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PROTEIN CRYSTALLOGRAPHY IN ACTION VIA X-RAY TECHNIQUES AT THE SYNCHROTRON FACILITIES

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Abstract

At the end of the XX Century, most investigations were focused on structural elucidation of large macromolecular complexes for applications in Medicine and Drug´s Design. Recently, techniques like X-ray diffraction, Small Angle X-ray Scattering (SAXS), X-ray Powder Diffraction, Neutron and Electron Diffraction techniques have emerged to obtain the 3D structure of important biological macromolecules for a variety of applications in Structural Biology, Materials Science and Structural Genomics research. Particularly, the X-ray diffraction techniques, which are a hallmark in this search, as these are the most powerful techniques for structure elucidation of biological macromolecules, reaching quasi-atomic resolution in the most favorable cases, and without a priori limitations on the size and complexity of the studied molecules, requires crystals of a high quality. New techniques are emerging like the free electron lasers (FELs) with requirement of micro to nano-sized crystals to solve the 3D structure of very important macromolecular complexes. The XFEL facilities, which generates extremely intense X-ray pulses of tens of femtoseconds duration with nine-to-ten orders of magnitude higher peak brilliance than third-generation synchrotrons tend to get the 3D structure of any macromolecules. Finally, as we have learnt from recent publications cryo-EM with near-atomic resolution for biomolecular structures is one of the most promising techniques to solve the 3D structure of large macromolecular complexes and recently even small molecular weight proteins have been solved.

The aim of this talk will be concentrated on showing the Crystallography in Action, a modern concept to elucidate peculiar biomolecules important in biology or biomedical sciences. The author has sorted out some answers related to basic scientific questions from his laboratory using synchrotron techniques: 1) What is the role of the intramineral proteins into the biomineralization of calcium carbonate? What is the crystallographic role of these biological part and mineral part to understand the evolution of the dinosaurs found in the Northern part of Mexico? Would it be possible to recover ancestral proteins? 2) What is the importance of synchrotron radiation to investigate the 3D structure of biological macromolecules, which are difficult to solve by conventional X-ray in-house diffraction? 3) Polyphenol Oxidase from Vitis vinifera, Cytochrome C from Bovine´s heart and Apo and Holo Human Transferrins: Are these proteins easy to crystallize and be solved by conventional X-ray diffraction or do we need to grow the crystals in situ and to use synchrotron facilities to sort out this structural problem? Can we use non-conventional methods of crystal growth to obtain crystals of different size and appropriate crystal quality to get high resolution structures even for membrane proteins? Finally, the end of this talk will focus on showing how we still lack a unique powerful technique that will help us solve all the structural problems that are arising. Therefore, by crystallography in action, we are looking further into the future in the hope of finding out different ways to solve the 3D structure of proteins that are recalcitrant to crystallize properly, or that are structurally disordered. Based on that, we intend to use the XFEL as the final aim of all these kinds of research projects.

About

Dr. Abel Moreno is a full Professor of Biological and Physical Chemistry at the Institute of Chemistry of the National Autonomous University of Mexico (UNAM) in Mexico City. He has been distinguished as a member of the National System of Researchers of Mexico (SNI) at level 3 (the highest category of Mexican scientists), a member of the Mexican Academy of Sciences, Mexican Society of Crystallography, Mexican Society of Synchrotron Light, the New York Academy of Sciences, and member of the Mexican and American Chemical Societies. Dr. Abel Moreno has published more than 108 papers in prestigious international journals cited 2300 times having a H-index of 25. He is the author of 15 book chapters and 7 books on his specialties in Biological Crystallogenesis, Crystallochemistry, and Biomineralization processes. Into the Academia he has graduated more than 30 students at all levels from BSC up to the PhDs and postdoctoral fellows. Prof. Moreno was the former President of the International Organization for the Biological Crystallization from September 2010 to September 2012 (IOBCr). Doctor Moreno is an expert in Protein Crystallization, Crystal Growth Methods, Crystallochemistry, Protein Crystallography, Biomineralization Processes and Structural Research using X-ray Diffraction, Scanning/Transmission Electron Microscopy, Atomic Force Microscopy and Synchrotron Radiation Techniques. His work as well as contributions have been applied to Biological Chemistry and Biomedical Sciences.

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