

# **COMPARISON AND CONTRAST OF MICROSCOPES, INCLUDING SEM AND TEM**

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## Curriculum Overview

### Summary

Microscopic work is needed in most areas of endeavor in the life sciences and health related fields. Form and function are so closely linked that observational inspection of the form can often be used to find the pathway of functional problems. Thus familiarity of the microscopic world can often provide students with the concrete foundation for learning in areas of life science and the health related fields. This unit provides activities and instruction using different microscopes so that work and learning in the related areas of science can be accomplished.

### Big Picture

In the hook activity, students will make and examine a hay infusion microscopically. This will allow them to appreciate how life infects or colonizes new environments and it will allow them to discover and view for themselves this microscopic world. This will allow them to experience the “unseen” world of the scientist or medical technician themselves.

### Preparation of the unit

The instructor needs to make arrangements with the Tech Trek organization for teacher training the summer before the mobile SEM (scanning electron microscope) unit is to visit their school. Then, at least two months in advance, the mobile SEM should be scheduled. If these resources are not available to the local teacher, contact with a nearby university or industry that uses a SEM might be made to see if suitable visitation and or use of the SEM might be arranged. If the local school has a computer lab or similar instructional area reservations need to be made for the internet and print materials research. Microscopic slides, specimen, microscopes, and lab equipment need to be reserved or collected prior to the unit. If this unit is interdisciplinary as is suggested, other subject matter teachers will need to be consulted so that they can coordinate times and lessons in the appropriate sequence. As written, this unit could be conducted entirely within the constructs of a science class, but cooperation with English, math, and social studies teachers would allow for reinforcement and cooperation with other teachers. If this is to be accomplished, prior planning with the other discipline teachers will be necessary.

Science	Math	Technology	Social Studies/ English
<b>ALT-1 Light Microscope Use</b> The students will learn to use the light microscope, calculate magnification, and measure the diameter of the field of view.	<b>ALT-1 Light Microscope Use</b> The students will learn to use the light microscope, calculate magnification, and measure the diameter of the field of view.	<b>ALT-1 Internet Research</b> The students will use the internet to gather information about the different types of microscopes.	<b>ALT-1 Print Media Research</b> The students will use the library to research information about scientists who helped develop microscopes.
<b>ALT-2 Microscopic Calculation</b> The students will use their microscopes to view objects and calculate the size of the objects.	<b>ALT-2 Microscopic Calculation</b> The students will use their microscopes to view objects and calculate the size of the objects.		
<b>ALT-3 SEM Microscope Use</b> The students will use the SEM to compare specimen.			

### Transfer Activity

The students will develop their own research projects that are suitable for use with the SEM. This show their learning and demonstrate the utility of the SEM for other projects.

## **Summary**

Students will make a hay infusion, use the low power on a light microscope to view small microorganisms gathered from the hay infusion, and learn about making wet mount slides. Students will begin to quantify their observations by calculating magnification and also measure the diameter of the field of view of their microscope.

## **Competencies**

1. The students will learn to make wet mount slides.
2. The students will learn to make hay infusions.
3. The students will use a metric ruler to measure the low power objective lens field of view diameter.
4. The students will learn to focus the microscope on low power.
5. The students will make drawings of the organisms they observe under the scope.
6. The students will calculate the magnification of their low power objective lens.
7. The students will learn what happens to the size of an image with magnification.
8. The students will learn how microorganisms can infect a sterile environment.
9. The students will learn one way to culture microorganisms.

## **Time**

Approximately 45 minutes will be needed to make the initial hay infusion. Approximately 45 minutes will be needed for the final observations. During the first session students will make their hay infusions and become familiar with their microscopes. During the second session they will make wet mount slides and view and draw microorganisms.

## **Materials**

A small supply of Timothy hay (or other hay) obtained from a horse farm. Hot plates, Pyrex beakers, pond water, scissors, compound microscopes, clear plastic metric rulers, paper, and pencils will be needed.

## **Instructions**

1. Students will be given the attached handout explaining how to make their hay infusion and instructions for use, care, and basic microscopic measurement (magnification and diameter on low power).
2. After students have set up their hay infusion boiling beakers, they can use their “down time” to work with the microscopes.
3. On the third day after this, the students will return to their infusions for observation and complete their handouts.

## **Evaluation/Assessment of Student’s Competency**

Students will complete their lab handouts with calculations and drawings of microorganisms. They will use these to complete an open note quiz requiring them to perform the same type of calculations and referencing the observations they made.

