History of the Microscope

A microscope is a scientific instrument that makes small objects appear larger so they can be seen in more detail. A light microscope makes use of light and lenses to magnify images of objects that cannot be seen with the naked eye. Microscopes have greatly improved our understanding of microbiology, including the role of pathogens in disease. Before the invention of the microscope, it was believed that diseases were caused by evil spirits or bad air called 'miasma'. However, the invention of the microscope enabled the observation of cells and microorganisms to help us better understand mechanisms of disease.

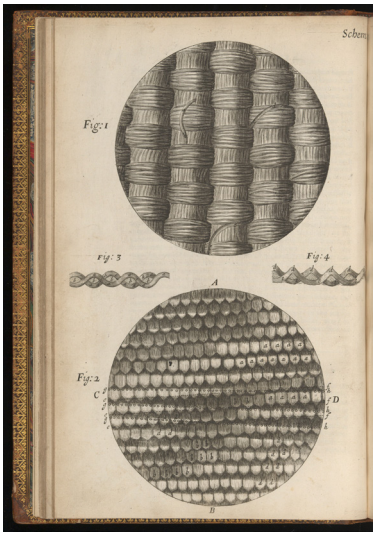
The invention of the microscope spans many centuries. Ancient Egyptians and Romans worked with glass, experimenting with bending light and making objects appear bigger.

However, it was not until 1590 that a device was designed to specifically produce magnified images of objects. This consisted of a sliding tube with different-sized lenses on opposite ends. By sliding the tube in and out, you could focus on an object. Although it is unclear who actually created the first microscope, Dutch lens makers Hans and Zacharias Janssen (who were father and son) and Hans Lippershey have all been credited with the invention.

An early version of the microscope

In 1609, while trying to develop the telescope, Galileo Galilei created one of the first compound microscopes with a convex and a concave lens. This microscope provided a magnification of around ×20-30. The term 'microscope' was coined in 1625 by Giovanni Faber, while referring to Galileo's invention.

Robert Hooke, a 17th-century scientist, used a simple microscope illuminated by an oil lamp to view tiny organisms and objects. These included the hairs on a flea and the pores within cork. He referred to the pores as 'cells' because they reminded him of the rooms in monasteries, which were also called cells. From this, cell theory began to develop. In 1665, Hooke published the book 'Micrographia', which detailed some of these observations. By the late 17th century, it was discovered that images of objects could be further magnified by using different-shaped lenses that were ground and polished. It was this discovery that led Dutch microbiologist Antonie van Leeuwenhoek to view tiny organisms suspended in water, which he called 'animalcules' (little animals). He was also the first to observe bacteria and protozoa.



Engraving from 'Micrographia' by Robert Hooke

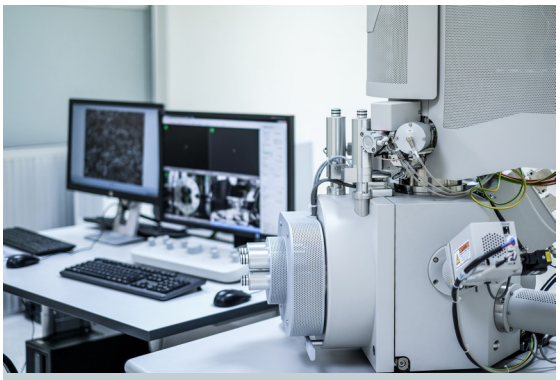
In 1729, Chester Moor Hall made further developments in microscope technology when he created the achromatic lens, which is made by combining two different types of lenses with different focal powers. The lenses are combined in such a way that the image formed does not have an aberration (blurriness). By 1826, Joseph Jackson Lister had used this lens to improve microscope design. Previously, microscopes were not precise instruments – light was often refracted when passing through lenses, altering the image of the object being observed. The achromatic lens improved the visual acuteness of the microscope.

A 19th-century microscope featuring an achromatic lens

The late 18th and 19th centuries saw improvements in microscope mechanics such as design and quality. Microscopes became smaller and more stable, and further lens developments solved many optical problems of their predecessors. Many people around the world worked on similar microscope issues and concurrently developed solutions to these problems.

In 1931, the first electron microscope was developed by Max Knoll and Ernst Ruska. This used electrons instead of light to view images of objects and was capable of achieving higher magnifications and producing higher-resolution images compared to light microscopes. Modern electron microscopes can view objects as small as the diameter of an atom.

There are two main types of electron microscope. A scanning electron microscope (SEM) scans the surface of an object using a beam of electrons. SEMs have magnifications of around ×30 000 and a resolving power of 1-50 nm. In comparison, transmission electron microscopes (TEMs) have a maximum magnification of around ×1 000 000 and a resolution of less than 1 nm. A TEM uses a beam of electrons to examine thin slices or sections of cells or tissues.



A scanning electron microscope

Improvements continue to be made to microscope technology. The early 1930s saw the development of phase-contrast microscopy by Dutch physicist Frits Zernicke. This technique allows the viewing of transparent samples without the need for staining, which means it can be used to observe live cells. In 1952, Polish physicist Georges Nomarski developed differential interference contrast (DIC) microscopy to enhance the contrast in unstained, transparent samples, allowing otherwise invisible cell structures to be observed. Fluorescent chemicals that could be used to stain samples were developed in the 1970s, making it easier to detect and identify biological structures. More recently, in 2010, researchers were able to view the atoms of a virus using a cryo-electron microscope.

History of the Microscope

1. State the purpose of a microscope.

2. Briefly describe how a light microscope works.

3. People used to believe that illness was caused by evil spirits and 'miasma'.
   Explain how the development of the microscope has contributed to our understanding of disease.

4. Outline the contribution of Hans and Zacharias Janssen and Hans Lippershey to the development of the microscope.

5. Name the scientists who coined the following terms:

   microscope _____

   cell _____

   animalcule _____

6. Compare the two types of electron microscope.

BEYOND SCIENCE

7. Complete the timeline to summarise the development of the microscope between 1500 and 2020.

1 cm = 20 years

History of the Microscope **Answers**

1. State the purpose of a microscope.

   A microscope makes small objects appear larger so they can be seen in more detail.

2. Briefly describe how a light microscope works.

   A light microscope uses light and a series of glass lenses to produce a magnified image of the object being viewed.

3. People used to believe that illness was caused by evil spirits and 'miasma'.

   Explain how the development of the microscope has contributed to our understanding of disease.

   Microscopes have allowed scientists to view microorganisms such as bacteria and fungi, as well as the structure of cells.

4. Outline the contribution of Hans and Zacharias Janssen and Hans Lippershey to the development of the microscope.

   These Dutch lens makers have been credited as being the first to develop an early version of the microscope. This consisted of a sliding tube with different sized lenses in opposite ends. By sliding the tube in and out, you could focus on an object.

5. Name the scientists who coined the following terms:

   microscope **Giovanni Faber**

   cell **Robert Hooke**

   animalcule **Antonie van Leeuwenhoek**

6. Compare the two types of electron microscope.

   - **A scanning electron microscope (SEM) scans the surface of an object using a beam of electrons, whereas a transmission electron microscope (TEM) uses a beam of electrons to examine thin slices or sections of cells or tissues.**
   - **SEMs have magnifications of around ×30 000 and a resolving power of 1-50 nm, while TEMs have a maximum magnification of around ×1 000 000 and a resolution of less than 1 nm.**

7. Complete the timeline to summarise the development of the microscope between 1500 and 2020.

   Students may include various dates and information from the text to complete their timeline.