Invisible Worlds

Background Information for Teachers

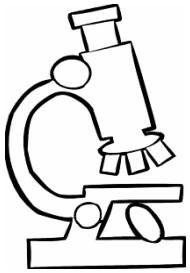
People have wondered about invisible worlds forever. After prehistoric man first saw an image through a crystal that was thicker in the middle than on the edges, he has sought to see beyond what the unaided eye could see. The earliest microscopes were invented at the end of the 16th century by the Dutch spectacle maker Janssen. The man to enhance and study material under the microscope – the father of microscopy – was Anton van Leeuwenhoek. Leeuwenhoek worked in a store counting threads in cloth using a magnifying lens. He taught himself grinding and polishing techniques to make better and better lenses. This led to the production of a ball of glass that could produce 270X magnification and the development of the single-lens microscope. However, that could only take you so far into the invisible world. The compound microscope that incorporated more than one lens was invented and that is the most common type used today.

Optical microscopes magnify because the light rays reflected from the object bend as they pass through one or more lenses. The bent rays form an image larger than the original. A compound microscope has two systems of lenses: the objective lens that magnifies the object, and the ocular lens that magnifies the image from the objective lens.

Microscopy – the study of materials under a microscope – has led to amazing discoveries in the field of science from cells to fungi, bacteria, and viruses. The next time you have an infection, thank a microscope for helping to discover that fungi kill bacteria – leading to the invention of antibiotics.

Life in an invisible world is amazing – bring your students on a journey to a world many people could not believe existed when the microscope was first invented.

Time to Experiment: INTRODUCTION TO A MICROSCOPE –



Materials: (you must provide materials unless otherwise noted)
Parts of a Microscope Puzzle sheet (provided)
Parts of a Microscope Picture and Fill-in sheet (provided)
Microscope (provided)
Microscope slides (provided)
Crayons/pens/pencils

Procedure:
1. Read the "Parts of a Microscope and their Function" sheet and point out and explain them to your class using the microscope provided in the trunk.
2. Using Parts of a Microscope sheet, photocopy so each student has their own sheet and help them complete their own parts list after you point out the parts on the microscope.
3. Check your students' knowledge, by having them cut out and then reassemble the "Microscope Parts" puzzle, using the sheet provided.

Extensions:
1. Photocopy one of the "Parts of a Microscope" sheet and have the students color in and cut out the parts (eye-piece = yellow, arm = blue, stage = orange, objective lens = green, focus knob = red, light = purple, diaphragm = brown, etc.), then try to rebuild their colorful microscopes.

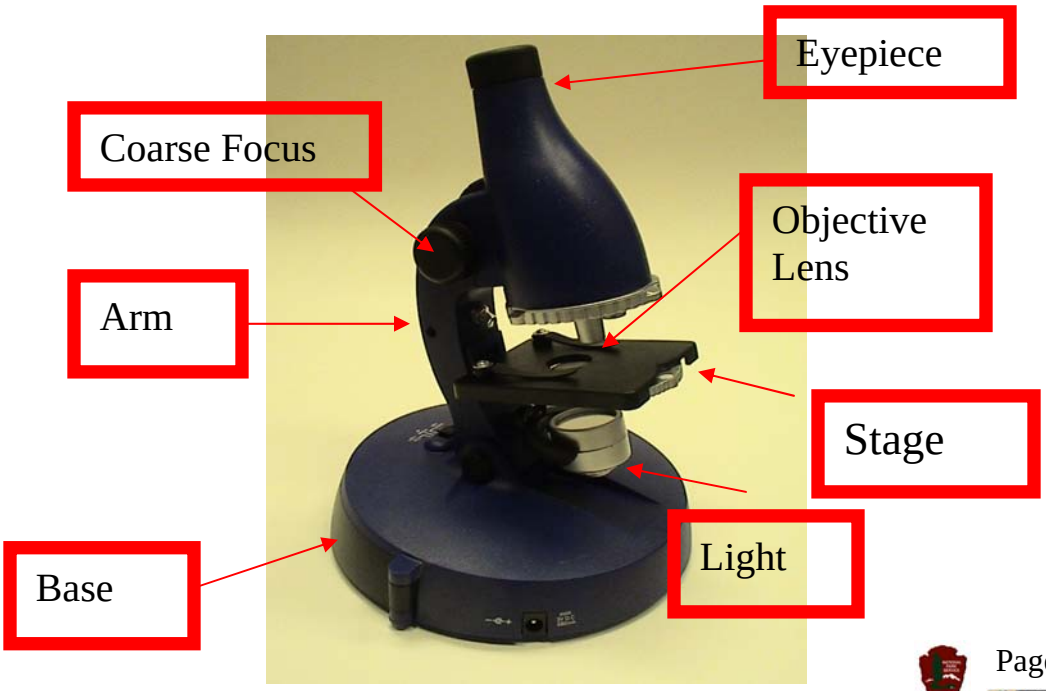
Conclusions:
Your students should be able to identify and label all the parts and functions of the parts of the microscope, after they completed the following experiments.

