LAB EXERCISE 28

The Ear

The **ear** is a complex sensory organ located on each side of the skull, mostly buried within each temporal bone. The ear serves as a receptor organ for at least three special senses: *hearing, static equilibrium,* and *dynamic equilibrium.* This exercise challenges you to learn the basic divisions and structures of the human ear. Once you are familiar with the structure of the ear, you will be ready to explore the functional aspects of hearing and equilibrium in Exercise 29.

Before you begin

- ❑ Read Chapter 15 in your textbook.
- ❑ Set your learning goals. When you finish this exercise, you should be able to
  - ❑ distinguish the three main divisions of the ear
  - ❑ identify the principal structures of the human ear in models and figures
  - ❑ locate features of the cochlea in a prepared microscopic specimen
- ❑ Prepare your materials:
  - ❑ model or chart of the human ear
  - ❑ microscope
  - ❑ prepared microslide: *cochlea c.s.*
  - ❑ computer setup with DISSECTIBLE HUMAN or similar human dissection program (optional)
- ❑ Read the directions and safety tips for this exercise **carefully** before starting any procedure.

HINT

Using the DISSECTIBLE HUMAN or similar computerized human dissection program, explore the human body and try to find the structures listed in this activity.

Use a chart or model of the human ear to locate and study the ear structures listed in the three activities of this exercise.

A. External ear

You may want to use your textbook as an additional aid in this activity. The **external (outer) ear** is the ear division comprising the elements described in the following steps.

❑ 1 **Auricle (pinna)**—This external ear flap protects the auditory opening, directing sound waves toward it. It also functions as a "radiator" in thermoregulation.

❑ 2 **External auditory meatus**—This tubelike passage carries airborne sound waves further into the ear apparatus; also called the *ear canal.*

❑ 3 **Tympanic membrane**—Also called the *eardrum,* it covers the end of the external auditory meatus to form a boundary with the middle ear. It vibrates when struck by airborne sound waves, carrying the sound energy into the middle ear.

B. Middle ear

The **middle ear** begins where the external ear ends, with the tympanic membrane. The middle ear is an air-filled cavity lined with mucous membrane. Identify the important parts of the middle ear described in the following steps.

❑ 1 **Malleus**—It is one of the three *auditory ossicles* in each ear. Also called the *hammer,* it is a tiny club-shaped bone attached to the eardrum. It vibrates when sound waves pass to it from the eardrum.

❑ 2 **Incus**—Also called the *anvil,* this tiny bone forms a synovial joint with the malleus. The incus vibrates when it receives energy from the malleus.

❑ 3 **Stapes**—Called the *stirrup* because of its shape, this ossicle is joined to the incus, from which it receives vibrations. A flat portion of the stapes fits into the **oval window,** a passage into the inner ear. Because of the structural relationship of this chain of ossicles, sound waves are carried from the tympanic membrane to the oval window (that is, from the external ear to the inner ear). Along the way, the vibrations are amplified for better reception.

❑ 4 **Auditory (eustachian) tube**—It is a collapsible tube running between the middle ear and pharynx. It allows internal air pressure to equalize with atmospheric air pressure so that high pressure on one side does not distort or muffle the eardrum.

❑ 5 The middle ear also has an opening to the mastoid air cells in the mastoid process of the temporal bone. What significance might this have if the middle ear becomes infected?

SAFETY FIRST!
Observe the usual precautions when using the microscope and prepared slides.

C. Inner ear

The **inner ear** is the third division of the ear apparatus. The receptors for hearing and equilibrium are located here. The inner ear is within a hollow area in the petrous portion of the temporal bone. A mazelike **bone labyrinth** contains a similarly shaped but smaller **membranous labyrinth.** The fluid inside the membranous labyrinth is called **endolymph,** and the fluid outside the membranous labyrinth is called **perilymph.** The bony labyrinth, and the membranous labyrinth inside it, is composed of the three main regions described in the following steps.

