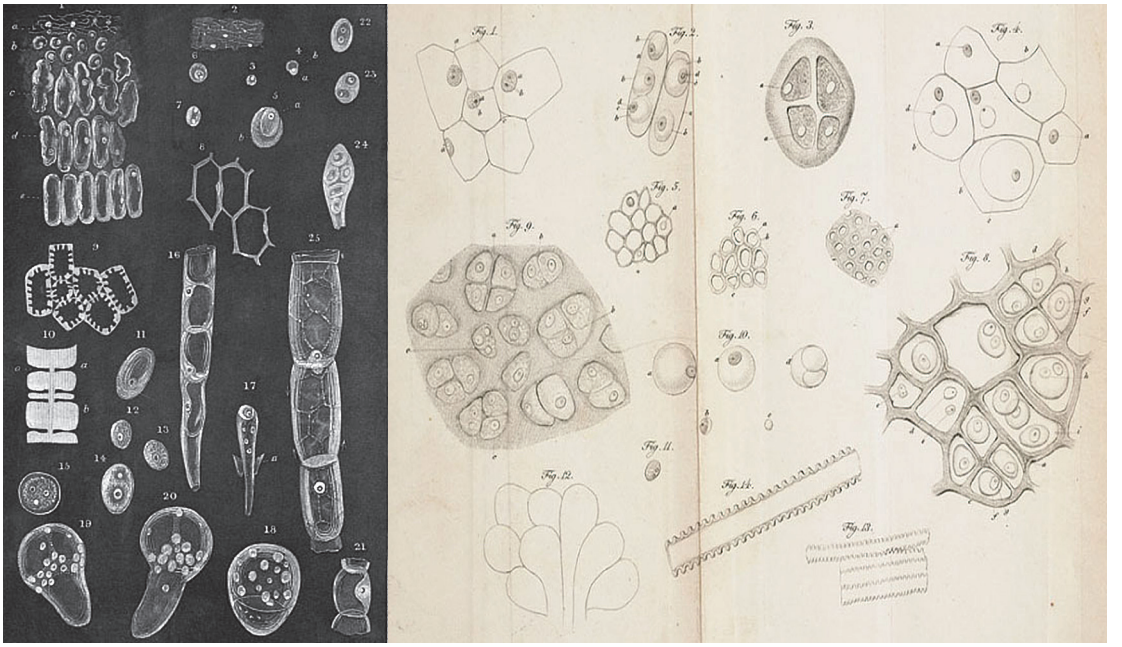
THE CELL THEORY



The findings of different scientists who independently studied various organisms proved the presence of cells in all living things. These fundamental elements that make up the organisms were eventually found to be functional components involved in the production of more units of the same kind. The illustrations above drawn by Matthias Jacob Schleiden and Theodor Schwann in the early 1800s show various kinds of cells from plants and animals.

In this unit, you will learn about the discovery of the cell and the postulates of the cell theory.

THE CELL AND THE ANIMALCULES

Before the development of magnifying tools, people believed that organisms were intact and could not be divided into smaller constituents. With the invention of microscope, tiny organisms that could not be seen by the naked eye became visible.

In 1665, English physicist Robert Hooke (1635–1703) published *Micrographia*, a significant book that showed various microscopic observations. Hooke used the term "cell" for the first time to refer to the tiny units that he observed on a slice of cork (fig. 1.1), associating these with cells (Latin *cella*) or small rooms in a monastery. However, what he actually saw were not living cells but dead cells without any noticeable organelles. In examining the specimen, Hooke used a compound microscope (fig. 1.2) with three glass lenses (ocular, objective, and tube), a base, and a lighting system. Hooke's microscope had a total magnification of about 300 times.

Robert Hooke

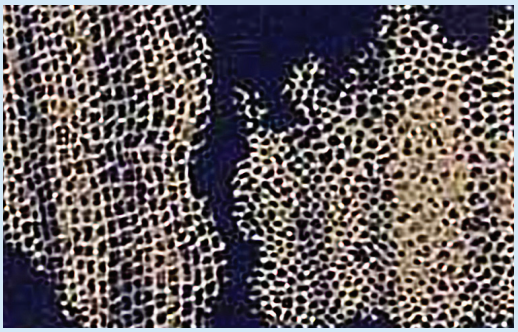


Fig. 1.1 Hooke discovered empty spaces in a thin cutting of cork and called them cells.

