

Anatomy of a microscope

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1. Components of an optical microscope
2. Types of Optical microscopes
 - ❖ Inverted
 - ❖ Upright
 - ❖ Stereo or dissecting microscope
3. How are lenses used in the context of the microscope
4. Understanding conjugate planes in microscopy

What a microscope needs to do ?

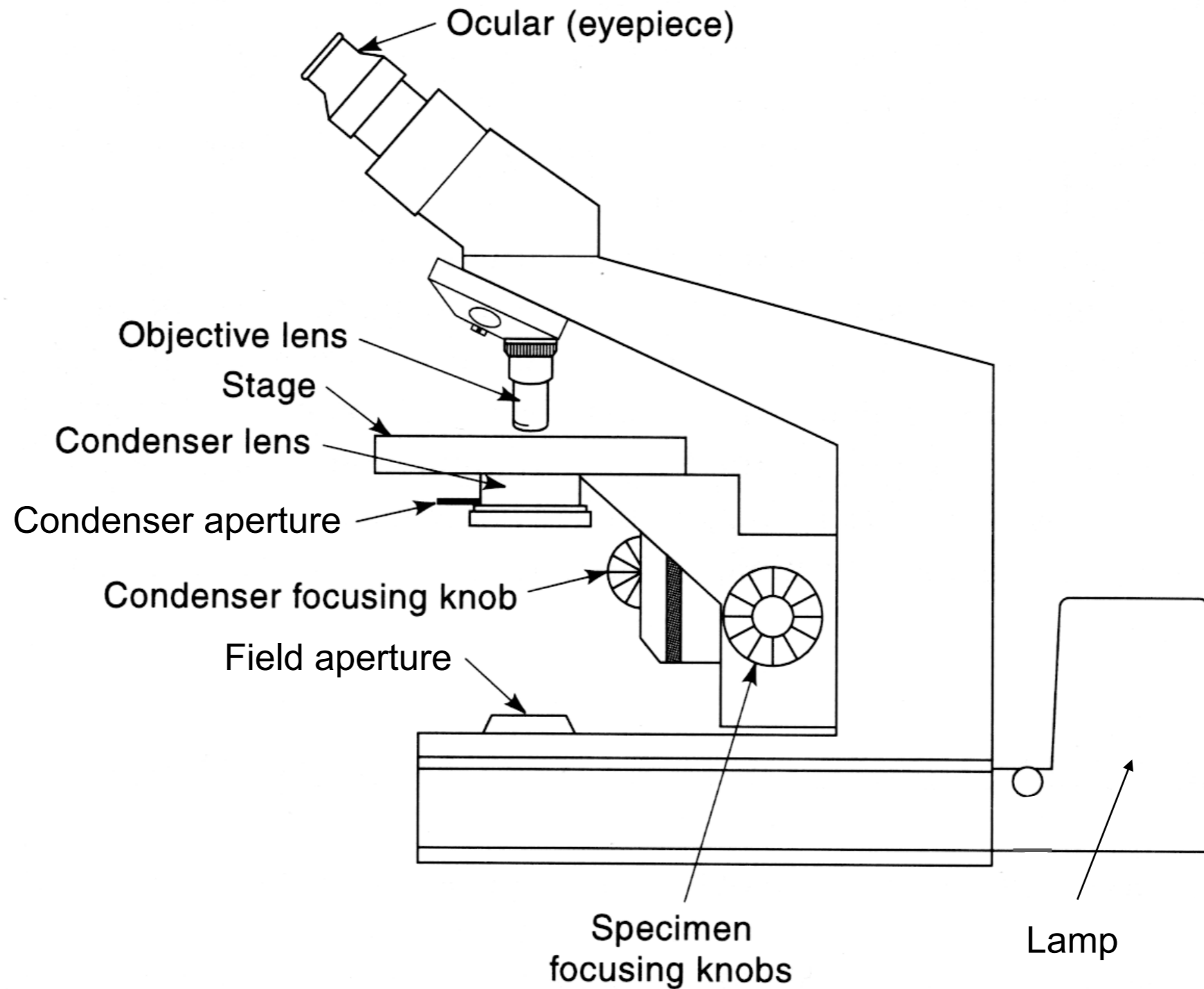
- ▶ Produce magnified images
- ▶ Capture details in the sample
- ▶ Collect as much light as possible
- ▶ Do all of the above while introducing as little distortion as possible



Use 2 lenses to form a magnified image of the specimen

Compound microscope

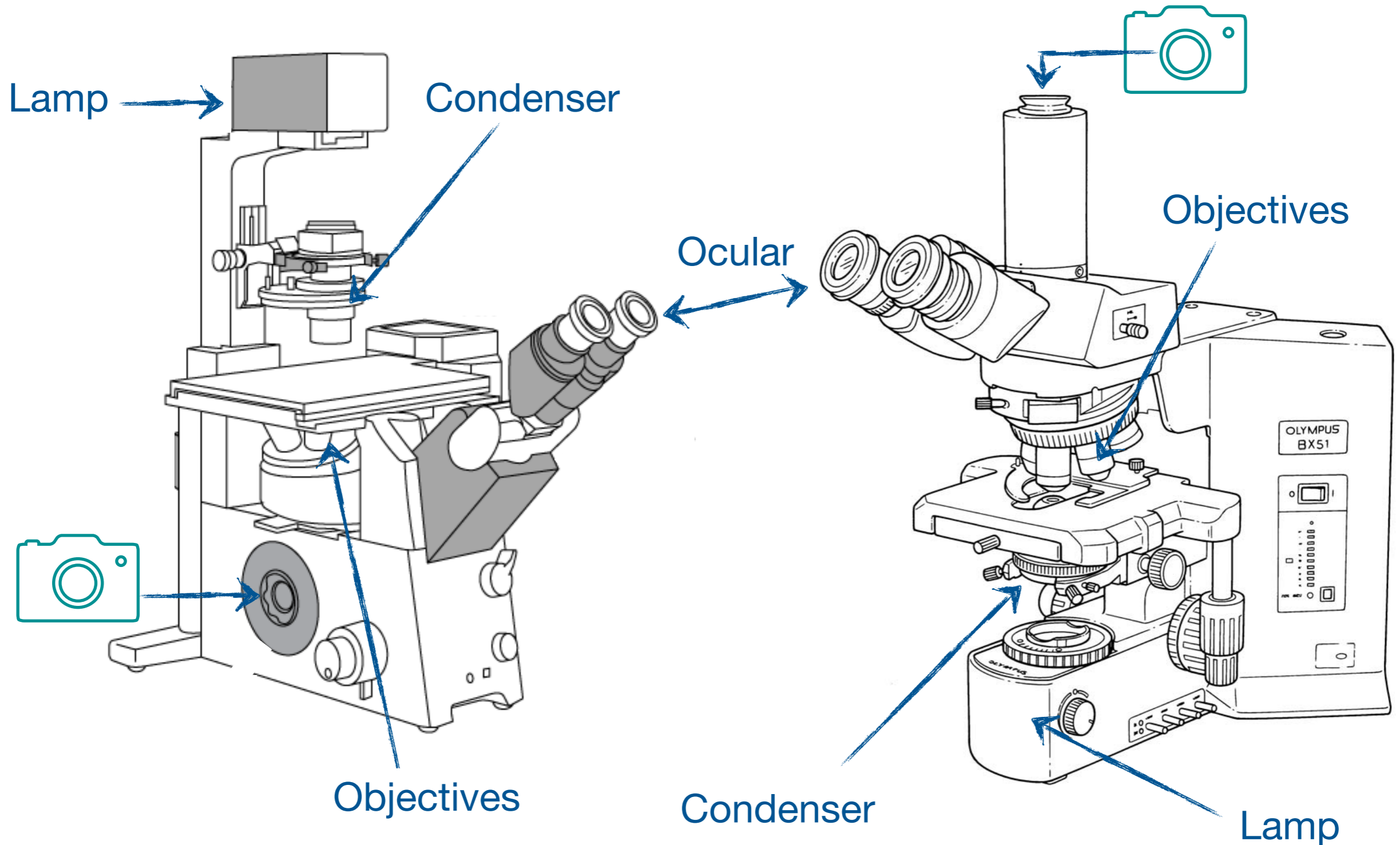
1. Components of an compound microscope



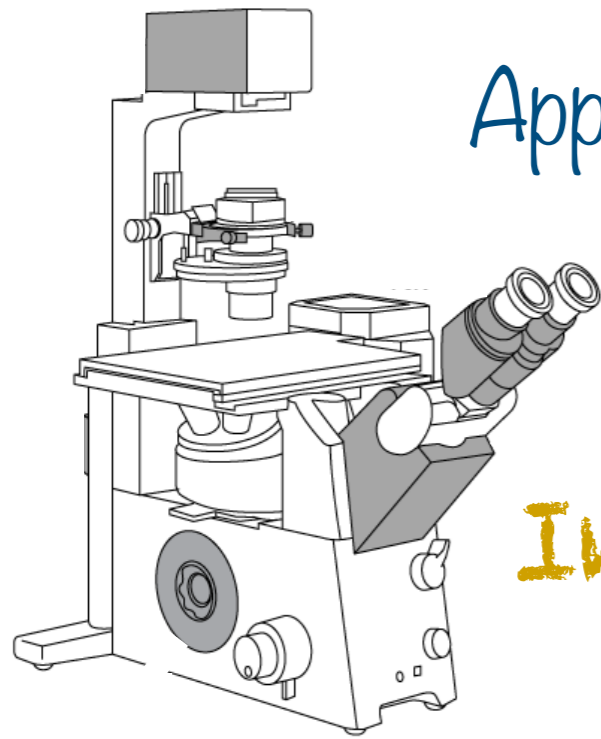
Total magnification = Objective x Eyepiece

