Taste dysfunction is a significant but underestimated issue for patients with cancer. Impaired taste results in changes in diet and appetite, early satiety, and impaired social interactions. Nurses can play a key role in educating patients and families on the pathophysiology of taste dysfunction by suggesting interventions to treat the consequences of taste dysfunction, when available, and offering psychosocial support as patients cope with this often devastating consequence of treatment. Taste recognition helps humans identify the nutritional quality of food and signals the digestive tract to begin secreting enzymes. Spoiled or tainted foods typically are recognized by their bad taste. Along with the other sensory systems, taste is crucial for helping patients treated for cancer feel normal. This article will review the anatomy and physiology of taste; define the different types of taste dysfunction, including the underlying pathophysiologic basis related to cancer treatment; and discuss potential nursing interventions to manage the consequences of taste dysfunction.

Anatomy of Taste

Taste receptor cells are found in the back of the throat and in the upper one-third of the esophagus, but most are located on the tongue. The anterior surface of the tongue is covered with tiny dome-shaped projections called papillae. Taste receptor cells are found inside the taste buds located on the taste papillae. Four different types of taste papillae are found on the tongue: fungiform, foliate, circumvallate, and filiform (see Figure 1).
The function of the fungiform, foliate, and circumvallate taste papillae is to sense taste, but they each have a unique structure and are located on different parts of the tongue. The fungiform taste papillae have the highest concentration of taste receptor cells of any taste papilla. They densely populate the tip of the tongue and are scattered across the rest of the tongue surface. The foliate taste papillae are located on the posterior sides of the tongue. Circumvallate papillae are found in a V shape on the back of the tongue. The filiform taste papillae cover most of the surface of the tongue, but they do not sense taste.

The sides of the taste papillae contain the taste buds (see Figure 2) and the taste buds are lined with taste receptor cells (see Figure 3). Taste receptor cells are the only epithelial cells in the body that generate action potentials and use neurotransmitters (Scott, 2005; Vandenbeuch & Kinnamon, 2009). Those receptor cells of taste act like nerve cells, but they lack axons. The net internal charge of taste receptor cells is negative and the net external charge is positive. When taste stimuli enter the taste cells, they cause the charge inside the cell to change from negative to positive. The neurotransmitters then are released and cross from the taste cell to the nerve, which carries the taste signal to the brain (see Figure 4).

### Physiology of Taste

Some taste stimuli enter the taste receptor cell directly, whereas others require a mediator. Taste sensations begin when solid or liquid food is taken into the mouth. Food comes in contact with taste receptor cells and the taste sensation is transmitted to the brain. Every taste receptor cell is capable of recognizing all of the basic tastes. Each of the taste modalities enters the taste receptors cells and causes an action potential in a different way.

Taste stimuli that are electrolytes can enter the taste cells directly. The taste stimulus sodium enters the taste receptor cell and, once enough positive charge accumulates, depolarization occurs to transmit the taste sensation of salty (Smith & Margolskee, 2001). Calcium channels then are opened and the taste cell repolarizes. Citric acid, which is perceived in the brain as sour, disassociates in solution into hydrogen ions. Those hydrogen ions enter the taste cell directly, block potassium ion channels, and open other ion channels at the same time to cause depolarization inside of the taste cell and the transmission of sour taste (Smith & Margolskee, 2001).

Quinine and sucrose are not electrolytes; they need mediators to enter the cell and induce the action potential. Sucrose attaches to G-protein–coupled receptor cells to enter the taste cell and mediates potassium channel closure, which results in the accumulation of a positive charge within the cell to transmit sweet taste (Smith & Margolskee, 2001). Quinine enters the taste cell by attaching to G-protein–coupled receptor cells just like sucrose, but, once inside the taste cell, quinine stimulates the release of calcium from within the taste cells’ endoplasmic reticulum. Calcium builds up in the cell and causes depolarization and the transmission of bitter taste sensation (Smith & Margolskee, 2001).

### Nerves of Taste Transmission

The sensation of taste is independent of the sensation of smell, but taste and smell dysfunctions commonly are confused.
Taste and flavor recognition often are confused in the mind. When a person is asked if he or she can taste sour foods like lemon, the mind leaps to an image of a lemon. That person thinks of the tingle of the sour juice on the lips and tongue and puckering face made when sipping lemonade that doesn’t have enough sugar. Although all of those describe the flavor of sour food, none describe the taste of sour.

