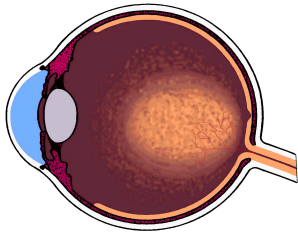




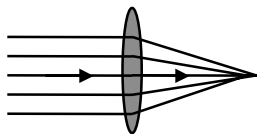
Just the Facts... Lasers and Their Effects on the Human Eye

➤ Eye Biology



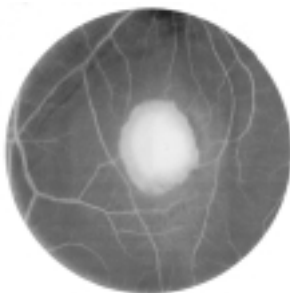
The Eye

➤ 1 to 100,000 Magnification



Property of the Eye

➤ Laser Damage



Laser Damage to the Retina of the Eye

Purpose.

To provide information and facts on the anatomy of the eye as it relates to laser eye exposure and the potential for laser eye injury.

Laser Effects on Visual Performance.

Figure 1 shows a soldier being exposed to a laser beam. Lasers may interfere with vision either temporarily or permanently in one or both eyes. At low-power levels, lasers may produce a temporary reduction in visual performance in critical military tasks, such as aiming weapons, driving a vehicle, or flying an aircraft. At high-power levels, greatly exceeding exposure limits, they may produce serious long-term visual loss or permanent blindness.

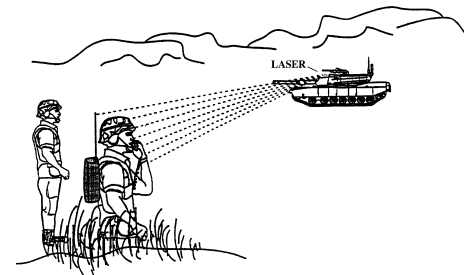


Figure 1

Anatomy of the Eye.

Figure 2 is a simple schematic of the eye. The following parts of the eye are important with regard to laser effects:

- The **Cornea**, a transparent front part of the eye, transmits most laser wavelengths except for far-ultraviolet and far-infrared radiation.
- The **Iris**, a pigmented diaphragm with an aperture (pupil) in its center, controls the amount of light entering the eye. During low-light conditions, such as in a dark room, visible and near-infrared lasers are slightly more dangerous since the pupil is larger than it would be in high-illumination conditions, such as in daylight.
- The **Lens**, a transparent structure located behind the pupil, which focuses light on the retina, allows visible and near-infrared energy to pass through while absorbing near-ultraviolet radiation.

