

Exercise 01

1 Review Biomicroscopy I: Wide Field Microscopy

1.1 Microscope Comparison

For the two microscope systems given in **Figure 1** answer the following questions:

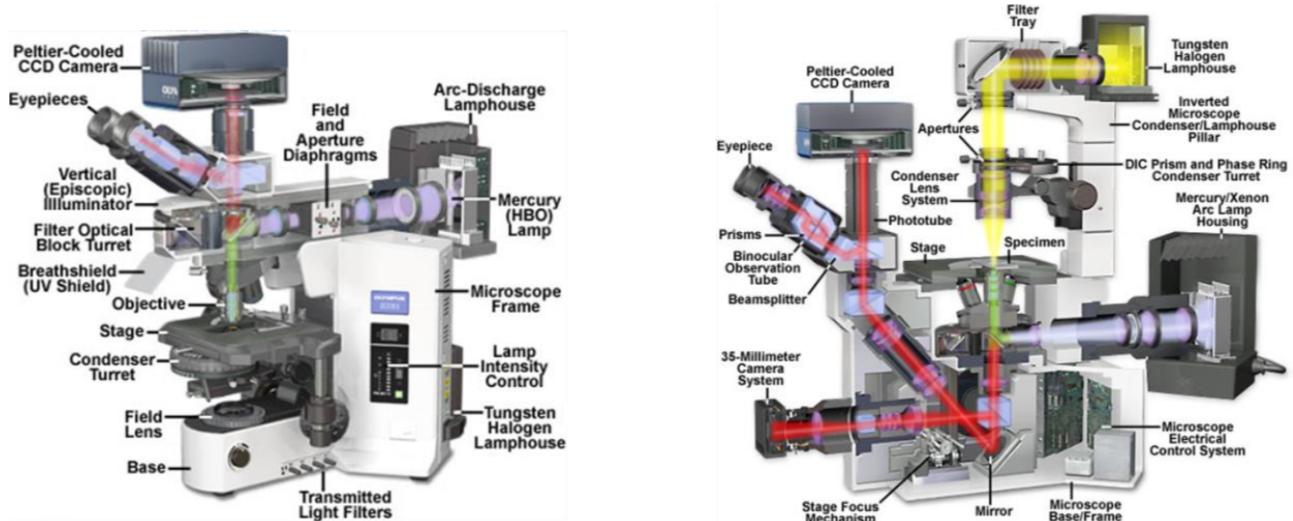


Figure 1: Cross-sectional schematic of two commonly used microscopes.

- Determine the upright and inverted microscope out of these two systems.
- For each microscope type, find the objective(s), condenser, collector lens, eyepiece, aperture(s) and other optical components.
- For each microscope type: trace the optical pathway for bright-field microscopy in transmission configuration: start from illumination, next to the sample, and then to detector/eye. What is the bright-field microscopy illumination source?
- For each microscope type: to bring the sample into focus should you move up/down the sample stage or objective lens?

1.2 Optical Aberrations in Microscopy

- Name several commonly encountered optical aberrations in microscopy.
- Explain in a few short sentences the reason for chromatic dispersion.
- Suggest a solution to minimize spherical aberration.

1.3 Infinity Corrected System (ICS)

You are asked to build a basic ICS microscope. ICS microscope objective collimates rays from an object point. For this task you have following optical elements:

- An objective indicating “50x/0.6NA” and “∞” with a description indicating an ICS objective (design tube lens is 160 mm)
- An achromatic lens with $f = 160$ mm
- An ocular (a.k.a. eyepiece) with magnification $M_{oc} = 10$

- What is the focal length of the objective?
- What is the focal length of the ocular?

- (c) If you switch objective with another lens of focal length 32 mm, what will be the magnification of the microscope?
- (d) Why are most modern microscopes infinity corrected?

