RED BLOOD CELL ACTIVITY UNDER OPTICAL TWEEZERS

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Red blood cells (RBCs) possess unique mechanobiology that allows them to navigate efficiently through capillaries smaller than their own size. This ability is underpinned by the active biomechanics of the cells, which is driven by glycolytic ATP production and manifests as out-of-equilibrium fluctuations of the plasma membrane [1, 2]. These fluctuations, often seen as enhanced flickering, are propelled by motor proteins that mediate interactions between the spectrin skeleton and the lipid bilayer [3].

However, modulating this flickering in living RBCs without permanently altering their mechanical properties has been a significant challenge.

Our study aims to explore the effect of optical tweezers on RBC membrane flickering activity. We applied optical tweezers directly on individual RBC membrane. Our approach allows (i) for sensing the local force exerted by active kickers and (ii) for inducing a programmable trapping potential that can modulate flickering oscillations [4]. Our optical tweezers show negligible phototoxicity and a reversible manipulation of membrane flickering. We underscore the critical role of ATP in maintaining RBC membrane flexibility and dynamic behavior. Our findings provide insights into the mechanisms of RBC deformability and pathological conditions and set the basis for a novel approach to the optical control of biophysical forces.

Figures

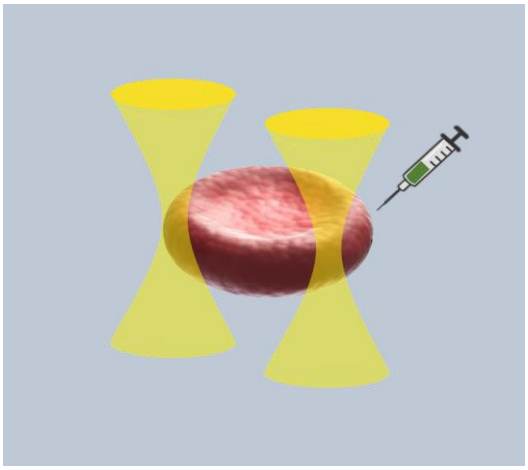

Figure 1. Schematics of a single red blood cell tested by multiple optical tweezers under different drug treatment.

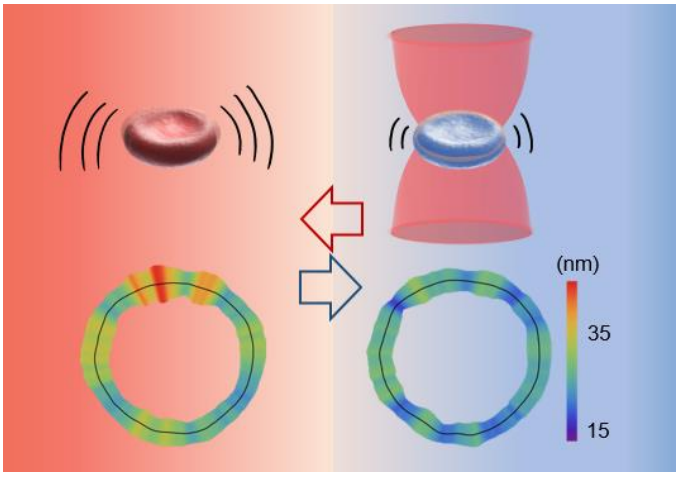

Figure 2. Free standing and active RBC (left panel) reversibly trapped by holographic optical tweezers (right panel), alongside the corresponding membrane deformation maps.

References

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