Chapter 17: The Special Senses

The Big Idea: The Special Senses and Homeostasis
- Sensory organs have special receptors that allow us to smell, taste, see, hear, and maintain equilibrium or balance
- Information conveyed from these receptors to the CNS is used to help maintain homeostasis
- A sensation is the conscious or subconscious awareness of an internal or external stimulus
- Receptors for the special senses of smell, taste, vision, hearing, and equilibrium are anatomically distinct from one another and are concentrated in specific locations in the head
- There are specific afferent pathways and translation sites in the brain for information assembled from these special senses

17.1: Olfaction: The Sense of Smell
- Smell and taste are chemical sensations that arise from the interaction of molecules with smell or taste receptors; to be detected, the molecules must be dissolved
  - Gustation and olfaction work together, but olfaction is much stronger/more sensitive
- Because impulses for smell and taste propagate to the limbic system, certain odors and tastes can evoke strong emotional responses of a flood of memories

Anatomy of Olfactory Receptors
- There are 10-100 million of these receptors in the nose that respond to odorant molecules
  - It is estimated that humans can recognize about 10,000 different odors
- The olfactory epithelium is located in the superior part of the nasal cavity covering the surface of the cribriform plate and extending along the superior nasal concha
- The olfactory epithelium consists of 3 kinds of cells
  - The olfactory receptors are the first-order neurons of the olfactory pathway
    - Each receptor is a bipolar neuron with cilia (called olfactory hairs) that respond to inhaled chemicals
    - Chemicals that have an odor and can stimulate olfactory hairs are called odorants
  - Supporting cells are columnar epithelial cells of the mucous membrane lining the nose
    - They provide support, nourishment, and electrical insulation for the olfactory receptors; also helps to detoxify chemicals that come in contact with the olfactory epithelium
  - Basal cells are stem cells that constantly replace olfactory receptors; located between the bases of the supporting cells
  - Olfactory (Bowman’s) Glands, found within the CT that supports the olfactory epithelium, produce mucus that is carried to the surface of the epithelium by ducts
    - Moistens the epithelium and dissolves odorants for transduction
  - Supporting cells and olfactory glands are innervated by the facial nerve (VII), which can be stimulated by certain chemicals
    - Impulses in these nerves will stimulate the lacrimal glands in the eyes and the nasal mucous glands (ex. tears and runny nose after smelling ammonia)
Anatomy of Taste Buds & Papillae

- We have nearly 10,000 taste buds located on the tongue, soft palate, pharynx, and larynx
- Each taste bud is composed of about 50 gustatory receptor cells, surrounded by a number of supporting cells
  - Basal cells located near the CT base multiply and differentiate, first to become the supporting cells around the bud, then the gustatory receptor cells inside the taste bud
  - A single, long microvillus, called a gustatory hair, projects from each receptor cell to the surface through the taste pore
  - Each gustatory receptor cell has a lifespan of about 10 days
- At their base, the gustatory receptor cells synapse with dendrites of first-order neurons that form the first part of the gustatory pathway
- The dendrites of each first-order neuron branch profusely and contact many gustatory receptor cells in several taste buds
- Taste buds are found in 3 different types of papillae (elevations on the tongue which provide a rough texture and increase surface area)
✓ About 12 very large vallate papillae form a row at the back of the tongue (each houses 100–300 taste buds)
✓ Fungiform papillae are mushroom-shaped and are scattered over the entire surface of the tongue (containing about 5 taste buds each)
✓ Foliate papillae are located in small trenches on the lateral margins of the tongue, but most of their taste buds degenerate in early childhood
✓ In addition, the entire surface of the tongue has filiform papillae that contain tactile receptors but no taste buds
✓ They increase friction between the tongue and food, making it easier to move food in the oral cavity

Physiology of Gustation
✓ Tastants are chemicals that stimulate gustatory receptor cells
✓ When dissolved in saliva, it can make contact with the plasma membrane of the gustatory hairs, which are the sites of taste transduction
  o The result is a receptor potential for different tastants
✓ For salty foods, sodium ions enter gustatory receptors via sodium channels in the plasma membrane → accumulation of sodium leads to depolarization and the release of a neurotransmitter
✓ In sour foods, hydrogen ions flow into gustatory receptors via hydrogen ion channels → leads to depolarization and the release of a neurotransmitter
✓ For sweet, bitter, and umami, tastants bind to receptors linked to G proteins → activates second messengers in the gustatory receptor cell → release neurotransmitter
✓ Different tastes arise from the activation of different groups of taste neurons

