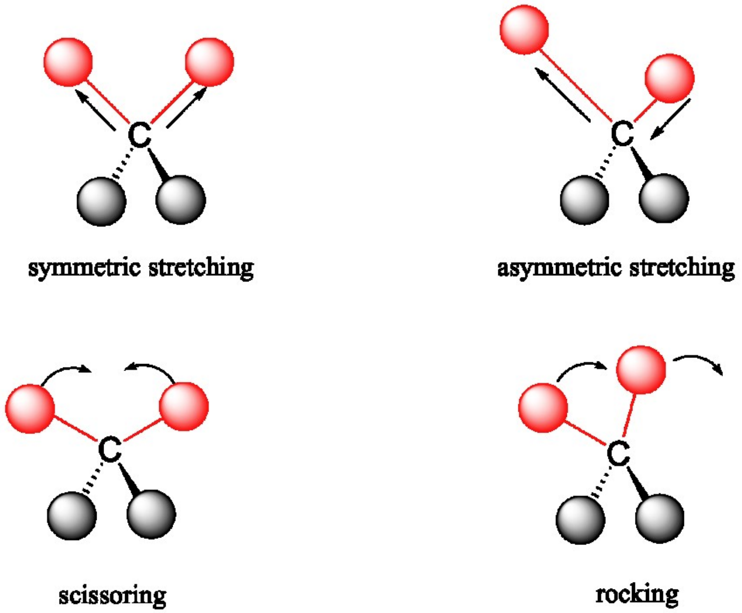
Olfaction

- Molecular structure detection ?
  - Functional group ?
  - Molecular shape ?
- Molecular vibration detection?



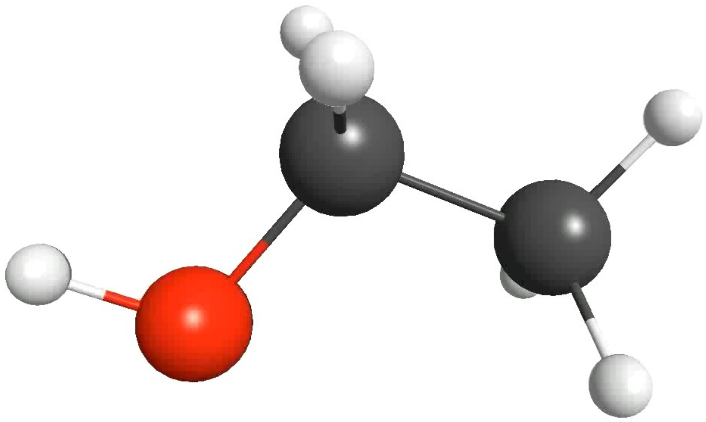


Molecular vibration



https://orgspectroscopyint.blogspot.com/2014/12/infrared-spectroscopy.html

https://www.youtube.com/watch?v=O5dulWd-OnQ



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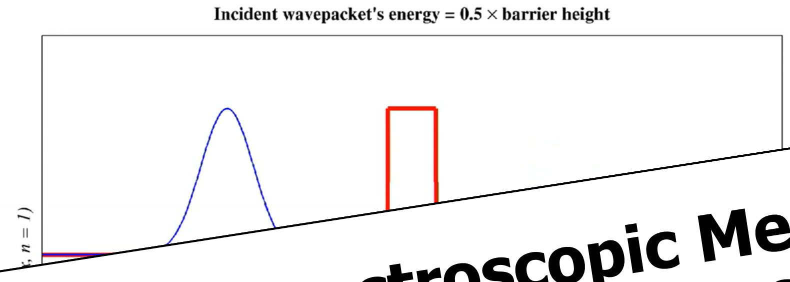
Molecular vibration



Turin L. **A Spectroscopic Mechanism for Primary Olfactory Reception.** *Chem Senses*. 1996;21:773–791.

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https://www.youtube.com/watch?v=cV2fkDscwvY