2. Types of optical microscopes

Inverted vs. Upright



2. Types of optical microscopes

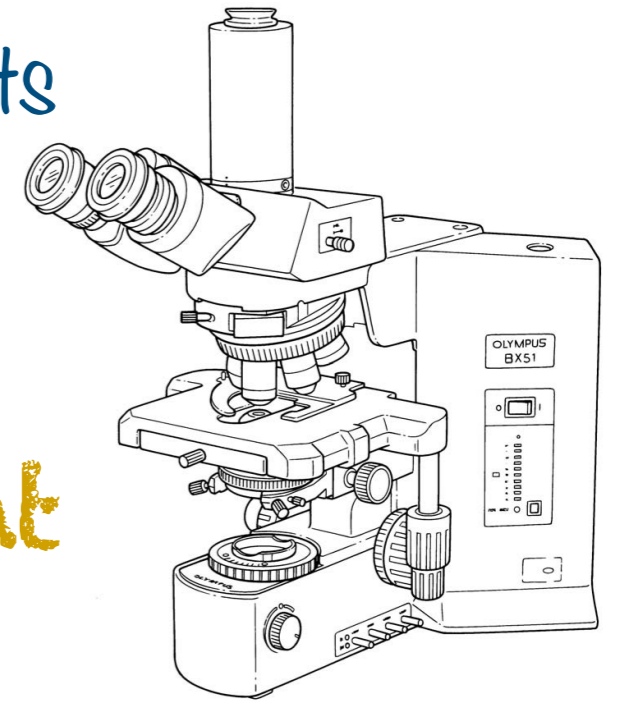


Applications driven by sample requirements

Inverted

vs.

Upright



Samples mounted between coverglass and slide

Live cell imaging in glass bottom petri dishes

Allows sterile environment for live cell imaging

Samples mounted between coverglass and slide

~~Live cell imaging in glass bottom petri dishes~~

Live imaging with dipping objectives

Particularly useful for larger samples like tissues

and animals

2. Stereoscope or dissecting microscope

3D view of opaque, thick, solid specimens



3. How are lenses used in a microscope to...

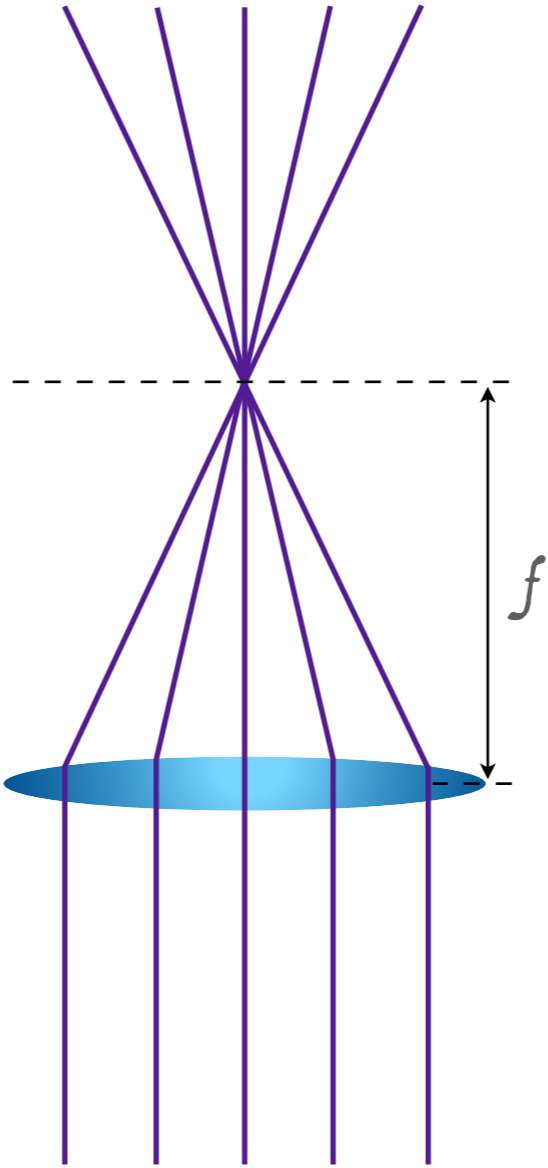
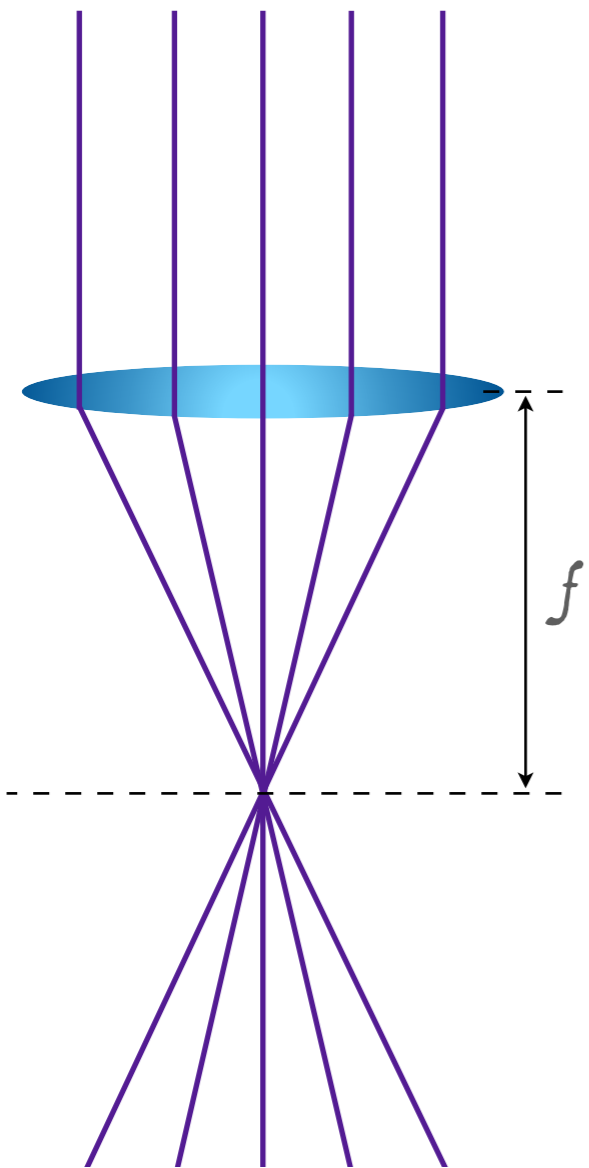
... collect light from the specimen to create an image at the camera and ocular?

... focus light from the light source to illuminate the sample?

