After study of this chapter you should be able to:

1. Explain the role of the sensory system.
2. Label diagrams of the ear and the eye, and briefly describe the function of each part.
3. Describe the pathway of nerve impulses from the ear to the brain.
4. Roots Pertaining to the Ear and Hearing
5. Describe the roles of the retina and the optic nerve in vision.
6. Identify and use word parts pertaining to the senses.
7. Describe the main disorders pertaining to the ear and the eye.
8. Interpret abbreviations used in the study of the ear and the eye.
9. Analyze several case studies pertaining to vision or hearing.

Pretest

1. The scientific name for the sense of smell is ________.
2. The two senses located in the ear are ________ and ________.
3. Otitis is ________.
4. The receptor layer of the eye is the ________.
5. The scientific name for the white of the eye is ________.
6. Clouding of the lens is termed ________.
The sensory system is our network for detecting stimuli from the internal and external environments. It is needed to maintain homeostasis, provide us with pleasure, and protect us from harm. Pain, for example, is an important warning sign of tissue damage. The signals generated in the various receptors of the sensory system must be transmitted to the central nervous system for interpretation.

The Senses

The senses are divided according to whether they are widely distributed or localized in special sense organs. The receptors for the general senses are found throughout the body. Many are located in the skin (Fig. 18-1). These senses include:

- **Pain.** These receptors are found in the skin and also in muscles, joints, and internal organs.
- **Touch,** the tactile sense, located in the skin. Sensitivity to touch depends on the concentration of these receptors in different areas, high on the fingers, lips and tongue, for example, but low at the back of the neck or back of the hand.
- **Pressure,** or deep touch, located beneath the skin and in deeper tissues.
- **Temperature.** Receptors for heat and cold are located in the skin and also in the hypothalamus, which regulates body temperature.
- **Proprioception,** the awareness of body position. Receptors in muscles, tendons, and joints help to judge body position and coordinate muscle activity. They also help to maintain muscle tone.

Figure 18-1  Receptors for general senses in the skin. Synapses for these pathways are in the spinal cord.
The special senses are localized within complex sense organs in the head. These include:

- **Gustation** (taste) is located in receptors in taste buds on the tongue. These receptors basically detect only sweet, sour, bitter, and salty, although researchers have recently identified receptors for alkaline (bases), metallic taste, and the amino acid glutamate, as found in the flavor enhancer MSG. The senses of smell and taste are chemical senses, that is, they respond to chemicals in solution.

- **Olfaction** (smell) is located in receptors in the nose. Many more chemicals can be discriminated by smell than by taste. Both senses are important in stimulating appetite and warning of harmful substances.

- **Hearing** receptors are located in the ear. These receptors respond to movement created by sound waves as they travel through the ear.

- **Equilibrium** receptors are also located in the ear. These receptors are activated by changes in the position of cells as we move.

- **Vision** receptors are light-sensitive and located deep within the eye, protected by surrounding bone and other support structures. The coordinated actions of external and internal eye muscles help in the formation of a clear image.

The remainder of this chapter concentrates on hearing and vision, the senses that have received the most clinical attention.

---

**TERMINOLOGY**

**Key Terms**

**Senses**

**NORMAL STRUCTURE AND FUNCTION**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>equilibrium</td>
<td>The sense of balance</td>
</tr>
<tr>
<td>gus-TÁ-shun</td>
<td>The sense of taste</td>
</tr>
<tr>
<td>HER-ing</td>
<td>The sense or perception of sound</td>
</tr>
<tr>
<td>ol-FAK-shun</td>
<td>The sense of smell</td>
</tr>
<tr>
<td>pró-pré-Ó-SEP-shun</td>
<td>The awareness of posture, movement, and changes in equilibrium; receptors are located in muscles, tendons, and joints</td>
</tr>
<tr>
<td>ré-SEP-tor</td>
<td>A sensory nerve ending or a specialized structure associated with a sensory nerve that responds to a stimulus</td>
</tr>
<tr>
<td>TAK-til</td>
<td>Pertaining to the sense of touch</td>
</tr>
<tr>
<td>ViZH-un</td>
<td>The sense by which the shape, size, and color of objects are perceived by means of the light they give off</td>
</tr>
</tbody>
</table>

Go to the pronunciation glossary in Chapter 18 of the CD-ROM to hear these words pronounced.
Table 18-1

<table>
<thead>
<tr>
<th>SUFFIX</th>
<th>MEANING</th>
<th>EXAMPLE</th>
<th>DEFINITION OF EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>-esthesia</td>
<td>sensation</td>
<td>cryesthesia</td>
<td>sensitivity to cold</td>
</tr>
<tr>
<td>-algiesia</td>
<td>pain</td>
<td>hypalgiesia*</td>
<td>decreased sensitivity to pain</td>
</tr>
<tr>
<td>-osmia</td>
<td>sense of smell</td>
<td>pseudosmia</td>
<td>false sense of smell</td>
</tr>
<tr>
<td>-geusia</td>
<td>sense of taste</td>
<td>parageusia</td>
<td>abnormal (para-) sense of taste</td>
</tr>
</tbody>
</table>

*Prefix hyp/o.

Exercise 18-1

Define the following words:
1. dysesthesia (di-s-es-the-ze-a)
2. parosmia (par-OZ-me-a)
3. ageusia (a-Gu--ze--a)

Synonyms. Write words that mean the same as the following:
4. lack (an-) of sensation
5. false sense of taste
6. sensitivity to temperature
7. excess sensitivity to pain
8. abnormal (dys-) sense of taste
9. muscular (my/o-) sensation

The Ear

The ear has the receptors for both hearing and equilibrium. For study purposes, it may be divided into three parts: the outer, middle, and inner ear (Fig. 18-2).

The outer ear consists of the projecting pinna (auricle) and the external auditory canal (meatus). This canal ends at the tympanic membrane, or eardrum, which transmits sound waves to the middle ear. Glands in the external canal produce a waxy material, cerumen, which protects the ear and helps to prevent infection.

Spanning the middle ear cavity are three ossicles (small bones), each named for its shape: the malleus (hammer), incus (anvil), and stapes (stirrup) (Fig. 18-3). Sound waves traveling over the ossicles are transmitted from the footplate of the stapes to the inner ear. The eustachian tube connects the middle ear with the nasopharynx and serves to equalize pressure between the outer ear and the middle ear.

The inner ear, because of its complex shape, is described as a labyrinth, which means “maze” (Fig. 18-4). It consists of an outer bony framework containing a similarly shaped membranous channel. The entire labyrinth is filled with fluid.

The cochlea, shaped like the shell of a snail, has the specialized organ of Corti, which is concerned with hearing. Cells in this receptor organ respond to sound waves traveling through the fluid-filled ducts of the cochlea. Sound waves enter the cochlea
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Figure 18-2 The ear. Structures in the outer, middle, and inner divisions are shown.

Figure 18-3 The ossicles of the middle ear. The malleus is in contact with the tympanic membrane. The base of the stapes is in contact with the oval window of the inner ear.
from the base of the stapes through an opening called the oval window and leave through another opening called the round window (see Fig. 18-4).

The sense of equilibrium is localized in the vestibular apparatus. This structure consists of the chamberlike vestibule and three projecting semicircular canals. Special cells within the vestibular apparatus respond to movement. (The senses of vision and proprioception are also important in maintaining balance.)

Nerve impulses are transmitted from the ear to the brain by way of the vestibulocochlear nerve, the eighth cranial nerve, also called the acoustic or auditory nerve. The cochlear branch of this nerve transmits impulses for hearing from the cochlea; the vestibular branch transmits impulses concerned with equilibrium from the vestibular apparatus (see Fig. 18-4).

