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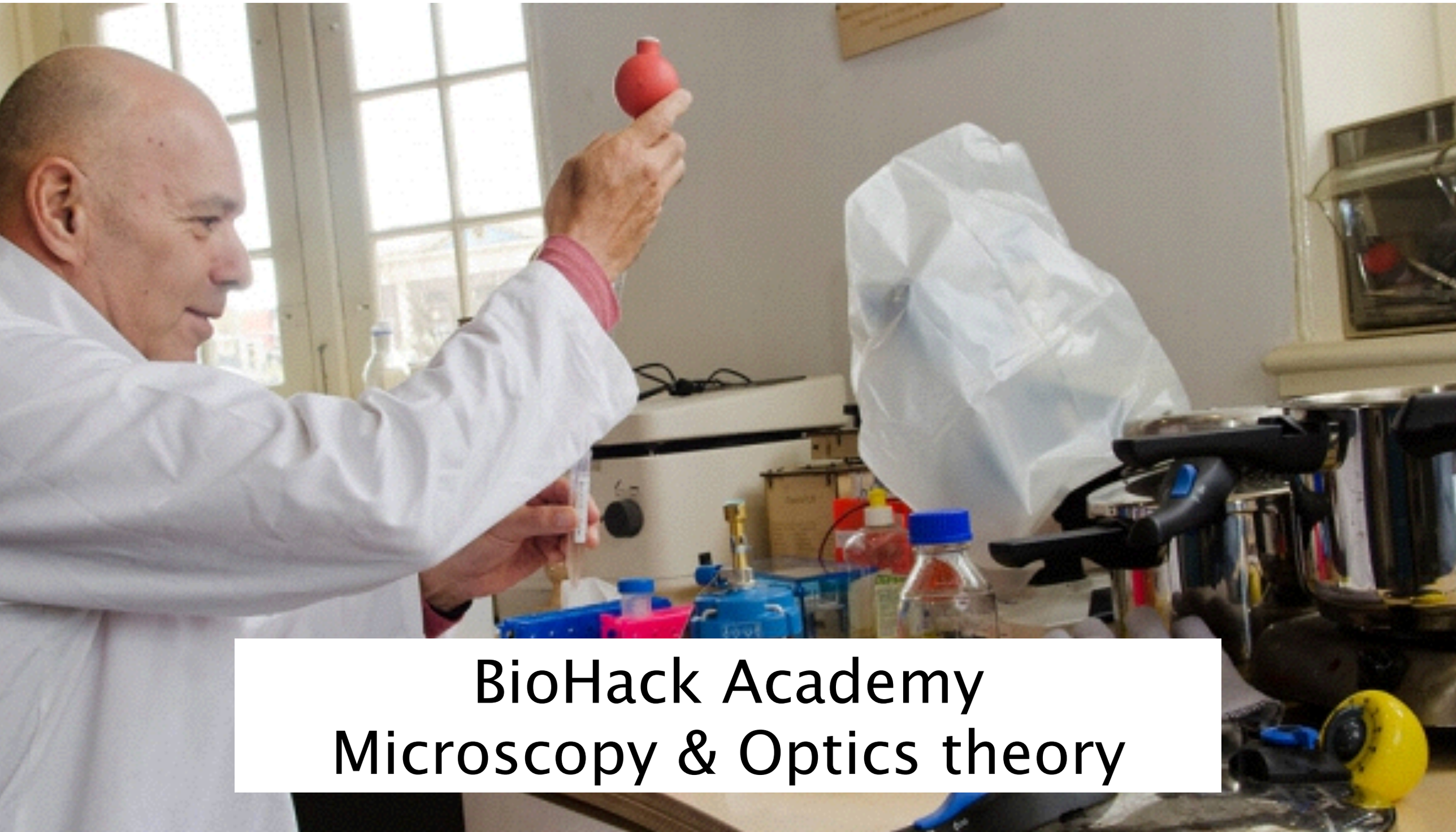


BioHack Academy
Microscopy & Optics theory

Antonie van Leeuwenhoek

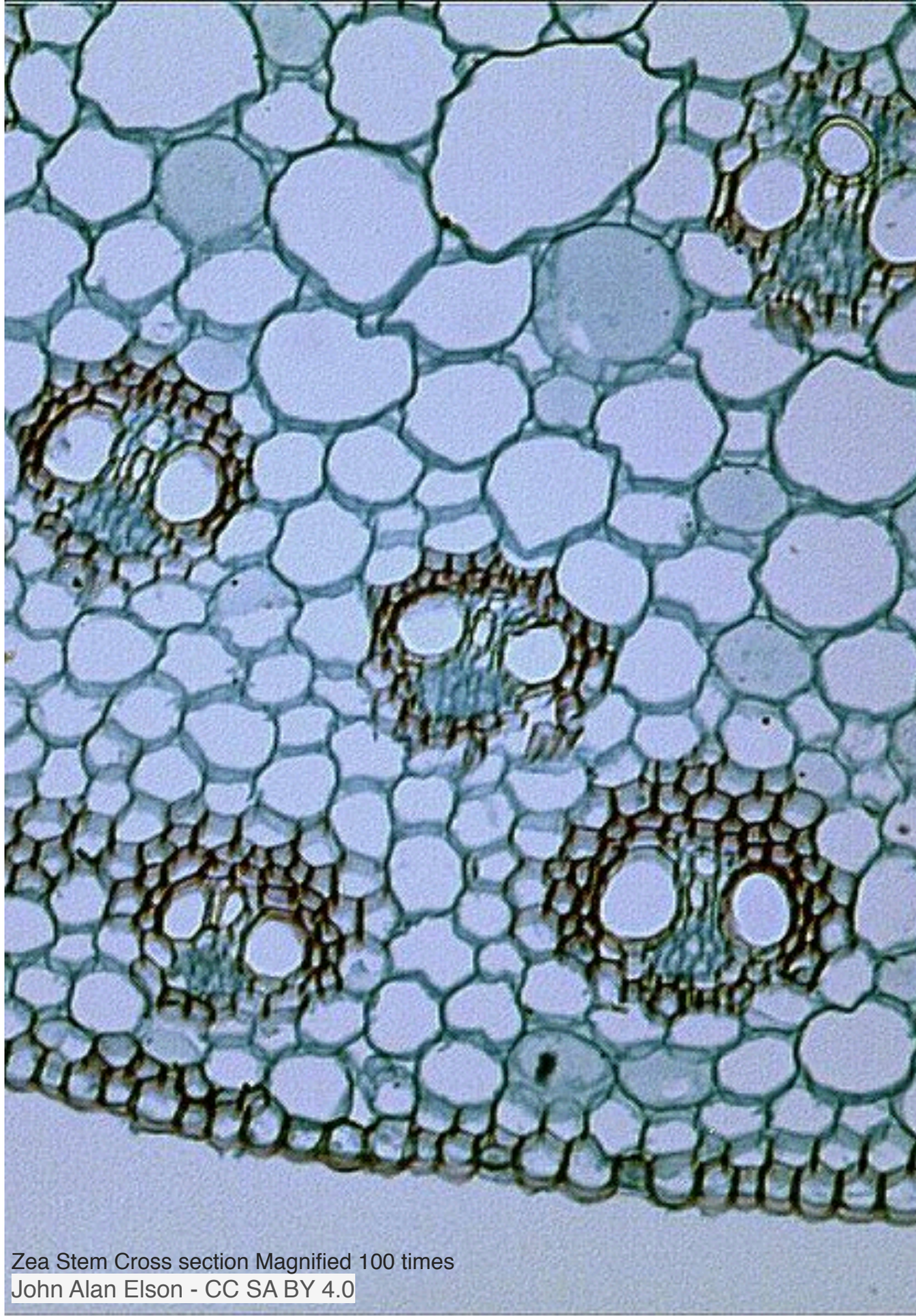
- Businessman
- Amateur biologist
- Lenses made from pulling glass in flame

