AUTOMATED MULTI-STIMULI BIOREACTOR PLATFORM FOR BONE AND CARTILAGE MECHANOBIOLOGY AND TISSUE ENGINEERING INVESTIGATIONS

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Introduction

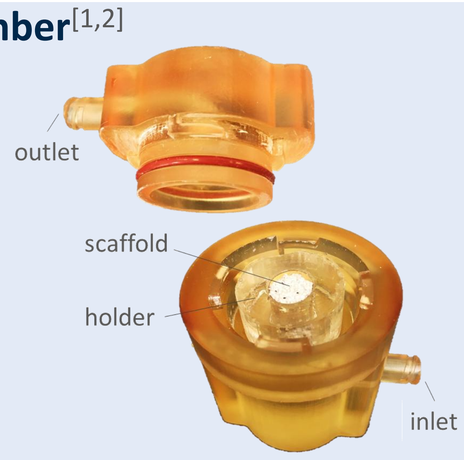
Bioreactors for **bone** and **cartilage tissue engineering** (TE) **often fail to recapitulate** the *in vivo* **physical microenvironment**, limiting the relevance of experimental outcomes.

AIM: develop and characterize an automated, parallelized multi-stimuli bioreactor, designed for delivering combinations of biomimetic physical stimuli to three-dimensional (3D) bone and cartilage tissue models..

Bioreactor platform

Culture chamber[1,2]

- **3D printed** (Dental SG resin)
- **Versatile scaffold housing** (diameter = 7-10 mm, height = 1-15 mm)
- **Direct perfusion** guaranteed by the presence of the PDMS holder



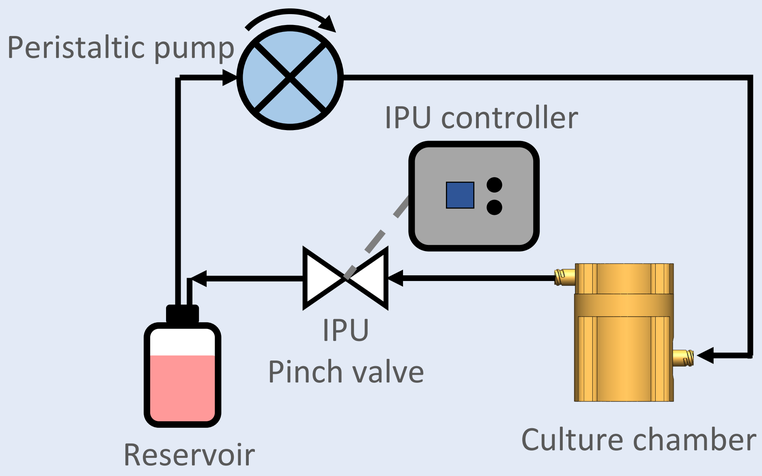
Direct perfusion (DP) unit[1,2]

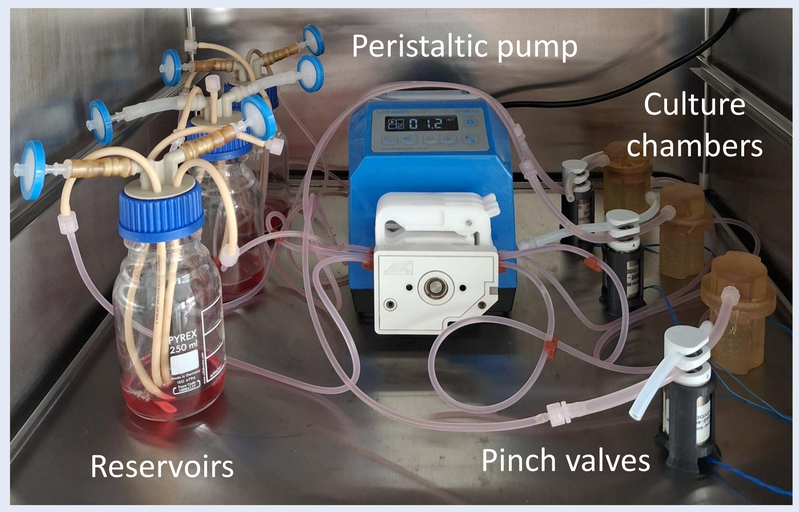
- **Peristaltic pump** (Longer, Darwin Microfluidics, flow rate = 0.006 - 24 ml/min)
- **Fully automated control box for imposing uni-/bi-directional flow** (Arduino-based control box)
- **Parallelizable (up to 3 culture chambers)**



