Medical student gets a break from class — to do research on programming cells

Tim Kamerzell Ph.D., Buddhadeb Dawn, M.D., Cardiovascular Research Institute

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Tim Kamerzell loves the process of scientific discovery. Ultimately, the second-year medical student wants to make his mark as a physician-scientist. "Growing up on a small farm in rural Nebraska, I didn't even know what this meant," he says. "We saw a family doctor for everything. But given my three loves — science, people and therapies that save lives — I think it'll be a natural fit."

Kamerzell, who has a Ph.D. in pharmaceutical chemistry from the University of Kansas, left a promising industry career at Genentech, Inc. to return to KU for medical school. Working with Buddhadeb Dawn, M.D., director of KU's Cardiovascular Diseases division and the Cardiovascular Research Institute, he's kept a hand in research, balancing a hectic class schedule alongside hours at the laboratory bench.

And now Kamerzell has earned a year-long research sabbatical, starting this summer, through the Sarnoff Cardiovascular Research Foundation, which annually offers a handful of outstanding medical students the opportunity to explore careers in cardiovascular research. Kamerzell is one of just 12 Sarnoff fellows nationwide this year; he'll return to the grind of medical school in the fall of 2013.

Juggling science and medicine

Back in 2001, right before his senior year at Nebraska's Chadron State College, Kamerzell spent his summer break in Lawrence, Kan., where Carey Johnson, Ph.D., a professor of chemistry, introduced him to ultrafast spectroscopy, which employs exceedingly short time scales — often femtoseconds (one millionth of one billionth of a second) — to study molecules excited with laser beams.

"The name just sounded cool, even if I knew nothing about it," Kamerzell says. "Once I got the hang of it, I discovered that I loved everything about life in the lab." He pursued doctoral training at KU and

spent the next five years doing experiments in biophysics, quantum mechanics, protein dynamics — and more ultrafast spectroscopy — under the tutelage of Russell Middaugh, Ph.D., a professor of pharmaceutical chemistry.

During this time, Kamerzell's mother and two grandparents were diagnosed with cancer; a little later, his father-in-law succumbed to leukemia. "I spent a lot of time in hospitals; that's when I first learned about physician-scientists and academic medicine," he says. Though he was intrigued by medical school, he finished graduate training, then moved to San Francisco to work as a physical chemist at Genentech.

While there, he helped develop processes to make several of the company's drugs work more efficiently. His bosses and colleagues, noting his interest in exploring different questions and the fact that he'd filed three patents in four years, chose him to receive a Genentech Award for Innovation and Risk.

Throughout his time in industry, Kamerzell still felt that something was missing professionally. "So I shadowed a physician-scientist at Stanford, and another at UCSF," he says, "which helped me decide that I wanted my career to include medicine." His wife being a Kansas native, returning to KU for medical school was a natural decision.

"Four years away from the lab while getting my M.D. seemed too long a gap, though," Kamerzell adds. So he looked up KU researchers studying the use of stem cells in regenerative medicine, which had long fascinated him — at Genentech, he often read the field's latest *Science* and *Nature* publications in his spare time. He quickly gravitated toward Dawn as a mentor.

Of stem cells and heart repair

Currently, much of Dawn's laboratory research focuses on identifying populations of stem cells, derived from the adult bone marrow, that could aid the repair of injured hearts. These cells, if successfully transplanted into the heart's infarct zone — dead and damaged tissue created during a heart attack — could help restore blood flow and promote cell growth, improving the heart's overall function.

"The initial thought was that these stem cells would home to the heart and, because of their inherent potential, become new heart cells," Kamerzell says. "But it's not that straightforward — science rarely is."

He's carefully studying the molecular events underlying the behavior of the stem cells that most interest Dawn: adult mesenchymal stem cells. He hopes to find a way to predispose these cells toward becoming heart cells *before* they're infused into damaged hearts.

Reprogramming one cell type into another is not a new feat; over the last few years, scientists have

coaxed heart cells out of scar tissue, human skin and other unrelated cells. The point, Kamerzell stresses, is that the use of viruses is still necessary to deliver specific genes that can then stably integrate into these cells and assist with the reprogramming process. Because viruses have enormous replicative potential, they often prime reprogrammed cells into becoming cancerous, provoking uncontrolled cell growth and tumor formation.

Therefore, moving from animal studies to the clinic will require a new approach. "I think we'll eventually be able to use small chemicals the same way we now use viruses," Kamerzell says, "but it's a very young field."

Meanwhile, he's figuring out what his own research focus will be during his upcoming Sarnoff sabbatical.

"My chief interest, really, is understanding how cells make decisions in the first place," Kamerzell says. "A cell has a circuit of sorts that controls what it becomes; if we know the blueprint of this circuit, we can modulate it any way we want." But it's complicated, because the "blueprint" is dynamic, with constantly shifting signals and crosstalk between multiple components in a cell.

Broadly speaking, Kamerzell would like to spend his fellowship year using a systems biology approach to explore cellular decision-making. "A better understanding of how and why genes are silenced or switched on will, I think, help our efforts to reprogram cells for regenerative medicine," he says. "I'm excited about using my medical training to come up with scientific questions that are more clinically relevant."

Bridging bench and bedside

Kamerzell is aware of the fine line many physician-scientists walk between seeing patients in the clinic and carrying out experiments in the laboratory. "The perception that you can't do both equally well needs to change," he says. "It's challenging, but not impossible. We do need better communication between basic scientists and clinicians, as patient care and research should be mutually beneficial."

He believes good mentors are key in developing future generations of doctors, scientists *and* those who seek to straddle both worlds. "My mentors have been vitally important," he says. "I wouldn't be doing anything I'm doing now without their influence and help along the way."

Passion and curiosity will always be important too. One of Kamerzell's favorite authors is the late Richard Feynman, a physicist and Nobel laureate. "The title of his book, *The Pleasure of Finding Things Out*, sums it up nicely," he says. "It's what keeps me coming back to the lab — even on weekends, or when I'm also trying to study for my neuroanatomy board exam."