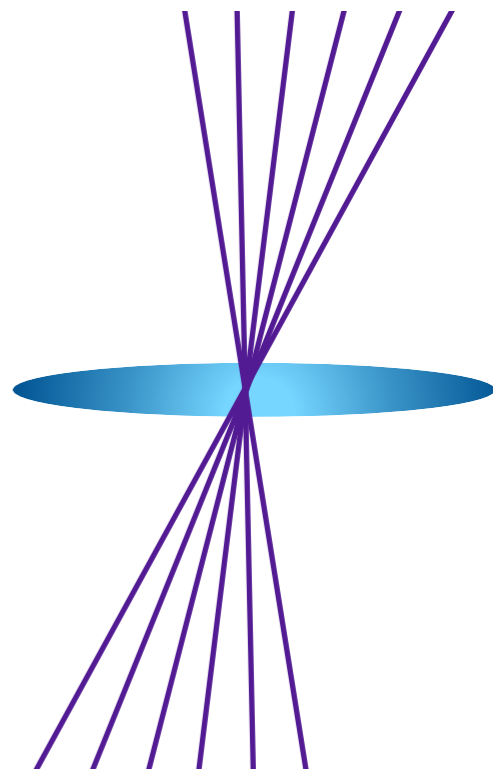


3. How images are formed - Recap from Ray tracing

Parallel rays converge at the focal plane

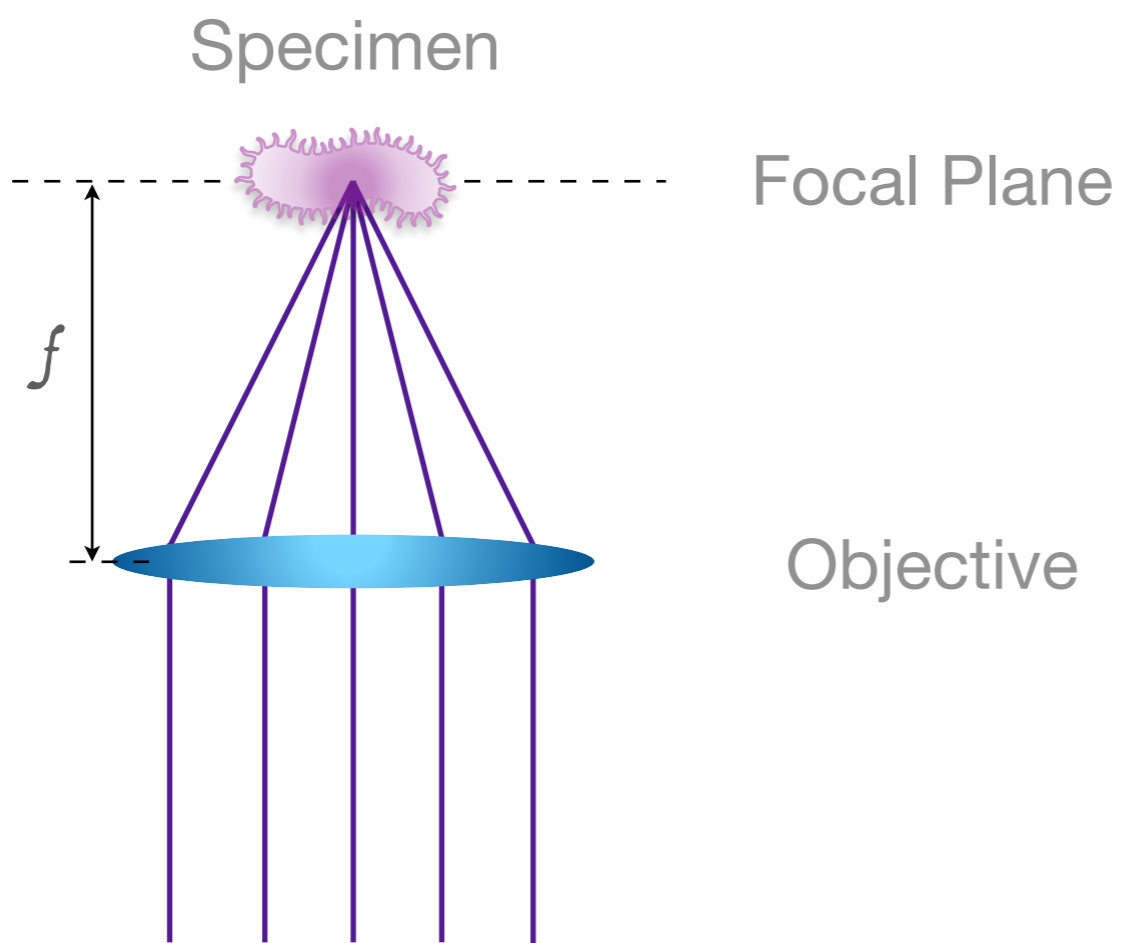


Rays from the focal plane exit parallel



Rays through the centre of the lens continue straight (i.e. are not refracted)

3. How images are formed in the context of the microscope



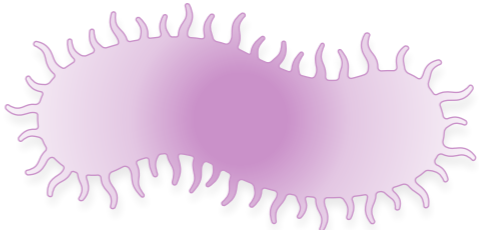
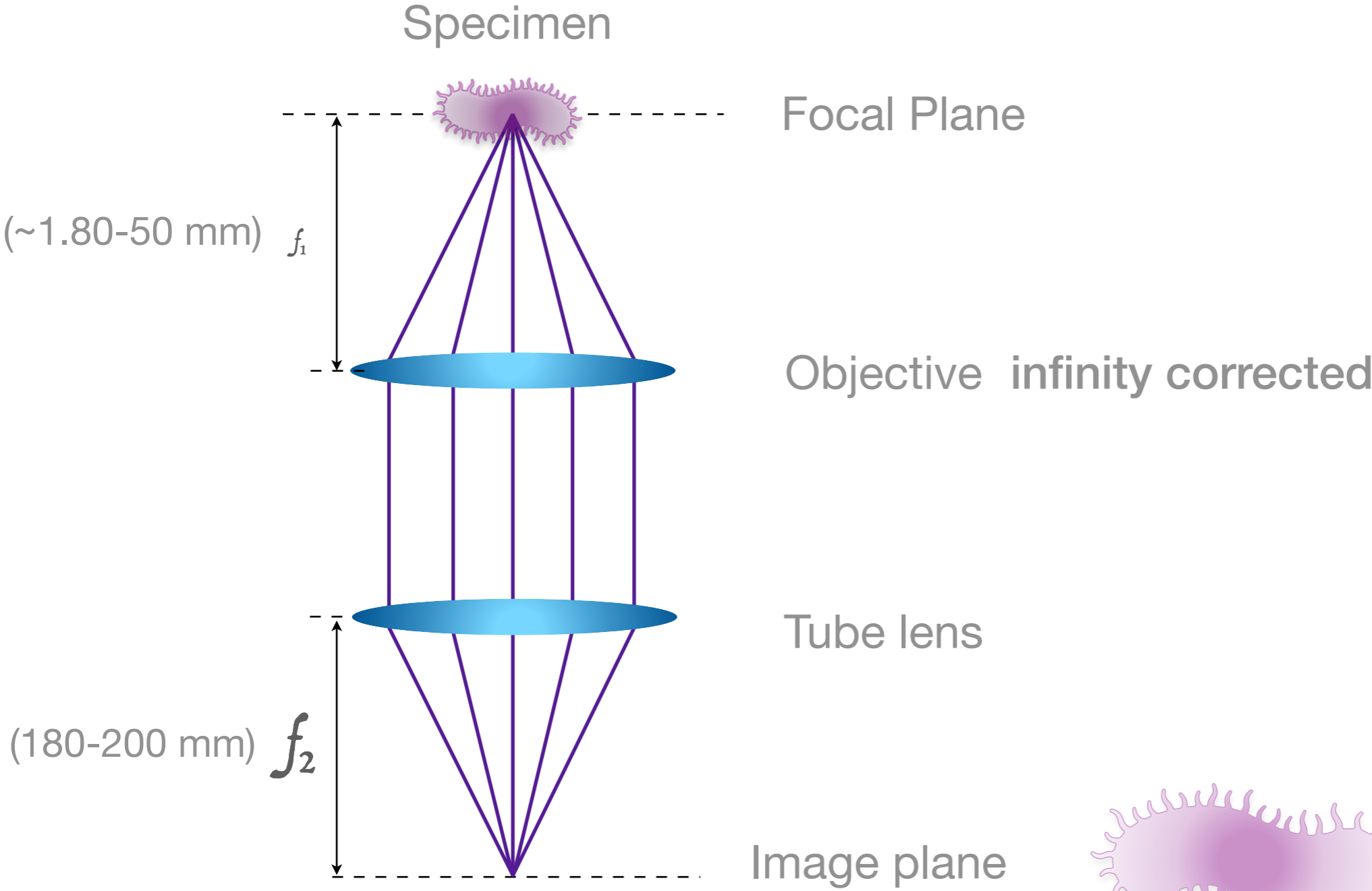
Lecture 7



<https://www.olympus-lifescience.com/en/discovery/the-anatomy-of-an-objective-lens/>

