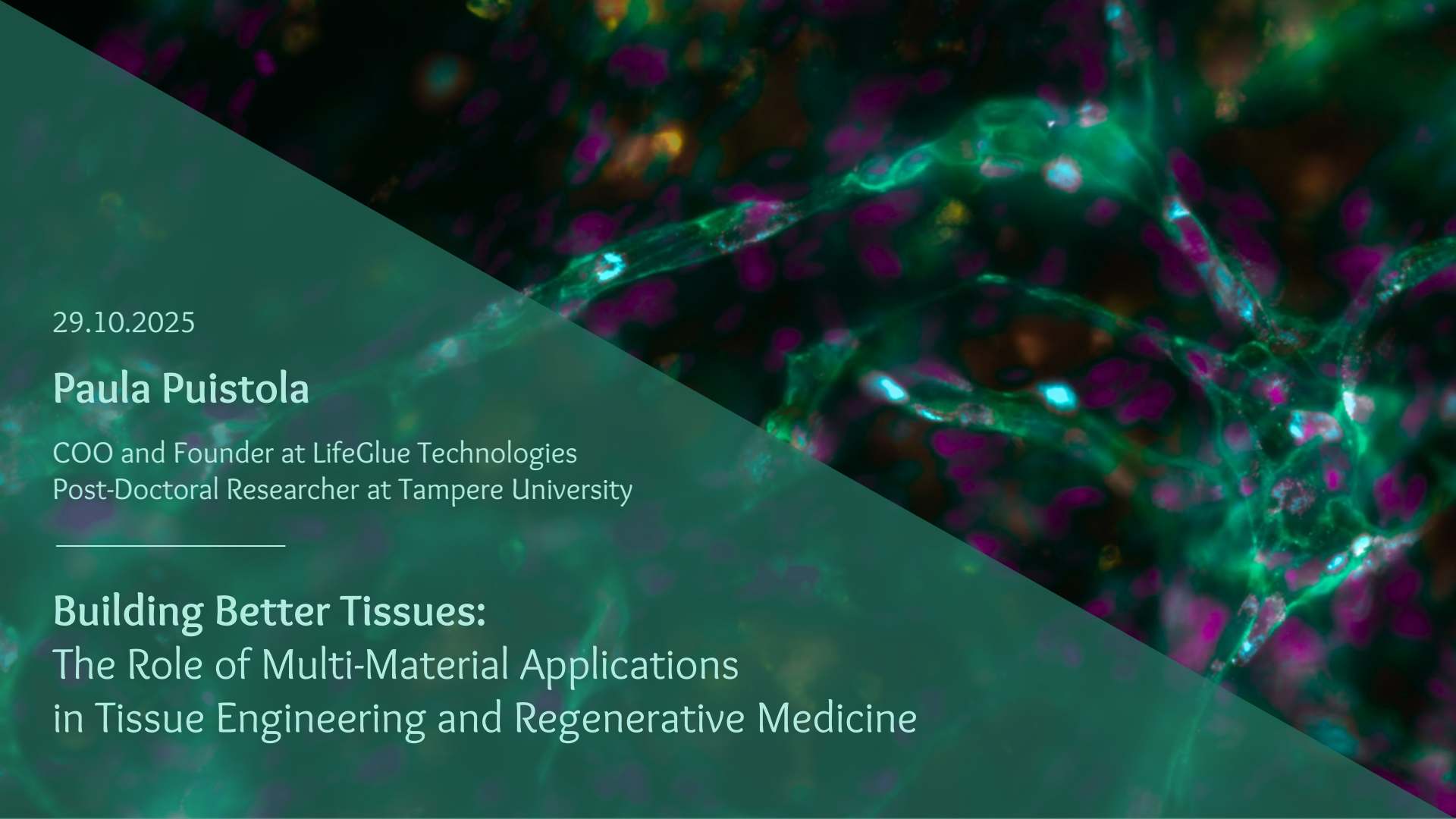
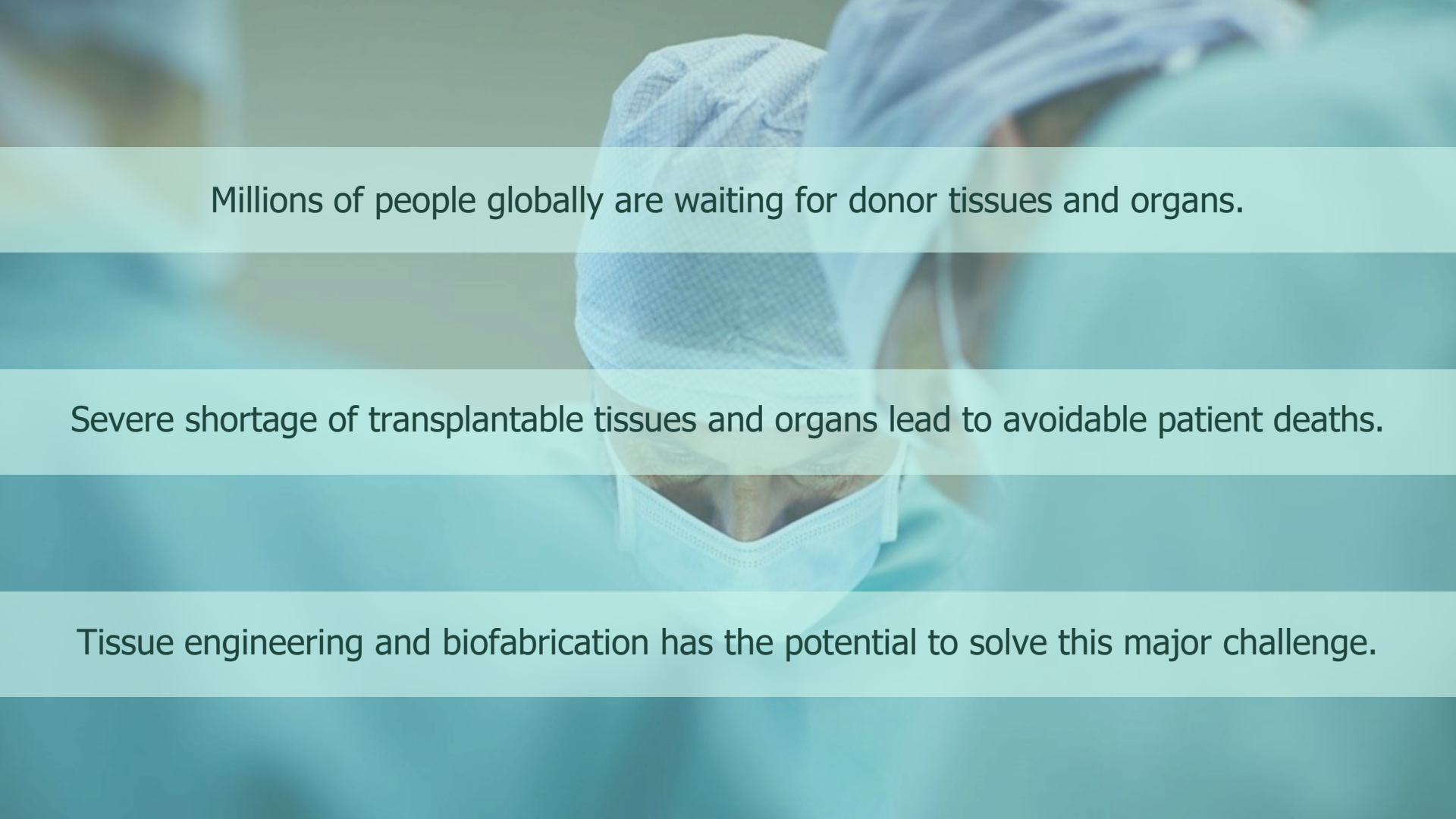


