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Membranes in the cell exist in a wide range of shapes and provide for compartmentalization and transport throughout the cell. Curvature plays an important role in this cellular organization and even the organization of lipids within the membrane itself. Supported lipid bilayers (SLB) continue to be an important means of measuring the thermodynamic and mechanical properties of phospholipid membranes, but on some supports, the proximity of the solid surface may modify the behavior of the adsorbed bilayer. To overcome this problem, we use a technique for spin coating lipids on the substrate that creates multilamellar stacks of membranes[1] where the influence of the substrate on upper layers is weakened. The substrates we have used are nanoscopically patterned with steps and these features induce curvature in the membranes that appear to be step-height dependent. This provides a platform for adhesion, mobility and organizational studies. We show that multilamellar SLB on patterned substrates exhibit curvature induced phase separated domain organization and increased lateral lipid mobility. Molecular dynamics of coarse-grained supported lipid bilayers[2] are used to simulate membranes supported on corrugated surfaces and we discuss and compare the behavior with experimental systems. We show that substrate corrugation height, adhesion energy, and mechanical moduli can be controlled to predict adsorbed membrane curvature. Furthermore we model lipid mixtures in the regions of substrate induced curvature to show the relationship between bending energies and phase separation.

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Concerning a Percolation Concept of Zeta Potential and Electrokinetic Phenomena in Bio-Systems
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The electrokinetic or zeta potential is the basic notion in theory of electrokinetic phenomena. It is defined as electric potential in the interfacial electrical double layer (EDL) at the location of the ''slipping plane'' versus a point in the bulk fluid away from the interface. Many interfacial/electrokinetic phenomena in biological systems can be interpreted in terms of the membrane electrical properties of the cells involved. However, the conventional definition of the zeta potential and a ''slipping plane'' are based on two unrealistic assumptions: (1) that one can realize a procedure of the ''infinitesimal'' change of the continuous layer thickness without changing its topology, during both thinning and growth, and (2) that the interface is ideally homogeneous. These assumptions are already denied with many experimental facts in modern interface science. Instead of the infinitesimal variations of the continuous layer thickness, one has to account topologic transitions from continuous to discrete EDL structures at the interface [1]. During EDL thinning, the hydrodynamic flow stops at a percolation level (effective thickness), corresponding to a discrete film. It brings us to a real and exact meaning of a mythic ''slipping plane''. The zeta potential is the potential corresponding to beginning of percolation of the EDL, or shortly, the ''zeta potential is the percolation potential''. This new paradigm gives effective heuristic keys for quantitative analyzing electrokinetic processes in real disperse systems with heterogeneous interfaces, in part, biointerfaces, such as transport processes in cellular ion channels, cell electrophoresis, electroosmosis, adhesion and fusion [2-3]. Refs.:
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Steady-State Electrochemical Determination of Lipidic Nanotube Diameter Utilizing An Artificial Cell Model
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By exploiting the capabilities of steady-state electrochemical measurements, we have measured the inner diameter of a lipid nanotube using Fick's first law of diffusion in conjunction with an imposed linear concentration gradient of electroactive molecules over the length of the nanotube. Fick's law has been used in this way to provide a direct relationship between the nanotube diameter and the measurable experimental parameters change in current and nanotube length. Catechol was used to determine the change in current attributed to its flux out of the nanotube.

Comparing the nanotube diameter as a function of nanotube length revealed that membrane elastic energy was playing an important role in determining the size of the nanotube and was different when the tube was connected to either end of two vesicles or to a vesicle on one end and a pipette tip on the other. We assume that repulsive interaction between neck regions can be used to explain the trends observed. This theoretical approach based on elastic energy considerations provides a qualitative description consistent with experimental data.

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Statistical Thermodynamic Determination of Chemical Potential From Hamiltonian For Sterol Superlattice Domains in Phospholipid Bilayers
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Multiple experiments suggest that at certain mol fractions ($\chi_{sterol} = C_r$) sterol molecules, cholesterol (chol) and ergosterol (erg), form superlattice (SL) structures occupying particular acyl chain sites in a phospholipid bilayer. We have successfully tested a model against our own nystatin-erg channel data and fluorescence measurements of sterol concentration [1]. Using Kirkwood's coupling parameter method we previously obtained partial agreement with chemical potential data at $\chi_{sterol} = 0.4$. Here we report the results of a more appropriate statistical thermodynamic analysis to determine the chemical potential for our model. We obtained the density of states (DOS) using a binning procedure and the recently developed Wang-Landau algorithm [2]. The form of the DOS dictated a numerical summation for the partition function. Piecewise linearity of the statistical thermodynamic Helmholtz Energy yielded plateaus in the chemical potential consistent with experimental data for $0.20 \leq \chi_{sterol} \leq 0.60$ [3].
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Micro- and Nanoscale Devices For Controlling Two-Dimensional Chemistry
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There is an ever increasing need for methods to perform chemical reactions involving individual molecules, or small molecular assemblies in applications ranging from single enzyme dynamics to molecular electronics. To meet these demands, a transition from traditional 3D, to 2D or 1D reactor systems that reduces the dimensionality, and hence exponentially reduces the number of interacting particles would be beneficial. Low-dimensional systems, unlike bulk ensembles, exhibit some degree of order and can be made on small foot-prints using nanofabrication techniques. However, whereas chemistry can easily be performed in e.g. test tubes, and droplets, initiating and controlling chemistry with the same ease on planar surfaces has been a tremendous challenge. We here present a 2D micro-/nano-fluidic technique with such a capability, and where reactant-doped molecular liquid crystal lipid films spread and mix on patterned amphiphilic substrates. These substrates can be micro- and nanopatterned photoresist, or even micropatterned Teflon. Eventually, all reactants are present in two dimensions, mimicking a situation in the lipid bilayer of cells or cell compartments.
Phospholipid monolayer films are spread and contain complementary DNA strands modified with a lipophilic anchor and with a fluorescent dye. By using resonance energy transfer, we monitor the hybridization of the complementary strands, and are able to detect the double-stranded DNA in flowing streams on lanes as small as 250 nm wide, with as few as 900 molecules in the cross section. Our results show that the density and number of different reactants, can be controlled within liquid crystal films confined to patterned substrates. The technology introduced here provides a platform for nano-chemistry with the potential for kinetic control where molecules with 2D orientational order can be synthesized, controlled, routed, and probed. Therefore, this technology could become a model system for dynamic biological surfaces.