Singlet Oxygen in Mammalian Cells: Exploiting Nanoscopic Tools in Single Cell Experiments

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Abstract

Singlet oxygen, the lowest excited electronic state of molecular oxygen, is a "mature citizen" that has been studied for many years from a wide range of perspectives. Among other things, singlet oxygen has a unique chemistry that results in the oxygenation of many organic molecules. In this way, it plays important roles in biology, particularly in mechanisms of cell signaling and cell death.

Singlet oxygen is commonly produced in a photosensitized process wherein light is absorbed by a given molecule (the so-called sensitizer) followed by energy transfer from the excited state sensitizer to ground state oxygen. The production of singlet oxygen in this way is a natural phenomenon (*i.e.*, we live in a world of light, oxygen, and suitable sensitizers).

We have a multi-faceted program in which the behavior of singlet oxygen is examined under conditions and in systems that have, heretofore, been inaccessible. We are particularly interested in developing and exploiting tools that provide unique insight into the mechanistic behavior of singlet oxygen in cells. I will briefly describe our latest work that is relevant to phenomena on the nano-scale: (a) focused two-photon sensitizer excitation to impart spatial selectivity in single cell experiments, (b) protein-encapsulated sensitizers that can be localized in specific intracellular domains, (c) electric fields associated with nanoparticle surface plasmons to enhance radiative transitions in oxygen, and (d) added quenchers to influence diffusion-dependent singlet oxygen deactivation.

Our results indicate that there is still much to be gained from studies of singlet oxygen.