29.10.2025

Paula Puistola

COO and Founder at LifeGlue Technologies
Post-Doctoral Researcher at Tampere University

Building Better Tissues:
The Role of Multi-Material Applications in Tissue Engineering and Regenerative Medicine



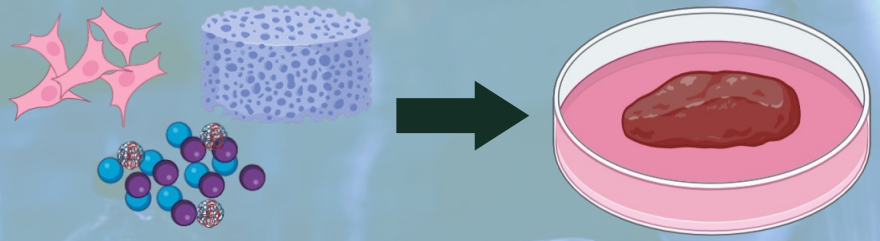
Millions of people globally are waiting for donor tissues and organs.

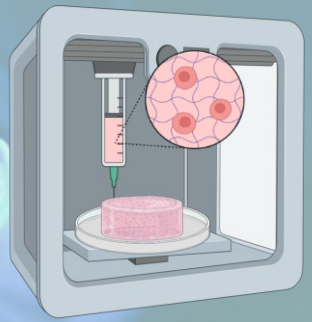
Severe shortage of transplantable tissues and organs lead to avoidable patient deaths.

Tissue engineering and biofabrication has the potential to solve this major challenge.

