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Design of single nanoparticle optical probes for the study of multidrug ABC membrane transporters in single living cells

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Abstract

Multidrug membrane transporters, or efflux pumps, in both prokaryotic and eukaryotic cells are responsible for non-treatment of a wide variety of diseases, ranging from bacterial infections to cancers, accounting for multidrug resistance (MDR). This makes it essential to study the structures and functions of the efflux pumps in order to have better understanding of how they work to aid in the design of more effective treatment therapies. In this study, we synthesized and purified spherical silver (Ag) NPs with diameters, ranging from 12 to 95 nm, that are stable (non-aggregated) in PBS (1.5 mM NaCl). We developed new imaging approaches using dark-field optical microscopy and spectroscopy (DFOMS) to characterize single Ag NP size-dependent localized surface plasmon resonance (LSPR) spectra in single living cells (*Bacillus subtilis*) in real-time at nanometer resolution. Using Ag NPs as optical probes, we continuously imaged and probed size-dependent transport kinetics of our efflux pump, ATP-binding cassette (ABC) membrane transporter in *Bacillus subtilis* for hours and discovered the transport patterns. We showed that the smaller Ag NPs stayed inside the cells longer than the larger NPs, suggesting size-dependent efflux kinetics of the ABC membrane transporter. This study demonstrates that, unlike traditional fluorescent probes, single Ag NPs exhibit size-dependent LSPR spectra and superior photostability, which can serve as an effective assay to characterize the efflux kinetics of multidrug membrane transporters.

Biography

Kerry J. Lee completed her Ph.D. in Biomedical Sciences from Old Dominion University. During her Ph.D. and postdoctoral research, she studied the design of *in vitro* and *in vivo* assays to study the transport, biocompatibility, and toxicity of different types of nanoparticles. She has published 10 first-author papers in peer-accepted journals, including ACS Nano, has more than 175 citations, and more than 17 selected presentations and conference abstracts. Kerry is currently assistant professor at South University and has expectations to continue her research using nanoparticle technology to identify and treat disease.