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PATHWAY INVOLVED IN TASTE

The tongue contains small bumps called papillae, within or near which taste buds

are situated. In the tongue’s taste buds, the taste receptors receive sensory input via

two important mechanisms – depolarization and neurotransmitter release. Intake of

salty foods leads more sodium ions to enter the receptor, causing the said mechanisms.

The same is true with intake of sour foods (hydrogen ions) and sweet foods (sugar

molecules), both of which result to the closing of K+ channels upon their entry.

From the axons of the taste receptors, the sensory information is transferred to the

three taste pathways via the branches of cranial nerves VII, IX and X. The chorda

tympani of CN VII (facial nerve) carries the taste sensory input from the tongue’s

anterior two-thirds. Then, the rest of the taste sensations from the throat, palate and

posterior tongue are transmitted by the branches of CN IX (glossopharyngeal nerve)

and CN X (vagus nerve). From these cranial nerves, taste sensory input travels

through the nerve fiber synapses to the solitary tract, the ventral posteromedial

thalamic nuclei , and the thalamus. In these three locations, there are clustered

neurons which respond to the same taste (sweet, sour, salty or bitter).The thalamus

relays the information to the primary gustatory cortex located in the somatosensory

cortex. The primary gustatory cortext is where the perception of a particular taste is

processed.

The sense of taste is mediated by taste receptor cells which are bundled in clusters

called taste buds. Taste receptor cells sample oral concentrations of a large number of

small molecules and report a sensation of taste to centers in the brainstem.

In most animals, including humans, taste buds are most prevalent on small pegs of

epithelium on the tongue called papillae. The taste buds themselves are too small to

see without a microscope, but papillae are readily observed by close inspection of the

tongue's surface. To make them even easier to see, put a couple of drops of blue food

coloring on the tongue of a loved one, and you'll see a bunch of little pale bumps -

mostly fungiform papillae - stand out on a blue background.

Taste buds are composed of groups of between 50 and 150 columnar taste receptor

cells bundled together like a cluster of bananas. The taste receptor cells within a bud are arranged such that their tips form a small taste pore, and through this pore extend

microvilli from the taste cells. The microvilli of the taste cells bear taste receptors.

Interwoven among the taste cells in a taste bud is a network of dendrites of sensory

nerves called "taste nerves". When taste cells are stimulated by binding of chemicals

to their receptors, they depolarize and this depolarization is transmitted to the taste

nerve fibers resulting in an action potential that is ultimately transmitted to the brain.

One interesting aspect of this nerve transmission is that it rapidly adapts - after the

initial stimulus, a strong discharge is seen in the taste nerve fibers but within a few

seconds, that response diminishes to a steady-state level of much lower amplitude.

Once taste signals are transmitted to the brain, several efferent neural pathways are

activated that are important to digestive function. For example, tasting food is

followed rapidly by increased salivation and by low level secretory activity in the

stomach.

Among humans, there is substantial difference in taste sensitivity. Roughly one in four

people is a "super taster" that is several times more sensitive to bitter and other tastes

than those that taste poorly. Such differences are heritable and reflect differences in

the number of fungiform papillae and hence taste buds on the tongue.

In addition to signal transduction by taste receptor cells, it is also clear that the sense

of smell profoundly affects the sensation of taste. Think about how tastes are blunted

and sometimes different when your sense of smell is disrupted due to a cold.

**Taste Sensations**

The sense of taste is equivalent to excitation of taste receptors, and receptors for a

large number of specific chemicals have been identified that contribute to the

reception of taste. Despite this complexity, five types of tastes are commonly

recognized by humans:

Sweet - usually indicates energy rich nutrients

Umami - the taste of amino acids

Salty - allows modulating diet for electrolyte balance

Sour - typically the taste of acids

Bitter - allows sensing of diverse natural toxins

None of these tastes are elicited by a single chemical. Also, there are thresholds for

detection of taste that differ among chemicals that taste the same. For example,

sucrose, 1-propyl-2 amino-4-nitrobenzene and lactose all taste sweet to humans, but

the sweet taste is elicited by these chemicals at concentrations of roughly 10 mM, 2

uM and 30 mM respectively - a range of potency of roughly 15,000-fold. Substances

sensed as bitter typically have very low thresholds.

It should be noted that these tastes are based on human sensations and some

comparative physiologists caution that each animal probably lives in its own "taste

world". For animals, it may be more appropriate to discuss tastes as being pleasant,

unpleasant or indifferent. Additionally, there are some clear differences among

animals in what they can taste. Cats, for example, do not respond to sweets due to a

deletion in the gene that encodes one of the sweet receptors.

Perception of taste also appears to be influenced by thermal stimulation of the tongue.

In some people, warming the front of the tongue produces a clear sweet sensation,

while cooling leads to a salty or sour sensation.

**Taste Receptors**

A very large number of molecules elicit taste sensations through a rather small

number of taste receptors. Furthermore, it appears that individual taste receptor cells

bear receptors for one type of taste. In other words, within a taste bud, some taste

receptor cells sense sweet, while others have receptors for bitter, sour, salty and

umami tastes. Much of this understanding of taste receptors has derived from

behavioral studies with mice engineered to lack one or more taste receptors.

The pleasant tastes (sweet and umami) are mediated by a family of three T1R

receptors that assemble in pairs. Diverse molecules that lead to a sensation of sweet

bind to a receptor formed from T1R2 and T1R3 subunits. Cats have a deletion in the

gene for T1R2, explaining their non-responsiveness to sweet tastes. Also, mice

engineered to express the human T1R2 protein have a human-like response to

different sweet tastes. The receptor formed as a complex of T1R1 and T1R3 binds

L-glutamate and L-amino acids, resulting the umami taste.

The bitter taste results from binding of diverse molecules to a family of about 30 T2R

receptors. Sour tasting itself involves activation of a type of TRP (transient receptor

potential) channel. Surprisingly, the molecular mechanisms of salt taste reception are

poorly characterized relative to the other tastes.