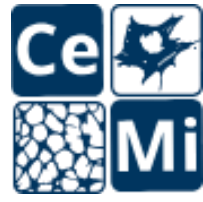


The Effects of Nanovibration on Cellular Yield in Serum-Free Conditions for Cultivated Meat

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Benefits & Challenges of Cultivated Meat

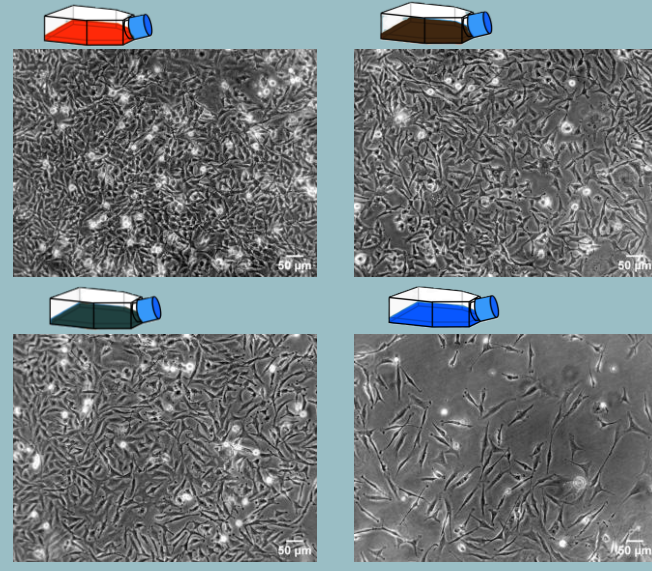
Cultivated meat is set for exponential growth within the UK but

cultivated meat still costs \$16 - \$400000 per kg [1]

Work is required to reduce production costs. One strategy towards this is to increase cellular yield during production.

CAN MECHANICAL STIMULATION OFFER A CHEMICAL-FREE ROUTE FOR IMPROVED YIELD?

DF-1 cells weaning



Brightfield microscopy (10x) of DF-1 cell culture on Day 7 of culture following introduction to a new media composition. Media compositions are presented in a ratio of serum-free media : DMEM (10% FBS)

Methodology

Vibration and characterisation of cells

100 Hz 10 kHz



Custom nanovibration bioreactor, generating a 30 nm amplitude



attached cells were detached and counted



suspension cells were stained for viability with trypan blue and live and dead counts were made

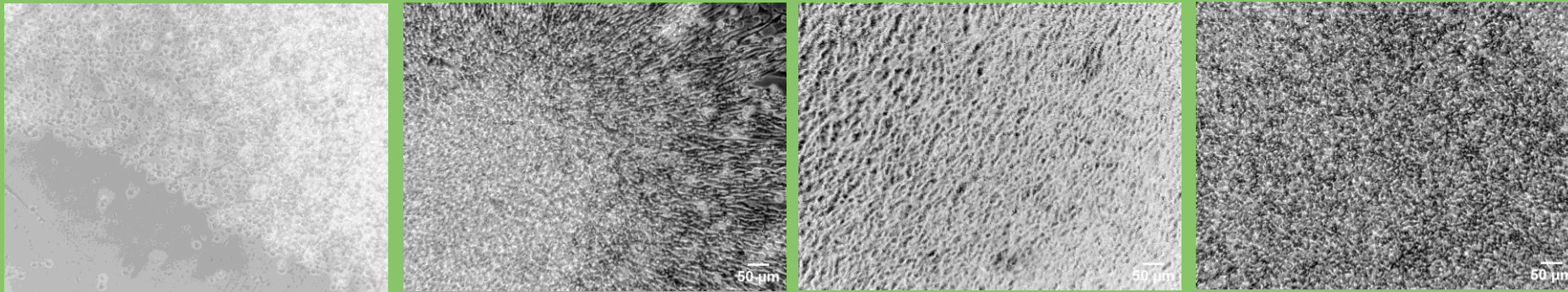
Nanovibration in Serum-Containing Media Increases Cell Proliferation

