A Meeting of the Minds

Rensselaer's new Center for Biotechnology and Interdisciplinary Studies opens with a scientific symposium.

By Sharon Tefft Bozovsky

Center for Biotechnology and Interdisciplinary Studies

An impressive array of some of today's most prominent scientists gathered at Rensselaer to mark the opening of the new Center for Biotechnology and Interdisciplinary Studies, and to speak of promising innovations in the field of biotechnology.

A biotechnology symposium titled "Biological Discoveries That Will Change the World" was held Sept. 9, showcasing stellar geneticists, biologists, engineers, and chemical, biological, and biomedical engineers. The following day they were joined by leaders in the biotechnology industry, policy makers, and top researchers who participated in a roundtable discussion led by Rensselaer President Shirley Ann Jackson, Ph.D. The new biotechnology center was opened officially with a ribbon-cutting ceremony on Sept. 10.

"The long-term potential is enormous — for drug delivery, replacement cells for degenerative diseases, and eventually even organ replacement," Jackson noted. "The number of patients in the United States awaiting organ transplantation has increased by 40 percent in the last five years, but the number of organ donors has increased only by 13 percent. More than 17,000 Americans await liver transplantation alone. Imagine the day when science could provide new livers for these people. Considering that Harvard researchers have implanted small, functioning kidneys in cows, it may be closer than we know.

"Other research programs have flourished by using new, interdisciplinary laboratory techniques, such as biocatalysis and metabolic engineering, which aims to use enzymes as catalysts to improve pharmaceutical or chemical production, or to design proteins which can neutralize viruses or harmful genes.

Here at Rensselaer, Jonathan Dordick's research group has drawn upon microelectronics to develop biochips capable of producing thousands of new compounds with potential medical or environmental uses. Working with researchers from Rensselaer's National Science Foundation Center for the Directed Assembly of Nanostructures, the team also is linking biomolecules with nanomaterials. By showing that proteins, for instance, can be absorbed into carbon nanotubes, they may be taking the first steps toward a new generation of micro-scale sensors, as well as self-cleaning, and self-healing surfaces.

A high-level discussion on biotechnology was held prior to the ribbon-cutting Sept. 10.

"In short," Jackson added, "the questions driving our research may come from biology, but the solutions often include the tools and methods of chemistry, computer science, engineering, mathematics, and nanotechnology. By drawing upon other disciplines, the biosciences are regenerating themselves.

Rensselaer's new Center for Biotechnology and Interdisciplinary Studies ranks among the world's most advanced research facilities focused on the application of engineering and the physical and informational sciences to the life sciences. The center is a 218,000-square-foot, $100,000 million (including $80 million for construction) facility with high-tech laboratories and an expansive atrium. It will provide a platform for collaboration among many diverse academic and research disciplines to enhance discovery and encourage innovation.

The center's opening attracted many of the nation's leading biotechnology experts who provided their insights into the promising future of interdisciplinary research in the life sciences.

Shirley Tilghman, Ph.D., president of Princeton University and a highly respected molecular biologist, detailed some of the highlights of the Human Genome Project. "[It] will have enormous impact on the life sciences...no field of biology will be untouched," she said.

Shirley Tilghman, Ph.D.

The Human Genome Project legitimized data-driven science, Tilghman said. Noting that today researchers are generating a large amount of data to be tested for validity, she said, "We're beginning to understand the pattern of inheritance of human varieties; to understand how inherited segments are inherited as segments.

"Previously, scientists used a reductionist approach to components that made up an organism. It was like the proverbial blindfolded men describing an elephant. With the information age and the parts list assembled, we have the opportunity to study the organism in its totality. We have taken off the blindfolds, and now we're poised to make major contributions to the life sciences," Tilghman added.

Robert Langer, Sc.D., the Kenneth J. Germeshausen Professor of Chemical and Biomedical Engineering at the Massachusetts Institute of Technology, discussed biomaterials and their potential to change lives. "Traditional drug-delivery systems are swallowed or injected. With those methods, the amount of drug in the body starts out low and peaks and then reaches a lower level. It's not as effective as a steady dose would be. In fact, there are 100,000 deaths a year caused by people taking their medicine the way they're supposed to," he said.

Robert Langer, Sc.D.

Langer described the potential impact of new drug-delivery systems using large molecules, such as peptides, to provide a controlled, continuous-release methodology to deliver pharmaceuticals.

