Blood platelet formation - a biological Rayleigh-Plateau instability

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Blood platelets form out of long protrusions, which are established by stem cells into blood vessels of the bone marrow. After extension these protrusions fragment into the blood platelets. Despite experimental identification of cytoskeletal dynamics, a biophysical understanding of this fragmentation into platelets and of its connection to blood flow is at present absent.

We use a newly developed 3D Lattice-Boltzmann/Immersed-Boundary method for active elastic cell membranes in presence of fluid flow [1] to investigate this fragmentation process and provide a biophysical explanation: cytoskeletal active stress triggers a pearling instability, which fragments the protrusion into platelets. This instability can be understood as a biological Rayleigh-Plateau instability with the active stress playing the same role as the surface tension of a liquid jet. Rather than to a biochemical regulation of platelet size, this points to a pure physical regulation, namely by the dominant wavelength of the instability. The presence of external blood flow accelerates the dynamics of the instability strongly in agreement with experimental observations.

[1] C. Bächer and S. Gekle, PRE 99(6), 062418 (2019).