Sunday Afternoon, October 18, 2015

Biomaterials Plenary Session
Room: 211D - Session BP-SuA

Biomaterials Plenary Session
Moderator: Graham Leggett, University of Sheffield

3:00pm **BP-SuA1 Phage, Peptides and Polymers: Targeted Polymeric Delivery using Peptide Ligands Identified by Phage Display**, *L. Chan, M. Cieslewicz, G. Liu, B. Livesay, C. Ngambenjawong,* ***Suzie Pun****, S. Salipante, N. White*, University of Washington **INVITED**

Peptide phage display is a powerful tool for identifying novel targeting ligands. We have recently used peptide phage display combined with next generation sequencing for efficient identification of targeting ligands. I will first present our discovery of a peptide that preferentially binds to "anti-inflammatory" (M2) macrophage. This peptide can be used to target tumor-associated, M2-like macrophage in the tumor microenvironment. Multivalent display of this peptide using peptide-based copolymers significantly increases binding avidity of the polymer with M2 cells. In a second example, a fibrin-binding peptide identified by the Caravan Group (Massachusetts General Hospital) using peptide phage display was incorporated into brush-shaped, peptide-based copolymers. These polymers were synthesized by controlled radical polymerization with well-defined compositions and molecular weights and possess the biological functions contributed by their peptide components. The resulting polymer incorporates into forming clots and increases clot strength while improving resistance to clot lysis. Delivery of this polymer to a rat model of trauma significantly improved survival compared to controls.

3:40pm **BP-SuA3 Experimental and Theoretical Challenges regarding the Fundamental Interactions between Biomolecules and Biosurfaces**, ***Jacob Israelachvili***, University of California at Santa Barbara **INVITED**

I will try to consider some key fundamental questions and challenges in the interactions of biomolecules and biosurfaces – what important interactions we still don't understand, what is known but is subtle and often misunderstood, and current experimental and theoretical limitations that need to be overcome – all with examples to illustrate the points being made.

The hydrophobic interaction is one of the most important for determining biomolecular organization (of membranes, proteins) but is still not understood both at the experimental and theoretical levels; for example, there is still no generally accepted "interaction potential" or "force law" for this interaction, although it appears to be an exponential functions of the separation between surfaces (but as yet totally unknown between molecules or hydrophobic groups).

Perhaps more importantly for biological interactions, given that living systems are never at rest, or at thermodynamic equilibrium, or even necessarily tending toward the equilibrium state, the issue of non-equilibrium interactions is still a very dark area. I am not referring here to viscous forces, but to interaction potentials that are *inherently* rate or time-dependent. Some ligand-receptor binding and unbinding interactions present good examples of such "dynamic" interactions.

A very commonly misunderstood feature in the area of bioadhesion is the difference between strong and weak bonds, or high adhesion and low adhesion. Without specifying whether one is talking about the energy or the force, any comparisons can be meaningless. Examples will be given of real situations where the same change in energy can result in 8 orders of magnitude difference in the forces (pressures or stresses) depending on the geometry, i.e., structure and mechanical properties of the adhering (bio)material surfaces. There are also many practical situations where friction and adhesion forces are involved simultaneously, for example, when geckos run on walls and ceilings, giving rise to very subtle effects.

Experimental and theoretical (e.g., simulation) challenges involving complex biological interactions will also be discussed: these involve 'scaling effects of *size*' (converting the interactions of single or a few molecules or bonds to those between biological surfaces that involve the correlated interactions of many molecules or bonds, usually at different locations), and 'scaling effects of *time*' where the time scales of a biological process involving multiple (sequential) interactions that evolve both in space and time over large distances and long times are currently inaccessible by computers.

4:20pm **BP-SuA5 Biomimetic Surface Coatings Inspired by Polyphenols Found in Mussels, Tea, Wine and Chocolate**, *T. Sileika, D. Barrett,* Northwestern University, ***Phillip Messersmith***, University of California at Berkeley **INVITED**

Polyphenols are found in both plant and animal tissues, where they serve a variety of functions including mechanical adhesion, structural support, pigmentation, radiation protection, and chemical defense. In animals, polyphenols are found in the adhesive proteins secreted by sessile marine organisms. In mussels, the adhesive proteins are known to contain high levels of 3,4-dihydroxy-L-alanine (DOPA), an amino acid that is believed to be important in adhesion to substrates. In plants, polyphenolic compounds containing benzenediol (catechol) and/or benzenetriol (gallol) functional groups are widely distributed secondary metabolites with a variety of biochemical and physical functions. Consumption of foods and beverages rich in polyphenols are claimed to be beneficial to one's health.

This talk will focus on selected biological polyphenols that are rich in catechol or gallol functional groups, with the goal of developing novel materials inspired by biological polyphenols. In the case of mussel-inspired biomaterials, we focus on understanding the molecular aspects of mussel adhesion, and in developing biomimetic polymer hydrogels and coatings from synthetic catechol containing polymers[1-4]. These biologically inspired materials have a variety of functional uses, including tissue repair, drug delivery and antifouling coatings. In the case of plant polyphenols, we as well as others have recently discovered that gallol-rich compounds found in tea, coffee beans, cacao beans and other plant tissues form thin adherent polymerized films on substrates by simple immersion [5,6]. Deposition is facile on a variety of solid, porous and nanoparticulate substrates composed of metals, ceramics and polymers. In addition to possessing inherent antibacterial and antioxidant properties, the nanoscale polyphenol films serve as versatile 'primers' facilitating secondary modifications of the primer coating such as metallization and covalent grafting of biomolecules and synthetic polymers. Such secondary modifications can be exploited for a variety of practical applications, including antibacterial, antioxidant and fouling resistant coatings on medical devices, metal deposition, plasmonic tuning and surface functionalization of nanoparticles.

References

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