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Finding Origins of Life in Ancient Biological Electric Wiring

Speaker: **Yana Bromberg, Ph.D.**
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Date: **Wednesday, October 6, 2021**

Time: 7:00 PM (Zoom link available from 6:45 PM).

Place: Zoom-only Meeting, link.

Abstract:
How did life appear on our planet? Alexander Oparin's 1924 theory of abiotic evolution of carbon-based molecules in a primordial soup suggests a means to the end. However, the evolutionary path beyond formation of individual molecules remains one of the most profoundly unanswered questions in biology. Although the first self-replicating biological molecules were possibly the catalytic RNA fragments, *i.e.* ribozymes, propagating these ribozymes requires energy. Biologically catalyzed redox reactions, *i.e.* proton coupled electron transfer, drive the energy requirements of all life on Earth. This observation implies that redox reactions must have been among the first (if not *the* first) functionalities acquired by early life. Hence, understanding the evolution of oxidoreductases, *i.e.* the enzymes responsible for the catalysis of redox reactions, potentially can elucidate the origin of life.

We aimed to explore the patterns of evolution of oxidoreductases. We found that the peptide structures that bind transition metals, ubiquitous in redox, have similar topology across the full diversity of exiting proteins. Moreover, similarity between these structures reflects the environmental (read: Archaean Ocean) availability of key transition metals over geological time – a fossil record of sorts. It also strongly suggests that metal binding had a small number of common origins. We also observed that metal-binding structures central to our network of structural similarities came primarily from oxidoreductases, further confirming the idea that ancestral peptides facilitated electron transfer reactions. Finally, our results suggest that the earliest, biologically-functional peptides were likely available prior to the assembly of the first fully functional protein domains over 3.8 billion years ago.

The work that will be described in this session was performed under the auspices of the ENIGMA (Evolution of Nanomachines In Geospheres and Microbial Ancestors) project

Tools of Science details ENIGMA research plans in a short You Tube video:
https://www.youtube.com/watch?v=DGTPPy2fNyc

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Dr. Yana Bromberg is a Professor in the Department of Biochemistry and Microbiology, and an adjunct Professor in the Department of Genetics, at Rutgers, the State University of New Jersey. She is also a fellow of the Institute for Advanced Study at the Technical University of Munich, Germany, and the vice-president of the International Society for Computational Biology.

Dr. Bromberg received her Bachelor degrees in Biology and Computer Sciences from the State University of New York at Stony Brook and a Ph.D. in Biomedical Informatics from Columbia University, New York. She is known for her seminal work on a machine learning-based method for screening for effects of genetic variation (SNAP). This work has led to Dr. Bromberg's current interests in the analyses of human genomes and associated microbial metagenomes for disease predisposition. Broadly, research in the Bromberg lab is focused on the molecular functional annotation of genes, genomes, and metagenomes in the context of specific environments and diseases. The lab also studies evolution of life's electron transfer reactions in Earth's history and as potentially applicable to other planets – a topic that she will discuss today. Dr. Bromberg is frequently invited to talk about her research in conferences all over the world and has, to-date, co-authored over 80 peer reviewed scientific articles. Her work has been recognized by numerous awards, including the NSF CAREER award, the Rutgers Board of Trustees Research fellowship for Scholarly Excellence, the PhRMA foundation young investigator research starter award, and the Hans-Fischer award for outstanding early career scientists. The work has also been funded by various agencies including the NSF, NIH, NASA, and a number of private foundations.

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