---

**Figure 18-4 The inner ear.** The outer bony labyrinth contains the membranous labyrinth. Receptors for equilibrium are in the vestibule and the semicircular canals. The cochlea contains the hearing receptor, the organ of Corti. Sound waves enter the cochlea through the oval window, travel through the cochlea, and exit through the round window. The inner ear transmits impulses to the brain in the vestibulocochlear nerve (VIIIth cranial nerve).
## Key Terms

### The Ear

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>eustachian tube</td>
<td>The tube that connects the middle ear with the nasopharynx and serves to equalize pressure between the outer and middle ear (root: salping/o); auditory tube</td>
</tr>
<tr>
<td>external auditory canal</td>
<td>Tube that extends from the pinna of the ear to the tympanic membrane; external auditory meatus</td>
</tr>
<tr>
<td>incus</td>
<td>The middle ossicle of the ear</td>
</tr>
<tr>
<td>labyrinth</td>
<td>The inner ear, named for its complex structure, which resembles a maze</td>
</tr>
<tr>
<td>malleus</td>
<td>The ossicle of the middle ear that is in contact with the tympanic membrane and the incus</td>
</tr>
<tr>
<td>ossicles</td>
<td>The small bones of the middle ear, the malleus, incus, and stapes</td>
</tr>
<tr>
<td>organ of Corti</td>
<td>The hearing receptor, which is located in the cochlea</td>
</tr>
<tr>
<td>pinna</td>
<td>The projecting part of the outer ear; auricle (AW-ri-kl)</td>
</tr>
<tr>
<td>semicircular canals</td>
<td>The three curved channels of the inner ear that hold receptors for equilibrium</td>
</tr>
<tr>
<td>stapes</td>
<td>The ossicle that is in contact with the inner ear (root: staped, stapedi/o)</td>
</tr>
<tr>
<td>tympanic membrane</td>
<td>The membrane between the external auditory canal and the middle ear (tympanic cavity), the eardrum. It serves to transmit sound waves to the ossicles of the middle ear (root: myring/o, tympan/o).</td>
</tr>
<tr>
<td>vestibular apparatus</td>
<td>The portion of the inner ear that is concerned with the sense of equilibrium; consists of the vestibule and the semicircular canals (root: vestibulo)</td>
</tr>
<tr>
<td>vestibule</td>
<td>The chamber in the inner ear that holds some of the receptors for equilibrium</td>
</tr>
<tr>
<td>vestibulocochlear nerve</td>
<td>The nerve that transmits impulses for hearing and equilibrium from the ear to the brain; eighth cranial nerve; auditory or acoustic nerve</td>
</tr>
</tbody>
</table>

Go to the pronunciation glossary in Chapter 18 of the CD-ROM to hear these words pronounced.
Table 18-2 Roots Pertaining to the Ear and Hearing

<table>
<thead>
<tr>
<th>ROOT</th>
<th>MEANING</th>
<th>EXAMPLE</th>
<th>DEFINITION OF EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>audi/o</td>
<td>hearing</td>
<td>audition</td>
<td>act of hearing</td>
</tr>
<tr>
<td>acous, acus, cus</td>
<td>sound, hearing</td>
<td>acoustic</td>
<td>pertaining to sound or hearing</td>
</tr>
<tr>
<td>ot/o</td>
<td>ear</td>
<td>otogenic</td>
<td>originating in the ear</td>
</tr>
<tr>
<td>myring/o</td>
<td>tympanic membrane</td>
<td>myringotome</td>
<td>knife used for surgery on the eardrum</td>
</tr>
<tr>
<td>tympan/o</td>
<td>tympanic cavity (middle ear), tympanic membrane</td>
<td>tympanometry</td>
<td>measurement of transmission through the tympanic membrane and middle ear</td>
</tr>
<tr>
<td>salping/o</td>
<td>tube, eustachian tube</td>
<td>salpingoscope</td>
<td>endoscope for examination of the eustachian tube</td>
</tr>
<tr>
<td>staped/o, stapedi/o</td>
<td>stapes</td>
<td>stapedoplasty</td>
<td>plastic repair of the stapes</td>
</tr>
<tr>
<td>labyrinth/o</td>
<td>labyrinth (inner ear)</td>
<td>labyrinthitis</td>
<td>inflammation of the inner ear (labyrinth)</td>
</tr>
<tr>
<td>vestibul/o</td>
<td>vestibule, vestibular apparatus</td>
<td>vestibulotomy</td>
<td>incision of the vestibule of the inner ear</td>
</tr>
<tr>
<td>cochle/o</td>
<td>cochlea of inner ear</td>
<td>retrocochlear</td>
<td>behind the cochlea</td>
</tr>
</tbody>
</table>

Exercise 18-2

Fill in the blanks:
1. Audiology (aw- dél-OL-ô-jê) is the study of ________________________________
2. Hyperacusis (hî-per-a-Kû-sis) is abnormally high sensitivity to ________________________________
3. Ototoxic (ô-tô-TOKS-ik) means poisonous or harmful to the ________________________________

Define the following adjectives:
4. auditory (Aw-di-tor-e-) ________________________________
5. otic (Ô-tik) ________________________________
6. labyrinthine (lab-i-RIN-thên) ________________________________
7. vestibular (ves-TIB-û-LÔT-ô-mê) ________________________________
8. cochlear (KOK-ô-år) ________________________________
9. stapedial (stâ-PÊ-dê-al) ________________________________

Word building. Write words for the following definitions:
10. measurement of hearing (audi/o-) ________________________________
11. pain in the ear ________________________________
12. plastic repair of the middle ear ________________________________
Clinical Aspects of Hearing

Hearing Loss

Hearing impairment may result from disease, injury, or developmental problems that affect the ear itself or any nervous pathways concerned with the sense of hearing.

Sensorineural hearing loss results from damage to the inner ear, the eighth cranial nerve, or central auditory pathways. Heredity, toxins, exposure to loud noises, and the aging process are possible causes for this type of hearing loss. It may range from inability to hear certain sound frequencies to a complete loss of hearing (deafness). People with extreme hearing loss that originates in the inner ear may benefit from a cochlear implant. This prosthesis stimulates the cochlear nerve directly, bypassing the receptor cells of the inner ear, and may allow the recipient to hear medium to loud sounds.

Conductive hearing loss results from blockage in sound transmission to the inner ear. Causes include obstruction, severe infection, or fixation of the middle ear ossicles. Often, physicians can successfully treat the conditions that cause conductive hearing loss.

Box 18-1 has information on careers in audiology, the study and treatment of hearing disorders.

Define the following terms:

19. audimeter (aw-dee-OM-e-ter)
20. vestibulopathy (ves-tib-u-LOP-a-the)
21. salpingopharyngeal (sal-ping-go-fa-RIN-je-al)
22. myringoscope (mi-RING-go-skoe)
23. otitis (oh-TI-tis)

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13. incision of the tympanic membrane
14. excision of the stapes
15. pertaining to the vestibular apparatus and cochlea
16. incision of the labyrinth
17. endoscopic examination of the eustachian tube
18. within the cochlea

Health Professions

Audiologists

Audiologists specialize in preventing, diagnosing, and treating hearing disorders that may be caused by injury, infection, birth defects, noise, or aging. They take a complete patient history to diagnose hearing disorders and use specialized equipment to measure hearing acuity. Audiologists design and implement individualized treatment plans, which may include fitting clients with assistive listening devices, such as hearing aids, or teaching alternative communication skills, such as lip reading. Audiologists also measure workplace and community noise levels and teach the public how to prevent hearing loss. Most audiologists in the United States have master's degrees or the equivalent from an accredited college or university and must pass a national licensing exam.

Audiologists work in a variety of settings, such as hospitals, nursing care facilities, schools, and clinics. Job prospects are good, as the need for audiologists' specialized skills will increase as populations age. The American Academy of Audiology has more information on this career.
Otitis

Otitis is any inflammation of the ear. Otitis media refers to an infection that leads to the accumulation of fluid in the middle ear cavity. One cause is malfunction or obstruction of the eustachian tube, as by allergy, enlarged adenoids, injury, or congenital abnormalities. Another cause is infection that spreads to the middle ear, most commonly from the upper respiratory tract. Continued infection may lead to accumulation of pus and perforation of the eardrum. Otitis media usually affects children under 5 years of age and may result in hearing loss. If not treated with antibiotics, the infection may spread to other regions of the ear and head. An incision, a myringotomy, and placement of a tube in the tympanic membrane helps to ventilate and drain the middle ear cavity in cases of otitis media.

Otitis externa is inflammation of the external auditory canal. Infections in this region may be caused by a fungus or bacterium and are most common among those living in hot climates and among swimmers, leading to the alternative name, “swimmer’s ear.”

Otosclerosis

In otosclerosis, the bony structure of the inner ear deteriorates and then reforms into spongy bone tissue that may eventually harden. Most commonly, the stapes becomes fixed against the inner ear and is unable to vibrate, resulting in conductive hearing loss. The cause of otosclerosis is unknown, but some cases are hereditary. Surgeons usually can remove the damaged bone. In a stapedectomy, the stapes is removed and a prosthetic bone is inserted.

