# Challenge based learning (CBL)

# Fabrication of “sticky” biomaterials with antifibrotic and vascularization properties to treat myocardial infarction

# Note for teachers: A CBL user guide can be found at www.jandeboerlab.com/TissueEngineering with instructions and tips to run an effective CBL teaching session.

# Background and vision

# Cardiovascular diseases are the number one reason for non-accidental deaths in the world. It is well documented that cardiovascular diseases worsen with a sedentary life style, sugar and fat diets, and stress. This can lead to fat and lipid deposits that can partially or totally block arteries like the coronaries in the heart. Sustained lack of irrigation to the heart muscle (myocardium) will alter heart function and lead to death if emergency medical care is not provided. This event is called a myocardial infarction (MI) and can lead to inadequate and incomplete tissue regeneration and fibrosis. The long-term vision is to develop a therapeutical tool to regenerate the myocardium immediately after infarction before it progresses into fibrotic tissue.

# Motivation and stakeholders

# Inhibition of the fibrotic response after an infarction is shown to be effective in reducing the loss of cardiac tissue function. In addition to this, myocardium regeneration requires irrigation of the new tissue via the formation of new vessels. Novel biomaterial formulations are not only biocompatible but actively support the recruitment of cardiomyocytes and vasculature, and inhibit the immune system. New solutions for minimally invasive technology to fix heart muscle defects after infarction should acknowledge the requirements set out by the stakeholders such as the patients, interventional cardiologists, cardiovascular surgeons, biomedical engineers, and material scientists.

# Problem definition

# Novel tissue engineering cardiovascular strategies should aim to develop a material that can promote healing and neo-vascularization as it adheres to the walls of the beating and dynamic heart. This material should be in the form of a hydrogel that can be compressed in a canula and deployed to the injured heart site via catheter to minimize additional myocardium damage. Currently no tissue engineering strategy is clinically available to be deployed using a catheter to mend fibrotic and avascular myocardium. A new generation of “sticky” biomaterials or hydrogels is required to recruit mesenchymal or progenitor-derived cells from the surroundings and the immune system (macrophages) to resolve fibrosis to ultimately replace it with healthy myocardium-like tissue.

# Challenge

# To design an effective “sticky” biomaterial or hydrogel with antifibrotic and vascularization properties that can be deployed on site non-invasively after myocardial infarction.

# Learning framework

# Reading the Cardiovascular Tissue Engineering chapter and related literature will help you to will help you to understand:

# Heart and cardiovascular anatomy and physiology in humans.

# Pathophysiology of heart injury such as myocardial infarction.

# Current cardio-interventions and state-of-art treatments to identify and resolve myocardial infarctions.

# For a more focused examination of the challenge, read scientific literature and create a mind map to include information about the following:

# Current biomaterials used for cardiac tissue engineering.

# Design criteria for biomaterials in cardiac tissue engineering.

# Arthroscopic techniques to deliver biomaterials in situ.

# Current strategies to produce sticky biomaterials.

# Cellular and molecular to be targeted by the biomaterials.

# End product

# A three-minute video explaining the solution of your challenge. Please include your motivation and the steps to execute your solution.

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