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proveg NEW FOOD FORUM

Applying Regenerative Medical Technologies in Cultivated Meat

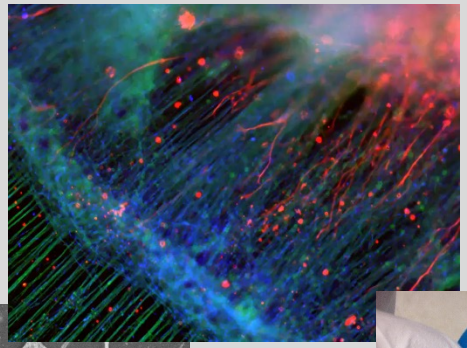
Speaker

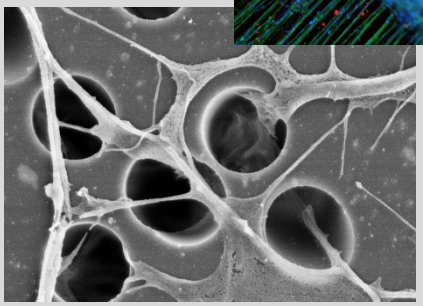
Ashton Choi

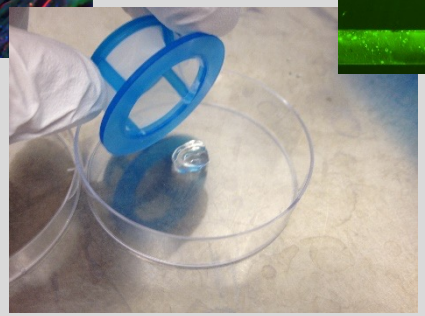
Tech Investor & Columnist

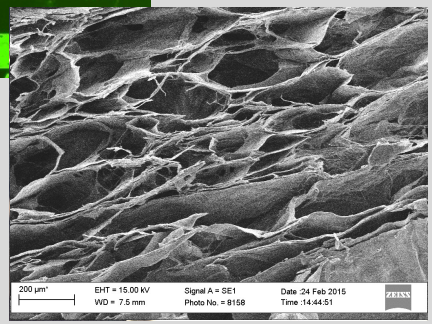
Researcher, Oxford Centre for Tissue Engineering and Bioprocessing

IBME The Institute of Biomedical Engineering









The Oxford Centre for Tissue Engineering and Bioprocessing

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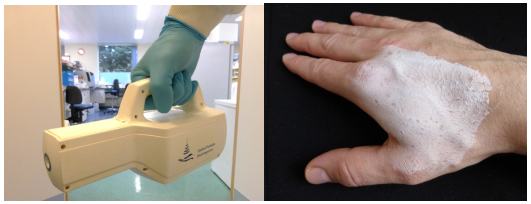
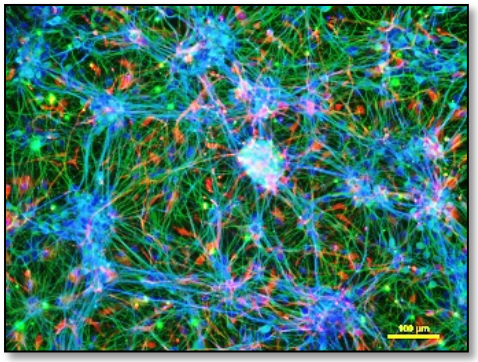
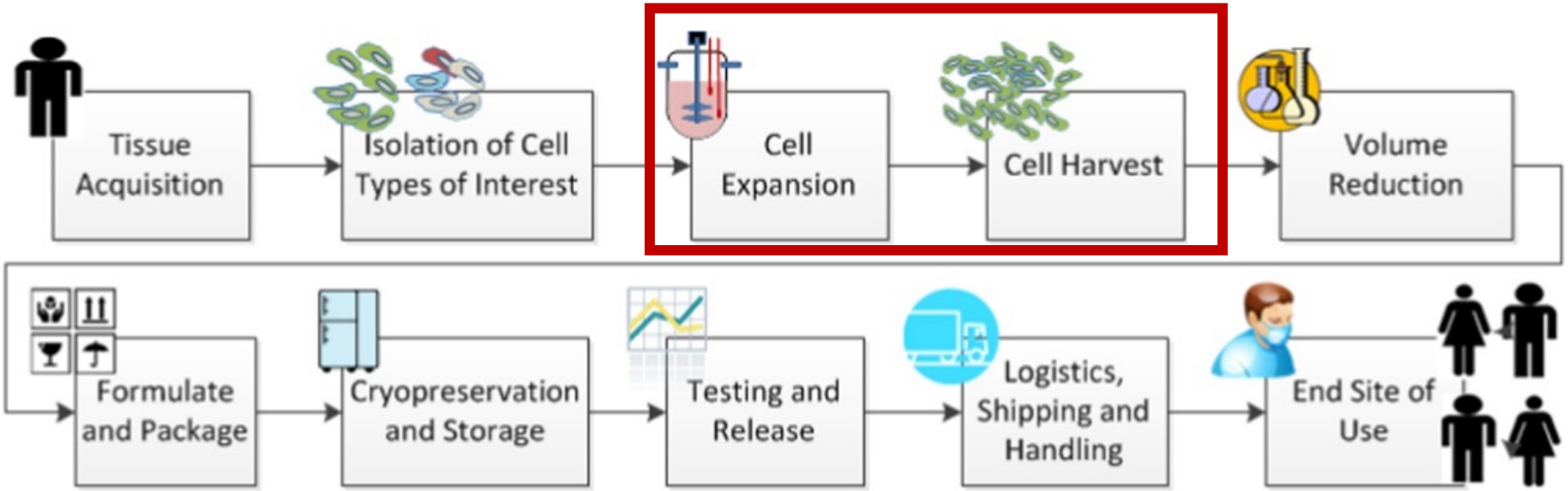
Main areas of research

