Optimized cell therapy manufacture process with Hydrogel-based CellFiber® encapsulation technology

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Introduction

Regenerative medicine offers a powerful modality for treating cancer and tissue injury, yet its diverse indications and cell types introduce complex manufacturing challenges for clinical dosages.
CellFiber is a technology which encapsulates cells inside a hollow alginate hydrogel fiber for 3D cell culture (Figure 1). This fiber structure reduces exposure to hydrodynamic shear, maintains a defined cell-dense microenvironment, while remaining highly permeable to nutrients, oxygen, and metabolites. Here we present the integrated CellFiber culture platform and summarize its adaptation to iPSC, MSC, and T cell expansion, including growth kinetics, viability, and phenotype retention across cell types.

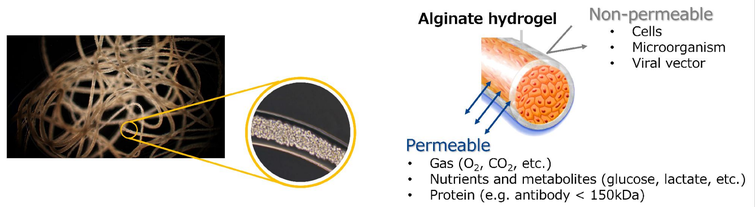

Figure 1. CellFiber® cell encapsulation technology

Method

[iPSC] Cryopreserved induced pluripotent stem cells (iPSCs) were thawed and pre-cultured under adherent conditions, then encapsulated and expanded for 7 days in hydrogel fibers within a 2 L Cellbag™ on a Xuri™ Cell Expansion System W25 (Cytiva).
[MSC] Human mesenchymal stem cells (MSCs) were thawed and pre-cultured under adherent conditions, then encapsulated and expanded for 8 days in hydrogel fibers within a 10 L Cellbag on the Xuri W25.
[T cells] $CD3^+$ T cells were MACS-selected from cryopreserved PBMCs and encapsulated directly, without prior activation, then cultured for 12 days within a 2 L Cellbag on the Xuri W25 . In a separate batch, $CD3^+$ T cells were activated and transduced with LV-GFP at MOI = 2 at the time of encapsulation, then cultured for 6 days.

After expansion or transduction, cells were harvested by dissolving the hydrogel fibers in EDTA. Recovery, viability, and cell type–specific marker expression were assessed by flow cytometry and qRT-PCR (Figure 2).

