Biological Applications of High Voltage Electron Microscopy

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A little has been known about a high voltage electron microscopy(HVEM) in our biological field. However, when distinctive features of HVEM are surveyed and well-understand, we will soon consider it as a quite fundamental instrument in many biological research areas. HVEM has been extensively used since 1960's in several countries such as U.S.A., Japan, France, and England among others. They have found many advantages of applying HVEM in biological fields compared to conventional EM. Such advantages are follows.

1) HVEM helps to increase the resolution of a work by using higher energy electrons with shorter wavelengths to the specimen. For instance, with 75kV of an accelerating voltage, a wavelength of EM is 0.042Å and with 100kV, 0.037Å. When accelerating voltage is 1000kV that fits well within a HVEM voltage range, its wavelength 0.0087Å that leads to a higher resolution that the one with a longer wavelength.

2) Higher voltage in HVEM produces higher energy electrons which helps to increase a penetrating capability in specimens. Thick specimens possibly studied only with a light microscope can be examined by a HVEM, although there may be some differences in penetrating capability by a type and/or density of cell proper. Moreover, the best advantage of applying HVEM in biological research is when a nonembedded specimen can be analysed directly under HVEM. It has shown much improved penetrating capability through such untreated samples.

3) Much more cellular structure information can be attained by such increased penetrating in thick samples. Reconstructing 3-dimensional structure is easily obtained photographing by 2 pictures taken from a different angle with a HVEM. A one image and a tilted(15° -20°) image can be photographed, thus making a pair for each image and viewed with stereo-viewer. In doing so, depth and volume of structures can be estimated and this aid us to reconstruct 3-D observation of specimens. Thus, applying HVEM in biological research areas would be a very useful tool to reveal many known structures within cells or to understand known structures better in many types of cells.

4) The coordinated application of high resolution cryo-electron microscopy (cryoEM) and

three-dimensional (3D) image reconstruction techniques helps to study the architecture of large biological complexes and the structural basis for their regulation. The cryoEM techniques involve the preparation of thin, unstained specimens suitable for transmission electron microscopy. Vitrified samples are maintained at -160 degrees Centigrade or below in the microscope while images are recorded under low-irradiation conditions to minimize electron beam damage to the specimen. Micrographs are digitized and analyzed by computer to combine information from up to hundreds of individual particle images to reconstruct the 3D structure of each virus. CryoEM techniques are popular since they provide a direct, objective approach to observe the "native", hydrated structure of biological specimens.