

# Taste Physiology

Last updated: April 20, 2019

**TASTE BUDS** (sense organs for taste) see 1826 (2-4) p.

- total  $\approx$  10.000 taste buds.
- each taste bud is innervated by  $\approx$  50 nerve fibers; each nerve fiber receives input from  $\approx$  5 taste buds.
- if sensory nerve is cut, taste buds it innervates degenerate and eventually disappear; if nerve regenerates, epithelial cells in neighborhood become organized into new taste buds.

## TASTE PATHWAYS

Tongue:

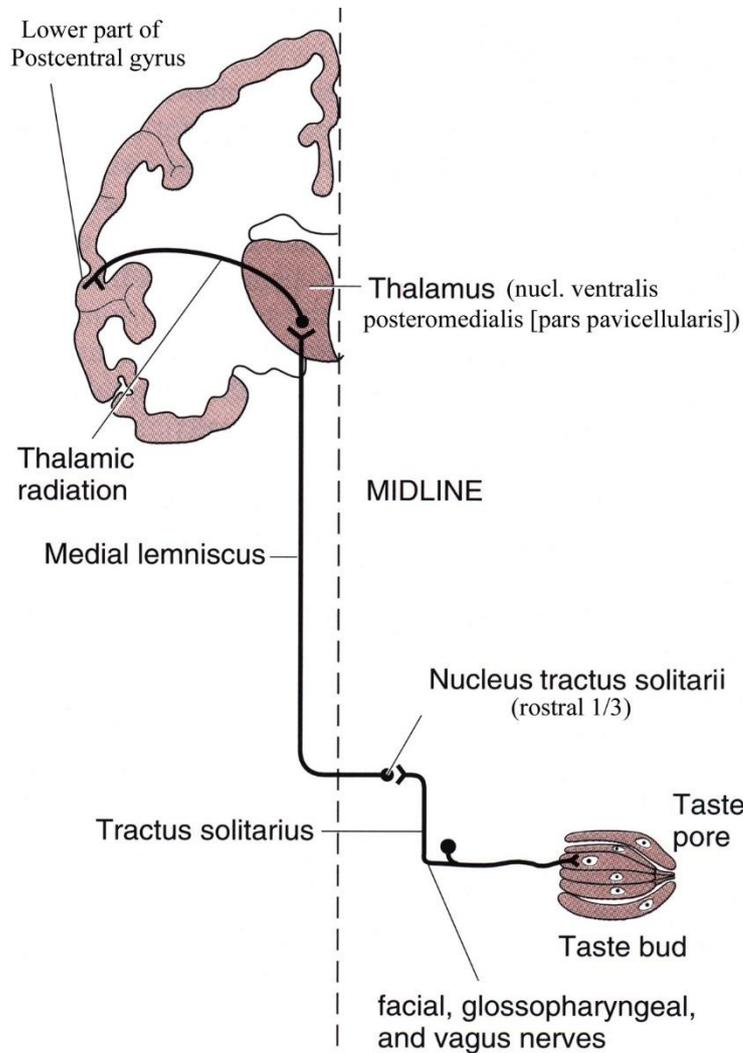
anterior two-thirds  $\rightarrow$  chorda tympani branch of **facial nerve**.

posterior third  $\rightarrow$  **glossopharyngeal nerve**.

Areas other than tongue  $\rightarrow$  **vagus nerve**.

- all taste fibers (myelinated but slowly conducting) unite in rostral third of **nucleus tractus solitarii** (in medulla oblongata); further way:
  - 1) axons *cross midline* and join **MEDIAL lemniscus**  $\rightarrow$  specific sensory relay nuclei of THALAMUS.
  - 2) **GUSTATORY lemniscus** - *uncrossed* ascending fibers; some switch in **parabrachial nuclei** (rostral pons) and continue to **thalamus, hypothalamus, amygdala**.
  - 3) some axons connect to adjacent **RF** and **dorsal motor nucleus n. vagi** – salivatory and lingual reflexes.
- taste projection area is in foot of **POSTCENTRAL GYRUS** (parietal operculum).

N.B. taste does not have separate cortical projection area and is represented in face area.