Crafting life with biofabrication

Living cells, biomaterials and molecules are built into functional tissues



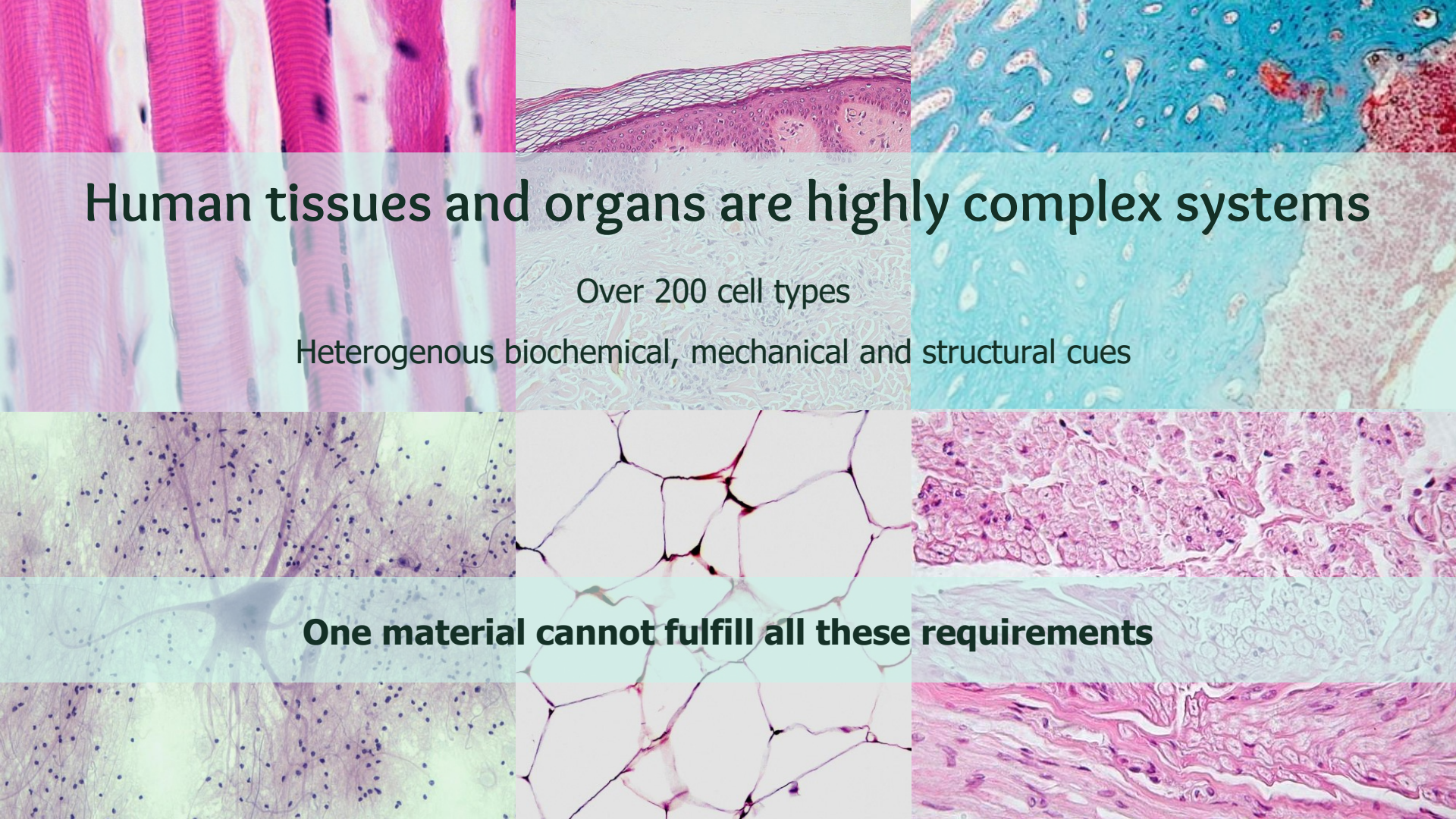


3D bioprinting

Layer-by-layer positioning of bioinks into pre-designed structures

- ☑ Spatial control and automation
- ☑ Scalable and reproducible
- ☑ Design flexibility and personalization

Schematic images created with Biorender.com



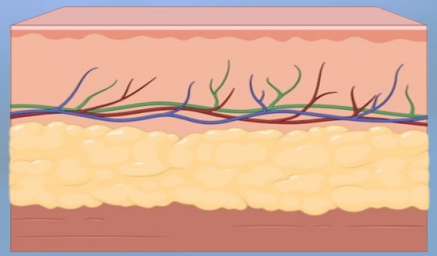
Human tissues and organs are highly complex systems

