Chemical Senses:
Taste and Smell

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Office Hours with Dr. McLoon

Monday (Oct 22)
12:00-1:00pm and 2:30-3:30pm

Jackson Hall 4-158

Course News

Review Session

Tuesday (Oct 23)
4:00-5:00pm

in MCB 3-146B (the main lab room)

with Dr. Riedl

Course News

Midterm Exam Wednesday (Oct 24)

The exam will cover lectures 12-20 and labs 3-5.

A –L last names in MoosT 2-650
M – Z in MoosT 2-620

An extra hour will be available for those who need it.

PLEASE BRING #2 PENCILS!!!

Be sure to check out last year's exam on the course website!!!

Olfaction

- The sense of smell or olfaction is the most important component of taste and is a major determinant of what we like and do not like to eat.

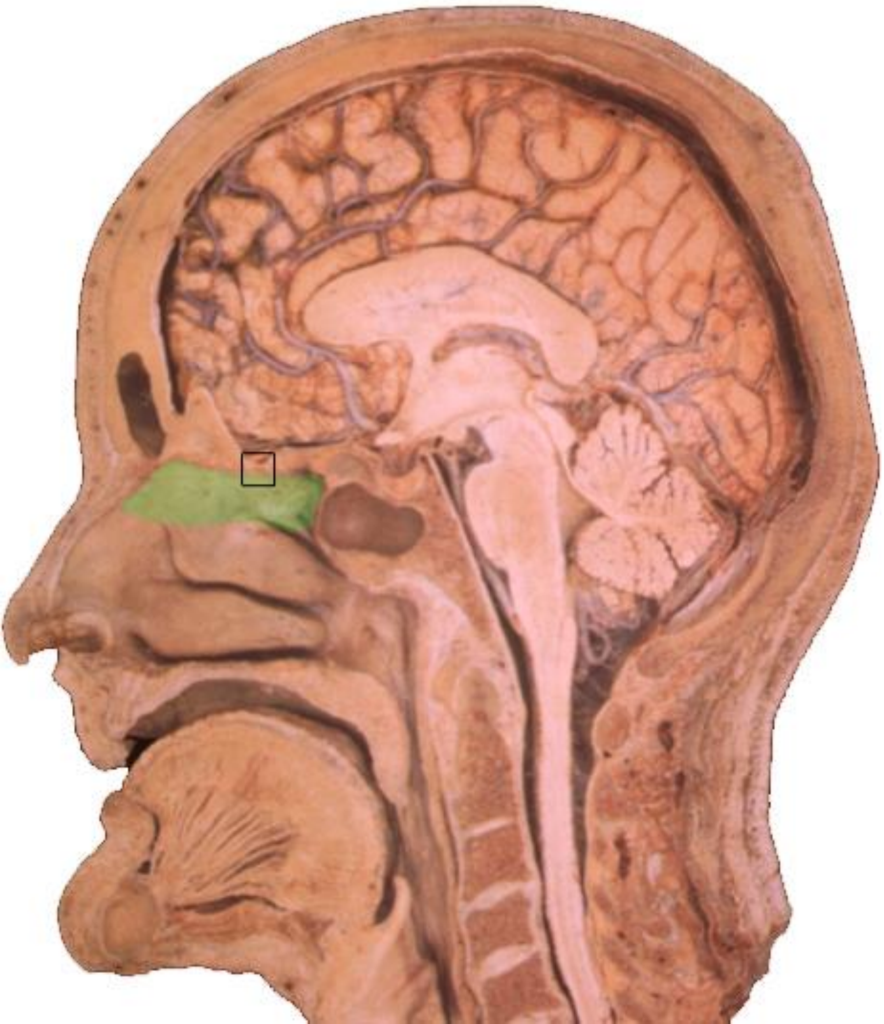
- Certain smells can initiate physiological responses in preparation for eating, including salivation.

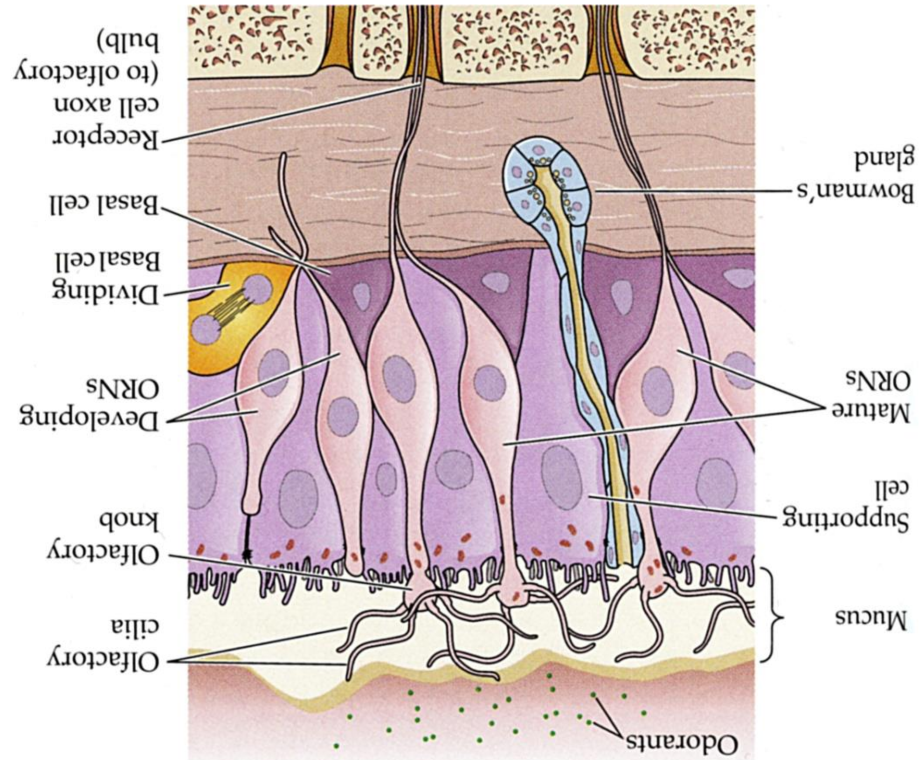
- Certain smells can initiate sexual attraction (and repulsion).

- The sense of smell also can be a safety mechanism.

Olfaction

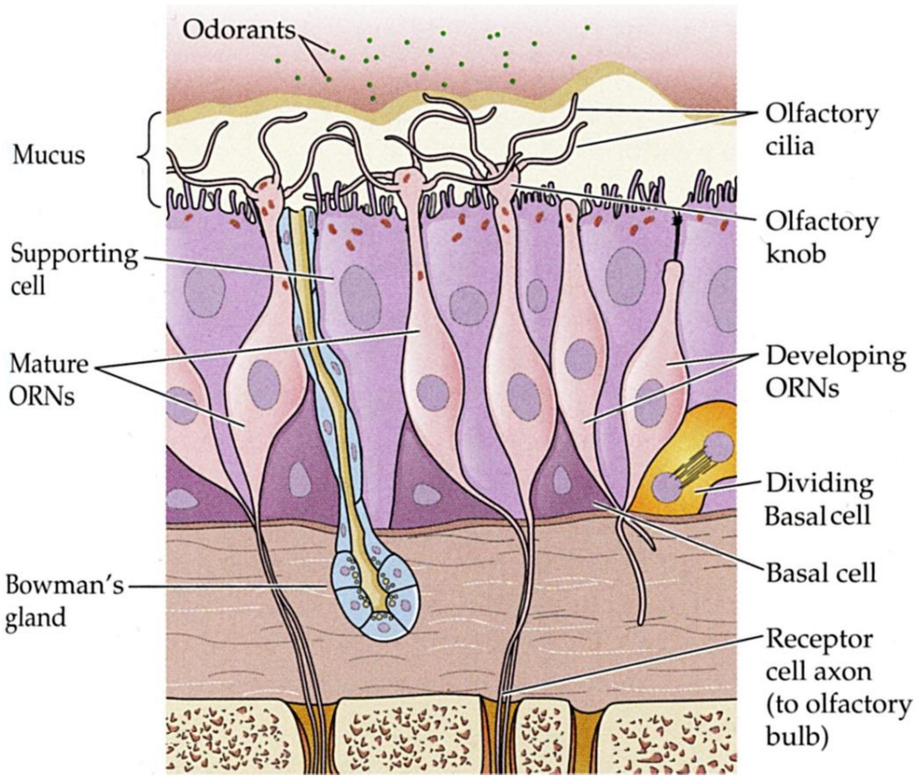
- Olfactory receptor neurons are in the lining of the nasal cavity.





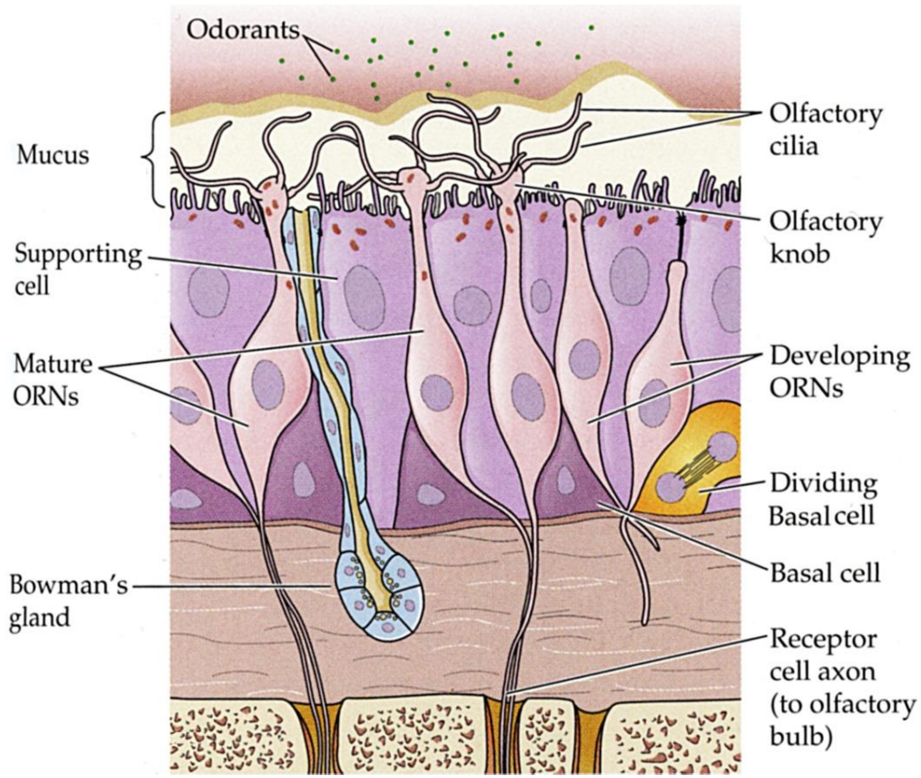
Olfaction

- The receptor neurons have cilia in the mucus.
- The odorant receptor proteins are in the membrane of the cilia.
- Each receptor neuron has only one type of odorant receptor.
- Humans have 339 different odorant receptor types.
- Each receptor neuron has an axon that enters the brain.



