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Effects of Thermal Variations on Lipid Monolayer Molecular Packing

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Lipids exhibit distinct transitions between the gel and fluid phase depending on various factors, such as the length of their fatty acid chains, the number of double bonds in the chains, and temperature. Our cell membranes contain different forms of lipids, with ratios that depend on cell membrane type. Therefore, how lipid molecules pack at different temperatures and within mixtures with other lipids is important to our understanding of the biological function of lipid membranes and their use as drug delivery carriers, also known as liposomal drug delivery. Common issues in liposomal drug delivery are the stability and circulation time of liposomal carriers. Importantly, liposomal structure is heavily influenced by temperature, which alters the physical state of lipids and their packing states. Here, we use 1,2-dimyristoyl-sn-glycero-3 phosphocholine (DMPC) to study the effect of thermal variations on lipid packing. Using Langmuir area-compression isotherms, we observe how the mean molecular area (Mma) of lipids changes over a range of temperatures, below and above the gel-fluid phase transition of DMPC. All mean molecular areas are reported at a surface pressure of 30 mN/m; i.e. ~ the surface pressure of biological membranes. Our measurements show that the mean molecular area increases with increasing temperature, in agreement with previous studies using other characterization methods. By comparing our results to studies of membrane mechanics, we infer that liposomal stability strongly depends on molecular packing – of direct implications in the design of stable liposomal carriers.

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