Chemical Senses

Gustation – sense of taste
Olfaction – sense of smell
} conscious senses

Unconscious senses:
- Osmosensation – sense of body fluid concentration
- pH, CO_2 + O_2 sensations – concentrations of H^+ ion, CO_2, + O_2

Gustation

Taste receptors are found in pharynx, throat, & tongue.

On tongue the taste receptors are located on papillae

undergo cell division to replace old taste receptor cells

50-150 life span of 2 wks

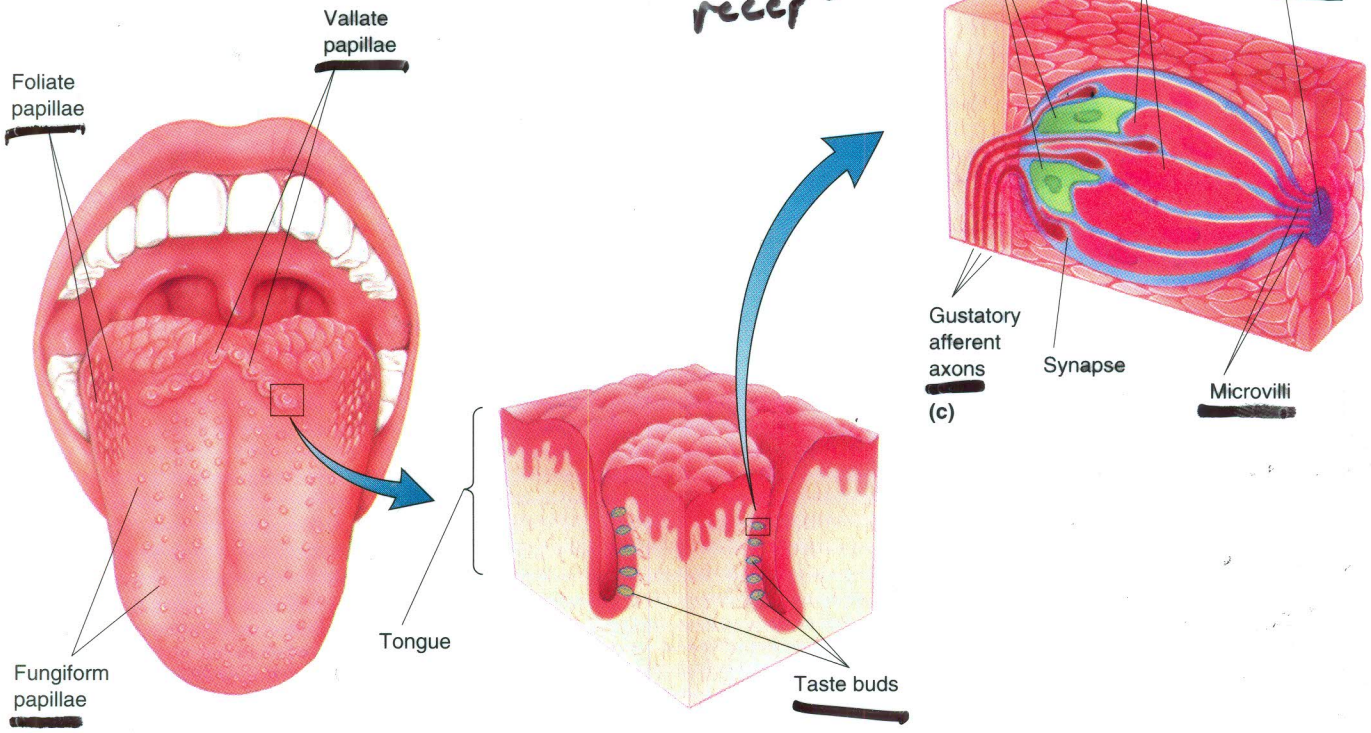
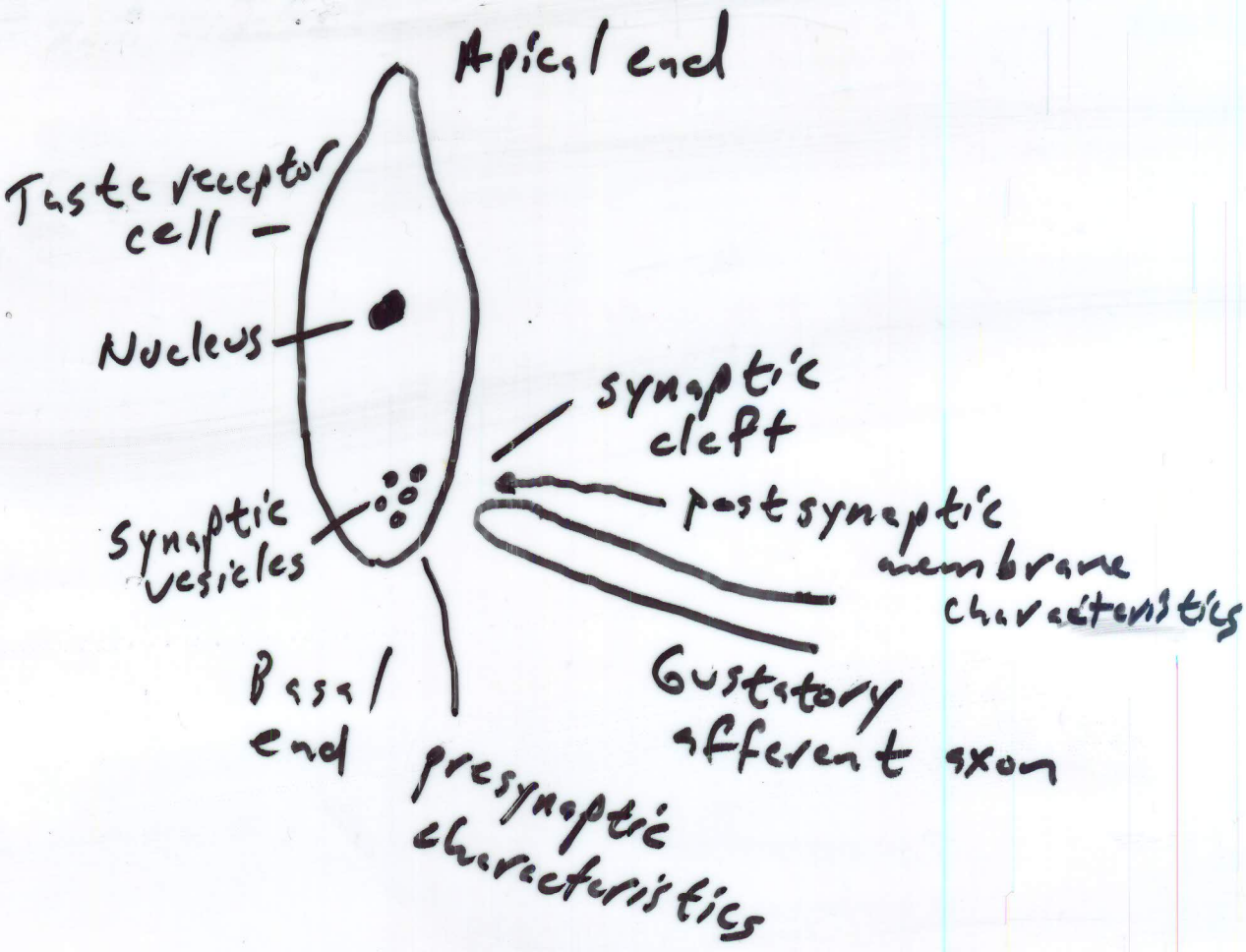


