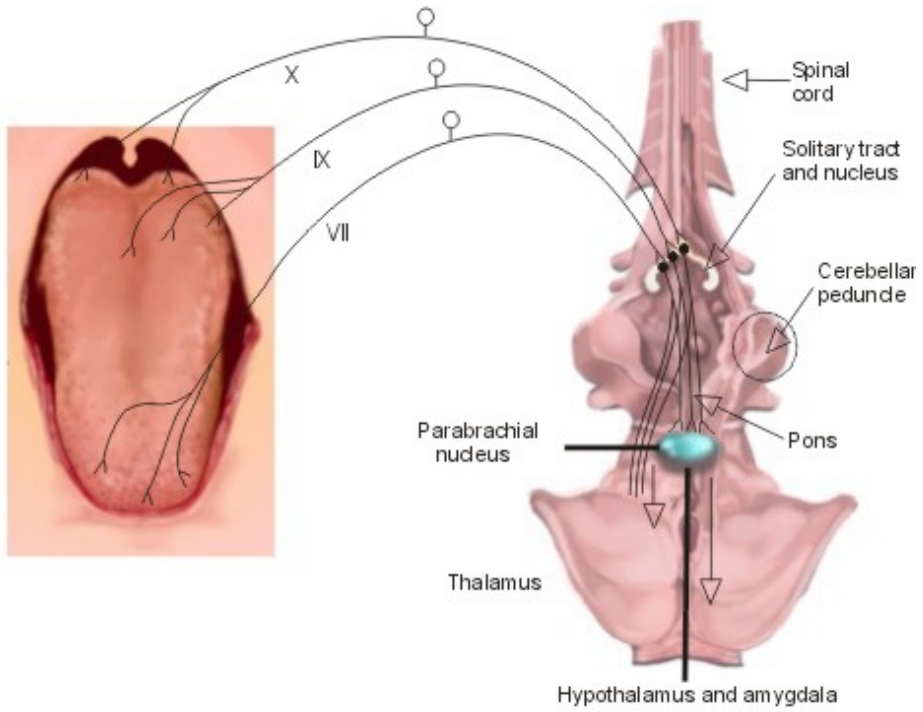
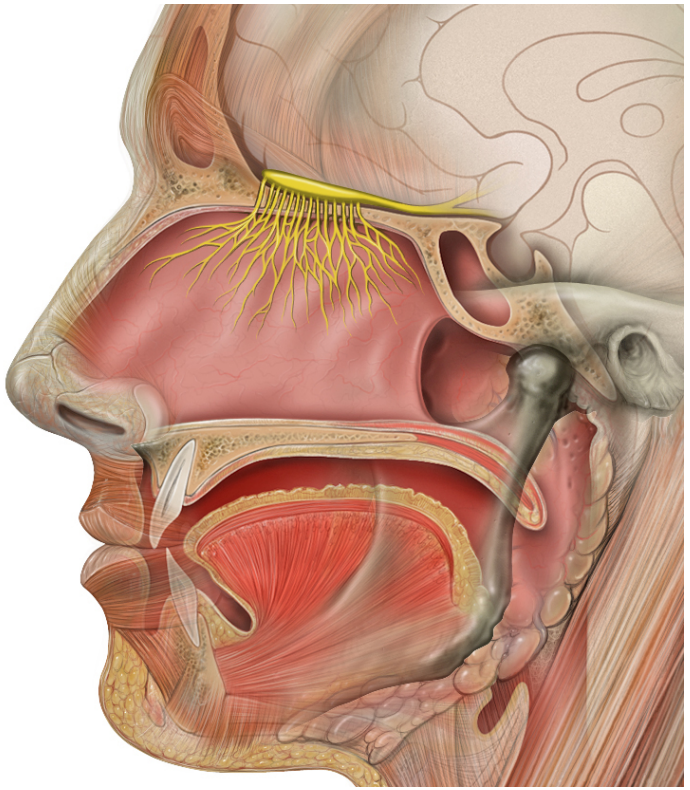
The chemical senses

Oldest sensory systems: Gustation and Olfaction





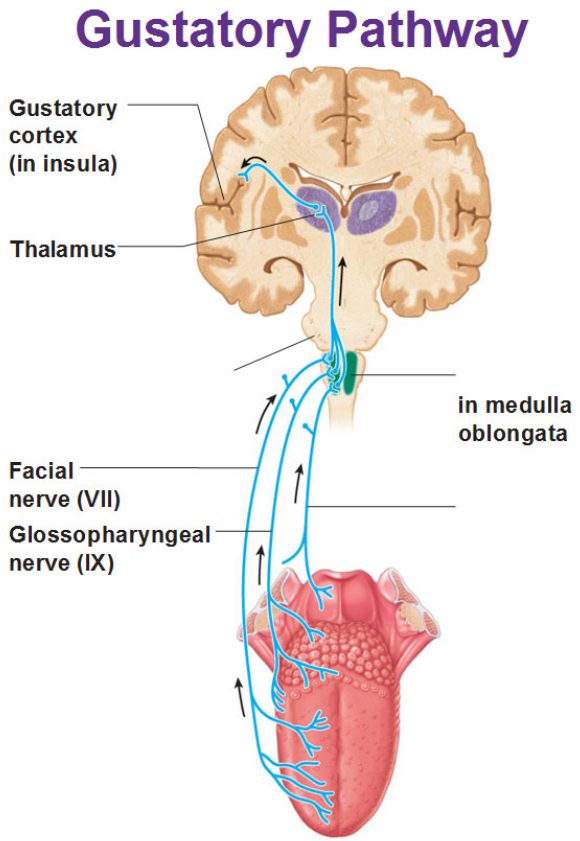
Work together to detect and perceive chemical signals in the oral and nasal cavities…