Taste Thresholds and Adaptation
✓ The threshold for taste varies for each of the primary tastes
✓ We are most sensitive to bitter substances, such as quinine
  o Because poisonous substances are often bitter, this high sensitivity may have a protective function
✓ The threshold for sour substances is somewhat higher, followed by salty and sweet substances
✓ Complete adaptation to a specific taste can occur in 1–5 minutes of continuous stimulation

The Gustatory Pathway
✓ Three cranial nerves contain axons of the first-order gustatory neurons that innervate the taste buds
  o The facial (VII) nerve serves taste buds in the anterior 2/3 of the tongue
  o The glossopharyngeal (IX) nerve serves taste buds in the posterior 1/3 of the tongue
  o The vagus (X) nerve serves taste buds in the throat and epiglottis
✓ Nerve impulses propagate along these cranial nerves to the gustatory nucleus in the medulla oblongata
✓ From there, axons carrying taste signals project to the hypothalamus, limbic system, and thalamus
✓ Taste signals arrive at the primary gustatory area at the base of the somatosensory cortex in the parietal lobe and give rise to the conscious perception of taste
17.3: Vision

- Our visual perception is dependent on the eye, its accessory structures, the optic tracts, and the 1st visual cortex and its association areas.
- Vision (the act of seeing) is possible because of photoreceptors that are able to “catch” photons of EM radiation in the 400-700 nm wavelengths – what we perceive as visual light.

Accessory Structures of the Eye

- The eyeball is about 2.5 cm in diameter, with only about 16% of it viewable by just looking at a person.
- The accessory structures of the eye are the extraocular muscles, palpebra, eyebrows, eyelashes, conjunctiva, and the lacrimal glands and ducts:
  - The upper and lower palpebrae are the eyelids, with the fissure being the space between them
  - Function is to shade the eyes during sleep, protect the eyes from excessive light and foreign objects, and spread lubricating secretions over the eyeballs.
  - The upper eyelid is more movable than the lower eyelid; the levator palpebrae superioris muscles that raise the upper eyelid.
  - The lacrimal caruncle contains sebaceous glands and sudoriferous glands.
  - The tarsal plate is a thick fold of CT that gives form and support to the eyelids.
  - Tarsal or Meibomian glands secrete a fluid that helps keep the eyelids from adhering to one another.
  - The conjunctiva is a clear mucous membrane that covers the white (vascular) part of the eye.
  - Palpebral conjunctiva lines the inner eyelids; bulbar conjunctiva passes from the eyelids onto the surface of the eyeball, where it covers the sclera but not the cornea.
  - Dilation and congestion of the blood vessels of the bulbar conjunctiva causes bloodshot eyes.
  - The eyelashes help protect the border of each eyelid.
  - Infection of sebaceous ciliary glands (at the base of hair follicles) causes sty eye.
  - The lacrimal apparatus is a group of structures that produces and drains lacrimal fluid (tears):
    - The lacrimal glands are each about the size an almond, situated superolateral to the eyeball.
    - Leading from the lacrimal glands are 6 to 12 excretory lacrimal ducts.
    - Tears (lacrimal fluid) run from the lacrimal glands, into the excretory lacrimal ducts, onto the surface of the conjunctiva; over the surface of the eyeball some lacrimal fluid also evaporates.
    - Tears are a watery solution containing salts, mucus, and lysozyme.
      - Protects, cleans, lubricates, and moistens the eyeball; each lacrimal gland produces about 1mL of lacrimal fluid a day.
    - Tears drain into the lacrimal puncta, which are two openings on the nasal side of the extreme edge of the eyeball.
    - Superior and inferior lacrimal canals empty the tears into the nasolacrimal sac and nasolacrimal duct.
    - The right and left sided nasolacrimal ducts empty into each side of the nose.
    - Watery eyes occur when lacrimal fluid builds up, as when something obstructs the nasolacrimal ducts for instance.
    - Blocked nasolacrimal ducts can be caused by an inflammation of the nasal mucosa, such as a cold.
    - Over production of lacrimal fluid occurs in response to parasympathetic stimulation, caused by an emotional response (crying), and tears spill over the edges of the eyelids and drain into the nasal cavity (causing nasal stuffiness).
The eyes sit in depressions called orbits, which help to protect the eyes, stabilizes them in a 3-D space, and anchors them to muscles that produce movement
- The extrinsic eye muscles extend from the walls of the bony orbit to the sclera of the eye and are surrounded by periorbital fat
  - These muscles can move the eye in almost every direction
  - Superior rectus, inferior rectus, lateral rectus, medial rectus, superior oblique, inferior oblique
  - Supplied by cranial nerves III, IV, and VI
  - Neural circuits in the brain stem and cerebellum synchronize movements of the eyes