Cancer Treatments and Taste Function

Individuals diagnosed with cancer have problems with taste related to both the tumor and its treatment. Tumor cells secrete inflammatory cytokines that are known to disrupt the transmission of taste sensations (Laviano et al., 2008). Cancer surgery may remove or alter the anatomical structures for taste (i.e., the tongue or nerves). Many chemotherapy and biotherapy drugs are associated with taste complaints (Rehwaldt et al., 2009). Radiation therapy to the head and neck and chemotherapy both are associated with mouth sores that alter taste sensation. A clear understanding of the pathophysiology of taste and the impact of specific cancer treatment modalities are necessary to provide patient education, select appropriate nursing interventions, provide effective psychosocial support, and potentially develop innovative nursing research projects to address the issues.

Pathophysiology of Taste

Three different taste dysfunctions exist: dysgeusia, hypogeusia, and ageusia (see Table 1). Dysgeusia refers to a distortion of taste perception and most often is reported in the literature as a persistent metallic or bitter taste. Hypogeusia is partial loss of taste and is characterized by the inability to recognize one or more of the following taste modalities at normal concentrations: sweet, sour, salty, and bitter. Ageusia is the complete loss of taste and occurs when the patient cannot recognize one or more taste modality, even at high concentrations (Mirza et al., 2008; Ruo Redda & Allis, 2006). Taste cells have a unique physiologic feature. If the nerve supply to a taste cell is severed, it will die. That finding is important because treatments outside the mouth can cause taste dysfunction by both interrupting the sensation signal to the brain and by directly affecting the number of taste receptor cells (Just et al., 2005). Cancer treatments, including surgery and radiation therapy, have the potential to disrupt the innervation of taste receptor cells if the facial, glossopharyngeal, or vagus nerves are affected.

Chemotherapy is a systemic therapy that acts on rapidly dividing cells. The epithelial cells of the mouth, including the taste receptors cells, have a high turnover rate and are adversely affected by chemotherapy. Taste receptor cells renew themselves every 10–12 days (Ruo Redda & Allis, 2006). Radiation therapy fields that involve the mouth and pharynx also cause taste loss from de-epithelialization of taste receptor cell. As long as the nerve pathways to the taste cells remain intact, taste cells will repopulate the tongue after the radiation therapy and/or chemotherapy is completed.

Xerostomia

Xerostomia is dry mouth caused by low saliva flow from the salivary glands. When the salivary glands are irradiated, their...
ability to secrete saliva is greatly diminished. Two basic types of salivary glands are present: the submandibular and the parotid. The submandibular glands keep the mouth moist and humidify inspired air by secreting saliva at a constant rate of about 0.3 ml per minute (Berk, Shivnani, & Small, 2005). The saliva flow rate of the parotid glands is dependent on central nervous system stimulation (Berk et al., 2005). For example, feeling nervous makes the mouth dry, whereas the smell of apple pie baking makes the mouth water.

Dry mouth affects taste for three reasons. First, taste stimuli have to be in liquid form to get down into the taste pores to be recognized by the taste receptors cells. An important function of saliva is to provide a vehicle for taste stimuli. Second, thick saliva is more highly concentrated in salt than thin saliva (Granot & Nagler, 2005). Salt is known to affect sweet, bitter, and sour tastes (Neta, Johanningsmeier, Drake, & McFeeters, 2009). Third, dry mouths are more acidic than moist mouths (Chambers, Garden, Kies, & Martin, 2004). Low mouth pH makes sweet taste sweeter and high mouth pH makes sweet tastes less sweet (Abe, 2008; Neta et al., 2009). Low mouth pH also has been known make sour taste more sour (DeSimone & Lyall, 2006).

A trend has been noted in treatment approaches that attempt to prevent dry mouth. Parotid-sparing radiation therapy techniques are becoming more common in the treatment of head and neck cancer (Haddad et al., 2009). In addition, amifostine has been approved by the U.S. Food and Drug Administration for the prevention of xerostomia in patients treated with radiation therapy and chemotherapy for head and neck cancer (Haddad et al., 2009). As therapies that prevent dry mouth become more commonly implemented, fewer patients may complain of taste dysfunctions and difficulty eating dry foods like bread and crackers.

Regional Neuropathy

Dysgeusia is described in the literature as distorted taste characterized as persistently bitter or metallic. However, those phantom tastes may really be clinical manifestations of regional neuropathy (Femiano, Scully, & Gombos, 2002; Granot & Nagler, 2005; Strasser et al., 2008). Peripheral neuropathy is a manifestation of nerve fiber injury in which patients report phantom sensations of numbness, tingling, and pain in the affected extremity. Because taste receptors cells are not capable of producing numbness or tingling sensation, they produce phantom taste sensations (Granot & Nagler, 2005).

