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Biophysics of Euglena phototaxis ALAN CHENG HOU TSANG, INGMAR H. RIEDEL-KRUSE, Stanford University — Phototactic microorganisms usually respond to light stimuli via phototaxis to optimize the process of photosynthesis and avoid photodamage by excessive amount of light. Unicellular phototactic microorganisms such as Euglena gracilis only possesses a single photoreceptor, which highly limits its access to the light in three-dimensional world. However, experiments demonstrated that Euglena responds to light stimuli sensitively and exhibits phototaxis quickly, and it's not well understood how it performs so efficiently. We propose a mathematical model of Euglena's phototaxis that couples the dynamics of Euglena and its phototactic response. This model shows that Euglena exhibits wobbling path under weak ambient light, which is consistent to experimental observation. We show that this wobbling motion can enhance the sensitivity of photoreceptor to signals of small light intensity and provide an efficient mechanism for Euglena to sample light in different directions. We further investigate the optimization of Euglena's phototaxis using different performance metrics, including reorientation time, energy consumption, and swimming efficiency. We characterize the tradeoff among these performance metrics and the best strategy for phototaxis.

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