Classroom Adventures

TEACHER ENRICHMENT RESOURCE PACKET

Microscopes & Magnifiers

A *Classroom Adventure* for Grades 4-6

Make a simple lens and use a microscope to investigate the wonders of the microscopic world from pond water life to your own fingerprints.

what's inside

Think it.
Try it.
Explorit.

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WELLS FARGO

Welcome

Thank you for choosing Explorit Science Center's *Classroom Adventures* to supplement your ongoing science curriculum. Whether you use the program to kick off a new unit, wrap up a nearly completed unit, or purely to excite and interest your students in the wonderful world of science, advance preparation and follow up with your students are critical to achieving the greatest educational benefit from this unique science experience.

Explorit provides two resources to help prepare you and your students for *Classroom Adventures*. First, simple logistics of the program are detailed in the confirmation letter. Second, this **Teacher Enrichment Resource Packet** outlines appropriate science content and processes to help you:

- successfully prepare your students prior to Explorit's visit;
- participate fully in *Classroom Adventure* yourself; and
- follow-up with your students after Explorit staff leave.

Learning Objectives

Learning objectives provide a broad overall guide to what students will begin to experience and understand through participation in Explorit's **Microscopes and Magnifiers** *Classroom Adventure* designed for Grades 4-6. During this program, students will:

- discover how a lens or combination of lenses can be used to magnify an object;
- understand some of the steps involved in the development of the modern microscope; and
- explore many wonders of the microscopic world using Explorit's classroom set of microscopes.

Science Standards

Explorit Science Center's *Classroom Adventures* programs address concepts teachers need to teach under the California Science Content Standards. The alignment of *Classroom Adventures* with the science standards allows you, the teacher, to bring exciting fun-filled science experiences to your students while at the same time fulfilling your requirements to teach particular science content and processes. For specific science standard concepts covered by **Microscopes and Magnifiers**, refer to Science Standard Alignment, page 8.

Our Mission:

To involve people in science experiences that touch our lives.

Background Information

Much of science involves observation of the natural and human-made world around us. We see many fascinating things everyday that provoke scientific questions. However, a huge portion of the world remains unobservable with our unaided eye. Technology allows scientists to extend their senses with intriguing tools such as magnifiers and **microscopes**.

WHAT ARE LENSES?

Generally, **light** travels in straight lines called rays. However, as a light ray passes through certain **transparent** materials, like water, glass or plastic, the ray's path bends. Scientists call this bending of light rays **refraction**.

A **lens** consists of a curved piece of transparent material, usually plastic or glass. As light hits a lens it refracts more or less depending on the curve and material of the lens. Microscopes and magnifiers contain **convex lenses** which curve outward on both sides. Light aimed perpendicular to the center of a convex lens will travel straight through the center of the lens, but where the light hits the lens nearer the edge it will refract (bend) inwards. If the curve of the lens is just right all the light entering the lens gets bent (**focused**) to one point on the other side of the lens. Greater curvature of the lens results in a a more powerful lens.

Microscope Trivia:
Some bacteria are so tiny that 50,000 of them would cover a square inch.

HOW WAS THE OPTICAL MICROSCOPE INVENTED?

Prehistoric spear fishers probably discovered refraction when they stuck their spear into the water and found that the fish was not in line with their spear. Around 150 B.C., the Greek scientist Claudius Ptolemy experimented with a brass rod in a pool. The underwater portion of the rod looked bent allowing Ptolemy to measure how much the light ray was bent as it went from air into water.

Records indicate that people wore glasses around 1280 in Italy. Even before glasses, engravers may have used water filled glass globes as magnifiers since the turn of the first century, and the Roman emperor Nero may have used an emerald as a corrective lens.

In the 1590s, Zacharias Janssen invented the first microscope, which was a **compound microscope** made up of two lenses. Janssen discovered that when you look at an object through two lenses, the image is magnified significantly. In 1665, scientist Robert Hooke, using a compound microscope that magnified forty times, first defined the cell as the structural unit of all living things.

In the late 1600s, a Dutch cloth dealer named Anton van Leeuwenhoek became famous for his work with the **simple microscope**, a microscope that uses only a single lens. Leeuwenhoek's lenses were able to **magnify** objects up to 500 times, better than any of the existing compound microscopes of the time. Leeuwenhoek is credited as the first man to see blood circulation in a fish's tail, protozoa in a water droplet, and bacteria.

