The Eye Exam

Assessment of Visual Acuity: The first part of the eye exam is an assessment of acuity. This can be done with either a standard Snellen hanging wall chart read with the patient standing at a distance of 20 feet or a specially designed pocket card (held at 14 inches). Each eye is tested independently (i.e. one is covered while the other is used to read). The patient should be allowed to wear their glasses and the results are referred to as "Best corrected vision." You do not need to assess their ability to read every line on the chart. If they have no complaints, rapidly skip down to the smaller characters. The numbers at the end of the line provide an indication of the patient's acuity compared with normal subjects. The larger the denominator, the worse the acuity. 20/200, for example, means that they can see at 20 feet what a normal individual can at 200 feet (i.e. their vision is pretty lousy). If the patient is unable to read any of the lines, indicative of a big problem if this was a new complaint, a gross estimate of what they are capable of seeing should be determined (e.g. ability to detect light, motion or number of fingers placed in front of them). In general, acuity is only tested when there is a new, specific, visual complaint.

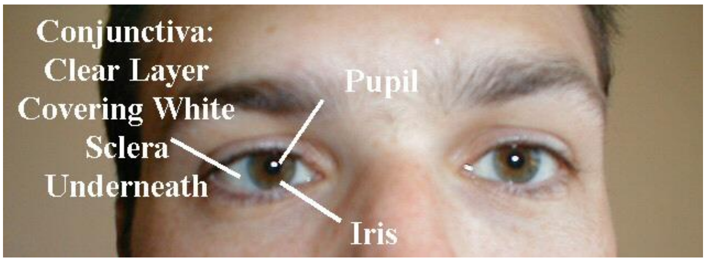
Hand Held Acuity Card

Snellen Chart

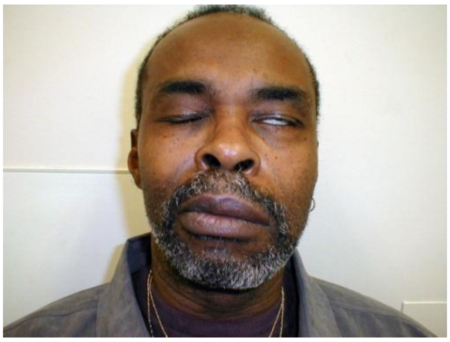
Pinhole Testing: The pinhole testing device can determine if a problem with acuity is the result of refractive error (and thus correctable with glasses) or due to another process. The pinholes only allow the passage of light which is perpendicular to the lens, and thus does not need to be bent prior to being focused onto the retina. The patient is instructed to view the Snellen chart with the pinholes up (below right) and then again with them in the down position (below left). If the deficit corrects with the pinholes in place, the acuity issue is related to a refractive problem.

Observation of External Structures:

1. Occular Symmetry: Occasionally, one of the muscles that controls eye movement will be weak or foreshortened, causing one eye to appear deviated medially or laterally compared with the other.



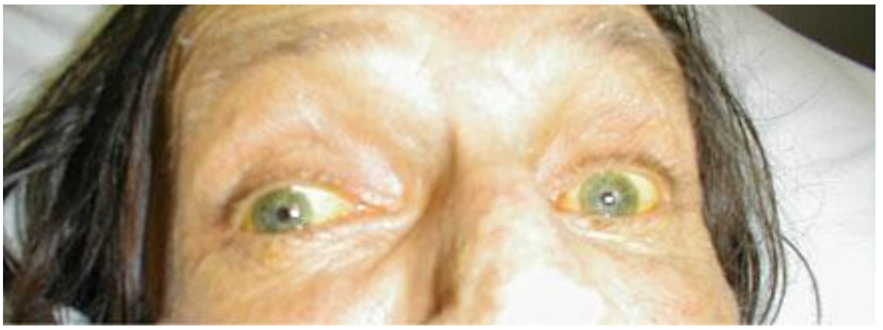
2. Eye Lid Symmetry: Both eye lids should cover approximately the same amount of eyeball. Damage to the nerves controlling these structures (Cranial Nerves 3 and 7) can cause the upper or lower lids on one side to appear lower then the other.



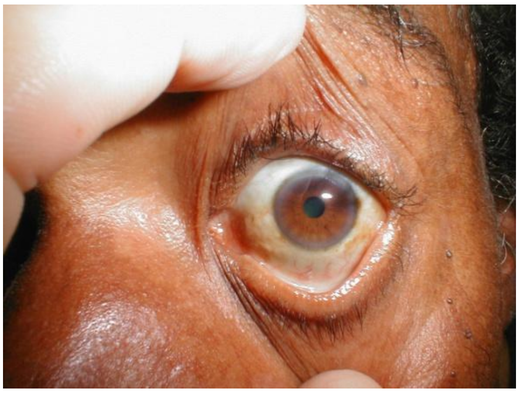
Patient unable to completely close left upper eyelid due to peripheral CN 7 dysfunction.

3. Sclera: The normal sclera is white and surrounds the iris and pupil. In the setting of liver or blood disorders that cause hyperbilirubinemia, the sclera may appear yellow, referred to as icterus. This can be easily confused with a muddy-brown discoloration common among older African Americans that is a variant of normal.

Icteric Sclera



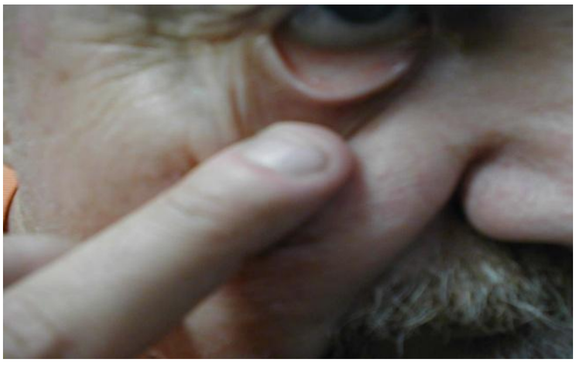
Muddy Brown Sclera

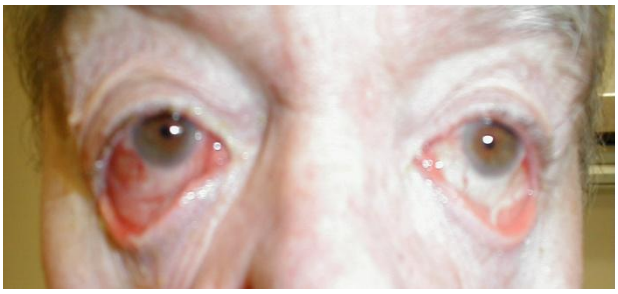


4. Conjunctiva: The sclera is covered by a thin transparent membrane known as the conjunctiva, which reflects back onto the underside of the eyelids. Normally, it's invisible except for the fine blood vessels that run through it. When infected or otherwise inflamed, this layer can appear quite red, a condition known as conjunctivitis. Alternatively, the conjunctiva can appear pale if patient is very anemic. By gently applying pressure and pulling down and away on the skin below the lower lid, you can examine the conjunctival reflection, which is the best place to identify this finding.

Normal Appearing Conjunctival Reflection, Lower Lid

Pale Conjunctiva, due to severe anemia.





Conjunctivitis

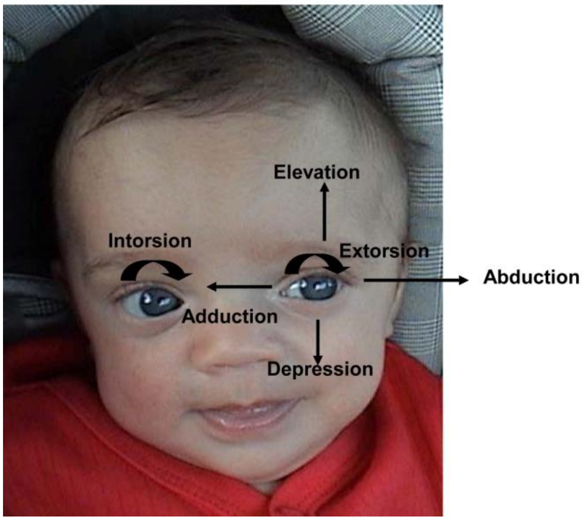
5. Blood can also accumulate underneath the conjunctiva when one of the small blood vessels within it ruptures. This may be the result of relatively minor trauma (cough, sneeze, or direct blow), a bleeding disorder or idiopathic. The resulting collection of blood is called a subconjunctival hemorrhage. While dramatic, it is generally self limited and does not affect vision.

Subconjunctival Hemorrhage

6. Pupil and Iris: Normally, both of these structures are round and symmetric.

Extraocular movements and cranial nerves:

Eye Movement Terminology



The medial and lateral rectus muscles are described first, as their functions are very straight forward:

Lateral rectus: Abduction (ie lateral movement along the horizontal plane)
Medial rectus: Adduction (ie. Medial movement along the horizontal plane)

The remaining muscles each causes movement in more than one direction (e.g. some combination of elevation/depression, abduction/adduction, intorsion/extorsion). This is due to the fact that they insert on the eyeball at various angles, and in the case of the superior oblique, thru a pulley. Review of the origin and insertion of each muscle sheds light on its actions (see links @ the end of this section). The net impact of any one EOM is the result of the position of the eye and the sum of forces from all other contributing muscles.

Specific actions of the remaining EOMs are described below. The action which the muscle primarily performs is listed first, followed by secondary and then tertiary actions.
Inferior rectus: depression, extorsion and adduction.
Superior rectus: elevation, intorsion and adduction
Superior oblique: intorsion, depression and abduction
Inferior oblique: extorsion, elevation and abduction

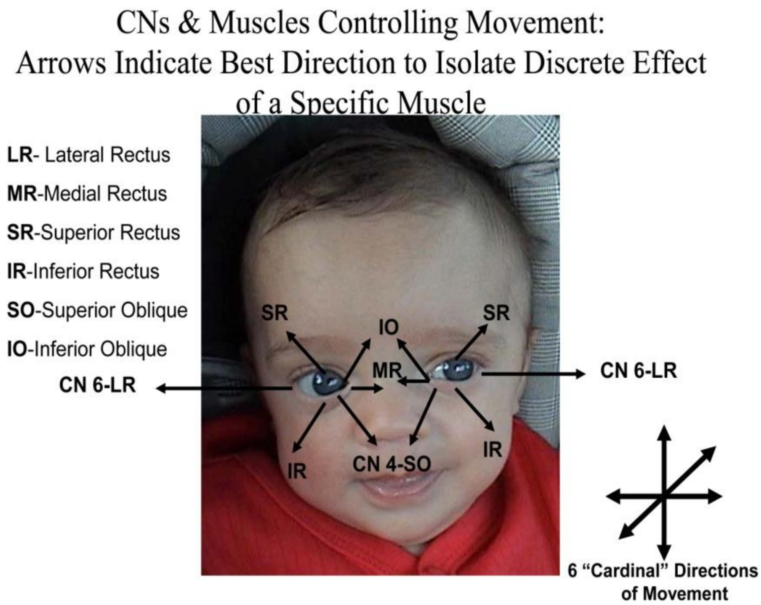
The muscles, in turn, are innervated by 3 different cranial nerves. Patterns of innervations are as follows:

Cranial 4 (Trochlear): innervates the superior oblique
Cranial Nerve 6 (Abducens): innervates the lateral rectus
Cranial Nerve 3 (Oculomotor): innervates all the remaining muscles (ie medial rectus, inferior oblique, superior rectus and inferior rectus).

You can remember this via the mnemonic: "SO-4, LR-6, All the rest 3" (ie Superior Oblique by CN 4, Lateral rectus by CN 6, and all the other EOMs by CN 3).

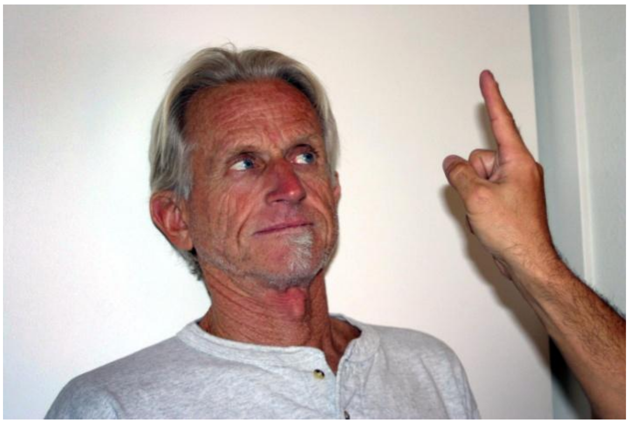
In the setting of an eye movement problem, isolating which muscle or CN is the culprit can be tricky. When trying to isolate a problem, it can help to check movement in the direction in which that muscle is the primary mover. This can be assessed as follows:

a. Superior oblique: Depresses the eye when looking medially
b. Inferior oblique: Elevates the eye when looking medially
c. Superior rectus: Elevates the eye when looking laterally
d. Inferior rectus: Depresses the eye when looking laterally
e. Medial rectus: Adduction when pupil moving along horizontal plane
f. Lateral rectus: Abduction when pupil moving along horizontal plane



Practically speaking, cranial nerve testing is done such that the examiner can observe eye movements in all directions. The movements should be smooth and coordinated. To assess, proceed as follows:

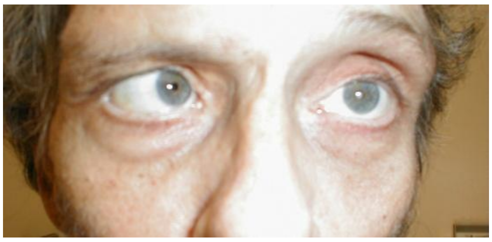
1. Stand in front of the patient.
2. Ask them to follow your finger with their eyes while keeping their head in one position
3. Using your finger, trace an imaginary "H" or rectangular shape in front of them, making sure that your finger moves far enough out and up/down so that you're able to see all appropriate eye movements (ie lateral and up, lateral down, medial down, medial up).
4. At the end, bring your finger directly in towards the patient's nose. This will cause the patient to look cross-eyed and the pupils should constrict, a response referred to as accommodation.



Testing Extraocular Movements

Interpretation: The eyes should be able to easily and smoothly follow your finger.

Pathology: Isolated lesions of a cranial nerve or the muscle itself can adversely affect extraocular movement. Patients will report diplopia (double vision) when they look in a direction that's affected. This is because the brain can't put together the discordant images in a way that forms a single picture. In response, they will either assume a head tilt that attempts to correct for the abnormal eye positioning or close the abnormal eye. As an example, the patient shown below has a left cranial nerve 6 lesion, which means that his left lateral rectus no longer functions. When he looks right, his vision is normal. However, when he looks left, he experiences double vision as the left eye can't move laterally. This is referred to as horizontal diplopia.



Left CN 6 Palsy
Patient was asked to look left. Note that left eye will not abduct.

Even with this information, trying to isolate the precise source of the problem can be tricky and subtle, sometimes requiring special testing (not discussed here). In addition, other findings can help localize the source of the problem. In the setting of a CN 3 palsy, the eye will tend to be positioned laterally and downward. This is because the unopposed action of CN 4 and 6 move the eye to this position. In addition, the lid will droop (known as ptosis) as CN3 controls lid elevation (Levator Palpebrae Superioris muscle). As well, the pupil will be dilated, as efferent parasympathetics (controlling constriction) travel with CN 3. This is well demonstrated in the picture below. In addition, the pupil will not respond well to direct or consensual (shined in the opposite eye) light. The unaffected eye will respond normally to light shined in either eye, as afferent impulses travel with CN2 and are unaffected.

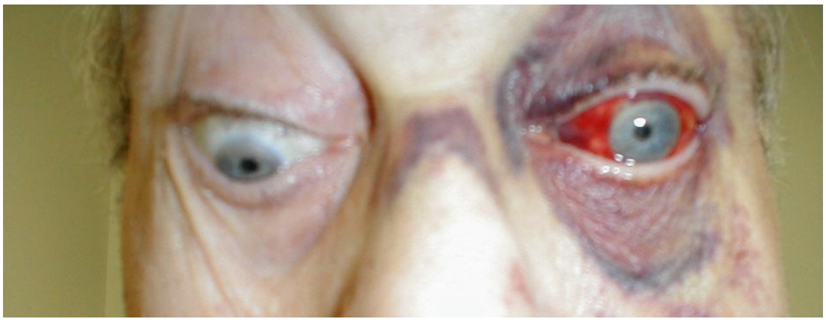
Close up: R Eye

Close up: L Eye

Note: Similar lighting was used for both of these close-up images

Right CN 3 Palsy - Note: Right eye is deviated laterally, there is ptosis of right lid, and the right pupil is dilated.

Disorders of eye movement can also be due to problems with the extraocular muscles themselves. For example, pictured below is a patient who has suffered a traumatic left orbital injury. The inferior rectus muscle has become entrapped within the resulting fracture, preventing the left eye from being able to look downward. The scleral blood and peri-orbital echymosis are secondary to the trauma as well.

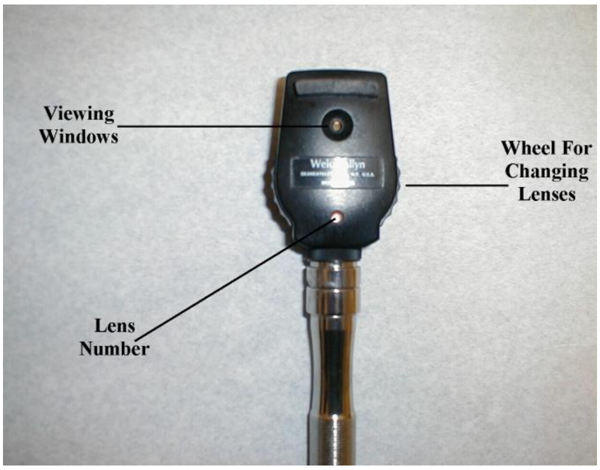


Visual fields: The normal visual field for each eye extends out from the patient in all directions, with an area of overlap directly in front. Field cuts refer to specific regions where the patient has lost their ability to see. This occurs when the transmitted visual impulse is interrupted at some point in its path from the retina to the visual cortex in the back of the brain. You would, in general, only include a visual field assessment if the patient complained of loss of sight; in particular "blind spots" or "holes" in their vision.Visual fields can be crudely assessed as follows:

1. The examiner should be nose to nose with the patient, separated by approximately 8 to 12 inches.
2. Each eye is checked separately. The examiner closes one eye and the patient closes the one opposite. The open eyes should then be staring directly at one another.
3. The examiner should move their hand out towards the periphery of his/her visual field on the side where the eyes are open. The finger should be equidistant from both persons.
4. The examiner should then move the wiggling finger in towards them, along an imaginary line drawn between the two persons.The patient and examiner should detect the finger at more or less the same time.
5. The finger is then moved out to the diagonal corners of the field and moved inwards from each of these directions. Testing is then done starting at a point in front of the closed eyes. The wiggling finger is moved towards the open eyes.
6. The other eye is then tested.

Using the Ophthalmoscope

Side of Scope Facing Examiner **Side of Scope Facing Patient**



Assessing Pupillary Response to Light:
The normal pupil constricts when either exposed directly to bright light or when that same light is presented to the other eye, referred to as the consensual response. This is due to the fact that stimulation of the afferent (i.e. sensory, carried with CN 2) nerves in one eye will trigger efferent (i.e. motor, carried with CN 3) activation and subsequent constriction of the pupils of both eyes. Disease affecting either the efferent or afferent limbs will alter these responses accordingly. Also, processes which raise intracranial pressure (e.g. brain tumors, collections of blood) can cause CN 3 dysfunction, resulting in dilatation of the pupils and uresponsiveness to direct stimulation by light. To assess pupillary reactions, proceed as follows:

1. Instruct the patient to look towards a distant area in the room (e.g. the corner where the wall and ceiling meet) while keeping both of their eyes open. You may need to gently remind them throughout the exam to continue looking in that direction as it is very difficult to examine a roving eyeball. Do not ask them to focus on a specific object as this will lead to pupillary constriction.
2. Turn on your opthalmoscope and adjust the light intensity to mid-range power. The cone of light produced should be a white, medium sized circle. Circle sizes available include small, medium and large. If possible, turn off most of the lights in the room. This allows the pupil to dilate and cuts down on reflections from the surface of the eye.
3. Make note of the size and shape of each pupil. Then assess whether each pupil constricts appropriately in response to direct and indirect stimulation. If you're having trouble detecting any change, have the patient close their eye for several seconds and place your hand over their eyebrows to provide additional shade. This helps to make it as dark as possible, encouraging greater pupillary dilation and therefore accentuating any change which may occur after light is introduced. It may be hard to detect the consensual response if the lighting in your room is sub-optimal (i.e. if it's too dark, you won't be able to see the other eye). Note that you do not need to look through the viewing window of the scope to perform this part of the exam as you are essentially using it as a flashlight.

Closer Exam of the Outer Structures of the Eye:

1. Every opthalmoscope has a mechanism for changing the viewing lens. These lenses vary in their ability to bend light and are numbered and color coded. The specific lens

that allows you to see something in focus will vary with your distance from that structure as well as the refractive error of both your eyes and the patients. To better examine the sclera, conjunctiva, pupil, cornea or iris, start with the lens identified by a green 4 or 6.

2. Now grasp the handle with your right hand (the following instructions are for examining the patient's right eye) such that your middle finger is resting on the lower, front aspect of the head of the opthalmoscope.
3. Bring your right eye up to the viewing window. While you can either wear or remove your own glasses, the patient's should be taken off. It's OK to leave contacts in place.
4. Take your left hand and place it on the patient's forehead and gently apply upward traction on the top lid with your thumb. This will "remind" them not to blink and let you know their precise location. Obviously, try not to poke them in the eye with this finger! Alternatively, you can place your left hand on the patient's shoulder as a means of keeping track of their location. Try to keep both of your eyes open when performing the exam as you might find it quite tiring to continually squint with the non-examining eye.
5. Start approximately 15 cm from the patient and approach from about 15 or 20 degrees to the left of center. When you look through the viewing window, the outer structures of the eye should come into sharp focus. If not, slowly move closer or further from the patient until these structures become clear. It takes a bit of experimentation to find the lens that is right for any given distance, so make lens changes slowly by rotating the adjustment wheel. There is no magic way of guessing which lens will allow the sharpest view.

Viewing the Fundus (the retina and associated structures):

1. Repeat steps 1 thru 5 as above. Adjust the lens selection wheel so that 0 appears in the display window.

Red Reflex

2. Look through the viewing window at the patient's pupil, using your right eye to examine their right eye. You should see a sparkly, orange-red color known as the red reflex. This is caused by light reflecting off of the retina and is the same phenomenon that produces red eyes in flash photographs. Occasionally, the translucent structures which allow light to pass unimpeded from outside the eye to the retina become opacified and the red reflex is lost. In adults, this is most commonly associated with cataracts, a process caused by clouding of the lens.

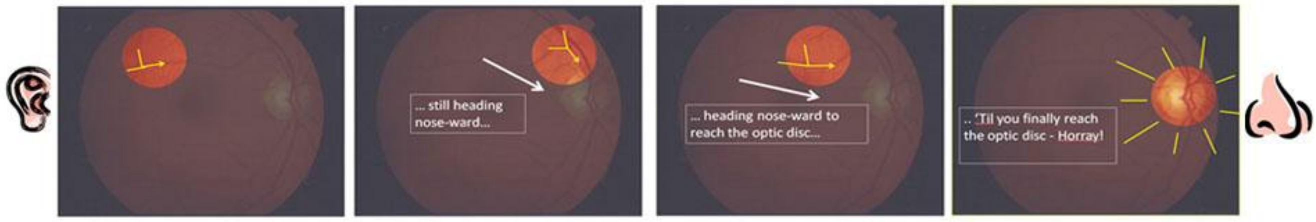
3. In order to see the fundus in greater detail, you will need to move very close to the patient, analogous to looking through a key hole (i.e. the closer you are, the more you'll see). Your middle finger, the one resting on the low front of the head piece, should be on or near the patient's cheek. Starting with the 0 lens in place, rotate the adjustment wheel counter clockwise. If you change lenses too quickly, you'll probably whizz right by the one that gives the sharpest picture, so be patient. In the event that this does not bring anything into focus, trying rotating the adjustment wheel in the opposite direction. It doesn't really matter what number lens is required to achieve the clearest view. Again, this will vary with the refractive error of both you and the patient. The numbers are simply provided for reference. Thus, while you may be able to see the fundus of some patients with the green numbers still visible, you will need red 8 or 10 to visualize the same region in a different person. Once you're close in and have the retina in clear view, you should only need to change the lens one or two clicks in order to keep all structures in focus as you scan across.
4. You will only be able to see a relatively small segment of the retina at any one time. Your initial view will probably be of blood vessels on a random patch of retina (see below).

