SMARTFREEZCRYO

CELL

Controlled directional freezing to maximize cell viability

CELL

CELL controlled rate directional freezer *by SMARTFREEZ*

CELL is a controlled-rate freezer featuring a bottom-up heat transfer geometry.

This innovative design limits natural convection, minimizes cryoconcentration and mechanical stresses, enhancing cell viability and functional recovery post-thawing.

- Enables precise control over ice nucleation, preventing the supercooling effect and increasing reproducibility between experiments.
- Promotes controlled ice crystal growth, both in velocity and direction.
- Preserves cell integrity more effectively, enabling significantly higher survival rates with reduced concentrations of the cryoprotectant dimethyl sulfoxide (DMSO).
- Flexible and Scalable: Fits 6 to 48 cryovials or up to 3 cryobags (30 mL each). Customized holders for vials and bags are available to meet specific needs.
- Enhances functional recovery results post-thawing relative to conventionally used CPA concentrations and radial
- Flexible temperature rates up to 5ºC per minute
- Nitrogen free technology

The CELL bottom-up freezing geometry

uniform ice growth velocity, attenuating mechanical stresses during freezing

CELL

Improving cell viability and reproducibility

Conventional methods for freezing cells in vials and bags often result in supercooling within the container, leading to high ice growth velocities that place significant stress on cells.
With the CELL freezer, these stresses are minimized by preventing supercooling. Freezing begins with the induction of ice nucleation, forming a thin ice layer at the bottom of the vials (Figure 1).
Ice then grows upward from this nucleation layer at a controlled rate, reducing cryoconcentration and minimizing mechanical stresses caused by pressure.

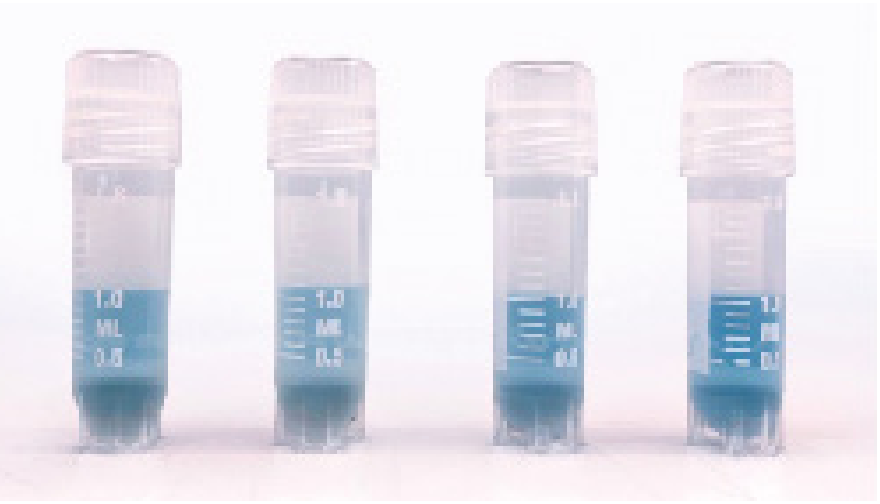


Fig. 1 *- Ice Nucleation layer (in dark blue) formed after controlled nucleation in 2 mL vials.*

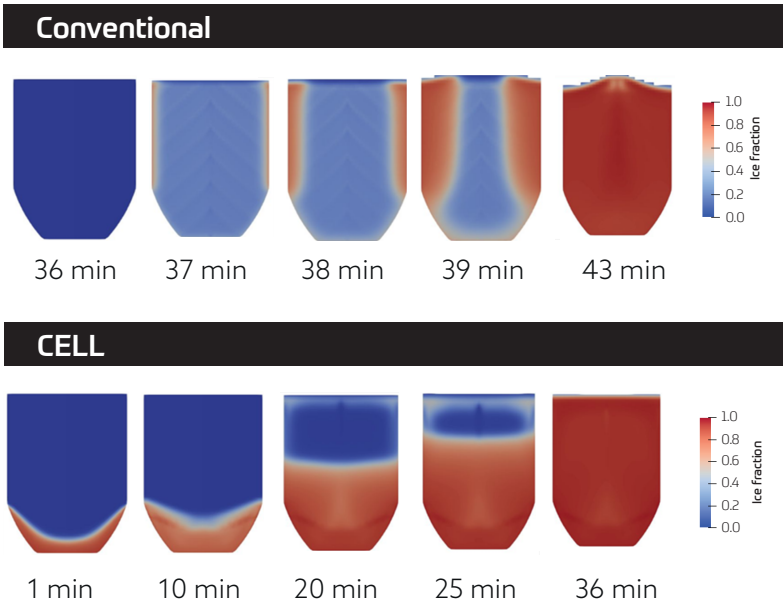
Quality by Design optimization

of cryopreservation protocols

A digital twin is available for the CELL rate-freezer, enabling you to design tailored, optimal cryopreservation methods efficiently. This streamlines development, reduces trial-and-error, and conserves biological material.