Replica of microscope by Leeuwenhoek

Jeroen Rouwkema - CC BY-SA 3.0

Bright Field

- Shadow of the object



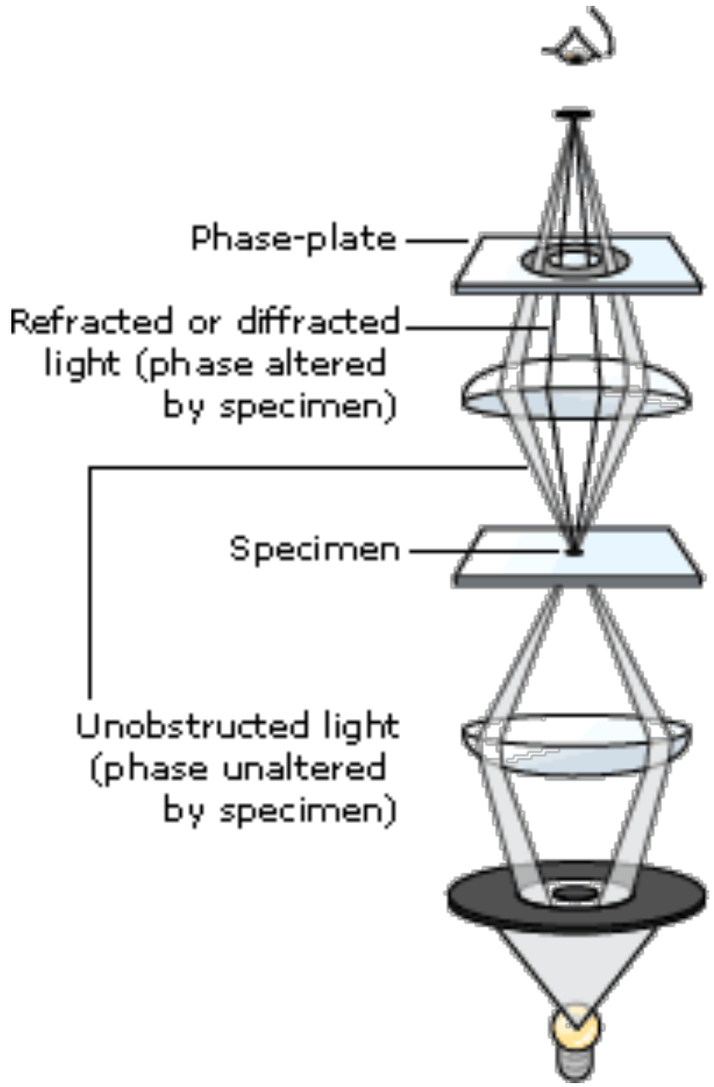
Zea Stem Cross section Magnified 100 times
John Alan Elson - CC SA BY 4.0

