Systems Neuroscience

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http://www.ini.uzh.ch/~kiper/system_neurosci.html
3. At the optic chiasm, axons from the temporal halves of each retina continue into the optic tract on the same side. Axons from the nasal halves cross to the optic tracts on the opposite side.

4. Most axons in the optic tract terminate in the lateral geniculate nucleus.

5. Some axons in the optic tract terminate in the superior colliculus.

6. Axons are sent back and forth between the lateral geniculate and the striate cortex via the optic radiations.

7. Most of the primary visual cortex is on the medial surface of the human brain.

8. An especially large proportion of primary visual cortex represents the foveal region.

9. The left primary visual cortex gets input from both eyes, but only from the right visual field.
The human eye

Dowling, 1987 (Fig 1.3a)  Wandell, 1995 (Fig 2.1)
Distribution of rods and cones: a view from the side

Wandell, 1995 (Fig 3.1)
Distribution of rods and cones:

a view from the front

Fovea

Periphery

10 micron

Wandell, 1995 (Fig 3.4)
Sensitivity for wavelength of the 3 types of cones

S  Rods  M  L
A section through the human retina

- Receptors: rods and cones
- Bipolar and Horizontal cells
- Amacrine cells
- Ganglion cells
- Optic nerve

Dowling, 1987 (Fig 2.1)
Boycott and Dowling (1969)
Basic retinal circuitry

Receptor terminals (RT)

Horizontal cells (H)

Bipolar cells (B)

Amacrine cells (A)

Ganglion cells (G)

Optic nerve

Dowling, 1987 (Fig 3.17)
Visual Pathways
The Lateral Geniculate Nucleus (LGN)

Hubel and Wiesel, 1979
Receptive fields of Ganglion cells and LGN neurones

A  M cells

On-center

Off-center

B  P cells

On-center

Off-center
Visual Pathways

- Left visual field
- Right visual field
- Temporal
- Nasal
- Optic chiasm
- Pulvinar nucleus
- Lateral geniculate nucleus
- Superior colliculus
- Optic radiation
- Primary visual cortex
Cortical representation measured with 2-deoxy-glucose
Retinotopic Maps in Human Cortex

fovea
20 deg
Hubel and Wiesel, circa 1969
Ocular dominance columns measured with radioactive proline

LeVay, Hubel and Wiesel (1975) in Nicholls et al. (1992)
After Hubel & Wiesel (1962) in Nicholls et al. (1992)
The “ice-cube” model of Hubel and Wiesel
Orientation columns measured with optical imaging

Bonhoeffer and Grinvald (1991)
in Nicholls et al. (1992)
Orientierung und Okular Dominanz Säule

Obermayer and Blasdel, 1983
Receptive fields of LGN and V1 simple cells
Extracellular recordings

Selectivity for stimulus orientation and direction in area V1:

Receptive field of a simple cell

Schematic of the receptive field

Responses to white dots - responses to black dots

DeAngelis, Ohzawa & Freeman (1995)
Receptive field of a complex cell

Responses to white dots

Responses to black dots

DeAngelis, Ohzawa & Freeman (1995)
Cortical visual areas of the macaque monkey

Van Essen, 1985
Multiple Visual Areas
Two cortical functional streams
Effects of lesions in two cortical regions

Lesion in temporal cortex

Lesion in parietal cortex

Ungerleider and Mishkin, 1982