

Matter to Life: Assembly of Synthetic Cells, *Scientific and Educational Challenges*

Joachim P. Spatz, Max Planck Institute for Medical Research, Heidelberg, Germany

The evolution of cellular compartments for spatially and temporally controlled assembly of biological processes was an essential step in developing life by evolution. Synthetic approaches to cellular-like compartments are still lacking well-controlled functionalities, as would be needed for more complex synthetic cells. With the ultimate aim to construct life-like materials such as a living cell, matter-to-life strives to reconstitute cellular phenomena *in vitro* – disentangled from the complex environment of a cell. In recent years, working towards this ambitious goal gave new insights into the mechanisms governing life. With the fast-growing library of functional modules assembled for synthetic cells, their classification and integration become increasingly important. We will discuss strategies to reverse-engineer and recombine functional parts for synthetic eukaryotes, mimicking the characteristics of nature's own prototype. Particularly, we will focus on large outer compartments, complex endomembrane systems with organelles, and versatile cytoskeletons as hallmarks of eukaryotic life. Moreover, we identify microfluidics and DNA nanotechnology as two highly promising technologies which can achieve the integration of these functional modules into sophisticated multifunctional synthetic cells.



Bio: Joachim P. Spatz joined the Max Planck Institute for Medical Research in Heidelberg in 2016 as a Director for the Department of Cellular Biophysics. Since 2004, he has been a Full Professor and head of the Department of Biophysical Chemistry at the University of Heidelberg, which he joined as an Associate Professor in 2000. From 2004 to 2015, he was a Director at the Max Planck Institute for Intelligent Systems, heading the Department of New Materials and Biosystems. Prof. Spatz received his Diploma in Physics (1994) and his Ph.D. in Physics (1996) from the University of Ulm under the supervision of Prof.

Möller (DWI & RWTH Aachen). From 1997 to 1998, he was a postdoc at the Institut Curie, Paris. He received his habilitation in Physics from 1999 to 2000 at the University of Ulm.