Objectives
- Students will understand how the auditory system works.
- Students will demonstrate an understanding of the chemical senses associated with taste.

Introduction
In contrast to the small and widely distributed general receptors (touch, temperature, pressure and pain), the special sense receptors are large complex sensory organs (eyes and ears) or localized clusters of receptors (taste buds or olfactory epithelium). This lab focuses on the functional anatomy and physiology of each of the special sense organs, individually, but please keep in mind those sensory inputs in fact overlap.

Anatomy of the Ear

The ear contains the sensory receptors for hearing and equilibrium. It can be divided into three compartments: the outer ear, the middle ear and the inner ear. The outer and middle ear function in hearing only, while the inner ear functions in both equilibrium and hearing reception.

The outer ear is composed of the pinna and the external auditory canal. The pinna is the skin-covered cartilage region encircling the auditory opening. The sound waves that enter the external auditory canal eventually hit the tympanic membrane, commonly called the eardrum. The eardrum separates the outer ear from the middle ear.

The middle ear is a small fluid-filled chamber known as the tympanic cavity. Within the cavity are three small bones collectively known as the ossicles (malleus, incus and stapes). These bones transmit the vibratory motion of the eardrum to the fluids of the inner ear via the oval window.

The inner ear is composed of many chambers referred to as the bony labyrinth. The three subdivisions of the bony labyrinth are the cochlea, vestibule and the semicircular canals.
Activity: Auditory Tests and Experiments

Acuity Test

Have your lab partner pack one ear with cotton and quietly sit with their eyes closed. Obtain a watch or ticking clock and hold it to your partner's unpacked ear. Then slowly move the clock away from the ear until your partner indicates that he/she can no longer hear the ticking. Record the distance at which the ticking is inaudible.

Right ear: ___________________________
Left ear: ___________________________

Weber Test

Obtain a tuning fork and rubber mallet. Strike the tuning fork with the mallet and place the handle of the tuning fork medially on your partner's head. Is the tone equally loud in both ears?

If it is equally loud in both ears then the subject has equal hearing or equal hearing loss. If sensineural deafness is heard in present in one ear, the tone will be heard in the unaffected ear but not in the ear with sensineural deafness. If conduction deafness is present, the sound will be heard more strongly in the ear in which there is hearing loss.

Rinne Test

Strike the tuning fork and place its handle on your partner's mastoid process, the bone behind the ear and slightly lower. Have your partner indicate when he/she can no longer hear the sound. At that point move the fork with the still vibrating prongs close to his/her auditory canal. If your partner can hear the fork again (by air conductance) then hearing is not impaired. Repeat for both ears. Record your observations.

Right ear: ___________________________
Left ear: ___________________________

Repeat this test, except do the air conductance first and the bone conductance second. If the subject hears the tone after hearing by air conductance is lost, then there is some conductive deafness. Repeat for both ears.

Right ear: ___________________________
Left ear: ___________________________

Does the subject hear better by bone or by air conductance?
Anatomy of the Tongue

The superior tongue surface is covered with small projections known as papillae. There are three major forms of papillae: filiform, fungiform and circumvallate. The taste buds, specific receptors for the sense of taste are distributed throughout the oral cavity; however, the majority are located on the tongue.

Each taste bud consists of a globular arrangement of two types of epithelial cells: the gustatory (taste cells) that are the actual receptors and the supporting cells.

Activity: Stimulating the Taste Buds

With the paper towels provided, dry the superior surface of the tongue. Place a few sugar crystals on your dried tongue. Do NOT close your mouth. Time how long it takes for you to taste the sugar.

Time:_________________

Why couldn’t you taste the sugar immediately?

Activity: Individual Differences in Taste

There is an inherited preference and/or disgust for certain tastes. Use the four test papers (control, PTC, Thiourea and Sodium benzoate) and record your reaction and taste.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Taste</th>
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<tr>
<td>Control</td>
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<td>PTC</td>
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<td>Thiourea</td>
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Activity: Effects of Olfactory Stimulation

There is no question that what is commonly tasted depends heavily on the sense of smell, particularly in the case of heavy scented substances. These following experiments should illustrate that.