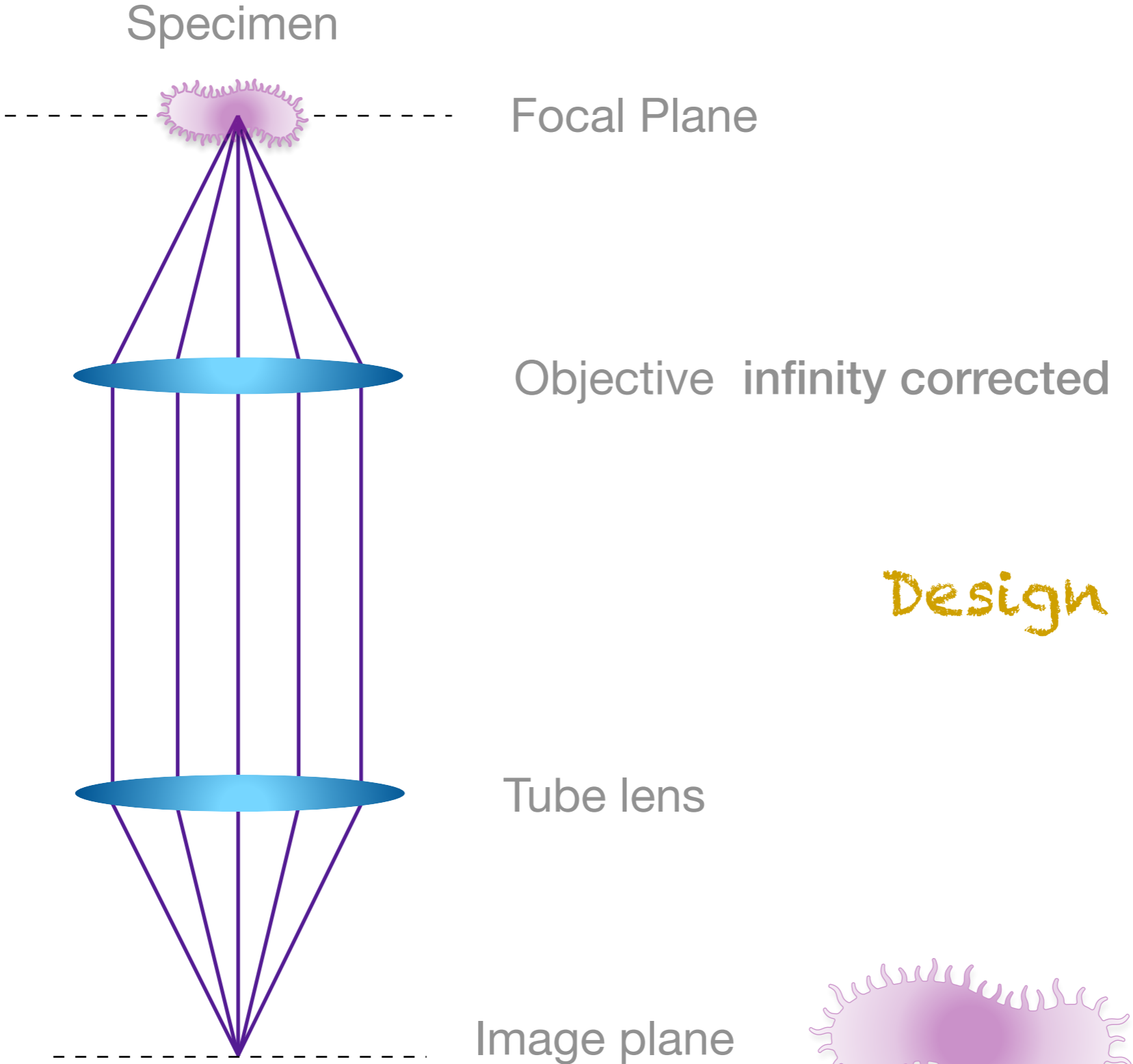
Parallel rays don't form images

A second lens is needed to form the image: Tube lens

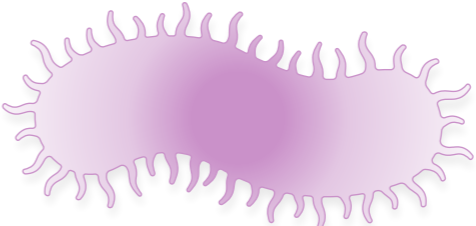


$$\text{Magnification} = \frac{f_2}{f_1} = \frac{180}{3} = 60X \text{ objective}$$

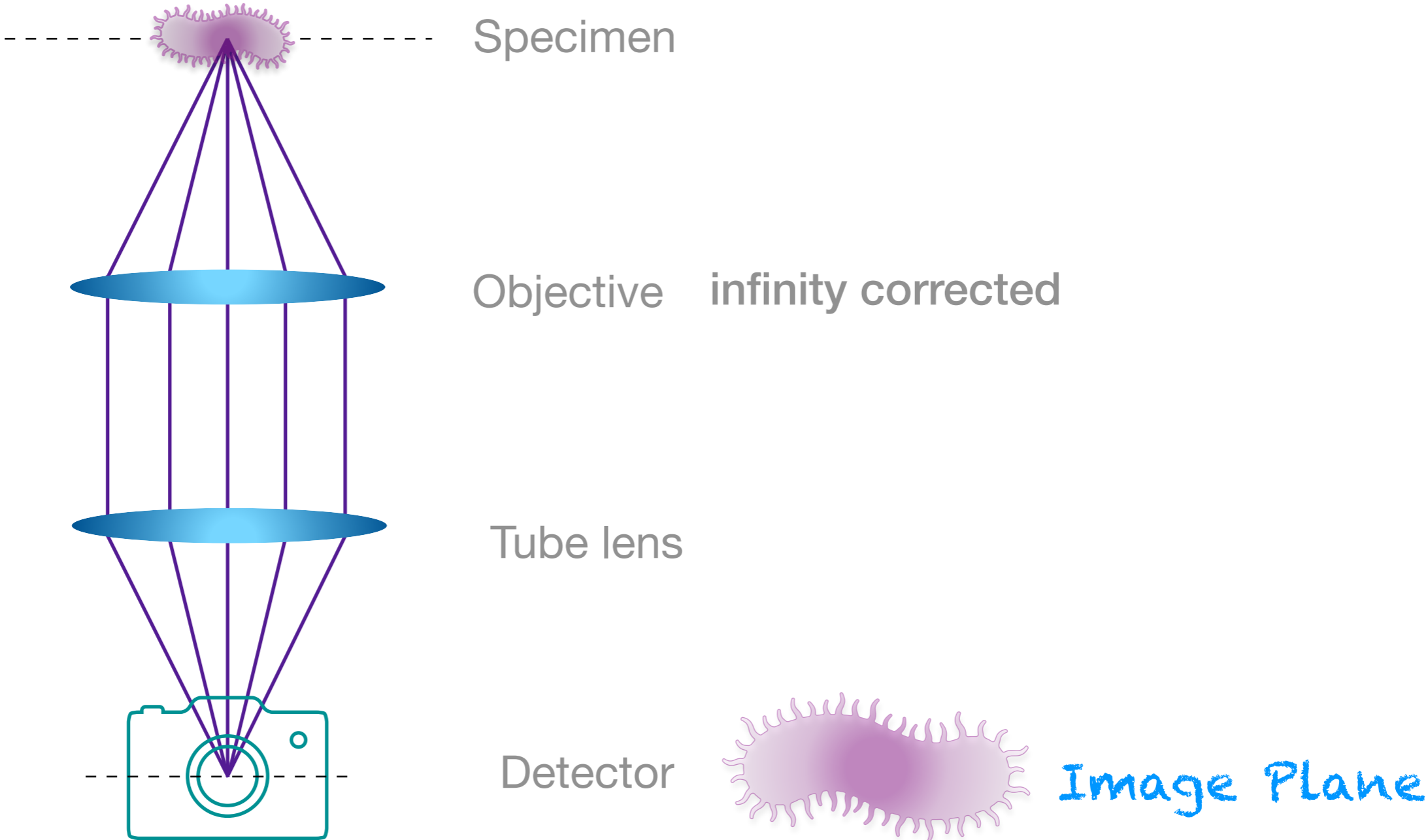
A second lens is needed to form the image: Tube lens