0 Hz Control

100 Hz

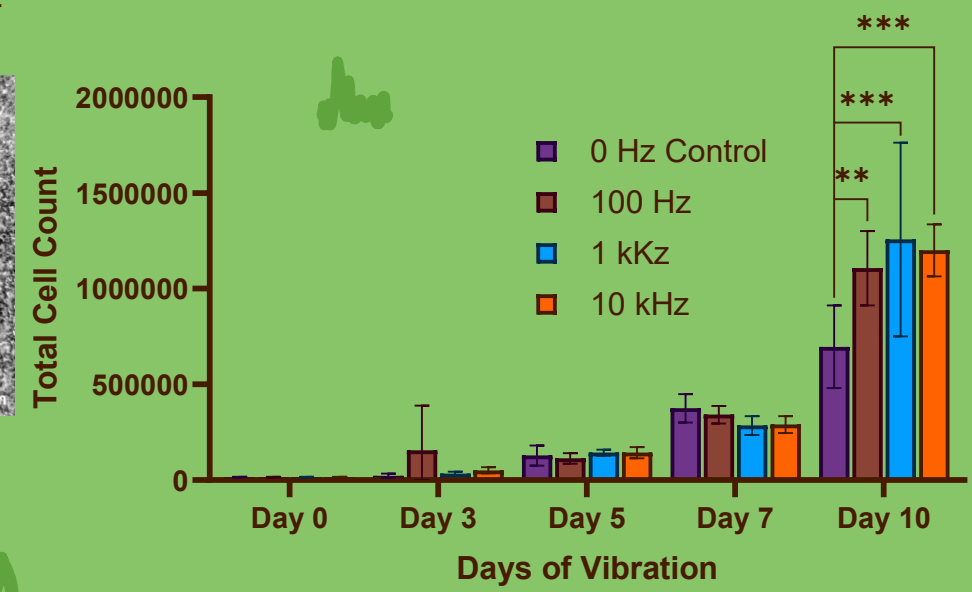
1 kHz

10 kHz



Brightfield microscopy (10x) of DF-1s following 10 days of nanoamplitude vibration in serum-containing media.

Following 10 days of nanovibration a significant increase in cell count was observed at 100 Hz, 1 kHz, and 10kHz when compared to a 0 Hz control



Average total attached cell count at 0 Hz, 100 Hz, 1 kHz, and 10 kHz (n=3) in DMEM 10% FBS.