- Bioreactor design
  - Large scale cell culture
  - Perfused bioreactor for cell/tissue culture
  - Hollow fibre membrane based bioreactor for generating bulky tissues
- Biomaterial selection, modification and processing
  - Cell culture substrate modification
  - Scaffolds for 3D cell culture
- 3D cell culture and characterisation
  - 3D human neural network
  - In vitro cancer model
  - Co-culture





Manufacturing process flow for cell based allogeneic regenerative medicine therapy



- Cell expansion step: the most expensive and time consuming step
- Cell harvesting step: not yet the optimum quality of cell harvesting

Biofabrication 7 (2015) 044103

Bioreactor: Fluidized Bed

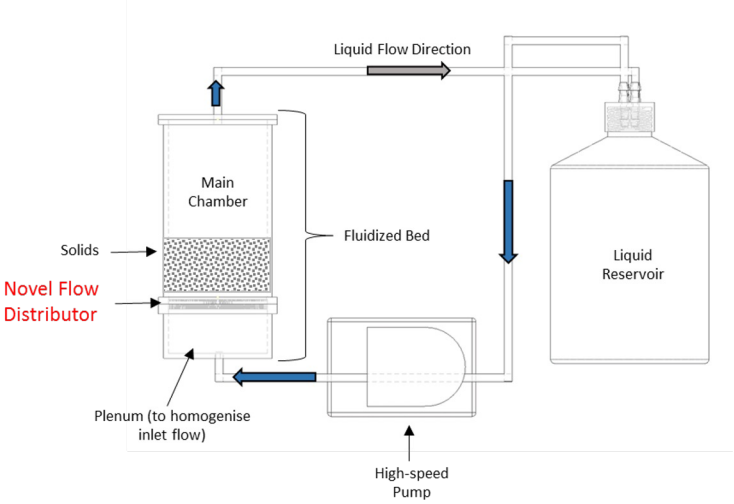
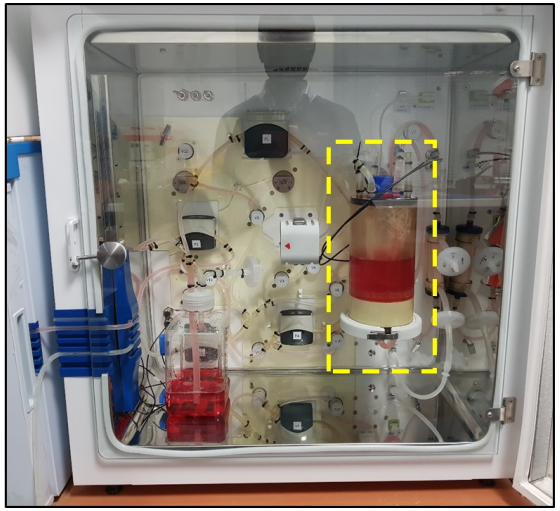
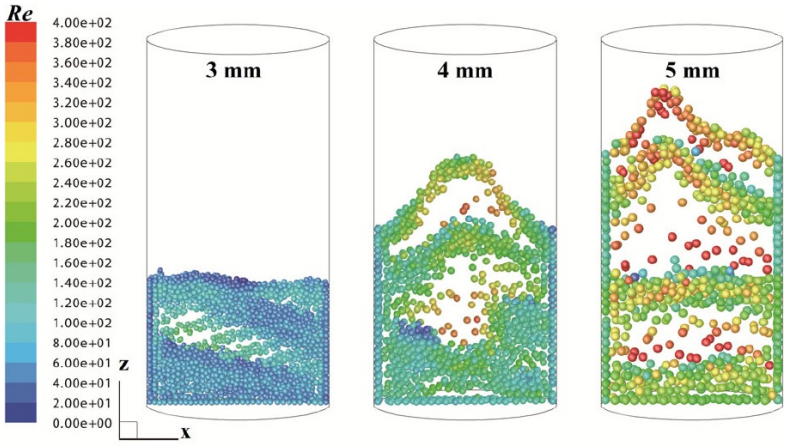
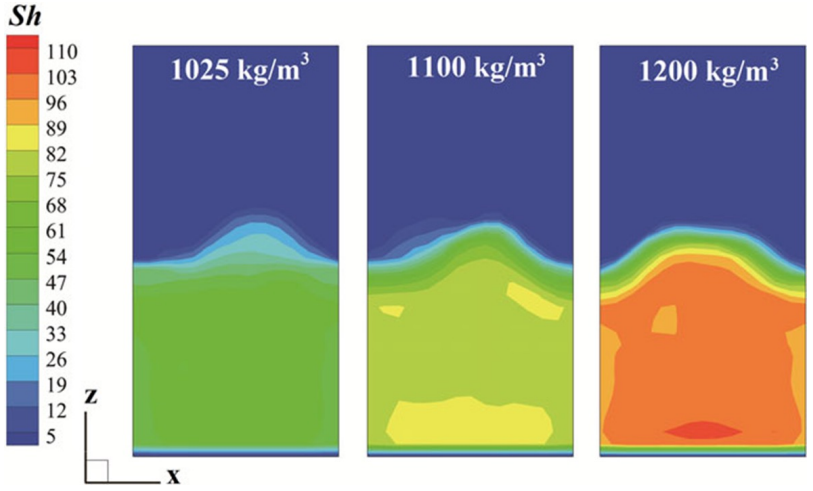