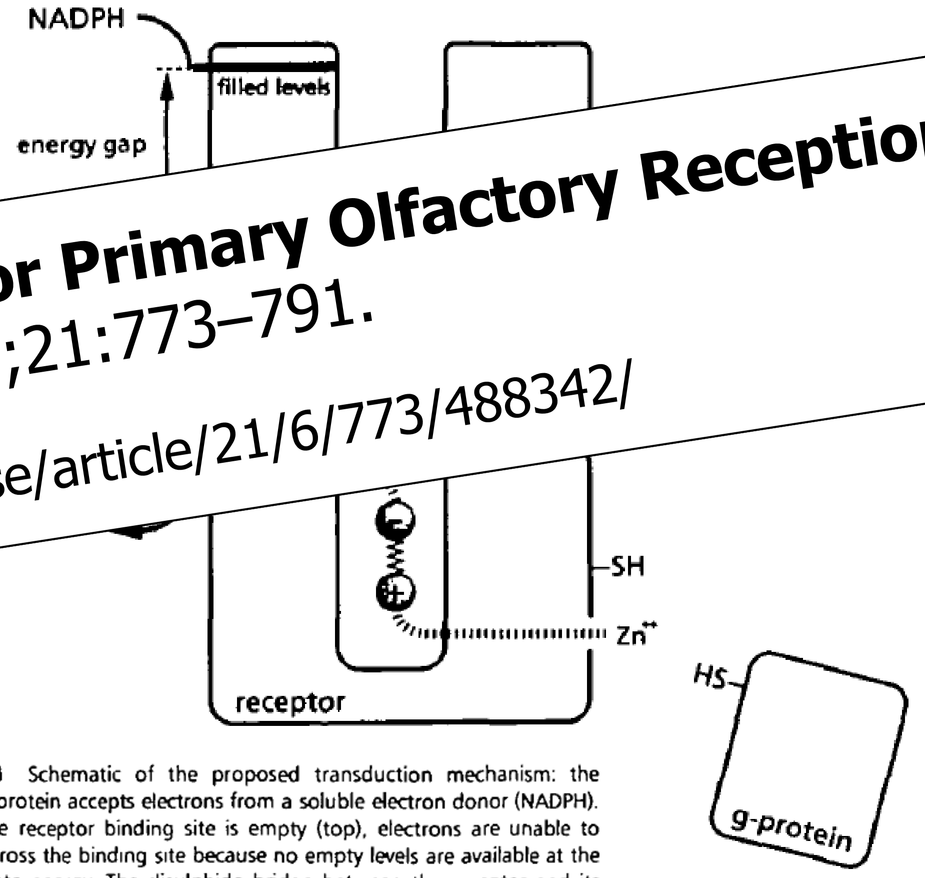

Figure 1 Schematic of the proposed transduction mechanism: the receptor protein accepts electrons from a soluble electron donor (NADPH). When the receptor binding site is empty (top), electrons are unable to tunnel across the binding site because no empty levels are available at the appropriate energy. The disulphide bridge between the receptor and its associated G-protein remains in the oxidized state. When an odorant (here represented as an elastic dipole) occupies the binding site (bottom), electrons can lose energy during tunnelling by exciting its vibrational mode. This only happens if the energy of the vibrational mode equals the energy gap between the filled and empty levels. Electrons then flow through the protein and reduce the disulphide bridge via a zinc ion, thus releasing the G-protein for further transduction steps.

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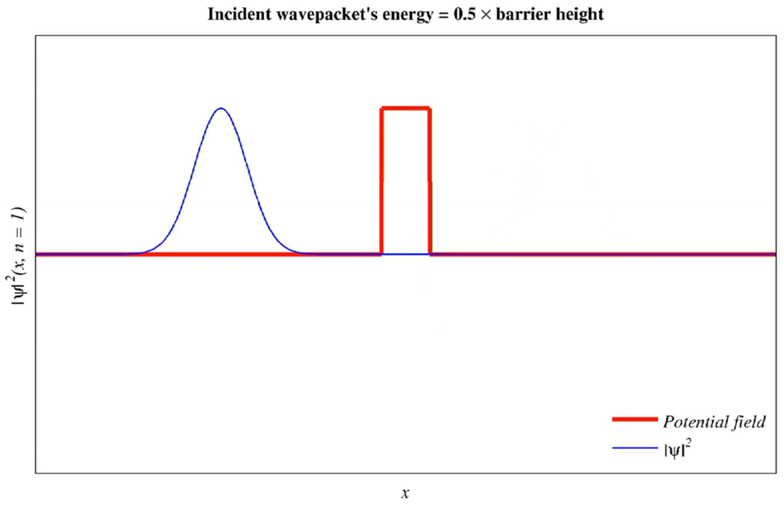
Molecular vibration



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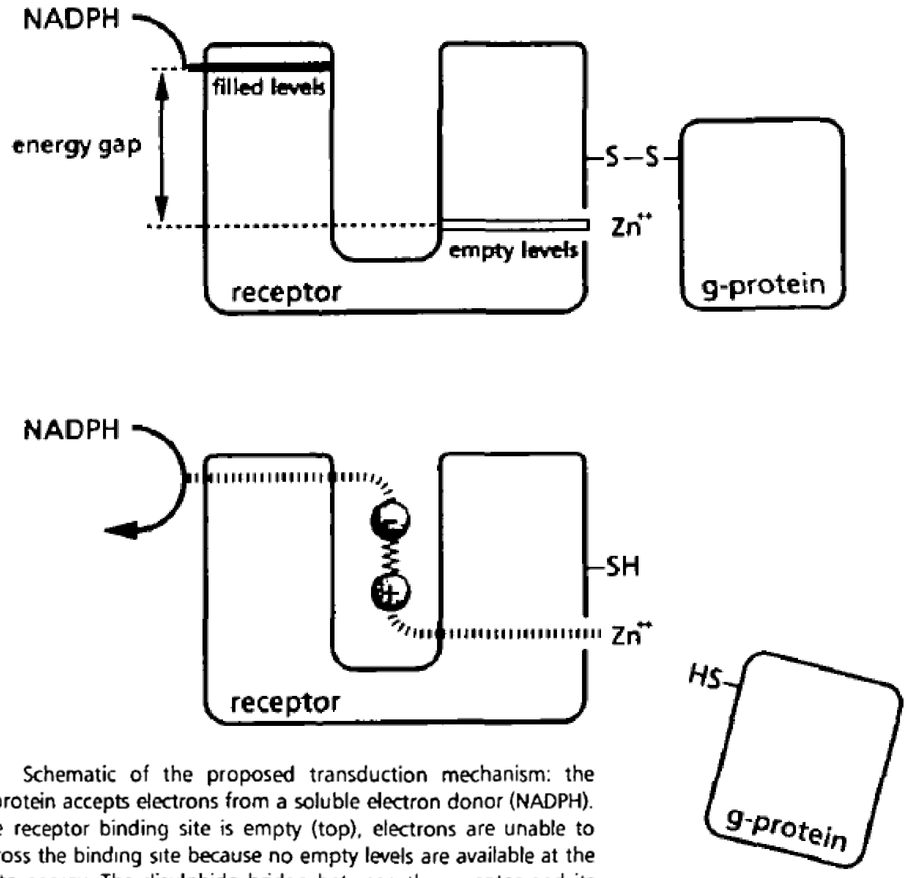