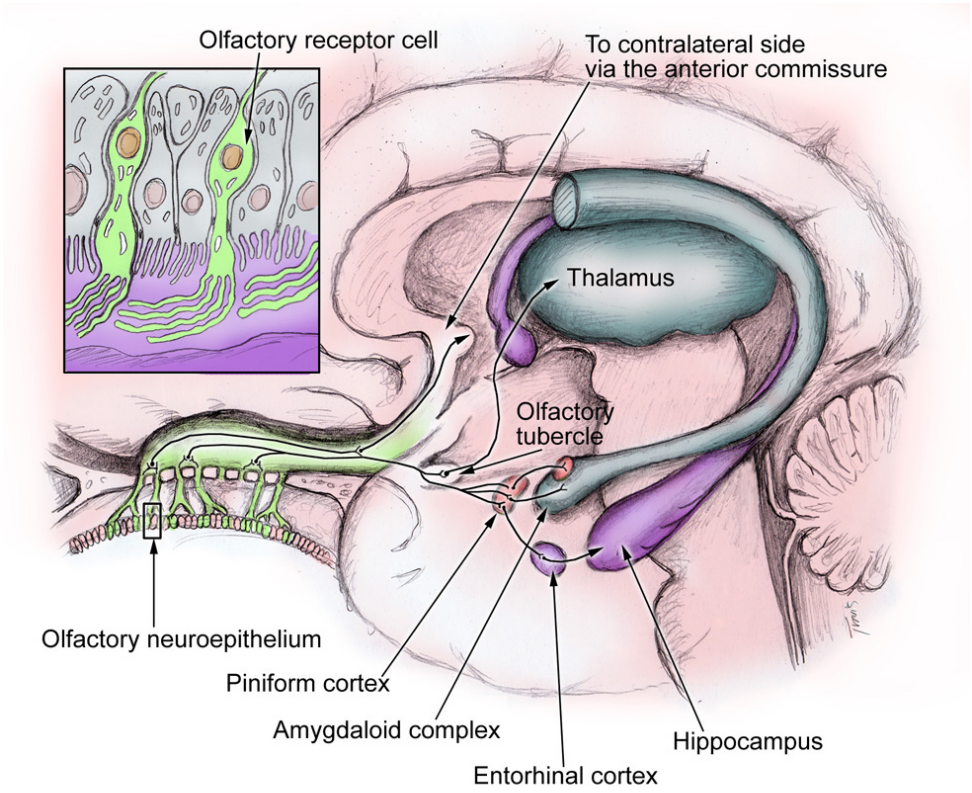
Taste and Smell versus Flavor

- The Greeks separated sensations from the mouth (**taste**) and nose (smell). But our experience of **flavor** involves *both…*
- In fact, there are even taste receptors in your nose!
- Lose olfaction; ***lose significant perceptual enjoyment of food***
- *Why hold your nose..?*

Chemical senses

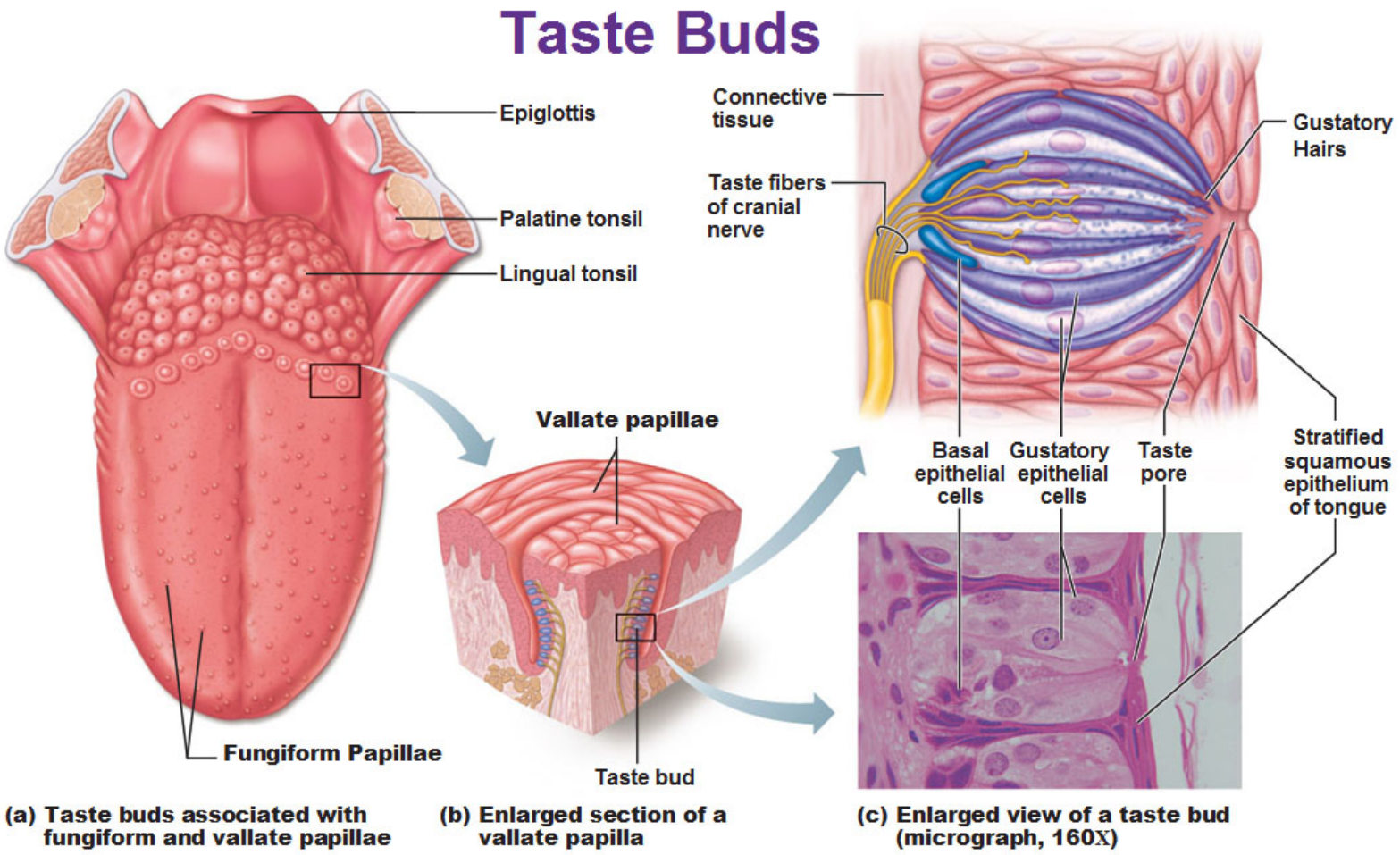
- Project **ipsilaterally** (no “crossing over”)
- Primary cortical areas are **limbic** (or paralimbic) - also true of pain, temperature, itch, sensual/massage touch sensations…





