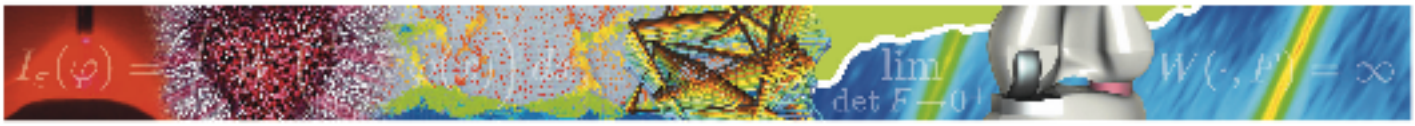

Master 2 internship offer.
Deadline : February 15, 2024.

Topic : Identification of the poro-hyperelastic behavior of a mucoid matrix derived from Wharton's jelly by inverse methods and finite element simulations.

Key words : biomechanics, soft tissues, poro-elasticity, Wharton jelly

Supervision :
Laboratory : LMGC, UMR CNRS, Université de Montpellier.
Team : BIOTIC
Supervisors : Simon Le Floc'h (LMGC), Cristina Cavinato (LMGC) and Adrien Baldit (LEM3).
Contact : simon.le-floc-h@umontpellier.fr

Summary :
Wharton's jelly (WJ) and its derivatives show promising biochemical properties for applications in regenerative medicine [1]. WJ is a human connective tissue from the umbilical cord. Its composition and behavior resemble many biological connective tissues. In this sense, we wish to use it as a model medium to study the fundamental behavior of biological connective tissues rich in collagen and hydrophilic glycosaminoglycan (GAG) macro-molecules. More specifically, we want to better understand and model the poro-elastic behavior and the coupling of this behavior with the tissue's ability to swell (osmotic behavior).

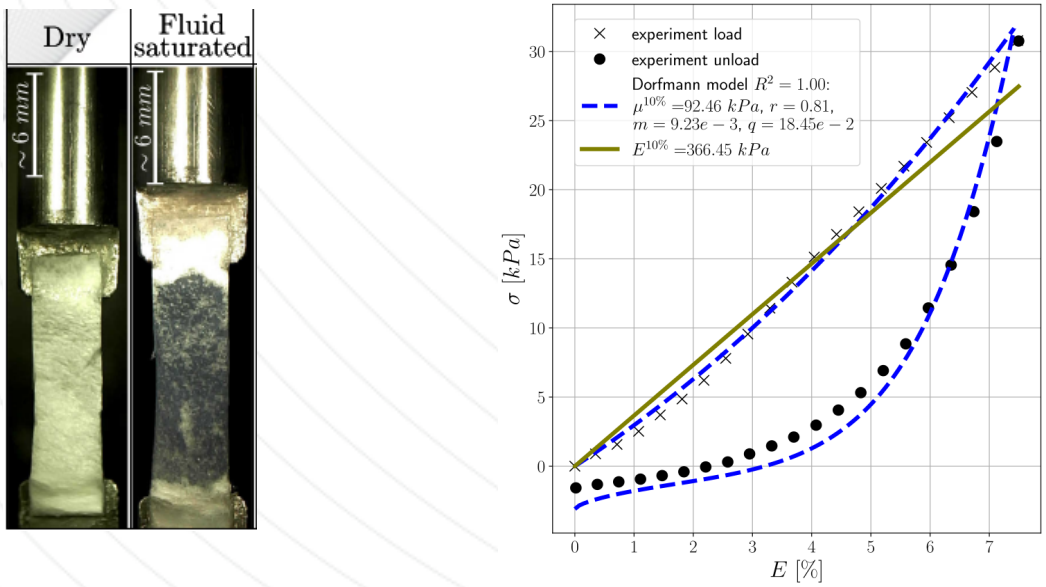

Figure 1: a) Effect of hydration on the visual appearance (transparency) of a Wharton's jelly membrane and b) force response as a function of displacement during a tensile loading cycle [2].

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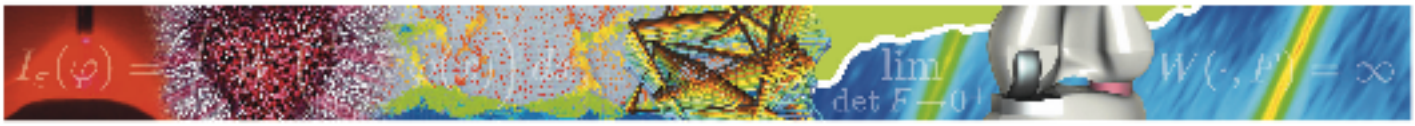
LABORATOIRE DE MÉCANIQUE ET GÉNIE CIVIL



To this end, the first task of the proposed internship will be to set up a poro-hyperelastic finite element model that respects the geometry of the sample under test. The aim will be to extract from this model the value of force as a function of displacement during the uniaxial tensile test, the response of which is shown in Fig. 1b.
Once this model has been set up, the sensitivity of the simulated force to the parameters of the behavior law will be estimated. It will enable us to verify the possibility of quantifying the parameters of the behavior law using a simple tensile test.
Finally, an identification strategy linked to the type of mechanical tests (choice of type of mechanical test, sequence of tests of different types, etc.) will be proposed to ensure the identification of the parameters of the poro-hyperelastic law.
This internship will take place at the LMGC. It is also part of a consortium supported by the ANR (Agence Nationale de la Recherche), and more specifically the HyCareMat project. Three other laboratories will play a role in the course of the internship: BIOS, which designs WJ-derived membranes, LEM3, which carried out the initial tensile tests, and ICUBE, which has 3D imaging facilities for observing WJ.

Allocated ressources :
Laptop or desktop PC with the necessary software suite (python, gmsh, LMGC90, paraview, all open-source software).

Candidat profile :
With a Master 1 in mechanics (or equivalent), and ideally a passion for continuum mechanics and modeling, we can broaden the profile according to the candidate's motivation and ability to adapt.

Skills :
A good understanding of the equations of continuum mechanics, as well as its modeling using the finite element method, would be a plus. Some competence in modeling hyperelastic media would also be a plus.

Duration of internship and traineeship grant :
Grant : approx 550€ / month.
Duration : 6 months.

Perspectives :
As part of the HyCareMat project, a PhD thesis will start in the last quarter of 2024 on the characterization of hydro-chemi-mechanical couplings in WJ.

Application :
Send CV and cover letter to simon.le-floc-h@umontpellier.fr before February 15, 2024.

References :
[1] Dubus et al., Antibacterial and Immunomodulatory Properties of Acellular Wharton's Jelly Matrix., Biomedicines, 2022
[2] Baldit et al., Biomechanical tensile behavior of human Wharton’s jelly. JMBBM, 2022