Leeuwenhoek, the Father of Microbiology

Fun with "Animicules"

By Jay Hardy, CLS, SM (NRCM)

Jay Hardy is the founder and president of Hardy Diagnostics. He began his career in microbiology as a Medical Technologist in Santa Barbara, California.

In 1980, he began manufacturing culture media for the local hospitals. Today, Hardy Diagnostics is the third largest culture media manufacturer in the U.S.

To ensure rapid and reliable turn around time, Hardy Diagnostics maintains six distribution centers, and produces over 3,000 products used in clinical and industrial microbiology laboratories throughout the world.

The distinction of being the first human to observe and record the existence of bacteria belongs to the Dutch scientist, Anthonie van Leeuwenhoek (pronounced with much difficulty as "lay-U-wen-hook").

Born to a working class family in Delft, Holland in 1632, Leeuwenhoek was truly a self-made scientist, having never received a degree, attended an institution of higher learning, or learned a foreign language. In fact, he began his working career as a draper (a seller of fabrics). He also dabbled in surveying, wine and beer inspection, and local city government.

However, around 1668, he became involved in a project that would later bring him notoriety as one of the greatest microbiologists of all time. He read the book *Micrographia* by Robert Hook, which described the use of a compound microscope. Hook was the first to name and describe the "cell" as he observed thin layers of cork tissue. Inspired by this discovery, Leeuwenhoek began to hand craft lenses and construct microscopes…many of them. He was known to make over 500 microscopes of which only ten survive to this day.

Leeuwenhoek's microscopes were actually little more than magnifying glasses, although surprisingly powerful. They consisted of only one lens mounted on a tiny hole on a small brass plate. The specimen was mounted on a spiked screw in front of the lens. The entire instrument was only 3-4 inches long, and had to be held up close to the eye. It required good lighting and acute eyesight along with great patience and skill to use.

Amazingly, Leeuwenhoek's single lens microscope was capable of magnifications of 270X and possibly 500X.

Being an astute businessman, Leuwenhoek closely guarded his technique for making lenses. Many believed at the time that he was grinding very small lenses, when in fact his secret technique consisted of placing the middle of a small rod of soda lime glass in a hot flame. He then pulled the hot section apart like taffy to create two long whiskers of glass. Then reinserting the end of one whisker into the flame, he could create a very small, high-quality glass sphere. These spheres became the lenses of his microscopes, with the smallest spheres providing the highest magnifications. This technique, “which I only keep for myself” he wrote, could not be imitated or duplicated for many years. It wasn’t until 1957 that a similar lens was created using the thin glass thread as Leeuwenhoek did in the late 1600’s.

Oddly enough, the compound microscope (using multiple lenses) was invented in 1595, forty years prior to Leuwenhoek’s birth. Even so, Leeuwenhoek’s devices were little more than powerful magnifying glasses, so he cannot be credited with being the “inventor of the microscope” as he so often is. However, because of various technical difficulties in building them, early compound microscopes were not practical for magnifying objects more than about twenty or thirty times natural size.

Leeuwenhoek's skill at crafting lenses, together with his naturally acute eyesight and great care in adjusting the lighting where he worked, enabled him to build microscopes that magnified over 200 times, with clearer and brighter images than any of his colleagues had ever achieved.

Although Robert Hooke’s compound microscope predates Leeuwenhoek’s and would appear to be more sophisticated, it could only achieve magnifications of about 50X, and thus unable to observe bacteria as Leeuwenhoek had.

Robert Hooke was asked by the Royal Society of London to confirm Leeuwenhoek's findings. He successfully did so, thus paving the way for the wide acceptance of Leeuwenhoek's discoveries. Hooke noted that Leeuwenhoek's simple microscopes gave clearer images than his compound microscope, but found the simple microscopes difficult to use: he called them "offensive to my eye" and complained that they "much strained and weakened the sight."