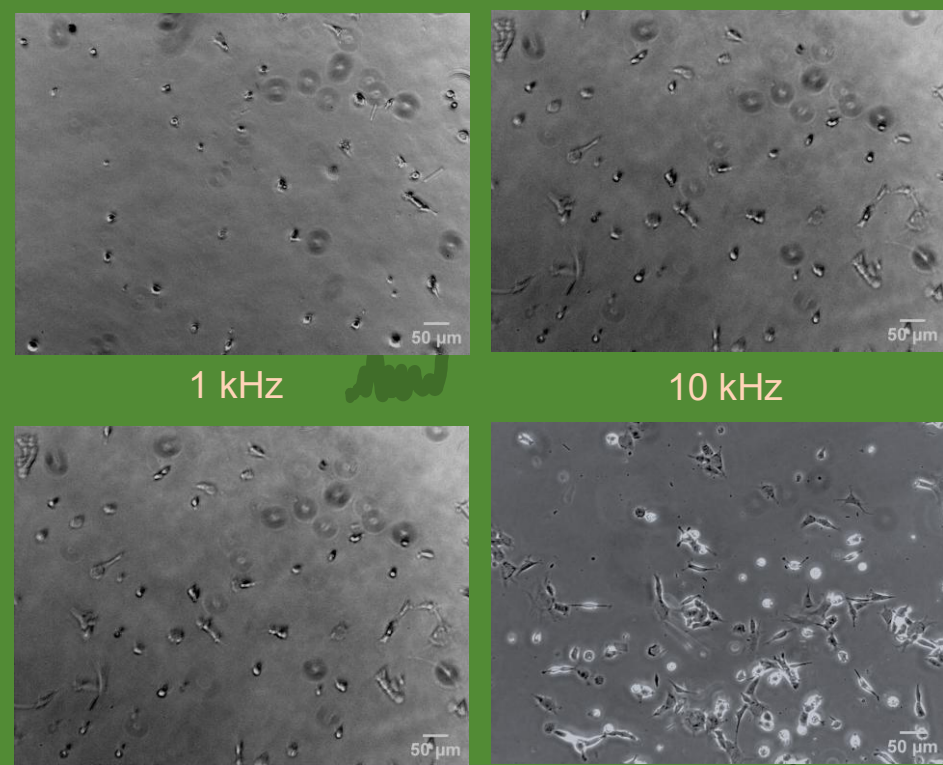
0 Hz Control

100 Hz

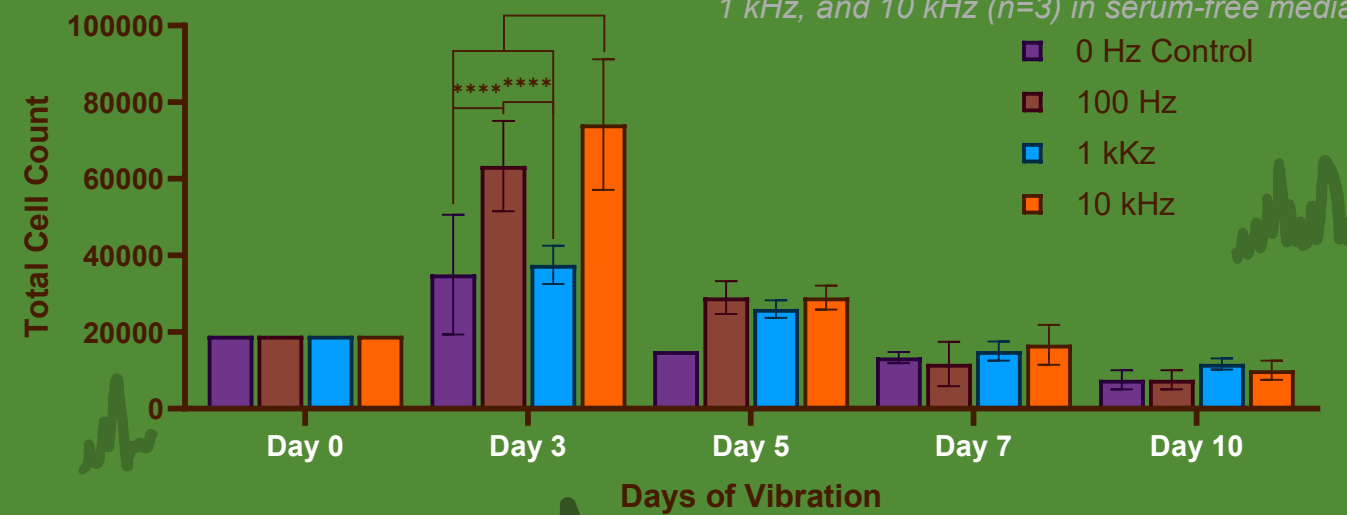
Three Days of Nanovibration in Serum-Free Media Increases Cell Proliferation

Following 10 days of nanovibration a significant increase in cell count was observed on Day 3 at 100 Hz and 10 kHz, when compared to a 0 Hz control and a 1 kHz sample. Between days 3 and 10 DF-1s began to detach from cultureware.

Average total attached cell count at 0 Hz, 100 Hz, 1 kHz, and 10 kHz (n=3) in serum-free media.

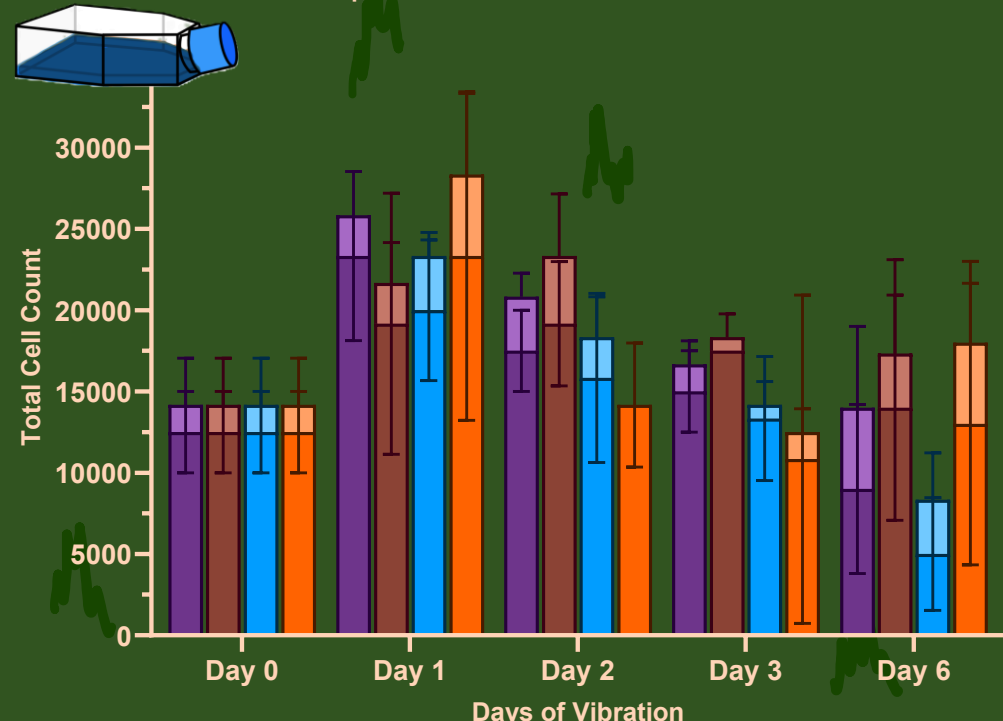


Brightfield microscopy (10x) of DF-1s following 3 days of nanoamplitude vibration in serum-free media.