Background Information
continued

Microscope Trivia:
Dozens of eight-legged creatures live in your eyelashes. They are much too small to see, since a line of 500 end to end would be less than an inch in length.

Microscope Trivia:
Certain orchids produce the world's smallest seeds. It takes more than 28 million of these seeds to weigh an ounce.

The next major breakthrough in microscope development came in the 1830s when J.J. Lister developed an **achromatic lens**, which is a combination of lenses made from different types of glass. The achromatic lens reduces a lens imperfection that causes images to be blurred and ringed with colors.

WHAT ARE THE DIFFERENT TYPES OF OPTICAL (LIGHT) MICROSCOPES?
There are two main types of **optical microscopes**: simple and compound . A simple microscope uses only one convex lens; it's simply a magnifying glass.

The compound microscope consists of two sets of lenses: the **objective lenses**, closest to the object, and the **ocular lenses** (eyepiece), closest to the eyes. These multiple sets of lenses can provide higher magnification than a single lens.

In a compound microscope the image appears upside down and backwards. When beginning to use a microscope this inversion can cause confusion. A specialized type of microscope, called a dissecting microscope, eliminates this inversion so that scientists may easily work under the microscope. Many other types of specialized microscopes have also been developed to aid scientists in their work.

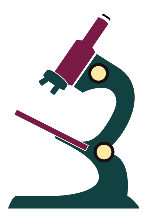
WHAT ARE ELECTRON MICROSCOPES?
To see extremely tiny objects, scientists use **electron microscopes**. In 1932, Ernst Rushka and Max Knoll built the first electron microscope.

Electron microscopes use a beam of **electrons** to magnify objects. Since light is not used in electron microscopes, glass or plastic lenses cannot be used either. Instead, electron microscopes use magnets to bend the electron paths just like lenses bend light rays. Since human eyes cannot see electrons, special equipment is used to show the images from an electron microscope on a screen.

Today, the best optical microscopes magnify objects up to 2,000 times bigger than their size. An electron microscope can magnify objects up to one million times.

CONCLUSION
Just imagine what life would be like without the ability to investigate the **microscopic** world. Biologists would not understand organisms such as bacteria and viruses that cause disease. Forensic scientists would know much less about fingerprints, fibers and chemical formulas. No geologist would have seen the wonder of rock and mineral composition.

Nearly all scientific disciplines depend on the microscope to continue their ongoing discoveries. Much remains to be discovered about the microscopic world by future scientists. Who knows? Those future scientists may be your students.



Vocabulary

This list includes words that may be used during *Classroom Adventures*. Specific vocabulary used depends on students' grade level and prior knowledge.

Achromatic Lens - a lens made of a combination of different types of glass to prevent color distortions of the image.
Compound Microscope - a microscope with two lenses or sets of lenses.
Concave Lens - a lens that is thicker at the edges and thinner in the middle.
Convex Lens - a lens that is thicker in the middle and thinner on the edges.
Electron - a negatively charged particle of an atom, with a very small mass that orbits around the nucleus of an atom.
Electron Microscope - a microscope that uses a stream of electrons to form magnified images of objects.
Focal Length - the distance between a lens and its focal point.
Focal Point - the point at which a lens causes light rays parallel to the lens' optical axis to focus. The optical axis is the line through the middle of the lens, perpendicular to it.
Focus - to produce a sharp, clear image.
Lens - curved piece of glass or other transparent material used to enhance vision in eyeglasses, microscopes or telescopes.
Light - electromagnetic radiation that is visible to the eye.
Macroscopic - large enough to be perceived or examined with the unaided eye.
Magnify - to cause to appear larger.
Microscope - an instrument that magnifies objects, some invisible to the human eye.
Microscopic - too small to be seen by the unaided eye, but large enough to be studied under a microscope.
Microscopists - people who specialize in using microscopes.
Objective Lens - the lower of the two lenses in a compound microscope.
Ocular Lens - the eyepiece, or upper lens, in a compound microscope.
Optical Microscope - a device that uses lenses and light to magnify and focus small objects.
Refraction - the bending of light rays that occurs at the boundary between one medium and another when light strikes it at an angle.
Simple Microscope - a microscope containing only one lens, essentially a magnifying glass.
Transparent - permitting light to pass through so objects can be seen clearly.

Microscope Trivia:
Body odor results not directly from sweat, but from sweat mixing with the millions of bacteria that live all over your skin.

