Receptor-mediated membrane-nanoparticle interaction

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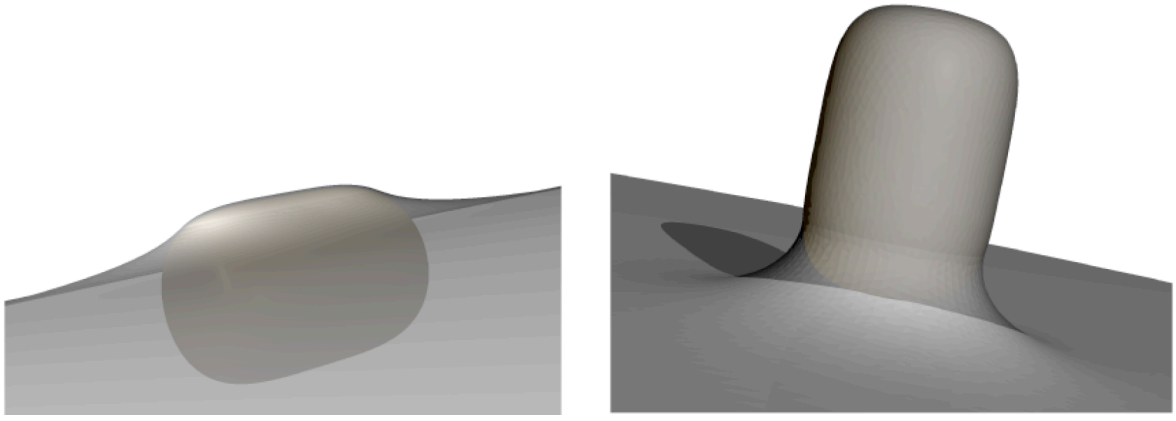
Abstract

Recent advances in nanotechnology have made a zoo of engineered particles with various shapes available for applications, and a wide variety of shapes is also found for viruses and parasites. For wrapping of nanoparticles with sizes above 20nm by lipid-bilayer membranes, the relevant energy contributions are the deformation energy cost for the membrane and the adhesion energy gain upon contact of nanoparticle and membrane. Particle shapes strongly influence deformation energies and therefore wrapping states, which can be free, membrane-bound, and completely wrapped.[1] Non-spherical particles, such as ellipsoidal, cube-like, and rod-like particles, experience increased stability of membrane-bound states compared with spherical particles.[2] Egg-shaped malarial parasites that invade erythrocytes have a very rich wrapping phase behavior.[3] In addition to the particle properties, the elastic properties of the membrane and the nanoparticle-membrane interaction determine the wrapping behavior.

Starting with systems for various shapes and sizes of particles and bending rigidities and tensions of membranes, I will discuss nanoparticle wrapping for systems where the adhesive interaction is mediated via receptor-ligand bonds. In addition to the strength of the bonds, in this case also receptor density and entropy have to be taken into account. Membrane-bound states are found for spherical particles that are wrapped by membranes without tension. Interestingly, these states can be suppressed for small bond energies that lead to more homogeneous receptor distributions on the membrane where we find complete wrapping. Our calculations bridge the gap between model membranes that interact with nanoparticles via van der Waals interaction and complex biological membranes, for that a multitude of molecular interactions may occur.



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[3] S. Dasgupta et al., Biophys. J. **107**, 43 (2014)