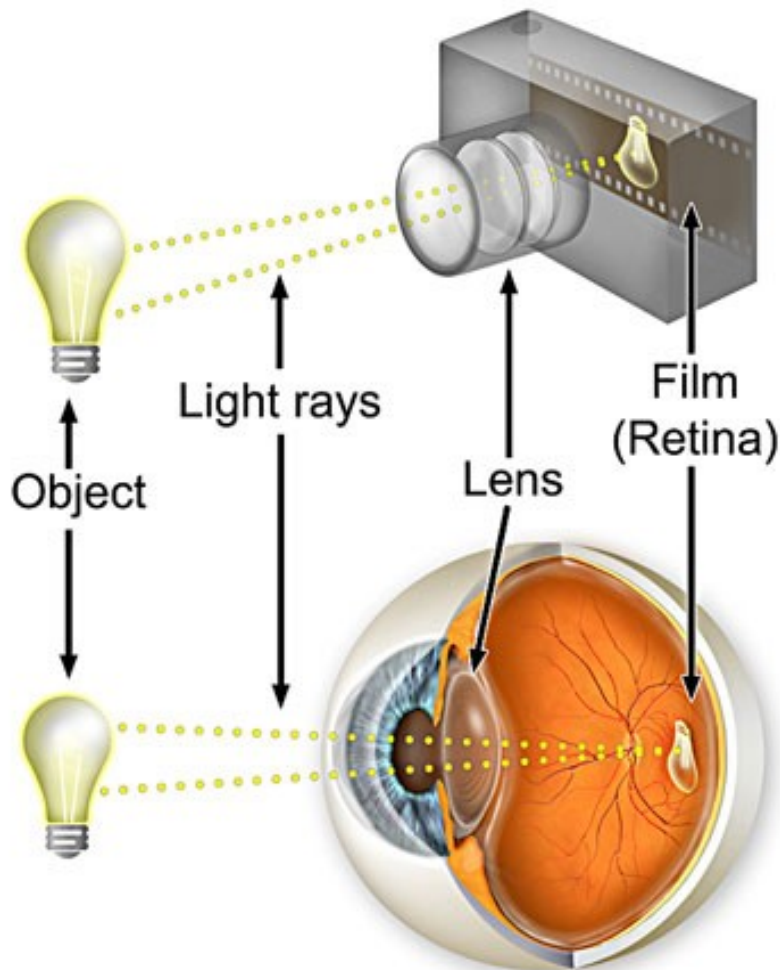


Anatomy and Function (A Short Course in the Physiology of Vision)

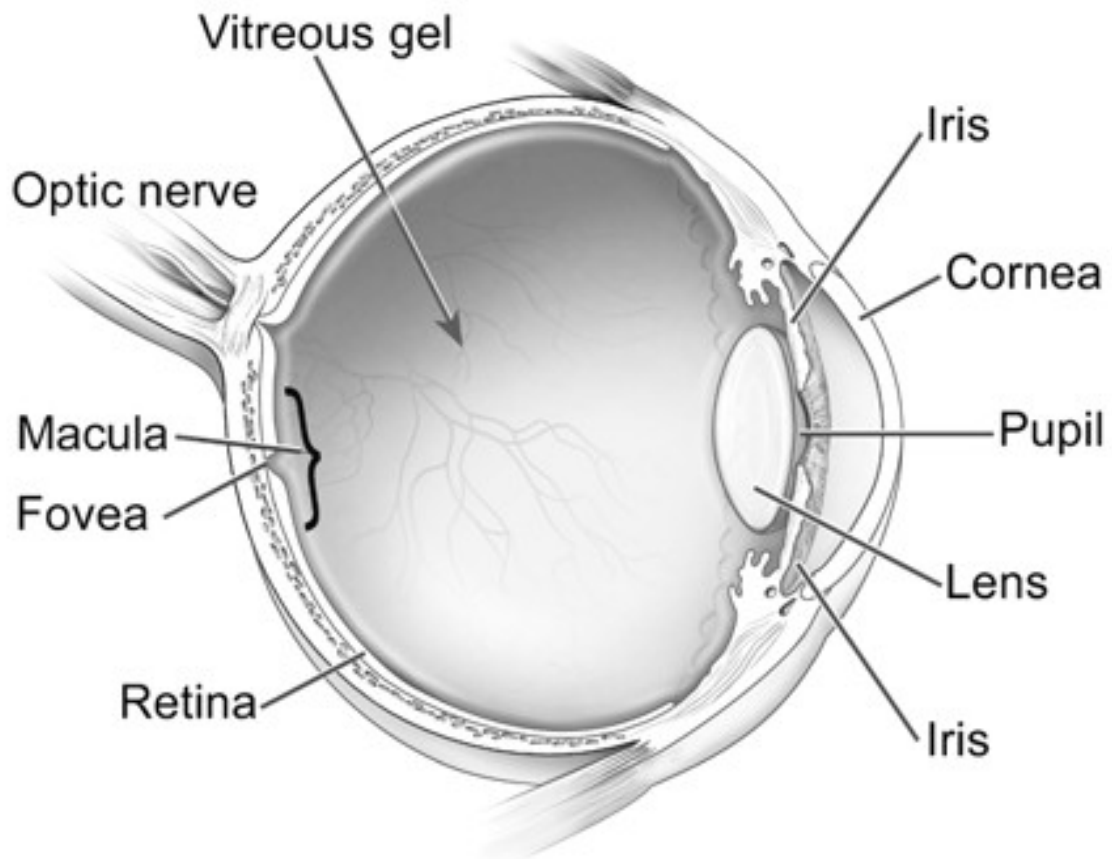
The human visual system has features analogous to a video-camera: a lens system for focusing, a sensor for recording the image, and a cable to transmit the image to a processor.



