Flow dynamic analysis of a custom made syringe pump for biomedical devices

The Institute of Medical Biotechnology (MBT) offers a Master's thesis for Life Science Engineering (LSE) or Chemical and Biological Engineering (CBI) students with an interest in the field of bioprocess technology and tissue engineering. The earliest date to start the thesis would be in early June, depending on the development of the Corona crisis and connected lab regulations.

In this project related to Tissue Engineering and Regenerative Medicine, a custom-made high-precision syringe pump was designed and manufactured as a support technology for two distinct novel systems in (i) bioprinting and (ii) medical bioreactor technology. Both technologies aim to create biostructures under controlled environmental chemico-mechanical conditions, which allow injected donor cells to grow and differentiate into various lineages. With these biostructures, we aim to mimic native 3D extracellular matrix (ECM) behavior on a biomechanical and morphological level to mitigate the shortage of donor organs and regenerate thick-tissues. Bioprinting is a bottom-up approach to mimic biological structures by additive manufacturing using cell-containing biomaterials. Especially in extrusion-based bioprinting, the technique used in our lab, the pressure, and resulting shear stress on the cells is critical for cell survival and therefore success of biofabrication. The MyoBio reactor system aims to address de-/recellularization challenges via an automated setup in a conjoint project with our industry partner (BlacBird, Erlangen). Currently, the MyoBio reactor is primarily used to produce tissue scaffolds for scaffold preparation for recellularization research.

However, to develop technology in biomedical context, quality standards of biological or synthetic scaffolds have to be met to ensure reproducibility. An important parameter includes the cell feed via a syringe pump. While syringe pumps are existing for medical and research applications, they normally lack in modifiability and adjustability. The student will commission the custom-made syringe pump, design, and optimize the syringe pumps' inlet to the MyoBio's perfusion tubing. The student will further reference all motor controls with their corresponding volume flow parameter and test the fluid system for fluid dynamics parameters like fluid residence time and the mixing abilities of the system. Other tasks will include Investigating the uniformity of containing cell numbers and the shear stress during the fluid flow. Furthermore, the student will investigate survival rates of C2C12 skeletal muscle stem cells with different flow rates, via conducting an MTT test.

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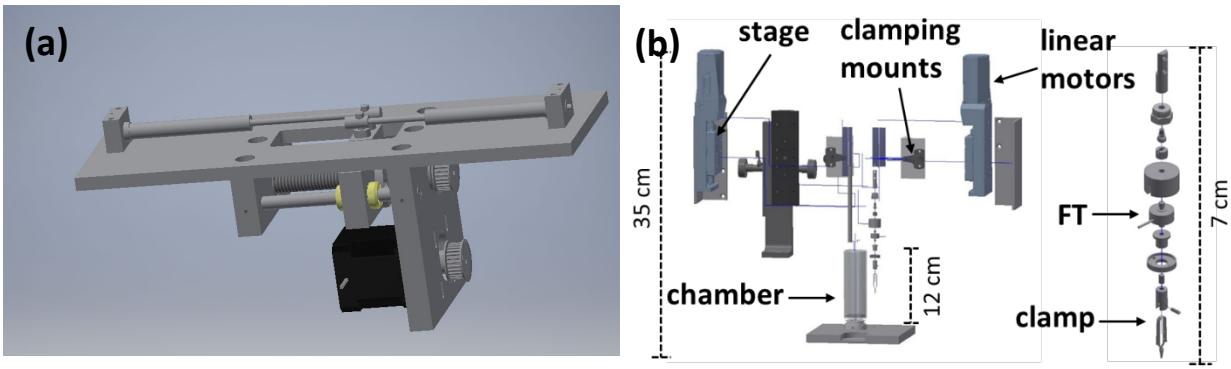

Figure 1 A custom-made syringe pump and a fully automated bioreactor for tissue de-/ and recellularization. CAD model of the syringe pump **(a)** and of the first bioreactor shown in an explosion assembly **(b)**.