## **Closure**

Students will grade each others quizzes and volunteer the answers for grading purposes.  
Also, there might be an art contest for the best drawings with extra credit points awarded.

Name \_\_\_\_\_

## MAKING A HAY INFUSION

In this activity you will make a hay infusion to promote the growth of microorganisms. You will learn how to calculate the magnification of your microscope, measure the “field of view” on low power, learn to make a wet mount slide, and observe and draw microorganisms. You will use this paper as “notes” to complete a quiz at the conclusion of this lab and there will be an artistic competition judged by your classmates with extra credit awards for the best microorganism drawings.

Microorganisms of many types form spores, cysts, or other protective forms that can be carried by wind as dust particles. These will grow when given a suitable place. A hay infusion is just such a place. The ability of the hay infusion to allow the growth of these microorganisms was once interpreted as **spontaneous generation**.

### Materials

two 400 ml Pyrex beakers, 300 ml of tap water, hot plate, two table spoons of hay, scissors, microscope, clear plastic metric ruler, 100 ml of distilled water, 100 ml of pond water.

### Procedure

A. Obtain a hand full of hay and some scissors. Use the scissors to cut the hay into small pieces that are about half the diameter of the 400 ml beaker. Place the cut hay into the beaker and cover it with water from the tap until it is 3/4 full or 300 ml in height. Place this hay mixture on the hot plate and allow it to heat until boiling. Allow it to boil for 10 minutes once it reaches boiling.

B. Once the hay mixture is on the hot plate, obtain your microscope and a clear plastic, metric ruler. Make sure the fine adjustment knob is centered the low power objective is centered over the condenser lens, the diaphragm is open to the largest opening, and the coarse adjustment knob is turned down all the way. Place the metric ruler under the stage clips and center the edge over the condenser lens. Focus using the coarse adjustment knob only. Then look through the ocular lens and carefully move the ruler back and forth and count the number of spaces it takes to reach across the diameter of the white circle you see (field of view). Count or estimate any partial spaces also. This will be the number of millimeters that equal the diameter of your field of view on low power.

Diameter of the field of view: \_\_\_\_\_ mm.

C. Look at the side of the ocular lens or its top. Record the power here. It is a number usually followed by an “X”.

Ocular lens power: \_\_\_\_\_

D. Look at the side of the low power objective lens and record the magnification of the low power. This is usually the whole number and not the decimal number on the lens. The decimal number is the focal length of the lens.

Low Power objective lens power: \_\_\_\_\_

E. To calculate the magnification of the microscope, multiply the objective lens power “D” by the ocular lens power “C”. This will give you the magnification of the microscope with these two lenses. Show your work below.

Total magnification of the microscope on low power: \_\_\_\_\_

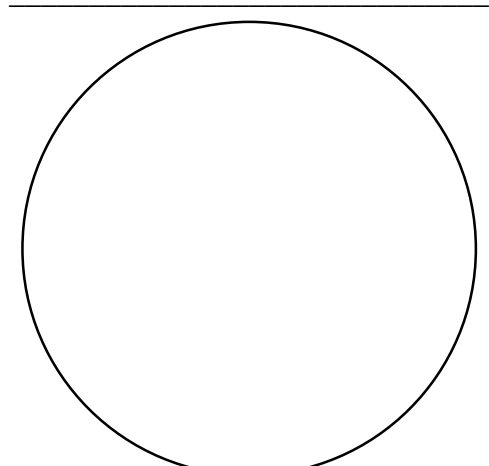
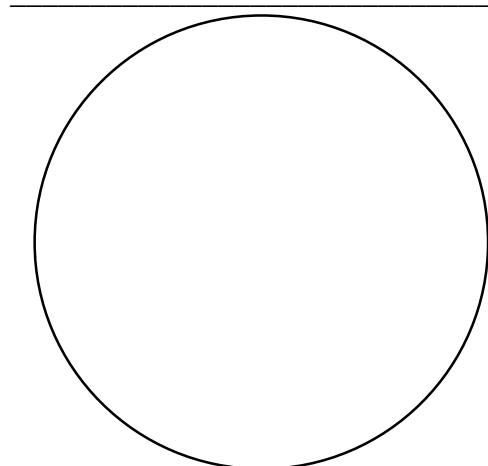
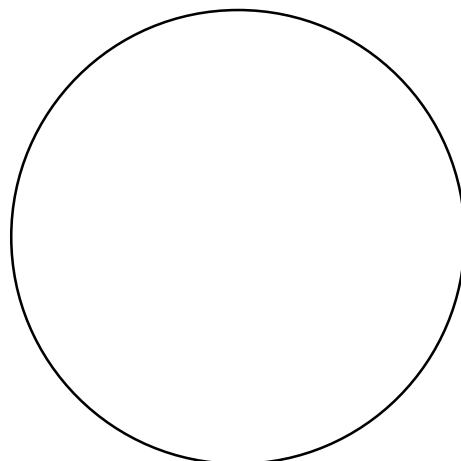
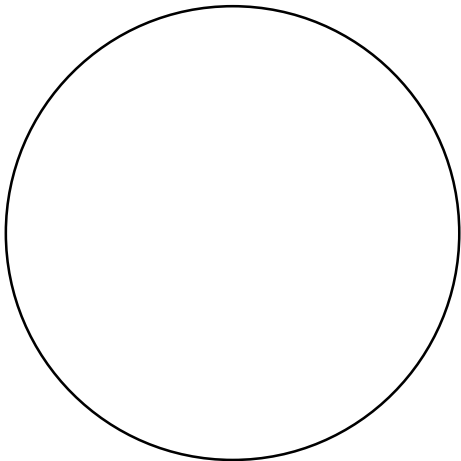
F. For practice calculate the magnification of a microscope that has a low power of 15 power and an ocular lens of 5 power.

