interactions, we need to know how salt ions and buffer molecules partition ions to phosphatidylcholine lipid headgroups. To properly analyze lipid ion. The electrostatic repulsion occurs due to binding of ions and zwitter- a reduction of van der Waals attraction and a creation of electrostatic repul- a ion theories, we provide the first experimental verification in free-floating (DOPC:POPC ratio). Furthermore, we find a direct correlation between domain size and the mismatch in bilayer thickness of the coexisting liquid-ordered and liquid-disordered phases, suggesting a dominant role for line tension in controlling domain size. While this result is expected from line tension theories, we provide the first experimental verification in free-floating bilayers. Importantly, we also find that changes in bilayer thickness, which accompany changes in the degree of lipid chain unsaturation, are entirely confined to the disordered phase. Together, these results suggest how the size of functional domains in homeothermic cells may be regulated through changes in lipid composition.

Lipid Bilayers Containing Sphingomyelins and Ceramides of Varying N-Acyl Lengths: a Glimpse into Sphingolipid Complexity
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The thermotropic properties of aqueous dispersions of sphingomyelins (SM) and ceramides (Cer) with N-acyl chains varying from C6:0 to C24:1, either pure or in binary mixtures, have been examined by differential scanning calorimetry. Even in the pure state, Cer and particularly SM exhibited complex endotherms, and their thermal properties did not vary in a predictable way with changes in structure. In some cases, e.g. C18:0 SM, atomic force microscopy revealed coexisting lamellar domains made of a single lipid. Partial chain interdigitation and metastable crystalline states were deemed responsible for the complex behavior. SM:Cer mixtures (90:10 mol ratio) gave rise to bilayers containing separate SM-rich and Cer-rich domains. In vesicles made of more complex mixtures (SM:PE:Chol, 2:1:1), it is known that sphingomyelinase degradation of SM to Cer is accompanied by vesicle aggregation and release of aqueous contents. These vesicles did not reveal observable domain separation by confocal microscopy. Vesicle aggregation occurred at a faster rate for the more fluid bilayers, according to differential scanning calorimetry. Contents efflux rates measured by fluorescence spectroscopy were highest with C18:0 and C18:1 SM, and in general those rates did not vary regularly with other physical properties of SM or Cer. In general, the individual SM and Cer appear to have particular thermotropic properties, often unrelated to the changes in N-acetyl chain.

Ion Exclusion from Multilamellar Lipid Vesicles
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We have shown previously that ions and zwitterionic pH buffers affect the interaction of neutral lipid membranes by a mechanism that involves both a reduction of van der Waals attraction and a creation of electrostatic repulsion. The electrostatic repulsion occurs due to binding of ions and zwitter-ions to phosphatidylcholine lipid headgroups. To properly analyze lipid interactions, we need to know how salt ions and buffer molecules partition between lipid bilayers and open solution. To address this issue, we use a sequence of solute concentrations to achieve neutral buoyancy (density matching) for suspensions of dilauroylphosphatidylcholine (DLPC) lipid membranes. We then calculate the ratio of solute concentrations outside and inside the multilamellar lipid vesicles from this density match point. We find that distinct series of monovalent salts, organic salts, and zwitter-ionic pH buffers are excluded from the interlamellar space, with more polarizable solutes being excluded less, in accord with measurements on membranes interactions. Our quantitative measurements are important for a proper analysis of ion interactions in membrane systems with applications to membrane biology.

Solution Polarizability Dependence of Lipid Bilayer Interactions
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We find that distinct series of monovalent salts, organic salts, and zwitter-ionic pH buffers are excluded from the interlamellar space, with more polarizable solutes being excluded less, in accord with measurements on membranes interactions. Our quantitative measurements are important for a proper analysis of ion interactions in membrane systems with applications to membrane biology.

Thermodynamic Characterization of the Association of Cholesterol with Phospholipids with Varying Degrees of Unsaturation
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The preferential association of cholesterol with saturated phospholipids, especially sphingomyelins, is responsible for the formation of coexisting fluid lipid phases, and is believed to play a critical role in the existence of more ordered membrane domains in biological systems, sometimes termed lipid rafts. The coexistence of separate fluid phases in model bilayer constructs must be an equilibrium phenomenon, and titration of bilayer choles- terol content allows for thermodynamic characterization of cholesterol partitioning. To achieve a more complete understanding of the parameters governing phase separation, high sensitivity isothermal titration calorimetry was employed to investigate the effects of degree of unsaturation at the sn-2 position of a series of biologically relevant phospholipids. Cholesterol was either extracted from or added to bilayers of a single phospholipid component, allowing determination of a partition constant and enthalpy of transfer. By varying the relative cholesterol content of the bilayer, the non-ideal partitioning behavior was also investigated. It was found that the rela- tive affinity of cholesterol for the bilayer decreased in a generally monotonous manner in response to increasing unsaturation, with the exception that both 20:4n6 and 22:6n3 acyl chains at the sn-2 position showed similar partition constants and enthalpies of transfer. The partitioning of cholesterol was also measured in membranes composed of mixtures of 18:0,22:6 PC and sphingomyelin. Values of both the partition constant and enthalpy of transfer extrapolated to pure sphingomyelin matched those previously reported for mixtures of 16:0,18:1 PC and sphingomyelin. This result suggests that the as- sociation of cholesterol and sphingomyelin is largely unaffected by other phospholipids in the bilayer.

