Leeuwenhoek, whose Invention Led the Way to the Extraordinary Advances to the Fields of Microbiology, Medicine, Agriculture and Industry

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Abstract Leeuwenhoek was born in Delft, Holland. He is commonly known as the father of microbiology and considered the first microbiologist. Raised in Delft, worked as a linen draper in his youth and founded his own shop (1654) and made a name for himself in municipal politics, and eventually developed an interest in lens making. Leeuwenhoek with his simple microscope for which he ground the lenses, achieved magnification of 270 times. Anton van Leeuwenhoek during the last quarter of the seventeenth century with exquisitely polished homemade lenses studied a great variety of natural materials such as pond water, vinegar, and blood. He observed protozoa (microscopic animals) in mixture of pepper and water, and bacteria in scrapings of human teeth. He described discovery of "animalcules", as he called them, raised protozoa, bacteria, blood corpuscles, spermatozoa and the striated fibers found in bundles in voluntary muscles, and many other microscopic creatures and structures. He also had many findings in dentistry. Leeuwenhoek earned for himself a place of honor as a Fellow of the Royal Society in London. For during his lifetime he sent 375 scientific papers to the Royal Society and 27 papers to the French Acade′mie des Sciences. Leeuwenhoek died at the age of 90 and was buried four days later in the Oude Kerk, in Delft. He did not author any books.

Keywords Microbiology, Microscope, Legacy.

One of the two giants of seventeenth-century microscopy*, was Anton van Leeuwenhoek (1632-1723), a self-taught Dutch linen draper who is commonly known and considered to be the first microbiologist. He was an amateur grinder of lenses and a maker of microscopes, through which he discovered and accurately described the protozoa in 1674 and the bacteria in 1676. For his contributions to the sciences of bacteriology and protozoology, Leeuwenhoek has been called the father of microbiology. He was elected a fellow in the Royal Society in London (1680), and reports on 375 of his discoveries appeared in the "Philosophical Transactions" of the society.

Leeuwenhoek , the Dutch ingenious microscopist, by holding up his tiny one-lens simple microscope close to his eye, he observed blood cells, sperm, muscle fibers and single-celled organisms which he called "animalcules". Ordinarily a simple microscope is limited to very low power of magnification by various technical factors, but it is notable that Leeuwenhoek's pioneer observations of yeast cell and other microorganisms were made with simple microscopes[1]. He examined biological materials included studies in anatomy, histology, physiology, embryology, botany, chemistry and physics.

Leeuwenhoek's revealing investigations of corpuscles and capillary circulation are classic. His comparative study of animal spermatozoa and the life history of the ant, and his descriptions of the different structure of the stem in monocotyledonous and dicotyledonous plants are other examples of Leeuwenhoek's versatility as a scientist and of his inter-

* The other gaint of microscopy was Marcello Malpighi (1628-1694), Italian physician, microscopist and founder of histology who studied microanatomy in animals and humans. He also described the tiny blood vessels called capillaries, which link arteries to veins, thereby completing the route for the circulation of the blood that had been suggested by William Harvey (1578-1657), brilliant British physician who discovered the circulation of blood, in 1628.

est in microscopic life. Some of his observations on metamorphosing and developing animals helped to refute the then accepted and widespread belief that some living things evolved from nonliving materials[2].

Leeuwenhoek's great invention reached university medicine in the 1840s, and microscope was central in diagnosing the true causes of death from tissue taken at autopsy. It was also highly useful for studying blood samples taken from the patients to determine if they were anemic and to judge from the size and shape of the red blood cells the kind of anemia. One could also look urine specimens under the microscope for evidence of pus to see if, say, an infection of the urinary tract were causing that deep pelvic pain. Or one could try to find the bacteria of pneumonia, tuberculosis, or bronchitis in sample of sputum. Also a microscope "looked good" in one's office. Daniel Cathell snickered in 1882 of the microscope and similar equipment, « If, at your office and elsewhere, you make up of instruments of precision… they will not only assist you in diagnosis, etc., but will also aid you greatly in curing people by heightening their confidence in you and enlisting their co-operation[3].»

