

Optimizing Algal Cultivation & Productivity: An Innovative, Multidiscipline, and Multiscale Approach

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Progress in algal biofuels has been limited by significant knowledge gaps in algal biology, particularly as they relate to scale-up. To address this we are investigating how culture composition dynamics (light as well as biotic and abiotic stressors) describe key biochemical indicators of algal health: growth rate, photosynthetic electron transport, and lipid production. Our approach combines traditional algal physiology with genomics, bioanalytical spectroscopy, chemical imaging, remote sensing, and computational modeling to provide an improved fundamental understanding of algal cell biology across multiple cultures scales. This work spans investigations from the single-cell level to ensemble measurements of algal cell cultures at the laboratory benchtop to large greenhouse scale (175 gal). We will discuss the advantages of this novel, multidisciplinary strategy and emphasize the importance of developing an integrated toolkit to provide sensitive, selective methods for detecting early fluctuations in algal health, productivity, and population diversity. Progress in several areas will be summarized including identification of spectroscopic signatures for algal culture composition, stress level, and lipid production enabled by non-invasive spectroscopic monitoring of the photosynthetic and photoprotective pigments at the single-cell and bulk-culture scales. Early experiments compare and contrast the well-studied green algae *Chlamydomonas* with two potential production strains of microalgae, *Nannochloropsis* and *Dunaliella*, under optimal and stressed conditions. This integrated approach has the potential for broad impact on algal biofuels and bioenergy and several of these opportunities will be discussed.

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