CHEMICAL & BIOMEDICAL ENGINEERING GRAD STUDENT SEMINAR

Beyond Bulk Rheology: The Hidden Mechanical Microenvironment of Blood

Friday, October 9
11:00 AM
COE B221

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ABSTRACT: Blood is a dense suspension of deformable cells. While its bulk rheology has been studied extensively, much less is known about the mechanical environment experienced by individual cells and molecules. In concentrated blood, red blood cells (RBCs) continuously interact and rearrange, generating strong fluctuations in local velocity and stress. I will first show how these collective RBC dynamics govern transport. Multiscale simulations reveal anomalous shear-induced diffusion of suspended particles that is strongly anisotropic and depends nonlinearly on shear rate and hematocrit, demonstrating behavior that cannot be explained by bulk flow alone. I will then show that the same microscale fluctuations can regulate molecular mechanobiology. Our simulations predict that concentrated RBC suspensions amplify tensile forces on von Willebrand factor (VWF), while our experiments show corresponding changes in VWF cleavage, platelet aggregation, and thrombotic occlusion. Finally, I will introduce our ongoing efforts to combine imaging, computational mechanics, and physics-informed machine learning to infer these microscale rheological fields that are otherwise inaccessible.

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