Figure 8.3

The tongue, its papillae, and its taste buds. (a) Papillae are the taste-sensitive structures. The largest and most posterior are the vallate papillae. Foliate papillae are elongated. Fungiform papillae are relatively large toward the back of the tongue and much smaller along the sides and tip. **(b)** A cross-sectional view of a vallate papilla, showing the locations of taste buds. **(c)** A taste bud is a cluster of taste cells (the receptor cells), gustatory afferent axons and their synapses with taste cells, and basal cells. Microvilli at the apical end of the taste cells extend into the taste pore, the site where chemicals dissolved in saliva can interact directly with taste cells.

Taste receptor cells have both electrical & chemical synapses with the basal cells.



Taste stimulus causes a receptor potential in the taste receptor cell. Spreads along membrane of taste receptor cell and triggers the opening of voltage gated Ca^{++} channels at basal end. The Ca^{++} that enters binds to SNARE proteins → synaptic vesicles releasing neurotransmitter into synaptic cleft → bind to receptors on the gustatory afferent axon and initiate action potentials in the Gustatory afferent axons → Brain

5 basic taste stimuli have been defined in mammals.

sweet
sour
salty
Bitter
Umami – japanese for "delicious" mediated by amino acids

Taste receptor cells are not specifically sensitive to a single tastes stimulus.

90% respond to two or more taste stimuli.

However most taste receptors are tuned (respond most strongly to one stimulus) to one taste stimulus.

