VISUAL SYSTEM

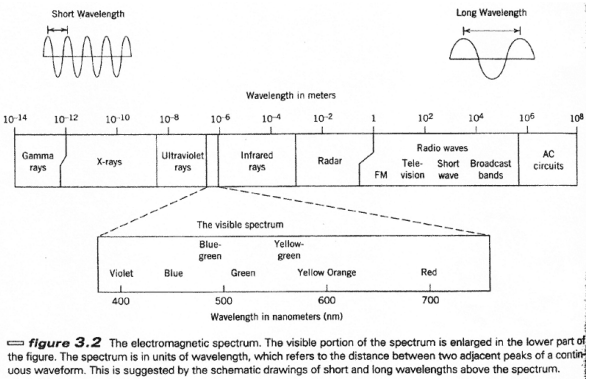


figure 3.2 The electromagnetic spectrum. The visible portion of the spectrum is enlarged in the lower part of the figure. The spectrum is in units of wavelength, which refers to the distance between two adjacent peaks of a continuous waveform. This is suggested by the schematic drawings of short and long wavelengths above the spectrum.

1) The Stimulus (Light)

   a) Wavelength

   b) Intensity

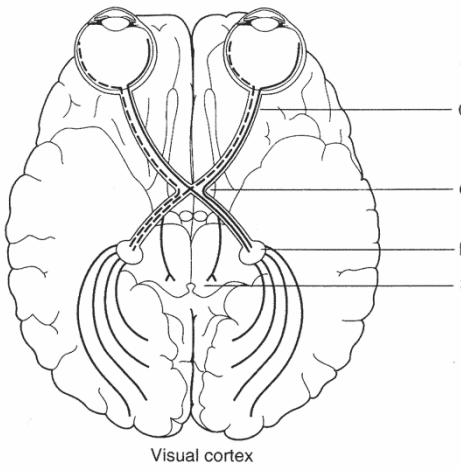
      i) Illuminance

      ii) Luminance

   c) Perceptual dimensions

      i) Color

      ii) Intensity



2) Visual System Overview

   a) Pathways

      i) Eyes

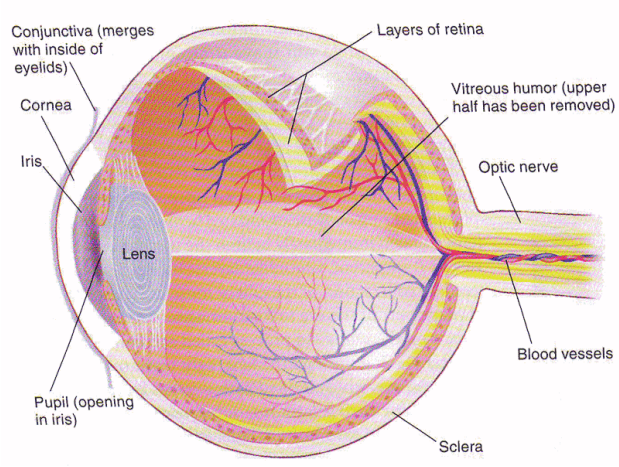
      ii) Lateral Geniculate Nucleus (LGN) of thalamus

      iii) Visual receiving area (striate cortex)

