Taste Physiology

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

- total ≈ 10.000 taste buds.
- each taste bud is innervated by ≈ 50 nerve fibers; each nerve fiber receives input from ≈ 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:

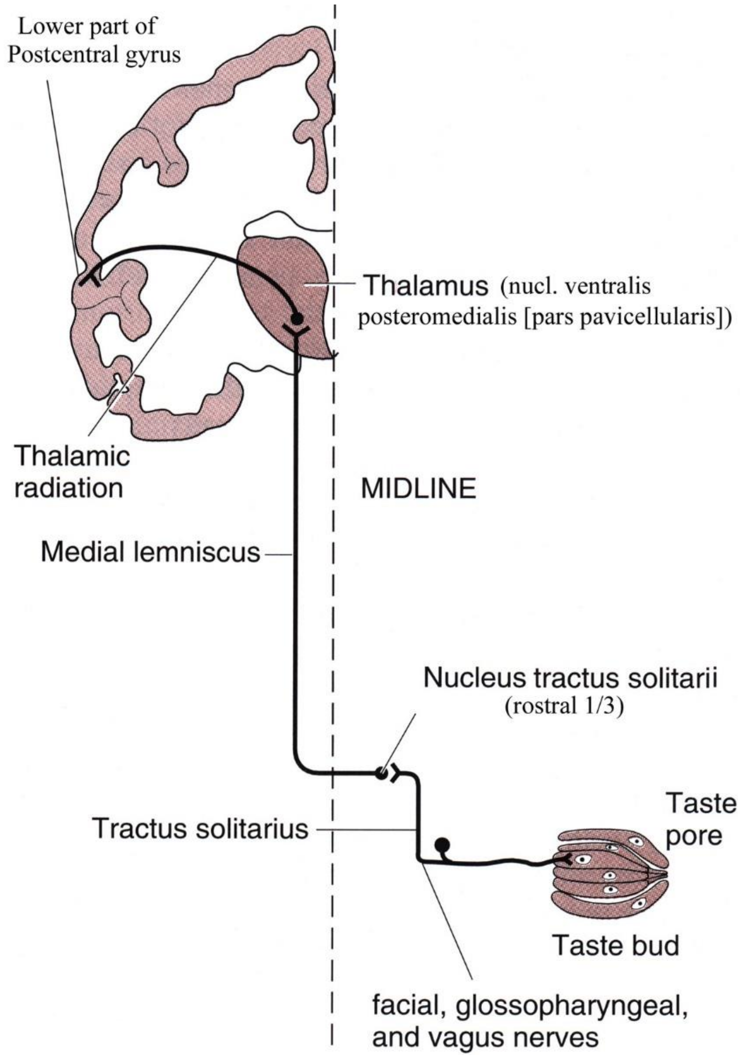
anterior two-thirds → chorda tympani branch of **facial nerve**.

posterior third → **glossopharyngeal nerve**.

Areas other than tongue → **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** → 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).

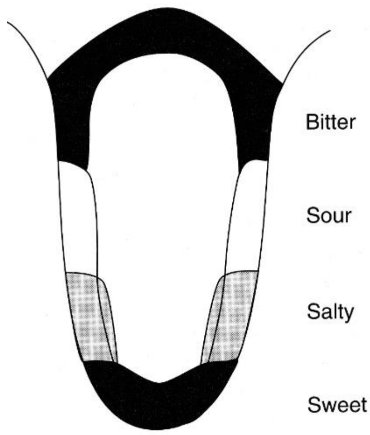
  N.B. taste does not have separate cortical projection area and is represented in face area.



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_S protein → cAMP↑ → reduced K^+ conductance → depolarization.

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

- sourness is proportionate to H^+ concentration.
- receptor activation: acids depolarize sour receptors by activating H^+-gated cation channels.

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

- salty taste is produced by Na^+ (and anions of ionizable salts).
- receptor activation: Na^+ depolarizes salt receptors via 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 IP_3 and DAG.

  *novel G protein (**α-gusducin**) 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 (μmol/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 >>
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