NUS National University of Singapore | Department of Pharmacy Faculty of Science

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S4A-L3 Room A & B

Chemically Engineered Protein Therapeutics – Advancing Beyond the Genetic Code for Biomedical Research

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Hosted by A/P Rachel Ee

Proteins are the central workhorse in Nature, accounting for numerous chemical processes that dictate the function of life. In recent years, their exclusive features such as, hierarchical order, specific activity and high efficiency have been exploited for technological advancements in both materials and biological sciences. Notably, there is an upsurge of activities in the field of pharmaceutics to exploit these macromolecules as potent weaponry to combat modern diseases such as infections and cancer. Nevertheless, the field is still fraught with challenges such as bioavailability, formulation and stability *in vivo*. Consequently, recombinant technologies that exploit the biochemical machinery has been engaged to modify native proteins to modulate their properties to overcome some of these challenges. However, with the complexity and parallel evolution of modern diseases e.g. multidrug resistance and heterogeneity of diseased cells, there is an increasing urgency to develop solutions that allow rapid customization and optimization of therapeutics to tailor to specific needs. Inspired by post-translational processes in Nature, chemical tools have been capitalized upon to combine synthetic entities with biomacromolecules to overcome the limitations of the genetic code and greatly expand the existing biomedical arsenal.

Our strategies focus on developing chemical functionalization of proteins in a precise fashion by adopting both covalent and supramolecular chemistry. In this manner, the exact placement of synthetic functionalities into proteins results in *avant garde* biomaterials with highly desirable features, namely cell-targeting, intracellular transport and stimuli responsiveness, for applications in drug and protein delivery and bioimaging. By further merging our chemical tools with molecular biology, the flexibility in customization can be greatly enhanced to even configure system that possess unique architectures and features, for e.g. to address hallmark targets in specific diseased cells. Through an overview of our current strategies, we will demonstrate that the integration of chemistry into biology can lead to the innovation of protein therapeutics that exceed the limits imposed by Nature and even surpass the performance of existing approved therapeutics.

Prof. Tanja Weil is the director of the Department of Macromolecule Synthesis at the Max Planck Institute for Polymer Research in Mainz, Germany since 2017. She studied chemistry (1993–1998) at the TU Braunschweig (Germany) and the University of Bordeaux I (France) and completed her PhD at the MPI for Polymer Research under the supervision of K. Müllen. From 2002 to 2008 she managed different leading positions at Merz Pharmaceuticals GmbH (Frankfurt) from Section Head Medicinal Chemistry to Director of Chemical Research and Development. In 2008 she accepted an Associate Professor position at the National University of Singapore in the Department of Chemistry. Tanja Weil joined Ulm University as Director of the Institute of Organic Chemistry III / Macromolecular Chemistry in 2010. In 2003 she received the Otto Hahn Medal of the Max Planck Society. In 2012 Tanja Weil has been awarded the ERC Synergy Grant together with Fedor Jelezko and Martin Plenio and the Bruno-Werdelmann-Lecture of the University Duesburg-Essen in 2014. She serves in several national and international advisory boards such as the International Advisory Board of Advanced Science (Wiley), the Editorial Advisory Board of the Journal Biomacromolecules, the Editorial Advisory Board of the Journal of the American Chemical Society and the Editorial Board of Biomaterials Science. Her scientific interests include the synthesis of protein hybrids and translational drug delivery, the synthesis of quantum materials, customized and adaptive macromolecules for precision sensing and therapy, as well as polymeric catalysts and hybrid membranes that outperform existing materials. She has published more than 130 papers, more than 200 patent applications and her articles have received 5500 citations.