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ELECTRON MICROSCOPY

1.

Microscopy (optical microscopy) dates back to at least the 17th-century. Earlier microscopes, single lens magnifying glasses with limited magnification, dates as far back as the widespread use of lenses in eyeglasses in the 13th century (Atti *et al*,1975) but more advanced compound microscopes first appeared in Europe around 1620 (William *et al,* 1996). The earliest practitioners of microscopy include Galileo Galilei, who found in 1610 that he could close focus his telescope to view small objects close up and Cornelis Drebbel, who may have invented the compound microscope around 1620. Antonie van Leeuwenhoek developed a very high magnification simple microscope in the 1670s and is often considered to be the first acknowledged microscopist and microbiologist.

Development of Early Light Microscopes.

During the 1590s, two Dutch spectacle producers experimented with these early lenses. Zaccharias Janssen and his father Hans Janssen realised that if you put a small object in a tube containing several lenses, the object would appear very large when at the end of the tube and was much more enlarged than when a simple magnifying glass was used.

The pair only achieved a magnification of 9x and these early microscopes were more novelties than scientific instruments

In the late 17th Century, Anthony von Leeuwenhoek from Holland invented a single lens, hand-held microscope that was able to achieve a magnification of 270x.

Using this lens, he developed the first microscope that could actually be used. Leeuwenhoek found out that he could see structures that no one had seen before such as blood cells and bacteria.

In the same century, Englishman Robert Hooke was acknowledged as the person that discovered the smallest most basic unit of an organism – the cell.

He was also recognised as the first person to use a microscope with three lenses, the configuration used in today’s microscopes.

Large Scale Production of Microscopes

There were few further developments made to the microscope until the middle of the 19th century, when sophisticated microscopes such as the ones we use today were developed. The German company Zeiss started to manufacture these refined devices.

During these early years, scientists worked to solve various problems with the microscopes, such as the unequal bending of light that hits the lens in different places. In 1830, Joseph Lister, realized that placing the lenses at specific distances from one another resolved this problem for all but the first in the series of lenses.

For the first lens, use of a low power lens with low curvature minimized this unequal light bending to the extent that the problem was almost eliminated.

Development of The Phase-Contrast Microscope

Frits Xernicke developed the phase-contrast microscope in 1932. This device enabled researchers to study transparent biological materials.

Electron Microscope

The use of visible light in microscopy limits the resolution that could be achieved, but this limitation was overcome in 1931 when two German scientists Max Knoll and Ernst Ruska discovered that beams of electrons could be used instead of light. The electron microscope could to be used to observe objects that were not visible using light microscopes.

Scientists working for corporations competed to develop the first commercial electron microscope and Ernst Ruska, working for Siemens, eventually achieved this in 1938. By the late 1930s, microscopes had been developed that could achieve resolutions as low as 10nm and by the mid 1940s, resolutions as low as 2nm had been achieved.

The main competitors in Europe were Siemens, Philips and Carl Zeiss. In the late 1930s, the scientists in Japan formed the Japan Electron Optics Laboratory that eventually manufactured the greatest variety of electron microscopes among all of the companies.

The early versions of electron microscopes used transmission electron microscopy. The first scanning electron microscope hit the market in 1965, which revolutionized the world of material science.

2.

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| Light Microscope | Electron Microscope |
| Uses light ( approx 400-700 nm) as an illuminating source | Uses electron beams (approx 1 nm) as an illuminating source. |
| Lower magnification than an electron microscope | Higher magnification |
| No risk of radiation leakage | Risk of radiation leakage |
| Specimen preparation takes about a few minutes or an hour | Specimen preparation takes several days |
| Both live and dead specimen can be seen | Only dead and the dried specimen can be seen |
| The image formation depends upon the light absorption from the different zones of the specimen | The image formation depends upon the electron scattering |
| Low resolution | High resolution |
| The image is seen through the ocular lens. No screen needed | The image is received on a zinc sulphate fluorescent screen |
| Inexpensive and requires low maintenance cost | Expensive and high maintenance |
| Useful magnification of 500x to 1500x | Direct magnification as high as 16000x and photographic magnification as high as 1000000 x |

3.

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| SEM | TEM |
| Based on scattered electrons | Based on transmitted electrons |
| Shows only the morphology of samples. | Shows many characteristics such as morphology, crystallization, stress or even magnetic domains. |
| Focuses on the sample’s surface and its composition | Provides the details about internal composition |
| The sample is not as thin as that of the TEM | The sample in has to be cut thinner |
| Low resolution | High resolution |
| Allows for large amount of sample to be analysed at a time | Only small amount of sample can be analysed at a time |
| Used for surfaces, powders, polished & etched microstructures, IC chips, chemical segregation | Used for imaging of dislocations, tiny precipitates, grain boundaries and other defect structures in solids |
| Provides a 3-dimensional image | Provides a 2-dimensional picture |
| Shown on monitor. | Shown on fluorescent screens |

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