Phase Coexistence in Ternary Lipid Mixtures Containing POPC and Phytosterols, Ergosterol or 7-Dehydrocholesterol
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1H-NMR spectroscopy was used to investigate the occurrence of phase coex- istence in multilamellar vesicles of DPPC and POPC (33mol%: 33mol%) with either stigmasterol, brassicasterol, ergosterol or 7-DHC (each 33mol %). In all cases, the sn-1 chains of DPPC and POPC were deuterated in turn, and 1H-NMR spectra were measured for both lipid components as a function of temperature between 5 °C and 48 °C. The chain order of DPPC...
GUVs encapsulating agarose polymer, and charged GUVs in the presence of NaCl and Triton X-100. Electroporation of vesicles with encapsulated agarose leads to larger values of Tpore and Trelax. For agarose, around 20% of the GUVs expel a gel-like meshwork through the formation of very large pores. Moreover, in most cases the membrane remains permeable to small molecules after macro pore closure. These effects do not depend on membrane composition. Negatively charged GUVs in the presence of NaCl display macro pores with long lifetime, which quite often lead to vesicle burst as the membrane is transformed into nanotubes along the pore rim. Vesicle bursting and Tpore depend on the fraction of the negatively charged lipid POPG and on [NaCl] (0-5 mM). Membrane composition is not altered at the pore rim. In the presence of non-solubilizing concentrations of Triton X-100, electroporation of negatively charged GUVs display a large distribution of Tpore values as compared with Tpore in the absence of Triton X-100 or for neutral GUVs. In summary, Tpore is a suitable parameter in the investigation of various membrane properties under different conditions. Acknowledgments: FAPESP.

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The Effect of Cholesterol on the Morphology of Mixed Phosphatidylinositol/Phosphoinositide/Phosphatidylethanolamine Model Membranes
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Although phosphoinositides (P IPs) comprise only a small amount of the total lipids in the inner leaflet of the plasma membrane, they have been shown to play an integral role in many membrane trafficking events. As a precursor to PI P s, Phosphatidylinositol (PI) is also involved in these signaling events. In previous studies we have observed binary mixtures of PI/PC and PI(4,5)P2/PC did not yield macroscopically discernible domains, but upon the addition of cholesterol, the mixture was condensed. In addition, we have also observed the cholesterol independent domain formation in ternary mixtures of PI/PI(4,5)P2/Cholesterol. Currently, we believe that PI causes a "diffusion" of the negatively charged headgroup of PI(4,5)P2, allowing this condensation effect to occur. We have extended this study to include fluorescence microscopy measurements of GUVs and monolayers at the air/water interface ternary mixtures of PC/PI/PI(4,5)P2. To better mimic the inner leaflet of the plasma membrane, we will then move ternary mixtures including PE/PI/PH45P2, PE/PI/Cholesterol, and PE/PI(4,5)P2/Cholesterol.

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Lipid Membranes as Solvent for Carbon Nanoparticles
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Carbon nanotubes (CNTs) and fullerene C60 are of interest to the scientific community due to their unique physical properties and applications. C60 fullerenes have a wide variety of applications, from nanomedicine to energy production. Most of these applications require fullerene to be dissolved, at one point. However, dissolving fullerene is difficult because of its low solubility in most common solvents, including apolar ones like alcanes. Despite low solubility in alcanes, fullerene has been shown to permeate and spread in lipid bilayers under certain conditions. The interior of the lipid bilayer is chemically identical to alcanes, so it is not clear why fullerene behavior in bilayers and alcanes would be different.

We used molecular dynamics simulations and the MARTINI coarse-grained force field to understand the different behavior of fullerene in alcanes vs lipid bilayers. We find that the free energy of association between fullerene in bilayers is lower than in alcanes, and the difference is due mostly to enthalpic contributions, not entropic ones. Confinement of fullerene in the bilayer thickness and alignment of the lipid chains do not contribute to fullerene dissolution in membranes. On the contrary, high solvent density and limited perturbation of solvent-solvent interactions upon solute aggregation favor fullerene dissolution in bilayers. Lipid bilayers are ubiquitous in living systems and their physical properties can easily be tuned by altering head group composition and chain length. We conclude that lipid bilayers are effective, tunable and biocompatible solvents for C60 fullerene.

1484-Pos  Board B214
Lattice-Based Monte Carlo Simulations of Lipid Membranes: Correspondence between Triangular and Square Lattices
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We have recently demonstrated [1, 2] that lattice-based Monte Carlo (MC) allows one to study the structure and dynamics of membranes on experimentally relevant spatial scales and time intervals with moderate computational