9.01 Introduction to Neuroscience
Fall 2007

Taste and smell

Sebastian Seung

Sensory transduction

- How is the receptor potential generated?
  - ion channel
  - GPCR

Psychology of taste

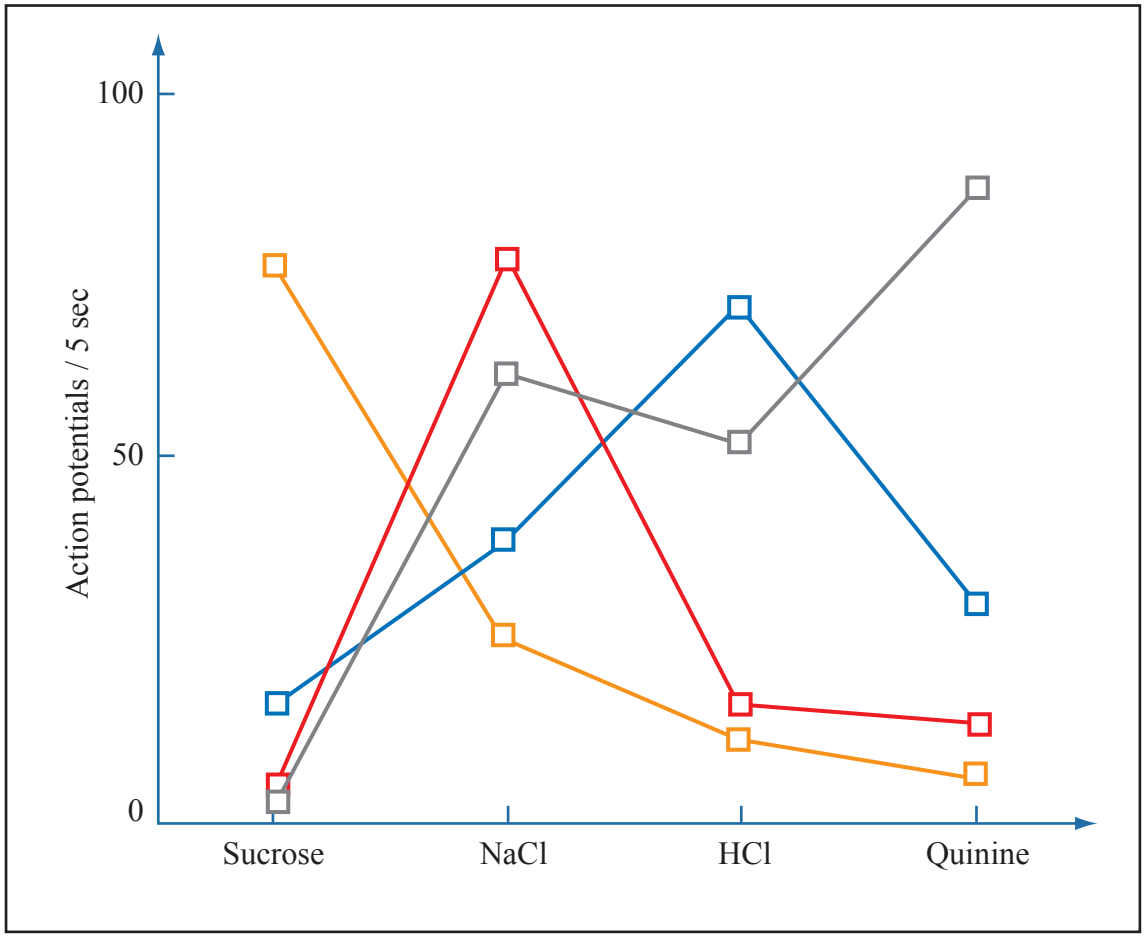
- What is taste for?
  - Distinguish between food and poison
  - Distinguish between types of food
- How many basic tastes are there?
  - salt, sour, sweet, bitter
  - umami

Central taste pathways

- Three cranial nerves from tongue
- Medulla: gustatory nucleus
  - common pathway
- Thalamocortical pathway
  - VPM
  - Gustatory cortex
  - Thought to be responsible for conscious perception

