Langmuir
The ACS Journal of Surfaces and Colloids

MARCH 4, 2003
VOLUME 19, NUMBER 5

Preface

The Biomolecular Interface

This special issue, *The Biomolecular Interface*, addresses an area of study that defines the field of biological surface science. This field, which has evolved naturally from the study of soft organic matter and the chemistry and physics of self-assembly, represents a fusion of two disciplines, materials science and biological science. Each of these highly multidisciplinary fields is experiencing explosive intellectual and technological progress. The tools for study of this new field include surface science techniques such as scanned probe microscopies and molecular biology strategies such as genetic engineering.

The articles in this issue of *Langmuir* are a clear indication of how the rapid advances that have occurred in materials chemistry, lithography, microfabrication, and microfluidics are providing important new analytical approaches, and important new insight, into the physical chemistry of biological responses at the molecular and supramolecular level. In this issue, we find that the field of biological surface science has progressed well beyond phenomenology and the demonstration of novel, interesting structures that are fabricated from biological molecules. The focus of these articles includes analytical applications based on closely controlled molecular arrangements, fundamental studies of the forces behind structural determinants in assemblies of biological molecules, and novel ways of testing the effect of molecular conformation or location of biomolecules on intracellular signaling. These studies use and probe the supramolecular arrangements of biological molecules that determine their complex biological functions.

The journal *Langmuir* is devoted to the study of the interactive forces of molecules at interfaces. Thus, it is natural that the interaction of biological proteins and lipids at the air−water interface constitutes an important subset of papers in this issue. Lipid monolayers at the air−water interface are used to address questions associated with membrane complexes known to be important in enzyme-mediated intracellular signaling (Momsen et al.) and other complexes that mimic the controversial putative membrane structure, the lipid raft (Keller). Protein crystallization at the lipid interface is addressed by examining the effect of subtle changes in ionic strength on streptavidin two-dimensional crystallization, a study inspired by the results from single-point mutations of the protein (Ratanabanangkoon et al.).

The solid−liquid interface is also of great importance in studies of biomolecular structure/function and in biological assay applications. The effect of surface adsorption on protein conformation is probed by time-of-flight secondary ion mass spectrometry (Horbett et al.). Surface confinement is shown to play an important and special role in the kinetics of biospecific interactions at cell membranes (Lagerholm et al.). Surface-supported lipid membranes provide new insight into membrane protein structure/function (Zhao et al.). New approaches are used to fabricate supported membranes that mimic the surface of biological tissues (Sengupta et al.).

Highly controlled surface chemistries are widely accessible thanks to the pioneering work of Nuzzo and Allara on alkanethiol self-assembly (*J. Am.*

10.1021/la034035z CCC: $25.00
Published on Web 02/25/2003

Chem. Soc. **1983**, *105*, 4481−4483), which spawned the large body of work that includes methodologies for two-dimensional patterning of surface chemistries. The impact of that work is evident in this current collection, particularly with respect to surface immobilization of DNA, lipids, and proteins. Systematic studies present the effect of surface hydrophobicity on protein adsorption (Ostuni et al.). New studies describe novel chemistries for controlling protein adsorption (Gawalt et al.) and preventing nonspecific adsorption of proteins (Grunze et al.; Horbett et al.). The order and organization of biological molecules in patterns at surfaces is used in applications development as well as for addressing fundamental questions of molecular interactions. A novel way of manipulating patterned lipid membranes at surfaces is demonstrated using laminar flow (Kam et al.). Measurement and predictive tools for fabricating microarrays of DNA and proteins are presented (Weisblum et al.; Reichert).

Perhaps the most enticing new developments in the area of biological surface science are the studies directed at cell biology. The confinement of lipid bilayers into small areas has been used to probe the role of features of subcellular dimensions on mast cell activation (Orth et al.). By patterning nonsymmetrical geometries of extracellular adhesive proteins, it is shown how the direction of cellular migration may be controlled (Brock et al.). Such control of surface chemistry has great potential for manipulating live cells (Esenar et al.) as well as for defining the molecular moieties responsible for cell response (Miller et al.; Collard et al.).

The physical and chemical manipulation and analysis of the biological interface clearly have had great impact on the areas of analytical chemistry and sensors, and this issue demonstrates the continued inspiration and energy in these areas. Of great promise and excitement is the role that interface chemistry may serve in understanding cell biology. The interaction between the biology and surface science communities portends a future where such interdisciplinary interactions will lead to new tools, systems, and theories that neither community would have reached alone. We hope that this special issue will initiate a forum for continued discussion between the scientists working at the intersection of biology and surface science.

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