Anatomy of the Eye

- The wall of the eyeball consists of three layers or tunics
- The fibrous tunic is the outer layer and is composed of the sclera (“white” of the eye) and the cornea (the transparent epithelium the protects the front of the eye)
  - Even though you can’t easily see it, the cornea is a very important structure in the outer avascular fibrous tunic
    - It’s composed of a transparent epithelium that covers the anterior eye and helps focus light onto the retina
    - The outer surface is stratified squamous epithelium; the middle layer consists of collagen and fibroblasts; and the inner surface is composed of simple squamous epithelium
    - Since the central part of the cornea receives oxygen from the outside air, contact lenses that are worn for long periods of time must be permeable
  - The sclera has a high amount of collagen fibers and fibroblasts and forms the tough, white part of the eye
    - The sclera gives the eye its shape, makes it more rigid, protects the inner anatomical parts, and serves as a site of attachment for the extrinsic eye muscles

- The vascular tunic or uvea is the middle layer and is composed of the choroid, the ciliary body, and the iris
  - The choroid forms the major vascular portion that lines the internal surface of the sclera
  - It also contains melanocytes that produce the pigment melanin; the melanin absorbs stray light rays, which prevents reflection and scattering of light within the eyeball; as a result, the image cast on the retina by the cornea remains sharp and clear
  - The ciliary body consists of the ciliary processes that secrete aqueous humor, and the ciliary muscle that changes the shape of the lens to adapt to near and far vision
  - The iris is the colored portion of the eyeball consisting of circular and radial smooth muscle fibers
    - It is suspended between the cornea and the lens, and is attached at the outer margin to ciliary processes
    - The amount of melanin in the iris determines the eye color
    - The primary function of the iris is to regulate the amount of light entering the eyeball through the pupil
    - Autonomic reflexes regulate pupil diameter in response to light levels; high levels → constriction, low levels → dilation

- The nervous tunic is the inner retinal layer
  - The retina consist of a layer of melanin pigmented epithelium that allows light to be absorbed rather than scattered
The eye requires a constant bath in a nourishing fluid to deliver enough O₂ to support the avascular lens and cornea.

- The exact center of the retina is called the macula lutea, and in its center is a small depression called the central fovea (or fovea centralis).
- There are no rods or nerve cells in the fovea, only a high concentration of cones - this gives us the sharp central vision necessary in any activity where detail is of primary importance.
- The retina can be viewed through the pupil using an ophthalmoscope, allowing direct inspection of the retinal vessels for any pathological changes.
- This is the only place in the body where arterial vessels can be so viewed (without opening the body).
- The optic disc is where the optic nerve and retinal vessels enter and exit the eyeball.
- Its existence creates a necessary defect on the retina - an area where there are no cones or rods.
- Bilateral vision, and saccade (involuntary, quick) muscle movements allow our brain to correct for this “blind spot”, and most are not even aware they have one.
- The retina consists of two types of photoreceptor cells, rods and cones:
  - Rods are abundant in the periphery of the retina whereas cones are found more frequently in the central areas.
    - Each eye contains ≈ 120 million rod-shaped photoreceptors that are adapted for a low light threshold (high sensitivity) - they produce low resolution, black and white images.
    - Loss of rods with age makes it difficult to drive at night.
  - Cone-shaped photoreceptors function in bright light to produce high resolution color images:
    - They exist in three varieties, corresponding to the type of pigment they contain: red, green or blue.
  - The photopigments are concentrated in the outer segment of the receptor, while the inner segment contains the nucleus and organelles.