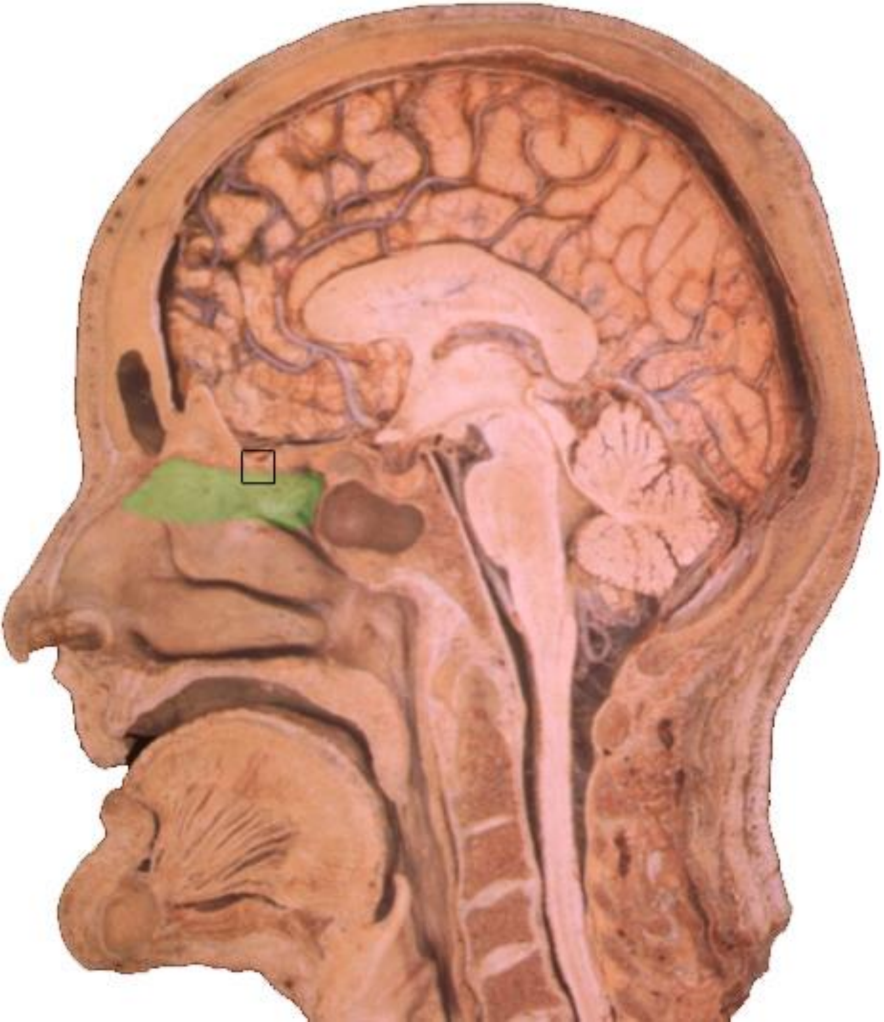
Olfaction

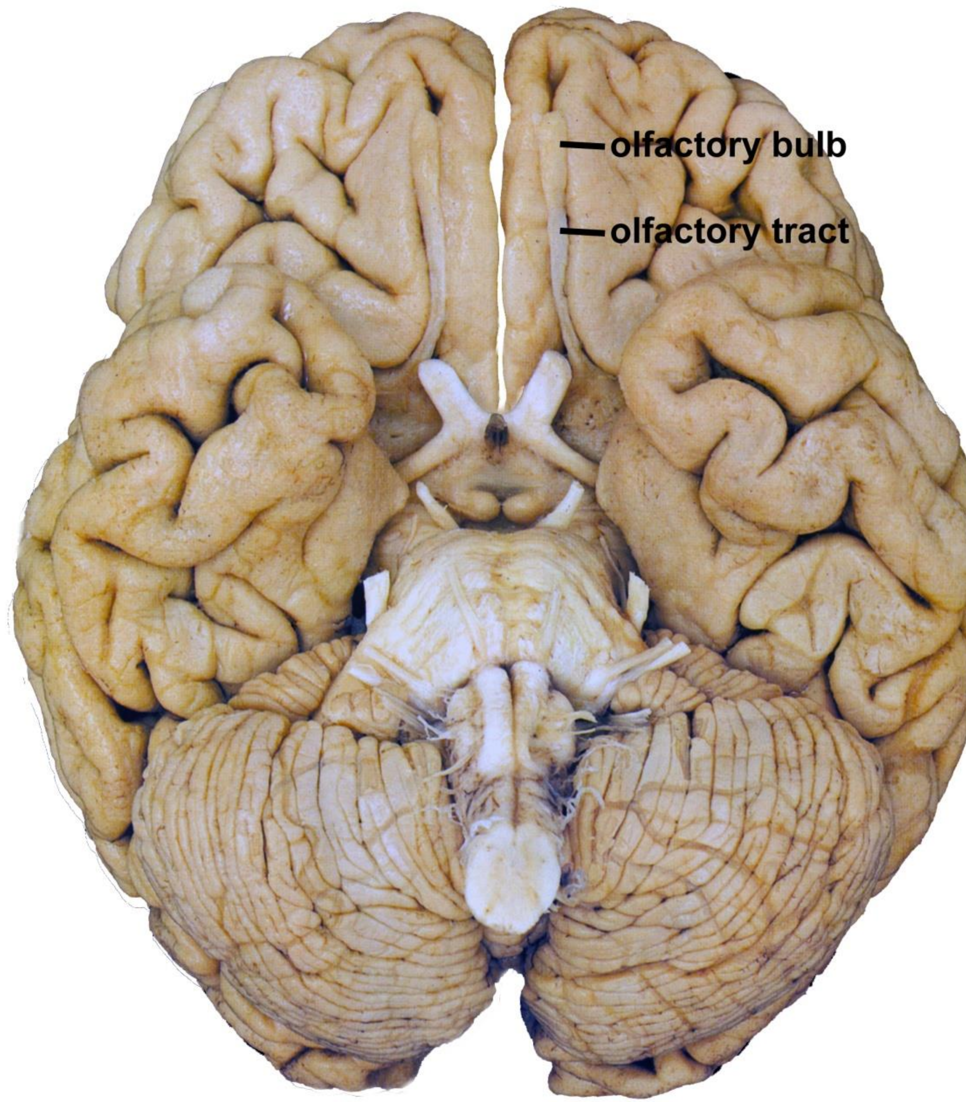
- The receptor neurons continually die and are replaced by division of basal cells.
- New receptor neurons grow axons into the brain and function.
- This is one of the few neuron populations that regenerate throughout life.



Olfaction

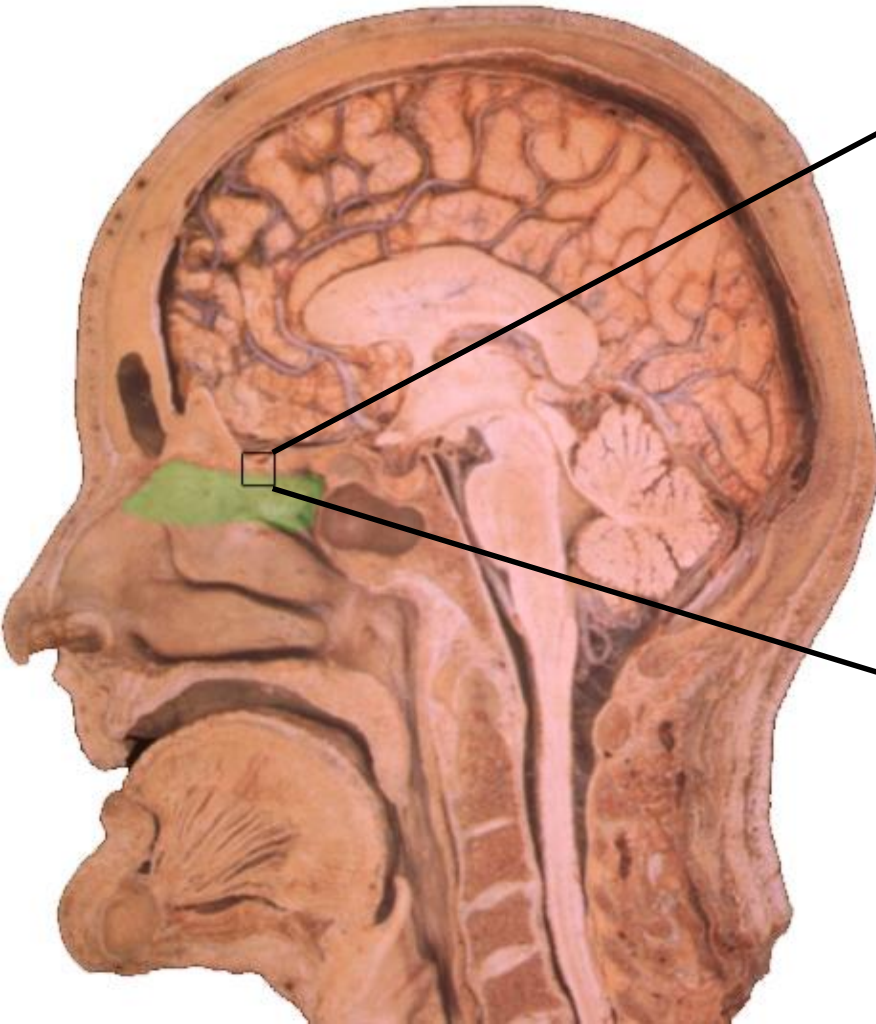
- Axons of the olfactory receptor neurons synapse in the olfactory bulb on the base of the forebrain.

