

4.3

The Compound Microscope

Most cells are too small to be seen with the unaided eye. Our knowledge of cells has been greatly improved by our ability to see them through the compound microscope. This microscope is commonly called the compound light microscope because it uses lenses and a light source to magnify the specimen. The compound light microscope is the most common and versatile type of microscope today (Figure 1). It is easy to use and relatively inexpensive.

LINKING TO LITERACY

Pause and Reflect

After reading a graphic, it is a good idea to pause and think about what you have read. Ask yourself, “Do I know the parts of the compound microscope and how they work?”

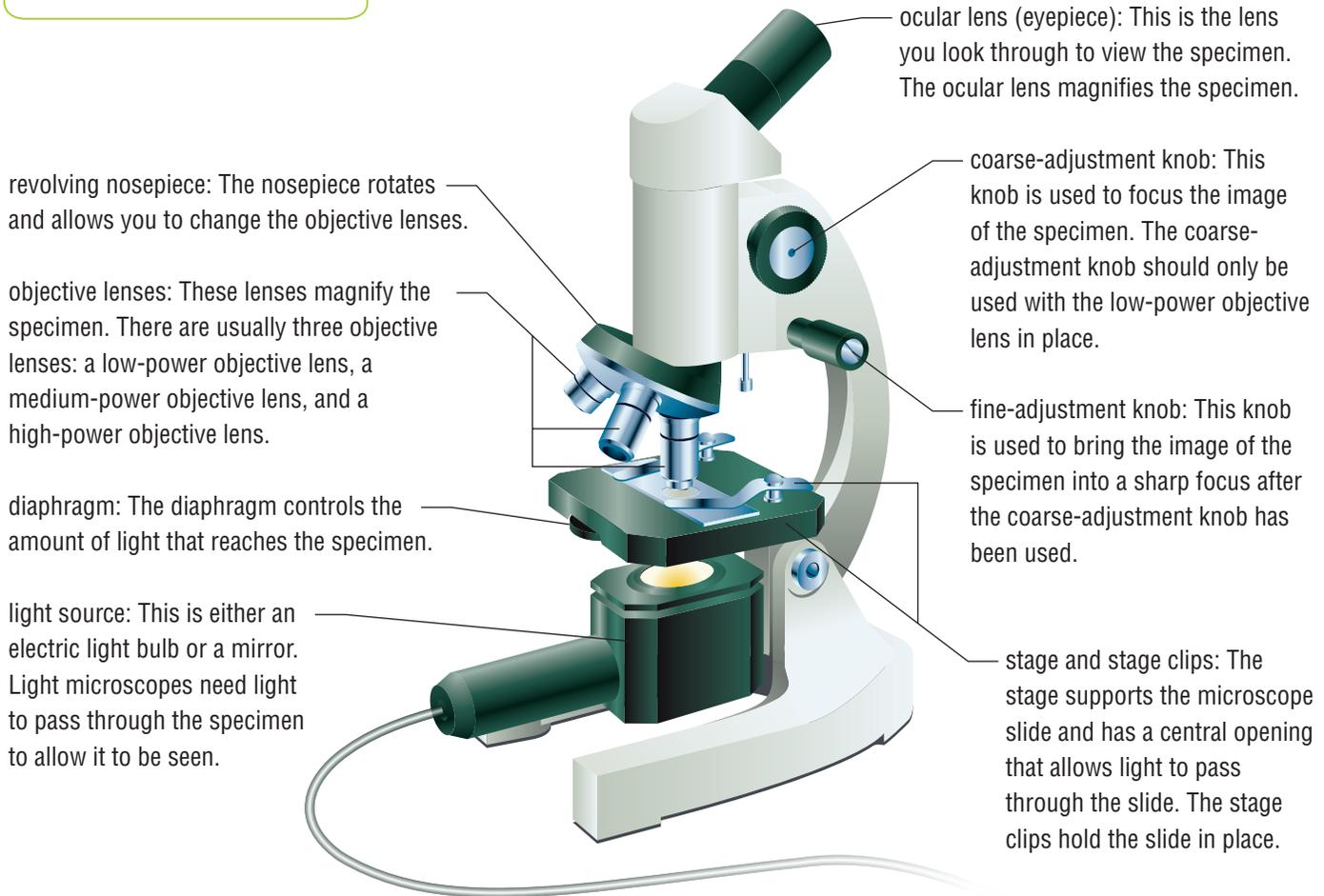


Figure 1 The parts of a compound light microscope

Magnification

Microscopes, magnifying glasses, binoculars, and some curved mirrors enable us to magnify the appearance of specimens.