Figure: Liquid-solid fluidized bed experimental set-up





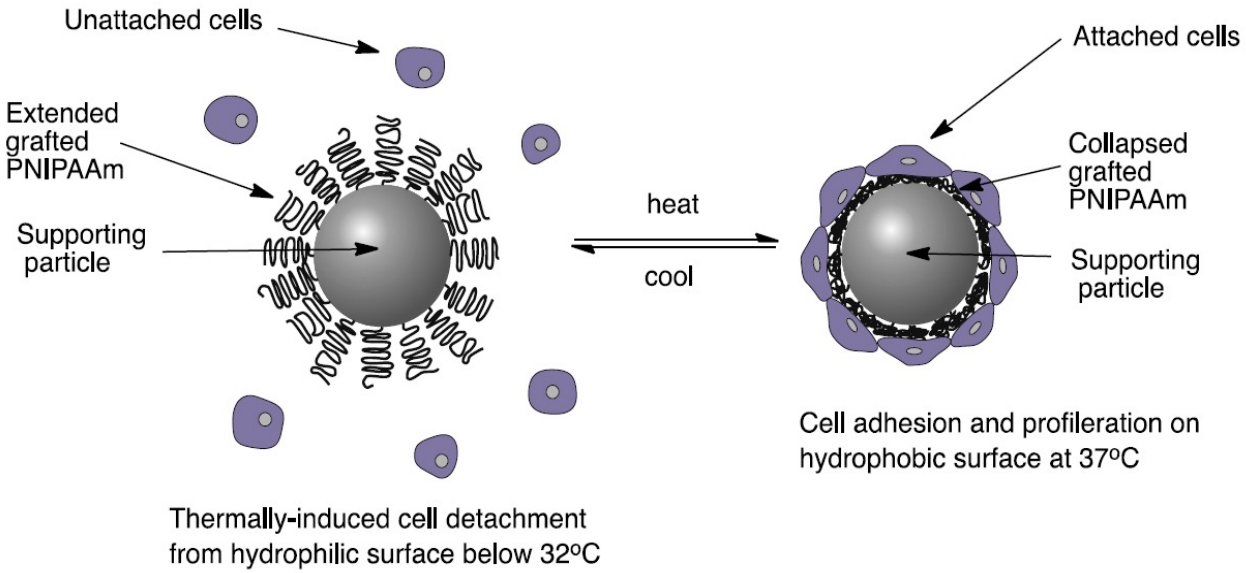


A Odeleye et al, Chem Eng Res Design, 2018
Z Huang et al, J Chem Technol Biotechnol, 2018

Particle Design: Thermoresponsive Macrocarriers

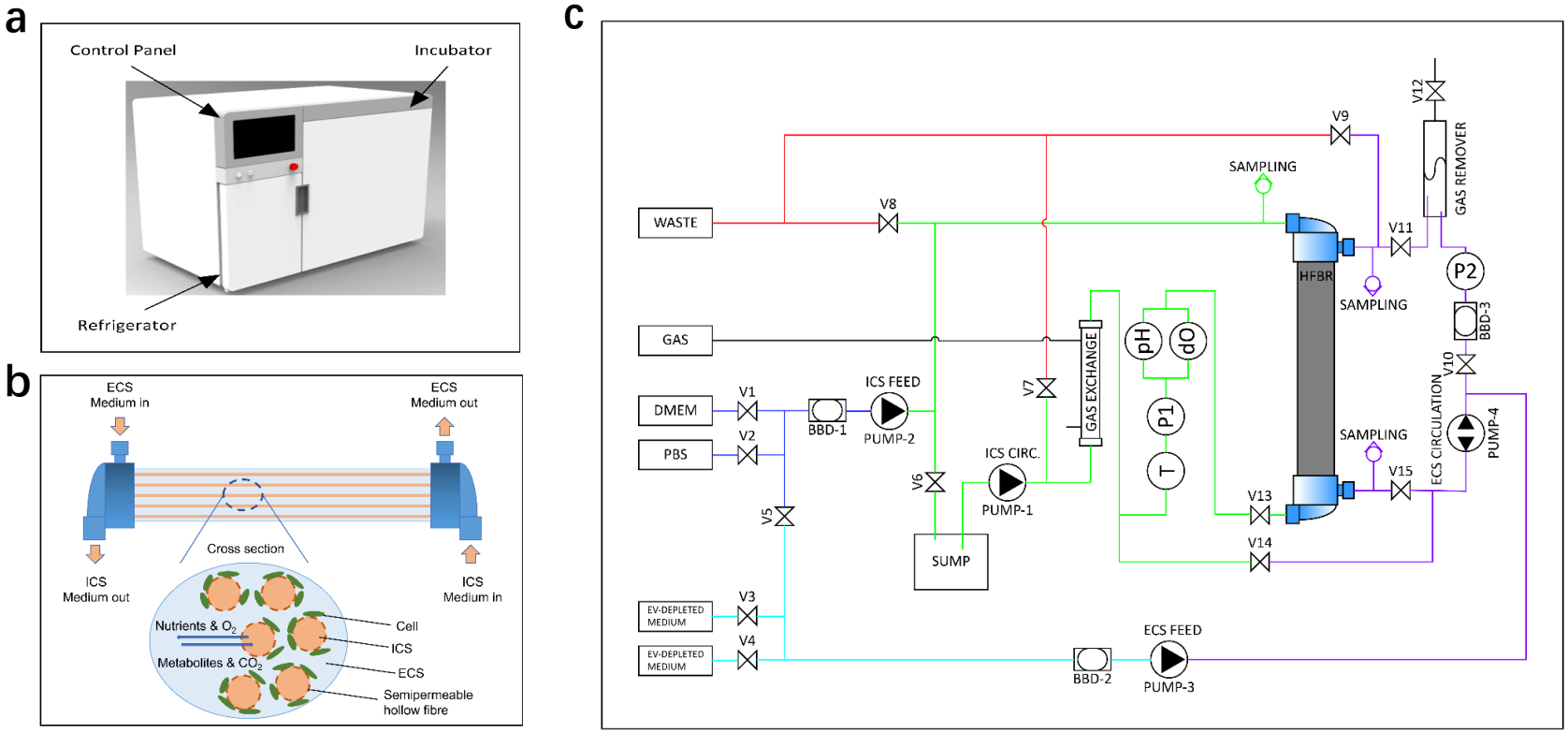
A thermo-responsive polymer is able to change its properties in response to changes in temperature.

