



Center for the Study of Systems Biology

Distinguished Lecture Series in Systems Biology



Boris Mizaikoff, Ph.D.
 School of Chemistry and Biochemistry
 Georgia Institute of Technology

"From Systems Biology to Systems Analytics - Seeing More by Looking at Less"

By: Boris Mizaikoff and Christine Kranz

Abstract: Systematic analysis of interactions between molecules and biological entities requires the development and application of experimental tools and analytical methods to quantitatively measure and image molecular events, molecular pathways, and molecular signals at the level of individual cells, ensembles of small biological entities, and entire organisms with the required molecular selectivity, sensitivity, and temporal/spatial resolution. While it is evident that current analytical techniques are frequently limited to averaged measurements or *ex-situ* analysis, the analytical challenges for *in-situ* multi-parametric characterization of living biological entities such as cells, microbes, bacteria, or ensembles thereof remain significant. Hence, in analogy and complementary to Systems Biology concerned with deciphering complex molecular processes and their relation to biological functionalities, we view Systems Analytics as the toolbox enabling the quantitative determination of multiple molecular parameters to elucidate these interactions and relations.

From the analytic chemistry point of view, we may describe individual cells as a measurement compartment with spatial/volume dimensions in the $\mu\text{m-nm}/\mu\text{L-nL}$ range, and quantitative molecular dimensions in the mM-nM domain. The spatial dimensionality of molecular events within or at cellular compartments (e.g. vesicular processes) or at the cell surface (e.g. exo- or endocytosis) along with the magnitude of the local species concentration determine the need for quantitative analytical measurements at the micro- and nanoscale. We will discuss the diversity of measurement challenges at these compartments, which include the small dimensions of the involved samples and volumes, the complex and frequently changing background matrix, the sensitivity and/or discriminatory power of *in-situ* analytical techniques, and their temporal and/or spatial resolution to quantitatively monitor dynamic processes associated with cellular functions. In turn, individual optical/spectroscopic, electrochemical, and surface sensitive analytical techniques have already demonstrated their potential at the macro- and microscopic level, i.e. identifying which molecular species are present, their concentration, their location, and – ideally - the kinetics/dynamics of the involved molecular processes.

In contrast to approaches utilizing individual analytical techniques, the development of generic multifunctional analytical platforms orchestrates a suite of complementary measurement techniques to cooperatively investigate complex biological systems, complemented by the development of (bio)sensing chemistries, synthetic molecular receptors, multivariate evaluation techniques, and micro/nanofabrication for functional system miniaturization. Thereby, we capitalize on the benefits of several analytical techniques addressing the conformational, electrochemical, and spectroscopic properties of the sample leading toward simultaneous rather than the classical sequential information acquisition process, aiming at maximizing the synchronicity between multiple methods in the temporal and spatial domain.

11:00 AM, Tuesday, October 9, 2007
 Klaus Advanced Computing Building
 Room 1116W

Sponsored by:

