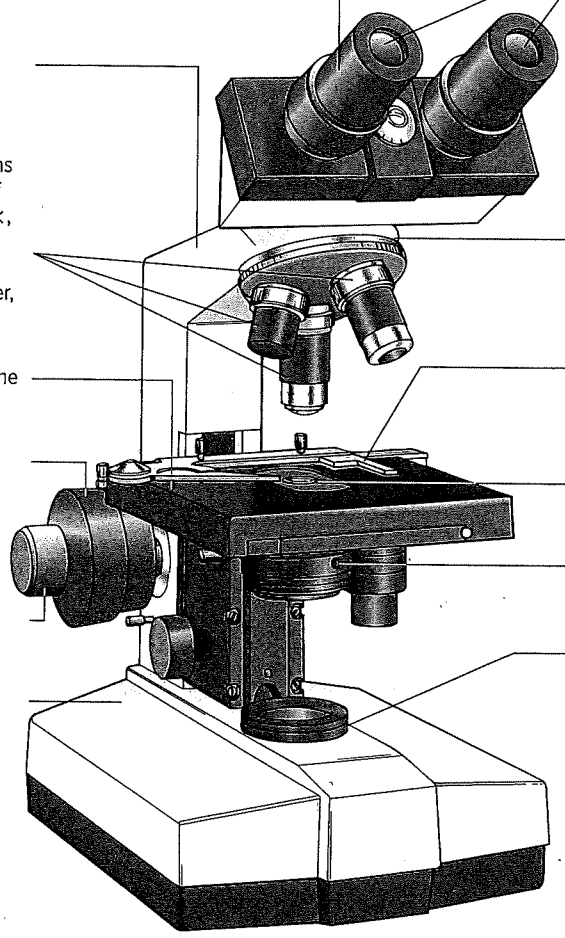
Care and Use of the Microscope

A compound light microscope is an instrument with a series of lenses that greatly magnify objects too small to be seen with the unaided eye. The diagram below shows the major parts of the microscope and their functions. Follow these tips to keep your microscope in good working condition.

1. Always use two hands to carry a microscope: one hand to hold the arm and the other hand to support the base.
2. Do not allow the electrical cord to become a trip hazard while working with your microscope.
3. Do not touch the lens surfaces with your fingers.
4. Use only lens tissue to clean the lens surfaces. Other kinds of paper can scratch the lenses.
5. Do not adjust any of the focusing knobs until you are ready to use the microscope.
6. Always focus using the coarse adjustment knob first, with the low-power objective lens in position.
7. Do not use the coarse adjustment knob with either the medium-power or high-power objective lens.
8. Always store the microscope with the low-power objective lens in place. Cover the microscope when not in use.

Compound Light Microscope



(B) **Body tube** Holds the eyepiece at the proper working distance from the objective lenses.

(C) **Arm** Supports the body tube. Use the arm for carrying the microscope.

(D) **Objective lenses** Each contains a lens with a different power of magnification, such as 4×, 10×, or 40×, engraved on the objective. They are referred to as low, medium, and high power, respectively.

(E) **Stage** Platform that supports the microscope slide

(F) **Coarse-adjustment knob** Focuses the image under low power

(G) **Fine-adjustment knob** Sharpens the image under medium-power and high-power magnification

(H) **Base** Provides support for the microscope

(A) **Eyepiece (or ocular lens)** Contains a magnifying lens you look through. The magnifying power, usually 10×, is engraved beside the lens.

(M) **Revolving nosepiece** Holds and turns the objectives into viewing position

(L) **Stage clips** Hold the microscope slide in place

(K) **Condenser lens** Directs light to the object being viewed

(J) **Diaphragm** Controls the amount of light entering the body tube

(I) **Light source** Directs light through the diaphragm, the specimen, and the lenses. Some microscopes have a mirror instead of a light. If so, the mirror must be adjusted to reflect the light from the source into the body tube. **CAUTION: Use an electric light, not sunlight, as the light source to reflect from the mirror.**

Troubleshooting Tips

The table below gives helpful tips for handling some problems you may have when you use a microscope.