The SMARTFREEZ*SIM*® simulation platform provides data to analyze the impact of your parameters on key stresses affecting cell viability and functionality (Figure 2).

Fig. 2 *- Ice-growth over time in 2 mL vials simulated using* SMARTFREEZ*SIM*® *comparing conventional radial geometry with CELL (bottom-up) with 1% DMSO and a cooling rate of 1ºC/min.*



Case study 1

Bottom-up ice growth geometry

improves cryopreservation of stem cells under low DMSO concentrations

This study compared bottom-up directional freezing with conventional radial freezing for human umbilical cord blood mononuclear cells (UCB-MNCs) and hematopoietic stem and progenitor cells (HPSCs). Stem cell viability and functional recovery were improved with bottom-up directional freezing, exposing the cells to lower mechanical stresses.

The CELL instrument enabled a reduction of DMSO concentration to 1% v/v while maintaining 80% MNC viability post-thawing.
In the 2.5% DMSO condition, the bottom-up method results in approximately 45% of late apoptotic and necrotic cells, while conventional freezing leads to around 80% of cells in a late apoptotic or necrotic state.

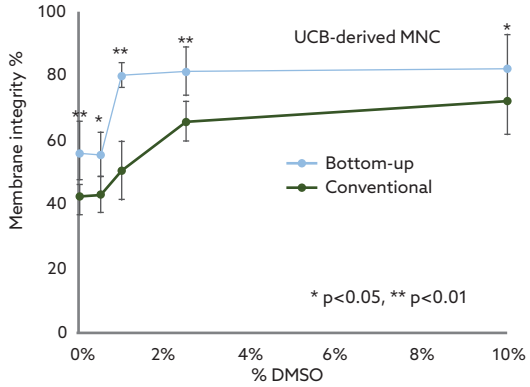


Fig. 3 *- Cell viability measured by trypan blue using cryo-solutions with different DMSO concentrations (v/v).*

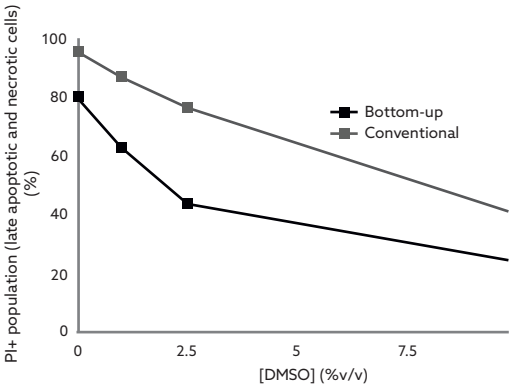


Fig. 4 *- Late apoptotic and necrotic cells measured by flow cytometry using cryo-solutions with different DMSO concentrations (v/v).*

The functional performance of HSPCs was assessed 14 days post-thaw, and 20% to 50% more BFU-E, CFU-GM, and CFU-GEMM colonies were obtained with bottom-up freezing using 2.5% v/v DMSO, compared with the conventional radial method using 10% v/v DMSO.

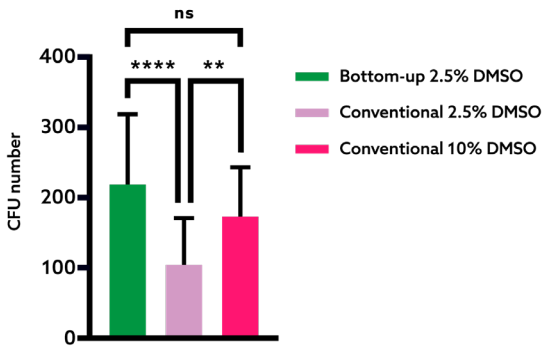
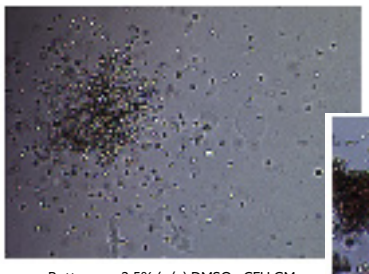
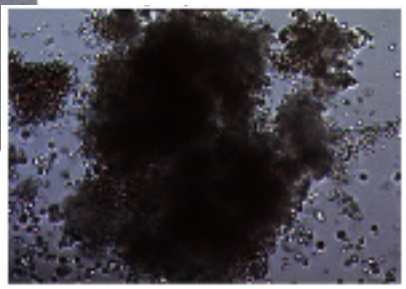


Fig. 5 *- Colony forming units (CFUs) of HSPCs post-thaw.*



Bottom-up 2.5% (v/v) DMSO - CFU GM



Bottom-up 2.5% (v/v) DMSO - CFU GEMM

Fig. 6 *- Microscopic view of colony forming units of HSPCs post-thaw.*

Case study 2

Reducing DMSO concentration

during freezing of hIPSc

Human-induced pluripotent stem cells (hIPSc) were frozen using the CELL freezer and a conventional freezing method, with varying DMSO concentrations and cooling rates.