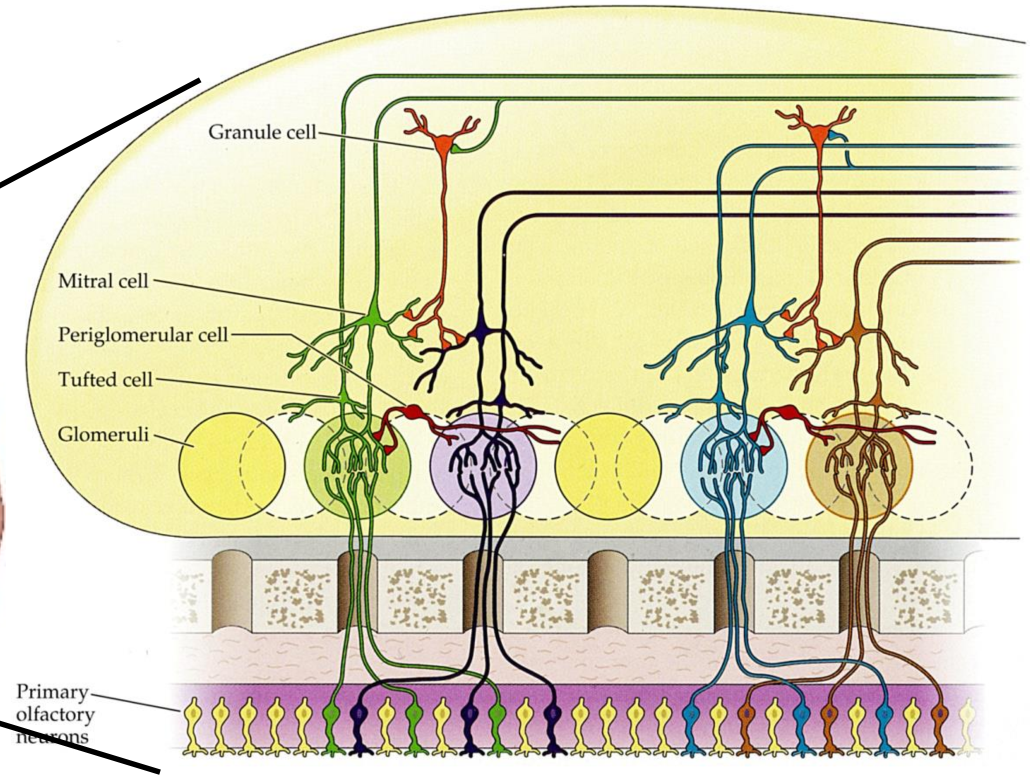




Olfaction

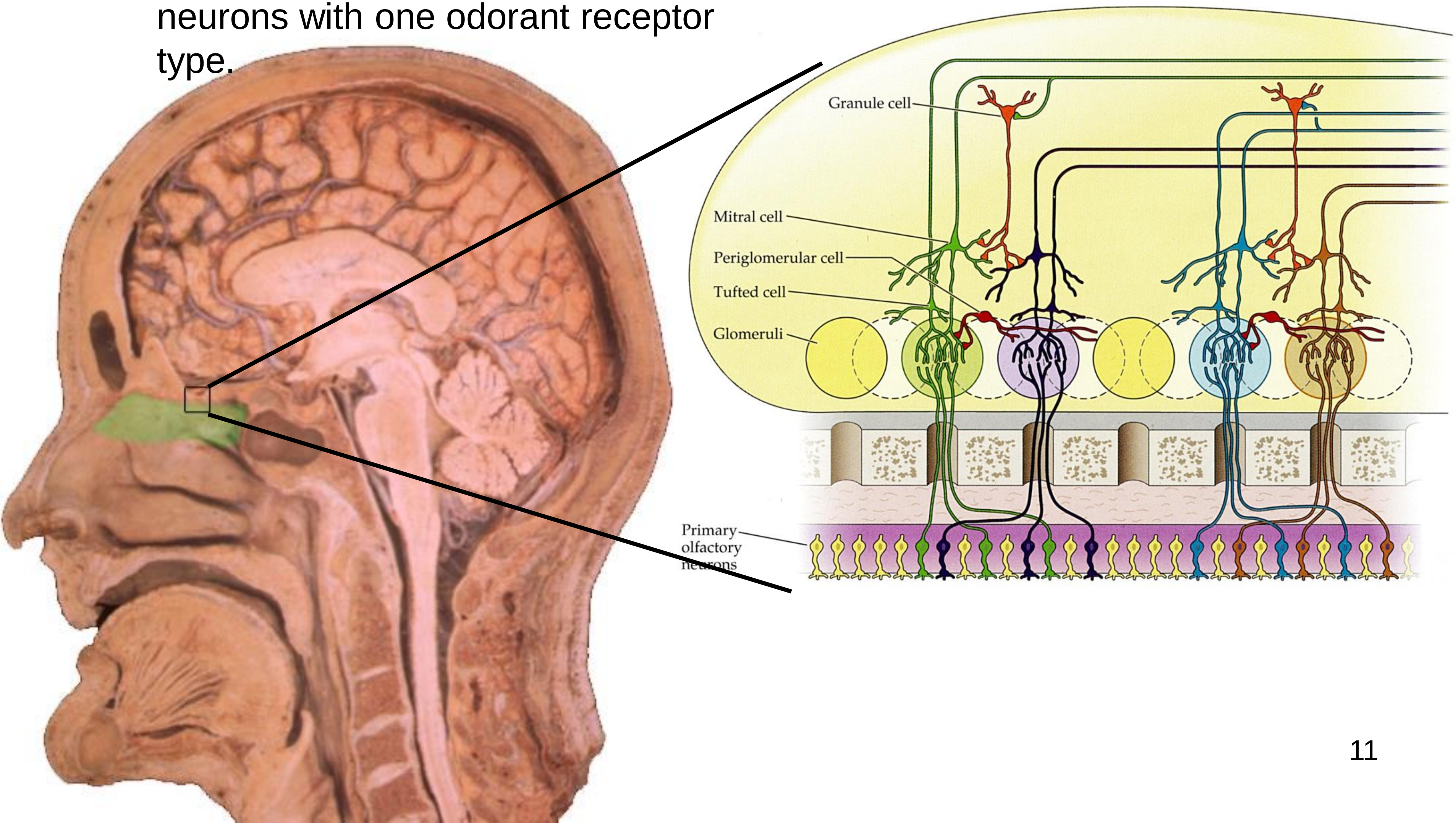
- Olfactory axons pass through the bone into the cranium in multiple fascicles, cranial nerve I (CN I).





