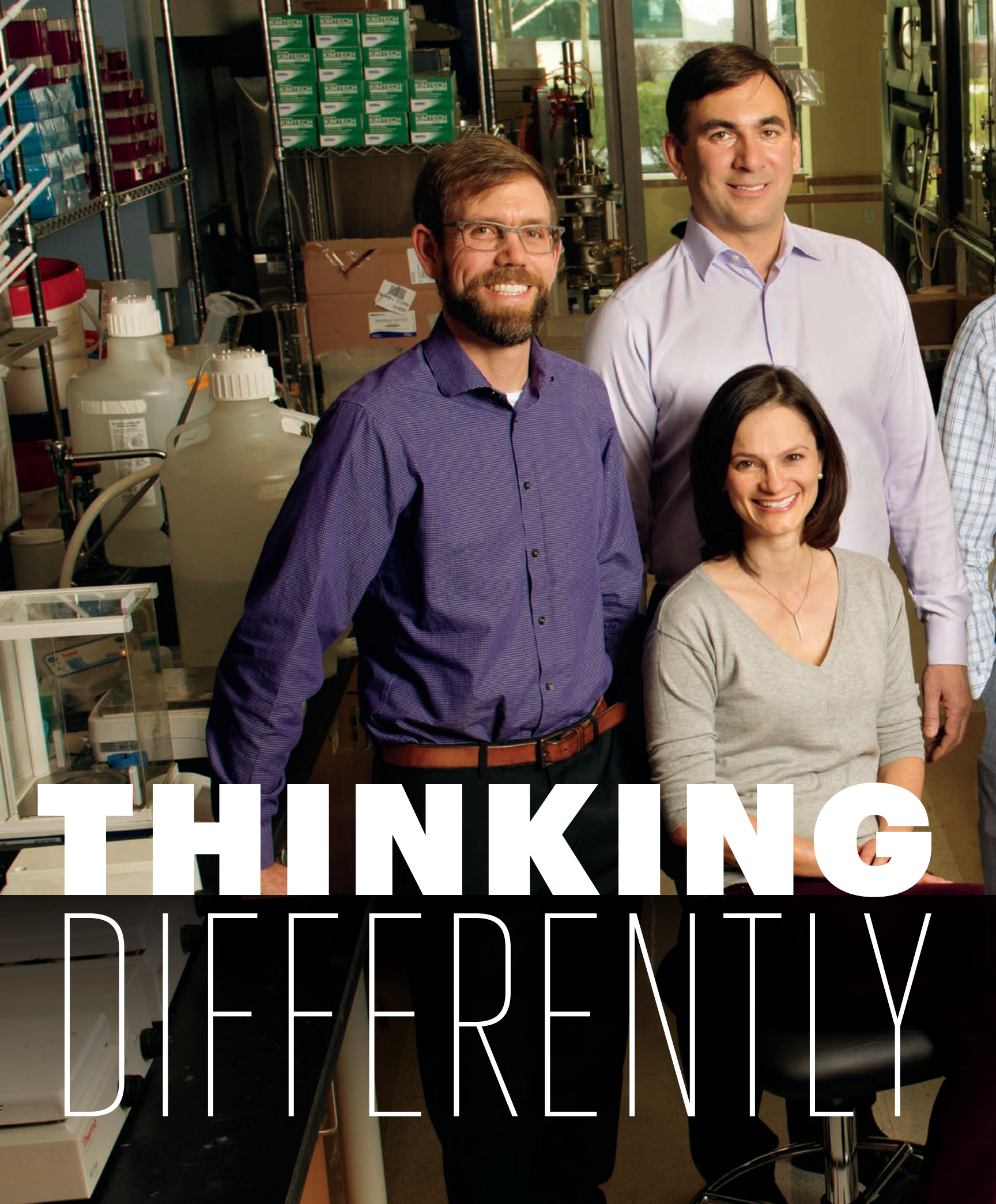
