3D-BIOPRINTING OF HYDROGEL-BASED SCAFFOLDS FOR COLORECTAL MUCOSA REGENERATION

Rui Pedro Silva [a], Juergen Groll [b], Andrea Ewald [b], Giovanni Vozzi [c], Debby Laukens [d], Chiara Vitale Brovarone [e], Nele Pien [a,f], Sandra Van Vlierberghe [a]

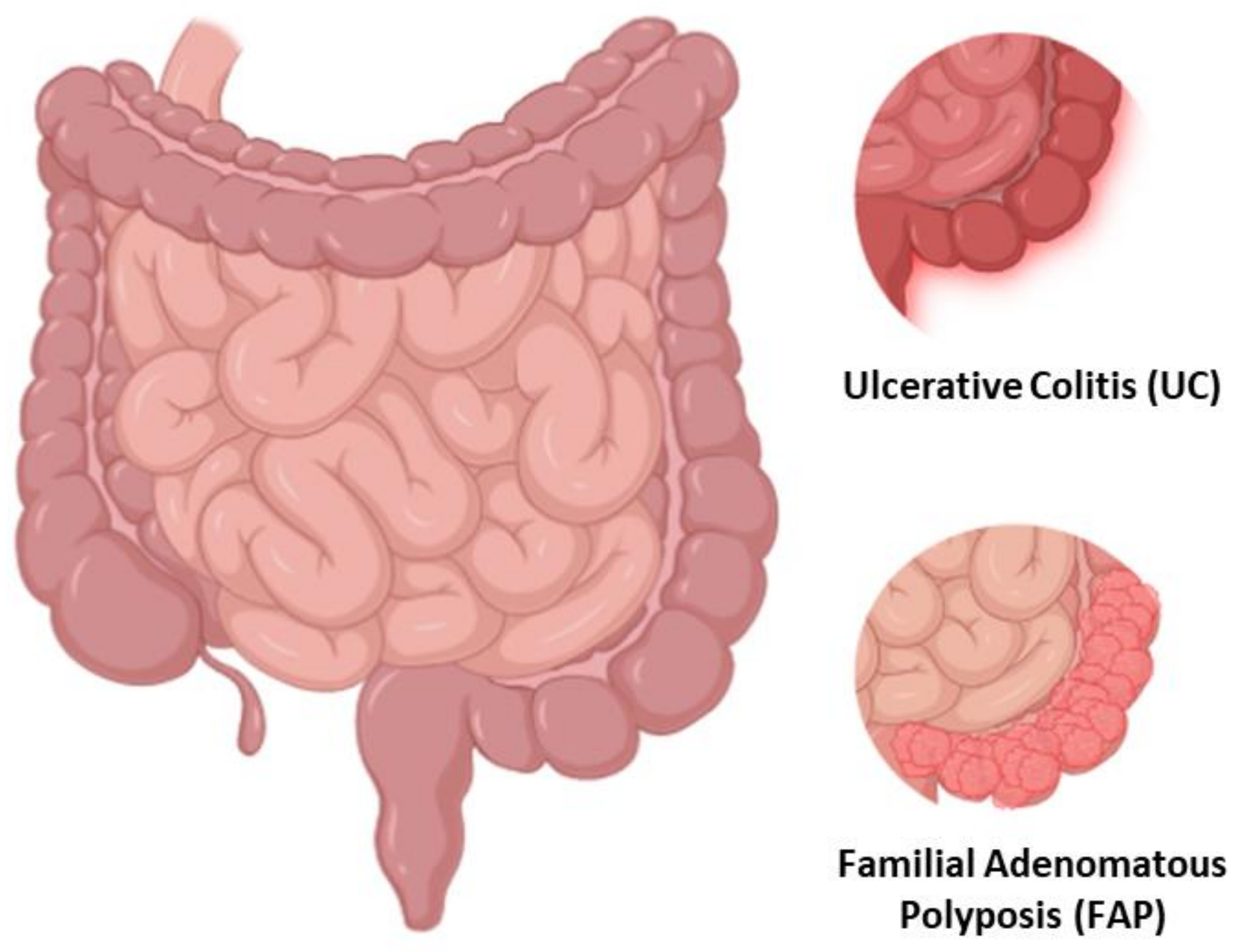
a Polymer Chemistry & Biomaterials Group, Centre of Macromolecular Chemistry, Department of Organic and Macromolecular Chemistry, Ghent University, Ghent, Belgium
b Polymers for medicine, Department for Functional Materials in Medicine and Dentistry, University of Würzburg, Würzburg, Germany
c Laboratory of Bioengineering and Chemical Bioengineering, University of Pisa, Pisa, Italy
d Ugent DiscoverE, Department of Internal Medicine and Pediatrics, Ghent University, Ghent, Belgium
e Biomedical Engineering Lab, Department of Scienza Applicata e Tecnologia, Politécnico de Torino, Torino, Italy
f Faculty of Veterinary Medicine, Department of Translational Physiology, Infectiology and Public Health, Ghent University, Merelbeke, Belgium

Problem Statement

2.2 million people affected by Ulcerative Colitis (UC) and Familial adenomatous polyposis (FAP) in Europe[1].

