Microscope Objective

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The objective of a microscope is the piece that gathers light from the object and focuses it as a magnified real image of what is being observed. The objectives are essentially specific lens combinations, depending on what magnification is wanted. Apochromats are highly color-corrected objectives for color photography using white light, most apochromats suffer some curvature of field but this is corrected for in plan apochromats.

Qualitative Description

Apochromats are highly color-corrected objectives for color photography using white light, most apochromats suffer some curvature of field but this is corrected for in plan apochromats. This large amount of color correction makes plan apochromats ideal for fluorescent imaging. This design also supports large numerical apertures (NA). The NA is the square root of the light gathering power, or $n\sin\Theta$, Θ being the maximum angle of light accepted by the objective. An infinity corrected objective is designed to have an image plane at infinity, therefore the rays leaving the objective are parallel. A major advantage of infinity corrected objectives is the focusing can be accomplished by moving just the objective, where without an infinity corrected object the only way to focus is to move the specimen or move the entire optical system (objective, tube lenses, eyepiece).
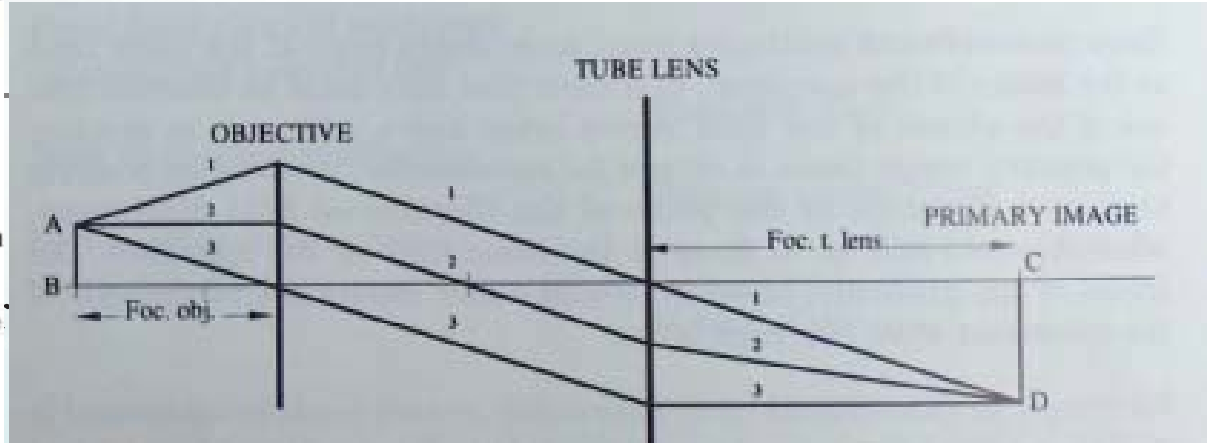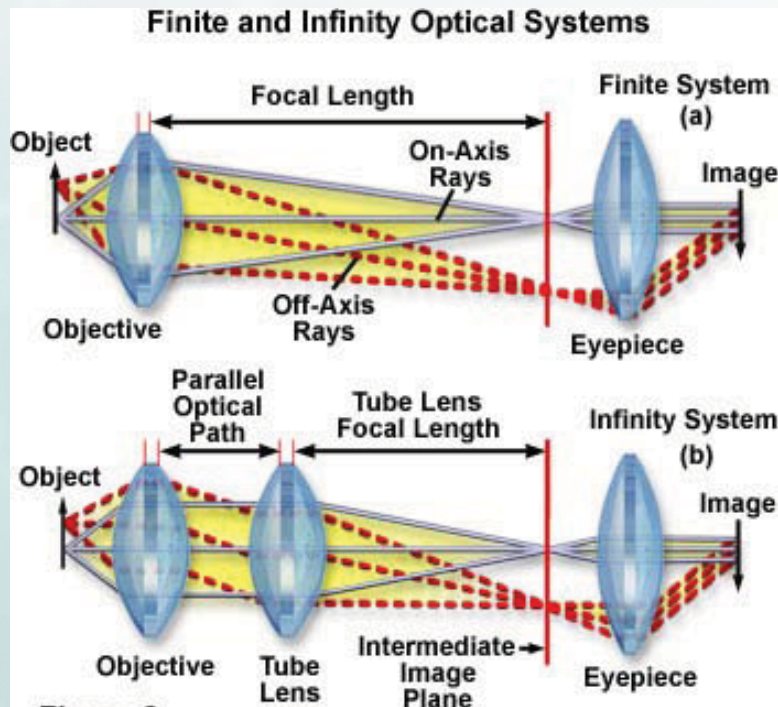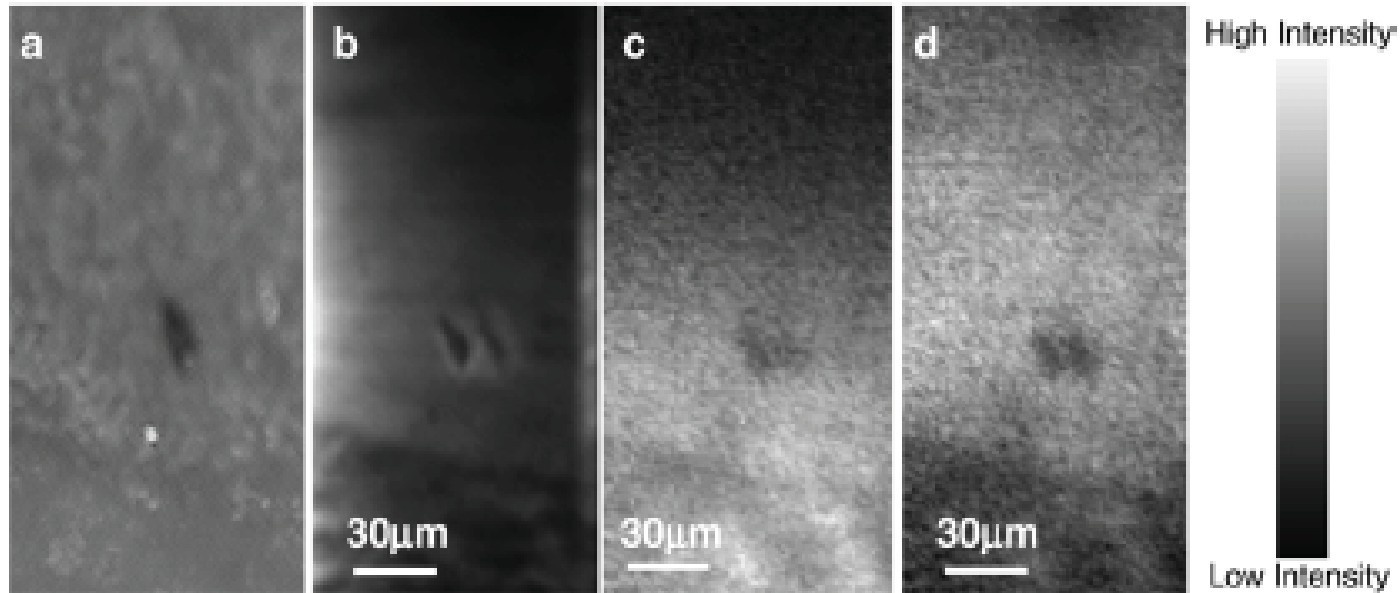
Pictures