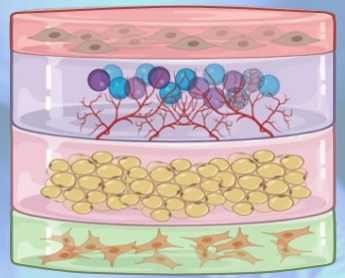
Over 200 cell types

Heterogenous biochemical, mechanical and structural cues

One material cannot fulfill all these requirements

Multi-material approaches increase the biorelevance of engineered tissues





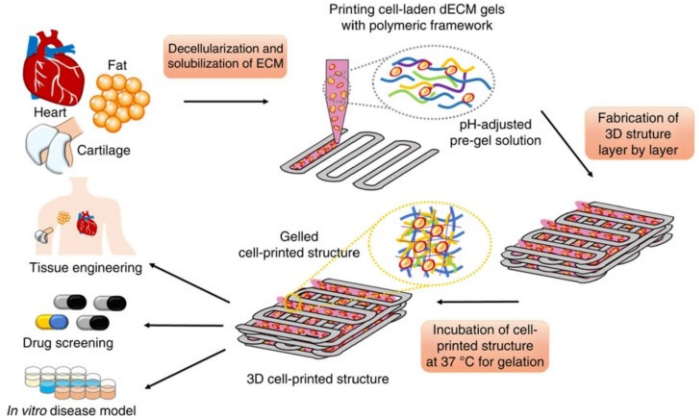
Possibilities

- ☑ Orientation and cell guidance
- ☑ Biomechanical and -chemical gradients
- ☑ Interactions of different cell types
- ☑ Signaling routes

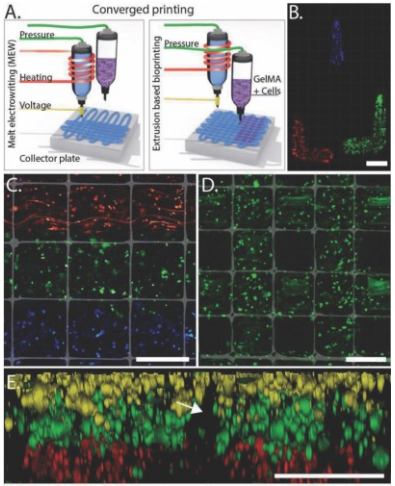
Challenges

- ✗ Traditional methods have limited spatial control
- ✗ Multiple processing steps can limit automation, affecting scalability and cost-efficiency

Schematic images created with Biorender.com



Printing three-dimensional tissue analogues with decellularized extracellular matrix bioink. Pati et al. 2014. *Nature Communications*.



Simultaneous Micropatterning of Fibrous Meshes and Bioinks for the Fabrication of Living Tissue Constructs. de Ruijter et al. 2018. *Advanced Healthcare Materials*.

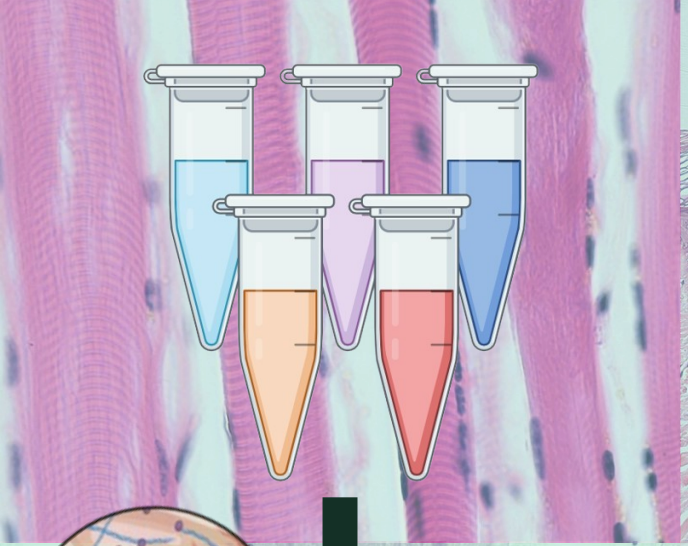
Biomaterials as the building blocks of possibility

Gelatin, GelMA, Collagen, Fibrin, Decellularized ECM, Hyaluronic acid, Alginate, Nanocellulose, PEG, PLA, PCL…

From animal or human tissue? | Biodegradable or not? | Synthetic or natural?