Most gustatory axons respond to more than one basic taste

- A distributed neural code



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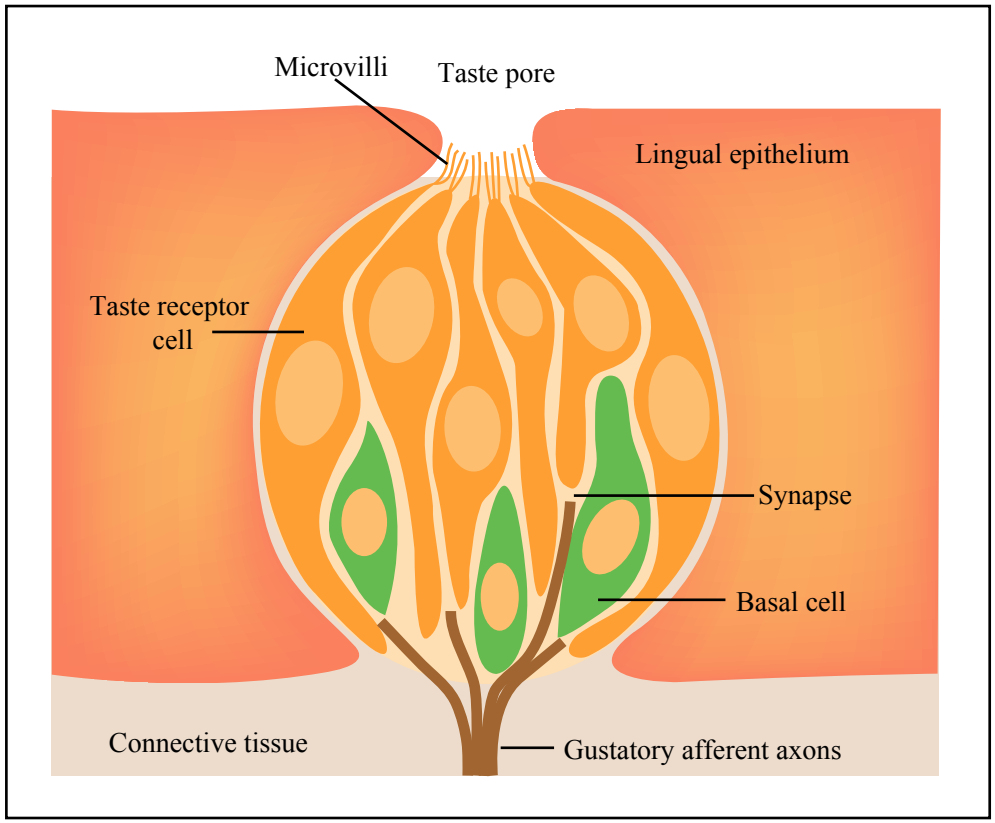
Taste receptor cells

- 50-150 in a taste bud
- Synapses onto gustatory afferents



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Taste receptors

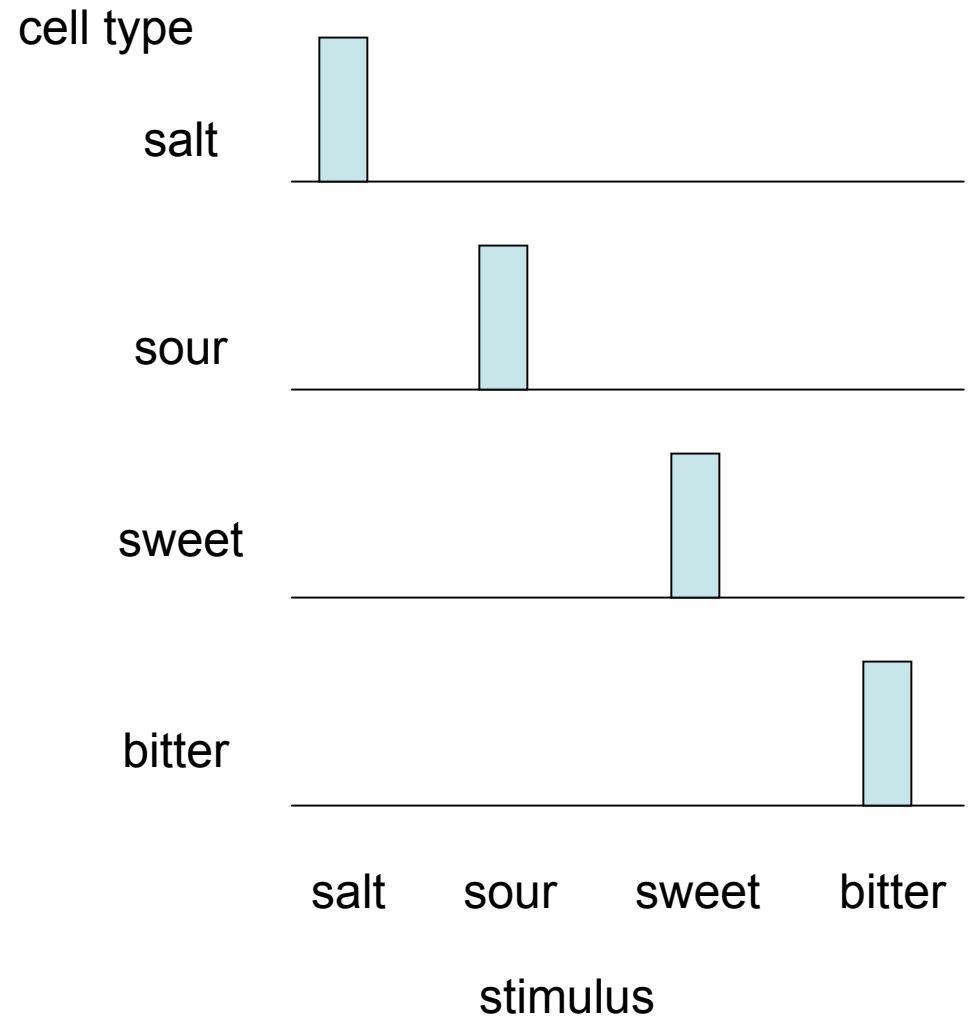
sweet	T1R2+T1R3	GPCR
umami	T1R1+T1R3	
bitter	T2R (~30 types)	
sour	PKD2L1	ion channel
salt	?	

