Current Electron Microscopy in Life Science

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Electron microscopy has been one of the most important tools for the research of life science during the past 50 years. The development of various preparation techniques for biological specimens made the microscope the research tool to investigate the ultrastructure of cells down to nanometer scale. Furthermore, developments in mordern computer-aided electron microscopy have provided surprising informations about the 3D relationships between structures.

Cryo-electron microscopy is the tremendous advance for the life science. It is possible to observe the sample at cryogenic temperature greatly improved the resistance of ribbon to beam damage, and allow preservation of the specimen in a more natural form, avoiding the artefacts associated with removal water from tissue. In particular, the application of cryopreparation methods; cryofixation, freeze-substitution, high pressure freezing, freeze-etching, and cryo-ultramicrotomy are so much helpful to preserve and maintain the hydrophobic molecules of cells such as lipids and glycolipids. Thus, overall structure of membranes are well studied by this method.

The application of cryo-immunoelectron microscopy has greatly understood the localization of many kinds of proteins and enzymes within the cells. Although immuno-lablling has become a very powerful technique in electron microscopy, antigenicity and accessibility have always been the biggist problems when specimens are chemically fixed and embedded with classical epoxy resins. However, these deteriorating effects can be largely overcome by the application of cryopreparation.

Electron microscopy can be invaluable in identifying viral agents in human and animals. The location of viruses within cells can be a clue to identification in thin sections. DNA viruses are usually constructed in the nucleus, however, RNA viruses are usually constructed in cytoplasm. Especially, infected cells with RNA virus induces a number of biochemical and morphological modifications to cellular structures. Recently, the combination of

cryo-electron microscopy and image reconstruction in virus has become established as a technique for the structural analysis of molecular assemblies in three dimensions.

Ultrastructural analysis by EM still holds its importance in diagnostic pathology. Electron microscopic examination of the biopsy is an essential component for definitive pathology diagnosis, which provides vital information to the doctors. The continued study of the fine structural changes shall support us in better understanding the disease processes.

High voltage electron microscopic stereo observation of thick section provides detailed three dimensional images of the cells. With serial thin sections, correct continuity of structures are also provided to recognize in a single 3D image. Stereoscopic reconstruction facility is sometimes used to handle images from TEM sections. Remote use of high voltage electron microscopes called telemicroscopy is more and more generalized between countries of the world. This practical access to advanced imaging instruments enable use of advanced software tools and computational resources for refinement of 3D data sets and their comparison to other related data sets in databases of biological structures.