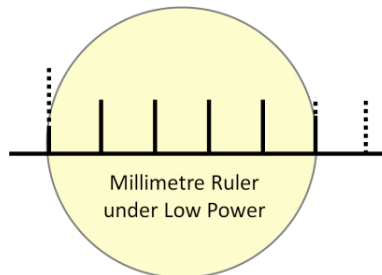# Microscope Calculations:

Field of View, Object Size, Drawing Magnification

When looking into a microscope, you will see a lit circular area. The distance across the center of the circle is referred to as the **diameter of field of view (dFOV)**. To calculate the dFOV, you will need to place a transparent ruler on the microscope stage and measure the dFOV under **low power**. Looking at the diagram below, we can see that the dFOV for this particular microscope is 5 mm.

Millimetre Ruler
under Low Power

As we continue to increase the magnification of our microscope, our dFOV begins to decrease. The use of a ruler may no longer be possible because you cannot see the scales. To calculate the dFOV for medium and high power, you will need to use the following equation:

$$dFOV \; \#1 \; \times \; magnification \; \#1 = dFOV \; \#2 \; \times magnification \; \#2$$

We can rearrange the equation to solve for dFOV #2:

$$dFOV \; \#2 = \frac{dFOV \; \#1 \; \times magnification \; \#1}{magnification \; \#2}$$

Before you can use this equation, however, you will need to determine the microscope magnification at low, medium, and high power. The **magnification** is how many times, the object has been enlarged. To calculate the magnification, you will need to multiply the magnification of the ocular lens with the magnification of the objective lens. See below for the equation.

$$magnification \; = \; magnification \; of \; ocular \; lens \; \times \; magnification \; of \; objective \; lens$$

Example: If the magnification of the ocular lens is x10 and the magnification of the objective lenses are x4, x10, and x40, what are the magnifications at low, medium and high power?

$$magnification \; at \; low \; power \; = \; 10 \; \times \; 4 \; = \; 40 \; times$$
$$magnification \; at \; medium \; power \; = \; 10 \; \times \; 10 \; = \; 100 \; times$$
$$magnification \; at \; high \; power \; = \; 10 \; \times \; 40 \; = \; 400 \; times$$

Authored by Katherine Cheung

Now that you know the magnifications at different magnification powers, you can calculate the dFOV for medium and high power:

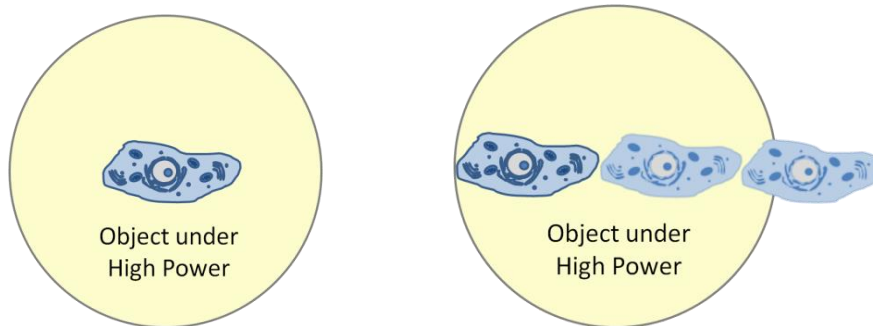$$dFOV\ \#2 = \frac{dFOV\ \#1\ \times\ magnification\ \#1}{magnification\ \#2}$$

$$dFOV\ (medium\ power) = \frac{5mm\ \times\ 40\ times}{100\ times} = 2\ mm$$

$$dFOV\ (high\ power) = \frac{5mm\ \times\ 40\ times}{400\ times} = 0.5\ mm$$

Helpful Hint: To better visualize all the information that you've calculated so far, put it in a table like the one below. Most times you will need to convert the dFOV into µm as well. For help on how to convert your values see a tutor in the Learning Centre.

	Magnification	dFOV (mm)	dFOV (µm)
Low power (4X)	40X	5	5000
Medium power (10X)	100X	2	2000
High power (40X)	400X	0.5	500

Knowing the dFOV allows you to find the size of the object you are observing. To find the **object size**, you will first need to estimate how many times the object fits across the dFOV. Looking at the example below, you can estimate that the object fits across our dFOV 2.25 times.