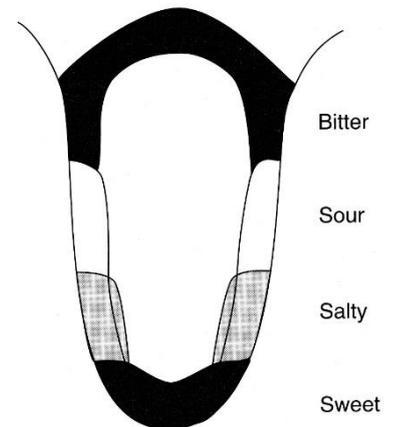


**BASIC TASTE MODALITIES**

- gustatory chemoreceptors (located on microvilli of taste cells) respond to sapid (taste-producing) substances dissolved in oral fluids bathing them.
- **concentrating & transporting protein** (delivers taste-producing molecules to receptors) is produced by *Ebner glands*.

**SWEET** - at tongue *tip*.

- most sweet substances are **organic**: *sucrose, maltose, lactose, glucose, polysaccharides, glycerol, some alcohols and ketones, chloroform, beryllium salts, various amides of aspartic acid.*
- artificial sweeteners (*saccharin* and *aspartame*) produce satisfactory sweetening without calorie burden.
- *thaumatin* and *monellin* (proteins isolated from African berries) are 100,000 times as sweet as sucrose; structures of these two proteins are very different, yet antibodies to one cross-react with antibodies to other (some sort of common 3D structure).
- receptor activation: sweet substances act via G<sub>s</sub> protein → cAMP↑ → reduced K<sup>+</sup> conductance → depolarization.



**SOUR** - along *posterior half of tongue side* (also on palate).

- sourness is proportionate to **H<sup>+</sup>** concentration.
- receptor activation: acids depolarize sour receptors by activating H<sup>+</sup>-gated cation channels.

**SALT** - along *anterior half of tongue side*.

- salty taste is produced by  $\text{Na}^+$  (and anions of ionizable salts).
- receptor activation:  $\text{Na}^+$  depolarizes salt receptors via  $\text{Na}^+$  channel related to amiloride-sensitive epithelial sodium channel (ENaC).
- some organic compounds also taste salty (e.g. dipeptides lysyltaurine & ornithyltaurine are more potent than NaCl).

**BITTER** - mostly on tongue *back* (also on palate).

- **no apparent common molecular feature** of substances that taste bitter.
- organic compounds (esp. alkaloids): quinine sulfate, strychnine hydrochloride, morphine, nicotine, caffeine, urea.
- inorganic salts of magnesium, ammonium, calcium.
- receptor activation: bitter substances reduce cAMP (via G protein\*) and increase  $\text{IP}_3$  and DAG.

\*novel G protein ( **$\alpha$ -gustducin**) has been cloned - it activates phosphodiesterase, but exact role remains unsettled.

- all four modalities can be sensed on pharynx and epiglottis.
- additional taste modality named **UMAMI** has been postulated to exist - taste of **monosodium glutamate**.
- taste cells are not different histologically; each nerve fiber responds to more than one taste stimulus (but responds best to one of four primary taste qualities).
- INTENSITY DISCRIMINATION is relatively crude (like in olfaction) - 30% change in concentration of substance being tasted is necessary before intensity difference can be detected.
- TASTE THRESHOLD concentrations vary with particular substance:

Substance	Taste	Threshold Concentration ( $\mu\text{mol/L}$ )
Hydrochloric acid	Sour	100
Sodium chloride	Salt	2000
Strychnine hydrochloride	Bitter	1.6
Glucose	Sweet	80,000
Sucrose	Sweet	10,000
Saccharin	Sweet	23

**FLAVOR** components:

- 1) combinations of *four basic TASTE components*.
- 2) *smell* – nn. olfactorii
- 3) may include element of *pain stimulation* (e.g. "hot" sauces) – n. trigeminus
- 4) *consistency* (texture) – n. trigeminus
- 5) *temperature* – n. trigeminus

N.B. taste is component of flavor!

### **AFTER-EFFECTS**

- taste exhibits after-reactions and contrast phenomena (similar to visual after-images and contrasts) - some are chemical "tricks," but others may be true central phenomena.
- **miraculin** - taste modifier protein discovered in plant - when applied to tongue, makes acids taste sweet.
- animals and humans form particularly *strong aversions to novel foods* if eating food is followed by illness (survival value of avoiding poisons).

## TASTE ABNORMALITIES

**AGEUSIA** (absence of taste sense); e.g. drugs which contain *sulfhydryl groups* (e.g. captopril, penicillamine) cause temporary ageusia.

**HYPOGEUSIA** (diminished taste sensitivity) - many different diseases.

**DYSGEUSIA** (disturbed taste sense).

BIBLIOGRAPHY for ch. "Taste" → follow this [LINK >>](#)

Ganong "Review of Medical Physiology", 2002

NMS Neuroanatomy 1998, Physiology 2001