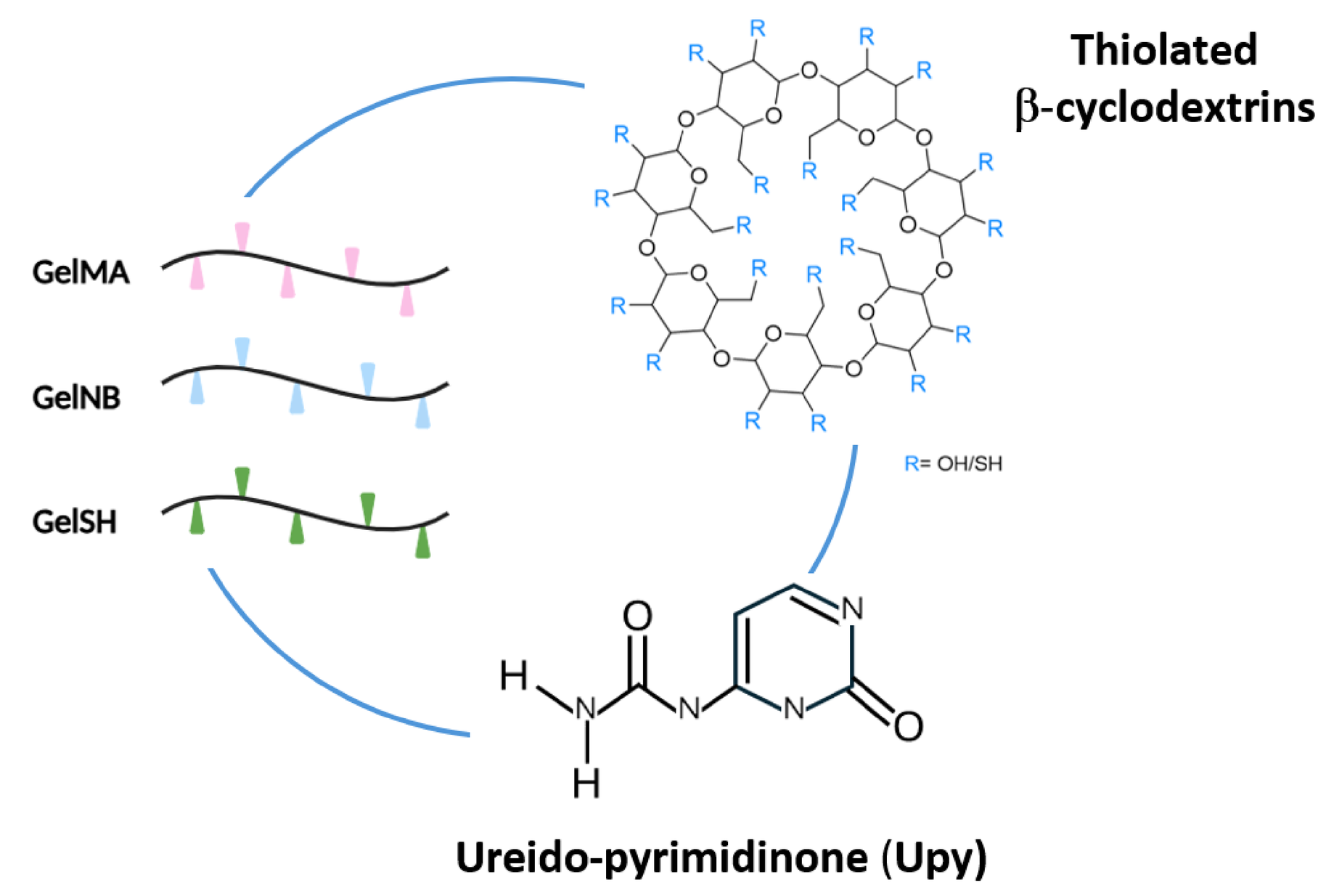
These conditions are often treated with total proctocolectomy and Ileal pouch–anal anastomosis (IPAA), procedures associated with high morbidity[2].

Failure to restore the colon's biomechanical or regenerative function[3].