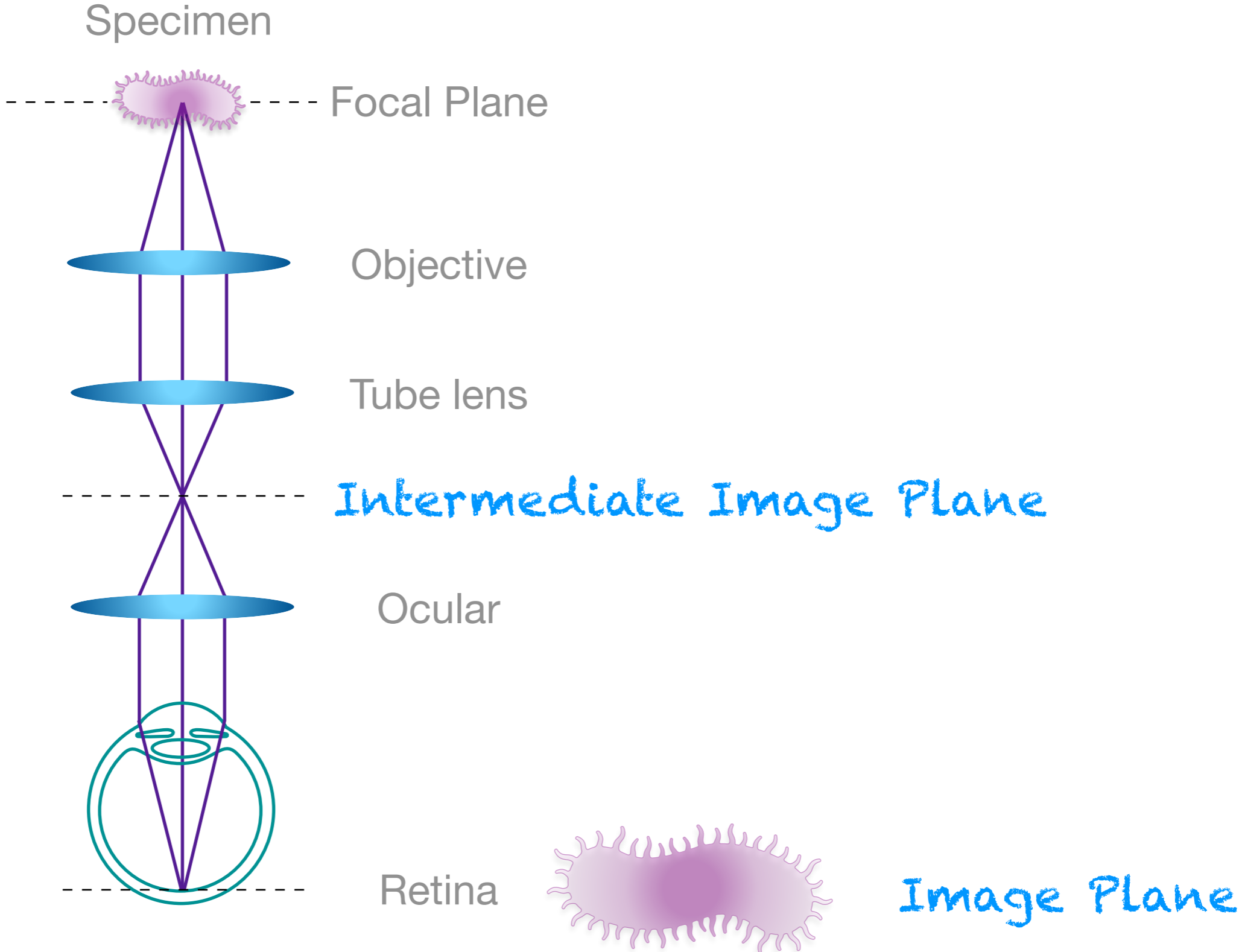
Design flexibility



How is the image formed at the camera?

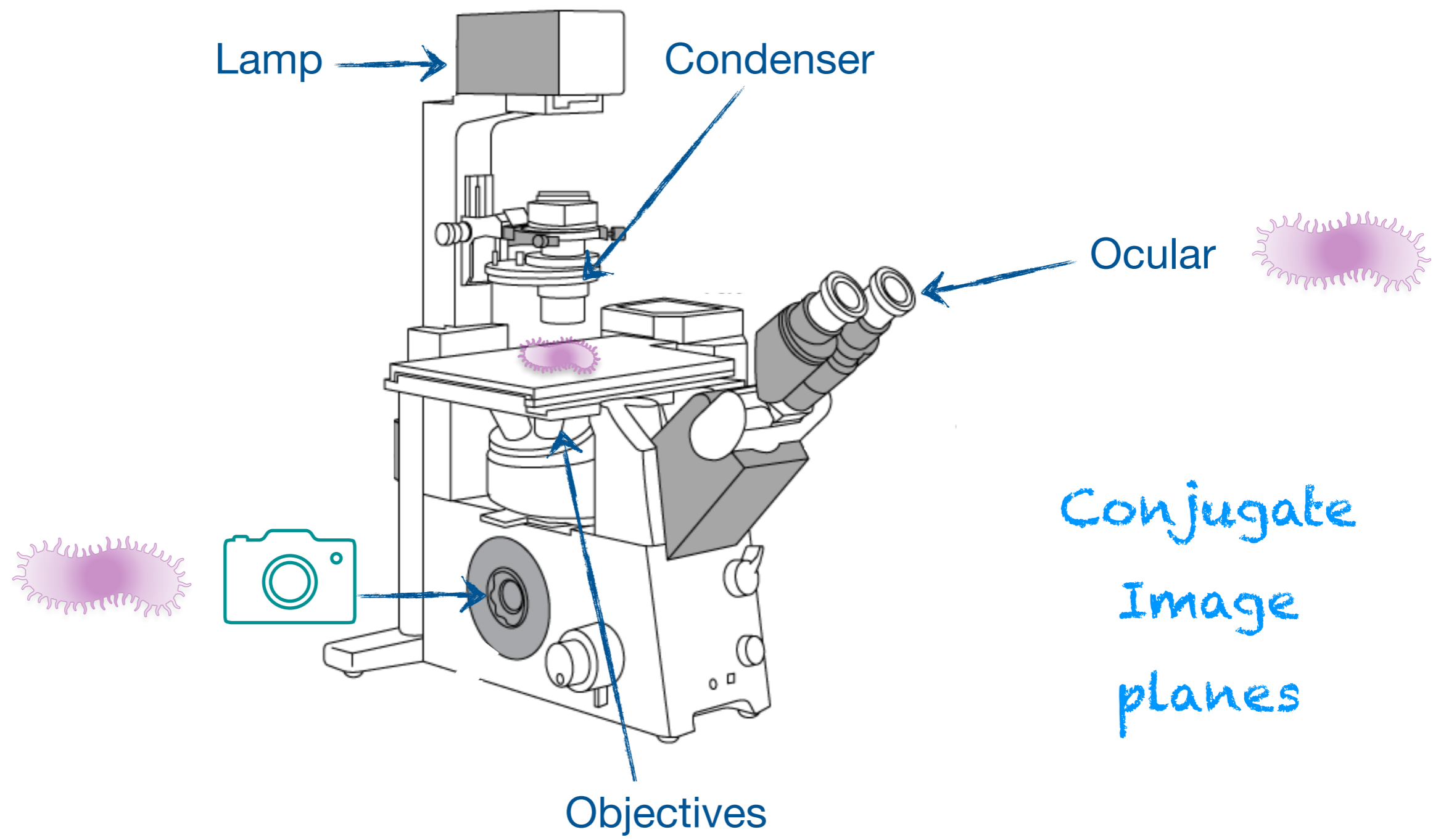


How is the image formed through the eyepieces?