Ménière Disease

Ménière disease is a disorder that affects the inner ear. It seems to involve production and circulation of the fluid that fills the inner ear, but the cause is unknown. The symptoms are vertigo (dizziness), hearing loss, pronounced tinnitus (ringing in the ears), and a feeling of pressure in the ear. The course of the disease is uneven, and symptoms may become less severe with time. Ménière disease is treated with drugs to control nausea and dizziness, such as those used to treat motion sickness. In severe cases, the inner ear or part of the eighth cranial nerve may be destroyed surgically.

Acoustic Neuroma

An acoustic neuroma (also called a schwannoma or neurilemoma) is a tumor that arises from the neurilemma (sheath) of the eighth cranial nerve. As the tumor enlarges, it presses on surrounding nerves and interferes with blood supply. This leads to tinnitus, dizziness, and progressive hearing loss. Other symptoms develop as the tumor presses on the brainstem and other cranial nerves. Usually it is necessary to remove the tumor surgically.
# Key Clinical Terms

## The Ear

### DISORDERS

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>acoustic neuroma</strong></td>
<td>A tumor of the eighth cranial nerve sheath; although benign, it can press on surrounding tissue and produce symptoms; also called a schwannoma or neurilemoma</td>
</tr>
<tr>
<td><strong>conductive hearing loss</strong></td>
<td>Hearing impairment that results from blockage of sound transmission to the inner ear</td>
</tr>
<tr>
<td><strong>Ménière disease</strong></td>
<td>A disease associated with increased fluid pressure in the inner ear and characterized by hearing loss, vertigo, and tinnitus</td>
</tr>
<tr>
<td><strong>otitis externa</strong></td>
<td>Inflammation of the external auditory canal; swimmer's ear</td>
</tr>
<tr>
<td><strong>otitis media</strong></td>
<td>Inflammation of the middle ear with accumulation of serous (watery) or mucoid fluid</td>
</tr>
<tr>
<td><strong>otosclerosis</strong></td>
<td>Formation of abnormal and sometimes hardened bony tissue in the ear. It usually occurs around the oval window and the footplate (base) of the stapes, causing immobilization of the stapes and progressive loss of hearing</td>
</tr>
<tr>
<td><strong>sensorineural hearing loss</strong></td>
<td>Hearing impairment that results from damage to the inner ear, eighth cranial nerve, or auditory pathways in the brain</td>
</tr>
<tr>
<td><strong>tinnitus</strong></td>
<td>A sensation of noises, such as ringing or tinkling, in the ear</td>
</tr>
<tr>
<td><strong>vertigo</strong></td>
<td>An illusion of movement, as of the body moving in space or the environment moving about the body; usually caused by disturbances in the vestibular apparatus. Used loosely to mean dizziness or lightheadedness.</td>
</tr>
</tbody>
</table>

### TREATMENT

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>myringotomy</strong></td>
<td>Surgical incision of the tympanic membrane; performed to drain the middle ear cavity or to insert a tube into the tympanic membrane for drainage</td>
</tr>
<tr>
<td><strong>stapedectomy</strong></td>
<td>Surgical removal of the stapes; it may be combined with insertion of a prosthesis to correct otosclerosis</td>
</tr>
</tbody>
</table>
### TERMINOLOGY

#### Supplementary Terms

**NORMAL STRUCTURE AND FUNCTION**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>aural</td>
<td>Pertaining to or perceived by the ear</td>
</tr>
<tr>
<td><strong>AW-ral</strong></td>
<td></td>
</tr>
<tr>
<td>decibel (dB)</td>
<td>A unit for measuring the relative intensity of sound</td>
</tr>
<tr>
<td><strong>DES-i-bel</strong></td>
<td></td>
</tr>
<tr>
<td>hertz (Hz)</td>
<td>A unit for measuring the frequency (pitch) of sound</td>
</tr>
<tr>
<td><strong>hertz</strong></td>
<td></td>
</tr>
<tr>
<td>mastoid process</td>
<td>A small projection of the temporal bone behind the external auditory canal; it consists of loosely arranged bony material and small, air-filled cavities</td>
</tr>
<tr>
<td><strong>stapedius</strong></td>
<td>A small muscle attached to the stapes. It contracts in the presence of a loud sound, producing the acoustic reflex.</td>
</tr>
<tr>
<td><strong>stò-PE-de-us</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### SYMPTOMS AND CONDITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cholesteatoma</td>
<td>A cystlike mass containing cholesterol that is most common in the middle ear and mastoid region; a possible complication of chronic middle ear infection</td>
</tr>
<tr>
<td><strong>kò-le-ste-a-TÔ-ma</strong></td>
<td></td>
</tr>
<tr>
<td>labyrinthitis</td>
<td>Inflammation of the labyrinth of the ear (inner ear); otitis interna</td>
</tr>
<tr>
<td><strong>lab-i-rin-THI-tis</strong></td>
<td></td>
</tr>
<tr>
<td>mastoiditis</td>
<td>Inflammation of the air cells of the mastoid process</td>
</tr>
<tr>
<td><strong>mas-toyd-I-tis</strong></td>
<td></td>
</tr>
<tr>
<td>presbycusis</td>
<td>Loss of hearing caused by aging; also presbyacusis</td>
</tr>
<tr>
<td><strong>prez-be-KU-sis</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### DIAGNOSIS AND TREATMENT

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>audiometry</td>
<td>Measurement of hearing</td>
</tr>
<tr>
<td>aw-de-OM-e-trê</td>
<td></td>
</tr>
<tr>
<td>electronystagmography (ENG)</td>
<td>A method for recording eye movements by means of electrical responses; such movements may reflect vestibular dysfunction</td>
</tr>
<tr>
<td>é-lek-trö-nis-tag-MOG-ra-te</td>
<td></td>
</tr>
<tr>
<td>otorhinolaryngology (ORL)</td>
<td>The branch of medicine that deals with diseases of the ear(s), nose, and throat (ENT); also called otolaryngology (OL)</td>
</tr>
<tr>
<td>ò-tô-ri-nô-lar-in-GOL-ô-jê</td>
<td></td>
</tr>
<tr>
<td>otoscope</td>
<td>Instrument for examining the ear (see Fig. 7-6)</td>
</tr>
<tr>
<td>Ò-tô-skôp</td>
<td></td>
</tr>
<tr>
<td>Rinne test</td>
<td>Test that measures hearing by comparing results of bone conduction and air conduction (Fig. 18-5)</td>
</tr>
<tr>
<td>spondee</td>
<td>A two-syllable word with equal stress on each syllable; used in hearing tests; examples are toothbrush, baseball, cowboy, pancake</td>
</tr>
<tr>
<td>spon-dê</td>
<td></td>
</tr>
<tr>
<td>Weber test</td>
<td>Test for hearing loss that uses a vibrating tuning fork placed at the center of the head (Fig. 18-6)</td>
</tr>
<tr>
<td><strong>Weber test</strong></td>
<td></td>
</tr>
</tbody>
</table>
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Figure 18-5 The Rinne test. This test assesses both air and bone conduction of sound.

Figure 18-6 The Weber test. This test assesses bone conduction of sound.
The Eye and Vision

The eye is protected by its position within a bony socket or orbit. It is also protected by the eyelids, or palpebrae, eyebrows, and eyelashes (Fig. 18-7). The lacrimal (tear) glands (Fig. 18-8) constantly bathe and cleanse the eyes with a lubricating fluid that drains into the nose. The protective conjunctiva is a thin membrane that lines the eyelids and covers the anterior portion of the eye. This membrane folds back to form a narrow space between the eyeball and the eyelids. Medications can be instilled into this conjunctival sac.

The wall of the eye is composed of three layers (Fig. 18-9). Named from outermost to innermost they are as follows:

1. The sclera, commonly called the white of the eye, is the tough surface protective layer. The sclera extends over the eye's anterior portion as the transparent cornea.
2. The uvea is the middle layer, which consists of:
   - the choroid, a vascular and pigmented layer located in the posterior portion of the eyeball. The choroid provides nourishment for the retina.
   - the ciliary body, which contains a muscle that controls the shape of the lens to allow for near and far vision, a process known as accommodation (Fig 18-10). The lens must become more rounded for viewing close objects.
   - the iris, a muscular ring that controls the size of the pupil, thus regulating the amount of light that enters the eye (Fig. 18-11). The genetically controlled pigments of the iris determine eye color.
3. The retina is the innermost layer and the actual visual receptor. It consists of two types of specialized cells that respond to light:

   ![Figure 18-7 Protective structures of the eye.](image-url)
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**Figure 18-8** Lacrimal apparatus. The right lacrimal (tear) gland and its associated ducts are shown.