In the eye, the cornea and lens serve to focus light upon the retina, the sensory layer, and the retina sends the visual information to the brain via the optic nerve. The **iris** and **pupil** help adjust to bright and dim illumination. As a living tissue, the retina contains cells that sense light, motion and colors, and blood vessels to supply the necessary oxygen and metabolites to support the biochemical activity that turns an image into an electrical signal to the brain. The eye-wall has three layers: innermost is the **retina**, the middle layer is the highly vascular and pigmented **choroid**, and the **sclera** forms the eye's white outer coat.

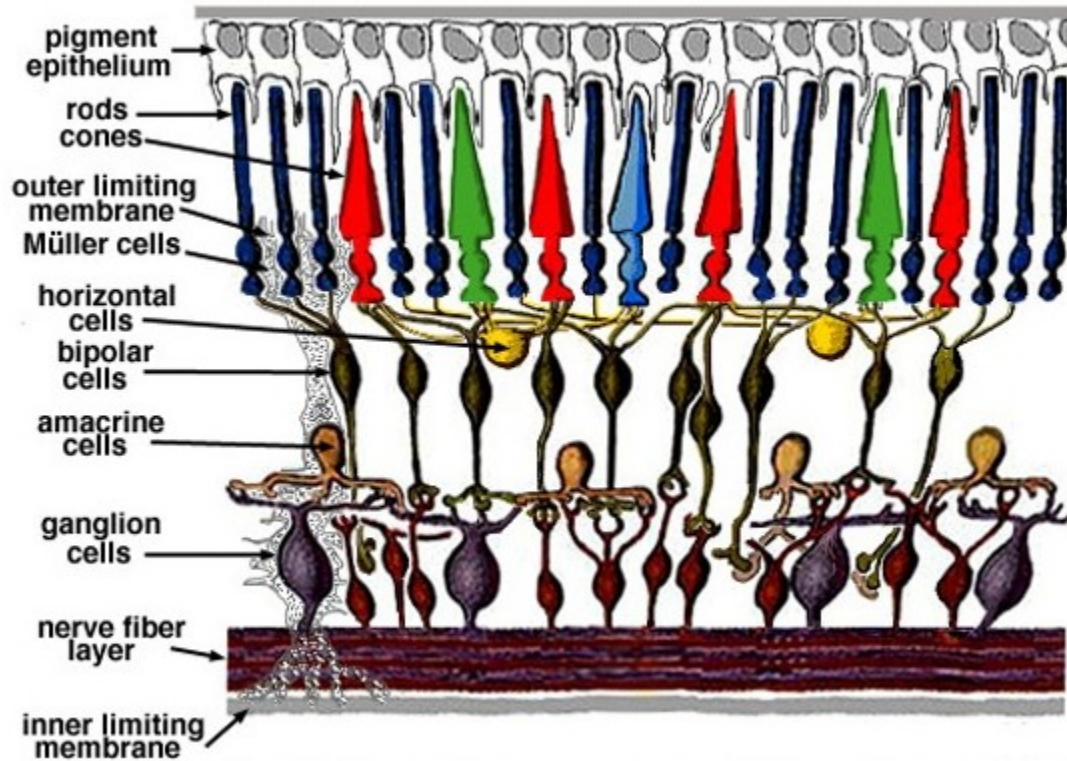
The cavities of the eye are filled with clear fluid. A salt solution (**aqueous humor**) fills the front of the eye in front of the **iris** (anterior chamber) and the thick jelly-like vitreous fills the center. The **vitreous** gel, 97% water and 3% protein and complex sugars, has fine attachments to the inner retinal surface that are strongest over peripheral blood vessels

