



Overview of Ophthalmic Equipment and Support Systems for Ophthalmology

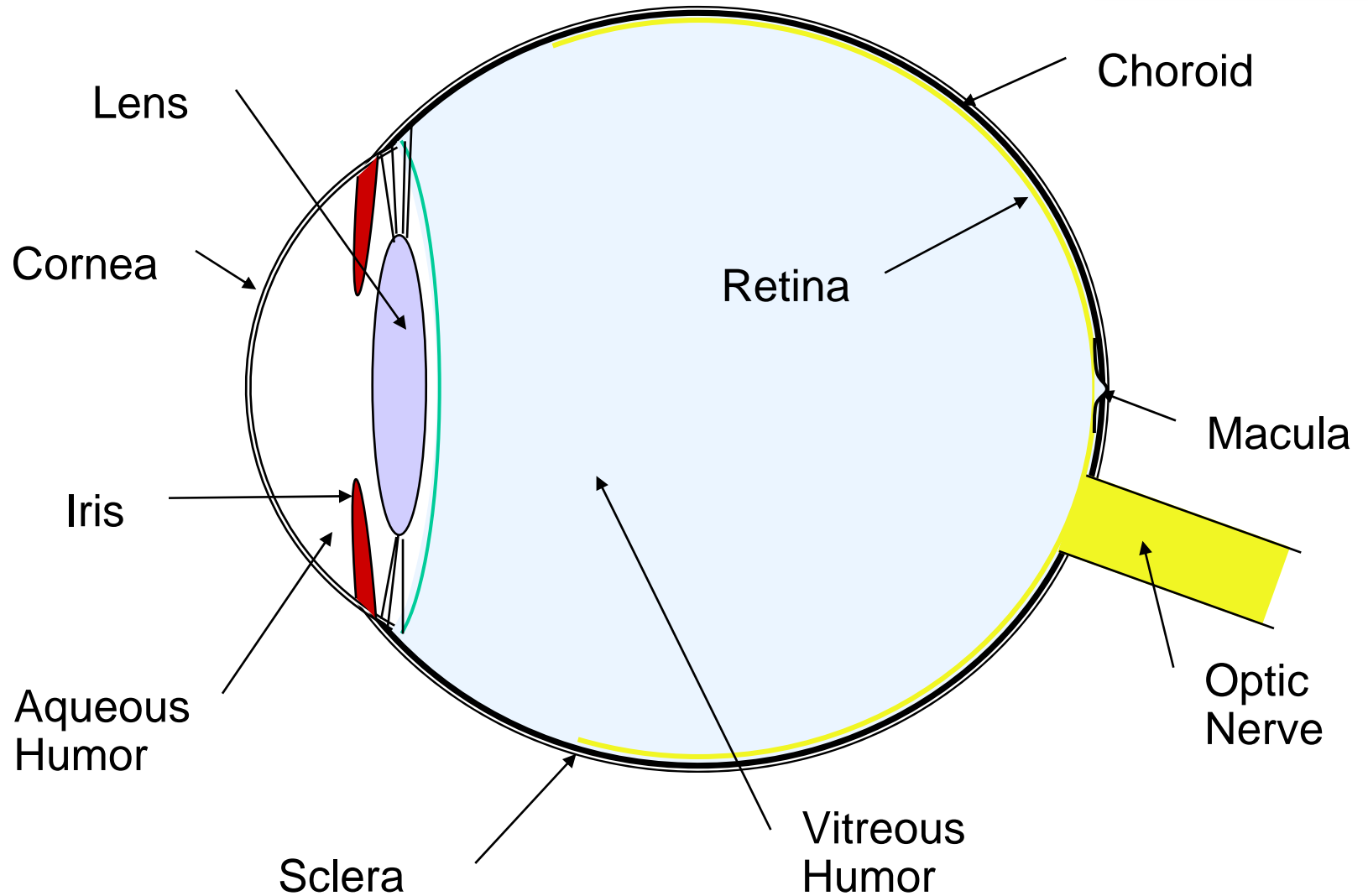
Health Care Technology Unit
ORBIS DC-10 Flying Eye Hospital

Introduction



- Eye anatomy and common diseases
- Diagnostic instruments
- Therapeutic instruments
- Additional ophthalmic instruments
- Support systems for Ophthalmology

Anatomy of the Eye



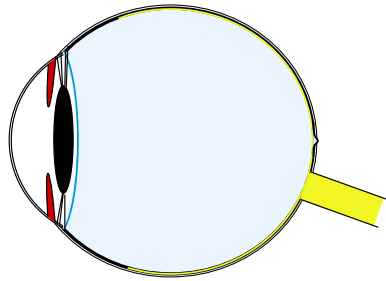
Key anatomy of



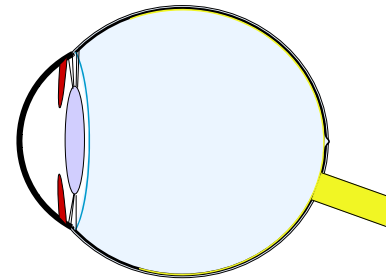
- **Cornea:** protective outer layer, triggers blink reflex, tear duct secretion, and 2/3 of total refraction.
- **Aqueous Humor:** clear fluid behind the cornea.
- **Iris:** (pupil) constricts and dilates
- **Retina:** coats the back of the eye, image sensor
- **Lens:** flexible, transparent, provides 1/3 refraction that focuses an image on the retina.
- **Vitreous Humor:** semi-gelatinous material filling the volume between the lens and the retina.

Six sub-specialties of ophthalmology

1. Cornea & Cataract

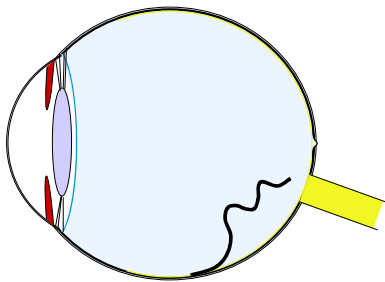


Cataract

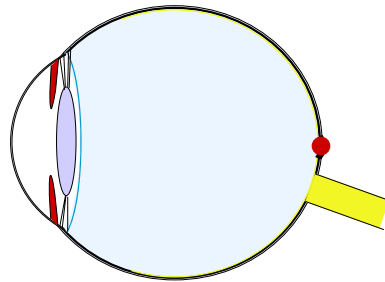


Corneal Diseases

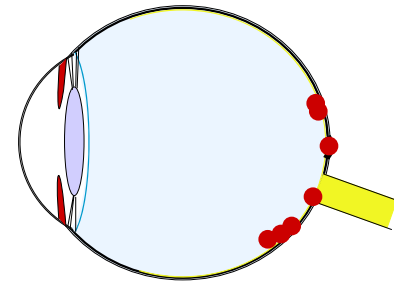
2. Retina & Vitreous



Retinal Detachment



Macular Diseases

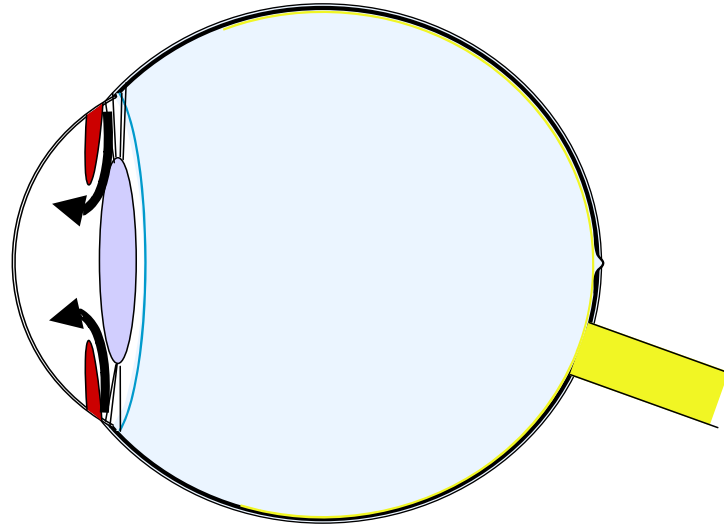


Diabetic Retinopathy

Six sub-specialties of ophthalmology



3. Glaucoma



4. Oculoplastics (trauma, birth defects, tumors, cosmetics)

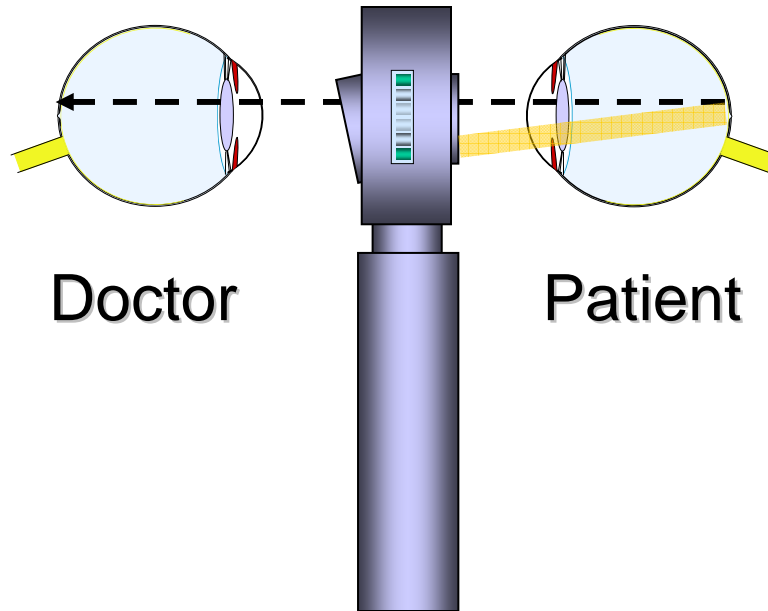
5. Pediatrics & Strabismus



6. Neuro-ophthalmology (optic disk, optic nerve, brain)

Optical tools to view the eye

Direct Ophthalmoscope



Optical tools to view the eye



- View provided by the direct ophthalmoscope:
 - monocular;
 - non-stereoscopic (2D);
 - narrow field (5°);
 - magnified about 15X.



Optical tools to view the eye



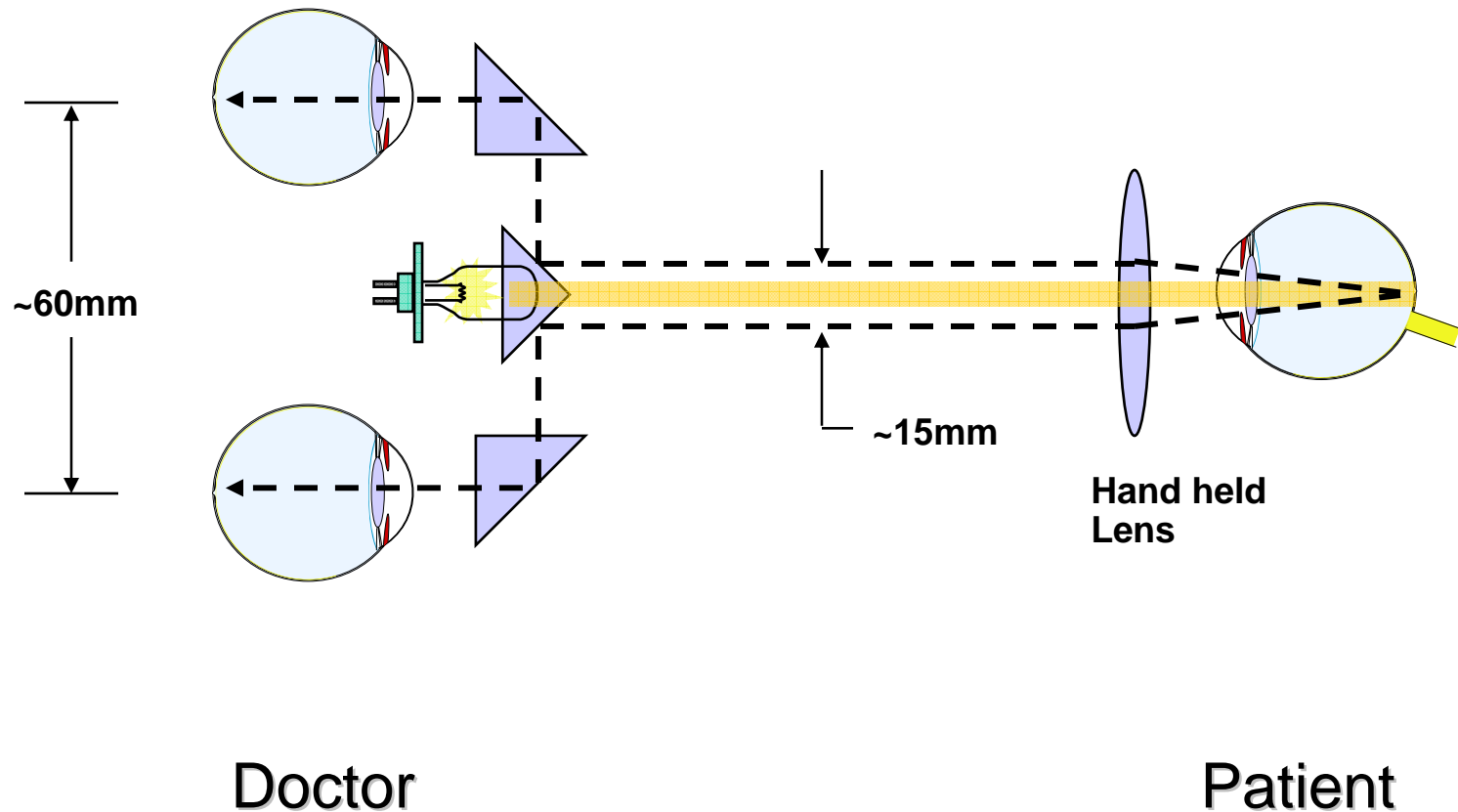
Binocular Indirect Ophthalmoscope (BIO)