The brain interprets the inputs from the entire population of receptors in

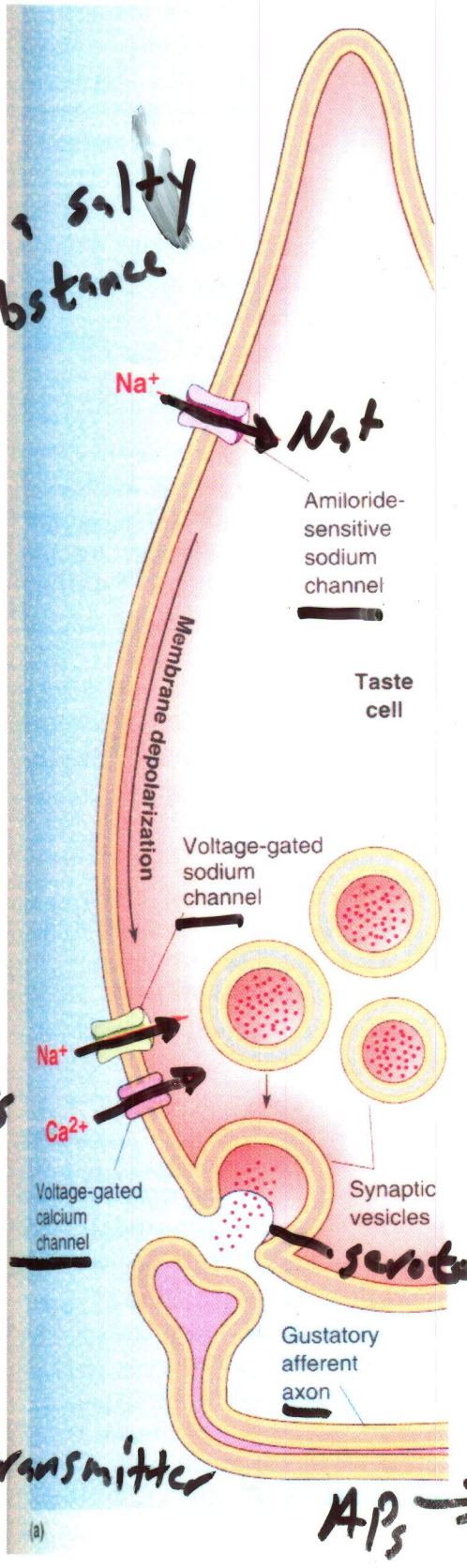
interpreting a taste stimulus.

"Population coding" — the brain interprets the input from the entire receptor population in determining a stimulus.

Transduction — process by which a receptor converts a sensory stimulus into a neural signal.