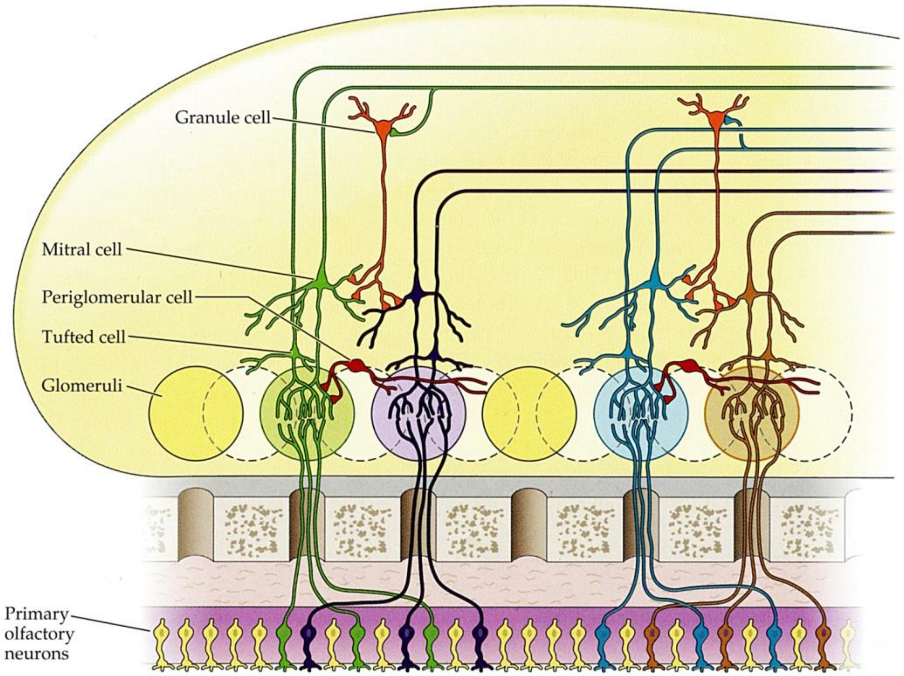
Olfaction

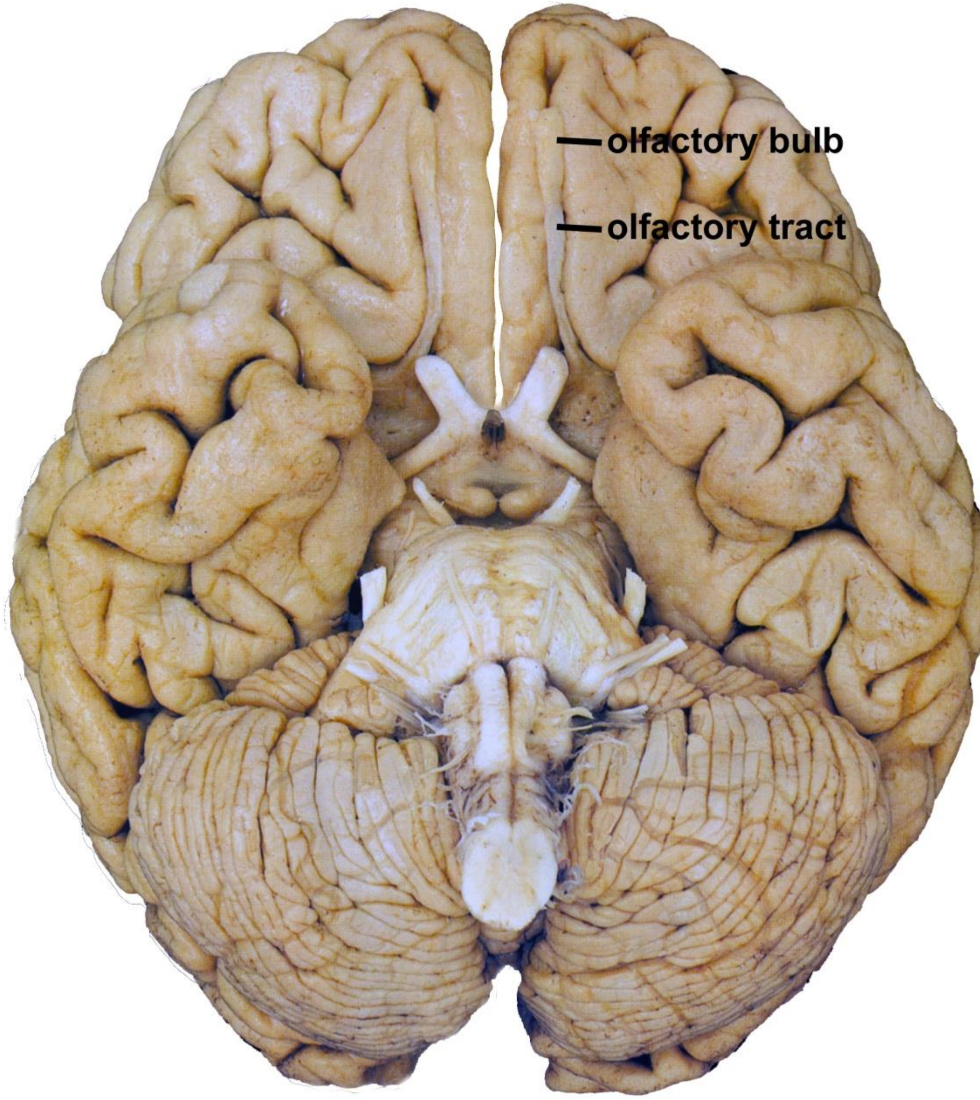
- Axons synapse in glomeruli. Each glomerulus receives input from neurons with one odorant receptor type.



Olfaction

- Olfactory bulb neurons send axons via the olfactory tract and synapse in olfactory areas of the cortex.



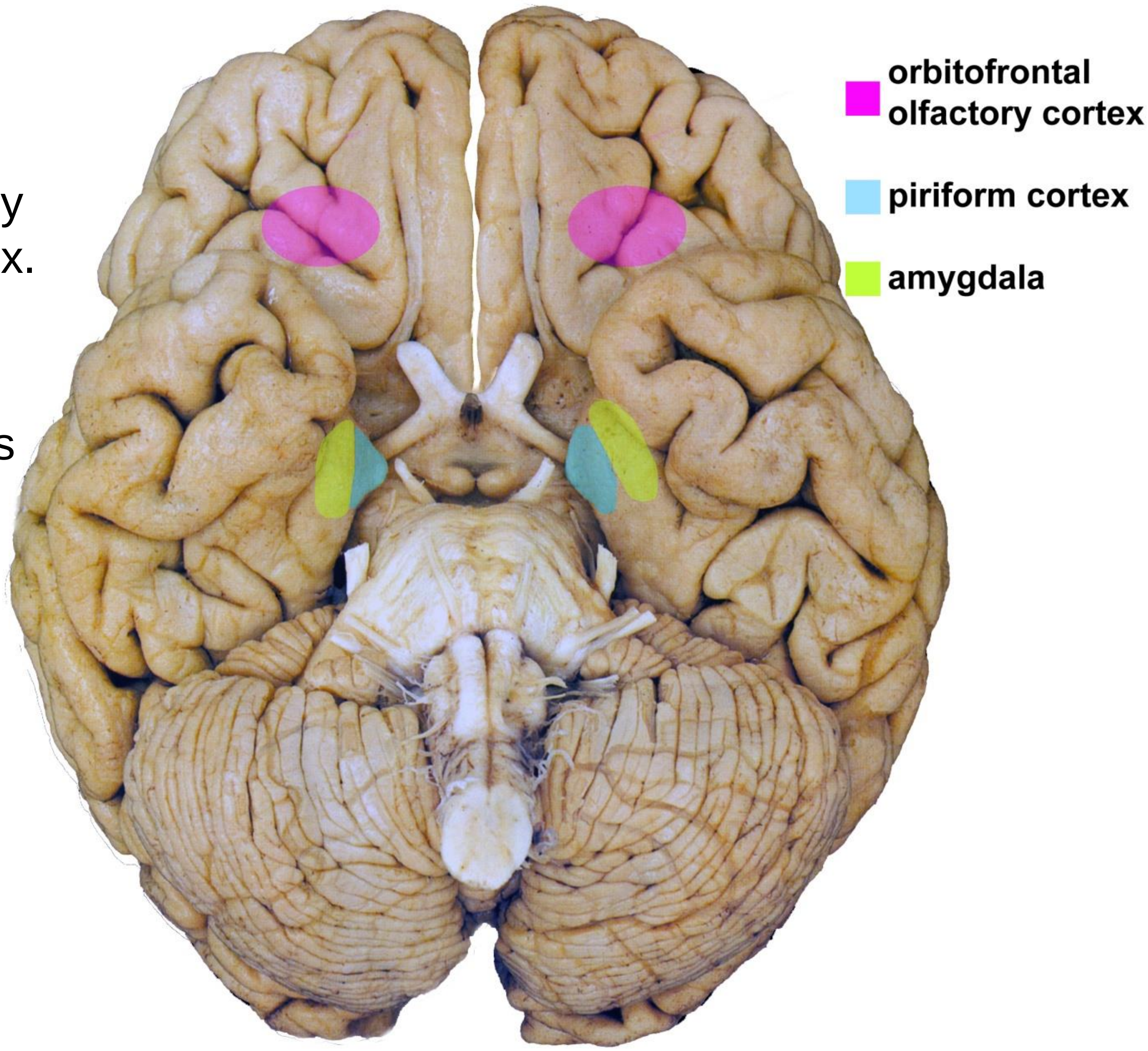


Olfaction

- Olfactory input to primary olfactory cortex does <u>not</u> go via the thalamus.

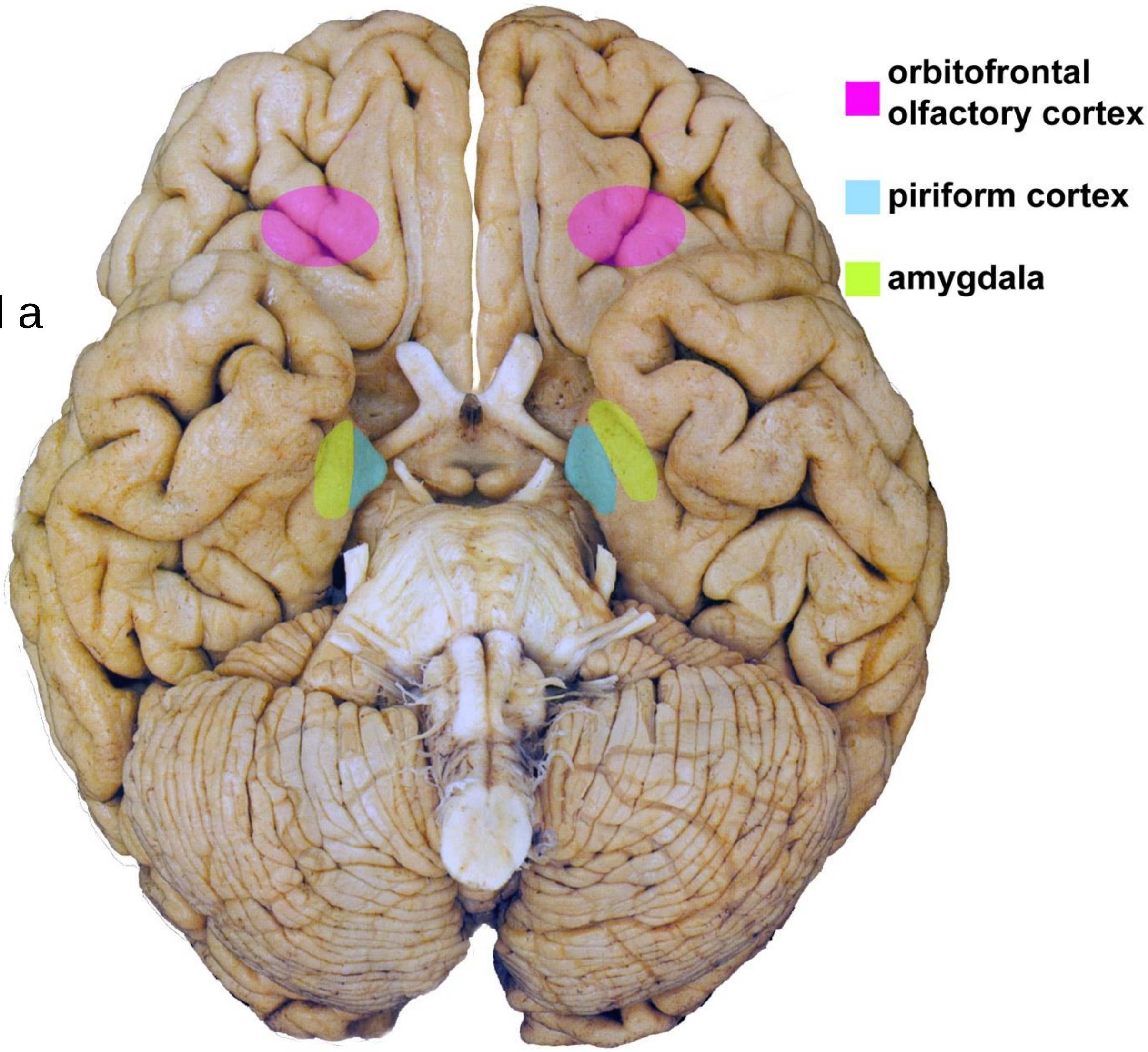
- The projection of the olfactory bulb is to the ipsilateral cortex.

- Primary olfactory cortex is allocortex, not neocortex. It is evolutionarily old cortex.