Optical tools to view the eye



Binocular Indirect Ophthalmoscope (BIO)



Optical tools to view the eye

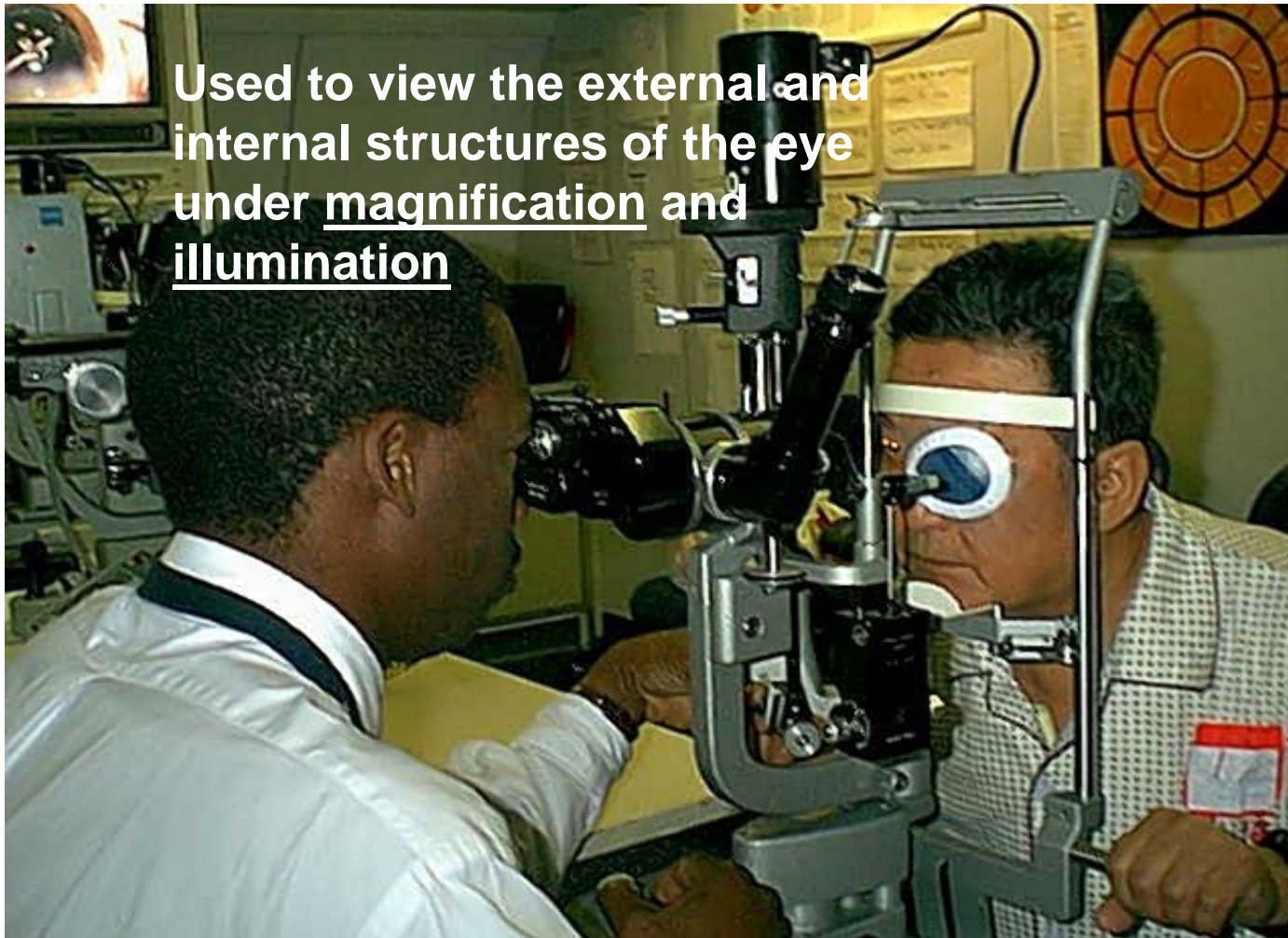


Binocular Indirect Ophthalmoscope (BIO)

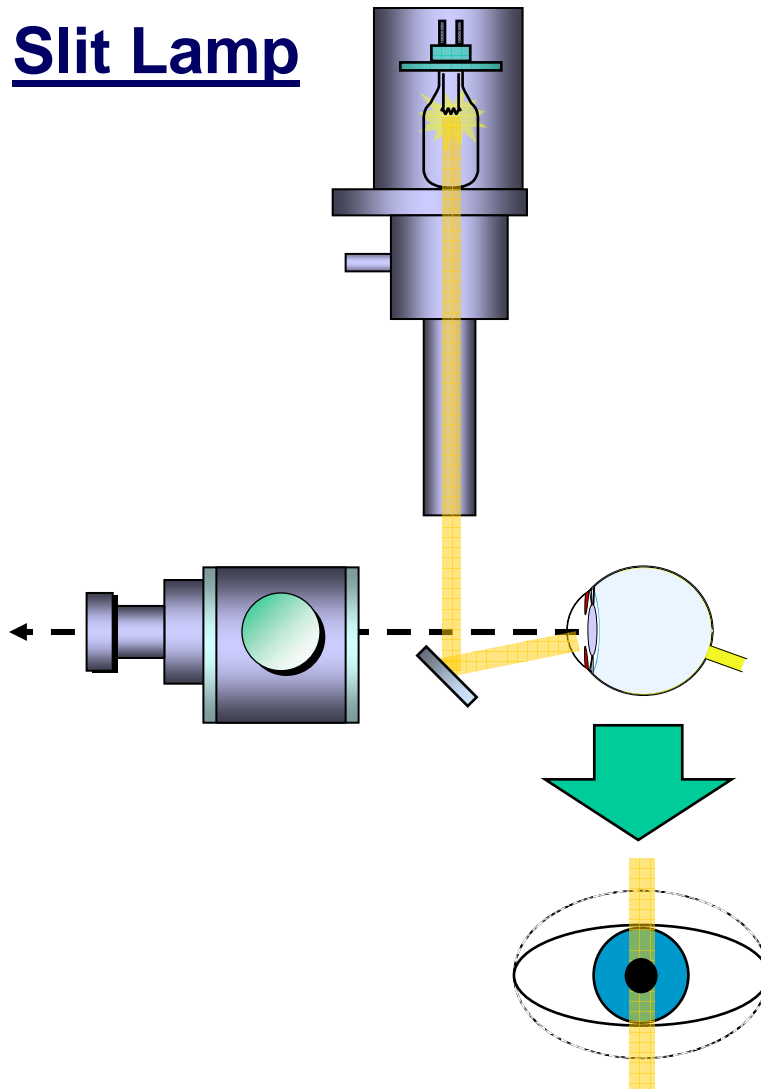
- Instrument of choice for retinal examinations.
- Used in conjunction with a condensing aspheric lens held close to the patient's eye.
- BIO provides:
 - a much wider field of view (45°) than a direct ophthalmoscope;
 - permits viewing of almost all the patient's retina;
 - stereoscopic view (3D);
 - inverted;
 - illuminated with magnification of about 5X.
- Some BIOs have a built-in video camera to permit eye care professionals in-training to view the examination on a video monitor.