Total magnification: \_\_\_\_\_

G. Once your hay infusion has boiled for 10 minutes, remove the beaker and hay from the hot place using beaker tongs. Place it on a paper towel on your table to cool for an additional 10 minutes. Divide the solution into two parts and label them “A” and “B”. Into “A” add 100 ml of pond water. Into “B” add 100 ml of distilled water.

H. After two to three days, obtain your hay infusion beakers. Label a slide “A” and one “B”. Place a drop of water onto the slide with the proper letter, touch the edge of a cover slip to the edge of the drop of water and let the cover slip fall over the drop. A drop of Protoslow might be added to add observations of the swimming microorganisms. Make sure the combined drop is at least the size of a nickel. Try to obtain the water from the bottom of the beaker. Your teacher may require you to make several slides and compare the number and type of organisms found at the different locations in the beaker

I. Make a drawing of four of the organisms in the circle below. Make two from each of the slides and label them “A” or “B”.



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J. Were there organisms in both slides? If there were not, why not, and if there were, where did the organisms come from in the beaker without the pond water.

K. What do you think the organisms were eating?

L. What is the purpose of the hay infusion?

M. How many types of organisms did you find?

N. Were the organisms the same in both slides (both hay infusions?)

O. Why would scientists of the past have hypothesized that there was spontaneous generation? If you don't know what spontaneous generation is, look it up in a biology book or look up both words in a dictionary.

P. What magnification did you have to use on your microscope to see the organisms clearly? Calculate it, showing your work.

Q. Estimate how many of one type of these organisms it might take to fit "end to end" across the field of view of your microscope.

R. Are these organism smaller or larger than a millimeter? (Explain) Remember how many millimeters it takes to go across the low power objective.

Name \_\_\_\_\_

### **Hay Infusion Lab Quiz**

Answer the following questions in complete sentences. For calculations, label your answer with the proper units, and show all your set ups.

1. What is the magnification of a microscope with an ocular lens of 7 power and an objective lens of 15 power?

2. How far was it across the diameter of the low power of your microscope?

3. Explain why scientists once believed in spontaneous generation.

4. What was the purpose of the hay in the hay infusion?

5. Why is the distance seen under high power less than the distance on low power?

6. Where did the organisms come from in hay infusion "B"?

## **Authentic Learning Task 1**

### **Summary**

Students will be expected use the light microscope. They will have to prepare a wet mount slide and observe the slide using all 3 powered objectives. They will move the slide to recognize spatial relationships. The field of view will be drawn under low, medium, and high power and calculate the magnification of each power. Students will then use the information they gathered to answer the questions provided.

### **Competencies**

1. Students will handle and operate a light microscope properly.
2. They will be able to prepare a wet mount slide using proper techniques, and examine it under a light microscope.
3. They will be able to focus under low, medium, and high power by moving the fine and coarse adjustment knobs.
4. They will learn the different parts of the microscope through use.
5. They will be able to transfer what they see in their field of view to a piece of paper, using the quadrant method for better accuracy.
6. Students will use calculations to determine the magnification of each objective.
7. They will be able to gain a better understanding of the magnification power of a light microscope, and determine which samples would be good to look at underneath a light microscope.

