materials-driven regeneration

- Wednesday April 14th, 2021 -

- 4:00pm (CET) -

MDR colloquium April 2021

Online - Teams meeting

The Research Center for Materials-Driven Regeneration (MDR) is proud to present a series of lectures (monthly). The MDR Gravitation program is a partnership between Eindhoven University of Technology, Maastricht University and Utrecht University, University Medical Center Utrecht and the Hubrecht Institute. MDR brings together materials scientists, cell biologists, tissue engineers and medical scientists to jointly work on the regeneration of tissue and organ function with intelligent, life-like materials.

Mechanisms of Calcification in Material-Driven in situ Tissue Engineered Heart Valves

Cardiovascular structures such as semilunar heart valves function in a complex hemodynamic environment, necessitating dynamic growth and adaptability. Current xenografted or non-biological prosthetic valves lack this ability. Tissue engineered heart valves (TEHVs) prospect a great alternative, enabling adaptive remodeling. To date, however, some outstanding challenges prevent safe clinical translation of this approach, one of them being the formation of calcification nodules within the grafts. Using systematic review, we studied the incidence of calcification in TEHVs implanted in the pulmonary position in large animal models. With meta-analysis we found an overall calcification event rate of 35% of TEHV valve implantations (95% CI [28%-43%]) from 78 experimental groups. There was no significant difference in calcification between natural or synthetic scaffolds, cell-seeding methods, or different animal models. This systematic review showed that scaffold calcification is a frequently occurring problem in TEHVs, yet underlying mechanisms still need to be exploited.

We currently aim to unravel the underlying mechanisms of calcification of material-driven *in situ* TE Heart Valves (TEHVs). Calcification in explanted valves from previous *in situ* TE animal studies is characterized using state-of-the-art imaging techniques. Using *ex-vivo* characteristic analysis, aided by knowledge from the fields of pathological valve calcification as well as bone mineralization, we aim to define potential pathways underlying *in situ* TE scaffold calcification. *In-vitro* scaffold calcification models are used to test these hypotheses.

This research can provide mechanistic pathways for material-driven scaffold calcification. Preventing this calcification will bring the field of material-driven *in-situ* TE forward towards safe clinical use.

Dewy van der Valk

Eindhoven University of Technology

From shape to function in biofabrication-based solutions for joint repair

Three-dimensional (3D) printing is already routinely used in the clinic, e.g. for pre-operative models or intra-operative guides. However, this does not involve the generation of living 3D structures, i.e., biofabrication of implants. This automated approach holds potential to advance the field of regenerative medicine as outer shapes can be personalised and organised constructs can be produced when printing with multiple bio-inks. Recent developments have now resulted in the availability of a plethora of bioinks, new printing approaches, and the technological advancement of established techniques. Nevertheless, it remains largely unknown which materials and technical parameters are essential for the fabrication of intrinsically hierarchical cell-material constructs that truly mimic biologically functional tissue. In order to achieve this, we urge that the field now shifts its focus from materials and technologies towards the biological development of the resulting constructs. Whilst biophysical, biochemical stimuli will be instrumental in achieving this, the combination of developmentally inspired assembly and bioprinting approaches will facilitate the shift of functional biofabricated structures towards clinical applications.

Prof. Jos Malda

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