Process Diagram 4.1
How the Eye Sees

1. Light first enters through the cornea, which helps focus incoming light rays.

2. The light then passes through the pupil, a small adjustable opening. Muscles in the iris allow the pupil to dilate or constrict in response to light intensity or emotional factors.

3. Behind the iris and pupil, the muscullarly controlled lens focuses incoming light into an image on the light sensitive retina, located on the back surface of the fluid-filled eyeball. Note how the lens reverses the image from right to left and top to bottom when it is projected on to the retina. The brain later reverses the visual input into the final image that we perceive.

4. In the retina, light waves are detected and transduced into neural signals by vision receptor cells (rods and cones).

5. The fovea, a tiny pit filled with cones, is responsible for our sharpest vision.

6. Rods are visual receptors that detect white, black, and gray and are responsible for peripheral vision. They are most important in dim light and at night.

7. Cones are visual receptors adapted for color, daytime, and detailed vision. They are sensitive to many wavelengths, but each is maximally sensitive to red, green, or blue.

8. Rods and cones generate neural signals that send their messages to the brain via activation of the bipolar and ganglion cells.

Do you have a blind spot?

Everyone with vision does. To find yours, hold this book about one foot in front of you, close your right eye, and stare at the X with your left eye. Very slowly, move the book closer to you. You should see the worm disappear and the apple become whole.
Process Diagram 4.2

How the Ear Hears

The **outer ear** (pinna, auditory canal, and eardrum) funnels sound waves to the middle ear. In turn, the three tiny bones of the **middle ear** (hammer, anvil, and stirrup) amplify and send along the eardrum’s vibrations to the cochlea’s oval window, which is part of the **inner ear** (cochlea, semicircular canals and vestibular sacs). Vibrations from the oval window cause ripples in the fluid-filled **cochlea**, which then cause bending of the hair cells in the cochlea’s basilar membrane. The bending hair cells then trigger neural messages that are sent to the brain via the auditory nerve. Finally, when the brain’s temporal lobe receives and interprets the neural messages, we hear.

1. The outer ear, or **pinna**, channels the sound waves into the tube-like **auditory canal**, which focuses the sound.
2. Sound waves collected by the outer ear cause the eardrum, or tympanic membrane, to vibrate.
3. Vibrations from the eardrum are then passed along to the middle ear, which contains three tiny bones called the **malleus** (hammer), **incus** (anvil), and **stapes** (stirrup).
4. Within the inner ear, the **stapes** presses on a membrane, known as the **oval window**, and causes it to vibrate.
5. Movement of the oval window creates waves in the fluid that fills the cochlea, a snail-shaped structure that contains the **basilar membrane**, which holds the hair cell receptors for hearing.
6. As the waves travel through the **cochlear fluid**, the hair cells on the basilar membrane bend from side to side. This movement stimulates the cells to transduce the mechanical energy of the sound waves into electrochemical impulses that are carried by the auditory nerve to the brain.

**Outer Ear** Pinna, auditory canal, and eardrum, which funnel sound waves to the middle ear

**Middle Ear** Hammer, anvil, and stirrup, which concentrate eardrum vibrations onto the cochlea’s oval window

**Inner Ear** Cochlea, semicircular canals, and vestibular sacs, which generate neural signals sent to the brain

**Cochlea** [KOK-lee-uh] Three-chambered, snail-shaped structure in the inner ear containing the receptors for hearing
The sensation of smell begins when we inhale airborne molecules though the nose and/or an opening in the back of the throat. These airborne odor molecules travel to the olfactory epithelium, a membrane lining the root of the nasal cavity.

Hair-like receptor cells on the olfactory membrane make contact with the inhaled air, and the odor molecules bind to appropriately shaped receptors, like a lock and key.

After olfactory receptor cells are stimulated, a neural impulse is sent to the brain's olfactory bulb, located just under the frontal lobes.

In the olfactory bulb, each odorous chemical appears to create various patterns of activation, and the sense of smell is coded accordingly.

From the olfactory bulb, messages then travel to other areas of the brain, including the temporal lobe and limbic system. The temporal lobe is responsible for our conscious recognition of smells; the limbic system is involved in emotion and memory, which explains why smells often generate emotion-laden memories.