Examine the parts of your microscope. A microscope has a heavy base to ensure stability. A frame, the limb, sits on the base and at its other end carries the tube support. A flat surface projects from the frame. This is the stage on which the specimens are placed. The stage can be either circular or rectangular. At its center is an opening so that light can enter from below into the optical system of the microscope. The mount has two specimen clamps for holding a slide during examination on the stage. One part of the optical system, the eyepiece, is situated at the upper end of the eyepiece tube that sits on the tube support. The other part of the optical system is situated at the lower end of the tube and consists of the objective lens, several of which you can screw into one nosepiece. The eyepieces and lenses have different magnifying powers. Many microscopes possess a revolving nosepiece to enable a quick change of objective lens. Turn the nosepiece to swing the objective lens required into the light path. Alter the distance between the specimen on the stage and the objective lens to focus the image. Turning the coarse adjustment knob does this. Move the tube or the stage up or down. A knob for fine focusing, fine adjustment, allows better focusing of the image at high power. Under the round hole in the stage is a diaphragm. It can be either a hole or an iris diaphragm similar to that found in a camera to regulate how much light enters the optical system.

Parts of a Microscope

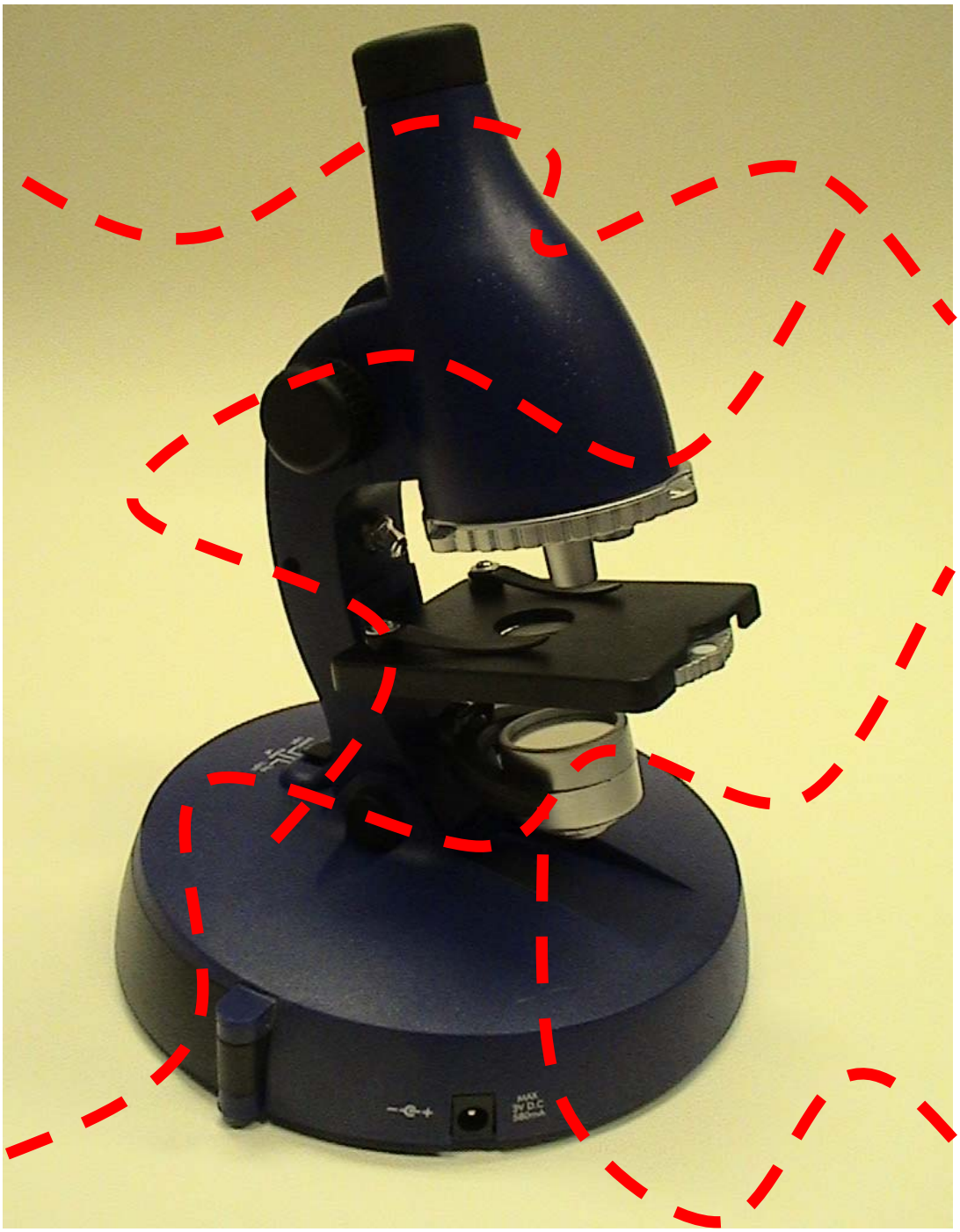
The parts of the microscope and their function:

1. Eyepiece – what you look through
2. Objective Lens - change these lenses to see at different magnification – always start with the lowest (10x)
3. Stage – the platform to put specimen on
4. Arm – support structure for the lenses
5. Diaphragm – what focuses the light
6. Focus knobs – focuses the lenses to allow you to see better
7. Light – light source under the platform
8. Base – sturdy platform on which the microscope sits