To illustrate, he pointed to a prototype remote control drug-delivery system comprising a miniature computer chip, with anode- and cathode-bearing reservoirs for drug storage, which can be implanted into a patient. Electronic pulses trigger drug release, and chemical sensors monitor drug levels and automatically dispense the proper amount of pharmaceuticals to the patient.

"We have learned how to get release in any time from a day to three years," Langer said.

Troy Duster, Ph.D.

Troy Duster, Ph.D., professor of sociology at New York University and Chancellor's Professor at the University of California, Berkeley, applauded the work of genetic sequencing and ancestor tracing by DNA analysis, but he cautioned about making certain assumptions on what appears to be evidential.

For example, he said that unless blacks are studied globally, it is erroneous to assume that diseases such as hypertension are universal in black culture, because environment plays a role.

Duster also raised the specter of "functional creep," in which DNA identification technology could be applied not only to tracking serious criminals such as murderers or rapists, but also could be used to apprehend individuals who commit lesser crimes, such as petty theft or misdemeanors.

Yale Professor of Chemical and Biomedical Engineering Mark Saltzman, Ph.D., illustrated how cells can be manipulated into different patterns and shapes and how it is possible to deliver DNA or drugs through the biomineralization of engineered tissues.

"Science can replace damaged tissue, grow new ears or noses, and have created materials that react to temperatures, such as self-knotting sutures, and materials we can program to any shape we want. It will totally change the paradigms of medicine."

Mark Saltzman, Ph.D.

Rensselaer Professor of Biomedical Engineering Natacha DePaola, Ph.D., elaborated on some how scientists can inhibit and control tissue growth using Cx mimetic peptides; and the promise of using magnetic fields to affect the growth of tissues.

Robert Linhardt, Ph.D.

Robert Linhardt, Ph.D., the Ann and John H. Broadbent Jr. '59 Senior Constellation Professor of Biocatalysis and Metabolic Engineering at Rensselaer, spoke of the promise of his work with the enzyme heparin. "By exploring a structure/activity relationship of different molecules, enzymes often become lead compounds for new drug development. They show promise for new bio-products in the areas of agriculture, manufacturing, environmental clean up, and other fields," Linhardt said.

University of Virginia Professor of Chemistry and Pathology Donald Hunt, Ph.D., described a database of peptide sequences identifiable with a mass spectrometer, which can enable scientists to identify a protein in a fraction of the time it used to. "This has great promise for use in medical science," Hunt said. "Someday scientists can develop a vaccine that identifies the proteins secreted by diseased cells and will be able to stimulate the cells to produce disease-destroying agents."

Donald Hunt, Ph.D.

"We are probing deep into the cellular level of life, using high-throughput technologies with a new mindset," said MIT Professor of Chemical Engineering Gregory Stephanopoulos, Ph.D.

Gregory Stephanopoulos, Ph.D.

"There is a new holistic approach to biologic research, and understanding networks is a significant part of systems biology."

In addition to discussing the status of biotechnology research, policymakers were on hand to consider the ethical and societal implications of biotechnology research. They agreed that scientists must initiate and actively participate in public debate and discussion of controversial scientific issues, such as stem cell research, genetically modified organisms, and human genetic science.

Claire Fraser '77, Ph.D., who serves as the president and director of The Institute for Genomic Research, said, "Collectively, we should generate a great deal of information to educate the general public on why they should be interested in developments, why our work will impact on them," said Fraser, a member of Rensselaer's board of trustees. "There is a critical need for public debate and the overall understanding in stakeholders. We should start very early on in the education system; placing more value on science and the role of technology in people's lives."

They also agreed that there needs to be a new way to fund pioneering research, and that collaborative, interdisciplinary efforts such as Rensselaer's new biotechnology center were the way of the future of scientific explorations.

National Institutes of Health Director Dr. Elias Zerhouni said, "In interdisciplinary science, at the end of that interaction, we become something different, a new discipline. In research there's not just juxtaposing, but there will be a fusion experience of real proportion. Success breeds success. There will be more breakthroughs; failure will only force change."

In the view of the researchers, biotechnology research holds promise for all of humanity.

"Stem cells are the most exciting thing to come along since the discovery of the atom," said Human Genomic Sciences Inc. CEO, William A. Haseltine, Ph.D. "It's possible to make any functional part of the human body. If we think of DNA as the information we need to create your body, the possibilities for understanding and for re-creating our bodies are virtually limitless."

"We're going to see huge opportunities on the environmental/conservation/energy fronts," said Biogen Idec Inc. President James Mullen '80, who also is a member of Rensselaer's board of trustees. "We're just beginning to see the impact of this."

Photos by Kris Qua