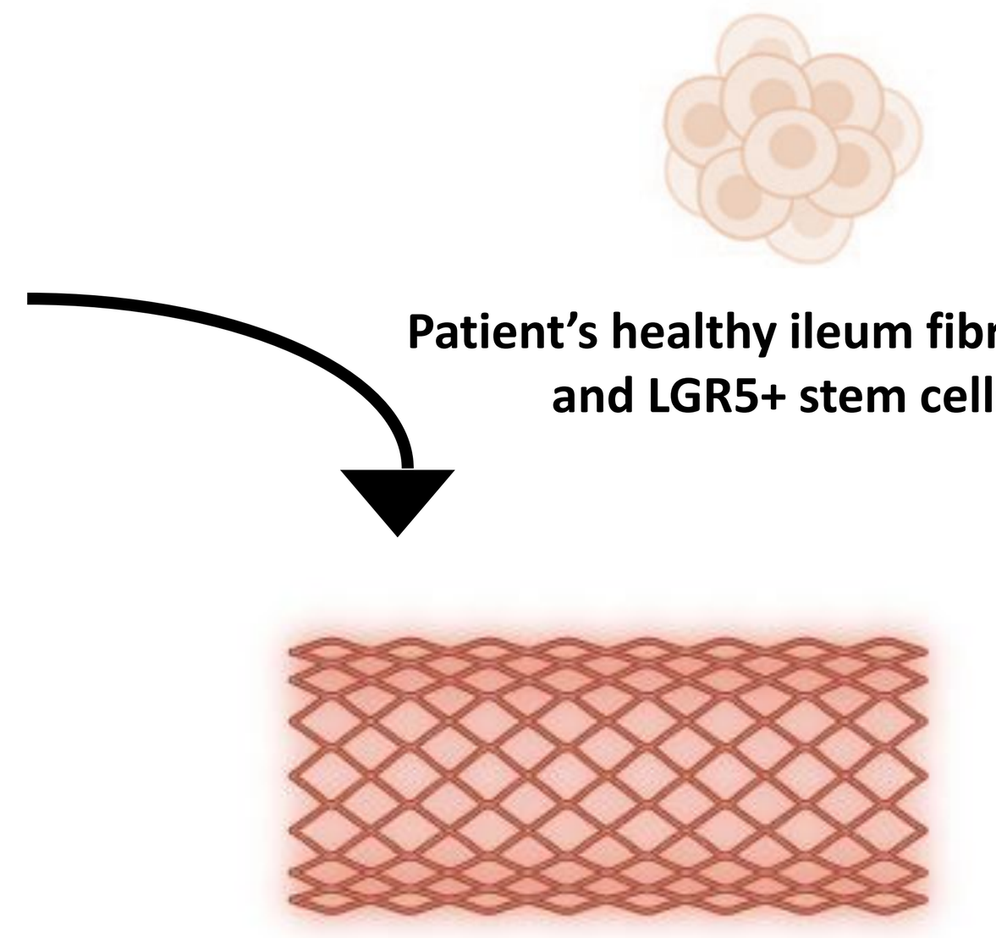


Research Objectives

1 Materials Formulation

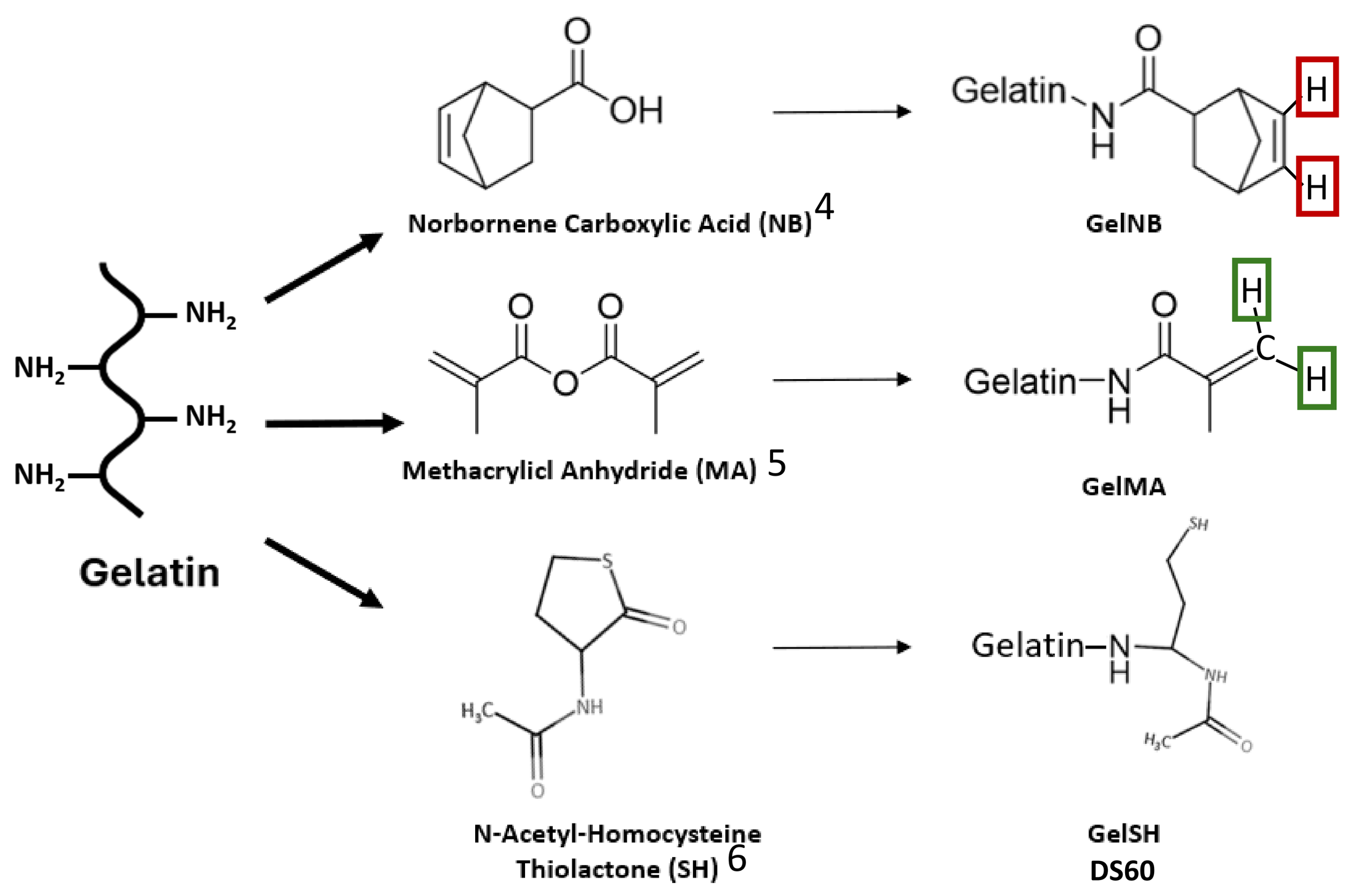