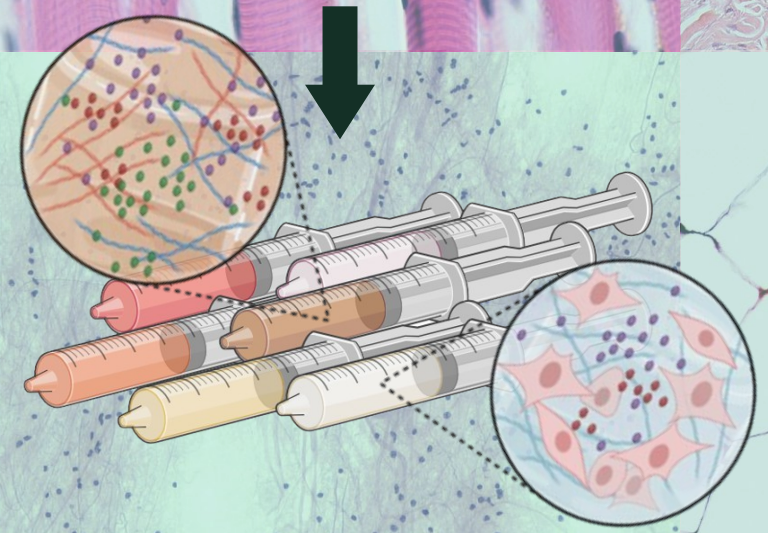
Diversity drives functionality…

… but also complexity in manufacturing, validation, and regulation.



Biomaterial platform technology

Fine tuning the base material components into cell-specific solutions



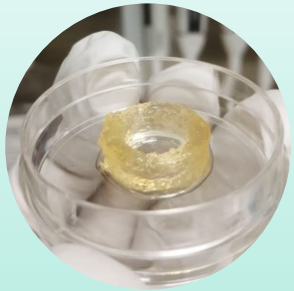
- ➔ Streamlining R&D
- ➔ Simplifying clinical translation
- ➔ Accelerating regulatory readiness

Schematic images created with Biorender.com

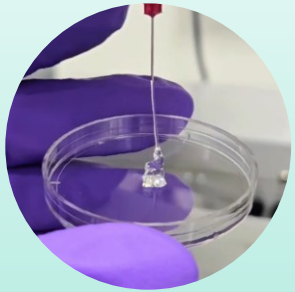
Glue4Life

Next-generation hydrogels for creating life.

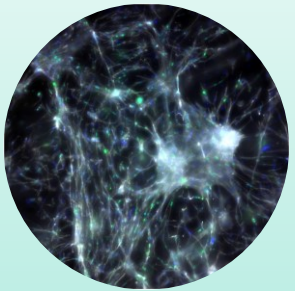
Human-relevant hydrogel platform for creating tissues