      iv) Extra-striate cortex

3) The Eye

a) Overview/Parts

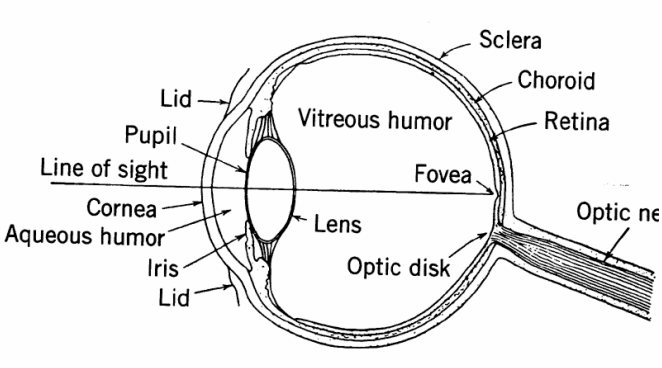


i) Sclera

ii) Cornea

iii) Choroids

iv) Iris



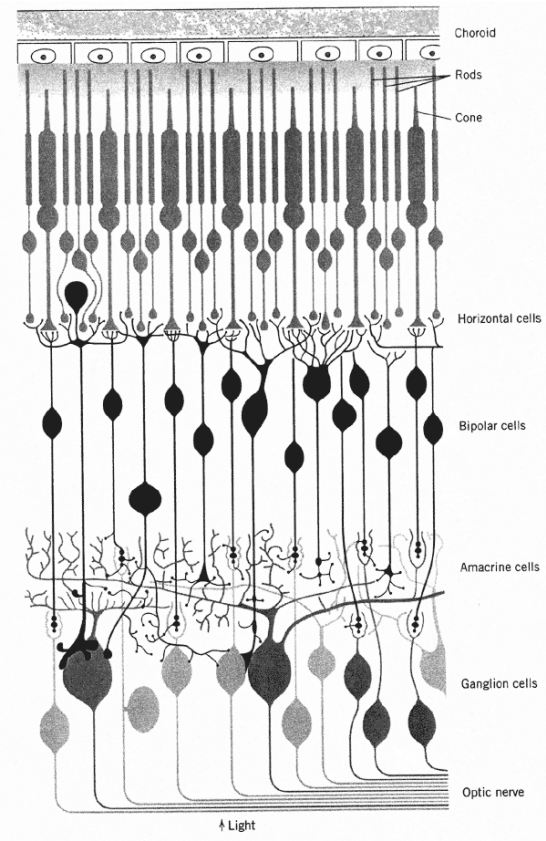
v) Lens

vi) Pupil

vii) Whytt's reflex

viii) Pupillometry: Aside on pupil diameter & task difficulty

ix) The Retina



(1) Rods

(2) Cones

(3) Fovea

(4) Note: the eye is “backwards”

(5) Bipolar cells

(6) Ganglion cells

(7) Horizontal cells

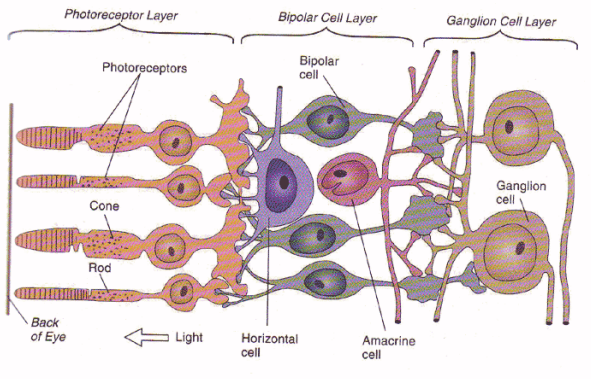
(8) Amacrine cells

(9) Note: lateral inhibition

(10) Sensitivity

(11) Spatial summation

(12) Acuity



x) Blind spot

4) Eye Movement

a) Occulomotor muscles

b) Convergence

c) Accommodation of lens

i) Refractive errors due to failures of accommodation

(1) Presbyopia

(2) Hyperopia

(3) Myopia

(4) Question: Can too much TV hurt your vision?

ii) Refractive errors due to lens shape

(1) Spherical aberration

(2) Chromatic aberration

(3) Astigmatism

5) Receptive Fields (in the Cortex)

