We investigate mechanical properties of biological and bio-inspired materials. The main biological tissue considered is bone and its interface with ligaments and tendons, which is a rather unexplored topic yet of paramount importance in the clinical context. We combine experimental tools with computer simulations to quantify and predicts tissue changes during aging, diseases and treatments as well as to establish new standards for the regeneration of soft tissue-to-bone interfaces. We also prototype novel bio-inspired material designs based on the mechanical construction principles identified in biological materials with the final mission of developing high-performance and multifunctional composite materials at the centimeter length scale.

**Bio-inspired materials: the application**

Strategy: replicate into synthetic materials building principles observed in biological structures such as embedding stiff fiber-like elements into a soft matrix, hierarchical structuring and cellular architectures.

- **In silico characterization:**
  - Link between mechanical properties and tissue composition/organization:
    - NanoDMA: elastic and viscoelastic properties nanoscale properties
    - Fluorescence image guided nano-indentation: mechanical assessment of highly specific regions only visible under fluorescence imaging

- **Prototyping by multimaterial 3-dimensional polymer printing & mechanical testing:**
  - Cellular structure alternating positive Poisson’s ratio and negative Poisson’s ratio

**COLLABORATIONS**

Ralph Müller, Zihui Li
ETH Zurich, Institute for Biomechanics

Richard Weinkamer
MPI, Dep. of Biomaterials, Potsdam

Luca Andena, Francesco Briatico Vangosa
Politecnico di Milano, Chemical Engineering

Thierry Marchal and Thomas Dalberto
Ansys Benelux, Wavre (Belgium)