Biomaterials Plenary
Room 209 F W - Session BP-SuA

Biomaterials Plenary Session (ALL-INVITED SESSION)

Moderators: Sapun Parekh, University of Texas at Austin, **Christopher So**, Naval Research Laboratory

3:00pm **BP-SuA-1 Protein Structure at Interfaces – Its Where the Action Is**, ***Tobias Weidner,*** Aarhus University, Denmark **INVITED**

Proteins are the machinery of life -– understanding protein structure provides important clues about their mode of action. For this reason, more than 100.000 protein structures have been determined experimentally and are available in databases. At the same time, information about interfacial proteins is sparse. Not a single structure of an interfacial protein can be found in databases. We lack critical information about interfacial proteins to understand biomembranes, the protein control of biominerals, the health impact of artifical biomaterials and the toxicity of microplastic. In addition, for sensor or nanotechnology application, understanding protein binding to surfaces will be key. The current lack of information is, in part, explained by the experimental difficulty of determining the structure of protein within a monomolecular layer in the overwhelmingpresence of unbound proteins in solution near the interface. Here, sum frequency generation (SFG) spectroscopy has been developed into a surface sensitive tool to probe protein structure in detail. We have recently developed methods combining molecular dynamics (MD) simulations with SFG spectroscopy to follow the binding, structure and motion of interfacial proteins. As recent examples, I will discuss breakthroughs in understanding how the formation of neurotoxic aggregates of α-synuclein, the protein implicated with Parkinson's disease, is accelerated at cell membrane. Our data show that at slightly elevated concentrations, α-synuclein assumes a binding pose that promotes lateral aggregation at membrane interfaces. Interfacial effects can also be pronounced atnanoparticle interfaces – which can be important for health in view of the large amounts of plastic particles found in humans. When elucidating the toxicity of plastic particles, we find that nanoparticles affect the conformation of human proteins much more than flat surfaces, with significant consequences for the toxicity of plastics particles.

3:45pm **BP-SuA-4 Platelet-Like Biomaterials for Hemostasis and Regenerative Medicine**, ***Ashley Brown,*** North Carolina State University and UNC Chapel Hill **INVITED**

Platelets play a critical role in hemostasis and tissue repair after injury. Our group has created synthetic platelet-like-particles that mimic the fibrin binding ability of native platelets to target wound sites, augment clotting, and mechanically enhance clot structure and stability via particle mediated clot retraction. These materials can be easily modified to deliver drugs and/or used in conjunction with fibrin scaffolds for cell delivery. In this talk, I will describe the development and use of the platelet-like-particle platform for applications in trauma care and tissue regeneration.

4:45pm **BP-SuA-8 Enzyme-Powered DNA Materials: Harnessing Tdt for Programmable Nanomedicine and Adaptive Assemblies**, ***Stefan Zauscher,*** Duke University **INVITED**

Nature rarely builds without a blueprint—but the enzyme terminal deoxynucleotidyl transferase (TdT) is an exception. This unique catalyst can stitch together natural and synthetic nucleotides *without* a template, offering a molecular "3D printer" for DNA-based materials. We have transformed this capability into TdT-catalyzed enzymatic polymerization (TcEP)—a versatile, aqueous, and programmable route to DNA nanomaterials with unprecedented chemical diversity and architectural control.

With TcEP, we design aptamer-targeted DNA block copolymers that self-assemble into micelles, stably encapsulating and delivering the chemotherapeutic 5-fluorouracil. These micelles resist nuclease degradation and exhibit strikingly higher tumor cell toxicity than the free drug—demonstrating the clinical potential of enzymatically tailored nanocarriers.

Beyond free nanoparticles, TcEP lets us "grow" polynucleotide brushes directly from DNA origami nanostructures (DONs), where we can precisely dictate *when*, *where*, and *how* growth occurs. By integrating restriction enzyme triggers, these modifications become reversible. Incorporating hydrophobic, non-natural nucleotides creates surface patches that drive DONs to assemble into higher-order mesoscale architectures—opening the door to reconfigurable and adaptive biomaterials.

This work positions TcEP as more than a synthetic tool—it is a conceptual bridge between biomolecular chemistry, nanomedicine, and materials science. By merging enzyme catalysis with programmable design, we chart a new path toward stable, multifunctional, and evolvable DNA materials for next-generation therapeutic and structural applications.

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