Magnification refers to how much a specimen is enlarged in appearance. In microscopy, magnification of a specimen is achieved using a lens system. The amount by which a specimen is magnified can be expressed as a number. A magnifying glass with a magnification of $2\times$ will make a specimen appear to be two times larger than its actual size.

magnification: the degree to which the appearance of a specimen is enlarged

Compound microscopes use two lenses to magnify a specimen—an ocular lens and an objective lens. The ocular lens commonly magnifies 10 times (10×). The three objective lenses usually magnify the specimen 4× (low-power objective lens), 10× (medium-power objective lens), and 40× (high-power objective lens). The total magnification is determined by multiplying the magnification of the ocular lens by the magnification of the objective lens being used (Table 1).

To practise total magnification calculations,

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Table 1 Determining Total Magnification

Ocular lens magnification	Objective lens magnification	Total magnification (ocular lens magnification × objective lens magnification)
10×	4× (low-power objective)	40×
10×	10× (medium-power objective)	100×
10×	40× (high-power objective)	400×

Safety and the Compound Microscope

The compound microscope is a delicate instrument that needs to be used safely. Some tips to keep in mind include the following:

- Always keep the microscope upright when handling it. Use two hands to carry the microscope—one under the base and one on the arm (Figure 2). Place the microscope near the centre of the desk or table where it will be used.
- Be careful when handling glass slides—they may shatter if dropped.
- When sunlight is used for illumination, ensure that the Sun cannot be focused directly through the microscope.
- When you are observing a specimen through the microscope, keep both eyes open to avoid straining your eyes.
- Always store the microscope with the lower-power objective lens in place and the stage lowered. This will prevent the objective lens from being accidentally scratched by the slide when you begin using the microscope.
- Only use the coarse-adjustment knob with low-power objective lenses. Use the fine-adjustment knob at higher powers.
- Use the microscope in a dry area. Your hands should also be dry when using a microscope.
- Remember to unplug the microscope from the electrical outlet by grasping and pulling the plug, not by pulling on the power cord. Coil the power cord neatly around the arm of the microscope when returning the microscope to its storage area.



Figure 2 The microscope should be carried with one hand under the base and one hand on the arm.

The Microscope's Field of View

field of view: the visible area of the specimen seen through the eyepiece of a compound microscope

When you look through the ocular lens of a microscope, you see a circular area in which the enlarged image of the specimen can be viewed. This is called the **field of view**. The diameter of the field decreases as you use more powerful lenses to view a specimen. The total magnification increases and the components of the specimen appear larger (magnified), but a smaller portion of the specimen is seen. Figure 3 shows two photos of human liver cells seen through a compound light microscope. In Figure 3(a), the cells were viewed under low power ($50\times$ total magnification), while in Figure 3(b), they were viewed under high power ($600\times$ total magnification). Can you see the difference in the two fields of view?

