# Are You A Supertaster?

*This course is no longer offered for Continuing Education credit.*

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**Disclaimer:** Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

### Conflict of Interest Disclosure Statement

- The authors report no conflicts of interest associated with this course.

### Introduction – Supertasters

As dental professionals, we get numerous questions about the tongue, taste and any sensation associated with the oral cavity. Super-tasting is being recognized by more healthcare professionals, researchers and industry. Are You A Supertaster? addresses the relationship of taste, smell and the etiology of these sensations; while presenting information on the health benefits and health risks of all three classifications of tasters. Specific techniques are outlined that assists the practitioner in determining the classifications of tasters.

## Course Contents



## Overview

As dental professionals, we get numerous questions about the tongue, taste and any sensation associated with the oral cavity. Super-tasting is being recognized by more healthcare professionals, researchers and industry. This course addresses the relationship of taste, smell and the etiology of these sensations; while presenting information on the health benefits and health risks of all three classifications of tasters. Specific techniques are outlined that assists the practitioner in determining the classifications of tasters.

## Learning Objectives

**Upon completion of this course, the dental professional should be able to:**

- List the three types of tasters in the population.
- Understand the mechanisms involved in the nerve supply to the oral tissues affecting taste.
- Logically assess the patient to determine if a referral to a specialist for taste and smell is warranted.
- List the three ways to determine a supertaster.
- List three foods that supertasters usually do not consume.
- Discuss the benefits and/or the disease states associated with each of the tasters.
- State the function of the taste buds and understand how taste is perceived.

## Glossary

**adiposity** - Excessive accumulation of lipids in a site or organ.

**ageusia** - A complete loss or absence of the sense of taste sensations.

**allele** - Any of a series of two or more different genes that may occupy the same locus on a specific chromosome.

**anosmia** - The loss of a sense of smell.

**atypical odontalgia** - Toothache-like pain for which no dental cause can be found.

**arthromyalgia** - Temporomandibular joint pain dysfunction syndrome (TMD).

**bitter taste receptors** - T2Rs detect harmful compounds including secreted bacterial products.

**burning mouth syndrome (BMS)** - The oral condition of the mouth is normal on clinical examination but elicits an oral burning sensation.

**cell** - The smallest unit of living structure capable of independent existence composed of a membrane-enclosed mass of protoplasm and containing a nucleus or nucleoid.[29]

**chromatid** - Each of the two strands formed by longitudinal duplications of a chromosome that becomes visible during prophase of mitosis or meiosis. When the two chromatids separate, each chromatid will become a chromosome.[29]

**chromosome** - Structures found in the nucleus of a cell that contains the genes.

**disorder** - Disturbance of function or structure, resulting from a genetic or embryologic failure in development or from exogenous factors such as poison, trauma or disease states.

**dysgeusia** - Alteration or distortion in the perception of taste.

**dysesthesia** - Burning painful sensation in the mouth.

**gene** - A functional unit of heredity that occupies a specific place (locus) on a chromosome is capable of reproducing itself exactly at each cell division and directs the formation of an enzyme or other protein.[29,30]

**gene expression** - The process by which the information encoded in a gene is converted into protein or some form of RNA. The DNA sequence is first transcribed into RNA and then usually, but not always, translated into protein.

**genetic code** - The genetic information carried by the specific DNA molecules of the chromosomes; specifically, the system whereby particular combinations of three consecutive nucleotides in a DNA molecule control the insertion of one particular amino acid in equivalent places within a protein molecule.[29]

**genetic counseling** - The educational process of informing an individual about their biological components and inheritance.

**genome** - All the genetic material in the chromosomes of a particular organism.

**genotype** - The genetic constitution of an individual.

**glossopyrosis** - Burning tongue.

**gustation** - Taste which is a chemical sense and involves taste sensations of sour, sweet, bitter, salty and umami or savory. All other flavors are combinations of the five primary taste sensations but also involve both olfactory and sensory sensations.

**gustatory hair** - A protrusion that originates from the taste buds and reaches the outside environment. Saliva mixes with the food or beverage and enters the taste bud through the gustatory hair. When stimulated an impulse is sent to the cerebral cortex. The brain is highly involved in the perception of taste.

**hypogeusia** - Gustatory hyposensitivity or the reduced ability to taste.

**hypergeusia** - Gustatory hypersensitivity.

**hyposmia** - The reduced ability to smell and to detect odors. This may be due to nasal polyps, infections or trauma.

**neuropathic pain** - Complex, chronic pain that usually is accompanied by tissue injury. The nerve fibers may be damaged, dysfunctional or injured.

**nociceptors** - Specialized peripheral sensory neurons. These nociceptors alert us to potentially damaging stimuli at the skin by detecting extremes in temperature and pressure, injury related chemicals, and transducing these stimuli into long-ranging electrical signals that are relayed to the higher brain centers.[9]

**normogeusia** - Normal gustatory sensitivity.

**olfaction** - Sense of smell.

**orodynia** - Painful, burning mouth.

**parageusia** - Changed perception of taste qualities.

**phantogeusia** - Perception of taste without a stimulus.

**phenotype** - Observable traits or characteristics of an organism produced by the individual's genes interacting with the environment. Phenotype is the immediate cause of genetic disease and the object of genetic selection. The physical appearance of an individual such as eye, hair color or general physical traits and characteristics of the person.

**PROP** - The PROP (6-n-prophylthioruacil) is a sensitivity test used to detect the bitter taste that the patient may or may not exhibit.

**pruritis** - Peculiar irritating sensation in the skin that arouses the desire to scratch.

**PTC** - Phenylthiocarbamide is a sensitivity test used to detect the bitter taste that the patient may or may not exhibit.

**receptor cells** - These cells detect taste and are referred to as gustatory receptor cells.

**taste phantom** - Taste with no obvious stimulus. Examples most common are bitter and metallic taste perception.

**somatosensory sensations** - Subjective feelings of oral sensations of sandiness, roughness or dryness in the mouth.

**stomatodynia** - Used as a synonym with BMS and idiopathic burning mouth.

**sub-tasters (also called non-taster)** - Approximately 25% of the population is known as sub-tasters. These individuals do not have a keen reaction to any taste sensation. They have no reaction to PROP when administered on a test strip.

**supertasters** - Patients who have a heightened sense of taste and of smell. Supertasters have a propensity toward BMS.

**syndrome** - The combination of several simultaneous signs and symptoms of varying intensities associated with a particular morbid process-which together constitute the picture of a disease or inherited anomaly.

**taste** - Taste or gustation is a chemical sense that includes five primary tastes: sour, sweet, bitter, salty and umami (savory). All taste sensations occur throughout the mouth and may be a combination of all the five tastes.

## Introduction

Have you ever had a patient who complains about everything that you use in their mouth during a dental appointment? Are they often bothered by the normal scents in your dental office? Perhaps they complain about the smell of disinfectant, the scent of a drill as it cuts tooth structure or maybe tactile stimulation such as the saliva ejector or possibly the placement of cotton rolls? The patient may complain about the highly flavored taste of fluoride to the extent it is almost intolerable and they may exhibit a gag reflex when a flavored prophy paste is used? Any dental products that are used in tooth restoration preparation, etc. may be profoundly objectionable to such patients. Perhaps you may be treating what is termed a patient who is a **Supertaster**! Or perhaps these characteristics remind you of a relative or even yourself. Could you be a supertaster?

So what is a supertaster? Supertasters are defined as a subgroup of individuals who are genetically programmed with a bitter receptor gene (TAS2R38). In testing for the supertaster status, the patient will report intense bitterness, specifically from the chemical propylthiouracil (PROP) and phenylthiocarbamide (PTC). Supertasters are genetically programmed to react to “bitter” taste and find food sources that are on the bitter side highly objectionable. See Appendix 1 for a list of foods that supertasters “like” and “dislike.” PROP is usually the chemical that is used since it is the least bitter and also the safest.[10] Supertasters are also more sensitive to **fats** and **sweet foods** with a tendency to avoid these types of foods. According to previous research studies, approximately 25% of the population may fall into this category of a supertaster. Most of the world’s general population tends to fall into a middle category, (sometimes referred to as a General Taster) 50% and at the other end of the spectrum are the non-tasters (sometimes called sub-tasters) that account for the other 25%. Non-tasters are opposites on a continuum with supertasters and find sugar, fat and sweeter foods more favorable.


