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Leukocyte Margination in a Model Microvessel JONATHAN FREUND, University of Illinois at Urbana-Champaign — In the inflammation response, multi-body interactions of blood cells in the microcirculation bring leukocytes (white blood cells) to the vessel walls. We investigated the fluid mechanics of this using numerical simulations of 29 red blood cells and one leukocyte flowing in a two-dimensional microvessel. The cells are modeled as linearly elastic shell membranes. Though obviously simplified, this model reproduced the increasingly blunted velocity profiles and increased leukocyte margination observed at lower shear rates. To study its effect, we varied the relative stiffness of the red cells by over a factor of ten, but the margination was found to be much less correlated with this than to the bluntness of the mean velocity profile. The detailed velocity field around near-wall leukocyte was sensitive to the red cell stiffness, but it changed little for strongly versus weakly marginating cases. In the more strongly marginating cases, however, a red cell is typically leaning on the upstream side of the leukocyte and appears to stabilize it. A well-known feature of the microcirculation is a near-wall cell-free layer. We observed that the leukocyte's most probable position was at the edge of this layer, whose thickness increased following a lubrication scaling. The leukocyte's near-wall position is observed to be less stable with increasing mean stand-off distance, but this distance would have potentially greater effect on adhesion since the range of the molecular binding is so short.

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