### **Time**

The time given for this activity should be approximately forty-five minutes. It will take about ten minutes to set-up and clean up and about thirty-five minutes to complete the lab.

### **Materials**

Students will receive a handout describing their tasks. They will need a light microscope, microscope slide, coverslip, water, dropper, scissors, and a small piece of newspaper print. Another piece of paper with 3 circles may be helpful for the students to record what they see.

### **Instructions**

1. Prior to this activity, the students should be familiar with the parts of the microscope.
2. Also, a lecture and possible demonstration on proper use of the light microscope may be helpful.

### **Evaluation/Assessment of Student's Competency**

The students will answer the questions at the end of the lab. If students finish early with the lab, they should quiz one another with the parts of microscope. Afterwards, a quiz will be given on the parts and functions of the light microscope, as well as magnification calculations. The quizzes will be graded in class, by collecting and redistributing.

## **Closure**

A discussion will follow to talk about the capabilities of the light microscope and situations in which other types of microscopes might be more helpful.

### *Introduction to the Light Microscope*

**Problems:**

How do you use the light microscope?

How do you determine the magnification?

**Materials:**

light microscope	forceps
microscope slide	magazine print
coverslip	scissors
water	dropper

**Procedure:**

**\*Always use 2 hands, one on the arm and the other on the base, when carrying a microscope.**

1. Place a drop of water in the center of the glass slide.
2. With forceps, place a small piece of magazine print in the drop of water. Make sure the piece of magazine has a letter e in it.
3. Hold a clean coverslip by the edges at one side of the drop of water. Carefully lower the coverslip into the drop of water. This is a wet mount slide.
4. Place the slide on the stage of the microscope. Put the stage clips into place. Move the slide so that the magazine print is directly over the hole in the stage.
5. Turn the low power objective into place.
6. Turn the coarse adjustment so that the low power objective is near the coverslip.
7. Open the diaphragm so that the most light enters the microscope.
8. Look through the eyepiece. Try to keep both eyes open. Raise the body tube until you can see the letters.
9. Use the fine adjustment to bring the letters into sharp focus. Find the letter e.
10. Adjust the slide so that the letter e is in the center of your field of view.
11. On a separate paper, make a drawing of the letter e on low power. Determine the magnification under low power.
12. Move the slide to the left, to the right, towards you, and away from you. Note the direction in which the e appears to move.
13. Turn the nosepiece to bring the medium power objective into position. Focus with the fine adjustment **ONLY**. Draw the letter e under medium-power and determine the magnification.
14. Be sure the letter e is in the center of your view. Bring the high power objective into position. Focus with the fine adjustment **ONLY**. Draw the letter e under high power and determine the magnification.
15. Remove the wet mount; be sure the microscope is on low power. Rinse and dry the slide and coverslip.

**Calculations:**

eyepiece lens X objective lens = total magnification

**Data and Observations:**

1. Describe the procedure to make a wet mount slide.
2. What happens when you move the slide to the left? To the right? Towards you? Away from you?
3. Describe the appearance of the letter e under low power? Under high power?

**Analyze and Apply:**

1. What is the purpose of the coverslip?
2. Why should the coverslip be held by the edges?

## **Summary**

Students will be expected to research on the Internet. They will be expected to select appropriate key words and use Boolean searching techniques to locate suitable information about electron microscopes and other types of microscopes. Students will synthesize this information into complete sentence answers to provide questions.

## **Competencies**

1. Students will be expected to down-load and print an article about their assigned microscope, as well as a picture.
2. Students will be expected to record references and identify site names, authors, and/or web masters.
3. Students will be able to share and explain the information obtained to fellow students.
4. Students will be able to discriminate between microscopes and what type should be selected for what level of magnification and what type of research or project.

## **Time**

An hour and a half should be allotted for this activity. One third of the time for finding information, one third for processing the questions, and one third for sharing information between group members.

## **Materials**

Students will be using printed handouts defining the task. A computer lab with Internet access is desirable along with table space to write and share as a group. Printer access will be necessary to obtain images and the required print outs of articles from the Internet.