Gustatory system

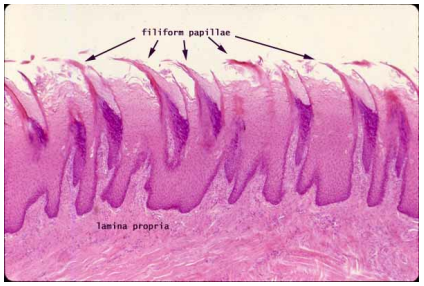
Begins with **taste receptor cells**, found in **taste buds**, in **papillae**…



Four types of papillae

1. Filiform
2. Fungiform
3. Foliate
4. Circumvallate

1.



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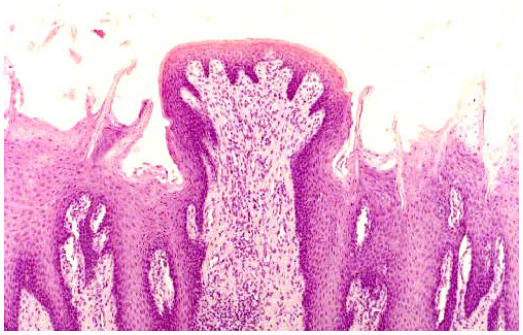
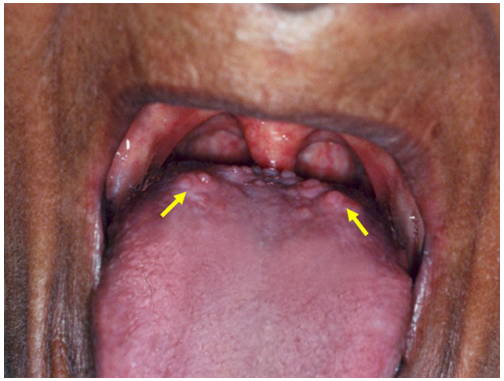


3.

4.

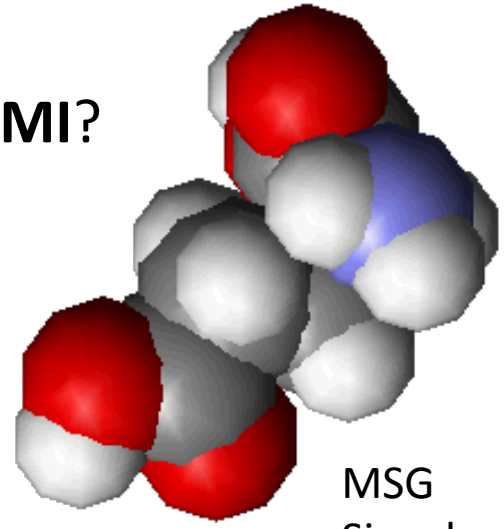


Four basic tastes – or five?

- Much of the complexity of taste comes from smell…
- Taste responses are simpler, and more stereotyped.

SWEET: Desirable
Only a few receptor types
VERY specific (hard to trick)
SALTY: Desirable
BITTER: Not desirable
Receptors bind MANY chemicals
Identifies dangerous substances
SOUR: Mixed
More H+ ions (acids)
Do you like pickles..?

UMAMI?

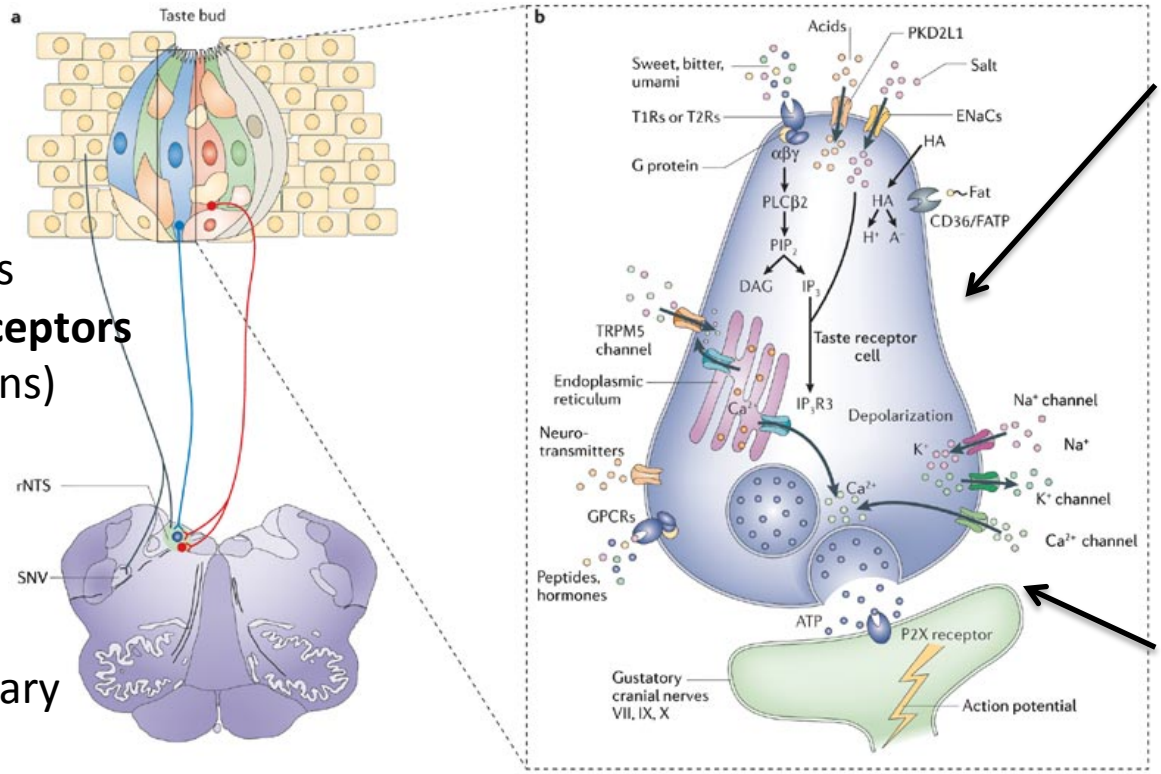


MSG
Signals protein?

