

Microscopy - Understanding Size and Scale	
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Subject: Biology / Chemistry	
Grade Level: 7 th - 9 th	
Standards:	
HS-LS 2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
SEP:	Using Mathematics and Computational Thinking
CCC:	Scale, Proportion, and Quantity
Schedule: ~ 3 Days	
CCMR Lending Library Connected Activities:	
First Step: How a Microscope Works (Students will learn about lenses, build their own microscopes, and calculate the magnification for it.)	
Next Step: Nano What? (Students will explore the nanoscale world and see how materials look and behave quite differently.)	



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<p>Objectives:</p> <ul style="list-style-type: none"> ● Activate prior knowledge about size, scale, and magnification ● Compare images taken from Optical and Scanning Electron Microscopes. ● Use microscope images to show relationship between scale bars and magnification ● Use technology simulation to understand the mechanics of an SEM. ● Apply understanding of proportions to create scale models. 	<p>Vocabulary:</p> <p>Metric System Conversion Algae Microbes Magnification Ratios Scale Model Scanning Electron Microscope (SEM) Light Microscope Scale Bar</p>
<p>Students Will:</p> <ul style="list-style-type: none"> ● Use optical microscopes to explore the microscopic world in pond water to build and understanding of size. ● Convert using the metric system ● Apply appropriate units to measurements ● Explain how scientists study phenomena that they cannot see with the naked eye ● Create a scale model ● Explain how an SEM works ● Compare images from different microscopes 	<p>Materials:</p> <p>Engage:</p> <ul style="list-style-type: none"> ● Computers w/Internet Access ● Microscope Images (unlabeled) <p>Explore:</p> <ul style="list-style-type: none"> ● Computer w/Internet Access ● Ziplock bags ● Pond or Spring Water ● Plastic pipettes ● Compound Light Microscopes, Stereo Dissecting Microscope, or Foldscopes ● Moss and/or Lichens ● Slides ● Wax Pencil <p>Explain:</p> <ul style="list-style-type: none"> ● Rulers ● Microscope Images ● Calculators <p>Elaborate:</p> <ul style="list-style-type: none"> ● Computers w/Internet Access <p>Evaluate:</p> <ul style="list-style-type: none"> ● Card Stock ● Markers / Colored Pencils ● Rulers ● Butcher Paper ● Craft Materials (Yarn, etc.)
<p>Safety: Use gloves and goggles when handling pond water samples.</p>	



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Science Content for the Teacher:

Nikon. “MicroscopyU”. <https://www.microscopyu.com/microscopy-basics>. Accessed 20 August. 2018.

Nikon MicroscopyU Tutorials. <https://www.microscopyu.com/tutorials/twolensssystem>. Accessed 20 August. 2018.

Technology Resources:

<https://www.nikon.com/about/sp/universcale/scale.htm>

<http://scaleofuniverse.com/>

http://www.microscopy-uk.org.uk/pond/x_index.html

<http://www.microscopy-uk.org.uk/index-no-ads.html?http://www.microscopy-uk.org.uk/ponddip/>

http://myscopeoutreach.org/virtualSEM_explore.html

<https://www.sciencelearn.org.nz/embeds/12-which-microscope#Stereomicroscope>

See additional information in Resources section.

Recommendation: CCMR “How a Microscope Works” Kit prior to this module.



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Classroom Procedure:

Engage: How big is big? How small is small?

Goal: Engage students in thinking about size, magnification, and scale.

Students will rotate among three stations which are designed to get them thinking about size, magnification, and scale. At each station, students will be asked to engage in small group discussion, reach a consensus (if possible), and explain their thinking.

A. What am I looking at?

Students will view images of different magnified objects/materials and try to identify what they are looking at.

B. Perception of Size

Students will be given a list of measurements of objects and they will be asked to indicate its size on the metric scale.

C. Scale of the Universe

Students will access the following resources to explore the scale of the universe. They will discuss how scientists observe, measure, and study things that are too small to be seen with the naked eye.

- a. <https://www.nikon.com/about/sp/universcale/scale.htm>
- b. <http://scaleofuniverse.com/powers-of-ten/>
- c. <http://scaleofuniverse.com/>

Explore: Van Leeuwenhoek Adventure

Goal: Use the natural microscopic environment to engage students in thinking about the size of small things.

Students will observe samples of pond water under a microscope. They will practice using an optical microscope. They will use the provided internet resource to identify organisms that they are able to observe. They will take pictures and record information about the magnification used to make their observations.



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Note: Obtaining Samples

Option #A: Students are assigned to obtain moss and/or lichens samples. Divide class into groups of three students. Each group should plan to take a field trip together to obtain their sample. Teacher should provide information about locations and methods for obtaining the samples. It is highly recommended that appropriate time is given to obtain the sample and letter is sent home to parents informing them of the assignment and expectations.