It is interesting that individuals do not taste products to the same extent, nor do we all experience scents with the same intensity. The sense of smell and taste are highly linked. The sense of smell is also a developed one, and we react to certain scents after being exposed to them in a prior experience with some being pleasant and others unpleasant. Our thoughts and emotions become associated with these scents of the past. Within the United States, roughly 25% of the population who are known to be supertasters are women, Asians and African-Americans. The mid-range of the population (approximately 50%) fall into a central category between the two extremes.

The taste perception of these individuals may also vary depending upon the number and size of the individual's own taste buds and receptors. There are ranges within each of these categories. Since most people have not heard of supertasters, it is probably safe to say these percentages may be considered estimates. The percentages are based on previous studies of select groups, and this is discussed in more depth within this article.

Taste and smell are intertwined. The NIH estimates over 200,000 individuals visit a physician yearly because of chemosensory problems such as taste disorders and many more go undiagnosed, but the patient may complain about taste and smell issues. Patients report surprise when they find that taste and most flavors are recognized through the sense of smell.[24,25] Because of this association, many supertasters cannot tolerate certain scents such as perfumes, scented lipsticks or, as mentioned previously, the scents in a dental office. So why is the designation of a supertaster important to the dental professional? Some disease states result in the total loss of the ability to detect an odor (anosmia) or the reduced ability to smell (hyposmia) along with these changes, a loss of taste (ageusia) may also suggest a disease state such as Parkinson's Disease. We continue to learn about these connections in taste or smell and their relation to serious disease states.[35,36] Rhinosinusitis is a common disorder accounting for an estimated 13 million physician office visits in the United States each year. It is known to have contributing factors such as genetics, environmental exposures, and impaired mucociliary clearance. Rhinosinusitis is associated with a poorer quality of life and may encompass a loss in the sense of smell over time, sinus/nasal surgeries, plus many office visits. Recent studies by Adappa, et al.[40] sought to determine if a correlation between T2R38 phenotype and in vitro biofilm formation existed.[39] The researchers found a correlation with bitter taste receptor T2R38 and decreased function in nonpolypoid chronic rhinosinusitis that may make patients more susceptible to sinonasal infections.

Although supertasters have some tendencies toward a few health concerns, and, according to current research, they may also be more ***protected*** from other disease states such as dental caries while sub-tasters are more ***prone*** to dental caries and even obesity because of their food choices (e.g., sugar and fats). Supertasters reportably use more salt and eat less vegetables because of their aversion to bitter tastes and this may predispose them to heart disease and to colon cancer.

Supertasters are found more often in women, and women tend to have more fungiform papillae than men. Women also perceive more oral burn from mouth irritants.[3] Since supertasters are genetically programmed, these tendencies to prefer certain foods may be observed in young children and may answer some age-old questions as to why my child will

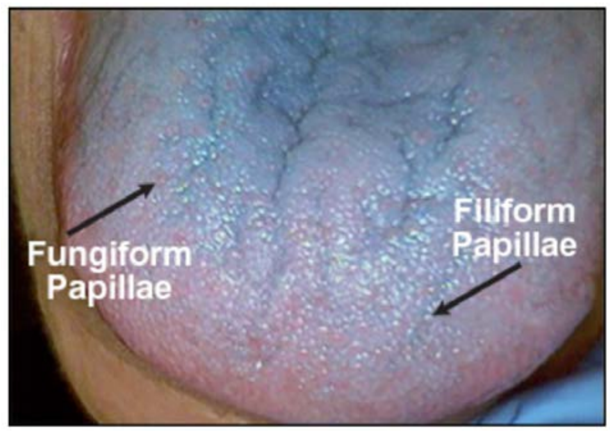


**Figure 1.** Arrow indicates fungiform papillae. Note the fungiform papillae are light pink, mushroom-shaped, in contrast to the filiform papillae.

**Figure 2.** Closer view of a supertaster tongue. Note the prominent fungiform papillae.

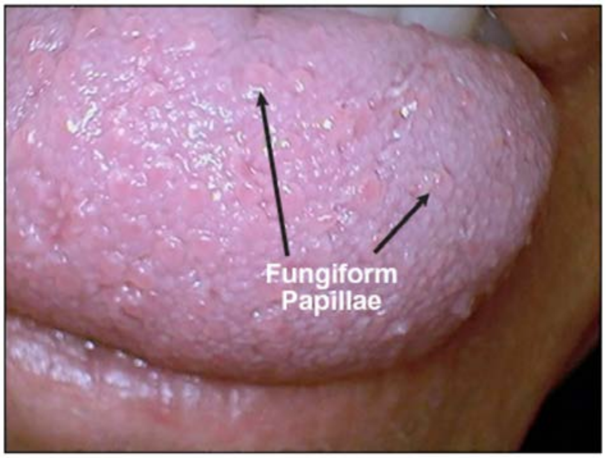

**Figure 3.** Unstained tongue: large fungiform papillae visible.


**Figure 4.** Supertaster.


**Figure 5.** Supertaster with stained tongue.

not eat certain foods or why the child is a "picky eater!" With our youth, who are susceptible to dental decay, obesity and even diabetes, this deserves considerable research now and in the future. Obesity rates continue to rise in the United States, and the current generation may be the first to have a shortened life span compared to their parents because of chronic diseases related to being overweight. From a dental perspective, their food choices may affect the oral tissues, future oral disease states and the teeth long-term. This course also gives the practitioner a better understanding of why some products used in the dental practice cause discomfort for the patient.

Studies by Melis et al. evaluated the density and morphology of fungiform papilla along with the gene that controls the salivary trophic factor known as gustin. Gustin has been described as a trophic factor responsible for the growth and maintenance of taste buds. In the study by Melis, the higher the taste intensity of the supertasters on a scale determined by the researchers, the greater the density of the fungiform papillae.[23] The fungiform papillae can be counted within a small area of the tongue after being stained with a blue dye or blue food coloring (Figures 4 and 5). The filiform will stain blue and the fungiform will retain a pink color making them appear more prominent.

The higher numbers of fungiform papillae can be associated with those numbers found in supertasters. The density is determined by more sophisticated histology and microscope procedures. Other simple tests can be performed such as the PROP or PTC tests that will be discussed later in this course. These tests are used to differentiate a supertaster from a non-taster or from the rest of the general population. Another indicator that assists in confirming a supertaster is to count the number of fungiform papillae in a designated area on the tongue after staining the tongue so the fungiform papillae are more distinct (Figures 6-10). The authors believe that since the numbers do vary greatly, the most accurate way to determine the supertaster is by using a genetic test or by using the PROP test strips.

