NIH project grants boost cardiovascular bioengineering at UCSD

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NIH RESEARCH AND TRAINING GRANTS BOOST CARDIOVASCULAR BIOENGINEERING AT UCSD

The bioengineering faculty in the Division of Engineering at the University of California, San Diego have received a five- year, $5.6 million Program Project Grant (PPG) from the National Heart, Lung and Blood Institute to develop fundamental knowledge that will help improve the diagnosis and treatment of cardiovascular and blood diseases.

The Bioengineering Group has also been awarded a $1.6 million graduate student and postdoctoral training grant for the same period.

The PPG consists of seven interrelated research projects and five core units, organized to elucidate the biomechanics of blood cells, blood vessels and microcirculation.

The program researchers will employ multidisciplinary approaches ranging from experimental molecular and cell biology methods to mathematical models and computer graphics.

"The experiments will be subjected to computational analysis, and serve as the basis of theoretical modeling," notes Shu Chien, UCSD professor of bioengineering and medicine, who will direct the PPG.

Chien, a leading authority in blood rheology (deformation and flow), came to UCSD two years ago from Columbia University, where he had been professor of physiology and director of the Division of Circulatory Physiology and Biophysics. At Columbia he directed another PPG on human blood cell membranes. When Chien left for San Diego, some of his co-investigators chose to accompany him.

"Many of us have been working together for 15 years or more," says Chien. "I think we have generated many new ideas and produced some significant results." In addition to Chien, the principal investigators of the PPG projects and cores are: Y.C. Fung, R. Hoffman, A. McCulloch, G.W. Schmid-Schoenbein, R. Skalak, L.A. Sklar, K.L. Paul Sung, L.P. Amy Sung and S. Usami.

The sequence of projects reflects the diverse inter-disciplinary backgrounds of the researchers, and proceeds from molecular biology and cell biology to rheology of single cells and cell interactions. These studies are followed by theoretical modeling and analysis, and finally in vivo studies on the microcirculation -- the part of the blood system composed of tiny blood vessels less than one-tenth millimeter in diameter, connecting the veins and the arteries.

"The end result will be very visual," says Chien. "The computer models of the blood flow will imitate exactly what is taking place in the body."

One specific study topic, for example, will be blood cell aggregates, or cell-cell adhesion. In the experimental phase, two cells will be forced together by using two micropipettes, each holding one cell. If the cells have proper

surface molecules, they will stick together, and force is required to move them apart. Mathematical modeling is needed to decide the amount of energy that holds the cells together.

"We have to look at the geometry of the cell at the interface and the mechanical properties such as elasticity and viscosity," says Chien. "In the end we come up with realistic computerized graphic presentations. The results are then compared with the experimental observations made under a microscope." Chien believes this approach, in addition to "opening up new things," also improves the efficiency of experiments.

A bioengineering approach to the study of blood circulation is relatively new. "By combining engineering, physiology, cell biology and molecular biology we are able to fully utilize the strengths of these disciplines," says Chien.

The Bioengineering Group at UCSD was initiated in 1967, and is part of the Department of Applied Mechanics and Engineering Sciences in the Division of Engineering. The bioengineering faculty includes several renowned researchers, among them Y.C. Fung, generally regarded as "the father of modern biomechanics."

The Bioengineering Group has more than 40 graduate students, of whom more than half are supported by grants. "The NIH doctoral training grant is very helpful," noted Chien. The grant is a continuation of an earlier training program directed by Y.C.

Fung, and will support 14 graduate students and six postdoctoral fellows.

At a time when NIH funding is increasingly difficult to obtain, "these grants will allow us to continue and amplify our efforts," says Chien. "And more important, pull together our resources around a common theme. The total result will be much stronger than the sum of the individual efforts."

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