**Figure 18-9** The eye. The three layers of the eyeball are shown along with other structures involved in vision.

**Figure 18-10** Accommodation for near vision. When viewing a close object, the lens must become more rounded to focus light rays on the retina.
> The rods function in dim light, provide low visual acuity (sharpness), and do not respond to color.
> The cones are active in bright light, have high visual acuity, and respond to color.

Proper vision requires the refraction (bending) of light rays as they pass through parts of the eye to focus on a specific point on the retina. The impulses generated within the rods and cones are transmitted to the brain by way of the optic nerve (second cranial nerve). Where the optic nerve connects to the retina, there are no rods or cones. This point, at which there is no visual perception, is called the optic disk, or blind spot (Fig. 18-12). The fovea is a tiny depression in the retina near the optic nerve that has a high concentration of cone cells and is the point of greatest visual acuity. The fovea is surrounded by a yellowish spot called the macula (see Fig. 18-12).

The eyeball is filled with a jellylike vitreous body (see Fig. 18-9), which helps maintain the shape of the eye and also refractions light. The aqueous humor is the fluid that fills the eye anterior to the lens, maintaining the shape of the cornea and refracting light. This fluid is constantly produced and drained from the eye.

Six muscles attached to the outside of each eye coordinate eye movements to achieve convergence, that is, coordinated movement of the eyes so that they both are fixed on the same point.

Box 18-2 explores the Greek origins of some medical words, including some pertaining to the eye.
Some of our most beautiful (and difficult to spell and pronounce) words come from Greek. *Esthesi/o* means sensation. It appears in the word *anesthesia*, a state in which there is lack of sensation, particularly pain. It is found in the word *esthetics* (also spelled *aesthetics*), which pertains to beauty, artistry, and appearance. The prefix *presby*, in the terms *presbycusis* and *presbyopia*, means “old,” and these conditions appear with aging. The root *cycl/o*, pertaining to the ringlike ciliary body of the eye, is from the Greek word for circle or wheel. The same root appears in the words *bicycle* and *tricycle*. Also pertaining to the eye, the term *iris* means “rainbow” in Greek, and the iris is the colored part of the eye.

The root *sthen/o* means “strength,” and occurs in the words *asthenia*, meaning lack of strength or weakness, and *neurasthenia*, an old term for vague “nervous exhaustion,” now applied to conditions involving chronic symptoms of generalized fatigue, anxiety, and pain. The root also appears in the word *calisthenics* in combination with the root *cali-*, meaning “beauty.” So the rhythmic strengthening and conditioning exercises that are done in calisthenics literally give us beauty through strength.

The Greek root *steth/o* means “chest,” although a stethoscope is used to listen to sounds in other parts of the body as well as the chest.

*Asphyxia* is derived from the Greek root *sphygm/o* meaning “pulse.” The word is literally “stoppage of the pulse,” which is exactly what happens when one suffocates. This same root is found in *sphygmomanometer*, the apparatus used to measure blood pressure. One look at the word and one attempt to pronounce it make clear why most people call the device a blood pressure cuff!
### The Eye

<table>
<thead>
<tr>
<th><strong>Key Terms</strong></th>
<th><strong>Definitions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Iris</strong></td>
<td>The muscular colored ring between the lens and the cornea; regulates the amount of light that enters the eye by altering the size of the pupil at its center (roots: <em>ir</em>; <em>irid/o</em>, <em>irit/o</em>; plural: <em>irides</em> [IR-i-dez])</td>
</tr>
<tr>
<td><strong>Lacrimal glands</strong></td>
<td>Pertaining to tears (roots: <em>lacrim/o</em>, <em>dacry/o</em>)</td>
</tr>
<tr>
<td><strong>Lens</strong></td>
<td>The transparent, biconvex structure in the anterior portion of the eye that refracts light and functions in accommodation (roots: <em>lent/i</em>, <em>phak/o</em>)</td>
</tr>
<tr>
<td><strong>Macula</strong></td>
<td>A small spot or colored area; used alone to mean the yellowish spot in the retina that contains the fovea</td>
</tr>
<tr>
<td><strong>Optic disk</strong></td>
<td>The point where the optic nerve joins the retina; at this point there are no rods or cones; also called the blind spot or optic papilla</td>
</tr>
<tr>
<td><strong>Orbit</strong></td>
<td>The bony cavity that contains the eyeball</td>
</tr>
<tr>
<td><strong>Palpebra</strong></td>
<td>An eyelid; a protective fold (upper or lower) that closes over the anterior surface of the eye (root: <em>palpebr/o</em>, <em>blephar/o</em>; adjective: <em>palpebral</em>; plural: <em>palpebrae</em> [pal-PE-brei])</td>
</tr>
<tr>
<td><strong>Pupil</strong></td>
<td>The opening at the center of the iris (root: <em>pupill/o</em>)</td>
</tr>
<tr>
<td><strong>Refraction</strong></td>
<td>The bending of light rays as they pass through the eye to focus on a specific point on the retina; also the determination and correction of ocular refractive errors</td>
</tr>
<tr>
<td><strong>Retina</strong></td>
<td>The innermost, light-sensitive layer of the eye; contains the rods and cones, the specialized receptor cells for vision (root: <em>retin/o</em>)</td>
</tr>
<tr>
<td><strong>Rod</strong></td>
<td>A specialized cell in the retina of the eye that responds to light; rods have low visual acuity, function in dim light, and do not discriminate color</td>
</tr>
<tr>
<td><strong>Sclera</strong></td>
<td>The tough, white, fibrous outermost layer of the eye; the white of the eye (root: <em>scler/o</em>)</td>
</tr>
<tr>
<td><strong>Uvea</strong></td>
<td>The middle, vascular layer of the eye (root: <em>uve/o</em>); consists of the choroid, ciliary body, and iris</td>
</tr>
<tr>
<td><strong>Visual acuity</strong></td>
<td>Sharpness of vision</td>
</tr>
<tr>
<td><strong>Vitreous body</strong></td>
<td>The transparent jellylike mass that fills the main cavity of the eyeball; also called vitreous humor</td>
</tr>
</tbody>
</table>

Go to the pronunciation glossary in Chapter 18 of the CD-ROM to hear these words pronounced.
Word Parts Pertaining to the Eye and Vision

<table>
<thead>
<tr>
<th>ROOT</th>
<th>MEANING</th>
<th>EXAMPLE</th>
<th>DEFINITION OF EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>blephar/o</td>
<td>eyelid</td>
<td>symblepharon</td>
<td>adhesion of the eyelid to the eyeball (sym- = together)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sim-BLEF-a-ron</td>
<td></td>
</tr>
<tr>
<td>palpebr/o</td>
<td>eyelid</td>
<td>palpebral</td>
<td>pertaining to an eyelid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PAL-pe-bral</td>
<td></td>
</tr>
<tr>
<td>dacry/o</td>
<td>tear, lacrimal apparatus</td>
<td>dacryolith</td>
<td>stone in the lacrimal apparatus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DAK-re-o-lith</td>
<td></td>
</tr>
<tr>
<td>dacryocyst/o</td>
<td>lacrimal sac</td>
<td>dacryocystocele</td>
<td>hernia of the lacrimal sac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dak-re-o-SIS-to-se-I</td>
<td></td>
</tr>
<tr>
<td>lacrim/o</td>
<td>tear, lacrimal apparatus</td>
<td>lacrimation</td>
<td>secretion of tears</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lak-ri-MA-shun</td>
<td></td>
</tr>
</tbody>
</table>

Exercise 18-3

Define the following words:
1. dacryocystectomy (dak-re-o-sis-TEK-tô-mé) ________________
2. blepharoplegia (BLEF-a-ro-plê-jê-a) ________________
3. interpalpebral (in-ter-PAL-pe-bral) ________________
4. nasolacrimal (nâ-zô-LAK-ri-mal) ________________

Word building. Use the roots indicated to write words with the following meanings:
5. spasm of the eyelid (blephar/o) ________________
6. discharge from the lacrimal apparatus (dacry/o) ________________
7. inflammation of a lacrimal sac ________________