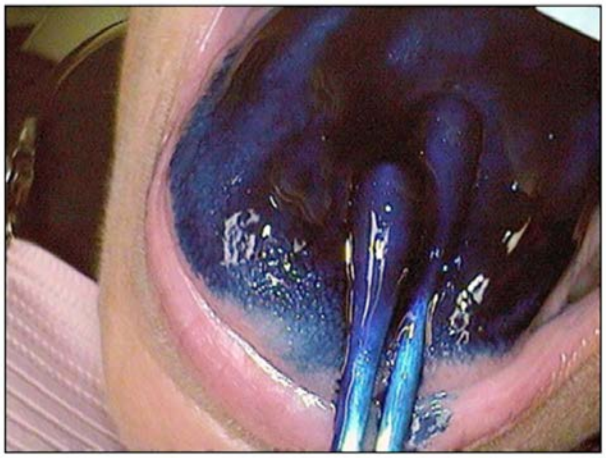

**Figure 6.** Staining tongue: Be sure to place Vaseline on the lips and also get the dye into the small crevices.

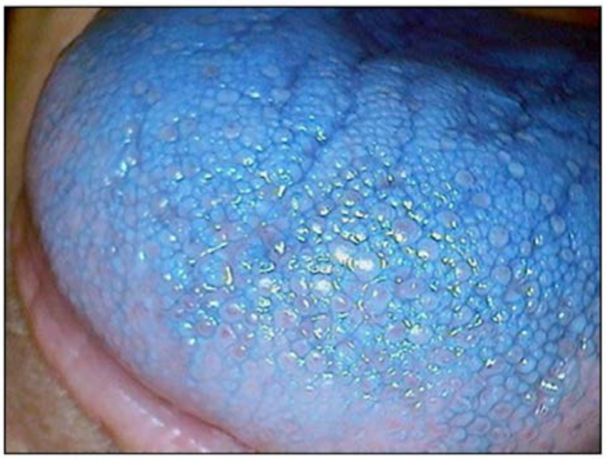

**Figure 7.** Blue stain on tongue of a supertaster. Note the numerous fungiform papillae.

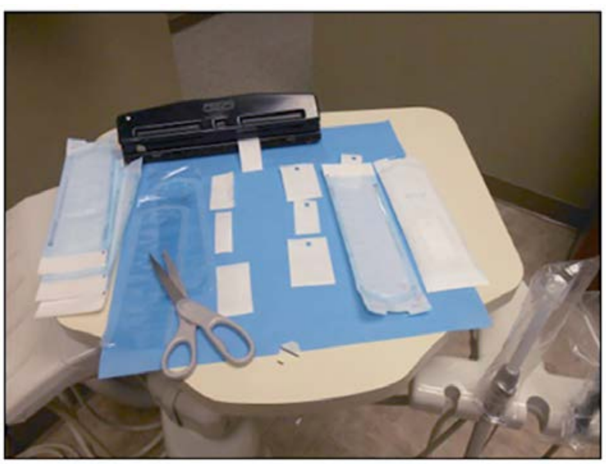

**Figure 8.** Set up for the hole punch.

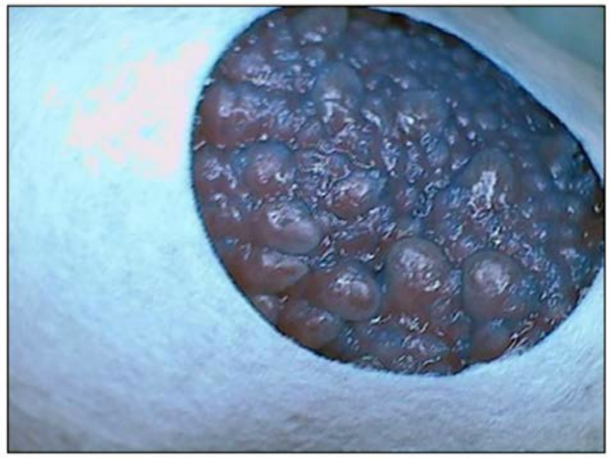

**Figure 9.** The use of paper with a hole punched out allows counting of the fungiform papillae. This acts to isolate the papillae within a 6mm diameter.

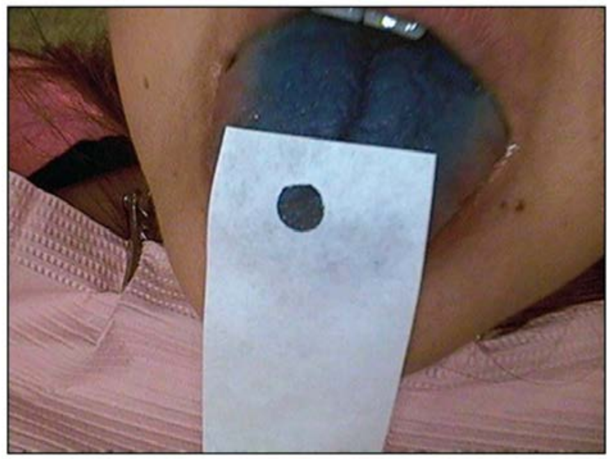

**Figure 10.** Hole punch for measurement of the fungiform may be used to test for supertaster individual.

On average, supertasters will have noticeable fungiform papillae numbering 35, average tasters will have between 15 and 35 and non-tasters will have less than 15 papillae (Figure 9). The numbers will vary with different researchers. There is some thought that the numbers vary with some patients who use this technique and that it is too subjective. Eldeghaidy, et al. 2018, expands on the numbers of fungiform by an automated technique of counting the fungiform rather than a manual calculation. The researchers suggest that this technique is a more reliable quantification in numbers over the anterior surface of the tongue in supertasters who tested for PROP.[38] It is known that the larger the fungiform, the more taste bud receptors the patient may have orally; therefore, the intensity of taste may increase with an increase of the receptors. The procedure of staining in the clinic does give the patient an opportunity to witness the appearance of the fungiform papillae as the clinician educates them about taste. Some studies have concentrated on small areas of the tongue and taste buds/ receptors are throughout the mouth, so data has been very mixed with regard to the relationship of supertasters and numbers of fungiform papillae.

The three ways to evaluate a supertaster would be (1) genetic testing, (2) use of the PROP test and (3) clinically evaluating the fungiform papillae for size and number. Genetic testing is the most reliable way to confirm a supertaster. However, the PROP test is easy and very immediate.

The tongue is an important structure in the mouth and is a predictor of many disease states. It has been used for hundreds of years in Chinese medicine as an indicator of overall health and is one of the first structures someone who practices Chinese medicine will evaluate in a clinical examination.[8] The tongue is covered with papillae containing numerous taste buds that are sensitive to the chemicals ingested in both food and drink. When these chemicals are dissolved in saliva, the specialized gustatory cells react to the chemicals (chemosensory acuity is heightened in supertasters). The receptor cells activate sensory neurons that are part of the facial and glossopharyngeal nerves (Figure 11).

Injury to the nerve supply may affect the taste sensations of the individual. So when a taste nerve is injured, taste may be affected. For instance if damage occurs to the chorda tympani in middle ear surgery, taste may be altered (Figure 11). Taste receptors are innervated by the chorda tympani branch of the facial nerve and oral burn receptors are innervated by the trigeminal nerve.[4] Taste buds are surrounded by trigeminal fibers. Supertasters have more taste buds and are