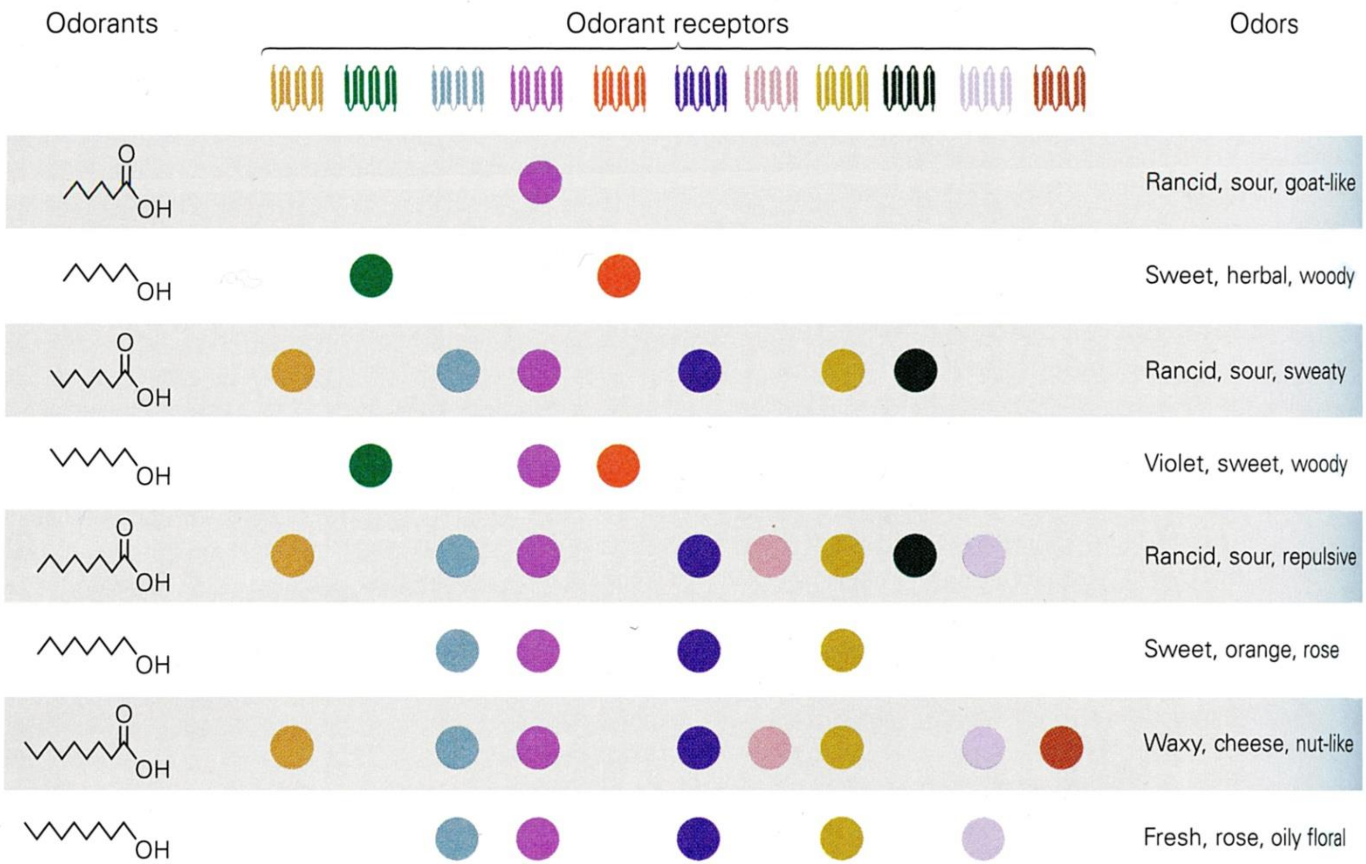
Olfaction

- Several forebrain areas receive axons from olfactory bulb including piriform cortex and amygdala.
- Amygdala connects with hypothalamus, thalamus and a number of limbic areas.
- Piriform cortex connects with orbitofrontal cortex.



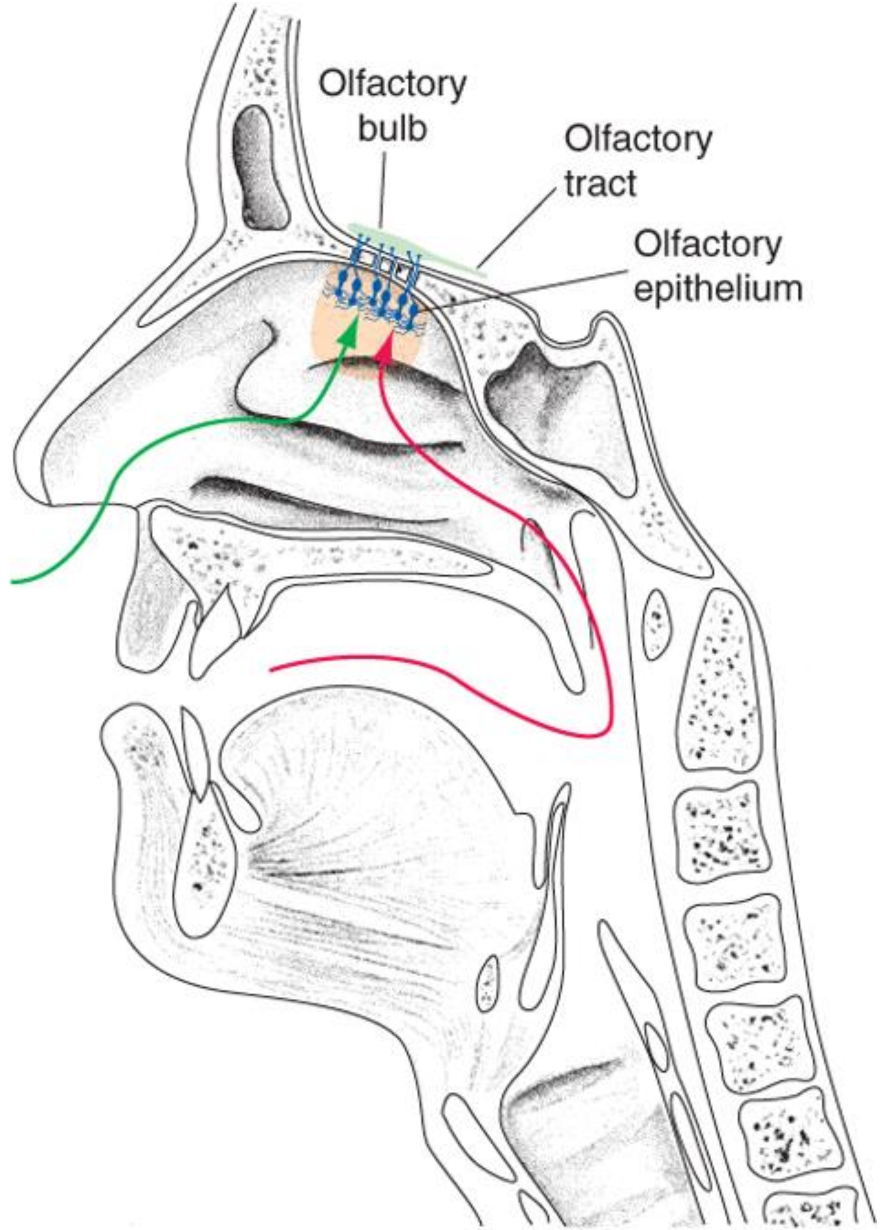
Olfaction

- How do we smell so many odors with only 339 different types of receptors?



Olfaction

How do we smell what we eat?



Olfaction

The sensitivity to smells varies considerably from person to person:

- The sensitivity to a specific odorant can vary as much as a 1000x among people.

- Many individuals are unable to detect specific odorants. (e.g. 12% of the population cannot smell musk.)

Olfaction

Anosmia is a complete lack of the sense of smell:

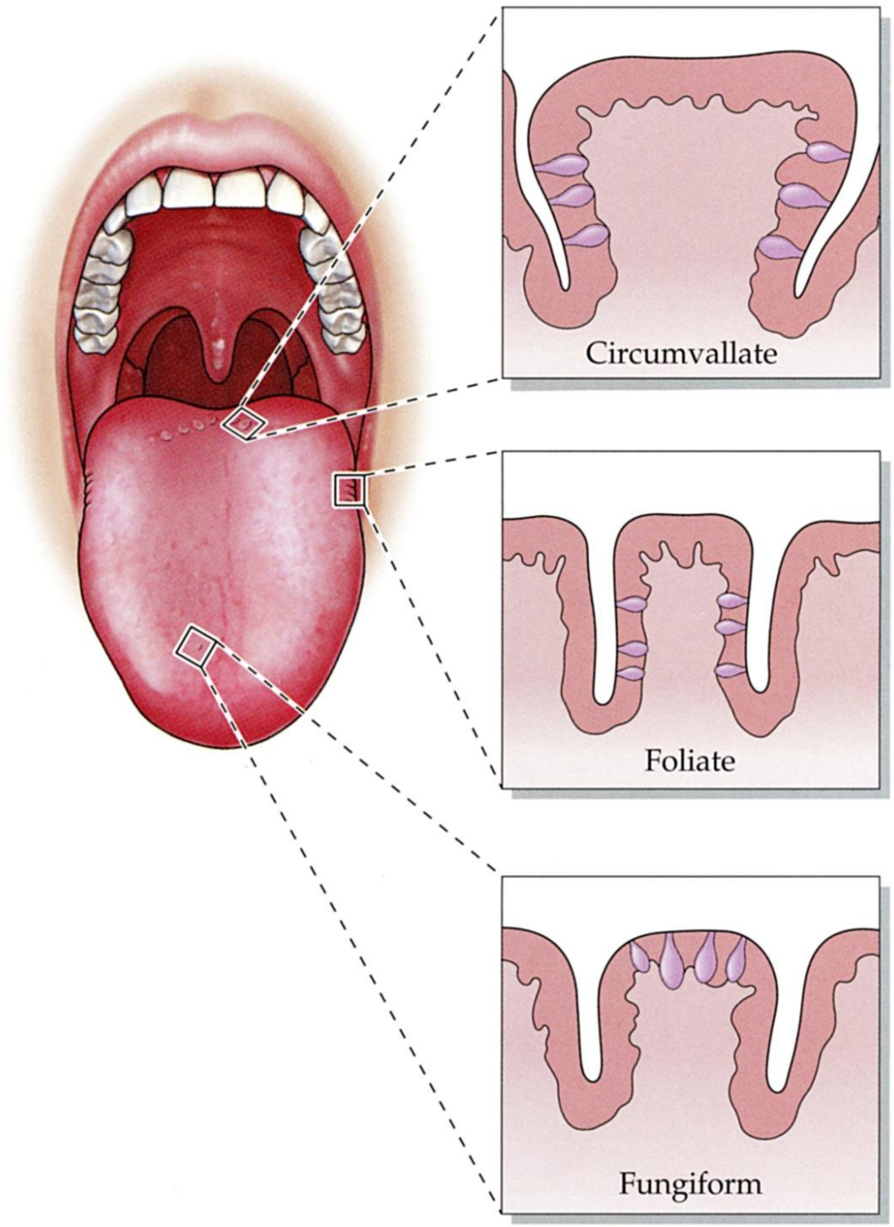
- Congenital anosmia typically has a genetic basis.
- Blocked nasal passages due to inflammation of the nasal epithelium can cause temporary anosmia.
- Head trauma can tear the olfactory receptor axons, which results in anosmia.
- Meningitis can result in temporary or permanent anosmia.
- Anosmia can be an early sign of Alzheimer’s disease.
- Zinc gluconate, sold as a nasal spray under several names by the (unregulated) dietary supplement and homeopathic industry to prevent colds, causes permanent anosmia.