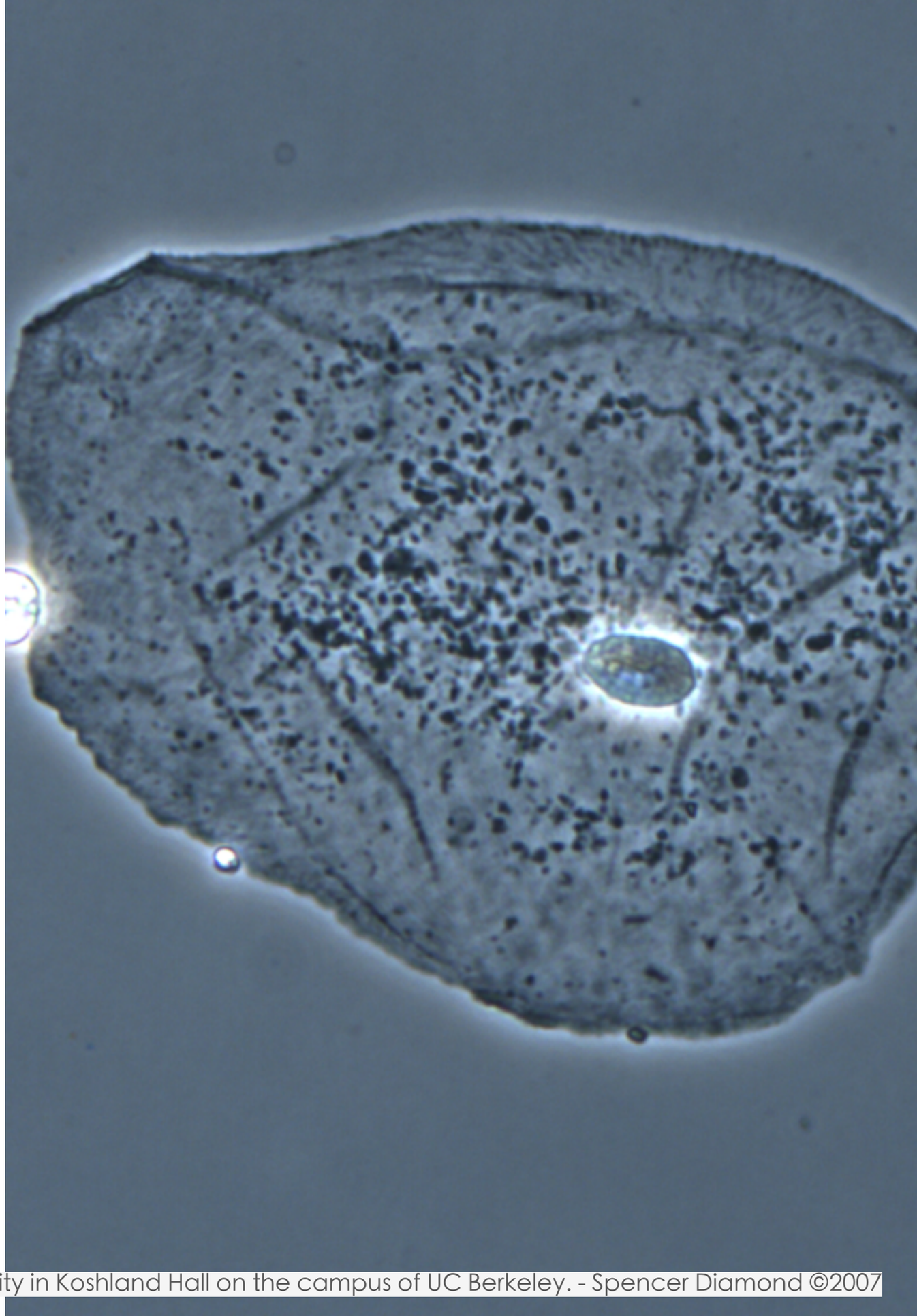
Dark Field

- Light from the side
- Reflected light
- Better contrast

Phase Contrast

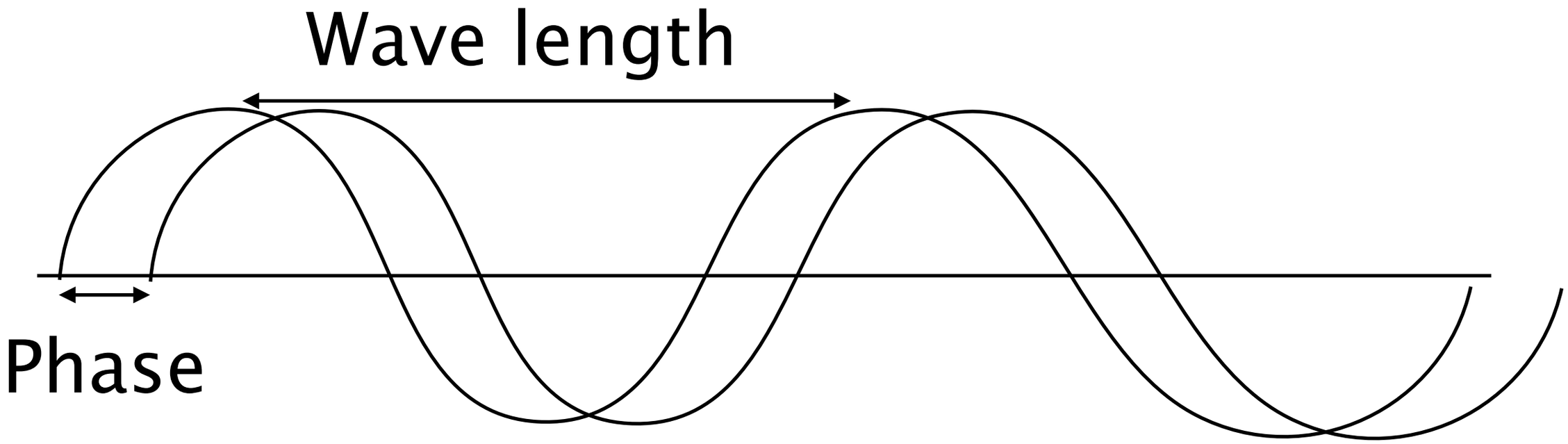
No need for staining



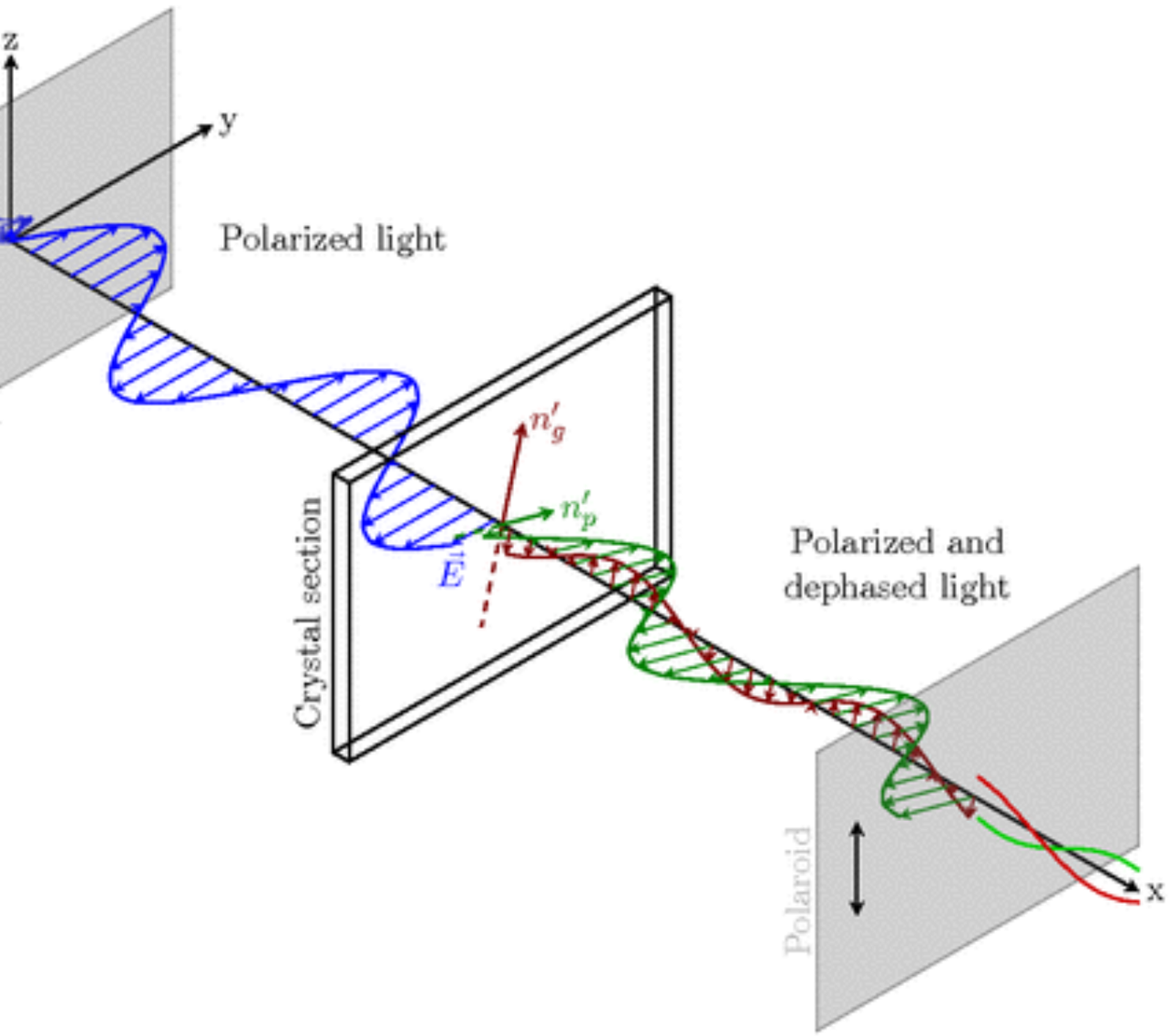


Spencer Diamond at the Biological Imaging Facility in Koshland Hall on the campus of UC Berkeley. - Spencer Diamond ©2007