a) Ganglion cells

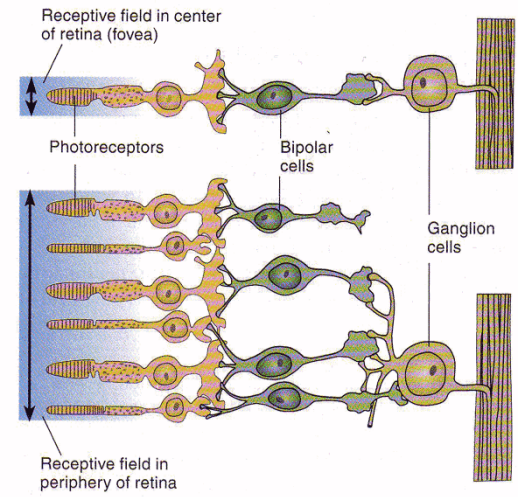
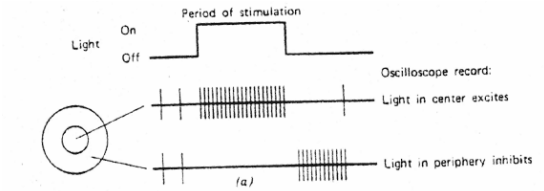


Figure 6.13
Central versus peripheral acuity. Ganglion cells in the fovea receive input from a smaller number of photoreceptors than in the periphery and hence provide more acute visual information.

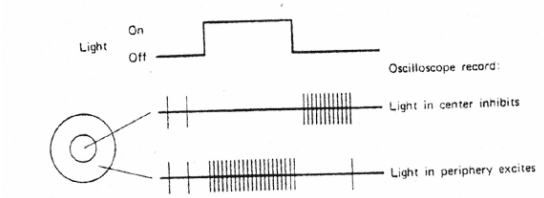
b) Center-surround field

i) ON cell



ii) OFF cell

iii) ON/OFF cell

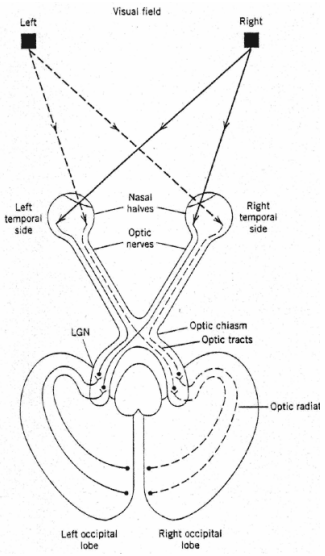


c) P-cells vs. M-cells

i) Parvocellular

ii) Magnocellular

6) Visual Pathways



a) Eye

b) Optic nerve

c) Optic chiasm

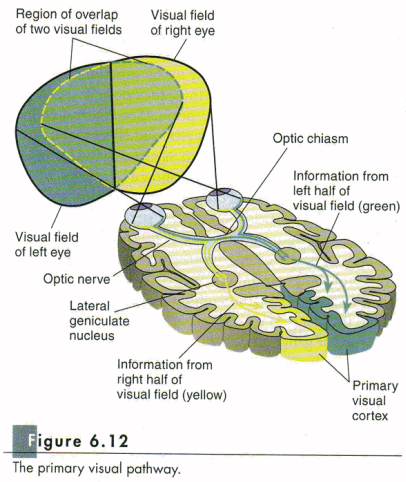


Figure 6.12
The primary visual pathway.