<table>
<thead>
<tr>
<th>ROOT</th>
<th>MEANING</th>
<th>EXAMPLE</th>
<th>DEFINITION OF EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>opt/o</td>
<td>eye, vision</td>
<td>optometer</td>
<td>instrument for measuring the refractive power of the eye</td>
</tr>
<tr>
<td></td>
<td></td>
<td>op-TOM-e-ter</td>
<td></td>
</tr>
<tr>
<td>ocul/o</td>
<td>eye</td>
<td>sinistrocular</td>
<td>pertaining to the left eye</td>
</tr>
<tr>
<td></td>
<td></td>
<td>si-nis-TROK-û-lar</td>
<td></td>
</tr>
<tr>
<td>ophthalm/o</td>
<td>eye</td>
<td>exophthalmos</td>
<td>protrusion of the eyeball</td>
</tr>
<tr>
<td></td>
<td></td>
<td>eks-of-THAL-mos</td>
<td></td>
</tr>
<tr>
<td>scler/o</td>
<td>sclera</td>
<td>episcleritis</td>
<td>inflammation of the tissue on the surface of the sclera</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ep-i-skle-RI-tis</td>
<td></td>
</tr>
<tr>
<td>corne/o</td>
<td>cornea</td>
<td>circumcorneal</td>
<td>around the cornea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sir-kum-KOR-né-al</td>
<td></td>
</tr>
</tbody>
</table>
Table 18-4  Continued

<table>
<thead>
<tr>
<th>Root</th>
<th>Meaning of Root</th>
</tr>
</thead>
<tbody>
<tr>
<td>kerat/o</td>
<td>cornea</td>
</tr>
<tr>
<td></td>
<td>keratoplast (ker-at-o-plas-te) plastic repair of the cornea; corneal transplant</td>
</tr>
<tr>
<td>lent/i</td>
<td>lens</td>
</tr>
<tr>
<td></td>
<td>lentiform (LEN-ti-form) resembling a lens</td>
</tr>
<tr>
<td>phak/o, phac/o</td>
<td>lens</td>
</tr>
<tr>
<td></td>
<td>aphakia (a-FÄ-ke-a) absence of a lens</td>
</tr>
<tr>
<td>uve/o</td>
<td>uvea</td>
</tr>
<tr>
<td></td>
<td>uveal (Ü-vē-al) pertaining to the uvea</td>
</tr>
<tr>
<td>chori/o, choroid/o</td>
<td>choroid</td>
</tr>
<tr>
<td></td>
<td>subchoroidal (sub-kor-OYD-al) below the choroid</td>
</tr>
<tr>
<td>cycl/o</td>
<td>ciliary body, ciliary muscle</td>
</tr>
<tr>
<td></td>
<td>cycloplegic (si-klo-PLE-jik) pertaining to or causing paralysis of the ciliary muscle</td>
</tr>
<tr>
<td>ir, irit/o, irid/o</td>
<td>iris</td>
</tr>
<tr>
<td></td>
<td>iridoschisis (ir-i-DOS-ki-sis) splitting of the iris</td>
</tr>
<tr>
<td>pupill/o</td>
<td>pupil</td>
</tr>
<tr>
<td></td>
<td>iridopupillary (ir-i-do-PU-pli-ler-ē) pertaining to the iris and the pupil</td>
</tr>
<tr>
<td>retin/o</td>
<td>retina</td>
</tr>
<tr>
<td></td>
<td>retinoscopy (ret-in-OS-kö-pē) examination of the retina</td>
</tr>
</tbody>
</table>

Exercise 18-4

Fill in the blanks:
1. The oculomotor (ok-ū-lō-MÖ-tor) nerve controls movements of the _____________________________.
2. The term phacolysis (fa-KOL-i-sis) means destruction of the _____________________________.
3. A keratometer (ker-a-TOM-e-ter) is an instrument for measuring the curves of the _________________.
4. The science of orthoptics (or-THOP-tiks) deals with correcting defects in _____________________________.
5. Lenticonus (LEN-ti-kō-nus) is conical protrusion of the _____________________________.

Identify and define the roots pertaining to the eye in the following words:

6. microphthalmos (mi-krof-THAL-mus) _____________________________.

7. interpupillary (in-ter-PÜ-pli-ler-ē) _____________________________.

8. retrolental (ret-ro-LEN-tal) _____________________________.

9. uveitis (ü-vē-Ī-tis) _____________________________.

10. phacotoxic (fah-ō-TOK-silt) _____________________________.

11. iridodilator (ir-id-ō-DĪ-lā-tor) _____________________________.

12. optometrist (op-TOM-e-trist) _____________________________.

Write words for the following definitions:

13. surgical fixation of the retina _____________________________.

14. inflammation of the uvea and sclera _____________________________.

Root  | Meaning of Root
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
--- | ---
15. pertaining to the pupil
16. softening of the lens (use phac/o)
17. inflammation of the ciliary body

Use the root ophthalm/o to write words for the following definitions:
18. an instrument used to examine the eye
19. the medical specialty that deals with the eye and diseases of the eye

Use the root irid/o to write words for the following definitions:
20. surgical removal of (part of) the iris
21. paralysis of the iris

Define the following words:
22. optical (OP-ti-kul)
23. retinoschisis (ret-i-NOS-ki-sis)
24. sclerotome (SKLE-R-o-tôm)
25. lenticular (len-TIK-u-lar)
26. keratitis (ker-a-TÍ-tis)
27. cyclotomy (si-KLOT-ô-mê)
28. iridocyclitis (ir-i-dô-si-KLÎ-tis)
29. chorioretinal (chor-i-ô-RET-i-nal)
30. dextrocular (deks-TROK-u-lar)

Table 18-5 Suffixes for the Eye and Vision*

<table>
<thead>
<tr>
<th>SUFFIX</th>
<th>MEANING</th>
<th>EXAMPLE</th>
<th>DEFINITION OF EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>-opsia</td>
<td>vision</td>
<td>heteropsia</td>
<td>unequal vision in the two eyes</td>
</tr>
<tr>
<td>-opia</td>
<td>eye, vision</td>
<td>hemianopia</td>
<td>blindness in half the visual field</td>
</tr>
</tbody>
</table>

*Compounds of -ops (eye) + -ia.

Exercise 18-5

Use the suffix -opsia to write words for the following definitions:
1. a visual defect in which objects seem larger (macr/o) than they are
2. lack of (a-) color (chromat/o) vision (complete color blindness)

Use the suffix -opia to write words for the following definitions:
3. double vision
4. changes in vision due to old age (use the prefix presby- meaning “old”)
Clinical Aspects of Vision

Errors of Refraction

If the eyeball is too long, images will form in front of the retina. To focus clearly, one must bring an object closer to the eye. This condition of nearsightedness is technically called myopia (Fig. 18-13). The opposite condition is hyperopia, or farsightedness, in which the eyeball is too short and images form behind the retina. One must move an object away from the eye for the focus to be clear. The same effect is produced by presbyopia, which accompanies aging. The lens loses elasticity and can no longer accommodate for near vision, so a person becomes increasingly farsighted.

An astigmatism is an irregularity in the curve of the cornea or lens that distorts light entering the eye and blurs vision.

Glasses can compensate for most of these refractive impairments, as shown for nearsightedness and farsightedness in Figure 18-13. See also Box 18-3 for information on a surgical technique to correct refractive errors.

Infection

Several microorganisms can cause conjunctivitis (inflammation of the conjunctiva). This is a highly infectious disease commonly called “pinkeye.”

The bacterium Chlamydia trachomatis causes trachoma, inflammation of the cornea and conjunctiva that results in scarring. This disease is rare in the United States but is a common cause of blindness in underdeveloped countries, although it is easily cured with sulfa drugs and antibiotics.

---

5. a lack of perfect refractive power in the eye
6. unequal refractive powers in the two eyes

The suffix -opia is added to the root metr/o (measure) to form words pertaining to the refractive power of the eye. Add a prefix to -metropia to form words for the following:

A convex (outwardly curved) lens corrects for hyperopia; a concave (inwardly curved) lens corrects for myopia.

Figure 18-13 Errors of refraction. (A) Hyperopia (farsightedness). (B) Myopia (nearsightedness).
Gonorrhea is the usual cause of an acute conjunctivitis in newborns called ophthalmia neonatorum. An antibiotic ointment is routinely used to prevent such eye infections in newborns.

Disorders of the Retina

Retinal detachment, separation of the retina from the underlying layer of the eye (the choroid), may be caused by a tumor, hemorrhage, or injury to the eye (Fig. 18-14). This condition interferes with vision and is commonly repaired with laser surgery.