❑ 1 **Cochlea**—It is a long passage coiled like a snail. A cross section reveals that the passage is divided into three chambers by a Y-shaped partition. The base of the Y is a projection of the bone called the **spiral lamina.** The two branches are pieces of membrane called the **vestibular membrane** and the **basilar membrane.** The space between the two membranes is the endolymph-filled **cochlear duct.** The space outside the vestibular membrane is the **scala vestibuli,** whereas the **scala tympani** is the space outside the basilar membrane. Sound waves move into the perilymph of the scala vestibuli as the stapes vibrates in the oval window. The vestibular membrane vibrates, causing the endolymph in the cochlear duct to vibrate. This, in turn, causes the flaplike **tectorial membrane** to vibrate and bend the hairs projecting from the **organ of Corti** on the basilar membrane (which also vibrates). The bending of hairs induces receptor potentials in the sensory neurons. The energy dissipates as it moves through the scala tympani to the round window. A branch of cranial nerve VIII called the **cochlear nerve** carries information to auditory areas in the brain. Observe a cross section of a mammalian cochlea in the microscope and sketch your observations. Label as many parts as you can identify.

HINT
LABORATORY REFERENCE Plate 51 shows a light micrograph of the mammalian cochlea and features a good view of the organ of Corti in cross section.

❑ 2 **Vestibule**—This is the central area of the inner ear. The vestibule contains saclike portions of the membranous labyrinth called the **utricle** and the **saccule.** Each has a patch of sensory hair cells called a **macul** (Figure 28-1, *A*). The macula's hair cells are covered by a gelatin coating embedded with hard, tiny crystals called **otoliths.** When the head is tilted, gravity pulls on the heavy otoliths and the hairs bend. This induces a receptor potential. Sensory information regarding the effects of gravity (static equilibrium) is transmitted to the brain through the **vestibular nerve,** another branch of cranial nerve VIII.

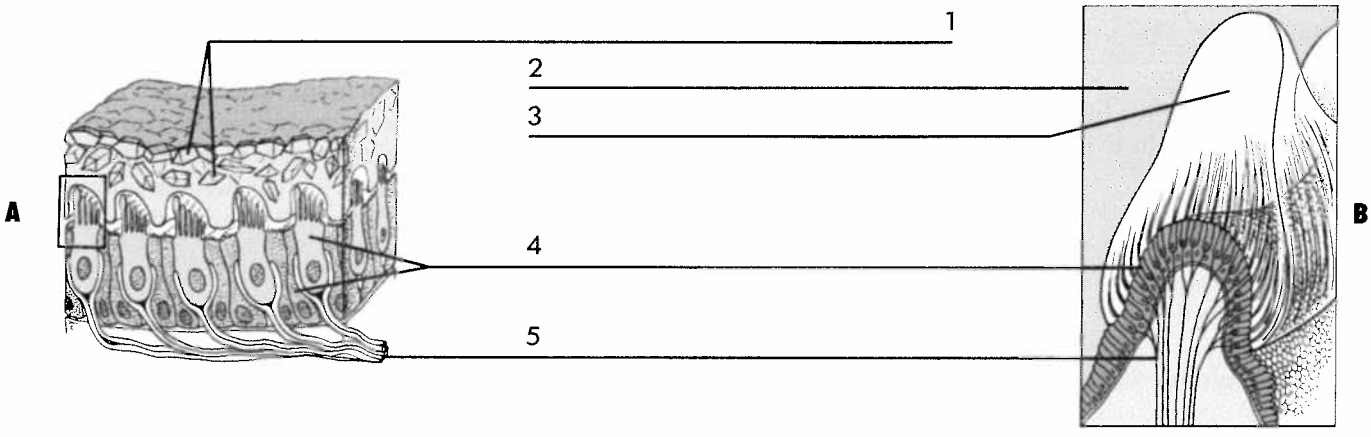


Figure 28-1 Identify the structures on the lines provided and also on the blanks in the Lab Report at the end of this exercise.

