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**Assignment; Elucidate the pathway involved in Taste**

The gustatory system or sense of taste is the sensory system that is partially responsible for the perception of taste (flavor). Taste is the perception produced or stimulated when a substance in the mouth reacts chemically with taste receptor cells located on taste buds in the oral cavity, mostly on the tongue. Taste, along with smell (olfaction) and trigeminal nerve stimulation (registering texture, pain, and temperature), determines flavors of food and other substances. Humans have taste receptors on taste buds and other areas including the upper surface of the tongue and the epiglottis. The gustatory cortex is responsible for the perception of taste. The tongue is covered with thousands of small bumps called papillae, which are visible to the naked eye. Within each papilla are hundreds of taste buds. The exception to this is the filiform papillae that do not contain taste buds. There are between 2000 and 5000 taste buds that are located on the back and front of the tongue. Others are located on the roof, sides and back of the mouth, and in the throat. Each taste bud contains 50 to 100 taste receptor cells.

Taste receptors in the mouth sense the five taste modalities: sweetness, sourness, saltiness, bitterness, and savoriness (also known as savory or umami). Sweetness helps to identify energy-rich foods, while bitterness serves as a warning sign of poisons. The basic taste modalities contribute only partially to the sensation and flavor of food in the mouth—other factors include smell, detected by the olfactory epithelium of the nose; texture, detected through a variety of mechanoreceptors, muscle nerves, etc.; temperature, detected by thermoreceptors; and "coolness" (such as of menthol) and "hotness" (pungency), through chemesthesis. Among humans, taste perception begins to fade around 50 years of age because of loss of tongue papillae and a general decrease in saliva production. Humans can also have distortion of tastes through dysgeusia.

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 cortex 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.

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 "supertaster" 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 (e.g. meat broth or aged cheese) 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  $\mu$ M 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. 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.

### Clinical significance

Patients with Addison's disease, pituitary insufficiency, or cystic fibrosis sometimes have a hyper-sensitivity to the five primary tastes.

### Disorders of taste

- ageusia (complete loss of taste)
- hypogeusia (reduced sense of taste)
- dysgeusia (distortion in sense of taste)
- hypergeusia (abnormally heightened sense of taste)