Name: Date:

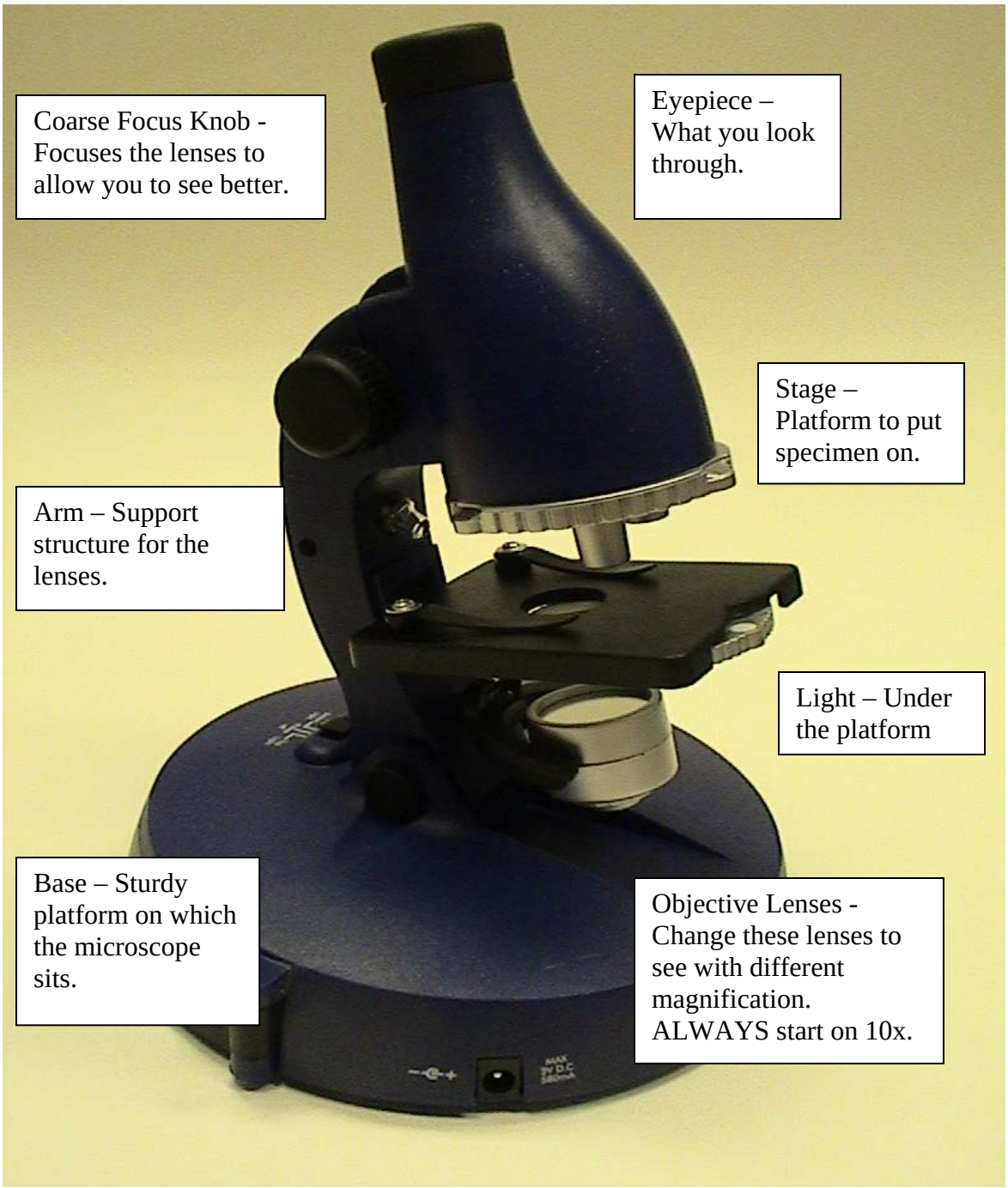
Parts of a Microscope



Photocopy this page and have your students cut out along the curved lines then put it back together again.