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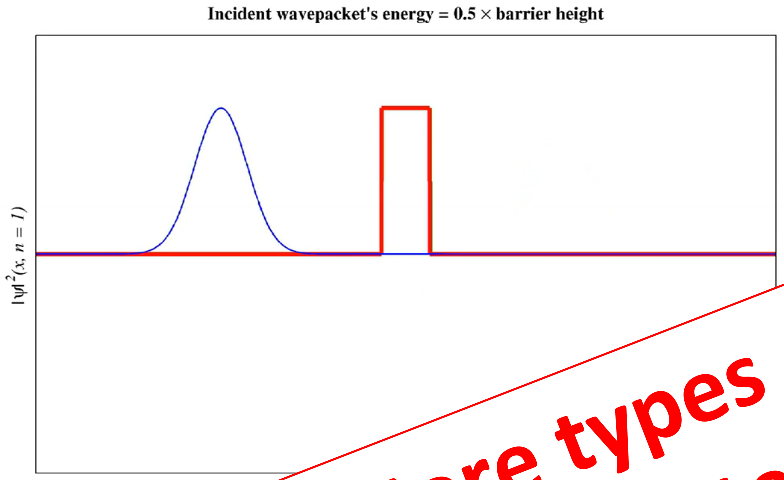
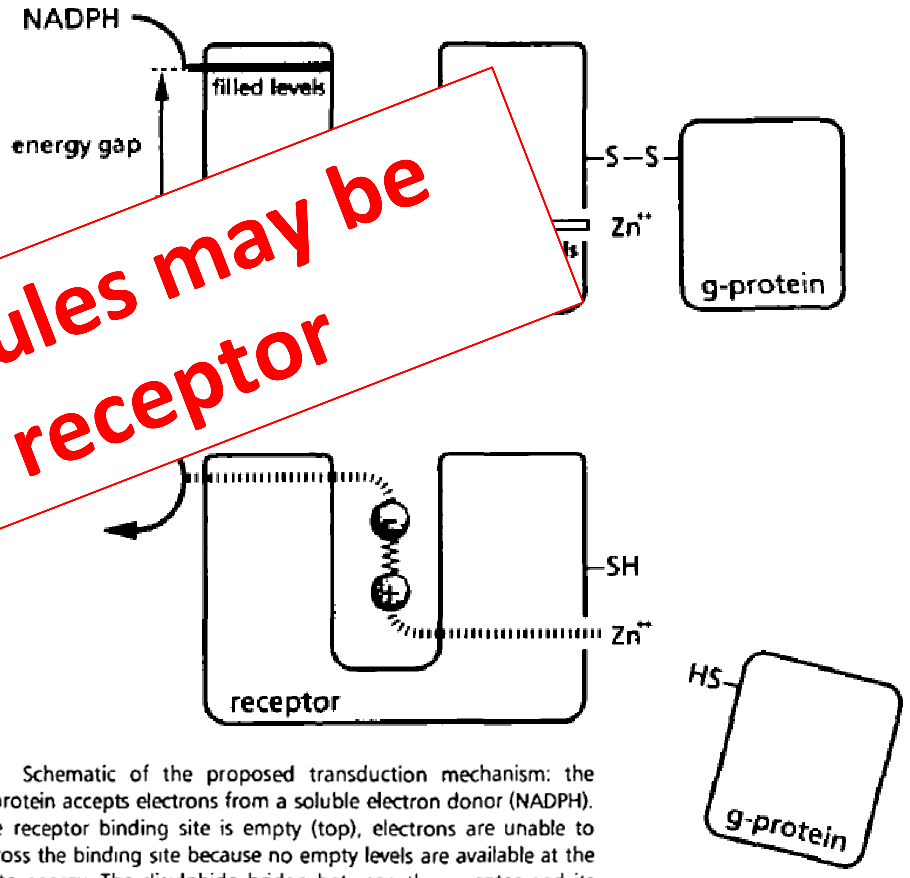
Molecular vibration





