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Biography

Marsha Rolle, Ph.D., is an associate professor of biomedical engineering at WPI. Dr. Rolle is an alumna of Brown University (ScB, Biochemistry), where she worked in Dr. Edith Mathiowitz’s lab on delivery vehicles for controlled release of plasmid DNA for her honors thesis project. She then worked for almost three years in the medical device industry on controlled release systems for orthopedic and cardiovascular regeneration. She earned her PhD in Bioengineering at the University of Washington, where she worked in Dr. Chuck Murry’s lab on controlled proliferation of grafted skeletal myoblasts for myocardial infarct repair. She then completed postdoctoral training in Dr. Tom Wight’s lab in the Hope Heart Program that the Benaroya Research Institute in Seattle, Washington, where she studied elastogenesis in vascular smooth muscle cells for tissue engineering applications. She joined the Biomedical Engineering faculty at WPI in 2007. Her research focuses on the application of cellular self-assembly for tissue engineering and manufacturing cell-derived extracellular matrix materials, vascular disease modeling, antimicrobial peptide delivery from extracellular matrix scaffolds to treat chronic infected wounds, and workforce training and technology development for cell and tissue manufacturing. Dr. Rolle’s research is funded by the National Science Foundation, the National Institutes of Health, and ARMI/BioFabUSA.

Abstract

“Modular assembly of tissue ring units for vascular tissue engineering”

Cardiovascular disease is the leading cause of death in the United States. Tissue engineered blood vessels (TEBVs) offer the potential to develop new treatments for vascular disease. TEBVs have been used clinically as vascular grafts, and may also serve as 3D human disease models to screen potential therapeutics. The majority of approaches to vascular tissue engineering utilize cells seeded on or within exogenous scaffold materials, resulting in homogenous tubular structures. However, most vascular diseases are localized in nature, and involve injury and remodeling to cells and extracellular matrix (ECM). Therefore, we developed an alternative approach to generating TEBV, by using engineered cellular self-assembly to create functional, 3D tissue rings from cells and cell-derived ECM. The self-assembly system allows one-step 3D tissue ring fabrication by seeding a cell suspension into custom agarose wells. Cell rings self-assemble within 24 hours, and are strong enough to harvest within 1-4 days after seeding. After 7-14 days in culture, the tissue ring format is well suited for quantitative functional analysis of cell-derived tissues (e.g., uniaxial tensile testing, wire myography). To date, we have created and analyzed self-assembled vascular tissue rings using primary human smooth muscle cells, mesenchymal stem cells, and induced pluripotent stem cell (iPSC)-derived human vascular smooth muscle cells from healthy subjects or patients with supravalvular aortic stenosis (SVAS). In addition, we have found that self-assembled tissue rings can serve as modular building units to create tubular tissue constructs. We have also shown that gelatin microspheres can be mixed and co-seeded with cells during assembly to achieve growth factor delivery. Finally, modular assembly and fusion of individual tissue ring units enables creation of tubular tissue with focal heterogeneities, which may enable modeling of vascular lesions. In addition to vascular grafts, the system can be used to create other tissue types, including cartilage/tracheae. In summary, modular tissue fabrication by self-assembled ring assembly and fusion may represent a new approach for the engineering of complex, living multi-tissue constructs.