Training Eye Instructions

Using the Direct Ophthalmoscope with the Model Eye

The Model Eye uses a single plastic lens in place of the cornea and crystalline lens of the real eye (Fig. 20). The lens is mounted at one end of an open plastic tube into which another tube holding the “retina” is inserted. The model eye also has two different pupil sizes (2, and 4 mm in diameter) that are selected by moving the plastic pupil strip left or right. Taking the pupil strip out completely provides a pupil diameter of 8 mm.

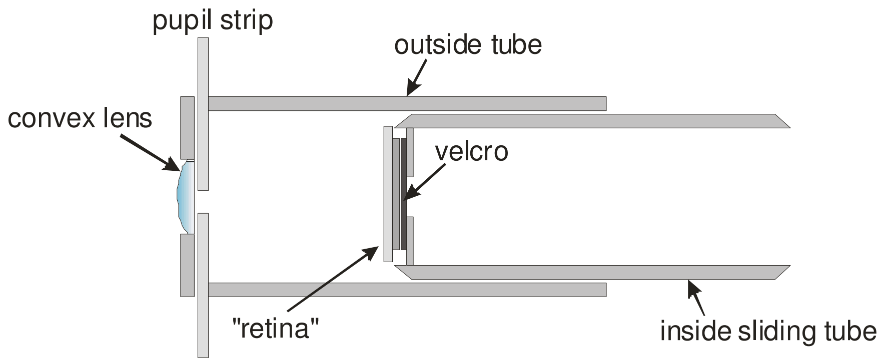


Fig. 20. Cross-section of the Model Eye.

Assembling the Model Eye

Each Model Eye kit contains:

- Stand
- Outer tube that mounts on the stand
- Inner tube that slides into the outer tube
- Pupil strip
- 6 black plastic disks
- 5 images of retinas and 1 mm grid with double-stick tape on back
- 1 cross hair focus disk

Attach the large, outer tube to the stand by pressing the black V-shaped plastic attached to the tube over the clear plastic ball on the stand. Next, insert the smaller-diameter inner tube into the Model Eye.

EXPERIMENT 1: Emmetropia

In a normal, emmetropic eye, parallel rays of light from a distant object come to focus on the retina (Fig. 21A). Light rays are “reversible”, that is they travel the same path whether going into or out of an optical system. Consequently, if the retina of an emmetropic eye could “light up”, light rays from a point on the retina would exit the eye as parallel rays (Fig. 21B).

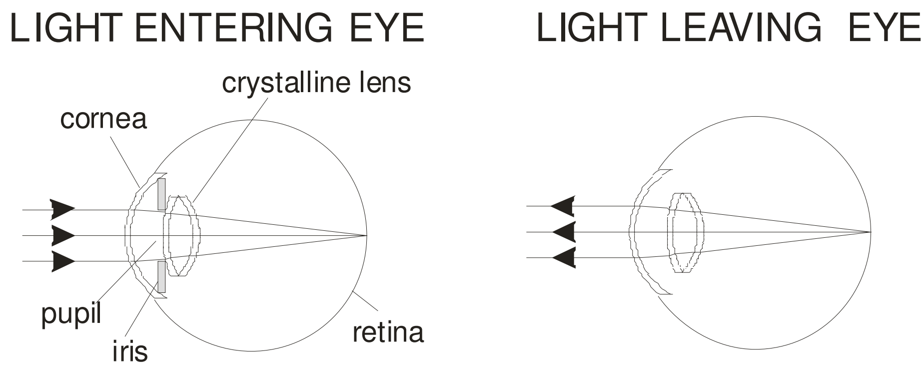


Fig. 21. Light rays are "reversible" illustrated with an emmetropic eye.