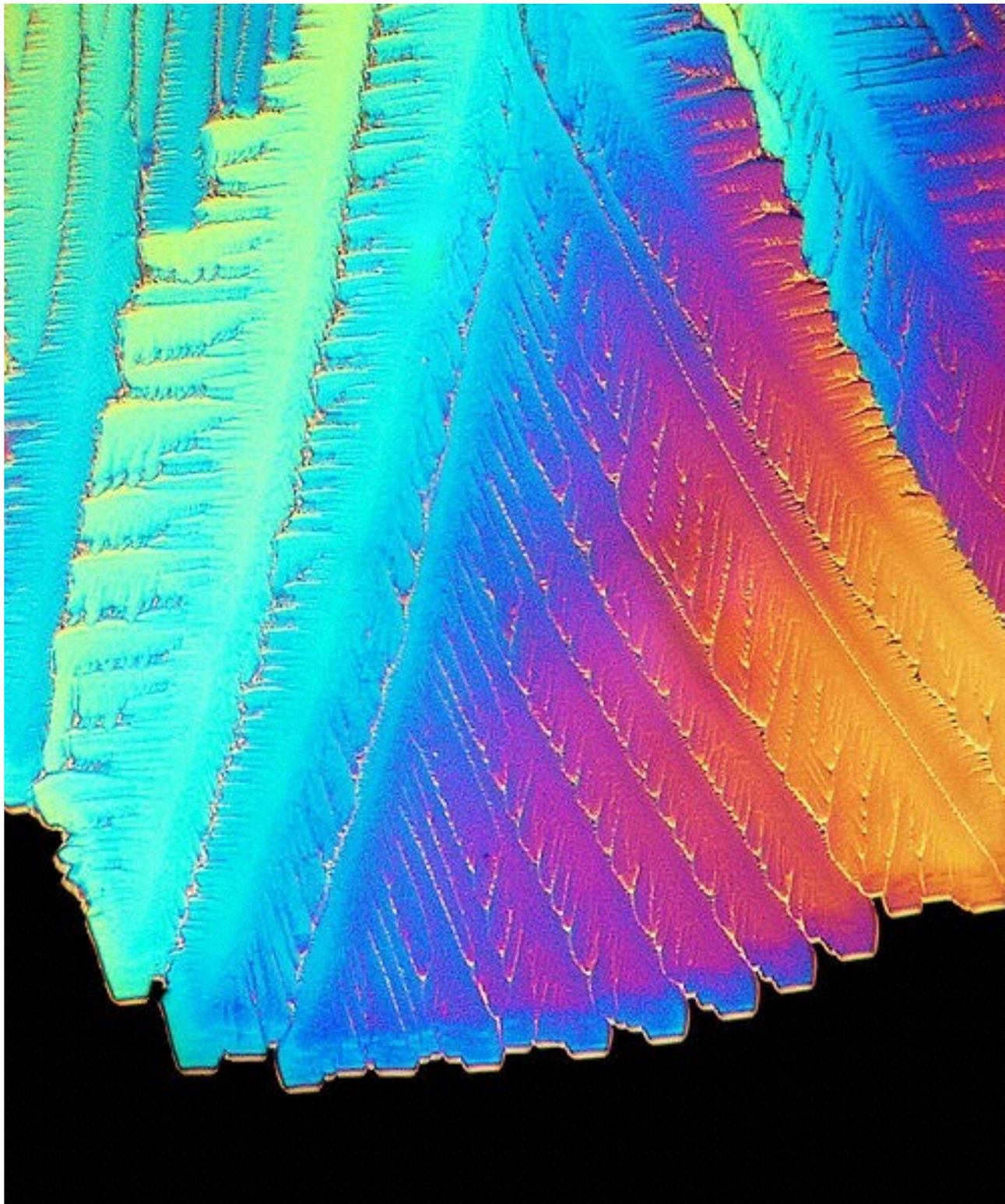
Light waves



Polarized microscopy



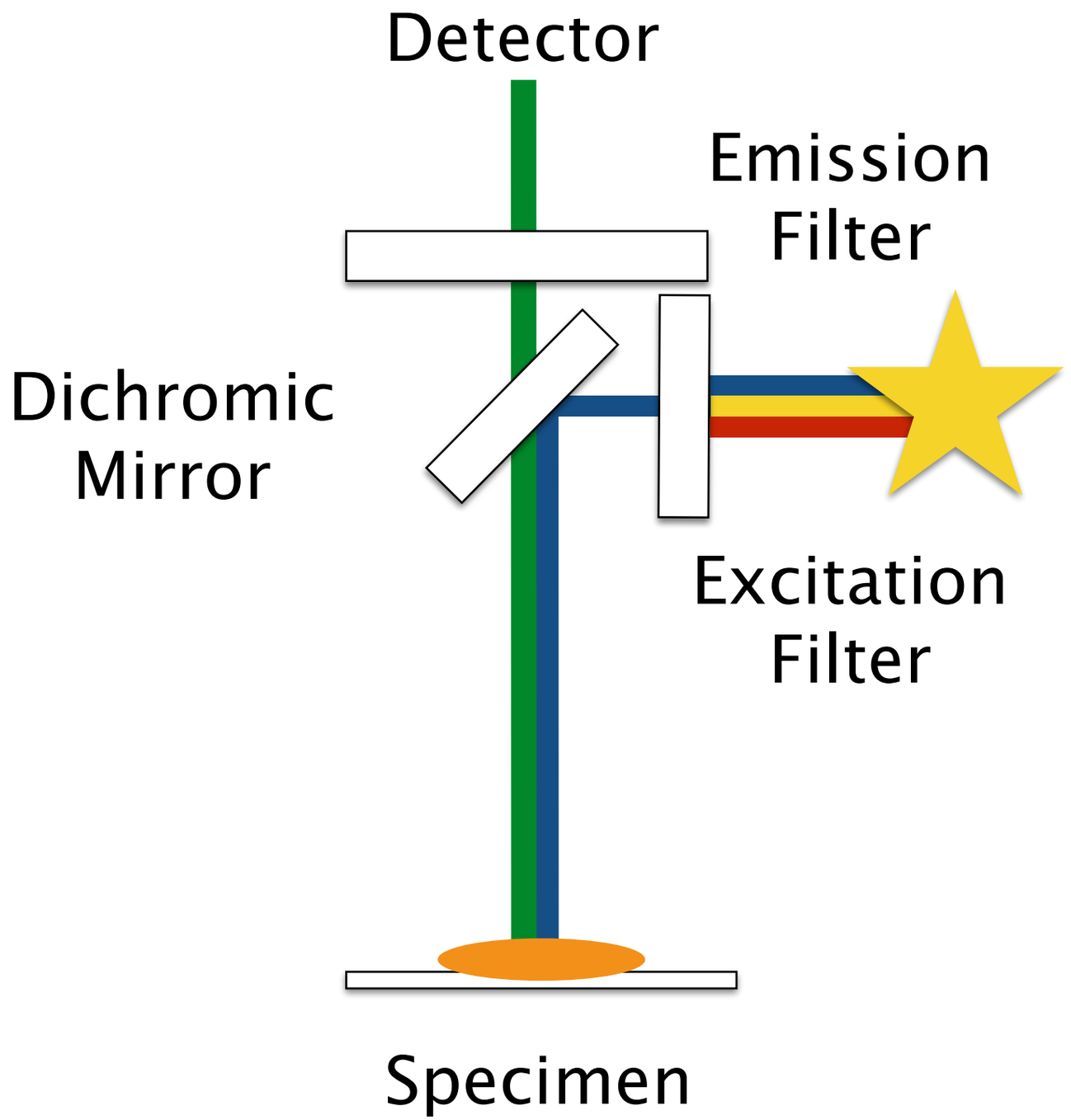
Cyril Langlois CC-BY 2.5



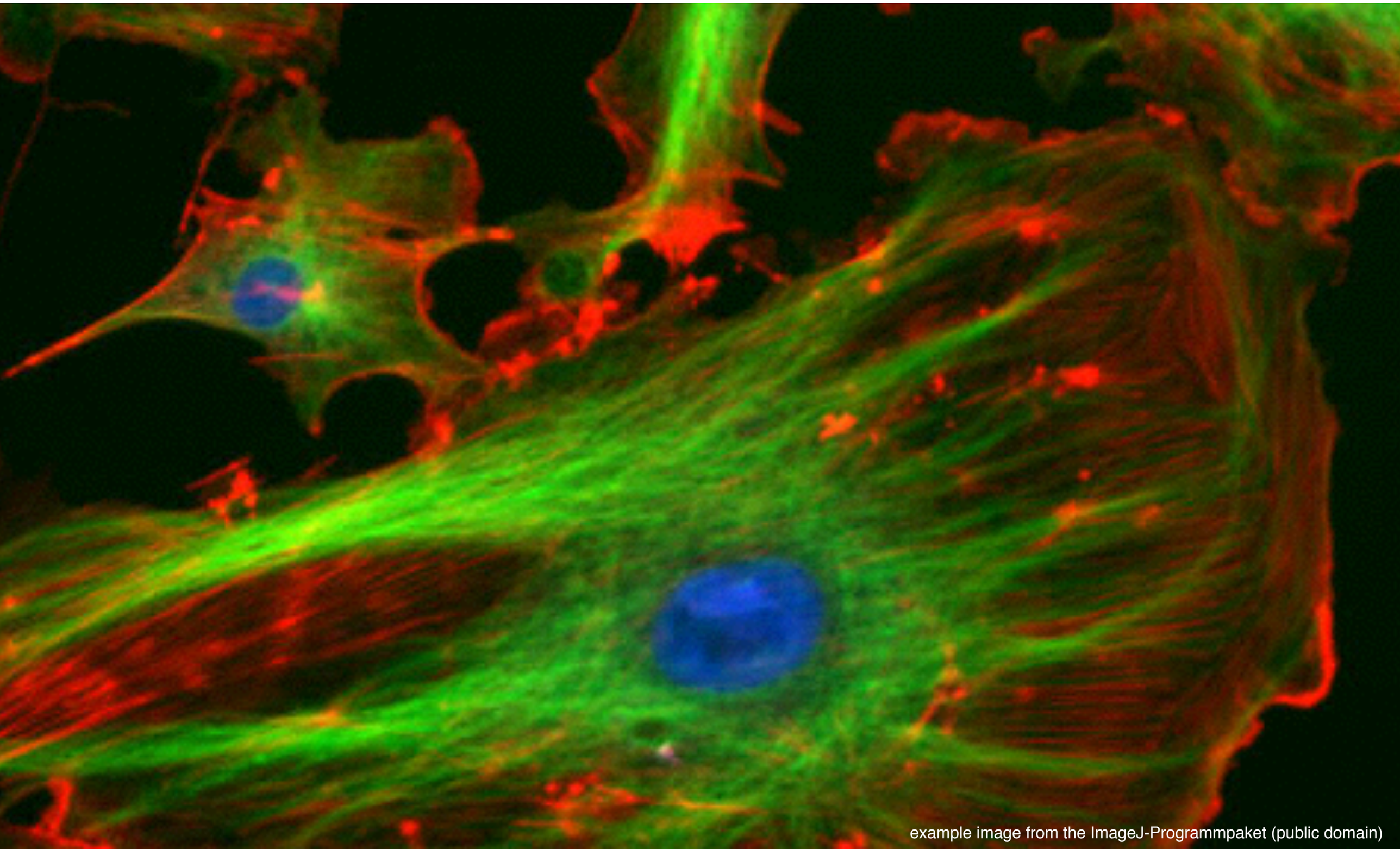
Fluorescent microscopy

- Excite with low wavelength
- Emits high wavelength

- Most important tool in optic biology



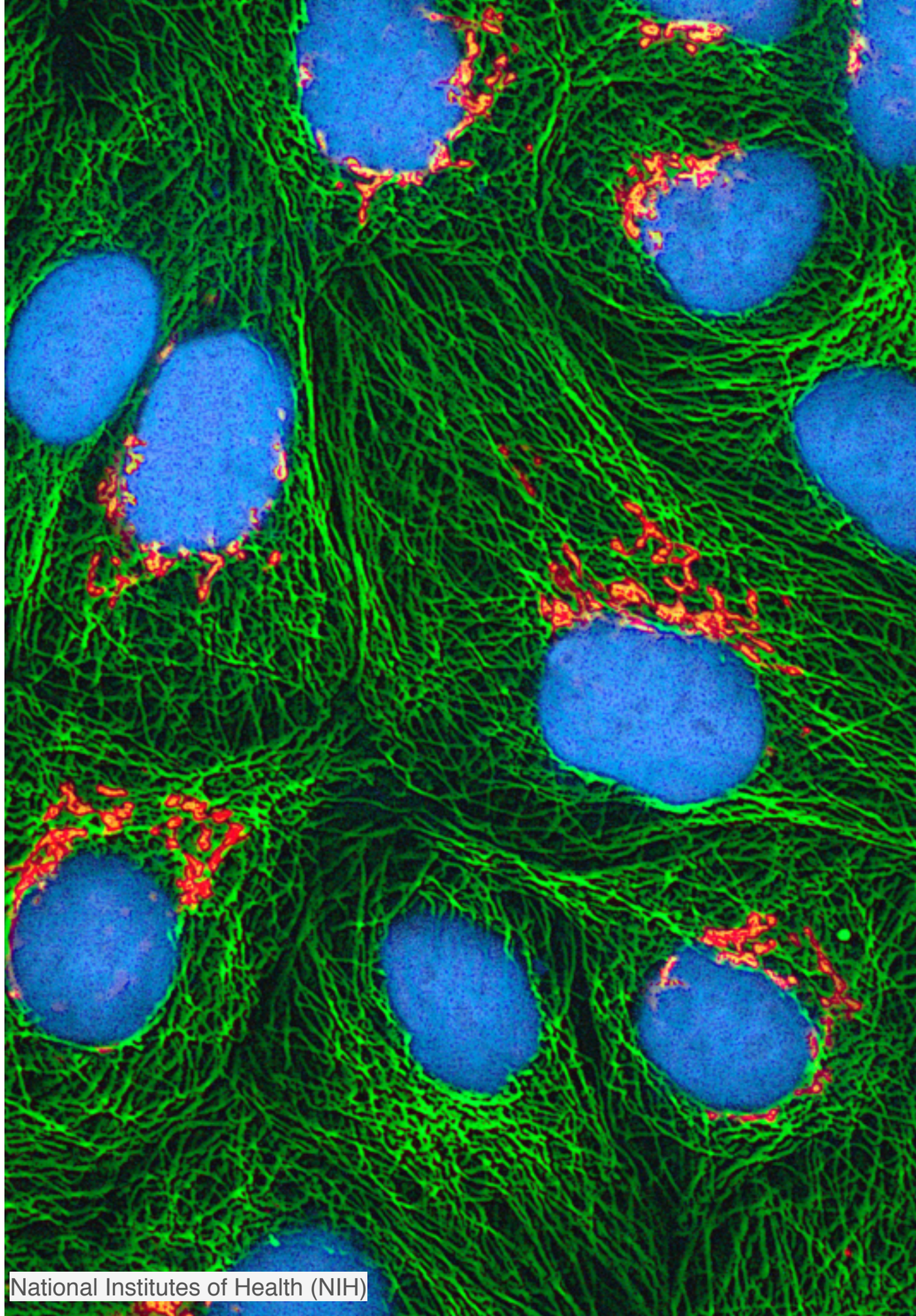
Fluorescence microscopy



example image from the ImageJ-Programmpaket (public domain)

