

Biotechnology and Life Sciences in Baden-Württemberg

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Stefan Schiller – understanding and copying complex molecule systems

Proteins, lipids, carbohydrates and nucleic acids are important building blocks of life – however, they need to become macromolecular structures before they are able to fulfil the functions of a cell's daily business. Dr. Stefan Schiller from the Institute for Macromolecular Chemistry at the University of Freiburg became interested in the diversity of molecular possibilities in nature as a student and is now a specialist in bionic chemistry and synthetic nanobiotechnology. Amongst other things, his work involves the construction of complex protein machines that transfer signals, protein networks for use in medicine and drug shuttles that enable the targeted delivery of drugs.



Dr. Stefan Schiller from the University of Freiburg carries out research in the field of bionic chemistry and synthetic nanobiotechnology. (© private)

Imagine sitting in the cabin of a crane and assembling building blocks and machines and establishing a production chain work process – but instead of being in a real crane, you're in an imaginary one in the world of molecules and cells. Modern chemists have long been transferring the principle of the polymer sciences to living systems as well as modelling natural principles for use in nanoengineering, a field of research that is nowadays widely known as 'synthetic biology'.

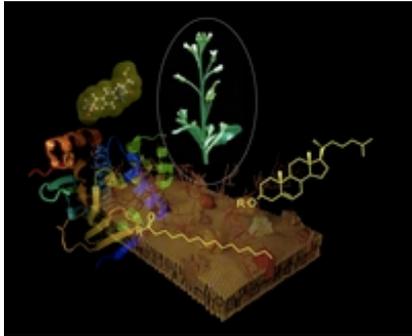
"I have always been interested in complex systems," said Dr. Stefan Schiller from the Institute for Macromolecular Chemistry at the University of Freiburg, Junior Fellow of the Freiburg Institute for Advanced Studies (FRIAS) and member of the Centre for Biological Signalling Studies (BIOSS). Like one of his role models, the Nobel Laureate Hermann Staudinger, Schiller is highly fascinated by the broad range of possibilities arising from combining molecules into higher-level structures. He has learned over the years how to specifically use these possibilities for different applications.

A kit with chemical and biotechnological methods

Artificial multifunctional biomembranes, biomimetic materials for clinical applications or novel energy transducers on solar cell electrodes based on the model of the photosynthesis apparatus of plants – is this possible? Schiller's current interest is based on experiences he had during his studies and a research stay at the University of Massachusetts/Amherst, USA where he learned to construct artificial membrane systems with proteins and lipids and use micromanipulators to form tube-like nanostructures reminiscent of nerve axons.

Schiller, who was born in Wiesbaden in 1971, returned to Germany after being in the States and did his degree thesis at the University of Mainz where he specialised in organic chemistry, biochemistry and macromolecular chemistry. He learned to synthesise so-called glycolipids such

financial injection from the University of Freiburg's Innovation Fund and from the Research Seed Capital (RiSC) programme run by the Baden-Württemberg Ministry of Education, Research and the Arts. This provided the basis for further funding of the idea as part of the DFG- (German Research Foundation) funded 1623 programme entitled "Chemoselective reactions for the synthesis and application of functional proteins".



Deciphering the lipid code: lipids that are attached to proteins have important functions in cells, including the anchoring of proteins in the cell membrane or in the membrane of other organelles, which is crucial for the control of the spatial and temporal distribution of enzymes and signalling molecules. (© Dr. Stefan Schiller)

This particular project focuses on the role of lipid components that are bound to cellular proteins. Lipids are important for many protein functions; for example, they mediate the binding of proteins to membranes inside cells, which makes them indispensable for the spatial and temporal distribution of proteins. In a way, they help conduct cellular processes. "The lipid code needs to be deciphered before it can be applied to cellular protein chemistry," said Schiller highlighting his team's plans for the next few years.

Two more examples show that Schiller's team is both interested in and dealing with a broad range of different topics. Schiller and his colleagues are currently experimenting with doughnut-like protein polymer structures that they attach to the surface of solar cell electrodes. The centre of the doughnuts can be equipped with different metal nanoparticles and used to convert sunlight into electricity, just like the reactive centres of the photosynthesis machines in plants. They provide excellent prospects for solar technology.

Using a patented biotechnological procedure based on a plasmid, Schiller and his team are also able to construct structures from modified components of the protein elastin, which normally occurs in the skin. The researchers thus create

novel polymers that can be used in all areas of the material sciences and in the field of biomedicine. These polymers can be produced in *E. coli*, which is a lot cheaper than chemical procedures and can also be easily scaled up. In summary, a lot of construction work is going on in Freiburg, albeit that most of the constructions are only visible under the microscope.

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A contribution from:



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