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Measuring with a Microscope

Pre-Lab Discussion

The microscope, developed more than three hundred years ago, is the basic tool of the biologist. The microscope enables biologists to investigate living things and objects that are too small to be seen with the unaided eye. The microscope is able to magnify these tiny specimens by means of lenses located in the eyepiece and objectives. The light microscope is also capable of revealing fine detail. This ability to reveal fine detail is known as resolving power. The type of microscope that you will be using throughout your study of biology is the compound light microscope.

Although it is interesting and informative to observe specimens under the microscope, it is often difficult to know the actual size of the object being observed. Magnification causes us to lose the idea of actual size. You cannot hold up a ruler to a paramecium or a plant cell while it is under the microscope. Therefore size must be measured indirectly—that is, it must be compared with the size of something you already know. The diameter of the microscope field seen through the eyepiece is a convenient standard to use. To measure objects under the microscope, a unit called the micrometer (μm) is used. One micrometer equals 0.001 millimeter.

In this investigation, you will develop skill in using the compound light microscope. You will also learn how to estimate the sizes of objects under the microscope.

Problem

How is the compound microscope used to make measurements of microscopic specimens?

Materials *(per group)*

Microscope	Transparent metric ruler
Lens paper	Prepared slides

Safety

Always handle the microscope with extreme care. You are responsible for its proper care and use. Use caution when handling glass slides as they can break easily and cut you. Note all safety alert symbols next to the steps in the Procedure and review the meanings of each symbol by referring to the symbol guide on page 10.

Procedure

1. Take a microscope from the storage area and place it about 10 centimeters from the edge of the laboratory table.
2. Carefully clean the eyepiece and objective lenses with lens paper.
3. Examine the markings on a metric ruler. Decide which marks indicate millimeter lengths. Place the ruler on the stage so that it covers half of the stage opening, as shown in Figure 1.
4. Prepare your microscope for low-power observation of the ruler.
5. Look through the eyepiece. Focus on the edge of the ruler using the coarse adjustment. Adjust the position of the ruler so that the view in the low-power field is similar to Figure 2.
6. Place the center of one mark at the left side of the field of view. Make sure that the edge of the ruler is exactly across the center of the field. If the ruler sticks to your fingers, use the eraser end of a pencil to arrange it.

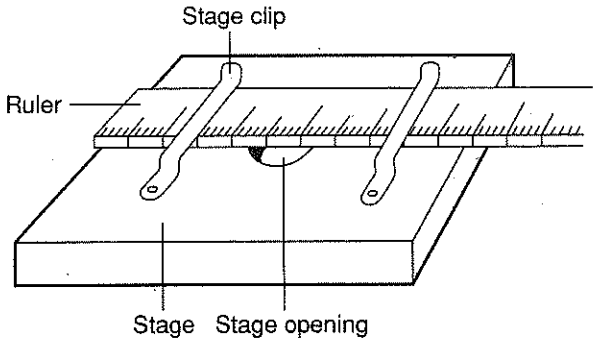

Figure 1

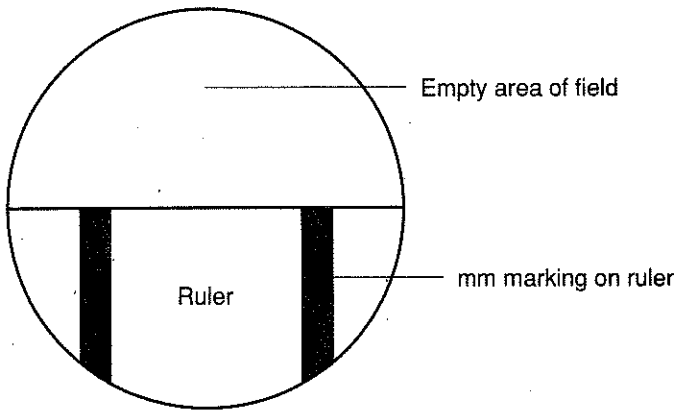

Figure 2

7. Note that 1 millimeter is the distance from the middle of one mark to the middle of the next mark. The diameter of the low-power field measures 1 millimeter plus a fraction of another. In Observations, record the measurement of the low-power field diameter in millimeters, expressing the length to the nearest tenth of a millimeter.
8. In Observations, record the measurement of the low-power field diameter in micrometers.
9. You cannot measure the diameter of the high-power field using the process you have just completed. Viewing a ruler under high power presents problems with light and focusing. Also, the high-power field diameter is less than 1 millimeter. But you can obtain the high-power field diameter indirectly. You know the low-power field diameter and the magnifying power of both objectives. Since the magnification of the objectives is inversely proportional to the field size, you can use this formula:

$$\text{high-power field diameter} = \frac{\text{low-power field diameter} \times \text{low-power magnification}}{\text{high-power magnification}}$$

   In Observations, record the high-power field diameter in micrometers. Show your calculations.
10. Now that you know the diameter of your field size under both low and high power, you can estimate the sizes of the objects you view under the microscope by comparing them with the diameter of the field of vision. For example, if a tiny organism takes up approximately one-half of a field of view that is 1000 micrometers in diameter, then its size is about one-half of 1000 micrometers, or 500 micrometers.

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11. Obtain prepared slides of various organisms and practice estimating their lengths. Write the name of the organism or part you examine and its estimated size in micrometers in the Data Table.
12. When you have finished examining the organisms in step 11, return your microscope to the storage area.

Observations

1. Measurement of the low-power field diameter = _____
2. Measurement of the low-power field diameter = _____ micrometers.
3. Low-power magnification = _____
4. High-power magnification = _____
5. Use the formula shown in step 9 of Procedure to calculate the high-power field diameter. Show your calculations.

Data Table

Name of Object	Measurement of Object (μm)

Analysis and Conclusions

1. How many micrometers are in 1 millimeter? _____
2. How many micrometers are in 1 meter? _____
3. What happens to the field of view when you change from low-power magnification to high-power magnification? _____

_____

_____

4. How many times is the magnification increased when you change from low-power to high-power magnification? _____

5. How many times is the diameter of a field decreased when you change from low-power to high-power magnification? _____

Critical Thinking and Application

1. Approximately 500 of a certain type of bacteria can fit across your low-power field of vision. What is the approximate size of 1 bacterium? _____

2. Approximately 7 of a certain type of protist can fit across your high-power field of vision. What is the approximate size of 1 protist? _____

3. If a microscope has a low-power magnification of 100X, a high-power magnification of 600X, and a low-power field diameter of 1800 micrometers, what is the high-power field diameter in micrometers? _____

4. If 20 objects fit across a low-power field of view whose field diameter is 3000 micrometers, what is the approximate size of each object? _____

Going Further

Make a temporary wet-mount slide of a culture of mixed protists. Choose one protist and observe it under low and high power. Estimate its length in micrometers.