Low Voltage Electron Microscopy for Imaging of Biological Thin Sections

Low voltage electron microscopy (LVEM) delivers high-contrast and high-resolution imaging of biological thin sections, offering a compact, cost-effective alternative to traditional TEM.

Transmission Electron Microscopy (TEM) is the benchmark for high magnification imaging of biological specimens, capable of producing high-resolution images of cellular ultrastructure providing insight into cell function, organization, and pathology. However, the significant cost, complex infrastructure, and high maintenance requirements associated with high-voltage TEM often limit its accessibility, especially for smaller laboratories or educational environments. When imaging biological thin sections, LVEM delivers imaging quality directly comparable to high-voltage TEM while offering several advantages, including lower costs, compact size, simplified operation, and simplified and safer sample preparation.

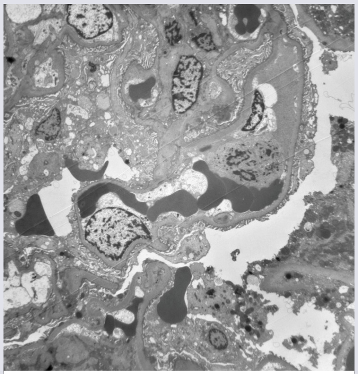

Fig A. *Kidney tissue section, showing glomerulus ultrastructure. (LVEM 25, TEM)*

Fig B. *Stained neural tissue, showing myelinated axons. (LVEM 25, TEM)*

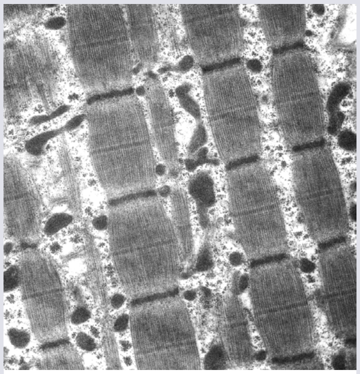

Fig C. *Muscle tissue section, showing actin and myosin structure. (LVEM 25, TEM)*

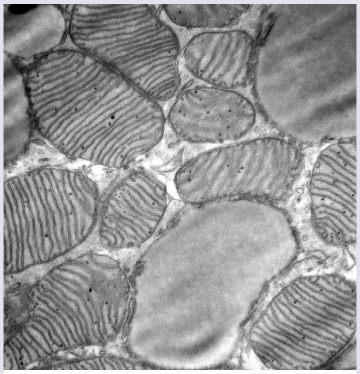

Fig D. *Brown adipose tissue section, showing mytochondria cristae detail. (LVEM 25, TEM)*

A study by Mrazova et al. (2023) compared the imaging capabilities of a FEI Talos F200C high-voltage TEM operated at 200kV and the Delong Instruments LVEM 25E compact TEM operated at 25kV, by examining stained and unstained thin sections of cyanobacterial cells. The findings demonstrated that LVEM effectively visualized essential intracellular structures with minimal background noise, matching the quality of high-voltage TEM when samples were stained and surpassing it when they were unstained.

High-voltage TEM has been the standard for high-resolution imaging of biological samples. This technique requires staining with heavy metals to achieve necessary contrast as biological samples are composed mainly of light elements, such as carbon, nitrogen, and oxygen. These staining agents complicate sample preparation and disposal. By employing a lower beam energy, LVEM increases scattering interactions between electrons and the sample, enhancing contrast, allowing for high-contrast unstained imaging. This makes LVEM especially valuable for ultrastructural studies requiring detailed visualization of cell membranes, organelles, and macromolecular complexes.

Mrazova et al. (2023) also tested a scanning electron microscope equipped with a transmission detector (STEM in SEM). The results indicated that STEM in SEM produced less sharp and generally lower image quality making it less suited for biological thin section imaging as compared to LVEM. Furthermore, LVEM is easier to use and allows rapid sample exchanges, taking only a few minutes between runs, in contrast to the more time-consuming operations of high-voltage TEMs and STEM in SEM. Additionally, LVEM's benefit from their compact size, reduced infrastructure requirements, and lower price point.

Conclusion

LVEM offers a practical and effective alternative to high-voltage TEM for imaging biological thin sections. Its ability to reproduce images with the same level of image quality as high-voltage TEM, its ability to produce high-contrast images without heavy metal staining, coupled with lower costs, simpler operation, and compact design. This study suggests that LVEM could serve as a more accessible tool for laboratories focused on biological thin sections, enabling high-quality imaging without the complexities associated with traditional TEM.

Reference

Mrazova, K., Bacovsky, J., Sedrlova, Z., Slaninova, E., Obruca, S., Fritz, I., & Krzyzanek, V. (2023). UranyLess Low Voltage Transmission Electron Microscopy: A Powerful Tool for Ultrastructural Studying of Cyanobacterial Cells. Microorganisms, 11, 888.