Receptors in rat papillae
But mostly found in gut!

Taste receptor mechanisms

Taste receptors (cells) in taste buds express special **receptors** (membrane proteins) that bind **tastants**



Both **ionotropic** (mostly for salty, sour) and **metabotropic** (primarily sweet, bitter) responses. Rapid depolarization or hyperpolarization, and/or release of G-proteins…

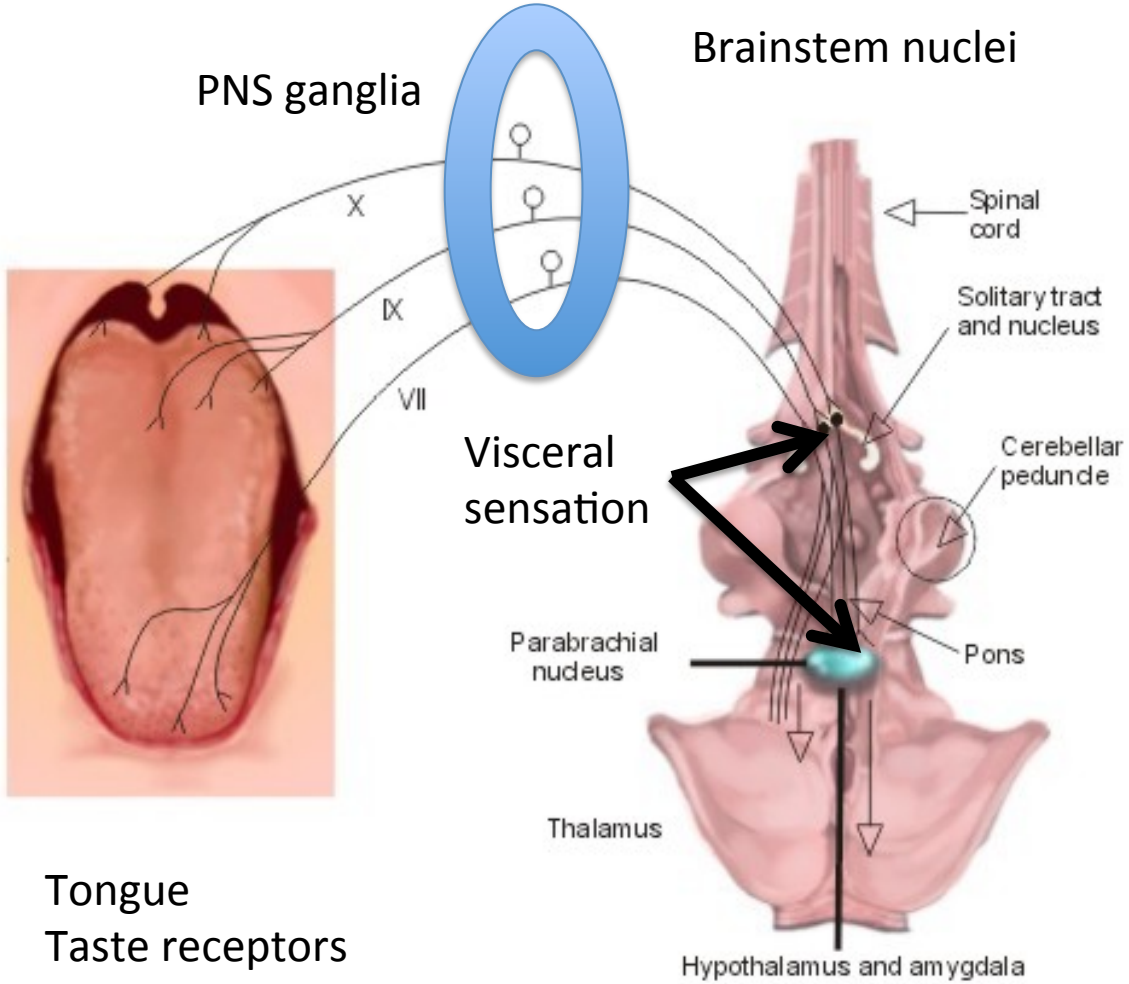
Gustatory pathways

Three cranial nerves

1. Facial (VII): anterior 2/3s of tongue
2. Glossopharyngeal (IX): posterior 1/3
