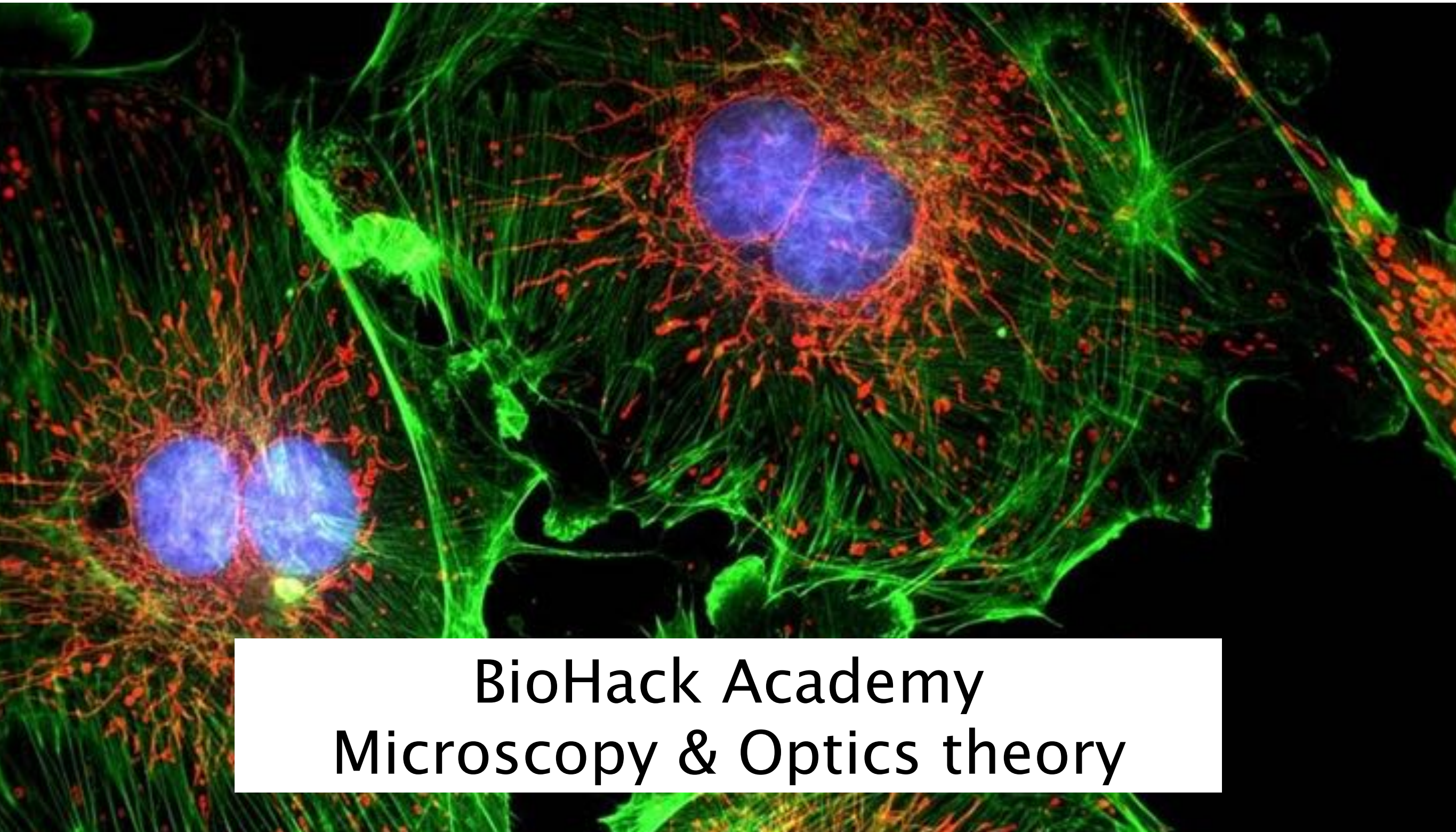




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**BioHack Academy
Microscopy & Optics theory**



Antonie van Leeuwenhoek

- Businessman
- Amateur biologist
- Lenses made from pulling glass rods apart in a flame