Optical tools to view the eye

Slit Lamp

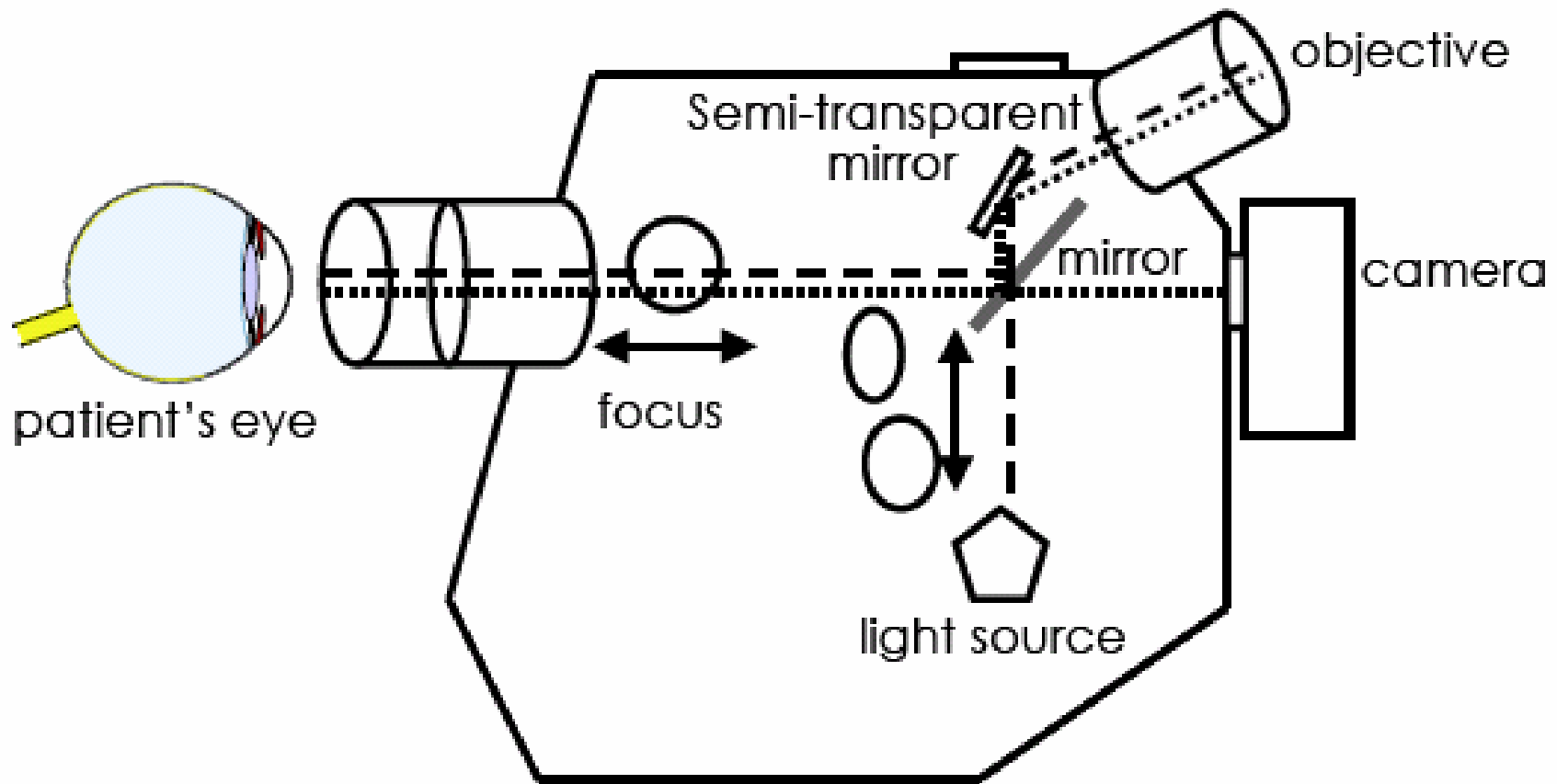


Optical tools to view the eye



Optical tools to view the eye

Fundus camera, retinal camera



Optical tools to view the eye



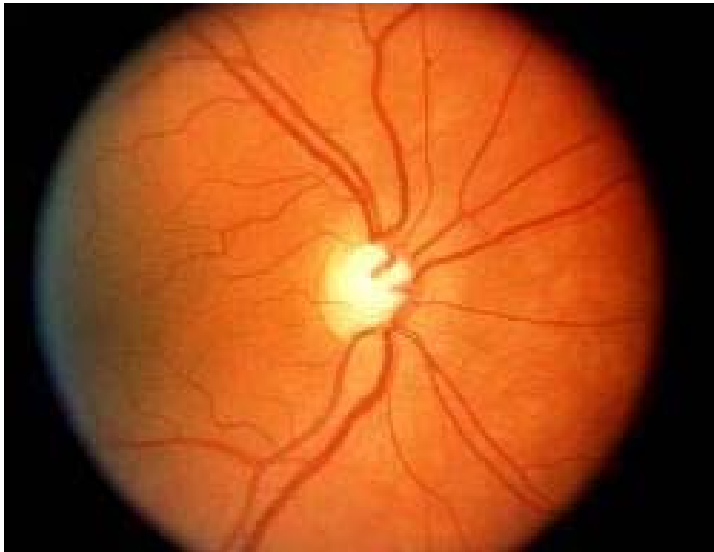
Fundus camera, retinal camera

- Specialized low power microscope with an attached camera, designed for taking pictures of the back of the eye, or fundus.
- Often used in fluorescein angiography:
 - fluorescein dye is injected into a patient to reveal retinal circulation.
- Digital fundus cameras can be interfaced with a computer for storage of the retinal images as graphic files:
 - files can be archived, edited, printed or sent to other eye care specialists through a local area network or over the World Wide Web.

Optical tools to view the eye

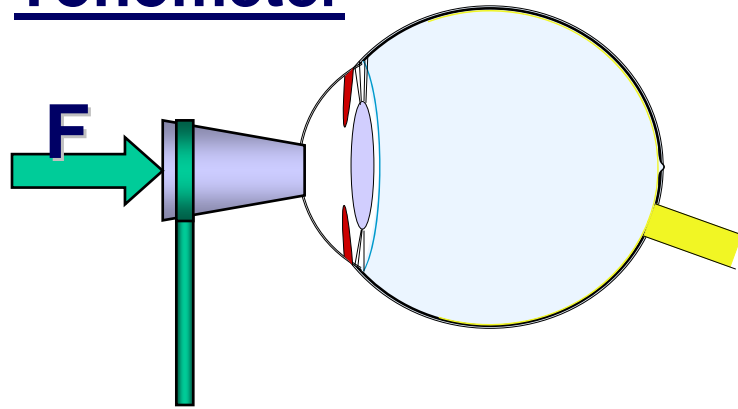


Fundus camera, retinal camera



Diagnostic tools for quantitative measurements

Tonometer



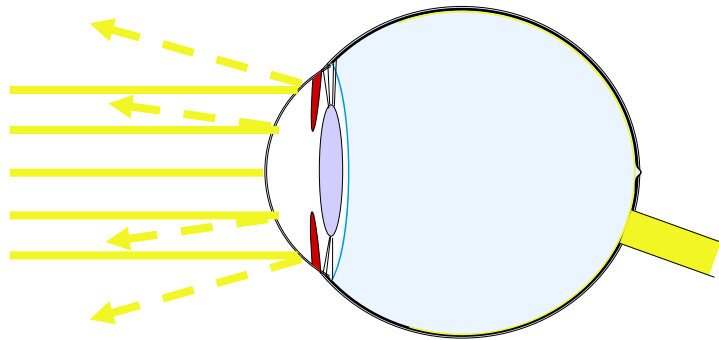
$F \sim IOP$



- Applanation: Measures the force that is required to flatten the cornea in mmHg.
- Non-contact: A soft puff of air is directed to the patient's eye and the resulting corneal deformity is measured and converted to pressure.
- Schiotz: A footplate that is placed on the cornea and a central movable plunger that is fitted into a barrel. Attached to the plunger is a needle and scale for measurement.

Diagnostic tools for quantitative measurements

Keratometer



- Measures the curvature of the anterior central zone of the cornea (K readings, in millimeters radius of curvature or in diopters);
- K readings are used for fitting contact lenses, evaluating corneal astigmatism and for calculating intraocular lens (IOL) power.

Diagnostic tools for quantitative measurements

Phoropter, refractor

- Can reproduce virtually any possible optical correction.
- Measures the curvature of the anterior central zone of the cornea (K readings, in millimeters radius of curvature or in diopters);
- K readings are used for fitting contact lenses, evaluating corneal astigmatism and for calculating intraocular lens (IOL) power.

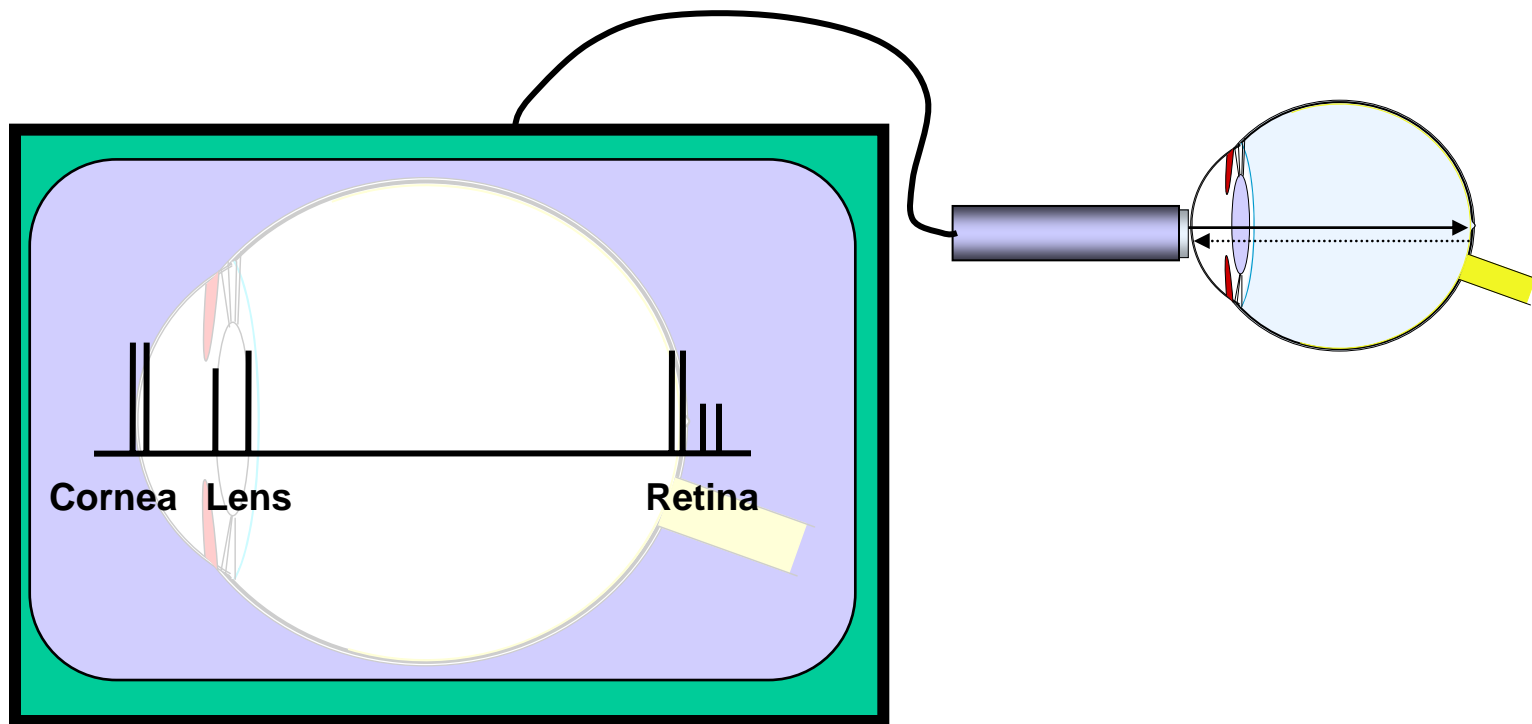


Ultrasound can provide quantitative and qualitative information about the eye



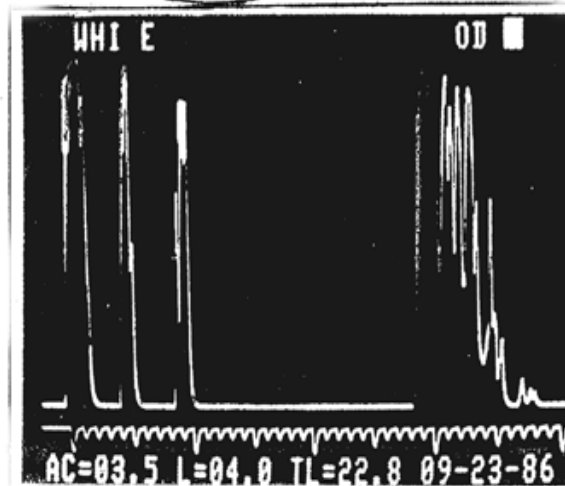
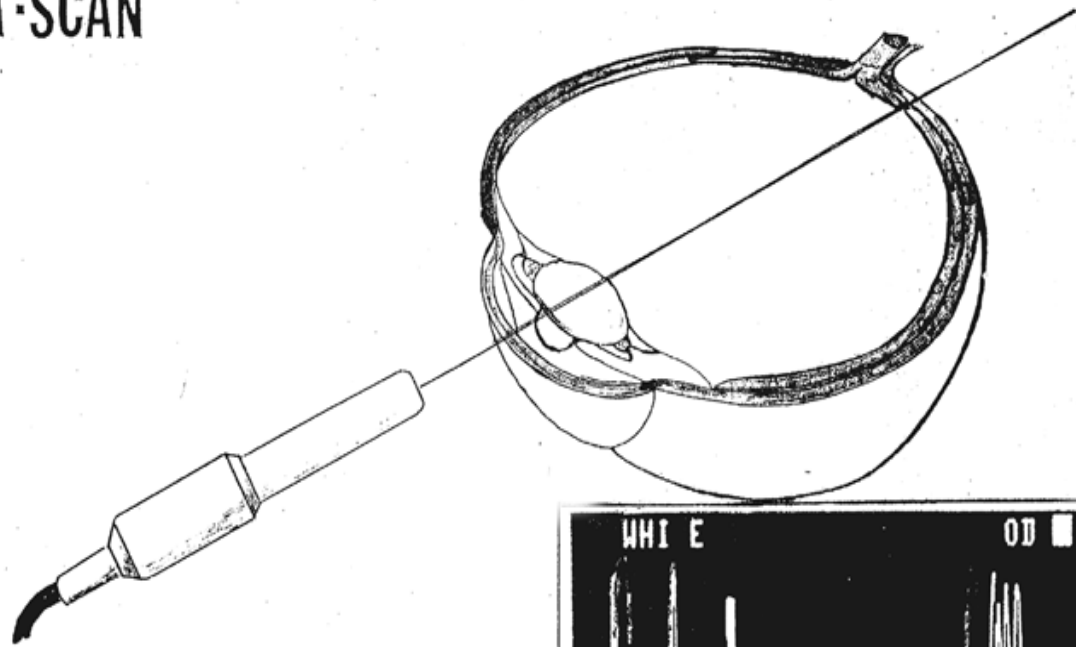
A-scan

