Bitter Taste Perception in a population

Purpose: To help students understand why they prefer or dislike certain foods.

Background: Take a moment and reflect upon those foods you absolutely love to eat and those foods you could certainly do without. If you turn to your lab partner, you will probably find that there is at least one difference in food preference that exists between the two of you. Now take a moment and think about why these differences exist. Is it because of texture? Is it because of a previous bad experience? Is it because of flavor? There are multiple reasons for differences in food preferences and one important contributor is taste perception. In humans, and many other species, certain chemicals in food stimulate taste cells on our tongue, which in turn send messages to a specific region of our brain. The central nervous system then interprets what these messages mean and determines the appropriate response (continue chewing OR spit it out). Collectively, which taste cells and how many taste cells are activated helps to characterize the flavor of food. Given a high enough concentration of the specific chemical outside a taste cell, a chemoreceptor will respond and begin relaying a message to the brain. In humans, there are five different classes of chemoreceptors: sour, salty, sweet, umami, and bitter. Each taste cell is proposed to exhibit only one type of chemoreceptor, but all five categories of chemical receptors are found somewhere on the tongue. Amazingly, scientific data show that there is only one type of receptor for sweet, sour and umami (interacts with monosodium glutamate: MSG), but at least 30 different receptors for bitter. (NOTE: the number of salt receptors is unknown.) Reflecting on the extensive variation in bitter receptors, in the number of taste cells and in the types of taste cells (each containing only one type of chemoreceptor), we can begin to see why individuals perceive foods differently.

In class today we will use (3) different chemicals to help us characterize our population. These chemicals are phenylthiocarbamide (PTC), thiourea, and sodium benzoate (a common food preservative). As you work through the activity, remember that evolution produced many different bitter receptors in our human population. From an evolutionary perspective, why might this be? You will be challenged to propose an answer to this question.

PTC: In 2003, discovery of a gene on human chromosome 7 helped explain why humans perceive PTC differently. There are several known alleles for the PTC gene, but two of these are most frequent in the human population. This genetic variation creates at least three different phenotypes. You will use PTC taste paper to determine your phenotype. Generally, students who find PTC paper very bitter are considered tasters, while students who find PTC paper without any flavor are considered nontasters. Those students who find PTC paper mildly bitter and unpleasant should be characterized as mild tasters. Using these loose definitions, ~70% of the human population are tasters and 30% are nontasters.

Thiourea: The genetic variation contributing to phenotypic taste perception of this bitter tastant is unknown. A majority of people taste this chemical and can be classified as tasters or mild tasters. Nontasters do not detect any chemical on the paper.

Sodium Benzoate:
As mentioned earlier, this chemical is often used as a food preservative. Individuals report varied responses to this substance: sweet, salty, bitter, or no taste. By tasting the paper with sodium benzoate you will characterize your taste perception.

Lab Procedure:
1) Rinse your mouth with water prior to starting the experiment. 2) Taste the PTC paper and classify your bitter perception as taster, mild taster or non taster. Record your result. 3) Rinse your mouth with water prior to starting the experiment. 4) Taste the thiourea paper and classify your bitter perception as taster, mild taster or non taster. Record your result. 5) Rinse your mouth with water prior to starting the experiment. 6) Taste the sodium benzoate paper and record whether you perceive bitter, salty and/or sweet (taster). You may also taste nothing (nontaster). Record whether you are a taster or non taster; if you are a taster describe the flavor. Keep in mind that you may taste one or all three of the sensations.

Laboratory Results
PTC: If taster, do you taste bitter?
Thiourea: If taster, do you taste salty?
Sodium Benzoate: If taster, do you taste sweet?

Question and Analysis
1) At your table, generate a list of other factors that could influence how food is perceived.

2) From an evolutionary perspective, why do you think there is so much variation in the human population for detecting bitter tastes as compared to sweet, umami or sour?

3) Now write a brief description of how parents would interact with and describe a very picky child.

4) Now write a brief description of how parents would interact with and describe a child who would eat anything.