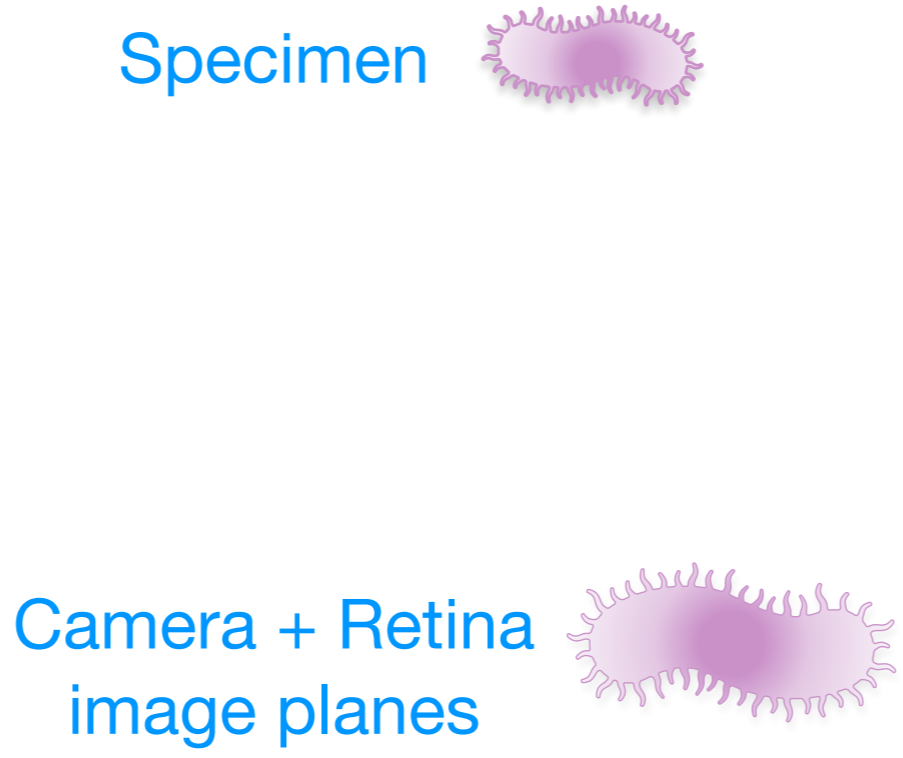
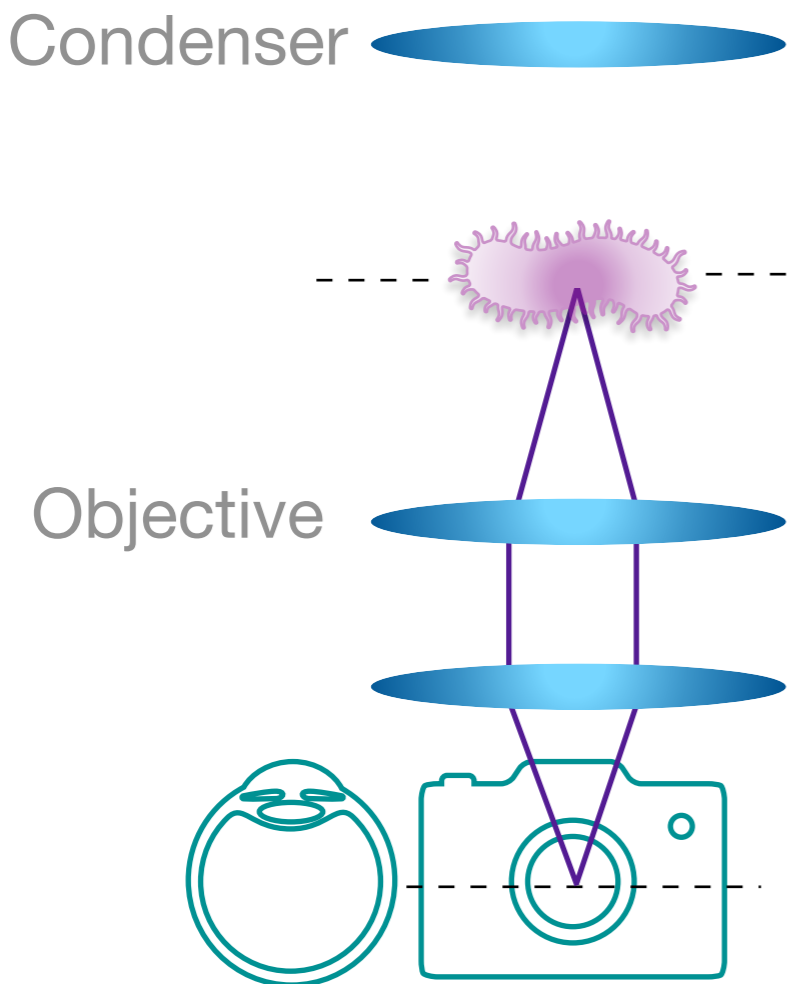


4. Understanding conjugate planes in microscopy

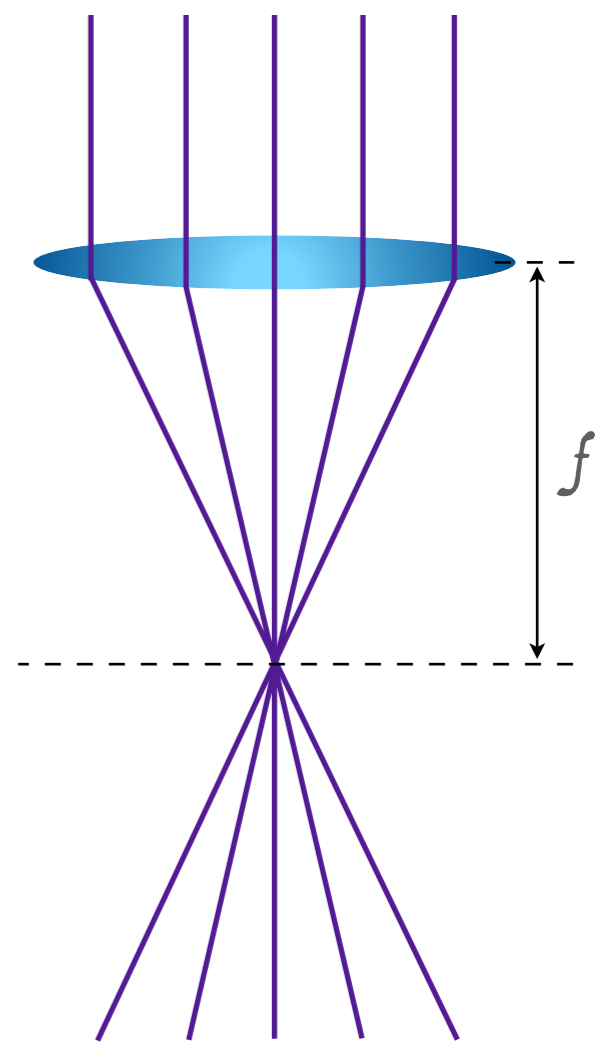
Why can we see the image of our specimen at the eyepieces and at the camera?



