

After reading the **Intro To Microscopy** on the *Molecular Expressions* website (<http://micro.magnet.fsu.edu/primer/anatomy/introduction.html>), please answer the following questions in complete sentences:

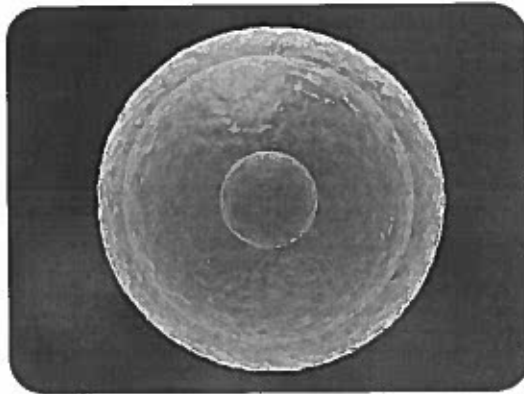
- 1.) What type of microscope is Robert Hooke credited with creating?
- 2.) Describe what types of visual information the eyes can actually take in and process?
- 3.) Distinguish between 'rods' and 'cones' in the eyes.
- 4.) Concisely describe how 'simple microscopes' work.
- 5.) What did Anton von Leeuwenhoek call single-celled animals?
- 6.) What type of microscope developed after 'simple microscopes'? Who is credited with their development?
- 7.) What is an 'aberration' in microscopy?
- 8.) Which professions rely heavily on microscopy?
- 9.) How can microscopy help forensic science?

Make sure you also download the file, "Chapter 1 Lesson 2- Discovery of Cells and Microscopes" and complete the lesson objectives and vocabulary! Expect to turn these assignments in on the second day in class!



Chapter 1: Introduction to Biology

Lesson 2: Discovery of Cells and Microscopes



What is this incredible object? Would it surprise you to learn that it is a human cell? The image represents a cell, similar to one that may be produced by a type of modern microscope called an electron microscope. Without this technology, we wouldn't be able to see the structures inside cells.

Lesson Objectives

- State the cell theory, and list the discoveries that led to it.
- Be able to identify the parts of a compound light microscope.
- Explain the differences between a SEM (Scanning Electron Microscope) and a TEM (Transmission Electron Microscope).

Vocabulary

- cell
- cell theory
- compound light microscope
- scanning electron microscope (SEM)
- transmission electron microscope (TEM)

INTRODUCTION

If you look at living matter with a microscope—even a simple light microscope—you will see that it consists of cells. Cells are the basic units of the structure and function of living things. They are the smallest units that can carry out the processes of life.

DISCOVERY OF CELLS

The first time the word *cell* was used to refer to these tiny units of life was in 1665 by a British scientist named Robert Hooke. Hooke was one of the earliest scientists to study living things under a microscope. The microscopes of his day were not very strong, but Hooke was still able to make an important discovery. When he looked at a thin slice of cork under his microscope, he was surprised to see what looked like a honeycomb. Hooke made the drawing in **Figure 1.13** on the next page to show what he saw. As you can see, the cork was made up of many tiny units, which Hooke called cells.



Figure 1.13: Cork Cells. This is what Robert Hooke saw when he looked at a thin slice of cork under his microscope. What type of material is cork? Do you know where cork comes from?

Leeuwenhoek's Discoveries

Soon after Robert Hooke discovered cells in cork, Anton van Leeuwenhoek in Holland made other important discoveries using a microscope. Leeuwenhoek made his own microscope lenses, and he was so good at it that his microscope was more powerful than other microscopes of his day. In fact, Leeuwenhoek's microscope was almost as strong as modern light microscopes. Using his microscope, Leeuwenhoek discovered tiny animals such as rotifers. The magnified image of a rotifer in **Figure 1.14** is similar to what Leeuwenhoek observed. Leeuwenhoek also discovered human blood cells. He even scraped plaque from his own teeth and observed it under the microscope. What do you think Leeuwenhoek saw in the plaque? He saw tiny living things with a single cell that he named *animalcules* ("tiny animals"). Today, we call Leeuwenhoek's animalcules bacteria.



Figure 1.14: Microscopic Rotifer. Rotifers like this one were first observed by Aton van Leeuwenhoek. This tiny animal is too small to be seen without a microscope.

THE CELL THEORY

By the early 1800s, scientists had observed the cells of many different organisms. These observations led two German scientists, named Theodor Schwann and Matthias Jakob Schleiden, to propose that cells are the basic building blocks of all living things. Around 1850, a German doctor named Rudolf Virchow was studying cells under a microscope when he happened to see them dividing and forming new cells. He realized that living cells produce new cells through division. Based on this realization, Virchow proposed that living cells arise only from other living cells. The ideas of all three

scientists—Schwann, Schleiden, and Virchow—led to the cell theory, which is one of the fundamental theories of biology.