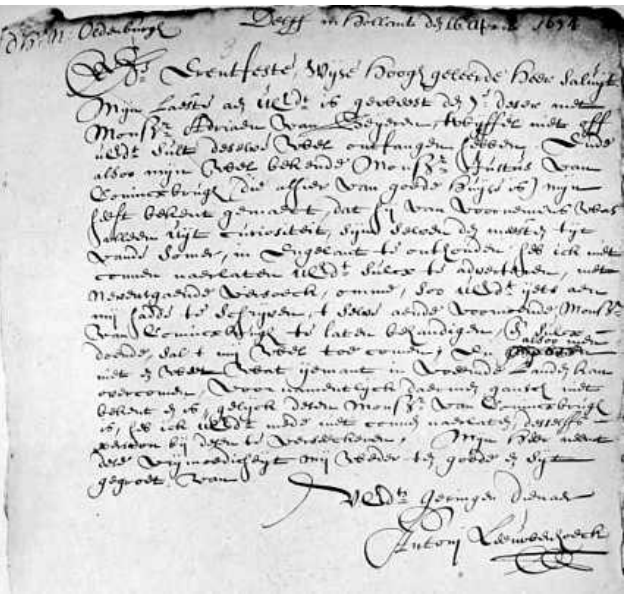
What further distinguished Leeuwenhoek was his curiosity to observe almost anything that could be placed under his lenses, and his care in describing what he saw. Although he himself could not draw well, he hired an illustrator to prepare drawings of the things he saw to accompany his written descriptions. Most of his descriptions of microorganisms are instantly recognizable today.

A view of blood cells as seen through a Leeuwenhoek microscope recreated by Brian Ford. In 1981 Ford discovered some of Leeuwenhoek’s original specimens hidden in envelopes within his letters to the Royal Society of London.

He began his work as a microscopist by examining the stingers and mouth parts from bees. He described his observations in a letter to the newly formed Royal Society of London in 1673. He continued to write these letters describing his work to the Royal Society for the next 50 years. Although he never published a book, he wrote 560 of these letters to the Society, which were translated from Dutch to English. Some of

which were published in the *Philosophical Transactions of the Royal Society*, which provides us with a wonderful record of his amazing discoveries.

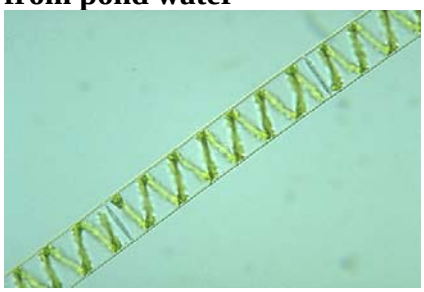
The description of single celled organisms was completely novel, if not revolutionary at the time. His work was received by the Royal Society with much doubt. So much so, that the unbelieving Society sent an agent to Holland to verify Leeuwenhoek's integrity in person.



One of Leeuwenhoek's many letters to the Royal Society of London.

Below is a partial list of what he observed along with his detailed, if not whimsical, descriptions.

Spirogyra and other algae from pond water

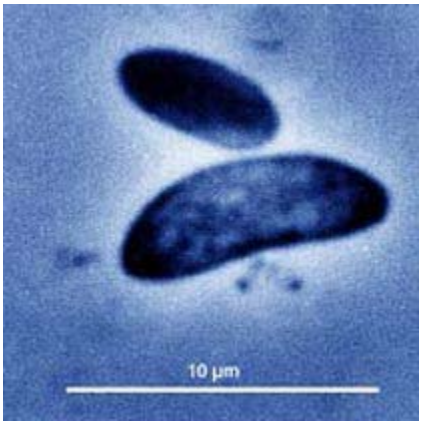


"Spirally wound serpent-wise, and orderly arranged, after the manner of the copper or tin worms, which distillers use to cool their liquors as they distill over. The whole circumference of each of these streaks was about the thickness of a hair of one's head. All consisted of very small green globules joined together: and there were very many small green globules as well"

Vorticella and other ciliates and protozoa

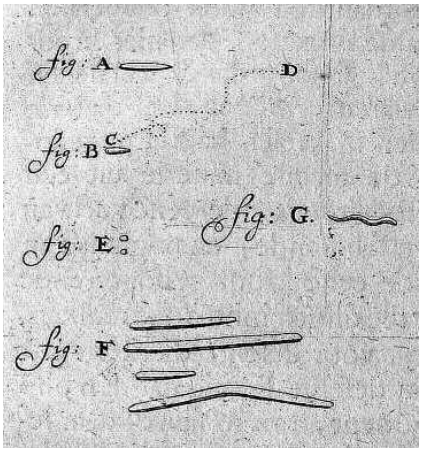
"In structure these little animals were fashioned like a bell, and at the round opening they made such a stir, that the particles in the water thereabout were set in motion thereby. . . And though I must have seen quite 20 of these little animals on their long tails alongside one another very gently moving, with outstretched bodies and straightened-out tails; yet in an instant, as it were, they pulled their bodies and their tails together, and no sooner had they contracted their bodies and tails, than they began to stick their tails out again very leisurely, and stayed thus some time continuing their gentle motion: which sight I found mightily diverting."

Motile Bacteria in plaque from his teeth (Selenomonas?)



