Robert Hooke One of the first people to observe cells was the English scientist and inventor Robert Hooke. Hooke built his own compound microscope, which was one of the best microscopes of his time. In 1663, Hooke used his microscope to observe the structure of a thin slice of cork. Cork, the bark of the cork oak tree, is made up of cells that are no longer alive. To Hooke, the empty spaces in the cork looked like tiny rectangular rooms. Therefore, Hooke called the empty spaces *cells*, which is a word meaning "small rooms."

Hooke described his observations this way: "These pores, or cells, were not very deep, but consisted of a great many little boxes. . . ." What most amazed Hooke was how many cells the cork contained. He calculated that in a cubic inch there were about twelve hundred million cells—a number he described as "almost incredible."

• Tech & Design in History •

The Microscope: Improvements Over Time

The microscope made the discovery of cells possible. Microscopes have improved in many ways over the last 400 years.

1674 Leeuwenhoek's Simple Microscope
Although Anton van Leeuwenhoek's simple microscope used only one tiny lens, it could magnify a specimen up to 266 times.

1590 First Compound Microscope
Dutch eyeglass makers Zacharias and Hans Janssen made one of the first compound microscopes. It was a tube with a lens at each end.

1660 Hooke's Compound Microscope
Robert Hooke's compound microscope included an oil lamp for lighting. A lens focuses light from the flame onto the specimen.

1500 1600 1700

nton van Leeuwenhoek At about the same time that obert Hooke made his discovery, Anton van Leeuwenhoek AY vun hook) also began to observe tiny objects with micro-opes. Leeuwenhoek was a Dutch businessman who sold oth. In his spare time, he built simple microscopes.

Leeuwenhoek looked at drops of lake water, scrapings from eth and gums, and water from rain gutters. In many materi-s, Leeuwenhoek was surprised to find a variety of one-celled ganisms. Leeuwenhoek noted that many of these tiny organ-ms moved. Some whirled, some hopped, and some shot rough water like fast fish. He called these moving organisms *imalcules* (an ih MAL kyoolz), meaning "little animals."

Reading Checkpoint **Which type of microscope—simple or compound—did Leeuwenhoek make and use?**

Writing in Science

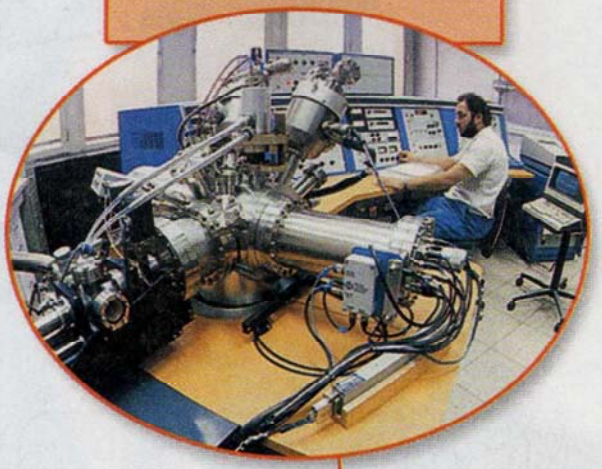
Research and Write Find out more about one of the microscopes. Then write an advertisement for it that might appear in a popular science magazine. Be creative. Emphasize the microscope's usefulness or describe the wonders that can be seen with it.

86
odern Compound ght Microscope
rman scientists Ernst bé and Carl Zeiss de a compound ht microscope with mplex lenses that eatly improved the age. A mirror focuses nt up through the ecimen. Modern mpound microscopes effectively magnify pecimen up to 1,000 es.

1965 Scanning Electron Microscope (SEM)
An SEM sends electrons over the surface of a specimen, rather than through it. The result is a three-dimensional image of the specimen's surface. SEMs can magnify a specimen up to 150,000 times.

1933 Transmission Electron Microscope (TEM)
German physicist Ernst Ruska created the first electron microscope. TEMs send electrons through a very thinly sliced specimen. TEMs can magnify a specimen up to 500,000 times.

1981 Scanning Tunneling Microscope (STM)
An STM measures electrons that leak, or "tunnel," from the surface of a specimen. STMs can magnify a specimen up to 1,000,000 times.



1800 1900 2000

Animal Cells

Development of the Cell Theory

Leeuwenhoek's exciting discoveries caught the attenti
other researchers. Like Hooke, Leeuwenhoek, and all
scientists, these other researchers were curious about the
around them, including things they couldn't normall
Many other people began to use microscopes to discover
secrets they could learn about cells.

Schleiden, Schwann, and Virchow Three German
tists made especially important contributions to pe
knowledge about cells. These scientists were Matthias Schl
(SHLY dun), Theodor Schwann, and Rudolf Virchow (FUR
In 1838, Schleiden concluded that all plants are made of
He based this conclusion on his own research and o
research of others before him. The next year, Theodor Sch
concluded that all animals are also made up of cells. Thus,
Schwann, all living things are made up of cells.

Schleiden and Schwann had made an important disc
about living things. However, they didn't explain where
came from. Until their time, most people thought that
things could come from nonliving matter. In 1855, Vir
proposed that new cells are formed only from cells that al
exist. "All cells come from cells," wrote Virchow.

What the Cell Theory Says Schleiden, Schwann, Vir
and others helped develop the cell theory. The **cell theor**
widely accepted explanation of the relationship between
and living things. **The cell theory states the following:**

- **All living things are composed of cells.**
- **Cells are the basic units of structure and functi**
  living things.
- **All cells are produced from other cells.**

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