Laser scanning microscopy

- Scan
- Focus better



National Institutes of Health (NIH)

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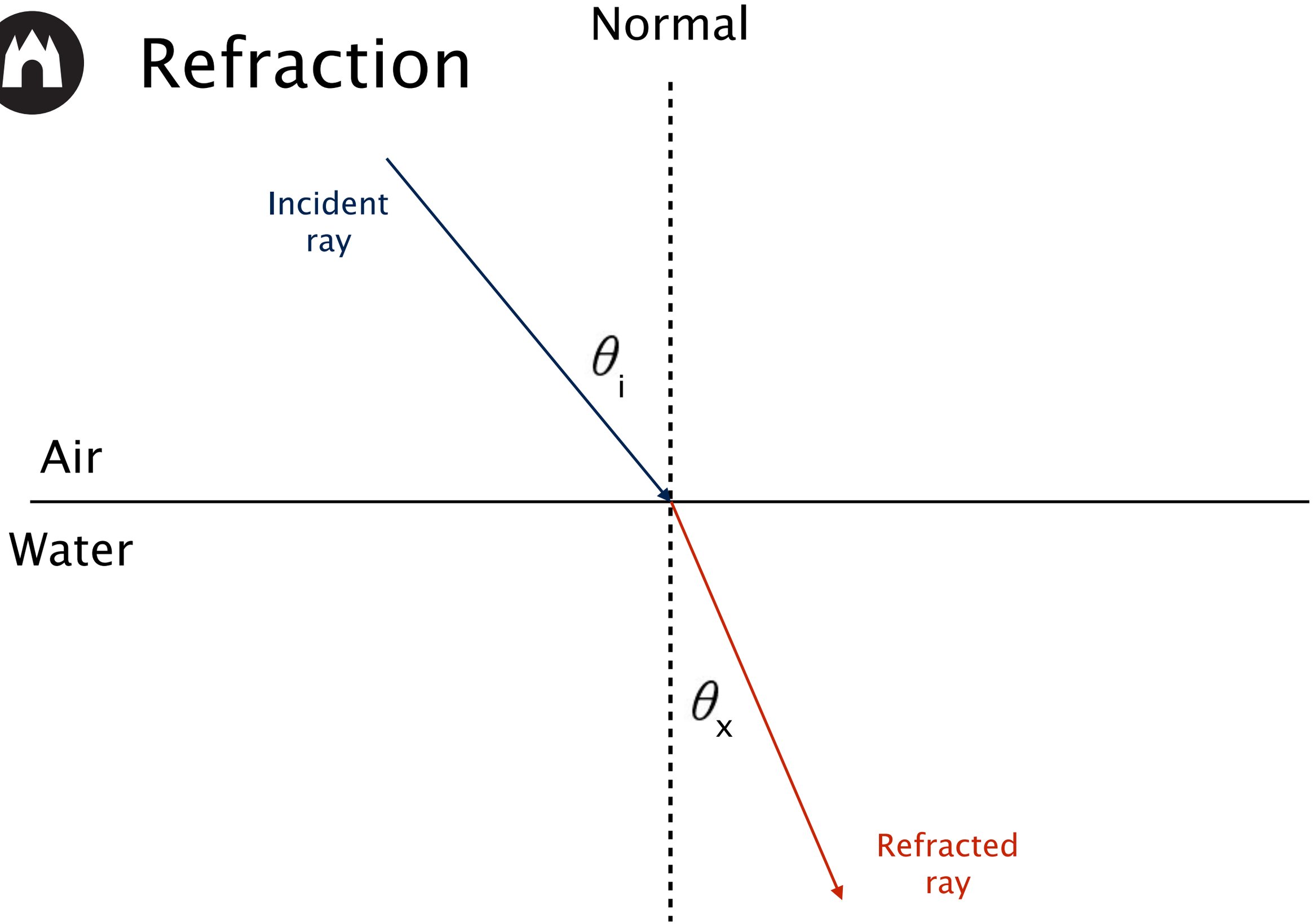
Optics

