Louisiana EPSCoR
Experimental Program to Stimulate Competitive Research
Volume 4
Number 2
Feb. 2007

Researchers Cross Boundaries with Human Genome Projects

It was on October 1, 1990, that the Human Genome Project — one of the greatest scientific undertakings in history — officially began in the U.S. Dr. Steven A. Soper, who had been awarded his Ph.D. in bioanalytical chemistry the year before, was a post doctoral researcher at the Los Alamos National Laboratory Human Genome Center.

"I was fortunate to be on the front end of human genome research, which at the time was such a challenge technically and scientifically that it fascinated and enthralled me then and still does," says Dr. Soper, who now heads Louisiana's Center for BioModular Multi-Scale Systems (CBM^2). The multi-million dollar research project was funded in 2004 through the National Science Foundation's Louisiana EPSCoR program and Louisiana Board of Regents (BoR).

CBM^2's research includes the development of numerous systems for the Human Genome Project that span a wide spectrum — from the creation of new molecular diagnostic tools to the development of new DNA fingerprinting technology — and cross the boundaries between micro- and nanotechnology, biology and engineering, medicine and homeland security.

Dr. Soper left Los Alamos in 1991 to join the Louisiana State University and A&M College (LSU) faculty as an assistant professor of chemistry. By 1998**,** he and two of his LSU colleagues — Dr. Robert Hammer, now the William A. Pryor Professor of Chemistry and Dr. Richard Bruch, now Associate Chair and Director of Undergraduate Studies, Department of Biological Sciences — had successfully decreased the size of the device that sequenced DNA, the building blocks of the human genome, from a box the size of a one-drawer filing cabinet to a one-inch square piece of Plexiglas.

The procedure also reduced the time required to sequence DNA from 120 to 10 - 20 minutes, reduced the quantity of required chemicals by 1,000 percent, and significantly decreased the cost.

In 2003, new techniques developed by Dr. Soper and his research group were featured in the May 5 issue of the American Chemical Society's *Chemistry.org* where they were hailed for what "could be an important contribution to the effort to map the human genome."

"We had developed an assay with which we could obtain information on the presence of point mutations with high diagnostic value for a variety of diseases in genomic DNA in less than five minutes, nearly 20 times faster than using conventional instrumentation," he says.

"Using an X-ray beam to cut tiny channels in plastic wafers, we also miniaturized the machines that identified DNA fragments for forensic applications. This new procedure was capable of analyzing DNA much faster than current technologies and at one-hundredth of their cost."

Dr. Steven Soper in the CBM^2 *DNA sequencing laboratory with graduate student Jason Emory.*

Explaining why increasing speed and accuracy while decreasing the cost of sequencing DNA are of especial importance, Dr. Soper points out that the Human Genome Project is dedicated to 1) discovering all of the roughly 40,000 human genes that make up the human genome, 2) determining the complete sequence and function of each set of genes in the three-billion base set of human chromosomes and 3) understanding how errors in these genes can give rise to certain diseases.

Technology Emphasis

CBM^2's technology emphasis is directed toward building enabling systems consisting of micro- to nanoscale structures and the use of novel materials for diagnostics, forensics and drug discovery in conjunction with LSU's Center for Advanced Microstructures and Devices.

"A team of CBM^2 researchers focusing on capturing rare tumor cells in circulating blood that carry cell surface markers associated with breast cancer have developed a device that can pre-select and quantitatively count tumor cells with high efficiency," notes Dr. Soper. "This integrated device, which will have important ramifications for the early diagnosis and management of breast-cancer patients, can also be used for screening water-born bacteria and viruses."

Center investigators are also 1) developing a pathogen detection system that could have homeland security applications by providing real-time molecular signatures of suspected biopathogens, 2) developing point-of-care molecular diagnostic tools, and 3) producing a miniaturized device for fast, low-cost DNA genotyping that allows rapid characterization of trace DNA samples at crime scenes in order to minimize the possibility of contamination.

Soper, Continued on pg 2

CBM^2 Director Steven Soper was awarded the 2006 Micro Chemical Society's A. A. Benedetti-Pichler Award, an international competition that recognizes outstanding research in the field of microchemistry in its broadest sense, as well as administration, teaching and other activities that promote and advance microchemistry. In 2001, he received both the Charles E. Coates Award for Outstanding Contributions in Chemical/Engineering Research in Louisiana and was appointed LSU's William L. & Patricia Senn, Jr. Professor of Chemistry.

Soper, *continued from pg 1*

"CBM^2 represents another new direction in scientific research to which I was introduced at Los Alamos: multidisciplinary research in which investigators with diverse areas of expertise collaborate on projects that cut across specializations" relates Dr. Soper.

The three primary specialties that the Center brings together are biological sciences, chemistry and engineering. This includes a variety of subspecialties, such as microbiology, analytical chemistry, mechanical engineering and electrical engineering. Specialists in other areas, such as physics, are also involved.

"The remarkable multidisciplinary nature of CBM^2 research is perfectly exemplified by DNA forensics projects in which systems under development will screen a large panel of human identification markers that are being discovered by molecular biologists," says Dr. Soper. He adds that the devices consist of nanometer/micrometer-sized structures fabricated using lithography, the same technique used in the electronics industry to fabricate integrated circuits.

"The lithography process creates masters from which replicate parts are molded using techniques similar to those used in making CDs. This work is supported by mechanical engineers," he explains. "The next phase of the device development requires new 'fluorescent reporters,' or dyes, created by organic chemists.

Dr. Steve Soper and graduate student Anne Obubuafo.

About CBM^2

The Center for BioModular Multi-Scale Systems is the centerpiece of a 2004 $9 million National Science Foundation EPSCoR grant matched by $3 million from the Board of Regents Support Fund and $1.5 million from the participating institutions.

CBM^2 includes researchers with expertise in microsystems, engineering, materials, chemistry and biological systems at LSU, LSU's Center for Advanced Microstructures and Devices (CAMD), the LSU Health Sciences Center in New Orleans, Tulane Health Sciences Center, and Xavier University.

External partners are Cornell Medical College, Sloan Kettering Memorial Cancer Research Center, and Baylor College of Medicine.

"New materials and their modifications are being used by analytical, surface and materials chemists for the isolation of DNA from samples, while meanwhile, hardware for reading the signatures from the genetic tests is being developed by optical engineers and method development is being supported by analytical chemists.

"Testing and commercialization of this system is a joint effort between CBM^2 and a local company specializing in human identification."

Twenty-seven research faculty members with expertise in biological and chemistry systems, computer sciences, materials and microsystems engineering from the various Louisiana institutional partners (see above) are currently involved in the Center's work. Over 200 people from around the state and country are taking part, including graduate students, undergraduates, post-doctoral researchers and staff members.

"The groundbreaking research of CBM^2 further demonstrates the increased possibilities that occur when scientists from different disciplines and institutions combine and focus their particular areas of expertise on a scientific challenge," says Dr. Michael Khonsari, Louisiana EPSCoR Project Director and BoR Associate Commissioner for Sponsored Programs Research and Development.

"The old saying that 'there is strength in numbers' was never truer that right now, right here in Louisiana. It is such collaborative research efforts that draw on the strengths of universities throughout the State that will accelerate Louisiana's ability to compete in today's knowledge-based regional, national and global economies."

Louisiana EPSCoR
P.O. Box 3677
Baton Rouge, LA 70821-3677
#4475