Patients with a bad taste in the mouth also frequently complain of a burning sensation in the mouth (Femiano et al., 2002). Burning mouth pain may be a trigeminal nerve reaction to taste stimuli received by taste receptors, which are innervated by the facial nerve or somatosensory reaction to stimuli that are conveyed by the glossopharyngeal nerve. Therefore, patients with dysgeusia often complain of increased pain with eating and prefer soft and bland foods.

Taste Dysfunction in Patients With Cancer

Some patients, particularly those with head and neck cancers, are at substantially increased risk for taste disturbances. Xerostomia is a significant issue for those who have been treated for cancers of the head and neck and is related to radiation therapy.
Surgery for head and neck cancer may remove part of the tongue or interrupt the neuropathways that transmit taste sensation to the brain. During eating, the tongue moves to aid in swallowing food, but the tongue also moves to maintain the flow of taste stimuli into the taste pores of the taste buds to promote contact with taste stimuli and taste receptor cells. Taste sensation fades within 20–30 seconds if the tongue remains motionless (Bartoshuk, 1989). When very spicy foods are taken into the mouth, a person instinctively opens his or her mouth and holds the tongue flat and motionless. That reflexive action illustrates the relationship between tongue movement and taste sensation perception.

Weight Loss

Taste problems lead to eating problems (Boyce & Shone, 2006; Hutton et al., 2007; Rehwaldt et al., 2009; Ruo Redda & Allis, 2006). If food cravings are not satisfied by taste, appetite is diminished (Breslin & Huang, 2006). Taste loss, therefore, often is associated with food aversions and loss of appetite (Ruo Redda & Allis, 2006; Sherry, 2001).

Taste plays a key role in identifying the safety of food. As previously mentioned, spoiled and tainted foods are recognizable by their sour or bitter taste. The inability to determine the palatability of food adversely affects appetite as a protective mechanism (Lundy, 2008). For those who hunt and gather food, recognizing the bitter taste of toxic alkaloid substances is crucial before too much is ingested and poisoning occurs. The ability to detect bitter taste at very low levels evolved because primitive people who were able to recognize poison before ingesting enough to cause toxicity had a survival advantage. That may be illustrated by the fact that the detection threshold for sucrose is 0.025 Mole (M), whereas quinine is detected at less than 0.00001 M (Pribitkin et al., 2003; Scott, 2005). Fortunately, humans can compensate for the loss of pleasant taste sensations. Smooth and creamy foods also have the mouth feel of fat elicit a hedonistic pleasure response in the brain as nutrient dense. Nutrient-dense foods that have the power to stimulate appetite because they are perceived in the brain as nutrient dense. Nutrient-dense foods that have the mouth feel of fat elicit a hedonistic pleasure response in the brain that increases the desire for those foods (Rolls, 2005).

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysgeusia</td>
<td>A persistent bitter, metallic, or hot taste in the mouth</td>
<td>Injury to gustatory nerve fibers or ascending nerve pathways</td>
</tr>
<tr>
<td>Hypogeusia</td>
<td>The condition of having decreased tasting ability</td>
<td>Injury to taste receptor cells, or receptor cell innervations Epithelial changes (mouth sores) or changes in saliva composition</td>
</tr>
<tr>
<td>Ageusia</td>
<td>The condition of not being able to taste one or more entire taste modality at all</td>
<td>Loss of taste receptor cells, severe changes in saliva composition, and severe damage to gustatory nerve fibers</td>
</tr>
<tr>
<td>Xerostomia</td>
<td>A dry mouth from cessation of normal saliva flow</td>
<td>Radiation therapy to the mouth or upper neck</td>
</tr>
<tr>
<td>Early satiety</td>
<td>Feeling full before eating adequate calories</td>
<td>Loss of taste sensation and/or impairment of other flavor-recognition sensations</td>
</tr>
<tr>
<td>Gustatory</td>
<td>Pertaining to the sense of taste</td>
<td>–</td>
</tr>
<tr>
<td>Olfactory</td>
<td>Pertaining to the sense of smell</td>
<td>–</td>
</tr>
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</table>

**TABLE 1. Definition of Taste Dysfunctions and Related Terms**

Sensory Deprivation

Patients with cancer find taste loss distressing (Sherry, 2001). Taste sensations are comforting (Lundy, 2008) because the areas in the brain that sense the pleasantness of food are closely related to the parts of the brain that process emotions (Rolls, 2005; Scott, 2005). Fortunately, humans can compensate for the loss of pleasant taste sensations. Smooth and creamy foods also have the power to stimulate appetite because they are perceived in the brain as nutrient dense. Nutrient-dense foods that have the mouth feel of fat elicit a hedonistic pleasure response in the brain that increases the desire for those foods (Rolls, 2005).

