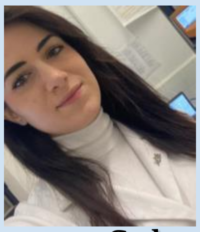
Instructive and adaptable hydrogels for tissue engineering



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Regenerative Medicine

Concept
Tissue engineering is a rapidly growing field focused on improving human health by developing advanced solutions for repairing and regenerating biological tissues. Every year injury, trauma and disease cause severe disabilities or deaths due to tissue and organ damage. Traditional treatments, such as autografts and allografts, face limitations including a shortage of suitable donors, long waiting lists, high costs and adverse immune/inflammatory responses. Tissue engineering aims to overcome these challenges by creating biomaterials that act as scaffolds, mimicking the extracellular matrix (ECM) to support cell proliferation and tissue regeneration.

Scientific approach
The research involves the design of biocompatible and biodegradable scaffolds that promote cellular interaction and tissue growth. Hydrogels, three-dimensional networks of hydrophilic polymer chains, are particularly promising scaffold materials due to their structural similarity to the ECM of biological tissues. Their rheological properties and biocompatibility make them suitable as bioinks for constructing scaffolds with specific morphological and functional characteristics using a layer-by-layer approach. 3D printing will be employed to fabricate these scaffolds, enabling the creation of complex and customized three-dimensional structures with high precision and reproducibility. The approach includes a detailed analysis of hydrogels through several phases of characterization. Chemical characterization by spectroscopy will analyze the composition of the materials. Physical characterization will assess their porosity, thermal and degradation properties. Mechanical properties will be explored to determine whether the scaffolds can resist physiological stress and provide structural support to cells. The porosity and interconnectivity of the scaffolds are crucial for cell infiltration, adhesion, and proliferation. Therefore, scanning electron microscopy and confocal microscopy will be used to study the morphology and distribution of cells within the scaffolds. To assess biocompatibility and biological efficacy, in vitro assays will include tests for cytotoxicity, proliferation, and cell differentiation, while in vivo assays will evaluate the immune response and tissue integration of the scaffolds. Spheroids of adipose-derived mesenchymal stem cells (SASCs) will be used due to their easy isolation from adipose tissue via minimally invasive procedures like liposuction. SASCs can differentiate into various cell types, including osteoblasts or chondrocytes, making them ideal for regenerating various tissues and organs.

Research objectives
The research project aims to develop advanced scaffold for regenerating damaged tissues, addressing the limitations of current treatment methods. These scaffolds will be biocompatible, bioactive and degradable, integrating into host tissue to provide temporary structural support while guiding stem cells in the regeneration process. The instructive and adaptable scaffolds will create a three-dimensional environment that mimics native tissue and can be customized for different tissue types and pathological conditions. Additionally, the research aims to understand the molecular mechanisms involved in tissue regeneration facilitated by these structures, optimizing scaffold design to improve the clinical efficacy of scaffold-based therapies, ultimately leading to better outcomes for patients requiring tissue repair and regeneration.

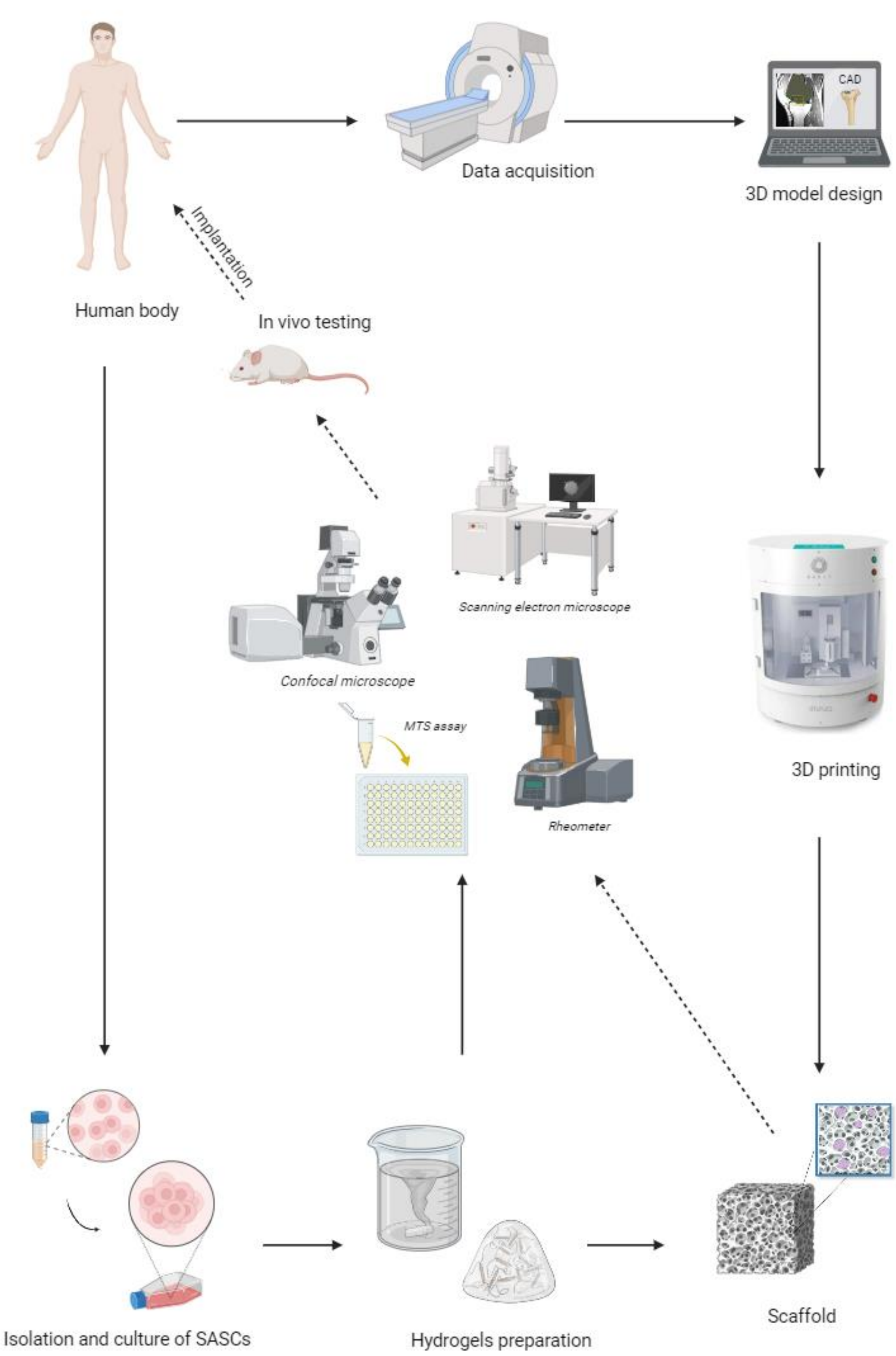

Figure 1. Workflow for tissue regeneration using autologous cells and 3D printed scaffolds