3. Vagus (X): epiglottis

Brainstem nuclei

1. Solitary: integration with visceral inputs
2. Parabrachial: conditioned taste aversion (Reilly S, 1999)

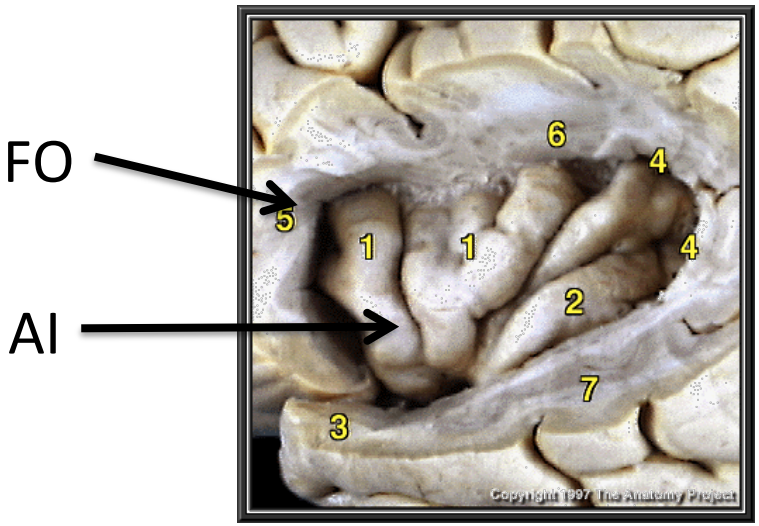


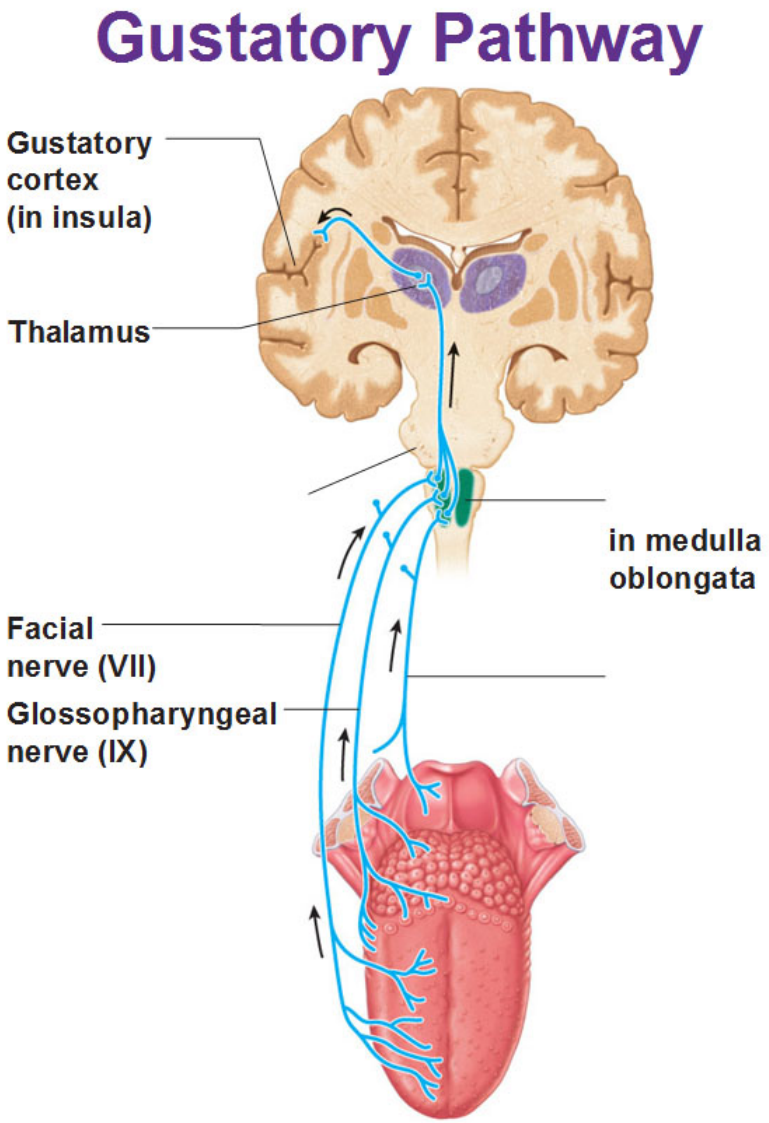
Tongue
Taste receptors
Cranial nerves VII, IX, X

Gustatory pathways (cont)…

Thalamic nucleus (VPM) processes gustatory input before arrival in **primary gustatory <u>cortices</u>**:

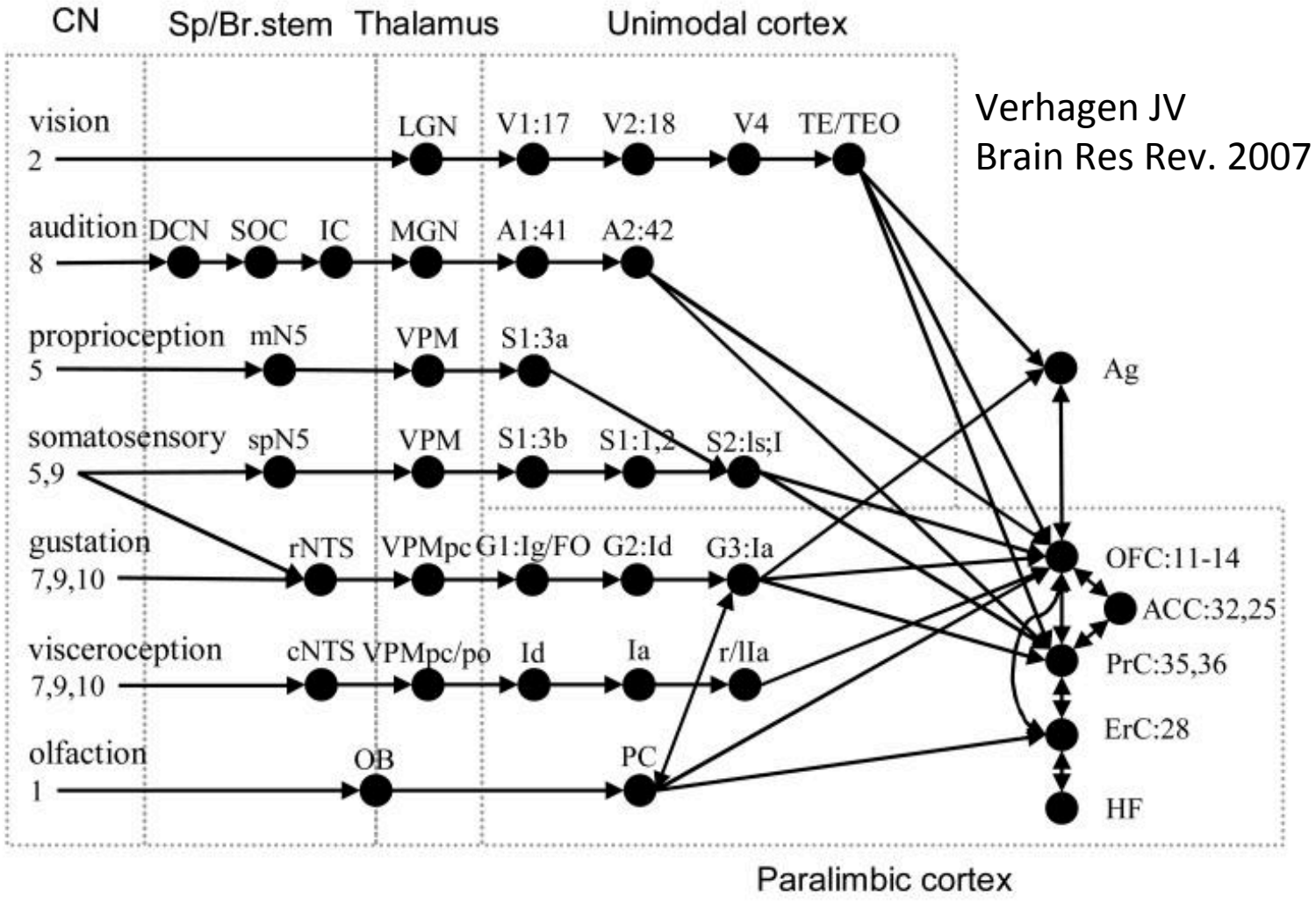
1. **Anterior Insula** (AI)
2. **Frontal operculum** (FO)