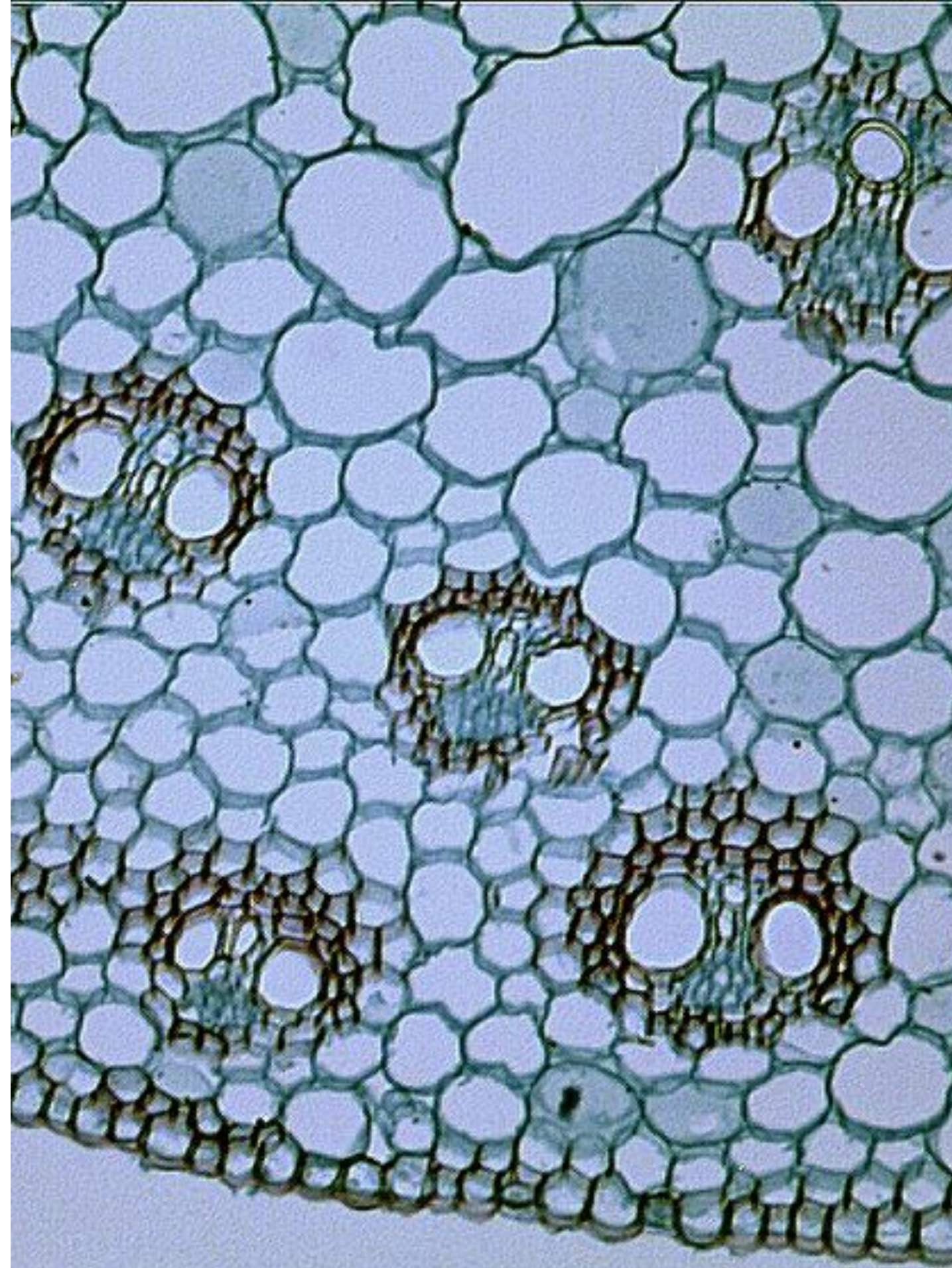


Replica of microscope by Leeuwenhoek
Jeroen Rouwkema - CC BY-SA 3.0



Bright Field

- Shadow of the object



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



Dark Field

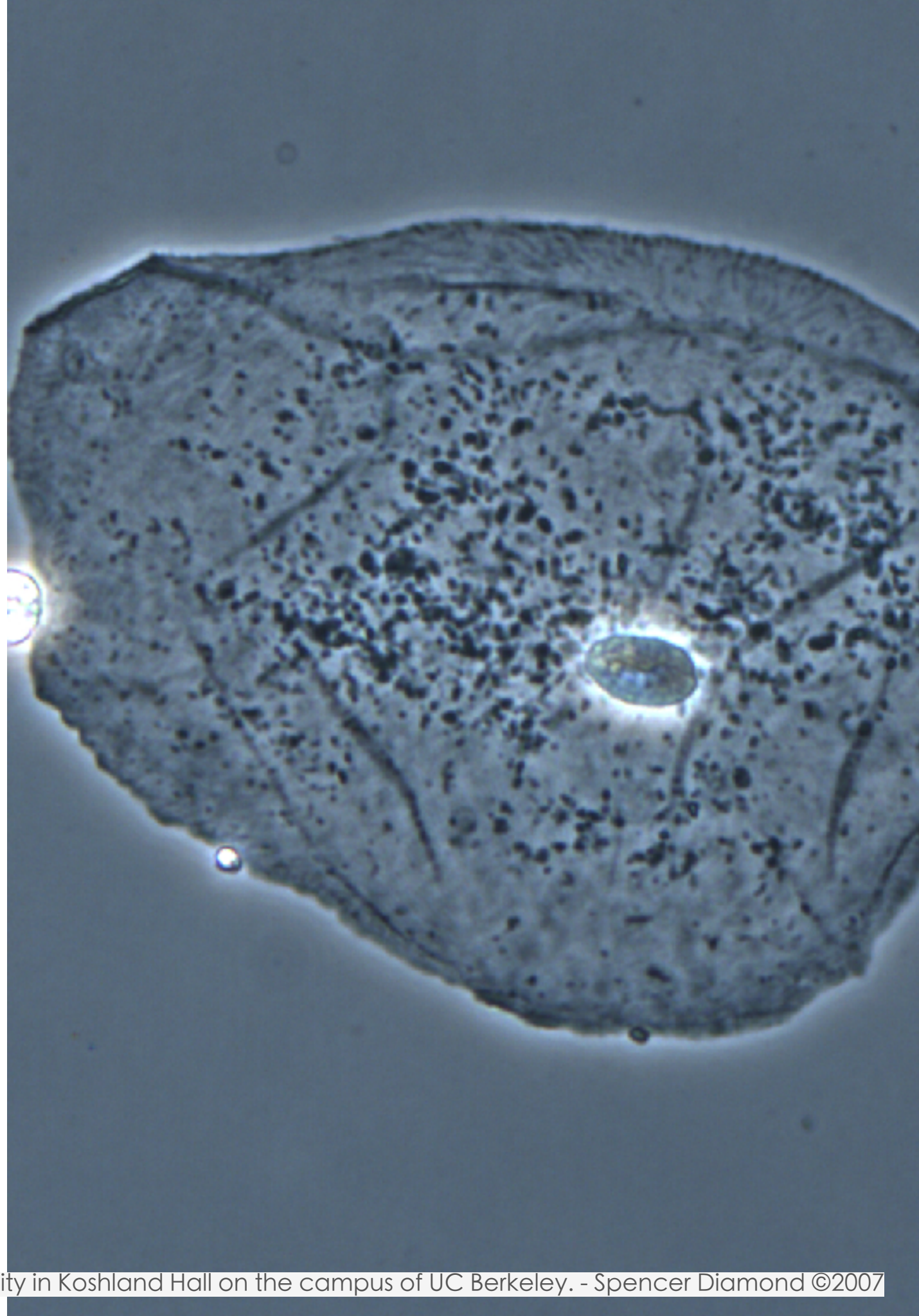
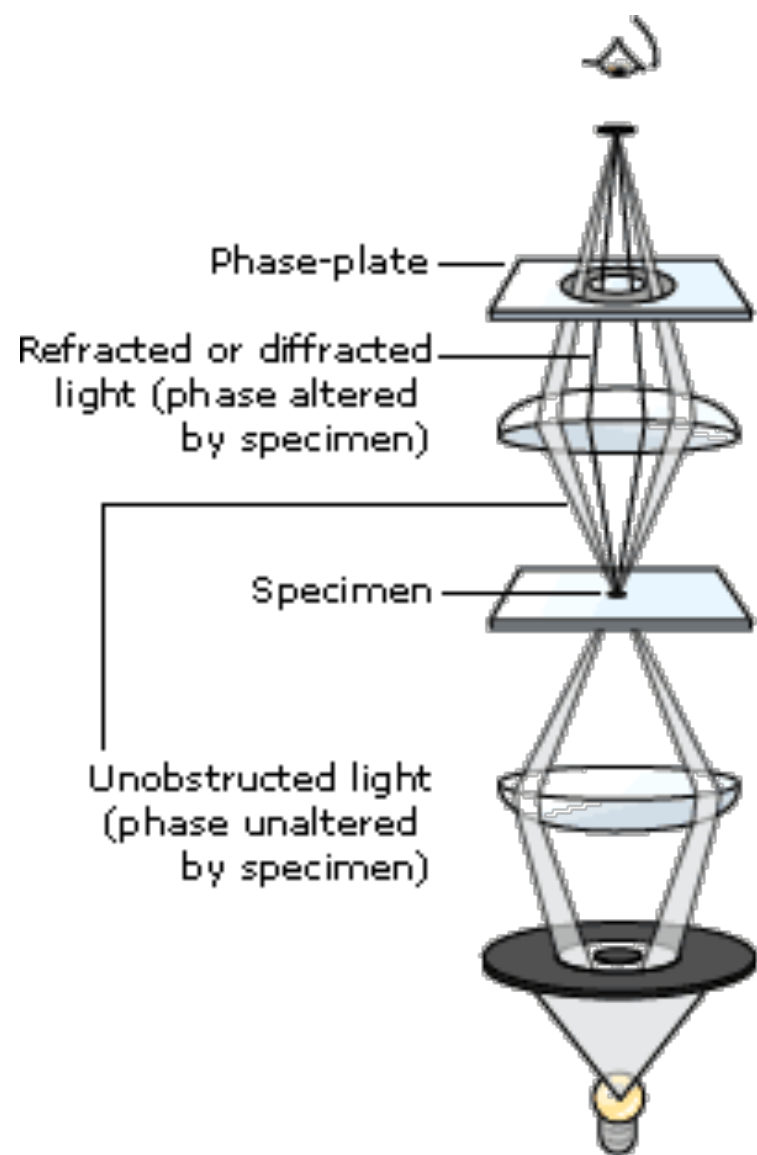
- Light from the side
- Reflected light
- Better contrast