Salty — Na^+ ions are the important chemical stimulus

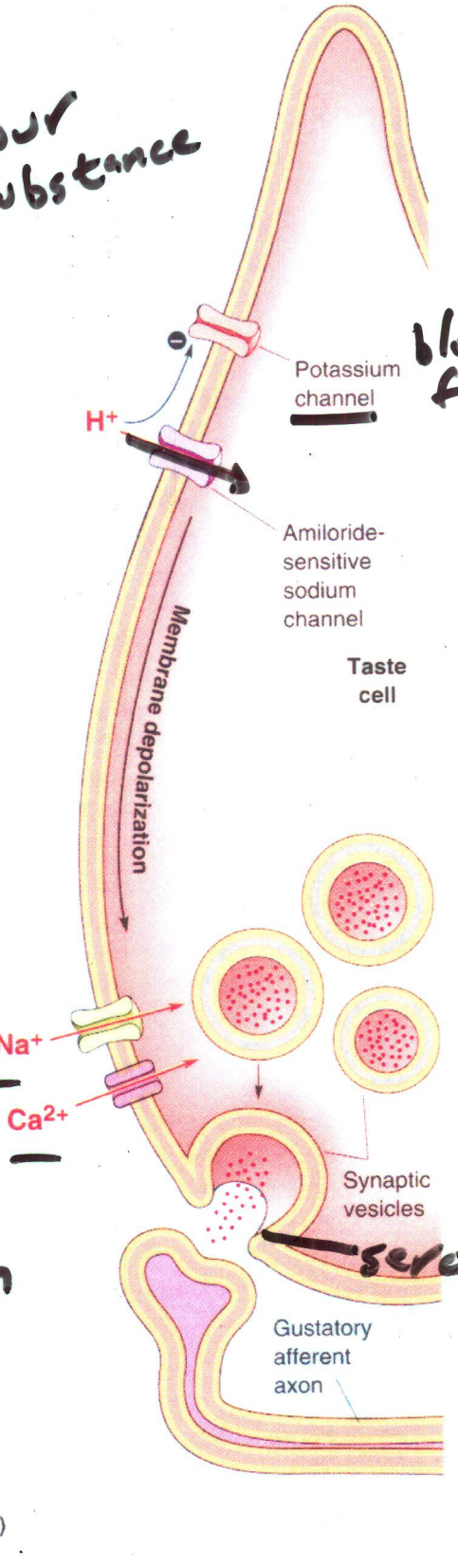
Eat a salty substance



Ca++ enters binds to SNARE proteins ↓ Release of neurotransmitter

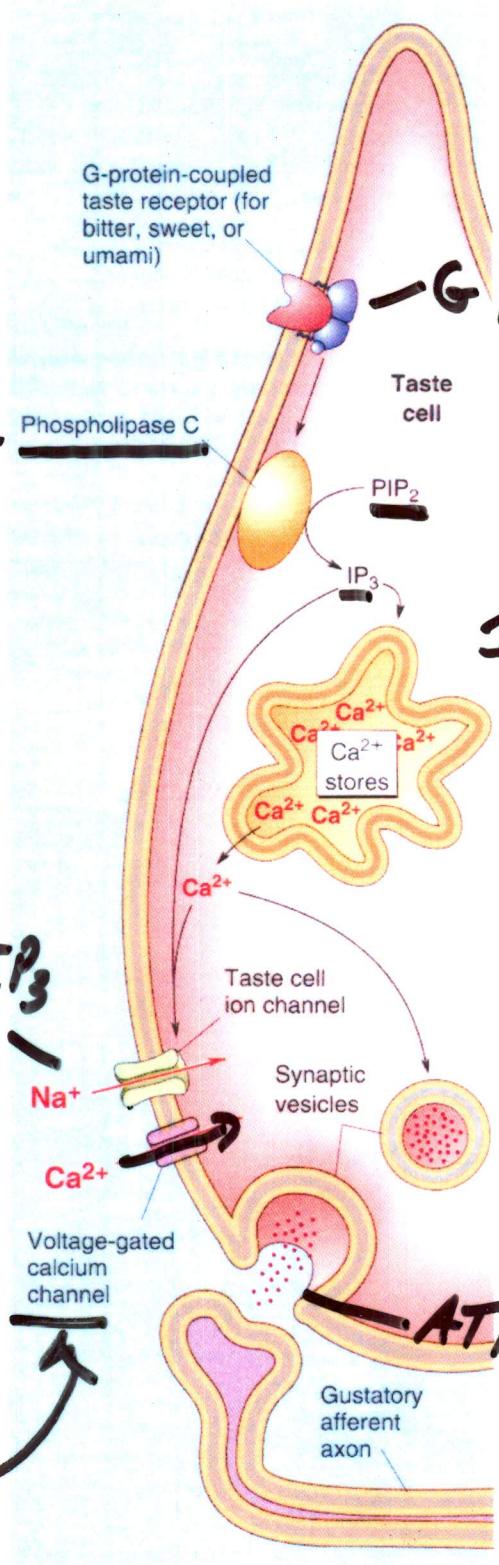
APs →

Sour substance



blocks out flow of K+

Sweet, Bitter, + Umami stimuli



G protein "Gustducin"

activated-

IP3 causes release of Ca++ stores inside of receptor cell.

Ca++ released can bind to SNARE proteins leading to release of neurotransmitter

opened by IP3

leading to depolarization of membrane potential causing opening of

FIGURE 8.6

3 cranial nerves provide sensory afferents to the taste receptor cells:

- VII (Facial nerve) - provides afferent innervation to taste receptor cells on anterior 2/3 of the tongue

- IX (Glossopharyngeal nerve) - provides afferent innervation to taste receptor cells on posterior 1/3 of tongue

- X (Vagal nerve) - provides afferent innervation to taste receptors cells of the pharynx + throat

