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—Krishnan Chakravarthy, MD/PhD, Class of 2011

A Start-Up Is Born

UB students establish a nanomedicine company

By S. A. Unger

A GROUP OF YOUNG ENTREPRENEURS, led by Krishnan Chakravarthy, an MD/PhD candidate in the School of Medicine and Biomedical Sciences, has launched a company called NanoAxis, which aims to take advances in nanotechnology and apply them to drug and gene delivery and to customized medical devices. The group is focusing its efforts on the development and utilization of a revolutionary new biomedical tool called "quantum dots," extremely tiny crystalline structures that were first developed in the 1980s for computing applications.

Over the last two decades quantum-dot technology has evolved at a rapid pace, spurring tremendous interest in its application to a wide variety of new high-tech endeavors.

Biomedical researchers are intrigued with quantum dots in large part due to their capacity to absorb white light and then release it in a broad spectrum of colors. The superior photophysical properties of quantum dots (they fluoresce brighter and longer than conventional organic materials) make them potentially invaluable tools in medical imaging and for use as highly versatile disease biomarkers. In addition, because quantum dots can be constructed in an almost limitless variety of shapes, they can be built to carry such payloads as antibodies, proteins and chemotherapeutic agents to targeted cells. In some cases, the photophysical and the payload properties are being combined to both image and treat disease, as is the case with experimental cancer therapies.

The founding members of NanoAxis—who, in addition to Chakravarthy, include Darren Leskiw, Indrajit Roy, PhD, and Thomas Sass—received a boost to their entrepreneurial aspirations in the spring of 2008, when they won first place in the Henry A. Panasci Jr. Technology Entrepreneurship Competition.

The competition, sponsored by the UB School of Management, awards $25,000 in seed money and business services to the team that presents the best plan for launch of a viable new business (a second-place prize of $10,000 also is awarded).

NanoAxis was established in January 2008 as part of the team's effort to enter the competition; their subsequent first-place finish over nine other teams gave them crucial seed money to move forward with their plans.

One of the stipulations for teams entering the competition is that they partner with a UB MBA graduate, which is how Chakravarthy, who is president and CEO of NanoAxis, connected with Sass, who now serves as vice president of business development for the company, and Leskiw, who is vice president of operations. The group then recruited Roy to serve as product development manager for the start-up. A nanomaterials and physical chemist by training, Roy currently is research assistant professor and deputy director of the UB Institute of Lasers, Photonics and Biophonics.

The executive director for the institute is Paras N. Prasad, PhD, SUNY Distinguished Professor of Chemistry, who, along with Paul R. Knight III, MD, PhD, UB professor of anesthesiology and microbiology and immunology, serves on the scientific board for NanoAxis.

Knight, who also is director of UB's MD/PhD Program and Chakravarthy's thesis advisor, says, "I don't know of too many MD/PhD students who have begun start-up companies. Krishnan is highly unusual in that regard. He is a very intelligent, creative individual who has incredible energy. He and his group are doing cutting-edge work with NanoAxis; it's very exciting."

Early on in the planning process, the NanoAxis team also received advice and direction from Martin Casstevens, business formation and commercialization manager in UB's Office of Science, Technology Transfer and Economic Outreach (STOR).

In 2008, NanoAxis, headquartered in Getzville, New York, filed for a grant through the National Institutes of Health's Small Business Innovation Research program. The goal is to use this or other funding to integrate their company's AxiCad quantum dots and microarray technology into a hand-held biomarker detection device in an effort to enhance sensitivity to acute respiratory distress syndrome clinical biomarkers in the intensive care unit.

In addition, they have contacted potential customers for the AxiCad quantum dots and have recently hired three full-time employees.

Currently, a NanoAxis collaborator and customer is Amnis Corporation, a Seattle-based company that has developed an instrument that combines the power of microscopy and flow cytometry in a single platform. The company is using the AxiCad quantum dots to devise a cellular labeling procedure and to target cellular transcription factor NF-κB.

