Description for the general public

Is it possible to fabricate in vitro artificial, functional tissues and organs?

Tissues and organs are complex hierarchical structures composed of multiple cell types and tailored extra cellular matrix. Reproducing *in vitro* the specific functions of organs and tissues, such as the regular beating of heart, the detoxification abilities of liver, the contraction of muscles etc. within an artificial engineered constructs is extremely challenging.

Nowadays, **the development of advanced *in vitro* models/equivalents of organs and tissues is becoming more and more needed**. The reasons of that are numerous. Firstly, the costs of new drug research and development are constantly growing. As a consequence, pharmaceutical companies are searching for more accurate and cost saving methods to screen pre-clinically their potential pipelines to reduce the risk of wasting potentially valuable drugs. Secondly, relying on animal research and testing to improve human health is not only expensive, but also unsafe, time-consuming, not always reliable and often considered cruel. Problems of extrapolation (i.e. applying information from animal research to humans) are inevitable when researchers use animal models to study human diseases. Last but not least, the development of artificial organs may represent a life-saving solution for all those people waiting for an organ transplant.

Large part of the research conducted worldwide on this topic is focusing the attention on mimicking native cell organization and matrix composition as close as possible so as to promote tissue/organ specific functions. In particular, great efforts are being spent to integrate capillary networks – i.e. **microvasculature** – inside engineered tissue constructs.

The integration of artificial microvascular networks to transport nutrients and oxygen and remove wastes is critical not only for developing engineered tissues for clinical applications but also for maintaining vital functions of cells within *in vitro* systems. Vascular networks are, in fact, particularly important for engineering physiological systems of highly metabolic organs, such as muscles, liver, and kidney. In addition, studying angiogenesis – i.e. the formation of new blood vessels form from pre-existing ones – is critical for understanding various physiological processes, including wound healing and tumor growth.

In this context, we propose to develop a new approach to guide endothelial cell (i.e. the cells specialized in the formation of blood vessels) organization into a capillary network. This is planned to be achieved through the fabrication of '***microvasculature seeds***' that, after maturation, will eventually form a microvasculature network within the engineered constructs.

The project will be implemented using state-of-the-art technologies such as microfluidics and 3D bioprinting. Throughout the project, we will study in details the biochemical and biomechanical processes that orchestrate the formation of the microvasculature, with the aim of unravelling new key aspects and factors involved with this complex process.

We believe that the outcome of the proposed project, if successful, may truly boost the development of advanced models of organs and tissues, with potential high economic and social repercussions in the short-to-middle term.