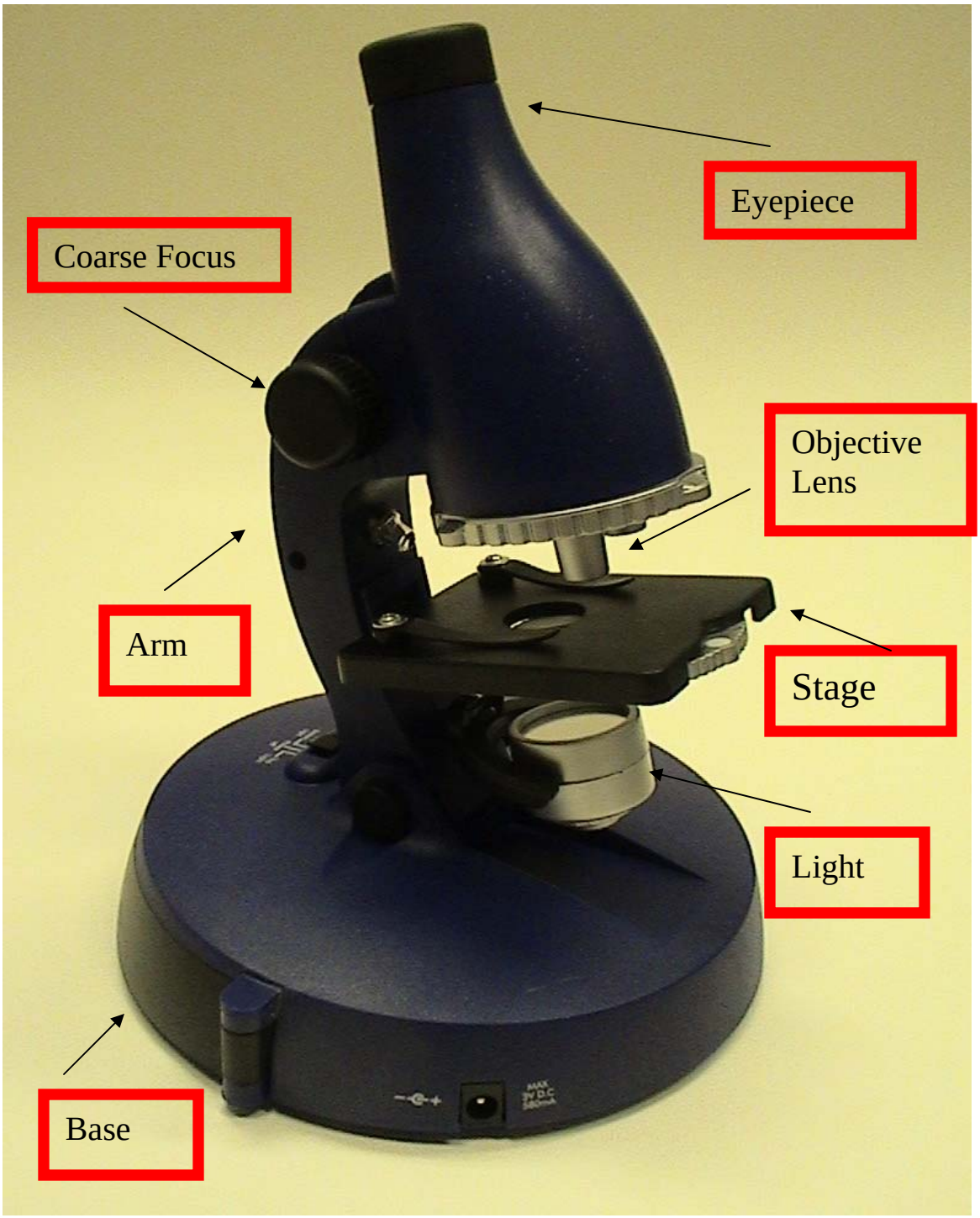
Name: Date:

Parts of a Microscope



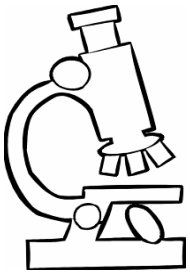
Photocopy this page and have your students match the names to the parts of the microscope.

Parts of a Microscope



Time to Experiment: MAGNIFIERS YOU CAN MAKE –

Materials: (you must provide materials unless otherwise noted)
Jean Lafitte National Historical Park and Preserve's newspaper (laminated) [provided]
Eyedropper
Tap water



Procedure:

1. Drop a single drop of water on the park's newspaper.

2. Have your students fill out the observation sheet.

3. Look through the drop of water and the letters beneath it. Compare the size of the drop with the letters not covered by the drop.

(TEACHER'S NOTE - The letters under drop should appear larger.)

Conclusions:
Your students should be able to make and better understand magnifiers after they complete the following experiments.

Extensions:

Make a hand-held magnifier.

You can make a magnifier that is a complex convex lens (like a real magnifying lens). Instead of being flat on one side, it is convex on both sides.

MATERIALS:

6" piece of 20 gauge wire.

Pencil

Saucer

Clear oil (corn syrup, baby oil, etc)

Sheet of acetate covered park newspaper.

PROCEDURE:

1. Roll a piece of wire around the pencil to make a loop.

2. Remove the pencil from the loop

3. Fill the bottom of the saucer with the clear oil (corn syrup, baby oil, etc)

4. Carefully lift the loop out of the syrup. Make sure that a large drop of syrup remains in the hole of the wire loop.

5. Describe the shape of the syrup drop within the loop.

6. Look down through the syrup drop and observe the letters in the park's newspaper.

7. Compare the size of the drop with the letters not covered by the drop.

A microscope is an instrument that magnifies objects. Magnification makes objects appear larger. You can make a simple magnifier with a drop of water. The water drop on the paper acts as a simple convex lens. This type of lens is thicker in the center than on the ends, it curves outward on one side and is flat on the opposite side. A magnifying lens is made with a double convex lens on both sides.