i) Visual fields

d) Superior colliculus

i) 1/5 of projections

e) Lateral Geniculate Nucleus (LGN) of thalamus

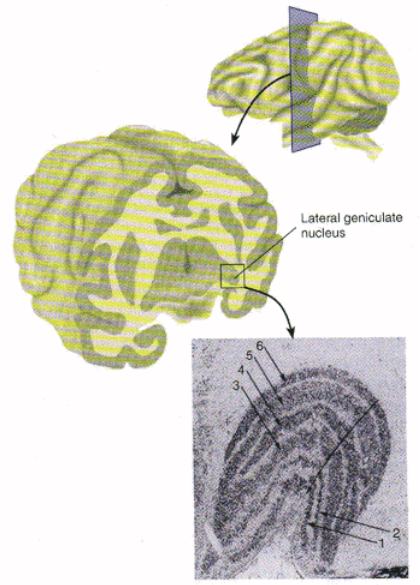


Figure 6.10
A photomicrograph of a section through the right lateral geniculate nucleus of a rhesus monkey (cresyl violet stain). Layers 1, 4, and 6 receive input from the contralateral (left) eye, and layers 2, 3, and 5 receive input from the ipsilateral (right) eye. Layers 1 and 2 are the magnocellular layers; layers 3–6 are the parvocellular layers. The koniocellular sublayers are found ventral to each of the parvocellular and magnocellular other layers. The receptive fields of all six principal layers are in almost perfect registration; cells located along the line of the unlabeled arrow have receptive fields centered on the same point.
(From Hubel, D. H., Wiesel, T. N., and Le Vay, S. *Philosophical Transactions of the Royal Society of London, B.*, 1977, *278*, 131–163.)

i) 4/5 of projections

ii) Retinotopic arrangement of ganglion projections

iii) 6 layers, 3 per eye

iv) Cell types:

(1) Magnocellular (inner 2 layers)

(2) Parvocellular (outer 4 layers)

(3) Koniocellular (on all layers)

f) Visual Cortex (Striate Cortex)

i) Occipital lobe

ii) Simple feature detectors

iii) Organized in modules (~2500), each with 150,000 neurons

g) Extra-striate cortex

7) Striate Cortex (visual area, V1)

i) Occipital lobe

ii) Retinotopic layout (contralateral half of visual field)

iii) Simple feature detection

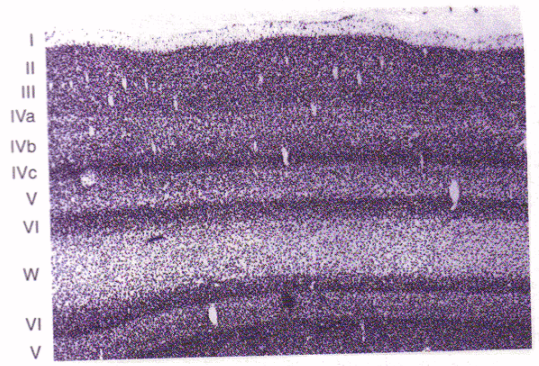


Figure 6.22

A photomicrograph of a small section of striate cortex, showing the six principal layers. The letter W refers to the white matter that underlies the visual cortex; beneath the white matter is layer VI of the striate cortex on the opposite side of the gyrus.

(From Hubel, D. H., and Wiesel, T. N. *Proceedings of the Royal Society of London, B*, 1977, *198*, 1–59. Reprinted with permission.)

b) Six layers (plus several sublayers)

c) Feature detection

i) Orientation and movement

(1) Simple cells

(2) Complex cells

(3) Hyper complex cells

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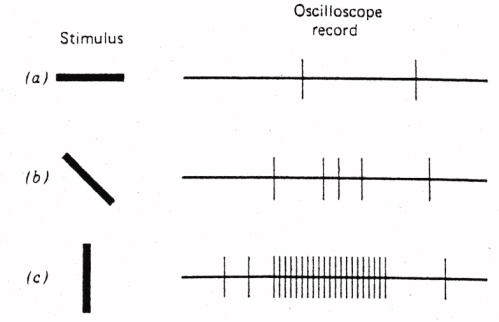

figure 3.28 Oscilloscope record of a simple cell whose maximal response is to a vertically oriented bar of light. The horizontal bar (*a*) produces no response; the oblique bar (*b*) produces a weak response; and the vertical bar (*c*) produces a strong response.

ii) Spatial frequency

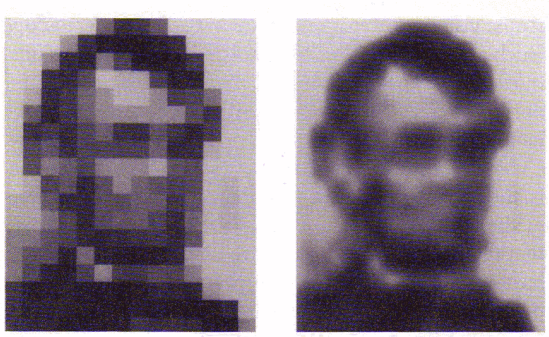

Figure 6.28
Spatial filtering. Both pictures contain the same amount of low-frequency information, but extraneous high-frequency informa-