Among his findings of importance to dentistry were the tubules in the dentin and the microorganisms, including bacteria, that he found in the "materia alba" adhering to the teeth. When the president of the Royal Society in London sent him several worms that, he was told, had been taken from a carious tooth, Leeuwenhoek effectively disproved that they were tooth worms by proving microscopically that they were identical to the maggots that infest over ripe cheese. He postulated that the maggots had entered the carious lesion when the owner of the tooth ate the cheese, for, as he said, he had extracted maggots from the damaged teeth of his own wife after she had partaken of infested cheese[4].

The highlights

- The study of organisms and the process which produces fermentation started with the invention of the microscope and the first description with drawings of yeast cells was submitted to the Royal Society in London (1680) by Leeuwenhoek.
- He ground his own lenses and constructed over 200 microscopes in the 17th century.
- Leeuwenhoek was the first to observe bacteria, spermatozoa and protozoa.
- The first protozoan parasite to be observed, "Giardia lamblia", was identified by Leeuwenhoek, who noted it in his stools, in 1681.
- He described the use of the crocus or saffron to stain muscle fibers, to the Royal Society, London in 1714.
- In crystallography (the study of the structure, forms and properties of crystals), he showed the morphological variation of crystals in different salts, in 1695.
- In 1698, Leeuwenhoek was invited in the boat of Peter I known as Peter the Great (1672-1725), Tsar of Russia (1682-1725). On the occasion Leeuwenhoek presented him an "eel-viewer," so Tsar could study the blood circulation, whenever he wanted.
- Physicians met scientists (or natural philosopher as they were then called) at such venues as the Royal Society and exchanged ideas and techniques. Physicians felt there was all to gain from making their doctrine more "scientific," Leeuwenhoek's microscope was a new aid and taken up by Robert Hooke (1635-1703) the brilliant British experimental philosopher who developed the early compound microscope.
- He was visited by Gottfried Wilhelm Leibniz (1646-1716); German philosopher; William III (William of Orange) (1650-1702), King of England, Scotland, and Ireland (1689-1702) and his wife; the Amsterdam burgomaster (the mayor), Johan Huydecoper; and all gazed at the Leeuwenhoek's tiny microscope.
- He made more than 500 optical lenses and at least 25 microscopes of different types, of which only 9 of them survived. Those that have survived are capable of magnification up to 275 times. The microscopes were made of silver or copper frames, holding hand-made lenses.
- Leeuwenhoek maintained throughout his life that there are aspects of microscope construction "which I only keep for myself," in particular his most critical secret of how he created lenses. For many years no-one was able to reconstruct Leeuwenhoek's design techniques. However, in 1957 C.L.Stong used thin glass thread fusing instead of polishing, and successfully created some working samples of a Leeuwenhoek design mi-

croscope. Such a method was also discovered independently by A. Mosolov and A. Belkin at the Russian Novosibirsk State Medical Institute[5].

- He used samples and measurements to estimate numbers of microorganisms in units of water.

Life

Anton or Antonie Philips van Leeuwenhoek or Leuwenhoek was born in Delft*, on October 24, 1632. His father, a basket maker, died when Anton was only five years old. His mother, Margaretha married Jacbon Janz Molijan, painter after Philips' death. Leeuwenhoek had four older sisters. Anton attended school near Leiden, city of the Western Netherlands, about 9 mi. northeast of the Hague, for a short time before being sent to live with his uncle, Benthuizen, an attorney and town clerk. At the age of 16, he became an apprentice at a linen draper's shop in Amsterdam.

He married Barbara de Mey in July 1654, with whom Anton would have one surving daughter, Maria (four other children died in infancy). In 1654 he returned Delft where he lived and studied for the rest of his life. He opened a draper's shop which he ran throughout the 1650 s.

Barbara died in 1666, and Anton married Cornelia Swalmius, with whom he had no surviving children. His status in Delft grew throughout the following years. Although he would remain an obscure figure outside of the city. He received a lucrative municipal title as chamberlain for the Delft sheriffs' assembly chamber in 1660, a position which he would hold for almost 40 years. In 1669 he was named a surveyor by the Court of Holland; later he would become a municipal "wine-gauger" in charge of the city's wine imports[6].