Problem	How to Solve the Problem
You cannot see anything.	Make sure the microscope is plugged in and the light is turned on. If the microscope has no electric light, adjust the mirror.
You have trouble finding anything on the slide.	Be patient. Make sure the object being viewed is in the middle of the stage opening. While watching from the side, lower the low-power objective lens as far as it will go. Then look through the eyepiece. Slowly raise the stage using the coarse adjustment knob.
You have trouble focusing, or the image is very faint.	Try closing the diaphragm slightly. Some objects are almost transparent. If there is too much light, a specimen may be difficult to see or it will appear "washed out."
You see lines and specks floating across the slide.	These are probably structures in the fluid of your eyeball that you see when you move your eyes. Don't worry; this is normal.
You see a double image.	Check that the objective lens is properly clicked into place.
Your eyes feel tired or you find it difficult to sketch an object.	Keep both eyes open. This will help prevent eye fatigue. It also lets you sketch an object while you are looking at it.
You no longer see the object when you turn from low power to medium or high power.	Always place the part of the slide you are interested in at the centre of the field of view before changing to a higher-power objective lens. Otherwise, when you turn to medium and high power, you may not see the object you were viewing under low power.

Finding Total Magnification

When you look through a microscope, you are actually looking through two lenses at once. These lenses are 1) the lens in the eyepiece and 2) the objective lens you have chosen (low-, medium-, or high-power). Each of the lenses (the eyepiece lens and the objective lens) adds to the total magnification. The table on the right shows how to calculate the total magnification you actually see when you look through each objective lens. The eyepiece usually has a magnification of 10×. The table shows typical magnifications for the objective lenses. Your teacher will tell you if the microscope you are using has different magnifications.

Total magnification =
(eyepiece magnification) ×
(objective lens magnification)

Magnification and Total Magnification of Each Objective Lens

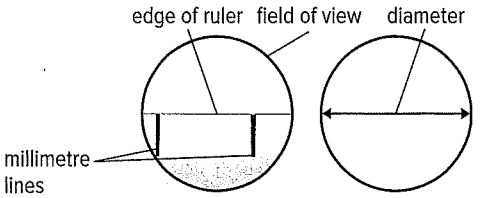
Objective Lens	Magnification	Total Magnification
Low-power	4×	10 × 4 = 40×
Medium-power	10×	10 × 10 = 100×
High-power	40×	10 × 40 = 400×

For example, suppose you are viewing an object under the medium-power lens. The object is magnified by the eyepiece lens (10×) and by the medium-power objective lens (10×). Therefore, the total magnification is 10 × 10 = 100×.

Finding the Diameter of the Field of View

The *field of view* is the circular area you can see when you look through the microscope. The diameter of the field of view is different depending on which lens you are using. For example, if you are using the medium-power lens (magnification 100×), then the area you can see is actually smaller than if you were using the low-power lens (magnification 40×).

1. Place a clear plastic ruler on the microscope stage.
2. Use the coarse-adjustment knob to focus on the ruler. Position the ruler so that one of the millimetre markings is at the left edge of the field of view, as shown below.



The diameter of the field of view under low power illustrated here is about 1.5 mm.

3. Measure and record the diameter of the field of view in millimetres (mm) for the low-power objective lens.
4. Use the following formula to calculate the field of view for the medium-power objective:

   Medium-power field of view =

   low-power field of view × $\frac{\text{magnification of low-power objective}}{\text{magnification of medium-power objective}}$

   For example, if the low-power objective lens has a magnification of 4× and a field of view of 2 mm, and the medium-power objective has a magnification of 10×, then

   Medium-power field of view

   $= 2 \text{ mm} \times \frac{4}{10}$

   $= 2 \text{ mm} \times 0.4$

   $= 0.8 \text{ mm}$

Calculating the Size of an Object under the Microscope

Once you know the diameter of your microscope's field of view, you can calculate the size of an object.

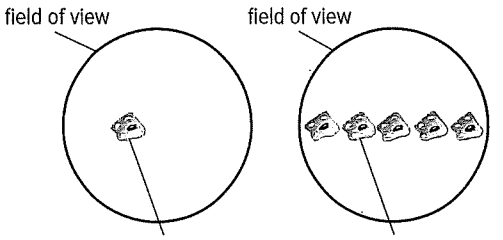
Objects in the field of view of a microscope are usually measured in micrometres (μm). One micrometre equals 0.001 mm (millimetres); or 1000 μm equals 1 mm (millimetre). For example, if the field of view under the medium-power objective is 0.8 mm, this is equal to 800 μm.

$$0.8 \text{ mm} \times 1000 = 800 \text{ μm}$$

Steps in Calculating the Size of an Object under the Microscope

This example shows you how to calculate the size of an amoeba that you are viewing under a microscope.