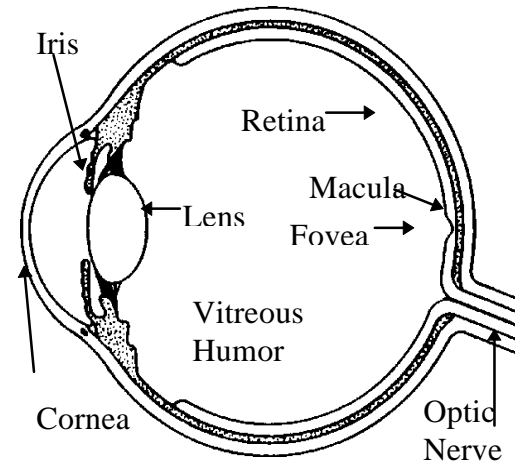


Figure 2

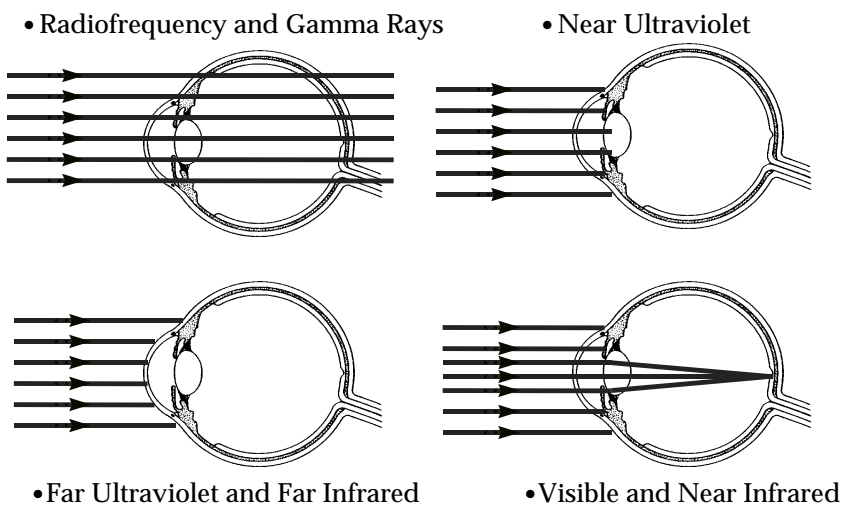


Figure 3

portions of the retinal periphery are involved). The retinal periphery is unable to detect small or distant objects or distinguish between fine shades of color. One of the primary functions of the retinal periphery is night vision. During bright conditions, the retinal periphery detects motion (peripheral vision).

- The **Macula**, the central 1.5 mm of the retina, which covers about 5° of the visual field, is the only part of the eye where precise vision takes place. The macula enables the location of small and distant targets and the detection of colors.
- The **Fovea**, located in the center of the macula, is the central part of the macula with the highest visual acuity. The visual precision of the fovea is high enough in humans to allow them to read. If the fovea is damaged, the person experiences severe loss of vision. The degree of the impairment will depend upon both the location and the extent of the injury and the inflammatory response. In general, the closer the injury to the center of the fovea, the greater the chance of severe dysfunction.

Laser Wavelength and the Eye's Response.

Figure 3 is a diagram of absorption of radiation in the eye.

- **Ultraviolet.** Lasers operating in the ultraviolet spectrum (below 400 nm) are absorbed in the anterior segments of the eye, primarily by the cornea, as well as by the lens.
- **Visible.** Laser radiation in the visible region of the spectrum (400-780 nm) is absorbed primarily within the retina. An ideal eye can focus a collimated visible beam by as much as 100,000 times.
- **Near Infrared.** Laser radiation in the near-infrared region of the spectrum (700-1400 nm) is absorbed primarily within the retina. An ideal eye can focus a collimated near-infrared beam by as much as 100,000 times. This portion of the spectrum is a very dangerous area. The eye will focus the energy, but it is not visible and thus creates a very dangerous situation.
- **Far Infrared.** Laser radiation in the far-infrared region of the spectrum (1400+ nm) primarily affects the cornea.

Questions?

Questions about lasers and laser safety can be referred to USACHPPM, Laser/Optical Radiation Program. Phone: DSN 584-3932 or Commercial (410) 671-3932.

References.

- FM 8-50, August 1990, *Prevention and Medical Management of Laser Injuries.*
- TB MED 524, June 1985, *Occupational and Environmental Health, Control of Hazards From Laser Radiation.*
- *Safety with Lasers and Other Optical Sources, A Comprehensive Handbook,* Sliney and Wolbarsht. New York: Plenum Press, 1981.
- *Vision,* Buser and Imbert. MIT Press, 1992.

- The **Vitreous Humor**, a jelly-like substance, which fills the volume of the eye between the lens and the retina, is transparent to both visible and near-infrared radiation.
- The **Retina**, the back of the inside of the eye where images are formed, has a high concentration of photoreceptor cells. During laser exposure, no extended image is formed, and all the energy is simply focused to a pinpoint. A laser exposure occurring in the retinal periphery, (the area surrounding, but not including, the macula) will have a minimal effect on normal visual functions (unless large