5.2: Discovery of Cells and Cell Theory

A Big Blue Cell

What is this incredible object? Would it surprise you to learn that it is a human cell? The cell is actually too small to see with the unaided eye. It is visible here in such detail because it is being viewed with a very powerful microscope. Cells may be small in size, but they are extremely important for life. Like all other living things, you are made of cells. Cells are the basis of life, and without cells, life as we know it would not exist. You will learn more about these amazing building blocks of life when you read this section.

If you look at a 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. All organisms are made up of one or more cells, and all cells have many of the same structures and

Figure \ref{PageIndex1}: (Public Domain; NIAID/NIH via Wikimedia Commons)

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carry out the same basic life processes. Knowing the structure of cells and the processes they carry out is necessary to understanding life itself.

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 the figure below to show what he saw. As you can see, the cork was made up of many tiny units, which Hooke called cells.

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 was the first person to observe human cells and bacteria.

Figure 1: Robert Hooke sketched these cork cells as they appeared under a simple light microscope. (Public domain; Robert Hooke via Wikimedia Commons)

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 cell theory, which is one of the fundamental theories unifying all of biology. 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.

Seeing Inside Cells

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 cell biology. With the electron microscope, many more cell discoveries were made. The figure below shows how the cell structures called organelles appear when scanned by an electron microscope.

Figure \(\PageIndex{3}\): An electron microscope produced this image of the structures inside a cell. (Public Domain; Dartmouth College via [Wikimedia.org](https://commons.wikimedia.org/wiki/File:Structure_of_cell.jpg))
Structures Shared By All Cells

Although cells are diverse, all cells have certain parts in common. These parts include a plasma membrane, cytoplasm, ribosomes, and DNA.

1. The **plasma membrane** (also called the cell membrane) is a thin coat of phospholipids that surrounds a cell. It forms the physical boundary between the cell and its environment, so you can think of it as the “skin” of the cell.
2. **Cytoplasm** refers to all of the cellular material inside the plasma membrane. The Cytoplasm is made up of a watery substance called cytosol and contains other cell structures such as ribosomes.
3. **Ribosomes** are structures in the cytoplasm where proteins are made.
4. **DNA** is a nucleic acid found in cells. It contains the genetic instructions that cells need to make proteins.

These parts are common to all cells, from organisms as different as bacteria and human beings. How did all known organisms come to have such similar cells? The similarities show that all life on Earth has a common evolutionary history.

Summary

- Cells are the basic units of structure and function of living things. They are the smallest units that can carry out the processes of life.
- The first cells from an organism (cork) were observed by Hooke in the 1600s. Soon after, microscopist van Leeuwenhoek observed many other living cells.
- In the early 1800s, Schwann and Schleiden theorized that cells are the basic building blocks of all living things. Around 1850, Virchow saw cells dividing and added that living cells arise only from other living cells. These ideas led to cell theory, which states that all organisms are made of cells, all life functions occur in cells, and all cells come from other cells.
- It wasn't until the 1950s that scientists could see what was inside the cell. The invention of the electron microscope allowed them to see organelles and other structures smaller than cells.
- There is variation in cells, but all cells have a plasma membrane, cytoplasm, ribosomes, and DNA. These similarities show that all life on Earth has a common ancestor in the distant past.

Review

1. Describe cells.
2. Explain how cells were discovered.
3. Outline how cell theory developed.
4. Identify structures shared by all cells.
5. *True or False.* Cork is not a living organism.
6. *True or False.* Some organisms are made of only one cell.
7. *True or False.* Ribosomes are found outside of the cytoplasm of a cell.
8. Proteins are made on _____________.
9. What are the differences between a light microscope and an electron microscope?
10. The first microscopes were made around
   A. 1965
   B. 1665
   C. 1950
   D. 1776

11. Which of these scientists made each of the following discoveries?
   Anton van Leeuwenhoek; Robert Hooke; Rudolf Virchow
   a. Observed some of the first cells and first used the term “cell”
   b. Observed the first human cells
   c. Observed cells dividing

12. Robert Hooke sketched what looked like honeycombs, or repeated circular or square units, when he observed plant cells under a microscope.
   a. What is each unit?
   b. Of the shared parts of all cells, what makes up the outer surface of each unit?
   c. Of the shared parts of all cells, what makes up the inside of each unit?

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To learn more about cell theory, and its history, watch the video below.
Watch the video below for an introduction to cells. This video shows animations and microscopic footage of many different types of cells.
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