The “typical” neuron is designed to receive neurotransmitter messages from other neurons. Sensory receptors, on the other hand, are specialized to receive sensory input from the outside world.

**Vision**

**The Eye and the Visual Receptors**

Stimulus which activates visual receptors: light waves in the visible spectrum.

Light waves are a small range of wavelengths (~350-750 nanometers) of electromagnetic energy.

**Transparent Cornea**
- Curve of cornea helps to focus light waves on retina
- “Astigmatism” causes 2 focal points instead of 1

**Green Muscular Iris & Black Pupil Hole**
- Muscles of iris under ANS control:
  - Symp: dilate pupil
  - Parasymp: constrict
Collagen structure of the human eye

Center (Macula) of Retina Needed for Detail Vision (Fovea especially)

Macular Degeneration

Loss of the critical central region of retina

Smoking is #1 preventable cause

What you might see

Rods vs Cones

- ~120 million/eye
- more in periphery
- very sensitive (low threshold)
- ~100 rods share same optic nerve fiber to brain
- night vision (scotopic vision)

- ~6 million/eye
- most in center, especially in the fovea
- Need bright light to reach threshold (photopic vision)
- have more private lines to brain - good for detail vision or “acuity”
- color vision

Looking Into Left Eye: Optic Disk or “Blind Spot”-
axons exit eye to form optic nerve

You can locate your own blind spot with the demo on p. 156.

Lens becomes less flexible later in life — need reading glasses
Turning Light Waves Into Electrical Messages (Transduction)

- Rods & cones have molecules of light sensitive photopigment embedded in cell membrane.

  Rods — rhodopsin
  Cones — 1 of 3 iodopsins
  - Like metabotropic transmitter receptors, except they receive light!
  - But receiving light has a surprising effect

Cones

- 3 different types, absorbing different ranges of wavelengths
- Supports the Trichromatic theory

2 Theories of Color Vision Proposed in 1800’s
Trichromatic Theory ("Component Theory") — 3 different types of color receptors work together to represent all colors of the spectrum.
- Opponent Process Theory — cells in the visual pathway receive input about pairs of colors (R-G or B-Y). One color makes them fire faster, the other makes them fire slower.

What Do You See?

- ~ 8% of men and <1% of women suffer R/G color deficiency
Many Regions of Cortex Involved in Visual Processing

- Primary visual cortex is just the first level of cortical processing
- Damage here → “cortical blindness”
- Secondary “visual cortex” has separate regions devoted to shape, color, location, & movement that extend beyond occipital lobe.

Visual Agnosia (not recognizing)

- Damage to different parts of this system lead to different kinds of visual agnosia (object agnosia, color agnosia, movement agnosia)
- Prosopagnosia- can’t recognize individual faces (or similar members of other complex classes of visual stimuli) – most often seen after damage to the inferior temporal lobe’s fusiform gyrus (in pink)

Visual Processing Cases

- Object Agnosia
  - http://www.youtube.com/watch?v=rwQpaHQ0hYw
  - Object agnosia & trouble locating visual stimulus
  - http://www.youtube.com/watch?v=dG8JGg-d2Pk&feature=related
- Prosopagnosia (“face blindness”)
  - http://www.youtube.com/watch?v=vwCnzmPkh7k&list=UU943UnajVxe9SpFJpwxpLsQ&index=8
- Blindsight
  - http://www.youtube.com/watch?v=RuNDkcbq8PY&feature=related
- Motion blindness
  - http://www.youtube.com/watch?v=B47Js1MtT4w&list=PL22D01B36165478AD
• Hair cells in the auditory and vestibular systems mechanically open ion channels.
Organ of Corti

http://www.youtube.com/watch?v=8wgfowbbTwO

Tectorial Membrane

Book Fig. 7.2

Fluid Waves Traveling Thru Cochlea Cause Basilar Membrane Movement

- Where wave peaks varies with pitch & determines which hair cells will be stimulated.

Georg von Bekesy – 1961 Nobel Prize for his research on the traveling waves in the cochlea.

http://www.youtube.com/watch?v=dyenMluFaUw&feature=related
http://www.youtube.com/watch?v=WO84KJyH5k8&feature=related

“Tonotopic” Relationship Between Place in Cochlea and Pitch

If our inner ear is working perfectly we can hear frequencies between 20-20,000 cps

“Place theory” best explains pitch perception for the upper 80% of our hearing range & explains freq specific hearing losses

20-100 – frequency theory

100-4000 – volley theory

Friction on tips of hair cells opens mechanically-gated K+ ion channels

K+ enters hair cells causing depolarization & transmitter release!

(fluid in cochlea has a different ion balance – disruption of that balance can lead to hearing abnormal sounds (tinnitus))

Normal & “Trampled” Hair Cells Exposed to Loud Sounds

- http://www.youtube.com/watch?v=Xo9bwcO3yRo (dancing hair cell)
- http://www.youtube.com/watch?v=ulA5CEQzRo
- (stereocilia)

Sound Localization

Brain processes time & intensity & phase differences in what the right & left ears hear.
Sound from right arrives sooner and louder in the right ear.
Note: Input from each ear goes to both sides of brain but more strongly to contralateral side. Brainstem areas involved in quick sound localization and auditory reflexes.

Types of Deafness
- ~250 million with hearing impairments; only a fraction are completely deaf
- Conductive or Middle Ear Deafness – auditory stimulus does not pass normally through middle ear to cochlea
- Nerve/Neural or Inner Ear Deafness – due to damage to inner ear hair cells or auditory nerve due to:
  - Genetics
  - Perinatal problems (illness during pregnancy, hypoxia during birth, PVS)
  - Illness (meningitis, MS, Meniere’s)
  - Ototoxic drugs (quinine, some antibiotics, high doses of NSAIDS, nicotine)
  - Loud sounds
- [Video Link](http://www.youtube.com/watch?v=9gOyThhJcxY)
- Mosquito tones

Cochlear Implant can take the place of missing or damaged hair cells as long as auditory nerve fibers still run from cochlea to brain.