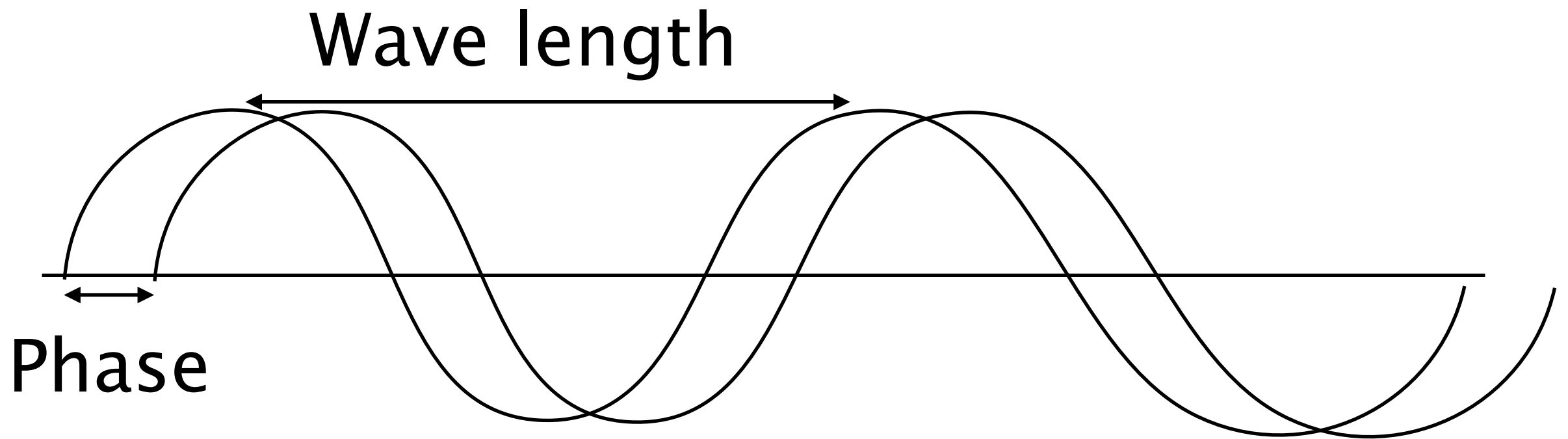
Phase Contrast

No need for staining





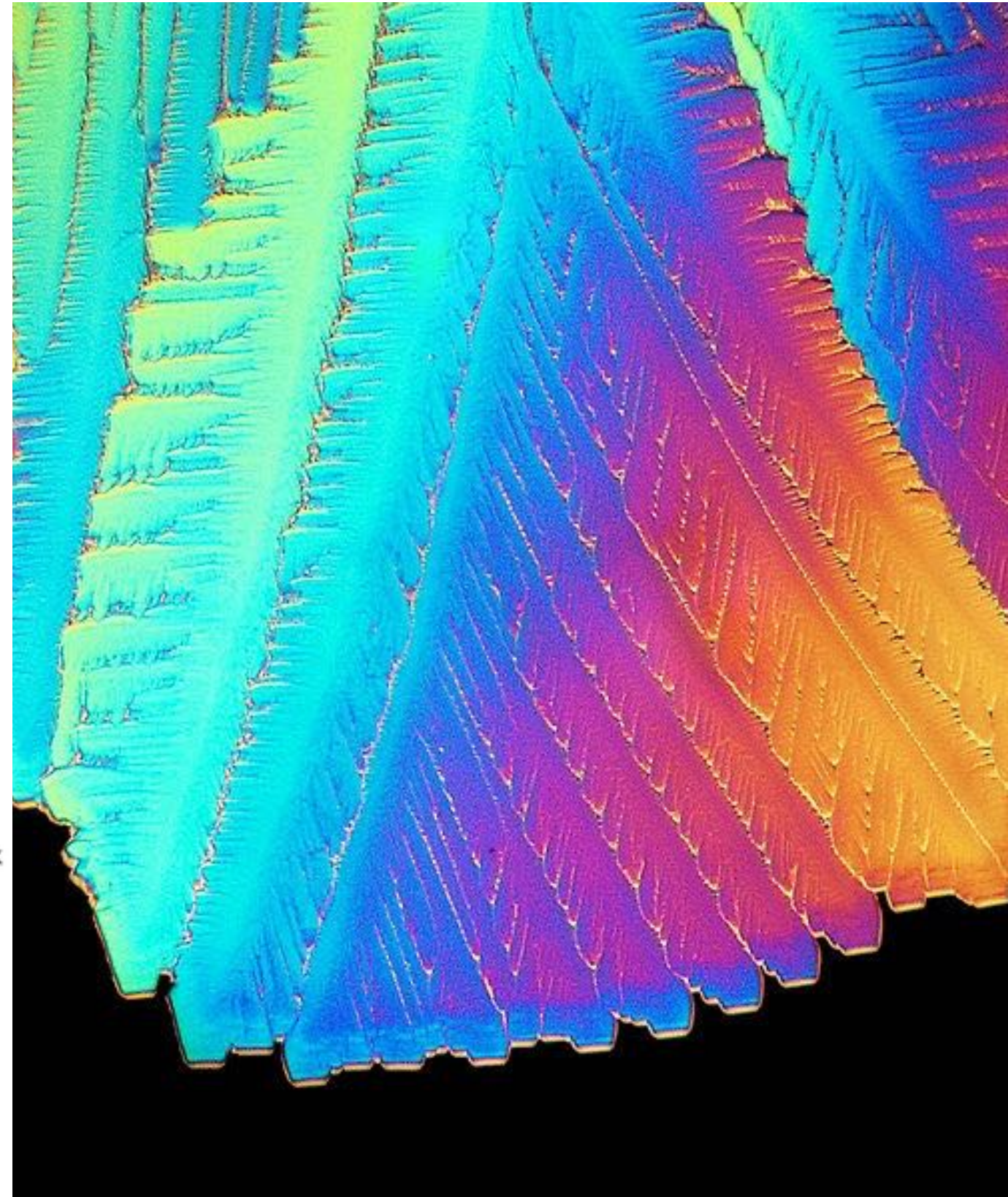
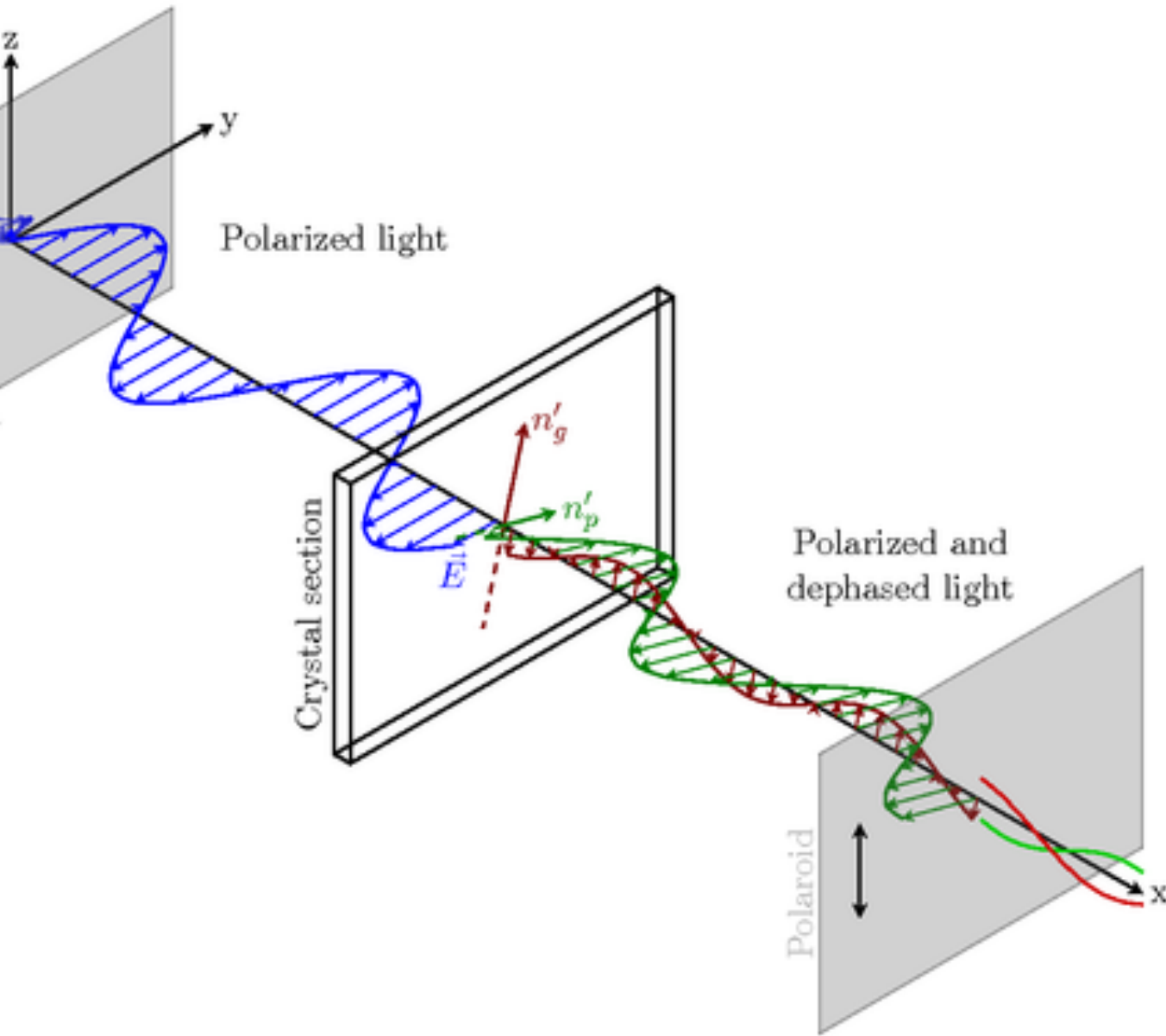
Light waves





