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## Ph.D. DISSERTATION DEFENSE

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| **Candidate:** | Mohammad Mir |
| **Degree:** | Doctor of Philosophy |
| **School/Department:** | Schaefer School of Engineering & Science/Biomedical Engineering |
| **Date:** | 08/10/2023 |
| **Time/Location:** | 2:00 PM – 3:30 PM \| https://stevens.zoom.us/j/94997947782 |
| **Title:** | Bioengineering Modalities and Tools for Diagnosis and Repair of Pathological Lung Tissue |
| **Chairperson:** | Professor Jinho Kim, Department of Biomedical Engineering |
| **Committee Members:** | Professor Dilhan Kalyon, Department of Chemical Engineering and Materials Science<br>Professor Carrie Perlman, Department of Biomedical Engineering<br>Professor Sarah Huang, Center for Stem Cell & Regenerative Medicine, The University of Texas Health Science Center |

## ABSTRACT

Chronic respiratory diseases remain a leading cause of fatality and disability worldwide. The increasing burden of respiratory diseases highlights the pressing need for new techniques in diagnosing and repairing lung conditions. While traditional approaches have been valuable, they often prove insufficient in providing comprehensive solutions for the diverse range of lung pathologies. Improved diagnostic tools are essential for early detection and accurate assessment of lung diseases, facilitating timely intervention and enhancing patient outcomes. Concurrently, novel repair and regenerative techniques, such as tissue engineering and biomaterials, hold the potential to transform lung tissue repair and transplantation, offering hope to patients with severe lung damage or disorders.

This dissertation makes contributions to the diagnosis and repair of respiratory diseases through different research projects: (*i*) An imaging-enabled bioreactor is constructed, allowing real-time monitoring of isolated rat trachea during controlled cell removal and stem cell delivery. This platform can facilitate the creation of bioengineered airway tissue for disease modeling and drug testing. (*ii*) A vacuum-based modality is utilized for accurate non-destructive measurement of the stiffness of soft biological materials, such as soft biomaterials and lung tissue. This method can be used to design and characterize biomimetic materials for use in therapeutics and potentially serve as a diagnostic tool for lung diseases. (*iii*) A tissue palpation device is developed to accurately quantify lung parenchyma stiffness using the compression-based technique. The device provides the surgeons with accurate and rapid detection of diseased tissues, such as tumors and fibrosis, during minimally invasive robot-assisted surgery. (*iv*) A sound-guided methodology is developed that enables rapid quantitative assessment and precise localization of air leaks by analyzing the distinct sounds generated as the air escapes through defective lung tissue. (*v*) A lung-mimetic sealant with physio-mechanical properties similar to human lung tissue is formulated to be topically applied to the air leak location and repair the air leak.