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# Directional freezing of biological matter: implications in biofabrication and cryobiology

**Tuesday, 23th April**
**12.00 p.m.**

**CIC biomaGUNE - Seminar Room**

Freezing is ubiquitous in nature. In oceans, rivers, soils, and in the atmosphere, ice is formed under radically different environmental conditions that depend on hydration, temperature and pressure. In most of these conditions freezing threatens the integrity and the viability of biological entities. Paradoxically, cryopreservation (i.e. freezing biological entities under strictly controlled conditions) is the only solution to extend the lifespan of living cells, and to preserve biomolecules. In this lecture we will focus on the interaction between biological matter (from biopolymers up to living mammalian cells) with a controlled freezing front[1] (Fig. 1)

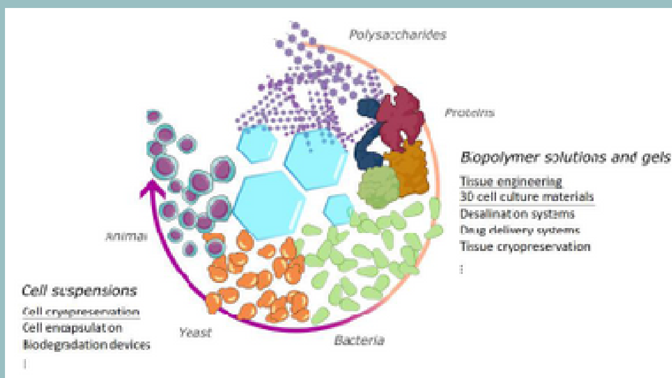


**Figure 1.** The interactions between growing ice crystals and biological entities of increasing complexity and their relevance in the field of biomaterials and cryobiology

During freezing, ice growth induces a phase separation between pure ice crystals, and the remaining solutes and suspended particles. These freezing events impose compositional, thermal and osmotic gradients that can be potentially deleterious to the integrity of the constitutive biological entities. We will discuss how, despite these harsh events, ice templating can be used to elaborate biomimetic materials exclusively from the proteins of the extracellular matrix. The resulting materials, used either as 3D cell culture systems[2] or as functional grafts[3], recapitulate the central features of native tissues such as their topology, as well as their mechanical and biological properties.

We will equally discuss some of our more fundamental works, which have allowed to decrypt the evolving physicochemical environment during the ice templating process.[4] Using an original coupling of techniques—spanning from calorimetry, in situ cryoconfocal microscopy and SAXS diffraction—we unveiled the relevance of directional freezing in the elaboration of living materials from model organisms like yeast[5] and bacteria, as well as in the cryopreservation of mammalian in the absence of toxic cryoprotectants.

References

[1] K. Qin, C. Parisi, F. M. Fernandes, Journal of Materials Chemistry B 2021, 9, 889.
[2] C. Rieu, C. Parisi, G. Mosser, B. Haye, T. Coradin, F. M. Fernandes, L. Trichet, ACS Appl Mater Interfaces 2019, 11, 14672.
[3] I. Martinier, F. Fage, A. Kakar, A. Castagnino, E. Saindoy, J. Frederick, I. Onorati, V. Besnard, A. I. Barakat, N. Dard, E. Martinod, C. Planes, L. Trichet, F. M. Fernandes, BioRxiv 2023, DOI 10.1101/2023.08.30.555553.
[4] N. Baccile, T. Zinn, G. P. Laurent, G. Ben Messaoud, V. Cristiglio, F. M. Fernandes, Journal of Physical Chemistry Letters 2020, 11, 1989.
[5] K. Qin, C. Eschenbrenner, F. Ginot, D. Dedovets, T. Coradin, S. Deville, F. M. Fernandes, The Journal of Physical Chemistry Letters 2020, 11, 7730.