Poly(N-isopropyl acrylamide) – PNIPAAm or PIPAAm



European Polymer Journal 67 (2015) 346–364

An Automated, High-throughput, Hollow Fibre Bioreactor System for MSC-sEV Production



Cell Expansion System. (a) The outside appearance of the CES. (b) Schematic diagram and working principle of the HFBR cartridge. (c) Process flow diagram of the CES. BBD – bubble detector, V – valve, T – temperature sensor, P – pressure sensor, pH – pH sensor, dO – oxygen sensor.

ivyfarm technologies

What if we could grow meat just like a plant?

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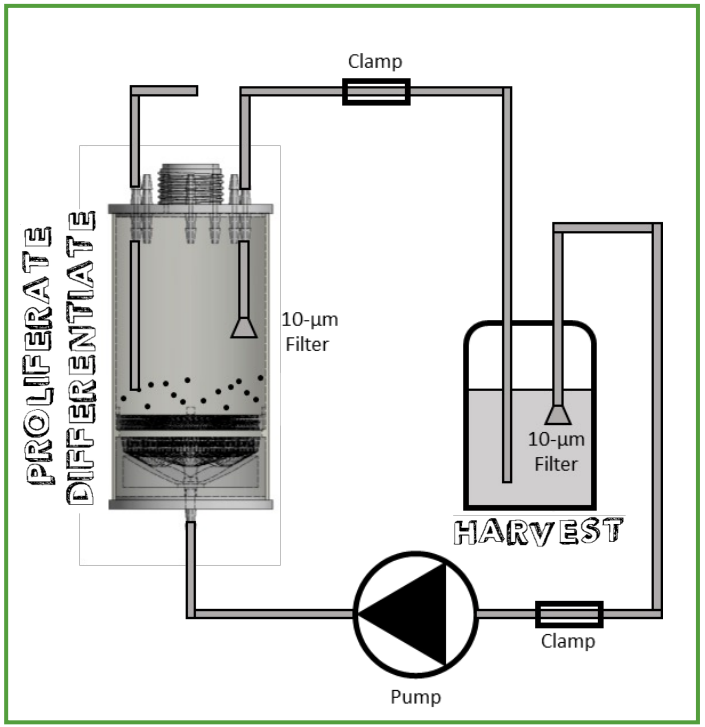
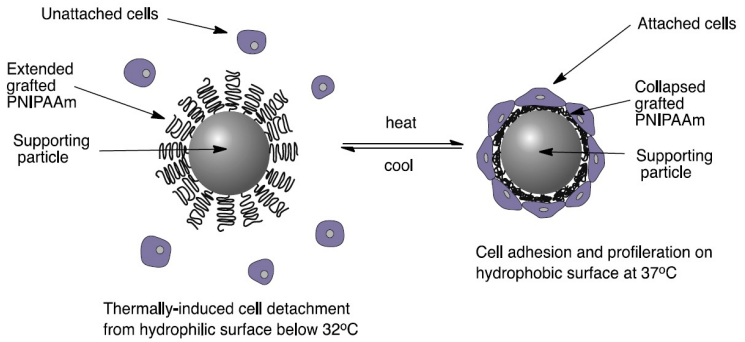
Understand

Ivy Farm Technologies: a spin-off company established in 2019

Bioreactor schematic



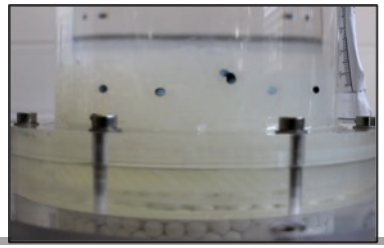
Exclusive license of patented thermo-responsive macrocarrier technology



- **Lower cost vs. others** (fewer steps in the process, fewer additives)
- Animal-free (alternative is trypsin, an animal-derived enzyme)
- No cytotoxicity
- No adverse effects on cell morphology/physiology
- Cell phenotype remains unaltered
- Predicted regulatory-friendly methodology

Commercial access to advanced bioreactor design

- Angled inlets to increase axial and vertical velocity of mixture
- Encourages mixing leading to better cell quality and higher growth rate
- Defined approach to automation established



ivyfarm technologies | sustainable meat co.