Polarized microscopy

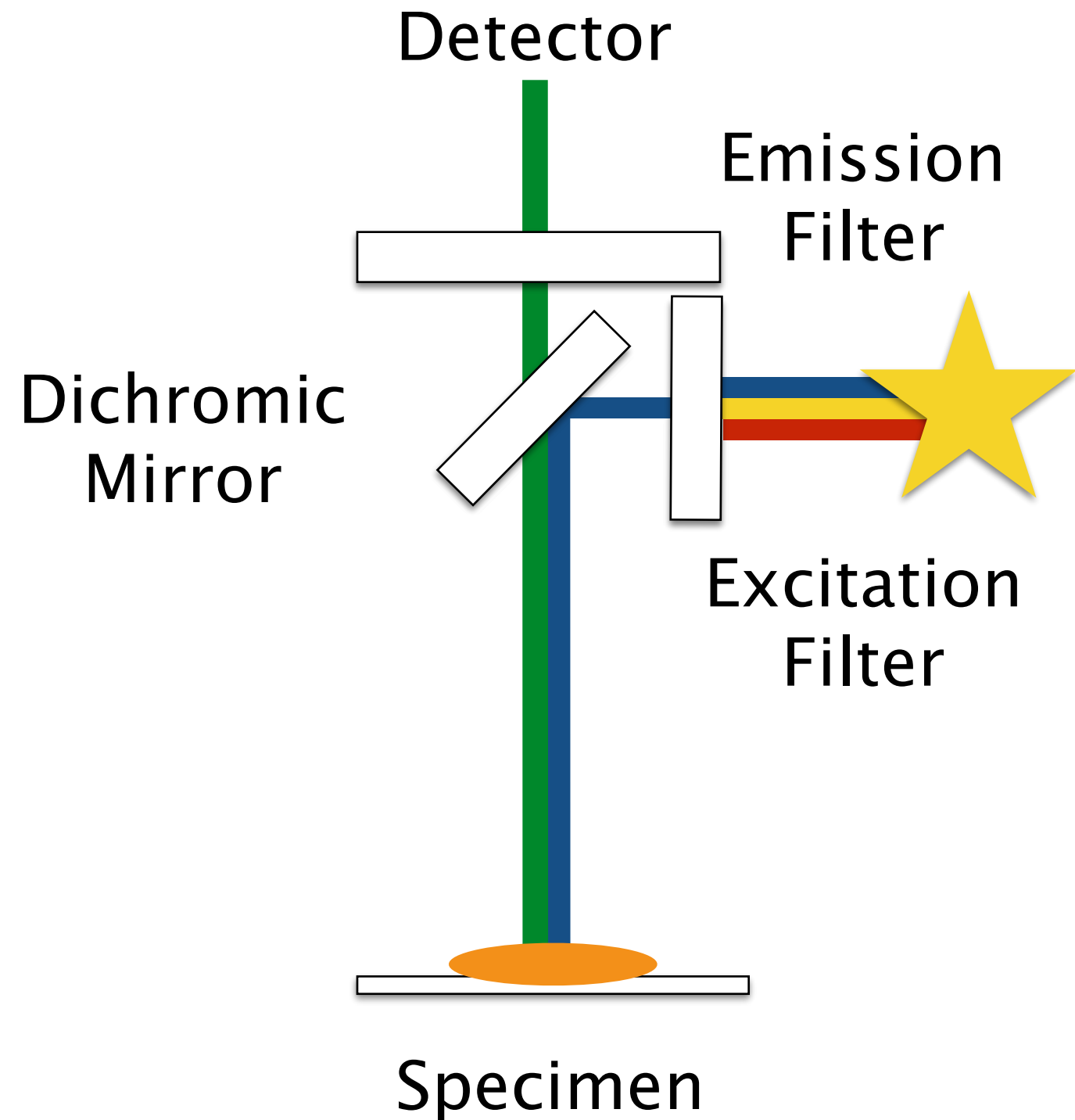
Cyril Langlois CC-BY 2.5





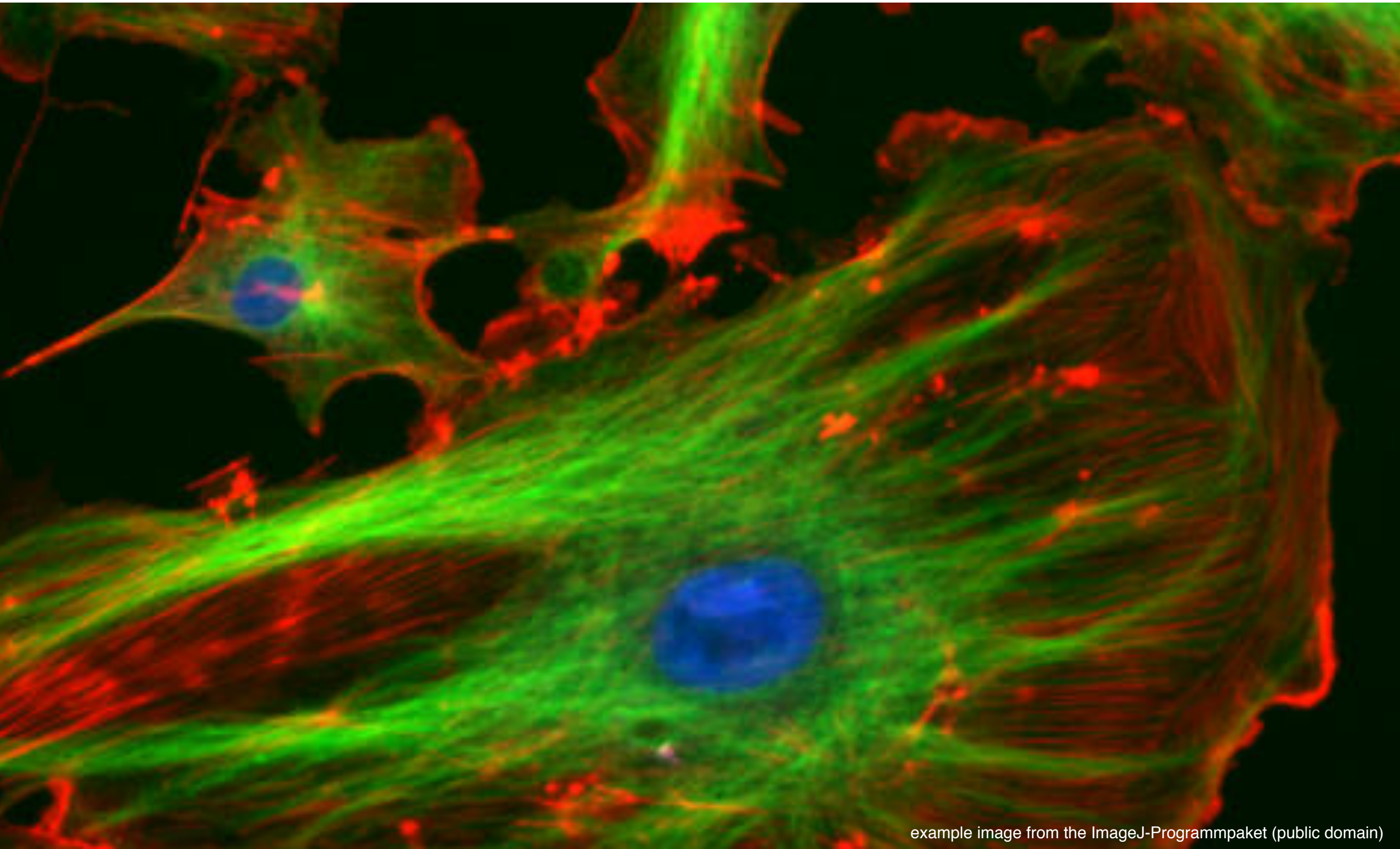
Fluorescent microscopy

- Excite with low wavelength
- Emits high wavelength
- Most important tool in optic biology





