Bio 236 Lab
Physiology of Taste: The Principles of Gustatory Perception

In this exercise, you will experience how the primary tastes are combined to produce overall taste. You will compare your qualitative primary taste experiences to salt, sugar, aspartame (Equal), chocolate, and sour candy before and after sampling of an herbal tea, which will have a profound effect on your taste perception. Although each student will serve as his/her own subject in this study, you will compare and discuss your observations as a class.

BACKGROUND
Taste perception begins with stimulation of sensory taste receptors, located on the epithelium of tongue taste cells, with specific molecules. There are two basic sensory receptor categories: ion-gated channel receptors and G-protein coupled receptors. In **ion-gated (or ligand-gated) channel receptors** the receptor and ion channel are one unit. Binding of the receptor immediately opens an ion channel and activates the sensory cell. In **G-protein coupled receptors** the receptor and the ion channel are separate units. Binding of the sensory receptor activates a G-protein, which in turn activates enzymes, second messengers, and then finally an ion channel within the sensory cell. Thus, since extra steps are involved in G-protein coupled receptors it takes slightly longer for a cell response. After receptor binding and activation of the sensory cell the sensory information ascends the afferent nervous system pathway to the brain. Within the brain the insula lobe of the cerebrum contains a gustatory cortex that interprets the taste sensory information.

According to common misunderstanding, the tongue has distinct regions, each responsible for the detection of one of the four primary tastes. This outdated "tongue map" on which sweet is tasted at the tip, sour and salt at the sides, and bitter at the back of the tongue is based on an overly simplified interpretation of 19th century German research. More recent research shows that all areas of the tongue respond to each of the primary tastes to varying degrees. The four primary tastes, which are **bitter**, **sour**, **sweet**, and **salty**, have been extended to include a fifth taste, referred to as "***umami***". Different "taste-producing molecules" stimulate different taste receptors. For example, salt (NaCl) sensation is a result of Na+ conductance through ion-gated channel receptors. Sour sensation is initiated when acid (H+) triggers cation (positively charged ions) movement through an **a**cid-**s**ensing **i**on **c**hannel (ASIC). In other cases, H+ acts by blocking the flow of K+ through ion channels. Sweet, bitter, and umami tastes result from molecules binding to certain types of G-protein coupled receptors. U*mami*, which means meaty or savory in Japanese, includes flavors of meat, cheese, mushrooms and fermented food are rich in glutamates, and the flavor additive **monosodium glutamate (MSG)** is used to enhance the taste of various food products.

Regardless of different tastes, activation of taste cells results in electrical changes in the taste cell, which are relayed to a neuron in the tongue when the taste cell releases neurotransmitters. In order for the sensation to reach the brain, a chain of neurons is required, each communicating with the next via neurotransmitters. Neural response to primary tastes is critical given that it is associated with substances that are either life-sustaining or life-threatening. Specifically, sweet perception signals the taste of sugar-rich foods, *umami* signals protein-rich foods and bitter signals potentially toxic substances. Taste is an area of active research. Accordingly, there is mounting evidence for a potential sixth basic taste that responds to fatty substances.

It is useful to distinguish "taste" from "flavor". Taste refers to sensations perceived by the tongue, whereas **flavor** refers to the overall experience of eating, which involves taste and **olfaction** (smell). The part of the brain that perceives smell is the olfactory cortex of the temporal cerebral lobe. Individuals who have a cold or perhaps **anosmia** (inability to smell) do not perceive food flavor very well. Other factors that might interfere with ability to taste include oral lesions, natural aging, nutrient deficiencies (like decreased zinc, copper, or nickel, which can lead to "**dysgeusia**" or distorted taste perception), hormonal fluctuations (such as those that occur during pregnancy), and sensory nerve damage of the mouth.

Herbal tea mixture = 1-2 tbsp/L

METHODS

Each table will be given samples of salt, aspartame (Equal), sugar, M&Ms, Sour candy and MSG from cups at the front desk. Each student at the table must sample each type of item. **It is important that you sample the substances in this order!**

1. Taste each substance in this exact order (rinse mouth with water between tasting substances): salt, aspartame (Equal), table sugar, M&Ms, Sour (either sour candy or lemon juice), and finally MSG (for umami). Rate each substance for the perception of sweet, sour, bitter and salty on a **scale of 0 - 10**. A rating of "0" represents no perceived taste; a rating of "10" represents a very intense taste.
2. Swish an ounce of herbal tea in the mouth for thirty seconds. It is not necessary for the tea to be swallowed; however, optimal results will be obtained if all areas of the mouth are thoroughly coated. Rinse mouth with water. **You will only sample the tea ONCE during this experiment!**
3. Beginning with salt, re-taste each substance in the same order and rate and record your perception of salt, sweet, bitter and sour tastes. It is important to rinse mouth with water between tasting substances to avoid any aftertaste confounds on subsequent ratings. Make sure to write down all your taste perceptions.
4. Check with your lab mates to see if the sensations are consistent among the class.

TABLE 1: INDIVIDUAL DATA ANALYSIS

	Rating of tastes before tea	**Rating of tastes after tea**
Salt		
Equal		
Sugar		
M&Ms		
Sour		
MSG		

QUESTIONS: **Name:_____________________________________**

1. How does taste aversion explain the effectiveness of this herbal tea to treat sugar cravings and obesity?

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2. What pathological conditions could affect taste perception? ____

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3. How would the therapeutic value of this tea change if the effects were more long-Lasting?

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4. For each taste, does the tea significantly alter taste perception? – yes or no?

Salty: Sweet: Sour: Umami:

5. For each taste, which type of receptor is used – ion channel or GPCR?

Salty: ____________ Sweet: ___________ Sour: ______________ Umami: ______________

6. Based on your observations, what do you propose is the mechanism (agonist or antagonist to receptor) of the herbal tea for:

Salty: ____________ Sweet: ___________ Sour: ______________ Umami: ______________

7. Briefly describe the difference between ion channel signaling and G-protein-receptor signaling.

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