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Opinion Article

Hydrostatic Pressure Investigation of the Dynamic Interaction between Lipids and Membrane Proteins

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DESCRIPTION

Membranes serve as the physical boundaries between cells and organelles including the nucleus, endoplasmic reticulum, and the golgi apparatus. These membranes exhibit a wide diversity of lipids and proteins to carry out a number of essential functions. With a few notable exceptions, lipid membranes are densely packed with proteins. Both lipids and proteins, define the geometry and physicochemical characteristics of membranes, which in turn control protein activity. The fluidity of the membrane which is the result of mobility of lipids and the concentration of proteins represents one of these characteristics that is fundamentally important for maintaining the homeostasis of cells throughout organisms and whose alteration can lead to a variety of metabolic disorders.

Poikilothermic animals, whose internal temperatures can change to adapt to environmental stress, continuously modify their lipid composition in response to temperature changes to maintain the fluidity of their membranes or to regulate their respiratory metabolism. Piezophilic organisms can withstand high pressures in the lithosphere and the deep marine environments of the piezosphere by adapting, specifically, their lipid composition, a process known as homeoviscous adaptation. It is believed that an increase in the unsaturated to saturated lipid ratio will preserve functional membrane fluidity and permeability in piezophiles at high pressure. In bacteria, fungi, plants, and animals, lipids play a critical role in the opening and closing of mechanosensitive channels.

Although biological membranes should be fluid under physiological pressures and temperatures, this does not preclude locally significant fluctuations in fluidity. Having too many proteins together or not having enough saturated fats or sterols can both affects the viscosity. Even though temperature and pressure do not have the same impact on the phase behavior of lipids, applying pressure is similar to lowering the temperature of the lipid bilayer. The acyl chains and heads of phospholipids tend to be more organized under pressure by molding themselves to the reduction in empty volume between lipids.

Lipid dynamics in the gel and Liquid Crystal (LC) phases differ enough to cause a noticeable shift in the 1H line shape and strength of phospholipid Nuclear Magnetic Resonance (NMR) signals, enabling the direct detection of the gel/LC transition. Model heterologous cell expression systems are frequently used in the drug development of G-Protein-Coupled Receptors (GPCRs), indicating an implicit belief that the membrane environment has minimal functional effect on these receptors or on their response to medicines. However, a wealth of new research has shown that intrinsic membrane proteins can be significantly affected functionally by membrane components. It is crucial to understand that the membrane offers a potential mechanism for lateral allosteric modulation of GPCRs and can influence the efficacy of medications and their biological responses in a variety of illness situations, which can even vary between individuals in the general population. We examine a class A GPCR that is altered in this manner by alterations in the plasma membrane, the type 1 cholecystokinin receptor.

In biological systems, polarity is a crucial microenvironment feature that is intimately linked to numerous cellular functions. Pathophysiological processes start and develop in the presence of abnormal polarity changes. Monitoring the aberrant polarity is therefore crucial from a scientific and practical standpoint.

Fluorescence imaging, which relies on single emission intensity and may result in erroneous detection due to heterogeneous aggregation of the probes, is the foundation of most modern state-of-the-art monitoring techniques. Here, we provide carbon dots with incredibly sensitive polarity reactions. Two linear correlations can be seen in the CDs: one between polarity and the maximum emission wavelength and the other between fluorescence intensity and polarity. Independent of the excitation intensity or probe concentration, the emission spectrum is a fundamental characteristic of the probes. These characteristics allow for *in situ* emission spectroscopy-based two-color imaging and measurement of polarity changes in lipid droplets and the cytoplasm. The probes display the polarity homogeneity and polarity heterogeneity in LDs, which can be used to distinguish between cancerous and normal cells.

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