Stochastic bond dynamics induce optimal alignment of malaria parasite

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Merozoites, malaria parasites during the blood-stage of infection, invade healthy red blood cells (RBCs) to escape from the immune response and multiply inside the host. The invasion occurs only when the parasite apex is aligned with RBC membrane, making the parasite alignment a crucial step for the invasion. Recent experiments have also demonstrated that there is a considerable membrane deformation during the alignment process. In this work, using mesoscopic simulations we assess the exact roles of RBC deformations and parasite adhesion during the alignment. Using coarse-grained models of a deformable RBC and a rigid parasite, we show that both RBC deformation and parasite adhesion bond dynamics are important for an optimal alignment. By calibrating the parasite's motion properties against experiments, we show that simulated alignment times match quantitatively with the experimental alignment times. We find that the stochastic nature of adhesion bond kinetics is the key for inducing optimal alignment times [1]. We also show that alignment times increase drastically for rigid RBC which signifies that parasite invasion is less probable into already infected RBC and that membrane deformations during the parasite alignment. Finally, we will demonstrate the importance of parasite shape in the alignment process [2].

[1] Hillringhaus, S., Dasanna, A. K., Gompper, G., & Fedosov, D. A., Stochastic bond dynamics facilitates alignment of malaria parasite at erythrocyte membrane upon invasion. *eLife*, *9*, e56500 (2020).

[2] Dasanna, A. K., Hillringhaus, S., Gompper, G., & Fedosov, D. A., Effect of malaria parasite shape on its alignment at erythrocyte membrane. *eLife*, *10*, e68818 (2021).