and some pigmented complexes ([lattice degeneration](#)) in the equatorial region of the globe.



The retina is comprised of millions of [rods and cones](#), cells that capture light and initiate a nerve impulse. Intermediary processing nerve cells (neurons) transmit signals to [ganglion cells](#) (other specialized neurons), which each send a long nerve fiber through the

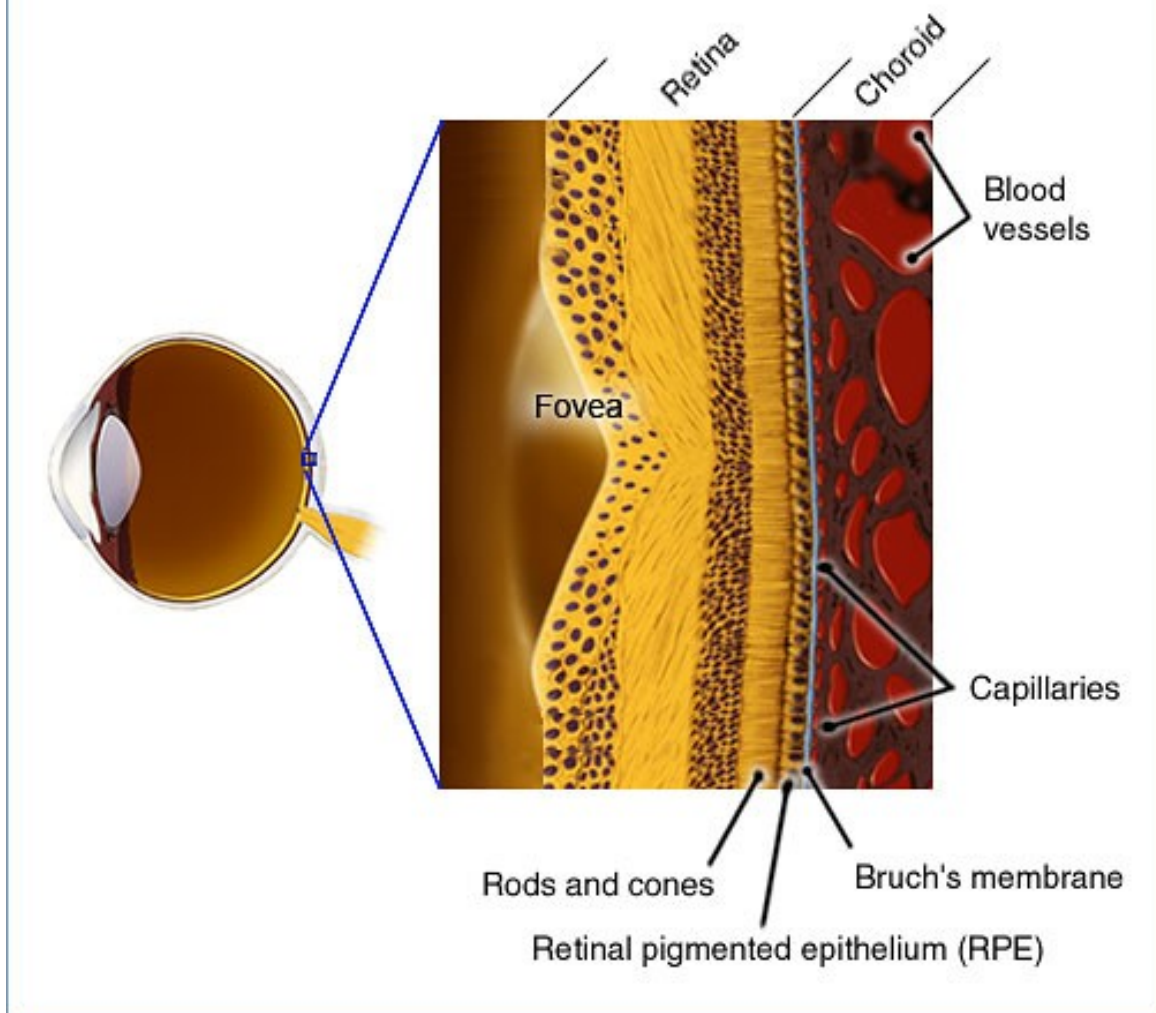
optic nerve to the brain. Over 6 million nerve fibers carry the visual output from over 120 million rods and cone. [Glial](#) cells (Müller) provide structural support to the retina. A thin membrane, the [inner limiting membrane](#), lies at the retina's inner surface.