## **Instructions**

1. Prior to the activity, a list of suitable internet sites can be obtain and supplied to the students. The list of microscopes can be amended by prior research.
2. Suggested web sites: <http://encarta.msn.com/find/Concise.asp?ti=02958000>
3. Students will be placed into 1 of 5 groups and assigned a particular microscope to research (light, stereo, phase-contrast, SEM and TEM).
4. They will then be expected to use the Internet to answer questions from a handout about their particular microscope, including a picture.
5. When finished, the students will then be placed in a group with 4 other students who researched the other microscopes and share the information they gathered.

## **Evaluation/Assessment of Student's Competency**

The students will complete and open note quiz over the microscopes researched using the information researched and shared between group members.

## **Closure**

Afterwards, different pictures can be shown of images taken with different microscopes to compare and contrast the capabilities of each microscope. Then, pictures can be shown and they have to guess what the picture is of and given the type of image and magnification, determine what microscope it was taken with.

Name\_\_\_\_\_

SCIENCE  
**Microscope Research**

In this activity you will use a computer hooked to the Internet and by using a suitable web browser you will locate a photograph and information about a type of microscope. Then you will use the information found to answer several questions that will allow one to identify this microscope. **Submit the photo of the microscope with this paper (3 points). Also, you are to submit a copy of the pages from the Internet in which you obtained your information.**

Your objectives will be to learn or practice using a web browser and the Internet, find sources that provide information on microscopes, and learn some of the characteristics of microscopes that are used to identify them. You will then share the information you gathered with your lab group who have researched the other types of microscopes. The five types of microscopes researched will be:  
Scanning Electron Microscopes, Compound Light Microscope, Transmission Electron Microscope, Stereomicroscope, and the Phase Contrast Microscope.

You will have approximately 20 minutes to use the Internet and approximately 20 minutes to answer questions.

Before you begin, you should gather any handouts received formerly regarding Boolean searching, or advanced search in on the Internet. This information is available at the suggested web browsers on line. Look for advanced searches. You can record any notes here. These are suggested web browsers:

<http://www.yahoo.com>      <http://www.altavista.com>      <http://www.lycos.com>

I. Record the name of your selected microscope here: \_\_\_\_\_

II. Record the keywords and browser that you tried to use to find the microscope here:

\_\_\_\_\_

III. Record the keywords that you tried to use to find the microscope here:

\_\_\_\_\_

IV. Record the keywords that you tried to use to find the microscope here:

\_\_\_\_\_

Try and record at least three times before you ask for assistance.

**Print your information and use it to answer the questions that follow with sentences.**



## **Summary**

Students will use printed materials and/or electronic encyclopedias to gather information on a particular scientist. They will research and answer a series of questions to find their assigned scientist's contribution to the field of microscopy. Students will then take the information, along with a picture of their scientist, and design a poster. They will share the posters with the rest of the class by hanging them up around the room and allowing the other groups of students to walk around the room and gather information on the scientists they did not research themselves.

## **Competencies**

1. Students will be able to use printed materials and/or electronic encyclopedias to completely answer all questions and locate a picture of their scientist.
2. They should be able to locate and summarize important and pertinent facts from a resource.
3. They also will need to record the resources they use by stating the book title, author, publishing company and date, and pages used.
4. They will need to transfer data from one source (handout) to another (poster), and vice versa, in a logical and legible way.
5. Students will gain an understanding of the history behind the development of the microscope, and learn 6 specific scientists' contributions to the advancement of microscopy.

## **Time**

Two hours should be the time allotted for this activity. An hour should be spent in the library gathering information for their answer sheet, thirty-five minutes should be used to transfer information from the answer sheet to the poster, and twenty-five minutes for examining other group's posters and gathering information for the other scientists.

## **Materials**

Students will be using printed handouts outlining their tasks. A library with printed resources and access to electronic encyclopedias is needed along with an area to transfer and share information. A printer and/or copier will be necessary to obtain a picture of their scientist. Poster-board or large pieces of construction paper will be needed for the students to create their information poster about their scientist. Markers and/or crayons should be available for students to design their poster.

## **Instructions**

1. Before the activity, remind students how to use the library materials with direct teaching or by taking them down to the library.
2. Hand out the answer sheet and be sure to be available to answer any questions they may have.
3. Possible web sites to find information to be sure the students have done accurate research are [www.utm.edu](http://www.utm.edu), [www.invent.org](http://www.invent.org), and [www.inventors.about.com](http://www.inventors.about.com).
4. Assign the students, in groups, one of 6 scientists to research (Robert Hooke, Zacharias Jansen, James Hillier, Charles Oatley, Anthony Leeuwenhoek, and Manfred von Ardenne).
5. Allow students the use of printed materials and/or electronic encyclopedias to conduct their research and answer the questions provided on the handout.

