Microscopes: Then & Now

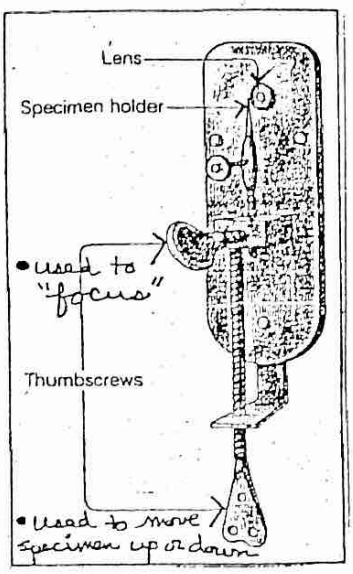
Anton van Leeuwenhoek (1632-1723)

One of the first people to study living things under a "microscope" was a Dutchman, Anton van Leeuwenhoek. Leeuwenhoek"s hobby was grinding glass into small lenses. He was a genius when it came to making lenses, although he earned his living as a caretaker and a "handy-man" at the Town Hall.

LEEUWENHOEK'S "TOY": What made Anton van Leeuwenhoek different from other men who experimented with magnifying lenses was the use to which he put these "toys"—as they were called in his day. His discoveries startled the scientific world and led others to use the microscope which became, perhaps, the most valuable instrument in the entire science of biology.

Anton made more than 200 lenses, and some of these lenses were able to magnify objects as much as 300 times! Using these lenses, he built a "simple microscope".

This is what Leeuwenhoek's "microscope" looked like: →

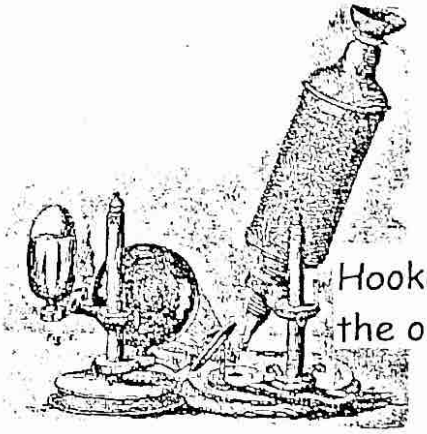


Leeuwenhoek observed many things with his microscope. He made careful records and drawings of everything that he saw through his lenses. He collected and examined rainwater from a large, wooden barrel. He looked at pond water, and he found green, spiral things. Today we know that these were one-celled plants. Swimming among these plants, he found a whole strange "world" of very odd looking tiny creatures. He called them "wee beasties" or "animalcules". Today we know that these were protists like the ameba and paramecium.

He took "scrapings" from his own teeth (as well as from other animals); and drew what he saw. Today we know that he was seeing bacteria! He also looked at his own skin and his own blood.

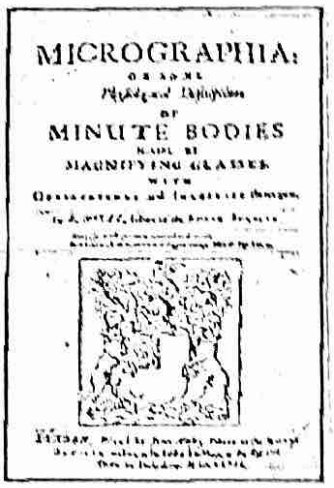
Robert Hooke (1635-1703)

At about the same time as van Leeuwenhoek was working on his hobby, an Englishman, Robert Hooke, was studying plants using a "compound light microscope" that he had designed and developed.



Hooke's microscope looked very different from the one that van Leeuwenhoek was using.

In 1665, he published a book, Micrographia in which he described how to make a microscope like the one he had used.
In the book, there were more than 30 detailed drawings, including the one that he is most famous for, the one from very thin shavings of dry cork. He noticed that the cork (which comes from a layer right below the bark of a tree) was made up of what looked like many little empty boxes, or rooms. He made careful drawings and wrote about these tiny boxes. It was in his description of the cork that he first used the word "cella". This was a Latin word for "little, empty space".



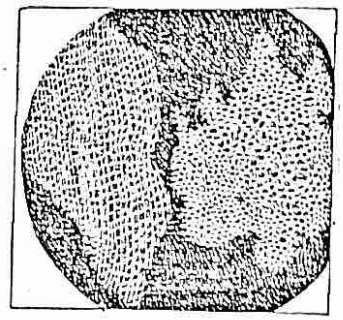
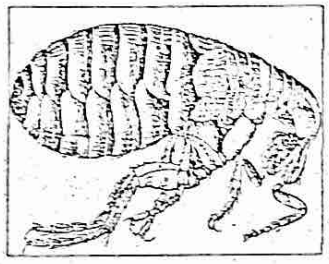


Illustration of cork drawn by Robert Hooke

He had no idea at the time how important his discovery would become! The "cell" wasn't really understood until 1839, when scientists finally began to discover its importance. By this time, of course, Hooke was long dead.

