

PowerPoint Lecture Outlines  
to accompany

**Hole's Human  
Anatomy and Physiology**  
Tenth Edition

Shier ♦ Butler ♦ Lewis

**Chapter 12  
Somatic and Special Senses**

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**Sense of Hearing**

1. The organ of hearing is the ear.
2. The three parts of the ear are external, middle, and inner.
3. The ear also provides the sense of equilibrium.

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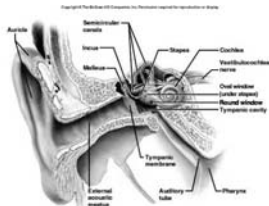
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**External Ear**

1. auricle (pinna)  
A.
2. external auditory meatus  
A.
3. tympanic membrane (ear drum)  
A.



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## Middle Ear

1. Function:
2. tympanic cavity
  - A.
3. auditory ossicles
  - A.
  - B. Malleus (hammer), incus (anvil) and stapes (stirrup)
4. oval window
  - A.
  - B.

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## Auditory (or Eustachian) Tube

1. connects middle ear to throat
- 2.
- 3.

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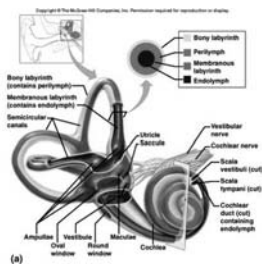
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## Inner Ear

1. intercommunicating chambers and tubes.
2. The osseous labyrinth
3. The membranous labyrinth



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## Inner Ear Labyrinth

can be divided into three regions

1. Cochlea
  - A. Function
  - B.
2. Semi-circular canals
  - A. ;
  - B. Function = dynamic equilibrium.
3. Vestibule
  - A. ;
  - B. Function = static equilibrium.

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## Pathway of sound waves

1. auricle
2. external auditory meatus
3. tympanic membrane
4. malleus
5. incus
6. stapes
7. oval window
8. perilymph of scala vestibuli
9. endolymph of cochlear duct
10. hair cells in Organ of Corti.

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## Organ of Corti

1. hair cells
2. located
3. frequencies of vibration move different parts of the basilar membrane.
4. hairs of a specific receptor cells bend
5. A nerve impulse is generated.

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## Organ of Corti

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## Summary of the Generation of Sensory Impulses from the Ear

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**TABLE 12-4** Steps in the Generation of Sensory Impulses from the Ear

- |   |   |
|---|---|
| <ol style="list-style-type: none"><li>1. Sound waves enter the external acoustic meatus.</li><li>2. Waves of changing pressures cause the tympanic membrane to reproduce the vibrations coming from the sound-wave source.</li><li>3. Auditory ossicles amplify and transmit vibrations to the end of the stapes.</li><li>4. Movement of the stapes at the oval window transmits vibrations to the perilymph in the scala vestibuli.</li><li>5. Vibrations pass through the vestibular membrane and enter the endolymph of the cochlear duct.</li><li>6. Different frequencies of vibration in endolymph move specific regions of the basilar membrane, thus stimulating specific sets of receptor cells.</li></ol> | <ol style="list-style-type: none"><li>7. A receptor cell becomes depolarized; its membrane becomes more permeable to calcium ions.</li><li>8. In the presence of calcium ions, vesicles at the base of the receptor cell release neurotransmitter.</li><li>9. Neurotransmitter stimulates the ends of nearby sensory neurons.</li><li>10. Sensory impulses are triggered on fibers of the cochlear branch of the vestibulocochlear nerve.</li><li>11. The auditory cortex of the temporal lobe interprets the sensory impulses.</li></ol> |
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## SENSE OF EQUILIBRIUM

1. Static Equilibrium
2. Dynamic Equilibrium

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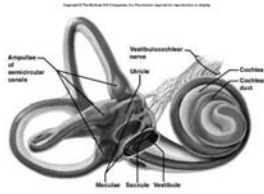
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## Vestibule

1. static equilibrium.
  - A. utricle
  - B. saccule
  - C. macula (organ of static equilibrium).



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## Macula

1. hair cells
  - A. otoliths.
  - B. changes in head position
  - C. hair cells bend.
  - D. generation of nerve impulse

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## Three Semi-circular Canals at right angles

1. ampulla
  - A.
  - B.
2. crista ampullaris,
  - A.
  - B. hair cells to bend.
  - C. nerve impulse.

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## Crista Ampullaris

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## Sense of Sight: Vision

1. retina
2. photoreceptors
3. Visual accessory organs
  - A. eyelids, lacrimal apparatus, and extrinsic eye muscles.

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## Eyelid

1. skin, muscle, connective tissue, and conjunctiva.
2. orbicularis oculi closes the eyelids.
3. levator palpebrae opens the eyelids.
4. Tarsal glands are modified sebaceous (oil) glands.
5. Conjunctiva is a mucous membrane

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## Lacrimal Apparatus

1. lacrimal gland and a series of ducts
2. secrete tears
  - A. lysozyme, an anti-bacterial agent.

