

# Vestibular System

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## Mission

Participants will be able to investigate the structure and function of the vestibular system and its response in space.

## Background information

### Vestibular System

The vestibular system is a sensory system responsible for providing our brain with information about motion, head position, and spatial orientation. It is also involved with motor functions that allow us to keep our balance, stabilize our head and body during movement, and maintain posture.

Balance and movement are controlled by our vestibular system. The vestibular system is made up of a bony labyrinth, the vestibule, and the membrane in between all within our inner ear. A part of the vestibular system that can affect our balance is the fluid in the semicircular canals. Depending on how we move or how our head turns, tiny hairs in our ear bends and moves as the fluid shifts from the movement.

Damage to the inner ear vestibular system may cause vertigo, which gives people spinning or dizzy sensations and other symptoms from just small or particular movements.

The way our brains process movement is not just with the fluid movement in our ears, but from visual cues from our eyes as well. Sometimes, when our eyes perceive movement, it gives your body a sensation or feeling of movement even if you're not moving. For example, think of a VR simulation; our brains process and visually see movement in the simulation, often in a first-person point of view, which gives people the feeling of movement. This sensation can also cause people to become nauseous or motion sick.

## Materials

### First Model-Canal

- Clear tube, at least 6-8 inches long
- Clear, viscous liquid, i.e., oil or water with pectin
- Plugs for tube ends
- Small beads
- Optional: small hairs, like eyelash extensions, attached to inside (no beads)

### Second Model-Otolith

- 2 soft bristle brushes (like make-up brushes)
- 2 beads with through holes
- Wire
- Glue
- Tape

## Vocabulary

- **Otolith organs**- collective term used to refer to the utricle and the saccule, two components of the vestibular system that are designed to detect gravitational forces and linear acceleration of the head.
- **Vestibular system**- sensory system found within the inner ear that is responsible for maintaining balance, coordination, and awareness of spatial orientation.
- **Orientation**- the relative physical position or direction of something.
- **Gravity**- the force by which a planet or other body draws objects toward its center.

## Methods

### First Model-Canal

1. Plug in one end of your tube but leave one end open.
2. Optional: attach your hair strip to the side of the tube.
3. Fill in your tube halfway with your liquid.
4. Pour about a teaspoon of beads into your tube, the larger your tube the more beads you might want to use.
5. Fill in your tube the rest of the way with your liquid until the tube is completely full.
6. Plug in the other end of your tube to seal it all in.
7. As you rotate it, the fluid lags behind, which is observed by the beads lagging after you rotate the tube.



### Second Model-Otolith

#### 1 G brush

1. Cut a piece of wire long enough to go from the top of the bristles to the brush handle.
2. Thread the wire through the bead and bend the tip of the wire to secure one end.
3. Position the bead so that it is just above the bristles in the center of the brush.
4. Use the tape to fasten the wire to the base of the brush.

#### Zero G brush

5. Depending on the softness of your bristles and width of the brush, you may need to cut away the sides of the brush to be able to see the action of the bead on the bristles.
6. Using a spot of glue, glue the bead to the top of the bristles and let dry.



### Extensions and modifications:

1. Have students attempt to design their own models of the vestibular system, or parts of it.
  - a. Models can be demonstrations of balance changes in the human body with explanations.
2. Try creating a magnetic model, for example, 2 electromagnets with a ball in the middle and a camera detecting the suspension and movement.

### Follow up Questions

1. Why is it important to study vestibular function in space?
2. What would happen to the balance of astronauts on another planet, like Mars?
3. How could astronauts adjust or adapt to vestibular changes in space?
4. How can the research on the changes to the vestibular system in space apply to people on Earth?

### References and Resources

<https://www.neuroscientificallychallenged.com/blog/know-your-brain-vestibular-system>

[https://www.nasa.gov/audience/forstudents/9-](https://www.nasa.gov/audience/forstudents/9-12/features/F_Human_Vestibular_System_in_Space.html)

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