Perception of flavor…

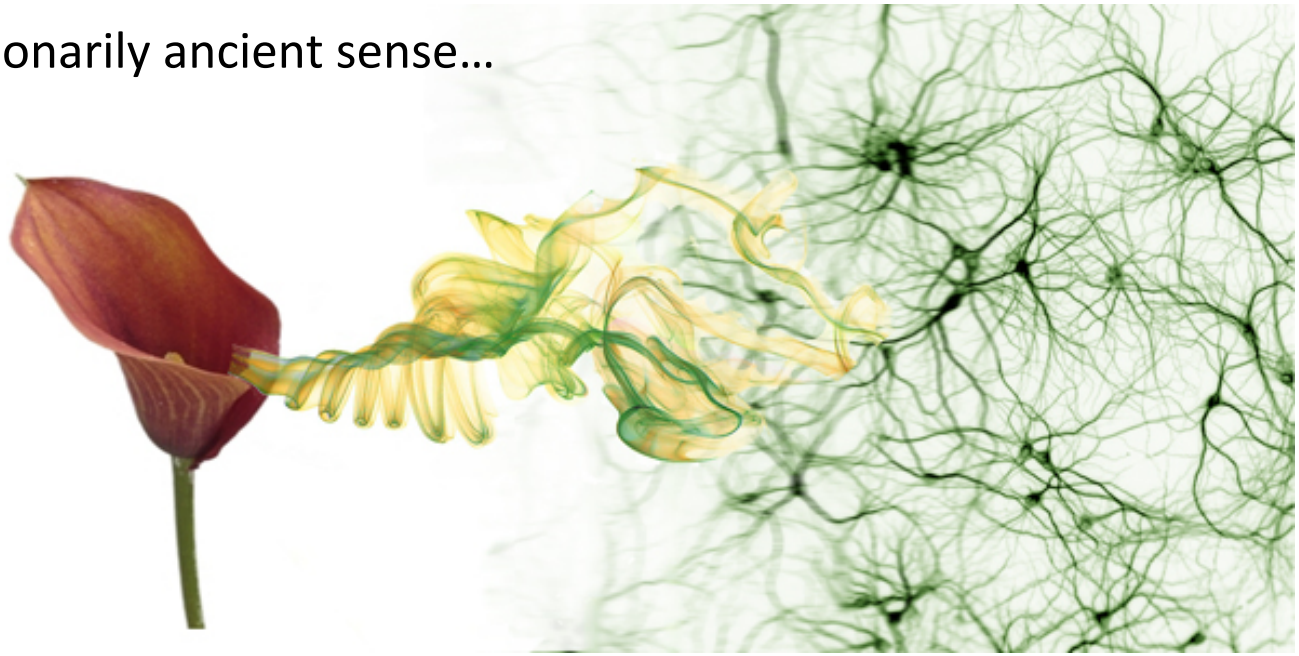
- **So much more than taste!**



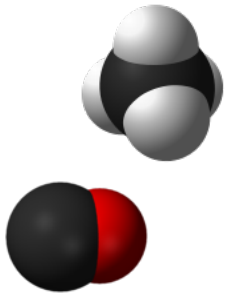
Verhagen JV
Brain Res Rev. 2007

Olfaction

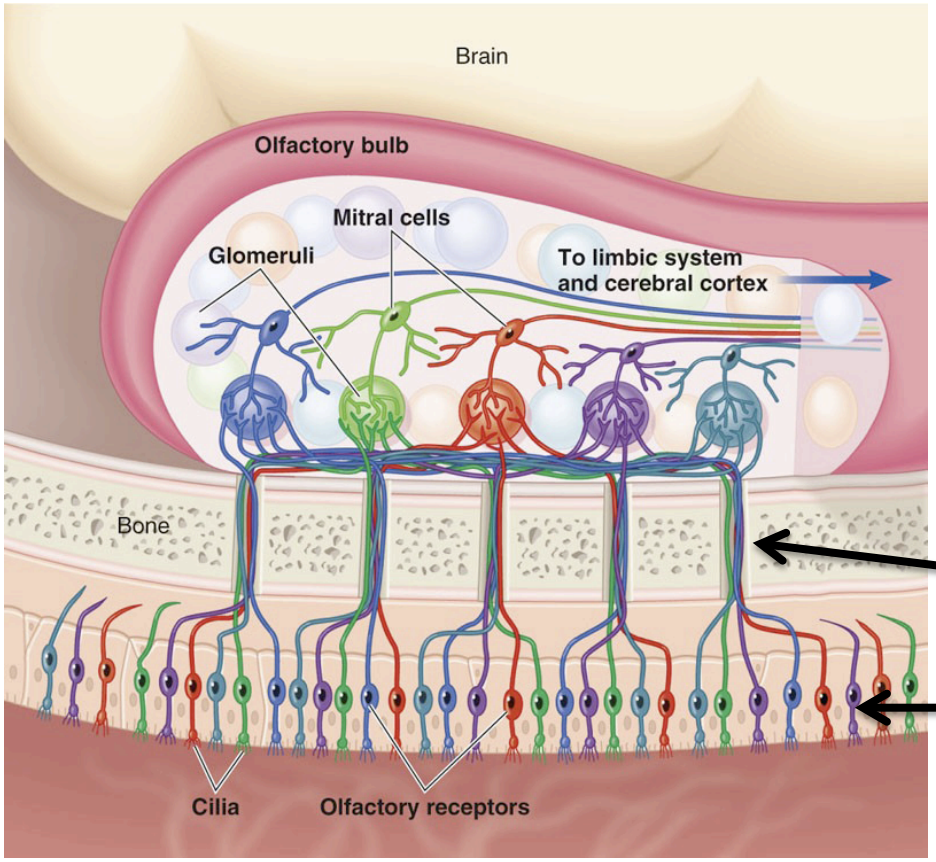
An evolutionarily ancient sense…



- Olfactory perceptions are called **odors**
- Result from detection of **odorants**
  - Volatile, small, hydrophobic chemicals
  - Not all chemicals detected (e.g., CO, CH_4)



