Comparative study on the effects of isochoric cryopreservation and liquid nitrogen flash freezing on the quality of biological cell

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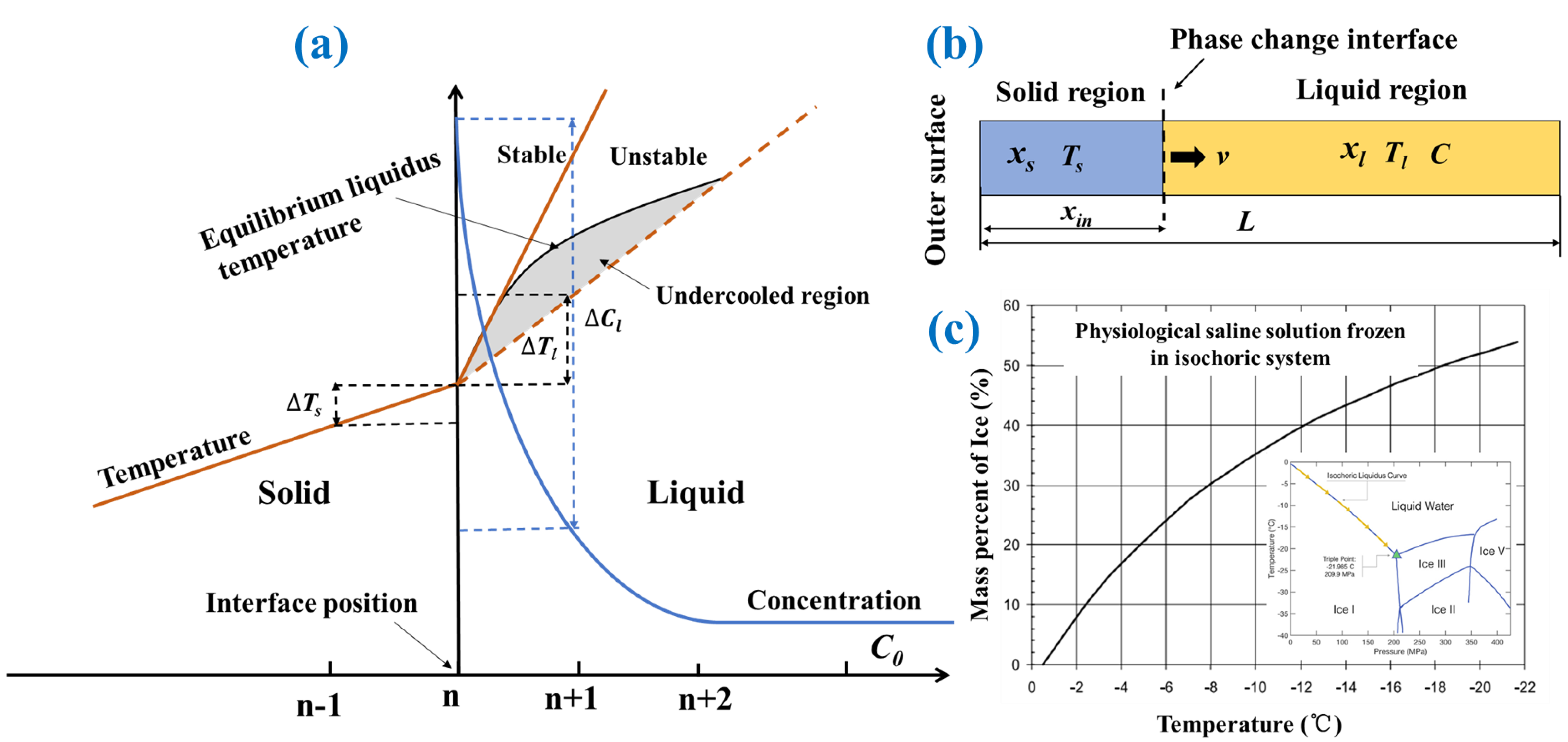
Background

Low temperature preservation of living organisms refers to the process of keeping biological samples at low temperatures to reduce or suspend their metabolic activities and achieve long-term preservation, which is of great significance for the development of biomedicine. The ice crystal damage caused by temperature reduction during biological freezing is an urgent problem that needs to be studied.

