CENTER FOR FLUID MECHANICS
AND
THE FLUIDS, THERMAL AND CHEMICAL PROCESSES GROUP
OF
THE DIVISION OF ENGINEERING
SEMINAR SERIES

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Red Blood Cell Dynamics in Microcirculatory Flows

Red blood cells (RBCs) exhibit rich behavior in viscous flows. For example, in steady shear flow, RBCs can tank-tread, tumble, or "swing" (tank-treading accompanied by oscillations in the inclination angle). I will present a model that quantitatively describes this behavior. The analysis accounts for the fact that the membrane is deformable, incompressible, and resistant to bending and shearing. Considering a nearly spherical shape, we obtain analytical solutions for the creeping-flow equations via a regular perturbation expansion in the excess area.

In steady shear flows, the theory shows that a closed lipid membrane (vesicle or RBC) deforms into a prolate ellipsoid, which tumbles at low shear rates, and swings at higher shear rates. The amplitude of the oscillations decreases with shear rate. In quadratic flows, the theory predicts a peculiar coexistence of parachute- and bullet-like vesicle shapes at the flow centerline. Vesicles and RBCs always migrate towards the flow centerline unlike drops, whose direction of migration depends on the viscosity ratio. In time-dependent flows, vesicles can exhibit chaotic dynamics.

Tuesday, April 14 2009
Barus & Holley, Room 190
4:00pm