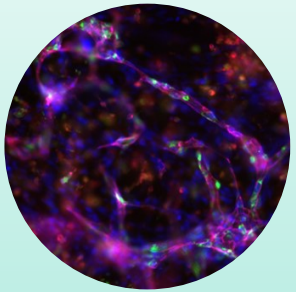
Clinically compatible components



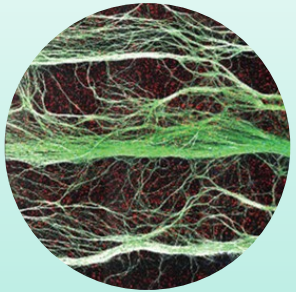
Injectable and tunable platform



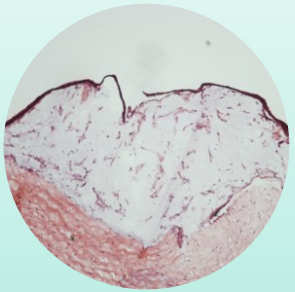
Tissue formation



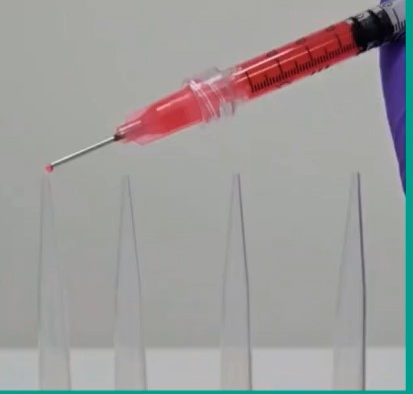
Vascularization



Innervation



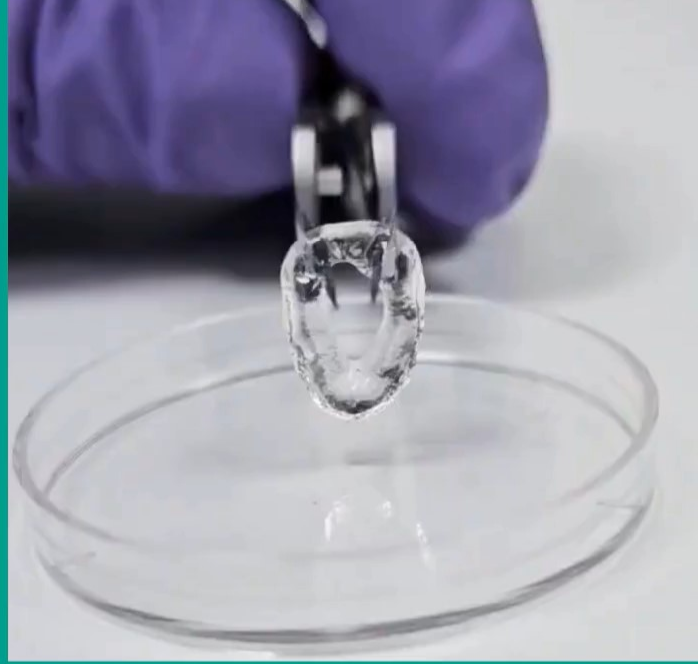
Integration

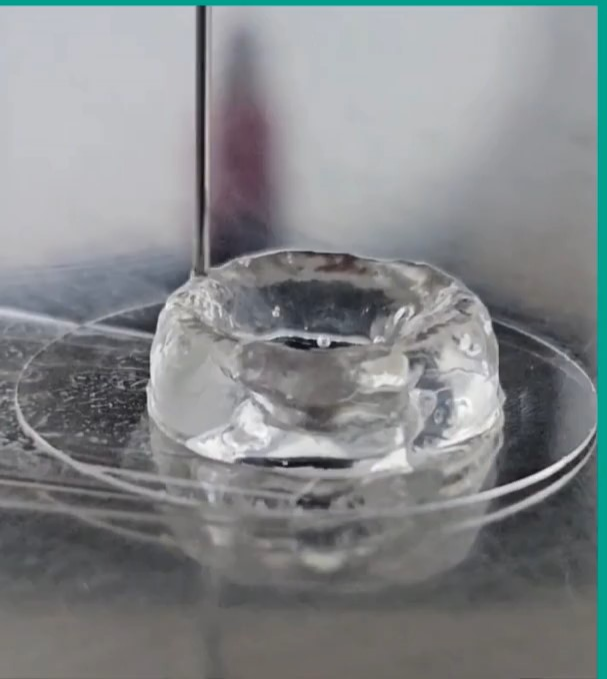


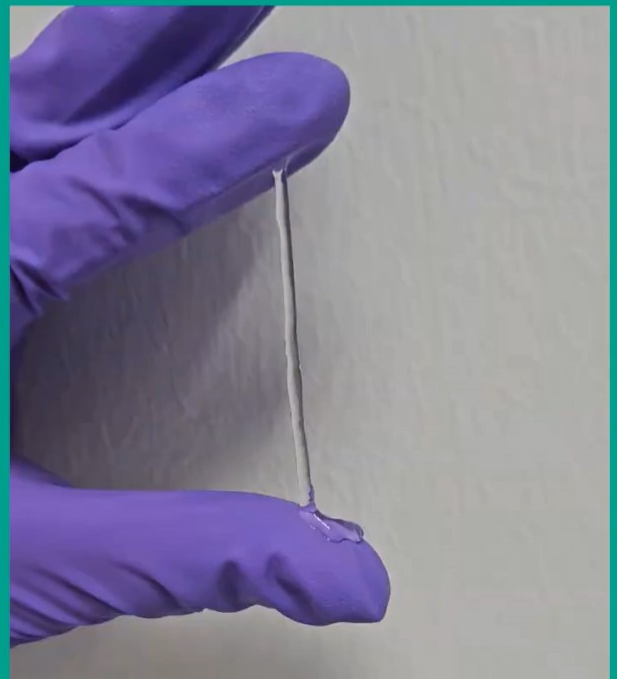
Glue4Life

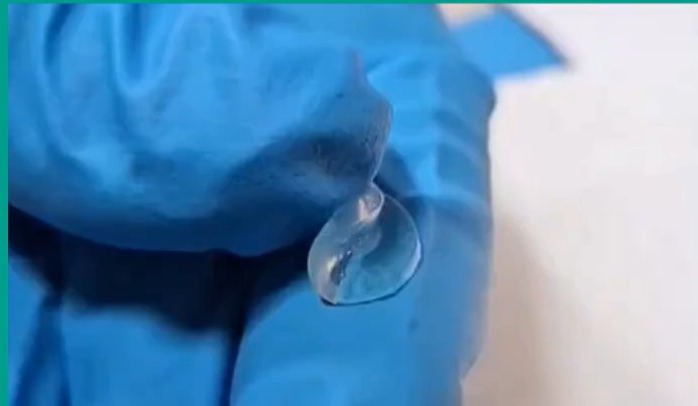
Next-generation hydrogels for creating life.

Soft | Elastic | Glue-like









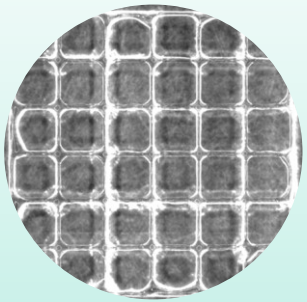
Glue4Life
Next-generation hydrogels for creating life.