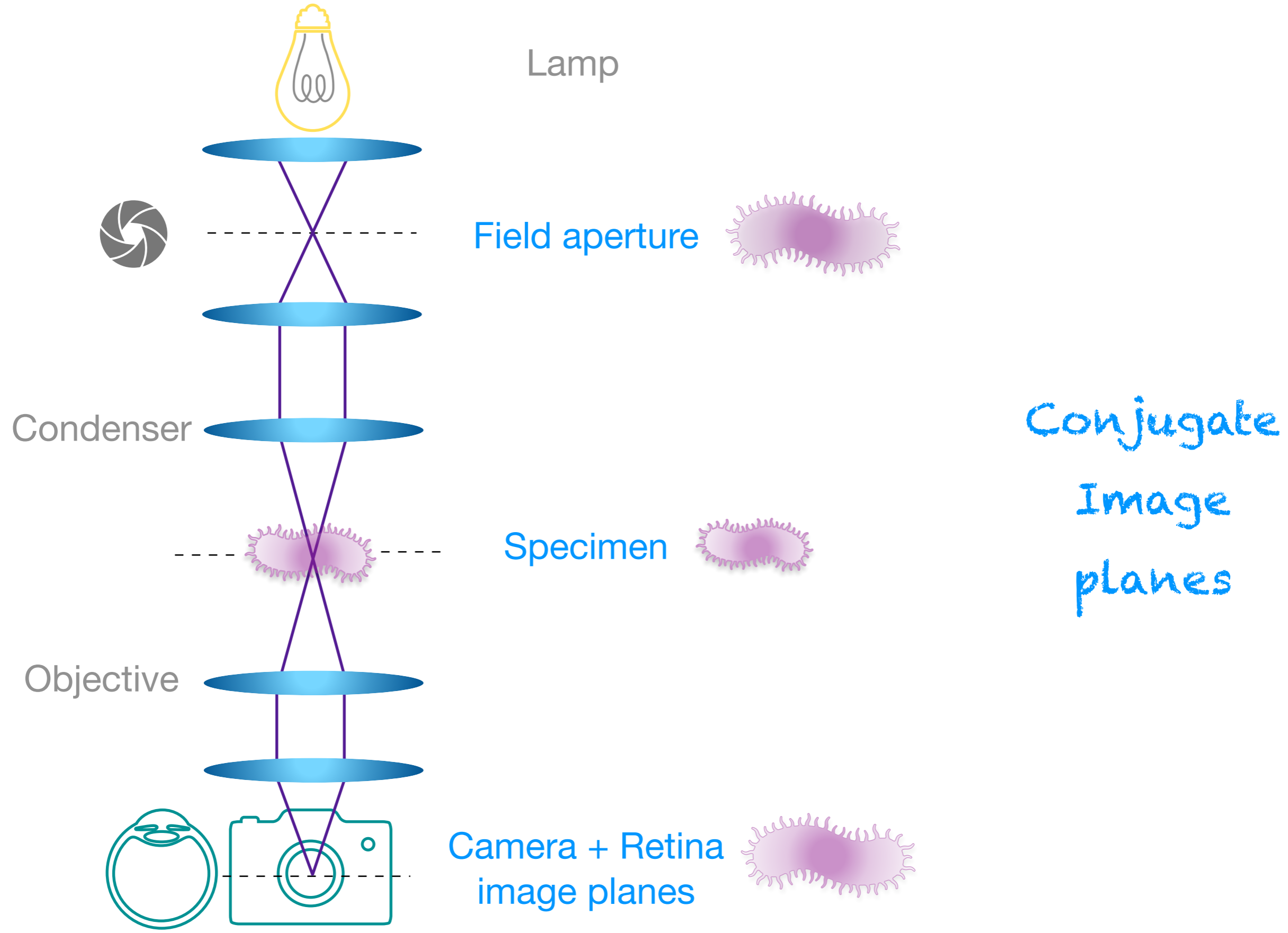
4. Conjugate planes on a microscope



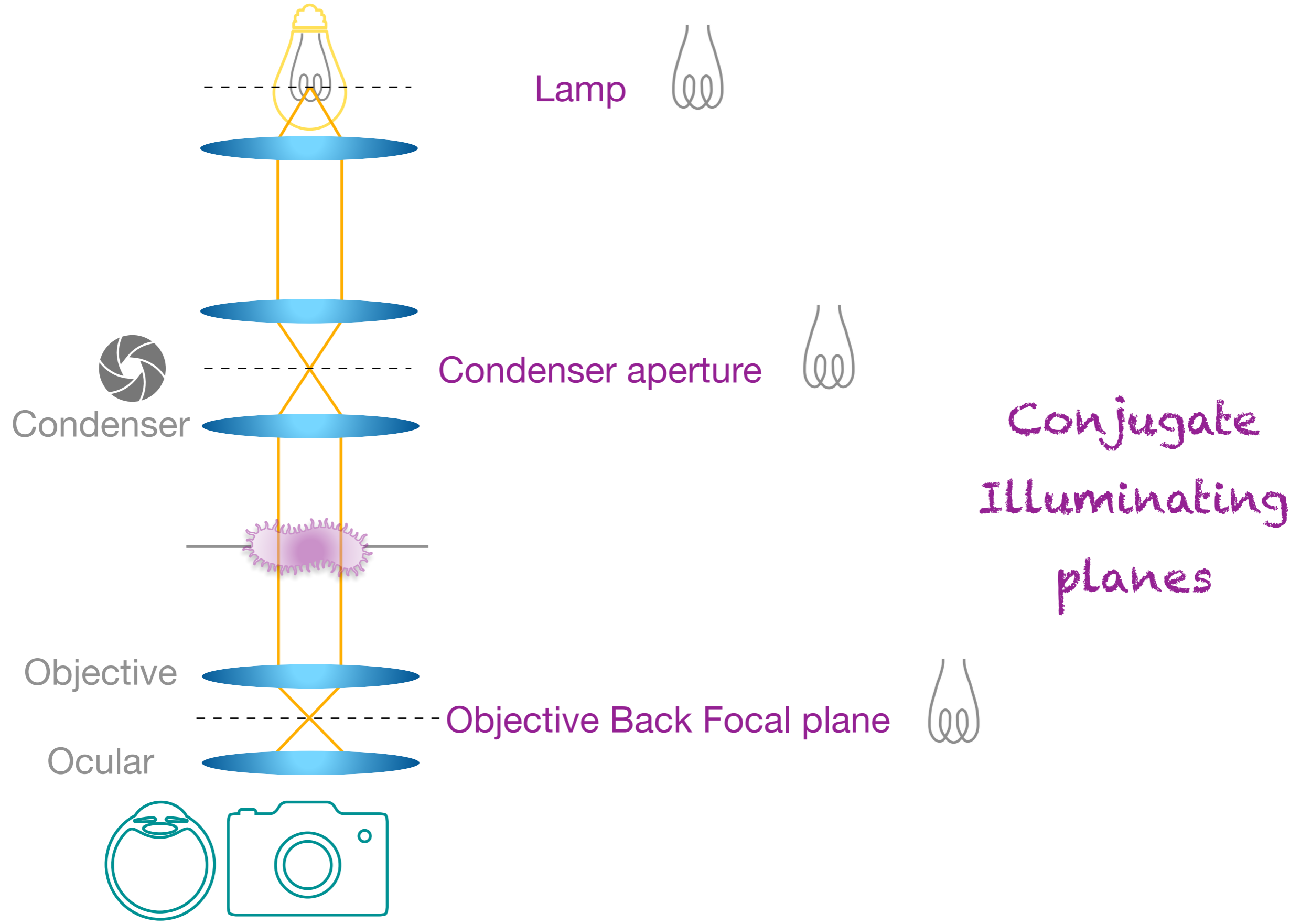
Parallel rays converge at the focal plane