More types of molecules may be detected by one receptor

https://www.youtube.com/watch?v=cV2fkDscwvY

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Molecular vibration

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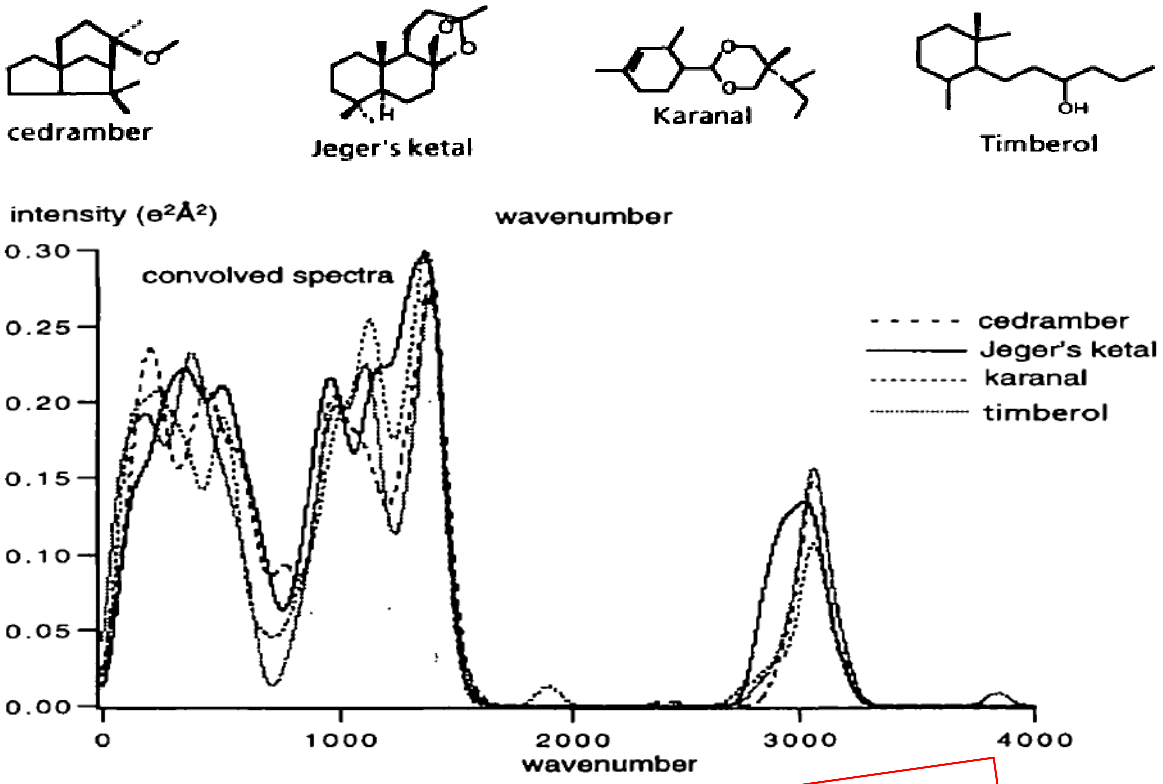
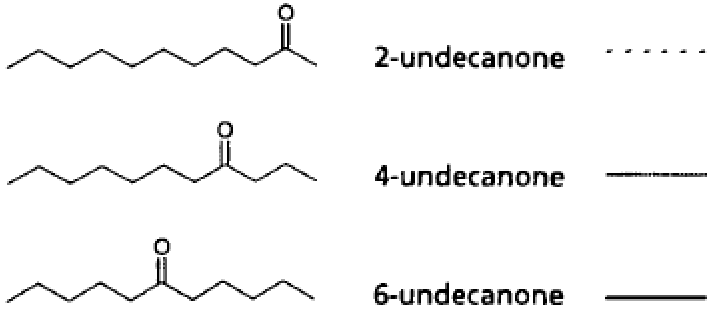
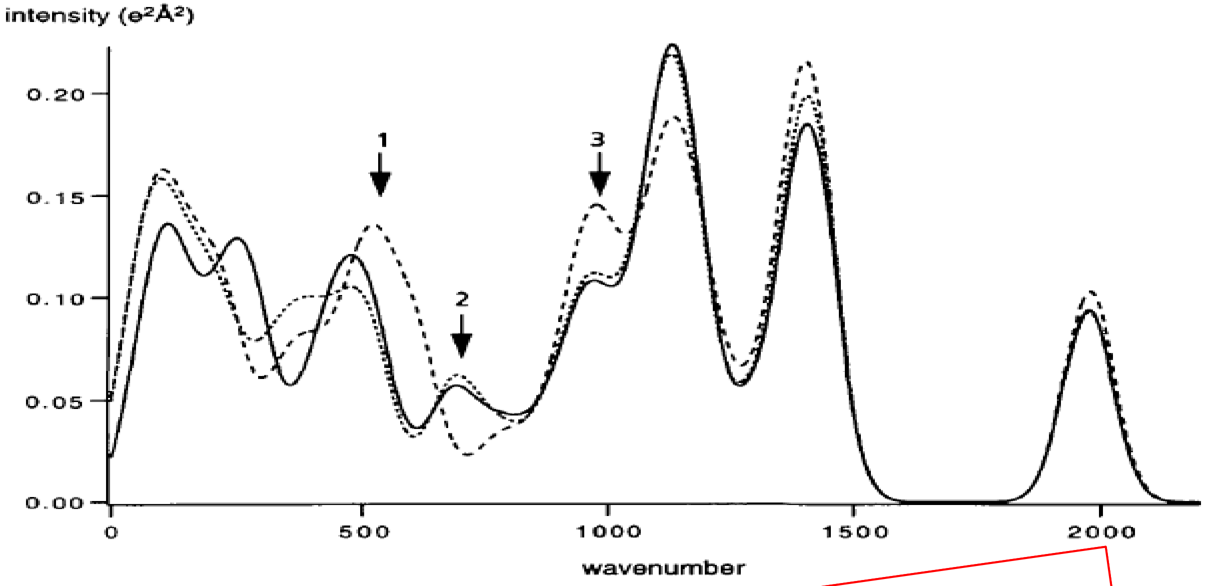


Different molecules, similar odours





Similar molecules, different odours

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Molecular vibration

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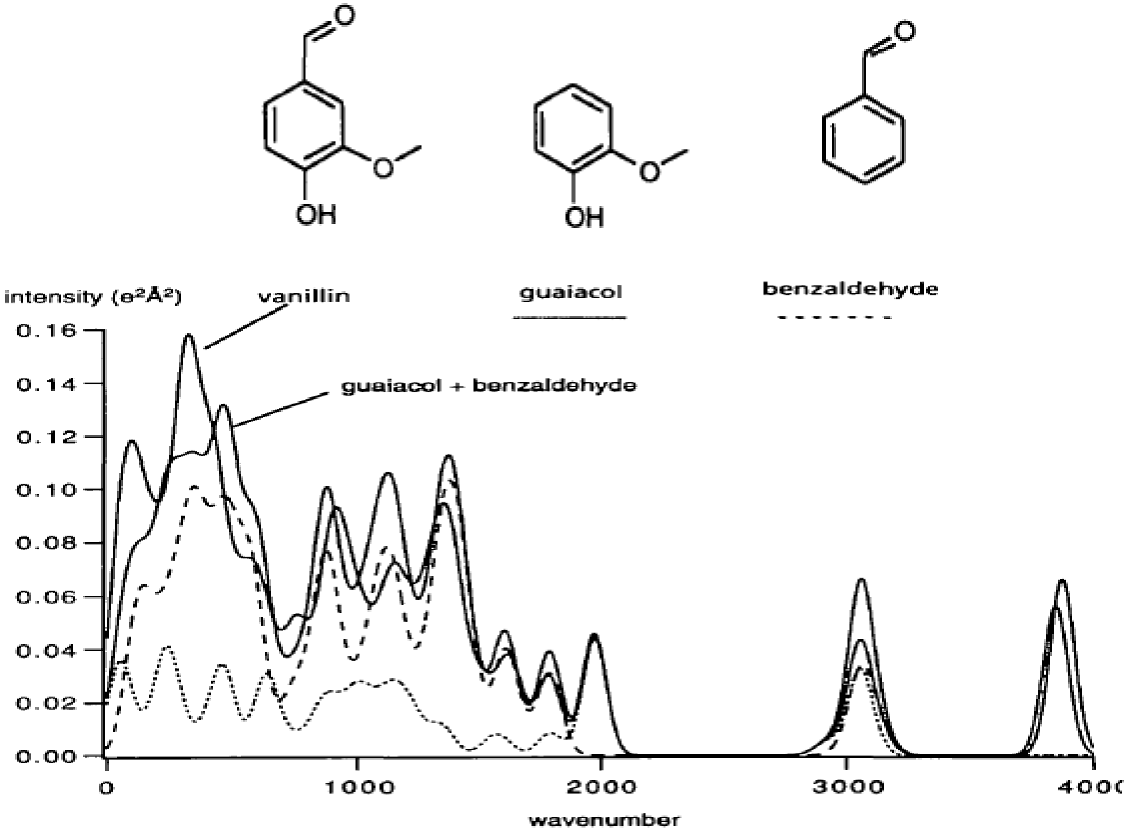