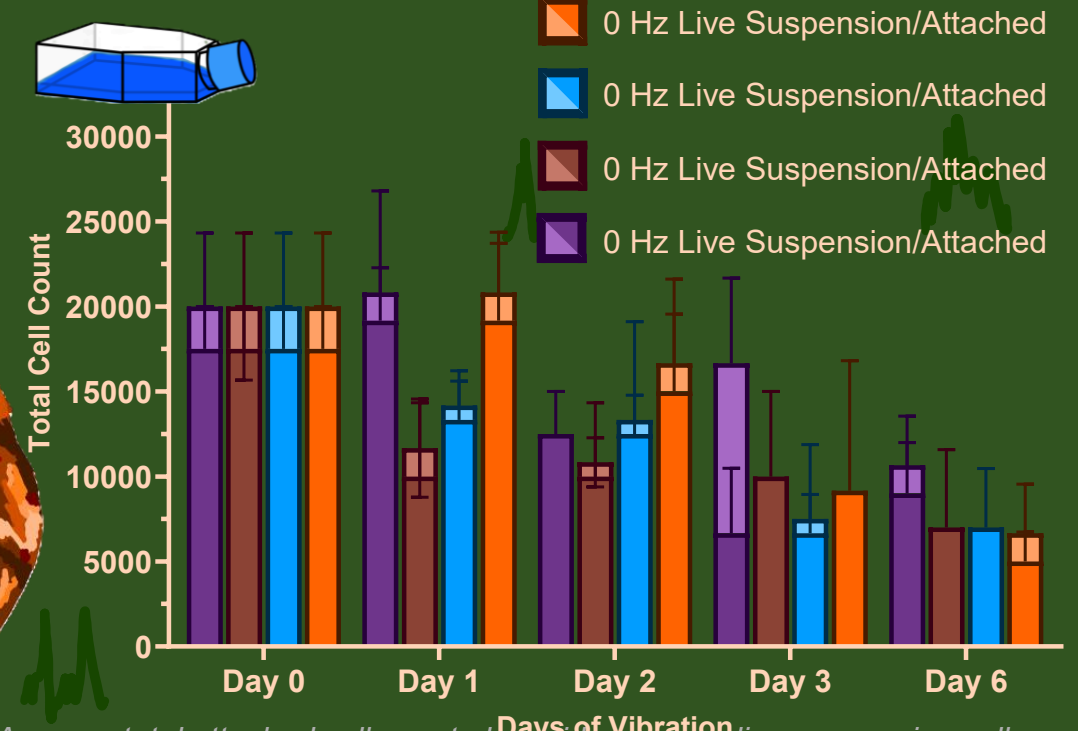
The Presence of Retained Media in Cells Promotes Attachment to Cultureware

The role of retained serum within cells was examined by introducing cells to nanovibration following 1 week of culture in 90:10 media composition and 100% serum-free media.



Day -8: cells from weaning (90:10)
Day 0: cells completely weaned (100% serum-free)

Cells seeded into 100% serum-free media and vibration started



Conclusions & Future Work

Nanoamplitude vibration has shown its ability to increase proliferation of cells following 10 days of exposure in serum-containing and serum-free conditions. However, it remains unclear requires cell attachment or may also benefit cells in suspension.

A characterisation of the serum-free and serum-containing cells examining morphology and mechanical properties is underway.

References

[1] S. Bamezai and J. Chapman, 'Cultivated Meat', UK Parliament, 740, Apr. 2025. Accessed: Apr. 20, 2026. [Online]. Available: <https://researchbriefings.files.parliament.uk/documents/POST-PN-0740/POST-PN-0740.pdf>
 [2] O. Johnson-Love, 'Optimisation of nanovibrational stimulation to control the mechanical properties and differentiation of adult stem cells', University of Strathclyde, 2025. doi: 10.48730/DB64-HV75.
 [3] L. Pasitka et al., 'Spontaneous immortalization of chicken fibroblasts generates stable, high-yield cell lines for serum-free production of cultured meat', *Nat Food*, vol. 4, no. 1, pp. 35–50, Dec. 2022. doi: 10.1038/s43016-022-00658-w.