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Integrated Computational and Experimental Biomechanics Approaches for Red Blood Cell-Borne Human Diseases

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This presentation summarizes our recent studies carried out both experimentally and computationally in understanding red blood cell (RBC) mechanics and biorheology, as well as RBC-borne human diseases. A wide variety of biomechanics experimental tools were used and/or developed including optical tweezers, microfluidic devices, atomic force microscopy, micropipette aspiration, diffraction phase microscopy, tomographic phase microscopy, etc. At the same time, integrated multiscale models were developed at molecular, cellular and tissue/organ levels, involving methods and techniques such as molecular dynamics (MD), dissipative particle dynamics (DPD), finite element method (FEM) and boundary element method (BEM). Specific examples will be detailed for Plasmodium falciparum malaria as well as heredity disorders such as sickle cell anemia. The presentation will also highlight some of the latest experimental results obtained using microfluidic devices, as well as the simulation results recently obtained using a two-component RBC membrane model where the spectrin network and the lipid-bilayer are modeled separately.

Keywords: Red blood cell, Biomechanics, Malaria, Sickle cell anemia