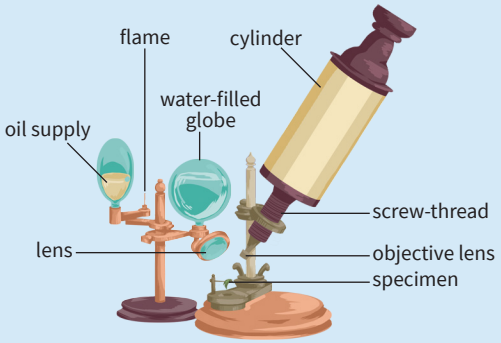


Fig. 1.2 Hooke's microscope (circa 1670) was designed by the scientist and built by a London instrument maker.

Another notable contributor to microscopy and the concept of cells in organisms is Dutch draper, tradesman, and masterful lens maker Anton van Leeuwenhoek (1632–1723). He used his own handheld microscope (fig. 1.3) by placing a specimen on the sharp point in front of the lens, turning the screws to adjust focus, and carefully observing the features of the specimen.

In 1674, while using a simple handheld microscope with a magnification of 270 times, Leeuwenhoek was able to see motile organisms, which he called *animalcules*. The term referred to organisms that were eventually known as *protozoa*. In 1676, he wrote a letter to the Royal Society of London, a group of scientists, described these moving organisms, and concluded that these organisms were living.

Leeuwenhoek was the first person to observe and describe clearly the red blood cells and sperm cells, the structure of plants, the compound eyes of insects, the bacteria, and the life cycles of fleas, aphids, and ants. Figure 1.4 presents some of his drawings.

He was also the first to describe the nucleus, a part that was present in almost all the specimens he examined.

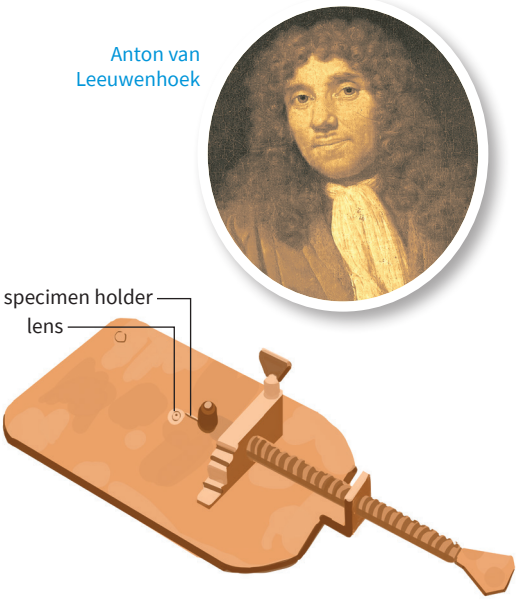


Fig. 1.3 Anton van Leeuwenhoek's microscope (circa late 1600s) was a simple device that used only one lens.

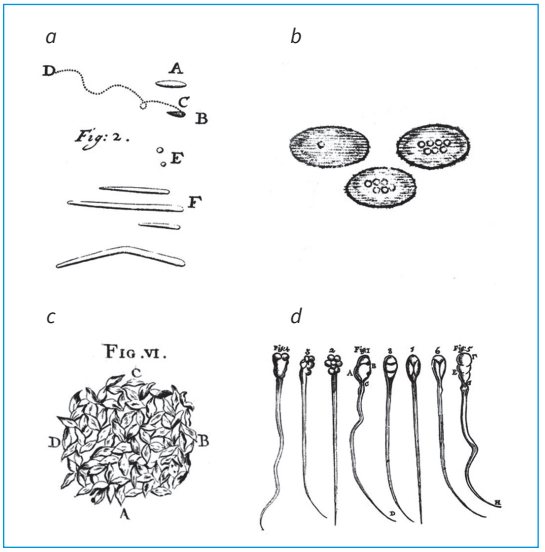


Fig. 1.4 Leeuwenhoek's drawings of his microscopic observations: (*a*) animalcules from his teeth, (*b*) red blood cells from fish, (*c*) dry epithelial cells from his callus, and (*d*) sperm cells from animals.

When Leeuwenhoek submitted a report of his numerous findings to the Royal Society of London, Hooke—who was asked to confirm these findings—was able to observe the specimens. Hooke reported that the simple microscope that was used to examine the specimens was better in providing high resolution images than the compound microscope that he used.

THE CELL THEORY BY SCHLEIDEN, SCHWANN, AND VIRCHOW

Because of the significance of the works of Hooke and Leeuwenhoek, the scientific community recognized them as the discoverers of the cell. However, the truth about the importance of cells in the organization of life was unknown that time. It took about 200 years before a theory about the cell was presented, as proposed by three German scientists, namely, Matthias Jacob Schleiden (1804–1881), Theodor Schwann (1810–1882), and Rudolf Virchow (1821–1902).