Ivy Farm Operates the Largest Culture Meat Pilot Plant in Europe in its 18,000 Sqft Campus in Oxford, UK

Our R&D center in Oxford has a low-rent space that is capable of hosting over 120 employees, while currently we have only 50. We are thus ready to expand for the upcoming stage of development

I cannot tell the difference between traditional farmed beef and Ivy Farm cultivated beef... Its absolutely delicious" – Tom Heap

January, 29, 2024 — sky news

"We combine just the best bits of meat - pure muscle and pure fat - to create a product that is better for the environment." – Rich Dillon

November 4, 2022 — web summit

"Ivy Farm is developing a healthier alternative to traditional and existing plant-based meat products, which is a key value proposition." – Hiral Patel

January 26, 2022 — BARCLAYS

"It's really good, and it's a real hot dog! Wow."- Poppy O'Toole

November 25, 2021 — COP26

First cultured burger

In 2013, this beef burger was made at the cost of eye-watering $300k

https://cmsw.mit.edu/angles/2020/the-new-food-revolution/

More companies are doing it

At much lower cost

cnbc.com/2020/12/18/singapore-restaurant-first-ever-to-serve-eat-just-lab-grown-chicken.html

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This restaurant will be the first ever to serve lab-grown chicken (for $23)

Published Fri, Dec 18 2020•2:30 PM EST • Updated Wed, Dec 23 2020•9:40 AM EST

Jade Scipioni
@JADESCIPIONI

SHARE

1880's crispy maple waffle with GOOD cultured chicken Credit: Eat Just and 1880

Trending Now

1 Dogecoin up 12,000%—here's how much money you'd have if you invested $1,000 at the beginning of 2021

2 Bill and Melinda Gates just announced their divorce — here's a breakdown of the billionaire's wealth

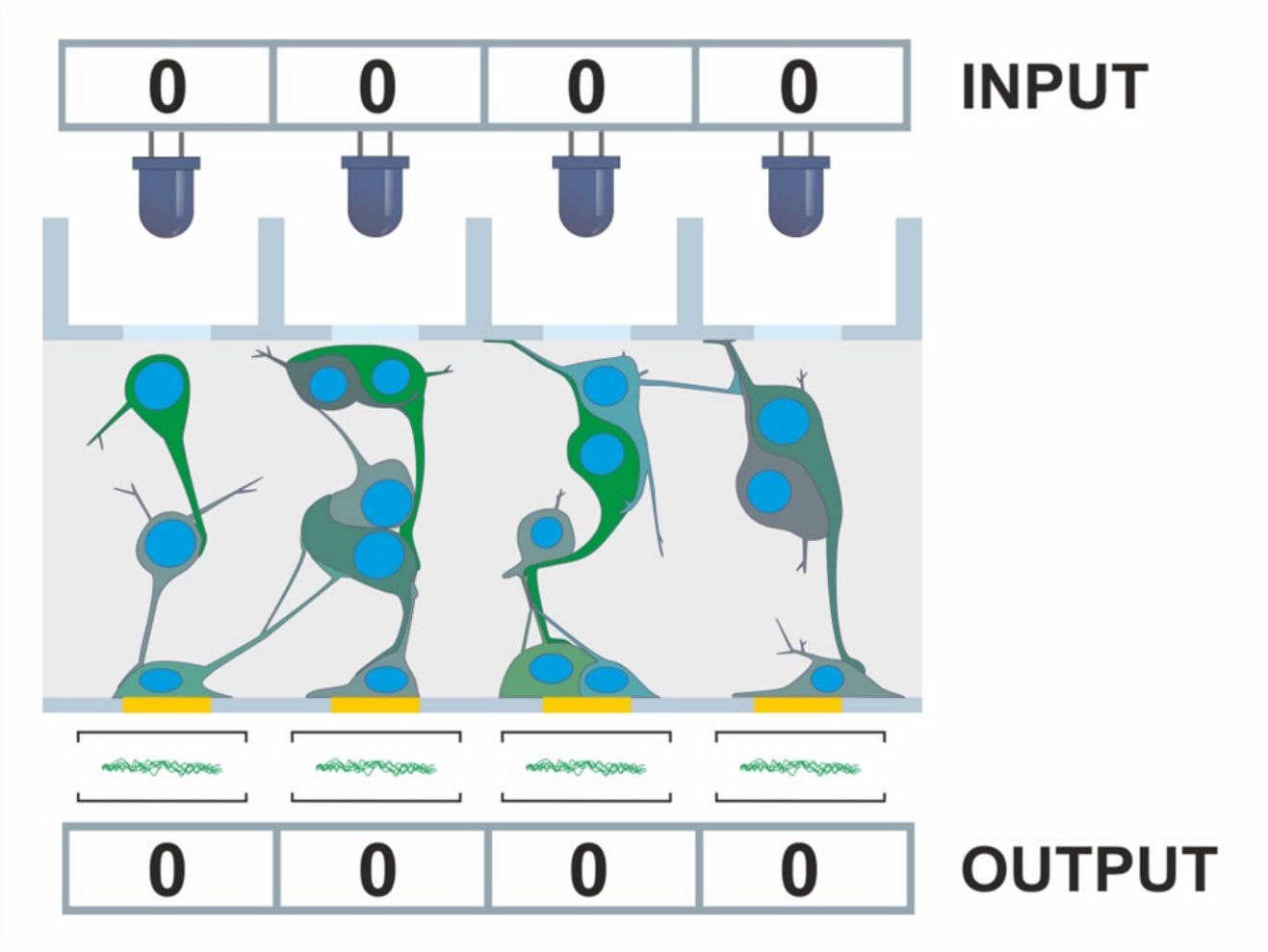
3 This 42-year-old made over $366,000 from her side hustle turned full-time job