Object under High Power

Object under High Power

The magnification is set at high power for this view, so the dFOV is 500 µm. Using the following equation, you can calculate the object size:

$$Object\ size = \frac{dFOV\ (in\ µm)}{number\ of\ times\ object\ fits\ across\ the\ field\ of\ view}$$

$$Object\ size = \frac{500µm}{2.25\ times} = 220\ µm$$

If you are asked to draw a diagram of the object you are observing, you can calculate the **drawing magnification**. This is the number of times your drawing has been

enlarged relative to the true size of the object. To calculate the drawing magnification, use the following equation:

$$Drawing\ magnification = \frac{drawing\ size}{object\ size}$$

Note: this equation requires the drawing size and object size to have the same units of measurement.

Example: Below is your drawing of the object viewed under the microscope at high power. Use the information from previous examples to calculate the drawing magnification of your object.
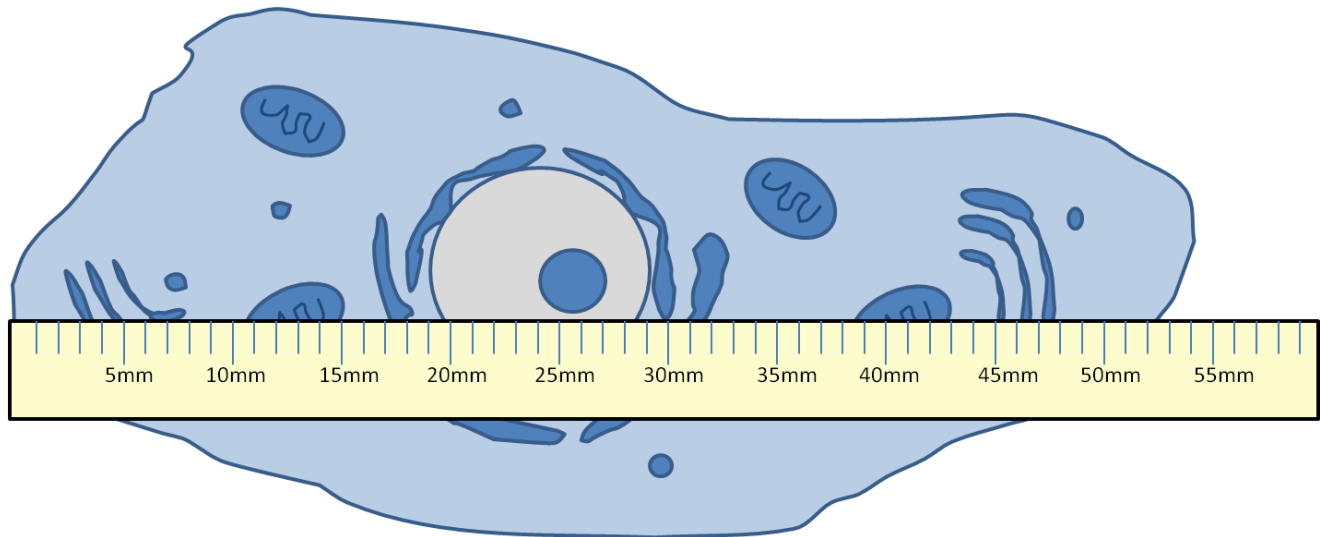
$$Drawing\ magnification = \frac{drawing\ size}{object\ size} = \frac{54\ mm}{220\ \mu m} = \frac{54000\ \mu m}{220\ \mu m} = 245\ times$$

### PRACTICE PROBLEMS:
1. You are in an Anatomy and Physiology lab observing onion cells under a microscope. Answer the following questions.
    a. If the magnification of the ocular lens of your microscope is 10X, calculate the magnification at
        i.   low power (magnification of objective lens is 5X)
        ii. medium power (magnification of objective lens is 10X)
        iii. high power (magnification of objective lens is 50X)
        iv. oil immersion (magnification of objective lens is 100X)
    b. If the dFOV under low power is 3.65 mm, calculate dFOV (in µm) for
        i.   medium power
        ii. high power
        iii. oil immersion
    c. If the onion cell spans the dFOV 5.75 times at high power, calculate the size of the onion cell (in µm to the nearest whole number).

If you produced a drawing of the onion cell and it measures 10.5 cm, using the answer calculated in part c (after rounding), what is the drawing magnification? Round to the nearest whole number.

2. The magnification of the ocular lens of a microscope is x10 and the magnification of the objective lens for low, medium, and high power are 4X, 10X, and 40X, respectively. The measured dFOV under medium power is 2.6mm. If 15 cells are observed across the dFOV under the high power, how long is each cell (in µm to the nearest whole number)?

3. A cell is observed under an oil immersion lens (1000X) to be about half the dFOV. The dFOV under the oil immersion lens is 4.6 µm. A student draws the cell 25 cm in length. What is the magnification of the drawing? Round to the nearest whole number.