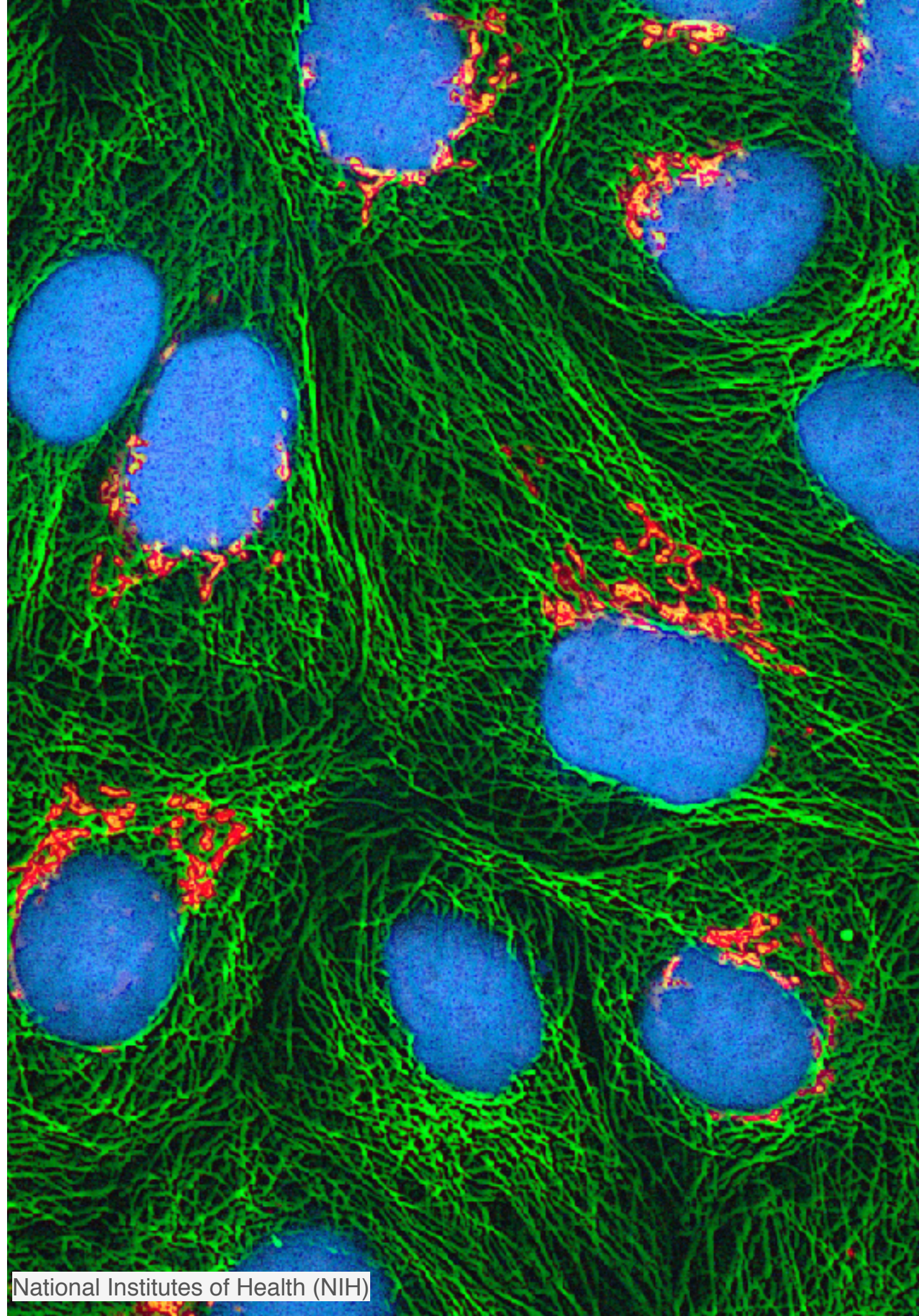
Fluorescence microscopy





Laser scanning microscopy

- Scan an image point by point
- Much better focus than other techniques





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Optics



Refraction

Normal

Incident ray

θ_i

Air

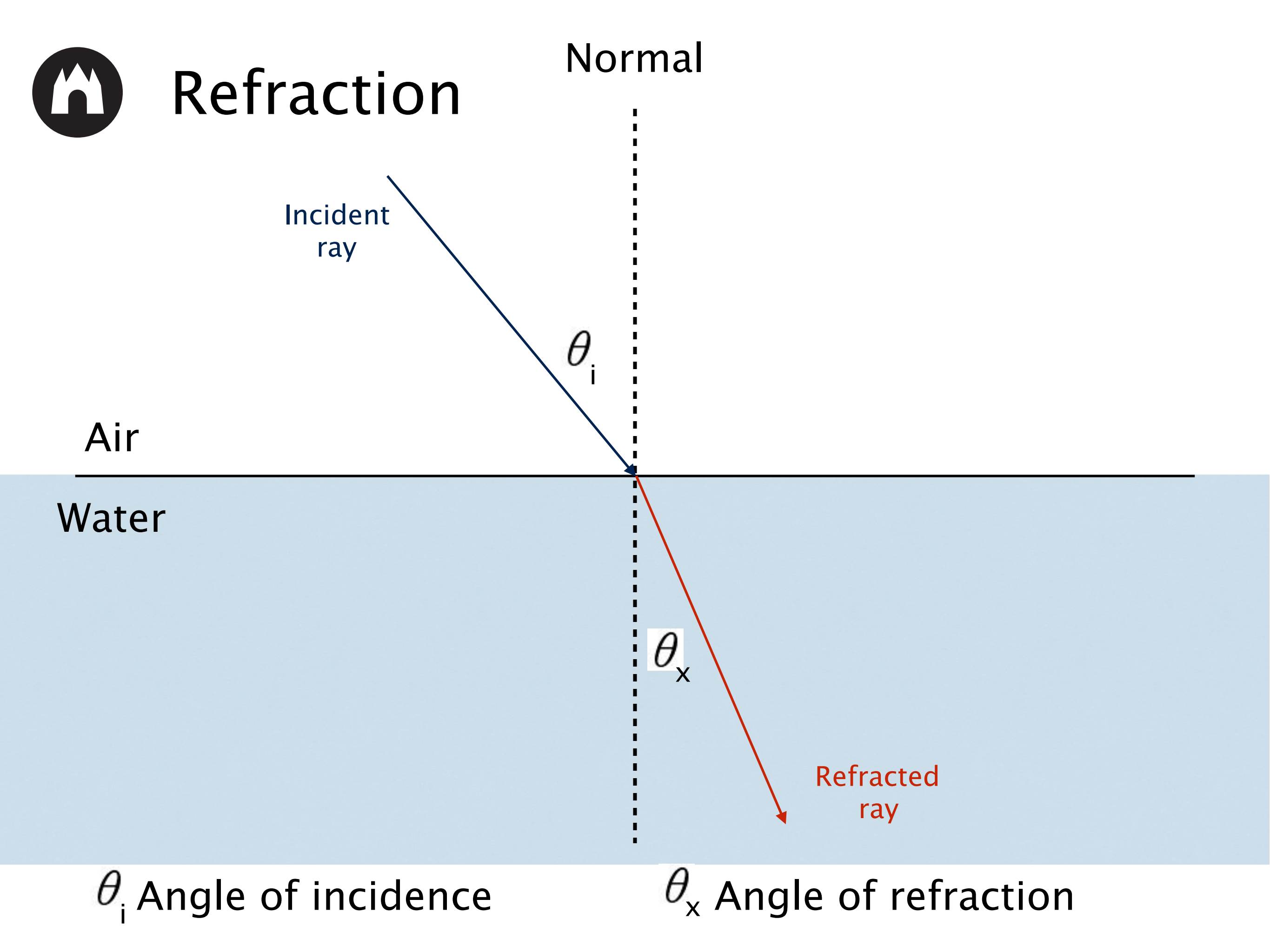
Water

θ_r

Refracted ray

θ_i Angle of incidence

θ_r Angle of refraction





Refraction

Normal

Incident ray

45°

θ_i

Air

Water

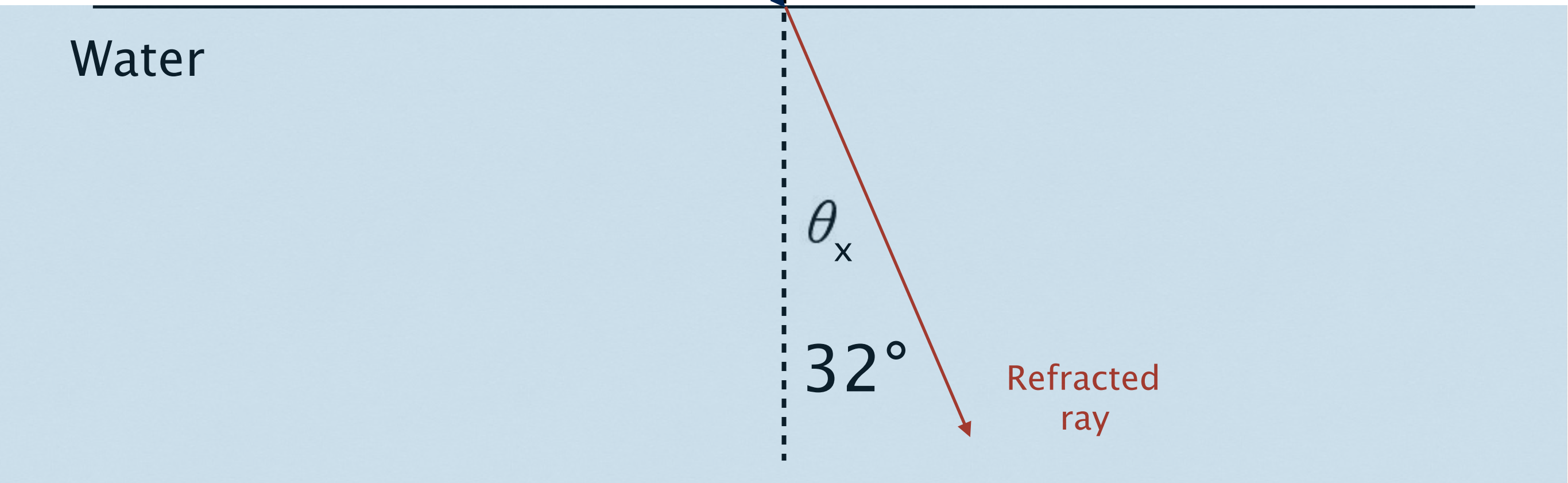