- Ultrasonic waves are reflected at interfaces
- A-scans give accurate quantitative measurements

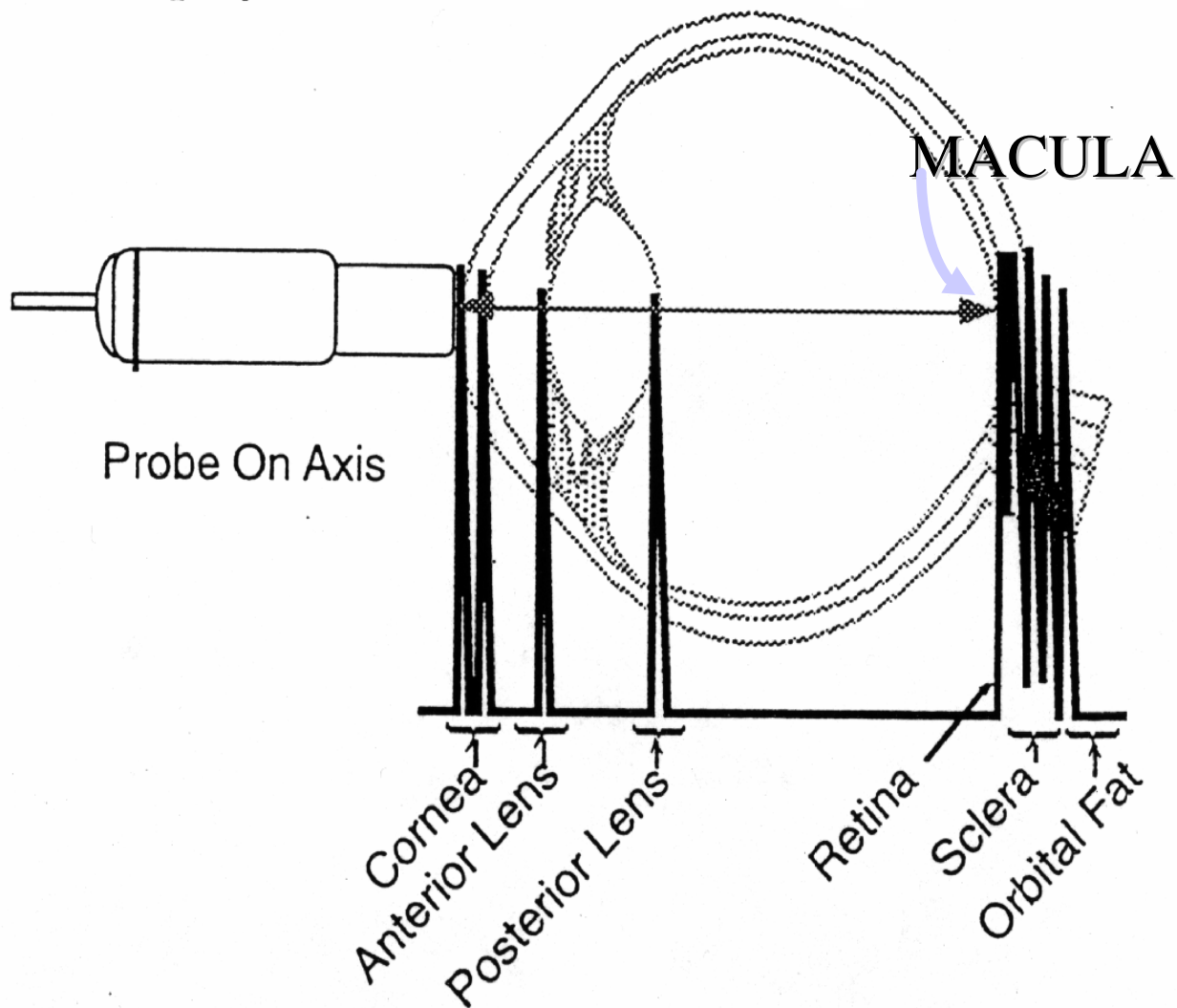


A MODE

A-SCAN



Probe on axis

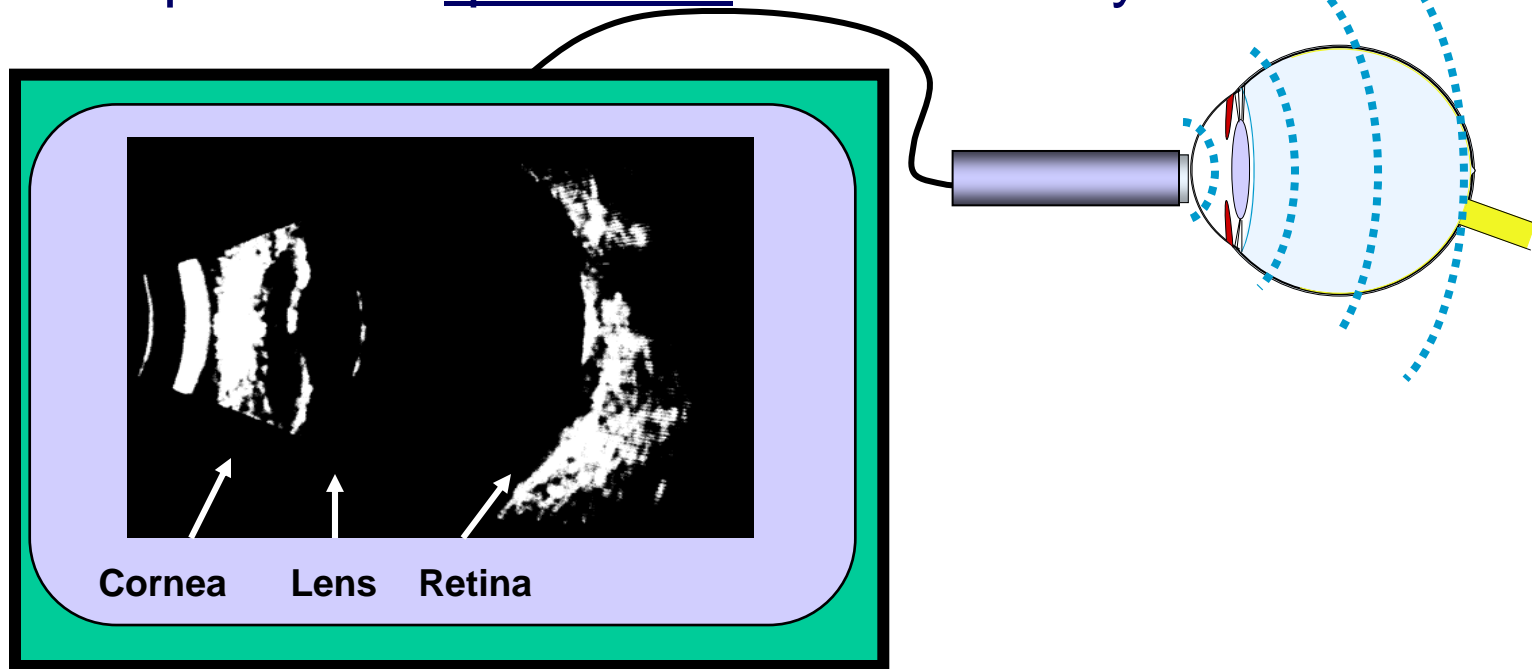


Ultrasound can provide quantitative and qualitative information about the eye



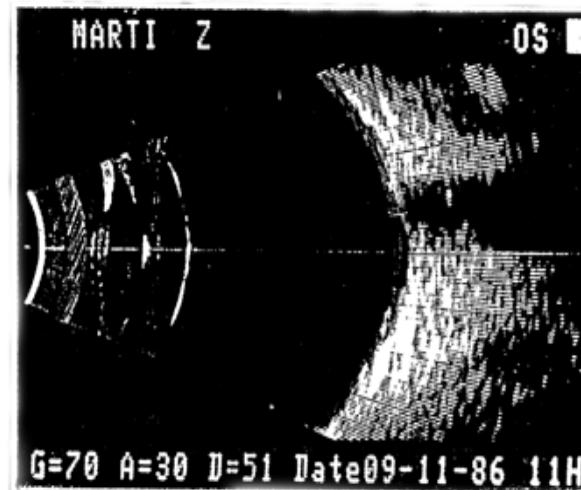
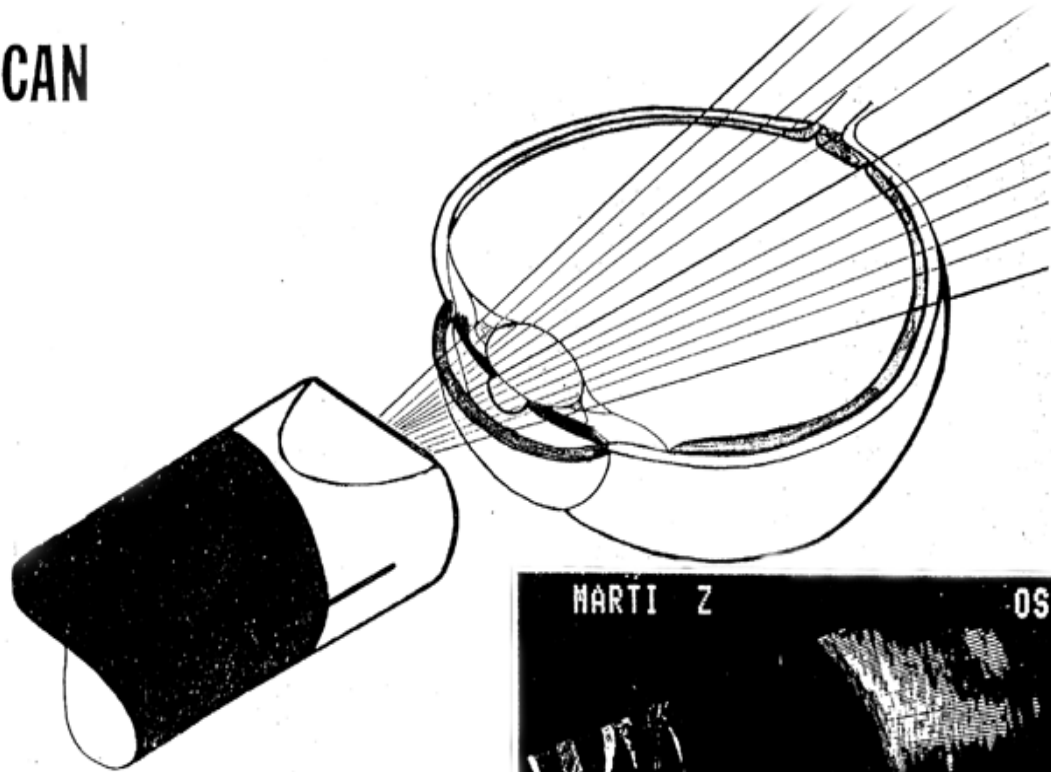
B-scan

- B-scans have a moving transducer which scans in 2 dimensions
- B-scans provide a qualitative view of the eye