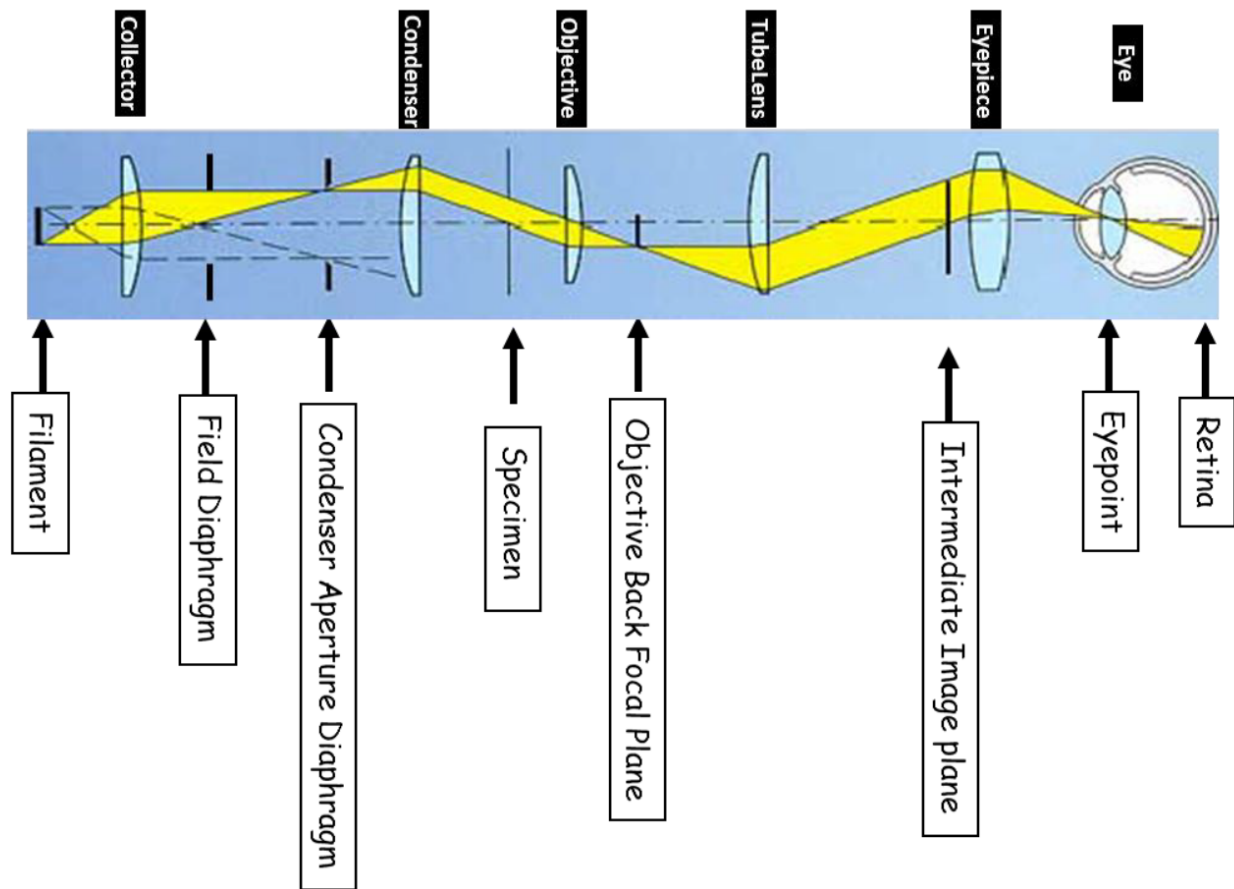


Figure 2: Cross-sectional schematic of the light path in Köhler illumination for an infinity corrected microscope.

1.4 Köhler illumination

- (a) Explain in a few short sentences why modern microscopes use Köhler illumination.
- (b) **Figure 2** shows the optical train for an infinity corrected transmission microscope. Find the planes that are conjugated (i.e. parfocal) with the lamp filament.

2 Dark Field Microscopy

Assume that you have a dark-field microscope with a dark field condenser having a numerical aperture of 0.9. To have a good contrast what should be the numerical aperture of the objective lens?