θ_x

32°

Refracted ray

θ_i Angle of incidence

θ_x Angle of refraction





Refraction

Normal

Incident ray

45°

θ_i

Air

Diamond

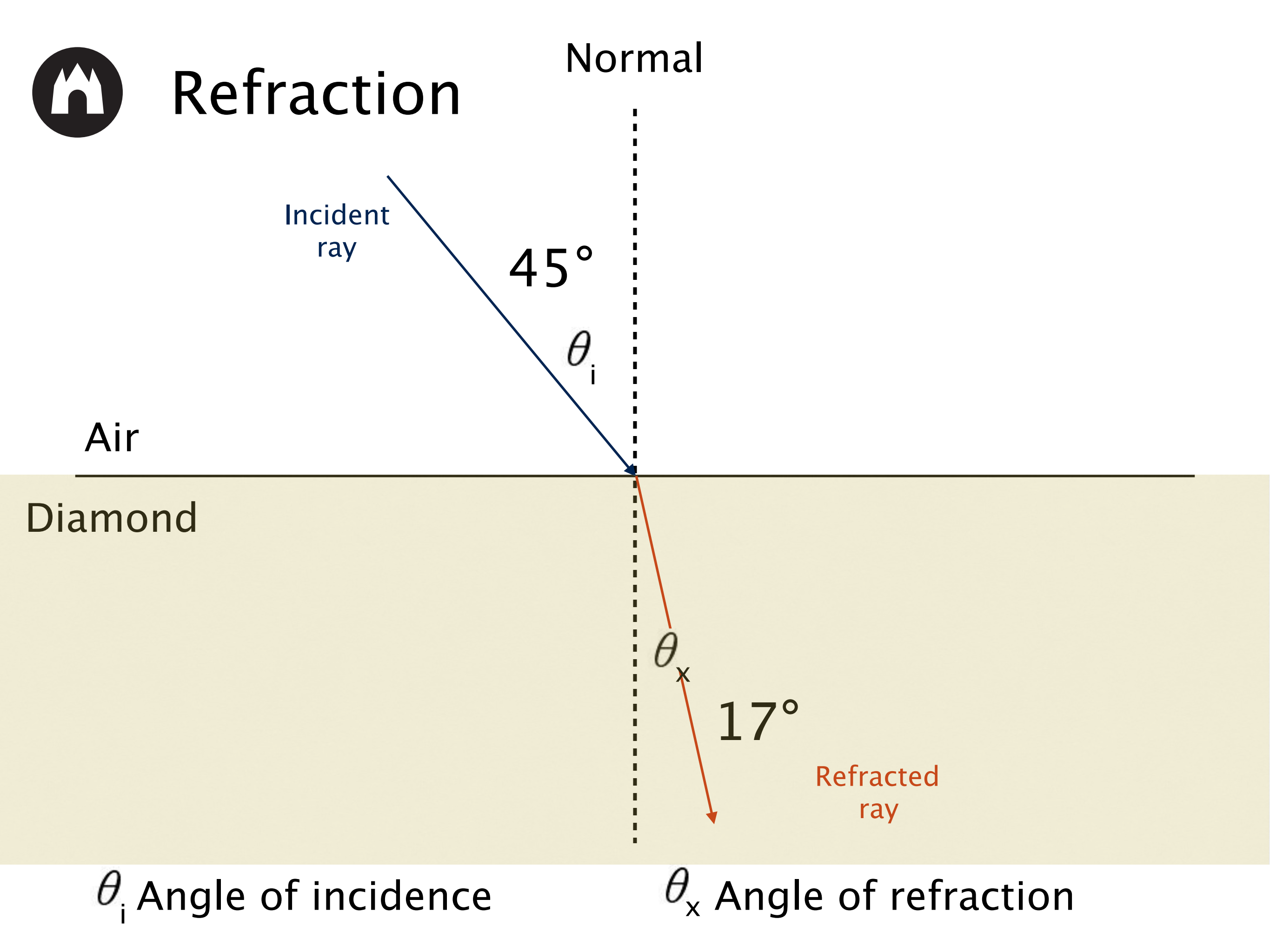
θ_r

17°

Refracted ray

θ_i Angle of incidence

θ_r Angle of refraction



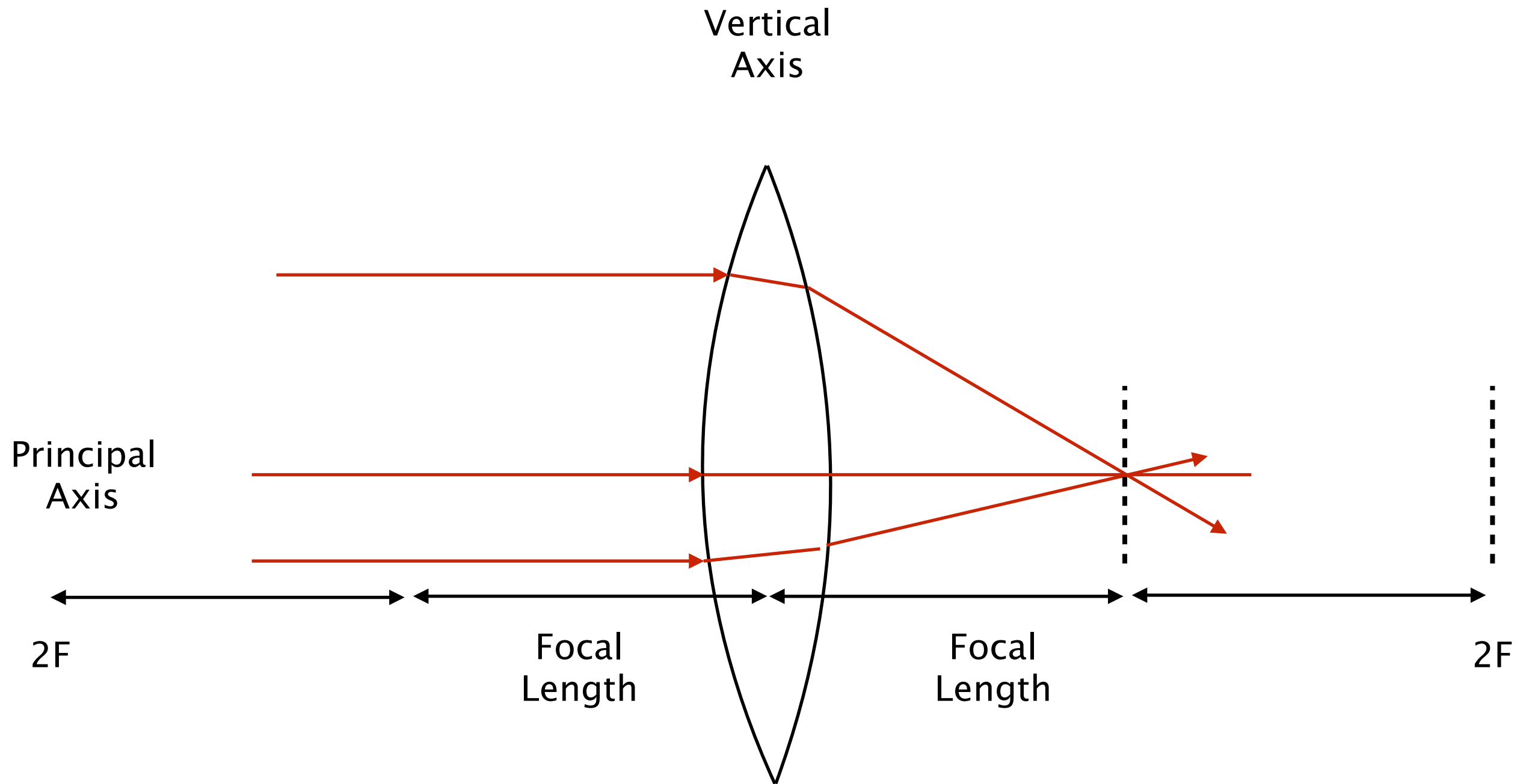


Snell's Law

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



Anatomy of a Lens





Refraction in a lens

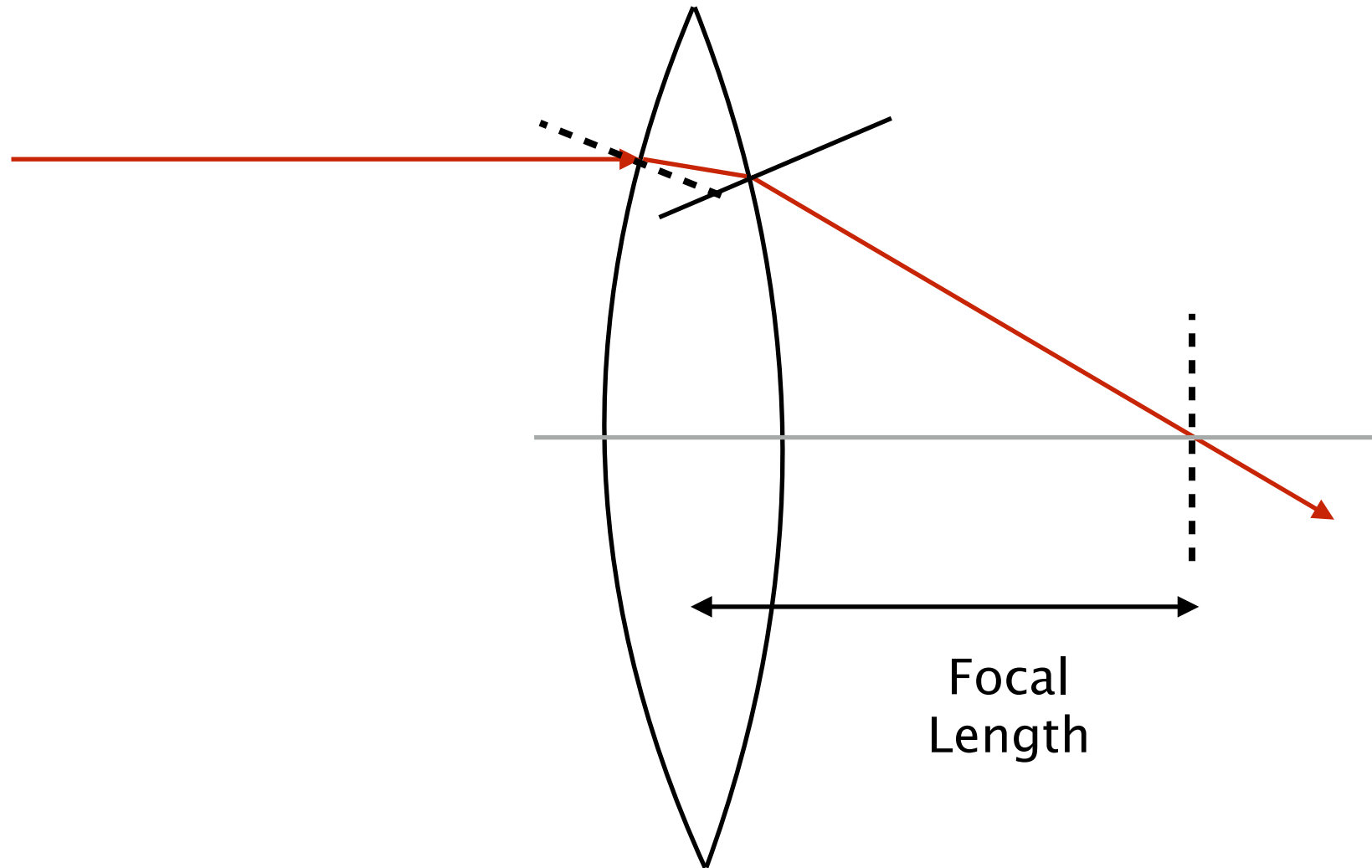
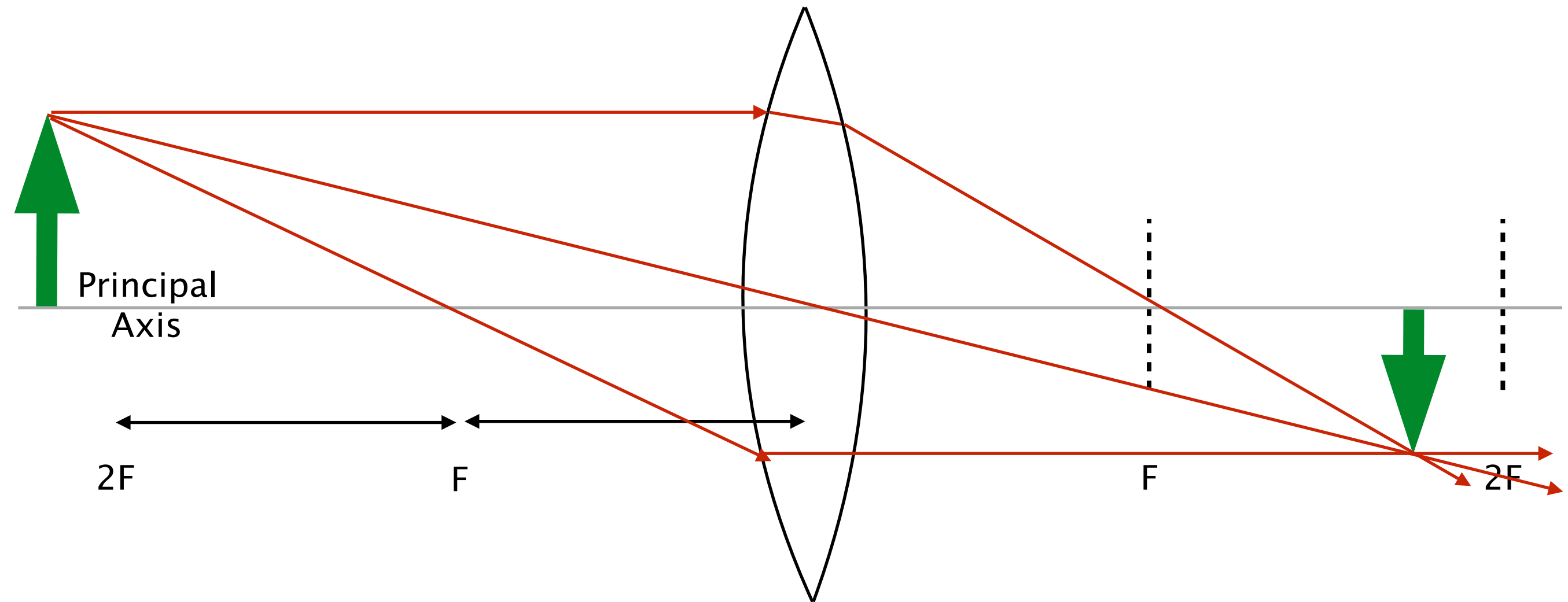


