Sensory Perception

Chapter 34 Part 2
34.6 Noise Pollution

- Noise louder than 90 decibels (chainsaw, rock concert, iPod earbuds at high volume) damages hair cells in the cochlea
34.4-34.6 Key Concepts
Balance and Hearing

- Organs in the ear function in balance and in hearing

- The inner ear’s vestibular apparatus detects body position and motion

- The outer and middle ear collect and amplify sound waves

- Mechanoreceptors in the inner ear send signals about sound to the brain
34.7 Sense of Vision

- **Vision**
  - Detection of light in a way that provides a mental image of objects in the environment
  - Requires eyes and a brain with ability to interpret visual stimuli

- **Eyes**
  - Sensory organs that hold photoreceptors
  - Pigment molecules absorb light energy
Simple Vision

- Some invertebrates (earthworms) detect light with photoreceptors but do not form an image.

- Compound eyes (insects) produce a mosaic image that is fuzzy but sensitive to motion:
  - Many individual units, each with its own lens.

- **Lens**: A transparent body that bends light rays to converge on photoreceptors.
Detailed Vision

- **Camera eye** (cephalopods, vertebrates)
  - Provides a richly detailed image
  - Has an adjustable opening and a lens that focuses light on a photoreceptor-rich retina

- **Retina**
  - A tissue densely packed with photoreceptors
  - Signals travel from photoreceptors along optic tracts to the brain
Camera Eye (Octopus)
Depth Perception: Forward-Facing Eyes
The human eye is a multilayered structure surrounded by protective structures
- Bony orbit, eyelids, eyelashes, tears
- Mucous membrane (*conjunctiva*)

Outer layer of the eye
- Transparent *cornea* in front
- Elsewhere covered by white, fibrous *sclera*
A Closer Look at the Human Eye

• Middle layer
  - Choroid darkens the eye
  - Iris controls the size of the pupil
  - Ciliary body holds the lens in place

• Two internal chambers
  - Anterior: aqueous humor
  - Inner eye: vitreous body and retina
Retinal Stimulation

- Both the cornea and lens bend incoming light, producing an upside-down image on the photoreceptor-rich retina at the back of the eye.
Animation: Visual accommodation
Focusing Mechanisms

- **Visual accommodation**
  - Changing shape or position of a lens so incoming light falls on the retina, not in front or behind it

- **Ciliary muscle** adjusts the shape of the lens
  - Contracts or relaxes to focus on near or distant objects
Focusing Mechanisms

A  Relaxed ciliary muscle pulls fibers taut; the lens is stretched into a flatter shape that focuses light from a distant object on the retina.

B  Contracted ciliary muscle allows fibers to slacken; the lens rounds up and focuses light from a close object on the retina.
A Relaxed ciliary muscle pulls fibers taut; the lens is stretched into a flatter shape that focuses light from a distant object on the retina.
**B** Contracted ciliary muscle allows fibers to slacken; the lens rounds up and focuses light from a close object on the retina.
34.9 From the Retina to the Visual Cortex

- Processing of visual signals begins in the retina

- **Fovea**
  - Area of the retina dense with photoreceptors
  - Normally, most light rays focus on the fovea
Examining the Retina
Fig. 34-20b, p. 590

Start of an optic nerve

Fovea
Cells of the Retina

- Interneurons involved in vision processing:
  - Amacrine cells, horizontal cells, bipolar cells

- Photoreceptors:
  - **Rod cells** detect dim light, coarse movement
  - **Cone cells** detect sharp, color vision
Organization of the Retina

incoming rays of light

ganglion cell (axon is part of one of two optic nerves)

horizontal cell
bipolar cell
amacrine cell
cone cell
rod cell
incoming rays of light

horizontal cell
bipolar cell
amacrine cell
rod cell
cone cell

ganglion cell (axon is part of one of two optic nerves)
Animation: Organization of cells in the retina
How Photoreceptors Work

- Rod cells contain rhodopsin (opsin and retinal) which responds to blue-green light

- Humans have three types of cone cells—red, green and blue—each with a different opsin

- Photon absorption by opsins leads indirectly to action potentials in other cells
Rod Cells and Cone Cells

- Rod cells
- Cone cell
- Stacked, pigmented membrane
Visual Processing

- Interneurons that overlie photoreceptors receive signals which converge on ganglion cells at the start of the optic nerve (blind spot).

- Signals cross over to opposite brain regions (lateral geniculate nucleus) and are processed.

- Final integration process in the visual cortex produces visual sensations.
Experiment: Response of Visual Cortex Cells

- Screen
- Projector
- Electrode in cat’s brain
- Signals picked up by oscilloscope

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signals picked up by oscilloscope electrode in cat’s brain

screen

projector

time (seconds)
Animation: Receptive fields
Flow of Information From Retina to Brain

- **left half of visual field**
- **right half of visual field**
- **pupil**
- **optic nerves**
- **optic chiasm (cross)**
- **corpus callosum**
- **lateral geniculate nucleus**
- **left visual cortex**
- **right visual cortex**

**Flow Process**

1. **reception of stimulus energy**
2. **transduction of stimulus energy**
3. **brain response (sensation or perception)**

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Fig. 34-24, p. 591

- Left half of visual field
- Right half of visual field
- Pupil
- Optic nerves
- Optic chiasm (cross)
- Corpus callosum
- Lateral geniculate nucleus
- Left visual cortex
- Right visual cortex

Reception of stimulus energy → Transduction of stimulus energy → Brain response (sensation or perception)
34.10 Visual Disorders

- Abnormalities in eye shape, in the lens, and in cells of the retina can impair vision

- Disorders may be caused by genetic conditions, age-related changes, nutritional deficits, and infectious agents
Some Vision Disorders

- **Color blindness**
  - X-linked recessive trait

- **Lack of focus**
  - Astigmatism, farsightedness, nearsightedness

- **Macular degeneration**
  - Loss of photoreceptors in center of visual field

- **Glaucoma**
  - Fluid pressure damages blood vessels, cells
Some Vision Disorders

- **Cataracts**
  - A clouding of the lens

- **Nutritional blindness**
  - Lack of vitamin A to make retinol

- **Infectious agents**
  - Bacteria, roundworms, syphilis, amoebas, fungi
Focusing Problems

(a) distant object

(b) close object

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distant object
close object
Vision Disorders: Macular Degeneration and Cataracts
34.7-34.10 Key Concepts

Vision

- Most organisms have light-sensitive pigments, but vision requires eyes

- Vertebrates have an eye that operates like a film camera; their retina, which has photoreceptors, is analogous to the film

- A sensory pathway starts at the retina and ends in the visual cortex
Animation: Eye structure
Animation: Pathway to visual cortex
Animation: Sound detection
ABC video: Painful Painkillers
ABC video: Tongue Tied
ABC video: To See Again
Video: A whale of a dilemma