# Laboratory Exercise 32

# Ear and Hearing

### Materials Needed

Textbook
Dissectible ear model
Watch that ticks
Tuning fork (128 or 256 cps)
Rubber hammer
Cotton
Meterstick

**For Demonstrations:**

Compound light microscope
Prepared microscope slide of cochlea (section)
Audiometer

The ear is composed of outer (external), middle, and inner (internal) parts. The outer structures gather sound waves and direct them inward to the tympanic membrane. The parts of the middle ear, in turn, transmit vibrations from the tympanic membrane (eardrum) to the inner ear, where the hearing receptors are located. As they are stimulated, these receptors initiate nerve impulses to pass over the vestibulocochlear nerve into the auditory cortex of the brain, where the impulses are interpreted and the sensations of hearing are created.

Although the ear is considered here as a hearing organ, it also has important functions for equilibrium (balance). The inner ear semicircular canals, utricle, and saccule have equilibrium functions. Equilibrium will be studied in Laboratory Exercise 33.

## Purpose of the Exercise

To review the structural and functional characteristics of the ear and to conduct some ordinary hearing tests.

## LEARNING OUTCOMES

After completing this exercise, you should be able to

1. Locate the major structures of the ear.
2. Describe the functions of the structures of the ear.
3. Trace the pathway of sound vibrations from the tympanic membrane to the hearing receptors.
4. Conduct four ordinary hearing tests and summarize the results.

EXPLORE

## Procedure A—Structure and Function of the Ear

1. Review the section entitled "Sense of Hearing" in chapter 12 of the textbook.
2. As a review activity, label figures 32.1, 32.2, and 32.3.
3. Examine the dissectible model of the ear and locate the following features:

**outer (external) ear**
- auricle (pinna)
- external acoustic meatus
- tympanic membrane (eardrum)

**middle ear**
- tympanic cavity
- auditory ossicles (fig. 32.4)
  - malleus
  - incus
  - stapes
- oval window
- tensor tympani
- stapedius

**auditory tube (pharyngotympanic tube; eustachian tube)**

**inner (internal) ear**
- osseous (bony) labyrinth
- membranous labyrinth
- cochlea
- semicircular canals and ducts
- vestibule
  - utricle
  - saccule

