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Overview

Students live in a world where creating infinitesimal objects and investigating small worlds is an integral part of developing technologies. Contemporary microscopes have developed to the point that they can be used to help manipulate objects as small as individual atoms. Microscopic electronic components that can fit entire computers onto the head of a pin are being designed. Medical science is learning to manipulate the tiny misshapen strands of genes that allow some diseases to occur.

One of the core concepts of our century—one that has influenced everything from physics to the nature of our heterogeneous society—is that what people see depends upon their point of view and the nature of their perceptive equipment. With the aid of tools like microscopes, students' perspective on the world changes. They begin to realize that things are often not as simple as they seem.

This Delta Science Module begins with the discovery that even a simple drop of water can magnify. Students find that some lenses magnify more than others and that combining lenses increases their power.

In Activity 2, students use magnifiers as tools for drawing and creating their own tiny objects. They discover that magnification not only makes objects look larger, but also reveals details that were invisible with the unaided eye.

Activity 3 introduces an even more powerful tool, the microscope. Practicing their focusing skills lets students master the magnifier and the microscope so that they can apply their newfound skills to a criminal investigation in Activity 4.

Next, students turn their investigative eyes to the study of crystals in Activity 5. They discover that patterns appear under the microscope that were not visible without that degree of magnification. By studying these patterns, they observe a basic difference between living and nonliving matter in Activity 6.

In Activities 7, 8, and 9, students compare structures of various types of plant cells and investigate the differences between plant and animal cells. They observe onion cells, bean-plant cells, and epithelial cells from their own cheeks.

In Activities 10 and 11, students meet an entire world of organisms invisible without the aid of microscopes. They nurture, identify, and observe fascinating organisms, including protists, that feed, breathe, and reproduce using just the structures inside their single tiny cells.

Finally, in Activities 12 and 13, students collect less-innocuous microorganisms: bacteria. They observe and record growth of a bacterial population in their own culture dishes. Then they test the effects of antiseptic on the growth of their bacteria colonies.

As students journey through all of these discoveries, they build valuable scientific skills and techniques. They learn to focus a magnifier, adjust a microscope, make a wet mount, and stain a slide. They develop predictions, test them, observe outcomes, record data, analyze the data, and draw possible conclusions. By the time students have completed this module, they will know more about the microscopic world and have the skills and the desire to investigate it further.

Activity 3
Mastering the Microscope

Objectives

Students learn to identify and adjust microscope parts to see small objects. Comparing views through single and compound microscopes, students discover that magnification can be increased by adding lenses.

The students

- focus a microscope to see small objects
- identify five parts of a microscope
- compare magnification through single and compound lenses

Schedule

About 40 minutes

Vocabulary

eyepiece
mirror
stage
focus wheel

Materials

For each student

1	Activity Sheet 3, Parts A and B
1	magnifier
1	slide, plastic

For each team of four

1	cup, plastic, small
1	dropper
1	microscope
1 pc	lens tissue
1 pr	*scissors

For the class

1 btl	*detergent (liquid)
1 sht	*newspaper
1 roll	*paper towel
	*water, tap

* provided by the teacher

Preparation

1. Each student will need a clean slide, a magnifier, and a copy of Activity Sheet 3, Parts A and B. Also, cut the newspaper so that each student can have a small piece.

2. Each team will need a dropper, a small plastic cup filled with water, a microscope, a piece of lens tissue and a pair of scissors. Do not attach telescoping eyepieces to the microscopes. Students will attach them during the activity.

3. The class will need liquid detergent, paper towels, and tap water for cleanup.

4. You may want to familiarize yourself with the parts of the microscope supplied in the kit and to practice focusing it.

