Lesson Title	Detecting backscattered electrons with scanning electron microscopy (SEM)
Length of Lesson	50 min class period
Created By	Kendra Wright
Subject	Science
Grade Level	7th grade
State Standards	Inquiry: 1b, 1c, 1f, 1h Life Science: 3b
DOK Level	DOK 1, DOK 2
DOK Application	Recall, Skill/Concept
National Standards	5-8th grade: A (Inquiry), C (Life Science)
Graduate Research Element	The Scanning Electron Microscope (SEM) is a key tool for my research and is used often to image the bacterial surface structures and biogenic manganese production for *Pseudomonas*.

Student Learning Goal

MS 7th grade

1b. Discriminate among observations, inferences, and predictions.

1c. Collect and display data using simple tools and resources to compare information (using standard, metric, and non-standard measurement).

1f. Explain how science and technology are reciprocal.

1h. Make relationships between evidence and explanations.

3b.Classify the organization and development of living things to include prokaryotic (e.g., bacteria) and eukaryotic organisms (e.g., protozoa, certain fungi, multicellular animals and plants).

National Science Education Standards 5-8th grade

Content Standard A: Communicate Scientific Procedures and Explanations.

Content Standard C: Structure and Function in Living Systems.

Materials Needed (supplies, hand-outs, resources):

Cardboard, aluminum foil, balls, portable Scanning Electron Microscope (SEM), prepared SEM samples

Lesson Performance Task/Assessment:

The performance task is for student to obtain an understanding of backscattered electrons and SEM imaging techniques. Students should be able to explain the SEM electron beam, backscatter, and surface image.

Lesson Relevance to Performance Task and Students:
Scanning Electron Microscopes (SEM) beam electrons onto a sample and scan the sample surface for backscattered electrons. The electron signals are collected during the scan, and an electron backscatter diffraction image is captured for the sample's surface topography.

SEM samples are usually coated with electron conductive materials such as gold, platinum, graphite, etc. The electron conductive material prevents the accumulation of electrostatic charge on the sample surface.
The purpose of the lesson is to give students an understanding of backscatter electrons and SEM microscopy.

In order to elicit the idea of backscatter electrons and sample preparation, a "sample" person will be dressed up in metal armor and balls acting as electron will be thrown at the "sample."

Lastly, the portable SEM will be used to image samples of insects, bacteria, penny, plant leaves, etc. The images will demonstrate the final product of electron backscatter.

Anticipatory Set/Capture Interest:
Students will throw electron balls at an armored sample person. This activity should capture interest.

Guided Practice:
SEM images will be taken for several objects including insects, bacteria, leaves, penny, etc. Student will first learn how the throwing of the electron balls represents the electron beam, how the balls bouncing off the armor represent electron backscatter, and how images are captured from the electron backscatter.

Independent Practice:
Students will draw a picture of how SEM works. Also, students will sketch what they think the image will look like.

Remediation and/or Enrichment:
Remediation will follow student Individualized Education Program. For enrichment, students will purpose a scientific scenario for which SEM imaging could be necessary.

Check(s) for Understanding:
When looking at a sample under an SEM microscope, what sample structures can be imaged? Can you see surface structures? Can you see inside the sample?
Why are samples given a metallic coating before being placed under an SEM?
What does SEM stand for?

Closure:
A class discussion based off of the checks for understanding questions will take place. Also, I will explain how the SEM is used for my research.

Possible Alternate Subject Integrations:
In this lesson, most of the samples are biological. However, industrial material composition, engineering factors, and mineralogy can be considered with SEM.

Teacher Notes: Lesson is to be fun and interactive. Also, teachers must contact local universities about borrowing a portable SEM.