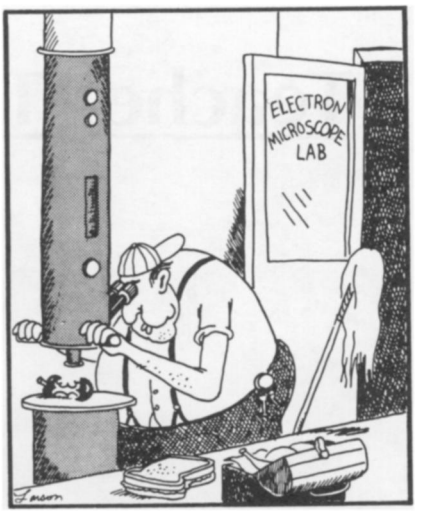
Teacher To Teacher

Electron Beams and Giant Spiders

Cartoon Inspires Inquiry

Jillyn Smith



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Gary Larson's cartoon of the janitor looking at his half-eaten apple through the electron microscope was published in *The Arizona Daily Star* soon after my biology class's discussion of how the electron microscope differs from the conventional light microscope.

It seemed appropriate to ask my students, on an exam, to criticize the drawing.

"What are two things wrong with this picture," I asked, "based on what you know about the electron microscope?"

"First of all," one student answered, "the janitor wouldn't have been able to get into the laboratory. Those microscopes are expensive and are kept locked up."

"You couldn't look at a whole apple through the microscope," said another. "The specimen has to be small."

"You don't look through eyepieces," said still another. "You see an image on a TV screen."

"The apple has to be stained and between glass," said another.

One critic looked hard, then played it safe: "The top isn't hooked to the bottom, and the knobs are wrong."

Right? Wrong?

Maybe I had bit off more apple than I could chew. I sought expert help.

David L. Bentley is the electron microscopist for the College of Agriculture at the University of Arizona.

"Sure, the janitors come in," said Bentley. He looked around his small laboratory. "Unfortunately, they don't come in enough."

As to cost, Bently said an electron microscope costs "as much as you want to pay."

"An electron microscope is like a car," he said. "It depends on what you want on it. An SEM [scanning electron microscope—for whole specimens] costs from 150-200 thousand dollars, and a TEM [transmission electron microscope—for thin slices] may cost from 30-180 thousand dollars.

"And that's probably close to what they cost to make. They're usually break-even, prestige items for a company. So they can say, 'See our electron microscope? Buy our toaster.' "

Bentley pulled out a tray of specimens mounted on disks smaller than a dime. "Specimens are usually small, about 3-5 millimeters," he said, "But they can be as large as the chamber can hold.

"The chamber for this SEM is about five inches in diameter. I have built a larger chamber, about 14 inches, to look at a deer antler tool that couldn't be cut. You can't see much at a time, though," he said.

So an apple would fit.

"But the main problem is that specimens have to be dry," he said. "If they're not dry, they vaporize under the electron beam."

The chamber Bentley described is inside a three-foot-long vacuum tube. "The air molecules are about three feet apart in the tube," he said. The electron source is a tungsten filament, charged to 20,000 volts."

Bentley popped a mounted silvery spider into the chamber, and turned on the vacuum pump. In two minutes, we were looking at the business end of a fang, magnified as large as a butcher knife, on the TV screen.

"The beam is focused by a magnetic lens, sort of like a giant solenoid," Bentley said. "The beam is very damaging to specimens. Oh, we could look at this spider on and off over a year, but some fungi, for instance, only last a couple of minutes. It's been said that the force of the electrons hitting the specimens is equivalent to being at ground zero of a 20 megaton atomic blast. Trying to stop the damage, especially at the molecular level, is a problem. In some sciences—metallurgy, for instance—part of the use of the electron microscope is to watch how things break apart."

Specimens for the SEM are coated with metals.

"The ideal metal gives us a signal from the sample," Bentley said, "and doesn't easily oxidize. Gold and gold palladium are commonly used. I've also used aluminum because it can be dissolved off later, important if the specimen needs to be returned to a museum.

"Specimen preparation is the toughest part of electron microscopy," he said. "Learning to use the SEM itself is easy. A person could take publication-quality photos after only a couple of hours on the microscope."

I thanked David Bentley for my adventure into the world of electron beams and giant spiders.

And I thank Gary Larson for starting it all . . . and for helping to make my students think.

One of them thinks like Larson. "It's an electron periscope," he said.

Jillyn Smith, is a research writer for the Office of Information Services at Utah State Univ., Logan, UT 84322. She received a bachelor's degree in biology in 1972 and a master's degree in zoology in 1974 from Arizona State Univ., Tempe. In 1984, she received a master's degree in journalism from the Univ. of Arizona, Tucson. She has illustrated scientific articles and books and has been editor of the *UA Graduate News*, *Arizona History* and *The Tombstone Epitaph*. Smith taught biology courses at Pima Community College in Tucson for eight years. She is a 1984 recipient of a Nate Haseltine Memorial Fellowship in Science Writing.