

# Exploring Tools— Transmission Electron Microscopes

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*How do scientists study tiny things?*



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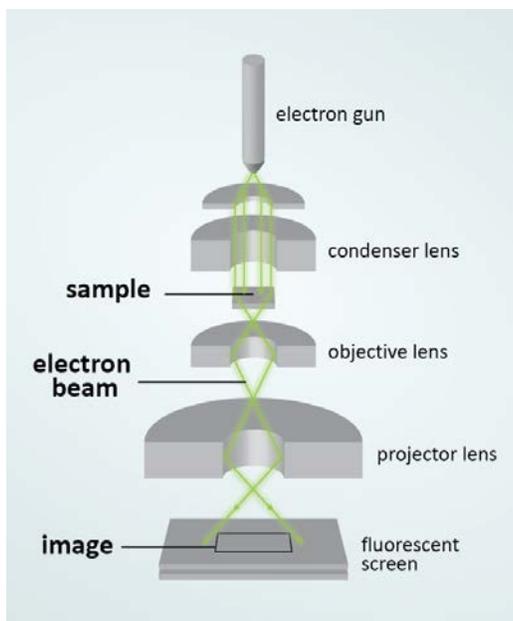
## Exploring Tools—Transmission Electron Microscopes

### Try this!

1. Shine the flashlight down the plastic imaging tube. With the flashlight on, look in the viewing window under the tube. What shadow shapes do you see?
2. Based on the shadow shapes, can you guess what the objects look like?
3. Take the large tube off so you can see the objects. Did you guess right?
4. Now try to build a sample from play dough to create the same shadow. When you shine the flashlight on it, do you get the same shadow? Try making some other shapes!



### What's going on?

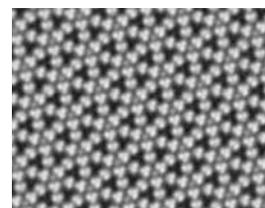


**Transmission Electron Microscope (TEM)**

When we shine the flashlight on objects in the plastic tube model, we can see their shadow in the viewing window. While we can see the shadow, we lose some information about exactly how the sample looks. Is it tall or short? Is it solid? Or does it have a hole in the middle? Some objects may have the same shadow but look quite different in 3D. With the TEM, scientists have developed ways to overcome this challenge, such as imaging their samples from different angles, or thinly slicing a sample and imaging each slice.

### How is this nano?

**Scientists use special tools and equipment to work on the nanoscale.** Transmission Electron Microscopes (TEMs) allow researchers to detect and make images of individual atoms and other features that are too small to see with other tools. The invention of transmission electron microscopy was a breakthrough in the field of nanotechnology. Once scientists could create pictures of nanoscale objects and features, they could begin to study and understand this super-tiny scale.



**TEM image of Silicon Nitride**

The imaging tube is a model for a transmission electron microscope (TEM). TEMs allow scientists to image nanometer-sized features (a nanometer is a billionth of a meter). TEMs can even produce images that show the locations of individual atoms!

In a TEM, a high-energy electron beam is focused at a sample. Researchers observe how the electron beam changes after it goes through the sample. The electron beam needs to penetrate the sample, so TEM samples have to be very thin. If a sample has a regular, crystalline pattern, scientists can use the TEM to produce images that provide information about the structure. Scientists can also use special detectors to determine what elements, like carbon or iron, are in the sample.

The model uses a flashlight, but TEMs use an electron beam. Electron beams, unlike visible light, can be focused into much smaller spots, allowing scientists to look at smaller features.

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