4 Dogecoin millionaire invested his savings in the meme

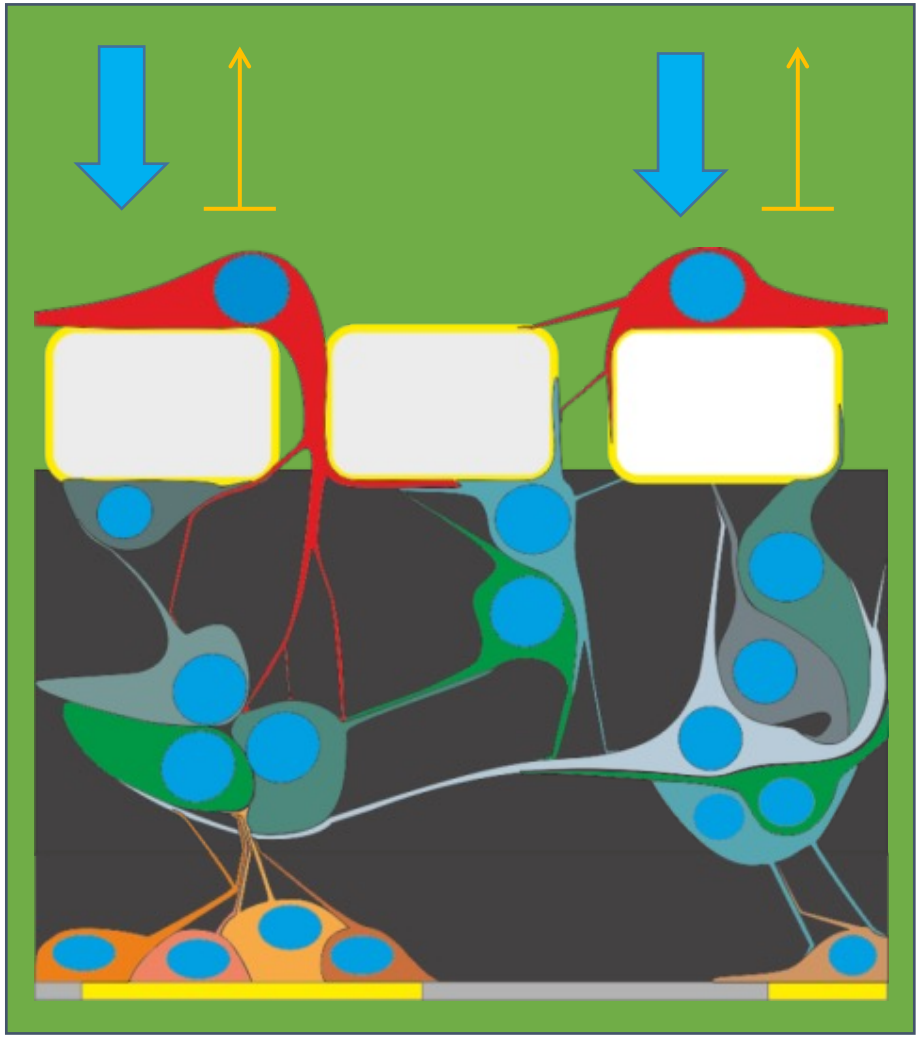
Scale up challenge

- There are ~100 billion cells in a kg of meat
- World meat consumption: 300 billion kg/year
- If cultured meat is to supply only 10% of the world meat consumption, i.e. 30 billion kg/year, we need to produce 30 billion × 100 billion cells (3×10^{21} cells /year)
- Even with high density cell culture in bioreactors, we would need at least 2×10^6 m^3 bioreactor volume (corresponding to ~200,000 of 10,000 litre bioreactors).
- Currently, there aren't even enough amount of stainless steel materials
- Innovation is needed:
  - Bioreactor design
  - Reduce waste
  - Regulation

