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Entrainment and capture by swimming cells ARNOLD MATHIJSSEN, Department of Bioengineering, Stanford University, RAPHAEL JEANNERET, MARCO POLIN, Department of Physics, Warwick University — Floating particles that collide with a micro-swimmer can be entrained for long distances (Jeanneret et al., Nat. Comm. 7: 12518, 2016), which provides an opportunity for numerous biological processes to occur with prolonged contact times, including the capture of nutrients and virus infection. Here, we show that the entrainment mechanism is universal for different organisms, C. reinhardtii, T. subcordiforms and O. marina, regardless of diversity in propulsion mechanism and hydrodynamic signature. The flows generated near these microbes are simulated throughout the swimming stroke, and the resulting entrainment lengths compared with our experiments. We find a series of compromises: Flagella can reduce contact times with less tidy interactions, but the entrainment frequency increases as flagella pull particles towards the body. The contact time grows quadratically with swimmer size, but decreases with swimming speed or encounter rate. With the inclusion of Brownian noise, there is an optimal particle size for each swimmer and, conversely, there is an optimal organism for each floating object. We analyse the features of the entrainment mechanism with a Taylor-dispersion theory, and demonstrate how the presented trade-offs may be tuned quantitatively in various biological situations.

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