Taste

Taste buds are on papillae of the tongue and pharynx:

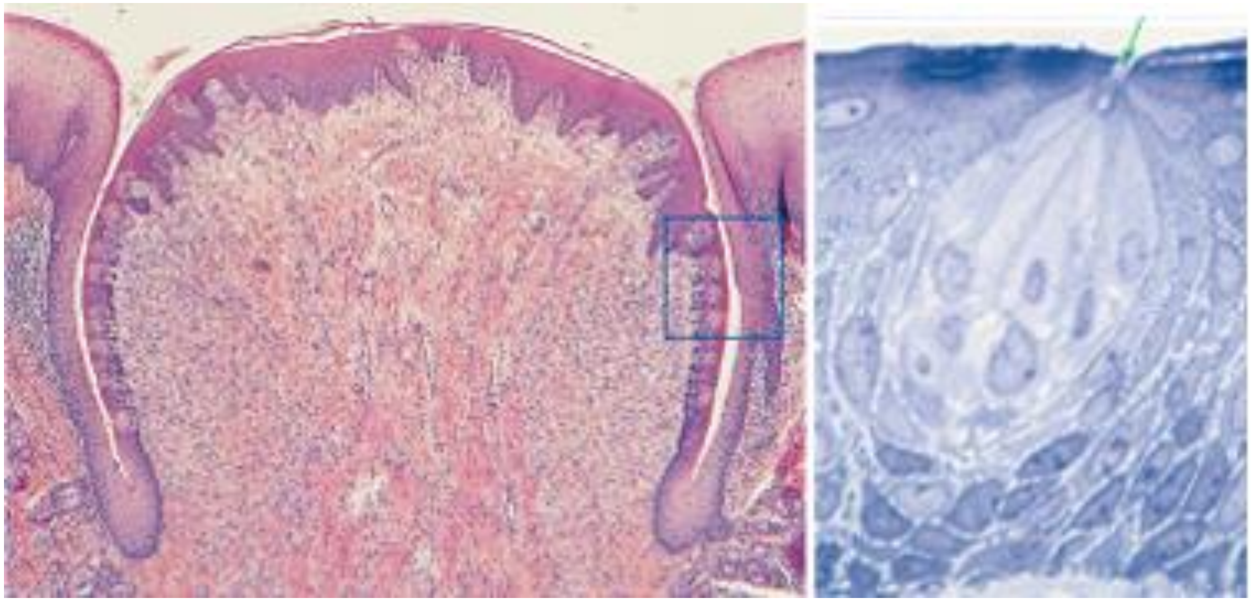
- Circumvallate papillae – largest in a V-shaped pattern at the back of the tongue
- Foliate papillae – in folds on the side of the tongue
- Fungiform papillae – broadly distributed across front of tongue

(you can see the papillae in the mirror)



Taste

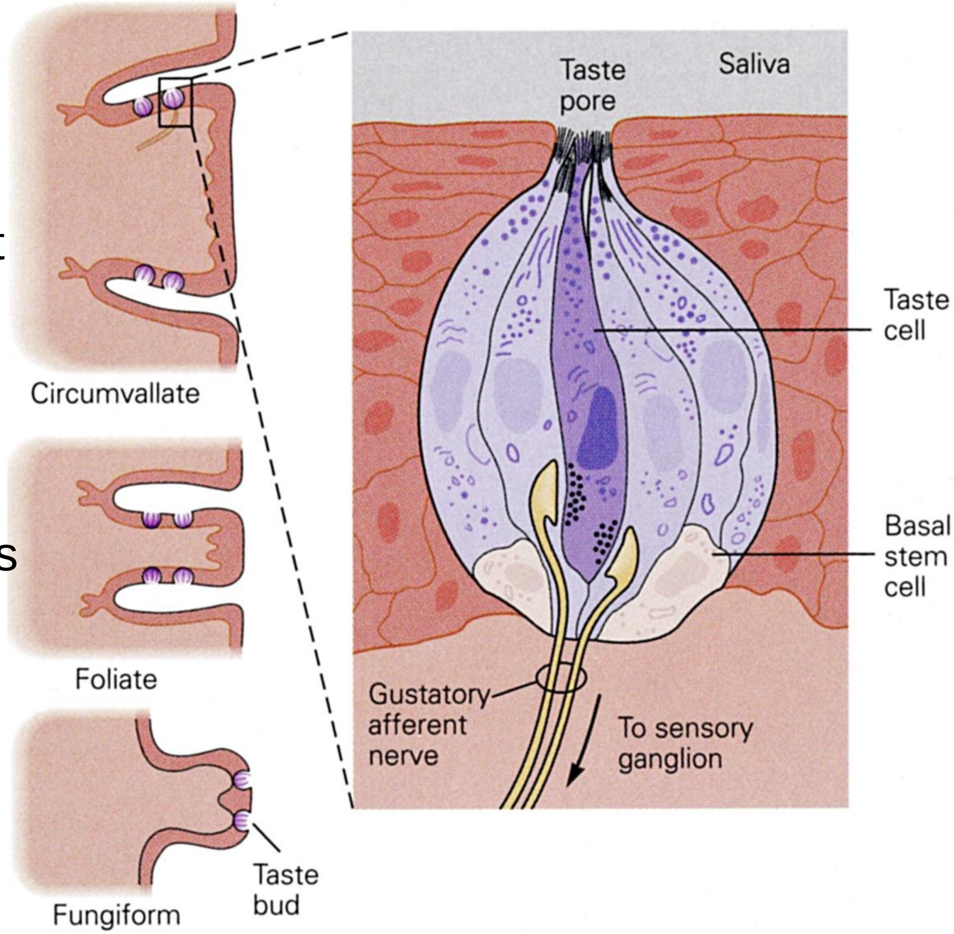
- Taste buds are in the folds on the sides of the papillae.



Taste

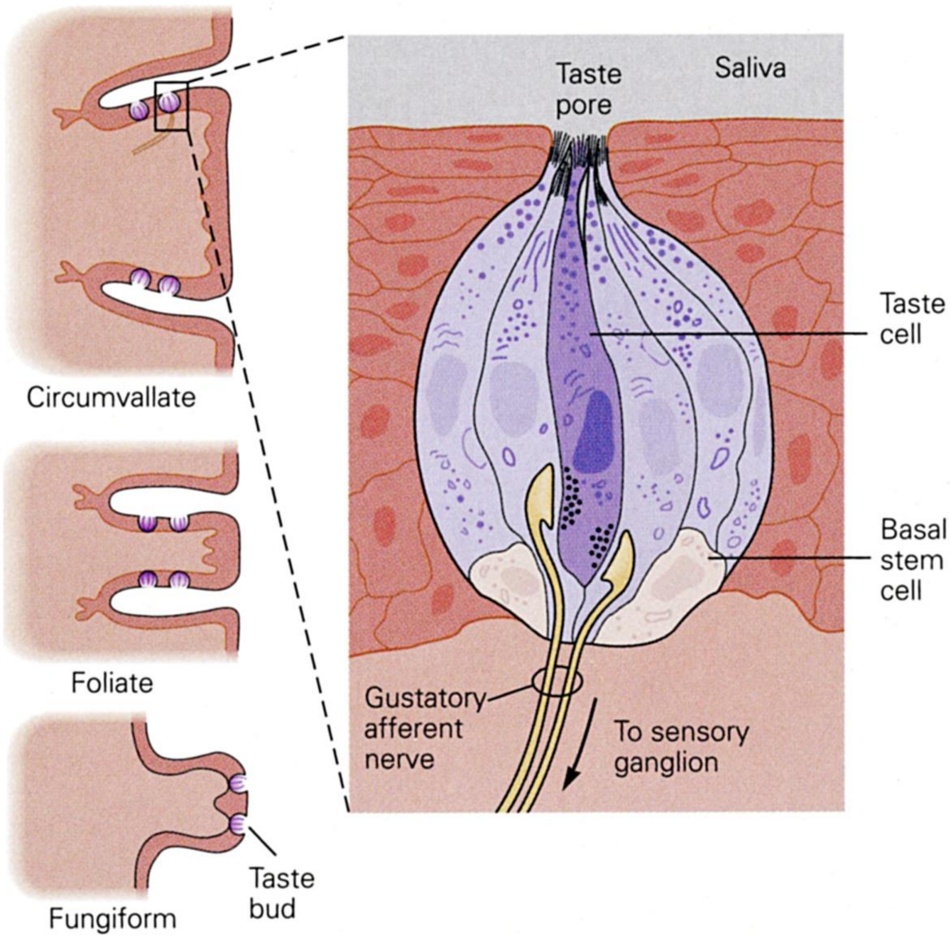
Taste receptor cells in taste buds:

- non-neuronal cells
- detect chemicals on the tongue that reach the receptor cells via taste pores
- communicate with sensory neurons via a chemical synapse; use ATP as the transmitter



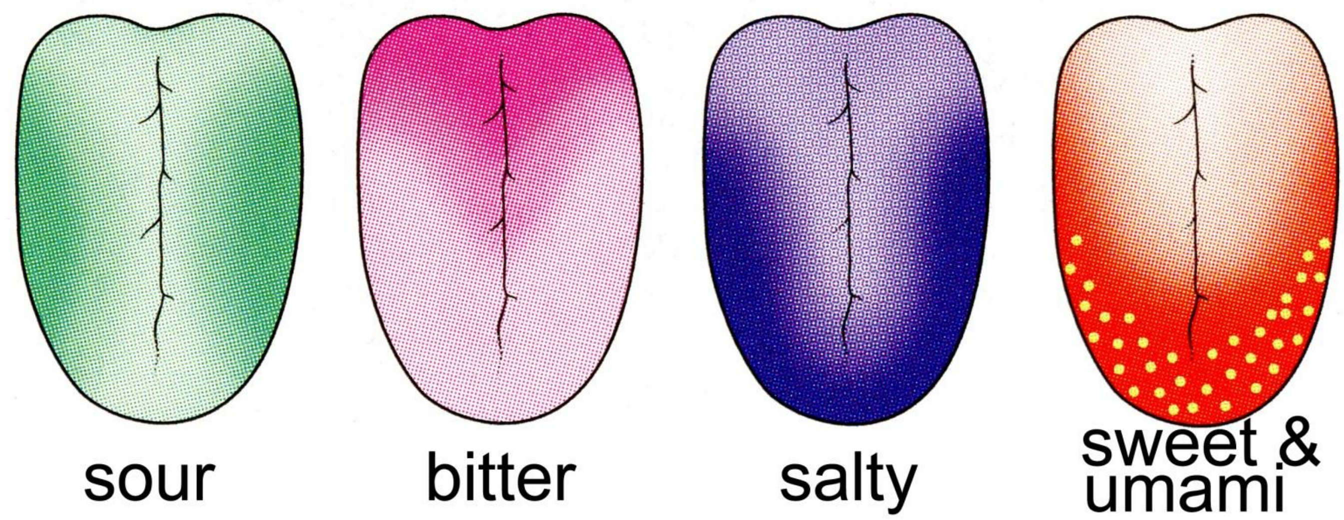
Taste

- Taste receptor cells live approximately two weeks.
- Receptor cells are continually replaced by division of basal cells in the taste bud.



Taste

- Taste receptors are sensitive to one of five tastes:
  - Sour (rotting food)
  - Bitter (poisonous plants)
  - Salt (electrolytes)
  - Sweet (high calories)
  - Umami (amino acids or protein)



Taste

- Monosodium glutamate (MSG) is a salt form of glutamate and is a strong activator of the umami taste receptor.
- MSG is commonly used as a flavor enhancer in cooking.

Taste

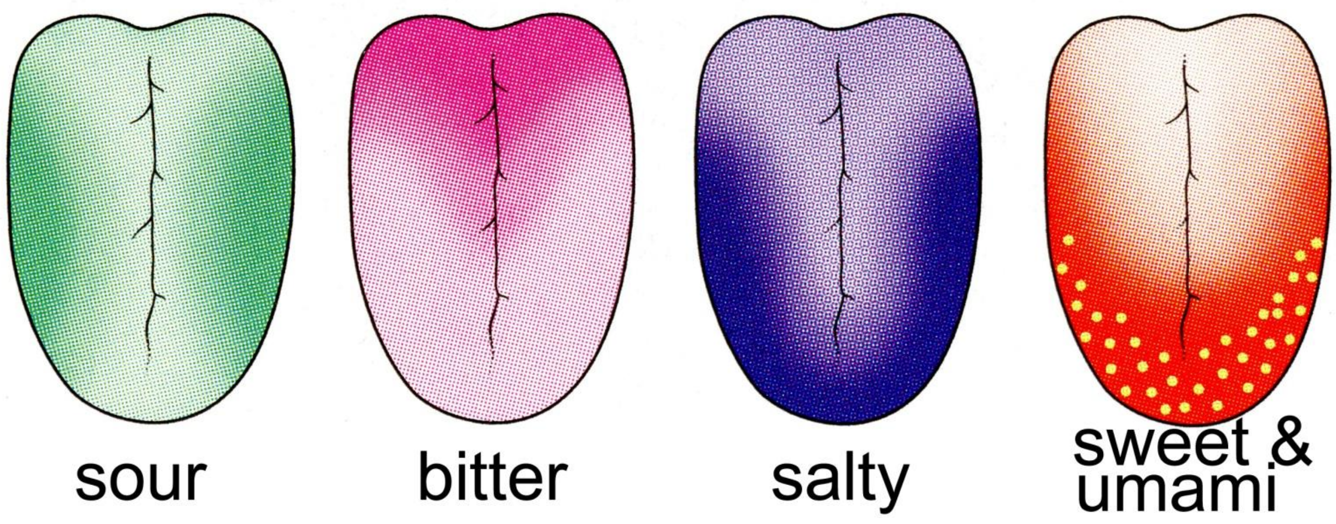
In 1908, Professor Ikeda in Japan first made MSG and patented it as a taste enhancer for food.

Its use in cooking quickly spread throughout east Asia.

MSG entered the US via Asian restaurants . In 1968, a Chinese American, Dr Robert Kwok wrote a single letter to *The New England Journal of Medicine* saying that eating Chinese food made his neck go numb and gave him headaches, and that he attributed this (with no scientific evidence) to the use of MSG in the food. He called his symptoms ‘Chinese Restaurant Syndrome’. As a result of that one letter, MSG has been damned in the west.

Taste

- Although each receptor type is concentrated in certain areas of the tongue, all are present across the entire tongue.

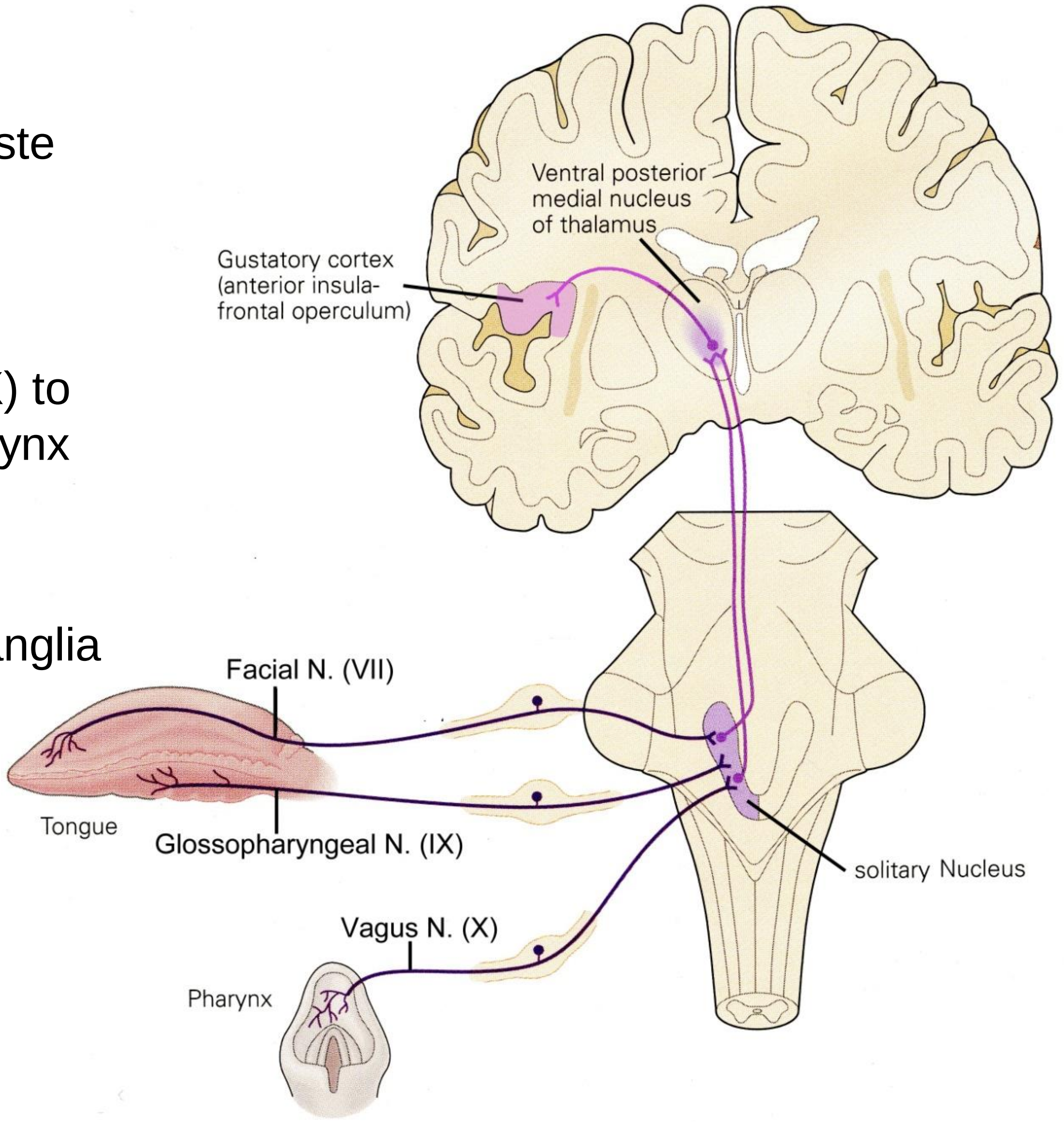


Taste

Sensory neurons for taste:

- Three cranial nerves have taste neurons:
  - Facial N. (VII) to front of tongue
  - Glossopharyngeal N. (IX) to back of tongue and pharynx
  - Vagus N. (X) to pharynx

- Cell bodies are in sensory ganglia associated with each nerve.