Degeneration of the macula, the point of sharpest vision, is a common cause of visual problems in the elderly. When associated with aging, this deterioration is described as age-related macular degeneration (AMD). In one form of macular degeneration (“dry”), material accumulates on the retina. Vitamins C and E, beta carotene, and zinc are important in preventing this problem.
supplements may delay this process. In another form (“wet”), abnormal blood vessels grow under the retina, causing it to detach. Laser surgery may stop the growth of these vessels and delay vision loss. Macular degeneration typically affects central vision but not peripheral vision (Fig. 18-15). Other causes of macular degeneration are drug toxicity and hereditary diseases.

Circulatory problems associated with diabetes mellitus eventually cause changes in the retina referred to as diabetic retinopathy. In addition to vascular damage, there is a yellowish, waxy exudate high in lipoproteins. With time, new blood vessels form and penetrate the vitreous humor, causing hemorrhage, detachment of the retina, and blindness.

Cataract

A cataract is an opacity (cloudiness) of the lens (Fig. 18-16). Causes of cataract include disease, injury, chemicals, and exposure to physical forces, especially the ultraviolet radiation in sunlight. The cataracts that frequently appear with age may result from exposure to environmental factors in combination with degeneration attributable to aging.

To prevent blindness, an ophthalmologist must remove the cloudy lens surgically. Commonly, the anterior capsule of the lens is removed along with the cataract, leaving the posterior capsule in place (Fig. 18-17). In phacoemulsification, the lens is fragmented with high-frequency ultrasound and extracted through a small incision (see Box 18-3). After cataract removal an artificial intraocular lens (IOL) usually is implanted to compensate for the missing lens. The original type of implant provides vision only within a fixed distance; newer implants are designed to allow for near and far accommodation. Alternatively, a person can wear a contact lens or special glasses.
Glaucoma

Glaucoma is an abnormal increase in pressure within the eyeball. It occurs when more aqueous humor is produced than can be drained away from the eye. There is pressure on blood vessels in the eye and on the optic nerve, leading to blindness. There are many causes of glaucoma, and screening for this disorder should be a part of every routine eye examination. Fetal infection with German measles (rubella) early in pregnancy can cause glaucoma, as well as cataracts and hearing impairment. Glaucoma is usually treated with medication to reduce pressure in the eye and occasionally is treated with surgery (see Box 18-3).

**Figure 18-17** Cataract extraction surgeries. (A) Cross section of normal eye anatomy. (B) Extracapsular lens extraction involves removing the lens but leaving the posterior capsule intact to receive a synthetic intraocular lens. (C) Intracapsular lens extraction involves removing the lens and lens capsule and implanting a synthetic intraocular lens in the anterior chamber.

### Key Clinical Terms

**The Eye**

- **age-related macular degeneration (AMD)**
  - Deterioration of the macula associated with aging; macular degeneration impairs central vision

- **astigmatism**
  - an-STA-glizm
  - An error of refraction caused by irregularity in the curvature of the cornea or lens

- **cataract**
  - KAT-a-rakt
  - Opacity of the lens of the eye

- **conjunctivitis**
  - kon-junk-ti-VI-tis
  - Inflammation of the conjunctiva; pinkeye

- **diabetic retinopathy**
  - ret-i-NOP-a-the
  - Degenerative changes in the retina associated with diabetes mellitus
# TERMINOLOGY

## Key Clinical Terms

### The Eye

**glaucoma**

*glaw-KO-ma*

A disease of the eye caused by increased intraocular pressure that damages the optic disk and causes loss of vision. Usually results from faulty fluid drainage from the anterior portion of the eye.

**hyperopia**

*hi-per-O-pe-a*

An error of refraction in which light rays focus behind the retina and objects can be seen clearly only when far from the eye; farsightedness; also called hypermetropia.

**myopia**

*mí-O-pe-a*

An error of refraction in which light rays focus in front of the retina and objects can be seen clearly only when very close to the eye; nearsightedness.

**ophthalmia neonatorum**

*of-THAL-me-ne-o-na-TOR-um*

Severe conjunctivitis usually caused by infection with gonococcus during birth.

**phacoemulsification**

*fak-o-e-mul-si-fi-KA-shun*

Removal of a cataract by ultrasonic destruction and extraction of the lens.

**presbyopia**

*prez-be-O-pe-a*

Changes in the eye that occur with age; the lens loses elasticity and the ability to accommodate for near vision.

**retinal detachment**

Separation of the retina from the underlying layer of the eye.

**trachoma**

*tra-KO-ma*

An infection caused by *Chlamydia trachomatis* leading to inflammation and scarring of the cornea and conjunctiva; a common cause of blindness in underdeveloped countries.

---

Go to the pronunciation glossary in Chapter 18 of the CD-ROM to hear these words pronounced.

---

## Supplementary Terms

### The Eye

**canthus**

*KAN-thus*

The angle at either end of the slit between the eyelids.

**diopter**

*DI-op-ter*

A measurement unit for the refractive power of a lens.

**emmetropia**

*em-e-TRO-pe-a*

The normal condition of the eye in refraction, in which parallel light rays focus exactly on the retina.
### TERMINOLOGY

#### Supplementary Terms

**Chapter Eighteen / The Senses**

#### The Eye

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<th>Definition</th>
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<tbody>
<tr>
<td><strong>fundus</strong></td>
<td>A bottom or base; the region farthest from the opening of a structure. The fundus of the eye is the back portion of the inside of the eyeball as seen with an ophthalmoscope.</td>
</tr>
<tr>
<td><strong>meibomian gland</strong></td>
<td>A sebaceous gland in the eyelid</td>
</tr>
<tr>
<td><strong>tarsus</strong></td>
<td>The framework of dense connective tissue that gives shape to the eyelid; tarsal plate</td>
</tr>
<tr>
<td><strong>zonule</strong></td>
<td>A system of fibers that holds the lens in place; also called suspensory ligaments</td>
</tr>
</tbody>
</table>

#### SYMPTOMS AND CONDITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>amblyopia</strong></td>
<td>A condition that occurs when visual acuity is not the same in the two eyes in children (prefix <em>ambly</em> means “dim”). Disuse of the poorer eye will result in blindness if not corrected. Also called “lazy eye.”</td>
</tr>
<tr>
<td><strong>anisocoria</strong></td>
<td>Condition in which the two pupils (root: <em>cor/o</em>) are not of equal size</td>
</tr>
<tr>
<td><strong>blepharoptosis</strong></td>
<td>Drooping of the eyelid</td>
</tr>
<tr>
<td><strong>chalazion</strong></td>
<td>A small mass on the eyelid resulting from inflammation and blockage of a meibomian gland</td>
</tr>
<tr>
<td><strong>druzen</strong></td>
<td>Small growths that appear as tiny yellowish spots beneath the retina of the eye; typically occur with age but also occur in certain abnormal conditions</td>
</tr>
<tr>
<td><strong>hordeolum</strong></td>
<td>Inflammation of a sebaceous gland of the eyelid; a sty</td>
</tr>
<tr>
<td><strong>keratoconus</strong></td>
<td>Conical protrusion of the corneal center</td>
</tr>
<tr>
<td><strong>miosis</strong></td>
<td>Abnormal contraction of the pupils (from Greek, meaning “diminution”)</td>
</tr>
<tr>
<td><strong>mydriasis</strong></td>
<td>Pronounced or abnormal dilation of the pupil</td>
</tr>
<tr>
<td><strong>nyctalopia</strong></td>
<td>Night blindness. Inability to see well in dim light or at night (root: <em>nyct/o</em>); often due to lack of vitamin A, which is used to make the pigment needed for vision in dim light</td>
</tr>
<tr>
<td><strong>nystagmus</strong></td>
<td>Rapid, involuntary, rhythmic movements of the eyeball; may occur in neurologic diseases or disorders of the inner ear's vestibular apparatus</td>
</tr>
<tr>
<td><strong>papilledema</strong></td>
<td>Swelling of the optic disk (papilla); choked disk</td>
</tr>
</tbody>
</table>
### TERMIINOLOGY