Classroom Activities

Materials:
- magnifying lenses
- 3x5 index cards or stiff paper
- pencils
- scissors
- lined paper

Science Standards:
- Investigation & Experimentation
- Fourth/Fifth: 6
- Sixth: 7

For your convenience, the following activities can be used as you deem most appropriate to integrate Explorit's **Microscopes and Magnifiers** into your ongoing curriculum. The activities are grade-level appropriate, but please note that this program is designed for a broad grade range (4-6) and thus all activities may not be appropriate for every group of children. Choose those activities that will work well for your students.

ACTIVITY #1: "MEASURING MAGNIFIERS"

Objective: We use magnifying lenses and microscopes to make small things look bigger. Magnification describes how much bigger the lens makes an object look. Most of the microscopes that Explorit brings to your classroom make things look twenty times bigger, so they have a magnification of 20 (usually written as 20x). Most magnifying lenses used in classrooms have a magnification of 3x or 5x, making things look 3 times or 5 times larger. You can measure the magnification of your magnifying lenses by doing the following activity.

Procedure:

1. Draw the outline of your magnifying lens in the middle of an index card.
2. Carefully cut along the line to make a hole the same size as your magnifier.
3. Place lined paper or a ruler on a flat surface such as a tabletop.
4. Hold the magnifying lens over the paper and parallel to the paper. Lean over the magnifying lens and look directly down through the lens at the paper. Adjust the placement of the lens and your eye until the lines of the paper appear clearly in focus and as large as they can be while still remaining in focus.
5. Consider the space between two lines on the paper as one section. Count the number of complete sections that you can see in the lens. For any partial sections that you can see, estimate the amount of the section that you can see, i.e., a half section, quarter section, etc.
   Record this number as A = ________.
6. Now hold the index card from which you cut the shape of your magnifying lens at exactly the same distance from the lined paper as you previously held the magnifying lens. Also, hold your eye at exactly the same height as you previously held it when looking through the magnifying lens. Look down at the paper through the hole in the index card.
7. Count the number of complete sections that you can see in the hole. For any partial sections that you can see, estimate the amount of the section that you can see, i.e., a half section, quarter section, etc.
   Record this number as B = ________.
8. Calculate the magnification by dividing B by A.
9. It is helpful if you know the actual magnification of the lenses, so as to check the students' work. If your students' calculations seem incorrect be sure that they are being very precise with their work. Working precisely and redoing work several times in an attempt to achieve the same results each time is excellent scientific training for your students. If calculations continue to be inaccurate consider the following questions as well as any other explanations

Classroom Activities
continued

the students might have about the situation. What effect will a very heavy rim on a magnifying lens have on the size of the hole in the index card? What happens if your magnifying lens is rectangular and you hold the index card in a different rotation than you held the lens itself? Remember the magnification due to a lens changes; it depends on how close the object is placed to the lens. The experiment here determines roughly the maximum magnification we can get from the magnifying lens.

Materials:
- magnifying lenses
- black paper
- white paper
- flashlights
- scissors
- tape
- large cardboard box

Science Standards:
- Investigation & Experimentation
- Fourth/Fifth: 6
- Sixth: 7

ACTIVITY #2: "UPSIDE UP OR UPSIDE DOWN"

Objective: To observe how a magnifying lens affects an image.

Procedure:

1. You may want to do this as a demonstration or have students work in groups.
2. Cut a circle out of black paper that fits over the end of the flashlight.
3. Cut out the shape of a thin capital "L" from the center of the circle and tape the circle over the end of the flashlight so the end is completely covered.
4. Place a mark on the side of the flashlight to indicate where the short leg of the "L" is pointing.
5. Stand the cardboard box on its side on a table and tape a sheet of white paper to the back inside wall of the box.
6. Turn on the flashlight and point it toward the paper so that you can see the image of the "L" on the paper.
7. Have your students draw the image they see.
8. Now hold a magnifying lens in between the flashlight and the paper (about three feet from the paper) in the box and shine the flashlight through the lens so that you can see an image of the "L" on the paper.
9. Have your students draw the image they see. What is the position of the "L" image on the paper compared to the position of the "L" on the flashlight? How does using the magnifying glass affect the image?
10. Move the magnifying lens slowly between the flashlight and the box. How does this affect the image?

Materials:
- paper or journal
- pencil

Science Standards:
- Investigation & Experimentation
- Fourth/Fifth: 6
- Sixth: 7

ACTIVITY #3: "WRITE A MICROSCOPIC ADVENTURE STORY"

Objective: To write an imaginative, microscopic adventure story, which includes at least 3 items they observed under the microscope.

