FACTA ANATOMICA

REGENERATIVE MEDICINE & STEM CELLS

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REGENERATIVE MEDICINE & STEM CELLS

- ***Articular cartilage tissue engineering***
- ***Principles of human epicardium biology in heart development and disease***
- **Middle-out methods for spatiotemporal tissue engineering of organoids**

Regenerative medicine is the branch of medicine that develops methods to regrow, repair or replace damaged or diseased cells, organs or tissues. Regenerative medicine includes the generation and use of therapeutic stem cells, tissue engineering and the production of artificial organs.

New refinements aim to optimize articular cartilage tissue engineering

"Long-term treatment of articular cartilage injuries is important for the prevention of osteoarthritis but remains a major challenge. "

- **A synthetic artificial stem cell (SASC) system, designed to mimic the secretome of mesenchymal stem cells, attenuates cartilage degeneration and improves the biomechanical properties of articular cartilage in vivo.**
- **A zonal microstructured scaffold proved to be robust and mechanically stable in a large-animal model of osteochondral defects.**
- **Scaffolds derived from solubilized articular cartilage extracellular matrix were able to successfully repair chondral lesions, particularly when loaded with TGFβ3**

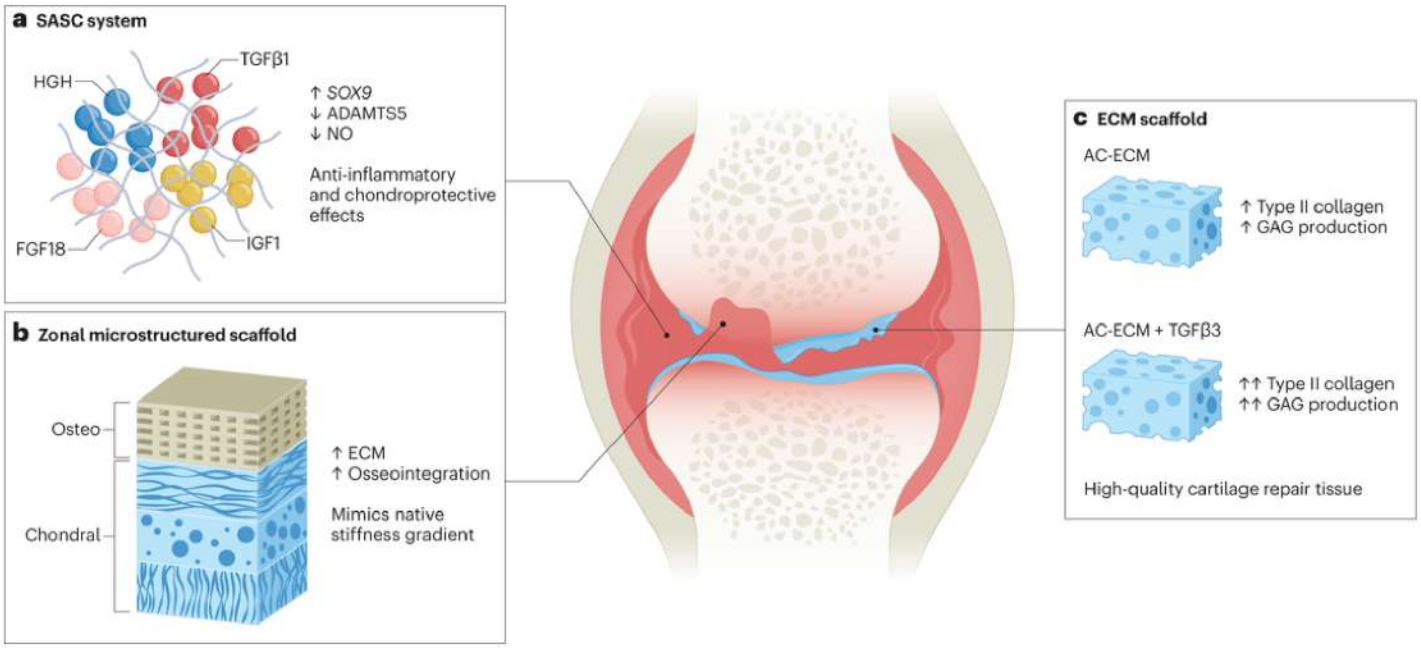

Figure 1: Zonal microstructured scaffold in articular tissue regeneration (*Source: Schäfer, N., Grässel, S. New refinements aim to optimize articular cartilage tissue engineering. Nat Rev Rheumatol 19, 66–67 (2023). https://doi.org/10.1038/s41584-022-00889-y*)