#### Supplementary Terms

#### The Eye

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>phlyctenule</td>
<td>A small blister or nodule on the cornea or conjunctiva</td>
</tr>
<tr>
<td>pseudophakia</td>
<td>A condition in which a cataractous lens has been removed and replaced with a plastic lens implant</td>
</tr>
<tr>
<td>retinitis</td>
<td>Inflammation of the retina; causes include systemic disease, infection, hemorrhage, exposure to light</td>
</tr>
<tr>
<td>retinitis pigmentosa</td>
<td>A hereditary chronic degenerative disease of the retina that begins in early childhood. There is atrophy of the optic nerve and clumping of pigment in the retina.</td>
</tr>
<tr>
<td>retinoblastoma</td>
<td>A malignant glioma of the retina; usually appears in early childhood and is sometimes hereditary; fatal if untreated, but current cure rates are high</td>
</tr>
<tr>
<td>scotoma</td>
<td>An area of diminished vision within the visual field</td>
</tr>
<tr>
<td>strabismus</td>
<td>A deviation of the eye in which the visual lines of each eye are not directed to the same object at the same time. Also called heterotropia or squint. The various forms are referred to as -tropias, with the direction of turning indicated by a prefix, such as esotropia (inward), exotropia (outward), hypertropia (upward), and hypotropia (downward). The suffix -phoria is also used, as in esophoria.</td>
</tr>
<tr>
<td>synechia</td>
<td>Adhesion of parts, especially adhesion of the iris to the lens and cornea (plural: synechiae)</td>
</tr>
<tr>
<td>xanthoma</td>
<td>A soft, slightly raised, yellowish patch or nodule usually on the eyelids; occurs in the elderly; also called xanthelasma</td>
</tr>
</tbody>
</table>

#### DIAGNOSIS AND TREATMENT

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>canthotomy</td>
<td>Surgical division of a canthus</td>
</tr>
<tr>
<td>cystitome</td>
<td>Instrument for incising the lens capsule</td>
</tr>
<tr>
<td>electroretinography (ERG)</td>
<td>Study of the electrical response of the retina to light stimulation</td>
</tr>
<tr>
<td>enucleation</td>
<td>Surgical removal of the eyeball</td>
</tr>
<tr>
<td>gonioscopy</td>
<td>Examination of the angle between the cornea and the iris (anterior chamber angle) in which fluids drain out of the eye (root gonio means “angle”)</td>
</tr>
<tr>
<td>keratometer</td>
<td>An instrument for measuring the curvature of the cornea</td>
</tr>
</tbody>
</table>
### Supplementary Terms

**The Eye**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mydriatic</td>
<td>A drug that causes dilation of the pupil</td>
</tr>
<tr>
<td>phorometer</td>
<td>An instrument for determining the degree and kind of strabismus</td>
</tr>
<tr>
<td>retinoscope</td>
<td>An instrument used to determine refractive errors of the eye; also called a skiascope (SKI-a-skop)</td>
</tr>
<tr>
<td>slit-lamp biomicroscope</td>
<td>An instrument for examining the eye under magnification</td>
</tr>
<tr>
<td>Snellen chart</td>
<td>A chart printed with letters of decreasing size used to test visual acuity when viewed from a set distance; results reported as a fraction giving a subject’s vision compared with normal vision at a distance of 20 feet</td>
</tr>
<tr>
<td>tarsorrhaphy</td>
<td>Suturing together of all or part of the upper and lower eyelids</td>
</tr>
<tr>
<td>tonometer</td>
<td>An instrument used to measure fluid pressure in the eye</td>
</tr>
</tbody>
</table>

Go to the pronunciation glossary in Chapter 18 of the CD-ROM to hear these words pronounced.

### Abbreviations

**The Eye**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, Acc</td>
<td>Accommodation</td>
</tr>
<tr>
<td>AMD</td>
<td>Age-related macular degeneration</td>
</tr>
<tr>
<td>ARC</td>
<td>Abnormal retinal correspondence</td>
</tr>
<tr>
<td>As, AST</td>
<td>Astigmatism</td>
</tr>
<tr>
<td>cc</td>
<td>With correction</td>
</tr>
<tr>
<td>Em</td>
<td>Emmetropia</td>
</tr>
<tr>
<td>EOM</td>
<td>Extraocular movement, muscles</td>
</tr>
<tr>
<td>ERG</td>
<td>Electroretinography</td>
</tr>
<tr>
<td>ET</td>
<td>Esotropia</td>
</tr>
<tr>
<td>FC</td>
<td>Finger counting</td>
</tr>
<tr>
<td>HM</td>
<td>Hand movements</td>
</tr>
<tr>
<td>IOL</td>
<td>Intraocular lens</td>
</tr>
<tr>
<td>IOP</td>
<td>Intraocular pressure</td>
</tr>
<tr>
<td>NRC</td>
<td>Normal retinal correspondence</td>
</tr>
<tr>
<td>NV</td>
<td>Near vision</td>
</tr>
<tr>
<td>OD</td>
<td>Right eye (Latin, oculus dexter)</td>
</tr>
<tr>
<td>ORL</td>
<td>Otorhinolaryngology</td>
</tr>
<tr>
<td>OS</td>
<td>Left eye (Latin, oculus sinister)</td>
</tr>
<tr>
<td>OU</td>
<td>Both eyes (Latin, oculi unitas); also each eye (Latin, oculi uterque)</td>
</tr>
<tr>
<td>sc</td>
<td>Without correction</td>
</tr>
<tr>
<td>VA</td>
<td>Visual acuity</td>
</tr>
<tr>
<td>VF</td>
<td>Visual field</td>
</tr>
<tr>
<td>XT</td>
<td>Exotropia</td>
</tr>
</tbody>
</table>
CHAPTER REVIEW

LABELING EXERCISE

The Ear

Write the name of each numbered part on the corresponding line of the answer sheet.

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

cochlea  
eustachian (auditory) tube  
external auditory canal  
incus  
inner ear  
malleus  
ossicles of middle ear  
outer ear  
pinna  
semicircular canals  
stapes  
tympanic membrane  
vestibule
The Eye

Write the name of each numbered part on the corresponding line of the answer sheet.

aqueous humor
choroid
ciliary muscle
conjunctival sac
cornea
fovea
iris
lens
optic disk (blind spot)
optic nerve
retina
sclera
vitreous body
TERMINOLOGY

Match the following terms and write the appropriate letter to the left of each number:

1. tactile
2. parosmia
3. hyperesthesia
4. ossicle
5. hemianopia
6. lens
7. fovea
8. rods and cones
9. vestibular apparatus
10. iris
11. phacosclerosis
12. ophthalmoplegia
13. anacusis
14. tinnitus
15. keratoplasty

Supplementary Terms

16. tarsus
17. mastoid process
18. stapedius
19. tonometer
20. hertz
21. emmetropia
22. nystagmus
23. mydriasis
24. diopeter
25. strabismus
26. AMD
27. AD
28. AST
29. dB
30. OU
Fill in the blanks:

31. The outermost layer of the eye wall is the __________________________.

32. The term ceruminous applies to __________________________.

33. The sense of awareness of body position is __________________________.

34. The ossicle that is in contact with the inner ear is the __________________________.

35. The bending of light rays as they pass through the eye is __________________________.

36. The innermost layer of the eye that contains the receptors for vision is the __________________________.

37. The transparent extension of the sclera that covers the front of the eye is the __________________________.

38. The scientific name for the eardrum is __________________________.

Eliminations. In each of the sets below, underline the word that does not fit in with the rest and explain the reason for your choice:

39. pain – temperature – taste – touch – pressure

40. vestibule – pinna – cochlea – oval window – semicircular canals

41. incus – lacrimal gland – conjunctiva – eyelash – palpebra

42. cataract – myopia – glaucoma – macular degeneration – presbycusis

True–False. Examine the following statements. If the statement is true, write T in the first blank. If the statement is false, write F in the first blank and correct the statement by replacing the underlined word in the second blank.

