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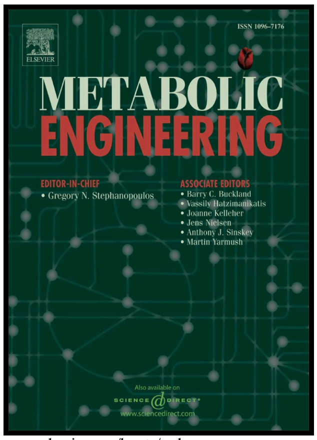

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Light-Optimized Growth of Cyanobacterial Cultures: Growth Phases and Productivity of Biomass and Secreted Molecules in Light-Limited Batch Growth

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Abstract

Cyanobacteria are photosynthetic microorganisms whose metabolism can be modified through genetic engineering for production of a wide variety of molecules directly from CO_2, light, and nutrients. Diverse molecules have been produced in small quantities by engineered cyanobacteria to demonstrate the feasibility of photosynthetic biorefineries. Consequently, there is interest in engineering these microorganisms to increase titer and productivity to meet industrial metrics. Unfortunately, differing experimental conditions and cultivation techniques confound comparisons of strains and metabolic engineering strategies. In this work, we discuss the factors governing photoautotrophic growth and demonstrate nutritionally replete conditions in which a model cyanobacterium can be grown to stationary phase with light as the sole limiting substrate. We introduce a mathematical framework for understanding the dynamics of growth and product secretion in light-limited cyanobacterial cultures. Using this framework, we demonstrate how cyanobacterial growth in differing experimental systems can be easily scaled by the volumetric photon delivery rate using the model organisms *Synechococcus* sp. strain PCC7002 and *Synechococcus elongatus* strain UTEX2973. We use this framework to predict scaled up growth and product secretion in 1 L photobioreactors of two strains of