Human epicardium biology in heart development and disease

- The epicardium, the mesothelial envelope of the vertebrate heart, is the source of multiple cardiac cell lineages during embryonic development and provides signals that are essential to myocardial growth and repair.
- Pluripotent stem cell (PSC)-derived cardiac organoids have emerged as powerful in vitro models of human development and disease
- **Self-organizing human pluripotent stem cell-derived epicardioids can be generated that displays retinoic acid-dependent morphological, molecular and functional patterning of the epicardium and myocardium typical of the left ventricular wall.**
- **Epicardioids can be used to investigate the functional cross-talk between cardiac cell types, gaining new insights into the role of IGF2/IGF1R and NRP2 signaling in human cardiogenesis.**
- **Epicardioids mimic the multicellular pathogenesis of congenital or stress-induced hypertrophy and fibrotic remodeling. As such, epicardioids offer a unique testing ground of epicardial activity in heart development, disease and regeneration.**

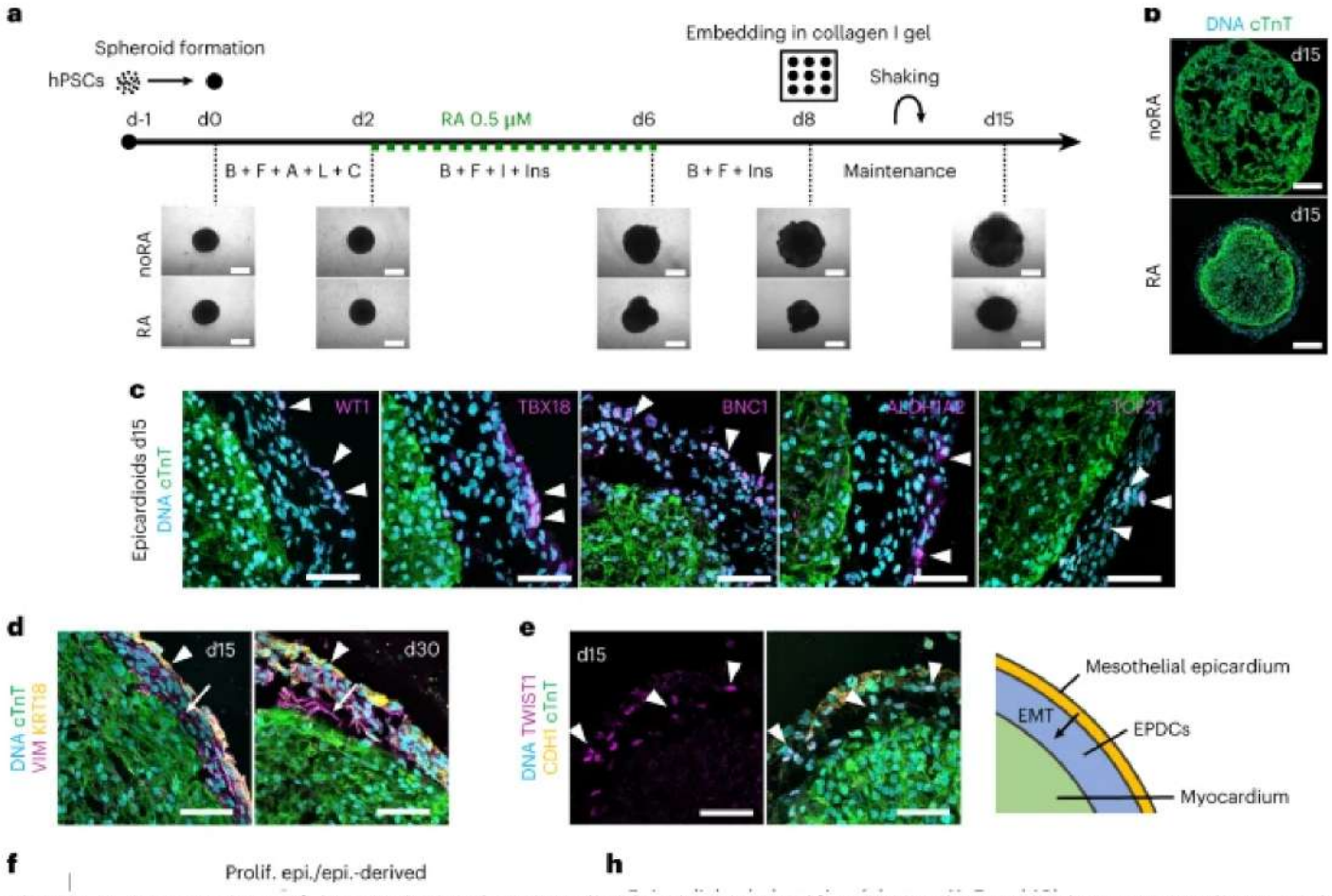

Figure 2: Generation of hPSC-derived epicardioids showing self-organized ventricular myocardium and epicardium. (*Resource: Meier, A.B., Zawada, D., De Angelis, M.T. et al. Epicardioid single-cell genomics uncovers principles of human epicardium biology in heart development and disease. Nat Biotechnol (2023). https://doi.org/10.1038/s41587-023-01718-7*

