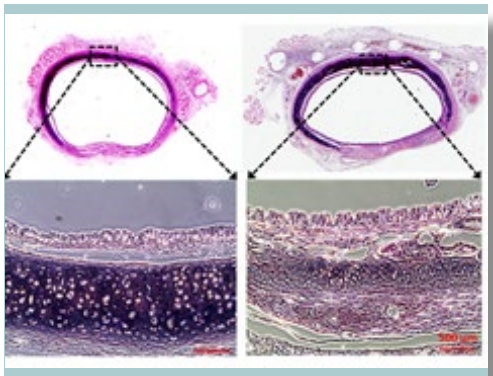
PENN CENTER FOR INNOVATION



Decellularized organ-derived tissue engineering scaffolds

Scaffold for regenerating mucosal trachea tissue

Inventor

Dan Dongeun Huh, Wilf Family Term Chair and Assistant Professor of Bioengineering

STATE OF DEVELOPMENT

- Proof-of-concept *in vivo* rat data and prototype construction

INTELLECTUAL PROPERTY

PCT pending

REFERENCE MEDIA

Philadelphia Inquirer article, 2015.
Pennsylvania Gazette cover and feature article, June 2016.
TEDx talk, 2015.

DESIRED PARTNERSHIP

License
Co-development

APPLICATIONS

- Tissue engineering
- Tissue regeneration and repair
- Biomimetic devices
- Cell-based 2D and 3D assays
- Organs-on-chips and microphysiological systems
- Pharmaceutical screening
- Environmental monitoring and screening

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Problem

Biomaterials that have been developed for tissue engineering are limited in their ability to induce differentiation or enhance the function of specific cells isolated from tissue. There is a need to create a material platform that emulates native biophysical and biochemical cellular microenvironments without inducing an immune response upon delivery to tissue.

Solution

The Huh lab, in collaboration with researchers at POSTECH in Korea, has developed a method for generating 2D and 3D cell culture scaffolds using native extracellular matrix (ECM) derived from decellularized primary tracheal tissue. The decellularized material can be used for ECM surface coatings, hydrogels, and vitrified membranes. To demonstrate biological advantages of this approach, the researchers established cell culture models and examined the promotive effects of the dECM materials on cell differentiation and maintenance. This study revealed that dECM hydrogels derived from primary porcine trachea influenced the differentiation of primary human bronchial epithelial cells by i) significantly reducing culture duration for ciliogenesis and mucus production and ii) allowing the cells to exhibit physiologically relevant functional phenotypes. Moreover, this technique was able to reconstruct airway mucosal tissue. *In vivo* proof-of-concept data in rats showed superior regeneration of defected tracheal epithelium following the implantation of bioengineered mucosal tissue containing the dECM hydrogel. The delivered hydrogel was stable at the defect site and did not induce significant inflammatory response during and post implantation. The defected tracheal wall was completely regenerated, with the thickness and morphology of regenerated epithelium nearly identical to native tracheal epithelium. In another study, the same material was used to produce thin porous membranes that can be integrated into microfluidic cell culture devices to develop organ-on-a-chip systems.

Advantages

- Short timeframe to obtain differentiated cells (acceleration of cell differentiation and induction of physiological phenotypes)
- Different types of materials can be generated by the invented approach (e.g., powder, hydrogel, membranes, hard scaffolds, etc.)
- Promote regeneration of injured and defective tissue in vivo for better clinical outcomes when implanted
- Enable the development of advanced in vitro cell culture models that allow cultured cells to express and maintain differentiated physiological phenotypes with high efficiency
- Expedite drug screening and lower cost by modeling the native environment more precisely in cell-based preclinical assays
- Reduce need for animal testing

Image Caption: Histological analysis of tracheal epithelium regeneration by H&E staining 2 weeks post-implantation. Native trachea, on left, and dECM-implanted trachea, on right.