Concluding Remarks

When water is absorbed in solid, dehydrated phospholipids, it will act as a spacer between lipid molecules. Larger lipid areas require more water. However, the area increase is not linear suggesting different types of water adsorption forming regions of different density and energy of interaction between water molecules themselves and with the lipid chemical groups.

In this book, water has been identified in several states: hydration water, confined water, water exchanged during membrane-membrane and membrane-perturbant interactions, water replaced or displaced by solutes in drying (dessicomes), water as informational units (aquaomics).

As a result of the gradual ingress of the water, the mobility and deformability of the membrane components strongly enhances, which gives to water a role of "external plasticizer".

A fraction of water tightly associates with lipid head groups and others interact with many of the membrane's other functional groups occupying free volume (hydration water). At this point the second hydration shell becomes important.

Presumably, at moderate surface pressure compatible with that in cell membranes, a water population appears, which may be identified as second shell or confined water beyond the hydration of the head groups of the phospholipids. The water organization at this level may be a link between stress states governed by lateral pressure in the membrane as a mechanochemical device and by osmosis that "reacts" to external perturbants, such as amino acid motifs in proteins, peptides or aminoacid residues.

A few number of water molecules, located beyond the hydration shell, is confined in hydrophilic and hydrophobic environments. This number of water molecules associated with each head group is correlated to the packing of acyl chains in the hydrophobic core.

The activity of water in this restricted membrane-water interface modulates the surface pressure and viceversa, surface pressure may modify water activity in these sites for amino acid residues insertion.

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In addition, they may provide specific domains for catalyzing organic reactions and to control metabolic pathways in cells.

Complex lipid and sterol compositions, the inclusion of proteins, glycosylation, as well as the formation of lipid domains all result in inhomogeneous local properties of the bilayer in which water molecules can stabilize. The lipid composition can determine a pattern in the interlamellar water structure not only in the bound water population but also farther away from the membrane. Thus, the link between structure and function appears at the water interphase in which changes in the excess free energy in the water arrangements trigger different processes. In this regard, lipidomics meet aquaomics.

Water as antenna for biological signals in lipids may control activities of membrane-bound enzymes through manipulation of the thermodynamic activity of water in the lipid-water interfacial region.

The replacement of water by compounds mimicking water structure in terms of H bonding stereochemistry is not enough. The dynamic properties of water as a liquid are necessary for biological response and function. In this regard, water is far more than the cement to attach membrane structure. It is a component essential for biological activity and hence the understanding of its behavior could be the clue to understand anomalous behavior in human health, plant resistance and preservation of cells and tissues.

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