Intermittent hydrostatic pressure (IHP) unit

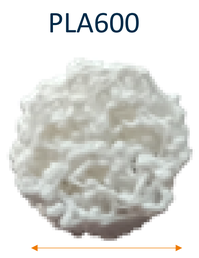
- **Solenoid-actuated pinch valve**
- **Intermittent hydrostatic pressure** (period = 0.25-30 s, duty cycle = 0%-100%)
- **Fully automated** (Arduino-based control box)
- **Easy and quick connection**
- **Parallelizable (up to 3 chambers)**

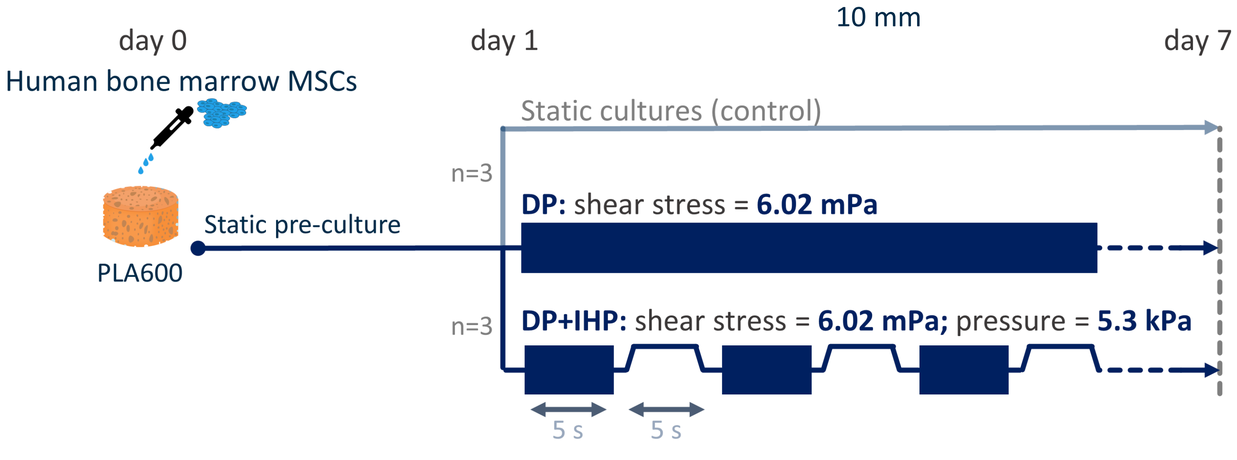


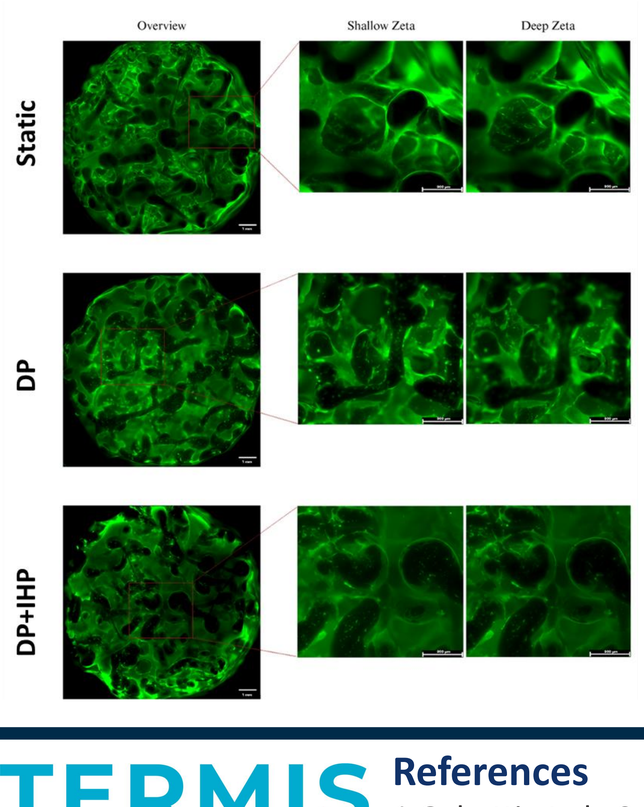


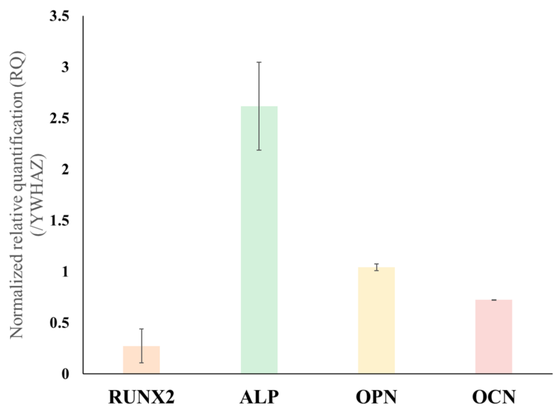
Bone TE validation

- **mimicking bone microarchitecture**
- pore sizes: **600 µm**
- diameter = 10 mm, height = 5 mm
- **3D printed** with poly-lactic acid (**PLA**)