**vestibulocochlear nerve**
- vestibular nerve (balance branch)
- cochlear nerve (hearing branch)

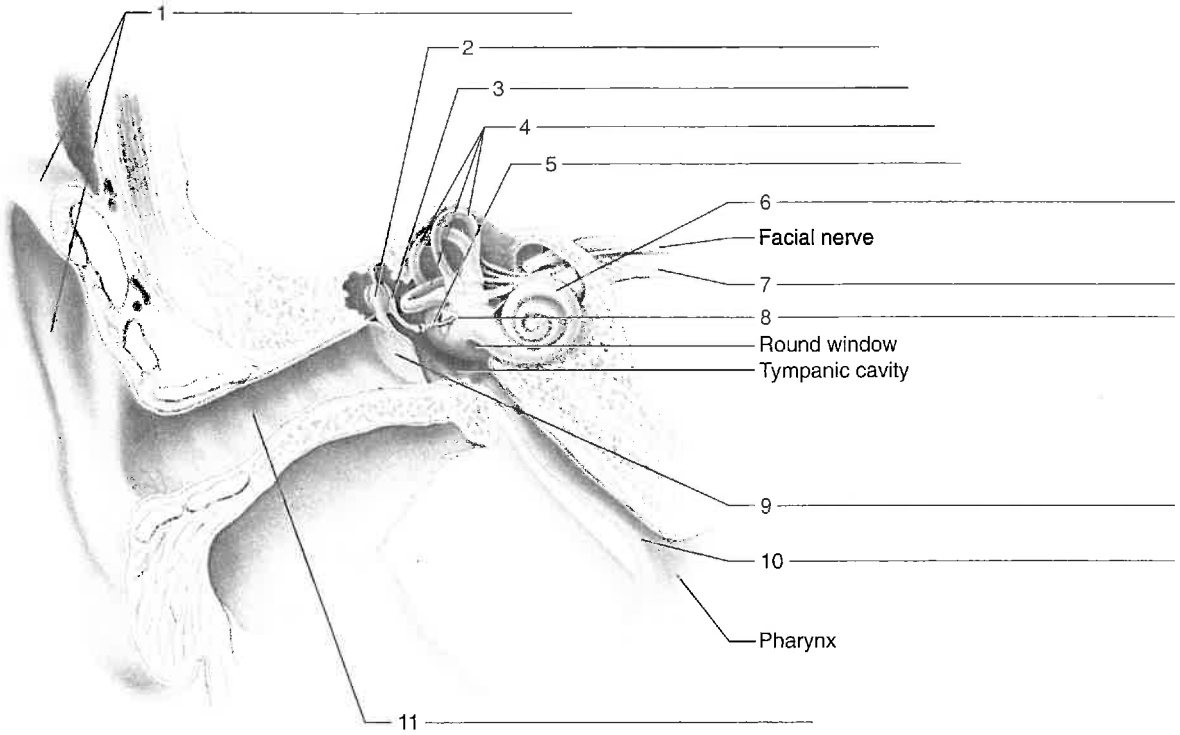



**Figure 32.1** Label the major structures of the ear. **1**

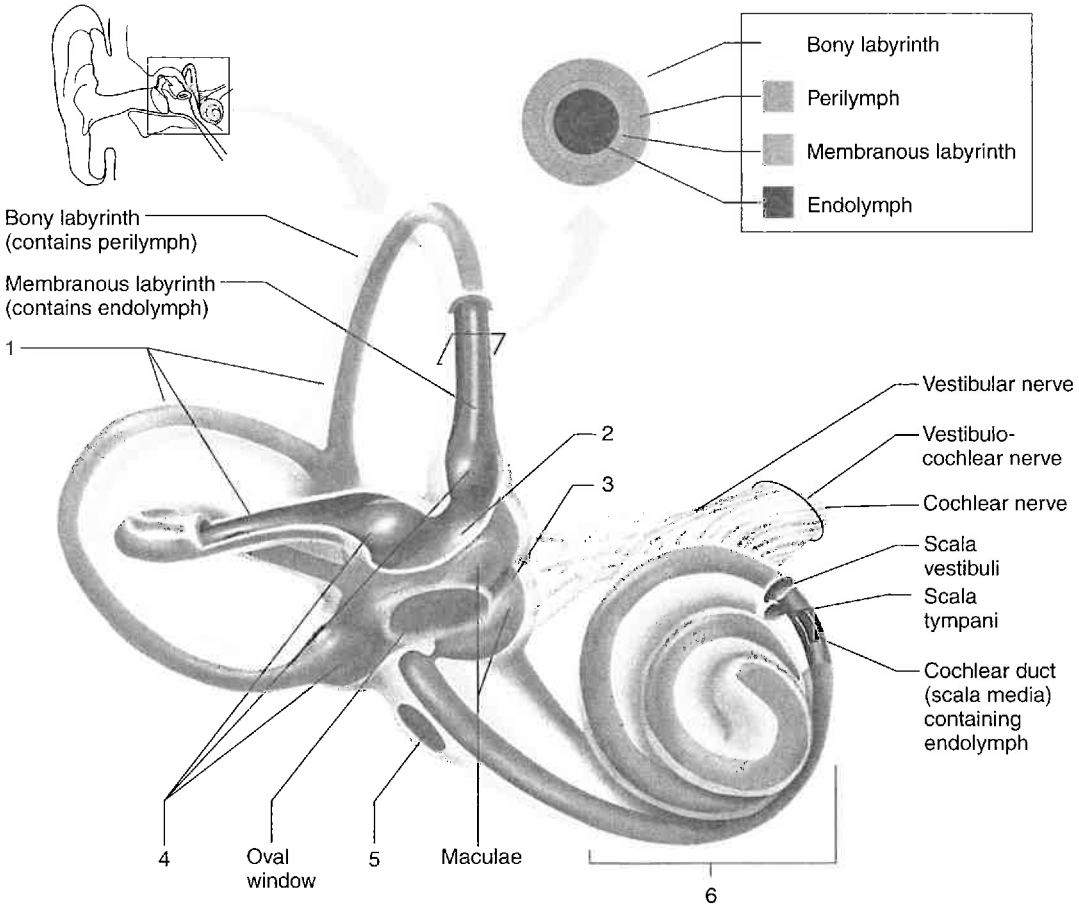



**Figure 32.2** Label the structures of the inner ear by placing the correct numbers in the spaces provided. **1**

___ Ampullae ___ Round window ___ Semicircular canals

___ Cochlea ___ Saccule ___ Utricle

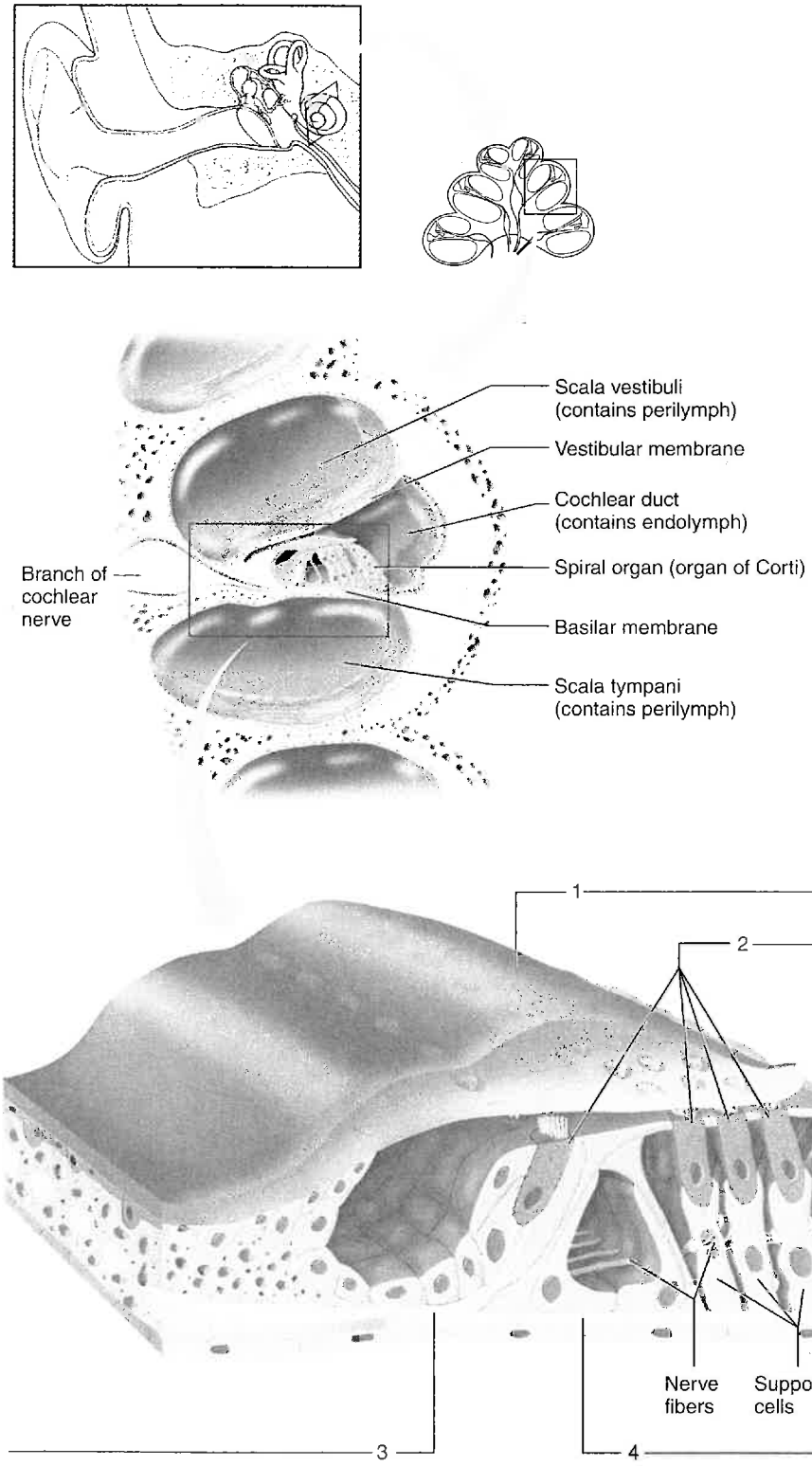