The Model Eye will be emmetropic when the retinal surface is just far enough from the lens so that light coming from the retinal surface will be parallel when it leaves the lens (Fig. 22a). This means that an image of the retinal surface will be formed at infinity. A scale showing optical power of the eye is attached to the side of the inner tube. The scale shows the amount of ametropia (-4, -8 and +4, +8 Diopters). The "E" stands for "Emmetropia." To verify that the "E" position of the inner tube produces Emmetropia, shine a flashlight into the inner tube and move the tube in or out until you see an image of the hole on a distant wall. You will need to perform this experiment in a very dark room. The "E" should line up with the outer edge of the outer tube as shown in Fig. 22B.

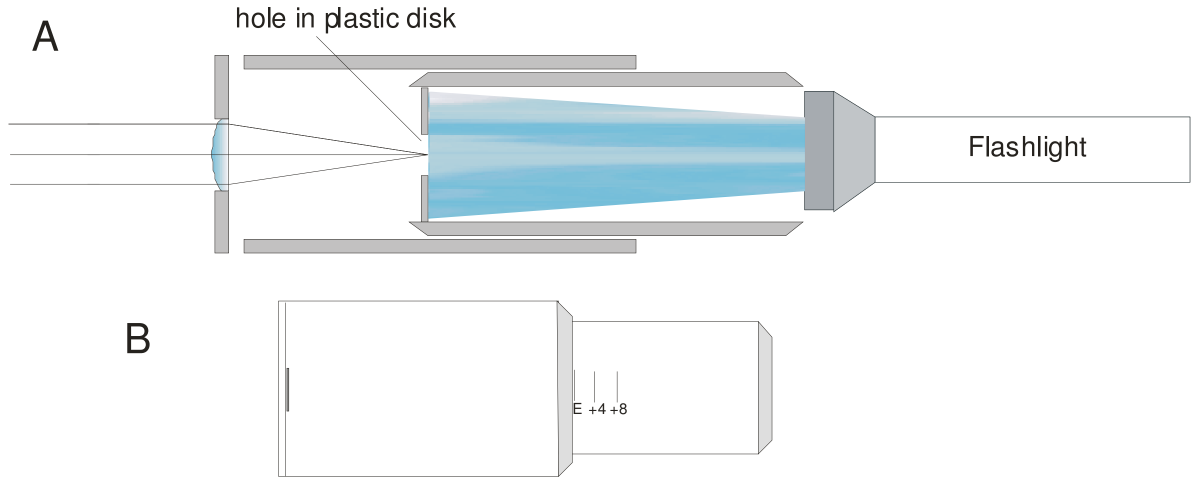


Fig. 22. A. Setup for adjusting Model Eye to Emmetropia. B. The "E" (for Emmetropia) lines up with the edge of the outer tube when the eye is adjusted for Emmetropia.

You can gain some appreciation of the retinal image of a myopic ("nearsighted") or hyperopic ("farsighted") individual by moving the box outward or inward respectively from the "E" and observing the image of the hole on the wall.

Preparing the "retinas." Using scissors carefully cut around the black edge of each of the photos of retinas. Remove the covering from the double-stick tape on the backside of the retina to expose the adhesive. Stick the retina onto one of the black disks being careful to align the edges of the retina and disk (excess can be trimmed off with a razor blade). Cut the 1 mm grid along the edges and mount on a plastic disk. Next, gently press one of the disks on the black plastic disk with the hole in the inner tube. Do not press too hard or the disk will detach from the white plastic tube.. If additional pressure is needed to firmly put one finger against the black disk from the inside of the tube before pressing on the outside.

EXPERIMENT 2. Observing the emmetropic retina

The fundamental idea in operating the ophthalmoscope is to illuminate the Subject's (S) retina and then make rays of light coming from the Subject's eye parallel so that they come to focus on the retina of your (i.e., the Observer, "O") emmetropic eye. This is no problem with an emmetropic subject since the rays coming from his/her retina are already parallel when they exit the eye. Consequently, no lens is needed in the ophthalmoscope (Fig. 23).