6. Students will then create a visual (poster) to post around the room, then other groups of students will go around the room collecting information on the other scientists.

### **Evaluation/Assessment of Student's Competency**

The students will complete an open note quiz over the research activity they did using the library to find information on scientists, as well as the research activity they carried out investigating different types of microscopes via the Internet. The quizzes will be graded in class to allow for immediate feedback, and to answer questions they may have about the scientists or microscopes.

### **Closure**

Students will use the information they gathered to construct a timeline, using the scientists we discussed in class to gain a better understanding of the progression of the microscope.

Name\_\_\_\_\_

SCIENCE  
**Scientist Research**

1-3. In this activity you will use printed materials and/or electronic encyclopedia ,but NO INTERNET, to locate a photograph and information about a scientist. Then you will use the information found to answer several questions about the scientist. **Submit the photo of the scientist with this paper (3 points). Also, you are to submit a copy of the pages from the Internet in which you obtained your information.**

Your objectives will be to learn or practice using printed materials and/or electronic encyclopedias, find sources that provide information on the scientist, and learn some of the characteristics and contributions of the scientist you will be researching to the field of microscopy. You will then create a poster to share the information you gathered with your lab group who have researched the other scientists.

You will have approximately 20 minutes to research and approximately 20 minutes to answer questions.

I. Record the name of your selected scientist here: \_\_\_\_\_

**Print your information and use it to answer the questions that follow with sentences.**

1. What microscope is this scientist credited for inventing, or modifying? In what year did it occur?

2. What is this person's date of birth? Date of death?

3. What is this person's nationality?

4. What type of training, employment, or education helped them with their discovery? What background did he/she have in microscopes?

5. What historical significance did their discovery have for the field of microscopes? What

major advances or break-throughs came as the result of their discovery?

6. What world events were happening during the time of the scientist's discovery?

7. List at least one references, one printed and/or one electronic. List the author's last name, first name, title of the book, publisher, date of publication, pages used.

Name \_\_\_\_\_

## Microscope and Scientist Quiz



1. In order to view a specimen with a scanning electron microscope, what must the sample be coated with? Why must it be coated?
2. Why must a specimen be thin when looked at underneath a light microscope?
3. What dimensional image does a stereomicroscope provide? What is the range of magnification for a stereomicroscope?
4. Which microscope would be optimum for viewing a clear specimen?
5. What type of microscope can magnify up to 1,000,000X?
6. What did Robert Hooke name the pores he saw when he looked at a cork underneath a microscope?
7. Who is credited with the invention of the 1<sup>st</sup> microscope?
8. What war's developments helped Charles Oatley with his involvement with the scanning electron microscope?
9. What was Anthony van Leeuwenhoek the first person to see and describe?
10. What scientist received his B.S. in 1937 and Ph.D. in physics in 1941 from the University of Toronto? What microscope did he help develop?

## Summary

Students will use the light microscope to look at 4 prepared slides. They will draw pictures of what they observe and determine the diameter of the specimen using a clear ruler and mathematical calculations.

## Competencies

1. Students will be able to better understand the capabilities of the light microscope.
2. They will be able to bring an object into focus under low, medium, and high power.
3. They will draw what they see under the microscope, using the quadrant method.
4. They will determine the diameter of a specimen by manipulating a proportion, and apply that knowledge to answer questions about the specimens.

## Time

This lab should take approximately 1 hour and 10 minutes. It should take about 10 minutes to set up and tear down the lab, and about 1 hour to complete the assignment.

## Materials

Students will be given a handout to complete. They will be using the light microscope, prepared slides (human red blood cells, paramecium, bacteria, and diatoms), and a clear ruler. Depending on the math capabilities of the students, calculators may be needed.

## Instructions

1. It may be helpful to do similar calculations before as those done in the lab. Try and use examples that relate to them.
2. Pairing a student with good math skills, with someone who does not, could minimize mathematical obstacles.
3. If the 4 prepared slides are not available, the lab can be altered to include any that are accessible.
4. At least one slide should be gone through as class to be sure that all students understand the calculations.

## Evaluation/Assessment of Student's Competency

The students will answer the questions at the end of the lab. A discussion on their observations of the samples will be held after, to help students understand the capabilities of the light microscope and what samples would be best observed using the light microscope.

