

## 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:

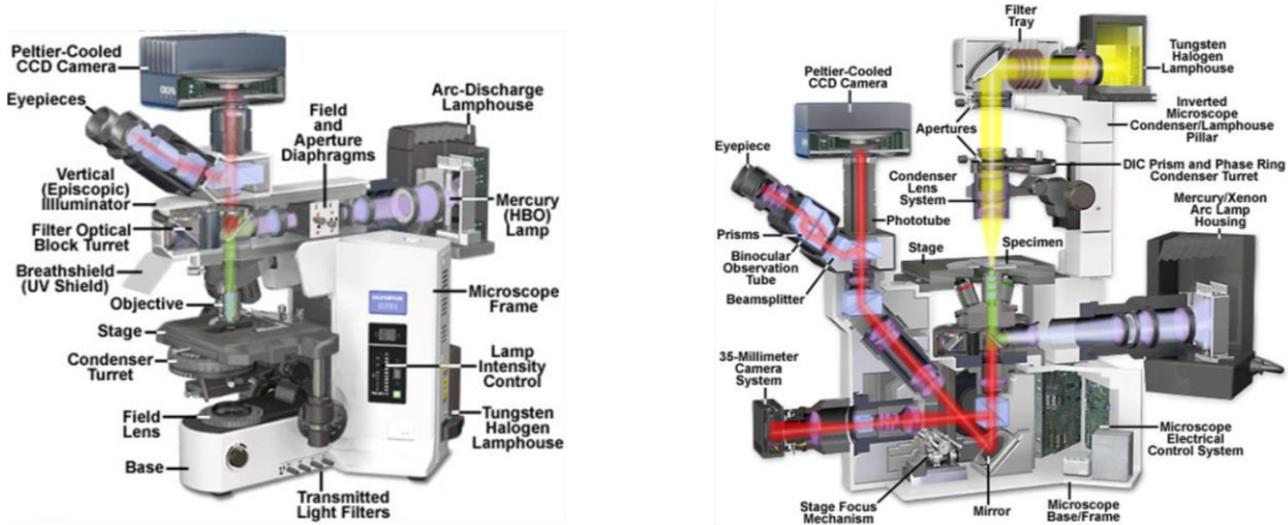


Figure 1: Cross-sectional schematic of two commonly used microscopes.

- 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 " $\infty$ " 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?

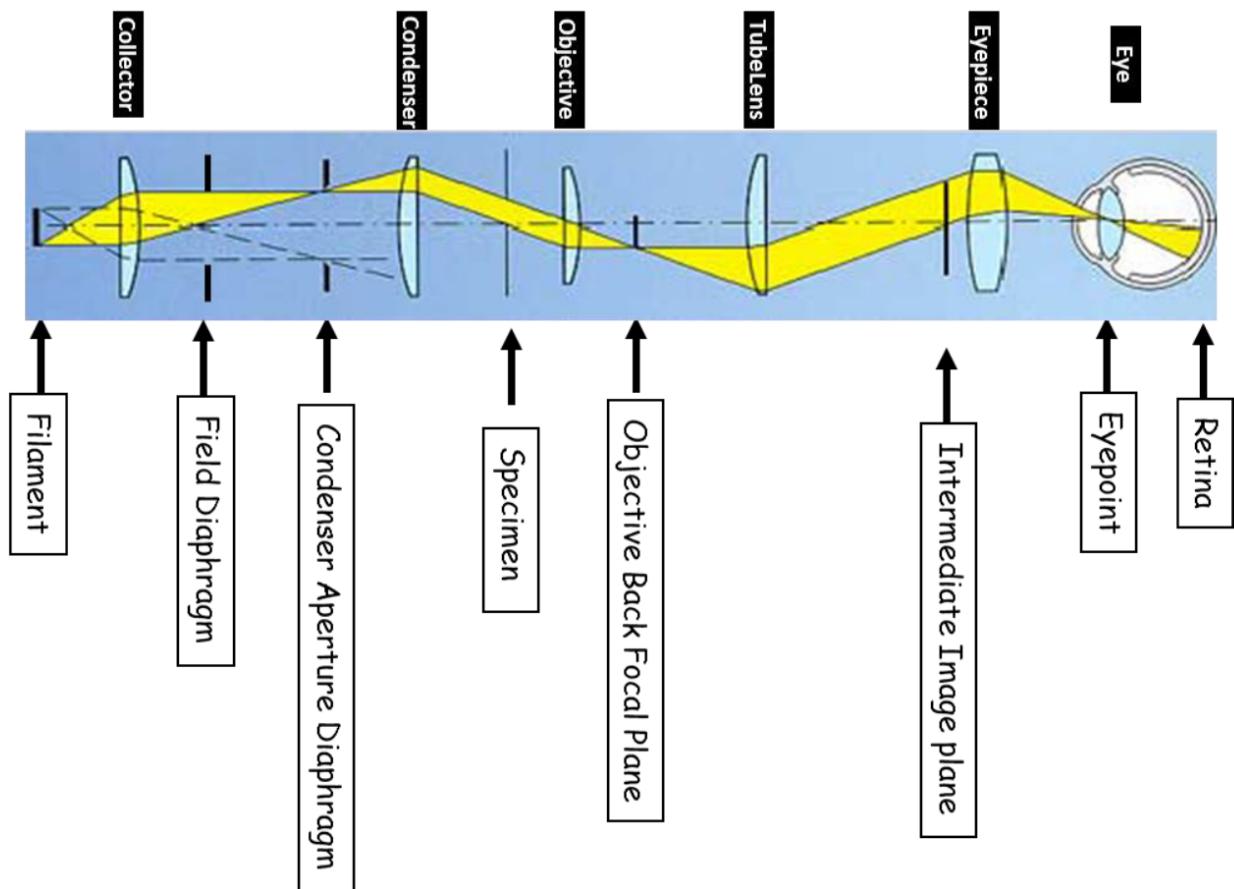


Figure 2: Cross-sectional schematic of the light path in Köhler illumination for an infinity corrected microscope.

## 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?