Additive synthesis of odour

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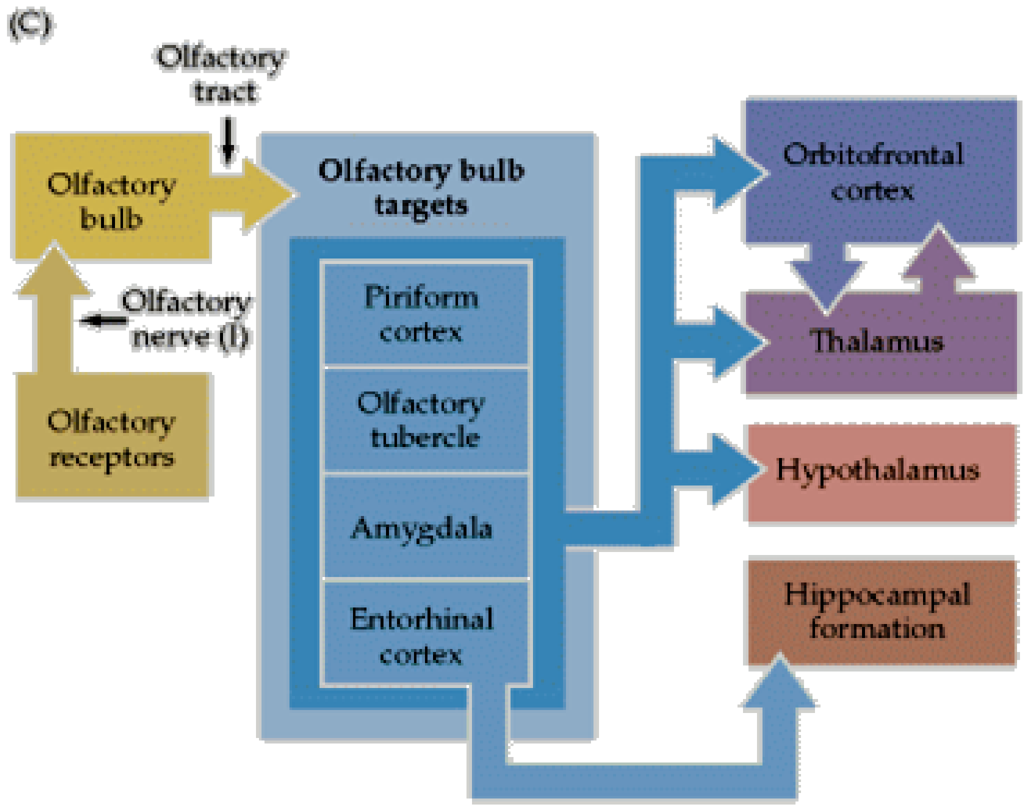
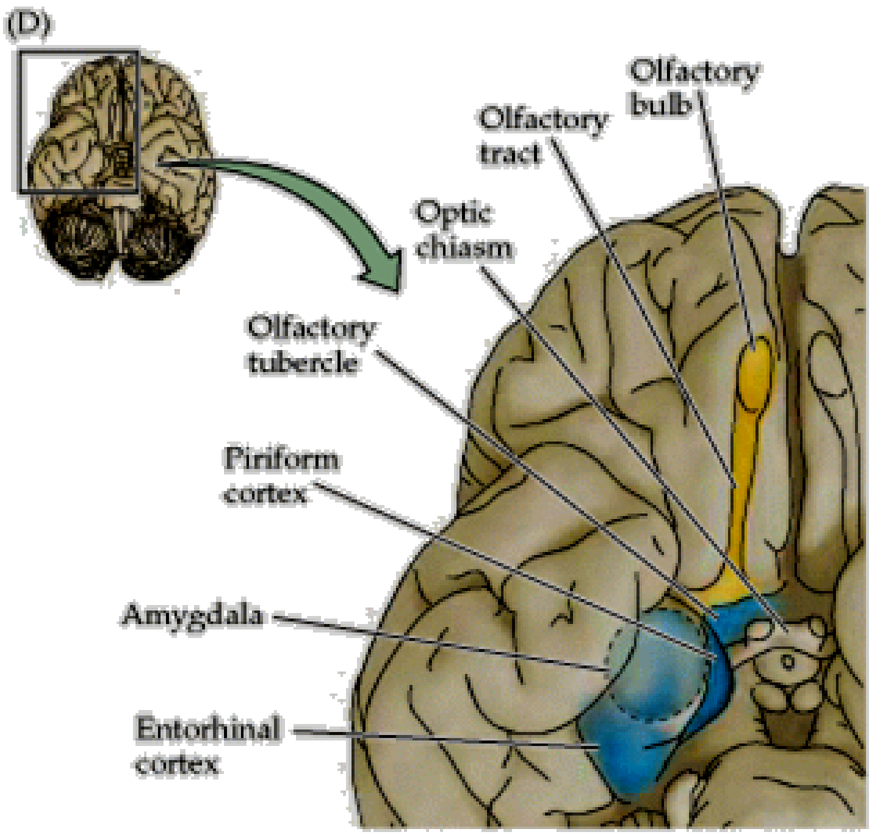
Olfaction





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Sense of taste

- Ability to sense chemical compounds dissolved in saliva

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Sense of taste

- Ability to sense chemical compounds dissolved in saliva
- Close connection with olfaction
- Food identification