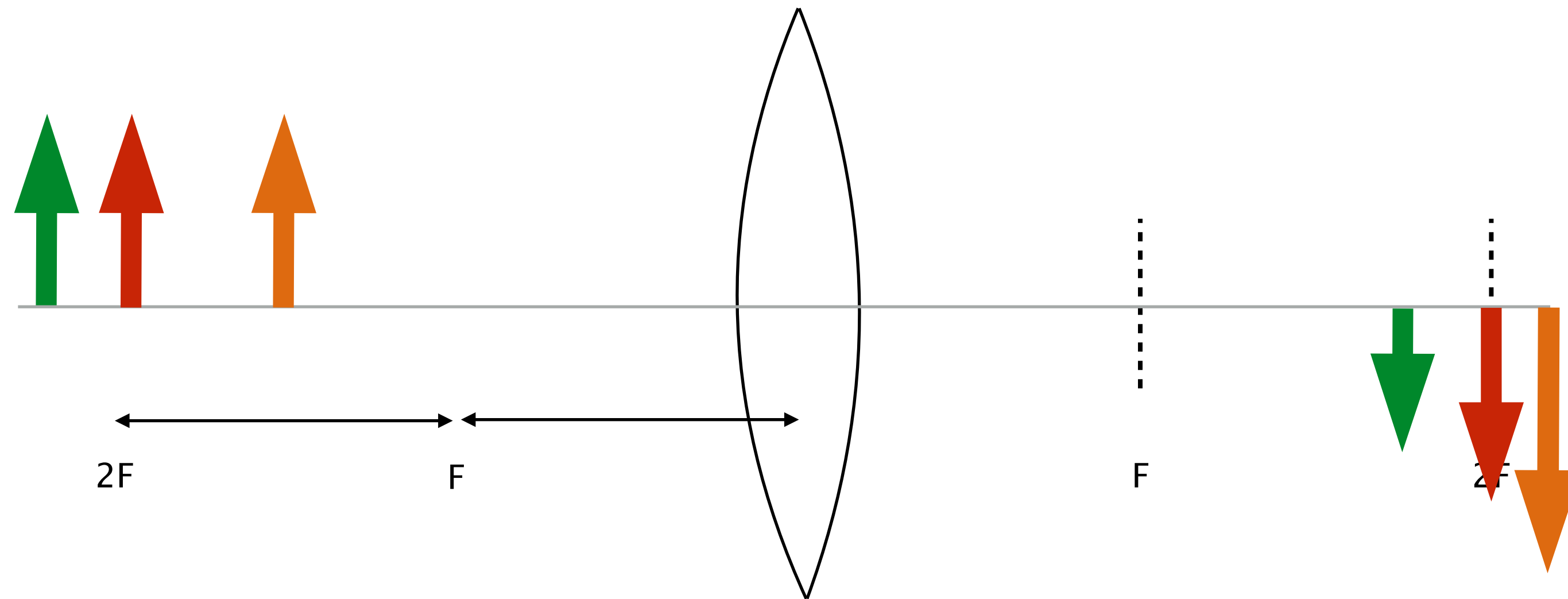


Image construction



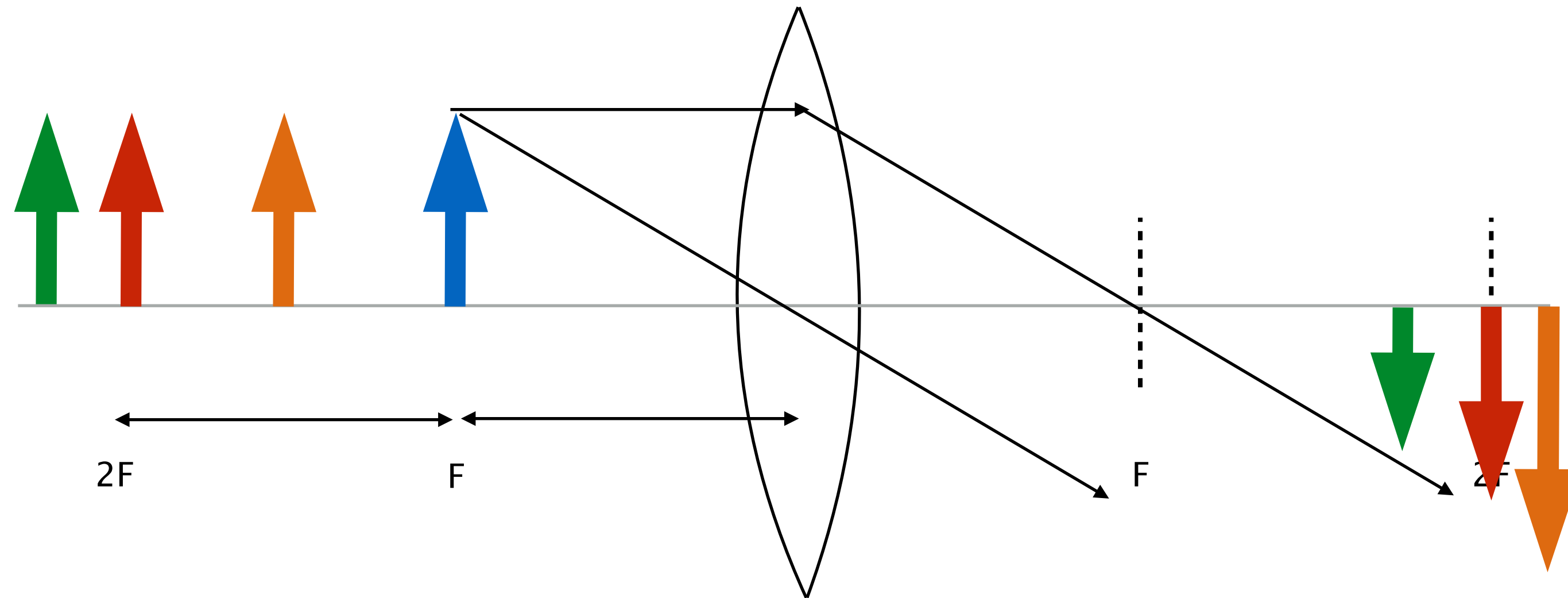


Object / Image positions





Object on focal point





Lens formula

Lens equation

f = focal length

p = distance to object

q = distance to image

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



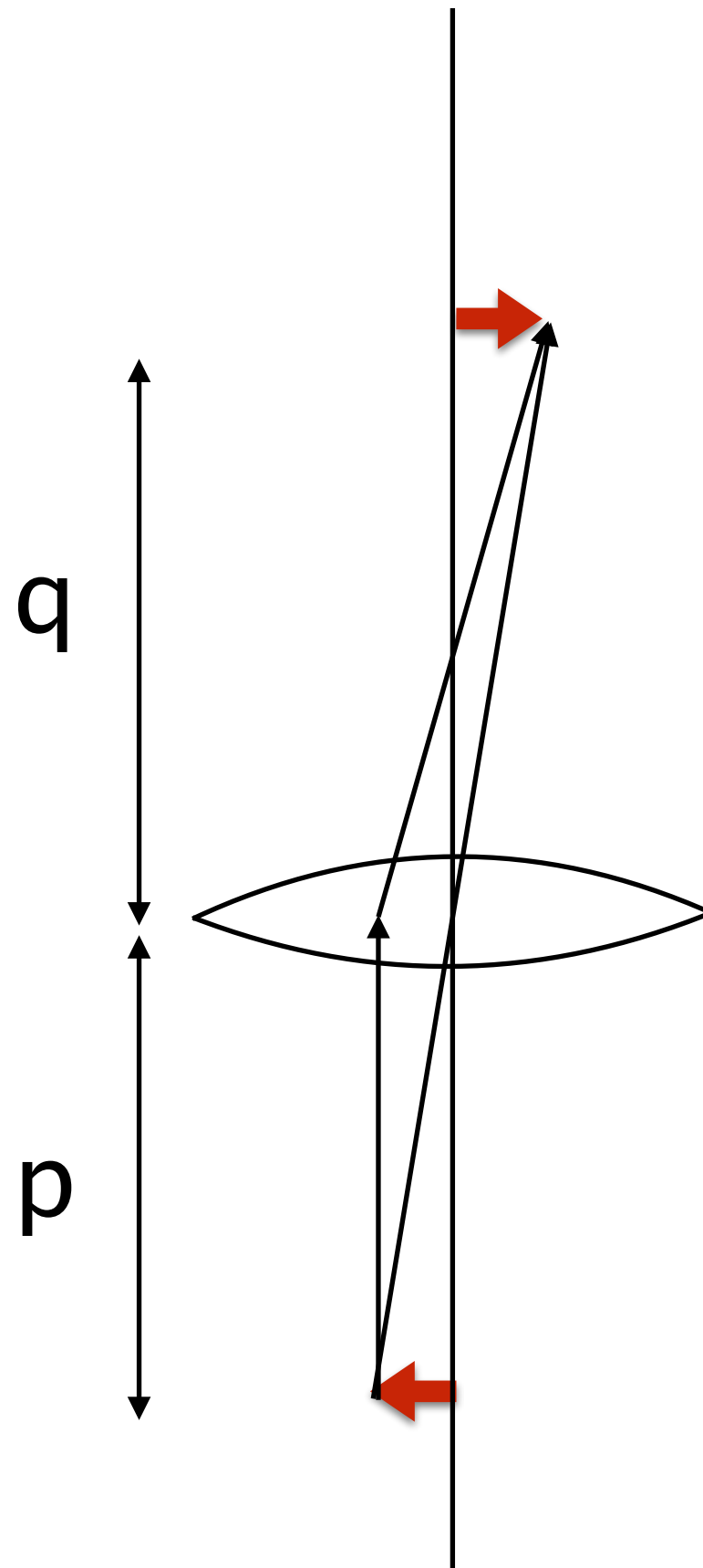
Microscope formulas

$$f = 18.2$$

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

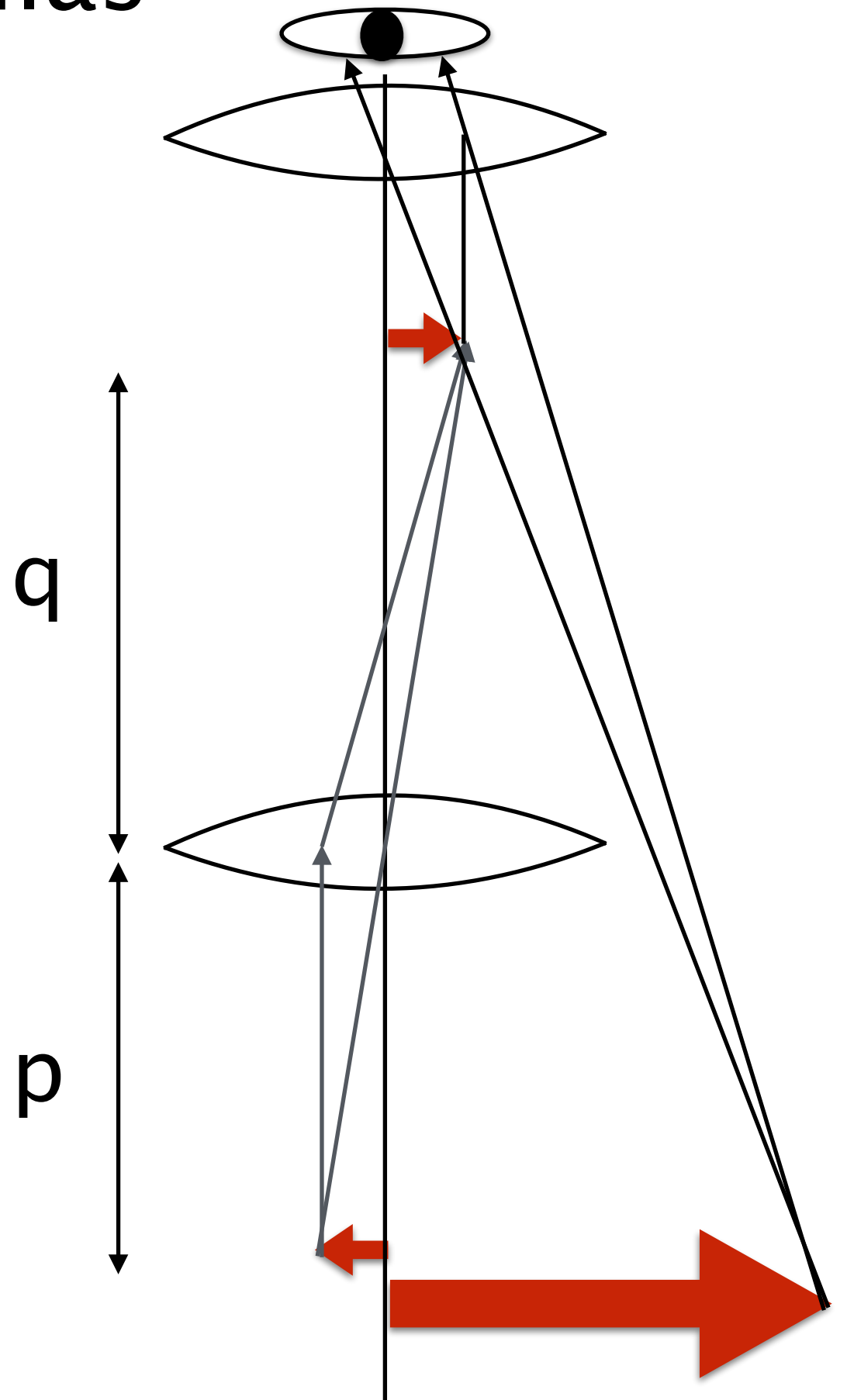
$$q = 160 \text{ mm}$$

$$p = 20.6 \text{ mm}$$





Microscope formulas



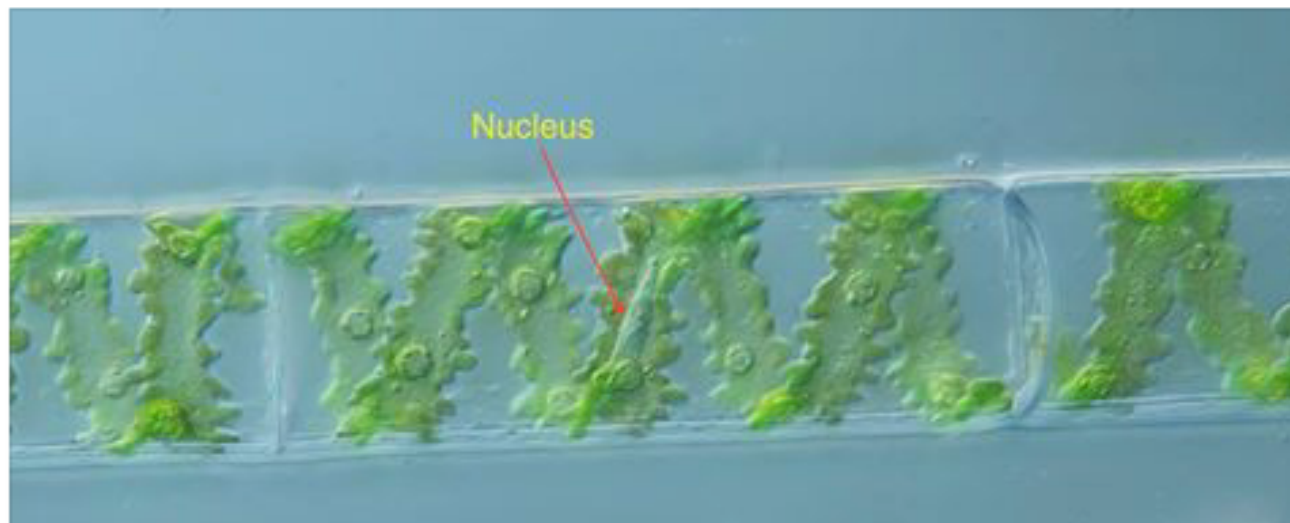


Online microscopy communities

