Department of Bioengineering
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Lehigh Bioengineering Seminar Series presents:

Dr. Juan Gnecco, PhD
Tufts University
Assistant Professor in the Department of Biomedical Engineering

"Tissue Engineering the Uterus and Reproductive Health"

Friday, November 21, 2025
10:45 AM-11:45 AM
HST 101

https://lehigh.zoom.us/j/97495411009

Please contact the Bioengineering Department (inbioe@lehigh.edu) with any questions or comments.

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Abstract:

Endometriosis is a chronic inflammatory disease affecting over 190 million women worldwide and is characterized by the growth of endometrial-like tissue outside the uterine cavity. Dysregulation of endocrine signals play an important role in the pathogenesis of endometriosis and influences symptoms like severe, chronic pelvic pain; however, the underlying mechanisms of disease pathogenesis remain elusive. A better understanding of the cellular and biomechanical components of the lesion microenvironment is needed to understand the early events in disease establishment. Recent technological advances in three-dimensional (3D) modelling including tissue clearing, high-content imaging, organoids and biomaterials that have enabled our team to dissect and reconstruct the endometriotic tissue microenvironment. Using patient-derived biospecimens we describe the tools that have transformed our understanding of origins of endometriosis. We deploy tissue clearing methods (i.e., CLARITY) and light-sheet and confocal microscopy on human endometriotic (adenomyosis and endometriosis, N=10) lesions to spatially characterize the lesion architecture, extracellular matrix (ECM) and cellular composition of lesions. These results provide 3D datasets that illuminate spatial relationships across disease subtypes and help guide development of disease modeling. From these results, we refined the hypothesis that lesion morphology is linked to tissue mechanics. To test this, we used our recently developed functionalized poly-ethylene glycol (PEG) synthetic matrices and multi-cellular organoid systems to explore tissue biomechanics and cell-cell communication in endometriotic disease. By embedding endometrial epithelial organoids (EEOs) in PEG matrices tuned to mimic physiologic (3wt%, 300pa) to pathologic (5wt%, 2kPa) regimes we identified morphometric, mitotic and inflammatory profiles using immunofluorescent imaging, transcriptomics and multiplexed bead arrays to identify the reprogramming toward an endometriotic-like disease phenotype that mimic the invasive, architectural, endocrine and inflammatory hallmarks of endometriosis. These results suggest that matrix and tissue biomechanics may be involved in disease progression. Given that ECM and the other components of the lesion microenvironment may also contribute to disease progression, we are now developing strategies to introduce other components in our endometriosis models.

Personal Bio:

Juan S. Gnecco, Ph.D., is an Assistant Professor in the Department of Biomedical Engineering at Tufts University and associate Principal Investigator at the Woman Mother + Baby Research Institute (WoMB) at Tufts Medical Center. His research lies at the interface of tissue engineering and reproductive biology to understand the underlying immune-endocrine mechanisms driving uterine inflammation and disease pathogenesis including endometriosis, adenomyosis and infertility. Dr. Gnecco obtained his B.S. in Biotechnology from Rutgers University, and a Ph.D. in Cellular and Molecular Pathology from Vanderbilt

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University Medical Center (VUMC) where he developed the first organ-on-chip (OoC) model of the perivascular endometrium to study the effects exerted by environmental toxicants on the female reproductive tract. Dr. Gnecco conducted his post-doctoral training at Massachusetts Institute of Technology (MIT) in the Department of Biological Engineering where he led efforts to transform the human clinical relevance of 3-dimensional (3D) reproductive tract models by defining the interplay between biophysical and cellular cues using organoid technologies and high-content 3D whole mount tissue imaging approaches. He has been awarded three rounds of funding from Gates Foundation (2018-present) for his work building phenotypic 3D models of the endometrial microenvironment. He was selected as a Rising Star in Engineering and Health by Columbia University in 2020, served organize a NASEM workshop on Regenerative Medicine for Women's in (2024) Health, was a project lead in the World Endometriosis Research Foundation (WERF) Experimental Organoid Model Unification Effort (2025), and serves on the editorial board for Frontiers in Reproductive Health. He is committed to advance women's health through educational and workforce strategies.