PREFACE

Eva-Kathrin Sinner,
Ingo Köper, and
Wolfgang Knoll

Solid supported membranes are a novel class of model membranes that complement the set of platforms traditionally available and used for biophysical and interfacial studies of lipid bilayers and lipid/protein composites. These include the Langmuir monolayers assembled at the water/ air interface, the bulk vesicle (liposomal) dispersions, and the bimolecular lipid membrane (BLMs). All these architectures have their advantages but also limitations. For example, in Langmuir monolayers spread and compressed at the water surface the packing density and the corresponding phase behavior of lipids in these half-membranes can be manipulated and characterized by a variety of experimental techniques. However, the incorporation of transmembrane proteins is problematic, because the other half of the membrane is missing. Vesicles in either the unilamellar (i.e., one lipid bilayer thick) or multilamellar form are the classical model membrane system, perfectly suited and often used for structural studies. Nevertheless, the simultaneous investigation of functional aspects of the bare membranes and after incorporation of functional units such as proteins is nearly impossible to do. Hence, also no correlation between structure and function can be deduced in either systems, neither the Langmuir monolayers nor the vesicular system. On the other hand, certain functions of lipid bilayer/protein composites, e.g., the translocation of ions across the hydrophobic barrier of a membrane can be studied nicely with the bimolecular lipid membranes, the black lipid membranes. However, due to their fragile nature hardly any structural studies on incorporated protein moieties were possible and were reported.

In this context, the various solid supported membranes including tethered bimolecular lipid membranes (tBLMs), suspended bilayers, or the tethered vesicle systems promise to bridge this gap. They offer the possibility of very detailed biophysical studies of membrane structure, order and dynamics and for the elucidation of the much-needed correlation of these parameters with the function of incorporated (or surface-associated) proteins or protein aggregates. Introduced in the 1980's by the McConnell group, supported membranes rapidly demonstrated their enormous potential for the application of a broad spectrum of experimental techniques. By virtue of the fact that the (fluid) lipid bilayer in this platform is structurally coupled to a robust solid support a much enhanced stability allows for the use of a variety of surface analytical tools, ranging from x-ray and neutron reflectometry, optical techniques, including ellipsometry, surface plasmon- and waveguide spectroscopies, vibrational spectroscopies, fluorescence based techniques, scanning probe methods, and many more. However, functional investigations, e.g., the behavior of membrane integral units diffusing in the two-dimensional matrix of the lipid bilayer, the binding of ligands to membrane-integral receptors, or the translocation of ions across the hydrophobic barrier of the bilayer could be studied in parallel and interpreted on the basis of the simultaneously monitored structural data.

However, the fact that in this system the bilayer is only physisorbed to the substrate, i.e., only floats on top a very thin water layer eventually can lead to delamination and the destruction of the membrane architecture. Hence, attempts were made to further stabilize the lipid matrix and the incorporated proteins by chemically tethering the membrane to the solid support. This was done, in most cases, via flexible spacers that coupled the membrane by these anchor lipids in a stable and robust way to the substrates. At the same time, this approach decoupled the membrane sufficiently from the solid surface to prevent the incorporated proteins from being denatured by their strong interaction with the polar groups of the typically hydrophilic support. An alternative approach was recently reported by which the membrane was coupled (wired) to the support via tethered proteins.

Another platform that resembles the BLMs of the early 1960's are the suspended (nano-) bilayers that span the typically nanoscopic hole(s) of a correspondingly structured solid support. The downscaling of the substrate holes gives this system a much better performance in terms of long term stability. The most recent addition to the family of solid supported membrane architectures was introduced by a concept that tethers whole vesicles via a flexible spacer to the substrate (without inducing the fusion of the vesicle bilayers with the support resulting in the aforementioned supported bilayers). This approach has already proven to allow for very interesting complementary studies combining elements of the classical vesicles with the benefits of an experimental

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platform that is stabilized by the solid support of the substrate.

The progress that has been made in recent years in this cross-disciplinary field of science is remarkable; first attempts to use these lipid bilayer membranes for biosensor development have further increased the interest and research activity in this area. We felt that it would be very beneficial to all of us sharing interests in membrane biophysics and bio-interfaces to bring together the leading experts reporting on their latest research results. To this end we invited the community to "TETHMEM 2007: Novel Model Systems for Bimolecular Lipid Membranes", an international workshop organized by the Max Planck Institute for Polymer Research, Mainz, Germany. It was held September 19–22, 2007 at Schloss Ringberg, Tegernsee, Germany in a continuation of two earlier events, i.e., the workshop "Biosensors utilizing Lipid Bilayer Membranes", organized in 1999 in Mainz, and the "TETHMEM 2005" conference, held in September 2005, also at Schloss Ringberg.

The current special issue of Biointer*phases* gives an account of some of the lectures presented at the last workshop covering all essential aspects of the various platforms. We think that the sum of all the papers gives an excellent overview of the field. Since we did not want to impose any restrictions as to the format of the contributions the reader will find chapters describing original work next to mini reviews (not found typically in Biointer*phases*, however, nicely summarizing the contribution of an individual research group). We are convinced that this special issue reflects the progress in the field and mirrors the enthusiasm of those committed to it.