Princeton University

Honors Faculty Members
Receiving Emeritus Status

June 2008

The biographical sketches were written by
colleagues in the departments of those honored.

Contents

Faculty Members Receiving Emeritus Status

John Joseph Hopfield

John Hopfield has made major contributions to all three of the major disciplines of modern science: physics, chemistry, and biology. His special and rare gift is his ability to cross interdisciplinary boundaries to discover new questions and propose answers that uncover the conceptual structure behind the experimental facts.

John's outstanding contribution to physics was a series of brilliant joint papers with D. G. Thomas that formed the basis of understanding of the optical spectroscopy of II-VI semiconductors in the late 1950s. Their work on the spectra of excitons, their interactions with photons, and the effects of electric and magnetic fields was a tour de force at the time: a complicated spectroscopy was quantitatively interpreted in terms of conduction electrons bound to associated holes in what amounts to a hydrogen atom. For this work he and Thomas, his experimental collaborator, were awarded the Buckley Prize, the field's most prestigious award, in 1969. One of the consequences of this work was the founding of an industry: semiconductor light-emitting diodes (LEDs) that have become ubiquitous. It is worth noting also that at Princeton, John trained a number of extraordinary students who have become leaders themselves: among them G. D. Mahan, whose thesis began the fertile subject of Fermi surface anomalies in spectra, and S. M. Girvin and Bert Halperin.

John and his collaborators made a major contribution to chemistry by their simple, yet quantitative explanation of the role of cooperativity in the binding of oxygen atoms to hemoglobin. In retrospect, it seems that this work was underestimated in favor of the then-current ideas of Max Perutz; in the fullness of time it appears that their conclusions are closer to the modern view of protein action than those of Perutz.

John's contributions to biology are two-fold, both characterized by great originality of insight and, like the semi-conductor work, the basis of entirely new ways of thinking about basic issues. The principle of "kinetic proofreading" is one of the truly profound conceptual discoveries of molecular biology. In this idea, he showed for the first time how it is possible that replication and translation of nucleic acids manages to use stored energy to achieve accuracy far beyond that possible in an equilibrium process. In collaboration with Shulman's group, this idea was checked experimentally, and remains one of the central theoretical achievements of molecular biology.

John's remaining major contributions to biology have been in the field of neural processing. The Hopfield neural net was not only an intriguing demonstration of possibility and a proof by demonstration of the information-handling capabilities of neural nets, but also was an enormous stimulant in reviving the perceptron and other machine-learning programs. More recently, he found an entirely different organizing principle for olfaction, and has demonstrated a new principle in which neural function can take advantage of the temporal structure of the "spiking" interneural communication.

John has been a recipient of many awards and honors, including the MacArthur Award, the Dirac Medal, and the Buckley Prize.

John's colleagues admire him for his ability to think broadly as well as deeply about science. His wisdom and insight about the conceptual structure that must lie behind the experimental facts as we observe them are legendary. Indeed, he remains one of the very few "theoretical biologists" who functions in relation to his field as a true theorist. John continues to be a wonderful example to others.