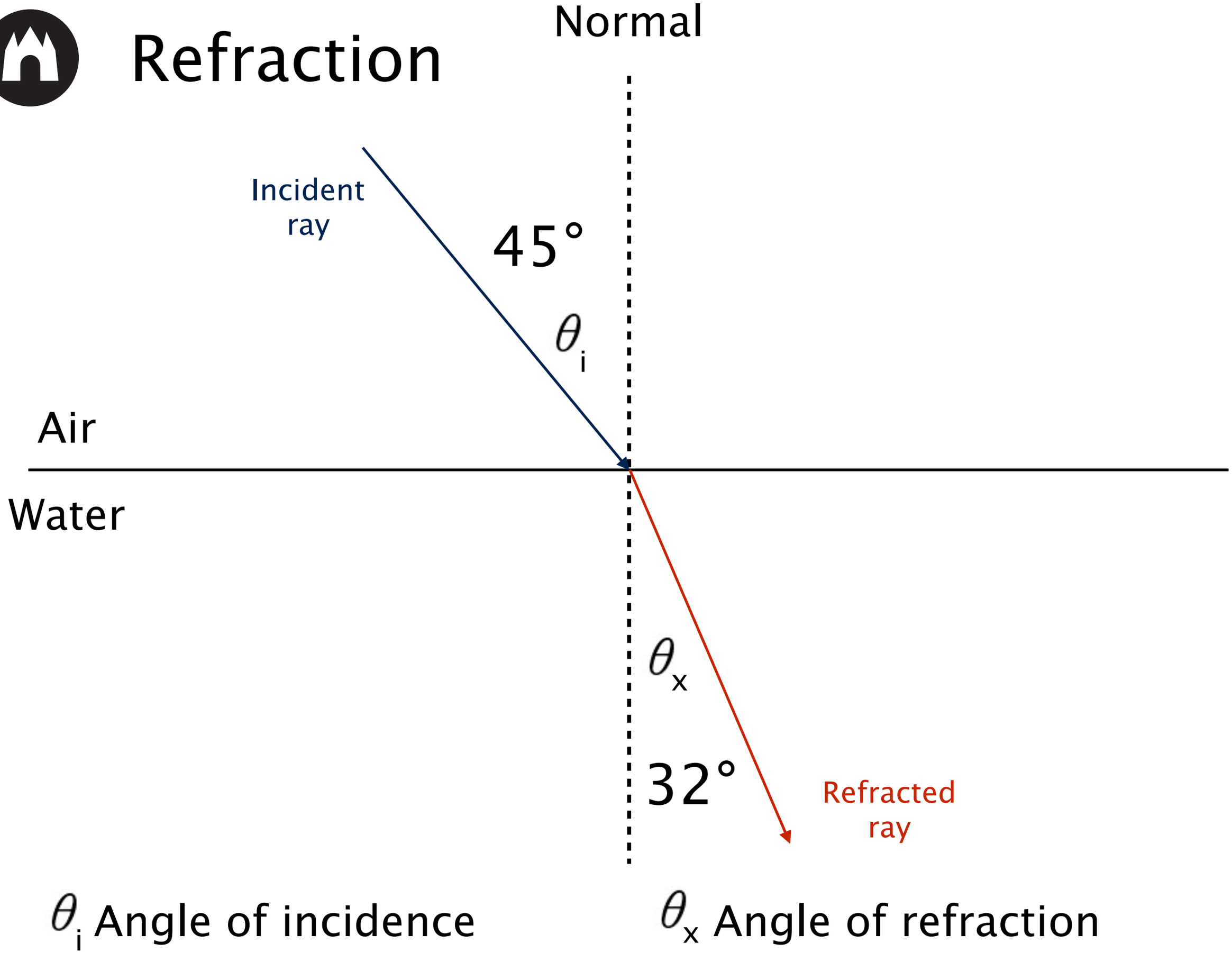
Refraction



θ_i Angle of incidence

θ_x Angle of refraction

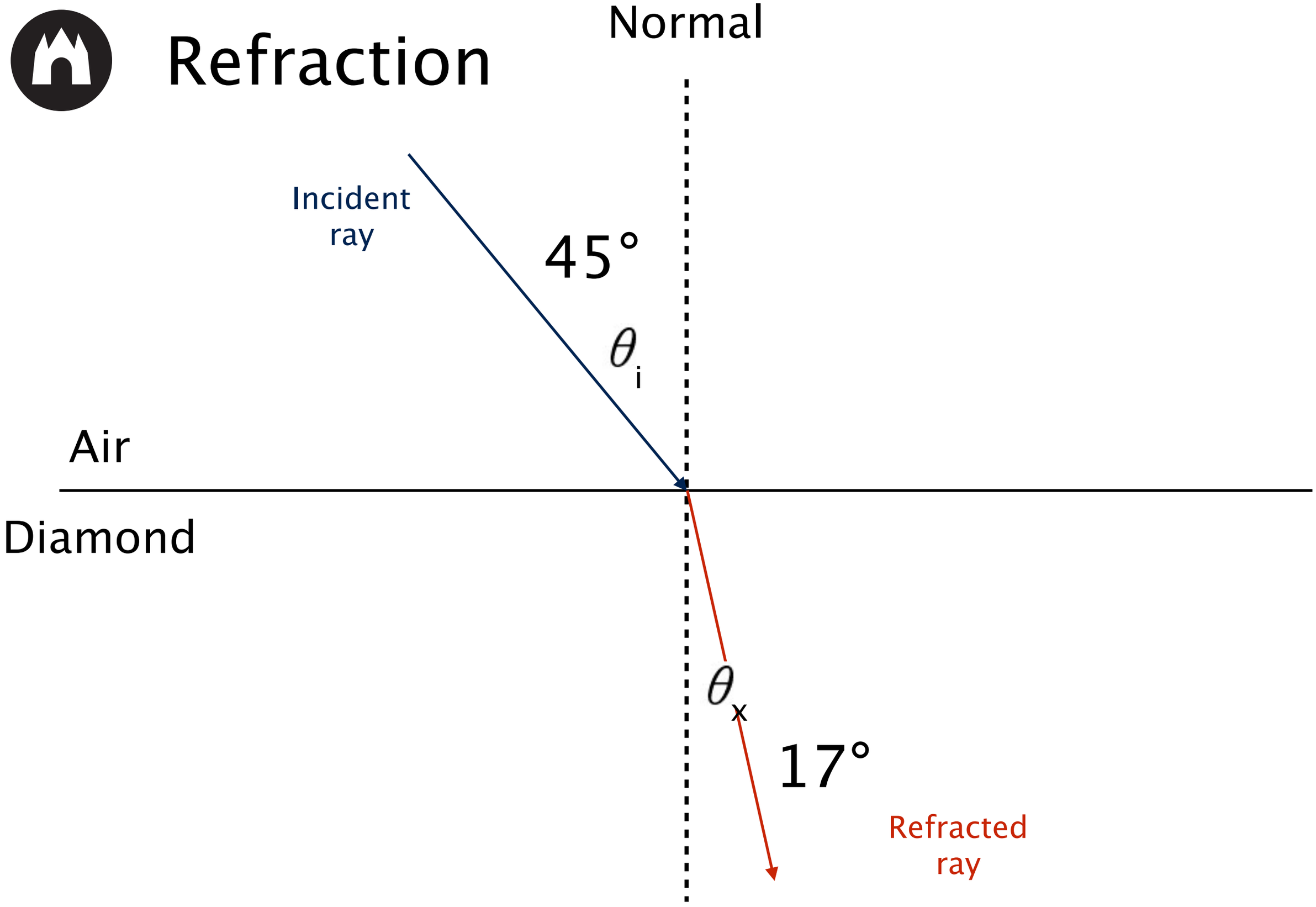
Refraction



θ_i Angle of incidence

θ_x Angle of refraction

Refraction



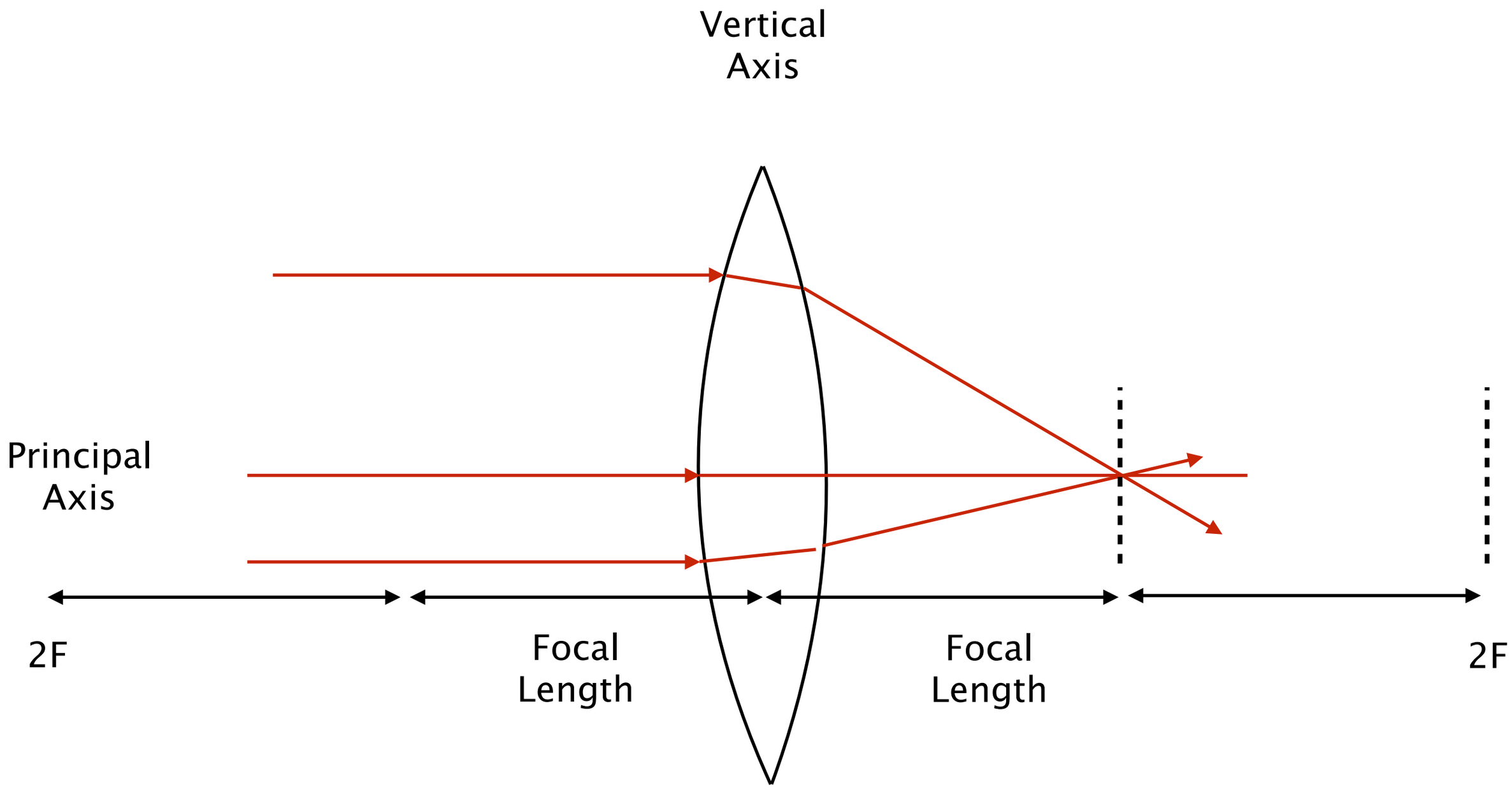
