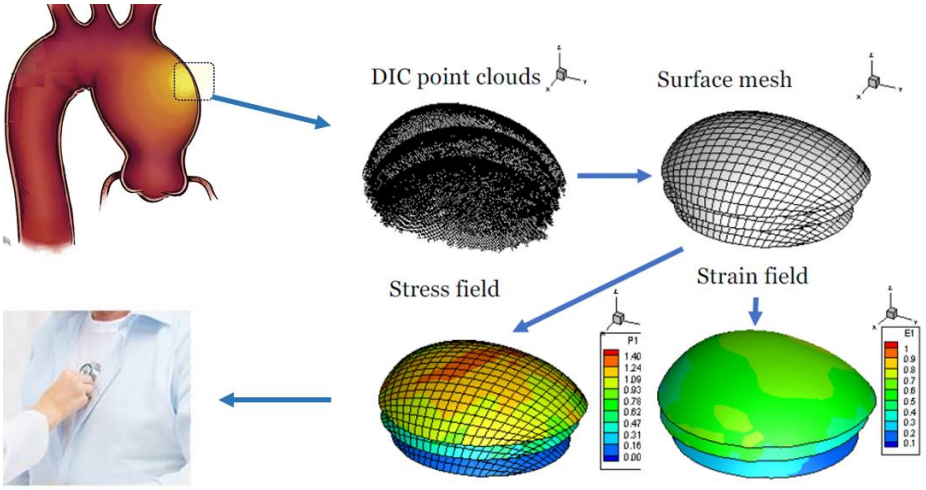
# 719.001
# Mechanics of Biological Tissues
## (2 SSt VO, WS 2021-2022)

**Lecturers:**
Prof. Stéphane Avril, Mines Saint-Etienne (France) (avril@emse.fr)
Prof. Gerhard A. Holzapfel, TU Graz (holzapfel@tugraz.at)




This figure shows advanced mechanical assessments of aortic tissues that can help understand and better predict the risks of aneurysm rupture and aortic dissection in patients. In this course we investigate such mechanical assessments of biological soft tissues.

**Start and place of the course:**
Wednesday October 6, 2021, 18:00, in the BMT lecture hall (BMTEG138)

**Learning outcome:**
The aim of this course is to provide students an understanding of the application of applied continuum mechanics to solve problems in biological systems, from cells to tissues. This course will also provide students with the education necessary to practice bioengineering in the medical devices industry.

**Contents:**
*Tissue biology basics:* Link between microstructure and macroscale properties, and experimental characterization techniques. Structure, function and mechanical behaviour of tissues and organs (bone, cartilage, ligament, tendon, intervertebral disc, skin, nerve, skeletal muscle, heart, lung, artery, vein). Composition, function and mechanics of biological fluids.

*Cardiovascular biomechanics:* Cardiovascular system. Biodynamic biological fluids. Biomechanics of the blood circulation. Ability to model specific problems such as the pulse wave in arteries, the effect of compression on the veins for the venous blood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*Modeling approaches for continuum biomechanics of soft tissues:* Reminders of the basics in finite deformation mechanics and hyperelasticity, poroelasticity, chemoelasticty, other constitutive equations, relationships between the constitutive equations and the microstructure of tissues.
Characterization of damage and failure mechanics of soft tissues, local analysis of rupture modes in soft tissues, experimental characterization and numerical implementation.

*Advanced experimental approaches for soft tissue mechanics:* Full-field measurement techniques, imaging techniques, link between experiments and modeling.

Introduction to inverse problems, Identification of material parameters from full-field measurements, Characterization of maps of material parameters at different scales.

**Teaching methods:**
Direct teaching and tutorials to introduce and practice theoretical aspects

**Examination modalities:**
Project assignment + final written exam

**Previous knowledge:**
Mathematics: linear algebra, matrices, tensors
Continuum solid mechanics: stress, strains, linear elasticity, equilibrium equations
Basics of fluid mechanics: Navier-Stokes equations
No specific background required in biology
Recommended to have the course on "Introduction of Biomechanics" (719.009)

**Short CV of Prof. Stéphane Avril:**

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| 2021-2022: | Visiting Professor, Graz University of Technology, Austria |
| 2017: | Co-founder of the start-up company Predisurge (www.predisurge.com) |
| 2014-2020: | Visiting Professor, Yale University, USA |
| 2015: | ERC consolidator grant laureate |
| 2010-2020: | Head of the Biomedical Engineering Department at Mines Saint-Etienne, France |
| 2002: | PhD at Mines Saint-Etienne, France |

Main interests: biomechanics, mechanobiology, cardiovascular engineering, aortic dissections, inverse problems

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