- The lens is an avascular refractory structure situated posterior to the pupil and iris:
  - It consists of a capsule with crystallin proteins arranged in layers, and like the cornea, the lens is transparent.
  - It attaches to the ciliary muscle of the ciliary body by suspensory ligaments that fine tune the focusing of light on the retina.
  - The lens divides the eyeball into two cavities: an anterior cavity anterior to the lens, and a posterior cavity (vitreous chamber) behind the lens.
    - The anterior cavity is further divided at the level of the iris into anterior and posterior chambers (both filled with aqueous humor).
    - The much larger posterior cavity of the eyeball (vitreous chamber) lies between the lens and the retina.
  - Within the vitreous chamber is the vitreous body, a transparent jellylike substance that holds the retina flush against the choroid, giving the retina an even surface for the reception of clear images.
    - Occasionally, collections of debris called vitreal floaters cast shadows on the retina and create a spot in our field of vision (they are usually harmless and do not require treatment).

- The eye requires a constant bath in a nourishing fluid to deliver enough O₂ to support the avascular lens and cornea:
  - It also needs fluid to help “inflate” the walls of the eyeball (maintain a constant intraocular pressure – IOP) and support the vitreous body.
  - This need is accomplished through the production of aqueous humor, which flows through the anterior cavity of the eye and is replaced every 90 minutes.
  - Aqueous humor is produced at the ciliary body and flows first through the posterior chamber (of the anterior cavity of the eye).
  - Traveling along the posterior surface of the iris it passes through the pupil to enter the anterior chamber.
  - It proceeds along the anterior surface of the iris until it is reabsorbed into the scleral venous sinus (canal of Schlemm) and returned to the venous system.
  - Any sort of blockage to aqueous humor flow, or overproduction at the ciliary body, may result in an increase of pressure inside the eye – a condition called glaucoma.
    - If not treated, glaucoma can lead to a degeneration of eye function.
  - The vitreous body (humor) also contributes to maintain proper intraocular pressure as it holds the retina against the choroid.
  - The vitreous humor, however, is only formed during embryological development and is not replaced.
- As we age, shrinkage of the vitreous body may lead to a detachment of the retina from the choroid.

**Image Formation**
- Normal image formation depends on refraction of light waves, accommodation of the lens, constriction of the pupil, and convergence of the two eyes.
- Refraction is the process of bending light rays.
  - Both the cornea and the lens refract light rays, and both must be functioning in order to properly focus light onto the right spot on the retina to produce clear vision.
  - Since the cornea has a fixed shape, its “focal length” is also fixed; and its ability to refract light is likewise fixed.
- In order to focus light that has already been bent by the cornea the lens must change shape – the amount depending on the type of light rays we are trying to “see”.
  - An increase in the curvature of the lens for near vision is called accommodation.
- The near point of vision is the minimum distance from the eye that an object can be clearly focused - about 4 in (a distance that increases with age due to a loss of elasticity in the lens).

**Convergence**
- Convergence is the inward movement of the eyes so that both are directed at the object being viewed - becoming a little cross-eyed when viewing things close up.
  - The nearer the object, the greater the degree of convergence needed to maintain binocular vision.
  - The coordinated action of the extrinsic eye muscles brings about convergence.
- Convergence helps us maintain our binocular vision and see in three dimensions.
- With nearsightedness (myopia), only close objects can be seen clearly.
  - Light rays coming from distant objects are naturally focused in front of the retina and appear blurry.
  - Correction involves the use of a concave (negative) lens.
With farsightedness (hyperopia), only distant objects can be seen clearly:
- Light rays coming in from nearer objects are naturally focused behind the retina
- Correction involves the use of a convex (positive) lens

Abnormal refractive capabilities of the eye are the result of a misshapen eyeball (usually too long or too short), or because the lens becomes stiff (usually with age)

Corrections are accomplished using either a positive (convex) or negative (concave) lens (eyeglasses, contacts, or lens replacements)

**Physiology of Vision**

- Once light waves have been successfully focused on the retina, the information “stored” in that electromagnetic energy must be changed by photopigments in the photoreceptors into signals our brain can interpret - a process called visual transduction
  - The single type of photopigment in rods is rhodopsin, whereas there are 3 different cone photopigments
  - Color vision results from different colors of light selectively activating the different cone photopigments

- The first step in visual transduction is absorption of light by a photopigment, a colored protein that undergoes structural changes when it absorbs light in the outer segment of a photoreceptor

- Light absorption initiates a series of events that lead to the production of a receptor potential (number 4 in the diagram)

- All photopigments associated with vision contain two parts: a glycoprotein known as opsin and a derivative of vitamin A called retinal
  - Although there are 4 different opsins, retinal is the light-absorbing part of all visual photopigments