Fine tuning the hydrogel platform

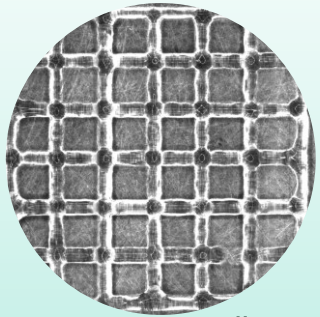
Lower crosslinking density

Higher crosslinking density

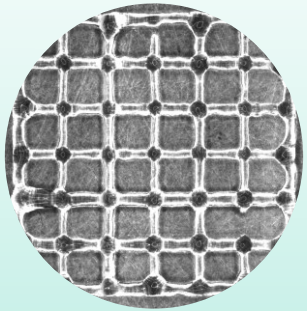
Printability



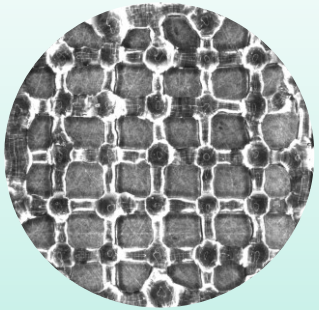
100 µm needle
G' 20 Pa



150 µm needle
G' 60 Pa

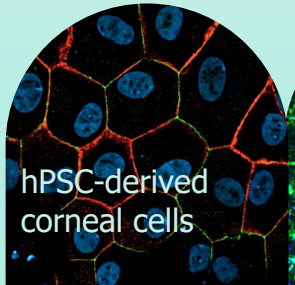


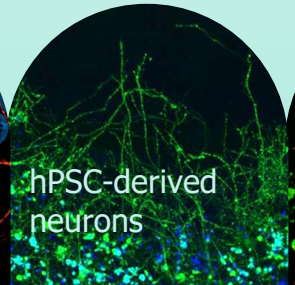
200 µm needle
G' 150 Pa

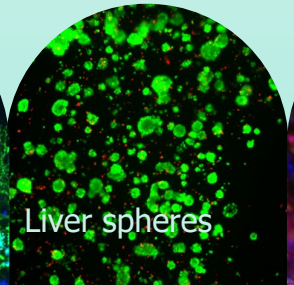


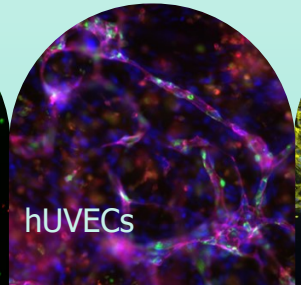
400 µm needle
G' 160 Pa

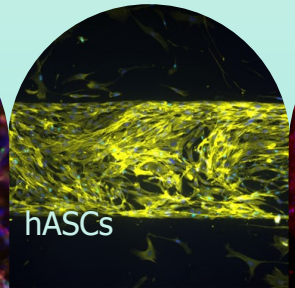
Cell type

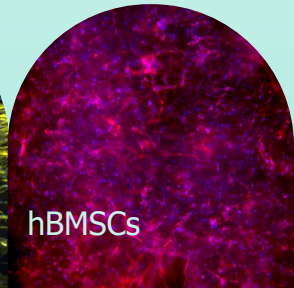












Glue4Life

Next-generation hydrogels for creating life.

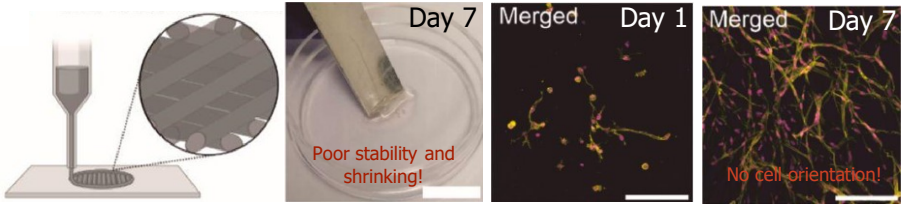
Case examples of hydrogel platform in multi-material action

Bioprinted cornea

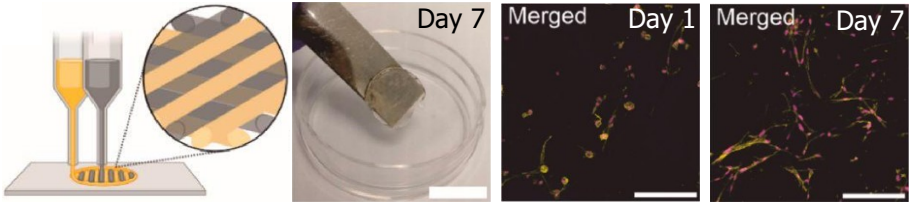
Novel strategy for multi-material 3D bioprinting of human stem cell based corneal stroma with heterogenous design. Puistola et al. 2024. Materials Today Bio.

Multi-material 3D bioprinting of human stem cells to engineer complex human corneal structures with stroma and epithelium. Puistola et al. 2025. Bioprinting.