1. Estimate how many amoebas could fit end to end across the field of view. (See the diagram below.)



2. Calculate the size of one amoeba using the following formula:

   Size of object =

   (field of view diameter) ÷ (number of specimens)

   Size of amoeba = 1500 μm ÷ 5

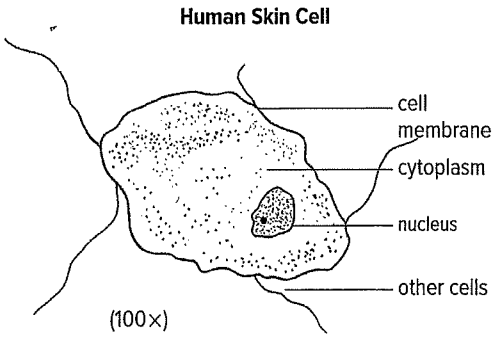
   = 300 μm

   Therefore, one amoeba measures about 300 μm across.

Important Features of Biological Drawings

The drawing of a human skin cell is from a student's notebook. The following are important features of biological drawings that you can see in this example.

- Use a pencil for drawing, not a pen.
- Use stippling (point-like pencil marks) to show darker areas instead of sketch lines or shading.
- Give your drawing a title.
- If possible, place all labels on the right-hand side of the drawing, with straight lines extending from the area you are labelling.
- Include the magnification used to view the specimen at the bottom of the drawing.



Instant Practice

PART 1

Viewing a Prepared Slide

CAUTION: Be sure your hands are dry when handling electrical equipment. Handle microscope slides carefully, since they can break easily and cause cuts.

1. Set up your microscope. Be sure to follow the tips just described.
2. Make sure that the low-power objective lens is in position. If not, rotate the nosepiece until the low-power objective lens clicks into place.
3. Look through the eyepiece and adjust the diaphragm until the view is as bright as possible.
4. Place a prepared slide on the stage and secure it in place with the stage clips. Make sure the object you want to view is centred over the opening in the stage.
5. Look through the eyepiece. Slowly turn the coarse adjustment knob until the object is in focus. Use the fine adjustment knob to sharpen the focus.
6. Once the object is in focus using low power, carefully rotate the nosepiece to the medium-power objective. Look at the objective from the side as you rotate the nosepiece to be sure the objective lens does not strike the surface of the slide. Adjust the focus using ONLY the fine adjustment knob.

   DO NOT use the coarse adjustment knob with the medium- or high-power objective lens.
7. To view the object under high power, follow the same process as in step 6.
8. Draw a sketch of what you are viewing. Use the tips provided about biological drawings.
9. Once you have finished, carefully rotate the nosepiece until the low-power objective is in position. Remove the slide from the stage and return it to its proper container. Unplug the light source and return the microscope to its storage area.

CAUTION: Never tug on the electrical cord to unplug it.

PART 2

Looking at the Letter "e" in a Wet Mount Slide

CAUTION: Be careful when using sharp objects such as tweezers. Handle microscope slides and cover slips carefully, since they can break easily.

Materials

newspaper
tweezers
cotton ball
cover slip
microscope slide
water dropper
microscope

Procedure

1. Begin with a clean slide and cover slip. Hold the slide and cover slip by their edges to avoid getting your fingerprints on their surfaces.
2. Cut out a small piece of newspaper containing a single letter "e." Use the tweezers to position the letter in the centre of the slide.
3. Use the dropper to place one drop of water on the letter.
4. Hold a cover slip over the sample at a 45° angle. Lower the cover slip until one edge touches the surface of the slide at the edge of the water drop.
5. Slowly lower the opposite edge of the cover slip over the sample. Be sure no bubbles form beneath the cover slip. If bubbles do form, repeat the procedure. This type of sample preparation is called a *wet mount.*
6. Make sure the low-power objective lens is in position. Place the slide on the stage and secure it with the stage clips. Centre the sample over the opening.
7. Look though the eyepiece. If necessary, reposition the slide until you can see the letter. Use the coarse adjustment knob to focus on the letter. Then adjust the focus with the fine adjustment knob.
8. Draw the letter "e" as it appears under low-power magnification.
9. Move the slide in different directions (left, right, away from you, and toward you). Record how the image moves in each case.
10. Move the letter back to the centre of the field of view. Rotate the nosepiece so that the medium-power objective lens is in position. At higher magnification, use ONLY the fine adjustment knob to focus the image. You may need to adjust the light level at this higher magnification.
11. Draw the letter "e" as it appears at medium-power magnification.
12. Rotate the nosepiece so that the high-power objective lens is in position. Remember: use ONLY the fine adjustment knob to focus the image.
13. Draw the letter "e" as it appears at high-power magnification.

Observations

Use a table like this to record your observations in step 9.

Letter "e" as Viewed under the Microscope

Direction of Slide Movement	Observed Direction of Movement
Left	
Right	
Away from you	
Toward you	

Look at your drawings of the letter "e" under low-, medium-, and high-power magnification.

a) How does the size of the field of view compare under each level of magnification?

b) How does the appearance of the printed letter change as you increase the magnification?