Images of a cortical bone taken with a 10x infinity-corrected, plan apochromat.

Quantitative Description

The objective of a microscope is the piece that gathers light from the object and focuses it as a magnified real image of what is being observed. The objectives are essentially specific lens combinations, depending on what magnification is wanted. As a lens combination, the focal point, f, of the objective can be found by using lens equations such as

$$1/s_o + 1/s_i = 1/f$$

where s_o is the distance of the lens to the object and s_i is the distance to the image. Now using each s_i as the following lens's s_o, each lens' focal point can be added together to find the effective focal point, the focal point of the entire objective.

$$1/f_1 + 1/f_2 + \ldots = 1/f_{eff}$$

More Quantitative Description

Depth of Field Ranges

High NA / Low NA

Object (Specimen) Plane

Depth of Field

Figure 7

Depth of field of an objective is the axial range where the objective can focused, and the sharpness of the image is not noticeably changed. The depth of filed range changes radically between high and low numerical aperture objectives. The total depth of field can be determined by the formula,

$$d_{tot} = \lambda n/NA^2 + (n/M \cdot NA)e.$$

Where λ is the wavelength of illumination, **NA** is the objective numerical aperture, **M** is the objective lateral magnification, **e** is the smallest distance that can be resolved with a detector that is at the image plane of the objective, and **n** is the index of refraction.
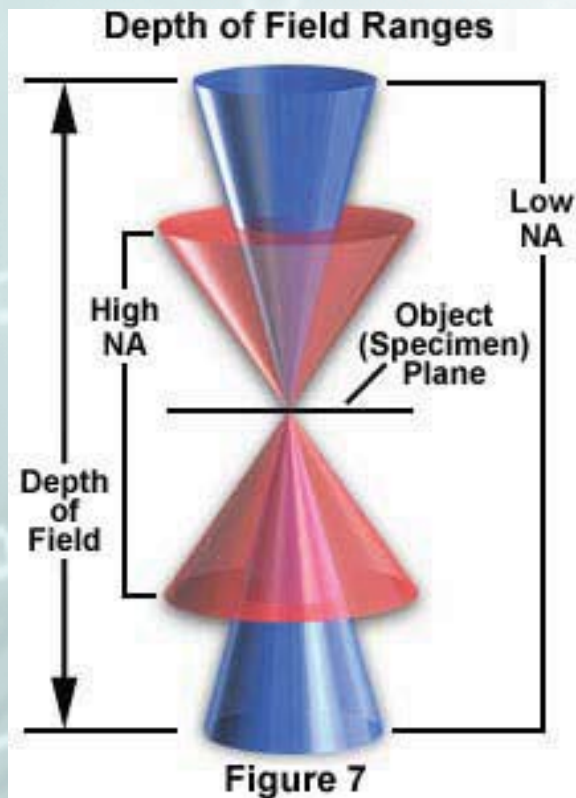
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Single Lens Reflex (SLR) Camera
## • Joel Cross, Jeff Dolan, Matt Wenderski

The first simple cameras consisted of a lens that focused the image on a piece of film and a separate viewfinder that the user looked through to see. The resulting picture was not always what the user saw through the view finder as a result.

The SLR camera fixed this problem by becoming the first camera that allowed users to see exactly what was going to be captured on film through the viewfinder.


The historic Contax S, 1949, the first pentaprism SLR for eye-level viewing

www.wikipedia.org

Qualitative Analysis

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- The SLR camera allows the user to point the camera in the same direction they are looking and still see exactly what the film is going to capture,

- This camera consists of three separate optical components that we have studied to make this possible.

- The lens must be used to make the image the correct size to fit on the piece of film. As a result of this the image is inverted and flipped left to right.

- The secret to the camera is the hinged mirror. This directs the image on a new path to the viewfinder while the user is acquiring the picture. This mirror swings out of the way when the shutter button is pushed, exposing the film to the light. It also flips the image back from left to right, undoing half of what the lens has done.

