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Expanding Fungal Diets Through Synthetic Algal-Fungal Mutualism

Fungi can synthesize numerous molecules with important properties, and could be valuable production platforms for space exploration and colonization. However, as heterotrophs, fungi require reduced carbon. This limits their efficiency in locations such as Mars, where reduced carbon is scarce. We propose a system to induce mutualistic symbiosis between the green algae *Chlamydomonas reinhardtii* and the filamentous fungi *Neurospora crassa*. This arrangement would mimic natural algal-fungal relationships found in lichens, but have added advantages including increased growth rate and genetic tractability. *N. crassa* would metabolize citrate ($C_6H_5O_7^{-3}$) and release carbon dioxide (CO_2) that *C. reinhardtii* would assimilate into organic sugars during photosynthesis. *C. reinhardtii* would metabolize nitrate (NO_3−) and release ammonia (NH_3) as a nitrogen source for *N. crassa*. A *N. crassa* mutant incapable of reducing nitrate will be used to force this interaction. This system eliminates the need to directly supply its participants with carbon dioxide and ammonia. Furthermore, the release of oxygen by *C. reinhardtii* via photosynthesis would enable *N. crassa* to respire. We hope to eventually create a system closer to lichen, in which the algae transfers not only nitrogen but reduced carbon, as organic sugars, to the fungus for growth and production of valuable compounds.