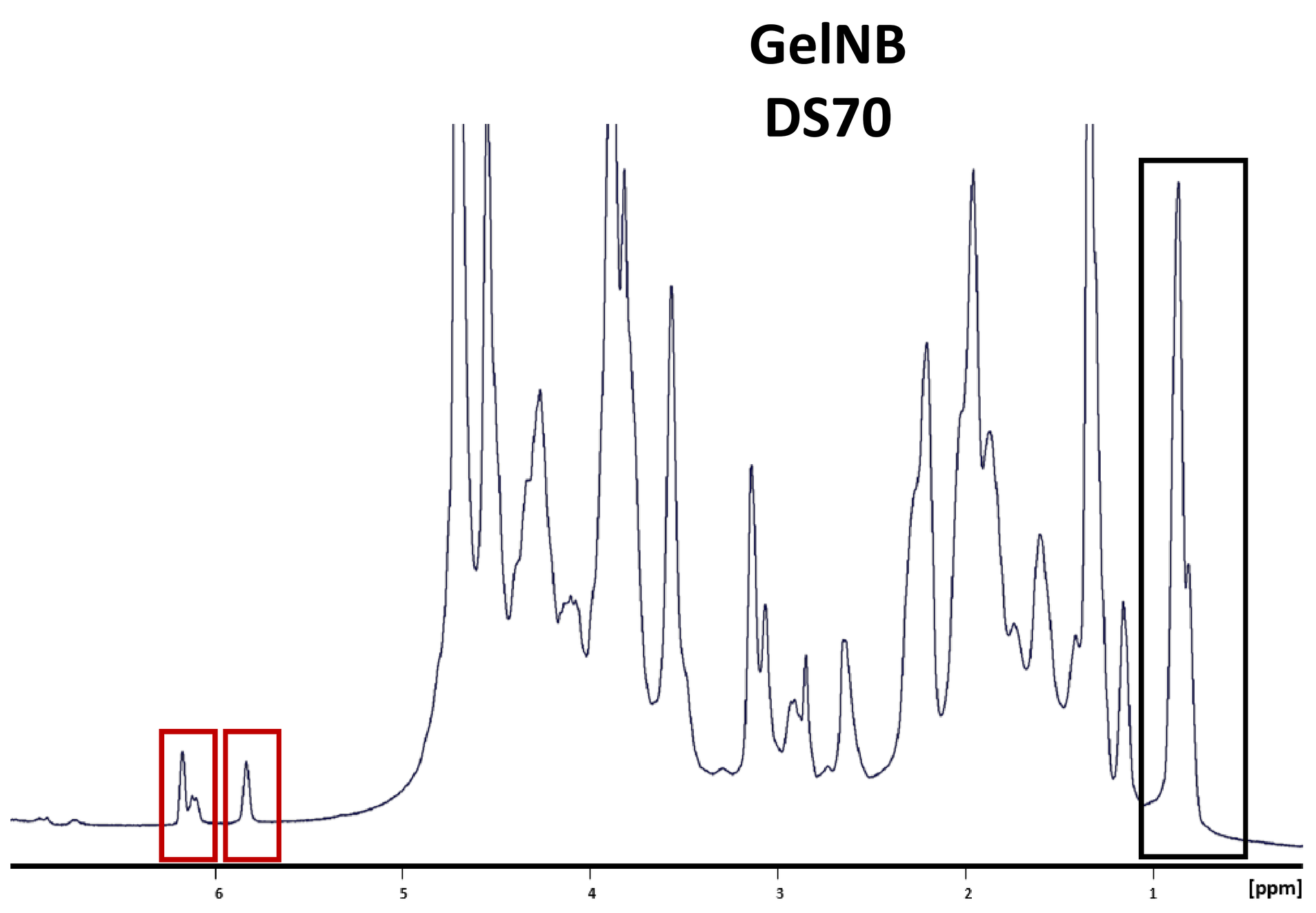
2 Isolation and expansion of patient-derived cells