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- Connection to the reward system

Sense of taste

- Ability to sense chemical compounds dissolved in saliva
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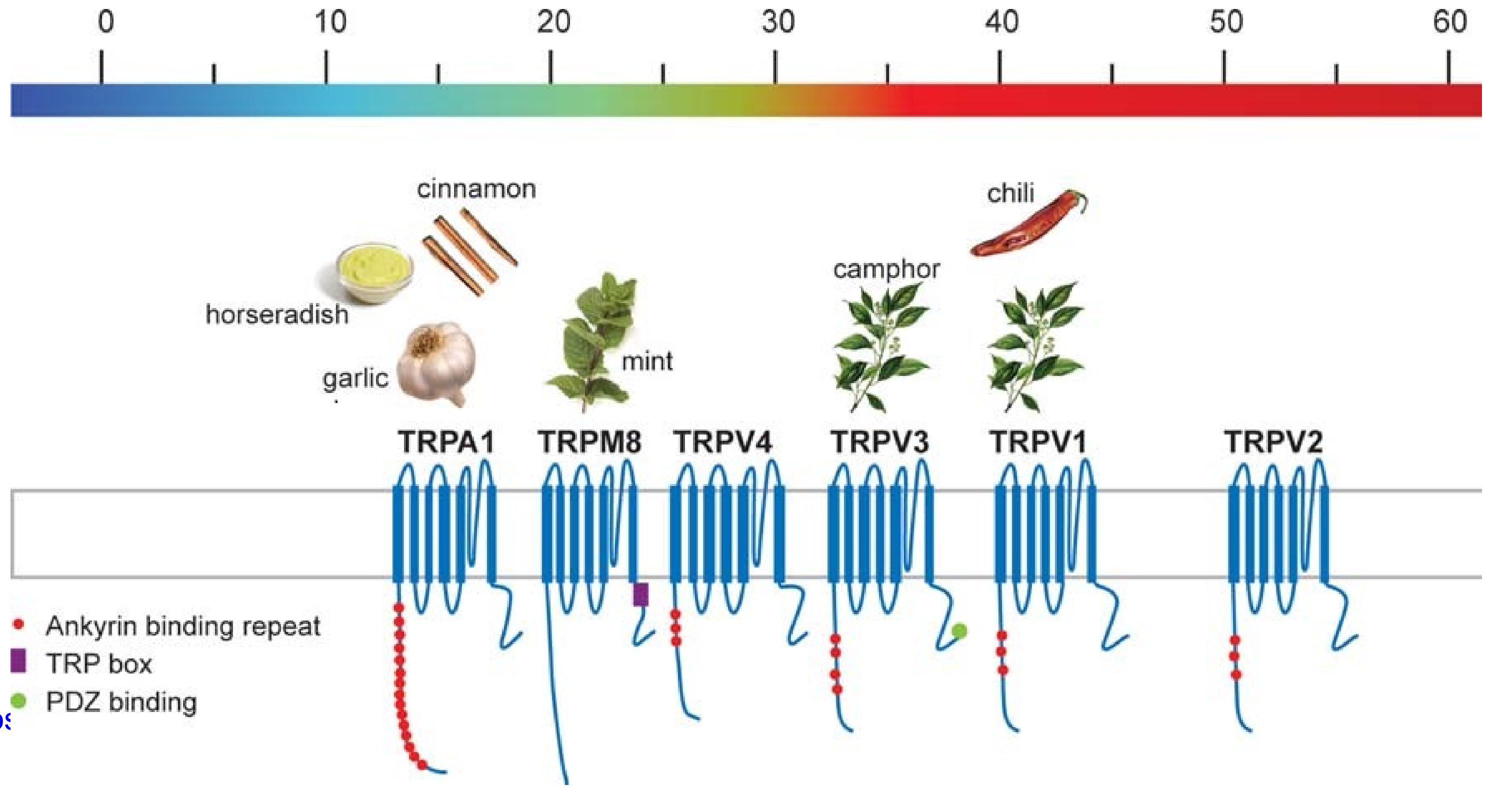
✓ Sweet
✓ Salty
✓ Sour
✓ Bitter

✓Umami
➢Taste-mGluR4 receptor – L - glutamate

✓Hot
➢Nociceptors and thermoreceptors

Thermoreceptors

- Free nerve endings receptive to thermal stimuli
- TRP (transient receptor potential) channels
  - Polymodal recetor (chemoreception, thermoreception)
  - Present also in many cells (including neurons, keratinocytes, mechanoreceptros)



