Distinguished Seminar Series
Mechanical Engineering and the Purdue Center for Cancer Research

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Lecture: 1:00 PM –
https://purdue-edu.zoom.us/j/91820682168?pwd=NXY2d2tPZ2xHUy95VjBkUU04MnZIQT09

Q & A and Social – Purdue Cancer Center: 2:00 PM –
https://purdue-edu.zoom.us/j/95543446595?pwd=bGhaYkw5ZlpBRVUvaGxZelRUUkJvdz09

Q & A and Social – Purdue ME: 3:00 PM –
https://purdue-edu.zoom.us/j/94238026651?pwd=NEJnQXgxclN0aHRNWGFjb0cyZXJUQT09

To See a World in a Grain of SAND, EXODUS, and MAP for Precision Medicine

Abstract:

In this talk, I will present how to gaze at the health status of humanity and the Earth in a grain of sand and find solutions for preventive precision medicine against a global pandemic such as COVID-19. Quantum nanoplasmonics-based speedy analytical nano-optofluidic diagnostic system (SANDs) can help us to predict and stop the spread of infectious disease. As an example of smart SANDs, integrated molecular diagnostic systems that comprise three key elements are developed: (1) a self-contained sample preparation and liquid biopsy on chip, which allows a rapid sample-to-answer readout platform; (2) ultrafast nanoplasmonic amplifications of DNA, RNA, and protein biomarkers; (3) interface of smartphone optical system.

I will also describe exosome detection via the ultrafast-isolation system (EXODUS). The EXODUS allows automated label-free purification of exosomes from varied biofluids by two coupled oscillators, which generate dual-frequency transverse waves on the filter membranes. By eliminating the fouling layers through acoustofluidic streaming, EXODUS generate a high speed, purity, and yield. As an example of EXODUS applications, we demonstrated the significantly improved purification method of exosomes from the urine samples of cancer patients and validated the practical relevance in exosomal RNA profiling for the comparison of enriched pathways of kidney cancer and bladder cancer.

For nanomedicine, I will present the development of organoids Microphysiological Analysis Platforms (MAP), or integrated organoids on chip with nanobiotechnological sensors and therapeutic modulations, which will benefit to predict the most effective treatment of diseases for each patient. Human induced pluripotent stem cells-based organoids MAP provides an ideal model to address fundamental questions of molecular organogenesis and pathogenesis. In addition, patient-derived organoids can recapitulate patient responses and help personalized medicine. Current development of mini-brains MAP, pancreatic islets MAP, kidney organoids MAP, and cancer organoids MAP will be discussed. Smart SANDs and organoids MAPs by the convergence of biology, chemistry, physics, and engineering will impact on quantitative life sciences and precision medicine.

Biography:

Prof. Luke P. Lee received both his BA in Biophysics and PhD in Applied Physics and Bioengineering from UC Berkeley. He joined the faculty at the UC Berkeley in 1999 after more than a decade of industry experience. He became the Lester John and Lynne Dewar Lloyd Distinguished Professor of Bioengineering in 2005. He also served as the Chair Professor in Systems Nanobiology at the ETH Zürich from 2006 to 2007. He became Arnold and Barbara Silverman Distinguished Professor at Berkeley in 2010. He founded the Biomedical Institute for Global Healthcare Research & Technology (BIGHEART) and served as Associate President (International Research and Innovation) and Tan Chin Tuan Centennial Professor at the National University of Singapore from 2016 to 2018. He is the founding director of Institute for Quantum Biophysics, Sungkyunkwan University, Korea. He is a Fellow of the Royal Society of Chemistry and the American Institute of Medical and Biological Engineering. His work at the interface of biological, physical, and engineering sciences for medicine has been recognized by many honors including the IEEE William J. Morlock Award, NSF Career Award, Fulbright Scholar Award, and the HoAm Prize. Lee has over 350 peer-reviewed publications and over 60 international patents filed. His current research interests are quantum biological electron tunneling (QBET) in living organisms, integrated smart optical system (iSOS) for the early detection of infectious diseases, cancer, and neurodegenerative diseases, and in vitro neurogenesis, and solving ill-defined problems of global healthcare.