❑ 3 **Semicircular canals**—These are three round passages, each on a different plane. The semicircular canals have bubbles at their bases called **ampullae** (Figure 28-1, *B*). Within each ampulla is a crest of tissue called the **crista ampullaris.** Each crista is a patch of sensory hair cells covered with a gelatinous mass (without otoliths) called the **cupula.** When the speed or direction of movement of the head changes, the inertia of the perilymph within semicircular canals causes it to circulate. As t lymph circulates, it pushes the cupula and ge receptor potentials in the crista's sensory cell vestibular nerve carries the signal to the brai where it is interpreted as kinetic (dynamic) e rium (see Figure 28-2).

COLORING EXERCISE
Using colored pens or pencils, shade in the figure and accompanying labels in contrasting colors of your choice as indicated by the red numerals.

The Ear

EXTERNAL EAR

AURICLE 1
EXTERNAL AUDITORY MEATUS 2
TYMPANIC MEMBRANE 3

MIDDLE EAR

MALLEUS 4
INCUS 5
STAPES 6
AUDITORY TUBE 7

INNER EAR

COCHLEA 8
SPIRAL LAMINA 9
VESTIBULAR MEMBRANE 10
BASILAR MEMBRANE 11
COCHLEAR DUCT 12
SCALA VESTIBULI 13
SCALA TYMPANI 14
TECTORIAL MEMBRANE
ORGAN OF CORTI 16
COCHLEAR NERVE 17
VESTIBULE 18
VESTIBULAR NERVE 19
SEMICIRCULAR CANALS 20

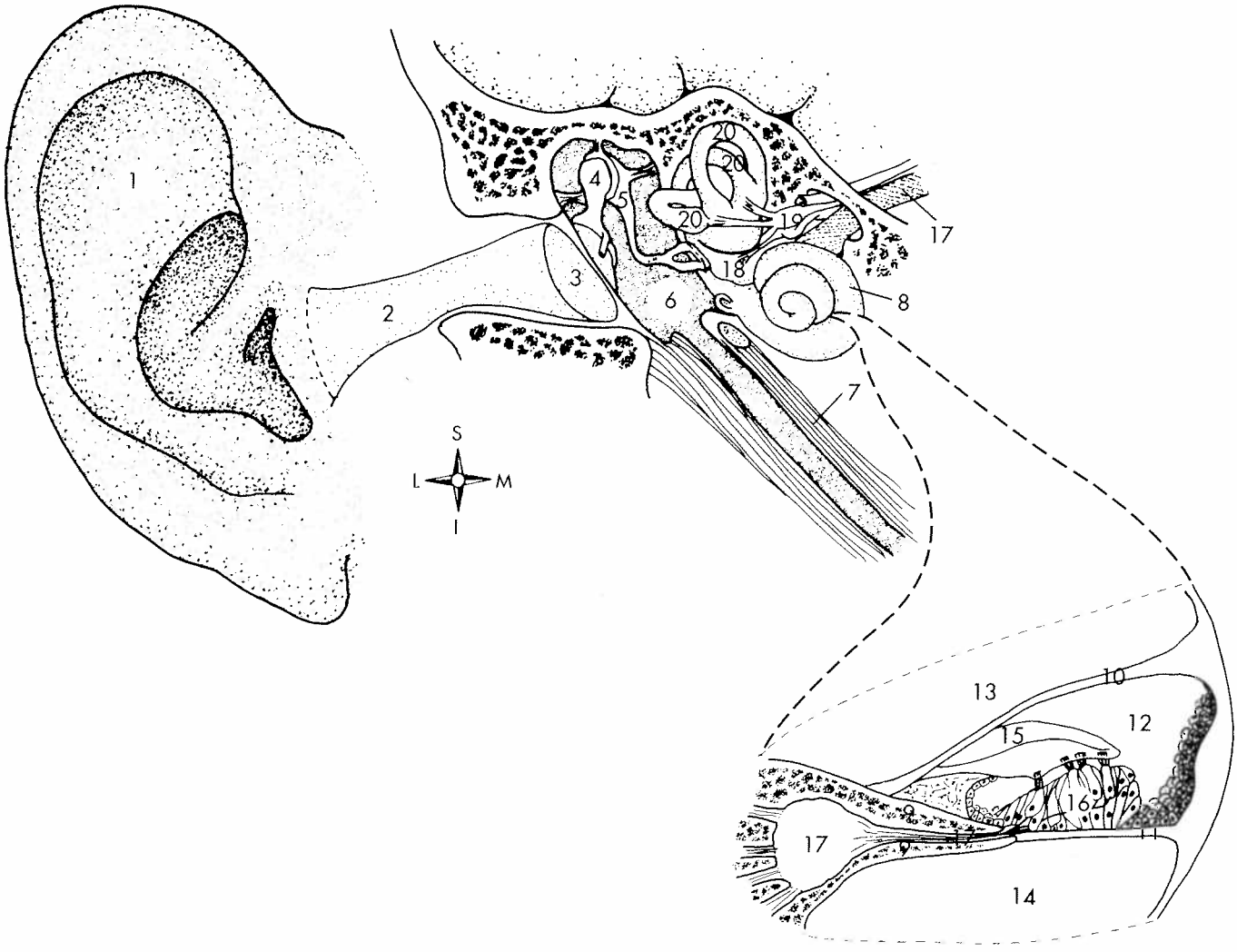
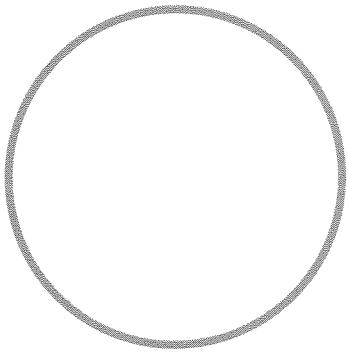