Name: Date:

Student Observation Sheet: Water Drop Magnifier Experiment

Water Drop Magnifier:

Write or draw the shape and size of the letter and the drop:

I predict (think will happen)

W*hen you place the drop of water on a letter on the laminated newspaper*

_____

BEFORE I PUT THE DROP OF WATER ON THE LETTER IT LOOKED LIKE:

I observed (saw what happened)

What did the letter look like before and then after you put the drop on it

_____

AFTER I PUT THE DROP OF WATER ON THE LETTER IT LOOKED LIKE:	THE WATER DROP WAS SHAPED LIKE: Looking from the side, the drop looked like?

Conclusions (What happened and why):

What really happened?

When I placed the water drop on the newspaper it changed the size of the letter _____

Whey you look from the side, the shape of the water drop was convex (thicker in the middle) or concave (thinner in the middle)

_____

I think this happened because _____

_____

Instructor Sheet: Water Drop Magnifier Experiment

Water Drop Magnifier:

The students can write or draw the shape and size of the letter and the droplet:

I predict (think will happen)

When you place the drop of water on a letter on the laminated newspaper

---

BEFORE I PUT THE DROP OF WATER ON THE LETTER IT LOOKED LIKE:

e

I observed (saw what happened)

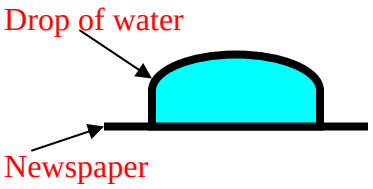
What did the letter look like before and then after you put the drop on it

---

AFTER I PUT THE DROP OF WATER ON THE LETTER IT LOOKED LIKE:

e

THE WATER DROP WAS SHAPED LIKE:



Looking from the side, the drop looked like?

Conclusions (What happened and why):

What really happened?

When I placed the water drop on the newspaper it changed the size of the letter the letter got larger.

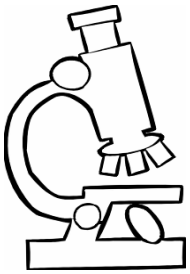
Whey you look from the side the shape of the water dropl was convex (thicker in the middle) or concave (thinner in the middle)

The drop is convex – because the bonding of water molecules is so strong it forms a dome shape – like when you blow a bubble it always forms a "ball" shape. This is the same thing only it's flattened on one side.

I think this happened because the drop of water acted like a magnifier because the convex shape magnifies.

Time to Experiment: PREPARING AND USING YOUR MICROSCOPE –

Materials: (you must provide materials unless otherwise noted)
Microscope [provided]
Small sheets of paper (1"x1")
Student Observation Sheet
Crayons/pens/pencils
Ink pad



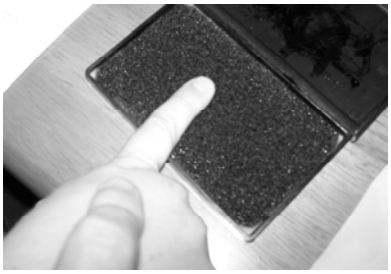
Procedure:

1. Have your students make a copy of their fingerprint as outlined below.
2. Have your students fill out the observation sheet.
3. Have your students determine the type of fingerprint they have.

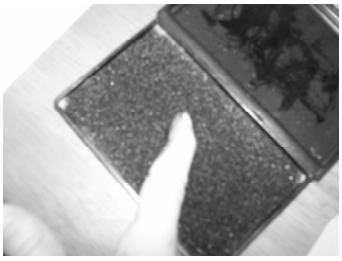
(TEACHER'S NOTE – There are 3 main types of fingerprints: whorls, loops, and arches.)

Directions for getting a fingerprint –

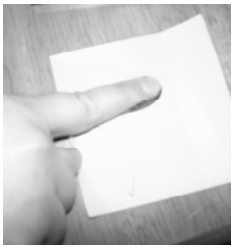
Using the index finger



Roll the index finger back and forth on the surface of the ink pad



Until the entire tip is covered in ink



Carefully place the inked finger on a sheet of paper

LOOP

Most common type worldwide.

WHORL

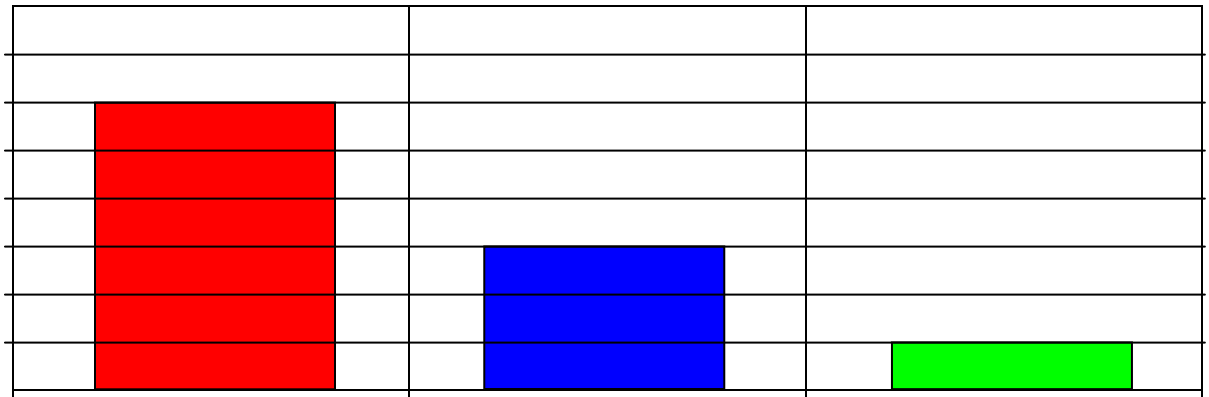
Next most common type worldwide.