The [choroid](#), lying underneath the retina, supplies additional nutritional support and powers many of the necessary biochemical reactions that transform light energy into a nerve impulse. A specialized layer of the choroid, lying against the outer retina, is called the [retinal pigment epithelium \(RPE\)/ Bruch's membrane complex](#). The RPE and Bruch's membrane keep blood away from the retina, yet permit the passage of oxygen and nutrients. Suction generated by the [choroid](#) holds the retina in place against the RPE. The potential space between these layers can expand with disease, injury and [retinal detachment](#).



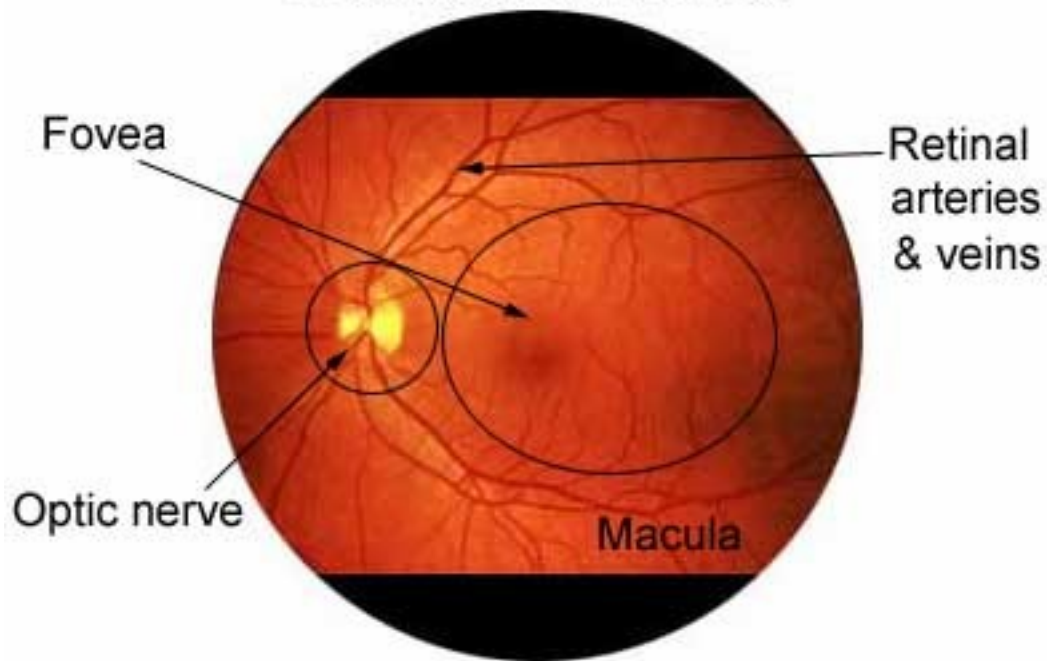
Normal Macula (Cross-Section)



Our retina and brains separate visual information into two categories: central and peripheral vision. We rely on central acuity to discriminate fine details and subtle color alterations. The peripheral system senses motion and shadows.

