Anatomy and Physiology of the Retina

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Light entering the Eye
Eye Exam
The retina
Function of the retina

- To absorb photons of light
- Translate light into a biochemical message
- Translate biochemical message into electrical impulse
- Transmit electrical impulse to the brain via ganglion cells
Sagittal section of the retina
Cellular detail of the retina
Octopus Retina
Octopus Retina
Layers of the retina

- Pigment epithelium
- Photoreceptors
  - Outer nuclear layer
  - Outer plexiform layer
  - Inner nuclear layer
  - Inner plexiform layer
- Ganglion cell layer
- Horizontal cells
- Bipolar cells
- Amacrine cells
- Ganglion cells
- Rods & cones
- Ganglion cell axons
Cell bodies and synapses

All vertebrate retinas are composed of three layers of cell bodies and two layers of synapses.

Cell bodies of rods/cones

Cell bodies of bipolar cells

Cell bodies of ganglion cells
Neuropil layers

Photoreceptor - bipolar synapse
Neuropil layers

Bipolar - ganglion synapse
Photoreceptors
Photoreceptors
Photoreceptors

- o.s. (outer segments)
- discs
- i.s. (inner segments)

- rods
- cones

Scale: 3 µm
Rhodopsin and photoreceptor cells

Rhodopsin molecule adapted from Hargrave, 1996
Rhodopsin

Phosphorylation sites
Sites of interaction with cytoplasmic proteins

Region containing oligosaccharides

Retinal attachment site

adapted from Hargrave et al. 1984
Piantanida, 1991
Central and peripheral retina

- Photo-receptors
- Rods and cones
- OLM
- ONL
- OPL
- INL
- IPL
- GCL
- ILM
- Pedicles
- Spherules
- Horizontal bipolar cells
- Amacrine cells
- Ganglion cells, axons
- Muller cell endfeet
Central and peripheral retina
Optic Nerve
Optic Nerve
Blood supply to the Retina

Choroid supplies 85%
Mainly outer retina
Photoreceptors

Central retinal artery supplies 15%
Inner retinal layer
IV Fluorescein Angiogram
IV Fluorescein Angiogram

Human retina

fovea

optic nerve
IV Fluorescein Angiogram
IV Fluorescein Angiogram
The fovea

Foveal pit + foveal slope + parafovea + perifovea = Macula
Eagle Vision
Photoreceptor cell diameter

Rods (IS) - 2 microns

Cones (IS) - 6 microns

However, in the fovea
Cones (IS) - 1.5 microns
Photoreceptor cell diameter

Rods (IS) - 2 microns

Cones (IS) - 6 microns

However, in the fovea
Cones (IS) - 1.5 microns

However, in the fovea
Cones (IS) - 1.5 microns
Photoreceptor density

Osterberg, 1935
Acuity of the retina
The Macula Lutea

Xanthophyll carotenoids – zeaxanthin & lutein

Tapetum
Colour Absorbancy

Dowling, 1987
Colour Blindness

Red/green colour blindness - X linked

Males only have a single X chromosome. Almost all genes on the X have no counterpart on the Y. Any gene on X, even if recessive in females, will be expressed in males.
Summary of photoreceptors

Rods - Low light levels (scotopic)
  Peripheral vision
  Slow response

Cones - Visual acuity
  Colour vision
  Fast response
Clinical examination of photoreceptors

Form & spatial vision, measured by visual acuity
Reflects rod & cone distribution

Colour vision testing is indicative of cone function and associated processing of the signal