## Closure

The students could then brainstorm how each of the samples would have looked under a stereomicroscope, phase-contrast microscope, scanning electron microscope, and transmission electron microscope.

Name \_\_\_\_\_

## *Calculating the Diameter of a Specimen using a Light Microscope*

### **Problems:**

How do you calculate the size of a specimen?

### **Materials:**

light microscope  
prepared human blood slide  
prepared paramecium slide  
prepared bacteria slide  
prepared diatom slide

### **Procedure:**

1. Draw the field of view under high power for all 4 prepared slides.
2. Determine the diameter of a red blood cell, a paramecium, bacteria, and diatom of all 3 objectives.
3. Use a clear ruler to find the length of the specimen under one objective, then use calculations to solve for the diameter under the other 2 objectives. **SHOW ALL OF YOUR WORK.**

### **Calculations:**

proportion of magnification = inverse proportion of diameter

$$\text{Ex: } \frac{\text{low power magnification}}{\text{high power magnification}} = \frac{\text{high power diameter}}{\text{low power diameter}}$$

### **Analyze and Apply:**

1. Why should a clear ruler be used when finding the diameter of a sample?
2. How many paramecium could fit side by side in the low power field of view?
3. How many blood cells could fit side by side in the high power field of view?
4. How many diatoms could fit side by side in the medium power field of view?

## **Summary**

Students will be given a topic to research using the electron microscope. Students will be responsible for collecting the samples that will be examined under the scanning electron microscope. Students will then use the Tech Trek, a mobile scanning electron microscope unit, to research their characteristic by comparing different species of living things (hair, pollen grains, insect wings, feathers, leaves, and fabric). They will then make conclusions and design a poster to share with the class on their comparisons.

## **Competencies**

1. Students will be able to collect samples and prepare them for the SEM by placing them on metal holders and sputter coating the samples.
2. Students will be expected to examine their samples under the SEM. They will use proper techniques in the operation of the SEM to find, focus, and take micrographs of their samples.
3. Students will be expected to find the diameter of each sample as a way of comparison.
4. Students will be able to distinguish among samples from different species. They will analyze the micrographs to determine the similarities and differences among different plants and animals. They will then try to relate the differences they observe in the micrographs to each species adaptations to their particular environment.
5. Students will gain a full understanding of the mechanics of the SEM and its importance to science.

## **Time**

The estimated time for this activity is 5 hours. Approximately 1 hour should be allowed for final preparation of the samples, 3 hours to examine the samples under the SEM and prepare a poster, and 1 hour for the groups to share their results with the rest of the class.

## **Materials**

For this activity, the Tech Trek, mobile SEM, will need to be reserved at least 1 month in advance. The metal holders to hold the samples in the SEM will need to be received a day or 2 in advance to begin preparing samples. Placing students in groups of 3, they will need approximately 4-5 holders per group. Other microscopes (light and stereo) need to be available to allow students to look at samples when they are not using the SEM. A large piece a paper, along with glue, scissors, and markers, need to be on hand for students to design their posters. Books and computers with Internet access will allow students the ability to research their species.

## **Instructions**

1. Students will receive a handout that describes the activity. Each group of 3 will receive 1 particular characteristic to examine.
2. Students will be given a couple days to find samples to examine. Students will then dry samples and place them on the metal holders.
3. Using the Tech Trek, the samples will then be sputter coated and examined using the SEM. Students will then analyze the samples determining how the same feature changes among species. When not on the SEM groups can use other microscopes to look at samples, begin designing their poster, and researching their species.

4. Students will then share their micrographs and findings with the class in a poster format.

### **Evaluation/Assessment of Student's Competency**

Students' posters will be examined and graded using a rubric. Part of their grade will be their presentation, as well as each group member's participation.

### **Closure**

The teacher should talk about different types of research done using the SEM and what advances they have made in science because of the SEM. A connection to classification could be made. Each student could write a paragraph of how their results could be used in the classification of their different species.

## Scanning Electron Microscope Research Project



Congratulations! You and your classmates have been chosen to be research scientists for the state of Ohio. The Biologists Association of Ohio has had a lot of trouble distinguishing among the same characteristics of different species. They themselves have done several tests to observe differences among several species but they have unfortunately been unsuccessful. Now, it is your turn to help the Biologists Association of Ohio by conducting your own research. You, unlike the Association, have access to a Scanning Electron Microscope (SEM), which will hopefully prove most useful in your research. Thanks for your participation and we look forward to seeing the results.