θ_i Angle of incidence

θ_x Angle of refraction

Snell's Law

$$\sin(\theta_i) = n_{material} \times \sin(\theta_x)$$

Anatomy of a Lens



Refraction in a lens

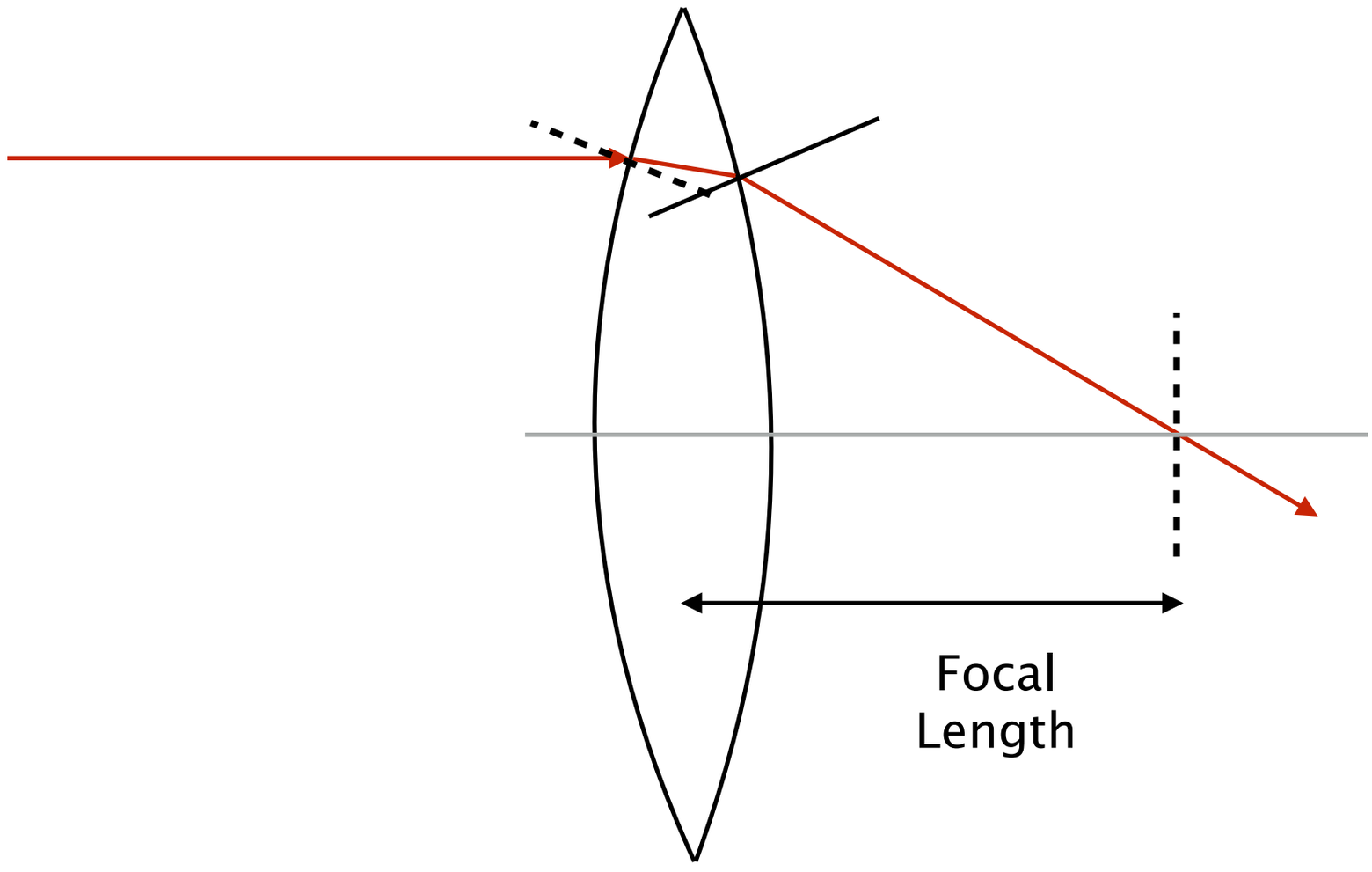
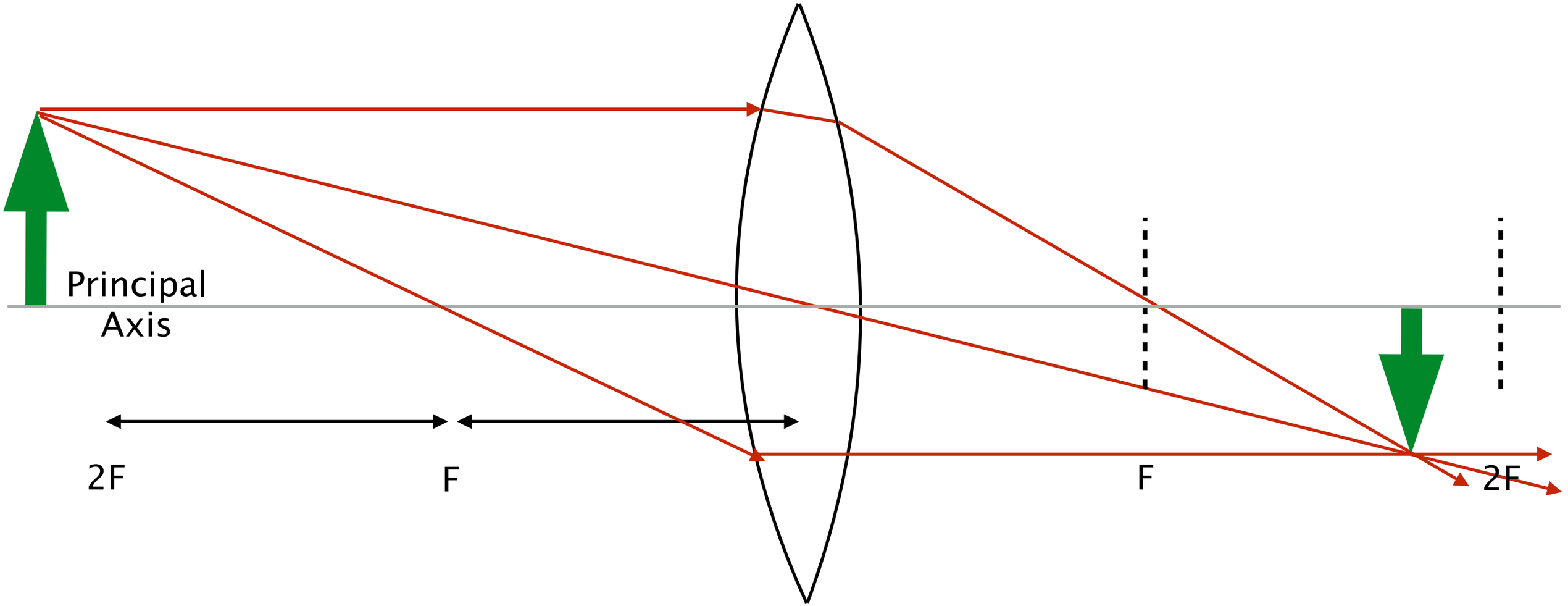
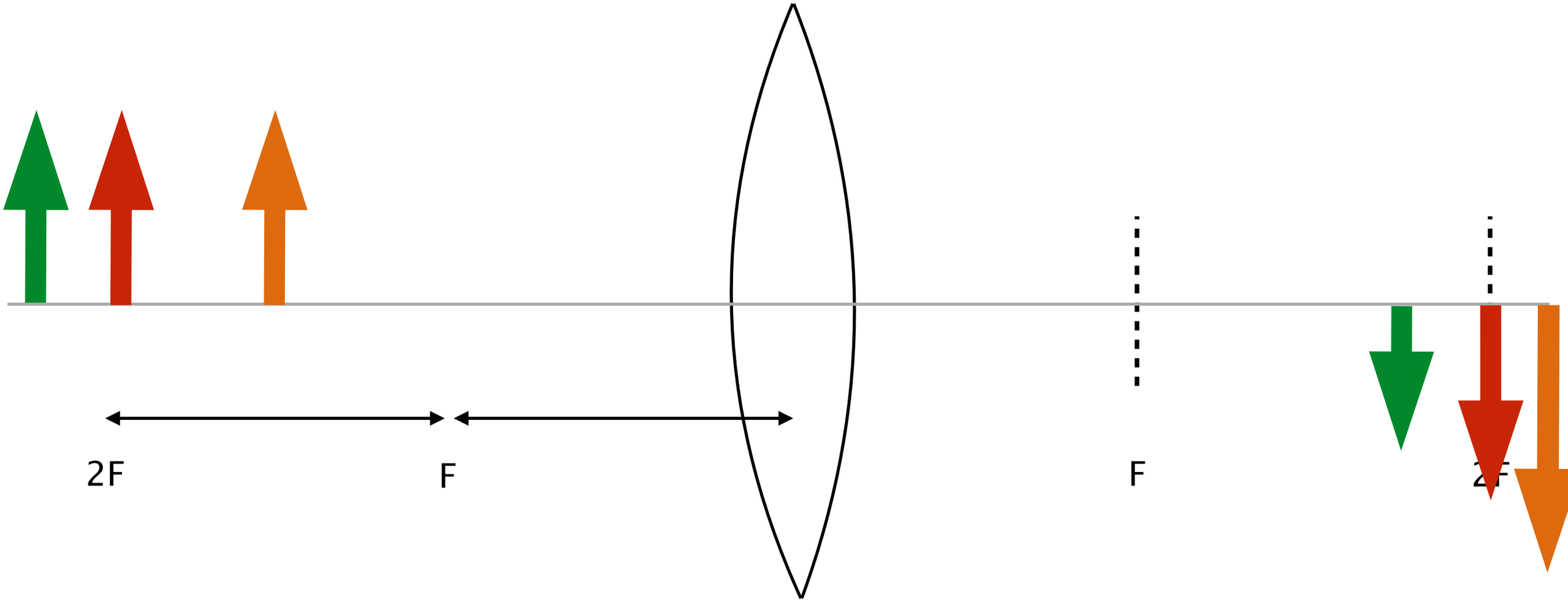


