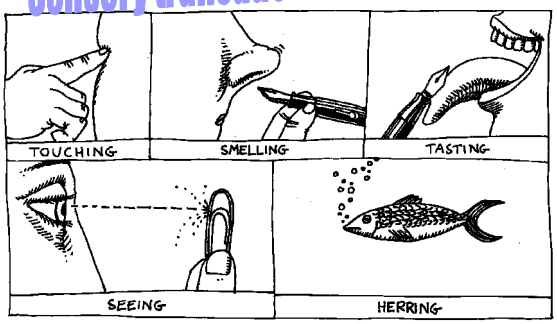
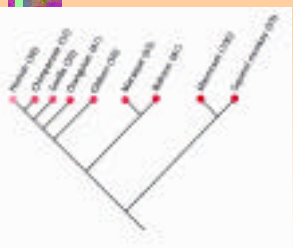
Sensory transduction*



*besides vision!

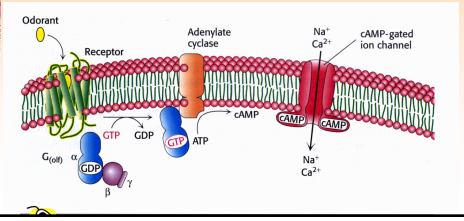
Olfaction



- In late 80's odorant receptors were cloned from cilia
- These were 7TM helix G-protein receptors (OR) stimulating a unique Gα protein, G_{olf}
- Human OR genes number 500 but only about 30 are not pseudogenes!

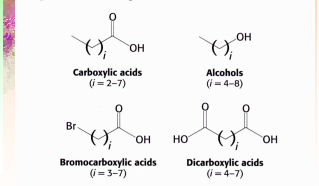
Olfaction

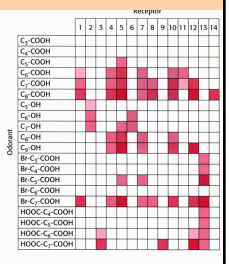
- Each neuron expresses only 1 OR
- G_{olf} stimulates Ad. Cyclase
- cAMP opens cation channels;depolarization occurs; action potential propagates



Olfaction

- Decoding of olfactory stimuli -in mouse suggests a combinatorial mechaism



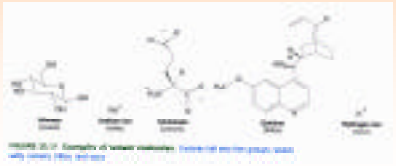


Olfaction

- All neurons expressing a given OR converge on a discrete area in the olfactory bulb
- The spatial pattern of OR stimulation is somehow transformed to a unique scent.

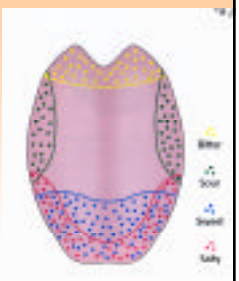
Taste

- More limited scope of possible tastes
- Olfaction contributes to complex tastes



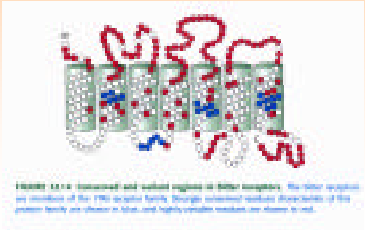
Taste

- Gustation receptors are located in different areas
- In taste buds (~150 cells w/ sensory neurons) in papillae (big knobs)



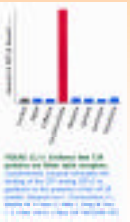
Taste-Bitter

- So far only bitter receptors (G-protein Receptors) with Gα, gustducin have been found
- There are 50-100 genes (for bitter?) in the genome but they are mixed on taste buds



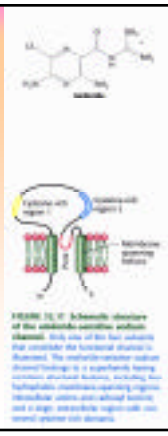
Taste

- Bitter receptors ? Stimulation by specific bitter substance of mT2R
- But different ones get mixed up in brain



