STRUCTURES AND FUNCTION OF THE EYE

The human eye is structured very much like a powerful camera. Light rays are focused via the cornea and lens on the retina. (The retina is like the photosensitive film of the camera).The retina transmits the image via the nerve of sight (optic nerve) to the brain. This nerve is like an electric cable. It contains about one million wires, each carrying a message to the brain. The brain co-ordinates and interprets these messages to provide distant vision (including side vision) as well as sharp reading vision.

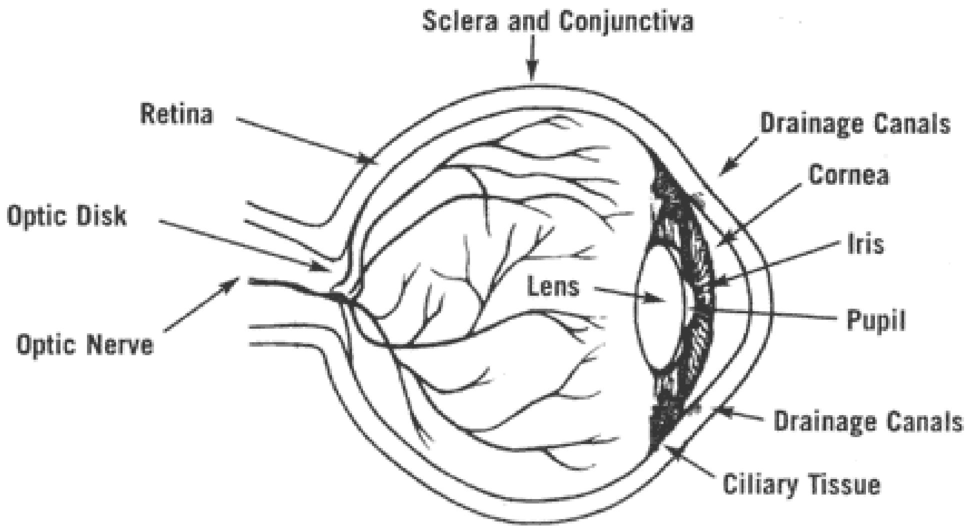
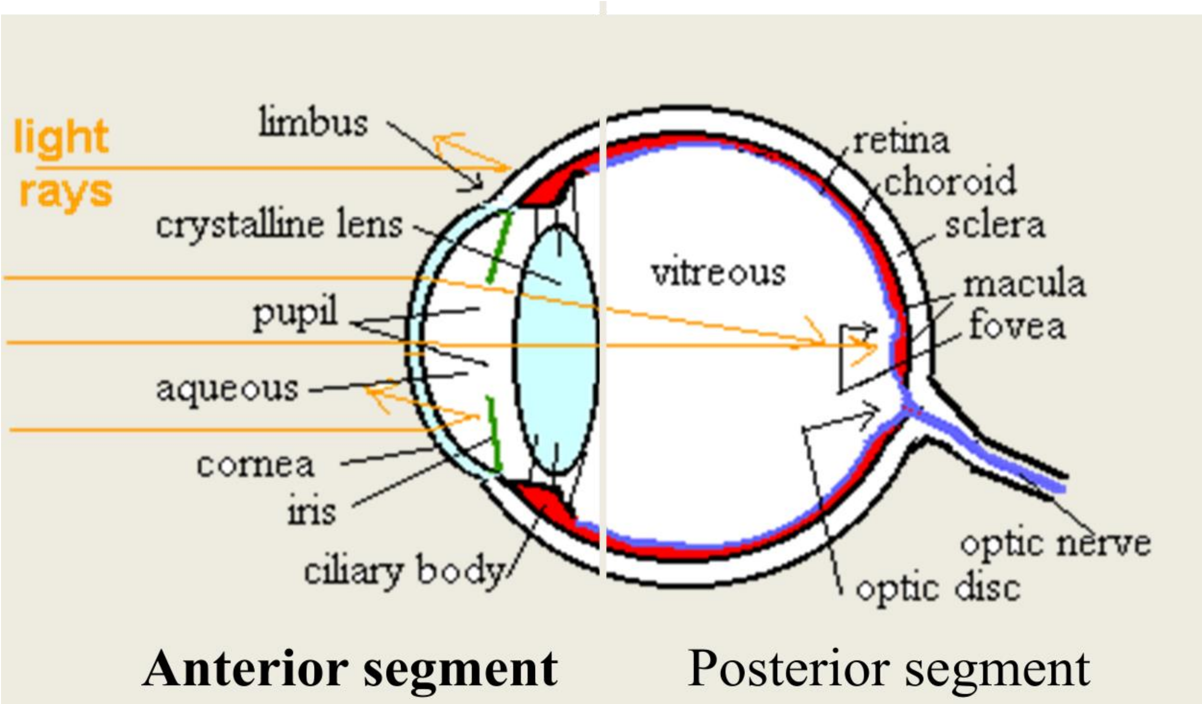