**Figure 32.3** Label the structures associated with the spiral organ (organ of Corti) of a cochlea. 1

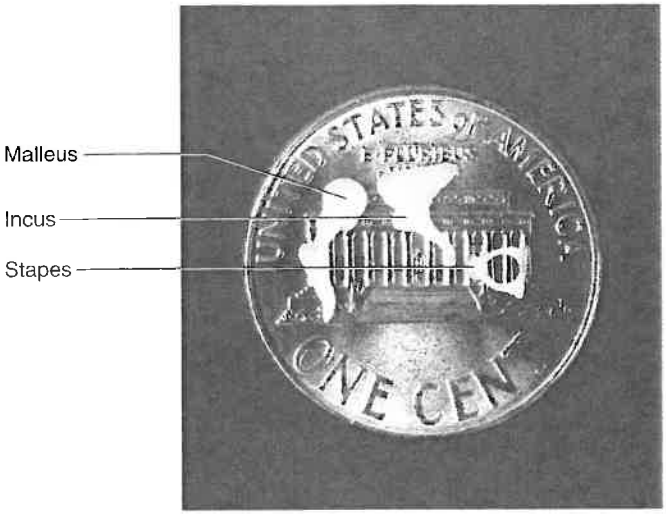



**Figure 32.4** Middle ear bones (auditory ossicles) superimposed on a penny to show their relative size. The arrangement of the malleus, incus, and stapes in the enlarged photograph resembles the articulations in the middle ear.

## Demonstration

Observe the section of the cochlea in the demonstration microscope. Locate one of the turns of the cochlea, and using figures 32.3 and 32.5 as a guide, identify the *scala vestibuli, cochlear duct (scala media), scala tympani, vestibular membrane, basilar membrane,* and the *spiral organ (organ of Corti).*

4. Complete Parts A and B of Laboratory Report 32.

EXPLORE

## Procedure B—Hearing Tests

Perform the following tests in a quiet room, using your laboratory partner as the test subject.

1. *Auditory acuity test.* To conduct this test, follow these steps:
   **a.** Have the test subject sit with eyes closed.
   **b.** Pack one of the subject's ears with cotton.

