Demonstrating How the Ear Works

Description:

Students will construct a model of the ear using common household materials. After constructing their models, students will make different sounds to demonstrate how the human ear works and reflect on the effects loud sounds have on different parts of the ear.

Objectives:

- Plan and engineer a model ear
- Demonstrate how the ear works, showing how sensitive the ear is to stimulus
- Increase awareness of the effects sound and noise can have on our ears

Vocabulary:

Cochlea, ear, ear canal, pinna, stimulus, vibration

Materials:

- Aluminum foil pie pans
- Card stock or construction paper
- Straws (bendable straws preferred)
- Ping-pong balls or balloons
- Container of water
- Tape
- Drawing of activity and ear model (for reference)

Background Information:

Our ear is a sound receiver, or a motion sensor that receives sound vibrations and helps communicate messages to the brain in order for humans to hear. The ear is composed of three parts – outer ear (pinna), ear canal, and inner ear (cochlea). Once captured by our external ear, vibrations travel through the ear canal and cause the movement of the eardrum. Sound is amplified by the middle ear and transferred to the inner ear, or cochlea, which transforms the sound vibrations into a neural signal. The auditory nerve feeds this coded message containing the sound's attributes to the brain. Inside the cochlea are hair cells (there are typically about 15,000 hair cells in our inner ear). Human hair cells cannot regenerate (like they do for some animals), and over time loud sounds can cause physical damage to the ear and may lead to hearing loss.

Method:

- Introduce the vocabulary words and share the drawing of the ear that's provided to aide understanding of how the different parts of the ear function independently and together.
- Explain to students that they will make a model of the ear that will allow them to see how it works.
- Split the students into small groups.
- Have each group assemble a model using the materials, diagram, and instructions provided.

Assembly:

- Refer to the provided ear model and diagram for guidance. Remove the bottom of the pie pan, so that only the circumference of the pan remains. Tightly secure plastic wrap on the now exposed bottom. *This will function as the outer ear.* Ask students: What part of the ear do you think this represents and why?
- Cut the card stock into a triangle with one long side and fold it in half. The paper should now be shaped like a "V." Attach the paper to the center of the plastic wrap with tape. *This will function as a stand for the straw to rest on.*
- Attach the straw to the card stock, in the center of the "V."

- If the straw does not naturally bend, cut the edge of another straw to connect two together. The straw(s) should be at an angle with one end angled toward the water in the container. *This will function as the ear canal.*
- Attach a ping-pong ball to the end of the straw and set it so that it floats in the water. *This will function as the ear drum.*
- Sounds made near the outer ear (the plastic and cake pan) should result in vibrations on the water. *This will serve as the cochlea.*

Hearing with the Model:

- Test out the model by making a variety of sounds and noises at different levels near the plastic wrap.
    - Remind students to examine how each sound affects the straws, ping-pong ball, and water surface.
- Have students create a chart and record the effects of sound and noise levels on their model. Students should note the type or source of sound and impacts on the model. Think about how this may relate to hearing loss.

Discussion:

- What happened when you made sounds near the pie pan?
- Did the model react differently when you made loud sounds versus soft sounds?
- What parts of the ear might the different parts of the model represent?
- Imagine the small parts in your ear that this model mimics. If a similar reaction can occur inside your ear when you hear loud sounds, could this cause a problem? Why?

Extension:

- You can use a sound meter to test how loud your sounds are and see what happens to the model when you make loud versus soft sounds. If you do not have access to a professional sound meter, use a phone or computer application such as the Arduino Science Journal (available for both iOS and Android) or the CDC NIOSH Sound Level Meter (available only on iOS).
- Check out the DEP Loudness Scale. What were some of the sounds you made that are equivalent to sounds you hear in everyday life?
- Explore the Wisc-Online's resource Anatomy of the Ear on your classroom or individual computers to visualize and study the different parts of the ear.
- Watch How Hearing Works from the Hearing Health Foundation as a class to learn more about hearing and hearing loss.
    - Then, discuss ways in which students can protect their hearing. Use this list of tips from the CDC to guide students on ways to protect their hearing in various settings.

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For more information visit www.nyc.gov/dep

Ear Model:

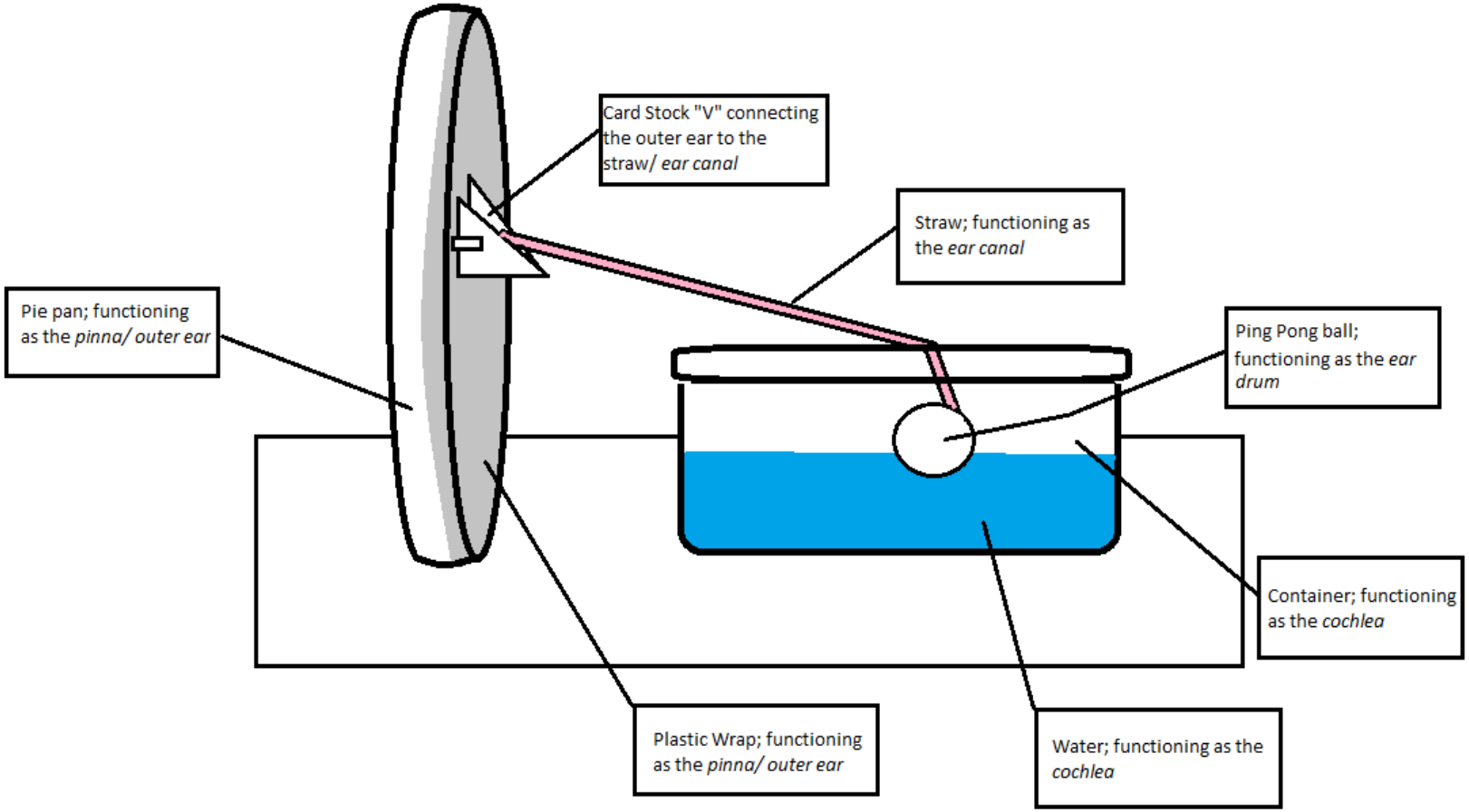
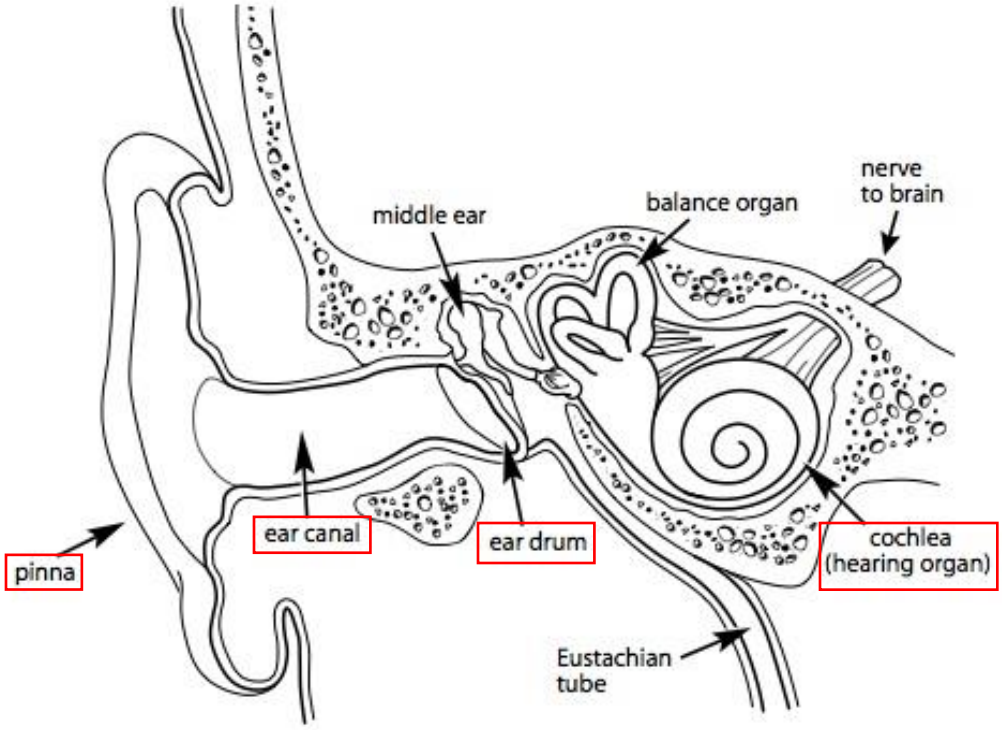

Card Stock "V" connecting the outer ear to the straw/ *ear canal*
Straw; functioning as the *ear canal*
Pie pan; functioning as the *pinna/ outer ear*
Ping Pong ball; functioning as the *ear drum*
Container; functioning as the *cochlea*
Plastic Wrap; functioning as the *pinna/ outer ear*
Water; functioning as the *cochlea*

Diagram of the Human Ear:



Parts of the Ear Chart

EAR	The sense organ that detects sounds
OUTER EAR/ PINNA	Acts as a funnel on the outside of the ear that directs sound into the ear
EAR CANAL	A tube running from the outer ear to the middle ear to transmit sound
INNER EAR/ COCHLEA	A hollow tube in the inner ear of higher vertebrates, usually coiled like a snail shell where sound waves are transformed into electrical impulses which are sent on to the brain