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Observing Molecular-Level Transient Oxygen Stress in Obligate Anaerobes In Vivo

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ABSTRACT

Aerobic respiration of intracellular polyglucose reserves is postulated to play a central role in oxygen adaptive response in obligatory anaerobes like Desulfovibrios, but it has been difficult to probe this event at chemical scale in vivo. Here we present a non-invasive synchrotron infrared (SIR) spectromicroscopy approach to reveal time-dependent composition and structure changes at a lateral scale of several individual Desulfovibrio vulgaris. The advantage of infrared spectroscopy is that it is non-invasive, and it uses vibration movements of atoms and chemical bonds within functional groups of biomolecules as an intrinsic contrasting mechanism; thus it allows one to immediately detect composition and structure changes within living cells. The advantage of using a synchrotron light source is that its high brightness allows us to detect signals ~1000 times weaker than the conventional infrared spectroscopy allows us to. Comparative analysis of SIR spectra of the same individual D. vulgaris exposed to air-level oxygen at different time points reveals chronological information regarding the level of oxidative stress and the extent of cellular injury and repair. These results, together with microscopy images, mark a critical step toward the use of SIR spectromicroscopy as an uninterrupted microprobe at a chemical scale level of physiological events in microbiology applications.

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