Background Information

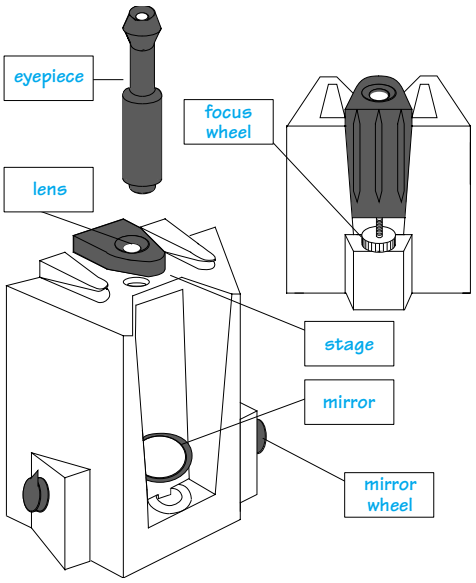
When used as a simple microscope, which has a single, objective lens, this microscope magnifies samples 50 times (50x). For more power, the telescoping eyepiece, which contains an additional ocular lens, can be attached to form a compound microscope. With the eyepiece in its collapsed position,

the compound microscope magnifies 100 times (100x). With the eyepiece fully extended, it magnifies 200 times (200x). In addition to magnifying more than simple microscopes, compound microscopes reverse images left to right and top to bottom; simple microscopes do not.

Name _____ Activity Sheet 3, Part A

Mastering the Microscope

1. Label the six parts of the microscope shown below.



Name _____ Activity Sheet 3, Part B

Mastering the Microscope

1. Draw the newspaper as it appears through these three devices:

As seen through a:	
	magnifier
	simple microscope
	microscope with eyepiece

2. Which device magnifies the most?

The microscope with the eyepiece extension magnifies the most.

3. How is the view through the microscope different with the eyepiece extension and without?

With the eyepiece on the microscope, the letters in the word appear larger. Also, the letters appear reversed and upside down with the eyepiece extension, but not without.

Teaching Suggestions

Distribute a magnifier, a slide, a piece of newspaper, and a copy of Activity Sheet 3, Parts A and B, to each student. Distribute a microscope, its telescoping eyepiece, a dropper, a piece of lens tissue and a pair of scissors to each team. Do not attach the eyepiece to the microscope.

To reinforce the concept that lenses magnify, ask, **We have seen how two types of lenses magnify. Does anyone recall what two types of lenses we have looked through so far?** After students respond, continue with, **Can you find the lens in your microscope?** Have students clean the lens with a tissue only if it is very dirty.

Additional Information

1 Caution students to be careful not to dirty or scratch the microscope's lenses.

Students should recall looking through water-drop and magnifier lenses.

One lens in this simple microscope is located at the top, above the stage. Students may note the other lens in the eyepiece. Caution students to clean lenses very gently with the lens tissue, since even the tissue can scratch a plastic lens.

Materials List

Qty		Description
2	c	bouillon cubes, beef
1		cover slips, p/100
16		cups, plastic, large
16		cups, plastic, small
16		dishes, plastic
8		droppers
8	c	filter papers
8		knives, plastic
2	c	lens tissue, p/50
16		lids, for dishes
32		magnifiers
1	c	methyl cellulose, 2 oz
8		microscopes
1	c	mouthwash, 6 oz
8	c	salt, packets
1	c	seeds, bean, p/90
2		slides, depression, p/40
8		slides, plastic, p/12
8		slides, prepared, cornstalk
2	c	stain, Lugol's, 2 oz
1	c	stain, methylene blue, 2 oz
1	c	toothpicks, p/750
8		tweezers
1		teacher's guide

Qty		Description
Teacher provided items		
2		buckets
16		comic strips, color
16		cotton swabs
32		crayons
1	c	detergent (liquid), bottle
–	c	hay, grass, or lettuce, unwashed
8		inkpads
–	c	newspaper
2	c	onions
–	c	paper towels
–		pencils, black, blue, red, and yellow
1		pitcher, 2-qt
–	c	plastic wrap
3	c	potatoes
1		razor blade
9	c	roast beef, slices
8		scissors
–	c	tape, masking and transparent
1		thread, spool
-	c	water, pond and spring

c = consumable item

What other parts can you find on your microscope besides the lens? Can you guess the purpose of each part? Have students handle the microscope, pick it up, and rotate the mirror wheel and the focus wheel gently to become familiar with the instrument. Help them label the parts on Activity Sheet 3, Part A. Write the new vocabulary words *eyepiece*, *stage*, *focus wheel*, and *mirror* on the board.

Can you reflect light off the mirror and into the lens? Show students how to slip a slide under the slide clips and center a sample under the lens. Have team members practice adjusting the mirror with the mirror wheel to reflect light from a window or overhead while looking through the microscope.