Option #B: Teacher secures moss and/or lichen samples for student groups.

Resources permitting, connect the microscope to a monitor to project the view. Using the Luminara software, have students find organisms and take images that include scale bars.

Explain: Size, Scale, & Magnification**Part I: Metric System Review & Practice**

Goal: Review the metric system units of length and converting between units. Actively measure, convert among units, and compare sizes.

Recommendation: It is suggested that Part I be assigned as HW. Students in each group should compare their responses to the last question at the beginning of the next class session.

Part II: Measure, Convert, and Compare

Students will measure the width of their thumb in cm and convert to m, mm, and μm . They will then consider the diameter of a period at the end of a sentence and using the given measurement (in mm), they will convert to cm, mm, and μm . Students will then determine the number of periods that could fit across their thumb.

Part III: Scale Bars and Magnification

Goal: Understand the importance of scale bars on magnified images. Use scale bars to determine magnification and actual size.

Students will analyze an image of a Daphnia which includes a scale bar. They will be asked to find the length and width of the Daphnia using the image provided. They will then build understanding of using scale bars to determine magnification and actual size. They will create a simple scale model of a Daphnia magnified 1000x.



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Elaborate: Scanning Electron Microscope Simulation

Goal: Students will build an understanding of the technology that exists beyond the familiar optical microscope. They will use a simulation to explore the mechanics of a Scanning Electron Microscope and observe images of other materials.

Teacher Facilitated Discussion. Explain to students that there are many different types of microscopes that are available to scientists today, each one with its own advantages. Use resource,

<https://www.sciencelearn.org.nz/embeds/12-which-microscope#Stereomicroscope>, to review with students how scientists choose the microscope they will use in their research. Explain to students that they will further investigate the scanning electron microscope using an online simulation. Assign SEM basics for HW.

Part I: SEM Basics (Completed at home)

Students will access http://myscopeoutreach.org/2_howdoesansemworks.html to review the basics of an SEM microscope. They will annotate an SEM schematic to highlight important information about the SEM. They will complete a graphic organizer to demonstrate their understanding of the difference between an optical microscope and a scanning electron microscope.

Part II: SEM Simulation

Students will access: http://myscopeoutreach.org/virtualSEM_explore.html. They will play with the simulation to deepen their understanding of the mechanics of an SEM. They will observe three different samples of a sponge and take pictures at different magnifications. They will compare the size of microbes observed on the sponge to the size of the microorganisms observed in the pond water.

Evaluate: Constructing a Scale Model

Goal: Students will demonstrate their understanding of size and scale by creating a scale model of one of the organisms or objects from the microscope images. They will compare their model to a scale model of a period.



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Assessment:

Students will be asked to perform the following assessment tasks during this module.

- Reflect on their understanding of size and scale (Diagnostic)
- Convert among metric units and apply appropriate units to measurements
- Compare sizes of objects / microorganisms
- Use scale bars to determine magnification and actual size
- Compare the images obtained from optical and SEM microscopes
- Apply understanding of size, scale, and magnification to create a scale model (Summative)

Resources:

1. Lichens and Mosses and Water Bears...Oh my! Cornell Institute for Biology Teachers, 2014
2. Project Neuron
3. Animated Life: Seeing the Invisible
4. Tretter, T. R., Jones, M. G., Andre, T., Negishi, A., & Minogue, J. (2005). Conceptual Boundaries and Distances: Students' and Experts' Concepts of the Scale of Scientific Phenomena. *Journal of Research in Science Teaching*.
5. Moreno, Tharp, Erdmann, Clayton & Denk. (2012). Comparing Sizes of Microorganisms.
<http://www.bioedonline.org/tasks/render/file/index.cfm?fileID=A1289E74-BBD5-07E2-3BC4E155304E18D9>. Accessed 20 August. 2018.
6. Microcosmos: Scanning Electron Microscope Images of Insects, Household Items, and Human Body Parts. The Telegraph.
<https://www.telegraph.co.uk/news/science/picture-galleries/8050581/Microcosmos-scanning-electron-microscope-images-of-insects-household-items-and-human-body-parts.html?image=10>. Accessed 20 August. 2018.



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Extra Activities:

1. Students research algae and its potential value as a biomaterial. They will work in small groups with each group focused on a specific use of algae (biofuel, food, etc.). They will locate research articles related to their topic and use the information to develop a formal presentation on the topic.
2. Students compare the light microscope and an SEM. They create posters that show the similarities and differences between the two microscopes. Their posters will include images taken from each type of microscope and a written explanation to explain the differences.
3. Use algae to explore photosynthesis as a carbon dioxide sequestration mechanism.

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