4. Use the diagrams below to answer the following questions.
   a. What is the size of the object (in µm)? Round to the nearest whole number.
   b. What is the drawing magnification?

Millimetre Ruler under Low Power (40X)

Object under Oil Immersion (1000X)
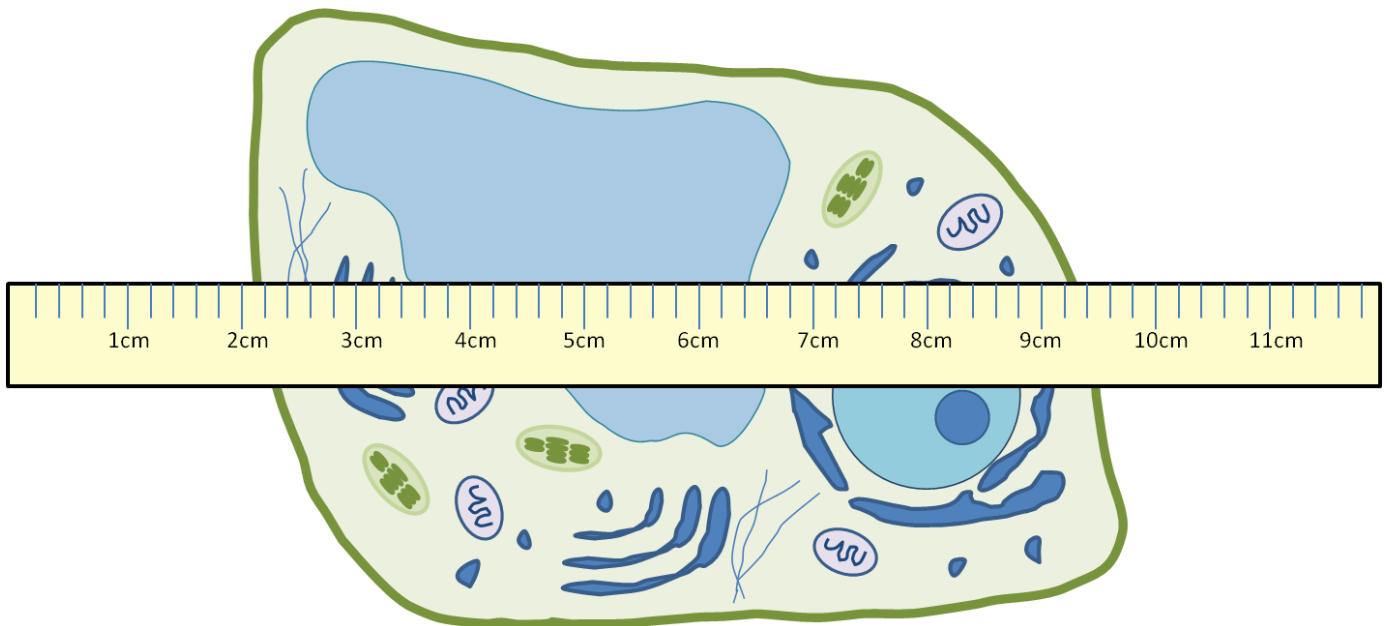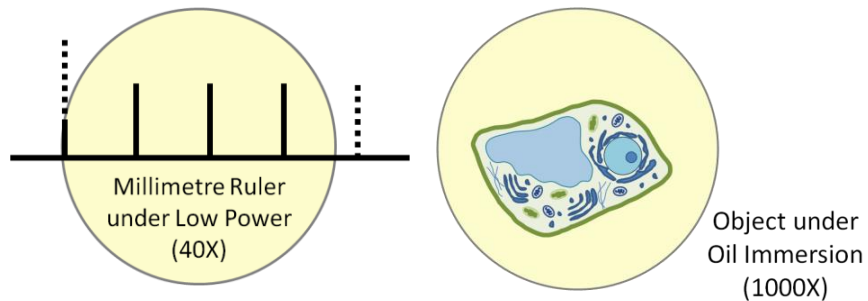
SOLUTIONS:

1. a) i) 50X ii) 100X iii) 500X iv) 1000X   1. b) i) 1825 µm ii) 365 µm iii) 182.5 µm
1. c) 64 µm   1. d) 1641X   2. 43 µm   3. 108,696X   4.a) 99 µm (assuming dFOV = 3.7 mm under low power and cell spans 1.5 times across) 4.b) 788X (assuming cell drawing measures 7.8 cm)