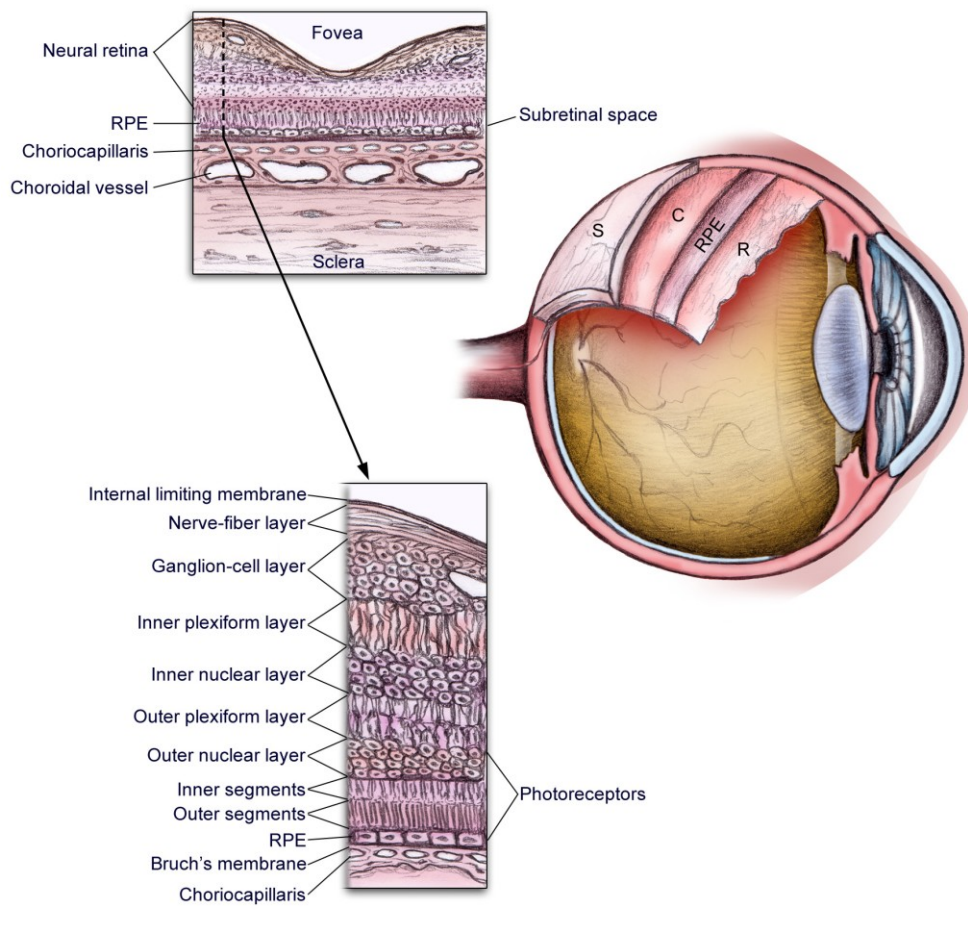
The critical retinal region for vision is called the [macula](#): it is responsible for precise visual and color perception. Damage to the [macula](#) can leave one unable to read, drive and identify faces.

Normal Macula



Within the macula is a specialized region, with a central depression, 500 microns (1/50th of an inch) in diameter, the **fovea**. The fovea has the highest concentration of ganglion cells, providing great sensitivity in visual processing, which we experience as fine acuity. The central avascular region (lacking retinal blood vessels) is called the **foveola**. Several layers of neural processing cells (horizontal, bipolar, and amacrine cells) and plexiform (interconnecting layers) transmit nerve impulses from the 120 million individual rods and cones to the **ganglion cells**. Each of 6 million retinal **ganglion cells** supplies a single axon (nerve fiber) that travels through the optic nerve to the brain. **Ganglion cells** transmit information regarding color, motion and contour of the received image.

The retina and its macula receive nutrition and blood supply from two sources: the innermost retina (containing the **ganglion cells**, and closest the **vitreous body**) is supported by retinal **capillaries**; the rods and cones are supported by the **chorio-capillaris**, a network of blood vessels, adjacent to the **retinal pigment epithelium**. Interruption of this blood supply for more than a few seconds may disrupt retinal function.



Visual impairment may come from various causes. Cataracts and corneal disease interfere with the quality of the focused light. Damage to blood vessels, as caused by high blood pressure and diabetes for example, may interfere with the supply of oxygen and nutrients to the retina and choroid or lead to the accumulation of blood and blood components within the retina and vitreous. The retina and choroid may fail to function – due to age, infection, inflammation, injury or genetic disorder. If the pressure within the eye is too high ([glaucoma](#)) or too low ([hypotony](#)), the ocular tissues fail to operate at a level consistent with prolonged ocular health and good vision.

In the developed world, the chief causes of blindness are [diabetes](#), [age-related macular degeneration](#), [cataract](#), injury and [glaucoma](#). Ophthalmologists are physicians (MDs) trained to identify and ocular disease. Retinal surgeons receive special training in the management of all manner of retinal disorders. (Revised 11/14/2010)