43. In bright light the pupils dilate. —______ — ______

44. Olfaction is the sense of smell. —______ — ______

45. The malleus is located in the middle ear. —______ — ______

46. Hypergeusia is an abnormal increase in the sense of touch. —______ — ______

47. The eustachian tube is also called the auditory tube. —______ — ______

48. The organ of Corti is located in the cochlea. —______ — ______

49. A myringotomy is incision of the vitreous body. —______ — ______

50. The lacrimal gland produces aqueous humor. —______ — ______

Define the following words:

51. audiologist __________________________

52. aphakia __________________________

53. subscleral __________________________

54. ophthalmometer __________________________

55. keratoiritis __________________________

56. iridotomy __________________________

57. perilental __________________________
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58. chorioretinal ____________________________
59. dacryorrhea ____________________________
60. myringotomy ____________________________

Word building. Write words for the following definitions:

61. pertaining to the vestibular apparatus and cochlea ____________________________
62. surgical removal of the stapes ____________________________
63. plastic repair of the ear ____________________________
64. absence of pain ____________________________
65. drooping of the eyelid ____________________________
66. any disease of the retina ____________________________
67. measurement of the pupil ____________________________
68. hardening of the tympanic membrane ____________________________
69. pertaining to tears ____________________________
70. endoscopic examination of the auditory tube ____________________________
71. excision of (part of) the ciliary body ____________________________

Adjectives. Write the adjective form of the following words:

72. cochlea ____________________________
73. palpebra ____________________________
74. vestibule ____________________________
75. uvea ____________________________
76. cornea ____________________________
77. sclera ____________________________
78. pupil ____________________________

Opposites. Write words that mean the opposite of the following:

79. mydriasis ____________________________
80. esotropia ____________________________
81. sc ____________________________
82. hyperopia ____________________________
83. hypoesthesia ____________________________
84. OS ____________________________

Word analysis. Define the following words and give the meaning of the word parts in each. Use a dictionary if necessary.

85. anisometropia (an-i-sō-me-TRÔ-pē-a) ____________________________
   a. an- ____________________________
   b. iso- ____________________________
   c. metr/o ____________________________
   d. -opia ____________________________
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86. asthenopia (as-the-NO-pe-a)
   a. a-
   b. sthen/o-
   c. -opia

87. otorhinolaryngology (ō-tō-rin-lar-in-ɡol-ē)
   a. oto-
   b. rhin/o
   c. laryng/o
   d. -logy

Go to the word exercises in Chapter 18 of the CD-ROM for additional review exercises.
CASE STUDY 18-1: Medical Records

An electrical fire in the physicians’ dictation room left a charred mass of burned and water-damaged medical records. Discharge charts had been stacked awaiting physician sign-off before they could be returned to Medical Records for storage. Several medical transcriptionists spent 3 days sorting through the remains to reassemble the charts, all of which were from the patients of the large otorhinolaryngology practice. In addition to patient identification information, the transcriptionists matched word cues to create piles of similar documents. Patients treated for middle and inner ear problems were identified with words such as stapedectomy, tympanoplasty, myringotomy, cochlear, cholesteatoma, otosclerosis, labyrinth, otitis media, and acoustic neuroma. Patients treated for external ear conditions were grouped using terms such as otoplasty, pinna, postauricular, and otitis externa. Mastoid, laryngeal, and nasal surgery patients were grouped separately. Restoring the charts was an impossible task, and the records were determined to be either incomplete or a total loss. The only document to survive the fire was an audiology report.

CASE STUDY 18-2: Audiology Report

S.R., a 55-year-old man, reported decreased hearing sensitivity in his left ear for the past 3 years. In addition to hearing loss, he was experiencing tinnitus and aural fullness. Pure-tone test results revealed normal hearing sensitivity for the right ear and a moderate sensorineural hearing loss in the left ear. Speech thresholds were appropriate for the degree of hearing loss noted. Word recognition was excellent for the right ear and poor for the left ear when the signal was present at a suprathreshold level. Tympanograms were characterized by normal shape, amplitude, and peak pressure points bilaterally. The contralateral acoustic reflex was normal for the right ear but absent for the left ear at the frequencies tested (500 to 4000 Hz). The ipsilateral acoustic reflex was present with the probe in the right ear and absent with the probe in the left ear. Brainstem auditory evoked potentials (BAEPs) were within normal range for the right ear. No repeatable response was observed from the left ear. A subsequent MRI showed a 1-cm acoustic neuroma.

CASE STUDY 18-3: Phacoemulsification with Intraocular Lens Implant

W.S., a 68-year-old woman, was scheduled for surgery for a cataract and relief from “floaters,” which she had noticed in her visual field since her surgery for a retinal detachment the previous year. She reported to the ambulatory surgery center an hour before her scheduled procedure. Before transfer to the operating room, she spoke with her ophthalmologist and reviewed the surgical plan. Her right eye was identified as the operative eye and it was marked with a “yes” and the surgeon’s initials on the lid. She was given anesthetic drops in the right eye and an intravenous bolus of 2.0 mg of midazolam (Versed).

In the OR, W.S. and her operative eye were again identified by the surgeon, anesthetist, and nurses. After anesthesia and akinesia were achieved, the eye area was prepped and draped in sterile sheets. An operating microscope with video system was positioned over her eye. A 5-0 silk suture was placed through the superior rectus muscle to retract the eye. A lid speculum was placed to open the eye. A minimal conjunctival peritomy was performed, and hemostasis was achieved with wet-field cautery. The anterior chamber was entered at the 10:30 o’clock position. A capsulotomy was performed after Healon was placed in the anterior chamber. Phacoemulsification was carried out without difficulty. The remaining cortex was removed by irrigation and aspiration.

An intraocular lens (IOL) was placed into the posterior chamber. Miochol was injected to achieve papillary miosis, and the wound was closed with one 10-0 suture. Subconjunctival Celestone and Garamycin were injected. The lid speculum and retraction suture were removed. After application of Eserine and Bacitracin ointments, the eye was patched and a shield was applied. W.S. left the OR in good condition and was discharged to home 4 hours later.
**Case Study Questions**

Multiple choice. Select the best answer and write the letter of your choice to the left of each number:

___ 1. The medical specialty of otorhinolaryngology is most often referred to as:
   a. ENT, or ear, nose, and throat
   b. optometry
   c. PERLA
   d. oral surgery
   e. EENT/dental

___ 2. The surgery to remove one of the microscopic bones of the middle ear is a(n):
   a. stapedectomy
   b. mastoidectomy
   c. myringotomy
   d. tympanoplasty
   e. otoplasty

___ 3. The procedure in question 2 may require construction of a new eardrum, a procedure called a(n):
   a. otoplasty
   b. myringotomy
   c. stapes transfer
   d. tympanoplasty
   e. otoscope

___ 4. Mastoid surgery incisions are made postauricularly, which is:
   a. anterior to the ear drum
   b. over the left ear
   c. behind the ear
   d. inferior to the tympanic membrane
   e. between the ears

___ 5. The study of hearing is termed:
   a. acousticology
   b. radio frequency
   c. light spectrum
   d. otology
   e. audiology

___ 6. Sensorineural hearing loss may result from:
   a. damage to the second cranial nerve
   b. otitis media
   c. otosclerosis
   d. damage to the eighth cranial nerve
   e. stapedectomy

___ 7. Ultrasound destruction and aspiration of the lens is called:
   a. cataractomy
   b. phacoemulsification
   c. stapedectomy
   d. radial keratotomy
   e. refraction
Continued

8. The term akinesia means:
   a. movement
   b. lack of sensation
   c. washing
   d. lack of movement
   e. incision

9. The term that means “on the same side” is:
   a. contralateral
   b. bilateral
   c. distal
   d. ventral
   e. ipsilateral

10. Another name for an acoustic neuroma is:
    a. macular degeneration
    b. neurilemoma
    c. otosclerosis
    d. labyrinthitis
    e. glaucoma

Write terms from the case studies with the following meanings:

11. record obtained by tympanometry
12. pertaining to or perceived by the ear
13. inflammation of the middle ear
14. inflammation of the external ear
15. physician who specializes in conditions of the eye
16. within the eye
17. abnormal contraction of the pupil
18. generic drug name for Versed

Abbreviations. Define the following abbreviations:

19. Hz
20. BAEP
21. OD
22. IOL
The Senses

ACROSS

1. Membranes that line the eyelids and cover the fronts of the eyes
6. Sharpness of vision
8. A light-sensitive cell of the retina
12. Lens implant: abbreviation
13. Eye disorder caused by increased pressure
14. Pertaining to tears
16. Inward deviation of the eye
19. Three: prefix

DOWN

1. Coordinated movement of the eyes toward fixation on the same point
2. The middle layer of the eye
3. The tactile sense
4. Left ear: abbreviation
5. Paralysis of the ciliary body: ___________ a
7. Iris: root
9. Medical specialty treating the ear and throat: abbreviation
10. Tear, lacrimal apparatus: combining form
11. Pertaining to the eye
15. Nose: root
17. Without correction: abbreviation
18. Right eye: abbreviation