2 The eyepiece contains an additional lens. The stage is the platform that holds the slide. The focus wheel moves the lens up and down. The mirror reflects light up through the slide and the lens. Other parts that students might identify include the metal clamps that hold the slide (slide clips), the wheel that rotates the mirror (mirror wheel), and the bottom of the microscope that sits on the table (the base).

Note: *Students should not aim the mirror directly at the sun as reflecting rays could damage their eyes.*

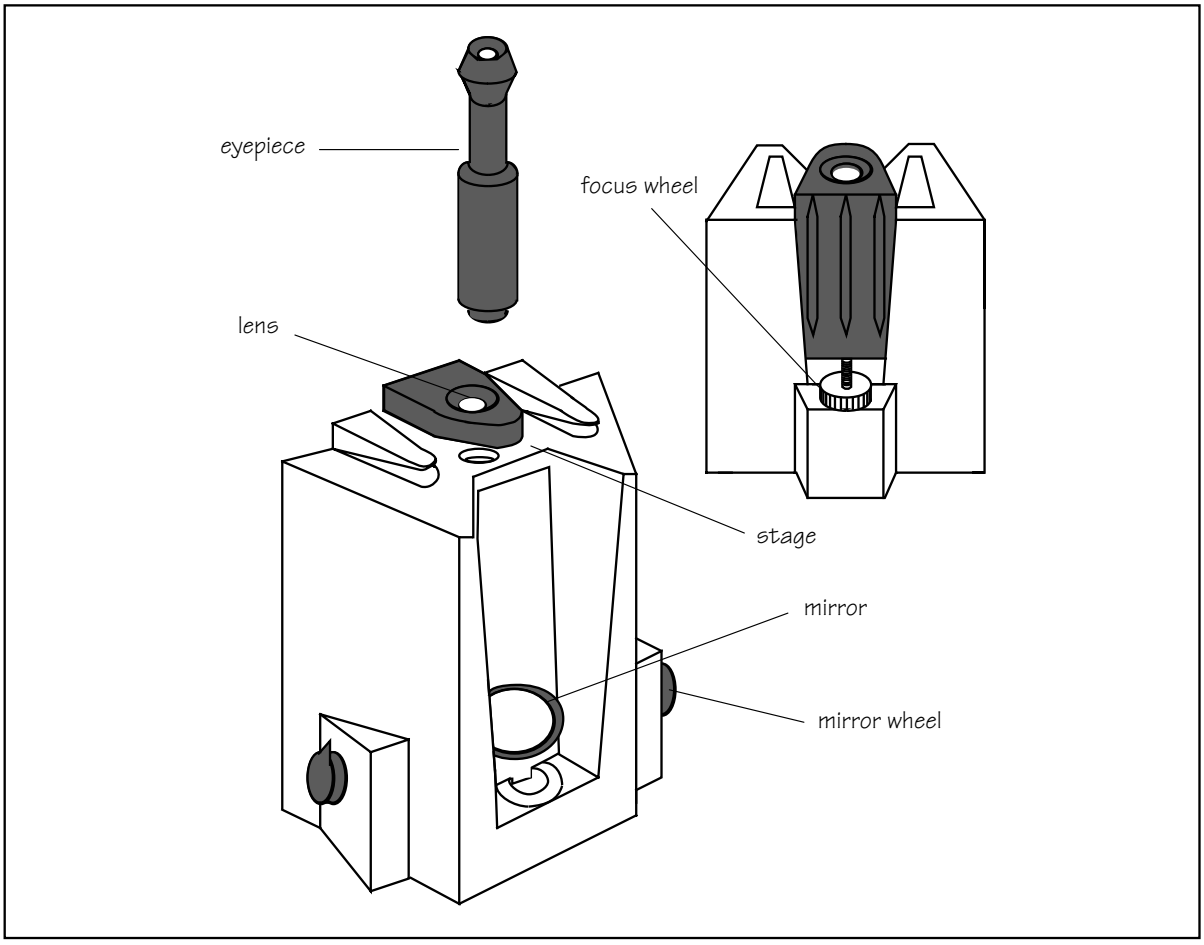


Figure 3-1. Five parts of a microscope.

