NJIT New Jersey Institute of Technology

BME

Department of Biomedical Engineering

Graduate Seminar

Dr. Muna Aryal, Ph.D.

Research Associate, Dr. Tyrone Porter's Lab - Biomedical Engineering Department, University of Texas at Austin, Texas

Subject: Noninvasive and Targeted Drug Delivery for Neurological Diseases and Disorders

Abstract:

Delivery of therapeutics into the brain is challenging because almost 100% of large and 98% of small molecules that exist in today's medicine are stopped by the blood-brain barrier (BBB) before entering into the brain tissue from the blood circulation. Even though the rest 2% of small molecules can pass into the brain naturally from the BBB, it bears systemic and off-target toxicity, which is a major challenge to further advance the neuroscience field because every part of the brain within few millimeters acts functionally different. Different methods have been used to overcome those challenges either by doing stereotactic surgeries or by designing new pharmaceuticals, but they are invasive and non-targeted. Focused ultrasound (FUS) has emerged as a viable non-invasive and targeted technique to deliver the right drug, to the right part of the body, and at the right time by transiently loosening the BBB. Combining FUS with stimuli-responsive nanodroplet (neuro-nanomedicine) holds a great promise on reducing systemic and off-target toxicity of a drug by designing an ultrasound-sensitive cargo that can carry the right drug and can release the payload at the right target in the presence of externally applied acoustic energy at the right time. Likewise, noninvasive ultrasonic glymphatic control improves the intrathecal drug delivery and opens up a new avenue for drug delivery to the brain and spine. During this seminar, I will introduce ultrasound-based brain drug delivery techniques, the BBB opening, the ultrasonic drug uncaging, and the ultrasonic glymphatic control. I will then share my experiences of using the BBB opening technique for glioblastoma treatment, using the ultrasonic drug uncaging method for achieving precise neuromodulation and neuroimaging, and using ultrasonic glymphatic control method for enhancing intrathecal drug delivery in preclinical models. Afterward, I will conclude my talk by sharing my future research goals.

Bio:

Dr. Aryal received her undergraduate degree in Physics and Mathematics from Tribhuvan University, Nepal in 2006 and her Ph.D. in Physics from Boston College, the USA in 2014. She worked as a postdoctoral research fellow in Dr. Nathan McDannold's Lab in the Radiology Department at Brigham and Women's Hospital at Harvard Medical School, where she performed most of her Ph.D. thesis work, before joining Stanford in 2016. Her second postdoctoral experience was from Dr. Raag Airan's Lab in the Radiology Department at Stanford University, where she received a training grant (T32-NIH) for two years from the Stanford Cancer Imaging Training program. At the end of 2020, she joined Dr. Tyrone Porter's lab in the Biomedical Engineering Department at The University of Texas at Austin as a research associate.

Her research focused on developing drug delivery tools using focused ultrasound and nanobiotechnology and tailoring their use for noninvasive and targeted brain imaging and therapy. She invented novel methods for brain tumor treatment, precise neuromodulation, functional connectivity, and glymphatic clearance. Her vision is to make those targeted drug delivery methods as personalized medicine while advancing the understanding of brain function followed by ultrasonic interventions. She envisions her research to mirror her multidisciplinary background in Physics, Biomedical Engineering, and Neuro-nanomedicine with a focus on basic, applied, and translational science.

In addition to her research, she was heavily involved in teaching and mentoring students at different levels such as high school, undergraduate, graduate, and medical residents for their academic degrees. Her passion is to bridge the gap between Science, Technology, Engineering, and Mathematics (STEM) and to provide a foundation for students who are building their careers on multidisciplinary applications of STEM.

Date and time: Monday, January 25th, 2021

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