After developing his method for making powerful lenses, he introduced the invention to his friend Regnier de Graaf (1641-1673) the eminent Dutch physician**. When the Royal Society in London published an Italian lens maker's work in the "Philosophical Transactions," Regnier de Graaf wrote to its secretary, Henry Oldenburg (1615-1667)*** with endorsement of Leeuwenhoek's microscopes. The Royal Society, in 1673 published a letter from Leeuwenhoek, including his microscopic observations on mold, bees, and lice. Until his death he wrote countless letters in his own colloquial flavor of Dutch to the Royal Society in London, detailing his findings in a wide variety of field, centered around his work **microbiology**.

He was elected to the Royal Society in London, in 1680 by nomination of William Croone (1633-1684), the British eminent physician[7]. Leeuwenhoek was "taken aback" which he considered a high honor, although he did not attend a Royal Society meeting.

Death

Leeuwenhoek suffered from a rare illness, an uncontrolled movement of the midriff, which is now named Van Leeuwenhoek's disease. He died on August 26, 1723, at the age of ninety, and was buried four days later in the Oude Kerk in Delft, Holland.

Works

Anton van Leeuwenhoek, although is best known for his work on microscopes and contributions towards the founding of microbiology, he did not wrote any books. His discovery came to light only through correspondence with Royal Society in London; the monthly Journal "Philosophical Transactions" published his scientific letters[8].

Conclusion and Impact

Before the invention of microscope physicians and surgeons did not understand how the body became infected or how diseases spread. The creation of microscope and the discovery of one-celled animals invisible to naked eye in 1675 called attention to the existence of microscopic organisms[9], and raised the question of their origin. Many scientists and most laymen, believed that certain organisms could be generated spontaneously from nonliving materials that frogs could arise from raindrops and maggots from the carcasses

*Delft, a historic and industrial center in the west-central Netherlands, between Rotterdam and 's Gravenhage (The Hague). Jan Vermeer (known also as Jan van der Meer van Delft) (1632-1675), Dutch painter was born in Delft and worked here.

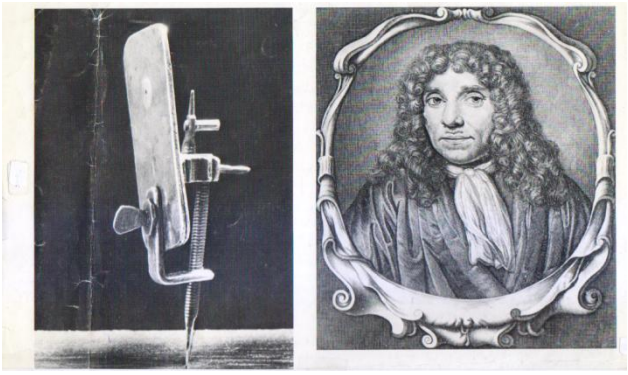
**Graaf was one of the first to experiment on the pancreas, and wrote on pancreatic juice. He also described the egg-containing follicle (Graaf follicle), and coined the term "ovary".

***Henry Oldenbrg from Bremen published the monthly "Philosophical Transactions" at his own expense.

of dead horses. But the theory of "spontaneous generation" finally resolved by Louis Pasteur (1822-1895) French chemist and the father of bacteriology who, in 1864, demonstrated that microorganisms arise from living "germs" rather than from nonliving matters. Pasteur from his studies concluded that there exist a great variety of microorganisms, each capable of reproducing its own kind. According to this theory, the different fermentations and diseases are caused by different types of microorganisms.

Indeed Leeuwenhoek's invention of microscope opened a new world for scientific study of microorganisms, such as bacteria, viruses, yeasts, molds, protozoa, and primitive algae, and the application of the knowledge derived from this study to the fields of medicine, agriculture, and industry. Of all forms of life, microorganisms are the smallest and simplest, and in many cases their bodies consist single cells. The largest are barely visible to naked eye, and the smallest, the viruses can be visualized only with electron microscope[10].

All in all, a linen draper, who was not a university-trained scientist developed microscope lenses so efficient that they were unsurpassed until the 19th century, and advanced and revolutionized knowledge immeasurably[11].



Anton van Leeuwenhoek and his microscope, through which he made many scientific studies that led to de discovery of spermatozoa. (Sebastian, Anton. Dates in Medicine. The Parthenon Publishing Group, New York-London, 2000, p.27.)

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