ARCH

Least common type worldwide.

4. Graph the different types of fingerprints. (Worldwide there are 60% loop type fingerprints, 30% whorl, and less than 10% arch type) See if the students in your class match these percentages.

Sample Graph with World percentages.



Loop type fingerprint	Whorl type fingerprint	Arch type fingerprint
In a class of 10 – 6 students had loop fingerprint types	In a class of 10 – 3 students had loop fingerprint types	In a class of 10 – 1 student had loop fingerprint types

Conclusions:
Your students should be able to better understand microscopes after making their own fingerprints and looking at them under the microscope.

Using a Microscope

Go over the following instructions to help your students handling their microscope:

- When you move your microscope, you should always use two hands. Place one hand around the arm, lift the scope, then put your other hand under the base of the scope for support.
- When you put the scope down, do so gently. If you are in the habit of banging your scope down on the table, eventually you could jar lenses and other parts loose.
- Always have clean hands when handling your scope. It would be a shame to damage your scope with too much peanut butter!

How to use the microscope:

Put the microscope on the table so that it is easy to look into the eyepiece when seated. Always sit when using a microscope.
Begin each microscopic examination with a low power objective. Look down into the eyepiece and adjust the mirror below the stage so that the circular area seen through the eyepiece is brightly and evenly illuminated. This circular area is called the field of view. If you use a microscope light, switch on the lamp to evenly illuminate the field of view.
Put the specimen on a glass slide then place on the stage. Use the coarse adjustment to move the stage upwards or the tube downwards so that the distance between objective and specimen is 1 inch. While doing this, do not look through the eyepiece but look at the microscope sideways so that the objective does not touch the specimen or damage the lens of the objective.
Now look into the eyepiece while slowly lowering the stage or raising the tube. When the stage or the tube reaches a certain position, the image of the object will appear blurred. With further careful adjustment the image becomes sharper then indistinct again and finally vanishes. Raise the stage upwards or lower the tube so that the image reappears distinctly. The low power objective gives a broad view of the specimen. Use a high powered objective when you must examine one part of the specimen. Turn the nosepiece until the high power objective sits exactly under the tube. An indistinct image of the object is formed with the high powered objective so adjust the stage or the tube to refocus. Adjust the brightness of the image with the iris diaphragm under the stage.

Name: Date:

Student Observation Sheet: Fingerprint Experiment

Fingerprints: (Follow directions when using the microscope.)

Write or draw the shape of their fingerprint:

I observed (saw what happened)

Looking at the fingerprint under 10x magnification, then 30x then 50x:

_____

10x magnification:	30x magnification:

50x magnification:

Conclusions (what happened and why):

What really happened?

When I placed the fingerprint under the microscope at 10x I saw

_____

When I placed the fingerprint under the microscope at 30x I saw

_____

When I placed the fingerprint under the microscope at 50x I saw

_____

Instructor Sheet: Fingerprint Experiment

Fingerprints:

The students can write or draw the shape of their fingerprint:

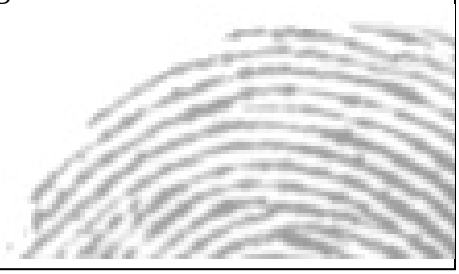
I observed (saw what happened)

Looking at the fingerprint under 10x magnification, then 30x then 50x:

10x magnification:

30x magnification:

50x magnification:



Conclusions (what happened and why):

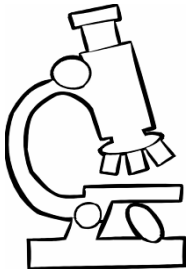
What really happened?

When I placed the fingerprint under the microscope at 10x I saw
my fingerprint larger than I could see it with just my eyes.

When I placed the fingerprint under the microscope at 30x I saw
my fingerprint lines.

When I placed the fingerprint under the microscope at 50x I saw
The lines of the fingerprint really up close and the paper fibers.

Time to Experiment: IT'S A SMALL WORLD –



Materials: (you must provide materials unless otherwise noted)
Microscope (provided)
Microscope slides (provided)
Student Observation Sheet (provided)
Crayons/pens/pencils

Procedure:
1. Follow the directions for using the microscope.
2. Place the microscope slide in the clips of the microscope and turn the top light on.
3. Have the students fill out the student observation sheet.

Conclusions:
Your students should be able to identify and label the parts of the microscope slides they will observe.

Extensions:

Check out the kitchen: you can look at crystals and other unusual materials under the microscope – sugar crystals and spices from your own kitchen.

MATERIALS:

Pencil

Microscope [provided]

Student Worksheet [provided]

Salt

Sugar

Pepper

Other spice if you'd like to use another one

PROCEDURE:

1. Under low power, examine the salt crystals.
2. Examine the sugar, noting any differences from the salt crystals.
3. Examine the black pepper, again noting any differences.