Figure showing GROSS STRUCTURE OF EYE IN LONGITUDINAL CUT SECTION

The eyeball, or **globe**, is spherical in shape and about 1 inch in length. It has many structures that works together to facilitate the sight. The human eye is comprised of layers and internal structures, each of which performs distinct functions. The outside layer of the eye is comprised largely of a tough, white, protective tissue called the **sclera**. The sclera helps maintain the shape of the eyeball. At the front of the eye is an equally tough but clear structure called the **cornea**, which allows light to pass through.

Middle coat of the eye is vascular coat called Uvea. The ciliary body is the mid-portion of the uveal tract lying just behind the iris (outer pigmented curtain like structure visible from outside of the eye) and is the site of f aqueous humor production. The angle of the anterior chamber refers to the region between the cornea and the iris that contains the trabecular meshwork, the principal site of outflow of aqueous humor from the eye. The front part of the eye is filled with a clear fluid called aqueous humor, continuously secreted by the ciliary body. The fluid flows out through the pupil and exits through as drainage system in the eye. This drainage system is a meshwork of drainage canals around the outer edge of the iris. The trabecular meshwork acts as a sieve of tissue that connects, via the Canal of Schlemm, to the venous system, where the aqueous humor is re-absorbed into the bloodstream. This fluid provides nutrition to the structure like lens, cornea which does not have their own blood supply. It is then absorbed into the bloodstream through the eye's drainage system. The production, flow, and drainage of this fluid is an active continuous process that is needed for the health of the eye. The Fluid or aqueous humor inside is different than tears. Tears are produced by glands outside the eye and moisten the outer surface of the eyeball. The tears production has no relation to glaucoma.



The eye is a globe and needs to maintain a level of pressure (intraocular pressure) to maintain proper function. Intraocular pressure (eye pressure) is dependent on the production of aqueous humor and resistance to aqueous humor outflow through the trabecular meshwork. If your eye's drainage system is working properly than fluid can drain out and prevent a buildup. Likewise, if your eye's fluid system is working properly, then the right amount of fluid will be produced for a healthy eye. IOP can vary at different times of the day, but it normally stays within a range (10 mm Hg to 21 mm Hg) that the eye can withstand.

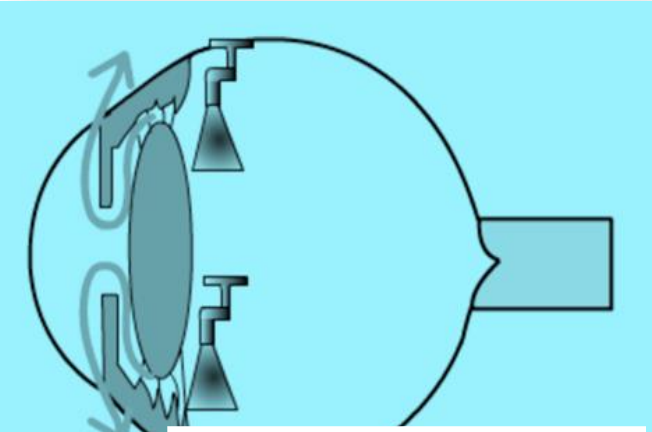


Figure shows normal Aqueous inflow and drainage; this balance maintains the normal eye pressure (IOP)

In the past, the level of the intraocular pressure was used to define and diagnose glaucoma. However, in recent decades, it has been recognized that many individuals with glaucomatous optic nerve damage lack elevation of the intraocular pressure. Therefore, intraocular pressure is now considered one of the many risk factors for the development of optic nerve damage. Measurement of intraocular pressure (tonometry) is possible by a variety of techniques, the most accurate of which uses a slit lamp and applanation device. Measurement of the intraocular pressure is used by the ophthalmologist to monitor the adequacy of intraocular pressure-lowering medications. Intraocular pressure above 21 mmHg is considered suspicious and may be a precursor to the development of glaucoma.

