BIOMECHANICS RESEARCH UNIT

GIGA IN SILICO MEDICINE & DEPT AEROSPACE & MECHANICAL ENGINEERING

UNIVERSITY OF LIÈGE

What is our field of research?

Biomechanics and Computational Tissue Engineering

Biomechanics: the application of engineering mechanics to biological and medical systems

Tissue Engineering: understanding the principles of tissue growth, and applying this to produce functional replacement tissue for clinical use by combining principles of engineering and life sciences

Bone & Joints: the number 1 economic health care problem

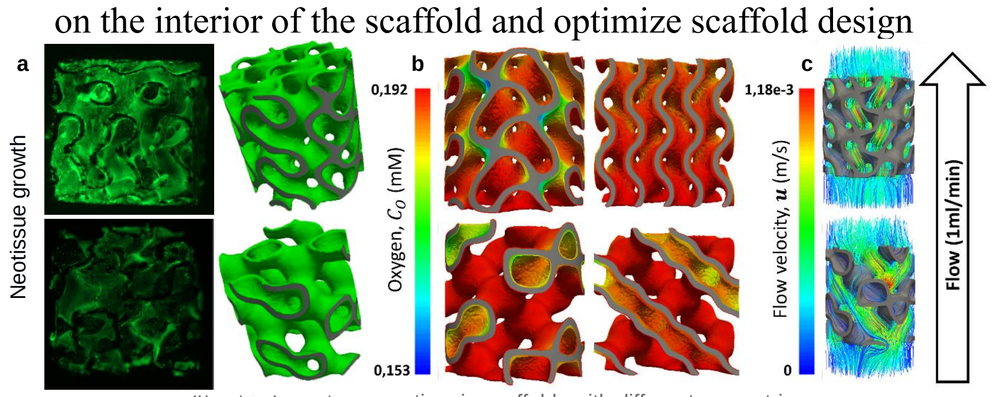
- Account for more than 50% of all chronic conditions in people over 50 years old in developed countries
- Most common cause of severe, long-term pain and disability
- Total associated direct + indirect cost: $600 \cdot 10^9$ €, equivalent to 6,2% of the national gross domestic product (USA, 2004)

Keywords: Biomechanics, Tissue Engineering, Biomimetic Process Design, Computational Modeling, Model Validation

What are the specific research lines we are developing?

Modeling in vitro processes

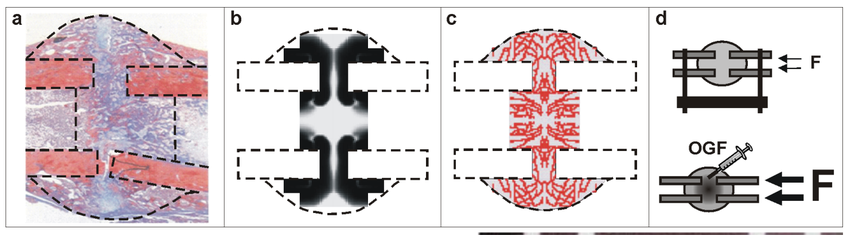
Couple in vitro online measurements to biological processes taking place on the interior of the scaffold and optimize scaffold design



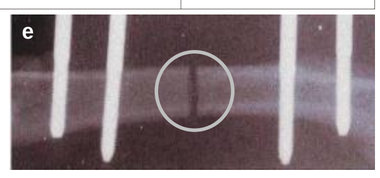
a: cell/matrix formation over time in scaffolds with different geometries;
b: oxygen distribution in neotissue during culture; c: fluid flow in scaffold during perfusion culture

Modeling in vivo processes

Investigate the dynamics of in vivo bone formation and regeneration in healthy patients and patients with specific (genetic or other) disorders

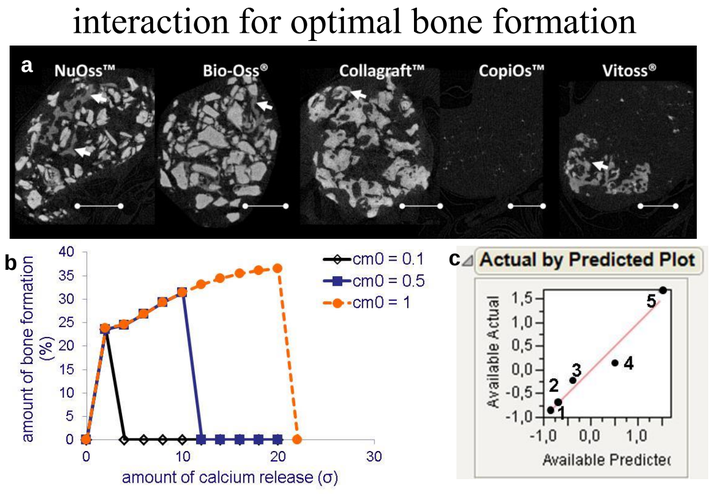


a: histological picture of healing fracture;
b: amount of bone formation predicted by model;
c: blood vessel formation predicted by model;
d: treatment strategies investigated by model;
e: X-ray of fracture



