Biology 1 / Sanderson Name_____ Per _____ Date:

Nervous System: Hearing and Balance Lab

1. **Audible Frequencies**
   The normal range of human hearing is from 20 Hz to 20 kHz (20,000 Hz). Humans normally lose sensitivity to high-pitched sounds as they get older.

   In this demo, I will play a series of high-pitched tones. Raise your hand when you cannot hear the tone. Record the number of people in class who cannot hear each tone. (http://www.noiseaddicts.com/2010/10/hearing-loss-test/)

   a. 8 kHz _____
   b. 12 kHz _____
   c. 15 kHz _____
   d. 16 kHz _____
   e. 18 kHz _____
   f. 20 kHz _____
   g. 22 kHz _____

The remaining experiments should be performed in groups of four.

2. **Bone and Air Conduction Hearing**
   Bone conduction is the transmission of sound to the inner ear through the bones of the skull. Your own voice sounds deeper and fuller to you than it does to other people because of the way the sound from your vocal cords travels through your skull. If you hear a recording of your own voice, it may sounder higher than you're used to.

   In this activity, you will test your subject's ability to hear sounds via bone conduction and air conduction. Only one person per group needs to be tested.

   a. Strike a tuning fork, and place the handle on your subject's forehead. When the sound is no longer audible to your subject, hold the prongs close to his or her ear. Can your partner hear the sound again? _____
   b. Reverse the order this time. Strike the tuning fork, and hold the prongs near your subject's ear. When the sound is no longer audible to your subject, place the handle on your subject's forehead. Can your subject hear the sound again? _____
   c. Does your subject hear better by bone conduction or air conduction? _____

3. **Rotation and Nystagmus** (note that "right" & "left" are relative to the subject)
   Nystagmus is a form of involuntary eye movement. Post-rotatory nystagmus happens after a person spins and then stops suddenly. It has two phases: a slow trailing of the eyes in one direction, and then a quick, jerky movement in the opposite direction. The direction of nystagmus is defined by the direction of its quick phase (*e.g.* a **right-beating nystagmus** is characterized by a rightward-moving quick phase, and a **left-beating nystagmus** by a leftward-moving quick phase).

   In these experiments, you will ask a subject to sit in a rotating chair. Only one person per group should be spun. Stop spinning if the subject complains of nausea. Be prepared to support the subject if he or she stumbles or falls.

   a. Rotate the chair clockwise approximately ten times in 20 seconds and then stop the rotation. Observe the movement of the subject's eyes. Towards what direction are the eyes' short, quick movements? That is, does the subject display a right-beating nystagmus or left-beating nystagmus? _____
   b. This time, rotate the chair counterclockwise. Now towards which direction are the quick movements of the subject's eyes? _____

4. **Rotation and Balance** (note that "right" & "left" are relative to the subject)
   When you spin around, the fluid in your semicircular canals moves too. When you stop spinning, the fluid continues to move for a short time afterwards. The hair cells in the semicircular canals send the message that you are spinning even though you are not. The conflict between what your eyes and limbs tell you ("I'm standing still") versus what your semicircular canals tell you ("I'm still moving") causes the feelings of dizziness you experience after spinning.

   You will perform these experiments in the courtyard outside. Be prepared to catch your subject if he or she stumbles or falls. Do NOT spin without partners to catch you!

a. Find a straight line or crack in the cement. Pick one person from your group and ask him or her to walk the line, putting one foot in front of the other. Was the subject able to walk the line without wobbling from side to side? _____ Did the subject experience any dizziness? _____
b. Ask the subject to spin around clockwise for 15 seconds. Immediately have the subject attempt to walk a straight line. Was the subject able to walk straight? _____ If not, did the subject's steps veer to the left or right? _____ Which direction do objects appear to be moving to your subject? (That is, which direction is "the world spinning?") _____
c. Give your subject a short break and then repeat the experiment. This time, ask the subject to spin around counterclockwise for 15 seconds. Is the subject able to walk a straight line? If not, did the subject's steps veer to the left or right? _____ Which direction do objects appear to be moving to your subject? (That is, which direction is "the world spinning?") _____

5. **Vision and Balance I**

You will perform these experiments inside the classroom, in front of the whiteboard. Ask one member of your group to stand in front the board, facing the room; the subject should not lean on or touch the board in any way. Draw two straight lines: one parallel to each side of the subject's body.

a. Ask the subject to stand still for one minute while you observe. Do you see any side-to-side swaying movements? _____
b. Now, ask the subject to close his or her eyes. Do you see any side-to-side swaying movements? _____ Are the movements large or small? _____
c. Repeat the test. This time, the subject should be positioned with his or her shoulder toward but not touching the board. Ask the subject to close his or her eyes. Do you see any front-to-back swaying? _____ Is the amount of front-to-back swaying greater or less than the amount of side-to-side swaying? _____
d. What conclusion can you draw about the role of vision in maintaining body equilibrium and balance?
_____
_____

6. **Vision and Balance II**

You may perform these experiments anywhere in the classroom.

a. Ask one person in your group to stand straight up, with his or her eyes open. The subject should lift one foot about 12 inches off the floor and hold it for one minute. Record your observations:
_____
b. Ask the same person to lift the other foot about 12 inches off the floor for one minute. This time, the subject should close his or her eyes. Record your observations:
_____

Comprehension Questions:

1. We observed post-rotatory nystagmus, the eye movements that happen after spinning. Some people are born with congenital nystagmus, which means they experience nystagmus even when they have not been spinning. Make a prediction about the eyesight of someone with congenital nystagmus.
_____
_____

2. Explain why people get dizzy after riding roller coasters, even after they are standing on non-moving ground.
_____
_____

3. When testing vision and balance (5 & 6) you were evaluated on how well you coordinate your visual input with your proprioception. Which part of your brain coordinates this information with your muscular movements?
_____