The cell theory states that:

- All organisms are made of one or more cells.
- All the life functions of organisms occur within cells.
- All cells come from already existing cells.

MICROSCOPES

Starting with Robert Hooke in the 1600s, the microscope opened up an amazing new world—the world of life at the level of the cell. As microscopes continued to improve, more discoveries were made about the cells of living things. However, by the late 1800s, light microscopes had reached their limit. Objects much smaller than cells, including the structures inside cells, were too small to be seen with even the strongest light microscope. Then, in the 1950s, a new type of microscope was invented. Called the electron microscope, it used a beam of electrons instead of light to observe extremely small objects. With an electron microscope, scientists could finally see the tiny structures inside cells. In fact, they could even see individual molecules and atoms. The electron microscope had a huge impact on biology. It allowed scientists to study organisms at the level of their molecules and led to the emergence of the field of molecular biology. With the electron microscope, many more cell discoveries were made. Figure 1.15 shows how the cell structures called organelles appear when scanned by an electron microscope.

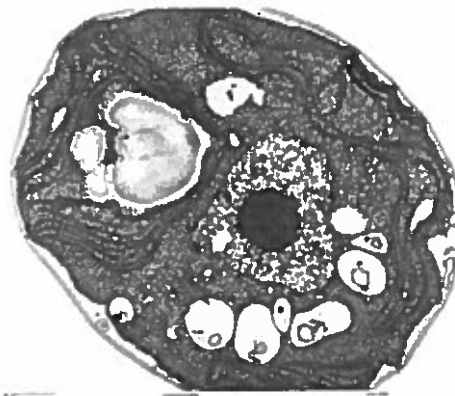


Figure 1.15: Electron Microscope Image of Organelles. An electron microscope produced this image of a cell.

Compound Light Microscopes

The microscope pictured on the next page Figure 1.16, is referred to as a compound light microscope. The term *light* refers to the method by which light transmits the image to your eye. *Compound* deals with the microscope having more than one lens. *Microscope* is the combination of two words; "micro" meaning small and "scope" meaning view. Can you label the parts numbered 1-14 in the picture of the compound light microscope on the next page?

Early microscopes, like Leeuwenhoek's, were called simple because they only had one lens. Simple scopes work like magnifying glasses that you have seen and/or used. These early microscopes had limitations to the amount of magnification no matter how they were constructed.

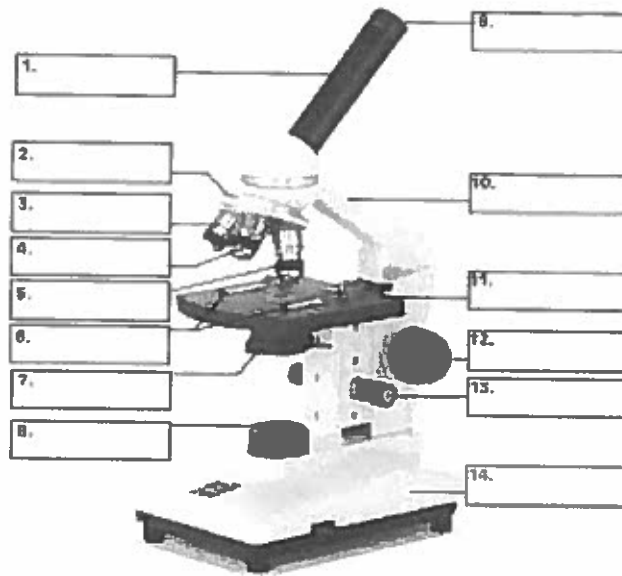


Figure 1.16: Compound Light Microscope: Can you label parts 1-14?

The creation of the compound microscope by the Janssens helped to advance the field of microbiology light years ahead of where it had been only just a few years earlier. The Janssens added a second lens to magnify the image of the primary (or first) lens.

Simple light microscopes of the past could magnify an object to 266X as in the case of Leeuwenhoek's microscope. Modern compound light microscopes, under optimal conditions, can magnify an object from 1000X to 2000X (times) the specimens original diameter.

The World's Most Powerful Microscopes

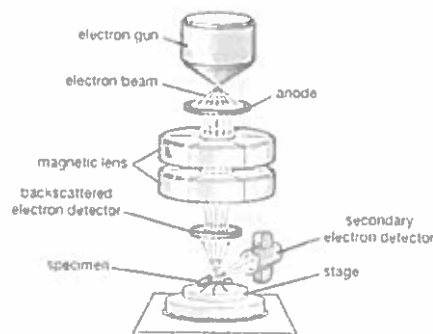
Scanning Electron Microscope

The SEM (Scanning Electron Microscope, Figure 1.17) is an instrument that produces a largely magnified image by using electrons instead of light to form an image. A beam of electrons is produced at the top of the microscope by an electron gun. The electron beam follows a vertical path through the microscope, which is held within a vacuum. The beam travels through electromagnetic fields and lenses, which focus the beam down toward the sample. Once the beam hits the sample, electrons and X-rays are ejected from the sample.