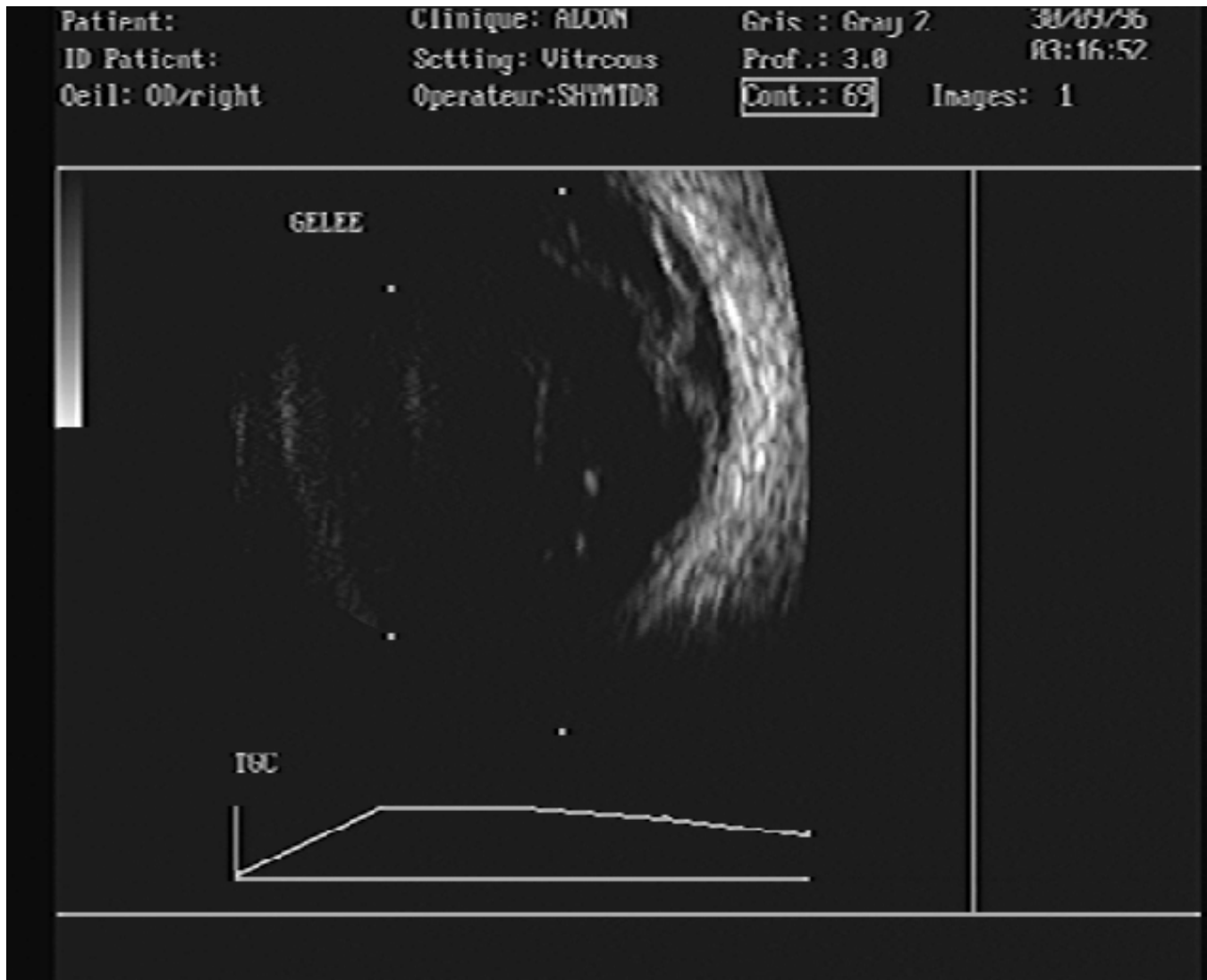


B MODE

B-SCAN



Example: Retinal detachment

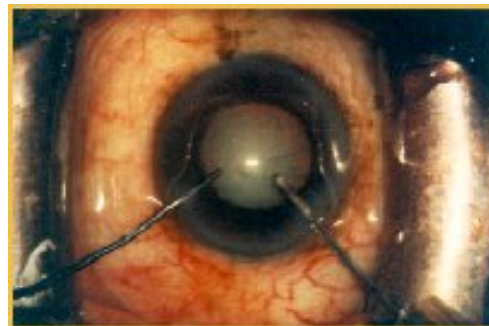
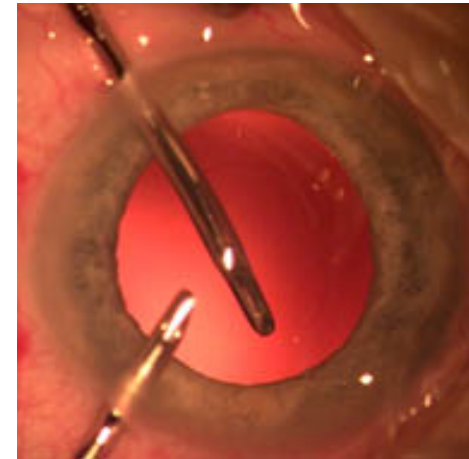


THE ULTRASONIC EXAMINATION OF THE EYE

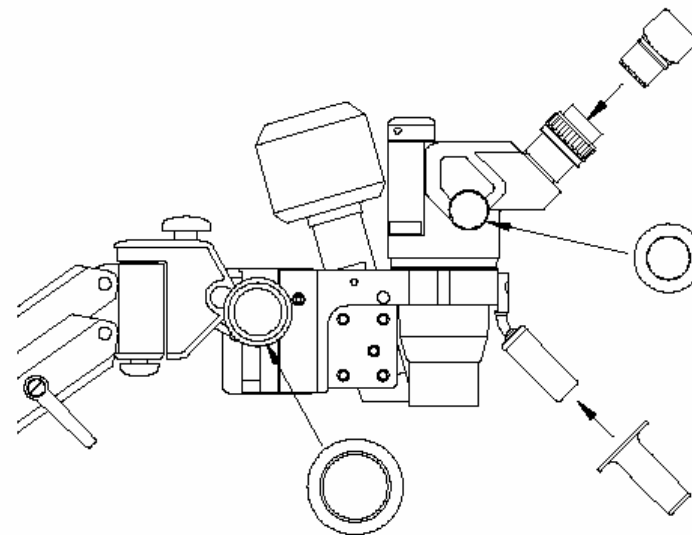


- **Topographic analysis:** **B mode (Brightness)**
- **Quantitative analysis:** **A mode (Amplitude)
Biometry**
- **Kinetic analysis:** **B Mode and/or Doppler**

Operating Microscopes allow Microsurgery on Exterior and Interior of the Eye



Operating Microscopes



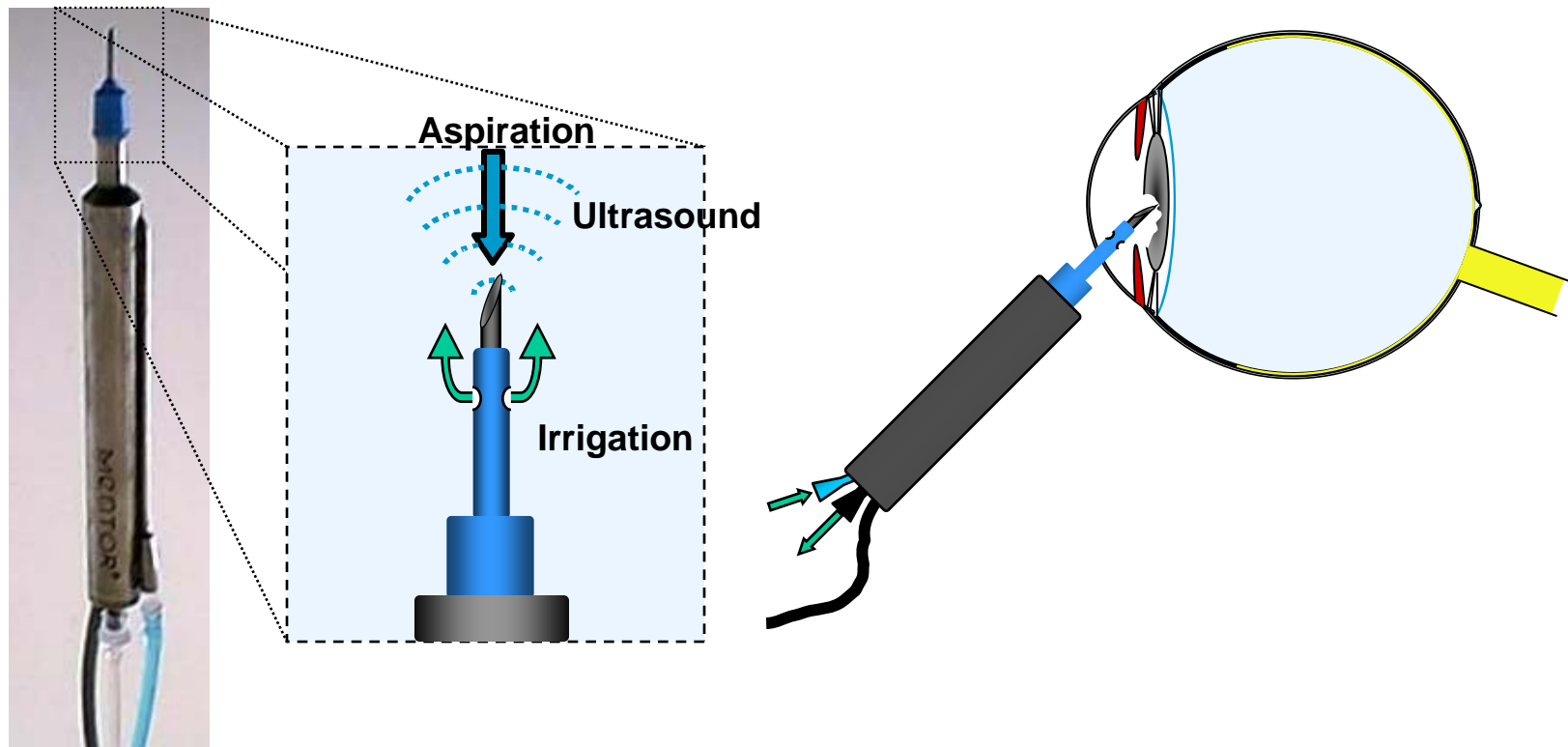
Operating Microscopes



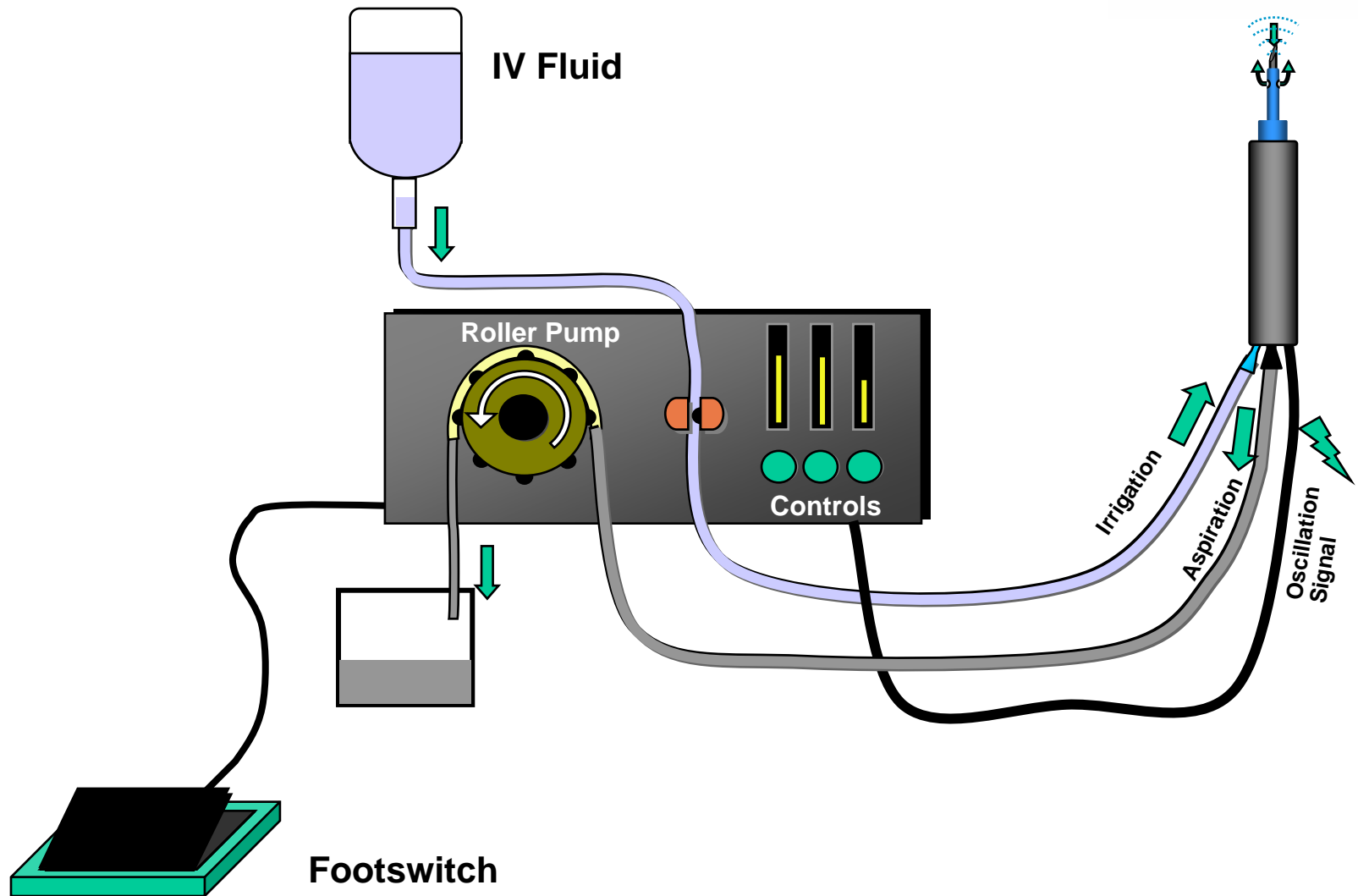
- Utilized for procedures that require high magnification and variable focusing.
- Light from a halogen light source is directed into the tube through prisms or fiber optic cables and shines through the objective lens onto the operating field.
- Magnification of the eyepieces is typically 8X to 20X.
- The typical focal length (working distance) of objective lenses for eye surgery using a 12.5X eyepiece is 175 to 200 mm

Phacoemulsification

- Ultrasonic energy (25 - 80Khz), is used to break up the opaque lens into smaller pieces that are then aspirated out of the eye.
- After the entire cataract is removed, an intraocular lens (IOL) is inserted in place of the eye's lens.