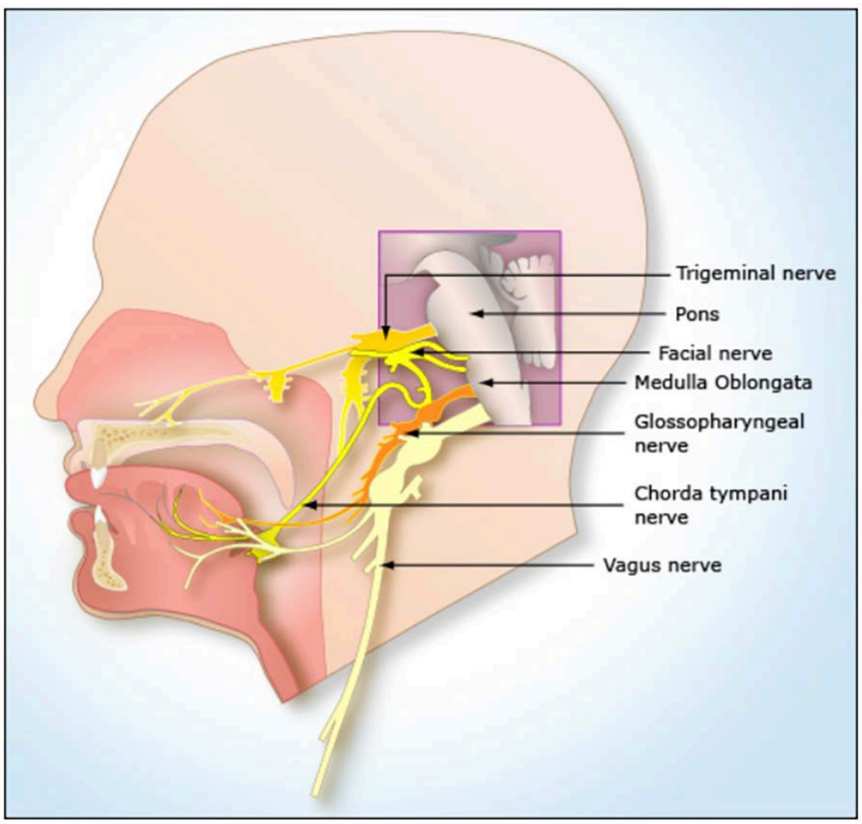


**Figure 11.** Nerve Diagram.

susceptible to more nerve fiber stimulation. A supertaster is described as someone who has an abundance of fungiform papillae as opposed to the “general tasters” and “sub-tasters” who have much fewer fungiform in number and density. Therefore, fewer taste buds may produce a decreased sense of taste. Taste is perceived in the brain via the nerves. Taste receptors actually are throughout the entire gut as well as the oral cavity. The entire tongue has abundant taste buds, and the fungiform papillae are most abundant in the anterior two thirds of the tongue. The taste buds have taste receptors that last about 10 days and are steadily replaced by the basal cells. The sister cells become a supporting cell and ultimately, a taste receptor cell (Figure 11).

Supertasters tend to enjoy foods that are relatively bland and non-spicy foods are preferred. Higher rates of supertasters are more likely to suffer from Burning Mouth Syndrome (BMS) in later life.

Sub-tasters or non-tasters, on the other end of the spectrum, have fewer fungiform papillae, in the anterior tongue region and are more likely to enjoy very spicy foods as they can better tolerate the nerve input since they also have fewer taste receptors and/or taste buds. The non-tasters, therefore, are also less likely to have BMS while the supertasters are believed to have higher rates of BMS. Orally, taste buds are receptors of taste and occur on the tongue, soft palate, pharynx and epiglottis. Early in life we have as many as 10,000 taste buds but these decrease with age. Each taste bud consists of three kinds of cells: basal cells, supporting cells and gustatory receptor cells. Supporting cells contain microvilli and gustatory receptor cells. In order to detect taste, the taste buds contain a taste pore with an opening allowing the gustatory hair to extend to the external surface (Figure 12).

A patient may complain of specific taste changes or changes in taste perception with no obvious stimulus. This is referred to as *“taste phantom”* and the patient may also complain of a “metallic or bitter” taste. Interestingly, patients who have BMS often voice this complaint of taste change.[27] A retrospective study by Fark et al., presented study results of 4,680 patients and 491 exhibited taste disorders. The most frequent cause of disorders was posttraumatic injury (24%), postoperative (15%) but 34% were termed idiopathic and often BMS falls into this category. Those who were idiopathic and postoperative complained mainly of taste sensations of bitter, salty and sour taste. Fark points out taste is primarily related to the

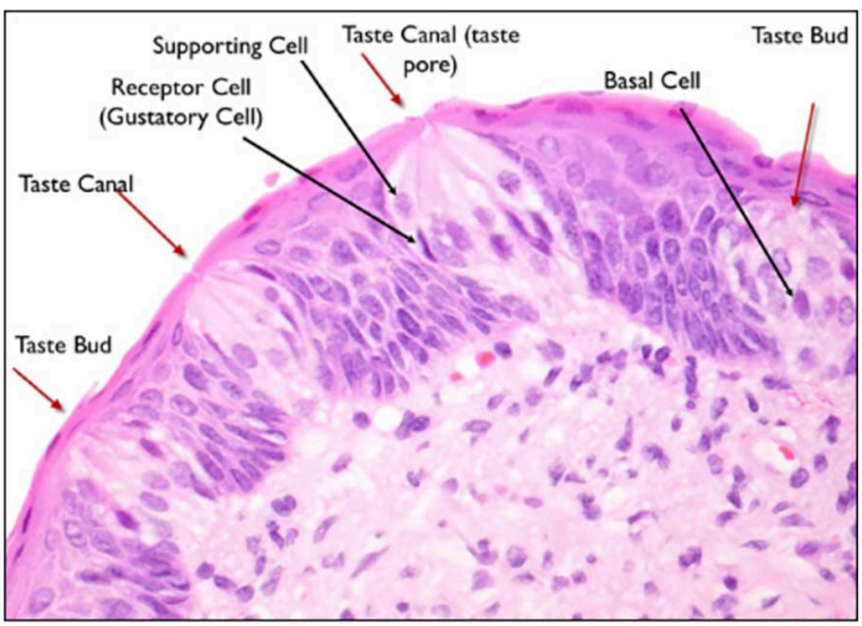


**Figure 12.** Histology of a papillae.

input from three different sensory systems: retronasal olfaction, mechano and chemo sensitivity via the trigeminal nerve and the gustatory system.[11] Taste sensation is very complicated and patients with long-term complaints usually are referred to a taste and smell clinic that specializes in assisting the individual in assessing and eliminating the offending taste or smell problem. For a list of Smell and Taste Clinics in the United States see **Appendix 2**.

## The Etiology of Taste

Taste or gustation is a chemical sense that includes five primary tastes: sour, sweet, bitter, salty and umami (savory). Basic taste was once described as being specific to certain tongue locations and this was referred to as “Tongue Mapping,” but we now know taste can occur at multiple locations in the mouth and taste is also intertwined with the sense of smell (along with all the memories we have stored that cause association with certain scents). All taste sensations occur throughout the mouth and may be a combination of all the five tastes as originally mentioned. When mixed with saliva, flavors and taste are disbursed throughout the mouth and perceived as those listed previously. Supertasters are more often detected in children because of their eating habits and food preferences. It is suggested a bitter sensitivity may be modified during life and may decrease somewhat in later life through “adaptation” but food preference is especially noted in children. The olfactory and tactile sensations also play major roles in our ability to perceive these taste sensations and tactile sensations. An example is that some children will not eat certain foods - and this is not only because of taste but also simply because of the texture. They are often described as “picky eaters.”

**Papillae of the tongue:**

- The fungiform papillae have taste buds on their dorsal surface. Generally, supertasters have an increased number and density of fungiform papillae on their tongue and especially on the anterior two thirds of the tongue.
- The filiform papillae are conical epithelial projections with thick cornified layers and they do not contain taste buds. These papillae act as an abrasive coating that aids in cleaning the mouth with the help of saliva. They also assist in moving food through the mouth.
- The vallate papillae contain numerous taste buds on their lateral surface. These papillae are eight to ten in number and are a V-shaped line at the base of the tongue. Each bud is a small ovoid or barrel-shaped organ that extends from the basal lamina to the surface of the epithelium. The outer surface is covered with epithelium.
- The foliate papillae are located on either side of the tongue, posterior to the vallate papillae.

These papillae contain taste buds as well. Taste buds are made up of gustatory cells (receptor cells), basal cells and supporting cells. As stated previously, each cell has a function. The taste pore is an opening to the outer surface of the papillae allowing the gustatory hair (only seen with electron micrography) found in the taste bud to reach the outside environment. Within each taste bud, there are gustatory cells (10 to 12 neuroepithelial cells) that are the receptors of taste stimuli (Figure 12).

These microscopic hair like processes reach into the space beneath the taste pore. Taste occurs when a chemical substance contacts a receptor cell in the taste bud and the chemical fires the nerve in that area of the taste bud. The electric impulse is then sent to the brain and the brain perceives this sensation as taste when it reaches the brain.