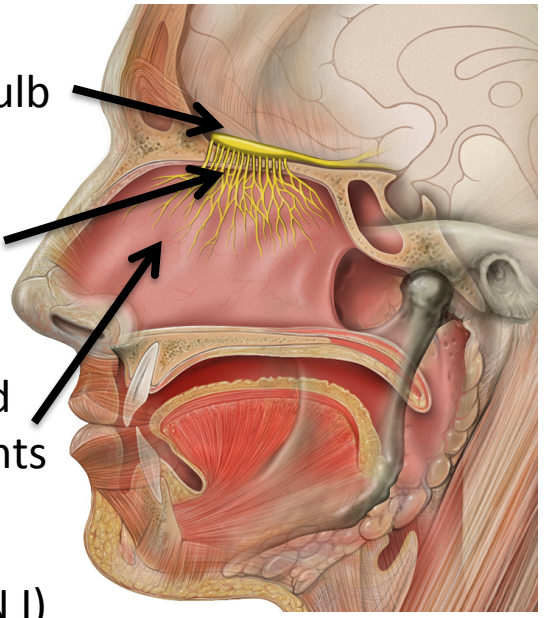
“The retina of the nose”



Olfactory bulb

Olfactory epithelium

Air and odorants

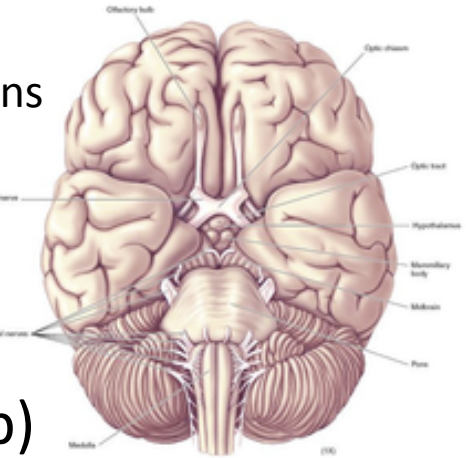


Olfactory nerve (CN I)

Olfactory sensory neurons

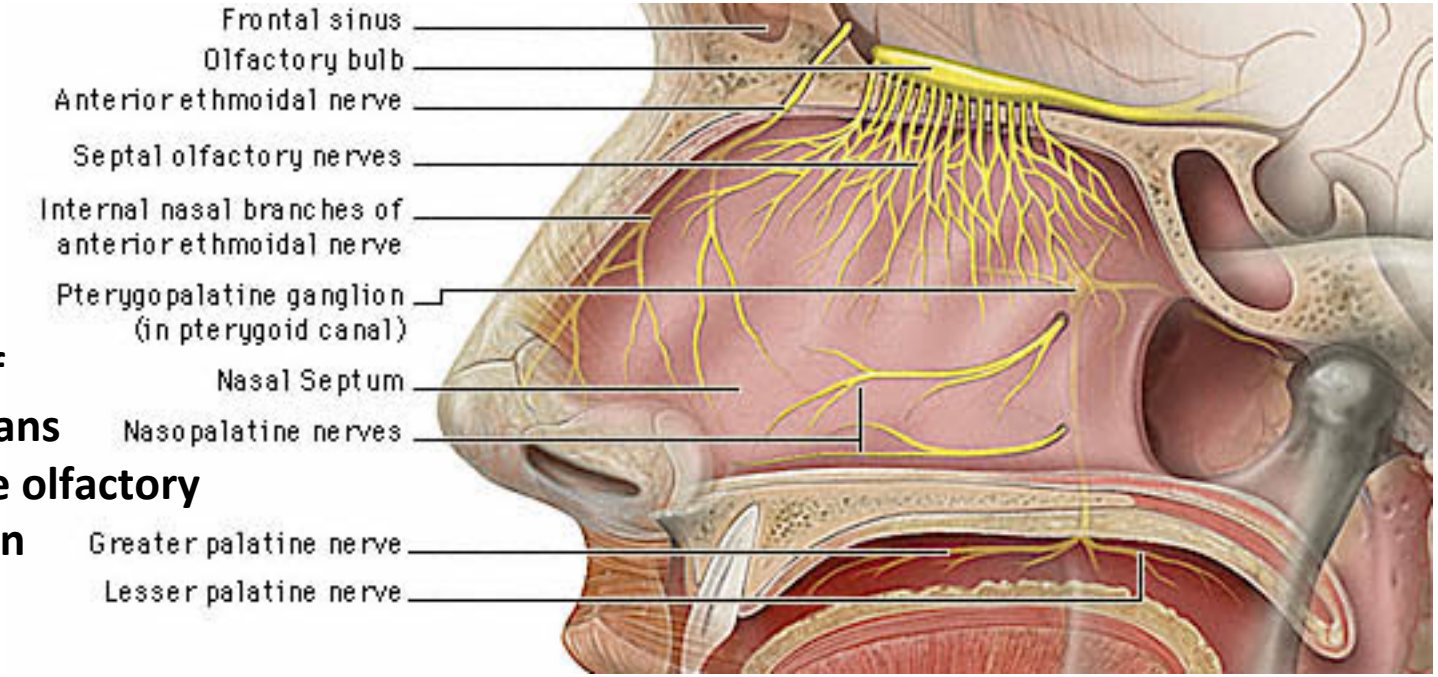
Basal cells

Support cells



Olfactory sensory neurons – Olfactory bulb (CN I)
(glomeruli: link up similar sensory neurons in bulb)