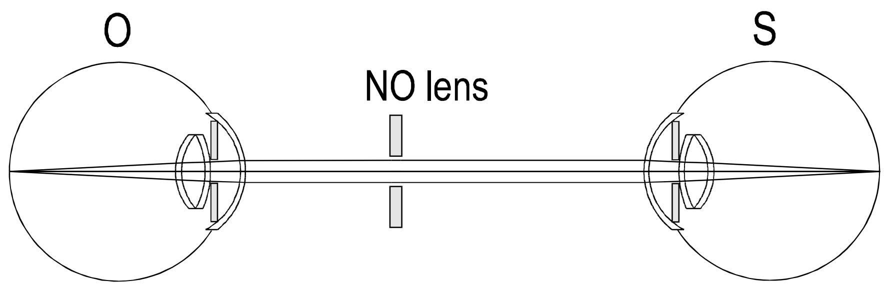


Fig. 23. Optical arrangement when an emmetropic observer (O) views the retina of an emmetropic subject (S) using the direct ophthalmoscope.

Remove the inner tube from the Model Eye and attach the disk with the mm grid. Reinsert the tube and set it to "E." Turn on your ophthalmoscope and select the smallest diameter white light illumination. Set the ophthalmoscope lens selection wheel to "0" so that there is no compensating lens between your eye and the Model Eye. If you wear spectacles or contact lenses, leave them on or in so you are emmetropic.

Tilt the Model Eye to a convenient position. Starting about 12 inches from the eye, look through the ophthalmoscope and move it around until you see the light on the front of the model eye. You should then begin to see the grid retina. Now, move closer and closer to the eye. Do the 1 mm grids appear to become larger or smaller or remain the same? Do you get a sharper image by changing lenses in the lens wheel? Get as close as possible to the eye without touching the lens. Move the ophthalmoscope (and your head) around and try to see the edges of the grid. How far can you see temporally and nasally? Superiorly and inferiorly?

EXPERIMENT 3. Observing the hyperopic retina.

The eye of a hyperopic ("farsighted") person is often shorter in axial length than normal. Light rays entering the eye come to focus "behind" the retina, so the image is out of focus at the retina. When the ophthalmoscope illuminates the retina, light rays from the retina *diverge* when they leave the eye (Fig. 24).

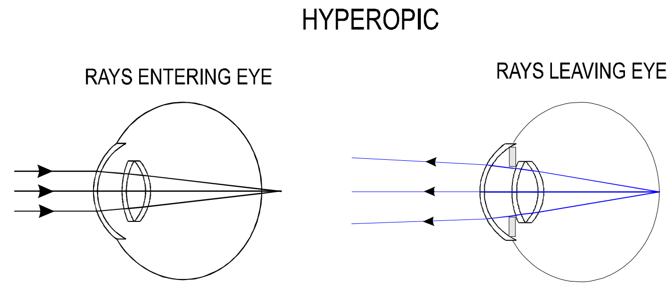


Fig. 24. Light entering and leaving the hyperopic eye.

When trying to observe the hyperopic retina, we must insert positive (convex) lenses in the ophthalmoscope as shown below in order to converge the diverging rays from the eye enough to make them parallel before entering the observer's eye (Fig. 25).

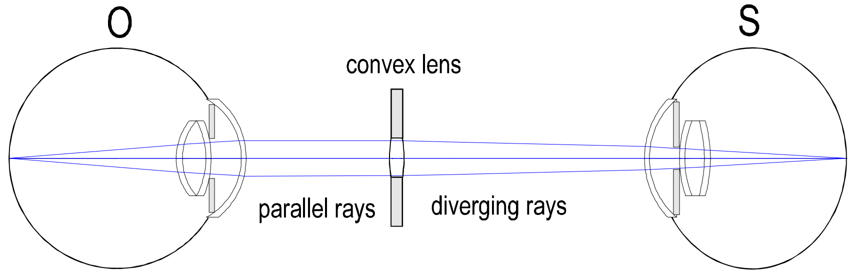


Fig. 25. To observe the retina of a hyperopic eye, convex lenses must be selected in the ophthalmoscope to converge the diverging rays from the hyperopic eye.

Set the model eye for +8 (Diopters) of hyperopia by sliding the inner tube until the +8 mark lines up with the edge of the outer tube. Use the grid "retina" and the 8 mm pupil. Hold the ophthalmoscope about 12 inches from the eye and observe the grid retina. Rotate the lens wheel on the ophthalmoscope until the retina is in focus and note the lens number. Now, gradually move closer and closer to the eye, changing the lens as necessary to keep the retina in focus. Did you increase or decrease the power of the convex lens as you moved inward toward the eye? Did the 1 mm grids appear to become larger or smaller as you moved in closer to the eye?

EXPERIMENT 4. Observing the myopic retina.

The eye of a myopic ("nearsighted") person is often longer than normal. Consequently, rays of light entering the eye come to focus before reaching the retina with the result that the image is out of focus at the retina. Rays of light *leaving* the myopic eye come to focus at a point in front of the eye known as the "far point" (Fig. 26A). Thus, rays from the eye first *converge*, and then *diverge* once past the far point. This means that you must use either concave or convex lenses to make the rays parallel, depending on your position relative to the far point. The use of a concave lens, when the ophthalmoscope is "inside" the far point, is illustrated in Fig. 26 B.

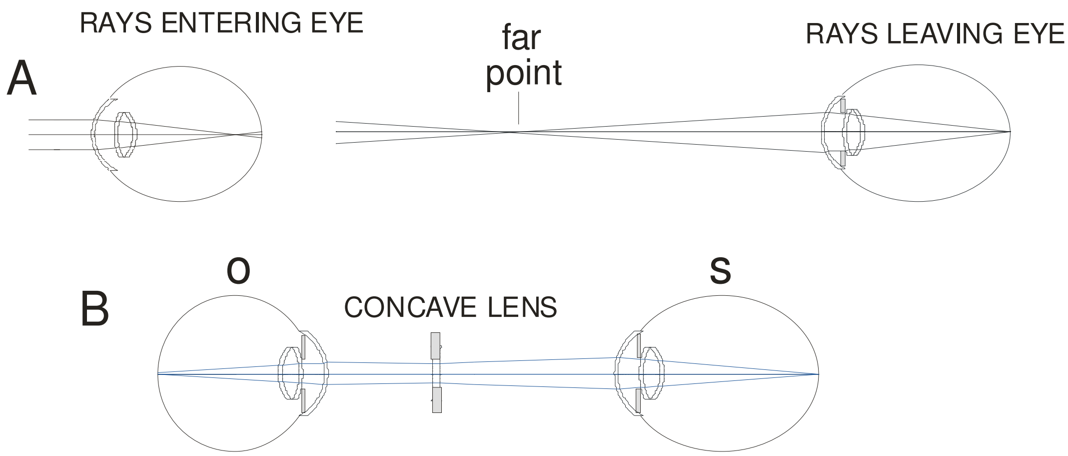


Fig. 26. A. Light rays leaving the myopic eye come to focus at the far point. B. A concave lens is selected in the ophthalmoscope when the observer is nearer to the eye than the far point.

Set the model eye for -8 D of myopia. When the model eye is set for -8 D, the far point is 125 mm (i.e., 1/8 m or ~ 5 inches) in front of the lens. Start with the ophthalmoscope about 12 inches from the eye and turn the lens wheel until the grid retina is in focus. Note the number of the lens. As you move closer to the eye, rotate the lens wheel to keep the retina in focus. Are you increasing or decreasing the lens power? When you reach the far point, you will find that you cannot see the retina with any lens setting. Continue moving inward from the far point, but now try concave (negative lenses). How did the magnification of the grid change as you moved inward?

