Lesson 1.8 Seeing with Electronic Eyes

optical: using light

electron: particle with a negative electrical charge found in an atom; electrons orbit the atom's nucleus, which contains protons and neutrons

pixels: small, colored dots that combine to form images on a computer or television screen

vacuum: space that is completely free of matter

freeze-dried: went through the freeze-drying process, which means all moisture was removed without damaging the original object

conductors: elements or other substances that allow electricity to easily pass through them

Electron microscopes can magnify objects up to two million times. Even the individual atoms inside certain materials can be seen with these powerful tools.

Objects also need to be good **conductors** in order to be "seen" by a beam of electrons. A freeze-dried bug wouldn't be a good conductor. Scientists coat these kinds of specimens with a thin layer of metal. Then, the electron beam has no trouble mapping the surface.

How is an optical microscope different from an electron microscope?

Optical microscopes use lenses and light to magnify objects too small to be seen with the naked eye. They help scientists peer into the miniscule worlds of bacteria, cells, and other tiny matter. The strongest optical microscopes can magnify objects up to about 1,000 times their original size. In order to see anything smaller, you need an **electron** microscope.

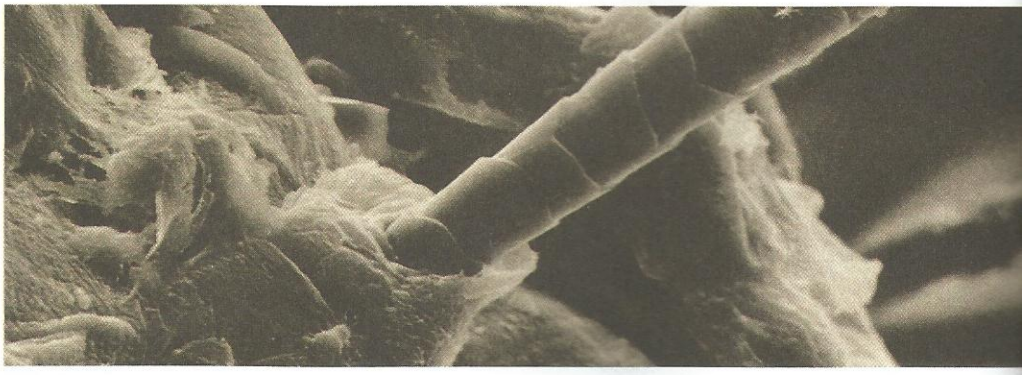
The amount an optical microscope can magnify something is limited because it uses light. Remember, light is a form of electromagnetic radiation or energy that moves in waves. You see because light waves bounce off objects and then enter your eyes. When you look through a microscope, the light waves coming off a tiny object, like a cell, are magnified by the lenses and focused directly into your eye. The smallest thing that could be seen might be a large virus.

Imagine enlarging a digital photo. If you go too far, you end up with a bunch of colored dots that don't show anything. The **pixels** are too big to show the smallest details. In a similar way, light waves can only show details to a certain point.

An electron microscope solves this problem because it doesn't use light. It uses electrons. A machine shoots a very thin beam of electrons toward the object to be viewed. The beam moves slowly back and forth across the object's surface. Everywhere the beam hits, its electrons repel a few electron off the object's surface. The microscope reads these electrons, and it uses them to make a 3-D image of the object. This image is shown on a computer monitor, or it can be used to create a photograph.

Anything that's going to be seen by an electron microscope has to be placed inside a **vacuum**. Otherwise, the beam of electrons will hit molecules in the air instead of whatever is to be magnified. Using a vacuum creates a special problem, though. Anything containing liquids or gases will quickly expand inside a vacuum.

To solve this problem, organisms are **freeze-dried** or dipped in liquid nitrogen before they are viewed. Everything viewed with an electron microscope is dead. Optical microscopes have the advantage of being used to see living cells or organisms.



NAME _____

Circle the letter of the best answer to each question below.

1. Optical microscopes use _____ to magnify objects.

   a. lenses

   b. light

   c. electromagnetic radiation

   d. All of the above

2. An electron microscope shoots a _____ of electrons at the object it's magnifying.

   a. radiation

   b. beam

   c. lens

   d. pixel

Write your answers on the lines below.

3. Living organisms contain water. Why does moisture need to be removed before an organism can be viewed with an electron microscope?

   _____

   _____

4. How are optical and electron microscopes similar?

   _____

   _____

5. How are optical and electron microscopes different?

   _____

   _____

6. What is one important advantage an optical microscope has over a more powerful electron microscope?

   _____

   _____