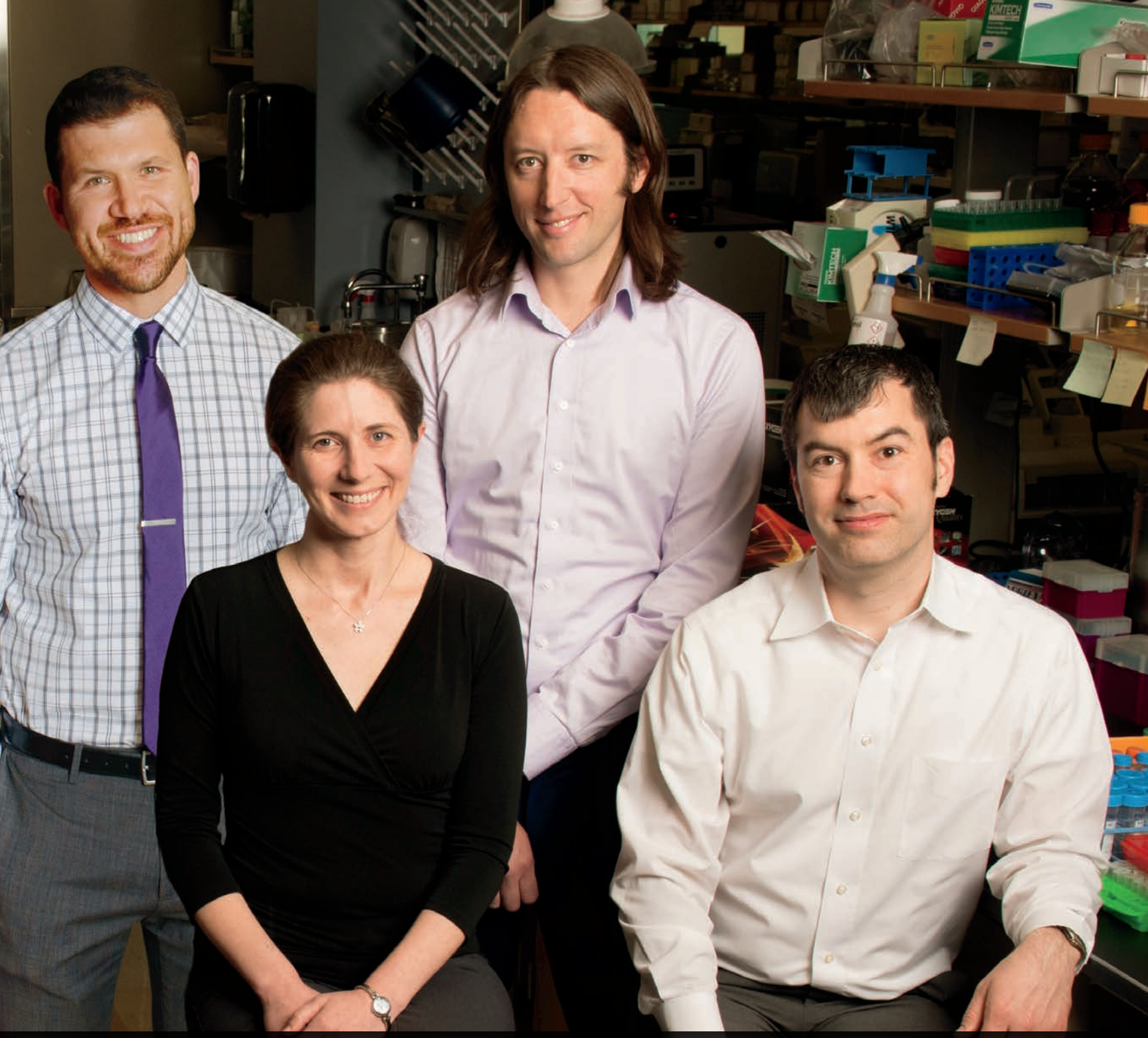