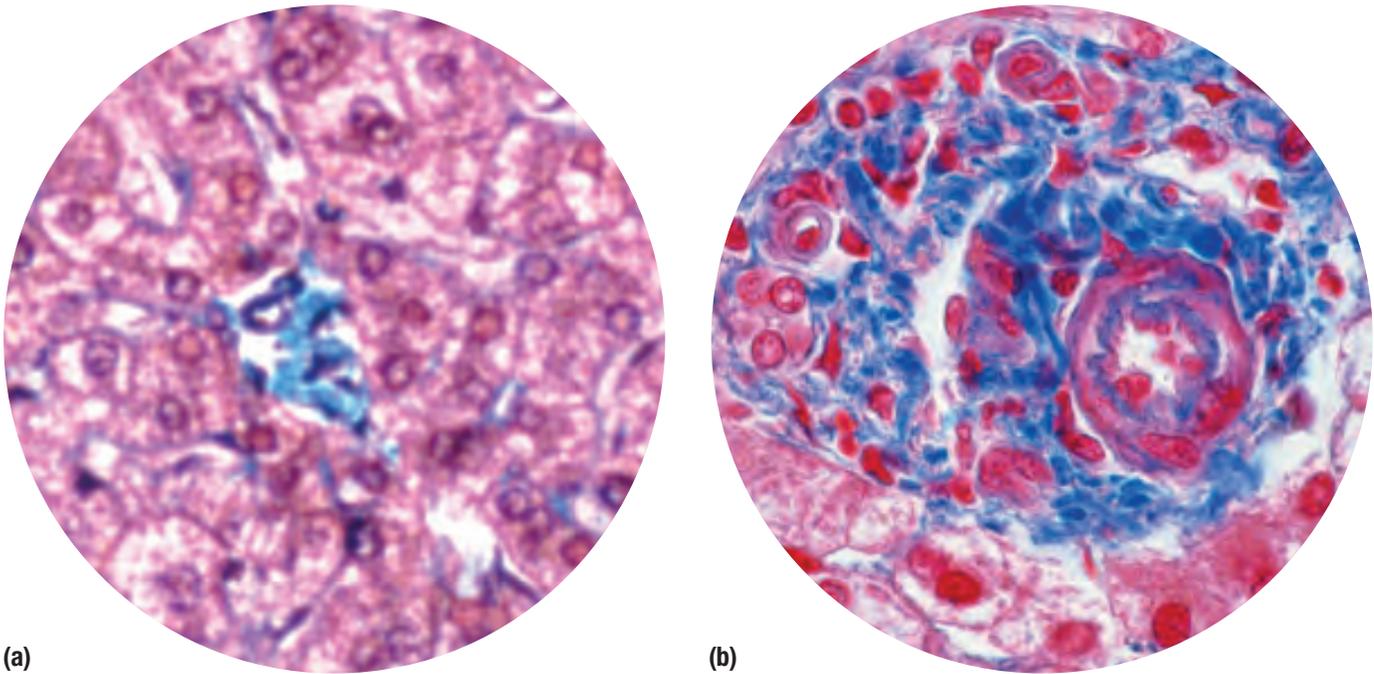


Figure 3 (a) Human liver cells magnified $50\times$ (b) Human liver cells magnified $600\times$

Since a larger portion of a specimen is seen under low power, scientists use low power to scan a specimen. When they see an area they are interested in, they switch to higher powers to see more detail.

Plant Cell

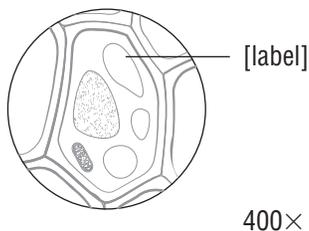


Figure 4 Scientists use lines and stipple for the details of their drawings.

Biological Drawings

To accurately record observations, scientists draw a circle to represent the field of view. Next, they draw what they see through the microscope in the circle. They label the total magnification and use straight, horizontal lines to label any visible structures. Biological drawings are drawn with firm, short strokes and are usually two-dimensional. To keep the drawing simple, scientists use dots called “stipple” instead of shading (Figure 4).

TRY THIS: Modelling a Microscope's Field of View

SKILLS MENU: performing, observing, analyzing, communicating

In this activity, you will model a microscope's field of view with your index finger and thumb.

Equipment and Materials: pencil; paper; ruler

1. On a sheet of paper, draw three circles, each 5 cm in diameter. Label the circles 1, 2, and 3.
2. Choose an object in your classroom to observe that is at least 2 m away from you, and at your eye level.
3. Form a finger circle with your index finger and thumb (Figure 5).



Figure 5 Step 3

4. Place your finger circle about 30 cm away from your right or left eye. Centre the distant object in your finger circle while looking through the circle with one eye. The visible portion of the object is the field of view. Draw what you see in the field of view in circle 1 on your sheet of paper.
 5. Move two paces closer to the object, keeping your finger circle the same distance from your eye. Draw what you see in the field of view in circle 2 on your sheet of paper.
 6. Carefully move four paces back from the object, again keeping your finger circle the same distance from your eye. Draw what you see in the field of view in circle 3 on your sheet of paper.
- A. What happened to the appearance of the object in the field of view as you moved closer to the object?
 - B. What happened to the appearance of the object in the field of view as you moved away from the object?
 - C. How do the steps in this activity relate to the changes in total magnification and field of view that occur when you observe a specimen through a microscope under different powers of magnification?

Before the invention of the compound microscope, it was almost impossible to see any type of detail in cells. Viewing cells is important for understanding our health and that of the environment around us. In the next section, you will learn how to use this powerful tool.

Unit Task How can you apply your new knowledge of the microscope when completing the Unit Task? What important concepts in this section will be especially useful?

CHECK YOUR LEARNING

1. Look back at the image of skin in the Unit Opener. What are your thoughts as you look at this image? What questions do you have about this photo?
2. A scientist will first focus on a specimen using the low-power objective lens, and then move to a higher magnification. Explain why.
3. What is "field of view"?
4. When observing a specimen under medium power, which adjustment knob should be used to focus the image? Why?
5. In a well-written paragraph, describe how you would bring a microscope back to its storage area after using it.
6. Create a biological drawing of the specimen shown in Figure 6. Assume that the photograph was taken through a microscope with a total magnification of 400 \times .

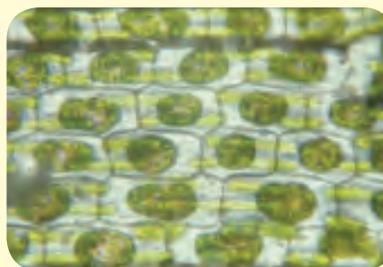


Figure 6