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Electroosmosis: A possible role in the intracellular transport

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Abstract

The objective of the paper is to show that electroosmotic flow might play an important role in the intracellular transport of biomolecules. Two mathematical models were developed describing the transport of the negatively charged messenger proteins to the negatively charged nucleus and the recovery of the fluorescence after photobleaching. The parameters of the models were derived from the extensive review of the literature data. Computer simulations were performed within the COMSOL 4.2a software environment. The first model demonstrated that the presence of electroosmosis could intensify the flux of messenger proteins to the nucleus and allow the efficient transport of the negatively charged phosphorylated messenger proteins against the electrostatic repulsion of the negatively charged nucleus. The second model revealed that the presence of the electroosmotic flow made the fluorescence recovery time dependent on the position of the bleaching spot relative to cellular membrane. The magnitude of the electroosmotic flow effect was shown to be quite substantial, i.e. increasing the flux of the messengers onto the nucleus up to 4-fold relative to pure diffusion and resulting in the up to 3-fold change in the values of fluorescence recovery time, and therefore the apparent diffusion coefficient determined from the fluorescence recovery after photobleaching experiments. Based on the results of the modeling and the universal nature of the electroosmotic flow, the potential wider implications of electroosmotic flow in the intracellular and extracellular biological processes are discussed.

Biography

Victor P Andreev, PhD is an Associate Professor at the Department of Psychiatry & Behavioral Sciences and Department of Biochemistry & Molecular Biology, University of Miami School of Medicine. Dr. Andreev is a bioinformatician and computational scientist with a strong background in mathematics, physics, and analytical chemistry. Prior to University of Miami, he worked for the Northeastern University, Boston, and prior to this for the Institute for Analytical Instrumentation, Russian Academy of Sciences, St. Petersburg, Russia. Dr. Andreev is a member of several editorial boards, including the Journal of Pharmacogenomics and Pharmacoproteomics.