

VII. Interdisciplinary Research - Fusing the envelopes of knowledge from different disciplines

The faculty, with the support of Arizona State University, believe that future creative ideas will flow from the interaction among areas that were once considered distinct disciplines. The cross-disciplinary understanding of approaches, paradigms, vocabulary, and limitations will lead to creativity, new technologies, and new science. Arizona State University has many examples of this merging among disciplines. A few examples are listed below.

PHOTOSYNTHESIS CENTER

The ultimate scientific objective of the Center, elucidation of the basic principles governing the biochemical and biophysical processes of photosynthetic energy storage, is being realized through investigation of the most significant early events of photosynthesis, including: light absorption and excitation transfer in photosynthetic antennas, the mechanism of primary photochemistry in plant and bacterial systems, secondary electron transfer processes, structure and assembly of photosynthetic complexes and electron transfer proteins, pigment-protein interactions and the mechanisms of biological electron transfer reactions. In addition, several research groups are exploring artificial, biomimetic photosynthetic systems in order to both learn more about the natural process and find ways to apply the photochemistry of natural photosynthesis to other areas of science. These topics are studied using techniques and approaches ranging from molecular biology and biochemistry to physical and organic chemistry, ultrafast laser spectroscopy, X-ray crystallography, electron spin resonance, nuclear magnetic resonance and theoretical chemistry.

<http://photoscience.la.asu.edu/photosyn/>

WHITAKER FOUNDATION AWARD/DEPARTMENT OF BIOENGINEERING

A \$3 million grant from the Whitaker Foundation for the bioengineering program in CEAS was announced recently. The innovative project has created new links for Arizona State University with medical institutions and with local medical device and biomedical companies. The award established curricula in Neuroengineering and in Molecular, Cell and Tissue Engineering. This initiative has initiated many collaborative research interactions as well as multi-disciplinary grants among engineers and life scientists as well as at the regional research institutions.

Along with the Whitaker funding, ASU will receive \$230,000 from ASU's biology programs for a biotechnology instructional laboratory. The Harrington Arthritis Research Center is transferring the 1.5 million Olin Endowed Chair in Bioengineering to ASU along with \$400,000 for laboratory facilities for the Olin Endowed Chair and two graduate assistantships. The Mayo Clinic Scottsdale and the Barrow Neurological Institute will contribute \$100,000 each toward seed funding for collaborative research projects and will allow students to access core research laboratories. The Neurosciences Institute in LaJolla, California will participate by helping ASU develop a special course

for pre-doctoral students focused on significant problems in neuroscience.

<http://www.eas.asu.edu/~bme/>

MUSCULOSKELETAL AND NEURAL ADAPTIONS (IGERT AWARD)

Several faculty members at Arizona State University were recently awarded a grant under the prestigious Integrative Graduate Education and Research Traineeship Program (IGERT) at the National Science Foundation. From the NSF's description of the program, the IGERT was "developed to meet the challenges of educating Ph.D. scientists and engineers with multidisciplinary backgrounds and the technical, professional, and personal skills needed for the career demands of the future."

The theme of ASU's IGERT submission was musculoskeletal and neural adaptations in form and function, examined with integrated approaches from bioengineering, neurophysiology, physical anthropology, exercise sciences, computer and system sciences. The goal of our program is to introduce students with diverse biological and engineering backgrounds to the challenges involved in deciphering complex phenomena in integrative and computational neuroscience, motor disorders and rehabilitation. Our program fosters interdisciplinary education and training in research efforts designed to meet these challenges. <http://www.eas.asu.edu/~bme/>

CENTER FOR THE STUDY OF STRESS AND ADAPTATION

This multi-disciplinary center within the Arizona Biomedical Institute conducts basic research on social, biomedical and environmental aspects of stress and adaptation in order to identify and effect outcomes to improve health, safety, and the quality of life. Researchers have recognized that stress and adaptation are critical processes that have important consequences for medicine, health, quality aging and society at large. The Center was established to attract large-scale support from the community, federal agencies, and industry for programs emphasizing multi-disciplinary approaches. The approach of the Center is: 1) To provide an environment for collaborative advances in understanding the mechanisms and consequences of stress at the cellular and molecular, individual and societal levels. 2) To encourage interdisciplinary collaborations to understand individual differences in how stress perturbs the complex, reciprocal interactions between cognition, affect and behavior. 3) To develop strong, collaborative interactions with the local biomedical community. 4) To translate basic research into practical interventions for clinical practice, behavior, and environmental and health policies for the benefit Arizonans.

ADVANCED NEURAL IMPLANTS AND CONTROL

This multi-disciplinary project involves engineers, biologists, mathematicians, computer scientists, material scientists, and microdevice technologists to develop the next-generation of neuroprosthetic systems. This approach will emphasize adaptive control-of tissue responses to neural implants utilizing underlying neural computation, and external signal processing. The initial objective is to develop new implant technologies that optimize information transmission across the tissue/device interface. Results from these experiments will be employed for the rational design of a new class of flexible, polymer-substrate implantable microdevices. These microdevices will actively sense and control the induced biological responses in an effort to improve long-term

biocompatibility and enable the control of neural plasticity effectively making a “smart electrode.” Additionally efforts will be directed to optimize information processing between the external world and the neural system that is accessed through the neural interface. This involves developing new classes of adaptive, real-time controllers that optimally decode or encode neural signals for both a particular "problem-space", and a neural interface that may have information channels with time-varying characteristics. These efforts focus on two classes of problems that require a high-capacity neural interface: (1) Robust direct-brain control of an external actuator in the presence of significant perturbations, and (2) Detection of novel external stimuli using neural recordings from selected regions of the brain.

3-DIMENSIONAL KNOWLEDGE

At PRISM, we are developing a knowledge network for the acquisition, representation, query, and analysis of 3D knowledge (3DK) in a distributed environment. Our premise is that most 3DK is inherent in and derivable from 3D geometric structures and is integral to a wide variety of scientific applications. The 3DK network will advance research of three-dimensional objects in the target areas of Bioscience, Biotechnology and Anthropology. We are developing a software library KERNEL, tools for DATA ARCHIVING and an internet-accessible INTERFACE to enable a user to construct a customized 3D shape browser search engine. Test bed projects include Shape characterization of archaeological artifacts (BONES, POTS, LITHICS); Shapes and forms of intra-cellular bio-molecular machines to gain insight into their functions (CELLS, BIO-STRUCTS) and Spatial symmetry in phenomena observed in experimental simulations in Plant Biology (DIATOMS). Please visit our web page from time to time to see new developments, publications, activities and other news.

<http://3dk.asu.edu/home.html>