Genetic manipulations

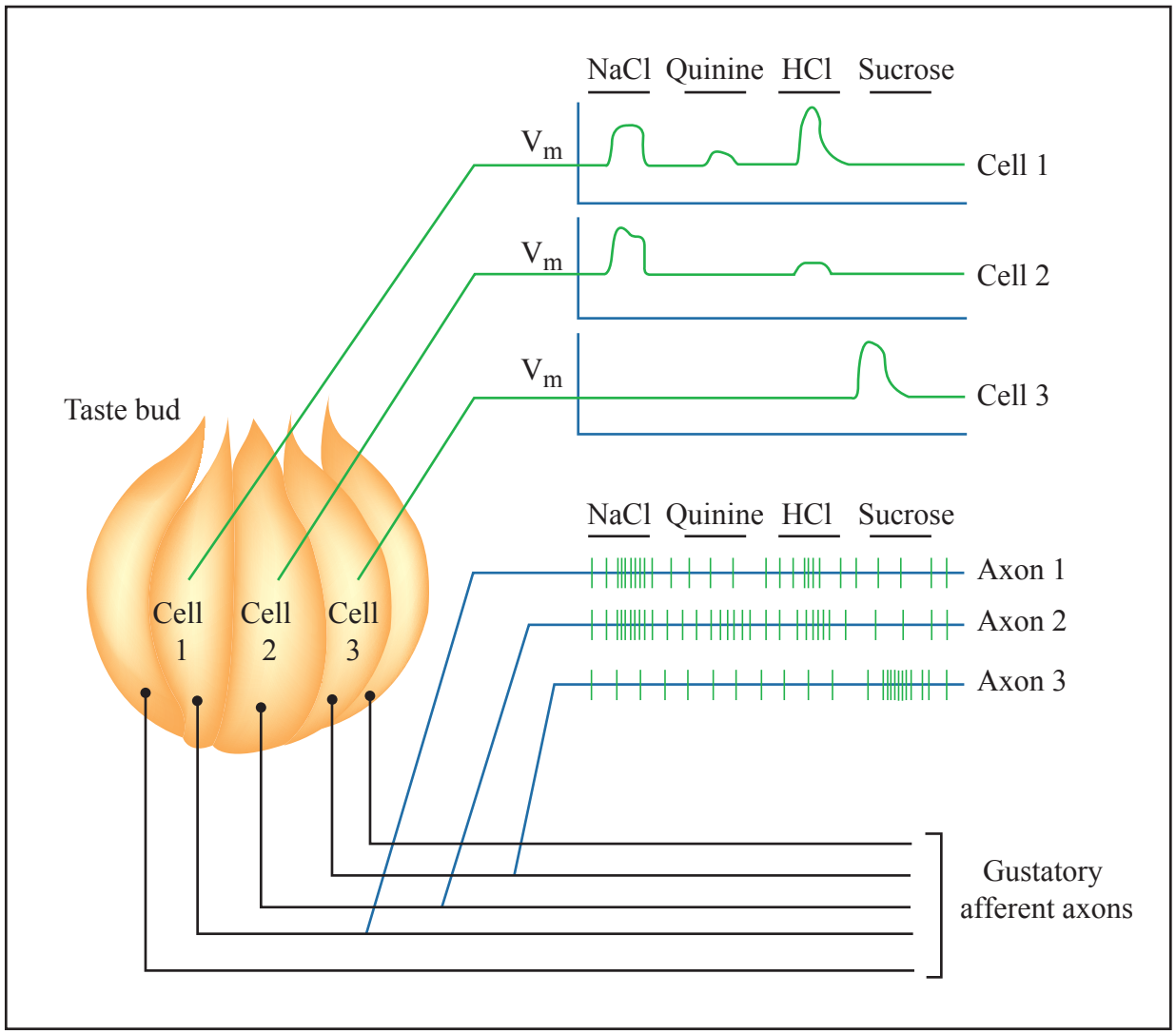
- Knockout
  - heterozygous
  - homozygous
- Transgenic