EXPERIMENT 5. Changing pupil size.

Thus far, we have used the 8 mm diameter pupil, approximately equivalent to a dilated human pupil. In the clinic, however, one often must examine the retina with an undilated pupil (~2 mm in diameter) when the eye is exposed to the light from the ophthalmoscope. It requires more skill to view the retina with a smaller pupil. In addition, the size of the pupil can limit your field of view of the retina. With a small pupil, the field of view is relatively small making it easier to "get lost" when exploring the retina.

Before inserting the pupil strip into the model eye, observe the grid retina at a very close distance and note how many grid squares you can see. Now, insert the pupil strip into the model eye as follows. There are two 15 mm long slits on either side of the lens in the front of the outer tube of the model eye. The pupil strip slides through these two slits. Push the pupil strip through one of the slits. Slide the strip toward the opposite slit and through it. If the strip meets resistance, try wiggling it slightly as you push forward, or remove it and insert it through the opposite slit. Move the strip so that the 4 mm pupil holes lines up with the center of the lens.

With the 4 mm pupil, observe the grid retina at a very close distance and note how many grid squares you can see. Now change to the 2 mm pupil, making sure it is centered behind the lens. How many grid squares are visible? Finally, set the ophthalmoscope illumination to the largest diameter and repeat the steps above. Did increasing the diameter of illumination have any effect on what you saw?

EXPERIMENT 6. Scanning the retina.

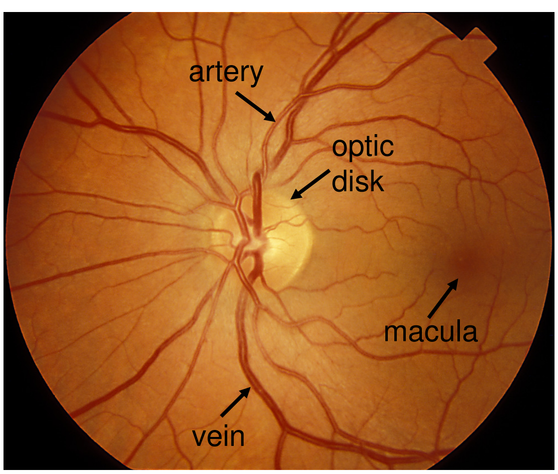
The direct ophthalmoscope illuminates only a small area of retina and it is usually necessary to move the illumination beam to various parts of the retina in order to see them. It is easiest to practice this with the model eye since it does not move and does not have eyelids!

Remove the grid retina and attach the disk with an image of a normal human retina. Set the eye for Emmetropia and remove the pupil strip so there is an 8 mm pupil. Start about 12 inches from the eye and move in until you are very close. Rotate your head and the ophthalmoscope until you find the optic disk, macula, and the vessels of the central arcade. Now insert the 4 mm pupil and repeat the procedure. Do the same thing with the 2 mm pupil. Finally, set the eye for 8 D hyperopia and then -8 D myopia and repeat.

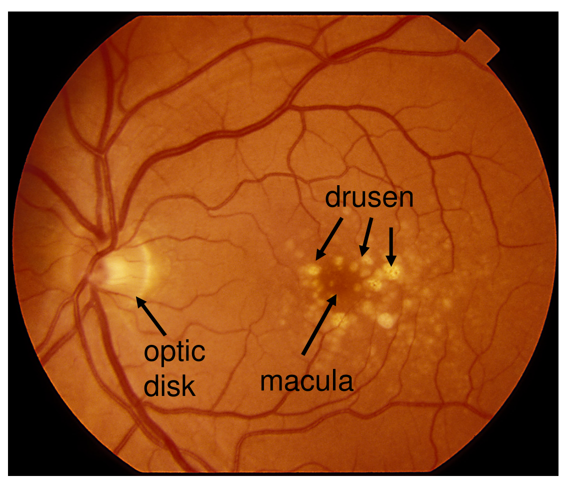
EXPERIMENT 7. Practice observing retinal pathology.