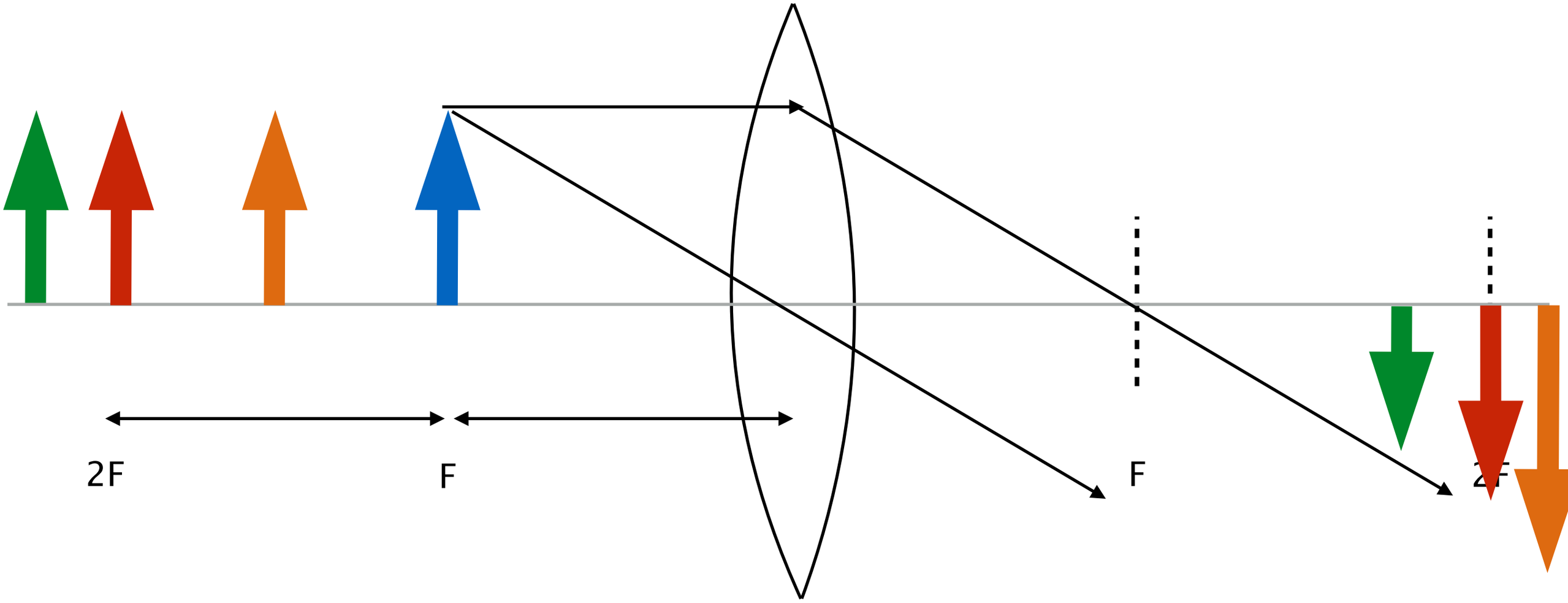
Image construction



Object / Image positions



Object on focal point



Lens formula

Lens equation

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

f = focal length
p = distance to object
q = distance to image

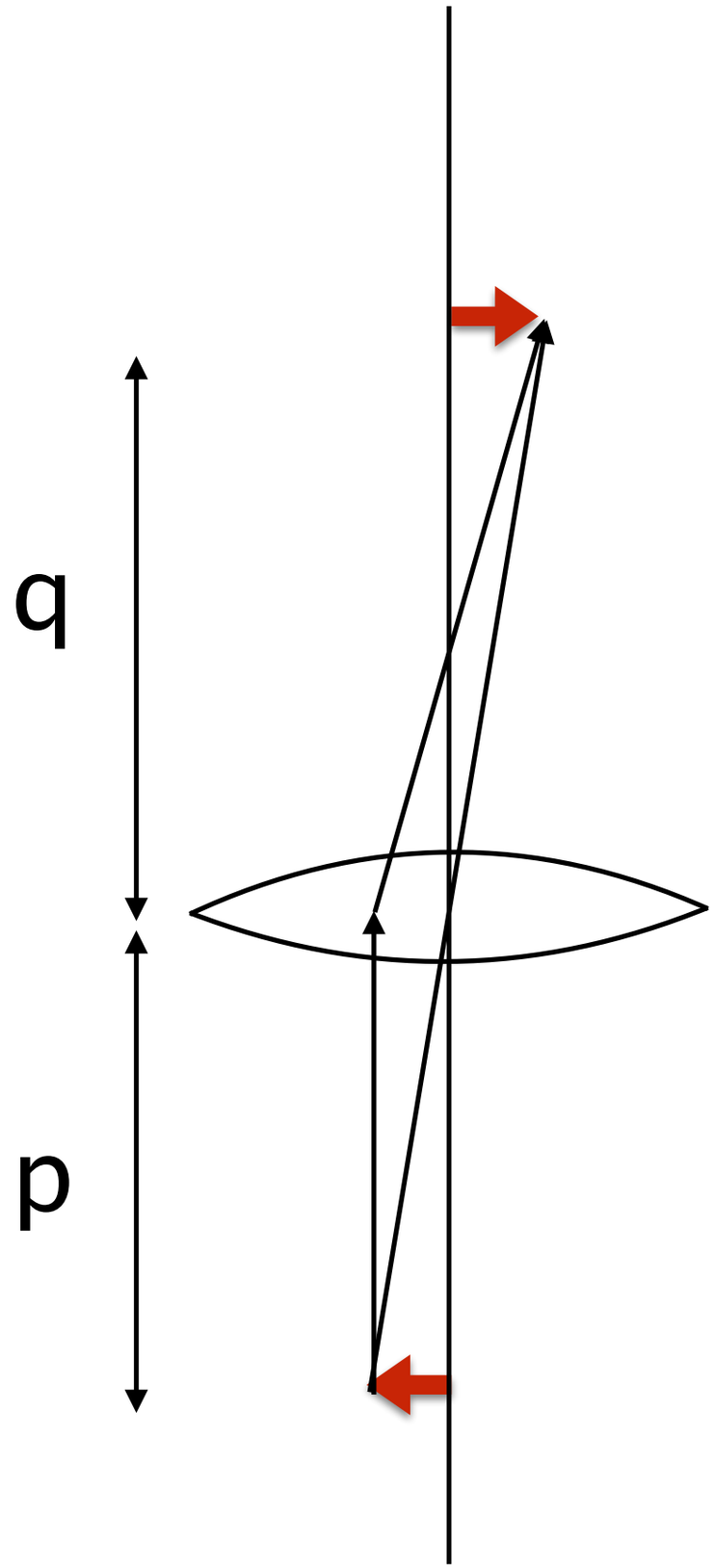
Microscope formulas

F = 18.2

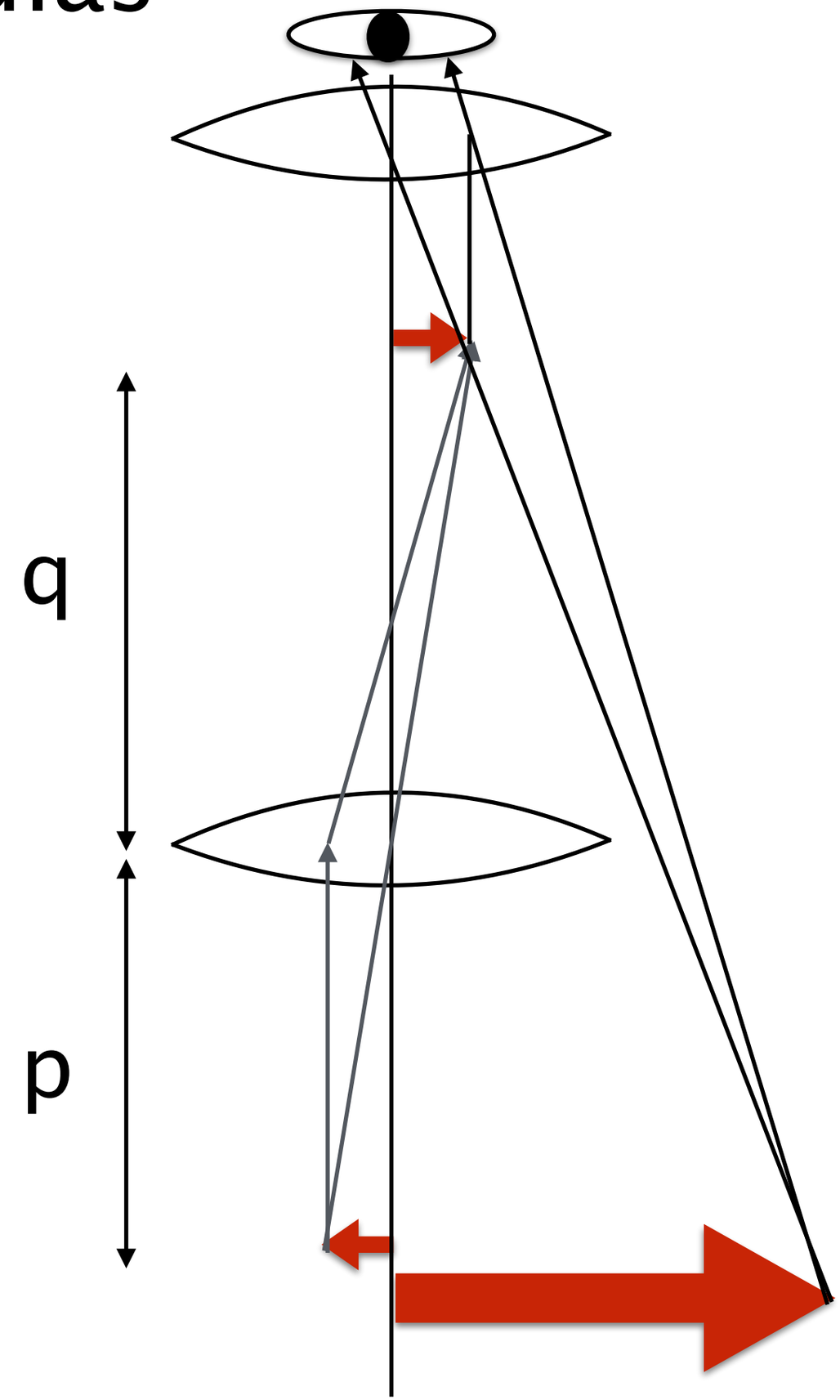
$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

q = 160 mm

p = 20.6 mm



Microscope formulas



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