NOTE: salt and sugar are crystals (although sugar is crystallized plant material). Pepper is actually the dried berry of the pepper tree. Other spices are usually taken from the fruit, bark (cinnamon), root (ginger), or even flower pollen (saffron) of plants.

http://www.greatscopes.com/act015.htm

Name: Date:

Student Observation Sheet: Microscope Slide Experiment

Microscope Slides:

Write or draw the shape of the items:

POLLEN & SPORE slide

10x – What does pollen look like?	30x – What does pollen look like?	50x – What does pollen look like?

TINY CREATURES slide

10x – What does ant look like?	30x – What does ant look like?	50x – What does ant look like?

INSECTS slide

10x – What does butterfly wing look like?	30x – What does butterfly wing look like?	50x – What does butterfly wing look like?

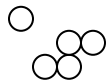
Instructor Sheet: Microscope Slide Experiment

Microscope Slides:

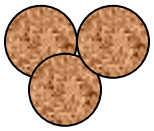
The students can write or draw the shape of the items they need to look for in the slides:

POLLEN & SPORE slide

10x – what does pollen look like?



30x – what does pollen look like?



50x – what does pollen look like?

TINY CREATURES slide

10x – what does ant look like?

30x – what does ant look like?

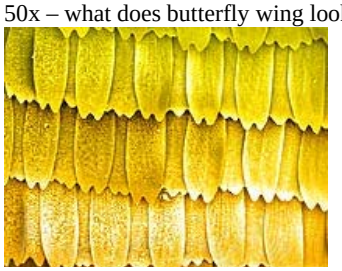
50x – what does ant look like?

INSECTS slide

10x – what does butterfly wing look like?

30x – what does butterfly wing look like?

50x – what does butterfly wing look like?



Point out to your students how much more they will be able to see as they increase the magnification of the microscope.

Name: Date:

Student Observation Sheet: Kitchen Spices Experiment

Extension Kitchen Spices:

The students can write or draw the shape of the items they need to look for in the slides:

SALT

10x – What does salt crystals look like?	30x – What does salt crystals look like?	50x – What does salt crystals look like?

SUGAR

10x – What does sugar crystals look like?	30x – What does sugar crystals look like?	50x – What does sugar crystals look like?

PEPPER

10x – what does pepper look like?	30x – what does pepper look like?	50x – what does pepper look like?

OTHER SPICE?

10x – What does it look like?	30x – What does it look like?	50x – What does it look like?

Benchmarks and Grade Level Expectations

Benchmarks K-4

Science as Inquiry

A. Abilities Necessary to do Scientific Inquiry

SI-E-A1	asking appropriate questions about organisms and events in the environment (1, 3);
SI-E-A2	planning and/or designing and conducting a scientific investigation (2, 3);
SI-E-A3	communicating that observations are made with one's senses (1, 3);
SI-E-A4	employing equipment and tools to gather data and extend the sensory observations (3);
SI-E-A5	using data, including numbers and graphs, to explain observations and experiments (1, 2, 3);
SI-E-A6	communicating observations and experiments in oral and written formats (1, 3);
SI-E-A7	utilizing safety procedures during experiments (3, 5);

B. Understanding Scientific Inquiry

SI-E-B1	categorizing questions into what is known, what is not known, and what questions need to be explained (2, 4);
SI-E-B2	using appropriate experiments depending on the questions to be explored (2, 4);
SI-E-B3	choosing appropriate equipment and tools to conduct an experiment magnifiers, microscope, etc.(2, 3, 5);
SI-E-B4	developing explanations by using observations and experiments (1, 2, 3, 4);
SI-E-B5	presenting the results of experiments (1, 3);
SI-E-B6	reviewing and asking questions about the results of investigations(1, 3, 4).

Life Science

A. Characteristics of Organisms

LS-E-A3	locating and comparing major plant and animal structures and their functions (1, 3);
LS-E-A4	recognizing that there is great diversity among organisms (1);

Language Arts: Reading

ELA-1-E1	Gaining meaning from print and building vocabulary using a full range of strategies (e.g.,self-monitoring and correcting, searching, cross-checking), evidenced by reading behaviors using phonemic awareness, phonics, sentence structure, and meaning
ELA-1-E2	Using the conventions of print(e.g., left-to-right directionality, top-to-bottom, one-to-one matching, sentence framing)
ELA-1-E3	Adjusting speed of reading (e.g., appropriate pacing, intonation, expression) to suit the difficulty of materials and the purpose for reading (e.g., enjoying, learning, problem solving)
ELA-1-E5	Reading, comprehending, and responding to written, spoken, and visual texts in extended passages (e.g., range for fiction passages-450-1,000 words; range for nonfiction-450-850 words)
ELA-1-E6	Interpreting (e.g., retelling, summarizing) texts to generate connections to real-life situations

