TASTE PRIMER

Our sense of taste acts as a gatekeeper when we ingest food. By analyzing food quality (sweet, bitter, salty, etc.), taste helps us decide whether to swallow something that's in our mouth. The sense of taste also sends signals to our digestive system to help the body use the nutrients in foods effectively.

We currently believe that humans detect five basic taste qualities – sweet, sour, bitter, salty, and savory. Savory is also known as *umami*, which is the Japanese word for "delicious essence." Umami is the taste of glutamate, an amino acid found throughout the human body and in protein-containing foods. Glutamate elicits a sensation which is often described as brothy, full-bodied, meaty, and savory. Umami taste has been regarded as an essential component of Japanese cuisine for hundreds of years.

To imagine savory taste, think of chicken broth, a ripe beefsteak tomato, or Parmesan cheese. Other foods that have high concentrations of glutamate include miso, peas, and human breast milk. Glutamate is often added to foods in the form of its monosodium salt, MSG, which breaks down into its component parts, sodium and glutamate, after being ingested. Recent biochemical studies have revealed a separate taste receptor that can detect this amino acid, increasing the likelihood that umami is a separate and distinct taste sensation, which perhaps evolved to ensure adequate consumption of protein.

Almost all humans like sweet taste. This is probably because the brain associates sweet taste with energy for the body. Salty taste is thought to signal sodium, which is necessary for survival. Taste can also signal danger, as many poisons taste bitter. However, not all bitter-tasting foods are poisonous.

Each taste quality is stimulated by specific chemicals, which are recognized by receptors on cells located in taste buds within the mouth. Taste stimuli need to dissolve in saliva before they can be detected by the receptors. Dissolved chemical stimuli come into contact with receptors located at the tips of taste buds. Most taste buds are located in papillae – the small rounded bumps you see on the tongue's surface. Some taste buds are also found on the roof of the mouth, epiglottis and throat. This is why some medicines taste bitter even while "going down".

All areas of the tongue can recognize each taste, with some areas better at responding to certain tastes than others. Humans have around 10,000 taste buds, clustered in projections called papillae. Each papillae can contain from 1 to 700 taste buds, depending upon its location on the tongue. Not all taste buds are located on the tongue - some are found on the roof of the mouth and in the throat. Each taste bud contains about 50-100 specialized cells, including two different types of specialized taste cells that contain the chemical receptors and intracellular molecular machinery needed to initiate the perception of taste. A third cell type appears to serve as a supporting cell. Each taste bud contains cells to detect the five basic tastes.

At the top of each taste bud is a taste pore, a small opening where a few cells are exposed to the inside surface of the mouth. These exposed cells contain the receptors that detect taste stimuli. A receptor cell is activated when a taste stimulus connects with its receptors.

Activated cells communicate with other cells within the taste bud, some of which relay messages about the presence of taste stimuli to nerves traveling to the brain.

When a taste receptor recognizes a chemical taste stimulus, the union triggers a series of biochemical reactions inside the receptor cell. Known as transduction, these reactions translate chemical information from the taste stimulus into an electrical message that can be understood by nerves in the brain. Different types of receptors and transduction sequences help distinguish the taste qualities: sweet, sour, salty, bitter or umami.

Most sweet, bitter and umami stimuli bind to a type of receptor known as a G protein-coupled receptor, which is embedded the receptor cell's membrane. The receptors and transduction sequences for salty and sour tastes still are not well defined; stimuli for these taste qualities most likely act at ion channels, which resemble gated pores that span the receptor cell's membrane.

The biochemical events of transduction cause the receptor cell to send a signal to a nearby nerve. Taste nerves travel to a part of the brain known as the nucleus of the solitary tract (NST), where initial taste processing occurs. From the NST, taste information travels to higher brain centers, where learning about taste occurs, taste information influences food selection and feeding behavior and the concept of flavor (taste + smell + chemical irritation+ texture + vision) is defined.