Changes in Social Interaction

The relationship between taste dysfunction and impaired social relationships has been documented (Larsson, Hedelin, & Athlin, 2003; Roing, Hirsch, Holmstrom, & Schuster, 2009). For some patients, eating simply takes so long that eating in social groups seems bothersome to other family members and friends. Patients have described eating as work instead of a pleasant social event. However, the impact of eating on social relationships may be more complex. Taste receptors also perceive pheromones (chemical factors that trigger social responses) (Breslin & Huang, 2006). Patients with cancer may report that they frequently eat alone or feel left out during social gatherings (Hutton et al., 2007; Larsson et al., 2005). Part of that feeling of isolation may be caused by missed social cues related to impaired taste function.

Implications for Practice

- Taste is a primary sense and, when impaired, appetite is diminished.
- Patients with dry mouth are at risk for taste dysfunction because food needs to be liquefied to have contact with the receptors of taste sensation.
- Appealing to the other senses by promoting the use of aromatic herbs, encouraging smooth and creamy foods, and preparing visually appealing meals help patients enjoy eating when taste is impaired.

Nurses play an important role in helping patients adapt to taste changes. Any side effect that impairs a sensory organ affects a patient’s ability to interact with their environment, which is why patients find taste dysfunction distressing. Through education, nurses help prepare patients to deal with treatment side effects. An understanding of the different types of taste changes helps nurses identify appropriate interventions.

Oncology nurses should ask patients about their taste function before, during, and after treatment. Asking patients with taste complaints how severe they find their taste changes to be and the methods...
they use to cope with these changes can be helpful. Questions about dry mouth and tongue mobility also should be included.

Interventions that help patients with oral discomfort also work for patients with dysgeusia (see Table 2). Healthcare professionals should recommend foods that are soft, smooth, or blended, as the mouth appeal of creamy foods feels good and helps stimulate appetite. Patients with hypogeusia and ageusia also benefit from comforting soft foods, because stimulation of the pleasure centers of the brain is important for feeling normal after treatment. With neuropathy, anything that stimulates the sensory input can cause more discomfort, so spicy food, food with rough textures, and temperature extremes should be avoided.

For patients with diminished taste, interventions that enhance flavor recognition are important. Using aromatic herbs and serving warm food enhances olfactory input and helps the patient recognize food flavor more readily. Patients also may use visual cues to help enhance appetite; therefore, the appearance of food is important. In addition, patients with severely impaired taste benefit from setting specific meal times. Eating several small meals a day helps patients ingest the necessary calories because those with decreased taste sensation often experience early satiety.

Sensory perception generally declines naturally with age, so older adults are at significant risk for flavor recognition issues and appetite suppression related to taste changes (Hoffman, Ishii, & MacTurk, 1998). Any patient with cancer who has other sensory losses is at greater risk for appetite problems. Attractively presented, warm, aromatic, and creamy foods are appealing to most patients. An example would be how, for most people, hot soup on a cold, dark day is appealing. Because food has the power to comfort, enhancing the other aspects of flavor recognition is beneficial when taste is diminished.

Laryngectomized patients are at significant risk for eating issues because they may have both taste and olfactory sensory loss. When the upper airway is separated from the lower respiratory tract, air does not move past olfactory receptors in the nose during breathing because air is inspired through a stoma in the neck. However, it has been reported that patients compensate for that deficit by using facial or neck muscles to create negative pressure in the oropharynx to bring in air through the nose and into contact with olfactory receptors (van Dam et al., 1999). Careful assessment of laryngectomized patients is necessary to encourage adaptation.

When taste is impaired, interventions should be geared toward enhancing contact between the food and taste receptor cells. Taste stimuli should be in liquid form to get down into the taste pores of the taste bud, so chewing food carefully and thoroughly will help with recognition of the taste of foods. Saliva composition changes related to dry mouth are a significant issue for patients with cancer. Using mouth rinses and saliva substitutes that make saliva less acidic will help with sweet and sour taste in particular. Mouth rinses and water also help adjust the sodium content of saliva. Healthcare professionals should encourage patients to try less salt as they experiment with seasoning.