Finally, the innermost coat of eye is **Retina**, lining the inside of the eye, which is sensitive to light and receives stimulation to its specialized cells. About 1 million small individual thread-like nerve fibers exits from the retina and bend about 90 degrees to form the optic nerve. Optic nerve carries visual information from the eye to the brain. The part of optic nerve visible on retina is known as the optic nerve head. Normally, there is a small crater-like depression seen at the front of the optic nerve head. This depression is known as the cup. Its diameter is smaller than the diameter of the optic nerve head. In glaucoma, cup increases in size as damage increases. Glaucoma can cause the cup to enlarge (actually little nerve fibers are being wiped out along the rim of the optic nerve in glaucoma). To discern whether a large cup is glaucomatous or normal requires the doctor to pay close attention to the rim of the nerve. Glaucoma damages the optic nerve fibres (the “wires” in the cable) causing blind spots to develop in areas of vision. People seldom notice these blind areas in the side vision until considerable optic nerve damage has occurred. If the entire Optic nerve is destroyed, blindness results. Fortunately this rarely occurs if glaucoma is diagnosed and treated before major damage has taken place. Unfortunately if diagnosis if delayed, permanent and irreversible optic nerve damage takes place which leads to loss of vision.

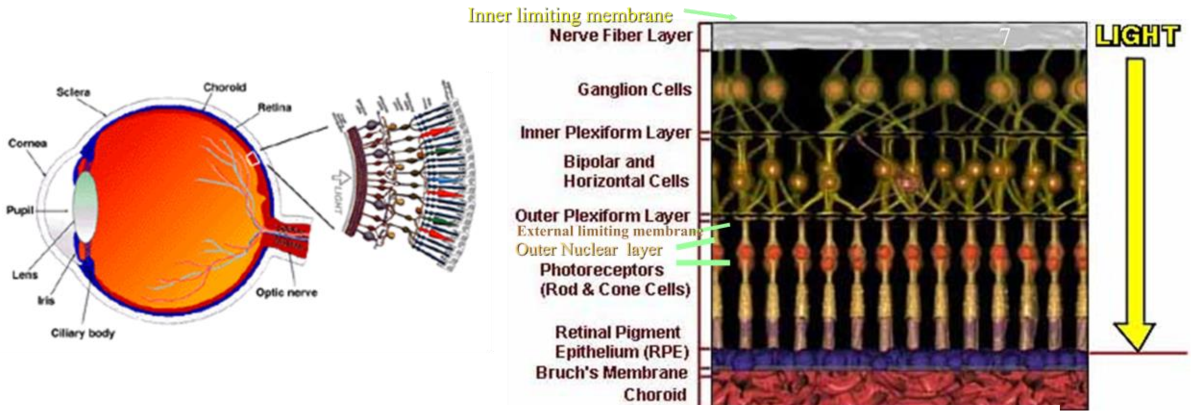
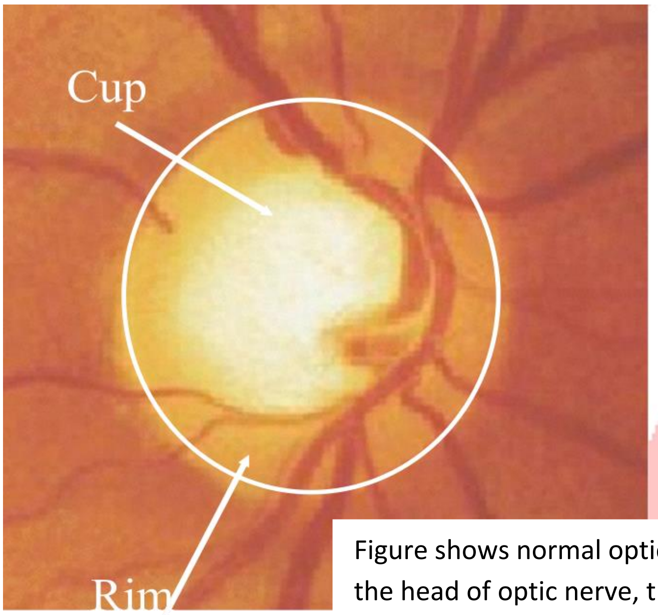


Figure shows Normal Retina; right image shows all 10 layers of Retina

What is the Optic Nerve?