3

Have each student cut a short word out of their scrap of newspaper and place the word on one of their slides. After wetting it with the barest touch of water from the dropper, they should smooth the paper flat on the slide.

Caution students that focusing a microscope takes practice. Tell them to start with the lens near the subject, just as with a magnifier. Demonstrate how to watch the microscope from the side as you turn the focus wheel until the lens almost touches the slide—but not quite. Have students check their mirrors to make sure they still direct light through the lens. Then show students how to look through the lens and slowly raise it, by turning the focus wheel, until they see the sample clearly.

Note: *Students should always begin focusing by lowering the lens almost to the slide while watching from the side—not through the microscope.*

If students have difficulty, they may need to reposition the mirror to reflect more light.

Have students take turns focusing on the newspaper and recording their observations on Activity Sheet 3, Part B. As some team members focus the microscope, others can draw the view through their magnifiers.

4

Instruct students to attach the eyepiece to the microscope. Ask, **Does newspaper look different through the microscope with the eyepiece attached?**

Remind students to adjust the mirror to reflect light through the lens. The sample should look significantly larger because of the extra magnification power of the lens in the eyepiece. In addition, the image is reversed top to bottom and left to right.

Instruct students to look at a sample through the eyepiece once more. Tell them to slide the sample in all directions under the clip, and observe which way the letters in the word move. Tell students to finish Activity Sheet 3, Part B.

Reinforcement

Have students compare the magnification of an object viewed through a microscope with the eyepiece in the collapsed position and with the eyepiece fully extended. Students should notice another leap in magnification, since the collapsed eyepiece magnifies at 100x and the extended eyepiece at 200x.

Cleanup

Students should rinse their slides carefully and leave them on a paper towel to air dry. Return microscopes and other equipment to the kit.

Science at Home

If students have microscopes at home or may borrow their school microscopes to take home, they can practice their focusing skills. Students may also bring to class an object from home that they think may look very different under the microscope. What is the tiniest object that anyone can see with the eyepiece fully extended?

Connections

Science and the Arts

Creating miniatures has fascinated artists for millennia. Under a microscope, modern artists can make elaborate paintings on sugar crystals or grains of rice. Working on art the size of a dust mote can be problematic, however. One day, while painting dancers on sugar crystals, one miniaturist accidentally inhaled his creations!

Students can try miniature painting with one-hair brushes. Have them tape a hair onto a toothpick so that it extends just beyond the end of the toothpick and the tape. Use a second piece of tape—double-sided or rolled into a loop—to hold a dry kidney bean in place during painting. Peering through the 8x magnifier lens, students can paint pictures with their one-hair brushes and tempera paint. After paintings have dried, paste them onto tiny rectangles of colored paper and pin them to a bulletin board for a miniature gallery, viewable through magnifiers.

Science and Health

One interesting use of the microscope in medicine today is the technique known as microsurgery. Operating microscopes are special binocular instruments that can be positioned over the surgical site, with overhead lighting and foot pedals to regulate focusing and movement. Microsurgery allows surgeons to operate on delicate structures such as severed nerves and blood vessels, parts of the eye, and the tiny bones of the middle ear.

Science and Math

To calculate the total magnification power of a compound microscope, just multiply the power of the objective (stage) lens by the power of the ocular (eyepiece) lens. The objective lens of the microscope in this kit is 50x. The ocular is 2x in the collapsed position and 4x in the extended position. That is a total magnification power of 100x with the lens collapsed and 200x, extended. What if the ocular lens were 6x and 12x, and the objective lens were 75x?

Science, Technology, and Society

Some researchers hope to build infinitesimal machines from individual atoms. Theoretically, once created, these nanotech robots could construct their own tiny city on the head of a pin. The way researchers push atoms is with a scanning tunneling electron microscope (STM). The first STM with two probes was created by university graduate student Mark Voelker.

Why are two STM probes better than one? Have students try to form the shape of a gear from salt crystals on black paper, using the tip of one toothpick. Do two toothpicks work better than one? To make nanotech machines, STMs will have to be able to pile atoms on top of each other as well as side by side. How many probes might be needed to lift an atom? Can students invent ways to pick up objects other than with finger-like probes?