### **Procedure:**

#### **Collecting Samples**

1. You and your research team will be given one of 6 topics to research. They include hair, pollen grains, insect wings, fabric, feathers and leaves. You and your team members will be given 2 days (on your own) to bring in samples from different species. For example if your team is to research hair then your group could bring in human, dog, cat, and horse hair. Your team must collect and examine 4 different samples.
2. The samples will then be given 2-3 days to completely air dry in the back of the classroom.
3. Afterwards, we will safely mount them on the metal holders using double sided metal coated tape.
4. Once the Tech Trek arrives, the samples will be sputter coated (coated with a thin layer of gold) and will then be ready for the SEM.

#### **Using the SEM**

1. There will be a person in charge helping you with the operations of the SEM. Please listen and follow ALL directions.
2. Find the diameter of each sample. There are different ways this can be done using the SEM. Ask for help if needed.
3. Take a micrograph of each sample. Try and use the same magnification to help with the estimation of size from one sample to the next. Be sure to label each picture with what the sample is and your group name or initials.
4. Examine each of the pictures to notice any differences. Take into account shape, size, texture, or any characteristic that can help set them apart.

#### **When not using the SEM**

1. Use the other microscopes available. A light microscope, as well as a stereomicroscope, could also be of help.

2. Use books or the Internet to find information on each of your species. Find at least 3 facts about each species, including their habitat.
3. Use the time to work on your poster. Be creative☺

**Poster**

1. The poster will be presented to the class at the end with your findings. It must include the following:

- All pictures taken with the SEM.
- The diameter of each sample. Show the calculations of how you arrived at your answer.
- Differences between species in your micrographs, as well as other microscopes.
- Three important facts about each species, including its habitat.
- As a group conclude how each of the species unique characteristics, in terms of the one trait you were researching, helps the animal or plant better survive in its environment.

\* At the very end of the project, you will rate your team members on their involvement with the project. Everyone will get the same grade on the poster, however the participation grades given by your team members will be averaged into your final project grade.

**GOOD LUCK!**

**Micrographs.....16**

- Are there 4?
- Are they quality/in focus?
- Are they labeled?

**Diameter of Samples.....8**

- Are there 4?
- Are they in appropriate units?
- Are calculations shown?

**Differences Among Samples.....12**

- Are all differences included?

**Facts About Species.....8**

- Are there 3 per species?
- Did they include habitat?

**Conclusion.....8**

- Are there 4?
- Did they say how the differences relate to that specie's survival?

**Participation.....8**

**TOTAL \_\_\_\_\_ / 60**

## **Transfer Activity Original SEM Research Proposal**

### **Summary**

This activity is designed to allow the student with experience and familiarity with the Scanning Electron Microscope to design an appropriate research proposal for the use of the microscope.

### **Competencies**

1. Students will demonstrate knowledge of the scientific method by proposing a question, forming a hypothesis, and designing an experiment implementing use of the SEM.
2. Students will show that they are familiar with specimens that are appropriately sized and of a suitable nature to work with the electron microscope.

### **Time**

The approximate time for this activity should be 1 hour and 15 minutes. Fifteen minutes should be allowed for the introduction, 45 minutes for them to work on their proposals, and 15 minutes to wrap-up the unit.

### **Materials**

A handout should be given to the students that outlines exactly what is expected of them, and also allows room for writing their proposal.

### **Instructions**

1. A brief review of the scientific method may be helpful.
2. Allow students the time to brainstorm ideas for their proposal.
3. Micrographs taken with a SEM might be on hand to give students ideas for research.

### **Evaluation/Assessment of Student's Competency**

Students will partner up and share their proposals. The other student will read and critique their proposal, stating why it is good or not. The paper will then be given back to original owner to make corrections. Student proposals will then be read by the teacher and evaluated.

### **Closure**

Pictures of the cell taken with the TEM and SEM will be shown to the class as a conclusion to microscopes and an introduction to cells.

Using all your experience and knowledge about Scanning Electron Microscopes, you are going to think of a question/problem that could be solved using the SEM. Use a nonliving or living specimen of interest. After proposing a question, you are going to write a hypothesis as a possible explanation to your question. Afterwards, you will design an experiment, in detail, on how you would conduct research to solve your problem. Include how you would prepare your sample, how to use the SEM, and describe what in your micrographs would help you come to a conclusion.

**Problem:**

**Hypothesis:**

**Experiment Proposal:**