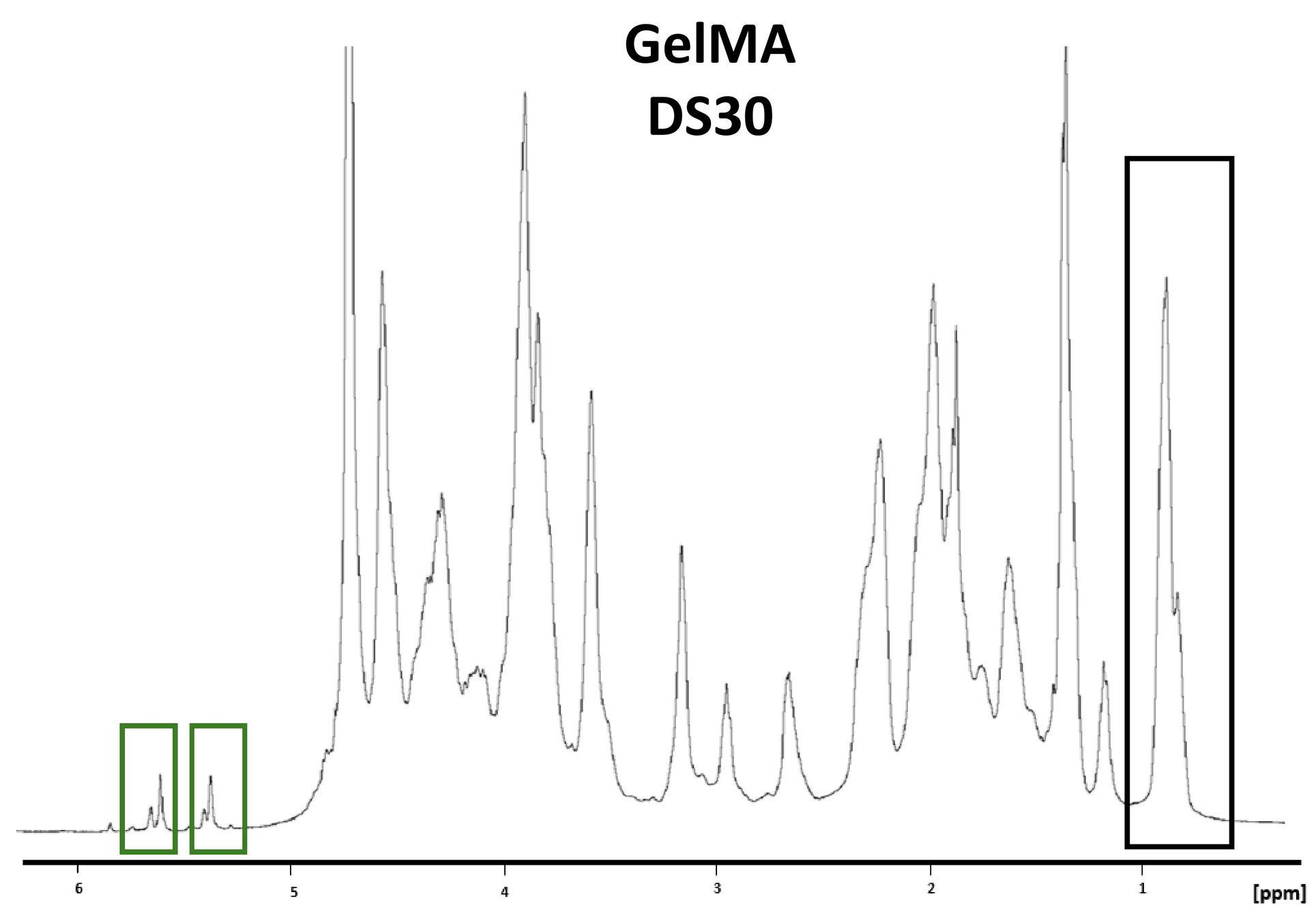


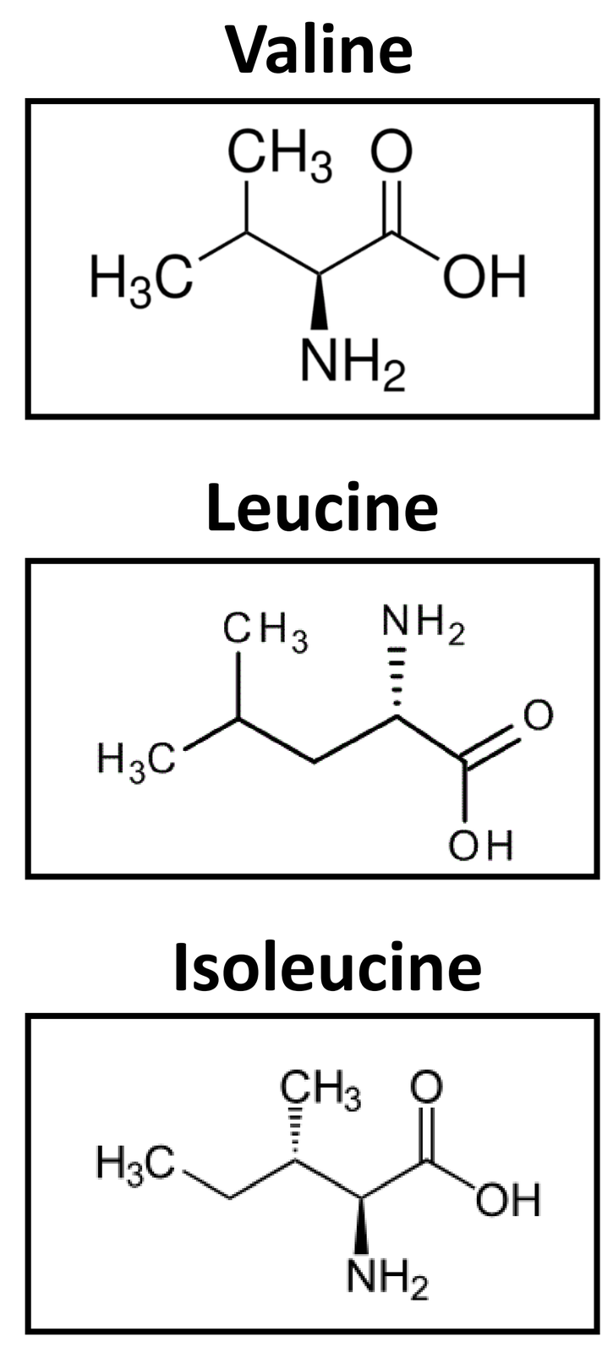
3 3D (Bio)fabrication

Material Development & NMR Spectroscopy

