

'Dancing With Nature' Is Key to Cures

By Van Jensen

Professor Ravi Bellamkonda's biomedical engineering lab has charged itself with the modest tasks of curing cancer and healing broken spinal cords.

"We seem to pick hard problems," he said with a smile.

Bellamkonda, who obtained postdoctoral training from MIT and a PhD from Brown, said the two very different research areas do have a common element.

"Our overall philosophy is that we're dancing with nature," he said. "It's not like automotive engineering, where you know every component. The human body, we don't know all that's in there. It's always an experiment."

At the most basic level, the key to biology is the action of proteins and sugars, said Bellamkonda, a member of the Wallace H. Coulter Department of Biomedical Engineering, a joint effort of Georgia Tech and Emory. If researchers can manipulate certain proteins and sugars to behave as they want, they could potentially affect tumors and stimulate healing in spinal cords.

It's through materials engineering, often at the nano scale, that Bellamkonda's lab seeks to "nudge nature."

The motivation for tackling cancer is in part personal for Bellamkonda. His mother-in-law is a breast cancer survivor. He lost a grandfather and uncle to cancer. But largely, finding ways to cure cancer and heal damaged spinal cords is a public service.

"My bottom line is our research is in part funded by taxpayers," he said. "We have a responsibility to use that support wisely."

A recent paper from Bellamkonda's lab revealed a modified enzyme and delivery system his team had developed to dissolve the scar tissue that prevents spinal cord regeneration.

When spinal cords are injured, neurons die immediately and for days afterward from inflammation. To fully treat such an injury would require better managing the inflammation, removing scar tissue and stimulating growth, Bellamkonda said.

So far, researchers haven't made it to that final step. And even if that gap is bridged, no one knows if the nervous system's connections between brain and body will be able to reconnect correctly.

The first goal is to improve the known areas, Bellamkonda said.

"We can do better managing the injury," he said. "We'll make progress there first. We can probably rescue a lot of neurons, and that's a big deal."

His lab's main focus on cancer is in developing a better knowledge of tumors. Particularly they've focused on characterizing the blood vessels within tumors that are a key indicator of how the tumors grow. Understanding a tumor would allow doctors to know the best course of treatment immediately instead of trying different treatments and waiting months for results, he said.

While much of the previous cancer

research was to identify single proteins associated with specific tumors, Bellamkonda is searching for "functional markers," more complex cancer states that correlate to the molecular structure of the tumor.

"Biology has a lot of redundancies," he said. "If I look at one protein, I miss the whole picture."

For a long time, biology wasn't seen as an area of focus for engineers, Bellamkonda said. But engineering allows scientists to control proteins and sugars using materials, imaging and other tools. This is key to overcoming problems such as cancer.

"All engineering schools have realized biology is an area of importance," he said. "Tech has made a humongous push."

He credited Don Giddens, dean of the College of Engineering, and Robert Nerem, founding director of the Parker H. Petit Institute for Bioengineering and Bioscience, for that push. Tech's bioengineering program already is ranked in the top five.

"There are lots of partnerships," Bellamkonda said, "and we have really, really good students."

As Tech moves forward in planning its strategic vision, Bellamkonda is a key part of that team as co-chair of the "big idea" committee. His goal is to set up Tech to tackle key global issues of health, energy, the environment, security and information.

"At Tech, the philosophy is, 'Let's roll up our sleeves and do something,'" he said. "We stand a good chance of making a dent in these problems if we hire the right people and are organized the right way."

needs of the state, the nation and the world.

An example of such an area is bio-science/bioengineering/biomedical engineering. By definition, bioengineering is the application of engineering principles to the study and control of biological processes. The goal of bioengineering research is to develop, through an integration of engineering and the life sciences, a better understanding of basic mechanisms in disease and new concepts and techniques that may be applied to problems in medicine and biology.

From the 1995 opening of the Petit

Institute for Bioengineering and Bioscience, funded in part by the generosity of Pete Petit, ME 62, MS EM 64, to the Ford Environmental Science and Technology building to the Molecular Science and Engineering building to the Biomedical Engineering building, funded in part by the Wallace H. Coulter (ClS 34) Foundation, Tech has invested more than \$200 million in facilities alone to set the stage for the future. These multipurpose facilities allow for co-locating faculty from different disciplines to work together in research instead of the silos that traditionally exist in higher education.

The fastest growing engineering academic program today is biomedical engineering, an area that has been in existence for just a decade. Tech's joint program with Emory is now the second-ranked biomedical engineering program in the country. The program's inception is illustrative of this concept of converging fields. Don Giddens, dean of the College of Engineering and triple degree holder from Tech in aerospace engineering, is the program's founder after leading the Johns Hopkins biomedical engineering program to its top ranking.