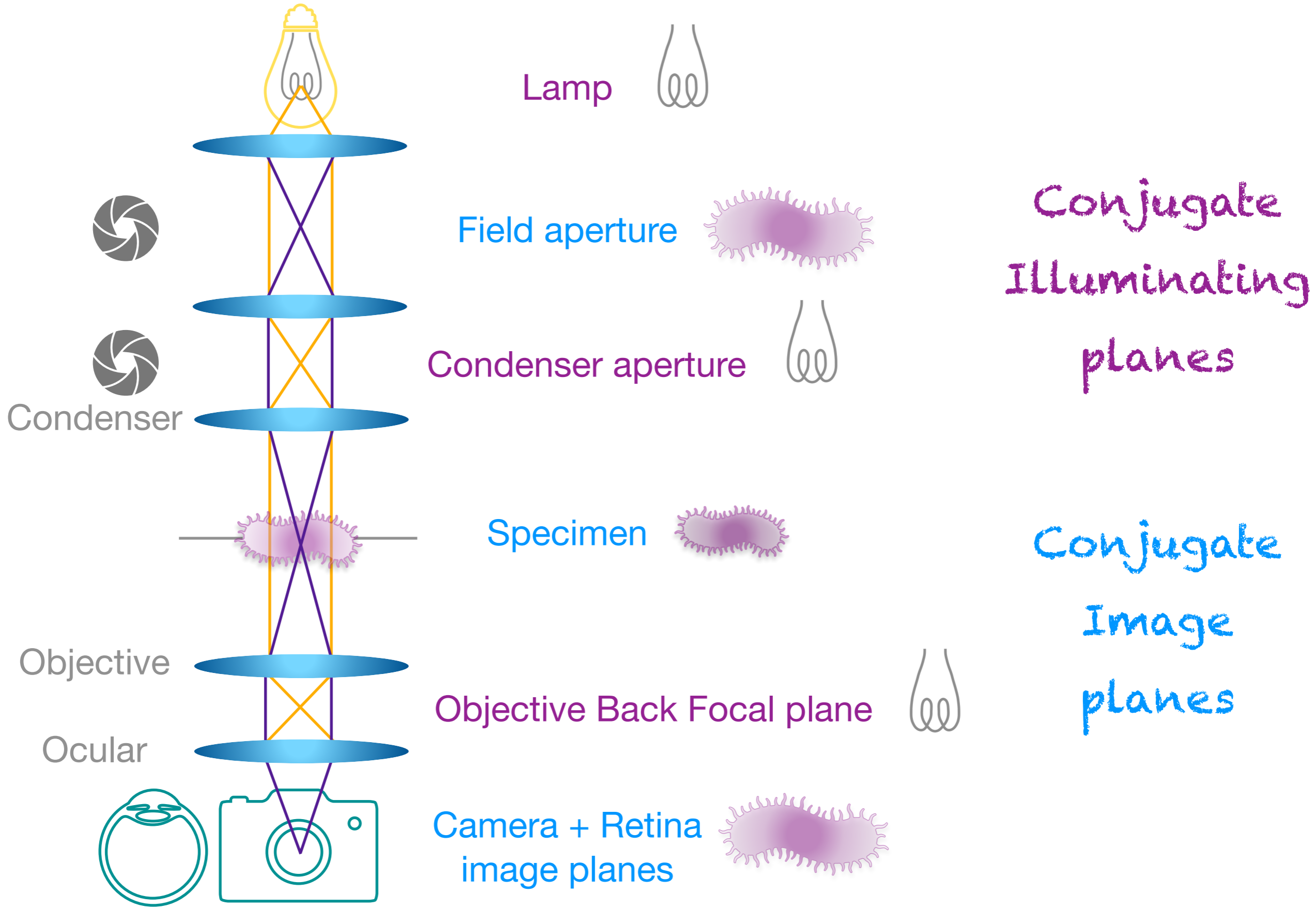
4. Conjugate planes on a microscope



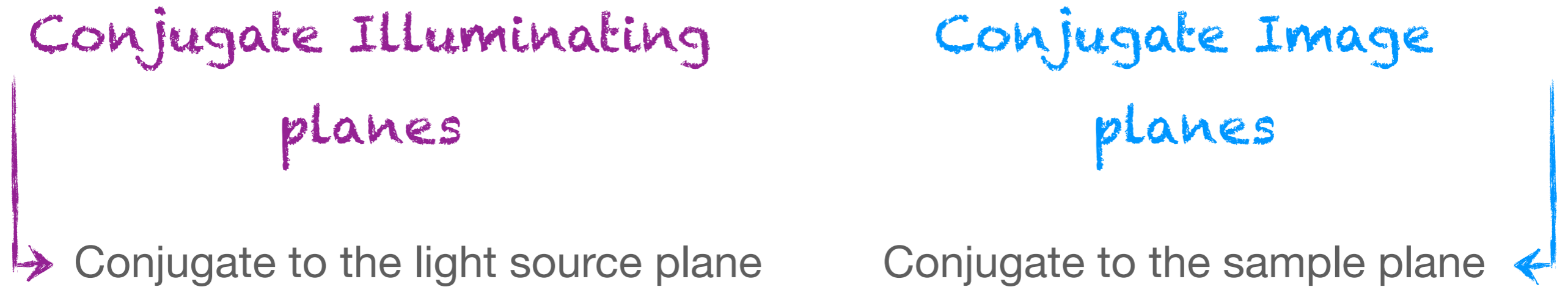
4. Conjugate planes on a microscope



4. Image and illuminating conjugate planes



4. Conjugate planes on a microscope



Each image formed at a plane within a conjugate set

... is simultaneously in focus

... appears superimposed upon one another

Microscope anatomy demo today at 1.35 pm



Conclusions



Components of an optical microscope



Inverted and Upright microscopes have the same optics, just opposite configurations



Stereomicroscope is used for 3D viewing of opaque specimens and to manipulate specimens minutely (e.g. during dissection)



How lenses are used in the context of the microscope to illuminate the specimen and to form images



2 independent sets of conjugated planes in microscopy:

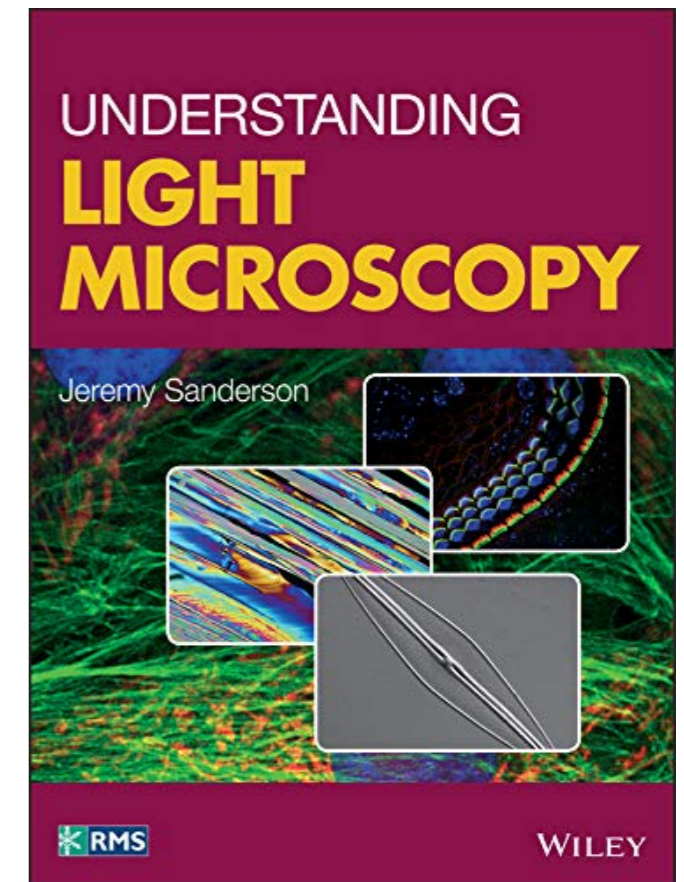
Image forming planes: Specimen, Retina, Camera and Field aperture

Illuminating planes: Lamp filament, Condenser aperture and Back focal plane of the objective

Useful resources

Book

J. B Sanderson, Understanding Light Microscopy
(Royal Microscopical Society)



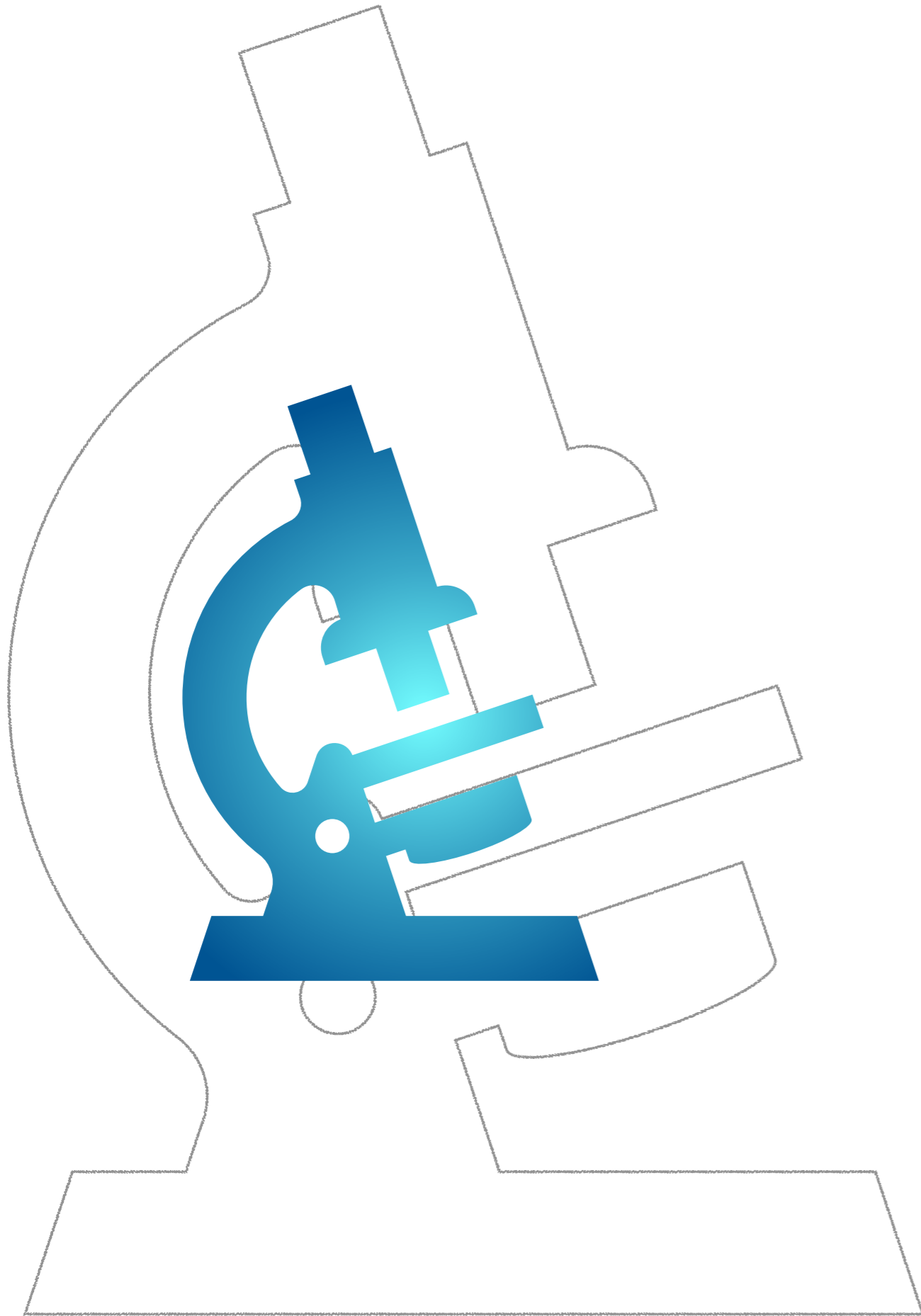
Useful websites

<https://www.ibiology.org/online-biology-courses/microscopy-series/>

<http://www.microscopyu.com>

<http://www.olympusmicro.com>

<https://www.zeiss.com/microscopy/int/solutions/reference/all-tutorials/basic-microscopy.html>



QUESTIONS?