COAXIAL: Width-controlled 3D bioprinting of thin and homogeneous biomimetic fibres

Challenge

Skeletal muscles show high structural complexity. They are constituted by 3D myofibers axially aligned, gathered in bundles connected to the vascular and neuronal network, and to the bones through tendons. Due to that complexity, research on skeletal muscle tissue has been mostly done in a 2D environment, and without measuring contraction forces.
One of the challenges is being able to provide a fabrication **method** that:

- allows to carefully **control the thickness** of the bioprinted constructs in the micro-meter range
- obtains **individual fibers that are not fused** with each other, improving the biomimicry of the organisational structure of, e.g., skeletal muscle tissue, and enhancing the cell viability in the inner parts of the constructs due to an enriched nutrient and oxygen diffusion
- is **universal** enough to include different types of hydrogels and different crosslinking strategies

Asset

IBEC researchers have developed a universal 3D bioprinting system for the fabrication of **thin, homogeneous, and width-controlled free-form individual fibres** that can be used with a **wide variety of cell-laden hydrogels.** The method inventively separates the fixation process of the 3D-printed fibre structure from the hydrogel polymer cross-linking step. In particular, our method enables the fabrication of multi-layer tissue constructs with **high versatility in terms of hydrogel composition and cross-linking processes**. Moreover, this method does not to rely on the use of sodium alginate, as most co-axial approaches do, being an agent that is not well received by certain tissues like skeletal muscle.
As proof of concept for the application of our 3D-bioprinted skeletal muscle tissue, we have developed a force measurement platform that allows studying the contraction dynamics of the tissue upon stimulation, for instance by applying electrical pulses or by adding drugs.

Market

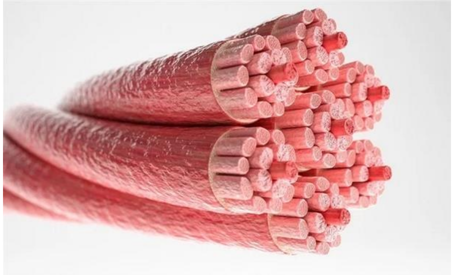
Muscles are subject to ageing, traumatic injury or myopathies. Hence, skeletal muscles are of high relevance for several industries like: **cosmetics** (market size $507.8 billion in 2018, expected $758.4 in 2025), since sustained contractions of facial muscles cause wrinkles; **biomedicine,** since diseases like muscle dystrophies are very heterogeneous and generally understudied; and **tissue engineering** and **regenerative medicine** (market size $9.9 billion in 2019, expected $28.9 in 2026), since implants like muscle grafts could help heal people with serious muscle damage.
Also, due to the **universality of our method**, derived compositions for different tissues could be designed and offered using the same method.

Asset Value

- Good **mimicking** of highly structured **skeletal muscle tissue**:
  - Individual fibres are printed with a controlled width
  - There is no significant fusion of adjacent fibres
- The system is **versatile**, it allows bioprinting with a wide variety of cell-laden hydrogels (also without support baths)
- The solution is based on co-axial nozzles that could be **used with different 3D printing systems**

IBEC Institute for Bioengineering of Catalonia — EXCELENCIA SEVERO OCHOA

A co-axial bioprinting method to better mimic the high-level structure of skeletal muscle tissue



Uses

- 3D-Bioprinting kit (Coaxial extrusion nozzle, bioink, protocol), especially designed, but not limited to, muscle application
- Platform for drug discovery and development in animal-free non-clinical tests
- Tissues for regenerative medicine

Team

Samuel Sánchez - Scientific Leader

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Stage of Development

TRL 4

- Full validation for skeletal muscle tissue (fiber morphology vs printing parameters, cell proliferation and differentiation), demonstrating improved cell differentiation and larger force outputs
- Tested for specific bioink formulations and drug applications
- Characterisation of different protocols to obtain high quality fibres with a wide combination of materials

Intellectual Property Status

Patent filed in July 2020

Current Status: national phases (EP, US)

Patent owners: IBEC and ICREA

Exploitation Plan

Service agreements and/or licensing with technical co-development

Contact

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