Procedure:

1. After Explorit's visit to your classroom and any other microscopic explorations you may have conducted, your students will have observed many items under the microscope.
2. Have your students write a creative, imaginative microscopic adventure story. Ask your students to include detailed, accurate descriptions within their story of at least three items they observed under the microscope.
3. Also, have your students include in their story information depicting the relative size of the three items observed under the microscope as compared to observations with their unaided eye.

Supplemental Resources

BOOKS

AIMS Educational Foundation. **Magnificent Microworld Adventures**. AIMS Foundation, 1997. www.aimsedu.org. *Introduces the microworld with several microscopy lessons, biographies, and about 20 biological lessons. Grades 4-9.*

Darling, David. **Micromachines and Nanotechnology: The Amazing World of the Ultrasmall**. Dillon Press, 1995.

GEMS Series. **Microscopic Explorations**. Lawrence Hall of Science, 1998. *Excellent unit for grades 4-8; www.lhs.berkeley.edu/GEMS. Spanish version also available. See also, GEMS unit More Than Magnifiers (grades 6-9).*

Levine, Shar and L. Johnstone. **Fun With Your Microscope**. Sterling Publishing Company, 1999. *Appropriate for children ages 9-12.*

Levine, Shar and L. Johnstone. **The Microscope Book**. Sterling Publishing Company, 1996. *Dozens of activities/experiments using everyday materials.*

Loewer, Peter. **Pond Water Zoo: An Introduction to Microscopic Life**. Atheneum Books for Young Readers, 1996. *Examines the role and function of many different microscopic organisms that exist in pond water. Ages 8-12.*

Snedden, Robert. **Yuck! A Big Book of Little Horrors: Micromarvels in, on, and around you!** Simon and Schuster, 1996. *Excellent images.*

Tomb, Howard and D. Kunkel. **Microaliens: Dazzling Journeys with an Electron Microscope**. Farrar, Straus and Giroux, 1993. *Great images.*

VanCleave, Janice. **Microscopes and Magnifying Lenses: Mind-boggling Chemistry and Biology Experiments You Can Turn into Science Fair Projects**. John Wiley & Sons, Inc., 1993. *Designed for children ages 8-12.*

Microscope Trivia:

Tiny flakes that fall from human skin drift around in the air until they settle as dust. Each of us sheds about a million of these flakes approximately every forty minutes.

WEB SITES

How Stuff Works!
http://science.howstuffworks.com/light-microscope.htm
Contains information regarding how light microscopes function, their image quality, types, parts, flourescence microscopes, and more.

Microscopy Society of America Project MICRO
http://microscopy.org/ProjectMicro/
Has classroom activities, as well as information about where to purchase microscopes and how to connect with microscopists in your area.

Museum of Science: Scanning Electron Microscopes
http://www.mos.org/sln/sem/intro.html
Diagrams and pictures of how scanning electron microscopes work. Also contains images of items magnified this way.

Science Standards Alignment

Below is the exact language of California's science standards that Explorit's **Microscopes and Magnifiers** program addresses either during our visit to your classroom or through materials in this Teacher's Packet that you may use.

CALIFORNIA SCIENCE CONTENT STANDARDS

Investigation and Experimentation

Grades 4-5, Concept 6 / Grade 6, Concept 7:

> Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in the other three strands, students should develop their own questions and perform investigations.

Explorit's Classroom Adventures *involve students' use of many science process skills. For grade level specific skills, see California Science Content Standards at www.cde.ca.gov/board.*

Explorit Programs for Schools and Groups

At Explorit's Site

Discovery Lessons & Labs Visit one or more of the Changing Exhibitions throughout the year
Nature Safaris & Labs Visit Explorit's outdoor spaces at Mace Park Branch

Explorit in Your Classroom

Classroom Adventures Explorit educators visit your classroom for hour-long presentations
Young Scientist Series Science investigations through multiple visits

For the Whole School

Health in Your World Learn about keeping your body and the world healthy and safe
Science in Your World The ultimate family science night
Science Assembly A multimedia presentation for the whole school

Think it.
Try it.
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Reservations required.
For information please call
530.756.0191

HOW TO CONTACT US

explorit
EXPLORIT SCIENCE CENTER

Location: 2801 2nd St, Davis
Phone: 530.756.0191
Fax: 530.756.1227
E-mail: explorit@explorit.org
Web: www.explorit.org