Cellular and Molecular Biology

Commentary Open Access

# Technological Frontiers in Cell Biology

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## Commentary

Microscopy has revolutionized the way we perceive the cellular structure and its functioning. Microscopic techniques have advanced to such an extent that the structure of the large biomolecules can be visualized with near atomic resolution. In cryo-electron microscopy a beam of electrons are fired at proteins that are frozen in a solution in order to reveal their structure. This technique has driven a rapid advance in cell biology. These advanced microscopic techniques have revealed the locations of different types of proteins and even enabled real time tracking of the protein movement and decipher how the enzymes functioned. Ever since the microscopic devices were invented there has been constant improvement in the technology and in fact the development of high resolution fluorescence microscope has resulted in conferring Nobel Prize in Chemistry in the year 2014. In the year 2017 the prize went to the development of cryo-electron microscope. The underlying working principles of these microscopes differ a great deal. In florescence microscopy the florescence molecules are used to light the target proteins,, cells, and other cellular components, and even allows the biologists to visualize the living samples on a real time basis. However, there was a limitation that visible light cannot differentiate components closer than 200 nanometers. Therefore electron microscope was developed in order to achieve greater resolution. But however this technique required the vacuum that limited its use for visualizing live cells. Therefore ol techniques of crystallography were replaced with the individual or combined usage of these microscopes.

Widefield microscope functions on the intense light source to illuminate the specimen. Confocal microscope was developed that uses a pin hole to illuminate the point of interest. This enables removal of background florescence and out of focus fields and hence a higher resolution and contrast was obtained in effect. Light sheet microscopy functions by scanning the samples based on a very thin plane of laser light and this technique allows real-time tracking of the living cells and tissues. Similarly the structured illumination microscopy also allows the magnified visualization of the live cells. The most advanced electron cryo-microscope has the potential to reveal that atomic structures of biomolecules such a large protein. This has many advantages over X-ray crystallography because with this techniques the samples required to be fixed and a crystal form.

This improvisation in the techniques of cell biology was definitely not possible without the involvement of physicists and chemists. Computer scientists and statisticians have also contributed for the improved image processing and analysis. The synergistic efforts of the cell biologists and the other professions have enabled the visualization of cellular trafficking pathways in the live cells at greater resolution. The interactions between the different organelles could be seen by capturing three dimensional color footage of light sheet fluorescence microscopy combined with confocal microscopy. This has opened new vistas for the aspiring cell biologists to design new experiments and test the biological hypothesis. Several of the cellular processes including mitosis and meiosis were decoded using these advanced microscopic visualizations. Understanding of inter molecular interactions has great relevance in the pharmaceutical sector. On an overall basis the imaging capability at sub cellular levels has open new avenues and far more attractive for the researchers who are interested in cell biology and its applications.

Genetic screening and editing have enabled the scientists the reengineer the cells and cellular processes and during these process the involvement of mathematical, statistical and computer science have been phenomenal. Due to advancements in the technology such as genetic engineering for experimental cell biology large scale experiments were possible and this has resulted in generation of huge volumes of complex and dynamic data that needed to be analyzed and interpreted. The diversity and the magnitude of the molecular and physiological processes necessitated the analysis of the data generated to derived logical interpretations. Genetic reprogramming is enabling the scientists to reengineer the cells such that they detect any abnormality in the early stage. The technique is also enabling regenerative medicine and cell regeneration and tissue reconstructions. The computation prowess, machine learning and modeling has enabled analysis of variables associated with thousands of genes and gene combination effects. All the technologies have facilitated synthesis and production of biological therapeutics such as monoclonal antibodies for various therapeutic applications. Cell biology is increasingly becoming more relevant to health science that ever before.

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