A characteristic deterioration of the optic nerve associated with cupping and atrophy is the common denominator of all forms of glaucoma (primary or secondary, open or closed angle, chronic or acute). Atrophy of the optic nerve is the primary cause of permanent visual loss in glaucoma. Because of the ready visibility of the anterior optic nerve with any ophthalmoscope, recognition of the early signs of glaucomatous optic neuropathy becomes the single most useful clinical tool for glaucoma screening. With the ophthalmoscope and visualization of the optic nerve head, recognition of the glaucomatous optic nerve is not difficult. The circular optic disc border is visualized as the junction between the nerve head and the surrounding retina.

The optic nerve is primarily composed of the axons (the retinal nerve fibers) from the retinal ganglion cells and acts as the connection between the retina and the brain. The optic nerve head represents the perpendicular transition of the retinal nerve fibers from the surface of the retina to the optic nerve as they exit the eye. The normal, healthy optic nerve is composed of approximately 1.2 to 1.5 million neurons or fibers. With advancing age, there is often some atrophy of the tissue surrounding the optic nerve that gives a pale halo around the disc edge and provides an obvious visual separation of the retina and the optic disc tissue. The neural tissue of the disc has an orange-pinkish hue and has a full, slightly elevated appearance, with a relatively distinct border at the disc edge. Centrally, the orange-pink neural tissue gradually gives way to a yellow-whitish central zone or optic disc cup that is slightly more excavated than the surrounding neural tissue. This renders a bagel-like or doughnut-like appearance to the nerve head, with the neural tissue or neural "rim" surrounding the central physiologic “cup.” The retinal vessels, arteries and veins, enter and exit the globe through the optic nerve in the area of the optic cup. In glaucoma, as the neural tissue atrophies, the central cup appears to enlarge due to the surrounding tissue loss. The ratio of the diameter of the cup to the total diameter of the disc (cup-disc ratio) is usually 0.3 or less, and greater than 0.5 should raise suspicion of glaucoma.



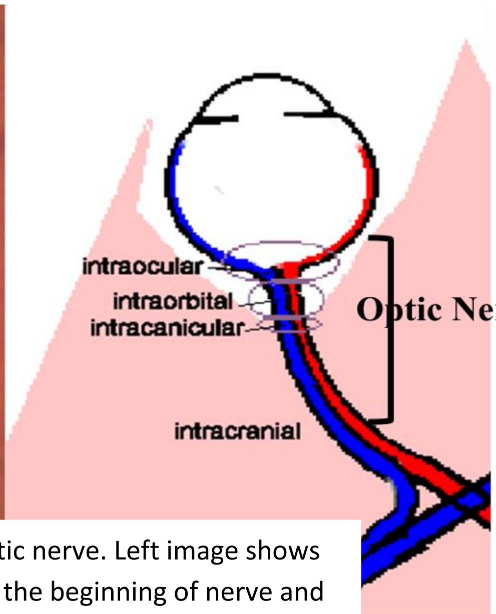


Figure shows normal optic nerve. Left image shows the head of optic nerve, the beginning of nerve and right image shows the entire optic nerve path

In addition to diffuse enlargement of the physiologic cup, focal thinning of the optic nerve rim is also very characteristic of glaucoma. Typically, the lower pole of the nerve head shows a focal loss of the neural rim earlier than the superior pole of the optic nerve; this results in a concomitant defect in the upper visual field. Small, "flame-shaped" hemorrhages at the disc edge are also often harbingers of advancing optic nerve damage and visual field loss and are quite characteristic of glaucomatous optic neuropathy.

As the central cup enlarges and the neural tissue of the optic nerve recedes, support for the retinal vessels traversing the disc disappears, and the vessels get pushed to the nasal, or inside, edge of the disc.