Matthias Jacob Schleiden

Theodor Schwann

Rudolf Virchow

Schleiden (a botanist) and Schwann (a physiologist) worked separately using different specimens. Nonetheless, they came up with similar generalizations about the cell and formulated what would become known as the *Cell Theory*. Schleiden and Schwann both studied the microscopic structures of their specimens—plants and animals, respectively—and published their observations a year apart with the same conclusion that "all living things are composed of cells and cell products."

Virchow, a German physiologist, physician, pathologist, and anthropologist, later joined Schleiden and Schwann as proponent of the Cell Theory because of his idea about the origin of new cells. He became famous for the statement "*Omnis cellula e cellula*." It translates to "All cells develop only from pre-existing cells." His concept was inspired by the description of the nucleus of English botanist Robert Brown and the observations on cell division of Swiss botanist Karl Wilhelm von Nägeli.

Despite the controversy about the originality of the mentioned aphorism about the origin of cells, it was Virchow who made the statement famous in support of his concept of cellular reproduction. This concept contributed to the demise of the *Theory of Spontaneous Generation*, which states that living things could arise from nonliving things, for example, maggots can come from dead meat.

The Cell Theory is considered a unifying principle in biology. The following are its postulates:

1. ***All living things are made of cells.*** Whether simple or complex, all living things consist of cells. A simple organism that has a single cell is called a *unicellular organism*. This organism is invisible to an unaided eye and can only be observed under a microscope. Even if a unicellular organism is microscopic, it has all the necessary parts and organelles with specific functions for the cell's survival and reproduction. Bacteria and some fungi are examples of unicellular organisms.

On the other hand, a complex multicellular organism consists of many different kinds of cells that have specialized structures and functions. These cells coordinate and work interdependently with one another for the efficient existence of the organism. For example, the human body contains approximately 30 trillion cells of about 200 different types of epithelial, blood, and muscle cells that work together for the proper functioning of the body.

2. ***The cell is the basic functional unit of all living things.*** In a cell, there are processes that are responsible for keeping the organism alive. A cell is life in miniature, that is, there are characteristics of life that can be observed in it, like respiration, reproduction, and movement. There are organelles with specialized functions that contribute to the overall health of the cell, such that if there are changes in them, the life of the organism, whether unicellular or multicellular, may be compromised.

3. ***Cells only come from pre-existing cells.*** New cells cannot be produced from raw materials like proteins and isolated organelles. There has to be a cell from which new cells will arise. It is referred to as the "mother cell" that divides to form daughter cells. These daughter cells then become mother cells that divide further to produce new daughter cells, and so on. A more thorough discussion on cell division will be provided in the next chapter.

DID YOU KNOW?

Some discoveries may have influenced Schleiden, Schwann, and Virchow in formulating the Cell Theory.

A number of scientists independently studied and observed several parts or processes inside the cell. In 1812, German botanist Johann Jacob Paul Moldenhawer (1766–1827) identified the parenchymatous (thin-walled) cells. French botanist Henri Dutrochet (1776–1847) argued in 1824 that animals and plants had similar cellular structures.

With orchids as specimen, Robert Brown (1773–1858) discovered the cell nucleus in 1833. In 1855, Polish physician-biologist Robert Remak (1815–1865) observed that cells come from pre-existing cells through a division process.

CHECK YOUR UNDERSTANDING

Do the following. You may provide properly labeled drawings to support your explanations.

1. Explain the similarities and differences in the microscopes used by Hooke and van Leeuwenhoek, and their subsequent findings.
2. Explain the postulates of the Cell Theory to a seven year-old child who is interested in your school lesson about the cell.

ENRICH YOUR LEARNING

Leeuwenhoek was fascinated by the animalcules that he observed in his pond water sample. His excellent drawings attest to the treasure that he found from the liquid and other kinds of samples he used. This is your opportunity to reproduce Leeuwenhoek's work and observations. However, you will use a compound microscope instead of a simple microscope. Do this activity following the given procedure.

MATERIALS

- water sample from a pond
- gloves
- sticks
- small jars
- marker or pen
- pipette or dropper
- slides for microscope
- cotton
- cover slip
- microscope
- notebook

PROCEDURE

1. Collect a small amount of water from a pond or from stagnant water in a pail or pot. Be sure to wear hand gloves to protect your hands and to use sticks to agitate the water. Dip a small jar to obtain a sample a few inches from the surface of the pond.
2. Get other samples from areas around the weeds and algae, and near the mud. Include weeds or algae, and, if possible, small amount of mud from the bottom.
3. Label the jars properly with the place and date of collection.
4. Using a pipette or dropper, draw a small amount of water from the pond or from the stagnant water sample. Place one or two drops onto a slide and put some strands of cotton to help restrain the movement of animalcules. Place a cover slip over the sample.