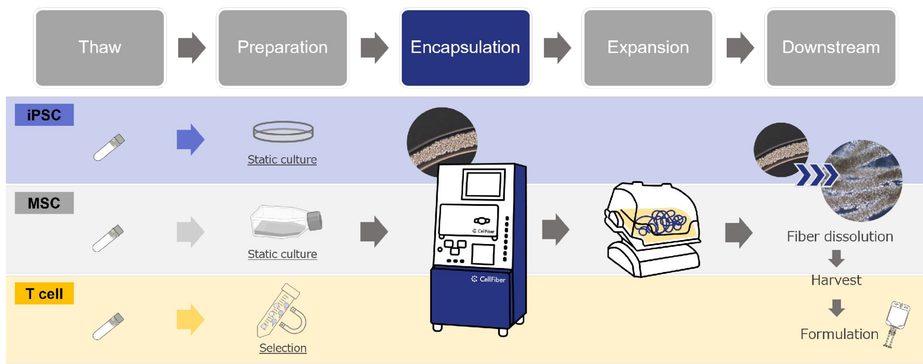

Figure 2. CellFiber integrated cell manufacturing platform

Results

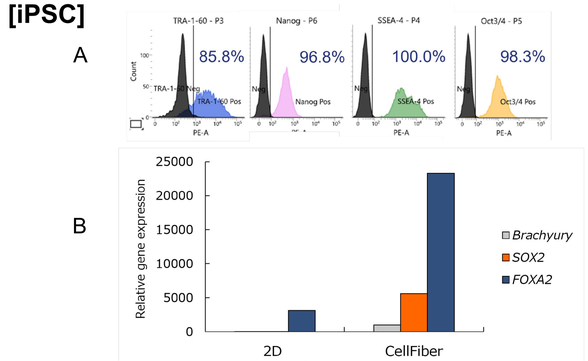

Figure 3. iPSC expansion and differentiation capacity in fiber culture. (A) A yield of 8.8 × 10^9 cells (56-fold expansion) was recovered after 7 days at 97.9% viability (not shown), with pluripotency markers retained. (B) Following subsequent trilineage differentiation to germ layers, marker expression was higher in fiber-cultured cells than in 2D control.

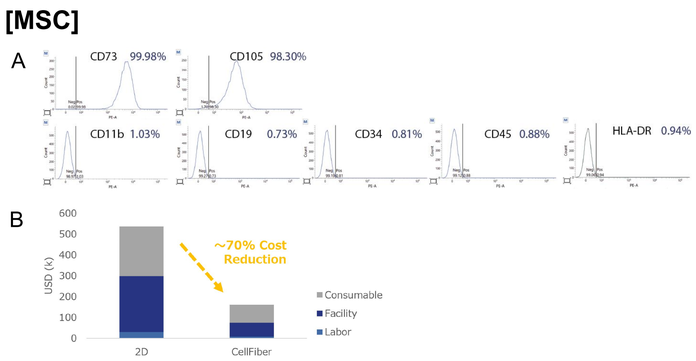

Figure 4. MSC expansion in fiber culture and modeled process economics. (A) A yield of 2.2 × 10^9 cells (530-fold expansion) was recovered after 8 days at 91.6% viability (not shown), with ISCT-defined surface marker expression retained. (B) A cost model based on a projected batch yield of 1.10 × 10^{10} cells indicates up to 70% cost reduction versus conventional 2D multilayer flasks culture.

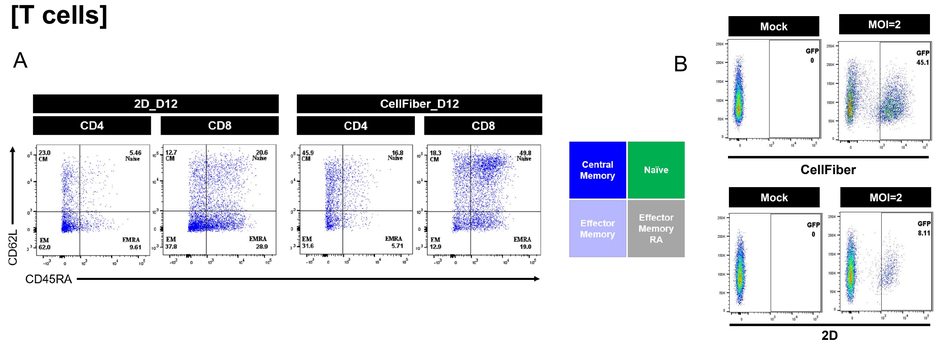

Figure 5. T cell expansion and transduction in fiber culture. A final yield of 2.0 × 10^{10} cells (750-fold expansion) was recovered at 92.2% viability after 12 days. Fiber culture yielded a higher proportion of $CD4^+$ central memory and $CD8^+$ naïve cells than 2D control (A). In a separate transduced batch, encapsulated T cells demonstrates significant increase of transduction efficiency with low lentiviral vector (MOI=2) without transduction enhancer (B).

Conclusion

- CellFiber® integrates encapsulation and expansion in a single closed process, and supports a combined encapsulation–activation–transduction workflow for T cells — reducing COGs, process length, and efficiency.
- Results on stem cells differentiation capability and T cells functional phenotype shows the advantages of CellFiber potentially improving therapeutic efficacy.
- A direct thaw-to-fiber workflow for MSC and iPSC, eliminating adherent pre-culture, is in development with availability targeted for late 2026.

CellFiber
Cell Culture Reimagined