Phacoemulsification



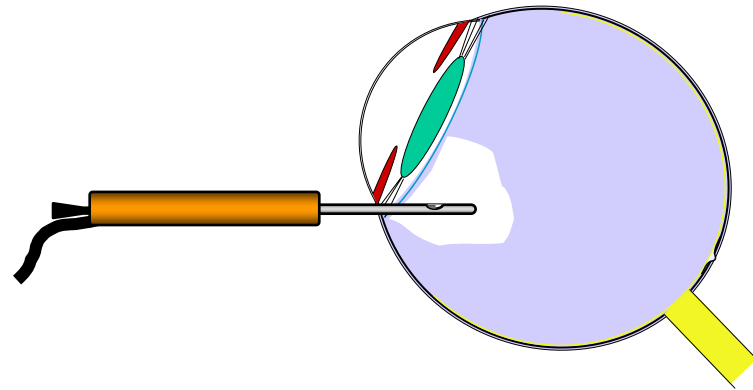
Vitrectomy



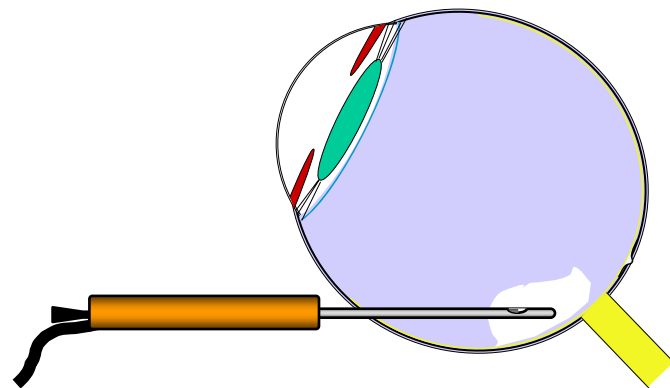
Vitrectomy



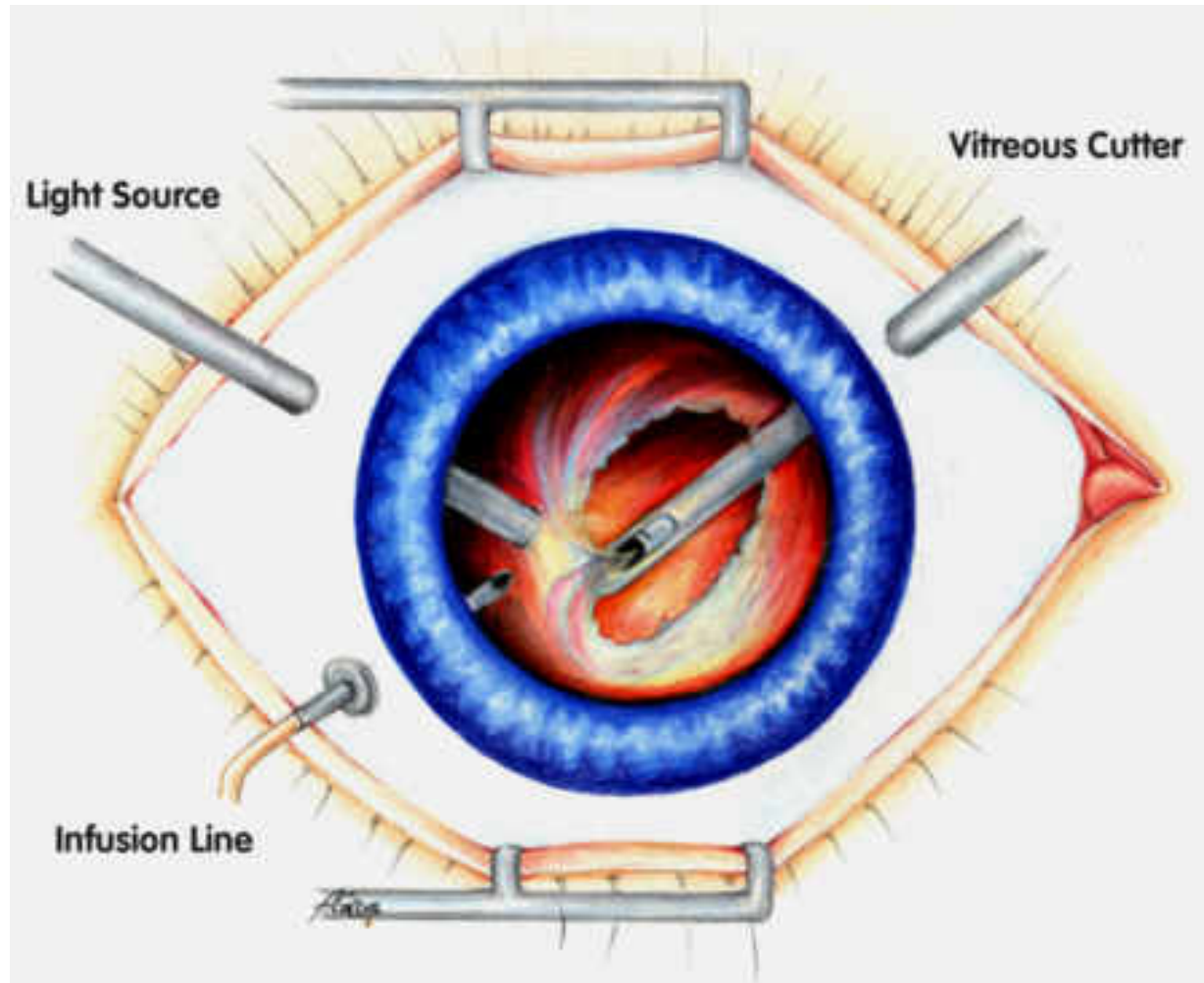
Anterior Vitrectomy



Posterior Vitrectomy



Vitrectomy



Cryo Surgical Units - CSU



Cryo Surgical Units - CSU



- CSU apply a refrigerant (cryogen) to withdraw heat from target tissue through contact with a cryogen-cooled probe.
- The effect is to freeze the surrounding tissue so that it dies.
- In the tissue immediately beyond the killed zone a degree of coagulation occurs thus limiting the resulting bleeding.
- Different types of interchangeable cryo probes are available for different applications.
- Cryogens in ophthalmology: Compressed nitrous oxide (N₂O) and carbon dioxide (CO₂).







Ophthalmic LASERs



Laser are used as therapeutic ophthalmic equipment



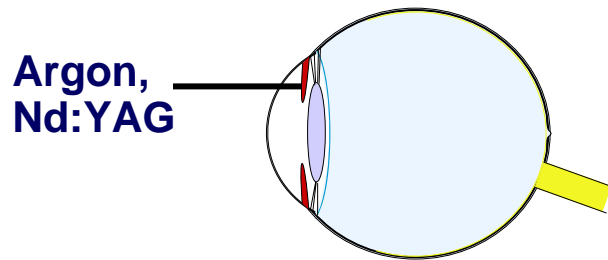
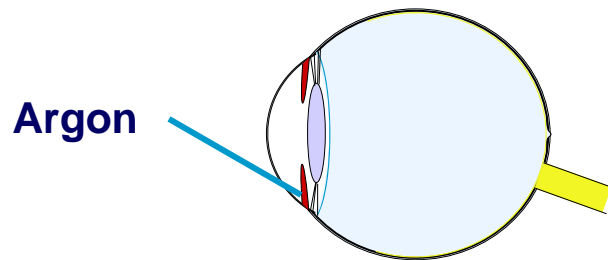
- Different laser have different properties and are used for different therapies

Argon		488, 515 nm blue/green
Nd:YAG		1064 nm infrared
Diode		810 nm infrared
Excimer		193 nm ultraviolet