Building a brain slice in a dish



The physical model



Stimuli - light

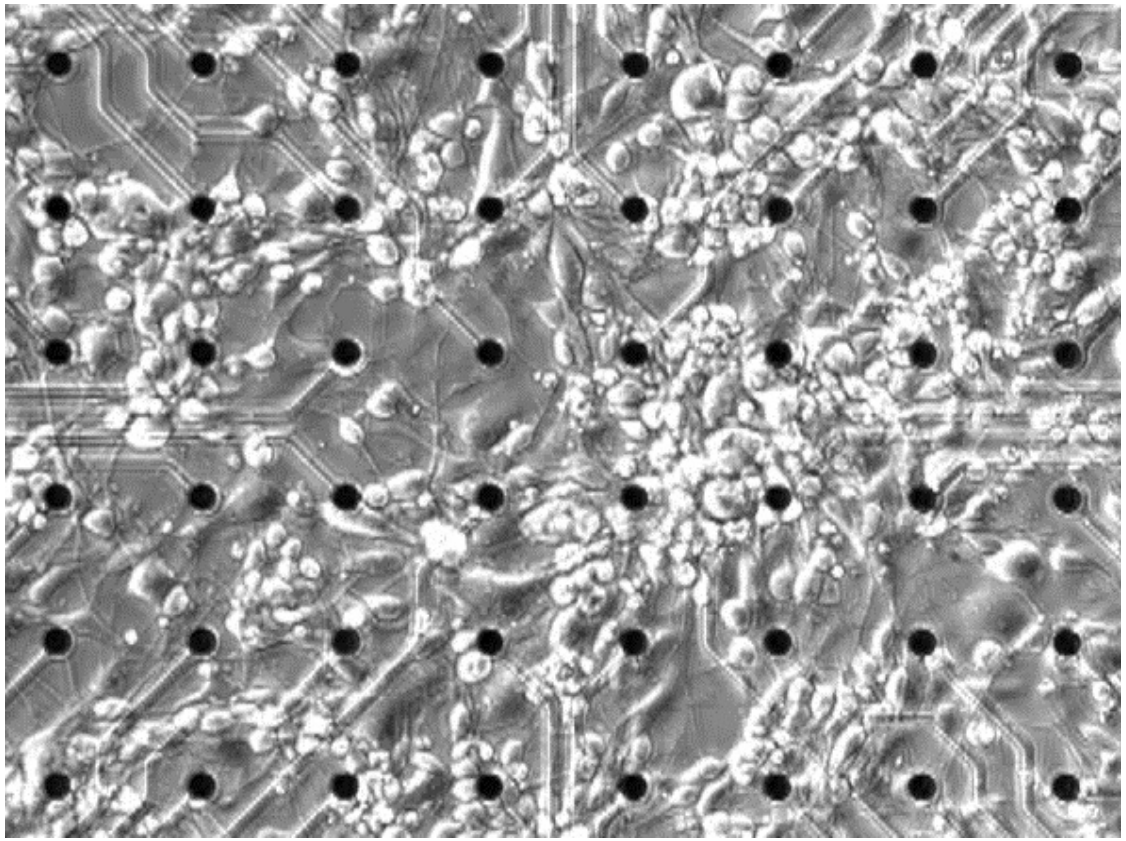
Light sensitive neurons

Porous membrane

3D Model neural network

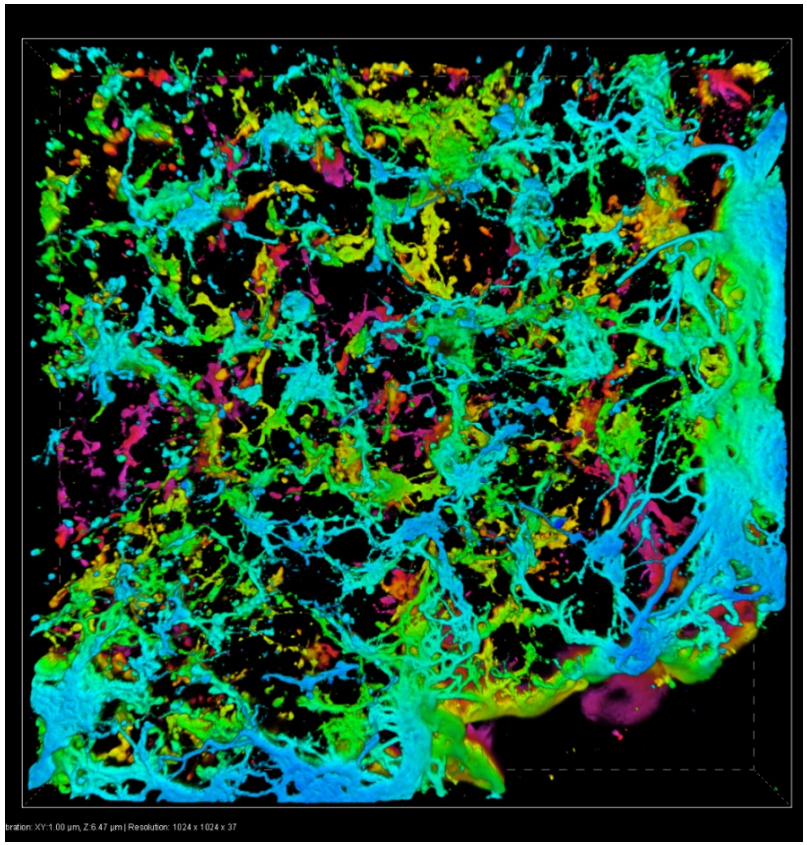
Neurons patterned on MEA

Neurons like to form clusters

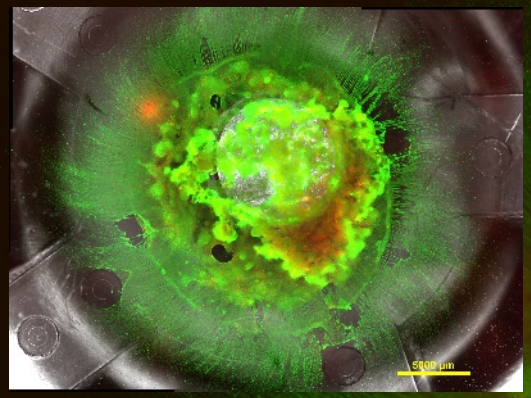


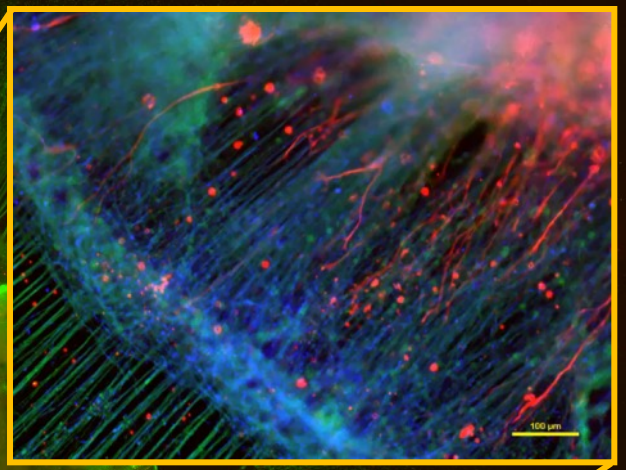
Seeding of human IPSC derived neurons on a Laminin coated MEA (720x, 4hr time-lapse)

