Spatiotemporal control over adhesions of synthetic cells using light

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Many functions in cells arise directly from the spatial and temporal regulation of cell-matrix and cell-cell interactions. [1] In this talk, I will present strategies of how such spatiotemporal control over adhesions of synthetic cell-like systems can be achieved with visible light. These light triggered and reversible interactions mimic the dynamics of interactions observed in biology, and allow modulating the interactions as desired without disturbing other processes in the system.
A prime example for spatiotemporal regulation resulting in function are the adhesions during cell motility. As cells move new adhesions form at the front and adhesions disassemble at the back. To replicate this dynamic and spatiotemporally controlled asymmetry of adhesions and achieve motility in a minimal synthetic cell, we controlled the adhesion of a model giant unilamellar vesicle (GUV) to the substrate with light. For this purpose, we immobilized the proteins iLID and Micro, which interact under blue light and dissociate from each other in the dark, on a substrate and a GUV, respectively. Under blue light the protein interaction leads to adhesion of the vesicle to the substrate, which is reversible in the dark. The high spatiotemporal control provided by light, allowed partly illuminating the GUV and generating an asymmetry in adhesions. Consequently, the GUV moves into the illuminated area, a process that can be repeated over multiple cycles. [2] Thus, our system reproduces the dynamic spatiotemporal distribution of adhesions and establishes mimetic motility of a synthetic cell.
Cell to cell communication is a process that depends on the proximity of a sender and a receiver cells. Similarly, using photoswitchable adhesions between sender GUVs and receiver GUVs we are able to regulate their communication through soluble molecules with light. [3] Overall, our work on one hand provides insight into underlying design principles of life and on the other hand allows addressing questions in cell biology as well as engineer new synthetic cell biology.

REFERENCES

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