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Fluorescence nanosensors for continuous glucose monitoring

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One of the major hurdles in studying the pathology of diabetes is the lack of adequate methodology for directly and continuously determining glucose transport and metabolism in cells and tissues. Here we present a new methodology that adopts frequency-domain fluorescence imaging microscopy measurement (FD-FLIM) to visualize the dynamics of glucose in living cells using a fluorescence nanosensor (GIP) developed in our early work. The GIP was developed by sandwiching a mutant glucose binding protein with AcGFP1 and mCherry. We observed the mono-exponential decay of AcGFP1 and found that its lifetime remained stable, despite significant reduction in its intensity during time-lapse imaging. By expressing the GIP in murine myoblasts, C2C12, we performed FD-FLIM and successfully monitored intracellular glucose dynamics from which we determined glucose uptake and clearance rates. This work realizes the continuous glucose monitoring within living cells through FD-FLIM with a GIP. These fluorescence nanosensors were also tested for continuous glucose monitoring in blood. Using one of the GIP mutants that have sensitivity within the blood glucose concentrations range, we developed a micro glucose sensor and demonstrated its capability of continuously monitoring glucose from 0 to 32 mM. The sensor was tested for its specificity, stability, and shelf-life. We demonstrated that the sensor was devoid of any interference from sugars like galactose, fructose, lactose, mannose and mannitol when tested at physiologically significant concentration of these glucose-like sugars. These sensors would be good candidates for developing implantable glucose sensors for continuous glucose monitoring.

Biography

Kaiming Ye is a Professor, Biomedical Engineering Program, University of Arkansas. He is also an Associate Program Director, Biomedical Engineering Program, National Science Foundation. His research interest focuses on stem cell, regenerative medicine, biosensors and bioimaging. He has published one book, one patent, and more than 65 papers in the field. He is best known for his creative works on development of fluorescence nanosensors for continuous molecular imaging and 3D scaffolds for tissue regeneration. His research has been funded by NIH, NSF, JDRF, ABI and industries. He serves as Executive, Associate Editor, and Editorial Board member of 12 journals.

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