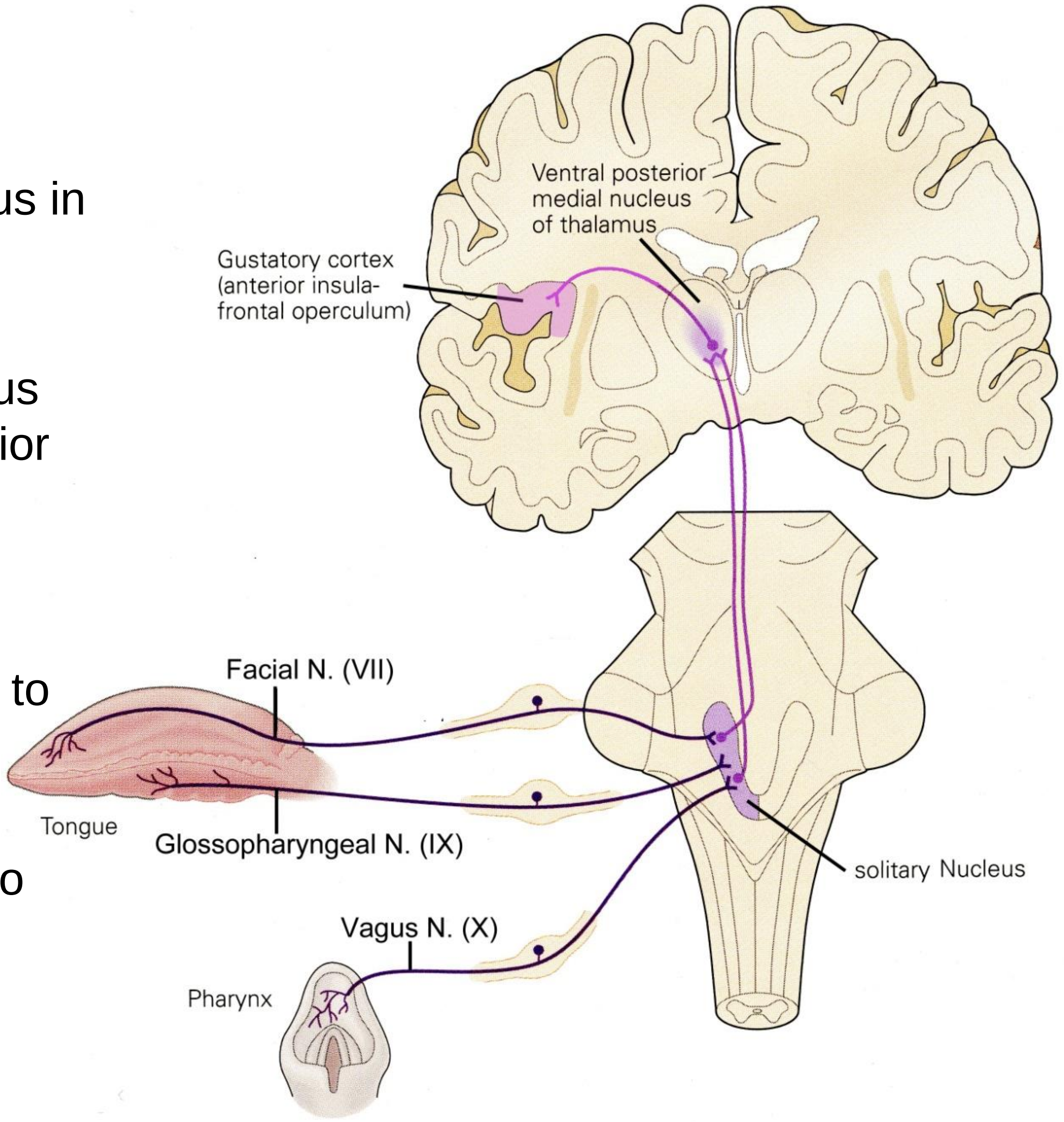


Taste

Taste pathway:

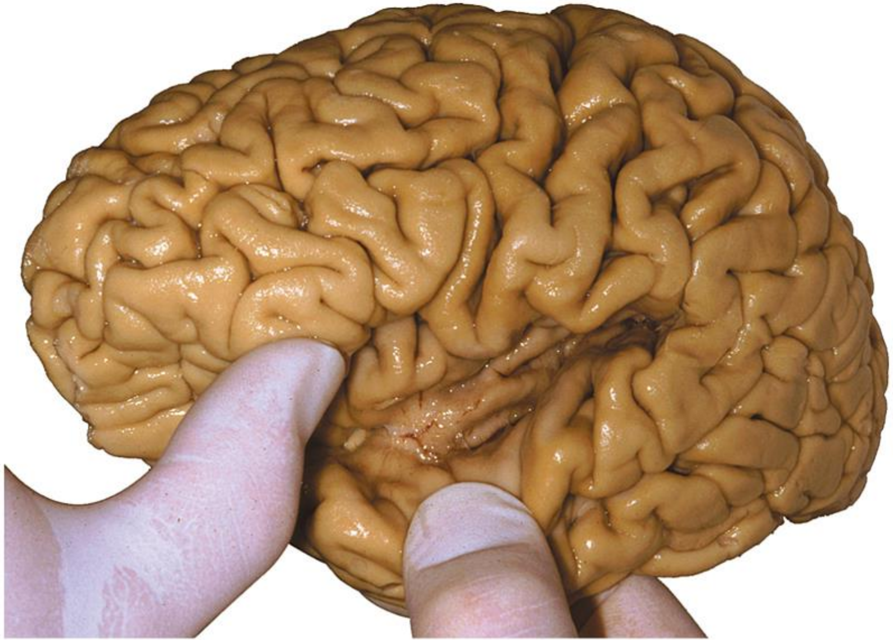
- All sensory neurons for taste synapse in the solitary nucleus in the upper medulla.
- Neurons in the solitary nucleus synapse in the ventral posterior medial nucleus (VPM) in the thalamus.
- VPM sends taste information to the insular cortex.

(Taste is an ipsilateral pathway to cortex.)



The 'ram's horn' pattern of growth of the cortex forms the temporal lobe.

- The temporal lobe covers the insula.



Taste

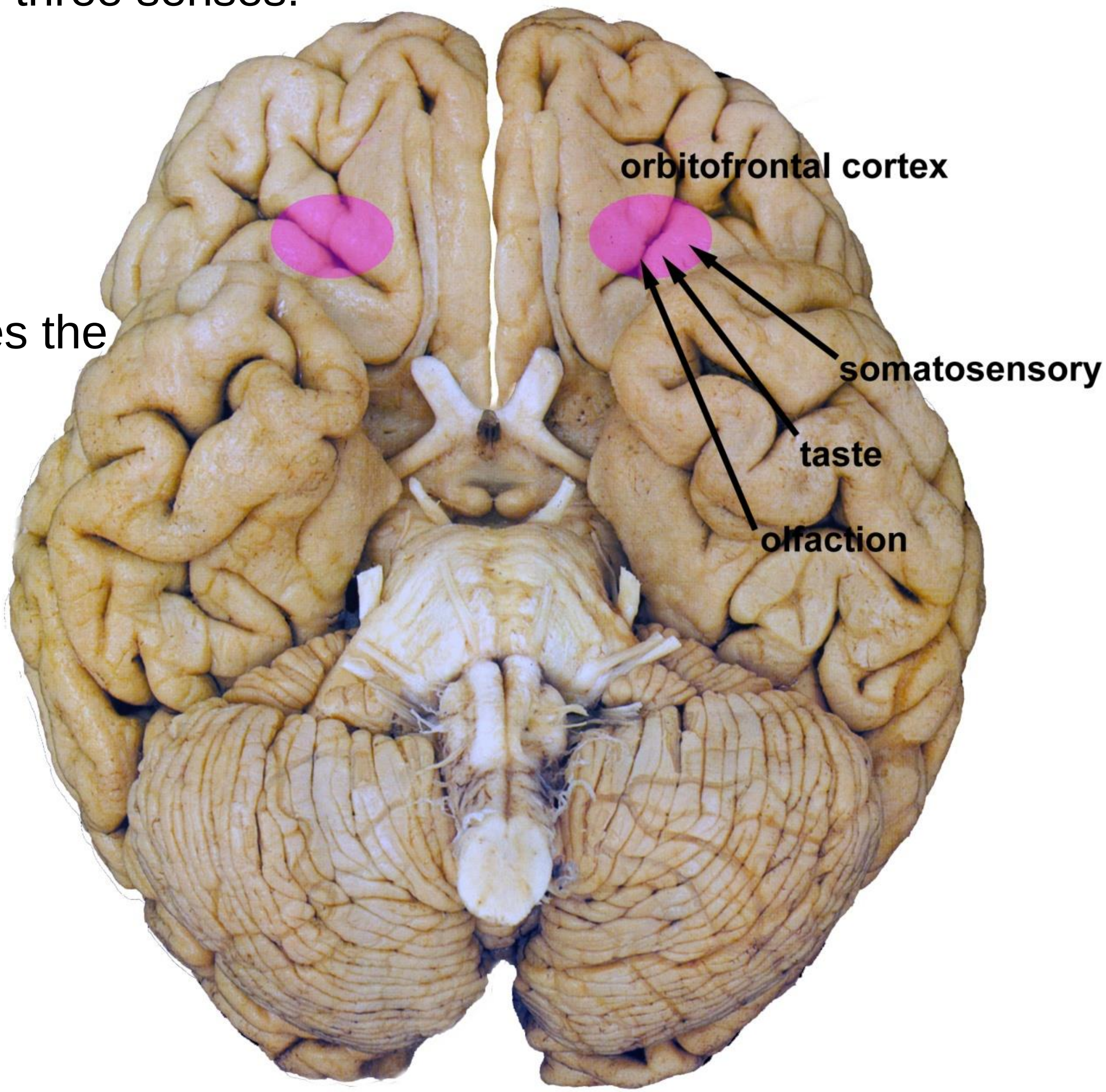
How can we distinguish so many flavors if we have only five types of taste receptors?

Taste

The perception of taste involves three senses:

- taste
- olfaction
- somatosensory

- Orbitofrontal cortex integrates the three senses.



Taste

Somatosensory nerves to the tongue:

- Trigeminal N. (V) innervates the front of the mouth and tongue.

- Glossopharyngeal N. (IX) innervates the back of the mouth and tongue.