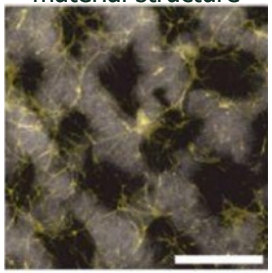
Uni-material structure

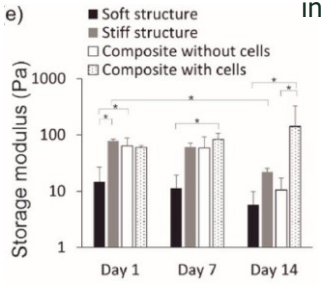


Multi-material structure

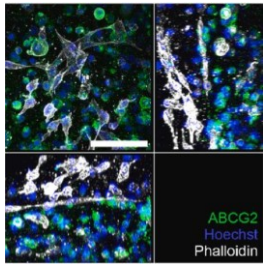


hASCs in multi–material structure





hASC-CSKs and hiPSC-LSCs in multi-material structure



Key benefits:

- ☑ Mechanical stability improved
- ☑ Guidance for cellular growth
- ☑ Different cell types combined

Glue4Life
Next-generation hydrogels for creating life.

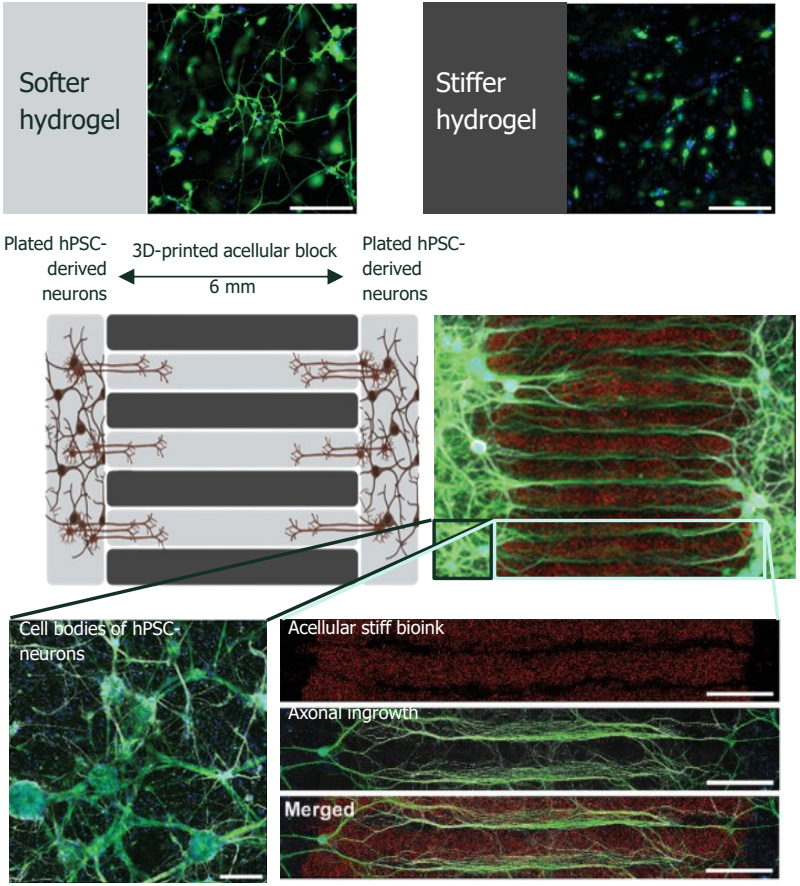
Skottman Lab

Adult Stem Cells

Miettinen Lab

Axonal guidance of neurons

Hyaluronic acid-based 3D bioprinted hydrogel structure for directed axonal guidance and modeling innervation in vitro. Honkamäki et al. 2024. Adv Healthc Mater.



Key benefits:

- ☑ Neuronal network formation supported
- ☑ Guidance for axonal growth
- ☑ Model for studying *in vitro* innervation

Glue4Life

NEUROGROUP TAMPERE UNIVERSITY FINLAND

Narkilahti Lab

Multi-material biofabrication is a must for recreating native human tissues.

Biomaterial platforms provide a path to manage technical and regulatory complexity.

Glue4Life
Next-generation hydrogels for creating life.
is a clinically compatible hydrogel platform,
designed for bridging the gap from engineered tissues to regenerative therapies.

Acknowledgements

Skottman Lab

BUSINESS FINLAND

BUSINESS TAMPERE

Narkilahti Lab
NEUROGROUP
TAMPERE UNIVERSITY FINLAND

Miettinen Lab
Adult Stem Cells

Glue4Life
Next-generation hydrogels for creating life.

LifeGlue Technologies Oy

Shaping the future of regenerative medicine, together!

Paula Puistola, DSc
COO and Founder
paula@glue4life.com