Abstract #357 | Invited

Bioinspired hydrogels for 3D bioprinting and regenerative medicine.

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To construct an adult human body, a typical composition includes approximately 60-65% water, 16% protein (comprising collagen and other extracellular matrix components), 16% fat, 1% carbohydrate, and a multitude of cells (**Fig. 1**). This composition serves as the baseline when attempting to replicate living soft tissues. In this endeavor, hydrogels have emerged as the most suitable materials, particularly when they are crafted from biomolecules like extracellular matrix supramolecular assemblies. In addition to their composition, soft tissues are distinguished by their mechanical properties, primarily characterized by their Young's modulus, which varies from 1 kPa for brain tissue to 1 MPa for cartilage. Achieving the appropriate mechanical properties is essential and must align with the previously mentioned composition.

Over the last five years, we have collectively dedicated ourselves to this pursuit, commencing with the development of a 3D printable hydrogel formulation compatible with the bioprinting of sizable living tissues. We will present how this approach enabled to create cellularized hydrogels with a broad range of mechanical properties while maintaining cell proliferation [1]. This extensive study involved over 19 mammalian cell types sourced from both healthy and pathological tissues, including cell aggregates such as human pancreatic pseudo-islets (**Fig. 2**). Two examples of clinical applications of the bioinspired hydrogel will be use to illustrate the approach:

- An intraoperative bioprinting approach for the reconstruction of severe burn skin using bioink robotic deposition [2].
- A breast cancer reconstruction method using non-cellularized 3D printed hydrogels of tuned properties.

Then, and for the first time, we will introduce to the community an advanced biofabrication platform enabling both bioprinting and cultivation of large 3D tissues within a confined and sterile space [3]. This new concept called the Flexible Unique Generator Unit (FUGU), will be presented together with its unique capabilities.

Affix

References

[1] Christophe A. Marquette et al.., Unlocking the potential of bio-inspired bioinks: A collective breakthrough in mammalian tissue bioprinting,. Bioprinting (PREPRINT available at Research Square) 2024.

[3] Dufour, A.; Essayan, L.; Thomann, C.; Petiot, E.; Gay, I.; Barbaroux, M.; Marquette, C., Confined biofabrication in inflatable bioreactor: toward the sterile production of implantable tissues and organs. Scientific Reports (PREPRINT available at Research Square 2024.

[2] Albouy, M.; Desanlis, A.; Brosset, S.; Auxenfans, C.; Courtial, E.-J.; Eli, K.; Cambron, S.; Palmer, J.; Vidal, L.; Thépot, A.; Dos Santos, M.; Marquette, C. A., A Preliminary Study for an Intraoperative 3D Bioprinting Treatment of Severe Burn Injuries. Plastic and Reconstructive Surgery – Global Open 2022, 10 (1), e4056.