### TABLE 2. Nursing Assessment and Interventions for Taste Dysfunction

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Intervention</th>
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</thead>
<tbody>
<tr>
<td><strong>Dysgeusia</strong></td>
<td></td>
</tr>
<tr>
<td>Do you have a bitter or metallic taste in your mouth since you were diagnosed with cancer?</td>
<td>Encourage smooth, blended foods. Discourage spicy foods and foods with rough texture. Dysgeusia is a problem of food texture and heat sensation.</td>
</tr>
<tr>
<td>Does eating cause you to experience pain?</td>
<td>Avoid temperature extremes and experiment with food temperatures. Temperature sensitivity is individualized, so cold or warm may hurt or feel soothing.</td>
</tr>
<tr>
<td><strong>Hypogeusia</strong></td>
<td></td>
</tr>
<tr>
<td>Does food taste as good to you since your cancer diagnosis?</td>
<td>Chew food well and take fluid in the mouth with each bite. Food has to be in a solution form to get down into the taste buds so it can be tasted.</td>
</tr>
<tr>
<td>Does food taste different since your cancer diagnosis?</td>
<td>Experiment with seasoning, particularly salt and aromatic herbs. Salt helps adjust sour and sweet tastes. Sweet helps adjust bitter. Aromatic herbs enhance flavor recognition.</td>
</tr>
<tr>
<td><strong>Ageusia</strong></td>
<td></td>
</tr>
<tr>
<td>Is there a specific taste, including sweet, sour, salty, or bitter, that you cannot taste at all?</td>
<td>Encourage attractively presented food and use of aromatic herbs to appeal to the other senses. Patients who lose the ability to taste one whole modality have the greatest difficulty with appetite changes. Encourage family members who prepare food to make it visually appealing.</td>
</tr>
<tr>
<td>Do you find that food texture is more important to you now than before cancer?</td>
<td>Encourage foods that are smooth and creamy. Smooth and creamy sensations stimulate the pleasure centers in the brain so that eating feels enjoyable.</td>
</tr>
<tr>
<td>Do you sometimes find you forget to eat?</td>
<td>Set aside specific meal times and make the eating environment pleasant. When taste is deceased, appetite often is decreased. Eating at set times helps prevent forgetting to eat.</td>
</tr>
<tr>
<td><strong>Xerostomia</strong></td>
<td></td>
</tr>
<tr>
<td>Visually inspect oral mucosa for dryness and cracking.</td>
<td>Chew food thoroughly and take more liquids. Food needs to be in solution to get down into the taste bud.</td>
</tr>
<tr>
<td>Do you have a dry mouth or thick saliva?</td>
<td>Try using less salt than usual. Thick saliva is more concentrated in salt than thin saliva, so sour and sweet taste perception may be impaired.</td>
</tr>
</tbody>
</table>
Helping patients understand taste changes is an important nursing function. An understanding of the pathophysiology of taste dysfunction in patients with cancer helps the interventions make sense. Knowledge of taste dysfunctions also helps illuminate why some commonly recommended interventions might not be effective (see Table 3).

Taste dysfunction in patients living with cancer is a complex, multifactorial problem. Most patients are at risk for more than one problem with more than one cause, so thorough assessment is necessary to help identify those at risk and enact appropriate interventions.

### References


TABLE 3. Common Myths About Taste

<table>
<thead>
<tr>
<th>Myth</th>
<th>Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste is tongue-site specific.</td>
<td>All taste buds are capable of sensing all taste modalities, regardless of their location on the tongue.</td>
</tr>
<tr>
<td>If olfactory function is impaired, then taste will be too.</td>
<td>Smell and taste are separate sensory processes, but both are involved with flavor recognition.</td>
</tr>
<tr>
<td>Using plastic utensils will help patients with dysgeusia.</td>
<td>Dysgeusia, or a bitter or metallic taste, is a clinical manifestation of regional neuropathy, not an excessive ability to taste bitter or metal.</td>
</tr>
<tr>
<td>Sucking on hard candy will help manage taste changes.</td>
<td>Although sour foods do stimulate saliva flow, which aids normal taste function, the intervention is only appropriate for patients who have enough saliva to dissolve hard sour candies. Saliva substitutes or rinsing the mouth and drinking more fluid work better.</td>
</tr>
<tr>
<td>Eating cold foods helps with taste dysfunction.</td>
<td>Eating cold foods helps decrease nausea associated with food aroma, but for people with impaired taste, eating warm aromatic foods enhances flavor recognition.</td>
</tr>
<tr>
<td>Use more salt to help with taste dysfunction.</td>
<td>Salt adjustment is sometimes helpful, but patients with thick saliva may need less salt because thick saliva is more highly concentrated in sodium chloride than in thin saliva.</td>
</tr>
</tbody>
</table>


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