An alternate reality: labeled line encoding

- Different tastes are represented by the activation of nonoverlapping sets of neurons.
- A single neuron can unambiguously signal the presence of a taste.



Most receptor cells respond to more than one basic taste.



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Genetic variation in taste

- Phenylthiocarbamide (PTC)
  - supertasters: extremely bitter
  - medium tasters: bitter
  - nontasters: no taste
- TAS2R38
  - nontasters and tasters differ in three amino acids

Perception of flavor is complex

- combination of basic tastes
- smell
- other sensory modalities
  - texture
  - temperature
  - pain
  - vision

What is smell for?

Identify foods

Communicate

How many smells are there?

- Professional “noses” can distinguish between thousands of scents.
- Are there basic smells?

Olfactory epithelium

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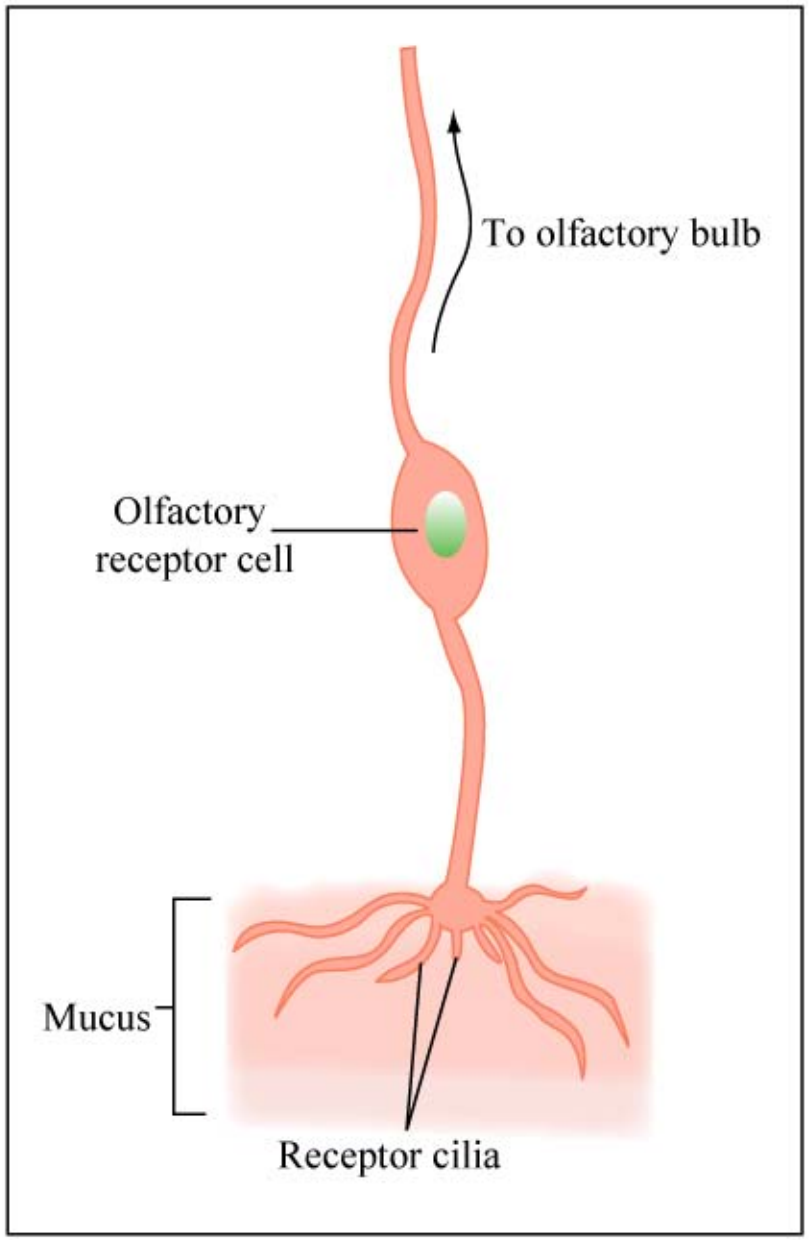
See Figure 8.9 in Bear, Mark F., Barry W. Connors,
and Michael A. Paradiso. *Neuroscience: Exploring the Brain*.
3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007.