- To simplify the process we can say that there is a cyclical bleaching and regeneration of photopigment

- Bleaching is a term describing a conformational change in the retinal molecule in response to light
  - In darkness, retinal has a bent shape called cis-retinal

- Absorption of a photon of light causes it to straighten into the trans-retinal form in a process called isomerization

- Trans-retinal completely separates from the opsin; since the final products look colorless, this part of the cycle is called bleaching of photopigment
  - An enzyme converts trans-retinal ←→ cis-retinal
  - The cis-retinal regenerates the photopigment

- In daylight, regeneration of rhodopsin cannot keep up with the bleaching process, so rods contribute little to daylight vision

- In contrast, cone photopigments regenerate rapidly enough that some of the cis form is always present, even in very bright light

- As a consequence, light adaptation (from dark conditions to light conditions) happens in seconds; dark adaptation (from light to dark) takes minutes to occur (up to 40 minutes to fully adapt)

- Most forms of color blindness, an inherited inability to distinguish between certain colors, result from the absence or deficiency of one of the three types of cones
  - Most common type is red-green color blindness in which red cones or green cones are missing

- Prolonged vitamin A deficiency and the resulting below-normal amount of rhodopsin may cause night blindness or nyctalopia, an inability to see well at low light levels
The Visual Pathway

- The graded potentials generated by the photoreceptors undergo considerable processing at synapses among the various types of neurons in the retina (horizontal cells, bipolar cells, and amacrine cells)—certain features of visual input are enhanced while others are discarded.
- Overall, convergence pre-dominates as 126 million photoreceptors impinge on only 1 million ganglion cells.
- The axons of retinal ganglion cells provide output that travels back “towards the light”, exiting the eyeball as the optic nerve, which emerges from the vitreous surface of the retina.
  - The axons then pass through a crossover point called the optic chiasm.
  - Some axons cross to the opposite side, while others remain uncrossed.
  - Once through the optic chiasm the axons enter the brain matter as the optic tracts (most terminate in thalamus).
  - Here they synapse with neurons that project to the first visual cortex in the occipital lobes.

---

[Diagram of the visual pathway from retina to occipital lobe with labels for optic nerve, optic chiasm, optic tract, lateral geniculate nucleus, and visual cortex.]
17.4: Hearing & Equilibrium

- Audition, the process of hearing (which the ability to perceive sounds), is accomplished by the organs of the ear
- The ear is an engineering marvel because its sensory receptors can transduce sound vibrations with amplitudes as small as the diameter of an atom of gold into electrical signals 1000 times faster than the eye can respond to light
- The ear also contains receptors for equilibrium

Anatomy of the Ear

- The ear has 3 principle regions
  - The external ear, which uses air to collect and channel sound waves
  - The middle ear, which uses a bony system to amplify sound vibrations
  - The internal ear, which generates action potentials to transmit sound and balance information to the brain

- The anatomy of the external ear includes
  - The auricle (pinna), a flap of elastic cartilage covered by skin and containing ceruminous glands
  - A curved 1” long external auditory canal situated in the temporal bone leading from the meatus to the tympanic membrane (TM – or ear drum) which separates the outer ear from the cavity of the middle ear

- The middle ear is an air-filled cavity in the temporal bone
  - It is lined with epithelium and contains 3 auditory ossicles (bones)
    - The handle of the malleus (hammer) attaches to the TM
    - The incus (anvil)
    - The stapes (stirrup)
  - Two small skeletal muscles (the tensor tympani and stapedius) attach to the ossicle and dampen vibrations to prevent damage from sudden, loud sounds
  - The Eustachian (auditory) tube connects the middle ear with the nasopharynx (upper portion of the throat)
    - It consists of bone and hyaline cartilage and is normally passively collapsed
    - It opens to equalize pressures on each side of the TM (allowing it to vibrate freely)