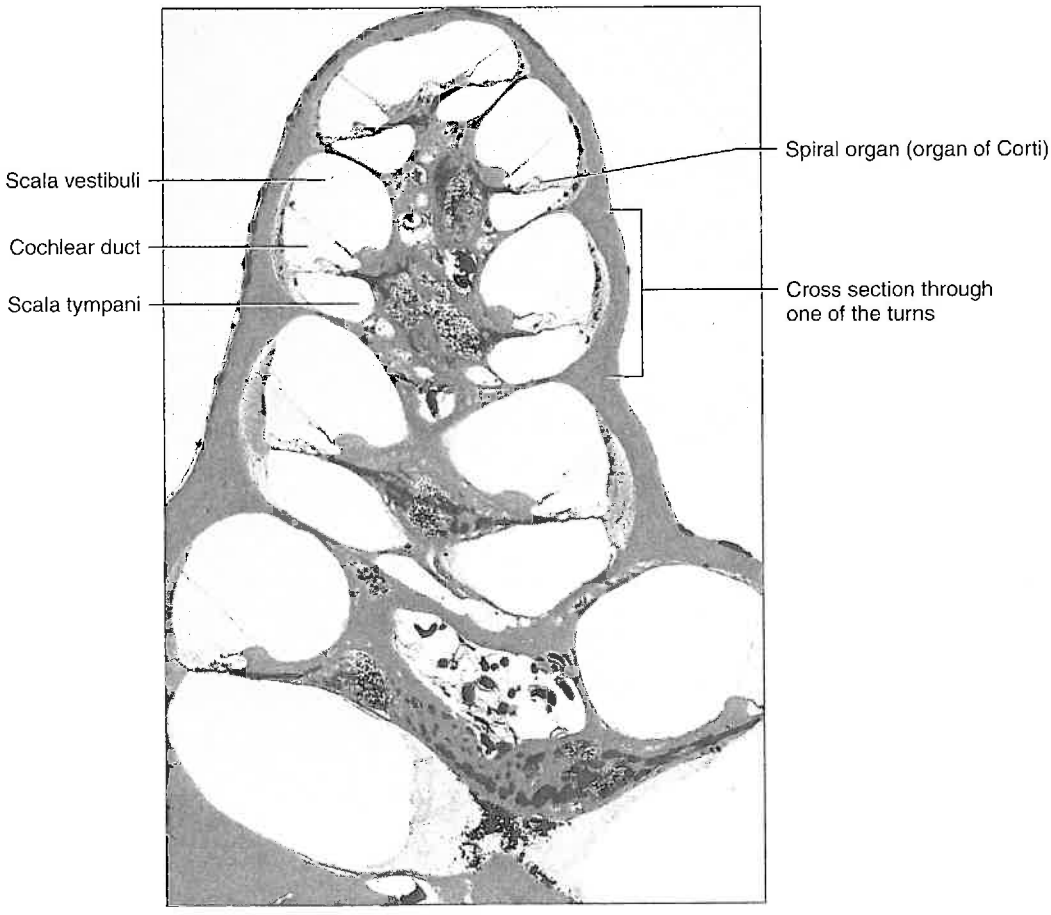


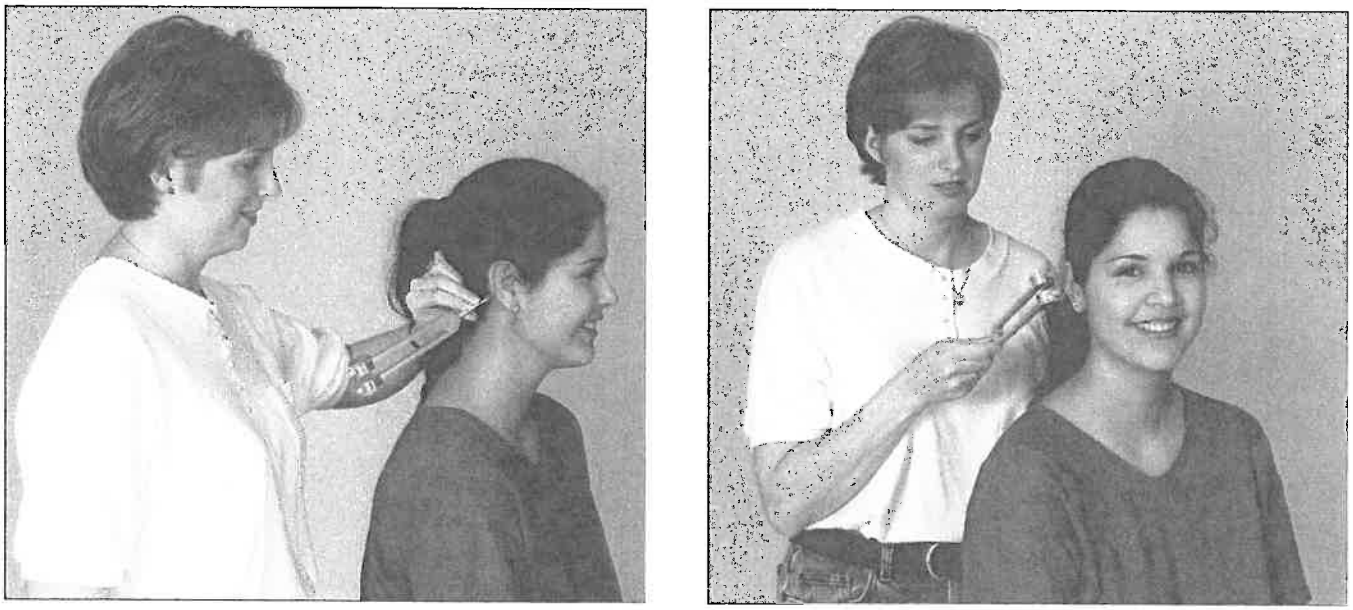

**Figure 32.5** A section through the cochlea (22×).

c. Hold a ticking watch close to the open ear, and slowly move it straight out and away from the ear.
d. Have the subject indicate when the sound of the ticking can no longer be heard.
e. Use a meterstick to measure the distance in centimeters from the ear to the position of the watch.
f. Repeat this procedure to test the acuity of the other ear.
g. Record the test results in Part C of the laboratory report.

2. *Sound localization test.* To conduct this test, follow these steps:
   a. Have the subject sit with eyes closed.
   b. Hold the ticking watch somewhere within the audible range of the subject's ears, and ask the subject to point to the watch.
   c. Move the watch to another position and repeat the request. In this manner, determine how accurately the subject can locate the watch when it is in each of the following positions: in front of the head, behind the head, above the head, on the right side of the head, and on the left side of the head.
   d. Record the test results in Part C of the laboratory report.

3. *Rinne test.* This test is done to assess possible conduction deafness by comparing bone and air conduction. To conduct this test, follow these steps:
   a. Obtain a tuning fork and strike it with a rubber hammer or on the heel of your hand, causing it to vibrate.
   b. Place the end of the fork's handle against the subject's mastoid process behind one ear. Have the prongs of the fork pointed downward and away from the ear, and be sure nothing is touching them (fig. 32.6*a*). The sound sensation is that of bone conduction. If no sound is experienced, nerve deafness exists.
   c. Ask the subject to indicate when the sound is no longer heard.
   d. Then quickly remove the fork from the mastoid process and position it in the air close to the opening of the nearby external acoustic meatus (fig. 32.6*b*).

   If hearing is normal, the sound (from air conduction) will be heard again; if there is conductive impairment, the sound will not be heard. Conductive impairment involves outer or middle ear defects. Hearing aids can improve hearing for conductive deafness because bone conduction