Figure 28-2 External, middle, and inner structures of the ear.

Name: _____ **Date:** _____ **Section:** _____

LAB REPORT 28

The Ear



Specimen: *cochlea c.s.*

Total Magnification: _____

Figure 28-1

1. _____
2. _____
3. _____
4. _____
5. _____

Put in Order

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

Put in Order (arrange these structures in the order in which sound waves pass through them)

auricle
endolymph
external auditory meatus
incus
malleus
perilymph
stapes
tectorial membrane/organ of Corti
tympanum

Ear Divisions

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

Fill-in

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____

Ear Divisions (for each structure, identify whether it is part of the *external ear, middle ear,* or *inner ear*)

1. auricle
2. bony labyrinth
3. cochlea
4. external auditory meatus
5. incus
6. malleus
7. membranous labyrinth
8. organ of Corti
9. saccule
10. semicircular canal
11. stapes
12. tympanic membrane
13. utricle
14. vestibule

Fill-in (complete each statement with the correct term)

1. The __?__ are three passages, each forming a circle and each in a different plane.
2. When traveling in an automobile, you sense that you have suddenly turned a corner. The sensation you have is mainly an aspect of the sense of __?__ equilibrium.
3. In a weightless environment, as in deep space, the sense of __?__ equilibrium would not work well, if at all.
4. The vestibular membrane and basilar membrane are walls of the __?__ labyrinth.
5. The sensory patch in the utricle's lining is called the __?__.
6. The sensory patch in the utricle's lining has receptors for the sense of __?__.
7. The __?__ is a passage that allows air pressure in the middle ear to reach equi librium with atmospheric air pressure.
8. The auditory ossicles are joined to one another with __?__ (type) joints.
9. The __?__ has a flat, pluglike portion that fits into the oval window.
10. Both the oval window and the __?__ window are on the boundary of the middle and inner ear.
11. During sound reception, the tectorial membrane vibrates and stimulates the hair cells in the __?__.
12. The __?__ is the most external portion of the external ear.
13. The __?__ amplify sound waves by as much as 20 times their original intensity.
14. The semicircular canals have sensory structures called __?__ within the ampullae.
15. The semicircular canals have sensory structures for the sense of __?__.
16. The maculae of the vestibular sensory regions are covered with gelatinous material. __?__ are embedded in this material.