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Modeling of Fluid-Membrane Interaction in Cellular Microinjection Process[1] MEHDI KARZAR-JEDDI, JHON DIAZ, NEJAT OLGAC, TAI-HSI FAN, University of Connecticut — Cellular microinjection is a well-accepted method to deliver matters such as sperm, nucleus, or macromolecules into biological cells. To improve the success rate of *in vitro* fertilization and to establish the ideal operating conditions for a novel computer controlled rotationally oscillating intracytoplasmic sperm injection (ICSI) technology, we investigate the fluid-membrane interactions in the ICSI procedure. The procedure consists of anchoring the oocyte (a developing egg) using a holding pipette, penetrating oocyte's zona pellucida (the outer membrane) and the oolemma (the plasma or inner membrane) using an injection micropipette, and finally to deliver sperm into the oocyte for fertilization. To predict the large deformation of the oocyte membranes up to the piercing of the oolemma and the motion of fluids across both membranes, the dynamic fluid-pipette-membrane interactions are formulated by the coupled Stokes' equations and the continuum membrane model based on Helfrich's energy theory. A boundary integral model is developed to simulate the transient membrane deformation and the local membrane stress induced by the longitudinal motion of the injection pipette. The model captures the essential features of the membranes shown on optical images of ICSI experiments, and is capable of suggesting the optimal deformation level of the oolemma to start the rotational oscillations for piercing into the oolemma.

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