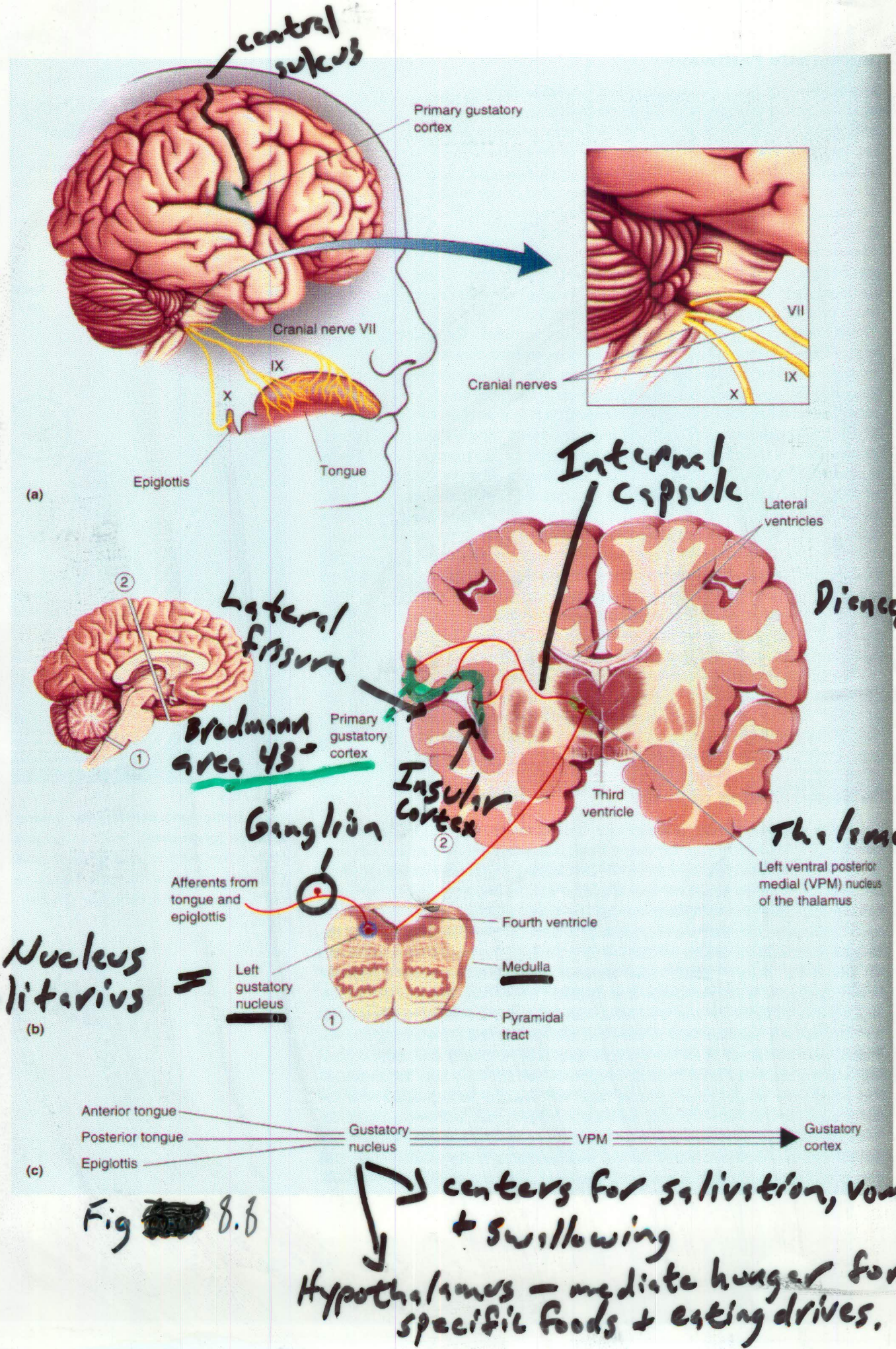


Fig 8.8

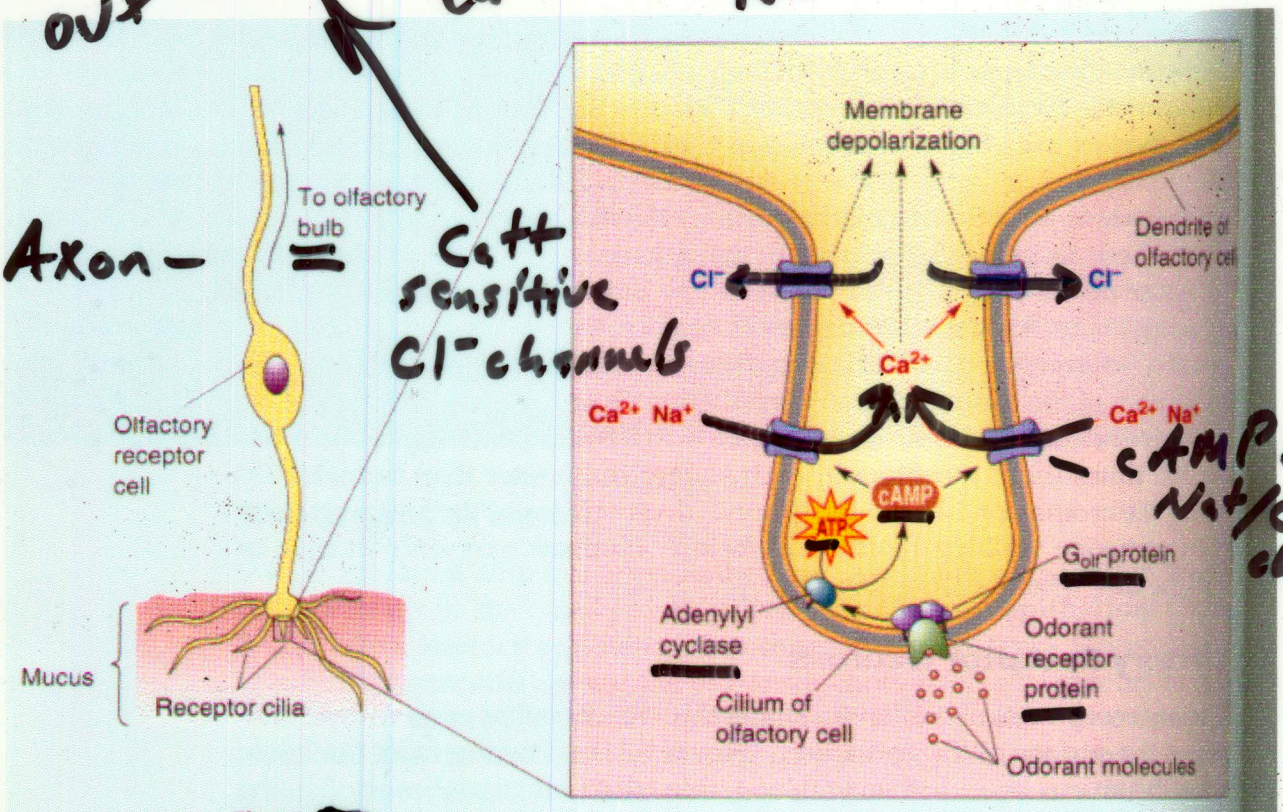
centers for salivation, vomiting, + swallowing

Hypothalamus – mediate hunger for specific foods + eating drives.

Olfaction

mediated by receptors in the olfactory epithelium in the roof of the nasal cavity

Allows Cl^- to flow out amplifying depolarization caused by inflow of Na^+ and Ca^{++}



