Discovery and Implementation of Comprehensive Biosignatures for Transforming Healthcare

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Everyone has the goal of living a long, healthy life. Our society aspires to chronic health. Biosignatures would foster a dramatically new health care system: one that focuses on keeping healthy people healthy and reducing the time sick people spend in hospitals and in clinical care. The goal is to enable the prediction of disease risk-vectors and the prevention of disease, with pre-symptomatic diagnosis and interventional therapeutic treatment of individuals based upon their personal biosignature – all the information about an individual (genomic, proteomic, cellomic, imaging, behavior, and other information) that enables prediction of disease predisposition and future health status.

This presentation will address the key challenges to discovering and implementing biosignatures in a nation-wide health care program. Specifics will be provided on single-cell biosignatures, including the quantification of physiological and morphological manifestation of underlying gene and protein alterations in disease. Novel technologies presented include 3D single-cell optical computed tomography, the Cell-CT, and a high-throughput microfluidic array for single-cell metabolic measurements, the Cellarium. Examples will be provided for lung cancer, esophageal cancer, and breast cancer. Successful implementation of biosignatures in a nation-wide health care program will require high-throughput automation for biosignature discovery, clinical validation, standardization, and qualification for use in pre-symptomatic diagnoses, drug development research, commercialization, and patient management for healthy patient outcomes.

Dr. Meldrum is the Director of the Center for Biosignatures Discovery Automation (CBDA) in the Biodesign Institute, and Professor of Electrical Engineering at Arizona State University. She was PI of the NIH Center of Excellence in Genomic Sciences: Microscale Life Sciences Center (2001–13). As Dean of the ASU Ira A. Fulton Schools of Engineering (2007–10), Meldrum transformed the engineering school into an organization fully aligned with the U.S. grand challenges. Prior to that, she was Professor of Electrical Engineering and Director of the Genomation Laboratory at the University of Washington (1992–2006). At the Jet Propulsion Laboratory (1985–7), she worked on the Galileo spacecraft, large flexible space structures, and robotics. With the NASA Johnson Space Center (1980–1), she was an instructor for the astronauts on the Shuttle Mission Simulator. Her research interests include single-cell analyses, genome automation, microscale systems, biosignatures, ecogenomics, and robotics. Her honors include: NIH Special Emphasis Research Career Award (1993); Presidential Early Career Award for Scientists and Engineers (1996); AAAS Fellow (2003); IEEE Fellow (2004); member of the National Advisory Council for Human Genome Research (2006–8, 2011–present); member of the advisory board for Microsoft Research Connections (2007–13).

Cell-CT (computed tomography) images of fixed cells progressing from normal cell (far left, top row) to invasive cancer cell (far right, bottom row).