When viewing fungiform papillae microscopically, they have a fairly distinct appearance. They show a slight elevation of the surface that is typically broad and flat-topped. The taste buds are found primarily on the flat top surface of fungiform papillae. In the circumvallate and foliate papillae, there is a crypt-like space around the structure and taste buds (the neuroepithelial cells that act as taste receptors) are found in the epithelium adjacent to the crypt-like space. A very prominent sub-epithelial nerve plexus is present in the connective tissue. As food is beginning to be broken down by the saliva, the chemicals responsible for taste are dissolved into the saliva that seeps into the crypt and is subsequently picked up by the receptors and interpreted as taste. The dissolution of the food also produces some aerosolization of the chemicals, which is picked up by the olfactory apparatus in the nose. So supertasters can sometimes be identified because they have a very strong sense of smell-they often can detect the most subtle of scents such as a light perfume or normal dental office scents. Hayes and Keast 2011 state there is continuing supporting evidence supertasters have a greater chemosensory acuity.[15] This concept fits into the current information that many supertasters are involved in food evaluation and food tasting (e.g., chefs, wine tasters) because these individuals are able to discern subtle taste changes. Some supertasters can identify even the least of ingredients that have been added to foods such as spices.[33] Wine tasters fall into this category and actually use these abilities to make a living. Hayes also suggests a more defined use of the terminology suggesting the term "Hyperguesia" as a heightened taste response.[15] More research needs to be conducted in chemosensory variation and the classification of all taste variations.

Taste sensations occur because they are conducted by three nerves that have direct supply to the tongue and oral tissues; they are the Facial nerve, the Glossophargyngeal and the Vagas nerve (Figure 11).

Surgery to the middle ear may affect the chorda tympani causing a change in the sense of taste. In some cases, a tonsillectomy may damage the glossopharngeal nerve causing this change.[11] Chronic ear infections and upper respiratory infections may also damage the middle ear since the cranial nerve passes through this area (refer to Figure 11 for the nerves involved).

The taste sensation is not recognized until it is mixed with certain chemicals when dissolved in saliva and then detected by the receptors in the taste buds. Various causes of xerostomia should be evaluated as well. A dry mouth limits taste perception because the food is not mixed with saliva and does not circulate throughout the mouth. Clinicians report that a dry mouth is often a complaint by patients describing a metallic taste, phantom taste and sometimes a bitter taste as voiced by supertasters. Some of the taste, dry mouth and taste-associated factors have been found in patients with BMS as well.[32] Patients with this complaint tend to be found more often in women.[14,20] Saliva acts to dissolve strong concentrations in the mouth, so a certain taste may be more accentuated within a dry mouth because it is not circulated throughout the taste buds. The patient may complain of somatosensory sensations that are subjective feelings of oral sandiness, roughness, phantom tastes or dryness.[4] Supertasters tend to avoid very textured foods and descriptions by patients are qualitative in nature with great variation. Supertasters also avoid very fatty foods, again because of the unpleasant texture they sense. A key point should be made here: although these sensations may be reported by some patients, supertasters are supertasters from birth because of the genetic component; therefore, the patient may not know any difference in taste or be able to describe these taste changes since they have always reacted the same way to foods and/or scents and have no comparison. Some confusion with other disorders may tend to overlap and need to be differentiated.[17]

Spicy foods like capsaicin (the substance that makes chili peppers taste hot) can sometimes be tolerated but the adjustment is not made by taste buds. Rather, the receptors that respond to hot spices are called "polymodal nociceptors," and the oral burn produced by these receptors projects to the brain via the trigeminal nerve (Figure 11). These receptors can desensitize the burning sensation over time.[18] If you eat foods containing capsaicin, the burn will diminish through desensitization. However, this adjustment is only temporary. If the person decides to discontinue the process and begin to use capsaicin again at a later time, the burning sensation will return. Even the airlines have begun to take notice of the way that individuals taste. This perception of taste is accentuated or diminished, while flying in pressurized cabins. Passengers often complain about tasteless food and how terrible the food is on an airplane. When flying at normal altitudes, our perception of sweet and saltiness drops by 30%. Pressurized cabins cause our mucous membranes to swell, blocking the pathway to the olfactory receptors in the nose. As stated previously, taste and smell work together to provide the wide range of tastes we experience. Airlines are introducing new ways to accommodate the different modes of tastes to address the wide range of tasters. Multiple airlines have been researching this problem and it is possible that we will see changes in the types of foods that are served.[34] Additional information on this subject can be found in the resources section.

The sense of taste evolved to discriminate beneficial foods from environmental poisons as a critical system to ensure human survival.[26] Recent studies by Herbert et al. looked at the startle reflex response or eye blink response.[17] Results from the study indicate a link between PROP positive tasters (supertasters) and relevant patterns of emotional responding. This link with supertasters may reinforce the survival mechanism and the heightened sense of both taste and emotional responding.

The characteristics of supertasters include their ability to taste foods with an increased awareness but also an increased intensity as well. Bartoshuk describes supertasters as being in a "neon taste world."[4] Supertasters tend to use more salt on their food and they eat less vegetables that have a bitter taste such as kale, brussels sprouts and broccoli.[34] These individuals report an aversion to dark coffee, radishes, hard liquor, chocolate, and any vegetable that has a somewhat bitter taste including the cruciferous vegetable category. See **Appendix 1** for a list of foods that supertasters "like" and "dislike."

## Diagnosis of Supertasters

So, how are **Supertasters** diagnosed (see **Appendix 3**)? Most supertasters know from childhood that they have a strong sense of taste and smell. They just know that certain foods appeal to them while they voice a strong aversion to other foods. Confirming they are supertasters provides the person with information not only for themselves, but also for other family members or possibly future children as well because of the genetic component. Supertasters are tested for a bitter sensation and for bitter taste receptors (T2Rs). These receptors belong to a family of genes, the T2Rs, and they are needed to complete all our taste receptors. They are thought to protect against the ingestion of toxic compounds, including bacterial products from spoiled foods. It is believed this genetic trait was useful for survival and has been retained by some individuals while not in others such as the non-tasters (sub-tasters) and the general population (mid-tasters). Mid-tasters may be able to taste some bitter, but it is not on the same scale as the taste perception of supertasters who react substantially to bitter tastes. See **Appendix 4** to view Using the Intraoral Camera to Educate Patients about Papillae. Several taste tests are used to diagnose the supertaster. A paper strip imbedded with the chemical known as PROP is placed on the anterior tongue region (Figures 13-14). A clinical assessment is also provided in the "*Let Me See Your Tongue*" video by Carol Perkins on supertasters.

And, a control strip is used prior to the PROP strip. A chemist named Fox discovered the origin of the supertaster quite by accident while transferring a white powder 6-n-propylthiouracil or PROP, from one container to another. When this product became airborne, his colleague, Noller, found the taste extremely bitter while Fox had no sense of taste from the powder. And, at this point, the quest was to discover the characteristics of the body's reaction to the powder and why one person would react in such a way, yet another person would have no reaction.

The supertaster will find the PROP strip *extremely* bitter, while a non-taster will find no difference in the two strips. The non-taster will find the PROP strip taste like a piece of paper that has no flavor. A general taster, 50% of the population, will find the PROP strip to have a very mild bitter flavor. The PROP sensitivity test (6-n-prophylthioruacil (PROP) and phenylthiocarbamide (PTC) are used to

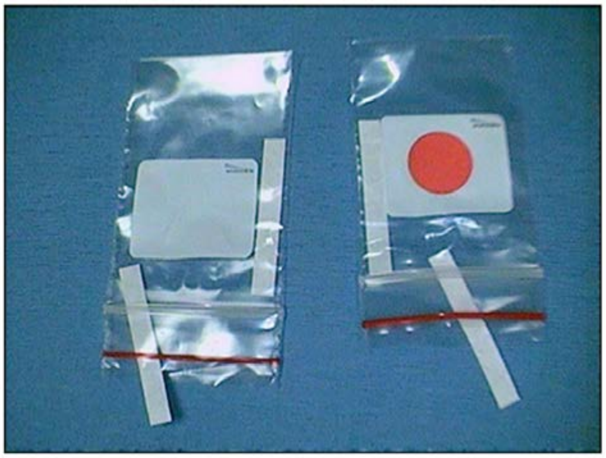

**Figure 13.** PROP strip with white circle on package. The control strip has no flavor and is in the package with a red dot on the outside.