(1) Note: uses of spatial frequency information:

(a) Long-range vision uses low spatial frequency

(b) Near, details uses high spatial frequency

iii) Texture

iv) Retinal disparity

v) Color

(1) Parvocellular and koniocelular ganglion cells

(2) CO (cytochrome oxidase) blobs

(3) Regions of cortex respond best to different cone input

d) Organization of striate cortex

i) Modules

ii) CO blobs – color

iii) Outside blobs – feature detectors

(1) Column

(2) Hypercolumn

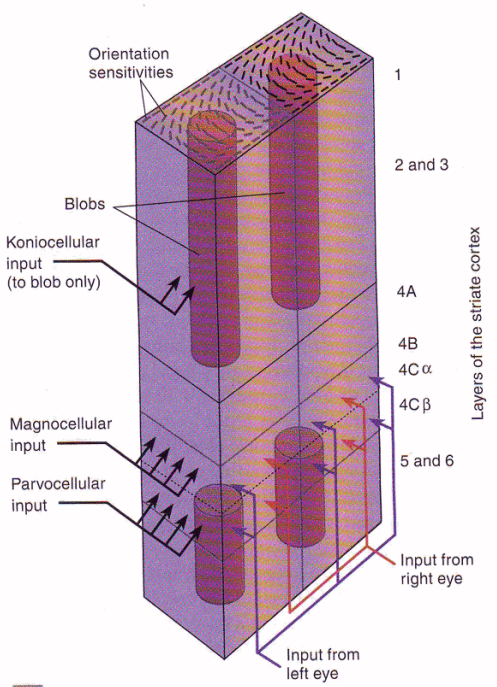

Figure 6.32
One of the modules of the primary visual cortex.

8) Extrastriate Pathway

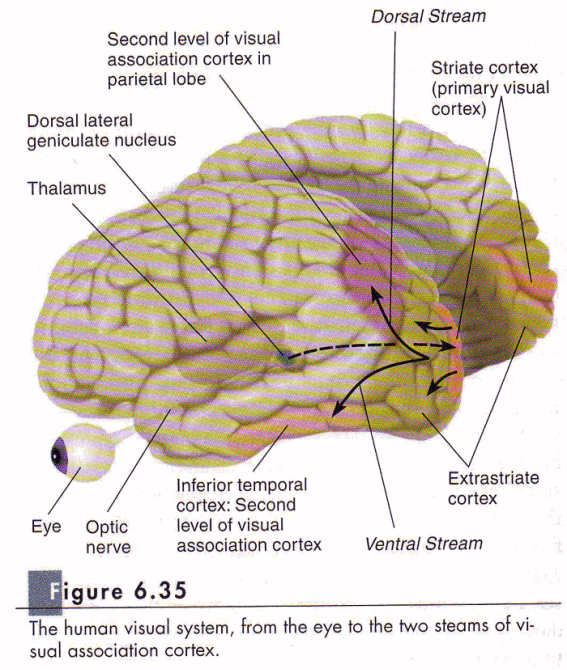

Figure 6.35
The human visual system, from the eye to the two steams of visual association cortex.

a) Ventral system

i) "What" pathway

ii) V1 to temporal lobe via V2, TEO, TE

iii) Perception of objects and form

iv) Damage leads to visual agnosias

b) Dorsal system

i) "Where" or "How" pathway

ii) From V1 to posterior parietal cortex via V5 (MT)

iii) Perception of movement, location, orientation

c) Blindsight ("Cortical blindness")

i) Blind people with ability to look at, point at, and be influenced by objects they cannot see

ii) Optical pathway is still intact

iii) Likely due to redundant pathways to extrastriate cortex via:

(1) Superior colliculus (SC)

(2) Dorsal lateral geniculate nucleus (LGN)