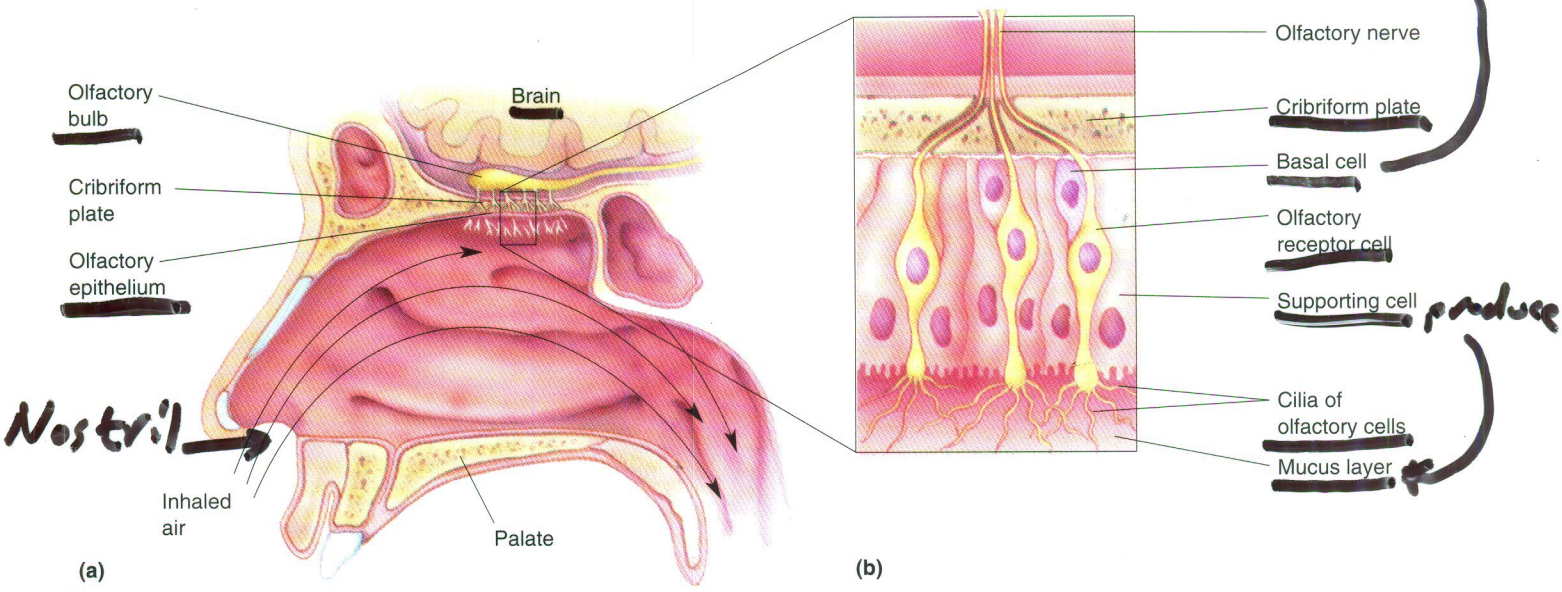
Ca^{++} sensitive Cl^- channels

cAMP sensitive Na^+/Ca^{++} channels

Figure [redacted]

Transduction mechanisms of vertebrate olfactory receptor cells. This drawing shows a single cilium of an olfactory receptor cell and the signaling molecules of olfactory transduction that it contains. G_{olf} is a special form of G-protein found only in olfactory receptor cells.

olfactory receptor cells have life span of 4-8 wks → undergo cell division to produce new olfactory receptor cells



Figure

(a) Location and (b) structure of the olfactory epithelium. The epithelium consists of a layer of olfactory receptor cells, supporting cells, and basal cells. Odorants dissolve in the mucus layer and contact the cilia of the olfactory cells. Axons of the olfactory cells penetrate the bony cribriform plate, on their way to the CNS.

A specific olfactory receptor cell will respond to a wide range of odorant molecules. Population coding is carried out by the brain to distinguish one odor from another.