(a) (b)

**Figure 32.6** Rinne test: (*a*) first placement of vibrating tuning fork until sound is no longer heard; (*b*) second placement of tuning fork to assess air conduction.

transmits the sound into the inner ear. Surgery could possibly correct this type of defect.

**e.** Record the test results in Part C of the laboratory report.

4. *Weber test.* This test is used to distinguish possible conduction or sensory deafness. To conduct this test, follow these steps:
   **a.** Strike the tuning fork with the rubber hammer.
   **b.** Place the handle of the fork against the subject's forehead in the midline (fig. 32.7).
   **c.** Ask the subject to indicate if the sound is louder in one ear than in the other or if it is equally loud in both ears.

      If hearing is normal, the sound will be equally loud in both ears. If there is conductive impairment, the sound will appear louder in the affected ear. If some degree of sensory (nerve) deafness exists, the sound will be louder in the normal ear. The impairment involves the spiral organ (organ of Corti) or the cochlear nerve. Hearing aids will not improve sensory deafness.

   **d.** Have the subject experience the effects of conductive impairment by packing one ear with cotton and repeating the Weber test. Usually the sound appears louder in the plugged (or impaired) ear because extraneous sounds from the room are blocked out.
   **e.** Record the test results in Part C of the laboratory report.
5. Complete Part C of the laboratory report.

**Figure 32.7** Weber test.

## Critical Thinking Application

Ear structures from the outer ear into the inner ear are progressively smaller. Using results obtained from the hearing tests, explain the advantage of this arrangement. **3**

## Demonstration

Ask the laboratory instructor to demonstrate the use of the audiometer. This instrument produces sound vibrations of known frequencies transmitted to one or both ears of a test subject through earphones. The audiometer can be used to determine the threshold of hearing for different sound frequencies, and, in the case of hearing impairment, it can be used to determine the percentage of hearing loss for each frequency.