Interactions of Cryoprotectants with Phospholipid Membranes

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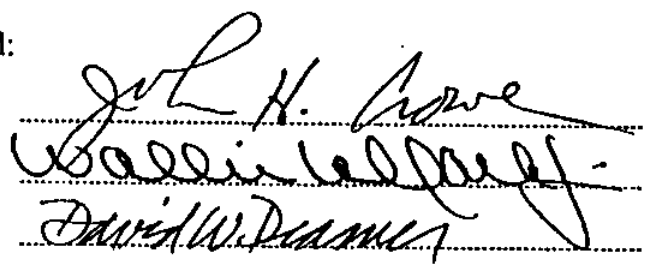

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ABSTRACT

Since the cryopreservation of viable cells was first achieved in 1949, many attempts have been made to explain the mechanism by which certain molecules are able to serve as cryoprotectants. Although the types of cellular injury occurring during freeze/thaw are quite varied, cryoprotection is thought to arise solely from the colligative properties of the solutes. However, it is evident from earlier cryopreservation studies that compounds with similar properties, e.g. solubility and permeability, do not offer equivalent cryoprotection as would be expected on a colligative basis. More recent studies have suggested that certain cryoprotectants interact directly with membranes and that this interaction may play a role in cryoprotection. The purpose of this work was to investigate interactions between cryoprotectants and phospholipid bilayers. Small unilamellar vesicles are used as a model membrane system to probe interactions between phospholipids and a variety of cryoprotectants. Different compounds are shown to interact with bilayers by distinctly different mechanisms that are critical for cryoprotection. These mechanisms of cryoprotection are in some cases dependent on the presence of other ions in solution and the lipid composition of the membrane. It is argued that cryoprotection in these cases cannot be due exclusively to the colligative properties

of the solutes. Finally, a practical application of cryopreservation is demonstrated in the development of a successful method for the cryopreservation of sperm from the marine shrimp, Sicyonia ingentis.

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