- The internal ear (inner ear) is also called the labyrinth because of its complicated series of canals
  - Structurally, it consists of two main divisions: an outer bony labyrinth that encloses an inner membranous labyrinth
  - The bony labyrinth is sculpted out of the petrous part of the temporal bone, and divided into three areas: (1) the semicircular canals, (2) the vestibule, and (3) the cochlea
    - The vestibule is the middle part of the bony labyrinth
    - The membranous labyrinth in the vestibule consists of two sacs called the utricle and the saccule
    - The three semicircular canals are above the vestibule, each ending in a swollen enlargement called the ampulla (for dynamic equilibrium)
  - The snail shaped cochlea contains the hearing apparatus
  - Two types of fluid (perilymph and endolymph) fill its 3 different internal channels: The scala vestibuli, scala tympani, and cochlear duct
    - Perilymph transmits the vibrations coming from the stapes in the oval window up and around the scala vestibuli, and then back down and around the scala tympani – causing the endolymph in the cochlear duct to vibrate
    - Pressure waves in the endolymph cause the basilar membrane of the cochlear duct to vibrate, moving the hair cells of the spiral organ of Corti against an overhanging flexible gelatinous membrane called the tectorial membrane
The Nature of Sound Waves

- Sound waves are alternating high-and low-pressure regions traveling in the same direction through some medium.
- The frequency of a sound's vibration is its pitch:
  - Most sounds: 500 to 5000 Hz
  - Audible range: 20 to 20,000 Hz
- The larger the intensity (amplitude), the louder the sound.
- Measured in decibels.

Physiology of Hearing & The Auditory Pathway

- Movements of the hair cells in contact with the tectorial membrane transduce mechanical vibrations into electrical signals which generate nerve impulses along the cochlear branch of CN VIII.
- The cell bodies of the sensory neurons are located in the spiral ganglia.
- Nerve impulses pass along the axons of these neurons, which form the cochlear branch of the vestibulocochlear (VIII) nerve.
- The nerve impulses follow CN VIII en route to the medulla, pons, midbrain, and thalamus, and finally to the primary auditory cortex in the temporal lobe.
- Slight differences in the timing of nerve impulses arriving from the two ears at the superior olivary nuclei in the pons allow us to locate the source of a sound.
**Physiology of Equilibrium**

- Equilibrium is another function of the inner ear - controlled by the vestibular apparatus (the saccule and utricle of the vestibule, and the 3 semicircular canals)
- Static equilibrium refers to a state of balance relative to the force of gravity
  - Static equilibrium is controlled by the sensory hairs within the macula of the utricle and saccule
  - An otolithic membrane, studded with dense calcium carbonate crystals (otoliths), responds to gravity when head position is changed
  - This movement opens transduction channels in the hair cells, producing local potentials which summate to form nerve AP
- Dynamic equilibrium involves the maintenance of balance during sudden movements
  - Dynamic equilibrium is controlled by the sensory hairs within the ampulla of the semicircular canals
- Within each ampulla is a small elevation called the crista
- Each crista contains hair cells and supporting cells covered by gelatinous material called the cupula
- With movement, the endolymph within the ampulla lags behind the moving cupola, causing a difference in the inertial forces – the hair bundle of the cupula bends and nerve impulses are generated

**Equilibrium Pathways**

- Once generated, nerve impulse travel up the vestibular branch of CN VIII
- Most of these axons synapse in the major integrating centers for equilibrium, in the medulla and pons, which also receive input from the eyes and proprioceptors
- Ascending neurons continue to the primary auditory area in the parietal lobe to provide us with conscious awareness of the position and movements of the head and limbs
**17.5: Development of the Eyes and Ears**

**Eyes**

- The eyes begin to develop about 22 days after fertilization when the ectoderm of the lateral walls of the prosencephalon (forebrain) bulges out to form the optic grooves.

**Ears**

- The ears begin to develop about 22 days after fertilization from a thickening of ectoderm on either side if the rhombencephalon (hindbrain)
  - Internal ear → middle ear → external ear

---

**17.6: Aging & the Special Senses**

- Most people do not experience any problems with the senses of smell and taste until about age 50.
- Gradual loss of receptor cells and slower rate of regeneration.
- The lens of the eye loses elasticity and cannot change shape easily; the sclera becomes thick and rigid and becomes discolored; the iris fades; and the muscles that regulate pupil size weaken and react more slowly to light and dark.
  - Some diseases of the retina are more likely to occur; cataracts form; tear production may decrease and lead to dry eyes; eyelids may lose elasticity, becoming wrinkled and baggy; the amount of fat around the orbits may decrease, causing the eyeballs to sink into the orbits.
  - Sharpness of vision decreases, color and depth perception and reduced, and vitreous floaters increase.
- By age 60, about 25% of people experience a decrease in hearing, especially for higher-pitch sounds.
  - May be related to damaged and lost hair cells in the spiral organ or degeneration of the nerve pathway for hearing.