KRISHNAN CHAKRAVARTHY, MD/PhD, CLASS OF 2011, is founding president and CEO of NanoAxis. He is currently participating in the Guest Researcher Program at the Centers for Disease Control and Prevention in Atlanta, where, among other things, he is researching the nanotechnology-based delivery method of a new pan-antiviral strategy devised by Suryaprakash Sambhara, DVM, PhD, chief of the Immunology Branch in the Influenza Division at the CDC.

NANOAXIS OWNS TWO PATENTS and has submitted applications for three more. Two of these are for docking technology related to drug/gene delivery that the company is in the process of acquiring and commercializing from UB's STOR.

"Our long-term goal is to be a leader in integrating nanotechnology into the art of medicine and to build a company that can be a foundation for jobs and economic development in Western New York," says Chakravarthy, a native of Williamsville, New York.

"Our AxiCad quantum dots have proven to be unique for various industrial applications within the life sciences market," he adds, "most especially in *ex vivo* diagnostics, such as flow cytometers and microarray technology."

A major hurdle for *in vivo* applications, he explains, is the fact that most quantum dots are made from the element cadmium, which is highly toxic. Although NanoAxis makes quantum dots that are both cadmium based and cadmium free, he says the company—as well as many other companies worldwide—is working to devise ways for the highly effective cadmium-based structures to be safely excreted from the body once they have delivered their payload.

Targeting Infectious Diseases

Of particular interest to NanoAxis is the development of therapies for infectious diseases, something few companies and labs around the world are currently doing, notes Chakravarthy.

"We hope to take the lead in the area of infectious disease research and believe that use of quantum dots may replace conventional targeting methods, such as adenoviral vectors, and provide a truly novel form of gene therapy," he says.

Chakravarthy is currently bolstering his research skills in this area by participating for six months in the Guest Researcher Program at the Centers for Disease Control and Prevention in Atlanta, Georgia.

The objective of his work at the CDC is twofold: to research the problem of secondary bacterial infections following influenza viral infection, and to research the nanotechnology-based delivery method of a new pan-antiviral strategy devised by Suryaprakash Sambhara, DVM, PhD, chief of the Immunology Branch in the Influenza Division at the CDC.

"The nanotechnological method of delivery [that we are working on at the CDC] consists of using gold nanoparticles and coupling them to our antiviral gene therapy," explains Chakravarthy. "We believe that this approach in conjunction with nanotechnology would be the first attempt to create a generic antiviral therapeutic. Currently, the therapy developed in Dr. Sambhara's lab has been shown to be efficacious in treating avian influenza and other important influenza strains worldwide, and it is showing effectiveness in combating Ebola virus.

"Our hope," he adds, "is that with the dearth of influenza vaccines and the potential for a pandemic breakout, we can alleviate the public burden using this therapeutic strategy in conjunction with nanotechnology."

In June 2008, Chakravarthy was invited to present at the NanoTech Conference in Boston, Massachusetts, one of the largest forums for the commercialization of nanotechnology products.

"At the conference we saw a lot of excitement about the company and received a lot of positive feedback about what we are trying to accomplish, which gave us a tremendous sense of satisfaction that we are on the right track," says Chakravarthy, who credits his mentors at UB and fellow NanoAxis founders for helping him to realize his aspirations.

"I entered the Panasci Competition in the first place because of my goal to be a successful physician-scientist, a goal that has been wholeheartedly supported by my mentor Dr. Paul Knight," Chakravarthy adds. "He has been a tremendous source of guidance and has allowed me to explore all aspects of being a physician-scientist, including the entrepreneurial side. This is important because near and dear to me will always be the passion I have to see research translated into the clinic." BP

FROM LEFT: Darren Leskiw, BS '05 (engineering), MBA '09; Krishnan Chakravarthy, MD/PhD (Class of 2011); Thomas Sass, BS '96 (engineering), MBA '04; Indrajit Roy, PhD (nanomaterials and physical chemistry)