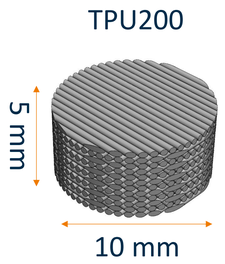


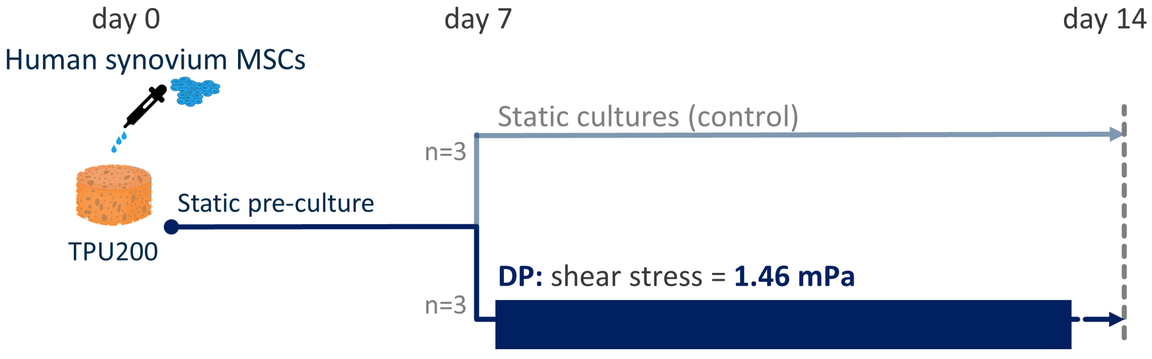


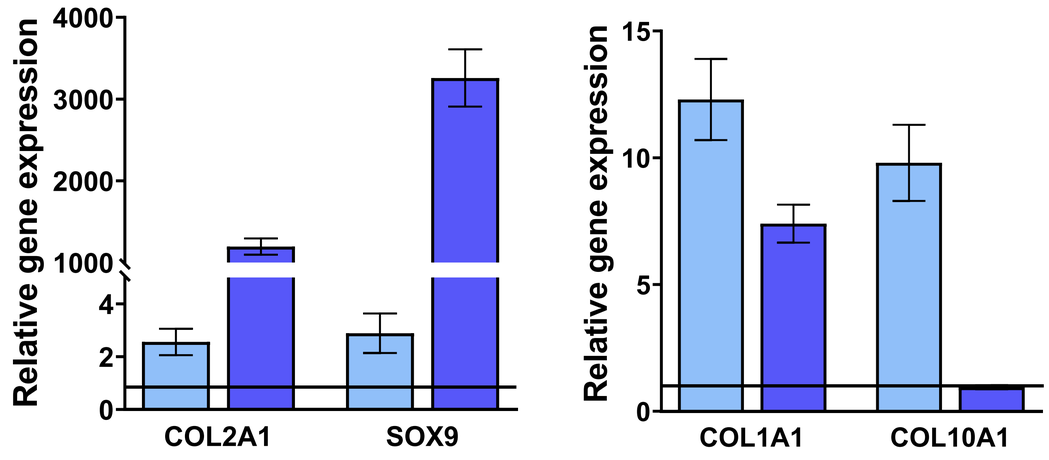
→ Cellular viability
↑ ALP expression
✓ Synergistic effects on early osteogenesis

Cartilage TE validation

- **regular geometry**
- squared pore sizes: **200 µm**
- diameter = 10 mm, height = 5 mm
- **3D printed** with Thermoplastic polyurethane (**TPU**)







↑ Chondrogenic markers
↓ Hypertrophy genes
✓ Chondrogenic commitment

✓ Highly versatile and modular bioreactor

References
1.Gabetti et al., Sci.Rep, 2022
2.Daou et al., Bone, 2024
3.Pecci et al., JMBBM, 2020