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Finite Element Modeling of Microswimmers with Applications in Reproductive Biology CARA NEAL, DAVID SMITH, MEURIG GALLAGHER, THOMAS MONTENEGRO-JOHNSON, University of Birmingham — The journey of human sperm to the egg is a complex and extremely important process. Sperm cells must navigate the intricate geometry of the fallopian tubes, generating active bending to swim through cervical mucus - a highly viscous, rheologically complex fluid. Many current models of sperm locomotion are computationally expensive, and most make the inaccurate assumption that the surrounding fluid is Newtonian. Here we develop a method capable of dealing with the non-linear equations associated with non-Newtonian fluids. This method uses a combination of a finite element technique and an elastohydrodynamic integral formulation (Hall-McNair et al. 2019) to model sperm cells with active flexible flagellum. This formulation provides an efficient way of modeling single or multiple cells, accounting for the hydrodynamic interactions between them. In particular, the finite element component is formulated in such a way that the solution can be calculated on a coarse mesh, for reduced computational costs compared to more commonly used body-fitted meshes. We study how the model can be made more biologically accurate through the inclusion of varying bending stiffness as well as a passive distal region of the flagellum, and the subsequent effect on swimming efficiency.

Cara Neal
University of Birmingham

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