Although most people think that flavor is the same as taste, that's not true. The distinctive flavor of most foods and drinks comes more from smell than it does from taste. Sugar has a taste (sweet), but strawberry actually is a smell. An airway between the nose and mouth lets people combine aroma with the five basic tastes to enjoy thousands of flavors. This can easily be demonstrated with the "jellybean test": take 2 red jellybeans of differing flavors, eg cherry and strawberry (but not cinnamon, which would activate the third chemical sense, chemesthesis or chemical irritation). While holding your nose tightly closed, pop one of the jellybeans into your mouth and chew. Try to identify the flavor. You'll know that it's sweet, but won't be able to determine whether it's cherry or strawberry until you let go of your nose and let the olfactory information whoosh up into your nose. Flavor also includes information from temperature, texture, irritation (eg, chili peppers or ginger), and other modalities.

Recent research has demonstrated that our genes help to determine how we detect the basic tastes by influencing the configuration of taste receptors. Part of why you might like broccoli while your best friend finds it bitter is because you have different genes that in turn code for different bitter receptors.

Research at Monell has shown taste sensitivity and food preferences may change across the lifespan, extending from infancy through old age, in ways we don't yet completely understand. Children appear to be more sensitive to some tastes than their parents, suggesting that kids and parents may live in different sensory worlds.

Olfaction is the chemical sense most affected by aging. Older people have more trouble detecting odors and find it harder to tell one odor from another. Because flavor is largely determined by olfaction, this decrease in the ability to smell can affect food preferences and even nutritional status of older adults.

The “spiciness” of food is conveyed through a third chemosensory system known as chemesthesis, or chemical feel. Chemesthesis is a warning system that tells us when the body’s surface may be harmed from chemicals. This system involves the trigeminal nerve, which has thousands of nerve endings located in the nose, mouth, throat and eyes. The nerve endings sense and respond to the sting of ammonia, the coolness of menthol, and the burn of chili peppers or ginger. We often enjoy these sensations, as well as bubbly drinks and spicy, tingly foods, when the chemicals are present in small amounts.

Our food preferences are determined by multiple factors, including genes, experience, and age. As mentioned above, we know that genes influence food perception, with corresponding effects on food preference and choice. Someone whose genes make them more sensitive to bitter taste may be less likely to consume enjoy bitter foods. This is an active area of research at Monell.

Experience is also an important determinant of food preferences. For example, infants and young children need to learn what foods are safe to eat. Even before birth, information about specific flavors of mothers’ diets passes to infants through amniotic fluid. This very early learning continues after birth through flavors in breast milk. We also know that repeated exposure can increase liking for a flavor in children and adults. For example, Monell research has shown that people who stick to a lower-sodium diet for a period of time come to prefer lower levels of saltiness in their food.

Unfortunately, we can’t change our genes, so some food likes or dislikes may be difficult to alter drastically. As mentioned above, repeated exposure can increase relative liking for a food, but may not be able to change a disliked food into one that is liked. In other words, exposure may make a disliked food less disliked.

BROADENING THE CONCEPT OF TASTE: The taste of food in the mouth signals nerves to cause release of enzymes and hormones in saliva, stomach, pancreas, and intestine. These cephalic reflexes contribute to the digestion, absorption and metabolism of nutrients as they are processed in the stomach and intestines and absorbed into the blood stream.

Taste receptors are also found in other parts of the body, including the intestines, pancreas, and upper airways, suggesting that the concept of ‘taste’ should be expanded to include these extra-oral chemical-detectors. Nutrients - such as glucose - cause the pancreas and enteroendocrine cells (EC) in the intestine’s lining to release hormones that influence how we digest and metabolize food. Thus, these ‘internal’ taste receptors may play an important role in metabolic diseases such as obesity and diabetes. In the upper airways, bitter and sweet receptors serve a sentinel function by monitoring bacteria and initiating immune responses when appropriate.