

44THNAFF Symposium

Bioelectrochemistry and Biocatalysis

March 23, 2018

chem.as.uky.edu/naff-symposium



SCHEDULE OF EVENTS

8:00 a.m.

Registration & Continental Breakfast Alumni Gallery, Room 1-65, W.T. Young Library

8:50 a.m.

Welcome President Eli Capilouto UKAA Auditorium, room 1-62, W.T. Young Library

9:00 a.m.

Prof. Richard M. Crooks University of Texas at Austin UKAA Auditorium, room 1-62, W.T. Young Library

"Quantitative Electrochemical Detection of Analytes at Sub-Picomolar Levels Using a Simple Paper Sensor"

The objective of the project described in this presentation is the creation of new, low-cost, appropriately sensitive paper universal diagnostic devices for the electrochemical detection of analytes ranging from biological weapons to DNA to biomarkers characteristic of organ failure in the human body. To satisfy this objective, we initiated development of a quantitative sensor using a magnetic microbead supported silver nanoparticle metalloimmunoassay. The sensor integrates picomolar affinity antibodies (or DNA) with an easily handled, but sophisticated, electrochemical detection platform. This device exhibits quantitative detection of analytes present at sub-picomolar levels using non-enzymatic signal amplification. The focus of this talk is detection of a heart failure marker called NT-proBNP. The total assay time is ≤ 5 min and the cost is \sim \$0.30/sensor (not including reagents).

10:00 a.m. Coffee Break & Refreshments

10:30 a.m.

Prof. Shelley Minteer University of Utah UKAA Auditorium, room 1-62, W.T. Young Library

"Enzymatic Bioelectrocatalysis: From Metabolic Pathways to Metabolons"

Oxidoreductase enzymes have been employed for almost 5 decades in biosensors and for energy conversion in the form of biofuel cells. However, most enzymatic bioelectrodes in the literature utilize complex biofuels (e.g. glucose), but only partially oxidize the complex biofuel via the use of a single enzyme (i.e. glucose oxidase or glucose dehydrogenase). This presentation will detail the use of enzyme cascades at bioanodes for deep to complete oxidation of substrates to improve performance (current density and power density), but will focus on the importance of forming metabolons for substrate channeling in multi-enzyme cascades. These enzyme cascade will include natural metabolons (i.e. the Kreb's cycle) and artificial metabolons utilizing DNA as a scaffold. It will discuss the importance of structural orientation of enzymes and enzyme complexation in enzymatic cascades for efficient bioelectrocatalysis.

11:30 a.m. Lunch & Break

1:00 p.m. Prof. James Rusling

University of Connecticut UKAA Auditorium, room 1-62, W.T. Young Library

"Microfluidic Arrays for Protein-Based Cancer Diagnostics and Toxicity Screening"

This lecture will describe low cost microfluidic arrays for reliable, ultrasensitive measurement of protein biomarkers for cancers diagnostics. High sensitivity and low LODs are achieved by combining massive labeling with nanostructured immunoarrays sensors. Microfluidic reagent and sample delivery systems are fabricated by precision cutting, molding or 3D printing. Sensitivities 1000-fold better that most commercial protein assays have been achieved. Similar technology was used to detect reactions of metabolites with DNA related to genotoxicity, i.e. chemical pathways that damage DNA. These arrays feature ECL detection and enzyme/DNA/metallopolymer films that form and identify reactive metabolites of test chemicals. Subsequent mass spectrometry on damaged DNA and tumor suppressor genes provide detailed information on reactive codons and toxicity pathways.

2:00 p.m.