Olfactory receptor neuron

- the axon projects to the olfactory bulb via the cribriform plate
- the dendrite sends cilia into the epithelium
- odorants bind to the cilia



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Olfactory transduction

- odorant binds to receptor
- G-protein is activated
- adenylyl cyclase is activated
- cAMP binds to cation channel
- influx of Na and Ca causes depolarization
- amplified by Ca-activated Cl channels

Odorant receptor genes

- roughly 1000 genes in rodents
- each receptor cell expresses only one gene
- 2004 Nobel prize

Olfactory glomeruli

- 2000 glomeruli in the bulb
- axons of receptor neurons meet dendrites of second-order neurons

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Each glomerulus receives input from one type of ORN

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Central olfactory pathways

- direct pathway to olfactory cortex
- thalamocortical pathway to neocortex

Broad tuning of ORNs

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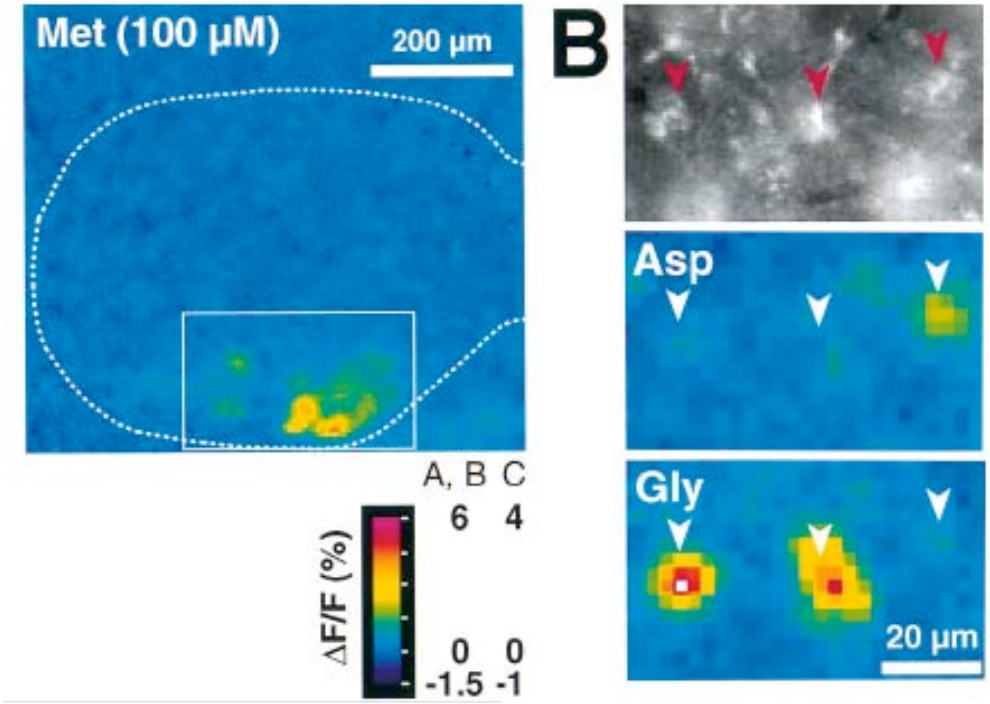
Calcium imaging



Friedrich & Korsching (1997)

Pheromones

- Secreted chemicals for communication
- Reproductive behaviors
- Territorial markings
- Identification of individuals
- Social hierarchy

Accessory olfactory system

- vomeronasal organ (VNO)
- to accessory olfactory bulb
- to hypothalamus

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