Nanoscale detection of (a)symmetries in biological interactions

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Résumé

Interaction and recognition of the same or different biological molecules play a pivotal role in the life sciences. Understanding antibody-antigen binding, DNA and RNA hybridization, protein oligomerization, enzyme-catalyzed substrate-product conversion, or other ligand-receptor interactions can help to both understand and diagnose various biological functions. Often, such biological interactions create symmetric or asymmetric systems with dimension at the nanometer scale. These can be analyzed by fluorescence and, in particular, by F´orster Resonance Energy Transfer (FRET), which is an important tool for the determination of concentrations and distances within nanometer-scale systems *in vitro* and *in vivo* in many fields of the life sciences. Using time-resolved optical spectroscopy and microscopy for the analysis of FRET systems offers several advantages concerning sensitivity and specificity. Luminescent lanthanide complexes exhibit extremely long luminescence lifetimes and multiple narrow emission peaks over a broad spectral range. These photophysical features make them highly interesting FRET donors in combination with different FRET acceptors, such as organic dyes or semiconductor quantum dots. Such FRET pairs have been successfully used for the multiplexed and highly sensitive detection of protein, peptide, DNA, and RNA biomarkers. This presentation will give an introduction to FRET and explain the specific benefits of lanthanide/dye/quantum dot FRET pairs for fluorescence detection. Then, application of these FRET pairs in different single-step FRET biosensors for the sensitive and specific detection of multiple biomarkers from low-volume liquid samples or on cell membranes and inside cells will be discussed. These lanthanide-based FRET biosensors provide a rapid, simple, selective, and sensitive tool for multiplexed detection of various oligonucleotides or proteins, which makes them highly interesting for clinical diagnostics and other biosensing applications.

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