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Real-Time 2D Visualization of Metabolic Activities in Zebrafish Embryos Using a Microfluidic Technology

Feng Zhu[1], Daniel Baker[2], Joanna Skommer[1], Mary Sewell[3], and Donald Wlodkowic[1]
[1]School of Applied Sciences, RMIT University, Melbourne, Victoria, Australia
[2]International Centre for Sturgeon Studies (ICSS), Vancouver Island University, Nanaimo, British Columbia, Canada
[3]School of Biological Sciences, The University of Auckland, Auckland, New Zealand

Abstract:

Non-invasive and real-time visualization of metabolic activities in living small model organisms such as embryos and larvae of zebrafish has not yet been attempted largely due to profound analytical limitations of existing technologies. Historically, our capacity to examine oxygen gradients surrounding eggs and embryos has been severely limited, so much so that to date, most of the articles characterizing in situ oxygen gradients have described predominantly mathematical simulations. These drawbacks can, however, be experimentally addressed by an emerging field of microfluidic Lab-on-a-Chip (LOC) technologies combined with sophisticated optoelectronic sensors. In this work, we outline a proof-of-concept approach utilizing microfluidic living embryo array system to enable in situ Fluorescence Ratiometric Imaging (FRIM) on developing zebrafish embryos. The FRIM is an innovative method for kinetic quantification of temporal patterns of aqueous oxygen gradients at a very fine scale based on signals coming from an optical sensor referred to as a sensor foil. We envisage that future integration of microfluidic chip-based technologies with FRIM represent a noteworthy direction to miniaturize and revolutionize research on metabolism and physiology in vivo.

Keywords: microfluidics, Lab-on-a-Chip, zebrafish embryo, metabolic activity, oxygen sensor foils, fluorescence ratiometric imaging