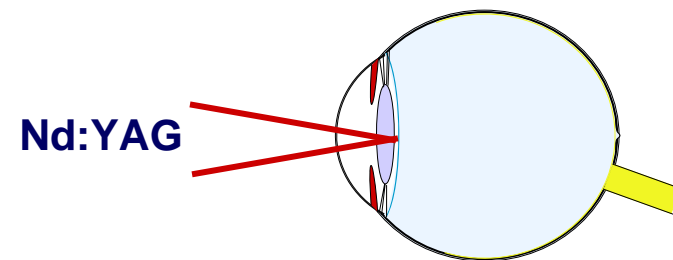
Lasers allow non-invasive surgery



Glaucoma



Cataract



Lasers allow non-invasive surgery



Retinal diseases

Argon
Or
Diode



Refractive correction

Excimer

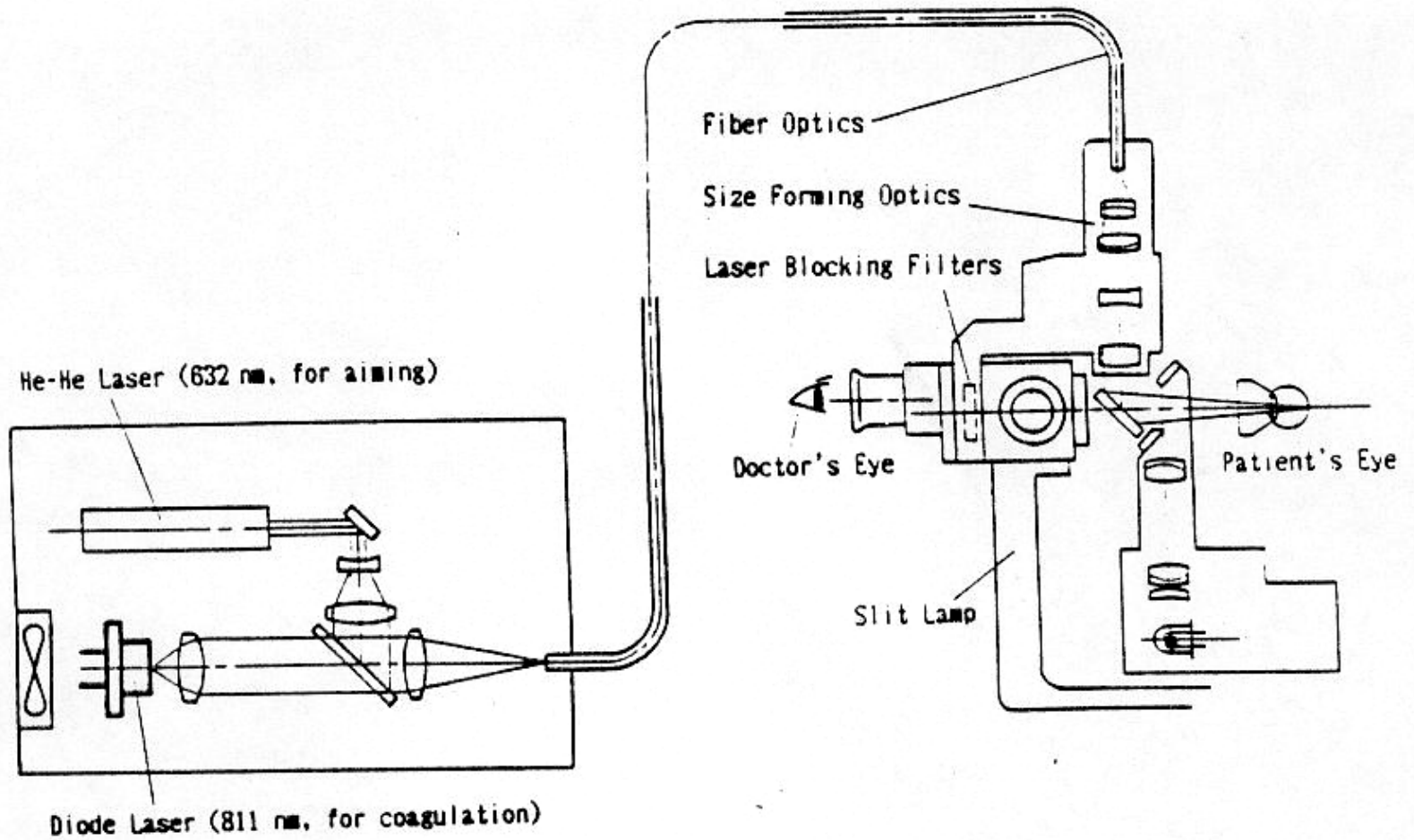


Laser Delivery systems

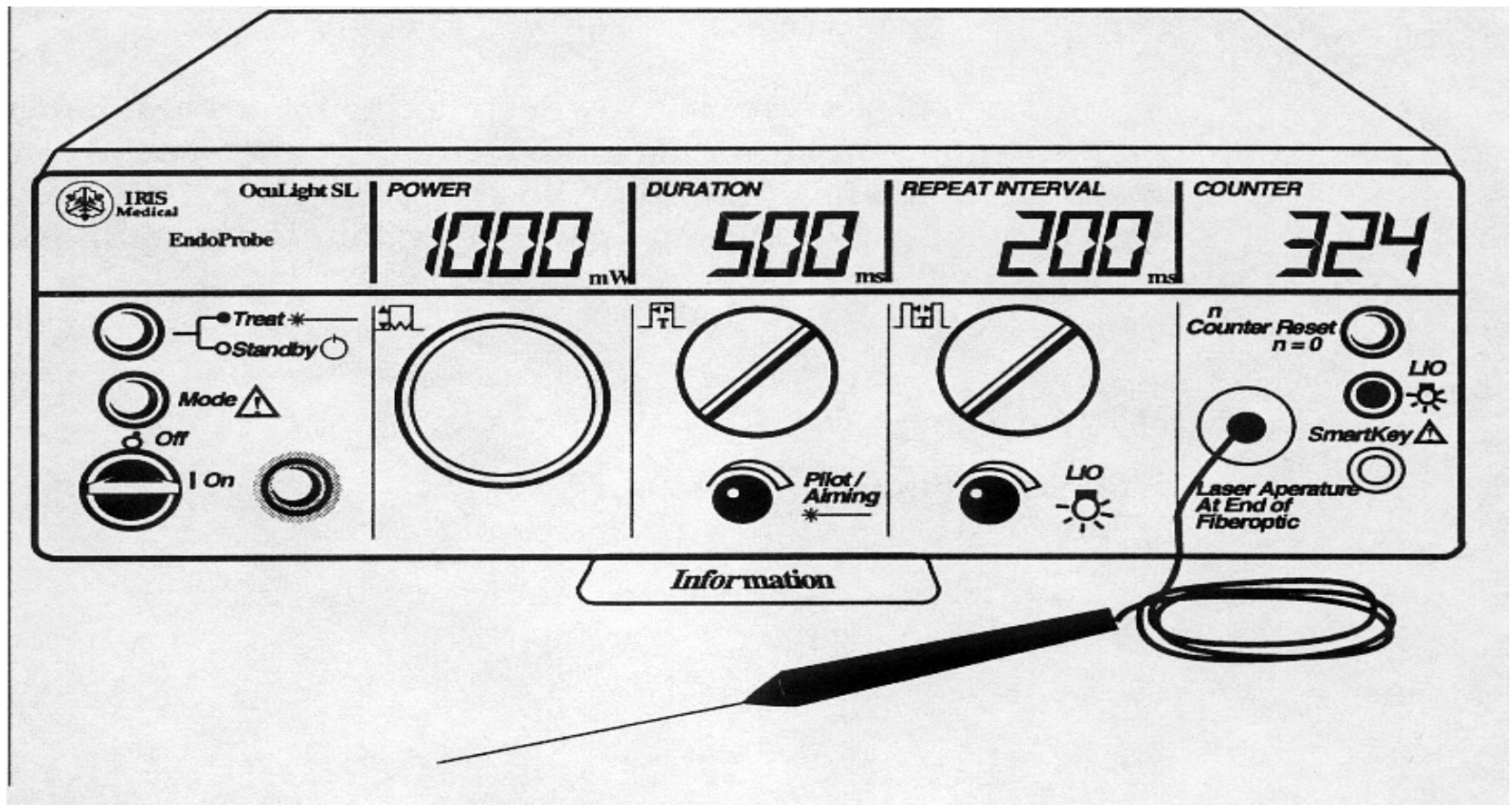


- Slit lamp
- Endoprobe
- Indirect ophthalmoscope
- Operating microscope

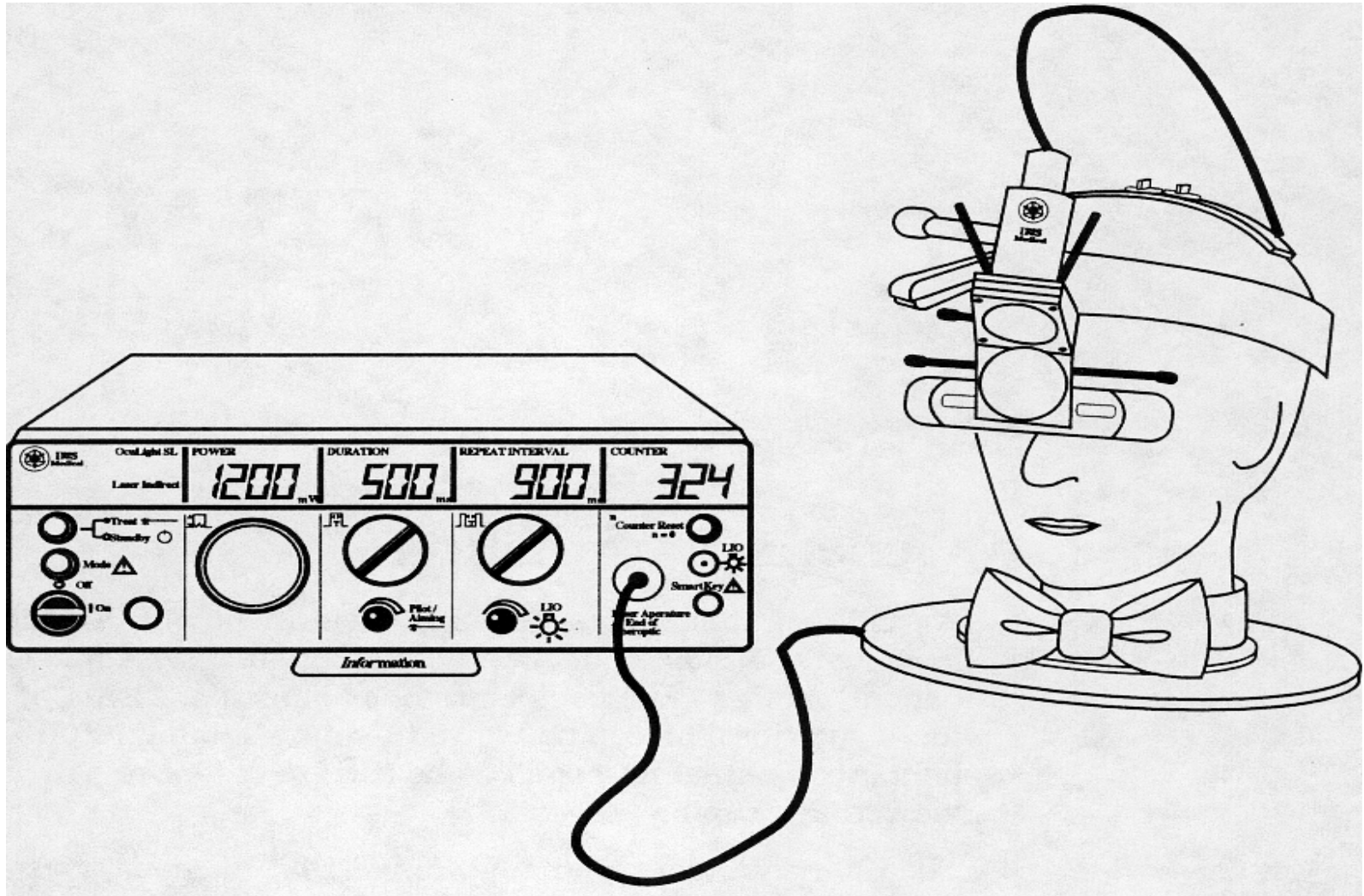
Diode Laser with Slit Lamp



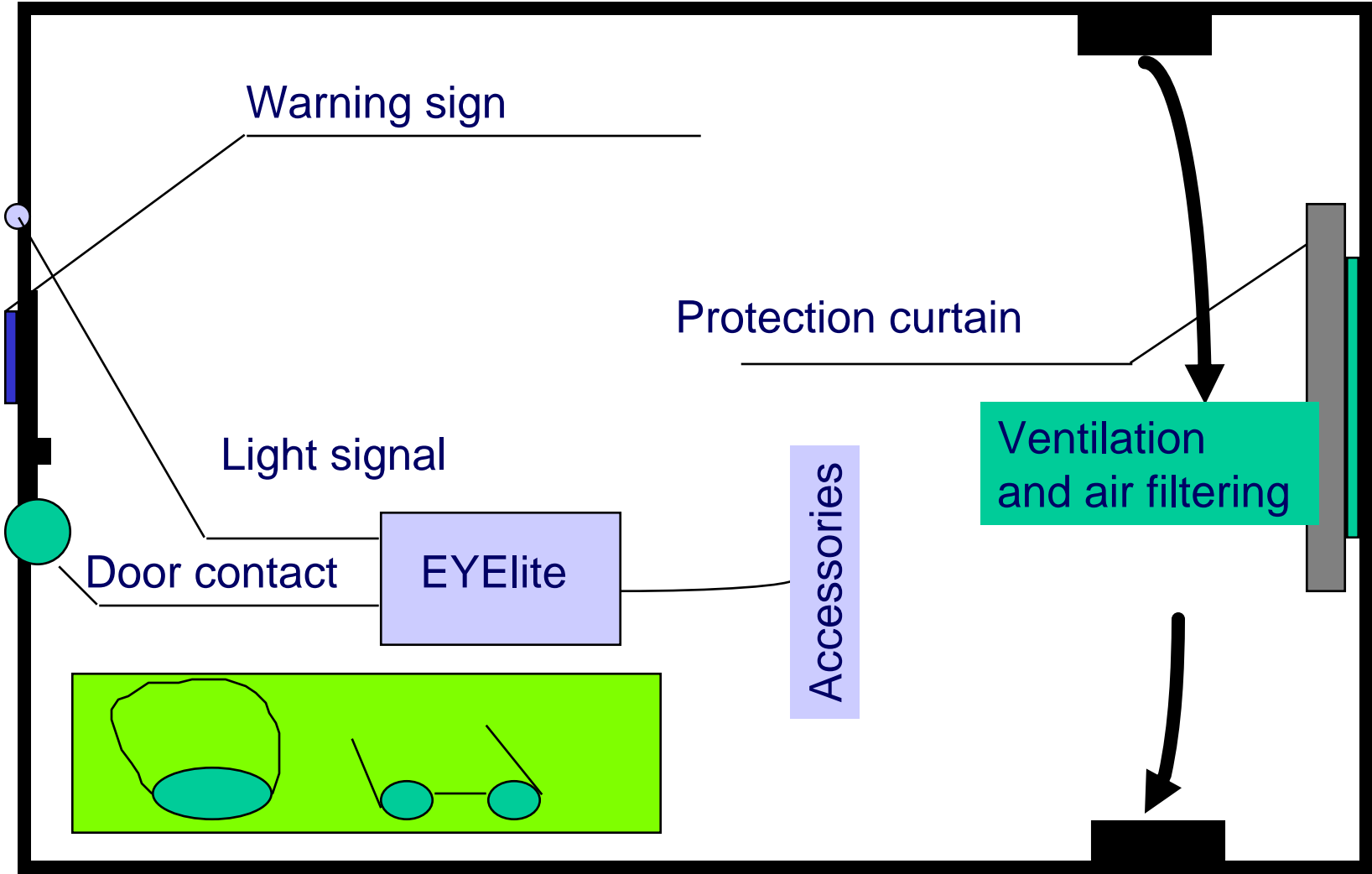
Diode Laser with Endoprobe



Diode Laser with Indirect Ophthalmoscope



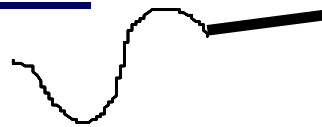
LASER SAFETY



Bioengineered operating room supplies



sutures

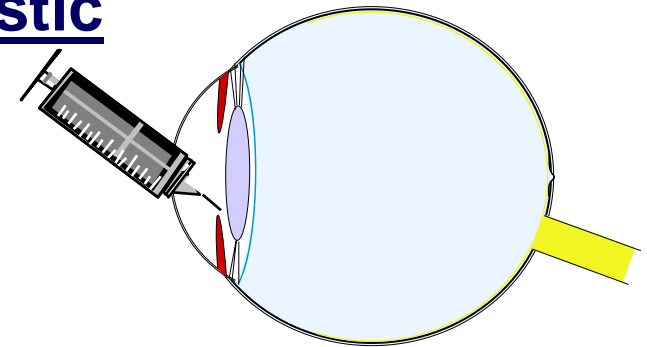


biodegradable

viscoelastic

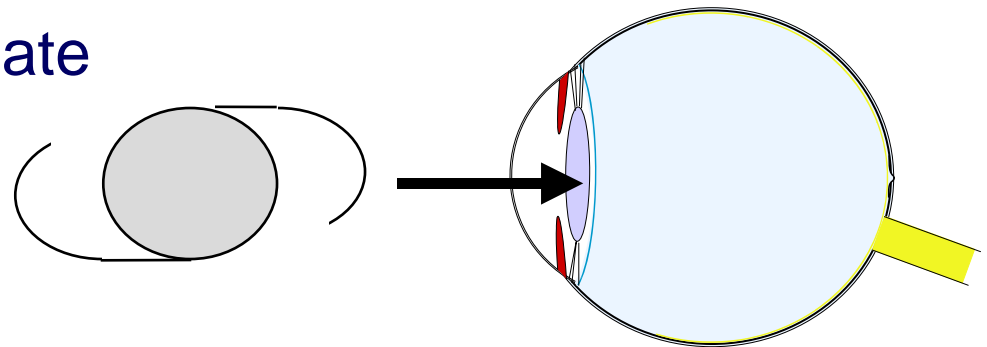


methylcellulose



intra-ocular lenses

- polymethylmethacrylate