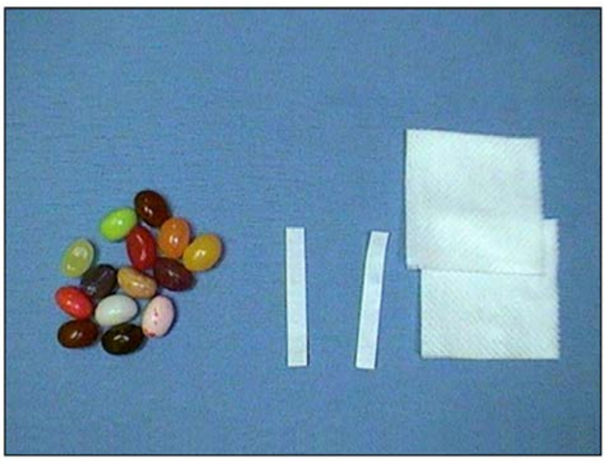

**Figure 14.** PROP strip with jellybeans that can be given to supertasters to counteract the bitter taste after using the PROP strip.

detect the bitter taste. PROP is a medication that has a bitter taste and is used in the treatment of Graves' disease (hyperthyroidism) but can be tasted by supertasters in a very low and safe concentration. The general population and non-tasters (sub-tasters) will not be able to discern a specific taste in most cases and only slightly bitter in some individuals in the general population. However, not with a highly objectionable taste as is found in the case of the supertaster. A jellybean or peppermint is usually offered to the supertaster in order to diminish the taste after using the PROP strip (Figure 14). (See the "*Let Me See Your Tongue*" and "*How to Know If You're a 'Supertaster'*" videos).

These individuals have a gene that allows them to taste the bitterness of the chemical immediately and there is no delay. It is thought by many researchers because of the numbers and density of the fungiform there are more taste receptors present for immediate pick up by the taste buds. Melis, et al. looked at Gustin and fungiform papilla density in groups of patients and found patients who perceived the highest PROP bitterness had higher papillae densities compared to those who perceived PROP at a lesser intensity. They also found a single A allele in the gustin gene produced small papillae with a regular morphology, but did not find this characteristic in the TAS2R38 genotypes.[23] Recent studies by Garneau et al. 2014, found some conflicting information in their study. The researchers presented results citing "our population data provides no evidence to substantiate prior reports that the increase and density of fungiform papillae is predictive of PROP intensity rating and it contributes to super tasting."[12] In studies by Negri et al., conclusions were made and their findings suggest variation in PROP sensitivity and ultimately in the chemosensory ability of supertasters, may be influenced by taste bud density mediated by a functional gustin gene.[26] The debate continues with varying information. The reason why supertasters so strongly react to bitter taste is debatable, but supertasters do react to the PROP strips and those tested do have the genetic trait (Figures 13-14).

## Discussion of Health Facts Regarding Supertasters

So, are there any positives or negatives to being a supertaster? Yes, there appear to be a few positives and concerns with all types of tasters. It is known that supertasters have enhanced defense mechanisms against inhaled toxins, pathogens and particulates in the respiratory system with enhanced immunity and maintenance of a clean airway as noted in the study by Lee et al.[21,22] Respiratory disease such as chronic rhinosinusitis affects approximately 35 million Americans at a cost of $6 billion annually. Added to this, Lee et al. state 1 in 5 antibiotic prescriptions occur because of rhinosinusitis. Adappa et al. found patients testing positive for the bitter receptor gene T2R38 were less likely to need surgical intervention for chronic rhinosinusitis.[1,2] More research is being conducted in this area of study with more funded research projects in the future.

A recent study by Shetty et al. in 2014 found a much lower caries rate in children who were supertasters compared to those in the non-taster group. The PROP test was used to assess the supertasters, tasters (mid-tasters) and non-tasters (sub-tasters). The research was undertaken because knowing the potential of an increased risk of caries rates in a group of children is beneficial in long-term oral health. Shetty found a lower rate of caries in the supertasters, but a higher rate in non-tasters (sub-tasters). The non-tasters tended to consume the sweeter type foods, but supertasters tended to avoid these foods.[28]

Hedge and Sharma found similar results in a group of 500 children ages 8-12. Body mass index was assessed and caries rates recorded. The supertasters appear to remain thinner than their non-taster counterparts or even the middle group of tasters. The non-tasters tended toward more obesity with higher caries rates.[16] Recent studies by Karmakar, et al. found that nontasters in a group of children had a greater caries rate than supertasters.[38] The preference for sugar and sweet products would increase the likelihood of decay. Keller and Tepper also assessed weight differences. Researchers found different results in eating habits and body weight of boys who were non-tasters, and they reported increased consumption of proteins compared to taster groups (the general population as well as supertasters).[19]

In a study by Goldstein, the PROP non-taster phenotype was strongly associated with several measures of adiposity in middle-aged women as well. The researchers suggested this might indicate the susceptibility of weight gain in non-tasters since they tend to consume more sugar/sweet foods and also more fatty foods such as fatty meats over time.[13] This may be a negative consideration for the non-taster since consumption of more fatty foods may increase the level of heart disease as well. Non-tasters have a lower perception of the taste of saccharine, potassium chloride, sodium benzoate and potassium benzoate and to the sweetness of sucrose. The sweetness consumption is associated with weight gain and high fructose corn syrup consumption to diabetes. Of course, this could increase the rate in adult onset diabetes as well.

A concern with the supertaster is the avoidance of the dark green vegetables since they may be beneficial in lessening the chance of diseases such as colon cancer. Not eating green vegetables may lead to more colon cancer because of the lack of protective chemicals. This may especially be relevant with young children since some tend to be labeled as "picky eaters" very early on. They will have a lifetime in avoidance of these types of cruciferous vegetables. Campa et al. did not establish a connection with colon cancer in a 2010 study, but the researchers concluded they lacked sufficient statistical power to exclude the possibility of a connection with colon cancer.[7] Searching for alternatives to the more bitter vegetables may insure the child receives enough of the needed nutrients and fiber. Researchers are investigating the connection of the supertaster with colon cancer.

A third positive factor related to supertasters is they **do not** tend to over indulge in alcohol. In fact, it is the non-tasters that tend to consume more alcohol. Studies by Duffy et al. found alcohol use to be less in supertasters but much higher in non-tasters.[10] This would make sense because alcohol often has a bitter taste and non-tasters do not react to this taste sensation making the product more tolerable or pleasant for non-tasters. Supertasters react more to the bitterness and non-tasters tolerate the bitterness much better. Individuals who taste the PROP chemicals as most bitter tend to experience more negative sensations from the alcohol. They concluded the decreased taste on the anterior portion of the tongue might remove the usual inhibition that taste has on trigeminal sensations from this part of the tongue in older individuals making alcohol more tolerable. Therefore, older age groups of supertasters may tolerate the taste much more than they did at a younger age.

Benson et al. sum up the importance of gene research and why the subject of supertasters should matter to us: “It matters because new knowledge about the molecular basis of food likes and dislikes in children, known to be a generation that will struggle with obesity and diabetes, may suggest strategies to overcome diet-induced diseases.”[5]

## Conclusion

The concept related to the supertaster is most interesting, and the facts related to sub-tasters have not been extensively explored in the dental community. The tongue and papillae are structures that the dental professional is so familiar with and yet, most of us do not know many of the facts stated in this continuing education course.

Most oral professionals have been asked taste questions by patients, and we often do not know how to respond nor do we know enough about taste functions to respond appropriately. When oral pain or taste changes occur, the patient associates any changes as being dentally related. The dental professional is the person who usually receives these questions related to the tongue and taste. BMS is an example of both taste changes and pain that usually fall into the realm of a dental issue.