Detectors collect these X-rays, backscattered electrons, and secondary electrons and convert them into a signal that is sent to a screen similar to a television screen. This produces the final image in 3-D. See colored 3-D pictures of sperm and eggs produced by a SEM in Figure 1.18 on the next page.



Figure 1.17 SEM (Scanning Electron Microscope)



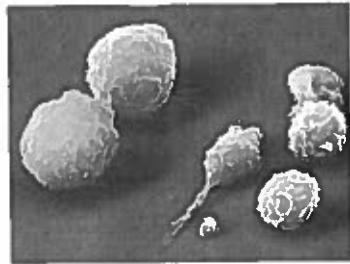


Figure 1.18: 3-D colored images of human eggs and sperm produced by a SEM.

Transmission Electron Microscope

TEM (Transmission electron microscope, see Figure 1.19) is a microscopy technique whereby a beam of electrons is transmitted through an ultra-thin specimen, interacting with the specimen as it passes through. An image is formed from the interaction of the electrons transmitted through the specimen; the image is magnified and focused onto an imaging device, such as a fluorescent screen, producing a one dimensional image. See the one dimensional pictures of mycobacteria produced by a TEM in Figure 1.20 below.

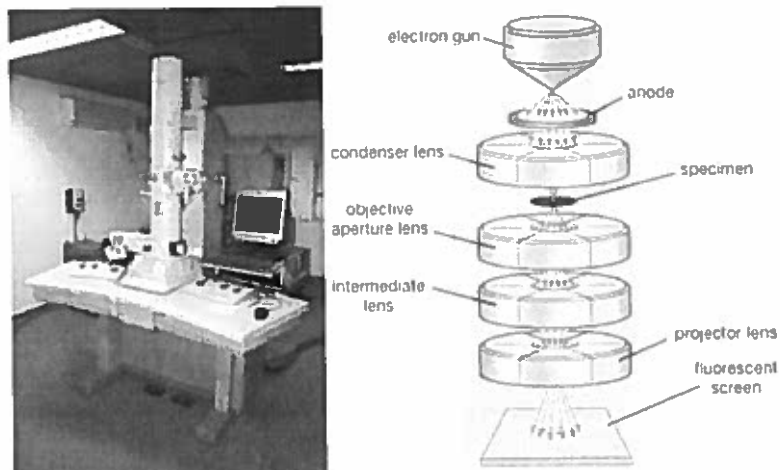


Figure 1.19 TEM (Transmission Electron Microscope)

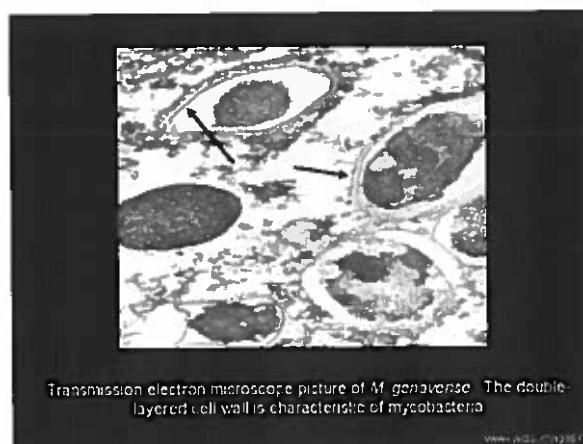



Figure 1.20 TEM one dimensional images of mycobacteria (pathogens serious diseases like tuberculosis and leprosy in mammals).

New Horizons for Electron Microscopy

 Lawrence Berkeley National labs use a \$27 million electron microscope to make images to a resolution of half the width of a hydrogen atom. This makes it the world's most powerful microscope. See <http://www.kqed.org/quest/television/the-worlds-most-powerful-microscope> for more information.

Lesson Summary

- Discoveries about cells using the microscope led to the development of the cell theory. This theory states that all organisms are made of one or more cells, all the life functions of organisms occur within cells, and all cells come from already existing cells.
- Electron microscopes can produce highly magnified one dimensional and 3-D image of specimens.

References/ Multimedia Resources

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"QUEST." *QUEST RSS*. N.p., n.d. Web. Summer 2013.

< <http://www.kqed.org/quest/television/the-worlds-most-powerful-microscope> >

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