- The final component of the SLR camera is the roof pentaprism. This prism contains angles that redirect the light 90 degrees and inverts the image back to its original state.
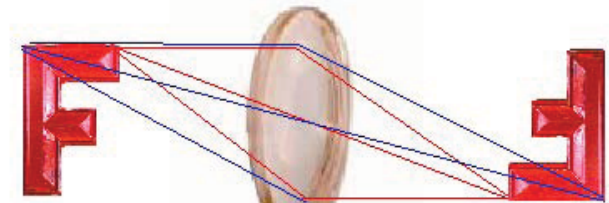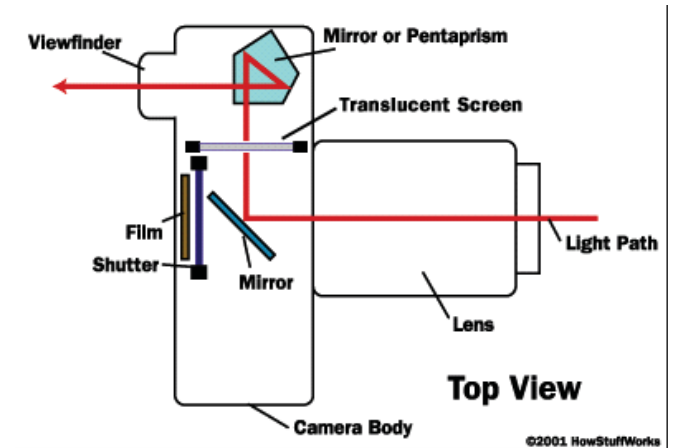

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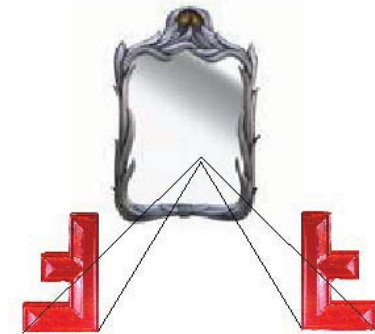

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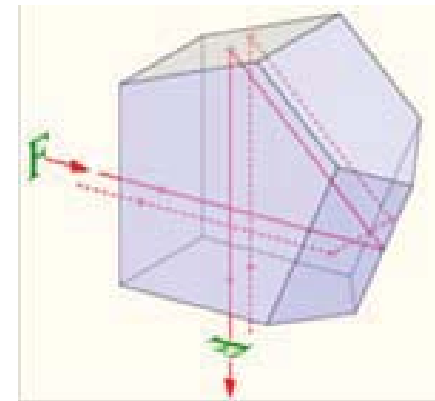
www.wikipedia.org