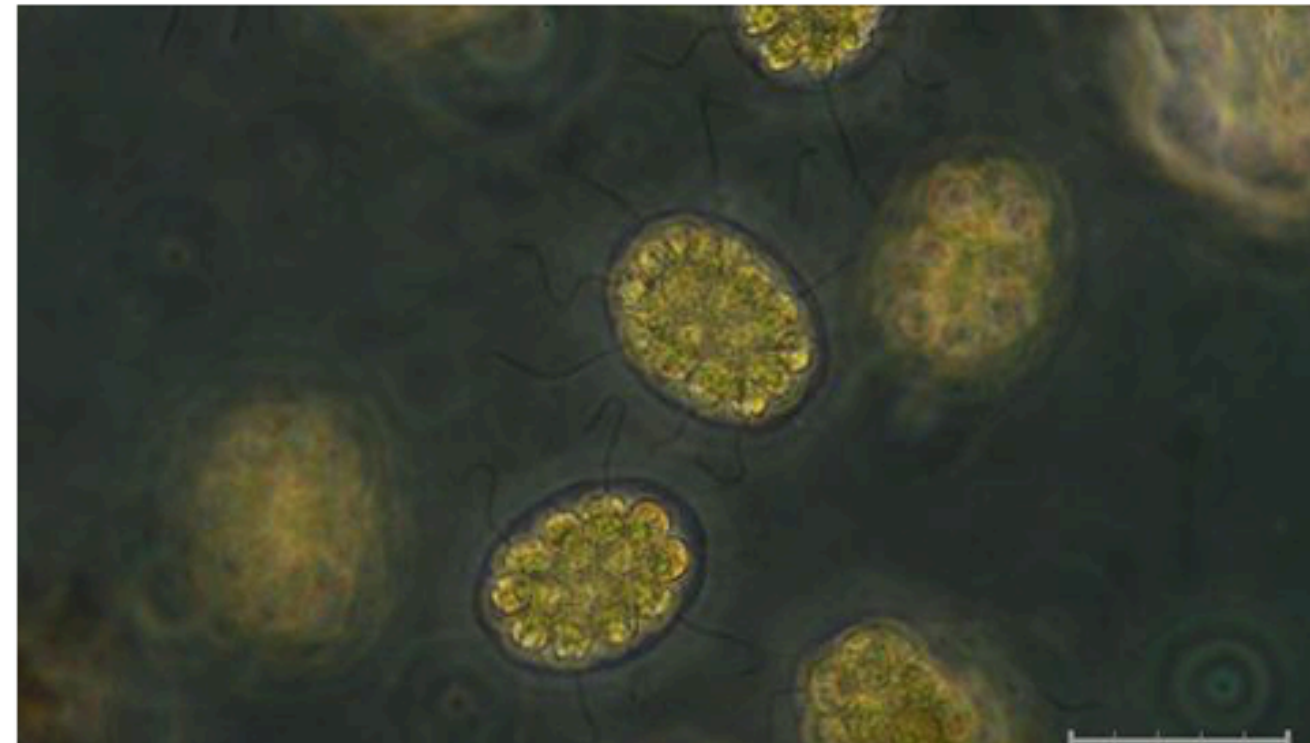
<https://www.facebook.com/groups/Amateur.Microscopy/>



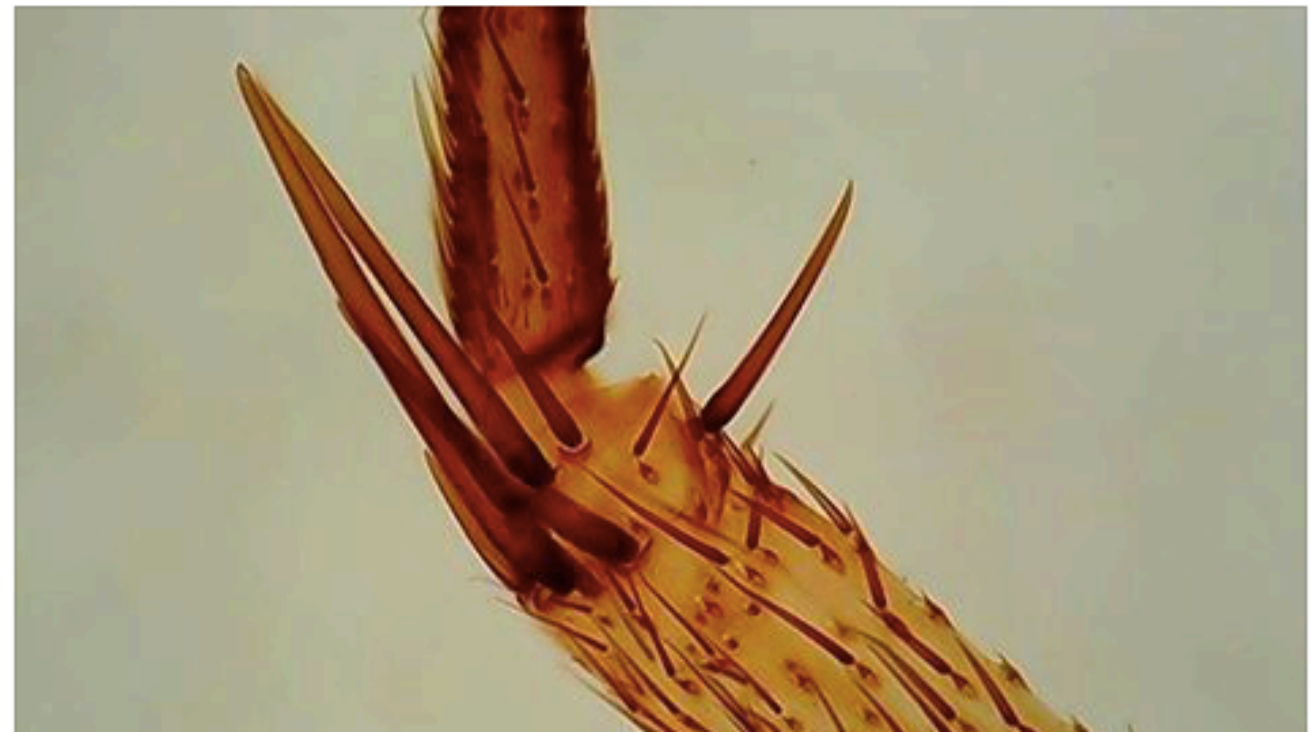
This is a photograph of the alga Spirogyra. It is a rare sight here in southern California--even rarer if you do not have a microscope! But when I find see one, it always brings a smile to my face. The spirally arranged chloroplasts in a clear cellulose tube always inspire me. This is a focus stack of 30 sections, put together with Helicon focus.



Eudorina, CdF 40x



flys leg..4 images stacked with czp..





some

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