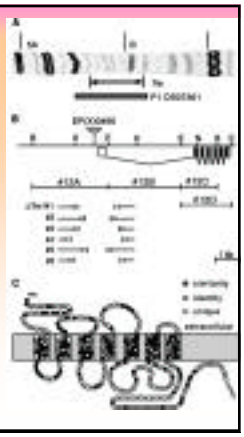
Taste-Salty

- Salt receptors ? Direct sensation by Na+ ion channels blocked by Amiloride
- Analogous to the 4 subunit type channels (like K+)



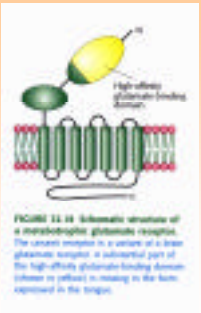
Taste-Sweet

- Not isolated in humans but likely G-protein since gustducin knock-out mice can't taste sweet substances
- Tre 1, a sugar responsive GPR has been found in flies



Taste-Umami

- Japanese-Deliciousness
- Lots in protein rich foods like soy sauce, roasted meat and and vegemite!
- Na+ Glutamate is the key (1903-Kikunae Ikeda)
- A GPR sensitive to glutamate in the brain is clipped by 309 amino acids in the buds to give low affinity umami receptor.

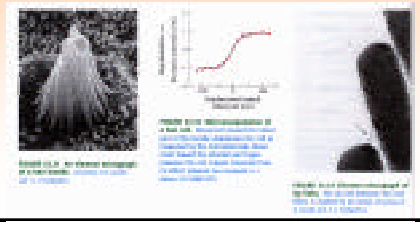


Hearing

- Mechanical stimulation of hair cells in cochlea is the key
- Hair cells are specialized neurons

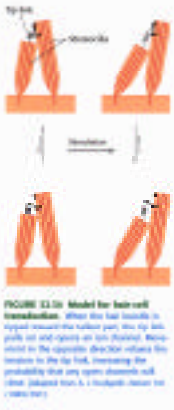
Hearing

- Displacement of bundle by 3 Å results in a measurable membrane potential change (like 1 inch movement at the top of the Empire State building)



Hearing

- Tip link seems to pull open an ion "hatch"; a mechanosensory channel
- Back and forth flow induces an oscillating ion current

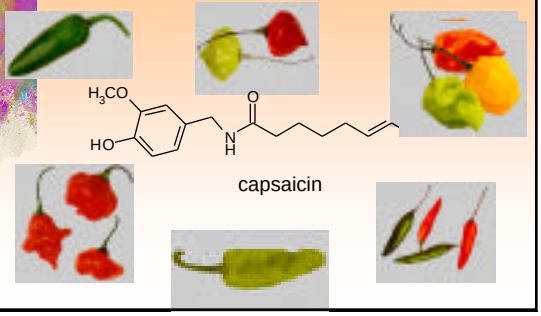


Touch

- Hot, Cold
- Pressure
- Capsaicin/hot receptor
- Cold/menthol receptor

Capsaicin and friends

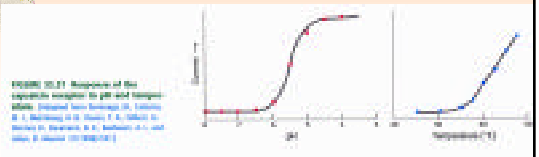
Capsicum (chili pepper)



capsaicin

Touch

- Example: Capsaicin
- Capsaicin/hot receptor
- Reacts to noxious stimuli (heat, acid]
- Also involved in taste



Touch-Capsaicin

- The receptor, VR1, is involved in nociception (pain sensation) as well.
- Used medicinally to alleviate pain by the principle of counterirritation
- How does this work?

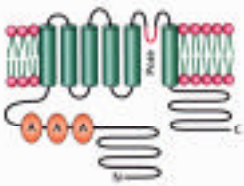


FIGURE 53.36 The membrane topology deduced for VR1, the capsaicin receptor. The proposed site of the membrane pore is indicated in red, and the three ankyrin (A) repeats are shown in orange. The active receptor comprises four of these subunits. (Adapted from Caterina, M. J., Schumacher, M. A., Tominaga, M., Rosen, T. A., Levine, J. D., and Julius, D. Nature 389 (1997):816.)

UCSF Study Suggests Capsaicin Significantly Reduces Debilitating Nerve Pain. Mice without it don't experience pain from heat (Science,2000).