"I then most always saw, with great wonder, that in the said matter there were many very little living animalcules, very prettily a-moving. The biggest sort. . . had a very strong and swift motion, and shot through the water (or spittle) like a pike does through the water. The second sort. . . oft-times spun round like a top. . . and these were far more in number." Observing plaque from an older man who never cleaned his teeth, *"an unbelievably great company of living animalcules, a-swimming more nimbly than any I had ever seen up to this*

time. The biggest sort. . . bent their body into curves in going forwards. . . Moreover, the other animalcules were in such enormous numbers, that all the water. . . seemed to be alive."



This represents the first description of bacteria by man.

Sperm cells from insects, dogs, and man

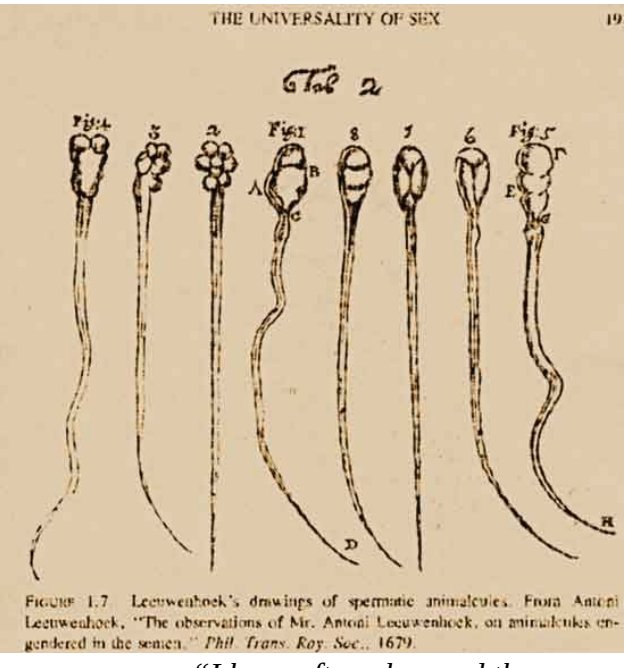
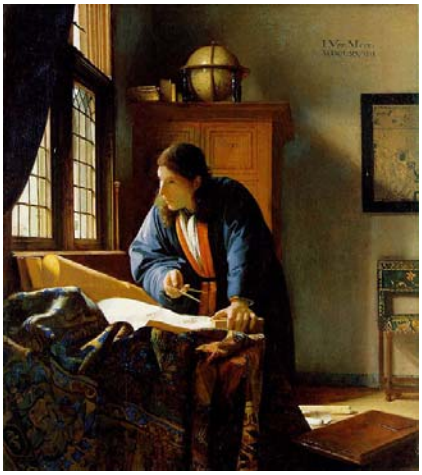


FIGURE 1.7 Leeuwenhoek's drawings of spermatic animalcules. From Antoni Leeuwenhoek, "The observations of Mr. Antoni Leeuwenhoek, on animalcules engendered in the semen." *Phil. Trans. Roy. Soc.*, 1679.

"I have often observed the sperm of a healthy man without waiting for it to become corrupt or fluid/watery, five or six minutes after ejaculation. I have noticed that a large number of small animals, I think it must be more than a thousand, on an area no larger than a grain of sand." He described the semen as "sperm animals", which he considered to be the nucleus of the new individual, while the egg cell was supposed to be just nourishment for the "sperm animal". These descriptions landed Leeuwenhoek in much trouble with the Calvinist church authorities of his day.

Leuwenhoek diligently continued his work by describing blood cells, sperm cells, muscle fibers, rotifers, formanifera, and the circulatory system of eels. All were recorded in great detail in his letters to the Royal Society.

Because Leeuwenhoek was born in the same town and in the same year as the famous Dutch painter Jan Vermeer, it has been thought that the two men were at least acquaintances, if not good friends. Others have surmised even further that Leeuwenhoek, with his superior knowledge of lenses, worked with Vermeer to project optical images to assist in the creation of the Dutch masterpieces of the renaissance, according to the theory of Hockney-Falco. The exact nature of the relationship is not known, however, upon Vermeer's death, Leeuwenhoek was named to be the executor of his will.



One of Vermeer's paintings thought to be of Anthonie Leeuwenhoek, but never verified.

In 1680 he was fully vindicated at last and elected a full member of the Royal Society, joining Robert Hooke, Henry Oldenburg, Robert Boyle, Christopher Wren, and other scientific luminaries of his day - although he never attended a meeting.

At the age of 90, he died in Delft in 1723. Considering the magnitude of his discoveries made during his lifetime, he has well deserved the title of the "Father of Microbiology".

Jay Hardy, CLS, SM (NRCM)
Santa Maria, CA