Examples of cross-disciplinary work are



Abby Vogel

plentiful. Manu Platt, PhD BME 06, an assistant professor in biomedical engineering, works in tissue remodeling for regenerative medicine and was named a 2009 Georgia Cancer Coalition distinguished cancer scientist. Andres Garcia, a mechanical engineering professor, does significant research focused on cellular and tissue engineering, areas that integrate engineering and biological principles to control cell function in order to restore and/or enhance function in injured or diseased organs. Mark Borodovsky, a Regents professor in the College of Computing, part of the Coulter

Department of Biomedical Engineering and director for the Center for Bioinformatics and Computational Genomics, and his research group work on the development of machine-learning algorithms for computational analysis of biological sequences — i.e. DNA, RNA and proteins.

Another significant strategic investment for Georgia Tech is in microtechnology and nanotechnology. The ability to work in multidisciplinary collaboration again is integral to the advancement of science and technology. The continuum of research in these fields is impressive. From the Center for

Organic Photonics and Electronics to the Center for MEMS and Microsystems Technology, Georgia Tech is poised for future development in a large number of fields.

The newest facility is the Marcus Nanotechnology Research Building, partially funded by a grant from the Marcus Foundation but also from significant contributions from the Robert W. Woodruff Foundation and alumni leaders like Steve Chaddick, EE 74, MS EE 82; Thomas Quigley, EE 84; Julian LeCraw Sr., IM 52; and William Coley, EE 66, as well as Georgia

In particular, energy and water are two defining issues. At best, the restriction of these resources will greatly reduce lifestyles around the world; at worst, people will be literally fighting to get to these resources. As technologists, our job is to provide solutions to these larger issues.”

Tech and the state of Georgia. The building houses 30,000 feet of clean-room space for both inorganic and organic work. This is unusual. Typically clean-room facilities exist separately. Inorganic research creates the latest generations of electronic chips, for example, while organic clean-room operations typically focus on the life sciences.

By facilitating the capability to co-exist, both benefit from each other. For example, biochips can be created using both broad fields of experimentation and expertise. Inorganic microfabrication techniques can be used in concert with biologic science to produce drug screen arrays.

The \$100 million investment in the Marcus Nanotechnology Building sets the stage for Georgia Tech not only to extend research capacity but to probe beyond the micro into the nano, and Tech now has several nanomedicine centers to try to understand and cure disease.

Allen talked about the importance of energy and sustainability, a major research area for the Institute.

“In particular, energy and water are two defining issues,” he said. “At best, the restriction of these resources will greatly reduce lifestyles around the world; at worst, people will be literally fighting to get to these resources. As technologists, our job is to provide solutions to these larger issues.”

Three institutes exist beneath this umbrella today: the Strategic Energy Institute, the Brook Byers Institute for Sustainable Systems and the Institute for Paper Science and Technology.

The Strategic Energy Institute is set up and funded to understand and promote the



Manu Platt

intelligent generation and distribution of energy.

The Brook Byers Institute for Sustainable Systems, funded by a generous gift from Byers, EE 68, is set up to study, understand and educate society about the intelligent use of such resources as energy and water to build a sustainable future.

The Institute for Paper Science and Technology focuses on the intelligent use of our forests and, in particular, the study and development of biofuels. The institute recently welcomed an experienced paper industry executive, Norman Marsolan, as its new leader.

President Peterson has suggested another piece — to utilize portions of Georgia Tech itself as test beds to demonstrate the latest energy research and sustainable solu-

tions that are developed at the Institute.

A fourth area for Georgia Tech’s strategic investment in research is high-performance computing. The tremendous increases in computational ability have enabled researchers using micro and nano techniques and tools to solve interesting problems of great relevance and complexity.

Improving the efficiency of combustion engines may not sound all that difficult, but it is, combining fluid mechanics with the understanding of chemical reactions under extreme conditions. A small improvement can have a significant impact on energy use for the future. The ability to model real-world problems like this utilizing high-performance computers enables true understanding and improvement.

On the life sciences front, the ability to model the operations of an entire cell could potentially provide the keys to solving disease through identification of the causes and learning how to treat cell mutation. Allen believes high-performance computing also will impact computer science in fundamental ways.

For years, following the development of the silicon microchip, growth in electronics followed Moore’s Law — named for Intel co-founder Gordon Moore — which states that the number of transistors that can be placed on a chip will double every two years. We’re nearing the stage where adding more transistors increases heat too much.

Now instead of adding more transistors, computer hardware companies are adding more computers on each chip using concepts like dual core processors.

Increasing the number of computers on