Obtain paper cups with labeled ingredients. Ask the subject to sit so that he/she cannot see which sample is being used. Have the subject dry the superior surface of their tongue and hold their nose closed. Apply one drop of the substance on the subject’s tongue. Can the subject distinguish the flavor?

Now have the subject open their nose and record the change in sensation.

Have the subject rinse their mouth out and dry their tongue. Prepare two swabs of differing substances. Hold one swab under the subject’s nose and hold the other on their tongue. Record your observations.

This lab has been adapted from E. N. Marieb’s *Essential of Human Anatomy and Physiology* Second Edition.
### Experimenting with the Sense of Taste: the Jelly Bean Lab

“I was most unfortunate in my youth to come across a vomit-flavored one. But I suppose I'll be safe with a nice toffee. (Eats candy.) Alas. Ear wax.”

- Albus Dumbledore in the 2001 movie *Harry Potter and the Sorcerer's Stone* about Bertie Bott's Every Flavor Beans

#### Question: Does Vision Influence Taste?

For each subject you test, you will need pairs of jelly beans. For example, get 2 cherry jelly beans, 2 lime jelly beans, 2 lemon jelly beans and 2 orange jelly beans. Each jelly bean flavor must have its own unique color: (for example) red for cherry, green for lime, yellow for lemon and orange for orange. Divide the jelly beans into two groups: each group should have one of each flavor.

Label small containers or napkins with the numbers 1 through 4. Place the jelly beans from the first group into a container or on a napkin - one jelly bean into each container or on each napkin. Place the jelly beans in the second group in a cup so that your subjects cannot see them. Label these cups with the numbers 1 through 4. Make sure that the flavors of the second group have different numbers than the flavors in the first group.

Now you are ready to start the experiment. Tell the subject to look at the jelly bean in container #1 of the first group and then taste the jelly bean. After they have tasted the jelly bean, tell the subject to write down its flavor. Do the same thing with jelly beans #2 - #4.

The next part of the experiment is a bit more difficult. You must keep the color of the jelly beans in group 2 hidden from your subjects. You can blindfold your subjects or have them close their eyes while they taste the jelly beans. Keep track of the flavors that your subjects say each jelly bean tastes like.

<table>
<thead>
<tr>
<th>Test Subject:</th>
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<tbody>
<tr>
<td>Jelly Bean Actual Flavor</td>
<td>Group 1 Number</td>
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Did you subjects make any mistakes when they could not see the color of the jelly bean? If they did, what was the most common mistake?

Does vision influence taste?

What would happen if you used an unusual flavor?

What would happen if you found a jelly bean with an abnormal color…for example a red-colored lemon-flavor jelly bean?
Question: Does Smell Influence Taste?
Identify a test subject. Choose one flavor of jellybean. Do not allow the subject to know the actual flavor or see the color. Have the subject hold his or her nose closed while they put the jellybean in their mouth. The subject should chew the jellybean for 10 seconds while holding the nose closed. Ask the subject the flavor of the jellybean.

Now have the subject release his or her nose. Now ask them to indentify the flavor of the jellybean. Repeat this experiment making sure that every group member has a chance to be the subject. Record your observations.

<table>
<thead>
<tr>
<th>Jelly Bean Actual Flavor</th>
<th>Subject</th>
<th>Subject’s Guess (no smell)</th>
<th>Subject’s Guess (with smell)</th>
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Could the subject(s) taste the jellybean while holding their nose(s)?

Was the subject(s) able to taste the jellybean once they regained their sense of smell?

Were any jellybean flavors so strong that the subject(s) could identify them without a sense of smell?

Why does food often seem tasteless when you have a cold?

Scientists have concluded that our taste buds on our tongues can distinguish five basic taste sensations -- sweet, sour, bitter, salty, and umami. Would the five basic taste sensations be sufficient to distinguish all the different flavors of food?

Could you identify the different flavors of jellybeans just by taste? Or do you need additional characteristics to distinguish the different flavors?