Designing novel biomaterials

Identify key material properties & cell-material interaction for optimal bone formation



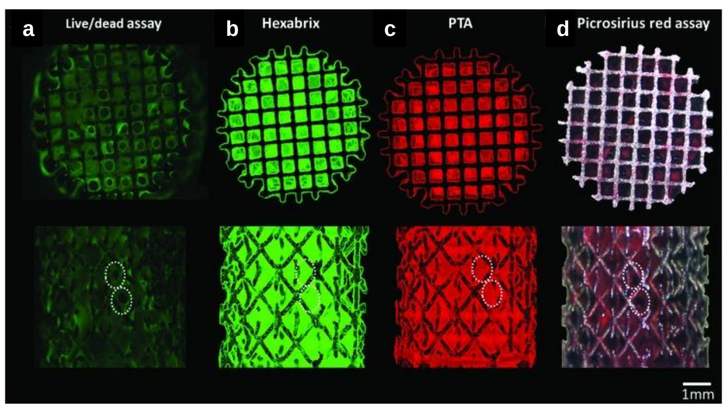
a: imaging bone formation in different materials; b: model prediction on cell-material interaction; c: empirical model predicting bone formation

Model development & characterization

Empirical models
Logical models
Differential equations
Multiscale models
Multiphysics models
Implementation strategies
Sensitivity analysis

Characterizing in vitro/vivo processes

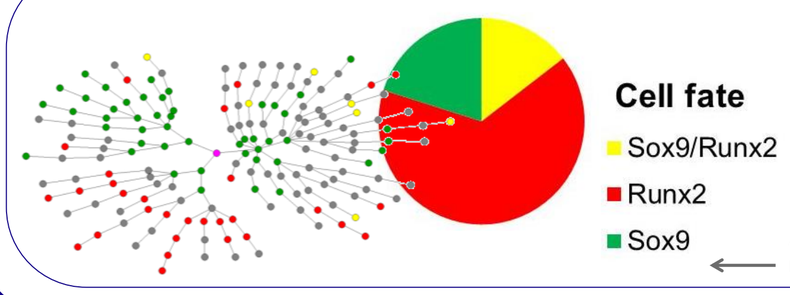
Assess biological processes & mechanical properties over time using e.g. imaging



Imaging cell and matrix formation inside a titanium scaffold; a: live/dead assay; b,c: contrast enhance nanoCT; d: picrosirius red assay

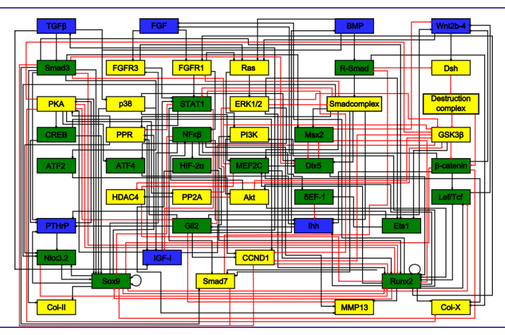
Deciphering signaling networks

Investigate the intracellular dynamics, identify missing links in the network and study its emergent behavior



← Attractor state analysis by means of Monte Carlo simulation

Gene and protein network capturing chondrogenic differentiation in 1 cell →



Is biomechanics something for you?

You…

- want to apply your technical skills to make a difference in the life of patients
- want to be part of an ever expanding and highly relevant research field
- are a team player
- like working with people with different scientific backgrounds, from engineers over molecular biologists to clinicians
- can think outside the box

Why join our team?

We…

- are an internationally known research group in the field of biomechanics and computational tissue engineering
- are funded by european, regional and foreign funding bodies
- offer you a highly interdisciplinary working environment with colleagues from different nationalities and scientific backgrounds
- cover every step in the tissue engineered product life cycle: from basic design to implantation in the patient

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