In his book he also had drawings of human hair, and he made a note that some of the hairs were "split at the ends". This is possibly the first notation of "split ends!!"

Another of Hooke's drawings was of a "flea". As it turned out, the flea in his illustration was the carrier of a very nasty bacterial disease that was infecting rats. It was called the "Bubonic Plague", and it was sweeping through Europe at the time. At its worst, it killed over 2,000,000 people a year! However, this was not known by Hooke.



Ceratophyllus faciatus

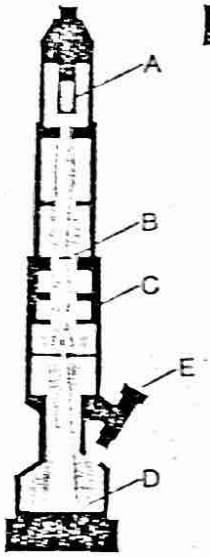
Electron Microscopes

Electron microscopes use a "beam of electrons" instead of rays from "ordinary white light" to magnify very, very small objects. Because of this, they are much more powerful than any optical light microscope.

There are currently 3 main types including TEM (transmission electron microscope) first invented in Germany in 1931, and the SEM (scanning electron microscope)first developed in the late 1960s, and the newest and most powerful, the STM (scanning tunneling electron microscope) first developed in the 1980s.

Ordinary light microscopes can only give clear images of ("to resolve") specimens that are larger than the wavelength of ordinary "white light". To "see" much smaller things, you need to use something with much smaller wavelengths.

"Electrons" have wavelengths that are so small, exceedingly small objects can be seen, even atoms!!



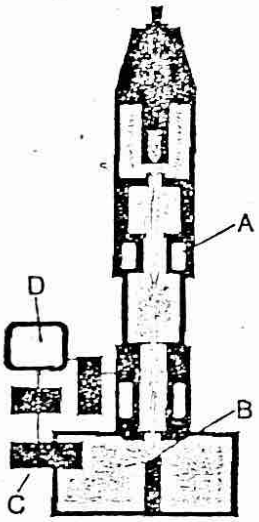
Transmission electron microscope (1931)

First microscope to replace light rays with electron beams, this instrument brought about a quantum leap in the life and physical sciences. Similar in principle to the optical microscope, its lenses are formed by magnetic coils that affect an electron beam in much the same manner as glass lenses affect light. A filament (A) generates a high-voltage electron beam which passes through a series of condensing lenses and then through the specimen (B). From there the electrons are scattered, creating an invisible image that is made visual by a system of magnetic lenses (C) that focus the image onto a fluorescent screen (D), viewed through an eyepiece (E). The TEM shares one property with the optical microscope: The illuminating beam must shine *through* a thin specimen, and the resultant image bears little resemblance to the object's overall appearance.

Paramecium (15,000×)

- Electrons pass through the specimen.
- A flat image is produced.

Scanning electron microscope



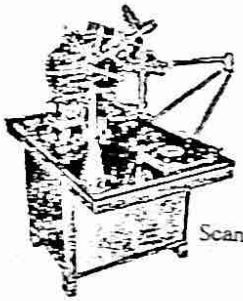
- With the advent of the SEM in the late 1960's, scientists were finally able to view the three-dimensional surface structure of infinitesimal objects. Instead of shining a beam through the specimen, the SEM's condensing lenses (A) form the electrons into an exceedingly fine beam that sweeps across the specimen (B), causing it to release a shower of its own electrons. These in turn are picked up by a signal detector (C) and transmitte onto a cathode-ray viewing screen (D). In this manner the SEM works in principle much the same way as a closed-circuit television system. Though this concept has revolutionized microscopy, it will serve as a complement to, and not a replacement for, conventional transmission instruments.

Paramecium (1,500×)

- Electrons bounce off the surface of the specimen.
- A three-dimensional (3-D) image is produced.

Scanning tunneling electron microscope (STM)

This is an "improved version" of the SEM that was first developed in the 1980's. It can magnify up to 300,000,000x !! It can be used to actually see atoms.



STM

Scanning Tunneling Microscopy