Scientists have found at least one gene that appears to influence a person’s ability to taste or appreciate a particular flavor and in the future we may find much more evidence that taste is highly influenced by one’s genetic make-up. Many of the factors related to tongue pain and taste changes continue to be researched and it becomes apparent how much the mouth is intertwined with systemic health. The current generation may be the first generation to have a higher rate of both obesity and diabetes. Chronic health issues mean the person may also have a shorter life span compared to previous generations. Taste and smell are intertwined and some health conditions have as side effects both changes in not only taste but the ability to differentiate various odors as well. Identifying supertasters and food choices may also make a difference in the quality of foods we all consume and better food choices will make a difference in our health. Children are at particular risk and current research data links sub-tasters to higher caries risk. Since supertasters avoid the types of green vegetables we know are healthy, food science researchers can use this information to alter food choices that appeal to various tasters whether they are sub-tasters or supertasters. Future research is very encouraging in this field linking diet and health.

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Appendix 1

# Is Your Patient a SUPERTASTER?

**Adult or child supertasters exhibit certain food preferences:**
Any individual supertaster may display exceptions to the list below. The foods listed will vary with different ethnic groups and within other food norms of various countries.

Create your own list using this example.

**Foods that supertasters tend to like:**

***Vegetables:***
- Green beans
- Peas
- Celery
- Lettuce
- Lima beans
- Carrots
- Snow peas
- Leeks
- Corn
- Cabbage raw as in coleslaw

***Meat:***
- Chicken breast
- Turkey breast
- Bacon
- Steak (no marinating or peppercorns)
- Pork chops or pork loin (no marinating)
- Ham
- Meat loaf with hamburger, ground veal or pork (hold the peppers & onions)

***Eggs:***
- Scrambled eggs only
- Egg salad

***Fish:***
Like most fish especially:
- Sole
- Halibut

***Soup:***
That are cooked down for hours the 'old fashion way' and not watery

- Split pea
- Chicken noodle
- Bean with bacon or ham
- Lentil Beef barley

***Pasta and Sauces***
- Macaroni & cheese
- Penne pasta
- Fettuccini Alfredo
- Rigatoni
- Spaghetti made with real Marinara sauce that contain no green peppers or onions
- Ravioli with cheese, Alfredo, marinara okay but Bolognese sauce without the garlic
- Marinara sauce that is only tomato sauce

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***Breads:***

- Persian bread
- Real grainy bread called Fred bread

***Fruit:***

- Apples
- Peaches
- Strawberries
- Rhubarb
- Oranges
- Tangerines
- Blackberries (no raspberry)

***Nuts:***

- Walnuts
- Cashews

***Desserts:***

- Cookies
- Plain ice cream
- Chocolate fudge is the best
- Candy in general especially with chocolate & Carmel

***Miscellaneous:***

- Peanut butter
- Sweet pickles
- Crackers
- Pork & beans
- Baked beans
- Olives
- Salad dressing on the side-usually prefer Thousand Island or Ranch
- A supertaster is known to take their own salad dressing out to the restaurant and order their salad with their dressing on the side so the supertaster can use their own.

**Foods that supertasters tend to <u>dislike</u>:**

***Vegetables:***

- Bell peppers (green, red, & yellow)
- Broccoli
- Asparagus
- Turnips
- Brussels sprouts
- Radishes
- Cooked cabbage

***Meats:***

- Steak that is marinating or cooked with peppercorns
- Pork chops or pork loin that has been marinating
- Generally any fatty type of meat

***Fish:***

- Shellfish due to texture
- Sea Bass because it is not firm
- Swordfish

***Desserts:***

- Dislike the lumps in Tapioca pudding because of rough texture
- Very sweet desserts
- Ice cream with nuts or brittle (texture)

***Miscellaneous:***

- Salty foods
- All chips
- Tea
- Wine
- Garlic
- Curry
- Mustard
- Licorice
- Cumin
- Cigarette fumes/odor are unpleasant for a supertaster
- Any type of chips with vinegar
- Dark roast coffee
- Hops beer
- Raw onions (including green onions)
- Dark chocolate
- Cilantro
- Vinegar
- Coriander

Appendix 2

## Smell and Taste Clinics

**University of Florida Center for Smell and Taste:**
Dr. Linda Bartoshuk
Director of Human Research
LMbart@ufl.edu
352-392-1991 Ext. 213

**Monell Chemical Senses Center**
3500 Market St.
Philadelphia, PA 19104-3308
http://www.monell.org/

**The Smell and Taste Center, The University of Pennsylvania**
http://www.med.upenn.edu/stc/

**University of Connecticut Health Center:**
http://uconntasteandsmell.uchc.edu/patientcare/

**University of Pennsylvania-Penn Medicine**
http://www.pennmedicine.org/ent/services/smell.html

**Henry Ford Health System: Neuroscience Institute**
http://www.henryford.com/body.cfm?id=49056

**University of Colorado Hospital**
http://www.uch.edu/conditions/ear-nose-throat/smell-tastedisorders

**The Taste and Smell Clinic, Washington DC 202-364-4180**
http://www.tasteandsmell.com/

**Massachusetts Eye and Ear Clinic**
http://www.masseyeandear.org/for-patients/patient-guide/patient-education/diseases-andconditions/smell-and-taste-disorders/

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Appendix 3

# Testing for Supertaster Status Orally

A test that is often conducted is to use a dark blue food coloring, stain the tongue and rinse the mouth. A paper is hole punched (6 mm diameter) and placed on the tongue. On average, supertasters will have noticeable fungiform papillae at a number of 35, average tasters will have between 15 and 35 and non-tasters will have less than 15 papillae. (see Figure 9). The numbers may vary with different researchers; however, the technique of staining is beneficial in providing an image for the patient and also to open dialogue related to tasting. The larger the fungiform, the more taste bud receptors the patient may have, therefore the intensity of taste may increase with an increase of these receptors.

**Figure 6.** Staining tongue: Be sure to place Vaseline on the lips and also get the dye into the small crevices.

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**Figure 7.** Blue stain on tongue of a supertaster.

**Figure 8.** Set up for the hole punch.

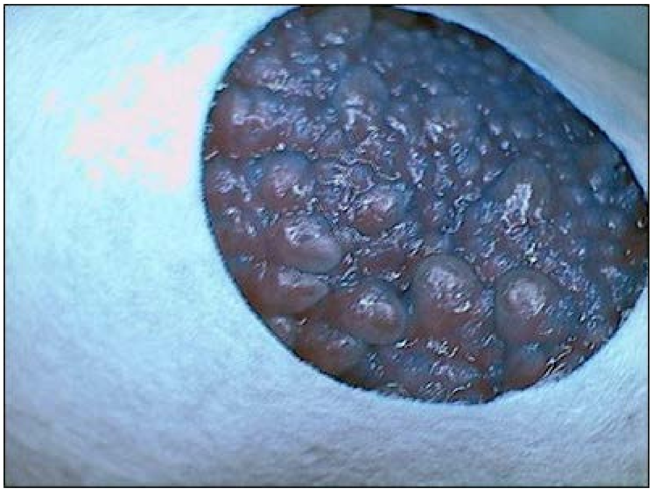

**Figure 9.** Circle paper in order to count the fungiform: This acts to isolate the papillae within a 6 mm diameter and instruct the patient.

