Information (from Wikipedia, the free encyclopedia): Date:

Electron microscope

The electron microscope is a microscope that can magnify very small details with high resolving power due to the use of electrons rather than light to scatter off material, magnifying at levels up to 500,000 times.

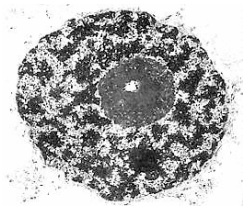
§ History

The first electron microscope was built in 1931 by Ernst Ruska and Max Knoll at the Berlin Technische Hochschule. It was greatly developed through the 1950s and has allowed great advances in the natural sciences. The advantage of an electron beam is that it has a much smaller wavelength, which allows a higher resolution (= the measure of how close together two things can be before they are seen as one).
Light microscopes allow a resolution of about 0.2 micrometer (200 nm, whereas electron microscopes can have resolutions as low as 0.1 nm.

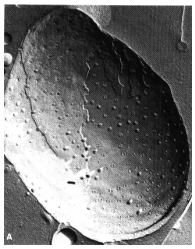
§ Process

High voltage electron beams from a cathode are focused by magnetic lenses on to the specimen. They are then magnified by a series of magnetic lenses until they hit photographic plate or light sensitive sensors — which transfer the image to a computer screen. The image produced is called an electron micrograph (EM).

§ Types



The Transmission electron microscope (TEM, photo left) produces images by detecting electrons that are transmitted through the sample, while the Scanning electron microscope (SEM, photo right) produces images of the surface of the specimen — so SEM can produce images that are a good representation of the 3D structure of the sample.

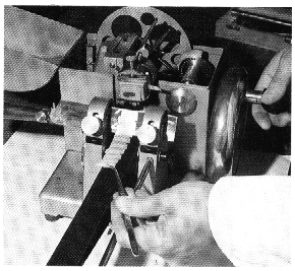


A Scanning Transmission Electron Microscope (STEM) is a specific sort of TEM, where the electrons still pass through the specimen, but, as in SEM, the sample is scanned in a raster fashion.

§ Treatment

Samples viewed under an electron microscope may be treated in many ways:

Freezing a specimen so rapidly, to liquid nitrogen temperatures, that the water forms ice. This preserves the specimen in a snapshot of its solution state. This technique produces the best specimen preservation, but isn't applicable to all specimens.



Fixation is preserving the sample to make it more realistic. Substances are used for hardening.

Dehydration is the removing of water which is to be replaced with an embedding medium such as ethanol.

Embedding supports the tissue for sectioning or cutting. Sectioning — produces thin slices. These can be cut on an ultramicrotome (see photo) with a diamond knife to produce very thin slices.

Staining uses metals such as lead and uranium to reflect electrons to give contrast between different structures.

§ Disadvantages

The samples have to be viewed in vacuum, as the molecules that make up air would scatter the electrons. This means that no living material can be studied. Recent advances have allowed samples to be imaged using lower vacuums and with partially hydrated samples, and the use of an electron transparent membrane between a biological sample and the vacuum has been shown to allow fully hydrated samples to be imaged, although there is a reduction in resolution and contrast, and the intense radiation of the electron microscope is sufficient to cause cell death.
The samples have to be prepared in many ways to give proper detail, which may result in artefacts — objects that are purely the result of treatment. This gives the problem of distinguishing artifacts from material, particularly in biological samples.
Electron microscopes are also very expensive to buy and maintain.