The Lens

- The first component is the lens. It focuses the light from the object onto the film.
- For the lens remember that $1/s_o + 1/s_i = 1/f$
- Lets use a 70mm lens and assume the object is 8m away.
- $((1/8m)-(1/.07m))^{-1} = .0706m$
- Next move the object to 6m away.
- $((1/6m)-(1/.07m))^{-1} = .0708m$
- Here we can see how the fine focus of the camera must be used. Changing the distance of the object by 2m means we must adjust the lens by .2mm.
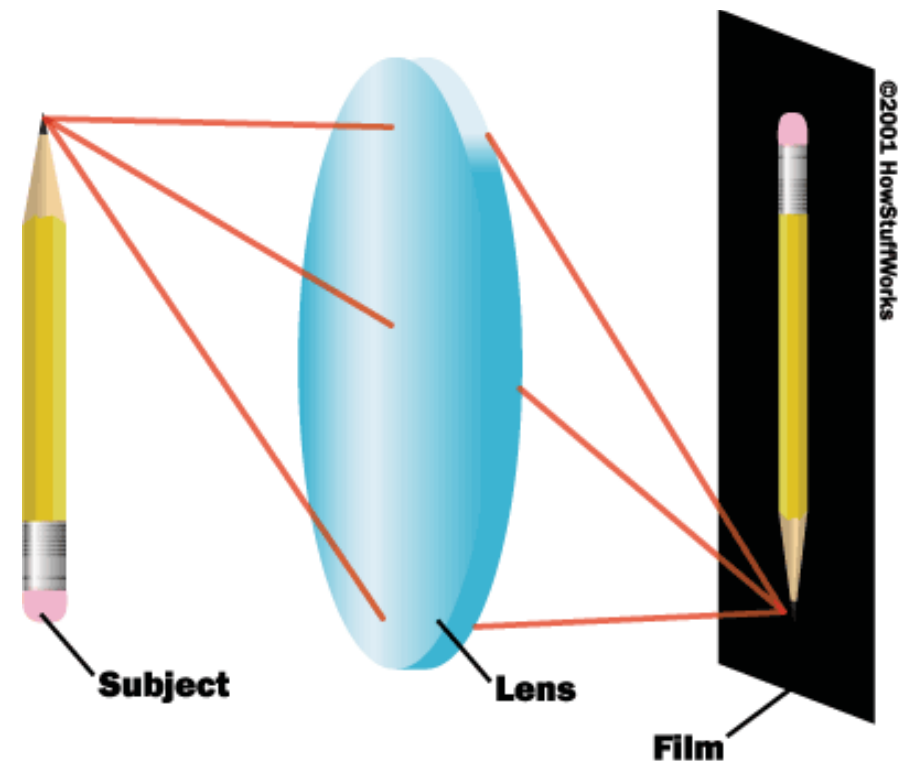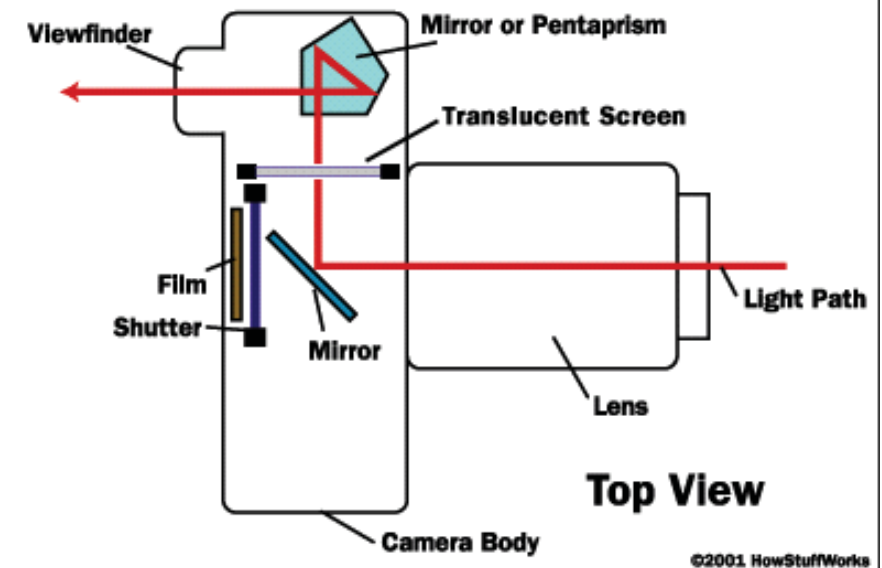
The Mirror

- The main feature that was added to make the SLR camera work was a hinged mirror. This mirror reflected the light at a 90 degree angle away from the film to the next component so that the user could see what was coming through the lens.
- The key to this component is that it is on a hinge. At the moment when the shutter button is pressed, the mirror swings out of the way and the light is now focused on the film.
- This is why the viewfinder of a SLR camera goes black when the picture is taken.
- The mirror must redirect the light 90 degrees off a flat 180 degree surface. This leaves 90 degrees that must be split evenly between the angle of incidence and the angle of reflection. So $\theta_i = \theta_r = 45$ deg.

Top View

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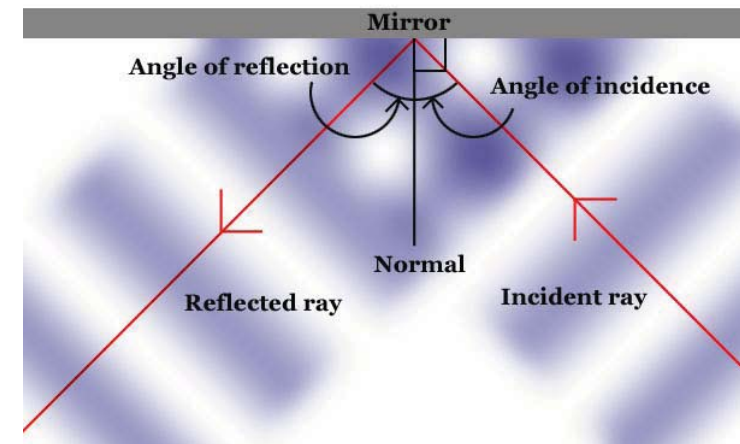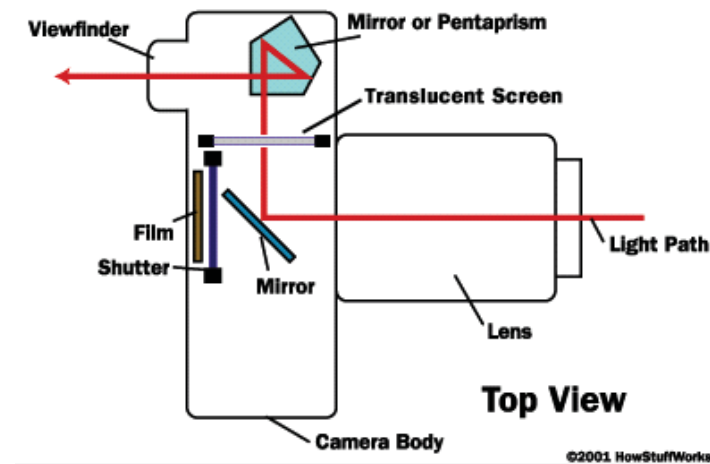
www.stevopia.com

The Pentaprism

- The final component of the SLR camera is the pentaprism.
- This prism uses silvered surfaces or mirrors to redirect the light by 90 degrees. This makes it so the camera can be pointed in the same direction the user is looking. Most cameras use a modified version of this called the roof pentaprism, which also inverts the image. This readjusts the effect of the mirror so that the image the user gets isn't backward.
- It is important to remember that in these optical components the main principle to consider is that the angle of incidence is equal to the angle of reflection.
- Consider the angles in the drawing for proof that $\theta_i = \theta_r$ on all of the flat surfaces, so these surfaces must be adjusted to redirect the light in the desired direction.
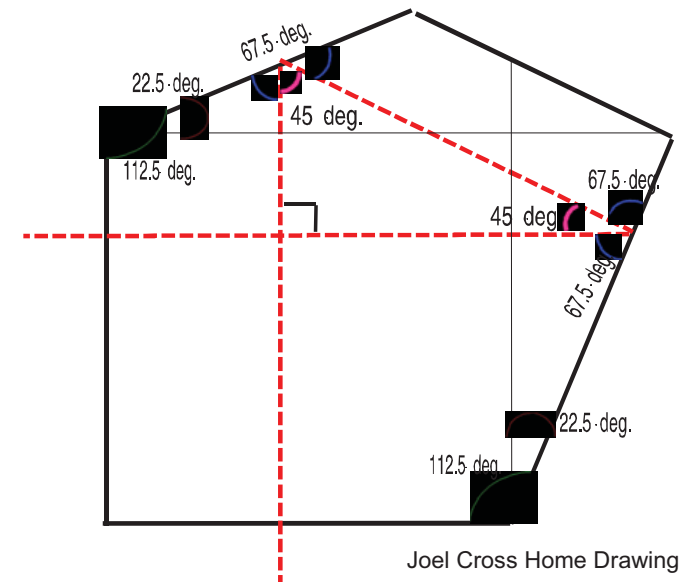
Joel Cross Home Drawing

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