Risk of anosmia



One out of 20 Americans experience olfactory dysfunction

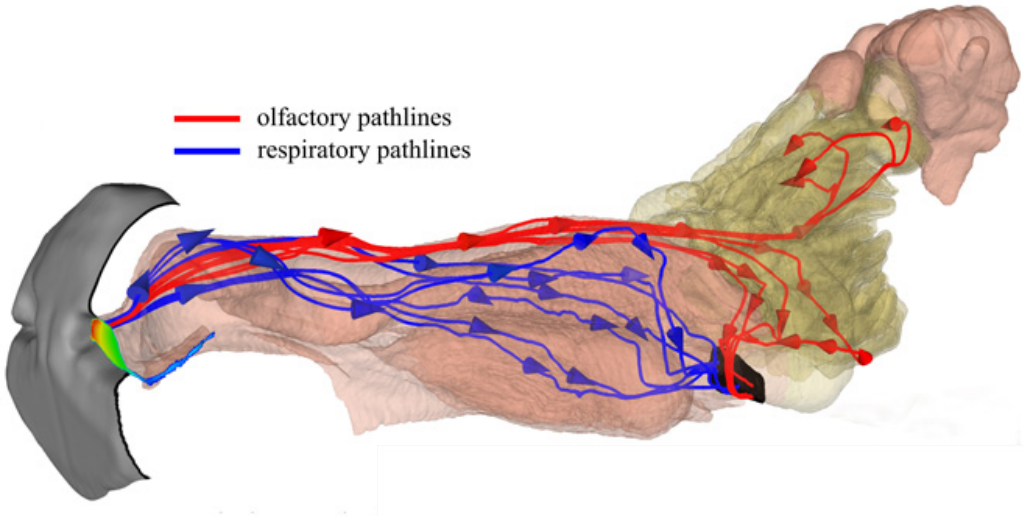
- From upper respiratory infection, sinonasal disease (e.g., polyps), head trauma…
- Loss of smell (no taste, link to depression)

Comparative detection ability

Dogs sense of smell
10,000 to 100,000 times
as acute as ours…

Up to 300 million olfactory
neurons (no more than 20
million in humans)

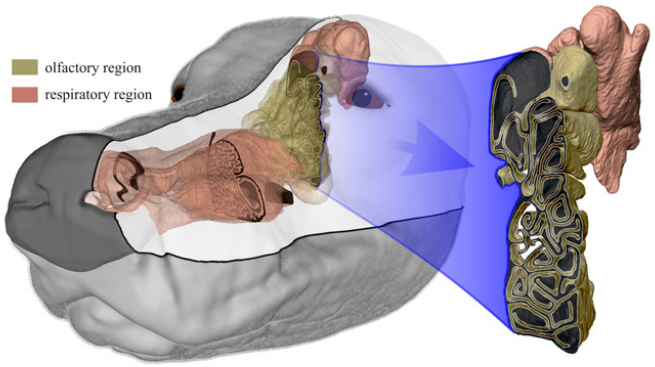
Brain areas 40 times larger



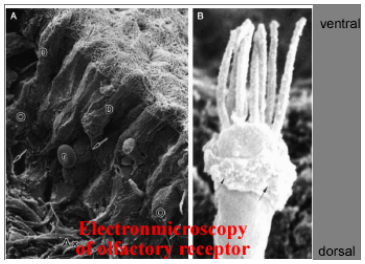
Flehmen response

Vomeronasal organ
(Jacobsen's organ)

Separate olfactory system
For pheromones: to amygdala,
Hypothalamus (medial preoptic area)



Olfactory tracts



- Five ventral brain targets…

1. Olfactory tubercle

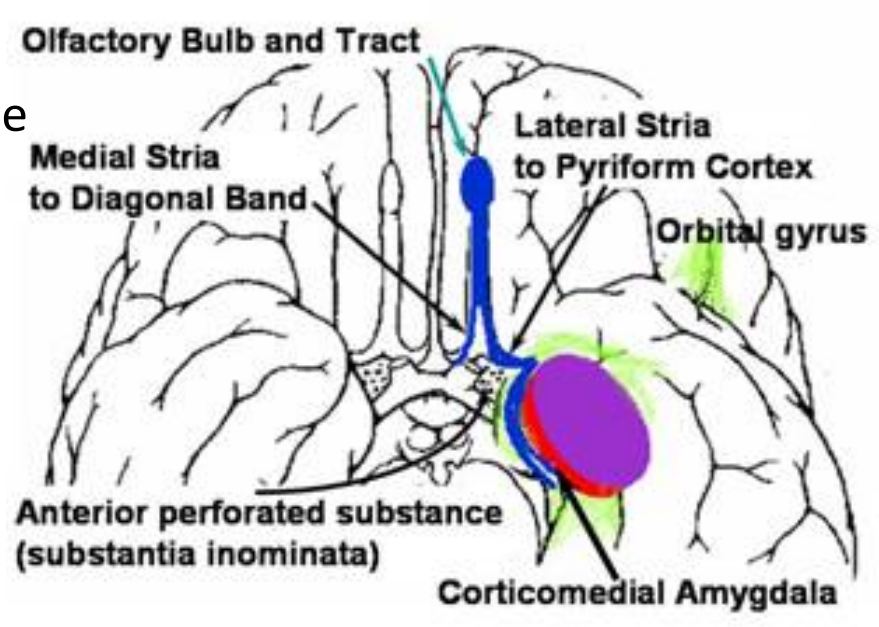
- Anterior perforated substance
- Part of basal forebrain

2. Amygdala

- Emotional response

3. Anterior olfactory nucleus

- Just behind olfactory bulb



4. Piriform and periamygdaloid cortex

- Projects to thalamus, then to orbitofrontal cortex (taste integration)

5. Rostral entorhinal cortex

- Lots of projections to and from hippocampus; Memory