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Dynamics of Red Cells in Spleen: How Does Vesiculation Happen? QIANG ZHU, SARA SALEHYAR, PEDRO CABRALES, ROBERT ASARO, UC San Diego — Vesiculation of red blood cells as a result of local separation between lipid bilayer and cytoskeleton is known to happen in vivo, most likely inside spleen where they sustain large mechanical loads during the passage through venus slits. There is, however, little knowledge about the detailed scenario and condition. We address this question via a fluid-cell interaction model by coupling a multiscale model of the cell membrane (including molecular details) with a fluid dynamics model based on boundary-integral equations. A numerical flow channel is created where the cell is driven through a narrow slit by pressure (imitating the transit through venus slits in spleen). The concentration is the occurrence of large dissociation (negative) pressure between the skeleton/membrane connection that promotes separation, a precursor of vesicle formation. Critical levels for the negative pressure are estimated using published data. By following the maximum range of pressure, we conclude that for vesiculation to happen there must be biochemical influences (e.g. binding of degraded haemoglobin) that significantly reduce effective attachment density. This is consistent with reported trends in vesiculation that are believed to occur in cases of various hereditary anemias and during blood storage. Our findings also suggest the criticality of understanding the biochemical phenomena involved with cytoskeleton/membrane attachment.

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