Language Arts: Writing

ELA-2-E3	Creating written texts using the writing process
ELA-2-E4	Using narration, description, exposition, and persuasion to develop compositions (e.g., stories, letters, poems, logs)
ELA-3-E1	Writing legibly, allowing margins and correct spacing between letters in a word and words in a sentence
ELA-3-E2	Demonstrating use of punctuation (e.g., comma, apostrophe, period, question mark, exclamation mark), capitalization, and abbreviations in final drafts of writing assignments
ELA-3-E3	Demonstrating standard English structure and usage by writing clear, coherent sentences
ELA-3-E4	Using knowledge of the parts of speech to make choices for writing
ELA-3-E5	Spelling accurately using strategies (e.g., letter-sound correspondence, hearing and recording sounds in sequence, spelling patterns, pronunciation) and resources (e.g., glossary, dictionary) when necessary

Language Arts: Critical Thinking

ELA-7-E1	Using comprehension strategies (e.g., sequencing, predicting, drawing conclusions, comparing and contrasting, making inferences, determining main ideas) to interpret oral, written, and visual texts
ELA-7-E2	Using basic reasoning skills, life experiences, and available information to solve problems in oral, written, and visual texts
ELA-7-E3	Recognizing an author's purpose (reason for writing), and viewpoint (perspective)
ELA-7-E4	Using basic reasoning skills to distinguish fact from opinion, skim and scan for facts, determine cause and effect, generate inquiry, and make connections with real-life situations

Math

N-1-E:	Constructing number meaning and demonstrating that a number can be expressed in many different forms (e.g., standard notation, number words, number lines, geometrical representations, fractions, and decimals) (1, 2, 4);
N-2-E	Demonstrating number sense and estimation skills, giving particular attention to common equivalent reference points (i.e., 1/4= 25% = .25; 1/2 = 50% = .5; $1 = 100%, etc.) (1);
N-3-E	Reading, writing, representing, comparing, ordering, and using whole numbers in a variety of forms (e.g., standard notation, number line, and geometrical representations) (1, 4);
N-4-E	Demonstrating a conceptual understanding of the meaning of the basic arithmetic operations (add, subtract, multiply, and divide) and their relationships to each other (1);
N-5-E	Selecting appropriate operation(s) (add, subtract, multiply, and divide) for a given situation) (2, 3, 4);
N-6-E:	pplying a knowledge of basic math facts and arithmetic operations to real-life situations (2, 4, 5);
N-7-E	Constructing, using, and explaining procedures to compute and estimate with whole numbers (e.g., mental math strategies) (1, 4);
N-8-E	Selecting and using appropriate computational methods and tools for given situations involving whole numbers (e.g., estimation, mental arithmetic, calculator, or paper and pencil) (2, 4);
N-9-E	Demonstrating the connection of number and number relations to the other strands and to real-life situations (1, 4, 5).

Grade Level Expectations K-4

Science as Inquiry

Abilities Necessary to do Scientific Inquiry

K	1	2	3	4	
1	1	1	1	1	Ask questions about objects and events in the environment
2	2	2	2	2	Pose questions that can be answered by using students' own observations, scientific knowledge, and testable scientific investigations
4	5	6	6	7	Use the five senses to describe observations
6	7	8	8	9	Select and use developmentally appropriate equipment and tools (e.g., magnifying lenses, microscopes, graduated cylinders) and units of measurement to observe and collect data
7	8	9	9	10	Express data in a variety of ways by constructing illustrations, graphs, charts, tables, concept maps, and oral and written explanations as appropriate
8	9	10	11	12	Use a variety of appropriate formats to describe procedures and to express ideas about demonstrations or experiments (e.g., drawings, journals, reports, presentations, exhibitions, portfolios)
9	10	11	12	13	Identify and use appropriate safety procedures and equipment when conducting investigations (e.g., gloves, goggles, hair ties)

Understanding Scientific Inquiry

K	1	2	3	4	
			13	14	Identify questions that need to be explained through further inquiry
			14	15	Distinguish between what is known and what is unknown in scientific investigations
				20	Determine whether further investigations are needed to draw valid conclusions

Life Science

Characteristics of Organisms

K	1	2	3	4	
22	28				Classify objects in a variety of settings as *living (biotic)* or *nonliving (abiotic)*

Language Arts

Standard 1 – READING

K	1	2	3	4	
1,5	1-5	1,2,4,5	1-6	1-3	ELA-1-E1
6,7	9				ELA-1-E2
9,10	15	10	10	5,7	ELA-1-E5
11	16	11	11	6	ELA-1-E6

Standard 2 – WRITING

K	1	2	3	4	
19,20	26				ELA-2-E1
21	27		23	22	ELA-2-E2
23	28				ELA-2-E3
25	29		25		ELA-2-E4
	30		26		ELA-2-E5
27	31		27	26	ELA-2-E6

Standard 3 – GRAMMAR

K	1	2	3	4	
28-30	32	27	28	27	ELA-3-E1
31	33,34	28,29	29,30	28	ELA-3-E2
	35-38	30	31	30,31	ELA-3-E3
	39	31,32	32		ELA-3-E4
32	40-43	33-35,37	33,34,36	32	ELA-3-E5

Standard 7 – CRITICAL THINKING

K	1	2	3	4	
	22		17	14	ELA-7-E1
		22	18	15	ELA-7-E2
	24		19,20	16	ELA-7-E3
	25	24	21	19	ELA-7-E4