Objectives

- Establishing a thermodynamic model for the constant volume freezing process based on the principle of liquid phase change during the cooling process under constant volume conditions
- Optimizing and obtaining the optimal constant volume cryopreservation process plan to achieve the best quality of frozen cell via comprehensive parameter investigation in terms of temperature, cooling rate, pressure, pressurization rate and storage time

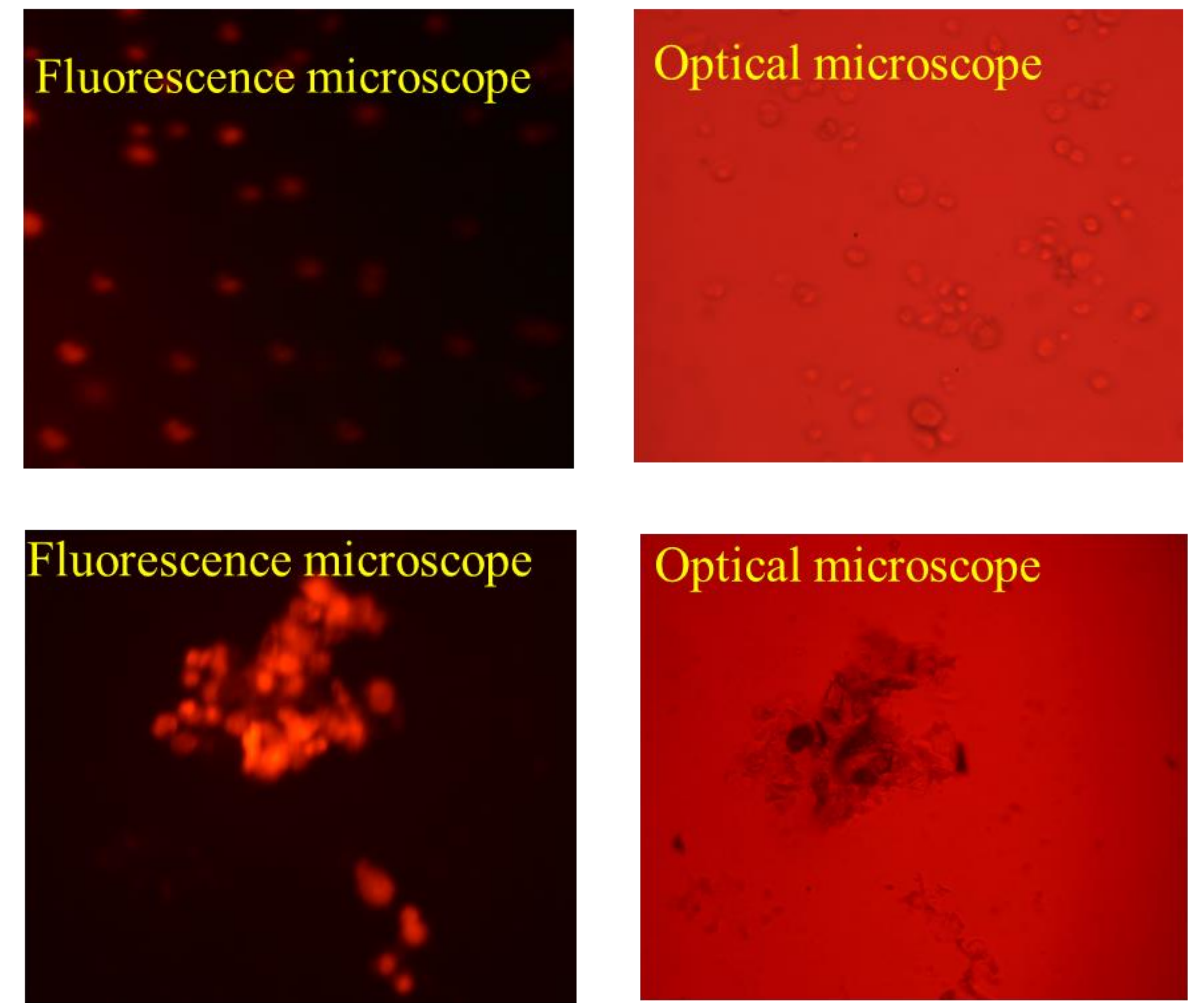
Results



Mathematical model of constant volume directional solidification

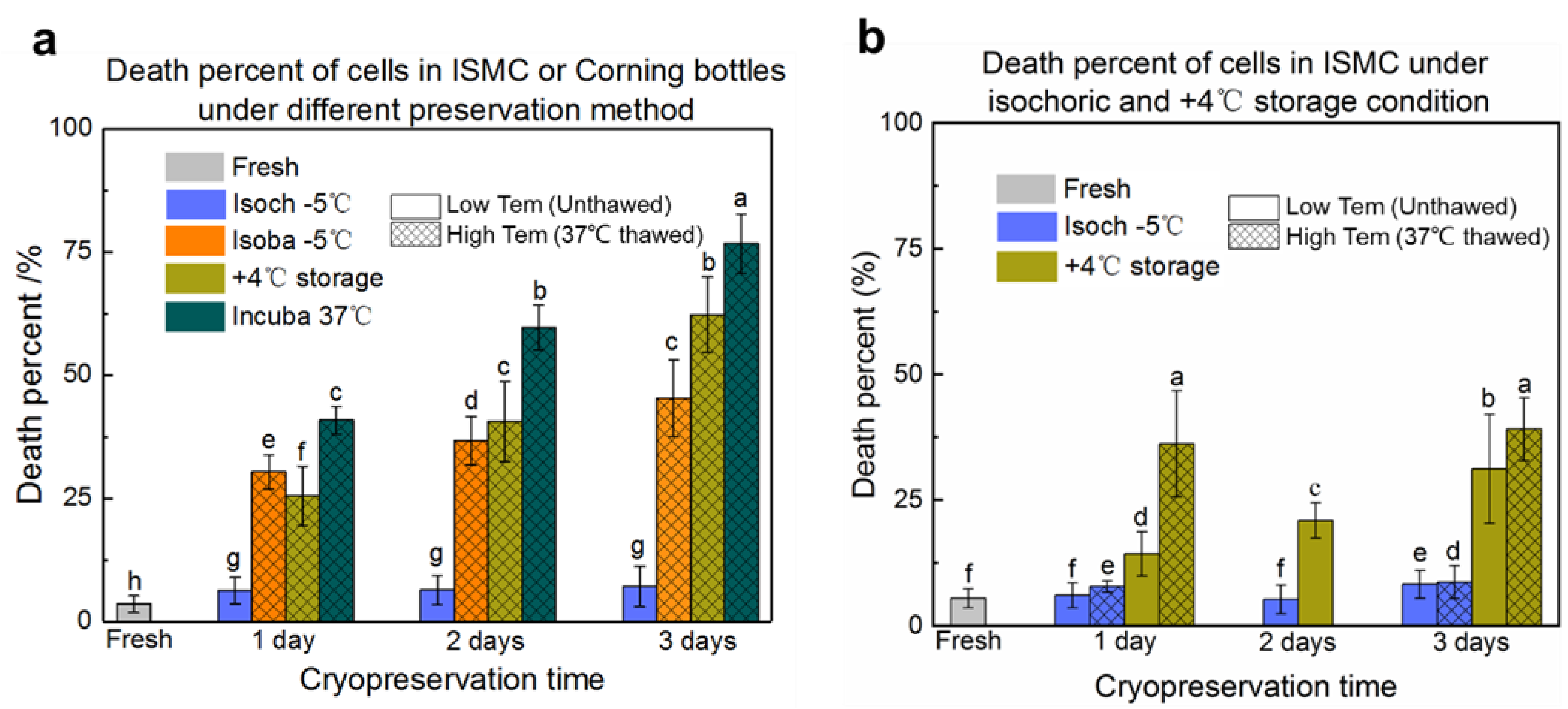
◆As the temperature decreases, the ice content in the constant volume system gradually increases. When the temperature drops to -22 º C, the volume percentage of ice content in the system is 52.13%

◆A constant volume system enhances interface stability and delays the occurrence of instability, where the percentage of constant volume instability at -22 º C is 11 times that of constant pressure



Isochoric supercooled after 3 days and thawing

Isobaric frozen for 3 days and thawing



◆Compared to isobaric frozen condition, cells maintain a smooth contour at -5 º C low temperature and remain active even after thawing under isochoric supercooled condition

◆ under isochoric supercooled condition, cells show high cellular activity during long term refrigeration as well as after thawing