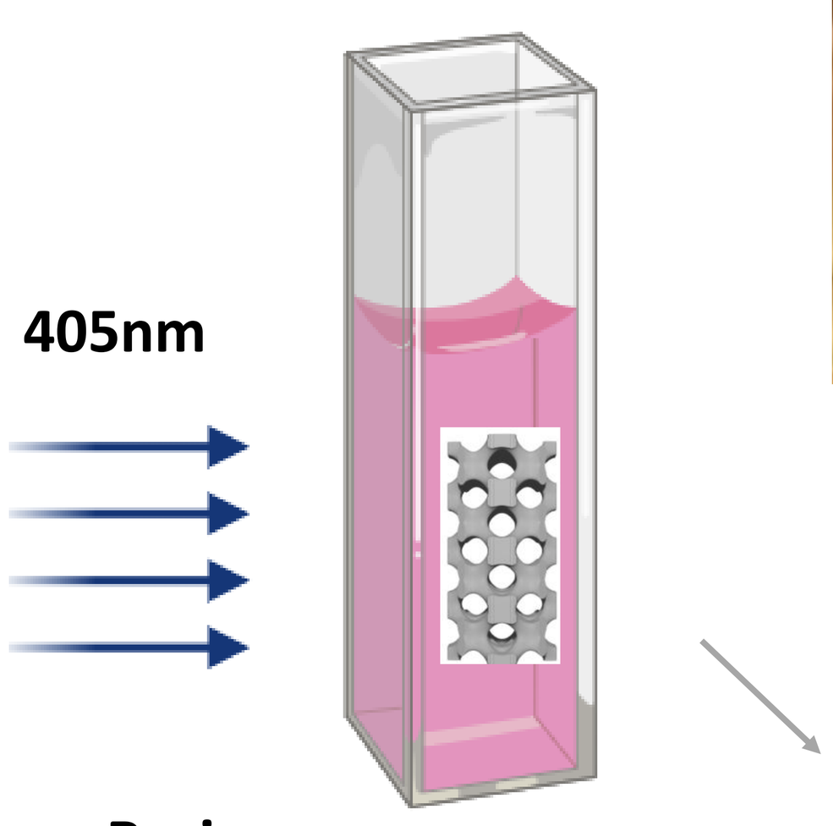




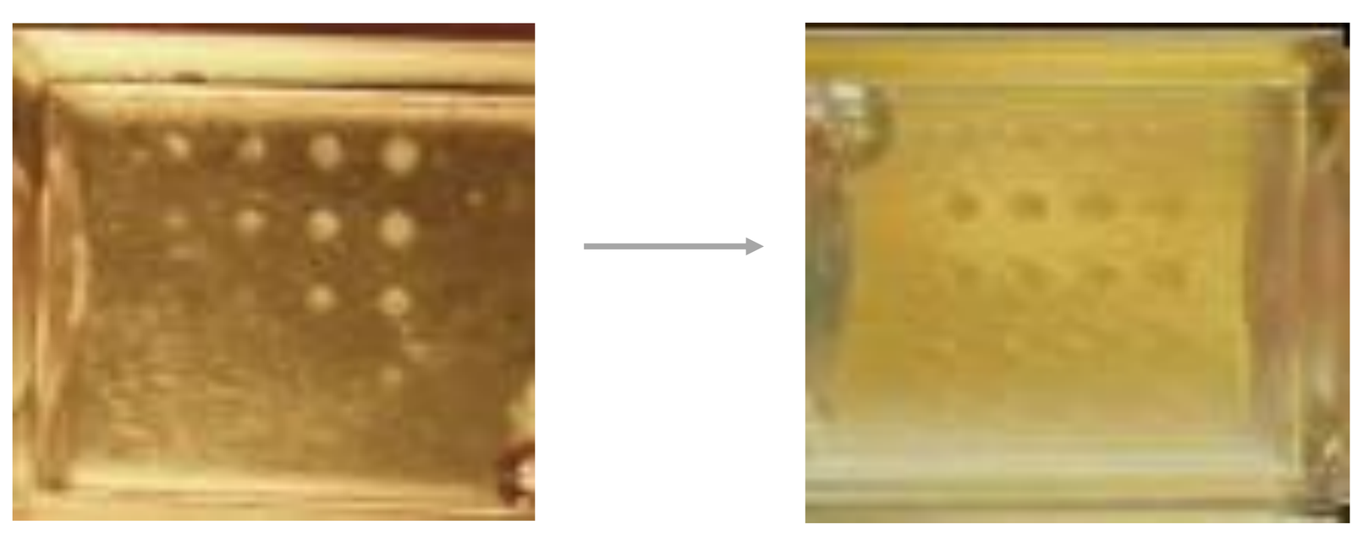




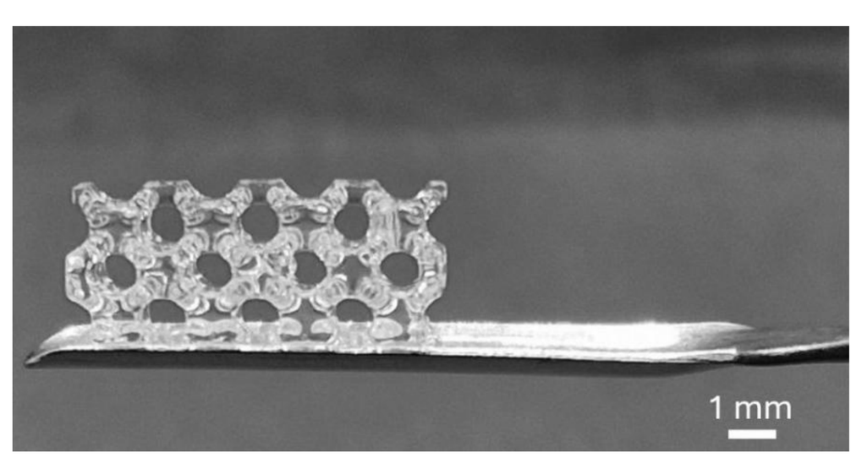
Volumetric Additive Manufacturing (VAM)



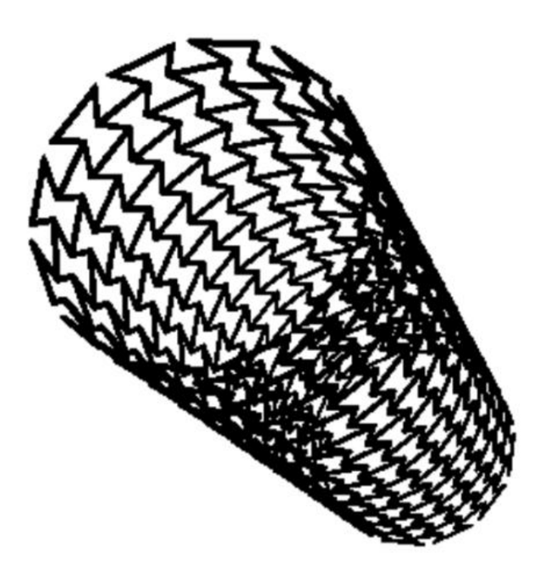
Resin
- GelNB DS70
- GelSH DS60
- Photo initiator (Li-TPO)
- Reducing agente (TCEP)