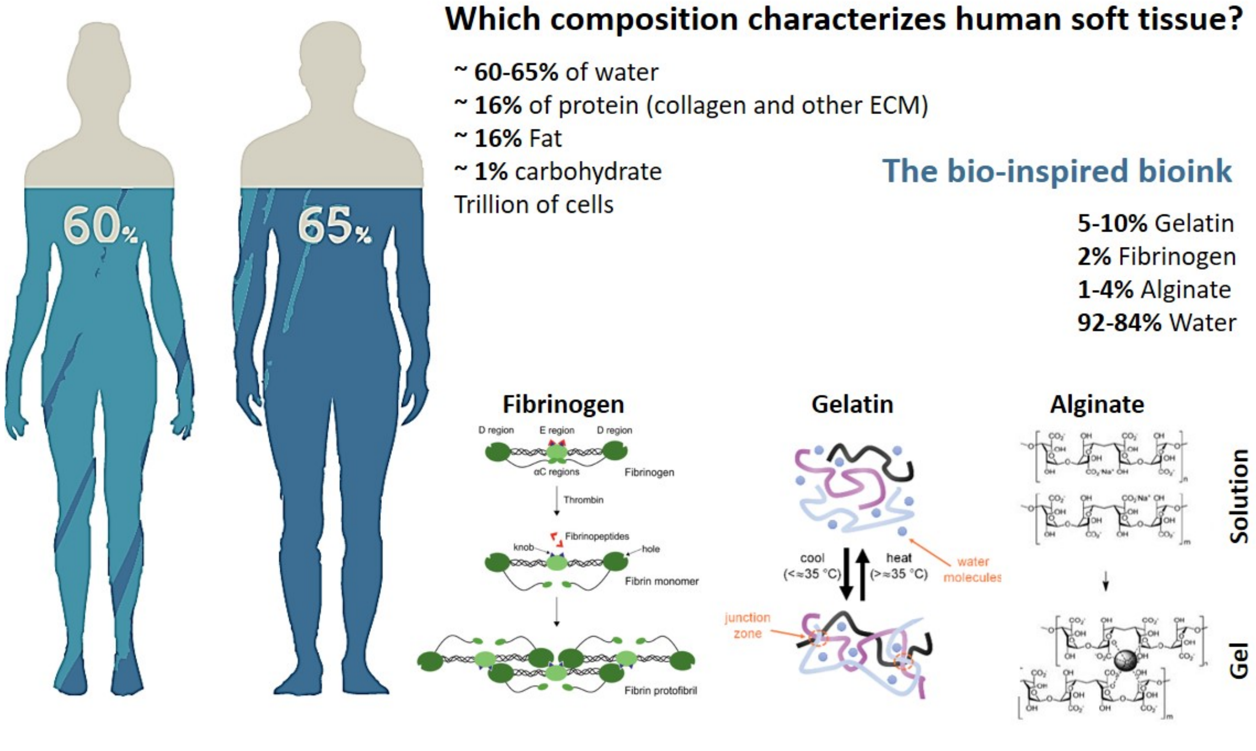

Figure 1. Concept and composition of the bio-inspired bioink.

The bioink recapitulates the mean human body composition using three well defined macromolecular assemblies. Presentation of the 3 components of the bioinspired bioink together with their consolidation mechanisms.

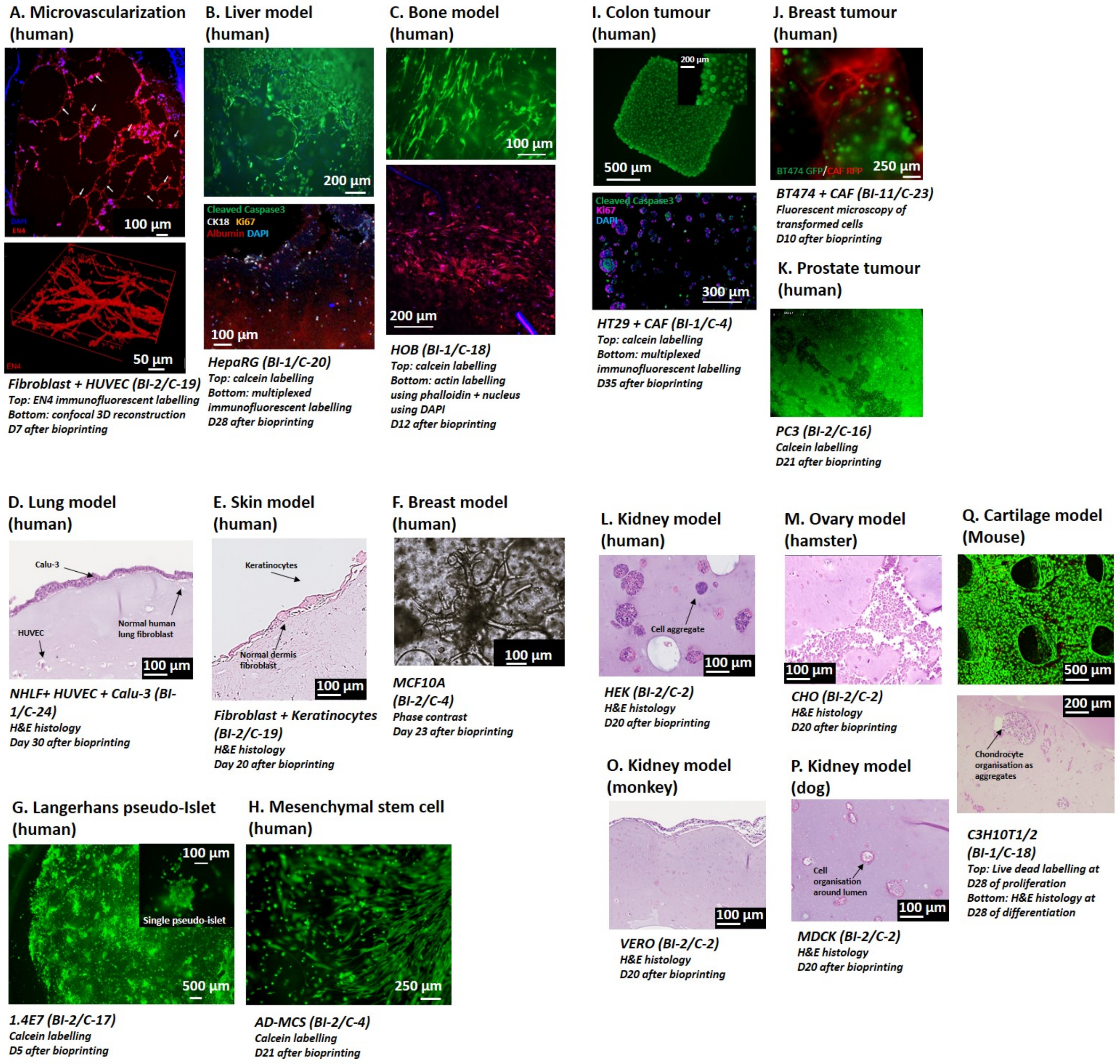

Figure 2. Tissue organisation of the 14 different tissues (0.3 cm3 objects: 1cm*1cm*3mm) bioprinted

Images were obtained by phase contrast, or after calcein staining, H&E staining or immunohistological labelling.