Five retinal photographs are included with the Model Eye, four of which show various pathologies (see figure below). You should try observing each retina with the direct ophthalmoscope with the Model Eye set to Emmetropia, hyperopia, and myopia. In addition, start with the 8 mm pupil and then work down to the 2 mm pupil. Try observing the relevant pathological features with each pupil and emmetropic combination.

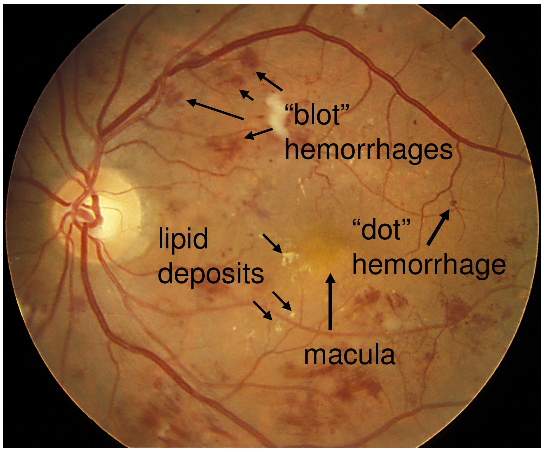
In clinical practice, you will rarely know whether the patient's eye is emmetropic, hyperopic, or myopic. As a result, the systematic manner of changing the ophthalmoscope lenses described in the experiments above is rarely used. Instead, most clinicians simply turn the lens wheel until some aspect of the patient's eye is in focus (for example, the iris) and then readjust the lenses until the retina is in focus. As you move the ophthalmoscope closer to the eye, the lens wheel is adjusted clockwise or counter-clockwise to keep the retina in focus. You may find it worthwhile to let someone else adjust the model eye for some amount of ametropia and then (without looking at the setting) attempt to observe the retina.



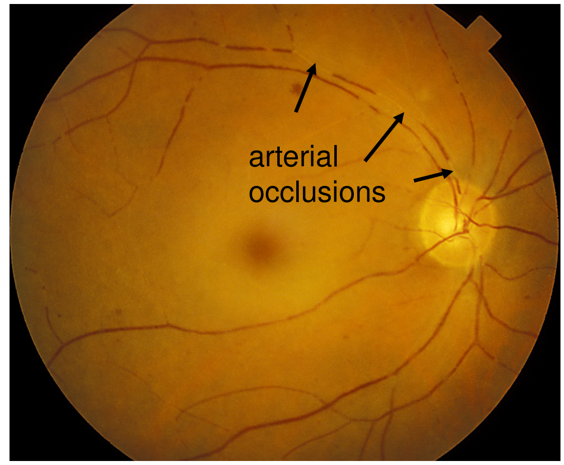
Normal Retina



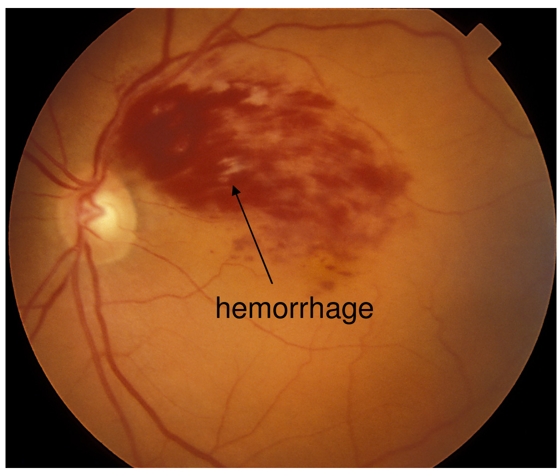
Drusen in Age Related Macular Degeneration



Non-proliferative diabetic retinopathy



Artery Occlusions



Branch retinal vein occlusion

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