Prof. David Cliffel Vanderbilt University UKAA Auditorium, room 1-62, W.T. Young Library

"Electrochemically Instrumenting Organs on a Chip"

The replacement of animal testing in toxicology assays with integrated organs on a chip is a major goal of the Human Microphysiological Systems initiative. In order to readout physiological changes in these organs in real time, we have built a multianalyte microphysiometer that detects multiple analytes involved in the cellular bioenergetics simultaneously. Metabolic processes such as glycolysis, mitochondrial ATP generation, and glycogenesis are all directly related to the flux of these analytes. Temporal resolution of metabolic responses is much faster than conventional well-plate studies, leading to dynamic metabolic data. By combining all of the information contained in the multianalyte "biosignature" we can observe metabolic pathway shifting from aerobic to anaerobic metabolism, the depletion of internal energy stores, and the dynamic decoupling of metabolic parameters. The adaption of this technology to instrumenting organs-on-a-chip is currently underway.

3:30 p.m.

Poster Session 2nd & 3rd Floors, Don & Cathy Jacobs Science Building

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GUEST SPEAKERS



PROF. RICHARD M. CROOKS University of Texas at Austin

Richard M. Crooks received B.S. and doctoral degrees in chemistry from the University of Illinois and The University of Texas at Austin. His independent career has been split between Texas A&M University and UT-Austin, where he is presently holds the Welch Chair in Materials Chemistry. His research program focuses on biosensing and electrocatalysis.



PROF. JAMES RUSLING University of Connecticut

James F. Rusling was awarded a B.Sc. in Chemistry from Drexel University in 1969, and Ph. D. from Clarkson University in 1979. He is Professor of Chemistry at University of Connecticut, and Professor of Surgery and member of the Neag Cancer Center at UConn Health Center, as well as adjunct Professor of Physical Chemistry at National Univ. of Ireland. Galway. Current research includes developing new cancer diagnostic devices for detection of biomarker proteins and peptides, low-cost 3D printed immunoarrays for point-of-care diagnostics, electrochemical and mass spectrometric arrays for toxicity screening, tumor suppressor gene damage, and fundamental bioelectrochemistry. He has authored over 400 research papers and several books, and is also a musician interested in traditional Irish and old time American folk styles.



PROF. SHELLEY MINTEER University of Utah

Dr. Shelley Minteer is a USTAR Professor in both the Departments of Chemistry and Materials Science and Engineering at the University of Utah. She received her PhD in Analytical Chemistry at the University of Iowa in 2000 under the direction of Professor Johna Leddy. After receiving her PhD, she spent 11 years as a faculty in the Department of Chemistry at Saint Louis University before moving to the University of Utah in 2011. She was also a Technical Editor for the Journal of the Electrochemical Society from 2013-2016 and is now an Associate Editor for the Journal of the American Chemical Society. She has published greater than 300 publications and greater than 400 presentations at national and international conferences and universities. She has won several awards including the Luigi Galvani Prize of the Bioelectrochemical Society, the Missouri Inventor of the Year, International Society of Electrochemistry Tajima Prize, Fellow of the Electrochemical Society, and the Society of Electrocanalytical Chemists' Young Investigator Award. Her research research interests are focused on electrocatalysis and bioanalytical electrochemistry. She has expertise in biosensors, biofuel cells, and bioelectronics.



PROF. DAVID CLIFFEL Vanderbilt University

David E. Cliffel, Cornelius Vanderbilt Professor and Chair, Department of Chemistry, Vanderbilt University, directs an innovative research effort in instrumental design and electroanalytical methods applied to nanotechnology and biotechnology. He is the deputy director in the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE), and the Technical Editor for Physical and Analytical Electrochemistry, Electrocatalysis and Photoelectrochemistry for the Journal of the Electrochemical Society. He was a member of the Board of Directors for SEAC from 2011-2016, and is the Treasurer-elect. He received his Ph.D. in analytical chemistry from UT-Austin under the direction of Allen J. Bard in 1998, was a post-doctoral assistant with Royce W. Murray at UNC-Chapel Hill, and joined Vanderbilt University in September 2000.



Professor Doo-Young Kim (Chemistry, Committee Chair), dooyoung.kim@uky.edu Professor Marcelo Guzman (Chemistry) Professor Jason DeRouchey (Chemistry) Professor Chad Risko (Chemistry) Professor Chris Richards (Chemistry)



For more information, contact Dr. Doo-Young Kim at dooyoung.kim@uky.edu.