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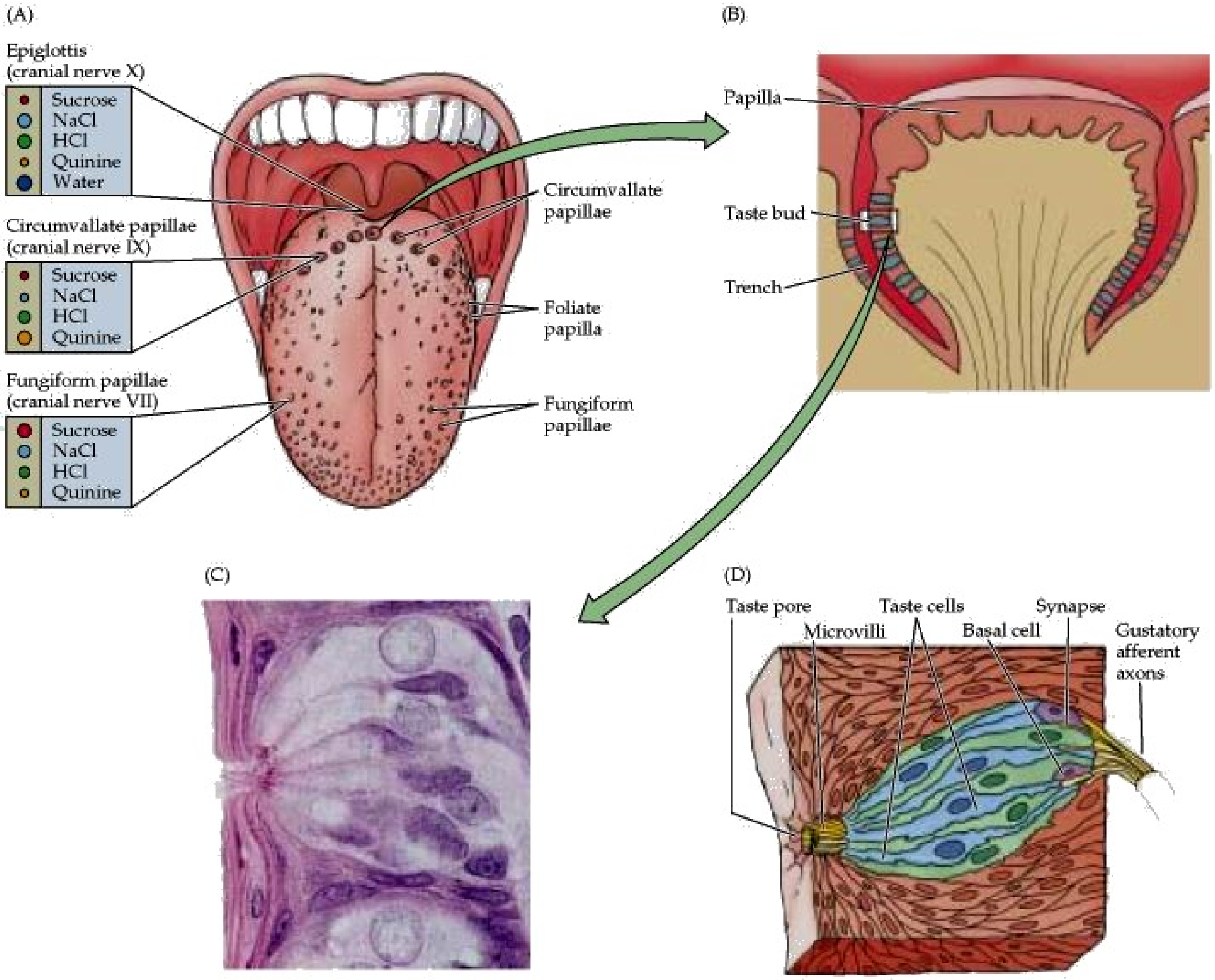
Gustatory system



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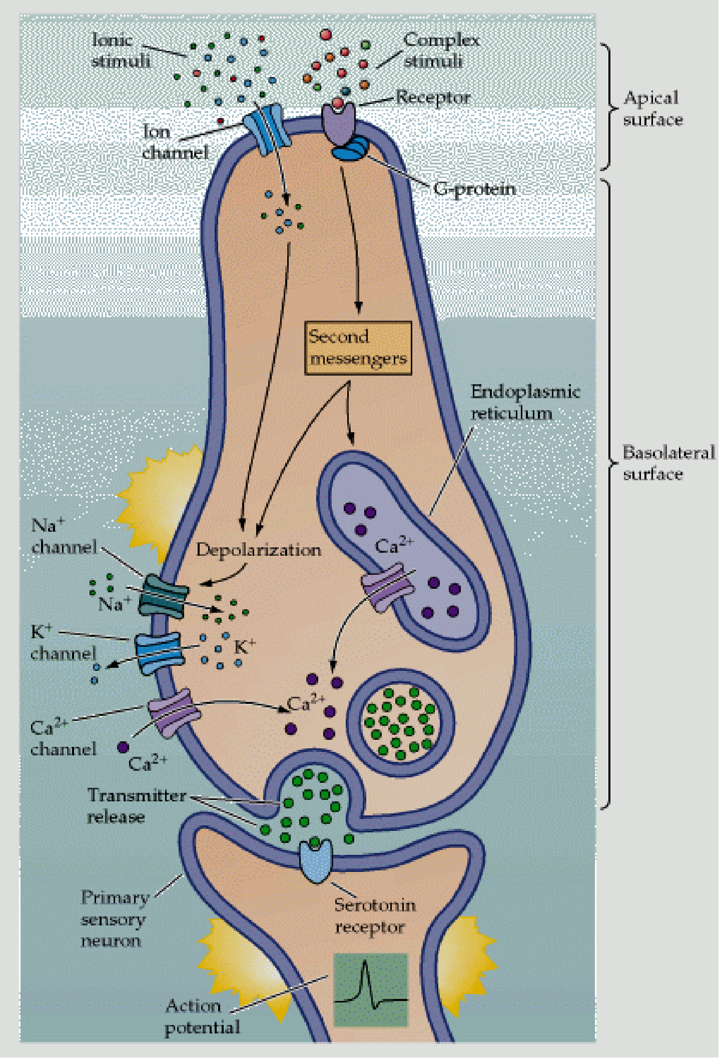
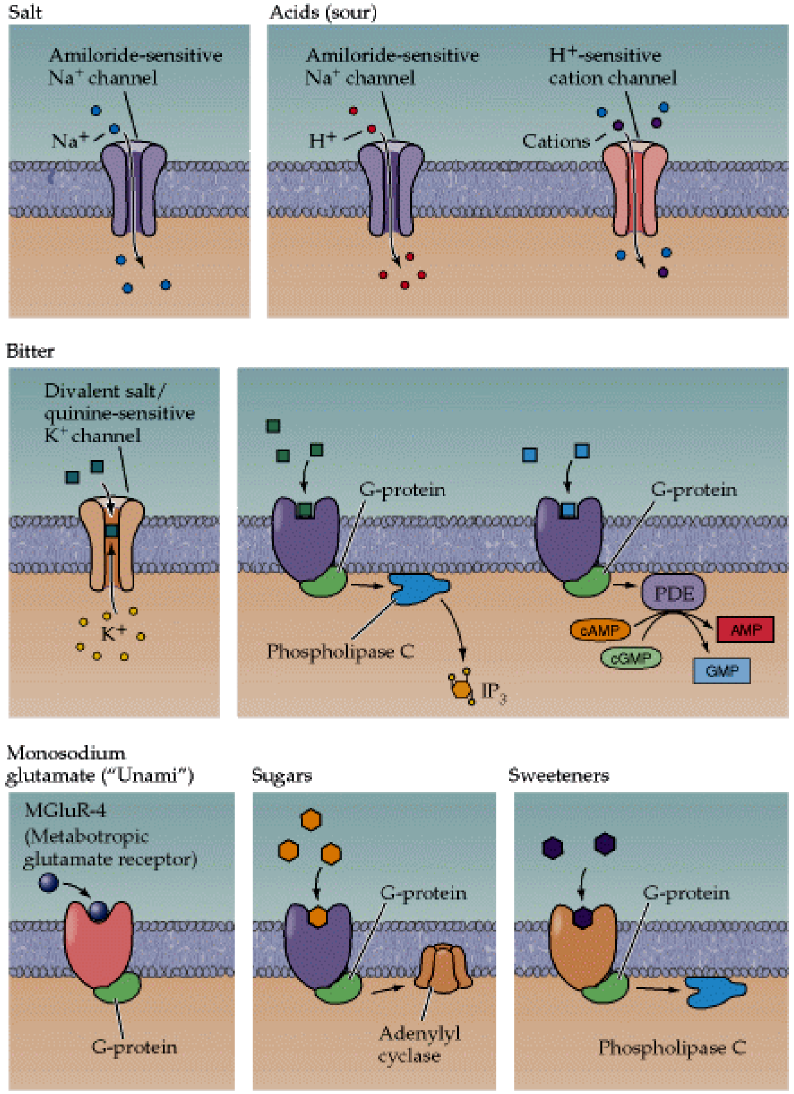
Gustatory svstem





