The 3M University Lecturer in Chemistry 2001-2002

Robert R. Birge

Harold S. Schwenk Sr. Distinguished Professor of Biological Chemistry
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Bob Birge received his B.S. degree in chemistry from Yale University in 1968, his Ph.D. in chemical physics from Wesleyan University in 1972, and was a National Institutes of Health postdoctoral fellow at Harvard University from 1973-1975. He was an Assistant and subsequently a tenured Associate Professor of Chemistry at the University of California, Riverside (1975-1984), and then served as Professor and Head of the Chemistry Department at Carnegie Mellon University (1984 - 1987). He joined the faculty at Syracuse University in 1988 where he was Distinguished Professor of Chemistry and Physics, Director of the W. M. Keck Center for Molecular Electronics, and Research Director of the New York State Center for Advanced Technology in Computer Applications and Software Engineering. In January 2000, he joined the faculty at UConn where he holds the Harold S. Schwenk Distinguished Chair in Biological Chemistry. He continues as a University Professor and Director of the W. M. Keck Center at Syracuse, and maintains research groups at both UConn (molecular biology and spectroscopy) and Syracuse (Protein Devices). He has served on the editorial advisory boards of four journals and has co-chaired advisory panels for the NIH and the National Academy of Sciences. His research is supported by the NIH, NSF, AFOSR, ARO, the W. M. Keck Foundation and four US companies. In 1997, he was listed among the fifty "Cyber Elite" by Time Digital for his work on protein-based devices, and the use of these devices for computer memories and processors. [He was ranked 26th, behind Bill Gates (#1) and Steve Jobs (#24), but ahead of Steven Spielberg (#28) and George Lucas (#33).]

Professor Birge will present three lectures during his visit to UWO.

All lectures will be in Room 193 Medical Sciences Building

Monday, March 11, 2002 3:00 p.m.

1. ***Protein-Based Three-Dimensional Memories***

Molecular electronics offers a powerful and cost-effective path towards computer miniaturization and the generation of neural and three-dimensional architectures. Bioelectronics investigates the use of native and genetically modified biomolecules and offers advantages because nature has often solved many of the key problems through evolution and natural selection. This presentation will explore the use of the protein, bacteriorhodopsin, in optical three-dimensional memories. These memories store information using volume elements (voxels), and provide as much as a thousand-fold improvement in effective capacity over current technology. A unique branching reaction of a genetically engineered protein is used to turn each protein into an optically addressed latched AND gate. The use of site directed mutagenesis and directed evolution to optimize the protein for data storage will also be discussed. Although three working prototypes have been developed, a number of cost/performance and architectural issues must be resolved prior to commercialization.

Tuesday, March 12, 2002 3:00 p.m.

2. ***Large-scale Associative Memories and Artificial Intelligence***

The human brain stores and retrieves information via association. Human intelligence is intimately connected to the nature and enormous capacity of this associative search and retrieval process. Creativity can be viewed as the association of two seemingly disparate concepts to form a totally new construct. Humor can be traced to resonant association across experiential boundaries, and can be appreciated by examining why some bumper stickers are funny while others are not. But computer programs have trouble deciphering bumper stickers and remain incapable of true artificial intelligence. One problem is that current computer hardware does not provide an optimal environment for creating artificial intelligence. The source of the problem is the serial nature of random access memories, and software cannot provide a satisfactory work-around that does not introduce unacceptable latency. This talk will focus on the design and construction of large-scale, protein-based associative memories and the potential use of these memories to create artificial intelligence.

Wednesday, March 13, 2002 3:00 p.m.

3. ***The Nature of the Chromophore Binding Sites of Cone Pigments***

It is generally believed that the photoreceptor systems of the three phyla with image resolving eyes, mollusks, arthropods and vertebrates, evolved independently. And yet all three have selected the identical chromophore, 11-cis retinal, as the photoactive component for both scotopic (dim light) and photopic (color) vision. This observation is all the more surprising because the absorption spectra of the cone pigments extend from the ultraviolet to the far red of the visible spectrum. Apparently, nature has converged on both an optimal chromophore but also the means to tune this chromophore so that it absorbs light across a large energy band. Of particular interest are the blue and violet cone pigments, because their wavelength selection mechanism is the most difficult to understand. In this talk we will examine how the protein tunes the bound chromophore to achieve absorption in the uv and blues while simultaneously maintaining a high photochemical quantum yield. Our studies have focused on two short wavelength cone opsins, frog (*Xenopus laevis*) violet and mouse UV. The Xenopus violet cone (VCOP) is a close evolutionary cousin of the human blue cone, and has a nearly identical absorption maximum at 425 nm. By studying over forty site directed mutants and chimera, we have mapped the primary mechanisms of wavelength regulation in both pigments. Our results provide an interesting window into how nature can simultaneously optimize both wavelength and photochemical behavior.

Refreshments served before talks

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