Middle-out methods for spatiotemporal tissue engineering of organoids

- Organoids have emerged as powerful in vitro models for a variety of organs and applications; however, their utility is currently limited by a lack of spatiotemporal control over the tissue-specific cell niches in which they reside.
- Tissue engineering approaches facilitate the generation of more physiologically relevant in vitro cell niches to improve methods for organoid culture.
- Top-down, scaffold-based tissue engineering approaches allow for macroscale control over organoid geometry and are amenable to cell-based remodelling and self-organization but suffer from a lack of spatiotemporal control of niche properties.
- Bottom-up, modular tissue engineering approaches allow for precise control over cellular and extracellular tissue building blocks for precision engineering but at the cost of minimizing the capacity for cellular self-organization.
- Middle-out, interventional tissue engineering approaches combine aspects of top-down and bottom-up tissue engineering methods to enable precise spatiotemporal control of engineered cell niches, thereby enabling deterministic control of cellular self-organization.

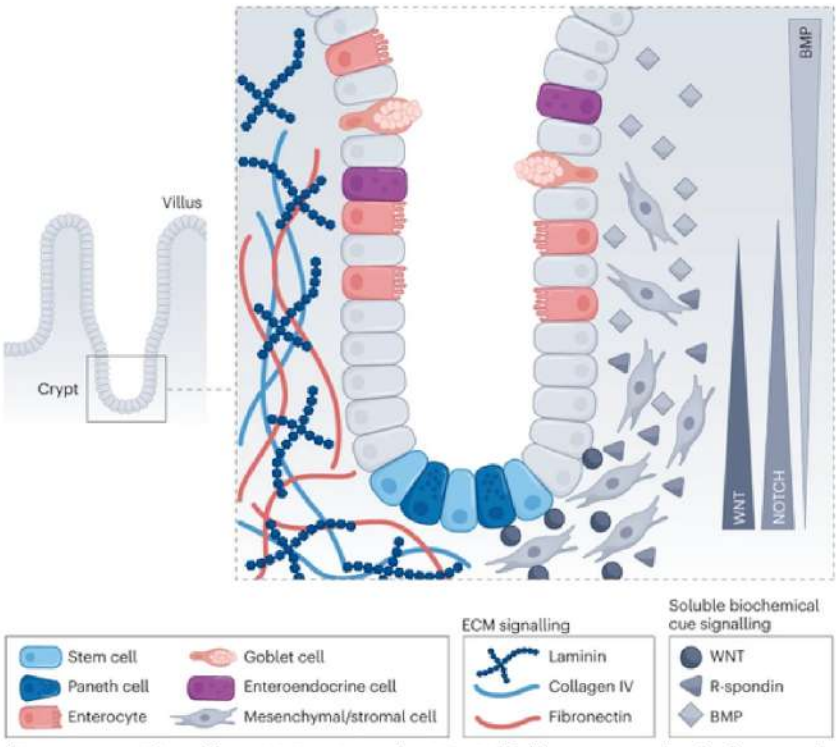

Figure 3: The intestine is organized into a crypt–villus architecture. The intestinal crypt contains crypt-base cell populations (such as intestinal stem cells and Paneth cells) and other differentiated cell types, including enterocytes, goblet cells, and enteroendocrine cells. The niche is regulated by epithelial interactions with the surrounding mesenchymal/stromal cells and gradients of extracellular matrix (ECM) composition and soluble biochemical cues. BMP, bone morphogenetic protein.
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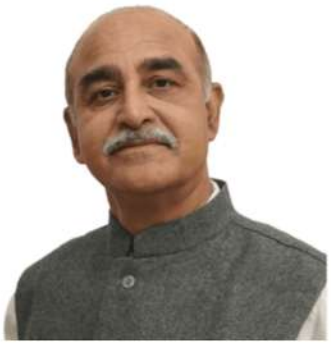
(Resource: Blatchley, M.R., Anseth, K.S. Middle-out methods for spatiotemporal tissue engineering of organoids. Nat Rev Bioeng (2023). https://doi.org/10.1038/s44222-023-00039-3)

MESSAGE FROM EXECUTIVE DIRECTOR

PROF.DR. (COL.) CDS KATOCH, AIIMS RAJKOT



I heartily congratulate the Department of Anatomy for bringing this informative newsletter on the unified anatomical explanation of regenerative medicine & stem cells. My best wishes to the entire team.

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- Dr Pradip Chauhan, Assistant Professor
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