Revealing the mechanism of IBPs for cryopreservation

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Abstract Cryopreservation is a science and technology of using ultra-low temperatures for the long-term storage of cells, tissues, or organs; also it ensures a recovery in function after thawing. Cryopreservation is currently the only effective method to realize long-term storage of biological samples, and it plays a critical role in areas of biomedicine such as cell therapy, regenerative medicine and organ transplantation. As the water content of cells and tissues can be as high as 70% ~ 90%, ice formation inevitably occurs both intracellularly and extracellularly, which can be lethal because of the mechanical damage, the osmotic shock and excessive solute accumulations. Therefore, the scientific challenge of cryopreservation is to inhibit or control ice formation in the freezing/thawing processes. Traditional cryopreservation strategies use large amounts of small molecules, such as dimethyl sulfoxide (DMSO), as cryoprotectants (CPA) to permeate into the cells and prevent intracellular ice formation; which to some extends are successful in the cryopreservation of cells. However, these molecules are chemically and epigenetically toxic to cells. Meanwhile, these strategies have proved refractory for the cryopreservation of tissues and organs. Therefore, great efforts have been made for effective ice-controlling materials to regulate the ice formation during cryopreservation. In nature, many cold-acclimated species can avoid cold damage and survive in the subzero environment due to the existence of ice-regulating proteins, i.e., ice nucleating proteins (INPs) and antifreeze (glyco) proteins (AF(G)Ps). Inspired by these proteins, intensive investigations have been made to reveal the protection mechanism of the ice-regulating proteins in order to develop their mimics. It has been reported that the bio-inspired ice-controlling materials are more effective and safer CPA in cryopreservation in comparison to small organic molecules. Therefore, this talk will focus on the recent results revealed by us on the mechanism of IBPs in controlling ice formation. And then, bio-inspired ice-controlling materials and their application in the cryopreservation of cells and tissues will be discussed. At last, the challenges and possible directions of bio-inspired ice-controlling materials as cryoprotective agents will be briefed.