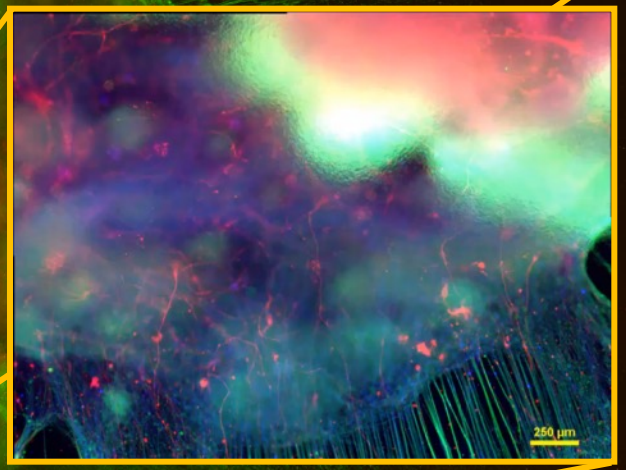
Neurons form networks throughout gel



4-week culture of human iPSC derived neurons in granular HyStem hydrogel + Laminin







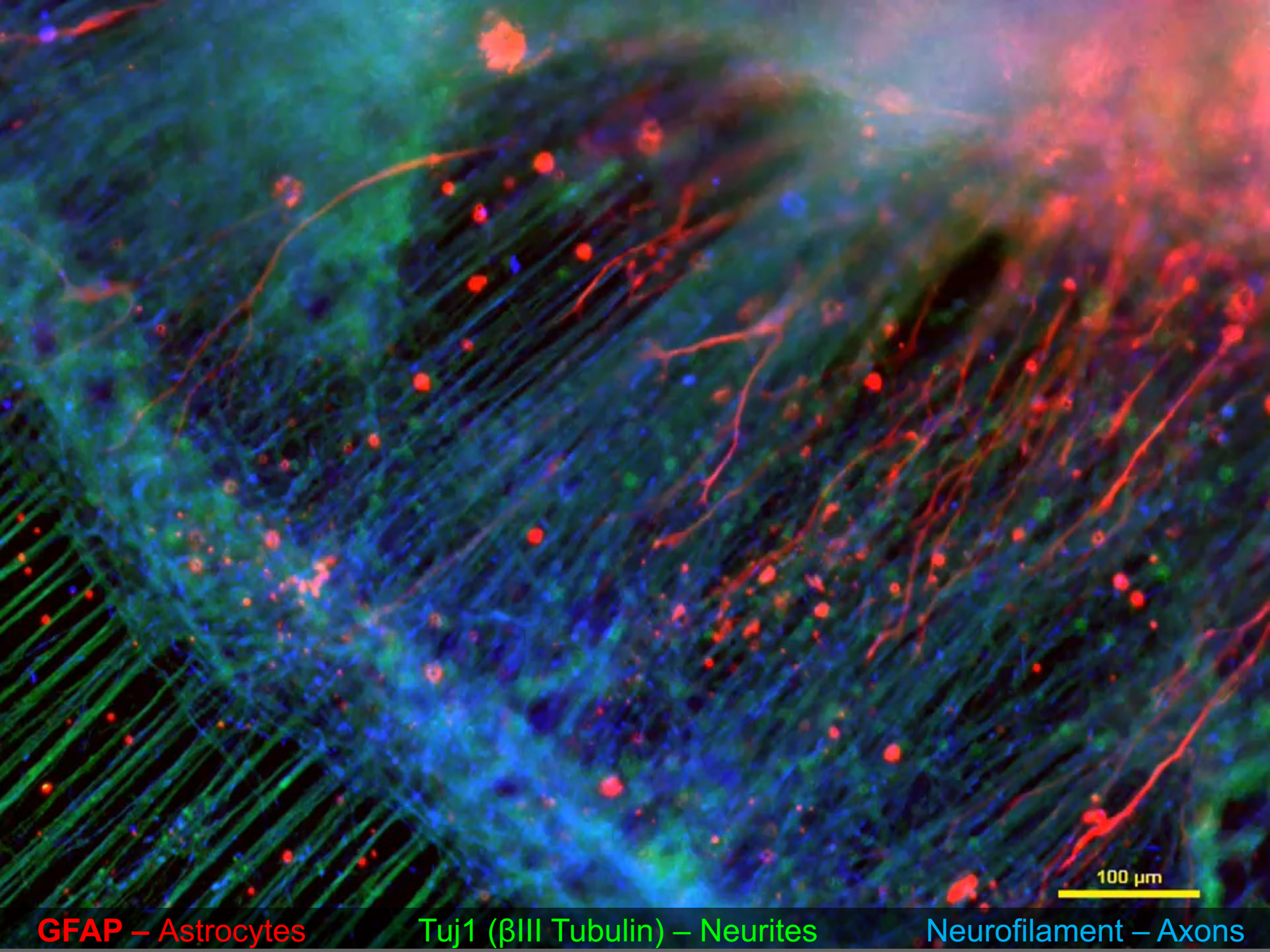
Fully dense cortical neural network hydrogel cultures

5000 µm

GFAP – Astrocytes

Tuj1 (βIII Tubulin) – Neurites

Neurof


100 µm
GFAP – Astrocytes
Tuj1 (βIII Tubulin) – Neurites
Neurofilament – Axons