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METABOLIC OPTOGENETICS AS A NEW PARADIGM TO STUDY AND ENGINEER METABOLISM

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ABSTRACT

Optogenetics uses light-responsive proteins to control biological processes. The unmatched spatiotemporal precision, high tunability, reversibility, and few side effects of light makes optogenetics a powerful strategy to study and engineer complex biological systems. For these reasons, optogenetics has already revolutionized disciplines such as neuroscience, developmental biology, and cell signaling, and is poised to do the same with cellular metabolism. I will show several classes of transcriptional optogenetic circuits that we have developed to control metabolic pathways for chemical production in Saccharomyces cerevisiae and Escherichia coli. Additionally, I will present optogenetic strategies to achieve post-translational regulation of metabolism, including light-controlled synthetic metabolic organelles, and optical binders. One of the most exciting prospects of metabolic optogenetics is combining optogenetic regulators with genetically encoded biosensor to achieve closed-loop controls of metabolism. I will present the progress we have made towards this goal, including rapid optogenetic circuits, and new biosensors that can function in combination with optogenetic controls in the same strain. I will discuss the challenges that lay ahead and the opportunities to overcome them to realize the full potential of metabolic optogenetics.

BIOGRAPHY

José Avalos earned a B.E. in chemical engineering from Universidad Iberoamericana in Mexico City and an MSc in biochemical research from Imperial College in London. He then received a Ph.D. in biochemistry and biophysics from Johns Hopkins University. He conducted postdoctoral research at The Rockefeller University in membrane biophysics, and at MIT, in the Department of Chemical Engineering, and the Whitehead Institute for Biomedical Research in metabolic engineering and synthetic biology. He has been a faculty member at Princeton since 2015, where he leads a research group focused on the use of biotechnology to address challenges in renewable energy, sustainable manufacturing, the environment, and human health. He has received several awards, including the Damon Runyon Cancer Research Fellowship, the Ruth L. Kirschstein National Research Service Award, the Alfred P. Sloan Foundation Research Fellowship Award, the Pew scholarship, the NSF CAREER Award, and the Camille Dreyfus Teacher-Scholar Award.