The retina has a refractile, orange-red appearance, varying a bit with the skin color and age of the patient. Fundoscopy provides important information as it not only enables you to detect diseases of the eyes but is also the only area of the body where small blood vessels can be studied with relative ease. Practice on every patient that you examine. It will come with time. A few things to pay attention to:

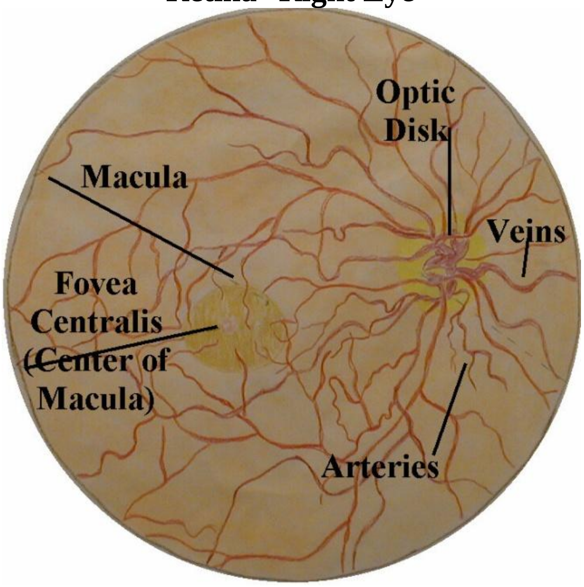
1. When you first visualize the retina, you will note branching blood vessels. The bigger, darker ones are the veins and the smaller, brighter red structures the arteries. Changes in the appearance of the arteries (copper wiring) as well as alterations in the arterial-venous crossing pattern (a-v nicking) occur with atherosclerosis and hypertension respectively (see any text for pictures). These vessels are more obvious in the superior and inferior aspects of the retina, with relative sparing of the temporal and medial regions.
2. Imagine that the blood vessels are the branches of a tree. Follow them in a direction that leads to less branching (i.e. towards the trunk). This will direct you towards the optic disc, the point at which the vessels enter the retina along with the head of the optic nerve. The edges of this round disc are sharp and well defined in the normal state. It should be a bit more yellow/orange when compared to the rest of the retina. At the center of the disc is the optic cup, a distinct circular area from which the blood vessels actually emerge. The disc is not located in the exact center of the retina but rather towards its medial/nasal aspect. Measurements in the eye are made using disc size as a measuring device (e.g. a finding may be described as being at 2 O'clock, 2 disc diameters from the center of the disc). If you are unable to locate the disc after following the vessels in one direction, simply head the other way.
3. The macula is a region located lateral to the optic disc. It looks somewhat darker then the rest of the retina and, as opposed to the disc, has no distinct borders. The macula provides the sharpest vision. It can be best visualized by asking the patient to stare directly at the light of the opthalmoscope while you remain focused on a fixed area of the retina.
4. You will not be able to visualize the entire retina at any one time (approximately one disc diameter should be visible). To view different areas, you'll have to shift the angle with which you peer through the pupil. This requires very small movements. Try to

examine the entire structure systematically, looking up, down, left and right. You will undoubtedly have to remind the patient to continue looking straight ahead, else the fundus will be in continual motion and you will have no chance of finding anything. It's also a good idea to periodically give the patient a break (particularly if the exam is taking a while), allowing them to blink in the dark before resuming.

You'll Only Get a Partial view of the Retina - So follow the "branches" towards the "trunk"...
They'll point the way to the optic disc...

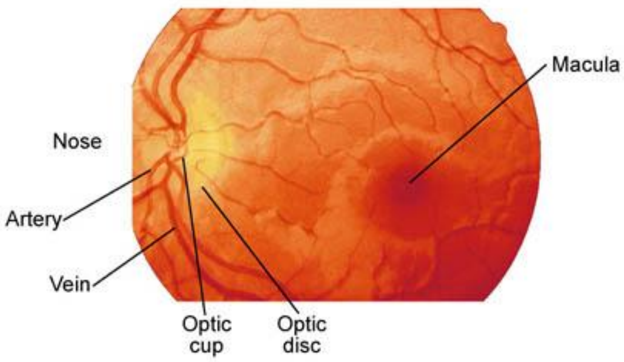


Retina--Right Eye



Normal Retina - Left Eye

(Photo courtesy of Dr. David Rapaport)



In order to view the patient's left eye, grasp the scope in your left hand and use your left eye; then repeat the process described above.