- silicone (foldable)



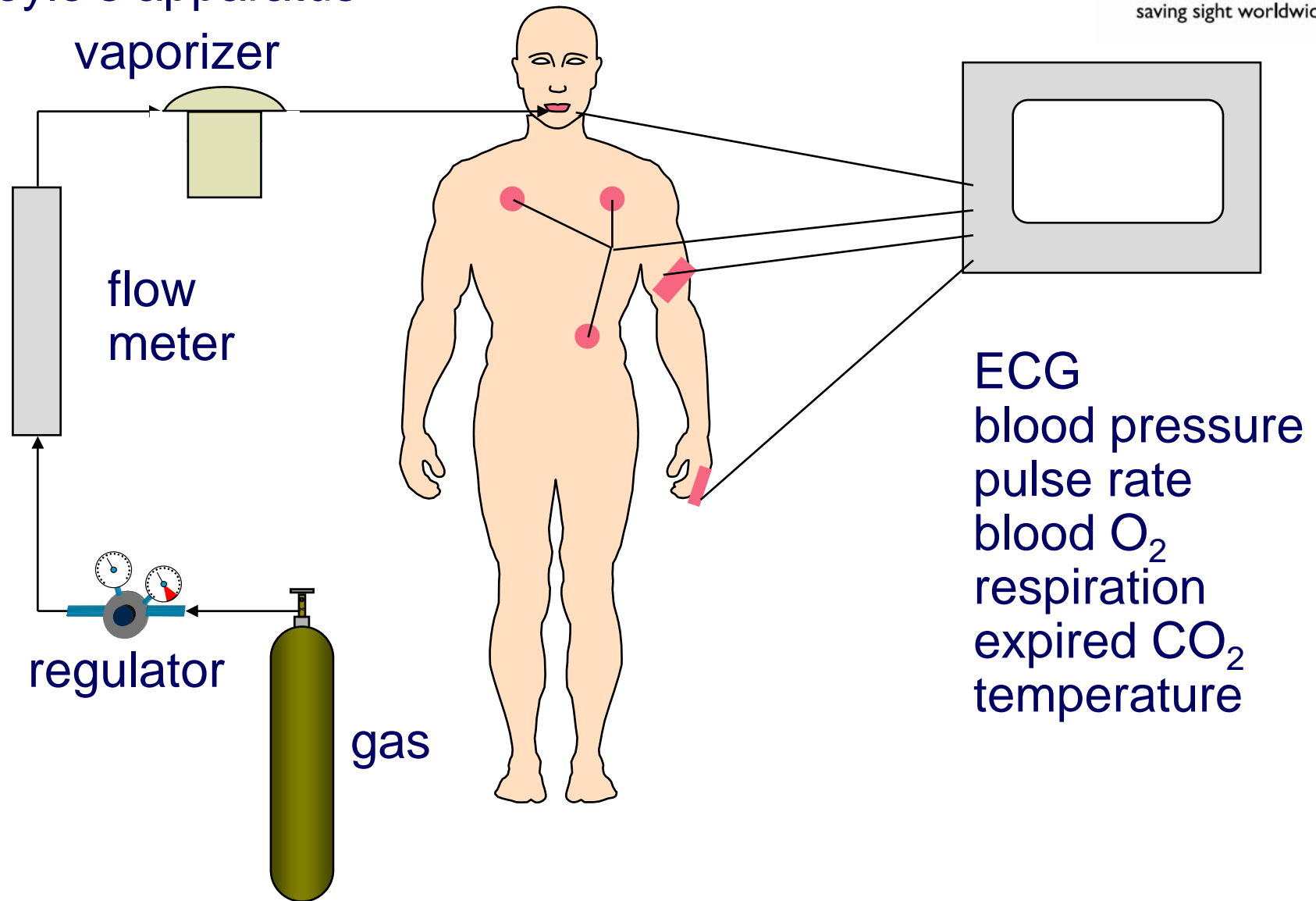


Support systems for ophthalmology



Machines to anesthetize and monitor the patients

Boyle's apparatus



Modern Anesthesia Machines



Continuous-flow anesthesia system

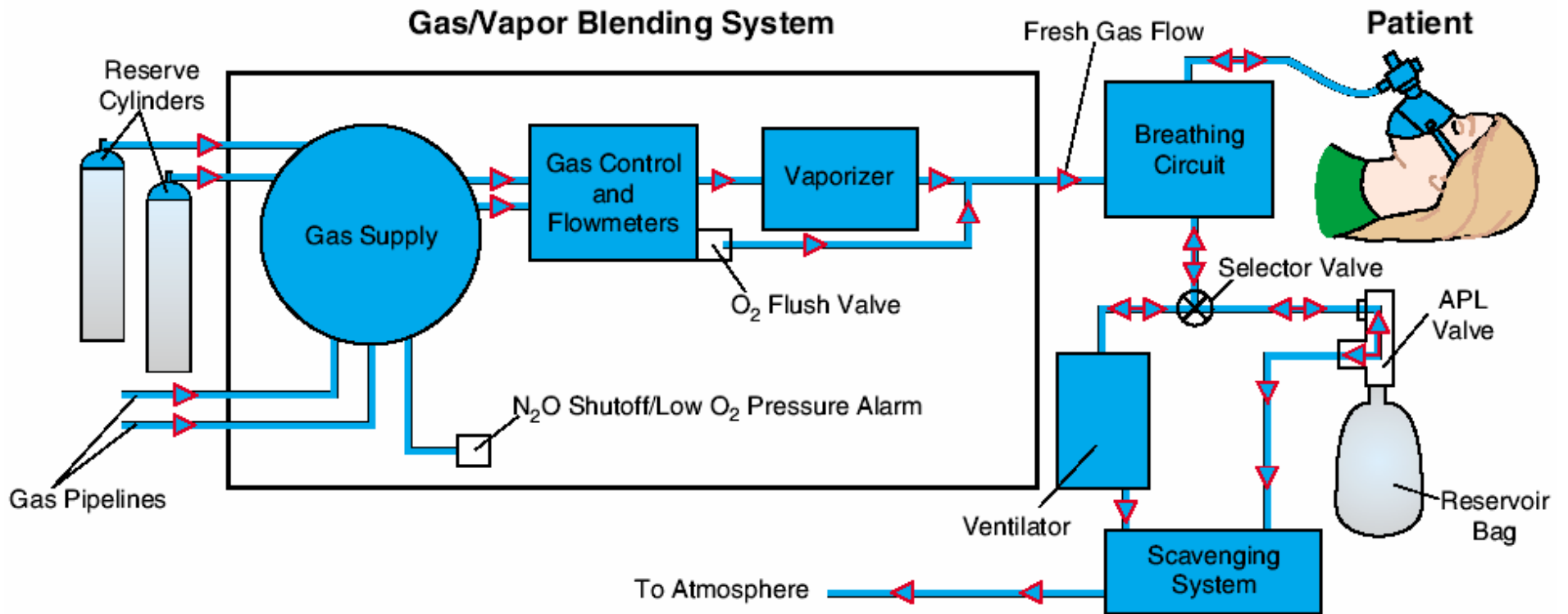


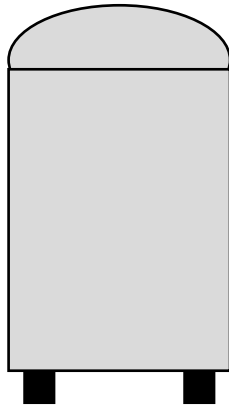
Figure . Continuous-flow anesthesia system

Reproduced from Health Care Product Comparison System, ECRI. 2003 – Anesthesia Units

Surgical equipment must be sterilized

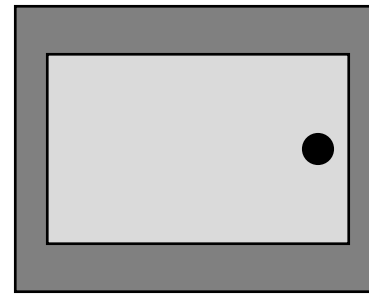


autoclave



27 psig
132 °C
10 min

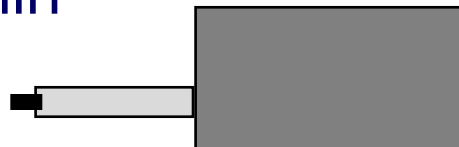
ethylene oxide (EtO)



55 °C
3.5 psia
1 hr treat
15 min vent

heat flash

190 °C
6 min



autoclave/EtO bags

clear,
impermeable
front



semi-
permeable
backing

Acknowledgements



- **ALCON Laboratories**



ORBIS
saving sight worldwide