KIMTECH
THINKING
DIFFERENTLY



NORTHWESTERN'S CENTER FOR SYNTHETIC BIOLOGY TURNS IN A BLOCKBUSTER PERFORMANCE ITS FIRST YEAR OUT.

Photograph by Rob Hart

"'Thinking different' is what my group has been—and is—doing. I really wanted to be a part of a larger group of people who were thinking differently about other aspects of synthetic biology—a critical mass that could innovate biotechnology to solve real, pressing issues that face the planet."

JULIUS LUCKS ASSOCIATE PROFESSOR OF CHEMICAL AND BIOLOGICAL ENGINEERING

In the late 1990s, Apple aired a TV commercial featuring slow-motion, black-and-white footage of iconic personalities. As images of Albert Einstein, Martin Luther King Jr., Amelia Earhart, Mahatma Gandhi, and others flickered silently across the screen, a faceless narrator described them as the "crazy ones" who dared greatly enough to change the world.

As the commercial ended, the narrator urged viewers to "think different." Dubbed "Here's to the Crazy Ones," the ad not only inspired consumers to buy Apple products, it also encouraged them to follow the misfits and rebels by thinking differently and ultimately changing the world.

Julius Lucks sometimes reflects on this commercial and visualizes an ideal trajectory for his life and career. When Apple first released the commercial, Lucks was an undergraduate student, deep into his chemistry studies at the University of North Carolina. Today, he's a successful synthetic biologist and associate professor at Northwestern Engineering. The ad's 20-year-old message still remains at the heart of his work.

"'Thinking different' is what my group has been—and is—doing," he says. "I really wanted to be a part of a larger group of people who were thinking differently about other aspects of synthetic biology—a critical mass that could innovate biotechnology to solve real, pressing issues that face the planet."

Lucks found what he was seeking at Northwestern's McCormick School of Engineering. "Northwestern immediately came on my radar as a place that has a special combination of a 'think different' mindset and a critical mass in synthetic biology," he says.

Moving from Cornell University, he joined Northwestern in 2016, a few months after the University had launched its Center for Synthetic Biology and outlined plans to assemble a dream team of complementary faculty members to lead innovative research. As Lucks met other faculty and reviewed plans for the new center, he was reminded of the philosophy. "As I got to know more about Northwestern," Lucks says, "I realized it has a rare combination of far-reaching vision and a desire to act on that vision to make major impacts far into the future."

A BLOCKBUSTER YEAR

Pioneers in the relatively new field of synthetic biology use tools and concepts from physics, engineering, and computer science to build new biological systems. Much of their research focuses on reprogramming cells by changing the cells' DNA to take on new, specialized purposes, such as creating sustainable chemicals, next-generation materials, or targeted therapies.

The "far-reaching vision" that Lucks found so appealing is embodied in Northwestern's Center for Synthetic Biology, which creates a supportive ecosystem for research and education to thrive. Just as the University's synthetic biology team has quickly earned recognition as among the best in the world, faculty members and administration believe the Center will serve to sustain that reputation.

"This center will raise our leadership profile in the field rapidly," says Milan Mrksich, Henry Wade Rogers Professor of Biomedical Engineering, Chemistry, and Cell and Molecular Biology, and the Center's director. "It will create a community where the best faculty, students, and postdoctoral fellows find an intellectual home, partners from diverse backgrounds, technologies for conducting research at the highest level, and a vibrant program that will attract new visitors from within and outside Northwestern."

In its first year alone, the Center made significant strides toward these goals. It has inspired multiple unexpected collaborations, hosted two significant events, helped its members publish groundbreaking research, and coalesced a supportive, enthusiastic synthetic biology community. In arguably its biggest win, the Center successfully recruited Lucks and Danielle Tullman-Ercek, an associate professor in chemical and biological engineering, who joined from the University of California at Berkeley.

"When we recruited these two exceptionally talented people, it created enormous excitement," says Michael Jewett, associate professor of chemical and biological engineering and the Center's co-director. "That bodes really well for the future."

DREAM TEAM

The Center takes a distinctive approach to advancing synthetic biology's quest to discover enduring solutions for such seemingly insurmountable issues as disease, energy shortage, and pollution. Rather than assemble a group of researchers with similar or overlapping interests, Northwestern has curated a team of synthetic biologists who each lend a distinctive area of expertise.

"We've recruited an impressive group of colleagues, all at the leading edge of their own sub-disciplines," Jewett says. "The complementary nature of their work allows us to form new collaborations and learn from each other. This collaborative, inclusive, and creative culture allows us to innovate relentlessly."

