FROM SCIENCE BEYOND BORDERS TO UNDERSTANDING THE BOUNDARIES OF CELLS

Every living cell, whether part of a simple bacterium or a complex human, is surrounded by a delicate, yet remarkably dynamic structure known as the cell membrane. Far from being a static barrier, this membrane acts as a living interface, controlling what enters and leaves the cell while maintaining the right conditions for all cellular components located inside. Although once thought to be a uniform bilayer, scientists now know that membranes are highly inhomogeneous, filled with tiny regions of specific composition, also known as membrane domains, where certain lipids and proteins gather together. These lateral heterogeneities play vital roles in many biological processes, from how cells communicate and transport materials, to how viruses and toxins find their way inside the cells. Our research explores how these micro- and nanoscopic membrane features form and behave. By recreating cell membranes in the laboratory and systematically varying factors such as lipid composition, temperature, pH, and hydration, we investigate how these conditions affect membrane structure and their dynamic responses to environmental changes. Understanding how membranes interact with their environment not only deepens our knowledge of their self-organization but also opens new avenues for controlling membrane behavior in medicine and biotechnology. Ultimately, our work helps us see the cell membrane not as a simple protective wall, but as a vibrant, adaptable structure, one that holds the key to many of life's most fundamental processes.