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## Structure of the Eye

1. hollow
2. spherical
3. three distinct layers
  - A. outer fibrous tunic
  - B. middle vascular tunic
  - C. inner nervous tunic

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## Outer Tunic

1. Cornea
  - A. transparent
  - B. Function:
    - a. transmission and refraction of light
2. Sclera
  - A. Opaque,
  - B. Functions:
    - a. Protection
    - b. attachment of eye muscles

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### Middle Tunic

1. Iris
  - A. pigmented
  - B. controls light intensity
2. Ciliary body
  - A. holds lens
  - B. moves lens for focusing
3. Choroid coat
  - A. provides blood supply

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### Anterior Portion of Eye

1. aqueous humor

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### Lens

1. transparent
2. biconvex
3. lies behind iris
4. largely composed of lens fibers
5. elastic
6. held in place by suspensory ligaments of ciliary body

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### Ciliary Body

1. thickest part of the middle layer
2. holds and moves the lens
  - A. ciliary processes: radiating folds
  - B. ciliary muscles: contract and relax to move lens

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### Accommodation

1. lens changes shape to focus
2. focusing incoming light rays.
3. If light rays are from a distant object, the lens is flat.
4. on a close object, the lens thickens

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### Iris

1. between cornea and lens
2. thin diaphragm muscle
3. colored ring around pupil
4. pupil is hole in iris
5. dim light, pupil dilates
6. bright light, pupil constricts

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## Inner Tunic

1. Retina
  - A. inner lining
  - B. photoreceptors.
  - C. optic disc.
    - a. blind spot.
2. vitreous humor
  - A. holds retina flat

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## Visual Receptors

1. Photoreceptors
  - A. Cones
    - a. color vision;
  - B. Rods
    - a. night vision;
2. Macula lutea
  - A. mostly cones
3. Fovea centralis
  - A. center of macula lutea;
  - B. ALL cones
  - C. sharpest vision

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## Visual Receptors: Rods

1. long, thin
2. sensitive to light
3. vision in dim light.
4. colorless vision
5. broad outlines of objects.
6. rhodopsin

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## Visual Receptors: Cones

1. Short, blunt
2. 1 of 3 color sensitive pigments
  - A. erythrolabe – responds to red
  - B. chlorolabe – responds to green
  - C. cyanolabe – responds to blue.
3. Color depends on cones stimulated
4. vision in bright light
5. sharp images,
6. cones decrease away from the macula lutea.

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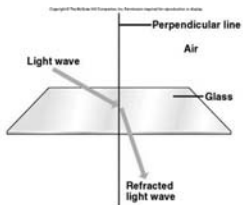
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## Light Refraction

1. bending of light
  - A. mediums of different densities



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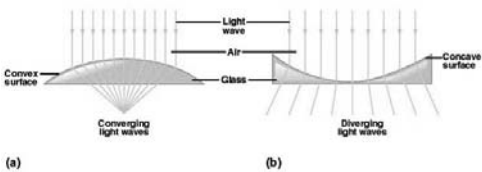
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## Types of Lenses

Convex lenses cause light waves to converge

Concave lenses cause light waves to diverge



(a)

(b)

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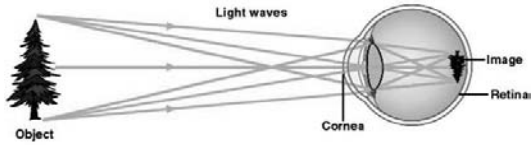
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## Focusing On Retina

1. light is refracted by
  - A. convex surface of cornea
  - B. convex surface of lens
2. image upside down and reversed



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## Stereoscopic Vision

1. perception of distance and depth
2. two slightly different retinal images

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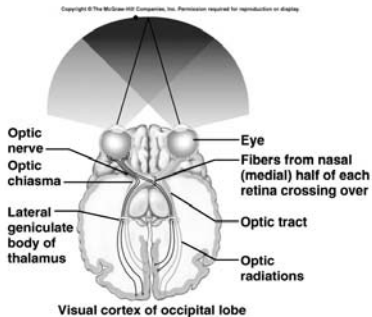
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## Visual Pathway



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## Life-Span Changes

Age related hearing loss due to

- damage of hair cells in organ of Corti
- degeneration of nerve pathways to the brain
- tinnitus

Age-related visual problems include

- dry eyes
- floaters (crystals in vitreous humor)
- loss of elasticity of lens
- glaucoma
- cataracts
- macular degeneration

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## Clinical Application

### 1. Refraction Disorders

- A. convex lens corrects farsightedness
- B. concave lens corrects nearsightedness

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