The CELL freezer enabled a reduction of DMSO content to below 5 % (v/v) while maintaining a cell survival rate of 80 % (Figure 5).

- A cooling rate of 1 °C/min allowed the DMSO content to be reduced to 4 % (v/v) while maintaining cell viability above 90 %.

- A cooling rate of 5 °C/min allowed the DMSO content to be reduced to 2 % (v/v) while maintaining approximately 80 % cell viability.

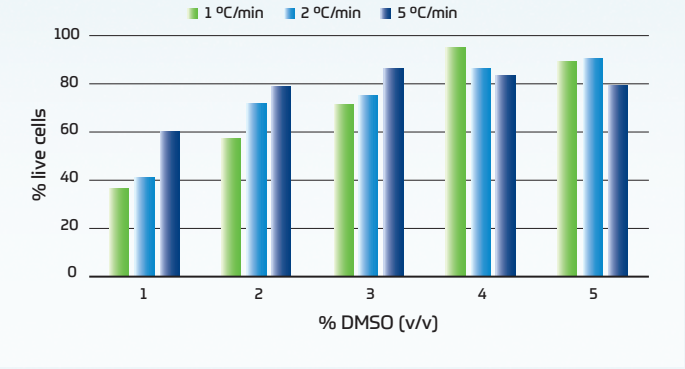


Fig. 7 *- Percentage of live cells after freezing using the CELL freezer (bottom-up freezing) for DMSO concentrations below 5 % v/v.*

CELL 's bottom-up freezing geometry significantly improves cell survival at both 1 % and 5 % DMSO concentrations (v/v). At 1 % DMSO and a cooling rate of 5 °C/min, bottom-up freezing resulted in six times more live cells compared to conventional radial freezing (Figure 6).

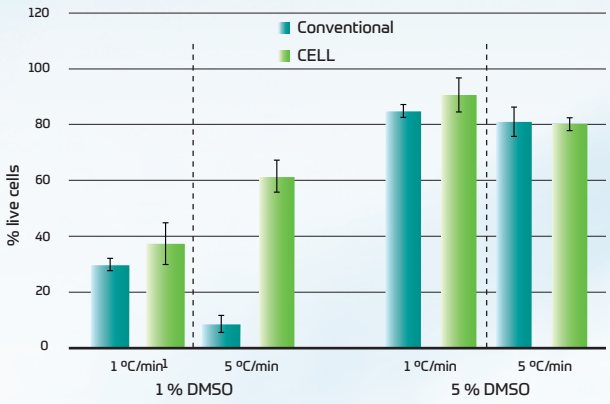


Fig. 8 *- Percentage of live cells after freezing using CELL (bottom-up freezing) and conventional freezing method (radial freezing) for DMSO concentrations of 1 and 5 % (v/v).*

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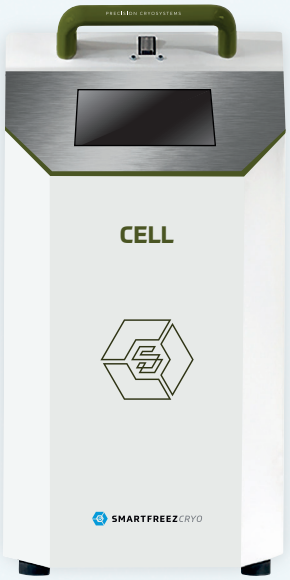

Key
Specifications

CAPACITY	• *1 holder for 48 x 2 mL vials* • *1 holder for 3 x 30 mL bags*
DIMENSIONS (mm)	*460 (d) x 360 (w) x 600 (h)*
TEMPERATURE	*-85 °C to 25 °C*
WEIGHT	*40 Kg*
PATENT STATUS	*Patented*

- *Developed to support GMP compliance*
- *21 CFR Part 11 compliant for electronic records*

References:

- doi.org/10.1002/btpr.70019
- doi.org/10.1002/bit.70116

Customizable to your needs

The CELL freezer can be configured for vials and bags of different sizes and shapes.

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