First Steps
- 10' Physical gelation
- Dose: 56 mJ/cm²
- n= 1.334



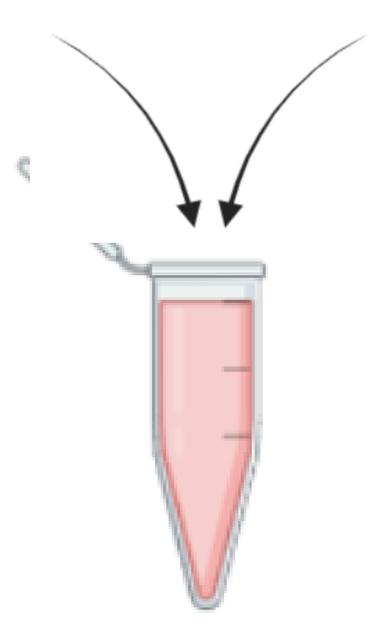
Design Prototype



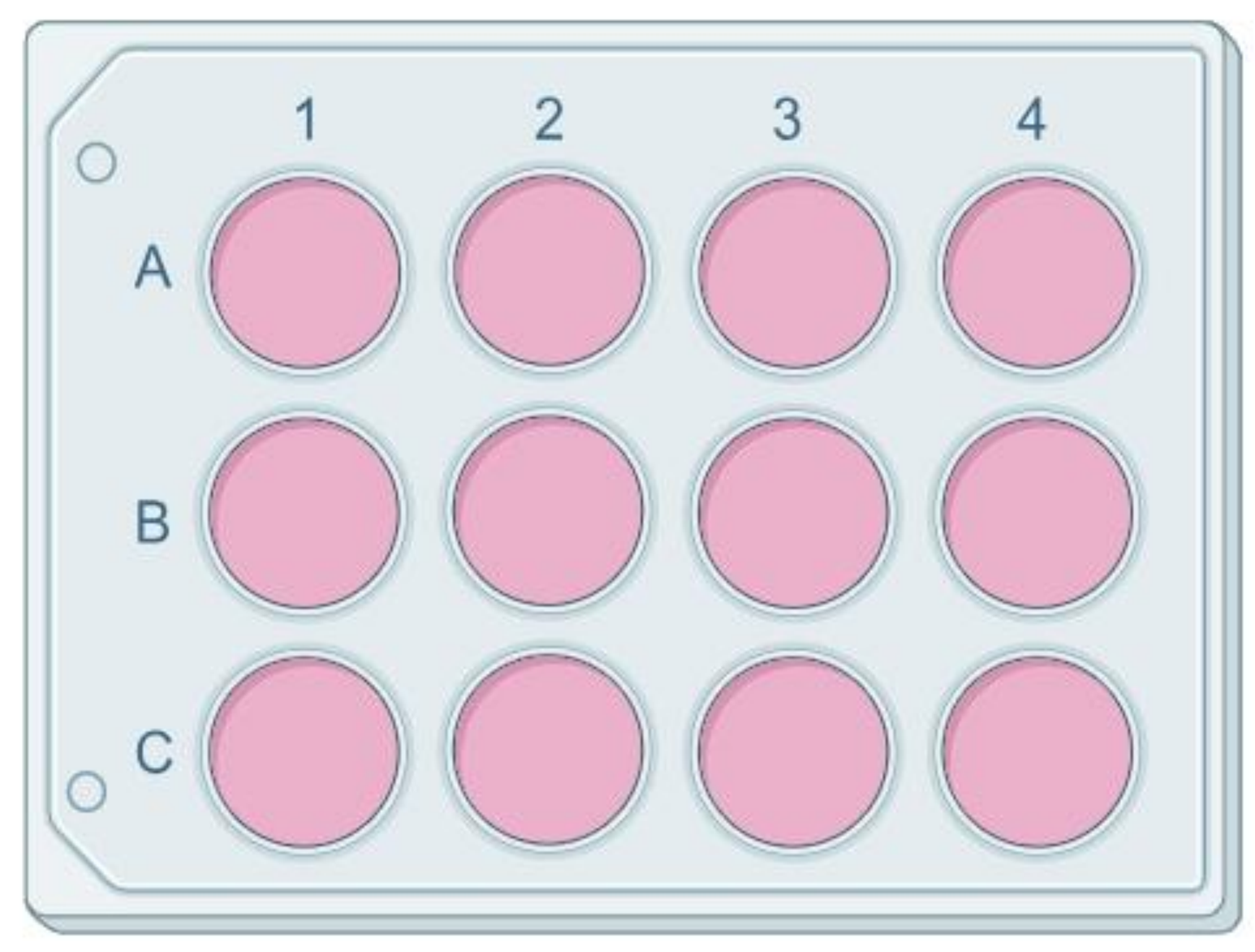
Auxectic Structure

Cell Encapsulation

GelSH + GelNB **TCEP + Li-TPO**



Hydrogel Formulation



(+) **Fibroblasts**
(-) **Hydrogel**

Negative and positive controls | Encapsulated cells

Conclusion

The formulation of novel biomaterials is expected to revolutionize tissue engineering enabling new treatment strategies and also by improving the quality of life for patients. This collaborative project aims to develop biodegradable stents capable of regenerating the mucosal layers of the large intestine, specifically in areas typically removed during surgery in patients with UC and FAP. Although still in its early stage, gelatin-based materials with defined degrees of substitution (GelSH – DS 60, GelNB – DS 70, GelMA – DS 30) were developed, and initial tests using GelSH and GelNB were performed exploiting VAM. In parallel, cell encapsulation protocols with fibroblasts were initiated using the same hydrogel matrix. As the project advances, we aim to develop stents that can closely mimic native tissue both the cellular environment and the mechanical properties (Viscosity ≈ 10^4 Pa·s, Yield point ≈ 100 Pa, Young's modulus between 1.5 and 2.9 kPa) .

Contact

@ ruipedro.santosilva@ugent.be

https://pbmugent.eu/
https://www.tentacle-project.eu/

linkedin.com/in/rui-pedro-silva-

linkedin.com/in/polymer-chemistry-and-biomaterials-groupghentuniversity-b619a433site

References

1. Arnold, M., et al., Gut, 2017. 2. Paiva, N. M., et al., Scientific Reports, 2018. 3. Ecker, N., et al., Coloproctology 2021 4. Lim, K. S., et al., Chemical Reviews,2020. 5. Lin, C. C., et al., Macromolecular Bioscience, 2024. 6. Puri, V., et al., Polymers, 2020.

Acknowledgements

Tentacle project (101191747), funded in Horizon Europe call.