

Strategies for Extreme Growth in *Chlorella*

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The fastest-growing known eukaryotic phototroph, the green alga *Chlorella ohadii*, is a polyextremophile which is capable of surviving full desiccation for much of its life cycle. This extraordinary growth is achieved by careful regulation of the photosynthetic electron transport chain, including a substantial contribution from Photosystem II (PSII)-cyclic electron flow (CEF). As compared to *C. ohadii*, its near relatives *Chlorella vulgaris* sp. NIES 642 and *C. sorokiniana* normally grow under significantly lower light intensities and do not contend with the same water stress. We have acclimated both of these strains to grow under the extreme light conditions under which *C. ohadii* achieves its maximum growth rate. While each achieves a minimum doubling time of under 2 hours, making these three of the five fastest-growing reported phototrophs under ideal conditions, their photosynthetic electron transport chains are regulated differently to achieve this. Both acclimated strains lack the ability to perform PSII-CEF to the same degree as *C. ohadii* and are accordingly somewhat slower-growing. However, *C. sorokiniana* uses its photosynthetic electron transport chain almost identically to that of *C. ohadii* outside of Photosystem II, while NIES 642 has alternate photoprotective strategies in place. A major factor allowing *C. ohadii* to grow faster appears to be the ability to separate out its linear and cyclic electron flow mechanisms, spatially partitioning electron transduction from non-photochemical and recombinative mechanisms of excess energy dissipation. The differential behavior of these closely related strains informs on strategies for increasing cell growth rates and phototolerance.