Development of a Fat Pad on Chip

MASTER THESIS PROPOSAL

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PROJECT DESCRIPTION

Hoffa's fat pad (HFP) is a specialized adipose tissue structure within the knee joint crucial for functions such as joint lubrication, shock absorption, and inflammation regulation. However, comprehensively studying its functions in a living organism is challenging due to its intricate microenvironment and limited accessibility for analysis. Therefore, there is a pressing need for advanced models that can faithfully recreate the *in vivo* conditions of the HFP.

Organ-on-chip (OoC) technology has transformed the *in vitro* modeling of human tissues, allowing for studies that closely mimic physiological conditions and reducing reliance on animal models. This study introduces a pioneering Fat Pad-on-Chip (FPoC) platform. This platform seamlessly integrates mechanical stimulation and a soft hydrogel matrix to accurately replicate the dynamics of the extracellular matrix (ECM) within adipose tissue. Tailored for disease modeling and drug testing, the FPoC aims to enable comprehensive investigations into HFP role in degenerative joint diseases.

PROJECT OBJECTIVES

Working on this project, the master's student will be able to culture and differentiate Mesenchymal Stem Cells into adipocytes in 2D culture conditions as well as in a 3D-soft hydrogel matrix. Then he/she will incorporate this engineered adipose tissue into an organ-on-a-chip (OoC) model to study the influence of the mechanical loading on the fat pad tissue. The development of the FPoC platform is anticipated to yield numerous benefits, including precise control over the tissue's microenvironment, the ability to investigate the tissue under conditions mirroring physiological relevance, and the potential for high-throughput screening of prospective therapeutics.

Laboratory Techniques that the Master's student will acquire:
Cell culture and differentiation techniques, qPCR, ELISA, immunofluorescence, immunohistochemistry, microscopy (bright field, fluorescence), hydrogel synthesis, and rheology.

Competences/Skills:
Problem-solving, experimental design, planning and execution of experiments, data recording, data analysis, presentation to expert and non-expert audiences, scientific writing, and teamwork.

SUMMARY OF THE PROJECT

hMSC differentiation into adipocytes — Fat Pat tissue engineering — Incorporation of different cell lines for a more physiologically relevant model — Incorporation into the chip — Optimization: Hydrogel + Cells + Mechanical Stimulation