Lucks, for example, studies synthetic biology as it applies to RNA, while Tullman-Ercek works to engineer proteins. Their work complements that of other members of Northwestern's high-powered synthetic biology team, which includes professors Mrksich, who has developed high-throughput methods to discover and optimize enzymes used in biosynthetic processes; Jewett, who transforms biochemical engineering with cell-free systems and synthetic biology; Neda Bagheri, who develops computational algorithms and models to understand biological functions; Joshua Leonard, who studies mammalian synthetic biology to enable design-driven medicine; and Keith Tyo, who works at the intersection of synthetic biology, metabolic engineering, and global health.

"I saw the opportunity to come to Northwestern and be the one person who does protein engineering," Tullman-Ercek says, "as opposed to joining a team where I am one of five who all do the same type of research and don't interact with others who have complementary skill sets."

GLOBAL STAGE

Within the past year, two major national events showcased some of this complementary work. The first, the Synthetic Biology: Engineering, Evolution, and Design (SEED) conference was held in Chicago and chaired by Jewett in July 2016. That was followed by the Engineering Biology Research Consortium (EBRC) retreat hosted by Northwestern in March 2017.

"Chicago was an obvious destination for SEED," Jewett says. "Our reputation for entrepreneurship is growing, and there's a lot of energy and excitement about the University's core synthetic biology group. Northwestern was chosen to host the EBRC retreat because of our new and strong presence in the field."

In addition to creating a lot of local excitement, these events gave Northwestern's synthetic biologists a highly visible opportunity to demonstrate that the "think different" approach is working. For example, at SEED, Julius Lucks received the 2016 Synthetic Biology Young Investigator Award, given annually by the American Chemical Society in recognition of a scientist's early impact on the field.

"To be recognized with this prestigious award is an inspiration for both my group and me," Lucks says. "We're more excited than ever about unlocking the potential of RNA and continuing to build the synthetic biology community."

Northwestern students also cleaned up with accolades at both events. Two graduate students from Jewett's laboratory, Erik Carlson and Ashty Karim, won awards for their posters at SEED: Carlson took the grand prize; Karim placed second. At EBRC, three students—Karim, Taylor Dolberg, and Angela Yu—received honorable mentions for their posters.

"You know that things are going well when you attract excellent students," Tullman-Ercek says. "I don't like to use the word 'amazing,' so I mean it when I say that the caliber of students here is amazing."

RESEARCH WRAP-UP

Northwestern's synthetic biologists rounded out the Center's first year by doing what they do best: research. Members of the community published several high-profile papers in high-impact journals.

Leonard's work, published in *Nature Chemical Biology*, relates to "rewiring" immune cells to sense and respond to tumor signals, an approach that could become a promising treatment for cancer. Says Leonard, "The simple cell rewiring we've done could ultimately help overcome immunosuppression at the tumor site, one of the most intransigent barriers to making progress in the field."

Lucks developed a new technology that can take a nucleotide-resolution snapshot of RNA folding during synthesis. Published in *Nature Structural & Molecular Biology*, the study lays the groundwork for future discoveries in basic biology, gene expression, RNA viruses, and disease.

Tullman-Ercek published a paper in *ACS Synthetic Biology* about a new platform for protein production. Her team developed an inexpensive method that drives proteins in bacteria to secrete industrially or pharmaceutically relevant proteins at much higher scales without the need for purification. "For the past decade, many of the top-ten drugs on the market have been protein rather than small molecule," she says. "Our platform can lower the production cost for manufacturers, so they can now more easily make generic forms of these drugs as they come off patent protection."

On another research front, Jewett and Mrksich currently are collaborating to develop a first-of-its-kind cell-free protein expression platform that uses engineered enzymes to precisely control the placement of sugars on therapeutic proteins for use in new antibacterial vaccines. "By the year 2050, more people may die from anti-microbial resistance than from cancer today, if left unchecked," Jewett says. "That certainly has kept me up at night."

These research projects demonstrate how, by thinking differently, synthetic biologists can reshape the living world to discover new solutions for old problems. Jewett believes this type of thinking will become more mainstream in the future.

"Engineering biology is going to be the technology for the next century," Jewett says. "What better discipline to build excellence around than that?"

AMANDA MORRIS