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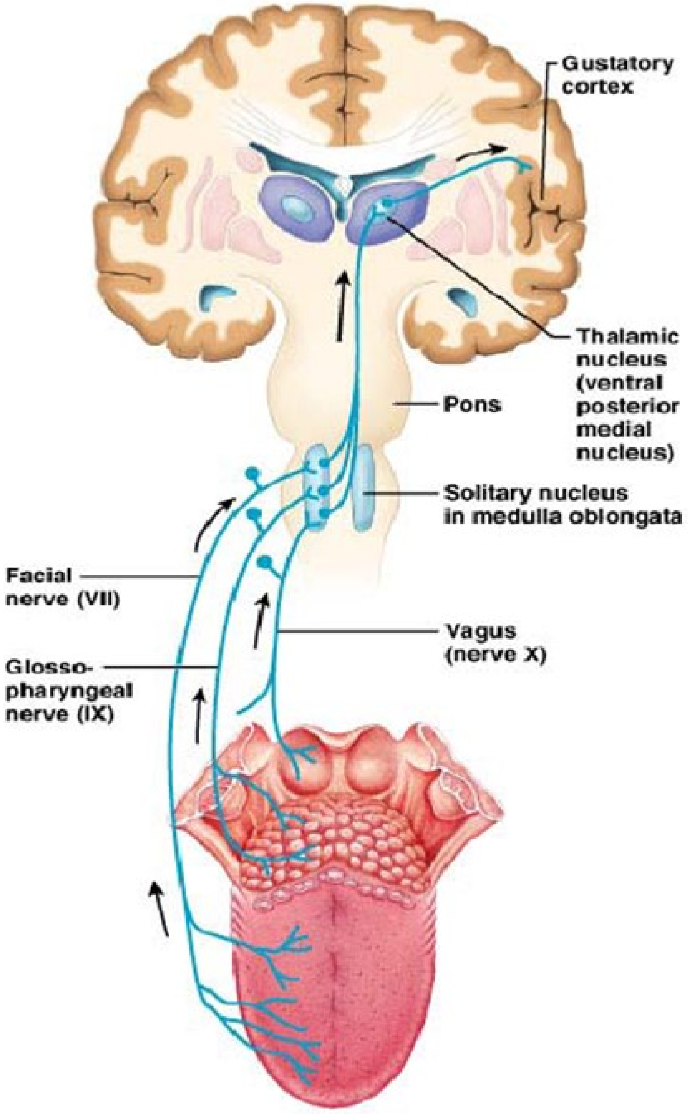
Gustatory system



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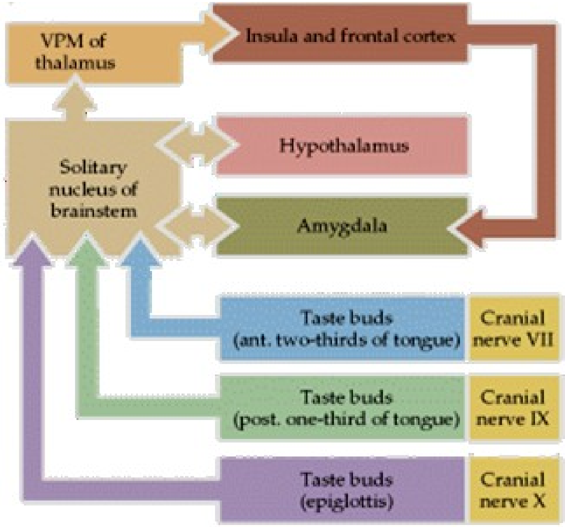

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75. The basic physiology of olfactory and gustatory system – brief characterization of the modality, basic information about signal detection and processing

- Chemical senses – detection of chemicals dissolved in air/saliva
- Olfaciton and gustation are interconnected
- Evolutionary old – olfaction influenced neocortex evolution
- Analysis of odors requires memory and “advanced” information processing

- Basic overview of human olfactory and gustatory systems
  - Main characteristics of olfaction and taste in human
    - Human is microolfactoric…
    - Mention examples of some smell types
    - List taste types
  - Structure of olfactory/gustatory epithelium
  - Mechanism of signal transduction
  - Brain structures associated with olfaction/gustatory system

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