Figure 8.11

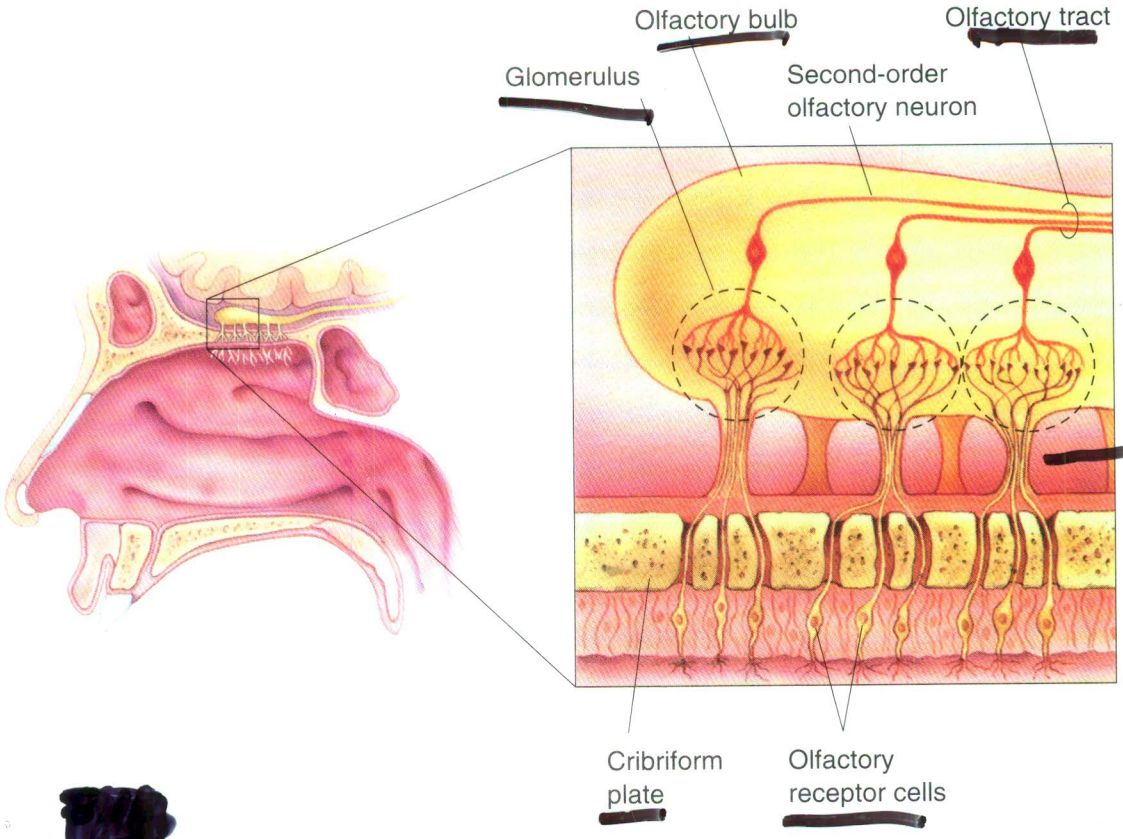
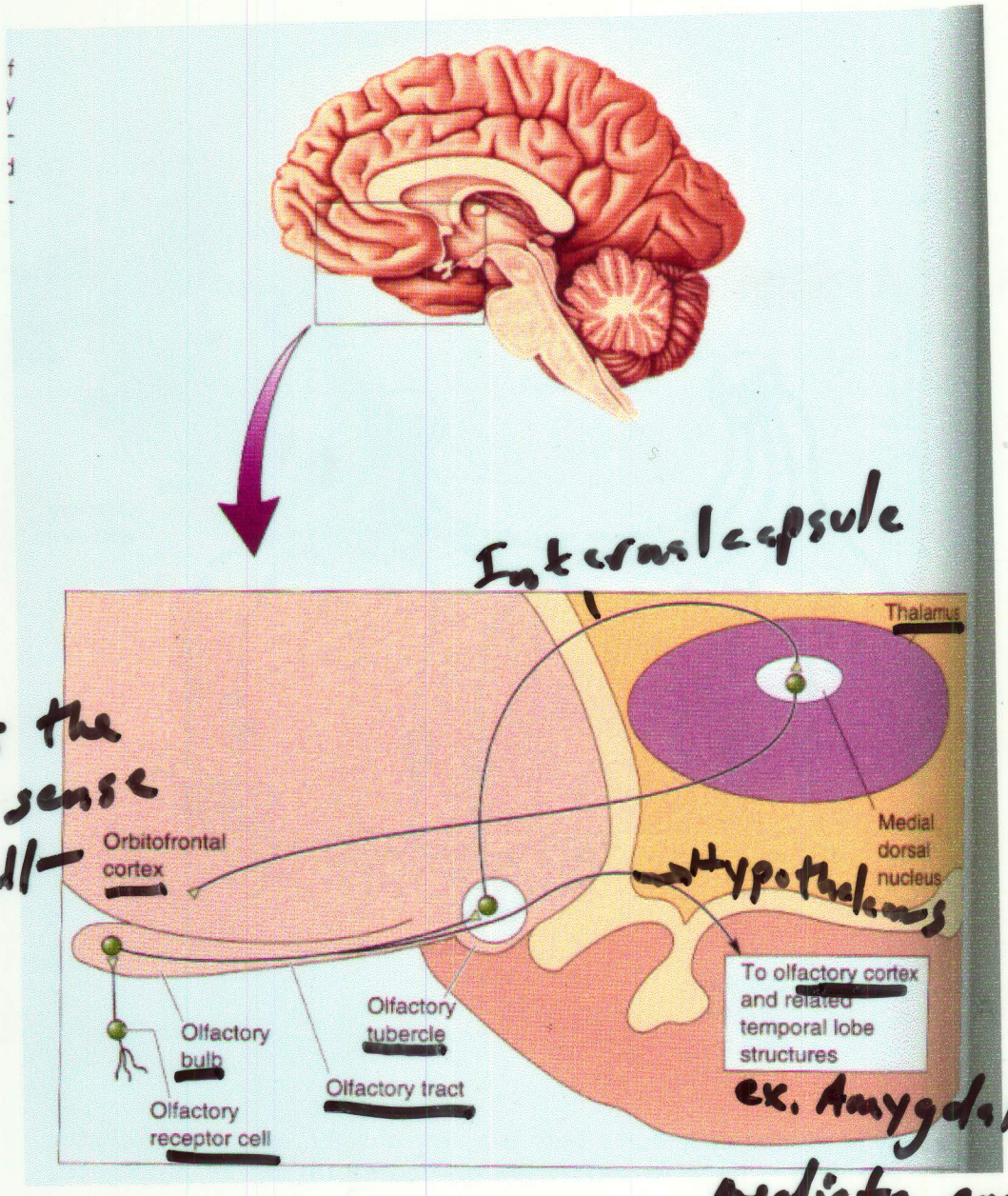


Figure
The structure of an olfactory bulb. Axons of olfactory receptor cells penetrate the cribriform plate and penetrate the olfactory bulb. After multiple branching, olfactory axons synapse upon second-order neurons within spherical glomeruli. The second- order neurons send axons through the olfactory tract further into the brain.

Figure 8.14



mediates the conscious sense of smell

ex. Amygdala mediate emotional responses to odors, as well as olfactory memories.

There are also direct olfactory bulb inputs to the hypothalamus that mediate behavioral drives like sexual arousal + feeding.