**Figure 10.** Hole punch for measurement of the fungiform.

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Appendix 4

# Using the Intraoral Camera to Educate Patients about Papillae

- **Ask patient if you may take an image of the fungiform papillae on their tongue**

- **Have camera ready with**
  1. Computer correctly set up and adjusted
  2. Intraoral camera ready to take the image
  3. Set camera to "one surface" tooth setting or adhere to the proper lens for close or far away images

- **The following information is to avoid a distorted photo because**
  1. Tongue is moving
  2. Your hand may move

- **Verbally inform patient of all steps before taking the image**
  1. Fungiform are visible and abundant *near the tip of tongue* so focus on this area of the tongue
  2. Ask patient to open mouth, stick out tongue and gently bite on tongue (to stabilize)
  3. Blow air on tongue
  4. Rest your "free hand" on a fixed location near the patient's mouth
  5. Rest your hand that is holding the camera on top of "free hand"
  6. Fulcrum technique will steady your hands
  7. Click camera and save to computer
  8. The patient will be able to view the fungiform in greater detail on the computer as you explain the findings

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## Course Test Preview

**1. The chemical that is used to test orally, using a taste strip, for a supertaster is:**
- A. TAS2R38
- B. Propylthiouracil
- C. Bitters
- D. TAS2R37
- E. Phenylthiocarbine

**2. Supertasters account for approximately ____________ of the population.**
- A. 30%
- B. 40%
- C. 50%
- D. 25%
- E. 10%

**3. Subtasters account for approximately ____________ of the population.**
- A. 10%
- B. 20%
- C. 25%
- D. 30%
- E. 35%

**4. The most prevalent class(es) of supertasters would be:**
- A. Asians and women
- B. women
- C. Asians
- D. African Americans
- E. women, Asians and African Americans

**5. It is known through research that a supertaster:**
- A. is influenced early in life to reject vegetables through behavioral conditioning
- B. is genetically marked as a supertaster
- C. learns through food choices, to be a supertaster
- D. may be a subtaster as well as a supertaster
- E. may learn to be a subtaster

**6. The current generation may be the first to:**
- A. have a decreased life span compared to previous generations
- B. develop diabetes at a higher rate than previous generations
- C. develop obesity at a higher rate than previous generations
- D. develop oral disease states including caries at a higher rate
- E. A, B, & C are correct.

**7. Bitter taste receptors T2Rs (Select BEST answer):**
- A. detect the saliva output
- B. are instrumental in detecting compound containing sucrose
- C. are sensitive to compounds that may be detrimental to digestion
- D. detect bitter, harmful compounds and secreted bacterial products
- E. detect bitter compounds

**8. You may evaluate a supertaster by using a PROP test strip, taking a good health history or to confirm by:**

A. taking a diet analysis
B. counting the fungiform papillae in a designated space
C. taking intraoral images
D. asking about family history
E. genetic testing

**9. Sub-tasters or non-tasters tend to eat which of the following types of foods?**

A. bland, low-taste food items
B. very few vegetables
C. many low-fat foods
D. highly spicy foods
E. no cheese or fatty meats

**10. Which of the following statements is false?**

A. early in life we have as many as 10,000 taste buds
B. each taste bud contains three types of cells
C. the taste buds contain an opening to the outside called a pore
D. each pore has a gustory hair that extends to the outside of the taste bud
E. taste buds are only found on the tongue and soft palate

**11. A patient with burning mouth may complain about:**

A. a salty taste
B. taste changes
C. a sour taste
D. a bitter or metallic taste
E. maybe all of these

**12. Which of the following are synonymous when referring to the five primary tastes?**

A. bitter and sour
B. alkaline and sour
C. savory and umami
D. sweet and acidic
E. salty and astringent

**13. The group of papillae not containing taste buds is:**

A. the fungiform
B. the filiform
C. the valate
D. the folate
E. All papillae contain taste buds.

**14. Taste buds contain a ____________ hair that extends to the outside of the taste bud:**

A. receptor
B. basal
C. supporting
D. gustatory
E. neuroepithelial

**15. Supertasters have a heightened sense of:**
A. balance
B. sight
C. smell
D. hearing
E. All senses are heightened.

**16. The nerve that may be injured during a tonsillectomy and cause taste changes is the ____________.**
A. vagus
B. facial
C. glossophargyngeal
D. chorda tympani
E. lingual

**17. Somatosensory means:**
A. a feeling of sandiness or roughness
B. a psychological disorder
C. numbness
D. pain
E. a fatty texture sensation

**18. The taste strip medication containing PROP is derived and prepared in a very low concentration from a medication used to treat:**
A. gout
B. Parkinson's Disease
C. Multiple sclerosis
D. Graves' Disease
E. ALS or Lou Gehrig's Disease

**19. A sub-taster in most cases, will have which of the following reactions to PROP?**
A. a sweet taste
B. a sour taste
C. decreased taste
D. a metallic taste
E. a spicy taste

**20. Supertasters appear to have increased susceptibility to:**
A. multiple sclerosis
B. tuberculosis
C. rhinosinusitis
D. parkinson's disease
E. oral cancer

**21. Sub-tasters or non-taster children have been shown to consume ____________?**
A. less vegetables
B. foods that contribute to more caries
C. high sugar foods
D. high fat foods
E. All of the above are true.

**22. Middle aged women who are non-tasters have been found to be ____________ in comparison to the general population or super-tasters.**

A. taller
B. shorter
C. heavier
D. thinner
E. more muscular

**23. A concern for supertasters is that avoidance of green vegetables such as kale, broccoli, brussels sprouts may increase the rates of ____________ over time.**

A. diabetes
B. kidney disease
C. colon cancer
D. heart disease
E. obesity

**24. Supertasters have been found to use less:**

A. cola drinks
B. alcohol
C. juice
D. tea
E. milk

**25. Alcohol may be better preferred more often by which of the following:**

A. sub-tasters or non-tasters
B. older individuals
C. general populations
D. those with decreased taste on anterior tongue
E. All of the above.

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## About the Authors


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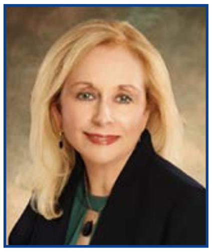

Dr. Burkhart received a Bachelor of Science degree in dental hygiene from Fairleigh Dickinson University School of Dentistry, a Master of Education degree from North Carolina State University in Occupational Health Education, a Doctor of Education Degree from North Carolina State University in Adult Education/Interdisciplinary studies. Nancy conducted a one-year postdoctoral fellowship in the section of Oral Pathology at the University of North Carolina School of Dentistry in Chapel Hill. Her dissertation topic was "Oral Lichen Planus Commonalities: Educational and Psychological Implications." Dr. Burkhart is an Adjunct Associate Professor and Educational Consultant in the Department of Periodontics/Stomatology at The Texas A&M Dental School where she has been a faculty member since 1997. She is founder and faculty Co-Host of the International Oral Lichen Planus Support Group established in 1997.

Dr. Burkhart has presented papers both nationally and internationally on Oral Lichen Planus/Mucosal Diseases and has published articles in national dental journals. She is co-author of "General and Oral Pathology for the Dental Hygienist" published through Lippincott, Williams & Wilkins now in its 3rd edition 2018. She was a 2006 recipient of the ADHA Crest Award through Procter and Gamble and The Philips Consumer Lifestyle and PennWell Corporation "Mentor of Distinction Award" in 2012. She is an Academic Affiliate Fellow of The American Academy of the Oral Medicine-awarded fellowship in 2016. Nancy is a 2017 recipient of the "Award of Distinction" through SUNSTAR and PennWell, Corporation and a 2017 "Dental Professional of the Year" recipient through The International Pemphigus and Pemphigoid Foundation. As a columnist for RDH since 2007, she writes a monthly column titled, "Oral Exams" for the PennWell publication that appears in both dental and dental hygiene literature. To date, she has written more than 130 columns for the publication on oral pathology/oral medicine topics. She is a reviewer for several national dental journals, Dimensions of Dental Hygiene, and a representative on the JCDE Joint Commission on National Dental Examinations-Dental Hygiene.

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Carol Perkins practices dental hygiene in northern California. She received her BA in Health Science at California State University Fresno. She was presented the Leadership and Professionalism Award upon graduation from her dental hygiene program at Fresno City College. She currently teaches classes on oral health in elementary schools as a volunteer. She has published in ACCESS magazine. She has been cited in Ester Wilkins' textbook and most recently in many RDH magazine articles. Her prime interests are in oral pathology and disease prevention.

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