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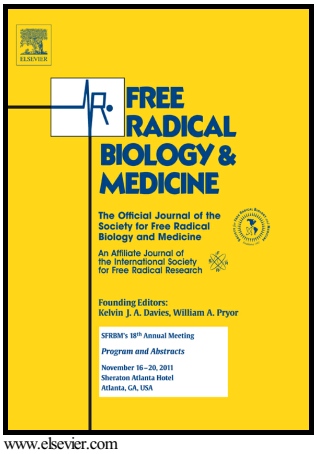

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Limitations of Oxygen Delivery to Cells in Culture: An Underappreciated Problem in Basic and Translational Research

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Abstract

Molecular oxygen is one of the most important variables in modern cell culture systems. Fluctuations in its concentration can affect cell growth, differentiation, signaling, and free radical production. In order to maintain culture viability, experimental validity, and reproducibility, it is imperative that oxygen levels be consistently maintained within physiological "normoxic" limits. Use of the term normoxia, however, is not consistent among scientists who experiment in cell culture. It is typically used to describe the atmospheric conditions of a standard incubator, not the true microenvironment to which the cells are exposed. This error may lead to the situation where cells grown in a standard "normoxic" oxygen concentration may actually be experiencing a wide range of conditions ranging from hyperoxia to near-anoxic conditions at the cellular level. This apparent paradox is created by oxygen's sluggish rate of diffusion through aqueous medium, and the generally underappreciated effects that cell density, media volume, and barometric pressure can have on pericellular oxygen concentration in a cell culture system. This review aims to provide an overview of this phenomenon we have termed "consumptive oxygen depletion" (COD), and includes a basic review of the physics, potential consequences, and alternative culture methods currently available to help circumvent this largely unrecognized problem.

Graphical Abstract

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